National Oceanography Centre, Southampton

Cruise Report No. 51

RRS *Discovery* Cruise D344
21 OCT-18 NOV 2009

RAPID mooring cruise report

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2010

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ABSTRACT

This cruise report covers RRS *Discovery* cruise D344. Cruise D344 was primarily used for the annual servicing of the eastern boundary and mid-Atlantic ridge moorings that form part of the RAPID-MOC mooring array across the North Atlantic at 26°N. In addition, the easternmost western boundary mooring, WB6, was serviced and the trial current meter mooring off the island of Abaco, WB-CM, was recovered. As the *Discovery* had made a faster passage than anticipated, a number of CTD stations were performed along 24° 30’N to augment the hydrography section scheduled to take place in January 2010.

The instruments deployed on the RAPID-MOC array consist of bottom pressure recorders, CTD loggers, and current meters which, combined with time series measurements of the Florida Channel Current, and wind stress estimates, will be used to determine the strength and structure of the MOC at 26.5°N.

(http://www.noc.soton.ac.uk/rapidmoc)

KEYWORDS

26.5°N, Atlantic Ocean, bottom pressure recorder, BPR, cruise D344, CTD, current meter, *Discovery*, Eastern Boundary, meridional overturning circulation, MicroCAT, Mid-Atlantic Ridge, MOC, mooring array, Moorings, North Atlantic, RAPID-WATCH, RAPID, RAPIDMOC, THC, thermohaline circulation

ISSUING ORGANISATION

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1 Scientific and Ship's Personnel

Scientific and Technical	
Stuart Cunningham	NOCS
Zoltan Szuts	MPIM Hamburg
David Ham	Imperial College, London
Darren Rayner	NOCS
Paul Wright	NOCS
John Wynar	NMFD – NOCS
Paul Duncan	NMFD – NOCS
Colin Hutton	NMFD – NOCS
Christian Crowe	NMFD – NOCS
Stephen Whittle	NMFD – NOCS
David Childs	NMFD – NOCS
David Handley	NMFD – NOCS
12 persons	

Table 1.1 *Details of science personnel on cruise D344*

Captain	Antonio Gatti
Chief Officer	John Leask
2nd Officer	James Gwinnell
3rd Officer	William McClintock
Chief Engineer	Ian Slater
2nd Engineer	Stephen Bell
3rd Engineer	John Harnett
3rd Engineer	Edin Silajdzic
ETO	Robert Masters
Purser	David Hartshorne
CPOD	Stuart Cook
CPOS	Martin Harrison
POD	Peter Smith
Motorman	Duncan Lawes
SG1A	Gary Crabb
SG1A	Ian Mills
SG1A	Anthony North
SG1A	William McLennan
Head Chef	John Haughton
2nd Chef	Walter Link
Steward	Jeffrey Osborne
21 persons	

Table 1.2 *Details of the ships's crew on cruise D344*

2 RRS *Discovery*

Figure 2.1 *RRS Discovery. (photo from web site)*

The RRS *Discovery*, built in 1962 with a major refit in 1992, is an oceanographic research ship operated and maintained by the Natural Environment Research Council (NERC) National Marine Facilities Division (NMFD). She has been regularly associated with the RAPID project and is ideally suited for mooring and hydrographic work. At nearly 50 years old she is starting to come to the end of her working life and scheduled to be replaced by a new ship.

3 Itinerary

Cruise D344 departed from Santa Cruz, Tenerife on Wednesday 21st October 2009 and arrived in Freeport, Grand Bahama on 17th November 2009.

4 Acknowledgements

Stuart Cunningham

I would like to acknowledge the professionalism of the Captain, officers and crew aboard *Discovery* on this our 18th RAPID cruise. Scientific operations – the moorings in particular – were the most efficiently conducted of any RAPID cruise. Clear and timely communication between the ship's team and the scientific and technical teams is vital, and Antonio Gatti's leadership set the tone throughout our programme.

5 Introduction and Background

Stuart Cunningham

The RAPID-MOC observing system has been operational since spring 2004. The purpose of this cruise was to recover and redeploy the eastern boundary mooring sub-array deployed off the Canary Islands and the sub-array on the flanks of the mid-Atlantic ridge.

This cruise is the 18th in total since Spring 2004. The cruises to date are shown in Table 5.1. The project web site is http://www.noc.soton.ac.uk/rapidmoc. The RAPID-MOC programme has completed the initial four years of planned deployments and has now moved into a second phase (NERC Directed Programme RAPID-WATCH http://www.noc.soton.ac.uk/rapid) through to 2014.

5.1 Scientific Background and Description of the RAPID-MOC Observing System

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. However, 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. 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, et al.*, 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 of the system 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 as during the period 2004-2008.

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 arrays and; To exploit the data from the RAPID-WATCH arrays 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.

5.2 The AMOC system

The 26.5°N Atlantic section 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 5.1). 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 QuikSCAT satellite-based observations. To monitor the mid-ocean flow we deployed an array of moored instruments along the 26.5°N section. The basic principle of the array is to estimate the zonally integrated geostrophic profile of northward velocity on a daily basis from time-series measurements of temperature and salinity throughout the water column at the eastern and western boundaries. Inshore of the most westerly measurement of temperature and salinity, the transports of the Antilles current and deep western boundary current are monitored by direct velocity measurements.

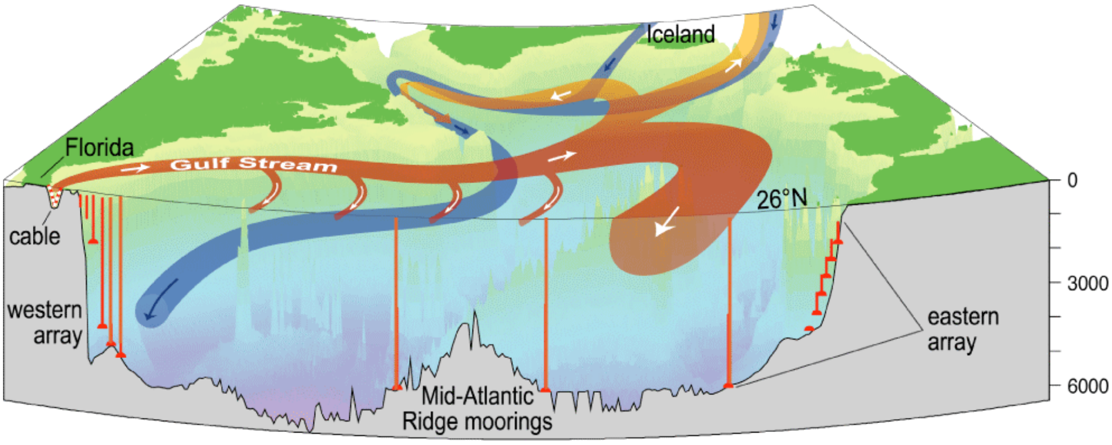


Figure 5.1 *Schematic of the principal currents of the Atlantic meridional overturning circulation. The vertical red lines across the Atlantic at 26.5°N indicate the main areas where moorings instrumented to measure the vertical density profile are located. The Gulf Stream transport is measured by submarine cable and the western boundary array includes current meters to directly measure transports of the shallow and deep western boundary currents. Bottom pressure recorders are located at several sites across the Atlantic to measure depth-independent fluctuations of the basin-wide circulation. Figure courtesy of Louise Bell & Neil White, CSIRO.*

5.3 Array Specification

The array as deployed in 2009-2010 consists of a total of 21 moorings, 13 landers and a single inverted echo sounders. Figures 5.2 and 5.3 show the eastern boundary and mid-Atlantic moorings as deployed from D344. The western boundary moorings (Fig 5.4) were serviced in the Spring of 2009 during cruise RB0901 and will be serviced again in Spring 2010 from the RV *Oceanus*, with the exception of the mooring furthest offshore at WB6. 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. **M** indicates a mini-mooring consisting of a 10m length mooring with one CTD instrument. Bottom landers instrumented with pressure recorders are indicated by **L** in the name. **ADCP** indicates an Acoustic Doppler Current Profiler mooring.

5.4 Eastern Boundary Sub-array

The Eastern Boundary sub-array currently consists of one tall mooring **EB1** consisting of eighteen CTDs and a series of shorter CTD moorings **EBHi**, **EBH1**, **EBH2**, **EBH3**, **EBH4,** and **EBH5** that step up the slope reducing the influence of bottom triangles when combined with the more offshore EB1 mooring. As from D334 EBH4 and EBH5 are co-located. Together they construct a single full depth density profile, which is also the location of the RAPID glider trial deployments. Inshore of EBH5 there are a series of four "mini-moorings", **EBM1**, **EBM4**, **EBM5** and **EBM6** that each consist of a single CTD and are relatively inexpensive meaning likely losses in this heavily fished area have less of an impact on the array. Finally the Eastern sub-array includes five bottom pressure landers; **EBL1** and **EBL3** – comprising two bottom pressure recorders (BPRS) each – at the site of EB1, and **EBL2** and **EBL4** – comprising one bottom pressure recorder each – at the site of EBH1. **EBL5** 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's overlap with the previous lander to remove instrument drift. There is also one PIES deployed in the eastern boundary sub-array, **EBP1** at the site of EB1. Data from the PIES are downloaded annually through acoustic telemetry but EBP1 was serviced on cruise D334, with EBP2 originally planned for turnaround during D344, but technical problems prevented this.

5.5 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 (**MARL1**, **MARL2**, **MARL3** and **MARL4**). **MAR0** is a recent addition to the array and consists of five CTDs 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 nineteen CTDs, with MAR2 acting as a backup to 1000m 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.

5.6 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 2009, WB2 comprises sixteen CTDs and seven current meters, whereas WB1 comprises fifteen CTDs and four current meters. Inshore of WB1 there is **WBADCP** (sometimes refered 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 seven current meters. Further offshore is **WB6**, serviced on this cruise, comprising five CTDs and a bottom pressure recorder – which combined with MAR0 measures the contribution to the MOC of deep water below 5200m including the Antarctic Bottom Water. There are again four landers in this sub-array; **WBL1** and **WBL3** (two BPRs each) at the site of **WB2**; and **WBL2** and **WBL4** (one BPR each) at the site of WB4.

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 serviced on D345. **WB0** comprises four CTDs and current meters and an upward looking ADCP. **WB3** is 22 km west 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.

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 2004	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 2004	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 2005	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 2005	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 2005	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 2005	Emergency recovery of drifting WB1 mooring	No report published
RB0602	RV *Ronald H. Brown*	Mar 2006	Service and redeployment of UK Western Boundary moorings and WBTS hydrography section	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 2006	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 2006	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 Oceanograpy Centre, Southampton Cruise Report, No 34
SJ0803	RV *Seward Johnson*	April 2008	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 the WBTS hydrography section	RV *Ronald H. Brown* Cruise RB0901, National Oceanography Centre, Southampton Cruise Report, No 39, 2009

Table 5.1 *Summary of previous Rapid-MOC cruises*

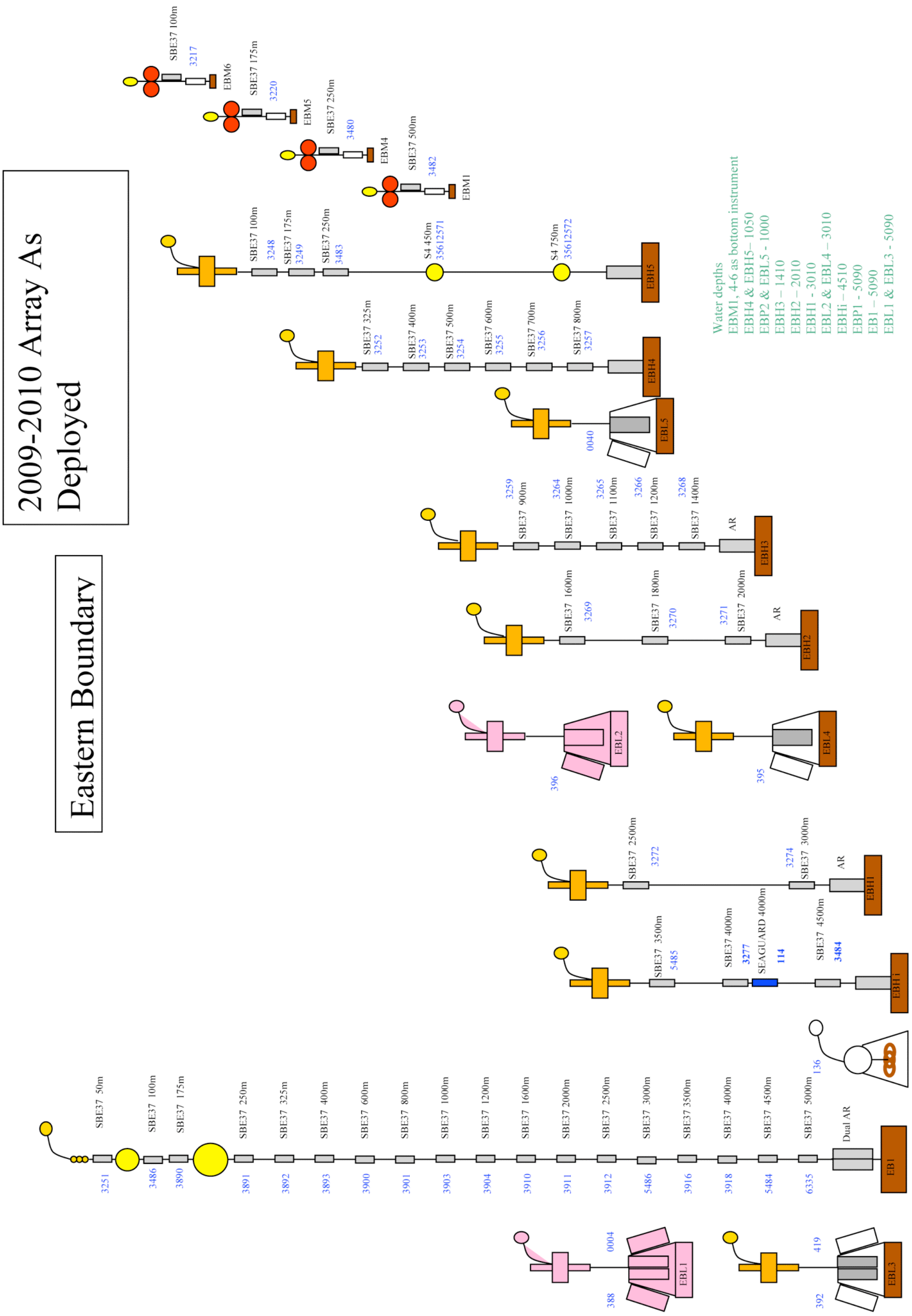


Figure 5.2 *Eastern boundary sub-array as deployed on cruise D344. The grey shaded landers were not serviced on this cruise.*

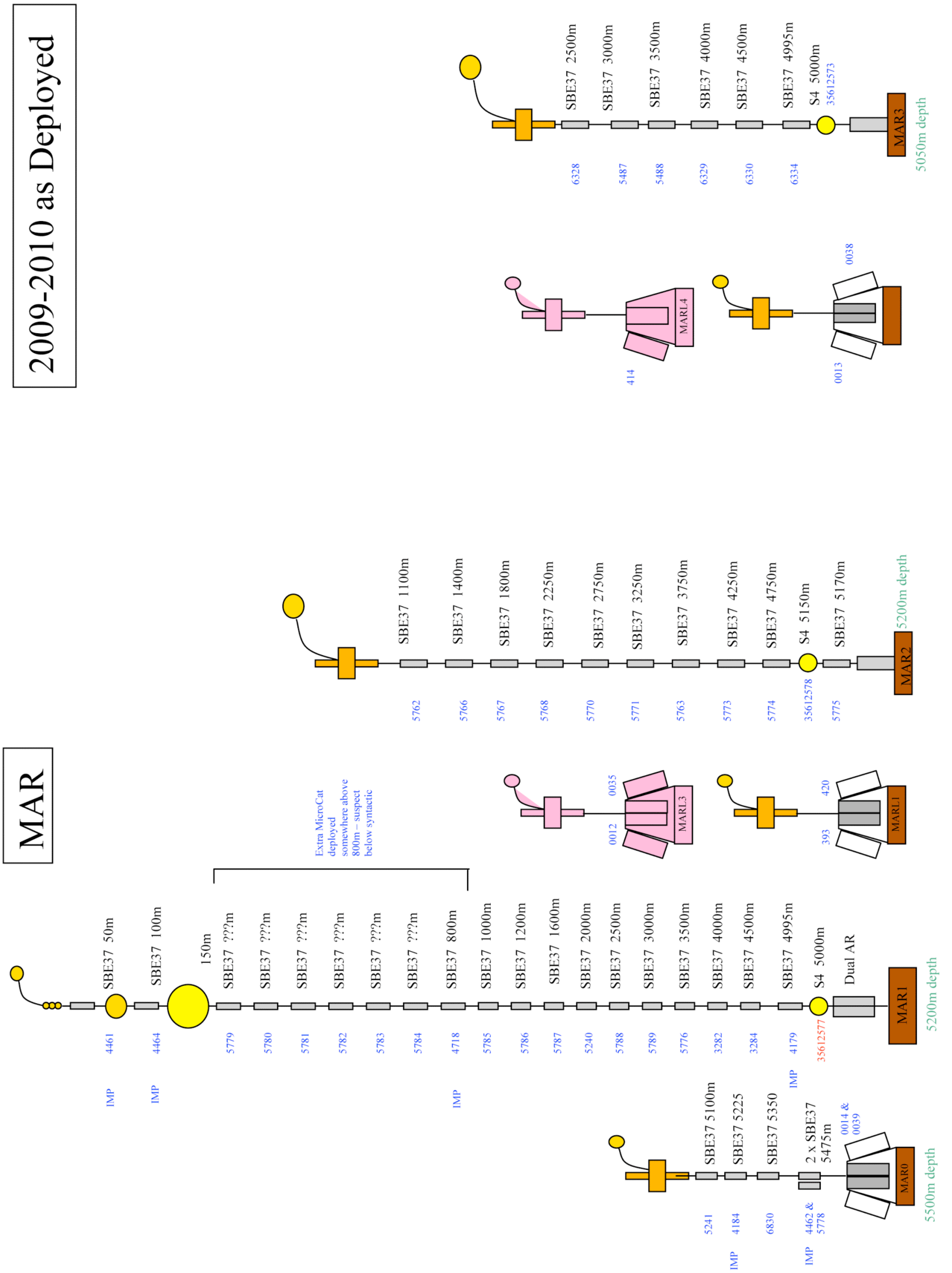


Figure 5.3 *The Mid-Atlantic Ridge sub-array as deployed on cruise D344. The grey shaded landers were not serviced by this cruise.*

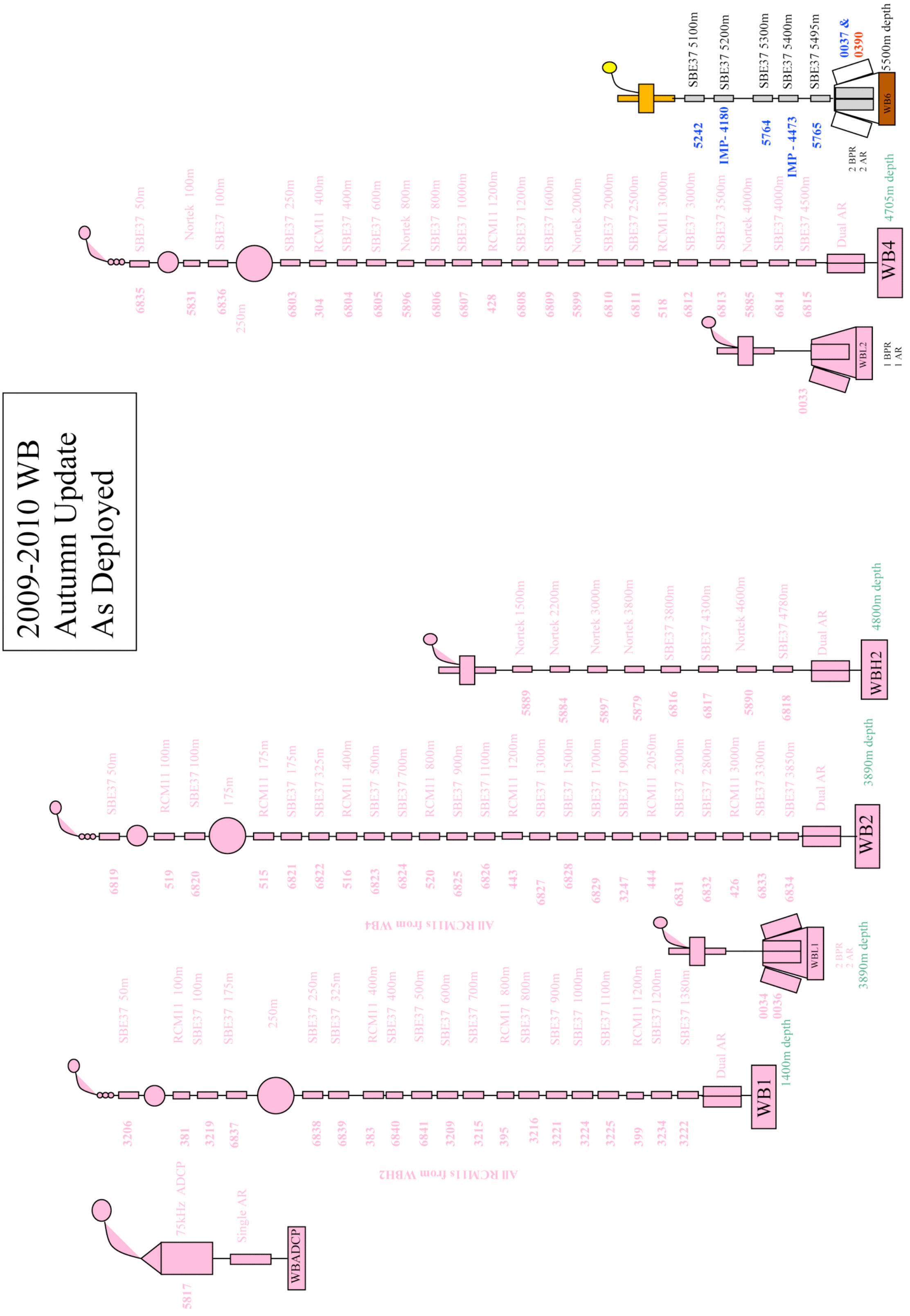
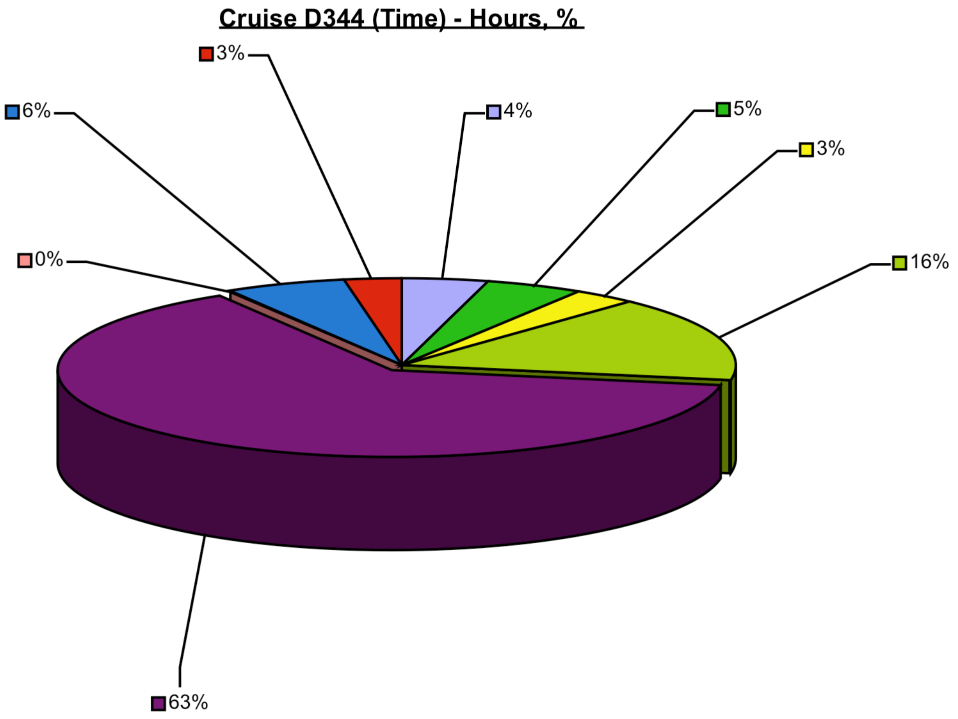


Figure 5.4 *The Western Boundary sub-array as updated on cruise D344. Only WB6 was serviced on this cruise. The current meter trial mooring, WBCM, was not redeployed. Landers WBL3 and WBL4 are not shown.*

6 Bridge Log

Captain Antonio Gatti



Pass	REC Mo	DEP Mo	CTD	RWP	DTwx	DTship	DTequip
27.30	33.50	20.78	106.32	430.28	0.35	38.78	19.18

Figure 6.1 *Chart to illustrate usage of ship time. The largest segment, RWP, includes the passages between the moorings. Not included: the mobilisation time of 49 hours and the starting and end port times.*

Indicator Legend	Description
Pass	Pilotage and Passage
REC Mo	The Recovery of moorings
DEP Mo	The Deployment of moorings
CTD	Deployment and recovery of CTD instruments
RWP	Reposition/Waiting/Preparation e.g. Sampling recovered CTD Triangulating Mooring sites Unsuccessful Acoustic Listening on moorings
DTxx	Downtime weather
DTship	Downtime ship systems
DTequip	Downtime scientific systems
DTother	Downtime other (Medical etc)

Table 6.1 *Key to the ship time legend for Fig 6.1*

Start		**End**		**Comment**
Date	**Time**	**Date**	**Time**	**All times GMT**
19/10/09	07:00	21/10/09	08:00	Mobilising / Preparations / Familiarisation/Safety Brief/including bunkering
21/10/09	08:00	21/10/09	08:48	Pilotage/Passage
21/10/09	08:48	21/10/09	12:00	Passage to 1st CTD station. 10:10 PES fish deployed
21/10/09	12:00	21/10/09	15:44	CTD deployment
21/10/09	15:44	21/10/09	16:34	Relocate to next CTD. Emergency and Lifeboat Musters for all
21/10/09	16:34	21/10/09	17:09	CTD deployment
21/10/09	17:09	21/10/09	20:44	Relocate to next CTD
21/10/09	20:44	21/10/09	21:18	CTD deployment. Recovered at 22:18 due communication fault.
21/10/09	21:18	22/10/09	04:21	Repairs to CTD and relocate to new position. Clocks retarded 1hour to UTC
22/10/09	04:21	22/10/09	08:40	CTD deployment
22/10/09	08:40	22/10/09	11:03	Relocating to EBP2
22/10/09	11:03	22/10/09	12:48	Fault finding and repairs to stbd radar
22/10/09	12:48	22/10/09	14:23	On passage to Las Palmas for radar repairs
22/10/09	14:23	22/10/09	15:00	Pilotage in to Las Palmas
22/10/09	15:00	23/10/09	19:00	Repairs to radars alongside Las Palmas
23/10/09	19:00	23/10/09	19:48	Pilotage departing Las Palmas
23/10/09	19:48	23/10/09	21:17	Passage to CTD station
23/10/09	21:17	23/10/09	22:56	CTD deployment
23/10/09	22:56	24/10/09	08:00	Relocating to EBP2
24/10/09	08:00	24/10/09	08:44	Recovering EBP2

24/10/09	08:44	24/10/09	09:02	Relocating to EBH4
24/10/09	09:02	24/10/09	10:11	Recovering EBH4
24/10/09	10:11	24/10/09	10:47	Relocating/waiting for EBH5 to surface
24/10/09	10:47	24/10/09	11:39	Recovering EBH5
24/10/09	11:39	24/10/09	13:08	Relocating to EBM1
24/10/09	13:08	24/10/09	13:31	Recovering EBM1
24/10/09	13:31	24/10/09	13:51	Relocating to EBM4
24/10/09	13:51	24/10/09	14:08	Recovering EBM4
24/10/09	14:08	24/10/09	14:22	Relocating to EBM5
24/10/09	14:22	24/10/09	15:02	Transducer deployed but no signal recovered from EBM5. Vessel move onto next mooring EBM6
24/10/09	15:02	24/10/09	15:19	Relocating to EBM6
24/10/09	15:19	24/10/09	15:33	Recovering EBM6
24/10/09	15:33	24/10/09	15:45	Deploying EBM6
24/10/09	15:45	24/10/09	16:06	Relocating for retry at EBM5 release
24/10/09	16:06	24/10/09	16:20	Attempting to release EBM5, unsuccessful, thought not to be there
24/10/09	16:20	24/10/09	16:36	Deploying EBM5
24/10/09	16:36	24/10/09	16:54	Relocating to EBM4
24/10/09	16:54	24/10/09	16:59	Deploying EBM4
24/10/09	16:59	24/10/09	17:35	Relocating to EBM1
24/10/09	17:35	24/10/09	17:36	Deploying EBM1
24/10/09	17:36	24/10/09	18:41	Relocating to EBH5
24/10/09	18:41	24/10/09	20:09	Deploying EBH5

24/10/09	20:09	24/10/09	20:57	Relocating to EBH4
24/10/09	20:57	24/10/09	21:47	Deploying EBH4
24/10/09	21:47	25/10/09	08:45	Vessel standing by EBP2 position while PIES mooring being worked upon, unable to maintain seal.
25/10/09	08:45	25/10/09	09:11	Unable to repair PIES mooring, EBL5 deployed
25/10/09	09:11	25/10/09	10:50	Relocating to EBH3
25/10/09	10:50	25/10/09	11:50	Recovering EBH3
25/10/09	11:50	25/10/09	12:55	Preparations for EBH3 deployment
25/10/09	12:55	25/10/09	12:56	Deploying EBH3
25/10/09	12:56	25/10/09	15:35	Relocating to EBH2
25/10/09	15:35	25/10/09	16:43	Recovering EBH2
25/10/09	16:43	25/10/09	17:10	Preparations for EBH2 deployment
25/10/09	17:10	25/10/09	17:26	Deploying EBH2
25/10/09	17:26	26/10/09	06:34	Relocating to EBH1
26/10/09	06:34	26/10/09	08:02	Recovering EBH1
26/10/09	08:02	26/10/09	08:41	Relocate to deployment position for EBH1
26/10/09	08:41	26/10/09	09:12	Deploying EBH1
26/10/09	09:12	26/10/09	09:57	Repositioning for EBL4 recovery
26/10/09	09:57	26/10/09	10:37	Recovery EBL4
26/10/09	10:37	26/10/09	10:54	Deploying EBL4
26/10/09	10:54	26/10/09	14:57	Awaiting for MCA exemption confirmation to proceed to Bahamas with one radar
26/10/09	14:57	28/10/09	00:00	Relocating to EBHi and CTD deployment
28/10/09	00:00	28/10/09	03:42	CTD deployment at EBHi. Clocks retarded 1hour to UTC-1

28/10/09	03:42	28/10/09	04:30	Preparing CTD
28/10/09	04:30	28/10/09	08:50	CTD deployment
28/10/09	08:50	28/10/09	09:39	Repositioning for EBHi recovery
28/10/09	09:39	28/10/09	11:18	Recovering EBHi
28/10/09	11:18	28/10/09	11:46	Repositioning for EBHi deployment
28/10/09	11:46	28/10/09	12:26	Deploying EBHi
28/10/09	12:26	29/10/09	04:30	Relocating to EBL3
29/10/09	04:30	29/10/09	08:13	Recovering EBL3
29/10/09	08:13	29/10/09	09:37	Reposition to EB1
29/10/09	09:37	29/10/09	13:53	Recovery EB1
29/10/09	13:53	29/10/09	14:29	Preparation and reposition for CTD
29/10/09	14:29	29/10/09	19:14	CTD deployment
29/10/09	19:14	29/10/09	20:22	Reposition for EBL3 deployment
29/10/09	20:22	29/10/09	20:23	EBL3 deployment
29/10/09	20:23	30/10/09	00:45	Monitoring descent
30/10/09	00:45	30/10/09	01:12	Preparations for CTD
30/10/09	01:12	30/10/09	04:38	CTD deployment
30/10/09	04:38	30/10/09	06:20	Vessel holding station at EB1 for 1st light deployment
30/10/09	06:20	30/10/09	10:10	Bathymetry survey prior to EB1 deployment
30/10/09	10:10	30/10/09	13:53	Deploying EB1
30/10/09	13:53	30/10/09	14:36	Monitoring descent
30/10/09	14:36	30/10/09	15:35	Triangulation of position of EB1

30/10/09	15:35	2/11/09	15:05	Relocating to CTD prior to MAR3. Clocks retarded 1 hour to UTC-2. Emergency Exercise "Fire in the Incinerator Room"
2/11/09	15:05	2/11/09	15:26	Assessing weather conditions prior to deployment
2/11/09	15:26	2/11/09	20:12	CTD deployment
2/11/09	20:12	3/11/09	09:33	Relocating to MAR3 recovery/deployment
3/11/09	09:33	3/11/09	12:10	Recovering MAR3
3/11/09	12:10	3/11/09	12:37	Repositioning for MARL2
3/11/09	12:37	3/11/09	14:05	Recovering MARL2
3/11/09	14:05	3/11/09	15:55	Preparation for MARL2 deployment
3/11/09	15:55	3/11/09	15:58	Deploying MARL2
3/11/09	15:58	3/11/09	16:19	Preparation for CTD
3/11/09	16:19	3/11/09	20:10	CTD deployment
3/11/09	20:10	3/11/09	21:05	Preparation for CTD
3/11/09	21:05	4/11/09	01:38	CTD deployment
4/11/09	01:38	4/11/09	02:25	Preparation for CTD
4/11/09	02:25	4/11/09	07:07	CTD deployment
4/11/09	07:07	4/11/09	08:18	Relocating to MAR3 deployment position
4/11/09	08:18	4/11/09	10:25	Preparation for MAR3 deployment
4/11/09	10:25	4/11/09	12:28	Deploying MAR3
4/11/09	12:28	4/11/09	13:38	Repositioning for NOGST recovery
4/11/09	13:38	4/11/09	15:26	Recovering NOGST
4/11/09	15:26	4/11/09	16:53	Preparation for NOGST deployment
4/11/09	16:53	4/11/09	18:08	Deploying NOGST

4/11/09	18:08	6/11/09	12:20	Relocating for MAR2 recovery/deployment. Emergency Exercise - Steering Gear Failure
6/11/09	12:20	6/11/09	12:50	Attempting to release MAR2, unsuccessful. Move to MARL1
6/11/09	12:50	6/11/09	13:14	Reposition to MARL1
6/11/09	13:14	6/11/09	14:56	Recovering MARL1
6/11/09	14:56	6/11/09	15:23	Reposition to MAR1
6/11/09	15:23	6/11/09	20:04	Recovering MAR1
6/11/09	20:04	6/11/09	21:11	Reposition for MARL1 deployment
6/11/09	21:11	6/11/09	21:14	Deploying MARL1
6/11/09	21:14	6/11/09	22:02	Reposition for CTD
6/11/09	22:02	7/11/09	02:22	CTD deployment
7/11/09	02:22	7/11/09	08:15	Reposition for MAR1 deployment
7/11/09	08:15	7/11/09	11:15	Bathymetry survey prior to MAR1 deployment
7/11/09	11:15	7/11/09	14:49	Deploying MAR1
7/11/09	14:49	7/11/09	15:25	Monitoring descent
7/11/09	15:25	7/11/09	17:00	Triangulation of position of MAR1
7/11/09	17:00	7/11/09	17:37	Preparation of MAR2 for deployment
7/11/09	17:37	7/11/09	20:30	Deploying MAR2
7/11/09	20:30	8/11/09	09:36	Relocating to MAR0. Clocks retarded to UTC-3
8/11/09	09:36	8/11/09	11:16	Recovering MAR0
8/11/09	11:16	8/11/09	11:48	Preparation for CTD
8/11/09	11:48	8/11/09	16:23	CTD deployment
8/11/09	16:23	8/11/09	17:10	Reposition for MAR0 deployment

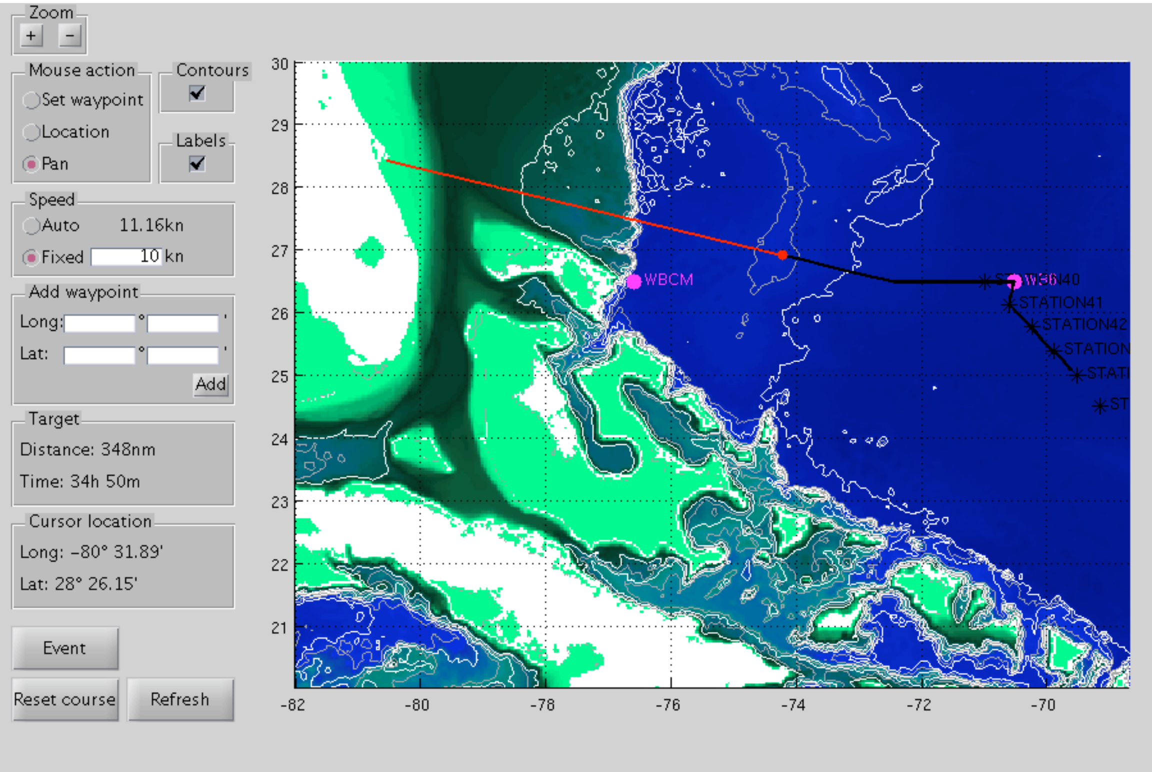
8/11/09	17:10	8/11/09	17:35	Deploying MAR0
8/11/09	17:35	8/11/09	18:31	Monitoring descent
8/11/09	18:31	9/11/09	15:52	Relocating to WB6
9/11/09	15:52	11/11/09	02:08	Change to overall plan. Extra CTD run due to overall time in hand. Course to 1st CTD not direct due to weather and motion.
11/11/09	02:08	11/11/09	06:40	CTD #55 deployment
11/11/09	06:40	11/11/09	11:04	Relocate to next CTD
11/11/09	11:04	11/11/09	15:18	CTD #54 deployment
11/11/09	15:18	11/11/09	20:00	Relocate to next CTD
11/11/09	20:00	11/11/09	20:12	CTD #53 deployment. Recovered early due to spooling problems
11/11/09	20:12	11/11/09	23:25	Proceeding to CTD #52 while fault rectifying continues on the spooling gear
11/11/09	23:25	11/11/09	23:55	Test of CTD spooling
11/11/09	23:55	12/11/09	10:43	Relocate to next CTD. Clock retarded 1hour to UTC-4
12/11/09	10:43	12/11/09	16:41	CTD #50 deployment
12/11/09	16:41	12/11/09	21:11	Relocate to next CTD. Emergency Training - Annual Review of SOPEP
12/11/09	21:11	13/11/09	01:04	CTD #49 deployment
13/11/09	01:04	13/11/09	05:20	Relocate to next CTD
13/11/09	05:20	13/11/09	09:27	CTD #48 deployment
13/11/09	09:27	13/11/09	13:30	Relocate to next CTD
13/11/09	13:30	13/11/09	17:45	CTD #47 deployment
13/11/09	17:45	13/11/09	22:01	Relocate to next CTD
13/11/09	22:01	14/11/09	02:20	CTD #46 deployment
14/11/09	02:20	14/11/09	06:40	Relocate to next CTD

14/11/09	06:40	14/11/09	11:11	CTD #45 deployment
14/11/09	11:11	14/11/09	15:06	Relocate to next CTD
14/11/09	15:06	14/11/09	19:18	CTD #44 deployment
14/11/09	19:18	14/11/09	22:53	Relocate to next CTD
14/11/09	22:53	15/11/09	02:39	CTD #43 deployment
15/11/09	02:39	15/11/09	09:25	Relocate to next CTD (#41, 42 missed out)
15/11/09	09:25	15/11/09	13:18	CTD #41 deployment
15/11/09	13:18	15/11/09	15:38	Relocate for mooring WB6 recovery and deployment
15/11/09	15:38	15/11/09	17:11	Recovering mooring WB6
15/11/09	17:11	15/11/09	17:46	Preparation for mooring WB6 deployment
15/11/09	17:46	15/11/09	18:02	Deploying mooring WB6
15/11/09	18:02	15/11/09	18:55	Monitoring descent
15/11/09	18:55	15/11/09	22:00	Relocate to next CTD
15/11/09	22:00	15/11/09	22:58	CTD #40. Recovered at 1000m due to error in equipment on the frame
15/11/09	22:58	15/11/09	23:10	Preparing CTD
15/11/09	23:10	16/11/09	03:46	CTD #40 deployment
16/11/09	03:46	17/11/09	09:35	Relocate for mooring WBCM recovery. Clocks retarded 1hour to UTC-5
17/11/09	09:35	17/11/09	12:11	Awaiting daylight for mooring recovery. Buoy on surface 1149. Buoy hooked on 1211
17/11/09	12:11	17/11/09	12:43	Recovering mooring WBCM
17/11/09	12:43	17/11/09	13:12	Recovering PES fish
17/11/09	13:12	18/11/09	11:33	Passage to Freeport
18/11/09	11:33	18/11/09	12:30	Pilotage in to Freeport. POB 1133. First Line 1218. All Fast 1330.

7 RAPID-WIDGIT

David Ham

RAPID-WIDGIT (RAPID – *Where is Discovery Going In Track mode*) is a MATLAB chart plotter, which provides a plot that shows bathymetry, ship's current position and the locations of markers for events such as CTD stations or mooring operations. It provides distance and ETA measurements to arbitrary locations specified by the user clicking an electronic chart. It was developed during D344 to provide planning support to the science program. RAPID-WIDGIT is to be found in the `rapid_widgit/` directory on the *noseal* workstation. An example output is shown below.



○ Set waypoint
○ Location
● Pan

Contours ☑

Labels ☑

Speed
○ Auto 11.16kn
● Fixed 10 kn

Long: ° '
Lat: ° '

Target
Distance: 348nm
Time: 34h 50m

Cursor location
Long: -80° 31.89'
Lat: 28° 26.15'

Figure 7.1 *Screen shot of RAPID-WIDGIT showing CTD and mooring stations near the Bahamas. The user is calculating the distance to Cape Canaveral to ascertain whether it would be possible to view the launch of the Space Shuttle Atlantis.*

8 Ship's Data Logging, Computing, Instrumentation and Sat-Comms

Paul Duncan

8.1 Primary Logger – hardware and software

As in earlier cruises, the primary data logging is performed by IFREMER's TECHSAS data logging system.

At present the operating system is still the aging release 3 of Red Hat's Enterprise Linux Workstation product. The reason for using this old version of the operating system is that the kernel it uses supports the National Instruments PCI serial cards used by the systems.

Chris Barnard has been doing some research with later kernels, and has also been communicating with National Instruments about the issue, and we hope to have a newer operating system, along with upgraded motherboards, processors, RAM in use in the near future. We are also hoping to switch over from an IDE-based hardware RAID solution, to one based on SATA drives.

8.2 Level C

The Level C software is still running on a Sun Blade 1500 SPARC-based workstation. The *fromtechsas* program is used to take data broadcast by the TECHSAS system over the ship's LAN, and then save it in individual data streams, which can then be examined in the graphical data editor, and/or have processing performed on them.

During the cruise, the graphical data editor was used to remove the worst of the spikes (including zero values) from the EA-500 bathymetry data, and the *prodep* program was then used to correct it for Carter Area. The *relmov/bestnav* navigation processing software was also run to create the bestnav and bestdrf streams. Finally the *windcalc* program was run to calculate the absolute wind speed and direction.

8.3 Visiting Workstations

The Sun Workstations *rapid* and *nosea1* were put on the ship's network and allocated static IP addresses in order for scientists to log into them using secure shell. Both machines have also had the TECHSAS NetCDF data area NFS mounted to allow access to navigation, winch, Surfmet and echo sounder data.

8.4 Backup/LAN based RAID

The scientists expressed dissatisfaction at the speed of the `/data32` shared online storage area which was used for storing CTD data, and also for backing up files from the *nosea1* and *rapid* workstations. The Drobo is available, but there is no fast way to back its data up to tape.

Hopefully the new TECHSAS hardware will be available shortly, and then the older hardware can be configured as online RAID storage with LTO-2 drives hooked up directly to them.

8.5 Instrumentation

The Surfmet sea-surface and meteorology instrumentation system was run during the cruise. The software on this system has recently been updated and allows a far greater number of displays than the old system.

At present there are two minor problems with gymbaling of the light sensors. Firstly, the fore-aft bearings on the port gymbal are rather stiff, and will hopefully be replaced during the next port call. Secondly, Kipp & Zonen seem to have changed the style of connectors used on their total irradiance sensors. The new connectors are about three times as long as the old ones, and foul the port-starboard gymbals. At present this is only affecting the port gymbal, as the starboard total irradiance sensor is using an older cable. Kipp & Zonen(UK) were E-mailed about the issue during the cruise, but so far no response has been received.

The Chernikeeff log has been operating reasonably well at lower speeds, but over-reading at the higher end of the speed scale. At the time of writing it is indicating 16 knots through the water and GPS is giving a speed made good of between 9 and 11 knots. It does need some calibration runs, but this will require one of two things:

a) NMF Operations to take the ship out between cruises when there is some unallocated time in the ships programme.

Or

b) A principal scientist willing to make time in his programme to do the necessary calibration runs.

The EA-500 echo sounder was used for tracking the CTD down to the bottom, using a 10KHz pinger on the CTD, as well as for its normal purpose of simply supplying the depth. At one point in the cruise the data from the echo sounder appeared to be better when the hull transducer was used instead of the fish. This was only determined when the fish had to be brought in, to allow the safe recovery of a mooring down the port side of the vessel.

The connector at the PES winch slip ring was cleaned, and capacitance tests on the individual transducer elements were performed. This indicated that there was no problem with fish and the wiring to it. The fish was eventually used again when the vessel had to steam into the weather, where it gave superior results to the hull transducer.

8.6 Sat-Comms

This is only the second cruise with the new satellite data communication equipment on board. This is mostly working, but there is still some optimisation to be done.

At the moment there is no operational Squid web cache running. Efforts were made to build and configure this during D344, but at the moment this is not complete.

The current DNS server is not correctly configured to perform reverse lookups, which some software requires. A new DNS server running on a Sun T5120 was configured, but although the Sun on which the DNS software was running could access the DNS service, for some reason, other systems seem to struggle, with only a few Linux boxes being able to use it properly.

SSH access to the vessel was configured during the cruise, and was successfully used by Brian King to log into the *nosea1* workstation – for a few days. Unfortunately it then stopped working. No idea why so far, but restarting the SSH demon on nosea1 and rebooting the Vigor firewall/router had no effect.

As well as configuring SSH access, VPN access was also configured and (I believe) this is still working properly.

The main data communications system is the Cruise-IP system, and this provides an unmetered, always-on connection to the Internet via the Peak-10 ISP in North Carolina, USA. This has mostly worked well, apart from the following problems:

- A large blindspot caused by the dish attempting to look through the radar mast. This is a problem when the relative azimuth of the satellite to the ship is between 193 and 244 degrees. The following is an extract from Gareth Knight's report from D343:

  > "Much more of a problem is the position of the main mast. The engineers have setup the system not to transmit between Azimuth 193 and 244 in practice this has meant that when head to wind and pointing 0 to 16 deg we currently have the mast in the way. This heading is obviously going to change for different satellites and different lat and lon though as the satellites are all geostationary and over the equator pointing north is generally going to be a problem this side of the equator. The system will track and will work into the 193 – 244 band however once the satellite is lost then it will not try to reacquire until it is outside of this quadrant. In practice we have found the system will reacquire by itself most of the time, however there have been a number of occasions where the link should have been up and running but was not. This tends to usually happen after we have had a prolonged period without connection (mast in the way)."
- Crashes of the satellite modem.
- The antenna controller losing track of the satellite.

The secondary data communications system is the Fleet Broadband 500. This system has been installed as it has worldwide coverage, unlike Cruise-IP which does not cover the South Atlantic or Indian Ocean regions. The big disadvantage of using the

Fleet Broadband system is that it is a metered service, and the more it is used, the more we will get charged. The system has been given some serious use during the cruise when there was a large transfer pending on the Globe Wireless E-mail system, and the Master elected to attempt to transfer the data over the Fleet Broadband system instead of the Cruise-IP system. All that was required, was to disconnect the Globe Wireless E-mail server from the main ship LAN and connect it to the Fleet Broadband 500 terminal. Once that was done, and the IP address on the computer set to automatic, the link was brought up and the E-mail transfer completed without incident.

As part of the implementation of the Shared Service Centre tests were performed on both Cruise-IP and Fleet Broadband 500 to verify that the ship would be able to access the Shared Service Centre portal, no matter which sat-comms system was in use. The tests were rather frustrating because no matter what was done on the ship, access to the portal was denied. The SSC personnel had been informed of the IP addresses used by the ship on several occasions, but despite this, it turns out that the problems had been caused by them firewalling our packets at the Rutherford Appleton Laboratory installation.

During D343, minimal setup was performed on the Draytech Vigor 3300 router – just enough to enable its DHCP functionality, and to allow it to use either Cruise-IP or the Fleet Broadband 500.

During this cruise, as well as working on SSH and VPN setup, the Vigor's firewall system was turned on, and partly configured. It is currently not as secure as it could be due to issues with the Globe Wireless E-mail system.

9 ADCP Processing

Zoltan Szuts

The vessel-mounted ADCP used during D344 was a RDI Ocean Surveyor 150 kHz (OS150). This instrument is situated at a depth of 5.3 m below the waterline and has 4 beams each at 30 degrees to the vertical (beam 3 points forward, beam 4 points aft). Although there also is an Ocean Surveyor 75 kHz mounted, it was not functional during D344.

The OS150 was operated primarily in water track mode, aside from the first and last couple of days when the vessel was operating in shallow water. The instrument is set up for a 6 m blanking, 55 bins of 8 m each, narrow-band single-ping profiling mode, and as fast a sampling rate as possible. The control files were either `D344_OS150NB_WT.txt` or `D344_OS150NB_BT.txt`, depending on whether water-track or bottom-track mode was enabled. The instrument setup and data recording are performed by a PC running Teledyne RDI VmDas (version 1.46).

name	start date	end date	tracking mode	comments
D344os150001	2009.10.21 8:52	2009.10.21 13:33	water	test run, no TSG data was available
D344os150002	2009.10.21 13:41	2009.10.22 15:06	bottom	
D344os150003	2009.10.23 20:13	2009.10.25 12:39	bottom	
D344os150004	2009.10.25 12:47	2009.11.06 23:05	water	closed after 11.5 days because of size
D344os150005	2009.11.06 23:11	2009.11.17 13:49	water	
D344os150006	2009.11.17 13:55	2009.11.18 6:26	bottom	calibration run along the shoal on the south side of the Northwest Providence Channel
D344os150007	2009.11.18 11:38	2009.11.18 12:27	bottom	turned on while entering Freeport harbor – no data

Table 9.1 *The different data records and configurations of the OS 150 kHz ADCP. Times come from the database generated by CODAS (using 'showdb di34400?nnx').*

Further processing is done using the University of Hawaii program CODAS. Brian King set up the processing software and directory trees. Diagnostic was performed during the cruise with single-ping ENX data. The base directory is `/noc/users/pstar/cruise/data/vmadcp/di344_os150/` on the computer *RAPID*.

The following steps were done for each of the 6 data records (Table 9.1). This is a summary of the file titled "CODAS processing quick summary" from Brian King, in which some of the details omitted below can be found. The first data record di344001 is used as an example.

Initial processing of raw data (from command line)

1 The raw data from the PC were moved into a folder named `rawdata001/`, either directly or else by running `vmadcp_movescript` from the base directory with the files in `rawdata/`.

2 The directory tree for the data name is created by running: `adcptree.py di344001nbenx --datatype enx`. Note that there are two dashes in front of `datatype`, that `nb` stands for narrowband, and that this is for processing ENX data (other options are ENS, ENR, STA, or LTA)

3 The control file `q_py_001.cnt` file is created, with the proper options.

4 Initial processing is done by running `quick_adcp.py --cntfile q_py_001.cnt` from the directory `di344001nbenx/`.

5 Depending on the cruise track and the instrument mode, the initial processing calculates statistics for evaluating the angle correction using bottom- and/or water-tracking. The angle corrections from bottom-track (water-track) calibration can be evaluated by looking at the text files in `cal/botmtrk/` (`cal/watertrk/`) named `btcaluv.out` (`adcpcal.out`), or the corresponding figure(s) `btcaluv.ps` (`cal1.ps` and `cal2.ps`).

6 The data can now be cleaned up in MATLAB by running `gautoedit` (see CODAS documentation for details). The program libraries are initialized by running `m_setup` and `codaspaths`, and the working directory should be `di344001nbenx/`. In addition to removing bad data points – a step not done for these data – `gautoedit` creates plots of the u and v components of velocity, the percent good, and ship heading and speed for diagnostic purposes.

There are two minor problems to note with `gautoedit`: 1) the positions in `nav/di344001nnx.gps` sometimes have repeated time stamps that prevent internal functioning of calls to interp1, and 2) the second figure's use of `m_map` plotting functions sometimes doesn't work properly. The first issue is corrected by interpolating over the 3-4 consecutive data points with improper time-stamps (the data are 5 minute averages and are corrected by linear interpolation) using the function `gautoedit_fixgpstimes.m`, and the second is corrected by entering `m_coord('get')` (with `dbstop if error` turned on, so that the function stops when the error with `m_map` is encountered) and replotting using the button in the gautoedit GUI figure.

Calculation of ship navigation and time-varying (gyro minus ashtech) heading correction

7 The data is loaded in MATLAB by running `mcod_01.m` from the `di344001nbenx/` directory.

8 The water speed, ship speed, and heading are calculated by running `mcod_02.m` and giving it the input `os150_di344001nnx`.

9 A time-varying correction is applied to correct the more robust gyro heading for Schuler oscillations with the more accurate but less reliable ashtech heading. This assumes that the daily ashtech file,

(`/local/users/pstar/cruise/ data/nav/ash/ash_di344_01.nc`) covers the period of the ADCP record. The call `make_g_minus_a(150,1)` (where `150` is the instrument type, and `1` is the sequential database number) creates a file with the heading correction every 5-minutes.

10 Apply the rotation by running in unix '`rotate rotate.tmp`'. The control file `rotate.tmp` needs to be modified to contain the line

```
time_angle_file: ../../edit/di344001nnx.rot
```

11 The time-varying heading corrections are propagated through the rest of the processing by rerunning `quick_adcp.py` with a `q_pytvrot.cnt` control file which reruns the navigation and calibration steps with the line

```
--steps2rerun navsteps:calib
```

12 Re-edit points if desired with `gautoedit.m`, and then rerun `quick_adcp.py` with a control file `q_pyrot.cnt` that contains the line:

```
--steps2rerun apply_edit:navsteps:calib:matfiles
```

13 Look at the calibration files again, and determine the constant angle offset and the scale factor to use for the final processing.

Adjust the ADCP soundspeed using data from the shipboard thermosalinograph

14 Modify `lst_temp.cnt` to include the following lines

```
dbname:  ../adcpdb/di344001nnx
output:  di344001nnx.tem
year_base=2009
```

and then run '`lst_temp lst_temp.cnt`'.

15 Use `plottemp_tsg.m` to load in the thermosalinograph (TSG) data in a form suitable for CODAS, as a replacement for the ADCP temperature at the transducer and for a constant salinity. The program outputs temperature, salinity, and sound-speed data from the TSG data to `adcpdb/di344001nnx.tst`, `….tss`, and `…tsv`. Plots are made for comparing the TSG data to those used by CODAS.

16 Modify `fix_temp.cnt` to include the following lines

```
dbname:  ../adcpdb/di344001nnx
original_soundspeed= 0
true_soundspeed= di344001nnx.tsv
```

and then run '`fix_temp fix_temp.cnt`' to incorporate the more accurate TSG data for determining sound speed. According to the CODAS manual, this command recalculates all variables calculated from the transducer temperature (namely the sound speed, U, V, W, and error velocities).

Apply the final angle correction

17 Simply rerun `quick_adcp.py` with the final control file `q_pyrot.cnt` that contains the lines:

```
--rotate_angle -1.57

--rotate_amp 1.009

--steps2rerun rotate:navsteps:calib
```

18 Verify that the angle and scale factors from the calibration step are not statistically different from zero.

Note that all adjustments are cumulative, so if any step is repeated the correction is applied twice. In such cases, it's easiest to just delete the directory and start again from the beginning.

The speed of sound used for velocity calculations is calculated from temperature measured at the transducer and from a constant salinity selected by the user. The dependence of sound speed on salinity is very small (0.1% for a change of 1 PSU), so the results are accurate to 0.05% if the in situ salinity does not differ by more than 0.5 PSU from the fixed value. With the two long records of di344004 and di344005 that each span almost half of the subtropical gyre, however, these conditions were not met. Thus, the thermosalinograph temperature and salinity were used to correct the implemented sound speed.

The final angle rotations was determined from record di344006, when the ship steamed slowly over shallow bathymetry on the south side of the North Providence Channel to obtain high quality bottom-track data. Statistics for all of the ADCP records are shown in Table 9.2 for comparison. Note that all records give consistent values, though perhaps with larger standard deviations than for di34406. After final rotation, the amplitudes and angles for all records (not shown) indicate that no more corrections are necessary; that is, the amplitudes and angles are statistically consistent with values of 1.0 and 0°.

record	mode	Bottom Track			Water Track		
		N	amplitude	angle	N	amplitude	angle
di344002	bottom				7	1.0069 ±0.0091	-1.19 ±0.47
di344003	bottom	23	1.0054 ±0.0070	-1.67 ±0.36	8	1.0028 ±0.0140	-1.86 ±0.44
di344004	water				31	1.0060 ±0.0086	-1.59 ±0.66
di344005	water				34	1.0076 ±0.0093	-1.61 ±0.30
di344006	bottom	17	**1.0090 ±0.0014**	**-1.57 ±0.24**			

Table 9.2 *The initial amplitude and angle statistics after step 16 of the processing. The values given are the number of edited points, and the mean and standard deviation of the amplitude and the phase from the files* `btcaluv.out` *(for bottom tracking) and* `adcpcal.out` *(for water tracking). Only statistics with N>2 are shown. The values from* `di344006` *were used for the final rotation and are shown in bold.*

After all of the records are processed, they are loaded into MATLAB and combined with `adcp_combine.m` for visualization purposes (Figures 9.1-3). To deal with the non-uniform sampling in time across the transect, I extracted only segments when the ship was headed westward, and where the easternmost point of each segment is further west than the previous segment. At each depth level the velocities are gridded to a uniform grid with a spacing of 0.01°, the velocities are spatially filtered with a

0.1° low-pass Butterworth filter, and then the velocities are subsampled every 0.1°. Temporal and spatial biasing of synoptic features is expected to remain. Plots of the meridional (u) and zonal (v) velocities across the full transatlantic transect are shown in Figure 9.1, with the eastern and western boundaries shown in detail in Figures 9.2 and 9.3.

