National Oceanography Centre, Southampton

Cruise Report No. 56

RRS *James Cook* Cruise 41
05-21 DEC 2009

UK DIMES1 cruise report: Diapycnal and Isopycnal
Mixing Experiment in the Southern Ocean

Principal Scientist
A Naveira Garabato

Editor
P Courtois

2010

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

Tel: +44 (0)23 8059 2680
Email: acng@noc.soton.ac.uk

DOCUMENT DATA SHEET

AUTHOR NAVEIRA GARABATO, A et al	*PUBLICATION DATE* 2010

TITLE

RRS *James Cook* Cruise 41, 05-21 Dec 2009. UK DIMES1 Cruise Report: Diapycnal and Isopycnal Mixing Experiment in the Southern Ocean.

REFERENCE

Southampton, UK: National Oceanography Centre, Southampton, 164pp.
(National Oceanography Centre Southampton Cruise Report, No. 56)

ABSTRACT

The DIMES (Diapycnal and Isopycnal Mixing Experiment in the Southern Ocean) research project seeks to test and, if necessary, redefine the present paradigm of Southern Ocean mixing by obtaining systematic measurements of mixing, upwelling and their underlying driving processes in two contrasting regimes of the Antarctic Circumpolar Current (ACC) - the Southeast Pacific and the Southwest Atlantic. The JC041 cruise is the second cruise of the DIMES experiment and the first conducted in a British vessel. Its primary goals are: (1) to deploy a cluster of six U.K. moorings in Drake Passage to investigate how the energetic mesoscale eddies of the ACC are dissipated, and how they interact with the regional internal wave field; and (2) to deploy four Florida State University (FSU) sound sources in the same area to track a large set of isopycnal RAFOS floats deployed elsewhere by our American collaborators.

All work planned in the JC041 cruise was carried out successfully. The work commenced with deployment of the six U.K. moorings (one of which contained an FSU sound source) in a cross-like pattern centred near 56.012 S, 57.825 W, in northeastern Drake Passage. A CTD / LADCP station was occupied at the location of each mooring, and a CTD / LADCP tow-yo transect was conducted in the lee of a topographic feature at the centre of the U.K. mooring area. Subsequently, the three FSU sound source moorings were deployed at different locations further south in Drake Passage. At the most easterly of those locations and in another site in northern Drake Passage we conducted upper-ocean CTD / LADCP tow-yos to survey the sub-mesoscale structure of interleaving features in the vicinity of the Polar Front. Finally, three profiling floats (two U.K. standard Argo floats, and one FSU Iridium Argo float with acoustics) were deployed at various locations near the western edge of Drake Passage.

UK DIMES1 Cruise Report

Diapycnal and Isopycnal Mixing Experiment

in the Southern Ocean

Principal Scientist:
Alberto Naveira Garabato

Editor: Peggy Courtois

National Oceanography Centre
Southampton, U.K.

RRS James Cook Cruise 41
5th December - 21st December 2009

Contents

List of Tables

4

List of Figures

1   UK DIMES1 Cruise Narrative

Alberto Naveira Garabato

1.1   Cruise Summary

The DIMES (Diapycnal and Isopycnal Mixing Experiment in the Southern Ocean) research project seeks to test and, if necessary, redefine the present paradigm of Southern Ocean mixing by obtaining systematic measurements of mixing, upwelling and their underlying driving processes in two contrasting regimes of the Antarctic Circumpolar Current (ACC) - the Southeast Pacific and the Southwest Atlantic. The JC041 cruise is the second cruise of the DIMES experiment and the first conducted in a British vessel. Its primary goals are: (1) to deploy a cluster of six U.K. moorings in Drake Passage to investigate how the energetic mesoscale eddies of the ACC are dissipated, and how they interact with the regional internal wave field; and (2) to deploy four Florida State University (FSU) sound sources in the same area to track a large set of isopycnal RAFOS floats deployed elsewhere by our American collaborators.

All work planned in the JC041 cruise was carried out successfully. The work commenced with deployment of the six U.K. moorings (one of which contained an FSU sound source) in a cross-like pattern centred near 56.012 S, 57.825 W, in northern Drake Passage (Figure 2). A CTD / LADCP station was occupied at the location of each mooring, and a CTD / LADCP tow-yo transect was conducted in the lee of a topographic feature at the centre of the U.K. mooring area (Figure 15). Subsequently, the three FSU sound source moorings were deployed at different locations further south in Drake Passage (Figure 2). At the most easterly of those locations and in another site in northern Drake Passage we conducted upper-ocean CTD / LADCP tow-yos to survey the sub-mesoscale structure of interleaving features in the vicinity of the Polar Front. Finally, three profiling floats (two U.K. standard Argo floats, and one FSU Iridium Argo float with acoustics) were deployed at various locations near the western edge of Drake Passage.
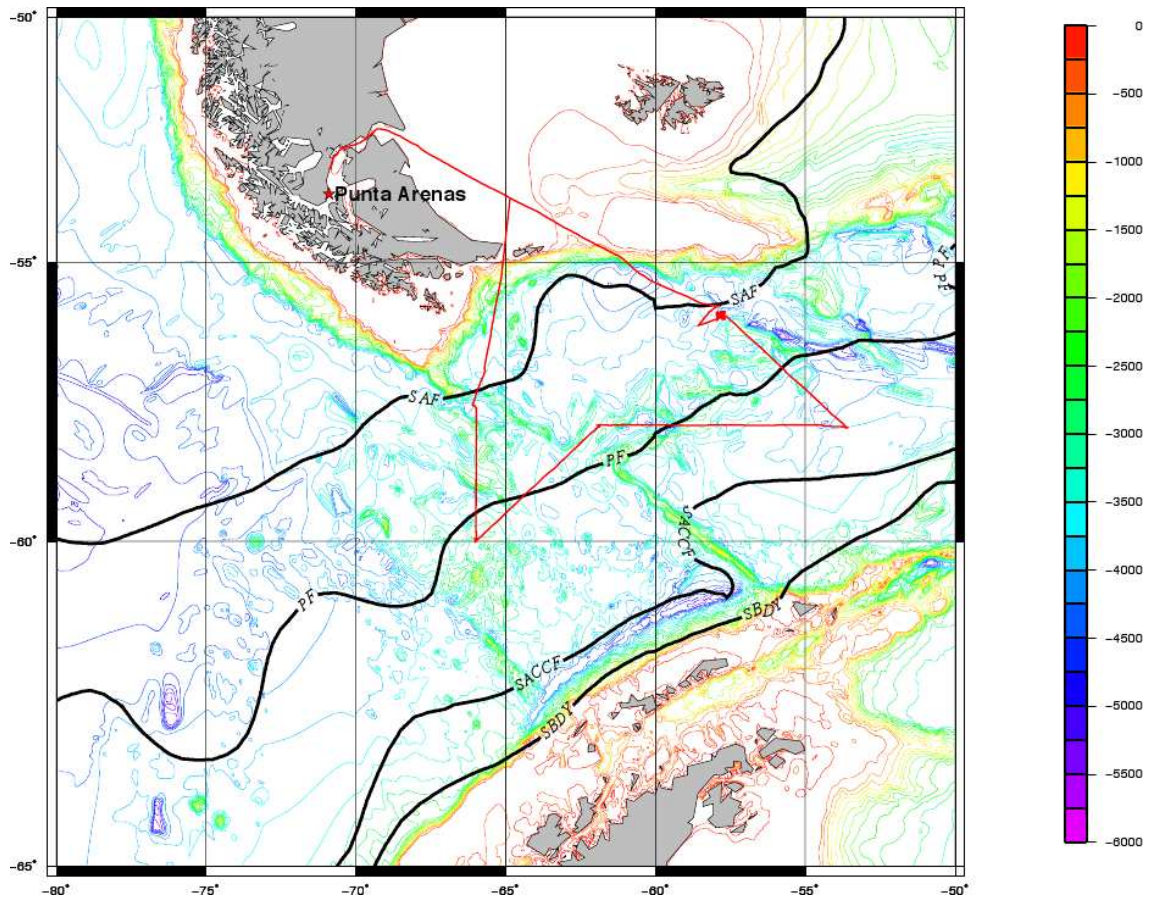
Figure 1: Complete cruise track for JC041.
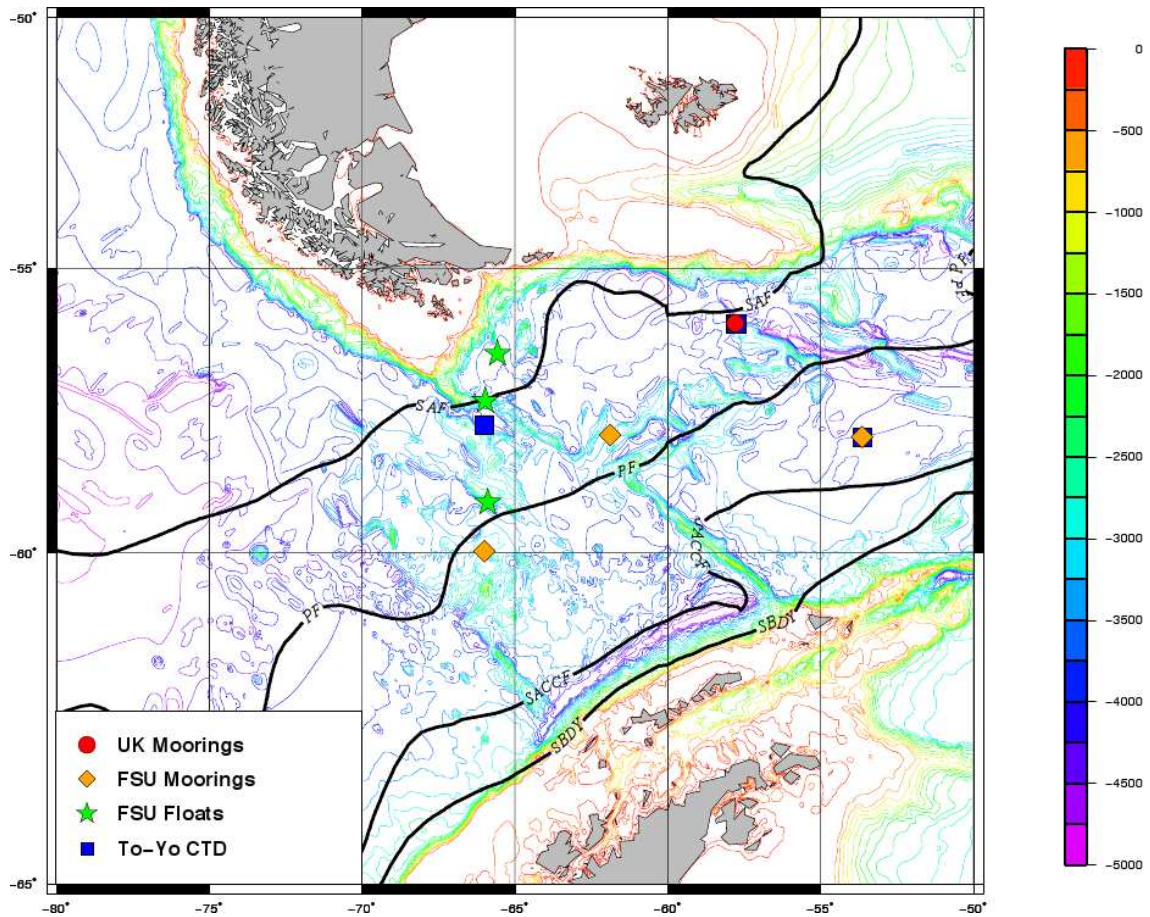
Figure 2: Map of deployments during JC041.

1.2 Cruise Participants

1.2.1 Scientific Party

Name	Institute	Email
Alberto Naveira Garabato	NOCS, UK	acng@noc.soton.ac.uk
Helen Johnson	Oxford, UK	helen.johnson@earth.ox.ac.uk
Peter Lazarevich	FSU , USA	lazarevich@ocean.fsu.edu
Kevin Speer	FSU, USA	kspeer@ocean.fsu.edu
Peggy Courtois	NOCS, UK	pc1o07@noc.soton.ac.uk
Flavia Burger	UOC, Chilie	fburger@udec.cl
Paul Provost	NOCS, UK	pgp@noc.soton.ac.uk
Darren Yound	NOCS, UK	dxy@noc.soton.ac.uk
Rhys Roberts	NOCS, UK	rhys@noc.soton.ac.uk
Michael Meyers	NOCS, UK	m.meyers@noc.soton.ac.uk
Colin Hutton	NOCS, UK	chut@noc.soton.ac.uk

NOC   National Oceanography Centre, Southampton
FSU   Florida State University
UOC   University of Concepción

1.2.2 Ship's Officers and Crew

Peter Sarjeant	Master	Kevin Luckhurst	CPOD
Richard Warner	Chief Officer	Stephen Smith	CPOS
John Mitchell	Second Officer	Iain Thomson	POD
Vanessa Laidlow	Third Officer	John Dale	SG1A
Nerys Lewis	Medical Officer	Nathaniel Gregory	SG1A
Anthony Stevens	Purser	Bob Spencer	SG1A
George Parkinson	Chief Engineer	Steven Gallagher	SG1A
Michael Ralph	Second Engineer	Lee Stephens	SG1A
Christopher Uttley	Third Engineer	Darren Caines	Head Chef
James Hayes	ETO	Dean Hope	Chef
Vivian Wythe	Deck Engineer	Peter Robinson	Stwd
Emlyn Williams	ERPO	Brian Conteh	A/Stwd

1.3   Cruise Diary

Saturday 5ᵗʰ December (Julian day 339)
We set sail at 17:00 (local time) from Punta Arenas and steamed eastward to the open ocean via the Magellan Strait, in fair seas.

Sunday 6ᵗʰ December (Julian day 340)
We kept steaming toward the UK mooring site. Most scientists and technicians were busy preparing the moorings and various instrumentation for upcoming deployments.

Monday 7ᵗʰ December (Julian day 341)
We reached the vicinity of the UK mooring site, but the weather had deteriorated and we were not able to start work this day.

Tuesday 8ᵗʰ December (Julian day 342)
We spent the night heaving to in rough seas. Weather conditions started improving in the morning, so in the afternoon and evening we conducted two CTDs (01 and 02) at the sites of the SE and NE moorings, respectively. Acoustic releases for the UK moorings were tested during those deployments. A kink in the CTD cable occurred during station 2, giving rise to some concern. The area appeared to lie near the equatorward edge of the Polar Front at the time of deployment.

Wednesday 9ᵗʰ November (Julian day 343)
After swath-surveying part of the UK mooring area during the night, mooring deployment operations commenced in the early hours of the morning. Moorings SE and NE were deployed successfully by the early afternoon. Much of the rest of the day was devoted to re-terminating the CTD cable, triangulating moorings SE and NE, and winding moorings C and NW onto the spool.

Thursday 10ᵗʰ December (Julian day 344)
We conducted three CTDs overnight at the locations of moorings C, NW and M (stations 3, 4 and 5). In the morning and early afternoon, we deployed moorings NW and C in benign seas and glorious sunshine. We finished the day by triangulating moorings C and NW, winding moorings M and SW onto the spool, and occupying a CTD station (06) at the location of the SW mooring.

Friday 11ᵗʰ December (Julian day 345)
During the night, we commenced a full-depth tow-yo CTD transect (07) oriented northeastward across the topographic feature at the centre of the mooring array. We concluded the transect in the early morning, and proceeded to deploy moorings SW and M. We then triangulated those two moorings, and continued the full-depth tow-yo CTD transect (08) initiated earlier in the day into deeper water.

Saturday 12th December (Julian day 346)

In the early hours of this day, we started steaming toward the FSU3 mooring site. We arrived there at the end of the day. It was decided that we would wait till the morning to deploy the mooring.

Sunday 13th December (Julian day 347)

We spent the night doing an upper-ocean tow-yo CTD transect (09) of the area, which appeared to be crossed by a branch of the Polar Front at the time. Morning brought strong winds and rough seas, so we were forced to wait till late the following evening to deploy the FSU3 mooring.

Monday 14th December (Julian day 348)

We steamed toward the FSU2 mooring site in benign seas.

Tuesday 15th December (Julian day 349)

We reached the FSU2 mooring deployment site in the early morning, and proceeded to deploy the mooring. After that, we continued to steam westward to the FSU1 mooring site.

Wednesday 16th December (Julian day 350)

We arrived at the FSU1 mooring deployment site in the early morning, but were not able to start deployment till the afternoon due to rough weather. After deploying the mooring we sailed northward, toward South America. We deployed an FSU Iridium Apex float with acoustics (number 4779).

Thursday 17th December (Julian day 351)

We sailed as far as the Polar Front and commenced an upper-ocean tow-yo CTD transect (10) across the front, just after breakfast.

Friday 18th December (Julian day 352)

Upon finishing the tow-yo in the early hours of the morning, we deployed a U.K. Argo float (number 4498) and sailed northward toward Tierra del Fuego. Later in the morning, we deployed a second U.K. Argo float (number 4499) on the poleward edge of the Subantarctic Front.

Saturday 19th December (Julian day 353)

We continued steaming toward South America. Data back ups were started. In the afternoon, a christmas tree was nicely decorated for those who do not have the chance to spend Christmas with their familly.

Sunday 20th December (Julian day 354)

We finally arrived at the Chilean coast, close to Punta Arenas. Back up and cruise reporting operations continued.

Table 1: Complete log-sheet of events for JC041.

Station number	Julian day	Date	Time (GMT)	Latitude	Longitude	Depth (m)	Activities
1	342	08-Dec	17:05	55° 57.724'S	57° 44.236'W	3970	CTD at SE mooring location and mooring release test.
2	342	08-Dec	22:26	56° 03.550'S	57° 44.053'W	4254	CTD at NE mooring location and mooring release test.
	343	09-Dec	09:20	55° 56.300'S	58° 00.000'W	3958	North East mooring.
	343	09-Dec	15:45	56° 03.690'S	57° 44.900'W	4200	South East mooring.
3	343	09-Dec	22:53	56° 00.743'S	57° 49.362'W	3555	CTD at C mooring location and mooring release test.
4	344	10-Dec	02:37	55° 57.790'S	57° 54.527'W	4204	CTD at NW mooring location.
5	344	10-Dec	07:19	56° 01.070'S	57° 47.180'W	3755	CTD at M mooring location.
	344	10-Dec	11:35	55° 57.480'S	57° 51.300'W	4089	North West mooring.
	344	10-Dec	15:15	56° 00.765'S	57° 50.014'W	4256	C mooring.
6	344	10-Dec	23:38	56° 03.454'S	57° 54.456'W	4059	CTD at SW location.
7	345	11-Dec	03:51	56° 03.121'S	57° 52.006'W	3792	Tow-Yo CTD.
	345	11-Dec	14:32	56° 03.753'S	57° 54.839'W	3940	South West mooring
	345	11-Dec	19:00	56° 01.458'S	57° 47.479'W	3777	M mooring
8	346	12-Dec	00:40	56° 01.933'S	57° 45.689'W	3807	Tow-Yo CTD.
9	347	13-Dec	02:01	57° 59.990'S	53° 41.960'W	4086	Tow-Yo CTD.
	348	14-Dec	01:00	58° 03.088'S	53° 38.754'W	4150	FSU III mooring.
	349	15-Dec	09:30	58° 00.842'S	61° 53.160'W	3640	FSU II mooring.
	350	16-Dec	16:00	59° 58.606'S	65° 59.405'W	3250	FSU I mooring.
10	351	17-Dec	11:40	57° 49.85'S	65° 59.710'W	5808	Tow-Yo CTD.

2 Conductivity - Temperature - Depth (CTD) Operations and Data Processing

Peggy Courtois, Paul Provost

2.1 CTD Operations and Configuration Procedures

A 24-bottle rosette Conductivity-Temperature-Depth (CTD), mounted on 24-way stainless steel frame, was used during the cruise JC041. In total, 10 CTD stations were carried out (Table 2), including three test casts with acoustic releases (CTD001 to CTD003) and 4 tow-yos (CTD007 to CTD010). The two first tow-yo casts (CTD007 to CTD008) were full-depth tow-yos going up to 500 m, with three up-and-down profiles each. The two last tow-yo casts (CTD009 to CTD010) were two tow-yos in shallow water, reaching a maximum depth of 500m, with 14 and 24 up-and-down profiles each. Hence, a total of 50 CTD profiles were obtained. Four casts were done where moorings were deployed, i.e. casts CTD003 to CTD006 for Central (C), North-West (NW), Middle (M) and South-West (SW), respectively (Figure 15, Chapter 4). No major operational issues were encountered with the CTD suite during the cruise.

2.1.1 24-way Stainless Steel CTD Frame

The stainless steel frame configuration was as follows:

1. Sea-Bird *9/11 plus* CTD system with fin-mounted secondary sensors
2. Sea-Bird SBE-32 24 way rosette pylon on NMF 24 way frame
3. 24 by 10l custom OTE external spring water samplers
4. Sea-Bird SBE-43 oxygen sensor
5. Chelsea MKIII Aquatracka fluorometer
6. Chelsea MKII Alphatracka 25cm path transmissometer
7. Wetlabs BBRTD 660nm backscatter sensor
8. NMF LADCP pressure-case battery pack
9. RD Instruments Workhorse 300 kHz lowered ADCP (upward and downward-looking master-slave configuration)
10. Benthos PSA-916T 200kHz altimeter

For the 10l bottles, the pressure sensor was located 34cm below the bottom of the water samplers, and 121cm below the top of the water samplers. The 10l niskins are 87cm in height between end-cap seals.

Table 2: CTD stations occupied on JC041 (UK DIMES1 cruise). The time, latitude and longitude are those recorded at the beginning of each CTD station. The maximum depth of CTD was calculated from pressure and latitude using the seawater routine sw_dpth. Except for the latitude and longitude, these data can be found in *ctd_jc041_nnn_2db.nc*, the latitude and longitude are in *ctd_jc041_nnn_1hz.nc*.

Station Number	Julian Day	Date d/m/t (GMT)	lat °S	long °E	max. press (dbar)	max. depth (m)	altimeter (m)
1	342	08/12/16:57	55.961	57.721	4047	3966	9.8
2	342	08/12/22:20	56.059	57.734	4249	4162	8.6
3	343	09/12/22:46	56.012	57.823	3741	3669	11.7
4	344	10/12/02:34	55.963	57.909	4257	4170	10.8
5	344	10/12/07:05	56.021	57.786	3781	3708	9.6
6	344	10/12/23:32	56.057	57.907	4049	3968	10.8
7	345	11/12/03:40	56.052	57.867	3827	3758	13
8	346	12/12/00:27	56.032	57.761	4271	4190	19.1
9	347	13/12/01:53	57.999	53.699	501	495.7	–
10	351	17/12/11:30	57.831	65.996	507	501.7	–

2.1.2 24-way Stainless Steel CTD Frame Instrument Configuration

The Sea-Bird CTD configuration for the stainless steel frame was as follows:

1. SBE 9 *plus* Underwater unit s/n 09P-19817-0528
2. Frequency 0-SBE 3P Temperature Sensor s/n 03P-4116 (primary)
3. Frequency 1-SBE 4C Conductivity Sensor s/n 04C-2580 (primary)
4. Frequency 2-Digiquartz Temperature Compensated Pressure Sensor s/n 73299
5. Frequency 3-SBE 3P Temperature Sensor s/n 03P-4383 (secondary - fin mounted)
6. Frequency 4-SBE 4C Conductivity Sensor s/n 04C-3567 (secondary - fin mounted)
7. SBE 5T Submersible Pump s/n 05T-3609 (primary)
8. SBE 5T Submersible Pump s/n 05T-3085 (secondary - fin mounted)
9. SBE 32 Carousel 24 Position Pylon s/n 32-19817-0243
10. SBE 11 *plus* Deck Unit s/n 11P-34173-0676 Main Unit with Powertecnique UPS
11. SBE 11 *plus* Deck Unit s/n 11P-24680-0589 Spare Unit

The auxiliary A/D output channels were configured as below (due to incorrectly labelled Y-cables V2/3 and V6/7 usages are transposed from historically used channels):

1. V0 — SBE 43 Oxygen s/n 43-0862 (primary duct - 9+ mounted)
2. V1 — Unused - obsolete oxygen temperature
3. V2 — Chelsea MKIII Aquatracka Fluorometer s/n 09-7117-001
4. V3 — Benthos PSA-916T Altimeter s/n 41302
5. V4 — Free
6. V5 — Free
7. V6 — Wetlabs BBRTD backscatter s/n 182
8. V7 — Chelsea MKII Alphatracka 25cm path Transmissometer s/n 07-6075-001

The additional self-logging instruments were configured as follows:

1. RDI Workhorse 300 KHz Lowered ADCP (down-looking master configuration) s/n 12920
2. RDI Workhorse 300 KHz Lowered ADCP (up-looking slave configuration) s/n 4275

The LADCP was powered by the NMF battery pack WH002. Battery pack WH005 was also available as a spare, but was not used.

2.1.3 Stainless Steel CTD Seasave Configuration

Date: 12/13/2009
Instrument configuration file:
C:\Program Files\Sea-Bird\SeasaveV7\JC041\0528SS_ JC041.con

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

1) Frequency 0, Temperature
Serial number: 4116
Calibrated on: 15 September 2009
G: 4.42620661e-003
H: 6.84911159e-004
I: 2.47884077e-005
J: 2.08871587e-006
F0: 1000.000
Slope: 1.00000000
Offset: 0.0000

2) Frequency 1, Conductivity
Serial number: 2580
Calibrated on: 10 September 2009
G: -1.03555819e+001
H: 1.52305177e+000
I: 6.34116122e-006
J: 8.63727710e-005
CTcor: 3.2500e-006
CPcor: -9.57000000e-008
Slope: 1.00000000
Offset: 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number: 73299
Calibrated on: 18 April 2008
C1: -5.087539e+004
C2: 2.199664e-002
C3: 1.589010e-002
D1: 3.721700e-002
D2: 0.000000e+000
T1: 3.011152e+001
T2: -2.857091e-004
T3: 4.528990e-006
T4: -5.484500e-011
T5: 0.000000e+000
Slope: 0.99983000
Offset: -1.48410
AD590M: 1.282870e-002
AD590B: -9.075590e+000

4) Frequency 3, Temperature, 2
Serial number: 4383
Calibrated on: 07 May 2009
G: 4.39884574e-003
H: 6.55750785e-004
I: 2.44567368e-005
J: 2.06041020e-006
F0: 1000.000
Slope: 1.00000000
Offset: 0.0000

5) Frequency 4, Conductivity, 2
Serial number: 3567
Calibrated on: 5 May 2009
G: -1.04193607e+001
H: 1.25347531e+000
I: -1.56176059e-003
J: 1.57355898e-004
CTcor: 3.2500e-006
CPcor: -9.57000000e-008
Slope: 1.00000000
Offset: 0.00000

6) A/D voltage 0, Oxygen, SBE 43
Serial number: 0862

Calibrated on: 10 March 2009
Equation: Sea-Bird
Soc: 4.36200e-001
Offset: -4.99200e-001
A: -1.09340e-003
B: 9.78700e-005
C: -2.32650e-006
E: 3.60000e-002
Tau20: 1.37000e+000
D1: 1.92630e-004
D2: -4.64800e-002
H1: -3.30000e-002
H2: 5.00000e+003
H3: 1.45000e+003

7) A/D voltage 1, Free

8) A/D voltage 2, Fluorometer, Chelsea Aqua 3
Serial number: 09-7117-001
Calibrated on: 10 June 2009
VB: 0.201500
V1: 2.078500
Vacetone: 0.466900
Scale factor: 1.000000
Slope: 1.000000
Offset: 0.000000

9) A/D voltage 3, Altimeter
Serial number: 41302
Calibrated on: 20 April 2007
Scale factor: 15.000
Offset: 0.000

10) A/D voltage 4, Free

11) A/D voltage 5, Free

12) A/D voltage 6, User Polynomial
Serial number: 182
Calibrated on: 20 June 2007
Sensor name: Wetlabs BBRTD
A0: -0.00035320
A1: 0.00301900

A2: 0.00000000
A3: 0.00000000

13) A/D voltage 7, Transmissometer, Chelsea/Seatech/Wetlab CStar
Serial number: 07-6075-001
Calibrated on: 18 October 2007
M: 23.8781
B: -0.2388
Path length: 0.250

2.1.4 Deployment Comments and Documentation

Early on the 09/12/2009 (day 343, CTD003), as a result of heavy weather, slack came on the CTD wire (Winch II) on recovery of the package to the surface that allowed a twist to form in the cable. Although no strands were broken, a retermination was required. This was performed after a mooring deployment and whilst the mooring anchor position was being determined by triangulation. There was no loss to science time or CTD casts.

A sensor information sheet 'JC041 Sensor Information.doc' and calibration and instrument history sheets were included in the main cruise archive in electronic format. Original copies of all log sheets were supplied to the PSO. Scanned copies of the CTD and LADCP rough log sheets will be supplied to BODC by NMF.

2.2 CTD Data Processing

2.2.1 Initial Processing using SeaBird Programs

During a cast, the CTD software Seawave (version 7.18) creates four output files with the extensions .HEX, .HDR, .BL, .CON. The .CON file contains the calibration coefficients of the instrument. The .HDR file contains all the metadata of the cast for a possible header. The data are contained in the .HEX file in hexagonal format. The .BL file contains all information on bottle firings of the rosette.

A first data processing is therefore necessary to obtain the data in a readeable format. This was done by using the Seabird software SBE Data Processing, Version 7.19 available on *ftp://ftp.halcyon.com/pub/seabird/OUT/SeasoftV2/SBEDataProcessing/*. Three files (.CNV, .ROS and .PSA) were obtained through this first stage. The .CNV file contains the converted data. The .ROS file gives the data relatively to the fired bottles. The PSA file gives all the steps of the processing. The different steps were carried out in the following order:

1. *Data Conversion*
2. *Align CTD*
3. *Cell Thermal Mass*
4. *Filter*
5. *Loop Edit*
6. *Derive*
7. *SeaPlot*

Data Conversion converts the raw data (.HEX file) into physical units (.CNV file) and applies the calibration coefficients from the instrument configuration file (.CON file). The necessary inputs are the .CON and .HEX files. It is at that stage that the parameters need to be adequately chosen (except for the salinity and the oxygen data which are added at a latter stage). In our case, we have chosen the following output variables:

1. Scan Count
2. Pump Status
3. Time, Elapsed (Seconds)
4. Latitude, (Degree)
5. Longitude, (Degree)
6. Bottle Fired
7. Pressure, Digiquartz (db)
8. Depth (Salt water, m)
9. Temperature (ITS-90, deg C) (primary temperature sensor)
10. Temperature, 2 (ITS-90, deg C) (secondary temperature sensor)
11. Conductivity (mS/cm) (primary conductivity sensor)
12. Conductivity, 2 (mS/cm) (secondary conductivity sensor)
13. Oxygen Voltage (SBE43) (raw oxygen sensor voltage output)
14. Altimeter (m)

Align CTD takes the output .CNV file and applies temporal shifts to align the sensor readings. We have not applied any offsets for primary and secondary temperature and salinity, as the CTD deck unit automatically applies the conductivity lag to the conductivity sensors. Only an offset of 5 was applied for the oxygen.

Cell Thermal Mass takes the latter output .CNV files (from *Align CTD*) and makes corrections for the thermal mass of the cell, in an attempt to minimise salinity spiking in steep vertical gradients due to temperature/conductivity mismatches. The constants used were the thermal anomaly amplitude $\alpha = 0.03$ and the thermal anomaly time constant $1/\beta = 7$.

Filter applies a low pass filter (time constant 0.15) to the pressure only.

Loop Edit flags pressure reversals, places where the package has slowed down or even stopped. It is also at that stage that the surface soak was removed from the data. A quick test was made to see any major differences on the data by leaving the surface soak. This attempt was done on one data file only. As no major difference was observed, the surface soak was removed for all data files.

Derive calculates primary and secondary salinity, and oxygen concentration. Two input files are necessary at that stage, the .CON file and the lattest .CNV file, issued from *Loop Edit*.

1. Salinity (psu) (salinity calculated from primary T and C sensors)
2. Salinity, 2 (psu) (salinity calculated from secondary T and C sensors)
3. Oxygen, SBE43 (μmol/kg), window size 2.00 sec

Thus the final version of each file renamed ctd*nnn*.cnv contains the following output variables:

1. Pump Status
2. Time, Elapsed (Seconds)
3. Scan Count
4. Latitude, (Degree)
5. Longitude, (Degree)
6. Bottle Fired
7. Pressure, Digiquartz (db)
8. Depth (Salt water, m)
9. Temperature (ITS-90, deg C) (primary temperature sensor)
10. Temperature, 2 (ITS-90, deg C) (secondary temperature sensor)
11. Conductivity (mS/cm) (primary conductivity sensor)
12. Conductivity, 2 (mS/cm) (secondary conductivity sensor)
13. Oxygen Voltage (SBE43) (raw oxygen sensor voltage output)
14. Altimeter (m)
15. Salinity (psu) (salinity calculated from primary T and C sensors)
16. Salinity, 2 (psu) (salinity calculated from secondary T and C sensors)
17. Oxygen, SBE43 (μmol/kg), window size 2.00 sec
18. and a final flag column, for flagging bad data

Finally, *SeaPlot* provided an initial look at the data to check for obvious problems such as large salinity spikes and primary and secondary sensors mismatch. Although our

records show 10 CTD casts, the last cast CTD010 was divided into 4 different output files (ctd010.cnv to ctd013.cnv) to avoid a too large ouput file. The LADCP was unplugged for the final cast (CTD010) as the battery would not have lasted long enough through this last shallow tow-yo cast.

2.2.2 MStar CTD Processing

After the initial processing with the Seabird routines, all data were run through the new MEXEC processing suite of programs based on PStar (gratefully developed by Dr. Brian King). The entire MStar software suite is written in Matlab and uses NetCDF file format to store all data. On JC041, the MStar CTD Processing was carried out on Alberto's personal laptop, which was set up with the appropriate folders and paths prior to the cruise by Brian King. Section 9 gives an overview of the MStar setup. In order to proceed the CTD data, it is important to rename the .CNV and .BL files as *ctd_jc041_nnn_ctm.cnv* and *ctd_jc041_nnn.bl* where *nnn* corresponds to the station number and to locate them in */local/users/pstar/cruise/data/ctd/ASCII_FILES* and *BOTTLE_FILES*, respectively. From now, the default working folder is */local/users/pstar/cruise/data/* and is noted ∼/.

In addition to the two input data files (.CNV and .BL), three input files are also necessary for the processing of the CTD data. These files are manually created and are located in ∼/*templates*:

dcs_jc041_varlist.csv:

statnum	number
time_start	seconds
dc_start	number
scan_start	number
press_start	dbar
time_bot	seconds
dc_bot	number
scan_bot	number
press_bot	dbar
time_end	seconds
dc_end	number
scan_end	number
press_end	dbar

sam_jc041_varlist.csv:

sampnum	numberstatnum
statnum	number
position	on.rosette
time	seconds
wireout	metres
bottle_number	number
bottle_qc_flag	woce_table_4.8
botpsal	pss-78
botpsalflag	woce_table_4.9
botoxy	umol/kg
botoxy	umol/l
botoxyflag	woce_table_4.9
botoxytemp	degc
upress	dbar
utemp	degc90
utemp2	degc90
ucond	mS/cm
ucond2	mS/cm
upsal	pss-78
upsal2	pss-78
upotemp	degc90
upotemp2	degc90
uoxygen	umol/kg

ctd_jc041_renamelist.csv:

scan	/	number
pumps	/	pump_status
timeS	time	seconds
latitude	/	degrees
longitude	/	degrees
nbf	/	number
prDM	press	dbar
depSM	depth_SM	meter
t090C	temp	degc90
t190C	temp2	degc90
c0mS_slash_cm	cond	mS/cm
c1mS_slash_cm	cond2	mS/cm
sbeox0V	oxygen_volt	volt
altM	altimeter	meters
sal00	sal1	PSU
sal11	sal2	PSU
sbeox0Mm_slash_Kg	oxygen	umol/Kg
flag	/	number

There are four principal types of output NetCDF files:

- **SAM files:** This file contains information about rosette bottles samples, including upcast CTD data from when the bottles were fired. Data from chemistry samples corresponding with each bottle could be uploaded into these files.

- **CTD files:** These files contain all data from CTD sensors. There are six different CTD files: _raw, _24hz, _1hz, _psal, _surf and _2db. The suite of programs averages and interpolates the raw data until it has 2 db resolution.

- **DCS files:** These two files store information necessary for CTD downcast processing (for example start, bottom and end points of te cast). These files are also used when merging in latitude and longitude.

- **FIR files:** These three files (_bl, _ctd and _time) contain information about rosette bottle firing.

Because the MEXEC suite was developed for simple casts and not for tow-yos, few matlab programs were developed to adapt the MEXEC suite to tow-yo casts. All MEXEC commands to process the CTD data (simple casts and tow-yos) are described below in the following order and are summarised in Table 4.

Matlab programs applied to all files *ctd001.cnv* **to** *ctd013.cnv* **(adequatly renamed into** *ctd_jc041_nnn_ctm.cnv*)**:**

msam_01 creates an empty .SAM file to store all information about rosette bottle samples. Two input files are needed at that stage, the .CNV file (accordingly renamed and relocated) and the sam_jc041_varlist.csv file, located in the $\sim$/*templates* directory. The latter file contains a set of variables and space to store data for each sample bottle, their flags and appropriate CTD data needed for bottle analysis. It can also be easily changed depending on what variables are needed.

mctd_01 reads the converted data (*ctd_jc041_nnn_ctm.cnv*) and stores it in a NetCDF file named *ctd_jc041_nnn_raw*.

mctd_02 copies *ctd_jc041_nnn_raw.nc* into *ctd_jc041_nnn_24hz.nc* renaming SBE sensor variable names.

mctd_03 calculates salinity, 1Hz averaged data (*ctd_jc041_nnn_1hz.nc*), potential temperature and averaged potential salinity (*ctd_jc041_nnn_psal.nc*) using 24Hz data.

mdcs_01 creates an empty file named *dcs_jc041_nnn.nc* to store information about the start, bottom and end of the cast.

mdcs_ 02 populates *dcs_ jc041_ nnn* with deepest pressure information.

Matlab programs applied to the six first CTD casts only (*ctd001.cnv* to *ctd006.cnv*):

mdcs_ 03 selects and shows surface data <20db (*ctd_ jc041_ nnn_ surf.nc*) from which the analyst chooses the positions of the start and end scan numbers for the top and bottom of the cast (see Table 3).

mctd_ 04 uses information from *dcs_ jc041_ nnn.nc* to select the CTD downcast data from *ctd_ jc041_ nnn_ 24hz.nc* file to create a 2dB resolution file (*ctd_ jc041_ nnn_ 2db*).

mdcs_ 04 loads position from the navigation file and merge it onto the points previously defined by *mdcs_ 03* and stores it in *dcs_ jc041_ nnn_ pos.nc.*

Matlab programs applied to the tow-yo casts only (*ctd007.cnv* to *ctd013.cnv*):

my_ towyo reads the *ctd_ jc041_ nnn_ 1hz.nc* files and identifies the upward and downward casts using a reference number (*ctd_ jc041_ nnn_ towyo.nc*). Then, by isolating each up and downward cast, the data are averaged and interpolated into a 2db bin into *towyo_ jc041_ nnn_ 2db_ rf.nc* where *rf* is the reference number. Finally, these files are manually apended into *ctd_ jc041_ nnn_ 2db.nc* using *mapend.m.*

Matlab programs applied to the casts where niskin bottles were fired (*ctd001.cnv* to *ctd008.cnv*):

mfir_ 01 extracts information about fired bottles from *ctd_ jc041_ nnn.bl* and copies into a new file named *fir_jc041_ nnn_ bl.nc.*

mfir_ 02 uses information from *fir_jc041_ nnn_ bl.nc* and *ctd_ jc041_ nnn_ 1hz.nc* to merge the time from the CTD using scan numbers and puts this into a new file *fir_jc041_ nnn_ time.nc.*

mfir_ 03 stores the CTD data for the time each bottle was fired in *fir_jc041_ nnn_ ctd.nc.* The CTD data are taken from *ctd_ jc041_ nnn_ psal.nc* and selected according to the firing time information stored in *fir_jc041_ nnn_ time.nc.*

mfir_ 04 copies information of each bottle from *fir_jc041_ nnn_ ctd.nc* onto *sam_ jc041_ nnn.nc.*

Program applied to the six first CTD casts only (*ctd001.cnv* to *ctd006.cnv*):

mdcs_ 05 applies positions from *dcs_ jc041_ nnn_ pos.nc* to all files.

Matlab programs applied to the casts where niskin bottles were fired (*ctd001.cnv* to *ctd008.cnv*):

msal_01. Prior to running this routine, the excel files from the Autosal salinity analysis have to be converted into .CSV files containing three columns with the salinity, the station number and the bottle number, all separated by a comma. These .CSV files need to be located in $\sim/ctd/BOTTLE\_SALTS/$. The *msal_01* reads the bottle salinities (.CSV files).

msal_02 includes salinity data from *msal_01.m* to *sam_jc041_nnn.nc.*

Table 3: Start and end of the casts used by *mdcs_03* for the first six stations. These numbers were determined manually by plotting and observing the pressure behaviour.

CTD Casts	Start Scan	End Scan
001	16737	354874
002	11500	317786
003	14008	264230
004	11150	300705
005	15750	271440
006	18890	280560
007	17020	620055
008	20560	687400
009	9900	710350
010	22918	310519
011	1	345070
012	1	35000
013	8260	774525

In total, 14 output NetCDF files are issued from this MEXEC processing and are located in $\sim/ctd$ (see Table 5).

Some modifications were done on the MEXEC suite to be able to process the JC041 CTD data. The original code was converted into comments and the new code was written just below the original one. It is recommended to process the TECHSAS data first (see Section 9), especially the position data (processed file *pos_jc041_01.nc*) as they are used in the MEXEC processing. The reason is that the raw position data is likely to have repeated time which causes the MEXEC suite to crash.

Many other matlab routines, written by Dr. Brian King, allow the user to load and manipulate the data. The most used routines for JC041 are listed below.

- **mcalib.m:** modifies any variable by applying a function of a single variable ($y = f(x)$, e.g. $y = 2 * x$). Variable overwritten.

- **mcalc.m:** modifies any variable by applying any required functions ($y = f(x_1, x_2)$, e.g. $y = sw\_depth(x_1, x_2)$). New variable created.

