SAMS Report No. 292

R/V *Pelagia* Cruise PE399

16th June to 8th July 2015, Southampton, UK to Reykjavik, Iceland

Cruise Principal Scientist Prof. Stuart A. Cunningham

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Abstract

This cruise report details the scientific programme for the Scottish Association for Marine Science (SAMS) led by Professor Stuart Cunningham on R/V *Pelagia* cruise 339. This cruise is a contribution to the international Overturning in the Subpolar North Atlantic Programme (OSNAP). Two additional scientific teams (from Rosenstiel School of Marine and Atmospheric Sciences, and Woods Hole Oceanographic Institution / Ocean University of China) participated in this cruise. SAMS objectives were to recover and redeploy moorings in the Rockall Trough, measuring temperature, salinity, currents and bottom pressure and; recover Seaglider SG605 ''Bowmore'' in the Hatton-Rockall Basin.

The OSNAP array deployed since July 2014 is purposefully designed to provide a continuous record of the full-water column, trans-basin fluxes of heat, mass and freshwater in the subpolar North Atlantic, on a section from Newfoundland to Greenland to Scotland.

Keywords
Atlantic Ocean, North Atlantic, North Atlantic Current, subpolar gyre, meridional overturning circulation, MOC, AMOC, bottom pressure recorder, BPR, cruise PE399, CTD, current meter, Pelagia, MicroCAT, mooring array, moorings, thermohaline circulation, glider, Seaglider, OSNAP, UK-OSNAP, Rockall Plateau, Rockall-Hatton Plateau, Rockall Trough, Reykjanes Ridge, Iceland Basin, Irminger Basin, Mid-Atlantic Ridge

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1a: Ship's Personnel

Berth	Name	Function
1	Pieter Kuijt	Master
2	Joep V. Haaren	Chief Officer
3	Alle Fockema	2nd Officer
4	Jaap Seepma	Chief Engineer
5	Oleg Akimov	2nd Engineer
6	Roald vd Heide	Electrician
7	Sjaak Maas	Bosun
8	Freddie Hiemstra	AB1
9	Roel v.d. Heide	AB2
10	Jose Vitoria	AB3
11	Rik v Katwijk	Cook
12	Alex Popov	Steward

1b: NIOZ technical staff

Berth	Name	Function
13	Sven Ober	*NIOZ* Royal Netherlands Institute for Sea Research (CTD and salinity analysis)
14	Leon Wuis	NIOZ (Mooring winches)

1c: Science party

Berth	Name	Institute
15	Stuart Cunningham (Chief Scientist)	Scottish Association for Marine Science
16	Clare Johnson	SAMS
17	Loic Houpert	SAMS
18	Colin Griffiths	SAMS
19	John Beaton	SAMS
20	William Johns	University of Miami, Rosenstiel School of Marine and Atmospheric Sciences
21	Adam Houk	RSMAS
22	Athanasia Papapostolou	RSMAS
23	Mark Graham	RSMAS
24	Cobi Cristiansen	RSMAS
25	Heather Furey	Woods Hole Oceanographic Institution
26	Dalei Song	Ocean University of China, Qingdao

2 R/V Pelagia

The R/V *Pelagia* is owned by the Royal Netherlands Institute for Sea Research (NIOZ) and is based in Texel, the Netherlands. Length over all is 66.05m, beam 12.8m and gross tonnage of 1615tons. Cruising speed is 9kn giving a fuel consumption of ~4.5m^3/day with a total fuel oil capacity of 200m^3. *Pelagia* has 25 single berth cabins with toilet and shower. Prior to this cruise this accommodated 11 crew, and 14 technicians and scientists (on this cruise consisting of 2 NIOZ technical support staff and 12 scientists) in single cabins. Now the crew has been increased to 12 personnel with addition of a permanent ship's electrician who additionally supports the ship-board computing and instrumentation systems. Thus one berth for the science party needs doubled to accommodate 12 scientists. The limiting factor for the science party is that the ship is licenced only to carry 12 passengers (defined as those not in possession of a Seaman's Record Book or Continuous Discharge Certificate). Thus practically, the ship is limited to a science party of 12. Larger numbers of technical staff can be accommodated (NIOZ staff are contracted to have single cabins) if the science party shares.

Ship's fixed laboratory spaces are relatively small compared to the scientific capabilities. They are: measuring room (20m^2 on C-deck) which contains the CTD console and deck units, multibeam computer and VM ADCP deck-unit and computer. There is limited desk space for additional scientific computing; General wet lab (30m^2 on D-deck) with a range of stainless worksurfaces and under bench storage. This was used as a staging lab for mooring instrumentation and release preparation; Dry lab (15m^2 on D-deck) with approximately 5m length of bench top. This was the main lab on this cruise and accommodated 3 scientists (4 at a squash); Wet chem. Lab (15m^2 on D-deck) with approximately a 2m long island bench and 2m of bench top. This lab was used as the main mooring instrument preparation space.

To supplement the fixed laboratories a variety of containerised laboratories are available from NIOZ and the total capacity is 3+1(spare) on D-deck aft, 1 in hold on D-deck and 4 in hold on tanktop. For this trip we had one workshop container for mooring instrumentation located on D-deck aft. This was used for storage and preparation of RAFOS floats. A temperature controlled laboratory was installed on the tanktop level and contained a salinometer. We could usefully have installed another lab for additional mooring instrument preparation space and would have removed the need for constant shuffling of instruments in the limited lab space.

The main working deck is D-Deck with an area of 135m^2. We had one container lab and a double-barrel winch mooring system installed on a container base, reducing available deck space. All gear required during a cruise should be stored on D-deck as the upper storage on C-deck can only be accessed by shore crane for heavy items. The ship's fitted container crane is not used at sea. The ship is fitted with starboard A-frame for CTD operations and a stern A-frame for mooring operations. Mooring operations are also supported by a folding crane (starboard side D-deck) with a safe-working-load of 3.6 tons and reach of 0.6 to 10.75m.

3 Itinerary

Mobilisation at Empress Dock, National Oceanography Centre Southampton on Monday 15th June 2015. Sailed at 1330 on Tuesday 16th. Arrived Reykjavik, Iceland Monday 6th July 2015.

4 Acknowledgements

We thank Captain Pieter Kuijt, the officers and crew of the R/V Pelagia (Table 1a) and NIOZ technical staff (Table 1b) for their 'can do' attitude and proactive support of the science programme.

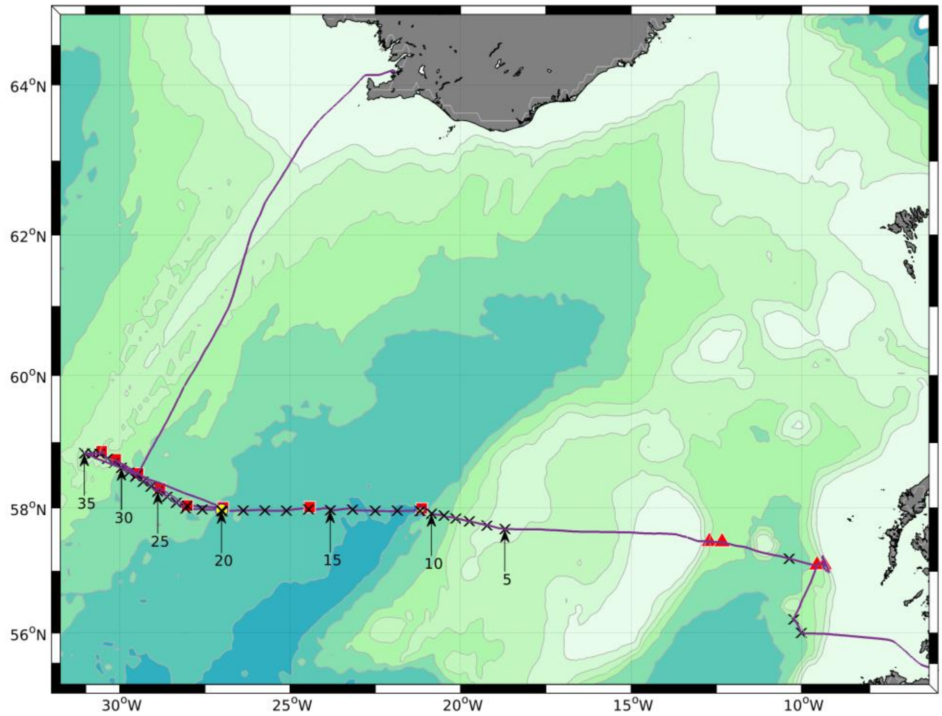


Figure 1: Bathymetry map (500m depth contours) with the track of the PE399 cruise. CTD stations are indicated by the black crosses and mooring locations by the red squares (RSMAS) and red triangles (SAMS). Recovery of the SAMS glider is indicated by the yellow star (58N-21W) and deployment of the WHOI-OUC Slocum glider is shown by the yellow circle.

5 Introduction

This report details the scientific programme which took place on the R/V *Pelagia* cruise PE399 as a contribution to the international Overturning in the Subpolar North Atlantic Programme (OSNAP)[1]. The cruise PE399 was led by Professor Stuart Cunningham of the Scottish Association for Marine Science (SAMS). Two additional scientific teams participated on this cruise (Table 1c). Professor William Johns from the Rosenstiel School of Marine and Atmospheric Sciences (RSMAS), University of Miami led and planned the US contribution to the cruise. Also participating was a team from the Woods Hole Oceanographic Institution (WHOI) and Ocean University of China.

SAMS objectives were to: 1. Recover and deploy moorings in the Rockall Trough, measuring temperature, salinity, currents and bottom pressure and; 2. Recover Seaglider SG605 “Bowmore” on the Hatton Plateau.

RSMAS objectives were to: 1. Recover and deploy moorings on the eastern flank of the Reykjanes Ridge and across the Iceland Basin measuring temperature, salinity and currents and; 2. Occupy a section of CTD/LADP stations from the Scottish continental shelf, through the Iceland Basin across the Reykjanes Ridge and part way across the Irminger Basin (Figure 1).

WHOI objectives were to: 1. Deploy RAFOS floats in the Irminger and Iceland Basins. 2. Deploy a Slocum Glider

Locations of the CTDs casts carried out during the cruise is shown on Figure 1, together with the locations of the moorings deployed by the different scientific teams.

[1] www.o-snap.org

6 Ship's Computing

6.1 Communications

Internet is available via VSAT and is accessed by Ethernet from all labs and cabins. Typical download and upload speed were 0.08Mbps and 0.05Mbps during the day and a little faster overnight. Colour laser printers are available in the meeting room on C-deck, which is inconvenient for regular use.

6.2 TECHSAS

Data acquisition is by the Ifremer system TECHSAS, logging a range of shipboard instrumentation (discussed section 0). Data is written to a number of TECHSAS netcdf streams (data files) in real time. Some data streams are additionally merged together into a second TECHSAS netcdf stream to provide a complete data set of a particular set of measurements (e.g. meteorological measurements from a variety of sensors logged separately are combined into a single file). Data are logged at a maximum rate of 1s.

On this cruise we directly accessed and processed data from the TECHSAS streams. We installed a Dell workstation, running MSTAR (oceanographic data processing software in MATLAB written by Brian King, NOC). The directory for the TECHSAS streams was mounted directly on this workstation and all data processed in daily chunks, being combined into single netcdf master files at the cruise end (described in more detail section 0). These MEXEC netcdf files have headers that contain complete meta-data.

Note that the VM ADCP and CTD data streams are logged separately (see below for details).

6.3 CASINO+

Casino is the data and event logging program for Pelagia (Corre, M.P, 2007). Casino records available data time-stamped and georeferenced at an interval of 30 seconds. The bridge officer on enters events manually to the data file. The CASINO+ data file is in excel format. There is one row per event (data every 30s and additional events entered by the bridge officer). There are 84 columns of data.

Corre, M. P. (2007). CASINO+ Software User Manual. DOP/CB/NSE/ILE/DTI/02-188 VERSION 4.2.

7 Underway data

7.1 Underway data

Pelagia is fitted with a range of instruments for measuring the ocean, the atmosphere and the ship's position and motion. These are logged via TECHSAS; the TECHSAS data streams are listed in Table 2. A number of instruments are logged to their own TECHSAS stream but are additionally included in a master TECHSAS stream for related measurements. The three main master TECHSAS streams that assemble various measurements were: 'hydrology' for ocean near surface measurements, 'weather' for meteorological observations and 'navigation' for ship information.

Various problems were encountered during the cruise. The ships GPS (as recorded by TECHSAS data stream SEAPATH) had problems at the start of the cruise. The gyro data stream did not work throughout the cruise. The EK600 data stream used a fixed speed of sound of 1500 m/s except between 19:57 on 21/6/15 and 08:08 24/6/15 when the sound speed profile was used in error. Finally, whilst the meteorological instruments are calibrated annually by KNMI, the TSG system had not been factory calibrated since 2003. Plans were made for this to be carried out later in 2015.

7.2 MEXEC data processing

The underway data during the cruise were processed using MEXEC which is a MATLAB-based bespoke processing suite for ship-based oceanographic data (King et al., 2015). Significant help was received from Brian King at the start of the cruise to help set up MEXEC and the associated directories. MEXEC is designed for use with data produced by a TECHSAS logging system. The TECHSAS read-only netcdf data streams on the ships data servers were auto-mounted onto our Dell work station enabling continuous real-time access to data logged by TECHSAS. The MEXEC short names for each TECHSAS data stream are given in Table 2, and the location of the netcdf data files created by MEXEC are shown in Table 3.

Data were processed in daily chunks referenced by day of the year using the MEXEC script *mday_00_get_all_pe399*. This script first calls *mday_00* which extracts the appropriate 24 hour period of raw data from each TECHSAS data stream. The script will skip any data streams without data. After this initial step the script then removes any bad data and averages. A second script, *mday_02_run_all_pe399*, appends the daily files to create a master cruise file for each data stream. The file name is in the form of MEXECname_pe399_01.nc.

Table 2: TECHSAS stream names and variables with the associated MEXEC name. All times are shown as days since 1899-12-30 00:00:00 UTC.

MEXEC name	TECHSAS stream	Variables (units)
pesbe21raw	externalAD-PE_SBE21_01.ths	CAName (dimensionless) CBName (dimensionless) CCName (dimensionless) CDName (dimensionless) ChannelA (dimensionless) ChannelB (dimensionless) ChannelC (dimensionless) ChannelD (dimensionless) time
pefluor	fluorimeter-TS_FLUOR_01.fluorimeter	fluor (microgram/liter) time
gyro_s	gyro-PE_GYROCOMPASS_01.gyr	head (degree) time
petsg	hydrology-PE_SBE21_01.ctd	intakeTemperature (deg Celsius) temp (deg Celsius) conduct (S/m) salinity (PSU) sndspeed (m/s) density (kg/m^3) time
peinlet	inletTemp-PE_INLET_01.thm	watertemp (deg Celsius) time
peintake	intake-PE_SBE21_01.ths	intaketemp (deg Celsius) time
pemetpres	KNMI_Pressure-PE_KNMIPRESSURE_01.met	airpressure (mbar) time
pemetrad	KNMI_Radiation-PE_KNMIRADIATION_01.met	radiation (W/m^2) time
petemphum	KNMI_TempHum-PE_KNMITEMPHUM_01.met	airtemp (deg Celsius) humidity (100*Pa/Pa) dewpoint (deg Celsius) time
pewind	KNMI_Wind-PE_KNMIWIND_01.met	relairspeed (m/s) relairheading (degree) time
pewinaft	PEWinch-PEWinch_AFT.winch	Error in mtgetvars (line 43) techsas_varnames = m_unpack_varnames(ncf);
winch	PEWinch-PEWinch_SIDE.winch	Error in mtvars (line 30) [v u] = mtgetvars(tstream);
seapos	position-PE_SEAPATH_01.gps	measureTS (time) lat (deg_north) long (degree_east) alt (m) prec (dimensionless) mode (dimensionless) gndcourse (degree) gndspeed (knot) heading (degree) zdaTime

		time
sercelgps	position-PE_SERCELGPS_01.gps	measureTS (time) lat (deg north) long (deg east) alt (m) prec (dimensionless) mode (dimensionless) gndcourse (degree) gndspeed (knot) heading (degree) time
satinfosea	satelliteinfo-PE_SEAPATH_01.gps	nbseen (dimensionless) nbused (dimensionless) HDOP (dimensionless) VDOP (dimensionless) PDOP (dimensionless) time
satinfosercel	satelliteinfo-PE_SERCELGPS_01.gps	nbseen (dimensionless) nbused (dimensionless) HDOP (dimensionless) VDOP (dimensionless) PDOP (dimensionless) time
ea600m	sb_depth-PE_EA600_01.depth	snd (m) freq (kHz) time
furuno	sb_depth-PE_FURUNO_01.depth	snd (m) freq (kHz) time
penav	shipnav-NAVIGATION.nav	lat (deg north) long (deg east) alt (m) gndspeed (knot) gndcourse (degree) surfspeed (knot) surfcourse (degree) driftspeed (knot) driftcourse (degree) heading (degree) roll (degree) pitch (degree) heave (m) depth (m) draught (m) time
peweather	weather-PE_WEATHER_01.met	airtemp (deg Celsius) watertemp (deg Celsius) moisture (100*Pa/Pa) airpressure (mbar) heatflux (W/m^2) dewpoint (deg Celsius) relairspeed (m/s) relairheading (degree) trueairspeed (m/s) trueairheading (degree) time

Table 3: MEXEC name and Data directory. The MEXEC filenames for each data stream are constructed as MEXEC_name_pe399_dnnn_raw.nc where nnn is the day-of-year. All these data files were processed by running one MEXEC script mday_00_get_all_pe399.

MEXEC_name	Data directory
petsg	tsg
pefluor	tsg
pegyr	nav/gyros
peseapos	nav/seapos
pesercel	nav/sercel
penav	nav/shipnav
pesim	sim
pefuruno	furuno
peweather	met/weather
pewind	met/wind
petemphum	met/temphum
perad	met/rad
pepres	met/pres

King, B. A., N. P. Holliday and S. Garry (2015). A user guide to MEXEC. A MATLAB-based bespoke processing suite for ship-based oceanographic data.

7.3 TSG calibration

In order to calibrate the TSG conductivity sensor, bottle samples were taken and run on the salinometer. However, the two data sets did not compare particularly well and the relationship was not 1:1 (Figure 2 and Figure 3). At lower salinities (< 35.1) the TSG values tended to be higher than those obtained from bottle samples (residuals 0.015-0.087). At higher salinities (> 35.3) the residuals were smaller (-0.016-0.012). However, only a relatively small number of calibration samples were taken (15) and it is unclear whether this offset came from the TSG system (which has not been factory calibrated since 2003), or whether the bottle samples were of poor quality. (The TSG system in Pelagia is situated in the hold and is not near a sink. Samples therefore have to be taken over a bucket meaning that it was difficult to flush the system thoroughly before collecting a sample.). As such, a comparison between TSG values and the lowered CTD system was carried out for both the temperature and conductivity sensors. For each CTD cast, the temperature, conductivity and time stamp for the point at which the sensor was 3 m below the surface was extracted from calibrated CTD data files. 3 m was chosen because this is the approximate depth of the intake for the TSG system. TSG values for the same time were extracted from the processed master tsg data file (petsg_pe399_01.nc).

A comparison of the two for salinity shows a similar pattern to the comparison between bottle samples and the TSG. At lower salinities the TSG values tend to be higher than those measured by the lowered CTD, with a decreased offset at higher salinities (Figure 4). If we combine the lowered CTD and bottle results to get the best possible calibration (Figure 5) the correction is: sal = (TSG sal –

4.472) / 0.873. However, the TSG did not function well and we therefore did not apply a calibration and do not recommend use of the data.

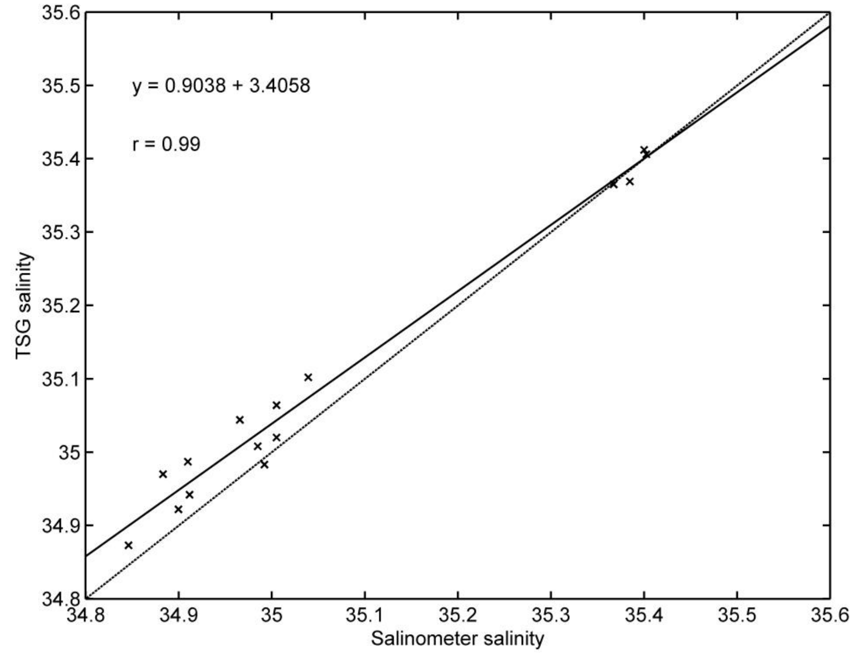


Figure 2: Plot of salinometer derived salinity and TSG salinity from PE399. Solid line shows line of best fit. Dashed line shows 1:1 relationship.

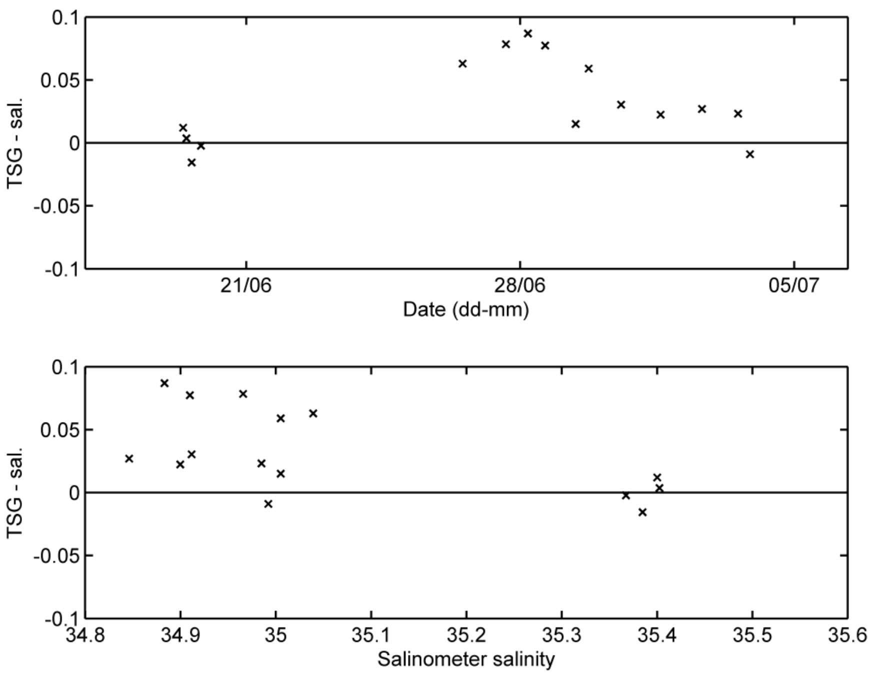


Figure 3: Plot of residuals (TSG salinity minus salinometer salinity) against (a) time and (b) salinometer-derived salinity.

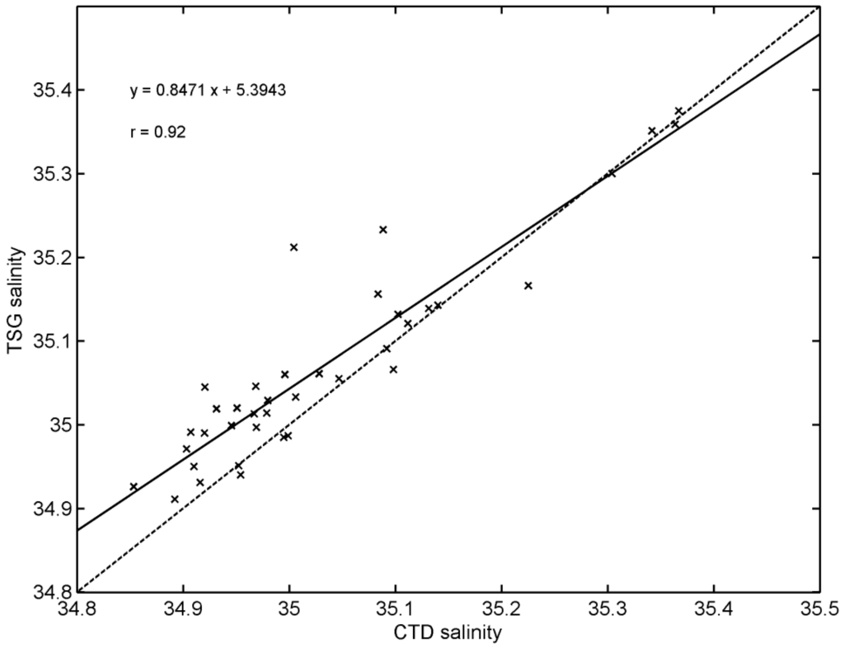


Figure 4: Plot of CTD derived salinity at 3 m on the upcast and TSG salinity from PE399. Solid line shows line of best fit. Dashed line shows 1:1 relationship.

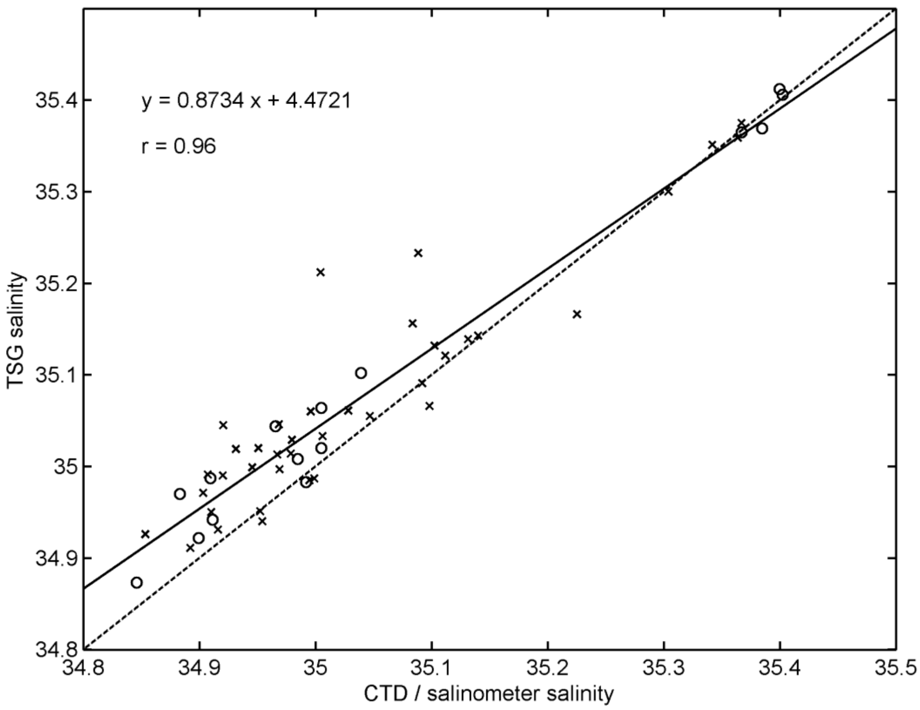


Figure 5: Comparison of CTD derived salinity at 3 m on the upcast and TSG salinity (crosses), and salinometer derived salinity and TSG salinity (circles). Solid line shows line of best fit. Dashed line shows 1:1 relationship.

The comparison between the TSG temperature sensor and the lowered CTD (Figure 6) again shows the TSG performed poorly. The TSG is consistently warmer than for lowered CTD (0.5-1.7 °C). We are unsure whether this is due to poor performance of the TSG system or variable warming of the water between intake and the TSG location. We again did not apply a calibration and advise against use of this data. We additionally recommend that the TSG system undergoes a regular program of factory calibrations and that the possibility of moving it to a more suitable position on Pelagia is considered.

