RRS James Cook

Cruise JC88

Glasgow to Southampton

FASTNEt Cruise to the Malin Shelf Edge

28th June to 24th July 2013

M.E. Inall et al.

A FASTNEt Cruise led by
The Scottish Association for Marine Science

Internal Report No. xxx

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SUMMARY

JC88 was the second of two cruises under the NERC-funded Consortium grant FASTNEt (Fluxes across the Sloping Topography of the North East Atlantic). Sailing 08:30 BST on Friday 28th June 2013 from King George V Dock, Govan, JC88 was a 26 day cruise to the Malin shelf edge, retuning to Southampton at 09:00 on Wednesday 24th July 2013.

The scientific aims for JC88 were four-fold: 1) A process study of the internal tide and its contribution to cross shelf exchange and vertical mixing, 2) An investigation of on-shelf intrusions of high-salinity water of oceanic origin, 3) deployment of long term platforms (Drifters and Gliders) for an investigation of the state of exchange at the shelf edge during the transition from summer-stratified to winter well-mixed conditions and 4) A dye-release study of the recruitment of shelf waters into the off-shelf flowing bottom Ekman layer of the slop current.

1 Introduction

1.1 Scientific Crew

		Institution	Primary Activity
1	Mark Inall	SAMS	PS
2	Dmitry Aleynik	SAMS	Scanfish
3	Andrew Crabb	SAMS	Filming
4	Andrew Dale	SAMS	Dye release
5	Estelle Dumont	SAMS	CTD
6	Colin Griffiths	SAMS	Moorings
7	Sam Jones *	SAMS	VMADCP
8	Vincent Lamache#	SAMS	
9	Marie Porter	SAMS	Drifters/LADCP
10	Matthew Toberman*	SAMS	
11	Joanne Hopkins	NOC Liverpool	Moorings
12	Terry Doyle	NOC Liverpool	Landers
13	Carl Spingys*	NOC Liverpool	
14	Juliane Wihsgott#	NOC Liverpool	Underway data
15	Victoria Hemsley	NOC Southampton	Chemistry
16	Samer Abi Kaed Beyh	NOC Southampton	Systems Design
17	Anna Glüder	Uni of Bangor	
18	Gordon Stephenson	Uni of Bangor	
19	Sophie Wilmes	Uni of Bangor	
20	Nealy Carr	Uni of Liverpool	Chemistry
21	Prima Anugerhanti§	Uni of Plymouth	Chemistry
22	Morwena Cooper	Uni of Plymouth	Chemistry
23	Jaimie Cross	Uni of Plymouth	MSS
24	Philip Hosegood	Uni of Plymouth	MSS/Dye release
25	Mark Hebden	BODC	Data
26	Marian McGrath		Irish Observer

* PhD student, § Undergraduate student, ¤ MSc student # Graduate

NMFSS Technicians

Jonathan Short	Mark Maltby
Benjamin Poole	James Burris
Dougal Mountfield	

Ship's Crew

Peter Sarjeant	Master	John Macdonald	CPO (Scientific)
Peter Newton	Chief Officer	David Price	POD
Ian Mcleod	2nd Officer	Adam Osborne	Seaman
Nicholas Norrish	3rd Officer	Mark Moore	Seaman
Robert Lucas	Chief Engineer	Stephen Toner	Seaman
Michael Murray	2nd Engineer	Kenneth Sims	Seaman
Francis Davitt	3rd Engineer	Graham Bullimore	PCO
Gary Slater	3rd Engineer	Peter Lynch	Chef
John Smyth	ERPO	Lloyd Sutton	Assistant Chef
Paul Damerell	ETO	Graham Mingay	Steward
Andrew Mclean	CPO (Deck)	Melvin Pius	Steward

1.2 Chronology

Date	Julian Day	Day	Location	Activity
28-Jun-13	179	Fr	Govan/Glasgow	Under way
29-Jun-13	180	Sa	Line "A"	CTD
30-Jun-13	181	Su	Line "A"	CTD
1-Jul-13	182	Mo	Line "A" / "B"	CTD/Mooring/Scanfish
2-Jul-13	183	Tue	Line "A"	CTD/Mooring
3-Jul-13	184	Wed	Line 'B'/SC/SF	CTD/Moorings/Gliders
4-Jul-13	185	Thu	Line 'B'/SE/SG	CTD/Moorings
5-Jul-13	186	Fr	Line 'B'/SF	CTD/Glider
6-Jul-13	187	Sa	Line 'C'/	CTD/Glider
7-Jul-13	188	Su	Line 'C' /D1	CTD/Dye release/Drifter/MSS
8-Jul-13	189	Mo		MSS
9-Jul-13	190	Tue	D1	Drifter/Glider/MSS
10-Jul-13	191	Wed		MSS
11-Jul-13	192	Thu	Line 'C'	CTD
12-Jul-13	193	Fr	Line 'C'/D2	Drifter/Dye release
13-Jul-13	194	Sa		MSS
14-Jul-13	195	Su		MSS
15-Jul-13	196	Mo		MSS
16-Jul-13	197	Tue	Line 'C'/LA/LB/SB	Mooring/CTD/Gliders
17-Jul-13	198	Wed	Line 'C'/LA/LB/SB	CTD/Mooring/Drifter
18-Jul-13	199	Thu	Line 'A'/SC/SD	MSS/Mooring/CTC
19-Jul-13	200	Fr	SE/SF1/SF4/SF2/B9	Mooring/CTD/Gliders
20-Jul-13	201	Sa	Line 'B'	CTD/Gliders
21-Jul-13	202	Su	Line 'B'	CTD/MSS
22-Jul-13	203	Mo		Underway
23-Jul-13	204	Tue		Underway
24-Jul-13	205	Wed	Southampton	Dock

1.3 Cruise track

Figure 1.1 Cruise Track

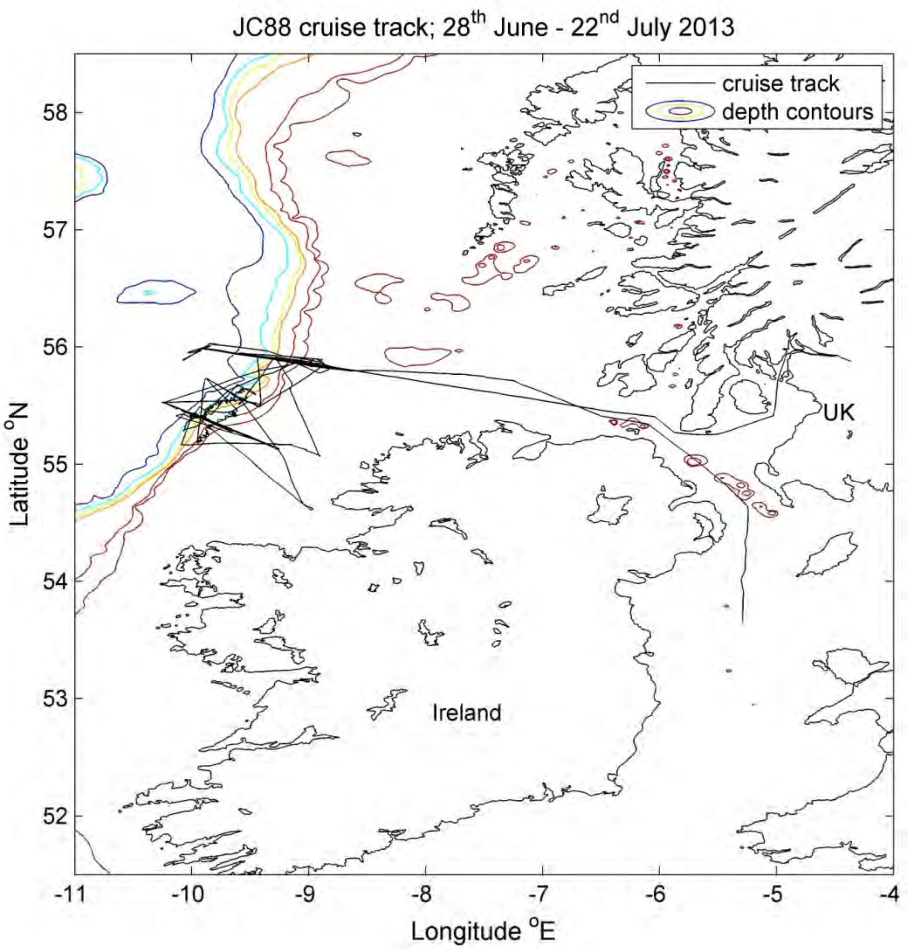

Figure 1.1 Cruise Track

1.4 Sea surface temperature field

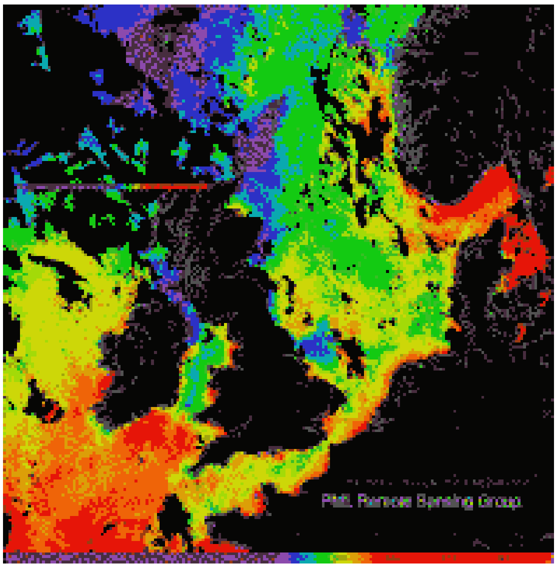

Figure 1.2: AVHRR image of the Celtic Sea showing a composite of sea surface temperature for the 7 day period from 24th-30th June 2013. Satellite data were received and processed in near real time by the NERCEarth Observation Data Acquisition and Analysis Service (NEODAAS) atDundee University and Plymouth Marine Laboratory (www.neodaas.ac.uk).

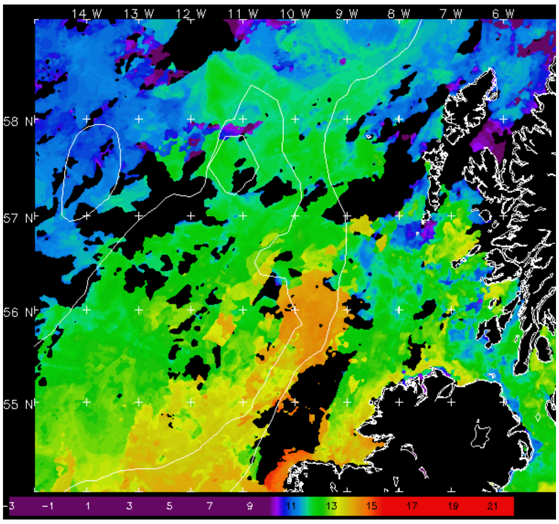

Figure 1.3: As for Figure 1.2, but for the seven day period to 09th July 2013

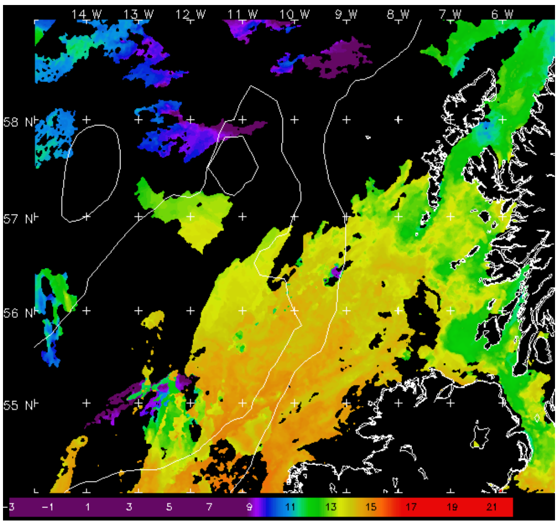

Figure 1.4: As for Figure 1.2, but for the seven day period to 15th July 2013

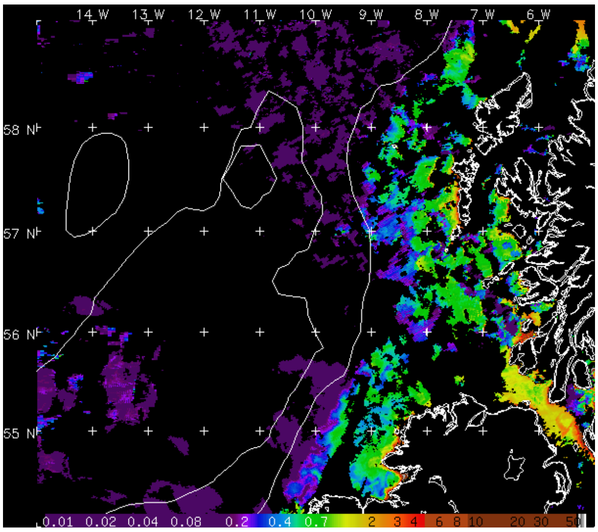

Figure 1.5 **:**MODIS image of the Celtic Sea showing the sea surface chlorophyll *a*from a composite of the 7 day period to 1st July 2013. Courtesy of PML Remote Sensing Group

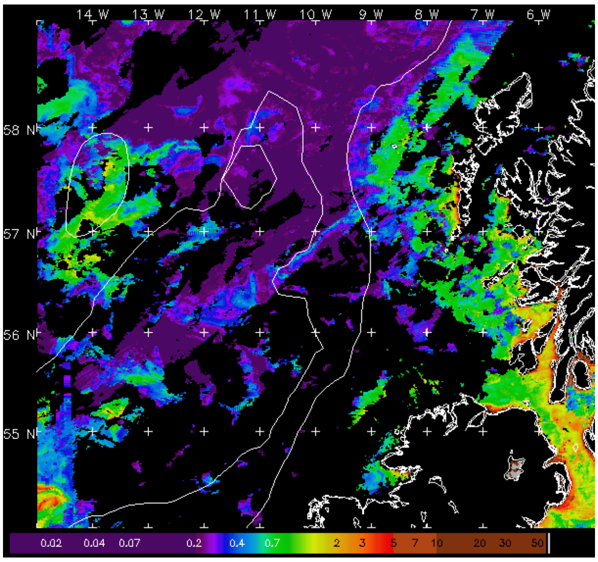

Figure 1.6**:** As for Figure 1.5, but for the seven day period to 07th July 2012

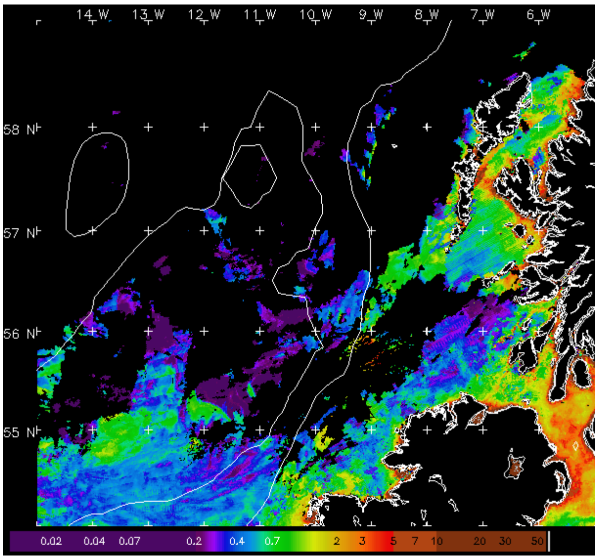

Figure 1.7**:** As for Figure 1.5, but for the seven day period to 14th July 2012

1.5 Meteorological measurements

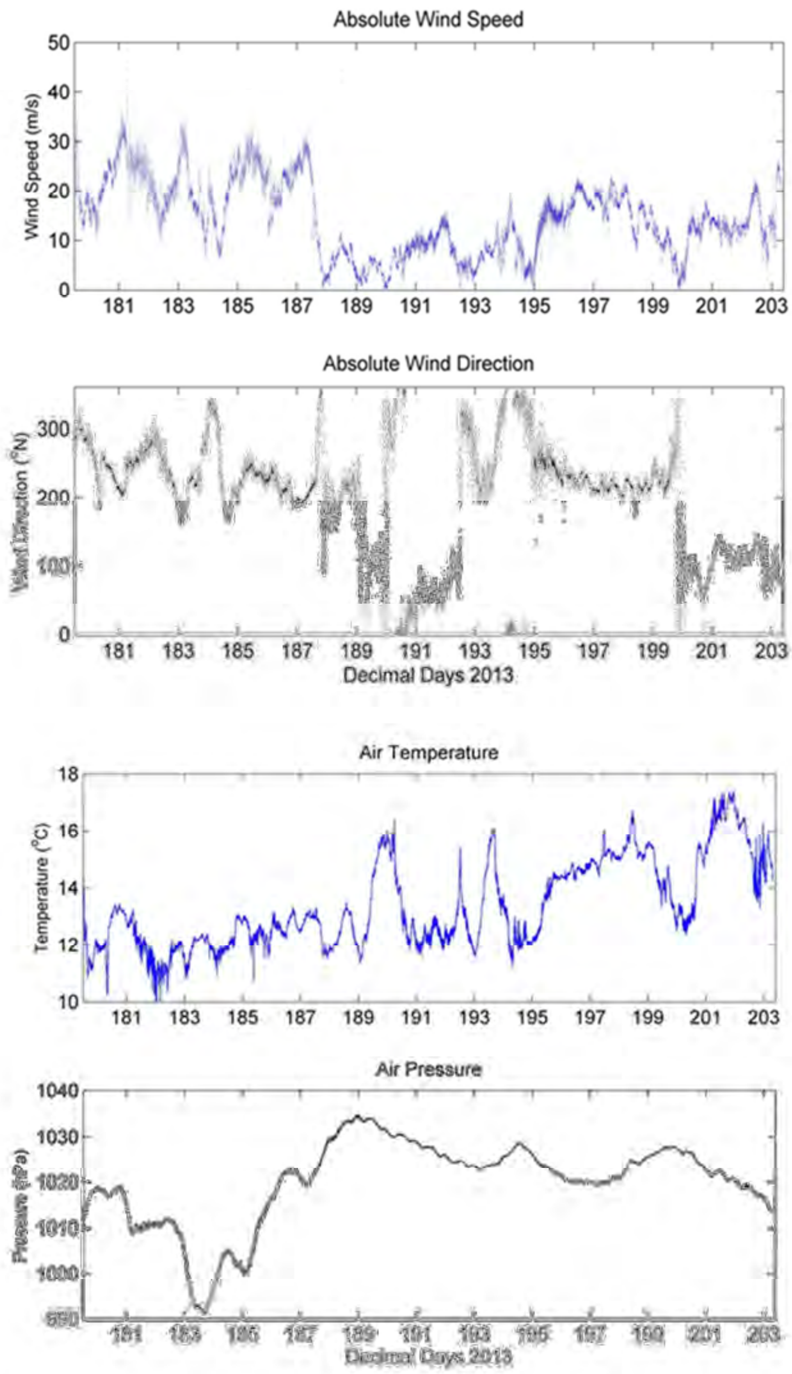

Figure 1.7 A summary of the meteorological measurements from the Surfmet logging system. For more details see section 15.

1.6 Sea surface observations

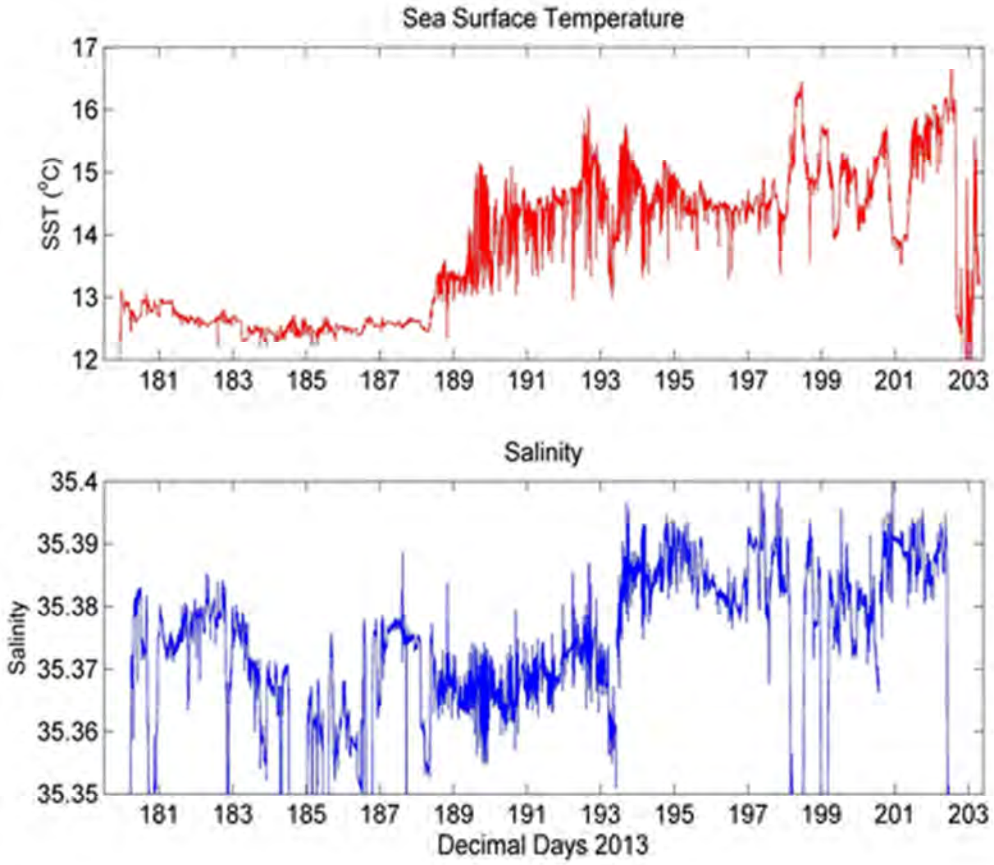

Figure 1.8. A summary of the oceanographic measurements from the Surfmet logging system. Gaps in the depth data are due to spike removal. For more details see section 15**.**

2 Narrative

Mark Inall, SAMS, PS

2.1 Daily Diary

All times in BST (UTC + 1), except for events in GMT/UTC (Z).

Friday 28th June:

Sailed 08:30 from King George V Dock, Govan.

Saturday 29th June:

Slowed during the night due to poor sea conditions, arrived 10:00 on site west of station "LA" in 2300 m for CTD wire test. Wire test successfully un-wound worrying turns in CTD wire. Shake-down CTD at station LA at 13:10Z prior to planned mooring deployment. Flat batteries discovered in two longer-ranger ADCPs, to mooring operations had to be postponed, and CTD line "A" commenced (A1, A3, A5, A5X).

Sunday 30th June:

Blown away. Sea conditions deteriorated during the night, and CTD operations had to cease at 01:10Z after station A5X. Poor conditions continued throughout the day, with winds of 30 to 35 knots from the west and significant wave heights up to 4.8m, max wave heights up to 10m. VMADCP line across the slope current run repeatedly between stations A4 and A7X

Monday 1st July:

Conditions still far from ideal, but improving with wind dropping to 20 knots at 05:00 but sea state unchanged. Slope current VMADCP survey continued until after breakfast when the sea state allowed for a CTD (@A7X), after which mooring operations started, with moorings at LA and LB successfully deployed. The brand new Scanfish II deployed post-moorings, flying well between 10m and 120m when comms with the control module where lost. Upon recovery a flooded communications pressure housing was discovered – irreparable and not something carried as spare. CTD line A completed during the night hours.

Tuesday 2nd July:

Eastward swell which had been causing trouble now joined by a northward one. Seas more confused, but conditions still workable – though not for planned Glider recovery. Moorings SB and SD deployed without any problems. Steamed north to "B" section to run CTDs across the slope through the night. Some trouble with bird-caging on CTD wire on the first cast, fixed by streaming to 2300m.

Wednesday 3rd July:

CTD Section B finished during the early morning: conditions much improved for a busy day. Quite complex moorings at SC1 and SC2 completed in the morning, with even some sunshine to help us! Glider SG550 deployed with little trouble, followed by a pre-deployment test of the wire-walker system with a loose tether. All went well enough for deployment, but winds increasing and conditions becoming more challenging as the afternoon wore on. Lander, Toroid, directional wave buoy and wirewalker moorings all deployed - sterling efforts from all on the deck. CTD section B resumed over night.

Thursday 4th July:

Wind freshening again from the west with a second cyclone to the north of us. Sea building only slowly though and CTD section completed. Two pairs of moorings deployed (Doppler Lander, and in-line T/S) at stations SE and SG – completing all mooring deployment operations. Conditions not suitable for Glider deployments, with winds steady force 7 most of the day and seas building to 6m significant wave height by 8pm. Too rough to work during the night.

Friday 5th July:

Wind decreased sharply from 4am, conditions became manageable by 7am, allowing for CTD Line B to recommence. Break off line at B6 to deploy turbulence Glider – full instrument array at SF now in place. CTD line “B” finished off over night, and moved south to occupy canyon CTD section “C” into the early hours.

Saturday 6th July:

Break off at C3 to shake-down MSS – all OK. Slocum Gliders Sn 330 and 331 deployed in the afternoon. C-line of CTDs recommenced.

Sunday 7th July:

C Line station C11 completed by 07:00, re-positioned south to dye release position D1. CTD on D1 whilst final preparations for dye release finished. Perfect calm conditions for release. Dye pumped to 115m without a hitch, tracking drifter deployed and long MSS stint begins.

Monday 8th July:

Dye chasing all day with MSS. Termination issues with SAMS MSS winch, so switched to Plymouth winch and re-terminated SAMS winch sea cable.

Tuesday 9th July:

Dye chasing all day with MSS. Conditions perfect, if a little misty in the afternoon. Quick Glider deployment (SG550 with PAR sensor) in the afternoon between MSS section turns – very slick, with no interruption to MSS/Dye time series. Minor panic during the day with MSS data storage format issue, fully resolved.Wind slight and seas calm. SAMS MSS90 communications problems late in the evening, so switched to Plymouth unit to continue profiling unbroken.

Wednesday 10th July:

Dye chasing again all day with MSS. Conditions calm with mist and occasional fog. Kept track all day of the dye patch, with no technical issues!

Thursday 11th July:

MSS termination failure at 1am – SAMS winch and profiler swapped back in. Dye tracking continued throughout the remainder of the day. Conditions calm and still, sun slowly burning through the mist by mid-afternoon. MSS profiling continued on with final dye detection mid-evening prior to end of experiment. Short steam to station C2 to run CTD stations through the night.

Friday 12th July:

CTDs C2, C4, C6, C8 and C11 completed through the night and into early afternoon.Re-positioned for dye release #2. Perfect conditions, sunny with light winds and light swell. Pumped full quantity of remaining dye into the core of the slope current. MSS recommenced for the start of another marathon.

Saturday 13th through Tuesday 16th July:

Non-stop MSS profiling following the dye patch on its way northward with the slope current. Finished off in the early hours of Tuesday 16th with long sections at the north end of our survey, then returned to the release latitude for a final long cross-isobath MSS section to give good boundary conditions for the very successful experiment. 08:30, after a quick inter-comparison dip between the two MSS profilers, so ends the longest ever microstructure experiment? Eight and a half days continuous profiling! Well done everyone. Moved straight into mooring recovery mode; LA, LB recovered, then Slocum glider sn345.Started CTDs along line C for nutrient chemistry.

Wednesday 17th

Had to break off at ~2am for a precautionary passage to the Irish coast; seawater pipe leak in engine room. All repaired by ~11am and returned to LA position for evening re-deployment of mooring. Steamed 15nm south to deploy all 30 lagrangian drifters in 600m water depth in the core of the slope current. Back towards the Irish coast over-night, this time CTD'ing with the MSS for speed to make up for lost time. Conditions fair all day, overcast with SW 4, some mist, winds decreasing into the evening

Thursday 18th

On site at SC1, winds light, surface calming light swell – sun trying to burn through. SC1 recovered without hitch – a relief given the fishing activity seen very close to the mooring location earlier in the cruise. Pieces of freshly baited long-line on the upper parts of the recovered mooring. Likewise thermistor mooring at SC2 had 27 from 100 thermistors stripped off by long lines,doppler at SD had line and hooks on the recovery line. Fog prevented recovery attempts of the four moorings at SF, so we returned to the C line to completed our CTD section there.

Friday 19th

Fog again, but occasionally sufficient visibility to allow for some cautious mooring recovery. Both SE moorings recovered, all four at SF and the final two at SG in the glorious evening sunshine. Four hour steam to B9.

Saturday 20th

Awoke early, expecting fog, to clear skies! Short steam north to collect Glider SG525 (following calibration CTD to 1600m), then longer steam east to recover the turbulence Glider. All moorings and Gliders now recovered. Final CTD line along section B.

Sunday 21st

Final line of MSS stations running shoreward from the innermost B-line CTD station - across the shelf towards the isle of Islay on the way back to Southampton via the Irish Sea. Final MSS station at 17:30 after we'd crossed the Islay front and into Irish Sea waters. End of science.

2.2 Watch keepers

A standard watch keeping system of 4h on, 8h off was maintained by the scientific staff throughout the cruise.

Watch	Name	Name
8 to 12	Philip Hosegood*	Marie Porter
	Colin Griffiths	Matthew Toberman
	Sam Jones	Anna Glüder
12 to 4	Andrew Dale*	Vincent Lamache
	Estelle Dumont	Sophie Wilmes
	Dimitry Aleynik	Prima Anugerhanti
		Carl Spingys
4 to 8	Joanne Hopkins*	Jaimie Cross
	Juliane Whisgott	Marian McGrath
	Mark Hebden	Gordon Stephenson
		Terry Doyle

* Watch leader

3 Sensor on gliders project

Samer Abi Kaed Beyh

3.1 Test and deploy a fast CT sensor on a glider

A miniature high precision conductivity and temperature (CT) sensor system has been developed for ocean salinity monitoring. The CT sensor is manufactured using micro fabrication technology. A novel 7-electrode conductivity cell has been developed which has no field leakage. This is combined with a platinum resistor temperature bridge to produce an integrated CT sensor. A generic impedance measurement circuit has been developed, with 3-parameter sine fitting algorithm. It has a 10 days battery life at 2 seconds sampling interval. Calibration results show that the initial CT accuracies are ±0.03 mS/cm and ±0.01 oC respectively. Testing of the CT was carried out on an irobot sea glider sg550 Eltanin which is due to be recovered in October 2013. The glider was launched successfully on the 9th of July from James Cook (JC88). The sensor is self logging and makes use of non pumped technology and hence we should obtain a fast response across the shelf under investigation.

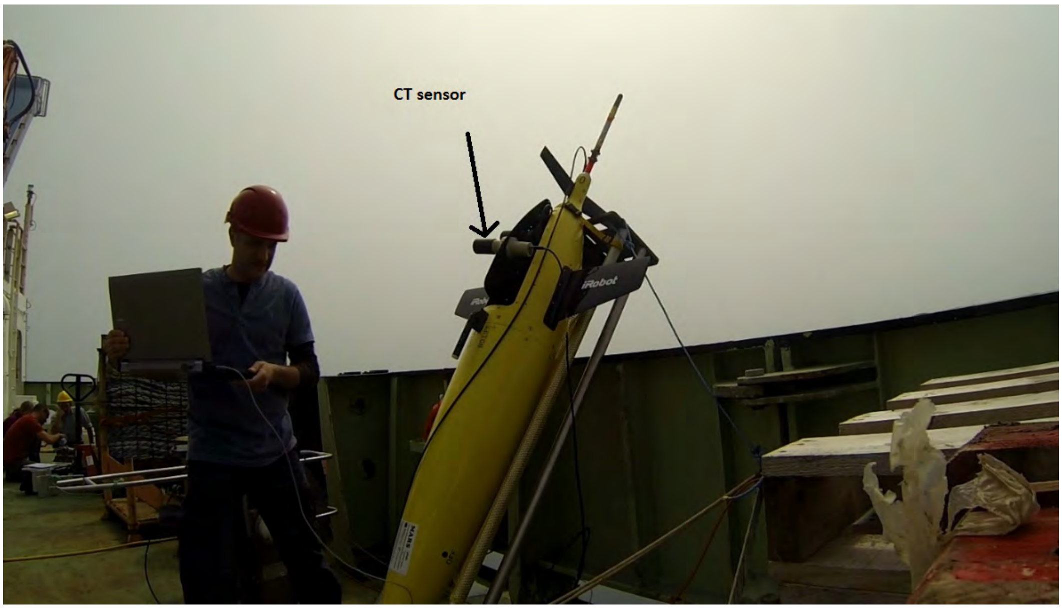

Figure 2 CT sensor fitted on glider

3.2 Test and deploy a fast CT sensor on a CTD

A similar CT sensor to that used on a glider but with a pressure housing rated down to 3000 metres was also used and tested on a CTD. By the end of the JC88 cruise, a total of around 15 casts were measured using this sensor. Preliminary data from the sensor shows close profiles to that obtained from the seabird CTD sensor but with a possible offset (Figure 3 and figure4). A calibration of the CT sensor is needed and it is anticipated that this should optimise the data further. An example of the data obtained is shown below.

Ideally data should be plotted against each other to compare but this will be conducted and investigated in more details at a later stage.

Figure 3 fast CT sensor mounted on a CTD

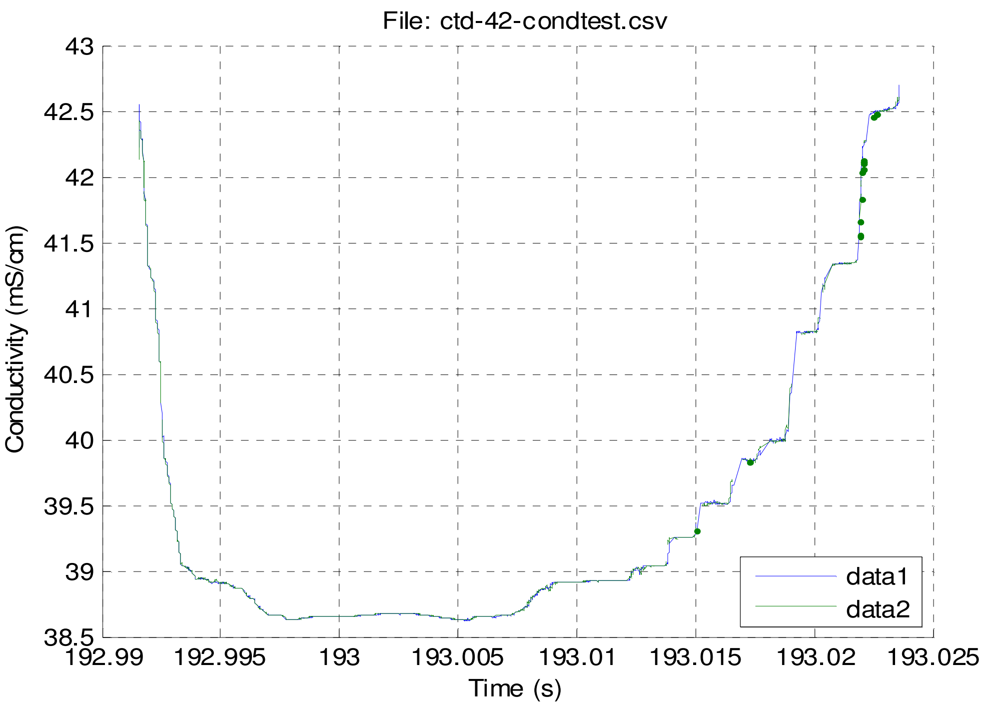

Figure 4 conductivity obtained from the seabird mounted on the CTD during cast 42

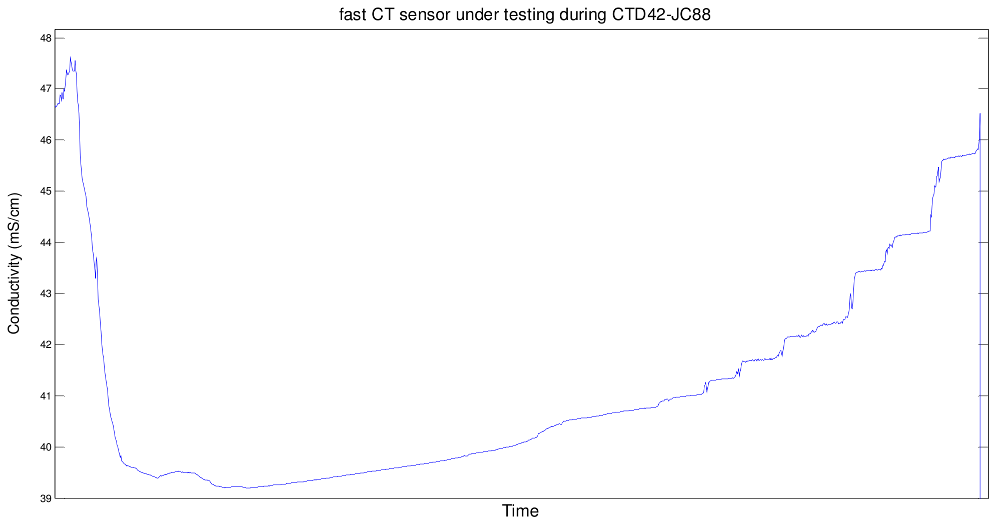

Figure 5 Conductivity data obtained from cast 42 using the developed CT sensor mounted on a CTD

3.3 Compare a newly designed nitrate analyser on the bench with the Quattro analyser and test the nitrate analyser on a CTD for insitu measurements

Nitrate analyser:

High-resolution measurements of nitrate are essential for our understanding of biogeochemical nitrogen cycling in aquatic systems. Determination of nitrate levels in sea water is traditionally performed via manual sample collection and subsequent analysis using bench top analysers. This method is time and labor intensive, and also carries the inherent risks of sample contamination and degradation during transfer and storage. To reduce these issues, as well as arrive at high temporal and spatial resolution monitoring, we have developed a miniaturised nitrate system version of the Quattro and has been tested on this cruise JC88 both on the bench and on the CTD. The future application will be to mount this sensor on sea gliders. In this cruise, the nitrate system was compared to the Quattro on the bench during transect A and then mounted on the CTD for pressure testing and for brief in situ analysis in Transect C (figure 5). Generally, the objectives have been carried out with success on various occasions. But our instrument seems to have lower precision than the Quattro but initial tests shows that the sensor detected the nitrate changes along the water columns. Some samples storage and processing errors could be behind some accuracy offset which will be investigated experimentally. Overall the sensor has been successfully deployed on a CTD and had no leaks at depth down to 2000 metres. Pump and valves worked all ok for more than 12 casts in total. Main issues arised on occasions were from the data logging side (electronics) which prevented logging the custom long CTD cast C9 (8 hour long cast designated for this sensor). However, we have obtained data on another relatively shorter casts. In general, testing the sensor on a CTD was a harsher experiment than would be on future potential deployments on sea gliders due to the speed of descent and ascend of the CTD.

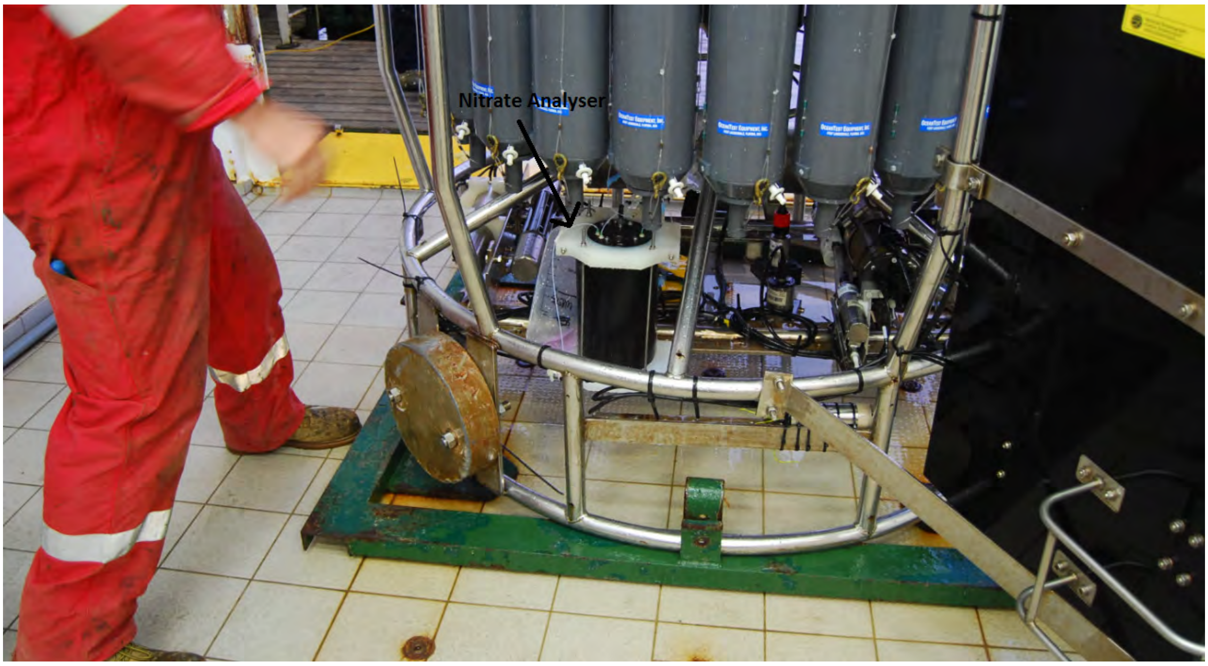

Figure 6 Nitrate analyser mounted on a CTD

Data are still under analysis and the outcome will feed back to the sensor optimisation. A more detailed comparison with the Quattro will be also conducted.

4 CTD report

4.1 CTD Operations

73 CTD casts were conducted in total. The system was deployed from the CTD winch on the starboard side. The usual procedure was to first lower the CTD to around 10m deep for the pumps to switch on. The system was then brought back up close to the surface (2 to 5m) before starting the cast. The Niskin bottles were fired on the way up, and the CTD package was stopped for at least 30 seconds before firing to allow the sensors to settle.

All sensors appeared to function correctly, and the dual CT sensors were in close agreement.

4.2 Data processing

The CTD data were processed according the standards described in the SAMS CTD data Processing Protocol (Dumont and Sherwin, 2008, SAMS internal report No 257), using Seabird Data Processing version 7.21f and Matlab R2012a. The processing steps were:

- Step 1(SBE Data Processing, batch processing): modules Data Conversion, Wild Edit, Align CTD, Cell Thermal Mass, Filter, Derive, Translate and Bottle Sum.
- Step 2 (Matlab): despiking of the 24Hz data
- Step 3 (SBE Data Processing, batch processing): modules Ascii In,, Bin Average (2db-bins) and Ascii Out
- Step 4 (Matlab): calibration of salinity and dissolved oxygen data on both 24Hz and 2db-bin averaged datasets (post-cruise).

4.2.1 Raw data processing (SBEDataProcessing)

Data Conversion converted raw data from engineering units to binary .cnv files and produced the .ros files. Variables exported were scan number, pump status, Julian day, latitude, longitude, pressure [db], depth [m], temperature0 [ITS-90, deg C], conductivity0 [mS/cm], temperature1 [ITS-90, deg C], conductivity1 [mS/cm], oxygen [mg/l], altimeter [m], fluorescence [µg/l], beam transmission [%],beam attenuation [1/m], turbidity [m^{-1}/sr], primary PAR, secondary PAR.

Please note:

The primary TC sensors were labelled 0, secondary 1.

The depth exported here was only for indicative purposes in the bottle files. Accurate depth calculation was performed at the Derive stage, and this first depth removed in processed files.

Wild Edit detected and removed the major spikes in the data. Wild Edit's algorithm requires two passes through the data: the first pass removed data points over 2 standard deviations of a 100 scans average, while the second pass removed the data over 20 standard deviations of a 100 scans average.

AlignCTD was then run to compensate for sensor time-lag.

Both conductivities were automatically advanced by **0.073s** by the deck unit.

The oxygen sensor response was advanced relative to pressure by **+5s**. This value was found to give the best results after testing several offsets on a subset of the data. This offset ensures that calculations of dissolved oxygen concentration are made using measurements from the same parcel of water.

In **Cell Thermal Mass**, a recursive filter was run to remove conductivity cell thermal mass effects from the measured conductivity. The constants used were the ones recommended by Seabird: thermal anomaly amplitude α=0.03 and thermal anomaly time constant 1/β=7.

Filter applied a low-pass filter (value of 0.2) on the pressure and depth data, which smoothed the high frequency (rapidly changing) data. To produce zero phase (no time shift), the filter was first run forward through the data and then run backward through the data. This removed any delays caused by the filter.

At the **Derive** stage, twin salinities (psu), twin densities sigma-theta (kg/m3) and depth (m) were calculated.

The data was converted from binary to ASCII format by the module **Translate**. The data had been kept in binary format up to this stage to avoid any loss in precision that could occur when converting to Ascii.

Finally, the module **BottleSum** created the ASCII bottle files (.btl) from the .ros files, for each bottle fired during a cast. These files contain mean, standard deviation, maximum and minimum values for all variables (average of 48 scans, i.e. 2s).

4.2.2 Despiking (Matlab)

The pressure, oxygen, temperature (primary and secondary) and salinity (primary and secondary) data were manually despiked. Any data recorded while the pumps were not on were deleted at this stage.

Notes on the despiking:

- When a spike occurred in the pressure, primary temperature or primary salinity data, making that/those point(s) flagged as bad, the whole corresponding scan was deleted.

- When a spike occurred in the oxygen data, making that point flagged as bad, the erroneous value was set to NaN, and other variables of the scan (i.e. temperature, salinity, etc) were kept in the dataset (if not flagged as bad themselves).

- When a spike occurred in the secondary temperature or secondary salinity data, making that/those point(s) flagged as bad, the secondary temperature, conductivity, salinity and density values were set to NaN, and other variables of the scan (i.e. primary temperature, primary salinity, etc) were kept in the dataset (if not flagged as bad themselves).

In addition to occasional spurious readings, some large “spikes” lasting a few seconds were observed in the data from both CT sensors (and therefore in the salinity and density data), predominantly in the thermocline area. See example on figure 5 below. This issue has already been observed on previous cruises (e.g. D340, D352, D376, D379, D381, JC086). A possible explanation was described in the D352 cruise report: “The spikes appear to be associated with a decrease in the decent rate of the CTD package and are therefore likely associated with inefficient flushing of the CTD package […]. As the veer rate on the winch slows ‘old’ water is pushed back passed the sensors out the base of the rosette. As the rate of decent increases again ‘new’ water is flushed back passed the sensors.”

The WildEdit and LoopEdit routines proved inefficient in removing those spikes, therefore they were removed manually in the Matlab despiking routine. This explains the sometimes irregular data interval observed on the 24Hz dataset. For the bin-averaged data, the Seabird software interpolates any missing values, and data users should therefore use caution when interpreting the data. For more details on the interpolating routine see SBE Data Processing manual (http://www.seabird.com/software/sbedataprocforwindowsdetails.htm).

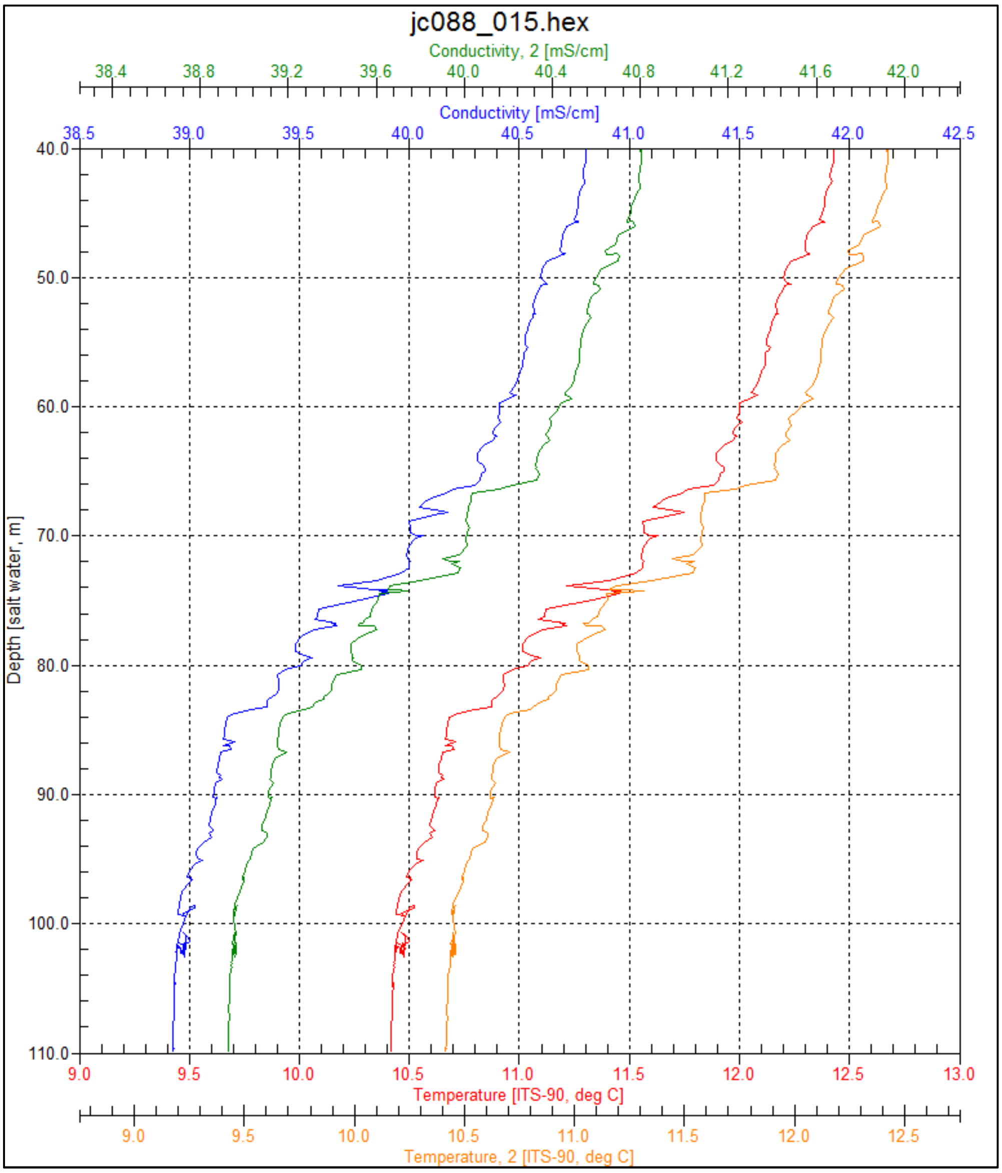

Figure 5: Typical “spikes” observed on CT sensors in the thermocline area (example from cast 15)

Additionally, the CT data on the upcast seemed particularly noisy and delayed in the thermocline and surface layers. The linear interpolation done by the Seabird bin-averaging routine, combined with the heavy data despiking described above results in some erroneous values in places. Data users are advised to use only the downcast data for CT readings and other related parameters (salinity, density, and oxygen). However, the sensors readings at the time of bottle firings should be acceptable as the CTD package was stopped in the water for at least 30 seconds before any firings, in order to allow sufficient time for the sensors to give stable readings.

4.2.3 Averaging (SBEDataProcessing)

After going through Matlab, the data files needed to be re-formatted to be recognised by SBE Data Processing. **ASCII In** added a header to the input .asc file and output a .cnv file (XXX_2.cnv).

The module **Bin Average** was run several times, to average the 24Hz data into 2db-bins (downcast data only), 1m-bins and 1s-bins (for the LADCP processing).

Ascii Out output the bin-averaged data files as ASCII (with a simplified header).

4.2.4 Calibration and export (Matlab)

The salinity and oxygen data were calibrated in the final files, according to the results detailed in the next paragraph.

The 2db-bin averaged data was exported in the WOCE standard format. To follow WOCE data format conventions, the raw O_2 values in the final datafiles have been converted from mg/l to µmol/kg using the formula:

[µmol/Kg] = (([mg/L] / 1.42903) * 44660) / (sigma_theta + 1000)

4.2.5 Datafiles

The different types of files created are (example of cast no. 001):

jc088_001_1.cnv: non-despiked, non-calibrated 24Hz data

jc088_001_2.asc: despiked, non-calibrated 24Hz data

jc088_001_2_2db.asc: despiked, non-calibrated 2db-bin averaged data

jc088_001_2_1m.asc: despiked, non-calibrated 1m-bin averaged data

jc088_001_2_1s.asc: despiked, non-calibrated 1s-bin averaged data

jc088_001_3.asc: despiked 24Hz data, primary and secondary salinities calibrated

jc088_001.CTD: despiked 2db-bin averaged data (WOCE format conventions), salinity and O_2 calibrated

jc088_001.btl: bottle data file, non-calibrated jc088_001.hdr: header file, detailing the data processing

4.3 Data calibration

4.3.1 Salinity calibration

Throughout the cruise salinity samples were taken from the CTD, in order to calibrate the conductivity sensors. The sampling procedure was to rinse the sample bottle 3 times with water from the Niskin bottle, collect sample, wipe the neck of the bottle, insert a clean/dry white cap and place the lid. The samples were kept in the salinometer room for at least 24 hours before analysis.

Salinity was measured using a Guildline Autosal8400, s/n 60839 in a temperature-controlled room onboard the ship. The CTD data used for calibration comes from the .btl files (created by the Seabird software).

The Autosal was standardised only at the start of the cruise in order to monitor the instrument drift. A standard seawater sample was measured at the beginning and end of each crate (24 samples) and results recorded to allow for manual correction of the salinometer drift. The standard sweater ampoules used were from batch P154, with a double conductivity ratio of 1.99980.The readings (double conductivity ratio) and derived offsets for each crate are summarised in table 1. The calculated offsets (last column in Table 1) were then applied to each crate's Autosal data.

Table 1: Standard Seawater (SSW) measurements at the beginning and end of each crate. 'CTD' indicates samples taken from the CTD, and 'TSG' samples from the underway system (ThermoSalinoGraph).

Date Time	Crate	Read 1	Read 2	Read 3	Avg read	Offset (SSW – avg read)	Avg offset for each crate
06/07/13 18:10	standardised – no readings recorded				1.999830	-0.000030	
07/07/13 18:02		1.999857	1.999832	1.999841	1.999843	-0.000043	
	CTD 13						**-0.000055**
07/07/13 19:22		1.999864	1.999867	1.999871	1.999867	-0.000067	
	TSG 6						**-0.000073**
07/07/13 20:49		1.999873	1.999882	1.999881	1.999879	-0.000079	
11/07/13 19:02		1.999811	1.99984	1.999849	1.999833	-0.000033	
	TSG 1						**-0.000048**
11/07/13 20:22		1.999857	1.999872	1.999861	1.999863	-0.000063	
	CTD 6						**-0.000065**
11/07/13 21:55		1.99987	1.999869	1.999865	1.999868	-0.000068	
12/07/13 14:20		1.999775	1.99981	1.999815	1.999800	0.000000	
	CTD 15						**-0.000033**
12/07/13 16:37		1.999865	1.999874	1.99986	1.999866	-0.000066	

18/07/13 00:49		1.999847	1.999819	1.999845	1.999837	-0.000037	
	TSG3						**-0.000065**
18/07/13 02:12		1.99989	1.999892	1.999897	1.999893	-0.000093	
19/07/13 18:21		1.99985	1.999841	1.999857	1.999849	-0.000049	
	CTD42						**-0.000058**
19/07/13 19:37		1.999877	1.999853	1.999872	1.999867	-0.000067	
22/07/13 18:17		1.999821	1.999835	1.999836	1.999831	-0.000031	
	TSG4						**-0.000046**
22/07/13 19:34		1.999863	1.999851	1.999868	1.999861	-0.000061	
23/07/13 07:28		1.999808	1.999825	1.999833	1.999822	-0.000022	
	TSG6						**-0.000045**
23/07/13 08:46		1.99986	1.999872	1.999871	1.999868	-0.000068	
	CTD14						**-0.000073**
23/07/13 10:11		1.999871	1.999878	1.999884	1.999878	-0.000078	
23/07/13 11:39		1.999867	1.99986	1.999872	1.999866	-0.000066	
	CTD33						**-0.000081**
	TSG1						**-0.000081**
23/07/13 12:57		1.999895	1.9999	1.999895	1.999897	-0.000097	

A total of 129 salinity samples were collected and analysed, including a few duplicate samples. The Autosal and the Seabird values were in very good agreement. A few outliers were removed (4 for the primary sensor, and 6 for the secondary), where the difference between the Autosal and CTD values was greater than 2 standard deviations from the average. Final calibration equations are shown in Figure 2 and 3.