Table 4: Sequence for CTD and bottle processing

CTD files	Scripts	Input files	Output files
ctd001 to ctd013	msam_01	sam_jc041_varlist.csv	sam_jc041_nnn.nc
	mctd_01	ctd_jc041_nnn_ctm.nc	ctd_jc041_nnn_raw.nc
	mctd_02	ctd_jc041_renamelist.csv ctd_jc041_nnn_24hz.nc	ctd_jc041_nnn_24hz.nc
	mctd_03	ctd_jc041_nnn_24hz.nc	ctd_jc041_nnn_1hz.nc ctd_jc041_nnn_psal.nc
	mdcs_01	dcs_jc041_varlist.csv	dcs_jc041_nnn.nc
	mdcs_02	dcs_jc041_nnn.nc	dcs_jc041_nnn.nc
		ctd_jc041_nnn_psal.nc	dcs_jc041_nnn.nc
ctd001 to ctd006	mdcs_03	ctd_jc041_nnn_surf.nc	dcs_jc041_nnn.nc ctd_jc041_nnn_surf.nc
	mctd_04	ctd_jc041_nnn_psal.nc dcs_jc041_nnn.nc	ctd_jc041_nnn_2db.nc
	mdcs_04	dcs_jc041_nnn.nc pos_jc041_01.nc	dcs_jc041_nnn_pos.nc
ctd007 to ctd013	my_towyo	ctd_jc041_nnn_1hz.nc	ctd_jc041_nnn_towyo.nc towyo_jc041_nnn_2db_rf.nc ctd_jc041_nnn_towyo_2db.nc
ctd001 to ctd008	mfir_01	ctd_jc041_nnn.bl	fir_jc041_nnn_bl.nc
	mfir_02	fir_jc041_nnn_bl.nc ctd_jc041_nnn_1hz.nc	fir_jc041_nnn_time.nc
	mfir_03	fir_jc041_nnn_time.nc ctd_jc041_nnn_psal.nc	fir_jc041_nnn_ctd.nc
	mfir_04	fir_jc041_nnn_ctd.nc	sam_jc041_nnn.nc
ctd001 to ctd006	mdcs_05	dcs_jc041_nnn_pos.nc	dcs_jc041_nnn_pos.nc ctd_jc041_nnn_raw.nc ctd_jc041_nnn_24hz.nc ctd_jc041_nnn_1hz.nc ctd_jc041_nnn_psal.nc ctd_jc041_nnn_surf.nc ctd_jc041_nnn_2db.nc fir_jc041_nnn_bl.nc fir_jc041_nnn_time.nc fir_jc041_nnn_ctd.nc sam_jc041_nnn.nc dcs_jc041_nnn.nc

Table 5: Summary of the output files for the different CTD casts.

Output Files	ctd001 - 006	ctd007 - 008	ctd009 - 013
ctd_jc041_nnn_1hz	√	√	√
ctd_jc041_nnn_2db	√	√	√
ctd_jc041_nnn_24hz	√	√	√
ctd_jc041_nnn_psal	√	√	√
ctd_jc041_nnn_raw	√	√	√
ctd_jc041_nnn_surf	√	×	×
ctd_jc041_nnn_towyo	×	√	√
dcs_jc041_nnn_pos	√	×	×
dcs_jc041_nnn	√	√	√
fir_jc041_nnn_bl	√	√	×
fir_jc041_nnn_ctd	√	√	×
fir_jc041_nnn_time	√	√	×
sam_jc041_nnn	√	√	√
towyo_jc041_nnn_rf	×	√	√

- **mcalib2.m:** combination of mcalib and mcalc.

- **datpik.m:** selects any part of a variable.

- **mlist.m:** lists the variables of a NetCDF file.

- **mavrge.m:** averages data into bins, producing associated statistics. Gridded data accepted.

- **mreset.m:** allows to reset a NetCDF file already opened (flag).

- **msort.m:** sorts a variable.

- **mapend.m:** appends files into another file.

- **mcopya.m:** copies a variable into a NetCDF file.

- **mhistory.m:** displaies what has just been written to history file, can be then copied into a matlab script. Very useful!

- **mload.m:** loads a NetCDF file into matlab.

- **msave.m:** saves the variable in matlab workspace.

- **mintrp.m:** interpolates variables.

- **mplotxy.m:** allows a 2D plots by selecting any variables.

2.2.3   MStar CTD Processing: quick and dirty

In order to make things a bit simpler, this section describes the steps used for the CTD processsing. More information can be found in the previous section (see Section 2.2.2).

1. Rename the output .CNV and .BL files from the Seabird processing into *ctd_jc041_nnn_ctm.cnv* and *ctd_jc041_nnn.bl* and relocate them in ∼/*ctd/ASCII_FILES* and *BOTTLE_FILES*, respectively.

2. Manually reproduce the input files *sam_jc041_varlist.csv*, *dcs_jc041_varlist.csv* and *ctd_jc041_renamelist.csv* and locate them in ∼/*templates*.

3. Manually convert the Autosal files into .CSV files and locate them in ∼/*ctd/BOTTLE_SALTS*.

4. Run Matlab and apply the following commands:
   cd /local/users/pstar/cruise/data/mexec_processing_scripts
   m_setup_jc041
   cd /local/users/pstar/cruise/data/ctd

5. Then, run the matlab programs individually as described in the previous section (Section 2.2.2). *My_script.m* is not a program which can be run by itself, but it contains all the commands used in Section 2.2.2 and provides a good help to get started.

6. When all .SAM files contain salinity data from the sampling bottles and every cast has been averaged into a 2db resolution (*ctd_jc041_nnn_2db.nc*), it is useful to append all .SAM and .CTD files into one big file. The file containing all .SAM is *sam_jc041_all.nc*. Because the towyo casts were processed differently, the .CTD files were appended into two different files: *ctd_jc041_casts.nc* for all simple casts and *ctd_jc041_towyos.nc* for all towyo casts.

7. Then, these two latter files can be easily loaded into matlab structures (*'mload file_name.nc'*) and finally saved into a .MAT file. For JC041, the processed data are in *ctd_jc041_all.mat*.

2.3   Rosette Water Sample Analysis

2.3.1   Salinometer

Two NERC National Marine Facilities operated Autosal 8400B salinometers (Guildline Instrument Ltd., serial numbers 65764 and 68426) equipped with an Ocean Scientific

International Ltd. (OSIL) peristaltic pump were available for use. Unit s/n 65764 was used for the analysis of the niskin bottle rosette water samples, with unit s/n 68426 being reserved as a spare. The main salinometer was located in the controlled temperature laboratory and operated at 19.5°C (+/- 0.5°C) room temperature. A clear area was established around the CT temperature sensor, a fan was installed at deck-head height to circulate air around the lab, and the deadlights were closed to prevent solar heat gains. The conductivity cell was kept in a water bath at a constant temperature of 21.588°C (+/- 0.002°C). The salinometer was connected to a desktop computer with Windows operating system via an OSIL Autosal Computer Interface. This allowed the conductivity values to be read instantaneously into a processing software program, namely the OSIL Salinometer Data Logger (version 2009), which then applied all necessary corrections and converted the reading into salinity values.

2.3.2 Salinity Samples and Analysis

The water samples from the rosette were collected in 200 ml flat bottles. Before each collection, the sample bottles and caps were rinsed three times with water from the CTD niskin bottles to eliminate any eventual salinity residual. The bottles were filled just under the shoulder and their necks were wiped dry carefully to prevent salt crystallization at the bottle openings, which could contaminate the sample and introduce an error into the measurements. The bottles were then closed with airtight single-use plastic inserts and secured with the original bottle caps. The samples were stored upside down in open crates in the controlled temperature lab beside the salinometer for at least 24 hours before analyzing in order to adjust to the ambient lab temperature. The sample analysis was carried out using the OSIL Salinometer Data Logger software (version 2009), which was communicating to the salinometer via the OSIL Autosal Computer Interface. Once the salinometer standby/read/zero switch was set to 'read', the program would automatically start acquiring data from the salinometer.

Before analysis, the sample bottles were inverted several times to remove any salinity gradients that might have formed over time. The conductivity cell was flushed three times before an actual reading was taken. For each sample three separate readings were taken with the conductivity cell being flushed again between each reading. The data logger software acquired ten values for each reading calculated the average of these. Furthermore, an average of the three individual readings was calculated to give an overall conductivity value for the sample resulting in a single average salinity value for each bottle. Between each sample, the collection tube was wiped dry to prevent contamination of the following sample by the previous one. At the end of each analysis the salinometer was flushed several times and then filled with milliQ water until the next sample analysis to prevent the formation of salt crystals in the cell. Two minor mistakes were made during

the collection of the samples. Two bottles were not sealed with white airtight plastic inserts, this results with one bottle loosing half of the sea water, which strongly affected the final measurements. The other minor mistake concerns a sampling bottle which was fully filled, hence no mixing could be done to remove the small salinity stratification and therefore a high standard deviation was obtained.

Three analysis were done on JC041 so that three crates (around 45 sampling bottles) were done per analysis. At the beginning of each analysis, the salinometer was calibrated using OSIL IAPSO standard seawater batch P150 (K_{15}=0.99978, S=34.991). The calibration was done by adjusting the reading of the instrument (button at the bottom of the instrument) before each analysis. However, it was suggested that this was not necessarily a good practice as the history of the analysis through the cruise was lost. A good practice would have been to adjust the reading of the calibration at the beginning of the cruise only. A standardisation was carried out at the beginning and the end of each analysis. It is also a good practice to analyse standard water as a normal sample at the beginning and the end of each analysis, this was done on JC041. For each analysis, it was not required to apply manual corrections to the data since the instrument was drifting only a negligibly small amount and continuously delivered a consistent and stable output. However, an offset was found between the salinity from the CTD and that of the sample bottles. To compensate the lack of history for JC041, three different offsets (equal to the means of the data) were applied to the dataset for the three different analysis (see Table 6). Figure 3 depicts the difference between the CTD salinity and the bottle salinity as a function of the number of sample bottles, whereas Figure 4 shows the same difference as a function of the pressure after calibration.

Table 6: Means, standard deviations and root mean squares of the sample salinity for the three different analyses.

Mean	Standard Deviation	Root Mean Square
-0.00130	0.00398	0.00413
-0.00351	0.00332	0.00480
-0.00500	0.00323	0.00476

Usually, the difference between the salinity of the CTD and that of the sample bottle tends to be small at the surface (below 0.004) and smaller in deeper ocean (below 0.002), as seen in previous reports (*cf.* JC029 cruise report - SOFINE). Figure 4 shows a completely different picture where the difference is much more scattered, below 0.01 at the surface and below 0.008 as we go deeper. Several possible explanations were taken into account. First, it could have been a bad Autosal analysis, either induced by the operator or by the instrument. However, the operator used the same procedure
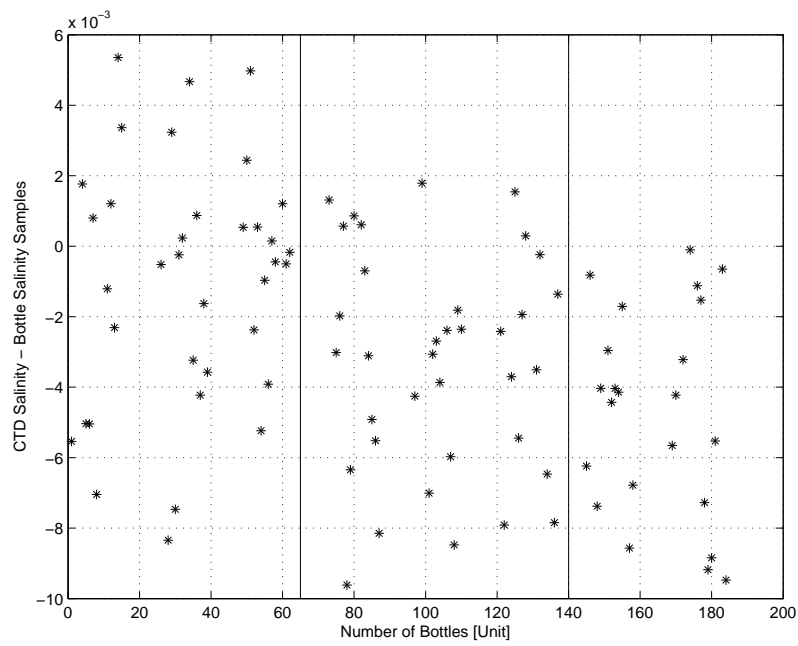
Figure 3: CTD salinity minus bottle salinity samples. Calibration coefficients were determined from the primary CTD sensor. The vertical black lines shows the start and the end of an analysis.
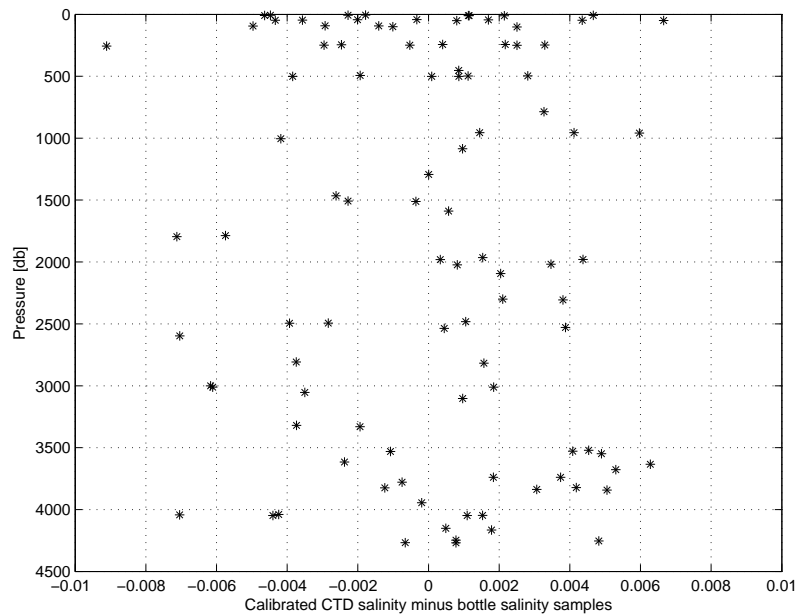
Figure 4: CTD salinity minus bottle salinity samples. Calibration coefficients were determined from the primary CTD sensor.

used during JC029, where the data were correctly processed and the procedure was checked after the cruise. Nothing makes one think that the analysis was badly carried out. Regarding the data issued from the Autosal, they seem consistent despite a higher mean standard deviation on the salinity $(3.9 * 10^{-4})$ compared to the mean standard deviation from the JC029 data $(1.56 * 10^{-4})$. As no standard deviation was given for the salinity from the OSIL software, each averaged reading of the conductivity ratios was converted into salinity according to the definition of the Practical Salinity Scale of 1978, and the standard deviation was then calculated. Second, a comparison between the pre- and post-cruise calibrations of the CTD sensors would be a good hint to see any *in situ* measurement discrepancies. Unfortunately, these sensors have not been calibrated since JC041 and will not be before the end of the JC044 cruise. Therefore, only the pre-cruise calibrations are available and these sensors seemed to be working fine before the JC041 cruise. It was also mentioned that sometimes there can be problems with the conductivity cell and these sensors need to be replaced from time to time. So far, no clear explanation has been established.

In total, 109 salinity samples were taken from the CTD niskin bottles and analyzed, excluding eight niskin cylinders which failed to close properly. Over these 109 salinity data, three were erroneous due to a bad sampling practice and eight gone spurious readings for unknown reasons. Table 7 shows the various events during the CTD stations and during the sample analysis, as well as the residuals between the salinity measured *in situ* and the salinity from the sample bottles. The CTD salinity and pressure were obtained from the *sam_jc041_all.mat* file, processed with the MEXEC suite (see Section 2.2.2). Data annotated with a star symbol * were not taken into account for the calibration of the CTD data.

Table 7: Significant events during and after CTD stations.

BOTTLE		CTD		Difference	Comments	
Bottle Number	Bottle Salinity	CTD Salinity	Pressure (dB)	CTD sal - BTL sal	CTD Comments	Sal. Comments
Calibration						
CTD01_1	34.7079	34.70236066	4040.002557	-0.005539336		
CTD01_2		34.70245853	4042.629428		Leaked	
CTD01_3*	34.7261	34.70366083	3938.38346	-0.022439168		
CTD01_4	34.7041	34.70586457	3836.919221	0.001764569		
CTD01_6	34.731	34.72066334	3320.30182	-0.010336663		
CTD01_5	34.7257	34.72595714	2807.38189	0.000257144		
CTD01_7	34.72	34.72080089	2299.876878	0.000800886		
CTD01_8	34.6871	34.6800538	1786.862299	-0.007046198		
CTD01_9*	34.8055	34.58618836	1276.388156	-0.219311644		No white cap, leaked, 2/3 of water left
CTD01_10*	34.4537	34.33322703	766.6823854	-0.120472971		No white cap but remains full
CTD01_11	34.1065	34.10529241	500.581796	-0.001207588		
CTD01_12	34.0406	34.04180602	249.1436111	0.001206025		
CTD01_13	34.0291	34.02678985	99.56432726	-0.002310146		
CTD01_14	34.0232	34.02855581	49.51341146	0.005355809		
CTD01_15	34.0295	34.03286438	8.299065104	0.003364383		too full, can't mix it!
CTD02_164		34.69982209	4248.336193		Did not seal properly	
CTD02_165	34.7002	34.69967945	4247.09528	-0.000520553		
CTD02_166*	34.7335	34.70094261	4145.076851	-0.032557394		
CTD02_167	34.7125	34.70415637	4042.896104	-0.008343634		
CTD02_168	34.7141	34.71733424	3520.853786	0.003234238		
CTD02_169	34.7359	34.72843344	3000.383727	-0.007466557		
CTD02_170	34.7104	34.71015509	2481.703756	-0.000244913		
CTD02_171	34.6895	34.68973325	1965.1115	0.000233253		
CTD02_172*	34.7589	34.64301436	1456.780793	-0.115885644		
CTD02_173	34.4899	34.49456947	958.3096623	0.004669467		
CTD02_174	34.1428	34.13956525	493.8825234	-0.003234752		
CTD02_175	34.0762	34.077073	242.7552422	0.000873002		
CTD02_176	34.0242	34.01997464	91.89043924	-0.004225362		
CTD02_177	34.0217	34.0200692	42.30684375	-0.001630795		
CTD02_178	34.0229	34.01932381	6.71953125	-0.003576187	5m below surface	
CTD03_188	34.7118	34.71233593	3739.604833	0.000535933		
CTD03_189	34.7097	34.71213898	3739.456805	0.002438982		
CTD03_190	34.7102	34.71517757	3633.589485	0.004977569		
CTD03_191	34.7195	34.71712519	3530.36087	-0.002374809		
CTD03_192	34.7269	34.72744536	3011.656946	0.000545362		
CTD03_193	34.7143	34.70906521	2495.236203	-0.005234786		
CTD03_194	34.683	34.68203309	1980.278041	-0.000966915		
CTD03_195	34.6513	34.64738504	1465.388013	-0.003914959		
CTD03_196	34.4983	34.49844931	955.0867812	0.000149313		
CTD03_197	34.1554	34.15495609	452.7144071	-0.000443908		
CTD03_198	34.0515	34.04109143	256.0183021	-0.010408569		
CTD03_199	34.0216	34.02280459	101.5570521	0.001204587		
CTD03_200	34.0219	34.02140027	50.07481076	-0.000499728		
CTD03_201	34.0193	34.01912947	9.591730903	-0.000170534		
CTD03_std_1	34.9919	34.991		-0.0009		

BOTTLE		CTD		Difference	Comments	
Bottle Number	Bottle Salinity	CTD Salinity	Pressure (dB)	CTD sal - BTL sal	CTD Comments	Sal. Comments
Calibration						
CTD04_236	34.7001	34.70141205	4253.819457	0.001312052		
		34.70142311	4255.76216		Bottle did not seal	
CTD04_237	34.7048	34.70178094	4151.267849	-0.003019057		
CTD04_238	34.7045	34.70252216	4047.292169	-0.001977845		
CTD04_std_1	34.9917	34.991		-0.0007		
CTD04_239	34.7186	34.7191718	3529.042381	0.000571802		
CTD04_240	34.7364	34.72678242	3010.7662	-0.00961758		
CTD04_241	34.7173	34.71095514	2493.685979	-0.006344859		
CTD04_242	34.6796	34.68046233	1979.443078	0.000862328		
		34.63669873	1467.053219		Bottle did not seal	
CTD04_243	34.4828	34.48340963	955.9521589	0.000609628		
CTD04_244	34.1422	34.14150025	496.647875	-0.000699753		
CTD04_245	34.0332	34.03009102	243.3304766	-0.003108978		
CTD04_246	34.0256	34.02068146	93.58524653	-0.004918542		
CTD04_247	34.0244	34.01888044	43.47109983	-0.005519557		
CTD04_248	34.0247	34.01655317	8.778197916	-0.008146835		
CTD05_212	34.7154	34.71114221	3779.247389	-0.004257795		
		34.71115894	3779.228161		Bottle did not seal	
CTD05_213	34.7118	34.71359037	3677.208004	0.001790369		
CTD05_214*	34.7383	34.71692224	3573.084319	-0.021377755		
CTD05_215	34.7345	34.72749048	3054.040112	-0.007009522		
CTD05_216	34.7135	34.71043553	2536.880352	-0.003064471		
CTD05_217	34.6868	34.6841061	2023.738307	-0.002693898		
CTD05_218	34.6556	34.65173312	1511.641016	-0.003866881		
		34.53422865	1000.358842		Bottle did not seal	
CTD05_219	34.1808	34.17841169	497.7238776	-0.00238831		
CTD05_220	34.0581	34.05212613	245.2461901	-0.005973871		
CTD05_221	34.0276	34.01912189	94.03952604	-0.008478109		
CTD05_222	34.0231	34.02128411	43.97750347	-0.001815886		
CTD05_223	34.0185	34.01614237	10.60246962	-0.002357626		
CTD06_260	34.7036	34.70118383	4048.216702	-0.002416171		
CTD06_261	34.7092	34.70128644	4048.002022	-0.007913565		
		34.70120238	4046.791467		Failed to close	
CTD06_263	34.7071	34.70339757	3944.929222	-0.003702427		
CTD06_264	34.7038	34.70534259	3842.543095	0.001542591		
CTD06_265	34.7257	34.72025385	3330.92782	-0.005446148		
CTD06_267	34.7295	34.72755906	2817.540786	-0.001940935		
CTD06_268	34.7099	34.7101952	2306.618433	0.000295205		
CTD06_269	34.6872	34.67656872	1795.391986	-0.010631281		
CTD06_266*	34.735	34.67662703	1797.095236	-0.058372972		Missing the bottle number, guessed it was 266
CTD06_270	34.5977	34.59419471	1292.927766	-0.003505289		
CTD06_271	34.388	34.38775866	786.6533333	-0.000241337		
CTD06_272*	34.1923	34.17515259	499.4980087	-0.017147407		
CTD06_273	34.0722	34.0657353	248.3843793	-0.006464696		
		34.02566579	98.19520226		Leak	
CTD06_275	34.0263	34.0184543	47.5246849	-0.007845701		
CTD06_276	34.0212	34.01983806	10.80221788	-0.001361936		
CTD06_std_2	34.9911	34.991		-0.0001		

BOTTLE		CTD		Difference	Comments	
Bottle Number	Bottle Salinity	CTD Salinity	Pressure (dB)	CTD sal - BTL sal	CTD Comments	Sal. Comments
Calibration						
CTD07_572	34.7123	34.70606243	3824.225174	-0.006237573		
CTD07_573	34.7069	34.7060813	3822.811577	-0.000818699		
CTD07_574	34.7207	34.71332123	3615.682944	-0.00737877		
CTD07_std_1	34.992	34.991		-0.001		
CTD07_575	34.7292	34.72516712	3102.966536	-0.004032883		
CTD07_576	34.733	34.72096012	2597.094747	-0.012039884		
CTD07_577	34.6966	34.6936423	2093.522918	-0.002957703		
CTD07_578	34.664	34.65956809	1589.404728	-0.004431913		
CTD07_579	34.5681	34.56406253	1085.654781	-0.004037474		
CTD07_580	34.2034	34.19925847	500.8048524	-0.004141525		
CTD07_581	34.0904	34.08869239	247.46402	-0.001707606		
CTD07_582	34.0343	34.02573298	46.7231276	-0.008567023		
CTD07_583	34.0233	34.01652019	6.187475694	-0.006779812		
CTD08_932	34.686	34.68034212	4267.679938	-0.005657883		
CTD08_933	34.6848	34.68057591	4268.397109	-0.00422409		
CTD08_934	34.6874	34.68418302	4164.89991	-0.003216979		
CTD08_935*	34.7158	34.69808485	4062.217096	-0.017715148		
CTD08_936	34.7159	34.71579679	3549.29219	-0.000103214		
CTD08_937*	34.7448	34.72555029	3036.891561	-0.019249713		
CTD08_938	34.7251	34.72397668	2528.429687	-0.001123317		
CTD08_939	34.6956	34.69406787	2017.626441	-0.00153213		
CTD08_940	34.6658	34.65852371	1508.239785	-0.007276286		
CTD08_941	34.5451	34.53591943	1004.146354	-0.009180569		
CTD08_942	34.2274	34.21855618	500.3690573	-0.008843824		
CTD08_943	34.058	34.05247391	248.2424635	-0.005526089		
CTD08_944*	34.0554	34.03211305	96.3862092	-0.023286954		
CTD08_945	34.0317	34.0310528	47.4389809	-0.000647201		
CTD08_946	34.0407	34.03122441	7.155424479	-0.00947559		
TSG_std_2	34.9913	34.991		-0.0003		

2.3.3 CTD sensors comparison

A comparison of the two sensors (through the bottle salinities) shows that there was a drift in the second sensor seemingly linear in depth (see Figure 5). No data from the second CTD sensor were taken into account for the calibration of the CTD data.
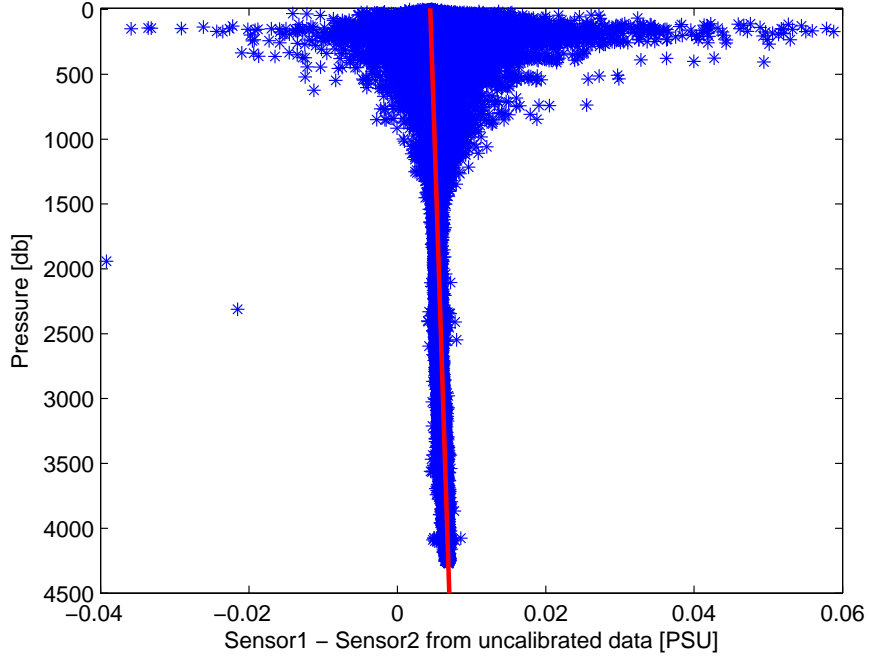
Figure 5: Difference between the salinities measured by the two sensors.

The following correction was calculated from the salinities of the sample bottles only. This correction was then applied to the salinity from the second sensor (S_2) to match the uncalibrated salinity measured by the first sensor (S_1):

$$S_1 = S_2 + \frac{Depth + 7841.5}{1760592.9} \tag{1}$$

2.4 Preliminary Figures

Figure 6 represents a TS diagram of the first six stations (CTD001 to CTD006) with the isopycnal contours in orange.

The eight following plots (from Figure 7 to Figure 14) show the potential temperature (top) and the salinity (bottom) of the four towyo casts (CTD007 to CTD010).
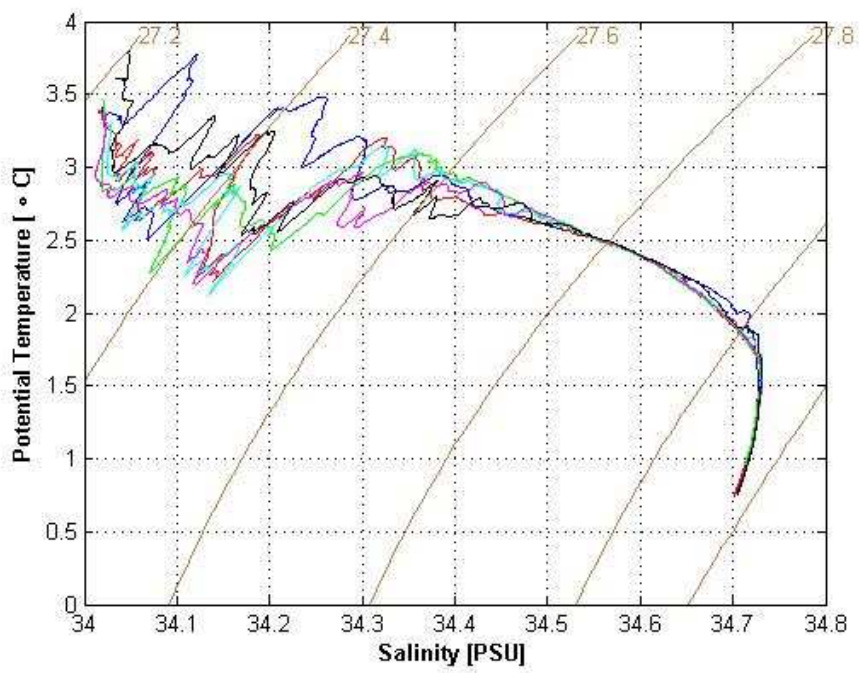
Figure 6: TS diagrams for the first six stations.
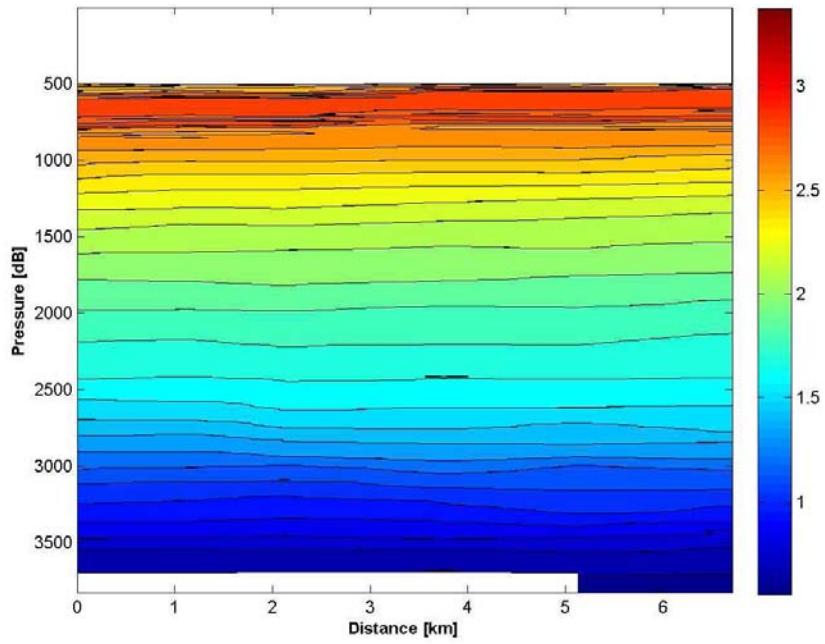
Figure 7: CTD potential temperature in degrees Celcius (°C) for the towyo cast CTD007
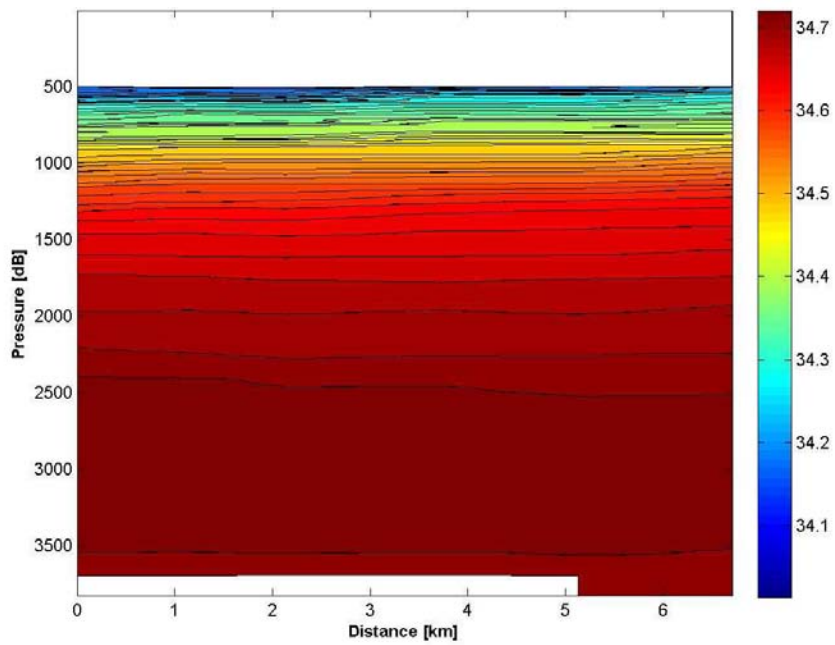
Figure 8: CTD salinity (PSU) for the towyo cast CTD007

43
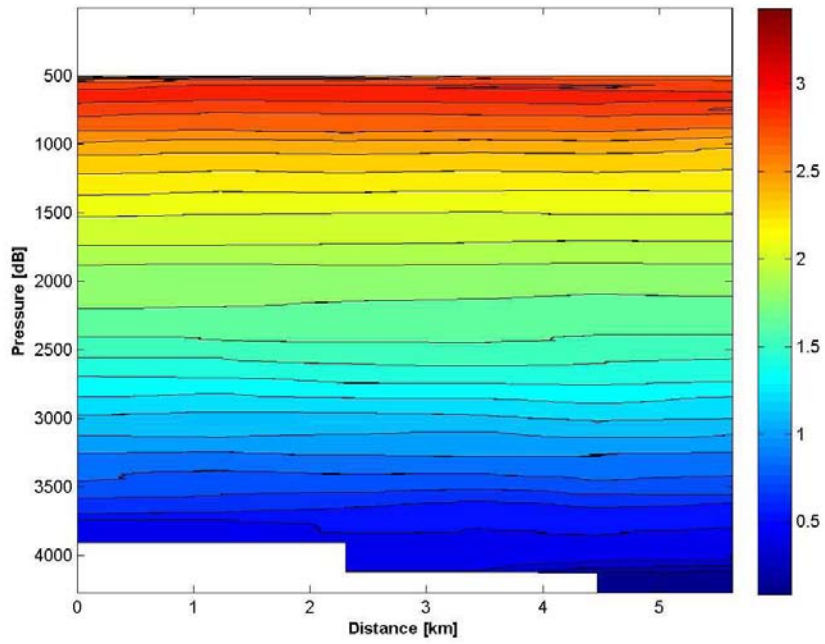
Figure 9: CTD potential temperature in degrees Celcius (°C) for the towyo cast CTD008
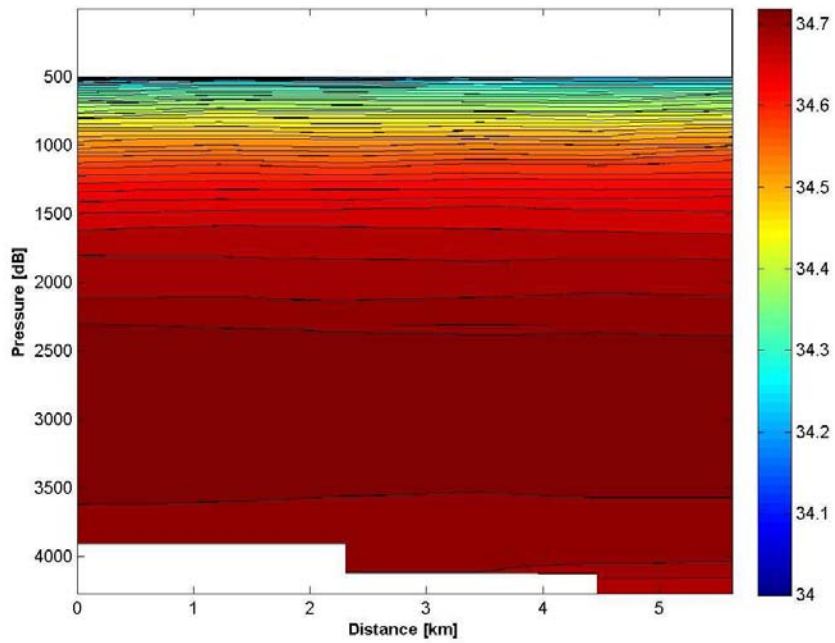
Figure 10: CTD salinity (PSU) for the towyo cast CTD008
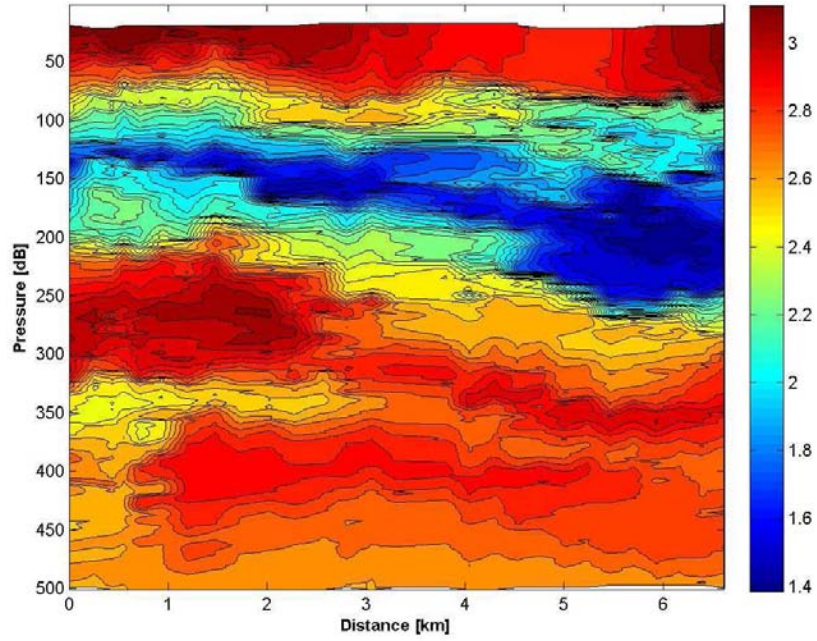
Figure 11: CTD potential temperature in degrees Celcius (°C) for the towyo cast CTD009
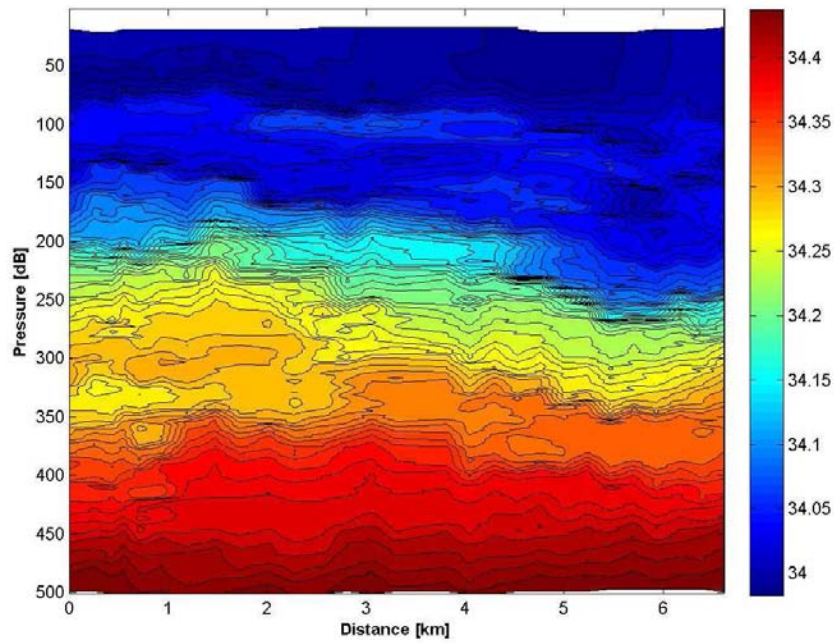
Figure 12: CTD salinity (PSU) for the towyo cast CTD009
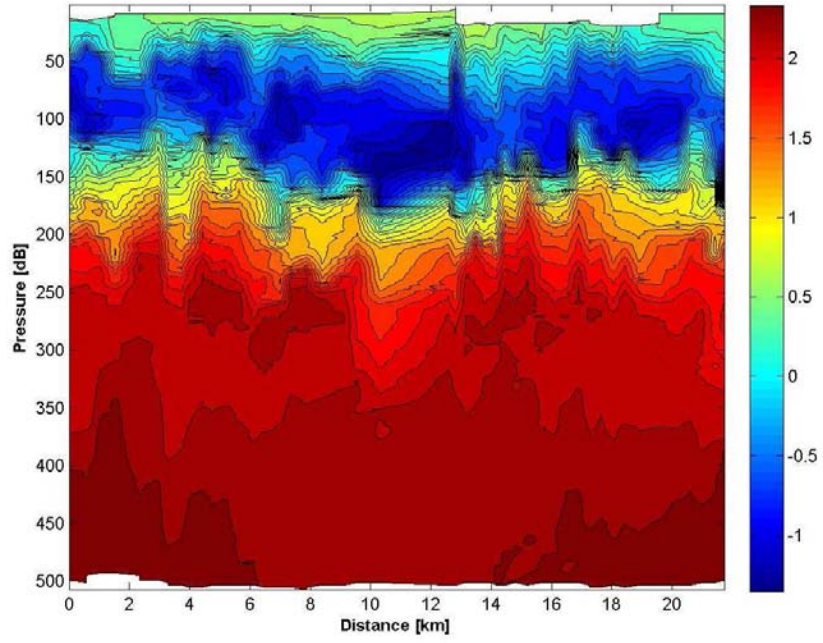
Figure 13: CTD potential temperature in degrees Celcius (°C) for the towyo cast CTD010
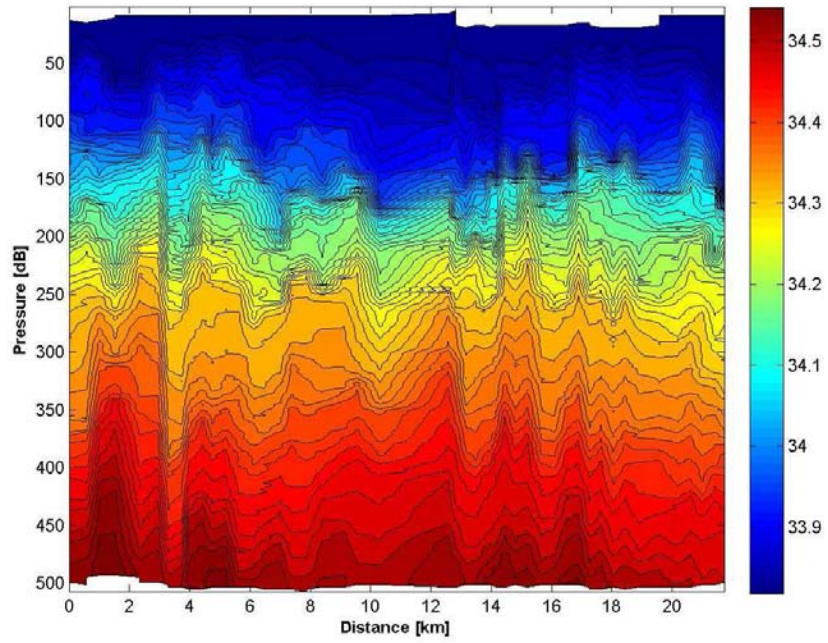
Figure 14: CTD salinity (PSU) for the towyo cast CTD010

46

3 Lowered Acoustic Doppler Current Profiler (LADCP) Operations and Data Processing

Alberto Naveira Garabato, Paul Provost, Peggy Courtois

3.1 JC041 LADCP Operations

The LADCP package used during JC041 consisted of two RDI 300 kHz Workhorse ADCPs looking down (WHM) and looking up (WHS). The WHM was mounted off-centre at the bottom of the rosette frame and the WHS was mounted outside the main frame. The details of their sampling configurations are briefly described in section 3.1.1. The battery packs for both LADCPs were mounted horizontally at the level of the CTD. Between stations, each ADCP was connected to a controlling PC in the Deck Lab through a serial cable for delivery of pre-deployment instructions and post-deployment data retrieval. Further, the battery package was connected to a charging unit in the Deck Lab via a power lead.