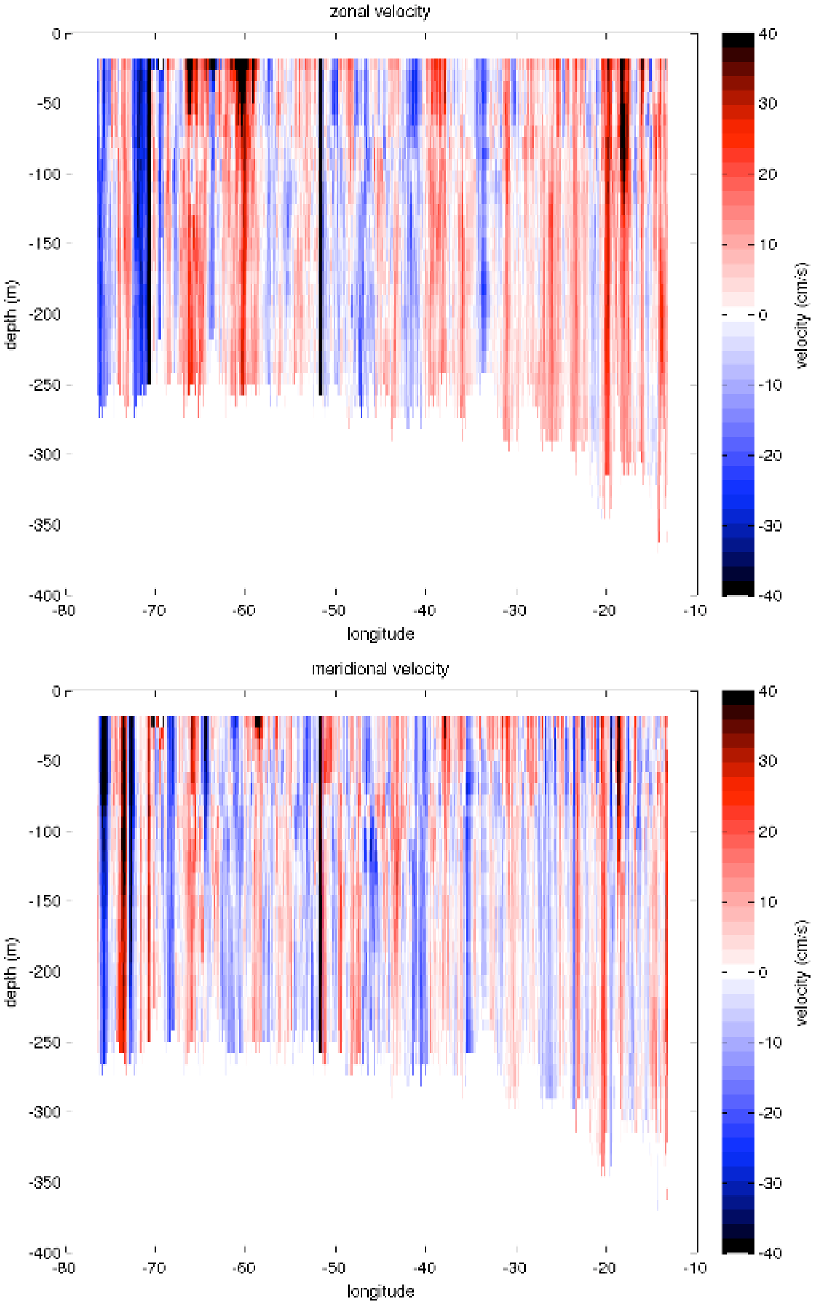


Figure 9.1 *The trans-Atlantic velocity section from the OS150, for (top) meridional and (bottom) zonal velocities, in cm/s.*

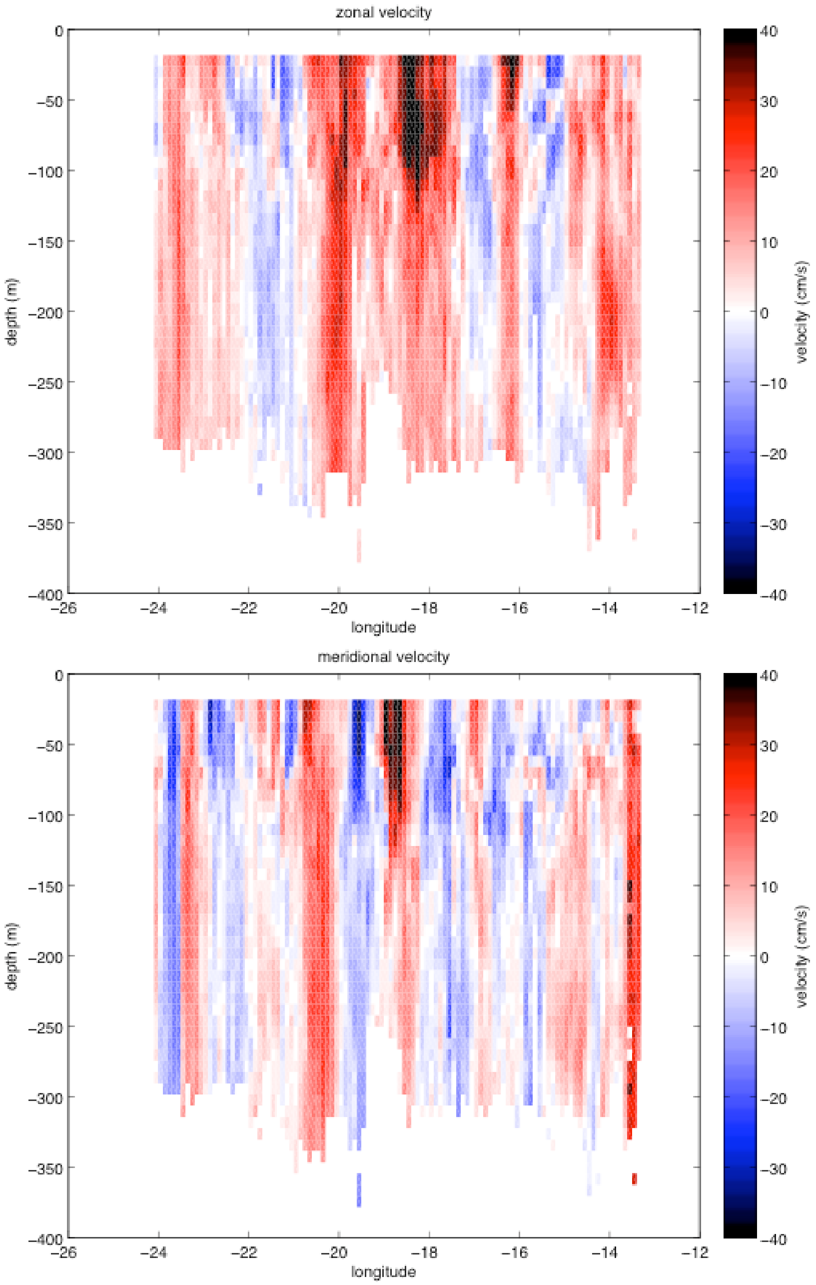


Figure 9.2 *The eastern boundary velocity section from the OS150, for (top) meridional and (bottom) zonal velocities, in cm/s.*

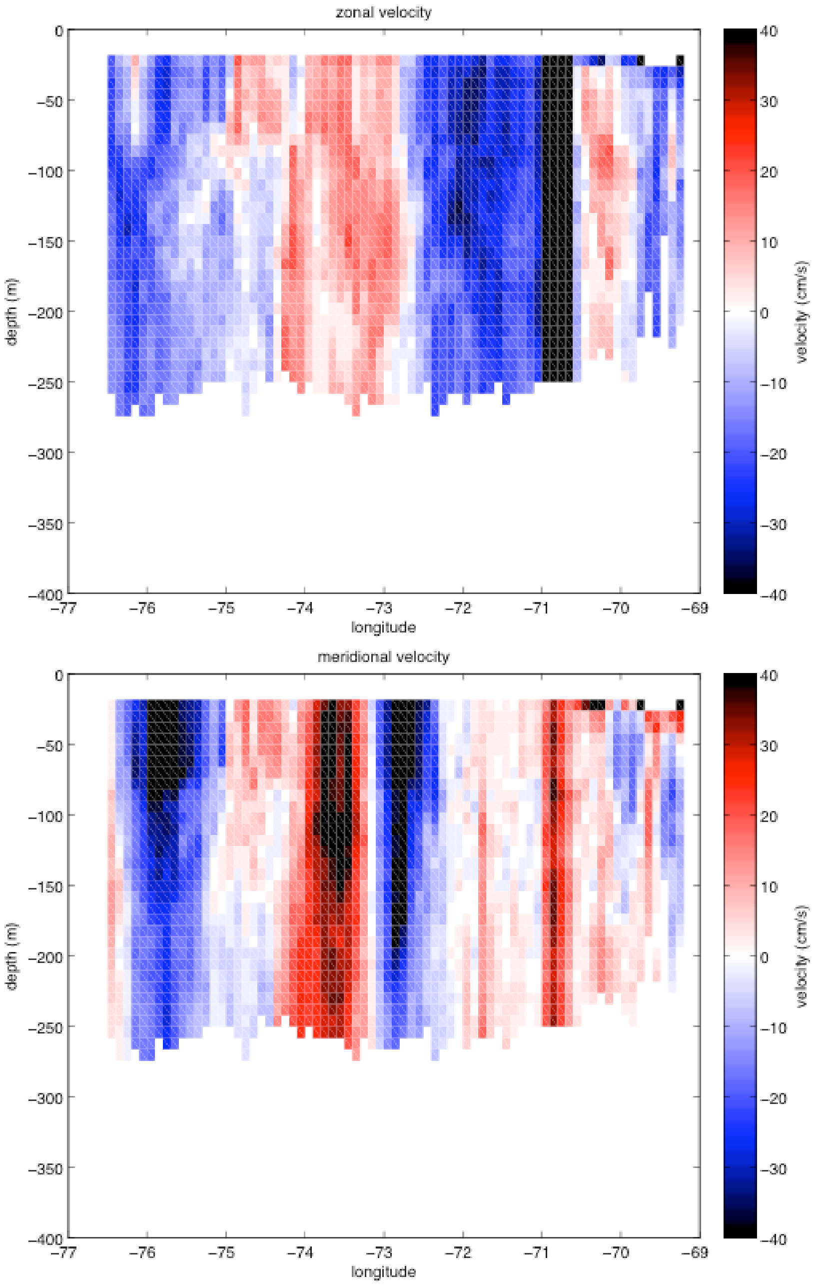


Figure 9.3 *The western boundary velocity section from the OS150, for (top) meridional and (bottom) zonal velocities, in cm/s. The vertical stripe between -71 and -70.5 (entirely black for u, red for v) is an artifact of bad data points.*

10 Underway Data Logging

David Ham

The main underway data logging was performed with a series of scripts provided by Dr Brian King.

10.1 Overview

The key steps performed each day were as follows:

Calculate the year day for yesterday:	`day=yearday(now-1)` `day=floor(day(2));saveday=day`
Retrieve data fields from techsas:	`mday_00_get_all(day)`
Post-process gyro data:	`mgyr_01`
Post-process Ashtech data:	`day=saveday` `mash_01`
Produce the true wind data:	`day=saveday` `mtruewind_01`
Append all the day's files to the running logs:	`day=saveday` `mday_02_run_all(day)`

10.2 Retrieving Data from Techsas

Data were retrieved from the following Techsas streams. At this stage of processing, the only data change that is made is that the time variable is changed to the RAPID standard of seconds after 2009-01-01 00:00.

Ashtech - `nav/ash/`

lat (degrees)
long (degrees)
alt (m)
head_ash (degrees)
pitch (degrees)
roll (degrees)
mrms (m)
brms (m)

The Ashtech is not the primary navigation device so the latitude, longitude and altitude from this instrument are not used by other tools. The *mrms* and *brms* are indicators of the accuracy of the Ashtech reading.

CTD Winch - `nav/winch/`

cablout (m)
cabltype (unknown dimension)
rate (m/min)
tension (tonne)
btension (tonne)
angle (degrees)

Echo sounder - `nav/sim/`

snd (m) – sounding depth

Surfmet - `met/surfmet/`

speed (m/s) – wind speed
direct (degrees) – wind direction
airtemp (degrees)
humid (%)

Surfmet light sensors - `met/surflight/`

press (mb) atmospheric pressure
ppar (mV) photosynthetically active radiation (port sensor)
spar (mV) photosynthetically active radiation (starboard sensor)
ptir (mV) total incident radiation (port sensor)
stir (mV) total incident radiation (starboard sensor)

Thermosalinograph - `tsg/`

temp_h (degrees) housing temperature
temp_r (degrees) sea surface temperature
cond (S/m) conductivity
salin (PSU)
sndspeed (m/s)

Chernikeef log - `chf/`

speedfa (knots) – speed forward/aft
speedps (knots) – speed port/starboard

Gyroscope - `nav/gyros/`

head_gyr (degrees)

GPS position - `nav/gps4000/`

lat (degrees)
long (degrees)
alt (m)
prec (dimensionless) – current relative precision
mode (dimensionless)

This is the primary GPS system used for navigation information in all further processing steps.

GPS satellite information - `nav/satinfo4000/`

nbused – number of GPS satellites in use by system

HDOP – horizontal precision

VDOP – vertical precision

PDOP – precision

This quality control information refers to the primary GPS system immediately above.

10.3 Post-Processing

Post-processing gyro data

The gyroscope data reported by Techsas on previous cruises has sometimes included multiple data points with the same timestamp. The gyro post-processing stage removes any data, which is not in the correct chronological order.

Post-processing Ashtech data

The Ashtech is used as a correction to the gyroscope data in determining ship heading. The post-processing stage first calculates the difference between the Ashtech and gyroscope heading readings, then cleans the resulting data to produce the gyro correction field *a_minus_g*. The cleaning which occurs is as follows:

the ashtech and gyro *heading* are filtered for values outside [0, 360]

pitch is clamped to the interval [-5, 5]

roll is clamped to the interval [-7, 7]

mrms is clamped to the interval [0.00001, 0.01]

brms is clamped to the interval [0.00001, 0.1]

a_minus_g is clamped to the interval [-5, 5]

finally, the data is averaged over 2 minutes.

Truewind calculation

See section 13.1 for more information on this. The truewind data is stored in the `nav/surfmet/` directory.

Appending to the running logs

Running logs for the whole cruise are updated daily using the `mday_02_run_all(day)` command. This process is inherently error-prone as the data must be added sequentially in order. Fortunately the day by day data files are always available so if mistakes are made, then the whole set of running logs can be regenerated from scratch in a few minutes.

To assist the operator in logging days in the correct order, all executions of `mday_02_run_all` are logged to the file `day_log`. Should it become necessary to reconstruct the running logs, this is achieved as follows:

First, use a shell script to move the (presumably invalid) existing logs out of the way:

```
mkdir backup
```

```
for dir in $(cat underway_dirs); do echo $dir; mv $dir/*01.nc backup; done
```

Next, the following Matlab loop reconstructs the logs:

```
for day=startday:endday
   mday_02_run_all
end
```

substitute the first and last days to be logged for the bounds of the loop.

11 CTD Report and Salinity Sample Processing

John Wynar

11.1 CTD system configuration

One CTD system was prepared; the main water sampling arrangement was a NOC 24-way stainless steel frame system (s/n SBE CTD1415) and the sensor configuration was as follows:

Additional instruments:

Ocean Test Equipment 10L ES-115B water samplers were used in alternate positions (see log sheets for exact positions for each cast). The term N/C appears on the log sheets where a bottle did not close or seal properly.

Sea-Bird 9*plus* configuration file `0720.con` was used for CTD casts 1 and 2, and details are as follows:

Instrument configuration file:

```
     C:\Program Files\Sea-Bird\SeasaveV7\D344\0720.con

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 : 4151
   Calibrated on : 25 June 09
   G             : 4.39944763e-003
   H             : 6.70304058e-004
   I             : 2.54058069e-005
   J             : 2.10452712e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

2) Frequency 1, Conductivity
```

```
   Serial number : 2571
   Calibrated on : 8 July 09
   G             : -1.02858203e+001
   H             : 1.59663019e+000
   I             : -2.63621750e-004
   J             : 1.12175094e-004
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

   Serial number : 90573
   Calibrated on : 20 Oct 08
   C1            : -4.666978e+004
   C2            : -2.615846e-001
   C3            : 1.373870e-002
   D1            : 3.884300e-002
   D2            : 0.000000e+000
   T1            : 3.015158e+001
   T2            : -3.442071e-004
   T3            : 4.048350e-006
   T4            : 2.094500e-009
   T5            : 0.000000e+000
   Slope         : 0.99987000
   Offset        : -0.40170
   AD590M        : 1.280800e-002
   AD590B        : -9.338280e+000

4) Frequency 3, Temperature, 2

   Serial number : 4782
   Calibrated on : 16 May 09
   G             : 4.35005123e-003
   H             : 6.36826669e-004
   I             : 2.11517506e-005
   J             : 1.82906585e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

5) Frequency 4, Conductivity, 2

   Serial number : 2841
   Calibrated on : 25 Aug 09
   G             : -1.02602597e+001
   H             : 1.41367116e+000
   I             : 5.07883486e-004
   J             : 3.94664169e-005
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

6) A/D voltage 0, Free
```

```
7) A/D voltage 1, Free

8) A/D voltage 2, Altimeter

   Serial number : 47597
   Calibrated on :
   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
```

After examining the data from the first two casts the primary conductivity sensor was found to be out of spec. and was replaced. The Benthos altimeter was not functioning correctly and was also replaced. Hence for casts 3 – 9 inc. the configuration file 0720v1.con was used - as above but with the following modification:

Instrument configuration file:

```
     C:\Program Files\Sea-Bird\SeasaveV7\D344\0720v1.con
```

```
2) Frequency 1, Conductivity

   Serial number : 3054
   Calibrated on : 25 June 2009
   G             : -1.03620455e+001
   H             : 1.42481281e+000
   I             : 2.48034455e-004
   J             : 5.16175303e-005
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

8) A/D voltage 2, Altimeter

   Serial number : 6196.118171
   Calibrated on : 15 November 2006
   Scale factor  : 15.000
   Offset        : 0.000
```

The secondary temperature sensor was changed after cast 9 to eliminate a sudden shift of 0.5mC at pressures between 2500 and 3600dB. Hence for casts 10 – 27 inc. the configuration file 0720v2.con was used - as above but with the following modification:

Instrument configuration file:

```
      C:\Program Files\Sea-Bird\SeasaveV7\D344\0720v2.con

4) Frequency 3, Temperature, 2

   Serial number : 2674
   Calibrated on : 08 May 2009
   G             : 4.35700797e-003
   H             : 6.42749241e-004
   I             : 2.38365168e-005
   J             : 2.38861412e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000
```

11.2 CTD Operations

During cast 2 the deck unit alarm sounded and the sea cable fuse blew indicating a short circuit. The CTD was recovered and the wire "meggered". This test indicated that there had been water ingress somewhere along the wire. Approx. 30m of winch wire cut off and the cable meggered again, this time giving over 900M ohms, and re-terminated. The cast was repeated but the same event occurred again at approx. 300m of wire out. The package was again recovered and some 320m of wire pulled off and cut. The central conductor at this point was noticeably cleaner than before and the cable again gave values of over 900M ohms when meggered. Although communication with the CTD-deck unit system was initially established, as the cast was begun another fault occurred indicating a problem with the deck unit. This was replaced with the spare unit although no NMEA navigation input could be established. Over the course of the cruise this was solved by re-configuring the deck unit using the Seaterm program (see Note 1 below) and using an RMC type message. In summary, casts with no NMEA input were: 2, 3, and 12-17 inclusive.

Deck unit problems during casts 6 and 11 meant that they had to be power-cycled shortly after the start of the upcast. This necessitated a re-start of the Seasave software and hence a different file, appended with the letter U (e.g. `ctd_di344_011U`).

Altimeter problems meant that casts 1, 9, 10 and 11 were carried out with no altimetry.

11.3 Data Processing

CTD cast data was post-processed according to guidelines established from BODC as per SOLAS parameters. Bottle fire scan duration was set to 5 seconds. Initially the CTD casts were used for the purpose of calibrating SBE37 MicroCATs and/or testing acoustic releases, hence the time spent at various depths before bottle closure varied. These periods were not post-processed for removal from the final .cnv file. Bottle mapping details are provided on cast log sheets. As there was no DO sensor on the CTD, AlignCTD was not run. Good weather and minimal sea states were experienced throughout the cruise, and therefore Filter, Loop Edit and Wild Edit were not necessary.

11.4 Salinity Analysis

The salinometer used was a Guildline 8400B (s/n: 68958), installed in the Constant Temperature Laboratory as the primary instrument (Autosal set point 24°C). The instrument was standardised at the start of the cruise. However, the adjustment *pot., Rs*, was left alone when subsequent standards were run. This was to ascertain the drift of the salinometer during this period. Salinity samples were taken from each water sampler on the CTD rosette, a maximum of 12 per cast. A standard was run at the beginning and end of each set of 12 samples.

Results were recorded and salinity values calculated using the "Autosal" software on a PC (conductivity ratios were also separately noted on log sheets). Initial discrepancies between measurements written on the log sheets and those recorded by the PC led to an investigation of the hardware. The problem was traced to a faulty connector on a cable linking the salinometer to the Autosal interface box. The connector was replaced.

After careful scrutiny of the data obtained from the first two casts, it was found that the primary conductivity sensor, C1, was not operating within specification. Hence the data obtained must be discounted. No water samples were taken on casts 16 and 26. Water sampler closure failure was due to one of the following: (i) rosette geometry, (ii) insufficient spring tension, or (iii) poor sampler cocking technique. The remedy for (i) was to move the sampler to a different position, possible because there were 12 free positions (used for the occasional fitting of SBE37 MicroCATs). To attempt to solve the second problem the lanyards were shortened and hence the spring tension was increased. The solution for problem (iii) was better practice!

The full data set is included in the spreadsheet `D344_Salform.xls`. An edited version with the values from casts 1 and 2 and any obvious outriders omitted presented in `D344_Sal_edit.xls`. After an initial "settling down period" over the first few casts, possibly attributable to some of the problems with the CTD wire and equipment at the beginning of the cruise, both primary and secondary errors average out at approximately -0.01. It is clear from the edited version of the data set that the primary and secondary conductivity error is cyclical, generally increasing (becoming more negative) with reducing pressure.

12 CTD Operations and Processing

Zoltan Szuts

The ship's CTDs 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. Extra time at the end of the cruise allowed a 14-station CTD transect to be obtained.

12.1 CTD Operations

A total of 27 CTD casts were made, of which (not exclusively) 14 were for microcat calibration or pressure release testing, 12 were part of an extra hydrographic section to sample AABW waters in the western basin, and 2 (stations 16 and 26) were for testing purposes. The stations are summarized in Table 12.1.

The first two CTD casts had large disagreements between the primary and secondary sensors. CTD 001 was compared with casts from previous cruises (CD170 and D304), and in T/S space the conductivity cells did not agree in deep water (3000 m, temp around 2.60˚C and salinity around 34.945). The primary conductivity cell was 0.0127 psu lower than the historical casts, and the secondary cell was 0.0055 psu lower than the historical casts. (Note that, although the secondary cell from the CD170 cast agrees with the secondary sensor of CTD 001, the remaining 3 sensors from historical data are all in close agreement.) These differences are much larger than acceptable, and so the primary conductivity cell was changed to S/N 3054 for cast 003.

After cast 009 it was noticed that there was a jump between the two temperature sensors. On the downcast there would consistently be a sudden change between them of 0.2-0.5 millidegrees that would occur in less than 100 db at depths between 2500 and 3500 db. Close examination of the T/S relationship showed that the secondary temperature sensor contained this jump: in cast 008 it showed a change of 0.5 millidegree between depths of 2700 and 2800 db (around a temperature of 2.925˚C). The secondary thermistor was changed to S/N 2674 for cast 010.

Some difficulties were also encountered with one of the Seabird CTD deck units, which turned off twice near the bottom of two CTD casts (casts 006 and 011). The exact problem was not identified and Seabird were not able to help us identify the problem, and so the deck unit in question is being returned to Seabird for repair. It is approximately 10 years old.

Initially, the deck unit was configured to receive GGA positions and HDT heading, both of which should be fully supported by Seabird software and equipment. During attempts to isolate the problem, a new splitter for the NMEA data stream was used and it was reconfigured to take an RMC message. Diagnostics showed that the negative part of the RS232 feed changed value depending on which splitter was used. The reconfigured position format, the new splitter, and the new deck unit removed the problems for casts 018 and later.

#	Date	Time	Lat	Lon	P_{max} (db)	D_{max} (m)	corr depth (m)	corr depth - D_{max} (m)
1	2009-10-21	13:25:06	28.454	-15.666	3555.5	3502.3	3541.4	39.1
2	2009-10-22	6:16:20	28.519	-14.983	3499.0	3447.0	3479.2	32.2
3	2009-10-23	21:59:06	28.080	-15.176	487.4	483.6	1570.9	1087.3
4	2009-10-28	1:55:28	24.936	-21.314	4581.7	4503.8	4528.5	24.7
5	2009-10-28	7:12:13	24.971	-21.306	4574.2	4496.6	4516.8	20.2
6	2009-10-29	16:09:39	23.761	-24.093	5103.0	5010.8	5078.6	67.8
7	2009-10-30	2:17:08	23.822	-24.085	3558.8	3506.7	5091.0	1584.2
8	2009-11-02	17:04:33	23.864	-38.589	5303.9	5205.7	5578.8	373.1
9	2009-11-03	17:37:02	23.865	-41.099	4072.1	4007.8	5014.5	1006.7
10	2009-11-03	22:54:10	23.904	-41.060	5518.0	5413.4	5672.4	259.1
11	2009-11-04	4:08:01	23.901	-41.059	5517.4	5412.7	5642.4	229.7
12	2009-11-06	23:37:39	24.201	-49.710	5244.6	5148.1	5214.2	66.2
13	2009-11-08	13:40:09	25.105	-52.014	5573.7	5466.8	5560.4	93.6
14	2009-11-11	4:13:22	24.493	-61.779	5913.6	5796.1	5881.9	85.8
15	2009-11-11	13:05:50	24.497	-62.522	6003.6	5883.1	5915.1	32.0
16	2009-11-11	23:43:38	24.499	-63.728	252.3	250.5	5798.0	5547.5
17	2009-11-12	12:51:41	24.503	-65.458	5643.1	5534.3	5554.8	20.5
18	2009-11-12	22:57:55	24.492	-66.176	5262.2	5165.1	5114.7	-50.4
19	2009-11-13	7:14:20	24.498	-66.918	5847.9	5732.6	5752.6	20.0
20	2009-11-13	15:16:32	24.502	-67.671	5813.7	5699.5	5728.7	29.3
21	2009-11-13	23:56:57	24.491	-68.405	5816.4	5702.1	5724.3	22.3
22	2009-11-14	8:42:03	24.498	-69.147	5738.6	5626.7	5648.7	22.0
23	2009-11-14	17:10:14	24.992	-69.509	5700.3	5589.5	5611.0	21.5
24	2009-11-15	0:40:49	25.365	-69.879	5602.7	5494.9	5512.7	17.8
25	2009-11-15	11:14:31	26.132	-70.601	5599.0	5490.9	5523.4	32.4
26	2009-11-15	22:30:58	26.502	-70.997	1168.5	1157.6	5495.1	4337.5
27	2009-11-16	0:58:22	26.501	-71.006	5583.7	5475.9	5494.0	18.1

Table 12.1 *Deployment information for CTD stations. Time and position are given when the CTD is at the bottom of the cast.*

12.2 CTD Processing

The CTD casts were processed with the MEXEC routines that Brian King wrote. 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 *noseal* is `/noc/users/pstar/cruise/data/ctd/`.

The raw CTD files – e.g. `XXX.bl` and `XXX.hex`, where `XXX` stands for the base part of the file name such as `ctd_di344_001` (cast `001` will be used as the example for the rest of this document) – are converted with Seabird processing software (SBE Data Processing, v7.18) to `XXX.cnv`, `XXX.ros`, and `XXX_ctm.cnv`. The data in `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 12.2. The files used in later steps by MEXEC are shown in bold. The files `XXX_ctm.cnv`, and `XXX.ros` are put into `ASCII_FILES/`, the file `XXX.bl` is put into `BOTTLE_FILES/` and the remaining files are put into `rawdata/` (except for `XXX.cnv`).

Raw CTD files	
`ctd_di344_001.CON`	configuration file
`ctd_di344_001.bl`	bottle file
`ctd_di344_001.hdr`	header file
`ctd_di344_001.hex`	data, in ASCII format but data are in hex
Processed CTD files	
`ctd_di344_001.btl`	bottle summary file
`ctd_di344_001.cnv`	data, in plain text arranged in columns
`ctd_di344_001_ctm.cnv`	data, corrected for the conductivity cell's thermal mass
`ctd_di344_001.ros`	rosette file

Table 12.2 *Example CTD files (from cast 001) that are copied from the PC that runs the CTD and deck unit rosette to NOSEA1.*

In MATLAB, the MEXEC routines are initialized with `m_setup.m`. The following routines are run in the order given (all written and described by B. King, except for `ctd_all_part3.m`):

1) `ctd_all_part1.m`, which runs the following programs in the order listed: `msam_01.m`, `mctd_01.m`, `mctd_02.m`, `mctd_03.m`, `mdcs_01.m`, `mdcs_02.m`.
2) `mdcs_03.m`, which requires user input for identifying the start of the down-cast and the end of the up-cast.
3) `ctd_all_part2.m`, which runs the following programs in the order listed: `mctd_04.m`, `mdcs_04.m`, `mfir_01.m`, `mfir_02.m`, `mfir_03.m`, `mfir_04.m`, `mwin_01.m`, `mwin_03.m`, `mwin_04.m`, `mdcs_05.m`. To this file two others scripts were added at the end: `mstar_to_mat.m`, which loads via `mload.m` the files `ctd_X_1hz.nc`, `ctd_X_24hz.nc`, `ctd_X_2db.nc` and saves the variables in MATLAB format (.nc replaced with .mat), and then transfers these six files to the computer RAPID for combination with the mooring processing; and `ctd_plot.m`, which makes three plots (combined profiles of potential temperature and salinity for both primary and secondary CTD sensors, T/S diagrams for both sensors, and the profile of the difference between the sensors for temperature, conductivity, and salinity).
4) `ctd_all_part3.m`, which, once the bottle salinity files are created (e.g. `BOTTLE_SALTS/sal_di344_001.csv`), runs `msal_01_di344.m`,

`msal_02.m`, `msam_02.m` to create the bottle and CTD salinities that are then used to determine the CTD conductivity calibrations.

The MATLAB routines created by Brian King are listed in Table 12.3 along with a brief description of what they do, what they require as input or as previous steps, and what they output. The `ctd_all_part?.m` files are short-hands for running the steps individually. Each file can be run by entering the file name into the command line, e.g. `msam_01`, and then supplying the numeric value of the CTD cast, or else by initializing the variable `stn=1` for cast `001` before calling `msam_01`. All output files from these routines are saved in the base CTD directory, except for the figures, which are saved in a subdirectory `pdf/`.

The processing can only be continued at step 4) after the sample bottle salinities are calculated. Conductivity data from the salinometer are entered into Excel files (for instance `SALTS/ctd344001_master.xls`), which then calculate the bottle salinities. These salinities are extracted to a bottle salinity file (in comma-separated format, `BOTTLE_SALTS/sal_di344_001.csv`) that has 3 columns and 24 rows. The columns stand for Niskin bottle number, salinity sample bottle number, and calculated salinity. The first two columns are copied from the CTD log sheet, and the last is from the salinometer file. There are 24 rows for the 24 rosette positions, which were necessary because, despite there only ever being 12 samples, the positions of the Niskin bottles on the rosette changed during the cruise. Columns two and three were filled with dummy values of -999 as necessary.

This processing had to be modified for CTD casts 006 and 011, during which the deck unit blew out near the bottom of the cast and resulted in there being two sets of Seabird CTD files (`006` and `006U`; `011` and `011U`). In both cases the interruption occurred after the first bottle was fired. (Files are given only for cast 006 below, but equivalent ones also exist for cast 011.)

The two halves of each cast were combined by running `combine_ctd_006.m`. In preparation for this file, the two raw Seabird input files in `ASCII_FILES/` (`XXX_ctm.cnv`) need to be renamed `106` (from `006`) and `206` (from `006U`) so that they are in a numeric format allowable by MEXEC. The bottle files (`XXX.bl`) copied into `BOTTLE_FILES/` are renamed in a similar fashion. The script to combine the two halves does the following:

a) Processes 106 and 206 with msam_01 and mctd_01 to insert the raw data into MSTAR/netcdf format (`ctd_di344_106_raw.nc` and `ctd_di344_206_raw.nc`).

b) Runs `concatenate_ctd_006.m`, which pastes the two raw data files together into one named `ctd_di344_006_raw.nc` using MSTAR routines. Three variables need to be adjusted in doing so: the scan values of 206 are incremented by the last value from 106, the *nbf* values (number of bottles fired) of 206 are incremented by one for the one bottle fired in 106, and the *timeS* values are calculated relative to the common time origin in 106 (performed automatically by `mapend`).

c) Runs the remaining files called by `ctd_all_part1` (`mctd_02` through `mdcs_02`), then `mdcs_03`, and then `ctd_all_part2`.

d) Runs the last three steps (`msal_01_di344`, `msal_02`, `msam_02`) for bottle processing.

<table>
<tr><th>Step</th><th>Script</th><th>infile(s)</th><th>outfile(s)</th><th>Needs prior step</th></tr>
<tr><td>1</td><td>msam_01</td><td>—</td><td>sam_X.nc</td><td>—</td></tr>
<tr><td colspan="5">1: creates an empty sam file</td></tr>
<tr><td>2</td><td>mctd_01</td><td>ctd_X_ctm.cnv</td><td>ctd_X_raw.nc</td><td>—</td></tr>
<tr><td>3</td><td>mctd_02</td><td>ctd_X_raw.nc</td><td>ctd_X_24hz.nc</td><td>2</td></tr>
<tr><td>4</td><td>mctd_03</td><td>ctd_X_24hz.nc</td><td>ctd_X_1hz.nc
ctd_X_psal.nc</td><td>3</td></tr>
<tr><td colspan="5">2: reads in ctd data
3: renames SBE variables
4: averages to 1 Hz and calculates psal, potemp</td></tr>
<tr><td>5</td><td>mdcs_01</td><td>—</td><td>dcs_X.nc</td><td>—</td></tr>
<tr><td>6</td><td>mdcs_02</td><td>dcs_X.nc</td><td>dcs_X.nc</td><td>3, 5</td></tr>
<tr><td>7</td><td>mdcs_03</td><td>dcs_X.nc</td><td>dcs_X.nc
ctd_X_surf.nc</td><td>3, 6</td></tr>
<tr><td>8</td><td>mdcs_04</td><td>dcs_X.nc
pos_Y_01.nc</td><td>dcs_X_pos.nc</td><td>7, nav</td></tr>
<tr><td>9</td><td>mdcs_05</td><td>dcs_X_pos.nc</td><td>dcs_X_pos.nc
ctd_X_raw.nc
ctd_X_24hz.nc
ctd_X_1hz.nc
ctd_X_psal.nc
ctd_X_surf.nc
ctd_X_2db.nc
fir_X_bl.nc
fir_X_time.nc
fir_X_winch.nc
fir_X_ctd.nc
sal_X.nc
sam_X.nc
sam_X_resid.nc
dcs_X.nc</td><td>8</td></tr>
<tr><td colspan="5">5: creates empty dcs file with info about start, bottom, and end of ctd cast
6: insert bottom of cast
7: needs user input to insert the start and end of cast
8: merge positions from nav file onto start, bottom, and end times (requires nav file pos_di344_01.nc from techsas stream)
9: apply positions to sets of files. This step can be used at any time, once step 8 is complete. This list should be extended to include any additional chemistry or winch files.</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>10</td><td>mctd_04</td><td>ctd_X_psal.nc</td><td>ctd_X_2db.nc</td><td>4,8</td></tr>
<tr><td colspan="5">10: extract downcast data from ctd_X_psal.nc using index information in dcs file, and then sort and interpolate gaps and average to 2 db</td></tr>
</table>

Table 12.3 *Continued overleaf*

<table>
<tr><th>step</th><th>script</th><th>infile(s)</th><th>outfile(s)</th><th>needs prior step</th></tr>
<tr><td>11</td><td><code>mfir_01</code></td><td><code>ctd_X.bl</code></td><td><code>fir_X_bl.nc</code></td><td>—</td></tr>
<tr><td>12</td><td><code>mfir_02</code></td><td><code>fir_X_bl.nc</code>
<code>ctd_X_1hz.nc</code></td><td><code>fir_X_time.nc</code></td><td>4, 11</td></tr>
<tr><td>13</td><td><code>mfir_03</code></td><td><code>fir_X_time.nc</code>
<code>ctd_X_psal.nc</code></td><td><code>fir_X_ctd.nc</code></td><td>4, 12</td></tr>
<tr><td>14</td><td><code>mfir_04</code></td><td><code>fir_X_ctd.nc</code></td><td><code>sam_X.nc</code></td><td>1, 13</td></tr>
<tr><td colspan="5">11: read ctd bottle file and create firing (fir) file
12: merge time from ctd onto fir file using scan number
13: merge CTD upcast data onto fir file
14: paste CTD fir data into sam file</td></tr>
<tr><td>15a</td><td><code>mwin_01</code></td><td><i>techsas files</i></td><td><code>win_X.nc</code></td><td>4</td></tr>
<tr><td>15</td><td><code>mwin_03</code></td><td><code>fir_X_time.nc</code>
<code>win_X.nc</code></td><td><code>fir_X_winch.nc</code></td><td>12, 15a</td></tr>
<tr><td>16</td><td><code>mwin_04</code></td><td><code>fir_X_winch.nc</code></td><td><code>sam_X.nc</code></td><td>1, 15</td></tr>
<tr><td colspan="5">15a: extract times from CTD 1Hz file, 10 minutes on either side of start and end times
15: merge winch wireout onto fir file (if winch data are available)
16: paste win fir data into sam file</td></tr>
<tr><td>17</td><td><code>msal_01_di344</code></td><td>—</td><td><code>sal_X.nc</code></td><td>—</td></tr>
<tr><td>18</td><td><code>msal_02</code></td><td><code>sal_X.nc</code></td><td><code>sam_X.nc</code></td><td>1, 17</td></tr>
<tr><td colspan="5">17: read in the bottle salinities
18: past sal data into sam file</td></tr>
<tr><td>19</td><td><code>msam_02</code></td><td><code>sam_X.nc</code></td><td><code>sam_X_resid.nc</code></td><td>14, 18</td></tr>
<tr><td colspan="5">19: calculate residuals in sam file</td></tr>
</table>

Table 12.3 *MEXEC routines created by Brian King and his comments on the input, output, and processing steps required for each, where* `X` *stands for, e.g.,* `di344_001`.

Before step d) will run, the bottle salinity files `BOTTLE_FILES/sal_di344_106.bl` and …/`sal_di344_206.bl` need to be combined by hand into a file called `sal_di344_006.bl`. The last two numbers on each row are scan numbers, and so the values in `206` need to be incremented by the last scan value from `ctd_di344_106_raw.nc`. This way of renaming the raw data files preserves a consistent output cast number, and given the few CTD casts on this cruise we don't have to worry about cast numbers reaching beyond 100 (unlike on a hydrography cruise).

The raw CTD data also needed to be combined together, because many of the scripts written by Torsten Kanzow for evaluating MicroCAT calibrations (on the RAPID machine) load in SBE-formatted data files that are untouched by the MSTAR/MEXEC processing done above. The script `combine_ctdraw_006.m` combines the two data files `ASCII_FILES/ctd_di344_106_ctm.cnv` and …`/ctd_di344_206_ctm.cnv` (adjusting the variables *scan*, *nbf*, and *timeS* in the same way as performed above) and saves the output in …`/ctd_di344_006_ctm.cnv`. The `XXX.ros` files are also combined. Two functions were created for reading and saving the SBE data format (all ASCII format, with header lines and data in columns): `read_sbefile.m` and `save_sbefile.m`.

The CTD processing also had to be modified for incomplete (shallow) casts that lacked bottle stops (casts 016 and 026). Lacking any data for bottle stops, the scripts that depend on a firing file `fir_X_`... (`mfir_0?` and `mwin_0?`, steps 11-16) failed in execution. Accordingly, only the files `mdcs_04`, `mdcs_05`, and `mctd_04` were run (in the order given) after `mdcs_03`.

12.3 CTD Calibration

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 corrections 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 (Δ_C) between bottle conductivities (C_{bot}) and CTD conductivities (C_{CTD}). Data points are removed if the residual exceeds certain limits (selected as > 0.008 or < -0.002 mS/cm for CTD casts 3-27, and > 0.015 mS/cm for casts 1 and 2) or if it is larger than three standard deviations from each station average. Out of 310 bottle samples, 16 are removed by the first criterion and none by the second. The data points picked for analysis are shown in Figure 12.1.

The first correction is to correct for a multiplicative factor between the bottle conductivity (C_{bot}) and the CTD conductivity (C_{ctd}), or $K = < C_{bot} / C_{ctd} >$, which is called a ‘slope correction.’ Although this can be applied over all CTD casts, either changes in sensors or else empirical changes in offset suggest that different CTD casts be grouped together (called here ‘block’ correction). The first two casts used a different primary conductivity sensor, and then from inspection the conductivity residual of CTDs 4-7, 8-13, and 14-27 have similar offsets and so are grouped together. The slopes applied are 1.000232 for casts 1–2, 1.000043 for casts 4–7, 1.000010 for casts 8–13, and 1.000027 for casts 14–27. Applying this correction produces residuals that are better centered around zero (Figure 12.2a).

Cast 3 was excluded from the block-averaging analysis because it was a shallow cast with shorter bottle stops (30 s instead of 5 minutes), and so the larger residuals can be attributed to the different sampling technique. The ratio from the block of CTDs 4-7 was applied to cast 3, and, though not ideal in that the mean conductivity residual is non-zero (0.0015 mS/cm), the mean residual remains less than the 0.002 mS/cm target. Casts 16 and 26 were not included in the calibration because of their lack of bottle stops.

After the block ratio correction there still remains an increase of residual with depth (Figure 12.2d). It was found that a quadratic fit of residual difference against pressure

$$\Delta_C = C_{bot} - C_{CTD} = a_2 p^2 + a_1 p + a_0$$

was able to remove this dependence and produce residuals that are evenly distributed and ratios that are independent of conductivity (Figure 12.3c) or pressure (Figure 12.3d). The values used for the quadratic fit are $a_2 = 3.7 \times 10^{-11} \pm 2.5 \times 10^{-11}$ mS cm^{-1} db^2, $a_1 = 2.0 \times 10^{-7} \pm 1.4 \times 10^{-7}$ mS cm^{-1} db^{-1}, and $a_0 = -7.1 \times 10^{-4} \pm 1.5 \times 10^{-4}$ mS/cm (quadratic relation plotted in Figure 12.2d).

The decision to use a quadratic instead of a linear fit was made by eye, given that the deepest bottle data (below 5000 m) inflect upward by a small amount. Although the quadratic has a slightly smaller rms residual (not significant), the linear fit yields coefficients with much smaller p-values ($< 1 \times 10^{-10}$) than does the quadratic fit (0.13, 0.16, 6×10^{-6} for a_2, a_1, and a_0). The constant coefficient obtained with the linear fit is not statistically significant from that obtained with the quadratic fit, while the linear coefficient is marginally statistically different between the two fits. The difference between the linear and quadratic fits is 0.00017 mS/cm at p=0 db, 0.00011 mS/cm at p=2250 db, and 0.00015 mS/cm at p=5400 db, so the choice of linear or quadratic fitting is immaterial for the desired precision of 0.002 mS/cm.

Both the ratio and the quadratic calibrations were calculated by `ctd_cal_di344.m`. The chosen calibration was applied with `calibrate_ctd_di344.m` for looping through each station and with `apply_calibration.m` for performing the calibration.

Although a bug in `apply_calibration.m` resulted in 4×10^{-11} being used for a_2 instead of a greater precision number, the resulting error in the calibrated conductivity is only 6×10^{-5} mS/cm at 4500 db (8×10^{-5} mS/cm at 5500 db). As these values are well below the target accuracy of 0.002 mS/cm, the corrected values were left as is. The residuals and ratios between the calibrated CTD data and the bottle conductivities are shown in Figure 12.3, and the station-averaged conductivity differences before and after calibration is shown in Table 12.4.

Before `calibrate_ctd_di344.m` was run, the uncalibrated sam files (`sam_di344_all.nc`) and calibration plots in `pdf/` were preserved by appending `_orig` in the file name before the extension. Then, the file `calibrate_ctd_di344` loops through each cast, saves a copy of the uncalibrated 24hz file to `ctd_di344_001_24hz_uncal.nc`, and writes the calibrated 24hz file to `ctd_di344_001_24hz_cal.nc` and to `ctd_di344_001_24hz.nc`. The MEXEC files are then run in the following order: `mctd_03`, `mdcs_02`, `ctd_all_part2`, and `ctd_all_part3`. Casts 16 and 26 were processed with the first two steps above, and then with `mdcs_04`, `mdcs_05`, and `mctd_04`. Lastly the applied calibration is verified for correctness with `verify_ctd_cal_di344` and for the absence of any further biases by running `ctd_cal_di344` again (making sure not to overwrite the previously calculated initial calibration).

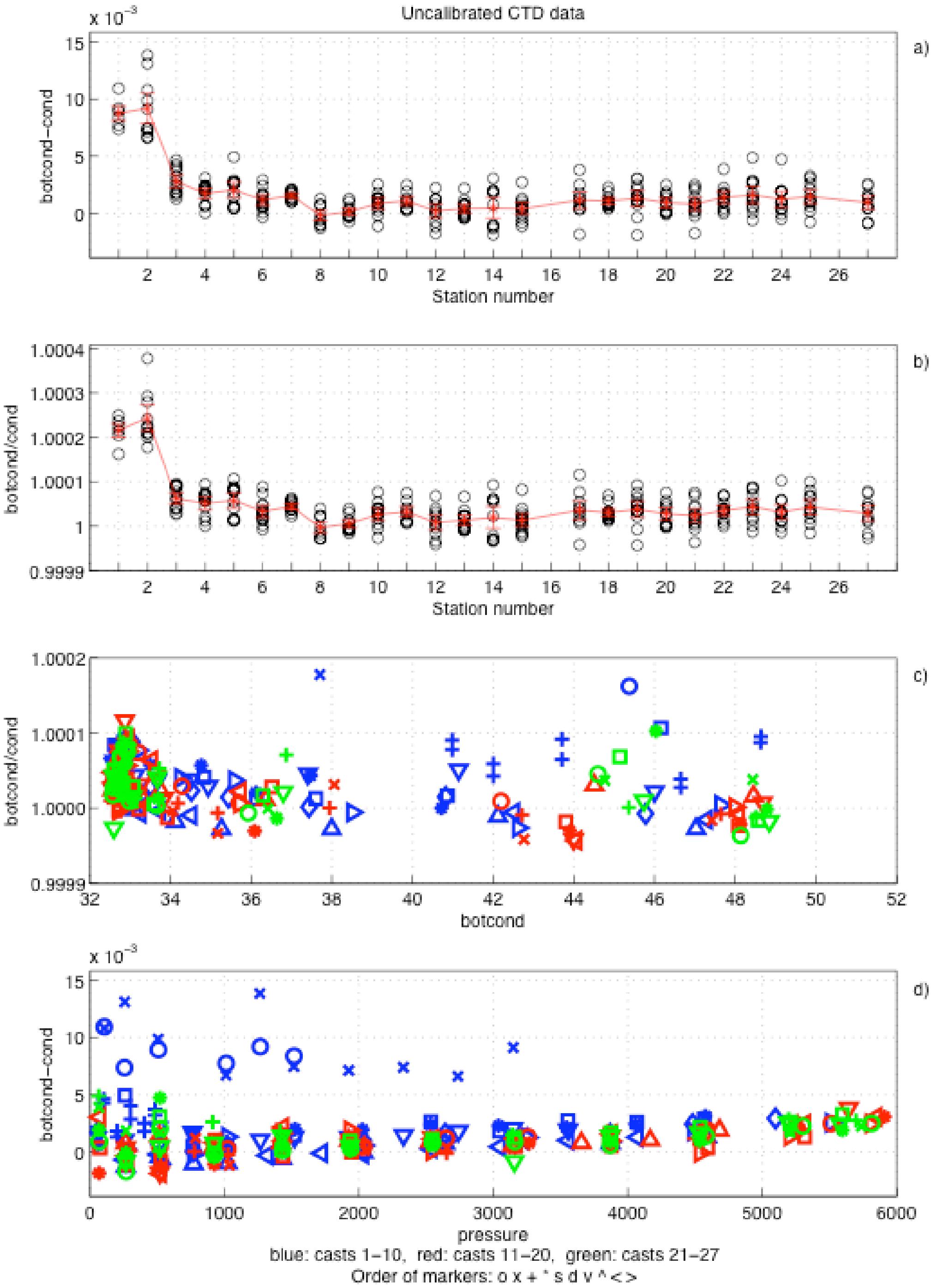


Figure 12.1 *The uncalibrated data used for calculating CTD calibrations. a) The conductivity difference for each CTD station. b) The conductivity ratio for each CTD station. c) The conductivity ratio plotted against conductivity. d) The conductivity difference plotted against pressure.*

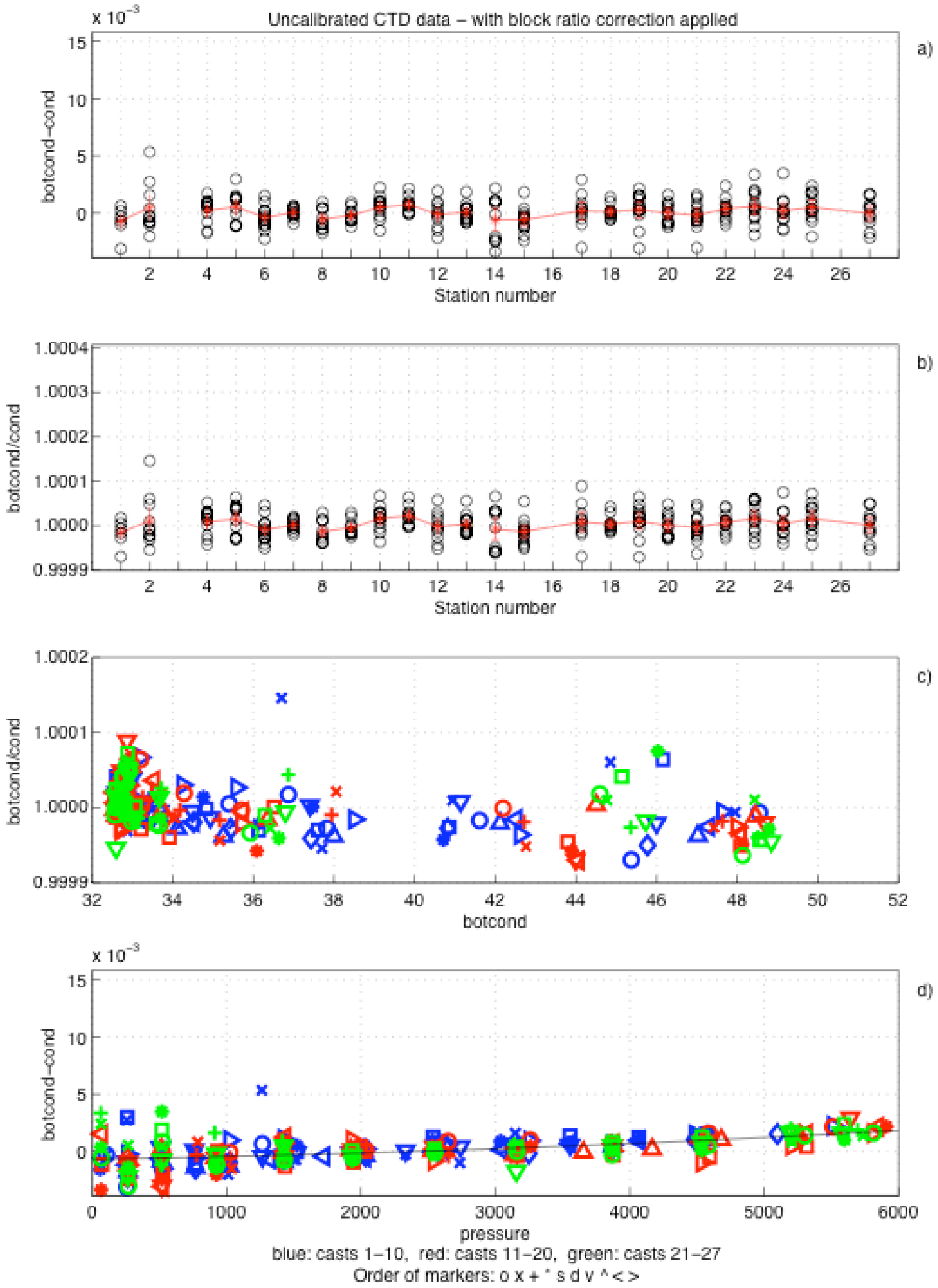


Figure 12.2 *The uncalibrated data used for calculating CTD calibrations with the block ratio correction applied. Otherwise the same as Figure 12.1.*

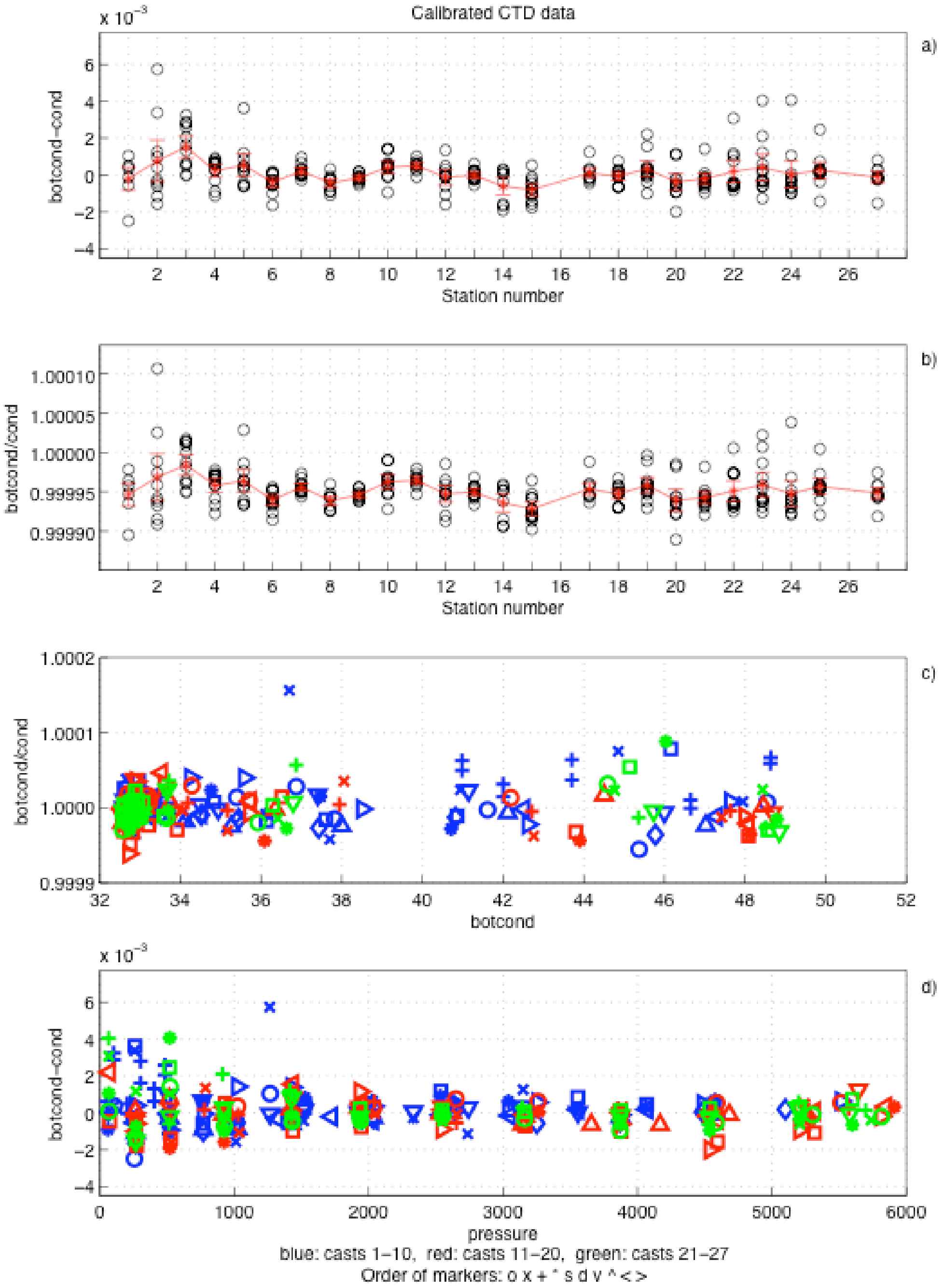


Figure 12.3 *The calibrated CTD data. Otherwise the same as Figure 12.1.*

Station	**conductivity difference (in mS/cm) average ± standard deviation**	
	before calibration	**after calibration**
1	0.0088±0.0013	-0.0002±0.0012
2	0.0092±0.0027	0.0008±0.0022
3	0.0028±0.0011	0.0015±0.0012
4	0.0017±0.0009	0.0002±0.0007
5	0.0021±0.0014	0.0006±0.0012
6	0.0012±0.0009	-0.0004±0.0005
7	0.0016±0.0004	0.0002±0.0004
8	-0.0002±0.0009	-0.0004±0.0005
9	0.0002±0.0006	-0.0001±0.0003
10	0.0009±0.0010	0.0004±0.0007
11	0.0011±0.0007	0.0005±0.0003
12	0.0002±0.0012	-0.0001±0.0008
13	0.0004±0.0008	0.0000±0.0003
14	0.0005±0.0018	-0.0008±0.0012
15	0.0004±0.0010	-0.0008±0.0007
17	0.0011±0.0015	-0.0001±0.0010
18	0.0011±0.0006	0.0000±0.0004
19	0.0013±0.0014	0.0001±0.0012
20	0.0009±0.0009	-0.0003±0.0009
21	0.0008±0.0012	-0.0004±0.0009
22	0.0014±0.0011	0.0002±0.0012
23	0.0016±0.0015	0.0004±0.0015
24	0.0012±0.0014	0.0001±0.0014
25	0.0015±0.0012	0.0003±0.0009
27	0.0009±0.0012	-0.0003±0.0009

Table 12.4 *Station-averaged conductivity differences before and after calibration.*

12.4 Salinometer Performance

The measurements of standard seawater (SSW) over the duration of the cruise were inspected to assess the stability of the salinometer and of the measurement precision.
The bottle samples (both from the CTD and from the thermosalinograph) are measured with a Guildline Autosal (OSIL) salinometer (s/n 68958) located in a constant temperature room. The first two casts were measured when the salinometer cell temperature was 27˚C (room temperature was 25˚C), after which the cell temperature was lowered to 24˚C (room temperature was 22.5-23˚C). The salinometer readout was zeroed before the first use by adjusting the measurement of

the first standard salinity to equal the printed 2 × K15 value on the standard salinity bottle. After this initial zeroing the adjustment knob was not touched further. John Wynar made all of the measurements.

Figure 12.4 shows the SSW measurements during each salinometer session, which have been normalized by the value 2 × K15 to remove the effect of different batches (shown by marker type). The three lines show SSW sample made at the beginning (red), middle (green) and end (if applicable, blue) of the salinometer session. Note that sessions 2 and 5 did not use the same SSW batch throughout the session. The first session is not shown because it was done at a higher cell temperature (27°C instead of 24°C) .

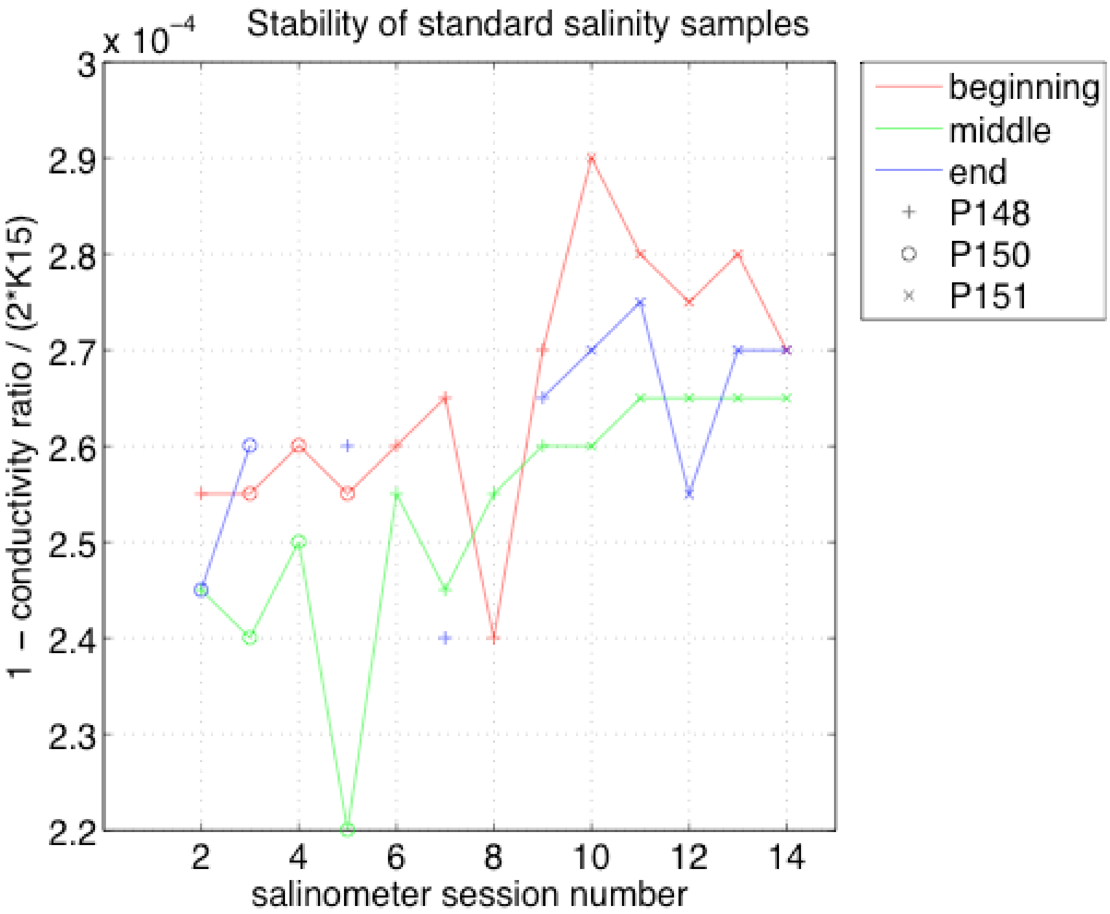


Figure 12.4 *The stability of SSW samples measured by the salinometer. All sessions shown were performed at 24°C. The measured conductivity ratio is normalized by the value 2*K15 for each SSW batch, and is subtracted from 1 for display purposes.*

13 Surface Meteorology

David Ham

13.1 True Wind

The true wind is calculated using the truewind subroutine published by Smith et al. (1998). The input data required is sourced from the following shipboard instruments whose output is logged in the Techsas system:

GPS position – Navtech4000 GPS

Ship's heading – Ships gyro corrected using the Ashtech attitude sensors.

Measured wind speed and direction – Anemometer readings from the SurfMet instruments.

13.1.1 Pre-processing of data

The `mtruewind_01` script was written to employ mexec routines to prepare the data fields required for the truewind calculation and merge them into a single NetCDF file. It is invoked as follows:

```
>> day=301; mtruewind_01
```

The year day number of the day to be processed should be substituted for 301. The script encompasses the following steps.

The `mposspd_polar` script is used to generate Speed Over Ground (in m/s) and Course Over Ground (degrees relative to True North) from position and time data logged by the GPS system.

The `mclean_speed` passes a 5 point median filter over the SOG data with a filter width of 0.5m/s.

`mcalc` is employed to add the Ashtech correction field (*a_minus_g*) to the ship's heading (*head_gyr*) producing a new field *heading.*

`mmerge` is employed to merge *sog*, *cog* and *heading* onto the same time points as the wind data.

The result of these steps is a file `met/surfmet/wind_di344_d<day>.nc` where <day> is the year day number for the day concerned. `mtruewind_01` then invokes `add_truewind` to calculate the true wind and add it to this file.

13.1.2 The Program `add_truewind`

This is a Fortran program which provides a wrapper to the `truewind` subroutine provided by Smith *et. al* (1998). The program takes two arguments, the name of a NetCDF file containing *SOG, COG, heading* and *wind speed* and *direction*; and a single real value indicating the zero line reading. The latter is the angle between the zero reading on the anemometer data and the ship's bow. For RRS *Discovery,* this argument is 0. `truewind` calculates the true wind speed and direction and the apparent direction (apparent wind speed is the same as the anemometer wind speed). These values are appended to the input NetCDF file under the names *true_wind_speed*, *true_wind_direction* and *apparent_wind_direction*.

The program `add_truewind` is written in Fortran 90 and must be linked against the Fortran 90 interface to NetCDF provided by `libnetcdff90.a`. It may prove necessary to compile your own NetCDF library as the Fortran 90 interface is not always compiled by default on all platforms.

13.1.3 Results

The consolidated true wind data is in file `met/surfmet/wind_di344_01.nc`. Figures 13.1 and 13.2 show the 5-minute averaged true wind speed and direction for the duration of the cruise.