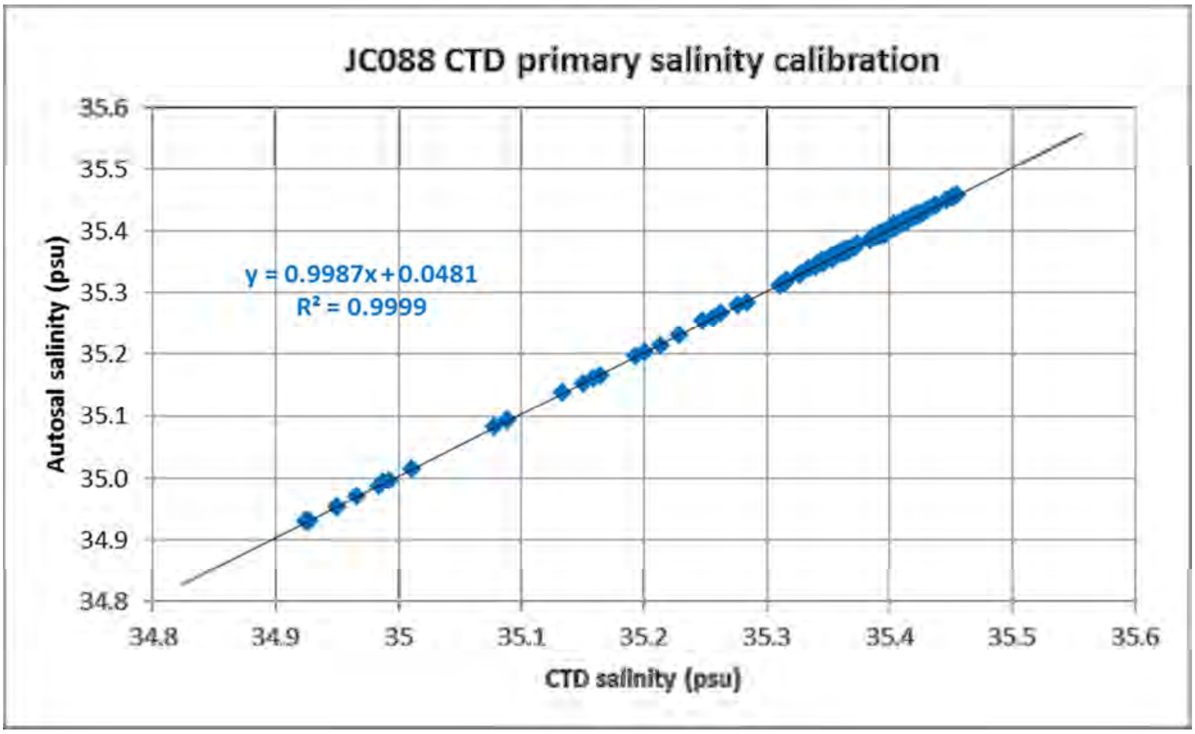

Figure 2: CTD primary salinity calibration data

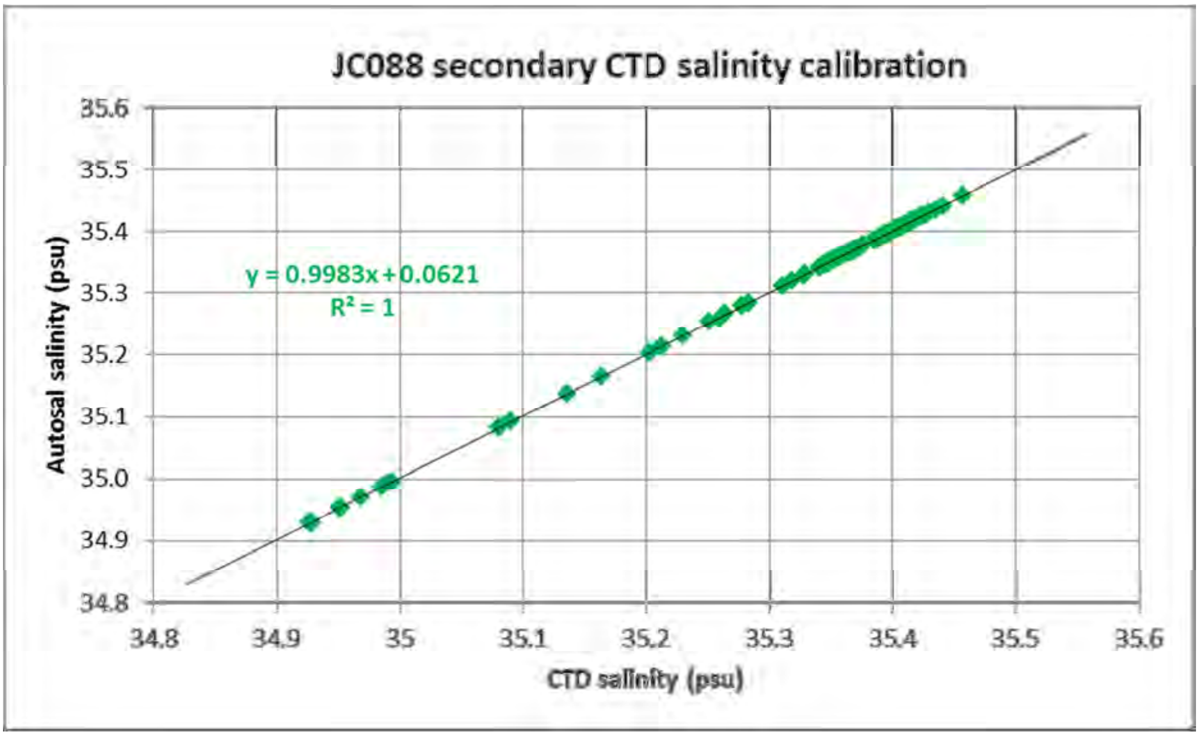

Figure 3: CTD secondary salinity calibration data

4.3.2 Dissolved oxygen calibration

In total, 468 samples were collected to calibrate the dissolved oxygen sensor on the CTD. A few outliers were removed (20 points in total), where the difference between the titration and CTD values was greater than 2 standard deviations from the average difference. 75% of these outliers occurred on samples taken from cast 001, which could suggest a sampling issue at the start of the cruise.The final calibration data is shown in Figure 4.

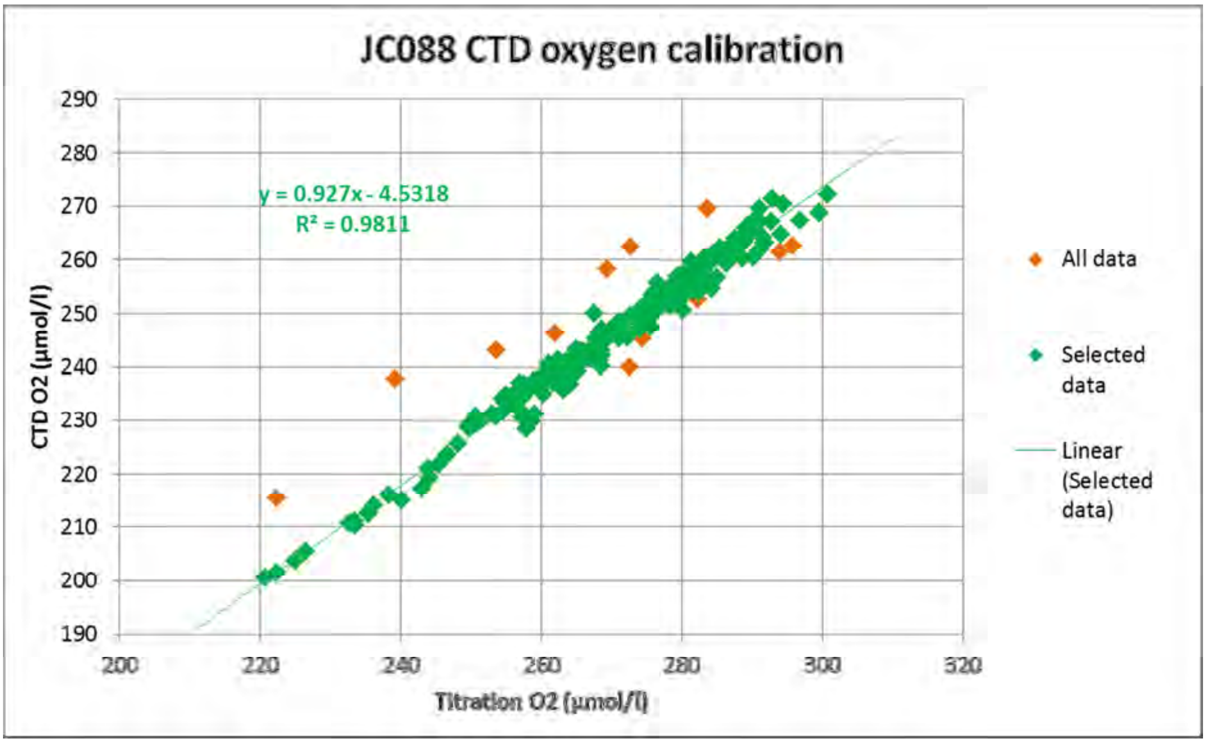

Figure 4: CTD oxygen calibration data

4.4 Configuration file examples

Casts 1 to 53, 62 (with v2 and v3 inverted), and 63 to to 73:

```
 Configuration report for SBE 911plus/917plus CTD
------------------------------------------------
Frequency channels suppressed : 0
Voltage words suppressed      : 0
Computer interface            : RS-232C
Deck unit                     : SBE11plus Firmware Version >= 5.0
Scans to average              : 1
NMEA position data added      : Yes
NMEA depth data added         : No
NMEA time added               : No
NMEA device connected to      : deck unit
Surface PAR voltage added     : No
Scan time added               : No

1) Frequency 0, Temperature
   Serial number : 03P-4116
   Calibrated on : 4 September 2012
```

```
   G              : 4.42604774e-003
   H              : 6.84578968e-004
   I              : 2.45663449e-005
   J              : 2.04105560e-006
   F0             : 1000.000
   Slope          : 1.00000000
   Offset         : 0.0000

2) Frequency 1, Conductivity
   Serial number : 04C-2164
   Calibrated on : 6 July 2012
   G              : -1.02341772e+001
   H              : 1.41388892e+000
   I              : -3.96938005e-003
   J              : 3.59567414e-004
   CTcor          : 3.2500e-006
   CPcor          : -9.57000000e-008
   Slope          : 1.00000000
   Offset         : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC
   Serial number : 110557
   Calibrated on : 29 May 2012
   C1             : -6.010548e+004
   C2             : -1.565601e+000
   C3             : 1.823090e-002
   D1             : 2.668300e-002
   D2             : 0.000000e+000
   T1             : 3.020528e+001
   T2             : -6.718318e-004
   T3             : 4.457980e-006
   T4             : 1.203850e-009
   T5             : 0.000000e+000
   Slope          : 0.99998000
   Offset         : -0.22270
   AD590M         : 1.280700e-002
   AD590B         : -9.299640e+000

4) Frequency 3, Temperature, 2
   Serial number : 03P-4872
   Calibrated on : 4 September 2012
   G              : 4.34397681e-003
   H              : 6.38469956e-004
```

```
   I              : 2.09853317e-005
   J              : 1.74298308e-006
   F0             : 1000.000
   Slope          : 1.00000000
   Offset         : 0.0000

5) Frequency 4, Conductivity, 2
   Serial number : 04C-2580
   Calibrated on : 6 July 2012
   G              : -1.04697943e+001
   H              : 1.53838150e+000
   I              : 7.23482843e-004
   J              : 3.17416542e-005
   CTcor          : 3.2500e-006
   CPcor          : -9.57000000e-008
   Slope          : 1.00000000
   Offset         : 0.00000

6) A/D voltage 0, Oxygen, SBE 43
   Serial number : 43-0619
   Calibrated on : 22 October 2011
   Equation       : Sea-Bird
   Soc            : 5.09100e-001
   Offset         : -5.00400e-001
   A              : -3.71370e-003
   B              : 1.62450e-004
   C              : -3.03420e-006
   E              : 3.60000e-002
   Tau20          : 2.39000e+000
   D1             : 1.92634e-004
   D2             : -4.64803e-002
   H1             : -3.30000e-002
   H2             : 5.00000e+003
   H3             : 1.45000e+003

7) A/D voltage 1, Free

8) A/D voltage 2, PAR/Irradiance, Biospherical/Licor
   Serial number        : PAR 07
   Calibrated on        : 2 May 2012
   M                    : 0.47653200
   B                    : 1.05683900
   Calibration constant : 100000000000.00000000
```

```
   Multiplier           : 0.99960000
   Offset               : 0.00000000

9) A/D voltage 3, PAR/Irradiance, Biospherical/Licor, 2
   Serial number        : PAR 01
   Calibrated on        : 14 June 2011
   M                    : 0.44365900
   B                    : 2.19172000
   Calibration constant : 100000000000.00000000
   Multiplier           : 0.99950000
   Offset               : 0.00000000

10) A/D voltage 4, Transmissometer, Chelsea/Seatech
    Serial number : 09-7107-001
    Calibrated on : 11 June 2012
    M             : 23.7954
    B             : -0.1452
    Path length   : 0.250

11) A/D voltage 5, Fluorometer, Chelsea Aqua 3
    Serial number : 088195
    Calibrated on : 21 August 2012
    VB            : 0.612800
    V1            : 1.973000
    Vacetone      : 0.635000
    Scale factor  : 1.000000
    Slope         : 1.000000
    Offset        : 0.000000

12) A/D voltage 6, Turbidity Meter, WET Labs, ECO-BB
    Serial number : BBRTD-168
    Calibrated on : 24 September 2012
    ScaleFactor   : 0.003764
    Dark output   : 0.070000

13) A/D voltage 7, Altimeter
    Serial number : 41302
    Calibrated on : 13 March 2006
    Scale factor  : 15.000
    Offset        : 0.000

Scan length                 : 37
```

Casts 54 to 61:

```
Configuration report for SBE 911plus/917plus CTD
------------------------------------------------

Frequency channels suppressed : 0
Voltage words suppressed      : 0
Computer interface            : RS-232C
Deck unit                     : SBE11plus Firmware Version >= 5.0
Scans to average              : 1
NMEA position data added      : Yes
NMEA depth data added         : No
NMEA time added               : No
NMEA device connected to      : deck unit
Surface PAR voltage added     : No
Scan time added               : No
1) Frequency 0, Temperature
   Serial number : 03P-4116
   Calibrated on : 4 September 2012
   G             : 4.42604774e-003
   H             : 6.84578968e-004
   I             : 2.45663449e-005
   J             : 2.04105560e-006
   F0            : 1000.000
   Slope         : 1.00000000
   Offset        : 0.0000

2) Frequency 1, Conductivity
   Serial number : 04C-2164
   Calibrated on : 6 July 2012
   G             : -1.02341772e+001
   H             : 1.41388892e+000
   I             : -3.96938005e-003
   J             : 3.59567414e-004
   CTcor         : 3.2500e-006
   CPcor         : -9.57000000e-008
   Slope         : 1.00000000
   Offset        : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC
   Serial number : 110557
   Calibrated on : 29 May 2012
   C1            : -6.010548e+004
```

```
   C2             : -1.565601e+000
   C3             : 1.823090e-002
   D1             : 2.668300e-002
   D2             : 0.000000e+000
   T1             : 3.020528e+001
   T2             : -6.718318e-004
   T3             : 4.457980e-006
   T4             : 1.203850e-009
   T5             : 0.000000e+000
   Slope          : 0.99998000
   Offset         : -0.22270
   AD590M         : 1.280700e-002
   AD590B         : -9.299640e+000

4) Frequency 3, Temperature, 2
   Serial number : 03P-4872
   Calibrated on : 4 September 2012
   G              : 4.34397681e-003
   H              : 6.38469956e-004
   I              : 2.09853317e-005
   J              : 1.74298308e-006
   F0             : 1000.000
   Slope          : 1.00000000
   Offset         : 0.0000
```

5 Vessel Mounted ADCP (VMADCP) Processing using an RDI OS75 and PosMV on RRS James Cook

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Adapted from D376, D312, JR239, JR165 and JC29 cruise reports

- For those hoping to access processed VMADCP data, you are most likely to require file type: CRUISE_000_000000_zz_abs.mat; detailed in section 4.5.8. Dates and times covered by files are given in section 5.1.
- A 'quick start' guide to setting up the software on another machine is included in section 4.3.

5.1 OS75 configuration

RRS James Cook is fitted with RD Instruments 75kHz Ocean Surveyor ADCP. Positional and attitude information is provided via a PosMV multi-receiver GPS attitude sensor. Ship's heading information from the vessel's Gyro, though streamed to and saved by the logging PC, was not used in the processing steps described here. The RDI proprietary software VMDAS was used to configure the ADCP and perform velocity mapping to the reference frame of the vessel. Bottom tracking was enabled where possible. A suite of MATLAB routines were used to perform data screening and transformation to absolute velocities in Earth coordinates: A summary of configuration and the processing steps is given below.

OS75 VMADCP Configuration

- No. bins = 48
- Bin size = 16 m
- Blank after transmit = 8 m
- Transducer depth = 6 m
- Bottom track (when on) maximum depth 1200m
- Time between pings = as fast as possible (typically 5s)
- Low-resolution long-range processing mode

Note: files 13 and 14 were run using bin size = 8 m but this setup resulted in more noise in the data.

5.2 Output data format

The filenames of the VmDas data are of the general structure CRUISE_xxx_yyyyyy.END where CRUISE is the name set in the data options recording tab of VmDas (see above), xxx is the number set in the same tab and changed before every restart of recording, and yyyyyy is a number automatically set by VmDas starting at 0 and increasing when the file size becomes larger than max size and a new file is created. END is the filename extension, denoting the different files that are created for each recording. The following list shows all the different file types that were created during D376 and their content.

-.ENR: binary; raw ADCP data file.

-.STA: binary; average ADCP data, using the short time period specified in VmDas Data Options.

-.LTA: binary; average ADCP data, using the long time period specified in VmDas Data Options.

-.ENS: binary; ADCP data after screening for RSSI and correlation, either by VmDas or adjusted by user, and navigation data from .NMS file.

-.ENX: binary; : ADCP single-ping data and navigation data, after having been bin-mapped, transformed to Earth coordinates and screened for error velocity, vertical velocity and false targets.

-.N1R: ASCII text; raw NMEA data, see section 3.

-.N2R: ASCII text; raw NMEA data, see section 3.

-.NMS: binary; navigation data after screening and pre-averaging.

-.VMO: ASCII text; option setting used for collection the data.

-.LOG: ASCII text; all logging output and error messages. More options are available and information about the data files and their format is available in the various OS user guides. Here, a short overview about the structure of the binary data files is given. The structure varies slightly depending on whether only narrowband OR broadband mode are turned on or both are on.

-**Header**: header ID, data source ID, number of data types (i.e. fixed leader, variable leader, etc.) and their offsets;

-**Fixed leader data**: fixed leader ID, ADCP hardware configuration, number of beams, cells, and pings per ensemble, depth cell length, blank after transmit, signal processing mode (narrow- or broadband), output controls, amount of time between ping groups, coordinate transform parameters, heading alignment, heading bias, sensor source, sensors available, distance to middle of first depth bin, length of transmit pulse, distance between pulse repetitions;

-**Variable leader data**: variable leader ID, ping ensemble number, date and time, speed of sound, transducer depth, heading, pitch and roll, salinity and temperature;

-**Variable data**: velocity, correlation magnitude, echo intensity, and status data

-Bottom track (BT): BT ID, BT number of pings, correlation magnitude, evaluation amplitude, BT mode, error velocity maximum, BT range, BT velocity, BT correlation magnitude, BT evaluation amplitude, BT maximum depth, receiver signal strength indicator, gain level for shallow water, most significant byte of the vertical range from the ADCP to the sea bottom;

-Attitude: fixed and variable attitude data. Fixed attitude data includes the command settings and is the same for all pings. Variable attitude data changes with every ping and consists of heading, pitch and roll;

-Navigation (ENS, ENX, STA, and LTA-files only): navigation ID, UTC date and time, PC clock offset, latitude and longitude received after the previous ADCP ping, UTC time of last fix, last latitude and longitude received prior to the current ADCP ping, average navigation speed, true navigational ship track direction and magnetic navigation ship track direction, speed made good, direction made good, flags, ADCP ensemble number, date and time, pitch, roll and heading, number of samples average since the previous ADCP ping for speed, true track, magnetic track, heading, pitch and roll;

-Checksum: modulo 65536 checksum (sum of all bytes in the output buffer excluding the checksum). If data storing by VmDas is interrupted by e.g. a software crash and/or the data files are not closed properly by VmDas, the checksum can be incorrect and the check in the post processing can fail.

Note: The date recorded by VmDas is given as Julian day. VmDas takes 1st Jan to be day no. 0, different from the ship clock and the other data logging systems!

5.3 Navigation data in the VmDas output files

There are two NMEA feeds into the VmDas software. The NMEA1 stream is written to the N1R-files, the NMEA2 stream to the N2R-files. They are also included in the binary (.ENX) data files. The NMEA1 feed provides the following strings: HCHDM, TIROT, HEHDT, PPLAN. **NMEA2 gives the GPZDA, PASHR, PRDID, GPGGA, GPHDT, GPRMC messages (the highlighted file is the one used by the processing software).** In both files, a message from VmDas is stored in the PADCP line at every ADCP ping.

Note: On JC88 the file contents were reversed, so that headings GPZDA, PASHR, PRDID, etc were written to the .N1R file. I'm unsure where in the VMDAS setup this is determined, but the important thing is to ensure the postprocessing is reading in the file containing the above strings. If they are the wrong way round, I think all you need to do is change the variable 'extension' in read_nmea_att_jc.m.

For the postprocessing, the PADCP, PASHR and PRDID messages are used. They contain, amongst other things: pitch, roll, heading, ensemble number, date (yyyymmdd), time from PC clock, PC clock offset. A search online using the above strings as keywords helps if you need to know exact contents or the strings have changed since this report was written.

5.4 Processing in Matlab

5.4.1 The Matlab routines

For the post-processing of the VmDas data, we used a set of Matlab routines. They were first obtained from IfM Kiel by Mark Inall and adapted for use on the RRS James Clark Ross by Deb Shoosmith. During JR165, Mark Brandon and Angelika Renner cleaned up large parts of the routines and added comments throughout. Since JR165, some further debugging and refinement have been done by Deb Shoosmith, Hugh Venables and Angelika Renner. The structure, general processing, and in- and output formats remain the same. The following description of the routines and the output data files are adapted from the JR235 and D376 cruise reports.

5.4.2 Remarks and Glossary

Whenever it says 'run a routine/program/function', it means type in the function name in the Matlab command window and hit enter... A few terms should be clear:

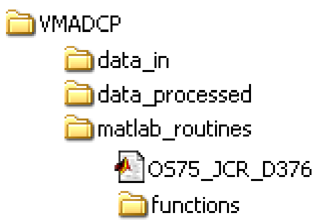
-file sequence: all files for which in the filename CRUISE_xxx_yyyyyy.END the number at position xxx is the same. These files have been recorded without stopping the ADCP in between and the same setting was used.

-amplitude, scaling factor, A: Throughout the routines the factor by which the ADCP data has to be scaled for calibration is called either amplitude, scaling factor or A.

-misalignment (angle), phi: synonyms for the angle by which the ADCP is misaligned in addition to the physical misalignment set in the command files.

5.5 Quick'n'dirty

5.5.1 How to get processed ADCP data



- Create a file structure as shown above.

- The master function (OS75_JC88.m) lives in 'matlab_routines', all others go in the subfolder 'functions'.

- Depending on your version of Matlab, you may need the **signal processing** and **stats** toolboxes.

-There are a few things that have to be set for each cruise in file OS75_JC88.m. These are:

1. Add the correct path to the 'functions' subfolder (line ~54).

2. Point Matlab variable '*RAWPATH*' to 'data_in' and '*PATH*' to 'data_processed' (Remember the 'forward slash' character!). Lines ~62 – 70.

3. The expected VMDAS output: '*filename*'. Line ~73. Note that both the length and the position of file numbers has to be correct or the program will not get very far! If file length/numbering is different, there's also a bit of tinkering to be done at line ~287… (hint: the program counts backwards from the end of the filename).

3. The cruise name: variable *'cruise'*. The name is used when reading in raw data and saving processed data, and appears in the plots. Line ~74.

4. The file sequences: variable '*files*'. This determines which of the file sequences are to be processed. 'Files' can be a single number or a vector containing the numbers of several file sequences **(A new file sequence is begun each time you switch the VMDAS on / off).** Line ~105

5. The averaging interval: variable '*superaverage'. 'superaverage'* sets the interval over which ping ensembles will be averaged. Unit is seconds. **Leave as is if unsure.** Line ~117.

6. The year: variable '*YYYY*'.

7. A switch for which lat/lon fix to be used (see below, 5.4): variable '*which_prdid_fix'*. Options are a) 1 to use the fix directly after the previous ADCP ping, or b) any other number to use the fix directly before the current ADCP ping. **Set it to 1 presently and has negligible impact on the resultant data.**

8. The upper and lower limit of the reference layer: variables '*ref_uplim'* and *'ref_lowlim'*. Those are needed for calculation of a reference velocity which is used when doing calibration by water tracking. Unit is meters. Useful if a particular layer of water is known to be particularly good / bad as a reference level due to tides, etc. **Leave as is if unsure**.

9. The misalignment angle and the scaling factor: variables '*misalignment_nb'* and '*amplitude_nb'. nb = narrowband, see note below.* **When running *OS75_JC88.m* the first time, set the misalignment to 0 and amplitude to 1. (Currently Line ~ 183).** After the first run, to correct for the angle and the scaling, set the variables to the mean, median, mode or whichever value is preferred, and run OS75_JC88.m again. The Mean, median, and standard deviation are displayed in the plot *adcp_calib_calc.ps.* (The commented out values used on JC88 should give a ballpark value for James Cook). To keep track of which values were used, it is a good idea to note down, which file

sequences require which correction factors. *Deb Shoosmith modified this bit so that only 'misalignment_nb' and 'amplitude_nb' are used. On JR235/6/9, almost all data are in narrowband mode so that we just use the changed version. It is possible though to return to the previous version. The description below therefore still includes this option.*

That is all that should be set. All that needs to be done then is:

1. Put raw files into 'data_in' folder. Note the program only requires .N1R / .N2R **(see note in section 3 on getting the right file!)** and .ENX files to run, just make sure you get the whole file sequence (on JC88 max file size was set at 10 Mb after which a new file was started by the VMDAS).

2. Run OS75_JC88.m.

3. Check which values for misalignment angle and scaling factor are derived.

4. Set 'misalignment_nb' and 'amplitude_nb' in OS75_JC88.m to these values. Note: setting these values other than 1 and 0 invokes some additional statistical routines which increase the processing time…

5. Run OS75_JC88.m again.

Existence of files in 'data_processed' and 'data_in' folders

If the program encounters files or plots of the current working name in the 'data_processed' folder, it skips much of the processing, assuming them to be completed. Therefore until you are happy with the outputs it is best to regularly delete the contents of the 'data_processed' folder, or at least move them elsewhere.

5.5.2 What's it doing? (In brief)

The misalignment angle of the transducer relative to the vessel (α) and the velocity amplitude correction factor (A) are determined as follows. A reference layer velocity between 100 and 300m is calculated from the super-ensembles (u and v), and the ship velocity calculated for the corresponding super ensembles (su and sv). First differences are taken (du, dv, dsu, and dsv) between all possible pairs of super ensembles, then differences selected for when the ship speed exceeds 3 ms^{-1} over the ground between ensembles not more than 5000m or 3600s apart in space or time. Then the following function is minimised for α and A using the Matlab function FMINSEARCH.m (a multidimensional minimization method).

$$f(A,\alpha) = \left(Adu\cos\alpha - Adv\sin\alpha + dsu\right)^2 + \left(Adu\sin\alpha + Adv\cos\alpha + dsv\right)^2$$

An initial guess at A and α is made in order to perform the minimisation on the super-ensembles outlined above. The whole processing procedure is then repeated for the newly determined values for A and α to give the final absolute velocities.

5.5.3 Brief description of Matlab processing steps

RDI binary file with extension ENX (single-ping ADCP ship referenced data from VMDAS) and extension N1R (ascii NMEA output from PosMV saved by VMDAS) read into MATLAB environment. NB: The N1R file consists of ADCP single ping time stamps ($PADCP string) and PosMV pitch, roll and heading information ($PRDID string).

Ensembles with no ADCP data removed

Ensembles with bad or missing PosMV GPS heading data identified and adjusted GYRO heading substituted

Attitude information time-merged with single ping data

Heading data used to rotate single ping ADCP velocities from vessel centreline reference to True North reference

Transducer mis-alignment error corrected for (derived from the mis-alignment determination – see text below)

Ship velocity derived from PosMV positional information

Further data screening performed:

-Max heading change between pings (10 degrees per ping)

-Max ship velocity change between pings (>2ms^{-1}pingrate^{-1})

-Error velocity greater than twice Stdev of error velocities of single ping profile

All data averaged into 120-second super-ensembles (user selectable)

Determine absolute water velocities from either bottom track derived ship velocity or PosMV GPS derived ship velocity, dependent on depth.

5.6 Detailed description of the processing functions

5.6.1 The master function: OS75_JC88.m

The main function for the processing is OS75_JC88.m. In there, the environment and variables are set, and the subfunctions are called. Fig. 1 gives an overview of the processing routines, their order and the output. In the first part the work environment is defined: the paths to the processing routines are added to the Matlab search path, the directory with the raw data and the directory for the processed data are declared, the file- and cruise names are defined, and the vector containing the numbers of the file sequences that are to be processed is created. Several choices can be made for the processing: the variable *superaverage* is used to define the interval over which pings will be averaged in time, unit is seconds; which $PASHR string sets, i.e. the first $PASHR fix after the previous $PADCP string or the last one before the current $PADCP string. The values for *ref_uplim* and *ref_lowlim* give the upper and lower limits of the reference layer of which a velocity is calculated and used as reference velocity. This is of importance mostly for water track calibration in cases where no bottom track data is available or the bottom track calibration is not satisfactory.

Then, during the first run through OS75_JC88.m, where no data are processed yet and no calibration data are available, the correction values for the misalignment angle (*misalignment_xb*) and the scaling factor (*amplitude_xb*) are set to 0 and 1 respectively (x=n for narrowband mode, x=b for broadband mode). For the second run, when values for *misalignment_xb* and *amplitude_xb* have been calculated, they should be set to the median, mean, mode or whichever value works best (i.e. gives the smallest angle and amplitude after the second run). To keep a record of the settings used to process a set of ADCP data, the settings and the text displayed on screen during the processing are written to a diary called *adcp_proc_log_runX.txt.* X will be 1 for the first run (when *misalignment_xb* and *amplitude_xb* are equal to 0 and 1, resp.) and 2 for the second run *(misalignment_xb* and *amplitude_xb* unequal 0 and 1, resp.).

After this introductory part, the processing starts. Arrays are declared for later use when calling some of the subroutines, and the file containing calibration point data is deleted if it exists in the processed data directory. Then, the loop through all file sequences specified above starts. First, the filename is set. Its general structure is *CRUISE_xxx_yyyyyy.* At this point, *xxx* is set to the file sequence number that is the current in the loop and *yyyyyy* is 000000. After the initialisations, the run through the subroutines begins! This includes all routines described in 5.6.2 to 5.6.11. Once all files have been passed through these routines and the loop is finished, the functions described in 5.6.12 to 5.6.16 are called. After that, all data is processed and saved in the specified directory. The last thing in the main function is a plot of velocities: cross sections of the zonal and meridional velocities against time are produced and the plots are saved in *adcp_vel_contours.ps.*

5.6.2 read_os.m In this routine, the raw binary data from VmDas are read. In case of JC88, we used the .ENX files, which contain ADCP single-ping and navigation data. The ADCP single-ping data has already been bin-mapped, transformed to Earth coordinates, and screened for error velocity, vertical velocity and false targets (see VmDas User's Guide).

read_os.m is called with the file name variable and optional arguments. The latter define which part of the raw data is read:

-'ends': ???

-'ens list': list of ensemble numbers

-'yearbase': start year

-'second set': read narrow band mode data when both broad and narrow band are collected.

-'vel': read velocity.

-'cor': read correlation magnitude.

-'amp': read echo intensity.

-'pg': read percent good.

-'ts': read pitch, roll, and heading.

-'bt': read bottom track data.

-'nav': read navigation data

-'all': includes vel, cor, amp, ts, bt, and pg.

More than one argument can be passed on to read_os.m. Arguments can also be numbers. After the switches are set, the subroutine os_id, which is within read_os.m, is called with the argument *id_arg*. The value of *id_arg* depends on the offset of the positions of the data. If both narrowband and broadband data are collected in broadband mode, this also decides which data are read. If *id_arg*=1, the narrowband data is extracted. os_id returns the structure id with the positions/identifiers of the data fields in the binary data files. The next step is the first call to the subroutine read_buf, also within read_os.m.

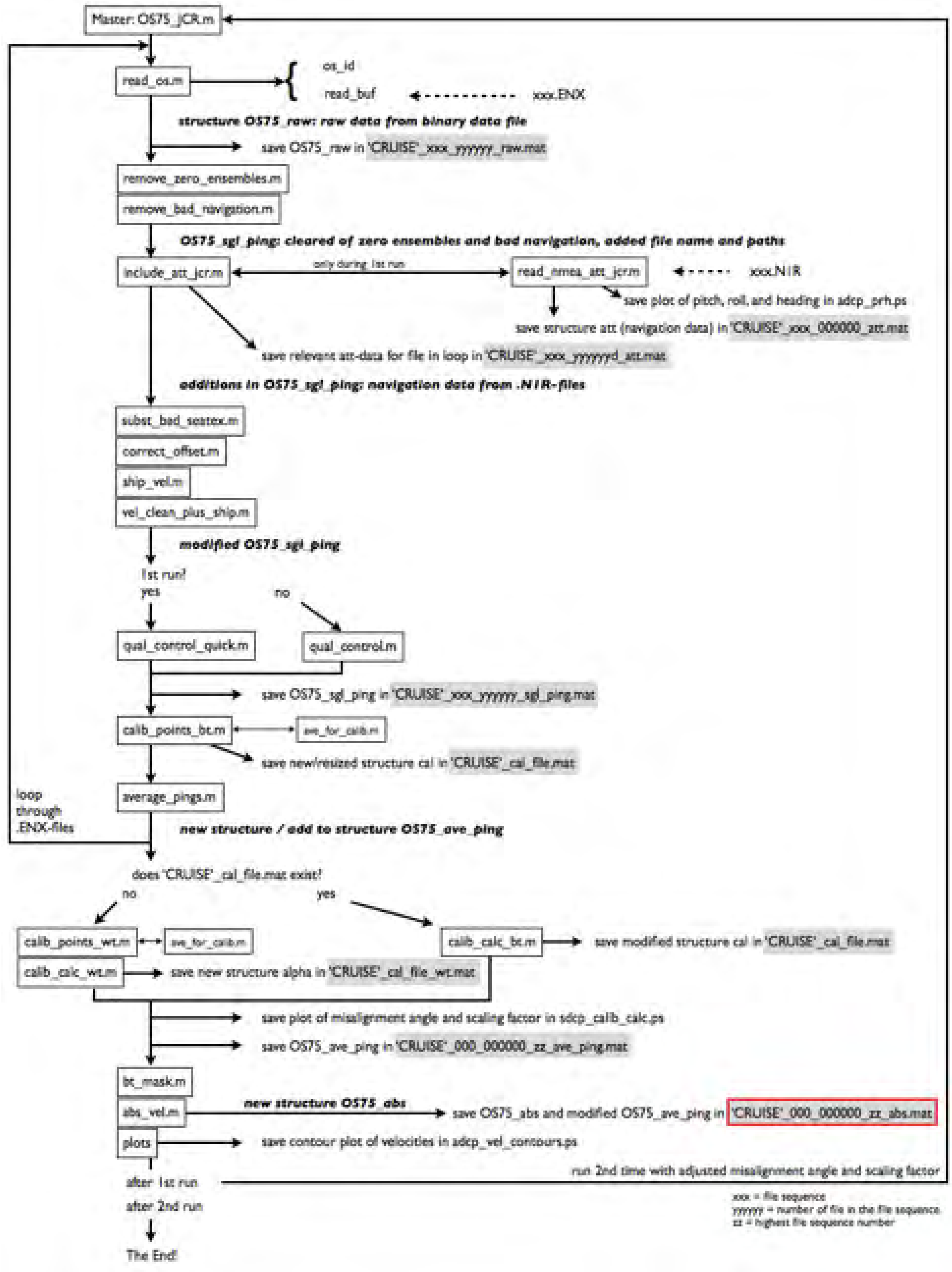


Figure 1. *The master for JC88 is OS75_JC88.m*

read_buf This is the part where the binary data is read. During the first call with only one argument, the configuration of the OS75 ADCP is extracted from the fixed leader data and stored in the structure config. If one of the checks on number of bytes, header or data source ID or checksum fails, an error message will be returned to read_os.m. Otherwise, information about ADCP hardware and setup that remains the same for all pings is read. After that and during the second call (with two arguments), the variable, bottom track, attitude, and navigation data is extracted. After the first call to read_buf, the configuration data is used to set up the variables and the reading loop. During the second call, the data requested by using the various switches is stored. Before returning to the main routine, variables are adjusted for negative numbers or NaNs. All raw data read in is stored in the structure OS75_raw and returned to the main function and written to the file *CRUISE_xxx_yyyyyy_raw.mat.*

5.6.3 patch_heading_data.m (Presently commented out). This was written during D376 as an attempted fix for a couple of periods where heading input to the .ENX file failed, resulting in a heading of zero and nonsensical velocities. The routine patches in the heading data from the ascii .N2R file and adjusts for the quoted misalignment angle. The fix works but on completing I realised that velocities in the ENX file must have already been rotated based on the bad heading. There may be a way to recover these by transforming vectors but it is beyond the scope of my time on the cruise. Therefore this is a work in progress.

5.6.4 remove_zero_ensembles.m The structure OS75_raw is handed over to remove_zero_ensembles.m. A search for all ensembles whose ensemble number (OS75_raw.ens_num) is not zero is done and only those are kept and handed back to the main routine as *OS75_sgl_ping*.

5.6.5 remove_bad_navigation.m Depending on *which_prdid_fix*, *OS75_sgl_ping.nav.txy1* or *2* is checked for time (first row), longitude (second row) and latitude (third row) duplicates. The number of rejected data cycles is printed on screen and saved as bad and good (=number of data cycles - number of rejected cycles) in the file *CRUISE_bad_nav.mat.* The rejected data cycles are then removed from *OS75_sgl_ping* and the structure handed back to the main routine.

5.6.6 include_att_jc.m Note there is also a version for the James Clarke Ross, though I don't know if it's up-to-date. Arguments passed on to this routine are *OS75_sgl_ping*, *add_to_ensnum* (for the correction of ensemble numbers; see below) and *which_prdid_fix*. If no file *CRUISE_xxx_000000_att.mat* exists yet in the processed data directory (i.e. the navigation data in the .N1R-files has not been read yet), *OS75_sgl_ping* is passed on to read_nmea_att_jc.m which is called to read the .N1R-files.

Clean_nmea_file.m (currently commented out)A D376 addition due to the poor quality of .N2R files being produced. Main problem was tendancy of *$PADCP* line to cut the previous line in half in (various modes of failure). This function scans through the N2R file, compiling a clean version as it goes. This is then saved with file extension .N3R, and used on all subsequent processing steps. If the .N3R file in question is already present in the 'data in' folder, this function is skipped.

read_nmea_att_jc.m (Works on the James Cook file output. Also a version named …_jcr). The routine goes through all .N1R-files in a file sequence. The number of lines to be read in one go is limited to a maximum of 160000, the loop will go on until all lines are read. The text in the .N1R-file is read into a matrix. Then lines containing the $PADCP or the $PASHR string are extracted. If two $PADCP-lines are consecutive, the first of them is discharged (no attitude data available for this ping ensemble!). From the $PASHR-lines the one following the $PADCP-line are extracted, the others discharged. Pitch, roll and heading are read from the remaining $PASHR-lines and stored. If heading is missing (=999), pitch and roll are set to 999 as well. From $PADCP-lines, the ping ensemble number and the PC time of the ping ensembles (converted to decimal Julian days) are extracted. After all files are read, the ping ensemble number is checked and corrected for duplicates, which can appear due to the splitting of the files after the maximum number of lines is read. The data is stored in the structure *att* which is written to *CRUISE_xxx_000000_att.mat*. Pitch, roll and heading are plotted and the figures saved to *adcp_prh.eps*. (Figures need to be improved!) After that, return to include_att_jc.m.

The file *CRUISE_xxx_000000_att.mat* with the att-structure is loaded in. If the structure contains data, the following is done: For further processing the ping ensemble number has to be increasing. When the ADCP times out while waiting for a response and resets, the ensemble number goes back to 1. Here, the ensemble numbers are modified so that they increase throughout the file (for *att*) and throughout the files of a file ensemble in *OS75_sgl_ping.ens_num*. There is already attitude data in the structure *OS75_sgl_ping* which comes from the .ENX-file. To extract pitch, roll, heading, and PC clock offset which are relevant for the current .ENX-file, a vector is created for each variable of the length max (highest ensemble number in *att*, highest ensemble number from the .ENX attitude data) and filled with NaNs. Then, the attitude information from *att* is written into the vector and on the data points corresponding to the ensemble numbers from the .ENX-file are stored. If *att* is empty, heading, pitch, roll, and PC clock offset are set to NaN.

The extracted attitude data is written to *OS75_sgl_ping.att.* The attitude data relevant to the current .ENX- file is also saved in the new structure *att* in *CRUISE_xxx_yyyyyyd_att.mat.* The modified OS75_sgl_ping is returned to the main routine.

5.6.7 subst_bad_seatex.m The arguments *OS75_sgl_ping.att,* and *sea_file* are handed over. In *sea_file* the number of accepted and rejected (due to bad Seatex data) data points will be stored. A search on *OS75_sgl_ping.att* data is done for ensembles where:

-heading = 0;

-heading = 999;

-pitch and roll = 0;

-the second differential of heading = 0.

The total number of those ensembles is printed on screen and saved as bad in '*CRUISE'_bad_heading.mat. OS75_sgl_ping* contains two headings: *OS75_sgl_ping.heading* which comes from the .ENX-file and *OS75_sgl_ping.att.heading* from the .N1R-file. Both are from the same instrument (Seapath Seatex), but maybe slightly different due to a (very) small time difference in when they are recorded. Therefore, the velocities in OS75_sgl_ping are rotated by the difference. To get bottom track velocities in the correct orientation, *OS75_sgl_ping.bt.vel* is multiplied by -1. *OS75_sgl_ping* with the modified values is returned to the main routine.

5.6.8 correct_offset.m Using the helper routine *uvrot.m*, this routine scales the water and bottom track velocities and corrects them for misalignment. From the main routine, the arguments *OS75_sgl_ping, misalignment_xb* and *amplitude_xb* are passed on, x=n or b depending on whether the current file ensemble is in narrow- or broadband mode. The horizontal velocities are multiplied by the scaling factor *amplitude_xb* and rotated by the specified misalignment angle *misalignment_xb.* The heading is adjusted by subtracting the misalignment angle. The modified structure *OS75_sgl_ping* is returned to the main routine.

5.6.9 ship_vel.m The routine is called with the arguments *OS75_sgl_ping* and *which_prdid_fix.* The latter decides which navigation fix is used for the calculation of the ship velocity: either *txy1* or *txy2.* With the help of the routine *sw_dist.m* from the CSIRO Seawater toolbox, the distance and the direction between the fixes is calculated and then converted to distance in east- and northward direction in meters and time difference in seconds. Dividing distance by time difference results in ship velocity in m/s, which is written to *OS75_sgl_ping.ship_velocity.* If bottom tracking was on, the horizontal bottom track velocities *OS75_sgl_ping.bt.vel(1:2,:)* should contain values other than NaN. If that is the case, the ship velocity is set to *OS75_sgl_ping.bt.vel(1:2,:).*The structure *OS75_sgl_ping* is then handed back to the main routine.

5.6.10 vel_clean_ship_vel.m This routine was added by Hugh Venables during JR218 to filter out spikes in the GPS data. It is called with the arguments *OS75_sgl_ping* and *which_prdid_fix* and returns the modified structure *OS75_sgl_ping.*

5.6.11 qual_control.m Several criteria are used in this routine for further quality control. Therefore, the arguments *OS75_sgl_ping, beam, heading_change* and *ship_velocity_change* are included in the call. *beam* is the number of beams of the ADCP instrument, *heading_change* is the maximum change in heading allowed at any one time step, and *ship_velocity_change* is the maximum change in ship velocity allowed at any one time step. Large changes lead to less reliable ADCP data.

The first step of quality control uses the error velocity provided through the fourth beam *(vel(:,4,:)).* A variable *err_vel* is set to 2 times standard deviation of the error velocity, and the velocities of all ping ensembles where the absolute value of this velocity exceeds *err_vel* are set to NaN.

Then, if *beam* = 0, a check using *percent good* is performed: velocities of ping ensembles with percentage of good four beam solutions equal to zero are set to NaN.

The two following steps look at the heading changes. First, a smoothed version of the heading change *(diff(heading)),* created using a Hamming-window based, second order filter is checked for values exceeding heading change, and the velocities of affected ping ensembles (i.e. the two ensembles in between which the change is large) are set to NaN. The same is done for the unfiltered heading change.

NOTE: for mfilter.m and the therein used Matlab function filtfilt.m, the data needs to have a minimum length of 3 times the filter order! **This means that files with less than 5 minutes of data cannot be used.**

Velocities are set to NaN if the change in ship speed exceeds ship velocity change.

A last control is done on absolute horizontal velocities in a reference layer: The eastward and northward velocities in the ninth depth bin are chosen and the ship velocity is added to obtain absolute velocities. Then, velocities of ping ensembles between which the change of either of these reference velocities is larger than 2m/s are set to NaN.

The structure with the modified velocity array is returned to the main routine.

Hugh Venables modified the call to the quality control routine such that in the first run, a quicker, less thorough quality check is done using the routine qual_control_quick.m to allow faster processing for quick data checks. During the second run, the above quality control is done.

5.6.12 calib_points_bt.m In this routine, calibration points are extracted using 2-minute averages of ADCP data and various criteria these points have to fulfill. It is called with the arguments *OS75_sgl_ping*, *cal_file, which_prdid_fix, ref_*uplim and *ref_lowlim. cal_file* specifies where the data for calibration extracted here will be written to, *which_prdid_fix* does the same as in ship_vel.m.

To average the ADCP data over 2 minutes, the routine ave_for_calib.m is called with the arguments *OS75_sgl_ping, av_time* (set to 120 seconds), *ref_uplim, ref_lowlim,* and *which_prdid_fix.*

ave_for_calib.m This routine is a reduced version of average_pings.m (see 4.4.13), including only variables required by calib_points_bt.m. The possibility of missing out ping ensembles in the averaging process when several .ENX-files exist in a file sequence is ignored here (for more about that issue see 4.4.13).

After the averaging, a check is done whether bottom track velocities are available or not. If all bottom velocities are NaNs, the routine stops and returns to the main program.

The principle used is based on a comparison of ADCP bottom track data and GPS tracks. The bottom velocity recorded by the ADCP should be the same as the GPS derived ship velocity. Therefore, the value GPS ship speed/ADCP bottom track speed gives the scaling factor to adjust ADCP velocities, and −(GPS ship heading − ADCP bottom track heading) is the misalignment angle. As velocities from bottom tracking are crucial for the calibration, ping ensembles with NaNs in either zonal or meridional bottom velocity are discharged. The ship velocity is derived from navigation data in *OS75_sgl_ping.nav* and *which_prdid_fix* sets which fix is used. Ship velocity is then calculated as in ship_vel.m as distance in east- and northward direction divided by time difference. The criteria potential calibration points have to fulfill are:

-the change in ship heading is small;

-the change in ship speed is small;

-the ship speed is within the interval average ship speed ± standard deviation;

-the ship heading is within the interval average ship heading ± standard deviation;

-the bottom speed is larger than a specified minimum speed;

-there are a minimum number of possible calibration points in a row that fulfill the criteria.

Relevant data at the calibration points are extracted and saved in the structure cal. This includes bottom velocity, speed, heading and range, ADCP velocities and heading, ship speed and heading, and the navigation data. The scaling factor at the calibration points is calculated as is the misalignment angle. To enable quality control of the intervals of calibration points (interval=row of successive calibration points) and possible filtering by hand after the processing, some statistics are done and included in the structure: average and standard deviations of ship velocity and heading, bottom velocity and heading, scaling factor and misalignment angle, and the number of 2-minute averages in the interval. If the cal_file does not exist yet, it is created, otherwise, the data is added to the existing file.

5.6.13 average_pings.m The routine is called with the arguments *OS75_sgl_ping*, *d_missed, OS75_ave_ping, superaverage, ref_uplim, ref_lowlim,* and *which_prdid_fix.*

The time in seconds over which the ping ensembles are averaged is given by *superaverage.* As the ping ensembles in a file of a file sequence are not necessarily divisible into the specified time intervals without remainder, the structure d_missed is used to carry on the surplus ensembles and add them to the ping ensembles of the next file in the same file sequence. If there are ping ensembles left at the end of a file sequence, they will not be included in the averaging.

First, a check is done whether any ping ensembles from the previous file were carried forward. If that is the case, and the bin depth is the same in both files, they are added to the current file in the loop. A depth range for the reference layer velocity is set as is the maximum number of depth bins.

Pings are averaged in intervals determined by *superaverage* and using the time stamps in *OS75_sgl_ping.nav.txyX* where *X* is either 1 or 2 depending on *which_prdid_fix.*

Throughout the routine, there are various occasions where (usually) three dimensional arrays are split up into several 2d-arrays. This is done using the reshape-command and the size of the velocity fields. To avoid problems when the original velocity field is 2d instead of 3d, a check is introduced and the variable containing the size of the field is adjusted.

Several variables are extracted and derived: the reference layer velocity (zonal and meridional) as mean of the horizontal velocities in the depth range specified by *ref_uplim* and *ref_lowlim*; absolute velocities by adding the ship velocity to the horizontal velocities; percent good from the fourth beam; a value for bottom range for each ping ensemble with the condition that it is between 50 and 1200 m depth and using the median of the four beams; the difference between the headings from the .ENX- and from the .N1R-file (set to NaN if the .ENX-heading does not change for two successive ping ensembles); pitch and roll (set to NaN if data is missing, i.e. > 998); the PC clock offset; the echo intensity as mean over all beams.

The navigation data is set to NaN for ping ensembles where there is no velocity data in any of the beams and any of the depth bins. For the averaging, the heading is broken up into components (-cos and sin) and reconverted to angles in degrees afterwards.

Of the extracted variables, the ones included in the averaging are: absolute velocity (all three directions), reference velocity, heading, difference in .ENX- and .N3R-heading, PC clock offset, echo intensity, percent good, and bottom range. Additionally, ship velocity and navigation data (time, longitude, latitude) are averaged. For pitch and roll, the standard deviation is calculated.

The data from ping ensembles that were remainders after the averaging is written to *d_missed* and returned to the main routine. The averaged absolute velocity is converted back to velocity relative to the ship by subtracting the averaged ship velocity. The reference layer velocity is then recalculated from the resulting averaged (relative) velocity. The averaged variables are added to the structure *OS75_ave_ping* as are the variables depth and *ref.bins* (=numbers of the bins in the reference layer). The structure is then returned to the main routine.

average_pings.m is the last routine called within the loops through all files in a file sequence and through all file sequences specified. At the end of the loops, the structure *OS75_ave_ping* contains averaged data for all files included in the processing. Before the loops are left, the array *bindepth* containing bin depths for each of the averaged velocity profiles is created.

Next steps are the final part of the calibration, blanking the bottom, and removing the ship velocity from the ADCP velocity data.

5.6.14 calib_points_wt.m If there is no bottom track data available, the calibration is done using water track. Again, the search for possible calibration points is done using 2 minute averages produced by ave_for_calib.m. First differences are calculated from the average data for the reference velocities (i.e. the water velocities in the reference layer specified by *ref_uplim* and *ref_lowlim*) du and dv, and the ship velocities dsu and dsv. Of those, only differences were considered for when ship speed exceeded 3 m/s between ensembles not more than 5000 m or 3600 s apart. Using the Matlab function fminsearch.m, the following function was minimized for phi and A:

$$f(A,\alpha) = \left(Adu\cos\alpha - Adv\sin\alpha + dsu\right)^2 + \left(Adu\sin\alpha + Adv\cos\alpha + dsv\right)^2$$

Values for A and phi are written to the array alpha together with relevant heading, navigation, and velocity data, and alpha is handed back to the main routine.

5.6.15 calib_calc_wt.m After alpha has been created in calib_points_wt.m, it is passed on to this subroutine. Here, average, median, and standard deviation for phi and A are calculated and written to *cal_file_wt.* The average or the median should then be used during the second run of OS75_JC88.m for misalignment and amplitude correction.

Several plots of the misalignment and the scaling are also produced and stored in *adcp_correction_stats.ps.*

5.6.16 calib_calc_bt.m During the first run of OS75_JC88.m, the misalignment angle and the scaling factor which are to be used for the second run are calculated here. In the second run, the results for phi and A should be closer to zero and one, respectively, than before.

The arguments handed over are *cal_file*, which specifies the file with the calibration point data, cruise, *misalignment_xb* and *amplitude_xb*, which are used for the plots created in this routine. After *cal_file* is read in, scaling factors and misalignment angles outside the interval average ± standard deviation are sorted out.

From the remaining points, the average, the median and the standard deviation for A and phi are calculated and added to the structure *cal*. The median is less affected by outliers which might have survived the screening in calib_points_bt.m and calib_calc_bt.m and should therefore be used as correction value in the second run.

Before returning to the main routine, a plot showing the distribution of the misalignment angles and the scaling factors and their temporal evolution is produced. (After returning to the main program, the plot is written to the file *adcp_calib_calc.ps*.)

5.6.17 bt_mask.m *OS75_ave_ping* and *bindepth* are passed on to this routine. Here, a mask is created using the bottom range *bt.range*. With this mask, velocity data below 86% of the bottom range (= water depth) is set to NaN. The structure containing the modified velocity fields is returned to the main routine.

5.6.18 abs_vel.m *OS75_ave_ping* and *bindepth* are handed over from the main routine. In order to derive absolute water velocities independent of the ship movement, the east- and northward ship velocity is added to the horizontal water velocity (*OS75_ave_ping.vel*). The same is done for the velocity in the reference layer (*OS75_ave_ping.ref.vel*). The resulting absolute velocities, the navigation data and the depth array (set to *bindepth*) are handed back to the main routine within the structure *OS75_abs*.

5.6.19 Helper routines: julian.m, sw_dist.m, uvrot.m, rot_fun_1.m, mfilter.m These routines are called on various occasions during the processing. sw_dist.m is part of the CSIRO Seawater toolbox.

5.7 Overview of output files

5.7.1 CRUISE_xxx_yyyyyy_raw.mat

The structure *OS75_raw* in this file contains the raw, unedited data from the .ENX-file as read in in `include_att_jc.m` and `read_nmea_att_jc.m`. The structure consists of:

- vel, cor, amp, pg (arrays of size [number of bins x number of beams x number of ensembles]): velocity, correlation magnitude, echo intensity and percent good for the four beams.

- heading, pitch, roll as [1 x number of ensembles]-array.

- temperature, soundspeed: [1 x number of ensembles]-array. The temperature here is the temperature of the water at the transducer head. It is either set manually or measured. The soundspeed is calculated or set manually.

- dday, ens_num,num pings: [1 x number of ensembles-]array. dday is decimal day, ens_num the ensemble number of the pings, and num ping the number of pings in each ensemble.

- bt: structure containing the bottom track data:

- vel, range, cor, amp, rssi (arrays of size [4 x number of ensembles]): bottom track velocity, range, correlation magnitude, echo intensity and receiver signal strength indicator for the four beams

- nav: structure containing navigation data:

- sec pc minus utc: [number of ensembles x 1]-array containing the PC clock offset in seconds;

- txy1, txy2: [3 x number of ensembles]-arrays; first row: time in decimal Julian days, second row: longitude, third row: latitude. txy1 is data from the first $PASHR -fix after the previous ADCP ping, txy2 is

from the last $PASHR -fix before the actual ADCP ping.

- config: structure containing the setup information about the OS75 and VmDas

- depth: [1 x number of bins] array. The array contains the depth of the bins in the configuration used for the actual file sequence.

- error: if reading of data fails, an error message will be stored here, otherwise it should be empty. There is one such file for each .ENX-file in a file sequence.

5.7.2 CRUISE_xxx_000000_att.mat

In this file, the structure *att* contains the attitude information from all .N1R-files of a file sequence, read during `read_nmea_att_jc.m`. This includes the following [1 x number of ensembles]-arrays:

• heading, pitch, roll;

• pc_time: time from the ADCP PC clock;

• pc_time_offset: offset of the ADCP PC clock from UTC in seconds;

• ens_num: the ping ensemble number.

Per file sequence, one file CRUISE_xxx_000000_att.mat is produced.

5.7.3 CRUISE_xxx_yyyyyyd_att.mat

For each file in a file sequence, attitude data is extracted and saved in CRUISE_xxx_yyyyyyd_att.mat. It contains a structure *att* which consists of the following arrays of size [1 x number of ensembles] per .ENX-file:

- att_heading, att_pitch, att_roll: heading, pitch and roll from the .N1R-files for the ping ensembles in the corresponding .ENX-file;

- heading_orig: heading from the .ENX-file;

- ens_num: the ping ensemble number;

- lat: latitude of the ping ensemble.

The difference between att_heading and heading_orig should be small and therefore negligible.

5.7.4 CRUISE_xxx_yyyyyy_sgl_ping.mat

Again, one file with single ping data is produced for each .ENX-file. In the structure *OS75_sgl_ping*, after several steps of quality control, filtering and correcting for misalignment and scaling (after final processing), data from the four beams, bottom track data, navigation data, configuration data and information about the

processing environment are stored:

- all variables that exist in *OS75_raw* in the file CRUISE_xxx_yyyyyy_raw.mat are included;

additional variables:

- filename: CRUISE_xxx_000000;

- path, rawpath: paths to the directories where the processed data is written to (path) and where the raw data files are stored (rawpath);

- att: structure containing heading, pitch, roll, and PC clock offset;

- heading_orig: [number of ping ensembles x 1]-array, heading from the .ENX-file;

- ship velocity: [2 x number of ping ensembles]-array, containing the eastward (first row) and the northward (second row) ship velocity.

5.7.5 CRUISE_cal_points.mat

In this file, all information at bottom track calibration points needed for the calculation of misalignment angle and scaling factor are stored. This includes:

- bt: structure with bottom track data: arrays vel ([2 x number of calibration points]), speed, heading, and range ([1 x number of calibration points]);

- vel: [number of bins x 2 x number of calibration points]-array of east- and northward velocity heading: [1 x number of cal. points]-array; heading from .N1R-data; nav: structure containing txy1 data at the calibration points;

- ship speed, ship heading: [1 x number of cal points]-arrays;

- scaling, phi: scaling factor and misalignment angle at each calibration point; [1 x number of cal. points]-array;

- intervals: stats for each interval of successive calibration points; see description of routine `calib_points_bt.m`;

- mode: [1 x number of cal points]-array. 1 or 10 for each calibration point depending on broadband or narrowband mode.

- which file: [number of cal points x 16]-character array with file name of the file the calibration point is from.

- stat: structure with values for the scaling factor (a) and the misalignment angle (phi) as calculated in the routine `calib_calc_bt.m`; the values stored here after the first run of the main routine `OS75_JC88.m` are the ones that should be used for the second run!

Only one file for all file sequences processed in a run is created.

5.7.6 CRUISE_cal_points_wt.mat

If no bottom track data is available, calibration is done using water track. For this, the array alpha is created. From data in alpha, the misalignment angle phi and the scaling factor scaling are derived and alpha, phi, and scaling are stored in this file.

5.7.7 CRUISE_000_000000_zz_ave_ping.mat

(zz=highest file ensemble number included in the processing)

The structure *OS75_ave_ping* contains data after averaging over a chosen time interval (xyz = number of velocity profiles after averaging):

- vel: [number of bins x 3 x xyz]-array of average velocity (zonal, meridional and vertical);

- amp, pg: [number of bins x xyz]-arrays; echo intensity and percent good;

- ship velocity: [2 x xyz]-array of zonal and meridional ship velocity; if bottom track velocity is available, then the ship velocity equals the bottom track velocity;

- heading: [1 x xyz]-array;

- nav: structure containing txy1: [3 x xyz]-array of time (decimal Julian days), longitude and latitude;

- att: structure containing:

- heading difference: [1 x xyz]-array of the difference between heading from .ENX and .N1R (hopefully equal to zero);

- pitch, roll, pc time: [1 x xyz]-arrays;

- ref: structure with velocity ([2 x xyz]-array): average over the reference layer,and bins: vector containing the depth bins that lie within the reference layer;

- bt: structure containing range: [1 x xyz]-array of bottom track range;

- depth: [1 x number of bins]-array (bin depths of the setting of the last file sequence processed).

5.7.8 CRUISE_000_000000_zz_abs.mat

(zz=highest file ensemble number included in the processing) In this file, both *OS75_abs* and *OS75_ave_ping* are saved. The latter contains the same fields as in

CRUISE_000_000000_zz_ave_ping.mat, where only the values in the velocity field are changed.

Additionally, the variable bindepth is included.

OS75_abs includes (xyz = number of velocity profiles after averaging):

- vel: [number of bins x 2 x xyz]-array of absolute velocity (zonal, meridional), i.e. horizontal velocities are corrected for ship velocity;

- nav: structure containing txy1: [3 x xyz]-array of time (decimal Julian days), longitude and latitude;

- ref: structure with velocity ([2 x xyz]-array): average over the reference layer, and bins: vector containing the depth bins that lie within the reference layer;

- depth: [number of bins x xyz]-array (bin depths corresponding to the settings used for the velocity profiles).