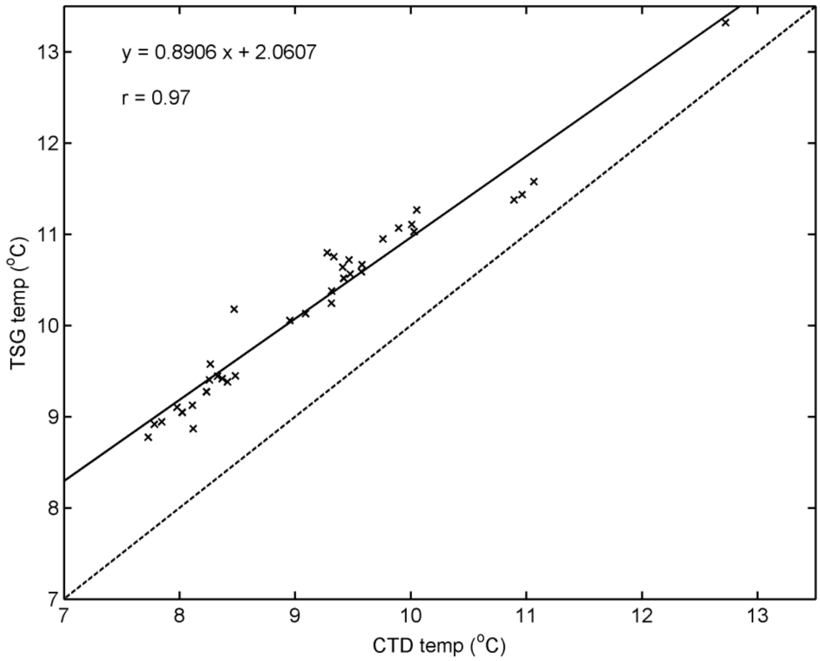


Figure 6: Plot of CTD derived temperature at 3 m on the upcast and TSG temperature from PE399. Solid line shows line of best fit. Dashed line shows 1:1 relationship

7.4 VM ADCP Measurements

The gyrocompass was not working during the cruise and so no heading corrections were available for the processing of the ship ADCP data. However A. Houk (RSMAS) is working on a way to reconstruct a useful dataset.

8 CTD Measurements

38 CTD stations were carried out during the PE399 cruise (Figure 1), the details of their positions is summarized in Table 4. At each station, profiles of temperature, salinity (conductivity), dissolved oxygen, transmission and fluorescence were collected from the surface to within approximately 5 m of the bottom, using a Sea-Bird SBE-911plus CTD system.

Table 4: Summary of the positions of the PE399 CTD stations. The asterisks indicate the CTD stations where the SBE37 Microcat were lowered on the rosette for calibration

Station Number	Date yy/mo/dd	Time hhmm	Latitude dg	min		Longitude dg	min		Max Depth	Depth above bottom
1	15/06/17	1320	50	22.77	N	5	52	W	65	5
2	15/06/19	1755	56	0.38	N	10	0.73	W	2048	7
3*	15/06/19	2214	56	13.69	N	10	14.17	W	2033	7
4*	15/06/21	1403	57	12.22	N	10	22.27	W	2255	8
5	15/06/23	1543	57	40.05	N	18	41.99	W	705	6
6	15/06/23	1844	57	43.73	N	19	13.8	W	902	9
7	15/06/23	2159	57	47.52	N	19	44.99	W	1306	1
8	15/06/24	0114	57	50.26	N	20	8.51	W	1556	9
9	15/06/24	0436	57	52.95	N	20	29.77	W	2245	8
10	15/06/24	0804	57	54.86	N	20	51.36	W	1994	8
11	15/06/25	0005	57	57.33	N	21	11.79	W	2940	9
12	15/06/25	0508	57	57.48	N	21	51.62	W	3008	10
13	15/06/25	1000	57	57.44	N	22	30.73	W	2976	8
14	15/06/25	1551	57	58.46	N	23	10.51	W	2981	8
15	15/06/25	2105	57	58.12	N	23	49.51	W	2929	10
16	15/06/26	0403	57	58.72	N	24	27.48	W	2823	8
17*	15/06/26	2218	57	57.57	N	25	6.89	W	2735	8
18	15/06/27	0407	57	57.76	N	25	44.41	W	2727	7
19	15/06/27	0907	57	57.69	N	26	22.7	W	2816	9
20	15/06/27	1349	57	57.69	N	27	0.7	W	2674	8
21	15/06/27	2042	57	58.77	N	27	34.47	W	2250	9
22	15/06/28	0112	57	59.71	N	28	4.23	W	2401	8
23	15/06/28	0429	58	4.95	N	28	20.48	W	2288	8
24	15/06/28	0808	58	10.51	N	28	37.04	W	2294	9
25	15/06/28	1201	58	15.64	N	28	52.79	W	2202	11
26	15/06/28	1457	58	20.08	N	29	5.56	W	2155	9
27	15/06/28	1800	58	24.65	N	29	19.2	W	1902	33
28	15/06/28	2103	58	29.33	N	29	32.11	W	2508	11
29	15/06/29	0007	58	33.29	N	29	43.96	W	1977	9
30	15/06/29	0305	58	37.47	N	29	56.76	W	1982	9
31	15/06/29	0559	58	41.91	N	30	10.22	W	1711	8
32	15/06/29	0824	58	45.72	N	30	21.91	W	1617	9
33	15/06/29	1939	58	49.94	N	30	34.78	W	1583	33
34	15/06/29	2146	58	50.25	N	30	48.27	W	1453	9
35	15/06/29	2358	58	50.53	N	31	2.05	W	1474	8
36	15/06/30	1845	57	56.87	N	26	59.76	W	2674	10
37	15/07/01	2149	58	2.14	N	28	1.23	W	2360	10
38*	15/07/03	1826	58	31.28	N	29	29.58	W	2515	12

8.1 System Configuration

The CTD package included several sensors indicated in Table 5. Preliminary calibrations of the conductivity sensor showed that it had stable behaviour and only minor offsets with respect to bottle salinity samples, which result in a relatively straightforward final CTD calibration after the cruise (see section *9.2 CTD Calibration*). No calibration samples were collected for dissolved oxygen or the other computed CTD parameters.

Table 5: Serial Number and calibration date of the sensors using on the CTD package during the cruise PE399.

Sensor	Serial Number	Calibration Date
Temperature	1219	24 April 2015
Conductivity	3262	24 April 2015
Pressure	127486	16 September 2014
Transmissometer, WET Labs C-Star	1406	15 July 2015
Fluorometer, Chelsea Aqua 3	088-008	22 May 2015
Oxygen, SBE 43	043-1932	23 April 2015
Altimeter	58580	2012

The reference-thermometer SBE35

A reference-thermometer SBE35 was mounted in the CTD-frame for the in-situ calibration of the profiling CTD-thermometer SBE3. The distance between the tips of both thermometers was as small as possible, around 10 cm on the same horizontal level. This SBE35 was calibrated by Seabird on April 26, 2015.

8.2 CTD Operations

Generally one person of the science shift was helping the crew for the deployment and recovery operations of the Rosette. The R/V Pelagia has a reinforced hull on her starboard side, allowing the crew to keep the Rosette close to ship during the deployment and recovery phases. One of the main advantages of this system is the ability to keep control of the Rosette even in rough seas, by preventing it from swinging.

A typical operation started by the deployment of the Rosette 1m below the sea surface. After approximately 1 minute, the Seabird deck unit displays that the pump is on (code 0011 on the LCD screen). The descent begins at approximatively a rate of 1 m/s until the altimeter starts detecting the bottom, then the science party ask the crew operating the CTD to slow down. When the Rosette becomes close to the bottom (5 or 10m according to the length of the rope), an alarm indicated the science party and the crew to stop the cast. Then the upcast starts with 1min stops (or 5mins for the caldip casts) at different depth levels to fire the Niskin bottles. Once the Rosette reaches the sea surface, the power supply is stopped, and after confirmation from the bridge, the CTD package is brought on board.

Water samples for calibration of the conductivity sensor were collected using a 24-bottle Rosette system containing 10 litre Niskin bottles. Only 12 bottles were used and so the outer rack of bottles was removed from the package. A bottle firing program was set up in the Seasave data acquisition software to fire these 12 bottles in sequence.

8.3 SBE37 cal-dip stations

Five of the CTD stations (including a test station) were performed to provide calibration data for SBE37 microcat instruments which were recovered from moorings, as well as for those planned to be deployed. These instruments were lowered to specific depths not necessarily near to the bottom. During these casts, straps were added to the CTD frame to secure the moored instruments and the CTD package was lowered to its target depth, with 5 minute bottle stops during the package retrieval. These casts are indicated by an asterisk in Table 4.
Comparisons with the shipboard CTD conductivity, temperature and pressure data can be done for all the SBE37 Microcat lowered on the rosette. This stage allows us to assess the quality of the sensor before and after the deployment (Table 6). These results will also be used in the post-deployment calibration of the SBE37 data to correct any potential offset or drift in the conductivity, temperature or pressure time-series (section 15.1).

Table 6: Mean differences in conductivity, temperature and pressure of the SBE37 lowered on the shipboard CTD during the calibration casts.

CTD Cast	Details		Location before and after the caldip		CTD-Microcat difference (mean and std) During 5mins stop at maximum depth of the cast						Comments
	Type	s/n	Before	After	C (µS/cm)		T (mK)		P (db)		
					mean	std	mean	std	mean	std	
CTD003	IMP	3279	ship	RTEB1	-0.1	0.076	0.05	0.085	4.3	0.87	Small offset in temp. (relative to others SBE37)
	IMP	4069	ship	ship	-3.4	0.082	-0.14	0.084	-0.1	0.81	Small offset in conductivity
	IMP	4073	ship	ship	-1.0	0.079	-0.2	0.084	-8.7	0.83	Pressure offset
	IMP	4463	ship	RTEB1	-1.3	0.093	-0.31	0.114	-1.7	1.06	
	SMP	8077	ship	RTEB1	-0.4	0.056	-0.18	0.077	1.8	0.14	
	SMP	9372	ship	CTD38	-0.9	0.078	-0.1	0.097	-2055	0.76	No pressure data
	SMP	9373	ship	RTEB1	-0.3	0.085	-0.18	0.102	-0.3	0.09	
	SMP	10576	ship	CTD38	-4.1	0.085	-0.15	0.111	0.8	0.07	Small offset in conductivity
	SMP	13019	ship	RTEB1	-0.8	0.072	-0.16	0.092	1.5	0.09	
	SMP	13020	ship	RTEB1	-0.6	0.048	-0.15	0.063	0.6	0.13	
	SMP	13021	ship	RTEB1	-3.0	0.044	-0.16	0.058	2.1	0.14	Small offset in conductivity
	SMP	13022	ship	RTEB1	-0.5	0.065	-0.17	0.089	1.6	0.29	
CTD004	SMP	3218	ship	RTWB2	-0.6	0.097	-0.18	0.07	1.6	1.32	
	SMP	3276	ship	CTD38	-37.1	0.108	0.08	0.078	0.8	1.27	Large offset in conductivity
	SMP	3481	ship	RTWB2	-0.6	0.086	0.01	0.076	-3.7	1.09	
	SMP	8082	ship	RTWB1	0.1	0.084	-0.25	0.083	7.2	1.07	Pressure offset
	SMP	8443	ship	RTWB1	-0.2	0.076	-0.13	0.073	4.2	0.77	
	SMP	11321	RTEB1	RTWB1	0.2	0.082	-0.05	0.069	2.2	0.75	
	SMP	11322	RTEB1	CTD38	6.5	0.076	-0.06	0.065	2.3	0.83	Offset in conductivity
	SMP	11323	RTEB1	RTWB1	0.1	0.065	-0.03	0.072	2.6	0.75	
	SMP	11324	RTEB1	RTWB1	-0.1	0.057	-0.09	0.05	1.8	0.8	

	SMP	11331	RTEB1	RTWB1	-0.2	0.059	-0.09	0.054	2.7	0.8	
	SMP	11332	RTEB1	RTWB1	0.1	0.059	0.1	0.053	2.8	0.82	
	SMP	11333	RTEB1	RTWB1	-0.1	0.074	0.15	0.083	1.6	0.82	
CTD017	SMP	10575	RTWB1	ship	-1.7	0.039	-0.1	0.037	3.8	0.91	
	SMP	10577	RTWB1	ship	-0.4	0.037	-0.11	0.054	5	0.36	
	SMP	10578	RTWB1	ship	-0.9	0.039	-0.11	0.047	4.7	0.52	
	SMP	10579	RTWB1	ship	-0.7	0.042	-0.1	0.047	3.8	0.89	
	SMP	11288	RTWB1	ship	-0.3	0.049	-0.13	0.043	2.9	1.14	
	SMP	11289	RTWB1	ship	-0.4	0.043	-0.11	0.052	3	0.95	
	SMP	11290	RTWB2	ship	-0.3	0.036	-0.08	0.043	-0.7	0.48	
	SMP	11320	RTWB2	ship	-0.2	0.043	-0.08	0.047	2.9	0.61	
	SMP	11334	RTWB1	ship	0.9	0.046	0.07	0.035	2.4	1.06	
	SMP	11335	RTWB1	ship	0.1	0.037	-0.02	0.052	2.5	0.53	
CTD038	SMP	3276	CTD03	ship	-37.9	0.064	-0.03	0.064	0.7	0.52	Important offset in conductivity
	SMP	9372	CTD03	ship	-1.1	0.073	-0.13	0.067	-2549	0.57	No pressure data
	SMP	10576	CTD03	ship	-3.4	0.058	-20.8	0.061	1.4	0.26	Pressure dependant temperature offset
	SMP	11322	CTD04	ship	7.2	0.075	-20.8	0.083	2.3	0.14	Pressure dependant temperature offset

9 CTD Data Processing and Calibration

9.1 Data processing

The CTD data processing used the mstar software suite (also known as mexec), developed at NOC. The initial Seabird data conversion, align[2] and cell thermal mass[3] were performed using SBE Data Processing, Version 7.21d software. The processed CTD data were copied automatically on a shared network drive (Portus) through the execution of a seabird batch file. The network data drive, Portus, was linked to the */home/mstar/cruise/data/shipfs* and the ctd folder was linked to *~/cruise/data/ctd/ASCII_files/shipfs_ctd* . The script *ctd_linkscript* was used to copy files from the network drive to the mstar computer and set up additional symbolic links to filenames following mstar convention.

The first step of the processing is the creation of empty sample files *sam_pe399_nnn.nc* for all casts *nnn*. These files were generated from the list of variables indicated in the file *~/cruise/data/templates/sam_pe399_varlist.csv* through the execution of the scripts *msam_01*, *msam_01b* (as described in the comments at the beginning of *msam_01b*).

For each cast the following matlab files were run, using a wrapper *script ctd_all_part1*: *mctd_01*, *mctd_02a*, *mctd_02b*, *mctd_03*, *msam_putpos*, *mdcs_01*, *mdcs_02*. The processes completed by these scripts include:

- read ASCII cnv data from *data/ctd/ASCII_FILES/ctd_pe399_nnn_ctm.cnv;*
-convert variable names from SBE names to mstar names using *data/templates/ctd_pe399_renamelist.csv*
- convert raw file to 24hz file
- make oxygen hysteresis ajustment on 24hz file
- average to 1hz
- calculate derived variables psal and potemp
- extract information from the ship navigation data for the bottom of cast identified by maximum pressure

Then the script *mdcs_03g* was run to inspect profiles and hand-select cast start and end times. The start, bottom and end data cycles are stored for each cast *nnn* in files *dcs_pe399_nnn.nc*. After selecting the limits for start and end, *ctd_all_part2_pe399* was then run, executing *mctd_04_pe399*, *mfir_01*, *mfir_02*, *mfir_03*, *mfir_04*, *mbot_00*, *mbot_01*, *mbot_02*. The processes completed by these scripts include:

- extract down and upcasts using scan numbers stored in *dcs_pe399_nnn.nc*, and average into 2dbar files (2db down and 2db up)
- read the *data/ctd/ASCII_FILES/ctd_pe399_001.bl* file and extract scan numbers corresponding to bottle firing events.
- add time from CTD file, merging on scan number
- add CTD upcast data corresponding to bottle firing events
- paste these data into master sample file *data/ctd/sam_pe399_nnn.nc*
- paste the bottle firing codes and quality flag into the master sample file

2 Set to 5s only for the data from the SBE43 sensor (oxygen sensor)

3 Thermal anomaly amplitude (alpha) set to 0.03 and thermal anomaly time constant (tau) set to 7.0, according to Seabird recommendations

When a conductivity calibration is available, it is applied to the 24hz files using *mctd_condcal*. Then a subset of scripts can be rerun, specifically *mctd_02b*, *mctd_condcal*, *mctd_03*, *mctd_04_pe399*, *mfir_03*, *mfir_04*. This collection of calls can be run through the script *smallscript_pe399.*

9.2 CTD Calibration

9.2.1 Salinity Analysis

During the cruise a salinity-sample was drawn from each closed Niskin. These samples were stored in crates in a temperature controlled laboratory-container. The temperature of the container was kept around 20 degrees C and this temperature was logged. The air-conditioning failed once during the cruise. This problem was solved by the ships engineer. The crates were stored on the same table as the salinometer and not on the cold container floor. In this way the samples could warm up to container temperature for at least 24 hours before analysis.

The salinometer used was an Autosal 8400B (brand: Guildline). This Autosal was connected to a laptop via an Autosal computer interface (brand: OSIL). Installed software was Salinometer Data Logger version 1.2 . In addition to this Excel was installed.

The salinometer was standardized once, in the beginning of the cruise. Except for one small 'jump' in the very beginning of the cruise (between analysis of CTD-3 and CTD-4) the salinometer was stable (see Figure 7). The samples were analysed in batches of a few CTD's. A bottle of standard water was analysed at least at the start and end of each batch, with a new bottle being used each time. During long batches (4 stations) a bottle of standard water was also used in the middle of the analysis, (i.e. after 2 CTD's). During a batch the salinometer showed a small upward drift. This drift is measured with standard water and the measurements are corrected for this drift.

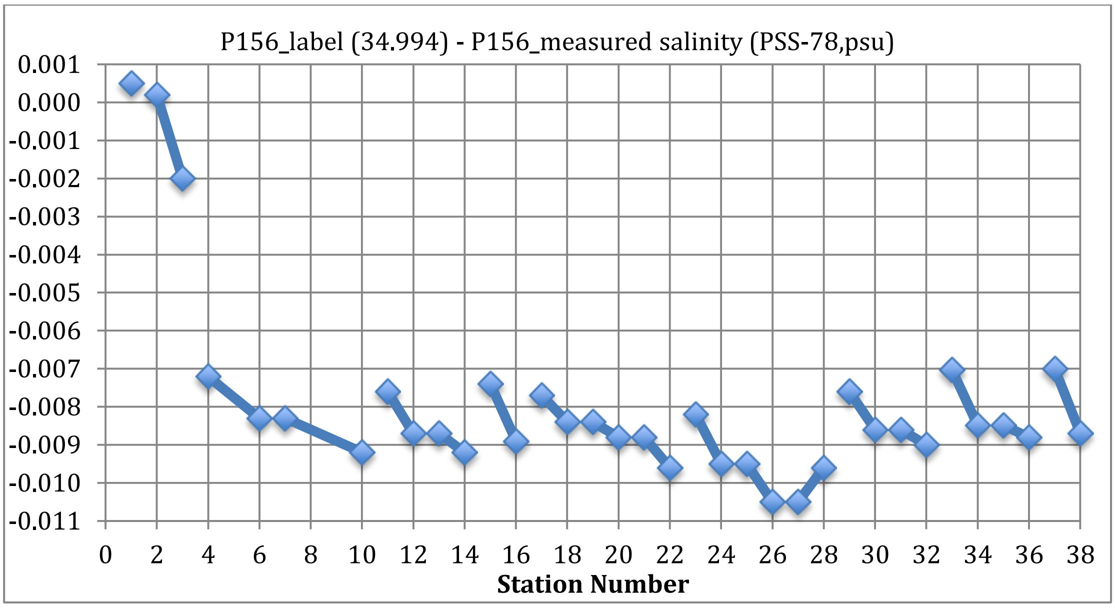


Figure 7: Differences between the labelled salinity value of the standard water and the measurement from the salinometer analysis

Applied standard water was OSIL standard water, batch P156 (practical salinity of 34.994). A total of 417 samples were analysed, only 4 had to be rejected due to mistakes during the measuring process and 1 due a very strong gradient in the water in combination with a rolling ship.
Overall results were good. The average residual (= SAL(salinometer) – SAL(ctd)) is -0.0013 with a standard-deviation of 0.0022.

9.2.2 Temperature calibration

The SBE35 temperature data can be logged when a Niskin bottle is fired. Data are stored internally and must be downloaded at the CTD deck unit as a separate process from the CTD data transfer. The SBE35 data are then transferred as a unique ASCII file with the measurements for all the stations. On pe399, this file is found in data/ctd/ASCII_FILES/SBE35/.
The script msbe35_01_pe399 reads the data for a single station. It reads the ASCII file and extracts data cycles for the station based on the start and end times. Data with a diff value >100 are flagged as bad, this value indicating too big a heterogeneity in the measurements (due to a strong gradient or a bottle stop not being long enough).
The script msbe35_02 pastes the SBE35 data from one station (in data/ctd/SBE35/) into the master sample file (data/ctd/sam_pe399_nnn.nc). Then we used the script ctd_evaluate_temp_pe399 to compare the SBE35 temperature measurements taken each time a bottle is fired with the coincident measurements by the CTD temperature sensor. The CTD and the SBE35 were found to be in acceptable agreement. The median SBE35 minus CTD value suggested that the SBE35 readings are generally slightly colder than the CTD (Figure 8), by an amount smaller than 0.001 °C (median of -0.86mK, interquartile range of 0.92mK). This may be attributed to the accuracy of each sensors (0.002 °C for the SBE3, 0.0005 °C for the SBE35) and the fact the thermometers are not mounted tip-to-tip (not possible).

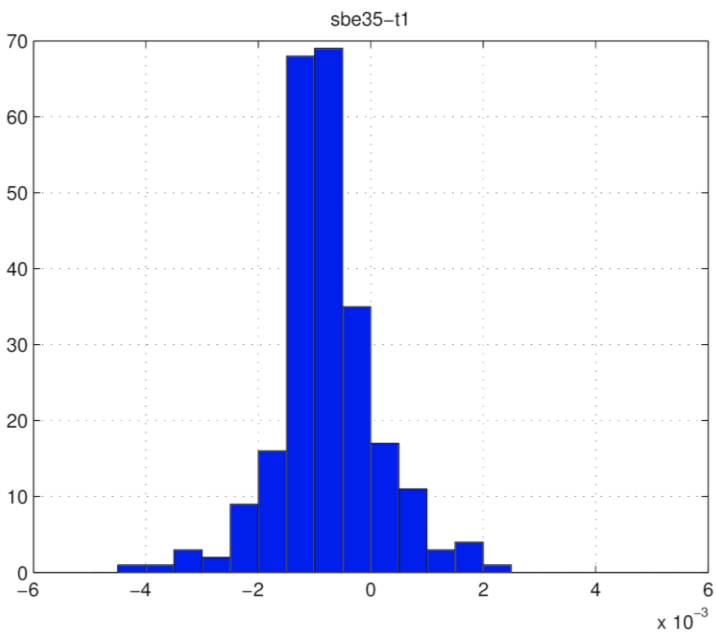


Figure 8: Histogram of the temperature difference between the reference thermometer SBE35 and the temperature sensor of the shipboard CTD

9.2.3 Conductivity calibration

The bottle salinity is added in the sample master file *sam_pe399_nnn.nc* by using the functions *msal_01_pe399* and *msal_02_pe399*, which read the csv files from the analysis of the salinity bottle (*data/ctd/BOTTLE_SAL/sal_pe399_nnn.csv*) and paste the data into the sample files.
The script *ctd_cal_pe399* can be used to examine the difference between the CTD conductivity sensor and the results from the bottle conductivity analysis. Plots are generated to reveal biases between sensors, and either pressure- or station-dependence of bottle minus sensor differences.

When the calibration adjustment is satisfactory, it can be transferred to a switch/case in *cond_apply_cal*. The wrapper smallscript_pe399 can be run on a set of stations. This will produce calibrated CTD profiles in all the derived files (24hz, 1hz, psal, 2db, 2up) and paste the adjusted CTD data into the sam bottle files, with the exception of *ctd_pe399_nnn_raw.nc* file which still contains raw data.
In the case of different sensor configurations during the cruise, the script *ctd_evaluate_sensors.m* can be used to examine the difference between the CTD cond1 and cond2 sensors, and the residuals with the bottle salinity. If sensors are changed during the cruise, subgroups of stations corresponding to sensor configurations can be declared in *ctd_evaluate_sensors*. Once a satisfactory set of residuals is obtained for both sensors, the calibration ajustment can be transferred to a switch/case in *cond_apply_cal.*

On the cruise PE399, the conductivity measured by the CTD was adjusted for subgroups of stations with slope corrections indicated in the Table 7.

Table 7: Slope corrections applied for the calibration of the shipboard CTD

Stations	Slope corrections
1	1.00003473
2	1.00000263
3-4	0.99996611
5-8	0.99999965
9-10	0.99992157
11-18	0.99996427
19	0.99993471
20-27	0.99996746
28-32	0.99993625
33-38	0.99996400

The script *ctd_cal_pe399* produces Figure 9 which presents, for each station, the bottle conductivity and summarises the differences and the ratios between the sample analysis and the CTD values.

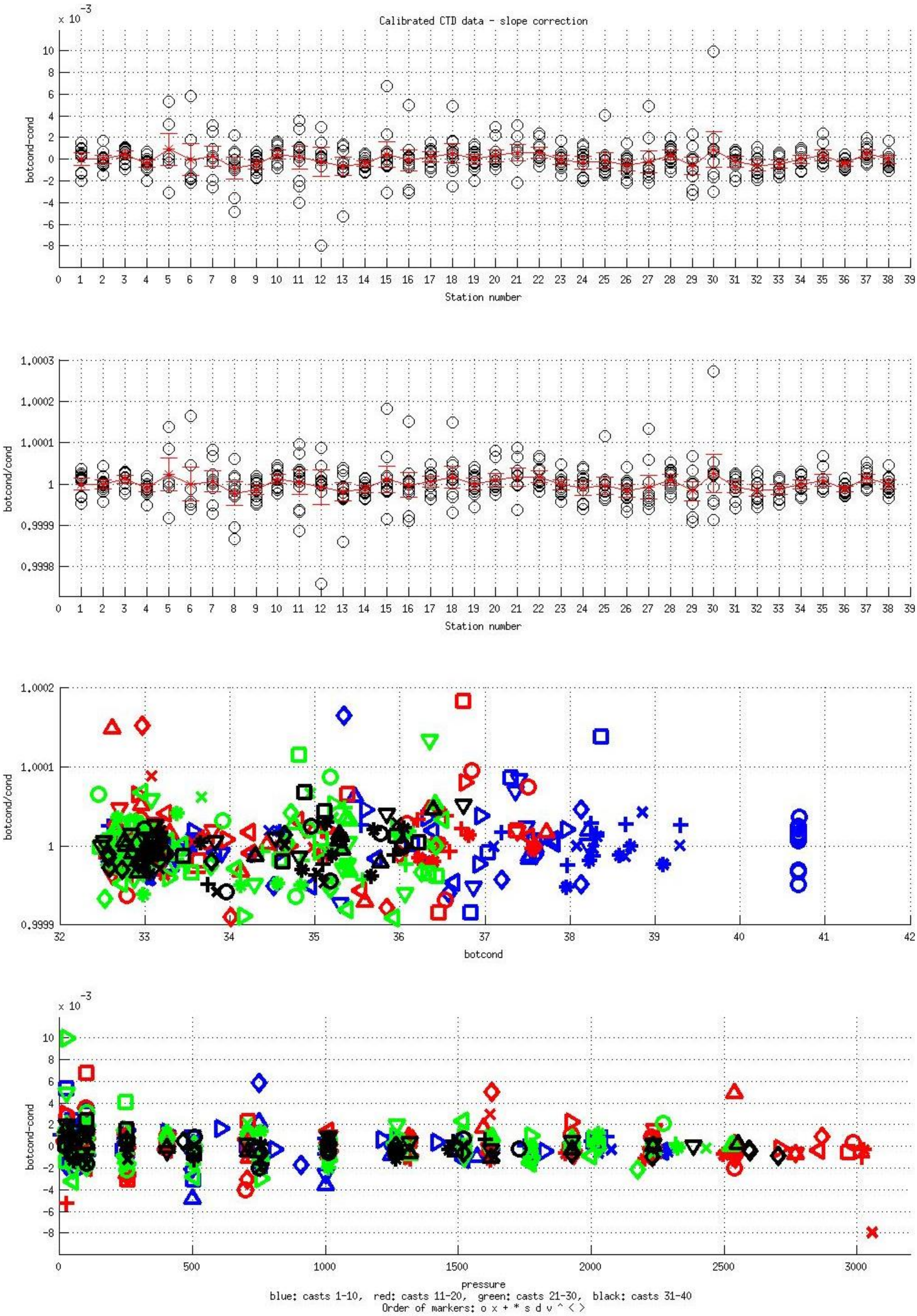


Figure 9: Comparison of the water sample analysis with the shipboard CTD measurements. From top to bottom: conductivity differences as a function of the CTD stations; conductivity ratios as a function of the CTD stations; conductivity ratio as a function of the conductivity of the water sample; conductivity differences as a function of sampling depth

9.3 Initial analysis of the CTD data

9.3.1 Section plots

The highest temperatures (9-10 °C) and salinities (35.25-35.30) in the upper waters (0-800 m) are associated with the NAC branch over the western flank of the Hatton Bank (Figure 10). Slightly cooler and fresher values (7-8 °C and 35.15-35.20 respectively) are observed in the NAC branch over the deepest portion of the Iceland Basin at around 250 km. In the central Iceland Basin cooler and fresher SubArctic Intermediate Water (SAIW) is observed before salinities in the upper waters again increase as recirculating Atlantic Water on the eastern flank of the Reykjanes Ridge is encountered.

