CRUISE REPORT: SOFine / JC029

(Updated OCT 2021)
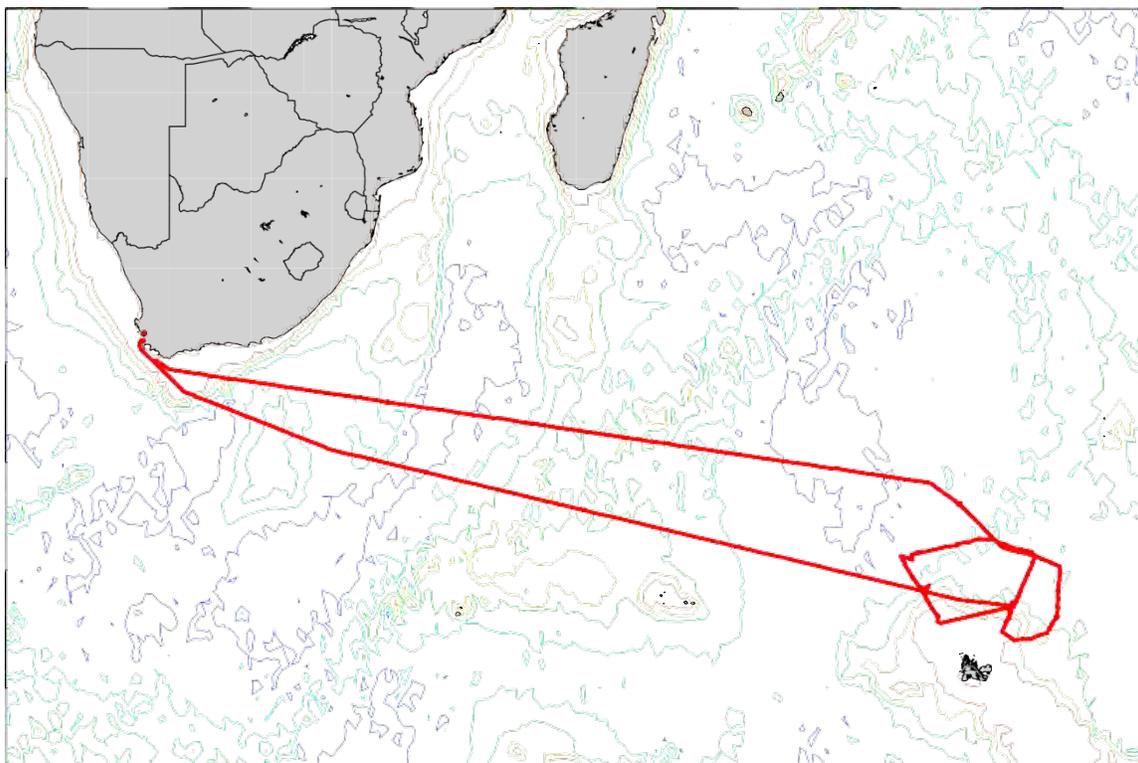
Highlights

Cruise Summary Information

Section Designation	**SOFine / JC029**
Expedition designation (ExpoCodes)	**740H20081101**
Chief Scientists	**Alberto Naveira Garabato / NOC, UK**
Dates	2008 NOV 01 - 2008 DEC-22
Ship	RRS *JAMES COOK*
Ports of call	Cape Town - Cape Town
Geographic Boundaries	36° 89.0' S 24.460' E 74° 47.27' E 47° 57.038' S
Stations	65
Floats and drifters deployed	32 floats deployed; 10 drifting buoys deployed
Moorings deployed or recovered	3 short-term moorings deployed & recovered 2 long-term moorings deployed

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Final report assembly by Jerry Kappa, SIO/UCSD

National Oceanography Centre, Southampton

Cruise Report No. 35

RRS *James Cook* Cruise 29
01 NOV-22 DEC 2008

SOFine cruise report:
Southern Ocean Finestructure

Principal Scientist
A Naveira Garabato

2009

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ABSTRACT

The SOFINE research project aims to investigate two important, inter-related aspects of the physics of the Antarctic Circumpolar Current (ACC) and the Southern Ocean overturning circulation: (a) the 'frictional' processes that slow down the ACC as it meanders around major bathymetric obstacles and flows over small-scale topographic roughness; and (b) the meso- and small-scale phenomena that move water masses across the ACC and modify their properties in the process. These issues will be studied using a collection of data gathered during cruise JC 29, which is described in this report.

The JC 29 cruise consisted primarily of a series of transects across the standing meander that the ACC forms around the northern edge of the Kerguelen Plateau. The transects delineate a double box (Fig. 2), with the outer transects sampling the ACC as it enters and exits the meander, and the inner transect surveying the current in an area within the meander and downstream of some complex small-scale topography. During the transects, hydrographic, velocity and microstructure profiles were obtained with a CTD, lowered ADCP and VMP-5500 (a free-fall vertical microstructure profiler) suite, and quasi-continuous measurements of upper-ocean currents and high-resolution bathymetry were made with vessel-mounted ADCPs and a multibeam system. A variety of profiling floats (including EM-APEX, Iridium and standard Argo units) were also deployed at the upstream end of the meander, with the goal of obtaining measurements of the downstream evolution of water mass properties and both thermohaline and shear finestructure. Opportunistic measurements of upper-ocean turbulence were obtained with an ISW tethered turbulence profiler. Finally, a cluster of three short-term (2.5 weeks) moorings and two long-term (> 1 year) moorings were deployed at the southern end of the inner transect to measure the generation of internal waves by flow-topography interaction at a small ridge and the mesoscale eddy statistics of the area, respectively. The short-term moorings were successfully recovered toward the end of the cruise.

SOFine Cruise Report

Southern Ocean Finestructure

Principal Scientist:
Alberto Naveira Garabato

National Oceanography Centre
Southampton, U.K.

RRS *James Cook* Cruise 29
1st November - 22nd December 2008

Contents

4

List of Tables

7

List of Figures

1 SoFINE Cruise Narrative

Alberto Naveira Garabato

1.1 Cruise Summary

The SOFINE research project aims to investigate two important, inter-related aspects of the physics of the Antarctic Circumpolar Current (ACC) and the Southern Ocean overturning circulation: (a) the 'frictional' processes that slow down the ACC as it meanders around major bathymetric obstacles and flows over small-scale topographic roughness; and (b) the meso- and small-scale phenomena that move water masses across the ACC and modify their properties in the process. These issues will be studied using a collection of data gathered during cruise JC 29, which is described in this report.

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Figure 1: Complete cruise track for JC029.
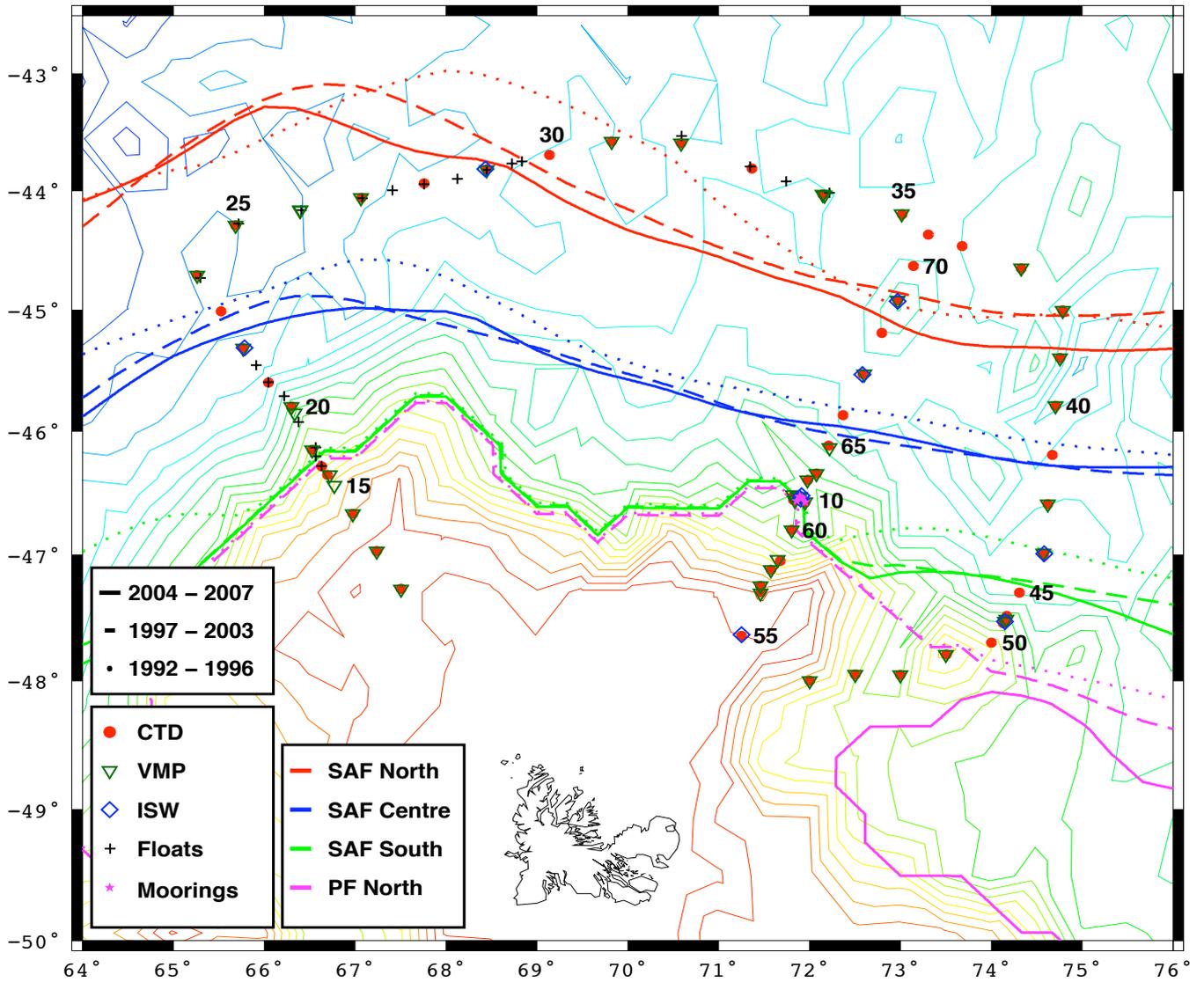
Figure 2: Detail of cruise track in the SOFINE study region. The deployment of the various instruments is marked by different symbols. The coloured lines refer to the locations of several frontal jets identified by Sergei Sokolov using three multi-year periods of altimetric observations.

1.2 Cruise Participants

1.2.1 Scientific Party

Name	Institute	Email
Phil Adams	CSIRO, AUS	phil.adams@csiro.edu
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Stephanie Waterman	MIT / WHOI, USA	snw@mit.edu

BAS	British Antarctic Survey			
CSIRO	Commonwealth Scientific and Industrial Research Organisation			
IFM - GEOMAR	Institut für Meereskunde - GEOMAR			
MIT	Massachusetts Institute of Technology			
NOC	National Oceanography Centre			
UEA	University of East Anglia			
WHOI	Woods Hole Oceanographic Institution			
UTAS	University of Tasmania			

1.2.2 Ship's Officers and Crew

Peter Sarjeant	Master		Kevin Luckhurst	CPOD
Richard Warner	Chief Officer		Stephen Smith	CPOS
Malcolm Graves	Second Officer		Iain Thomson	POD
Vanessa Laidlow	Third Officer		John Dale	SG1A
Paul Lucas	Purser		Ian Cantlie	SG1A
Martin Holt	Chief Engineer		Charles Cooney	SG1A
John Hagan	Second Engineer		Lee Stephens	SG1A
Ian Collin	Third Engineer		Emlyn Williams	ERPO
Ian Wight	ETO		Darren Caines	Head Chef
Matthew Zglobis	C/ETO		Dean Hope	Chef
Michael Myers	SSM		Graham Mingay	Steward
Vivian Wythe	Deck Engineer		Stephen Oliver	Cat. Assistant

1.3 Cruise Daily Summary

Saturday 1ˢᵗ November (Julian day 306)
We set sail at 18:00 (local time) from Cape Town and steamed southeastward toward Kerguelen. We lowered the drop keel to gather SADCP data over the continental shelf off South Africa.

Sunday 2ⁿᵈ November (Julian day 307)
We kept steaming southeastward in moderate seas at a speed of around 10 kn. Most scientists and technicians were busy preparing the CTD, VMP, ISW profiler and EM-APEX floats for upcoming deployments.

Monday 3ʳᵈ November (Julian day 308)
We kept steaming southeastward in moderate seas at a speed of around 10 kn. We successfully conducted an ISW profiler test station (station 01) in deep water. At the end

of the test station, we retracted the drop keel to speed up passage to Kerguelen.

Tuesday 4th November (Julian day 309)

We kept steaming as in the previous two days. We deployed the first drifter (83355) for the Global Drifter Program (GDP).

Wednesday 5th November (Julian day 310)

We kept steaming in benign seas, occupied with mooring, CTD and VMP preparations. We deployed a second GDP drifter (83344) and a CSIRO (standard) Argo float (3975).

Thursday 6th November (Julian day 311)

We kept steaming in benign seas, occupied with mooring, CTD and VMP preparations. We deployed a third GDP drifter (83341).

Friday 7th November (Julian day 312)

We kept steaming in calm seas. We deployed two CSIRO (standard) Argo floats (3976 and 3977). We conducted a VMP buoyancy check and a test CTD cast to nominally 2000 m (station 02). The VMP's nose cap became loose during the buoyancy check, so it was taken apart and tightened.

Saturday 8th November (Julian day 313)

We kept steaming toward Kerguelen, with some rough seas overnight. We deployed a fourth GDP drifter (83343) and a CSIRO (standard) Argo float (3978). We conducted a test VMP cast to 250 m (station 03) and, some hours later, a test CTD cast to 2000 m with the LADCPs in operation (station 04).

Sunday 9th November (Julian day 314)

We kept steaming toward Kerguelen in fair seas. We deployed a fifth GDP drifter (83340) and a CSIRO (standard) Argo float (3979). We conducted a test VMP cast to 800 m (station 05). The VMP cradle got damaged during recovery and, after some discussion, we decided to use the old fashioned wooden stand in subsequent VMP operations.

Monday 10th November (Julian day 315)

We kept steaming toward Kerguelen in good seas and at last entered the SOFINE experimental domain. We deployed a sixth GDP drifter (83342). We lowered the SADCP keel to start gathering velocity data in the study area.

Tuesday 11th November (Julian day 316)

We kept steaming toward Kerguelen in eerily calm seas. We conducted a tethered VMP drop with the hydroboom above the CTD annex to test the new VMP deployment / recovery procedure. We deployed the seventh GDP drifter (83357).

Wednesday 12th November (Julian day 317)

We arrived in the mooring deployment area and commenced the watches. We conducted a VMP cast (station 06) at a site immediately to the east of a thin ridge extending northward from the Kerguelen Plateau, in 1900 m of water and within a strong eastward jet associated with a branch of the Subantarctic Front. We saw stunning signatures of vigorous internal waves and turbulence in the VMP fall rate and measurements. It was very foggy, so it took a while to find the VMP, which had surfaced nearly 1 km away from the ship. In the end, the RDF directed us there and, as usual, we found the

instrument surrounded by a group of albatrosses. One of the albatrosses ripped away the plastic flag, and looked clearly disappointed that it was not edible! Upon VMP recovery, we did a CTD profile at the same site (station 06) with the SVP mounted on the rosette. We then input the measured sound velocity profile to the multibeam data acquisition system, and commenced swathing the area of the ridge overnight, in calm seas.

Thursday 13th November (Julian day 318)

We finished the swath survey in the early morning, and made a decision as to where to deploy the U.K. moorings. Deployment of the first (northern) of these moorings took place during the day, but mooring deployment activities had to be interrupted due to a sudden turn of the weather. We had force 8 winds and rough seas during the latter part of the day. We obtained upper-ocean turbulence measurements using the ISW profiler for over 1 hour (station 07). In the evening and overnight, we conducted a CTD tow-yo transect (station 08) across the ridge.

Friday 14th November (Julian day 319)

Upon finishing the tow-yo at first light, we sailed toward the deployment site of the second U.K. (central) mooring, which we deployed in the morning. After triangulating to pinpoint the position of the mooring, we moved off to the location of the third U.K. (eastern) mooring, deployed it and triangulated it. In the evening, we conducted a CTD / VMP station at the ridge's eastern edge (station 09).

Saturday 15th November (Julian day 320)

In the early hours, we did a CTD / VMP station at the position of the deep (2500 m) Australian mooring (station 10). We then steamed to the site of the shallow (2000 m) Australian mooring, where we conducted a set of ISW profiles (station 11). We deployed and triangulated the mooring in the morning. Later on in the day, we deployed and triangulated the deep Australian mooring.

Sunday 16th November (Julian day 321)

We sailed slowly, against the weather, toward the position of the first station in the western transect of the SOFINE survey. Many of us made us of the somewhat reduced workload to recuperate from the intense mooring deployment days.

Monday 17th November (Julian day 322)

We began occupying CTD / VMP stations (12 to 16) proceeding northward along the western transect. On station 15, the CTD was not deployed as the technicians were busy removing the broadband and upward-looking workhorse LADCPs out of the frame (the former, because it did not work well; the latter, because we were concerned with running out of spare ADCP units in this and subsequent cruises). The SVP was used to gather measurements of sound velocity at station 16.

Tuesday 18th November (Julian day 323)

We conducted a CTD deployment at station 17, in thick fog, due to which deployment of the VMP was skipped. Later in the morning, we did a CTD profile at station 18. This was followed by a VMP deployment, still in thick fog, but fortunately the fog was blown away by the time the VMP surfaced. We deployed four floats at and between stations:

two EM-APEX floats (3760 and 3761), a SOLO float (2823) and an Iridium float (5346). Strong winds picked up rapidly in the afternoon, and stopped us from doing any more over-the-side work for the rest of the day.

Wednesday 19th November (Julian day 324)

We conducted a VMP deployment in the morning (station 19). The CTD deployment was skipped due to the heavy swell caused by the previous night's gale. Both the CTD and the VMP were deployed in station 20, which was occupied in the late afternoon near the base of the Kerguelen continental slope. Station 21, a little further down the slope, consisted of a CTD deployment only. The VMP shear microstructure measurements had been deteriorating over the preceding few stations, so we decided to investigate the problem by disassembling the instrument during and after station 21. Three floats were deployed at and between stations: two SOLO floats (2825 and 2826) and an Iridium float (5345).

Thursday 20th November (Julian day 325)

We commenced station 22 by conducting some ISW profiling in the early morning, and continued with a combined CTD / VMP cast. The VMP cast was terminated some 600 to 700 m off the bottom due to low battery voltage. Only the CTD was deployed at station 23, as the VMP had not charged sufficiently by the time we got to the station. Both instruments were deployed jointly at station 24, the last station in the western transect, where the VMP cast was again terminated a fair distance off the sea floor, this time due to a worn out corrosive link. An EM-APEX float (5952) and a SOLO float (2827) were deployed in the course of the day. The VMP was disassembled again during the night in order to replace the battery, which had shown signs of wearing.

Friday 21st November (Julian day 326)

Heavy seas and strong winds halted our progress during much of the day. We were merely able to conduct a CTD / VMP cast (station 25, the first of the northern transect) in the evening. The RDF beacon in the VMP had been damaged during a maintenance operation, so the VMP was deployed without it at this and the next station (in fact, the RDF never worked again for the duration of the cruise). The only LADCP remaining in the CTD rosette at this point was found to have a broken beam during station 025, and was replaced by a different unit after the cast. We deployed a SOLO float (2828).

Saturday 22nd November (Julian day 327)

After waiting for the weather to die down over much of the day, in the evening we deployed the CTD and VMP at station 26. The VMP's weight release mechanism failed for unknown reasons and the instrument got stuck in the mud for around 3 hours, after which it initiated its ascent and was safely recovered the following night.

Sunday 23rd November (Julian day 328)

On recovering the VMP after its eventful cast, we deployed a SOLO float (2829) and moved on to station 27. There, we conducted a combined CTD / VMP cast. The VMP profile was terminated before the instrument approached the sea floor due to low battery voltage. After deploying Iridium (0056) and SOLO (2830) floats, we arrived in station

28 in the late afternoon. A CTD-only cast was done there, as the VMP battery was insufficiently charged. EM-APEX (3950) and CSIRO Argo (2954) floats were deployed in the evening.

Monday 24th November (Julian day 329)

We kept sailing eastward along the northern transect in fair weather. At station 29, we conducted separate CTD, ISW and VMP casts in a very strong (over 1 m s^{-1}) jet. As a result of the current, it was difficult to keep a low wire angle during the CTD profile. The wire bird-caged and had to be re-terminated after the cast. ISW profiling also proved difficult due to the strong flow, which applied tension to the cable and introduced swell contamination into the ISW measurements. A CTD-only cast was conducted at station 30. Two EM-APEX floats (3951 and 4051) and a CSIRO Argo float with an oxygen sensor (3639) were deployed this day.

Tuesday 25th November (Julian day 330)

The day opened with a CTD / VMP cast at station 31, followed by another joint cast at station 32. Finding the VMP after this station was problematic, with the instrument having surfaced some distance away from the ship in light fog. With the RDF out of order, we attempted to use a GONIO Argos receiver to find the VMP, but failed to get this to work. Eventually, after a long hour, the VMP was sighted. It became apparent that from this day forward we would have to rely primarily on visual aids to find the profiler. EM-APEX float 3764 was deployed on completion of the station. A CTD-only cast was conducted at station 33 so as to allow the VMP battery to recover from the previous two stations. We concluded the day's work by deploying Iridium (5334) and SOLO (2834) floats.

Wednesday 26th November (Julian day 331)

We occupied stations 34, 35 and 36, still on the northern transect. In the first two, we deployed the CTD and the VMP, whereas at 36 we did a CTD cast only to allow the VMP battery to charge up. The last float of the cruise (CSIRO Argo float 3638, with an oxygen sensor) was deployed.

Thursday 27th November (Julian day 332)

We concluded the northern transect with a joint CTD / VMP cast at station 37, where the CTD hit the sea floor with no apparent damage. We then sailed southeastward to the first (38) and second (39) stations of the eastern transect, in which we did further joint CTD / VMP deployments.

Friday 28th November (Julian day 333)

We continued CTD / VMP operations along the eastern transect, occupying stations 40-42 in good weather. There was no VMP deployment at station 41 to prevent the instrument's battery from discharging. At station 42, a spool problem occurred when hauling back the CTD, but this was promptly corrected by lowering the CTD to re-spool.

Saturday 29th November (Julian day 334)

In stunningly calm seas, a tense day ensued as the VMP hit the sea bed at station 43,

apparently due to a failure of the weight release mechanism. Upon recovering the CTD in the same station, we triangulated the position of the VMP and spent much of the rest of the day monitoring its pressure. Whilst doing that, we conducted other activities: a series of ISW profiles at station 43, and an upper-ocean CTD tow-yo (station 44) along and across the strong eastward jet that was flowing through the area. When we were coming to the end of the tow-yo, the VMP's corrosive link dissolved, the weights fell off, and the instrument began its ascent. It was recovered shortly afterwards, and found to have experienced some damage to the microstructure probes.

Sunday 30th November (Julian day 335)

We proceeded along the eastern transect with two CTD-only stations (45 and 46), during which the VMP's weight release unit and cable were replaced and the instrument's flat battery was re-charged. At stations 47 and 48, we conducted joint CTD / VMP deployments. In the latter, the VMP's weight release mechanism failed again and the profiler hit the sea bed. A tense 10 hours of waiting followed, after which the VMP initiated its ascent and was recovered. During the wait, we carried out an ISW profiling exercise (station 48) and an electronic re-termination of the CTD cable.

Monday 1st December (Julian day 336)

The day commenced with two CTD casts at stations 49 and 50, which culminated the ascent to the crest of a zonally elongated ridge extending eastward from the Kerguelen Plateau. In that time, the VMP was taken apart and both the main and weight release batteries replaced by new ones. This fixed the failures of the weight release mechanism. Three successful joint CTD / VMP casts (stations 51 to 53) were conducted above the ridge's crest in what remained of the day.

Tuesday 2nd December (Julian day 337)

We concluded the eastern transect with CTD / VMP station 54, above the eastern flank of the Kerguelen Plateau, and steamed for 4 hours to the first station of the central transect. We kicked off this transect with a shallow CTD / ISW station (55), and continued with two further CTD / VMP stations (56 and 57) before temporarily interrupting the transect to recover the U.K. moorings.

Wednesday 3rd December (Julian day 338)

We arrived in the mooring area after first light in this day, and spent many of the daylight hours recovering the three moorings. Upon completing the recovery, we steamed southward to pick up the transect work again with CTD / VMP stations 58 and 59.

Thursday 4th December (Julian day 339)

We continued the central transect with three CTD / VMP stations (60, 61 and 62) in the vicinity of the ridge feature by which the moorings had been deployed. This work was interjected by a multibeam survey of the western flank of the ridge, the rest of which had already been surveyed during mooring deployment operations.

Friday 5th December (Julian day 340)

We proceeded northward along the central transect, in the same fair seas that were characteristic of the preceding fortnight. We conducted CTD / VMP stations 63, 64 and 65,

and a CTD-only station (66) to allow the VMP battery to charge up.

Saturday 6th December (Julian day 341)

The day commenced with CTD / VMP station 67. The VMP's weight release failed inexplicably, and the instrument landed on the seabed where it spent 6 hours. During the wait, we conducted a set of ISW profiles. Toward the end of the day, we recovered the VMP and moved on to the next station (68), where we did a CTD-only deployment.

Sunday 7th December (Julian day 342)

We opened the day with a CTD / VMP deployment at station 69, where once more the VMP's weight release failed and the instrument got stuck in the sea bed. After 10 hours, the VMP started to rise and was subsequently recovered. Due to the mysterious nature of the weight release failures and the little science time remaining, we decided not to deploy the VMP again during this cruise. The day concluded with CTD-only station 70.

Monday 8th December (Julian day 343)

The last CTD of the central transect (71) was conducted in the early hours of this day. Upon recovery, we started making our way to Cape Town in fair weather.

Tuesday 9th December (Julian day 344)

We kept steaming northwestward toward Africa. It was a fairly quiet day, with many of the scientists taking the opportunity to recuperate and adjust to life without watches. The drop keel was retracted, and underway salinity sampling ceased.

Wednesday 10th December (Julian day 345)

We kept steaming in fair seas. We deployed the GDP drifter 83359.

Thursday 11th to Saturday 13th December (Julian days 346 to 348)

Some uneventful days went by, steaming toward Africa amongst cruise reporting, data calibration and scientific talks.

Sunday 14th December (Julian day 349)

Scientific activities were interrupted in order to celebrate a Christmas lunch in stunningly calm seas. This day felt like the first proper break in the entire cruise.

Monday 15th December (Julian day 350)

Steaming toward Africa continued in rougher seas. The last ISW profiling exercise of the cruise (station 72) was conducted, and GDP drifter 83358 was deployed.

Tuesday 16th December (Julian day 351)

The last over-the-side instrument (ISW) was dismantled and put away. Steaming continued in fair seas.

Wednesday 17th December (Julian day 352)

We deployed the last GDP drifter (83356) while continuing our steam back to Cape Town.

Thursday 18th December (Julian day 353)

Steaming continued in benign weather, amongst cruise reporting and related work.

Friday 19th December (Julian day 354)

We continued steaming toward Africa in fair seas. Data back ups were started. At the end of the way, an end-of-cruise barbeque was celebrated on deck as we were entering

the African continental shelf.

Saturday 20th December (Julian day 355)

We had the first sight of land since leaving Cape Town 50 days before. Back up and cruise reporting operations continued.

Table 1: Complete log sheet of events for JC029.

Station number	Julian day	Date	Time (GMT)	Latitude	Longitude	Depth (m)	Activities
1	308	03-Nov	14:49	37° 44'S	24° 47'E	3900	ISW deployed (test station). SADCP keel retracted at end of station.
	309	04-Nov	15:12	39° 25'S	30° 11'E	4254	Drifter 83355 magnetic strip removed at 09:00, then deployed.
	310	05-Nov	19:11	40° 30'S	36° 00'E	3860	Drifter 83344 magnetic strip removed at 15:00, then deployed at 19:11. CSIRO Argo float 3975 deployed.
	311	06-Nov	20:21	41° 36.7'S	42° 00.3'E	2460	Drifter 83341 clock synchronised at 16:00, then deployed.
	312	07-Nov	03:24	41° 54.8'S	43° 40.7'E	2975	Deployed CSIRO Argo float 3676.
2	312	07-Nov	12:14	42° 14.9'S	45° 33.3'E	3300	CTD test at station 002 with mooring releases.
	312	07-Nov	16:02	42° 20.8'S	46° 00.1'E	3500	Deployed CSIRO Argo float 3977.
	313	08-Nov	06:02	42° 58.1'S	49° 31.1'E	3147	Deployed drifter 83343.
3	313	08-Nov	07:49	43° 01.1'S	49° 47.5'E	2730	Test VMP cast to 250 m.
4	313	08-Nov	13:00	43° 09.85'S	50° 39.00'E	3255	Test CTD cast to 2000m with LADCP and mooring releases.
	313	08-Nov	20:11	43° 24.63'S	51° 59.87'E	3600	CSIRO Argo float 3978 deployed.
	314	09-Nov	06:00	43° 46.4'S	54° 08.2'E	3957	Deployed drifter 83340.
5	314	09-Nov	10:08	43° 56.8'S	55° 06.0'E	4154	VMP test station to 800m.
	314	09-Nov	16:02	44° 07.00'S	56° 00.18'E	4468	CSIRO Argo float 3979 deployed.
	315	10-Nov	07:06	44° 50.4'S	60° 11.8'E	4760	Deployed drifter 83342.
	316	11-Nov	10:00	45° 52.866'S	66° 20.208'E		Deployed drifter 83357.
6	317	12-Nov	09:59	46° 31.96'S	71° 52.679'E	1900	VMP deployment to 1900 m depth. Microtemperature sensor 2 needs to be replaced before next cast.
6	317	12-Nov	13:12	46° 31.963'S	71° 52.682'E	1900	CTD deployed.
7	318	13-Nov	02:54	46° 31.66'S	71° 53.626'E	1840	UK (short-term) northern mooring deployed.
7	318	13-Nov	10:03	46° 31.372'S	71° 54.842'E	1900	ISW deployed.
8	318	13-Nov	16:56	46° 33.460'S	71° 49.386'E	1400	Various CTD / LADCP / TowYO deployments.
8	319	14-Nov	01:34	46° 32.417'S	71° 55.049'E		UK (short-term) central mooring deployed.
9	319	14-Nov	08:30	46° 31.8178'S	71° 53.4706'E	1992	UK (short-term) eastern mooring deployed.
9	319	14-Nov	15:27	46° 33.68'S	71° 50.35'E	1330	VMP to 1421 dbar.
9	319	14-Nov	15:44	46° 33.70'S	71° 50.443'E	1370	CTD deployed.
10	319	14-Nov	19:26	46° 34.4910'S	71° 56.9833'E	2540	VMP to 2502 dbar.
10	319	14-Nov	19:36	46° 34.5204'S	71° 57.0243'E	2530	CTD deployed.
11	319	14-Nov	23:37	46° 33.0'S	71° 54'E	2306	ISW deployed.
	320	15-Nov	03:28	46° 33.7834'S	71° 51.4655'E	2000	AUS (long-term) mooring 1 (2000 m) deployed.
	320	15-Nov	09:57	46° 34.50'S	71° 56.9529'E	2500	AUS (long-term) mooring 2 (2500 m) deployed.
12	322	17-Nov	01:33	47° 16.319'S	67° 30.119'E	417	CTD deployed.
12	322	17-Nov	02:26	47° 16.333'S	67° 30.127'E	417	VMP deployed.
13	322	17-Nov	07:00	46° 58.15'S	67° 14.2285'E	586	CTD deployed.
13	322	17-Nov	08:12	46° 58.1493'S	67° 14.2277'E	586	VMP to 544 dbar.
14	322	17-Nov	12:05	46° 40.140'S	66° 58.430'E	751	CTD deployed.
14	322	17-Nov	13:32	46° 40.149'S	66° 58.429'E	750	VMP to 713 dbar.
15	322	17-Nov	17:15	46° 26.4608'S	66° 46.2135'E	1040	VMP deployed with short brushes. No CTD as LADCP was being removed from CTD frame.
16	322	17-Nov	19:57	46° 21.2195'S	66° 43.0660'E	1319	VMP deployed.
16	322	17-Nov	20:06	46° 21.236'S	66° 41.706'E	1424	CTD deployed with sound velocity probe.