5.8 JC88 specifics

Few modifications were necessary to get the processing software up and running on JC88. Just a few tweaks:

-.N1R, rather than .N2R files were found to contain the ascii information needed for the processing, so the variable ‘extension’ was changed to reflect this in read_nmea_att_jc.m.

-Line headers and exact contents in the ascii files (‘PASHR’, ‘PRDID’ etc) can change due to different software versions, setups etc. but on this occasion everything worked ‘out of the box’. It’s good to check that you’re grabbing the right data however; the functions which handle these files are include_att_jc.m and read_nmea_att_jc.m.

-File names were of the length and structure expected. But this is another potential stumbling block.

5.9 Calibration and processing

The instruments (ADCP and PosMV) both functioned well during the cruise. Occasionally on stopping and starting the output, a serial port crash would require a restart of the system before continuing. With the exception of continuous section monitoring, a new file was generated more or less daily to keep track of the contents.

Due to rough weather and the presence of air bubbles under the hull, profiles were quite poor around 30/06/2013 and again on 04/07/2013.

Raw data files and processed data files in MATLAB format will be logged with BODC after the cruise, the approximate total quantity of data will be 5GB. Raw data are divided into around 20 series (ADCP75_JC8800**8**_000000 to ADCP75_JC880**32**_000000), with some gaps. Within each series files are subdivided into files of maximum 20MB in size. Series number is incremented each time VMDAS is stopped and restarted; the number of sub-files per series is therefore variable.

JC88 operated both on and off the shelf, so bottom tracking was possible on some program runs. Alignment and amplitude corrections were calculated for the whole cruise period (excluding the steam through the Irish Sea) and were as follows:

misalignment_nb = -0.1874º

amplitude_nb = 1.000816

5.10 File sequences during JC88

Raw data

Date	Time	Filename	File open/closed	Comments
28/06/2013	16:26	ADCP75_JC88008_000000	closed	
28/06/2013	16:35	ADCP75_JC88012_000000	opened	closed/opened to enable test processing
29/06/2013	07:20	ADCP75_JC88012_000000	closed	
29/06/2013	07:22	ADCP75_JC88013_000000	opened	changed bin size to 8, bin no. etc
30/06/2013	07:24	ADCP75_JC88013_000000	closed	
30/06/2013	07:24	ADCP75_JC88014_000000	opened	bin size 8
30/06/2013	11:50	ADCP75_JC88014_000000	closed	

30/06/2013	**11:50**	**ADCP75_JC88015_000000**	**opened**	**Changed bin size back to 16. NOTE impromptu survey between stations A7X and A4 due to rough weather**
30/06/2013	**23:18**	**ADCP75_JC88015_000000**	**closed**	
30/06/2013	**23:18**	**ADCP75_JC88016_000000**	**opened**	**Closed/opened on turn @ A7X-ish. (Andy D highlighted interesting vectors!) NOTE due to shortage of calibration points file 16 is presently appended to beginning of file 17**
30/06/2013	**02:18**	**ADCP75_JC88016_000000**	**closed**	
01/07/2013	**02:18**	**ADCP75_JC88017_000000**	**opened**	**Closed/opened @ A4**
01/07/2013	**22:24**	**ADCP75_JC88017_000000**	**closed**	
01/07/2013	**22:24**	**ADCP75_JC88018_000000**	**opened**	**Closed/opened @ A4**
02/07/2013	**19:12**	**ADCP75_JC88018_000000**	**closed**	
02/07/2013	**19:12**	**ADCP75_JC88019_000000**	**opened**	
04/07/2013	**17:10**	**ADCP75_JC88019_000000**	**closed**	
04/07/2013	**17:10**	**ADCP75_JC88020_000000**	**opened**	**Bad weather! Small quantity of corrupted data in this file may upset plotting routines**
05/07/2013	**22:49**	**ADCP75_JC88020_000000**	**closed**	
05/07/2013	**22:49**	**ADCP75_JC88021_000000**	**opened**	
07/07/2013	**07:12**	**ADCP75_JC88021_000000**	**closed**	
07/07/2013	**07:12**	**ADCP75_JC88022_000000**	**opened**	**Dye track 1 commenced late afternoon on 7th**
08/07/2013	**23:32**	**ADCP75_JC88022_000000**	**closed**	
08/07/2013	**23:32**	**ADCP75_JC88023_000000**	**opened**	**Dye track 1**
10/07/2013	**21:36**	**ADCP75_JC88023_000000**	**closed**	
10/07/2013	**21:36**	**ADCP75_JC88024_000000**	**opened**	**Dye track 1**
11/07/2013	**22:39**	**ADCP75_JC88024_000000**	**closed**	**Closed after last dye track profile**
11/07/2013	**22:39**	**ADCP75_JC88025_000000**	**opened**	
		ADCP75_JC88025_000000	**closed**	
		ADCP75_JC88026_000000	**opened**	**Dye track 2**

15/07/2013	**17:45**	**ADCP75_JC88026_000000**	**closed**	
15/07/2013	**17:45**	**ADCP75_JC88029_000000**	**opened**	**Dye track 2- skipped file numbers due to comm port issues**
18/07/2013	**20:12**	**ADCP75_JC88029_000000**	**closed**	
18/07/2013	**20:12**	**ADCP75_JC88030_000000**	**opened**	
21/07/2013	**18:00**	**ADCP75_JC88030_000000**	**closed**	**End of science activities**
21/07/2013	**18:00**	**ADCP75_JC88031_000000**	**opened**	**Steam through North Channel, Irish Sea**
22/07/2013	**12:09**	**ADCP75_JC88031_000000**	**closed**	**End Irish Sea transect, roughly parallel to Anglesea**
22/07/2013	**12:09**	**ADCP75_JC88032_000000**	**opened**	
23/07/2013	**12:30**	**ADCP75_JC88032_000000**	**closed**	**End of data logging**

Processed data

It was initially hoped that it would be possible to generate one large file from the post-processing, but as different bin sizes were used in the early stages of the cruise (which can't be mixed in the same file) the final processed file structure is as follows:

ADCP75_JC8800x_000000_12_abs; series 12; 16:35 on 28/06/2013 – 07:20 on 29/06/2013 (steam from North Passage to shelf edge).

ADCP75_JC8800x_000000_14_abs: series 13,14; 7:22 on 29/06/2013 – 11:50 on 30/06/2013 (short period using bin size = 8 m).

ADCP75_JC8800x_000000_31_abs; series 15 – 31; 11:50 on 30/06/2013 – 12:09 on 22/07/2013 (main body of cruise, ending on steam south, roughly parallel to Anglesea)

ADCP75_JC8800x_000000_32_abs; series 32; 12:09 on 22/07/2013 – 12:30 on 23/07/2013 (steam between Irish Sea and Channel).

The file number corresponds to the highest series number contained therein. (Other file types are included but the **_abs files should be sufficient for most purposes).

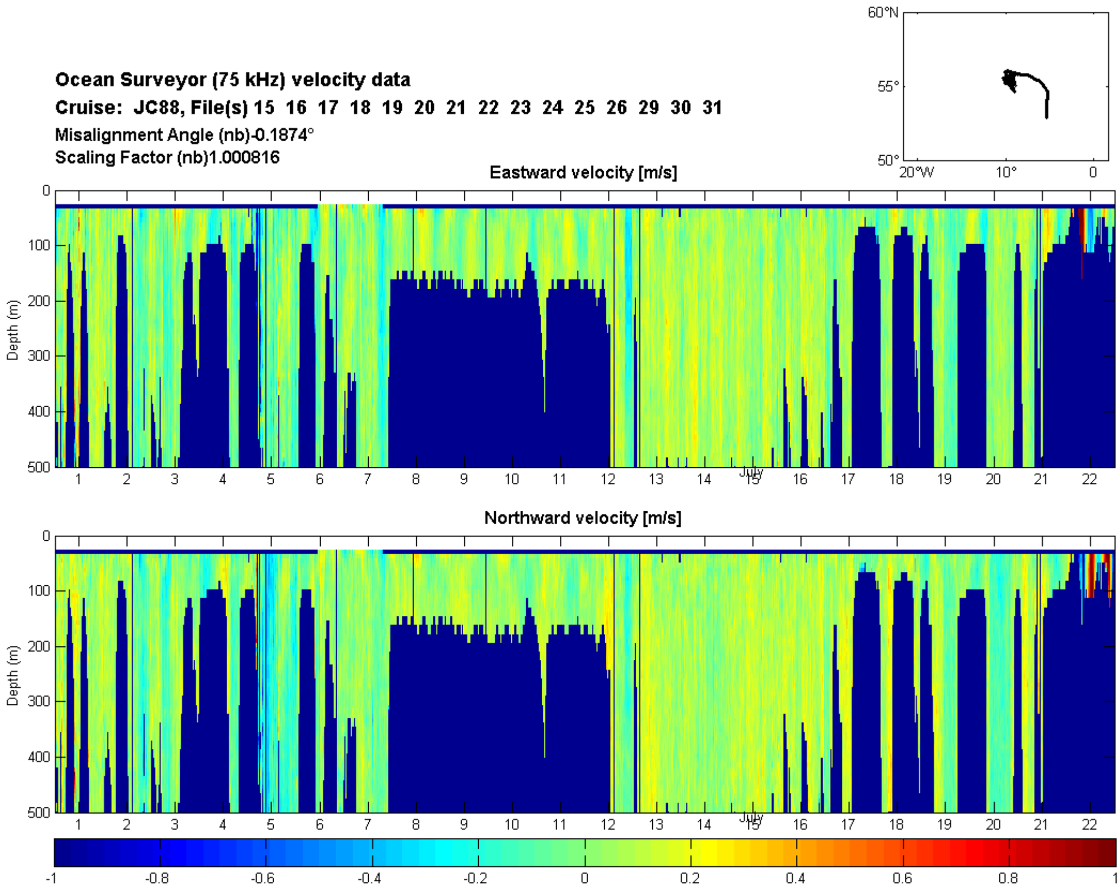


Figure 2: *Example processed OS75 VMADCP data covering the majority of JC88*

6 Scanfish Processing

Dr Dmitry Aleynik , SAMS

6.1 Introduction

Photo 1

Photo 2

Scanfish CTD data were obtained from the Seabird SBE 9/11plus CTD unit, Chelsea Aquatracka MKIII Fluorometer calibrated for dye release experiments (fluorescein), Turner Cyclops C7 for Chlorophyll measurements, the Oxygen SBE 43 sensor and Kongsberg 1007 altimeter. The CTD sensors and Turner fluorometer were sited on port side of the Scanfish-II EIVA A/S wing body and Aquatracka Fluorometer sensor on its starboard side. The specification details of the Scanfish are given at technical report, this section describes data processing. For acquisition CTD data from the instrument the Software *Version Seasave V 7.22* was used. All profiles were processed by soon after acquisition using *SBE Data Processing Version 7.21h* software and the batch ".psa" scripts recently adapted to the cruise conditions.

The original CTD data were combined with ship navigation data to provide accurate information on vertical distribution of the water parameters, and to calculate its position in the water using the ship as a reference. This section below describes data acquisition and processing.

6.2 Acquisition

Before start data acquisition there is required turn on deck units – one for Scanfish flying operations and other one for collecting data from SBE CTD. The other one was used for visualization of the data stream in real-time using the software designed especially for mapping dye-release surveys during the James Cook JC25 cruise in 2008 by M. Inall and recently updated (D. Aleynik) for simultaneous visualization of the vertical transects of the dye (fluorescence), Temperature, Salinity and Density fields.

The main deck unit hard disk and the network drive were used to store SBE binary files (.hex .hdr and .con) \\cookfs\cook.local\JC88\Specific_Equipment\SCANFISH\Scanfish_CTD\

In addition to this to run the visualization software several steps required to perform

1. **Option I.** Establish communication to the shared network folder \\192.168.62.34\Scanfish where-to data are stored by Seasave V 7.22 software as an ascii file in a parallel to the main (binary) data stream. The structure of this ascii file 'JC088_Scanfish_CTD_Shared.txt' should consist of 12 columns:

1 2 3 4 5 6 7 8 9 10 11 12

'scan_no','P','Z','T','S','SigmaT0','O2_mg/L','FLA_ug/L','TU_ug/L','lat','lon','j day'

2. **Option 2.** Required direct connection between the acquisition PC-1 and the visualization PC-2 through the com port (com1 with baud rate 9600 in JC88 cruise) and run BBtalk.exe (program is a part of RDI-Instruments software package), which will transmit and update the data into another ascii file (JC088_Scanfish_Tow1_S1_01.txt) stored locally on PC-2 (at folder 'c:\JC88\Scanfish\scanfish_realtime\in_JC88\'). The order of the ascii columns in that file preferably should be the same as for the *Option 1*.
3. Matlab script '*get_data_real_time_JC88.m*' will produce the Map with location of the ship and the fluorescence values vertically averaged from target depth range, and a number of vertical transects with T,S, Fluorescence or Density, plotted against the time;

4. In case of breaking the script will need restart, with option to re-plot the transects and map from the beginning of the acquisition (of rom a new file).

The *Option 2* was used with Windows PC and Matlab 2007, while the *Option I* was running at the OpenSuse12 Linux PC with Matlab 2013a with *get_Unix_data_ real_time_JC88.m* script where the only path to the folders was modified for Unix/Linux environments.

6.1 Processing

6.1.1 Raw Scanfish SeaBird CTD Data and calibration parameters

Raw Scanfish CTD data were processed following standard way used in hydrographic cruises. After the series of tow-yo of Scanfish CTD casts were completed the raw data were saved to the deck unit PC and transferred over the ship network to the network data disk as *"JC088_scanfish_Tow#"* with the following extensions: *.HEX* (raw data file), *.CON* (data configuration file), and *.HDR* (a header file).

All raw data files will be banked with BODC.

SBE Data Processing Version 7.21h software was used to perform all raw data processing steps. Processed data were loaded into Matlab for plotting.

The Instrument type: **911plus CTD** Calibration parameters from .CON files for each sensor are in the **Tables 6a -f**

Table.6a Temperature Sensor calibration parameters

Sensor ID	**55**
Software Version Seasave	**V 7.22**
SerialNumber	**2919**
CalibrationDate	**15 Feb 2013**
UseG_J	**1**
A	**0.00000000e+000**
B	**0.00000000e+000**
C	**0.00000000e+000**
D	**0.00000000e+000**
F0_Old	**0.000**
G	**4.31705918e-003**
H	**6.44487661e-004**

I	2.28169462e-005
J	2.13085582e-006
F0	1000.000
Slope	1.00000000
Offset	0.0000

Table.6b Pressure Sensor calibration parameters

Sensor ID	3
SerialNumber	90573
CalibrationDate	10 Nov 2010
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
Slope	0.99999000
Offset	-0.60960
T5	0.000000e+000
AD590M	1.280800e-002
AD590B	-9.338280e+000

Table.6c Conductivity Sensor calibration parameters

Sensor ID	3
SerialNumber	2841
CalibrationDate	27 July 2012
SeriesR	0.0000
CellConst	2000.0000
Coefficients equation	"0"

A	0.00000000e+000
B	0.00000000e+000
C	0.00000000e+000
D	0.00000000e+000
M	0.0
CPcor	-9.57000000e-008
coefficients	
coefficients equation="1"	
G	-1.03700800e+001
H	1.42962199e+000
I	1.69435010e-004
J	5.89321805e-005
CPcor	-9.57000000e-008
CTcor	3.2500e-006
WBOTC	0.00000000e+000
Slope	1.00000000
Offset	0.00000

Table.6d Fluorometer Chelsea Aqua 3 Sensor calibration parameters

Sensor ID	**5**
SerialNumber	**06-5706-001**
CalibrationDate	**12 June 2013**
VB	**0.155100**
V1	**2.384200**
Vacetone	**0.278400**
ScaleFactor	**1.000000**
Slope	**1.000000**
Offset	**0.000000**

Table.6e Oxygen Sensor , SBE 43 calibration parameters

Sensor ID	**38**
SerialNumber	**1882**

CalibrationDate	**2 Aug 2011**
Use2007Equation	**1**
Coefficients for Owens-Millard equation	
Boc	**0.0000**
Soc	**0.0000e+000**
offset	**0.0000**
Pcor	**0.00e+000**
Tcor	**0.0000**
Tau	**0.0**
Soc	**4.9530e-001**
offset	**-0.4977**
A	**-3.4838e-003**
B	**1.7257e-004**
C	**2.7017e-006**
D0	**2.5826e+000**
D1	**1.92634e-004**
D2	**-4.64803e-002**
E	**3.6000e-002**
Tau20	**1.3300**
H1	**-3.3000e-002**
H2	**5.0000e+003**
H3	**1.4500e+003**

Table.6f Fluorometer Turner Cyclops calibration parameters

Sensor ID	**68**
SerialNumber	**2100432**
CalibrationDate	**12 June 2013**
ScaleFactor	**1.00000000e+000**
Offset	**0.00000000e+000**
!-- 1 = C	**Chlorophyll --**
!-- 2 = R	Rhodamine --
!-- 3 = F	Fluorescein --
!-- 4 = P	Phycocyanin --
!-- 5 = E	Phycoerythrin --

!-- 6 = U	CDOM --
!-- 7 = O	CrudeOil --
!-- 8 = B	OpticalBrightness --
!-- 9 = T	Turbidity --
!-- 10 = G	Refined Fuels --
MeasuredParameter	**1**

6.1.2 Scanfish SeaBird Data processing routine descriptions

The list of routines applied to the raw Scanfish CTD data is in the file *c:/JC88/Scanfish\psa_files/JC88_scan_v0.txt* which was invoked by program *sbebatch* within the script files, prepared for each Scanfish transects respectively:

JC88_batch_L_v0.bat for SB-E (Tow1)

DatCnv: converted raw CTD data in the .dat file from engineering units using the calibration information provided in the configuration file (.CON). Files output consisted of binary .CNVfiles containing the 24hz down and up casts.

FilterFilter runs a low-pass filter on each column of data. A low-pass filter smooth high frequency (rapidly changing) data. To produce zero phase (no time shift), the filter is first run forward through the data and then run backward through the data. This removes any delays caused by the filter. The pressure channel was filtered with a time constant of 0.5 seconds.

AlignCTD: usually used to shift the dissolved oxygen sensor output (if it presents) relative to the pressure data by 5 seconds to compensate for lags in the sensor response time. This routine was not applied to Scanfish CTD oxygen in JC88 cruise because the oxygen sensor was not installed. But the shifts equal 0.5 seconds were applied to the temperature and Conductivity sensors output, due to the fast horizontal movement of the instrument during tow-yo with the average speed 8 knots (~ 4.1 m/s).

CellTM: removes the effect of thermal 'inertia' on the conductivity cells using the algorithm:

a = 2 * alpha / (sample interval * beta + 2)

b = 1 - (2 * a / alpha)

dc/dt = 0.1 * (1 + 0.006 * [temperature - 20]) dt = temperature - previous temperature

ctm [S/m] = -1.0 * b * previous ctm + a * (dc/dt) * dt

The sample interval is measured in seconds and temperature in ℃, and ctm is calculated in S/m. The thermal anomaly amplitude (alpha), was set at 0.03 and the thermal anomaly time constant (1/beta) was set at 7 (the SeaBird recommended values for SBE911plus). The sample interval is 1/24 second, dt is the temperature (t) difference taken at a lag of 7 sample intervals, ctm is the corrected conductivity at the current data cycle.

Corrected conductivity = c + ctm

Bin average averages data, using averaging intervals based on pressure, depth, time or scan number. In the JC88 cruise we used *time* with 1second bin size for both up- and downcasts.

Derive subroutine were used for calculation of depth (m), potential temperature (ITS-90), salinity (PSU) and potential density (Kg m^{-3})

AsciiOut: converts the binary .cnv files into ASCII format .cnv and ascii files for reading into other packages, for example Matlab in the same format as was used in several previous cruises for data-post processing.

Time series of Scanfish CTD data were aligned with the ship GPS navigation data. These ascii files have been de-spiked against main outliers using sorting for Pressure, Temperature and Conductivity columns and resorted again using Scan number column data.

Along the scanfish transect(s) the topography was extracted from a combined dataset of the Etopo1 (Smith and Sandwell 1-mile Topography grid, embedded in *m_map* Matlab toolbox) and The International Multibeam dataset gridded at 160x280m resolution for the area of Malin shelf and downloaded from www.arrctic.ngdc.noaa.gov.

6.1.3 Scanfish Conductivity/Temperature and Oxygen data alignment

For alignment between platinum temperature sensor and conductivity cell we used minimisation of the variance of resulting salinity calculated with aligned Conductivity C:

$$C = C_i \cdot R + (1 - R) \cdot C_{i-1}$$

where i is the index of the current data point (scan number for SBE CTD), and R is the delay coefficient. The minimum of the variance was obtained when conductivity was delayed from Temperature with R=0.046 sec, which is smaller than SBE recommended value (0.073 sec), because the length of pumping tube was shorter, than in standard SBE package. The result of alignment applied is shown ***Figure 1***. The number of spikes on salinity profile reduced essentially.

For SBE 43-oxygen sensor alignment the standard recommended value (5 sec) was used.

6.1.4 Scanfish ASCII data post-processing

In JC88 cruise Scanfish was generally 'flown' at a tow speed of 6 knots on a 8.03 mm coax cable wire released on 650 m behind the ship from 1-5 m below the surface to the depth 100-120 m in. Cycling every 2 minutes this gives an effective horizontal resolution of approximately 400 - 500 m. Similar to the method used in (*Inall et al, 2011*) data from Scanfish presented in this report have been gridded onto tz- and xz-planes using linear

a) – *time weighting*, with Δt=120/86400 seconds, Δz=2 m and a search radius defined by sx=300/86400seconds and sz=2 m. and / or
b) - *distance* along the transect *weighting*, with Δx=500 m, Δz=2m and a search radius defined by sx=3*Δx and sz=2 m.

For post-processing of the Scanfish data several Matlab scripts has been developed, adjusted and stored at c*:\JC88\scanfish\code*

R1_get_scanfish_JCE88.m – to read ascii input data and store it in mat arrays.

*R2_mk_combined_tgrid_JC88.m – g*ridding along transects time or distance array

R4_plot_combined_dist_ JC88.m – plotting of the combined grid for each tow.

R5_plot_segments_gridit_T.m – plotting of the segments.

6.2 Results from the Tow 1 test line

The first transect was performed between 01-July-2013 15:48 and 17:10 GMT in coordinates 55° 24.00' N, 9 55.00'W and 55 25.00' N, 10 °08.00'W (*Figure 2*) over sea-bed depth range 500 m to ~1500 m. The transect line was approximately perpendicular to the Shelf Break isobaths with a start near CTD007 (A6) and moorings LB and LA.

In the beginning of deployment, after the 5rd dive, after the instrument approached depth 120 m the control data flow from the communication unit were lost as well as the link to the instrument and soon it was recovered on dec*k.*

Several dives of the Scanfish on the first (and a single in the JC88 cruise) transect the capture the major feature of the thermo-haline structure in the upper part of the water column over the shelf break zone shown on **Figures. 2 - 4**. This transects cover the major slope area between 500 and 1500 m isobaths. The depth of upper mixed layer varies from 40 m at the shallow part of transect to 60 m on its deepest par. There was found two distinct layers with higher temperature (T> 12ºC) and lower salinity (S<35.37 psu) in the upper zone and the waters with lower temperature (T<10.5 ºC) and higher Salinity (S>35.39psu) below the pycnocline. The maximum concentration in Oxygen (>8.8 µg L^{-1}) and Chla (>2 µg L^{-1}) where found in a strongest density gradient. Signal from Aquatraka III fluorometer did not reveal significant values because the dye (fluorescein) was released 7 days later after Scanfish Tow-1 in the area.

There was no further use of the Scanfish in this cruise due to major malfunctions discovered on the recovery and inspection of the instrument:

- Significant interference between the frequencies of the data communication link modem and noise frequency generated by the power supply unit of the Scanfish, which often (in 98% test cases) prevent proper communication with the instrument and expose the risk for scanfish tow over shallow topography without stable link.
- Leak was found inside the pressure case of the communication unit, in result of tiny misfit (0.2mm) between the diameter of the top lid (bulkhead connector end), and the inner diameter the pressure housing. The measurements of the o-rings diameter also show deviation from the best practice. Conclusion from carful inspection of the flooding results reveal necessity for replacement of the unit as a whole, as was agreed with manufacturer (EIVA) *(Photo 3-4*).

Photo 3

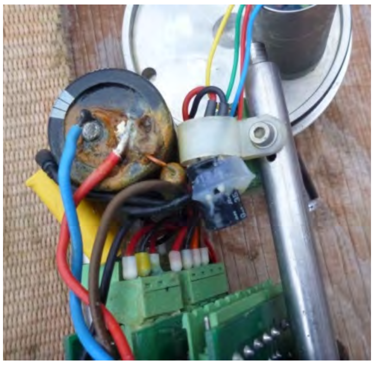


Photo 4

The technical details of the discovered issues are summarized in Technical Section of this Cruise Report.

6.3 References

Inall, M., Aleynik, D., Boyd, T.,Palmer, M., Sharples, J. 2011 Internal tide coherence and decay over a wide shelf sea. *Geophysical Research Letters*, 38, L23607. 6, pp.10.1029/2011GL049943

6.4 Figures

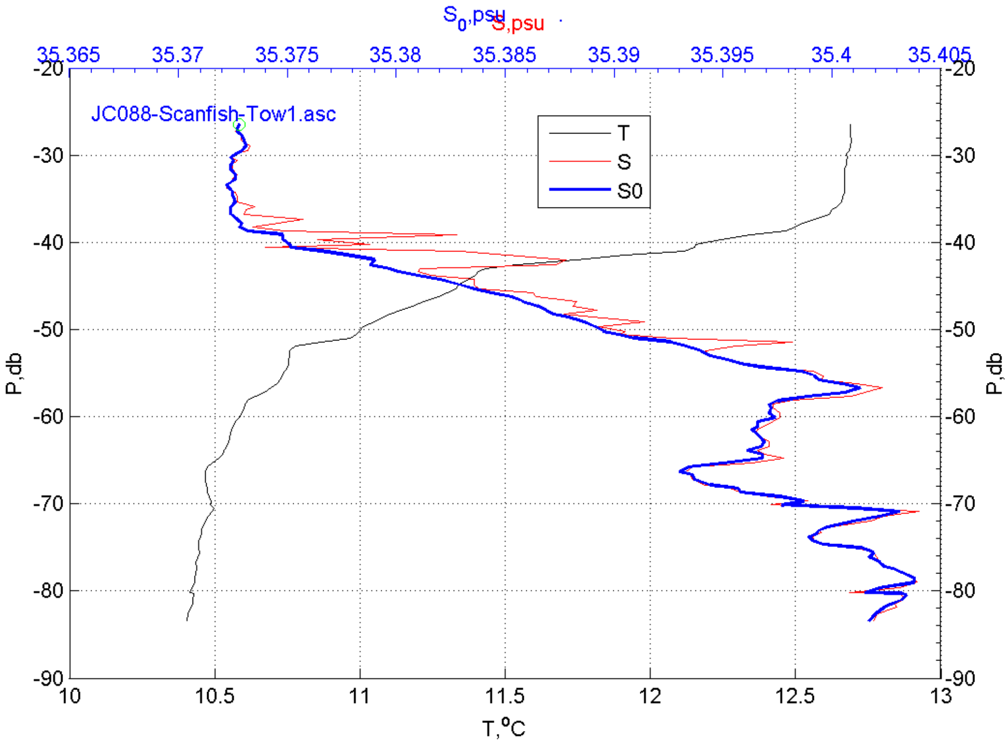


Figure 1. The fragment of downcast vertical profiles of temperature (T℃, grey line), the original salinity (PSU, **red**) and **the aligned salinity** (**blue line**) form Scanfish Tow1 transect 1st July 2013.

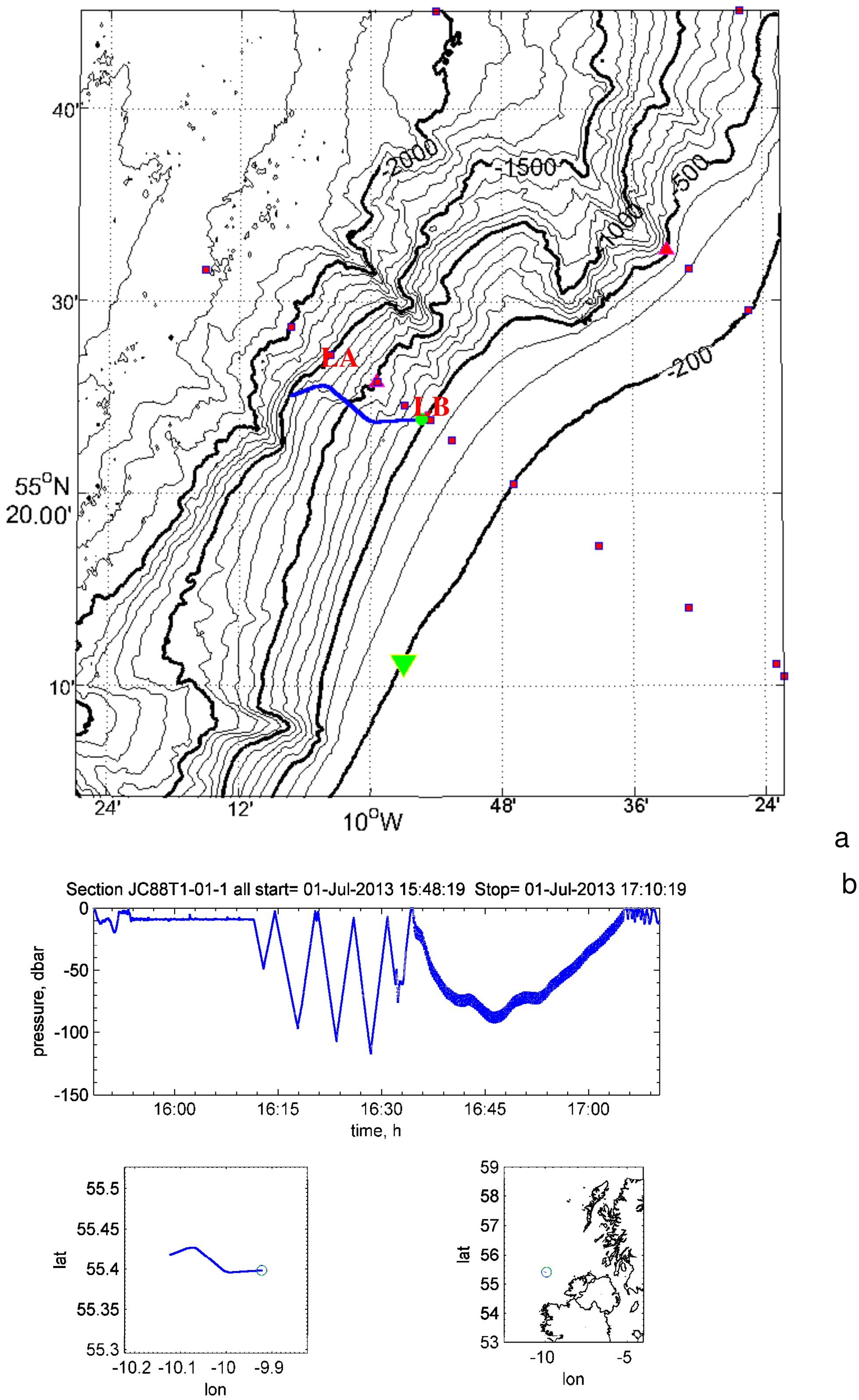


Figure 2. Position of the Scanfish survey 1st July 2013 (blue line), JC88 cruise: along the **Line A** across Shelf Break between Mooring stations **LA** and **LB.** Topographic map is the combined multibeam data and ETOPO-1 (Smith and

Sandwell) bathymetry of the Malin shelf. Vertical track of the instrument is shown on panel (b).

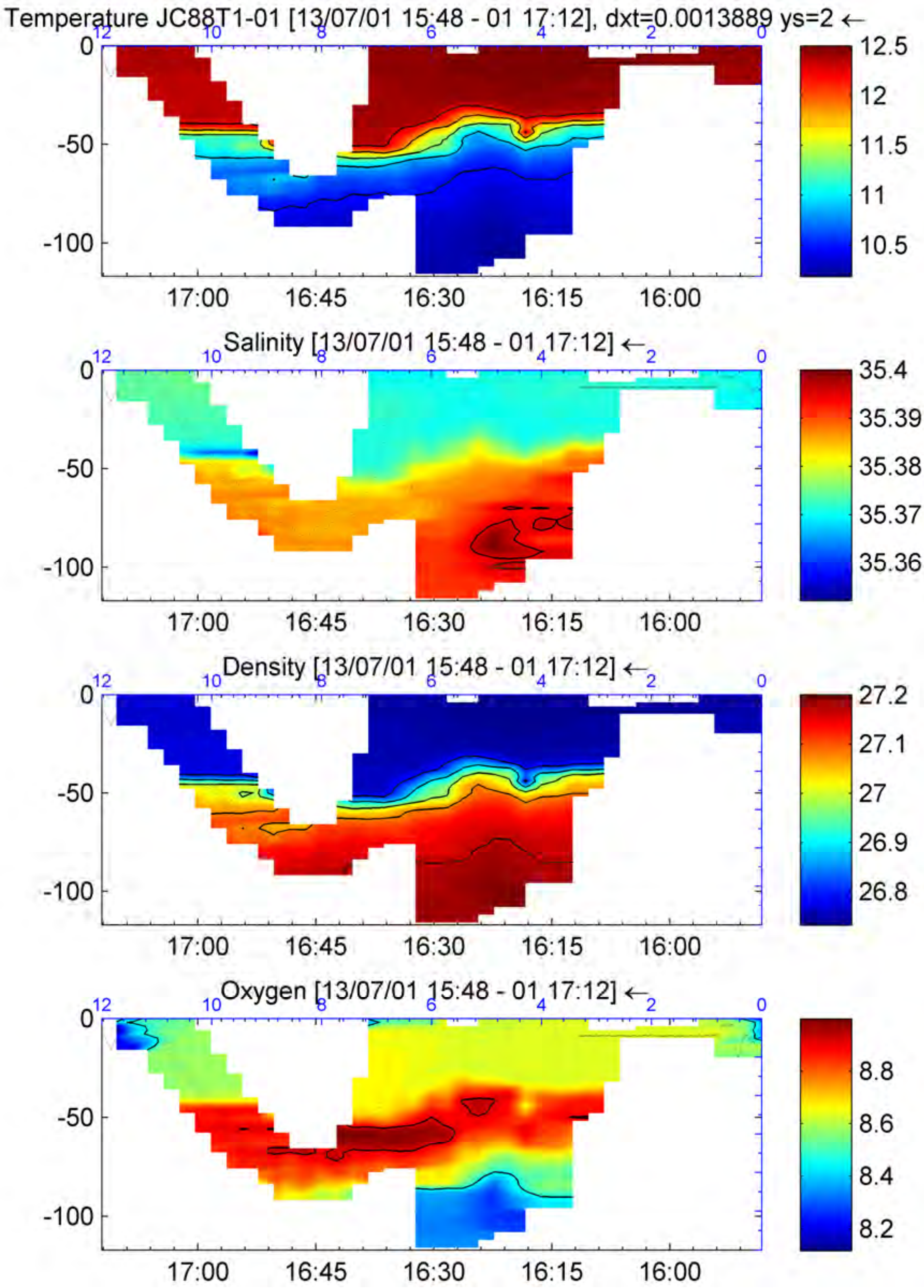


Figure 3. Vertical distribution of temperature, salinity, potential density and oxygen along the Scanfish transect Tow1 from East to West, 1th July 2013.

Distance (in km) ish shown on top x-axis, time stamps on a lower x-axis. Scanfish track is shown with dots.

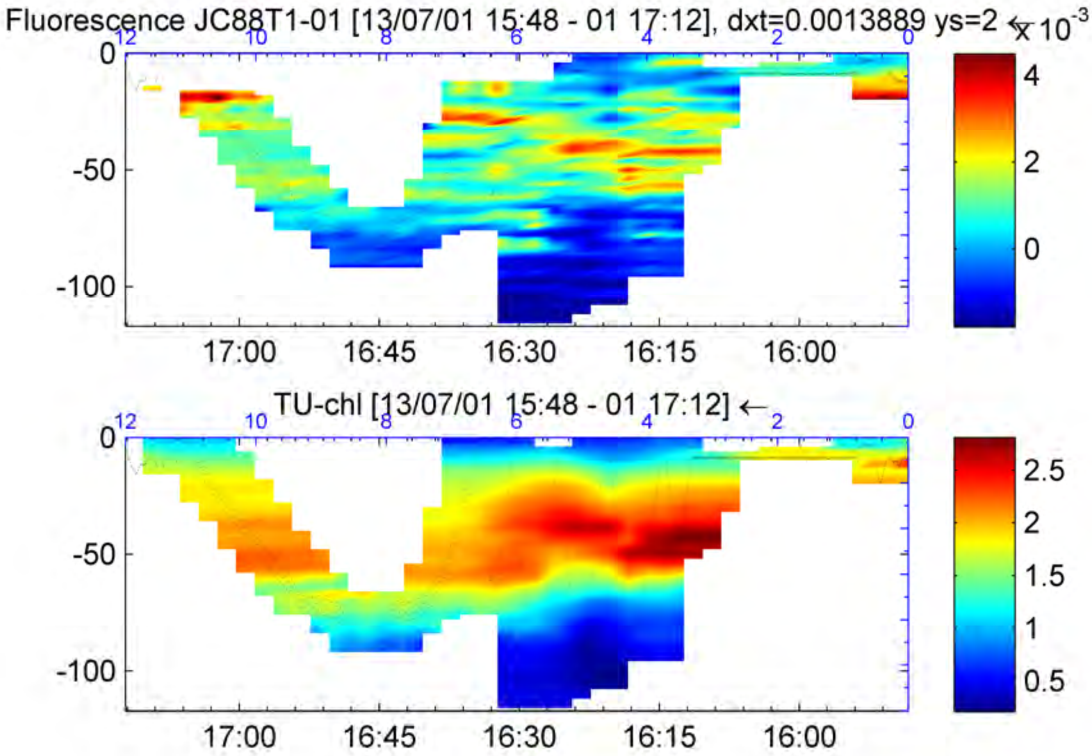


Figure 4. Vertical distribution of fluorescence (µg L^{-1}) and Chlorophyll (µg L^{-1}) form along the Scanfish transect Tow1 from East to West, 1th July 2013. Distance (in km) ish shown on top x-axis, time stamps on a lower x-axis. Scanfish track is shown with dots.

7 Nutrient Biogeochemistry and dissolved oxygen.

Nealy Carr, Morwenna Cooper and Victoria Hemsley

7.1 Aims during JC88

Aim: The aims of the nutrient biogeochemistry team were to (a) identify gradients in inorganic and organic nutrients across the shelf edge of the Celtic Sea, (b) calibrate the fluorescence sensor on the underway uncontaminated seawater supply and the fluorescence and oxygen sensors on the CTD and fluorescence, oxygen and CDOM sensors on the wire-walker and (c) collect seawater samples to determine the stable nitrogen and oxygen isotope composition of nitrate (δ^{15}N and δ^{18}O-nitrate) in deep waters.

7.2 Sampling

A series of sampling regimes were followed: (a) three cross shelf transects consisting of 9 - 10 stations (Transect A, B and C), (b) sampling of higher spatial resolution stations Transect B and (c) sampling from the uncontaminated seawater supply.

Table 7.1; Locations of cross-shelf edge stations for transects A, B and C, approximate water depth (meters, taken from altimeter during CTD casts), date sampled and corresponding CTD number.

Station	Latitude (N)	Longitude (W)	Water depth (approx. m)	Date Sampled	CTD Number
A1	55˚ 07.58’	009˚ 15.49’	98	29/06/2013	002
A2	55˚ 11.040’	009˚ 23.005’	106	01/07/2013	008
A3	55° 14.062’	009° 31.055’	110	29/06/2013	003
A4	55˚ 17.214’	009˚ 39.019’	128	01/07/2013	009
A5	56˚ 20.458’	009˚ 46.968’	197	29/06/2013	004
A6	55˚ 23.692	009˚ 54.857’	480	01/07/2013	007
LA/A7	55˚ 25.83’	009˚ 59.44’	986	29/06/2013	001
A8	55˚ 28.66’	010˚ 07.32’	1951	02/07/2013	011
A9	55˚ 31.66’	010˚ 15.23’	2293	02/07/2013	012
B1	55˚ 47.755’	008˚ 39.115’	111	03/07/2013	022
B2	55˚ 49.233’	008˚ 48.323’	121	05/07/2013 21/07/2013	028 072
B3	55˚ 50.174’	008˚ 57.870’	134	03/07/2013	023
B3X	55˚ 51.530’	009˚ 03.650’	144	21/07/2013	070
B4	55˚ 52.157’	009˚ 07.564’	159	05/07/2013	029

B4X	55˚ 53.506’	009˚ 15.281’	200	20/07/2013	066
B5	55˚ 53.790’	009˚ 17.004’	386	04/07/2013	024
B5X	55˚ 54.013’	009˚ 18.812’	596	20/07/2013	068
B6	55˚ 55.153’	009˚ 26.441’	1033	05/07/2013	030
B7	55˚ 56.6’	009˚ 35.7’	1383	04/07/2013	025
B8	55˚ 58.093’	009˚ 45.12’	1675	05/07/2013	027
B9	55˚ 59.25’	009˚ 54.73’	1990	05/07/2013	026
C1	55˚ 29.522’	009˚ 25.298’	195	16/07/2013	048
C2	55˚ 31.729’	009˚ 30.820’	301	11/07/2013	042
C3	55˚ 32.293’	009˚ 32.153’	401	16/07/2013	050
C4	55˚ 32.792’	009˚ 33.280’	601	12/07/2013	043
C5	55˚ 32.995’	009˚ 33.925’	796	16/07/2013	052
C6	55˚ 33.89’	009˚ 35.86’	992	12/07/2013	044
C7	55˚ 34.418’	009˚ 37.220’	1180	18/07/2013	058
C8	55˚ 35.760’	009˚ 39.044’	1384	12/07/2013	045
C9	55˚ 37.528’	009˚ 41.174’	1587	18/07/2013	059
C11	55˚ 43.880’	009˚ 52.116’	1983	12/07/2013	046

7.3 Calibration of the underway fluorescence sensor

Seawater samples were periodically taken from the uncontaminated seawater supply in the wet laboratory. 300ml of seawater was filtered through GF/F filters using vacuum filtration. The filter was removed with tweezers and chlorophyll measured fluorometrically on a Turner trilogy fluorometer with pigment extraction in 90% acetone at 4^{o}C over a 20 hour period before analysis (Welschmeyer, 1994).

7.4 Analytical methods

7.4.1 Dissolved organic nutrients: Seawater was collected in 1L pre-cleaned HDPE bottles and filtered through a pre-combusted glass fiber filter (nominal pore size 0.7 μm) using a metal filter holder and pre-cleaned glass syringe. Filtered seawater samples were collected into acid-washed and combusted glass vials pre-filled with 20µl 50% (v/v) hydrochloric acid. Samples were stored in the fridge at 4°C. The concentration of dissolved organic carbon and dissolved organic nitrogen will be determined at the University of Liverpool by high temperature catalytic oxidation.

7.4.2 Chromophoric dissolved organic matter: Seawater from 12 depths was filtered from the same sample in the same manner as above for dissolved organic nutrients. The filtrate was placed directly into a glass test tube, capped and immediately placed in the Turner 10 Au fluorometer fitted with an optical kit for DOM/Ammonium (PN:10-303) and fluorescence was recorded. The DOM was calibrated using quinine sulphate with a calibration being performed approx. 30 minutes before sample measurement. Standard concentrations ranged from 0.0005 to 0.005 μM. The instrument blank (fluorescence without test tube in test tube holder) was subtracted from each sample (rather than the calibration blank, which consisted of mill-q water) and the result was divided by the slope of the calibration curve to obtain a CDOM concentration in units of quinine sulphate (QSU).

7.4.3 Stable nitrogen and oxygen isotope composition of nitrate: From between 11 to 22 depths sampled on each CTD cast, 250ml or 125ml HDPE bottles were rinsed 3 times and filled to 80% capacity. Samples were immediately frozen at -20°C. The stable nitrogen and oxygen isotope composition of nitrate ($\delta^{15}N$ and $\delta^{18}O$ of nitrate, respectively) will be analysed according to methods described and updated by McIlvin and Casciotti 2011 using a Gas Bench attached to a Thermo Finnigan isotope ratio mass spectrometer. This stable isotope approach will provide insight into the source and cycling of nitrate at the shelf edge.

References:

Grasshoff (1999). Method of Seawater Analysis. Wiley-VCH. New York.

McIlvin, M. R. and Casciotti, K. L. (2011). Technical updates to the Bacterial Method for Nitrate Isotopic Analyses. *Analytical Chemistry*, **83**, 1850-1856.

Strickland JDH, Parsons TR (1972) A Practical Handbook of Seawater Analysis. Fisheries Research Board of Canada. 167 pp.

8 Drifters

Marie Porter, SAMS

8.1 Introduction

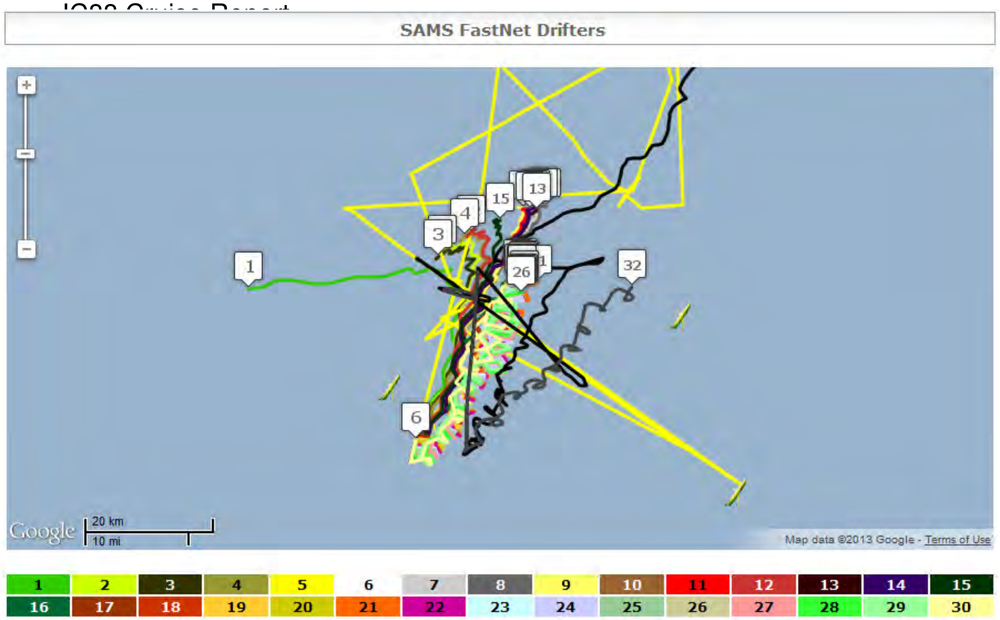
30 Metocean SVP drifters were deployed on the self-break between 55°12.00 N, 10°04.52 W and 55°10.21 N, 10°05.36 W, on the 17/7/13. Of these drifters 15 were drogued at 15 m (drifters 16-30) and 15 at 70 m (drifters 1-15). The drifters are equipped with Iridium and GPS tracking and report GPS location along with sea surface temperature every 3 hours. They were released over the 600 m isobath in alternating order (1 long, 1 short, 1 long …) over 1 hour and 20 minutes. The 600 m isobaths was chosen as a release site as other experiments had indicated the presence of a slope current at this depth. The drifters were released south of a large canyon and to the south of the dye release experiment.

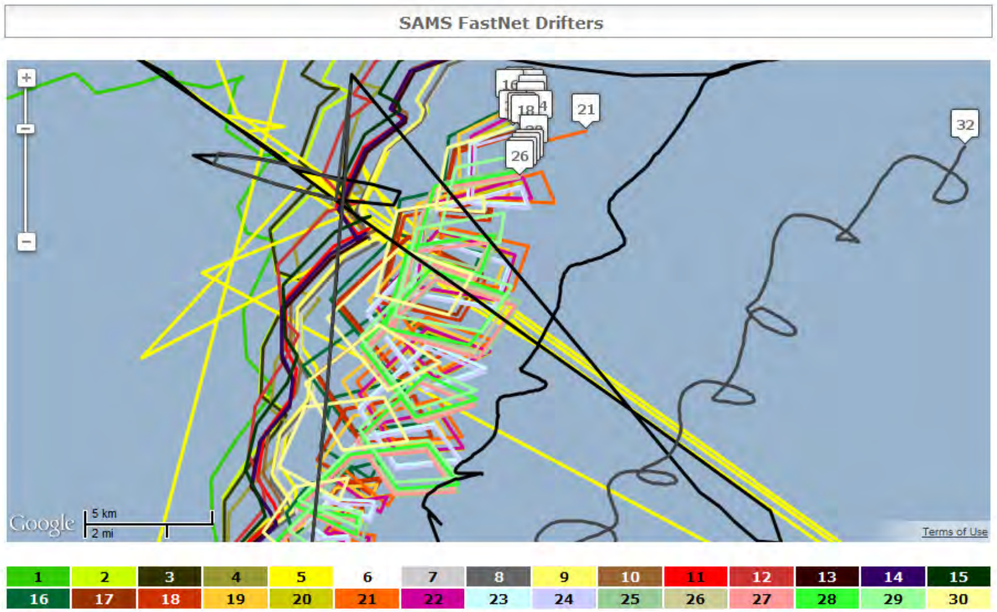
8.2 Observations

The locations of the drifters at 12:00 (GMT) on the 23/7/2013 are shown in Figure 2.

In general the drifters have remained grouped by drogue depth. The 70 m drifters travelled northwards along the shelf break showing little evidence of strong tidal modulation. The westernmost group began to break away, possible showing the presence of an eddy. Drifter number one behaved anonymously within this group, the reason for this behaviour is yet to be identified but does not appear to be related to loss of the drogue. Within the 15 m group there has been little initial dispersion and all drifters have followed similar patterns, showing a strong tidal signal.

Figure 1: The deployment of one of the 15 m drifters from the stern of the ship.





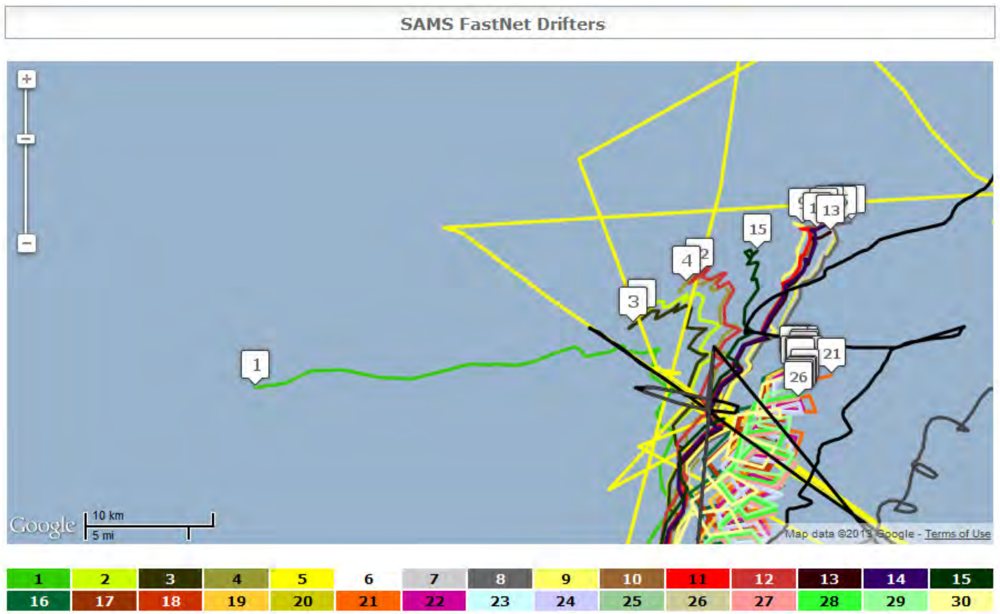


Figure 2: The locations of the drifters at 12:00 GMT on the 23/7/13. Plot 1 shows the entire drifter field. 2 zooms in on the 15 m tethers and 3 on the 70 m tethers.

9 Dye Tracer Releases

Andy Dale, SAMS

9.1 Overview

Two releases were made, of 50 kg and 100 kg respectively (dry weight) of a fluorescein dye tracer, into the core and flanks of the slope current. The intent was to directly observe secondary circulation associated with recruitment to the bottom Ekman layer (release #1) and adjustment of the slope current to a topographic feature (canyon) (release #2). Dye patches were initially sub-surface streaks aligned approximately with isobaths and their subsequent evolution was monitored using a fluorometer-equipped vertical profiler (MSS) aided by drogued iridium/GPS drifters.

9.2 Fluorescein dye solution

The fluorescent dye tracer used was fluorescein sodium salt (also known as uranine, or acid yellow 73) supplied by Unicolour Ltd as a 40% water soluble liquid. Dye was mixed in three 400 litre tanks. The 40% fluorescein solution had a density of 1220 kg m^{-3}, so was mixed with isopropyl alcohol (density 785 kg m^{-3}) and sea water in order to more closely approximate oceanic density. This density adjustment was not precise. It is not known to what extent such a solution entering the water column moves vertically as it equilibrates, however for these releases it was not seen as important to achieve a perfectly isopycnal release (such a release would initially spread slowly and would potentially be difficult to find with MSS surveys at 0.5-1 knots).

Tank A (release #1):

- 125 kg of 40% fluorescein solution (i.e. 50 kg of fluorescein)
- 125 litres of isopropyl alcohol
- ≈ 125 litres of sea water to top up tank
- Estimated density (assuming linear mixing): 997 kg m^{-3}

Tanks B+C (release #2):

- 250 kg of 40% fluorescein solution (i.e. 100 kg of fluorescein)
- 175 litres of isopropyl alcohol
- ≈ 325 litres of sea water to top up tanks
- Estimated density (assuming linear mixing): 1023 kg m^{-3}

The lower density of release #1 was due to the addition of more isopropyl alcohol than intended. Since mixing of density is not linear, confidence in these estimated densities is relatively low and actual density was likely somewhat higher (based on prior experience).

9.3 Release methodology

Dye was released via a hose, cable-tied to a near-vertical weighted wire (Fig 1.1). Holes in the final 1 m of the hose served as a diffuser. Sea water was pumped through this hose during deployment in order to prime the system. Pumping of the dye solution used twin Speroni 110v pumps (Fig 1.2) at an estimated 29-35 litres/minute with the vessel underway slowly along an isobath, resulting in an elongated dye streak. As much full-strength dye solution was pumped as possible, then the tanks were flushed with sea water and the resulting weaker dye solution pumped. This was repeated 2-3 times. As a final step, sea water was pumped through the hose to flush it. The main dye patch thus had a tail of decreasing concentration flush water containing around 3% of the total dye mass.

During each release, a SBE37 logging CTD was attached to the cable approximately 1 m beneath the end of the release hose to provide a record of the temperature, salinity and depth during dye pumping. CTD data were not available in real time, so depth/density adjustments were not made during the release.

Figure 1.1: Hose, diffuser and CTD configuration for release #1. Photo: Jaimie Cross.

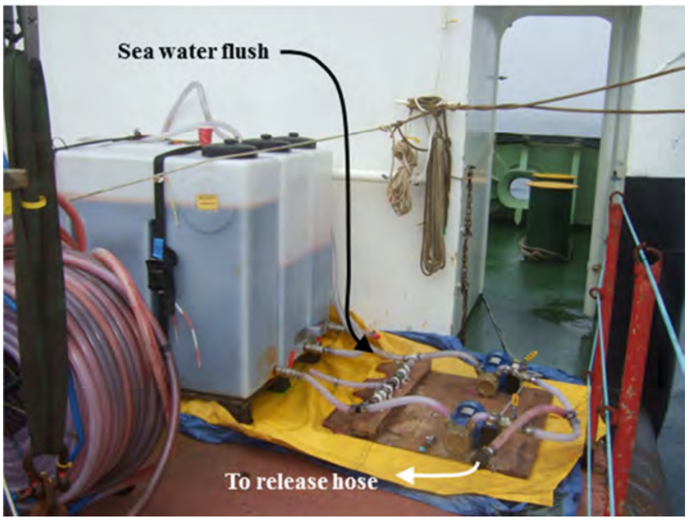


Figure 1.2: Plumbing configuration for release #1 (from the nearest tank, Tank A). Photo: Jaimie Cross.

9.4 Description of release #1

Release #1 was made in 200 m of water, in the lower half of the water column on the inner flank of the slope current.

Time line (07/07/2013, all GMT)

- 12:45:21 Begin pumping dye solution @ 55 11.15N, 9 57.17W
  Drifter in (drogue 70 m, IMEI 300234011346100)
- 12:55:00 End of pumping full strength dye
- 13:13:00 End of flushing @ 55 10.97N, 9 57.30W

CTD characteristics during dye pumping

Taking into account the lag between dye exiting the tank and entering the water column (based on hose volume = 91 litres and pump rate = 35 l/min), the CTD characteristics during the release of full-concentration dye lay within a narrow range:

- Depth: 115.6 ± 1.4 m
- Temperature: 10.111 ± 0.014 °C
- Salinity: 35.407 ± 0.0015 psu
- Density: $\sigma_\theta = 27.253 \pm 0.002$ kg m^{-3}

The 1-2 m offset between the CTD and the diffuser has not been taken into account in these values.

Estimated length of initial dye streak

During the period that full strength dye solution was leaving the diffuser, the vessel travelled 188 m to the SW along the 200 m isobath at an average speed of around 0.5 knots. Consideration of ambient currents (from VMADCP), which were largely along isobaths in the opposite direction, increases the estimated dye streak length to 229 m. Including the flushing period yields 487 m.

9.5 Description of release #2

Release #2 was made in 615-635 m of water into the presumed core of the slope current.

Timeline (all GMT, 12/07/2013)

- 15:09:03 Begin pumping dye @ 55°27.165 N, 9°52.858 W
  Drifter in (drogue 120 m, IMEI 300234011347110)
- 15:33:30 End of pumping full strength dye
- 15:59:12 End of flushing @ 55°26.608 N, 9°53.367 W

CTD characteristics during dye pumping

Taking into account the lag between dye exiting the tank and entering the water column (based on hose volume = 115 litres and pump rate = 29 l/min), the characteristics of the release of full-concentration dye were as follows:

- Depth: 181.1 ± 3.4 m
- Temperature: 10.200 ± 0.017°C
- Salinity: 35.414 ± 0.002 psu
- Density: σ_θ = 27.245 ± 0.004 kg m^{-3}

The 1-2 m offset between the CTD and the diffuser has not been taken into account.

Estimated length of initial dye streak

During the period that full strength dye solution was leaving the diffuser, the vessel travelled 537 m to the SW roughly along an isobath at an average speed of around 0.8 knots. Consideration of ambient currents (from VMADCP) increases the estimated dye streak length to 721 m. Including the flushing period yields 1717 m.