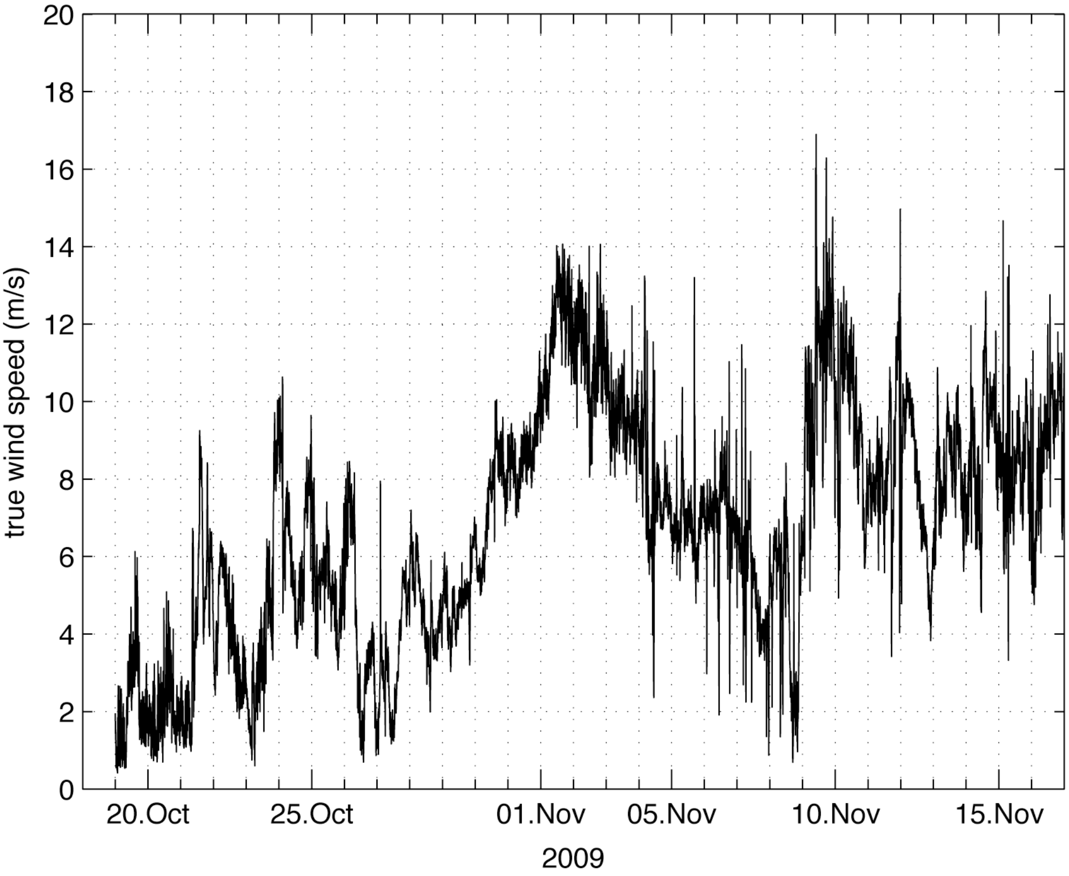


Figure 13.1 *5-minute averaged true wind speed during D344*

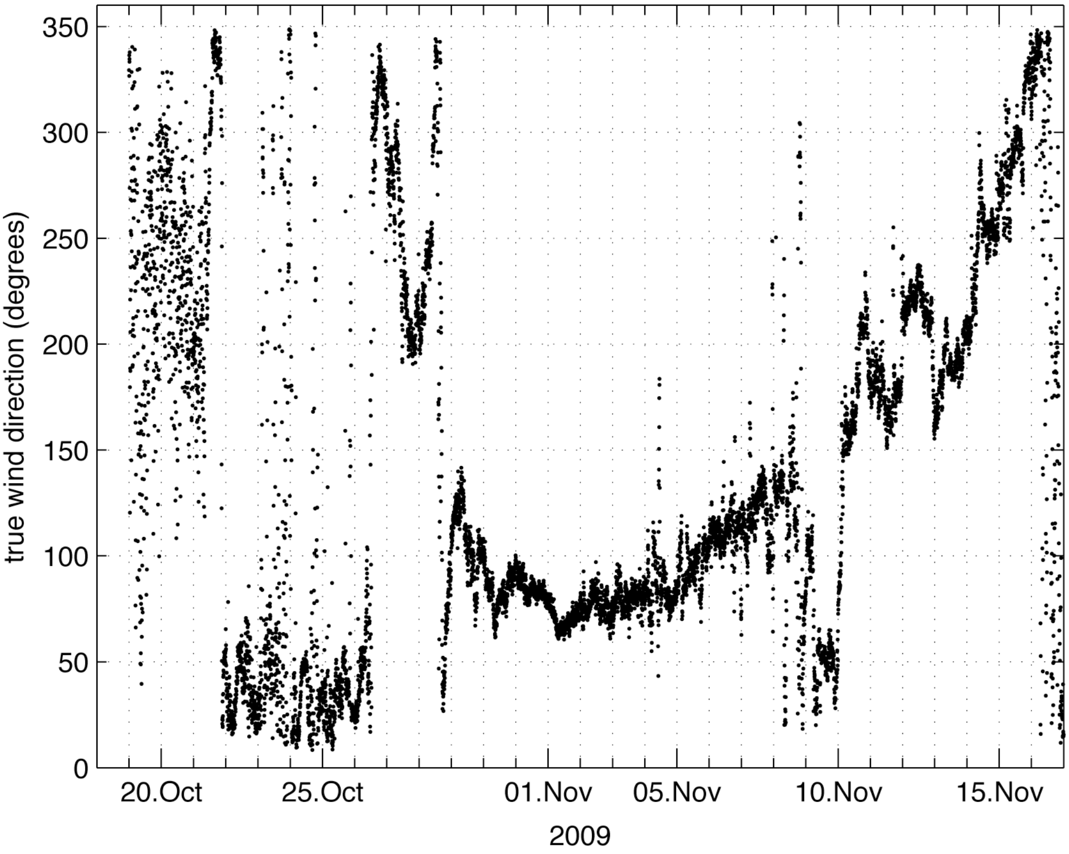


Figure 13.2 *5-minute averaged true wind direction during D344*

13.2 Surface Light and Pressure

Stuart Cunningham

During the cruise irradiance measurements from port and starboard PAR and TIR sensors on the foremast and air pressure from the barometer in the main lab were logged to TECHSAS file `Light-SURFMET.SURFMETv2` (variables: *press* mb, *ppar* mV, *spar* mV, *ptir* mV, *stir* mV, *time* days since 1899-12-30 00:00:00 UTC). These raw data were read into daily mstar files `met_light_di344_dnnn_raw.nc`. These raw files were subsequently processed using three new matlab scripts running several mstar routines.

`mmetlight_01` file in: `met_light_di344_dnnn_raw.nc`
file out: `met_light_di344_dnnn_cal.nc`

1. `medita`: change surmet absent data value from 99999 to NaNs
2. `mmerge`: merge lat and lon from the gps4000 file using time as the independent variable.
3. `mcalib`: Apply calibrations to the air pressure and light sensors from calibration sheets provided for the current sensors to produce physical units

```
% D344 calibrations for air pressure and light sensors
% Vaisala pressure transmitter, model PTB100A, s/n S3610008
% Calib cert: N0C00437P, 23-Feb-2009
% y=-1.17483+1.00152*press
% Skye sPAR, s/n 28556, 12-Feb-2009; 10.53 microV/W/m2
% Skye pPAR, s/n 28557, 12-Feb-2009; 11.04 microV/W/m2
% Kipp&Zonen sTIR, s/n 962301, 19-Feb-2009; 9.76 microV/W/m2
% Kipp&Zonen pTIR, s/n 994133, 23-June-2008; 9.60 microV/W/m2

mcalib(otfile1,'y','press','y = -1.17 + 1.00152*x','/','/',
    'ppar','y = 0 + (10/11.04)*x','/','W/m2','spar',
    'y = 0 + (10/10.53)*x','/','W/m2','ptir','y =
0+(10/9.60)*x',
    '/','W/m2','stir','y = 0 + (10/9.76)*x','/','W/m2',' ')
```

`mmetlight_02` files in: `met_light_di344_dnnn_cal.nc` to `dmmm`
file out: `met_light_di344_cal_01.nc`
4. `mapend`: append daily _cal files to a master file.
`mmetlight_03` file_in: `met_light_di344_cal_01.nc`
5. plot versus time of the light and air pressure data.

Air pressure ranged from 1007 mb to 1023 mb between the 18th of October and the 15th of November (Figure 13.3). The diurnal cycle amplitude was about 1 mb or 2 mb peak-to-peak peaking about 2300 and 1100, with minima at approximately 0500 and 1700. Atmospheric pressure has a twice-daily cycle with periods of 12 and 24hrs caused by global atmospheric tides. These are strong in the tropics, with amplitude of a few millibars and almost zero in polar areas.

A matlab script, `airpressure_tide.m`, fits 12hr and 24hr cycles to two-day high pass filter data (Figure 12.4). The amplitude of the diurnal cycle is 0.7 mb, phase of 0° and the amplitude of the semi-diurnal cycle is 0.07 mb with a phase of +6.3° in advance of the diurnal cycle (the significance of the fits and variance explained has not been tested).

Total incidence radiation sensors from port and starboard agreed well throughout the cruise. Peak incident radiation was in the range 800 to 1000 W/m^2. Photosynthetically active radiation showed good consistency between port and starboard sensors. Peak PAR radiation showed less day-to-day variability than TIR and was around 400 W/m^2.

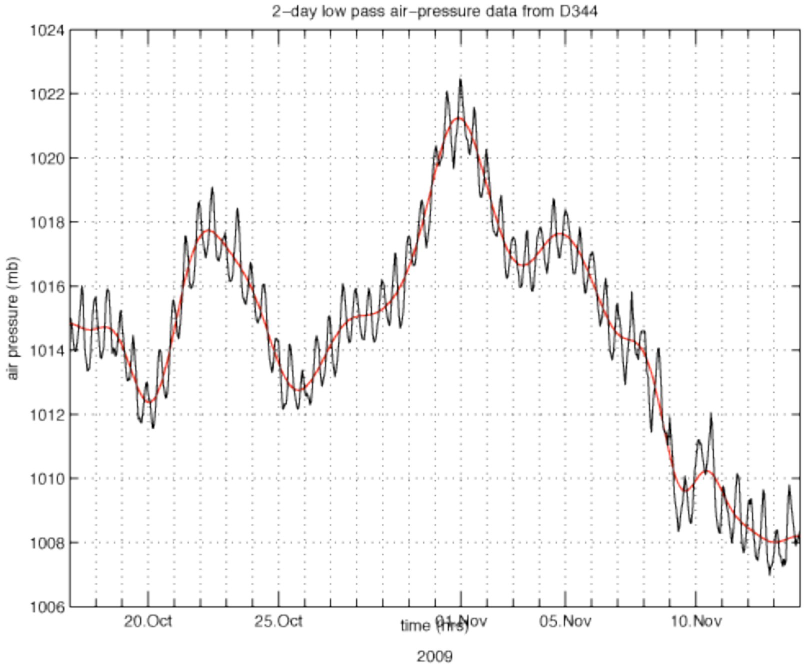


Figure 13.3 *Air pressure (black) and two day low-pass filtered air pressure (red).*

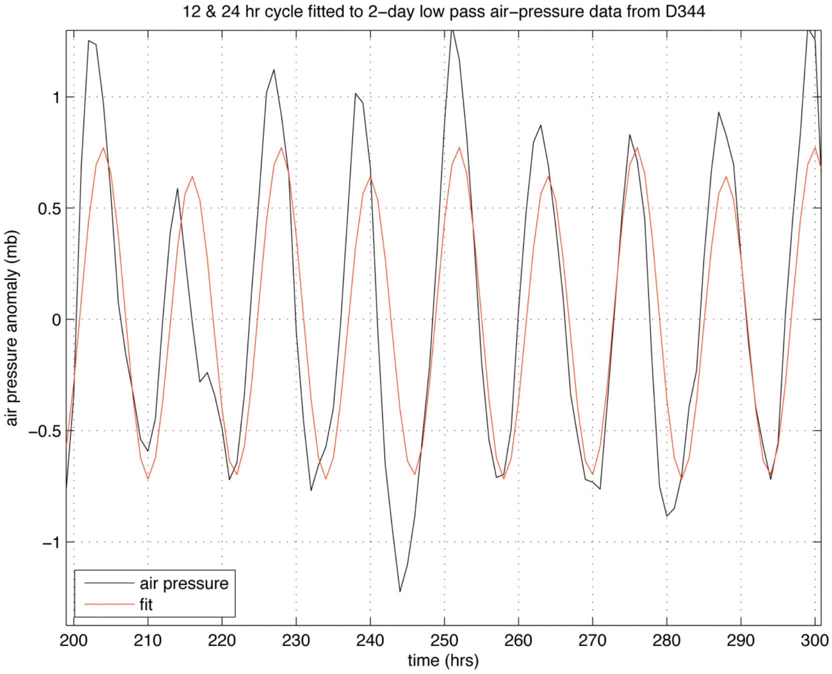


Figure 13.4 *Two day high-pass filtered air pressure anomaly (black) and the diurnal plus semidiurnal fits (red). Time in hours from 17th October to 14th November.*

14 Near Surface Salinity and Temperature Measurement

Stuart Cunningham

RRS *Discovery* has recently been fitted with new sensors for measuring near surface temperature and salinity. Near surface temperature is measured with a SBE38 probe, located in the forward hold on the starboard side, measuring the temperature of water 6-7 m below the surface. The seawater intake is a pipe (Fig 14.1) projecting about 0.5m below the hull. A SBE45 MicroTSG is fitted in the wet lab and the non-toxic supply runs from this intake. The temperature specification for the SBE38 and SBE45 gives an initial accuracy of 1 m°C and 2 m°C respectively with a typical stability per month of around 0.0002 m°C. Conductivity has a stability of 0.003 S/m and resolution of 0.0001 S/m. When not being pumped with seawater the TSG pipework is flushed with fresh water, which remains in situ until the next use.

Typically the conductivity will read lower than expected due to contamination of the cell and calibration against bottle salinities is required. During the cruise we drew fifty-one samples from the non-toxic supply on the upstream side of the SBE45. Usually samples were drawn every four hours when underway but rarely between the hours of 0000 to 0600. The salinity samples were drawn and analysed as reported in section 11.4. Sample salinities were entered into an EXCEL spreadsheet, `tsg_di344_001.csv`, with seven columns containing: salinity sample bottle number, day of year, hour, minute, second, time in seconds from start of year, salinity. (i.e. *time* = *julian day* x 86400 + *hr* x 3600 + *min* x 60 + *sec*). This file was transferred to *nosea1* and processed using some mexec scripts written during this cruise.

By investigation a linear fit in time of the bottle minus TSG conductivities seemed the most reasonable correction. The fit is

$$cond\_corr = 2.4543 \times 10^{-9}\, t - 0.07596$$

where time, t, is measured in seconds. Conductivity residuals have zero mean with standard deviation of 0.0028 S/m (which is about 0.028 psu) (Figure 14.2). The TSG conductivities before correction are around 0.011 higher than the bottles, but the difference decreases with time and may indicate that the conductivity cell became progressively fouled during the cruise.

Figure 14.1 *Hull of RRS Discovery during dry-dock. The TSG intake pipe in the centre of the figure projects down below the hull by about 0.5m and has a forward facing chamfer. The intake is located in the forward hold, starboard side. Photography courtesy of Paul Duncan.*

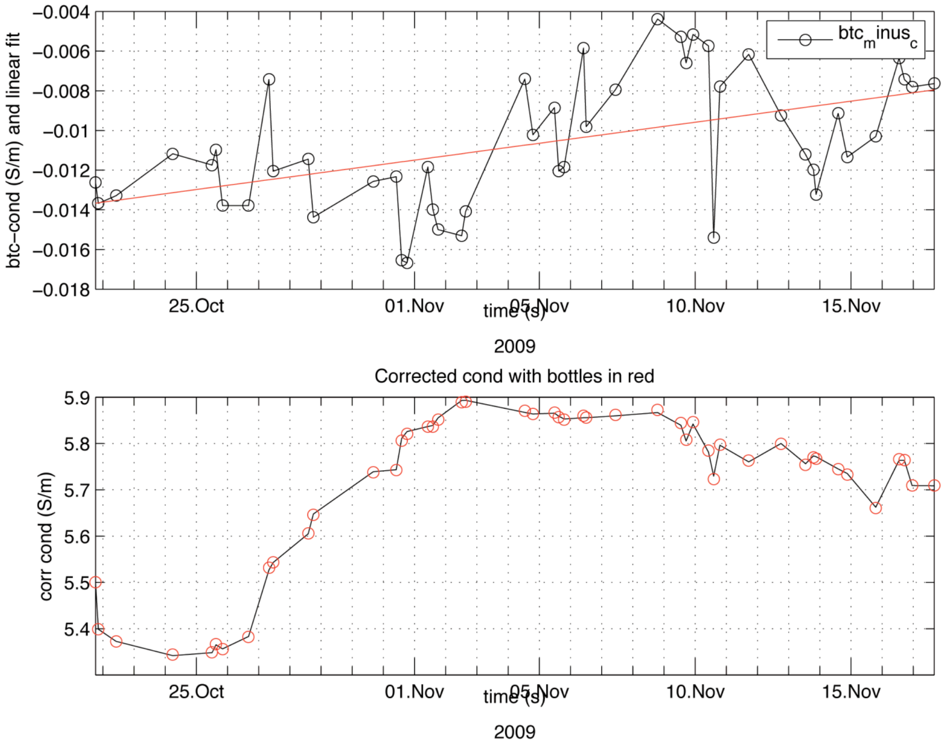


Figure 14.2 *Top panel shows bottle conductivities minus TSG conductivities plotted as a function of time with a linear fit (red). The lower panel shows the corrected TSG conductivities overlaid by the bottle conductivities (red circles).*

`mtsg_01`	read tsg sample times and salinities from csv file and save in mexec nc file format. File in: `tsg_di344_001.csv`, File out: `tsg_di344_001.nc`.
`mtsg_02`	merge TSG data onto sample file and datpik reasonable values of btc-c. File1 in: `tsg_di344_001.nc`, File2 in: `tsg_di344_01.nc`, File out: `tsg_di344_001_merge.nc`.
`mtsg_03`	Fits a first order polynomial to btc-c as a function of time. File in: `tsg_di344_001_merge.nc`.
`mtsg_04`	Apply conductivity calibration, compute surface salinity, merge on lat and long from gps4000 file, datpik data on temperature, salinity and time, median despike the salinity and finally average to 10mins. File in: `tsg_di344_01.nc`, File out: `tsg_di344_01_cal.nc` and `tsg_di344_01_cal_av.nc`.
`mtsg_05`	Plot finally calibrated near surface salinity. File in: `tsg_di344_01_cal.nc`.

Near surface salinity and temperature is plotted against date (Figure 14.3) and longitude (Figure 14.4). Salinity samples for calibration are distributed throughout the timeseries and the data record from the TSG has been truncated in time to lie within the dates of bottle sampling. Near surface temperature is lowest in the eastern Atlantic and highest on the west. Salinity, in contrast, while low near the eastern boundary, is maximum around 35°W in the middle of the eastern Atlantic basin. Low salinities and weak zonal gradients exist from 58° to 79°W.

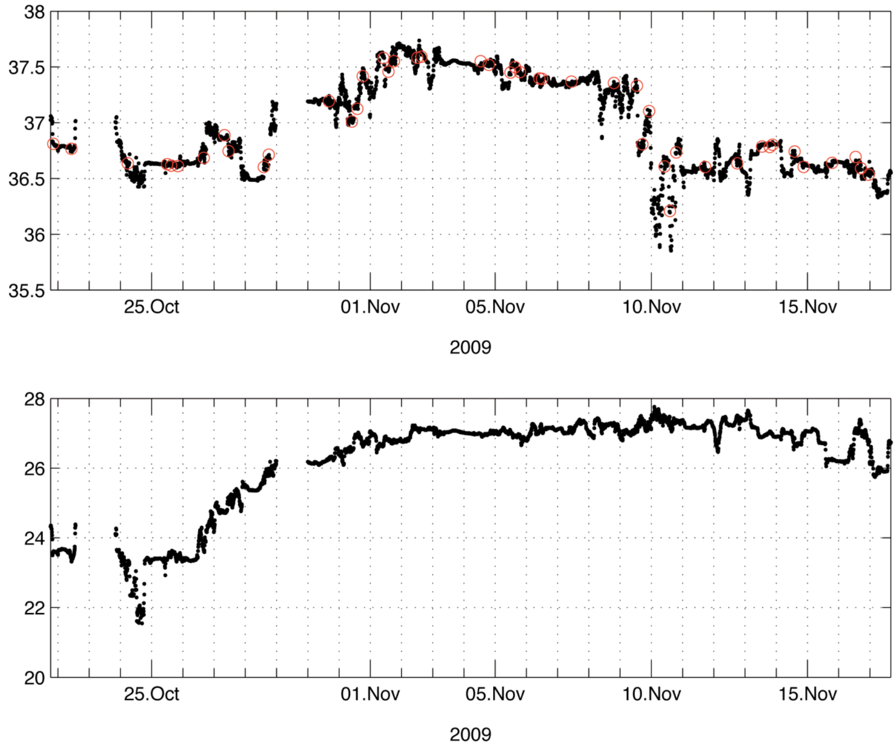


Figure 14.3 *10-minute average near surface salinity (top panel) and temperature (bottom panel) plotted against date. Red circles are bottle salinity values.*

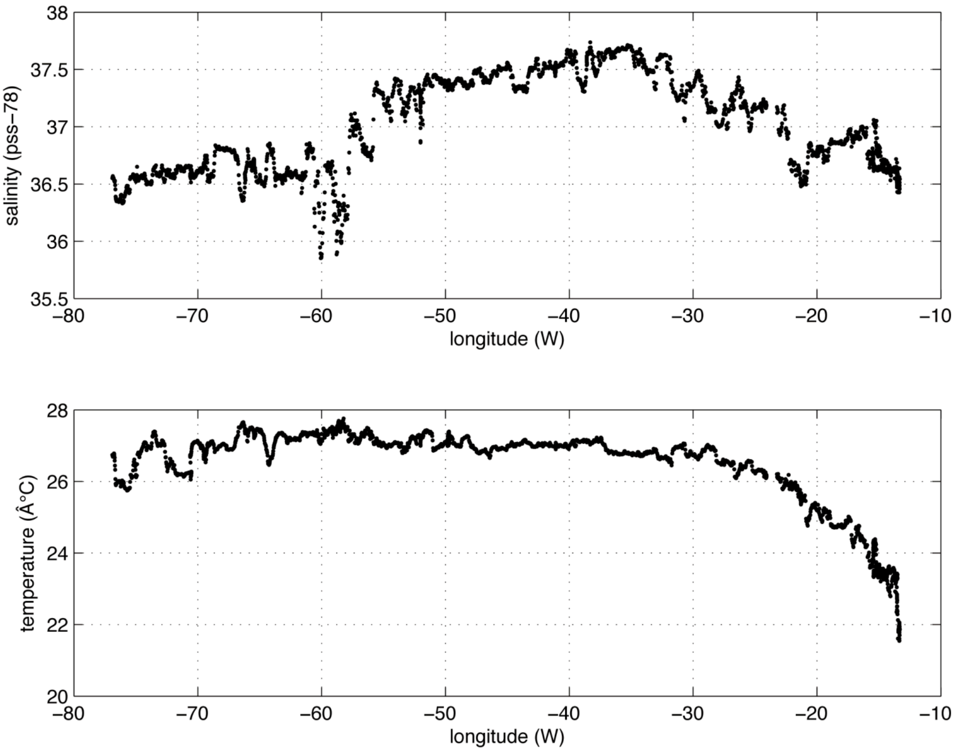


Figure 14.4 *10-minute average near surface salinity (top panel) and temperature (bottom panel) plotted against longitude.*

15 Bathymetry

Darren Rayner

The bathymetry system used aboard *RRS Discovery* for this cruise consisted of a Simrad EA500 hydrographic echosounder with precision echosounding transducers mounted in the hull and a towed fish (see section 8.5 for a description of which transducers were used). Data are logged to the Techsas computing system with subsequent processing completed using MEXEC Matlab routines.

Data from the Techsas stream are collated into single files for each day of the cruise (see section 10.2) with the file naming following the convention `sim_di344_dnnn.nc` with *nnn* the appropriate day number. The following processing steps were then completed:

1. Daily file is backed up to create file for editing. Produces `sim_di344_dnnn_edit.nc`
2. In Matlab the Mexec routine *mplxyed* is run with the independent variable being time, and the dependent variable being depth (named "snd" in the NetCDF file for this cruise). Bad data are manually selected using the data selection crosshairs, and replaced with NaNs. NB: the variable *ans* output to the Matlab workspace when first running *mplxyed* can be used as the plot description file for subsequent use. For ease this variable was saved to a `.mat` file, which can then be loaded to the workspace before subsequently running *mplxyed*. On this cruise the saved file was called `di_344_sim_pdf.mat`. The pdf file contains a variable for the input file, so this needs to be changed for each day once the pdf file is loaded and prior to running *mplxyed* (use the command *d344_sim_pdf.ncfile = sim_di344_dnnn_edit.nc* with *nnn* replaced accordingly).
3. Run *msim_01.m*, which reads in the edited file output from *mplxyed*, merges the navigation data from the concatenated navigation file for the whole cruise, applies a Carter correction to the raw depth data, and averages into 5 minute files. Produces `sim_di344_dnnn.nav` and `sim_di344_dnn.5min`.

16 Mooring Operations

Steve Whittle

Table 16.1 summarises mooring deployments with positions and times.

16.1 Diary of events

Note: all times are recorded in GMT. The recovery start/finish times are when the first and last part of mooring hits the deck respectively, similarly with the deployment, when top float and the anchor hit the water.

17th October
Started the mobilization, including unloading containers shore side and bolting the winches and deck hardware in place.

18th October
Connected all winches into ship's hydraulic deck supply and ran up to check operation. Unpacked and set up labs for instrumentation and checked instruments. Wound on moorings EBH4 and EBH5, also started to sort rope moorings into baskets for deployment, these were EBH1, EBH2, EBH3.

19th October
Last minute adjustments to placing of cages and anchors boxes. Wound on mooring EB1, also mooring EBHi's rope was put into baskets for deployment. Built four of the mini-moorings. Rhys Roberts had to cut counting sheave framework down in height as it was thought that it was too high for the Hydraulic DB winch system and shackles and links may get caught in deployment. Instrument preparation.

20th October
Joined ship 08:00. After moving cages yesterday the GP winch was reconnected to the ships deck hydraulic system. Built glass spheres for the deployment of EBH moorings. Instrument preparation.

21st October
Ship sailed 09:00.
Wound on MAR1 mooring onto large reeling winch.
First CTD cast at 12:14 from port, second CTD cast had to be aborted at 300m depth with termination problems, new termination done by John Wynar and Paul Duncan. On the second attempt alarms again went at 300m depth and it was decided to cut a further 300m from CTD cable, there was also a problem with the CTD deck unit.

22nd October
CTD in the water at 04:23 and all went to plan. After the CTD cast it was found that the ships radar was not working so a break from science for a port call at Las Palmas for a fix.

23rd October
Sailed at 19:00 with dispensation from MCA concerning the radar. A 500m CTD cast at 21:20 for release test for six of the release units for mini-moorings, four out of six

worked for required depth ratings and the CTD was onboard by approx 23:00. Transited to EBP2 mooring site for the following days recovery.

24th October
Arrived on station at approx 07:59, recovered EBP2. Transited to recover EBH4 at 09:27, all onboard by 10:11hrs. Transit to recover EBH5 at 1105, all completed by 11:39, steamed to next station to recover mini-moorings EBM1, EBM4, EBM5 and EBM6. EBM5 did not respond to release commands, and was lost. The mini moorings were then deployed. Transited to next station to deploy EBH5, started at 19:00 and completed by 20:10. Transit to EBH4, started deploying at 20:57 and this was completed by 21:47. In the mean time Chris Crowe had been working on EBP2 and was not successful in getting the glass sphere to seal, it was then decided to make a new mooring EBL5 as a replacement. This was manufactured ready for deployment next day.
Deck cleared by 23:00.

25th October
Deployed lander EBL5 at 09:00. Recovered EBH3 at 11:21 and completed by 11:50 then straight into a deployment of same mooring which was started at 12:34 and completed at 12:56. Transited to EBH2 site for a recovery which started at 16:20 and was completed at 16:42, then again straight into a deployment which was started at 17:11 and completed at 17:26. Transited overnight to next station.

26th October
Recovered EBH1 at 07:41, which was completed by 08:00. Then deployed same mooring, which was started at 0841 and completed at 09:12. Short transit to next station, which was the lander EBL4, this was recovered by 10:37 and then deployed by 10:54hrs. Hove to after mooring operations waiting for further dispensation from MCA, again concerning ships radar, this was given at approx 15:00 so steamed ahead with science program and the transit to mooring station EBHi. In the meantime the deck crew manufactured the glass for moorings EB1 and EBL3.

27th October
On transit. Ships chiller unit turned on for NOG sediment trap samples. CTD cast near to midnight.

28th October
Two CTD casts for release and calibration dips during the night. Started the recovery of the EBHi mooring at 11:50 and completed by 12:18. The deployment of the new EBHi mooring was started at 12:48 and all complete by 13:26. Also extra weight was added to the CTD frame by means of transferring the lead weights from the spare CTD frame.

29th October
Recovered lander EBL3 at 08:00. Then steamed short distance to recover mooring EB1 at 10:44. This mooring was recovered with a few tangles but nothing to worry about, and was completed by 13:52. On changing over to the second recovery drum during the EB1 recovery, one of the bolts holding down the drum bearing block on the small reeling winch was found to have stripped threads. We continued with the recovery and at the end of operations it was decided to drill out all tapped holes and

replaced them with nuts and bolts as this seems to be a problem on these winches. Next operation was the deployment of the lander EBL3, which was completed at 20:19.

30th October
Set deck up for the deployment of mooring EB1, which was started at 10:07 and was completed at 13:54 then steamed for approx four days to the MAR mooring sites.

31st October
Built the glass for mooring MAR3 and lander MARL3. Sorted ropes into deployment baskets for moorings MAR0 and WB6. Serviced release units.
Halloween B-B-Q on deck tonight.

1st November
Wound on MAR3 and NOG sediment trap moorings. Serviced release units.

2nd November
Wound on mooring MAR2. Built glass for NOG sediment trap mooring. Serviced release units. CTD cast for release and cal dips.

3rd November
Arrived at the MAR3 mooring site, started recovery at 10:40, the mooring came aboard with a few tangles but nothing too bad. This was done in force 5-6 winds and rough seas and was completed at 12:11. Due to the weather conditions it was decided to postpone the deployment until the weather had died down. We still managed to recover the lander MARL2 at 14:04 and deployed the same lander at 15:58. Built glass for mooring MAR2. CTD cast for cal dips.

4th November
The weather was better today for deploying mooring MAR3, this was started at 10:25 and completed at 12:28. This mooring was towed for approximately 35minutes. Transited to NOG sediment trap mooring for recovery, this mooring was started at 14:48 and completed at 15:34. During the recovery of this mooring the length of rope under the second trap which was three lengths of 500m and two lengths of 250m had become tangled around the top of the first trap as the buoyancy packages came quite close together during recovery. Although this did not cause too many problems on recovery we did have to use both cleats on port and starboard crane pedestals and the 200m length of rope under the last package of glass which connect to the release had to be cut to enable the recovery to continue. This mooring was then deployed and started at 16:53 and completed at 17:55. Transited for approx 48 hours to MAR 2 mooring site.

5th November
Built glass for moorings MAR1 and MAR2, also built lander MARL1. Serviced releases to put onto the CTD frame for test dips.

6th November
Arrived on station for recovery of MAR2, on first ranging at 12:13 it seemed that all was well. The mooring was in position and the command was sent to release, this came back as "Released OK", however, on transmitting the arm code to work out the

assent rate it was found that the mooring had not moved from the sea bed. The diagnostic command was sent and confirmed that the release was horizontal, this was checked three times with the same reply each time. This could only mean one of two things; a major glass implosion along the whole mooring which seemed very unlikely or that the mooring had parted just above the release. MAR2 was declared a total loss. It was then decided to move onto MARL1 site to recover the lander.

This was released and recovered at 14:49 and was onboard by 14:55. It was then decided to recover MAR1 mooring to make sure of a return of instrumentation, this recovery started at 16:41, although this mooring came up tangled in parts and sometimes had three or four wires coming in at a time it was no major problem for the moorings team and was all recovered by 20:02. As the MARL1 lander did not take long to build it was decided to deploy the lander straight after MAR1 mooring, and this was deployed at 21:13. CTD cast overnight.

7th November
First deployment of the day was the MAR1 mooring, after setting up the deck we started deployment at 11:22. The deployment went smoothly and the complete mooring was in the water by 14:33, it was then towed into position and the anchor away at 14:50, this was then ranged down and a diagnostic command showed the mooring in an upright position with nothing above the surface. The position was triangulated. While this was happening the deck was set up for the deployment of the replacement MAR1 mooring, the 10m and 20m lengths of 3/16" at the bottom of this mooring were removed on deployment and a 30m length of nylon braid was added under the release as a shock line, this mooring was completed at 20:30. Transited to MAR0 overnight.

8th November
Arrived in the morning and started recovery of MAR0 mooring at 10:45, again only a small tangle on recovery and this mooring was completed at 11:15. After this it was a CTD cast for release and cal dips, while this was going ahead we inspected and built glass for moorings MAR0 and WB6. After the CTD cast it was into deployment of MAR0, this was started at 17:11 and completed by 17:34. Now we began the long transit to the WB6 mooring site.

9th November
Inspected the rest of recovered glass, weather not so good.

10th November
Wound off the rope from MAR0 from steel reeling drums onto the wooden ones, also marked the rope for the WB6 mooring. Started dismantling tripods, some packing and getting equipment ready for next leg.

11th -14th November
Completed some packing, serviced some release units, started writing up the equipment list for demob. Set up drum for recovery of WB6 mooring. Composed the "Sea and Air Freight" list, continued packing and servicing equipment.

15th November
Recovery of WB6 started at 16:43 and was all on board by 17:11 with no problems, this was a quick turn round in getting the deck ready for deployment, which started at 17:46 and was completed at 18:02. Transited to CTD station.

16th November
Inspected the glass recovered and continued with packing up equipment, on transit to WB-CM mooring site.

17th November
Recovered the WB-CM mooring at first light, 12:12, and all on board by 12:43, two of the glass had imploded in the top buoyancy package, otherwise a straight-forward recovery. Broke down the glass, continued with the ongoing packing and headed to Freeport. Another RAPID cruise over and nearly a 100% record but not quite - sadly.

16.2 Mooring Table

The mooring table was used at the start of D344 on mooring numbers EBHi, EBH1 to EBH5. After, I decided to change over to stopping off on the deck on all other moorings during the cruise, this was just a personal preference because of longer streams of glass buoyancy. I thought it would be quicker and easier for recovery and deployment.

16.3 Lost Instruments and Hardware

Two moorings, MAR2 and EBM5 were lost with the following instrumentation and associated hardware.

Mooring	Instruments	Serial numbers	Hardware	Quantity
MAR2	MicroCATs	6130	Billings Float	1
		6131	Glass buoyancy	28
		6132		
		6133		
		6134		
		6135		
		6136		
		6109		
		6110		
		6111		
	S4	35612567		
	Release AR861	914		
	Light	H01-008		
EBM5	MicroCAT	3208	Trimsyn float	1
	LRT Release	252343-005	Mast Assembly	1
	VHF Beacon	W03-114	12” Glass buoyancy	2

Table 16.1 *Instruments and hardware lost during D344*

Mooring	NMFD-ID	Cruise	Anchor Drop		Anchor Triangulation		Fallback	Depth	Date	Time	Duration	Argos IDs	
			Latitude N	Longitude W	Latitude N	Longitude W	(m)	(m)		(GMT)	(hrs)	1	2
EBM6	2009/23	D344	27° 55.27′	13°19.99′	-	-	-	103	24 Oct	15:47	0:02	-	-
EBM5	2009/24	D344	27° 54.67′	13° 21.65′	-	-	-	206	24 Oct	16:38	0:02	-	-
EBM4	2009/25	D344	27° 54.49′	13° 22.19′	-	-	-	291	24 Oct	16:59	0:02	-	-
EBM1	2009/26	D344	27° 53.67′	13° 24.36′	-	-	-	496	24 Oct	17:36	0:03	-	-
EBL5	2009/27	D344	27° 52.09′	13° 30.87′	-	-	-	1005	25 Oct	09:11	0:04	-	-
EBH4	2009/28	D344	27° 51.01′	13° 32.38′	-	-	-	1055	24 Oct	21:47	0:50	-	-
EBH5	2009/29	D344	27° 50.50′	13° 32.75′	-	-	-	1055	24 Oct	20:09	1:08	-	-
EBH3	2009/30	D344	27° 48.47′	13° 44.80′	-	-	-	1414	25 Oct	12:56	0:18	-	-
EBH2	2009/31	D344	27° 36.71′	14° 12.73′	-	-	-	2023	25 Oct	17:27	0:16	-	-
EBH1	2009/32	D344	27° 17.13′	15° 25.73′	-	-	-	3003	26 Oct	09:12	0:31	-	-
EBL4	2009/33	D344	27° 17.17′	15° 25.76′	-	-	-	3001	26 Oct	10:54	0:04	-	-
EBHi	2009/34	D344	24° 56.81′	21° 15.78′	-	-	-	4471	28 Oct	13:26	0:38	-	-
EB1	2009/35	D344	23° 45.34′	24° 09.25′	23° 45.30′	24° 09.49′	417	5093	30 Oct	13:54	3:47	60211	-
EBL3	2009/36	D344	23° 48.77′	24° 06.41	-	-	-	5053	29 Oct	20:19	0:01	-	-
MAR3	2009/37	D344	23° 52.24′	41° 05.29′	-	-	-	5056	4 Nov	12:28	2:03	-	-
MARL2	2009/38	D344	23° 57.95′	41° 05.56′	-	-	-	5014	03 Nov	15:58	0:03	-	-
NOG	2009/39	D344	23° 46.29′	41° 05.85′	-	-	-	4261	4 Nov	17:54	1:54	-	-
MAR1	2009/40	D344	24° 10.14′	49° 43.00′	24° 10.32′	49° 43.17′	440	5214	7 Nov	14:50	3:28	-	-
MARL1	2009/41	D344	24° 12.02′	49° 44.26′	-	-	-	5227	6 Nov	21:13	0:13	-	-
MAR2	2009/42	D344	24° 10.98′	49° 44.58′	-	-	-	5221	7 Nov	20:30	2:52	-	-
MAR0	2009/43	D344	25° 06.35′	52° 00.62′	-	-	-	5508	8 Nov	17:34	0:23	-	-
WB6	2009/44	D344	26° 29.68′	70° 31.30′	-	-	-	5516	15 Nov	18:02	0:16	-	-

Table 16.2 *Mooring deployment summary (taken from deployment log sheet recorded data)*

17 Changes to the Mooring Array

Darren Rayner

There were only a few minor changes to the array and mooring designs for the 2009-2010 deployment.

The pressure recording inverted echosounder (PIES) at EBP2 was recovered with the intention of servicing and redeploying it. However the glass housing would not seal correctly and the unit could not be redeployed. Instead an additional lander equipped with a bottom pressure recorder (BPR) was prepared. This replacement lander was called EBL5 and was deployed to maintain continuity of the bottom pressure measurements at this site.

Following problems with BPRs for the last couple of deployments (e.g. low-pressure floods, battery depletion, sensor failures), it was decided to double up the instruments on the MARL2 lander and the WB6 and MAR0 moorings. The decision was made after EBL4 and EBL5 had been deployed so these landers were not doubled. MARL4 also had dual acoustic releases fitted instead of a single release as used during previous deployments.

18 MicroCAT Processing

Paul Wright

18.1 Introduction

Processing of the MicroCAT data was done aboard the ship as soon as the instruments were recovered. Paths refer to the normal starting directory `rapid/`. For D344 the base directory on the UNIX box, also named “rapid”, was `/local/users/pstar/Data/rpdmoc/`.

An ‘`info.dat`’ file was created for each mooring that lists the metadata for each mooring, i.e. target depth of each instrument, its type and its serial number. The RCMC numbers refer to the conductivity ranges on the RCM11 current meters – not used on this cruise.

310 – RCM11 Current meter
337 – SBE 37 MicroCAT CTD
465 – SBE 53 or SBE 26 BPR
302 – S4 Current meter
366 – Sontek Argonaut Current meter
368 – Nortek Aquadopp Current meter
369 – TRDI DVS Current meter
327 – TRDI ADCP

The path for the moorings info.dat file is

rapid/data/moor/proc/*mooring*/*mooring*info.dat

where *mooring* refers to the full mooring name. A subdirectory, named `microcat/`, was created in each mooring directory for the processed MicroCAT data,

rapid/data/moor/proc/*mooring*/microcat/

```
Mooring           = ebh4_6_200837
Latitude          = 27 51.00 N
Longitude         = 13 32.39 W
WaterDepth        = 1052
MagDeviation      = -5.2
StartDate         = 2008/11/19
StartTime         = 18:41
EndDate           = 2009/10/24
EndTime           = 09:03
Columns           = z:instrument:serialnumber:RCMC1:RCMC2
   325   337   4307     -999  -999
   400   337   5238     -999  -999
   500   337   5240   -999    -999
   600   337   5239     -999  -999
   700   337   5242     -999  -999
   800   337   5241     -999  -999
```

Figure 18.1 *Example of an info.dat file, the RCMC1/2 columns refer to conductivity ranges for the RCM11 current meters (-999 is the dummy variable)*
Path – *`rapid/data/moor/proc/ebh4_6_200837/ebh4_6_200837info.dat`*

18.2 Stage 0 - Download

Raw instrument data are downloaded from the older MicroCATs using SeaBird's SeaTerm software and saved as ASCII files. Details are recorded on paper and kept for reference. After downloading, the files are transferred to:

```
rapid/data/moor/raw/d344/microcat/5238_data.asc
```

using a filename based on their serial number (in this case `5238_data.asc`).

For the newer 6000 series of MicroCATs it was discovered that the older version of the SeaTerm software misses a line of data every time it completes a block of 220 lines. The newer SeaTermV2 software downloads the data in .xml format, which is then converted to .cnv format using the 'tools' menu (see section 18.6).

18.3 Stage 1 – Conversion to the .raw RDB format

Stage 1 processing converts the data for all the MicroCATs on each mooring from the manufacturers ASCII or cnv format to the RAPID RDB standard. i.e. header information, a standard date and time format and SI units rather than imperial. The script was modified by Darren Rayner to convert the .cnv files of the newer 6000 series MicroCATs.

The MATLAB script `mc_call_2_003.m` runs the conversion function `microcat2rodb_3.m` as a batch file for each mooring. The script will need editing for the specific mooring being processed, as the name and paths are hard coded into the script at the beginning. It uses the relevant `info.dat` file to select the instruments that it needs, therefore it is critical that the `info.dat` files accurately reflect the instruments, positions and times of deployment. For ease of use, a MATLAB startup file was set up in `exec/d344/`, which established the necessary paths to enable all processing to take place, avoiding older versions of functions.

```
rapid/data/exec/d344/stage1/microcat/mc_call_2_003.m
```

The script opens the files and converts them to .raw files. It also produces summary plots of the data and creates a `stage1_log` file, which records a summary of the operations carried out. Output .raw files are stored in:

```
rapid/data/moor/proc/mooring/microcat/
```

where *`mooring`* is the unique mooring name. e.g.

```
rapid/data/moor/proc/ebh4_6_200837/microcat/
ebh4_6_200837_5238.raw
```

The plot is stored as a postscript plot:

```
rapid/data/moor/proc/ebh4_6_200837/microcat/
ebh4_6_200837_5238.raw.ps
```

18.4 Stage 2 – Trimming of Data Record, Basic Statistics and Summary Plots

Stage 2 processing removes the launching and recovery periods of the data, calculates the basic statistics and produces summary plots including 2-day low pass filtered data. The data is still uncalibrated. The file is converted from *`mooring_serialnumber`*`.raw` file to *`mooring_serialnumber`*`.use` file using the MATLAB script `microcat_raw2use_003.m`.

```
rapid/data/exec/d344/stage2/microcat/
microcat_raw2use_003.m
```

There are a few things that need to be changed in the header of the MATLAB script.

- The variable 'moor' needs to changed to the mooring name (e.g. ebh4_6_200837)
- The 'operator' needs to be changed (e.g. PW)
- The 'plot interval' changed to make the output summary plots fit - generally the period enveloping the deployment period is fine.
- The paths need to be adjusted to match the directory structure of the cruise.

The output files are placed in the following:

```
rapid/data/moor/proc/mooring/microcat
```

e.g.

```
rapid/data/moor/proc/ebh4_6_200837/microcat/
ebh4_6_200837_5238.use
```

Three files are produced for each instrument:

`ebh4_6_200837_5238.use`	A data file of the truncated time series data
`ebh4_6_200837_5238.use.ps`	A postscript plot of the truncated conductivity, temperature and depth time series
`ebh4_6_200837_5238.use_lowpass.ps`	A postscript plot of the truncated and 2-day low pass filtered time series

The plots and files produced are carefully inspected for record length, gaps, spikes, drift and other irregularities such as bad conductivity readings (see Appendix B). Occasionally it was necessary to edit the deployment times of a mooring in the `info.dat` file and re-process the data to remove the deployment spikes. This can occur when the instruments log some data between the time of the recorded anchor drop and reaching the bottom.

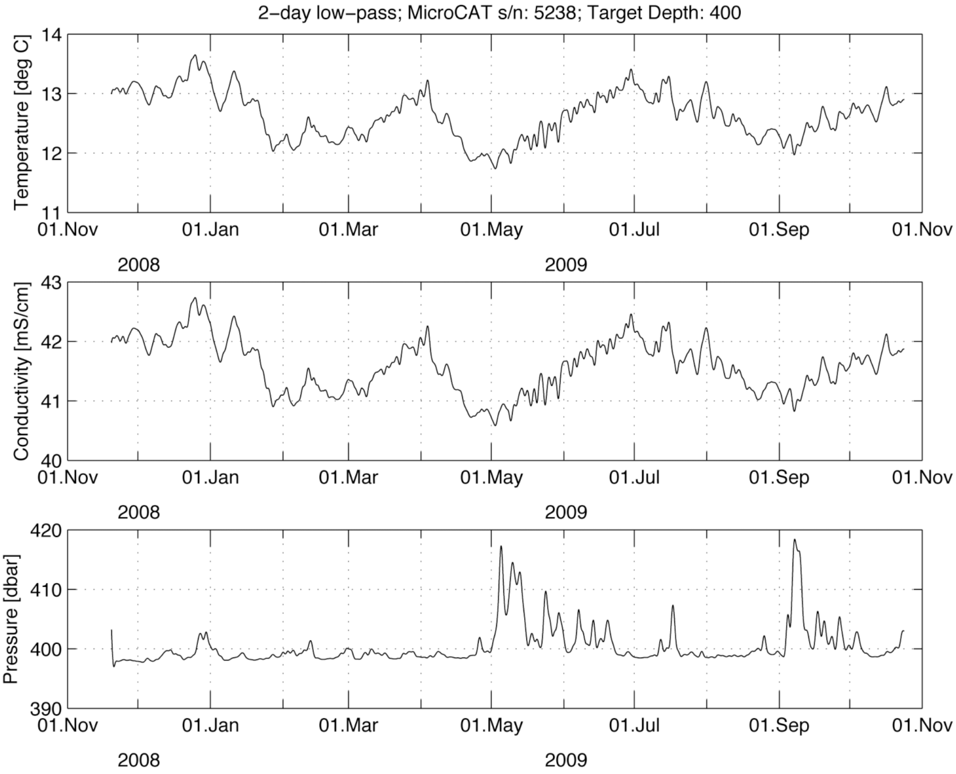


Figure 18.2 *Low-pass filtered data for ebh4_6_200837_5238.use*

18.5 Calculation of MicroCAT Battery Endurance

Following unexpected and repeated delays with cast 2, 12 pre-deployment MicroCATs were left logging in a bucket of fresh water while the CTD was being worked on. As casts kept being started and then aborted due to problems with the cable, the MicroCATs were unclipped from the CTD frame and placed in a large bucket of water to ensure that the conductivity pumps did not run dry. Overall they were logging for a total of 19 hours at 10-second intervals. This initially caused some concern as to whether the batteries would last on a mooring up to a possible contingency of 18 months. Based on the SeaBird manual, the lithium batteries have a nominal capacity of 10.6 Amp-hours, although they recommend using a lower value of 8.8 Amp-hours for conservative planning purposes.

There are three current values:

- Sampling current, I_s – with pressure sensor this is 0.013 A over a 2.4 s period.
- Pumping current, I_p – the ctd pumps seawater through in a single pulse at 0.26 Amp-seconds per pulse.
- Quiescent current, I_q – the base loading of the instrument of 0.11 Amp-seconds/hr.

This led to a total usage in 19 hours of 1,992.5 A-secs or 0.55 A-hrs out of 8.8 A-hrs, leaving a further 4.9 years battery life at the mooring sample rate. Therefore, the batteries were not changed.

	RAPID [Amp-sec/hr]	CAL-DIP [Amp-sec/hr]	RAPID [%]	CAL-DIP [%]
Sampling	1800 s	10 s	-	-
I_s	0.062	11.16	8.96	10.6
I_p	0.52	93.6	75.1	89.3
I_q	0.11	0.11	15.9	1.05
Total	0.692	104.87		
Endurance	5.2 yr	12.6 days		

Table 18.1 *Lithium battery endurance based on data from SeaBird*

18.6 Instrument Problems

Darren Rayner

The newer 6000 series MicroCATs that are installed with firmware version 3.0 and greater miss data when downloading ASCII files using the usual SeaTerm software. This has something to do with the change in the download blocks. eg. dd1,220 etc. Every 220th record is skipped. This has not been previously noticed on CTD calibration dips but shows up during the low-pass filtering in the stage two processing of mooring data as missing date/times is filled with -9999 which, when filtered, causes a spike and because of the regularity of the gaps it causes regular spikes in the filtered time series.

There are two solutions. The first is to download using the newer SeaTermV2 software, which is designed for the newer firmware. The trouble is that it doesn't download in the same format. It downloads in .xml format, which the software can convert to .cnv files that have a different header and timestamps. At the conversion stage it is important to set the timing to "output data with seconds since 1st Jan 2000". The stage 1 processing code, `mc_call_2_002.m`, was modified to `mc_call_2_003.m` and `microcat2rodb_2_002.m` to `microcat2rodb_3.m`. These codes read in the .cnv format files and output in the RBD format as before.

The second solution was used when a further problem occurred. When there is corrupted data the new software cannot successfully complete a download from the MicroCAT. This occurred with three MicroCATs.

6137 – corrupted data for 17 days
6121 – corrupted data between pre-deployment cal-dip and subsequent deployment
6128 – refused to download in xml format for no discernable reason.

The ASCII files were downloaded twice from each MicroCAT, using the older software, with a 10-sample separation. The two files were then merged to fill in the gaps every 220 lines. The corrupted section on 6137 between 22 May and 8 June 2009 was set to the dummy variable of -9999.

19 Calibration Dips

Paul Wright

19.1 Processing

Up to 14 MicroCATs were clipped or bolted to a CTD frame and dipped before and after deployment for calibration purposes. Additionally, by careful inspection of the pre-deployment dips, problems with MicroCATs can be detected, particularly with the conductivity cell (Figs 19.1 and 19.2). Instruments that are not functioning correctly are then removed from the mooring allocation. A total of 13 calibration dips were made. (see Appendix A for details of which MicroCATs were on which cast.)

The processing technique for pre and post deployment calibration is identical. The MicroCATs are set up using SeaBird's software on the Windows laptops. Recovered data are stored in:

```
rapid/data/moor/raw/d344/microcat_cal_dip/castX
```

where, X = number of the cast. As the gaps in the data are not important in this situation most of the 6000 series of MicroCATs, with the new firmware, were downloaded as ASCII files. For each cast an `info.dat` file was constructed containing the metadata, i.e. the serial number and instrument codes for each of the MicroCATs involved in the cast. The file names follow the pattern `castXinfo.dat` and are located in the `proc_calib` directory:

e.g. `rapid/data/moor/proc_calib/d344/cal_dip/cast11info.dat`

There is only one stage to calibration dip casts, following a similar pattern to the previous section. However, this depends on whether the CTD data have been made available or not. If there are no CTD data available, then a quick inspection can be carried out using the MATLAB script `mc_call_calib2_noCTD.m` (see Fig 19.1).

```
rapid/data/exec/d344/stage1/microcat/
mc_call_calib2_noCTD.m
```

In the script the paths header information need to be edited to match the current cruise and the cast number needs to be added (`'moor' = castX`). The script converts the ASCII or CNV data files into RODB format by calling the `microcat2rodb_3.m` routine. It produces plots of the temperature, conductivity and pressure for quick checks for consistency.

If the CTD data are available then the MATLAB code `mc_call_calib2_d344.m` performs the same tasks as before but adding the CTD data to the plots, based on the CTD file format and paths aboard *Discovery*. As work was done on the D334 and RB0901 data, another two codes were produced named `mc_call_calib2_d334.m` and `mc_calib2_rb0901.m`, again tailored to use each cruises files formats and path structure. (see Kanzow 2006 for details of the calibration dip procedure).

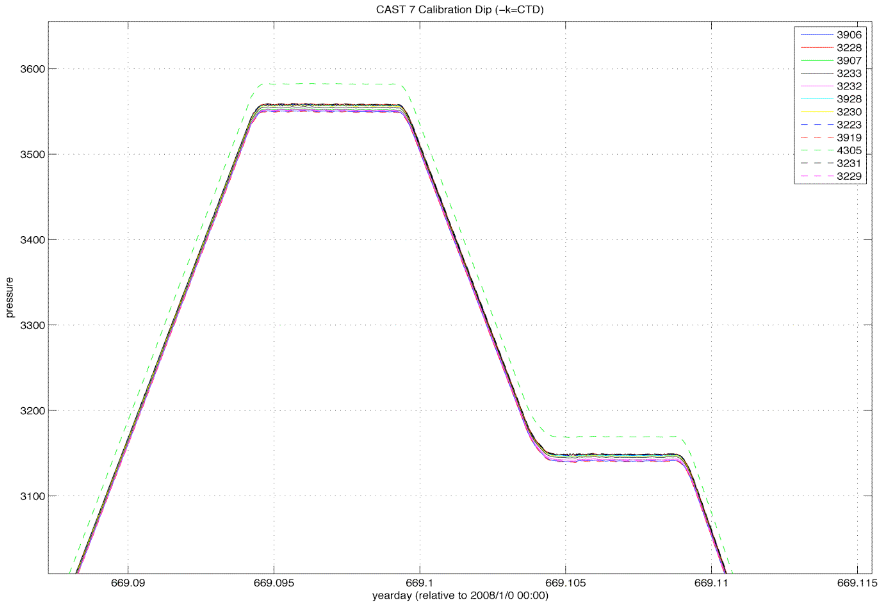


Figure 19.1 *Detail of a plot of the pressure calibration cast 7 from D344. The flat steps are the bottle stops. Note the large offset for instrument 4305.*

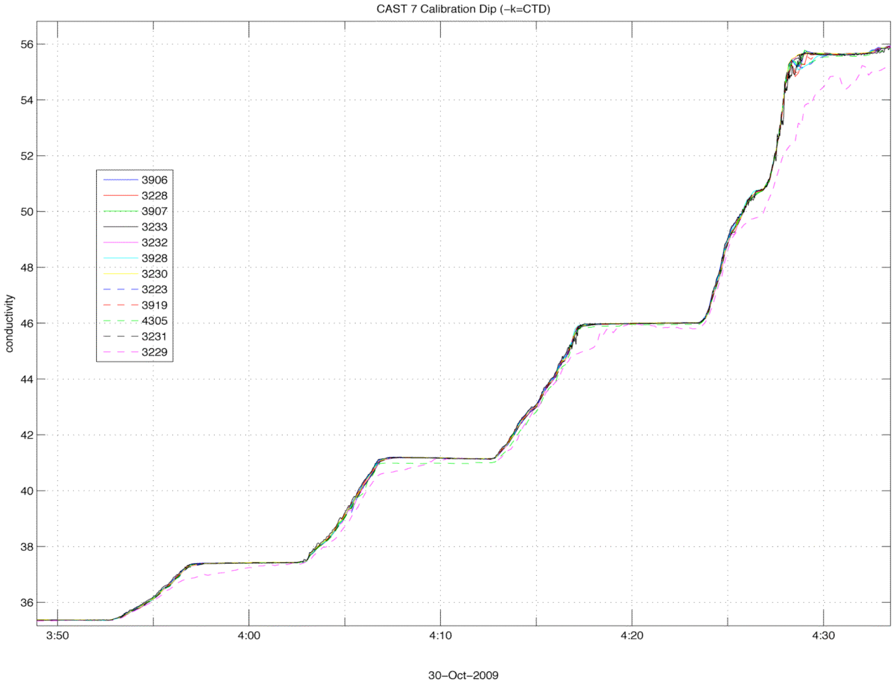


Figure 19.2 *Detail of a conductivity calibration dip cast bottle stop from cast 7. The problem with the conductivity cell pump on instrument 3229 stands out clearly. Closer inspection also shows that instrument 4305 is under reading the conductivity by approximately 0.05 mS/cm.*

19.2 Problems with the Calibration Dips

Cast 5: This cast had to be extended deeper than planned as the acoustic releases that were required for the next mooring had failed to respond on the previous cast.

Therefore MicroCATs 3207, 3212, 3213, and 3214 exceeded the pressure range of their pressure sensors, which required that the pressure data be unwrapped manually during the processing.

19.3 Testing the Relaxation Time of the Thermistor on the MicroCAT Pressure Sensor

David Ham

The MicroCAT pressure sensor reading is temperature dependent. To compensate, the sensor incorporates a thermistor and applies a correction to the measurements. The thermistor used to make this correction is distinct from the primary temperature sensor and is believed to be located with the pressure sensor. The correction is applied by the firmware installed on the MicroCAT itself so the results returned are corrected results. The correction made is as follows:

$$n = \frac{\left(p_{raw} - PTCA0 - PTCA1 \times t - PTCA2 \times t^2\right) \times PTCB0}{PTCB0 + PTCB1 \times t + PTCB2 \times t^2} \quad (19.1)$$

$$p_{corrected} = PA0 + PA1 \times n + PA2 \times n^2 \quad (19.2)$$

Where p_{raw} is the raw output of the pressure sensor in units not specified on the sensor calibration sheet, t is temperature in degrees Celsius and $p_{corrected}$ is the corrected pressure in psia. psia is converted to dbar using the formula:

$$p_{dbar} = \left(p_{corrected} - 14.7\right) \times 1.4503774 \quad (19.3)$$

The temperature used is obtained from the separate thermistor located near the pressure sensor inside the MicroCAT case and is related to the raw thermistor reading by the following formula:

$$t = PTEMPA0 + t_{raw} \times PTEMPA1 + t_{raw}^2 \times PTEMPA2 \quad (19.4)$$

The remaining symbols are calibration constants with example values given in Table 19.1.

During calibration casts on the CTD rig, the pressure reported by the MicroCAT has been observed to lag behind that reported by the pressure sensor on the CTD rig, especially when passing through the large temperature gradients in the upper ocean. The purpose of this experiment is to investigate whether this lag could be caused by the thermistor on the MicroCAT pressure sensor taking time to adjust to the ambient temperature in the water.

	MicroCAT 3890	**MicroCAT 6830**	**MicroCAT 6333**
PA0	0.000000E+0	1.635873E+1	0.000000E+0
PA1	0.000000E+0	6.484860E-2	0.000000E+0
PA2	0.000000E+0	-9.340258E-10	0.000000E+0
PTEMPA0	Not available	6.157386E+1	0.000000E+0
PTEMPA1	Not available	-3.209992E-2	0.000000E+0
PTEMPA2	Not available	4.098708E-6	0.000000E+0
PTCA0	0.000000E+0	5.207743E+5	5.231059E+5
PTCA1	0.000000E+0	1.609136E+1	0.000000E+0
PTCA2	0.000000E+0	1.435350E-2	0.000000E+0
PTCB0/PTCSB0*	0.000000E+0	2.624400E+1	0.000000E+0
PTCB1/PTCSB1*	0.000000E+0	5.300000E-3	0.000000E+0
PTCB2/PTCSB2*	0.000000E+0	0.000000E+0	0.000000E+0

Table 19.1 *Symbols and calibration constants for the three MicroCATs tested.*
**This parameter is marked PTCSB on older MicroCATs. These models do not report their pressure sensor thermistor calibration constants.*

19.3.1 Method

There are two different pressure sensors installed in the MicroCATs used by rapid. Older models have a Druck pressure sensor while the newer models use a Paine sensor. MicroCATs 3890 (Druck sensor) and 6830 (Paine sensor) were selected to be tested. The test consisted of taking the MicroCATs at ambient temperature and placing them in a bucket of iced fresh water for two hours. Figure 19.3 illustrates the experimental configuration. The temperature reported by the primary temperature sensor and the reported pressure were recorded every ten seconds for instrument 3890 and every six seconds for instrument 6830. In each case this is the maximum sampling rate supported by the instrument.

Figure 19.3 *The experimental configuration: two MicroCATs in a bucket of iced water.*

In this configuration, the MicroCAT does not report the raw output of the pressure sensor and the pressure thermistor. However, newer MicroCATs do have the capability to do this if the instrument is directly connected to a computer and the results returned in real time. For this reason, the experiment was repeated using MicroCAT 6333 (instrument 3890 is not capable of this form of output and instrument 6830 had already been deployed).

19.3.2 Results

Part I: MicroCATs 3890 & 6830

Figure 19.4 shows the reported pressure as a function of time for each MicroCAT in the first experiment while the temperature reported by the primary temperature instrument on each unit is shown in figure 19.5.

The large drop in temperature and corresponding increase in pressure at 2.85 minutes coincides with the MicroCATs being inserted into the water. The temperature record moves almost immediately (less than 1 minute adjustment time) to approximately 4°C for instrument 3890 and 0.25°C for instrument 6830. 4°C is the maximum temperature at the bottom of a bucket of iced fresh water. The lower reading for instrument 6830 may be attributable to pieces of ice being caught on the primary thermistor upon insertion.

The pressure initially overshoots and then relaxes over approximately 15-20 minutes to approximately steady values, although those for instrument 6830 are very noisy. Since the pressure some 20cm below the surface is far from that for which the instrument is designed, it is not possible to draw conclusions from the magnitude of the pressure overshoot. However, since the temperature change is of the correct magnitude, the time over which the instrument equilibrates is likely to be fairly accurate.

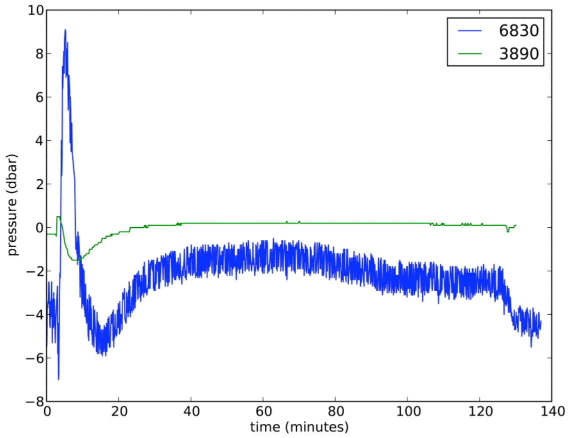


Figure 19.4 *Reported pressure for MicroCATs 6830 and 3890*

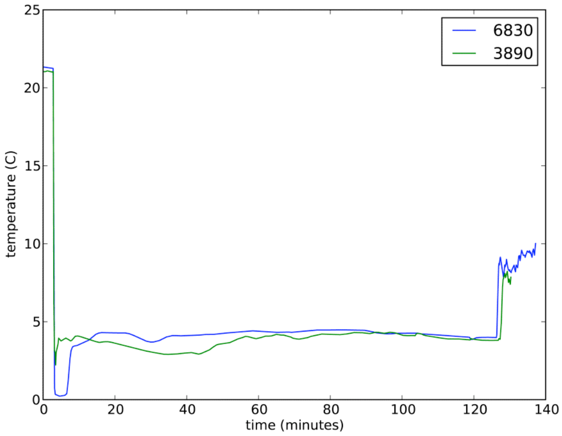


Figure 19.5 *Temperature recorded by the primary temperature sensor for MicroCATs 6830 and 3890*

Part II: MicroCAT 6333

For this instrument, the separate readings for the primary temperature sensor and the pressure sensor thermistor are directly available. These are shown in figure 19.7. The primary sensor adjusts to a near-zero temperature almost instantly. The movements in the intial few minutes may be caused by ice near the sensor once again. After this initial period, the temperature increases slowly, presumably as the ice melts and the water temperature near the thermistor converges on 4 degrees.