Station number	Julian day	Date	Time (GMT)	Latitude	Longitude	Depth (m)	Activities
17	322	17-Nov	23:43	46° 17.030'S	66° 37.966'E	1730	CTD deployed. Sound velocity probe removed before deployment.
	323	18-Nov	02:02	46° 16.85'S	66° 37.82'E	1730	EM-APEX float (3760) deployed.
	323	18-Nov	02:47	46° 12.13'S	66° 34.03'E	2122	SOLO float (2823) deployed.
18	323	18-Nov	03:37	46° 09.065'S	66° 31.510'E	2240	CTD deployed – no attachments.
18	323	18-Nov	06:16	46° 09.0'S	66° 31.50'E	2240	VMP deployed in thick fog.
	323	18-Nov	09:13	46° 07.86'S	66° 33.96'E	2226	Iridium float 5346 deployed.
	323	18-Nov	11:50	45° 55.39'S	66° 22.71'E	2438	EM-APEX float 3761 deployed.
19	324	19-Nov	05:26	45° 51.0'S	66° 20.0'E	2810	VMP deployment only, no CTD due to swell.
20	324	19-Nov	10:58	45° 47.876'S	66° 17.754'E	3183	VMP to 3184 dbar.
20	324	19-Nov	11:07	45° 47.870'S	66° 17.741'E	3183	CTD deployed.
	324	19-Nov	15:55	45° 42.71'S	66° 13.04'E	3360	SOLO float 2825 deployed.
21	324	19-Nov	17:30	45° 35.88'S	66° 02.608'E	3704	CTD deployment only, no VMP due to suspected moisture in shear probes (investigation in progress).
	324	19-Nov	17:34	45° 35.80'S	66° 02.760'E	3708	Iridium float 5345 deployed.
	324	19-Nov	22:17	45° 27.41'S	65° 54.630'E	4269	SOLO float 2826 deployed.
22	325	20-Nov	00:05	45° 18.82'S	65° 46.987'E	4276	ISW deployed while waiting for VMP to be reassembled.
22	325	20-Nov	01:40	45° 18.985'S	65° 46.08889'E	4276	VMP and CTD deployed.
	325	20-Nov		45° xxxx'S	65° xxxx'E		EM-APEX float 5952 deployed.
23	325	20-Nov	09:19	45° 0.668'S	65° 31.334'E	4442	CTD deployed, no VMP due to insufficient charge ($\sim$ 11.98 V).
24	325	20-Nov	17:17	44° 42.636'S	65° 15.527'E	4510	VMP and CTD deployed.
	325	20-Nov	22:20	44° 44.03'S	65° 17.560'E	> 4000	SOLO float 2827 deployed.
25	326	21-Nov	11:05	44° 17.492'S	65° 41.022'E	4609	VMP to 4648 dbar – longer expected dive time due to RDF missing, therefore falling more slowly.
25	326	21-Nov	11:21	44° 17.509'S	65° 41.011'E	4610	CTD deployed, after small delay in CTD deployment due to CLAM (winch control) issue.
	326	21-Nov	17:22	44° 16.67'S	65° 43.11'E	4610	SOLO float 2828 deployed.
26	327	22-Nov	14:53	44° 09.997'S	66° 23.401'E	4529	VMP deployed to 4565 dbar without the RDF, so will fall more slowly.
26	327	22-Nov	19:35	44° 09.886'S	66° 23.787'E		Searching for VMP – moving 2 cables (sim200 m) N, S, E, W of central location.
	327	22-Nov	23:50	44° 09.86'S 66°	24.460'E	4552	SOLO float 2829 deployed.
27	328	23-Nov	03:58	44° 03.504'S	67° 03.776'E	4433	VMP deployed. Dive terminated early due to suspected low battery voltage – instrument charging before data can be recovered from it.
27	328	23-Nov	04:10	44° 03.600'S	67° 03.920'E	4444	CTD deployed.
	328	23-Nov	08:13	44° 03.76'S	67° 04.560'E	4460	Iridium float 0056 deployed.
	328	23-Nov	09:55	43° 59.78'S	67° 24.62'E	4398	SOLO float 2830 deployed.
28	328	23-Nov	11:58	43° 56.260'S	67° 45.302'E	4262	CTD deployed, no VMP due to insufficient battery voltage (12.1 V).
	328	23-Nov	15:44	43° 56.62'S	67° 45.40'E	4287	Deployed EM-APEX float 3950 (first of three with memory problems).
	328	23-Nov	18:00	43° 53.87'S	68° 07.27'E	3796	CSIRO Argo float 2954 deployed.
29	328	23-Nov	21:50	43° 49.149'S	68° 26.785'E	4033	CTD deployed prior to EM-APEX float 3951 deployment; the CTD wire birdcaged, now changed.
29	329	24-Nov	03:27	43° 49'S	68° 26'E	4033	ISW deployed.
	329	24-Nov	03:38	43° 49.28'S	68° 26.65'E	4031	EM-APEX float 3951 deployed (some problems with floats).
29	329	24-Nov	05:16	43° 49.33'S	68° 26.9'E	4025	VMP to 4021 dbar – start delayed due to insufficient charge; charge more then deployed after CTD.
	329	24-Nov	11:48	43° 46.14'S	68° 43.55'E	4033	CSIRO APEX float 3639 with optode oxygen sensor deployed.
	329	24-Nov	12:18	43° 45.11'S	68° 49.97'E	3712	EM-APEX float 4051 (last of 3 with memory problems) deployed.
30	329	24-Nov	13:58	43° 41.8611'S	69° 08.33343'E	3748	CTD deployed, no VMP due to insufficient charge.

Station number	Julian day	Date	Time (GMT)	Latitude	Longitude	Depth (m)	Activities
31	329	24-Nov	21:33	43° 34.915'S	69° 49.46'E	4060	CTD and VMP deployed; VMP to 4057 dbar.
32	330	25-Nov	06:10	43° 35.733'S	70° 35.233'E	3984	VMP to 4000 dbar.
32	330	25-Nov	06:20	43° 35.757'S	70° 35.211'E	3990	CTD deployed.
	330	25-Nov	11:44	43° 32.07'S	70° 35.54'E	4037	EM - APEX float 3764 deployed (good float).
33	330	25-Nov	16:10	43° 48.789'S	71° 21.889'E	3714	CTD deployed, no VMP due to low battery charge (VMP fully charged at 19:25).
	330	26-Nov	19:42	43° 47.72'S	71° 20.55'E	3663	Iridium float 5334 deployed.
	330	26-Nov	22:01	43° 55.26'S	71° 44.48'E	3850	SOLO float 2834 deployed.
34	331	26-Nov	00:30	44° 01.872'S	72° 08.678'E	3780	CTD deployed.
34	331	26-Nov	00:19	44° 02.363'S	72° 09.816'E	3766	VMP deployed.
35	331	26-Nov	05:20	44° 00.90'S	72° 13.15'E	3780	CSIRO Argo float 3638 (with oxygen).
35	331	26-Nov	12:37	44° 11.794'S	73° 00.943'E	3770	VMP to 3756 dbar.
35	331	26-Nov	12:47	44° 11.910'S	73° 01.119'E	3584	CTD deployed.
36	331	26-Nov	21:36	44° 27.881'S	73° 40.720'E	3673	CTD deployed, no VMP as battery not fully charged.
37	332	27-Nov	05:01	44° 39.133'S	74° 19.765'E	3640	VMP to 3626 dbar.
37	332	27-Nov	05:11	44° 39.187'S	74° 19.829'E	3657	CTD deployed - hit bottom.
38	332	27-Nov	13:46	45° 00.16'S	74° 47.27'E	3780	VMP to 3770 dbar.
38	332	27-Nov	13:54	45° 00.161'S	74° 47.268'E	3780	CTD deployed.
39	332	27-Nov	21:30	45° 23.90'S	74° 45.34'E	3746	VMP to 3729 dbar.
39	332	27-Nov	21:40	45° 23.91'S	74° 45.35'E	3746	CTD deployed.
40	333	28-Nov	04:47	45° 47.363'S	74° 42.414'E	3246	VMP to 3273 dbar - safety allowance set to zero until pressure offset is worked out.
40	333	28-Nov	05:00	45° 47.4'S	74° 42.4'E	3295	CTD deployed.
41	333	28-Nov	11:56	46° 11.4978'S	74° 40.3696'E	3726	CTD deployed, no VMP due to insufficient charge.
42	333	28-Nov	18:16	46° 35.37'S	74° 37.22'E	3475	VMP deployed - pressure safety set to zero based on CTD pressure vs VMP pressure plots.
42	333	28-Nov	18:27	46° 35.403'S	74° 37.321'E	3479	CTD deployed - spool problem when hauling back; lowered CTD to re-spool.
43	334	29-Nov	02:34	46° 59.253'S	74° 34.378'E	3430	VMP deployed - hit bottom at 04:21; triangulated position : 46° 59.275'S 74° 34.881'E
43	334	29-Nov	02:42	46° 59.268'S	74° 34.715'E	3449	CTD deployed and bottles not sampled; VMP dilemmas + fire drill = forgot!
43	334	29-Nov	11:42	46° 59.283'S	74° 34.917'E	3440	ISW deployed.
44	334	29-Nov	13:51	46° 59.540'S	74° 34.027'E	3440	Along-jet + cross-jet CTD tow-yo centred at VMP position.
45	334	29-Nov	21:58	47° 17.957'S	74° 18.576'E	3364	CTD deployed, no VMP due to repairs.
46	335	30-Nov	03:16	47° 29.184'S	74° 10.29'E	3240	CTD deployed, no VMP due to repairs and charging.
47	335	30-Nov	07:37	47° 30.890'S	74° 10.016'E	2690	VMP to 2605 dbar.
47	335	30-Nov	07:45	47° 30.910'S	74° 10.044'E	2652	CTD deployed; noisy - needs new termination.
48	335	30-Nov	12:23	47° 31.797'S	74° 09.091'E	2175	VMP to 2079 dbar in very steep slope; VMP on bottom at 13:36; VMP off bottom at 23:33.
48	335	30-Nov	12:32	47° 31.799'S	74° 09.099'E	2120	CTD deployed.
48	335	30-Nov	19:13	47° 31.81'S	74° 09.15'E	2261	ISW deployed.
49	336	01-Dec	01:30	47° 32.652'S	74° 07.9'E	1539	CTD deployed.
50	336	01-Dec	05:08	47° 41.7925'S	74° 0.143'E	1066	CTD deployed.
51	336	01-Dec	09:38	47° 47.476'S	73° 30.107'E	1260	VMP to 1153 dbar.
51	336	01-Dec	09:46	47° 47.526'S	73° 30.219'E	1309	CTD deployed.

Station number	Julian day	Date	Time (GMT)	Latitude	Longitude	Depth (m)	Activities
52	336	01-Dec	15:04	47° 57.038'S	73° 00.058'E	1230	VMP to 1122 dbar.
52	336	01-Dec	15:08	47° 57.03'S	73° 00.00'E	1229	CTD deployed.
53	336	01-Dec	19:45	47° 57.007'S	72° 30.0197'E	950	VMP deployed.
53	336	01-Dec	19:54	47° 57.005'S	72° 30.013'E	1006	CTD deployed.
54	337	02-Dec	00:31	47° 59.979'S	72° 0.071'E	837	CTD deployed - last CTD in closure against Kerguelen Plateau.
54	337	02-Dec	02:00	47° 59.97'S	72° 00.07'E	837	VMP deployed.
55	337	02-Dec	07:39	47° 38.644'S	71° 15.061'E	222	CTD deployed.
55	337	02-Dec	08:43	47° 38'S	71° 15'E	222	ISW deployed.
56	337	02-Dec	12:40	47° 18.177'S	71° 27.695'E	585	VMP to 491 dbar.
56	337	02-Dec	13:34	47° 17.857'S	71° 27.899'E		CTD deployed.
57	337	02-Dec	16:47	47° 14.831'S	71° 27.575'E	1240	VMP to 1132 dbar.
57	337	02-Dec	16:56	47° 14.855'S	71° 27.565'E		CTD deployed.
58	338	03-Dec	16:18	47° 07.057'S	71° 34.498'E	1860	VMP to 1788 dbar.
58	338	03-Dec	16:25	47° 07.090'S	71° 34.484'E	1825	CTD deployed.
59	338	03-Dec	20:25	47° 02.289'S	71° 38.814'E	1260	VMP to 1199 dbar.
59	338	03-Dec	22:17	47° 02.82'S	71° 40.61'E	1419	CTD deployed.
60	339	04-Dec	02:22	46° 47.992'S	71° 48.212'E	1741	CTD deployed.
60	339	04-Dec	04:46	46° 48.00'S	71° 48.196'E	1740	VMP to 1575 dbar.
61	339	04-Dec	11:00	46° 31.745'S	71° 53.685'E	2020	VMP to 1922 dbar.
61	339	04-Dec	11:15	46° 31.754'S	71° 53.701'E	2026	CTD deployed.
62	339	04-Dec	20:30	46° 31'S	71° 49'E	1750	VMP deployed.
62	339	04-Dec	20:40	46° 31.60'S	71° 49.2'E	1720	CTD deployed.
63	340	05-Dec	01:04	46° 23.68'S	71° 58.8'E	2420	CTD deployed.
63	340	05-Dec	00:58	46° 23.61'S	71° 58.63'E	2450	VMP deployed.
64	340	05-Dec	05:36	46° 20.54'S	72° 04.54'E	3145	VMP to 3049 dbar.
64	340	05-Dec	05:49	46° 20.629'S	72° 04.588'E	3397	CTD deployed.
65	340	05-Dec	11:34	46° 06.977'S	72° 12.691'E	3312	CTD deployed.
65	340	05-Dec	13:22	46° 08.016'S	72° 13.276'E	3310	VMP deployed.
66	340	05-Dec	19:37	45° 52.12'S	72° 22.10'E	3480	CTD deployed.
67	341	06-Dec	02:45	45° 31.8'S	72° 35.12'E	3693	CTD deployed.
67	341	06-Dec	02:36	45° 31.79'S	72° 36.15'E	3671	VMP deployed - hit the bottom at 4:40; started up at 10:38.
67	341	06-Dec	10:03	45° 32'S	72° 35'E	3671	ISW deployed.
68	341	06-Dec	18:02	45° 11.384'S	72° 47.657'E	3889	CTD deployed.
69	342	07-Dec	00:24	44° 55.130'S	72° 58.064'E	3784	CTD deployed.
69	342	07-Dec	04:33	44° 55.6'S	72° 58.1'E	3784	ISW deployed.
69	342	07-Dec	00:17	44° 55.13'S	72° 58.08'E	3749	VMP deployed - hit bottom at 2:30, 3785 dbar; started coming up again after 10 hours; not charged for Dougal's battery checks - data still need to be retrieved.
70	342	07-Dec	14:40	44° 38.032'S	73° 08.428'E	3798	CTD deployed.
71	342	07-Dec	20:49	44° 22.212'S	73° 18.480'E	3651	CTD deployed.
	344	10-Dec	06:07	42° 01.12'S	68° 42.06'E	4230	Drifter 83359 deployed.
69	350	15-Dec	06:02	38° 07.14'S	42° 37.14'E	3650	Drifter 83358 deployed.
69	350	15-Dec	08:12	38° 04.0'S	42° 19.0'E	3200	ISW deployed.
72	352	17-Dec	07:04	36° 89.0'S	29° 14.35'E	3650	Drifter 83356 deployed.

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

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2.1 CTD Operations and Calibration Procedures

Sixty-five Conductivity-Temperature-Depth (CTD), 24-bottle rosette stations were occupied during cruise JC029 (Table 2). Table 3 refers to significant events that occurred during a CTD station, prior to and / or after the station. These included two test casts with acoustic releases (CTD002 and CTD004). CTD008 was a full-depth tow-yo with 4 complete profiles. CTD044 was a shallow tow-yo in deep water with two profiles, the first to 500 m and the second to 1500 m. Hence a total of 69 CTD profiles were obtained. The stations were occupied along the various transects around the study area (Fig. 2). All casts used the 24-way stainless steel frame. There were no major operational issues with the CTD suite during the cruise. However two RDI WH300 LADCPs (s/n's 5415 and 9192) failed due to flooding during the cruise. Failed instruments were replaced with spares prior to the subsequent cast.

2.1.1 24-way Stainless Steel CTD Frame

The stainless steel frame configuration was as follows:

- Sea-Bird *9/11 plus* CTD system with fin-mounted secondary sensors

- Sea-Bird SBE-32 24 way rosette pylon on NMF 24 way frame

- 24 by 10l custom OTE external spring water samplers

- Sea-Bird SBE-43 oxygen Sensor

- Chelsea MKIII Aquatracka fluorometer

- Chelsea MKII Alphatracka 25cm path transmissometer

- Wetlabs BBRTD 660nm backscatter sensor

- NMF LADCP pressure-case battery pack

Table 2: CTD stations occupied on JC029 / SOFINE cruise. The time, latitude, longitude and water depth are those recorded at the bottom of the CTD station, apart from stations 8, 34, 37 and 44. The maximum depth of CTD was calculated from pressure and latitude using the seawater routine sw_dpth.

station number	Bottom Julian day	Bottom d/m/t (GMT)	lat °'S	long °'E	max. press (dbar)	max. depth (m)	altimeter (m)	water depth (m)	surf. press offset (dbar)	No. samples
2	312	7/11/12:57	42 14.940	45 33.256	2022	1996		3226		12
4	313	8/11/13:45	43 09.85	50 39.00				3255	-0.143	12
6	317	12/11/14:20	46 31.96	71 52.68	1958	1933	10	1912	-0.012	24
8	318	13/11/16:56	46 33.46	71 49.39	1907	1883	25	1250	-0.085	24
9	319	14/11/16:28	46 33.702	71 50.767	1740	1718	15	1730	-0.091	18
10	319	14/11/20:27	46 34.472	71 57.389	2536	2500	10	2512	-0.072	24
12	322	17/11/01:51	47 16.319	67 30.118	414	410	7	417	+0.116	11
13	322	17/11/07:17	46 58.150	67 14.226	577	571		585	-0.309	14
14	322	17/11/12:32	46 40.139	66 58.429	742	735		753	-0.322	17
16	322	17/11/20:39	46 21.238	66 41.728	1356	1340	2	1348	+0.196	20
17	323	18/11/00:21	46 17.032	66 37.963	1745	1723	10	1730	+0.016	12
18	323	18/11/04:30	46 08.886	66 31.605	2268	2237	5	2241	+0.180	12
20	324	19/11/12:26	45 47.876	66 17.744	3233	3182		3183	-0.614	24
21	324	19/11/18:56	45 35.981	66 02.435	3765	3701	10	3701	-0.539	24
22	325	20/11/03:12	45 18.984	65 46.090	4357	4278	12	4276	+0.152	24
23	325	20/11/10:50	45 01.04	65 31.035	4531	4447	5	4439	-0.244	24
24	325	20/11/18:52	44 42.49	65 15.60	4603	4517	10	4520	-0.610	24
25	326	21/11/12:50	44 17.72	65 41.00	4689	4601	7	4607	-0.765	24
26	327	22/11/17:22	44 09.881	66 23.790	4615	4529	8	4538	-0.447	24
27	328	23/11/05:42	44 03.636	67 3.637	4523	4440	10	4440	+0.255	24
28	328	23/11/13:27	43 56.282	67 45.298	4350	4271	6	4249	-0.436	24
29	328	23/11/23:21	43 50.592	68 27.427	4095	4023	25	4050	+0.008	24
30	329	24/11/15:36	43 42.648	69 09.682	3915	3848	4	3789	-0.238	24
31	329	24/11/22:55	43 34.789	69 49.464	4258	4182	10	4190	+0.085	24
32	330	25/11/07:42	43 34.861	70 34.568	4064	3993	15	4010	-0.033	24
33	330	25/11/17:36	43 48.363	71 21.389	3782	3719	4	3714	-0.070	24
34	331	26/11/01:59	44 02.287	72 09.103	3794	3730		3780	-0.023	24
35	331	26/11/14:22	44 12.669	73 00.625	3811	3747	6	3754	-0.240	24
36	331	26/11/22:52	44 27.998	73 40.266	3719	3657	7	3666	-0.057	24
37	332	27/11/06:25	44 39.707	74 19.450	3720	3658	0	3657	+0.141	24
38	332	27/11/15:28	45 00.474	74 46.998	3819	3754	7	3762	-0.474	24
39	332	27/11/22:58	45 24.229	74 45.536	3804	3739	12	3760	+0.095	24
40	333	28/11/06:14	45 47.43	74 42.31	3330	3277	12	3295	+0.021	24
41	333	28/11/13:15	46 11.450	74 40.941	3780	3716	6	3730	+0.095	24
42	333	28/11/19:43	46 35.402	74 38.51	3534	3476	11	3496	+0.111	24
43	334	29/11/03:57	46 59.133	74 36.704	3447	3391		3405	+0.124	24
44	334	29/11/13:51	46 59.540	74 34.027				3440	-0.398	0
45	334	29/11/23:09	47 17.946	74 19.832	3385	3330	10	3368	+0.144	24
46	335	30/11/04:28	47 29.180	74 11.206	3258	3206	10	3219	+0.093	24
47	335	30/11/08:49	47 30.926	74 10.102	2712	2672	7	2678	+0.0163	24
48	335	30/11/13:34	47 31.799	74 09.098	2280	2249	8	2258	-0.019	24
49	336	1/12/02:17	47 32.656	74 07.944	1526	1508		1550	-0.414	24
50	336	1/12/05:41	47 41.795	74 00.143	1070	1058	7	1066	+0.138	24
51	336	1/12/10:30	47 47.53	73 30.296	1407	1391	5	1394	-0.256	18
52	336	1/12/15:49	47 56.965	73 00.082	1261	1247	7	1253	-0.612	18
53	336	1/12/20:24	47 56.934	72 29.959	1018	1007	10	1017	-0.094	14
54	337	2/12/00:59	47 59.975	72 00.070	839	830		840	-0.082	12
55	337	2/12/07:56	47 38.646	71 15.063	215	213	6	219	+0.022	7
56	337	2/12/14:11	47 17.857	71 27.485	617	611	7	617	-0.213	11
57	337	2/12/17:35	47 14.855	71 27.571	1244	1230		1242	+0.071	14
58	338	3/12/17:17	47 07.17	71 34.913	2014	1988	10	2000	-0.387	24
59	338	3/12/22:54	47 02.926	71 41.002	1428	1411	13	1419	-0.057	16
60	339	4/12/3:19	46 47.999	71 48.208	1768	1746	5	1741	-0.084	20
61	339	4/12/12:15	46 31.740	71 53.276	2015	1989	4	2004	-0.226	21
62	339	4/12/21:21	46 31.66	71 49.025	1774	1752	10	1760	+0.110	24
63	340	5/12/02:16	46 23.887	71 59.14	2690	2651		2650	+0.264	14
64	340	5/12/06:58	46 21.263	72 05.158	3149	3100	10	3109	+0.083	24
65	340	5/12/13:09	46 07.897	72 13.196	3374	3320	10	3309	+0.252	24
66	340	5/12/21:05	45 53.04	72 22.35	3524	3465	25	3480	-0.335	21
67	341	6/12/04:10	45 32.348	72 35.072	3742	3679	10	3603	+0.374	20
68	341	6/12/19:25	45 11.604	72 47.671	3972	3903	10	3915	-0.088	21
69	342	7/12/01:49	44 55.334	72 58.074	3836	3771	10	3784	+0.215	19
70	342	7/12/16:17	44 37.934	73 07.585	3906	3839	10	3832	-0.021	24
71	342	7/12/22:08	44 22.429	73 18.194	3737	3674	11	3684	+0.218	19

Table 3: Significant events before, during and after CTD stations.

Station	Comments
2	Test, All bottles fired at bottom
4	Test, All bottles fired at bottom
8	Tow-yo. Bottles fired on last upcast; bottles 10 and 11 leaked, bottle 20 failed to fire.
13	Bottle 11 did not seal properly
14	Bottle 9 failed to close
17	Bottle 6 leaked
18	Bottle 7 leaked
20	Altimeter failed
21	Altimeter fixed
24	Bottle 24 failed to close
26	Bottle 11 leaked
27	CTD hit the sea floor. Bottle 3 leaked
28	Bottles 20, 23 leaked
29	Large swell, electrical re-termination after cast
31	Bottle 9 leaked
34	Bottle 11 leaked
36	Bottles 1 and 10 leaked
37	Bottle 3 leaked
39	Bottle 6 leaked
40	Bottles 3 and 5 leaked
42	After firing bottle 4 had to lower CTD back to 3100 to correct problem with wire spool on drum
43	CTD watch standers forgot to sample Niskin bottles
44	Tow-yo
46	Bottle 9 leaked
47	Numerous deck error units on down cast. Large sections of downcast data in cnv file flagged as bad using cnv_flag.f
48	New electrical re termination after station
49	Bottle 2 leaked. New altimeter installed after station
50	Bottles 5, 10 and 24 leaked
51	Bottle 10 leaked
55	Bottle 10 leaked
57	Bottle 23 leaked
58	Bottles 13 and 14 leaked
59	Bottle 3 leaked
60	Bottle 11 leaked
65	Bottle 20 failed to fire
66	Bottle 3 leaked
64	Bio-foiling on secondary CTD sensors. Large off-set between secondary salinity and hydrographic salinity
70	Bottle 11 leaked

- NMF BB150 pressure-case battery pack

- RD Instruments Workhorse 300 KHz lowered ADCP (Downward-looking configuration)

- RD Instruments Workhorse 300 KHz lowered ADCP (Upward-looking configuration)

- RD Instruments Broadband 150 KHz lowered ADCP (Downward-looking configuration)

- Benthos 200kHz altimeter

- NMF 10kHz pinger (s/n B9)

The pressure sensor was located 35 cm below the bottom of the water samplers, and 122 cm below the top of the water samplers. The niskins were 87 cm in height between end-cap seals.

2.1.2 24-way Stainless Steel CTD Frame Instrument Configuration

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

- SBE *9 plus* Underwater unit s/n 09P-24680-0636

- Frequency 0-SBE 3P Temperature Sensor s/n 03P-4151 (primary)

- Frequency 1-SBE 4C Conductivity Sensor s/n 04C-2571 (primary)

- Frequency 2-Digiquartz Temperature Compensated Pressure Sensor s/n 83008

- Frequency 3-SBE 3P Temperature Sensor s/n 03P-2919 (secondary - fin mounted)

- Frequency 4-SBE 4C Conductivity Sensor s/n 04C-2450 (secondary - fin mounted)

- SBE 5T Submersible Pump s/n 05T-4166 (primary)

- SBE 5T Submersible Pump s/n 05T-2793 (secondary - fin mounted)

- SBE 32 Carousel 24 Position Pylon s/n 32-45661-0621

- SBE 11 plus Deck Unit s/n 11P-34173-0676 (CTD1 master)

- SBE 11 plus Deck Unit s/n 11P-24680-0589 (CTD2 slave)

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):

- V0 — SBE 43 Oxygen s/n 43-0363 (primary duct - 9+ mounted)

- V1 — Unused - obsolete oxygen temperature

- V2 — Chelsea MKIII Aquatracka Fluorometer s/n 088108

- V3 — Benthos PSA-916T Altimeter s/n 1040

- V4 — Unused - usually used for 2PI PAR

- V5 — Unused - usually used for 2PI PAR

- V6 — Chelsea MKII Alphatracka 25cm path Transmissometer s/n 161045

- V7 — Wetlabs BBRTD backscatter s/n 115R

The additional self-logging instruments were configured as follows:

- RDI Workhorse 300 KHz Lowered ADCP (downward-looking master configuration) s/n 9192. Failed on beam 3 during CTD025.

- RDI Workhorse 300 KHz Lowered ADCP (upward-looking slave configuration) s/n 5415 from cast CTD004 through to CTD010. Failed on beam 2 during CTD010.

- RDI Workhorse 300 KHz Lowered ADCP (spare) s/n 9191 used as upward-looking slave from casts CTD012 through to CTD014.

- RDI Workhorse 300 KHz Lowered ADCP (spare) s/n 9191 used as downward-looking master from cast CTD026 onwards.

- RDI Broadband 150 KHz Lowered ADCP s/n 1503 used as downward-looking slave - removed from frame from CTD016 through to CTD040.

The LADCPs were powered by the NMF BB150 battery pack s/n 02. Battery pack WH004 was also fitted to the CTD frame available as a spare, but was not used. Battery pack WH002 was also available as a spare. Additionally spare batteries were available for all battery packs.

A complete spare CTD suite including instruments was available for use but was not required.

2.1.3 Configuration

Date: 12/09/2008

Instrument configuration file:

C:/Program Files/Sea-Bird/SeasaveV7/JC029/Data/0636.CON

Configuration report for SBE *911plus/917plus* CTD

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

1) Frequency 0, Temperature
Serial number : 03P-4151
Calibrated on : 3 September 2008
G : 4.39934049e-003
H : 6.70093996e-004
I : 2.52816067e-005
J : 2.07999701e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity
Serial number : 04C-2571
Calibrated on : 26 August 2008
G : -1.02755078e+001
H : 1.59450900e+000
I : -4.98577960e-005
J : 1.08942486e-004
CTcor : 3.2500e-006

CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC
Serial number : 83008
Calibrated on : 10 Sep 08
C1 : -4.093335e+004
C2 : -1.005887e-001
C3 : 1.104120e-002
D1 : 3.017600e-002
D2 : 0.000000e+000
T1 : 2.992572e+001
T2 : -3.202788e-004
T3 : 3.724670e-006
T4 : 2.870340e-009
T5 : 0.000000e+000
Slope : 0.99995000
Offset : -1.45830
AD590M : 1.285350e-002
AD590B : -8.337660e+000

4) Frequency 3, Temperature, 2
Serial number : 03P-2919
Calibrated on : 3 Sept 2008
G : 4.31701294e-003
H : 6.44541613e-004
I : 2.28940162e-005
J : 2.15626966e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2
Serial number : 04C-2450
Calibrated on : 26 Aug 2008
G : -1.02002178e+001
H : 1.62513362e+000

I : -1.56700539e-003
J : 2.12152601e-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 : 43-0363
Calibrated on : 9 September 2008
Equation : Murphy-Larson
Coefficients for Owens-Millard:
Soc : 3.5000e-001
Boc : 0.0000
Offset : -0.6480
Tcor : 0.0003
Pcor : 1.35e-004
Tau : 0.0
Coefficients for Murphy-Larson: Soc : 3.23400e-001
Offset : -6.49200e-001
A : -4.25280e-004
B : 8.76010e-005
C : -2.11390e-006
E : 3.60000e-002
Tau : 1.13000e+000

7) A/D voltage 1, Free

8) A/D voltage 2, Fluorometer, Chelsea Aqua 3
Serial number : 088108
Calibrated on : 9 January 2008
VB : 0.174500
V1 : 2.092100
Vacetone : 0.198200
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

9) A/D voltage 3, Altimeter
Serial number : 1040
Calibrated on : March 2003
Scale factor : 15.000
Offset : 0.000

10) A/D voltage 4, Free

11) A/D voltage 5, Free

12) A/D voltage 6, Transmissometer, Chelsea/Seatech/Wetlab CStar
Serial number : 161045
Calibrated on : 8 September 2005
M : 24.0279
B : -0.4806
Path length : 0.250

13) A/D voltage 7, User Polynomial
Serial number : BBRTD-115R
Calibrated on : 13 May 2008
Sensor name : WETLabs Backscatter
A0 : -0.00034810
A1 : 0.00295000
A2 : 0.00000000
A3 : 0.00000000

2.1.4   24-way Stainless Steel CTD Frame Deployment Notes

Wetplug Y-cables

NMF Seabird 9+ CTD systems are in the process of being converted to 'wet-pluggable' style underwater connectors. This will improve the reliability of the systems, most notably in cold water. A reduction in the frequency of sensor spiking events is expected. The conversion to wet-pluggables also makes the Break-Out Box (BOB) pressure case redundant using Y-cables instead. During the first CTD cast it became obvious that the labelling of the Y-cable pairs was transposed. This transposes the even and odd

analogue channels. The CON file was edited to swap V2 with V3 and V6 with V7. Hence the altimeter, fluorimeter, BBRTD and transmissometer are not on the historically used channels. Please see the con file for clarification. The old con file was deleted and the new one copied over the existing CTD002.con. Hence there is only one con file which is the same for all casts. The wetplug connectors proved to be very reliable with no major spiking events. The fluorimeter and transmissometer cables were pulled and the connectors serviced after some spiky data in productive waters, but the spikiness was later determined to be real and not connectivity artefact. No other connectors required pulling for servicing during the cruise.

Comments on CTD deployment duration

It should be noted that due to the nature of the winch system on RRS *James Cook* the launch and recovery of the CTD takes somewhat longer than on RRS Discovery. However this is only of the order of 5-6 minutes for launch and about the same for recovery. There is also a delay of a few minutes whilst the winch system is switched from belly box control to lab control at approximately 100 m of wire out. It was estimated that the whole cast took about 10-15 min longer than on RRS Discovery. This should be set in the context of the wider operating envelope that the Cook has with weather compared to Discovery - during JC029 stations were worked in 40-50 kn of wind which would not be possible on Discovery. It should also be noted that due to the sheltered location of the CTD in the wetlab it is possible to steam straight off station whilst sampling the CTD in shelter. In higher sea states Discovery has to remain hove-to with the sea fine on the port-bow to provide shelter whilst the CTD is sampled.

CTD Wire Terminations

A new mechanical termination was completed after removing about 2 m of old wire and load-tested at the start of the cruise, and a new wet-pluggable electrical splice was made. One mechanical retermination was necessary when the wire bird-caged after jumping sheaves on the hydroboom on recovery of CTD029 - about 10 m of wire was removed. A new electrical splice had to be made prior to CTD049 due to flooding causing bad CTD telemetry during CTD047. Hence in total one complete retermination and one new electrical splice were required during the cruise.

Sensor Failures and Post-cruise Calibrations

There were no CTD sensor failures during the cruise excepting the anticipated problems with LADCP transducers developing bad beams and flooding.

The two 3p temperature, two 4c conductivity and one 43 dissolved oxygen sensors used during the cruise are to be returned to Seabird, Seattle for calibration post-cruise.

Altimetry

The Benthos altimeter worked very reliably, obtaining a good bottom return within 80 m of the bottom in low sediment areas and 35 m from the bottom when a lot of sediment was present. The NMF pinger was also used both as a backup and as a double check on proximity to the bottom.