9.6 Dye patch tracking

Both dye patches were successfully located following release and followed for around 4 days as they moved largely along isobaths with the slope current at speeds of order 10 cm s^{-1}. Iridium drifters (Fig 1.3) reporting on a 10-minute interval were released as a reference location within each patch, although they ultimately diverged considerably from the dye.

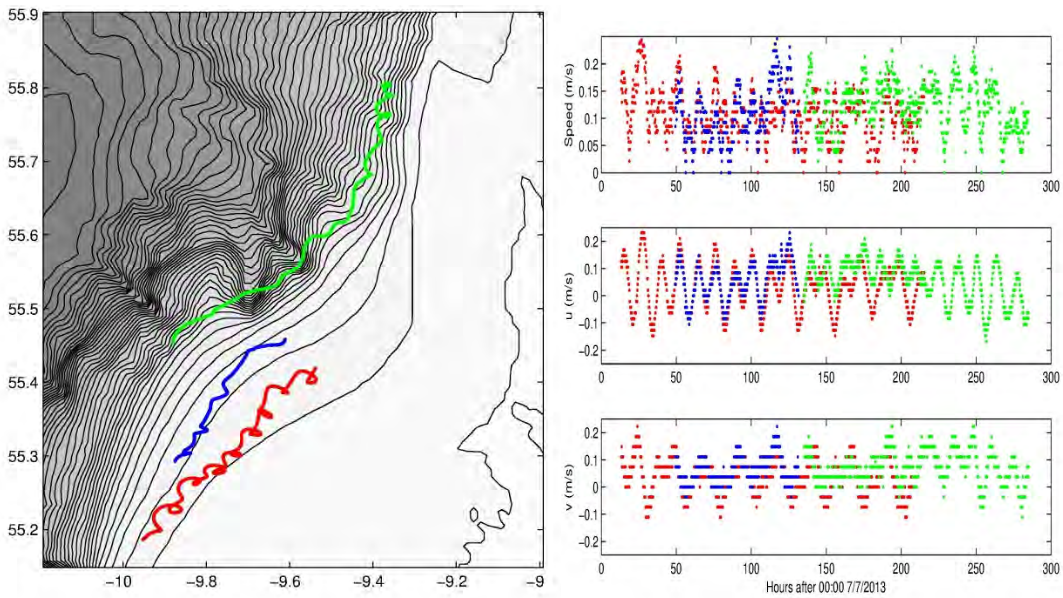


Figure 1.3: The tracks and velocity components of drifters released with the two dye patches. These extend beyond the periods during which the dye was tracked, and do not perfectly follow the dye patches. Red: Drogue 70 m, deployed with release #1. Blue: Drogue 80 m, deployed into the tail of the dye patch ~36 hours after the release #1. Green: Drogue 120 m, deployed with release #2.

The principal dye survey tool was the MSS profiler, instrumented with a Turner Cyclops-7 fluorometer, detecting fluorescein in the concentration range 0-5 or 0-50 µg/l. The MSS aspect of this study is described separately.

10 Microstructure profiler

Phil Hosegood, Plymouth University

10.1 Introduction

The primary instrument used to track the dye described in Section ?? was the ISW Microstructure Sensor, MSS90 (the numerical value refers to the standard diameter of the pressure housing). The MSS is a vertically profiling instrument package equipped with a variety of sensors that primarily include microstructure shear and temperature, standard CTD sensors To track the dye, the MSS was also equipped with a fluorescein-tuned fluorometer. Due to the rapid deployment and recovery of the MSS as compared to the CTD rosette, the MSS was also used to extend CTD sections A and B to a position close to the Irish and Scottish coats, respectively.

10.2 ISW Wassermesstechnik MSS90

During JC88 two similar versions of the ISW Wassermesstechnik manufactured MSS90 (Figure ?.1) were used during the dye release experiments. Each instrument contains essentially the same electronics and sensors and differ only in terms of the pressure housing and accompanying winches used for deployment and recovery. A deep version (MSS90-D, serial number 054) was provided by the Scottish Association for Marine Science (SAMS) and has a depth rating of 4000 m. Due to the internal reinforcing, this version is slightly heavier than the standard MSS90 (serial number 042) provided by Plymouth University that has a depth rating of 500 m.

*Figure **: (left) ISW Wassermesstechnik MSS90-D (provided by SAMS) and (right) swm1000 electric winch (provided by Plymouth University).*

The use of both instruments was required due to malfunctions with various aspects of the two systems. The problems were largely due to failure of the cable termination attaching the cable to the MSS. Water penetration caused subsequent interruptions in power supply to the profiler and data transmission back to the deck unit. Additionally, the hand units used to control the winches failed temporarily on two occasions and the SAMS power supply deck unit on a single occasion. In each case, the respective unit was swapped with the spare unit from either SAMS or Plymouth University. When re-termination of the cable was not possible, the entire winch system was swapped.

During JC88 the winch was located on the port quarter and the MSS deployed over the stern. Profiling was conducted whilst underway at approximately one knot and to a depth that varied depending on initial release depth. Both instruments were ballasted to fall at a speed of approximately 0.7 – 1.0 m s^{-1}. Data were acquired using the Sun & Sea Technology software, Standard Data Acquisition (SDA). Post-processing and conversion of binary data to engineering units will be performed using MSS-Pro (supplied by ISW).

In addition to the standard downwards profiling, the up-cast during which the MSS was recovered to the surface was also recorded due to the valid data provided for fluorescence. These data, whilst of no use in estimating turbulence properties due to the direction of travel, nonetheless improve the horizontal resolution of the data pertaining to water properties and fluorescein concentration/distribution. At a speed of 1 knot the typical horizontal resolution between subsequent profiles was 150 m for profiles to a depth of 300 m.

10.3 Sensor configurations

The primary scientific sensor configurations of both MSS units are:

Sensor	Manufacturer
Shear (two channels)	ISW
Pressure (dbar)	Keller, PA7LHE/50bar/80933.4
NTC (°C)	Sea & Sun Technology
Conductivity (ms/cm)	ADM
Turbidity (FTU)	Seapoint
Dissolved Oxygen (%)	Oxyguard, DO522M18
Fluorescence (µg/l)	Turner Cyclops

The fluorometer on both systems was tuned to fluorescein. Three gain settings (Range 1: 0 – 5 parts per billion (ppb), Range 2: 0 – 50 ppb, Range 3: 0 – 500 ppb) are available and controlled by dip-switches located on the main boards inside the MSS pressure housing. Throughout the majority of the experiments, Range 2 was selected except for a period during the first half of the second release when Range 1 was used.

10.4 Release #1

Following the end of flushing of the dye tanks at 13:13 on 07/07/2013 (yearday 187), profiling commenced using the SAMS MSS90-D. Profiles extended to depths of approximately 200 m as the instrument was allowed to reach the bed. Due to cable termination failures that required changing instruments, the total dataset is composed of four parts during which a total of 537 profiles were obtained (and thus in excess of 1000 when including the upcasts):

	Instrument	Fluorometer Range	Date, Time (UTC)	Profiles
Part 1	SAMS 054	1*	07/07/2013, 14:53 – 09/07/2013, 20:37	1 - 276
Part 2	PU 042	1	09/07/2013, 21:45 – 10/07/2013, 22:56	278 - 409
Part 3	SAMS 054	1*	10/07/2013, 23:33 – 11/07/2013, 17:36	410 - 515
Part 4	PU 042	1	11/07/2013, 18:31 - 11/07/2013, 22:20	516 - 537

* The different Ranges require changes to be made to the calibration coefficients. During release #1, the 6th coefficient (B[1]) for the SAMS unit was erroneously set to 10 instead of the correct value of 1. The correct coefficient will be used in the post-cruise processing.

10.5 Release #2

Following the end of flushing of the dye tanks at 15:59 on 12/07/2013 (yearday 192), profiling commenced using the PU MSS90. Profiles extended to depths of approximately 300 m to ensure that we profiled through the dye and captured the water profiles associated with the slope current core. The PU MSS was changed to the SAMS unit due to water ingress into the cable that caused data drop-out and communication failure. The total dataset is composed of three parts due to the change in fluorometer gain settings midway through the tracking as the concentration decreased.

	Instrument	Fluorometer Range	Time	Profiles
Part 1	PU 042	1	12/07/2013, 17:23 – 12/07/2013, 20:34	1 - 15
Part 2	SAMS 054	2	12/07/2013, 21:00 - 13/07/2013, 21:16	15 - 127
Part 3	SAMS 054	1	13/07/2013, 21:36 - 16/07/2013, 07:15	128 - 363

A calibration cast using the PU MSS was performed after profile 363 (SAMS MSS).

10.6 CTD extended lines

Due to time limitations, two of the principal CTD sections (A and B) were extended inshore using the PU MSS. The same procedure was employed as during the dye tracking whereby the vessel slowed to one knot. Two profiles were obtained at each location after allowing the conductivity cell sufficient time to equilibrate.

	Instrument	Time	Profiles
Transect A	PU 042	18/07/2013, 01:02 – 18/07/2013, 03:10	A1 – AM2_02
Transect B	PU 042	21/07/2013, 07:40 – 21/07/2013, 16:37	B1 – BM10

During Transect B shear probe 6015 was changed to 6016 after station BM3. The estimated dissipation rates using the new probe are significantly higher than estimates obtained using probe 6014 (that was not changed) and would appear to be erroneous. Further investigation will be required.

10.7 Additional comments

Short wave radios were used to communicate between the winch and laptop controller. It was noticed during the second release that data drop out occurred when the radio was being used by the laptop operator if they were in close proximity to the MSS deck unit. In future radios should be kept at least 1 m from the deck unit to avoid interference.

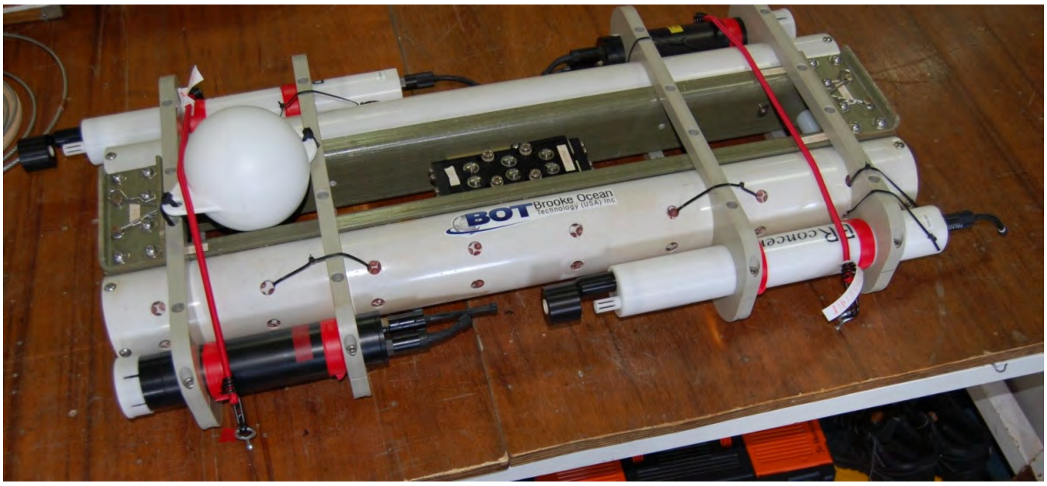
The probe files used by the MSS data acquisition require adjustment if all sensor channels are not being used, as is the case with the SAMS MSS. Midway through release #1 it was noted that the fluorometer data was not being saved to the raw data file. Following communication with the instrument supplier, Dr. Hartmut Prandke (ISW), it was conveyed that when any sensor channels are unused, dummy channels are required within the probe files so that all data can be allocated to the correct channels. A new probe file was sent from SST and the data recovered.

11 Wirewalker mooring

Jo Hopkins

11.1 Introduction

The short term mooring (SF) deployed at 55° 50.597 N, 8° 51.425 W at 19:36 GMT on 03/07/2013 consisted of a Wirewalker mounted on a 100 m length of wire. The Wirewalker is a wave-powered autonomous profiler, manufactured by Brook Ocean, and kindly loaned to us by Ricardo Torres (Plymouth University) for use in this FASTNEt cruise. It uses the surface wave field to power continual vertical profiling. Internally powered and recording instrumentation attached to the Wirewalker collects a two-dimensional depth-time record. Briefly, the mooring itself includes a surface buoy, a wire suspended from the buoy, a weight at the end of the wire, and the profiler attached to the wire via a cam mechanism. A mooring diagram is included below. The wire and weight follow the surface motion of the buoy. The wave-induced motion of the water is reduced with increasing depth, and the relative motion between the wire and the water is used to propel the profiler. The cam engages the wire as it descends and releases it as it ascends, pulling the profiler downwards. At the bottom of the wire, the wirewalker hits a mechanical stop that causes the cam to remain open and the profiler free floats to the surface. At the top of the wire, the cam is reset and the wirewalker is ratched downwards again.



Wirewalker setup

11.2 Instrumentation

The profiler was fitted with two RBRconcerto CTD fast instruments measuring continually at 6 Hz, and two Wetlabs FLB flourometers set for 1 Hz and 0.5 Hz sampling respectively.

Instrument	Serial number	Position on profiler	Sampling rate	Internal clock set (GMT)	Logging started (GMT)	Logging stopped (GMT)	Drift (sec)

Wetlabs FLB	938	Top left	1 Hz	28/06/13 13:09	Manual start at 03/07/13 18:59:23	19/07/13 15:00:54	+55
Wetlabs FLB	907	Bottom right	0.5 Hz	28/06/13 17:16	Manual start at 03/07/13 18:57:01	20/07/13 08:52:27	+64
RBRconcerto CTD	60047	Top right	6 Hz	03/07/2013 15:18L20	03/07/2013 15:30:00	19/07/2013 12:37:00	?
RBRconcerto CTD	60048	Bottom left	6 Hz	27/06/13 10:04	06/07/13 12:00	19/07/2013 13:09:00	?

11.3 Calibration

The following manufacturer calibration will be applied to the chlorophyll fluorescence.

S/N 938

CHL (µg/l) = scale_factor x (output - dark_counts)

scale_factor = 0.0077 µg/l/count

dark_counts = 78 counts

(Maximum output = 16334 counts, Resolution = 1.5 counts)

S/N 907

CHL (µg/l) = scale_factor x (output - dark_counts)

scale_factor = 0.0076 µg/l/count

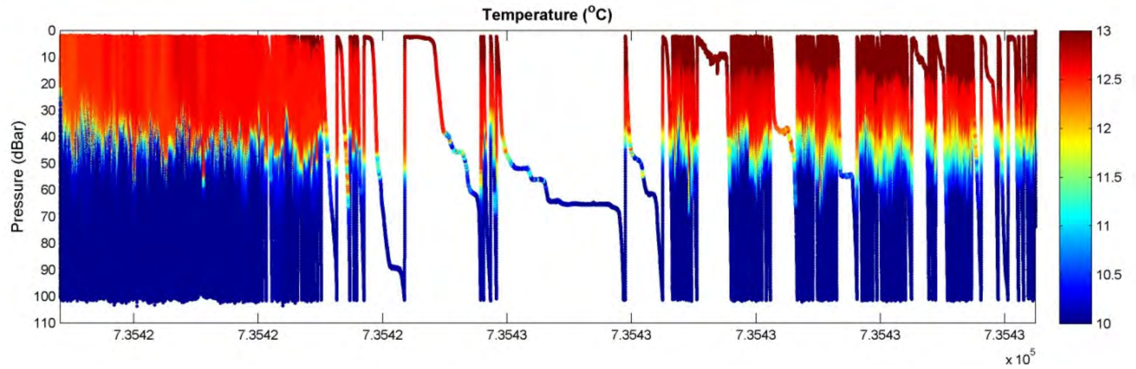
dark_counts = 83 counts

(Maximum output = 16333 counts, Resolution = 1.4 counts)

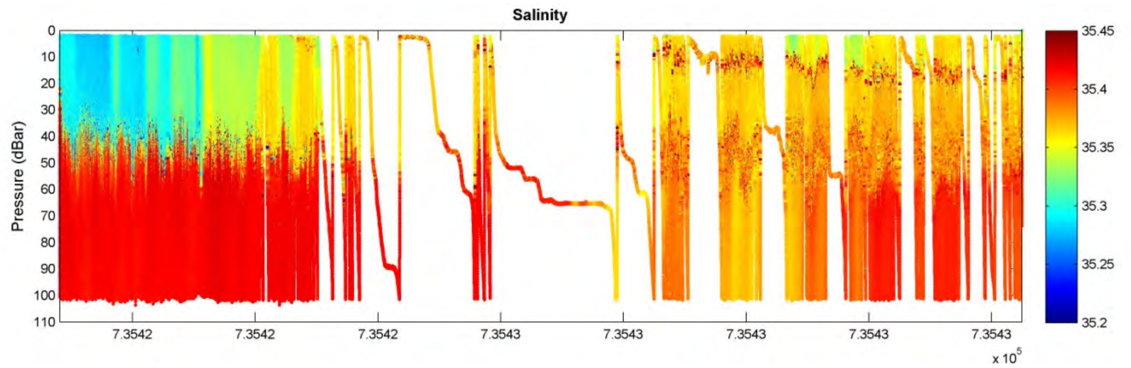
Post processing of temperature and conductivity will also be applied at a later date.

11.4 Results

The wirewalker successfully profiled recording data during its 16 day deployment. Periods of no profiles coincided with exceptionally calm periods when there were insufficient waves to ratchet the wirewalker down the line.



Uncalibrated temperature record from RBR 060047 (matlab serial date)



Uncalibrated salinity record from RBR 060047 (matlab serial date)

11.5 Mooring diagram

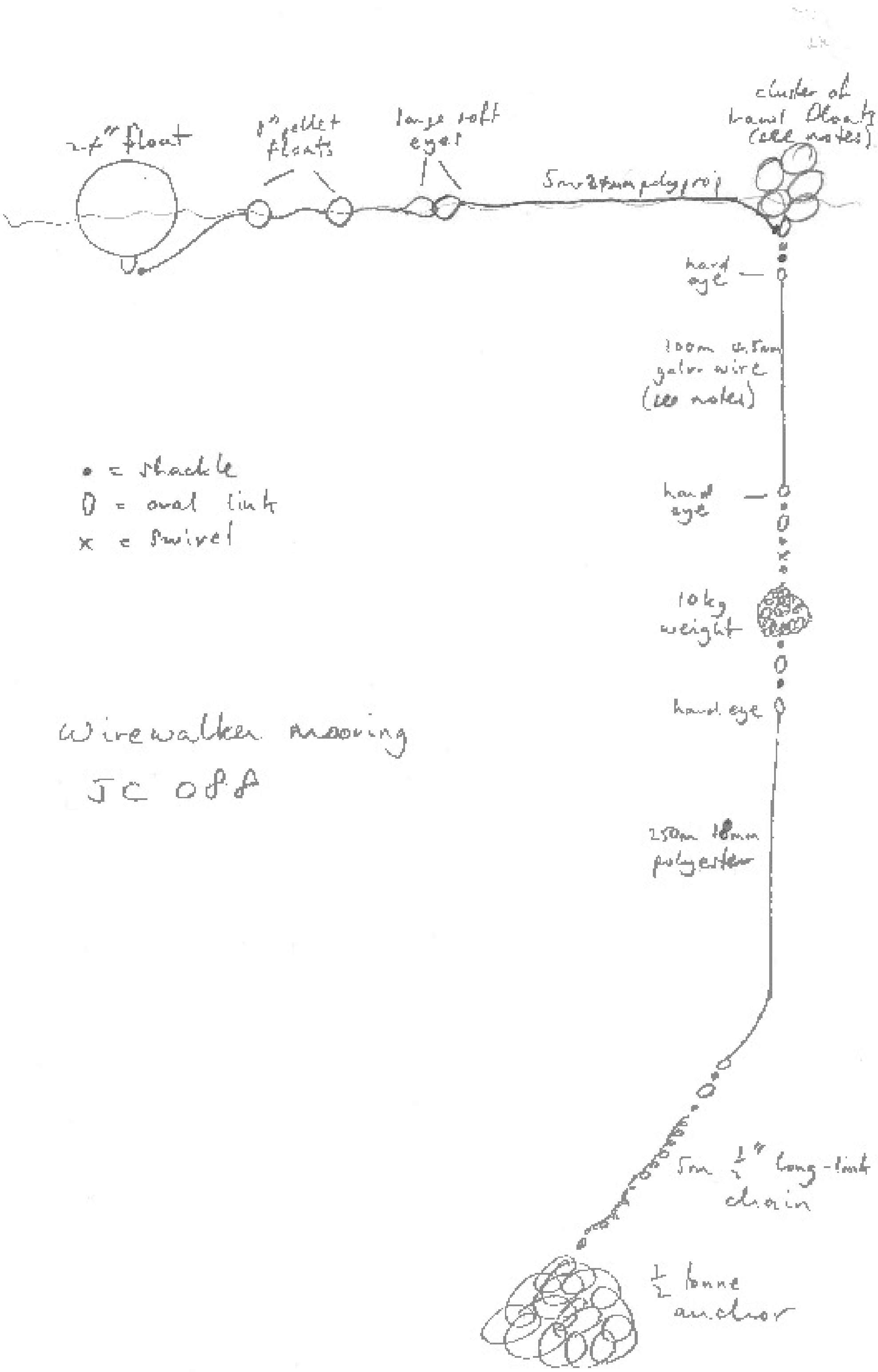


Figure: *Wirewalker mooring diagram*

12 Lowered ADCP (LADCP) Processing

Marie Porter

12.1 Introduction

Lowered Acoustic Doppler Current Profiler (LADCP) data were obtained from every CTD cast. A single downward looking 300 kHz RDI 'Workhorse' LADCP was deployed on the frame (rather than the more common 2 ADCPs) because there have been some recent problems with the integrity of the transducer heads under repeated deep cycling of new ADCPs and it was not considered prudent to risk two at once. The specification details of the LADCP are given elsewhere, this section describes data processing.

12.2 Processing

Profiles 1-41 were processed by the end of the cruise, while profiles 42-73 will not be done until shortly afterwards. The profiles have been processed using 'Visbeck' routines recently adapted and improved (A.M. Thurnherr, 2008, 'How to process LADCP data with the LDEO software') and identified as LDEO version IX.5. They were combined with CTD data to provide accurate information on vertical velocity of the frame through the water, and with the ship's navigation data to calculate its exact position in the water using the ship as a reference. Each processed cast is listed in Table ** along with the depth of that cast and comments about it.

12.3 Results

On the shelf the water tends to flow towards the north east at the surface with a speed of around 5 cm/s (Figure 1). Below the mixed layer this velocity tends to the south east, still with speeds of around 5 cm/s. Over the shelf the velocities are south-westward from the surface to around 1000 m where they swing to the north-east, throughout the profiles the velocities are in the order of 10 cm/s (Figure 2). Over the shelf break the velocity is around 10 cm/s in a north-eastwards direction (Figure 3). At approximately 150 m the flow becomes north-westwards and faster (15 cm/s), suggesting the presence of a slope current.

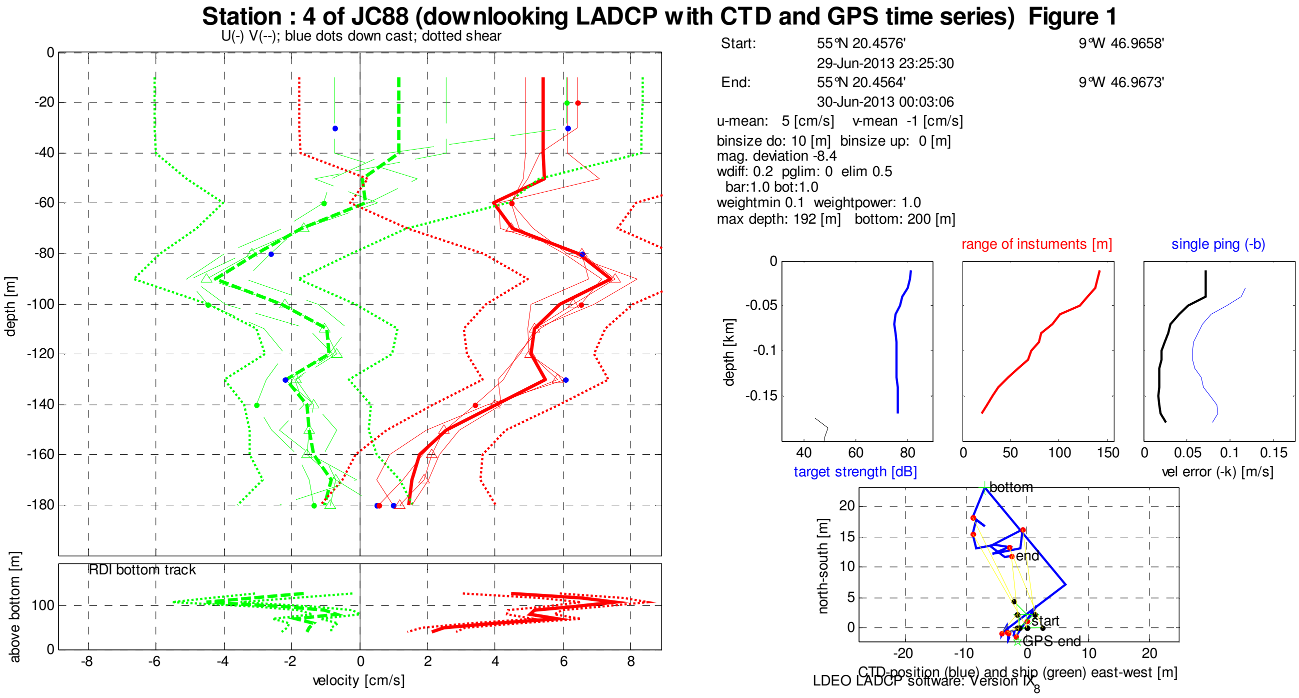


Figure 1: The velocity profile for a typical shelf station

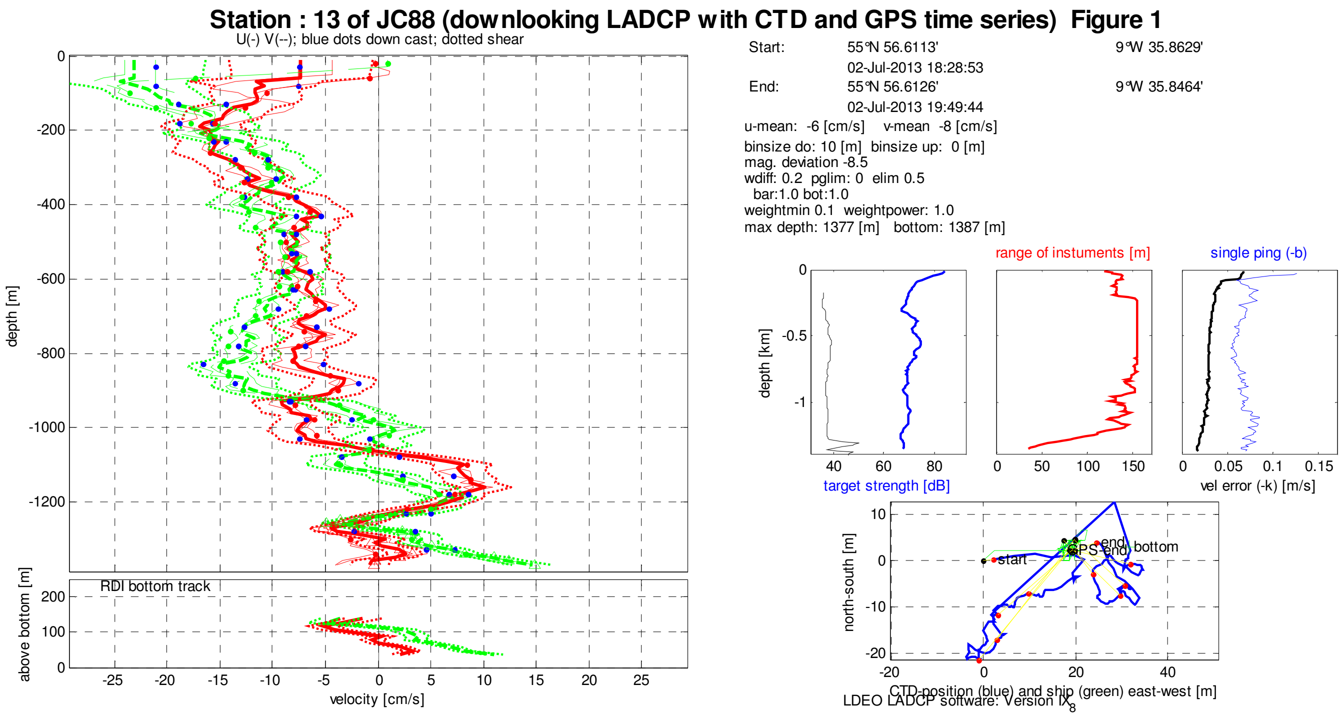


Figure 2: The velocity profile for a typical deep water station.

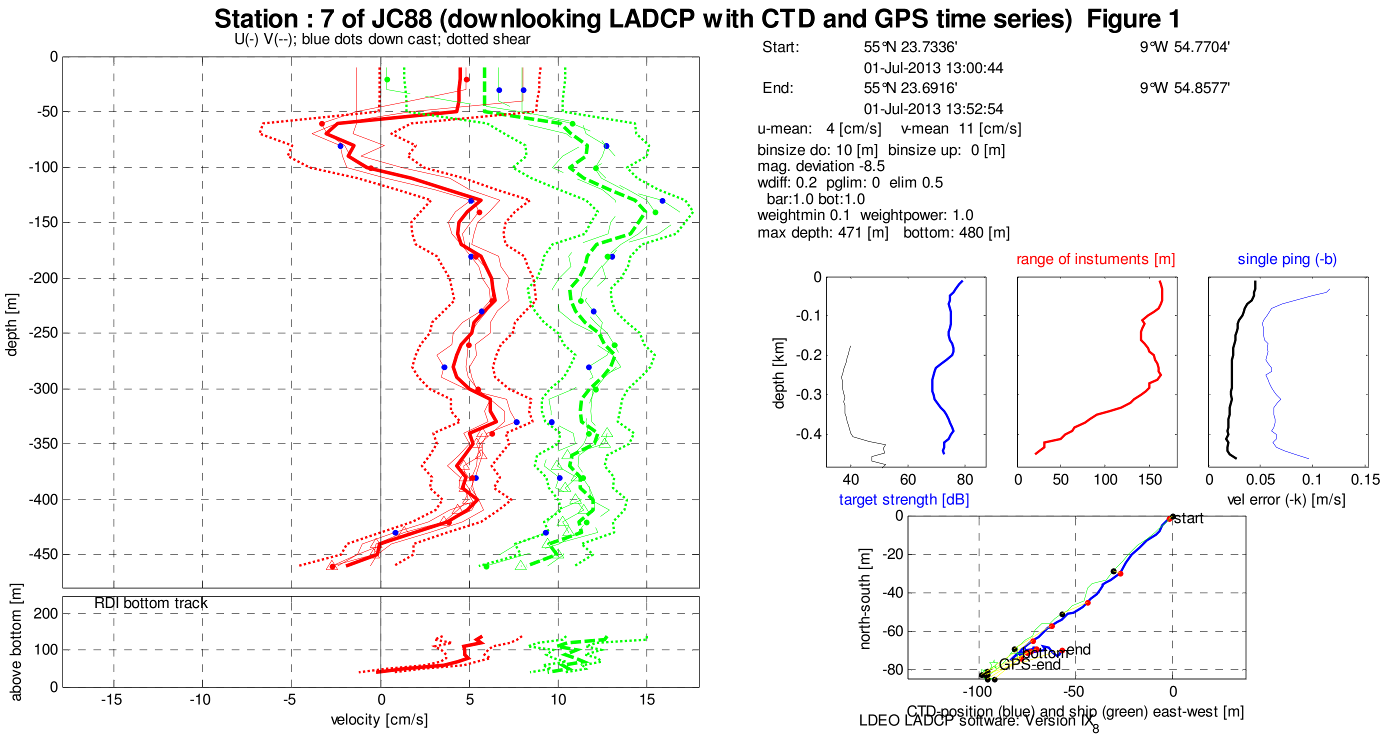


Figure 3: The velocity profile for a typical shelf break station.

13 Moorings

Jon Short, Terry Doyle, Joanne Hopkins, Juliane Wihsgott, Estelle Dumont & Colin Griffiths

13.1 Objectives

- To deploy a series of short term moorings:- LA,LB,SB,SC1,SC2,SD,SE1,SE2,SF1,SF2,SF3,SF4,SG1 & SG2

for the duration of the cruise.

- To deploy one long term mooring, LA – Long Term. This mooring will be recovered during the EEL trip in 2014.

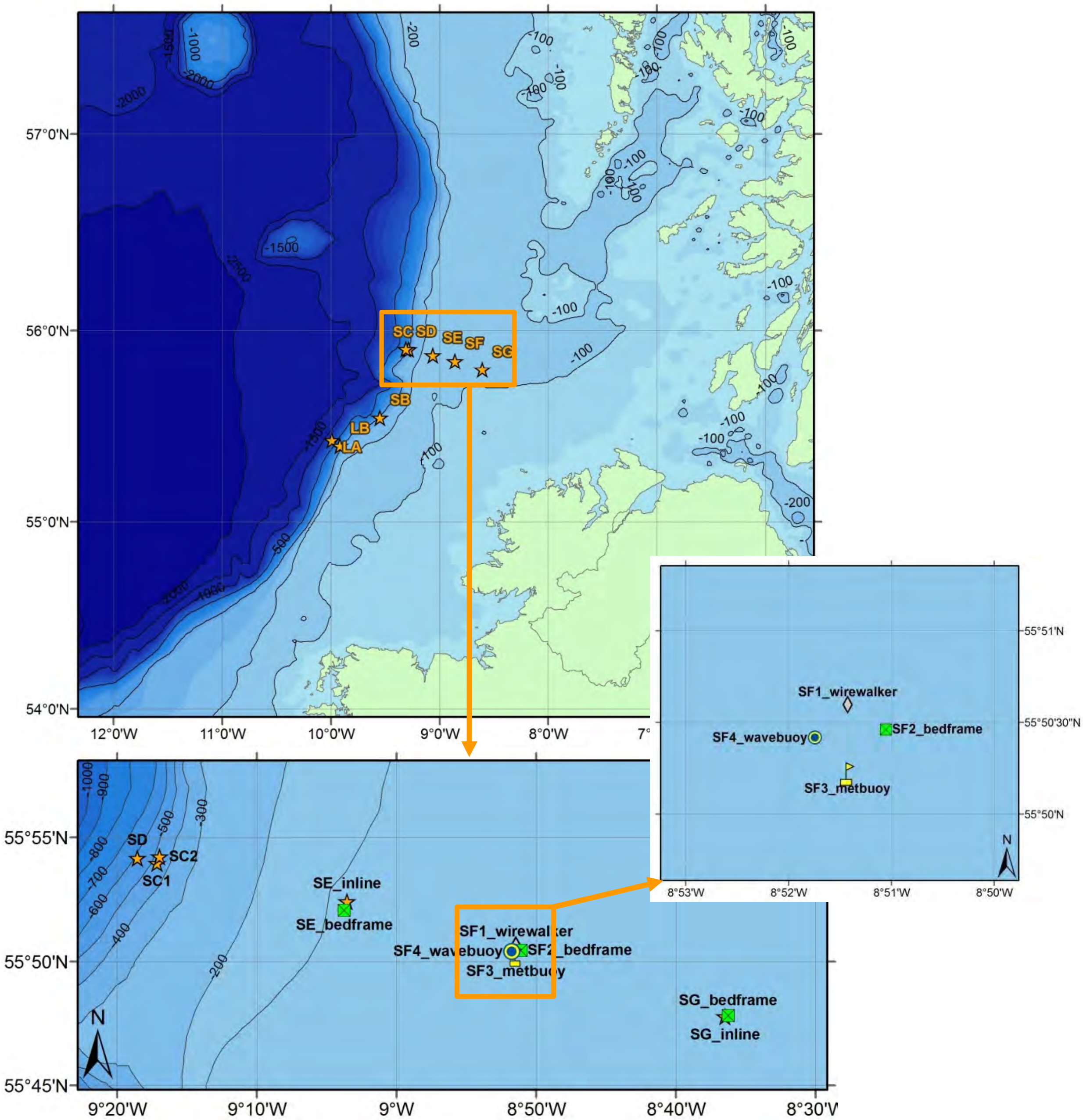


Figure 13.1 JC088 Mooring Array

13.2 Overview

A total of 14 moorings were deployed during JC088, 13 were just for the duration of the trip. The mooring at LA was redeployed towards the end of the trip. This mooring will hopefully be recovered during the EEL trip in 2014. All moorings were recovered. There were however some instrument losses. 23 thermistors were lost from SC2, this was due to long-lining. Monofilament had to be cut away from the mooring on recovery. Long-lining had also interfered with SC1 & SD. One SBE microcat was slightly damaged on SD. One of the SBE microcats was also lost from LB. With the exception of 4 Vemco miniloggers good data was collected from the moored instruments.

13.3 Mooring Summary

Mooring	Lat North	Long West	Depth (m)	Deployed	Recovered
LA	55º 25.779’	009º 59.357’	985	11:41Z 01/07/2013	08:20Z 16/07/2013
LB	55º 23.903’	009º 54.867’	499	15:10Z 01/07/2013	10:01Z 16/07/2013
SB	55º 32.725’	009º 32.772’	504	13:46Z 02/07/2013	14:48Z 16/07/2013
SC1	55º 53.964’	009º 17.134’	404	10:42Z 03/07/2013	08:32Z 18/07/2013
SC2	55º 54.230’	009º 16.934’	396	11:34Z 03/07/2013	09:39Z 18/07/2013
SD	55º 54.168’	009º 18.528’	544	16:56Z 02/07/2013	10:59Z 18/07/2013
SE - inline	55º 52.425’	009º 03.512’	144	10:18Z 04/07/2013	08:28Z 19/07/2013
SE - frame	55º 52.078’	009º 03.730’	143	08:46Z 04/07/2013	09:36Z 19/07/2013
SF1- W/W	55º 50.597’	008º 51.425’	124	19:36Z 03/07/2013	12:06Z 19/07/2013
SF2-Bed-frame	55º 50.463’	008º 51.052’	124	16:21Z 03/07/2013	15:13Z 19/07/2013
SF3-Met-buoy	55º 50.220’	008º 51.427’	122	18:26Z 03/07/2013	13:18Z 19/07/2013
SF4-Wave Buoy	55º 50.418’	008º 51.744’	124	16:58Z 03/07/2013	14:31Z 19/07/2013
SG – inline	55º 47.784’	008º 36.455	113	12:52Z 04/07/2013	16:28Z 19/07/2013
SG – frame	55º 47.830’	008º 36.240’	113	12:32Z 04/07/2013	17:58Z 19/07/2013
LA – Long Term	55º 25.614’	009º 59.327’	964	17:40Z 17/07/2013	EEL 2014?

Table 11,1 JC088 Mooring Summary

13.4 Instrument Summary

A few instruments failed to record good quality data for various reasons. These have not been included in the instrument summary tables.

The codes for the instruments:

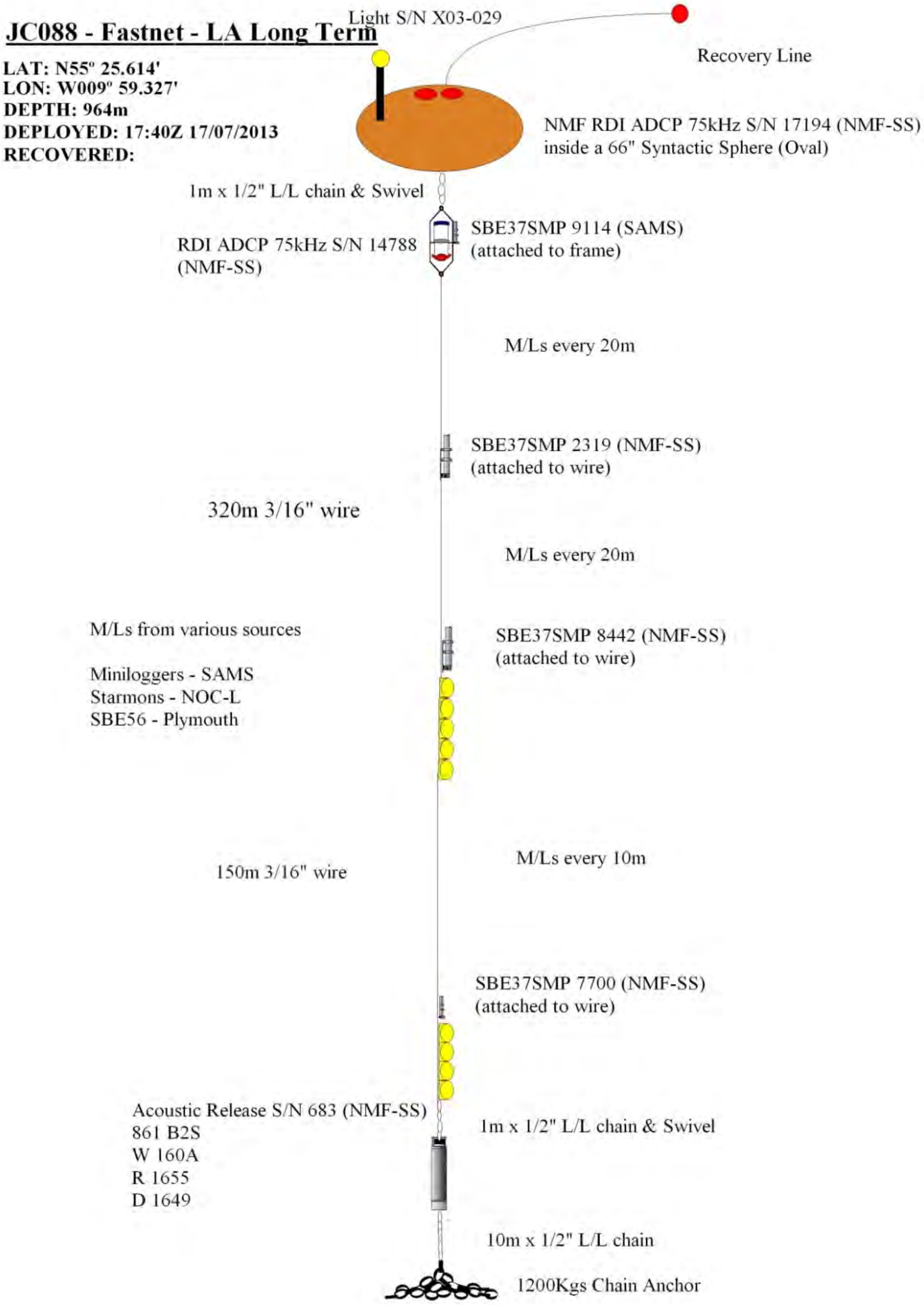
ADCP	RDI ADCP (U, V, W, Temperature & Pressure)
SBE37	SBE37 CTD (Conductivity, Temperature & Pressure)
SBE56	SBE56 logger (Temperature)
SM	STAR-ODDI Starmon mini (Temperature)
ML	VEMCO Minilogs (Temperature)
SO (TP)	STAR-ODDI DST centi-T (Temperature & Pressure)
NIOZ_t	Thermistor on NIOZ chain (Temperature)
A/R	Acoustic release

Other instruments mentioned on diagrams but not in tables:

FQ - FlowQuest ADCP (U,V,W)

13.5 Mooring Diagrams and tables

Inline moorings

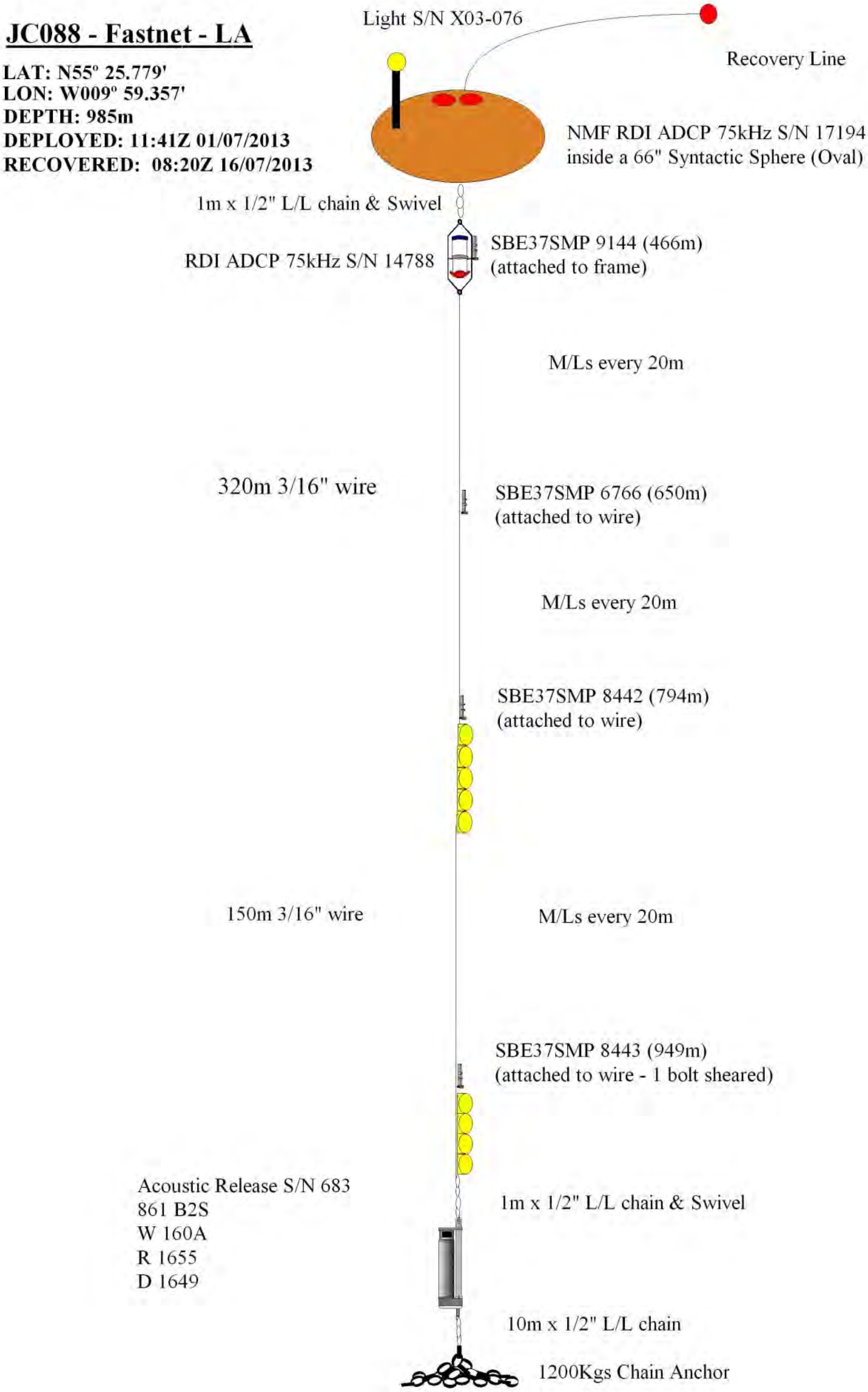


MOORING ID: LA (long-term)

DEPLOYMENT	
Event #	089
Date	17/07/2013
Release time	17:40
Release latitude	55° 25.614'N
Release longitude	009° 59.327'W
Release depth	964m

Depth below subs. buoy	Approx depth (m)	Incre-mental depth	Instrument	S/N	Owner	Comments
0	504.5	0	Subsurf float (top)			
0.5	505	0.5	ADCP 75KHz	17194	NMF	
4.5	509	4	SBE37 SMP	9114	SAMS	on ADCP frame
6	510.5	1.5	ADCP 75KHz	14788	NMF	
24.5	529	18.5	SM	3904	NOCL	18m after start of wire
44.5	549	20	ML	350772	SAMS	
64.5	569	20	SM	3576	NOCL	
84.5	589	20	ML	350773	SAMS	
104.5	609	20	SM	3888	NOCL	
124.5	629	20	ML	350774	SAMS	
144.5	649	20	SM	3892	NOCL	
164.5	669	20	SBE37 SM	9111	SAMS	
184.5	689	20	ML	350775	SAMS	
204.5	709	20	SM	3577	NOCL	
224.5	729	20	ML	350776	SAMS	
244.5	749	20	SM	3906	NOCL	
264.5	769	20	ML	350779	SAMS	
284.5	789	20	SM	3585	NOCL	
304.5	809	20	ML	350780	SAMS	
324.5	829	20	SBE37 SMP	8442	NMF	5m before end of wire
334.5	839	10	SBE56	2320	UoP	2.5 after start of wire
344.5	849	10	SM	3579	NOCL	
354.5	859	10	SBE56	2321	UoP	
364.5	869	10	ML	350781	SAMS	
374.5	879	10	SBE56	2322	UoP	
384.5	889	10	SM	3902	NOCL	
394.5	899	10	SBE56	2323	UoP	
404.5	909	10	ML	350782	SAMS	
414.5	919	10	SBE56	2324	UoP	
424.5	929	10	SM	3889	NOCL	
434.5	939	10	SBE56	2325	UoP	
444.5	949	10	ML	350783	SAMS	
454.5	959	10	SBE56	2326	UoP	
464.5	969	10	SM	3895	NOCL	
474.5	979	10	SBE56	2327	UoP	
478.5	983	4	SBE37 SMP	7700	NMF	As close to the end of the wire as

484.5	989	6	SBE56	2328	UoP	possible – please note position
488.5	995	4	A/R	683	NMF	
500.5	1007	12	anchor			

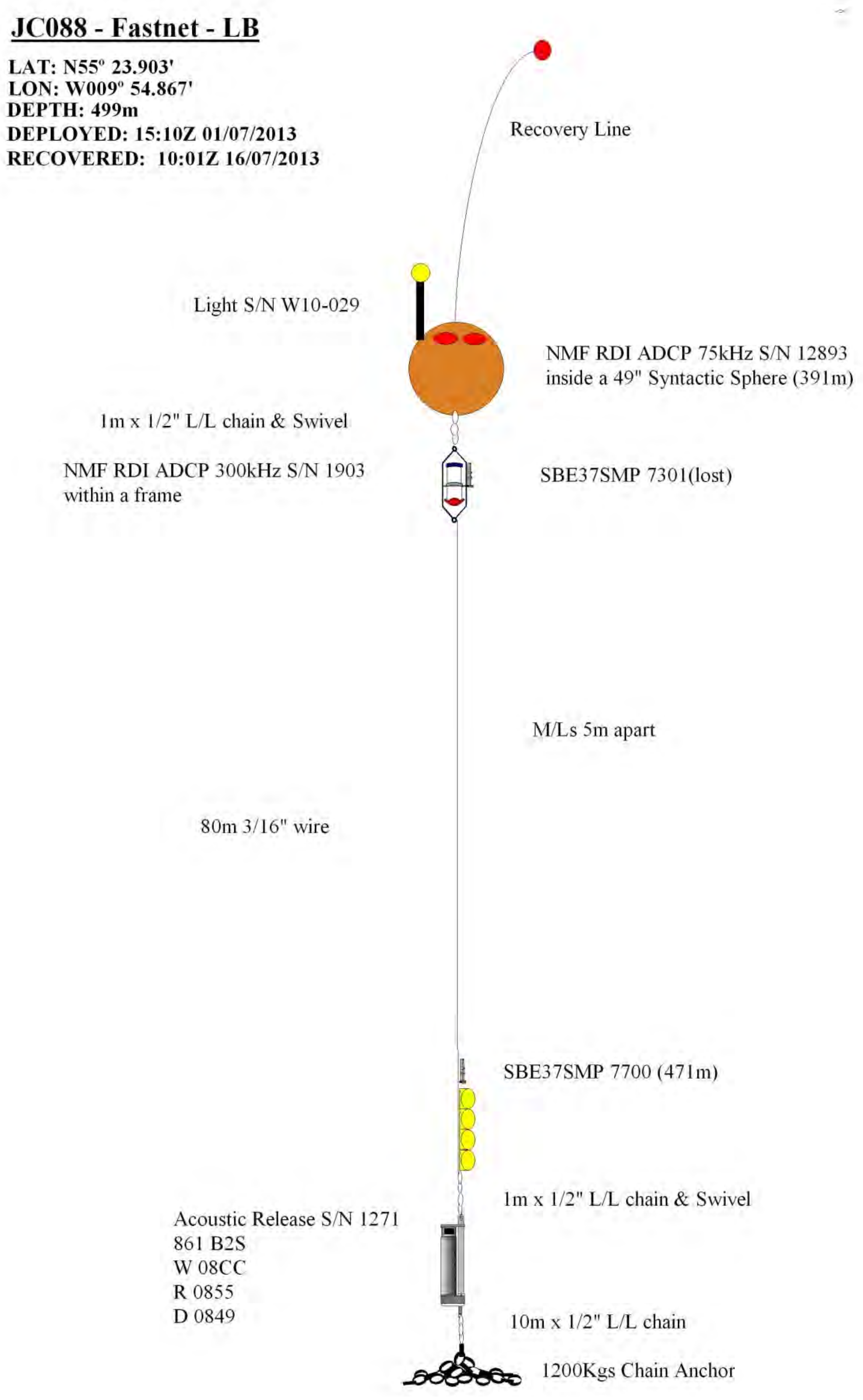

JC088 - Fastnet - LA
LAT: N55º 25.779'
LON: W009º 59.357'
DEPTH: 985m
DEPLOYED: 11:41Z 01/07/2013
RECOVERED: 08:20Z 16/07/2013
Light S/N X03-076
Recovery Line
NMF RDI ADCP 75kHz S/N 17194
inside a 66" Syntactic Sphere (Oval)
1m x 1/2" L/L chain & Swivel
RDI ADCP 75kHz S/N 14788
SBE37SMP 9144 (466m)
(attached to frame)
M/Ls every 20m
320m 3/16" wire
SBE37SMP 6766 (650m)
(attached to wire)
M/Ls every 20m
SBE37SMP 8442 (794m)
(attached to wire)
150m 3/16" wire
M/Ls every 20m
SBE37SMP 8443 (949m)
(attached to wire - 1 bolt sheared)
Acoustic Release S/N 683
861 B2S
W 160A
R 1655
D 1649
1m x 1/2" L/L chain & Swivel
10m x 1/2" L/L chain
1200Kgs Chain Anchor

MOORING ID: LA (short-term)

DEPLOYMENT		RECOVERY	
Event #	007	**Event #**	078
Date	01/07/2013	**Date**	16/07/2013
Release time	11:41	**Release time**	08:20
Release latitude	55° 25.779'N	**Release latitude**	55° 25.983'N
Release longitude	009° 59.357'W	**Release longitude**	009° 59.106'W
Release depth	985m	**Release depth**	1346m

Calculated depth (m)	Incremental depth (m)	Instrument	S/N	Owner	Comments
467	0	subsurface float (top)			
467.5	0.5	ADCP 75KHz	17194	NMF	average depth reading = 464m
470.5	3	SBE37 SMP	9114	SAMS	average depth reading = 466m
472	1.5	ADCP 75KHz	14788	NMF	average depth reading = 469.5m
515	43	SM	3904	NOCL	
534.5	19.5	ML	350772	SAMS	
554	19.5	SM	3576	NOCL	
573.5	19.5	ML	350773	SAMS	
593	19.5	SM	3888	NOCL	
612.5	19.5	ML	350774	SAMS	
632	19.5	SM	3892	NOCL	
651.5	19.5	SBE37 SM	6766	SAMS	average depth reading = 650m
671	19.5	ML	350775	SAMS	
690.5	19.5	SM	3577	NOCL	
710	19.5	ML	350776	SAMS	
729.5	19.5	SM	3906	NOCL	
749	19.5	ML	350779	SAMS	
768.5	19.5	SM	3585	NOCL	
788	19.5	SBE37 SMP	8442	NMF	average depth reading = 794m
811.5	23.5	SM	3579	NOCL	
831.5	20	ML	350781	SAMS	
851.5	20	SM	3902	NOCL	
871.5	20	ML	350782	SAMS	
891.5	20	SM	3889	NOCL	
911.5	20	ML	350783	SAMS	
931.5	20	SM	3895	NOCL	
943.5	12	SBE37 SMP	8443	NMF	average depth reading = 949m
950.5	7	A/R	683	NMF	
962.5	12	anchor			

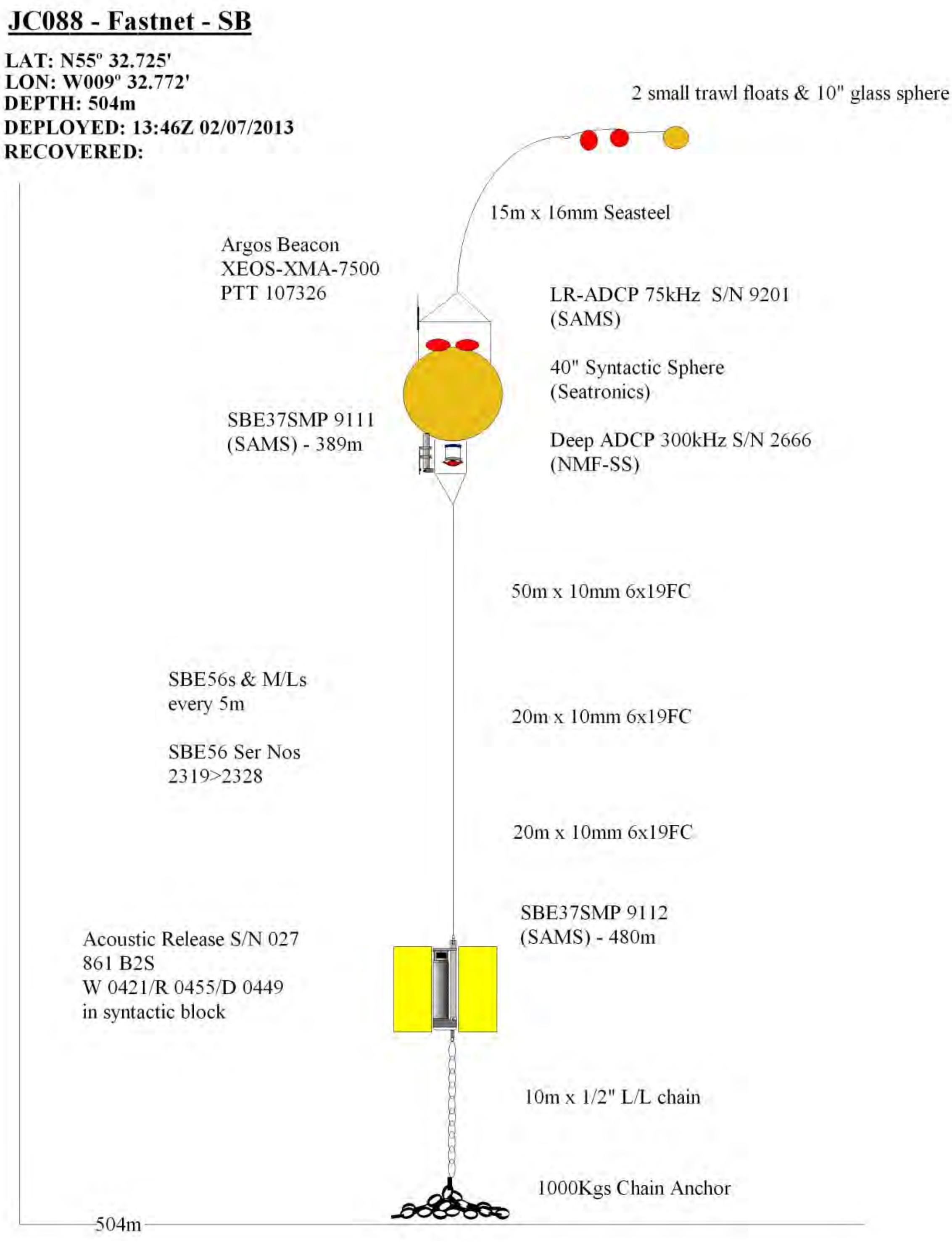
Note: the depths recorded by the instruments did not match the mooring diagram (+/- 6m), an average correction has been applied to determine the final depth (first column).