The pressure sensor thermistor takes approximately 20 minutes to converge to the primary sensor value and thereafter lags the primary sensor by perhaps the same amount. This lag would be consistent with the relative thermal isolation of this sensor.

This MicroCAT was configured to report the raw pressure reading (p_{raw}). This was used in the pressure equation (above) to calculate the pressure. The pressure was calculated using both the temperature reported by the pressure thermistor (this value would be the actual value reported by the instrument) and using the temperature reported by the primary temperature sensor. The results are shown in figure 19.6.

It is noteworthy that the initial spike in pressure reported using each of these methods is in opposite directions. There is then a spike upwards in pressure followed by a very slow adjustment to a quasi-steady state approximately 60 minutes after immersion.

Analytical solution

To investigate the likely magnitude of any pressure difference caused by the reported temperature differing from the in-situ temperature of the pressure sensor, we can derive the rate of change of pressure with respect to reported temperature:

$$
\begin{aligned}
\frac{dp}{dt} = {} & \frac{PA1 \cdot PTCB0 \cdot \left(-PTCA1 - 2PTCA2 \cdot t\right)}{PTCB0 + PTCB1 \cdot t + PTCB2 \cdot t^2} \\
& + \frac{PA1 \cdot PTCB0 \cdot \left(-PTCB1 - 2PTCB2 \cdot t\right) \cdot \left(p_{raw} - PTCA0 - PTCA1 \cdot t - PTCA2 \cdot t^2\right)}{\left(PTCB0 + PTCB1 \cdot t + PTCB2 \cdot t^2\right)^2} \\
& + \frac{PA2 \cdot PTCB0^2 \cdot \left(p_{raw} - PTCA0 - PTCA1 \cdot t - PTCA2 \cdot t^2\right)^2 \cdot \left(-2PTCB1 - 4PTCB2 \cdot t\right)}{\left(PTCB0 + PTCB1 \cdot t + PTCB2 \cdot t^2\right)^3} \\
& + \frac{PA2 \cdot PTCB0^2 \cdot \left(-2PTCA1 - 4PTCA2 \cdot t\right) \cdot \left(p_{raw} - PTCA0 - PTCA1 \cdot t - PTCA2 \cdot t^2\right)}{\left(PTCB0 + PTCB1 \cdot t + PTCB2 \cdot t^2\right)^2}
\end{aligned}
$$

This result can be used in combination with the pressure correction formula to calculate what the effect of a change in reported temperature is at a given pressure and temperature. The algorithm proceeds as follows: for a given temperature and pressure, the correction formula is inverted to produce a raw pressure reading. This value is then used along with the given temperature in the formula above to calculate the rate of change of pressure with respect to temperature at that temperature and pressure. Figure 19.8 shows this gradient calculated using the calibration values for MicroCAT 6333 for temperatures ranging from 0 to 20C and pressures ranging from 0 to 5000 dbar. It can be seen that the gradient is almost constant as a function of pressure but varies almost linearly (the contour interval is constant) from around -1.6dbar/°C at the surface to -2.4dbar/°C at 5000m. The gradient is always negative which means that if the temperature reported by the thermistor is too high, the pressure reported will be too low. For example, at a temperature of 5°C and a depth of 2000m, if the temperature reported by the pressure thermistor is 1° higher than the temperature experienced by the pressure sensor, this will result in a reported pressure which is approximately 1.7dbar too low.

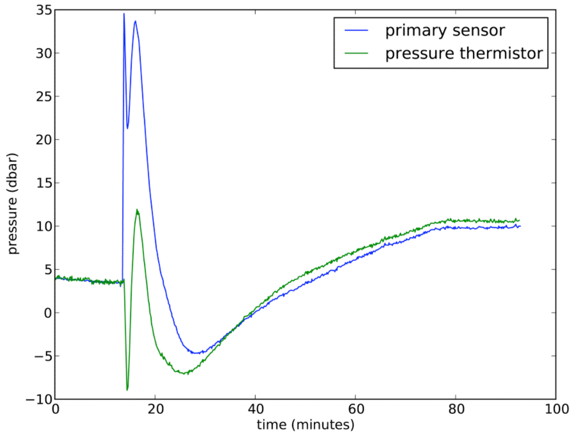


Figure 19.6 *Pressure calculated using the primary temperature sensor (blue) and pressure thermistor (green)*

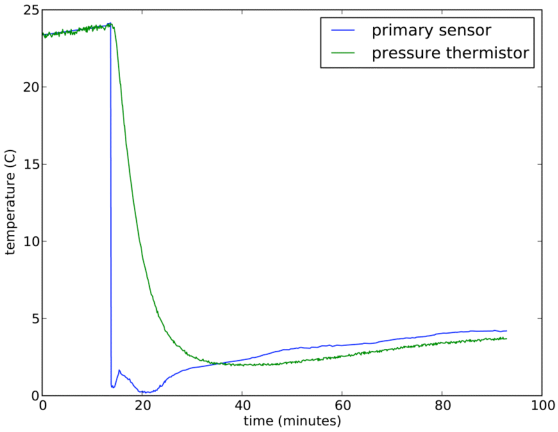


Figure 19.7 *Temperature recorded by the primary sensor and pressure sensor thermistor for MicroCAT 6333*

Returning to Figure 19.7, it is possible to use this information to diagnose the relative temperatures of the two temperature sensors in comparison to the temperature experienced by the pressure sensor. The initial spike upwards in pressure calculated using the temperature from the primary temperature sensor indicates that the primary temperature sensor was much colder than the pressure sensor. Conversely, the spike downwards in pressure calculated using the pressure sensor thermistor indicates that the pressure sensor thermistor was reading a warmer temperature than that experienced by the pressure sensor. These results seem physically reasonable. The pressure sensor and the thermistor are somewhat insulated from the outside conditions and would therefore read warmer than the primary temperature sensor which is mounted outside the MicroCAT case. The results also indicate that the thermistor reading lags behind the temperature actually experienced by the pressure sensor.

However, the results fail to fully explain the very long adjustment time exhibited by MicroCAT 6333. The temperature results appear to indicate that the instrument reaches thermal equilibrium after approximately 20 minutes, with the leading and lagging temperature indicators reporting essentially the same numbers.

19.3.3 Implications

In the deep ocean when the CTD frame is moving upwards, the temperature gradient is very small and the instruments will typically have been at approximately constant temperature for a number of hours. For this reason, temperature errors are unlikely to be significant. However, when the instrument is moved through the thermocline, the temperature change inside the approximate 20 minute adjustment time could be a number of degrees. This would result in an error in the reported pressure of several decibars.

More significantly there is an unexplained adjustment time for MicroCAT 6333 of approximately 60 minutes. This result is not explained by the temperature adjustment and requires further investigation. Further insight into this behaviour might be obtainable by studying the time response of the pressure sensor in a laboratory setting.

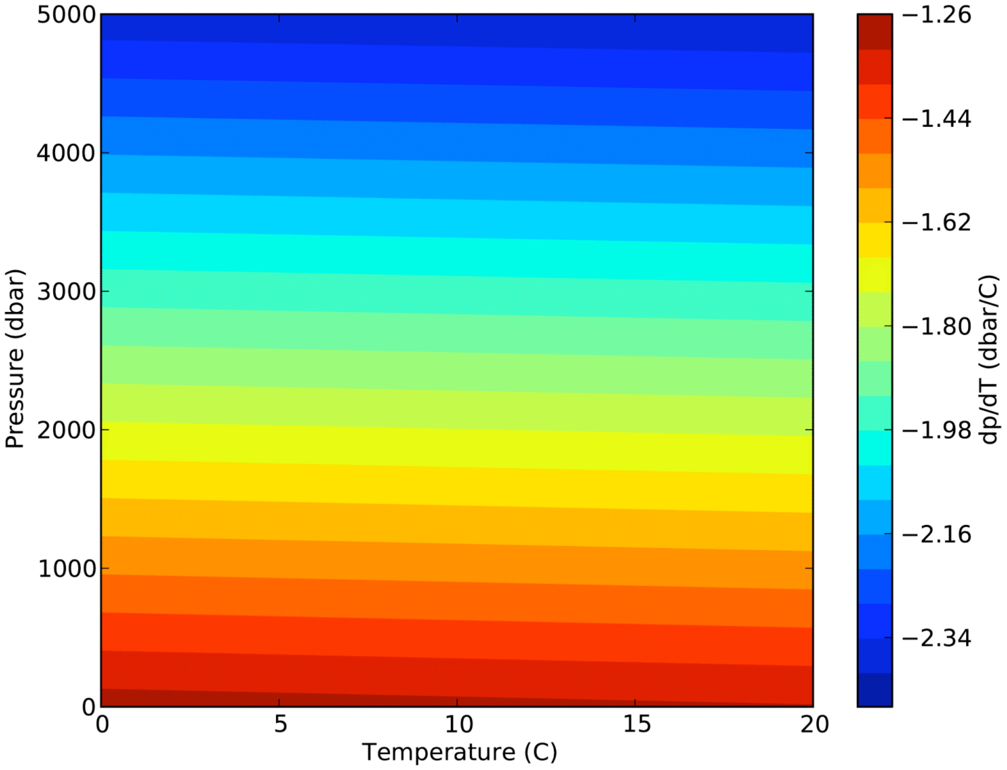


Figure 19.8 *The rate of change of the reported pressure reading with respect to the temperature measured by the pressure sensor thermistor for MicroCAT 6333*

20 BPR Processing

Paul Wright

RAPID uses the SeaBird SBE26 Seagauge and/or the SeaBird SBE53 BPR to measure bottom pressure. They are mounted to frames that hold the anchor and the acoustic releases. No modifications were made to any of the file structures, formats or processing on this cruise. The following is based on the RAPID Data processing document (Collins 2009) and uses ebl3_2_200734_0390 as an example.

20.1 Stage 0

Raw instrument data is downloaded from the BPR using SeaBird's 'SeaSoft for Waves' software and saved as .hex files. These are converted to .tid files using the previous software and loading the initial calibration files, e.g. `0390.ini`. These are currently located on Darren Rayner's old survey laptop in the directory: `/My Documents/calibration/seagauge SBE 26/`. Note: The above step is not necessary for the SBE53 BPRs. After downloading the files are transferred to:

```
/rapid/data/moor/raw/d344/seagauge/0390_data.tid
          and 0390_data.hex
```

under filenames based on their serial number (in this case `0390_data.tid`). An `info.dat` file is created for each mooring (see Chapter 18). In order for the programs to work the necessary empty folders must be created in the relevant directories.

20.2 Stage 1

Stage 1 processing takes the ASCII file and converts it into RDB format. The units are changed from psi to dbar. If there has been a clock offset recorded then this is applied at this point. The code is found in:

```
/rapid/data/exec/d344/stage1/seagauge/
seagauge2rdb_002.m
```

The RDB output file is saved as `ebl3_2_200734_0390.raw` with the header information taken from the `info.dat` file. A stage 1 log file is created that records activity. If the data has been "wrapped" this may be fixed. This has not been necessary for D344.

20.3 Stage 2

Stage 2 processing takes the .raw file and trims off the deployment and recovery sections and calculates the basic statistics. Additionally the routine applies an exponential-linear drift removal to the data and filters it through a 48-hr low pass filter in order to remove the tidal signals. The empirical fit is calculated by the subroutine `purge_bp.m` called up by the stage 2 program `seagauge_raw2use.m`.

```
rapid/data/exec/d344/stage2/seagauge/seagauge_raw2use.m
```

The output file is a `.use` file located in the `moor/proc` directory e.g. `ebl3_2_200734_0390.use`. Two postscript graphs are created.

```
rapid/data/moor/proc/ebl3_2_200734/seagauge/
        ebl3_2_200734_0390.use(.ps)
```

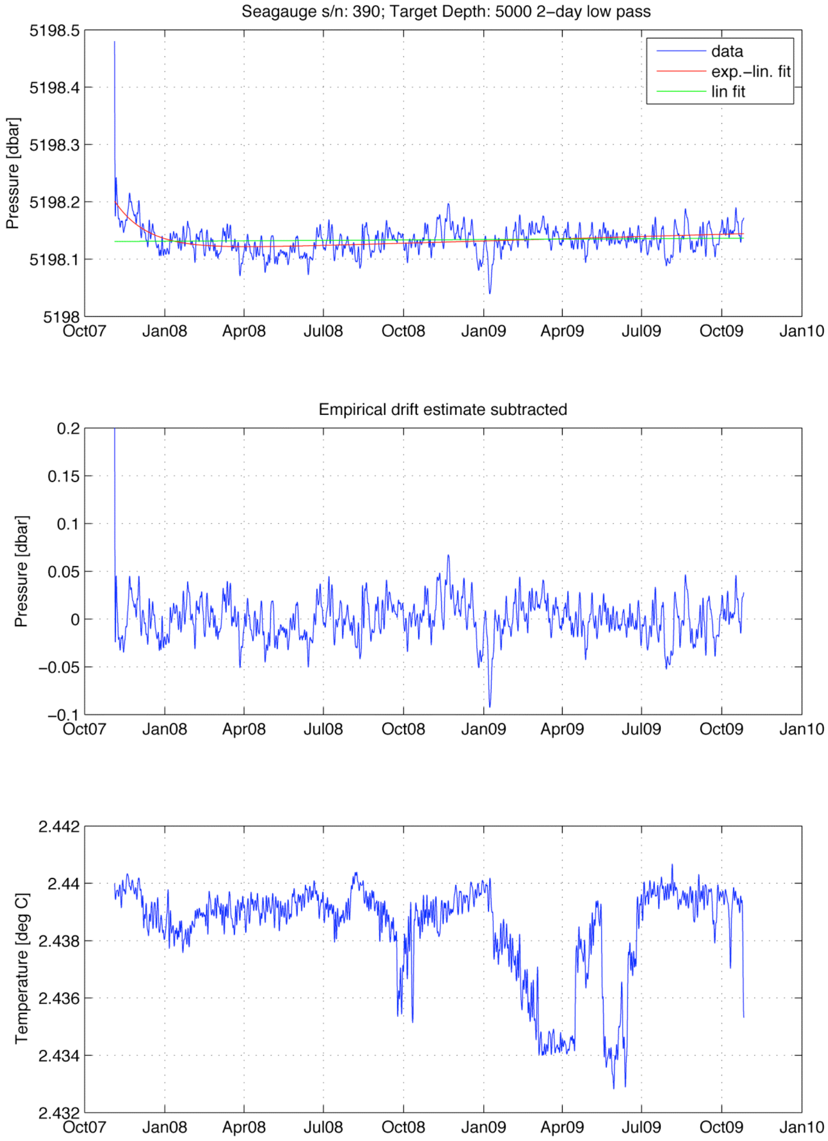


Figure 20.1 *The output from the stage 2 processing of ebl3_2_200734. Fig 20.1a shows the raw data with the ends removed; Fig 20.1b shows the bottom pressure with the exponential-linear drift removed. Fig 20.1c is the temperature curve.*

20.4 Problems

- SBE26 sn 0390 had the date set up incorrectly. Instead of being set to 2nd November 2007 it had been set to 11th February 2007 (11/02/2007 rather than 02/11/2007). Another example of the requirement to be absolutely clear as to whether the instrument requires the date to be entered in International or American format. This was corrected in the processing by applying a 264 day offset. Both the .raw and .use files have been corrected.
- All the SBE26s scrambled the dates when first connected to the PC, resulting in it being impossible to obtain a time offset from GMT. The timestamp in the data files was untouched.
- SBE53 sn 0031 had a small leak that corroded the circuit boards, resulting in a loss of all data.

21 S4 Current Meter Processing

Paul Wright

The current meters recovered from the principal moorings of the RAPID array during D344 were InterOcean S4s. The additional WB-CM trial mooring will be treated separately.

21. 1 Stage 0

The S4 is downloaded to a PC using a combination of the InterOcean software, which does not work very well, and the simpler software written by Darren Rayner. The file is converted and saved as an ASCII file. See the download instruction sheets for further details. E.g. S4 current meter number 35612577 would be stored as:

```
rapid/data/moor/raw/d344/s4/35612577_data.asc
```

21.2 Stage 1

The program `s42rodb_v5.m` converts the `.asc` file to the RAPID standard RBD .raw format ASCII file with the relevant header. This is set up as a function with the input arguments: mooring name, info.dat file path, inpath and outpath. Alternatively, simply type in the functions name and the code asks for the paths etc as inputs. A stage1 log file is created noting the time of conversion and any changes that have been made.

```
rapid/data/exec/d344/stage1/s4/s42rodb_v5.m
```

The new file, `ebh5_4_200842_35612577.raw` is stored under the moorings name in the `rapid/moor/proc/` directory.

21.3 Stage 2

Stage 2 processing is done by `s4raw2use_v2.m`, which chops the deployment and recovery periods off the data and produces plots that allow the user to check whether the record is complete, i.e. if any data has been incompletely downloaded from the S4. As before, a stage2 log file is created. The .use file is stored in the proc (processed data) folder under the relevant mooring name.

```
rapid/data/exec/D344/stage2/s4/s4raw2use_v2.m
```

Files stored in the proc folder, e.g.

```
rapid/data/moor/proc/ebh5_4_200842/
     ebh5_4_200842_35612577.use
```

For easier visualization of the current data it is possible to use the function `stick_plot.m` to produce a quiver plot time series of the current vectors. However, for some of the deeper MAR moorings, which recorded very weak currents, the feature that keeps the vectors to scale (i.e NE = 45°) makes the final plot too small to be useful. The pressure data from at least one S4 (35612565) is suspicious as it reads approximately 20 dbar lower than the MicroCAT immediately above it on the mooring, additionally its batteries failed on 6th October 2009.

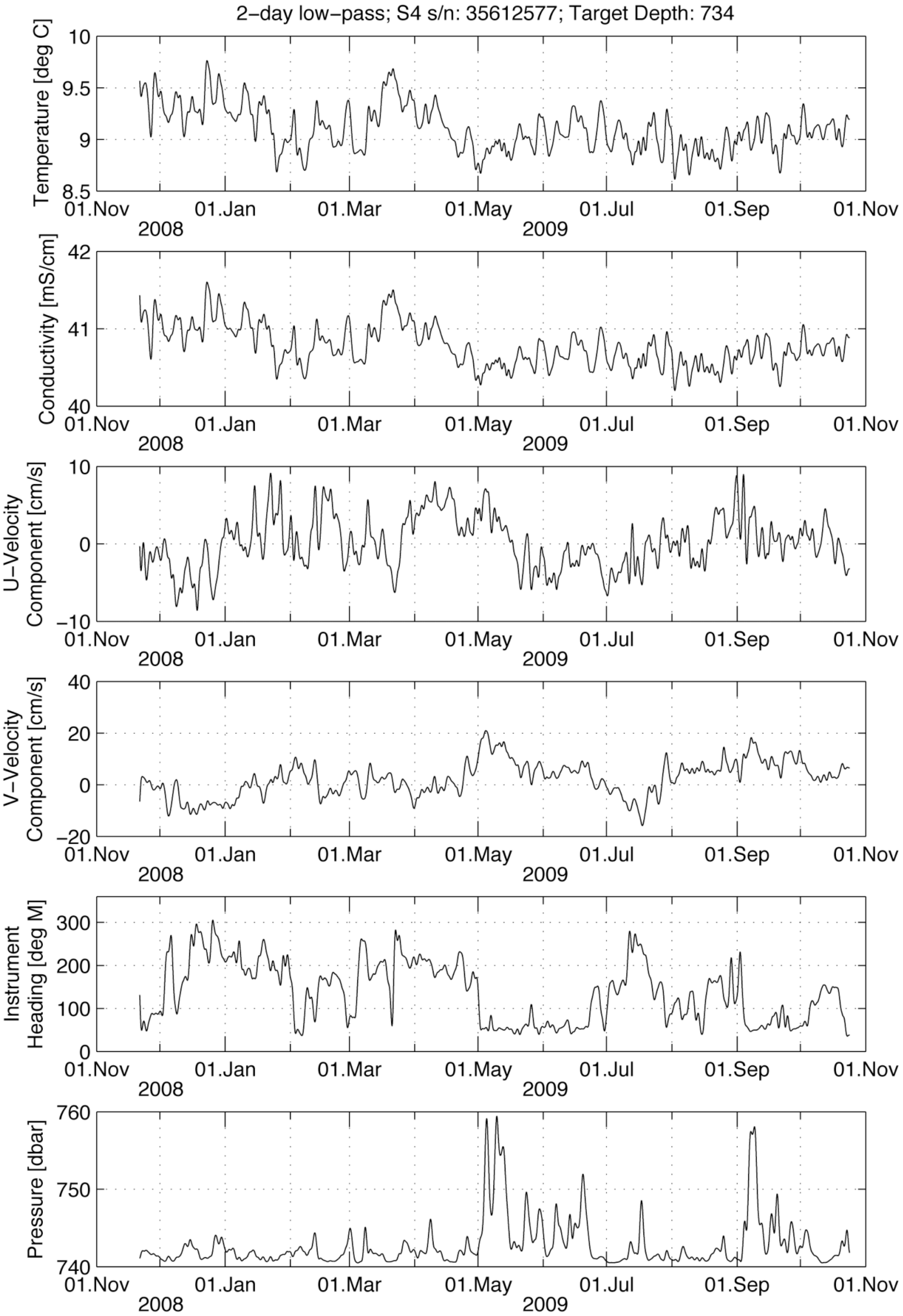


Figure 21.1 *The output plot of stage 2 processing of the S4 data from ebh5_4_200842*

22 PIES Instruments and Processing

Zoltan Szuts

22.1 Data Processing for ebp2_1_200565

The data processing for this instrument proceeded as described in the cruise report for D334 (chapter 17). Only the differences are described here.

The raw data output from the stage1 processing (`ebp2_1_200565_131.raw_orig`) had 24 instances where the time value was repeated. The extra records did not contain valid data, and so they were simply deleted by hand and the resulting file (…`131.raw_mod`) was copied to the expected file name (…`131.raw`). After recovery the instrument clock was found to be 33 seconds slower than GMT – this was corrected in the stage 2 processing.

The pressure record has an apparent base-line shift at 2006/03/11 18:10 of +1.737 db. The data both before and after does not seem to suffer from any other visible defects, so the initial 106 days of pressure are adjusted upward by 1.737 db

22.2 Telemetry with ebp1_2_200832

As this mooring was only deployed last year (during D334, on 15th November 2008), it did not need to be recovered. We used telemetry to download the year-long data record instead. When communicating with the instrument, we found that a ‘CLEAR’ command was necessary in addition to ‘TELEM’ to resume telemetry after the instrument’s end-of-the-day processing between 23:30:00 and 24:00:00.

The setup was similar to that used in previous years: a Benthos DS-7000 deck unit was attached to a laptop running MATLAB. The transducer was suspended over the side of the ship as deep as possible, and the electronics were set up just inside the hatches of the instrument lab. The MATLAB routine `PPDTb_v3.m` received the signals, and `PPlotPDT.m` plotted them as they were received.

A detailed list of steps done for setting up communications with the PIES follows.

1) Turn off the echo sounder
2) Setup and connect the DS-7000 deck set and computer
3) Make a new directory for telemetry with EBP1 and copy IES telemetry MATLAB files into this directory. Change paths in `PPDTb_c3.m` and adjust gain if necessary. Change paths in `PPlotPDT.m`, `renamePDT.m`, and `deletePDT.m`.
4) Run `Traxset.m` with the DS-7000 in REMOTE mode. Reboot the laptop if there are problems opening the com port (com1).
5) Check that the gain and frequency of the channels are the same as is set by Traxset. For this telemetry session, the settings were:

channel	1	2	3	4	5	6	7	8
gain	6	8	6	6	6	6	6	6
reception frequency (kHz)	12.0	12.5	12.0	11.5	11.0	10.5	10.0	15.0
transmission frequency (kHz)	12.5	15	15	15	15	15	15	15

6) Put the transducer into the water.
7) Wait to hear the PIES sampling (every 10 minutes), recording the time of first ping to calculate the clock drift (make sure to correct for travel-time through the water column).
8) Switch to COMMAND mode on the DS-7000 and send CLEAR (76). Wait for the 2-ping response (at 12.0 kHz). If no reply heard, resend the command.
9) Send the TELEM code (65 for this instrument), wait for 2-ping reply.
10) After the next scheduled sampling time the PIES will switch to data telemetry mode as detailed in the IES User's Manual
11) Open 2 MATLAB sessions, one to run `PDTb_v3.m` to receive the signals, and the second to plot them with `PPlotPDT.m`.

The ship maintained position over the station with her bow thrusters, for which, according to the bridge, required continual adjustments. The sea state was calm and signal reception was good. The gain used in PPDTb_v3 was set at 6. The few false MSBs received in the middle of data blocks suggests that perhaps a value of 5 would have been sufficient (lower gain reduces false MSBs according to the manual).

Record of events on 2009/10/29-30

21:10:20	hear first of 4 sampling pings (then at 21:10:36, 21:10:45, and 21:11:10, each 16 seconds apart). The instrument clock is 17 seconds slow, which properly removes the 3.3 sec delay for the signal to transit the water-column.
21:13:41	CLEAR (76) command sent, 2-ping reply heard
21:14:16	TELEM (65) sent, 2-ping reply heard
21:20:20	next sampling heard (first of 4 pings), after which the instrument goes into telemetry mode. Initial transmissions lost while adjusting the gains on the deck unit
21:29:00	receive LSB for yearday 285 (in 2009) [Reception improves when the echo sounder is turned off]
21:30:22	LSB for yearday 362 (in 2008) received, end of 34 day interval PIES locks out telemetry for daily data processing session
00:00:20	the first sampling ping is heard
00:02:37	TELEM sent, faint reply heard
00:08:49	TELEM resent, no reply heard
00:10:20	the first of the sampling pings heard
00:13:26	CLEAR sent, 2-ping reply heard
00:13:56	TELEM sent, no reply heard
00:14:24	TELEM resent, 2-ping reply heard
00:20:20	first sampling ping heard
00:22:50	telemetry resumes with MSB for yearday 361
00:41:17	beginning of file reached (yearday 377 received, within 2 of the expected 375) – telemetry ends and instrument resets itself.

22.3 GEM Analysis for Eastern Boundary PIES

In an effort to assess the utility of PIES for obtaining vertical profiles of temperature, salinity, or geopotential anomaly, a Gravest Empirical Mode (GEM) analysis (Watts et al., 2001) was performed for both EBP1 and EBP2.

Three databases were used for generating the GEM database: CTD casts from previous RAPID cruises, profiling floats (typically ARGO floats) from the World Ocean Database 2005 (WOD), and gridded data from RAPID moorings. The WOD does not contain any CTD casts distinct from those collected by RAPID. All cruises in the RAPID data tree, as available on the shipboard computers, were loaded into the database – this includes cruises CD170, CD177, D279, D304, D324, D334, KN182, P343, P345, and SJ08. Calibrated CTD profiles were not yet available for D344. The gridded RAPID data is only usable if the mooring samples the entire water column, and thus only mooring EB1 is suitable and is included for EBP1.

The methodology follows Watts et al. (2001) and Meinen and Watts (1998). Every profile in each data set is characterized by pressure or depth, salinity, and temperature. From these quantities we

1) calculated sound speed using the formula of Del Grosso (1974) (as recommended by Meinen and Watts, 1998),

2) calculated the two-way travel time τ (in seconds) by integrating with respect to pressure:

$$\tau = 2\int_0^{p_0} \frac{1}{\rho g c} dp$$

   where p_0 is the reference pressure (namely the depth at which the PIES is located), ρ is the in situ density, and c is the sound speed,

3) interpolated temperature, salinity, and specific volume anomaly onto a regular grid (every 25 m), where each value of τ is associated with its corresponding profile,

4) calculated the functional forms of temperature, salinity and specific volume anomaly against τ at each depth-level. This was done by bin-averaging every 0.001 s to obtain an average and a standard deviation.

The average relation from step 4 is the GEM relationship. Whether the GEM effectively recovers the desired signal can be addressed in numerous ways. As a first look, one can compare the slope of the GEM (the signal) to the standard deviation in each bin (the noise), which generates a signal-to-noise ratio. More quantitatively, the GEM can be used to reconstruct the profiles, and the rms deviation from the original profile indicates how much variance can be recovered at each depth level. Finally, for implementation of the technique, it is necessary to verify that the distribution of τ from the GEM spans the range of direct measurements.

The steps above are applied for both EBP1 and EBP2 below, with particular details elaborated as necessary.

22.3.1 GEM Analysis at EBP1

The main selection criteria for profiles were that they be close to the PIES. For EBP2, this was chosen as all profiles south of the Canary Island chain and within 300km (Figure 22.1) and that their maximum depth were deeper than the PIES from EBP2_1_200565 (1025.2 m). For EBP1 the full-depth signal could only be constrained by nine historical CTDs and the gridded EB1 data. Better statistics were obtained by only considering the upper part of the water column that was frequently sampled by ARGO floats. Profiles were further quality-controlled by removing any with salinities greater than 45 or less than 20, and by removing a few which suffered from bad data in T-S space.

22.3.2 GEM Analysis at EBP2

The selection criteria for Fig 22.1 were that all profiles be within 250 km and lie south of the Canary Islands. This second constraint was to avoid water-masses that might more frequently be found north of the islands, namely Mediterranean water. Two profiles within this region were excluded because their T/S plots showed spikes or inaccurate calibrations. The GEM contains 153 profiles: 134 from WOD profiling floats and 19 from RAPID CTD casts (1 from D304, 7 from D279, and 11 from D334).

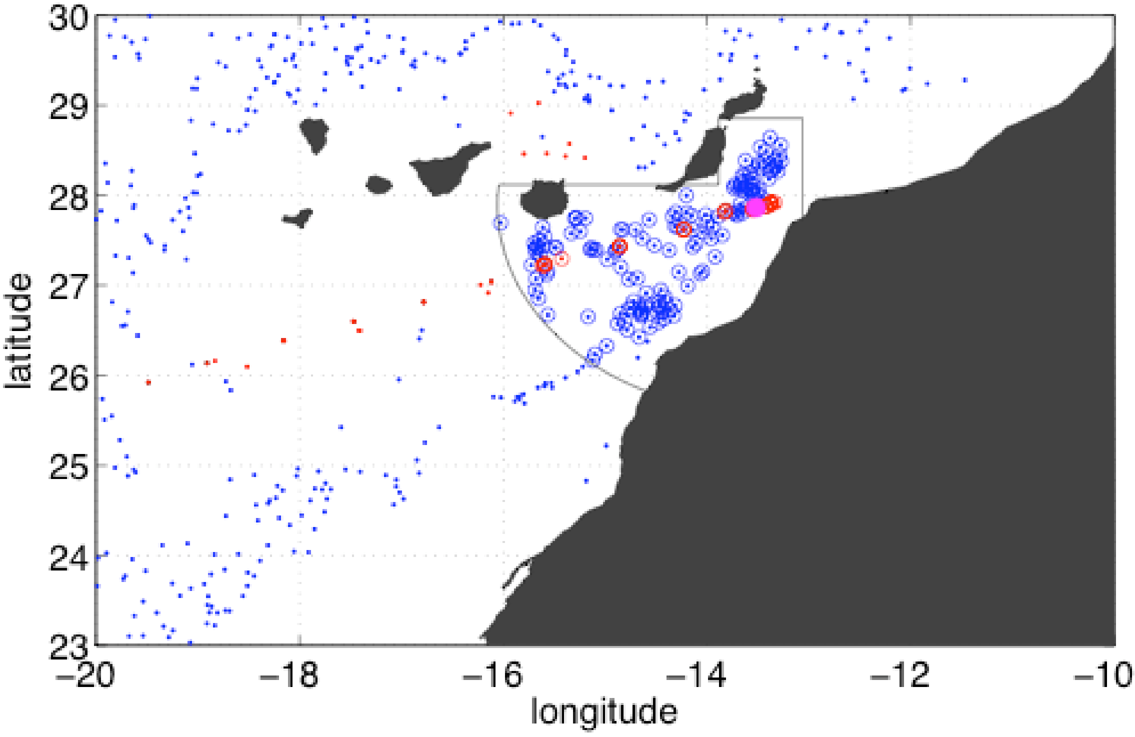


Figure 22.1 *Profiles selected for making the GEM database for EBP2 (shown in magenta). The quarter is a radius of 250 km and is cropped to only select profiles south of the Canary Islands, and the profiles included in the database are circled, either CTD profiles (in red) or ARGO profiles from WOD (in blue).*

The generation of the GEM database is performed as described above, and it is shown at specific depth levels in Figures 22.2-4. Although smoothing splines were used by

Watts *et al*. (2001) at each depth-level for fitting the trends of temperature, salinity, and specific volume anomaly against τ, the scatter at our location made binned averages just as effective as a smoothing spline. The mean structure against τ is not large compared with the scatter or standard deviation, and there is much less signal than when compared with GEM analysis in regions with much stronger flow (the North Atlantic Current, Meinen *et al*., 2000; the Antarctic Circumpolar Current, Watts *et al*., 2001; or the region just east of the Bahamas, Meinen *et al*., 2004).

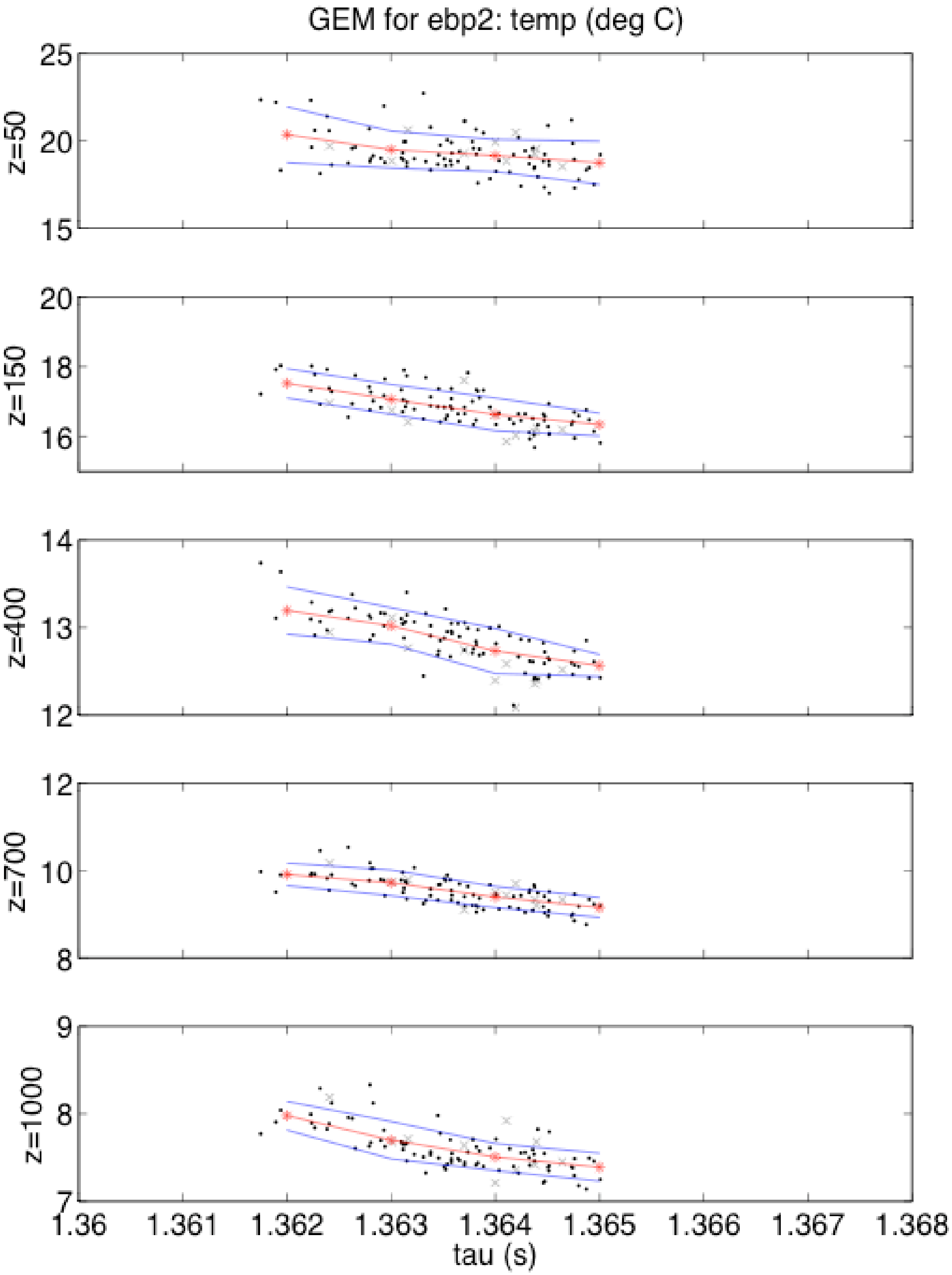


Figure 22.2 *The GEM at EBP2 for temperature (°C) at fixed depth levels (at left) plotted against two-way travel time* τ. *The mean structure (red) and its standard deviation (blue) is calculated by binning the profiles every 0.001 s.*

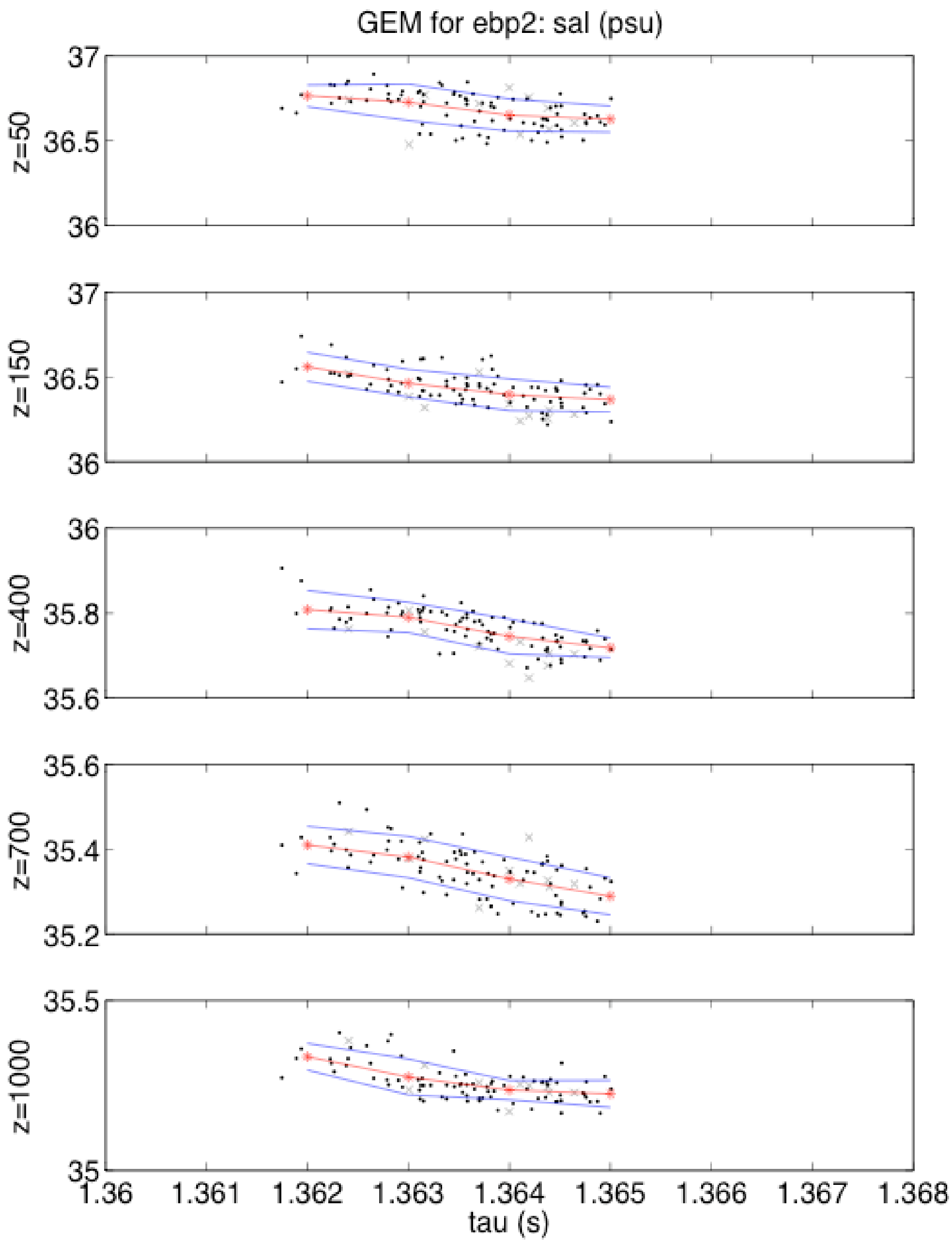


Figure 22.3 *The GEM at EBP2 for salinity (PSU) at fixed depth levels (at left) plotted against two-way travel time τ. The mean structure (red) and its standard deviation (blue) is calculated by binning the profiles every 0.001 s.*

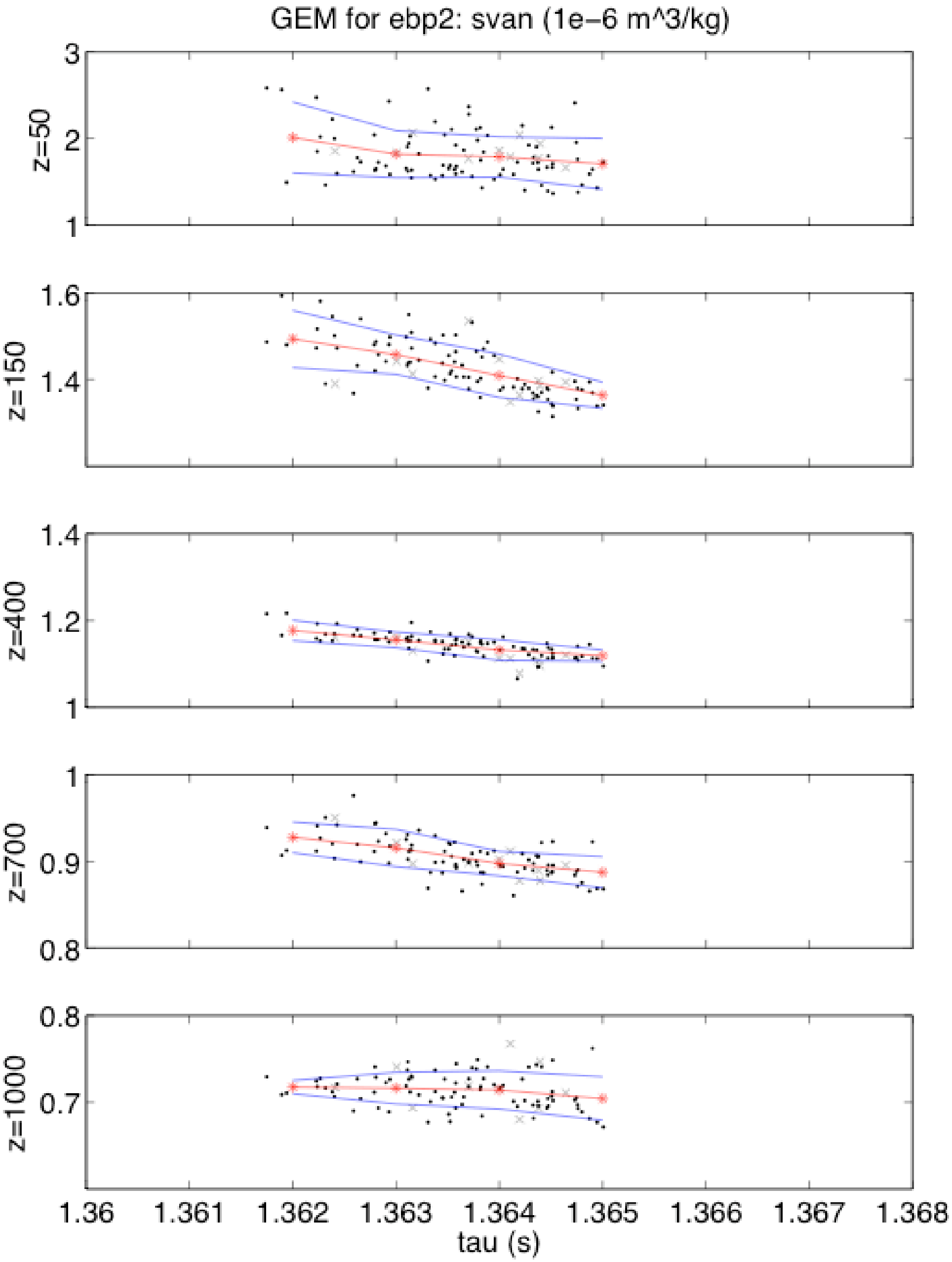


Figure 22.4 *The GEM at EBP2 for specific volume anomaly (m^3/kg, multiplied by 10^6 for visualisation purposes) at fixed depth levels (at left) plotted against two-way travel time τ. The mean structure (red) and its standard deviation (blue) is calculated by binning the profiles every 0.001 s.*

The GEM can also be considered in its two-dimensional (2D) space: we only present the fields for specific volume anomaly, as this is the quantity needed for reconstructing geostrophic transport. Although the fields for temperature and salinity have more pronounced structure, the positive correlation of temperature and salinity results in density compensation, such that their combined influence on specific volume anomaly (or density) is much reduced relative to that implied by looking at either temperature or salinity alone. Figure 22.5 shows the specific volume anomaly GEM, in addition to the scatter in the GEM (the standard deviation in each bin), while Figure 22.6 shows the value of the specific volume anomaly changes from one bin to another (“incremental change,” a measure of how much structure exists in the GEM), and an estimate of the signal-to-noise ratio (snr). The snr is the ratio of the incremental change between adjacent bins of the mean GEM to the standard deviation in each bin, and it highlights where the slope of the GEM is large enough to extract a signal over the 2D space (depth versus τ). The specific volume anomaly GEM is not able to recover changes in the upper or lower 100 m, but it does have moderate success between 100 and 800 m.

A more qualitative measure of the accuracy of the GEM comes from reconstructing specific volume anomaly profiles based solely on travel time and comparing them to the original data. The residual is defined as the difference between the original profile and the reconstructed one. Compared to the standard deviation inherent in the GEM, the rms residual is not that much smaller (Fig. 22.7). When considered in terms of the amount of variance explained (Fig. 22.8), we see that the temperature and salinity GEMs explain 40-60% of the variance below 100 m, while the specific volume anomaly only explains more than 50% of the variance between 150 and 600 m.

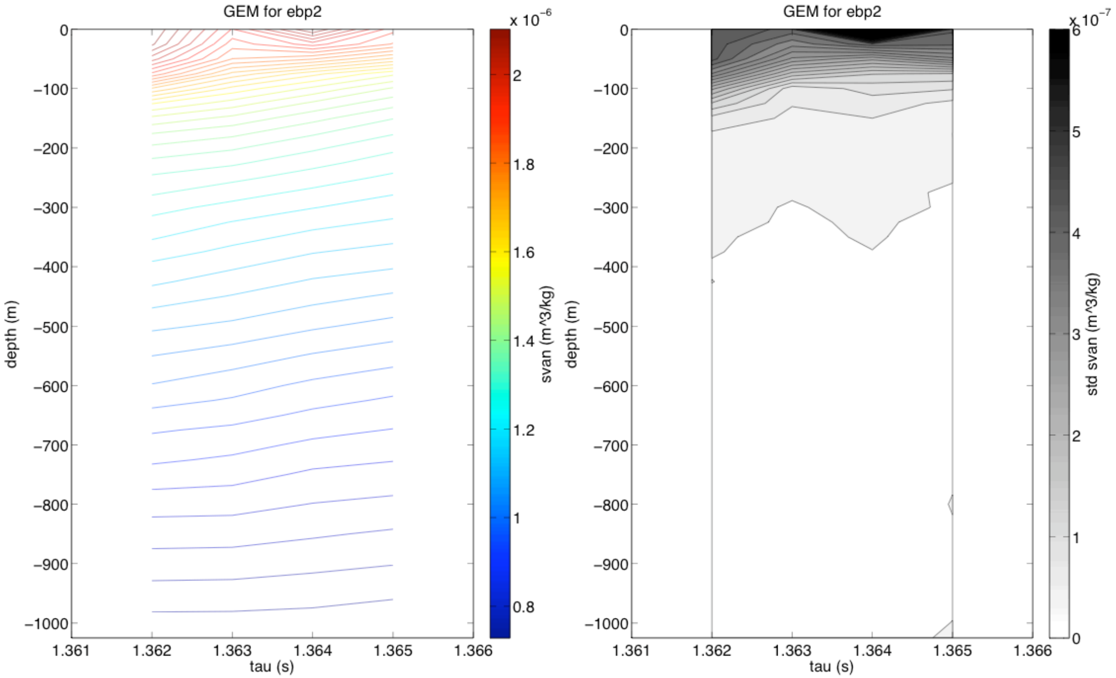


Figure 22.5 *The GEM at EBP2 for specific volume anomaly (m^3/kg). Contour plots of (left) the mean structure and (right) the standard deviation.*

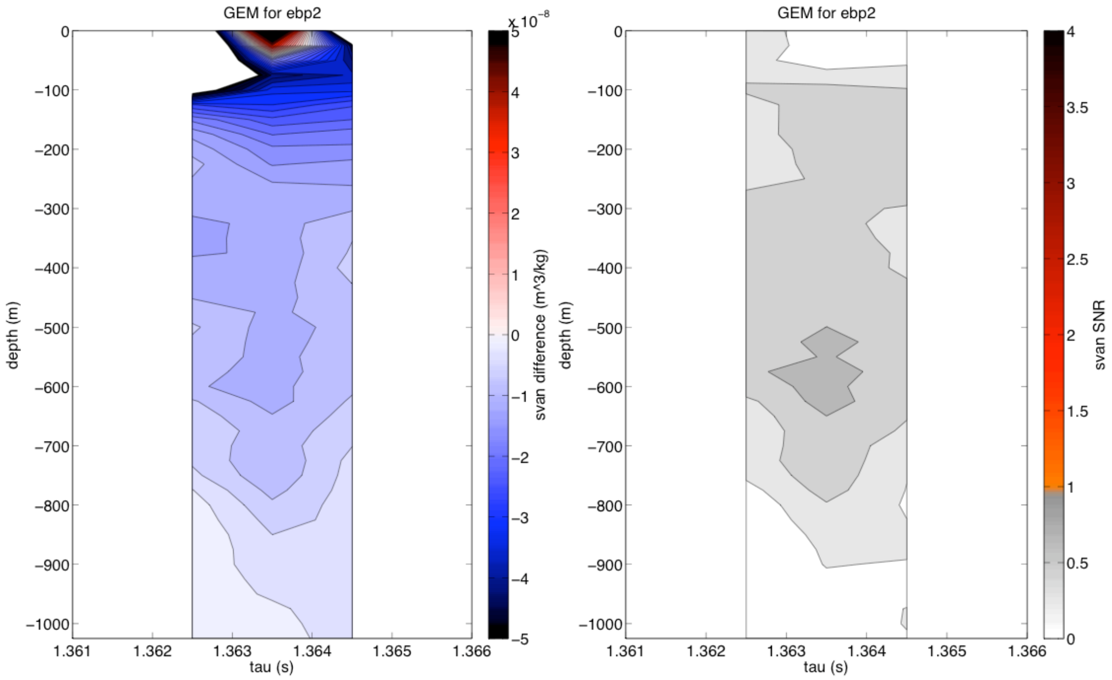


Figure 22.6 *The GEM at EBP2 for specific volume anomaly. (left) The incremental change of the mean structure, and (right) the signal-to-noise ratio, defined as the ratio of the incremental change to the standard deviation in each bin. Because the difference is a centered-difference, it and the signal-to-noise ratio are calculated between the centres of the bins (e.g. 1.3625, 1.3635, etc.). The color scale for the signal-to-noise changes color at 1 for visualization purposes – this does not mean that a value of 1 is necessary for accurate recover, just that the signal and the scatter are the same magnitude.*

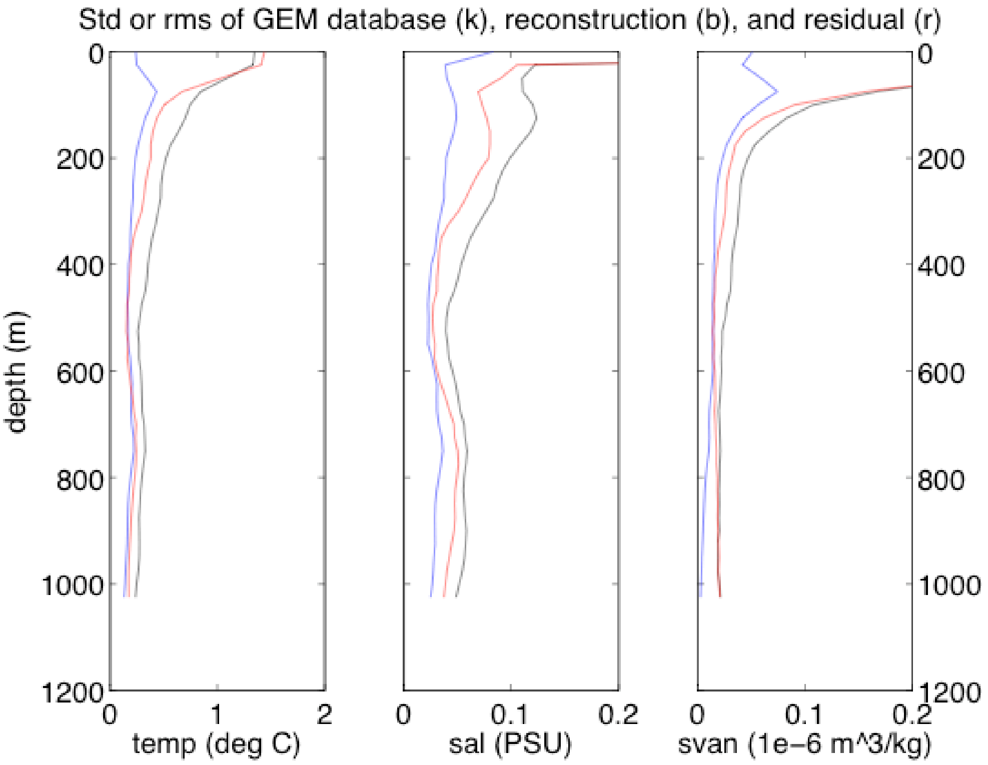


Figure 22.7 *The amount of variance recovered in the GEM-reconstructed profiles. For (left) temperature, (middle) salinity, and (right) specific volume anomaly, the standard deviation of the GEM database is in black, the standard deviation of the GEM is in blue, and the rms of the residual between original and reconstructed profiles is in red.*

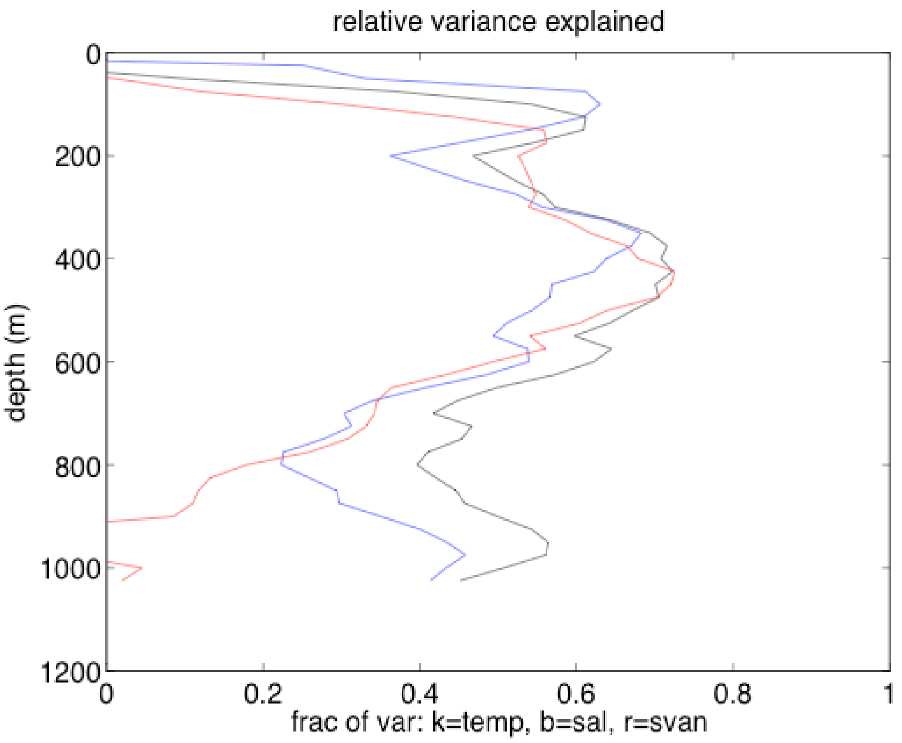


Figure 22.8 *The fraction of variance recovered by the GEM-reconstructed profiles. The ratio of 1 – [rms(residual)/std(GEM)]^2 is shown for temperature (black), salinity (blue), and specific volume anomaly (red).*

There is expected to be a strong seasonal signal at this location (Chidichimo *et al,* 2010), and this may be another reason for the poor fits. If so, a more refined GEM method would be more appropriate, such as one by Park *et al* (2005) that accounts for a wind- and season-dependent surface mixed layer. Figure 22.9 shows the same data as in Figure 22.2, except plotted against day of year (Jan 1 12:00 is day 1.5). Except near the surface, there does not appear to be a consistent seasonal cycle that would help explain the travel time measurements.

In addition to whether the hydrographic variability can be recovered, implementation of the GEM requires that the distribution of τ from the GEM database matches that from the PIES itself. The distribution of τ from the PIES and from the GEM (Fig. 22.10) have median values that are different by 0.012 s, which is equivalent to a vertical difference of 8.7 m. This difference remains despite my best efforts to find its source. Errors could arise in my own calculations for the GEM, but different sound speed formulas only change the median difference by 0.002 (the sound speed from Fofonoff and Millard, 1983 results in a median difference of 0.009 s) and my calculations follow well-established methods. The bottom pressure from the PIES (deployment EBP2_1_200565) could also be in error, although the stated accuracy of the pressures sensor (0.01% of full scale or 7000 m) is only 0.7 m, an order of magnitude smaller than the perceived difference. The range of the distributions is also significantly different: the PIES shows a range of 0.012 s with a standard deviation of 0.0022 s, while the GEM has a much smaller range of 0.005 s and a standard deviation of 0.0008 s. Even if the medians agreed, the GEM would not be able to account for the larger range of τ seen by the PIES.

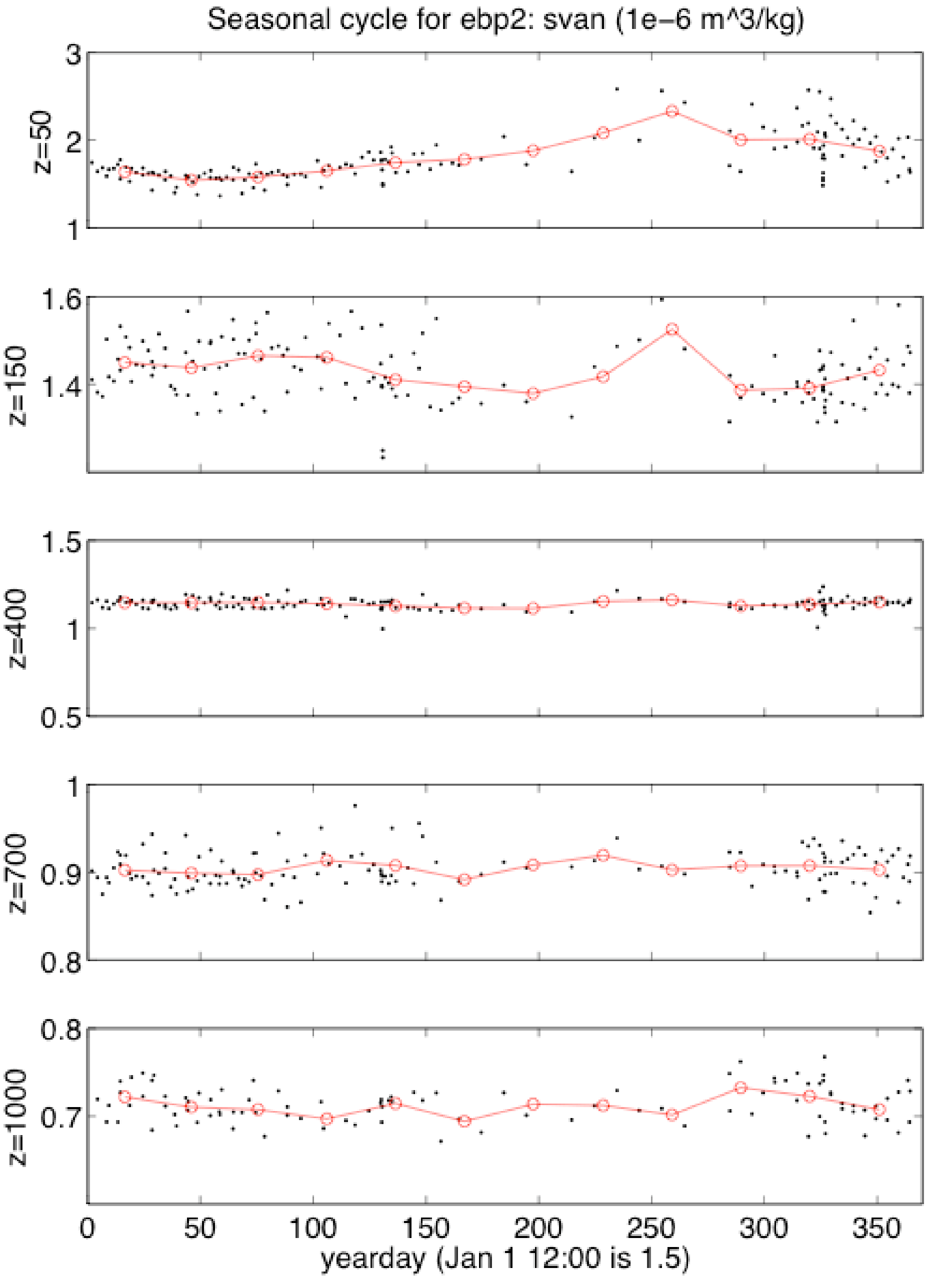


Figure 22.9 *The seasonal cycle in specific volume anomaly at the same depth levels as in Figure 22.2, with a seasonal cycle shown in red calculated by binning the data every month. Volume anomaly (red).*

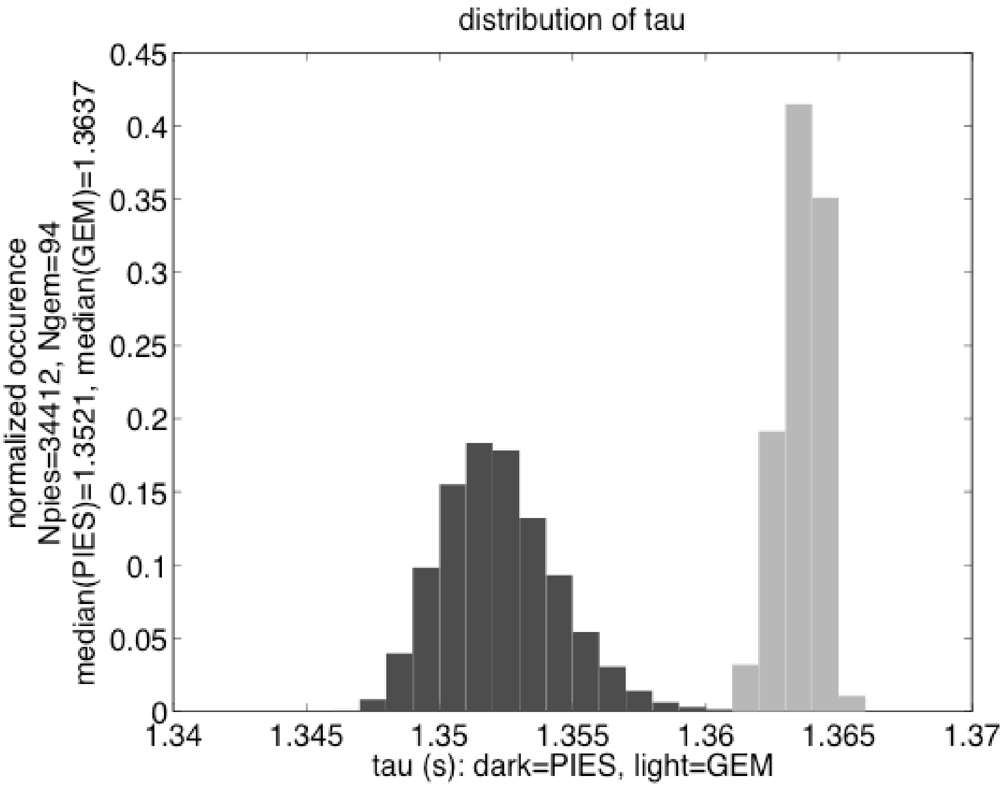


Figure 22.10 *The distribution of τ from the PIES (dark) and from the GEM (light). The median values are different by 0.012 s, which is equivalent to a vertical separation of 8.7 m.*

22.3.3 GEM Analysis at EBP1

The selection criteria for EBP1 were that all profiles be within 300 km (Figure 22.11). Twelve profiles within this region were excluded because their T/S plots showed spikes or inaccurate calibrations. The GEM contains 2108 profiles: 696 from WOD profiling floats, 27 from RAPID CTD casts (1 from CD170, 4 from D304, 3 from P343, 5 from CD177, 2 from D324, 4 from P345, 6 from D279, and 3 from D334), and 1385 half-daily profiles from gridded mooring data (ebp1_2_200516, eb1_3_200561, and eb1_5_200654, with eb1_4_200619 excluded because of anomalous deep salinities in my regridded version).