At intermediate depths the constant salinity, potential temperature and potential density of Labrador Sea Water (LSW) is observed centred upon 1800 m. This layer is partially eroded in the western Iceland Basin by Iceland Scotland Overflow Water (ISOW); this can be more clearly observed in θ-S space (Figure 11). The more saline ISOW underlies the LSW and is clearly seen as a body of higher salinity water hugging the eastern flank of the Reykjanes Ridge as it flows southward along this bathymetric feature.

9.3.2 T-S diagrams

The NAC branch over the western flank of the Hatton Bank appears to contain water with a signature of Eastern North Atlantic Water (ENAW; Figure 2.a). However, the NAC branch associated with the deepest part of the Iceland Basin (Maury Channel) has water with characteristics slightly cooler and fresher than this water mass (Figure 11.b). Some influences of SAIW are also observed between 250 and 300 km (stations 11 to 15; Figure 11.c). The signature of SAIW is more clearly seen west of station 15 up until around 625 km (station 26) when higher salinity water again indicates the presence of Atlantic Water. This Atlantic Water is likely to be a recirculation around the Iceland Basin and is probably moving in a south-westward direction. A smaller parcel of Atlantic Water is observed at around 550 km (station 22; green, Figure 11.c).
At intermediate depths a clear salinity minimum is observed indicating the presence of LSW. Whilst this water mass has a range of temperatures (3.2-4.0 °C) at a fairly constant salinity in the eastern Iceland Basin (Figure 11.a-c); in the western basin (west of 625 km, station 27) the lower portion of this water mass is eroded by the underlying higher salinity ISOW (Figure 11.d-e). This is most clearly seen in the westernmost stations (stations 29 -35, Figure 11.f) where more saline water is observed at the same density level as LSW, suggesting the influence of ISOW at these depths. In the remainder of the deep Iceland Basin ISOW is observed as the bottom water mass.

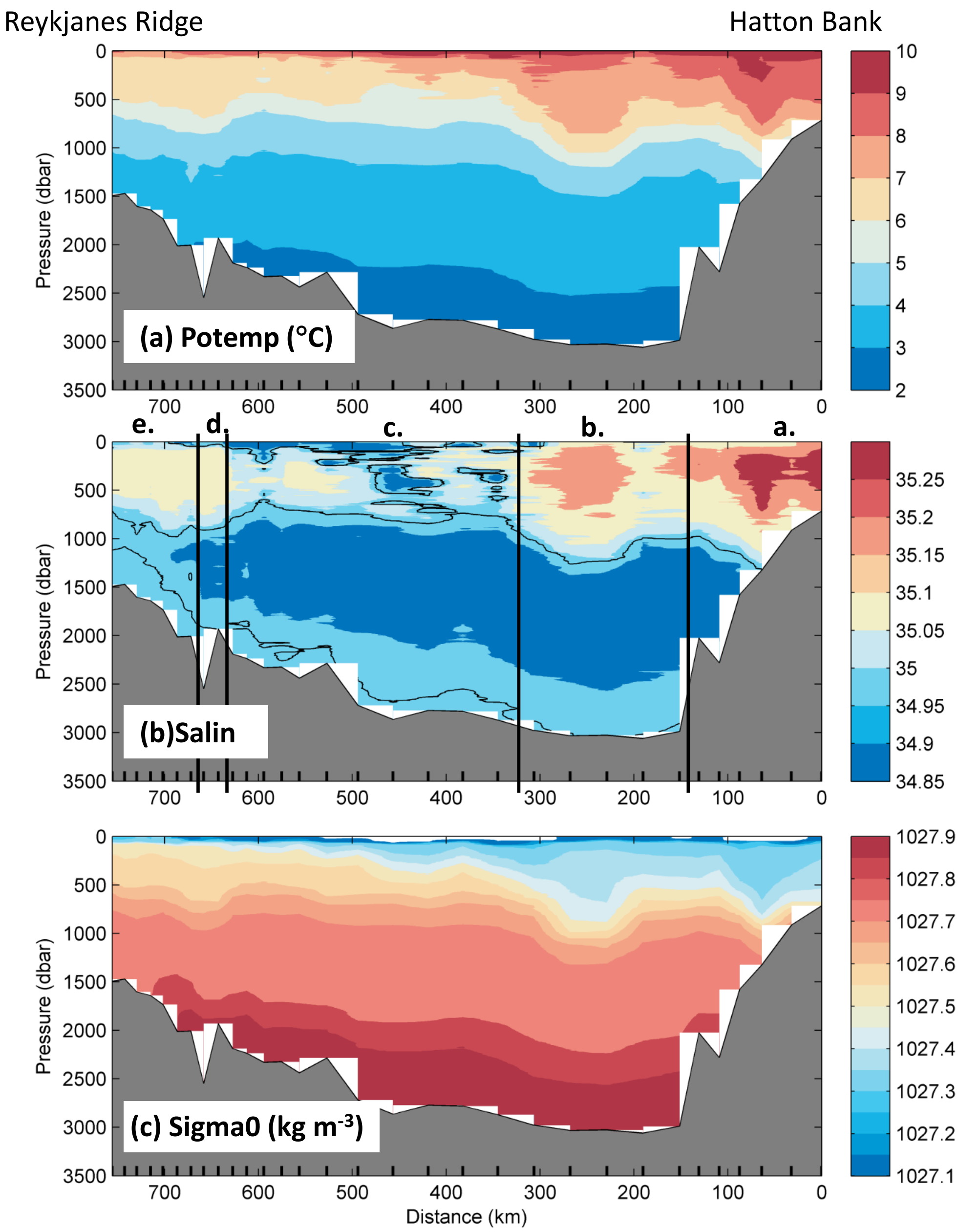


Figure 10: Section plots of (a) potential temperature, (b) salinity and (c) sigma0. Ticks on the lower x-axes show station positions. Black contour in (b) is the 24.98 isopycnal chosen to clearly identify the ISOW. Letters in (b) show geographical areas in Figure 11.

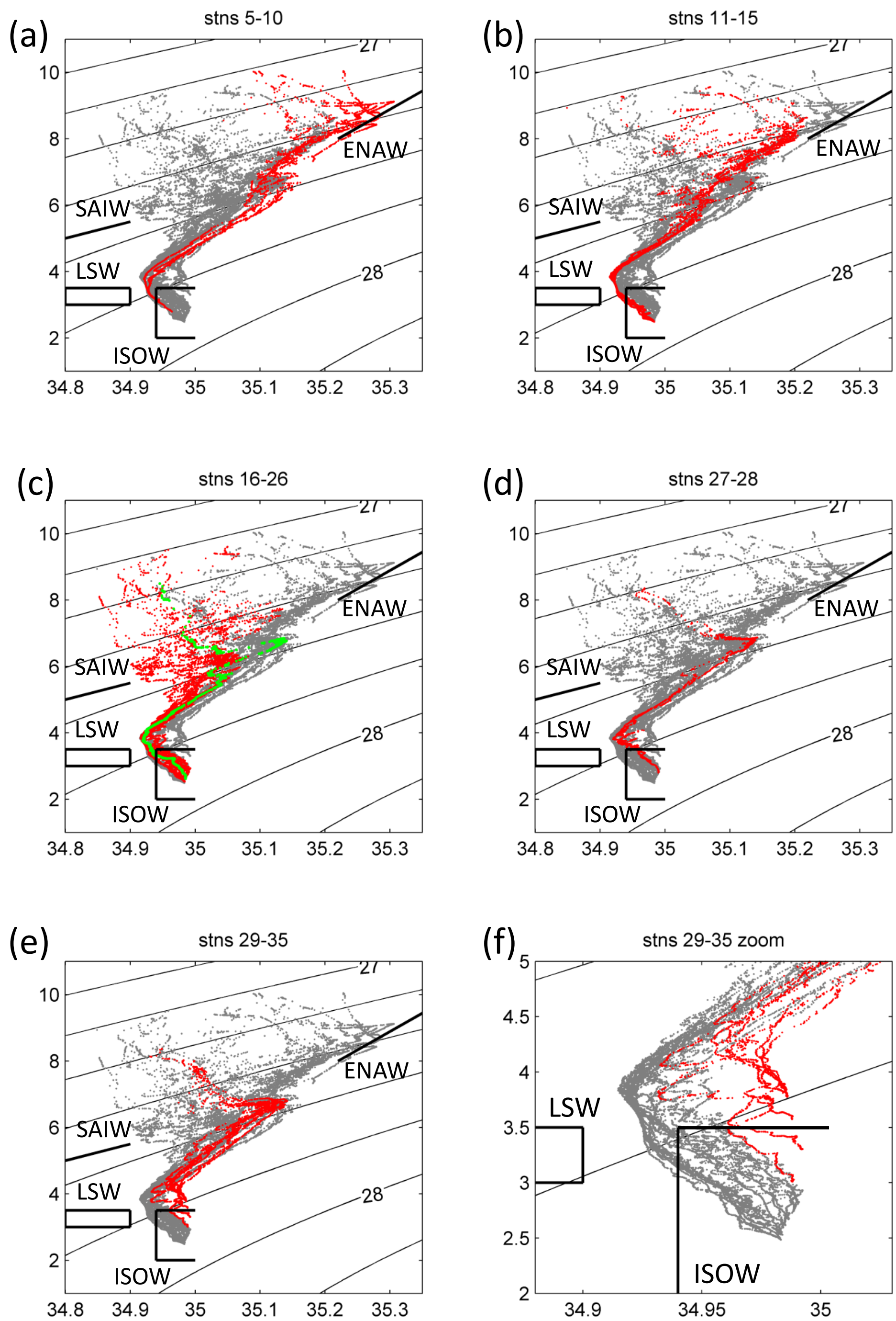


Figure 11: Potential temperature-salinity diagrams split geographically by water mass regime running east to west along the PE399 section in the Iceland Basin. Grey dots show all data from the entire section and red dots a geographical subset of stations within the basin. Green station in (c) is station 22. (e) shows a zoomed-in view of the intermediate and deep waters for station 29 to 35.

10 LADCP Measurements

10.1 LADCP Setup

Full water column velocity profiles for the OSNAP East July 2015 cruise were collected using a dual 300 kHz Workhorse master/slave configuration. The instruments, cables, and related equipment were provided by NIOZ, with a spare 300 kHz Workhorse ADCP (S/N: 6280) provided by UM. The primary downward-looking ADCP was S/N: 13154 (firmware v.51.40) and the primary upward-looking 300 kHz ADCP was S/N 12369 (firmware v.50.40). The two Workhorse ADCPs were mounted on the CTD rosette using mounting brackets and hardware supplied by NIOZ. The brackets were welded to a rigid vertical bar attached to the inner ring of the rosette. The upward-looking ADCP was positioned near the outer edge of the rosette, situated just above the upper rim of the frame. The downward-looking ADCP was positioned directly below; with the transducer face about 10cm above the bottom plane of the rosette. Power was supplied to both instruments by a RD Instruments ADCP dual-battery pack housing, mounted between the two ADCPs.

Both ADCPs were initially configured for 20 8-meter bins, one ping per ensemble, zero blanking distance, an ambiguity velocity of 250 cm s-1, and measurements saved in beam coordinates. The downward-looking ADCP was designated as master, and set to send a synchronization pulse to the upward-looking ADCP and wait for 0.55 seconds before sampling. The master was set to burst sample, with two ensembles per burst, at approximately 1 Hz, while the slave was set to sample as quickly as possible (time-per-ping at 0 sec). The exact ping timing parameters were adjusted several times throughout the cruise in an attempt to compensate for a persistent acoustic interference pattern, but the resulting sampling frequencies never varied by more than a few tenths of a second.

Early on in the cruise, the preliminary processing results indicated that the signal strength of beam 4 on the downward-looking ADCP was significantly weaker than the other beams. While this problem did not render the instrument unusable, the overall effective range of the instrument was substantially less than the upward-looking ADCP. Eventually it was decided to replace this unit (S/N: 13154) with the spare UM Workhorse starting with CTD cast number 21, and arrange the instruments such that S/N: 12369 would now be the downward-looking ADCP and S/N: 6280 would be the upward-looking instrument. This setup was then in place for the remainder of the cruise.

10.2 Data Acquisition Setup

Inside the CTD lab on the Pelagia, a dedicated PC laptop running Ubuntu Linux with two usb-to-serial ports was set up as the primary data acquisition platform. A dual-terminal program written in Python, which is included in the UH-DAS ADCP software package, was used to communicate with the instruments. Data files downloaded to the acquisition PC were transferred to the processing laptop via shared network drive.

10.3 Deployment and Recovery

Lowered ADCP operations began on June 19th, 2015 with a "test" cast to about 2000 meters near the beginning of the main transect line. LADCP data for the first two casts were not processed, as there were some minor problems with data acquisition and some confusion over file naming conventions. The first fully processed LADCP profile was at cast number 3. A total of 36 profiles were collected, ending with cast number 38.

10.4 Data Processing

The two raw ADCP data files were first copied to a dedicated laptop for processing. Navigation data were extracted from the uncorrected one-second time-series CTD data provided by the CTD operator, downloaded over the ship's network. Once the files were in the proper directories, the "first-pass" processing could be executed. The initial processing of the raw ADCP data was done using version 10.16 of the M. Visbeck & A. Thurnherr MATLAB toolbox, modified by G. Krahmann. The 'process_cast(nnn)' script was run, with 'nnn' representing the station number, which called subroutines to copy, load, scan in, and run the shear and least-squares inverse methods. About a dozen graphics are generated with useful diagnostic information and the final water column profile. The processing scripts required some code modifications, primarily to ensure the ADCP and GPS data were properly loaded. The prepnav.m script was modified to call the load_sbe9.m function, which reads in a 1-Hz bin-averaged CTD timeseries which includes latitude and longitude information. Manual changes to the 'prepare_cast.m' code were also necessary to ensure that only the navigation data would be used in the first-pass processing. Bottom-track processing was left enabled. A small section of code in 'misc_composefilenames.m' was commented out to better handle the raw LADCP filename convention. When the first-pass was finished, the operator would note in the log sheet the calculated depth based on the integrated vertical velocity and compare it to the maximum depth reported by the CTD.

11 Rafos and Argo Float Deployments

11.1 National Oceanography Center APEX

As an ancillary activity, two APEX floats were deployed for the National Oceanography Center (NOC) Argo Program. The APEX floats were delivered in pressure activated mode. Deployment went smoothly, details may be found in Table 8.

Table 8: National Oceanography Center APEX float deployments

s/n	Date (YYYY-MM-DD THH:MM)	Latitude (°N)	Longitude (°W)	Corrected Depth (m)	Station	Closest CTD
NOC Apex 7209	2015-06-24 T10:58:13	58.000	-21.000	2564	17	CTD_10 (Station 16 in ship's Casino database)
NOC Apex 7210	2015-06-26 T00:22:15	58.003	-23.995	2923	26	CTD_15 (Station 25 in ship's Casino database)

11.2 RAFOS Floats

A total of ~120 subsurface acoustically tracked RAFOS floats were and are being released during the 2014, 2015, and 2016 OSNAP cruises to directly observe pathways of Overflow Waters through the subpolar North Atlantic. An array of 10 260-Hz sound sources moored during the 2014 OSNAP cruises are being used to track the floats until all the moored arrays are recovered in 2018 (Figure 12). This seeding is similar to last year's deployment, with one major difference: The floats launched in the deep Charlie-Gibbs Fracture Zone in 2014 were moved to the OSNAP line west of the Reykjanes Ridge crest. In 2014, the ship travelled over the Charlie-Gibbs when deploying the sound source array and a single seeding of 10 floats was made at this location, targeting the Iceland–Scotland Overflow Water as it travels east to west through the fracture zone. The 2015 OSNAP cruises do not travel in this region, so this deployment position has been re-located downstream to seed the deep mean northward flow that blankets the west Reykjanes Ridge. During Year 2, 47 OSNAP RAFOS deployments are planned. This increase from 40 to 47 is due to the manufacturer decreasing the cost of the RAFOS unit, and providing the difference in the form of five additional

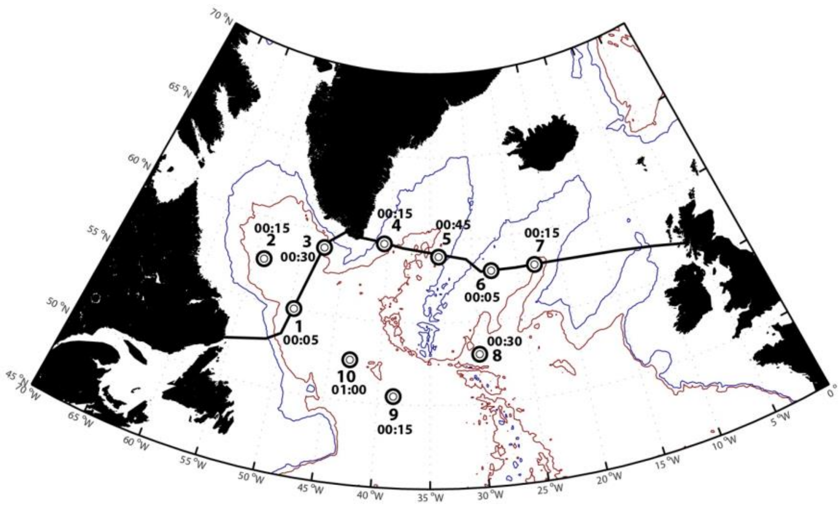


Figure 12: Sound source mooring positions and pong times (once daily) for 10 sound sources deployed as part of the OSNAP program. The 2000 and 3000 m isobaths are drawn.

RAFOS, and two 2014 RAFOS that were held back because they were thought to have imperfections in glass housing, but were later deemed sound.
Deployments for 2015 are as follows:

- 64PE399: 15 RAFOS on the eastern flank of the Reykjanes Ridge programmed for 730-day missions; three monitoring RAFOS floats in the Iceland Basin to give sound source information at 10, 100, and 317 days. The monitor day counts equate to: information returned in enough time to hold back deploying 2015 Leg 2 floats, in enough time to procure, ship and moor a replacement sound source, and in enough time to halt shipment on 2016 RAFOS floats.
- 64PE400: 12 RAFOS over the western flank of the Reykjanes Ridge programmed for 730-day missions; 20 RAFOS floats over the east Greenland slope programmed for 730-day missions; three monitoring RAFOS in the Irminger Basin to give sound source information at 10, 80, and 300 days, which mimics the above staggered surfacing plans.

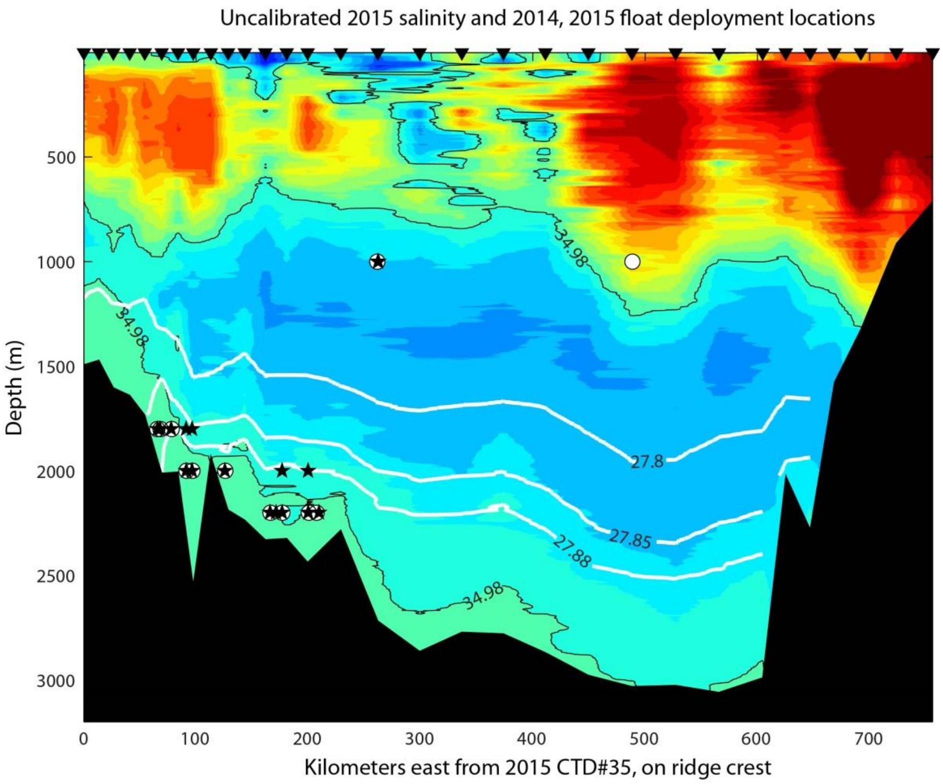


Figure 13: Uncalibrated salinity from 64PE399, with RAFOS float positions overlaid. Black stars are 2015 deployment locations, and white circles are 2014 deployment locations, drawn for comparison. The single 34.98 isohaline is drawn, as well as the 27.80, 27.85, and 27.80 isopycnals, all to highlight the deep Iceland Scotland Overflow Water. Bathymetry is suggested by a patch created from deepest points in the CTD casts.

Table 9 lists the deployment information for the floats on 64PE399, OSNAP Year 2 Leg 1. Floats released on the eastern flank of the Reykjanes Ridge were ballasted for 1800, 2000, and 2200 m. The general deployment strategy was to release them 100-200 meters above the seafloor of the ridge flank to target the thin Iceland-Scotland Overflow Water layer flowing southward at that location, repeating the Year 1 deployment sites. Five new sites were added due to the increased number of floats. Four of the five new floats were stacked vertically at deeper float sites, and an additional 2200-dbar float was placed close to the ridge between two deep float stations. Figure 13 shows the Year 1 and Year 2 deployment sites superimposed on uncalibrated CTD salinity. Figure 14 shows the two years' deployment locations over bathymetry.

Two changes were made to the 2015 RAFOS float manufacturing, both changes an attempt to mitigate the effects of bottom contact, which happens on occasion when a float is pushed by current horizontally into the bottom. First, the UHDP "insulator" was retooled to remove a pocket that could potentially collect sediment, causing the float to become heavy and sink once off the bottom. Second, on half the floats, thin two meter lengths of plastic-coated SS wire weighing approximately 10 grams were added. This wire hangs vertically from the float bottom and will contact the seafloor first in case of bottom-brush. Because the wire is flexible, it will partially rest on the seafloor, effectively lessening the weight of the float, thus increasing float buoyancy. The flexible wire prevents the float itself from coming in contact with the bottom and picking up sediments. On all deployments where a float was particularly close to the bottom, wired floats were chosen.

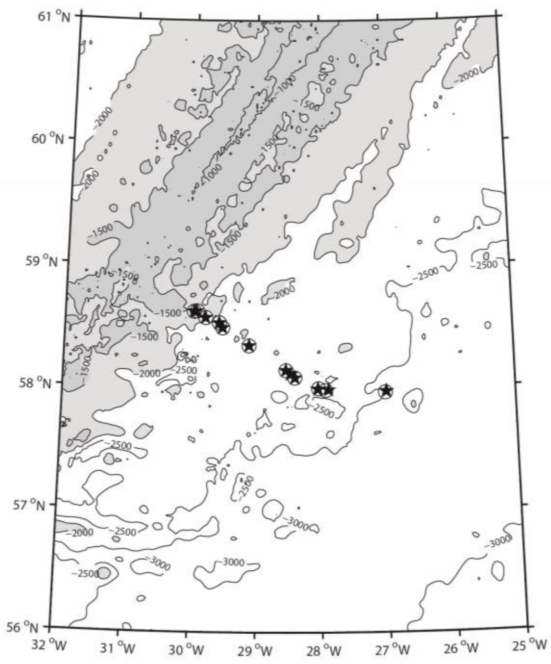


Figure 14: RAFOS deployment locations over bathymetry, shaded at 1500 and 2000 m. Black pentagrams are 2015 locations; white circles are 2014 locations, for comparison.

Most of the RAFOS floats were released using the "holey tube" made out of ~0.25-m diameter, 2.5-m long PVC pipe. Normally this tube is used with a starch-ring piston that releases a bottom gate once the starch ring dissolves in water, an event that takes approximately 15 seconds. However, the floats were not able to be launched using this method for fear that wire would be damaged (therefore changing ballasting weight) or hang up on the PVC launcher bottom gate. We brought a "Ross Perot" clip launcher, a simple metal clip with quick release pin, which worked well but the float glass came too close to the fantail deck when seas were rough, and this method was scrapped. What worked best was to use the holey tube as a deployment chute. The float was loaded into the tube horizontally on deck, the wire carefully unwound and fed over the ship's fantail. One (strong) person would hold the top of the glass float, while another person would edge the tube over the side, tilting both in concert at 45-60 degree angle to the water. The float and tube were then lowered as much as possible to minimize distance to water surface. Waiting for swell to come up, the float was then let go and dropped through the tube into the water. In this manner, the tail wire was not damaged, and the glass housing had no contact with the deck.

Table 9: RAFOS float deployment metadata, Leg 1 R/V Pelagia 2015, Iceland Basin.

s/n	Ballast / Target Depth Meters	wired float	mission length (days)	Deployment Date	Deployment Time GMT	decimal Latitude (N)	decimal Longitude (W)	Corrected Water Depth Meters	Iridium IMEI Number
1084	1000	n	10	27-Jun-2015	17:11:09	57.971	-26.993	2688	300234010725580
1108	1000	n	100	27-Jun-2015	17:04:33	57.970	-26.995	2664	300234011471420
1135	1000	n	317	27-Jun-2015	17:12:47	57.971	-26.993	2688	300234011478510
1379	2200	n	730	27-Jun-2015	23:11:01	57.983	-27.885	2389	300234062926640
1370	2200	y	730	28-Jun-2015	0:01:28	57.991	-28.047	2391	300234062619890
1366	2000	n	730	28-Jun-2015	0:04:26	57.991	-28.049	2392	300234062612950
1378	2200	n	730	28-Jun-2015	5:55:02	58.082	-28.403	2363	300234062927640
1365	2000	n	730	28-Jun-2015	5:53:35	58.082	-28.404	2363	300234062611950
1373	2200	y	730	28-Jun-2015	6:21:12	58.112	-28.474	2317	300234062610940
1369	2200	y	730	28-Jun-2015	6:48:44	58.143	-28.545	2313	300234062612930
1356	2000	y	730	28-Jun-2015	16:21:14	58.344	-29.117	2263*	300234062617940
1357	2000	y	730	28-Jun-2015	20:02:30	58.490	-29.534	2525*	300234062616910
1358	1800	n	730	28-Jun-2015	20:04:08	58.490	-29.534	2525	300234062611940
1360	2000	y	730	28-Jun-2015	22:41:10	58.528	-29.587	2164	300234062616890
1359	1800	n	730	28-Jun-2015	22:43:10	58.529	-29.588	2163	300234062615940
1351	1800	y	730	29-Jun-2015	1:35:42	58.571	-29.801	2031	300234061827890
1354	1800	y	730	29-Jun-2015	2:23:44	58.623	-29.945	1992	300234061829890
1355	1800	y	730	29-Jun-2015	4:18:51	58.620	-29.981	1937	300234061825340

*Station depths at RAFOS 1356 and 1357 on the Casino data base were bad data points. I used depths from nearest time stamp on Casino, and verified with more detailed echosounder data (same data source).