JC088 - Fastnet - LB
LAT: N55° 23.903'
LON: W009° 54.867'
DEPTH: 499m
DEPLOYED: 15:10Z 01/07/2013
RECOVERED: 10:01Z 16/07/2013
Recovery Line
Light S/N W10-029
NMF RDI ADCP 75kHz S/N 12893
inside a 49" Syntactic Sphere (391m)
1m x 1/2" L/L chain & Swivel
NMF RDI ADCP 300kHz S/N 1903
within a frame
SBE37SMP 7301(lost)
M/Ls 5m apart
80m 3/16" wire
SBE37SMP 7700 (471m)
1m x 1/2" L/L chain & Swivel
Acoustic Release S/N 1271
861 B2S
W 08CC
R 0855
D 0849
10m x 1/2" L/L chain
1200Kgs Chain Anchor

MOORING ID: LB

DEPLOYMENT		RECOVERY	
Event #	009	**Event #**	079
Date	01/07/2013	**Date**	16/07/2013
Release time	15:10	**Release time**	10:01
Release latitude	55° 23.903'N	**Release latitude**	55° 24.234'N
Release longitude	009° 54.867'W	**Release longitude**	009° 54.417'W
Release depth	499m	**Release depth**	-

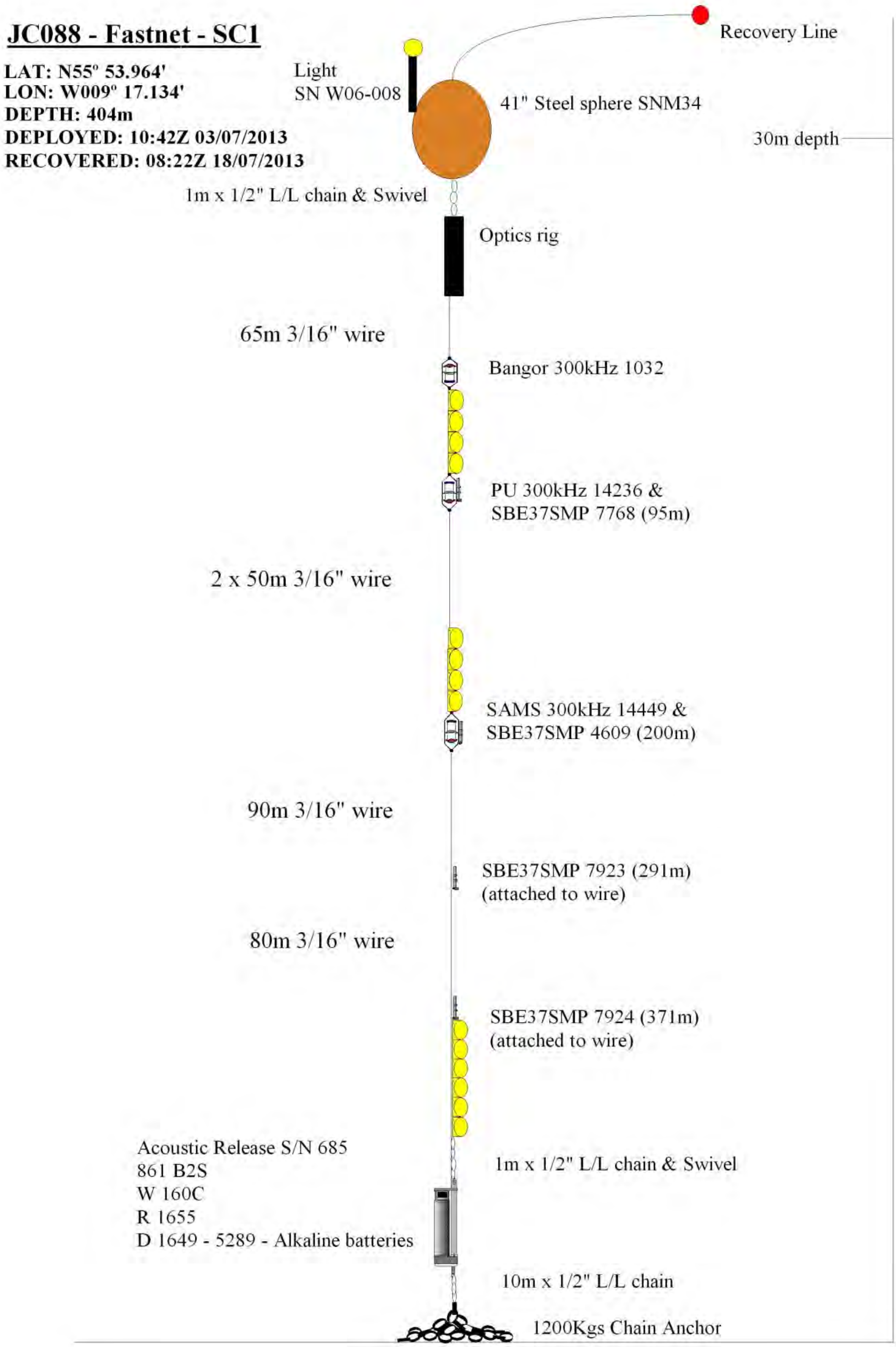
Calculated depth (m)	Incremental depth (m)	Instrument	S/N	Owner	Comments
390.5	0	subsurface float			
391	0.5	ADCP 75KHz	12893	NMF	average depth reading = 392m
392.5	1.5	SBE37 SMP	7301	NMF	
394.5	2	ADCP 300KHz	1903	NMF	
394.5	0	ML	350780	SAMS	
400	5.5	ML	1443	SAMS	
405	5	ML	1444	SAMS	
410	5	ML	1445	SAMS	
415	5	SO (TP)	3655	NOCL	
420	5	ML	1446	SAMS	
425	5	ML	1448	SAMS	
430	5	ML	1592	SAMS	
435	5	SO (TP)	5264	NOCL	
440	5	ML	1593	SAMS	
445	5	ML	1598	SAMS	
450	5	ML	1602	SAMS	
455	5	SO (TP)	5270	NOCL	
460	5	ML	1622	SAMS	
465	5	ML	1623	SAMS	
470	5	ML	1624	SAMS	
472.5	2.5	SBE37 SMP	7700	NMF	average depth reading = 472m
476.5	4	SO (TP)	5269	NOCL	
476.5	0	A/R	1271	NMF	
488.5	12	anchor			


JC088 - Fastnet - SB
LAT: N55º 32.725'
LON: W009º 32.772'
DEPTH: 504m
DEPLOYED: 13:46Z 02/07/2013
RECOVERED:
2 small trawl floats & 10" glass sphere
15m x 16mm Seasteel
Argos Beacon
XEOS-XMA-7500
PTT 107326
LR-ADCP 75kHz S/N 9201
(SAMS)
40" Syntactic Sphere
(Seatronics)
SBE37SMP 9111
(SAMS) - 389m
Deep ADCP 300kHz S/N 2666
(NMF-SS)
50m x 10mm 6x19FC
SBE56s & M/Ls
every 5m
SBE56 Ser Nos
2319>2328
20m x 10mm 6x19FC
20m x 10mm 6x19FC
SBE37SMP 9112
(SAMS) - 480m
Acoustic Release S/N 027
861 B2S
W 0421/R 0455/D 0449
in syntactic block
10m x 1/2" L/L chain
1000Kgs Chain Anchor
504m

MOORING ID: SB

DEPLOYMENT		RECOVERY	
Event #	016	**Event #**	082
Date	02/07/2013	**Date**	16/07/2013
Release time	13:46	**Release time**	14:48
Release latitude	55° 32.725'N	**Release latitude**	55° 32.926'N
Release longitude	009° 32.772'W	**Release longitude**	009° 32.407'W
Release depth	504m	**Release depth**	-

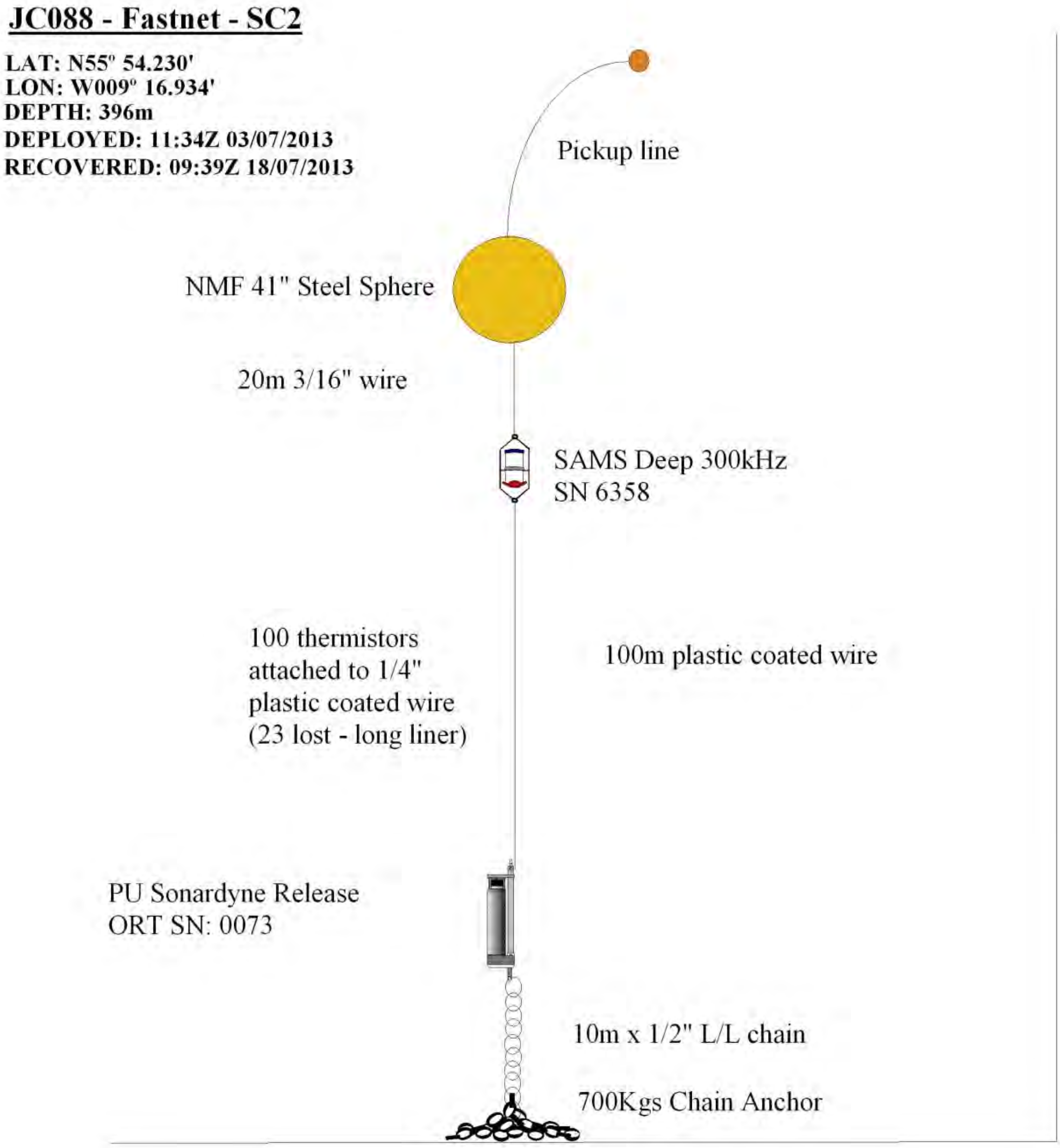
Calculated depth (m)	Incremental depth (m)	Instrument	S/N	Owner	Comments
387	0	subsurface float			
387.5	0.5	ADCP 75KHz	9201	SAMS	average depth reading = 387m
389	1.5	ADCP 300KHz	2666	NMF	average depth reading = 378m - faulty
389	0	SBE37 SMP	9111	SAMS	average depth reading = 389m
394	5	SBE56	2319	UoP	
399	5	SBE56	2320	UoP	
404	5	ML	1066	SAMS	
409	5	SBE56	2321	UoP	
414	5	SO (TP)	5284	NOCL	
419	5	SBE56	2322	UoP	
424	5	ML	1068	SAMS	
429	5	SBE56	2323	UoP	
434	5	SO (TP)	5286	NOCL	
439	5	SBE56	2324	UoP	
444	5	ML	1692	SAMS	
449	5	SBE56	2325	UoP	
454	5	SO (TP)	5263	NOCL	
459	5	SBE56	2326	UoP	
464	5	ML	6178	SAMS	
469	5	SBE56	2327	UoP	
474	5	SBE56	2328	UoP	
479	5	SBE37 SMP	9112	SAMS	average depth reading = 479m
480	1	A/R	027	NMF	
492	12	anchor			


JC088 - Fastnet - SC1
LAT: N55º 53.964'
LON: W009º 17.134'
DEPTH: 404m
DEPLOYED: 10:42Z 03/07/2013
RECOVERED: 08:22Z 18/07/2013
Light
SN W06-008
Recovery Line
41" Steel sphere SNM34
30m depth
1m x 1/2" L/L chain & Swivel
Optics rig
65m 3/16" wire
Bangor 300kHz 1032
PU 300kHz 14236 &
SBE37SMP 7768 (95m)
2 x 50m 3/16" wire
SAMS 300kHz 14449 &
SBE37SMP 4609 (200m)
90m 3/16" wire
SBE37SMP 7923 (291m)
(attached to wire)
80m 3/16" wire
SBE37SMP 7924 (371m)
(attached to wire)
Acoustic Release S/N 685
861 B2S
W 160C
R 1655
D 1649 - 5289 - Alkaline batteries
1m x 1/2" L/L chain & Swivel
10m x 1/2" L/L chain
1200Kgs Chain Anchor

MOORING ID: SC1

DEPLOYMENT		RECOVERY	
Event #	027	**Event #**	095
Date	03/07/2013	**Date**	16/07/2013
Release time	10:42	**Release time**	14:48
Release latitude	55° 53.964'N	**Release latitude**	55° 53.926'N
Release longitude	009° 17.134'W	**Release longitude**	009° 17.063'W
Release depth	404m	**Release depth**	404m

Calculated depth (m)	Incremental depth (m)	Instrument	S/N	Owner	Comments
26	0	subsurface float			
29	3	Optics rig	/	NOCL	
91	62	ADCP 300KHz	1032	Bangor	
95	4	MC	7768	SAMS	average depth reading =95m
95.5	0.5	ADCP 300KHz	14236	UoP	
200.5	105	MC	4609	SAMS	average depth reading = 200.5m
201.5	1	ADCP 300KHz	14449	SAMS	average depth reading = 201.5m
292	90.5	MC	7923	SAMS	average depth reading = 292m
371	79	MC	7924	SAMS	average depth reading = 371m
377	6	A/R	685	NMF	
389	12	anchor			


JC088 - Fastnet - SC2
LAT: N55º 54.230'
LON: W009º 16.934'
DEPTH: 396m
DEPLOYED: 11:34Z 03/07/2013
RECOVERED: 09:39Z 18/07/2013
Pickup line
NMF 41" Steel Sphere
20m 3/16" wire
SAMS Deep 300kHz
SN 6358
100 thermistors
attached to 1/4"
plastic coated wire
(23 lost - long liner)
100m plastic coated wire
PU Sonardyne Release
ORT SN: 0073
10m x 1/2" L/L chain
700Kgs Chain Anchor

MOORING ID: SC2

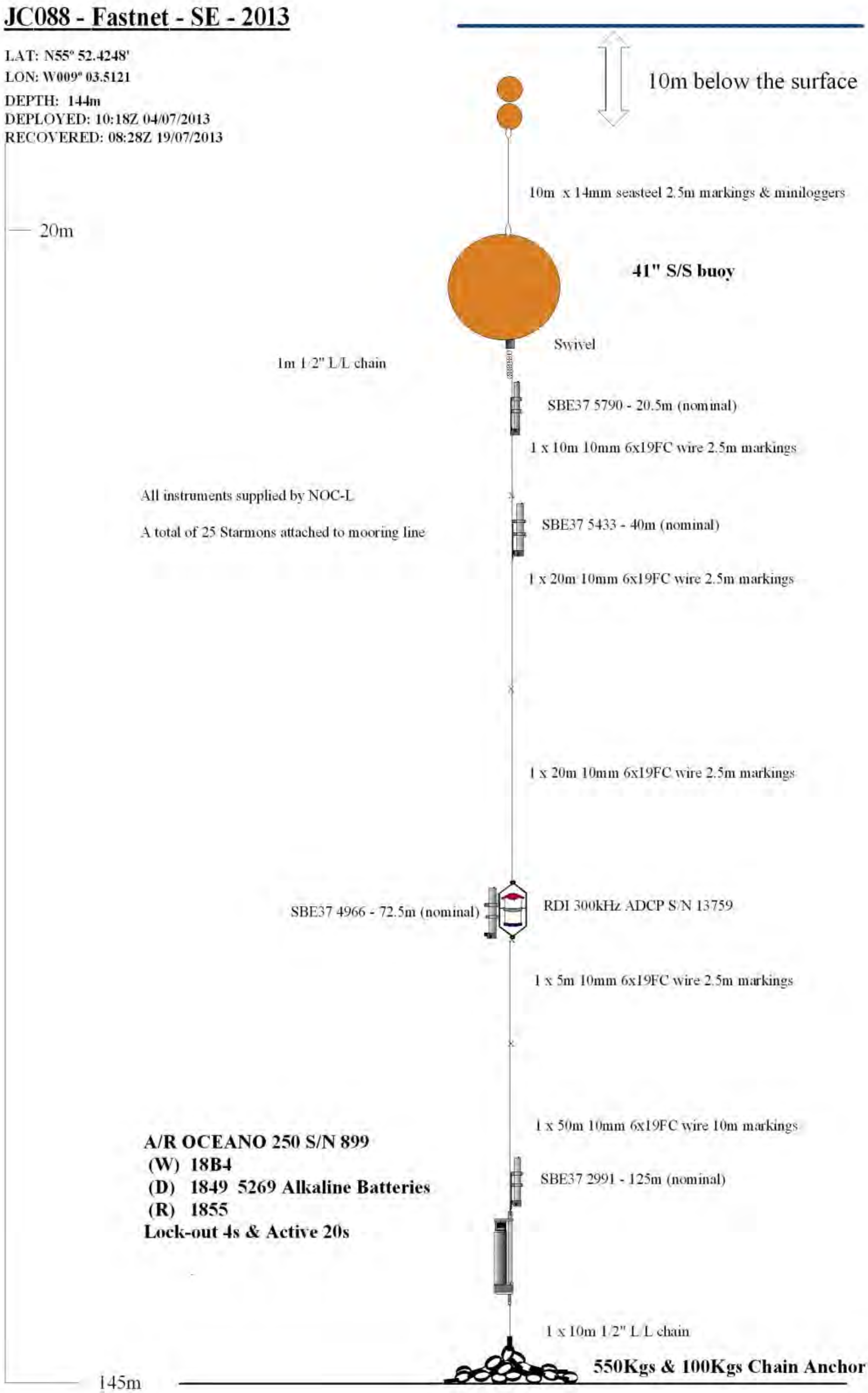
DEPLOYMENT		RECOVERY	
Event #	028	**Event #**	096
Date	03/07/2013	**Date**	18/07/2013
Release time	11:34	**Release time**	09:39
Release latitude	55° 54.230'N	**Release latitude**	55° 41.198'N
Release longitude	009° 16.934'W	**Release longitude**	009° 16.307'W
Release depth	396m	**Release depth**	354m

Original position	Final position	Calculated depth (m)	Increm. depth (m)	Instrument	S/N	Owner	Comments
		252.5	0	subsurface float			
		274.5	22	ADCP 300KHz	6358	SAMS	average depth reading = 274.5m
102	102	275.5	1	NIOZ_t	251	UoP	
101	101	276.5	1	NIOZ_t	252	UoP	
100	100	277.5	1	NIOZ_t	253	UoP	
99	99	278.5	1	NIOZ_t	254	UoP	
98	98	279.5	1	NIOZ_t	255	UoP	
97	97	280.5	1	NIOZ_t	256	UoP	
96	96	281.5	1	NIOZ_t	257	UoP	
95	95	282.5	1	NIOZ_t	258	UoP	
94	94	283.5	1	NIOZ_t	259	UoP	
93	93	284.5	1	NIOZ_t	260	UoP	
92	92	285.5	1	NIOZ_t	261	UoP	
91	91	286.5	1	NIOZ_t	262	UoP	
90	90	287.5	1	NIOZ_t	263	UoP	
89	89	288.5	1	NIOZ_t	264	UoP	
88	88	289.5	1	NIOZ_t	265	UoP	
87	87	290.5	1	NIOZ_t	266	UoP	
86	86	291.5	1	NIOZ_t	267	UoP	
85	85	292.5	1	NIOZ_t	268	UoP	
84	84	293.5	1	NIOZ_t	269	UoP	
83	83	294.5	1	NIOZ_t	270	UoP	
82	82	295.5	1	NIOZ_t	271	UoP	
81	81	296.5	1	NIOZ_t	272	UoP	
80	80	297.5	1	NIOZ_t	273	UoP	
79	79	298.5	1	NIOZ_t	274	UoP	
78	78	299.5	1	NIOZ_t	275	UoP	
77	77	300.5	1	NIOZ_t	276	UoP	
76	76	301.5	1	NIOZ_t	277	UoP	
75	75	302.5	1	NIOZ_t	278	UoP	
74	74	303.5	1	NIOZ_t	279	UoP	

Original position	Final position	Calculated depth (m)	Increm. depth (m)	Instrument	S/N	Owner	Comments
73	73	304.5	1	NIOZ_t	281	UoP	
72	72	305.5	1	NIOZ_t	282	UoP	
71	71	306.5	1	NIOZ_t	283	UoP	
70	70	307.5	1	NIOZ_t	284	UoP	
69	69	308.5	1	NIOZ_t	285	UoP	
68	68	309.5	1	NIOZ_t	286	UoP	
67	67	310.5	1	NIOZ_t	287	UoP	
66	66	311.5	1	NIOZ_t	288	UoP	
65	65	312.5	1	NIOZ_t	289	UoP	
64	64	313.5	1	NIOZ_t	290	UoP	
63	63	314.5	1	NIOZ_t	291	UoP	
62	62	315.5	1	NIOZ_t	292	UoP	
61	61	316.5	1	NIOZ_t	293	UoP	
60	60	317.5	1	NIOZ_t	294	UoP	
59	59	318.5	1	NIOZ_t	295	UoP	
58	58	319.5	1	NIOZ_t	297	UoP	
57	57	320.5	1	NIOZ_t	298	UoP	
56	lost	321.5	1	NIOZ_t	299	UoP	
55	lost	322.5	1	NIOZ_t	300	UoP	
54	53.5	323.5	1	NIOZ_t	301	UoP	dragged up the line by 0.5m
53	53	324.5	1	NIOZ_t	302	UoP	
52	52	325.5	1	NIOZ_t	303	UoP	
51	50	326.5	1	NIOZ_t	304	UoP	may be sensor 48 dragged up instead
50	50	327.5	1	NIOZ_t	305	UoP	
49	lost	328.5	1	NIOZ_t	306	UoP	lost
48	lost	329.5	1	NIOZ_t	307	UoP	lost
47	lost	330.5	1	NIOZ_t	308	UoP	lost
46	lost	331.5	1	NIOZ_t	309	UoP	lost
45	lost	332.5	1	NIOZ_t	310	UoP	lost
44	lost	333.5	1	NIOZ_t	311	UoP	lost
43	lost	334.5	1	NIOZ_t	312	UoP	lost
42	lost	335.5	1	NIOZ_t	313	UoP	lost
41	lost	336.5	1	NIOZ_t	314	UoP	lost
40	lost	337.5	1	NIOZ_t	316	UoP	lost
39	lost	338.5	1	NIOZ_t	317	UoP	lost
38	lost	339.5	1	NIOZ_t	318	UoP	lost
37	lost	340.5	1	NIOZ_t	319	UoP	lost
36	lost	341.5	1	NIOZ_t	320	UoP	lost
35	lost	342.5	1	NIOZ_t	321	UoP	lost
34	lost	343.5	1	NIOZ_t	322	UoP	lost
33	29	344.5	1	NIOZ_t	323	UoP	dragged to position 28 in a clump
32	29	345.5	1	NIOZ_t	324	UoP	dragged to position 28 in a clump

Original position	Final position	Calculated depth (m)	Increm. depth (m)	Instrument	S/N	Owner	Comments
31	29	346.5	1	NIOZ_t	325	UoP	dragged to position 28 in a clump
30	29	347.5	1	NIOZ_t	326	UoP	dragged to position 28 in a clump
29	29	348.5	1	NIOZ_t	327	UoP	dragged to position 28 in a clump
28	lost	349.5	1	NIOZ_t	328	UoP	lost
27	27	350.5	1	NIOZ_t	329	UoP	
26	26	351.5	1	NIOZ_t	331	UoP	
25	25	352.5	1	NIOZ_t	332	UoP	
24	23	353.5	1	NIOZ_t	333	UoP	
23	23	354.5	1	NIOZ_t	334	UoP	
22	22	355.5	1	NIOZ_t	335	UoP	
21	21	356.5	1	NIOZ_t	336	UoP	
20	20	357.5	1	NIOZ_t	337	UoP	
19	lost	358.5	1	NIOZ_t	338	UoP	lost
18	18	359.5	1	NIOZ_t	340	UoP	
17	lost	360.5	1	NIOZ_t	341	UoP	lost
16	16	361.5	1	NIOZ_t	342	UoP	
15	lost	362.5	1	NIOZ_t	343	UoP	lost
14	14	363.5	1	NIOZ_t	344	UoP	put back in position but displaced on recovery
13	13	364.5	1	NIOZ_t	345	UoP	
12	12	365.5	1	NIOZ_t	346	UoP	
11	11	366.5	1	NIOZ_t	347	UoP	
10	9	367.5	1	NIOZ_t	348	UoP	
9	9	368.5	1	NIOZ_t	349	UoP	
8	lost	369.5	1	NIOZ_t	350	UoP	lost
7	lost	370.5	1	NIOZ_t	351	UoP	lost
6	lost	371.5	1	NIOZ_t	352	UoP	lost
5	lost	372.5	1	NIOZ_t	353	UoP	lost
4	4	373.5	1	NIOZ_t	354	UoP	
3	lost	374.5	1	NIOZ_t	355	UoP	lost
2	2	375.5	1	NIOZ_t	356	UoP	
1	1	376.5	1	NIOZ_t	357	UoP	
		377.5	1	A/R	073	UoP	
		389.5	12	anchor			

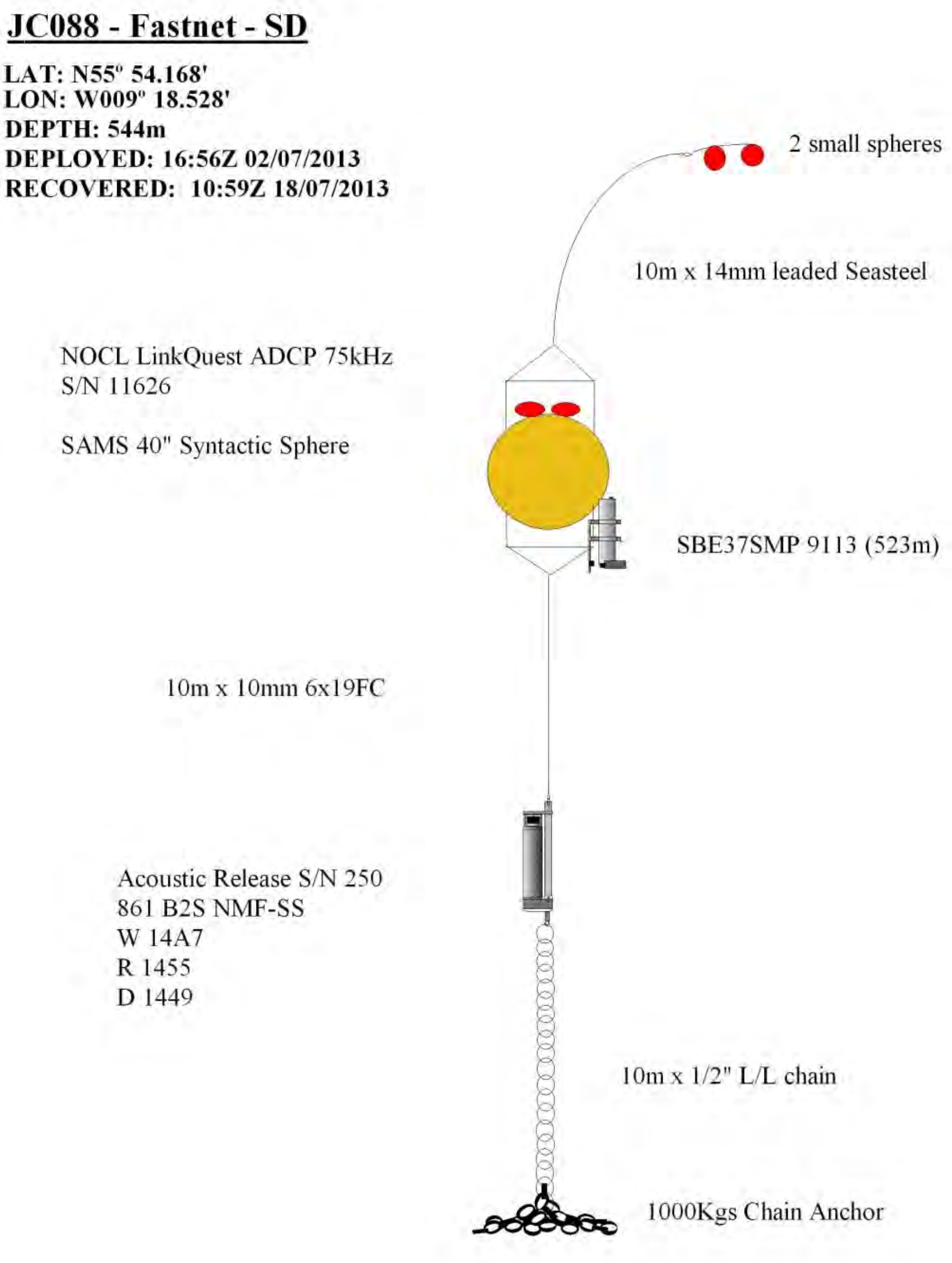
The depths calculated (3rd column) are based on the original positions of the thermistors on the line (1st column), as it is believed the entanglement of the line and subsequent shift of some sensors occurred at recovery.

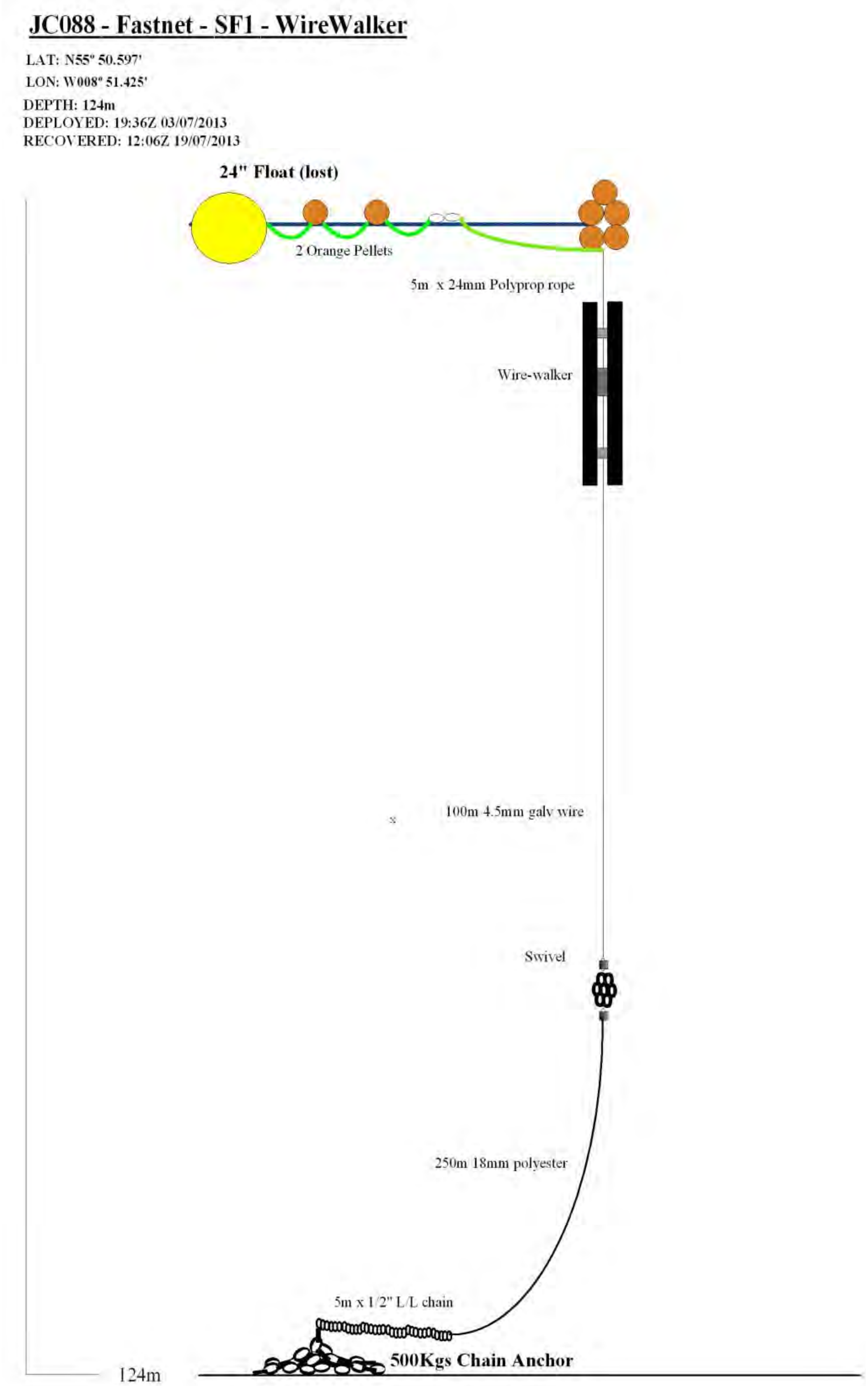

JC088 - Fastnet - SE - 2013
LAT: N55° 52.4248'
LON: W009° 03.5121
DEPTH: 144m
DEPLOYED: 10:18Z 04/07/2013
RECOVERED: 08:28Z 19/07/2013
10m below the surface
10m x 14mm seasteel 2.5m markings & miniloggers
20m
41" S/S buoy
Swivel
1m 1/2" L/L chain
SBE37 5790 - 20.5m (nominal)
1 x 10m 10mm 6x19FC wire 2.5m markings
All instruments supplied by NOC-L
A total of 25 Starmons attached to mooring line
SBE37 5433 - 40m (nominal)
1 x 20m 10mm 6x19FC wire 2.5m markings
1 x 20m 10mm 6x19FC wire 2.5m markings
SBE37 4966 - 72.5m (nominal)
RDI 300kHz ADCP S/N 13759
1 x 5m 10mm 6x19FC wire 2.5m markings
1 x 50m 10mm 6x19FC wire 10m markings
A/R OCEANO 250 S/N 899
(W) 18B4
(D) 1849 5269 Alkaline Batteries
(R) 1855
Lock-out 4s & Active 20s
SBE37 2991 - 125m (nominal)
1 x 10m 1/2" L/L chain
550Kgs & 100Kgs Chain Anchor
145m

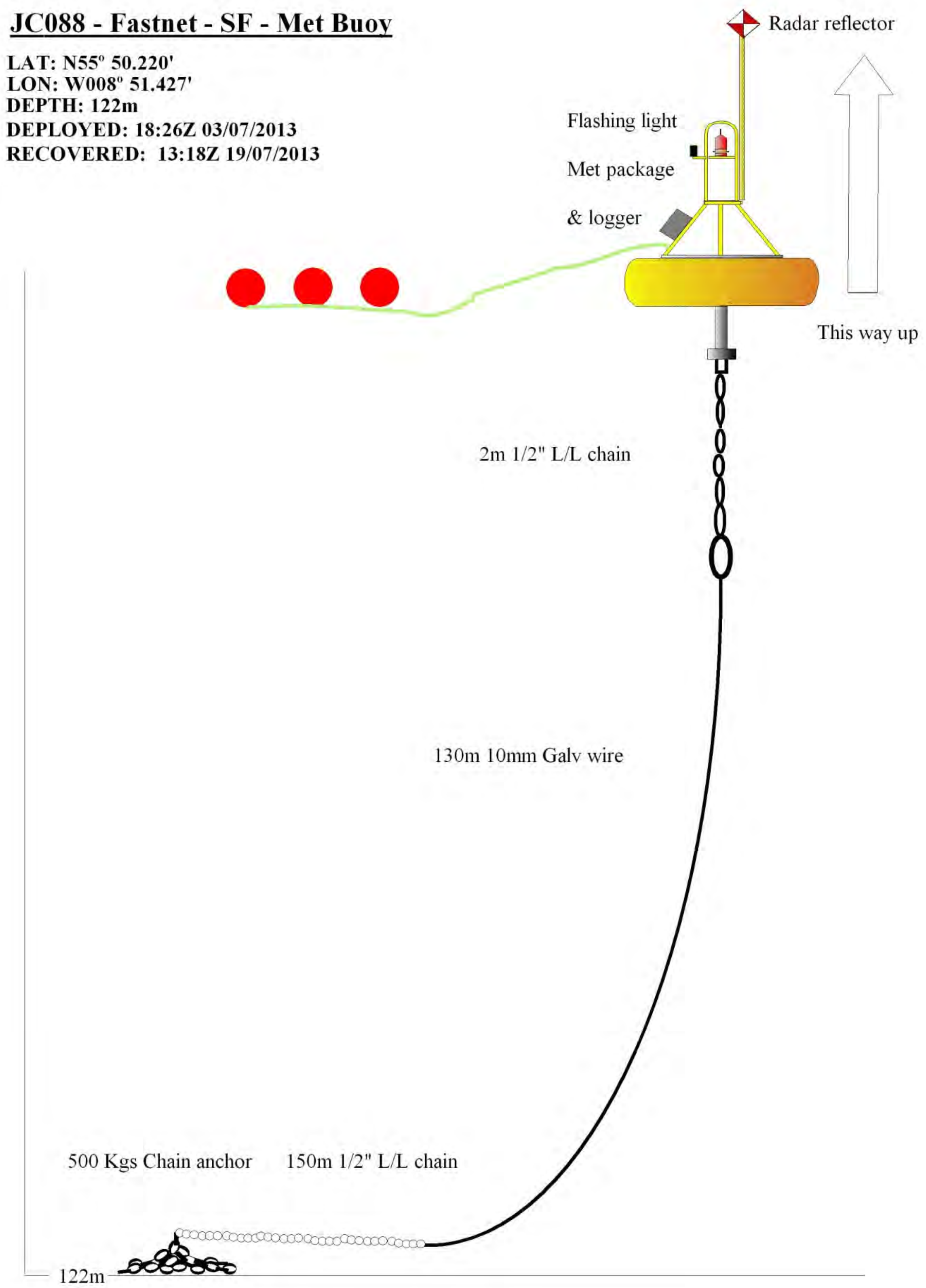
MOORING ID: SE

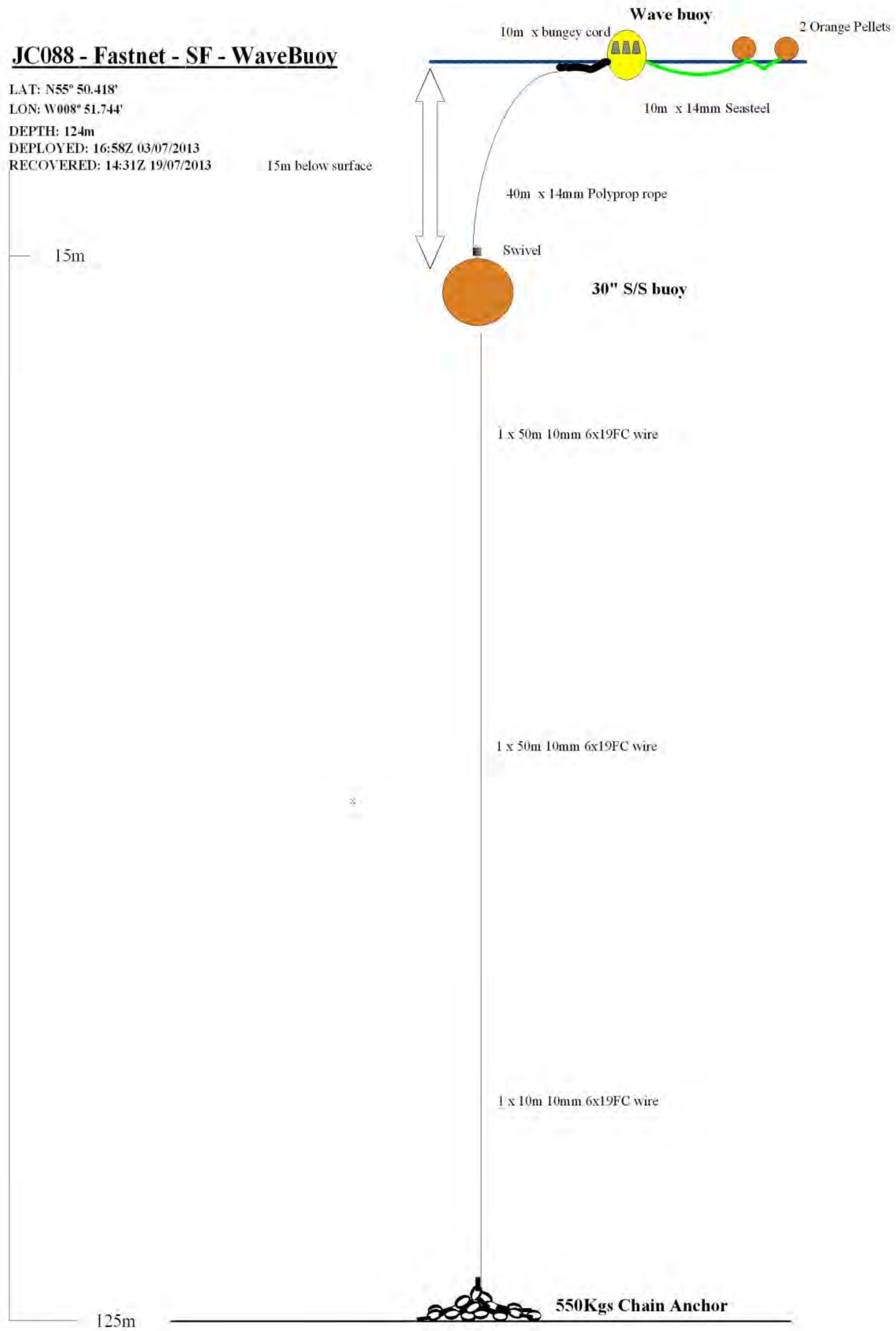
DEPLOYMENT		RECOVERY	
Event #	040	**Event #**	104
Date	04/07/2013	**Date**	19/07/2013
Release time	10:18	**Release time**	07:39
Release latitude	55° 52.425'N	**Release latitude**	55° 52.399'N
Release longitude	009° 03.512'W	**Release longitude**	009° 03.892'W
Release depth	144m	**Release depth**	149m

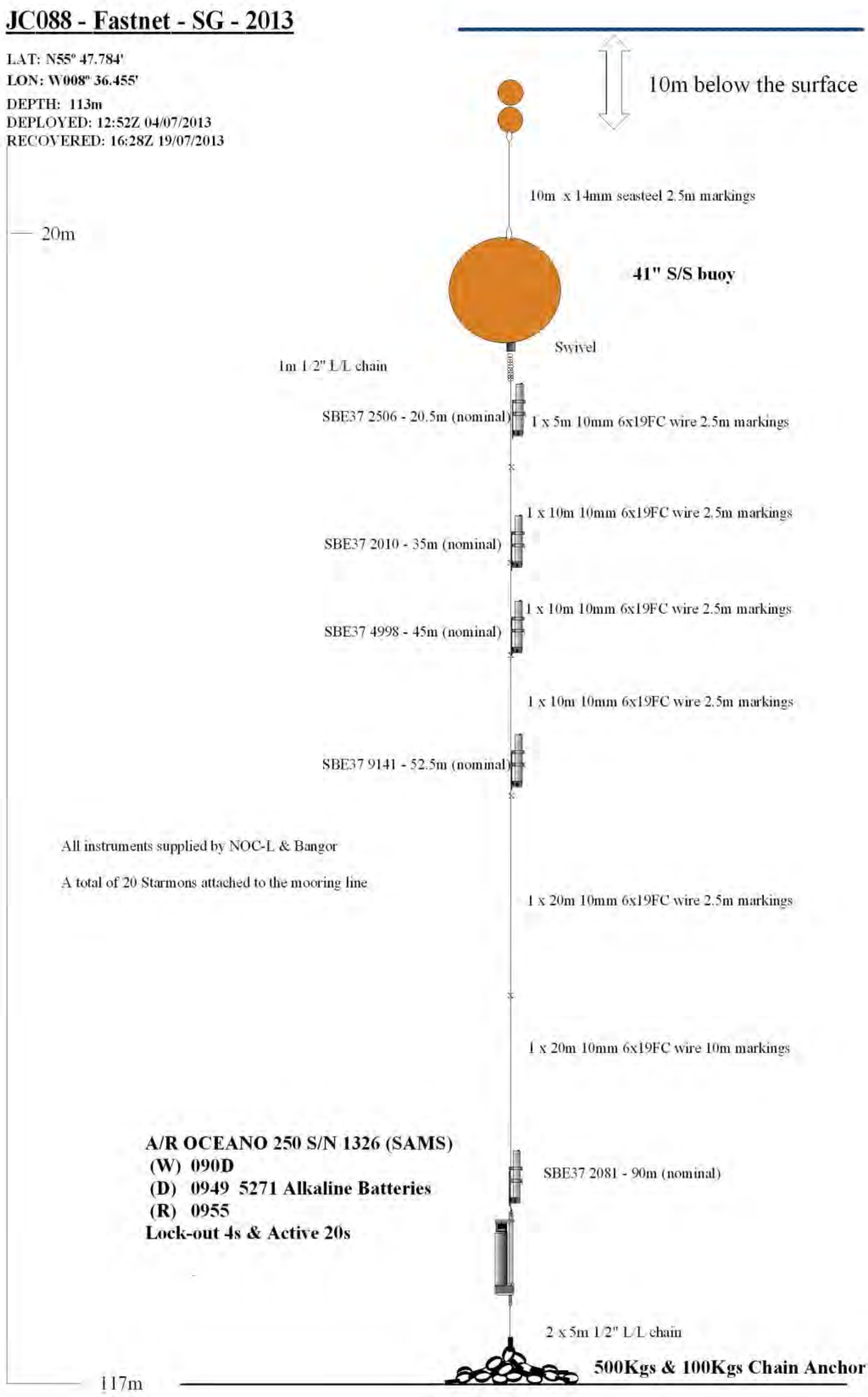
Calculated depth (m)	Incremental depth (m)	Instrument	S/N	Owner	Comments
18.0	0	SM	3581	NOCL	
22.9	5.0	SM	3578	NOCL	
25.4	2.5	SM	3903	NOCL	
27.8	2.5	subsurface float			
28.1	0.2	SM	4130	NOCL	
28.4	0.3	MC	5790	NOCL	
30.3	2.0	SM	3891	NOCL	
32.8	2.5	SM	3583	NOCL	
35.3	2.5	SM	3896	NOCL	
37.8	2.5	SM	3580	NOCL	
40.3	2.5	SM	3894	NOCL	
42.7	2.5	SM	3897	NOCL	
45.2	2.5	SM	3582	NOCL	
48.2	3.0	MC	5433	NOCL	
50.7	2.5	SM	2842	NOCL	
53.2	2.5	SM	2838	NOCL	
55.7	2.5	SM	2849	NOCL	
58.1	2.5	SM	2848	NOCL	
60.6	2.5	SM	2841	NOCL	
63.1	2.5	SM	2851	NOCL	
68.0	5.0	SM	2836	NOCL	
73.0	5.0	SM	2837	NOCL	
77.9	5.0	SM	3887	NOCL	
79.5	1.6	ADCP 300KHz	13759	NMF	average depth reading = 79.5m
80.1	0.6	MC	4966	NOCL	
85.1	5.0	SM	3899	NOCL	
90.0	5.0	SM	3898	NOCL	
95.0	5.0	SM	3890	NOCL	
104.9	9.9	SM	3584	NOCL	
114.8	9.9	SM	3901	NOCL	
134.6	19.8	SM	2991	NOCL	
147.9	13.4	MC	4597	NOCL	
153	5	A/R	899	NMF	
165	12	anchor			


JC088 - Fastnet - SD
LAT: N55° 54.168'
LON: W009° 18.528'
DEPTH: 544m
DEPLOYED: 16:56Z 02/07/2013
RECOVERED: 10:59Z 18/07/2013
2 small spheres
10m x 14mm leaded Seasteel
NOCL LinkQuest ADCP 75kHz
S/N 11626
SAMS 40" Syntactic Sphere
SBE37SMP 9113 (523m)
10m x 10mm 6x19FC
Acoustic Release S/N 250
861 B2S NMF-SS
W 14A7
R 1455
D 1449
10m x 1/2" L/L chain
1000Kgs Chain Anchor


JC088 - Fastnet - SF1 - WireWalker
LAT: N55º 50.597'
LON: W008º 51.425'
DEPTH: 124m
DEPLOYED: 19:36Z 03/07/2013
RECOVERED: 12:06Z 19/07/2013
24" Float (lost)
2 Orange Pellets
5m x 24mm Polyprop rope
Wire-walker
100m 4.5mm galv wire
Swivel
250m 18mm polyester
5m x 1/2" L/L chain
500Kgs Chain Anchor
124m


JC088 - Fastnet - SF - Met Buoy
LAT: N55º 50.220'
LON: W008º 51.427'
DEPTH: 122m
DEPLOYED: 18:26Z 03/07/2013
RECOVERED: 13:18Z 19/07/2013
Radar reflector
Flashing light
Met package
& logger
This way up
2m 1/2" L/L chain
130m 10mm Galv wire
500 Kgs Chain anchor
150m 1/2" L/L chain
122m


JC088 - Fastnet - SF - WaveBuoy
LAT: N55° 50.418'
LON: W008° 51.744'
DEPTH: 124m
DEPLOYED: 16:58Z 03/07/2013
RECOVERED: 14:31Z 19/07/2013
15m below surface
15m
125m
Wave buoy
10m x bungey cord
2 Orange Pellets
10m x 14mm Seasteel
40m x 14mm Polyprop rope
Swivel
30" S/S buoy
1 x 50m 10mm 6x19FC wire
1 x 50m 10mm 6x19FC wire
1 x 10m 10mm 6x19FC wire
550Kgs Chain Anchor


JC088 - Fastnet - SG - 2013
LAT: N55° 47.784'
LON: W008° 36.455'
DEPTH: 113m
DEPLOYED: 12:52Z 04/07/2013
RECOVERED: 16:28Z 19/07/2013
10m below the surface
10m x 14mm seasteel 2.5m markings
20m
41" S/S buoy
Swivel
1m 1/2" L/L chain
SBE37 2506 - 20.5m (nominal)
1 x 5m 10mm 6x19FC wire 2.5m markings
1 x 10m 10mm 6x19FC wire 2.5m markings
SBE37 2010 - 35m (nominal)
1 x 10m 10mm 6x19FC wire 2.5m markings
SBE37 4998 - 45m (nominal)
1 x 10m 10mm 6x19FC wire 2.5m markings
SBE37 9141 - 52.5m (nominal)
All instruments supplied by NOC-L & Bangor
A total of 20 Starmons attached to the mooring line
1 x 20m 10mm 6x19FC wire 2.5m markings
1 x 20m 10mm 6x19FC wire 10m markings
A/R OCEANO 250 S/N 1326 (SAMS)
(W) 090D
(D) 0949 5271 Alkaline Batteries
(R) 0955
Lock-out 4s & Active 20s
SBE37 2081 - 90m (nominal)
2 x 5m 1/2" L/L chain
500Kgs & 100Kgs Chain Anchor
117m

MOORING ID: SG

DEPLOYMENT		RECOVERY	
Event #	042	**Event #**	104
Date	04/07/2013	**Date**	19/07/2013
Release time	12:52	**Release time**	16:35
Release latitude	55° 47.784'N	**Release latitude**	55° 47.744'N
Release longitude	008° 36.455'W	**Release longitude**	009° 36.855'W
Release depth	113m	**Release depth**	-

Calculated depth (m)	Incremental depth (m)	Instrument	S/N	Owner	Comments
18.1		SM	4118	UoB	
23.1	5.0	SM	4139	UoB	
25.6	2.5	SM	4134	UoB	
26.5	1	subsurface float			
29.0	2.5	MC	2506	NOCL	
31.0	2.0	SM	4121	UoB	
33.5	2.5	SM	4137	UoB	
36.0	2.5	SM	4122	UoB	
38.4	2.5	SM	4124	UoB	
40.9	2.5	SM	4131	UoB	
43.4	2.5	MC	2010	NOCL	
45.9	2.5	SM	4136	UoB	
48.3	2.5	SM	4128	UoB	
50.8	2.5	SM	4125	UoB	
54.5	3.6	MC	4998	NOCL	
56.9	2.5	SM	4133	UoB	
59.4	2.5	SM	4127	UoB	
61.7	2.3	MC	9141	NOCL	
64.2	2.5	SM	4123	UoB	
69.2	5.0	SM	4120	UoB	
74.1	4.9	SM	4135	UoB	average depth reading = 79.5m
79.1	5.0	SM	4138	UoB	
84.0	5.0	SM	4126	UoB	
89.0	4.9	SM	3893	NOCL	
96.4	7.4	MC	2081	NOCL	
103.8	7.4	SM	3905	NOCL	
106	2	A/R	1326	SAMS	
118	12	anchor			

MOORING ID: SF1 (wire-walker)

DEPLOYMENT		RECOVERY	
Event #	034	**Event #**	106
Date	03/07/2013	**Date**	19/07/2013
Release time	19:36	**Release time**	11:46
Release latitude	55° 50.597'N	**Release latitude**	55° 50.725'N
Release longitude	008° 51.425'W	**Release longitude**	008° 51.422'W
Release depth	124m	**Release depth**	-

MOORING ID: SF3 (met buoy)

DEPLOYMENT		RECOVERY	
Event #	033	**Event #**	107
Date	03/07/2013	**Date**	19/07/2013
Release time	18:26	**Release time**	12:50
Release latitude	55° 50.220'N	**Release latitude**	55° 50.306'N
Release longitude	008° 51.427'W	**Release longitude**	008° 51.419'W
Release depth	122m	**Release depth**	-

MOORING ID: SF4 (wave buoy)

DEPLOYMENT		RECOVERY	
Event #	032	**Event #**	108
Date	03/07/2013	**Date**	19/07/2013
Release time	16:58	**Release time**	14:13
Release latitude	55° 50.418'N	**Release latitude**	55° 50.467'N
Release longitude	008° 51.744'W	**Release longitude**	008° 51.683'W
Release depth	124m	**Release depth**	-

13.6 Bedframe moorings

The Seabird 16+'s, ADVs, ADCPs and Aquadops were all mounted on the frames this number of metres above the bottom:
SBE 16 + - 0.75 m
ADV - 1.1 m
ADCPs - 0.95 m
Aquadops - 0.85 m

The total water depths established after recovery were:
SE - 148.70 m
SF - 128.66m
SG - 117.24

MOORING ID: SE (bed-frame)

DEPLOYMENT		**RECOVERY**	
Event #	039	**Event #**	105
Date	04/07/2013	**Date**	19/07/2013
Release time	08:46	**Release time**	09:18
Release latitude	55° 52.078'N	**Release latitude**	55° 52.082'N
Release longitude	009° 03.730'W	**Release longitude**	009° 03.908'W
Release depth	143m	**Release depth**	153m

MOORING ID: SF (bed-frame)

DEPLOYMENT		**RECOVERY**	
Event #	031	**Event #**	109
Date	03/07/2013	**Date**	19/07/2013
Release time	16:21	**Release time**	14:50
Release latitude	55° 50.463'N	**Release latitude**	55° 50.459'N
Release longitude	008° 51.052'W	**Release longitude**	008° 51.266'W
Release depth	124m	**Release depth**	-

MOORING ID: SG (bed-frame)

DEPLOYMENT		**RECOVERY**	
Event #	041	**Event #**	111
Date	04/07/2013	**Date**	19/07/2013
Release time	12:32	**Release time**	17:41
Release latitude	55° 47.830'N	**Release latitude**	55° 47.764'N
Release longitude	008° 36.240'W	**Release longitude**	009° 36.481'W
Release depth	113m	**Release depth**	-

SBE16 + (Pumped conductivity and digiquartz pressure)								
Mooring ID	Serial number	Clock set	Start	Stop	Clock drift (sec)	Depth (m)	Interval (min)	Measures per sample
		Date + Time (GMT)	Date + Time (GMT)	Date + Time (GMT)				
SE	4597	27/06/13 19:02:30	29/06/13 09:00:00	20/07/13 08:39:15	2	147	2	4
SF	4848	27/06/13 19:14:40	29/06/13 09:00:00	20/07/13 08:53:40	1	127.91	2	4
SG	5309	27/06/13 19:24:30	29/06/13 09:00:00	20/07/13 08:48:30	3	116.49	2	4

Sontek ADVs											
Mooring ID	Serial number	Clock set	Delayed start	Stop	Clock drift (sec)	Depth (m)	Sample rate	Burst interval (sec)	Samples per burst	Memory (GB)	Electronics case
		Date + Time (GMT)	Date + Time (GMT)	Date + Time (GMT)							
SE	B292	27/06/13 17:07:19	29/06/13 12:00:00	20/07/13 09:23:30	-8	147.60	16 Hz	1800	26,400	1	G358
SF	B285	27/06/13 17:20:55	29/06/13 12:00:00	20/07/13 09:15:30	-9	127.56	16 Hz	1800	26,400	1	G355
SG	D281	27/06/13 17:34:04	29/06/13 12:00:00	20/07/13 09:31:30	-9	116.14	16 Hz	1800	26,400	1	G496

Nortek Aquadopps (2MHz Coherent Doppler)							
Mooring ID	Serial number	Clock set	Delayed start	Stop	Clock drift (sec)	Depth (m)	Memory (GB)
		Date + Time (GMT)	Date + Time (GMT)	Date + Time (GMT)			
SE	P24977-1	28/06/13 07:15:51	29/06/13 12:00:00	20/07/13 10:06:07	-1.26	147.85	4
SF	P24977-2	28/06/13 07:24:51	29/06/13 12:00:00	20/07/13 09:46:20	-1.26	127.81	4

	ADCPs													
Mooring ID	Instrument	Serial number	Clock set	Delayed start	Stopped	Clock drift (sec)	Depth (m)	Bin size (m)	No. bins (RDI)	MWD (FQ) (m)	Ens. (secs)	Ping rate (sec)	Pings per ens.	Memory (GB)
			Date + Time (GMT)	Date + Time (GMT)	Date+ Time (GMT)									
SE	RDI 300	14745	27/06/13 18:38:50	29/06/13 09:00:00	20/07/13 08:10:45	22	147.75	2	46	N/A	1.2	1.2	1	2.5
SF	Flowquest150	11043	25/06/13 10:40:30	29/06/13 12:00:00	20/07/13 17:01:55	-9	127.71	2	N/A	180	60	1	60	
SG	Flowquest150	11625	25/06/13 10:08:30	29/06/13 12:00:00	20/07/13 17:06:58	16	116.29	2	N/A	180	60	1	60	

ACOUSTIC RELEASES + CODES								
Mooring ID	ACOUSTIC 1				ACOUSTIC 2			
	Serial number	Rx (kH)	Tx (kH)	Rc	Serial number	Rx (kH)	Tx (kH)	Rc
SE	72382	10	12	A	69679	11.5	12	B
SF	72863	13.5	12	A	70356	10.5	12	D
SG	71922	11.5	12	A	70355	10	12	B

14 Glider Operations

James Burris, NOCS

14.1 Introduction

During JC088 the National Oceanography Centre, MARS (Marine Autonomous and Robotics Systems) group was responsible for supplying and deploying three Slocum electric gliders (this included one supplied by National Oceanography Centre, Liverpool). The Slocums provided were of the upgraded G2 type. MARS was also responsible for supplying two Seagliders.