The generation of the GEM database is performed as described above, and it is shown at specific depth levels in Figures 22.12-14. Despite the large number of gridded profiles from EB1, the profiles are not as consistent as the CTD profiles in terms of the absolute value at each depth level. My regridding of the eb1_4_200619 data (done in August 2009) used uncorrected salinity values (since corrected) that were 0.02 PSU too salty, and so was excluded. There is still apparent bias in T/S values between the different deployments: although the differences of 0.002°C and 0.002 PSU at 5000 m fall within the calibration accuracy used for RAPID, these systematic differences between deployments are larger at shallower depths (0.004°C and 0.007 PSU at 1000 m). Because this analysis focuses on the PIES/GEM, it does not investigate the root cause of these differences. Aside from some of these errors being explained by the calibration accuracy, the remaining errors could be caused by the gridding procedure or by incorrectly-calibrated microcat data.

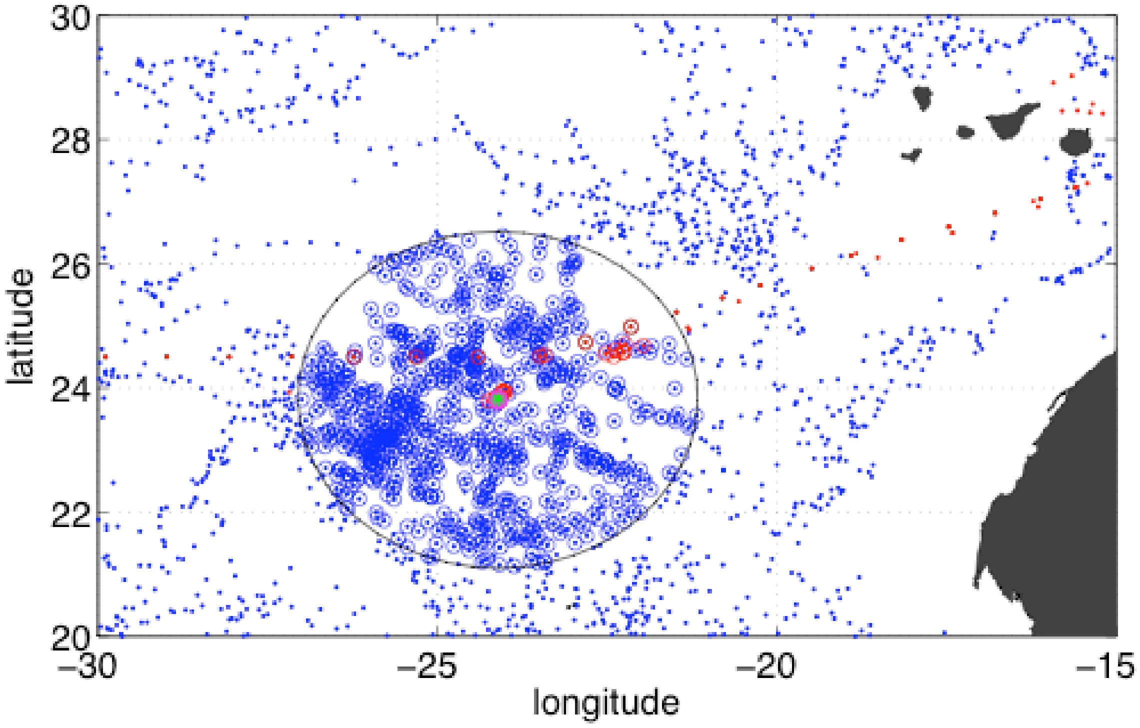


Figure 22.11 *Profiles selected for making the GEM database for EBP1 (shown in green). The circle is a radius of 300 km, and the profiles included in the database are circled, either CTD profiles (in red) or ARGO profiles from WOD (in blue).*

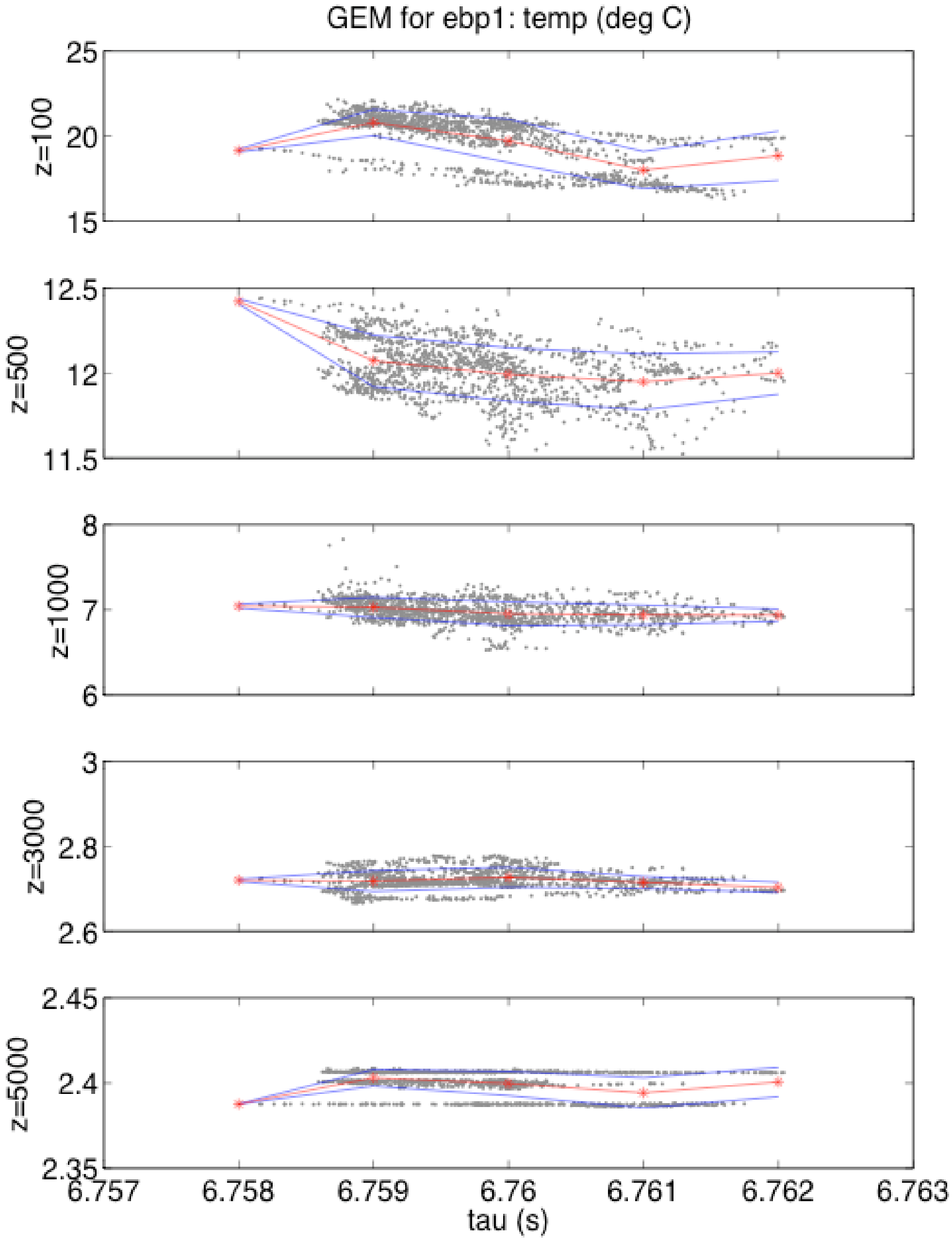


Figure 22.12 *The GEM at EBP1 for temperature (°C) at fixed depth levels (at left) plotted against two-way travel time τ. The mean structure (red) and its standard deviation (blue) is calculated by binning the profiles every 0.001 s.*

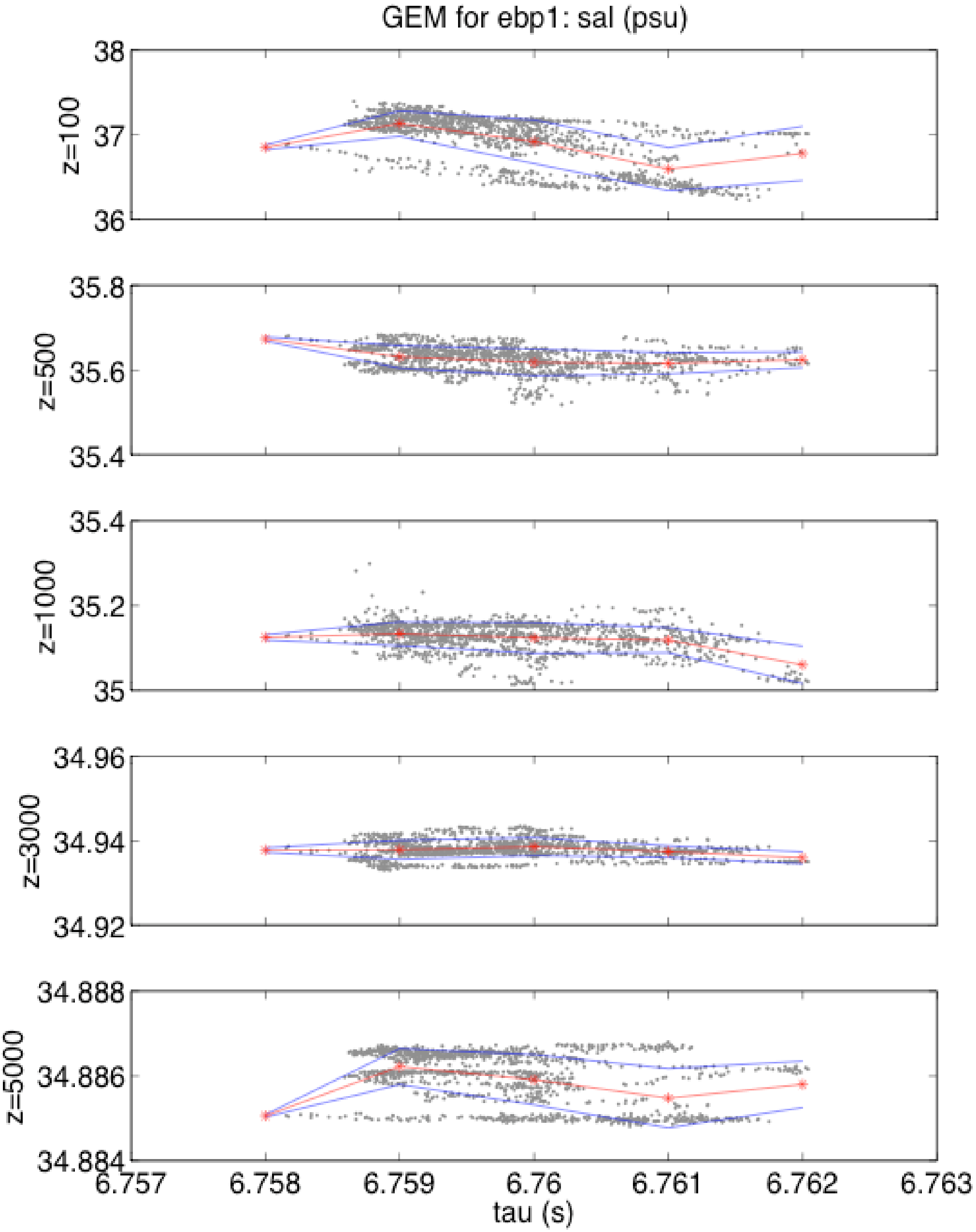


Figure 22.13 *The GEM at EBP1 for salinity (PSU) at fixed depth levels (at left) plotted against two-way travel time τ. The mean structure (red) and its standard deviation (blue) is calculated by binning the profiles every 0.001 s.*

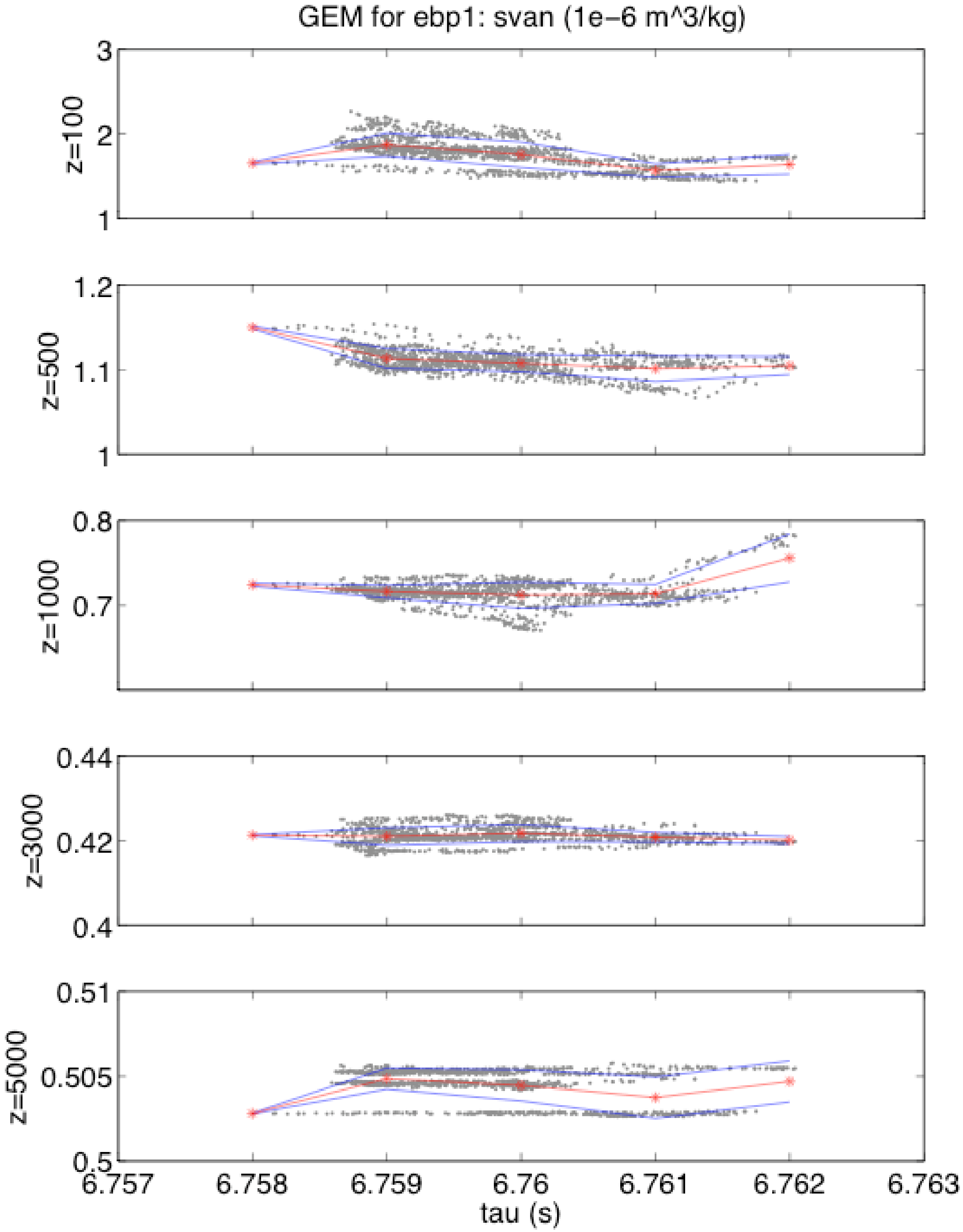


Figure 22.14 *The GEM at EBP1 for specific volume anomaly (m^3/kg, multiplied by 10^6 for visualisation purposes) at fixed depth levels (at left) plotted against two-way travel time τ. The mean structure (red) and its standard deviation (blue) is calculated by binning the profiles every 0.001 s.*

The mean structure against τ is again not large compared with the scatter or standard deviation. The systematic differences in the gridded data would need to be removed for fully-accurate determination of the GEM, but it is apparent from Figures 22.12-14 that the mean signal is small. By only considering the profile data we remove the GEM's dependence on the gridded data, but at the expense of only covering the upper 1500 m. Of the available CTD casts, only 3 are deeper than the median depth of the

PIES of 5200 db, while only 5 more reach deeper than 5000 db. Of the 696 WOD profiles, 379 reach down to 1500 db. Figures 22.15-17 show the GEM based on profiling floats and CTDs in the upper water column. The bins for τ less than 1.996 s do not contain enough data points to be reliable. For τ larger than 1.996 s, however, the small slopes apparent in the temperature and salinity GEMs mostly cancel, such that the slopes in the specific volume anomaly GEM are very weak.

The two-dimensional GEM shows a very small mean structure. The bins on either end of Figure 22.18 are biased by inconsistencies in the database, and so only the two middle bins of Figure 22.19 (τ of 6.7595 and 6.7605 s) give representative results. The signal-to-noise ratio is only consistently larger than 0.25 in the upper 1000 m of the water column.

The variance recovered by reconstructed profiles is a bit more promising. The residual variance is largely reduced in the upper water column (Figures 22.22-23). The GEM that includes the gridded data recovers 80% of the variance in specific volume anomaly between 500 and 2000 m, whereas the profile-based GEM recovers 40-60% between 250 and 1500 m. Thus, although the gridded data adds useful information to the GEM in the upper 2000 m, below 2000 m – where the gridded data predominates the GEM – the GEM is only able to recover 10-20% of the variance.

The distribution of the GEM has a median value that is substantially different from that observed by the PIES (Figure 22.25): the difference of 0.015 s is equivalent to a vertical distance of 11 m. For discussion about this disagreement, see the end of the previous section.

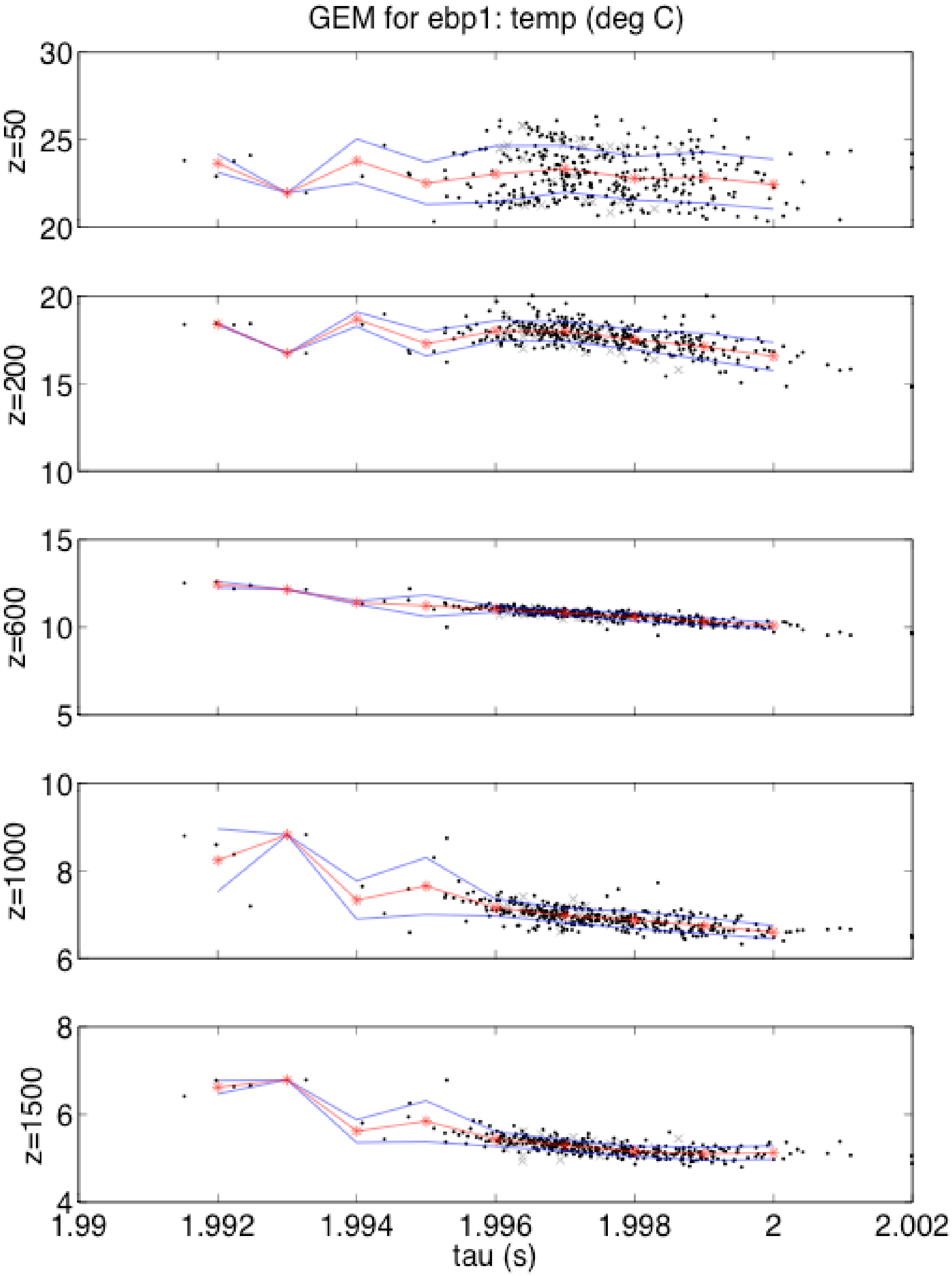


Figure 22.15 *The profile-based GEM at EBP1 for temperature (°C) at fixed depth levels (at left) plotted against two-way travel time τ. The mean structure (red) and its standard deviation (blue) is calculated by binning the profiles every 0.001 s.*

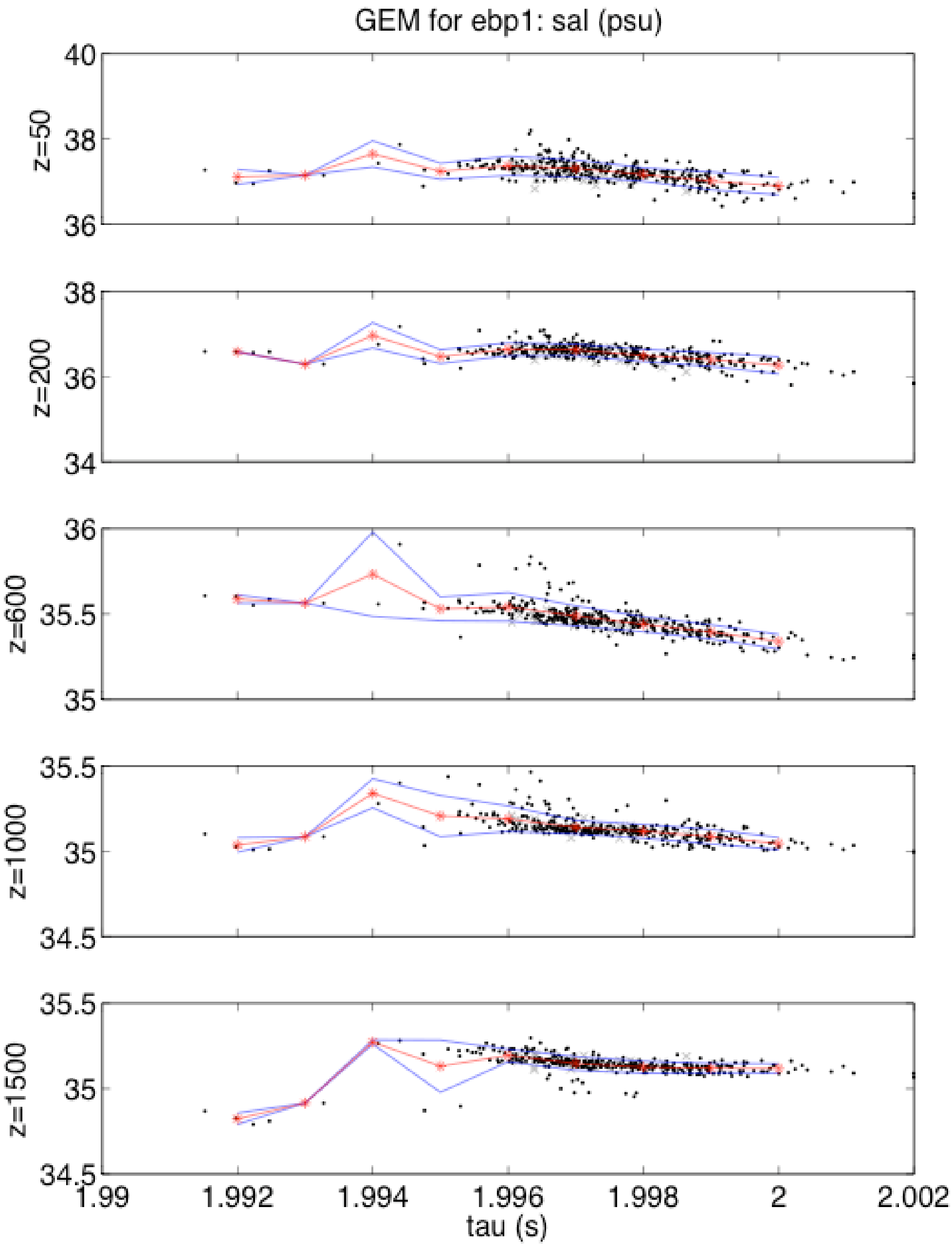


Figure 22.16 *The profile-based GEM at EBP1 for salinty (PSU) at fixed depth levels (at left) plotted against two-way travel time τ. The mean structure (red) and its standard deviation (blue) is calculated by binning the profiles every 0.001 s.*

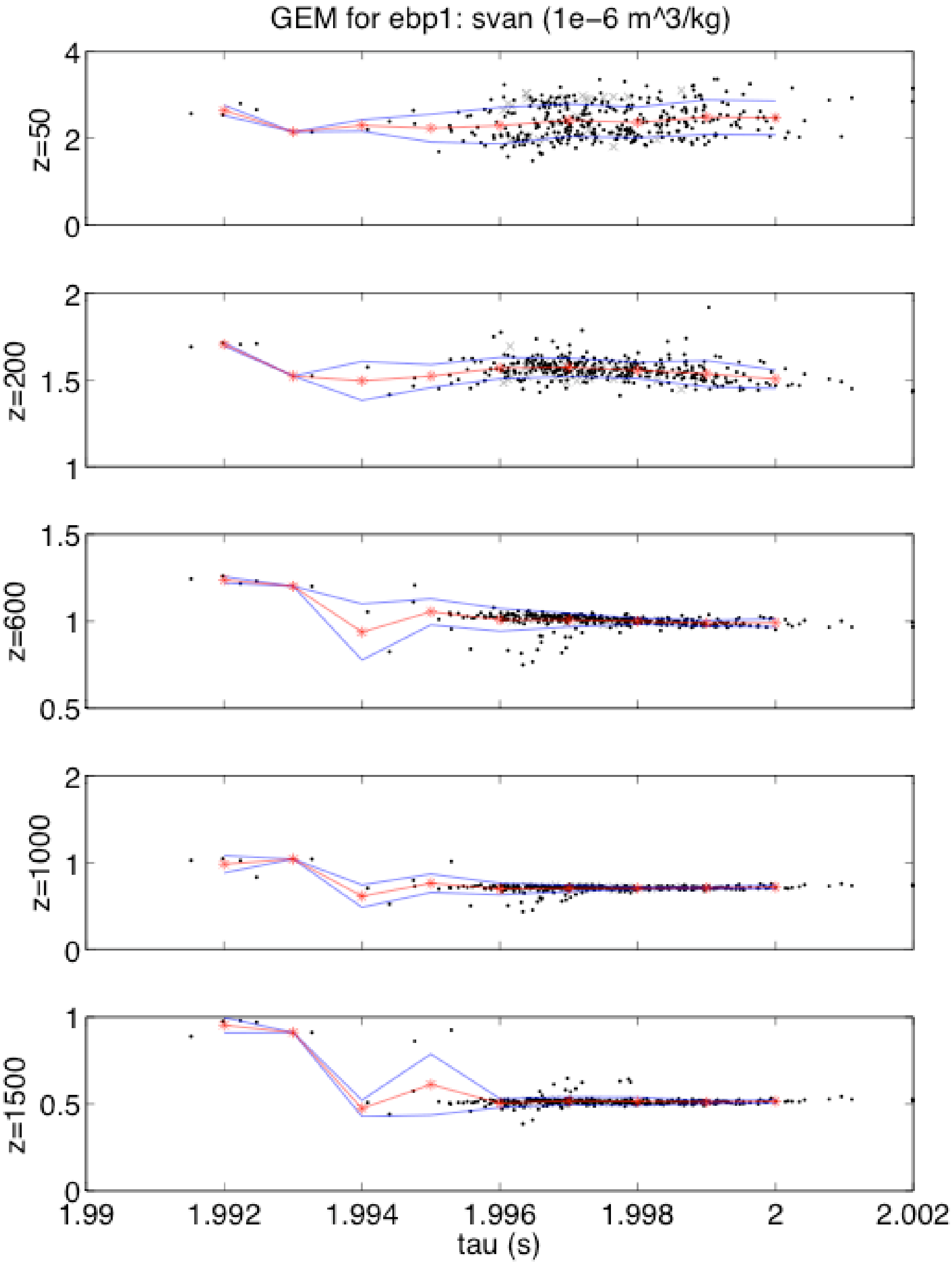


Figure 22.17 *The profile-based GEM at EBP1 for specific volume anomaly (m^3/kg, multiplied by 10^6 for visualisation purposes) at fixed depth levels (at left) plotted against two-way travel time* τ. *The mean structure (red) and its standard deviation (blue) is calculated by binning the profiles every 0.001 s.*

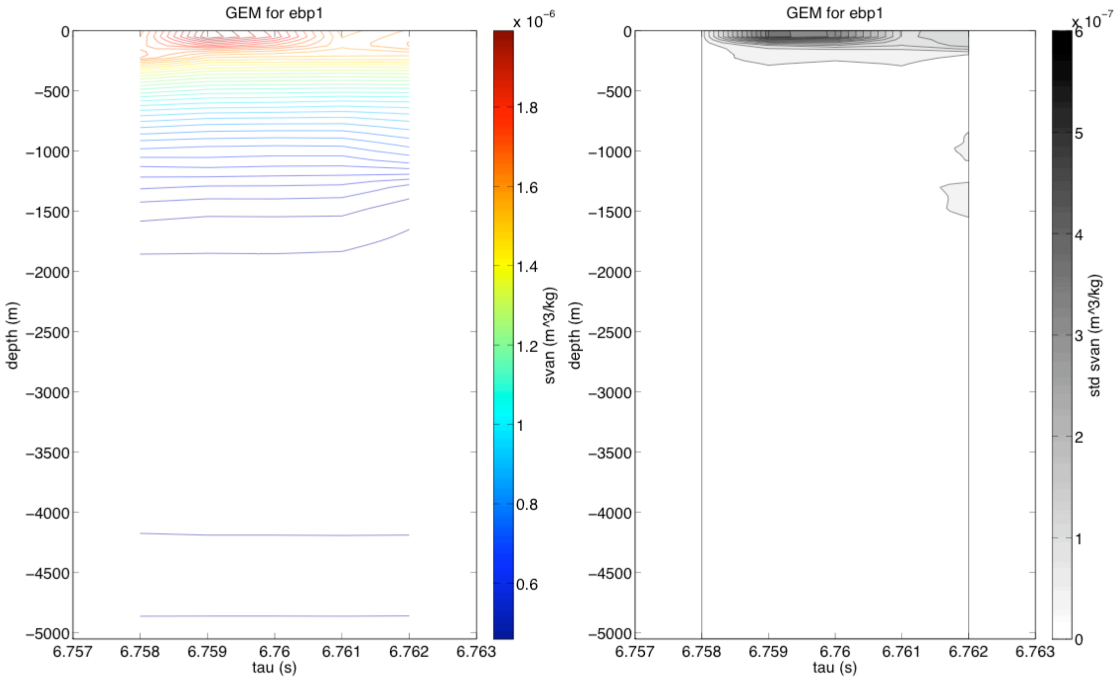


Figure 22.18 *The GEM at EBP1 for specific volume anomaly (m^3/kg). Contour plots of (left) the mean structure and (right) the standard deviation.*

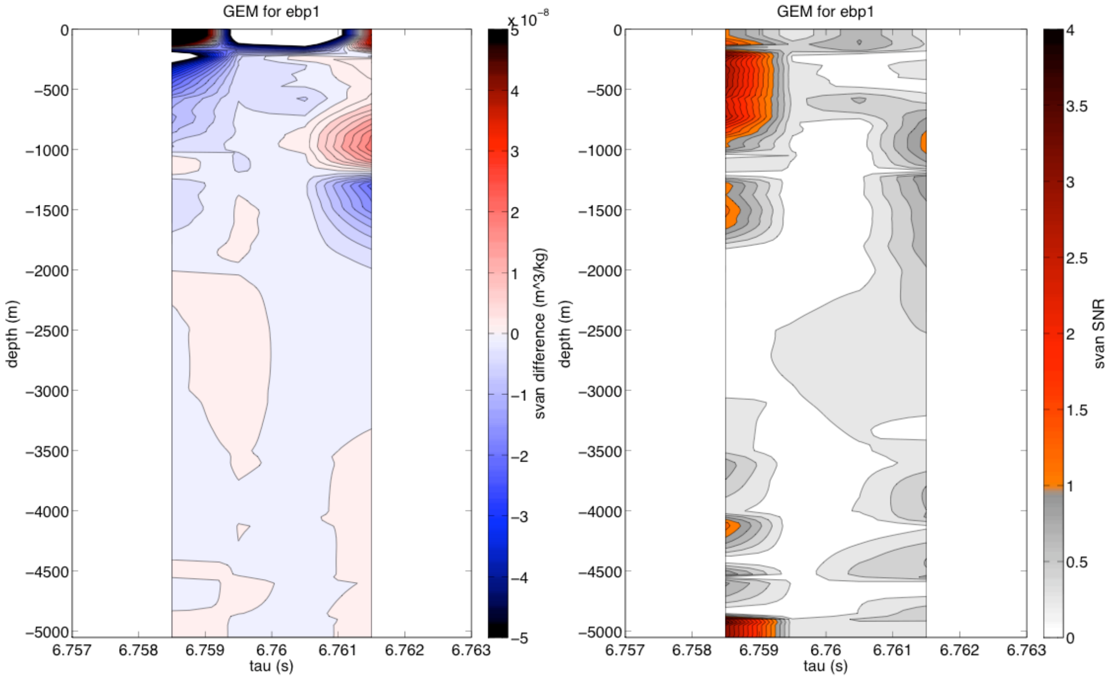


Figure 22.19 *The GEM at EBP1 for specific volume anomaly. (The same as Figure 22.6).*

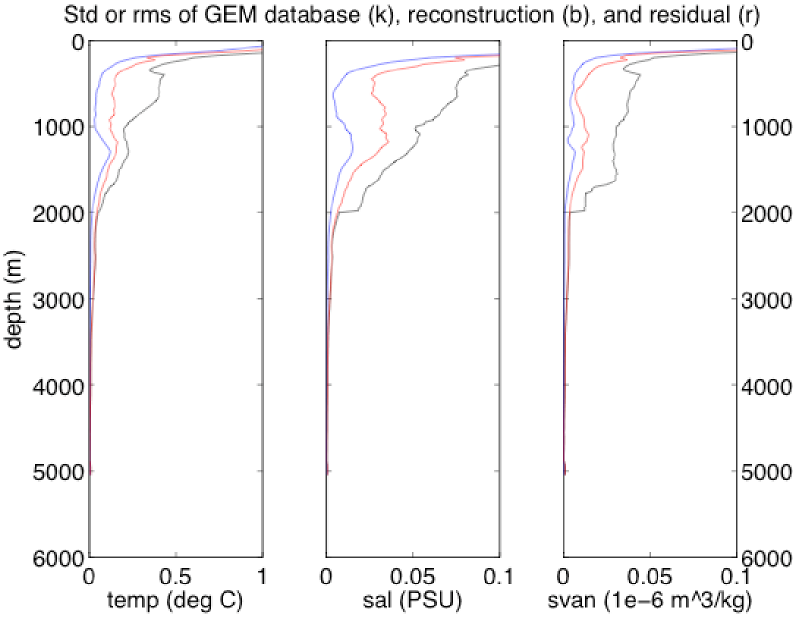


Figure 22.20 *The amount of variance recovered by the GEM-reconstructed profiles at EBP1. For (left) temperature, (middle) salinity, and (right) specific volume anomaly, the standard deviation of the GEM database is in black, the standard deviation of the GEM is in blue, and the rms of the residual between original and reconstructed profiles is in red.*

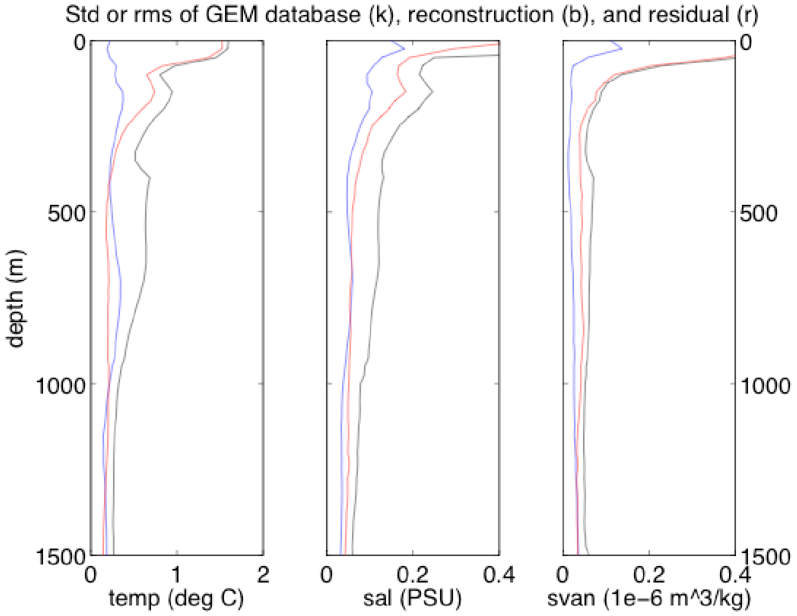


Figure 22.21 *The amount of variance recovered by the profile-based GEM-reconstructed profiles at EBP1. Otherwise the same as Figure 22.20.*

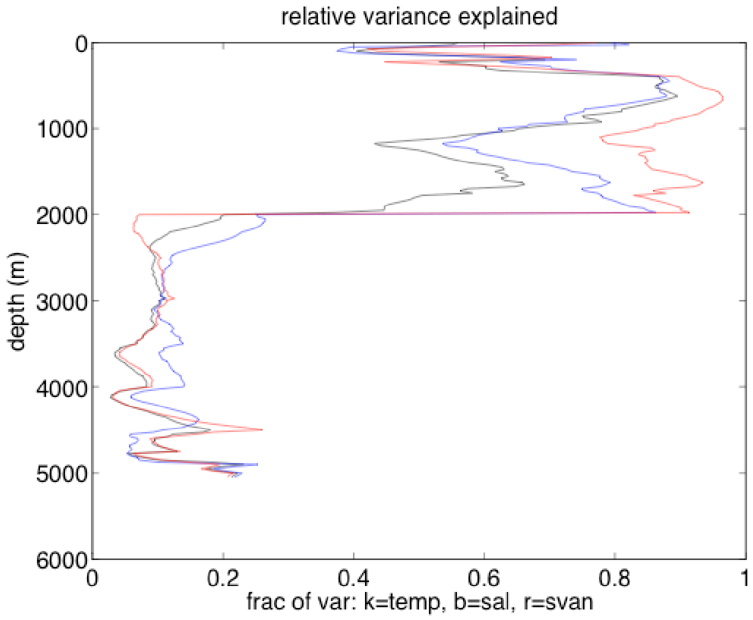


Figure 22.22 *The fraction of variance recovered by the GEM-reconstructed profiles at EBP1. The ratio of 1 – [rms(residual)/std(GEM)]^2 is shown for temperature (black), salinity (blue), and specific volume anomaly (red).*

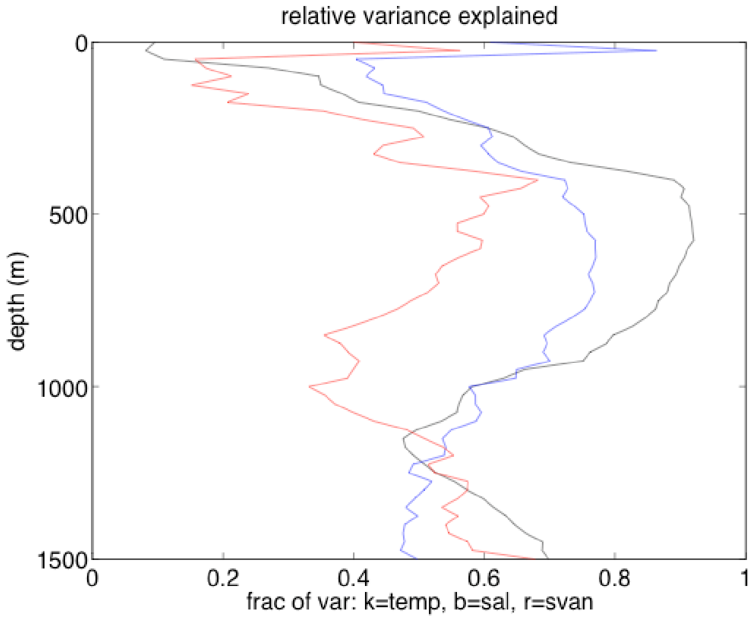


Figure 22.23 *The fraction of variance recovered by the profile-based GEM-reconstructed profiles at EBP1. Otherwise the same as Figure 22.22.*

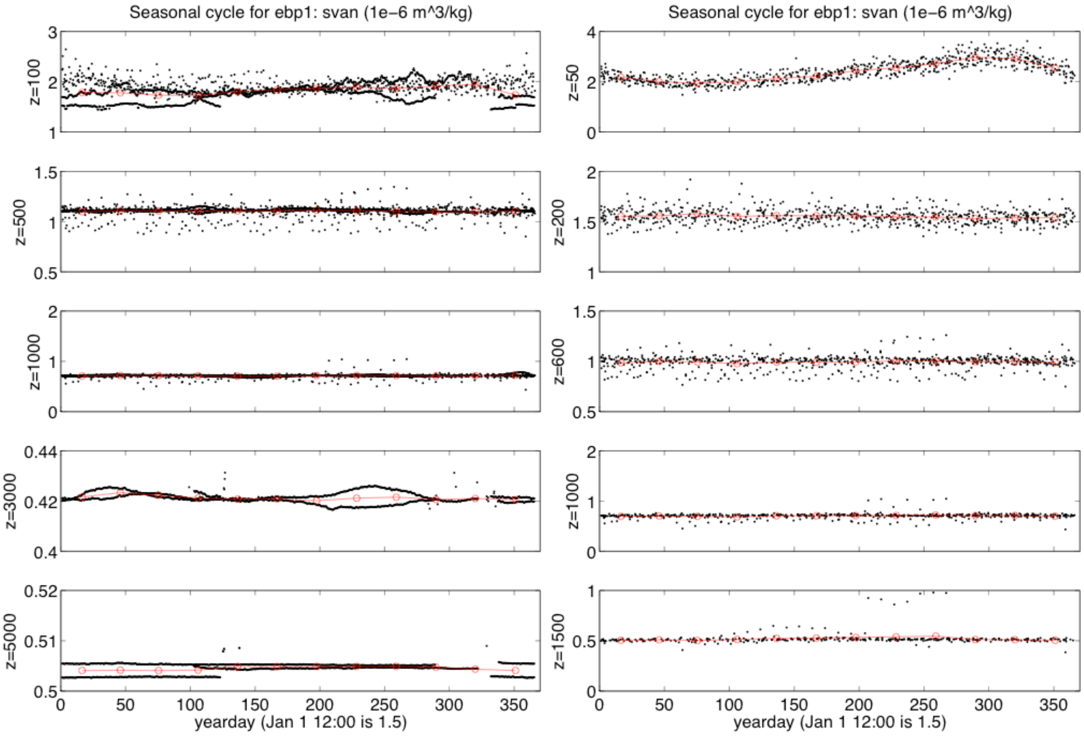


Figure 22.24 *The seasonal evolution in specific volume anomaly from the GEMs at EBP1, (left) the GEM with all data and (right) the profile-based GEM. The levels are the same as in Figures 22.14 and 22.17, respectively. The seasonal climatology in red is calculated by binning the data every month.*

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Appendix A - Details of Instruments Lowered on CTD Calibration Casts

Cruise Cast Number	Instrument Details			
	Type	s/n	pre- or post-deployment calibration	comments
1	SMP	3217	Pre-deployment	
	SMP	3220	Pre-deployment	
	SMP	3480	Pre-deployment	
	SMP	3482	Pre-deployment	
	SMP	3248	Pre-deployment	
	SMP	3249	Pre-deployment	
	SMP	3251	Pre-deployment	C – 0.1 mS/cm lower than CTD
	SMP	3252	Pre-deployment	
	SMP	3253	Pre-deployment	
	SMP	3254	Pre-deployment	
	SMP	3255	Pre-deployment	
	SMP	3256	Pre-deployment	
2	SMP	3257	Pre-deployment	
	SMP	3259	Pre-deployment	
	SMP	3264	Pre-deployment	
	SMP	3265	Pre-deployment	
	SMP	3266	Pre-deployment	
	SMP	3268	Pre-deployment	
	SMP	3269	Pre-deployment	
	SMP	3270	Pre-deployment	
	SMP	3271	Pre-deployment	
	SMP	3272	Pre-deployment	C – poor, cell cleaned so calibration invalid
	SMP	3274	Pre-deployment	
	SMP	3483	Pre-deployment	
4	SMP	5485	Pre-deployment	
	SMP	3277	Pre-deployment	
	SMP	3484	Pre-deployment	
	SMP	3251	Pre-deployment	
	SMP	3486	Pre-deployment	
	SMP	3890	Pre-deployment	
	SMP	3891	Pre-deployment	
	SMP	3892	Pre-deployment	
	SMP	3893	Pre-deployment	
	SMP	3900	Pre-deployment	
	SMP	3901	Pre -deployment	
	SMP	3903	Pre-deployment	

Table A.1 *Calibration Casts during D344*

5	SMP	3207	Post-deployment	3500m rated – P wrapped
	SMP	3212	Post-deployment	3500m rated – P wrapped
	SMP	3213	Post-deployment	3500m rated – P wrapped
	SMP	3214	Post-deployment	3500m rated – P wrapped
	SMP	5243	Post-deployment	
	SMP	5244	Post-deployment	
	SMP	6328	Post-deployment	
	SMP	6329	Post-deployment	
	SMP	6330	Post-deployment	
	SMP	6333	Post-deployment	
	SMP	6334	Post-deployment	
	SMP	5245	Post-deployment	
6	SMP	3904	Pre-deployment	
	SMP	3910	Pre-deployment	
	SMP	3911	Pre-deployment	
	SMP	3912	Pre-deployment	
	SMP	3913	Pre-deployment	C – BAD PUMP
	SMP	3916	Pre-deployment	
	SMP	3918	Pre-deployment	
	SMP	5484	Pre-deployment	
	SMP	6335	Pre-deployment	
	SMP	5486	Pre-deployment	
	SMP	5487	Pre-deployment	
	SMP	5488	Pre-deployment	
7	SMP	3223	Post-deployment	
	SMP	3228	Post-deployment	
	SMP	3229	Post-deployment	C – BAD PUMP
	SMP	3230	Post-deployment	
	SMP	3231	Post-deployment	
	SMP	3232	Post-deployment	
	SMP	3233	Post-deployment	
	SMP	4305	Post-deployment	C – 0.05 mS/cm lower than CTD
	SMP	3906	Post-deployment	
	SMP	3907	Post-deployment	
	SMP	3928	Post-deployment	
	SMP	3919	Post-deployment	
8	SMP	5766	Pre-deployment	
	SMP	5767	Pre-deployment	
	SMP	5768	Pre-deployment	
	SMP	5770	Pre-deployment	
	SMP	5771	Pre-deployment	
	SMP	5762	Pre-deployment	
	SMP	5773	Pre-deployment	
	SMP	5774	Pre-deployment	
	SMP	5775	Pre-deployment	
	SMP	5763	Pre-deployment	
	SMP	6830	Pre-deployment	
	SMP	5778	Pre-deployment	

Table A.2 *Calibration Casts 5 → 8*

9	SMP	5779	Pre-deployment	
	SMP	5780	Post-deployment	
	SMP	5781	Post-deployment	
	SMP	5782	Post-deployment	
	SMP	5783	Post-deployment	
	SMP	5784	Post-deployment	
	SMP	5785	Post-deployment	
	SMP	5786	Post-deployment	
	SMP	5787	Post-deployment	
	SMP	5788	Post-deployment	
	SMP	5789	Post-deployment	
	SMP	5776	Post-deployment	
10	IMP	3282	Pre-deployment	
	IMP	3284	Pre-deployment	
	IMP	4718	Pre-deployment	
	IMP	4179	Pre-deployment	
	IMP	4180	Pre-deployment	
	IMP	4184	Pre-deployment	
	IMP	4461	Pre-deployment	
	IMP	4462	Pre-deployment	
	IMP	4464	Pre-deployment	
	IMP	4473	Pre-deployment	
	SMP	5764	Pre-deployment	
	SMP	5765	Pre-deployment	
11	SMP	3258	Post-deployment	
	SMP	4306	Post-deployment	P – very high >50 dbar above CTD
	SMP	4307	Post-deployment	P – very high >80 dbar above CTD
	SMP	5238	Post-deployment	
	SMP	5239	Post-deployment	
	SMP	5240	Post-deployment	
	SMP	5241	Post-deployment	
	SMP	5242	Post-deployment	
	SMP	5246	Post-deployment	P – very low >120 dbar below CTD
	SMP	5247	Post-deployment	
	SMP	3244	Post-deployment	
	SMP	3902	Post-deployment	
12	SMP	3905	Post-deployment	
	SMP	3930	Post-deployment	
	SMP	3931	Post-deployment	
	SMP	3932	Post-deployment	
	SMP	3933	Post-deployment	
	SMP	3934	Post-deployment	
	SMP	6112	Post-deployment	
	SMP	6113	Post-deployment	
	SMP	6114	Post-deployment	
	SMP	6115	Post-deployment	
	SMP	6116	Post-deployment	
	SMP	6117	Post-deployment	

Table A.3 *Calibration Casts 9 → 12*

13	SMP	6137	Post-deployment	
	SMP	6126	Post-deployment	
	SMP	6127	Post-deployment	
	SMP	6324	Post-deployment	
	SMP	6325	Post-deployment	
	SMP	6326	Post-deployment	
	SMP	6320	Post-deployment	
	SMP	6118	Post-deployment	
	SMP	6119	Post-deployment	
	SMP	6120	Post-deployment	
	SMP	6122	Post-deployment	
	SMP	6123	Post-deployment	
	SMP	6124	Post-deployment	
	SMP	6125	Post-deployment	
27	SMP	6323	Post-deployment	
	SMP	6121	Post-deployment	
	SMP	6802	Post-deployment	
	SMP	6800	Post-deployment	
	SMP	6801	Post-deployment	
	SMP	6799	Post-deployment	
	SMP	6128	Post-deployment	
	SMP	6129	Post-deployment	
	SMP	6327	Post-deployment	P – large offset > 40dbar below CTD
	SMP	6321	Post-deployment	
	SMP	6331	Post-deployment	
	SMP	6322	Post-deployment	
	SMP	6332	Post-deployment	
	SMP	6798	Post-deployment	

Table A.4 *Calibration Casts 13 and 27.*

Appendix B - Instrument Record Lengths

Mooring	Instrument	Serial Number	Approx Depth (dbar)	Date of first usable record	Date of last usable record	Comment
ebp2_1_200565	PIES	131				
ebh4_6_200837	SBE37	4307	295	19 Nov 2009	24 Oct 2009	C - Spike
	SBE37	5238	398	19 Nov 2009	24 Oct 2009	
	SBE37	5240	495	19 Nov 2009	24 Oct 2009	
	SBE37	5239	600	19 Nov 2009	24 Oct 2009	
	SBE37	5242	702	19 Nov 2009	24 Oct 2009	
	SBE37	5241	806	19 Nov 2009	24 Oct 2009	
ebh5_4_200842	SBE37	3214	118	21 Nov 2009	24 Oct 2009	C – low in Late Dec
	SBE37	3213	195	21 Nov 2009	24 Oct 2009	
	SBE37	3212	270	21 Nov 2009	24 Oct 2009	
	S4	35612576	440	21 Nov 2009	24 Oct 2009	Heading wrapped?
	S4	35612577	742	21 Nov 2009	24 Oct 2009	Heading wrapped?
ebm1_3_200838	SBE37	4306	509	20 Nov 2009	24 Oct 2009	P - Spike
ebm4_3_200839	SBE37	3258	294	20 Nov 2009	24 Oct 2009	PCT - Spike at start
ebm5_3_200840	SBE37	3208	-	-	-	LOST
ebm6_3_200841	SBE37	3207	104	20 Nov 2009	24 Oct 2009	C - 3 spikes
ebh3_5_200836	SBE37	5243	858	19 Nov 2009	25 Oct 2009	
	SBE37	5244	970	19 Nov 2009	25 Oct 2009	
	SBE37	6328	1088	19 Nov 2009	25 Oct 2009	
	SBE37	6329	1200	19 Nov 2009	25 Oct 2009	
	SBE37	6330	1425	19 Nov 2009	25 Oct 2009	P - Large drift
ebh2_5_200835	SBE37	6333	1610	19 Nov 2009	25 Oct 2009	
	SBE37	6334	1830	19 Nov 2009	25 Oct 2009	
	SBE37	5245	2045	19 Nov 2009	25 Oct 2009	P - Large drift
ebh1_5_200833	SBE37	5246	2478	18 Nov 2009	26 Oct 2009	P – large drift
	SBE37	5247	3056	18 Nov 2009	26 Oct 2009	P – large drift
ebhi_5_200822	SBE37	3244	3445	29 Oct 2008	28 Oct 2009	C -Spike in May
	SBE37	3902	4018	29 Oct 2008	28 Oct 2009	P – large drift
	SBE37	3905	4563	29 Oct 2008	28 Oct 2009	P - Spike at start
ebl3_2_200734	BPR26	0390	5198	4 Nov 2007	26 Oct 2009	Clock drift unknown
	BPR26	0391	5198	4 Nov 2007	26 Oct 2009	Clock drift unknown
ebl4_2_200735	BPR26	0394	3057	5 Nov 2007	26 Oct 2009	Clock drift unknown
eb1_7_200823	SBE37	3223	30	30 Oct 2008	29 Oct 2009	C – poor record March
	SBE37	3228	80	30 Oct 2008	29 Oct 2009	
	SBE37	3229	170	30 Oct 2008	29 Oct 2009	
	SBE37	3230	230	30 Oct 2008	29 Oct 2009	TC – odd record April
	SBE37	3231	310	30 Oct 2008	29 Oct 2009	
	SBE37	3232	390	30 Oct 2008	29 Oct 2009	
	SBE37	3233	590	30 Oct 2008	29 Oct 2009	
	SBE37	4305	805	30 Oct 2008	29 Oct 2009	
	SBE37	3906	1000	30 Oct 2008	29 Oct 2009	C – poor record June
	SBE37	3907	1205	30 Oct 2008	29 Oct 2009	C – poor record April
	SBE37	3908	-	-	-	FLOODED
	SBE37	3919	2020	30 Oct 2008	29 Oct 2009	
	SBE37	3928	2530	30 Oct 2008	29 Oct 2009	
	SBE37	3930	3040	30 Oct 2008	29 Oct 2009	
	SBE37	3931	3552	30 Oct 2008	29 Oct 2009	
	SBE37	3932	4068	30 Oct 2008	29 Oct 2009	

Table B.1 *Summary of the instrument record lengths recovered by D344*

Mooring	Instrument	Serial Number	Depth (m)	Date of first usable record	Date of last usable record	Comment
eb1 (cont)	SBE37	3933	4563	30 Oct 2008	29 Oct 2009	
	SBE37	3934	5081	30 Oct 2008	29 Oct 2009	
mar3_5_200826	SBE37	6112	2484	4 Nov 2008	3 Nov 2009	
	SBE37	6113	3003	4 Nov 2008	3 Nov 2009	
	SBE37	6114	3511	4 Nov 2008	3 Nov 2009	
	SBE37	6115	4075	4 Nov 2008	3 Nov 2009	
	SBE37	6116	4586	4 Nov 2008	3 Nov 2009	P – odd drift
	SBE37	6117	5129	4 Nov 2008	3 Nov 2009	P – odd drift
	S4	35612565	5110*	4 Nov 2008	6 Oct 2009	*P – low readings? Short - batteries died
marl1_2_200726	BPR53	0003	5325	27 Oct 2007	6 Nov 2009	
	BPR26	0418	5325	27 Oct 2007	6 Nov 2009	
marl2_2_200725	BPR53	0002	5162	25 Oct 2007	3 Nov 2009	T – rise during Aug – Oct 2009?
mar2_5_200829	-	-	-	-	-	LOST
mar1_5_200828	SBE37	6137	38	8 Nov 2008	6 Nov 2009	17 days missing 22 May → 8 June
	SBE37	6323	124	8 Nov 2008	6 Nov 2009	
	SBE37	6324	246	8 Nov 2008	6 Nov 2009	
	SBE37	6325	169	8 Nov 2008	6 Nov 2009	
	SBE37	6326	400	8 Nov 2008	6 Nov 2009	
	SBE37	6320	325	8 Nov 2008	6 Nov 2009	
	SBE37	6118	601	8 Nov 2008	6 Nov 2009	
	SBE37	6119	803	8 Nov 2008	6 Nov 2009	
	SBE37	6120	1200	8 Nov 2008	6 Nov 2009	
	SBE37	6121	1001	8 Nov 2008	6 Nov 2009	
	SBE37	6122	1620	8 Nov 2008	6 Nov 2009	P – large drift
	SBE37	6123	2033	8 Nov 2008	6 Nov 2009	P – large drift
	SBE37	6124	2555	8 Nov 2008	6 Nov 2009	P – large drift
	SBE37	6125	3075	8 Nov 2008	6 Nov 2009	P – large drift
	SBE37	6126	3558	8 Nov 2008	6 Nov 2009	P – large drift
	SBE37	6127	5158	8 Nov 2008	6 Nov 2009	P – large drift
	SBE37	6128	4135	8 Nov 2008	6 Nov 2009	P – large drift
	SBE37	6129	4635	8 Nov 2008	6 Nov 2009	P – large drift
	S4	35612568	5000	8 Nov 2008	6 Nov 2009	SPIKEY
mar3_5_200826	SBE37	6112	2485	4 Nov 2008	3 Nov 2009	P – large drift
	SBE37	6113	3004	4 Nov 2008	3 Nov 2009	P – large drift
	SBE37	6114	3512	4 Nov 2008	3 Nov 2009	P – large drift
	SBE37	6115	4076	4 N0ov 2008	3 Nov 2009	P – large drift
	SBE37	6116	4586	4 Nov 2008	3 Nov 2009	P – weird drift
	SBE37	6117	5128	4 Nov 2008	3 Nov 2009	P – weird drifts
	S4	35612565	5110?	4 Nov 2008	6 Oct 2009	Pressure suspect
mar0_2_200831	SBE37	6327	5475	9 Nov 2008	8 Nov 2009	P – large drift - reversed
	SBE37	6321	5475	9 Nov 2008	8 Nov 2009	P – large drift
	SBE37	6331	5580	9 Nov 2008	8 Nov 2009	P – large drift
	SBE37	6322	5315	9 Nov 2008	8 Nov 2009	P – large drift
	SBE37	6332	5430	9 Nov 2008	8 Nov 2009	P – weird drift
	BPR53	0031	-	-	-	FLOODED
wb6_2_200913	SBE37	6798	5150	24 Apr 2009	15 Nov 2009	P – large drift
	SBE37	6801	5250	24 Apr 2009	15 Nov 2009	P – large drift
	SBE37	6799	5370	24 Apr 2009	15 Nov 2009	P – large drift
	SBE37	6802	5490	24 Apr 2009	15 Nov 2009	P – large drift
	SBE37	6800	5600	24 Apr 2009	15 Nov 2009	P – large drift
	BPR53	0032	5608	24 Apr 2009	15 Nov 2009	