An LADCP profile was obtained from each of the CTD casts, except for the cast CTD007 due to a mistake in setting up the instrument. There is no slave data for the final towyo cast (CTD010) as it was disconnected to preserve battery life for the originally planned 24 hour deployment, although this was reduced to two 18 and 8 hour deployments with a short (1.25 hr) charge midway through.

3.1.1 RDI Workhorse LADCP Configuration

Two main command files were used during the cruise and are seen in Table 8 (WHM_JC041.CMD and WHS_JC041.CMD).

3.1.2 Deployment

These instructions, provided by Paul Provost and adapted from the JC029 cruise report, are for use in conjunction with the LADCP log sheet.

- Connect the communication and battery leads for instruments to be deployed. During the UK DIMES1 cruise, the WHM to the COM3 port and the WHS to the COM4 port.

Table 8: LADCP information.

Downlooking Master Workhorse 300 kHz Aluminium Pressure Case WHM_JC041.CMD	Uplooking Slave Workhorse 300 kHz Aluminium Pressure Case WHS_JC041.CMD
PS0	PS0
CR1	CR1
CF11101	CF11101
EA00000	EA00000
EB00000	EB00000
ED00000	ED00000
ES35	ES35
EX11111	EX11111
EZ0011111	EZ0011111
TE00:00:01.00	TE00:00:01.00
TP00:01.00	TP00:01.00
WM15	WM15
LD111100000	LD111100000
LF0500	LF0500
LN016	LN016
LP00001	LP00001
LS1000	LS1000
LV250	LV250
LJ1	LJ1
LW1	LW1
LZ30,220	LZ30,220
SM1	SM2
SA001	SA001
SW05000	ST0
CK	CK
CS	CS

- **<F3>:** The BBtalk terminal session was logged to a file named with the format CTDxxxm.txt for the down-looking master and CTDxxxs.txt for the up-looking slave, where *xxx* was the CTD cast number. This is done by pressing <**F3**> which creates a log file in which all subsequent BB-related BBTALK output will be stored. The locations of these files are C:\Documents and Settings\Administrator\My Documents\LADCP\JC041\WH{Master/Slave}\CTDnnn{m/s}.txt (where *nnn* is the station number).

- **<fn><END> or [B]:** To wake up the LADCP press <**fn**><**END**> or the **[B]** button below the menu bar in BBTALK. A message will appear. If the connection fails, check that the communications lead is properly connected at the LADCP end.

- **CB411**: To change baud rate to 9600 for sending the command file.

- **PS0**: To provide an additional check of serial number (also in the command file).

- **TS?**: Check the LADCP clock with the GPS clock. If the times differ by more than 1∼s, reset the LADCP clock by typing **TSYYMMDDhhmmss**.

- **RS?**: To check flashcard space. If the memory is insufficient, clear the memory by typing **re ErAse**. The memory should only be cleared after all data has been transferred to another machine and checked.

- **PA and PT200**: Pre-deployment and built in self tests. Type **PT200** to run diagnostic checks. Note that the Receive Path (PT3) and Bandwidth (PT6) tests may fail if the BB is not in water. Other tests should pass. Next type **PA** for further checks.

- Switch off the battery charge unit and check the battery voltage.

- **<F2>:** Press <**F2**> and enter the name of the LADCP configuration file.

- **<F3>:** Press <**F3**> to stop logging. Deployment and end of pinging times have to be recorded on the rough log sheets.

- Finally, detach charger and communication cables for all instruments and fit blanks to all cable ends.

3.1.3 Recovery

- Remove blanks and attach the communication and charger cables.

- **<fn><END> or [B]:** In BBTALK press <**fn**><**END**> or the **[B]** button below the menu bar to terminate logging. Note the time.

- Switch on the charger.

- **PSO:** Type **PS0** to check communications.

- **CB711:** Type **CB711** to set the baud rate to 115200.

- **RA?:** Type **RA?** to check the number of deployments.

- In the file menu, select recover recorder. Select directory and then select the last file in the list. Note the file name and file size. (Note for the BB type **RY#** where # is the number of the deployment you wish to recover).

- **CB411:** Type **CB411** to set the baud rate back to 9600 and power down by typing **CZ**.

- Rename the default RDI-xxx.000 file names to CTDxxxm/s.000. All filenames were noted on the rough log sheets.

- Finally, transfer the data files and logs to cook3. The data are now ready for processing.

The battery was fully charged at 58V until it was drawing 100mA between each cast.

3.2   LADCP Processing

Two software packages are used to process the LADCP data for the first six stations. No processing has been done yet on the tow-yo data, as it requires a modification of the packages used. Both packages were installed on Alberto Naveira Garabato's laptop by Brian King and the data processing was done on this laptop. The first software package is originally from Eric Firing's group at the University of Hawaii (UH). The second Visbeck software from Lamont-Doherty Earth Observatory (LDEO) is mainly used for obtaining bottom tracked profiles. Below is a description of the two different processings:

3.2.1   UH Processing

This processing stage allows the user to examine the quality of the data and to calculate relative velocity profiles in the absence of CTD or navigational data. The raw (*.000 etc) LADCP data should be copied from */data32/JC041/LADCP* to
~*/jc041/data/ladcp/uh/raw*
/jc0912/ladcp.

1. Set up the paths required for the processing.
   cd ∼/cruise/data/ladcp/uh
   source LADall

2. Create symbolic links with required names from the binary *.000 files to the real raw files. The UH software requires a filename of jNNN_cc.000, where NNN is the station number and cc is 01 for the BB, 02 for the WHM, and 03 for the WHS. We use the suffix 02 for the LADCP being down looking.
   cd proc/Rlad; linkscript.

3. Scan the raw data and create a station-specific directory structure in the *proc/casts* directory. Data printed to screen should be checked to ensure the details of the cast (depth, downcast/upcast times) agree approximately with those in the CTD and LADCP logsheets.
   cd proc
   perl -S scan.prl NNN_02

4. In that directory, run Matlab and type **m_setup**.
   Get the position of the cast by accessing the techsas datastreams, by typing:
   putpos(NNN,02)
   Apply the magnetic correction to the compass on the LADCP:
   magvarsm(NNN,02)
   This updates *stations.asc* and *magvar.tab* (using Matlab).
   Quit Matlab.

5. To load the raw data, correcting for *magvar.tab* and to start processing, type
   perl -S load.prl NNN_02.
   Reply '**y**' at both prompts. Sometimes the program does not execute because path names in LADall are too long for the length of environmental variables predetermined in the UH software. Use symbolic links if this happens. It is very important that this step is only done once. If you need to do it again delete the database files (∼/jc041/data/uh/pro/jc0912/ladcp/proc/casts/jNNN_02/scdb) first.

6. Merge the velocity shear profiles from individual pings into a single downcast or upcast profile. The option *-c0* states that we do not have CTD data yet.
   perl -S domerge.prl -c0 NNN_02

7. To make a smoothed navigatoin file for the cast:
   cd Rnav
   Run Matlab and type **make_sm**.

8. Still in Matlab, change directory:
   cd proc

Calculate the relative velocity profiles by typing:

plist = NNN.02; do_abs

Check that these plots look sensible, i.e. reasonable agreement between the downcast and upcast profiles and that the vertical velocity is of order $1{\sim}\text{m.s}^{-1}$ and reverses sign between the downcast and upcast. It may be necessary to rescale some of the plots.

Once the CTD data has been processed, this can be incorporated into the LADCP processing to make more accurate estimates of depth and sound velocity and to obtain a final absolute velocity profile.

9. The inclusion of CTD data requires an ASCII file containing 1 Hz CTD data for the station created in Matlab. To do so, type:
   cd proc; cd Rctd
   Open a Matlab session and run the script **mk_ctdfile(NNN)**.
   An ASCII file ctd.NNN.02.asc should be created for each station in $\sim$/*jc041/data/ladcp/uh/raw/jc0912/ctd*. Each file should have 4 columns with time (Julian day expressed in s), pressure, temperature and salinity.

10. Still in matlab, type:
    cd proc/Pctd
    ctd_in(NNN,02)
    This will read the 1 Hz CTD data in.
    plist = NNN.02; fd
    This aligns the LADCP and CTD data sets in time. Then, quit Matlab.

11. Back in $\sim$/**jc041/data/ladcp/uh/pro/jc0912/ladcp/proc/** type:
    cd proc
    perl -S add ctd.prl NNN_02 to add CTD data to the **.blk* LADCP files in the *scdb* directory.

12. Merge the single pinngs into corrected shear profiles, by typing:
    perl -S domerge.prl -c1 NNN_02. The option *-c1* states that we now have CTD data.

13. Finally, run Matlab and calculate the final absolute velocity profiles.
    plist = NNN.02; do_abs

3.2.2 LDEO Processing

As with the UH processing, the LDEO processing can first be carried out without the CTD data to monitor the results and performance of the beams. The LDEO processing extracts the useful bottom track velocities.

1. Create additional symbolic links in ($\sim/jc041/data/ldeo/jc0912/$), such as
   ln -s ../../uh/raw/jc0912/ladcp ladcp
   ln -s ../../uh/raw/jc0912/gps gps
   ln -s ../../uh/raw/jc0912/ctd ctd
   ln -s ../../uh/raw/jc0912/ladcp/proc/matprof uhmat

2. Type
   cd ladcp
   cd ldeo/jc0912.

3. Start Matlab and run **setpar_jc041.m**. This will set up the path and various parameters. Then type **sp**. At the prompts enter station number and the run letter **whmvisbt**. If you work without the CTD data, it is recommanded to use different letters (e.g. 'noctd' for no CTD data and 'wctd' when CTD data are included).

4. To run the processing scriptes, type **lp**.

When CTD are available the processing automatically uses it. The required format of the CTD data is common for Visbeck and UH processing. On JC029 (SOFINE cruise), scientists used the Matlab command *readctd* in the raw ctd directory to read a 24 Hz **.cnn* file and produces the correct format 1 Hz data. They then re-run the steps above, but used *whmvisbtctd* as the identifier to distinguish the output.

We used a matlab program mlad_01_jc041.m to load both LDEO and UH processed LADCP velocity profiles. This routine also saves the data into 3 m* files for each station containg UH, LDEO and bottom velocities.

4   Mooring Operations

Helen Johnson, Paul Provost

The mooring program comprised two components. A UK mooring cluster of 6 moorings measuring velocity, temperature, salinity and pressure was first deployed in a cross-like pattern centred on 56° 0.7′ S, 57° 49.7′ W to investigate the interactions between the mesoscale flow field, topography and internal wave field. A total of 34 current meter/CTD pairs, two McLane moored profilers and one ADCP were deployed. Three further (US) moorings were then deployed containing RAFOS sound sources which will track DIMES isopycnal floats entering the Scotia Sea.

Mooring deployment operations began at 09:39 UTC on 9 December 2009 with the deployment of the NE UK mooring and were completed at 17:39 UTC on 16 December 2009 with the deployment of the third US RAFOS sound source mooring. All moorings were deployed from the aft-deck of the RRS *James Cook* by Paul Provost, National Oceanographic Centre, Southampton (NOCS), UK, with assistance from NMF technicians and the ship's crew. Additional assistance was provided by Peter Lazarevich, Florida State University, Tallahassee, US.

All moorings were deployed using a NOCS double barrel winch (electro-hydraulic) and reeling winch, using the ship's two aft cranes as necessary. The moorings were deployed 'top first - anchor last', allowing the buoyancy to stream away from the vessel during deployment. Vessel speed varied between 0.3 and 1.2 knots during mooring deployment.

4.1   UK Mooring Deployment

Prior to the beginning of the mooring operations a swath bathymetry survey was completed of the UK mooring deployment area to confirm the topographic data on which the array design was based. The central and Middle moorings (C and M) lie on top of a topographic bump of depth approximately 3650m. As a result of the swath survey the decision was made to move the target location of the M mooring to 56° 1.32′ S, 57° 47.22′ W. Estimated actual mooring positions are given in Table 9 and are shown in Figure 15. Note that a bias was observed in the swath bathymetry data, when compared with depths measured at the bottom of CTD casts, with swath depths approximately 50m deeper.

Current meter/CTD pairs were configured to sample quasi-synchronously, every 15 minutes, with the exception of the 5 Sontek current meters and the RCM-11 (together with corresponding SBE37 microcats) which were set up to sample every 20 minutes

due to battery constraints. All instruments except the two moored profilers commenced recording data at 12:00:00 UTC on 7 December 2009, and their operation was confirmed prior to deployment.
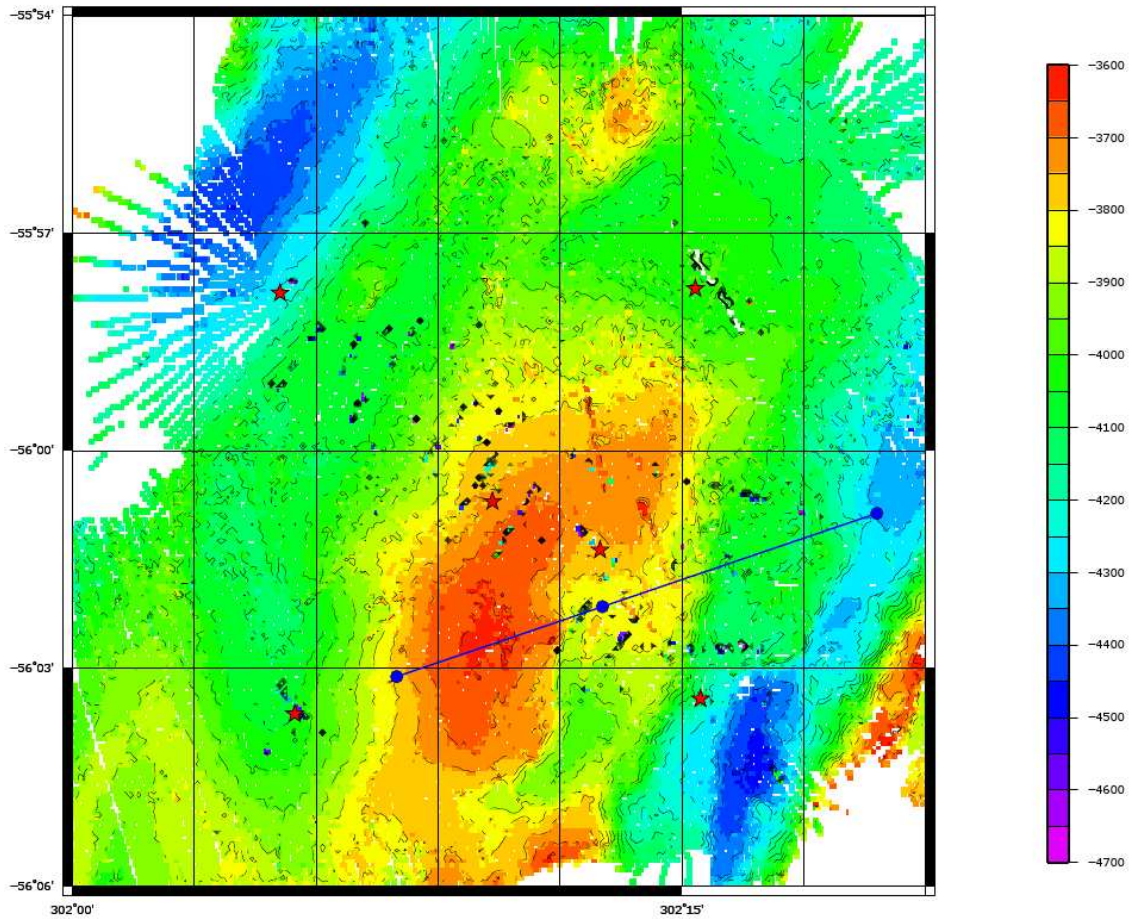
Figure 15: Position of mooring array in relation to the bathymetry and tow-yo locations. Note that there was a bias in the swath bathymetry data, with values shown approximately 50m greater than actual depths as measured at the bottom of CTD casts.

Table 9: Positions of the six UK moorings as estimated from triangulation.

Mooring	Latitude	Longitude
C	56° 00.709′ S	57° 49.661′ W
M	56° 01.379′ S	57° 47.010′ W
NE	55° 57.779′ S	57° 44.660′ W
NW	55° 57.837′ S	57° 54.878′ W
SE	56° 03.430′ S	57° 44.543′ W
SW	56° 03.636′ S	57° 54.527′ W

Table 10: Distance (km) between mooring positions

	NE	SE	C	M	NW
SE	10.47				
C	7.50	7.31			
M	7.10	4.58	3.01		
NW	10.59	14.89	7.58	10.46	
SW	14.90	10.33	7.40	8.83	10.75

Table 11: Acoustic release ranging codes for all of the moorings in the UK array. See Appendix 1 for details of release codes and frequencies etc.

Mooring	Release	Serial number	Ranging code
NE	RT661	321	C446 (mode A)
SE	RT661	439	EC67
C	AR861	831	1668
C	AR861	832	1669
M	AR861	474	14C7
M	AR861	311	1525
NW	AR861	255	14AC
SW	AR861	830	1667

4.1.1 NE Mooring

The nominal target position for the NE mooring of the UK array was 55° 57.84′ S, 57° 44.40′ W in 3975m of water. The mooring consisted of five current meter/CTD pairs (Figure 16, Table 12).

The mooring operation began at 09:39 UTC on 9 December 2009. Attachment of in-line current meters and conductivity-temperature-depth sensors continued until 11:14 UTC (Table 12). At this time the ship was still some distance from the nominal position, and the mooring was towed behind the ship for approximately 45 minutes. The mooring anchor was released from the ship at 11:57 UTC, 55° 57.940′S 57° 44.807′W in 3958m water depth. This was approximately 400 m past the intended anchor position to allow for fall back of the mooring during release and descent.

Table 12: Instruments, time and position of deployment for NE mooring of UK mooring cluster, deployed on 9/12/2009.

Instrument and Equipment	Serial Number	Time (UTC) Overside	Latitude Overside	Longitude Overside
Xenon Flash	S01-180	9:41	55.9420 S	57.6771 W
Argos Sercel Beacon	016-111	9:41	55.9420 S	57.6771 W
Seaguard	113	9:51	55.9427 S	57.6790 W
SBE37 SMP	7292	9:51	55.9427 S	57.6790 W
Seaguard	116	9:58	55.9432 S	57.6806 W
SBE37 SMP	7293	9:58	55.9432 S	57.6806 W
Seaguard	118	10:13	55.9458 S	57.6880 W
SBE 37SMP	7294	10:13	55.9458 S	57.6880 W
Aquadopp Nortek	5883	10:31	55.9494 S	57.6990 W
SBE37 SMP	7295	10:31	55.9494 S	57.6990 W
RCM 11	300	10:59	55.9565 S	57.7201 W
SBE37 IMP	4063	10:59	55.9565 S	57.7201 W
IxSea RT661	321	11:14	55.9592 S	57.7281 W
Anchor (1950 kg)		11:57	55.9656 S	57.7466 W

After the anchor was released from the vessel, the acoustic releases were ranged until the anchor was confirmed to be on the seabed. The descent rate calculated from this ranging was found to be 170 m/min, and the final (slant) range from transducer to acoustic release was 3955m.
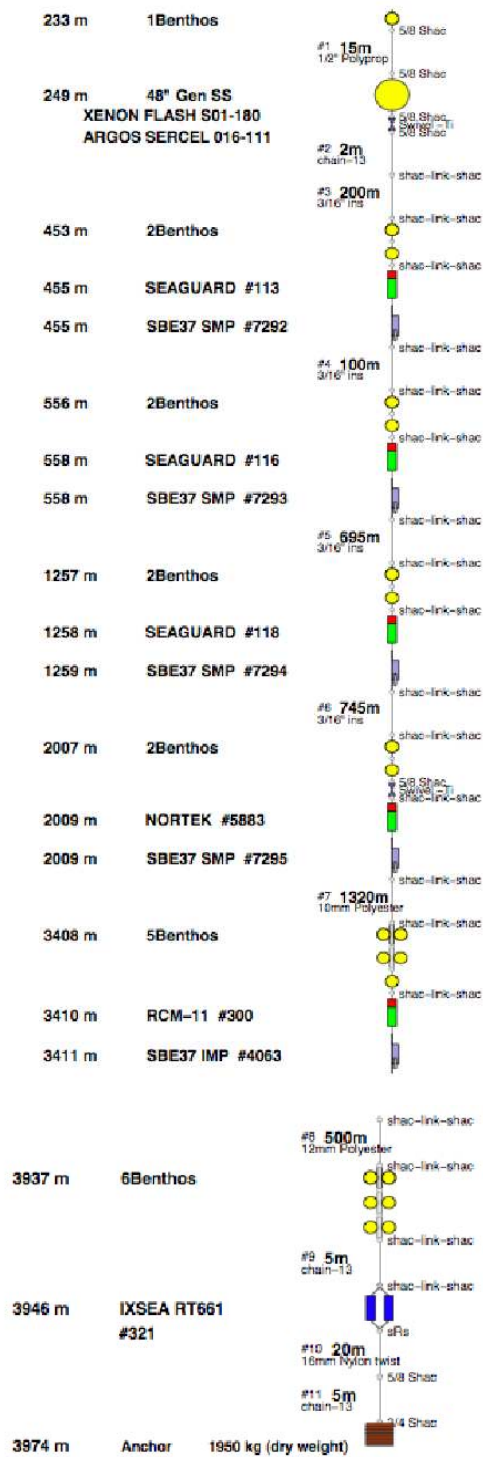
Figure 16: Diagram of NE mooring.

58

An estimated mooring location of 55° 57.779′ S, 57° 44.660′ W was determined via triangulation from three independent ranging locations. This required the ship to position itself approximately an ocean depth horizontally away from the likely location of the mooring. A transducer was deployed over the side of the ship and the slant range (distance) to the mooring was obtained. The calculated horizontal distance provided an estimate of the radius from the ship location within which the mooring was located. The cross-over of the three range circles ("cocked hat") provided an estimate of the location of the mooring (Figure 17).
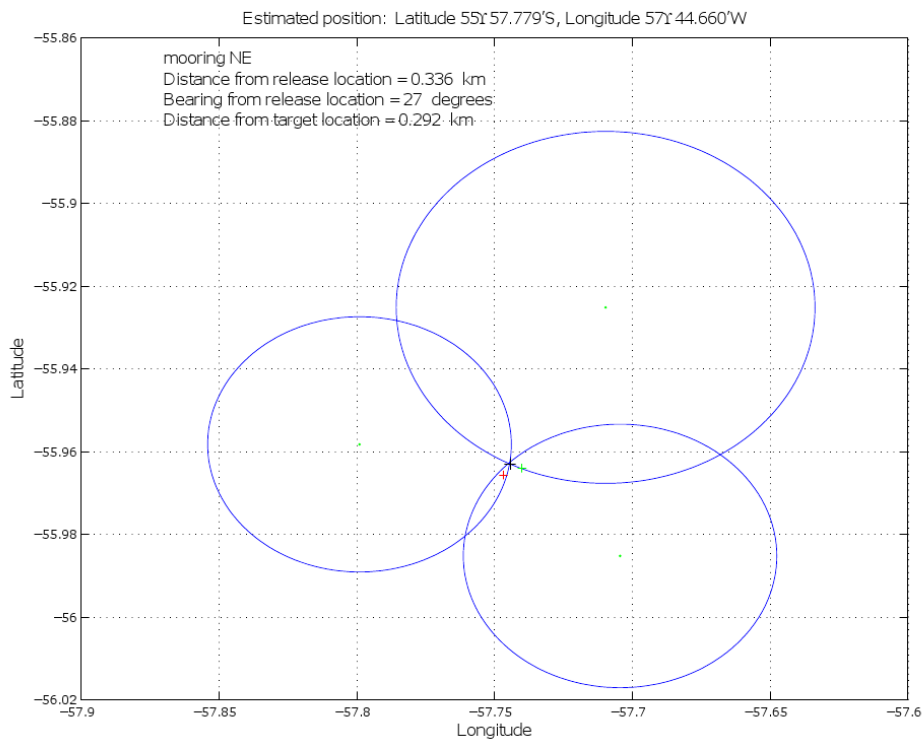
Figure 17: Triangulation estimate of the position of the NE mooring. Green dots mark the position of the ship and the blue circles the horizontal range calculated from the slant (direct) range and water depth. Estimated position of mooring (black cross), target position (green cross) and mooring release position (red cross) are also shown.

4.1.2   SE Mooring

The nominal target position for the SE mooring of the UK array was 56° 3.60′ S, 57° 44.40′ W in 4200m of water. The mooring consisted of five current meter/CTD pairs (Figure 18, Table 13).

The mooring operation began at 13:26 UTC on 9 December 2009. Attachment of in-line current meters and conductivity-temperature-depth sensors continued until 15:23 UTC (Table 13). At this time the ship was still some distance from the nominal position, and the mooring was towed behind the ship until the anchor was released at 15:42 UTC, 56° 3.686′S 57° 44.925′W in 4200m water depth. This was approximately 600m past the intended anchor position to allow for fall back of the mooring during release and descent. Note that some problems were experienced with the winch level-wind during the deployment which required repair.

After the anchor was released from the vessel, the acoustic releases were ranged until the anchor was confirmed to be on the seabed. The descent rate calculated from this ranging was found to be 190 m/min, and the final (slant) range from transducer to acoustic release was 4178m.

An estimated mooring location of 56° 3.430′ S, 57° 44.543′ W was determined via triangulation from three independent ranging locations (Figure 19).

Following the triangulation, moorings NW and C were wound onto the winch drums ready for deployment the following day and three CTD casts were conducted overnight.

Figure 18: Diagram of SE mooring.

Table 13: Instruments, time and position of deployment for SE mooring of UK mooring cluster, deployed on 9/12/2009.

Instrument and Equipment	Serial Number	Time (UTC) Overside	Latitude Overside	Longitude Overside
Xenon Flash	W06-008	13:29	56.0516 S	57.6868 W
Argos Sercel Beacon	016-112	13:29	56.0516 S	57.6868 W
Seaguard	119	13:40	56.0522 S	57.6908 W
SBE37 SMP	7296	13:40	56.0522 S	57.6908 W
Seaguard	120	13:46	56.0526 S	57.6931 W
SBE37 SMP	7297	13:46	56.0526 S	57.6931 W
Seaguard	121	14:02	56.0539 S	57.7015 W
SBE 37SMP	7298	14:02	56.0539 S	57.7015 W
Seaguard	122	14:32	56.0556 S	57.7120 W
SBE37 SMP	7299	14:32	56.0556 S	57.7120 W
Sontek	290	15:05	56.0585 S	57.7307 W
SBE37 IMP	4069	15:05	56.0585 S	57.7307 W
IxSea RT661	439	15:23	56.0601S	57.7406 W
Anchor (1970 kg)		15:42	56.0615 S	57.7485 W
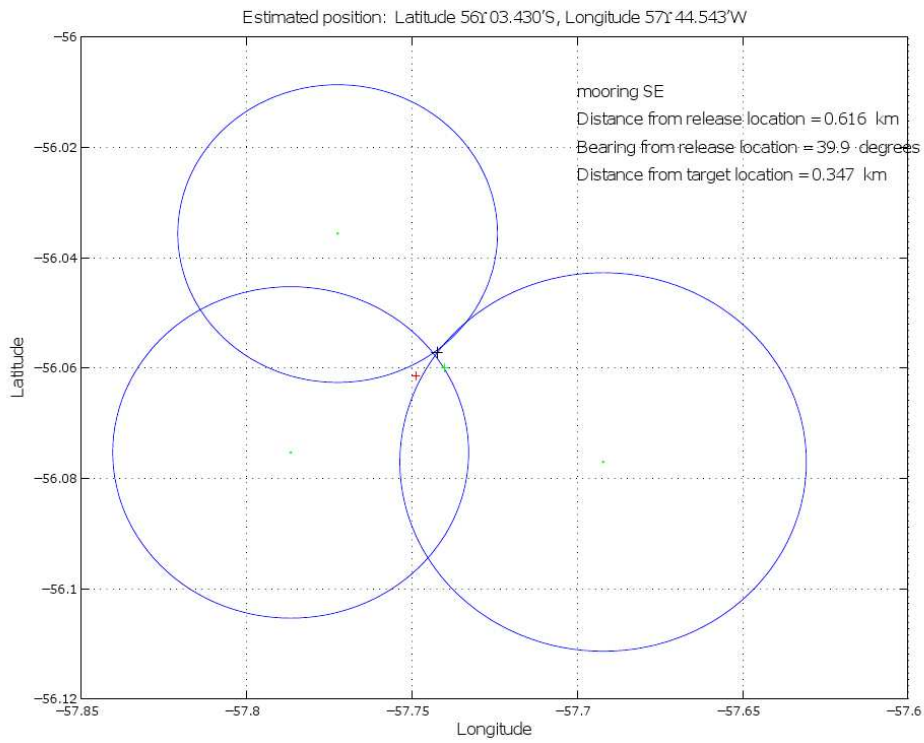
Figure 19: Triangulation estimate of the position of the SE mooring. Green dots mark the position of the ship and the blue circles the horizontal range calculated from the slant (direct) range and water depth. Estimated position of mooring (black cross), target position (green cross) and mooring release position (red cross) are also shown.

4.1.3 NW Mooring

The nominal target position for the NW mooring of the UK array was 55° 57.84′ S, 57° 54.60′ W in 4135m of water. The mooring consisted of five current meter/CTD pairs (Figure 20, Table 14).

The mooring operation began at 11:34 UTC on 10 December 2009. Attachment of in-line current meters and conductivity-temperature-depth sensors continued until 13:10 UTC (Table 14). The mooring was then towed behind the ship until the anchor was released at 13:24 UTC, 55° 57.86′S 57° 55.10′W in 4089 m water depth. This was approximately 500m past the intended anchor position to allow for fall back of the mooring during release and descent.

After the anchor was released from the vessel, the acoustic releases were ranged until the anchor was confirmed to be on the seabed. The descent rate calculated from this ranging was found to be 170 m/min, and the final (slant) range from transducer to acoustic release was 4202m.

An estimated mooring location of 55° 57.837′ S, 57° 54.878′ W was determined via triangulation from three independent ranging locations (Figure 21).

226 m — 1Benthos

5/8 Shac
#1 15m
1/2" Polyprop
5/8 Shac

242 m — 48" Gen SS
XENON FLASH W06-006
ARGOS SERCEL 016-110

5/8 Shac
Swivel-1
5/8 Shac
#2 2m
chain-13
shac-link-shac
#3 200m
3/16" ins

shac-link-shac

446 m — 2Benthos

shac-link-shac

448 m — SEAGUARD #109

448 m — SBE37 SMP #7288

shac-link-shac
#4 100m
3/16" ins
shac-link-shac

549 m — 2Benthos

shac-link-shac

551 m — SEAGUARD #110

551 m — SBE37 SMP #7289

shac-link-shac
#5 695m
3/16" ins
shac-link-shac

1250 m — 3Benthos

shac-link-shac

1252 m — SONTEK #D332

1252 m — SBE37 SMP #7308

shac-link-shac
#6 745m
3/16" ins
shac-link-shac

2001 m — 2Benthos

5/8 Shac
Swivel-1
shac-link-shac

2003 m — SEAGUARD #111

2003 m — SBE37 SMP #7290

shac-link-shac
#7 1315m
10mm Polyester
shac-link-shac

3398 m — 5Benthos

shac-link-shac

3401 m — SEAGUARD #112

3401 m — SBE37 SMP #7291

shac-link-shac
#8 660m
12mm Polyester
shac-link-shac

4097 m — 6Benthos

shac-link-shac
#9 5m
chain-13
shac-link-shac

4106 m — IXSEA AR861
#255

sRs
#10 20m
16mm Nylon twist
5/8 Shac
#11 5m
chain-13
3/4 Shac

4134 m — Anchor — 1970 kg (dry weight)

Figure 20: Diagram of NW mooring.

65

Table 14: Instruments, time and position of deployment for NW mooring of UK mooring cluster, deployed on 10/12/2009.

| Instrument and Equipment	Serial Number	Time (UTC) Overside	Latitude Overside	Longitude Overside
Xenon Flash	W06-006	11:36	55.9580 S	57.8546 W
Argos Sercel Beacon	016-110	11:36	55.9580 S	57.8546 W
Seaguard	109	11:46	55.9583 S	57.8576 W
SBE37 SMP	7288	11:46	55.9583 S	57.8576 W
Seaguard	110	11:52	55.9586 S	57.8603 W
SBE37 SMP	7289	11:52	55.9586 S	57.8603 W
Sontek	D332	12:09	55.9597 S	57.8713 W
SBE 37SMP	7308	12:09	55.9597 S	57.8713 W
Seaguard	111	12:26	55.9607 S	57.8817 W
SBE37 SMP	7290	12:26	55.9607 S	57.8817 W
Seaguard	112	12:52	55.9625 S	57.9000 W
SBE37 SMP	7291	12:52	55.9625 S	57.9000 W
IxSea AR861	255	13:10	55.9637 S	57.9117 W
Anchor (1970 kg)		13:24	55.9643 S	57.9178 W
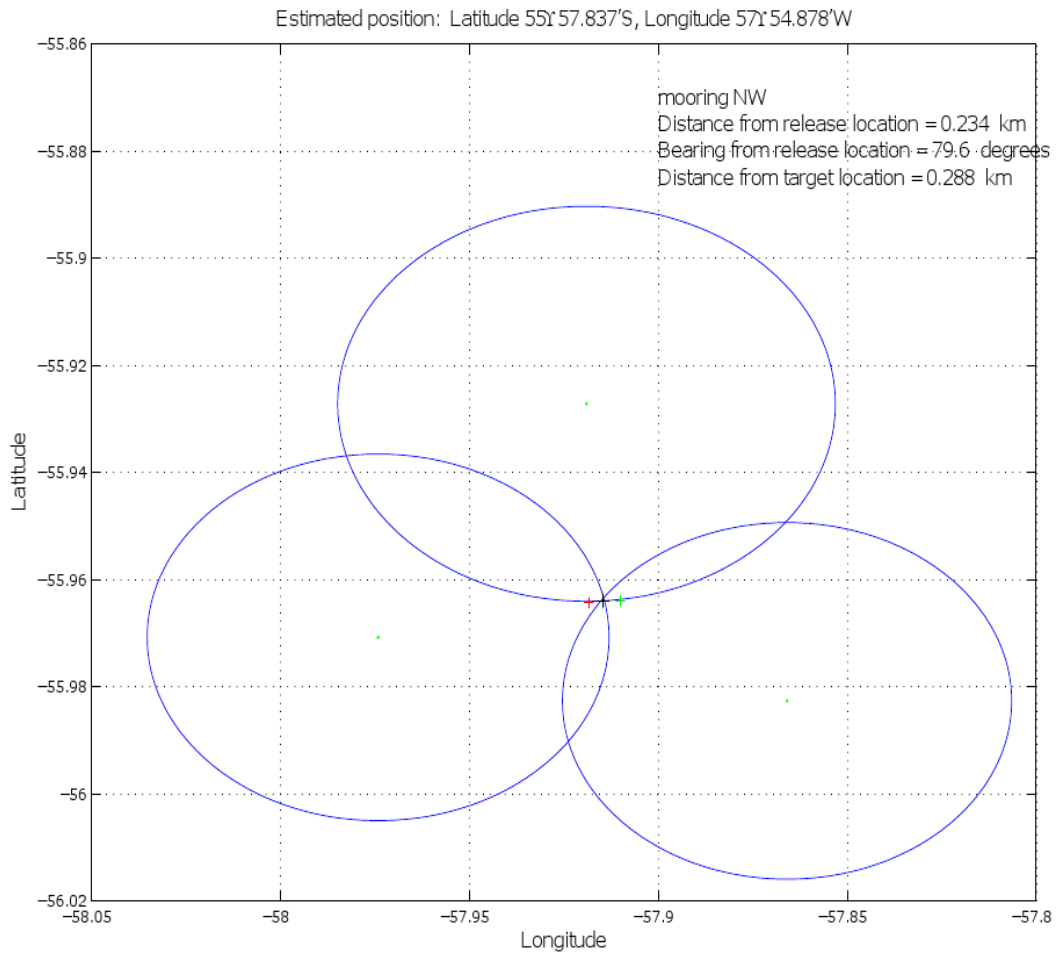
Figure 21: Triangulation estimate of the position of the NW mooring. Green dots mark the position of the ship and the blue circles the horizontal range calculated from the slant (direct) range and water depth. Estimated position of mooring (black cross), target position (green cross) and mooring release position (red cross) are also shown.

4.1.4   C Mooring

The nominal target position for the C mooring of the UK array was 56° 0.72′ S, 57° 49.50′ W in 3705m of water. The mooring consisted of twelve current meter/CTD pairs and a deep, downward looking long-range Acoustic Doppler Current Profiler (Figure 22, Table 15). The ADCP was configured to take an average over 11 evenly spaced pings every 30 minutes, with 37 x 16m depth bins.

The mooring operation began at 15:32 UTC on 10 December 2009 in sunshine with a light breeze and 1-2m swell. Attachment of in-line current meters and conductivity-temperature-depth sensors continued until 17:35 UTC (Table 15). The mooring was then towed behind the ship until the anchor was released at 17:52 UTC, 56° 0.77′S 57° 50.02′W in 4256m water depth. This was approximately 500m past the intended anchor position to allow for fall back of the mooring during release and descent.

After the anchor was released from the vessel, the acoustic releases were ranged until the anchor was confirmed to be on the seabed. The descent rate calculated from this ranging was found to be 170 m/min, and the final (slant) range from transducer to acoustic release was 3723m.

An estimated mooring location of 56° 0.709′ S, 57° 49.661′ W was determined via triangulation from three independent ranging locations (Figure 23). Following triangulation moorings M and SW were wound onto the winch drums for deployment the following day and a CTD tow-yo was conducted across the ridge overnight.
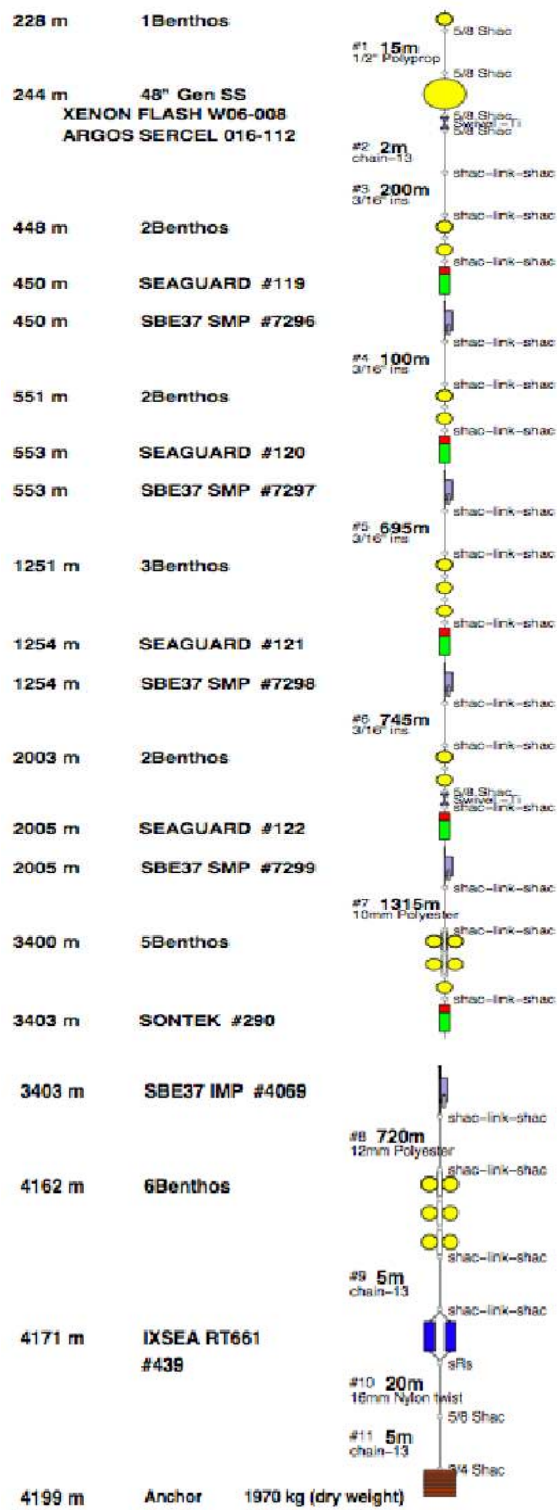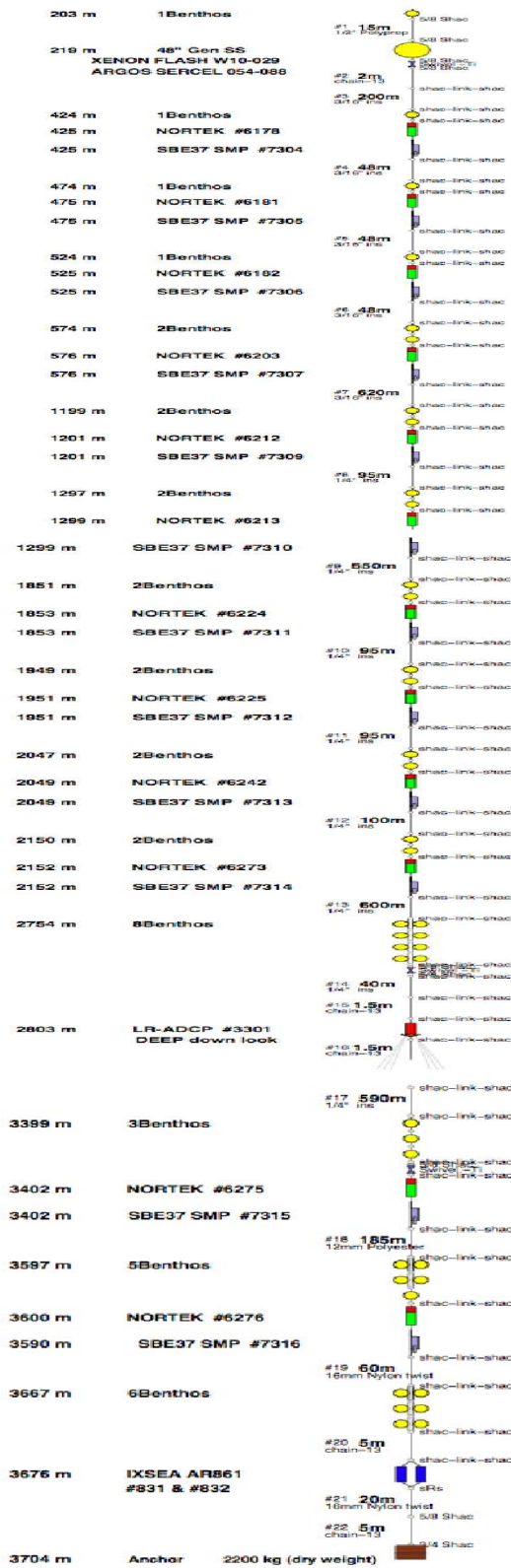
Figure 22: Diagram of C mooring.