The breakdown of naming and intended use is listed below:

SG 525 Seaglider. To be deployed for the duration of JC088 as part of the Sensors on gliders program. (SAUG).

Instruments installed on glider: Sea Bird CT sail, Wetlabs triplet puck (chlorophyll, CDOM and back scatter) Aanderra optode.

SG 550 Seaglider. To be deployed with the NOC Fast CT sensor as part of the sensors on gliders project. Length of deployment approx 3 months.

Instruments installed: Sea Bird CT sail, Wetlabs triplet puck (chlorophyll, CDOM and backscatter) Aanderra optode, NOC fast CT sensor. PAR sensor.

Slocum 1000m electric glider 330 (Bellimite) To be deployed as part of the FASTNET project. Length of deployment approx 3months.

Instruments installed: Sea Bird CTD, Aanderra optode, triplet puck.

Slocum 200m electric glider 331 (Coprolite) to be deployed as part of the FASTNET project. Length of deployment approx 3months.

Instruments installed: Sea Bird CTD, Aanderra optode, triplet puck.

Slocum 200m electric glider 352 Ocean Mixing Glider (OMG). To be deployed as part of the FASTNET project. Length of deployment; Duration of JC088.

Instruments installed: Rockland Micro Structure profiler. (Aandera optode, seabird CTD).

In addition to deploying these gliders, MARS was also responsible for the recovery of three gliders. Two of these are listed above (OMG and SG525). The third glider to be recovered was Unit 345, another shallow rated (200m) slocum electric glider that had been deployed in May 2013 as part of the FASTNET project. Units 330 and 331 were deployed on JC088 to switch out Unit 345, due to 345 batteries being depleted.

14.2 Pre-deployment preparation and testing

Prior to mobilising for the cruise all of the gliders (apart from the OMG Slocum which was prepared and tested at NOC Liverpool) were pre cruise checked at National Oceanography centre Southampton.

This included dissembling the gliders and checking O rings etc. SG550 had been checked previously for trials at SAMS. SG525 need a new Iridium SIM card, once this was changed out the glider was back filled with Nitrogen to reduce the relative internal humidity, which in turn lowered the Dew Point. All gliders had their vacuums checked, and all gliders were ballasted checked in the fresh water tank, with calculations being done to ballast them for a target density of 1027 kg/m$^{3.}$

The gliders were then transported to Glasgow for mobilisation. Due to the fact they had been transported by road transport (and therefore ran the risk of vibration problems) all vacuum were checked again on arrival. These were found to be within tolerance. The dew point values for the two Seagliders were also rechecked. The dew point for SG525 was calculated at 5.45^{0}C. The dew point for SG550 was calculated as being 0.830C. (The differences between the two being that SG525 had a relative humidity of 41.8% and SG550 RH being 28%.

(Note: When on site in the work area, the temperature at 1000m was checked when carrying out CTDs. It was found that the temperature at that depth was 6℃, therefore the Dew point of 5.45℃ would not cause condensation to develop at the intended working depths).

Self tests and SIM dives were carried out repeatedly on both Seagliders. It was found that the Port side aft area of the RRS James Cook was the best location for glider communications via iridium. During testing it was also noticed that SG525 consistently had a higher failure rate when calling in over iridium. SG525 also had several retries when pumping the VBD during tests, due to this commands were sent to ensure that the pump was fully exercised from minimum to maximum inflation. The pump passed this test; the results of the self tests were also passed onto the manufacturer (I-Robot) for them to double check. They confirmed that all should be well with the glider on deployment. It was also noted that there is the beginnings of perishing on the buoyancy bladder, this will be monitored and changed out soon. (SG525 is only deployed for the duration of JC088.)

The science sensors (and in particular the temperature sensor) was also checked. The temperature values seemed reasonable whilst on deck.

Testing was then carried out on the two slocums supplied by NOCS. Vacuums were still found to be within tolerance. The other tests run on the slocums included ballast/ oil pumped (to ensure full movement), altimeter voltage and science sensor outputs. All tests passed.

Once on location at the Malin shelf site, the mobile tank was filled with local seawater to test the ballasting and trim of all three Slocums. The density of the tank water was calculated as being 1026.6 -1026.2 (due to testing being spread over two days, with the tank having to be refilled). All gliders tested well for ballasting and trim.

14.3 Deployment methods

The Seagliders and Slocums were both deployed off the stbd gantry rozler winch. This winch was pre loaded with Kevlar line with a breaking strain of approx 5 tons.

The stbd gantry was chosen for two reasons; 1) by launching gliders at the stbd waist, it would help to keep the gliders well clear of the fore and aft thruster ports and also the props. 2) By using Kevlar line with a small shackle, it was possible to construct a lightweight lifting rig. This was beneficial as it removed the need for a large heavy crane block. Using such a block would run the risk of the glider impacting with the crane block when in the water.

The Slocums were deployed using the horizontal method (details can be found in appendix 2).

The Seagliders were deployed by the vertical method, (details can be found in appendix 3). This method worked well, but was improved on the second deployment of a sea glider (SG550) by including a small swivel in between the shackle on the end of the Kevlar and the lifting rig. Both methods were successful with no damage to the gliders.

Fig 1. Vertical deployment method for the Sea glider. (Note blue alcathen pipe on the lifting rig, to prevent the lines twisting and snapping the antenna.)

Prior to deployment of SG550 the light shield was raised to the deployment position (halfway up the Teflon sphere).

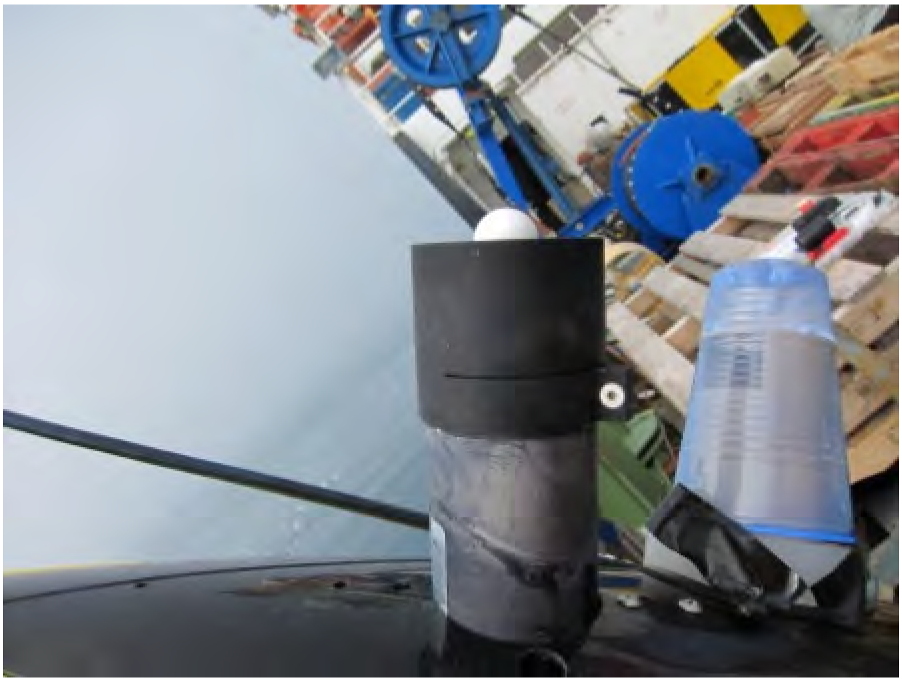


Fig 2. PAR sensor with light shield in deployment position. (The drinking cup in the right back ground is to prevent airbourne debris from damaging the NOCS Fast CT sensor.)

Slocum deployment:

This was the first time the new horizontal method for deploying Slocums was used. This new method worked very well (even for a glider as delicate as the OMG). When launching the Slocums, they were orientated so that the nose was facing aft. This was done so that breaking waves would not smash into the front of the glider as it was being lowered.

This enabled the deployment of the glider in less than ideal conditions (i.e. flat calm and from a small boat).

The previous method was to sling the glider horizontally using two strops and one sea catch. This method was not ideal as it was a heavier rig with less release control.

Fig 3. OMG glider being lifted into deployment position. Note weighted free running spreader bar underneath glider.

Fig 4. OMG glider being lowered to water line to be deployed.

14.4 Deployment information

SG 525 Deployed 3rd July 2013, 13:23 GMT. Position: 55° 52.072'N 008° 58.295'W. 134m depth. Weather conditions : 15-20knts sea state 1.5m

OMG (SN: 352) Deployed 5th July 2013, 15:18 GMT. Position: 55° 50.538'N 008° 53.759' W. 128m depth. Weather conditions: 25-30knts, sea state 2-2.5m.

Slocum 330 (Bellimite) Deployed 6th July 2013, 14:25 GMT. 55° 34.346' N 009° 31.228' W. 400m depth. Weather conditions: 20Knts, sea state 2m.

Slocum 331 (Coprolite) Deployed 6th July 2013, 17:05 GMT. 55° 33.911'N 009° 31.923'W. Weather conditions: 20Knts, sea state 2m.

SG550. Deployed 9th July 2013, 13:42 GMT. 55° 20.179'N 009° 51.330'W. 242m depth. Weather conditions: 8Knts, sea state flat calm, slight swell.

14.5 Recovery

14.5.1 U 345

Prior to recovery of U 345 a calibration CTD (CTD 047) was carried out. This was in location: 55° 37.305'N 009° 40.954'W to a depth of 1575m.

Unit 345 was recovered on Tuesday 16th of July at 13:40 GMT. Position: 55° 37.656'N 009° 42.144'W. Weather conditions 20knts, seas approx 1.5 occasional 2m.This glider was recovered with the releasable nose cone method. This worked well, but it should be noted that it is advisable to wait at least 10mins from sending the command to the burn wire, to the nose cone beginning to move away from the glider.

Figure 5. U 345 with nose cone released (seen on the right hand side of the image), with line paying out behind the glider. Note that the recovery line is not fully streamed.

Fig 6. Glider being lifted from the water via the nose recovery line. (This line was shackled onto the rozler winch Kevlar line on the stbd gantry.)

Fig 7. Bio fouling on the glider was fairly minor on most surfaces. Light coating of algae with some goose necked barnacles.

Fig 8. Close up of barnacles around the Seabird CTD. No significant bio fouling was noted on the intake/outtake ports.

14.5.2 Recovery of SG 525

Prior to the recovery of SG525, CTD cast 061 was carried out in position: 56° 01.451’N 009° 47.335’W. This was to a depth of 1790m and was approx 2.5km from the glider recovery location. The data from this CTD will be used as a calibration check of the sensors on the glider.

SG 525 was recovered using the pole lasso method (see image below). This was recovered at 07:42 GMT on the 20th of July 2013. Location: 56° 01.50549’N 009° 49.74741’W.

Bio fouling was almost non-existent due to the short deployment duration. No part of the glider was damaged in the recovery.

Fig 9. Pole with aluminium hoop to hold lasso. This was placed over the tail fin lifting point, and the heaving line pulled tight.

14.5.3 Recovery of OMG. (Unit 352)

Prior to the recovery of Unit 352, CTD062 was carried out at location: 55° 52.128’N 008° 53.157’W. This was to a depth of 127m. The data from this will be used as a calibration of the CT sensors on the glider.

The Glider was recovered at 12:26 GMT on the 20th of July 2013. This was recovered in location: 55° 53.340’N 008° 53.105’W. This was recovered using the nose recovery line technique. This worked well with no damage to the glider or the sensors.

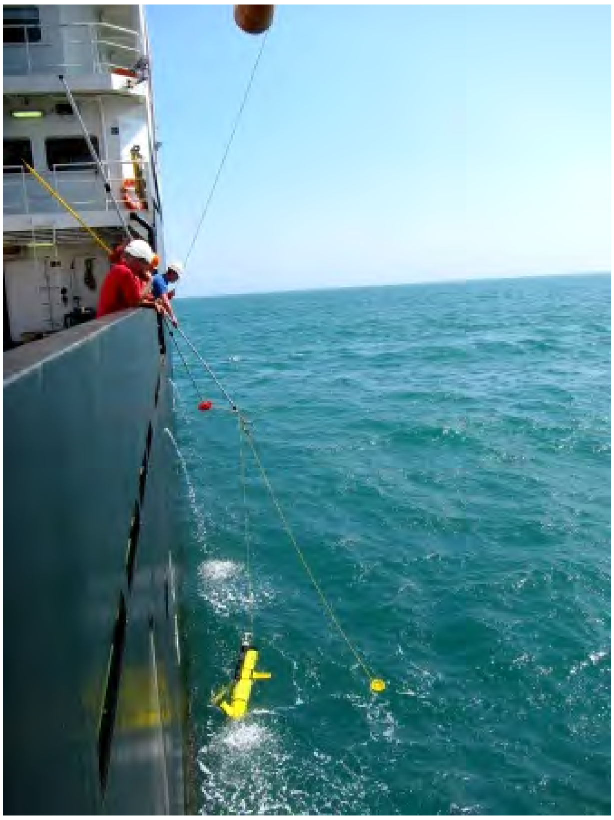


Fig 10. OMG glider with nose cone released, recovery line picked up with modified boat hook.

Fig 11. OMG glider being lifted on winch on stbd gantry. Line well clear of the turbulence sensors.

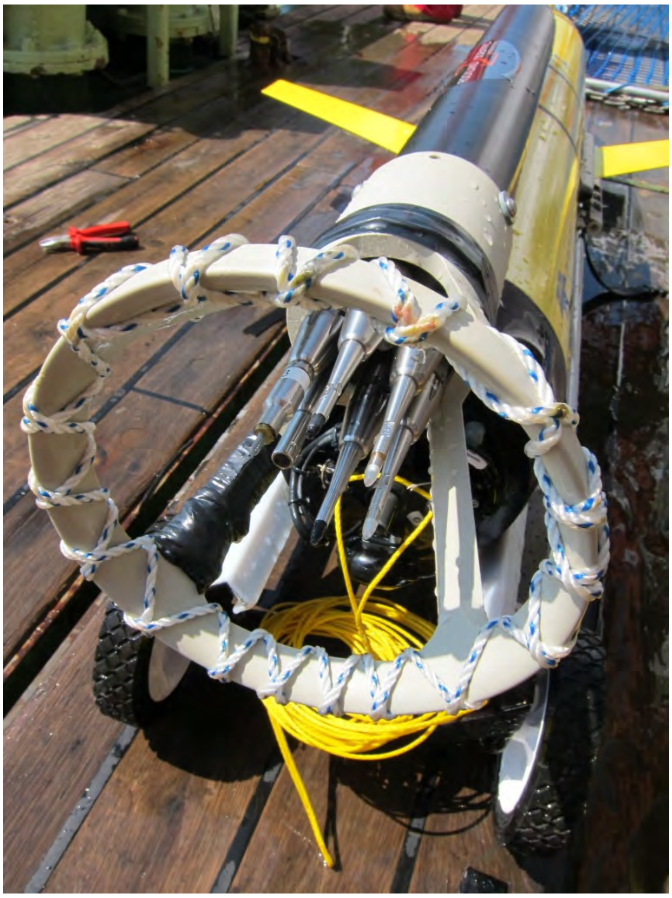


Fig 12. Photo of turbulence sensors, complete and having sustained no visible damage in recovery.

14.6 Conclusion

From a glider point of view, I think the cruise was a success. All gliders were deployed with no damage, and those that were recovered also received no visible damage.

This cruise also provided the opportunity to try some new techniques, namely an improved horizontal deployment rig for the slocums, and also the nose line recovery method for retrieving slocums. Both of these methods worked well, even in marginal conditions. (F6 for the first Slocum deployment).

Having someone filming on board was also advantageous as it provided a good record of the deployment and recoveries. This footage can be used to evaluate the deployments to identify any further improvements.

Having tried the new deployment techniques, I think these will both work well in future deployments from large ships.

15 Underway measurements

Julian Whisgott

15.1 Introduction

All the ships navigation, echo soundings, surface hydrography and meteorology (surfmet), magnetometer and winch data are stored on a central logging system, TECHSAS (TECHnical and Scientific sensors Acquisition System), in NetCDF format. This underway data can be transferred from TECHSAS to an RVS Level-C logging system where data processing modules (described later) are applied. On JC88 navigation, echo soundings, surface hydrography and meteorology data were taken every 1 second from these processed data streams.

15.2 RVS Level-C data streams and processing

The following processed Level-C files were produced daily containing 1 second data.

Filename	Start of file	End of file
JC88-179-1s-dos.txt	28-Jun-2013 08:00:00	28-Jun-2013 23:59:59
JC88-180-1s-dos.txt	29-Jun-2013 00:00:00	29-Jun-2013 23:59:59
JC88-181-1s-dos.txt	30-Jun-2013 00:00:00	30-Jun-2013 23:59:59
JC88-182-1s-dos.txt	01-Jul-2013 00:00:00	01-Jul-2013 23:59:59
JC88-183-1s-dos.txt	02-Jul-2013 00:00:00	02-Jul-2013 23:59:59
JC88-184-1s-dos.txt	03-Jul-2013 00:00:00	03-Jul-2013 23:59:59
JC88-185-1s-dos.txt	04-Jul-2013 00:00:00	04-Jul-2013 23:59:59
JC88-186-1s-dos.txt	05-Jul-2013 00:00:00	05-Jul-2013 23:59:59
JC88-187-1s-dos.txt	06-Jul-2013 00:00:00	06-Jul-2013 23:59:59
JC88-188-1s-dos.txt	07-Jul-2013 00:00:00	07-Jul-2013 23:59:59
JC88-189-1s-dos.txt	08-Jul-2013 00:00:00	08-Jul-2013 23:59:59
JC88-190-1s-dos.txt	09-Jul-2013 00:00:00	09-Jul-2013 23:59:59
JC88-191-1s-dos.txt	10-Jul-2013 00:00:00	10-Jul-2013 23:59:59
JC88-192-1s-dos.txt	11-Jul-2013 00:00:00	11-Jul-2013 23:59:59
JC88-193-1s-dos.txt	12-Jul-2013 00:00:00	12-Jul-2013 23:59:59
JC88-194-1s-dos.txt	13-Jul-2013 00:00:00	13-Jul-2013 23:59:59

JC88-195-1s-dos.txt	14-Jul-2013 00:00:00	14-Jul-2013 23:59:59
JC88-196-1s-dos.txt	15-Jul-2013 00:00:00	15-Jul-2013 23:59:59
JC88-197-1s-dos.txt	16-Jul-2013 00:00:00	16-Jul-2013 23:59:59
JC88-198-1s-dos.txt	17-Jul-2013 00:00:00	17-Jul-2013 23:59:59
JC88-199-1s-dos.txt	18-Jul-2013 00:00:00	18-Jul-2013 23:59:59
JC88-200-1s-dos.txt	19-Jul-2013 00:00:00	19-Jul-2103 23:59:59
JC88-201-1s-dos.txt	20-Jul-2013 00:00:00	20-Jul-2013 23:59:59
JC88-202-1s-dos.txt	21-Jul-2013 00:00:00	21-Jul-2013 23:59:59
JC88-203-1s-dos.txt	22-Jul-2013 00:00:00	22-Jul-2013 07:15:00

The table below details the data contained within each file and the instrument that it has come from. Details of any processing routines applied are described below.

Heading	**Description**	**Instrument / processing**
Time	YY DDD HH:MM:SS, where DDD is the Julian day of the year	1 second intervals
Latitude	Latitude [decimal degrees]	POSMV 3.8
Longitude	Longitude [decimal degrees]	POSMV 3.8
SMG	Speed over the ground [knots] (speed made good)	POSMV 3.8
CMG	Course over the ground [degree true] (course made good)	POSMV 3.8
POSMV	True heading of ship [degree]	POSMV 3.8
Pitch	Pitch [degree]. Bow up gives positive value.	POSMV 3.8
Roll	Roll [degree]. Starboard roll gives positive value.	POSMV 3.8
UncDepth	Sounding value [m]	Simrad EA600
CorDepth	Sounding value [m]	Simrad EA600, calculated by *prodep*
Temp_h	Water temperature measured in SBE45 housing [degree Celsius]	Seabird Micro TSG SBE45

Cond	Conductivity measured by the SBE45 [siemen per metre]	Seabird Micro TSG SBE45
SndSpeed	Velocity of sound in the sampled water calculated by the SBE45 [metre per second]	Seabird Micro TSG SBE45
SST	Water temperature measured by the SBE38 remote thermometer at the raw water inlet to the ship (Temp_r)	Seabird SBE8 Digital Oceanographic Thermometer
Salinity	Water salinity calculated by the SBE45 [pss]	Seabird Micro TSG SBE45
Fluorescence*	Voltage measured by the Nudam Analogue to Digital Convertor (ADC) [volts]	Wetlabs WS3S Fluorometer
Transmittance*	Raw voltage measured by the Nudam ADC	Wetlabs C-Star Transmissometer
AirTemp	Air temperature [degree Celsius]	Vaisala HUMICAP temperature sensor (model HMP45AL)
Pressure	Atmospheric pressure [hPa]	Vaisala BAROCAP (model PTB100)
PPAR* and SPAR*	Photosynthetically Active Radiation. Voltage measured by the Nudam ADC in millivots and multiplied by 100 in the surfmet software [volt x 10^{-5}]	Skye Instruments Photosynthetically Active Radiation Sensor (model SKE 510) on port/starboard side
PTIR* and STIR*	Total Incidental Radiation.Voltage measured by the Nudam ADC in millivolts and multiplied by 100 in the surfmet software [volt x 10^{-5}]	Kipp and Zonen Total Incidental Radiation sensor (model CM6B) on port/starboard side
RelWindSPD	Relative wind velocity [m/s]	Gill Windsonic anemometer on ships met platform (approx. 19.4 m above sea surface)
RelWindDIR	Relative wind direction [degree] with 0° being at the bow.	Gill Windsonic anemometer on ships met platform (approx. 19.4 m

		above sea surface)
Humidity	Relative humidity of the air [%]	Vaisala HUMICAP 180 humidity sensor (model HMP45AL)
AbsWindSpd	Absolute wind speed [m/s]	from *pro_wind* (every 10 seconds)
AbsWindDir	Absolute wind direction [degree]	from *pro_wind* (every 10 seconds)
Heading	True heading of ship	Ships Gyro Heading

* *Requires manufacturer calibration*

15.2.1 Corrected depth variable

The corrected depth variable (CorDepth) was obtained from the processing routine ***prodep***. The programme corrects the raw depths (UncDepth) recorded by the hull-mounted, single beam echo sounder (Simrad EA600) for local variations in sound velocity using values from the Carter tables published by the Hydrographic Office. These tables divide the world's oceans into areas of similar water masses and provide depth corrections for each area. The program uses a navigation file to find the position of each depth record and applies the relevant correction.

15.2.2 Calculation of absolute winds

Unlike all other variables, the absolute wind speed and direction (AbsWindSpd, AbsWindDir) is output every 10 seconds (as opposed to every 1 second). This is due to the routine ***pro_wind,*** which calculates the absolute wind, relying on output from the programme *bestnav*, which is only available every 10 seconds. ***pro_wind*** removes the relative variables from the wind. It removes any fixed offsets in the system and any effect of the ship motion (using heading, CMG and SMG produced by *bestnav* – not those in the table above) to produce a true representation of the ships wind.

bestnav reads position fixes from up to three GPS sources (1. POSMV 3.8, 2. Seapath 200, 3. AshTech ADU5) along with the ships motion (calculated by *relmov*). When the primary GPS source (POSMV 3.8) fails the program resorts to the secondary GPS source (Seapath 200) until the primary source resumes and so on. Dead reckoning is used to fill in gaps where all three sources fail and draws upon the relative motion of the ship calculated in *relmov* and an estimate of the ships drift velocity. *bestnav* also calculates speed and course made good. Given the reliability of the primary GPS feed (POSMV 3.8), and the desire for 1 second instead of 10 second navigational data *bestnav* is only used to produce the variables required by *pro_wind.*

relmov: Calibrates and calculates the relative movement of the ship. Data are obtained from the electromagnetic speed log and the ship's gyro. *relmov* calibrates the ships gyro heading by applying a fixed offset to obtain a true heading. The electromagnetic log is calibrated for misalignment, maximum slew and a multiplier. *Relmov* then calculates the ship's northward and eastward velocities. The relative movement of the ship is used to calculate the ship's track during periods of dead-reckoning.

bestdrf: This is a product of *bestnav*. When run *bestnav* uses the *relmov* data which contains a predicted vn and ve (ships velocities) based upon direction and speed through the water. The *bestdrf* file is the accurate drift velocity of what actually occurred based on the GPS changes between each record.

15.3 Matlab processing and calibration

Each Level-C file was read into Matlab so that further processing, calibration and quality control could be performed on selected variables.

15.3.1 Manufacturer calibrations

The SBE 45 and SBE 38 sensors have manufacturer calibrations applied prior to ingestion into the TECHSAS and RVS data formats. Channels requiring a manufacturer calibration are: fluorometry, transmissometry, PAR, and TIR. No calibrations are necessary for air temperature and pressure, humidity, wind speed and direction.

Chlorophyll (WETLabs WETStar)

The following calibration was applied to obtain chlorophyll concentration, CHL:

CHL(µg/l) = SF x (output – CWO)

SF = Scale factor = 12.7 µg/l/V

CWO = Clean water offset = 0.057 V

Output in volts

Transmission (WETLabs C-Star)

The following calibration was applied to obtain beam transmission (Tr) and the beam attenuation coefficient (c):

Beam transmittance = T_r = (Vs_{ig} - V_d) / (V_{ref} - V_d)

Beam attenuation coefficient = c = -1/x * ln(T_r)

V_d Meter output with the beam blocked (the offset) 0.060 V

V_{air}Meter output in air with a clear beam path4.758 V

V_{ref}Meter output with clean water in the path4.665 V

V_{sig}Measured signal outputV

XPathlength0.25 m

The beam transmission is a value between 0 and 1 (or 0-100%).

PPAR and SPAR (Skye Instruments)

For the calculation of Photosynthetically Active Radiation (PAR) the following equation was applied:

PAR (W/m^2) = (output x 10) [µV] / sensitivity [$µV/W/m^2$]

The PAR output in the processed files is in a non-standard voltage unit (millivolts x 100). This means that the output needs to be multiplied by 10^{-5} to convert to volts (V) or by 10 to convert to microvolts (µV). The sensitivity for the port and starboard sensors is 10.81 and 9.53 $µV/W/m^2$, respectively.

PTIR and STIR (Kipp and Zonen)

For calculation of solar irradiance the following equation is applied:

TIR (W/m^2) = (pyranometer output x 10) [µV] / sensitivity [$µV/W/m^2$]

The TIR output in the processed files is in a non-standard voltage unit (millivolts x 100). This means that the output needs to be multiplied by 10^{-5} to convert to volts (V) or by 10 to convert to microvolts (µV). The sensitivity for the port and starboard sensors is 11.41 and 9.67 $µV/W/m^2$, respectively.

15.3.2 In-situ calibrations

Samples from the ships underway water supply were taken every 4 hours up until 21st July 2013 in order to provide calibration for salinity and chlorophyll concentration.

Salinity

A total of 136 useable salinity samples were analyzed using a Guildline Autosal salinometer (S/N 60839) against standard seawater. After the residuals were calculated, three distinct step changes were detected in the data. These coincided with the weekly non-toxic cleaning of the underway data. As a result, four periods were chosen to be analysed separately.

These periods were:

1st: 28th June – 4th July 2013 (Figure 1; black dots)

2nd: 4th – 12th July 2013 (Figure 1; blue dots)

3rd: 12th – 19th July 2013 (Figure 1; green dots)

4th: 19th – 22nd July 2013 (Figure 1; magenta dots).

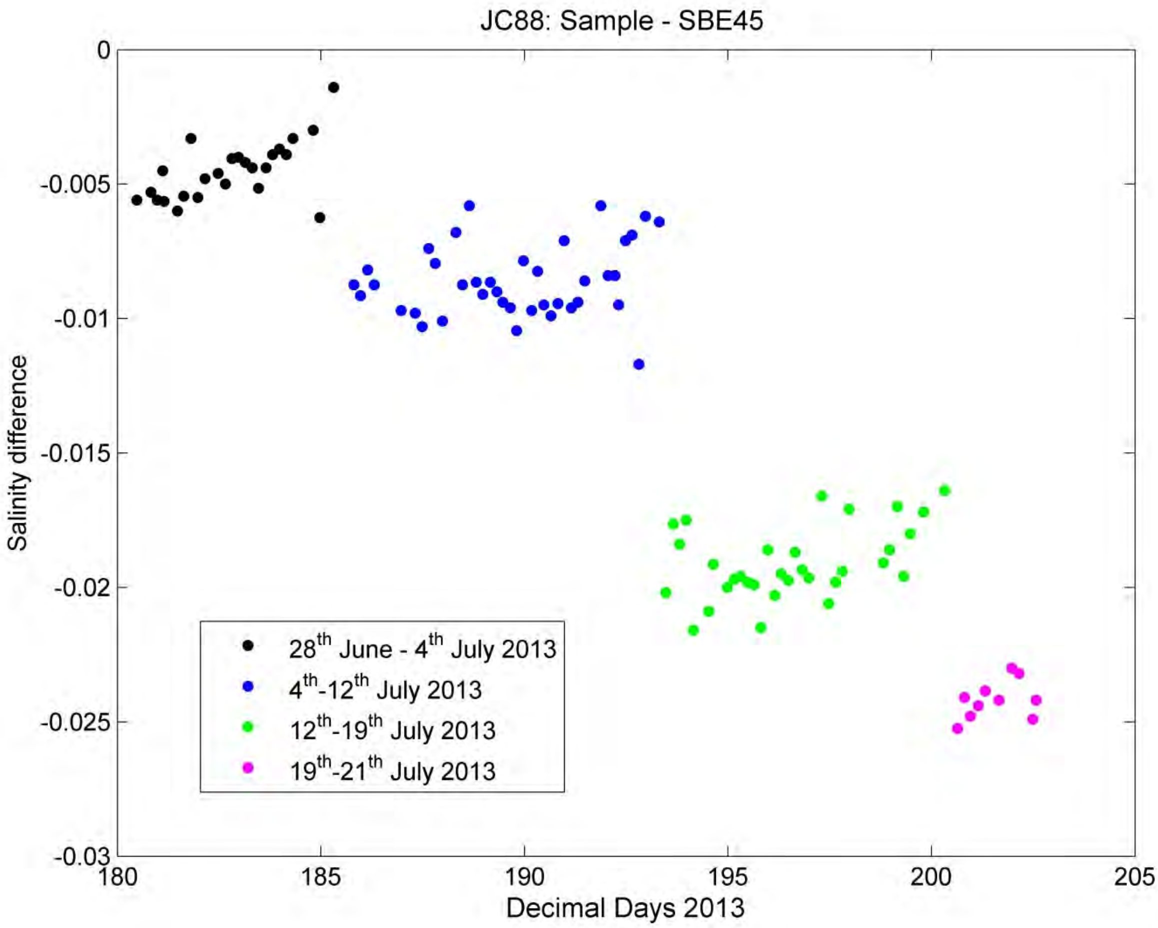


Figure 7 Residuals of all samples-SBE45. Clear step changes on 4th, 12th and 19th July 2013.

During the first period (08:00 GMT on 28th June – 12:25:37 GMT on 4th July 2013) a total of 25 samples were used from which the mean and standard deviation of residuals (Sample – SBE45) is -0.0045 ±0.0011 (Figure 2). An offset of -0.0045 has therefore been applied to the SBE45 underway salinity during this period.

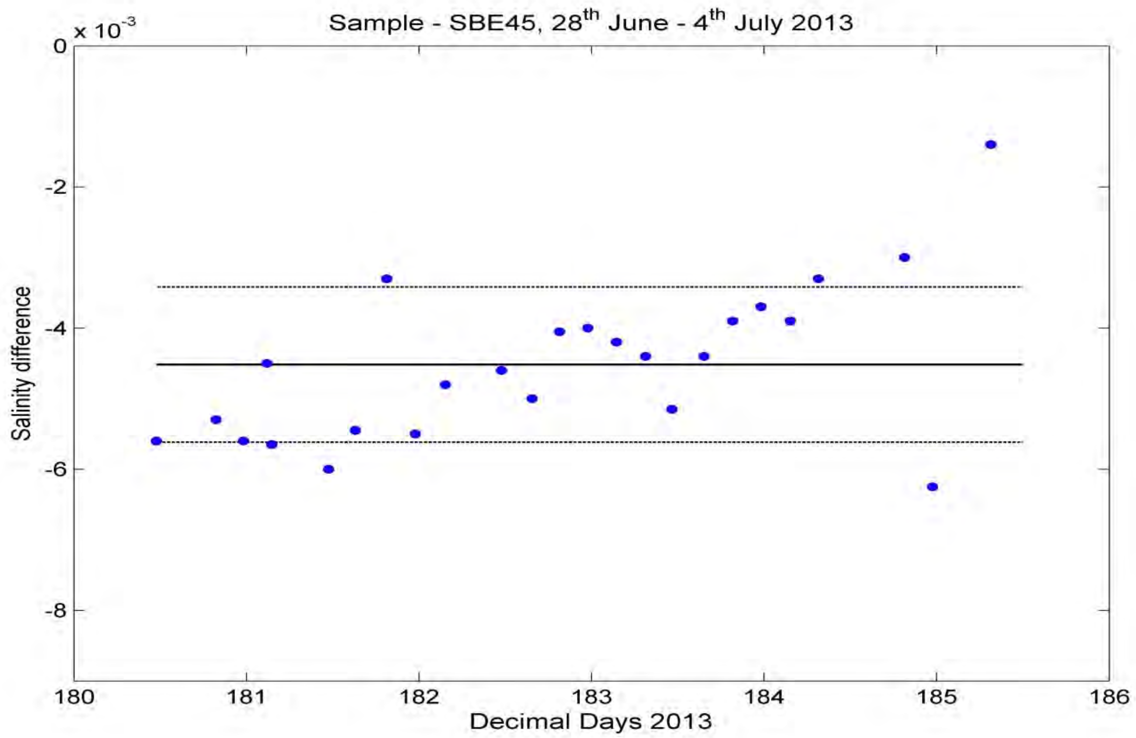


Figure 8 ***First period: residual salinity (Sample – SBE45). Dashed lines mark 1 standard deviation above and below the mean residual (solid line)***

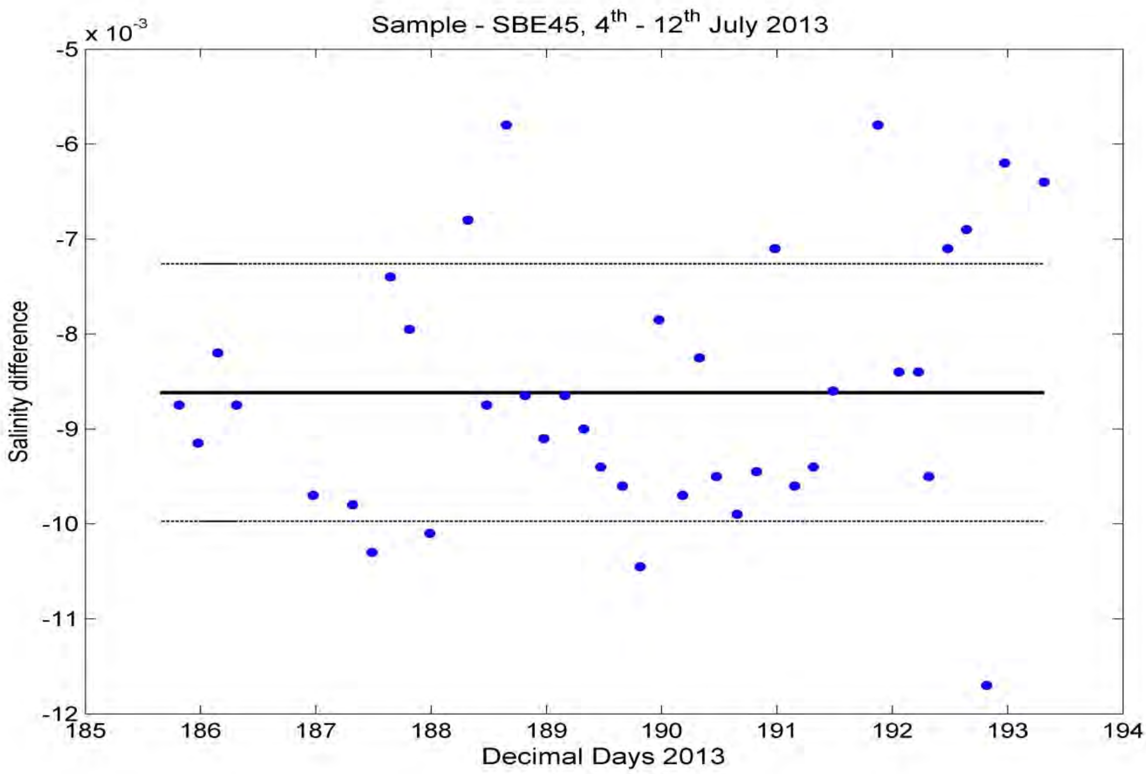


Figure 9 ***Second period: residual salinity (Sample – SBE45). Dashed lines mark 1 standard deviation above and below the mean residual (solid line)***

During the second period (12:25:38 GMT on 4th – 10:03:38 GMT on 12th July 2013 a total of 39 samples were used from which the mean and standard deviation of residuals (Sample – SBE45) is -0.0086 ±0.0014 (Figure 3). An offset of -0.0086 has therefore been applied to the SBE45 underway salinity during this period.

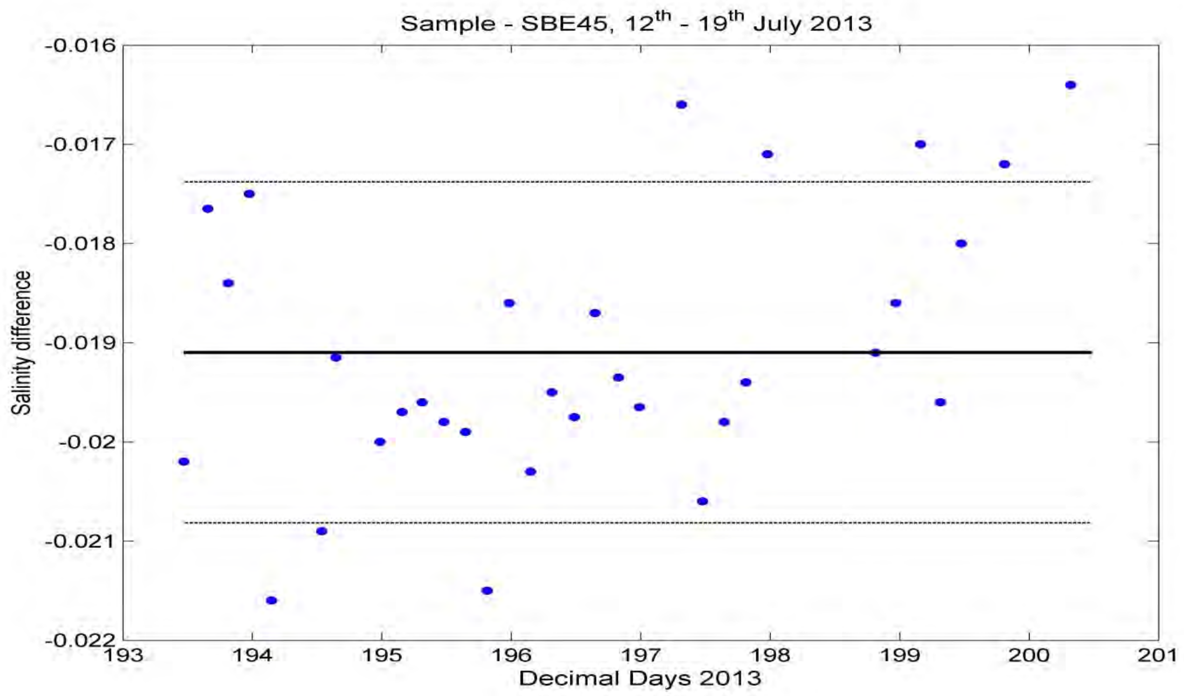


Figure 10 ***Third period: residual salinity (Sample – SBE45). Dashed lines mark 1 standard deviation above and below the mean residual (solid line)***

During the third period (10:03:39 GMT on 12th - 13:32:52 GMT on 19th July 2013) a total of 32 samples were used from which the mean and standard deviation of residuals (Sample – SBE45) is -0.0191 ±0.0014 (Figure 4). An offset of -0.0191 has

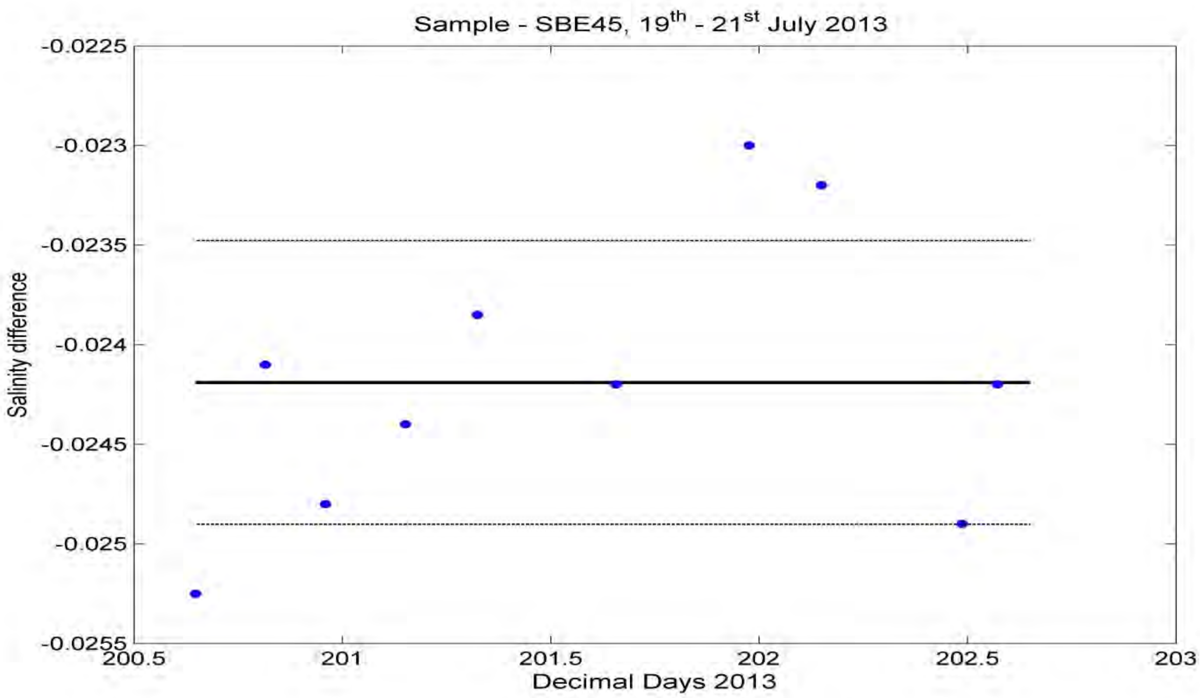


Figure 11 ***Fourth period: residual salinity (Sample – SBE45). Dashed lines mark 1 standard deviation above and below the mean residual (solid line)***

therefore been applied to the SBE45 underway salinity during this period.

During the last period (13:32:52 GMT on 19th – 07:15:00 GMT on 22nd July 2013 [a total of 10 samples were used from which the mean and standard deviation of residuals (Sample – SBE45) is -0.0242 ±0.000712 (Figure 5). An offset of -0.0242 has therefore been applied to the SBE45 underway salinity during this period.

Chlorophyll

A chlorophyll calibration was not attempted while at sea. The voltage (Fluor) and manufacturer calibration (CHL in µg/l) are provided in the .mat files but should be treated with caution. Calibration of underway fluorometry is notoriously difficult because of daytime fluorescence quenching in surface waters. During the day when the amount of incoming solar radiation is highest, light levels exceed the amount that phytoplankton cells in the surface can process and the excess energy is dissipated as heat rather than fluorescence. In this situation, the amount of fluorescence measured, relative to the amount of chlorophyll pigment present is decreased. In-situ measurements of chlorophyll concentration would therefore not show the same amount of chlorophyll present in the water. Other factors that can add significant variability in the relationship between fluorescence and pigment concentration are: community composition, light history of the cells (changes in mixed layer depth or stratification caused for example by a wind event), and nutrient limitation.

15.3.3 Quality control, de-spiking and smoothing

The worst spiking from a number of channels was removed (turned into a NaN), by identifying measurements falling beyond *x* standard deviations of the median within a ∆t second window. In exceptional cases, spikes were identified and removed manually. The window size and standard deviation used for each variable are detailed in the table below. Variables NOT in the table below have not been de-spiked or smoothed.

Variable	**Window size (∆t in seconds)**	**No. of standard deviations (*x*)**
Temp_h, Temp_r (SST), Salinity	30	3
CHL, Fluor	30	2
Tr (beam transmission), c (beam attenuation coef.)	30	2

PPAR/SPAR, PTIR/STIR	30	3
AirTemp, Humidity	30	3
Pressure	60	4
AbsWindSpd, AbsWindDir	30	2.5

Smoothing of the absolute winds was performed on the complex wind vector Z = R exp(-*i*θ), where R = absolute wind speed and θ is the absolute wind direction in radians. The speed and direction scalars were then re-formed after smoothing.

In an attempt to account for shading of the sensors total PAR and TIR values were created by taking the maximum value recorded between the port and starboard sensors (TIR = max([PTIR STIR]), PAR = max([PPAR SPAR])). The de-spiked and smoothed versions of PPAR/SPAR and STIR/PTIR were used to do this.

Any headings in either POSMV or Heading > 360 or <0 were removed. Subsequent comparison of the headings recorded by the ships gyro and the AshTech GPS revealed a median offset of -0.52 degrees (gyro > POSMV).

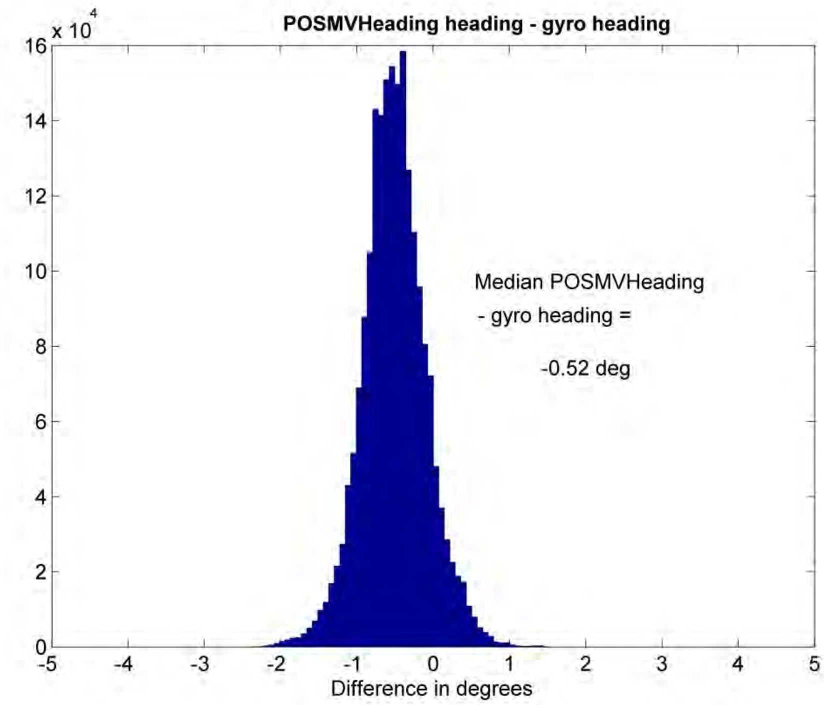


Figure 12 ***POSMV – Gyro compass heading comparison.***

Notes

From 14:09 GMT on 07/07/213 strong variations in SST (measured at the raw water inlet and in the housing; Temp_r, Temp_h) and Salinity, were observed. Subsequently, the sensors were switched off and on, on 11th July 2013 at 12:30 GMT, however this had no effect on the data. It was noted that these variations coincided with the beginning of the MSS (microstructure) profiling, during which the ship's speed was reduced to 0.5-1 kn. Increasing atmospheric pressure and rising air temperatures were also observed during this period, and subsequently a strong thermocline developed in the surface layer. It was concluded that the vertical motion of the ship through the stratified surface layer caused the strong variations in observed SST.

Depth (CorDepth) errors appeared during 06:00:00 GMT and 07:26:24 GMT on 19/07/2013. The incorrect depths were blanked (NaN) and filled with the respective gebco depths.

The following Matlab *.mat* files were produced daily containing quality controlled data:

Filename	Start of file	End of file
JC88-179-1s-QC.mat	28-Jun-2013 08:00:00	28-Jun-2013 23:59:59
JC88-180-1s-QC.mat	29-Jun-2013 00:00:00	29-Jun-2013 23:59:59
JC88-181-1s-QC.mat	30-Jun-2013 00:00:00	30-Jun-2013 23:59:59
JC88-182-1s-QC.mat	01-Jul-2013 00:00:00	01-Jul-2013 23:59:59
JC88-183-1s-	02-Jul-2013	02-Jul-2013

QC.mat	00:00:00	23:59:59
JC88-184-1s- QC.mat	03-Jul-2013 00:00:00	03-Jul-2013 23:59:59
JC88-185-1s- QC.mat	04-Jul-2013 00:00:00	04-Jul-2013 23:59:59
JC88-186-1s- QC.mat	05-Jul-2013 00:00:00	05-Jul-2013 23:59:59
JC88-187-1s- QC.mat	06-Jul-2013 00:00:00	06-Jul-2013 23:59:59
JC88-188-1s- QC.mat	07-Jul-2013 00:00:00	07-Jul-2013 23:59:59
JC88-189-1s- QC.mat	08-Jul-2013 00:00:00	08-Jul-2013 23:59:59
JC88-190-1s- QC.mat	09-Jul-2013 00:00:00	09-Jul-2013 23:59:59
JC88-191-1s- QC.mat	10-Jul-2013 00:00:00	10-Jul-2013 23:59:59
JC88-192-1s- QC.mat	11-Jul-2013 00:00:00	11-Jul-2013 23:59:59
JC88-193-1s- QC.mat	12-Jul-2013 00:00:00	12-Jul-2013 23:59:59
JC88-194-1s- QC.mat	13-Jul-2013 00:00:00	13-Jul-2013 23:59:59
JC88-195-1s- QC.mat	14-Jul-2013 00:00:00	14-Jul-2013 23:59:59
JC88-196-1s- QC.mat	15-Jul-2013 00:00:00	15-Jul-2013 23:59:59
JC88-197-1s- QC.mat	16-Jul-2013 00:00:00	16-Jul-2013 23:59:59
JC88-198-1s- QC.mat	17-Jul-2013 00:00:00	17-Jul-2013 23:59:59
JC88-199-1s- QC.mat	18-Jul-2013 00:00:00	18-Jul-2013 23:59:59
JC88-200-1s-	19-Jul-2013	19-Jul-2103

QC.mat	00:00:00	23:59:59
JC88-201-1s-QC.mat	20-Jul-2013 00:00:00	20-Jul-2013 23:59:59
JC88-202-1s-QC.mat	21-Jul-2013 00:00:00	21-Jul-2013 23:59:59
JC88-203-1s-QC.mat	22-Jul-2013 00:00:00	22-Jul-2013 07:15:00

The table below details the quality controlled data contained within each QC file.

Heading	**Description**
Time	YY DDD HH:MM:SS, where DDD is the Julian day of the year
Latitude	Latitude [decimal degrees]
Longitude	Longitude [decimal degrees]
SMG	Speed over the ground [knots] (speed made good)
CMG	Course over the ground [degree true] (course made good)
POSMV	True heading of ship [degree]
Pitch	Pitch [degree]. Bow up gives positive value.
Roll	Roll [degree]. Starboard roll gives positive value.
UncDepth	Sounding value [m]
CorDepth	Sounding value [m]
Temp_h	Water temperature measured in SBE45 housing [degree Celsius]
Cond	Conductivity measured by the SBE45 [siemen per metre]
SndSpeed	Velocity of sound in the sampled water calculated by the SBE45 [metre per second]
SST	Water temperature measured by the SBE38 remote thermometer at the raw

	water inlet to the ship (Temp_r)
Salinity	Water salinity calculated by the SBE45 [pss]
Fluorescence*	Voltage measured by the Nudam Analogue to Digital Convertor (ADC) [volts]
CHL	Chlorophyll concentration (ug/l)
Transmittance*	Raw voltage measured by the Nudam ADC
Tr	Beam transmission
c	Beam attenuation coefficient
AirTemp	Air temperature [degree Celsius]
Pressure	Atmospheric pressure [hPa]
PPAR* and SPAR*	Photosynthetically Active Radiation. Measured at Port and Starboard.
PAR	Photosynthetically Active Radiation. The maximum value recorded between the port and starboard sensors.
PTIR* and STIR*	Total Incidental Radiation. Measured at Port and Starboard.
TIR	Total Incidental Radiation. The maximum value recorded between the port and starboard sensors.
RelWindSPD	Relative wind velocity [m/s]
RelWindDIR	Relative wind direction [degree] with 0° being at the bow.
Humidity	Relative humidity of the air [%]
AbsWindSpd	Absolute wind speed [m/s]
AbsWindDir	Absolute wind direction [degree]
Heading	True heading of ship

The following Matlab *.mat* files were produced containing concatenated data streams for the entire cruise:

File name	Variables in file	Time stamp (sec)
JC88_NAV1_1s.mat	Latitude, Longitude, date, dd[$], daynum[*], POSMVHeading, Heading, SMG, CMG	1
JC88_NAV2_1s.mat	Latitude, Longitude, date, dd[$], daynum[*], CorDepth, UncDepth, Pitch, Roll	1
JC88_SURF1_1s.mat	Latitude, Longitude, date, dd[$], daynum[*], Temp_h, Cond, Temp_r, Salinity	1
JC88_SURF2_1s.mat	Latitude, Longitude, date, dd[$], daynum[*], Fluor, CHL, Trans, Tr, c	1
JC88_PAR_1s.mat	Latitude, Longitude, date, dd[$], daynum[*], PPAR, SPAR, PAR	1
JC88_TIR_1s.mat	Latitude, Longitude, date, dd[$], daynum[*], PTIR, STIR, TIR	1
JC88_MET1_1s.mat	Latitude, Longitude, date, dd[$], daynum[*], AirTemp, Pressure, Humidity	1
JC88_MET2_1s.mat	Latitude, Longitude, date, dd[$], daynum[*], RelWindSPD, RelWindDIR, AbsWindSpd, AbsWindDir	1

[*]Decimal Julian day number (01-Jan-2013 = daynum 1)

[$] Matlab serial date number

15.4 Instrumentation

The following table contains details of instrumentation, calibration dates and serial numbers (where known).