The pinger was visualised using the old EA500 PES display from RRS Charles Darwin. In calm seas the CTD was worked to around 10 m from the bottom. This was increased to approximately 15 m from the bottom in swell. During shelf stations in large currents, it was not possible to work the CTD close to the bottom. When the vessel was in D.P. and using large amounts of thrust the acoustic noise made bottom tracking with the pinger impossible. Due to the relatively close proximity of the azimuth thruster to the drop keels, we suspect this has the biggest effect on sounding noise.

Comments on CTD bottom impact during CTD037

Prior to this cast the bottom was sounded on the EA600 at 3657 m (corrected). The CTD was deployed and after soaking at 10 m was veered to the changeover depth of 100 m where control was switched to the lab. The CTD was veered to 3600 m. As the wire out approached 3100 m a new sounding was taken with the EA600 placing the bottom at 3674 m. The CTD was stopped at 3600 m on 'autodepth' HMI control. The CTD was then veered in stages to 3630 m, during which the altimeter obtained a good bottom return of 55 m at 3615 m, and then 3660 m where the CTD was now 12 m from the bottom.

The final approach of 3665 m was then called by the CTD operator (an additional 5 m) to place the CTD 7 m from the bottom. As normal, the CTD operator observed the CLAM data on the 'green display' and the altimeter trace from the CTD. When the wire out on the green display passed 3665 m and the winch was still veering the CTD operator shouted the winch driver to stop. By the time the winch had stopped, the CTD had made contact with the bottom. By the time that the winch had started hauling the CTD had been in contact with the bottom for 30 s. The CTD was recovered at the end of the cast clean and with no damage.

A new SSoW for CTD near bottom operations was promulgated via the Master and posted by the CTD and winch stations. However there were subsequently numerous

times where conversations within the Main Lab were creating considerable distraction and compromising clear communication between the CTD operator and the winch driver. Hence I think that the siting of winch control in the middle of a busy working lab is inappropriate for the task in hand. The use of the winch cab and radio communication would be more appropriate.

Other comments

During CTD042 the upcast had to be terminated at ~ 2300 m and the CTD lowered back down to ~ 3100 m to remove badly scrolled wire on the storage winch.

When positioning the ship during concurrent CTD and VMP deployments, occasionally the winch had to be stopped due to excessive wire angle. There were also a few occasions where the winch had to be stopped due to D.P. dropouts.

Further Documentation

A sensor information sheet 'JC029 Sensor Information.doc' and calibration and instrument history sheets were included in the main cruise archive in electronic format (Adobe Acrobat and Microsoft Word). Original copies of all log sheets were supplied to the PSO in addition to the copies that NMF will retain and also supply to BODC.

2.2   Initial Processing using SeaBird Programs

The files output by Seasave (version 7.18) have appendices: .HEX, .HDR, .BL, .CON. The .CON files for each cast contain the calibration coefficients for the instrument. The .HDR files contain the information in the header of each cast file. The .HEX files are the data files for each cast, and are in hex format. The .BL files contain information on bottle firings of the rosette.

Initial data processing was performed on a PC using the Seabird processing software SBE Data Processing, Version 7.18. We used the following options in the given order:

- *Data Conversion*

- *Align CTD*

- *Cell Thermal Mass*

- *Filter*

- *Loop Edit*

- *Derive*

- *SeaPlot*

Data Conversion turns the raw data into physical units. It takes the .CON and .HEX files and outputs a file called c08291*nnn*.cnv, where c08291 is a reference to the cruise, (Cook, in 08, cruise no. 29, digit 1), and *nnn* is the station number. The surface soak was removed from the data at this point, and a surface pressure offset (obtained from the first ~30 readings) was applied to the .CON file, which was then saved as c08291*nnn*p.con. *Data Conversion* was also used to create a .nav file for each station, (c08291*nnn*.nav), with the Scan Counts and Latitude, Longitude and Julian Time for each Scan Count.

Align CTD takes the .cnv file and applies temporal shifts to align the sensor readings. The offsets applied were zero for primary and secondary temperature and salinity, as the CTD deck unit automatically applies the conductivity lag to the conductivity sensors and, 5 for oxygen.

Cell Thermal Mass takes the .cnv files output 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 mismatch. The constants used were: thermal anomaly amplitude $\alpha = 0.03$; 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.

Derive calculates primary and secondary salinity, and oxygen concentration. Thus the final version of each file c08291*nnn*.cnv contains the following output variables

- Scan Count

- Pressure, Digiquartz (db)

- Temperature (ITS-90, deg C) (primary temperature sensor)

- Conductivity (mS/cm) (primary conductivity sensor)

- Oxygen Voltage (SBE43) (raw oxygen sensor voltage output)

- Temperature, 2 (ITS-90, deg C) (secondary temperature sensor)

- Conductivity, 2 (mS/cm) (secondary conductivity sensor)

- Altimeter (m)

- Salinity (psu) (salinity calculated from primary T and C sensors)

- Salinity, 2 (psu) (salinity calculated from secondary T and C sensors)

- Oxygen, SBE43 (μmol/kg), window size 2.00 sec

- 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.

2.3   Rosette Water Sample Analysis

2.3.1   Salinometry

One NERC National Marine Facilities operated autosal 8400B salinometer (Guildline Instrument Ltd., serial number 68426) equipped with and Ocean Scientific International Ltd. (OSIL) peristaltic pump was used for the analysis of the Niskin bottle Rosette water samples. The salinometer was located in the controlled temperature laboratory and operated at 20-21°C room temperature. The conductivity cell was kept in a water bath at a constant temperature of 21°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, which then applied all necessary corrections and converted the reading into salinity values. The salinometer proved very reliable and stable throughout the entire sampling period with only a negligibly small drift between calibrations.

One Guildline Autosal 8400A and one 8400B salinometer were available for use having serial numbers 57738 and 68426. Unit s/n 68426 was used for all samples with unit s/n 57738 being reserved as a spare.

The main salinometer was located in the Constant Temperature (C.T.) lab and operated at 21°C bath temperature in 21°C ambient lab temperature. The CTD and underway samples were taken and run using the OSIL PC by the science party. The science party also processed the salinity data from the Autosal.

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 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, 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. At the beginning of each analysis, the salinometer was calibrated using OSIL IAPSO standard seawater batch P149 (K_{15}=0.99984, S=34.994). The calibration was repeated each time after analyzing a sequence of two crates ($\sim$48 bottles) and at the end of each analyzing period to check if the instrument was drifting. It was not required to apply manual corrections to the data since the instrument was drifting only a negligibly small amount between calibrations and continuously delivered a consistent and stable output. 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 period of 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. In total 1209 salinity samples were taken from the CTD Niskin bottles and analyzed.

2.4 CTD temperature and conductivity calibration

Pre-cruise calibrations were applied to the temperature, conductivity, pressure, and oxygen sensors. Post-cruise calibration of the oxygen sensor is planned and final assessment of quality of oxygen data will be assess after this calibration.

Calibration of the CTD conductivity sensors with bottle salinity samples was undertaken using a suite of fortan and matlab programs provided by Mark Rosenberg, Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC), University of Tasmania, Hobart, Australia. Prior to the cruise all programs were modified based on presumed data inputs and formats. Minor modification to these programs were needed due to slight format change in SeaBird header data in the ∗.cnv files. The calibration of the primary and secondary conductivity sensors were carried out by comparing the upcast CTD burst data with the hydrology data obtained from the analysis of the water samples. The calibration coefficients were then applied to the entire CTD data and 2 dbar averaged salinity, temperature and oxygen data are produced from the downcast data, apart from station 8 and 44 tow-yo stations and station 47. The conductivity calibration follows the method of Millard and Yang (1993). For groups of consecutive stations, a conductivity slope and bias term are found to fit the CTD conductivity; a linear station-dependent slope correction is applied to account for calibration drift of the CTD conductivity cell. Data from the entire cast are used to determine the conductivity calibration.

The following steps summarise the conductivity calibration procedure:

1. Create a file (∗.ros) of burst CTD data from the upcast part of the ∗.cnv file, using bottle firing scan numbers from ∗.bl file. The ∗.ros file contains bursts of 10 seconds of CTD data (i.e. 240 data points from the 24 Hz ∗.cnv file). The data in the ∗.ros file are centred on the scan number of each bottle fire. Program: *sberosform.f*; input: *∗.cnv* and *∗.bl*; output: *∗.ros*

2. Average the upcast CTD burst from the ∗.ros. Program: *sbebtlformnew.f*; input: *∗.ros*; output: *∗.btl*.

3. Create primary and secondary pseudo CTD bottle files for all stations from the individual stations ∗.btl files. The output files are primary CTD bottle data - calib1.dat and, secondary CTD bottle data - calib2.dat. The calib1.dat and calib2.dat files must contain 24 pseudo bottle entries for each station. Finally the calib1.dat and calib2.dat files are copied into subdirectories primary and secondary, respectively, and all subsequent calibration steps are preformed on both the primary and secondary files. Program: *calibform.f*; input: *∗.btl*; output: *calib1.dat* and *calib2.dat*.

4. Merge the pseudo CTD primary (calib1.dat) and secondary (calib2.dat) bottle data with the hydrographic salinity bottle data. The bottle salinity is contained in the a comma separated ascii file (c0829.csv). Each station contains 24 lines with the following information per line: station number, rosette position, niskin number, pressure, salinity sample bottle number, salinity. The salinity of the bottle sample was obtained from the Guildline automated salinometer located in the temperature controlled room. The program that merges the pseudo CTD with the bottle salinity data checks the pressure of the CTD data and bottle salinity data are the same within the error of the on-deck CTD pressure offset (poff.lis). Misaligned pressure results in an error warning. The pressure error between the two data sources was investigated and corrected. All pressures error were the result of incorrect hydrographic bottle salinity pressure either due to wrong pressure recorded on log sheet or transcription of log sheet information to c0829.csv file. Program: *merge_ excel_ sbe.f*; input: *calib1/2.dat, c0829.csv, poff.lis*, output: *calib1.dat:01* or *calib2.dat:01*, for primary or secondary CTD sensors, respectively.

5. An iterative process was undertaken to determine and if appropriate remove bottle salinity outliers. In the first instance large outliers were removed. These bad bottle salinity samples were associated with samples from either leaking niskin bottles or those surface samples taken on the fly in significant swell conditions. The next iteration removed smaller outliers and resulted in a CTD salinity - bottle salinity standard deviation significantly less than 2×10^{-3}psu. Program: *bottlezap.f*; input: *calib1/2.dat*; output: *calib1/2.dat:01*. Diagnostic programs to determine bottle outliers used were: *calplot_ sbe.f* and *histdiffsbe.f*.

6. Conductivity calibration coefficients were calculated for the primary and secondary conductivity sensors following Millard and Yang (1993). Stations were grouped together based on overall trends shown in ratio of CTD conductivity and hydrography sample. Three files are produced for each station grouping: grp*.rej is a file with rejected bottles that lie outside 2.8 times the standard deviation of the scatter; grp*.res contains a list of retained bottle samples used in calibration of conductivity cell and; grp*.his is the calculated calibration coefficients for each station within the station grouping. These rejected bottle data were within the steep salinity gradient regions. These were removed from the data used to calculate the conductivity calibration coefficients. Program: *new_ cal_ sbe.f*; outputs: *grp*.rej, grp*.res, grp*.his*

7. The derived conductivity coefficients are applied to the pseudo CTD bottle data. Program *calhist_ sbe.f*; output: *histcal1/2.lis.*

8. The pseudo CTD bottle data and hydrography salinity samples are converted to matlab. Programs: *sbebotmatform0829.f* and *sbematform0829.m*; output: *botform.out* and *c0829bot_ primary(secondary).mat.*

9. Gather the calibration coefficients from the different station grouping contained in grp∗.his into a single file. Program: *findccoeff.f*; input: *grp∗.his*; output: *coeff.dat*.

10. Produce a calibrated 24 Hz CTD data file by applying the conductivity coefficients to the ∗.cnv files. Program: *ccalnew.f*; inputs: *coeff.dat* and ∗.*cnv* files; outputs: ∗.*cnn*.

11. Create the calibrated 2 dbar-averaged downcast CTD station data. The temperature and conductivity data are averaged within each bin and these average values assigned to the exact even pressure value at the centre of each bin. Salinity is then calculated for each bin using the average temperature and salinity and central pressure. Program: *aver_ sbenew.f*; input: ∗.*cnn*; output: ∗.*all*.

12. A matlab file of the 2 dbar-averaged downcast CTD data is produced. Programs: *sbematform0829.f* and *sbematform0829.m*; input: ∗.*all*; outputs: *matform.dat*, *headinfo.dat* and *c0829_ primary(secondary).mat*.

Calibration of both the primary and secondary sensor were completed. The primary sensor was very stable over the entire cruise. Primary sensor calibrated conductivity and bottle salinity data standard deviation of 9.68×10^{-4} was achieved (Fig 3). The secondary conductivity sensor was fouled on Station 64 leading to a marked offset between CTD salinity and bottle data. The sensor was cleaned for subsequent stations but a larger scatter to bottle data persisted when compared to the primary conductivity sensor. The primary sensor was used to derive the conductivity calibration coefficients and these were applied to both the primary and secondary conductivity sensors.

Matlab was used to create section plots of potential temperature, salinity and geostrophic velocity distribution for various transects (Fig. 4, Fig. 5 and Fig. 6). The topography in these figures is NOT an accurate representation - it is simply based on the measured water depth at each station, and was included to improve the appearance of the figures.

On the western, eastern and central transects in figure 6, positive velocity is in the expected direction of the mean flow, i.e. approximately eastwards. On the northern and southern transects, positive velocity is approximately northwards. (Approximately because geostrophic velocity is found perpendicular to the line of stations, so is not precisely eastwards or northwards for these transects.)
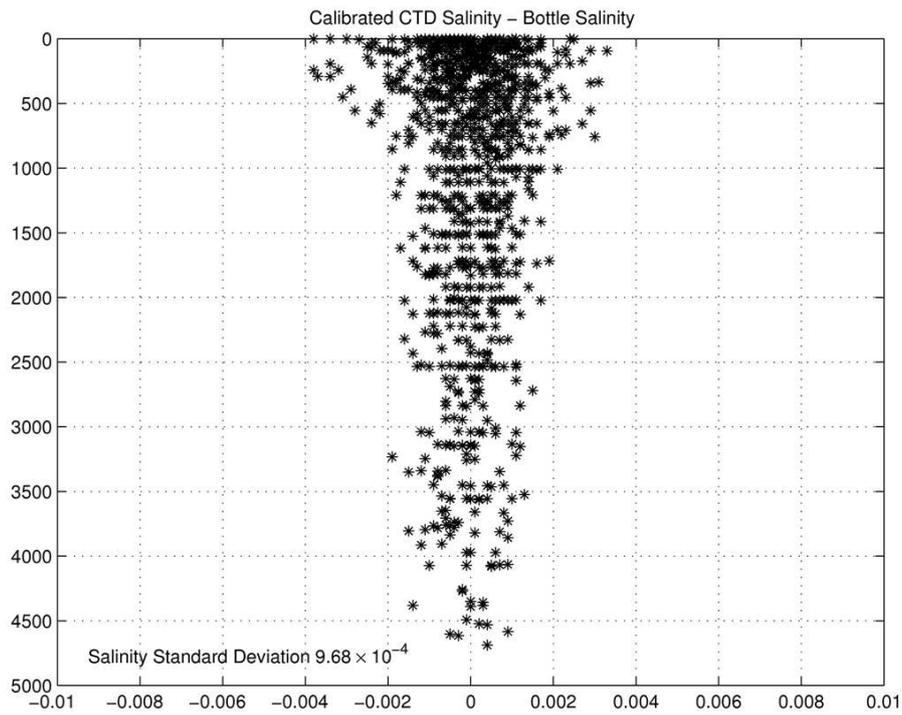
Figure 3: CTD salinity minus bottle salinity samples. Calibration coefficients were determined from the primary CTD sensor.
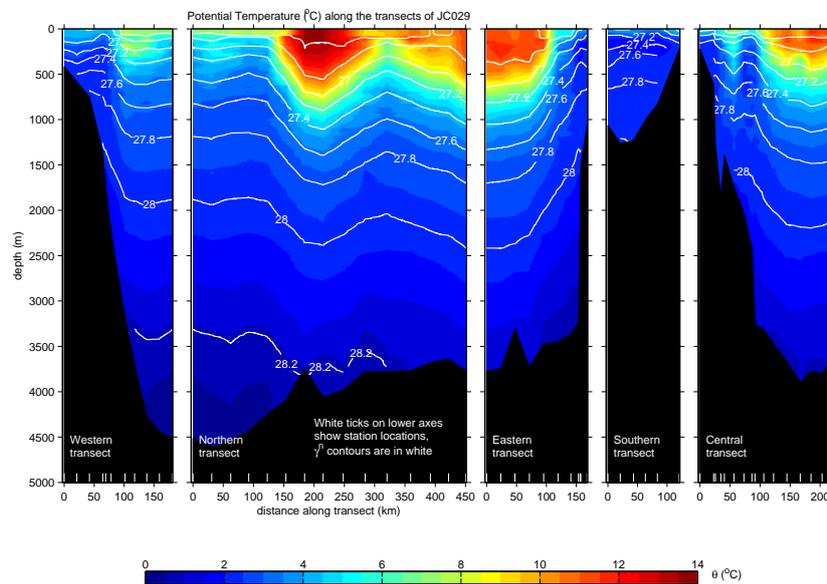
Figure 4: CTD potential temperature (^{o}C, colour) and neutral density (white contours) along the JC029 CTD transects.
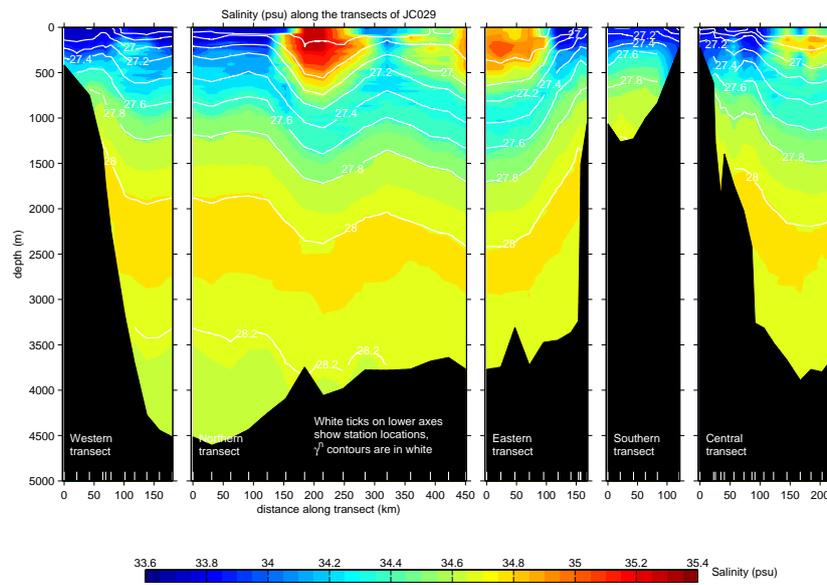
Figure 5: CTD salinity (colour) and neutral density (white contours) along the JC029 CTD transects.
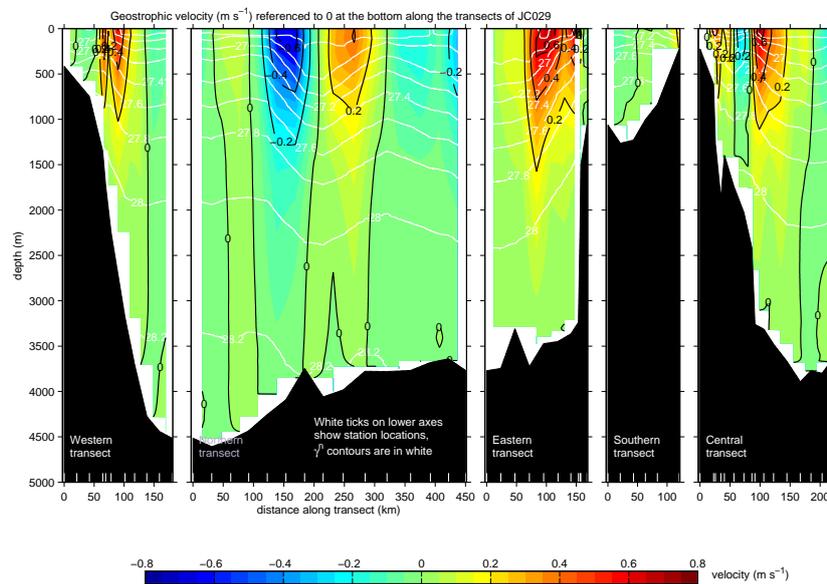
Figure 6: Geostrophic velocity (m/s) relative to the deepest common level across the JC029 CTD transects.

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

David Stevens, Andrew Dawson, Jennifer Graham, Dougal Mountifield

3.1 JC29 Operations

The LADCP package used during JC29 consisted of the existing National Oceanography Centre (NOC) RDI 150 kHz BroadBand (BB) ADCP (downward looking, Phase III, with transducers mounted at 20° from the vertical) and two RDI 300 kHz Workhorse ADCPs looking down (WHM) and looking up (WHS). The BB was mounted at the centre of the rosette frame, below the rosette mechanism, the WHM was mounted off-centre at the bottom of the frame, and the WHS, was mounted outside the main frame. The details of their sampling configurations are briefly described in section 3.2. 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.

3.1.1 Station Summary of LADCP Operations

Table 4 lists serial numbers and command files used at different stations.

Stations 4 and 6 were test casts and were not full depth. Therefore there is no bottom tracked data.

The BB data from the test casts were poor. This was confirmed during consultations with Dr Brian King at NOC. The instrument does not receive a very strong return signal. This was not unexpected as this instrument has a chequered history. It was tried again at station 14 and stations 41 and 43 (after a number of components had been tested and replaced by Dougal Mountifield). It is possible that the tuning board is faultly. Our recommendation is that this instrument needs very careful scrutiny.

The Workhorses suffer failure on repeated pressure cycling. The WHS failed on station 10 (it had a weak beam from station 6) and the WHM failed on station 25 (beam 3 failed and it was wet inside). A decision was made to just use a single WHM from station 16 to conserve instruments for the following three cruises.

At station 32 a ping rate of 0.5 seconds was tested. This became the default from station 35.

Stations 8 and 44 were 'To-Yo' stations. Each 'To-Yo' consisted of 4 down and up casts. The numbering convention 1nn, 2nn, 3nn, 4nn, where nn is the station number, was used for each pair of down and upcast.

Table 4: Station Summary of LADCP Operations.

Station numbers	LADCPs	Command files
4	WHM (s/n 9192)	WHM_JC029.CMD
	WHS (s/n 5415)	WHS_JC029.CMD
	BB	BBS_JC029.CMD
6	WHM (s/n 9192)	WHM_JC029.CMD
	WHS (s/n 5415)	WHS_JC029.CMD
8 (108, 208, 308, 408)	WHM (s/n 9192)	WHM_JC029.CMD
	WHS (s/n 5415)	WHS_JC029.CMD
9, 10	WHM (s/n 9192)	WHM_JC029.CMD
12	WHM (s/n 9192)	WHM_JC029.CMD
	WHS (s/n 9191)	WHS_JC029.CMD
14	WHM (s/n 9192)	WHM_JC029.CMD
	WHS (s/n 9191)	WHS_JC029.CMD
	BB	BBS_JC029.CMD
16-18, 20-25	WHM (s/n 9192)	WHMNS_JC029.CMD
26-31	WHM (s/n 9191)	WHMNS_JC029.CMD
32	WHM (s/n 9191)	WHMNSP5_JC029.CMD
33, 34	WHM (s/n 9191)	WHMNS_JC029.CMD
35,40	WHM (s/n 9191)	WHMNSP5_JC029.CMD
41	WHM (s/n 9191)	WHM_JC029.CMD
	BB	BBS_JC029.CMD
42	WHM (s/n 9191)	WHMNS_JC029.CMD
43	WHM (s/n 9191)	WHM_JC029.CMD
	BB	BBS_JC029.CMD
44 (144, 244, 344 444)	WHM (s/n 9191)	WHMNSP5_JC029.CMD
45-50	WHM (s/n 9191)	WHMNSP5_JC029.CMD
51		LADCP did not deploy
52-71	WHM (s/n 9191)	WHMNSP5_JC029.CMD

Deployment Comments

The LADCPs were not run on the first CTD cast (CTD002) as the battery was not charged.

Three members of the science party were trained to use the RDI LADCPs and after the first few casts they routinely set up the ADCPs for deployment and downloaded data after each cast.

Prior to each deployment 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.

Then the following commands were sent:

PS0 - to check that the deck cables were connected to the correct unit TS? - time set, offset from GPS clock noted and time reset if greater than a few seconds. RS? - to check flashcard space and re ErAse if necessary PA and PT200 - pre-deployment and built in self tests

A few minutes before the CTD was deployed the command files were sent and BBtalk file logging stopped. Deployment and end of pinging times were recorded on the rough log sheets.

After pinging was stopped, the number of deployments in the recorder was queried with RA? And the most recent file downloaded in the default RDI-xxx.000 name format. The broadband was downloaded using RYxxx with the default filename of Bddhhxxx.553, where dd is the deployment day and hh is the hour that logging was stopped. The file was then renamed to the form CTDxxxm.000 for the master and CTDxxxs.000 for the slave. All filenames were noted on the rough log sheets.

The broadband battery was fully charged at 55 V until it was drawing 100 mA between each cast. Every 10-15 casts the battery was vented. Mid-cruise it was discovered that the VMP intelligent battery chargers were not maintaining their stated constant current charge rate of 1.5 A. Subsequently the LADCP bench power supply was used for charging the VMP at 1 A. Charging the VMP was given priority and hence the BB150 battery pack was not always fully charged between casts.

During CTD010 the upward looking slave LADCP s/n 5415 failed. The unit was dismantled and evidence of a low pressure leak via the transducer potting was found. The unit was replaced with s/n 9191 from CTD012 to CTD014 when the use of Workhorses was reduced to one downlooking unit to mitigate against beam failures.

During CTD025 the downward looking master WH300 s/n 9192 failed. Once again the unit was dismantled and as before evidence of a low pressure leak via the transducer potting was found. The unit was replaced with s/n 9191 that had previously been used as an upward looking slave.

Both failed LADCPs are to be returned to TRDI San Diego post-cruise for repair. A further unit, s/n 10629 (titanium), remains available onboard as a spare.

3.2   JC29 LADCP Configuration Files

The following LADCP configuration files were used by default during JC29. The files combined existing NMF and JR80 (derived from RRS Charles Darwin cruise 139) configurations as the use of three instruments simultaneously is unusual. When more than one instrument was used they were synchronised so that the WHM ping 0.5 s after the BB and WHS. From station 16 the single WHM used the configuration file *WHMNS_JC029.CMD*.

3.2.1   BroadBand Configuration (*BBS_JC029.CMD)*

```
CR1 CF11101 EA00000 EB00000 ED00000 ES35 EX11101 EZ0011101
WM1 WD111100000 WF1600 WN016 WP00001 WS1600 WV250 BP0 CX1
TE00:00:01.00 TP00:00.00 WL0,4 WC056 WB1 BP000 CK CS
```

This water-track configuration uses 16 16-m bins per ping, a 16 m blank after transmit and an ambiguity velocity of 2.5 m s^{-1}. It pings 0.5 s before the WHM.

3.2.2   Workhorse Master Configuration (*WHM_JC029.CMD*)

```
PS0 CR1 CF11101 EA00000 EB00000 ED00000 ES35 EX11111 EZ0011101
LW1 LD111100000 LF0500 LN016 LP00001 LS1000 LV250 SM1 SA001
SW05000 TE00:00:01.00 TP00:00.00 CK CS
```

This water-track configuration uses 16 10 m bins per ping, a 5 m blank after transmit and an ambiguity velocity of 2.5 m s^{-1}. It has a ping cycle of 1 s.

3.2.3   Workhorse Slave Configuration (*WHS_JC029.CMD*)

```
PS0 CR1 CF11101 EA00000 EB00000 ED00000 ES35 EX11111 EZ0011101
LW1 LD111100000 LF0500 LN016 LP00001 LS1000 LV250 SM2 SA001
ST0 TE00:00:01.00 TP00:00.00 CK CS
```

This water-track configuration uses 16 10 m bins per ping, a 5 m blank after transmit and an ambiguity velocity of 2.5 m s^{-1}. It pings 0.5 s before the WHM.

3.2.4 Workhorse Configuration (No Slave) (*WHMNS_ JC029.CMD*)

```
PS0 CR1 CF11101 EA00000 EB00000 ED00000 ES35 EX11111 EZ0011101
LW1 LD111100000 LF0500 LN016 LP00001 LS1000 LV250 SM0
TE00:00:01.00 TP00:00.00 CK CS
```

This water-track configuration uses 16 10 m bins per ping, a 5 m blank after transmit and an ambiguity velocity of 2.5 m s^{-1}. It has a ping cycle of 1 s.

3.2.5 Workhorse Configuration (No Slave, 0.5 s pings) (*WHMNSP5_ JC029.CMD*)

```
PS0 CR1 CF11101 EA00000 EB00000 ED00000 ES35 EX11111 EZ0011101
LW1 LD111100000 LF0500 LN016 LP00001 LS1000 LV250 SM0
TE00:00:00.50 TP00:00.00 CK CS
```

This water-track configuration uses 16 10 m bins per ping, a 5 m blank after transmit and an ambiguity velocity of 2.5 m s^{-1}. It has a ping cycle of 0.5 s.

3.3 Instructions For LADCP Deployment and Recovery

These instructions, provided by Dougal Mountfield, are for use in conjunction with the LADCP log sheet included in the present report.

3.3.1 Deployment

Connect the communication and battery leads for instruments to be deployed. The BB should be connected to the COM1 port, the WHM to the COM7 port and the WHS to the COM8 port.

1. In the controlling PC, use **BBTALK**. Press <F3> to create a log file in which all subsequent BB-related BBTALK output will be stored. Enter filename of the

form *C:\Documents and Settings\Administrator\My Documents\LADCP\JC029\ WH{Master/Slave}\CTD###{m/s}.txt* (where *###* is the station number).

2. 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.

3. Make sure the LADCP is communicating at 9600 baud by typing *CB411*.

4. Check the LADCP clock against the the scientific clock. Type *TS?*<ENTER> for the LADCP time. If the times differ by more than 1 s, reset the LADCP clock by typing *TSYYMMDDhhmmss*<ENTER>.

5. Check the available memory of the LADCP by typing *RS?*<ENTER>. If insufficient memory is available, clear it by typing *RE ErAsE*<ENTER>. The memory should only be cleared after all data has been transferred to the processing machine(s) and checked.

6. Type *PT200*<ENTER> 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*<ENTER> for further checks.

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

8. Press <F2> and enter the name of the LADCP configuration file.

9. Press <F3> to stop logging.

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

3.3.2 Recovery

Remove blanks and attach the communication and charger cables.

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

2. Switch on the charger.

3. Type *PS0*<ENTER> to check communications.

4. Type *CB711*<ENTER> to set the baud rate to 57600.

5. Type *RA?*<ENTER> to check the number of deployments.

6. 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).

7. Type *CB411*<ENTER> to set the baud rate back to 9600 and power down by typing *CZ*<ENTER>.

8. Rename the default file names to *CTD###.000*

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

3.4 LADCP Processing

The data from each instrument is processed separately, thus providing independent estimates of full-depth velocity profiles. This gives an indication of the quality of instrument when compared with other LADCPs and the VMADCPs. In principle, combining data sets at the processing stage may be conducive to more accurate velocities. This is an issue that can be investigated in the future.

The primary tool used in processing each of the LADCP data sets during JC29 was the software originating from Eric Firing's group at the University of Hawaii (UH). The software package (and a great deal of advice on its use) was provided by Brian King of NOC. The Visbeck software from Lamont-Doherty Earth Observatory (version 7b) is used for obtaining bottom tracked profiles.

The LADCP processing sequence (common to all instruments) during JC29 is outlined below.

3.4.1 Initial UH Processing Stage

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/JC029/LADCP* to ∼*/jc29/ladcp/uh/raw /jc0811/ladcp*. We followed the conventional nomenclature at NOC (i.e. *jsss_cc.000*, where sss is the 3-digit station number; cc is 01 for the BB, 02 for the WHM, and 03 for the WHS). This was achieved by symbolic links. Alternatively cd ∼*/jc29/ladcp* and type *sh cpln_ladcp.sh sss* to do the above by script.

1. Source the file $\sim/jc29/uh/LADalljc0811$ to set up the software.

2. After typing $cd \sim/jc29/uh/pro/jc0811/ladcp/proc$, type $perl$ $-S$ $scan.prl$ sss_cc to scan the raw data and create a station-specific directory structure in the $proc/casts$ directory. Check that the details of the cast (depth, downcast/upcast times) agree approximately with those in the LADCP log sheet.

3. Enter station position information and get mag var correction by typing $putpos2$ sss cc. This updates $stations.asc$ and $magvar.tab$ (using **Matlab**). Note that $magvar.m$ is only valid between 1900 and 2005. Here we are assuming the errors due to magnetic variation is much smaller than all other errors.

4. Type $perl$ $-S$ $load.prl$ sss_cc. Reply 'y' at both prompts. This loads the raw data, correcting for $magvar.tab$, to start processing. 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 ($\sim/jc29/uh/pro/jc0811/ladcp/proc/casts/jsss\_cc/scdb$) first.

5. Type $perl$ $-S$ $domerge.prl$ $-c0$ sss_cc to merge 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.

6. cd $Rnav$ and type $updatesm.exec$ to update the nav file (calls **Matlab**). Then return to the $proc$ directory (cd - or cd $proc$).