69

Table 15: Instruments, time and position of deployment for C mooring of UK mooring cluster, deployed on 10/12/2009.

| Instrument and Equipment	Serial Number	Time (UTC) Overside	Latitude Overside	Longitude Overside
Xenon Flash	W10-029	15:34	56.0041 S	57.7636 W
Argos Sercel Beacon	054-088	15:34	56.0041 S	57.7636 W
Aquadopp Nortek	6178	15:42	56.0045 S	57.7668 W
SBE37 SMP	7304	15:42	56.0045 S	57.7668 W
Aquadopp Nortek	6181	15:46	56.0047 S	57.7683 W
SBE37 SMP	7305	15:46	56.0047 S	57.7683 W
Aquadopp Nortek	6182	15:51	56.0049 S	57.7700 W
SBE 37SMP	7306	15:51	56.0049 S	57.7700 W
Aquadopp Nortek	6203	15:55	56.0051 S	57.7714 W
SBE37 SMP	7307	15:55	56.0051 S	57.7714 W
Aquadopp Nortek	6212	16:08	56.0059 S	57.7784 W
SBE37 SMP	7309	16:08	56.0059 S	57.7784 W
Aquadopp Nortek	6213	16:14	56.0062 S	57.7810 W
SBE37 SMP	7310	16:14	56.0062 S	57.7810 W
Aquadopp Nortek	6224	16:26	56.0071 S	57.7876 W
SBE37 SMP	7311	16:26	56.0071 S	57.7876 W
Aquadopp Nortek	6225	16:32	56.0074 S	57.7905 W
SBE 37SMP	7312	16:32	56.0074 S	57.7905 W
Aquadopp Nortek	6242	16:39	56.0079 S	57.7939 W
SBE37 SMP	7313	16:39	56.0079 S	57.7939 W
Aquadopp Nortek	6273	16:44	56.0082 S	57.7963 W
SBE37 SMP	7314	16:44	56.0082 S	57.7963 W
LR-ADCP DEEP	3301	17:01	56.0096 S	57.8078 W
Aquadopp Nortek	6275	17:20	56.0112 S	57.8205 W
SBE 37SMP	7315	17:20	56.0112 S	57.8205 W
Aquadopp Nortek	6276	17:29	56.0118 S	57.8257 W
SBE37 SMP	7316	17:29	56.0118 S	57.8257 W
2 x IxSea AR861	831/832	17:35	56.0121 S	57.8280 W
Anchor (2200 kg)		17:52	56.0127 S	57.8332 W
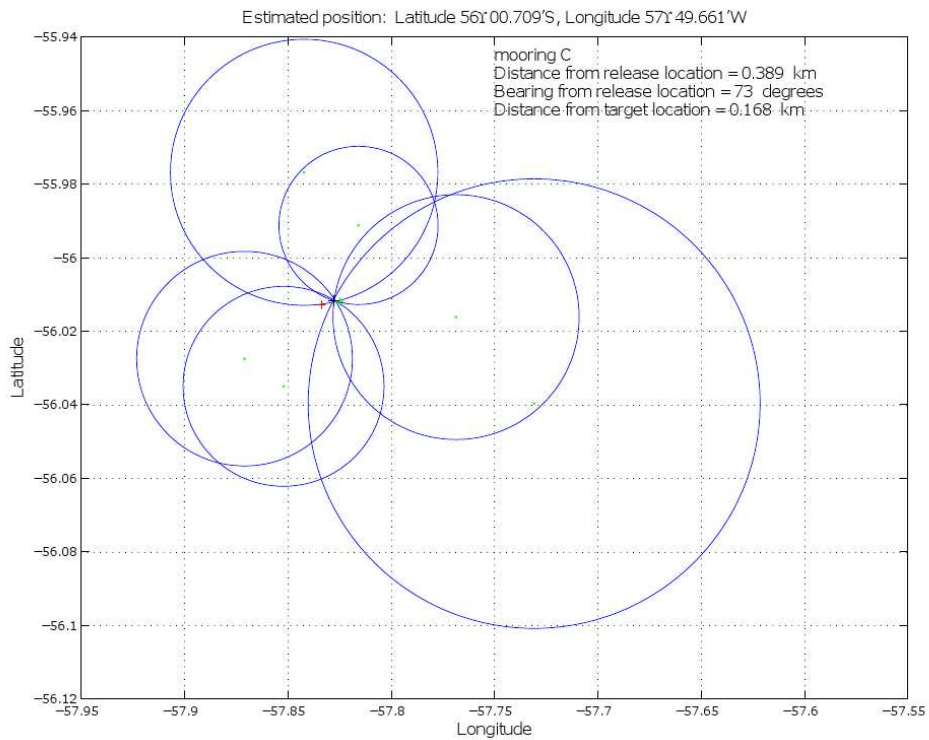
Figure 23: Triangulation estimate of the position of the C mooring. Green dots mark the position of the ship and the blue circles the horizontal range calculated from the slant (direct) range and water depth. Estimated position of mooring (black cross), target position (green cross) and mooring release position (red cross) are also shown.

4.1.5　SW Mooring

The nominal target position for the SW mooring of the UK array was 56° 3.60′ S 57° 54.60′ W in 3900m of water. The mooring consisted of five current meter/CTD pairs (Figure 24, Table 16). Because the actual depth was found to be deeper, an extra 80m of polyester line was added above the release as 3 x 10m plus 1 x 50m lengths.

The mooring operation began at 12:40 UTC on 11 December 2009. Attachment of in-line current meters and conductivity-temperature-depth sensors continued until 14:18 UTC (Table 16). The mooring was then towed behind the ship until the anchor was released at 14:32 UTC, 56° 3.753′S 57° 54.839′W in 3940m water depth. This was approximately 350m past the intended anchor position to allow for fall back of the mooring during release and descent.

After the anchor was released from the vessel, the acoustic releases were ranged until the anchor was confirmed to be on the seabed. The descent rate calculated from this ranging was found to be 190 m/min, and the final (slant) range from transducer to acoustic release was 4037m.

An estimated mooring location of 56° 3.636′ S, 57° 54.527′ W was determined via triangulation from three independent ranging locations (Figure 25).
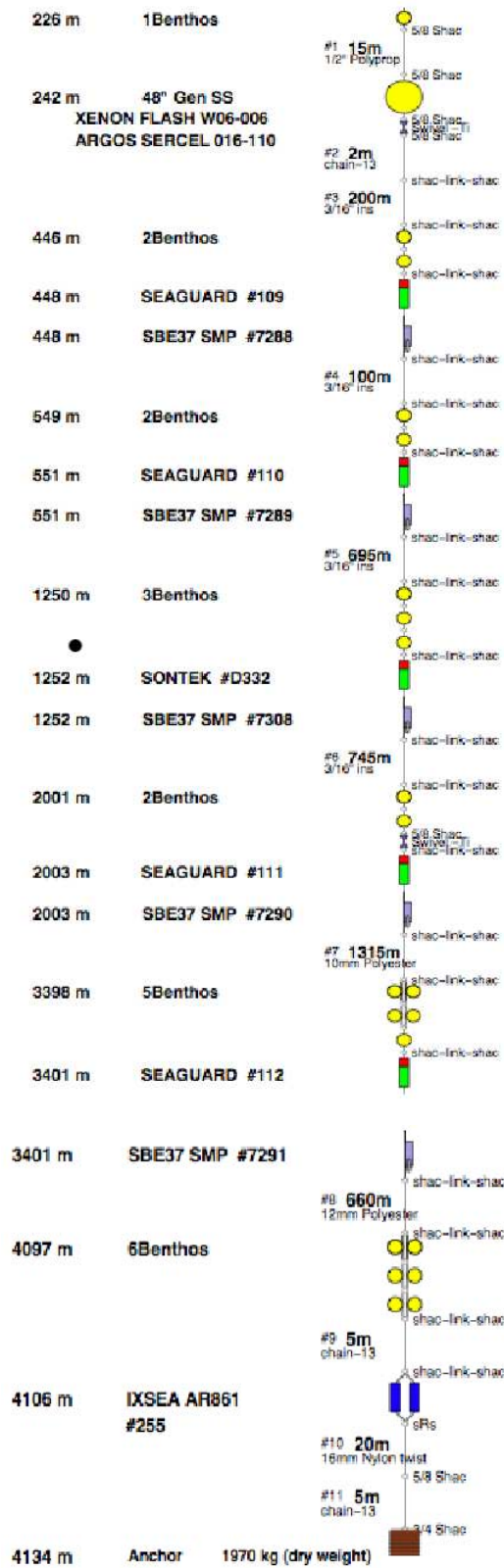
231 m	1 Benthos
247 m	48" Gen SS
	XENON FLASH W10-028
	ARGOS SERCEL 054-086
452 m	2 Benthos
453 m	SEAGUARD #123
454 m	SBE37 SMP #7300
555 m	2 Benthos
557 m	SEAGUARD #124
557 m	SBE37 SMP #7301
1255 m	2 Benthos
1257 m	SEAGUARD #125
1257 m	SBE37 SMP #7302
2005 m	2 Benthos
2007 m	SONTEK #D298
2008 m	SBE37 IMP #4465
3406 m	5 Benthos
3409 m	SEAGUARD #127
3409 m	SBE37 SMP #7303
3862 m	6 Benthos
3871 m	IXSEA AR861 #830
3899 m	Anchor 1955 kg (dry weight)

Diagram labels: 5/8 Shac; #1 15m 1/2" Polyprop; 5/8 Shac; 5/8 Shac; 5/8 Shac; #2 2m chain-13; shac-link-shac; #3 200m 3/16" ins; shac-link-shac; shac-link-shac; shac-link-shac; #4 100m 3/16" ins; shac-link-shac; shac-link-shac; shac-link-shac; #5 695m 3/16" ins; shac-link-shac; shac-link-shac; shac-link-shac; #6 745m 3/16" ins; shac-link-shac; 5/8 Shac; shac-link-shac; shac-link-shac; #7 1320m 10mm Polyester; shac-link-shac; shac-link-shac; shac-link-shac; shac-link-shac; #8 430m 12mm Polyester; shac-link-shac; shac-link-shac; #9 5m chain-13; shac-link-shac; sRs; #10 20m 16mm Nylon twist; 5/8 Shac; #11 5m chain-13; 3/4 Shac

Figure 24: Diagram of SW mooring.

73

Table 16: Instruments, time and position of deployment for SW mooring of UK mooring cluster, deployed on 11/12/2009.

Instrument and Equipment	Serial Number	Time (UTC) Overside	Latitude Overside	Longitude Overside
Xenon Flash	W10-028	12:42	56.0427 S	57.8766 W
Argos Sercel Beacon	054-086	12:42	56.0427 S	57.8766 W
Seaguard	123	12:53	56.0437 S	57.8785 W
SBE37 SMP	7300	12:53	56.0437 S	57.8785 W
Seaguard	124	12:58	56.0444 S	57.8798 W
SBE37 SMP	7301	12:58	56.0444 S	57.8798 W
Seaguard	125	13:15	56.0478 S	57.8866 W
SBE 37SMP	7302	13:15	56.0478 S	57.8866 W
Sontek	D298	13:35	56.0517 S	57.8939 W
SBE37 IMP	4465	13:35	56.0517 S	57.8939 W
Seaguard	127	14:05	56.0573 S	57.9049 W
SBE37 SMP	7303	14:05	56.0573 S	57.9049 W
IxSea AR861	830	14:18	56.0602 S	57.9106 W
Anchor (1955 kg)		14:32	56.0625 S	57.9139 W
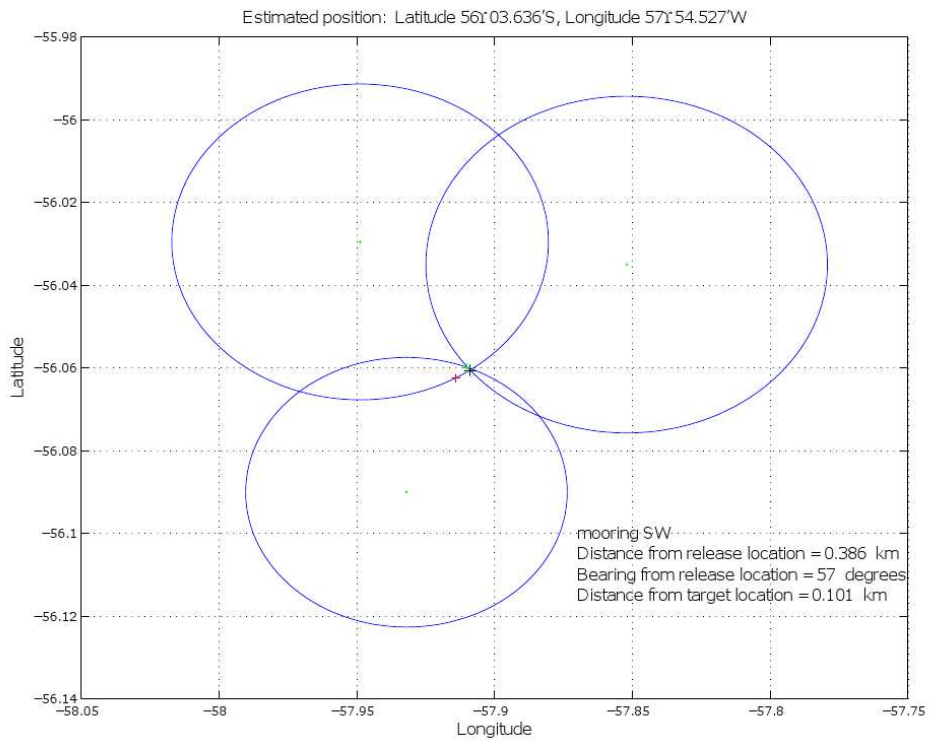
Figure 25: Triangulation estimate of the position of the SW mooring. Green dots mark the position of the ship and the blue circles the horizontal range calculated from the slant (direct) range and water depth. Estimated position of mooring (black cross), target position (green cross) and mooring release position (red cross) are also shown.

4.1.6 M Mooring

The revised nominal target position for the M mooring of the UK array was 56° 1.32′ S 57° 47.22′ W in 3740m of water. The mooring consisted of two McLane moored profilers (MMPs), two current meter/CTD pairs and a RAFOS sound source (Figure 26, Table 17). The MMPs were set up to profile from 1770db to 2712db and from 2778db to 3757db, continuously for 2 days (46 profiles) every 25 days.

The mooring operation began at 16:47 UTC on 11 December 2009. Attachment of in-line current meters and conductivity-temperature-depth sensors continued until 18:48 UTC (Table 17). The mooring was then towed behind the ship until the anchor was released at 18:59 UTC, 56° 1.449′S 57° 47.467′W in 3777m water depth. This was approximately 350m past the intended anchor position to allow for fall back of the mooring during release and descent.

After the anchor was released from the vessel, the acoustic releases were ranged until the anchor was confirmed to be on the seabed. The descent rate calculated from this ranging was found to be 185 m/min, and the final (slant) range from transducer to acoustic release was 3766m.

An estimated mooring location of 56° 1.379′ S, 57° 47.010′ W was determined via triangulation from three independent ranging locations (Figure 27).

Table 17: Instruments, time and position of deployment for M mooring of UK mooring cluster, deployed on 11/12/2009.

| Instrument and Equipment	Serial Number	Time (UTC) Overside	Latitude Overside	Longitude Overside
Xenon Flash	W10-027	16:49	56.0076 S	57.7567 W
Argos Sercel Beacon	054-087	16:49	56.0076 S	57.7567 W
RAFOS sound source	56 (pong @ 0145)	17:15	56.0114 S	57.7645 W
Sontek	D272	17:43	56.0145 S	57.7710 W
SMP37 IMP	3889	17:43	56.0145 S	57.7710 W
MMP	12305-01	17:55	56.0162 S	57.7746 W
Sontek	D278	18:18	56.0190 S	57.7803 W
SMP37 IMP	4061	18:18	56.0190 S	57.7803 W
MMP	11794-03	18:32	56.0207 S	57.7838 W
2 x IxSea AR861	474/311	18:48	56.0229 S	57.7884 W
Anchor (2320 kg)		18:59	56.0242 S	57.7910 W
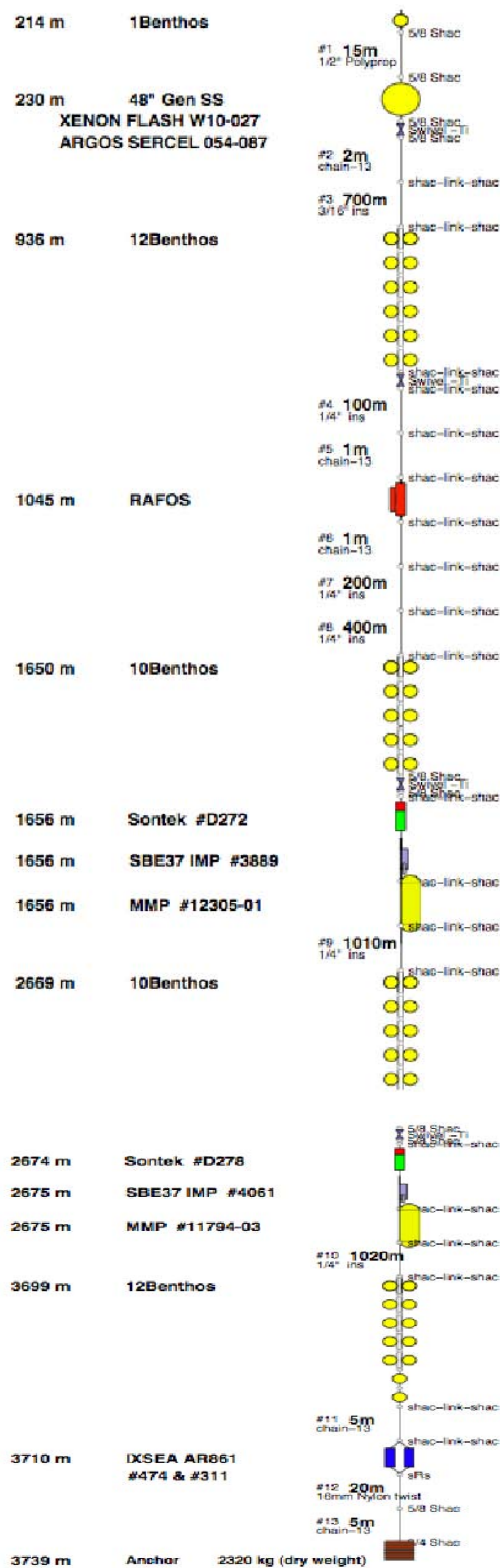
Figure 26: Diagram of M mooring.
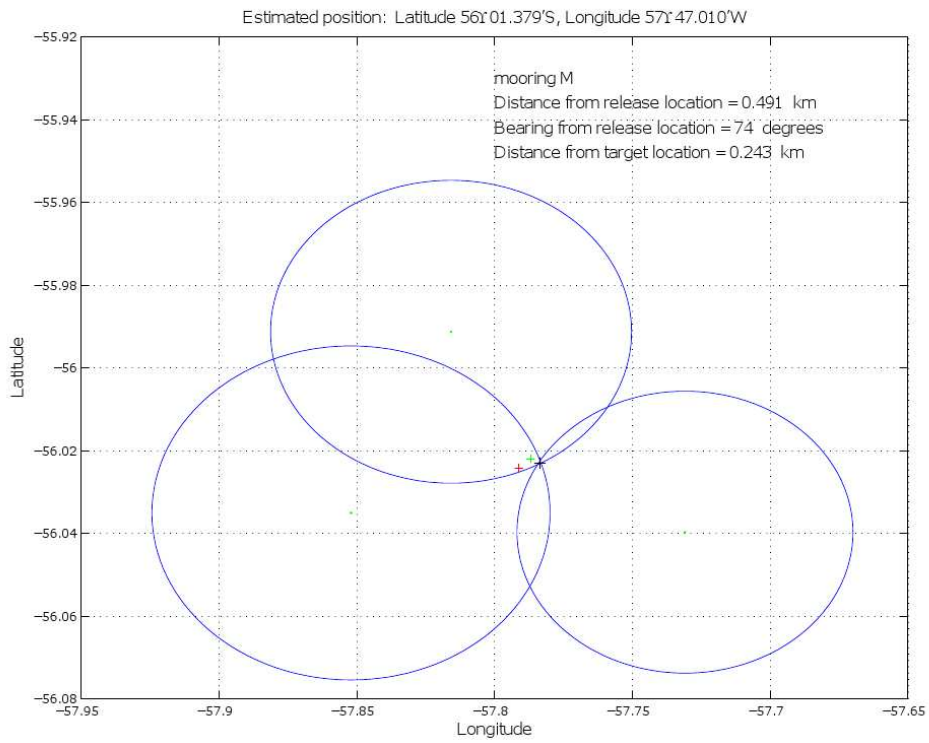
Figure 27: Triangulation estimate of the position of the M mooring. Green dots mark the position of the ship and the blue circles the horizontal range calculated from the slant (direct) range and water depth. Estimated position of mooring (black cross), target position (green cross) and mooring release position (red cross) are also shown.

4.2 FSU Mooring Deployment

Four sound sources were planned for the Scotia Sea DIMES float experiment. All four of the sources were standard Webb rafos sources. Position and pong schedules are shown in Table 18. One of the sources was placed on the UK mooring M; the rest were on dedicated moorings designed at FSU and Miami (Mooring Diagram Figures 28, 30 and 32). Once the moorings were released the opportunity for triangulating using the release ranging capability was available. This was done with the same routines as used by the UK group. The triangulation results reduced the uncertainty in anchor location to about 200m (Table 18 mooring positions).

Table 18: Estimated position for the three FSU moorings and M with an FSU sound source.

FSU1:	Pong 0125	Latitude 59 58.606'S	Longitude 65 59.405'W
FSU2:	Pong 0135	Latitude 58 00.842'S	Longitude 61 53.160'W
FSU3:	Pong 0105	Latitude 58 03.088'S	Longitude 53 38.754'W
UK-M:	Pong 0145	Latitude 56 01.379'S	Longitude 57 47.010'W

Table 19: Bottom depth and sound source depth at each mooring.

	FSU1	FSU2	FSU3	UK-M
Depth	3250m	3640m	4100m	3740m (target)
Source	1050m	1132m	1097m	1045m (target)

MOORING # 1   PROJECT: DIMES   DATE: Deploydled

RADIO S/N: _____ FREG: _____MHZ
STROBE S/N: _____
ARGOS ID_____

946.m   5-17" glass floats

          3/8 chain"   0.5m
          1/4" wire   20.0 m.   1-A

          30- 17"glass floats
          (6-Strings)

          1/4" wire   100.0 m.   1-B
          3/8 chain"   0.5m

1100m   Sound Source s/n _____

          3/8 chain"   0.5m
          1/4" wire   200.0 m.   1-C

          5-17" glass floats
          RELEASE: MODEL: Edgetech 8242XS
1310.m   S/n_____
          3/8 chain"   0.5m
          1/4" wire   500.0 m.   1-D

          1/4" wire   300.0 m.   1-E

          3/8" dacron rope   100.0m.   1-F

700.0m=   3/8" dacron rope   600.0m.
          3/8" dacron rope   100.0m.   1-G

          1/4" wire   250.0m.   1-H

          1/4" wire   100.0m.   1-I

          1/4" wire   10.0m.   1-J
          3/8" chain   5.0 m.

3300 m   Anchor Air   3000.0 lb.

FSU 1

Figure 28: Diagram of FSU1 mooring.

80
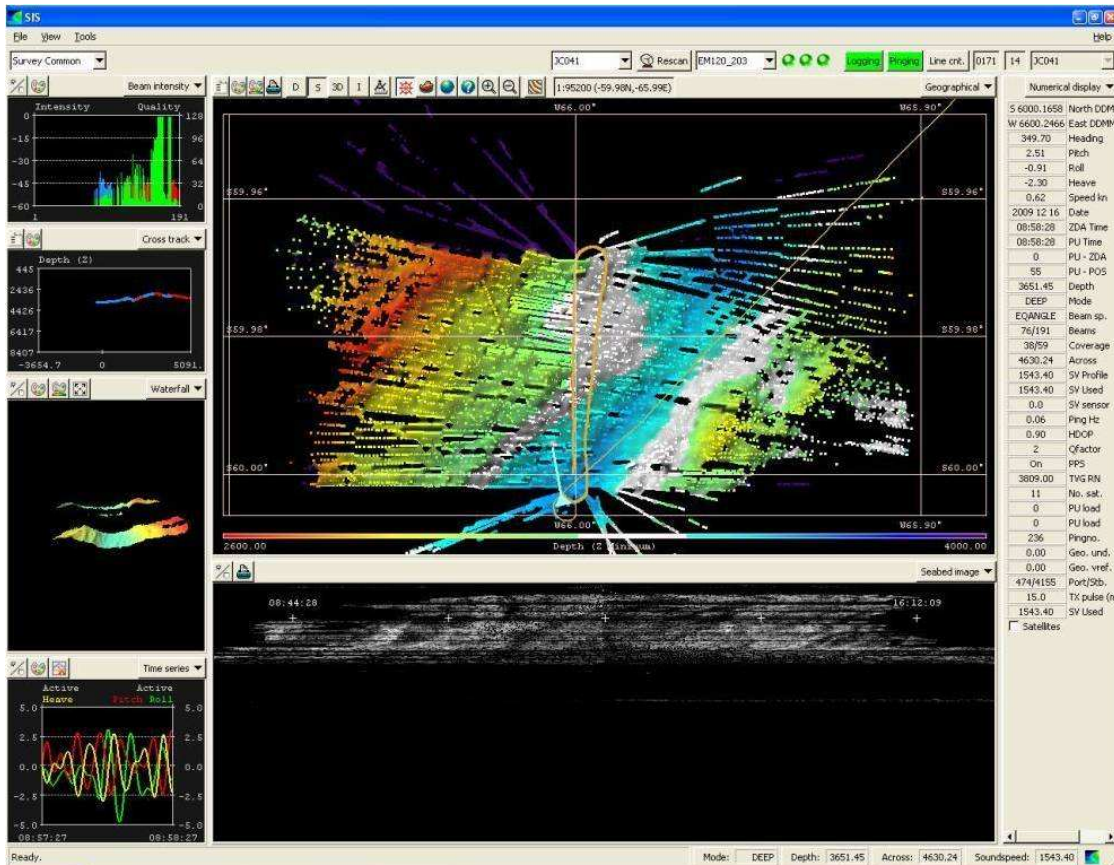
Figure 29: FSU1 Multibeam screenshot.

MOORING # 2   PROJECT: DIMES   DATE: Deployded

RADIO S/N: _____ FREG: _____MHZ
STROBE S/N: _____
ARGOS ID_____

940.m   5-17" glass floats

                 3/8 chain"   0.5m
                 1/4" wire   20.0 m.   2-A

             30- 17"glass floats
             (6-Strings)

                 1/4" wire   100.0 m.   2-B

                 3/8 chain"   0.5m

1092m   Sound Source s/n _____

                 3/8 chain"   0.5m
                 1/4" wire   200.0 m.   2-C

             5-17" glass floats
             RELEASE: MODEL: Edgetech 8242XS
1302.m   S/n_____
                 3/8 chain"   0.5m
                 1/4" wire   500.0 m.   2-D

                 1/4" wire   300.0 m.   2-E

                 3/8" dacron rope   100.0m.   2-F

                 3/8" dacron rope   1000.0m.   2-G

                 1/4" wire   250.0m.   2-H

                 1/4" wire   100.0m.   2-I

                 1/4" wire   10.0m.   2-J
                 3/8" chain   5.0 m.

3600 m   Anchor Air   3000.0 lb.

FSU 2

Figure 30: Diagram of FSU2 mooring.
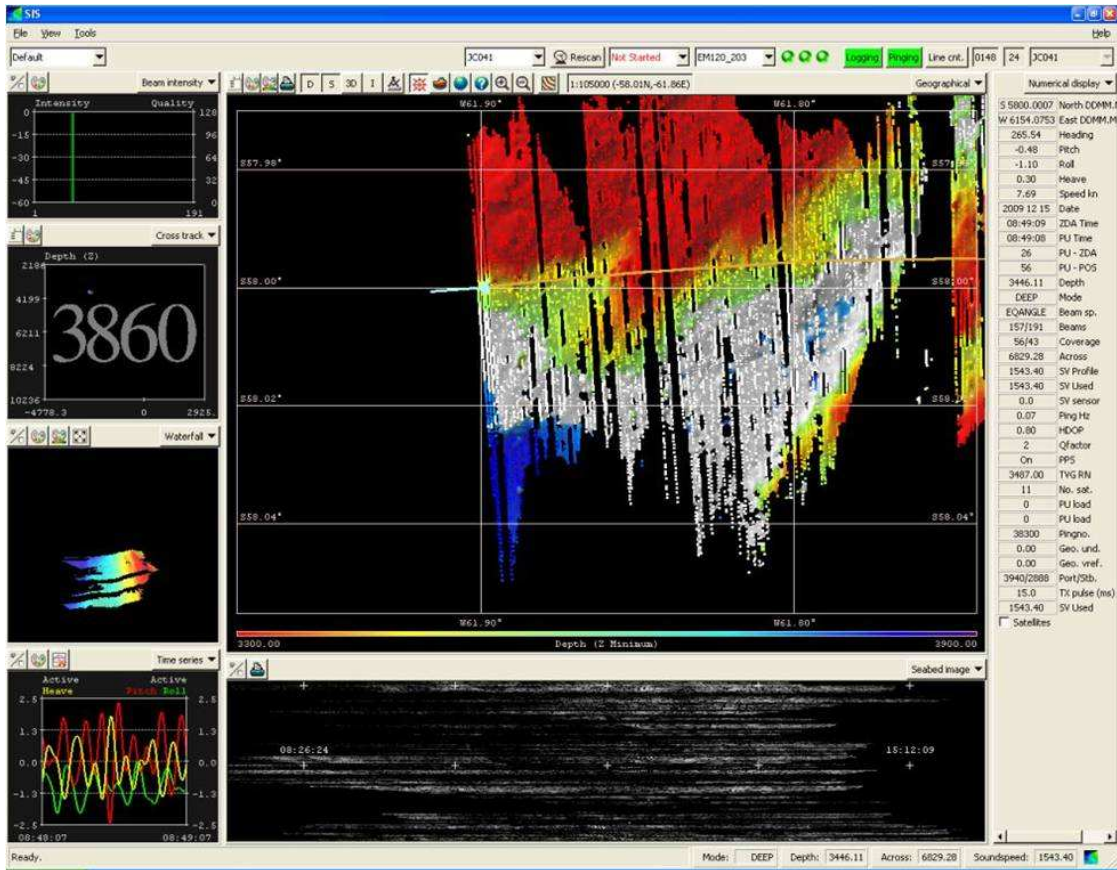
Figure 31: FSU2 Multibeam screenshot.
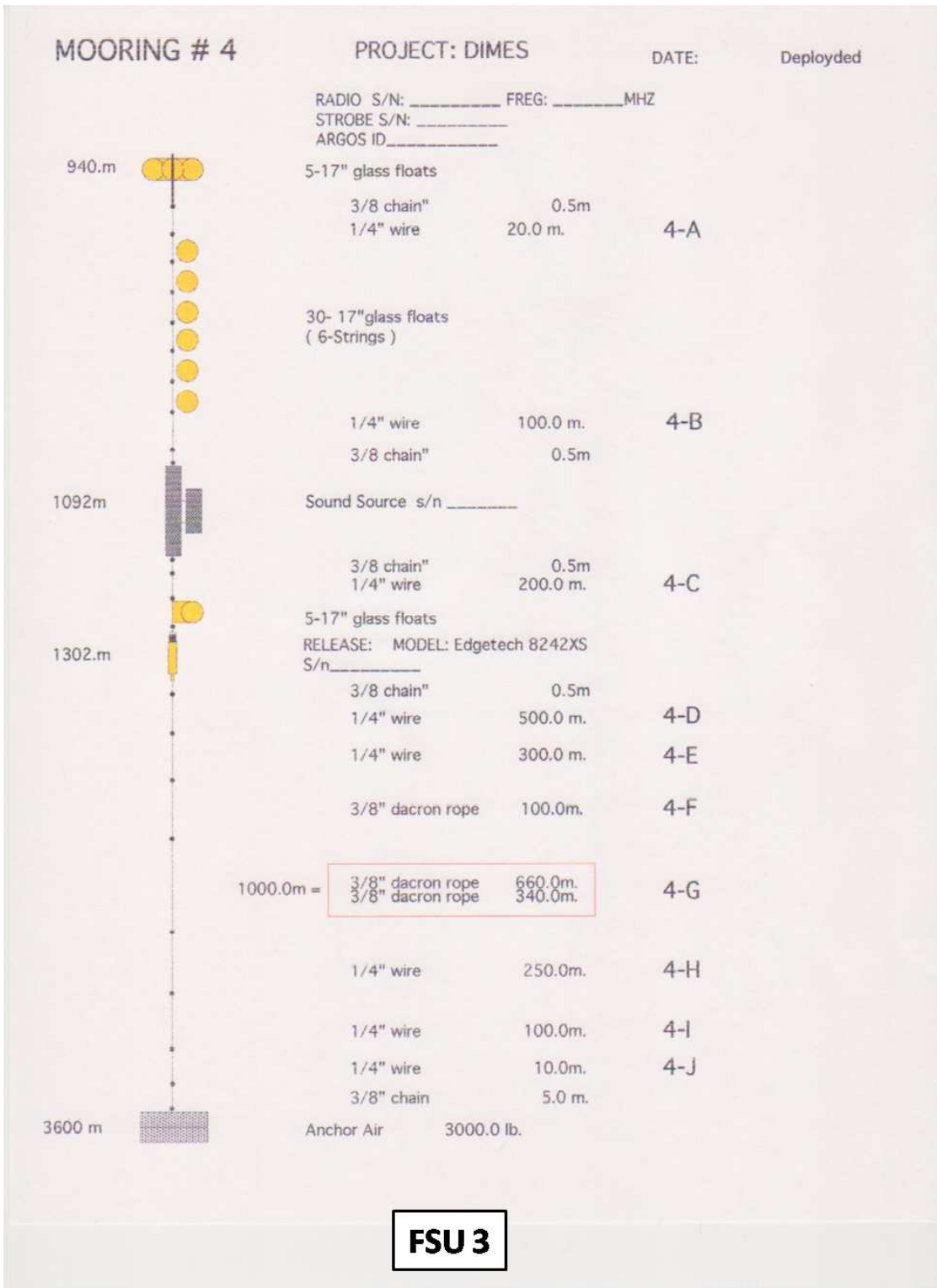
Figure 32: Diagram of FSU3 mooring.

84
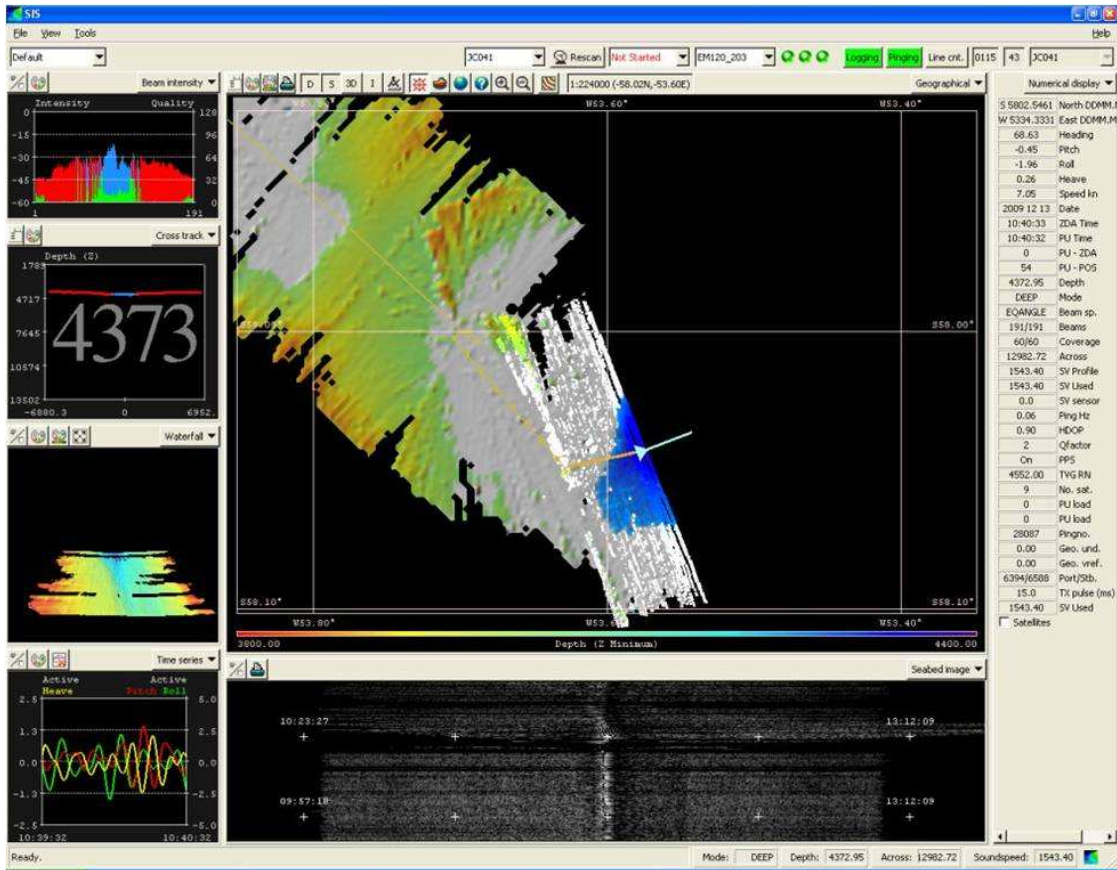
Figure 33: FSU3 Multibeam screenshot.

5 Profiling Float Operations

Kevin Speer, Peter Lazarevich

5.1 FSU Float Operations

5.1.1 Deployment Strategy

Two profiling APEX floats were brought along to provide information about the sound sources and additional CTD information in the Scotia Sea during DIMES. These were Iridium and rafos enabled versions of the standard APEX float. During testing one of the floats had inconsistent telemetry and was not deployed. The other float was deployed near FSU3, at the western end of the cruise track, and furthest point 'upstream'. The location was chosen based on altimetry maps obtained from WHOI (Valery Kosnyrev) which showed that the Polar Front was somewhat farther north than usual. An SSH contour that approached the other mooring locations downstream was chosen for deployment, near 59.1S, 65.8W, at 0200 GMT 17 Dec 2009 (see Figure 34).
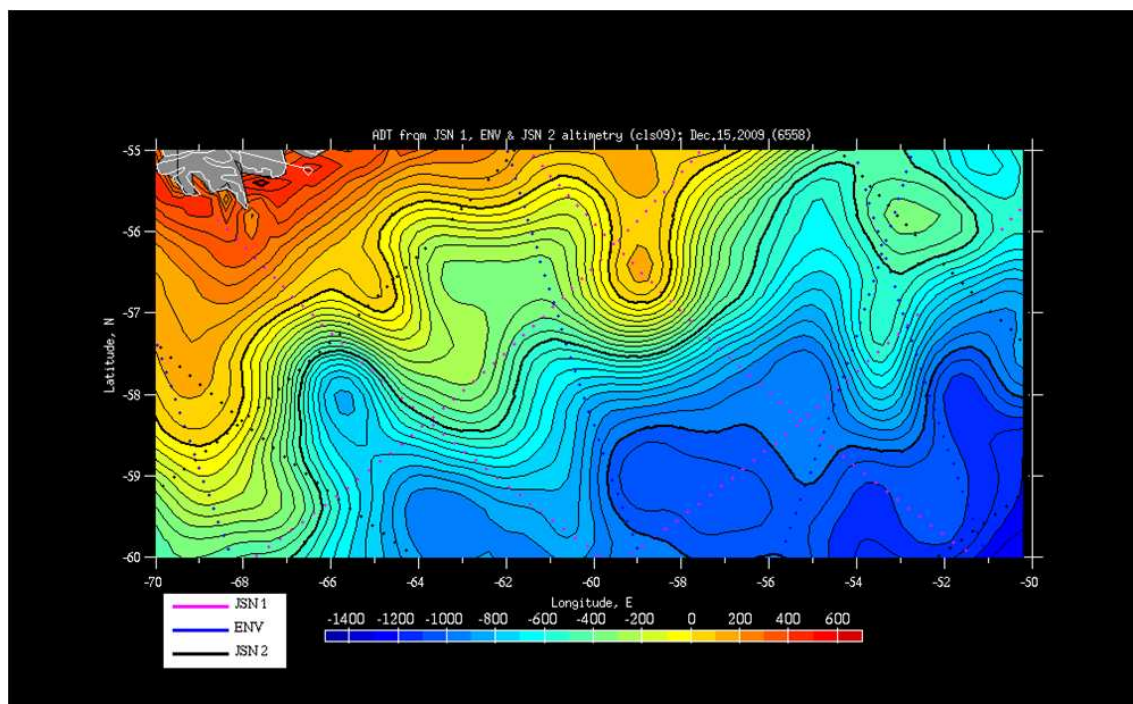
Figure 34: Absolute SSH and float deployment location (X); FSU and UK-M mooring locations also shown.