12 Glider Operations

12.1 WHOI-OUC Slocum glider

One Teledyne Webb Research Slocum Glider was deployed, identifier 'WHOUC1', during Leg 1 of the Pelagia OSNAP cruise. The glider is one of two bought by Ocean University China as part of the OSNAP program. This glider is intended to measure oceanographic properties between the central Iceland Basin and the west edge of Rockall Plateau, a ~200 kilometer section between moorings M3 and M4 and from 0-1000 meters depth. Thus, this glider program will compliment the SAMS glider program, which surveys from the west edge of the Rockall Plateau to the east side of the Rockall Trough.

This glider is equipped with a Seabird Pumped CTD system, Wet Labs 'Ecopuck' with FLBBCD-SLK, CDOM, and backscatter, Satlantic radiance sensor, Aanderaa oxygen optode, and SUNA nitrate analyzer. This glider includes an extended bay Lithium battery pack, for longer endurance, and a strobe light and nose recovery system for pickup. Details of deployment may be found in Table 10. The glider was ballasted for surface density of ~1026.6 kg/m^3, this value chosen after review of both smoothed historical hydrographic data from Hydrobase, and quasi-synoptic section data from the SAMS gliders.

Table 10: WHOI-OUC Slocum glider deployment

s/n	Date (YYYY-MM-DD THH:MM)	Latitude (°N)	Longitude (°W)	Corrected Depth (m)	Station	Closest CTD
WHOUC1	2015-06-27 T16:24:06	57.965	-27.005	2894	35	CTD_20 (Station 34 in ship's Casino database)

Due to heavy seas and strong wind, the glider deployment, originally intended to be located at M3 on the east to west transect of the R/V Pelagia, was delayed by two days. Work continued while the ship continued to transit, and the glider was finally deployed about 180 km west of M3 (Table 10). Using FreeWave, the initial engineering checkout was performed. Vacuum and battery were within normal ranges, and glider reported a normal prompt after the 'run WHOISTAT.MI' mission was completed. A bridle system was used in deployment (Figure 15), and glider placement in the water went smoothly. No buoy test was performed. The ship remained on station for about one hour while WHOI-based glider pilot Ben Hodges performed a shallow-cast test dive, downloaded and checked the data, and sent the glider on its science mission.

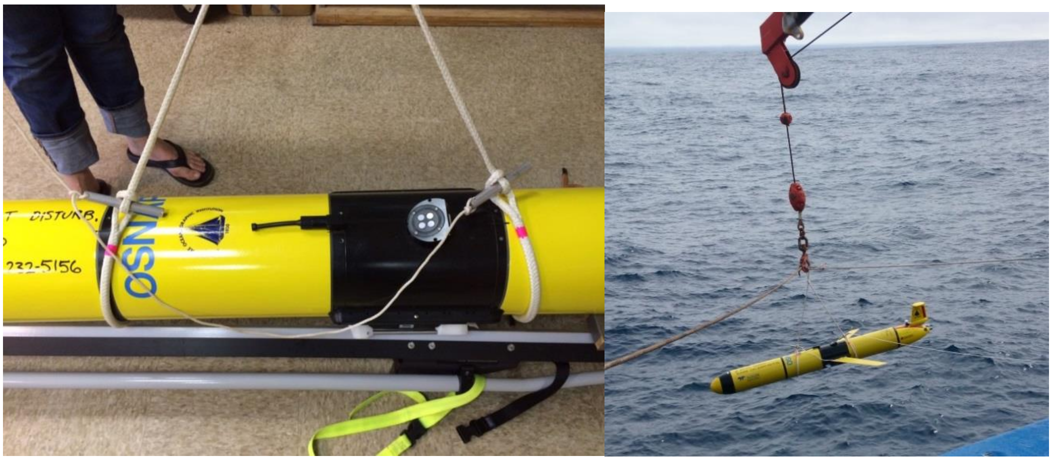


Figure 15: Bridle system used for the extended bay Slocum Glider (left), and glider deployment (right).

12.2 Recovery of Bowmore

The glider recovery was planned after the recovery of the mooring M4, on the 24th of June 2015, during the OSNAP cruise PE399. Shallower dives were initiated the morning of the recovery (500m), and the waypoint (57 57.0'N, 21 11.0'W) was set ~3nm south of the mooring M4. The pilot (at SAMS) continued to decrease the depth of the dive and put a the glider in recovery mode at 14:10 UTC. Then after 14:30UTC, the team on the Pelagia got the gps position of the glider every 5 minutes, through emails. The glider was recovered at 15:25UTC using a long pole, and a crane from the side of the ship.

13 Iceland Basin and Reykjanes Ridge Deep Western Boundary Current Array (RSMAS, UoM)

Sixteen mooring operations (eight mooring recoveries, eight mooring deployments) were performed between 24 June to 3 July, 2015 to service the U.S. (University of Miami) mooring array across the Iceland Basin (Table 11 and Table 12). The array consists of a basin-wide array of four full-water column “dynamic height” moorings (M1-M4) carrying vertical arrays of moored T/S sensors, to monitor geostrophic transports across broad segments of the Iceland Basin; and a closely-spaced Deep Western Boundary Current (DWBC) array along the eastern flank of the Reykjanes Ridge made up of four additional deep (>1200 m) moorings (D1-D4). In all, the array contains 28 current meters, 60 temperature/salinity recorders, and 4 acoustic Doppler current profilers.

The array is designed to capture several key elements of the North Atlantic subpolar gyre (NASPG) circulation: (1) the DWBC along the eastern flank of the Reykjanes Ridge, composed of Iceland-Scotland overflow water and its entrainment products; (2) the northward flow of upper ocean waters transported by the main branch of the North Atlantic Current toward the Norwegian Seas; and (3) the southward recirculation of the Iceland basin sub-gyre of the NASPG along the eastern flank of the Reykjanes Ridge.

Most of the moorings were recovered and redeployed on the same day, with the exception of mooring M2 which was recovered late on one day and deployed early on the next. The moorings were deployed in typical fashion where the mooring was streamed out starting at the top elements of the mooring, with the ship steaming toward the target site at about 1.5- 2.0 kt. through the water, and the anchor then being deployed after passing over the target site to allow for the estimated fall-back of the mooring on its way to the bottom. The mooring deployment times ranged from 3 hours to about one hour, and in most cases ended with a tow of between 15-45 minutes to the target site before launching the anchor. Most of the moorings were landed very close to the intended bottom site. In one case (M3) the ship slightly overshot the target due to a following current and a delayed start to the mooring deployment, resulting in the mooring being about 500 m from the target site on the bottom, but still within a few meters of the target depth. All moorings were acoustically surveyed after settling to the bottom by obtaining at least two - and typically three - lateral ranges from the ship through communication with the mooring releases (tri-lateration).

Mooring recoveries commenced by positioning the ship usually directly above the mooring location, and stopping all propulsion including the bow thrusters while laying the ship to with the wind on the starboard side. Acoustic communications were then established with the mooring releases and the moorings were released after drifting a safe distance away (or by repositioning the ship if necessary) to observe the mooring and its components come to the surface. Once all mooring components were visible on the surface the ship moved in to bring the mooring alongside. Recovery commenced by grappling the surface elements off the starboard side of the ship and then tending the recovery line aft to retrieve the rest of the mooring through the stern A-frame. All of the mooring operations went smoothly and safely on the aft deck without incident.

Table 11: U.S. Moorings recovered on PE-399

Mooring #	Site	Latitude	Longitude	Depth(m)	Recov. date
M423	M1	58° 52.33' N	30° 31.95' W	1710	06/29/2015
M427	D1	58° 44.77' N	30° 07.01' W	1740	07/03/2015
M428	D2	58° 32.11' N	29° 27.82' W	2513	07/03/2015
M429	D3	58° 18.42' N	28° 49.12' W	2175	07/02/2015
M424	M2	58° 02.26' N	28° 01.29' W	2370	07/01/2015
M430	D4	58° 00.58' N	26° 58.07' W	2670	07/01/2015
M425	M3	58° 00.77' N	24° 25.72' W	2850	06/26/2015
M426	M4	57° 59.56' N	21° 08.61' W	2920	06/24/2015

Table 12: U.S. Moorings deployed on PE-399 (final surveyed mooring positions)

Mooring #	Site	Latitude	Longitude	Depth(m)	Depl. date
M431	M1	58° 52.33' N	30° 31.73' W	1710	06/29/2015
M435	D1	58° 44.75' N	30° 07.23' W	1740	07/03/2015
M436	D2	58° 31.93' N	29° 27.53' W	2513	07/03/2015
M437	D3	58° 18.36' N	28° 48.97' W	2175	07/02/2015
M432	M2	58° 02.28' N	28° 01.39' W	2370	07/02/2015
M438	D4	58° 00.59' N	26° 58.09' W	2670	07/01/2015
M433	M3	58° 01.04' N	24° 25.09' W	2850	06/26/2015
M434	M4	57° 59.54' N	21° 08.49' W	2920	06/24/2015

14 Rockall Trough Mooring Array

14.1 Array description

The Rockall Trough mooring array consists of five moorings (Figure 16) with the following objectives: **RTWB1** & **RTEB1** are end-point density moorings measuring the baroclinic circulation across the width of the Rockall Trough using CTDs distributed in the vertical; **RTWB1** & **RTWB2** measure the Wyville-Thomson Ridge overflow current along the Feni Ridge using current meters; **RTEB1, RTADCP1 & RTADCP2** measure the Shelf Edge Current using current meters and 75khz long-ranger acoustic Doppler current profilers. **RTWB1** and **RTEB1** include bottom pressure recorders to determine the barotropic variability across the Rockall Trough. The Rockall Trough section is also being surveyed by **glider** up to 10 times per year as the glider transits to and from the Hatton Bank at the beginning and end of the 4-monthly glider missions.

The array as deployed in July 2014 (Figure 16) consisted of three moorings and one bottom mounted ADCP in a trawl resistant frame. RTADCP1 was deployed in October 2014 on DY017.

The array deployed in June-July 2015 (Figure 17 and Appendix A.1) exists in the same configuration as the one deployed in July 2014, except for RTADCP2. We were unable to communicate with the bottom lander once we arrived on site. After a survey (details in the subsection "Survey for RTADCP" (p 56)), the instrument was declared as lost.

Figure 16 and Figure 17 show each mooring, instrument (CTDs, current meters, bottom pressure recorders and ADCPs) locations, beacons and releases by name and serial number. The set-up details of the SAMS instruments deployed during the PE399 cruise are presented in Appendix A.2.

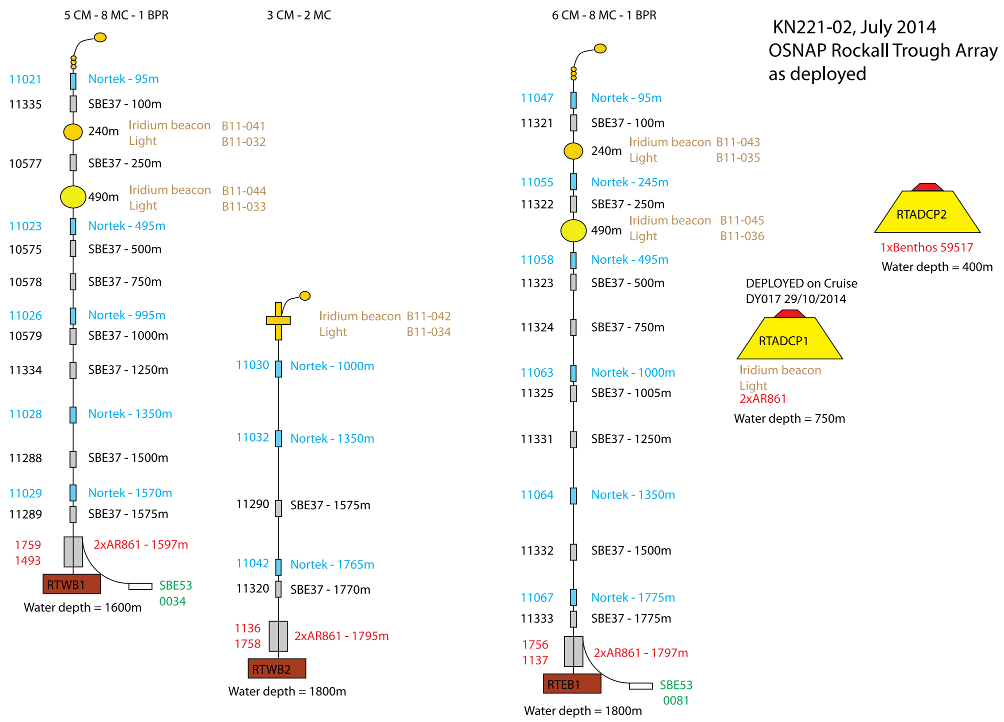


Figure 16: SAMS mooring array as deployed in 2014

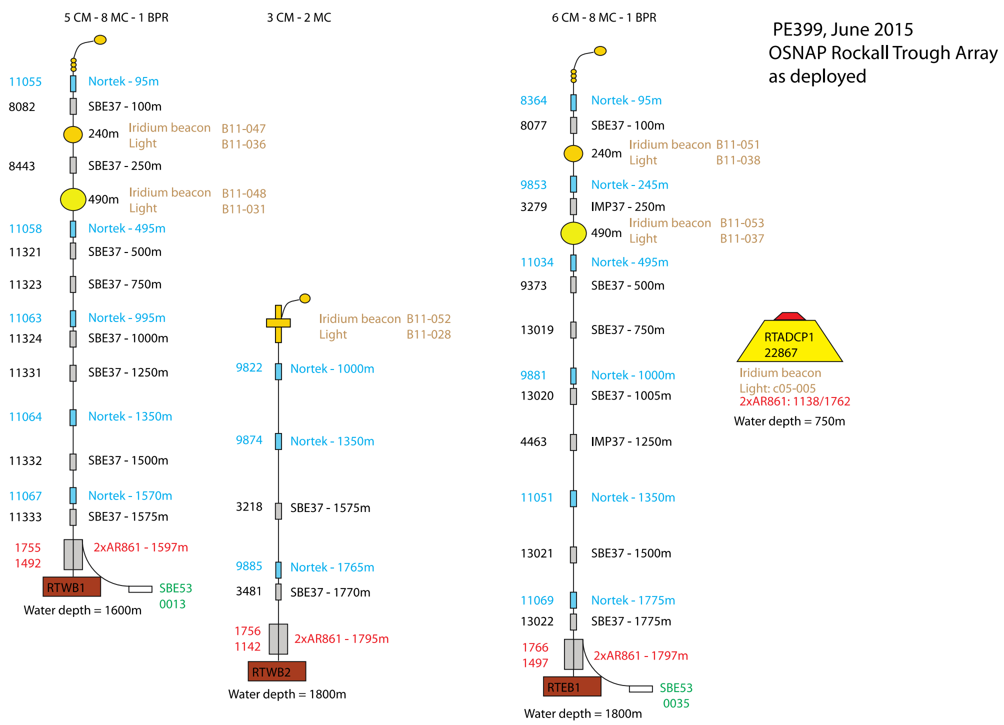


Figure 17: SAMS mooring array as deployed in 2015.

14.2 Mooring Operations

Mooring operations were conducted from the aft deck (Figure 18) using a Lebus double-barrelled winch from the Royal Netherlands Institute for Sea Research (NIOZ). The winch (Figure 19 and Figure 20) was operated by NIOZ personnel throughout the trip using a remote control unit. A member of the crew operated the A frame and the winch controlling the height of the block from the cab overlooking the aft deck on the portside. Two A/Bs were on deck to assist with the mooring operations. The crane mounted on the starboard side was controlled by a remote control unit by one of the A/Bs. Three members of the scientific mooring team would assist with moorings operations on deck (Figure 21). Another member of the mooring team was responsible for keeping a log of the mooring operation (Appendices A.3 and 0). The remaining members of the team would be responsible for keeping an eye on the spooling winch on the starboard side and carrying instruments from the wet lab to the deck (or vice-versa).

The standard procedure on recovery was for the ship to keep a safe distance from the nominal mooring position whilst the releases were interrogated and subsequently released. The ship would move in closer for the recovery operation once all the buoyancy packages were spotted on the surface. Moorings were grappled adjacent to the wet lab, mid-ships on the starboard side. A line was run from here aft to the Lebus winch. Once the mooring and pickup line were clear of the stern the mooring would be recovered using the Lebus winch. The crane was used for lifting the heavier items on deck during recovery. The standard procedure was to stop off the mooring line to remove either instruments or buoyancy packages. A rope stopper line with a hook attached to an eye in the deck was used for this purpose. This was not necessary for the instruments which were clamped onto the mooring line e.g. SBE37 microcats.

The standard procedure for all deployments was similar to the recovery procedure. The one difference being that for the deployments all operations were carried out from the aft deck. The one exception being the deployment of the AL500 trawl proof frame. This was deployed from the starboard side using the crane and a quick release hook.

Weather conditions were good for all recoveries and deployments.

Figure 18: Deck stopper used for all moorings

Figure 19: NIOZ LEBUS Double Barrel Winch

Figure 20: Spooling Winch used with the DB winch

Figure 21: Typical Mooring Operation Deck Scene

14.3 Mooring Recoveries

14.3.1 Recovery of Rockall Trough EB1 – 20/06/2015

The mooring was released at 0658, the first instruments were aboard at 0737. Some fouling was evident on both the near surface Aquadopp & SBE37 (Figure 22). The rest of the instruments were clear of any fouling. The iridium beacon, s/n B11-043, on the 40" syntactic sphere was damaged whilst being moved on the deck following recovery. The recovery was completed by 0936. The final instrument recovered was the SBE53 BPR s/n 0081 which was hanging down from the releases as expected. Some mud was lodged in one of the eyes of the BPR (Figure 23). All mooring components were recovered in good condition. There was no sign of any wear or corrosion on any of the mooring hardware.

Figure 22: Light fouling on the two near surface instruments

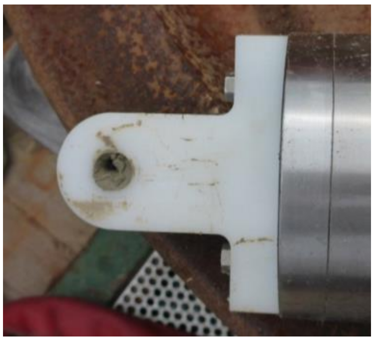


Figure 23: Mud lodged in the eye of the SBE BPR

14.3.2 Recovery of Rockall Trough RADCP1 – 20/06/2015

On station at 1015. There was no reply from the parachute acoustic release. Contact was made with the two units within the trawl proof frame. The range was ~821 m, both units were horizontal with a voltage of 8.6 V. The release command was sent at 1030. The frame ascended at ~40m/min. The frame reached the surface at 1050. There was no pickup line on the frame. Two snap hooks were connected to the handles of the frame. The frame was recovered through the A frame (Figure 24). A small part of the syntactic frame came away during recovery. Once on deck it was clear that the frame had been trawled at some stage. Trawl wire marks were clearly visible especially on one of the corners (Figure 25). On further inspection, when the frame was stripped down to remove all the instruments, one of the acoustic releases, s/n 1326, had suffered severe corrosion of the top plate of the cage protecting the transducer (Figure 26 and Figure 27). The other release, s/n 899, was in very good condition. It looks like a case of mismatched materials; this is not the first time that this has happened with an IXSEA acoustic release.

Figure 24: Recovery of the Trawl proof frame

Figure 25: Trawl wire damage to frame

Figure 26: IXSEA Acoustic Releases within the frame

Figure 27: Sever corrosion of the A/R top plate

14.3.3 Recovery of Rockall Trough WB2 – 22/06/2015

The mooring was released at 0434 with a range of 1845 m. The mooring was spotted on the surface at 0450. The pellet line, beacons and top buoyancy package and Nortek were all tangled (Figure 28). Grappling the mooring was not straight forward. The tangled top was recovered in one lift and untangled on deck. The second buoyancy package was also tangled with the Nortek. This again was untangled on deck. The final two buoyancy packages, Nortek, SBE37 & 2 A/Rs were also tangled. This was all recovered on deck in a single lift. No instruments were damaged during the recovery. The recovery was completed by 0617.

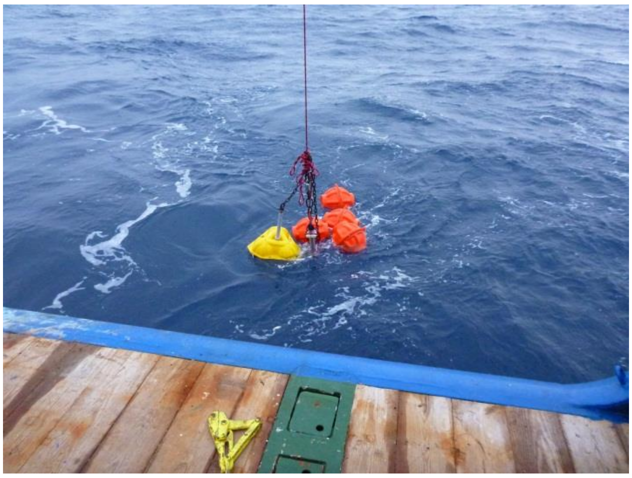


Figure 28: Tangled top section of mooring

14.3.4 Recovery of Rockall Trough WB1 – 22/06/2015

The mooring was grappled at 1138, the top part of the mooring was recovered with no issues. This was not the case for the lower part of the mooring. The buoyancy package above the release had tangled with the packages above. The tangled packages were brought on deck at 1222 (Figure 29). This included both releases and the BPR which was hanging free. It took quite some time to untangle the mess. The wire had to be cut in several places. Ferrules were used to create loops so the rest of the mooring could be recovered via the winch. The last remaining package was brought on board at 1253. The tangles aside, all instruments and hardware were in good condition.

Figure 29: Tangled wires and instruments on the deck

14.3.5 Survey for RTADCP2

Unfortunately we did not recover bottom lander RTADCP2. Arriving on site (at 12:30) we were unable to communicate with the Benthos release, trying from several locations around the mooring. No replies were obtained. We also borrowed a Telydyne Benthos Universal Deck Box and transducer from Adam Houk (UoM, RSMAS) that we programmed appropriately. We repeated our survey around the known site with no replies.

Later we conducted an extensive survey for this lander. Assuming the benthos release to be functioning the most likely explanation was that the lander had been moved by the extensive fishing trawling known to take place in this area. From a prior analysis of fishing boat positions (supplied to us from Marine Scotland Science) we know that trawling takes place along isobaths, so it seemed likely that the lander could have been dragged along the depth contour at which it was deployed. Therefore we focused our efforts along the 500m isobath (the deployed depth was 480m), but practically it was easier to design a survey along the 500m contour as this is drawn on the ship's electronic navigation charts. The horizontal separation of the 480m and 500m contour is not significant for this survey.

We surveyed an 18 nm track along the 500m isobath (Figure 30), stopping to interrogate for the benthos release every 1 nm along this track. Based on past experience we estimate that we would be able to range over at least a radius of 1nm, so we conservatively estimate the survey covered a minimum area of 36 square nautical miles (~144 km^2).

No replies were obtained and we consider the lander lost.

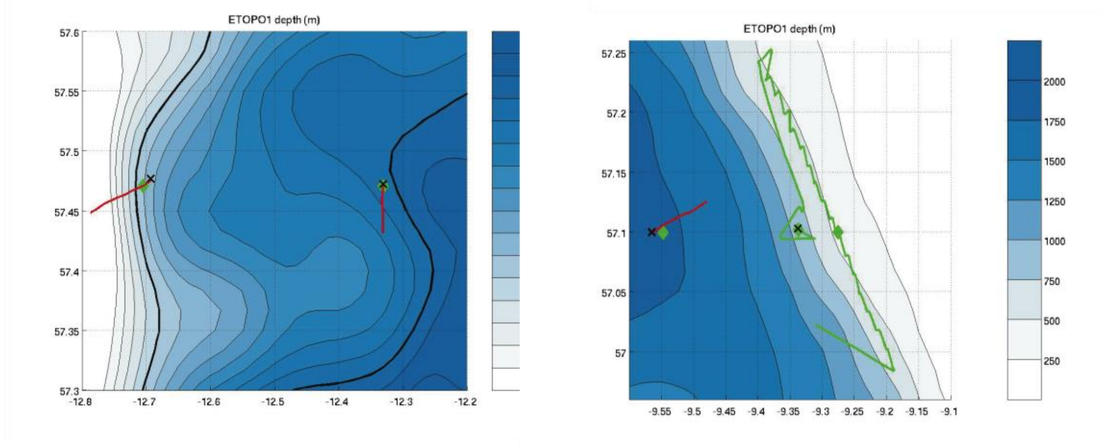


Figure 30: ETOPO1 1 min resolution bathymetry contoured in the region of the Rockall Trough moorings. Note that the panels have differing depth contour scales. In the left hand figure the 1600m and 1800m depth contours are highlighted in bold. Mooring seabed positions from 2014 are given by the green diamonds. The black crosses give mooring positions in 2015. The red tails are the ship's track during mooring deployments. In the right hand panel the green cruise track is the survey conducted searching for RTADCP2_2014. The survey started after the trilateration of RTADCP1_2015. We headed north to a start position 9 nm north of RTADCP2_2014 on the 500m isobath. We then headed south for 18 nm tracking the 500m isobath. Every 1 nm the ship hove-to (see the slight doglegs in the track), deploying a transducer to range the benthos release in ADCP2. This survey was conducted between 20/6/15 @ 1740 and 21/6/15 @ 0300.

14.4 Mooring Deployments

Mooring deployments durations were based on the deployments of the previous years. Based on these our set-up distance was calculated based on a ship's speed of 0.5 kn as advised by the bridge. However, in reality the ship typically made a minimum ground speed of about 1.5 kn. We also found that the deployment was considerably slower than in the previous year: this being early in the cruise.

14.4.1 Deployment of Rockall Trough RADCP1 – 20/06/2015

The frame was released from the Starboard crane using a quick release mechanism using loop bridles attached to the frame. The frame was released at 1633. The frame was on the bottom by 1643. The corrected depth when the frame was released was 745.5m, at the planned location: 57° 6.168'N; 9° 20.269'W.

14.4.2 Deployment of Rockall Trough EB1 – 21/06/2015

Mooring deployment commenced at 0552, the setup distance was 3nm. The starting position was 57° 7.5095'N; 9° 28.8184'W. Problems were encountered with the third Nortek instrument. Initially it was thought that a slightly larger bush was preventing the shackle from fitting properly to the end of the bar. The problem was the bar itself, regardless of whatever bushes were used it was not compatible with the shackles provided. The bar was replaced and the instrument remounted. The anchor was released at 0833, corrected bottom depth 1809m, 57° 05.988'N; 9° 33.894'W. This mooring was deployed 0.5 nm west of our target position. This was an error in transcribing positions and more care will be taken to return to the 2014 target position.

14.4.3 Deployment of Rockall Trough WB2 – 22/06/2015

Mooring deployment commenced at 0729. The mooring was released at 0854. The anchor drop position was 57° 28.327'N; 12° 19.8726'N, corrected depth 1802.9m.

14.4.4 Deployment of Rockall Trough WB1 – 22/06/2015

Mooring deployment commenced at 1425. All was well until the release of the anchor. The quick release was incorrectly aligned for the release to operate. As the anchor was retrieved the BPR knocked against the stern of the ship dislodging itself from the frame which was attached to one of the acoustic releases. The BPR and double A/Rs were retrieved on deck enabling the reconnection of the BPR to the frame. The second drop site was cancelled due to the presence of submarine cables. The anchor was released at the third attempt at 1640. Release position 57° 28.6068'N; 12° 41.5704'W, corrected depth 1608 m (Figure 31). This mooring was deployed 0.5 nm to the north-east of our target position. This was because the mooring took longer to deploy than expected, ship's speed over the ground was higher than expected and finally we had to run well past the target drop point to clear the track of a mapped submarine cable.

Figure 31: Successful deployment of BPR and A/R's

14.4.5 Acoustic Release Record

The serial numbers of the acoustic releases deployed in 2015 are indicated in Table 13.

Table 13: Serial numbers of the acoustic releases deployed during PE399.

Mooring	AR s/n
ADCP1	1762
ADCP1	1138
EB1	1766
EB1	1497
WB2	1142
WB2	1765
WB1	1755
WB1	1492

14.5 Trilateration of moorings

In most of the cases the positions of deployed moorings were checked by obtaining acoustic ranges from a transducer deployed over the side of the ship. On the Pelagia, we couldn't use the ship transducer to communicate with the mooring acoustic release. We used the script:
osnap/exec/pe399/mfiles/triangulation/SAMS_moorings/anchor3_scu_cj_loh.m to determine a position for the mooring anchor. The routine reads a *tri_pos_moor.txt* file to get the corrected water depth at the anchor drop position, the distance of the acoustic release from the seabed, immersion depth of the acoustic transducer, the position of the anchor drop, and the 3 trilateration positions (corrected water depth, latitude, longitude).
Maps of the trilateration surveys after the deployment of the moorings are shown in Appendix

Trilateration survey maps of SAMS moorings0A.3.
To get information about the ship position and the uncorrected and corrected water depth for a specific time, we used the script :
osnap/exec/pe399/mfiles/triangulation/get_position_depth_pe399.m

14.6 Mooring Location Table

Locations of SAMS moorings deployed during the cruise are indicated in Table 14.