7. In **Matlab**, set the variable $plist = sss.cc$ and run do_abs to calculate relative velocity profiles. Check that there is a reasonable agreement between the downcast and upcast profiles, and that the vertical velocity is of order 1 m s^{-1} and reverses sign between the downcast and upcast. Resize the axes for figure 3 and type do_abs_plot to send figures to printer.

3.4.2 Calculating Absolute Velocity Profiles With UH Software

Obtaining a final absolute velocity profile requires the incorporation of CTD information into the processing.

8. The inclusion of CTD data permits a revision of the LADCP velocity profile according to more accurate estimates of depth and sound velocity. A file containing 1 Hz CTD data (calibrated and de-spiked) from both the downcast and upcast must be created for each station and LADCP in $\sim/jc29/uh/raw/jc0811/ctd$. This

should contain the variable *ctd*, which must have 4 columns in the following order: 1) time (Julian day expressed in s); 2) pressure; 3) temperature; and 4) salinity. In JC29, 24 Hz data from the Seabird CTD were binned to 1 Hz using the **Matlab** script *readctd*.

9. Type *cd Pctd* and run *ctd_in(sss,cc)* in **Matlab** to read the 1Hz CTD data in. Still in **Matlab**, type *cd ∼/jc29/uh/pro/jc0811/ladcp/proc/Fitd*, set *plist=sss.cc* and run *fd* to align the LADCP and CTD data sets in time. This can be done in an automatic or an interactive mode.

10. Back in *cd ∼/jc29/uh/pro/jc0811/ladcp/proc/* type *perl -S add ctd.prl sss_cc* to add CTD data to the **.blk* LADCP files in the *scdb* directory.

11. Run *perl -S domerge.prl -c1 sss_cc*. The option *-c1* states that we now have CTD data.

12. Finally, in **Matlab**, set *plist = sss.cc* and run *do_abs* to calculate the final absolute velocity profiles.

3.4.3   Processing With Visbeck Software

Provide additional symbolic links in the ∼/jc29/uh/raw/jc0811/ladcp directory to *JC29Msss.000* and *JC29Ssss.000* for the WHM and WHS respectively.

1. *cd ∼/jc29/ldeo/jc0811*

2. Start **Matlab** and type *sp*. At the prompts enter station number and *whmvisbt*. This sets up for the processing step.

3. Next type *lp* to process the WHM.

4. Type *visplot* to send plots to printer.

When CTD are available the processing automatically uses it. The required format of the CTD data is common for Visbeck and UH processing. The **Matlab** command *readctd* in the raw ctd directory reads a 24 Hz **.cnn* file and produces the correct format 1 Hz data. Re-run the steps above, but use *whmvisbtctd* as the identifier to distinguish the output.
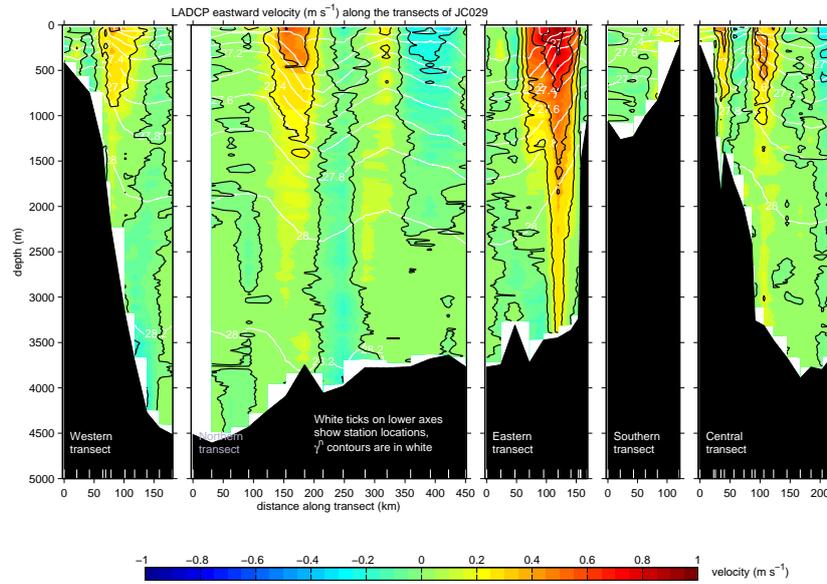
Figure 7: LADCP eastward velocity (m s^{-1}, colour) and neutral density (white contours) along the JC029 CTD transects.
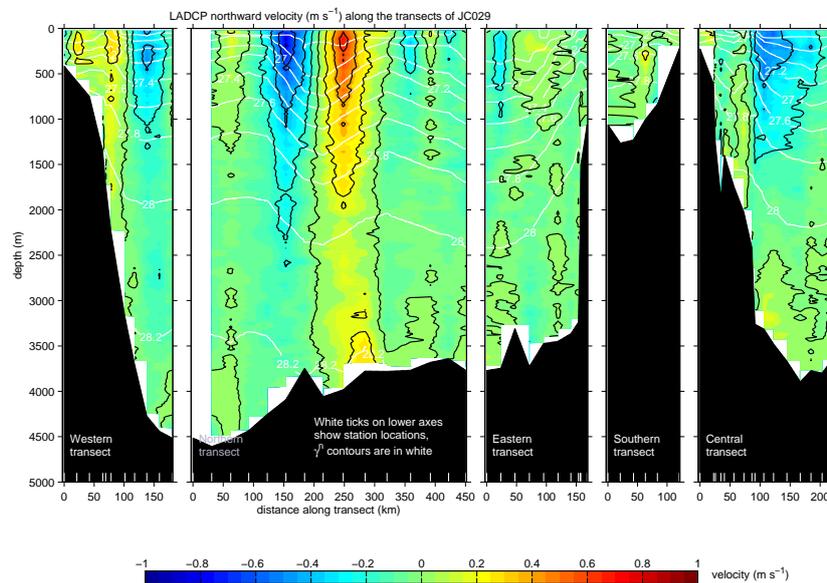
Figure 8: LADCP northward velocity (m s^{-1}, colour) and neutral density (white contours) along the JC029 CTD transects.

4 VMP-5500 Operations and Measurements

Kurt Polzin, Stephanie Waterman, Alberto Naveira Garabato, Dougal Mountifield and Bernadette Sloyan

4.1 Cruise narrative

The Vertical Microstructure Profiler (VMP-5500) is a novel scientific instrument manufactured by Rockland Scientific International that measures profiles of temperature, conductivity and velocity microstructure (i.e. on the length scales of the dissipation of turbulent flows, typically a few millimetres to tens of centimetres) throughout the water column. The VMP-5500 is at the heart of the science of the Southern Ocean Finestructure (SOFine) project.

We joined the ship in Cape Town, South Africa, on 2 November 2008, for the northern flank of the Kerguelen Plateau. The VMP-5500 was assembled during 3-5 November. Over-the-side operations commenced on 8 November and included a check for gross buoyancy (the instrument floated without weights) and a short (250 m) profile to test the performance of the weight release mechanism (it fired and the weights dropped). A second test cast was conducted on 9 November using drag elements trimmed so as to reduce drag and increase the fall rate. A fall rate of 0.58 m s^{-1} was obtained, an increase over the 0.48 m s^{-1} with the standard drag elements. Forty seven (47) VMP deployments were accomplished as part of a total 71 scientific stations. Weather and sea state were essentially as expected for this location and season, occasionally becoming severe enough to prevent VMP-5500 operations. Several deployments were conducted with winds in excess of 30 knots and sea states judged excessive for deployment of the CTD. Primary limitations on the operational use of the VMP-5500 were battery charge issues (7 missed stations and additional station time used waiting for sufficient charge levels [$\sim$ 12 hours]) and downtime associated with profiler refurbishment after bottom impacts (of which there were five, resulting in 8 missed stations and additional station time used waiting for profiler surfacing [44 hours]).

Deployment/recovery operations used the aft crane and a custom cradle at the outset. The cradle was designed to mechanically raise the profiler into an upright position prior to being hoisted with the crane. The intent was to alleviate manhandling of the profiler. It proved difficult to get the profiler into the cradle on a rolling deck and the mechanical lift mechanism required 5 minutes to operate by hand. The custom cradle and aft crane deployment/recovery were abandoned in favor of deployment and recovery from the hydro-boom amidships.

4.2 Technical remarks on the VMP-5500

Configuration

The VMP-5500 s/n 016 was deployed with 2 microshear probes, 2 microtemperature probes, one microconductivity probe, one Seabird 3F fast temperature sensor (s/n 4634), one Seabird 4C conductivity sensor (s/n 3240) and the Rockland Geo-ElectroMagnetic Current Meter (GEMCM). Internally there was also a 3 axis accelerometer and 3 axis magnetometer.

Seabird sensors 3F-4969 and 4C-3490 were available as spares but were not deployed.

Deployment and Recovery

A new launch and recovery frame had been developed prior to JC029 to move the VMP from the horizontal storage attitude to its vertical deployment attitude. However this system proved unworkable partially due to the time it took to winch it up and down, but most notably the difficulty in safely landing the VMP in the cradle on a rolling and pitching vessel.

The VMP was subsequently deployed and recovered using the centre 'trolley' section of the cradle as securing frame on the starboard waist just aft flush hatch and using the aft Rotzler winch on the starboard gantry. The VMP was deployed using a sling around the tail bale and released with a Seacatch. It was recovered using a large aluminium pole with large 'clip-stick' snap shackles made fast to a polyprop pickup line. Apart from the reduced vessel motion at the midships gantry this location also kept the profiler away from thruster wash and prevented it going out of sight under the stern flare.

This method required somebody to steady the nose whilst the profiler was being picked up and set down on the trolley. This increases the risk of damaging the nose mounted sensors or injuries to personnel and also puts significant bending load on the main joint between the nose and tail assembly (two bolts popped from the dovetail tabs during the cruise). The consequences of this joint failing would be serious injury to personnel or loss of the nose section of the profiler. The trolley was useful in that on the occasion where the VMP was deployed mid-CTD it could be easily wheeled down to the after deck for deployment using the after pedestal crane. The trolley also allowed the VMP to be easily moved into the hangar or wetlab for servicing during bad weather. Further thought needs to be given to assisting deployment and recovery of the VMP.

Acoustic Telemetry

Whilst submerged the profiler was tracked using an LBL telemetry system consisting

of:

Ixsea TT801 deck unit s/n 013 (with firmware modification for pressure telemetry)

Ixsea Model MT861S-R-P1 LBL Acoustic Transponder with Pressure Sensor S/N 196

This allowed the slant range to the beacon and also the pressure to be determined. Hence the horizontal range from the ship could be calculated. The VMP was deployed and once it had accelerated to its profiling velocity and was clear of the vessel, the CTD was deployed. The 75 kHz and 150 kHz VMADCPs were used to estimate the VMP drift direction and magnitude. The bridge were given the horizontal range to the VMP every 10-15 min and tried to keep the range between 300 and 800 m. When the VMP was near the bottom it was 'pinged' more frequently to catch turnaround. When the VMP was a few hundred metres from the surface the bridge were given more frequent updates. Only on one occasion was it necessary to take evasive action to increase the range to the VMP shortly before surfacing.

Recovery Aids

A flag on a mast was used with the following recovery aids:

Seimac Ltd Novatech Model ST-400A Strobe S/N U03-042 Seimac Ltd Novatech Model RF-700A1 RDF Beacon S/N U03-040 Seimac Ltd Novatech Model AS-900A Argos Beacon S/N V01-053 ID 74853

During the cruise the RDF beacon failed and the only spares available were on a band that was incompatible with the DF handset. The loss of the RDF made minimising the range to the VMP at surfacing critical.

The Argos positons received via email at surface largely had the lowest quality status of 1, but were occasionally 2. Only once did we receive a position fix with the highest quality status of 3. A few fixes with a status of 1 were compared to the actual recovery location and errors of the order of 50 nm were seen. It is believed that with longer time in the water the fixes will improve in quality, but this needs to be assessed in a trials situation.

If the acoustic transponder could be located such that it was still submerged when the profiler was on the surface, it would further assist ranging for recovery.

Pressure Calibration Coefficient Error

The square term in the pressure sensor calibration coefficients were found to be incorrectly signed as positive in the Rockland documentation. This resulted in pressure

over-reading on deep casts and therefore downcasts were terminated early missing up to 70 m of near bottom water. The coefficients for channel 10 (without pre-emphasis filter) should be:

$$P = -16.2 + 0.29495 * N_{10} - 2.263 * 10^{-7} * N_{10}^2 \text{ [dbar]}$$

Deck Cable

The supplied deck cable was insufficiently long for use on a large ship. An extra 10 m was spliced into one deck cable to provide adequate length. Longer deck cables should be made prior to the next use of the VMP system - about 25 m would be ideal.

Corrosion and Endcap Sealing

The nose section pressure case and nose cone is constructed from aluminium with stainless steel end caps. This interface of dissimilar metals is creating advanced corrosion rates. Most of the anodizing on the end faces of the pressure case has bubbled away and the pitting is now encroaching upon the o-ring location. This seal is a single o-ring face seal at both ends of the pressure case. I would suggest remanufacture of the end-caps from anodized aluminium to mitigate corrosion and the addition of a single piston seal as a backup. The face seal should be retained. The tension rod threads are already suffering from galling even with the liberal application of Tef-Gel. Sufficient spares of the rod ends should be acquired - these may need replacing after every cruise.

Nose Guard Mounting

The nose guard is also manufactured from stainless steel and is mounted to the nose cone bulkhead. This is putting all the load from manual handling onto the o-ring face, most notably rotation. It is also providing further corrosion sites where it touches the main pressure case. I would recommend remanufacture from anodized aluminium and mounting it to the main pressure case instead of the end cap.

Nose/Tail Mechanical Interface

The mechanical arrangement for mounting the nose section to the tail section is adequate when the profiler is in a vertical attitude, but is unsuitable and may be dangerous when under the bending loads that is sees as the profiler is moved between horizontal and vertical attitudes. The use of a bayonet style arrangement is unnecessary. The thin aluminium dovetail plates suffer corrosion at the threads because of the stainless steel fasteners even with liberal use of Tef-Gel. The bending loads at deployment and recovery then cause the bolts to pull through the threads resulting in weakening of the joint. It is recommended that a more secure arrangement without a bayonet fit is developed using larger bolts with more thread engagement.

Main System Battery

The 110 VAC supply intelligent charger originally supplied with the VMP and also the 240 VAC replacement of the same specification do not maintain constant current of 1.5 A as expected. This increased the charging time and often did not fully charge the battery even though the charger had switched to constant voltage 'float' charge. The 60 V, 1 A bench used for charging the LADCP battery was subsequently used.

There was insufficient information in the VMP manual regarding the total supply current of the VMP system as deployed, but it was estimated to be of the order of 0.8 A. When charging at 1 A, this roughly equates to 1hr charging required for each hour powered up. This was impractical during a hydrographic section in 4000 m of water with 20 nm station spacing, so stations had to be dropped to allow the VMP battery to fully charge. A 15 V, 2.5 A charger has already been purchased at the NOC for future use with the VMP. This should yield charge times of about 2hrs after a 5000 m profile.

During the time that the VMP was on the bottom after failing to release its drop weights the battery continued to run down and terminal voltages of 3 V were seen upon recovery. This deep discharge then required even longer charging time to allow the pack to recover. It is strongly recommended that a system be installed that completely isolates the main battery when its terminal voltage falls to 10.5-11 V to prevent deep discharge. The use of a battery technology that tolerates deep discharge should also be investigated.

The main battery was swapped with a fully charged spare during the cruise as it was suspected that its performance had deteriorated. However after removal the battery was placed on charge and monitored. The removed pack was found to be within specification.

Release Battery

The release battery was also swapped with a fully charged spare after repeated problems with release failure. However, this was also checked afterwards and found to be within specification. The manufacturer's datasheet states a maximum discharge current of 1 A, and yet the Rockland sheet on the release mechanism states that the solenoid current is 4 A. I suspect that the terminal voltage of the release battery is collapsing when the solenoid is energised thus severely limiting the solenoid current and compounding release problems. This is confirmed by the presence of large negative spikes in the main battery voltage when the solenoid is fired. I would recommend changing the release battery for a larger capacity model with much higher maximum discharge current rating.

The Rockland datasheet on the release system states that the release battery is charged at 0.25 A by the release board. When charging a discharged release battery with a bench power supply I found that after the initial inrush current that the battery would not

pull much more than 100 mA so I am sceptical about the charging rate of 250 mA. This has implications for assumptions about charging time for the release battery. There were no drawings/circuit diagrams for the release board in the manual so these figures could not be confirmed. It is recommended that a means of monitoring the state of the release battery is provided without having to dismantle the VMP.

External Battery Arrangement

Due to the large overhead (one person 8-10 h) in dismantling and reassembling the VMP to change batteries, the use of an external pressure case with both main and release batteries in should be investigated for future use. There is potential for this to be installed between the nose end-cap and the nose cone if pass-through wiring is incorporated for the nose sensor cables.

Release Mechanism and Release Logic

Several on-deck tests confirmed that the release mechanism is very sensitive to shear loads on the piston shaft. On one release it is possible to bind the bearings with finger pressure across the shaft. The release mechanism already reduces the force of the line tension ($\sim$ 10 lbs) by approximately 5 fold ($\sim$ 2 lbs) where it engages with the end of the piston shaft. The force that the solenoid can produce at or near full extent is also very low. It rapidly increases as the piston retracts, but this is not the position that the release is set in. It is also suspected (due to all the release failures occurring in deep water) that the pressure balancing of the solenoid is not perfect and a differential pressure is developing across the piston at depths of 2000-4000 m sufficient to prevent the solenoid from moving the piston. These problems may be mitigated by increasing the specification of the release battery, but should be investigated nevertheless and solutions sought where possible.

The manual states that the solenoid is energised 4 times with a 2 seconds on, 6 seconds off duty cycle due to heating of the coil. As the coil is oil bathed and the whole assembly is submerged in water, I am not convinced that this is necessary.

The weights can be released under several conditions ($P > P_{max}$, $dP/dt \sim 0$, $t > t_{max}$, hardware timeout 4.5 h, battery failure). However once a condition has been met and the solenoid has been energised the release logic locks out all other conditions until the original condition has been cleared. For example, if the VMP exceeds it maximum pressure and the solenoid is energised but the piston does not move, the profiler will continue downward until it hits the bottom. Now $dP/dt \sim 0$ but the release will not be energised again as P is still greater than P_{max}. Time passes and $t > t_{max}$, but once again the solenoid will not be energised as $P > P_{max}$, etc. This is incorrect logic. In the scenario that occurred 5 times during the cruise, it would be helpful to have 5 shots

at moving the release piston as each condition arose rather than just P>Pmax. The conditions should be OR arranged not XOR

Summary

The VMP proved to be very maintenance intensive and many deployment opportunities were lost. Nearly all the problems centred on battery and release mechanism issues. However these are now largely understood and it is hoped that in partnership with the manufacturer they can be resolved prior to the next usage.

4.3 Operations

We used the VMP-5500 in the following ballasting - drag configuration: all foam flotation, two (of four) drag brushes and large paddles. Fall rates were roughly 0.48 m s^{-1} before trimming the drag brushes and 0.58 m s^{-1} thereafter. To best match the station time of the CTD/LADCP and VMP, short brushes were used in water depths exceeding 2000 m, long brushes in water depths of 800-2000 m and the instruments were deployed separately in water shallower than 800 m. We used the following recovery aids: Novatech strobe and radio direction finding (RDF), an Argos beacon, an Ixsea acoustic transponder and an improvised flag attached to the antenna. The Ixsea MT861 transponder conveys slant range and pressure information to an Ixsea TT801 deck unit. The RDF was dropped on the deck and ceased functioning about 1/3 of the way through the cruise. No spare was available. An attempt was made to use the Argos beacon in RDF mode, but results were not satisfactory.

Although the performance of the VMP-5500 was fairly satisfactory during the cruise, it is not quite ready for prime time as a standard complement to hydrographic sampling.

As previously experienced, the battery proved problematic. During JC018 the instrument's main battery failed to charge sufficiently in several occasions, leading to delays in several casts; this was found to result from the charger's 'intelligent' response to connecting the VMP-5500, E/CRG cable, charger and power supply in an incorrect order; the problem was resolved by establishing precise pre-cast and post-cast protocols. In JC029, we found that, even with this protocol, charge rates were insufficient to keep pace with the deployment schedule during occupation of the hydrographic lines. In all, the VMP was not used on seven such stations due to lack of charge. Half way through the hydrographic lines the supplied charger was replaced with standard bench power supply with adjustable voltage and current supply rates. Even though the rated maximum current draw of the bench supply did not exceed that of the charger, only one station was not occupied due to insufficient charge. We infer that the charger was not

typically supplying current at its nominal rating.

Given that the charge rating of the VMP's main battery (2 A) was twice that of either charger or bench supply, *we strongly advise the purchase and use of a 2 A /15 volt constant voltage / constant current bench supply.* This should alleviate the incidence of skipped stations due to insuicient charge. The only drawback is the potential for overcharging the main battery if the bench supply is neglected.

Weight release issues. Our belief is that the weight release mechanism of the VMP is not fully functional. It is likely compounded by battery issues.

Previously (JC018) we experienced a high rate of loss of the drag brushes due to the VMP contacting the ship's hull. In JC029, no drag brushes were lost and perhaps 8 paddles needed replacing. As significant potential exists for a high loss rate of these elements, we strongly recommend that many spares be supplied.

Corrosion on the dummy cap of the E/CRG cable and on the shorting plug, a problem on previous cruises, was minor.

The electromagnetic (EM) velocity sensor made its debut on this cruise. The sensor showed an extreme amount of thermal sensitivity that made the development of processing algorithms and assessment of the sensor problematic. Data quality of one channel appeared to improved with time. This may be indicative of a connectivity problem. Repotting of the electrodes was done with a solution of leaf gelatin and standard seawater. This was not optimal as gelatin has a lower melting point than that of agar. Agar is cheap and readily available as a food product. We recommend purchase of said product.

If NOC is willing to spend funds in building a cradle for the VMP, it should consider building a self-contained hydraulic rig like that employed with the High Resolution Profiler (http://hrp.whoi.edu/hrpgrp/divepix.jpg, http://hrp.whoi.edu/hrpgrp/new/OperOv.html, http://hrp.whoi.edu/hrpgrp/new/depl _img.html). Over the side operations would be substantially quicker and safer: it would not require personnel to stand under 6.5 kg steel weights. This would require a small opening of the starboard rail and a couple cleats for tag lines during foul weather. This action will need to be taken if the HRP is used on the Cook during DIMES.

Crash Diagnostics:

An attempt is made below to tabulate what might be pertinent diagnostics relating to bottom impacts. For all bottom impacts, the maximum pressure exceeds the estimated pressure at solenoid activation (Table 5, columns 3 and 4). In all cases the presence of four voltage spikes (dips) indicates that an attempt was made to fire the solenoids (column 6). Weight release is presumed in all cases to be initiated by the corrosive link,

with rise of the instrument being potentially delayed due to being embedded in mud.

Several hypotheses have been forwarded about why the solenoid failed to release the weights. At the first instance (Station 26) a new main battery was installed prior to Station 25 and so excessive tension on the release line and hence torque on the lever arm against the solenoid pin was suspected. A protocol was developed to minimize the tension and contact area between lever arm and solenoid pin. After a second bottom impact (Station 43) the weight release mechanism itself was replaced with a spare. Two dives later (Station 48) a third failure was experienced and attention was focussed upon battery issues. Both the main and weight release batteries were renewed at this point. No problems were encountered until stations 67 and 69.

In reviewing the battery diagnostics, there are no clear-cut criteria for failure. Table 5 documents solenoid activation at lower values of main battery voltage than that at which failure occurs. An unknown quantity is the condition of the weight release battery and its functionality. After station 69, the instrument rack was pulled prior to charging the instrument and the weight release battery voltage checked. It was found to be in a charged status. This may simply be indicative of a normal status: after firing, the weight release battery charges from the main whenever the instrument is 'on'.

It is suspicious that multiple failures happen after a main battery has been in use for 15 or so profiles.

It is suspicious that the current draw of the solenoid (4 A) exceeds the weight release battery's nominal discharge rating of 1 A.

A problem: all the nominal ratings assume an ambient temperature of about 70°F. It is well known that the amperage of a lead acid car battery is limited at cold temperatures by simple battery chemistry.

Hypothesis: (i) The main battery is an important part of the weight release current supply, especially at cold temperatures. (ii) degradation of the main battery with time limits the maximum current that can be supplied to the release solenoid.

Question: can the weight release battery affect release on its own?

Recommendations: Degradation of the main battery through deep cycling results from a combination of low charging rates and extended station time. Deployment at less than full charge can be avoided by using a robust bench power supply that will charge at near the maximum recharge rate. Avoiding extended station time is more problematic. There were instances in which it took hours to find and recover the profiler. Better and redundant recovery aids would help in this regard: a GPS/Iridium module in place of the Argos beacon, spare RDF modules, an acoustic transducer head that faces downwards

Table 5: Crash Diagnostics. An attempt is made below to tabulate what might be pertinent diagnostics relating to bottom impacts: dive termination status, the pressure at estimated solenoid activation, maximum pressure in the data record (Pmax), main battery voltage at weight release attempt (Vbat), the height of the voltage spike (dip) during solenoid activation (ΔV), estimates of the main battery voltage at instrument start up, and voltage estimates prior to cast set up and at download time. These are hand picked out of the setup sheet and represent the voltmeter readings. FC is full charge, whatever that was intended to mean by the operator. Stations with * are those where the VMP hit the bottom.

Station	Dive termination mode and last record number	Presc. Pmax (incl. oversh.) (dB)	Pmax (actual) (dB)	Vbat (V)	ΔV (V)	$V(t=0)$ (V)	Main battery voltage estimates
03	pressure release @ 0000			12.29	-0.40	12.52-12.47	12.95-12.47
05	pressure release @ 2129			12.42	-0.58	12.51-12.50	12.80-12.36
06	pressure release @ 3814			12.28	-0.58	12.44-12.43	12.84-12.21
09	pressure release @ 2851			12.34	-0.58	12.43-12.41	12.95-12.24
10	pressure release @ 5110			11.76	-0.60	12.29-12.29	12.75-11.68
12	pressure release @ 1169			12.39	-0.53	12.45-12.45	12.74-12.57
13	pressure release @ 1430			12.46	-0.56	12.58-12.58	13.12-12.59
14	pressure release @ 1641			12.46	-0.57	12.60-12.56	13.17-12.52
15	pressure release @ 2148			12.35	-0.58	12.58-12.58	12.70-12.0
16	pressure release @ 3147			12.15	-0.55	12.58-12.56	13.00-12.93
18	pressure release @ 4492			12.35	-0.56	12.60-12.58	13.14-12.27
19	pressure release @ 5636			12.28	-0.56	12.57-12.51	non -12.07
20	pressure release @ 5496			11.70	-0.58	12.31-12.24	12.73-11.39
22	fall rate release @ 7598			09.02	-1.34	11.70-11.68	12.00- 5.48
24	fall rate release @ 6730			11.76	-0.55	12.24-12.20	12.70- 9.20
25	pressure release @10914			11.87	-0.53	12.51-12.51	12.92-11.50 new VMP battery
*26	pressure release @10683	4472.9	4631.8	11.956	-0.50	12.48-12.47	12.75-6.00
27	fall rate release @6952			11.87	-0.53	12.51-12.51	12.45- 5.55
29	pressure release @7816			12.12	-0.50	12.60-12.58	FC 13.40-12.83
31	pressure release @7909			12.01	-0.49	12.46-12.46	12.50-11.80
32	pressure release @7553			11.82	-0.50	12.47-12.46	12.80-11.00 ADCP Power Supply
34	pressure release @7028			12.10	-0.49	12.48-12.46	12.70-11.80
35	pressure release @0000			12.02	-0.48	12.44-12.44	12.48-11.90
37	pressure release @6958			12.18	-0.46	12.57-12.53	12.80-12.00
38	pressure release @7112			12.10	-0.46	12.55-12.54	12.70-11.80
39	pressure release @7048			11.95	-0.46	12.54-12.52	12.78-11.68
40	pressure release @6356			11.89	-0.45	12.48-12.47	12.80-11.60
42	pressure release @6427			12.14	-0.46	12.50-12.48	13.15 - 11.80
*43	pressure release @6421	3429.2	3470.1	11.926	-0.45	12.46-12.42	12.90- 3.30 changed Pcal
47	pressure release @5331			12.24	-0.40	12.68-12.60	13.15-12.08 changed weight release
*48	pressure release @4199	2097.8	2252.0	11.912	-0.40	12.45-12.42	12.91- 3.0
51	pressure release @2609			12.29	-0.40	12.52-12.33	13.20-12.31 changed both batteries
52	pressure release @2592			12.31	-0.40	12.60-12.55	12.97-12.15
53	pressure release @1968			12.39	-0.38	12.65-12.59	13.40-12.18
54	pressure release @1490			12.42	-0.40	12.63-12.58	FC - 12.48
56	pressure release @1089			12.47	-0.38	12.56-12.53	13 - 12.58
57	pressure release @2575			12.30	-0.42	12.48-12.47	13.96-11.58
58	pressure release @3992			11.67	-0.47	12.01-12.01	12.93-12.0 voltmeter issue
59	pressure release @2399			10.84	-0.62	11.30-11.30	12.90- 8.8 voltmeter issue
60	pressure release @3138			12.21	-0.40	12.55-12.52	12.80-12.14
61	pressure release @3992			12.35	-0.40	12.72-12.64	13.25-11.8 VMP @surface for 2 hrs
62	pressure release @3776			12.21	-0.40	12.46-12.44	13.22-12.05
63	pressure release @5253			11.86	-0.41	12.44-12.41	FC@12.90-11.8
64	pressure release @6261			11.52	-0.46	12.21-12.17	12.45-11.25
65	pressure release @6550			11.78	-0.41	12.36-12.28	12.75-11.5
*67	pressure release @7231	3624.9	3760.2	12.155	-0.40	12.67-12.59	FC@12.90- 4.4
*69	pressure release @7231	3684.8	3836.8	12.055	-0.41	12.64-12.50	FC@12.80- na weight rel. bat. at 6 v

68

and can be heard while the profiler is at the surface. Repowering the profiler with alkaline battery packs arranged on the exterior of the instrument should be seriously considered. Changing batteries would be a matter of ten minutes rather than the ten hours required to dismantle the VMP in order to open the instrument case. We strongly recommend that the weight release battery be replaced with a unit rated at a higher instantaneous current capacity. Finally, changing the mechanical design of the weight release unit so that there is less possible variation in line tension / torque on the solenoid pin.

Crash Diagnostics Summary

Our opinion is that the weight release design is not optimal. It allows for a highly variable amount of tension being applied to the line and consequent torque applied through the lever arm to the solenoid pin. However, it is also obvious that design issues are compounded by battery issues: the progressive degradation of the main battery through inadequate charging and deep cycling, the obvious supplement of the weight release battery by the main battery during weight release and exacerbation of battery condition by the operation at low temperatures.

4.4   VMP Logsheet

VMP – 5500 Dive LOG

Cruise:	Station Number:

Sensor Information

Fine. Var.	Channel	Used	Micro. Var.	Channel	Used	Probe
GND1	0		Ax	1		
T1	4	___	Ay	2	___	___
T2	6	___	Az	3	___	___
P	10	___	T1_dT1	5	___	___
SBT1E	16	___	T2_dT2	7	___	___
SBT1O	17	___	Sh1	8	___	___
SBC1E	18	___	Sh2	9	___	___
SBC1O	19	___	P_dP	11	___	___
Mz	32	___	C_dC	12	___	___
My	33	___				
Mx	34	___				
EM vel1	35	___				
EM vel2	36	___				
Vbat	37	___				

Sensor notes:

Deployment

Date:

Time instrument turned on (weight release battery charge start) (GMT):

Available memory (/root/data):		Enough (at ca. 100Mb /1000 m)?:	
Memory cleared?:		If not, most recent data file in memory:	

Acoustic depth (m):   Bottom press. P_{bot} (db):

On-deck press. P_{deck} (db):   Assumed overshoot P_{over} (db):

Safety allowance P_{safe} (db, ≥ 50db recommended):

Specified max. press. (db, must not exceed P_{bot} + P_{deck} – P_{over} - P_{safe}):

Estimated dive time (s, at a dive rate of 0.58 (short brushes) or 0.48 (long brushes) ms^{-1}):

Specified max. time (s):

Time instrument turned off (make sure >20 minutes after time instrument is turned on) (GMT):

Main battery voltage (V):

Dive start time i.e. LED flashing (GMT):		Time when VMP released (GMT):	
Lat/Lon when VMP released:		Expected surface time (GMT):	

Comments:

Recovery	
Date / Time when VMP spotted (GMT):	
Ship Position (Lat/Lon) when VMP spotted:	
Range / bearing at which VMP spotted:	
Date / Time when VMP on deck (GMT):	
Ship Position (Lat/Lon) when VMP on deck:	
Acoustic depth (m) / corrected bottom pressure when VMP on deck:	
Post-dive main battery voltage (V):	
Name / size of data file:	
Method of dive end (from dive .txt file):	
Max. pressure of dive:	
Comments:	

ATTACH COPY OF VMP SETUP FILE AND QUICK LOOK FIGURES FOR DIVE

AND

MARK WITH STATION NUMBER

4.5 VMP Instructions For Launch and Recovery

4.5.1 Instructions For Launch

At the Computer:

1. **Start a new log sheet in the VMP dive log.** Enter the cruise (JC29), station number and date. If a probe needs to be replaced, note failed probe number, cause of failure, new probe number, channel on instrument, and calibration info for new probe if required on the log sheet (ask Kurt if you need help).