5.1.2 FSU Float Mission Activation Log File 4779

Asynchronous wake-up detected (ie., wake-up not initiated by alarm signal).

Entering Command Mode [ApfId 4779, FwRev 101109]

> l APEX version 101109 sn 4779

User:

Pwd:

Pri: AT+CBST=71,0,1;DT0088160000509 Mhp

Alt: ATDT0012066163256 Mha

Rafos: 60;60 (Minutes) Mtw

INACTV ToD for down-time expiration. (Minutes) Mtc

06770 Down time. (Minutes) Mtd

00430 Up time. (Minutes) Mtu

00340 Ascent time-out. (Minutes) Mta

00360 Deep-profile descent time. (Minutes) Mtj

00360 Park descent time. (Minutes) Mtk

00360 Mission prelude. (Minutes) Mtp

00015 Telemetry retry interval. (Minutes) Mhr

00060 Host-connect time-out. (Seconds) Mht

1200 Continuous profile activation. (Decibars) Mc

1200 Park pressure. (Decibars) Mk

1200 Deep-profile pressure. (Decibars) Mj

016 Park piston position. (Counts) Mbp

016 Deep-profile piston position. (Counts) Mbj

010 Ascent buoyancy nudge. (Counts) Mbn

022 Initial buoyancy nudge. (Counts) Mbi

254 Park-n-profile cycle length. Mn

-1.80 Ice detection: Mixed-layer Tcritical (C) Mit

0xffd Ice detection: Winter months [DNOSAJJMAMFJ] Mib

124 Maximum air bladder pressure. (Counts) Mfb

096 OK vacuum threshold. (Counts) Mfv

226 Piston full extension. (Counts) Mff

016 P-Activation piston position. (Counts) Mfs

2 Logging verbosity. [0-5] D

0002 DebugBits. D

5a1b Mission signature (hex).

> c Battery [191cnt, 14.7V] Current [4cnt, 19.3mA] Barometer [83cnt, -6.1"Hg]

> t Real time clock: Thu Dec 17 01:23:32 2009

> e Executing mission activation sequence.

(Dec 17 2009 01:25:16, 370974 sec) SelfTest() Executing self-test for ApfId 4779.

(Dec 17 2009 01:25:17, 370975 sec) PistonMoveAbsWTO() 016->020 017 018 019 0
20 [17sec, 14.6Volts, 0.161Amps, CPT:1156sec]

(Dec 17 2009 01:25:35, 370992 sec) PistonMoveAbsWTO() 020->016 019 018 017 0
16 [17sec, 14.6Volts, 0.145Amps, CPT:1173sec]

(Dec 17 2009 01:25:52, 371010 sec) SelfTest() Passed: Timed piston movements from 16 to 20 counts and back.

(Dec 17 2009 01:25:55, 371013 sec) SelfTest() Passed: internal pressure [83, -5.9"Hg] less than threshold [96, -2.1"Hg].

(Dec 17 2009 01:25:56, 371014 sec) SelfTest() Passed: FLASH file system has been initialized.

(Dec 17 2009 01:25:59, 371017 sec) SelfTest() Passed: FLASH file system has been reformatted.

(Dec 17 2009 01:26:01, 371019 sec) SelfTest() Passed: Response received from SBE41cp.

(Dec 17 2009 01:26:08, 371025 sec) SelfTest() Passed: Sbe41cp SerNo: 2805

(Dec 17 2009 01:26:22, 371040 sec) SelfTest() Passed: SBE41cp (SerNo 2805) FwRev accepted: [2.0]

(Dec 17 2009 01:26:31, 371049 sec) Sbe41cpConfig() Configuration successful.

(Dec 17 2009 01:26:42, 371060 sec) Sbe41cpEnablePts() PTS output enabled during CP mode.

(Dec 17 2009 01:26:51, 371069 sec) Sbe41cpTsWait() Configuration successful.

(Dec 17 2009 01:26:55, 371073 sec) SelfTest() Passed: SBE41cp configuration was successful.

(Dec 17 2009 01:26:56, 371074 sec) SelfTest() Passed: LBT model: 9522A

(Dec 17 2009 01:26:57, 371074 sec) SelfTest() Passed: LBT firmware revision: IS06004

(Dec 17 2009 01:26:58, 371075 sec) IrModemConfigure() Modem configured for fixed (19200) baud rate.

(Dec 17 2009 01:26:58, 371076 sec) IrModemConfigure() Configuration saved to modem's NVRAM.

(Dec 17 2009 01:26:58, 371076 sec) IrModemConfigure() Modem configuration successful.

(Dec 17 2009 01:26:58, 371076 sec) SelfTest() Passed: LBT configuration was successful.

(Dec 17 2009 01:26:59, 371077 sec) SelfTest() Passed: LBT IMEI: 300224010638560

(Dec 17 2009 01:27:01, 371079 sec) SelfTest() Passed: SIM card ICCID:8988169514000126479 MSISDN:881693721534

(Dec 17 2009 01:27:03, 371080 sec) ConfigGarmin15() Garmin GPS15 configuration initiated.

(Dec 17 2009 01:27:09, 371087 sec) ConfigGarmin15() Garmin GPS15 successfully configured.

(Dec 17 2009 01:27:11, 371089 sec) MissionLaunch() Self-test passed - initiating six 4-second squawks & mission prelude.

(Dec 17 2009 01:28:03, 1 sec) PreludeInit() Mission restarted. [pid=0, itime=371141]

(Dec 17 2009 01:28:04, 1 sec) PistonMoveAbsWTO() 016->226 [1040sec, 14.5Volts, 0.137Amps, CPT:1040sec]

Mission activated.

5.2 UK Met Argo Floats

5.2.1 Deployment Strategy

Three Argo floats belonging to the UK Met Office were onboard for deployment on a previous leg. However, there were problems activating the floats and they were not deployed. Tests run on JC041 showed that one of the floats appears to have a bad internal barometer hence vacuum was outside the expected range and the mission could not be activated. The other two floats checked out after being awakened with the terminal connection and were deployed, one on the southern side of the Polar Front (near surface current at deployment was above 1 m/s) and one in the Subantarctic Front. Across the area at this time the two fronts were essentially merged according to satellite SSH maps, although the Polar Front itself was distinct on the SST (TSG) near 56 30'S 65 35'W as a steep gradient in SST from 1.5 C to 5 C. The SST at the second deployment was near 6 C, and again we were within a strong, c. 1m/s current.

Table 20: UK Argo float deployments

UKMet 4499	Lat 57 25'S	Lon 65 58' W	18 Dec 2009 0830 GMT
UKMet 4498	Lat 56 34'S	Lon 65 34'W	18 Dec 2009 1410 GMT

5.2.2 Log file for Mission Activation Float 4498

Asynchronous wake-up detected (ie., wake-up not initiated by alarm signal).

Entering Command Mode [ApfId 6455, FwRev 060408]

> t Real time clock: Fri Dec 18 13:54:55 2009

> c Battery [194cnt, 15.0V] Current [3cnt, 12.1mA] Barometer [80cnt, -6.9"Hg]

> l APEX version 060408 sn 6455

98FA4AD 28-bit hex Argos id. Ma

042 Argos repetition period (Seconds) Mr

INACTV ToD for down-time expiration. (Minutes) Mtc

225 Down time. (Hours) Mtd

015 Up time. (Hours) Mtu

009 Ascent time-out. (Hours) Mta

006 Deep-profile descent time. (Hours) Mtj

006 Park descent time. (Hours) Mtk

006 Mission prelude. (Hours) Mtp

1000 Park pressure. (Decibars) Mk

2000 Deep-profile pressure. (Decibars) Mj

066 Park piston position. (Counts) Mbp

000 Compensator hyper-retraction. (Counts) Mbh

016 Deep-profile piston position. (Counts) Mbj

010 Ascent buoyancy nudge. (Counts) Mbn

022 Initial buoyancy nudge. (Counts) Mbi

001 Park-n-profile cycle length. Mn

120 Maximum air bladder pressure. (Counts) Mfb

096 OK vacuum threshold. (Counts) Mfv

225 Piston full extension. (Counts) Mff

100 Piston storage position. (Counts) Mfs

2 Logging verbosity. [0-5] D

0002 DebugBits. D

d4bc Mission signature (hex).

> e Activating mission.

(Dec 18 2009 13:58:10, 251904 sec) SelfTest() Passed: internal pressure [80, -6.8"Hg] less than threshold [96, -2.1"Hg].

(Dec 18 2009 13:58:12, 251905 sec) SelfTest() Passed: response received from SBE41.

(Dec 18 2009 13:58:19, 251913 sec) SelfTest() Passed: SBE41 (SerNo 4577) FwRev accepted: [3.0]

(Dec 18 2009 13:58:23, 251917 sec) Sbe41Config() Configuration successful.

(Dec 18 2009 13:58:25, 251919 sec) SelfTest() Passed: SBE41 configuration was successful.

(Dec 18 2009 13:58:26, 1 sec) PreludeInit() Mission restarted. [pid=0, itime=251920] * * * * * *

(Dec 18 2009 13:59:10, 44 sec) PistonMoveAbsWTO() 225->225 [0sec, 0.0Volts, 0.000Amps, CPT:0sec]

Mission activated.

5.2.3   Log file for Mission Activation Float 4499

Asynchronous wake-up detected (ie., wake-up not initiated by alarm signal).

Entering Command Mode [ApfId 6455, FwRev 060408]

> t Real time clock: Fri Dec 18 06:39:20 2009

> c Battery [195cnt, 15.0V] Current [4cnt, 20.1mA] Barometer [80cnt, -6.7"Hg]

> l APEX version 060408 sn 6456

98FA4BE 28-bit hex Argos id. Ma

044 Argos repetition period (Seconds) Mr

INACTV ToD for down-time expiration. (Minutes) Mtc

225 Down time. (Hours) Mtd

015 Up time. (Hours) Mtu

009 Ascent time-out. (Hours) Mta

006 Deep-profile descent time. (Hours) Mtj

006 Park descent time. (Hours) Mtk

006 Mission prelude. (Hours) Mtp

1000 Park pressure. (Decibars) Mk

2000 Deep-profile pressure. (Decibars) Mj

066 Park piston position. (Counts) Mbp

000 Compensator hyper-retraction. (Counts) Mbh

016 Deep-profile piston position. (Counts) Mbj

010 Ascent buoyancy nudge. (Counts) Mbn

022 Initial buoyancy nudge. (Counts) Mbi

001 Park-n-profile cycle length. Mn

120 Maximum air bladder pressure. (Counts) Mfb

096 OK vacuum threshold. (Counts) Mfv

226 Piston full extension. (Counts) Mff

100 Piston storage position. (Counts) Mfs

2 Logging verbosity. [0-5] D

0002 DebugBits. D

17f6 Mission signature (hex).

> e Activating mission.

(Dec 18 2009 06:43:00, 213291 sec) SelfTest() Passed: internal pressure [80, -6.8"Hg] less than threshold [96, -2.1"Hg].

(Dec 18 2009 06:43:02, 213292 sec) SelfTest() Passed: response received from SBE41.

(Dec 18 2009 06:43:10, 213300 sec) SelfTest() Passed: SBE41 (SerNo 4580) FwRev accepted: [3.0]

(Dec 18 2009 06:43:14, 213304 sec) Sbe41Config() Configuration successful.

(Dec 18 2009 06:43:15, 213306 sec) SelfTest() Passed: SBE41 configuration was successful.

(Dec 18 2009 06:43:17, 1 sec) PreludeInit() Mission restarted. [pid=0, itime=213307] * * * * * *

(Dec 18 2009 06:44:00, 44 sec) PistonMoveAbsWTO() 226->226 [0sec, 0.0Volts, 0.000Amps, CPT:0sec]

Mission activated.

6 Vessel-Mounted ADCP Instruments, Data Collection and Processing

Peggy Courtois

(Adapted from the JC029 cruise report, Angelika Renner and Mijam Glessmer)

6.1 The Instruments: OS75 and OS150

6.1.1 Installation

Two vessel mounted RD Instruments ADCPs are installed on the port drop keel. The 75kHz Ocean Surveyor (OS75) sits in front of the 150kHz Ocean Surveyor ADCP (OS150). The latter is situated behind a plate and thus roughly 10 cm higher than the OS75 which is aligned with the bottom of the hull. The draft of the ship is 6.9 m. When lowered, the keel extends 2.8 m below the hull. The resulting transceiver depths are 6.9 m and 6.8 m for the OS75 and the OS150 respectively when the keel is retracted, and 9.7 m (OS75) and 9.6 m (OS150) when the keel is lowered. During JC041, the keel was retracted all the time.

6.1.2 The PCs

The ADCPs are controlled via VmDas through separate PCs. They are located in the main lab. The ADCP data are written to the respective PCs. From there they have to be transferred onto the UNIX server. No backup system is installed for either of the ADCP PCs.

6.1.3 Alignment

According to the installation report from the contractors, both ADCPs should be perfectly aligned with the ship's axis. However, during JC029, scientists noticed that the OS75 was roughly 9 degrees off, which was also the case during the UK DIMES1 cruise. Contrary to JC029, no settings were changed to correct that offset, as the ADCPs were not the major concern.

6.2 Data Aquisition: VmDas

The ADCPs were controlled using the proprietary RDI VmDas software, version 1.42. The software is installed on the ADCP PCs in the main lab. VmDas can be used for data acquisition, archiving, processing, display, and reporting. During JC041, ADCP setup, data logging, preliminary screening and mapping of beam data onto Earth coordinates were done with VmDas. The final processing was performed after the cruise using a set of Matlab routines (see section 6.4).

6.2.1 General settings

OS150: Three different settings are available for the OS150:

- Broadband with Bottom Tracking on

- Narrowband with Bottom Tracking on

- Narrowband with Bottom Tracking off

OS75: Two different settings are available for the OS75:

- Narrowband with Bottom Tracking on

- Narrowband with Bottom Tracking off.

For both, the ADCP configuration files used were *OS75NB_BToff_JC37_up.txt* and *OS150NB_BToff_JC37_up.txt*. The mode used for both OS was narrowband. For more information on the commands refer to the RDI Ocean Surveyor manuals, in particular the volume 'Commands and Output Data Format'.)

6.2.2 What to set and to check

In VmDas, several things have to be set or checked before start acquiring data. The VmDas setting used for the OS75 and the OS150 instruments were identical and as follows:

Open VmDas, click on 'file' →'collect data'. Then in 'options' →'edit data options':

- Communications tab:

set up such that under Current Setting the COM Port Setup is set to:

ADCP Input: COM1, 9600, N, 8, 1

NMEA1 Input: COM3, 4800, N, 8, 1

NMEA2 Input: COM4, 19200, N, 8, 1

- ADCP setup tab:

  ADCP setup from file (enter the required command file)

  time between ping ensembles: 2 seconds

- Recording tab:

  name: OS150_JC041 (or OS75_JC041)

  number: 1 (has to increase everytime the ADCP recording is stopped and restarted, otherwise data loss can occur as VmDas overwrites previously created files!)

  max size: 10 (MB; when that size is reached, VmDas starts a new file with automatic numbering)

  no dual output directories

- Nav tab:

  NMEA Ship Position (GGA) Source: Enable, choose NMEA2 from drop down menu

  disable NMEA Ship Speed (VTG) Source

- Transform tab:

  Heading Source: PRDID, NMEA Port: NMEA2, Fixed Heading set to 0

  Tilt Source: Fixed Tilts 0 Fixed Pitch,0 Fixed Roll (don't enable tilt correction)

  Heading Sensor Magnetic/Electrical Corrections: 0 EV: Primary Heading Error, 0 EV Backup Heading Error

  disable all other corrections

- Averaging tab:

  check Temporal

  The STA interval was set to 120 seconds, LTA to 600 seconds

  Profile Ping Normalisation Reference Layer was enabled and set to start bin = 3, end bin = 10

No changes in Data Screening, User Exit, and Sim Input tabs.

The physical misalignment of the ADCP is set in the command files, not in VmDas.

When the ADCPs are recording, several things should be checked regularly:

- Check the size of the .LOG-files: If there are any problems (e.g. buffer overload, timeouts and resetting of the ADCP, problems with the navigation data stream), they get recorded here. If the file size suddenly increases or the file becomes bigger than 10 KB, an error might have occurred that needs to be resolved[1].

- Check regularly that the size of the data files is increasing.

- Create and maintain a list with all files created and the setup used. For extraction of on/off station data etc it helps to note station times together with the file sequences.

- Check that GPS data is properly logged and written to the N2R-files.

- Keep an eye on the PC clock deviation from the ship's clock: the last entry in the $PADCP line in the N2R-files gives the difference in seconds. It should be small (during JC029, it was usually around 0.10). Jumps in the PC clock time can be detected by checking this.

6.2.3   Output data format

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

- **.ENR**: binary; raw ADCP data file.

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

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

---

[1]A frequent error occurred during JC029 regarding the NAV data feed(see section 6.3) which led to much larger LOG-files. The error was found to not affect the postprocessing.

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

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

- **.N1R**: ASCII text; raw NMEA data, see section 6.3.

- **.N2R**: ASCII text; raw NMEA data, see section 6.3.

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

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

- **.LOG**: ASCII text; all logging output and error messages.

More options are available and information about the data files and their format is available in the various OS user guides. Here, a short overview about the structure of the binary data files is given. The structure varies slightly depending on whether only narrowband OR broadband mode are turned on or both are on.

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

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

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

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

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

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

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

- **Checksum**: modulo 65536 checksum (sum of all bytes in the output buffer excluding the checksum).

Notes:
* If data storing by VmDas is interrupted by e.g. a software crash and/or the data files are not closed properly by VmDas, the checksum can be incorrect and the check in the postprocessing can fail.
* The date recorded by VmDas is given as Julian day. VmDas takes 1st Jan to be day no. 0, different from the ship clock and the other data logging systems!

6.3 Navigation data input

The navigation data is fed directly to the ADCP PCs from the Applanix POSMV System (see Section 8.2). When starting data recording in VmDas, the navigation data link is opened and started automatically. Errors during the data streaming can be displayed in VmDas in the NMEA Communication-window and are written to the LOG-file.

There are two NMEA feeds into the VmDas software. The NMEA1 stream is written to the N1R-files, the NMEA2 stream to the N2R-files. They are also included in the binary data files. The NMEA1 feed provides the following strings: HCHDM, TIROT, HEHDT, PPLAN. NMEA2 gives the GPZDA, PASHR, PRDID, GPGGA, GPHDT, GPRMC messages. In both files, a message from VmDas is stored in the PADCP line at every ADCP ping. For the postprocessing, the PADCP and the PRDID messages are used. They contain:
```
$PRDID, pitch, roll, heading
$PADCP, ensemble number, date (yyyymmdd), time from PC clock, PC clock
offset.
```

6.4 Post-processing in Matlab

6.4.1 Remarks and Glossary

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

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

- Ping and ping ensemble: in case of JR165, they are the same, as a ping ensemble was set to include one ping only.

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

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

In the following section, the processing is described for the OS75. It is controlled through the main routine *OS75_ JC_jc41.m*. The processing of the OS150 data works in exactly the same way, only the main routine needs to be adjusted (*OS150_ JC_jc41.m*).

6.4.2 Quick'n'dirty: How to get processed ADCP data

There are a few things that have to be set for each cruise in file *OS75_ JC_jc41.m*. These are:

- Add the path where the routines are stored to the Matlab search path.

- The cruise name: variable 'cruise'. The name is used when reading in raw data and saving processed data, and appears in the plots.

- The file sequences: variable 'files'. This determines which of the file sequences are processed, 'files' can be a single number or a vector containing the numbers of several file sequences.

- Paths to data files: variables 'RAWPATH' and 'PATH'. They contain the directory paths to the directory where the raw data is stored ('RAWPATH'), and where the processed data will be written to ('PATH').

- The averaging interval: variable 'superaverage'. This sets the interval over which ping ensembles will be averaged. Unit is seconds.

- The year: variable 'YYYY'. This parameter was setup to 120.

- A switch for which lat/lon fix to be used (see below, 6.4.3): variable 'which_prdid_fix'. Options are a) 1 to use the fix directly after the previous ADCP ping, or b) any other number to use the fix directly before the current ADCP ping. Set it to 1 if you don't want to bother, it works.

- The upper and lower limit of the reference layer: variables 'ref_uplim' and 'ref_lowlim'. Those are needed for calculation of a reference velocity which is used when doing calibration by water tracking. Unit is meters. The limits were setup to 400m and 600m for the OS75 and 200 and 300 for the OS150.

- The misalignment angle and the scaling factor: variables 'misalignment_xb' and 'amplitude_xb' with x=b for broadband and x=n for narrowband. When running *OS75_JC_jc41.m* the first time (see below), set the misalignment to 0 and amplitude to 1. After the first run, to correct for the angle and the scaling, set the variables to the mean, median, mode or whichever value is preferred, and run *OS75_JC_jc41.m* again. Mean, median, and standard devation are displayed in the plot adcp_calib_calc.ps. *Deb Shoosmith modified this bit so that only 'misalignment_nb' and 'amplitude_nb' are used. It is possible though, to return to the previous version and then process data in both broadband and narrowband mode at the same time. The description below therefore still includes this option.*

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

1. Run *OS75_JC_jc41.m*.

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

3. Set 'misalignment_xb' and 'amplitude_xb' (with x=b or n) in *OS75_JC_jc41.m* to these values.

4. Run *OS75_JC_jc41.m* again.

If you reprocess the raw data, make sure to remove the old .ps-files containing the various plots, otherwise the new plots will simply be added instead of written to a new file.

6.4.3 Detailed description of the processing functions

The master function: *OS75_ JC_jc41.m*

The main function for the processing is *OS75_ JC_jc41.m*. In there, the environment and variables are set, and the subfunctions are called. Figure 35 gives an overview of the processing routines, their order and the output.

In the first part the work environment is defined: Matlab paths to the processing routines are added to the Matlab search path, the directory with the raw data and the directory for the processed data are declared, and the file- and cruise names are defined. Then the vector containing the numbers of the file sequences that are to be processed is created. Several choices can be made for the processing: the variable *superaverage* is used to define the interval over which pings will be averaged in time, unit is seconds. *which_ prdid_ string* sets, if the first PRDID fix after the previous PADCP string or the last one before the current PADCP string (see JC029 cruise report for more information). The values for *ref_ uplim* and *ref_ lowlim* give the upper and lower limits of the reference layer of which a velocity is calculated and used as reference velocity. This is of importance mostly for water track calibration in cases where no bottom track data is available.

Then, during the first run through *OS75_ JC_jc41.m*, where no data are processed yet and no calibration data are available, the correction values for the misalignment angle (*misalignment_ xb*) and the scaling factor (*amplitude_ xb*) are set to 0 and 1 respectively (x=n for narrowband mode, x=b for broadband mode). For the second run, when values for *misalignment_ xb* and *amplitude_ xb* have been calculated, they should be set to the median, mean, mode or whichever value works best. For JR165, scientists found that separate misalignment and amplitude correction values for broadband and narrowband mode calculated from files in the respective mode worked better than only one for both modes. To know later how the values used were derived, it is best to write down where they came from.

To keep a record of the settings used to process a set of ADCP data, the settings and the text displayed on screen during the processing are written to a diary called *adco_ proc_ log_ runX.txt*. X will be 1 for the first run (when *misalignment_ xb* and *amplitude_ xb* are equal to 0 and 1, resp.) and 2 for the second run (*misalignment_ xb* and *amplitude_ xb* unequal 0 and 1, resp.).

After this introductory part, the processing starts. Arrays are declared for later use when calling some of the subroutines, and the file containing calibration point data is deleted if it exists in the processed data directory.

Then, the loop through all file sequences specified above starts. First, the filename is set. Its general structure is *CRUISE_ xxx_ yyyyyy*. At this point, *xxx* is set to the file

Master: OS75_JCR.m

read_os.m → { os_id
             read_buf ◄······· xxx.ENX

structure OS75_raw: raw data from binary data file

save OS75_raw in 'CRUISE'_xxx_yyyyyy_raw.mat

remove_zero_ensembles.m
remove_bad_navigation.m

OS75_sgl_ping: cleared of zero ensembles and bad navigation, added file name and paths

include_att_jcr.m — only during 1st run → read_nmea_att_jcr.m ◄······· xxx.N1R

save plot of pitch, roll, and heading in adcp_prh.ps

save structure att (navigation data) in 'CRUISE'_xxx_000000_att.mat

save relevant att-data for file in loop in 'CRUISE'_xxx_yyyyyyd_att.mat

additions in OS75_sgl_ping: navigation data from .N1R-files

subst_bad_seatex.m
correct_offset.m
ship_vel.m

modified OS75_sgl_ping

qual_control.m

save OS75_sgl_ping in 'CRUISE'_xxx_yyyyyy_sgl_ping.mat

calib_points_bt.m ↔ ave_for_calib.m

save new/resized structure cal in 'CRUISE'_cal_file.mat

loop through .ENX-files

average_pings.m

new structure / add to structure OS75_ave_ping

does 'CRUISE'_cal_file.mat exist?
no   yes

calib_points_wt.m ↔ ave_for_calib.m
calib_calc_wt.m

save new structure alpha in 'CRUISE'_cal_file_wt.mat

calib_calc_bt.m

save modified structure cal in 'CRUISE'_cal_file.mat

save plot of misalignment angle and scaling factor in adcp_calib_calc.ps

save OS75_ave_ping in 'CRUISE'_000_000000_zz_ave_ping.mat

bt_mask.m
abs_vel.m

new structure OS75_abs

save OS75_abs and modified OS75_ave_ping in 'CRUISE'_000_000000_zz_abs.mat

plot

save contour plot of velocities in adcp_vel_contours.ps

run 2nd time with adjusted misalignment angle and scaling factor

after 1st run
after 2nd run
↓
The End!

xxx = file sequence
yyyyyy = number of file in file sequence
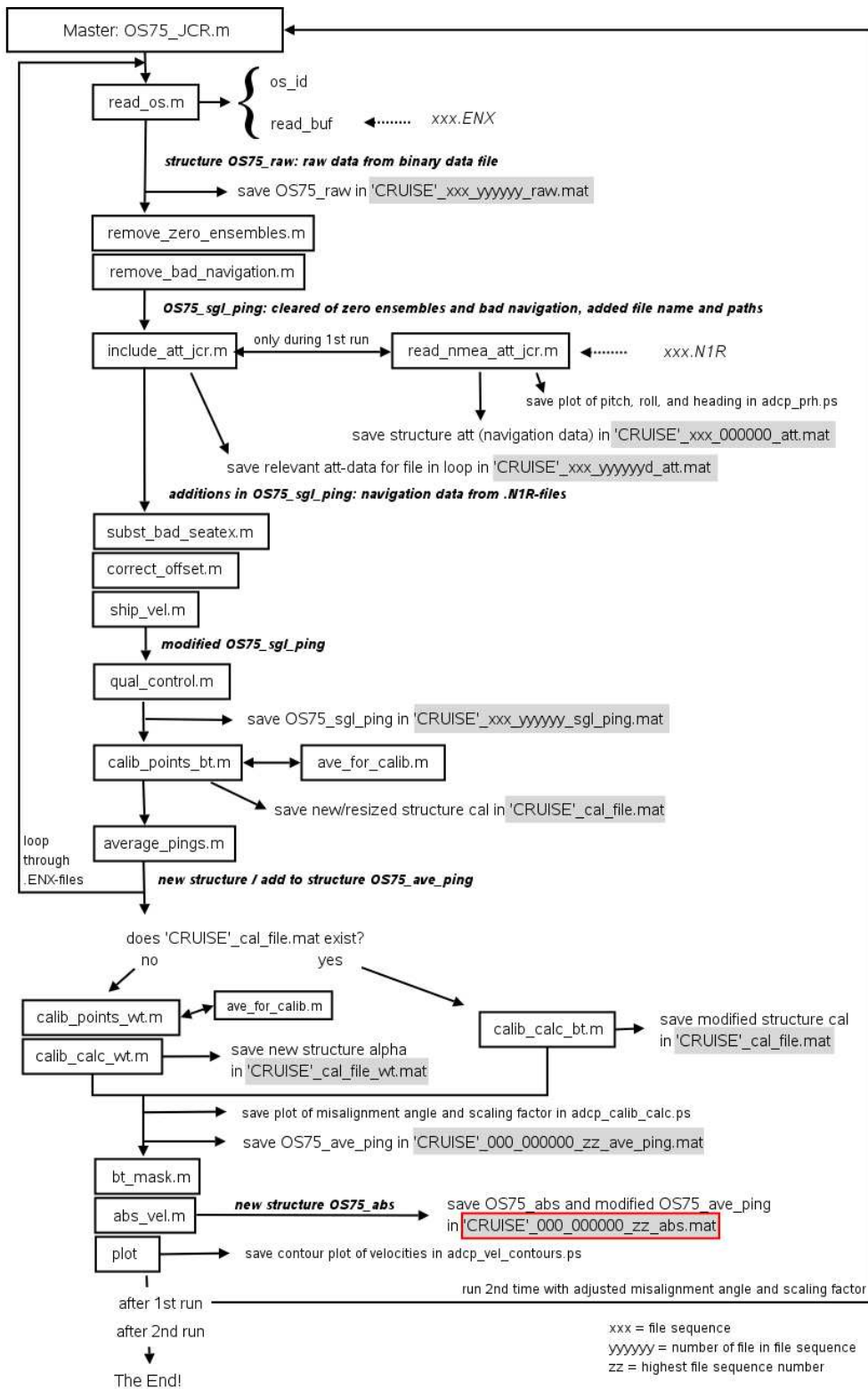zz = highest file sequence number

Figure 35: Flowchart of the processing path from the JR165 report.

sequence number that is the current in the loop and *yyyyyy* is 000000.

The files created by *remove_ bad_ navigation.m* and *subst_ bad_ seatex.m* are deleted if they exist in the processed data directory.

To go through all files in a file sequence, the switch *ex* and the counter *I* are used. In the while-loop depending on the value of *ex*, the first thing adjusted is the filename so that *yyyyyy* corresponds to the current file of the current file sequence. If the file 'filename'.ENX exists in the raw data directory, *ex* will keep the value 1, otherwise it will become zero.

After this, the run through the subroutines begins. This includes all routines described from *read_ os* to *average_ pings*. Once all files have been passed through these routines and the loop is finished, the functions described from *calib_ points_ wt* to *abs_ vel* are called. After that, all data is processed and saved in the specified directory. The last thing in the main function is a plot of velocities: cross sections of the zonal and meridional velocities are produced and the plots are saved in *adcp_ vel_ contours.ps*.

read_ os.m

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

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

- 'ends': *???*

- 'ens_list': list of ensemble numbers

- 'yearbase': start year

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

- 'vel': read velocity.

- 'cor': read correlation magnitude.

- 'amp': read echo intensity.

- 'pg': read percent good.

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

- 'bt': read bottom trakc data.

- 'nav': read navigation data

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

More than one argument can be passed on to *read_os.m*. Arguments can also be numbers.

After the switches are set, the subroutine *os_id*, which is within *read_os.m*, is called with the argument *id_arg*. The value of *id_arg* depends on the offset of the positions of the data. If both narrowband and broadband data are collected in broadband mode, this also decides which data are read. If *id_arg*=1, the narrowband data is extracted. *os_id* returns the structure *id* with the positions/identifiers of the data fields in the binary data files.

The next step is the first call to the subroutine *read_buf*, also within *read_os.m*.

read_buf   This is the part where the binary data is read.

During the first call with only one argument, the configuration of the OS75 ADCP is extracted from the fixed leader data (see Section 6.2.3) and stored in the structure config. If one of the checks on number of bytes, header or data source ID or checksum fails, an error message will be returned to *read_os.m*. Otherwise, information about ADCP hardware and setup that remains the same for all pings is read. After that and during the second call (with two arguments), the variable, bottom track, attitude, and navigation data is extracted.

After the first call to *read_buf*, the configuration data is used to set up space and size of variables and the reading loop. *read_buf* is called the second time, and the data requested by using the various switches is stored. Before returning to the main routine, variables are adjusted for negative numbers or NaNs.

All raw data read in is stored in the structure *OS75_raw* and returned to the main function. There, the structure is written to the file *CRUISE_xxx_yyyyyy_raw.mat*.

remove_zero_ensembles.m

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

remove_bad_navigation.m

Depending on *which_ prdid_ fix*, *OS75_ sgl_ ping.nav.txy1* or *2* is checked for time (first row), longitude (second row) and latitude (third row) duplicates. The number of rejected data cycles is printed on screen and saved as *bad* and *good* (=number of data cylces - number of rejected cycles) in the file *CRUISE_ bad_ nav.mat*. The rejected data cycles are then removed from *OS75_ sgl_ ping* and the structure handed back to the main routine.

include_ att_ jc.m

Arguments passed on to this routine are *OS75_ sgl_ ping*, *add_ to_ ensnum* (for the correction of ensemble numbers; see below) and *which_ prdid_ fix*. If no file *CRUISE_ xxx_ 000000_ att.mat* exists yet in the processed data directory (i.e. the navigation data in the .N2R-files has not been read yet), *OS75_ sgl_ ping* is passed on to *read_ nmea_ att_ jc.m* which is called to read the .N2R- (or .N1R-) files.

read_ nmea_ att_ jc.m

The routine goes through all .N2R-files in a file sequence. To change to .N2R, modify the variable *extension*. The number of lines to be read in one go is limited to a maximum of 160000, the loop will go on until all lines are read.

The text in the .N2R-file is read into a matrix. Then lines containing the \$PADCP or the \$PRDID string are extracted (for more information on the \$PADCP and \$PRDID format see Section 6.3). If two \$PADCP-lines are consecutive, the first of them is discharged (no attitude data available for this ping ensemble!). From the \$PRDID-lines the one following the \$PADCP-line are extracted, the others discharged. Pitch, roll and heading are read from the remaining \$PRDID-lines and stored. If heading is missing (=999), pitch and roll are set to 999 as well. From \$PADCP-lines, the ping ensemble number, the PC clock offset, and the PC time of the ping ensembles (converted to decimal Julian days) are extracted.

After all files are read, the ping ensemble number is checked and corrected for duplicates, which can appear due to the splitting of the files after the maximum number of lines is read.

The data is stored in the structure *att* which is written to *CRUISE_ xxx_ 000000_ att.mat*. Pitch, roll, heading, and the PC clock offset are plotted and the figures saved to *adcp_ prh.eps*.

After that, return to *include_ att_ jc.m*.

The file *CRUISE_ xxx_ 000000_ att.mat* with the *att*-structure is loaded in. If the structure contains data, the following is done: For further processing the ping ensemble number has to be increasing. When the ADCP times out while waiting for a response and

resets, the ensemble number goes back to 1. Here, the ensemble numbers are modified so that they increase throughout the file (for *att*) and throughout the files of a file ensemble in *OS75_ sgl_ ping.ens_ num*.

There is already attitude data in the structure *OS75_ sgl_ ping* which comes from the .ENX-file. To extract pitch, roll, heading, and PC clock offset which are relevant for the current .ENX-file, a vector is created for each variable of the length *max(highest ensemble number in att, highest ensemble number from the .ENX attitude data)* and filled with NaNs. Then, the attitude information from *att* is written into the vector and only the data points corresponding to the ensemble numbers from the .ENX-file are stored. If *att* is empty, heading, pitch, roll, and PC clock offset are set to NaN.

The extracted attitude data is written to *OS75_ sgl_ ping.att*. The attitude data relevant to the current .ENX-file is also saved in the new structure *att* in *CRUISE_ xxx_ yyyyyyd_ att.mat*. The modified *OS75_ sgl_ ping* is returned to the main routine.

subst_ bad_ seatex.m

The arguments *OS75_ sgl_ ping.att*, and *sea_ file* are handed over. In *sea_ file* the number of accepted and rejected (due to bad Seatex data) data points will be stored.

A search on *OS75_ sgl_ ping.att* data is done for ensembles where

- heading = 0;

- heading = 999;

- pitch and roll = 0;

- the second differential of heading = 0.

The total number of those ensembles is printed on screen and saved as *bad* in *'CRUISE'_ bad_ heading.mat*.

OS75_ sgl_ ping contains two headings: *OS75_ sgl_ ping.heading* which comes from the .ENX-file and *OS75_ sgl_ ping.att.heading* from the .N2R-file. Both are from the same instrument (Seapath Seatex), but may be slightly different due to a (very) small time difference in when they are recorded. Therefore, the velocities in *OS75_ sgl_ ping* are rotated by the difference.

To get bottom track velocities in the correct orientation, *OS75_ sgl_ ping.bt.vel* is multiplied by -1.

OS75_ sgl_ ping with the modified values is returned to the main routine.

correct_ offset.m

Using the helper routine *uvrot.m*, this routine scales the water and bottom track velocities and corrects them for misalignment. From the main routine, the arguments *OS75_ sgl_ ping*, *misalignment_ xb* and *amplitude_ xb* are passed on, x=n or b depending on whether the current file ensemble is in narrow- or broadband mode. The horizontal velocities are multiplied by the scaling factor *amplitude_ xb* and rotated by the specified misalignment angle *misalignment_ xb*. The heading is adjusted by subtracting the misalignment angle. The modified structure *OS75_ sgl_ ping* is returned to the main routine.

ship_ vel.m

The routine is called with the arguments *OS75_ sgl_ ping* and *which_ prdid_ fix*. The latter decides which navigation fix is used for the calculation of the ship velocity: either txy1 or txy2 (see also Sections 6.4.3 and 6.4.4). With the help of the routine *sw_ dist.m* from the CSIRO Seawater toolbox, the distance and the direction between the fixes is calculated and then converted to distance in east- and northward direction in meters and time difference in seconds. Dividing distance by time difference results in ship velocity in m/s, which is written to *OS75_ sgl_ ping.ship_ velocity*.

If bottom tracking was on, the horizontal bottom track velocities *OS75_ sgl_ ping.bt.vel(1:2,:)* should contain values other than NaN. If that is the case, the ship velocity is set to *OS75_ sgl_ ping.bt.vel(1:2,:)*.

The structure *OS75_ sgl_ ping* is then handed back to the main routine.

qual_ control.m

Several criteria are used in this routine for further quality control. Therefore, the arguments *OS75_ sgl_ ping*, *beam*, *heading_ change* and *ship_ velocity_ change* are included in the call. *beam* is the number of beams of the ADCP instrument, *heading_ change* is the maximum change in heading allowed at any one timestep, and *ship_ velocity_ change* is the maximum change in ship velocity allowed at any one timestep. Large changes lead to less reliable ADCP data. The values used during JC041 are the same as those for JC029, which are 10° per ping for the heading change and 0.5514 m per ping for the ship velocity change. These parameters can be changes in *OS75_ JC_jc41.m*.

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

Then, if *beam* = 0, a check using percent good is performed: velocities of ping ensembles

with percentage of good four beam solutions equal to zero are set to NaN.

The two following steps look at the heading changes. First, a smoothed version of the heading change (diff(heading)), created using a Hamming-window based, second order filter (see 6.4.3), is checked for values exceeding *heading_ change*, and the velocities of affected ping ensembles (i.e. the two ensembles in between which the change is large) are set to NaN. The same is done for the unfiltered heading change.

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

Velocities are set to NaN if the change in ship speed exceeds *ship_ velocity_ change*.

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

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

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

calib_ points_ bt.m

In this routine, calibration points are extracted using 2-minute averages of ADCP data and various criteria these points have to fulfill. It is called with the arguments *OS75_ sgl_ ping*, *cal_ file*, *which_ prdid_ fix*, *ref_ uplim* and *ref_ lowlim*. *cal_ file* specifies where the data for calibration extracted here will be written to, *which_ prdid_ fix* does the same as in *ship_ vel.m*.

To average the ADCP data over two minutes, the routine *ave_ for_ calib.m* is called with the arguments *OS75_ sgl_ ping*, *av_ time* (set to 120 seconds), *ref_ uplim*, *ref_ lowlim*, and *which_ prdid_ fix*.

ave_ for_ calib.m

This routine is a reduced version of *average_ pings.m*, including only variables required by *calib_ points_ bt.m*. The possibility of missing out ping ensembles in the averaging process when several .ENX-files exist in a file sequence is ignored here (for more about that issue see *average_ pings.m* described below.

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

The principle used is based on a comparison of ADCP bottom track data and GPS tracks. The bottom velocity recorded by the ADCP should be the same as the GPS derived ship velocity. Therefore, the value *GPS ship speed/ADCP bottom track speed* gives the scaling factor to adjust ADCP velocities, and $-(GPS\ ship\ heading - ADCP\ bottom\ track\ heading)$ is the misalignment angle.

As velocities from bottom tracking are crucial for the calibration, ping ensembles with NaNs in either zonal or meridional bottom velocity are discharged. The ship velocity is derived from navigation data in *OS75_sgl_ping.nav* and *which_prdid_fix* sets which fix is used. Ship velocity is then calculated as in *ship_vel.m* as distance in east- and northward direction divided by time difference. The criteria potential calibration points have to fulfill are:

- the change in ship heading is small;

- the change in ship speed is small;

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

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

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

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

Relevant data at the calibration points are extracted and saved in the structure *cal*. This includes bottom velocity, speed, heading and range, ADCP velocities and heading, ship speed and heading, and the navigation data. The scaling factor at the calibration points is calculated as is the misalignment angle.

To enable quality control of the intervals of calibration points (interval=row of successive calibration points) and possible filtering by hand after the processing, some statistics are done and included in the structure: average and standard deviations of ship velocity and heading, bottom velocity and heading, scaling factor and misalignment angle, and the number of 2-minute averages in the interval.

If the *cal_file* does not exist yet, it is created, otherwise, the data is added to the existing file.

average_pings.m

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

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

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

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

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

Several variables are extracted and derived: the reference layer velocity (zonal and meridional) as mean of the horizontal velocities in the depth range specified by *ref_uplim* and *ref_lowlim*; absolute velocities by adding the ship velocity to the horizontal velocities; percent good from the fourth beam; a value for bottom range for each ping ensemble with the condition that it is between 50 and 1200 m depth and using the median of the four beams; the difference between the headings from the .ENX- and from the .N2R-file (set to NaN if the .ENX-heading does not change for two successive ping ensembles); pitch and roll (set to NaN if data is missing, i.e. > 998); the PC clock offset; the echo intensity as mean over all beams.

The navigation data is set to NaN for ping ensembles where there is no velocity data in any of the beams and any of the depth bins.

For the averaging, the heading is broken up into components (-cos and sin) and reconverted to angles in degrees afterwards.

Of the extracted variables, the ones included in the averaging are: absolute velocity (all three directions), reference velocity, heading, difference in .ENX- and .N2R-heading, PC clock offset, echo intensity, percent good, and bottom range. Additionally, ship velocity and navigation data (time, longitude, latitude) are averaged. For pitch and roll, the standard deviation is calculated.

109

The data from ping ensembles that were remainders after the averaging is written to *d_missed* and returned to the main routine.