Table B.2 *Summary of the instrument record lengths recovered by D344*

Appendix C – Acoustic Release Record

Serial Number	Type	Deployed On	Date Deployed	Lat [N]	Long [W]	Corr. Depth [m]	Tested Depth [m]
917	AR861	EBL5	25/10/2009	27°52.09	13°30.87	1009	3500
928	" "	MARL2	03/11/2009	23°57.95	41°05.56	5060	5470
826	" "	MARL2	" "	" "	" "	" "	5470
323	" "	NOG	04/11/2009	23°17.09	41°50.08	4261	5470
243	" "	MAR(3)	04/11/2009	23°52.24	41°05.29	5051	5008
361	" "	WB6	15/11/2009	26°29.67	70°31.30	5516	5450
827	" "	WB6	" "	" "	" "	" "	5450
248	" "	EB1	30/10/2009	23°45.34	24°09.25	5089	5008
687	" "	EB1	" "	" "	" "	" "	5008
260	" "	EBH1	26/10/2009	27°17.13	15°25.73	3011	3500
258	" "	EBH2	25/10/2009	27°36.71	14°12.73	2018	3500
916	" "	EBH3	25/10/2009	27°48.49	13°44.80	1416	3500
364	" "	EBH4	24/10/2009	27°51.01	13°32.38	1055	3500
918	" "	EBH5	24/10/2009	27°49.50	13°32.75	1061	3500
821	" "	EBHI	28/10/2009	24°56.81	21°15.78	4501	4496
262	" "	EBL3	29/10/2009	23°48.23	24°06.35	5096	5008
316	" "	EBL3	" "	" "	" "	" "	5008
322	" "	EBL4	26/10/2009	27°17.17	15°25.76	3009	3500
925	" "	MAR(0)	08/11/2009	25°06.35	52°00.62	5508	5203
930	" "	MAR(0)	" "	" "	" "	" "	5450
908	" "	MAR(1)	07/11/2009	24°10.14	49°43.00	5214	5203
822	" "	MAR(1)	" "	" "	" "	" "	5203
370	" "	MARL1	06/11/2009	24°12.02	49°44.26	5227	5470
216	RT661	MARL1	" "	" "	" "	" "	5470
319	AR861	MAR(2)	07/11/2009	24°10.98	49°44.57	5221	5470
252343-004	LRT	EBM6	24/10/2009	27°55.27	13°19.99	103	200
252343-006	LRT	EBM5	24/10/2009	27°54.67	13°21.65	210	300
245798-002	LRT	EBM4	24/10/2009	27°54.49	13°22.09	295	300
245798-004	LRT	EBM1	24/10/2009	27°53.67	13°24.36	501	480

Table C.1 *Acoustic release record for cruise D344. All releases were serviced and re-batteried prior to testing and deployment.*

Appendix D - Instrument Setup Details

EBM6_4_200923

SBE37 MicroCAT	SMP CTD unit, s/n:	**3217**
	Sample interval:	1800 seconds
	Start Date:	24 Oct 2009
	Start time:	14:00
	Target depth:	95 m

EBM5_4_200924

SBE37 MicroCAT	SMP CTD unit, s/n:	**3220**
	Sample interval:	1800 seconds
	Start Date:	24 Oct 2009
	Start time:	14:00
	Target depth:	176 m

EBM4_4_200925

SBE37 MicroCAT	SMP CTD unit, s/n:	**3480**
	Sample interval:	1800 seconds
	Start Date:	24 Oct 2009
	Start time:	14:00
	Target depth:	275 m

EBM1_4_200926

SBE37 MicroCAT	SMP CTD unit, s/n:	**3482**
	Sample interval:	1800 seconds
	Start Date:	24 Oct 2009
	Start time:	14:00
	Target depth:	420 m

EBH5_5_200929

SBE37 MicroCAT	SMP CTD unit, s/n:	**3248**
	Sample interval:	1800 seconds
	Start Date:	24 Oct 2009
	Start time:	18:00
	Target depth:	107 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3249**
	Sample interval:	1800 seconds
	Start Date:	24 Oct 2009
	Start time:	18:00
	Target depth:	175 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3483**
	Sample interval:	1800 seconds
	Start Date:	24 Oct 2009
	Start time:	18:00
	Target depth:	250 m
Interocean S4	Current Meter, s/n:	**35612572**
	Header:	ebh5_2009
	Sampling period:	1 min
	Channels to average:	2 (Hx), 3 (Hy), 4 (Con), 5 (T), 6 (z)
	Special record block count:	48 Channels: 2,3,4,5,6
	Write mode:	Internal
	Log mode:	North/East
	Start date:	24 Oct 2009
	Tart time:	18:00
	Target depth:	442 m
Interocean S4	Current Meter, s/n:	**35612571**
	Header:	EBH5_2009
	Sampling period:	1 min
	Channels to average:	2 (Hx), 3 (Hy), 4 (Con), 5 (T), 6 (z)
	Special record block count:	48 Channels: 2,3,4,5,6
	Write mode:	Internal
	Log mode:	North/East
	Start date:	24 Oct 2009
	Tart time:	18:00
	Target depth:	734 m

EBH4_7_20098

SBE37 MicroCAT	SMP CTD unit, s/n:	**3252**
	Sample interval:	1800 seconds
	Start Date:	24 Oct 2009
	Start time:	18:00
	Target depth:	325 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3253**
	Sample interval:	1800 seconds
	Start Date:	24 Oct 2009
	Start time:	18:00
	Target depth:	400 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3254**
	Sample interval:	1800 seconds
	Start Date:	24 Oct 2009
	Start time:	18:00
	Target depth:	500 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3253**
	Sample interval:	1800 seconds
	Start Date:	24 Oct 2009
	Start time:	18:00
	Target depth:	600 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3256**
	Sample interval:	1800 seconds
	Start Date:	24 Oct 2009
	Start time:	18:00
	Target depth:	700 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3257**
	Sample interval:	1800 seconds
	Start Date:	24 Oct 2009
	Start time:	18:00
	Target depth:	800 m

EBL5 _1_200927

SBE53 BPR	BPR unit, s/n:	**0040**
	INITLOGGING:	Y
	Info header:	EBL5 replacement for EBP2
	Tide interval:	30 mins
	Tide Measurement Duration:	30 mins
	Reference sample freq:	96
	Start:	25 Oct 2009 @ 09:00:00
	Target depth:	1000 m

EBH3_6_200930

SBE37 MicroCAT	SMP CTD unit, s/n:	**3268**
	Sample interval:	1800 seconds
	Start Date:	25 Oct 2009
	Start time:	10:00
	Target depth:	900 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3266**
	Sample interval:	1800 seconds
	Start Date:	25 Oct 2009
	Start time:	10:00
	Target depth:	1000 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3265**
	Sample interval:	1800 seconds
	Start Date:	25 Oct 2009
	Start time:	10:00
	Target depth:	1100 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3264**
	Sample interval:	1800 seconds
	Start Date:	25 Oct 2009
	Start time:	10:00
	Target depth:	1200 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3259**
	Sample interval:	1800 seconds
	Start Date:	25 Oct 2009
	Start time:	10:00
	Target depth:	1400 m

EBH2_6_200931

SBE37 MicroCAT	SMP CTD unit, s/n:	**3271**
	Sample interval:	1800 seconds
	Start Date:	25 Oct 2009
	Start time:	12:00
	Target depth:	1600 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3269**
	Sample interval:	1800 seconds
	Start Date:	25 Oct 2009
	Start time:	12:00
	Target depth:	1800 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3270**
	Sample interval:	1800 seconds
	Start Date:	25 Oct 2009
	Start time:	12:00
	Target depth:	2000 m

EBH1_6_200932

SBE37 MicroCAT	SMP CTD unit, s/n:	**3272**
	Sample interval:	1800 seconds
	Start Date:	26 Oct 2009
	Start time:	09:00
	Target depth:	2500 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3274**
	Sample interval:	1800 seconds
	Start Date:	26 Oct 2009
	Start time:	09:00
	Target depth:	3000 m

EBL4 _3_200933

SBE26 BPR	BPR unit, s/n:	**0395**
	Memory reset	Y
	Tide interval:	30 mins
	Wave Burst:	9999
	Wave samples:	68
	Number of 0.25s periods:	33
	Start:	26 Oct 2009 @ 09:10:00
	Target depth:	3004 m

EBHi_6_200934

SBE37 MicroCAT	SMP CTD unit, s/n:	**5485**
	Sample interval:	1800 seconds
	Start Date:	28 Oct 2009
	Start time:	12:00
	Target depth:	3500 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3277**
	Sample interval:	1800 seconds
	Start Date:	28 Oct 2009
	Start time:	12:00
	Target depth:	4000 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3484**
	Sample interval:	1800 seconds
	Start Date:	28 Oct 2009
	Start time:	12:00
	Target depth:	4500 m

EBL3 _3_200936

SBE26 BPR	BPR unit, s/n:	**0392**
	Memory reset	Y
	Tide interval:	30 mins
	Wave Burst:	9999
	Wave samples:	68
	Number of 0.25s periods:	33
	Start:	29 Oct 2009 @ 14:30:00
	Target depth:	5083 m
SBE53 BPR	BPR unit, s/n:	**0419**
	INITLOGGING:	Y
	Info header:	EBL3 deployed D344
	Tide interval:	30 mins
	Tide Measurement Duration:	30 mins
	Reference sample freq:	96
	Start:	29 Oct 2009 @ 16:00:00
	Target depth:	5083 m

EB1_8_200935

SBE37 MicroCAT	SMP CTD unit, s/n:	**3251**
	Sample interval:	1800 seconds
	Start Date:	30 Oct 2009
	Start time:	09:00
	Target depth:	50 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3486**
	Sample interval:	1800 seconds
	Start Date:	30 Oct 2009
	Start time:	09:00
	Target depth:	100 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3890**
	Sample interval:	1800 seconds
	Start Date:	30 Oct 2009
	Start time:	09:00
	Target depth:	175 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3891**
	Sample interval:	1800 seconds
	Start Date:	30 Oct 2009
	Start time:	09:00
	Target depth:	250 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3892**
	Sample interval:	1800 seconds
	Start Date:	30 Oct 2009
	Start time:	09:00
	Target depth:	325 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3893**
	Sample interval:	1800 seconds
	Start Date:	30 Oct 2009
	Start time:	09:00
	Target depth:	400 m

SBE37 MicroCAT	SMP CTD unit, s/n:	**3900**
	Sample interval:	1800 seconds
	Start Date:	30 Oct 2009
	Start time:	09:00
	Target depth:	600 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3901**
	Sample interval:	1800 seconds
	Start Date:	30 Oct 2009
	Start time:	09:00
	Target depth:	800 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3903**
	Sample interval:	1800 seconds
	Start Date:	30 Oct 2009
	Start time:	09:00
	Target depth:	1000 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3904**
	Sample interval:	1800 seconds
	Start Date:	30 Oct 2009
	Start time:	09:00
	Target depth:	1200 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3910**
	Sample interval:	1800 seconds
	Start Date:	30 Oct 2009
	Start time:	09:00
	Target depth:	1600 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3911**
	Sample interval:	1800 seconds
	Start Date:	30 Oct 2009
	Start time:	09:00
	Target depth:	2000 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3912**
	Sample interval:	1800 seconds
	Start Date:	30 Oct 2009
	Start time:	09:00
	Target depth:	2500 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5486**
	Sample interval:	1800 seconds
	Start Date:	30 Oct 2009
	Start time:	09:00
	Target depth:	3000 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**3916**
	Sample interval:	1800 seconds
	Start Date:	30 Oct 2009
	Start time:	09:00
	Target depth:	3500 m

SBE37 MicroCAT SMP CTD unit, s/n: **3918**
Sample interval: 1800 seconds
Start Date: 30 Oct 2009
Start time: 09:00
Target depth: 4000 m

SBE37 MicroCAT SMP CTD unit, s/n: **5484**
Sample interval: 1800 seconds
Start Date: 30 Oct 2009
Start time: 09:00
Target depth: 4500 m

SBE37 MicroCAT SMP CTD unit, s/n: **6335**
Sample interval: 1800 seconds
Start Date: 30 Oct 2009
Start time: 09:00
Target depth: 5000 m

MAR3_6_200937

SBE37 MicroCAT SMP CTD unit, s/n: **6334**
Sample interval: 1800 seconds
Start Date: 3 Nov 2009
Start time: 12:00
Target depth: 5000 m

SBE37 MicroCAT SMP CTD unit, s/n: **6330**
Sample interval: 1800 seconds
Start Date: 3 Nov 2009
Start time: 12:00
Target depth: 4500 m

SBE37 MicroCAT SMP CTD unit, s/n: **6329**
Sample interval: 1800 seconds
Start Date: 3 Nov 2009
Start time: 12:00
Target depth: 4000 m

SBE37 MicroCAT SMP CTD unit, s/n: **6328**
Sample interval: 1800 seconds
Start Date: 3 Nov 2009
Start time: 12:00
Target depth: 3500 m

SBE37 MicroCAT SMP CTD unit, s/n: **5488**
Sample interval: 1800 seconds
Start Date: 3 Nov 2009
Start time: 12:00
Target depth: 3000 m

SBE37 MicroCAT SMP CTD unit, s/n: **5487**
Sample interval: 1800 seconds
Start Date: 3 Nov 2009
Start time: 12:00
Target depth: 2500 m

Interocean S4	Current Meter, s/n:	**35612573**
	Header:	MAR3_DEPLOYED_3NOV09
	Sampling period:	1 min
	Channels to average:	2 (Hx), 3 (Hy), 4 (Con), 5 (T), 6 (z)
	Special record block count:	48 Channels: 2,3,4,5,6
	Write mode:	Internal
	Log mode:	North/East
	Start date:	3 Nov 2009
	Start time:	13:00
	Target depth:	5015 m

MARL2_3_200938

SBE53 BPR	BPR unit, s/n:	**0038**
	INITLOGGING:	Y
	Info header:	MARL2_DEPLOYED_D344_2009
	Tide interval:	30 mins
	Tide Measurement Duration:	30 mins
	Reference sample freq:	96
	Start:	3 Nov 2009 @ 15:00:00
	Target depth:	5060 m
SBE53 BPR	BPR unit, s/n:	**0013**
	INITLOGGING:	Y
	Info header:	MARL2_DEPLOYED_D344_2009
	Tide interval:	30 mins
	Tide Measurement Duration:	30 mins
	Reference sample freq:	96
	Start:	3 Nov 2009 @ 14:30:00
	Target depth:	5060 m

MARL1_3_200941

SBE53 BPR	BPR unit, s/n:	**0420**
	INITLOGGING:	Y
	Info header:	MARL1_DEPLOYED_D344_2009
	Tide interval:	30 mins
	Tide Measurement Duration:	30 mins
	Reference sample freq:	96
	Start:	6 Nov 2009 @ 18:00:00
	Target depth:	5227 m
SBE26 BPR	BPR unit, s/n:	**0393**
	Memory reset	Y
	Tide interval:	30 mins
	Wave Burst:	9999
	Wave samples:	68
	Number of 0.25s periods:	33
	Start:	6 Nov 2009 @ 18:00:00
	Target depth:	5227 m

MAR1_6_200940

SBE37 MicroCAT	IMP CTD unit, s/n:	**4461**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	50 m
SBE37 MicroCAT	IMP CTD unit, s/n:	**4464**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	100 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5779**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	175 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5780**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	250 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5781**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	325 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5782**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	400 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5783**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	600 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5784**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	600 m
SBE37 MicroCAT	IMP CTD unit, s/n:	**4718**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	800 m

SBE37 MicroCAT	SMP CTD unit, s/n:	**5785**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	1000 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5786**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	1200 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5787**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	1600 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5240**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	2000 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5788**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	2500 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5789**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	3000 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5776**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	3500 m
SBE37 MicroCAT	IMP CTD unit, s/n:	**3282**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	4000 m
SBE37 MicroCAT	IMP CTD unit, s/n:	**3284**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	4500 m
SBE37 MicroCAT	IMP CTD unit, s/n:	**4179**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	12:00
	Target depth:	4995 m

Interocean S4	Current Meter, s/n:	**35612577**
	Header:	MAR1_D344
	Sampling period:	1 min
	Channels to average:	2 (Hx), 3 (Hy), 4 (Con), 5 (T), 6 (z)
	Special record block count:	48 Channels: 2,3,4,5,6
	Write mode:	Internal
	Log mode:	North/East
	Start date:	7 Nov 2009
	Start time:	13:30
	Target depth:	5000 m

MAR2_6_200942

SBE37 MicroCAT	SMP CTD unit, s/n:	**5762**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	16:00
	Target depth:	1100 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5766**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	16:00
	Target depth:	1400 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5767**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	16:00
	Target depth:	1800 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5768**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	16:00
	Target depth:	2250 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5770**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	16:00
	Target depth:	2750 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5771**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	16:00
	Target depth:	3250 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5763**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	16:00
	Target depth:	3750 m

SBE37 MicroCAT	IMP CTD unit, s/n:	**5773**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	16:00
	Target depth:	4250 m
SBE37 MicroCAT	IMP CTD unit, s/n:	**5774**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	16:00
	Target depth:	4750 m
SBE37 MicroCAT	IMP CTD unit, s/n:	**5775**
	Sample interval:	1800 seconds
	Start Date:	7 Nov 2009
	Start time:	16:00
	Target depth:	5160 m
Interocean S4	Current Meter, s/n:	**35612578**
	Header:	MAR2_2009_d344
	Sampling period:	1 min
	Channels to average:	2 (Hx), 3 (Hy), 4 (Con), 5 (T), 6 (z)
	Special record block count:	48 Channels: 2,3,4,5,6
	Write mode:	Internal
	Log mode:	North/East
	Start date:	7 Nov 2009
	Start time:	19:00
	Target depth:	5168 m

MAR0_3_200943

SBE37 MicroCAT	SMP CTD unit, s/n:	**5241**
	Sample interval:	1800 seconds
	Start Date:	8 Nov 2009
	Start time:	16:00
	Target depth:	5100 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5778**
	Sample interval:	1800 seconds
	Start Date:	8 Nov 2009
	Start time:	16:00
	Target depth:	5225 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**6830**
	Sample interval:	1800 seconds
	Start Date:	8 Nov 2009
	Start time:	16:00
	Target depth:	5350 m
SBE37 MicroCAT	IMP CTD unit, s/n:	**4184**
	Sample interval:	1800 seconds
	Start Date:	8 Nov 2009
	Start time:	16:00
	Target depth:	5475 m

SBE37 MicroCAT	IMP CTD unit, s/n:	**4462**
	Sample interval:	1800 seconds
	Start Date:	8 Nov 2009
	Start time:	16:00
	Target depth:	5475 m
SBE53 BPR	BPR unit, s/n:	**0039**
	INITLOGGING:	Y
	Info header:	MAR0_DEPLOYED_D344_2009
	Tide interval:	30 mins
	Tide Measurement Duration:	30 mins
	Reference sample freq:	96
	Start:	8 Nov 2009 @ 15:00:00
	Target depth:	5500 m
SBE53 BPR	BPR unit, s/n:	**0014**
	INITLOGGING:	Y
	Info header:	MAR0_DEPLOYED_D344_2009
	Tide interval:	30 mins
	Tide Measurement Duration:	30 mins
	Reference sample freq:	96
	Start:	8 Nov 2009 @ 15:00:00
	Target depth:	5500 m

WB6_3_200944

SBE37 MicroCAT	SMP CTD unit, s/n:	**5242**
	Sample interval:	1800 seconds
	Start Date:	15 Nov 2009
	Start time:	16:00
	Target depth:	5200 m
SBE37 MicroCAT	IMP CTD unit, s/n:	**4180**
	Sample interval:	1800 seconds
	Start Date:	15 Nov 2009
	Start time:	16:00
	Target depth:	5170 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5764**
	Sample interval:	1800 seconds
	Start Date:	15 Nov 2009
	Start time:	16:00
	Target depth:	5275 m
SBE37 MicroCAT	IMP CTD unit, s/n:	**4473**
	Sample interval:	1800 seconds
	Start Date:	15 Nov 2009
	Start time:	16:00
	Target depth:	5375 m
SBE37 MicroCAT	SMP CTD unit, s/n:	**5765**
	Sample interval:	1800 seconds
	Start Date:	15 Nov 2009
	Start time:	16:00
	Target depth:	5475 m

SBE53 BPR	BPR unit, s/n:	**0037**
	INITLOGGING:	Y
	Info header:	WB6_DEPLOYED_D344
	Tide interval:	30 mins
	Tide Measurement Duration:	30 mins
	Reference sample freq:	96
	Start:	15 Nov 2009 @ 18:00:00
	Target depth:	5488 m
SBE26 BPR	BPR unit, s/n:	**0390**
	Memory reset	Y
	Tide interval:	30 mins
	Wave Burst:	9999
	Wave samples:	68
	Number of 0.25s periods:	33
	Start:	15 Nov 2009 @ 17:30:00
	Target depth:	5488 m

Appendix E – Deployment Tracks

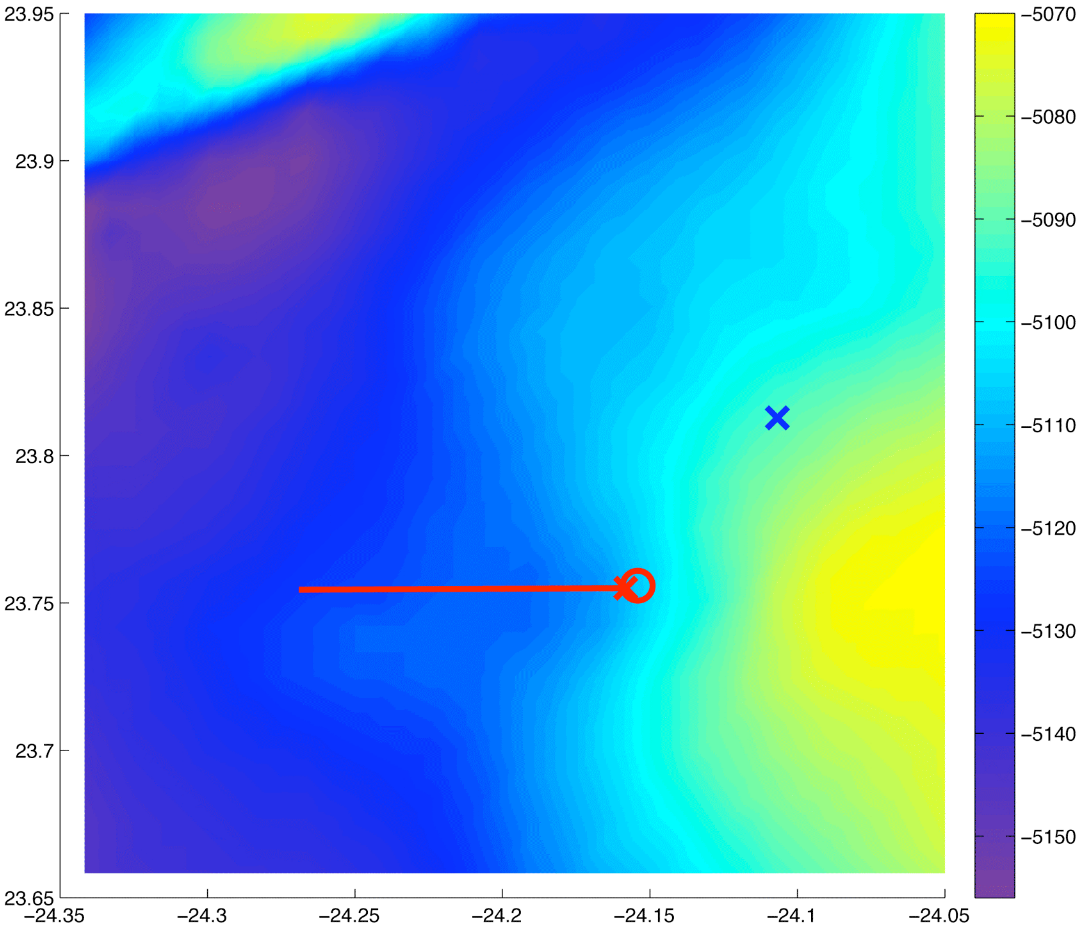


Figure D1 *Region of the EB1 mooring as deployed on cruise D344 showing the deployment track, anchor launch (circle) and seabed position (cross). EB1 = red, EBL3 = blue. NB; for EBL3 there is no deployment track and the seabed position is taken as the anchor launch position.*

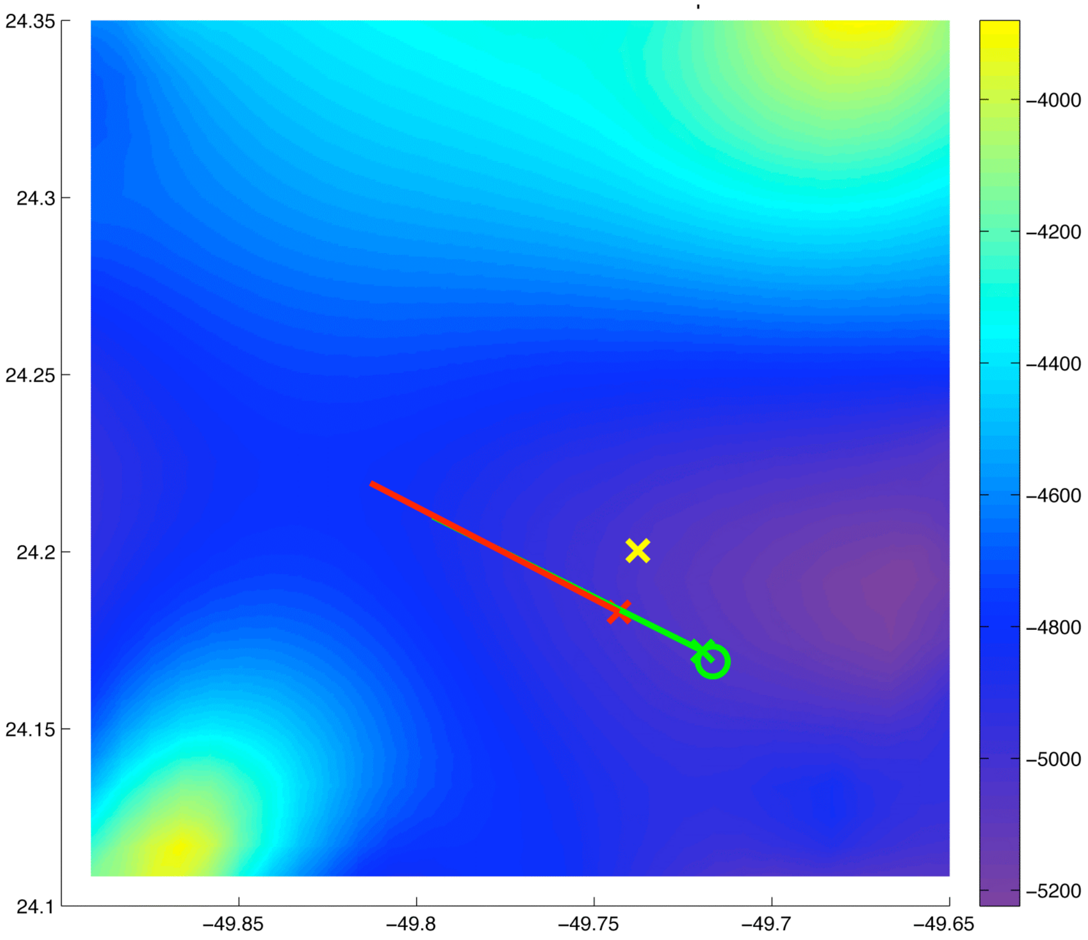


Figure D2 *Region of the MAR1 mooring as deployed on cruise D344 showing the deployment track, anchor launch (circle) and the seabed position (cross). MAR1 = green, MAR2 = red, MARL1 = yellow. NB; for MARL1 there is no deployment track and the seabed position is taken as the anchor launch position.*

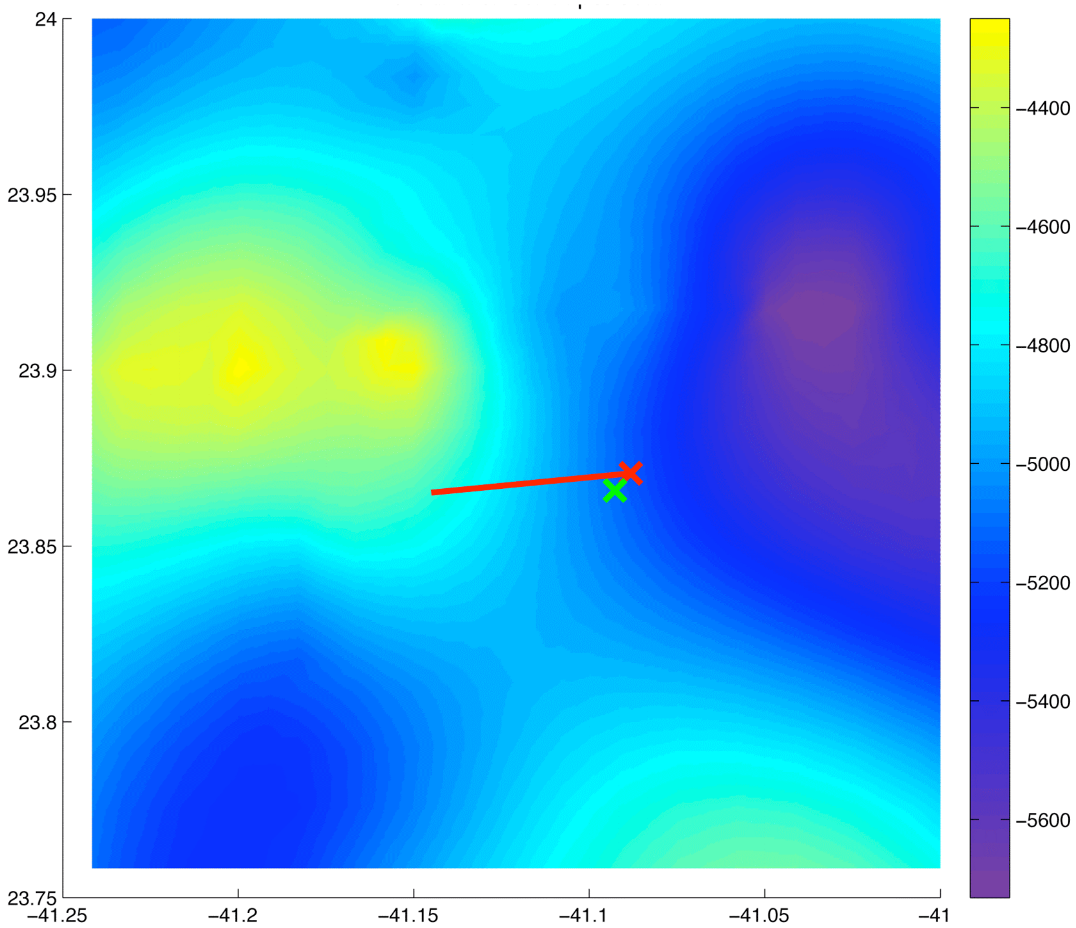
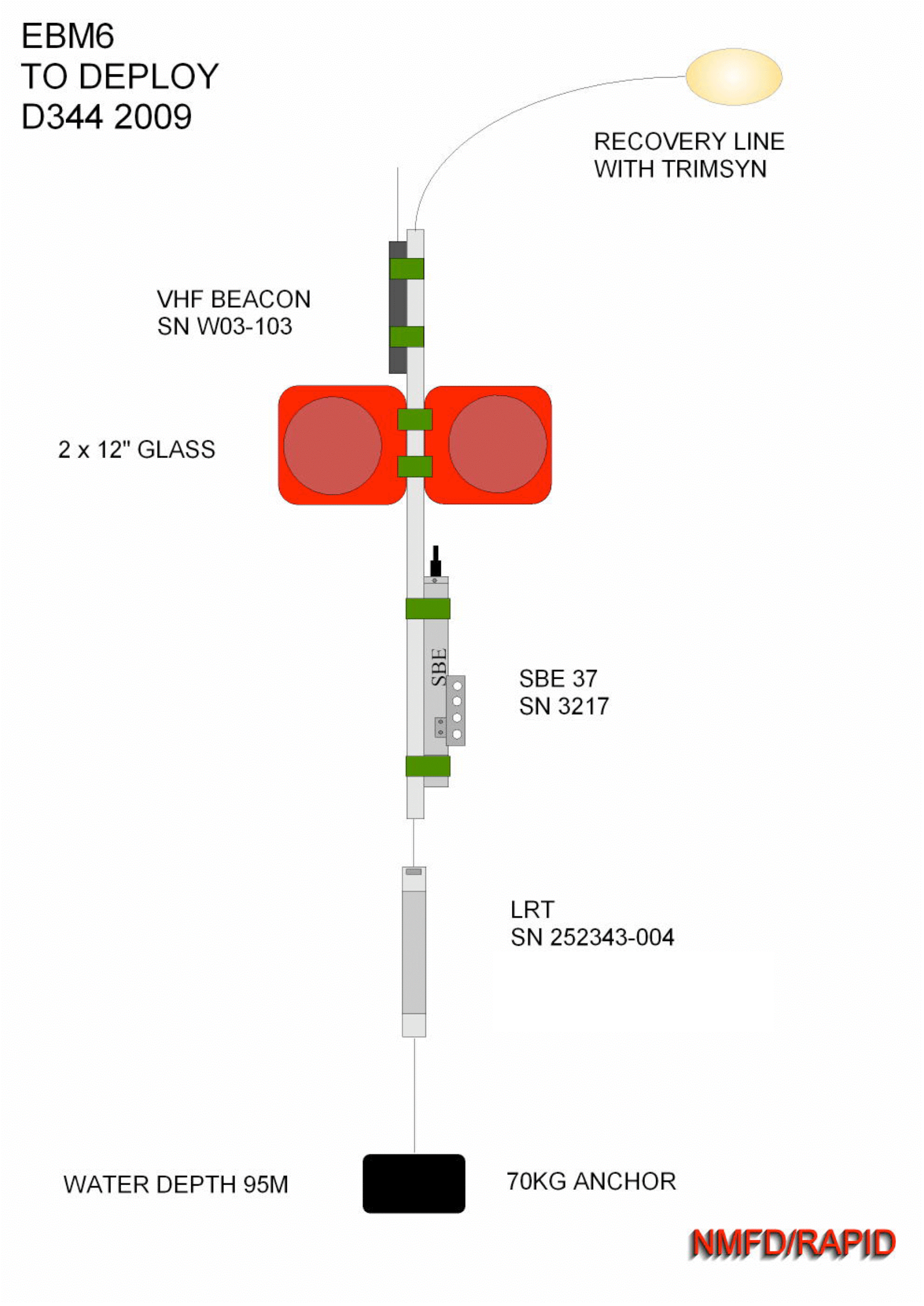
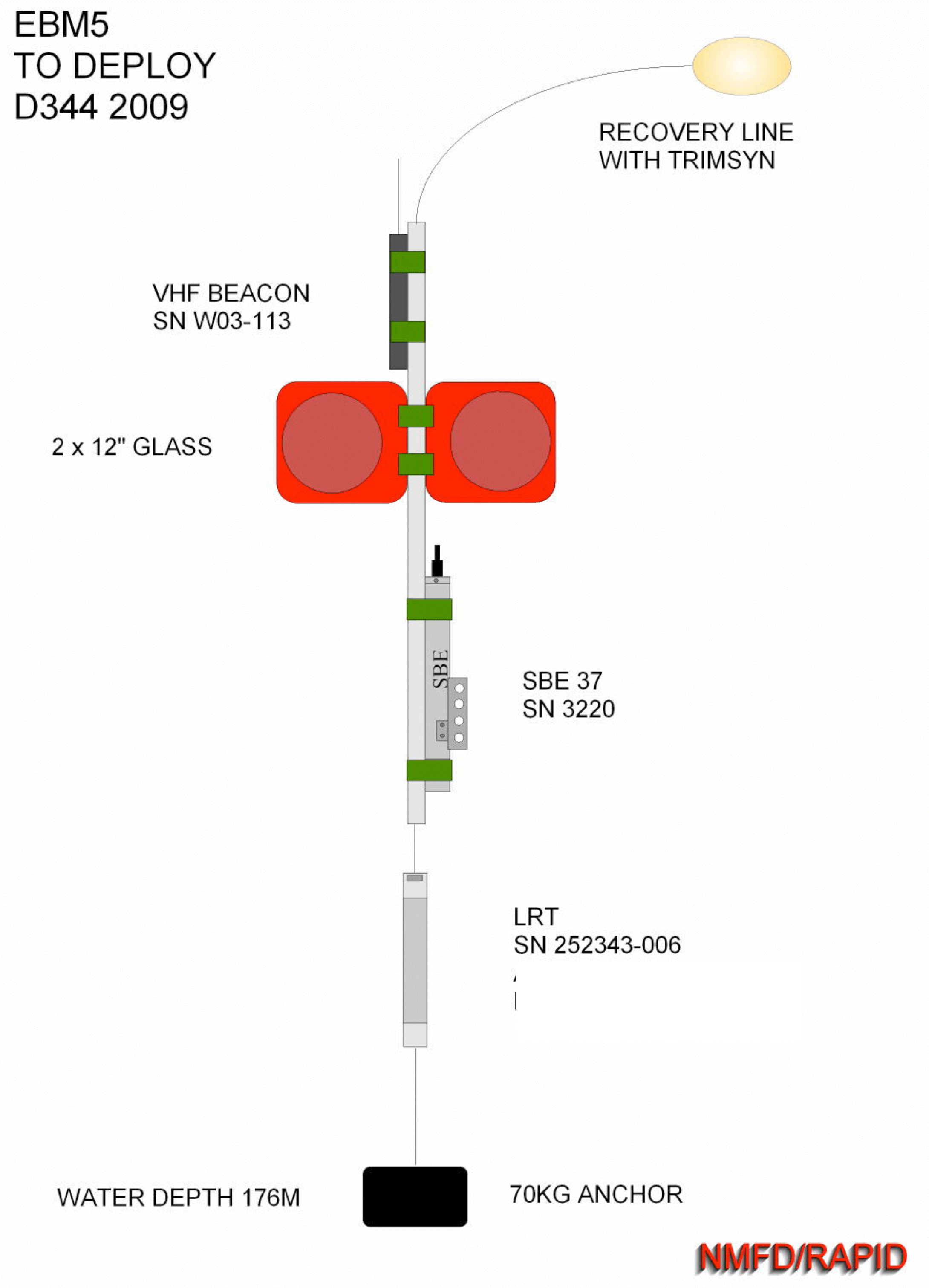
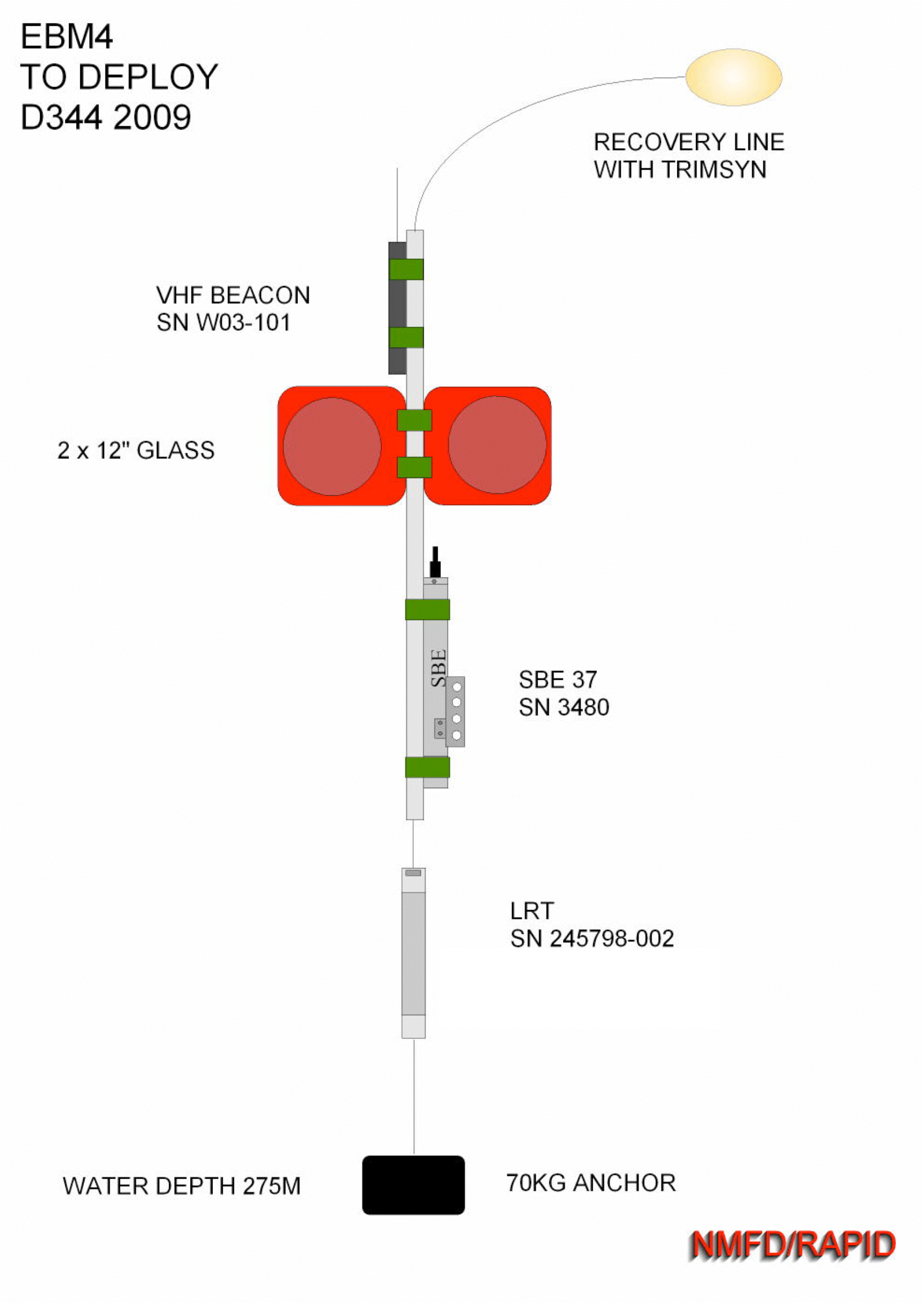


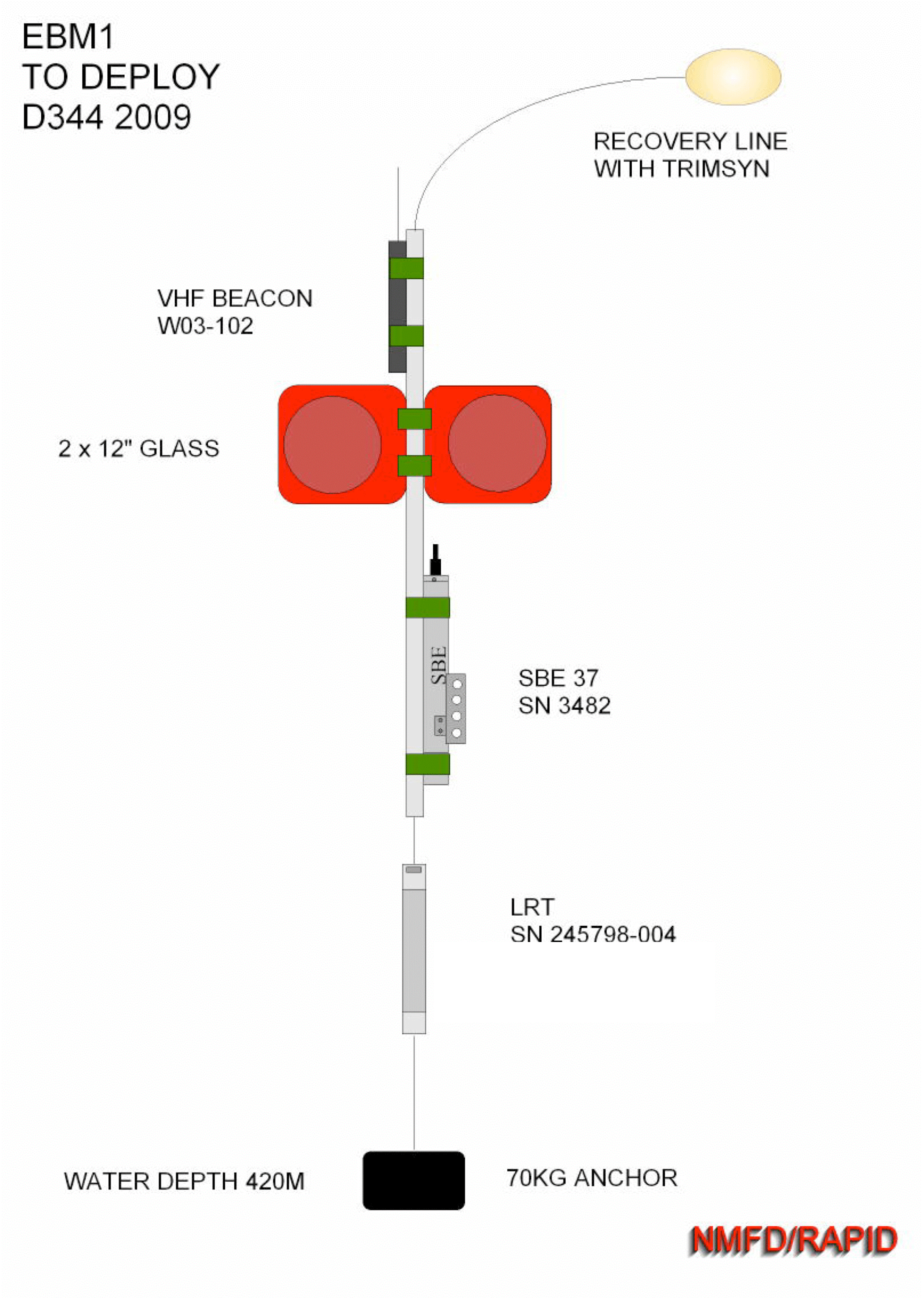
Figure D3 *Region of the MAR3 mooring as deployed on cruise D344 showing the deployment track and seabed position (cross). MAR3 = red, MARL2 = green. NB; for MARL2 there is no deployment track and the seabed position is taken as the anchor launch position.*

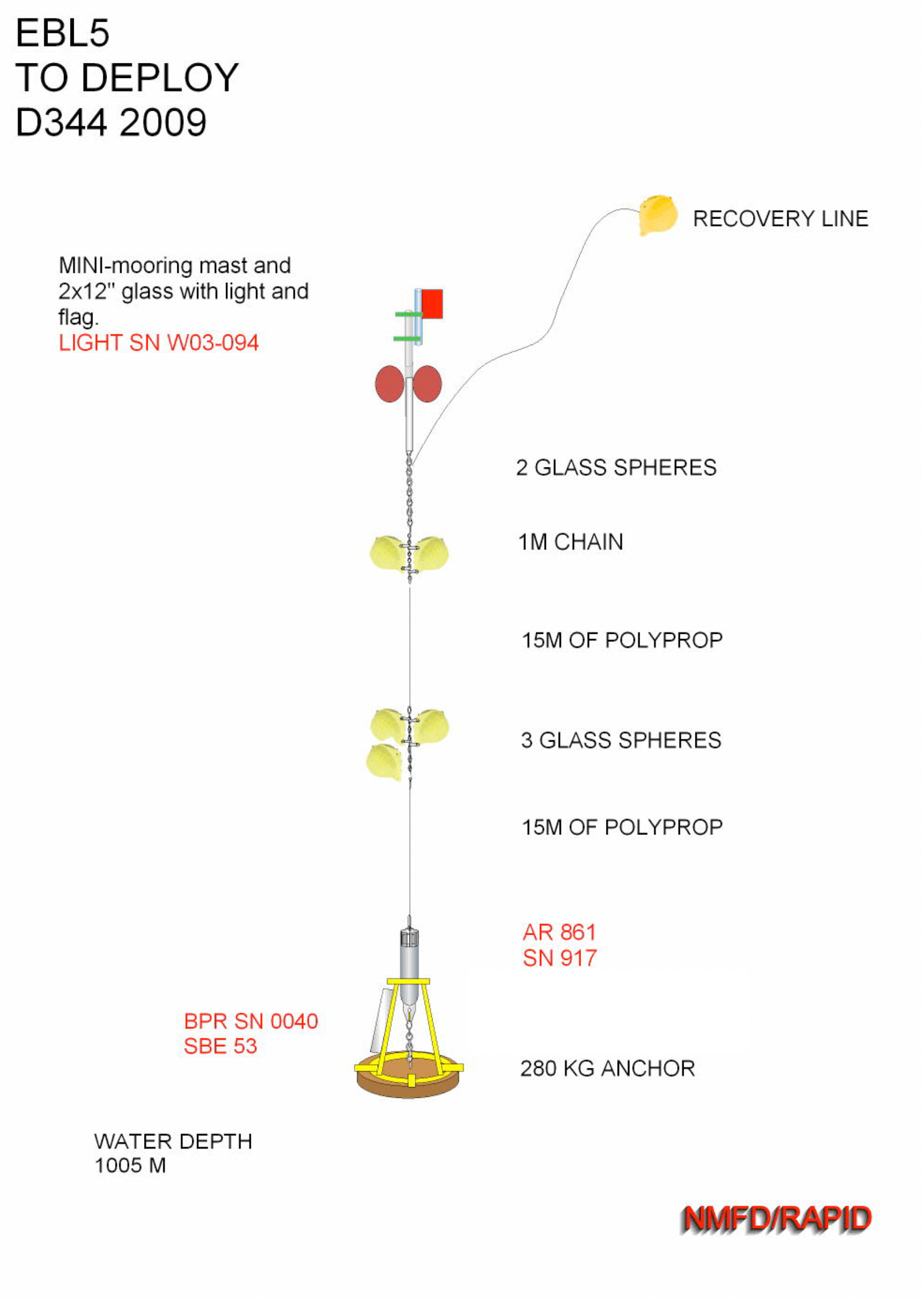
Appendix F – Mooring Diagrams

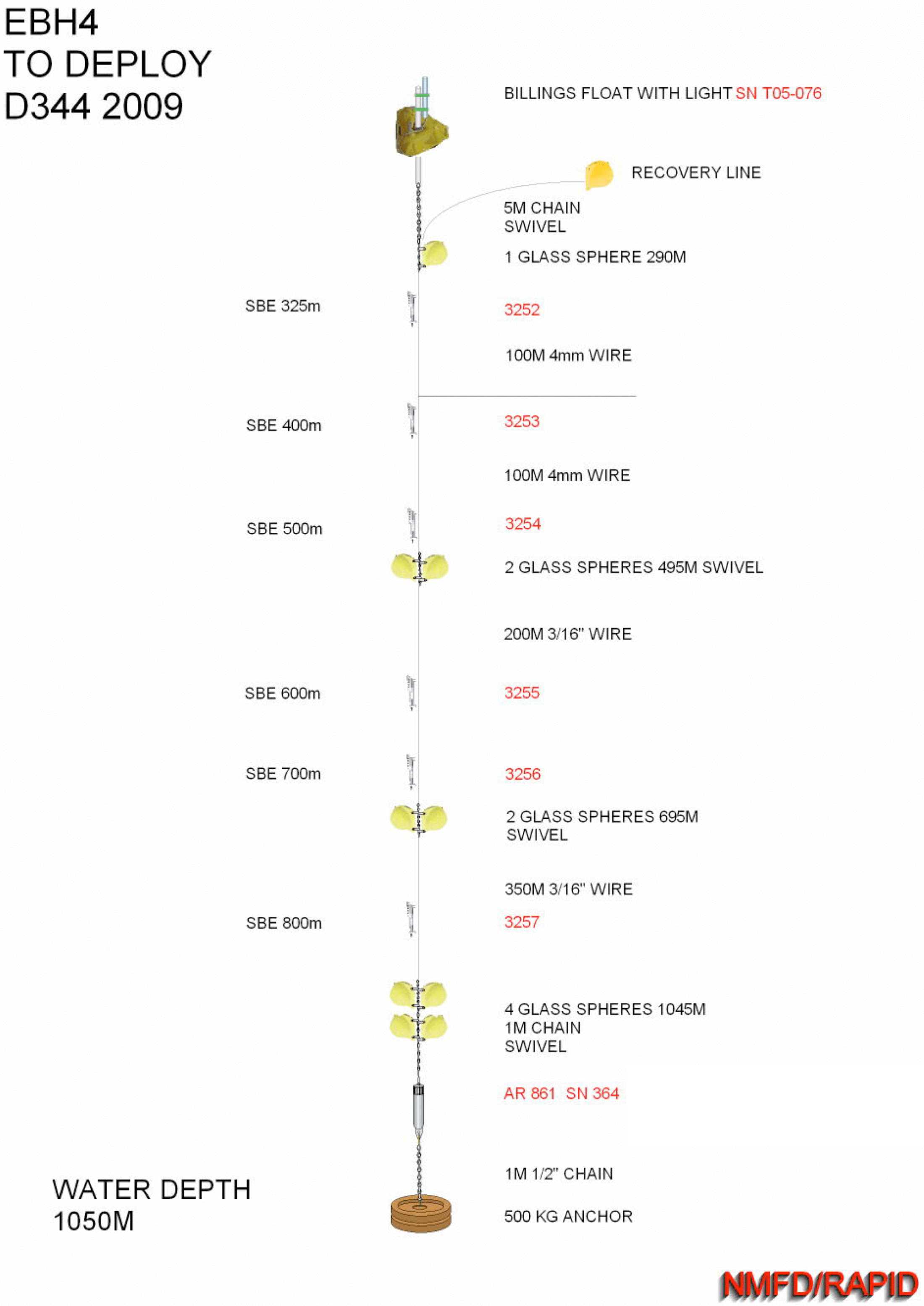


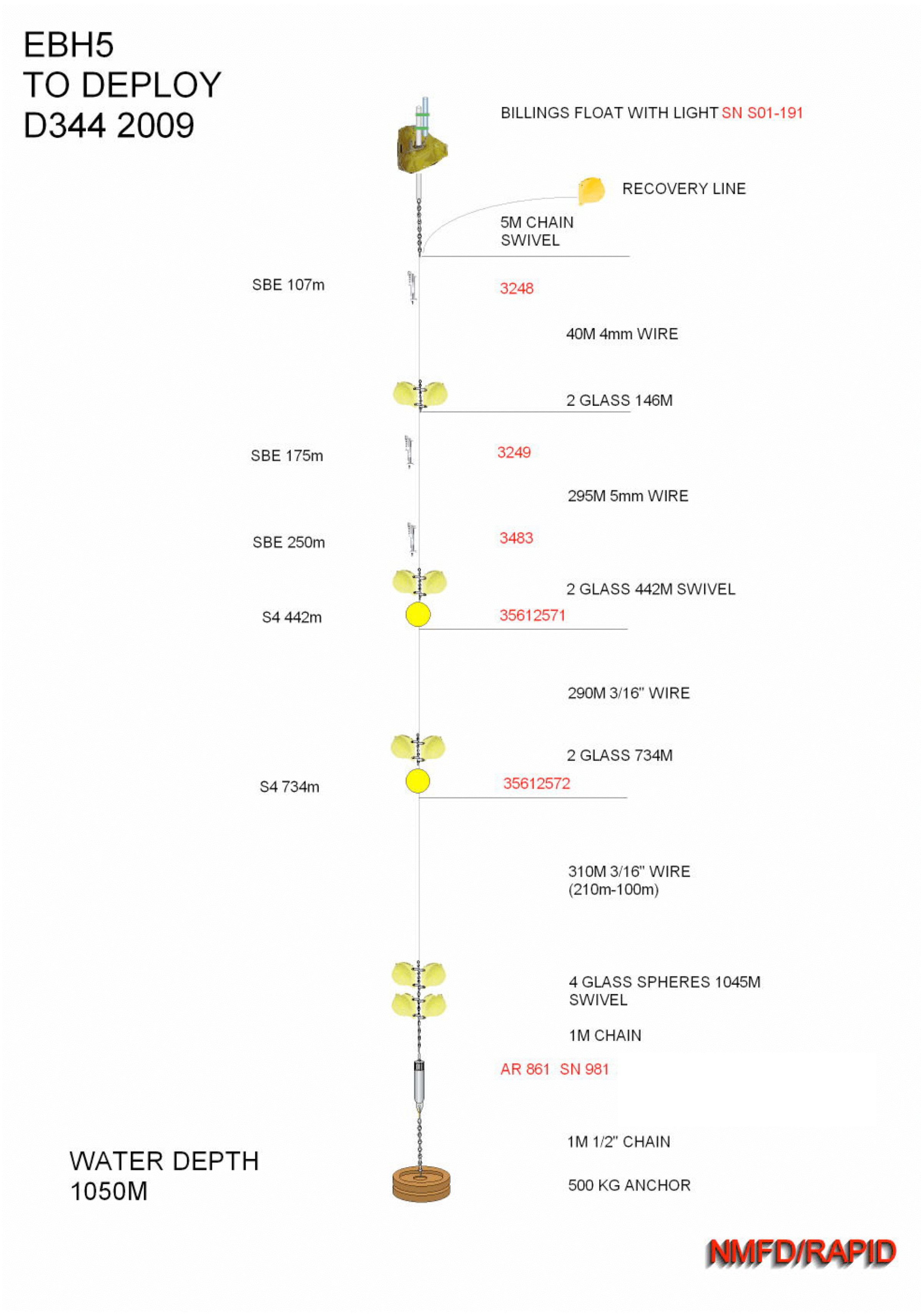

EBM5
TO DEPLOY
D344 2009
RECOVERY LINE
WITH TRIMSYN
VHF BEACON
SN W03-113
2 x 12" GLASS
SBE
SBE 37
SN 3220
LRT
SN 252343-006
WATER DEPTH 176M
70KG ANCHOR
NMFD/RAPID

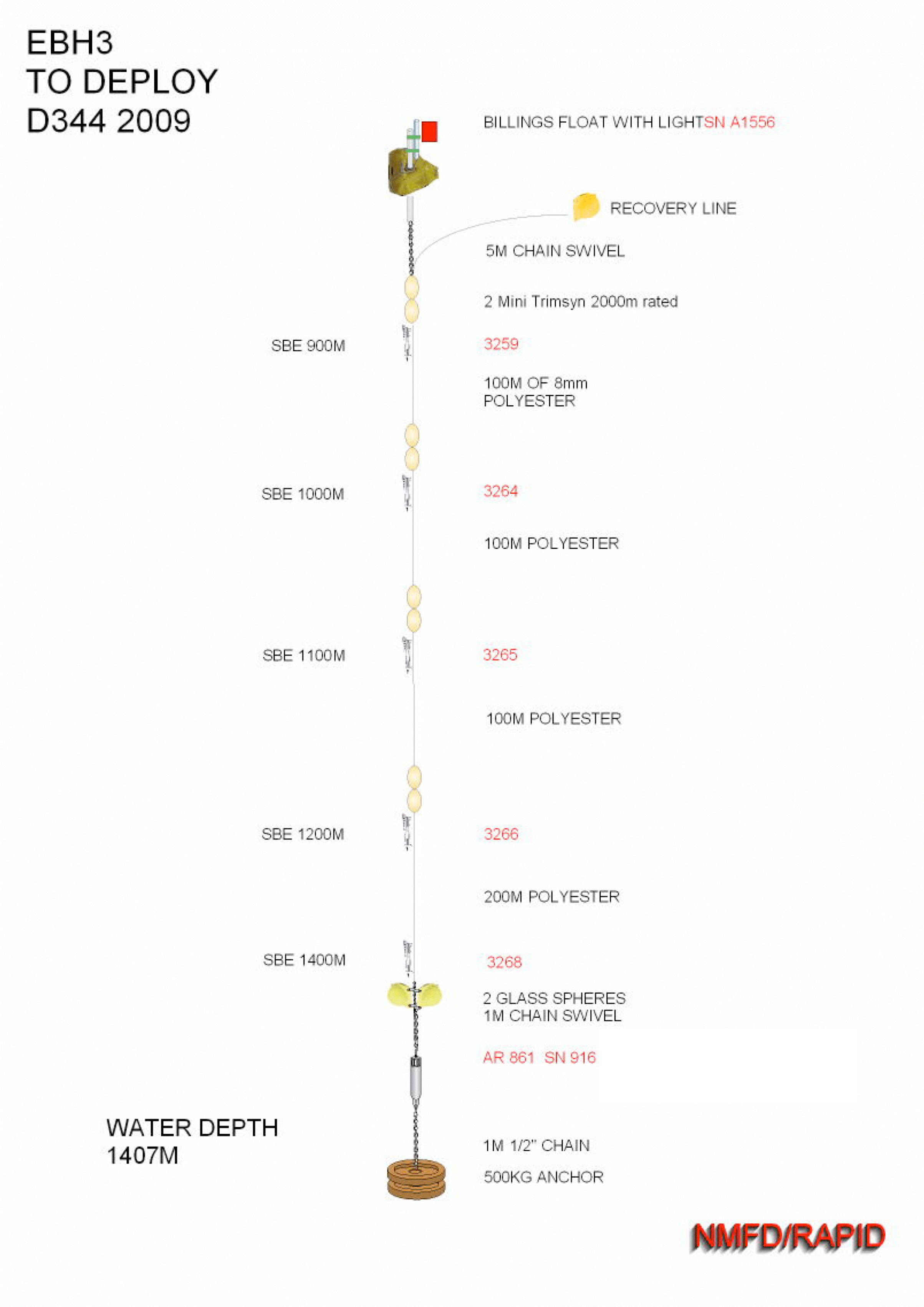

EBM4
TO DEPLOY
D344 2009
RECOVERY LINE
WITH TRIMSYN
VHF BEACON
SN W03-101
2 x 12" GLASS
SBE
SBE 37
SN 3480
LRT
SN 245798-002
WATER DEPTH 275M
70KG ANCHOR
NMFD/RAPID