14.7 Instrument Losses

The following equipment was lost:-

RADCP2 mooring comprising of:-

Benthos Acoustic Release s/n 59517 (Marine Scotland)
Workhorse 75 kHz LR-ADCP s/n 20466
Ext battery case for LR-ADCP
Trawl Proof frame for LR-ADCP (Marine Scotland)

IXSEA Acoustic Release used to lower the RADCP1 frame during DY017 s/n 1916.

One item was damaged on recovery:-

Novatech Iridium Beacon (EB1) s/n B11-043 plastic cover smashed.

Two instruments had flooded, no communication was possible with either instrument:-

Aquadopp Current Meter s/n 11032
SBE37 SMP s/n 11325

Table 14: Summary of SAMS mooring deployments during PE399. For mooring start and end times without seconds, position found using xx:xx:00. * Sea-bed position and fall back for WB2 was estimated using the fall back in 2014 of 152 m.

Mooring id	Date (dd/mm/yy)	Start of deployment			Anchor drop				Seabed position		Fall-back (m)
		Latitude (°N)	Longitude (°W)	Time (GMT)	Latitude (°N)	Longitude (°W)	Corr. Depth (m)	Time (GMT)	Latitude (°N)	Longitude (°W)	
RT-ADCP1	20/06/15	57.10276	9.33778	16:32:00	57.10280	9.33782	746	16:32:45	57.1040	9.3386	129
RT-EB1	21/06/15	57.12515	9.48032	05:52	57.09976	9.56490	1809	08:33:16	57.1014	9.5626	224
RT-WB2	22/06/15	57.43103	12.33157	07:28:30	57.47212	12.33121	1803	08:54:06	57.4707 *	12.3312 *	152 *
RT-WB1	22/06/15	57.44803	12.78628	14:25	57.47678	12.69284	1608	16:40	57.4764	12.6953	156

14.8 Instrument Performance

With the exception of the two flooded instruments, full data sets were recovered from all the remaining instruments with one exception.

The SBE53 BPR s/n 0081 deployed on EB1 recorded fewer measurements than expected. The reason for this was due to the data being collected at a slightly longer interval than the programmed interval. This was not due to a drifting issue with the clock. A number of bench tests were carried out following advice from engineers at SBE. Tests were carried out on both units recovered from the Rockall Trough moorings. The other unit s/n 0035 worked perfectly over a range of sampling intervals from 1 minute to 30 minutes. The faulty unit worked fine for intervals less than 20 minutes. Then the following error message appeared:-

error --> power off with alarm not set
setting alarm for one minute from now

This resulted in the interval being increased by 1 minute and 12 seconds for every sample. Exact cause of this fault is still being examined.

The performances of the SAMS moorings are detailed in Appendix 0.

15 SAMS Mooring Data Processing

15.1 SBE37 Microcat Data Processing

Before the processing of the different datasets, a control file is created for each mooring. Each mooring deployed has an associated ASCII info.dat file in the mooring directory. (e.g. *rtwb1_01_2014info.dat* is created in the directory *osnap/data/moor/proc/rtwb1_01_2014/*). The info.dat file contains metadata of mooring position, deployment period, and nominal depths and serial numbers of each instrument on the mooring.

15.1.1 Stage0 – Data Download

Raw instrument data are downloaded from the instrument after the recovery of the mooring. Data are downloaded in ASCII and cnv format. Record keeping of the download is done on paper and for each instrument a download sheet is completed. After download the data are backed up and transferred to the network drive Portus on the cruise directory e.g. *pe399/SAMS_moorings/microcat.* Then the data are copied onto the processing computer in the directory *osnap/data/moor/raw/pe399/microcat/*

15.1.2 Stage1 – Conversion to standard RDB format

The script *mc_call_2_pe399* performs stage1 processing on microcat data. It converts microcat data from raw to RDB format for an entire mooring. The user needs to modify some information in the beginning of the script like the directory trees, the mooring name, the year of the first measurement. *mc_call_2_pe399* calls *microcat2rodb_4*, which saves the file downloaded by the instrument software (stage 0) to the RDB formatted file *.raw*. The stage1 processed data are stored in the directory *~/osnap/data/moor/proc/nocnn_01_2014/microcat*, which is created manually. For the cruise pe399, the script *microcat2rodb_4* was setup to read cnv or ASCII files with the 5 columns (temperature [ITS-90, deg C], conductivity [S/m], pressure [db], time [julian days], and quality flag).

15.1.3 Stage2 – Trimming of data, basic statistics and summary plots

To perform stage 2 processing, the script *microcat_raw2use_003.m* was used. This script uses the raw data file *mooring_serialnum.raw* generated by stage1 and the *mooringinfo.dat* file. It removes the launching[4] and recovery[5] period, creates a data overview sheet including basic statistics, and produces summary plots, including filtered data.

4 The launching period is defined as the time from the start of the data logging until the mooring settles on the sea-bed.

5 The recovery period is defined as the time from when the mooring is released from the seabed until the end of the data logging.

15.1.4 Calibration Measurements

The script *osnap/exec/pe399/stage1/microcat/mc_call_caldip_pe399.m* loads the raw microcat data located in *osnap/data/moor/raw/pe399/microcat_cal_dip/castnnn/ (this data is first copied over manually from portus)* , the CTD data files for the cast*nnn* (*osnap/data/pe399/ctd_pe399_nnn_raw.nc* and *osnap/data/pe399/ctd_pe399_nnn_psal.nc)*, and the *castnnninfo.dat* file located in *osnap/data/moor/proc_calib/pe399/cal_dip/,* which is a control file summarising the type and the serial of the different instruments on the caldip cast. The control file is edited with the information for each cal dip. The script writes to a directory *~/osnap/data/moor/proc_calib/cal_dip/pe399/microcat/castnn/* which is created manually.

The script *mc_call_caldip_pe399* also plots all microcat data from one CTD cast, with the CTD data. The program *mc_caldip_check_pe399* provides a quick quantitative comparison of Microcat cal-dip data with the SBE911 data from the CTD. For each instrument differences of conductivity, temperature and pressure between the instrument and the CTD sensor were calculated. The mean and standard deviation of the differences for each instrument are then presented on the plots in Appendix 0 and statistics for the deepest bottle stop are presented in Table 6.

15.1.5 Data Problems

Some microcats had large offsets in conductivity or temperature when compared to the rosette CTD (Table 6). In addition, the microcat S/N 9372 was found to have a deficient pressure record on the cal-dip cast 3, and the microcat S/N 10576 and 11322 have a large pressure-dependent temperature offset, with a maximal value of 0.2 °C at 2554 db.

15.2 SBE53 Bottom Pressure Recorder Processing

Bottom pressure was measured at the positions of moorings RTEB1 and RTWB1. SeaBird SBE53 BPR instruments were deployed to the seabed from the acoustic release by means of a dissolving link. They remain attached to the release via a long tether. Thus the BPRs were decoupled from the mooring motion. The SBE 53 BPR measures full ocean depth water level with high resolution, accuracy and stability. A description of the instrument and specification can be found at http://www.seabird.com/sbe53bpr-bottom-pressure-recorder. The instrument measures pressure with a Paroscientific Digiquartz temperature-compensated pressure sensor, and temperature with an aged, pressure-protected thermistor. Pressure is measured to an accuracy of ±0.01% of full scale (here 10,000 psi ~ 6894.7 dbar), repeatability is 0.005% of full scale and resolution is 0.045 ppm (=0.3mm for 10,000 psi range with a 1 minute integration for a continuously powered sensor).

The BPR integrates pressure measurements to obtain water levels (tides) unaffected by wave action. The interval between each water level measurement is programmable (1 minute to 1 hour), and the integration duration is also programmable (1 minute to entire tide interval). The BPR can continuously power the pressure transducer and reference frequency oscillator, eliminating turn-on transients and providing the highest quality data. Alternatively, it can enter a power-down state between measurements to conserve battery power, with a user-specified warm-up period before each pressure measurement. Temperature data is recorded with each pressure integration. Logging start and stop times are programmable, allowing lab setup before deployment. Parameters for this deployment continuously powered the sensor during the full year integrating 30mins of tide measurements, every 30mins, so we have samples every 30mins (Table 15).

Table 15: SBE53 BPR instrument and sensor serial numbers deployed at moorings RTEB1 and RTWB1. Also included are the sampling intervals.

RTEB1	RTWB1
SBE 53 BPR V2.0 SN 81 20/06/15 11:28:36	SBE 53 BPR V1.1e SN 34 22/06/15 15:06:41
user info=kn221-02 rteb1 sa02sc	user info=kn221-02:rtwb1 sa02sc
quartz pressure sensor: serial number = 122877, range = 10000 psia	quartz pressure sensor: serial number = 113131, range = 10000 psia
internal temperature sensor	internal temperature sensor
conductivity = NO	conductivity = NO
Tide measurement interval (mins) 30	Tide measurement interval (mins) 30
Tide measurement duration (mins) 30	Tide measurement duration (mins) 30
Frequency of reference measurement every 96 tide samples	Frequency of reference measurement every 96 tide samples
Start date (dd/mm/yy) 17/07/14 Start time (GMT, hh:mm:ss) 06:00:00	Start date (dd/mm/yy) 17/07/14 Start time (GMT, hh:mm:ss) 06:00:00

15.2.1 Stage0

Data were uploaded in binary format using the SeatermW terminal launched via Seasoft for Waves. Data logging was stopped then careful note of the instrument clock drift was made. After uploading, hex data were converted to ascii using the routines in Seasoft from Waves. Slope and offset corrections of 1 and 0 were applied respectively. Details are shown in

Table 16.

Table 16: Details of BPR data upload

s/n on mooring	Comments	Date & time stopped	Number of recorded measurements	Filename
81 on EB1	1,2,3,5	GMT:105200 81:105233 dt=+33s	15610	0081_data.tid
34 on WB1	4,6	GMT:125230 34:125301 dt=+31s	16338	0034_data.tid

1. Fine mud in BPR lug indicating instrument on seabed.
2. No evidence in data that the BPR deployed to seabed after mooring deployment.
3. Data interval for this instrument was 1min, 12s longer than 30mins for every sample. Seabird confirm this is a software problem, however the data time stamps are correct. Thus 81 sampled at an interval of 31mins, 12 seconds.
4. 34 sampled at the expected 30min interval.
5. 84 has an increase in pressure of 4.5 dbar between sample numbers 13850 and 13851 in the edited file. This is at times of 5/13/2015 @ 072848 to 080000. Could the BPR have dropped to the seabed at this point – close to the end of the deployment. Will mooring motion be evident in the data prior to this point?
6. 34 seen clearly to drop to seabed a few hours after deployment (7/17/14 at 120000). Pressure jumb of 5 dbar on 7/17/14 between 1330 to 1400.

15.2.2 Stage 1

Save raw ascii data from SBE53 to rdb format. Basic data checks, apply clock offset.
/exec/pe399/stage1/bpr /seagauge2rdb_003.m
Infiles: rtwb1_01_2014info.dat ; clock_offset.dat ; 0034_data.tid
Outfile: /proc/rtwb1_01_2014/seagauge/ rtwb1_01_2014_00034.raw ; stage1_log

15.2.3 Stage 2

Add linear clock drift and determine the functional form of the pressure sensor drift (exponential-linear or linear). Cut-off deployment and recovery periods.
/exec/pe399/stage1/bpr _processing/seagauge_processing_003.m
infile: rtwb1_01_2014info.dat ; clock_offset.dat; rtwb1_01_2014_0034.raw
Outfile: rtwb1_01_2014_0034.use ; stage2_log

15.2.4 Data Problems

15.2.4.1 rteb1_01_2014_0081

Suffered a pressure offset as indicated in Figure 32 and Table 17. The pressure seems to increase abruptly by 4.6948 dbar between these two time stamps. This offset between the two records will need to be corrected at stage 2, but before the exponential-linear or linear fit is computed and removed.

Table 17: BPR s/n 0081. Record dates, times, pressures and temperature.

Year	Month	Day	Hour	Press	Temp
2015	05	13	7.48000	1816.5533	3.5700
2015	05	13	8.00000	1821.2418	3.5927

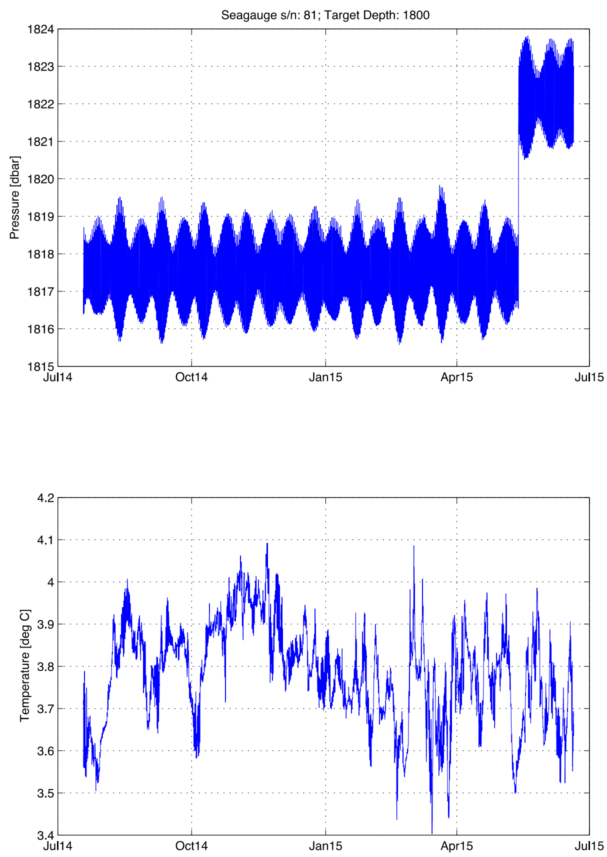


Figure 32: Pressure (top) and Temperature (bottom) from the BPR s/n 81

15.2.4.2 rtwb1_01_2014_0034

This instrument has a rather peculiar pressure record (Figure 33) that requires additional investigation and post cruise processing. Starting around 1900 GMT on 15/2/15 the sensor seems to loose stability, making two small jumps of around 0.25 dbar to lower pressures and exhibits a strong drift to the end of the record. It is unclear at this point if the record is useable after this point. We may need to send this record to the manufacturer for an opinion.

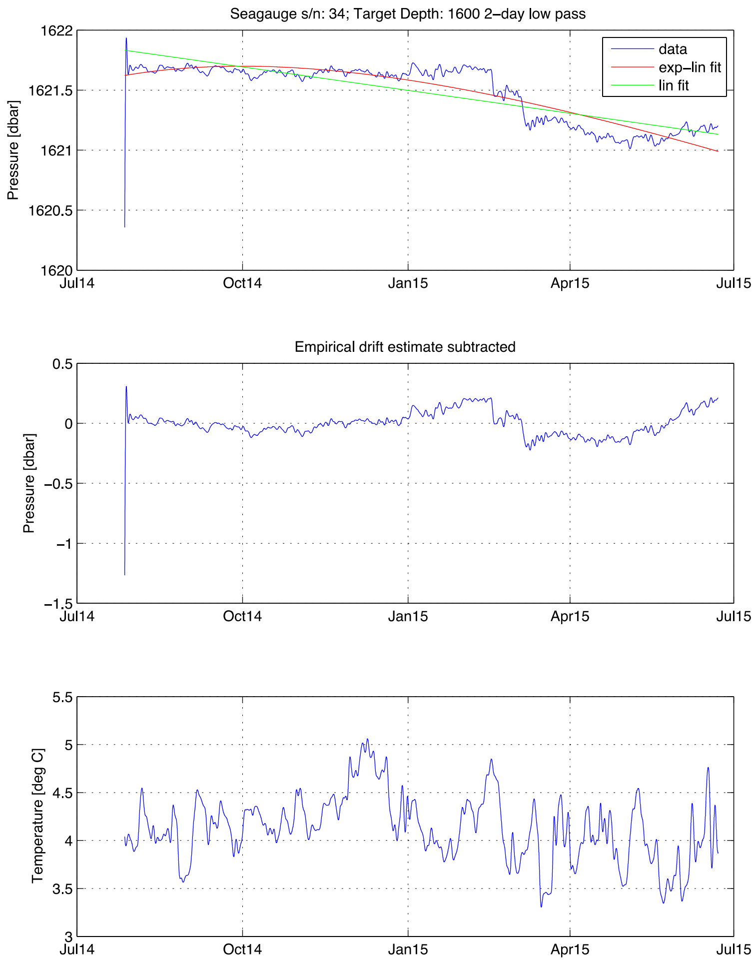


Figure 33: Pressure with different drift fits (top), pressure with drift substracted (middle), and temperature (bottom) time-series for the BPR s/m 34

15.3 Nortek Current Meter Measurements

15.3.1 Stage0 – Data Download

Raw instrument data are downloaded from the instrument after the recovery of the mooring. Record keeping of the download is done on paper and for each instrument a download sheet is completed. After download the data are backup and transferred to the network drive Portus on the cruise directory *pe399/SAMS_moorings/nortek* . Instrument setup details and data are sorted in different directory by mooring name.

Then the data (.data, .dat, .aqd and .hdr files) are copied on the processing computer in the directory e.g *osnap/data/moor/raw/pe399/nor/*

15.3.2 Stage1 – Conversion to standard RDB format

The script process_nors_pe399 performs stage1 and stage 2 processing on nortek data. It converts nortek data from raw to RDB format for an entire mooring. The user needs to modify some information in the beginning of the script like the directory trees, the mooring name, and the year of the first measurement. A text file containing the serial numbers of the Nortek on the mooring and the filenames containing the data is also created before running the script, e.g.

~/osnap/data/moor/raw/pe399/nortek/EB1_recovery/rteb1_01_2014_filenames.txt.

process_nors_pe399 calls *nortek2rodb_01*, which saves the files downloaded by the instrument software (stage 0) to the RDB formatted file *.raw*. in e.g. */osnap/data/moor/proc/rteb1_01_2014/nor.*

15.3.3 Stage2 – Trimming of data, basic statistics and summary plots

The script *process_nors_pe399* also performs stage 2 processing on nortek data by calling the script *nortek_raw2use_02.* This script uses the raw data file *mooring_serialnum.raw* generated by stage1 and the *mooringinfo.dat* file. It removes the launching and recovery period, creates a data overview sheet including basic statistics, and produces summary plots, including filtered data.

15.4 ADCP Data

15.4.1 Stage0 – Data Download and conversion to Matlab file format

Raw instrument data are downloaded from the instrument after the recovery of the mooring. After download the data are backup and transferred to the network drive Portus on the cruise directory *pe399/SAMS_moorings/adcp* . Instrument setup details and data are sorted into different directories by mooring name.

The raw data file ****.000 needs to be converted to Matlab file format, by using WinADCP (''Export'' option, then select ''Series'', tick all the Series Data Types, all the Anclliary Data Types, the Bottom track and all the bins. Precise the number of the last ensemble). The matlab file has to have a name as *ADCPSerialNumber*_data.mat (e.g. *20467_data.mat)*

Then the data (.000 and .mat files) are copied on the processing computer in the directory e.g *osnap/data/moor/raw/pe399/adcp/*

15.4.2 Stage1 – Conversion to standard RDB format

The script *process_adcps_pe399* performs stage1 and stage 2 processing on ADCP data. It converts RDI ADCP data from raw ADCP data in .mat format to RDB format. The user needs to modify some information in the beginning of the script like the directory trees and the mooring name.

process_adcps_pe399 calls *adcp2rodb_01*, which saves the files downloaded by the instrument software (stage 0) to the RDB formatted file *.raw*. in e.g. *osnap/data/moor/proc/rtadcp1_01_2014/adcp*. This function also remaps bin depths for different speed of sound as inputted by the user or obtained from ctd profile. This stage does not correct velocities for speed of sound.

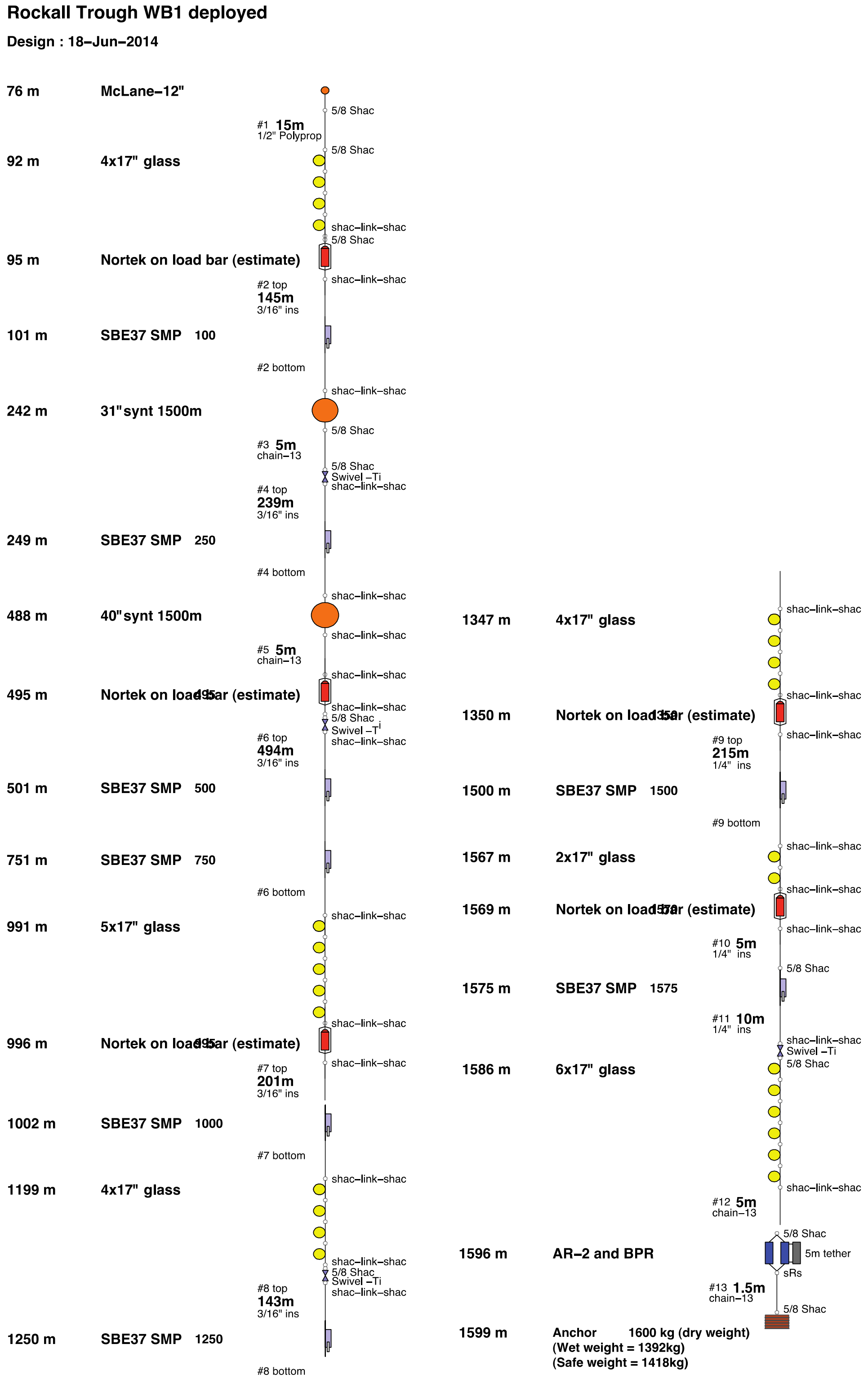
15.4.3 Stage2 – Trimming of data, basic statistics and summary plots

The script *process_adcps_pe399* also performs stage 2 processing on RDI ADCP data by calling the script adcp_*raw2use_01.* This script uses the raw data file *mooring_serialnum.raw* generated by stage1 and the *mooringinfo.dat* file. As for the nortek, it removes the launch and recovery periods, creates a data overview sheet including basic statistics, and produces summary plots, including filtered data.