Instrument	Serial Number	Calibration date
WETLabs Chlorophyll WETStar (model WS3S)	WS3S-351P	24th July 2012
WETLabs C-Star transmissometer (model CST)	CST-1132PR	19th July 2012
Seabird SBE45 thermosalinograph	4548881-0230	27th November 2012
Seabird SBE38 Thermometer	3854115-0490	12th December 2012
Vaisala temperature and humidity (model HMP45AL)	C1320001	2nd July 2012
Vaisala barometric air pressure (model PTB100)	U1420016	21th March 2012
Gill Windsonic anemometer	064537	Not required
Skye PAR (model 510) on forward mast port	28562	22nd September 2011
Skye PAR (model 510) on forward mast starboard	38884	13th August 2012
Kipp and Zonen TIR (model CM6B) on forward mast port	994132	10th July 2012
Kipp and Zonen TIR (model CM6B) on forward mast starboard	994133	10th July 2012

15.5 Results

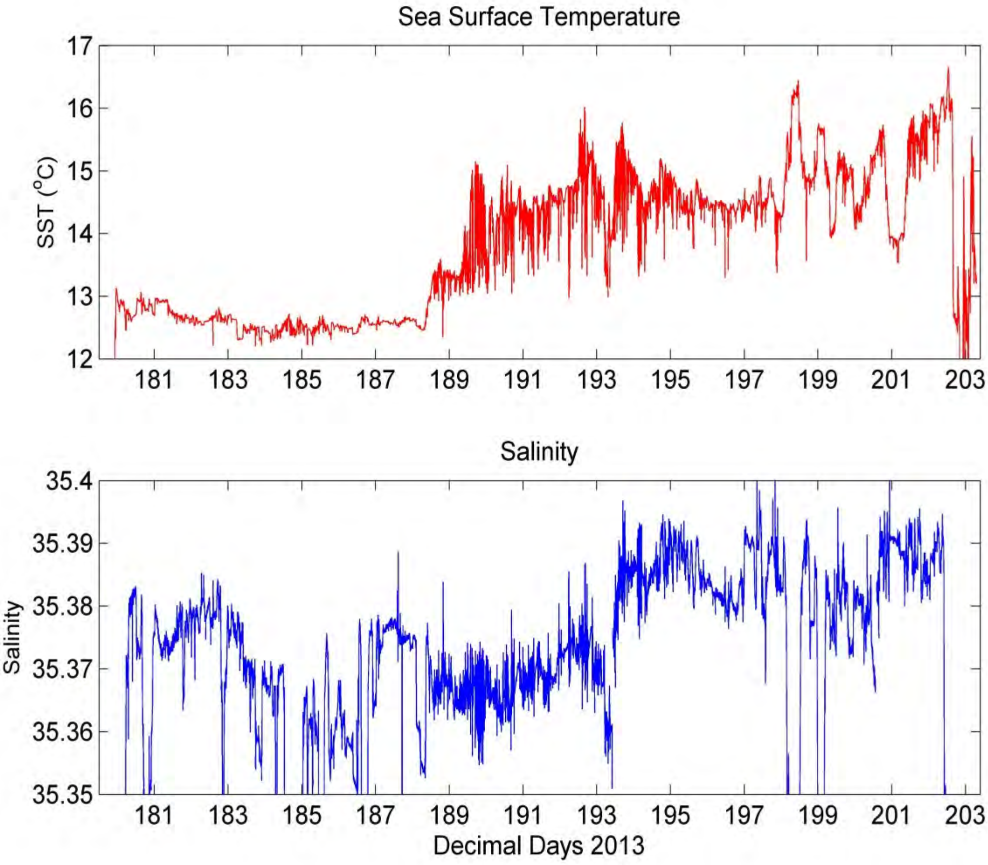


Figure 13 ***Underway sea surface temperature and salinity***

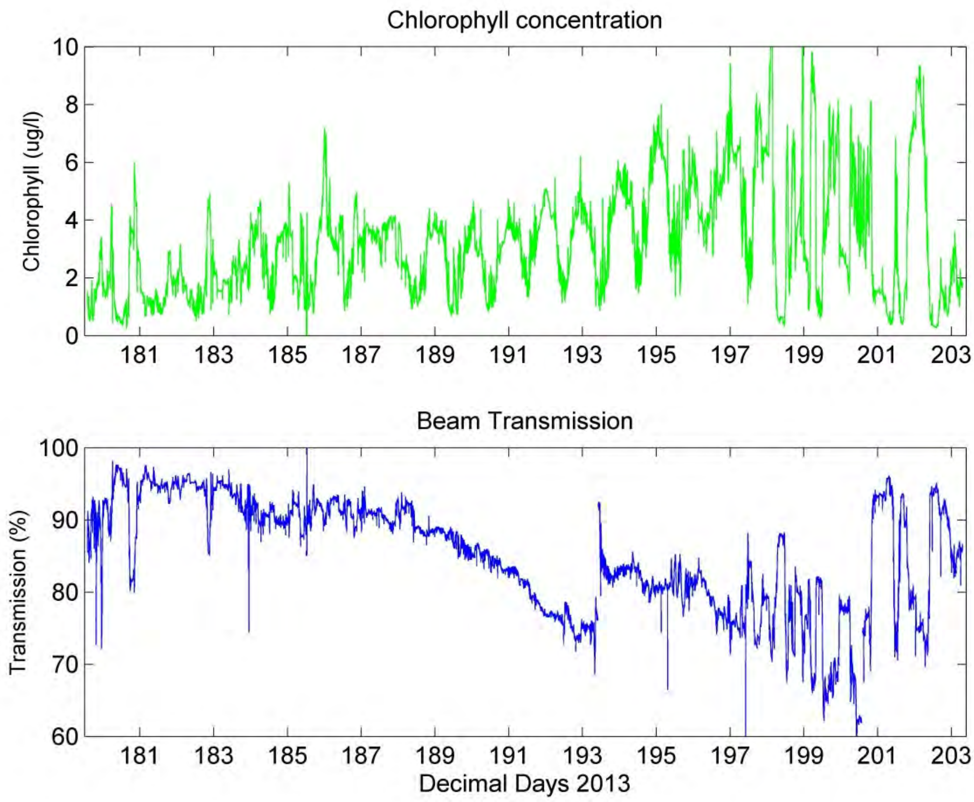
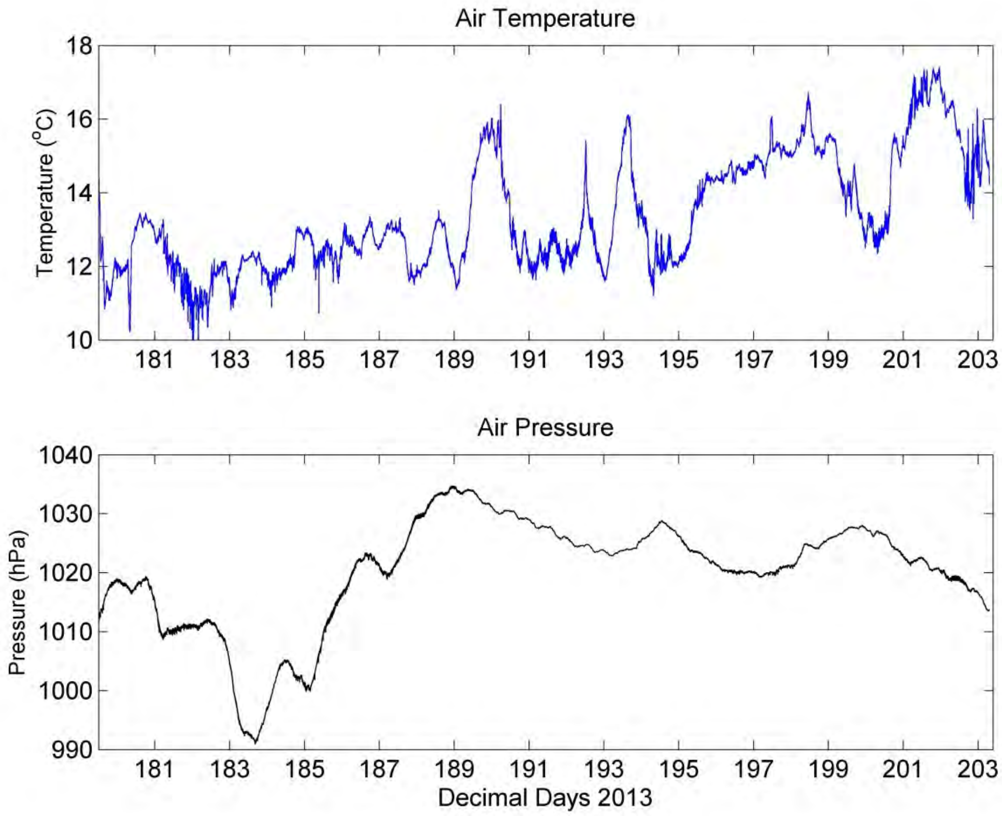


Figure 14 ***Underway chlorophyll and beam transmission***



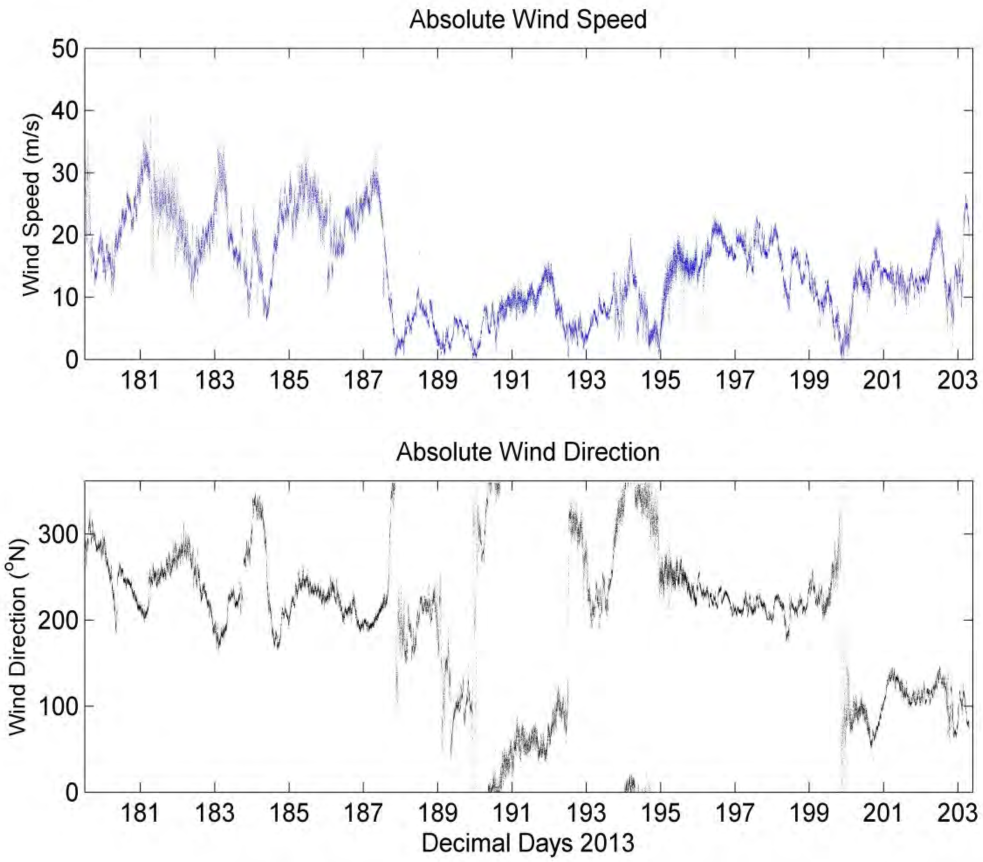


Figure 16 Absolute wind speed and direction

16 NMFSS Sensors and Moorings CTD Report

Estelle Dumont, SAMS

16.1 CTD System Configuration

The sensor configuration for the stainless steel (s/s) system was as follows:

- Sea-Bird 9*plus* underwater unit
- Frequency 0: Sea-Bird 3P temperature sensor, s/n: 03P- 4116
- Frequency 1: Sea-Bird 4 conductivity sensor, s/n: 04C-2164
- Frequency 2: Digiquartz temperature compensated pressure sensor, s/n: 110557
- Frequency 3: Sea-Bird 3P temperature sensor, s/n: 03P - 4872
- Frequency 4: Sea-Bird 4 conductivity sensor, s/n: 04C-2580
- V0: Sea-Bird 43 dissolved oxygen sensor, s/n: 43-0619
- V1: free
- V4: Chelsea/Seatech transmissometer, s/n: 09-7107-001
- V5: Chelsea Aqua 3 fluorometer, s/n: 088195
- V6: WETLabs ECO-BB turbidity meter, s/n: BBRTD-168
- V7: Altimeter, s/n: 41302

For casts 1 to 53, and 63 to 73:

- V2: Biospherical/Licor PAR/Irradiance sensor, S/N: PAR07
- V3: Biospherical/Licor PAR/Irradiance sensor, S/N: PAR01

In the datafiles, PAR07 was labeled as the primary sensor and PAR01 as the secondary sensor.

For casts 62

- V2: Biospherical/Licor PAR/Irradiance sensor, S/N: PAR01
- V3: Biospherical/Licor PAR/Irradiance sensor, S/N: PAR07

Despite the switch of the voltage channels PAR07 was kept as the primary sensor and PAR01 as the secondary sensor for consistency.

For casts 54 to 62:

- V2: Seapoint fluorometer, s/n: SFF5122
- V3: free

Ancillary instruments & components:

- Sea-Bird 11*plus* deck unit
- Sea-Bird 24-position Carousel
- 24 x Ocean Test Equipment 10L Niskin bottles

For the full configuration and sensors calibration

information please see the CTD technical report in annex.

Figure 17: SBE911+ CTD package (photo by Mark Hebden, BODC)

17 The Scientifc Crew of JC88 - Photo

18 Appendices 1 and 2 Event Logs and CTD Logs

Appendix A

JC088 Event Log

Cruise JC088 Event Log

Mooring deployments: Time IN relates to anchor release.
Mooring recoveries: Time OUT relates to all equipment back onboard.
CTDs: Positional informational and water depth from start of cast.

Event No.	Date	Station	Latitude	Longitude	Water depth (m)	Time IN (GMT)	Time BOTTOM (GMT)	Time OUT (GMT)	Activity	Comments
001	29/06/2013	LA	55° 25.84' N	009° 59.43' W	983	13:10	13:45	15:05	CTD	CTD001 (Shakedown)
002	29/06/2013	A1	55° 07.58' N	009° 15.50' W	98	18:26	18:37	19:05	CTD	CTD002
003	29/06/2013	A3	55° 14.048' N	009° 31.021' W	108	21:12	21:24	21:45	CTD	CTD003
004	29/06/2013	A5	55° 20.487' N	009° 46.951' W	197	23:20	23:35	00:06	CTD	CTD004
005	30/06/2013	A5X	55° 22.764' N	009° 52.598' W	343	01:08	01:28	01:45	CTD	CTD005
006	01/07/2013	A7X	55° 27.23' N	010° 03.69' W	1483	07:00	07:40	08:15	CTD	CTD006
007	01/07/2013	LA	55° 25.779' N	009° 59.357' W	985	11:41	-	-	MOORING DEPLOYMENT	In-line mooring LA. Work commenced at ~ 10:00
008	01/07/2013	A6	55° 23.814' N	009° 54.504' W	467	12:57	13:20	13:55	CTD	CTD007
009	01/07/2013	LB	55° 23.903' N	009° 54.867' W	499	15:10	-	-	MOORING DEPLOYMENT	In-line mooring LB. Work commenced at 14:17
010	01/07/2013	LB	55° 23.885' N	009° 55.357' W	512	15:48	-	17:13	SCANFISH	Early recovery. Recovery pos^n 55° 25.094' N, 010° 07.359' W and water depth 1474 metres
011	01/07/2013	A2	55° 11.088' N	009° 22.999' W	102	20:35	20:44	21:02	CTD	CTD008
012	01/07/2013	A4	55° 17.268' N	009° 39.098' W	125	22:33	22:43	23:05	CTD	CTD009
013	02/07/2013	A6X	55° 24.592' N	009° 56.884' W	734	00:45	01:15	01:35	CTD	CTD010
014	02/07/2013	A8	55° 28.657' N	010° 07.326' W	1951	02:42	03:50	05:25	CTD	CTD011

Event No.	Date	Station	Latitude	Longitude	Water depth (m)	Time IN (GMT)	Time BOTTOM (GMT)	Time OUT (GMT)	Activity	Comments
015	02/07/2013	A9	55˚ 31.66' N	010˚ 15.23' W	2293	06:35	07:47	09:20	CTD	CTD012
016	02/07/2013	SB	55˚ 32.727' N	009˚ 32.766' W	504	13:46	-	-	MOORING DEPLOYMENT	In-line mooring SB. Deployment started at 12:52
017	02/07/2013	SD	55˚ 54.173' N	009˚ 18.511' W	544	16:56	-	-	MOORING DEPLOYMENT	In-line mooring SD
018	02/07/2013	B7	55˚ 56.60' N	009˚ 35.90' W	1382	18:25	19:01	19:50	CTD	CTD013
019	02/07/2013	B6	55˚ 55.229' N	009˚ 26.420' W	1044	22:32	23:02	23:24	CTD	CTD014
020	03/07/2013	B5XX	55˚ 54.350' N	009˚ 21.247' W	785	00:07	00:32	00:51	CTD	CTD015
021	03/07/2013	B5X	55˚ 53.984' N	009˚ 18.790' W	575	01:27	01:50	02:15	CTD	CTD016
022	03/07/2013	B5	55˚ 53.783' N	009˚ 17.010' W	386	02:47	03:07	03:23	CTD	CTD017
023	03/07/2013	B4X	55˚ 53.506' N	009˚ 15.277' W	200	04:00	04:12	04:25	CTD	CTD018
024	03/07/2013	B4	55˚ 52.161' N	009˚ 07.581' W	159	05:20	05:31	05:44	CTD	CTD019
025	03/07/2013	B3X	55˚ 51.541' N	009˚ 03.463' W	143	06:13	06:22	06:30	CTD	CTD020
026	03/07/2013	B3	55˚ 50.70' N	008˚ 57.89' W	130	07:20	07:30	07:37	CTD	CTD021
027	03/07/2013	SC1	55˚ 53.965' N	009˚ 17.139' W	399	10:42	-	-	MOORING DEPLOYMENT	In-line mooring SC1
028	03/07/2013	SC2	55˚ 54.230' N	009˚ 16.934' W	396	11:34	-	-	MOORING DEPLOYMENT	In-line mooring SC2. Deployment started 11:22
029	03/07/2013	GLIDER 1	55˚ 52.072' N	008˚ 58.295' W	134	13:23	-	-	GLIDER DEPLOYMENT	Seaglider SG525 (Fomalhaut) deployment
030	03/07/2013	-	55˚ 51.911' N	008˚ 59.149' W	135	14:00	-	14:46	MOORING TEST	Wire Walker mooring test deployment. Buoyancy imploded
031	03/07/2013	SF	55˚ 50.463' N	008˚ 51.052' W	124	16:21	-	-	MOORING DEPLOYMENT	Lander mooring SF2

Event No.	Date	Station	Latitude	Longitude	Water depth (m)	Time IN (GMT)	Time BOTTOM (GMT)	Time OUT (GMT)	Activity	Comments
032	03/07/2013	SF	55˚ 50.418’ N	008˚ 51.744’ W	124	16:58	-	-	MOORING DEPLOYMENT	Mooring SF4 – wave rider buoy. Deployment started 16:45 55˚ 50.50’ N, 008˚ 51.71’ W
033	03/07/2013	SF	55˚ 50.220’ N	008˚ 51.427’ W	122	18:26	-	-	MOORING DEPLOYMENT	Mooring SF3 - guard buoy toroid. Deployment started 18:07 55˚ 50.32’ N, 008˚ 51.42’ W. Deployed upside down
034	03/07/2013	SF	55˚ 50.597’ N	008˚ 51.425’ W	124	19:36	-	-	MOORING DEPLOYMENT	Mooring SF1 – wire walker
035	03/07/2013	B1	55˚ 47.808’ N	008˚ 39.043’ W	111	21:43	21:55	22:23	CTD	CTD022
036	03/07/2013	B3	55˚ 50.184’ N	008˚ 57.830’ W	131	23:51	00:02	00:27	CTD	CTD023
037	04/07/2013	B5	55˚ 53.839’ N	009˚ 16.951’ W	378	01:58	02:15	02:46	CTD	CTD024
038	04/07/2013	B7	55˚ 56.60’ N	009˚ 35.70’ W	1383	04:24	05:02	06:35	CTD	CTD025
039	04/07/2013	SE	55˚ 52.07756’ N	009˚ 03.73016’ W	143	08:46	-	-	MOORING DEPLOYMENT	Lander mooring SE
040	04/07/2013	SE	55˚ 52.4248’ N	009˚ 03.5121’ W	144	10:18	-	-	MOORING DEPLOYMENT	In-line mooring SE. Deployment started 10:00
041	04/07/2013	SG	55˚ 47.830’ N	008˚ 36.240’ W	113	12:32	-	-	MOORING DEPLOYMENT	Lander mooring SG. Deployment started 12:30
042	04/07/2013	SG	55˚ 47.784’ N	008˚ 36.455’ W	113	12:52	-	-	MOORING DEPLOYMENT	In-line mooring. Deployment started 12:43
043	05/07/2013	B9	55˚ 59.25’ N	009˚ 54.73’ W	1990	06:10	07:08	08:45	CTD	CTD026
044	05/07/2013	B8	55˚ 58.091’ N	009˚ 45.126’ W	1675	09:45	10:30	11:49	CTD	CTD027
045	05/07/2013	SF	55˚ 50.538’ N	008˚ 53.759’ W	128	15:18	-		GLIDER DEPLOYMENT	OMG glider s/n 352 (originally 175) deployment
046	05/07/2013	B2	55˚ 49.234’ N	008˚ 48.318’ W	121	17:44	17:52	18:29	CTD	CTD028
047	05/07/2013	B4	55˚ 52.165’ N	009˚ 07.545’ W	159	20:10	20:20	20:53	CTD	CTD029
048	05/07/2013	B6	55˚ 55.159’ N	009˚ 26.418’ W	1033	22:21	23:04	00:09	CTD	CTD030

Event No.	Date	Station	Latitude	Longitude	Water depth (m)	Time IN (GMT)	Time BOTTOM (GMT)	Time OUT (GMT)	Activity	Comments
049	06/07/2013	C1	55˚ 29.54' N	009˚ 25.35' W	200	03:34	03:52	04:20	CTD	CTD031
050	06/07/2013	C2	55˚ 31.68' N	009˚ 30.80' W	300	05:25	05:52	06:10	CTD	CTD032
051	06/07/2013	C3	55˚ 32.29' N	009˚ 32.15' W	403	07:18	07:47	08:10	CTD	CTD033
052	06/07/2013		55˚ 32.757' N	009˚ 33.331' W	593	09:40	-	09:50	MSS	MSS TEST 1
053	06/07/2013		55˚ 32.632' N	009˚ 33.491' W	598	10:24	-	10:29	MSS	MSS TEST 2
054	06/07/2013	GLIDER 2	55˚ 34.346' N	009˚ 31.228' W	400	14:25	-	-	GLIDER DEPLOYMENT	Slocum glider s/n 330 (Bellamite) deployment
055	06/07/2013	GLIDER 3	55˚ 33.911' N	009˚ 31.923' W	396	17:05	-	-	GLIDER DEPLOYMENT	Slocum glider s/n 331 (Coprolite) deployment
056	06/07/2013	C4	55˚ 32.786' N	009˚ 33.290' W	590	18:13	18:37	19:03	CTD	CTD034
057	06/07/2013	C5	55˚ 32.993' N	009˚ 33.924' W	775	19:28	20:01	20:26	CTD	CTD035
058	06/07/2013	C6	55˚ 33.883' N	009˚ 35.881' W	992	20:53	21:31	22:01	CTD	CTD036
059	06/07/2013	C8	55˚ 35.761' N	009˚ 39.037' W	1380	22:36	23:26	23:57	CTD	CTD037
060	07/07/2013	C7	55˚ 34.462' N	009˚ 37.241' W	1182	00:36	01:20	02:00	CTD	CTD038
061	07/07/2013	C9	55˚ 37.440' N	009˚ 41.107' W	1584	02:45	03:46	04:33	CTD	CTD039
062	07/07/2013	C10	55˚ 43.820' N	009˚ 52.046' W	1985	05:43	06:35	07:16	CTD	CTD040
063	07/07/2013	D1	55˚ 11.47' N	009˚ 56.97' W	197	11:26	11:42	11:52	CTD	CTD041
064	07/07/2013	D1	55˚ 11.15' N	009˚ 57.17' W	194	12:15	-	13:32	DYE RELEASE 1	
065	07/07/2013	D1	55˚ 11.142' N	009˚ 57.177' W	183	12:47	-	-	DRIFTER DEPLOYMENT	Short-term drifter #1 S/N 346100

Event No.	Date	Station	Latitude	Longitude	Water depth (m)	Time IN (GMT)	Time BOTTOM (GMT)	Time OUT (GMT)	Activity	Comments
066	07/07/2013	MSS1	55˚ 11.525' N	009˚ 55.470' W	177	14:43	-	11/07/2013 22:20	MSS SURVEY 1	Positions at start of survey. MSS_001 (538 individual profiles)
067	09/07/2013	D1B	55˚ 17.571' N	009˚ 52.536' W	220	01:13	-	-	DRIFTER DEPLOYMENT	Short-term drifter #2 S/N 347110
068	09/07/2013	GLIDER 4	55˚ 20.179' N	009˚ 51.330' W	242	13:42	-	-	GLIDER DEPLOYMENT	Seaglider SG550 (Eltanin) deployment
069	11/07/2013	C2	55˚ 31.730' N	009˚ 30.820' W	298	23:43	00:02	00:34	CTD	CTD042
070	12/07/2013	C4	55˚ 32.794' N	009˚ 33.280' W	586	01:28	01:53	02:27	CTD	CTD043
071	12/07/2013	C6	55˚ 33.89' N	009˚ 35.86' W	991	03:08	03:36	04:36	CTD	CTD044
072	12/07/2013	C8	55˚ 35.760' N	009˚ 39.041' W	1384	05:31	06:11	07:22	CTD	CTD045
073	12/07/2013	C11	55˚ 43.870' N	009˚ 52.065' W	1927	08:38	09:28	10:55	CTD	CTD046
074	12/07/2013		55˚ 27.489' N	009˚ 36.610' W	241	-	-	13:18	DRIFTER RECOVERY	Short-term drifter #2 (S/N 347110). Grappled at 13:07
075	12/07/2013	D2	55˚ 27.235' N	009˚ 52.791' W	621	15:08	-	-	DRIFTER DEPLOYMENT	Short-term drifter #2 (S/N 347110). Deployment began at 15:01
076	12/07/2013	D2	55˚ 27.165' N	009˚ 52.858' W	610	15:09	-	16:15	DYE RELEASE 2	Dye release 2. TIME IN and positions refer to pump on. Finishing position 55˚ 26.380' N, 009˚ 53.572' W
077	12/07/2013	D2	55˚ 27.312' N	009˚ 52.482' W	294	17:02	-	16/07/2013 ~07:20	MSS SURVEY 2	Followed by calibration dip to compare both MSS instruments
078	16/07/2013	LA	55˚ 25.98293' N	009˚ 59.10568' W	1346	-	-	09:25	MOORING RECOVERY	Mooring released at 08:19
079	16/07/2013	LB	55˚ 24.2343' N	009˚ 54.4174' W	1434(?)	-	-	11:31	MOORING RECOVERY	Mooring released at 10:01
080	16/07/2013	G345 PICKUP	55˚ 37.305' N	009˚ 40.954' W	1575	12:29	12:40	12:52	CTD	CTD047. CTD pre-recovery of Slocum glider S/N 345
081	16/07/2013	G345 PICKUP	55˚ 37.656' N	009˚ 42.144' W	1527	-	-	13:40	GLIDER RECOVERY	Slocum glider S/N 345 (deployed on JC086)
082	16/07/2013	SB	55˚ 32.926' N	009˚ 32.407' W	-	-	-	15:18	MOORING RECOVERY	Mooring released at 14:48

Event No.	Date	Station	Latitude	Longitude	Water depth (m)	Time IN (GMT)	Time BOTTOM (GMT)	Time OUT (GMT)	Activity	Comments
083	16/07/2013	C1	55˚ 29.522' N	009˚ 25.294' W	195	16:32	16:45	17:14	CTD	CTD048
084	16/07/2013	C2	55˚ 31.682' N	009˚ 30.811' W	295	18:07	18:26	18:43	CTD	CTD049
085	16/07/2013	C3	55˚ 32.294' N	009˚ 32.151' W	400	19:09	19:29	20:08	CTD	CTD050
086	16/07/2013	C4	55˚ 32.798' N	009˚ 33.281' W	588	20:43	21:06	21:25	CTD	CTD051
087	16/07/2013	C5	55˚ 32.995' N	009˚ 33.922' W	776	21:45	22:14	23:16	CTD	CTD052
088	17/07/2013	C6	55˚ 33.893' N	009˚ 35.882' W	994	00:03	00:34	00:55	CTD	CTD053. Cast aborted following order by bridge. Bottles fired on upcast without stopping the package
089	17/07/2013	LA	55˚ 25.61441' N	009˚ 59.32461' W	964	17:40	-	-	MOORING DEPLOYMENT	Second deployment of mooring LA. Deployment began at 16:37
090	17/07/2013	-	55˚ 12.00577' N	010˚ 04.52317' W	585	19:36	-	21:00	DRIFTER DEPLOYMENTS	30 Metocean drifters (followed by outreach drifter 'Kraken'). End position of ship after releases 55˚ 10.18365' N, 10˚ 5.37527' W
091	18/07/2013	A1N	55˚ 10.268' N	009˚ 15.727' W	107	00:03		00:15	MSS	2 casts (A1N-01 and A1N-02)
092	18/07/2013	A0	55˚ 09.868' N	009˚ 08.380' W	102	01:02	-	01:14	MSS	2 casts (A0-1 and A0-2)
093	18/07/2013	AM1	55˚ 07.113' N	009˚ 01.057' W	89	02:00	-	02:16	MSS	2 casts (AM-01 and AM-02)
094	18/07/2013	AM2	55˚ 04.181' N	008˚ 54.032' W	78	03:00	-	03:16	MSS	2 casts (AM2-01 and AM2-02)
095	18/07/2013	SC1	55˚ 53.9255' N	009˚ 17.0630' W	404	-	-	09:04	MOORING RECOVERY	Mooring was released at 08:22
096	18/07/2013	SC2	54˚ 41.198' N	009˚ 16.307' W	354	-	-	10:20	MOORING RECOVERY	Mooring released at 09:39. On crane at 10:01. Multiple thermistors missing/displaced by fishing activity
097	18/07/2013	SD	55˚ 54.314' N	009˚ 17.970' W	~ 550	-	-	~ 11:00	MOORING RECOVERY	Mooring released 10:38
098	18/07/2013	C1	55˚ 29.535' N	009˚ 25.334' W	197	16:25	16:39	16:49	CTD	CTD054. Fitted with nutrient sensor and fluorescein fluorometer
099	18/07/2013	C3	55˚ 32.298' N	009˚ 32.224' W	408	17:37	17:54	18:11	CTD	CTD055. Fitted with nutrient sensor and fluorescein fluorometer

Event No.	Date	Station	Latitude	Longitude	Water depth (m)	Time IN (GMT)	Time BOTTOM (GMT)	Time OUT (GMT)	Activity	Comments
100	18/07/2013	C4	55˚ 32.858’ N	009˚ 33.262’ W	591	18:32	18:53	19:11	CTD	CTD056. Fitted with nutrient sensor and fluorescein fluorometer
101	18/07/2013	C5	55˚ 32.994’ N	009˚ 33.920’ W	773	19:37	20:03	20:24	CTD	CTD057. Fitted with nutrient sensor and fluorescein fluorometer
102	18/07/2013	C7	55˚ 34.418’ N	009˚ 37.220’ W	1175	20:51	21:25	22:41	CTD	CTD058. Fitted with nutrient sensor and fluorescein fluomometer
103	18/07/2013	C9	55˚ 37.528’ N	009˚ 41.174’ W	1587	23:30	00:07	04:18	CTD	CTD059. ‘Long bottle stop’ CTD cast. Fitted with nutrient sensor and fluorescein fluorometer
104	19/07/2013	SE	55˚ 52.400’ N	009˚ 03.887’ W	149	-	-	08:28	MOORING RECOVERY	In-line mooring. Positions are from time of release. Mooring released at 07:39. Tangled pellet line
105	19/07/2013	SE	55˚ 52.082’ N	009˚ 03.908’ W	153	-	-	09:36	MOORING RECOVERY	Lander recovery. Mooring released at 09:18
106	19/07/2013	SF1	55˚ 50.725’ N	008˚ 51.422’ W	~ 130			12:06	MOORING RECOVERY	Wire Walker recovery. Started recovery at 11:46. 24” float missing
107	19/07/2013	SF3	55˚ 50.306’ N	008˚ 51.419’ W	~ 130	-	-	13:18	MOORING RECOVERY	Met Guard Buoy recovery. Mooring grappled at 12:50
108	19/07/2013	SF4	55˚ 50.467’ N	008˚ 51.683’ W	~ 130	-	-	14:31	MOORING RECOVERY	Wave Rider recovery. Mooring grappled at 14:13
109	19/07/2013	SF2	55˚ 50.459’ N	008˚ 51.266’ W	~ 130	-	-	15:13	MOORING RECOVERY	Lander recovery. Mooring released at 14:50 and grappled at 15:08. Position at end of recovery 55˚ 50.496’ N, 008˚ 50.922’ W
110	19/07/2013	SG	55˚ 47.744’ N	008˚ 36.855’ W	?	-	-	17:17	MOORING RECOVERY	In-line mooring recovery. Mooring released at 16:35 and grappled at 16:49. Position at end of recovery 55˚ 47.807’ N, 008˚ 36.213’ W
111	19/07/2013	SG	55˚ 47.764’ N	008˚ 36.481’ W	?	-	-	17:58	MOORING RECOVERY	Lander recovery. Mooring released at 17:41 and grappled at 17:53. Position at end of recovery 55˚ 47.852’ N, 008˚ 36.328’ W
112	19/07/2013	B9	55˚ 59.254’ N	009˚ 54.715’ W	1987	22:39	23:29	04:17	CTD	CTD060. ‘Long bottle stop’ CTD cast. Fitted with nutrient sensor and fluorescein fluorometer
113	20/07/2013	SG525 PICKUP	56˚ 01.451’ N	009˚ 47.335’ W	1790	05:56	06:38	07:15	CTD	CTD061
114	20/07/2013	SG525 PICKUP	56˚ 01.50549’ N	009˚ 49.74741’ W	1864	-	-	07:42	GLIDER RECOVERY	SG525 (Fomalhaut) glider recovery
115	20/07/2013	OMG PICKUP	55˚ 52.128’ N	008˚ 53.157’ W	126	11:32	11:41	11:50	CTD	CTD062

Event No.	Date	Station	Latitude	Longitude	Water depth (m)	Time IN (GMT)	Time BOTTOM (GMT)	Time OUT (GMT)	Activity	Comments
116	20/07/2013	OMG PICKUP	55˚ 53.340' N	008˚ 53.105' W	129	-	-	12:26	GLIDER RECOVERY	OMG glider
117	20/07/2013	B7	55˚ 56.638' N	009˚ 35.934' W	1389	15:27	16:00	16:31	CTD	CTD063
118	20/07/2013	B6	55˚ 55.148' N	009˚ 26.474' W	1034	17:23	17:51	18:27	CTD	CTD064. Fitted with nutrient sensor
119	20/07/2013	B5XX	55˚ 54.356' N	009˚ 21.368' W	790	19:09	19:35	19:56	CTD	CTD065. Fitted with nutrient sensor
120	20/07/2013	B4X	55˚ 53.506' N	009˚ 15.285' W	198	20:35	20:48	21:28	CTD	CTD066. Fitted with nutrient sensor
121	20/07/2013	B5	55˚ 53.781' N	009˚ 17.014' W	383	22:22	22:45	23:00	CTD	CTD067. Fitted with nutrient sensor
122	20/07/2013	B5X	55˚ 54.012' N	009˚ 18.812' W	576	23:24	23:46	00:22	CTD	CTD068. Fitted with nutrient sensor
123	21/07/2013	B4	55˚ 52.153' N	009˚ 07.577' W	159	01:21	01:32	02:25	CTD	CTD069. Fitted with nutrient sensor
124	21/07/2013	B3X	55˚ 51.530' N	009˚ 03.650' W	143	03:06	03:16	03:44	CTD	CTD070. Fitted with nutrient sensor
125	21/07/2013	B3	55˚ 50.164' N	008˚ 57.993' W	132	04:39	04:46	05:00	CTD	CTD071
126	21/07/2013	B2	55˚ 49.210' N	008˚ 48.441' W	121	05:49	05:58	06:21	CTD	CTD072
127	21/07/2013	B1	55˚ 47.752' N	008˚ 39.121' W	111	07:20	07:30	07:37	CTD	CTD073
128	21/07/2013	B1	55˚ 47.743' N	008˚ 39.081' W	111	07:40	-	07:51	MSS	MSS/CTD calibration
129	21/07/2013	BM0	55˚ 47.946' N	008˚ 29.884' W	107	08:29	-	08:41	MSS	
130	21/07/2013	BM1	55˚ 47.821' N	008˚ 21.307' W	130	09:16	-	09:27	MSS	
131	21/07/2013	BM2	55˚ 47.471' N	008˚ 13.278' W	135	10:00	-	10:14	MSS	
132	21/07/2013	BM2	55˚ 47.423' N	008˚ 12.816' W	-	10:23	-	10:35	CTD	40 metre cast for 'Go-Pro' video footage. No data recorded

Event No.	Date	Station	Latitude	Longitude	Water depth (m)	Time IN (GMT)	Time BOTTOM (GMT)	Time OUT (GMT)	Activity	Comments
133	21/07/2013	BM3	55˚ 46.985' N	008˚ 04.035' W	119	11:29	-	11:43	MSS	2 casts. A shear probe was changed before these casts
134	21/07/2013	BM4	55˚ 46.665' N	007˚ 56.156' W	113	12:17	-	12:27	MSS	1 cast
135	21/07/2013	BM5	55˚ 46.257' N	007˚ 47.321' W	93	13:04	-	13:13	MSS	1 cast
136	21/07/2013	BM6	55˚ 45.849' N	007˚ 39.135' W	81	13:48	-	13:56	MSS	1 cast
137	21/07/2013	BM7	55˚ 44.356' N	007˚ 28.825' W	55	14:49	-	14:56	MSS	1 cast. Slightly off station due to fishing activity in the area
138	21/07/2013	BM8	55˚ 43.387' N	007˚ 20.417' W	60	15:43	-	15:47	MSS	1 cast

Appendix B

JC088 CTD Log Sheets

Key to CTD Logs

I/W = In Water

O/W = Out of Water

Shaded rows of CTD logs indicate problem with bottle firing

Positions are those noted at the bottom of the CTD downcast.

JC088 CTD log sheet

Station	LA	CTD No	001	Date	29/06/2013
Lat (at bottom)	55° 25.83’ N	Event No	001	Time I/W (GMT)	13:10
Lon (at bottom)	009° 59.44’ W	Water Depth (m)	986	Time bottom (GMT)	13:46
Filename	JC088_001.hex	Cast Depth (m)	972	Time O/W (GMT)	15:05
Weather	A bit sunny, wind force 6				
Comments	Shakedown CTD and A/R on frame for testing				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	972	13:46	x	x	x	x			x	x	1
2	2	2	900	14:06	x		x	x					2
3	3	3	760	14:10	x		x	x				x	3
4	4	4	680	14:14	x	x	x	x					4
5	5	5	550	14:18	x	x	x	x			x	x	5
6	6	6	480	14:21		x	x	x					6
7	7	7	430	14:23	x	x	x	x				x	7
8	8	8	393	14:26			x	x					8
9	9	9	250	14:30	x		x	x			x	x	9
10	10	10	150	14:34			x	x		x			10
11	11	11	120	14:36	x		x	x		x		x	11
12	12	12	100	14:38	x	x	x	x		x			12
13	13	13	90	14:39			x	x		x		x	13
14	14	14	80	14:41			x	x					14
15	15	15	80	14:41		x	x	x		x			15
16	16	16	70	14:43	x		x	x		x			16
17	17	17	60	14:44		x	x	x		x		x	17
18	18	18	48	14:47			x	x					18
19	19	19	48	14:47	x	x	x	x		x			19
20	20	20	42	14:49			x	x		x		x	20
21	21	21	32	14:51		x	x	x		x			21
22	22	22	24	14:53	x	x	x	x		x			22
23	23	23	15	14:57			x	x		x	x	x	23
24	24	24	5	14:59		x	x	x		x		x	24
			Sampler		**Victoria**	**Nealy**	**Morwenna**	**Carl**		**Vincent**	**Estelle/ Andy**	**Samer**	

JC088 CTD log sheet

Station	A1	CTD No	002	Date	29/06/2013
Lat (at bottom)	55° 07.58' N	Event No	002	Time I/W (GMT)	18:26
Lon (at bottom)	009° 15.49' W	Water Depth (m)	98	Time bottom (GMT)	18:37
Filename	JC088_002.hex	Cast Depth (m)	90	Time O/W (GMT)	19:05
Weather	Overcast, moderate swell. Wind force 6				
Comments					

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**$\delta^{15}N$**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	90	18:38	x	x	x	x				x	1
2	2	2	90	18:38							x		2
3	3	3	80	18:40	x	x	x	x				x	3
4	4	4	80	18:40									4
5	5	5	60	18:44	x	x	x	x				x	5
6	6	6	60	18:44									6
7	7	7	48	18:47	x	x	x	x		x		x	7
8	8	8	48	18:47									8
9	9	9	42	18:49	x	x	x	x		x		x	9
10	10	10	42	18:49									10
11	11	11	32	18:52	x	x	x	x		x		x	11
12	12	12	32	18:52									12
13	13	13	29	18:55	x	x	x	x		x			13
14	14	14	29	18:55									14
15	15	15	24	18:57	x	x	x	x		x		x	15
16	16	16	24	18:57									16
17	17	17	20	18:59	x	x	x	x		x			17
18	18	18	20	18:59									18
19	19	19	15	19:01	x	x	x	x		x		x	19
20	20	20	15	19:01									20
21	21	21	5	19:03	x	x	x	x		x			21
22	22	22	5	19:03							x	x	22
23	23	23	5	19:04			x			x			23
24	24	24	5	19:04									24
			Sampler		**Victoria**	**Nealy**	**Morwenna**	**Jaimie**		**Marian**	**Mark**	**Samer**	

JC088 CTD log sheet

Station	A3	CTD No	003	Date	29/06/2013
Lat (at bottom)	55° 14.062' N	Event No	003	Time I/W (GMT)	21:12
Lon (at bottom)	009° 31.055' W	Water Depth (m)	110	Time bottom (GMT)	21:24
Filename	JC088_003.hex	Cast Depth (m)	102	Time O/W (GMT)	21:45
Weather					
Comments	Bottle 3 leaked				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**$\delta^{15}N$**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	102	21:24	x	x	x	x				x	1
2	2	2	102	21:25									2
3	3	3	85	21:27									3
4	4	4	85	21:28	x	x	x	x			x	x	4
5	5	5	65	21:30									5
6	6	6	65	21:30	x	x	x	x		x		x	6
7	7	7	55	21:31									7
8	8	8	55	21:31	x	x	x	x		x		x	8
9	9	9	48	21:33									9
10	10	10	48	21:33	x	x	x	x		x		x	10
11	11	11	42	21:34									11
12	12	12	42	21:35	x	x	x	x		x		x	12
13	13	13	37	21:36									13
14	14	14	37	21:36	x	x	x	x		x		x	14
15	15	15	32	21:37									15
16	16	16	32	21:38	x	x	x	x		x		x	16
17	17	17	28	21:38									17
18	18	18	28	21:39	x	x	x	x		x		x	18
19	19	19	24	21:40									19
20	20	20	24	21:40	x	x	x	x		x		x	20
21	21	21	15	21:42									21
22	22	22	16	21:42	x	x	x	x		x	x	x	22
23	23	23	5	21:43									23
24	24	24	5	21:44	x	x	x			x		x	24
			Sampler		**Victoria**	**Nealy**	**Morwenna**	**Sam**		**Marie**	**Matt**	**Samer**	

JC088 CTD log sheet

Station	A5	CTD No	004	Date	29/06/2013
Lat (at bottom)	56˚ 20.458' N	Event No	004	Time I/W (GMT)	23:20
Lon (at bottom)	009˚ 46.968' W	Water Depth (m)	197	Time bottom (GMT)	23:35
Filename	JC088_004.hex	Cast Depth (m)	190	Time O/W (GMT)	00:06
Weather	Wind force 7				
Comments					

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**$\delta^{15}N$**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	190	23:36	x	x	x	x				x	1
2	2	2	190	23:37							x		2
3	3	3	160	23:39	x	x	x	x				x	3
4	4	4	161	23:40									4
5	5	5	141	23:42	x	x	x	x				x	5
6	6	6	141	23:43									6
7	7	7	115	23:45	x	x	x	x				x	7
8	8	8	115	23:45									8
9	9	9	96	23:48	x	x	x	x				x	9
10	10	10	95	23:48									10
11	11	11	70	23:50	x	x	x	x		x		x	11
12	12	12	71	23:51							x		12
13	13	13	48	23:53	x	x	x	x		x		x	13
14	14	14	48	23:54									14
15	15	15	42	23:55	x	x	x	x		x		x	15
16	16	16	42	23:56									16
17	17	17	32	23:57	x	x	x	x		x		x	17
18	18	18	32	23:58									18
19	19	19	24	23:59	x	x	x	x		x		x	19
20	20	20	24	00:00									20
21	21	21	15	00:01	x	x	x	x		x		x	21
22	22	22	15	00:02							x		22
23	23	23	6	00:03	x	x	x			x		x	23
24	24	24	6	00:04									24
			Sampler		**Victoria/Dima**	**Nealy**	**Morwenna**	**Carl**		**Vincent**	**Sophie**	**Samer**	

JC088 CTD log sheet

Station	A5X	CTD No	005	Date	30/06/2013
Lat (at bottom)	55˚ 22.762' N	Event No	005	Time I/W (GMT)	01:08
Lon (at bottom)	009˚ 52.598' W	Water Depth (m)	345	Time bottom (GMT)	01:28
Filename	JC088_005.hex	Cast Depth (m)	338	Time O/W (GMT)	01:45
Weather	Wet, wind force 7				
Comments	No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**$\delta^{15}N$**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	A7X	CTD No	006	Date	01/07/2013
Lat (at bottom)	55˚ 27.23' N	Event No	006	Time I/W (GMT)	07:00
Lon (at bottom)	010˚ 03.70' W	Water Depth (m)	1483	Time bottom (GMT)	07:40
Filename	JC088_006.hex	Cast Depth (m)	1476	Time O/W (GMT)	08:15
Weather	~ 20 knots, easing, residual swell 2-3 metres, overcast				
Comments	No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	A6	CTD No	007	Date	01/07/2013
Lat (at bottom)	55˚ 23.692' N	Event No	008	Time I/W (GMT)	12:57
Lon (at bottom)	009˚ 54.857' W	Water Depth (m)	480	Time bottom (GMT)	13:20
Filename	JC088_007	Cast Depth (m)	469	Time O/W (GMT)	13:55
Weather	Wind force 4				
Comments					

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	469	13:21	x	x	x	x		x	x	x	1
2	2	2	470	13:21							x		2
3	3	3	400	13:24	x	x	x	x		x		x	3
4	4	4	400	13:25									4
5	5	5	260	13:29	x	x	x	x		x		x	5
6	6	6	260	13:29							x		6
7	7	7	200	13:32	x	x	x	x		x		x	7
8	8	8	200	13:32									8
9	9	9	90	13:37	x	x	x	x		x		x	9
10	10	10	90	13:38									10
11	11	11	65	13:40	x	x	x	x		x		x	11
12	12	12	65	13:40									12
13	13	13	48	13:42	x	x	x	x		x		x	13
14	14	14	48	13:43									14
15	15	15	42	13:44	x	x	x	x		x		x	15
16	16	16	42	13:45									16
17	17	17	32	13:47	x	x	x	x		x		x	17
18	18	18	32	13:47									18
19	19	19	24	13:49	x	x	x	x		x		x	19
20	20	20	24	13:49									20
21	21	21	15	13:51	x	x	x	x		x		x	21
22	22	22	15	13:51									22
23	23	23	5	13:53	x	x	x			x		x	23
24	24	24	5	13:54							x		24
			Sampler		Victoria	Nealy	Morwenna	Carl		Vincent	Sophie	Samer	

JC088 CTD log sheet

Station	A2	CTD No	008	Date	01/07/2013
Lat (at bottom)	55˚ 11.040' N	Event No	011	Time I/W (GMT)	20:35
Lon (at bottom)	009˚ 23.005' W	Water Depth (m)	106	Time bottom (GMT)	20:44
Filename	JC088_008.hex	Cast Depth (m)	97	Time O/W (GMT)	21:02
Weather	18 knots, overcast, damp				
Comments	Problem with bottle 1 firing				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
1	1	1	97	20:43									1
2	2	2	97	20:43	x	x	x	x		x	x	x	2
3	3	3	80	20:46									3
4	4	4	80	20:46	x	x	x	x		x		x	4
5	5	5	55	20:49									5
6	6	6	55	20:49	x	x	x	x		x		x	6
7	7	7	48	20:51									7
8	8	8	48	20:51	x	x	x	x		x		x	8
9	9	9	42	20:53									9
10	10	10	42	20:53	x	x	x	x		x		x	10
11	11	11	37	20:54									11
12	12	12	37	20:54	x	x	x	x		x		x	12
13	13	13	32	20:56									13
14	14	14	32	20:56	x	x	x	x		x		x	14
15	15	15	24	20:57									15
16	16	16	24	20:57	x	x	x	x		x		x	16
17	17	17	15	20:59									17
18	18	18	15	20:59	x	x	x	x		x		x	18
19	19	19	5	21:02									19
20	20	20	5	21:02	x	x	x	x		x	x	x	20
21	21	21	5	21:02									21
22	22	22	5	21:02									22
23	23	23	5	21:02									23
24	24	24	5	21:02									24
			Sampler		Victoria	Nealy	Morwenna	Sam		Anna	Marie	Samer	

JC088 CTD log sheet

Station	A4	CTD No	009	Date	01/07/2013
Lat (at bottom)	55˚ 17.214' N	Event No	012	Time I/W (GMT)	22:33
Lon (at bottom)	009˚ 39.019' W	Water Depth (m)	128	Time bottom (GMT)	22:43
Filename	JC088_009.hex	Cast Depth (m)	120	Time O/W (GMT)	23:05
Weather	20 knots, fair, wave height 2.4 metres				
Comments	Bottle 14 did not close properly				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
1	1	1	120	22:42	x	x	x	x				x	1
2	2	2	120	22:42							x		2
3	3	3	100	22:45	x	x	x	x				x	3
4	4	4	100	22:45									4
5	5	5	80	22:49	x	x	x	x		x		x	5
6	6	6	80	22:49									6
7	7	7	60	22:51	x	x	x	x		x		x	7
8	8	8	60	22:51									8
9	9	9	48	22:53	x	x	x	x		x		x	9
10	10	10	48	22:53									10
11	11	11	42	22:54	x	x	x	x		x		x	11
12	12	12	42	22:54									12
13	13	13	37	22:55	x	x	x	x		x		x	13
14	14	14	37	22:55									14
15	15	15	32	22:57	x	x	x	x		x		x	15
16	16	16	32	22:57							x		16
17	17	17	28	22:58	x	x	x	x		x		x	17
18	18	18	28	22:58									18
19	19	19	24	23:00	x	x	x	x		x		x	19
20	20	20	24	23:00									20
21	21	21	15	23:02	x	x	x	x		x		x	21
22	22	22	15	23:02							x		22
23	23	23	5	23:04	x	x	x	x		x		x	23
24	24	24	5	23:04									24
			Sampler		Victoria	Nealy	Morwenna	Carl		Vincent	?	Samer	

JC088 CTD log sheet

Station	A6X	CTD No	010	Date	02/07/2013
Lat (at bottom)	55˚ 24.593’ N	Event No	013	Time I/W (GMT)	00:45
Lon (at bottom)	009˚ 56.886’ W	Water Depth (m)	741	Time bottom (GMT)	01:15
Filename	JC088_010.hex	Cast Depth (m)	730	Time O/W (GMT)	01:35
Weather					
Comments	No bottles were fired				

Fire Seq	Bot. No.	Rosette pos.	Depth (m)	Time (GMT)	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	Bot. No.
			Sampler										

JC088 CTD log sheet

Station	A8	CTD No	011	Date	02/07/2013
Lat (at bottom)	55˚ 28.66’ N	Event No	014	Time I/W (GMT)	02:42
Lon (at bottom)	010˚ 07.32’ W	Water Depth (m)	1951	Time bottom (GMT)	03:50
Filename	JC088_011.hex	Cast Depth (m)	1936	Time O/W (GMT)	05:25
Weather	30 knots wind from south, 1.7 metre waves, rain				
Comments	Bottle 21 leaked				

Fire Seq	Bot. No.	Rosette pos.	Depth (m)	Time (GMT)	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	Bot. No.
1	1	1	1936	03:50	x	x	x	x			x	x	1
2	2	2	1800	03:56	x		x	x				x	2
3	3	3	1700	04:03			x	x			x	x	3
4	4	4	1600	04:07	x		x	x				x	4
5	5	5	1400	04:13		x	x	x				x	5
6	6	6	1200	04:18	x		x	x				x	6
7	7	7	950	04:25	x	x	x	x				x	7
8	8	8	800	04:30			x	x			x	x	8
9	9	9	640	04:35	x	x	x	x				x	9
10	10	10	500	04:40	x	x	x	x				x	10
11	11	11	300	04:46	x	x	x	x				x	11
12	12	12	150	04:53		x	x	x		x	x	x	12
13	13	13	100	04:56			x	x		x		x	13
14	14	14	90	05:00	x		x	x		x		x	14
15	15	15	80	05:02			x	x		x		x	15
16	16	16	70	05:04	x	x	x	x		x		x	16
17	17	17	58	05:06		x	x	x		x		x	17
18	18	18	53	05:07	x		x	x		x		x	18
19	19	19	48	05:09		x	x	x		x		x	19
20	20	20	42	05:10								x	20
21	21	21	32	05:12									21
22	22	22	24	05:14		x	x	x		x		x	22
23	23	23	15	05:16	x		x			x		x	23
24	24	24	5	05:18		x	x			x	x	x	24
			Sampler		Victoria	Nealy	Morwenna	Jaimie		Terry	Mark	Samer	

JC088 CTD log sheet

Station	A9	CTD No	012	Date	02/07/2013
Lat (at bottom)	55˚ 31.66' N	Event No	015	Time I/W (GMT)	06:35
Lon (at bottom)	010˚ 15.23' W	Water Depth (m)	2293	Time bottom (GMT)	07:47
Filename	JC088_012.hex	Cast Depth (m)	2280	Time O/W (GMT)	09:20
Weather	25 knots wind speed				
Comments	Final station on CTD Transect A				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	2280	07:48		X	X	X			X	X	1
2	2	2	2000	07:55			X	X				X	2
3	3	3	1600	08:04		X	X	X				X	3
4	4	4	1500	08:10			X	X				X	4
5	5	5	1400	08:13		X	X	X				X	5
6	6	6	1200	08:20		X	X	X				X	6
7	7	7	1000	08:25		X	X	X				X	7
8	8	8	900	08:30			X	X				X	8
9	9	9	670	08:37		X	X	X				X	9
10	10	10	600	08:40			X	X				X	10
11	11	11	400	08:48			X	X				X	11
12	12	12	150	08:56			X	X		X		X	12
13	13	13	110	08:59		X	X	X		X		X	13
14	14	14	90	09:02			X	X		X		X	14
15	15	15	75	09:05			X	X		X		X	15
16	16	16	65	09:06		X	X	X		X		X	16
17	17	17	60	09:07			X	X		X		X	17
18	18	18	55	09:09			X	X		X		X	18
19	19	19	48	09:10		X	X	X		X	X	X	19
20	20	20	42	09:12		X	X	X		X		X	20
21	21	21	32	09:14		X	X	X		X		X	21
22	22	22	32	09:15			X			X			22
23	23	23	15	09:18			X			X		X	23
24	24	24	5	09:20		X	X			X	X	X	24
			Sampler			**Nealy**	**Morwenna**	**Sam**		**Anna**	**Marie**	**Samer**	

JC088 CTD log sheet

Station	B7	CTD No	013	Date	02/07/2013
Lat (at bottom)	55˚ 56.61' N	Event No	018	Time I/W (GMT)	18:25
Lon (at bottom)	009˚ 35.84' W	Water Depth (m)	1387	Time bottom (GMT)	19:01
Filename	JC088_013.hex	Cast Depth (m)	1377	Time O/W (GMT)	19:50
Weather	Wind force 2. Overcast				
Comments	No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	B6	CTD No	014	Date	02/07/2013
Lat (at bottom)	55˚ 55.199’ N	Event No	019	Time I/W (GMT)	22:32
Lon (at bottom)	009˚ 26.398’ W	Water Depth (m)	1044	Time bottom (GMT)	23:02
Filename	JC088_014.hex	Cast Depth (m)	1034	Time O/W (GMT)	23:24
Weather	Fine				
Comments	No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	B5XX	CTD No	015	Date	03/07/2013
Lat (at bottom)	55˚ 54.354’ N	Event No	020	Time I/W (GMT)	00:07
Lon (at bottom)	009˚ 21.360’ W	Water Depth (m)	794	Time bottom (GMT)	00:32
Filename	JC088_015.hex	Cast Depth (m)	784	Time O/W (GMT)	00:51
Weather	Wind force 6				
Comments	No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	B5X	CTD No	016	Date	03/07/2013
Lat (at bottom)	55˚ 53.990' N	Event No	021	Time I/W (GMT)	01:27
Lon (at bottom)	009˚ 18.791' W	Water Depth (m)	591	Time bottom (GMT)	01:50
Filename	JC088_016.hex	Cast Depth (m)	581	Time O/W (GMT)	02:15
Weather	OK, wind force 5				
Comments					

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	48	02:03					X				1
2	2	2	48	02:03							X		2
3	3	3	42	02:05					X				3
4	4	4	42	02:05									4
5	5	5	32	02:07					X				5
6	6	6	32	02:08									6
7	7	7	24	02:09					X				7
8	8	8	24	02:10									8
9	9	9	15	02:11					X				9
10	10	10	15	02:12									10
11	11	11	5	02:14					X				11
12	12	12	5	02:14							X		12
			Sampler						**Victoria**		**?**		

JC088 CTD log sheet

Station	B5	CTD No	017	Date	03/07/2013
Lat (at bottom)	55˚ 53.781' N	Event No	022	Time I/W (GMT)	02:47
Lon (at bottom)	009˚ 17.011' W	Water Depth (m)	386	Time bottom (GMT)	03:07
Filename	JC088_017.hex	Cast Depth (m)	375	Time O/W (GMT)	03:23
Weather	Wind force 5 (17 knots)				
Comments	No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	B4X	CTD No	018	Date	03/07/2013
Lat (at bottom)	55˚ 53.506’ N	Event No	023	Time I/W (GMT)	04:00
Lon (at bottom)	009˚ 15.273’ W	Water Depth (m)	200	Time bottom (GMT)	04:12
Filename	JC088_018.hex	Cast Depth (m)	188	Time O/W (GMT)	04:25
Weather	Wind force 4				
Comments	No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	B4	CTD No	019	Date	03/07/2013
Lat (at bottom)	55˚ 52.161’ N	Event No	024	Time I/W (GMT)	05:20
Lon (at bottom)	009˚ 07.581’ W	Water Depth (m)	159	Time bottom (GMT)	05:31
Filename	JC088_019.hex	Cast Depth (m)	147	Time O/W (GMT)	05:44
Weather	Wind force 5				
Comments	No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	B3X	CTD No	020	Date	03/07/2013
Lat (at bottom)	55˚ 51.542’ N	Event No	025	Time I/W (GMT)	06:13
Lon (at bottom)	009˚ 03.463’ W	Water Depth (m)	143	Time bottom (GMT)	06:22
Filename	JC088_020.hex	Cast Depth (m)	133	Time O/W (GMT)	06:30
Weather	Overcast. Wind force 4. Calm seas				
Comments	No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	B3	CTD No	021	Date	03/07/2013
Lat (at bottom)	55˚ 50.69’ N	Event No	026	Time I/W (GMT)	07:20
Lon (at bottom)	008˚ 57.89’ W	Water Depth (m)	130	Time bottom (GMT)	07:30
Filename	JC088_021.hex	Cast Depth (m)	123	Time O/W (GMT)	07:37
Weather	Wind force 3. Swell ~ 2 metres				
Comments	No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	B1	CTD No	022	Date	03/07/2013
Lat (at bottom)	55˚ 47.755' N	Event No	035	Time I/W (GMT)	21:43
Lon (at bottom)	008˚ 39.115' W	Water Depth (m)	111	Time bottom (GMT)	21:55
Filename	JC088_022.hex	Cast Depth (m)	104	Time O/W (GMT)	22:23
Weather	25 knots wind speed				
Comments					