The averaged absolute velocity is converted back to velocity relative to the ship by subtracting the averaged ship velocity. The reference layer velocity is then recalculated from the resulting averaged (relative) velocity.

The averaged variables are added to the structure *OS75_ave_ping* as are the variables *depth* and *ref.bins* (= numbers of the bins in the reference layer). The structure is then returned to the main routine.

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

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

calib_points_wt.m

If there is no bottom track data available, the calibration is done using water track. Again, the search for possible calibration points is done using two minute averages produced by *ave_for_calib.m*.

First differences are calculated from the average data for the reference velocities (i.e. the water velocities in the reference layer specified by *ref_uplim* and *ref_lowlim*) *du* and *dv*, and the ship velocities *dsu* and *dsv*. Of those, only differences were considered for when ship speed exceeded 3 m/s between ensembles not more than 5000 m or 3600 s apart. Using the Matlab function fminsearch.m, the following function was minimised for *phi* and *A*:

$$f(A, phi) = (A \cdot du \cdot \cos(phi) - A \cdot dv \cdot \sin(phi) + dsu)^2 + (A \cdot du \cdot \sin(phi) + A \cdot dv \cdot \cos(phi) + dsv)^2$$

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

calib_calc_wt.m

After *alpha* has been created in *calib_points_wt.m*, it is passed on to this subroutine. Here, average, median, and standard deviation for *phi* and *A* are calculated and written to *cal_file_wt*. The median should then be used during the second run of *OS75_JC_jc41.m* for misalignment and amplitude correction.

Several plots of the misalignment and the scaling are also produced and stored in *adcp_ correction_ stats.ps.*

calib_ calc_ bt.m

During the first run of *OS75_ JC_jc41.m*, the misalignment angle and the scaling factor which are to be used for the second run are calculated here. In the second run, the results for *phi* and *A* should be closer to zero and one, respectively, than before.

The arguments handed over are *cal_ file*, which specifies the file with the calibration point data, *cruise*, *misalignment_ xb* and *amplitude_ xb*, which are used for the plots created in this routine.

After *cal_ file* is read in, scaling factors and misalignment angles outside the interval *average ± standarddeviation* are sorted out. From the remaining points, the average, the median and the standard deviation for A and phi are calculated and added to the structure *cal*.The median is less affected by outliers which might have survived the screening in *calib_ points_ bt.m* and *calib_ calc_ bt.m* and should therefore be used as correction value in the second run.

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

bt_ mask.m

OS75_ ave_ ping and *bindepth* are passed on to this routine. Here, a mask is created using the bottom range *bt.range*. With this mask, velocity data below 86% of the bottom range (= water depth) is set to NaNs. The structure containing the modified velocity fields is returned to the main routine.

abs_ vel.m

OS75_ ave_ ping and *bindepth* are handed over from the main routine. In order to derive absolute water velocities independent of the ship movement, the east- and northward ship velocity is added to the horizontal water velocity (*OS75_ ave_ ping.vel*). The same is done for the velocity in the reference layer (*OS75_ ave_ ping.ref.vel*). The resulting absolute velocities, the navigation data and the depth array (set to *bindepth*) are handed back to the main routine within the structure *OS75_ abs*.

Helper routines: *julian.m*, *sw_ dist.m*, *uvrot.m*, *rot_ fun_ 1.m*, *mfilter.m*

These routines are called on various occasions during the processing. *sw_ dist.m* is part of the CSIRO Seawater toolbox.

6.4.4 Overview of output files

CRUISE_xxx_yyyyyy_raw.mat

The structure *OS75_raw* in this file contains the raw, unedited data from the .ENX-file as read in in *include_att_jc.m* and *read_nmea_att_jc.m*. For JC041 the structure consists of:

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

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

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

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

- bt: structure containing the bottom track data:

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

- nav: structure containing navigation data:

  - sec_pc_minus_utc: [number of ensembles x 1]-array containing the PC clock offset in seconds;

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

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

- depth: [1 x number of bins] array. The array contains the depth of the bins *(centre or bottom???)* in the configuration used for the actual file sequence.

- error: if reading of data fails, an error message will be stored here, otherwise it should be empty.

There is one such file for each .ENX-file in a file sequence.

CRUISE_xxx_000000_att.mat

In this file, the structure *att* contains the attitude information from all .N2R-files of a file sequence, read during *read_nmea_att_jc.m*. This includes the following [1 x number of ensembles]-arrays from the $PRDID and $PADCP lines:

- heading, pitch, roll;

- pc_time: time from the ADCP PC clock;

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

- ens_num: the ping ensemble number.

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

CRUISE_xxx_yyyyyyd_att.mat

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

- att_heading, att_pitch, att_roll: heading, pitch and roll from the .N2R-files for the ping ensembles in the corresponding .ENX-file;

- heading_orig: heading from the .ENX-file;

- ens_num: the ping ensemble number;

- lat: latitude of the ping ensemble.

The difference between att_heading and heading_orig should be small and therefore negligible. In the case of JC041, they both come from the Applanix POSMV, but there is a small time lapse between the writing of data to the .ENX- and the .N2R-files (see also Section 6.3).

CRUISE_xxx_yyyyyy_sgl_ping.mat

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

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

  additional variables:

- filename: CRUISE_xxx_000000;

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

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

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

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

CRUISE_cal_points.mat

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

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

- vel: [number of bins x 2 x number of calibration points]-array of east- and northward velocity

- heading: [1 x number of cal. points]-array; heading from .N2R-data;

- nav: structure containing txy1 data at the calibration points;

- ship_speed, ship_heading: [1 x number of cal points]-arrays;

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

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

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

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

- stat: structure with values for the scaling factor (a) and the misalignment angle (phi) as calculated in the routine *calib_calc_bt.m*. The values stored here after the first run of the main routine *OS75_JC_jc41.m* are the ones that should be used for the second run!

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

CRUISE_cal_points_wt.mat

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

CRUISE_000_000000_zz_ave_ping.mat

(zz=highest file ensemble number included in the processing)
The structure OS75_ave_ping contains data after averaging over a chosen time interval (xyz = number of velocity profiles after averaging):

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

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

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

- heading: [1 x xyz]-array;

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

- att: structure containing:

    - heading_difference: [1 x xyz]-array of the difference between heading from .ENX and .N2R (hopefully equal to zero);

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

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

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

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

CRUISE_000_000000_zz_abs.mat

(zz=highest file ensemble number included in the processing)
In this file, both OS75_abs and OS75_ave_ping are saved. The latter contains the same fields as in CRUISE_000_000000_zz_ave_ping.mat, where only the values in the velocity field are changed. Additionally, the variable bindepth is included as well.

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

- vel: [number of bins x 3 x xyz]-array of absolute velocity (zonal, meridional and vertical), i.e. horizontal velocities are corrected for ship velocity;

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

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

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

Plots

adcp_prh.ps For each .N2R-file a plot of pitch, roll, heading, and PC clock offset is produced in *read_nmea_att_jc.m* and saved to adcp_prh.ps.

adcp_calib_calc.ps After the final filtering of calibration points, misalignment angle and scaling factor are plotted in form of histograms and timeseries (in *calib_calc_bt.m*). There should be two plots after completed processing: the first plot from the first run of *OS75_JC_jc41.m* with amplitude = 1 and misalignment angle = 0, and second plot from the second run using the calculated values for amplitude and misalignment.

adcp_correction_stats.ps These plots show the results of the water track calibration if no bottom track is available, similar to the ones in adcp_calib_calc.ps.

adcp_vel_contours.ps The final step in *OS75_JC_jc41.m* is to plot meridional and zonal velocity as it is saved in the structure *OS75_abs* in file *CRUISE_000_000000_zz_abs.mat*. Added in the figure are the cruise track, the values used for correction for misalignment and scaling, the cruise name, and numbers of the file sequences processed. As in adcp_calib_calc.ps the first plot is from the first run, the second plot from the second run.

6.4.5   Further processing

Blanking the bottom   Three of the sequences for each instrument were recorded in Bottom Track mode. However, the bottom range does not seem to match with the actual bottom depth. Instead of using the range to blank out data below the actual water depth, we used the gradient in the return signal strength fields. The Matlab routine is *jc29_ bt_ blank.m*.

Filtering bad data   To filter bad data points (e.g. from interference, bubbles, outliers), we use the routine *jc41_ post_ proc_ filter.m*. Various criteria were applied to sort out bad data:

- velocities greater than 1.5 m/s are discarded;

- data with error velocities outside running average error vel. $\pm 2\times$ standard deviation are discarded;

- velocities outside running average velocity $\pm 2\times$ std. dev. or running median velocity $\pm 2\times$ std. dev. are discarded.

The running averages and medians are calculated with a window size of $2 \times 15 + 1$, both rowwise and columnwise.

Final averaging   To get usable data, we calculated 10 minute averages from the clean, filtered data. This is done in the same way as the two minute averages during the processing. The Matlab routine is *jc41_ ave_ after_ filtering.m*. The routine ignores the possibility of varying bin depths (e.g. when there are sequences in broadband and in narrowband mode), which does not apply to the JC041 files. The depth variable was therefore added manually to the final 10 minute average.

6.5   Calibration

Despite the fact that the cruise track during JC041 was mostly above deep water, the main routine (*OS150_ JC_jc41.m*) managed to identify a bottom tracking with the OS150 ADCP (the setup files *OS75NB_ BToff_ JC37_ up.txt* and *OS150NB_ BToff_ JC37_ up.txt* were both not available during the writing up of this present report). The results of the calibration are shown in Figures 37 and 36 for the OS75 and OS150, respectively.

MISALIGNMENT ANGLE DETERMINATION (JC041)
(Water Tracking)

```
from:  2009/12/06 - 13:38        Total Duration    : 11.628 days
to:    2009/12/18 - 04:42        Calibration Points: 12035 of 14697
```
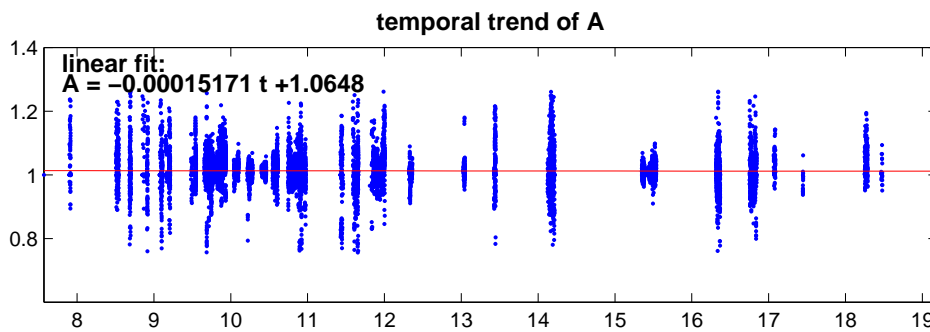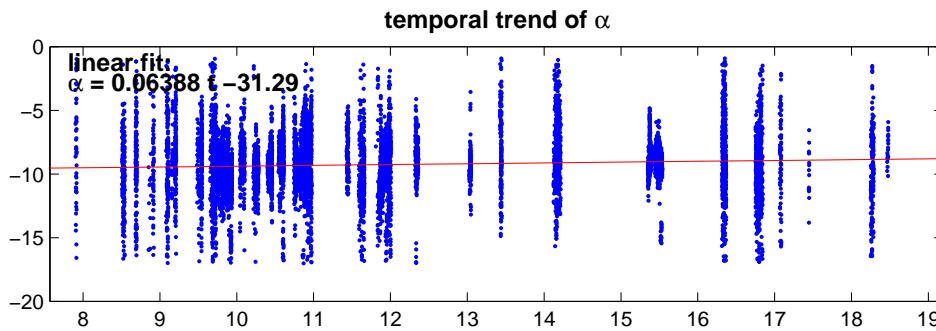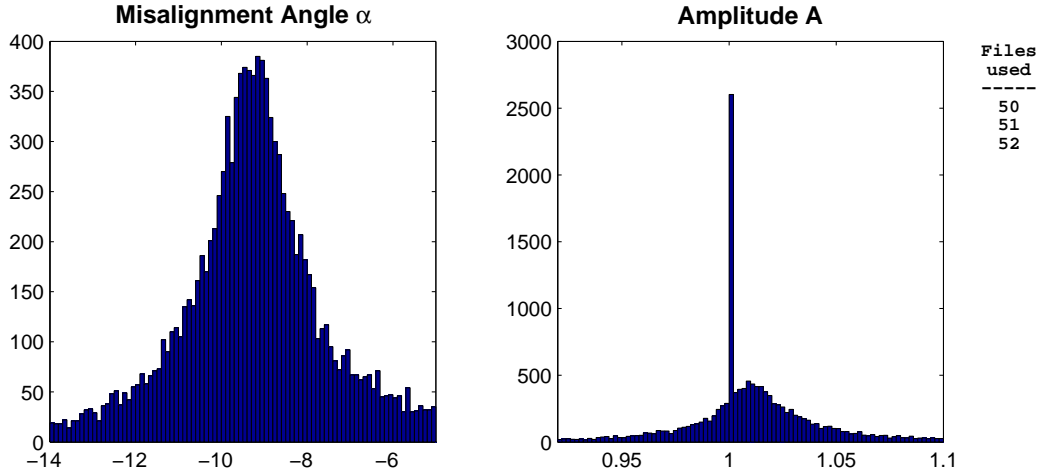

Figure 36: Calibration results for the OS75 using water tracking only.

MISALIGNMENT ANGLE DETERMINATION (JC041)
(Bottom Tracking)

from: 2009/12/14 – 05:08	Total Duration : 5.140 days
to: 2009/12/19 – 08:29	Calibration Points: 881 of 950

Figure 37: Calibration results for the OS150 using bottom tracking only.

119

The values used for the processing are:

- OS75 (BT off): misalignment = -9.2590; amplitude = 1.006817

- OS150 (BT on): misalignment = -0.6546; amplitude = 1.002284.

Note: Due to the mechanics, the adjustment and alignment of the keel vary each time that the keel is lowered or brought up. Because the calibration does not include the times the keel is retracted or is down, it is therefore important to calibrate the ADCPs in each instance separately.
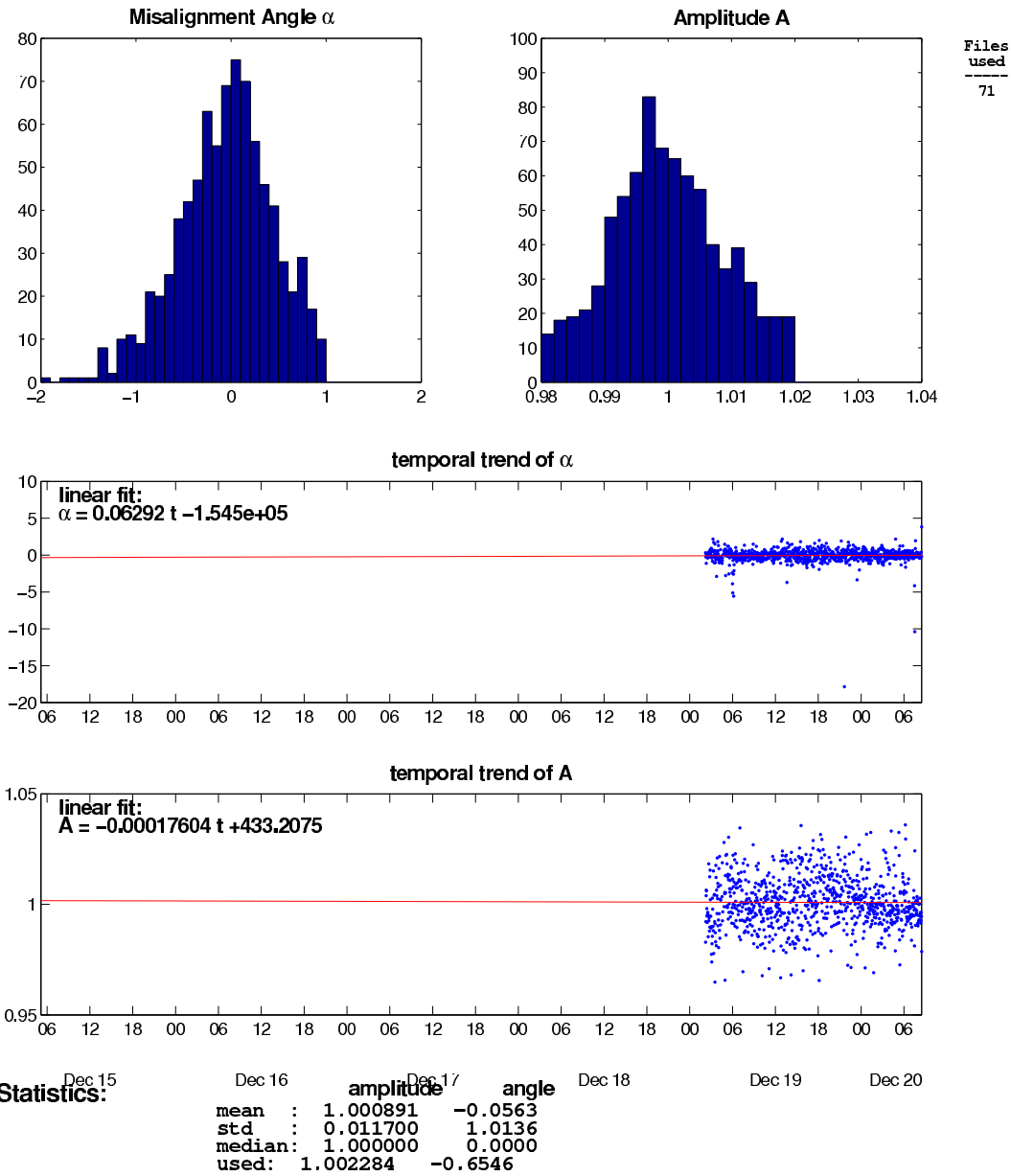
Figures 38 and 39 show velocity profiles during the whole cruise for the OS75 and OS150, respectively. The upper plots depict the eastward velocities, whereas the bottom plots show the nothward velocities. It is worth noting that both ADCPs coincide.

6.6 Data quality issues

No interference was found between the ADCPs and the acoustic instrument such as the EM120. Figures 40 and 41 show the zonal and meridional velocities (upper and middle panel) and the amplitude of the backscattered signal (lower panel) for the whole cruise. Stars marks represent the moment when the echo-sounder EM120 was turned on or off and the black line determines the moment when the echo-sounder started recording spurious data. As seen on this plots, no interference was detected.

It is well known that ADCP data on the *James Cook* are contaminated by bubbles which are generated by the hull shape and the exposed position of the instruments on the drop keel. This contamination can be seen in the uppermost ping and is mostly removed by filtering out during processing.
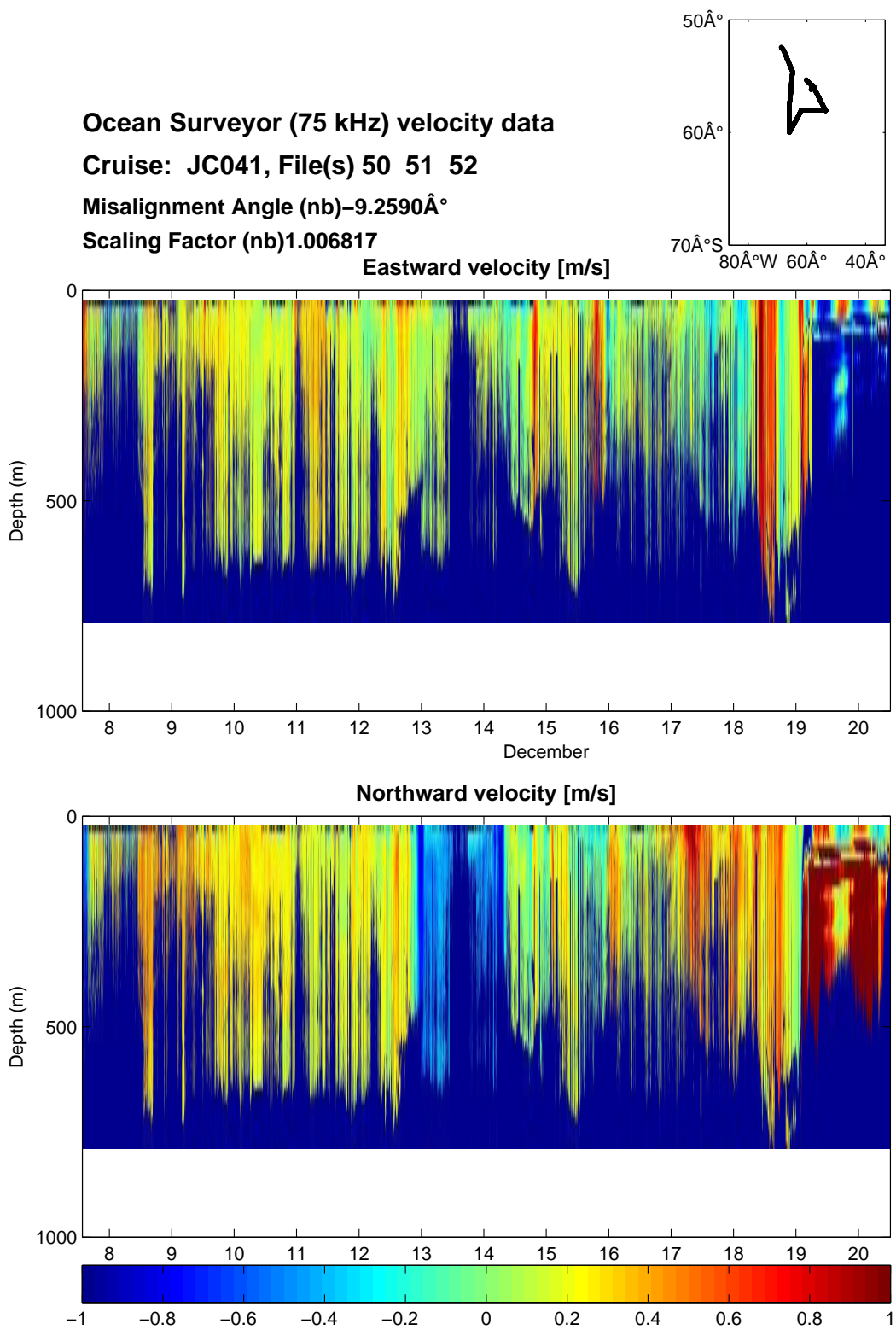
Figure 38: Velocity profiles for the OS75.
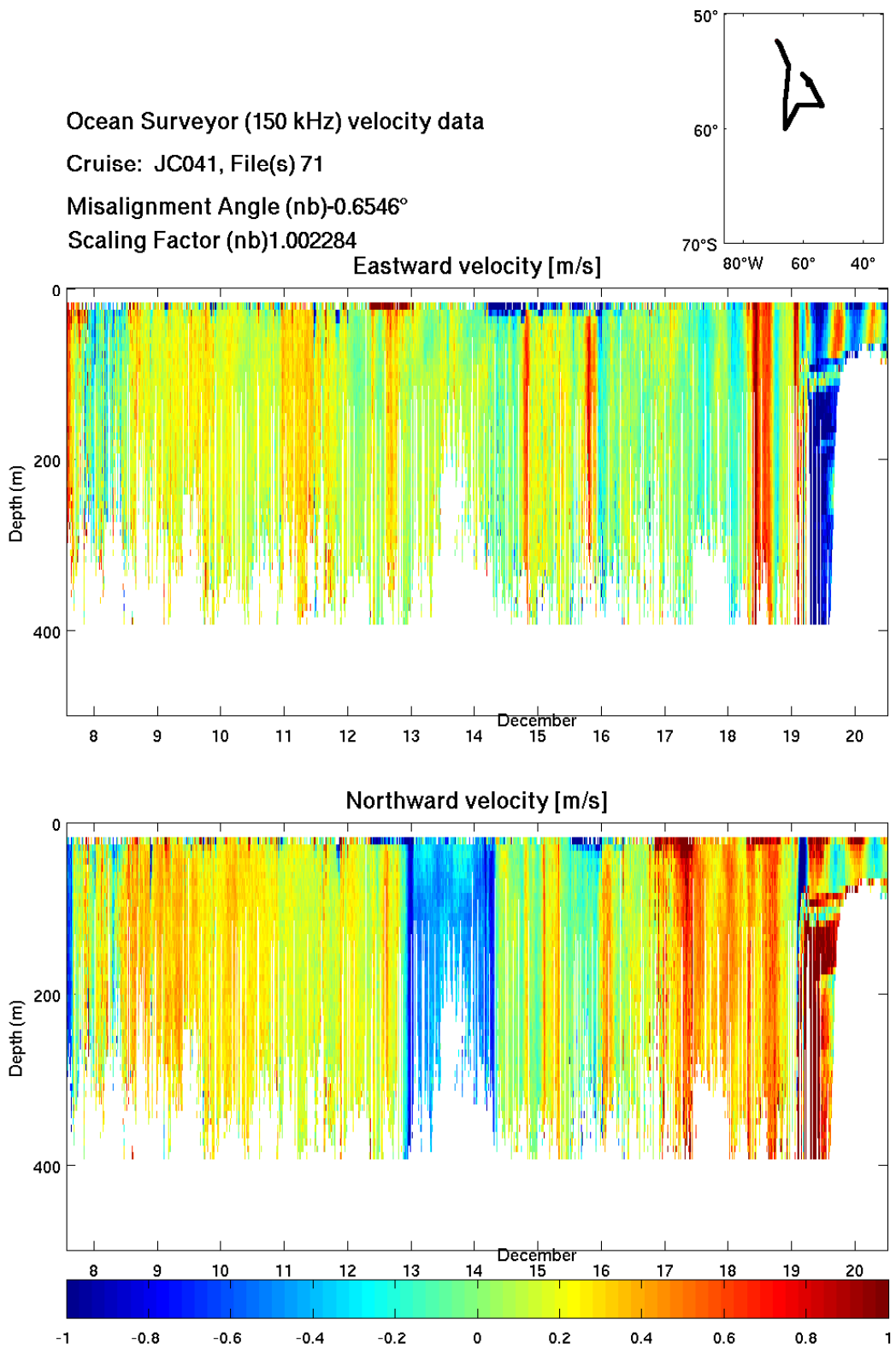
Figure 39: Velocity profiles for the OS150.
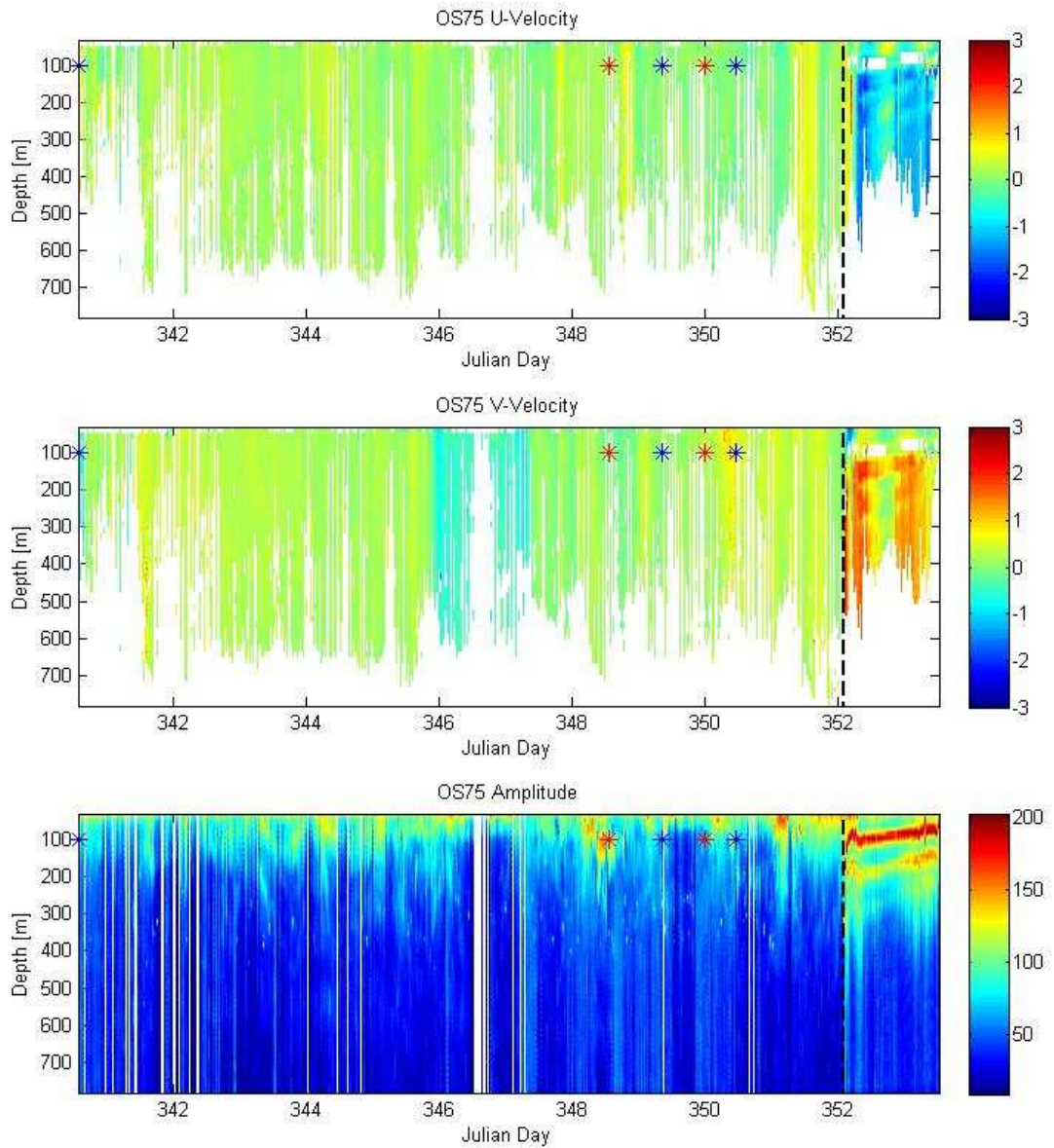
Figure 40: Interference of OS75 between the EM120 instrument. The upper panels show the eastward and northward velocities, respectively. The lower panel shows the amplitude of the signal. The stars mark the time when the EM120 is turned on or off. The black line determines the time when the echo-sounder started recording spurious data.

123
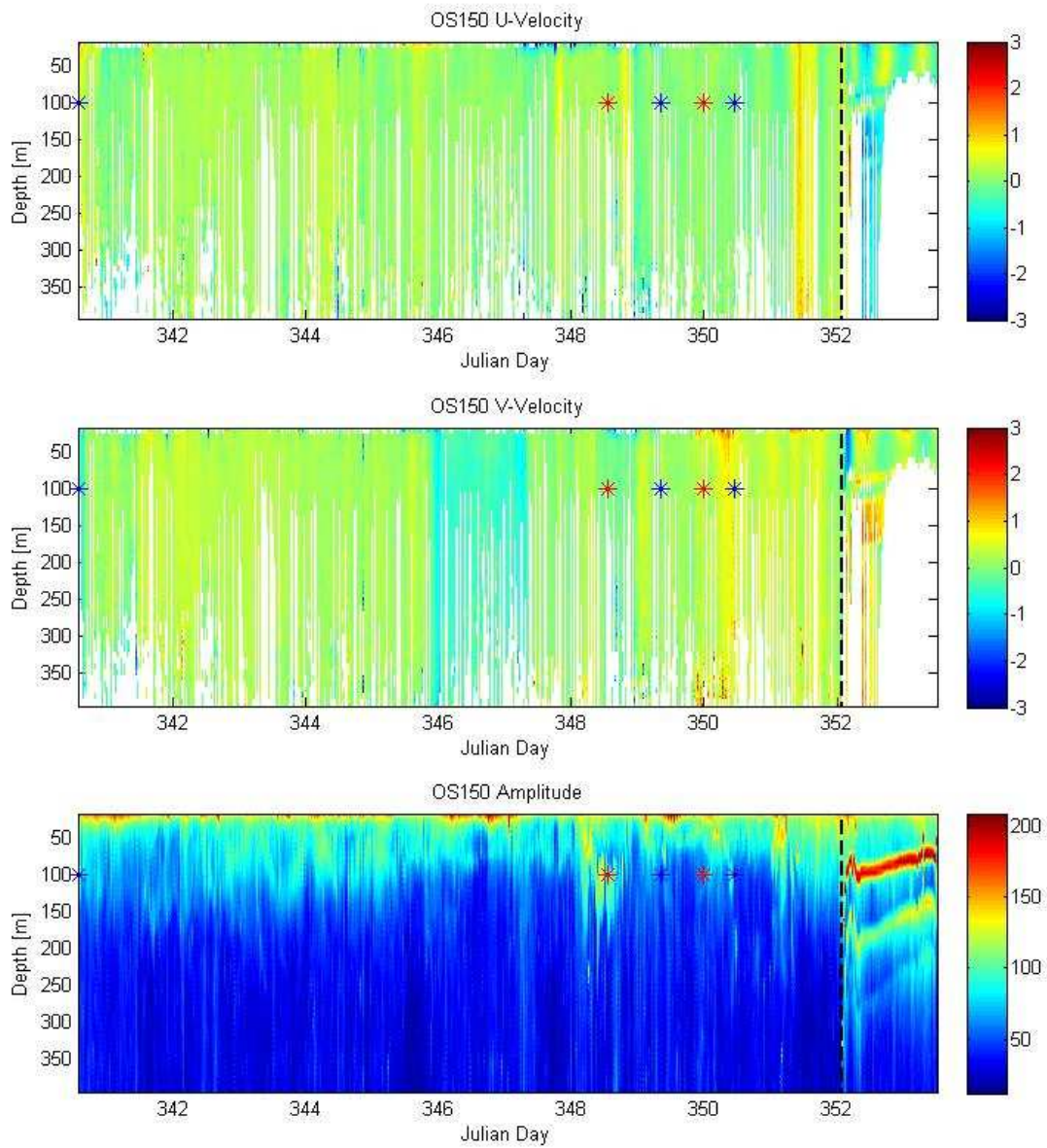
Figure 41: Interference of OS150 between the EM120 instrument. The upper panels show the eastward and northward velocities, respectively. The lower panel shows the amplitude of the signal. The stars mark the time when the EM120 is turned on or off. The black line determines the time when the echo-sounder started recording spurious data.