2. **IF the instrument isn't already plugged in and charging, plug the instrument in.** Connect one end of the E/CRG charging cable to the instrument and the other end to the charger. Connect the charger to the power supply and turn the power supply on.

3. **Turn the instrument on and start the weight battery charging.** Connect the on-off switch (plastic plug) on the E/CRG cable and note the time on the log sheet. The instrument needs to be turned on to allow the weight battery to charge for at least 20-30 minutes before launch.[1]

4. **Get the laptop talking to the instrument.** IF it isn't connected already, connect the Ethernet cable on the E/CRG cable to the laptop. Open Putty (via short-cut on desktop). Select "odas4ir" under "saved settings" and double click or hit the "load" button then the "open" button. This should open a terminal window. Log on with login="root" and password=rglr0x (zero not 'o').

5. **Make sure there is enough free file space on the instrument for the next profile.** Type 'df' in the terminal window to get memory available. Record available memory in the "root/data" directory on the log sheet. Determine if there is enough memory for the next profile (you require $\sim 100\,000$ kB per 1000 m depth of dive). IF required, make space by deleting all data files (.p) except for the most recent. Otherwise note most recent data file (.p) in memory on the log sheet.

6. **Get the pressure on deck from the instrument.** Type "odas4ir -f setup.txt" in the terminal window. Multiple readings of the on-deck pressure will be printed to the screen (should be close to 0). Record the pressure to nearest first decimal point as "On-deck press Pdeck" on the log sheet. Exit with CRTL-C.

7. **Make the specified maximum pressure and specified maximum time calculations for this dive.** When you have arrived on station, make a decision

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[1]How best to charge the weight battery and whether this is necessary is in question.

about the water depth and the safety factor for this dive. Run "calculate max press and time" in Matlab on the laptop. Note the fall rate is ∼0.48 m/s with long brushes and ∼ 0.58 m/s with short brushes. Record "Bottom press Pbot", "Assumed overshoot Pover", "Safety allowance Psafe", "Specified max. press.", "Estimated dive time" and "Specified max. time" from Matlab output on the log sheet. Take a second and make sure it makes sense!

8. **Enter this dive's information in the setup.txt file on the instrument.** Open the setup.txt file by typing "edit setup.txt" in the terminal window. Update the prefix field with station number (prefix format=jc29 station no). Enter the maximum time and maximum pressure as calculated above into the appropriate fields. Save and exit by hitting "ESC" and hitting enter once to select "Leave Editor" and enter again to select "Save Changes".

9. **Test the setup.txt file.** Type "odas4ir -f setup.txt" at the command line in the terminal window. Check for any error messages. If all is well, exit with "CTRL-C".

10. **Turn off the instrument and disconnect from the power supply.** Type "shutdown now" in the terminal window. Close the Putty terminal window. Wait 30 seconds. IF the weight release battery has been charging for at least 20 minutes, disconnect the instrument from the power supply by disconnecting the plastic on-off switch. Turn off the power supply.

11. **Test the instrument battery voltage**. Disconnect the instrument from the power supply. Using the voltmeter test the instrument battery voltage by measuring the voltage at the connector to the power supply. Record the main battery voltage on the log sheet. IF the voltage is greater than (about) 12.8 V it is OK to deploy, if it is less, charge the instrument more (with plastic on-off switch disconnected).

On Deck:

1. **Replace the brushes if necessary.** If the depth is in the range of 800 to 2000 m use the long brushes. Use the short brushes for depths greater than 2000 m. (This is to adjust the fall rate so the VMP and CTD finish about the same time).

2. **Turn on and test the recovery aids.** For each, loosen the clamps and remove the instruments. For the two antennas and strobe light, switch on with the on/off switch on the shaft. For the pressure transducer, test by setting to "test" and listen for 2 pings ∼6 s apart (6 s indicates good battery charge, less than 6 s indicates that the battery charge is low) then set to F3. Replace the recovery aids keeping the strobe sticking out. Tighten the clamps. Test the radio by ensuring that the RAF sees the instrument.

3. **Remove the tube protecting the SeaBird conductivity cell.**

4. **Remove the tape from the EM current meter ports (5).**

5. **WHEN the laptop work is done, disconnect the E/CRG cable from the instrument and install the dummy plugs (on both ends).** Wait 36 s (the weight release mechanism will fire as part of normal procedure).

6. **Install the weights.** Check the magnetism of the weights. Demagnetize if greater than 2G. Check the state of the magnesium corrosive link and replace if necessary and note on the log sheet. Install the weights and check the cable tension.

7. **Turn the instrument on.** Turn the instrument on by replacing the dummy plug with the shorting plug. Watch for the LED on the tip of the probe to start flashing (~2.5 minutes). Record the time as the "Dive start time" on the log sheet.

8. **Throw it in the water.** Note the time when the VMP is released and record the expected surface time on the log sheet. Make an offering to the VMP gods.

4.5.2 Instructions For Recovery

On Deck:

1. Approximately 10 minutes prior to the expected surface time, send a look-out with the RAF to the top of the bridge and all others to the bridge for look-out.

2. Find it! Record the date, time, ship position, and range and bearing on the log sheet.

3. Get it on the deck. Record the date, time, ship's position and acoustic depth on the log sheet.

4. Turn the 4 recovery aids off.

5. Replace the tube full of millipore water on the SeaBird conductivity cell.

6. Replace the tape over the EM current meter probes.

7. Rinse with fresh water. Be gentle with the flow rate over the shear probes!

8. Turn the instrument off by removing the shorting plug and connecting the E/CRG charging cable to the instrument.

9. Inspect the magnesium corrosive link on the weight release. IF needed, replace and record on the log sheet.

At the Computer:

1. Test the instrument battery voltage by measuring the voltage at the instrument's connector to the power supply using the voltmeter. Record the battery voltage on the log sheet.

2. Plug the instrument in and start it charging by connecting the E/CRG charging cable to the charger and turning on the power supply.

3. **Get the laptop talking to the instrument.** Turn the instrument on by connecting the plastic plug on the E/CRG cable. IF it is not already connected, connect the Ethernet cable on the E/CRG cable to the laptop. FTP to the instrument using Mozilla (via the shortcut on the desktop). Connect to the instrument via "Quick Connect" (left-most button on the toolbar) and selecting "odasir4".

4. **FTP the data and log file from the instrument to the laptop.** Make a new directory on the laptop labeled by the station number in E:/JCO29 (shortcut on desktop). Select this local directory in the left-hand window of Mozilla. Drag and drop ALL .p (data) and the .txt files for this station from the remote directory on the instrument (right-hand window of Mozilla) to the new laptop directory (left-hand window of Mozilla). Put a copy of the setup.txt file in the laptop station directory as well.

5. Once the file transfer is complete, turn off the instrument by disconnecting the plastic on-off switch on the E/CRG cable so it is in the "off" position. Leave the instrument plugged in to charge for the next dive.

6. **Do a quick look of the data in Matlab on the laptop.** In Matlab go to the station directory and run "firstlook vmp2 new2". Inspect the output and check for broken microstructure probes. IF a microstructure probe needs replacing, record this on the log sheet and alert Kurt. Record the maximum pressure of the dive on the log sheet (outputted at the command line in the Matlab window).

7. Record the data file names and the size of data files (.p). Open the station .txt file and note the method of dive end (pressure release? time release? other?). Record on the log sheet.

8. **Archive.** As soon as there is time, backup the new station directory on the laptop to COOK 3. Put the station directory onto a memory stick and bring to a computer connected to the network. SCP the directory via "scp -r *station directory name* pstar@cook3.cook.local: /data32/pstar/jc29/vmp/raw" (password is "1pstar"). Print the setup.txt file for the dive and the output figures from "firstlook vmp2 new2", mark with the station number, and put in the red VMP binder with log sheet.

9. Get ready to do it all again!

Summary of Seabird sensors used

Seabird Fast Temperature sensor, s/n 03F-4634.
Seabird Conductivity sensor, s/n 04C-3240.

Data quality

The data we obtained were of the high quality anticipated for the instrument. The shear probes had noise levels of 5×10^{-11} W kg^{-1} in deep, weakly stratified regimes. Temperature probes were wonderful and the breakage rate acceptable. The conductivity channel returned a higher noise level in weak stratification than experience suggests possible with the Seabird electronics employed by Rockland. This issue warrants further attention.

Table 6: Summary of untethered operations

Station	Date	Deployment Time (GMT)	Latitude	Longitude	Recovery Time (GMT)	Latitude	Longitude	Depth (m)	Comment
01	03/11								ISW test station
02	07/11								CTD test station
03	08/11	07:56	43 01.212	49 47.860	08:44	43 01.303	49 47.945	2730	VMP test station
04	08/11								CTD/LADCP test station
05	09/11	10:18	43 56.8	55 06.0	11:45	43 56.6	55 05.9	4154	VMP test station
06	12/11	09:59	46 31.96	71 52.679	12:29	46 32.16	71 54.82	1900	
07	13/11								ISW
08	13/11								CTD/LADCP Tow-Yo
09	14/11	15:27	46 33.68	71 50.35	18:14	46 33.372	71 53.018	1330	
10	14/11	19:26	46 34.491	71 56.983	22:28	46 34.641	71 57.953	2540	
11	14/11								ISW
12	17/11	02:35	47 16.333	67 30.127	03:06	47 16.503	67 30.171	420	
13	17/11	08:12	46 58.149	67 14.228	09:05	46 57.771	67 14.418	583	
14	17/11	13:28	46 40.149	66 58.429	16:37	46 40.054	66 58.130	750	
15	17/11	17:15	46 26.264	66 45.951	23:35	46 26.461	66 46.214	1040	
16	17/11	19:57	46 21.182	66 41.722	22:23	46 21.220	66 43.066	1350	wrong
17	17/11								Too Foggy for VMP
18	18/11	06:16	46 09	66 31.5	08:54	46 07.95	66 33.70	2240	
19	19/11	05:26	45 5	66 20	09:26	45 51.074	66 23.371	2810	
20	19/11	10:58	45 47.876	66 17.754	14:43	45 47.470	66 19.599	3183	
21	19/11								
22	20/11	01:38	45 18.987	65 46.091	05:58	45 20.834	65 46.203	4270	µsensor repair
23	20/11								
24	20/11	16:59	44 42.608	65 15.544	22:00	44 43.876	65 17.168	4510	low battery
25	21/11	11:05	44 17.492	65 41.022	17:10	44 16.905	65 42.709	4609	
26	22/11	14:53	44 09.997	66 23.402	23:35	44 09.823	66 23.855	4529	Bottom Impact
27	23/11	03:59	44 03.504	67 03.776	08:05	44 03.761	67 04.451	4433	
28	23/11								
29	24/11	05:16	43 49 19.8	68 26 54.0	09:43	43 52.06	68 29.14	4025	low battery
30	24/11								
31	24/11	21:22	43 34 53.0	69 49 27.5	01:54	43 34.164	69 49.602	4060	low battery
32	25/11	06:10	43 35.733	70 35.233	11:31	43 32.124	70 34.747	3984	
33	25/11								
34	25/11	00:19	44 01.872	72 08.686	05:04	44 00.173	72 11.327	3784	low battery
35	26/11	12:37	44 11.794	73 00.943	17:18	44 12 45.07	73 00 14.44	3770	

Station	Date	Deployment Time (GMT)	Latitude	Longitude	Recovery Time (GMT)	Latitude	Longitude	Depth (m)	Comment
36	26/11	05:01	44 39.133	74 19.765	09:02	44 39.874	74 19.053	3640	low battery
37	27/11	13:46	45 00.	74 47.	18:05	45 00.468	74 47.366	3780	
38	27/11	21:33	45 23.901	74 45.331	01:40	45 25.00	74 45.376	3740	
39	28/11	04:50	45 47.363	74 42.414	08:43	45 47.467	74 42.170	3246	
40	28/11								
41	28/11								low battery
42	28/11	18:18	46 35.373	74 37.221	22:53	46 35.267	74 40.990	3475	Bottom Impact
43	29/11	02:34	46 59.253	74 34.378	18:23	46 59.289	74 41.028	3430	refurbish VMP
44	29/11								refurbish VMP
45	29/11								refurbish VMP
46	30/11								
47	30/11	07:37	47 30.890	74 10.016	10:52	47 30.919	74 10.639	2690	Bottom Impact
48	30/11	12:23	47 31.797	74 09.091	00:54	47 31.85	74 09.19	2175	refurbish VMP
49	01/12								refurbish VMP
50	01/12								
51	01/12	11:05	47 47.476	73 30.107	11:54	47 47.615	73 30.929	1260	
52	01/12	15:04	47 57.038	73 00.058	17:08	47 57.064	73 00.107	1230	
53	01/12	19:47	47 57.001	72 30.020	21:46	47 57.010	72 30.679	950	
54	02/12	02:00	47 59.97	72 00.07	02:53	48 00.14	72 00.47	837	
55	02/12								ISW instead of VMP
56	02/12	12:40	47 18.177	71 27.695	13:19	47 17.955	71 27.751	585	
57	02/12	16:47	47 14.831	71 27.575	18:51	47 15.390	71 29.911	1240	
58	03/12	16:18	47 07.056	71 34.975	19:08	47 07.860	71 36.996	1860	
59	03/12	20:25	47 02.289	71 38.814	22:08	47 02.810	71 40.560	1260	
60	04/12	04:46	46 48.000	71 48.196	06:50	46 47.77	71 47.98	1740	
61	04/12	10:50	46 31.745	71 53.685	?	46 30.157	71 50.633	2020	
62	04/12	20:32	46 31.569	71 49.161	23:15	46 31.19	71 49.10	1750	
63	05/12	00:58	46 23.61	71 58.63	13:51	46 24.29	71 59.54	2416	
64	05/12	05:36	46 20.54	72 04.54	08:59	46 21.713	72 06.015	3145	
65	05/12	13:22	46 08.016	72 13.276	17:01	46 09.801	72 15.874	3310	
66	05/12								low battery
67	06/12	02:36	45 31.79	72 35.15	15:04	45 32.776	72 35.757	3671	Bottom Impact
68	06/12								refurbish VMP
69	07/12	00:17	44 55.13	72 58.08	12:16	44 55.844	72 58.770	3749	Bottom Impact
70	07/12								refurbish VMP
71	07/12								refurbish VMP

Table 7: Summary of micro-sensors

Sensor s/n	Cal Date	[C(nF),R(Ω)]	
M389	0.0713 22/05/08	[1.085, ∞]; [0.000, ∞]	Probe Noisy. Toast.
M390	0.0793 22/05/08	[1.089, ∞]; [1.004, ∞]	Try Probe Again.
M394	0.0760 22/05/08	[1.192, ∞]; [1.089, ∞]	Signal Intermittent. Not Convinced The Probe Is Bad.
M539	0.1195 19/05/08	[1.070, ∞]; [∞, ∞]	Bottom Impact (Sta 26 43), Probe Dead after 43.
M540	0.1021 22/05/08	[1.100, ∞]; [1.194, ∞]	Bottom Impact (Sta 26 43), Probe to be Recalibrated.
M395	0.0958 06/11/06	[1.158, ∞]; [1.03, ∞]; [0.840*, ∞]; [1.045, ∞]	Bottom Impact (Sta 48 67 69), Probe to be Recalibrated.
M396	0.1178 06/11/06	[1.136, ∞]; [1.05, ∞]; [1.05, ∞]	Bottom Impact (Sta 48), Probe OK?†.
M400	0.0927 22/05/08	[1.119, ∞]; [0.856*, ∞]; [1.052, ∞]	Bottom Impacts (Sta 67 69), Probe to be Recalibrated.
T259		3-5 T1	No Signal; Tip NOT Apparent
T277		3-6 T2, 22-24 T2	No Signal; Tip NOT Apparent
T278		6-18 T1	No Signal; Tip NOT Apparent
T279		9-20 T2	Probe Removed With Out Cause. Tip Intact. Try Again.
T282		19-43 T1	Bottom Impact (Sta 26 43), (Probe OK, Tip NOT Apparent)
T281		25-43 T2	Bottom Impact (Sta 26 43), (Probe OK, Tip NOT Apparent)
T280		47-69 T1	Bottom Impact (Sta 48 67 69), Tip Intact.
T283		47 - 69 T2	Bottom Impact (Sta 48 67 69), Tip Intact.
C25		3-14	High Noise Levels.
C26		15-20	Replacing the sensor made very little visual difference.
C25		22-26	Put back on after dismantling and reassembling profiler. This is likely in error.
C27		27-43	High Noise Level Too.
C28		47-61	High Noise Level Too.
C70		62-69	High Noise Level Too.

Resistances were not measured due to the unavailability of an ohmeter with an appropriate scale.

† Probe removed at Sta 51 as response was low by a factor of 2.

*evidently minus the test lead capacitance.

5   ISW Profiler Operations and Measurements

5.1   Summary of ISW turbulence stations

During the *James Cook* cruise JC29 the microstructure profiler MSS90L, serial number 35, was used for microstructure turbulence measurements in the upper ocean. The ISW profiler is an instrument for simultaneous microstructure and precision measurements of physical parameters in marine and limnic waters, it is designed for vertical profiling within the upper 300 m.

From experience analysing turbulence probe data from D306 cruise to the PAP site and D321 cruise to the Iceland Basin it was decided that between 5 to 10 profiles would be taken per station. This is because the above analysis revealed the turbulent diffusivities to be log-normally distributed (if not worse) with the causative mixing being intermittent. Five profiles was considered to be the minimum practical number of profiles to calculate profiles of mean turbulent diffisivity and ten profiles the most profiles achievable within an hour and a half elapsed sampling time. For all stations, except the velocity calibration station 1, seven profiles or more were achieved within the sampling time.

The ISW profiler had no pre-planned stations and was deployed on an ad-hoc basis whenever the station schedule allowed, or whenever there was downtime due either to equipment problems or the weather. ISW profiling was successfully carried out in weather approaching F9 (Beaufort scale) when operations using both the CTD and VMP (vertical microstructure profiler) had been suspended.

The ISW profiler proved to be quite robust and easy to deploy. There are only two issues with deployment: cable should be fed out sufficiently quickly to ensure that at least two loops are always visible in the top few meters of water and the cable has a tendency to catch occasionally, possibly because of salt crystals forming on it, so it is necessary to keep one hand between spooling out cable (but not touching the cable as there is an outside chance this can induce vibrations that would be recorded as turbulence) and the drum to quickly catch and throw off any loops that catch. The latter may be rectified by fastening of a metal pin where the hand would otherwise be held. This should be looked into prior to the next use of the probe.

Mounting of the winch and cable drum on the bulwark of the vessel leaves it exposed to weather for the duration of the cruise, however, the winch motor is not fully marinised and it requires additional weather protection. Due to the bulky and awkward size of the winch and cable drum, dismounting the equipment each time after use is not practical. It is recommended that a rugged, waterproof shroud for the winch and cable drum should

be purchased prior to the next use of the profiler on an open ocean cruise.

5.2   Summary of turbulence measurements

Table 8: Turbulence measurements made on JC29

St.	Date	jday	Position (start/end)	Time (GMT)	Filename (.mrd)	no. of casts	Wave height (m)	Comments
1	03/11/08	308	37°44'S;24°47'E 37°44'S;24°47'E	16:19 18:14	Velo0001 to Velo0005	4	n/k	Sinking velocity checking. Sinking speed approx 0.7 ms^{-1}
7	13/11/08	318	46°31'S;71°55'E 46°31'S;71°55'E	10:03 11:36	SO7C0001 to SO7C0010	9	∼5	Moorings site during storm
11	14/11/08	319 320	46°33'S;71°54'E 46°33'S;71°52'E	23.37 00:38	S11C0001 to SO7C0008	8	2	Moorings site after storm
22	20/11/08	325	45°18'S;65°47'E 45°18'S;65°46'E	00:12 01:03	S22C0001 to S22C0008	8	2.7	
29	24/11/08	329	43°49'S;68°26'E 43°49'S;68°26'E	03:28 04:47	S29C0001 to S29C0009	9	1.8	In frontal jet water speed ∼1 ms^{-1}
43	29/11/08	334	46°59'S;74°36'E 46°59'S;74°36'E	11:42 12:45	S43C0001 to S43C0007	7	0.5	In frontal jet water speed ∼1 ms^{-1}
48	30/11/08	335	47°31'S;74°09'E 47°31'S;74°08'E	19.02 20.07	S48C0001 to S48C0008	8	1.8	Night time.
55	02/12/08	337	47°38'S;71°15'E 47°38'S;71°14'E	08:43 09:37	S55C0001 to S55C0008	8	1.3	On Kerguelen plateau (depth 223 m).
67	06/12/08	341	45°32'S;72°35'E 45°32'S;72°35'E	10:03 11:16	S67C0001 to S67C0009	9	∼1	While awaiting VMP return.
69	07/12/08	342	44°55'S;72°58'E 44°55'S;72°58'E	04:32 05:33	S69C0001 to S69C0008	8	∼1	While awaiting VMP return
72	15/12/08	350	38°04'S;42°19'E 38°04'S;42°19'E	08:12 09:13	S72C0001 to S72C0008	2.5	∼1	Opportunistic on the way back

5.3 Profiler description

The MSS90L profiler is produced by Sea and Sun Technology GmbH in cooperation with ISW Wassermesstechnik. The main housing of the MSS90L profiler comprises a cylindrical titanium tube of length 1250 mm and diameter 90 mm. The housing is pressure tight to 5 MPa (500m). Weights and buoyancy rings can be added to the top and bottom of the probe respectively which allows the user to tune the sinking velocity by altering the buoyancy. The ISW profiler was equipped with 2 velocity microstructure shear sensors (serial number 6001 and 6080), a microstructure temperature sensor, standard CTD sensors for precision measurements, a turbidity (light scattering) sensor, a vibration control sensor, and a two component tilt sensor (see table below). The sampling rate for all

sensors is 1024 samples per second, the resolution 16 bit. All sensors are mounted at the measuring head of the profiler (sensor end). The microstructure sensors are placed at the tip of a slim shaft, about 150 mm in front of the CTD sensors. The data are transferred, from the profiler, via electrical cable to an onboard unit which pipes the data to a laptop PC.

Table 9: Sensor range, accuracy, and resolution for MSS90L microstructure profiler. Taken from the published specification of MSS90L.

Sensor	Range	Accuracy	Resolution
Microstructure shear (Airfoil lift force sensor)	0 to 6 s^{-1} (Dissipation rate 10^{-2} to 10^{-10} W kg^{-1})	not specified	approx. 10^{-3} s^{-1}
Microstructure temperature (FP07)	-2 to +30 °C	± 0.02 °C	500 μK (linear)
Pressure	50 bar	± 0.1 % fs[1]	0.002 % fs[1]
Temperature	-2 to +30 °C	± 0.01 °C	0.0005 °C
Conductivity	0 to 6 mS cm^{-1}	± 0.005 mS cm^{-1}	0.0001 mS cm^{-1}
Acceleration	-1 to +1 ms^2	0.02 ms^2	0.005 ms^2
[1]Full scale pressure range			

5.3.1 Calibration

Calibration of the shear sensors was performed by ISW Wassermesstechnik using a special shear probe calibration system. The probe rotates about its axis of symmetry at 1Hz under an angle of attack in a water jet of constant velocity. At different angles of attack the rms voltage output of the probe is measured. The probe sensitivity is the slope of the regression (best fit of a cubic approximation) of the sensor output versus the angle of attack. The calibration constants for the shear sensors used during cruise JC29 are given in the table below.

Table 10: Calibration constants for velocity microstructure shear sensors used during cruise JC29

Serial no.	Sensitivity	Gain	B0	B1
6001	9.08×10^{-5}	1.1×10^1	4.58×10^{-5}	9.16×10^{-5}
6080	6.20×10^{-5}	1.1×10^1	4.58×10^{-5}	9.16×10^{-5}

The calibration of the CTD sensors is to be carried out by Sea & Sun Technology GmbH

using standard calibration equipment and procedures for CTD probes post cruise. The vibration control sensor and the tilt sensors were calibrated by ISW Wassermesstechnik using special calibration equipment for both sensors.

5.4 Installation and operation of the microstructure measuring system

5.4.1 Profiler and winch installation

The ISW was operated via a winch SWM1000, mounted on the port stern quarter of the vessel. In addition to the fastening provided by the construction of the mounting plate, the plate was further secured to the bulwark with two steel bolts, running through bulwark and plate, and with a pair of G clamps. The power cable for the winch and the data cable connecting the PC to the profiler were run along the port side of the vessel and into the deck laboratory through the bosun's locker. The starboard side is not as good a location as the port side as there is no convenient way to route cabling into a dry area where power, for the winch and laptop, is available. When not in use the winch power pack was stored inside while the winch was additionally lashed to the bulwark and protected using plastic sheeting. When being used in rough weather both the winch power pack and profiler toolbox were lashed securely to the bulwark for the duration of the station.

5.4.2 Profiler deployment

For vertical sinking measurements, the profiler was balanced with a negative buoyancy which gave it a sinking velocity of $\sim$0.7 ms^{-1}. During the ISW measurements, the ship was moving with speed $\sim$0.5-1.0 knots with respect to the water against the wind. Disturbing effects caused by cable tension (vibrations) and the ship's movement were minimized by maintaining slack in the cable. As a rule of thumb two 'loops' should always be visible just below the sea surface.

In order to take into account the intermittent nature of marine turbulence, repeated ISW measurements were carried out in bursts of typically 5 - 10 profiles per station, with each station lasting between an hour and an hour and a half. The measurement interval was $\sim$10 min for a profile to 200 dbar. A profile depth of 200 dbar was chosen to ensure that both the upper mixed layer, if any, and the region directly below it were covered by each profile.

Profiler deployment can be carried out with a minimum of two people, one to operate the computer and one to drive the winch. However, in less than ideal conditions it is easier to deploy the profiler if three people are involved, the additional person being responsible for managing the cable spooling from the winch and preventing the cable from catching. Should the winch catch and rewind, a large amount of slack cable in the water gives time for the operators to resolve the snag and restart spooling before the profiler is affected. Data processing of the measurements is relatively robust to tension in the cable and only in cases where the profiler is pulled upwards by the cable do the measurements have to be discarded. Nevertheless, fluctuations in profiler sinking velocity increase the error in the shear calculation by an order of four, while cable tension increases the background noise recorded by the shear sensors reducing the recording accuracy of the instrument. Station 29, which was carried out within a fast flowing frontal jet, shows the signature of the surface swell in the velocity profiles for the profiler. This was due to insufficient slack being maintained in the profiler cable during deployment. For the subsequent station 43, also carried out in a fast flowing frontal jet, significantly more slack was maintained in the profiler cable during deployment and the profiler velocity profile is clean.

Slack cable in the water means that the profiler will continue to descend even after the winch has started to rewind. As a consequence of this, when deploying in areas where the water depth is close to the desired depth of the profile, it is recommended that the winch be stopped at least 50 dbar short of the target profile depth to allow for the additional depth the profiler sinks before the slack cable can be rewound. Monitoring of the maximum depth achieved by the profiler on each cast then allows the winch stop depth to be fine tuned to achieve a safe maximum profile depth.

5.4.3 Data collection and archiving

The raw data from the ISW profiler are transmitted via RS485 data link to the on board interface unit of the measuring system. Details relating to each station were noted in an XL file. For data acquisition, on-line display and storage of data the software package SDA 180 (Sea & Sun Technology GmbH) was used. The icon on the laptop desktop has label SSsda_183. The raw data are stored in the MRD (microstructure raw data) binary format.

Raw MRD format data are processed using the MSSpro software package (ISW Wasser-messtechnik) which calculates shear, turbulent kinetic energy dissipation, and turbulent diffusivity. The icon on the desktop has label Msspro. The processed data are stored in ASCII (filename extension .TOB) format. Data was processed, using the MSSpro software, according to the procedure for obtaining turbulent diffusivity described in the cruise report on Discovery cruise D321, which is reproduced below. An example of tur-

bulent KE dissipation rates calculated, for selected stations, using the MSSpro package is given in figure 9.

5.4.4 Basic guide to processing necessary to obtain turbulent diffusivity (reproduced from Discovery cruise D321 report).

It is important to set up different directories for the different stages of processing as there is the potential to overwrite files. Note also that the software has to sit directly under `C:` to use the current batch files. For D306 the following directories were used:

Directory	Comments
`C:\sst_sda\Rawdata`	for storage of raw files as they are generated
`C:\datpro\cutfiles`	raw files copied here for depth trimming
`C:\datpro\ascii`	for files now converted to ascii with shear calculated
`C:\datpro\dissThorpe`	for files once dissipation rate and Thorpe scale calculated
`C:\datpro\eddy_diff`	for files once turbulent diffusivity calculated

5.4.5 Checking sinking velocity

At the start of the cruise the sinking velocity of the probe should be checked. This should be between 0.5 and 0.7 ms^{-1} to give best signal to noise ratio. Only one cast is required to check the sinking velocity. Rather than go through the lengthy processing steps below there is a quicker route.

1. Copy file to `C:\datpro\cutfiles` and trim it as in 3. below.

2. Click `Run` button in top menu bar, then `Batch` job.

3. Choose `Velocity` option

4. Configure batch job as in 4.e - f. below but you may want to set up a new directory e.g. `C:\datpro\velocity` for doing this test

5. Click start

6. Use `Datgraf` (see 7 below) and the configuration file `Velocity` to check the vertical velocity profile
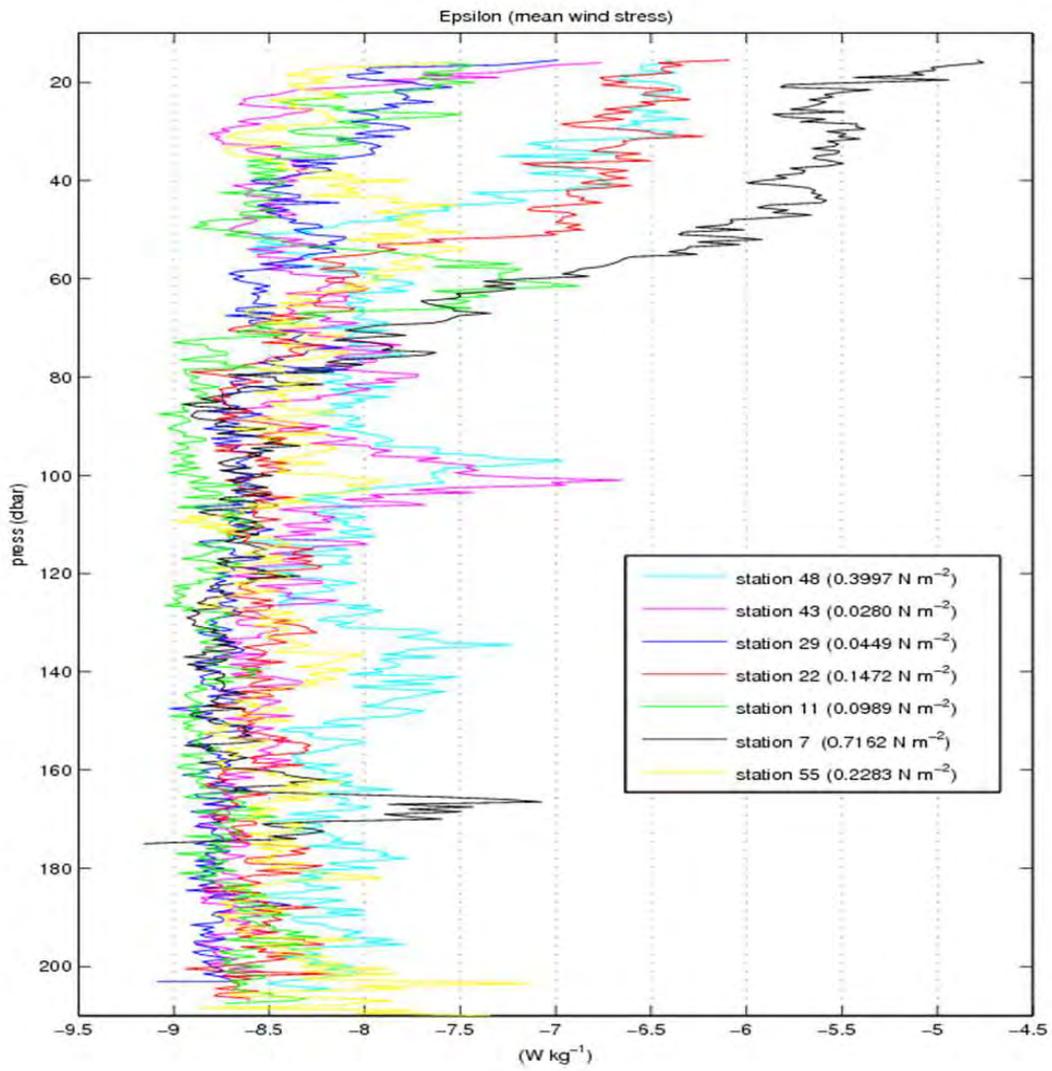
Figure 9: TKE dissipation rates for selected JC29 ISW stations with wind stress, for station duration, calculated from onboard met. data.

5.4.6   Processing steps

1. Copy files to process from `C:\sst_sda\Rawdata` to `C:\datpro\cutfiles`

2. Start msspro by double-clicking on icon

3. Trimming profiles

   (a) Click `Utilities` button once, then click once on the `Cutgraf` option and a new window should appear.