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	104	21:56	x	x	x	x			x	x	1
2	2	2	104	21:56									2
3	3	3	80	21:59	x	x	x	x					3
4	4	4	80	21:59									4
5	5	5	60	22:02	x	x	x	x				x	5
6	6	6	60	22:02									6
7	7	7	48	22:05	x	x	x	x		x			7
8	8	8	48	22:05									8
9	9	9	42	22:07	x	x	x	x		x			9
10	10	10	42	22:07									10
11	11	11	37	22:08	x	x	x	x		x			11
12	12	12	37	22:08									12
13	13	13	32	22:10	x	x	x	x		x		x	13
14	14	14	32	22:10									14
15	15	15	28	22:11	x	x	x	x		x			15
16	16	16	28	22:11									16
17	17	17	24	22:13	x	x	x	x		x			17
18	18	18	24	22:13									18
19	19	19	20	22:14	x	x	x	x		x			19
20	20	20	20	22:14									20
21	21	21	15	22:16	x	x	x	x		x		x	21
22	22	22	15	22:16									22
23	23	23	5	22:18	x	x	x			x	x	x	23
24	24	24	5	22:18									24
			Sampler		**Victoria**	**Nealy**	**Morwenna**	**Marie**		**Anna**	**?**	**Samer**	

JC088 CTD log sheet

Station	B3	CTD No	023	Date	03/07/2013
Lat (at bottom)	55˚ 50.174' N	Event No	036	Time I/W (GMT)	23:51
Lon (at bottom)	008˚ 57.870' W	Water Depth (m)	134	Time bottom (GMT)	00:02
Filename	JC088_023.hex	Cast Depth (m)	125	Time O/W (GMT)	00:27
Weather	Drizzle, wind force 6				
Comments					

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	125	00:02	x	x	x	x				x	1
2	2	2	125	00:03							x		2
3	3	3	100	00:06	x	x	x	x					3
4	4	4	100	00:07									4
5	5	5	90	00:08	x	x	x	x					5
6	6	6	90	00:09									6
7	7	7	75	00:10	x	x	x	x				x	7
8	8	8	75	00:11									8
9	9	9	60	00:12	x	x	x	x					9
10	10	10	60	00:13									10
11	11	11	48	00:14	x	x	x	x		x			11
12	12	12	48	00:15									12
13	13	13	42	00:16	x	x	x	x		x			13
14	14	14	42	00:17									14
15	15	15	37	00:18	x	x	x	x		x		x	15
16	16	16	37	00:18									16
17	17	17	32	00:19	x	x	x	x		x			17
18	18	18	32	00:19									18
19	19	19	24	00:22	x	x	x	x		x			19
20	20	20	24	00:22									20
21	21	21	15	00:24	x	x	x	x		x		x	21
22	22	22	15	00:24							x		22
23	23	23	5	00:26	x	x	x			x		x	23
24	24	24	5	00:26									24
			Sampler		**Victoria**	**Nealy**	**Morwenna**	**Carl**		**Vincent**	**Sophie**	**Samer**	

JC088 CTD log sheet

Station	B5	CTD No	024	Date	04/07/2013
Lat (at bottom)	55˚ 53.790’ N	Event No	037	Time I/W (GMT)	01:58
Lon (at bottom)	009˚ 17.004’ W	Water Depth (m)	386	Time bottom (GMT)	02:15
Filename	JC088_024.hex	Cast Depth (m)	377	Time O/W (GMT)	02:46
Weather	Raining, wind force 6				
Comments					

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	377	02:15		X	X	X				X	1
2	2	2	377	02:16							X		2
3	3	3	240	02:20		X	X	X				X	3
4	4	4	240	02:21									4
5	5	5	100	02:25		X	X	X		X			5
6	6	6	100	02:25							X		6
7	7	7	70	02:28		X	X	X		X			7
8	8	8	70	02:28									8
9	9	9	63	02:30		X	X	X		X		X	9
10	10	10	63	02:30									10
11	11	11	56	02:32		X	X	X		X		X	11
12	12	12	56	02:32									12
13	13	13	48	02:34		X	X	X		X			13
14	14	14	48	02:34									14
15	15	15	42	02:35		X	X	X	X	X			15
16	16	16	42	02:36									16
17	17	17	32	02:37		X	X	X	X	X		X	17
18	18	18	32	02:38									18
19	19	19	24	02:39		X	X	X	X	X			19
20	20	20	24	02:40									20
21	21	21	15	02:41		X	X	X	X	X			21
22	22	22	15	02:42							X		22
23	23	23	5	02:43		X	X		X	X		X	23
24	24	24	5	02:44									24
			Sampler			**Nealy**	**Morwenna**	**Carl**	**Victoria**	**Vincent**	**Sophie**	**Samer**	

JC088 CTD log sheet

Station	B7	CTD No	025	Date	04/07/2013
Lat (at bottom)	55˚ 56.6’ N	Event No	038	Time I/W (GMT)	04:24
Lon (at bottom)	009˚ 35.7’ W	Water Depth (m)	1383	Time bottom (GMT)	05:02
Filename	JC088_025.hex	Cast Depth (m)	1366	Time O/W (GMT)	06:35
Weather	Bright, sunny. Wind force 6/7				
Comments					

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	1365.6	05:03	X	X	X	X			X	X	1
2	2	2	1250	05:08			X	X					2
3	3	3	1150	05:13	X	X	X	X					3
4	4	4	1050	05:17	X		X	X					4
5	5	5	950	05:22	X	X	X	X					5
6	6	6	850	05:26	X		X	X				X	6
7	7	7	750	05:31			X	X					7
8	8	8	600	05:36	X		X	X					8
9	9	9	500	05:40			X	X					9
10	10	10	450	05:45	X	X	X	X			X		10
11	11	11	300	05:51		X	X	X					11
12	12	12	140	05:57	X		X	X		X		X	12
13	13	13	100	06:00	X	X	X	X		X			13
14	14	14	80	06:03	X	X	X	X		X			14
15	15	15	70	06:05			X	X		X			15
16	16	16	65	06:07		X	X	X		X			16
17	17	17	60	06:09		X	X	X		X		X	17
18	18	18	55	06:11	X	X	X	X		X			18
19	19	19	48	06:12			X	X		X			19
20	20	20	42	06:16			X	X		X		X	20
21	21	21	32	06:19	X	X	X	X		X			21
22	22	22	24	06:21			X	X		X	X	X	22
23	23	23	15	06:24			X			X		X	23
24	24	24	5	06:27		X	X			X			24
			Sampler		**Victoria**	**Nealy**	**Morwenna**	**Juliane**		**Gordy**	**Jo/Gordy**	**Samer**	

JC088 CTD log sheet

Station	B9	CTD No	026	Date	05/04/2013
Lat (at bottom)	55˚ 59.25’ N	Event No	043	Time I/W (GMT)	06:10
Lon (at bottom)	009˚ 54.73’ W	Water Depth (m)	1990	Time bottom (GMT)	07:08
Filename	JC088_026.hex	Cast Depth (m)	1975	Time O/W (GMT)	08:45
Weather	Good – some swell, 17 knots wind speed.				
Comments					

Fire Seq	Bot. No.	Rosette pos.	Depth (m)	Time (GMT)	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	Bot. No.
1	1	1	1975	07:09	x	x	x	x			x	x	1
2	2	2	1700	07:16			x	x					2
3	3	3	1400	07:23	x	x	x	x				x	3
4	4	4	1200	07:29			x	x					4
5	5	5	1100	07:33			x	x				x	5
6	6	6	950	07:38	x	x	x	x					6
7	7	7	800	07:46	x		x	x					7
8	8	8	750	07:49	x		x	x					8
9	9	9	700	07:52	x		x	x					9
10	10	10	500	07:59	x	x	x	x				x	10
11	11	11	400	08:03			x	x					11
12	12	12	350	08:06	x		x	x					12
13	13	13	200	08:12		x	x	x				x	13
14	14	14	170	08:15	x	x	x	x					14
15	15	15	100	08:19		x	x	x		x		x	15
16	16	16	90	08:23	x		x	x		x			16
17	17	17	55	08:26			x	x		x			17
18	18	18	48	08:27		x	x	x		x	x		18
19	19	19	42	08:30		x	x	x		x		x	19
20	20	20	37	08:31		x	x	x		x			20
21	21	21	32	08:33	x	x	x	x		x		x	21
22	22	22	24	08:35	x		x	x		x		x	22
23	23	23	15	08:36			x			x			23
24	24	24	5	08:38		x	x			x	x	x	24
			Sampler		Victoria	Nealy	Morwenna	Sam		Anna	Phil	Samer	

JC088 CTD log sheet

Station	B8	CTD No	027	Date	05/07/2013
Lat (at bottom)	55˚ 58.093’ N	Event No	044	Time I/W (GMT)	09:45
Lon (at bottom)	009˚ 45.12’ W	Water Depth (m)	1675	Time bottom (GMT)	10:30
Filename	JC088_027.hex	Cast Depth (m)	1660	Time O/W (GMT)	11:49
Weather	Beaufort 5, some swell (3.3 m on radar)				
Comments					

Fire Seq	Bot. No.	Rosette pos.	Depth (m)	Time (GMT)	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	Bot. No.
1	1	1	1660	10:31		x	x	x			x	x	1
2	2	2	1600	10:35			x	x					2
3	3	3	1500	10:40			x	x					3
4	4	4	1400	10:44		x	x	x					4
5	5	5	1300	10:49			x	x			x	x	5
6	6	6	1200	10:54			x	x					6
7	7	7	1100	10:58		x	x	x					7
8	8	8	1000	11:02			x	x			x		8
9	9	9	800	11:07		x	x	x					9
10	10	10	700	11:10			x	x				x	10
11	11	11	600	11:14		x	x	x			x		11
12	12	12	400	11:19		x	x	x					12
13	13	13	200	11:26		x	x	x					13
14	14	14	150	11:29			x	x		x			14
15	15	15	100	11:33			x	x		x			15
16	16	16	80	11:35			x	x		x			16
17	17	17	60	11:37		x	x	x		x		x	17
18	18	18	48	11:38		x	x	x		x		x	18
19	19	19	42	11:39		x	x	x		x		x	19
20	20	20	37	11:40		x	x	x		x			20
21	21	21	32	11:41			x	x		x		x	21
22	22	22	24	11:43			x	x		x			22
23	23	23	15	11:44			x			x	x	x	23
24	24	24	5	11:45		x	x			x			24
			Sampler			Nealy	Morwenna	Carl		Victoria	Sophie	Samer	

JC088 CTD log sheet

Station	B2	CTD No	028	Date	05/07/2013
Lat (at bottom)	55° 49.233' N	Event No	046	Time I/W (GMT)	17:44
Lon (at bottom)	008° 48.323' W	Water Depth (m)	121	Time bottom (GMT)	17:52
Filename	JC088_028.hex	Cast Depth (m)	115	Time O/W (GMT)	18:29
Weather	Wind speed 20 knots, direction 220°, sunny, 2.7 m swell				
Comments					

Fire Seq	Bot. No.	Rosette pos.	Depth (m)	Time (GMT)	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	Bot. No.
1	1	1	115	17:53	x	x	x	x				x	1
2	2	2	115	17:53							x		2
3	3	3	100	17:56	x	x	x	x					3
4	4	4	100	17:56									4
5	5	5	75	18:00	x	x	x	x		x			5
6	6	6	75	18:00									6
7	7	7	60	18:02	x	x	x	x		x			7
8	8	8	60	18:02									8
9	9	9	53	18:04	x	x	x	x		x		x	9
10	10	10	53	18:05									10
11	11	11	48	18:07	x	x	x	x		x			11
12	12	12	48	18:07									12
13	13	13	42	18:09	x	x	x	x		x			13
14	14	14	42	18:09									14
15	15	15	37	18:11	x	x	x	x		x		x	15
16	16	16	37	18:11									16
17	17	17	32	18:13	x	x	x	x		x		x	17
18	18	18	32	18:13									18
19	19	19	24	18:16	x	x	x	x		x		x	19
20	20	20	24	18:16								x	20
21	21	21	15	18:18	x	x	x	x		x			21
22	22	22	15	18:18							x		22
23	23	23	5	18:21	x	x	x			x		x	23
24	24	24	5	18:21									24
			Sampler		Victoria	Nealy	Morwenna	Gordy		Terry	Mark	Samer	

JC088 CTD log sheet

Station	B4	CTD No	029	Date	05/07/2013
Lat (at bottom)	55° 52.157' N	Event No	047	Time I/W (GMT)	20:10
Lon (at bottom)	009° 07.564' W	Water Depth (m)	159	Time bottom (GMT)	20:20
Filename	JC088_029.hex	Cast Depth (m)	150	Time O/W (GMT)	20:53
Weather	Wind speed 20 knots, sunny				
Comments					

Fire Seq	Bot. No.	Rosette pos.	Depth (m)	Time (GMT)	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	Bot. No.
1	1	1	150	20:21		x	x	x			x	x	1
2	2	2	150	20:21									2
3	3	3	125	20:24		x	x	x				x	3
4	4	4	125	20:24									4
5	5	5	100	20:27		x	x	x		x			5
6	6	6	100	20:27									6
7	7	7	75	20:30		x	x	x		x		x	7
8	8	8	75	20:30									8
9	9	9	60	20:32		x	x	x		x		x	9
10	10	10	60	20:32									10
11	11	11	52	20:35		x	x	x		x		x	11
12	12	12	52	20:35									12
13	13	13	48	20:37		x	x	x		x		x	13
14	14	14	48	20:37									14
15	15	15	42	20:39		x	x	x		x		x	15
16	16	16	42	20:39									16
17	17	17	32	20:41		x	x	x		x		x	17
18	18	18	32	20:42									18
19	19	19	24	20:44		x	x	x		x			19
20	20	20	24	20:44									20
21	21	21	15	20:47		x	x	x		x		x	21
22	22	22	15	20:47									22
23	23	23	5	20:49		x	x			x	x	x	23
24	24	24	5	20:49									24
			Sampler			Nealy	Morwenna	Sam		Anna	Marie	Samer	

JC088 CTD log sheet

Station	B6	CTD No	030	Date	05/07/2013
Lat (at bottom)	55˚ 55.153' N	Event No	048	Time I/W (GMT)	22:21
Lon (at bottom)	009˚ 26.441' W	Water Depth (m)	1033	Time bottom (GMT)	23:04
Filename	JC088_030.hex	Cast Depth (m)	1028	Time O/W (GMT)	00:09
Weather	25 knots, 2.2 metre waves				
Comments					

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	1028	23:05		X	X	X			X	X	1
2	2	2	950	23:08			X	X			X		2
3	3	3	900	23:12		X	X	X				X	3
4	4	4	850	23:14			X	X					4
5	5	5	800	23:17		X	X	X				X	5
6	6	6	750	23:19			X	X			X		6
7	7	7	700	23:22			X	X				X	7
8	8	8	650	23:25			X	X					8
9	9	9	600	23:27		X	X	X			X	X	9
10	10	10	500	23:31			X	X					10
11	11	11	400	23:35			X	X				X	11
12	12	12	300	23:39		X	X	X					12
13	13	13	250	23:42			X	X				X	13
14	14	14	200	23:45			X	X					14
15	15	15	150	23:48			X	X				X	15
16	16	16	100	23:52		X	X	X		X			16
17	17	17	71	23:54			X	X		X		X	17
18	18	18	55	23:57		X	X	X		X		X	18
19	19	19	48	23:59		X	X	X		X		X	19
20	20	20	42	00:00		X	X	X		X		X	20
21	21	21	32	00:02		X	X	X		X		X	21
22	22	22	24	00:03		X	X	X		X			22
23	23	23	15	00:05			X			X	X	X	23
24	24	24	5	00:07		X	X			X		X	24
			Sampler			**Nealy**	**Nealy**	**?**		**?**	**?**	**Samer**	

JC088 CTD log sheet

Station	C1	CTD No	031	Date	06/07/2013
Lat (at bottom)	55˚ 29.54' N	Event No	049	Time I/W (GMT)	03:34
Lon (at bottom)	009˚ 25.35' W	Water Depth (m)	200	Time bottom (GMT)	03:52
Filename	JC088_031.hex	Cast Depth (m)	200	Time O/W (GMT)	04:20
Weather	Wind force 6. CTD not returned to surface after initial soak – conditions too rough. CTD hit the bottom				
Comments	No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	C2	CTD No	032	Date	06/07/2013
Lat (at bottom)	55˚ 31.68’ N	Event No	050	Time I/W (GMT)	05:25
Lon (at bottom)	009˚ 30.87’ W	Water Depth (m)	300	Time bottom (GMT)	05:52
Filename	JC088_032.hex	Cast Depth (m)	290	Time O/W (GMT)	06:10
Weather	Wind force 6. Overcast. Slight – moderate swell				
Comments	Niskins 2, 11 and 12 removed from frame. No 10 m soak – too rough to return to surface before cast				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	C3	CTD No	033	Date	06/07/2013
Lat (at bottom)	55˚ 32.29’ N	Event No	051	Time I/W (GMT)	07:18
Lon (at bottom)	009˚ 32.14’ W	Water Depth (m)	403	Time bottom (GMT)	07:47
Filename	JC088_033.hex	Cast Depth (m)	392	Time O/W (GMT)	08:10
Weather	Wind force 6, overcast, 2.8 m swell				
Comments	No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	C4	CTD No	034	Date	06/07/2013
Lat (at bottom)	55˚ 32.786' N	Event No	056	Time I/W (GMT)	18:13
Lon (at bottom)	009˚ 33.290' W	Water Depth (m)	610	Time bottom (GMT)	18:37
Filename	JC088_034.hex	Cast Depth (m)	600	Time O/W (GMT)	19:04
Weather	Wind force 2, 2.3 metre waves				
Comments					

Fire Seq	Bot. No.	Rosette pos.	Depth (m)	Time (GMT)	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	Bot. No.
1	1	1	600	18:38							X		1
2	2	2	600	18:38							X		2
3	3	3	15	18:58							X		3
4	4	4	15	18:58							X		4
			Sampler								?		

JC088 CTD log sheet

Station	C5	CTD No	035	Date	06/07/2013
Lat (at bottom)	55˚ 32.995' N	Event No	057	Time I/W (GMT)	19:28
Lon (at bottom)	009˚ 33.925' W	Water Depth (m)	798	Time bottom (GMT)	20:01
Filename	JC088_035.hex	Cast Depth (m)	785	Time O/W (GMT)	20:26
Weather	Wind speed 4 knots. Clear skies				
Comments					

Fire Seq	Bot. No.	Rosette pos.	Depth (m)	Time (GMT)	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	Bot. No.
1	1	1	785	20:02							X		1
2	2	2	785	20:03							X		2
3	3	3	15	20:22							X		3
4	4	4	15	20:22							X		4
			Sampler								?		

JC088 CTD log sheet

Station	C6	CTD No	036	Date	06/07/2013
Lat (at bottom)	55° 33.883' N	Event No	058	Time I/W (GMT)	20:53
Lon (at bottom)	009° 35.888' W	Water Depth (m)	992	Time bottom (GMT)	21:31
Filename	JC088_036.hex	Cast Depth (m)	985	Time O/W (GMT)	22:01
Weather	Good				
Comments					

Fire Seq	Bot. No.	Rosette pos.	Depth (m)	Time (GMT)	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	Bot. No.
1	1	1	985	21:31							x		1
2	2	2	985	21:31									2
3	3	3	15	21:55							x		3
4	4	4	15	21:55									4
			Sampler								?		

JC088 CTD log sheet

Station	C8	CTD No	037	Date	06/07/2013
Lat (at bottom)	55° 35.762' N	Event No	059	Time I/W (GMT)	22:36
Lon (at bottom)	009° 39.044' W	Water Depth (m)	1381	Time bottom (GMT)	23:26
Filename	JC088_037.hex	Cast Depth (m)	1372	Time O/W (GMT)	23:57
Weather	Light wind, poor visibility				
Comments					

Fire Seq	Bot. No.	Rosette pos.	Depth (m)	Time (GMT)	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	Bot. No.
1	1	1	1372	23:27									1
2	2	2	1371	23:28							x		2
3	3	3	19	23:55									3
4	4	4	19	23:55							x		4
			Sampler								?		

JC088 CTD log sheet

Station	C7	CTD No	038	Date	07/07/2013
Lat (at bottom)	55° 34.411' N	Event No	060	Time I/W (GMT)	00:36
Lon (at bottom)	009° 37.230' W	Water Depth (m)	1182	Time bottom (GMT)	01:20
Filename	JC088_038.hex	Cast Depth (m)	1170	Time O/W (GMT)	02:00
Weather	Wind force 2, foggy, residual swell				
Comments					

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**$\delta^{15}N$**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	1170	01:21									1
2	2	2	1172	01:22							X		2
3	3	3	48	01:45					X				3
4	4	4	48	01:46									4
5	5	5	42	01:47					X				5
6	6	6	42	01:48									6
7	7	7	32	01:49					X				7
8	8	8	32	01:50									8
9	9	9	24	01:51					X				9
10	10	10	24	01:52									10
11	11	11	15	01:53					X				11
12	12	12	15	01:54							X		12
13	13	13	5	01:55					X				13
14	14	14	5	01:56									14
			Sampler						**Victoria**		**Vincent**		

JC088 CTD log sheet

Station	C9	CTD No	039	Date	07/07/2013
Lat (at bottom)	55° 37.482' N	Event No	061	Time I/W (GMT)	02:45
Lon (at bottom)	009° 41.152' W	Water Depth (m)	1585	Time bottom (GMT)	03:46
Filename	JC088_039.hex	Cast Depth (m)	1572	Time O/W (GMT)	04:33
Weather	Wind force 1, slight swell				
Comments					

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**$\delta^{15}N$**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	1572	03:47							X		1
2	2	2	1572	03:47									2
3	3	3	15	04:28							X		3
4	4	4	15	04:28									4
			Sampler								**Gordy/ Marian**		

JC088 CTD log sheet

Station	C11	CTD No	040	Date	07/07/2013
Lat (at bottom)	55˚ 43.880' N	Event No	062	Time I/W (GMT)	05:43
Lon (at bottom)	009˚ 52.135' W	Water Depth (m)	1987	Time bottom (GMT)	06:35
Filename	JC088_040.hex	Cast Depth (m)	1972	Time O/W (GMT)	07:16
Weather	Fine, light winds (force 2)				
Comments					

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
1	5	5	1972	06:36							X		5
2	6	6	1972	06:36									6
3	7	7	15	07:15							X		7
4	8	8	15	07:15									8
			Sampler								?		

JC088 CTD log sheet

Station	D1	CTD No	041	Date	07/07/2013
Lat (at bottom)	55˚ 11.46' N	Event No	063	Time I/W (GMT)	11:26
Lon (at bottom)	009˚ 56.97' W	Water Depth (m)	200	Time bottom (GMT)	11:42
Filename	JC088_041.hex	Cast Depth (m)	189	Time O/W (GMT)	11:52
Weather	Wind force 4. Foggy				
Comments	No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	C2	CTD No	042	Date	11/07/2013
Lat (at bottom)	55˚ 31.729' N	Event No	069	Time I/W (GMT)	23:43
Lon (at bottom)	009˚ 30.820' W	Water Depth (m)	301	Time bottom (GMT)	00:02
Filename	JC088_042.hex	Cast Depth (m)	293	Time O/W (GMT)	00:34
Weather	Good. Wind force 2. Fog				
Comments	Bottle 16 did not close properly				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	293	00:03	x	x	x	x				x	1
2	2	2	293	00:04							x		2
3	3	3	200	00:08	x	x	x	x				x	3
4	4	4	200	00:09									4
5	5	5	100	00:13	x	x	x	x		x		x	5
6	6	6	100	00:14									6
7	7	7	75	00:16	x	x	x	x		x		x	7
8	8	8	75	00:16									8
9	9	9	55	00:18	x	x	x	x		x		x	9
10	10	10	55	00:19									10
11	11	11	48	00:20	x	x	x	x		x		x	11
12	12	12	48	00:21									12
13	13	13	42	00:22	x	x	x	x		x		x	13
14	14	14	42	00:23							x		14
15	15	15	37	00:24	x	x	x	x		x		x	15
16	16	16	37	00:24									16
17	17	17	32	00:26	x	x	x	x		x		x	17
18	18	18	32	00:26									18
19	19	19	24	00:28	x	x	x	x		x		x	19
20	20	20	24	00:28									20
21	21	21	15	00:30	x	x	x	x		x		x	21
22	22	22	15	00:30									22
23	23	23	5	00:32	x	x	x			x		x	23
24	24	24	5	00:33							x		24
			Sampler		**Victoria**	**Nealy**	**Morwenna**	**?**		**?**	**?**	**Samer**	

JC088 CTD log sheet

Station	C4	CTD No	043	Date	12/07/2013
Lat (at bottom)	55˚ 32.792' N	Event No	070	Time I/W (GMT)	01:28
Lon (at bottom)	009˚ 33.280' W	Water Depth (m)	601	Time bottom (GMT)	01:53
Filename	JC088_043.hex	Cast Depth (m)	593	Time O/W (GMT)	02:27
Weather	Calm, foggy, wind force 2				
Comments					

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	593	01:54		x	x	x					1
2	2	2	593	01:55							x		2
3	3	3	399	02:00		x	x	x					3
4	4	4	399	02:00									4
5	5	5	201	02:05		x	x	x					5
6	6	6	201	02:06									6
7	7	7	75	02:10		x	x	x		x			7
8	8	8	75	02:11									8
9	9	9	55	02:13		x	x	x		x			9
10	10	10	55	02:13									10
11	11	11	48	02:15		x	x	x		x			11
12	12	12	48	02:15							x		12
13	13	13	42	02:16		x	x	x	x	x			13
14	14	14	42	02:17									14
15	15	15	37	02:18		x	x	x		x			15
16	16	16	37	02:18									16
17	17	17	32	02:20		x	x	x	x	x			17
18	18	18	32	02:20									18
19	19	19	24	02:22		x	x	x	x	x			19
20	20	20	24	02:22									20
21	21	21	15	02:24		x	x	x	x	x			21
22	22	22	15	02:24							x		22
23	23	23	5	02:26		x	x		x	x			23
24	24	24	5	02:26									24
			Sampler			**Nealy**	**Morwenna**	**Carl**	**Victoria**	**Victoria**	**Andy**		

JC088 CTD log sheet

Station	C6	CTD No	044	Date	12/07/2013
Lat (at bottom)	55˚ 33.89’ N	Event No	071	Time I/W (GMT)	03:08
Lon (at bottom)	009˚ 35.86’ W	Water Depth (m)	992	Time bottom (GMT)	03:36
Filename	JC088_044.hex	Cast Depth (m)	984	Time O/W (GMT)	04:36
Weather					
Comments					

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	δ^{15}N	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
1	1	1	984	03:38	x	x	x	x			x		1
2	2	2	964	03:41			x	x				x	2
3	3	3	955	03:43		x	x	x					3
4	4	4	940	03:46	x	x	x	x				x	4
5	5	5	920	03:48		x	x	x					5
6	6	6	850	03:51	x	x	x	x				x	6
7	7	7	800	03:54			x	x					7
8	8	8	650	03:59	x		x	x			x	x	8
9	9	9	450	04:05	x		x	x					9
10	10	10	375	04:08	x	x	x	x				x	10
11	11	11	200	04:13	x		x	x			x		11
12	12	12	125	04:16	x		x	x				x	12
13	13	13	100	04:18		x	x	x		x			13
14	14	14	90	04:20			x	x		x		x	14
15	15	15	70	04:22			x	x		x			15
16	16	16	65	04:24		x	x	x		x		x	16
17	17	17	60	04:25	x		x	x		x			17
18	18	18	55	04:26		x	x	x		x		x	18
19	19	19	48	04:28	x		x	x		x			19
20	20	20	42	04:29		x	x	x		x		x	20
21	21	21	32	04:31			x	x		x		x	21
22	22	22	24	04:32	x	x	x	x		x	x	x	22
23	23	23	15	04:34	x	x	x			x		x	23
24	24	24	5	04:35			x			x		x	24
			Sampler		Victoria	Nealy	Morwenna	Juliane		Jaimie	Mark	Samer	

JC088 CTD log sheet

Station	C8	CTD No	045	Date	12/07/2013
Lat (at bottom)	55˚ 35.760’ N	Event No	072	Time I/W (GMT)	05:31
Lon (at bottom)	009˚ 39.044’ W	Water Depth (m)	1384	Time bottom (GMT)	06:11
Filename	JC088_045.hex	Cast Depth (m)	1377	Time O/W (GMT)	07:22
Weather	Perfect!				
Comments					

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	δ^{15}N	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
1	1	1	1377	06:12		x	x	x			x		1
2	2	2	1300	06:15			x	x					2
3	3	3	1250	06:18			x	x					3
4	4	4	1175	06:21		x	x	x					4
5	5	5	1050	06:25		x	x	x					5
6	6	6	950	06:29		x	x	x					6
7	7	7	800	06:33		x	x	x					7
8	8	8	725	06:36		x	x	x					8
9	9	9	600	06:40		x	x	x					9
10	10	10	525	06:44			x	x					10
11	11	11	450	06:47		x	x	x					11
12	12	12	375	06:51			x	x					12
13	13	13	200	06:56			x	x					13
14	14	14	80	07:03		x	x	x		x			14
15	15	15	75	07:06			x	x		x			15
16	16	16	65	07:08		x	x	x		x			16
17	17	17	60	07:10			x	x		x			17
18	18	18	55	07:11			x	x		x			18
19	19	19	48	07:12		x	x	x		x	x		19
20	20	20	42	07:13			x	x		x			20
21	21	21	32	07:15			x	x		x			21
22	22	22	24	07:18		x	x	x		x			22
23	23	23	15	07:19			x			x	x		23
24	24	24	5	07:21			x			x			24
			Sampler			Nealy	Morwenna	Sam		?	?		

JC088 CTD log sheet

Station	C11	CTD No	046	Date	12/07/2013
Lat (at bottom)	55° 43.880' N	Event No	073	Time I/W (GMT)	08:38
Lon (at bottom)	009° 52.116' W	Water Depth (m)	1983	Time bottom (GMT)	09:28
Filename	JC088_046.hex	Cast Depth (m)	1972	Time O/W (GMT)	10:55
Weather	Sunny, wind speed <10 knots				
Comments	Bottle 7 did not fire				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	1972	09:30		X	X	X			X		1
2	2	2	1950	09:33			X	X				X	2
3	3	3	1925	09:35		X	X	X					3
4	4	4	1900	09:39			X	X				X	4
5	5	5	1800	09:44			X	X					5
6	6	6	1600	09:48		X	X	X				X	6
7	7	7	1400	09:54									7
8	8	8	1200	10:00			X	X				X	8
9	9	9	1000	10:05		X	X	X					9
10	10	10	800	10:11		X	X	X				X	10
11	11	11	700	10:15			X	X					11
12	12	12	600	10:20			X	X				X	12
13	13	13	400	10:25			X	X					13
14	14	14	300	10:28		X	X	X				X	14
15	15	15	200	10:33			X	X					15
16	16	16	100	10:37		X	X	X		X		X	16
17	17	17	60	10:40			X	X		X			17
18	18	19	48	10:43		X	X	X		X		X	18
19	19	19	42	10:45			X	X		X			19
20	20	20	37	10:47		X	X	X		X	X	X	20
21	21	21	32	10:49		X	X	X		X			21
22	22	22	24	10:50		X	X	X		X		X	22
23	23	23	15	10:52			X			X			23
24	24	24	5	10:53		X	X			X	X	X	24
			Sampler			**Nealy**	**Morwenna**	**?**		**?**	**?**	**Samer**	

JC088 CTD log sheet

Station	G345_pickup	CTD No	047	Date	16/07/2013
Lat (at bottom)	55° 37.294' N	Event No	080	Time I/W (GMT)	12:29
Lon (at bottom)	009° 40.976' W	Water Depth (m)	1575	Time bottom (GMT)	12:40
Filename	JC088_047.hex	Cast Depth (m)	200	Time O/W (GMT)	12:52
Weather	Grey, wind force 5				
Comments					

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	200	12:41									1
2	2	2	200	12:41							X		2
3	3	3	40	12:50									3
4	4	4	40	12:50							X		4
			Sampler								**?**		

JC088 CTD log sheet

Station	C1	CTD No	048	Date	16/07/2013
Lat (at bottom)	55˚ 29.522' N	Event No	083	Time I/W (GMT)	16:32
Lon (at bottom)	009˚ 25.298' W	Water Depth (m)	195	Time bottom (GMT)	16:45
Filename	JC088_048.hex	Cast Depth (m)	188	Time O/W (GMT)	17:14
Weather	Wind force 5, overcast, slight swell				
Comments	Bottle 14 did not fire				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**$\delta^{15}N$**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	188	16:46	X	X	X	X					1
2	2	2	188	16:46							X		2
3	3	3	150	16:49	X	X	X	X					3
4	4	4	150	16:49									4
5	5	5	125	16:52	X	X	X	X		X			5
6	6	6	125	16:52									6
7	7	7	75	16:56	X	X	X	X		X			7
8	8	8	75	16:56									8
9	9	9	55	16:58	X	X	X	X		X			9
10	10	10	55	16:59									10
11	11	11	48	17:01	X	X	X	X		X			11
12	12	12	48	17:01									12
13	13	13	42	17:03	X	X	X	X		X			13
14	14	14	42	17:03									14
15	15	15	32	17:05	X	X	X	X		X			15
16	16	16	32	17:05									16
17	17	17	24	17:07	X	X	X	X		X			17
18	18	18	24	17:07									18
19	19	19	20	17:09	X	X	X	X		X			19
20	20	20	20	17:09									20
21	21	21	15	17:10	X	X	X	X		X			21
22	22	22	15	17:10									22
23	23	23	5	17:12	X	X	X			X			23
24	24	24	5	17:12							X		24
			Sampler		**Victoria**	**Nealy**	**Morwenna**	**Gordy**		**Terry**	**Juliane/ Mark**		

JC088 CTD log sheet

Station	C2	CTD No	049	Date	16/07/2013
Lat (at bottom)	55˚ 31.684' N	Event No	084	Time I/W (GMT)	18:07
Lon (at bottom)	009˚ 30.808' W	Water Depth (m)	295	Time bottom (GMT)	18:26
Filename	JC088_049.hex	Cast Depth (m)	285	Time O/W (GMT)	18:43
Weather	Wind force 5, slight swell				
Comments	No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**$\delta^{15}N$**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	C3	CTD No	050	Date	16/07/2013
Lat (at bottom)	55˚ 32.293’ N	Event No	085	Time I/W (GMT)	19:09
Lon (at bottom)	009˚ 32.153’ W	Water Depth (m)	401	Time bottom (GMT)	19:29
Filename	JC088_050.hex	Cast Depth (m)	395	Time O/W (GMT)	20:08
Weather	Wind speed 20 knots				
Comments					

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	δ^{15}N	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
1	1	1	395	19:31		x	x	x			x		1
2	2	2	395	19:31									2
3	3	3	300	19:37		x	x	x					3
4	4	4	300	19:37									4
5	5	5	200	19:42									5
6	6	6	200	19:42		x	x	x					6
7	7	7	100	19:46		x	x	x		x			7
8	8	8	100	19:46									8
9	9	9	75	19:50		x	x	x		x			9
10	10	10	75	19:50									10
11	11	11	48	19:53		x	x	x		x			11
12	12	12	48	19:53									12
13	13	13	42	19:55		x	x	x		x			13
14	14	14	42	19:55									14
15	15	15	37	19:57		x	x	x		x			15
16	16	16	37	19:57									16
17	17	17	32	19:59		x	x	x		x			17
18	18	18	32	19:59									18
19	19	19	24	20:00		x	x	x		x			19
20	20	20	24	20:00									20
21	21	21	15	20:02		x	x	x		x			21
22	22	22	15	20:02									22
23	23	23	5	20:04		x	x			x	x		23
24	24	24	5	20:04									24
			Sampler			Nealy	Morwenna	?		?	?		

JC088 CTD log sheet

Station	C4	CTD No	051	Date	16/07/2013
Lat (at bottom)	55˚ 32.798’ N	Event No	086	Time I/W (GMT)	20:43
Lon (at bottom)	009˚ 33.282’ W	Water Depth (m)	588	Time bottom (GMT)	21:06
Filename	JC088_051.hex	Cast Depth (m)	578	Time O/W (GMT)	21:25
Weather	Wind speed 16 knots				
Comments	No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	δ^{15}N	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	C5	CTD No	052	Date	16/07/2013
Lat (at bottom)	55˚ 32.995’ N	Event No	087	Time I/W (GMT)	21:45
Lon (at bottom)	009˚ 33.925’ W	Water Depth (m)	796	Time bottom (GMT)	22:15
Filename	JC088_052.hex	Cast Depth (m)	785	Time O/W (GMT)	23:16
Weather	Wind speed 17 knots. 1.5 metre swell				
Comments	Bottles 3 and 16 leaked				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	δ^{15}N	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
1	1	1	785	22:16	x	x	x	x			x		1
2	2	2	755	22:19			x	x					2
3	3	3	740	22:22									3
4	4	4	700	22:26	x		x	x					4
5	5	5	650	22:29	x	x	x	x					5
6	6	6	600	22:32			x	x					6
7	7	7	500	22:36	x		x	x					7
8	8	8	400	22:40		x	x	x					8
9	9	9	350	22:43	x		x	x			x		9
10	10	10	300	22:46		x	x	x					10
11	11	11	250	22:49	x		x	x					11
12	12	12	200	22:52		x	x	x			x		12
13	13	13	150	22:56	x		x	x					13
14	14	14	100	22:58		x	x	x		x			14
15	15	15	75	23:01	x		x	x		x			15
16	16	16	65	23:02									16
17	17	17	55	23:04	x		x	x		x			17
18	18	18	48	23:06		x	x	x		x			18
19	19	19	42	23:08	x		x	x		x			19
20	20	20	37	23:09		x	x	x		x			20
21	21	21	32	23:10	x	x	x	x		x			21
22	22	22	24	23:12		x	x	x		x			22
23	23	23	15	23:13	x	x	x			x			23
24	24	24	5	23:15		x	x			x	x		24
			Sampler		Victoria	Nealy	Morwenna	Carl		?	?		

JC088 CTD log sheet

Station	C6	CTD No	053	Date	17/07/2013
Lat (at bottom)	55˚ 33.894’ N	Event No	088	Time I/W (GMT)	00:03
Lon (at bottom)	009˚ 35.884’ W	Water Depth (m)	1000	Time bottom (GMT)	00:34
Filename	JC088_053.hex	Cast Depth (m)	990	Time O/W (GMT)	00:55
Weather	Wind force 5				
Comments	Bridge ordered to recover CTD asap – bottles fired without stopping				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	δ^{15}N	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
1	1	1	42	00:53					x				1
2	2	2	32	00:53					x				2
3	3	3	24	00:53					x				3
4	4	4	15	00:54					x				4
5	5	5	5	00:54					x				5
			Sampler						Victoria				

JC088 CTD log sheet

Station	C1	CTD No	054	Date	18/07/2013
Lat (at bottom)	55˚ 29.534' N	Event No	098	Time I/W (GMT)	16:25
Lon (at bottom)	009˚ 25.337' W	Water Depth (m)	197	Time bottom (GMT)	16:39
Filename	JC088_054.hex	Cast Depth (m)	190	Time O/W (GMT)	16:49
Weather	Foggy. Wind force 1. Slight swell				
Comments	Nutrient sensor and fluorescein fluorometer fitted. Bottles 2-6 fired without stopping the CTD package				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
1	1	1	190	16:40								x	1
2	2	2	125	16:42								x	2
3	3	3	40	16:45								x	3
4	4	4	25	16:46								x	4
5	5	5	15	16:46								x	5
6	6	6	5	16:46								x	6
			Sampler									Samer/ Victoria/ Nealy	

JC088 CTD log sheet

Station	C3	CTD No	055	Date	18/07/2013
Lat (at bottom)	55˚ 32.298' N	Event No	099	Time I/W (GMT)	17:37
Lon (at bottom)	009˚ 32.225' W	Water Depth (m)	408	Time bottom (GMT)	17:54
Filename	JC088_055.hex	Cast Depth (m)	407	Time O/W (GMT)	18:11
Weather	Foggy, wind force 3				
Comments	Nutrient sensor fitted – no data. Bottles 2-6 fired without stopping. Fluorescein fluorometer fitted				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
1	1	1	407	17:55								x	1
2	2	2	225	17:59								x	2
3	3	3	40	18:05								x	3
4	4	4	30	18:05								x	4
5	5	5	15	18:05								x	5
6	6	6	5	18:06								x	6
			Sampler									Morwenna/ Nealy	

JC088 CTD log sheet

Station	C4	CTD No	056	Date	18/07/2013
Lat (at bottom)	55˚ 32.827' N	Event No	100	Time I/W (GMT)	18:32
Lon (at bottom)	009˚ 33.284' W	Water Depth (m)	611	Time bottom (GMT)	18:53
Filename	JC088_056.hex	Cast Depth (m)	600	Time O/W (GMT)	19:11
Weather	Foggy. Wind force 3				
Comments	Nutrient sensor fitted – no data. Fluorescein fluorometer fitted. Bottles 2-6 fired without stopping				

Fire Seq	Bot. No.	Rosette pos.	Depth (m)	Time (GMT)	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	δ^{15}N	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	Bot. No.
1	1	1	600	18:53								x	1
2	2	2	340	18:54								x	2
3	3	3	40	19:06								x	3
4	4	4	30	19:07								x	4
5	5	5	15	19:07								x	5
6	6	6	5	19:08								x	6
			Sampler									Nealy	

JC088 CTD log sheet

Station	C5	CTD No	057	Date	18/07/2013
Lat (at bottom)	55˚ 32.994' N	Event No	101	Time I/W (GMT)	19:37
Lon (at bottom)	009˚ 33.924' W	Water Depth (m)	791	Time bottom (GMT)	20:03
Filename	JC088_057.hex	Cast Depth (m)	780	Time O/W (GMT)	20:24
Weather	Foggy. Wind speed 5 knots				
Comments	Nutrient sensor/fluorescein fluorometer fitted. Bottles 2-6 fired without stopping CTD package				

Fire Seq	Bot. No.	Rosette pos.	Depth (m)	Time (GMT)	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	δ^{15}N	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	Bot. No.
1	1	1	780	20:04								x	1
2	2	2	435	20:12								x	2
3	3	3	40	20:21								x	3
4	4	4	30	20:21								x	4
5	5	5	15	20:21								x	5
6	6	6	5	20:22								x	6
			Sampler									Nealy/ Victoria	

JC088 CTD log sheet

Station	C7	CTD No	058	Date	18/07/2013
Lat (at bottom)	55˚ 34.418’ N	Event No	102	Time I/W (GMT)	20:51
Lon (at bottom)	009˚ 37.220’ W	Water Depth (m)	1180	Time bottom (GMT)	21:25
Filename	JC088_058.hex	Cast Depth (m)	1171	Time O/W (GMT)	22:41
Weather	Foggy. Wind speed <2 knots				
Comments	Bottle 16 leaked on recovery. Nutrient sensor/fluorescein fluorometer fitted				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
1	1	1	1171	21:26		x	x	x			x		1
2	2	2	1160	21:28	x		x	x				x	2
3	3	3	1150	21:30			x	x					3
4	4	4	1125	21:34	x	x	x	x					4
5	5	5	1100	21:37			x	x			x	x	5
6	6	6	1000	21:41	x		x	x					6
7	7	7	900	21:45	x	x	x	x			x		7
8	8	8	800	21:49	x	x	x	x					8
9	9	9	700	21:53	x		x	x					9
10	10	10	600	21:57		x	x	x			x		10
11	11	11	500	22:01	x		x	x					11
12	12	12	400	22:05		x	x	x					12
13	13	13	300	22:09	x		x	x					13
14	14	14	200	22:13			x	x					14
15	15	15	150	22:16	x	x	x	x					15
16	16	16	100	22:21									16
17	17	17	75	22:24	x		x	x		x		x	17
18	18	18	48	22:27		x	x	x		x		x	18
19	19	19	42	22:29		x	x	x		x			19
20	20	20	37	22:31	x	x	x	x		x			20
21	21	21	32	22:32		x	x	x		x			21
22	22	22	24	22:34			x	x		x			22
23	23	23	15	22:36	x		x			x	x	x	23
24	24	24	5	22:38		x	x			x		x	24
			Sampler		Victoria	Nealy	Morwenna	?		?	?	?	

JC088 CTD log sheet

Station	C9	CTD No	059	Date	18/07/2013
Lat (at bottom)	55˚ 37.528’ N	Event No	103	Time I/W (GMT)	23:30
Lon (at bottom)	009˚ 41.174’ W	Water Depth (m)	1587	Time bottom (GMT)	00:07
Filename	JC088_059.hex	Cast Depth (m)	1576	Time O/W (GMT)	04:18
Weather	OK. Wind force 2				
Comments	Nutrient sensor fitted. 30 min bottle stops for 6 depths (see asterisks). Top cap from bottle 24 missing				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
1	1	1	1576	00:08		x	x	x			x		1
2	2	2	1500	00:12			x	x					2
3	3	3	1400*	00:31			x	x			x	x	3
4	4	4	1151	00:51		x	x	x					4
5	5	5	1100	00:54			x	x			x		5
6	6	6	900	01:00		x	x	x					6
7	7	7	850	01:02			x	x					7
8	8	8	750*	01:20		x	x	x				x	8
9	9	9	650	01:38			x	x					9
10	10	10	600	01:41			x	x					10
11	11	11	500	01:45			x	x			x		11
12	12	12	400	01:49		x	x	x					12
13	13	13	300	01:53			x	x					13
14	14	14	201	01:57		x	x	x					14
15	15	15	100	02:00			x	x		x			15
16	16	16	75	02:04			x	x		x			16
17	17	17	55*	02:21		x	x	x		x		x	17
18	18	18	48	02:37			x	x		x			18
19	19	19	42*	02:53		x	x	x		x		x	19
20	20	20	37	03:09		x	x	x		x			20
21	21	21	32*	03:25		x	x	x		x		x	21
22	22	22	24	03:42			x	x		x			22
23	23	23	15*	03:59		x	x			x	x	x	23
24	24	24	5	04:16		x	x			x			24
			Sampler			Nealy	Morwenna	Gordy		Juliane	Jo	Samer	

JC088 CTD log sheet

Station	B9	CTD No	060	Date	19/07/2013
Lat (at bottom)	55˚ 59.255' N	Event No	112	Time I/W (GMT)	22:39
Lon (at bottom)	009˚ 54.715' W	Water Depth (m)	1989	Time bottom (GMT)	23:29
Filename	JC088_060.hex	Cast Depth (m)	1975	Time O/W (GMT)	04:17
Weather	Wind speed 14 knots. Light swell				
Comments	Nutrient sensor and fluorescein fluorometer fitted				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
1	1	1	1700	23:36									1
2	2	2	1700	23:50								X	2
3	3	3	1700	00:04									3
4	4	4	1200	00:15									4
5	5	5	1200	00:29								X	5
6	6	6	1200	00:43									6
7	7	7	500	00:58									7
8	8	8	500	01:12								X	8
9	9	9	500	01:26									9
10	10	10	200	01:35									10
11	11	11	200	01:48								X	11
12	12	12	200	02:02									12
13	13	13	75	02:08									13
14	14	14	75	02:23								X	14
15	15	15	75	02:36									15
16	16	16	49	02:39									16
17	17	17	49	02:53								X	17
18	18	18	50	03:09									18
19	19	19	25	03:13									19
20	20	20	25	03:28								X	20
21	21	21	25	03:42									21
22	22	22	15	03:45									22
23	23	23	15	03:59								X	23
24	24	24	15	04:15									24
			Sampler									**Samer**	

JC088 CTD log sheet

Station	SG525 PICKUP	CTD No	061	Date	20/07/2013
Lat (at bottom)	56˚ 01.451' N	Event No	113	Time I/W (GMT)	05:56
Lon (at bottom)	009˚ 47.335' W	Water Depth (m)	1790	Time bottom (GMT)	06:38
Filename	JC088_061.hex	Cast Depth (m)	1779	Time O/W (GMT)	07:15
Weather	Wind force 4. Sunny. Calm sea state				
Comments	No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	OMG PICKUP	CTD No	062	Date	20/07/2013
Lat (at bottom)	55˚ 52.128' N	Event No	115	Time I/W (GMT)	11:32
Lon (at bottom)	008˚ 53.160' W	Water Depth (m)	127	Time bottom (GMT)	11:41
Filename	JC088_062.hex	Cast Depth (m)	121	Time O/W (GMT)	11:50
Weather	Wind force 4. Sunny				
Comments	No bottles were fired. PAR back on CTD. Fluorescein fluorometer removed				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	B7	CTD No	063	Date	20/07/2013
Lat (at bottom)	55˚ 56.649' N	Event No	117	Time I/W (GMT)	15:27
Lon (at bottom)	009˚ 35.903' W	Water Depth (m)	1390	Time bottom (GMT)	16:00
Filename	JC088_063.hex	Cast Depth (m)	1380	Time O/W (GMT)	16:31
Weather	Wind force 4, sunny				
Comments	Noisy upcast transmissometer data caused by jellyfish on CTD package. No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	B6	CTD No	064	Date	20/07/2013
Lat (at bottom)	55˚ 55.149' N	Event No	118	Time I/W (GMT)	17:23
Lon (at bottom)	009˚ 26.470' W	Water Depth (m)	1034	Time bottom (GMT)	17:51
Filename	JC088_064.hex	Cast Depth (m)	1025	Time O/W (GMT)	18:27
Weather	Wind force 4. Sunny				
Comments	Nutrient sensor fitted to CTD frame				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	1030	17:52								x	1
2	2	2	825	17:58								x	2
3	3	3	500	1806								x	3
4	4	4	250	18:13								x	4
			Sampler									**Mark/Jo**	

JC088 CTD log sheet

Station	B5XX	CTD No	065	Date	20/07/2013
Lat (at bottom)	55˚ 54.355' N	Event No	119	Time I/W (GMT)	19:09
Lon (at bottom)	009˚ 21.363' W	Water Depth (m)	790	Time bottom (GMT)	19:35
Filename	JC088_065.hex	Cast Depth (m)	781	Time O/W (GMT)	19:56
Weather	Wind speed 12 knots. Sunny				
Comments	No bottles were fired. Nutrient sensor fitted to CTD package				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	B4X	CTD No	066	Date	20/07/2013
Lat (at bottom)	55˚ 53.506’ N	Event No	120	Time I/W (GMT)	20:35
Lon (at bottom)	009˚ 15.281’ W	Water Depth (m)	200	Time bottom (GMT)	20:48
Filename	JC088_066.hex	Cast Depth (m)	194	Time O/W (GMT)	21:28
Weather	Wind speed 13 knots. Sunny				
Comments	Nutrient sensor fitted to CTD package				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	194	20:49	X	X	X	X					1
2	2	2	194	20:49							X		2
3	3	3	175	20:52	X	X	X						3
4	4	4	175	20:52									4
5	5	5	150	20:56	X	X	X						5
6	6	6	150	20:56									6
7	7	7	100	21:01	X	X	X	X		X			7
8	8	8	100	21:01									8
9	9	9	48	21:06	X	X	X			X	X		9
10	10	10	48	21:06									10
11	11	11	42	21:08	X	X	X			X			11
12	12	12	42	21:08									12
13	13	13	37	21:10	X	X	X	X		X			13
14	14	14	37	21:10									14
15	15	15	32	21:13	X	X	X			X			15
16	16	16	32	21:13									16
17	17	17	24	21:16	X	X	X	X		X			17
18	18	18	24	21:16									18
19	19	19	15	21:18	X	X	X			X			19
20	20	20	15	21:18									20
21	21	21	10	21:20	X	X	X	X		X			21
22	22	22	10	21:20									22
23	23	23	5	21:22	X	X	X			X	X		23
24	24	24	5	21:22									24
			Sampler		**Victoria**	**Nealy**	**Morwenna**	**Marie**		**Anna**	**Phil**		

JC088 CTD log sheet

Station	B5	CTD No	067	Date	20/07/2013
Lat (at bottom)	55˚ 53.782’ N	Event No	121	Time I/W (GMT)	22:22
Lon (at bottom)	009˚ 17.015’ W	Water Depth (m)	385	Time bottom (GMT)	22:45
Filename	JC088_067.hex	Cast Depth (m)	373	Time O/W (GMT)	23:00
Weather	Wind speed 11 knots				
Comments	No bottles were fired. Nutrient sensor fitted to CTD package				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15}N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	B5X	CTD No	068	Date	20/07/2013
Lat (at bottom)	55˚ 54.013' N	Event No	122	Time I/W (GMT)	23:24
Lon (at bottom)	009˚ 18.812' W	Water Depth (m)	596	Time bottom (GMT)	23:46
Filename	JC088_068.hex	Cast Depth (m)	587	Time O/W (GMT)	00:22
Weather	Wind force 2				
Comments	Nutrient sensor fitted to CTD package				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
1	1	1	587	23:47		X	X	X					1
2	2	2	597	23:47							X		2
3	3	3	450	23:51		X	X						3
4	4	4	450	23:51									4
5	5	5	350	23:56		X	X	X					5
6	6	6	350	23:56									6
7	7	7	250	00:00		X	X						7
8	8	8	250	00:00							X		8
9	9	9	100	00:05		X	X	X		X			9
10	10	10	100	00:06									10
11	11	11	48	00:09		X	X			X			11
12	12	12	48	00:10									12
13	13	13	42	00:11		X	X	X		X			13
14	14	14	42	00:12									14
15	15	15	37	00:13		X	X			X			15
16	16	16	37	00:13							X		16
17	17	17	32	00:15		X	X	X		X			17
18	18	18	32	00:15									18
19	19	19	24	00:17		X	X			X			19
20	20	20	24	00:17									20
21	21	21	15	00:19		X	X	X		X			21
22	22	22	15	00:19									22
23	23	23	5	00:21		X	X			X			23
24	24	24	5	00:21							X		24
			Sampler			Nealy	Morwenna	?		Victoria	?		

JC088 CTD log sheet

Station	B4	CTD No	069	Date	21/07/2013
Lat (at bottom)	55˚ 52.153' N	Event No	123	Time I/W (GMT)	01:21
Lon (at bottom)	009˚ 07.560' W	Water Depth (m)	162	Time bottom (GMT)	01:32
Filename	JC088_069.hex	Cast Depth (m)	155	Time O/W (GMT)	02:25
Weather	Wind force 4				
Comments	Calibration cast for miniloggers. 5 min bottle stops. Nutrient sensor fitted to CTD				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	$\delta^{15}N$	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
1	1	1	155	01:33									1
2	2	2	155	01:33							X		2
3	3	3	70	01:44									3
4	4	4	70	01:44							X		4
5	5	5	42	02:01					X				5
6	6	6	42	02:01									6
7	7	7	32	02:07					X				7
8	8	8	32	02:07									8
9	9	9	24	02:12					X				9
10	10	10	24	02:13									10
11	11	11	15	02:18					X				11
12	12	12	15	02:18							X		12
13	13	13	5	02:23					X				13
14	14	14	5	02:24									14
			Sampler						Victoria		?		

JC088 CTD log sheet

Station	B3X	CTD No	070	Date	21/07/2013
Lat (at bottom)	55˚ 51.530' N	Event No	124	Time I/W (GMT)	03:06
Lon (at bottom)	009˚ 03.650' W	Water Depth (m)	144	Time bottom (GMT)	03:16
Filename	JC088_070.hex	Cast Depth (m)	137	Time O/W (GMT)	03:44
Weather	Wind force 4. Calm				
Comments	Nutrient sensor fitted to CTD package				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	δ^{15}N	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
1	1	1	137	03:18	X	X	X	X				X	1
2	2	2	137	03:18									2
3	3	3	120	03:20	X	X	X	X			X		3
4	4	4	120	03:20									4
5	5	5	90	03:24	X	X	X	X		X	X	X	5
6	6	6	90	03:24									6
7	7	7	70	03:27	X	X	X	X		X			7
8	8	8	70	03:27									8
9	9	9	48	03:30	X	X	X	X		X			9
10	10	10	48	03:30									10
11	11	11	42	03:31	X	X	X	X		X		X	11
12	12	12	42	03:31									12
13	13	13	37	03:33	X	X	X	X		X			13
14	14	14	37	03:33									14
15	15	15	32	03:35	X	X	X	X		X			15
16	16	16	32	03:35									16
17	17	17	24	03:37	X	X	X	X		X			17
18	18	18	24	03:37									18
19	19	19	15	03:39	X	X	X	X		X			19
20	20	20	15	03:39									20
21	21	21	10	03:41	X	X	X	X		X		X	21
22	22	22	10	03:41									22
23	23	23	5	03:42	X	X	X			X			23
24	24	24	5	03:42									24
			Sampler		Victoria	Nealy	Morwenna	Gordy		Jo	Jo	Samer	

JC088 CTD log sheet

Station	B3	CTD No	071	Date	21/07/2013
Lat (at bottom)	55˚ 50.164' N	Event No	125	Time I/W (GMT)	04:39
Lon (at bottom)	008˚ 57.992' W	Water Depth (m)	132	Time bottom (GMT)	04:46
Filename	JC088_071.hex	Cast Depth (m)	122	Time O/W (GMT)	05:00
Weather	Wind force 4. Calm				
Comments	No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	Dissolved Oxygen	Dissolved Organic Matter	Inorganic Nutrients	δ^{15}N	Primary Production	Chlorophyll	Salinity	Sensor Nutrients	*Bot. No.*
			Sampler										

JC088 CTD log sheet

Station	B2	CTD No	072	Date	21/07/2013
Lat (at bottom)	55˚ 49.210' N	Event No	126	Time I/W (GMT)	05:49
Lon (at bottom)	008˚ 48.445' W	Water Depth (m)	121	Time bottom (GMT)	05:58
Filename	JC088_072.hex	Cast Depth (m)	115	Time O/W (GMT)	06:21
Weather	Wind force 4. Calm				
Comments					

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15} N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
1	1	1	115	05:59			X				X		1
2	2	2	115	05:59									2
3	3	3	60	06:02			X						3
4	4	4	60	06:02									4
5	5	5	53	06:05			X						5
6	6	6	53	06:05									6
7	7	7	48	06:07			X						7
8	8	8	48	06:07									8
9	9	9	42	06:08			X						9
10	10	10	42	06:08									10
11	11	11	37	06:10			X						11
12	12	12	37	06:10									12
13	13	13	32	06:12			X						13
14	14	14	32	06:12									14
15	15	15	24	06:13			X				X		15
16	16	16	24	06:13									16
17	17	17	20	06:15			X						17
18	18	18	20	06:15									18
19	19	19	15	06:17			X						19
20	20	20	15	06:17									20
21	21	21	10	06:18			X						21
22	22	22	10	06:18									22
23	23	23	5	06:20			X						23
24	24	24	5	06:20									24
			Sampler				**Morwenna**				**Gordy**		

JC088 CTD log sheet

Station	B1	CTD No	073	Date	21/07/2013
Lat (at bottom)	55˚ 47.752' N	Event No	127	Time I/W (GMT)	07:20
Lon (at bottom)	008˚ 39.116' W	Water Depth (m)	111	Time bottom (GMT)	07:30
Filename	JC088_073.hex	Cast Depth (m)	101	Time O/W (GMT)	07:37
Weather	Fine				
Comments	No bottles were fired				

Fire Seq	*Bot. No.*	*Rosette pos.*	*Depth (m)*	*Time (GMT)*	**Dissolved Oxygen**	**Dissolved Organic Matter**	**Inorganic Nutrients**	**δ^{15} N**	**Primary Production**	**Chlorophyll**	**Salinity**	**Sensor Nutrients**	*Bot. No.*
			Sampler										