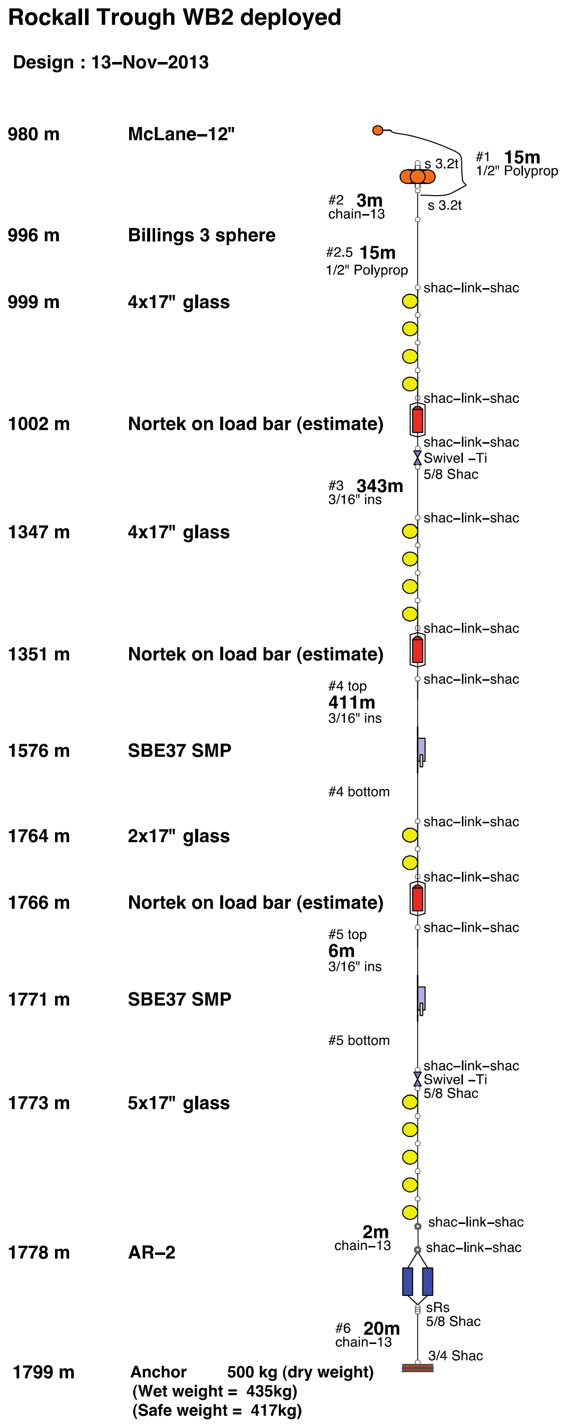
A Appendices

A.1 Diagrams of the SAMS moorings deployed in 2015

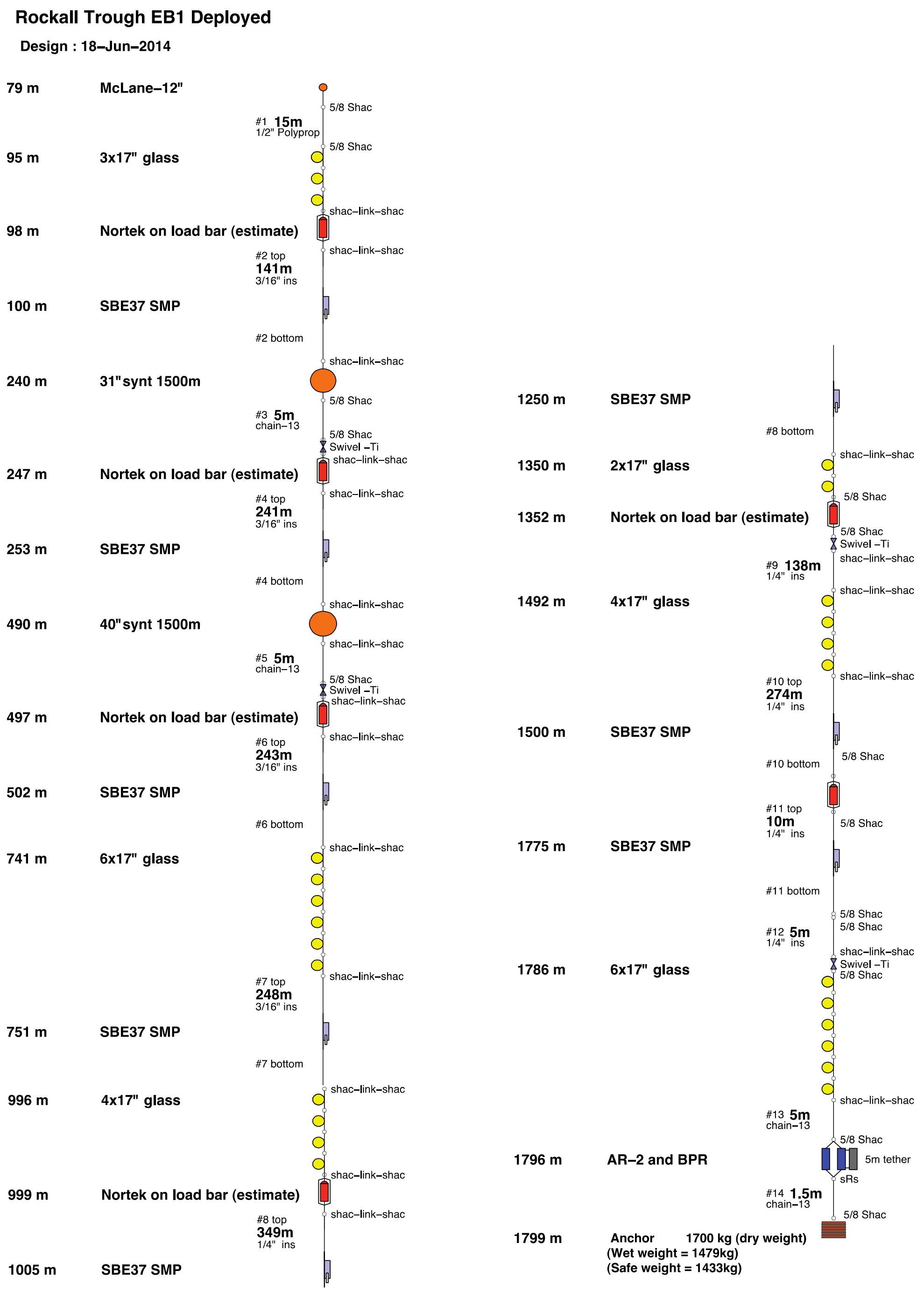
A.1.1 RTWB1



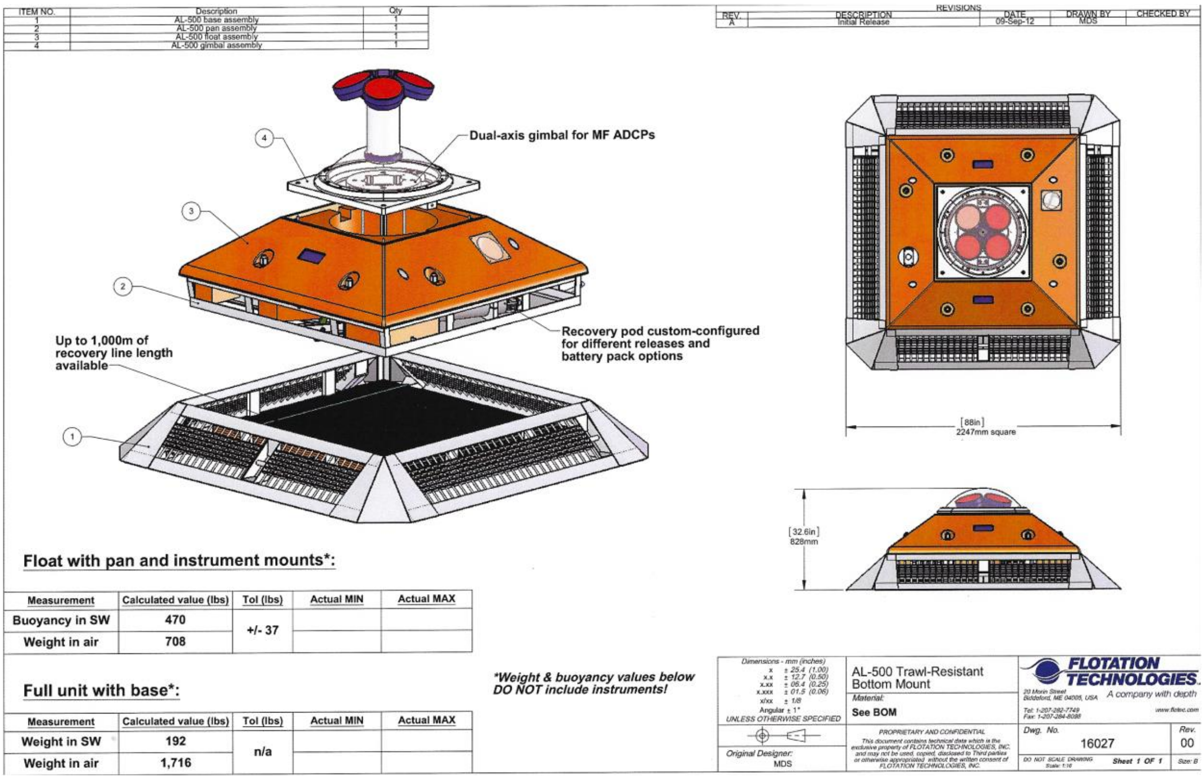
A.1.2 RTWB2


Rockall Trough WB2 deployed
Design : 13–Nov–2013
980 m
McLane–12"
#1 15m
1/2" Polyprop
s 3.2t
s 3.2t
#2 3m
chain–13
996 m
Billings 3 sphere
#2.5 15m
1/2" Polyprop
999 m
4x17" glass
shac–link–shac
shac–link–shac
1002 m
Nortek on load bar (estimate)
shac–link–shac
Swivel –Ti
5/8 Shac
#3 343m
3/16" ins
1347 m
4x17" glass
shac–link–shac
shac–link–shac
1351 m
Nortek on load bar (estimate)
shac–link–shac
#4 top
411m
3/16" ins
1576 m
SBE37 SMP
#4 bottom
1764 m
2x17" glass
shac–link–shac
shac–link–shac
1766 m
Nortek on load bar (estimate)
shac–link–shac
#5 top
6m
3/16" ins
1771 m
SBE37 SMP
#5 bottom
1773 m
5x17" glass
shac–link–shac
Swivel –Ti
5/8 Shac
shac–link–shac
2m
chain–13
shac–link–shac
1778 m
AR–2
sRs
5/8 Shac
#6 20m
chain–13
3/4 Shac
1799 m
Anchor 500 kg (dry weight)
(Wet weight = 435kg)
(Safe weight = 417kg)

A.1.3 RTEB1


Rockall Trough EB1 Deployed
Design : 18–Jun–2014
79 m McLane–12"
5/8 Shac
#1 15m 1/2" Polyprop
5/8 Shac
95 m 3x17" glass
shac–link–shac
98 m Nortek on load bar (estimate)
shac–link–shac
#2 top 141m 3/16" ins
100 m SBE37 SMP
#2 bottom
shac–link–shac
240 m 31"synt 1500m
5/8 Shac
#3 5m chain–13
5/8 Shac
Swivel –Ti
shac–link–shac
247 m Nortek on load bar (estimate)
shac–link–shac
#4 top 241m 3/16" ins
253 m SBE37 SMP
#4 bottom
shac–link–shac
490 m 40"synt 1500m
shac–link–shac
#5 5m chain–13
5/8 Shac
Swivel –Ti
shac–link–shac
497 m Nortek on load bar (estimate)
shac–link–shac
#6 top 243m 3/16" ins
502 m SBE37 SMP
#6 bottom
shac–link–shac
741 m 6x17" glass
shac–link–shac
#7 top 248m 3/16" ins
751 m SBE37 SMP
#7 bottom
shac–link–shac
996 m 4x17" glass
shac–link–shac
999 m Nortek on load bar (estimate)
shac–link–shac
#8 top 349m 1/4" ins
1005 m SBE37 SMP
1250 m SBE37 SMP
#8 bottom
shac–link–shac
1350 m 2x17" glass
5/8 Shac
1352 m Nortek on load bar (estimate)
5/8 Shac
Swivel –Ti
shac–link–shac
#9 138m 1/4" ins
shac–link–shac
1492 m 4x17" glass
shac–link–shac
#10 top 274m 1/4" ins
1500 m SBE37 SMP
5/8 Shac
#10 bottom
#11 top 10m 1/4" ins
5/8 Shac
1775 m SBE37 SMP
#11 bottom
5/8 Shac
5/8 Shac
#12 5m 1/4" ins
shac–link–shac
Swivel –Ti
5/8 Shac
1786 m 6x17" glass
shac–link–shac
#13 5m chain–13
5/8 Shac
1796 m AR–2 and BPR
5m tether
sRs
#14 1.5m chain–13
5/8 Shac
1799 m Anchor 1700 kg (dry weight)
(Wet weight = 1479kg)
(Safe weight = 1433kg)

A.1.4 RTADCP 1



Float with pan and instrument mounts*:

Measurement	Calculated value (lbs)	Tol (lbs)	Actual MIN	Actual MAX
Buoyancy in SW	470	+/- 37		
Weight in air	708			

Full unit with base*:

Measurement	Calculated value (lbs)	Tol (lbs)	Actual MIN	Actual MAX
Weight in SW	192	n/a		
Weight in air	1,716			

A.2 SAMS Instrument Set Up Details

A.2.1 MOORING RTADCP1

A.2.1.1 Workhorse Broadband ADCP

S/N 22867

Copy of RTADCP1_pe399.whp:

```
CR1
CQ255
CF11101
EA0
EB0
ED0
ES35
EX11111
EZ1111111
WA50
WB1
WD111100000
WF704
WN50
WP30
WS1600
WV175
TE01:00:00.00
TF15/06/20 16:00:00
TP02:00.00
CK
CS
;
;Instrument       = Workhorse Long Ranger
;Frequency        = 76800
;Water Profile    = YES
;Bottom Track     = NO
;High Res. Modes  = NO
;High Rate Pinging  = NO
;Shallow Bottom Mode= NO
;Wave Gauge       = NO
;Lowered ADCP     = NO
;Beam angle       = 20
;Temperature      = 5.00
;Deployment hours  = 6480.00
;Battery packs    = 4
;Automatic TP     = NO
;Memory size [MB]  = 512
;Saved Screen     = 2
;
;Consequences generated by PlanADCP version 2.02:
```

;First cell range = 24.27 m
;Last cell range = 808.27 m
;Max range = 603.80 m
;Standard deviation = 1.11 cm/s
;Ensemble size = 1148 bytes
;Storage required = 7.09 MB (7439040 bytes)
;Power usage = 1649.59 Wh
;Battery usage = 3.7
;

A.2.2 MOORING RTEB1

A.2.2.1 SeaBird SBE37 SMP Microcat

S/N 8077, 9373, 13019, 13020, 10321, 10323

Sample interval (secs)	1800
Data format	3
Output salinity	off
Transmit realtime	off
Sync mode	off
Start date (dd/mm/yy)	21/06/15
Start time (hh:mm:ss)	09:00:00

A.2.2.2 Seabird SBE37 IMP Microcat

S/N 3279, 4463

Sample interval (secs)	1800
Store time	on
Transmit sample number	off
AD cycles to average	1
Start date (dd/mm/yy)	21/06/15
Start time (hh:mm:ss)	09:00:00

A.2.2.3 Nortek Aquadopp

S/N 8364, 9853, 11034, 9881, 11051, 11069

Measurement interval (secs)	1200
Average interval (secs)	180
Blanking distance (m)	0.50
Measurement load (%)	4
Diagnostics interval (min)	720
Diagnostics samples	20
Compass update rate (secs)	1
Co-ordinate system	ENU
Speed of sound (m/s)	1500
Analog input 1	none
Analog input 2	none
Analog output	disabled
File wrapping	off
TellTale	off
AcousticModem	off
Serial output	off

Baud rate	9600
Start date (dd/mm/yy)	21/06/15
Start time (GMT, hh:mm:ss)	09:00:00

A.2.2.4 SeaBird SBE53 BPR

S/N 0035

Header	eb1 osnap 20th june 2015
Tide measurement interval (mins)	30
Tide measurement duration (mins)	30
Frequency of reference measurement	every 96 tide samples
Start date (dd/mm/yy)	20/06/15
Start time (GMT, hh:mm:ss)	16:00:00

A.2.3 MOORING RTWB2

A.2.3.1 SeaBird SBE37 SMP Microcat

S/N 3218, 3481

Sample interval (secs)	1800
Output sound velocity	off
Output salinity	off
Transmit realtime	off
Store time	on
Sync mode	off
Cycles to average	1
Start date (dd/mm/yy)	22/06/15
Start time (hh:mm:ss)	07:45:00

A.2.3.2 Nortek Aquadopp

S/N 9822, 9874, 9885

Measurement interval (secs)	1200
Average interval (secs)	180
Blanking distance (m)	0.50
Measurement load (%)	4
Diagnostics interval (min)	720
Diagnostics samples	20
Compass update rate (secs)	1
Co-ordinate system	ENU
Speed of sound (m/s)	1500
Analog input 1	none
Analog input 2	none
Analog output	disabled
File wrapping	off
TellTale	off
AcousticModem	off
Serial output	off

Baud rate	9600
Start date (dd/mm/yy)	22/06/15
Start time (GMT, hh:mm:ss)	09:15:00

A.2.4 MOORING RTWB1

A.2.4.1 SeaBird SBE37 SMP Microcat

S/N 8082, 8443, 11321, 11323, 11324, 11331, 11332, 11333

Sample interval (secs)	1800
Data format	3
Output salinity	off
Transmit realtime	off
Sync mode	off
Start date (dd/mm/yy)	22/06/15
Start time (hh:mm:ss)	16:15:00

A.2.4.2 Nortek Aquadopp

S/N 11055, 11058, 11063, 11064, 11067

Measurement interval (secs)	1200
Average interval (secs)	180
Blanking distance (m)	0.50
Measurement load (%)	4
Diagnostics interval (min)	720
Diagnostics samples	20
Compass update rate (secs)	1
Co-ordinate system	ENU
Speed of sound (m/s)	1500
Analog input 1	none
Analog input 2	none
Analog output	disabled
File wrapping	off
TellTale	off
AcousticModem	off
Serial output	off
Baud rate	9600
Start date (dd/mm/yy)	22/06/15
Start time (GMT, hh:mm:ss)	16:15:00

A.2.4.3 SeaBird SBE53 BPR

S/N 0013

Header	rtwb1_pe399_21062015
Tide measurement interval (mins)	30
Tide measurement duration (mins)	30
Frequency of reference measurement	every 96 tide samples
Start date (dd/mm/yy)	21/06/15
Start time (GMT, hh:mm:ss)	18:00:00

A.3 SAMS Mooring Recovery Logsheets

A.3.1 RTEB1 recovery

OSNAP – MOORING LOGSHEET **RECOVERY EB1**

Cruise PE399 **Mooring id Rockall Trough EB1**

[NB all times recorded in GMT, all dates dd/mm/yyyy]

Date 20/6/15

Start time 0658 End time 0956

Latitude 56° 5.96' N Longitude 9° 32.88' W

Item	S/N	Comments	Time
McLane 12"		Light green covering	0737
15 m polyprop			0751
3 x 17" glass			0751
Nortek on load bar	11047	✓ light green covering	0751
141 m wire			"
SBE37 SMP (1 m down wire)	11321	✓	"
31" syn 1500 m and Iridium beacon and Light	J08603-003 B11-047 B11-035	Slight green on upper half	0811
5m chain			0817
swivel		clean	0817
Nortek on load bar	11055	✓ clean	0818
241 m wire			
SBE37 SMP (5 m down wire)	11322	clean	0820
40" synt 1500 m and Iridium beacon and Light	J08604-001 B11-043 B11-036	IR beacon head smashed off on recovery @ 0842	0828
5m chain			
swivel			
Nortek on load bar	11058	✓	0835
243 m wire			
SBE37 SMP (5 m down wire)	11323	✓	0828
6 x 17" glass			0848
248 m wire			
SBE37 SMP (5 m down wire)	11324	✓	0848
4 x 17" glass		Eel attached to sphere!	0959

OSNAP – MOORING LOGSHEET

RECOVERY EB1

Nortek on load bar	11063	✓	0900
349 m wire			
SBE37 SMP (5 m down wire)	11325	✓	0902
SBE37 SMP (250 m down wire)	11331	✓	0909
2 x 17" glass			0912
Nortek on load bar	11064	✓	0912
swivel		✓	
138 m wire		✓	
4 x 17" glass		✓	0918
274 m wire		✓	
SBE37 SMP (5 m down wire)	11332	✓	0918
Nortek on load bar	11067	✓	0930
10 m wire			
SBE37 SMP (5 m down wire)	11333	✓	0932
5 m wire		✓	
swivel		✓	
6 x 17" glass		✓	0935
5 m chain		✓	
A/R **and** A/R **and** SBE53 (BPR)	**1756** **1137** 0081	BPR hanging down	0936
1.5 m chain			
Anchor – 1700 kg		NOT RECOVERED	

20/6/15
0658

EB1 recovery

Release

1137 ~~855~~ Diagnostic : vertical
1137 ~~855~~ 1950m , 1951m

Distance horiz ≈ 750m
Foggy so move closer

1756

Range
1956 , 1956 m

0715

Range
1137 1813 1813

1137 071330 Release 0714 Reply OK 1809.5m

On surface and sighted ~0715

Grappled 0737.

A.3.2 RTADCP1 recovery

OSNAP – MOORING LOGSHEET **RECOVERY RADCP1**

Cruise PE399 **Mooring id Rockall Trough RADCP1**
[NB all times recorded in GMT, all dates dd/mm/yyyy]

Date 20/6/15

Start time

End time 110729

Latitude 57° 6.11 N

Longitude 9° 20.21 W

Item	S/N	Comments	Time
Iridium beacon on		On Deck	
Light			
A/R 1762			
A/R 1138			
Workhorse ADCP	[illegible]		110729

Comments to be written below or over-leaf

On station 1015. Communicating with releases

1. No reply from parachute

2. Two A/R in frame ~821m range.

Diagnostics: Horizontal, batt ≈8.6V

Release sent 1030

Rising ≈40m/min

On surface 1050.

Time to surface 20 mins.

Floating slightly tilted. Water level close to top of syntactic. Recovery handles therefore u/w. One handle near surface, using poles with snap hooks. Hooked at 1100. Second line secured to second handle at 1101

Syntactic shows a number of wire cut marks and is missing a chunk on one corner. The ADCP cover is marked with black 'rubber', is cracked in several locations & has some puncture holes.

RT-ADCP1 recovery

Rel 849

Z(m)	t(hrs)
797	
736	1032
057	1034
552	1036
530	1038
494	1040
466	1042
374	1044
335	1045
313	1046
296	1047
271	1048
162	1050 on surface.

A.3.3 RTADCP2 recovery

OSNAP – MOORING LOGSHEET **RECOVERY RADCP2**

Cruise PE399 **Mooring id Rockall Trough RADCP2**
[NB all times recorded in GMT, all dates dd/mm/yyyy]

Date 20/6/15

Start time ____ End time ____

Latitude 57° 5.48' N Longitude 9° 16.52' W

Item	S/N	Comments	Time
Iridium beacon	B11-052		
Light	B11-037		
Benthos A/R	59517		
Workhorse ADCP	20466		

Comments to be written below or over-leaf

123620 Release sent after no confirm ranges.
Repositioned to far side of track.
1258

B ARM
D RELEASE

A.3.4 RTWB1 recovery

OSNAP – MOORING LOGSHEET

RECOVERY WB1

Cruise PE399

Mooring id Rockall Trough WB1

[NB all times recorded in GMT, all dates dd/mm/yyyy]

Date 22/06/2015

Start time 11:38

End time 12:57

Latitude

Longitude

Item	**S/N**	**Comments**	**Time**
McLane 12"			11:38
15 m poly prop			
4 x 17" glass			
Nortek on load bar	11021 /		11:39
145 m wire	/		
SBE37 SMP (5 m down wire)	11335 /		11:41
31" synt 1500 m and Iridium Beacon and Light	J08603-001 B11-041 B11-032 X		11:45
5m chain			11:50
swivel			
239 m wire			12:07
SBE37 SMP (1 m down wire)	10576 10577	Not the 10576 on the mooring	11:47
40" synt 1500 m and Iridium beacon and Light	J08604-002 B11-044 / B11-033 /		11:57 12:02
5 m chain			12:08
Nortek on load bar	11023 /		12:09
swivel			12:09
494 m wire			
SBE37 SMP (5 m down wire)	10577 10575	Not the 10577 on the mooring	12:10
SBE37 SMP (255 m down wire)	10578 /		12:16
5 x 17" glass		tangled with	
Nortek on load bar	11026 /	release. BPR	
201 m wire			

OSNAP – MOORING LOGSHEET

RECOVERY WB1

SBE37 SMP (5 m down wire)	10579 ✓		12:26
4 x 17" glass			12:47
swivel			
143 m wire			
SBE37 SMP (47 m down wire)	11334 11334V		12:50
4 x 17" glass			
Nortek on load bar	11028 ✓		12:53
215 m wire			
SBE37 SMP (149 m down wire)	11288 ✓		12:17
2 x 17" glass			" "
Nortek on load bar	11029 ✓		" "
5 m wire			" "
SBE37 SMP (1 m down wire)	11289 ✓		12:26
10 m wire			12:22
swivel			12:22
6 x 17" glass		✓	12:22
5 m chain			12:22
A/R and A/R and SBE53 (BPR)	1759 1493 0034		12:22
1.5 m chain			12:22
Anchor – 1600 kg			

Any comments to be written below or over-leaf.

A.3.5 RTWB2 recovery

OSNAP – MOORING LOGSHEET **RECOVERY WB2**

Cruise PE399 **Mooring id Rockall Trough WB2**

[NB all times recorded in GMT, all dates dd/mm/yyyy]

Date 22/6/15

Start time ______ End time ______

Latitude ______ Longitude ______

Item	S/N	Comments	Time
McLane 12"			0535
15 m poly prop			"
McLane 3 sphere and Iridium beacon and Light	B11-042 B11-034	Pickup floats line tangled with mclane. Trailing grapple	"
3 m chain		All top recovered in one	"
15 m poly prop		fantle.	"
4 x 17" glass			"
Nortek on load bar	11030	✓	"
swivel			"
343 m wire			
4 x 17" glass		Tangled ~ ½ way down	0602
Nortek on load bar	11032 ✓	#3 wire.	0602
411 m wire			
SBE37 SMP (224 m down wire)	11290	✓	0612
2 x 17" glass		All tangled together	0617
Nortek on load bar	11042 ✓		"
6 m wire			"
SBE37 SMP (5 m down wire)	11320 ✓		"
swivel			"
5 x 17" glass			"
A/R and A/R	1136 1758		"

Release at: 0434, release OK, r=1845m; On surface at 044950

OSNAP – MOORING LOGSHEET

RECOVERY WB2

20 m chain			
Anchor – 800 kg			

Any comments to be written below or over-leaf.

WB2 RECOVERY

34 45	1768
35 15	1729
45	1690
36 30	1632
37 30	1552
38 30	1484
39 30	1400
41 00	1272
42 00	1187
43 00	1107

A.4 SAMS Mooring Deployment Logsheets

A.4.1 RTEB1 deployment

OSNAP – MOORING LOGSHEET **DEPLOYMENT EB1**

Cruise PE399 **Mooring id Rockall Trough EB1**

[NB all times recorded in GMT, all dates dd/mm/yyyy]

Date 21/6/15 (DAY 172) Site arrival time 0400

Setup distance 3 nm

Start time 0552 End time 08:33

Start position:

Latitude 57,1152 (57°7,5095) Longitude 9,4803 (9°28,8184)

Item	S/N	Comments	Time
McLane 12"			0553
15 m polyprop			"
3 x 17" glass			"
Nortek on load bar	8364	✓	"
141 m wire			
SBE37 SMP (1 m down wire)	8077	✓	"
ON ✓ ON ✓ 31" syn 1500 m and Iridium beacon and Light B11-038 ✓	Xxxx xxxx xxxx	3/4 joltmn iner B11-051 ✓ 300234060471740	0608
5m chain			"
swivel			"
Nortek on load bar	9853		0612
241 m wire			
SBE37 IMP (5 m down wire)	3279		0616
ON ✓ ON ✓ 40" synt 1500 m and Iridium beacon and Light B11-037	Xxxx xxxx xxxx	B11-053 (9980)	0635
5m chain			
Swivel			
Nortek on load bar	~~9884~~	11034 New bush, shackle not fitting in 9884. Swapped.	0644
243 m wire			
SBE37 SMP (5 m down wire)	9373		0648
6 x 17" glass			0659
248 m wire			

OSNAP – MOORING LOGSHEET

DEPLOYMENT EB1

SBE37 SMP (5 m down wire)	13019		0702
4 x 17" glass			
Nortek on load bar	~~11054~~	~~13556~~ 9881	0717
349 m wire			
SBE37 SMP (5 m down wire)	13020		0722
SBE37 IMP (250 m down wire)	4463		0733
2 x 17" glass			
Nortek on load bar	11051		0741
Swivel		✓	
138 m wire			
4 x 17" glass			0747
274 m wire			
SBE37 SMP (5 m down wire)	10321		0749
Nortek on load bar	11069		0806
10 m wire			
SBE37 SMP (5 m down wire)	10322		0808
5 m wire			
Swivel		✓	
6 x 17" glass		✓	0818
5 m chain		A D R	
A/R and A/R and SBE53 (BPR)	Xxxx xxxx 0035	1766 / 1A15 / 1A49 / 1A55 1497 Ø9D8 / Ø949 / Ø955	
1.5 m chain			
Anchor – 1700 kg			0831

End pos. : 57,0998°N / 19,5649°W
Bot depth 1,815 m.