   (b) Click on `Input` files and select required files from `\cutfiles`. Note that this program will overwrite these files once edited which is why they must be copied here from `C:\sst_sda\Rawdata`

   (c) The filenames should appear in the right margin. Double-click on the first file.

   (d) Move cursor to top of hashed rectangle in lower half of plot such that double-headed arrow appears. Hold down left button and drag the top of the blue hashed rectangle downwards until just above the point at which the pressure starts to decrease again. Press F9 to cut the profile such that data within the remains of the blue hashed rectangle is deleted. The program automatically moves on to the next file. Note: it may be the over-sensitive touch pad but this can be a bit fiddly as if you click even slightly away from the top of the rectangle you instead zoom in (to an area within a red hashed rectangle which will appear). Right click to zoom out again.

   (e) Repeat until the end of the file list is reached - then click `OK` when it tells you this point is reached.

4. Converting files to ascii and calculating shear

   (a) In `datpro` click once on `File`, then click once on `Select` input files for file list

   (b) In window that appears, navigate to `C:\datpro\cutfiles`, set type to .mrd and choose required files.

   (c) Click once on Run in top menu bar

   (d) Select `Batch` job and choose `Convert+shear NOC` from the options that appear. If they don't appear, navigate to `C:\datpro\batch`

   (e) A configure batch job window should appear. Set the output directory to `C:\datpro\ascii`. A window of possible files will appear, but click any single letter into the filename box and hit OK.

   (f) Set the output filename prefix in the same window. Note

i. that the filenames are restricted to 8 characters and

ii. that this step will overwrite the relevant leading letters of your initial filename e.g. if the rawfile is called abcdefgh and you choose prefix D321A then the output file will be called D321Afgh. It is therefore important that you choose the structure of your filename and your prefixes carefully to avoid over-writing files. For D321 the prefix D321A was used for this stage leaving the last 3 characters for the sequential profile number.

(g) Click Start job. For 10 profiles of roughly 100m this batch job will take of order 3 hours to run, possibly longer.

5. Calculating turbulent dissipation rates and Thorpe scale

(a) If you have just done the preceding stage you will first need to clear the input file list. Click on the `Input` file list button. Select all the files visible. Click once on the `File` button on the top bar. Click on `Reject` selected input files.

(b) Now load files for this stage of processing. Click on the `File` button in the top menu bar, then on `Select` input files.

(c) Navigate to `C:\datpro\ascii` and select required files

(d) Click once on `Run` button in top menu bar, then on the `Batch` job option that appears.

(e) Choose `epsilon+Thorpe - new` from options (see 4.e)

(f) In Configure batch job window that appears set output directory to `C:\dissThorpe`, once again typing a random single letter into the output filename before hitting OK.

(g) In the same window set the output file prefix e.g. D321D

(h) Click Start. This stage will take a couple of hours roughly for 10 profiles to 100m.

6. Calculate turbulent diffusivities

(a) Clear previous input files as in 5.a.

(b) Now load files for this stage of processing. Click on the `File` button in the top menu bar, then on `Select` input files.

(c) Navigate to `C:\datpro\dissThorpe` and select required files

(d) Click once on `Run` in top menu bar then on `Batch` job option that should appear

(e) Choose `Eddy` option (see 4.e.)

(f) In Configure batch job window that appears set output directory to `eddy_diff` once again typing any single letter in as the output filename.

(g) In the same window set the output prefix e.g. D321E

(h) Click start job. This stage will take only a few minutes for 10 profiles to 100m.

7. Examining data i.e. dissipation rates

   (a) Click once on `Utilities` button on top menu bar.

   (b) Click on `Datgraf` option - a new window should appear.

   (c) Click on `Configure` button in `Datgraf`, then on the `Load` configuration option.

   (d) Choose `epsilon D321`

   (e) Set work path to `C:\datpro\dissThorpe`

   (f) Click on the file of interest in the right margin and the data should appear in the adjacent plots. The plot ranges (and parameters plotted) can be adjusted by clicking `Configure`, then `Options`, then the `Data` parameters tab.

   (g) Eps1 and eps2 are the dissipation rates as estimated from the two velocity microstructure probes. They should be pretty similar. If one is systematically much lower than the other or even just systematically different in structure and amplitude it may be an indication that one of the sensors is broken. In this case you need to work out which of the two you trust most. Looking at previous profiles should help in this regard.

6   Profiling Float Operations and Measurements

Helen Phillips, Amélie Meyer and Nathan Bindoff

6.1   Float types, sources and funding

The flagship of our profiling floats is the EM-APEX, a next-generation Argo float that measures horizontal velocity profiles in addition to temperature and salinity. Having secured funding for the EM-APEX we were able to lever further support from other international float groups to build the total number of floats to 32. Table 11 lists the 4 types of floats contributing to the SOFINE experiment and their source.

Table 11: Float types, source institution and funding provider

Float Type	Provider	Funding Source
EM-APEX	Bindoff/Phillips/Rintoul University of Tasmania and Antarctic Cooperative Research Centre, Australia	Australian Research Council Antarctic Cooperative Research Centre, CSIRO
Iridium	Steve Riser University of Washington USA	US Argo
SOLO	Dean Roemmich Scripps Institution of Oceanography, USA	US Argo
APEX	Susan Wijffels and Steve Rintoul CSIRO and Antarctic Cooperative Research Centre Australia	ACE-CRC and CSIRO

The EM-APEX (EM) is an enhancement to Webb Research Corporation's version of the Argo float, APEX (Autonomous Profiling EXplorer) that includes a package, with compass, accelerometers and electrodes, to measure horizontal currents. They are the result of a collaboration between the University of Washington, USA and Webb Research Corporation. The electromagnetic subsystem, measures motionally-induced electric fields

generated by currents moving through the vertical component of the earth's magnetic field. Velocity measurements are processed within the float and are transmitted over the Iridium global phone system as eastward and northward velocity components. Individual velocity profiles are relative to an unknown constant offset. By pairing profiles, and obtaining a GPS position for each we can determine a full depth profile of absolute velocity.

The EM floats profile twice per day while they are in the survey region, measuring temperature, salinity and horizontal velocity from 1600 m depth to the sea surface. The vertical spacing of samples is approximately 2 dbar for temperature and salinity, and 5 dbar for velocity. The time between the two profiles is chosen to resolve the inertial frequency. Once the floats are advected past the Kerguelen plateau, we will reduce the frequency of sampling to a 10-day cycle to increase the lifetime of the floats and to broaden the geographical extent of the mixing observations. In addition, the subsurface drift over 10 days will contribute to the Argo program's inventory of this parameter.

The Iridium floats are similar to the EM-APEX in the fine vertical sampling they provide and the ability to modify their mission after deployment via the Iridium satellite phone network. At deployment these floats were set to profile once every 2 days, reverting to 1 profile every 10 days after 2 weeks. Another 2 weeks of 2-day profiling will begin when the floats approach the eastern side of the CTD array, near 73ºE.

The SOLO and CSIRO APEX floats are standard Argo floats that cycle once every 10 days, with approximately 70 samples between the surface and 2000m. The floats transmit their data to the ARGOS satellite network, and cannot be modified after deployment.

Except for the EM-APEX, all floats report to the Argo Global Data Assembly Centre (GDAC). The EM-APEX data will also be contributed to the GDAC once the data stream is established after the cruise.

6.2 Deployment strategy

In defining the float deployment plan we relied heavily on the mean position of the ACC fronts determined by Sergei Sokolov for the Kerguelen region. This work is a recent circumpolar update of the work described in 'Multiple jets of the Antarctic Circumpolar Current south of Australia' by Sokolov and Rintoul, Journal of Physical Oceanography 37:1394-1412, 2007. On the northern side of the Kerguelen Plateau, in the survey region, we find the northern, middle and southern branches of the Subantarctic Front (SAF). In past years the northern branch of the PF passed north of Kerguelen. More recently it has been passing to the south through the Fawn Trough.

Figure 10 shows the original deployment plan with Sokolov's mean front positions. Most of the floats were to be deployed on the western leg so that they drift through the CTD/microstructure survey as it is being done. Float trajectories calculated by Andrew Meijers (Uni. of Tasmania) suggest the floats deployed on the western leg will take about 4-5 weeks to reach the eastern leg, provided meandering of the fronts is not too large. The ship time between the start of the western leg and the end of the eastern leg is about 17 days. So the float and ship sampling will be roughly synoptic. We also planned to deploy some standard Argo floats on the second meridional line to reseed the western leg floats in case some fail or become trapped in closed circulations.
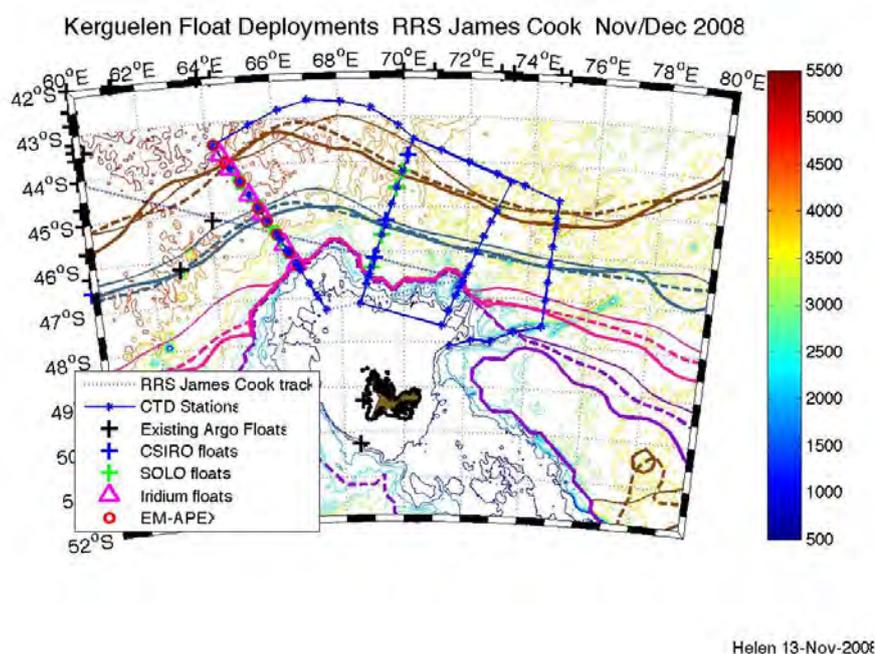
Figure 10: Planned deployment positions overlaid on Sokolov's mean front positions. SAF northern branch - brown, middle - black, southern - pink; PF northern branch - blue, middle - brown, southern - black. In each color there are 3 linestyles: thin solid is for the period 1992-96, heavy dashed is 1997-2002, heavy solid is 2003-2007.

We will keep all of the EM floats to the western leg, deployed to span as much of the cross-stream structure of the ACC as possible, and aiming for an EM to be south of, in and north of each of the 3 SAF branches. The shallowest deployment of the EMs will be about 1600m. This is approximately the depth the floats can achieve while ensuring that profiles are spaced one half inertial period apart in time. Sokolov's study suggests the deep fronts stay in water deeper than 2000m.

The Iridium floats will also be deployed to span as much of the ACC as possible, in water deeper than 2000m. They will profile once every 2 days, drifting at 1000 m in between. As a result they will likely travel slower than EMs, which will be spending more time above 1000m. We will use the Iridiums to fill the gap in dynamic height space not sampled by the EMs, also aiming to have some in the fronts and some either side.

The standard Argo floats, CSIRO and SOLO, will be distributed between the EM and Iridium floats to provide as much detail as possible of the cross-frontal structure, and some will be deployed on the 2nd meridional leg to re-seed the array. CSIRO requested that 5 of their floats be deployed on the transit leg to Kerguelen, to fill gaps in the Argo array. These floats, and others in the region may pass through the array within months of the SOFINE survey while the long-term moorings are still operating.

Three of the Iridium floats (0056, 5333 and 5334) and two of the CSIRO APEX floats (3638 and 3639) had oxygen sensors installed. We decided to deploy these in and around the northern branch of the SAF to sample the oxygen concentration of the Antarctic Intermediate Water and Subantarctic Mode Water.

Three Iridium floats (5346, 5345 and 5343) had ice-detection capability so we deployed these as far south as practicable.

6.2.1 Final deployment locations

Loss of time due to rough weather led to changes in the CTD station plan. The northern extent of the leg was reduced so that the northern part of the SAF was no longer crossed. However, the second leg did cross the range of dynamic heights spanning this jet. We therefore spread the float deployments across these two legs, covering with floats as much of the dynamic height range as was covered by the ship.

We received near real-time sea surface height (SSH) anomaly fields from Dr Madeleine Cahill at CSIRO in Hobart. The delay was about a week. Andrew Meijers from the Uni. of Tasmania subsampled the gridded fields to a size that could be downloaded to the ship. He also applied the near real-time anomaly to his Gravest Empirical Mode (GEM) fields of the Southern Ocean to produce near real-time maps of dynamic height, sea surface temperature, and subsurface temperature and salinity. We used these fields to monitor the constantly changing ACC jet locations. This information was vital not only to the float deployment planning and monitoring but also to the cruise planning in general. In addition to the GEM information, we also constructed near real-time dynamic height fields by adding the SSH anomaly to Sergei Sokolov's mean dynamic height field and using his SSH labels of the ACC branches to track their time-varying position. Using this information allowed us to alter the deployments to space the floats

well across the changing dynamic height field and to avoid deploying too many floats in closed circulations (rings). Figure 11 shows the final deployment positions of each float, with details listed in Table 14.
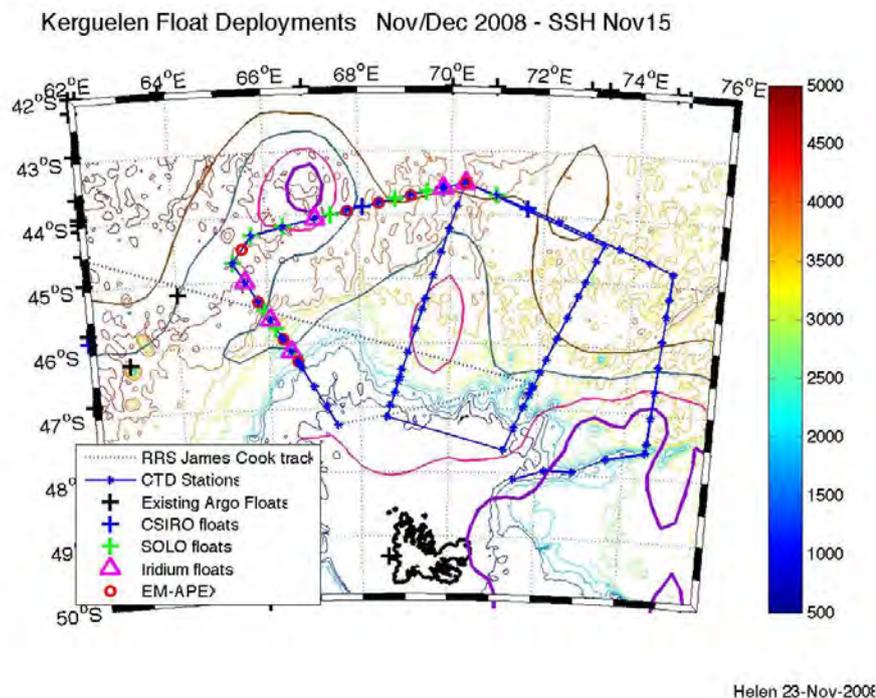
Figure 11: Final version of deployment plan overlaid on near-real time front positions (CSIRO gridded SSH anomaly added to Sokolov's mean 100/2500 dbar dynamic height field). SAF northern branch- brown, middle - black, southern - pink; PF northern branch - blue, middle - brown, southern - black

6.3 Preparation of floats

6.3.1 EM-APEX

Pre-cruise preparation

The EM floats were scheduled to be delivered to CSIRO Hobart for preparation and testing in May, 2008. Delays in manufacturing at Webb Research Corporation (WRC), USA meant that the floats were not ready in time to be shipped to Hobart, prepared and then shipped to Cape Town (even with air freight). A key part of the preparation

is replacing the alkaline batteries with lithium batteries. WRC have a policy of not working with lithium batteries and so could not do this step for us. We were very fortunate that the float group of the Woods Hole Oceanographic Institution (WHOI), led by Breck Owens agreed to make the battery changeover in their float laboratory. The EMs were delivered to WHOI on the 3rd October 2008. Over the weekend the battery changeover and associated re-ballasting, to ensure the weight of the float remains the same, took place. After the batteries were replaced each float was pressure tested. WRC staff then worked at WHOI to conduct final tests of the float programming, and test Iridium transmissions to the Hobart server. Each of the floats successfully logged in to our server during the tests. The floats were shipped to the agent of the *James Cook* in Cape Town, World Shipping Agencies, on the 10th October 2008, arrived on the 20th October 2008, were cleared through customs and delivered to the ship on the 28th October 2008. The first time we saw them was stacked neatly on the aft deck of the *James Cook* amongst the pile of other floats.

Pre-launch procedure

A simulation mode was used to test a variety of the EM-APEX hardware and software components, and to insert the parameters that defined our chosen sampling mission. Each float was connected to a computer using a RS-232 cable, a black box loop converter and alligator clips attached to the float. The program hyperterminal allows interrogation of the float and adjustment of mission parameters. The following procedure was then followed for each float:

- A log file is created in which the simulation mode is recorded;

- The mission parameters are updated onto the EEPROM memory of the float using the console 'mission params' submenu and then listed for the log file;

- The mission parameter list inside the float is then checked against the original list;

- The float's clock is set to UTC $\pm$ two seconds;

- The high-pressure pump is tested by moving the piston;

- The pneumatic system is tested by closing the air valve, pumping the air bladder to a nominated value and then monitoring the rate of change of the pressure within the bladder;

- The SeaBird CTD is checked by making sure the salinity, temperature and pressure readings are within a sensible range for a sensor in air;

- The compass is tested by tilting the float and recording the changes in the three channels of orthogonal acceleration;

- A "flash status" check is run to check the state of the flash memory and record any bad blocks in the flash table;

- Finally, the modem and GPS tests are performed. The float is disconnected from the computer and carried outside to download a new almanac of satellite locations, which needs to be less than two weeks old at the time of deployment.

- A log file is created in which the simulation mode is recorded;

External adjustments to the float include attaching a hose clamp to increase the weight of the float, putting reflective tape around the top end cap and antenna, and writing "If found please contact CSIRO Australia +61 3 6232 5222" in permanent pen. The ballasting details from Webb Research Corporation were checked by John Dunlap. He found that the floats were too light by between 30 and 50 g wet weight. Bob Weldon and Vito Dirita of CSIRO sourced 8 stainless steel hose clamps (Tridon Australia P/L SMPC8P regular clamp, 155-180 diameter, 12.7 mm wide, 304 steel strap, 301 steel nut), the dry weight of which was measured in Hobart. We used the formula (wet weight = dry weight x $(1 - \frac{1.03}{7.95})$) to convert to wet weight. The density of sea water is approximately 1.03 g cc^{-1} and the density of 304 stainless steel is approximately 7.95 g cc^{-1}. Table 12 lists the weight of the hose clamp fitted to each EM.

Table 12: Dry and wet weights of hose clamps added to EM-APEX

Hull #	Hose clamp #	Dry weight (g)	Approx. Wet weight (g)
3760	2	52.1	45.3
3761	4	52.2	45.4
3952	5	52.3	45.5
3762	6	52.3	45.5
3950	1	52.3	45.5
3951	3	52.4	45.6
4051	7	52.3	45.5
3764	8	52.0	45.2

Once all preparations are completed the CTD plugs and caps are removed and the float is packed into the cardboard deployment box. The internal supports are fitted to hold the EM firmly around the end cap waist. A hole is cut in the box to allow the electrodes to be removed and the computer to be connected to start the mission just

prior to deployment. The harness is fitted and secured with a water release mechanism, and the float's details are written on the box.

6.3.2 Faults with EM-APEX

As we checked each of the EM-APEX on the ship we found quite a few faults, listed in Table 13.

Table 13: Faults found with EM-APEX during the voyage

Hull #	Loose antenna	Oil around end-cap	Loose tension rod	Bad flash blocks	Cowling damage
3760	Yes	—	—	—	Yes
3761	Yes	—	—	—	—
3952	Yes	—	—	—	—
3762	—	Yes	—	—	—
3950	—	—	—	945, 1023	—
3951	Yes	—	—	710, 711	—
4051	—	Yes	Yes	353	—
3764	—	—	—	—	—

Four floats (3760, 3761, 3952 and 3951) had antennae that were loose by about $\frac{1}{4}$ turn. WRC advised we should tighten these with as much torque as can be applied by strong hands. This was done.

Float 3760 had a damaged cowling. It had been pushed or pulled away from the anodized end cap enough to distort the plastic around the bolts. WRC advised that they had seen this type of damage before and suspect that the crate was dropped during shipping. If dropped hard enough the foam cradles can be deflected so that the cowling hits the inside of the crate. We could see no damage to the bladder inside the cowling and judged the cowling to be well enough secured to be deployed as it was.

Two floats (3762 and 4051) had smears of oil around the end caps. We were concerned that this suggested a leak of oil from within the float. On consultation with WRC we determined that the oil was most likely excess o-ring lubricant leaking out of the seal. Unusual but harmless.

Float 4051 had a misaligned end cap (the 2 blue alignment marks were offset by about

Figure 12: Phil Adam's hands using the tool he made to obtain a vacuum, in a controlled manner, in float 4051.

3 cm. We were able to turn the end cap to make the lines meet. WRC advised that it should not be possible to turn the end cap and this means that the internal tension rod is loose. The float would probably leak if deployed in this condition. The two NOC moorings technicians Paul Provost and Dan Comben, and Phil Adams, moorings and electronics technician from CSIRO Hobart took up the challenge of fixing the float. The float was opened and we heard the vacuum release. We didn't have an APEX evacuation tool on board so Phil set about constructing one as well as an Alan key long enough to tighten the tension rod.

While the float was open we took the opportunity to explore potential fixes to the flash memory problem. See below. Once we had finished working with the float it was reassembled. The top o-ring was pinched during reassembly and this was replaced with a spare from the moorings supplies. The tension rod was then tightened and a vacuum was sucked down to -6.17" mercury, using a pump that happened to be on board. After 20 minutes the vacuum pressure was stable at -6.15" Mercury. We were satisfied that this float could be deployed if the flash problem could be fixed.

Floats 3950, 3951 and 4051 were found to have bad blocks in their flash memory. We discovered this at the deployment of float 3950, the first EM deployment, when it refused to start upon the issue of the 'mission start' command. It reported bad flash blocks as the reason for not starting. We had float 3760 ready and deployed this instead.

In consultation with John Dunlap we learnt that the float firmware should be able to handle bad blocks in the flash table but, since John had never had bad blocks before, this part of the firmware had not been tested. John was able to fix the code and test it on a float in his lab. Since we did not have a flash programming device on board we couldn't install the corrected firmware into the floats. While 4051 was apart we tried to reset the float memory by disconnecting the batteries. After reconnection and reformatting the flash there were still bad blocks.

John spent many days running simulations on his float, mimicking our bad flash block problem. He discovered that the float could be forced to start using a magnet placed over the reed switch. Furthermore, he found that the float would return good data until if filled the memory once and wrapped around. After this the data would begin to be scrambled. We decided that the 80 profiles each float could give us before the memory wrapped would be a valuable contribution to the project. We anticipated we might be able to recover the floats at the end of the voyage and deployed them along the northern leg on a dynamic height contour directed into the interior of the array. By the end of the CTD survey John Dunlap had worked out that he could decode 90% of the data after the flash had been filled with data and wrapped back to the beginning of the flash. This sounded like an excellent return rate and we decided not to recover any of the floats. They are all operating well and are returning data that comprise a significant part of our incredible dataset.

Deployment

Six of the eight EM floats were collocated with CTD stations to provide salinity observations to check the calibration of the float salinity sensor. These EMs were deployed at the end of the CTD station after the VMP was back on board, as the ship began to move away from the station. The ship's speed was usually around 5 knots. The other two EMs (3762 and 4051) were deployed while the ship was underway and travelling at 5-10 knots. Four EMs were deployed along the western cruise leg (Fig. 11 and Table 14), of which 3 were collocated with CTD stations. The remaining 4 floats, 3 collocated with CTDs, were deployed along the northern leg.

Once at the deployment location, the following procedure was carried out for each float:

- Check that the water depth is bigger than 1600 meters;

- Remove the covers from the 5 electrodes so the agar surface is exposed;

- Connect the float to the computer and start the mission with the 'mission start' command, or using the magnet;

- Watch the console screen until the piston has returned to the ballast point;

- The float within its box is then carried outside to the aft deck for the launch and lowered overboard with a line attached to the harness. The harness has a water soluble release mechanism. Once the salt tablet is wet it takes only 1-2 seconds for it to dissolve and free the box. The harness is pulled back on board and the box floats away;

- A position, time and depth are recorded during the deployment by the bridge and transcribed to the float log sheet later.

6.3.3 U. Washington Iridium

Pre-launch procedure

After the Iridium floats were delivered to the ship, Rick Rupan from the University of Washington came to prepare them for the cruise. He performed all of the necessary pre-launch checks and packed the floats back in their shipping crate. When Amélie and Helen arrived at the ship, Rick explained the rope deployment procedure.

Deployment

Once at the deployment location the Iridium floats were removed from their packing case, the date was written on the label, and the float was carried to the stern. A soft rope was passed through the hole in the float's damping ring and used to lower the float carefully over the stern. Once the float touches the water the rope is pulled back on board and the float goes free.

6.3.4 Scripps SOLO

Pre-launch procedure

The Solo floats were delivered to the ship already in deployment boxes with harnesses and salt releases attached, stored inside individual plastic bags. Sebastiaan Swart from the University of Cape Town came to the ship to run the pre-deployment checks on each float and to activate the floats for deployment. Amélie Meyer assisted with the checks. The checks took about 80 minutes to complete and all 10 floats passed the test at the first attempt. Once the float has been activated, it had to be deployed within two months. Sebastiaan and Amélie inspected each of the releases and noted which ones were faulty (2827, 2829, 2834) and would need to replaced prior to deployment with a release from a previous deployment.

Deployment

Once at the deployment position, the float is deployed over the stern of the ship inside a bio-degradable cardboard box held together with two bands of soluble PVA tape. The box protects the delicate parts of the float from impact during launch. The box is lowered on a line attached to the harness around the box. Once in the water, the water release on the harness activates and the box is released. After some time the tape dissolves, the box unfurls and the float is freed from the box.

On the second SOLO deployment (2825) the salt release took close to a minute to release, rather than the usual 2 seconds. On closer inspection we discovered that the diameter of the spring was just large enough to be forced down over the stopper on the release pin. The result was that the pin didn't withdraw fully when the salt dissolved. We decided to replace all SOLO float releases for future deployments with the CSIRO releases which had been 100% reliable.

Four SOLO floats (2827, 2828, 2829 and 2831) were deployed at the end of CTD stations, just as the ship got underway. The remaining 6 were deployed while the ship was underway and moving at 5-10 knots.

6.3.5 CSIRO APEX

Pre-launch procedure

Cardboard deployment boxes were provided for each of the CSIRO APEX floats. We constructed the boxes and packed each float into one, after removing the plugs and caps from the CTD intakes and exhaust. A CSIRO harness was fitted to the box, a water release mechanism was installed on the harness, and the float's identification and deployment position was marked on the box.

Deployment

Five APEX floats were deployed along the transit leg before we reached the survey region. The remaining 3 floats were deployed along the northern leg.

The APEX floats arrived at the ship in hibernate mode. An hour prior to deployment, they had to be activated using the following procedure:

- Reset the profiler using a magnet, which is held on the RESET location marked on the float hull. Once activated, the float is in mission mode and begins self testing ;

- After approximately 10 seconds, we check that the float sends six Argos transmis-

sions at six seconds intervals. These transmissions can be detected by putting an Argos receiver close to the antenna;

- The hydraulic piston pump then begins to move to full extension and the oil bladder to expand. It takes about 20 minutes for the oil bladder to be fully inflated and the float then starts to send test messages every 45 seconds , confirming mission start.

The float must then be deployed within two hours of reset within waters deeper than 2000m. The float within its box is carried outside for the launch and lowered over the stern with a line attached to the harness. Once the water release on the harness touches the water, the harness opens up, letting go of the box and therefore the APEX float. A position, time and depth are recorded during the deployment by the bridge officers, and transcribed to the float log sheet after the deployment.

6.4   Data reception

6.4.1   EM-APEX

Prior to the voyage we established a modem pool and data server at UTas to receive the Iridium phone calls from the floats and log the data. The data is backed up to a secondary server at the Tasmanian Partnership for Advanced Computing (TPAC), which in turn is backed up onto shared disk space distributed across Australia. Once a phone call is received the data is downloaded onto the server and MATLAB processing software is activated. The software was developed by John Dunlap at the University of Washington in the research group of Prof. Tom Sanford and Dr James Girton, where the EM float was originally developed. The software converts the raw data to matlab format, calculates and plots diagnostic information. We accessed the data by secure copy from the Hobart data server. The data and plots are displayed on a web server at TPAC http://ngportal.sf.utas.edu.au. The links to these files were sometimes lost so that the web server couldn't display them. John Dunlap ran a mirror to the files on his own server.

John Dunlap provided immense support in fine tuning the processing software to our local system and in helping us develop the parameters to achieve our profiling require-ments. John also provided valuable shore-based support (via secure VPN connection to our data server) while we were at sea. John was able to monitor the quality of the data, then suggest and apply modifications to the profiling mission. We also owe our thanks to Jamie Stevens for setting up the modem pool and data server, and Leigh Gordon for setting up the backup pathways through TPAC and the web display of the float plots.

6.4.2 Iridium

The Iridium floats use the same system as the EM floats, but the server they log into is operated by Dr Steve Riser's group at the University of Washington. We were supposed to receive a position report to our Iridium phone on the ship each time the floats logged in, but this never worked after the initial tests when the floats were still on the ship. While on the ship, the data has been sent to us once a week by email. For future profiles we will be able to access the data through the Argo Global Data Assembly Centres (http://www.coriolis.eu.org/cdc/argo.htm and http://www.usgodae.org/argo/argo.html).

6.5 Preliminary data

As of the 16th December 2008 we had received 766 profiles of temperature, salinity and horizontal velocity from the EM floats. This dataset looks absolutely fabulous. Figure 13 shows the path the EM floats have taken. The large eddy to the north of the survey region took 3 of the floats much further north than we expected but these will give a fascinating insight into the development of that particular eddy.

Figure 14 shows the dense coverage in potential temperature-salinity space and dynamic height space across the ACC that the EM floats have delivered. Figures 15 and 16 are sections of potential temperature and salinity along the track of float 3761.

6.6 People responsible for the above

The float team comprised Nathan Bindoff, Amélie Meyer and Helen Phillips. We also received wonderful support from quite a few people. NOC technicians Paul Provost and Dan Comben always responded enthusiastically to requests for help with deployments, for advice on deployment and recovery techniques, and faults with the floats. Phil Adams also provided fantastic technical support and constructed an elegant device to restore the vacuum to an EM-APEX that had to be opened up for adjustment. Mirjam Glessmer ably took control of deployments that occurred on the night watch so the float team could sleep. Charlie Cooney, Lee Stephens, Ian Cantlie and Steve Smith provided cheerful deck support and strong arms for deployments. Bernadette Sloyan, Mirjam Glessmer and Angelika Renner helped build the CSIRO deployment boxes.