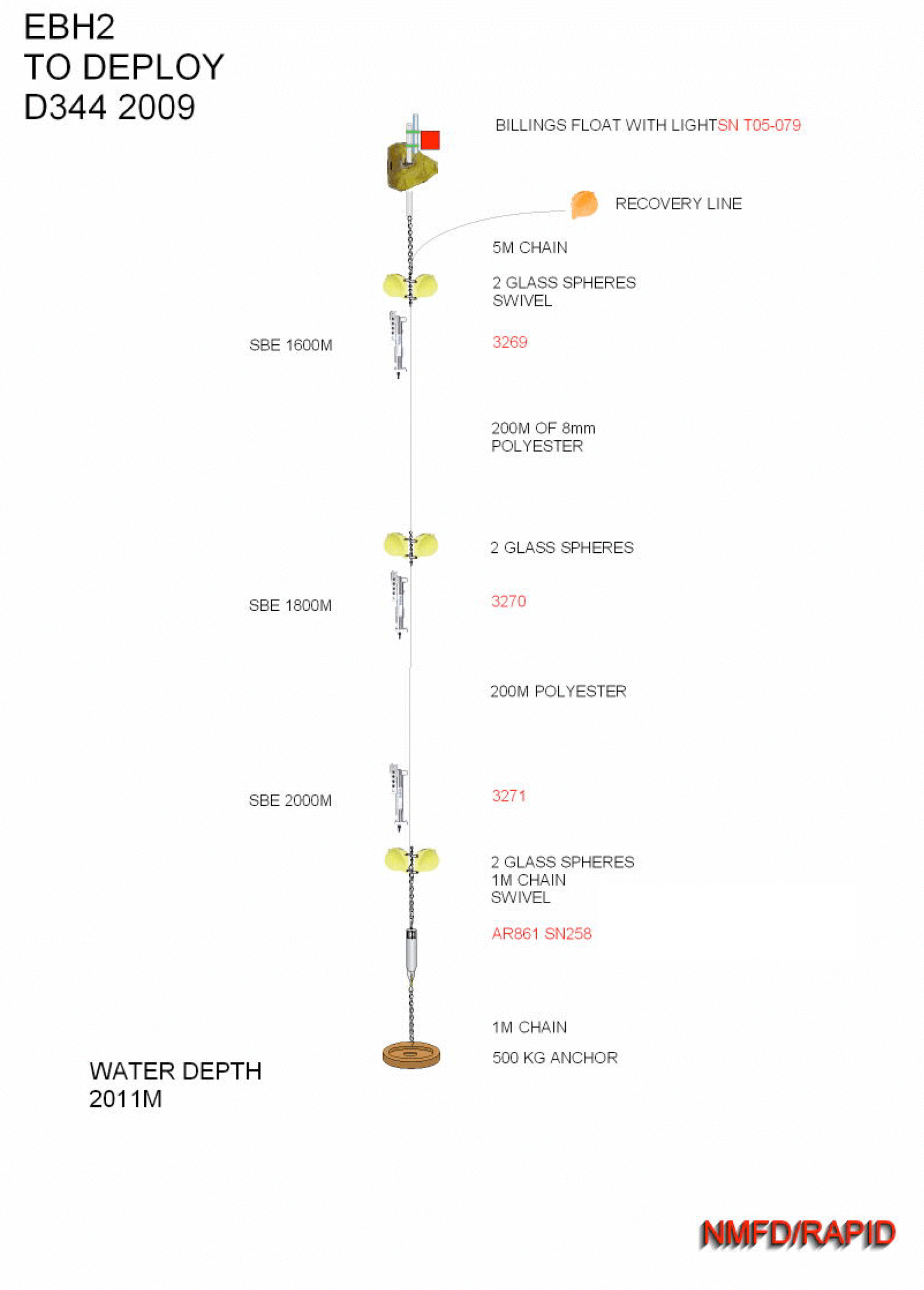

EBM1
TO DEPLOY
D344 2009
RECOVERY LINE
WITH TRIMSYN
VHF BEACON
W03-102
2 x 12" GLASS
SBE
SBE 37
SN 3482
LRT
SN 245798-004
WATER DEPTH 420M
70KG ANCHOR
NMFD/RAPID

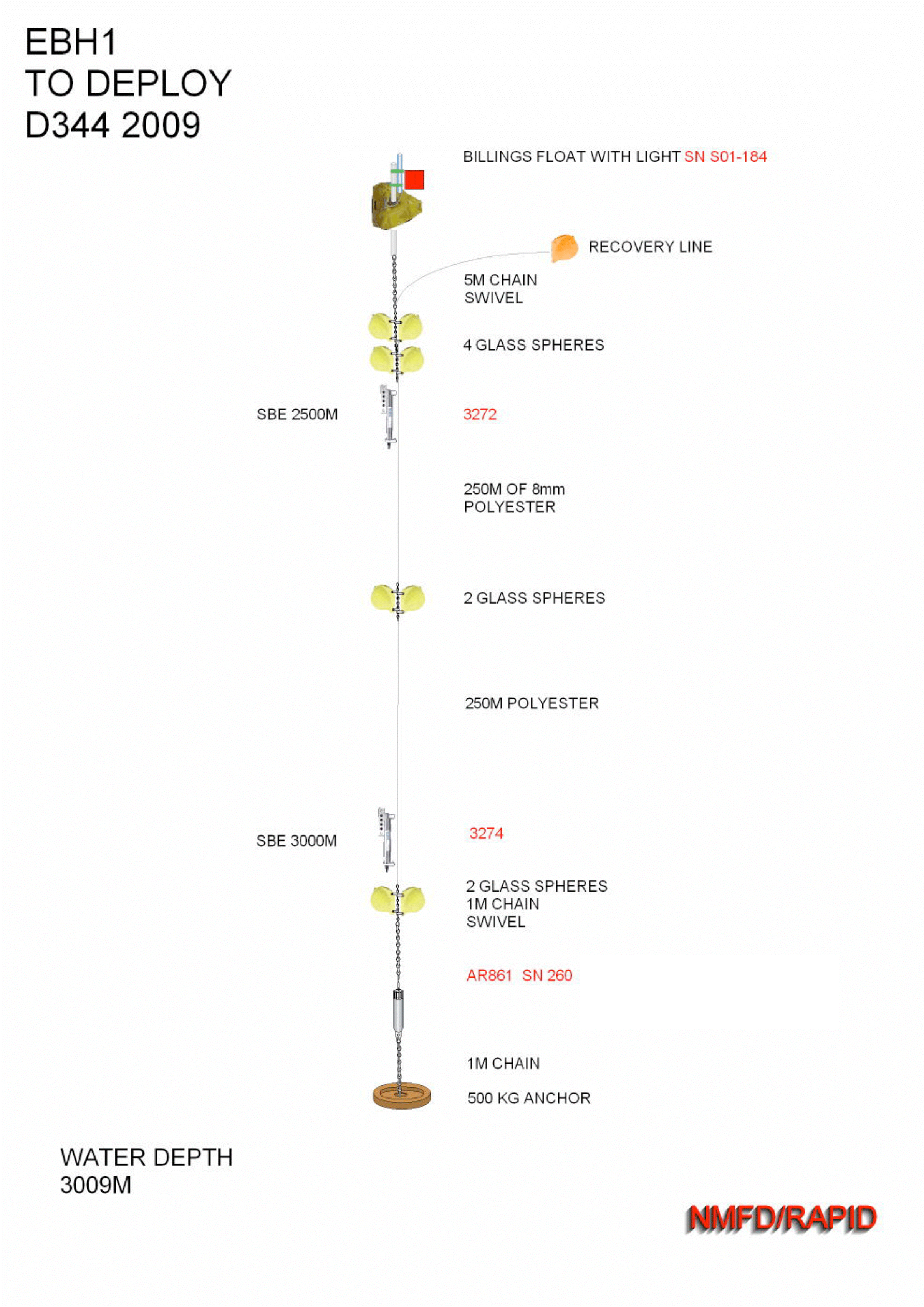

EBL5
TO DEPLOY
D344 2009
RECOVERY LINE
MINI-mooring mast and
2x12" glass with light and
flag.
LIGHT SN W03-094
2 GLASS SPHERES
1M CHAIN
15M OF POLYPROP
3 GLASS SPHERES
15M OF POLYPROP
AR 861
SN 917
BPR SN 0040
SBE 53
280 KG ANCHOR
WATER DEPTH
1005 M
NMFD/RAPID


EBH4
TO DEPLOY
D344 2009
BILLINGS FLOAT WITH LIGHT SN T05-076
RECOVERY LINE
5M CHAIN
SWIVEL
1 GLASS SPHERE 290M
SBE 325m
3252
100M 4mm WIRE
SBE 400m
3253
100M 4mm WIRE
SBE 500m
3254
2 GLASS SPHERES 495M SWIVEL
200M 3/16" WIRE
SBE 600m
3255
SBE 700m
3256
2 GLASS SPHERES 695M
SWIVEL
350M 3/16" WIRE
SBE 800m
3257
4 GLASS SPHERES 1045M
1M CHAIN
SWIVEL
AR 861 SN 364
1M 1/2" CHAIN
500 KG ANCHOR
WATER DEPTH
1050M
NMFD/RAPID

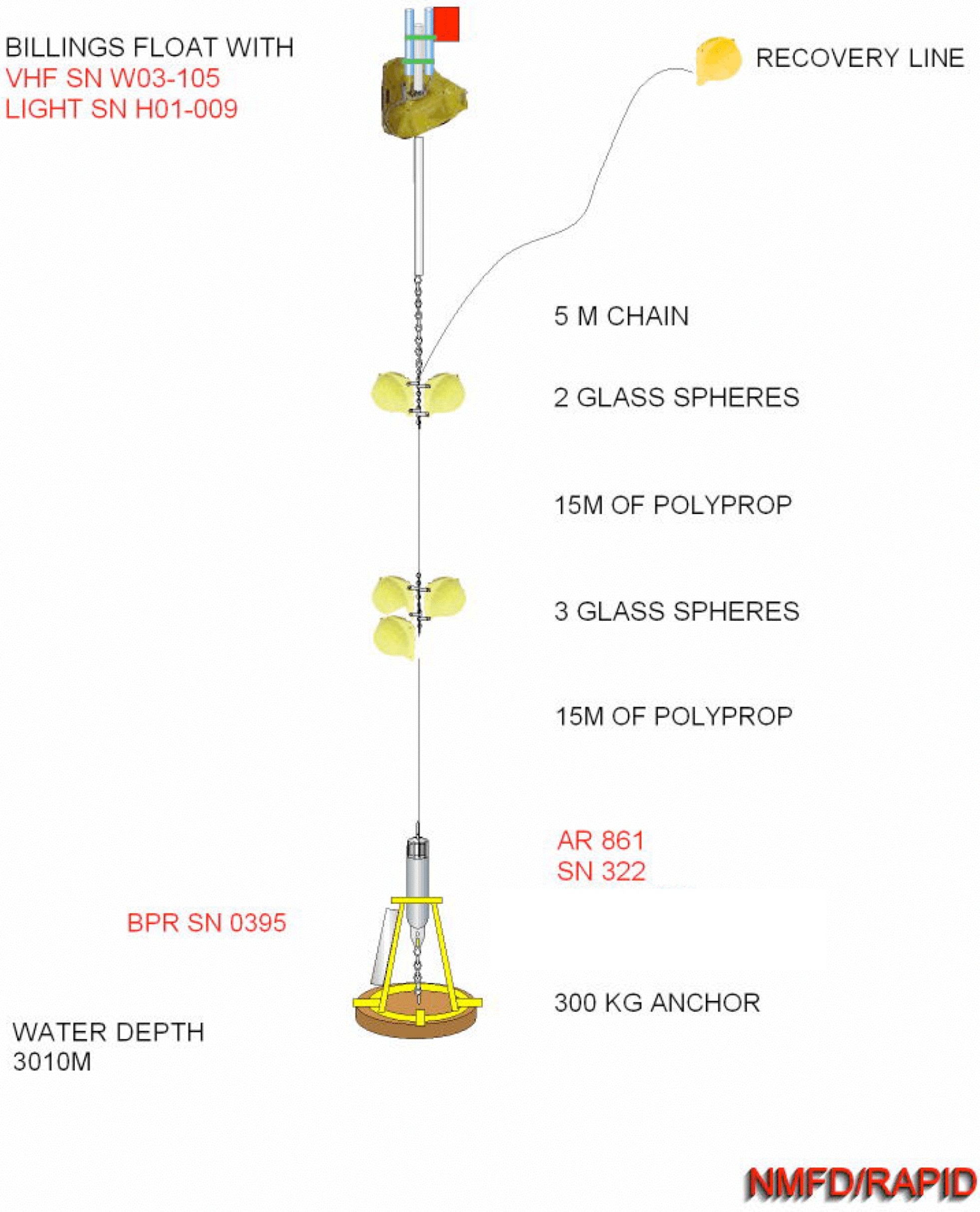

EBH5
TO DEPLOY
D344 2009
BILLINGS FLOAT WITH LIGHT SN S01-191
RECOVERY LINE
5M CHAIN
SWIVEL
SBE 107m
3248
40M 4mm WIRE
2 GLASS 146M
SBE 175m
3249
295M 5mm WIRE
SBE 250m
3483
2 GLASS 442M SWIVEL
S4 442m
35612571
290M 3/16" WIRE
2 GLASS 734M
S4 734m
35612572
310M 3/16" WIRE
(210m-100m)
4 GLASS SPHERES 1045M
SWIVEL
1M CHAIN
AR 861 SN 981
1M 1/2" CHAIN
WATER DEPTH
1050M
500 KG ANCHOR
NMFD/RAPID

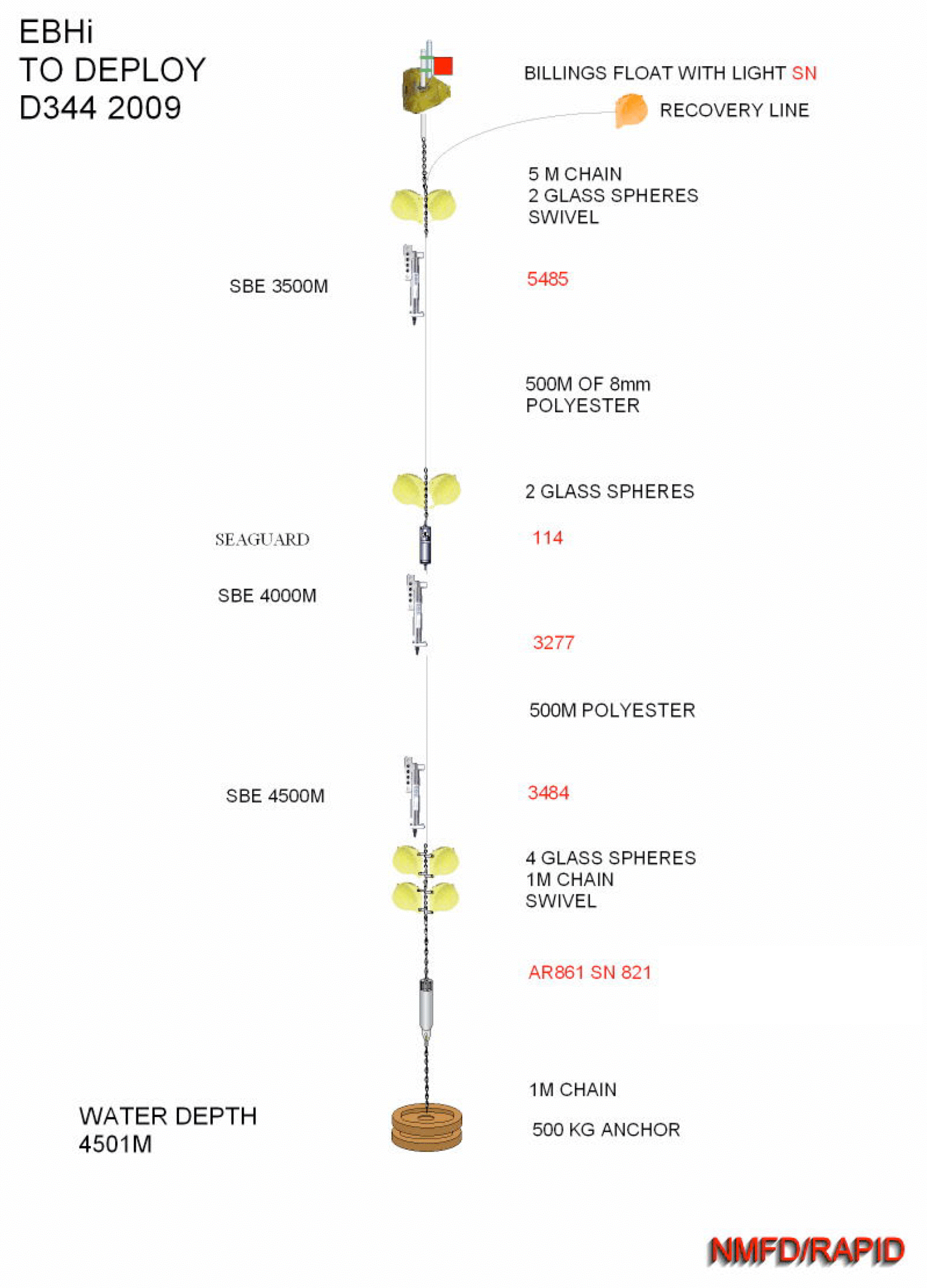

EBH3
TO DEPLOY
D344 2009
BILLINGS FLOAT WITH LIGHTSN A1556
RECOVERY LINE
5M CHAIN SWIVEL
2 Mini Trimsyn 2000m rated
SBE 900M
3259
100M OF 8mm
POLYESTER
SBE 1000M
3264
100M POLYESTER
SBE 1100M
3265
100M POLYESTER
SBE 1200M
3266
200M POLYESTER
SBE 1400M
3268
2 GLASS SPHERES
1M CHAIN SWIVEL
AR 861 SN 916
WATER DEPTH
1407M
1M 1/2" CHAIN
500KG ANCHOR
NMFD/RAPID

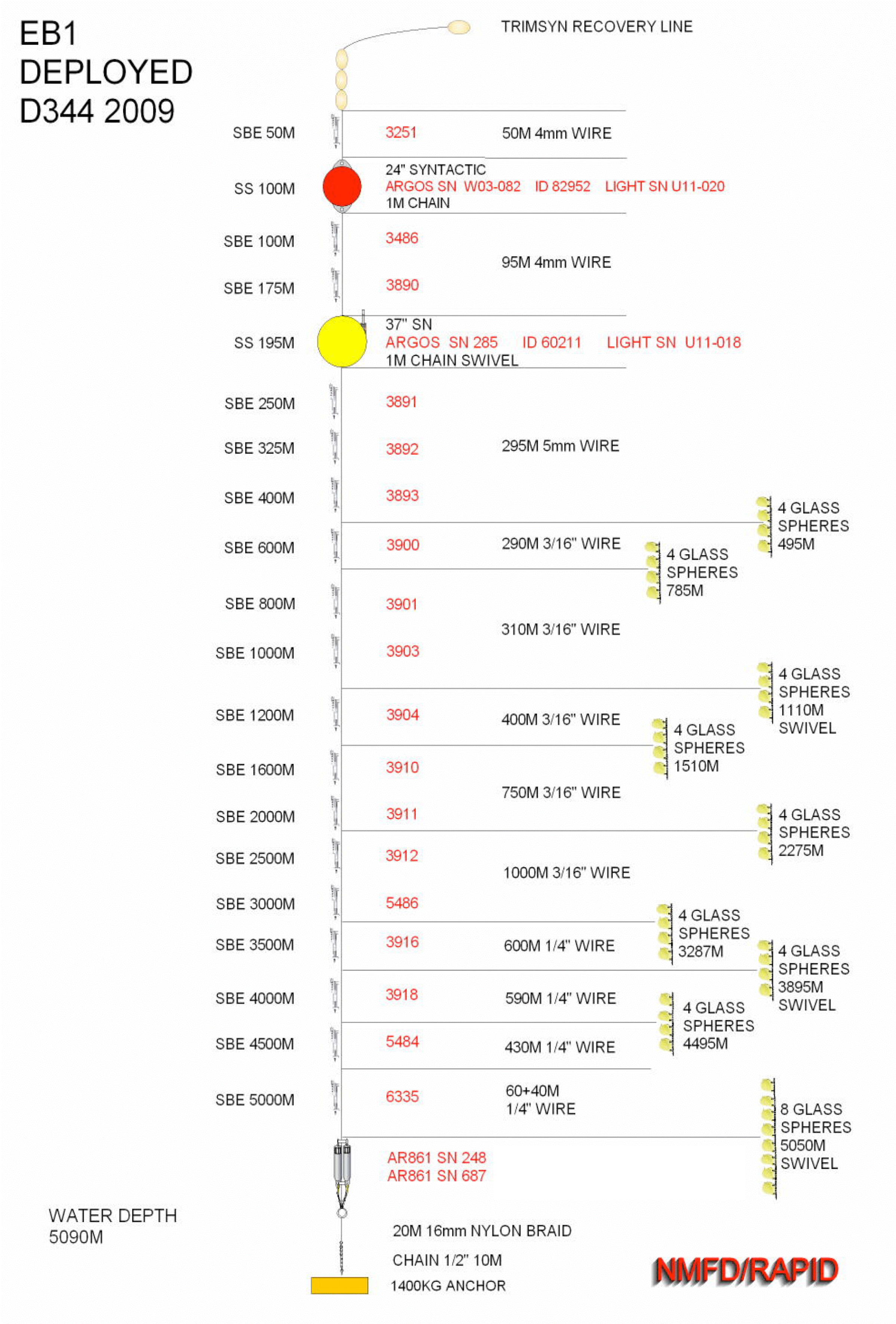

EBH2
TO DEPLOY
D344 2009
BILLINGS FLOAT WITH LIGHTSN T05-079
RECOVERY LINE
5M CHAIN
2 GLASS SPHERES
SWIVEL
SBE 1600M
3269
200M OF 8mm
POLYESTER
2 GLASS SPHERES
SBE 1800M
3270
200M POLYESTER
SBE 2000M
3271
2 GLASS SPHERES
1M CHAIN
SWIVEL
AR861 SN258
1M CHAIN
500 KG ANCHOR
WATER DEPTH
2011M
NMFD/RAPID


EBH1
TO DEPLOY
D344 2009
BILLINGS FLOAT WITH LIGHT SN S01-184
RECOVERY LINE
5M CHAIN
SWIVEL
4 GLASS SPHERES
SBE 2500M
3272
250M OF 8mm
POLYESTER
2 GLASS SPHERES
250M POLYESTER
SBE 3000M
3274
2 GLASS SPHERES
1M CHAIN
SWIVEL
AR861 SN 260
1M CHAIN
500 KG ANCHOR
WATER DEPTH
3009M
NMFD/RAPID

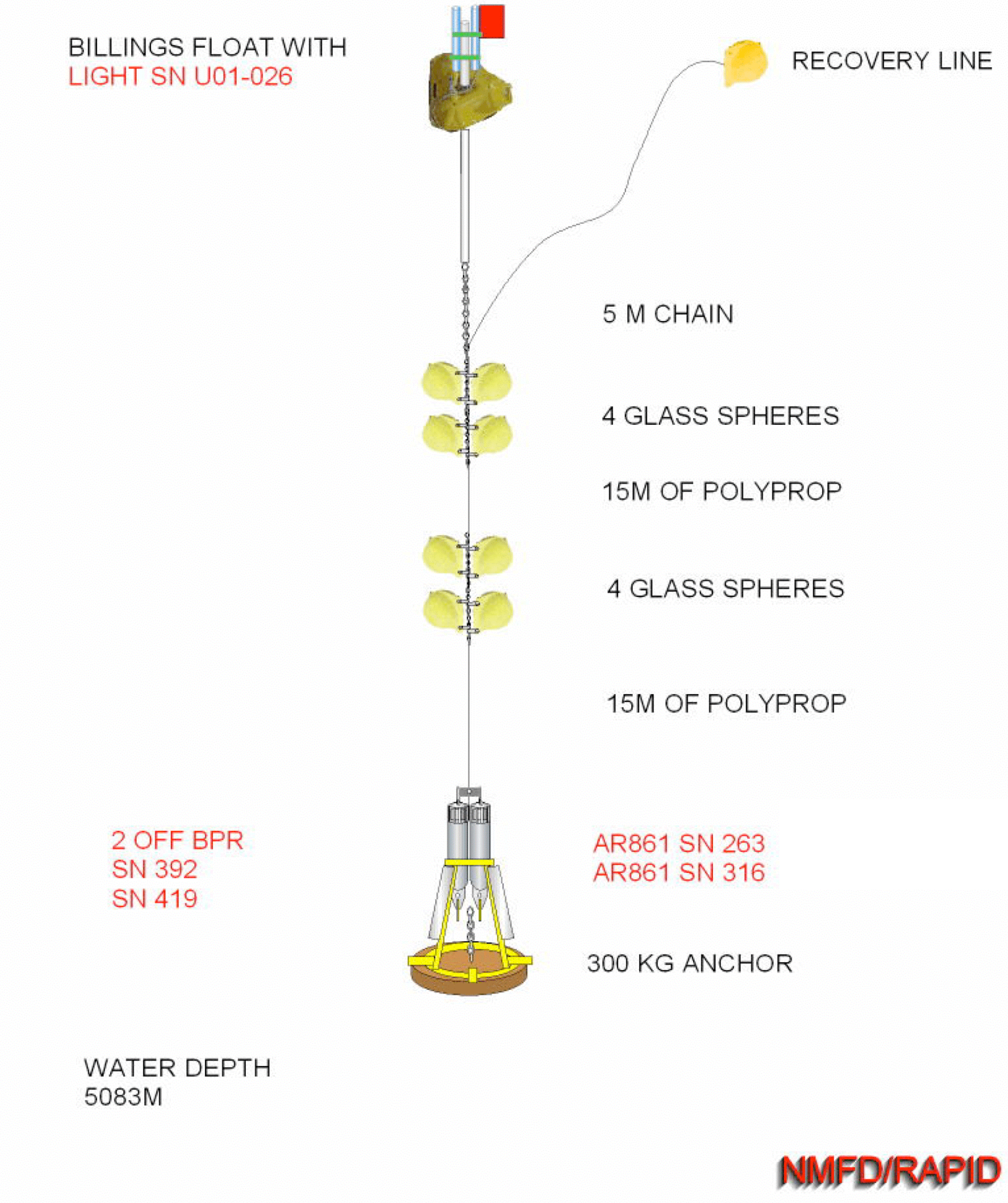
EBL4
TO DEPLOY
D344 2009



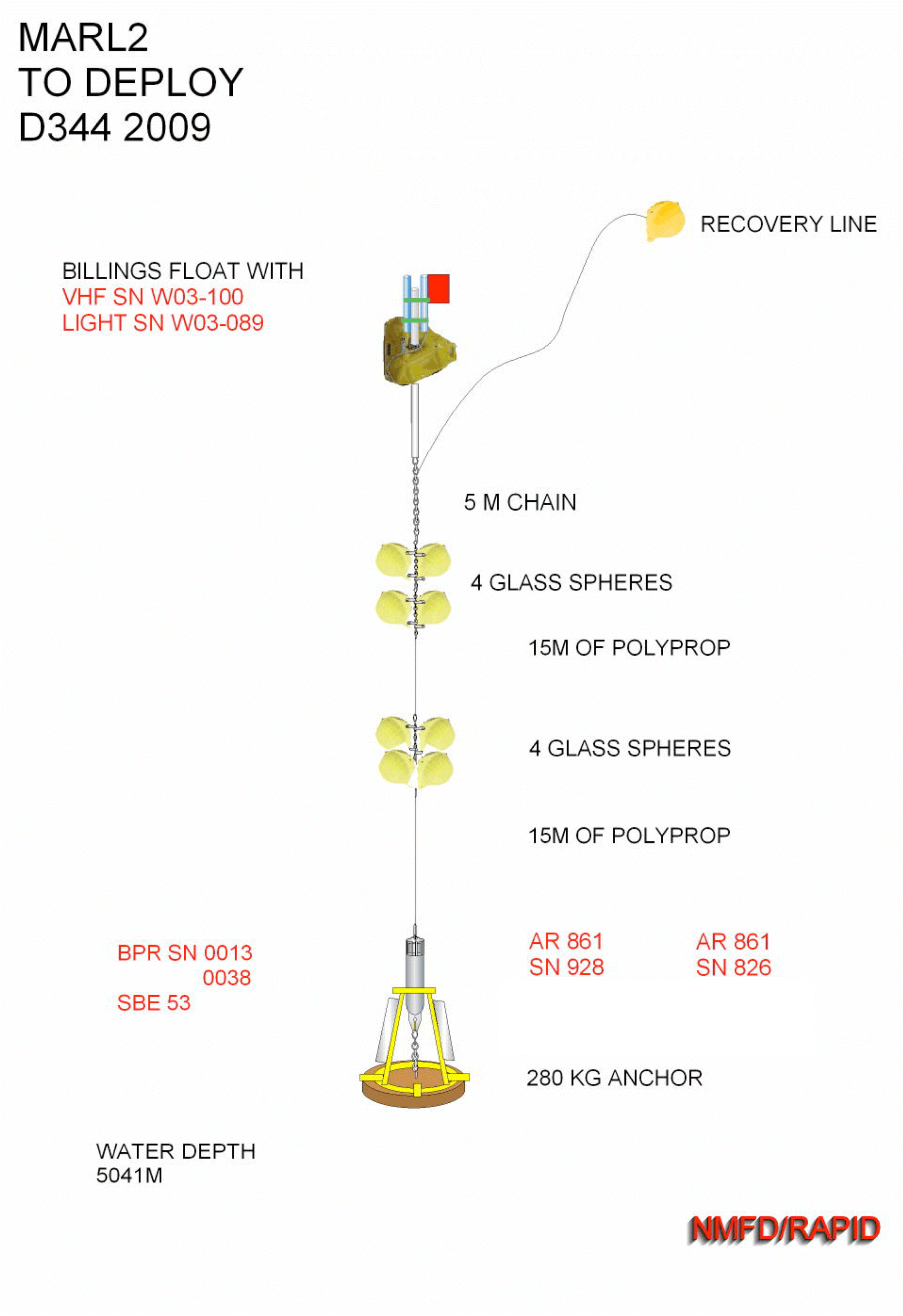

EBHi
TO DEPLOY
D344 2009
BILLINGS FLOAT WITH LIGHT SN
RECOVERY LINE
5 M CHAIN
2 GLASS SPHERES
SWIVEL
SBE 3500M
5485
500M OF 8mm
POLYESTER
2 GLASS SPHERES
SEAGUARD
114
SBE 4000M
3277
500M POLYESTER
SBE 4500M
3484
4 GLASS SPHERES
1M CHAIN
SWIVEL
AR861 SN 821
1M CHAIN
WATER DEPTH
4501M
500 KG ANCHOR
NMFD/RAPID

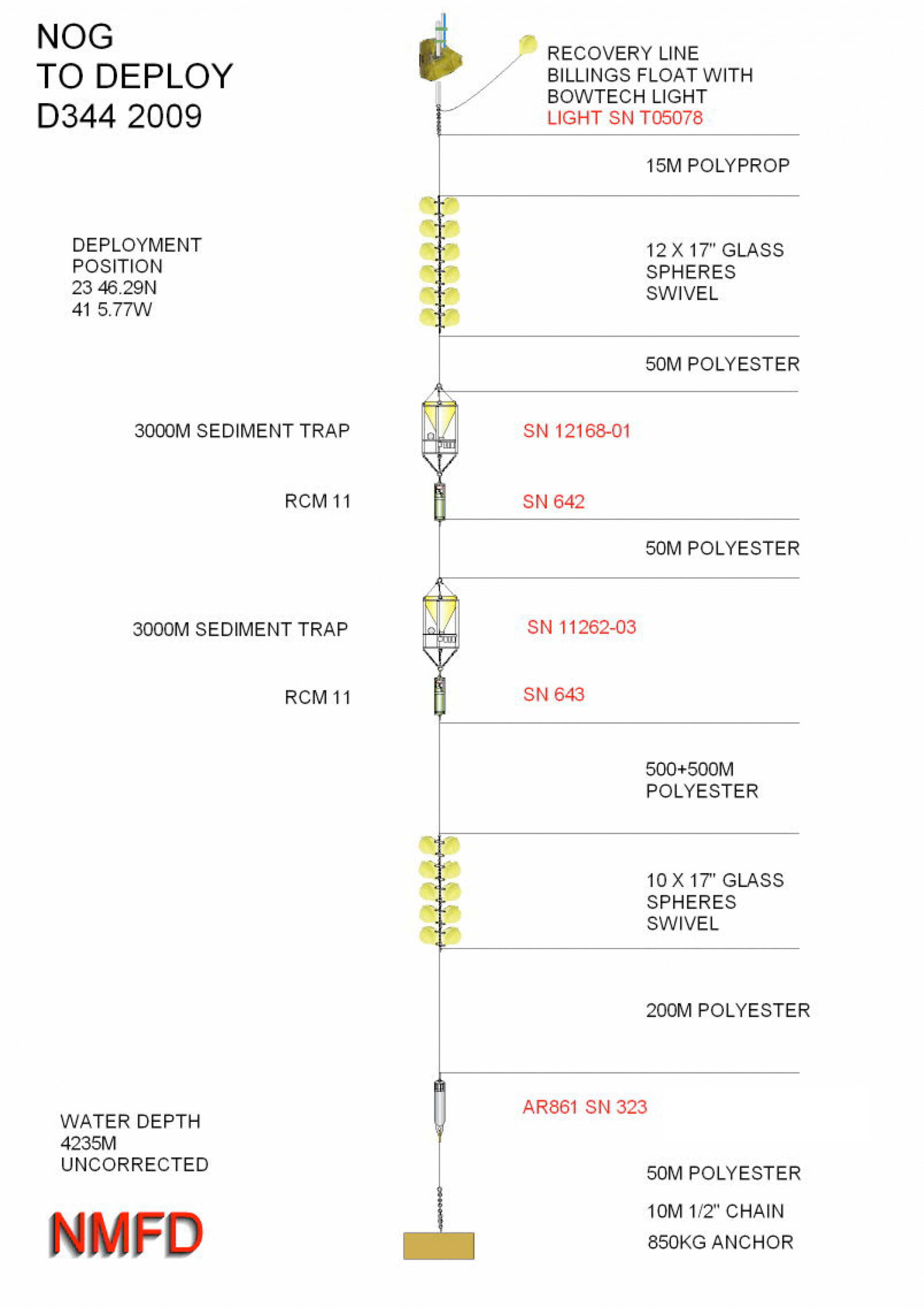

EB1
DEPLOYED
D344 2009
TRIMSYN RECOVERY LINE
SBE 50M
3251
50M 4mm WIRE
SS 100M
24" SYNTACTIC
ARGOS SN W03-082 ID 82952 LIGHT SN U11-020
1M CHAIN
SBE 100M
3486
95M 4mm WIRE
SBE 175M
3890
SS 195M
37" SN
ARGOS SN 285 ID 60211 LIGHT SN U11-018
1M CHAIN SWIVEL
SBE 250M
3891
SBE 325M
3892
295M 5mm WIRE
SBE 400M
3893
4 GLASS SPHERES 495M
SBE 600M
3900
290M 3/16" WIRE
4 GLASS SPHERES 785M
SBE 800M
3901
310M 3/16" WIRE
SBE 1000M
3903
4 GLASS SPHERES 1110M SWIVEL
SBE 1200M
3904
400M 3/16" WIRE
4 GLASS SPHERES 1510M
SBE 1600M
3910
750M 3/16" WIRE
SBE 2000M
3911
4 GLASS SPHERES 2275M
SBE 2500M
3912
1000M 3/16" WIRE
SBE 3000M
5486
4 GLASS SPHERES 3287M
SBE 3500M
3916
600M 1/4" WIRE
4 GLASS SPHERES 3895M SWIVEL
SBE 4000M
3918
590M 1/4" WIRE
4 GLASS SPHERES 4495M
SBE 4500M
5484
430M 1/4" WIRE
SBE 5000M
6335
60+40M
1/4" WIRE
8 GLASS SPHERES 5050M SWIVEL
AR861 SN 248
AR861 SN 687
WATER DEPTH
5090M
20M 16mm NYLON BRAID
CHAIN 1/2" 10M
1400KG ANCHOR
NMFD/RAPID

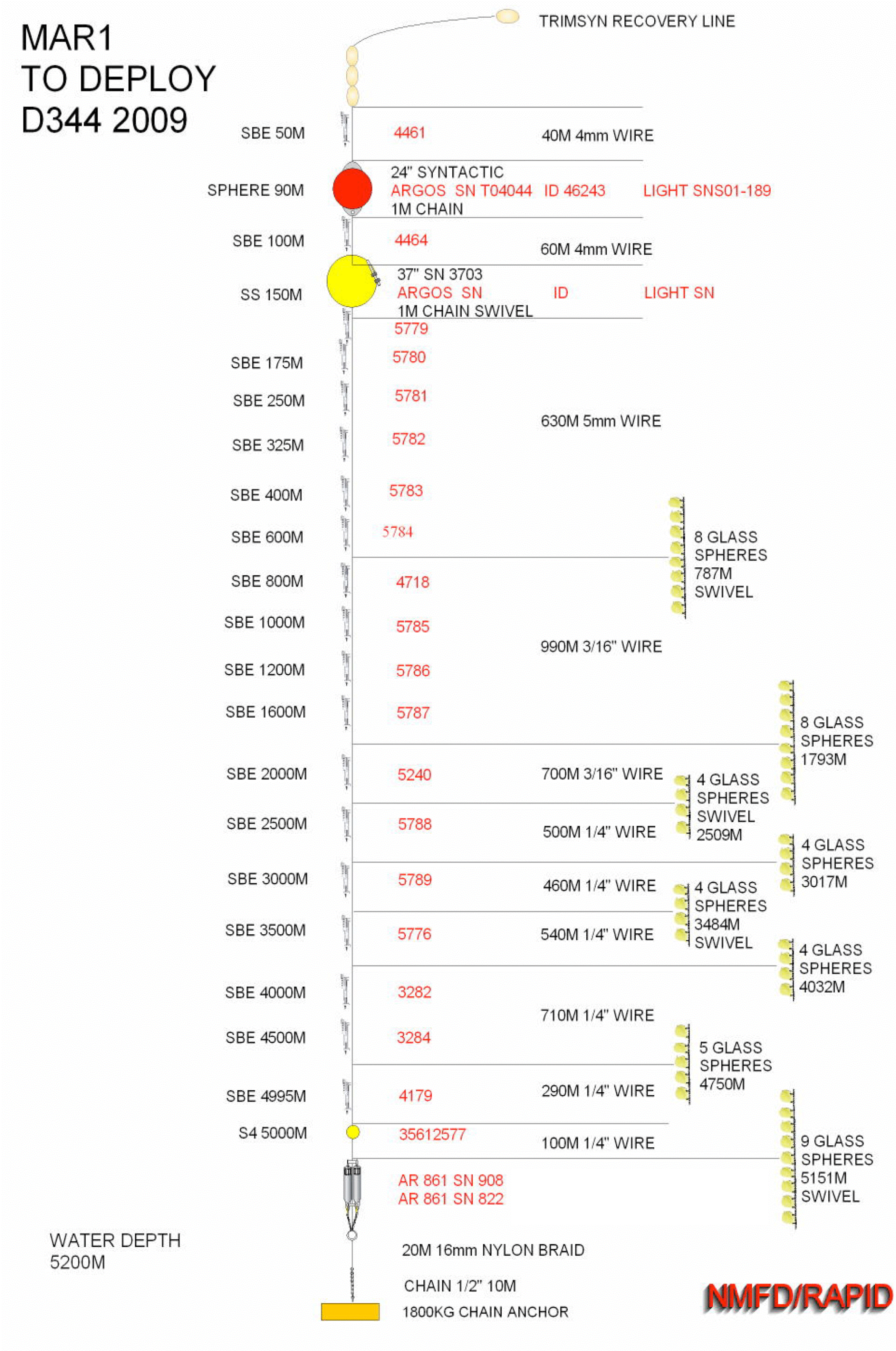
EBL3
TO DEPLOY
D344 2009

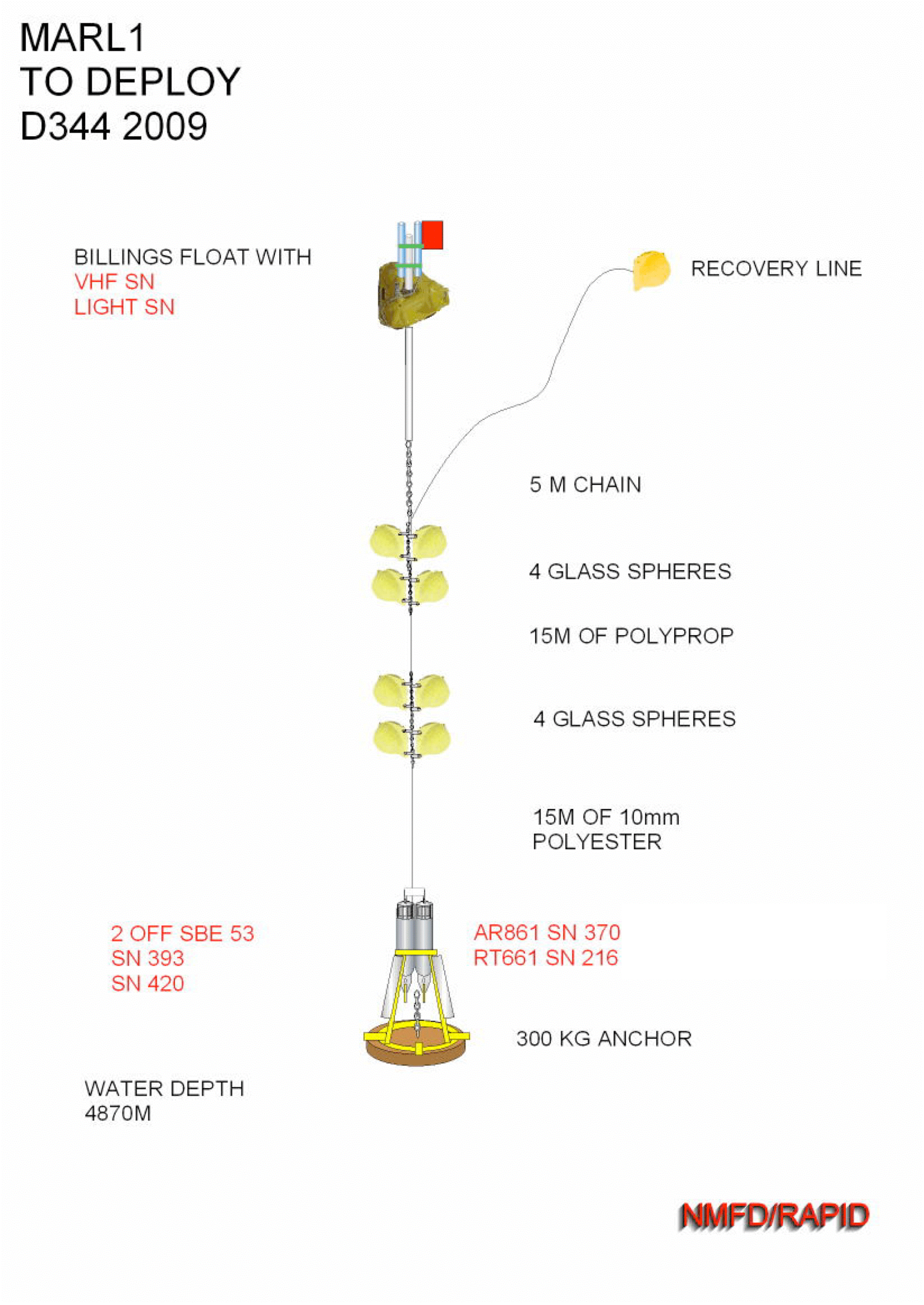


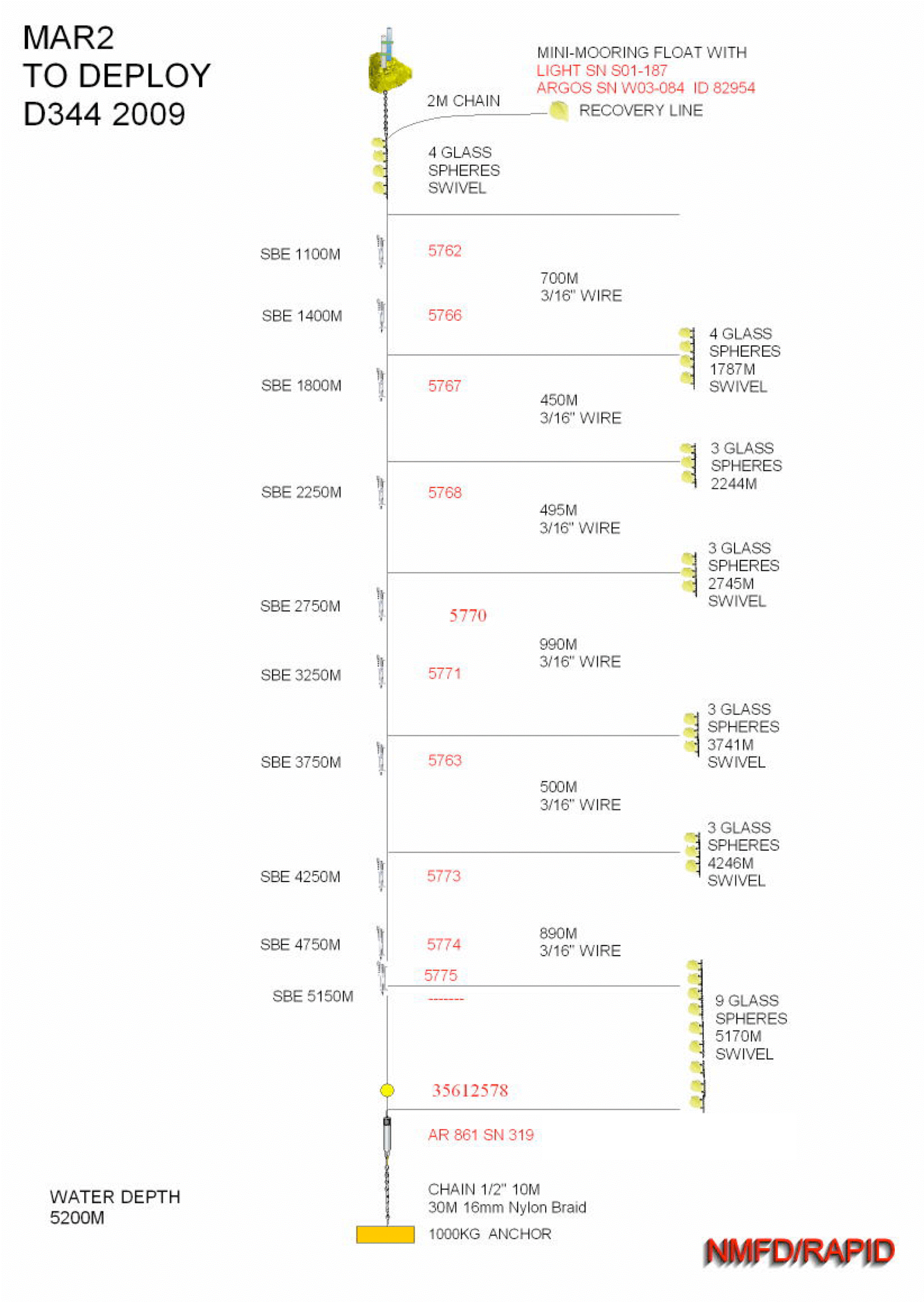

MAR3
TO DEPLOY
D344 2009
BILLINGS FLOAT WITH
LIGHT SN W03-090
5M CHAIN
RECOVERY LINE
2 GLASS SPHERES
SWIVEL 2500M
SBE 2500M
6328
500M
3/16" WIRE
3 GLASS SPHERES
3000M
SBE 3000M
5487
500M
3/16" WIRE
3 GLASS SPHERES
3500M
SBE 3500M
5488
500M
3/16" WIRE
3 GLASS SPHERES
SWIVEL 4000M
SBE 4000M
6329
500M
3/16" WIRE
3 GLASS SPHERES
4500M
SBE 4500M
6330
540M
3/16" WIRE
SBE 5000M
6334
S4 5015M
35612573
7 GLASS
SPHERES
SWIVEL
5017M
10M
3/16" WIRE
AR861 SN 243
CHAIN 1/2" 10M
1000KG CHAIN ANCHOR
WATER DEPTH
5050M
NMFD/RAPID

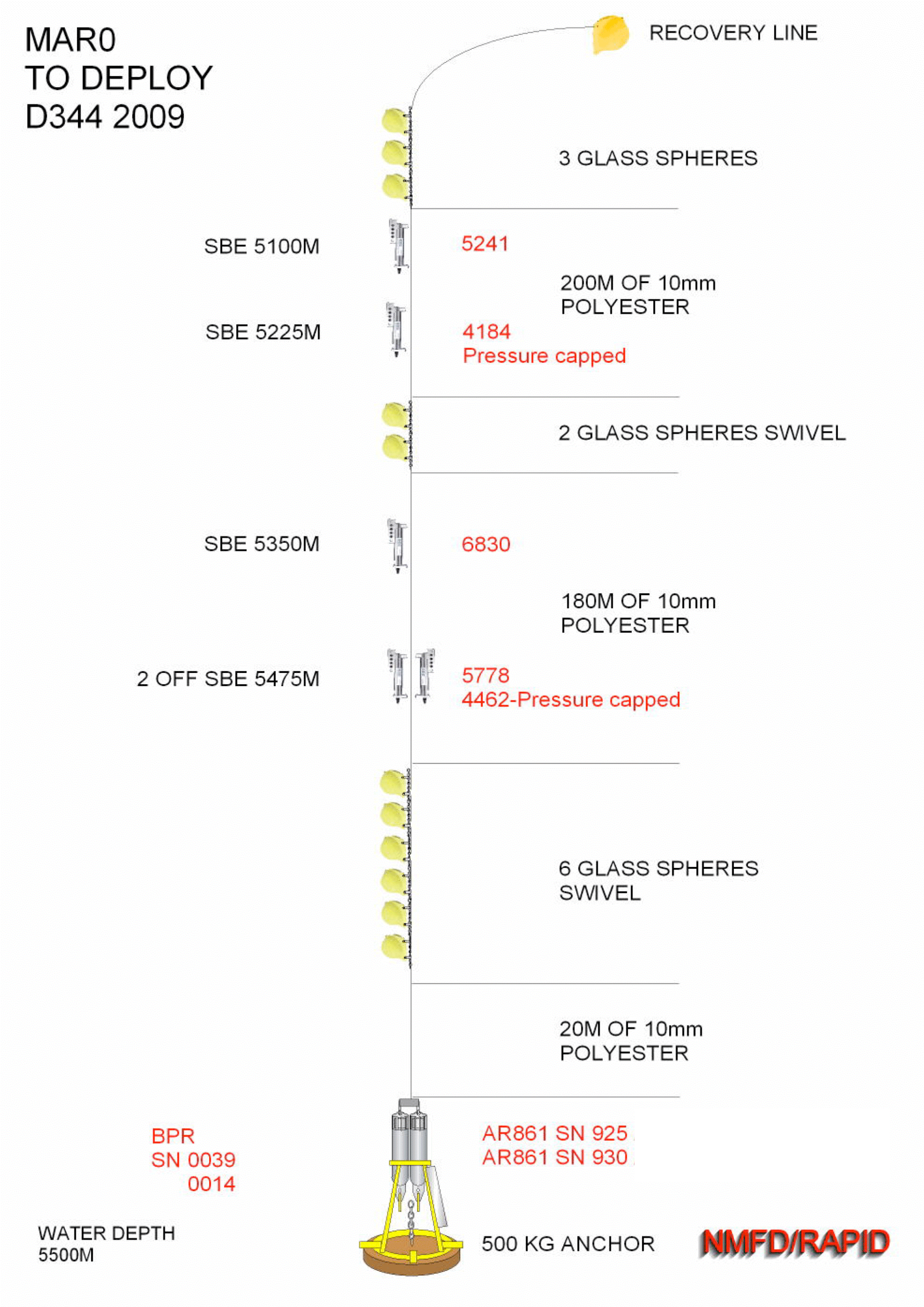

MARL2
TO DEPLOY
D344 2009
RECOVERY LINE
BILLINGS FLOAT WITH
VHF SN W03-100
LIGHT SN W03-089
5 M CHAIN
4 GLASS SPHERES
15M OF POLYPROP
4 GLASS SPHERES
15M OF POLYPROP
BPR SN 0013
0038
SBE 53
AR 861
SN 928
AR 861
SN 826
280 KG ANCHOR
WATER DEPTH
5041M
NMFD/RAPID

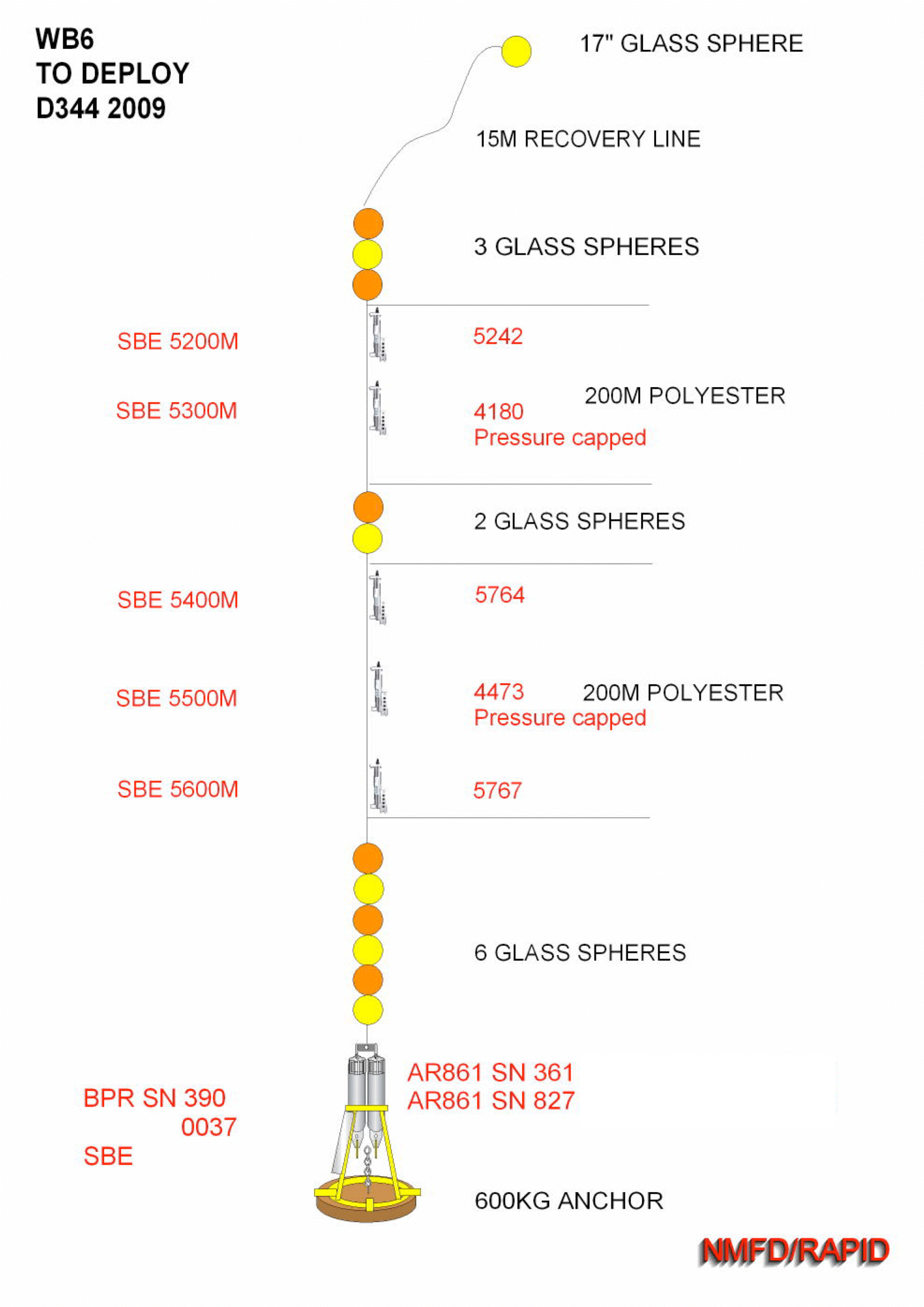

NOG
TO DEPLOY
D344 2009
DEPLOYMENT
POSITION
23 46.29N
41 5.77W
RECOVERY LINE
BILLINGS FLOAT WITH
BOWTECH LIGHT
LIGHT SN T05078
15M POLYPROP
12 X 17" GLASS
SPHERES
SWIVEL
50M POLYESTER
3000M SEDIMENT TRAP
SN 12168-01
RCM 11
SN 642
50M POLYESTER
3000M SEDIMENT TRAP
SN 11262-03
RCM 11
SN 643
500+500M
POLYESTER
10 X 17" GLASS
SPHERES
SWIVEL
200M POLYESTER
AR861 SN 323
WATER DEPTH
4235M
UNCORRECTED
50M POLYESTER
10M 1/2" CHAIN
850KG ANCHOR
NMFD


MAR1
TO DEPLOY
D344 2009
TRIMSYN RECOVERY LINE
SBE 50M
4461
40M 4mm WIRE
SPHERE 90M
24" SYNTACTIC
ARGOS SN T04044 ID 46243
LIGHT SNS01-189
1M CHAIN
SBE 100M
4464
60M 4mm WIRE
SS 150M
37" SN 3703
ARGOS SN
ID
LIGHT SN
1M CHAIN SWIVEL
5779
SBE 175M
5780
SBE 250M
5781
630M 5mm WIRE
SBE 325M
5782
SBE 400M
5783
SBE 600M
5784
8 GLASS SPHERES 787M SWIVEL
SBE 800M
4718
SBE 1000M
5785
990M 3/16" WIRE
SBE 1200M
5786
SBE 1600M
5787
8 GLASS SPHERES 1793M
SBE 2000M
5240
700M 3/16" WIRE
4 GLASS SPHERES SWIVEL 2509M
SBE 2500M
5788
500M 1/4" WIRE
4 GLASS SPHERES 3017M
SBE 3000M
5789
460M 1/4" WIRE
4 GLASS SPHERES 3484M SWIVEL
SBE 3500M
5776
540M 1/4" WIRE
4 GLASS SPHERES 4032M
SBE 4000M
3282
710M 1/4" WIRE
SBE 4500M
3284
5 GLASS SPHERES 4750M
SBE 4995M
4179
290M 1/4" WIRE
S4 5000M
35612577
100M 1/4" WIRE
9 GLASS SPHERES 5151M SWIVEL
AR 861 SN 908
AR 861 SN 822
WATER DEPTH
5200M
20M 16mm NYLON BRAID
CHAIN 1/2" 10M
1800KG CHAIN ANCHOR
NMFD/RAPID


MARL1
TO DEPLOY
D344 2009
BILLINGS FLOAT WITH
VHF SN
LIGHT SN
RECOVERY LINE
5 M CHAIN
4 GLASS SPHERES
15M OF POLYPROP
4 GLASS SPHERES
15M OF 10mm
POLYESTER
2 OFF SBE 53
SN 393
SN 420
AR861 SN 370
RT661 SN 216
300 KG ANCHOR
WATER DEPTH
4870M
NMFD/RAPID


MAR2
TO DEPLOY
D344 2009
MINI-MOORING FLOAT WITH
LIGHT SN S01-187
ARGOS SN W03-084 ID 82954
2M CHAIN
RECOVERY LINE
4 GLASS
SPHERES
SWIVEL
SBE 1100M
5762
700M
3/16" WIRE
SBE 1400M
5766
4 GLASS
SPHERES
1787M
SWIVEL
SBE 1800M
5767
450M
3/16" WIRE
3 GLASS
SPHERES
2244M
SBE 2250M
5768
495M
3/16" WIRE
3 GLASS
SPHERES
2745M
SWIVEL
SBE 2750M
5770
990M
3/16" WIRE
SBE 3250M
5771
3 GLASS
SPHERES
3741M
SWIVEL
SBE 3750M
5763
500M
3/16" WIRE
3 GLASS
SPHERES
4246M
SWIVEL
SBE 4250M
5773
SBE 4750M
5774
890M
3/16" WIRE
5775
SBE 5150M
----
9 GLASS
SPHERES
5170M
SWIVEL
35612578
AR 861 SN 319
WATER DEPTH
5200M
CHAIN 1/2" 10M
30M 16mm Nylon Braid
1000KG ANCHOR
NMFD/RAPID


MAR0
TO DEPLOY
D344 2009
RECOVERY LINE
3 GLASS SPHERES
SBE 5100M
5241
200M OF 10mm
POLYESTER
SBE 5225M
4184
Pressure capped
2 GLASS SPHERES SWIVEL
SBE 5350M
6830
180M OF 10mm
POLYESTER
2 OFF SBE 5475M
5778
4462-Pressure capped
6 GLASS SPHERES
SWIVEL
20M OF 10mm
POLYESTER
BPR
SN 0039
0014
AR861 SN 925
AR861 SN 930
WATER DEPTH
5500M
500 KG ANCHOR
NMFD/RAPID


WB6
TO DEPLOY
D344 2009
17" GLASS SPHERE
15M RECOVERY LINE
3 GLASS SPHERES
SBE 5200M
5242
SBE 5300M
4180
Pressure capped
200M POLYESTER
2 GLASS SPHERES
SBE 5400M
5764
SBE 5500M
4473
Pressure capped
200M POLYESTER
SBE 5600M
5767
6 GLASS SPHERES
AR861 SN 361
AR861 SN 827
BPR SN 390
0037
SBE
600KG ANCHOR
NMFD/RAPID

RAPID-WATCH MOORING LOGHSEET **RECOVERY**

Mooring **EBM6** Cruise **D344**

NB: all times recorded in GMT

Date 24/10/09 **Site arrival time** 15:20
Time of first ranging 15:20
Time of release 15:21:40

Latitude ____________ **Longitude** ____________
(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT		Heavy bio-fouling	1532
RECOVERY LINE		"	
VHF BEACON	W03 -112	"	
2 X GLASS SPHERE		"	
SBE37	3207	✓	
SONARDYNE LRT RELEASE	ID001 S/N 252343-007		1534

Ascent rate ____________
Time at end of recovery 1534

Ranging

Time	Range 1	Command /comment
	112-7	
	53	
15:21	110	
15:21:14	108	
15:21:40	104-9	ALL CONFIRMED ENBL
	104-5	SCT
	104-3	REL
15:23:00	55-9	
15:23:00	40-1	
	38-1	

15:25 SPOTTED ON SURFACE

RAPID-WATCH MOORING LOGHSEET **RECOVERY**

Mooring **EBM5** Cruise **D344**

NB: all times recorded in GMT

Date 24/10/09 **Site arrival time** 14:22

Time of first ranging ____

Time of release 14:35 – 1ST ATTEMPT – BLIND FIRE AS RANDOM RANGES

Latitude ____ **Longitude** ____

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			
RECOVERY LINE			
VHF BEACON	W03 – 114		
2 X 12"GLASS SPHERE			
SBE37	3208		
SONARDYNE LRT RELEASE	ID006 252 343-005		

Ascent rate ____

Time at end of recovery NOT RECOVERED

Ranging

Time	Range 1	Command /comment
14:24:00	275.1	
	182.7	
	632	
	531	
	393	
	31.7	
	380	
	628	
	130.3	
	253.8	
	590	
	498	
	568.9	BOW THRUSTER NOW OFF
	224	
	469	
	213	

514

431

194

397

200.3

CHANGE DECK UNIT
STILL RANDOM

CHANGE XDCR

Time Range
1617 610/586/98/
401/F/179.4
33.9/[illegible] F/

226.6

ALL RANDOM

NO SENSIBLE RANGES
NO SIGNAL AFTER
BLIND RELEASES.

ABANDON.