Release ID number ______________ Release frequency ______________

Anchor drop position:

Latitude ~~57,1017N~~ ______________ Longitude ~~19,5633W~~ ______________

Uncorrected water depth (at anchor launch) 1,819 m

Corrected water depth (at anchor launch) 1,809 m

A.4.2 RTADCP1 deployment

ORIGINAL
OSNAP – MOORING LOGSHEET

DEPLOYMENT ~~RADCP2~~ RADCP1

Cruise PE399

Mooring id Rockall Trough RADCP1

[NB all times recorded in GMT, all dates dd/mm/yyyy]

Date 20/6/15 (DOY 171)

Site arrival time

Setup distance on site

Start time 163200

End time 163245

Start position: 57° 6.17' N

Latitude 57.10276 N *

depth 748 m

Longitude -9.33778 W *

Start depth (uncorr):

* from nav data 9° 20.27' W

Item	S/N	Comments	Time
Iridium beacon	xxxx	~~MOBS~~ IMEI: 300434060153020	
Light	xxxx	S/N C05-005	
A/R861	xxxx	1158 (S/n) A: 0826 R: 0835	O: 0849
A/R861	xxxx	1762 (S/n) A: 1A11 R: 1A55	D: 1A49
Workhorse ADCP	12867		

IR on at ~1628

POSN FROM SEADOS @ 163245
57.10280, -9.33752

Release ID number

Release frequency

Anchor drop position:

Latitude ~~57.104N~~

Longitude ~~9.3336W~~

Uncorrected water depth (at anchor launch) 748 m

Corrected water depth (at anchor launch) 745.52 m

Comments to be written below or over-leaf

163345	82.3
163415	122.5
163445	163.5
163515	204.0
163545	247.0
163615	288
163645	328
163715	368
163745	412
163815	463
163845	490
1639[illegible]	567.6
164015	606.5
164045	645.6
164115	708.2 (2nd ping)
1642[illegible]	752.3
164315	752.3

Trilateration done using Mstar and an end time at 17:32:45 which seem to be more correct when looking the position of the anchor drop and the time of the different trilateration: 17:49, 18:10 and 18:34

COPY

OSNAP – MOORING LOGSHEET

DEPLOYMENT RADCP1

Cruise PE399

[NB all times recorded in GMT, all dates dd/mm/yyyy]

Mooring id Rockall Trough RADCP1

Date 20/6/15 (DOY 171)

Site arrival time

Setup distance on site

Start time 16 32 00

End time 163245

Start position:

Latitude 57.10276N *

Longitude -9.33778 W *

* from nav data

Item	S/N	Comments	Time
Iridium beacon	unknown	IMEI: 300434060133020	
Light	C05-005		
A/R A/R	1138 1762	A 0826 R 0855 D 0849 A 1A11 R 1A55 D 1A49	
Workhorse ADCP	22867		

IR on at ~16:28

Release ID number

Release frequency

Anchor drop position:

Latitude 57.10280 *

Longitude -9.33782 *

Uncorrected water depth (at anchor launch) 748

Corrected water depth (at anchor launch) 745.52

* from nav data

Comments to be written below or over-leaf

16:33:45 82.3
16:34:15 122.5
16:34:45 163.5
16:35:15 204.0
16:35:45 247.0
16:36:15 288
16:36:45 328
16:37:15 368
16:37:45 412
16:38:15 463
16:38:45 490

16:39:45 567.6
16:40:15 606.5
16:40:45 645.6

16:41:15 708.2 (2nd ping)
16:42:15 752.3
16:42:45 752.3

A.4.3 RTWB1 deployment

OSNAP – MOORING LOGSHEET

DEPLOYMENT WB1

Cruise PE399
[NB all times recorded in GMT, all dates dd/mm/yyyy]

Mooring id Rockall Trough WB1

Date 22/6 ([illegible])

Site arrival time 12 38

Setup distance

Start time 14 : 25

End time 16 : 40

Start position:

Latitude 57,4480 N

Longitude ~~12.7863~~ 12.7863 W
12.7863W

Item	S/N	Comments	Time
McLane 12"			14:25
15 m poly prop			
4 x 17" glass			14:26
Nortek on load bar	~~xxxx~~ 11055		14:26
145 m wire			14:34
SBE37 SMP (5 m down wire)	~~Xxxx~~ 8082		14:27
31" synt 1500 m and Iridium Beacon and Light	xxxx xxxx B11-047 xxxx BM-036	1HE1 300234060[illegible]	14:37
5m chain			
Swivel			
239 m wire			
SBE37 IMP (1 m down wire)	~~Xxxx~~ 8443		14:39
40" synt 1500 m and Iridium beacon and Light	xxxx xxxx xxxx B11-035	Iridium B11-047 1ML1 3002[illegible]	14:52
5 m chain			
Nortek on load bar	~~Xxxx~~ 11058		14:55
Swivel			
494 m wire			
SBE37 SMP (5 m down wire)	~~Xxxx~~ 11321	additional tape	14:58
SBE37 SMP (255 m down wire)	~~Xxxx~~ 11323	additional tape	15:07
5 x 17" glass			15:17

OSNAP – MOORING LOGSHEET **DEPLOYMENT WB1**

Nortek on load bar	~~Xxxx~~ 11063		15:17
201 m wire			
SBE37 SMP (5 m down wire)	~~Xxxx~~ 11324	Additional Tape	15:19
4 x 17" glass			15:26
Swivel			
143 m wire			
SBE37 IMP (47 m down wire)	~~Xxxx~~ 11331	Additional tape	15:29
4 x 17" glass			15:34
Nortek on load bar	~~Xxxx~~ 11064		" "
215 m wire			
SBE37 SMP (149 m down wire)	~~Xxxx~~ 11332	Additional Tape	15:39
2 x 17" glass			15:52
Nortek on load bar	~~Xxxx~~ 11067		" "
5 m wire			" "
SBE37 SMP (1 m down wire)	~~Xxxx~~ 11333	No Tape	" "
10 m wire			
Swivel			
6 x 17" glass			15:58
5 m chain			
A/R and A/R and SBE53 (BPR)	1755 1492 0013	1A0A 09D3	16:40
1.5 m chain			16:40
Anchor – 1600 kg			16:40

STUART: @ 1640 Lat = 57.47678, Lon = -12.69284

Release ID number ____________ Release frequency ____________

Anchor drop position:

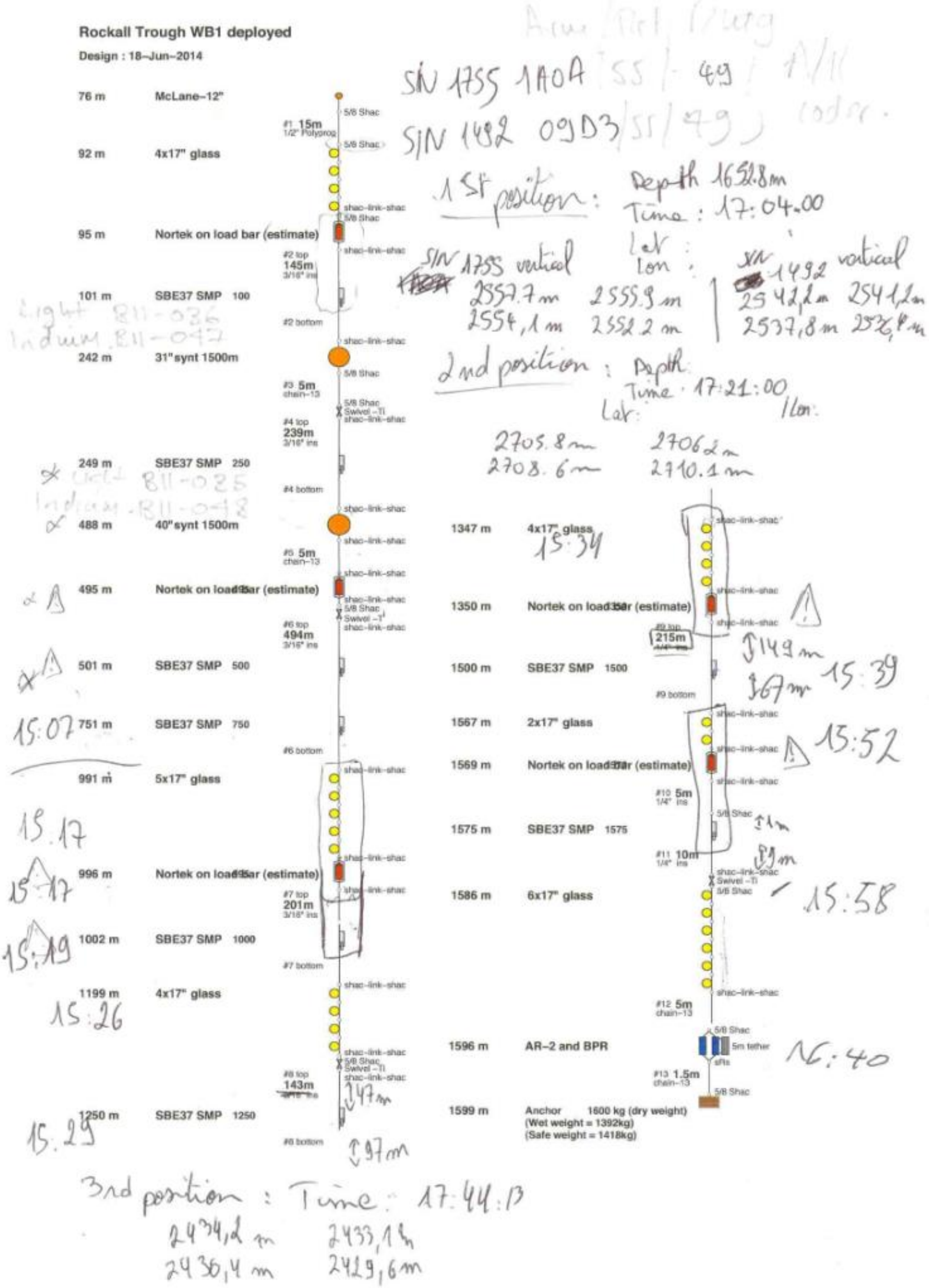
Latitude 57.4764 N Longitude ~~12.6953 W~~

Uncorrected water depth (at anchor launch) / (EA600 setup on corrected wd)

Corrected water depth (at anchor launch) 1608 m

Any comments to be written below or over-leaf.

Drop-off didn't work, BPR hit the ship hull. Anchor was back on the deck to attach the BPR again.
2nd drop cancelled (submarine cables)
3rd drop a success at 16:40


Rockall Trough WB1 deployed
Design : 18–Jun–2014
76 m McLane–12"
92 m 4x17" glass
95 m Nortek on load bar (estimate)
101 m SBE37 SMP 100
242 m 31" synt 1500m
249 m SBE37 SMP 250
488 m 40" synt 1500m
495 m Nortek on load bar (estimate)
501 m SBE37 SMP 500
751 m SBE37 SMP 750
991 m 5x17" glass
996 m Nortek on load bar (estimate)
1002 m SBE37 SMP 1000
1199 m 4x17" glass
1250 m SBE37 SMP 1250
1347 m 4x17" glass
1350 m Nortek on load bar (estimate)
1500 m SBE37 SMP 1500
1567 m 2x17" glass
1569 m Nortek on load bar (estimate)
1575 m SBE37 SMP 1575
1586 m 6x17" glass
1596 m AR-2 and BPR
1599 m Anchor 1600 kg (dry weight)
(Wet weight = 1392kg)
(Safe weight = 1418kg)
S/N 1755 1A0A
S/N 1492 09D3
1st position: Depth 1652.8m
Time: 17:04.00
2nd position: Depth
Time: 17:21:00
3rd position: Time: 17:44:13

A.4.4 RTWB2 deployment

OSNAP – MOORING LOGSHEET **DEPLOYMENT WB2**

Cruise PE399 **Mooring id Rockall Trough WB2**

[NB all times recorded in GMT, all dates dd/mm/yyyy]

Date 22/6/15 (DOY 173) Site arrival time 0700

Setup distance 2.2nm

Start time 072830 End time 085206.

Start position:

Latitude 57.43103 Longitude −12.33157

depth at start: 1806m *

Item	S/N	Comments	Time
McLane 12"			0729
15 m poly prop			"
McLane 3 sphere and Iridium beacon and Light B11-028	xxxx xxxx	Iridium - B11-052 IMEI 300[illegible]	"
3 m chain			"
15 m poly prop			"
4 x 17" glass			0729
Nortek on load bar	9822 ✓		"
swivel		s-l-s top & bottom of swivel	"
13 m wire			
4 x 17" glass			0743
Nortek on load bar	9874 ✓		0743
311 m wire			
SBE37 IMP (224 m down wire)	~~Xxxx~~ 3218 ✓		0750
2 x 17" glass			0806
Nortek on load bar	9885 ✓		0806
6 m wire			
SBE37 SMP (5 m down wire)	~~Xxxx~~ 3481 ✓		0809
Swivel			
5 x 17" glass			
A/R and A/R	[illegible]	1765 1A14 1142 082A	085206

Towing to drop

No twist on drum!

Confirmed on bottom, good ranges + diagnostics to both moorings

OSNAP – MOORING LOGSHEET **DEPLOYMENT WB2**

20 m chain	✓		
Anchor - 300 kg			0857406

Release ID number ____________ Release frequency ____________

Anchor drop position:

Latitude 57 47212 * Longitude - 12 33121 *

Uncorrected water depth (at anchor launch) ____________

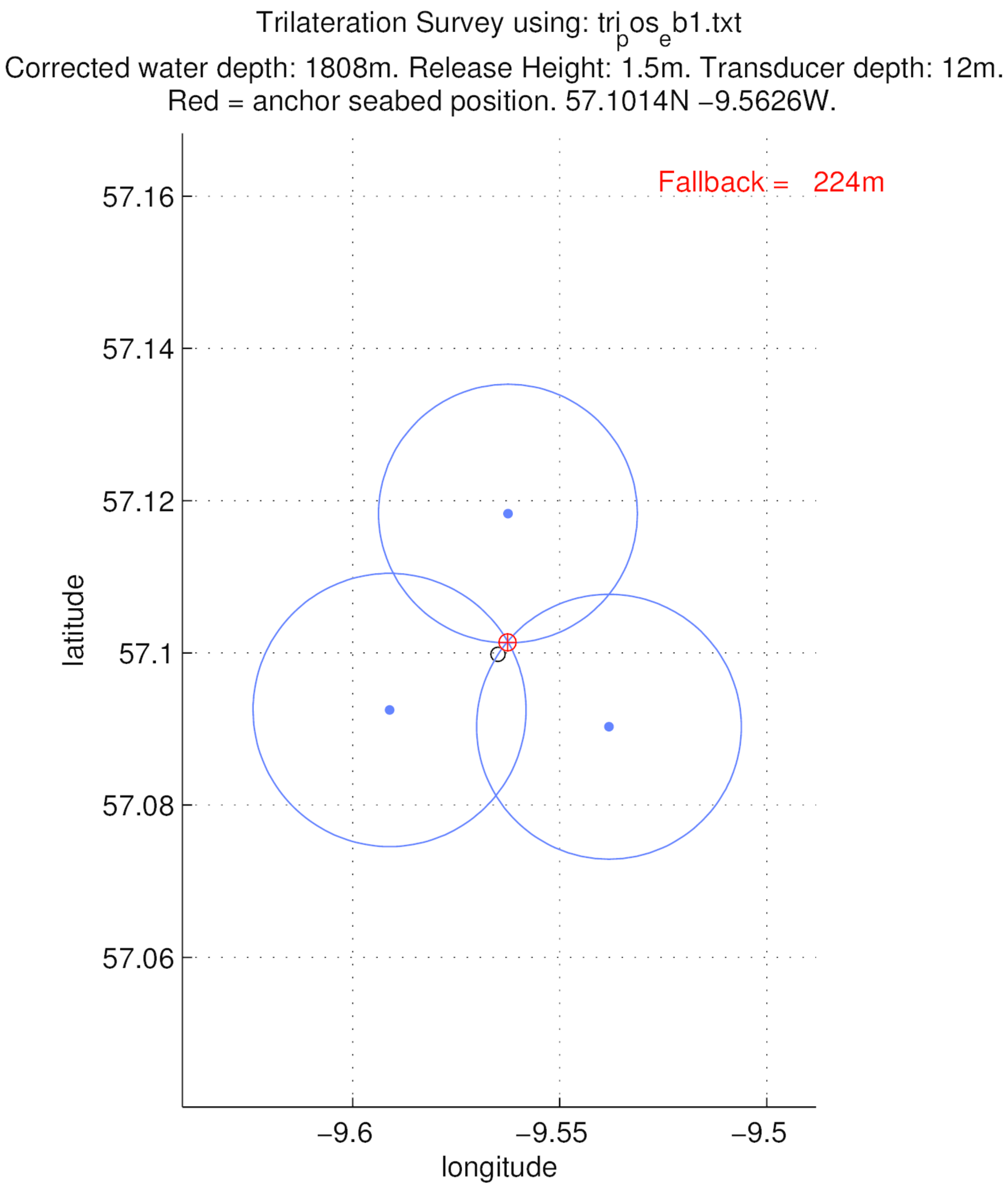
Corrected water depth (at anchor launch) 1802.9m *

Any comments to be written below or over-leaf.

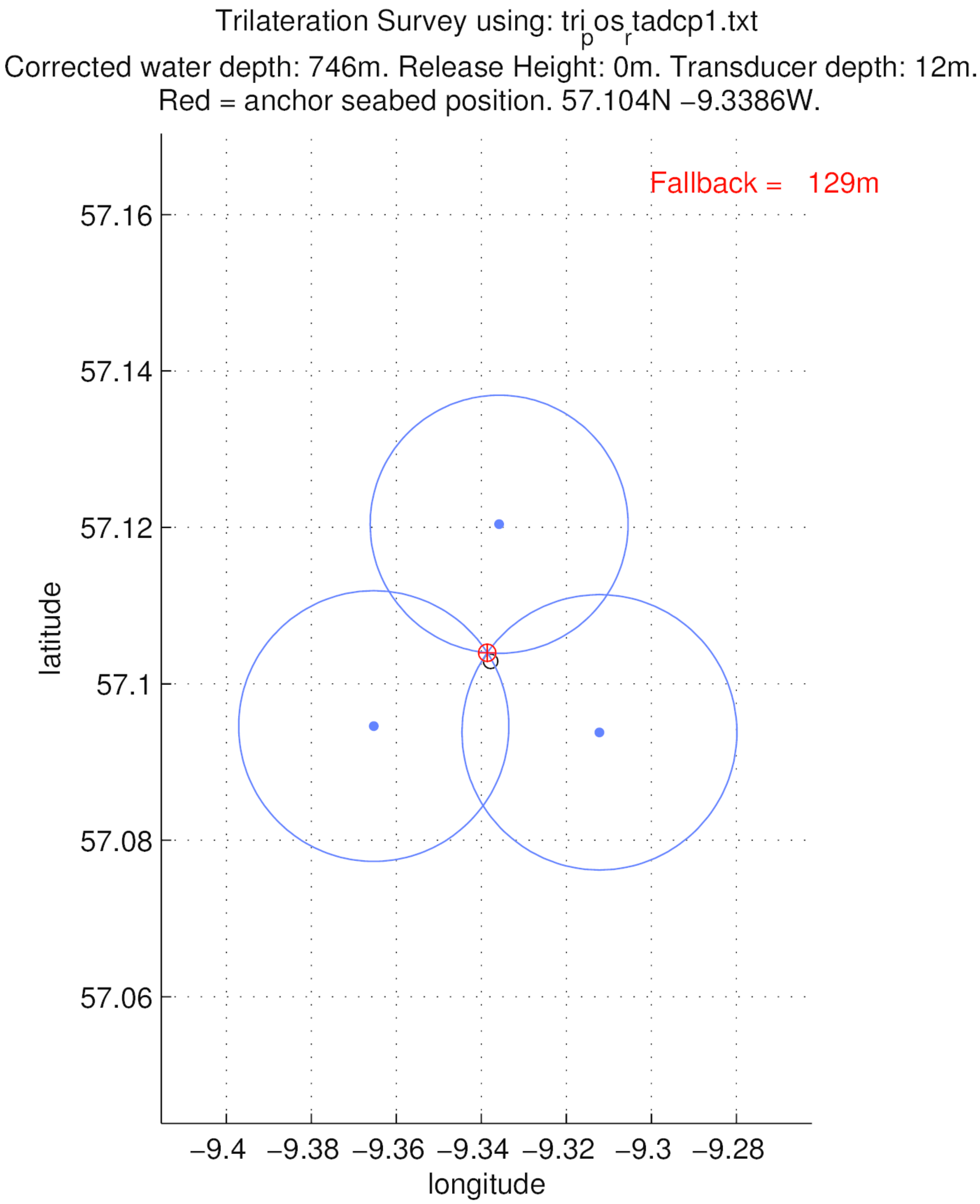
* from techsas files

A.5 Trilateration survey maps of SAMS moorings

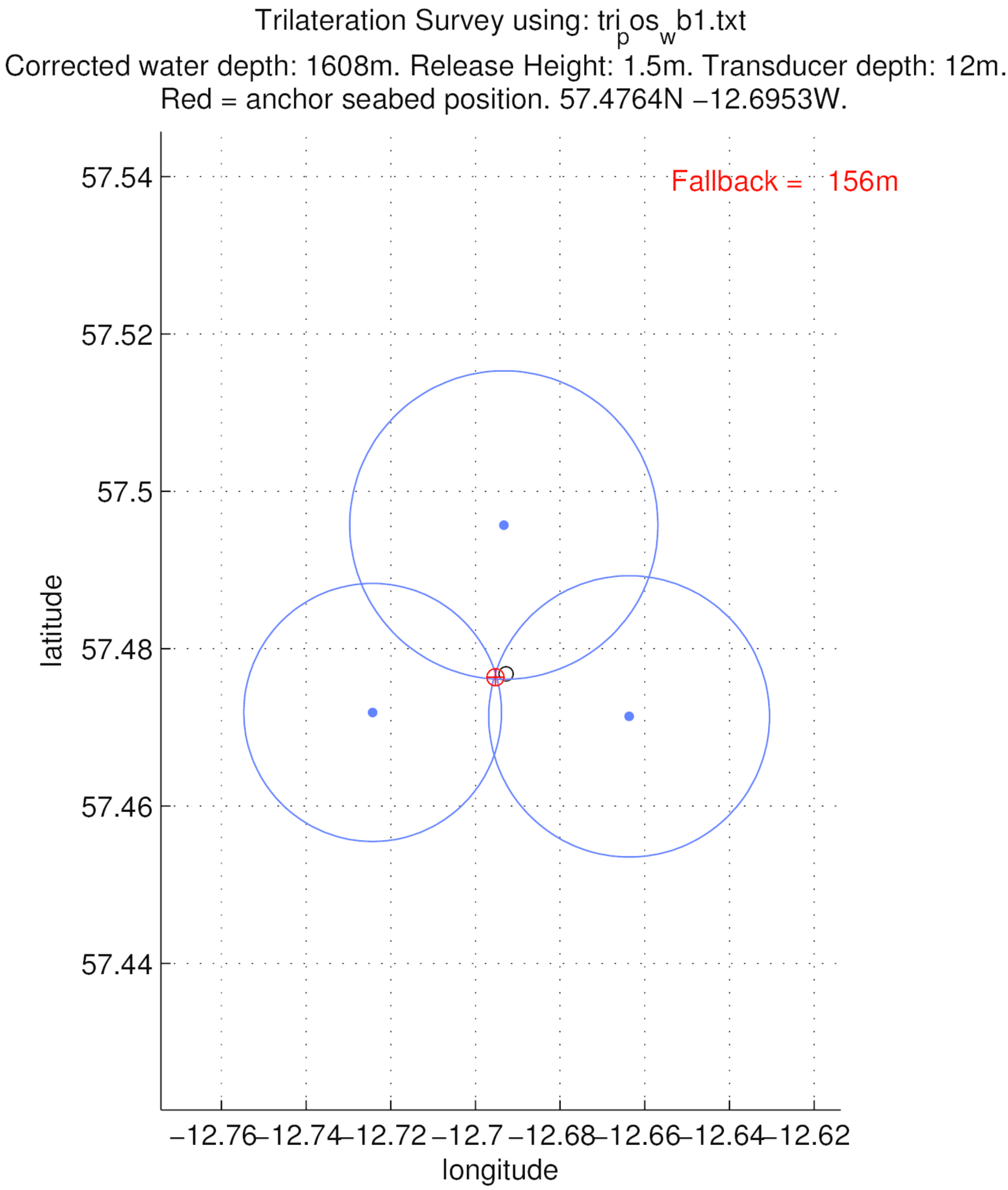
A.5.1 RTEB1



A.5.2 RTADCP1


Trilateration Survey using: tri_pos_rtadcp1.txt
Corrected water depth: 746m. Release Height: 0m. Transducer depth: 12m.
Red = anchor seabed position. 57.104N −9.3386W.
Fallback = 129m
57.16
57.14
57.12
57.1
57.08
57.06
latitude
−9.4
−9.38
−9.36
−9.34
−9.32
−9.3
−9.28
longitude

A.5.3 RTWB1


Trilateration Survey using: tri_pos_wb1.txt
Corrected water depth: 1608m. Release Height: 1.5m. Transducer depth: 12m.
Red = anchor seabed position. 57.4764N −12.6953W.
Fallback = 156m
57.54
57.52
57.5
57.48
57.46
57.44
latitude
−12.76
−12.74
−12.72
−12.7
−12.68
−12.66
−12.64
−12.62
longitude

A.6 SAMS Mooring Performance

RTADCP1 – It was clear from the marks on the frame that there had been some trawling interference. Looking at the ancillary data it would appear that the frame did not move a great deal during the deployment. The tilt does jump occasionally but these jumps are very small. The tilt however is fairly constant throughout at ~18.5 degrees (Figure 34). The instrument was not vertical either because the frame was tilted to such an extent that the gimbal assembly had reached its limit or more likely due to one of the ADCP transducer heads catching on the gimbal assembly. The heading is steady throughout the record (Figure 35). There are no obvious jumps in the pressure record (Figure 36).

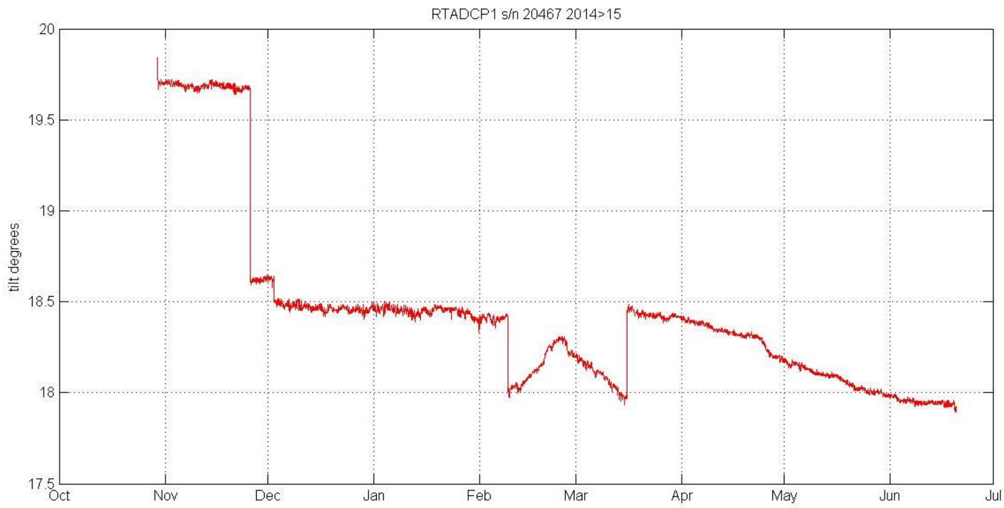


Figure 34: RTADCP 1 - Tilt of ADCP s/n 20467 (degrees)

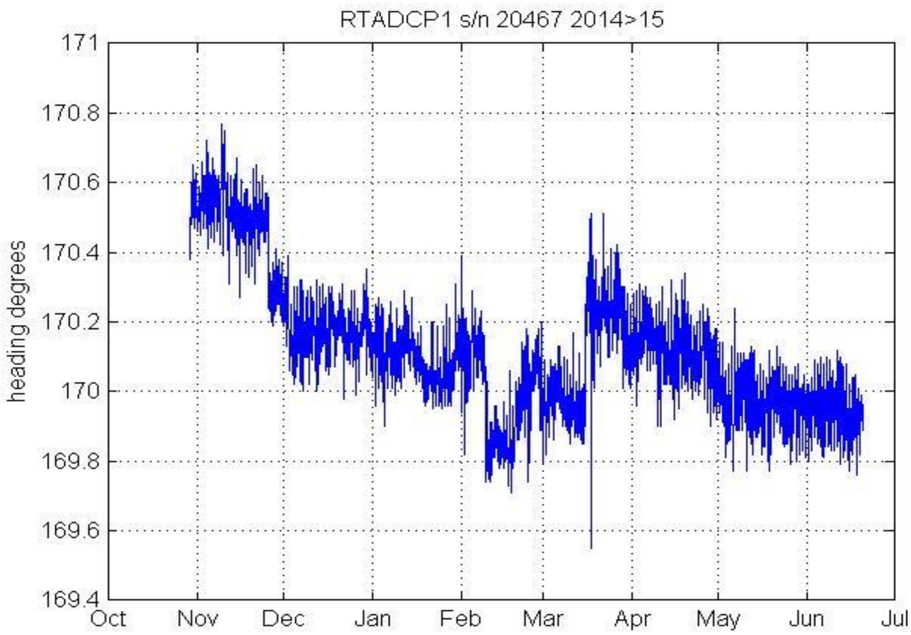


Figure 35: RTADCP1 - Heading of ADCP s/n 20467 (degrees magnetic)

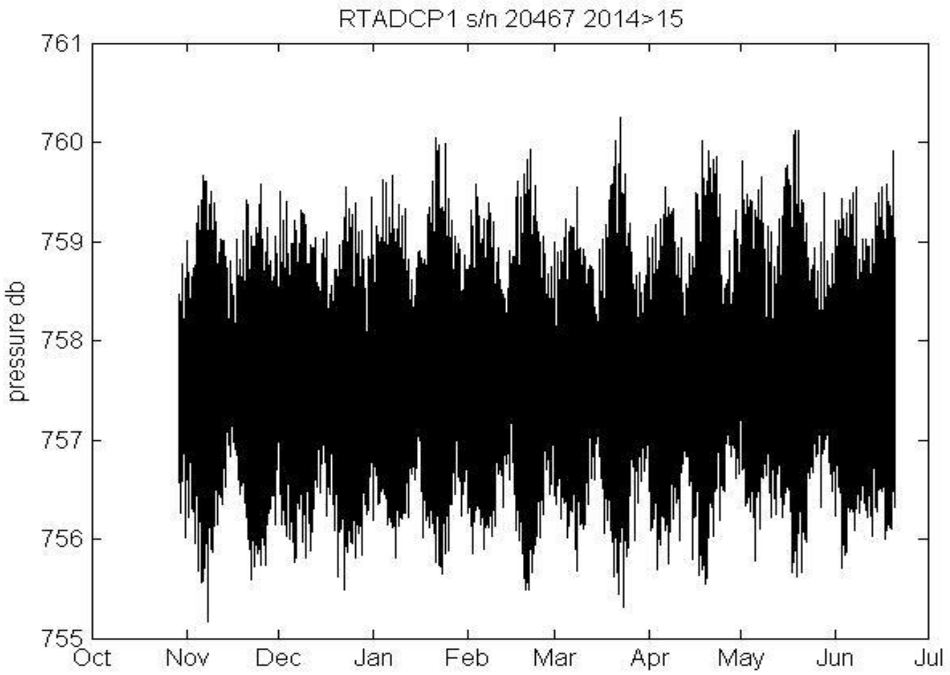


Figure 36: RTADCP1 Pressure of ADCP s/n 20467 db

RTEB1 – The maximum current measured by the near surface NORTEK moored at a depth of ~73m was ~66 cm/s. The largest tilt measured by this instrument was ~16 degrees (Figure 37). The maximum depth measured was ~230m during March 2015 (Figure 38).