Table 14: Float deployments from cruise JC029 aboard RRS *James Cook* November-December 2008

Hull #	WMO ID	Float Type	UTC Date and Time		Latitude	Longitude	Depth (m)	Station #	CTD type	Additional Sensor or Algorithm
3975	1901128	CSIRO Apf9	05/11/2008	19:13	40° 30.21'S	36° 00.87'E	3860 m	-	-	-
3976	1901129	CSIRO Apf9	07/11/2008	03:24	41° 54.80'S	43° 40.74'E	2975 m	-	-	-
3977	1901130	CSIRO Apf9	07/11/2008	16:02	42° 20.58'S	46° 00.10'E	3500 m	-	-	-
3978	1901131	CSIRO Apf9	08/11/2008	21:02	43° 24.63'S	51° 59.87'E	3600 m	-	-	-
3979	1901132	CSIRO Apf9	09/11/2008	16:02	44° 07.00'S	56° 00.18'E	4468 m	-	-	-
3760	1901136	EM-APEX	18/11/2008	02:02	46° 16.85'S	66° 37.82'E	1766 m	17	SBE41-ALACE	EM velocity
2823	1900804	SOLO	18/11/2008	02:47	46°07.86'S	66° 34.03'E	2122 m	-	-	-
5346	-	Iridium Apf9	18/11/2008	09:13	46° 55.39'S	66° 33.96'E	2226 m	18	SBE41cp	Ice detection
3761	1901137	EM-APEX	18/11/2008	11:50	45°42.71'S	66° 22.71'E	2438 m	-	SBE41-ALACE	EM velocity
2825	1900805	SOLO	19/11/2008	15:55	45° 35.80'S	66° 13.04'E	3360 m	-	-	-
5345	-	Iridium Apf9	19/11/2008	20:49	45° 27.41'S	66° 02.76'E	3708 m	21	SBE41cp	Ice detection
2826	1900806	SOLO	19/11/2008	22:17	45° 20.93'S	65° 54.68'E	4269 m	-	-	-
3952	1901138	EM-APEX	20/11/2008	06:08	45°01.66'S	65° 46.00'E	4625 m	22	SBE41-ALACE	EM velocity
5343	-	Iridium Apf9	20/11/2008	13:31	45° 44.03'S	65° 30.90'E	4432 m	23	SBE41cp	Ice detection
2827	1900807	SOLO	20/11/2008	22:20	44° 27.79'S	65° 17.56'E	>4000 m	24	-	-
3762	1901139	EM-APEX	21/11/2008	07:26	44° 16.67'S	65° 31.92'E	4383 m	-	SBE41-ALACE	EM velocity
2828	1900808	SOLO	21/11/2008	17:22	44° 09.86'S	65° 43.11'E	>4000 m	25	-	-
2829	1900809	SOLO	22/11/2008	23:50	44° 03.76'S	66° 24.46'E	4552 m	26	-	-
0056	-	Iridium Apf9	23/11/2008	08:13	44° 59.78'S	67° 04.56'E	4460 m	27	SBE41cp	Oxygen - Optode
2830	190010	SOLO	23/11/2008	09:55	43° 56.62'S	67° 24.62'E	4398 m	-	-	-
3950	1901140	EM-APEX	23/11/2008	15:44	43° 53.87'S	67° 45.40'E	4287 m	28	SBE41-ALACE	EM velocity
2954	1901691	CSIRO Apf8	23/11/2008	18:00	43° 49.28'S	68° 07.27'E	3796 m	-	-	-
3951	1901141	EM-APEX	24/11/2008	03:38	43° 51.97'S	68° 26.65'E	4031 m	29	SBE41-ALACE	EM velocity
5333	-	Iridium Apf9	24/11/2008	09:55	43° 51.90'S	68° 28.92'E	>3500 m	29	SBE41cp	Oxygen - Ido
2831	1900811	SOLO	24/11/2008	09:56	43° 54.80'S	68° 28.85'E	>3500 m	29	-	-
4051	1901142	EM-APEX	24/11/2008	12:18	43° 54.80'S	68° 49.97'E	3712 m	-	SBE41-ALACE	EM velocity
3639	1901692	CSIRO Apf9	24/11/2008	11:48	43° 54.80'S	68° 43.55'E	4033 m	-	-	Oxygen - optode
3764	1901143	EM-APEX	25/11/2008	11:44	43° 54.80'S	70° 35.54'E	4037 m	32	SBE41-ALACE	EM velocity
2832	1900812	SOLO	25/11/2008	14:00	43° 54.80'S	70° 58.15'E	3908 m	-	-	-
5334	-	Iridium Apf9	25/11/2008	19:42	43° 54.80'S	71° 20.55'E	3663 m	33	SBE41cp	Oxygen - Ido
2834	1900813	SOLO	25/11/2008	22:01	43° 54.80'S	71° 44.48'E	3773 m	-	-	-
3638	1901693	CSIRO Apf9	26/11/2008	05:20	44° 54.80'S	72° 13.15'E	3780 m	34	-	Oxygen - optode
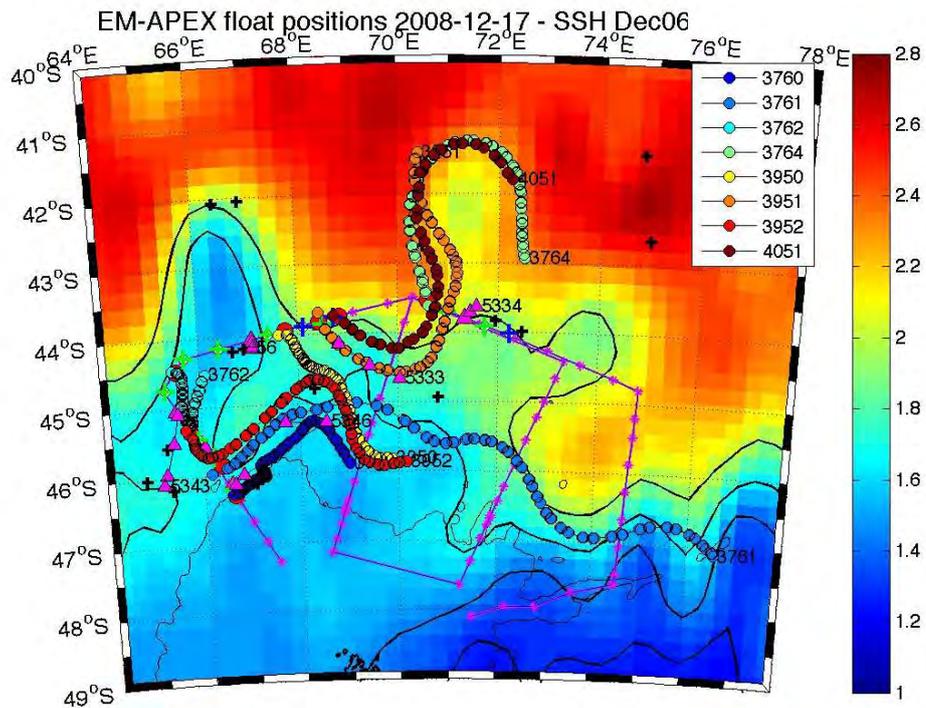
Figure 13: Path of the EM-APEX floats (colours) as of the 16th December 2008 overlaid on the SSH field from the 6th December 2008. Also shown are Iridium float positions from 7th December 2008. Blue/green crosses mark the deployment positions of CSIRO/SOLO floats. Black crosses mark Argo positions reported to the Argo Information Centre as of the 6th December 2008.
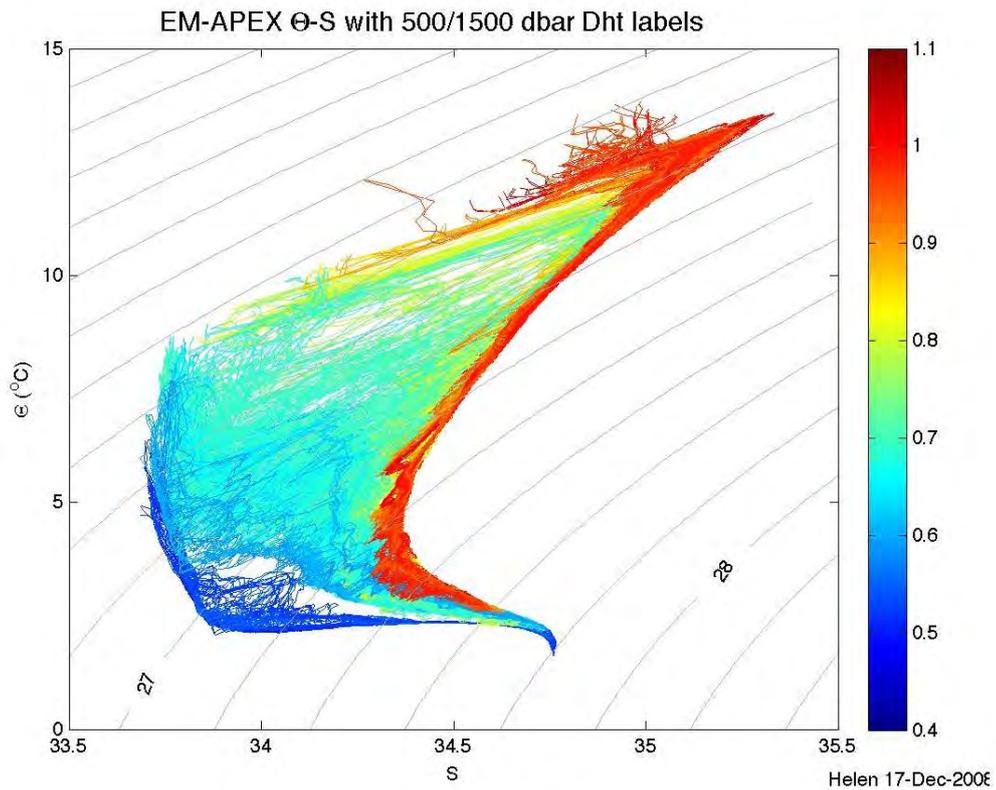
Figure 14: Potential temperature-salinity diagram for all EM-APEX profiles collected by the 17th December 2008. The profiles are coloured by dynamic height of 500 dbar referenced to 1500 dbar.
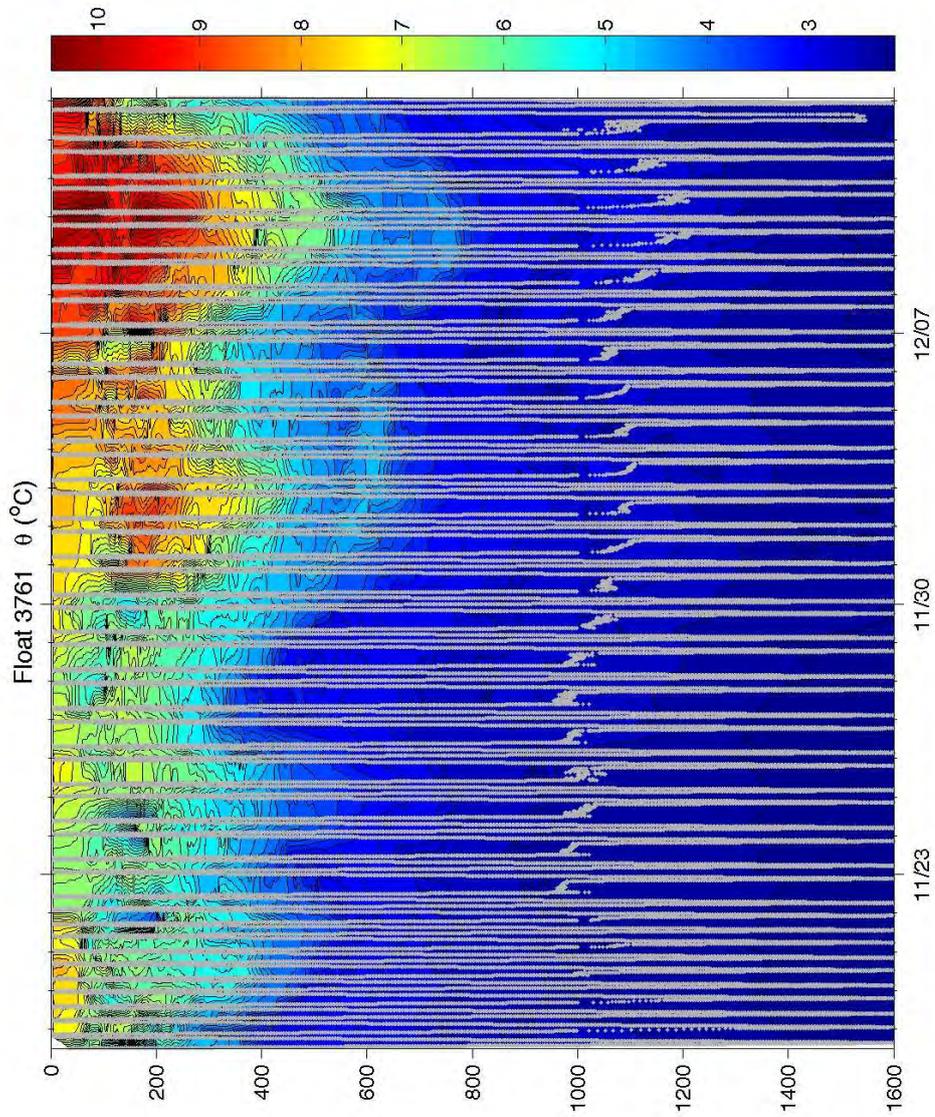
Figure 15: Vertical section of potential temperature along the path of float 3761, with distance shown as time. Grey lines indicate the pressure changes of the float with time.
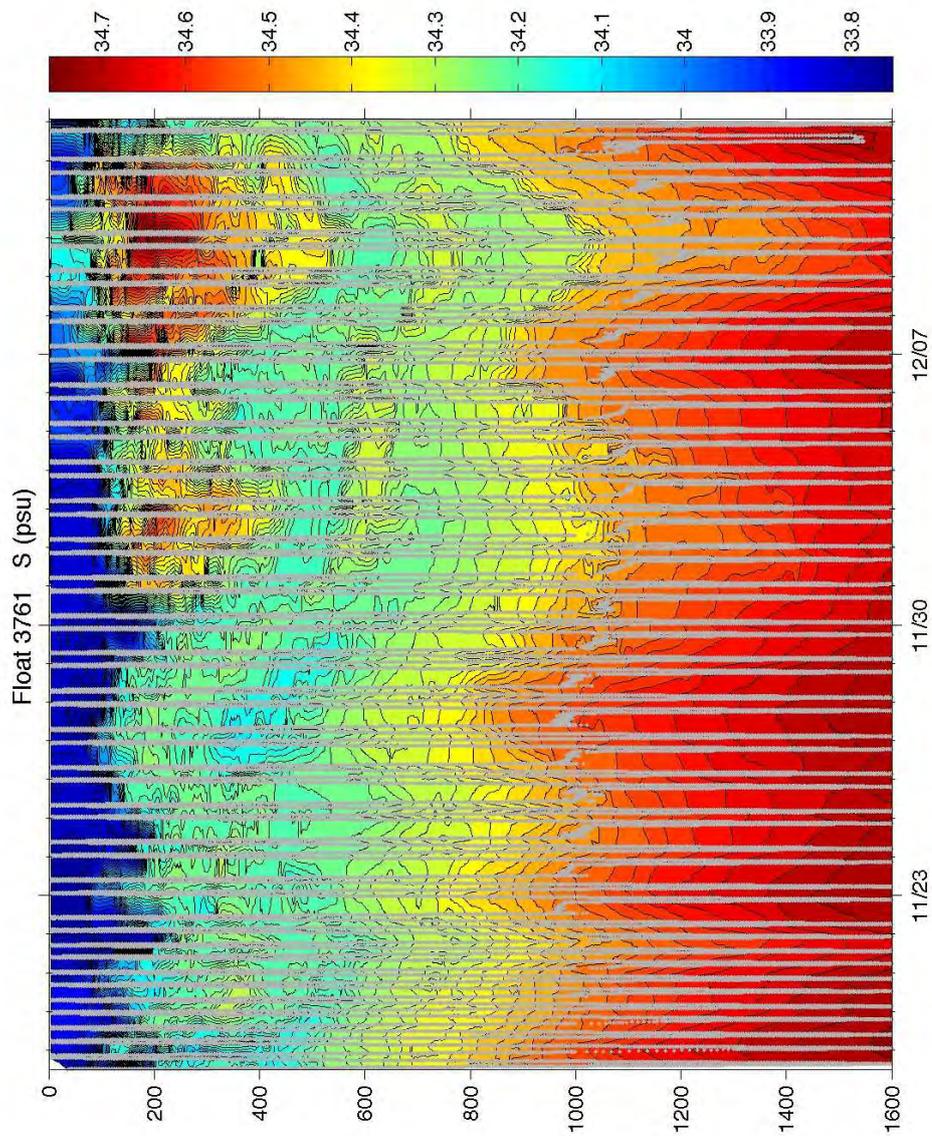
Figure 16: Vertical section of salinity along the path of float 3761, with distance shown as time. Grey lines indicate the pressure changes of the float with time.

7   Drifter Deployments

Alberto Naveira Garabato

Ten drifting buoys were deployed during JC029 for the Global Drifter Program as a result of a collaboration between NOAA / AOML (who funded the buoys and communication costs), Méteo-France (who paid for barometer upgrades and handled the deployment instructions), the South African Weather Service (who received the buoys in Cape Town and made arrangements for their loading aboard the RRS *James Cook*), and NOC (who agreed to deploy them). The drifters were deployed according to standard deployment guidelines found in http://www.aoml.noaa.gov/phod/dac/dep_inst.html. The drifter deployment positions were specified by Pierre Blouch and colleagues at Méteo-France.

Table 15: List of drifter deployments during JC029.

Drifter number	Julian day	Date	Time (GMT)	Latitude	Longitude	Water depth (m)
83355	309	04-Nov	15:12	39° 25'S	30° 11'E	4254
83344	310	05-Nov	19:11	40° 30'S	36° 00'E	3860
83341	311	06-Nov	20:21	41° 36.7'S	42° 00.3'E	2460
83343	313	08-Nov	06:02	42° 58.1'S	49° 31.1'E	3147
83340	314	09-Nov	06:00	43° 46.4'S	54° 08.2'E	3957
83342	315	10-Nov	07:06	44° 50.4'S	60° 11.8'E	4760
83357	316	11-Nov	10:00	45° 52.866'S	66° 20.208'E	3090
83359	344	10-Dec	06:07	42° 01.12'S	68° 42.06'E	4230
83358	350	15-Dec	06:02	38° 07.14'S	42° 37.14'E	3650
83356	352	17-Dec	07:04	36° 89.0'S	29° 14.35'E	3650

8 Navigation

David Stevens

The ship's primary GPS System for scientific data and also part of the Dynamic Positioning system is the Applanix POSMV. The POSMV data stream is logged by the techsas system and displayed in the main lab. The get_posmvpos script produced a daily file (e.g. *posmvpos327.pstar*) in *pstar* format containing the RVS 'posmvpos' position data at 1 second intervals. This contained latitude, longitude, altitude, prec, mode, cmg and smg. The cmg (course made good) and smg (speed made good) fields were empty. A **Matlab** script, *pstar_to_mstar_wrap*, produced an *mstar* file (e.g. *posmvpos327.nc*) in netcdf format with the correct meta data. Note: The **Matlab** command *m_setup* has to be issued to setup the paths for the *mstar* commands (e.g. *mload* , *mapend*). The daily files were combined into a master file *posmvpos_all_jc29.nc* using *mapend*.

A second plain *ascii* file *posmvpos_all_jc29.asc* was produced using the *listit* command *listit -s 08306100000 -e 08356160000 posmvpos lat lon alt prec mode cmg smg > posmvpos_all_jc29.asc*. The extracted navigation data are stored in the ∼*/jc29/nav* directory.

9 Vessel-mounted ADCP Instruments, Data Collection and Processing

Angelika Renner, Mirjam Glessmer

9.1 Introduction

As JC29/SOFINE was the first long cruise on the RRS James Cook with a purely physical interest, experience with the vessel-mounted ADCPs was little. The characteristics of the instruments with respect to best setup for data collection and the data quality were more or less unknown. We used the experience from previous cruises onboard RRS James Clark Ross with the same instrument and adapted procedures to the JC29 requirements. Help from land by Brian King was also highly appreciated.

During SOFINE, we run both ADCPs throughout most of the cruise. On transit to and from the Kerguelen Plateau, the keel was retracted most of the time to allow for faster steaming. The data collected during that time, though not thoroughly processed yet, present an opportunity to investigate data quality of both ADCPs when the keel is not lowered and the ship is making good speed. Once the plateau was reached, the keel was lowered and stayed down until we left the region.

9.2 The Instruments: OS75 and OS150

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.

The lowering of the keel has to be done by the Science System's Manager, in the case of JC29 Mick Myers, after consultation with the bridge. To lower and raise the keel, the ship has to slow down to 5 knots or less. When the keel is lowered, the maximum ship speed is limited to 10 knots. On passage between Cape Town and the Kerguelen Plateau, the ADCPs were run with the keel retracted to enable faster cruising speeds.

The switch to turn on the ADCPs themselves is in the transducer connection room on

the main deck. The Science System's Manager or the NERC technicians have access to that room.

The PCs The ADCPs are controlled via VmDas through separate PCs. They are located in the main lab in the EK500 rack. The monitors and keyboards are next to the rack. The PC clocks are adjusted to the ship's clock in very long intervals. However, we did not experience major drift or other problems with the clocks during the cruise. 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.

Alignment According to the installation report from the contractors, both ADCPs should be perfectly aligned with the ship's axis. However, after the first couple of days of data collection, we noticed that the OS75 is roughly 9 degrees off. To enable real time monitoring of the currents before and during VMP deployments using WinADCP, we changed the setting in the command files from EA00000 to EA00900. This was accurate enough for the VmDas internal processing to produce ship speed corrected velocities which were displayed in WinADCP.

Synchronisation The ADCPs were run independently from the Sound Synchronisa-tion Unit (SSU) with an internally set ping rate of 2 seconds or set to ping as fast as possible. Throughout the cruise, other acoustical instruments were running including the EM120, EA600, EK500 (during the later CTD stations) and the bridge's shallow echosounder. The effect of potential interference from these instruments is discussed in section 9.7.

9.3   Data Aquisition: VmDas

(Adapted from the JR165 cruise report)

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 JC29, the ADCP setup, data logging, preliminary screening, and mapping of beam data onto Earth coordinates was done with VmDas. The final processing was performed after the cruise using a set of Matlab routines (see section 9.5).

9.3.1 General settings

OS150: During JC29 we used three different settings for the OS150:

- Broadband with Bottom Tracking on

- Narrowband with Bottom Tracking on

- Narrowband with Bottom Tracking off

Additionally, transducer depth adjustments were made for when the drop keel was lowered or retracted. In broadband mode, the bin size was set to 4 m, profiling to 45 bins and the blanking distance at the surface was 6 m. In narrowband mode, the bin size was 8 m, number of bins was set to 60, and the blanking distance was again 6 m. The time between pings was 2 seconds (to be set in VmDas).

OS75: Two settings were used for the OS75:

- Narrowband with Bottom Tracking on

- Narrowband with Bottom Tracking off.

Transducer depth was adjusted as for OS150. In both settings, profiling was set to 60 bins, bin depth was 16 m, and the blanking distance at the surface was 8 m. The time between pings was 2 seconds.

For both: An overview over the available commands to set the ADCP operating parameters and the command files used during JC29 can be found in the Appendix (9.9). For more information on the commands refer to the RDI Ocean Surveyor manuals, in particular the volume 'Commands and Output Data Format'.)

To run the ADCPs through the SSU, a line in the command files has to be uncommented or added:
```
; Set Trigger In/Out [ADCP run through SSU]
CX1,3
```

9.3.2   What to set and to check

In VmDas, several things have to be set or checked before start acquiring data. During JC29, 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_JC29 (or OS75_JC29)

    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)

114

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[2].

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

- Create and maintain a list with all files created and the setup used. The lists for JC29 are shown in Appendix 9.10. 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 JC29, it was usually around 0.10). Jumps in the PC clock time can be detected by checking this.

9.3.3 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

---

[2]A frequent error occurred throughout JC29 regarding the NAV data feed(see section 9.4) which led to much larger LOG-files. The error was found to not affect the postprocessing.

changed before every restart of recording, and yyyyyy is a number automatically set by VmDas starting at 0 and increasing when the file size becomes larger than max size and a new file is created. END is the filename extension, denoting the different files that are created for each recording. The following list shows all the different file types that were created during JC29 and their content.

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

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

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

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

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

- **.N1R**: ASCII text; raw NMEA data, see section 9.4.

- **.N2R**: ASCII text; raw NMEA data, see section 9.4.

- **.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. During JC29, the first option was used and only one of the modes was active at any time.

- **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

116

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).

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.

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

9.4   Navigation data input

The navigation data is fed directly to the ADCP PCs from the Applanix POSMV System. For details of the navigation data system see David Stevens' part and the JC025 report.

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.`

A frequent error message appeared during JC29 regarding the source of heading, e.g.:
```
[2008/11/07, 10:28:29.997]: GGA data is now unavailable from its primary source
[2008/11/07, 10:28:29.997]: NO GGA data will be stored in the NAV field
starting with ens 76
[2008/11/07, 10:28:30.747]: GGA data can now be read from its primary source
[2008/11/07, 10:28:31.997]: PRIMARY GGA data will be stored in the NAV field
starting with ens 77
[2008/11/07, 10:38:40.728]: NMEA Heading data is now unavailable from its
primary source
[2008/11/07, 10:38:41.696]: NMEA Heading data can now be read from its primary
source
```
Trying different sources for heading in the 'edit data options' − > Nav tab did not help. It does not seem to affect the data though.

During JR141, Jeremy Robst wrote the program `nav_gaps.pl` that checks the ensemble numbers in the $PADCP line in the N1R- or N2R-files for missing numbers, duplicates or backward jumps (for details and the program see the JR165 report). Running the program with the JC29 data gave no faulty ensembles.

9.5   Post-processing in Matlab

9.5.1   The Matlab routines

For the post-processing of the VmDas data, we used a set of Matlab routines. They were first obtained from IfM Kiel by Mark Inall and adapted for use on the RRS James Clark

Ross by Deb Shoosmith. During JR165, Mark Brandon and Angelika Renner cleaned up large parts of the routines and added comments throughout. Since JR165, some further debugging and refinement have been done by Deb Shoosmith, Hugh Venables and Angelika Renner. The structure, general processing, and in- and output formats remain the same. The following description of the routines and the output data files are taken from the JR165 ADCP report with adjustments for JC29.

9.5.2 Remarks and Glossary

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

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

- 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_jc29.m`. The processing of the OS150 data works in exactly the same way, only the main routine needs to be adjusted (`OS150_JC_jc29.m`).

9.5.3 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_jc29.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 apears in the plots.

119

- 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'. 'superaverage' sets the interval over which ping ensembles will be averaged. Unit is seconds.

- The year: variable 'YYYY'.

- A switch for which lat/lon fix to be used (see below, 9.5.4): variable 'which_prdid_fix'. Options are a) 1 to use the fix directly after the previous ADCP ping, or b) any other number to use the fix directly before the current ADCP ping. Set it to 1 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 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_jc29.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_jc29.m` again. Mean, median, and standard devation are displayed in the plot adcp_calib_calc.ps. To keep track of which values were used, it is a good idea to note down, which file sequences require which correction factors. *Deb Shoosmith modified this bit so that only 'misalignment_nb' and 'amplitude_nb' are used. On JC29, almost all data are in narrowband mode so that we just use the changed version. It is possible though, to return to the previous version 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_jc29.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_jc29.m` to these values.

4. Run `OS75_JC_jc29.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.

That's it!

9.5.4   Detailed description of the processing functions

The master function: `OS75_JC_jc29.m`

The main function for the processing is `OS75_JC_jc29.m`. In there, the environment and variables are set, and the subfunctions are called. Fig.17 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; this will make sense later, see 9.5.4. 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 (see 9.5.4 and 9.5.4).

Then, during the first run through `OS75_JC_jc29.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, we 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
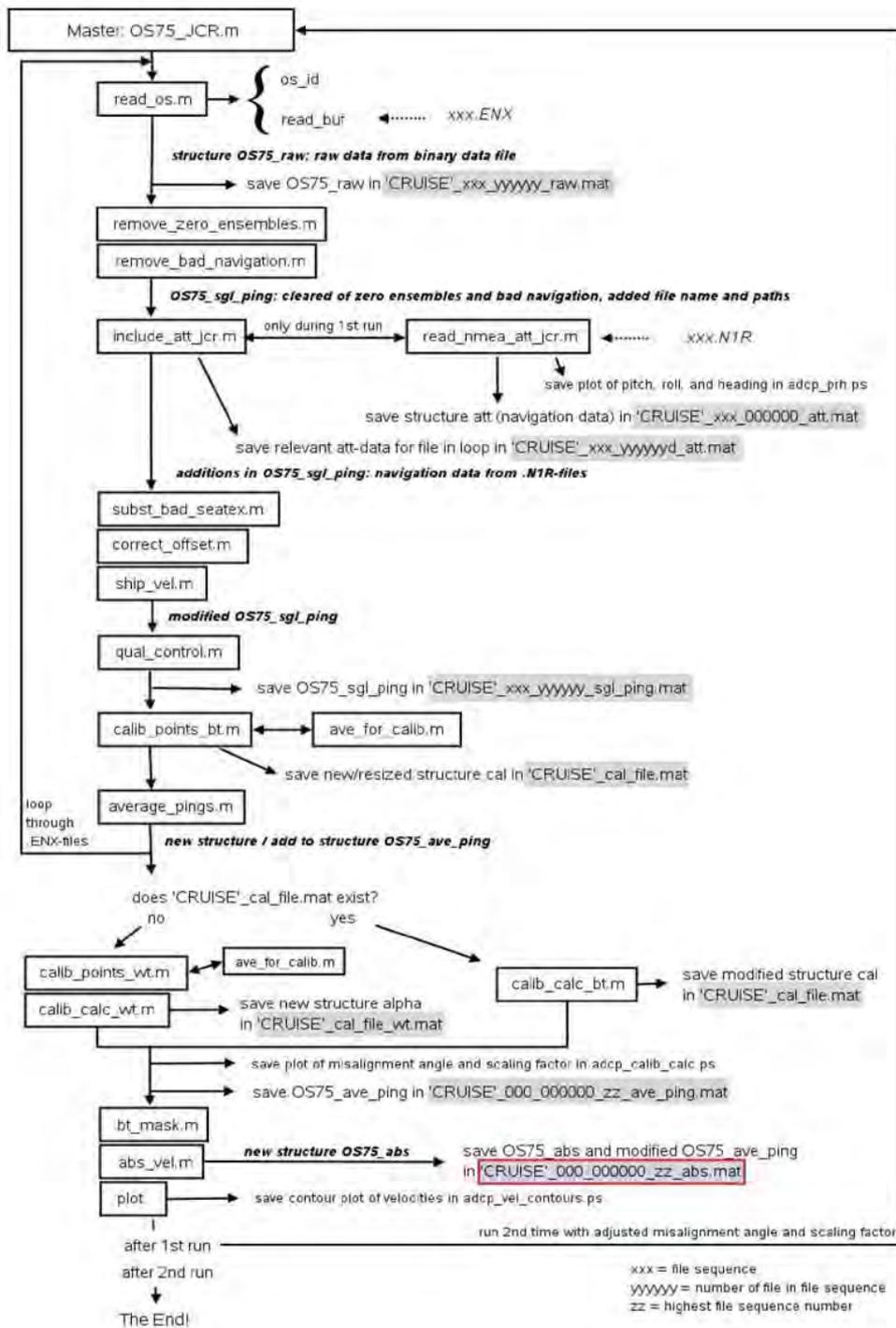
Figure 17: Flowchart of the processing path from the JR165 report. The master for JC29 is OS75_JC_jc29.m for the OS75 instrument. An additional routine `vel_clean_plus_ship.m` was added by Hugh Venables after `ship_vel.m`.

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 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 in 9.5.4 to 9.5.4. Once all files have been passed through these routines and the loop is finished, the functions described in 9.5.4 to 9.5.4 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. In case of JC29, we used the .ENX files, which contain ADCP single-ping and navigation data. The ADCP single-ping data has already been bin-mapped, transformed to Earth coordinates, and screened for error velocity, vertical velocity and false targets (see VmDas User's Guide)

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

- 'ends': *???*

- 'ens_list': list of ensemble numbers

- 'yearbase': start year

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

- 'vel': read velocity.

- 'cor': read correlation magnitude.

- 'amp': read echo intensity.

- 'pg': read percent good.

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

- 'bt': read bottom 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 9.3.3) 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 9.4). 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. (Figures need to be improved!)*

After that, return to `include_att_jc.m`.

The file *CRUISE_xxx_000000_att.mat* with the *att*-structure is loaded in. If the structure contains data, the following is done: For further processing the ping ensemble number has to be increasing. When the ADCP times out while waiting for a response and resets, the ensemble number goes back to 1. Here, the ensemble numbers are modified so that they increase throughout the file (for *att*) and throughout the files of a file ensemble in *OS75_sgl_ping.ens_num*.

There is already attitude data in the structure *OS75_sgl_ping* which comes from the .ENX-file. To extract pitch, roll, heading, and PC clock offset which are relevant for the current .ENX-file, a vector is created for each variable of the length *max(highest ensemble number in att, highest ensemble number from the .ENX attitude data)* and filled with NaNs. Then, the attitude information from *att* is written into the vector and 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

126

- 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 multipied 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 9.5.4, 9.5.5). 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 JC29 are 10° per ping for the heading change and 0.5514 m per ping for the ship velocity change.

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 9.5.4), 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` (9.5.4).

To average the ADCP data over 2 minutes, the routine `ave_for_calib.m` is called with
the arguments *OS75_ sgl_ ping, av_time* (set to 120 seconds), *ref_ uplim, ref_ lowlim*,
and *which_ prdid_ fix*.

`ave_for_calib.m`

This routine is a reduced version of `average_pings.m` (see 9.5.4), including only vari-
ables 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 9.5.4).

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 de-
rived 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` (9.5.4) 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.

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 2 minute averages produced by `ave_for_calib.m`.

First differences are calculated from the average data for the reference velocities (i.e. the water velocities in the reference layer specified by *ref_uplim* and *ref_lowlim*) *du* and *dv*, and the ship velocities *dsu* and *dsv*. Of those, only differences were considered for when ship speed exceeded 3 m/s between ensembles not more than 5000 m or 3600 s apart. Using the Matlab function fminsearch.m, the following function was 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 average or the median should then be used during the second run of `OS75_JC_jc29.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_jc29.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 $average \pm standard deviation$ are sorted out. From the remaining points, the average,

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

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

`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.

9.5.5   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 JC29 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 JC29, 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 9.4).

CRUISE_xxx_yyyyyy_sgl_ping.mat

Again, one file with single ping data is produced for each .ENX-file. In the structure OS75_sgl_ping, after several steps of quality control, filtering and correcting for 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);

135

- 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` in 9.5.4;

- 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`, see 9.5.4; the values stored here after the first run of the main routine `OS75_JC_jc29.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.

They need editing to make them really useful!

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_jc29.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_jc29.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.

9.5.6 Further processing and JC29 specifics

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 `jc29_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 2 minute averages during the processing. The Matlab routine is `jc29_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 JC29 files. The depth variable was therefore added manually to the final 10 minute average.