124

6.7 Preliminary Results

Figures 42 to 45 show u and v velocities along the four towyo casts for OS75, whereas Figures 46 to 49 show the same sections for OS150. No interpolation was done at this preliminary stage.
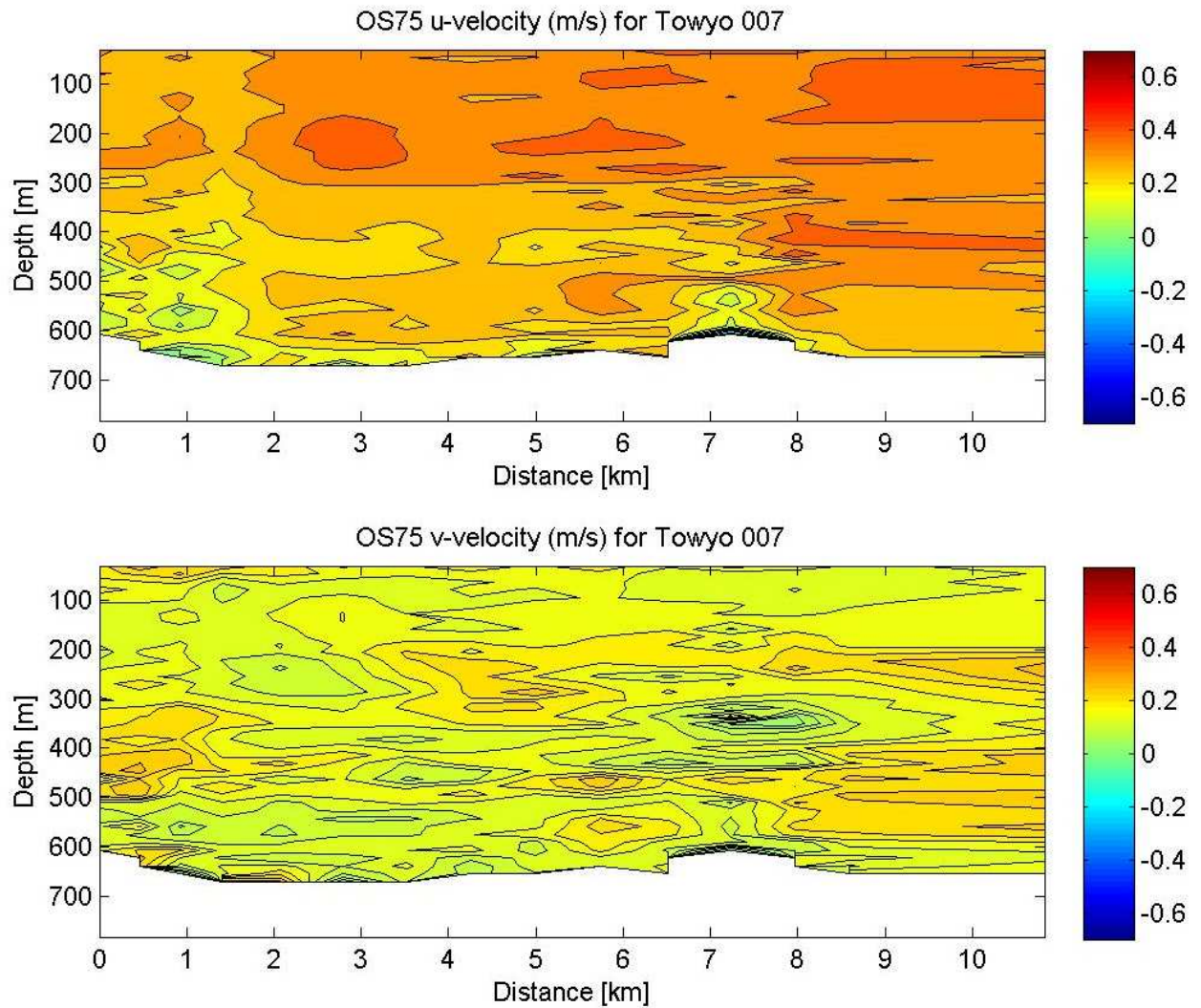
Figure 42: U and v velocities for the CTD007 towyo for OS75.
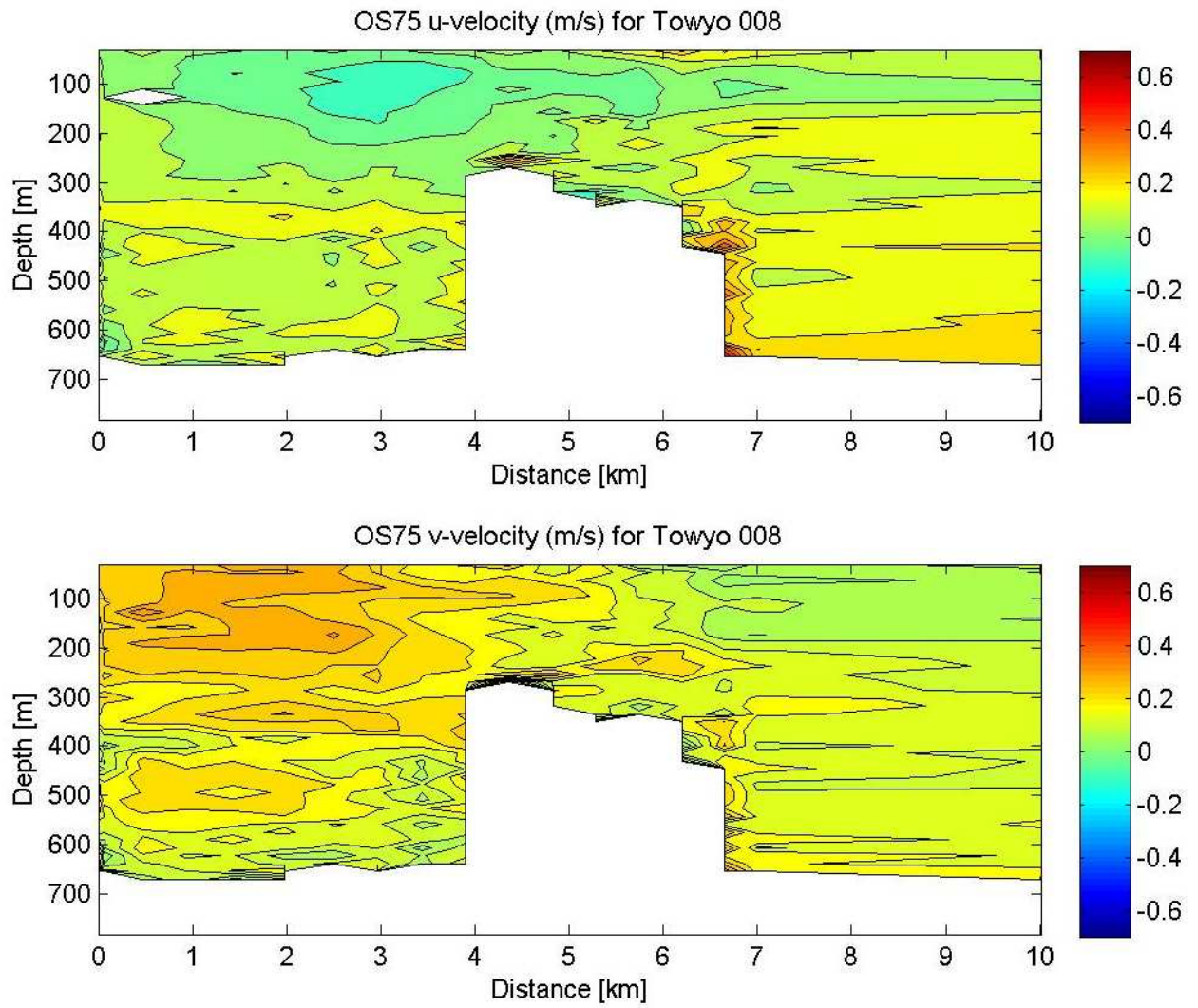
Figure 43: U and v velocities for the CTD008 towyo for OS75. The white part on the plot shows spurious data.
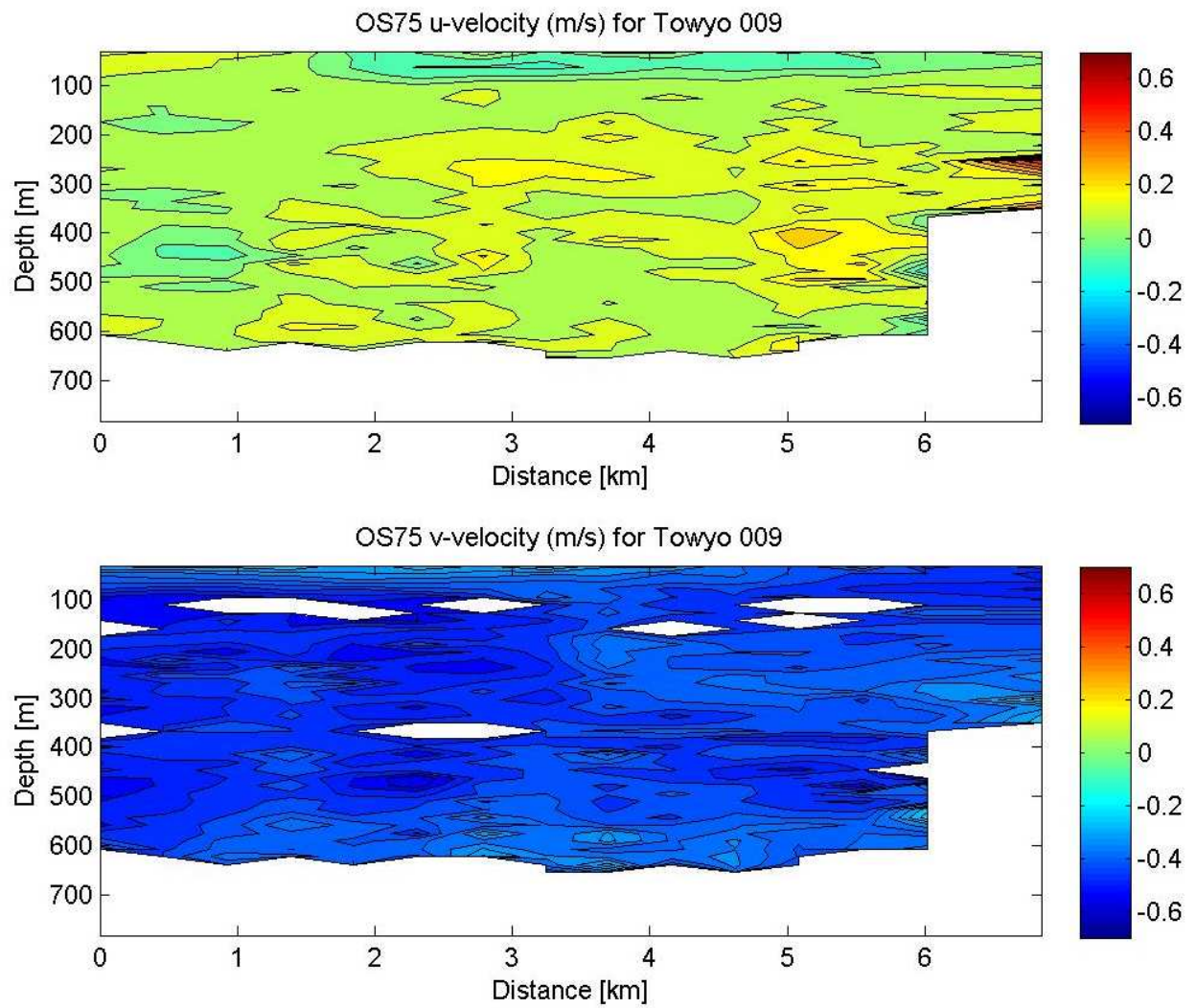
Figure 44: U and v velocities for the CTD009 towyo for OS75. The white part on the plot shows spurious data.
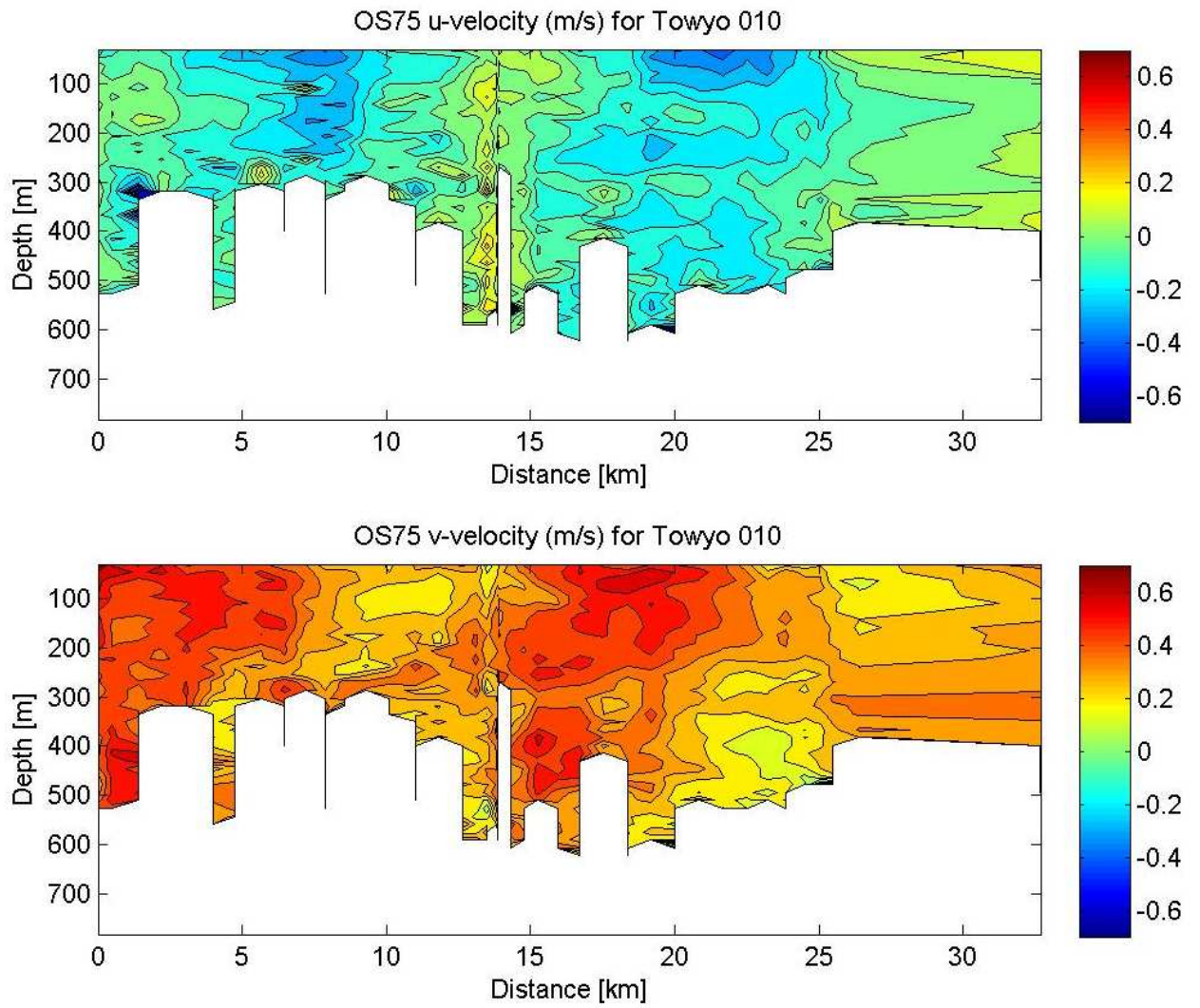
Figure 45: U and v velocities for the CTD010 towyo for OS75.
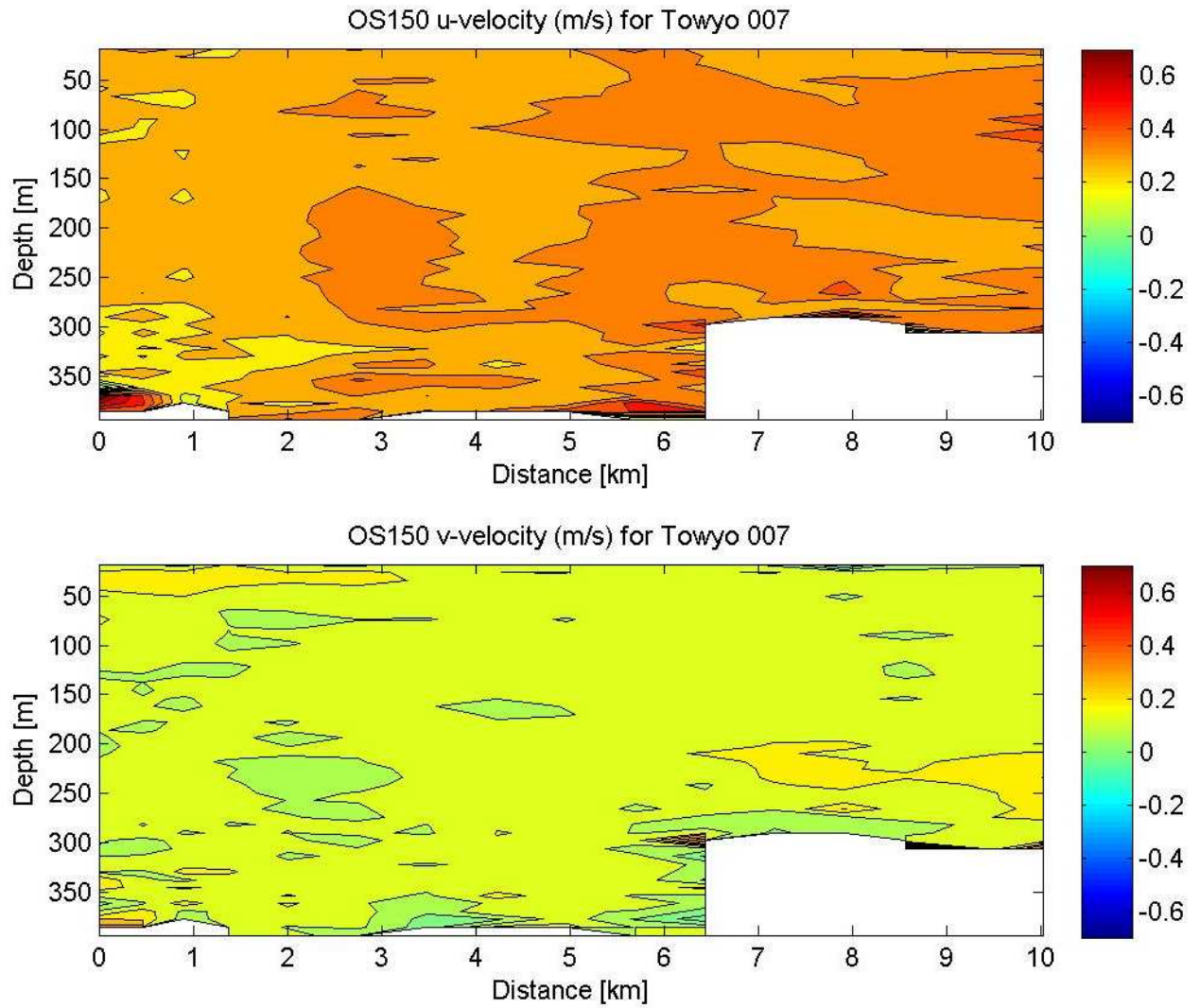
Figure 46: U and v velocities for the CTD007 towyo for OS150.
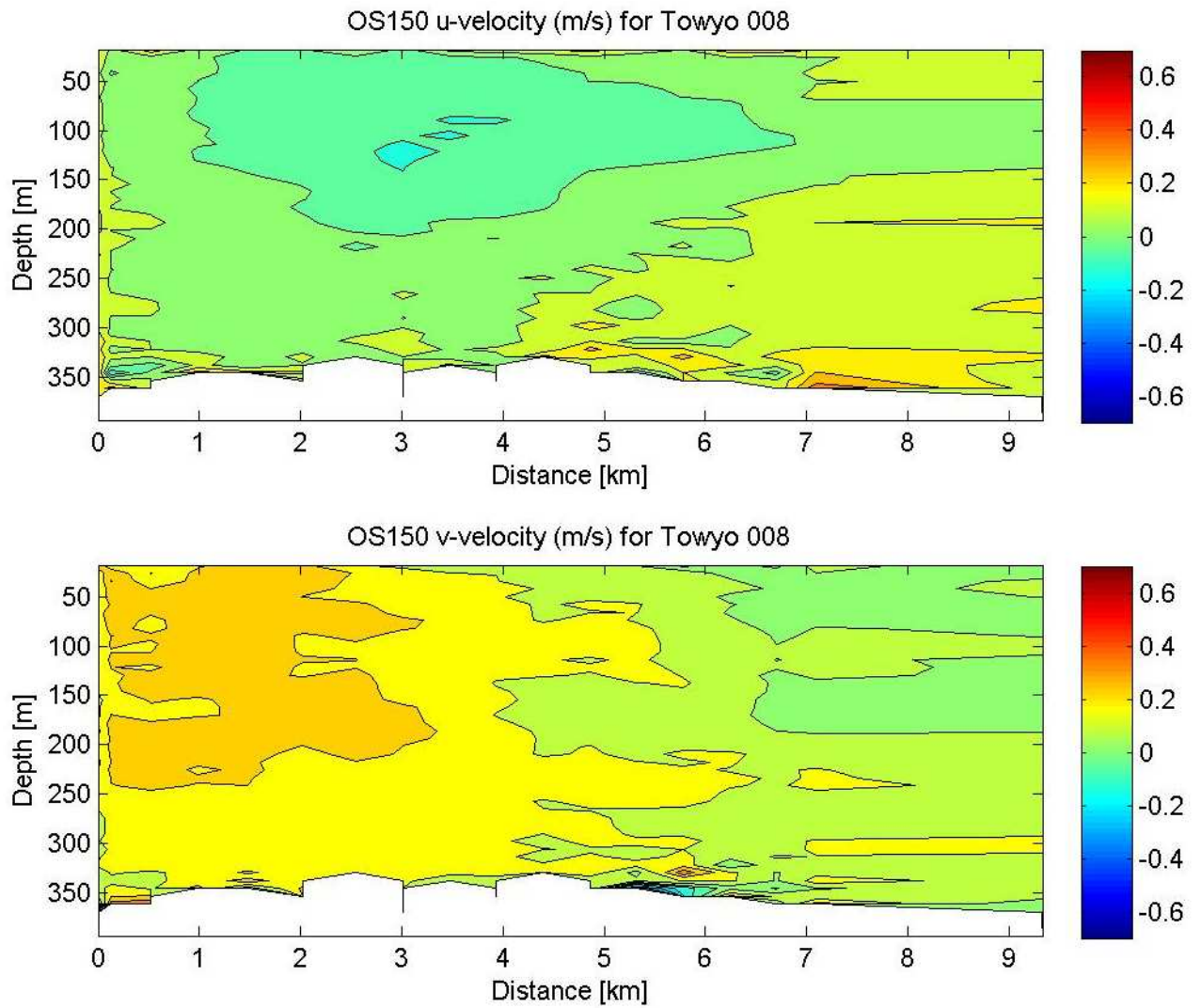
Figure 47: U and v velocities for the CTD008 towyo for OS150.
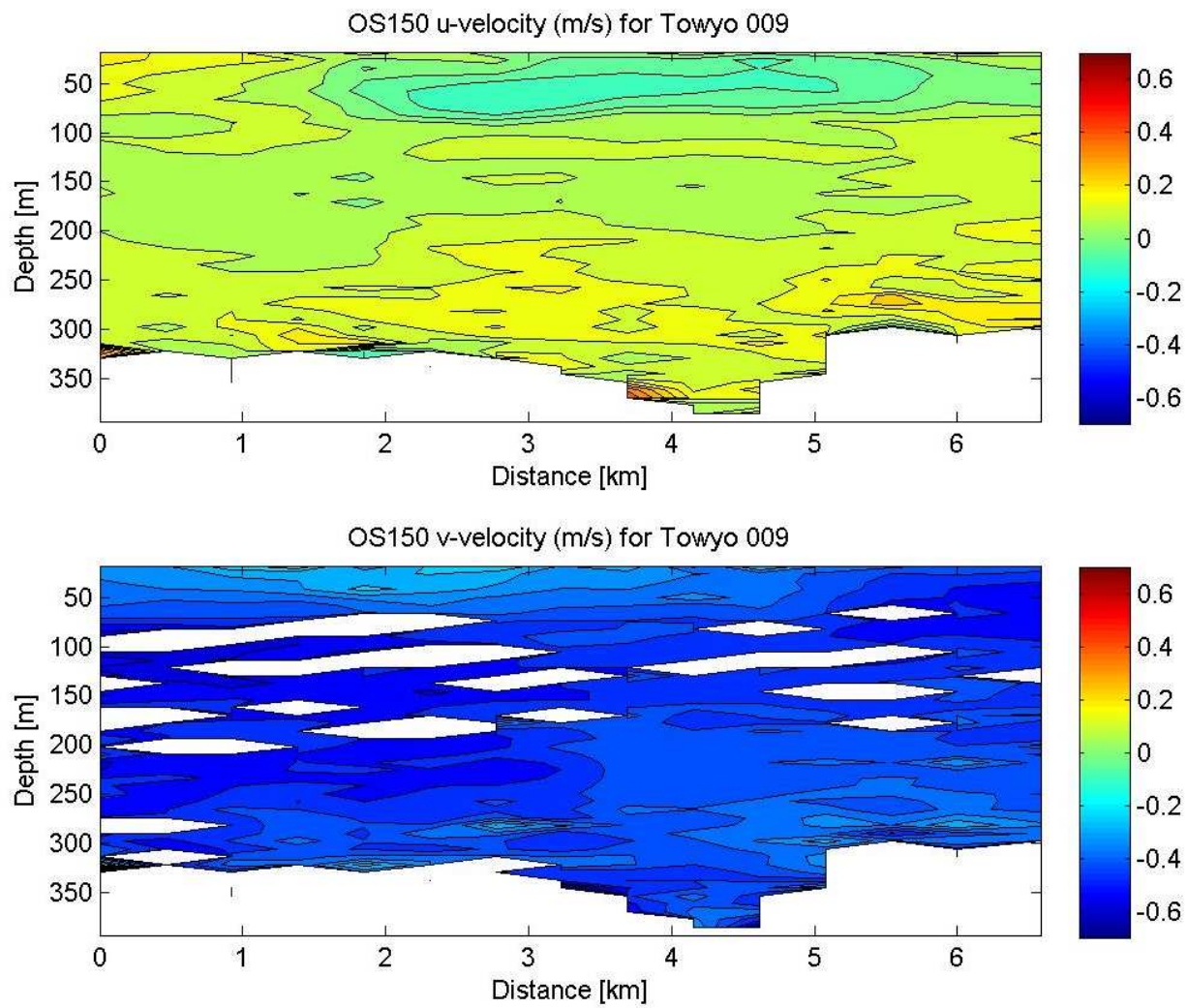
Figure 48: U and v velocities for the CTD009 towyo for OS150. The white part on the plot shows spurious data.
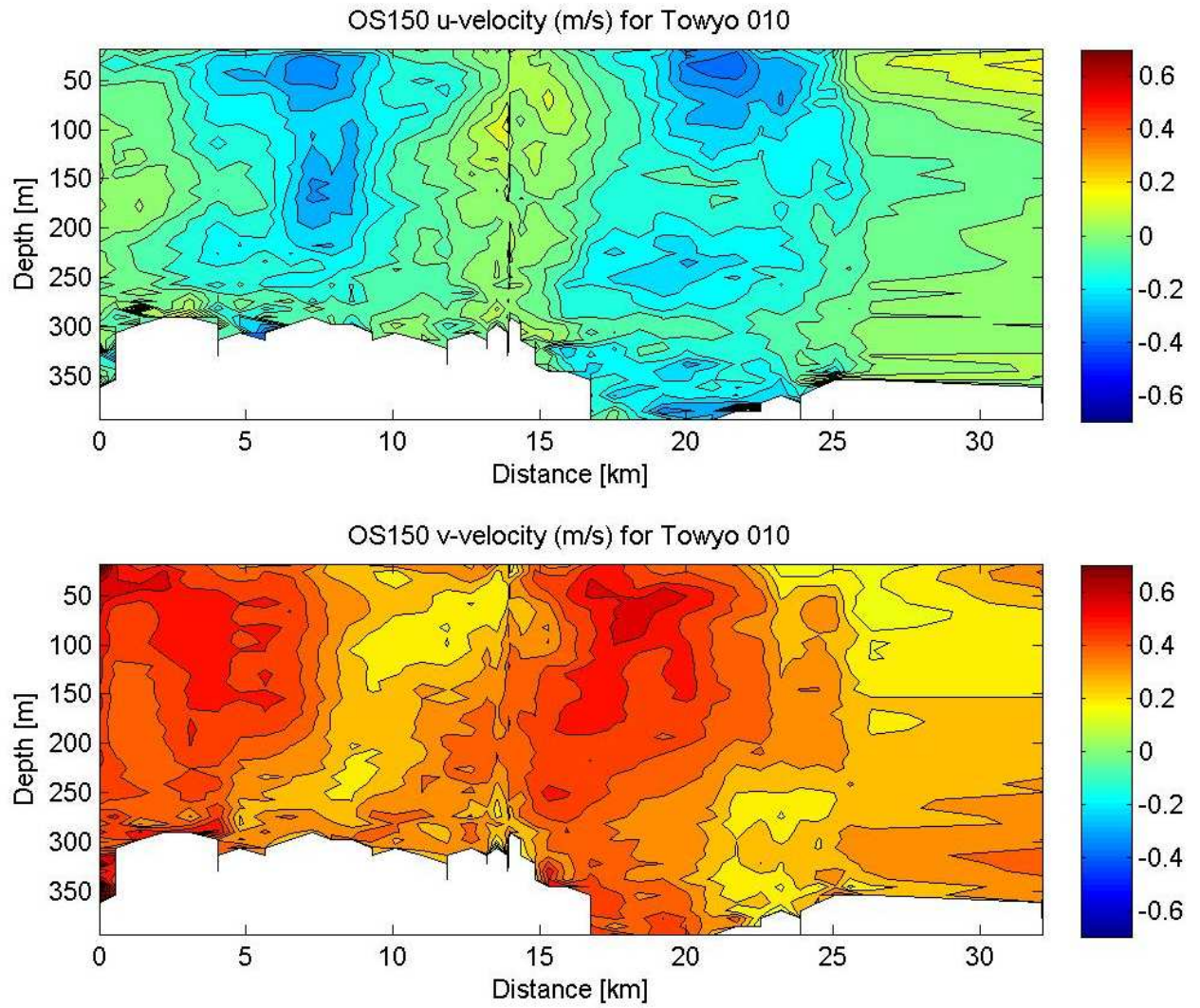
Figure 49: U and v velocities for the CTD010 towyo for OS150.

7 Underway Measurements

Peggy Courtois

(Adapted from the JC029 cruise report, Chris Barnard, Maria Broadbridge and Jennifer Graham)

7.1 Surface and Meteorological Sampling System (SURFMET)

The Surfmet system is the ship-fitted water and meteorological sampling system employed on board RRS *James Cook*. The Surfmet system is an in house system that combines all of the sensors built into the system into one stream and this stream is then logged by the on board logging system TECHSAS. All sensors are wired through Junction Boxes and connected in the Met Lab and then sent down via Cat 5 cabling directly to the Surfmet display in the lab. The SURFMET display parses the data into one output string and forward that to the TECHSAS system for time stamping and recording. The Surfmet system makes use of NUDAM modules for converting voltages into digital signals, were as some other instruments output digital messages directly to the system. These are displayed on the screen in a 6 hour log window which can be setup to the users own boundaries.

The Surfmet System was augmented with the addition of a new TSG system that will soon replace the ageing FSI sensors. The new SBE45 microTSG is a big step forward in gathering high accurate salinity data on board, avoiding the issues observed in using the inductive conductivity sensor that we currently use. The new SBE45 also allows live salinity data to be displayed which is currently only calculated internally by the surfmet system, protsg must be run for the surfmet stream to have a salinity value. A list of instruments is provided in Table 21.

7.2 Routine Processing

Files were transfered from the onboard logging system (TECHSAS) to the UNIX system (data32) on a daily basis, using the script *mday_00_get_all.m* (see Chapter 9). The raw SURFMET data files have names of the form *met_jc041_dnnn_raw.nc*, where *nnn* is the Julian Day number, whereas data from the SBE45 microTSG are in the *tsg_jc041_dnnn_raw.nc* files. Despite having the calibration sheet for each instrument, the data were not adjusted according to their calibration equations yet. A script *mcalib_surmet_41.m* is already available for that purpose, but some data need to be converted first into a NetCDF format.

Table 21: Surfmet instrument details. FSI Stands for Falmouth Scientific Instruments. FSI stands for Falmouth Scintific Instruments.

Instrument	Type	Variable Name
Sea Surface Temperature	FSI OTM	temp_r (r for remote)
Thermosalinograph:		
Housing temperature	FSI OTM	temp_h (h for housing)
Conductivity	FSI OCM	Cond
Fluorometer	Wetlabs WETStar WS35-134	fluorometer
Air Temperature and Humidity	Vaisala HMP45AL E1055002	airtemp and humidity
PAR Sensors	Skye SKE 510	PPAR (p for port)
		SPAR (s for starboard)
TIR Sensors	Kipp and Zonen CM6B 973134	PTIR (p for port)
	Kipp and Zonen CM6B 973135	STIR (s for starboard)
Barometer	Vaisala BAROCAP	press
Wind Speed	Gill Windsonic anenometer Option 3	speed
Direction	Gill Windsonic anenometer Option 3	direct
Transmissometer	WetLabs C-Star CST-1132PR	trans
Voltage Converters	Nudam 6017, 6018 $\pm$ 5V	NA
SBE45 Micro TSG	Seabird 0230	salin, cond, temp

The raw SURFMET data were averaged into one-minute bins using the script mavg_surfmet.m. More information can be found in Section 9.2. Only data from the SBE45 stream were used for the calibration of the TSG data set. The temperature used was temp_r, since it is the temperature at which the conductivity is measured by the instrument. The salinity was calculated from the conductivity (cond) and the temperature (temp_r) variables using the subroutine sw_salt (from the free CSIRO sea_water package).

7.3   Thermosalinograph Samples

Salinity samples were taken from the thermosalinograph roughly every 4-6 hours. The samples were collected in 200ml flat bottles. Before sampling, the tubing of the uncontaminated underway supply was flushed with the sampled water in order to eliminate eventual residual of previously sampled water. The bottles were then rinsed three times with the sampled water and filled just under the shoulder. The neck of the bottles was dried carefully before they were sealed with airtight single-use plastic insert caps and the bottle caps were screwed back on. The samples were stored in open crates in the controlled temperature lab beside the Guildline Salinometer for at least 24 hours before the conductivity was measured against Ocean Scientific International (OSIL) IAPSO

Standard Seawater batch P150. The sample conductivity values were then converted to salinity values in exactly the same manner as the water samples from the CTD Rosette system, specifically in the OSIL Salinometer Data Logger Software, then transferred into a Microsoft Excel spreadsheet. A total of 21 TSG samples were taken over the duration of the cruise (see Table 22).

Table 22: Time and positions at which TSG bottle samples were collected.

Bottle Number	Julian Day	Time GMT	Latitude	Longitude
97	341	14:06	55° 21.120'S	60° 08.220'S
98	342	13:51	56° 09.393'S	58° 22.720'S
99	342	17:00	55° 57.765'S	57° 44.365'S
100	342	23:31	56° 03.549'S	57° 44.055'S
101	343	02:38	56° 04.095'S	57° 43.080'S
102	343	16:53	56° 02.344'S	57° 46.120'S
103	343	22:41	56° 00.744'S	57° 49.362'S
104	344	05:08	55° 57.780'S	57° 57.530'S
105	344	16:31	56° 00.442'S	57° 47.405'S
106	344	22:53	55° 59.798'S	57° 57.905'S
107	345	05:03	56° 02.950'S	57° 51.101'S
108	346	00:14	56° 01.936'S	57° 45.688'S
109	346	20:11	57° 22.600'S	54° 57.860'S
110	347	03:48	58° 00.641'S	53° 41.468'S
111	347	16:37	58° 02.743'S	53° 38.067'S
112	347	23:57	58° 02.760'S	53° 38.068'S
113	348	18:52	57° 59.855'S	57° 43.026'S
114	349	17:52	58° 34.487'S	63° 00.879'S
115	350	15:53	59° 59.101'S	65° 58.806'S
116	351	14:12	57° 47.755'S	65° 58.417'S
117	352	12:40	56° 48.490'S	65° 39.789'S

7.4 Calibration

Calibration carried out with only 21 data points need to be considered with cautious. The next four Figures 50 - 53 represent an attempt to calibrate the SBE45 dataset. Figure 52 show the offset (-0.5768 PSU) found between the salinity from the sampling bottles and that of the SBE45. The calibration does not take into account the bottle number 1, 17 and 21. All SBE45 data were adjusted with that offset. No comparison between the SBE45 and the FSI sensors was done in this report as previous reports have proved a better reliability of the SBE45.
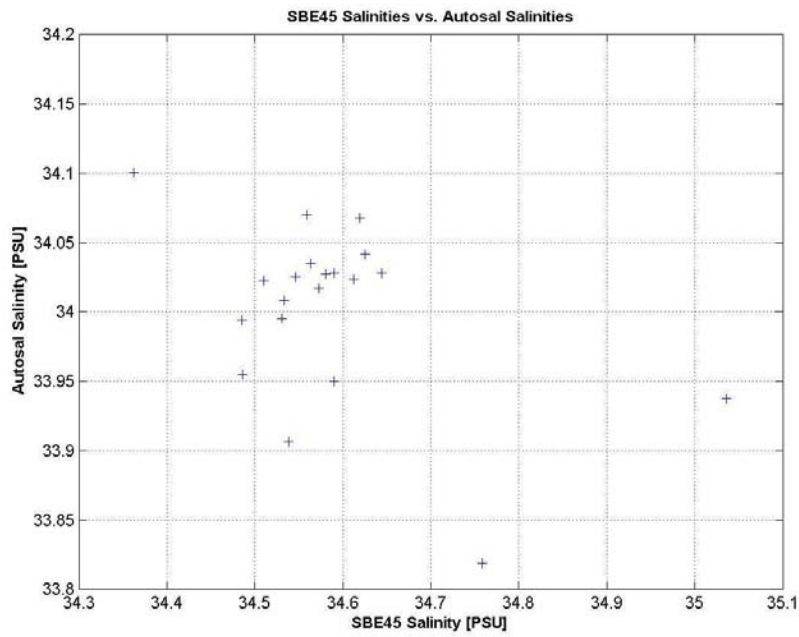
Figure 50: Comparison of SBE45 salinities with the Autosal data.
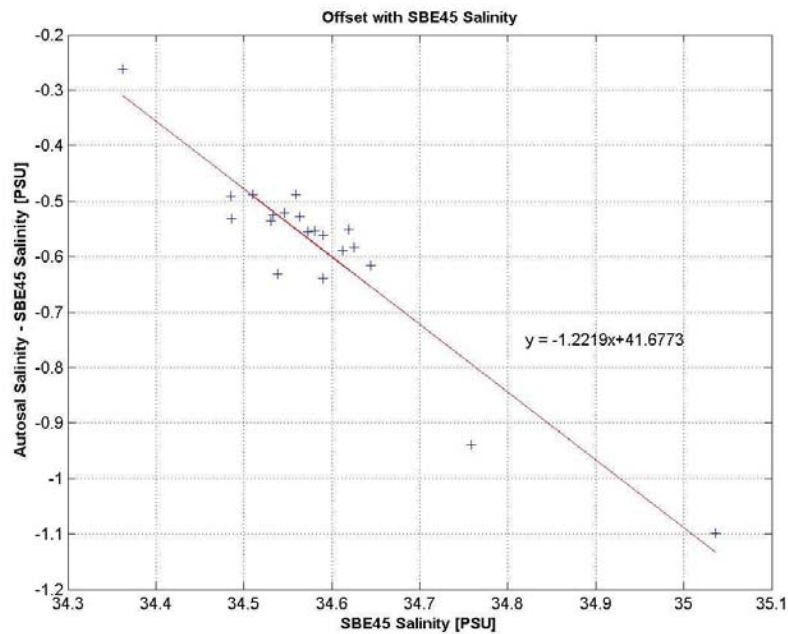
Figure 51: Offset between the Autosal and the SBE45 (Autosal-SBE45) as a function of the SBE45 salinity.
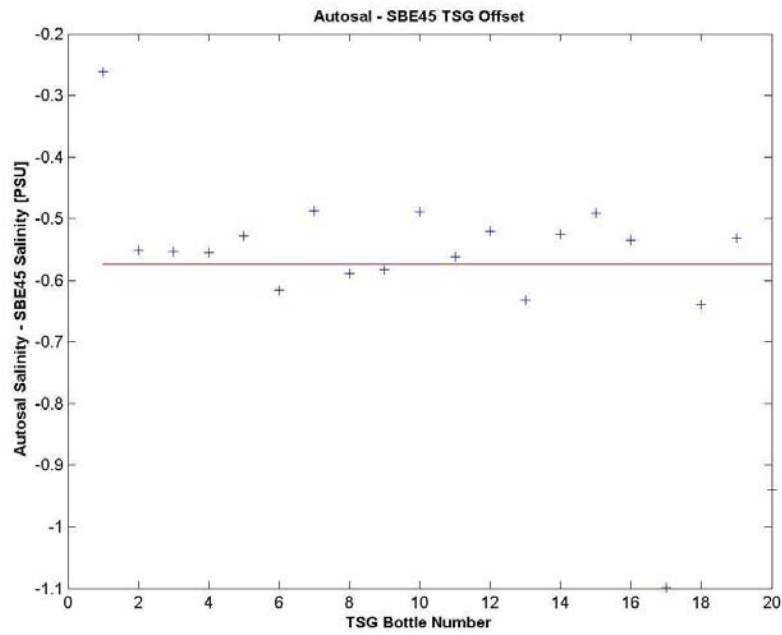
Figure 52: Offset between the Autosal and the SBE45 (Autosal-SBE45) as a function of the number of sampling bottles.
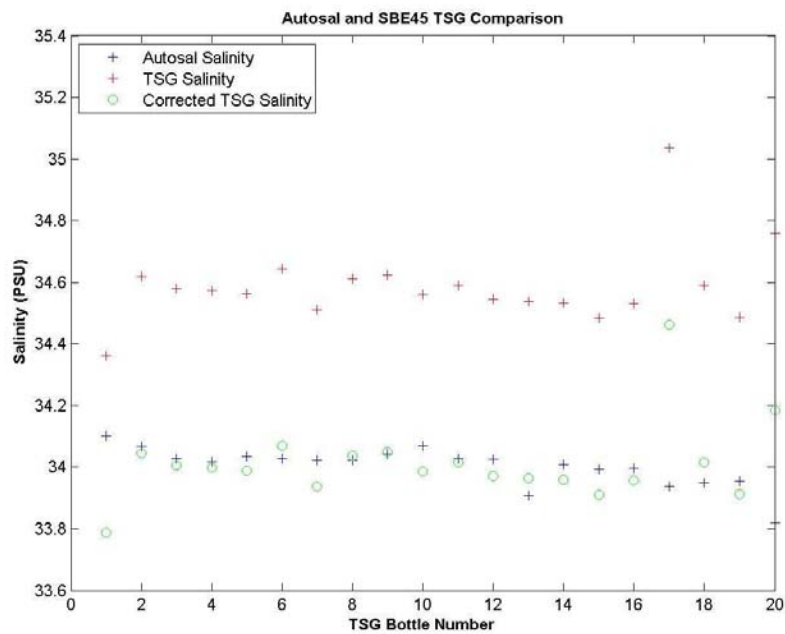
Figure 53: Salinities from the sampling bottles (blue crosses), the uncalibrated SBE45 (red crosses) and the calibrated SBE45 (green circles) as a function of the number of bottles. The calibration does not take into account the bottle number 1, 17 and 21.

7.5   Preliminary Results

Figure 54 shows the sea surface temperature (top) and the sea surface salinity (bottom) for the mooring area. The color scale on the bottom plot of Figure 54 was defined to capture the variation of the salinity. However, data greater than this scale are therefore missing from this plot and are represented by three small stars. Figure 55 shows the sea surface velocity from the VmADCP for the OS75 in red and the OS150 in blue.
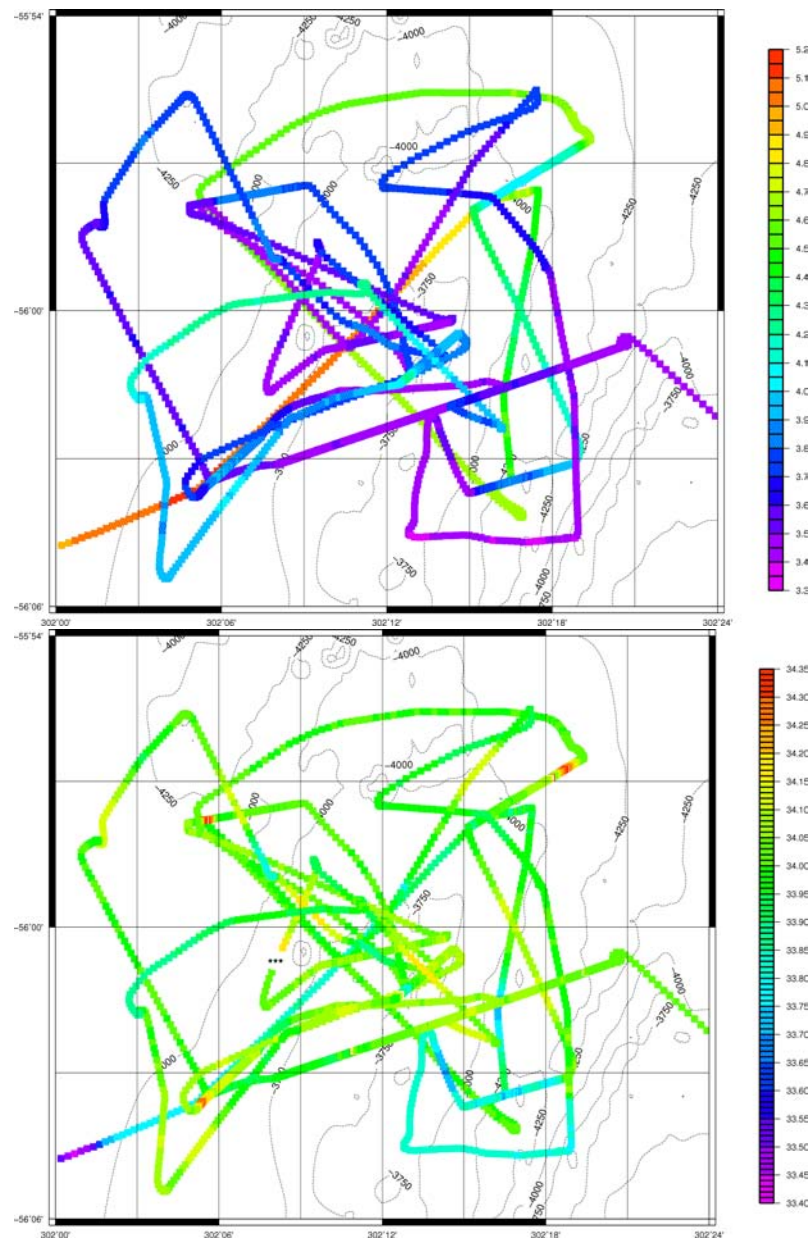
Figure 54: Sea surface temperature (top) and sea surface salinity (bottom).
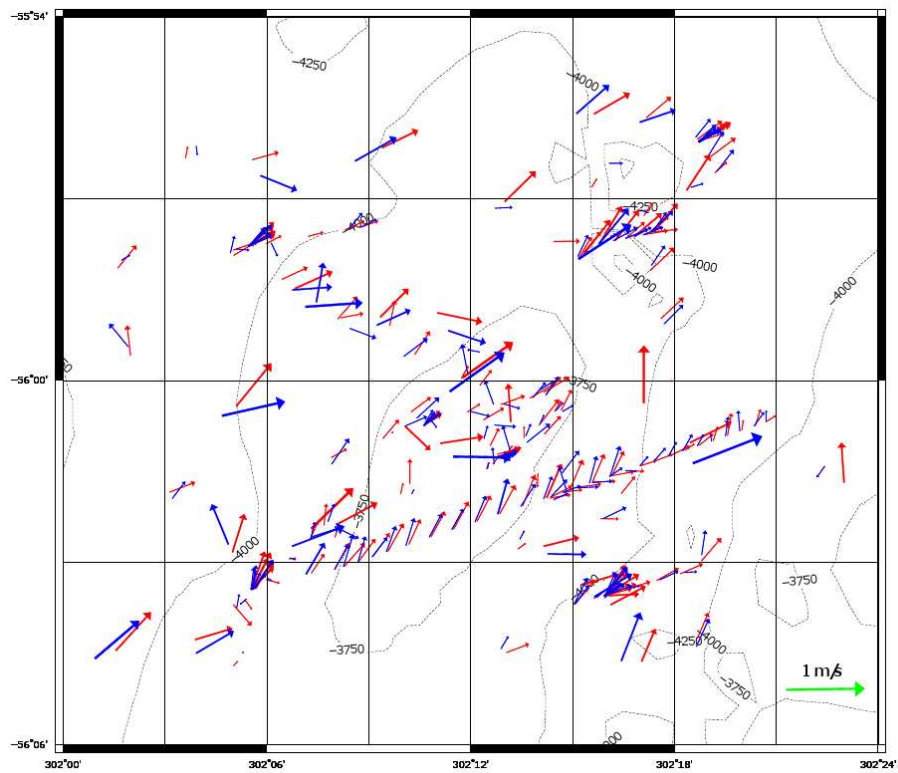
Figure 55: Sea surface velocity from OS75 in red and OS150 in blue. Data averaged over 30mn.

8   Computing and Instrumentation

Mick Myers

8.1   RVS LEVEL C System

Ifremer TECHSAS System

The Ifremer TECHSAS system is the primary data logger for all navigation, surfmet and winch data. The TECHSAS software is installed on an industrial based system with a high level of redundancy. The operating system is Centos Linux 5.2. The system itself logs data on to a RAID 0 disk mirror and also logs to the backup logger. The TECHSAS interface displays the status of all incoming data streams and provides alerts if the incoming data is lost. The ability exists to broadcast live data across the network via NMEA.

The storage method used for data storage is NetCDF (binary which is a self describing file and is OS independent) and also pseudo-NMEA (ASCII). The NetCDF data files are currently manually parsed through an application in order to convert them to RVS Format for data processing.

The TECHSAS data logging system was used to log the following instruments:

1. Applanix POSMV System (Converted to RVS Format as posmvpos, posmvatt, posmvsat)

2. Applanix POSMV System Heading

3. Kongsberg Seatex DPS-116 (Converted to RVS Format as dps116p and dps116s)

4. Chernikeef EM speed log (converted to RVS format as log_chf)

5. Ships Gyrocompass (converted to RVS format as gyronmea)

6. Simrad EA600 Precision Echo Sounder (Converted to RVS Format as ea600)

7. NMFD Surface-water and Meteorology instrument suite (Converted to RVS as sm_surf, sm_met and sm_light)

8. ASHTECH ADU-5 Altitude Detection Unit Converted to RVS Format as adu5pat and adu5pos)

9. NMFSS Cable Logging and Monitoring (Converted to RVS as winch)

10. MircroTsg SBE45

8.2 Instrumentations

Applanix POSMV System

The Ships primary GPS System for scientific data and also part of the Dynamic Positioning system is the Applanix POSMV. The POSMV includes an intertial measurement unit capable of providing heading pitch and roll data to the bridge, logged by the techsas system and displayed in the main lab. The POSMV data is also used by the ADCP systems in order to account for ships motion.