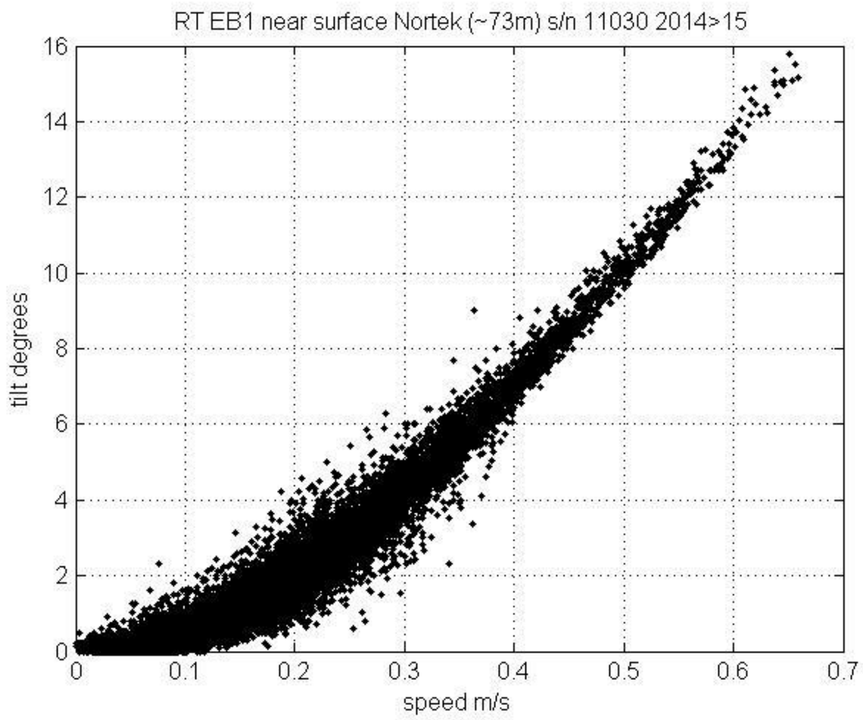


Figure 37: RTEB1 - Tilt of the near surface Nortek s/n 11030 as a function of speed

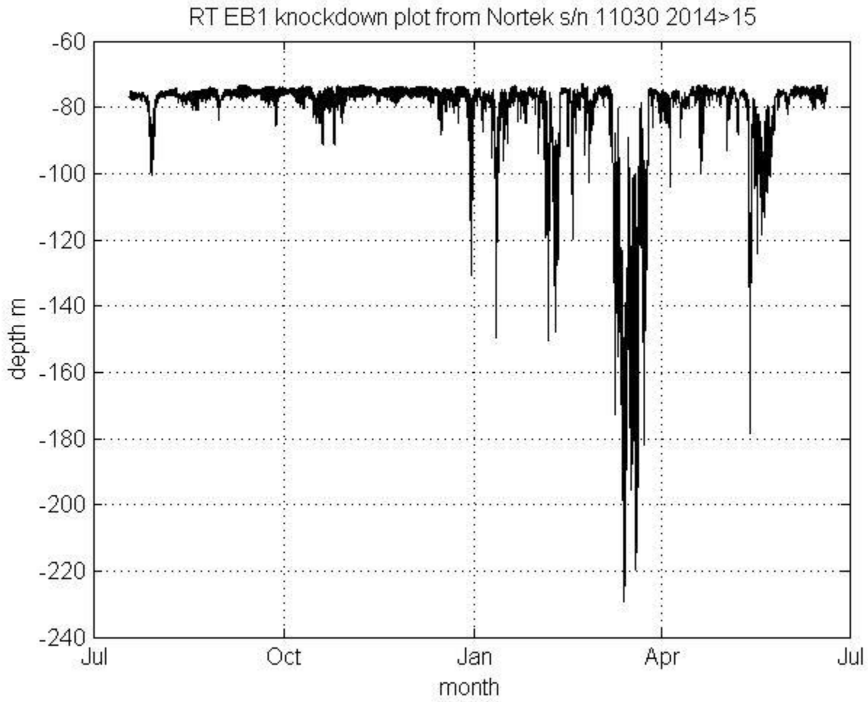


Figure 38: RTEB1 - Depth of the near surface Nortek s/n 11030

RT WB1 – The maximum current measured by the near surface NORTEK moored at a depth of ~77m was ~78 cm/s. The largest tilt measured by this instrument was ~16 degrees (Figure 39). The maximum depth measured was ~216m (Figure 40).

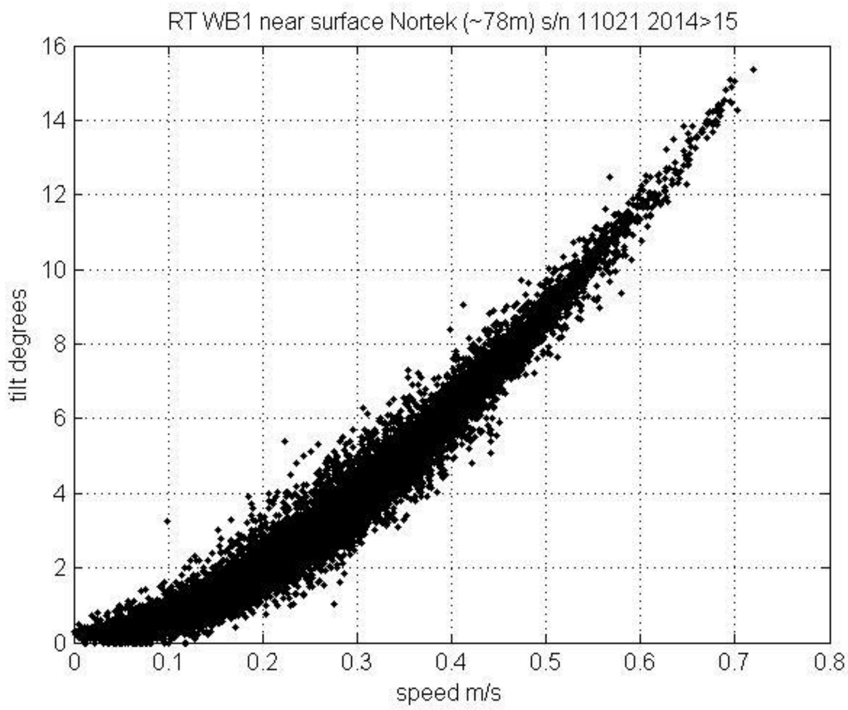


Figure 39: RTWB1 – Tilt as a function of speed of the near surface Nortek s/n 11021

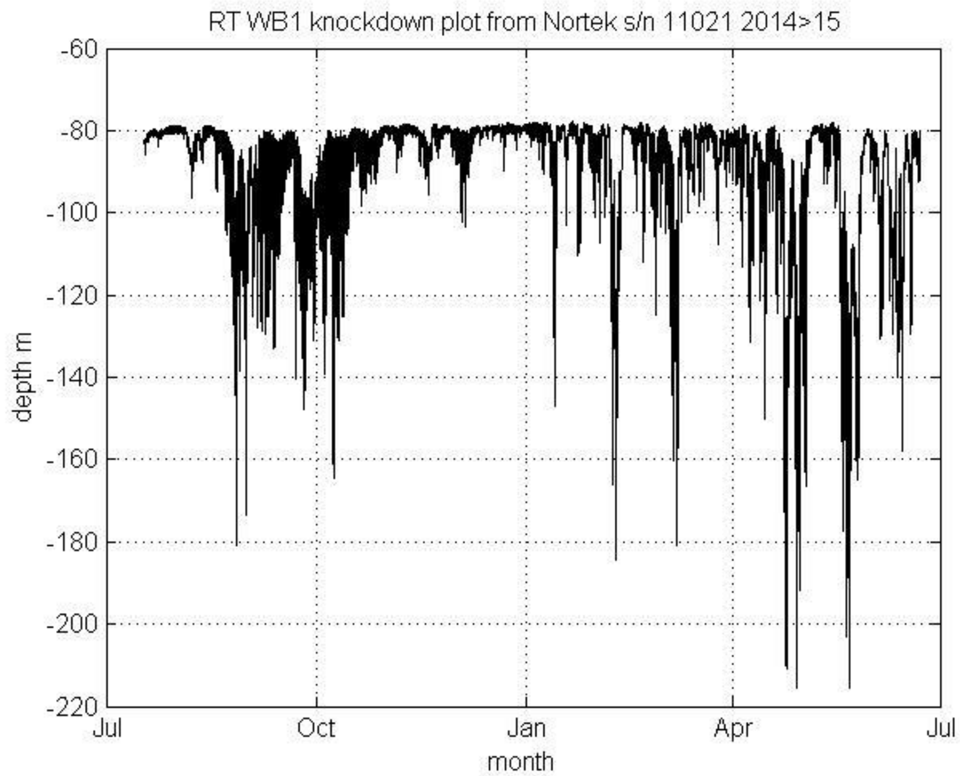


Figure 40: RTWB1 - Depth of the near surface Nortek s/n 11021

RT WB2 – The maximum current measured by the NORTEK moored at a depth of ~998m was ~45cm/s. The largest tilt measured by this instrument was ~8.5 degrees (Figure 41). The maximum depth measured was ~1077m (Figure 42).

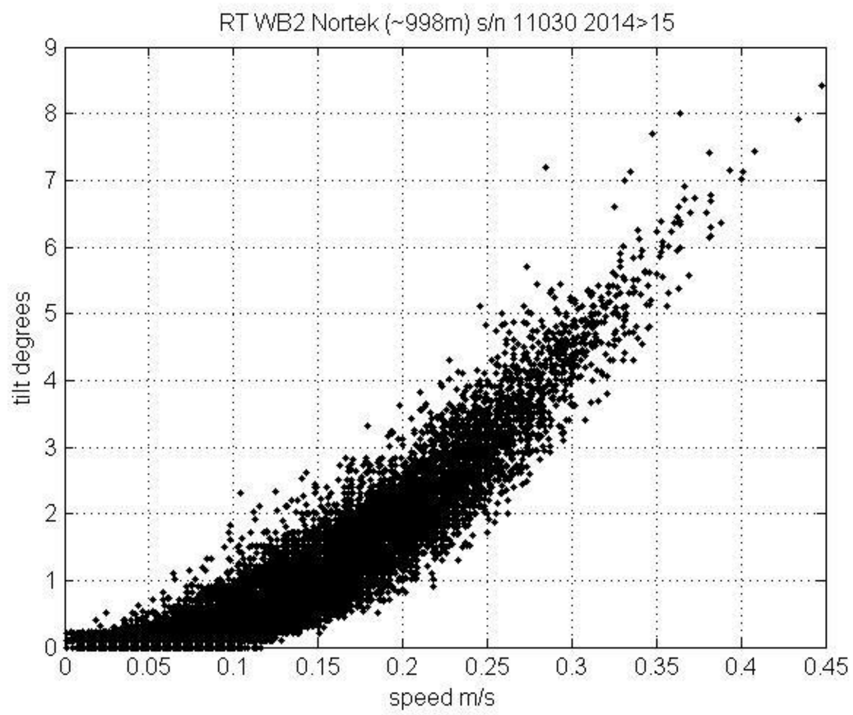


Figure 41: RTWB2 - Tilt as a function of speed of the top Nortek (~998m depth)

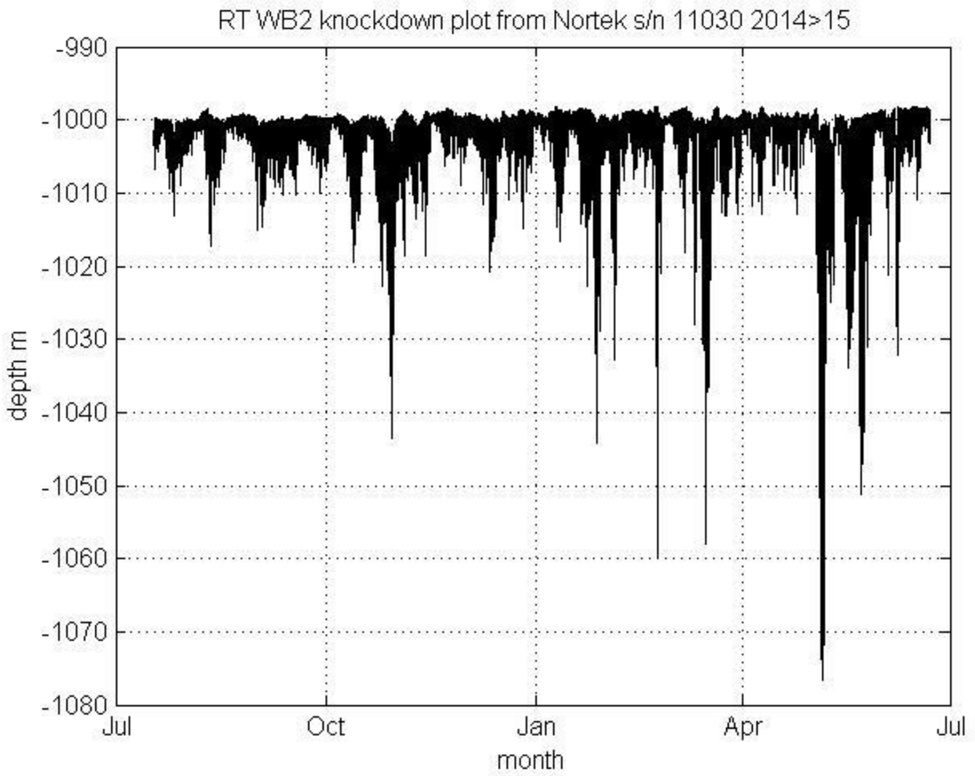
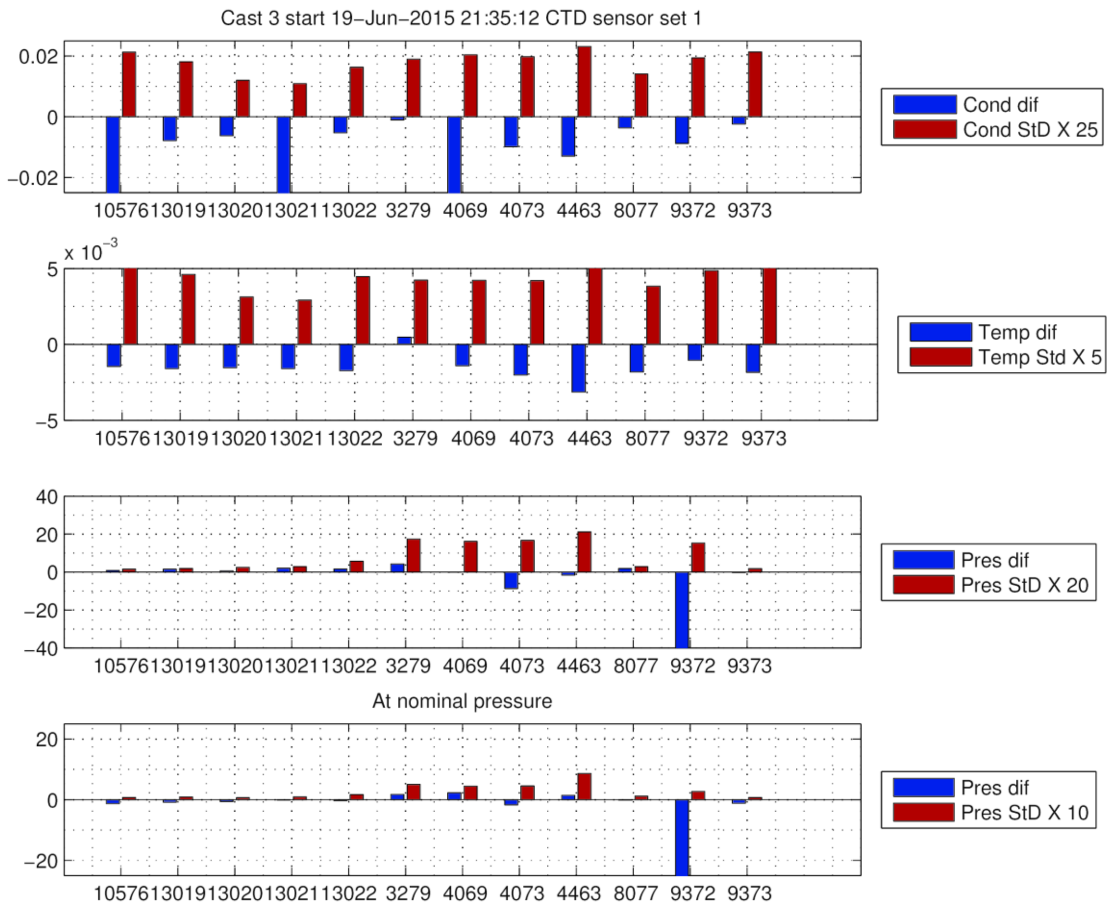


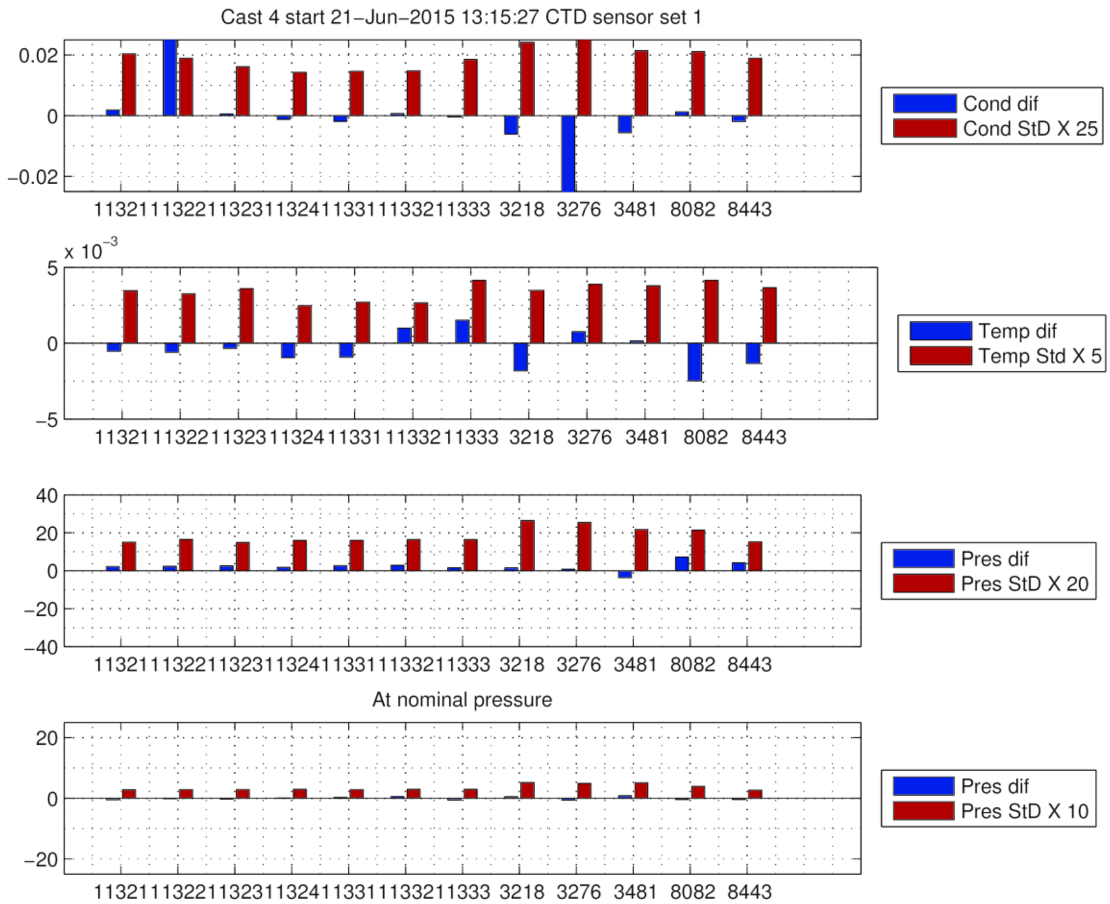
Figure 42: RTWB2 - Depth of the near surface Nortek

A.7 Statistics of SAMS microcat calibration casts

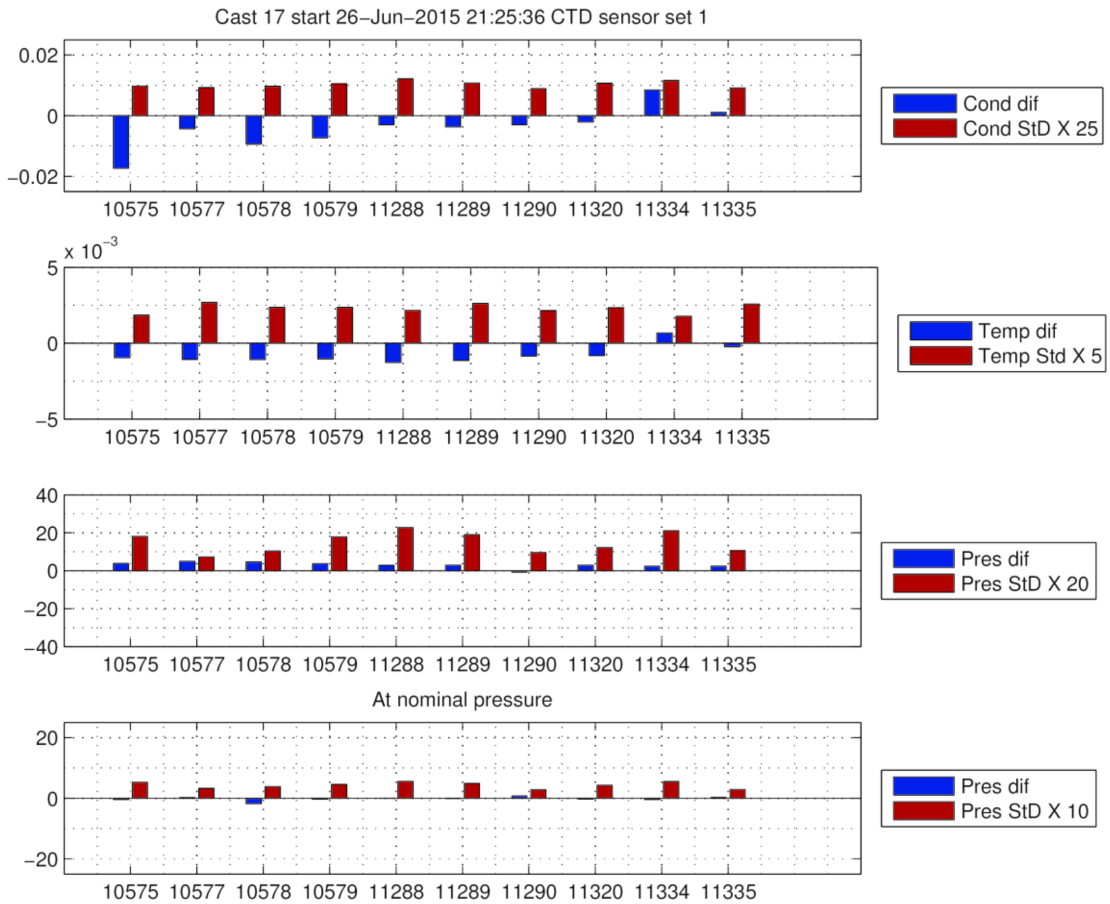
A.7.1 Cast 3



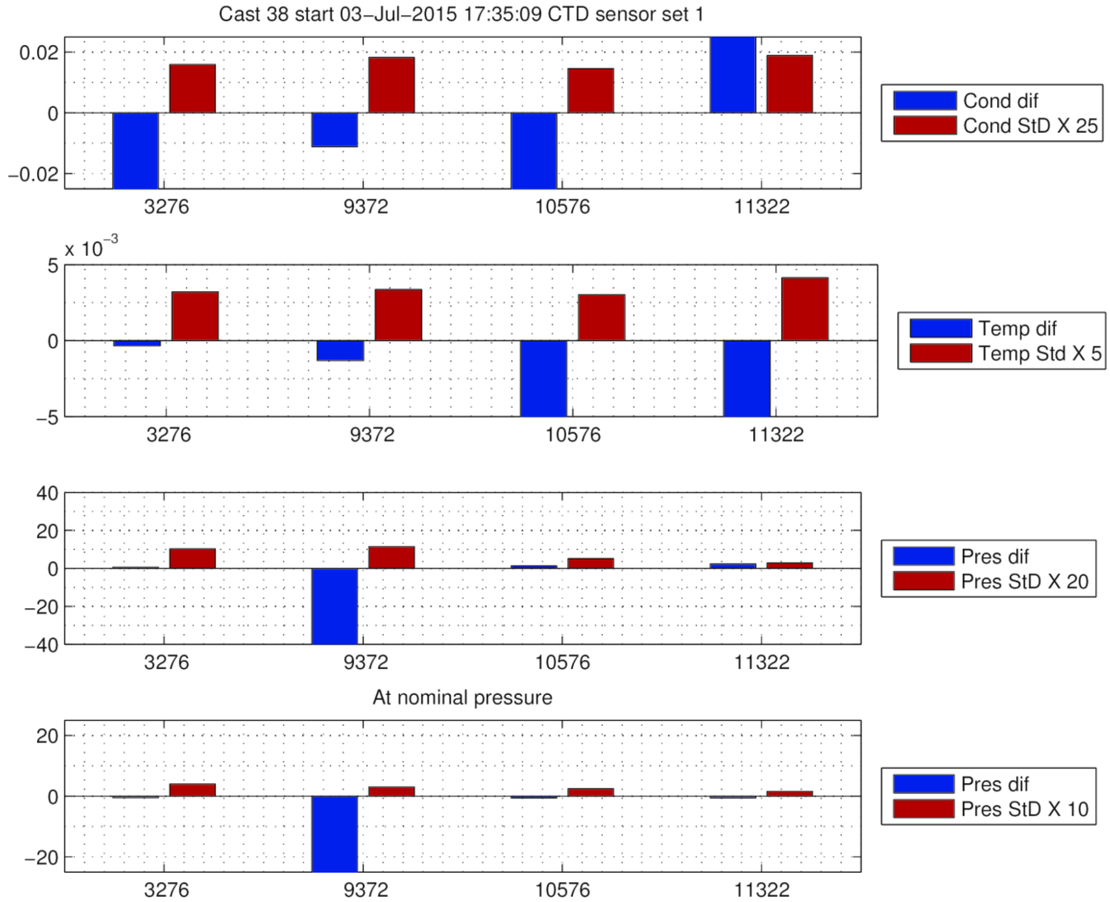
A.7.2 Cast 4


Cast 4 start 21–Jun–2015 13:15:27 CTD sensor set 1
0.02
0
–0.02
11321 11322 11323 11324 11331 11332 11333 3218 3276 3481 8082 8443
Cond dif
Cond StD X 25
x 10^-3
5
0
–5
11321 11322 11323 11324 11331 11332 11333 3218 3276 3481 8082 8443
Temp dif
Temp Std X 5
40
20
0
–20
–40
11321 11322 11323 11324 11331 11332 11333 3218 3276 3481 8082 8443
Pres dif
Pres StD X 20
At nominal pressure
20
0
–20
11321 11322 11323 11324 11331 11332 11333 3218 3276 3481 8082 8443
Pres dif
Pres StD X 10

A.7.3 Cast 17


Cast 17 start 26–Jun–2015 21:25:36 CTD sensor set 1
0.02
0
−0.02
10575 10577 10578 10579 11288 11289 11290 11320 11334 11335
Cond dif
Cond StD X 25
x 10−3
5
0
−5
Temp dif
Temp Std X 5
40
20
0
−20
−40
Pres dif
Pres StD X 20
At nominal pressure
Pres dif
Pres StD X 10

A.7.4 Cast 38


Cast 38 start 03–Jul–2015 17:35:09 CTD sensor set 1
0.02
0
–0.02
3276
9372
10576
11322
Cond dif
Cond StD X 25
x 10^–3
5
0
–5
Temp dif
Temp Std X 5
40
20
0
–20
–40
Pres dif
Pres StD X 20
At nominal pressure
Pres dif
Pres StD X 10