RAPID-WATCH MOORING LOGHSEET **RECOVERY**

Mooring **EBM4** Cruise **D344**

NB: all times recorded in GMT

Date 24/10/09 **Site arrival time** 13:51

Time of first ranging 13:52

Time of release 13:54

Latitude ____________ **Longitude** ____________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			14:08
RECOVERY LINE			↓
VHF BEACON	W03-111		
2 X 12" GLASS SPHERE			
SBE37	3258	SLIGHT BANG ON BULWARK DURING RECOVERY	
SONARDYNE LRT RELEASE	ID007 252 343-001		

Ascent rate 50 m/min FROM REL TO SURFACE (INCLUDING SCREWING TIME OF RELEASE)

Time at end of recovery 14:08

Ranging

Time	Range 1	Command /comment
13:52	306	X ECHOSOUNDER STILL ON
	188·6	
13:53:20	297·5	
13:53:45	296·5	
13:54:00		ENB RECEIVED
	180 ?	} RANDOM RANGES
	227 ?	
13:55:16	260·3	
13:55:30	244·7	
13:56:00	88·4	
13:56:07	205·7	
13:56:17	194·8	

13:59:04 SURFACING

14:07 GRAPPLED

RAPID-WATCH MOORING LOGHSEET RECOVERY

Mooring **EBM1** Cruise **D344**

NB: all times recorded in GMT

Date 24/10/09 **Site arrival time** 13:08

Time of first ranging 13:09:17

Time of release 13:13

Latitude ____________ **Longitude** ____________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			~~1042~~ 13:30
RECOVERY LINE			~~1042~~ ↓
VHF BEACON	W03 – 115		~~1042~~
2 X 12" GLASS SPHERE			~~1042~~
SBE37	4306		~~1042~~
SONARDYNE LRT RELEASE	ID002 252343 - 003		~~1048~~

Ascent rate 68 m/min

Time at end of recovery 13:31

Ranging

Time	Range 1	Command /comment
13:11:22	498.6	LOTS OF "FAILS" PRIOR TO THIS
13:12:00	499.1	
13:12:39	499	ENABLE – RECEIVED
~~13:~~	499	SET – RECEIVED
	499	REL – RECEIVED
13:14:25	428.1	
13:14:50	398.4	
13:15:05	381.6	34.3 m in 30 secs
13:15:35	347.3	
		⇒ 68 m/min

13:20 – SPOTTED ON SURFACE

13:30 – GRAPPLED

RAPID-WATCH MOORING LOGHSEET **RECOVERY**

Mooring **EBH5** Cruise **D344**

NB: all times recorded in GMT

Date 24/10/09 **Site arrival time** 10:33

Time of first ranging 10:33

Time of release 10:34:40

Latitude ____________ **Longitude** ____________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
LIGHT BEACON	S01 - 191		
BILLINGS FLOAT			11:05
1M CHAIN SWIVEL			
RECOVERY FLOAT			11:00
RECOVERY LINE			
SBE37	3214 ✓	LIGHT FOULING	11:05
2 GLASS SPHERES			11:11
SBE37	3213 ✓		11:15
SBE37	3212 ✓		11:17
2 GLASS SPHERES			11:22
S4	35612576 ✓		11:22
2 GLASS SPHERES			11:30
S4	35612577		11:30
4 GLASS SPHERES			11:39
SWIVEL			
1M CHAIN			
ACOUSTIC RELEASE	370		11:39

Ascent rate ____________

Time at end of recovery 11:39

Ranging

Time	Range 1	Range 2	Command /comment
09:24:15	—	1741	ARM + ARM] WHILST RECOVERING EBH4.
09:24:50	1745	1746	ARM + ARM
10:33:55	1155	1154	— " —
10:34:40	1147	1145	ARM + REL - REL OK
10:35:30	1085	1075	
10:36:10	1017	1006	

10:37 - MOORING SPOTTED ON SURFACE

WHOLE MOORING ON SURFACE 10:48

10:59 - GRAPNELLED

RAPID-WATCH MOORING LOGHSEET **RECOVERY**

Mooring **EBH4** Cruise **D344**

NB: all times recorded in GMT

Date 24/10/09 **Site arrival time** 08:53
Time of first ranging 08:53
Time of release 09:03:30

Latitude ____________ **Longitude** ____________
(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			09:27
RECOVERY LINE			
LIGHT			
BILLINGS FLOAT		V. LIGHT FOULING	09:35
1M CHAIN SWIVEL			↓
1 GLASS SPHERE			
SBE37	4307 ✓		09:35
SBE37	5238 ✓		09:42
SBE37	5240 ✓	TANGLED	09:47
2 GLASS SPHERES			09:47
SBE37	5239 ✓		09:54
SBE37	5242 ✓	TANGLED	09:58
2 GLASS SPHERES			09:58
SWIVEL			
SBE37	5241 ✓		10:04
4 GLASS SPHERES			10:11
1M CHAIN SWIVEL			
ACOUSTIC RELEASE	s/n 262		10:11

Ascent rate 73 m/min
Time at end of recovery 10:11

Ranging

Time	Range 1	Range 2	Command /comment
08:53:55	—	1670	[redacted] ARM + ARM RANGING WHILST APPROACHING
08:55:25	1401	1381	"
09:03:30	1155	1156	ARM + ~~ARM~~ RELEASE — RELEASE OK
09:04:27	1095	1087	ARM + REL
09:05:27	1022	1016	

~~EST 73 m/min~~

09:09 SPOTTED ON SURFACE
09:17 LAST PACK ON SURFACE MOVING IN FOR RECOVERY

RAPID-WATCH MOORING LOGHSEET **RECOVERY**

Mooring **EBP2** Cruise **D344**

NB: all times recorded in GMT

Date 24/10/09 **Site arrival time** 07:59

Time of first ranging 07:59:42

Time of release 8:02:40

Latitude ____________ **Longitude** ____________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
Plastic pickup float	n/a		08:43
PIES unit	131		08:43

Ascent ~~rate~~ TIME 34 MINS INCLUDING BURNWIRE

Time at end of recovery 08:43

Ranging

Time	Range 1	Command /comment
08:01	/	RANGING – BUT CURRENTLY SAMPLING.
08:01:40	1013	
08:02:00	1015	RELEASE CONFIRMED (6x 12kHz PULSES)
08:02:40	RELEASE	NOW TRANSMITTING AT 4 SECOND INTERVAL AS EXPECTED.
08:36:50		ON SURFACE + RADIO BEACON WORKING
		SPOTTED DEAD AHEAD

ET SURFACE 08:32 – ISH.

RAPID-WATCH MOORING LOGHSEET **RECOVERY**

Mooring **EBH3** Cruise **D344**

NB: all times recorded in GMT

Date 25/10/09 **Site arrival time** 10:48

Time of first ranging 10:41 WHILST APPROACHING

Time of release 10:48

Latitude ____________ **Longitude** ____________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT	AI556		11:21
RECOVERY LINE			
LIGHT BEACON			
BILLINGS FLOAT		SURFACED UPSIDE DOWN	11:27
5M CHAIN			
2 MINI TRIMSYN			
SBE37	5243 ✓		11:27
2 MINI TRIMSYN			11:34
SBE37	5244 ✓		11:34
2 MINI TRIMSYN			11:39
SBE37	6328 ✓		11:39
2 MINI TRIMSYN			11:43
SBE37	6329 ✓		11:43
SBE 37	6330 ✓		11:50
2 GLASS SPHERES			11:50
1M 1/2" CHAIN			
ACOUSTIC RELEASE	252		11:50

Ascent rate 78 m/min

Time at end of recovery 11:50

Ranging

Time	Range 1	Range 2	Command /comment
10:41:20	—	1517	ARM + ARM
10:41:48	1510	1509	ARM + ARM
10:48:20	1441		ARM + REL REL OK
10:49:07	1382] 78 m/min	1374] 77 m/min	ARM + REL REL OK
10:50:07	1304	1297	

11:00 PICKUP VISIBLE ON SURFACE

11:10 BOTTOM PACK OF GLASS ON SURFACE

11:20 GRAPPLED

RAPID-WATCH MOORING LOGHSEET **RECOVERY**

Mooring **EBH2** Cruise **D344**

NB: all times recorded in GMT

Date 25/10/09 **Site arrival time** 15:35

Time of first ranging 15:33 – WHILST APPROACHING

Time of release 15:36

Latitude ____________ **Longitude** ____________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			16:20
RECOVERY LINE			
LIGHT BEACON	T05-079		
BILLINGS FLOAT			16:26
1M CHAIN			
2 GLASS SPHERES			
SWIVEL			
SBE 37	6333 ✓		16:26
2 GLASS SPHERES			16:35
SBE 37	6334 ✓		16:35
SBE 37	5245		16:42
2 GLASS SPHERES			16:42
1M CHAIN SWIVEL			
ACOUSTIC RELEASE	243		16:42

Ascent rate 81 m/min

Time at end of recovery 16:42

Ranging

Time	Range 1	Range 2	Command /comment
15:33	2136	2133	ARM + ARM
15:36:21	2090	2089	ARM + REL REL OK
15:37:08	2027]	2017	ARM + REL REL OK
15:38:08	1946] 81m	1938	

ETA: 15:57

15:57 SPOTTED ON SURFACE

16:04 ALL MOORING ON SURFACE

16:19 GRAPPLED

RAPID-WATCH MOORING LOGHSEET RECOVERY

Mooring **EBH1** Cruise **D344**

NB: all times recorded in GMT

Date 26/10/09 **Site arrival time** OVERNIGHT

Time of first ranging 06:30

Time of release 06:31

Latitude ____________ **Longitude** ____________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			07:41
RECOVERY LINE			
LIGHT			
BILLINGS FLOAT			07:46
5 m CHAIN SWIVEL			
4 X 17" GLASS			07:46
SBE37	5246 ✓		07:46
2 X 17" GLASS			07:54
SBE 37	5247 ✓		~~[illegible]~~ 0801
2 X 17" GLASS			"
1M CHAIN SWIVEL			"
ACOUSTIC RELEASE	821 ✓		

Ascent rate 81m/min

Time at end of recovery ____________

Ranging

Time	Range 1	Range 2	Command /comment
06:30:00	—	3094	ARM + ARM
06:30:36	3094	3095	— " —
06:31:35	3094	3094	ARM + REL REL OK
06:32:30	—	—	— " — NO REPLY
06:33:15	2960] 81m	2951	— " — REL OK
06:34:15	2879	—	

ETA 07:03

07:02 SPOTTED ON SURFACE CLOSE TO SHIP ON PORT SIDE

GRAPPLED 07:41

RAPID-WATCH MOORING LOGHSEET **RECOVERY**

Mooring **EBL4** Cruise **D344**

NB: all times recorded in GMT

Date 26/10/09 **Site arrival time** 09:16

Time of first ranging 09:18

Time of release 09:31:10

Latitude ____________ **Longitude** ____________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			10:28
RECOVERY LINE			
LIGHT	H01 - 009		
VHF BEACON	T01 - 145		
BILLINGS FLOAT		SURFACED UPSIDE DOWN SO VHF NOT HEARD	10:31
1M CHAIN			
2 X GLASS SPHERES			10:31
ACOUSTIC RELEASE	826		10:37
BPR	394		10:37
TRIPOD ASSEMBLY			10:37

10:34

+3x GLASS

Ascent rate ~80 m/min

Time at end of recovery ____________

Ranging

Time	Range 1	Range 2	Command /comment
09:18:30	—	3031	ARM + ARM
09:19:10	3029	3029	ARM + ARM
09:31:10	3139	3138	ARM + REL REL OK
09:32:00	3089] 78	3081	ARM + REL REL OK
09:33:00	3011	3003	
09:35:00	2850] 161	2843	

ETA 10:10

SURFACED 10:10

GRAPPLED 10:27

RAPID-WATCH MOORING LOGHSEET **RECOVERY**

Mooring **EBHi** Cruise **D344**

NB: all times recorded in GMT

Date 28/10/09 **Site arrival time** 10:35

Time of first ranging 10:35

Time of release 10:37

Latitude ____________ **Longitude** ____________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			11:50
RECOVERY LINE			
LIGHT	ST – 400 A++		
BILLINGS FLOAT			11:54
5M CHAIN			
2 X GLASS SPHERES			11:54
SWIVEL			
SBE37	3244 ✓		11:54
2 X GLASS SPHERES			12:07
SBE37	3902 ✓		12:07
SBE37	3905 ✓		12:18
4 X GLASS SPHERES			12:18
1M CHAIN			
SWIVEL			
ACOUSTIC RELEASE	928		12:18

Ascent rate 78 m/min

Time at end of recovery 12:18

Ranging

Time	Range 1	Range 2	Command /comment
08:05:05	—	—	ARM + ARM – WHILST DOING CTD CAST
08:08:16	—	—	—— " ——
08:09:05	—	—	
10:16:20	—	—	REPOSITIONING – 1.5 m AWAY.
10:17:10	—	4956	
10:17:50	—	—	
10:35:20	—	4650	½ MILE DOWNWIND – ARM + ARM
10:36:00	4648	—	ARM + ARM
10:37:00	4642	4643	ARM + REL – REL OK
10:38:00	4575	—	ARM + REL —
10:39:00	—	—	
10:40:00	—	—	
10:41:00	4341	—	

42 mins to surface ETA 11:24 11:21 ON SURFACE

2ND PACK ON SURFACE 11:28
3RD PACK ON SURFACE 11:29
GRAPPLED 11:58

RAPID-WATCH MOORING LOGHSEET **RECOVERY**

Mooring **EB1** Cruise **D344**

NB: all times recorded in GMT

Date 29/10/09

Site arrival time 09:36

Time of first ranging 09:37

Time of release 09:42

Latitude ____________ **Longitude** ____________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			10:44
RECOVERY LINE			
TRIMSYN X 3			10:47
SBE37	3223 ✓	LIGHT FOULING	10:47
24" STEEL SPHERE and ARGos BEACON			10:53
SBE 37	3228 ✓		10:53
SBE 37	3229 ✓	connector damaged tangled	10:59
ARGOS BEACON	W03 095	with ARGOS	10:59
37" McLa STEEL SPHERE			10 59
1M CHAIN SWIVEL			10 59
SBE 37	3230 ✓		11 06
SBE37	3231 ✓	cable tangle 3231	11 09
SBE37	3232 ✓	only 20 m from 3232	11 14
4 X 17" GLASS FLOAT		3231 hanging on 5 m loose	11 19
SBE37	3233 ✓	cable.	11 26
4 X 17" GLASS FLOAT			11 35
SBE37	4305 ✓	wire tangle 4305 above	11 35
SBE37	3906 ✓	floats.	11 46
4 X 17" GLASS FLOAT			11 49
SBE37	3907 ✓		11 53
4 X 17" GLASS FLOAT			11 59
SBE37	3908 ✓	cap off. flooded.	1203
SBE37	3919 ✓		1209
4 X 17" GLASS FLOAT			1213
SBE37	3928 ✓		1223
SBE37	3930 ✓		1229
4 X 17" GLASS FLOAT			1234

spool changed recommenced recovery at 1248

GRAPPLED 10:44

SBE37	3931	✓	1252
4 X 17" GLASS FLOAT + swivel		✓ wire has many twists - top of glass ~~swivel required~~?	1300
SBE37	3932	✓	1310
4 X 17" GLASS FLOAT		] Tangled at join	1320
SBE37	3933	✓	1320
8 X GLASS FLOAT			"
SBE37	3934	✓	1348
SWIVEL			1352
ACOUSTIC RELEASE 1	909		"
ACOUSTIC RELEASE 2	908		"

Ascent rate ____________

Time at end of recovery 1352

Ranging

Time	Range 1	Range 2	Command /comment
09:37:50	—	5133	ARM + ARM SN: 909
09:38:30	—	5133	— " ————
09:39:40	—	5134	ARM + ARM SN: 908
09:40:15	5135	5135	— " ————
09:42:10	5134	5134	ARM + REL SN 908 REL OK
09:42:50	5084	—	ARM + REL — " — NOT CONFIRMED
09:43:30	5017	5002	ARM + REL REL OK.

RAPID-WATCH MOORING LOGHSEET **RECOVERY**

Mooring **EBL3** Cruise **D344**

NB: all times recorded in GMT

Date 29/10/09

Site arrival time OVERNIGHT

Time of first ranging 06:35

Time of release 06:39

Latitude ____________ **Longitude** ____________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT		Orange	08:02
RECOVERY LINE			
VHF BEACON	E (d=1) – (d=57)		
BILLINGS FLOAT			08:06
CHAIN			
4 X GLASS SPHERES			08:06
4 X GLASS SPHERES			08:10
ACOUSTIC RELEASE	827		08:13
ACOUSTIC RELEASE	361		
BPR	0390		
BPR	0391		
TRIPOD ASSEMBLY			

Ascent rate 88m/min

Time at end of recovery 08:13

Ranging

Time	Range 1	Range 2	Command /comment
06:35:35	—	5087	ARM +ARM SN 827
06:36:15	5086	5086	—11— SN 827
06:37:16	—	5083	ARM +ARM SN 361
06:37:50	5083	5083	ARM + ARM SN 361
06:39:20	5081	5081	ARM + REL SN 361 REL OK
06:40:05	5081	5080	ARM +REL SN 361 REL OK
06:41:05	5080	5080	ARM + REL SN 361 REL OK
06:42:05	5080	5081	ARM+ REL SN 361 REL OK
06:43:30	5080	5081	ARM +REL SN 827 REL OK
06:44:15	5038] 88m	5025	ARM +REL SN 827 REL OK
06:45:15	4950] 84m	4938	—11— —11—
06:46:15	4866	4852	—11— —11—

NOT RELEASED

ETA 07:42

RELEASE SN 361 DID NOT RELEASE DESPITE SAYING THAT IT HAD.

07:40 BEACON HEARD
07:41 SPOTTED

08:01 GRAPPLED

RAPID-WATCH MOORING LOGHSEET **RECOVERY**

Mooring **NOG_SED_TRAP** Cruise **D344**

NB: all times recorded in GMT

Date 4/11/09 **Site arrival time** 13:33

Time of first ranging 13:33

Time of release 13:38

Latitude ____________ **Longitude** ____________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
Recovery line		14:33 GRAPPLED	
Billings			14:38
Light			
12x17' glass			14:46
SED trap	11804-07	LINE TANGLING ROUND TOP OF TRAP	14:52
RCM11	423	✓	"
SED trap	11262-06		1505
RCM11	419	✓	"
10x17' glass		tangled line cut.	1527
AR	925		1534

Ascent rate 92 m/min

Time at end of recovery ____________

Ranging

Time	Range 1	Range 2	Command /comment
13:34	4189		ARM + ARM
13:34:52	4188	4189	— " —
13:37:56	4212	4212	— " —
13:38:46	4211	4212	ARM + REL NOT CONFIRMED
13:39:24	4166	4153	— " —
13:40:00	4104	4093	— " —
13:41:00	4012	4001	

ETA 14:10

14:16 1ST PACK SPOTTED

BOTTOM PACK SURFACED 1ST
PICKUP + BILLINGS SURFACED 2ND

RAPID-WATCH MOORING LOGHSEET **RECOVERY**

Mooring **MAR3** Cruise **D344**

NB: all times recorded in GMT

Date 3/11/09 **Site arrival time** ______

Time of first ranging 09:16 – WHILST APPROACHING

Time of release 09:29

Latitude ______ **Longitude** ______

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME	
RECOVERY FLOAT			10:40	
RECOVERY LINE				
LIGHT				
BILLINGS FLOAT			10:44	
2 X GLASS SPHERES			10:44	
SWIVEL				
SBE37	6112 ✓	WIRE TANGLED	10:44	wire tangled.
3 X GLASS SPHERES	✓		10:59	
SBE37	6113 ✓		10:59	
SBE37	6114 ✓	TANGLED TOGETHER	11:11	TANGLED
3X GLASS SPHERES	✓		11:11	
3 X GLASS SPHERES	✓	TANGLED	11:29	
SWIVEL	✓			
SBE37	6115 ✓		11:38	
3 X GLASS SPHERES	✓	TANGLED	11:47	
SBE37	6116 ✓		11:57	
SBE37	6117 ✓	TANGLED TOGETHER	12:10	
S4	35612565 ✓		12:10	
7 X GLASS SPHERES	✓		12:10	
SWIVEL	✓			
ACOUSTIC RELEASE	929 ✓		12:11	

Ascent rate ______

Time at end of recovery 12:11

GRAPPLED 10:39

10:56:30 – wire tangled.

11:00:00 – tangled wire clear.

~~**Ranging**~~

Time	Range 1	Range 2	Command /comment
09:16:00	—	5418	ARM + ARM
09:17:00	—	5324	—〃—
09:29:00	5026	5026	ARM + REL REL OK
09:29:45	4976	4965	ARM + REL REL OK
09:30:45	4882] 94	4870] 95	
09:31:45	4795] 87	4783] 87	

~~94m/min~~

87 m/min

ETA 09:57

SPOTTED 10:05 CLOSE TO SHIP

2ND PACK 10:08

3RD PACK 10:13

TRICKY LAY TO MOORING

RECOVERING FISH TO ATTEMPT PICK UP ON PORT SIDE

RAPID-WATCH MOORING LOGHSEET **RECOVERY**

Mooring **MARL2** Cruise **D344**

NB: all times recorded in GMT

Date 3/11/09 **Site arrival time** 12:30

Time of first ranging 12:30 - WHILST APPROACHING

Time of release 12:33

Latitude ____________ **Longitude** ____________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1355
RECOVERY LINE			"
LIGHT	T05-078		"
VHF BEACON	U01-018		"
BILLINGS FLOAT			"
1M CHAIN			"
5X GLASS SPHERES		3x	1400
ACOUSTIC RELEASE	822		1404
BPR	0002		"
TRIPOD ASSEMBLY			"

Ascent rate ~ 62m/min [estimated]

Time at end of recovery 1404

Ranging

Time	Range 1	Range 2	Command /comment
12:30:50	–	5046	ARM + ARM
12:31:40	–	5033	ARM + ARM
12:33:45	5033	5034	ARM + REL REL OK
12:34:40	4997	4989	ARM + REL REL OK
12:35:40	4950	4944	

] DOING 8KTS. AWAY FROM SITE

IF ASCENT RATE SAME AS EBL4 (80m/min)
ETA 62 mins FROM RELEASE
=> 13:35 SURFACE.

13:37 SPOTTED
VHF NOT HEARD BUT BILLINGS UPSIDE DOWN.

RAPID-WATCH MOORING LOGHSEET **RECOVERY**

Mooring **MAR2** Cruise **D344**

NB: all times recorded in GMT

Date 6/11/09 **Site arrival time** ________

Time of first ranging 12:13:10

Time of release ________ RELEASE HORIZONTAL.

Latitude ________ **Longitude** ________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT		NOTHING RECOVERED	
RECOVERY LINE			
LIGHT			
BILLINGS FLOAT			
4 X GLASS SPHERES			
SWIVEL			
SBE37	6130		
SBE37	6131		
4 X GLASS SPHERES			
SBE37	6132		
3 X GLASS SPHERES			
SBE37	6133		
3 X GLASS SPHERES			
SBE37	6134		
SBE37	6136		
3 X GLASS SPHERES			
SBE37	6109		
SWIVEL			
3 X GLASS SPHERES			
SBE37	6135		
SBE37	6110		
4 X GLASSS SPHERES			
S4	35612567		
SBE37	6111		
5 X GLASS SPHERES			
SWIVEL			
ACOUSTIC RELEASE	914		

Ascent rate ____________
Time at end of recovery ____________

Ranging

Time	Range 1	Range 2	Command /comment
12:13:10	—	—	ARM + ARM WHILST APPROACHING AT 11 KTS.
12:14:00	—	5181	ARM + ARM
12:14:40	—	—	
12:15:25	—	—	
12:22:20	5347	—	MOVE TO DOWNWIND ARM + ARM
12:23:00	5341	—	ARM + ARM
12:24:00	5331	5330	ARM + REL REL OK
12:25:00	5323	5322	ARM + REL REL NOT CONFIRMED
12:26:00	5314	5315	ARM + REL REL OK
12:27:00	5310	5309	ARM + REL REL OK
12:27:55	5304	5302	ARM + DIAG HORIZONTAL 8·9V
12:28:55	5295	5294	HORIZONTAL 8·9V
12:30:45	5281	5280	HORIZONTAL 8·9V
			HORIZONTAL 8·9V
12:39:10	5250	5248	HORIZONTAL 8·9V

NOT RECOVERABLE

RAPID-WATCH MOORING LOGHSEET RECOVERY

Mooring **MAR1** Cruise **D344**

NB: all times recorded in GMT

Date 6/11/09 **Site arrival time** 15:19

Time of first ranging VARIOUS DURING TRANSIT

Time of release 15:20

Latitude __________ **Longitude** __________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
TRIMSYN FLOAT		GRAPNELED PORT SIDE	16:41
RECOVERY LINE			16:43
3 X TRIMSYN			16:44
SBE37	6137 ✓		16:45
24" STEEL SPHERE	274 ✓	PTT-1D 60202 no light	16:51
SBE37	6323 ✓		16:55
ARGOS BEACON	264 ✓	PTT-1D 46242/S01-189	1657
37" STEEL SPHERE	✓		
1M CHAIN SWIVEL	✓		
SBE37	6325 ✓		17:01
SBE37	6324 ✓		17:05
SBE37	6320 ✓		17:07
SBE37	6326 ✓		17:10
SBE37	6118 ✓		17:14
8 X GLASS SPHERES	✓	ORANGE - TANGLED	17:17
SBE37	6119 ✓		17:22
SBE37	6121 ✓		17:27
SBE37	6120 ✓		17:30
SBE37	6122 ✓		17:38
8 X GLASS SPHERES	✓	ORANGE - TANGLED	17:41
SBE37	6123 ✓		17:51
4X GLASS SPHERES	✓	ORANGE - TANGLED	17:59
SWIVEL	✓		"
SBE37	6124 ✓		18:04
4 X GLASS SPHERES	✓	yellow - tangled 3 lines going	18:12
SBE37	6125 ✓	from glass	18:20
4 X GLASS SPHERES	✓	yellow - tangled	18:29

microcat up first

				18:29	
SBE37	6126	✓			19:19
4 X GLASS SPHERES			orange – came up tangled together*	~~[illegible]~~	19:14
SBE37	6128	✓		19:37	
SBE37	6129	✓		19:19	19:19
5 X GLASS SPHERES			orange – 1943 connection goes past	1955	
SBE37	6127	✓		1955	
S4	35612568			2002	
9 X GLASS SPHERES			Orange	2002	
SWIVEL				2002	
ACOUSTIC RELEASE	930			2002	
ACOUSTIC RELEASE	915				

* disconnected both sets of wires & took up 3 strands of wire & 1 pair of ends that were tangled ~~[illegible]~~ together higher up

Ascent rate ______

Time at end of recovery 2002

Ranging

6/11/09

Time	Range 1	Range 2	Command /comment
12:08:50	/	/	WHILST TRANSITING TO MAR2 AT 11KTS.
12:09:30	/	/	ARM + ARM SN 930
12:10:30	/	/	ARM + ARM SN 915
12:11:10	/	/	"
12:48:35	/	/	ARM + ARM SN 930 ~2 MILES WEST OF IT
12:49:40	/	/	"
12:50:30	6156	/	ARM + ARM SN 915
12:51:10	/	/	"
12:51:50	/	/	"
12:52:40	/	/	"
13:05:00	5356	/	ARM + ARM SN 930 ~1 MILE NORTH OF IT.
13:05:30	/	5378	"
13:06:15	5388	/	
15:11:00	5218	5214	ARM + ARM SN 930 – POST MARLI RECOVERY, ½ MILE AWAY
15:12:00	5197	5194	ARM + DIAG SN 930 VOLTAGE 8.9V
15:19:20	5209	5210	ARM + ARM SN 930
15:20:20	5210	5210	ARM + REL RELEASE NOT CONFIRMED
15:21:10	/	/	ARM + REL
15:21:50	/	-199 ×	
15:22:40	/	/	
15:23:30	4926		ARM + REL
15:24:00	4884	4872	

ALL ON SURFACE ≈ 16:18

RAPID-WATCH MOORING LOGHSEET **RECOVERY**

Mooring **MARL1** Cruise **D344**

NB: all times recorded in GMT

Date 6/11/09 **Site arrival time** 13:08

Time of first ranging 12:43

Time of release 13:08

Latitude ____________ **Longitude** ____________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			14:49
RECOVERY LINE			
LIGHT			
VHF BEACON		IN 1 TANGLE	1
BILLINGS FLOAT		IMPLODED	14:49
1M CHAIN			
4 X GLASS SPHERES			14:49
4 X GLASS SPHERES			14:53
ACOUSTIC RELEASE	244		14:55
ACOUSTIC RELEASE	818		14:55
BPR	0003		↓
BPR	0418		
TRIPOD ASSEMBLY			

Ascent rate ~70m/min

Time at end of recovery 14:56

Ranging

Time	Range 1	Range 2	Command /comment
12:43:20	—	—	AT MAR2 ATTEMPTED RECOVERY SITE 3 MILES AWAY
12:44:00	—	—	ARM + ARM SN. 818
12:44:45	—	—	"
12:46:15	—	—	ARM + ARM SN. 244
12:47:00	—	—	"
12:55:30	6622	—	ARM + ARM SN 818
12:56:50	—	—	"
13:02:35	—	—	"
13:03:15	—	5607	"
13:03:50	—	—	"
13:07:00	5345	5338	ARM + ARM SN 244
13:08:10	5306	5302	ARM + REL REL OK - SN 244
13:09:00	5246	5233	ARM + REL REL OK STILL DOING 4 KTS.
13:10:00	5164	5153	REL OK
13:11:15	5068	5057	REL OK
13:12:15	4994	4983	
13:13:15	4920	4909	
13:15:45	4744	4734	ARM + DIAG VERTICAL 8.8V
13:16:45	4674	4665	ARM + DIAG VERTICAL 8.8V

13:18:45 4534 4525 VERTICAL 8·8V

70m/min FROM 4534m = 64 mins

ETA 14:22

14:08:40 — 1272 ARM + ARM SN 244
14:09:40 1233 1228

SPOTTED 14:24

BILLINGS UPSIDED DOWN DUE TO SHORT LENGTH OF CHAIN

14:44 GRAPPLED IN TANKE

RAPID-WATCH MOORING LOGHSEET **RECOVERY**

Mooring **MAR0** Cruise **D344**

NB: all times recorded in GMT

Date 8/11/09 **Site arrival time** 09:21

Time of first ranging 09:21

Time of release 09:30

Latitude ____________ **Longitude** ____________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			10:45
RECOVERY LINE			
3 X GLASS SPHERES			10:48
SBE37	6322 ✓		10:48
SBE37	6332		10:56
2 X GLASS SPHERES			11:01
SBE37	6331 ✓		11:05
SBE37	6327 ✓		11:09
SBE37	6321 ✓	TANGLED	11:09
6 X GLASS SPHERES			11:09
ACOUSTIC RELEASE	913		11:15
ACOUSTIC RELEASE	912		11:15
BPR	0031		11:15
TRIPOD ASSEMBLY			11:15

Ascent rate 97 m/min

Time at end of recovery 11:15

Ranging

Time	Range 1	Range 2	Command /comment
09:21:45	—	5674	ARM + ARM AS APPROACHING - SN 913
09:22:45	5654	5650	—〃— SN 913
09:23:40	5633	5630	ARM + DIAG SN 913 VBATTERY 8.9V
09:24:35	—	5612	—〃— SN 912 VBATTERY 11.2V ?
09:25:20	5606	5603	—〃— —〃— VBATTERY 8.9V
09:30:40	5577	5577	ARM + REL SN 912 REL OK
09:31:30	—	—	—〃—
09:32:20	—	—	—〃—
09:33:10	—	—	—〃—
09:34:00	5276	5261	ARM + ARM SN 913
09:35:00	5180	5166	—〃—
09:37:00	4986	4971	—〃—

96 m/min

97 m/min

ETA 10:24 SPOTTED 10:24 ALL ON SURFACE 10:29

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WB6** Cruise **D344**

NB: all times recorded in GMT

Date 14/11/09

Site arrival time 15:35 ISH

Time of first ranging 15:36

Time of release 15:39

Latitude ____________ **Longitude** ____________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
Pick Up float		GRAPPLED 16:42	16:43
15m polyprop			
3 x 17" glass			16:46
Microcat at join	6798 ✓	~ 3m DOWN FROM JOIN	16:49
100m polyester			
Microcat about halfway	6801 ✓		16:54
100m polyester			
2 x 17" glass			17:00
Microcat at join	6799 ✓		17:02
100m polyester			
Microcat about halfway	6802 ✓		17:05
100m polyester	~~6802~~		
Microcat at join	6800		17:11
6 x 17" glass			17:11
BPR on tripod	0032		17:11
DOUBLE ~~Single~~ release in tripod			17:11

Ascent rate 102 m/min

Time at end of recovery ____________

Ranging

Time	Range 1	Range 2	Command /comment	
15:21:15	—	—	ARM + ARM WHILST APPROACHING	2·8 MILES SOUTH
15:22:10	—	—	SN 495	11 KTS.
15:23:35	—	—		2·5 MILES
15:24:50	—	—	SN 359 ARM + ARM	
15:25:55	—	—	"	2·2 MILES SOUTH
15:28:30	—	—	"	1·7 MILES SOUTH
15:31:00	—	—	"	1·3 MILES SOUTH
15:36:50	5506	5502	8 KTS 0·4 MILES SOUTH	
15:37:35	5486	5484	ARM + ARM	
15:39:05	5466	5467	ARM + REL NOT CONFIRMED	
15:39:50	—	—	"	
15:41:20	5257	—	"	
15:42:00	5191	5175	" REL OK	

15:43:00 5089] 102 5074

15:45:00 4885] 204 4870

ETA 16:28 16:27 SPOTTED.

RAPID-WATCH MOORING LOGSHEET **RECOVERY**

Mooring **WBCM** Cruise **D344**

NB: all times recorded in GMT

Date 17/11/09 **Site arrival time** OVERNIGHT

Time of first ranging ~10:20

Time of release 11:01

Latitude ____________ **Longitude** ____________

(record positions at time of pickup only if likely to be very different from deployment position)

ITEM	SER NO	COMMENT	TIME
Pick Up float			12:12
15m polyprop			
10 x 17" glass		2 GLASS IMPLODED	12:15
300kHz ADCP in frame	1903 ✓		12:15
2 x 20m polyester			
Nortek in frame	5893 ✓		12:21
InterOcean S4	35612564 ✓		↓
RCM11	507		
Sontek (clamped on)	D303		
DVS	12358		
4 x 17" glass			12:34
465m polyester			
4 x 17" glass			12:43
Swivel			
Single acoustic release			12:43

Ascent rate 83 m/min

Time at end of recovery 12:43

Ranging

Time	Range 1	Range 2	Command /comment
11:01:05	4778	4778	ARM + REL REL -OK
11:02:10	4703] 83	4692	-11- "
11:03:10	4620	4609	
11:04:10	4538] 82	4528	

49 MINS. 11:53 ETA.

11:49 ON SURFACE.

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **EBM6** Cruise **D344**

NB: all times recorded in GMT

Date 24/10/10 **Site arrival time** 1540

Setup distance –

Start time 1545 **End time** 154630

Start Position

Latitude ____________ **Longitude** ____________

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1545
RECOVERY LINE			〃
VHF BEACON		on	〃
2 X GLASS SPHERE			〃
SBE37	3217		〃
SONARDYNE LRT RELEASE		[redacted] id005 / v1 /	〃
ANCHOR 70kg			154630

Release 154707

Release ID number 005

Release frequency 1

Anchor Drop Position

Latitude 27° 55.27'N **Longitude** 13° 19.99' W

Uncorrected water depth 103 (at anchor launch)

Corrected water depth 103 (at anchor launch)

RAPID-WATCH MOORING LOGHSEET DEPLOYMENT

Mooring **EBM5** Cruise **D344**

NB: all times recorded in GMT

Date 24/10/09

Setup distance /

Start time

Start Position

Latitude

Longitude

Site arrival time 1634

End time 163845

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1637
RECOVERY LINE			"
VHF BEACON	W03-113	ON	"
2 X GLASS SPHERE			"
SBE37	3220		"
SONARDYNE LRT RELEASE		252343-006	"
ANCHOR 70kg			163845

Release ID number 012

Release frequency 2

Anchor Drop Position

Latitude 27° 54.67'N **Longitude** 13° 21.65'W

Uncorrected water depth 206 (at anchor launch)

Corrected water depth (at anchor launch)

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **EBM4** Cruise **D344**

NB: all times recorded in GMT

Date 24/10/09 **Site arrival time** 1652
Setup distance ______
Start time ______ **End time** 1659
Start Position
Latitude ______ **Longitude** ______

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1657
RECOVERY LINE			"
VHF BEACON	W03-101	ON	"
2 X GLASS SPHERE			"
SBE37	3480		"
SONARDYNE LRT RELEASE	245	798-002	"
ANCHOR 70kg			165900

Release ID number 011
Release frequency 1
Anchor Drop Position
Latitude 27°52.49'N **Longitude** 13°22.19' W
Uncorrected water depth 291 (at anchor launch)
Corrected water depth 295 (at anchor launch)

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **EBM1** Cruise **D344**

NB: all times recorded in GMT

Date 24/10/09

Site arrival time 1730 moving to drop site

Setup distance

Start time

End time

Start Position

Latitude

Longitude

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			173430
RECOVERY LINE			"
VHF BEACON	W03-102	ON / conf ch72	"
2 X GLASS SPHERE			"
SBE37	3482		"
SONARDYNE LRT RELEASE		s/n 245798-004	"
ANCHOR 70kg			173615

Release ID number 008

Release Frequency 1

Anchor Drop Position

Latitude 27° 53·67' N **Longitude** 13' 24·36' N

Uncorrected water depth 496 (at anchor launch)

Corrected water depth 501 (at anchor launch)

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **EBH5** Cruise **D344**

NB: all times recorded in GMT

Date 24/10/09 **Site arrival time** 1846
Setup distance 1 mile
Start time 1846 **End time** 2009
Start Position
Latitude 27°49.31 N **Longitude** 13° 32.67W

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1901
RECOVERY LINE			1901
LIGHT	S301-191	Confirmed flashing	1901
BILLINGS FLOAT			1901
5M CHAIN SWIVEL			1902
SBE37	3248		1902
2 GLASS SPHERES		YELLOW	1909
SBE37	3249		1911
SBE37	3483	Cable sheath damaged 2.5	1914
2 GLASS SPHERES YELLOW		m before spheres. Sheath	1930
S4	3561 2571	taped up.	1930
2 GLASS SPHERES	~~3561 2572~~	YELLOW	1949
S4	3561 2572		1944
4 GLASS SPHERES		ORANGE	
SWIVEL			
1M CHAIN			2009.16
ACOUSTIC RELEASE	918		
1M ½" CHAIN			
500KG ANCHOR			

Release #1 arm code [redacted]
Release #1 release code
Anchor Drop Position
Latitude 27°50.50N **Longitude** 13°32.75 W
Uncorrected water depth 1055 (at anchor launch)
Corrected water depth 1061 (at anchor launch)

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **EBH4** Cruise **D344**

NB: all times recorded in GMT

Date 24/10/09 **Site arrival time** 2051
Setup distance 1NM
Start time 2055 **End time** 2147
Start Position
Latitude 27°50.26'N **Longitude** 13°33.20'W

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT		ORANGE	2057
RECOVERY LINE			2057
LIGHT	TOS...	SERIAL OBSCURED BY maint	2057
BILLINGS FLOAT		YELLOW LIGHT OBSERVED ON.	2057
1M CHAIN SWIVEL			2057
1 GLASS SPHERE		YELLOW	2057
SBE37	3252		2100
SBE37	3253		2106
SBE37	3254		2114
2 GLASS SPHERES		YELLOW	2114
SBE37	3255		2119
SBE37	3256		2127
2 GLASS SPHERES		YELLOW	2127
SWIVEL			2127
SBE37	3257		2132
4 GLASS SPHERES		}	
1M CHAIN SWIVEL			
ACOUSTIC RELEASE	364		2147
1M 1/2" CHAIN			
500KG ANCHOR			

Release #1 arm code [redacted]
Release #1 release code
Anchor Drop Position
Latitude 27 51.01'N **Longitude** 13° 32.38' W
Uncorrected water depth 1049 (at anchor launch)
Corrected water depth 1055 (at anchor launch)

RAPID-WATCH MOORING LOGHSEET DEPLOYMENT

Mooring **EBL5** Cruise **D344**

NB: all times recorded in GMT

Date 25/10/09

Setup distance /

Start time 09:08

Site arrival time 09:00

End time 09:11

Start Position

Latitude ____________ **Longitude** ____________

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT	W03-094		09:08
RECOVERY LINE			
LIGHT + FLAG			
~~VHF ON~~		NO VHF	
2x12" GLASS + MAST			09:08
2M CHAIN + SWIVEL			
2 X 17" GLASS			09:08
3 X 17" GLASS			09:09
ACOUSTIC RELEASE	917		09:11
BPR	0040		09:11
ANCHOR in TRIPOD 300KG			09:11:23

Release #1 arm code [redacted]

Release #1 release code

Anchor Drop Position

Latitude 27°52.09' **Longitude** 13° 30.87'

Uncorrected water depth 1005 (at anchor launch)

Corrected water depth 1009 (at anchor launch)

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **EBH3** Cruise **D344**

NB: all times recorded in GMT

Date 25/10/09
Setup distance ½ mile
Start time
Start Position
Latitude Longitude

Site arrival time 1229
End time 1256

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1234
RECOVERY LINE			
LIGHT			
BILLINGS FLOAT			
5M CHAIN and SWIVEL			
2 MINI TRIMSYN			
SBE37	3259		1235 30
2 MINI TRIMSYN	3264		
SBE37			1238
2 MINI TRIMSYN			
SBE37	3265		1241 15
2 MINI TRIMSYN	~~32~~		
SBE37	3266		124500
SBE 37	3268		125420
2 GLASS SPHERES		YELLOW	
1M 1/2" CHAIN			
ACOUSTIC RELEASE	916	ARM	125445
CHAIN			
500KG ANCHOR			125610

Release #1 arm code [redacted]
Release #1 release code
Anchor Drop Position
Latitude 27°48.47N **Longitude** 13°44.80W
Uncorrected water depth 1414 (at anchor launch)
Corrected water depth 1416 (at anchor launch)

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **EBH2** Cruise **D344**

NB: all times recorded in GMT

Date 25/10/09

Setup distance 4 ca

Start time 171030

Site arrival time 1704

End time 1727

Start Position

Latitude ________ **Longitude** ________

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1711
RECOVERY LINE			
LIGHT BEACON			
BILLINGS FLOAT		Y	
5M CHAIN			
2 GLASS SPHERES		Y	
SWIVEL			
SBE 37	3269		171130
2 GLASS SPHERES		Y	171730
SBE 37	3270		171730
SBE 37	3271		172330
2 GLASS SPHERES		Y	"
1M CHAIN SWIVEL			"
ACOUSTIC RELEASE	258		"
1M CHAIN			"
500KG ANCHOR			172650

Release #1 arm code ________

Release #1 release code ________

Anchor Drop Position

Latitude 27 36.71 **Longitude** 14 12.73

Uncorrected water depth 2018 (at anchor launch)

Corrected water depth ? (at anchor launch)

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **EBH1** Cruise **D344**

NB: all times recorded in GMT
Date 26/10/09 **Site arrival time** 08:16
Setup distance 0·4 nMiles
Start time 08:41 **End time** 09:12
Start Position
Latitude ____________ **Longitude** ____________

ITEM	**SER NO**	**COMMENT**	**TIME**
RECOVERY FLOAT			0841
RECOVERY LINE			"
LIGHT			"
BILLINGS FLOAT			"
5 m CHAIN SWIVEL			"
4 X 17" GLASS		0	"
SBE37	~~5246~~	3272	"
2 X 17" GLASS		Y	084730
SBE 37	~~5247~~	3274	
2 X 17" GLASS		Y	090600
1M CHAIN SWIVEL			
ACOUSTIC RELEASE	~~821~~	260	
1M CHAIN			
ANCHOR 500KG			091200

Release #1 arm code ____________
Release #1 release code ____________
Anchor Drop Position
Latitude 27° 17.13' **Longitude** 15° 25.73'
Uncorrected water depth 3003 (at anchor launch)
Corrected water depth 3011 (at anchor launch)

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **EBL4** Cruise **D344**

NB: all times recorded in GMT

Date 26/10/09

Setup distance —

Start time 10:50

Site arrival time 10:39

End time 10:54

Start Position

Latitude — **Longitude** —

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			10:50
RECOVERY LINE			
LIGHT	H01-009	CONFIRMED WORKING — NO. COPIED FROM EBL4 REC.	
VHF SN	W03-105	CONFIRMED WORKING - NEW. NOT SAME AS EBL4 REC.	
BILLINGS FLOAT		TURNED AROUND FROM EBL4 RECOVERY	10:51
5M CHAIN SWIVEL			
2 X 17" GLASS			10:51
3 X 17" GLASS			10:52
ACOUSTIC RELEASE	322		
BPR	0395		
ANCHOR in TRIPOD 300KG			10:54:10

Release #1 arm code [redacted]

Release #1 release code

Anchor Drop Position

Latitude 27°17.17' **Longitude** 15°25.76'

Uncorrected water depth 3001 (at anchor launch)

Corrected water depth (at anchor launch)

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **EBHi** Cruise **D344**

NB: all times recorded in GMT

Date 28/10/09

Setup distance 1.5nm

Start time 1248

Site arrival time 1246

End time 1326

Start Position

Latitude ____________ **Longitude** ____________

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT		O	1248
RECOVERY LINE			"
LIGHT			"
BILLINGS FLOAT		Y	"
5M CHAIN			"
2 X GLASS SPHERES		Y	"
SWIVEL			"
SBE37	5285		"
2 X GLASS SPHERES		Y	1258
SEAGUARD	218		1258
SBE37	3277		1258
SBE37	3484		1308
4 X GLASS SPHERES		O	"
1M CHAIN			"
SWIVEL			"
ACOUSTIC RELEASE	821		"
1M CHAIN			1326 20
500 KG ANCHOR			1326 20

Release #1 arm code ____________

Release #1 release code ____________

Anchor Drop Position

Latitude 24° 56·81' N **Longitude** 21° 15·78' W

Uncorrected water depth 4471 (at anchor launch)

Corrected water depth 4501 (at anchor launch)

O = orange

Y = yellow

e

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **EB1** Cruise **D344**

NB: all times recorded in GMT

Date 30/10/09

Setup distance 6.25 N MILES

Start time 1007

Site arrival time 1002

End time

Start Position

Latitude 23° 45.27' N **Longitude** 24° 16.14' W

ITEM	SER NO	COMMENT	TIME	
RECOVERY FLOAT			1007	
RECOVERY LINE			"	
TRIMSYN X 3			"	
SBE37	3251		"	
ARGOS BEACON	W03-82	Record PTT number	1009	
24" STEEL SPHERE			"	
SBE 37	3486		"	
SBE 37	3890		1013	
ARGOS BEACON	285	60211 (id)	1020	
37" McLa STEEL SPHERE			"	
1M CHAIN SWIVEL			"	
SBE 37	3891		1023	
SBE37	3892		1027	
SBE37	3893		1030	
1 4 X 17" GLASS FLOAT		3 orange, 1 yellow	1036	
SBE37	3900		1040	
2 4 X 17" GLASS FLOAT		orange	1047	
SBE37	3901		1049	
SBE37	3903		1055	
3 4 X 17" GLASS FLOAT + SW		yellow	1101	
SBE37	3904		11:04	
4 4 X 17" GLASS FLOAT		YELLOW	11:14	
SBE37	3910		11:17	
SBE37	3911		11:26	4.3 nm TO GO
5 4 X 17" GLASS FLOAT		ORANGE	11:35	
SBE37	3912		11:40	
SBE37	5486		11:51	
* 6 4 X 17" GLASS FLOAT		ORANGE	11:59	6333 m to go
SBE37	3916		12:04.	

* call from bridge - 6333m to go - maintaining speed.

7	4 X 17" GLASS FLOAT +SW		ORANGE	12:14	
	SBE37	3918		12:18	5200m to go.
8	4 X 17" GLASS FLOAT		YELLOW	12:31	
	SBE37	5484		12:31	
	SBE37	6335		1244	
9	8 X GLASS FLOAT		orange [2 lines of 4 with link)	1304	
	SWIVEL			"	
	ACOUSTIC RELEASE 1	248		"	
	ACOUSTIC RELEASE 2	687		"	
	~~10~~ 20M NYLON BRAID		CHANGE TO 20m - CONFIRM WITH STEVE! ✓	"	
	10M CHAIN			1354	
	1400 KG ANCHOR [chain]			1354	

Release #1 arm code [redacted]
Release #1 release code
Release #2 arm code
Release #2 release code ____________
Argos beacon #1 ID ____________
Argos beacon #2 ID 60211
Anchor Drop Position
Latitude 23°45.34' **Longitude** 24°09.25' W
Uncorrected water depth ~~[illegible]~~ 5047 (at anchor launch)
Corrected water depth ____________ (at anchor launch)

1310 : Towing on chain 1.3nm at 1.8kn . ETA 1400
1320 : 1km : 1.8kn

~~[illegible]~~

Last sighted at 1426.

SN 248		
14:33:20	5071	5070
14:34:00	5071	5071

SN 687		
14:34:50	5072	5074
14:35:20	5072	5074

△

① 14:50:35

23° 46.313 5371m 5373m
24° 09.753

23° 46.321 — 5377
24° 09.754

② 15:08:30

23° 45.412 5241m 5240m
24° 08 692 5240 5239m

③ 15:31:45

23° 44.360 5339 5338
24° 09.801 5338 5338

FINAL POSITION =
23° 45.300' N
24° 09.492' W
FALL BACK OF 417m

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **EBL3** Cruise **D344**

NB: all times recorded in GMT

Date 29/10/04 **Site arrival time** ________
Setup distance 0.5nm.
Start time 220500 **End time** 202155
Start Position
Latitude 23°48.73'N **Longitude** 24°6.35' W

ITEM	**SER NO**	**COMMENT**	**TIME**
RECOVERY FLOAT			2019
RECOVERY LINE			"
LIGHT		observed working.	"
VHF SN			"
BILLINGS FLOAT			"
5m CHAIN and SWIVEL			"
4 X 17" GLASS			"
4 X 17" GLASS			"
ACOUSTIC RELEASE 1	316		
ACOUSTIC RELEASE 2	262		
BPR 1	0342		
BPR 2	0419		
300kg ANCHOR			

Release #1 arm code ________ } not visible
Release #1 release code ________ } no labels
Release #2 arm code ________
Release #2 release code ________
Anchor Drop Position
Latitude 2348 77N **Longitude** 24°6.41 W ~~23 48.77~~W
Uncorrected water depth 5053 (at anchor launch)
Corrected water depth 5096 (at anchor launch)

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **NOG_SED_TRAP** Cruise **D344**

NB: all times recorded in GMT

Date 4/11/09 **Site arrival time** 1600
Setup distance 1nm
Start time ________ **End time** 1754
Start Position
Latitude ________ **Longitude** ________

ITEM	**SER NO**	**COMMENT**	**TIME**
Recovery line			1653
Billings			
Light			
12x17' glass		Orange	1654
SED trap	12168-01		1701
RCM11	642		"
SED trap	11262-03		1707
RCM11	643		"
10x17' glass		orange.	1737
Acoustic release	323		1746
850kg Anchor			175542

Release #1 arm code ________
Release #1 release code ________
Anchor Drop Position
Latitude 23° 46 17.09' N **Longitude** 41° 5' 50.8" W
Uncorrected water depth 4240 (at anchor launch)
Corrected water depth 4261 (at anchor launch)

4210 to 4220 u/c
4231 to 4241m corr
Best 4215m u/corr.

23° 46.29' N 41° 5.9' W

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **MAR3** Cruise **D344**

NB: all times recorded in GMT

Date 4/11/09

Setup distance 3¾ MILES

Start time 1025

Site arrival time 0800

End time 1228

Start Position

Latitude ____________ **Longitude** ____________

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1025
RECOVERY LINE			"
LIGHT			"
BILLINGS FLOAT		Light [no flag on vhf] 5m chain	"
2 X GLASS SPHERES		orange	"
SWIVEL		✓	"
SBE37	6328		"
3 X GLASS SPHERES		orange	1043
SBE37	5487		"
3X GLASS SPHERES		orange	1057
SBE37	5488		1057
3 X GLASS SPHERES		orange	1110
SWIVEL			1110
SBE37	6329		1110
3 X GLASS SPHERES		orange	1124
SBE37	6330		1124
SBE37	6334		1137
S4	35612573		1145
7 X GLASS SPHERES		orange	1145
SWIVEL			1145
ACOUSTIC RELEASE	243		1152
10M CHAIN			1157
CHAIN ANCHOR 1000 KG			122839

Tow for 37mins

Release #1 arm code ____________

Release #1 release code ____________

~~Release #2 arm code~~ ____________

~~Release #2 release code~~ ____________

Anchor Drop Position

23 52 14.17"N 41° 5' 17.49" W

23° 52.24'N 41° 5.29'W

E-P strongly negative during deployment

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **MARL2** Cruise **D344**

NB: all times recorded in GMT

Date 3/11/09
Setup distance /
Start time 1555
Site arrival time ________
End time ________
Start Position
Latitude ________ **Longitude** ________

	ITEM	SER NO	COMMENT	TIME
	RECOVERY FLOAT			1555
	RECOVERY LINE			"
	LIGHT			"
	VHF SN			"
	BILLINGS FLOAT			"
	5M CHAIN and SWIVEL			"
	4X 17" GLASS			155530
	4X 17" GLASS			1556
2x	ACOUSTIC RELEASE		826 928	1558
2x	BPR		0013 0038	"
	ANCHOR 280KG			'

Release #1 arm code ________
Release #1 release code ________
Anchor Drop Position
Latitude 23°51·95 N **Longitude** 41° 5·56' W
Uncorrected water depth 5014m ~~41 5·56~~ (at anchor launch)
Corrected water depth 5060m (at anchor launch)

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **MAR2** Cruise **D344**

NB: all times recorded in GMT

Date 7/11/09

Setup distance 4.5 nm

Start time 17:38

Site arrival time 1735

End time 20:30

Start Position

Latitude ____________ **Longitude** ____________

ITEM	SER NO	COMMENT	TIME	
RECOVERY FLOAT			1738	
RECOVERY LINE			"	
LIGHT + ARGOS		S01-187 / W03-084 521	"	
BILLINGS FLOAT		ID 82454	"	
4 X GLASS SPHERES		yellow	1739	
SWIVEL			"	
SBE37	5762		"	1.8kn o/g
SBE37	5766		1747	
4 X GLASS SPHERES		Yellow	1802	
SBE37	5767		"	
3 X GLASS SPHERES		orange	1817	1.5og
SBE37	5768		1817	3.5kn go
3 X GLASS SPHERES		orange.	1831	1.6og
SBE37	5770		"	3.2kn go
SBE37	5771		1841	3.0kn go 1832
3 X GLASS SPHERES			1855	
SBE37	5763		1855	2.2kg
SWIVEL			1910	1.6og
3 X GLASS SPHERES			1910	
SBE37	5773		1910	
SBE37	5774		1922	1.76kg 1.6og
4 X GLASSS SPHERES		yellow (no swivel)	1940	
S4	35612578	At bottom of 9 glass	1949	
SBE37	5775	Above join on 890m length, Z~5140m	1937	
5 X GLASS SPHERES			1949	
SWIVEL			1949	
ACOUSTIC RELEASE	319		1949	0.9@1457
10M CHAIN			2030	1.6og
ANCHOR 1000 KG			"	

joined

INSERTED 30m NYLON SHOCK ABSORBER

TOWED FOR 0.9 MILES

~~20:43:15~~ ~~2156~~ 2171

Release #1 arm code [redacted]______
Release #1 release code ____________
Anchor Drop Position
Latitude 24° 10.981 **Longitude** 49° 44.575
Uncorrected water depth 5170 (at anchor launch)
Corrected water depth 5221 (at anchor launch)

RANGING ON DESCENT

20:43:15	2156	2171
20:45:40	2502	2518
20:49:40	3052	
20:54:40	3690	3710
21:00:40	4447	4463
21:03:40	4815	
21:09:20	5155 5154	5155 5154

— 500m IN 4 MINS
=125 M/MIN

648m IN 5 MINS
=129 M/MIN

757m IN 6 MINS
= 126 M/MIN

DIAGNOSTICS 5155 5154 VERTICAL 9.5V

NOTHING DETECTED ON GONIO.

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **MAR1** Cruise **D344**

NB: all times recorded in GMT

Date 7/11/09

Setup distance 5nm

Start time 1122

Start Position

Latitude ____________ **Longitude** ____________

Site arrival time 1100

End time ________

ITEM	SER NO	COMMENT	TIME	
TRIMSYN FLOAT			1122	
RECOVERY LINE			"	
3 X TRIMSYN			"	
SBE37	4461		"	
ARGOS BEACON			1124	
LIGHT			"	
24" STEEL SPHERE			"	
SBE37	4464		"	
ARGOS BEACON			"	
LIGHT			"	
37" STEEL SPHERE			1126	
1M CHAIN SWIVEL			"	
SBE37	5779	1150 additional under sphere in error(?)	"	
SBE37	5780	175	1130	
SBE37	5781	280	1133	
SBE37	5782	325	1137	
SBE37	5783	400	1140	4·1nm
~~SBE37~~	~~5784~~	600	1149	
8 X GLASS SPHERES		orange	1200	
SBE37 4718 ~~[illegible]~~ ~~[illegible]~~	~~5784~~	~~Mark above glass~~ @ 800m	~~1149~~ 1200	4·1nm
SBE37	5785	1000	1207	
SBE37	5786	1200	1213	
SBE37	5787	1600	1219	
8 X GLASS SPHERES		yellow	1232	
SBE37	5240	2000	1238	3·4nm to go
4X GLASS SPHERES			1252	
SWIVEL			"	
SBE37	5788	2500	"	
4 X GLASS SPHERES		orange	1306	
SBE37	5789	3000	1306	2·8nm to go

4 X GLASS SPHERES			1320	2.4nm
SBE37	5776	3500	1320	
4 X GLASS SPHERES		ORANGE	13:35	
SBE37	8282	4000	13:35	
SBE37	8284	4500	13:50	1.7nm 3000m
5 X GLASS SPHERES		YELLOW	1400	
SBE37	4179	4995	1400	
S4	36512577	wire nicked at bottom of 100m length.	1413	1nm @ 1409
9 X GLASS SPHERES		YELLOW	1428	
SWIVEL			"	0.5nm @ 1427
ACOUSTIC RELEASE 1	908		"	
ACOUSTIC RELEASE 2	822		"	
20M NYLON BRAID			"	
10M CHAIN			1450	
CHAIN ANCHOR 1800 KG			1450	

Release #1 arm code ____________

Release #1 release code ____________

Release #2 arm code ____________

Release #2 release code ____________

Argos beacon #1 ID ____________

Argos beacon #2 ID ____________

Anchor Drop Position

Latitude 24° 10.14' N **Longitude** 49° 43.00' W

Uncorrected water depth 5164 (at anchor launch)

Corrected water depth ____________ (at anchor launch)

Towing on chain at 1453, rel 1450

Trymsin under at 1517

15:23:30 5164 5165 – CHECKING IF ON BOTTOM
15:24:00 5165 5165

TELEMETRY INDICATES VERTICAL WITH BATTERY VOLTAGE OF 10.0V – SN 822
VERTICAL 9.9V – SN 908

△

①	24° 09.628	15:41:20
	49° 44.319	5606m 5607m
	24° 09.626	15:41:45
	49° 44.319	5608m 5609m
②	~~24° 09.423~~	16:01:00
	~~49° 43.326~~	5390m 5392m
	24° 09.429	16:01:40
	49° 43.035	5391m 5392
③	24° 10.533	16:18:35
	49° 42.381	5343m 5344m
		16:19:00
		5343m 5345

ANCHOR BOTTOM

24° 10.32'N 49° 43.17'W

440m FALLBACK.

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **MARL1** Cruise **D344**

NB: all times recorded in GMT

Date 6/11/09 **Site arrival time** 21:00

Setup distance 0.4NM

Start time ______ **End time** 2113

Start Position

Latitude 24° 12.12' N **Longitude** 49° 44.43 W

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT		VIOLENT PINK	2110
RECOVERY LINE			2111
LIGHT		Seen working	"
VHF SN			"
BILLINGS FLOAT			"
5m CHAIN and SWIVEL			"
4 X 17" GLASS		ORANGE	"
4 X 17" GLASS		ORANGE	"
ACOUSTIC RELEASE 1	370		2113
ACOUSTIC RELEASE 2	216		"
BPR 1	0420		"
BPR 2	0393		"
300kg ANCHOR			"

Release #1 arm code ______

Release #1 release code ______

Release #2 arm code ______

Release #2 release code ______

Anchor Drop Position

Latitude 24° 12.02' N **Longitude** 49° 44.26'

Uncorrected water depth 5177 (at anchor launch)

Corrected water depth 5227 (at anchor launch)

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **MAR0** Cruise **D344**

NB: all times recorded in GMT

Date 8/11/09

Site arrival time 1030

Setup distance 0·4

Start time

End time

Start Position

Latitude **Longitude**

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			1711
RECOVERY LINE			
3 X GLASS SPHERES			
SBE37	5241		
SBE37	4184	P capped	1715
2 X GLASS SPHERES			1716
SBE37	6830		1718
SBE37	4462	P capped	1722
SBE37	5778		"
6 X GLASS SPHERES			"
ACOUSTIC RELEASE 1	930		
ACOUSTIC RELEASE 2	925		
BPR			
TRIPOD ASSEMBLY			
ANCHOR 500 KG			173440

Lat: 25° 6.35' N
lon: 52° 0.62' W

Release #1 arm code

Release #1 release code

Release #2 arm code

Release #2 release code

Anchor Drop Position

Latitude ~~25° 06.34' N~~ **Longitude** ~~52° 06.0' W~~

Uncorrected water depth 5448 (at anchor launch)

Corrected water depth 5508 (at anchor launch)

s/n	925	174330	1174	1186
		174430	1305	1310
		178646	5511	5510

Diagnostic:
Vertical 9·9V.

s/n	930	175500	2574	2587	] 123 m/min
		175600	2697	2710	
		171800	5308	5325	
		172245	5511	5512	

Diagnostic 5512m 5513m
no answer
vertical 9V

RAPID-WATCH MOORING LOGHSEET **DEPLOYMENT**

Mooring **WB6** Cruise **D344**

NB: all times recorded in GMT

Date 15/11/09 **Site arrival time** 1740

Setup distance 0·38 DOING 1·3 KTS OVER THE GROUND.

Start time ____ **End time** ____

Start Position

Latitude ____ **Longitude** ____

ITEM	SER NO	COMMENT	TIME
RECOVERY FLOAT			17:46
RECOVERY LINE			
3 X GLASS SPHERES		ORANGE	17:46
SBE37	5242		11
SBE37	4180	PRESSURE CAPPED	17:50
2 X GLASS SPHERES		ORANGE	17:51
SBE37	5764		17:51
SBE37	4473	PRESSURE CAPPED	17:53
SBE37	5765		18:00
6 X GLASS SPHERES		ORANGE	18:01
ACOUSTIC RELEASE 1	827		18:02
ACOUSTIC RELEASE 2	361		↓
BPR X 2	0390 + ~~000~~ 0037		
TRIPOD ASSEMBLY			18:02
ANCHOR 500 KG			

2·5 CABLES TO GO

2 CABLES TO GO

1·3

Release #1 arm code ____

Release #1 release code ____

Release #2 arm code ____

Release #2 release code ____

Anchor Drop Position

Latitude 26° 29·675' N **Longitude** 70° 31·303' W

Uncorrected water depth 5456 (at anchor launch) → 2 MINS AFTER LAUNCH AS ECHOSOUNDER NOT TURNED ON!

Corrected water depth 5516m (at anchor launch)

TOWING FROM 1·3 CABLES

RANGING ON DESCENT

ARM + ARM SN 827

18:11:15	—	1192
18:12:00	1250	1261
18:15:05	1622	1635
18:16:05	—	1777
18:16:30	1796	1807
18:17:00	—	1887
18:17:33	1922	
18:25:30	2877	2890
18:26:30	2997	

≈ 126 m/min.

≈ 120 m/MIN

18:37:30	✓	✓	ARM TAMM SN ~~[illegible]~~ 361		
18:38:20	4392				
18:39:20	4509	4525			
18:46:10	5298	5315			
18:49:40	5458	5459			

#361	ARM +DIAG	5458	5458	VERTICAL	9.7V	
#827	ARM +DIAG	5459	5460	VERTICAL	8.9V	← ?
"	" "	5459	5460	VERTICAL	8.9V	