The Applanix IMU is located at the ships centre point and is used as reference for all offsets for instruments on board the RRS *James Cook* The GPS antenna positions are held within the POSMV and the GPS position is corrected for the position of the MRU and so the GPS position that is recorded is the position of the MRU itself.

Table 23: System Specifications:

	Specification (With Differential Correction)	During GPS Outages
Roll, Pitch Accuracy	0.02° (1 sigma with GPS or DGPS)	0.02°
Heave Accuracy	5cm or 5% whichever is greater for periods of 20 seconds or less	5cm or 5% whichever is greater for wave periods of 20 seconds or less
Heading Accuracy	0.02° with 2m antenna baseline	Drift less than 1° per hour (negligible for outages < 60 seconds)
Position Accuracy	0.5 - 2m (1 sigma) dependant on differential correction quality	Degredation: 2.5m (1 sigma for outages < 30s), <6m (1 sigma for outages < 60s)
Velocity Accuracy	0.03 m/s horzontal	

Magellan Ashtech ADU-5

This is a four antenna GPS system that can produce attitude data from the relative positions of each antenna and is used to correct the VMADCP for ship motion. The antenna array is located on the port side of the ships monkey island. The ADU-5 system worked reliably throughout the cruise with some gaps that are quite usual with this system due to the amount of calculations necessary and the roll of the ship causing bad satellite communication. No Large data gaps are present. The ADU-5 forms part of the bestnav system which is an assembly of multiple GPS signals including the gyronmea

Table 24: ADU5 Offsets with reference to Antenna 1 (used internally by ADU5 for HPR Calculations)

Vector	X(Right Positive)	Y(Forward Positive)	Z(Up Positive)
1-2	0.000	1.203	0.010
1-3	-0.599	0.600	0.010
1-4	0.597	0.598	0.012

and emlog stream in order to calculate the best possible position, speed heading pitch and roll of the ship.
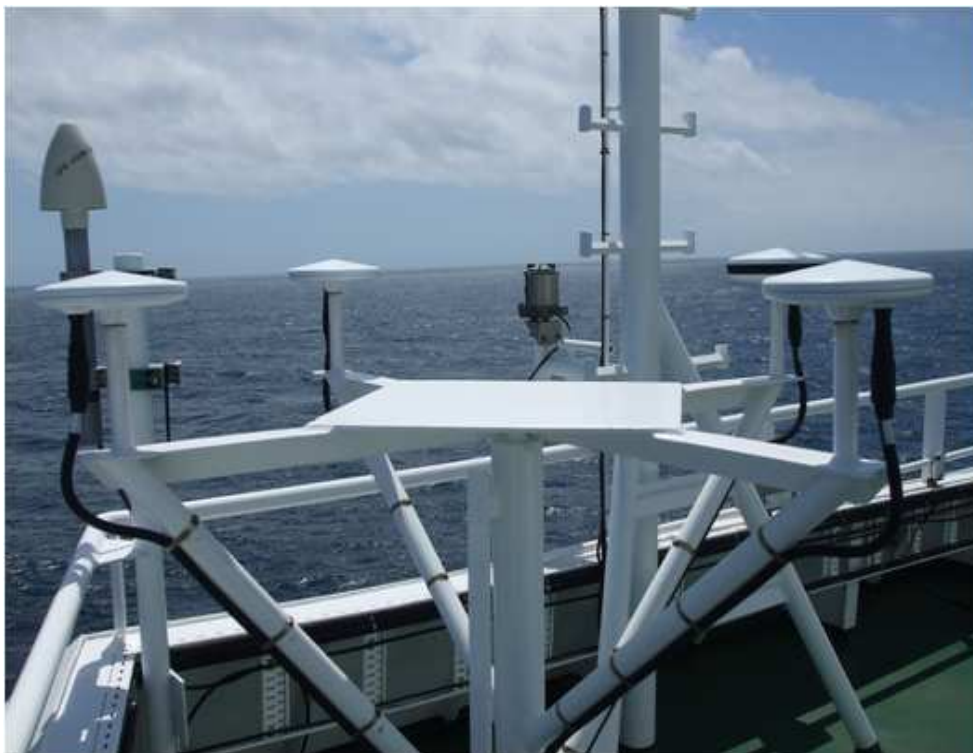
Figure 56: ADU5 Platform on the Starboard Side. Black surrounded Antenna indicates AFT. This is the primary antenna which sits behind all 3 other antennas.

SeaTex DPS 116

This DPS116 is a GPS system that was installed primarily as a backup for the POSMV to provide information for the ships DP system for ships use which we now receive an output from. The Seatex is only configured to output a single GPGGA message which we record on the TECHSAS System.

The DPS 116 is located at the top of the ships Main mast.

Ship's Gyrocompass
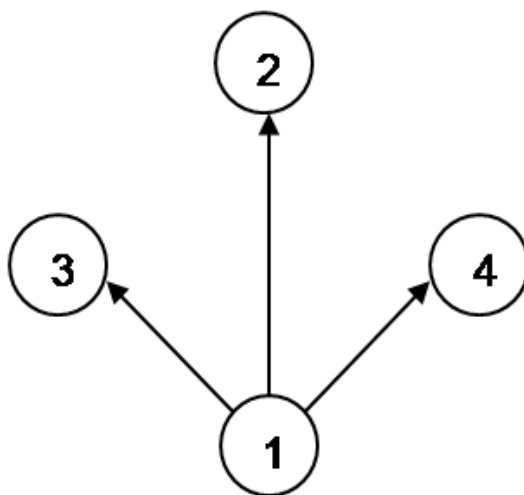
Figure 57: Schematic drawing of the Antennas.

Table 25: Antenna position on *James Cook* from MRU (0,0,0)

Antenna	X (Positive Starboard)	Y (Positive Forward)	Z (Positive Up)
1	9.265	1.541	19.416
2	10.463	1.537	19.419
3	9.863	0.932	19.426
4	9.870	2.138	19.419

The Gyronmea is a file that receives its data from the Ships gyro compass located in the Bridge Electronics Space. There are two such Gyros on the bridge and we are able to use either one of them as a source of heading. The selected Gyro is logged by the TECHSAS system and is used as part of the bestnav calculation.

Chernikeef EM log

The Chernikeef EM log is a 2-axis electromagnetic water speed log. It measures both longitudinal (forward-aft) and transverse (port - starboard) ships water speed.

The EM log system was not showing the correct data following the last calibration attempt. The system has been highly unreliable since its installation within the ship and continues to be an ongoing issue that we are attempting to get support from the manufacturer for, however they are not so forth coming.

Simrad EA600 Precision Echo Sounder (PES)

The EA600 Precision Echo Sounder is the ships primary depth readout. The EA600 output is passed to TECHSAS and also to the green display screens in the main lab. The

EA600 is mounted on the port drop keel. The keel was kept flush throughout the cruise and the system produced reasonably useable data in all but the worst sea conditions.

Kongsberg EM120 Multibeam Echo Sounder

Operating frequency and coverage sector.
The nominal sonar frequency is 12 kHz with an angular coverage sector of 150 degrees and 191 beams per ping as narrow as 1 degree. Achievable swath width on a flat bottom will normally be approximately six times the water depth. The angular coverage sector and beam pointing angles may be set to vary automatically with depth according to achievable coverage. This maximizes the number of usable beams. The beam spacing is normally equidistant with equiangle available.

Transmission

The transmit fan is split in several individual sectors with independent active steering according to vessel roll, pitch and yaw. This place all soundings on a 'best fit' to a line perpendicular to the survey line, thus ensuring a uniform sampling of the bottom and 100% coverage.

The sectors are frequency coded (11.25 to 12.60 kHz), and they are all transmitted sequentially at each ping. The sector steering is fully taken into account when the position and depth of each sounding is calculated, as is the refraction due to the sound speed profile, vessel attitude and installation angles. Pulse length and range sampling rate are variable with depth for best resolution, and in shallow waters due care is taken to the near field effects. The ping rate is mainly limited by the round trip travel time in the water up to a ping rate of 5 Hz.

Transducer arrays

The EM 120 transducers are linear arrays in a Mills cross configuration with separate units for transmit and receive.

The Multibeam was used extensively throughout the cruise with Replay/Neptune being employed to produce ascii xyz files for further processing. The system performed as expected with the data becoming virtually useless when heading into the sea due to the well known aeration problems, but improving markedly when the sea was from astern.

Surfmet System

This is the NMFD surface water and meteorology instrument suite. The surface water component consists of a flow through system with a pumped pickup at 5.5m depth. TSG flow is approx 18 litres per minute whilst fluoriometer and transmissometer flow is approx 1.5 l/min. Flow to instruments is degassed using a debubbler with 24 l/min

inflow and 10 l/min waste flow.

The meteorology component consists of a suite of sensors mounted on the foremast at a height of approx 16.4m above the waterline. Parameters measured are wind speed and direction, air temperature, humidity and atmospheric pressure. There is also a pair of optical sensors mounted on gimbals on each side of the ship. These measure total irradiance (TIR) and photo-synthetically active radiation (PAR). The gimbals were cleaned at the beginning of the cruise.

ADCPs

The 75Khz and 150Khz ship mounted ADCPs were used for the majority of the cruise with the data being collected for post-cruise processing and analysis. Both appeared to perform satisfactorily throughout.

PCO2 System

This system is an autonomous pCO2 system developed by PML and Dartcom. I advise that you contact Nick Hardman-Mountford at PML for information. The system was run at the same time as the Surfmet system and was cleaned on a weekly basis in order to remove fouling from the system as per the manual. Prior to JC041 investigation into a fault revealed damage to internal A-Line hose for standard 3 so this was isolated for the duration of the cruise.

Network Services

The network worked well without any issues, the wireless system also performed well throughout the cruise

Data Storage

Throughout the cruise data was stored in Data32. A Raided data store attached to Cook3. This performed well throughout. The Level C data was backed up to LTO daily.

VSAT

The VSAT functioned well throughout the cruise.

9 General Data Processing

Peggy Courtois

9.1 Getting the daily data

Prior to the cruise, Brian King set up Alberto Naveira Garabato's laptop to be the main machine (from the scientific side) able to communicate with the data acquisition system TECHSAS. Every day, the data were checked and downloaded by remotely logging into Alberto's laptop. All the programs used were developed by Brian King, who also supported us during the cruise. We are deeply grateful for his help. In order for the matlab scripts to be usable on the different research vessels, the matlab scripts use a common path for the data location and well defined names for data input files. It is therefore important to keep the location of the data unchanged and to rename the input files as expected.

The location of the data is */local/users/pstar/cruise/data/*. That folder contains the following subfolders:

- ctd

- exec

- mexec

- mexec_processing_scripts

- nav

- sim

- surfmet

- techsas

- templates

- tsg

The folder mexec_processing_scripts contains all the matlab scripts used for aquiring and processing the data. These scripts are made accessible by typing *m_setup_jc041.m* into matlab. All paths and names of files contain the word 'jc041' which recalls on which vessel the cruise took part (*James Cook*) and the number of the cruise (041).

Thus, the script *m_setup_jc041.m* will have to be modified prior to the future cruise (*m_setup_jcnnn.m*).

These matlab scripts are configured to process data from 7 datastreams, using two parameters in most of the cases: a short name refering to the dataset required and a Julian day number. The short name is present to translate a meaningful word from the user into the correct stream name on the TECHSAS side (see Table 26)

Table 26: TECHSAS abreviations for Brian King's matlab scripts

Stream Name	Short Name
SBE45	tsg
adu5pat	ash
ea600m	sim
gyro_s	gyr
gyropmv	gyp
posmvpos	pos
posmvtss	tss
surfmet	met

There are two main scripts used during the cruise: *mday_00* which reads in 24 hours of data and *mday_02* which appends the data to a growing appended file, both outputs are in NetCDF format. The output files are named as follows: 3 letters refering to the data stream (pos, gyr, gyp, etc...) + the cruise reference (jc041) + the Julian day (3 digits)+ raw, such as *pos_jc041_d338_raw.nc* for the navigation file. If the data were cleaned using another matlab script, the extension 'raw' disappears (e.g. *pos_jc041_d338.nc*). These two scripts (*mday_00* and *mday_02*) are wrapped into two major scripts: *mday_00_get_all* which reads all the data streams and converts them into a NetCDF file (e.g. *pos_jc041_d338_raw.nc*) and *mday_02_run_all* to append all the daily files to a NetCDF file (e.g. *pos_jc041_01.nc*). The rule is that *mday_02* appends the processed data first (file with no extension) and if they do not exit, the raw data will be appended.

So to keep it simple, every day the raw data were downloaded and converted into NetCDF files, by typing the following commands into matlab:
cd /local/users/pstar/cruise/data/mexec_processing_scripts
m_setup_jc041
mday_00_get_all(nnn)
mday_02_run_all(nnn)
where *nnn* is the Julian day.

Prior to use these later commands, it is recommanded to check the data by using one or several following commands:

- mtdfinfo: lists the start and end time and number of data cycles for a stream name.

- mtnames: lists the techsas stream names, nearest rvs stream name equivalents and the mexec short name equivalents reconized by mt programs. Needs to be configured for the cruise.

- mtvars: lists the var names and units.

- mtlast: gets the last data cycle from a file.

- mtlookd: all streams in the TECHSAS directory are scanned giving a summary of earliest and latest data for each stream.

- mtgetstreams: searches for the unique set of TECHSAS streams in the techsas_root directory.

- mtload: loads TECHSAS data into Matlab

- mtposinfo: obtains position from a TECHSAS nav file.

- mtgaps: searches for gaps in TECHSAS data.

- mtlistit: lists data in TECHSAS file.

- mplotxy: plot the data from any NetCDF file.

Most of these scripts have a Matlab help. Here is an example of the above commands:
mtlookd -f, this command gives a quick overlook of the data streams.
$[u, v] = mtload('surfmet',now-10,now,'speed')$, the 10 last seconds of the surfmet speed data are loaded in the variables u and v.
u.speed(1:100), quick look of the first 100 speed data points.
$[u, v] = mtload('posmvpos',now-10,now,'lat long')$, the 10 last seconds of the position latitude and longitude are loaded in the variables u and v.
[u.lat(1:100) u.long(1:100)], quick look of the first 100 data points of the latitude and longitude.
mtvars tsg, this command gives the list of the tsg variables available.
$[u, v] = mtload('tsg',now-10,now,'temp\_h cond salin')$, the 10 last seconds of the tsg variables such as temperature, conductivity and salinity are loaded in the variables u and v.
mtgaps surfmet, this command gives an overview of the gaps in surfmet data.

9.2   Data Processing

Seven data streams were daily downloaded during JC041:

- Four streams for the navigation, located in the *nav/* folder and containing data from the streams adu5pat (in *ash*), gyropmv (in *gyropmv*), gyros (in *gyros*) and posmvpos (in *posmvpos*).

- One stream ea600m for the echo-sounder ea600, located in the *sim/* folder.

- One stream for the surface meteorologic data (surfmet) in the *surfmet/* folder.

- Finaly, one stream for the thermosalinograph data (SBE45) in the *tsg/* folder.

One thing TECHSAS is inclined to do is to have data cycles with repeated times. Therefore, some data streams need some cleaning before they can be used. What follows lists the work carried out on each stream:

- Adu5pat: The script *mash_01* cleans the ashtech raw data and merge on gyro data. It also constructs ash-gyro difference. The full resolution data goes into *ash_jc041_dnnn_edt.nc*, while the two-minute averages go into *ash_jc041_dnnn.nc*. The processed data from the later file were then appended into *ash_jc041_01.nc*, whereas all the raw data were appended into *ash_jc041_01_raw.nc*.

- Gyropmv: No processing was done on this data yet. All the raw data were appended into *gyp_jc041_01_raw.nc*.

- Gyro_s: The script *mgyr_01.m* was used to discard data cycles with repeated or backwards time jumps. This created *gyr_jc041_dnnn.nc* from the raw file. The processed data were appended into *gyr_jc041_01.nc*, whereas the raw data were appended into *gyr_jc041_01_raw.nc*.

- Posmvpos: Two scripts were used separately on the raw data. First, the raw data were averaged into a 30-second nav file *pos_jc041_dnnn_30s.nc* from the 1-Hz positions, by using *xbest_01.m*. Second, the script *mavg_mav.m* was used to average the raw data into one minute bins (*pos_jc041_dnnn_avg.nc*). The _raw, _30s and _avg files were all appended into *pos_jc041_01_raw.nc*, *pos_jc041_01_30s.nc* and *pos_jc041_01_avg.nc*.

- Ea600: No processing was done on this data. All the raw data were appended into *sim_jc041_01_raw.nc*.

- Surfmet: The raw data were processed using *mavg_surfmet_jc041.m*. This script first copies the raw data into *met_jc041_dnnn_edit.nc*. Then, to avoid problems associated with averaging wind direction over time, the speed and direction were first converted to eastward (u) and northward (v) components (muvsd.m) into *met_jc041_dnnn_uv.nc*. From this file, (u) and (v) were averaged (*met_jc041_dnnn_uv_avg.nc*) and finally converted into speed and direction (*met_jc041_dnnn.nc*). The final processed data were appended into *met_jc041_01.nc*, whereas all the raw data were appended into *met_jc041_01_raw.nc*.

- Tsg: The raw data were averaged into one minute bin. The raw and averaged data were appended into *tsg_jc041_01_raw.nc* and *tsg_jc041_01_avg.nc*. See Chapter 7 for more information.

10 Acknowledgements

A Watches

WATCHES	
0 am - 12 am	**12 am - 0 am**
Helen Johnson	Peggy Courtois
Alberto Naveira Garabato	Kevin Speer
Peter Lazarevich helping when needed	

B   Sensor Information

SHIP: RRS JAMES COOK	CRUISE: JC041

FORWARDING INSTRUCTIONS / ADDITIONAL INFORMATION:
1) AS BUILT AT NOC PRIOR TO CRUISE
2) Also shipped:
   a) CTD T-C duct cleaning bucket and syringes, bottles etc
   b) Titanium CTD fastener kit
   c) 2 off Autosal Viglen PCs
   d) 70 off 200ml Standard Seawater bottles
   e) 12 off salinity sample bottle crates (288 bottles) with caps and inserts
   f) 2 off Dell Laptops for LADCP/FRRF use (with 2-port RS-232 cards)
   g) 2 off Dell 19" LCD monitors (spares) and empty boxes for CTD monitors
   h) CTD ladder
   i) CTD deck bedplate – steel (green) for S/S frame in Wetlab
   j) CTD toolkit/CTD consumables/CTD manuals/CTD cables/CTD spares
   k) 10l/30l Niskin spares/Autosal spares/LADCP spares
   l) Spare Workhorse Sealed Lead-acid Non-Spillable Batteries x 8

CHECKED BY: Paul Provost	DATE: December 2009

SENSOR / SYSTEM TYPE	SERIAL No	Service / Cal	Cruise Notes
SBE 9+ CTD Underwater Unit (1)	09P-19817-0528	Service Due 17/04/2013	Main unit for 24 way S/S frame (SBE CTD1)
SBE 9+ CTD Underwater Unit (2)	09P-39607-0803 (T)	Service Due 26/05/2013	Spare unit (SBE CTD TITA2)
SBE 9+ CTD Underwater Unit (3)	09P-34173-0758 (T)	Service Due 16/11/2013	Spare unit
Digiquartz Pressure sensor (1)	73299	Last Calibrated 18/04/2008	Fitted to 9+ 0528 Main S/S CTD Pressure Sensor
Digiquartz Pressure sensor (2)	93896	Last Calibrated 27/05/2008	Fitted to 9+ 0803(T) Spare TI CTD Pressure Sensor
Digiquartz Pressure Sensor (3)	90074	Last Calibrated	Fitted to 9+ 0758(T) Spare CTD Pressure Sensor

		17/11/2008	
SBE 3P Temperature Sensor (1)	3P-4116	Last Calibrated 15/09/2009	Primary Temperature Sensor S/S frame (Frame-mounted)
SBE 3P Temperature Sensor (2)	3P-4383	Last Calibrated 07/05/2009	Secondary Temperature Sensor S/S frame (Fin-mounted)
SBE 3P Temperature Sensor (3)	3P-4592 (T)	Last Calibrated 8/05/2009	Spare Temperature Sensor
SBE 4C Conductivity Sensor (1)	4C-2580	Last Calibrated 10/09/2009	Primary Conductivity Sensor S/S frame (Frame-mounted)
SBE 4C Conductivity Sensor (2)	4C-3567	Last Calibrated 05/05/2009	Secondary Conductivity Sensor S/S frame (Fin-mounted)
SBE 4C Conductivity Sensor (3)	4C-2164 (T)	Last Calibrated 30/04/2009	Spare Conductivity Sensor
SBE 43 Dissolved Oxygen Sensor (1)	43-0862	Last Calibrated 10/03/2009	Primary Oxygen Sensor S/S frame (Frame-mounted)
SBE 43 Dissolved Oxygen Sensor (2)	43-0363	Last Calibrated 19/02/2009	Spare Oxygen Sensor
SBE 43 Dissolved Oxygen Sensor (3)	43-0709	Last Calibrated 28/05/2008	Spare Oxygen Sensor
SBE 5T Pump (1)	5T-3609	Service Due 12/03/2013	Primary Pump S/S frame (Frame-mounted)
SBE 5T Pump (2)	5T-3085	Service Due 27/05/2013	Secondary Pump S/S frame (Fin-mounted)
SBE 5T Pump (3)	5T-3090	Service Due 6/10/2013	Spare
SBE 5T Pump (4)	5T-3088	Service Due 6/10/2013	Spare
SBE 5T Pump (5)	5T-3002	Service Due 19/10/2013	Spare
SBE 5T Pump (6)	5T-4513	Service Due 19/10/2013	Spare
SBE 32 24-way Carousel (1)	32-19817-0243	Last Serviced 20/10/2008	Main Carousel on 24-way S/S CTD
SBE 32 24-way Carousel (2)	32-24680-0346	Last Serviced 18/11/2008	Main Carousel on 24-way Ti CTD
General Oceanics 1016 Pylon	1544	Last Serviced N/A	Spare Carousel
SBE GO1016 Battery Pack	0015	Last Serviced N/A	Spare Carousel Battery Pack
SBE 11+ Deck Unit (1)	11P-34173-0676	New April 2004	Main CTD Deck Unit (w/ 9600 baud uplink, main link

Instrument	Serial No.	Date	Notes
SBE 11+ Deck Unit (2)	11P-24680-0589	New April 2001	set to 19,200 baud with Powertecnique UPS Serial No.: 10078860301 – batteries due for replacement 23/05/2012) Spare CTD Deck Unit (set to 9600 baud)
Chelsea Aquatracka III Fluorimeter (1)	09-7117-001	Last Calibrated 10/06/2009	Fitted to S/S CTD
Chelsea Aquatracka III Fluorimeter (2)	88-2615-124		Spare
Chelsea Aquatracka III Fluorimeter (3)	88-2960-160		Spare
Chelsea AlphaTracka II Transmissometer – 25cm pathlength (1)	07-6075-001	Last Calibrated 18/10/2007	Fitted to S/S CTD
Chelsea AlphaTracka II Transmissometer – 25cm pathlength (2)	161-2642-002	Last Calibrated 4/09/1996	Spare
Chelsea AlphaTracka II Transmissometer – 25cm pathlength (3)	161047	Last Calibrated 18/03/2008	Spare
Wetlabs BBRTD Light Backscatter Sensor	BBRTD-182	Last Calibrated 20/06/2007	Fitted to SS CTD
Wetlabs BBRTD Light Backscatter Sensor	BBRTD-167	Last Calibrated 13/05/2008	Spare
Chelsea 2 pi PAR (1)	09	Last Calibrated 21/06/2008	Spare
Chelsea 2 pi PAR (2)	10	Last Calibrated 14/04/2008	Spare
Chelsea 2 pi PAR (3)	11	Last Calibrated 6/12/2007	Spare
Chelsea 2 pi PAR (Titanium) (1)	02	Last Calibrated 12/01/2007	Spare returned to NOC ex JC041
Chelsea 2 pi PAR (Titanium) (2)	03	Last Calibrated 14/03/2008	Spare
Chelsea 2 pi PAR (Titanium) (3)	04	Last Calibrated 11/10/2007	Spare
RDI WH300 LADCP (New potting) (1)	12920	Last Serviced 10/06/2009	Downward Master on S/S CTD
RDI WH300 LADCP (New potting) (2)	12919	Last Serviced 15/06/2009	Spare for S/S CTD

Equipment	Serial / ID	Service	Comment
RDI WH300 LADCP (Old potting) (3)	4275	Last Serviced 23/9/2009	Upward Slave on S/S CTD
RDI WH300 LADCP (Titanium) (4)	10607	Last Serviced 26/03/2008	Slave Ti CTD
NMF WH300 LADCP Battery Pack (1)	WH002	New batteries installed 1/08/2005	Fitted to S/S CTD Frame
NMF WH300 LADCP Battery Pack (2)	WH005	New batteries installed 16/06/2004	Spare for S/S CTD Frame
NMF WH300 LADCP Battery Pack (Titanium) (3)	WH006T	New batteries installed 1/03/2008	Spare Ti CTD Frame
Tritech PA-200 Altimeter (1)	6196.112522	Last serviced 1/02/2006	Spare
Benthos PSA-916T Altimeter (2)	41302	New 20/04/2007	Fitted to S/S CTD Frame
Sonardyne Deep HF Marker Beacon	245116-001	New batteries installed 27/02/2007	Fitted to S/S CTD Frame (non available for Ti Frame)
NMF 10kHz Pinger (1)	B0 (2 sec ping rate)	New battery 2/05/2007	Spare Pinger (not used on CTD for any dragging)
NMF 10kHz Pinger (2)	B10 (2 sec ping rate)	New battery 8/08/2006	Spare Pinger (not used on CTD for any dragging)
Guildline Autosal 8400B (1)	65764	Last Serviced 24/09/2009; last Alignment 16/10/2008	Main Salinometer – CT Lab Shipped with 30L carbuoy
Guildline Autosal 8400B (2)	68426	Last Service 9/06/2009; last Alignment 9/06/2009	Spare Salinometer – Hold Shipped with 30L carbuoy
Ocean Test Equipment 10L water samplers	1A though 24A with 25 through 30 and 000 as spares		Fitted to S/S CTD.
Ocean Test Equipment 10L trace-metal free water samplers	1T through 24T with 25T through 30T as spares		Cleaned and packed at the end of JC039. All instruments and cables also removed from Ti frame, but all to remain onboard.
24-way stainless steel CTD frame	SBE CTD1	Lifting Bale Load tested 19/05/2006	S/S CTD
24-way titanium CTD frame	SBE CTD TITA2	Lifting Bale Load tested 19/05/2006	Ti CTD
General Oceanics Aluminium upper/lower adapter plates (24-way)			S/S CTD
OTE 10l Delrin upper/lower adapter plates (24-way trace-metal free)			Ti CTD

C   Acoustic releases information

MORS SYSTEMS
Operational Sheet

CRUISE   DATE

TYPE   RT 661 B2S
FUNCTION   RELEASE TRANSPONDER RT661 - B
SERIAL No. 321
Delivery   FEB 96

Int Frequency   Reply Frequency
FR1 = 9.0khz   FT1 = 13.0khz
FR2 = 13.0khz   FT2 = 09.0khz
FR3 =10.5khz
FR4 =14.5khz   FT4 = 10.0khz
FT0,FT5,FT6,FT7,FT8,FT9,FT10,FT11,FT15 = 08.0khz

Function / Code	TT301	Reply	Specifications
WINDOW	C446	FT0	Wait time sec Active sec
ON FR1-FR2	C447	FT0	
OFF FR1-FR2-PINGER	C448	FT0	
RELEASE 1 (W)	C485	FT0-FT5	
RELEASE 2 (W)	C486	FT0-FT6	
DIAGNOSTIC(W)	C487	FT0-FT7	Measure delay sec Vert offset sec
PYROTECHNIC(W)	C491	FT0-FT11	Wait time s Pulse s
PINGER (W)	C470	FT0-FT4	Pulse width Ms Recur sec

Power Configuration   3 banks of 6 Lithium D installed for
                      1 bank of 1 Alkaline PP3 installed for
Power partition   Standby - power motor

Diagnostic Measure $t(FT7) - t(FT0) - 3s$ (13 s in horizontal position)
Cells voltage (V)   Diagnostic measure x 4.1
Batteries fitted   :

Wire test   :
Functions check   :
Deployed Mooring :   Date :

Recovery limit   :   Date :

Recovered   :   Date :

COMMENTS ON CONDITION

ACTIONS REQUIRED AT LABORATORY

MORS SYSTEMS
Operational Sheet

CRUISE   DATE

TYPE   RT 661 B2S-DDL
FUNCTION   RELEASE TRANSPONDER RT661 - B
SERIAL No. 439
Delivery   FEB 2001

Int Frequency	Reply Frequency
FR1 = 9.0khz	FT1 = 12.5khz
FR2 = 12.5khz	FT2 = 9.0khz
FR3 =14.5khz	
FR4 = 15.5khz	FT4 = 10.0khz

FT0,FT5,FT6,FT7,FT8,FT9,FT10,FT11,FT15 = 12.0khz

Function / Code	TT301	Reply	Specifications
WINDOW	EC67	FT0	Wait time sec Active sec
ON FR1-FR2	EC68	FT0	
OFF FR1-FR2-PINGER	EC69	FT0	
RELEASE 1 (W)	EC85	FT0-FT5	
RELEASE 2 (W)	EC86	FT0-FT6	
DIAGNOSTIC(W)	EC87	FT0-FT7	Measure delay sec Vert offset sec
PYROTECHNIC(W)	EC91	FT0-FT11	Wait time s Pulse s
PINGER (W)	EC94	FT0-FT4	Pulse width Ms Recur sec

Power Configuration	3 banks of 6 Lithium D installed for
	1 bank of 1 Alkaline PP3 installed for
Power partition	Standby - power motor

Diagnostic Measure	t(FT7) - t(FT0) - 3s (13 s in horizontal position)
Cells voltage (V)	Diagnostic measure x 4.1
Batteries fitted	:

Wire test   :
Functions check   :
Deployed Mooring :   Date :

Recovery limit   :   Date :

Recovered   :   Date :

COMMENTS ON CONDITION

ACTIONS REQUIRED AT LABORATORY

BUILD SHEET

TYPE	:	**AR 861 B2S**
S/N	:	**255**
P/N	:	**392 9100**
Function	:	**Acoustic Release**
Modification	:	

Date of Manufacture	:	
Customer	:	**S.O.C.**
Representative	:	**iXSea Ltd**
Job file	:	
Customer approval	:	

TECHNICAL SPECIFICATIONS

ELECTRONIC BOARD							
Reference	**Rev**	**Function**	**S/N**
392 2001	**3.0**	AR 8x1 board	**305**
		Firmware:	
		PROM (U6) - ET8_V2.2	
		FPGA (U38) - REC_V1.0/3.3V	
		PROM (U32) - EM_V1.0	
		FPGA (U33) - EM_V1.0/3.3V	

ELECTRONIC SPECIFICATIONS		
Transmit width	:	**10** ms
Transmit level	:	**191** ± 4 dB ref 1 μPa at 1 m
Pinger rate	:	**5** s
Pinger duration after release	:	**3** mn
FR0	=	**09.0** kHz
FR1	=	**10.5** kHz
CAF	=	**12.0** kHz
PINGER	=	**12.0** kHz

FUNCTIONAL SPECIFICATIONS

Function / Code	TT801/ TT701/ TT301	TT201		Sequence	
ARM / RANGING	**14AC**	N.A.	⇒ CAF	Lock-Out time = 4s	
				Active time = 20s	
The following acoustic codes must be preceded by an ARM code					
RELEASE	**1455**	N.A.	⇒ CAF	⇒ CAF	
RELEASE WITH PINGER	**1456**	N.A.	⇒ CAF	⇒ CAF	⇒ PINGER
PINGER ON	**1447**	N.A.	⇒ CAF	⇒ PINGER	
PINGER OFF	**1448**	N.A.	⇒ CAF		
DIAGNOSTIC	**1449**	N.A.	⇒ CAF₁	⇒ CAF₂	
N.A. : Not applicable					

Word 97 - PC : Ar8X1-255.doc

iXSea	IS	DATE	**FAT-A-AR 8x1**	Page
	3	30/03/04	**S/N : ……..**	1/3

This document is the property of iX Sea and shall not be reproduced nor transmitted without written approval

159

BUILD SHEET

TYPE	:	AR 861 B2S		Date of Manufacture	:	09#06/04
S/N	:	311		Customer	:	S.O.C.
P/N	:	392 9100		Representative	:	iXSea Ltd
Function	:	Acoustic Release		Job file	:	4P000112
Modification	:			Customer approval	:	

TECHNICAL SPECIFICATIONS

ELECTRONIC BOARD				ELECTRONIC SPECIFICATIONS

Reference	Rev	Function	S/N
392 2001	3.0	AR 8x1 board	311
		Firmware:	
		PROM (U6) - ET8_V2.2	
		FPGA (U38) - REC_V1.0/3.3V	
		PROM (U32) - EM_V1.0	
		FPGA (U33) - EM_V1.0/3.3V	

Transmit width   :   **10** ms
Transmit level   :   **191 ± 4** dB ref 1 µPa at 1 m
Pinger rate   :   **2** s
Pinger duration after release :   **3** mn

FR0   = **09.0** kHz
FR1   = **10.5** kHz

CAF   = **12.0** kHz
PINGER = **12.0** kHz

FUNCTIONAL SPECIFICATIONS

Function / Code	TT801/ TT701/ TT301	TT201	Sequence		
ARM / RANGING	14C7	N.A.	⇒ CAF	Lock-Out time = 4s	Active time = 20s
The following acoustic codes must be preceded by an ARM code					
RELEASE	1455	N.A.	⇒ CAF	⇒ CAF	
RELEASE WITH PINGER	1456	N.A.	⇒ CAF	⇒ CAF ⇒ PINGER	
PINGER ON	1447	N.A.	⇒ CAF	⇒ PINGER	
PINGER OFF	1448	N.A.	⇒ CAF		
DIAGNOSTIC	1449	N.A.	⇒ CAF1	⇒ CAF2	

N.A. : Not applicable

iXSea	IS	DATE	FAT-A-AR 8x1	Page
	3	30/03/04	S/N :	1/3

BUILD SHEET

TYPE	:	**AR 861 B2S**
S/N	:	**474**
P/N	:	**392 9100**
Function	:	**Acoustic Release**
Modification	:	**20/10/05**

Date of Manufacture	:	**03/2001**
Customer	:	**SOC**
Representative	:	
Job file	:	**3S0109**
Customer approval	:	

TECHNICAL SPECIFICATIONS

ELECTRONIC BOARD			
Reference	Rev	Function	S/N
392 2001	3.0	AR 8x1 Board	474
		Firmware:	
		PROM (U6) - ET8_V2.2	
		FPGA (U38) - REC_V1.0/3.3V	
		PROM (U32) - EM_V1.0	
		FPGA (U33) - EM_V1.0/3.3V	

ELECTRONIC SPECIFICATIONS

Transmit width	:	**10** ms
Transmit level	:	**191 ± 4** dB ref 1 μPa at 1 m
Pinger rate	:	**2** s
Pinger duration after release	:	**3** mn
FR0	=	**09.0** kHz
FR1	=	**11.0** kHz
CAF	=	**12.0** kHz
PINGER	=	**10.0** kHz

FUNCTIONAL SPECIFICATIONS

Function / Code	TT801/ TT701/ TT301	TT201	Sequence	
ARM	1525	N.A.	⇒ CAF	Lock-Out time = 4s Active time = 20s

The following acoustic codes must be preceded by an ARM code

Function / Code	TT801/ TT701/ TT301	TT201	Sequence		
RELEASE	1555	N.A.	⇒ CAF	⇒ CAF	
RELEASE WITH PINGER	1556	N.A.	⇒ CAF	⇒ CAF	⇒ PINGER
PINGER ON	1547	N.A.	⇒ CAF	⇒ PINGER	
PINGER OFF	1548	N.A.	⇒ CAF		
DIAGNOSTIC	1549	N.A.	⇒ CAF1	⇒ CAF2	

N.A. : Not applicable

3   BUILD SHEET

Type	:	OCEANO 2500 S-Universal		Date of Manufacture	:	21/09/07
S/N	:	830		Customer	:	NOC UK
P/N	:	392 9100		Representative	:	
Function	:	Acoustic Release		Job file	:	7B000080
Modification	:			Customer Approval	:	30/08/07

TECHNICAL SPECIFICATIONS

ELECTRONIC BOARD				ELECTRONIC SPECIFICATIONS
Reference	**Rev**	**Function**	**S/N**	Transmit width : 10 ms
392 2001	3.4	AR 8x1 board	830	Transmit level : 191 ± 4 dB ref 1µPa at 1 m
		Firmware:		Pinger rate : 2 s
		PROM (U6) - ET8_V2.2		Pinger duration after release : 3 mn
		FPGA (U38) - REC_V1.0/3.3V		
		PROM (U32) - EM_V1.0		$FR0 = 09.0$ kHz $\Rightarrow$ BIT_0 = 02
		FPGA (U33) - EM_V1.0/3.3V		$FR1 = 11.5$ kHz $\Rightarrow$ BIT_1 = 07
				$CAF = 12.0$ kHz
				$PFR = 12.0$ kHz

FUNCTIONAL SPECIFICATIONS

Function / Code	TT301/TT701/TT801	TT201	Sequence
ARM / RANGING	1667	BIT_0 + BIT_1 + 67 $\Rightarrow$ CAF	Lock-out time = 4s Active time = 20s
The following acoustic codes must be preceded by an ARM code			
RELEASE	1655	BIT_0 + BIT_1 + 55 $\Rightarrow$ CAF $\Rightarrow$ CAF	
RELEASE WITH PINGER	1656	BIT_0 + BIT_1 + 56 $\Rightarrow$ CAF $\Rightarrow$ CAF $\Rightarrow$ PFR	
PINGER ON	1647	BIT_0 + BIT_1 + 47 $\Rightarrow$ CAF $\Rightarrow$ PFR	
PINGER OFF	1648	BIT_0 + BIT_1 + 48 $\Rightarrow$ CAF	
DIAGNOSTIC	1649	BIT_0 + BIT_1 + 49 $\Rightarrow$ CAF_1 $\Rightarrow$ CAF_2	

OCEANO 2500 S-Universal - S/N = 830

3   BUILD SHEET

Type	:	OCEANO 2500 S-Universal	Date of Manufacture	:	21/09/07
S/N	:	831	Customer	:	NOC UK
P/N	:	392 9100	Representative	:	
Function	:	Acoustic Release	Job file	:	7B000080
Modification	:		Customer Approval	:	30/08/07

TECHNICAL SPECIFICATIONS

ELECTRONIC BOARD				ELECTRONIC SPECIFICATIONS
Reference	**Rev**	**Function**	**S/N**	Transmit width : 10 ms
392 2001	3.4	AR 8x1 board	831	Transmit level : 191 ± 4 dB ref 1µPa at 1 m
		Firmware:		Pinger rate : 2 s
		PROM (U6) - ET8_V2.2		Pinger duration after release : 3 mn
		FPGA (U38) - REC_V1.0/3.3V		
		PROM (U32) - EM_V1.0		FR0 = 09.0 kHz ⟹ BIT_0 = 02
		FPGA (U33) - EM_V1.0/3.3V		FR1 = 11.5 kHz ⟹ BIT_1 = 07
				CAF = 12.0 kHz
				PFR = 12.0 kHz

FUNCTIONAL SPECIFICATIONS

Function / Code	TT301/TT701/TT801	TT201	Sequence
ARM / RANGING	1668	BIT_0 + BIT_1 + 68 ⟹ CAF	Lock-out time = 4s Active time = 20s
The following acoustic codes must be preceded by an ARM code			
RELEASE	1655	BIT_0 + BIT_1 + 55 ⟹ CAF ⟹ CAF	
RELEASE WITH PINGER	1656	BIT_0 + BIT_1 + 56 ⟹ CAF ⟹ CAF ⟹ PFR	
PINGER ON	1647	BIT_0 + BIT_1 + 47 ⟹ CAF ⟹ PFR	
PINGER OFF	1648	BIT_0 + BIT_1 + 48 ⟹ CAF	
DIAGNOSTIC	1649	BIT_0 + BIT_1 + 49 ⟹ CAF_1 ⟹ CAF_2	

163

3 BUILD SHEET

Type	:	**OCEANO 2500 S-Universal**	Date of Manufacture	:	**21/09/07**
S/N	:	**832**	Customer	:	**NOC UK**
P/N	:	**392 9100**	Representative	:	
Function	:	**Acoustic Release**	Job file	:	**7B000080**
Modification	:		Customer Approval	:	**30/08/07**

TECHNICAL SPECIFICATIONS

ELECTRONIC BOARD				ELECTRONIC SPECIFICATIONS
Reference	**Rev**	**Function**	**S/N**	Transmit width : **10 ms**
392 2001	3.4	AR 8x1 board	832	Transmit level : **191 ± 4 dB ref 1µPa at 1 m**
		Firmware:		Pinger rate : **2 s**
		PROM (U6) - ET8_V2.2		Pinger duration after release : **3 mn**
		FPGA (U38) - REC_V1.0/3.3V		
		PROM (U32) - EM_V1.0		FR0 = **09.0 kHz** $\Rightarrow$ BIT_0 = **02**
		FPGA (U33) - EM_V1.0/3.3V		FR1 = **11.5 kHz** $\Rightarrow$ BIT_1 = **07**
				CAF = **12.0 kHz**
				PFR = **12.0 kHz**

FUNCTIONAL SPECIFICATIONS

Function / Code	TT301/TT701/TT801	TT201	Sequence
ARM / RANGING	1669	BIT_0 + BIT_1 + 69 $\Rightarrow$ CAF	Lock-out time = 4s
			Active time = 20s
The following acoustic codes must be preceded by an ARM code			
RELEASE	1655	BIT_0 + BIT_1 + 55 $\Rightarrow$ CAF $\Rightarrow$ CAF	
RELEASE WITH PINGER	1656	BIT_0 + BIT_1 + 56 $\Rightarrow$ CAF $\Rightarrow$ CAF $\Rightarrow$ PFR	
PINGER ON	1647	BIT_0 + BIT_1 + 47 $\Rightarrow$ CAF $\Rightarrow$ PFR	
PINGER OFF	1648	BIT_0 + BIT_1 + 48 $\Rightarrow$ CAF	
DIAGNOSTIC	1649	BIT_0 + BIT_1 + 49 $\Rightarrow$ CAF$_1$ $\Rightarrow$ CAF$_2$	

OCEANO 2500 S-Universal - S/N = 832

164