9.6 Calibration

The cruise track during SOFINE was mostly above deep water so that bottom tracking was not possible. Bottom track data was collected on two occasions on the shelf (see 9.10), but unfortunately during the first period, the swell led to much ship motion and therefore lower data quality. Given the low number of suitable calibration points in bottom track mode, we used water tracking to calibrate the entire period with lowered
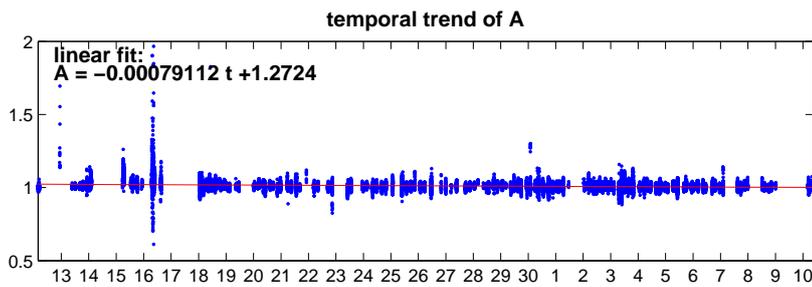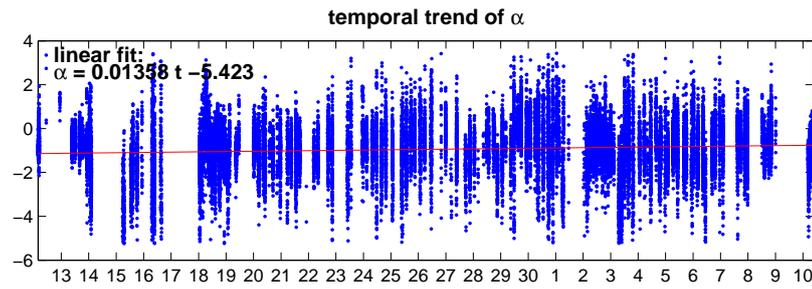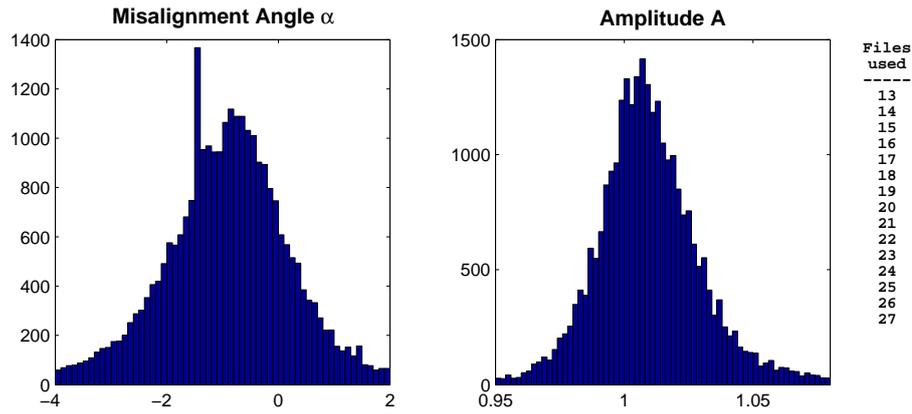
Figure 18: Calibration results for the OS150 using water tracking only.
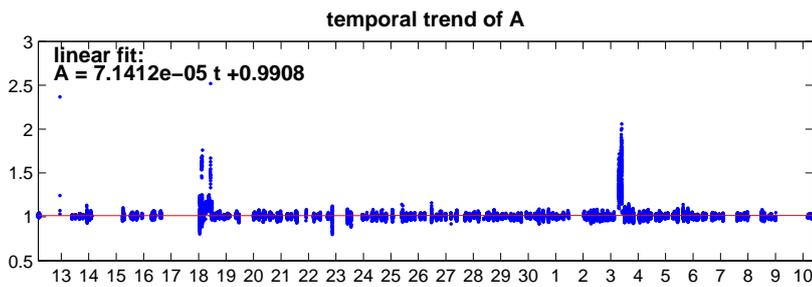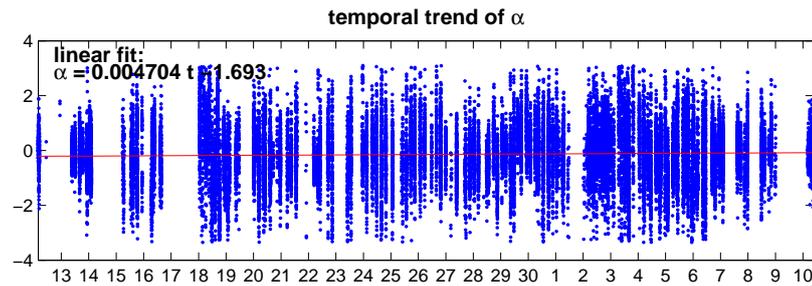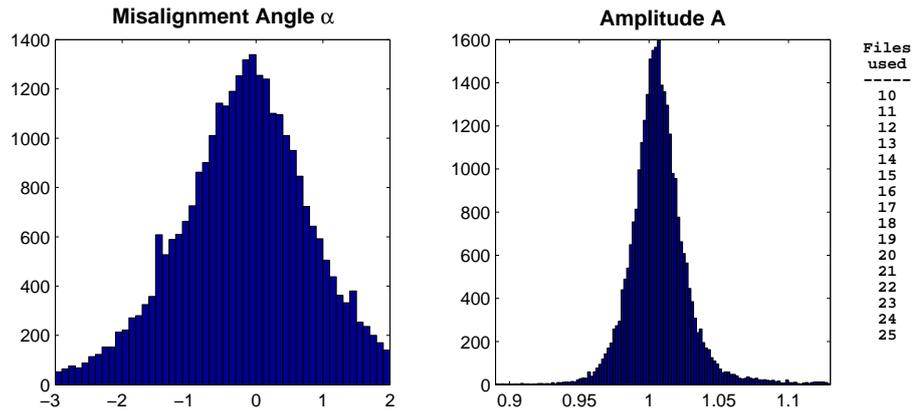
Figure 19: Calibration results for the OS75 using water tracking only.

drop keel in the study region. The results of the calibration are shown in Figs. 18 and 19 for the OS150 and OS75, respectively.

The values then used for the processing are:

- OS150: misalignment = -0.8982; amplitude = 1.008350

- OS75: misalignment = -0.1277; amplitude = 1.006196.

The calibration does not include the times the keel was retracted and the other times the keel was down. Due to the mechanics, the adjustment and alignment of the keel will vary each time it is lowered or brought up. The ADCP data therefore has to be calibrated in each instance separately.

After processing the first few sequences (001-008), we noticed a large misalignment of the OS75 instrument of roughly 9 degrees. To allow real-time monitoring of currents using WinADCP, the misalignment angle was subsequently changed in the command files (see 9.10). The above calibration results only consider files with this changed setting.

To check the calibration and calibrate other instruments, we did a cross after leaving the study region and before bringing the keel back up. The velocity vectors are shown in Fig. 20. Unfortunately, the current field at that location was weak and the velocity vectors look rather chaotic. Especially the OS150 displays an offset that can suggest issues with the calibration. To then check whether the calibration is working on the
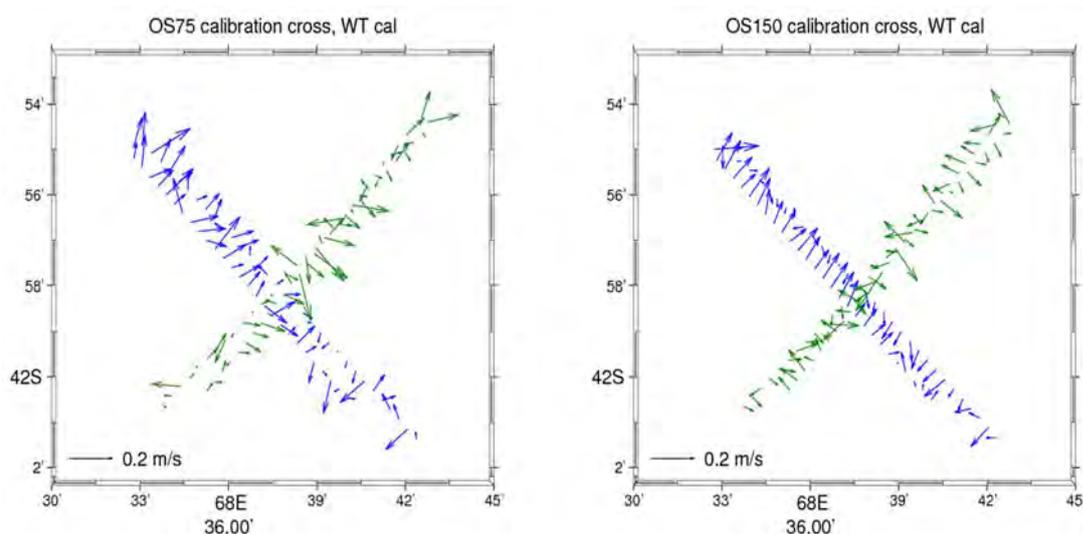
Figure 20: Depth integrated velocities along the calibration cross

CTD sections, we plotted the velocity vectors along the sections in the regions above the continental slope. There, the velocities look consistent. In the vertical section, stripes
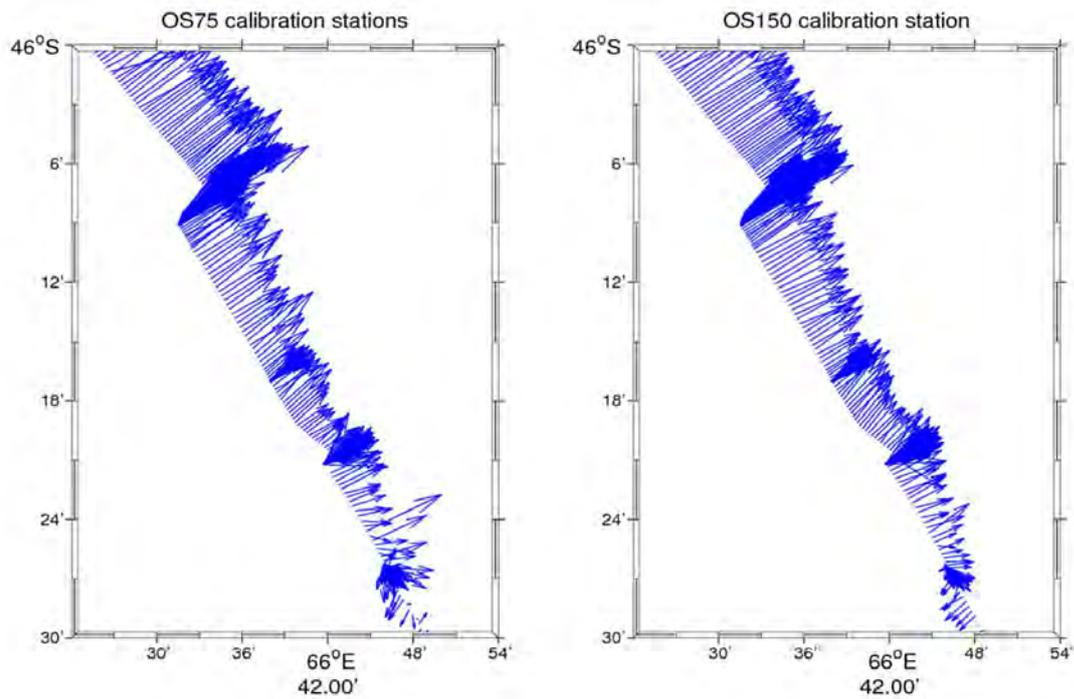
Figure 21: Depth averaged velocities along CTD sections above the continental slope.

associated with turns or de- and acceleration are not visible.

Testing the difference between the bottom track and the water track calibration gives slight differences, with favorable results for the water track.

9.7 Interference of the ADCPs with other instruments and other data quality issues

A concern is the possible interference of the ADCPs with other instruments, both acoustic instruments like e.g. the echo sounders, and "passive" instruments, like e.g. the VMP. Other acoustic instruments could interfere if the ADCP picks up their pings and interprets them as its own. And the CTD-rosette and the VMP act as strong reflectors with velocities different from the water velocities and could therefore induce interfering signals. All those possibilities will be discussed in the following.

9.7.1 Interference with other acoustic instruments

Other acoustic instruments used during JC29 are different echo sounders (EM 120, EK 500 and EA 600) and the lowered ADCP, which will be discussed in the next section. Interference of the ADCP with the echo sounders does not seem to exist. When comparing ADCP data at times when the echo sounders were on/off no difference can be seen. For an example see figure 22.
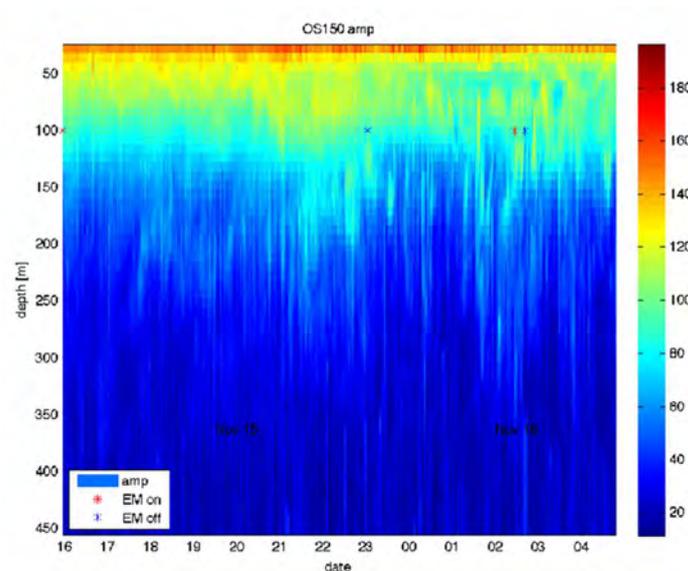
Figure 22: Interference of OS150 with the EM120, November 15th 4pm to November 16th 4am. Shown is the amplitude of the backscattered signal. EM120 on/off are indicated by red/blue stars.

9.7.2 Interference with non-acoustic instruments

Interference of the CTD-Rosette as well as of the lADCP mounted on the rosette with the ADCPs can be excluded. Figure 23 and figure 24 show the zonal and meridional velocities (upper and middle panel) and the amplitude of the backscattered signal (lower panel) for December 1st 4am to December 2nd 3am. Stars mark the start and end of stations (blue and red, respectively). The first five stations are CTD stations. No interference of the ADCP with the CTD can be detected. Stations 2, 3, 4 and 6 in figure 23 and figure 24 are VMP stations. Interference of the VMP with the ADCPs can be excluded.

There is no interference of the ADCP with the moorings during mooring deployment, see figure 23 and figure 24 where start/end of mooring deployments are marked with blue/ red plus signs. The end of mooring deployment is the moment when the weight is released, therefore interference could also occur while the mooring sinks to its final destination, however it does not occur.
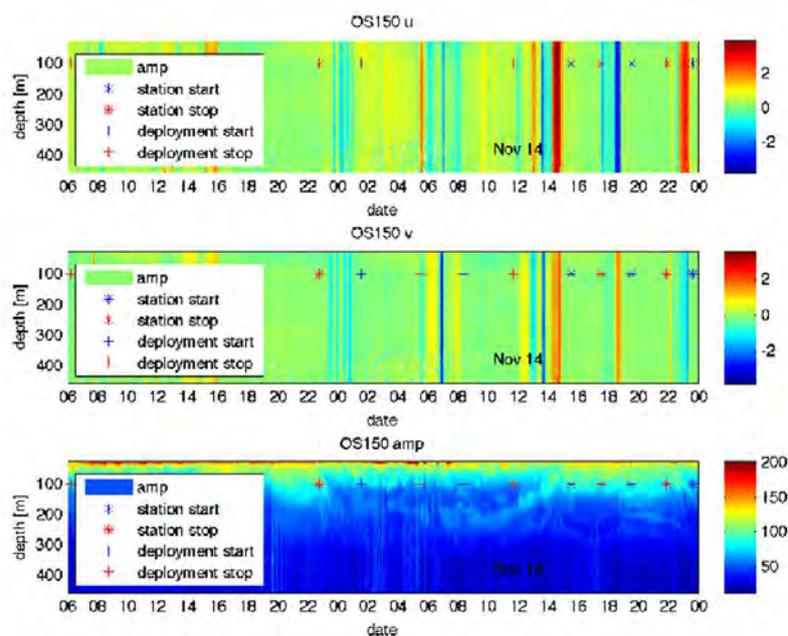
Figure 23: Interference of OS150 with CTD, VMP and mooring deployment, December 1st at 4am to December 2nd at 3am. Shown are u (upper panel), v (middle panel) and amplitude (lower panel). CTD station starts are marked with blue stars, station ends with red stars. VMP were done additionally to CTDs at stations 2, 3, 4 and 6. Mooring deployment starts/releases are indicated by blue/red plus signs.
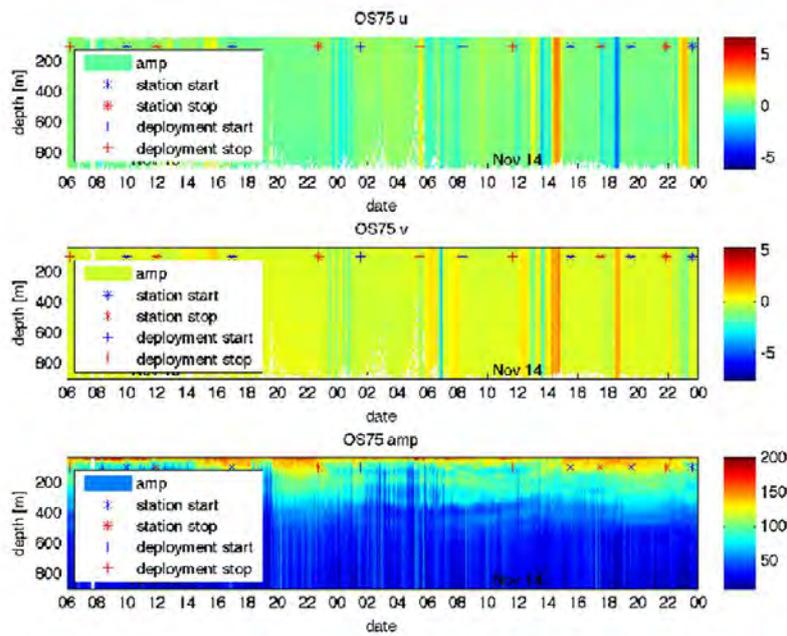
Figure 24: Interference of OS75 with CTD, VMP and mooring deployment, December 1st, 4am, to December 2nd, 3am. Shown are u (upper panel), v (middle panel) and amplitude (lower panel). CTD station starts are marked with blue stars, station ends with red stars. VMP were done additionally to CTDs at stations 1-4 + 6. Mooring deployment starts/releases are indicated by blue/red plus signs.

9.7.3 Interference signals found in the data

In figure 25 interference of the ADCP with something can be seen. However, this interference signal can only be found in the amplitude of the backscattered signal in the single ping files. It does not seem to affect the velocities in the single ping files or anything else.
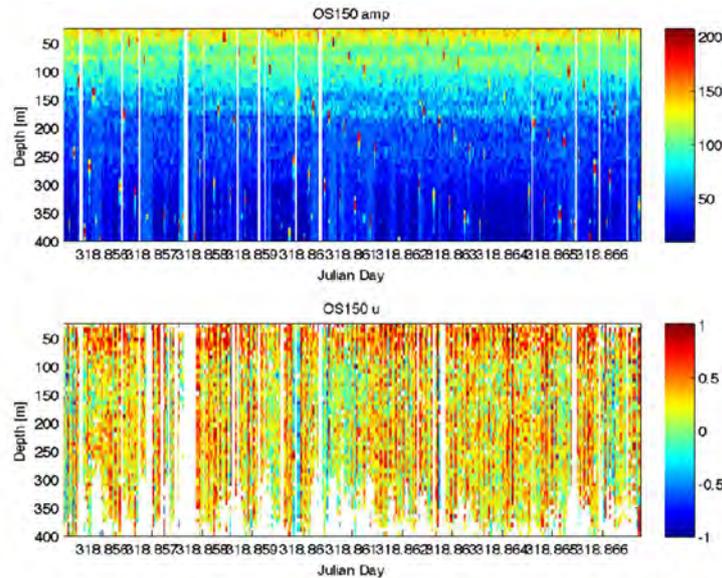
Figure 25: Interference of OS150 with something: Amplitude of the backscattered signal.

We have looked at the period of the spurious peaks in the amplitude of the backscattered signal and it appears that for OS150 every 222 (333, 555) data point is affected when running in WT mode with OS75 running at the same time. If on WT with OS75 not running the period changes to 792 (2721, 3514). BT + OS75 leads to a period of every 295th data point. For OS75 running in WT mode, both on its own and running in parallel with OS150 every 274 data point has spurious high amplitudes. For BT this changes to every 58th data point.

We would strongly recommend to conduct a trial where the acoustic instruments are tested for interference.

9.7.4 Contamination by bubbles

There have been persistent rumors that ADCP data on JC are contaminated by bubbles which are generated by a weird hull shape and the exposed position of the instruments on the drop keel. However, we only find occasional contamination in the uppermost ping, most of which is filtered out during processing. Figure 26 shows an example by spurious high velocities which are partly being captured by the filtering routine.
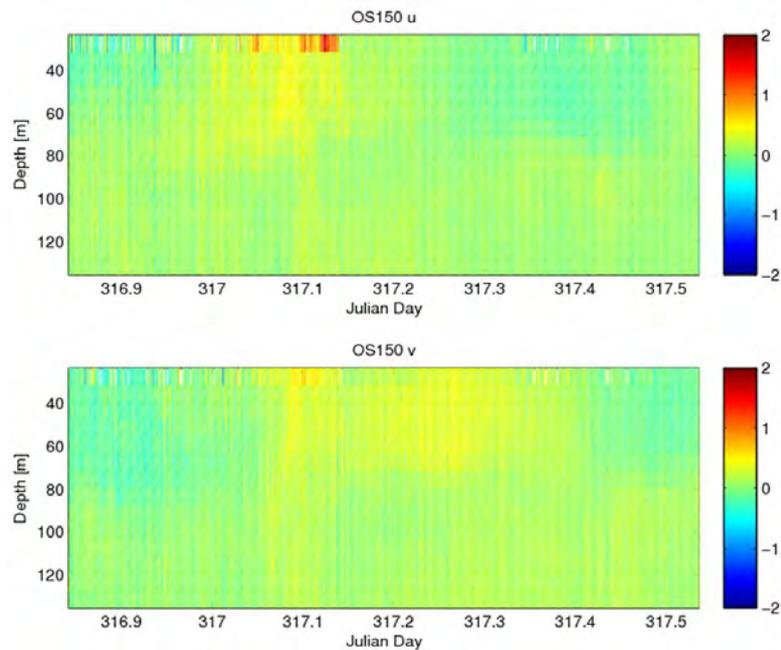
Figure 26: Contamination of the ADCP data by bubbles - only visible in the uppermost ping.

9.7.5 Note on WinADCP

When looking at ADCP data with WinADCP there seems to be an interference signal at depth. WinADCP can be used to monitor currents in real time reading the VmDAS data files. We used it to display the STA-files to help with VMP deployment and recovery. On the screen, a lot of the profiles are black below a certain depth. The pattern of those black bars resemble interference signals. However this can not be found in the data and seems to be an artefact of the software. WinADCP has therefore be used with caution.

9.8 Results

9.8.1 Vertical section

Figs. 27 to 28 show the vertical sections along the CTD sections. Clearly visible are the various fronts crossed along the line.
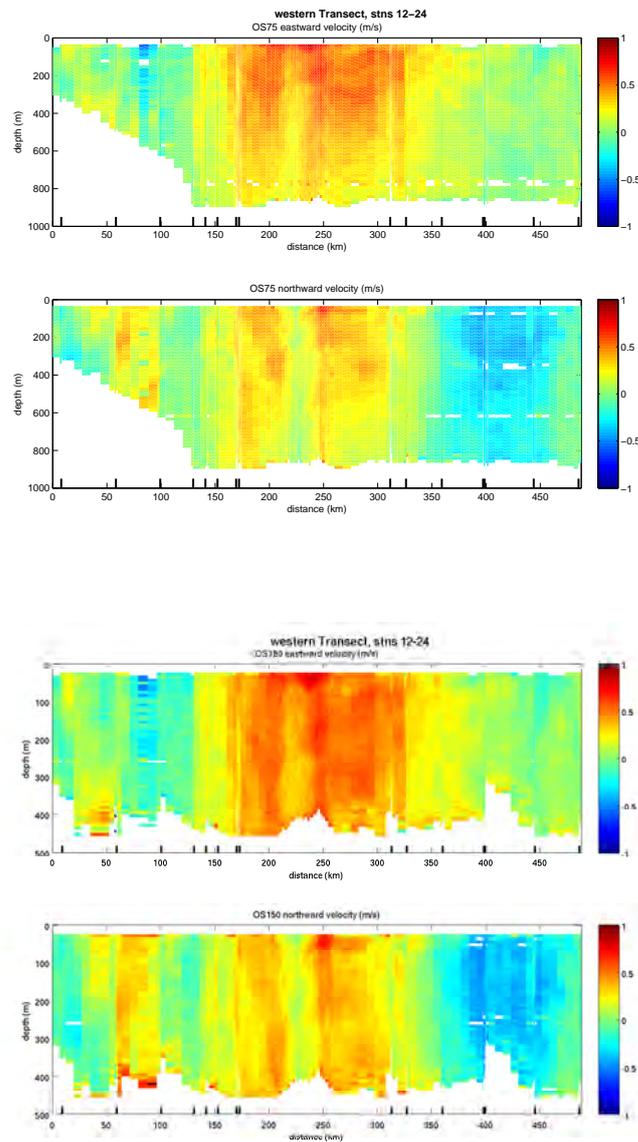
Figure 27: Vertical section of U and V for both ADCPs along the western transect.
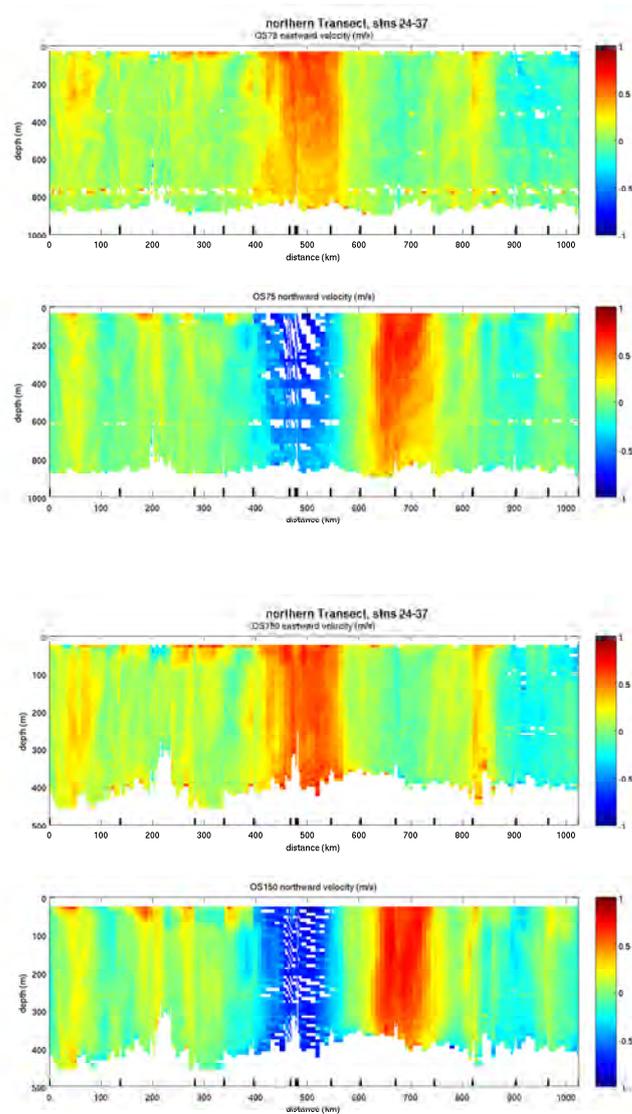
Figure 28: Vertical section of U and V for both ADCPs along the northern transect.
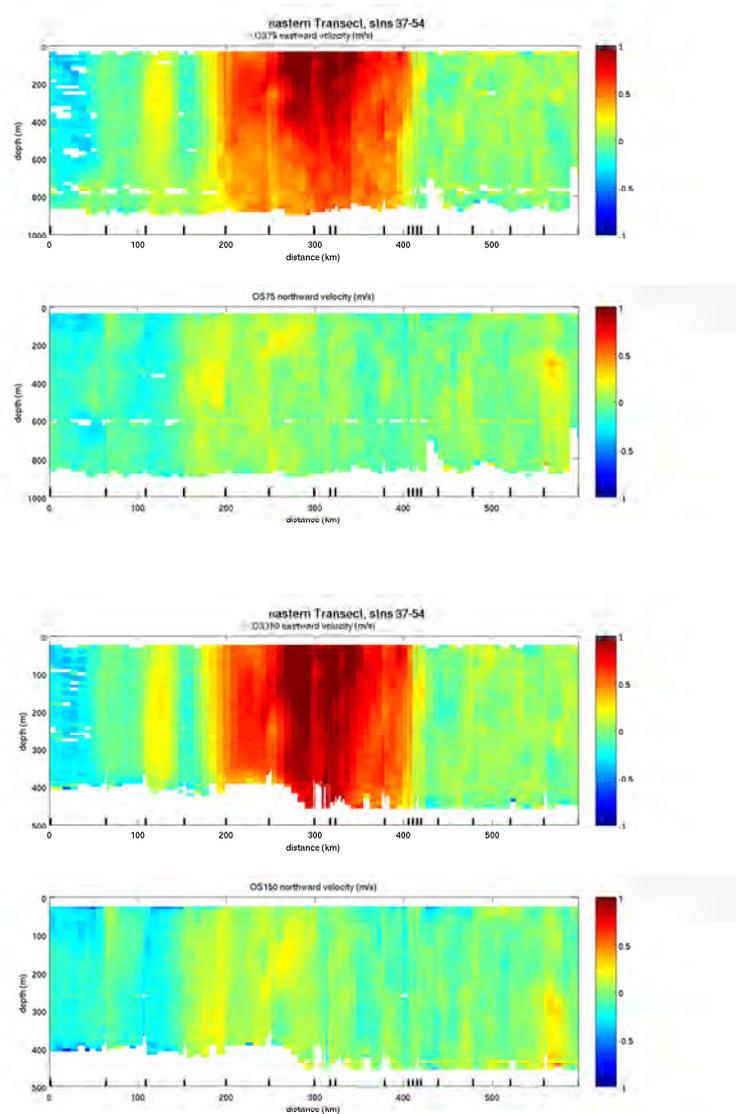
Figure 29: Vertical section of U and V for both ADCPs along the eastern transect.
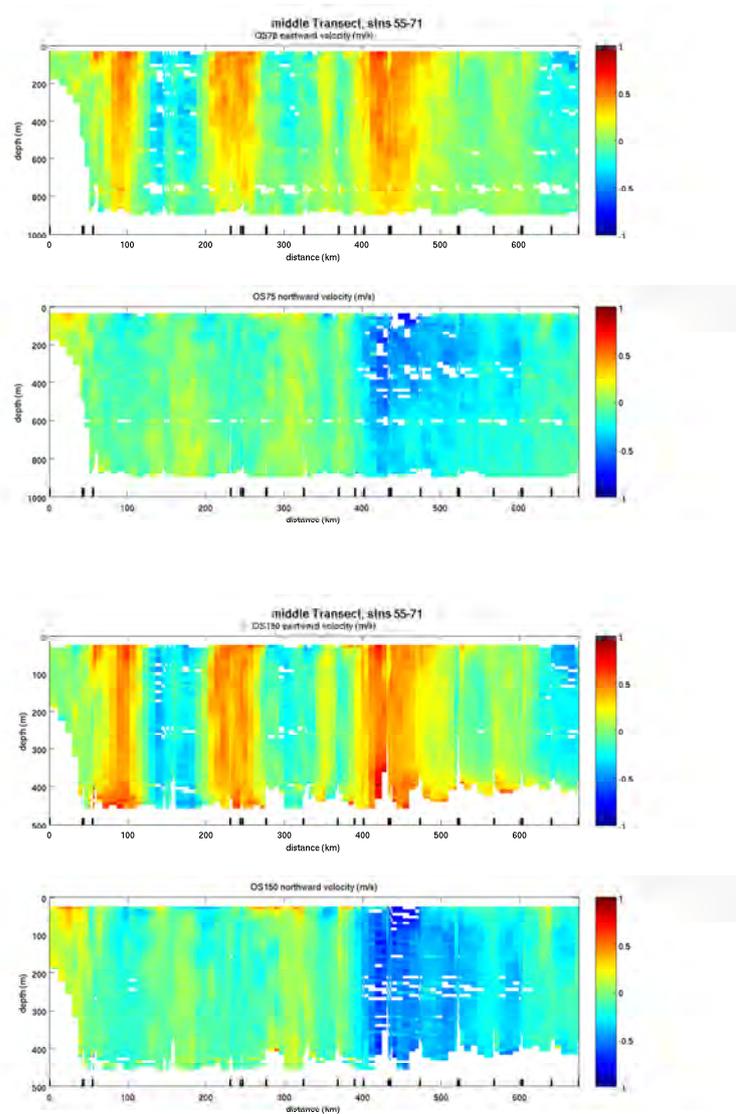
Figure 30: Vertical section of U and V for both ADCPs along the middle transect.

9.8.2 Underway data

Depth averaged ADCP velocities combined with underway SST show interesting features. Note the sharp SST gradient across fronts! The Agulhas Current is clearly visible as are other fronts (see figure 31).
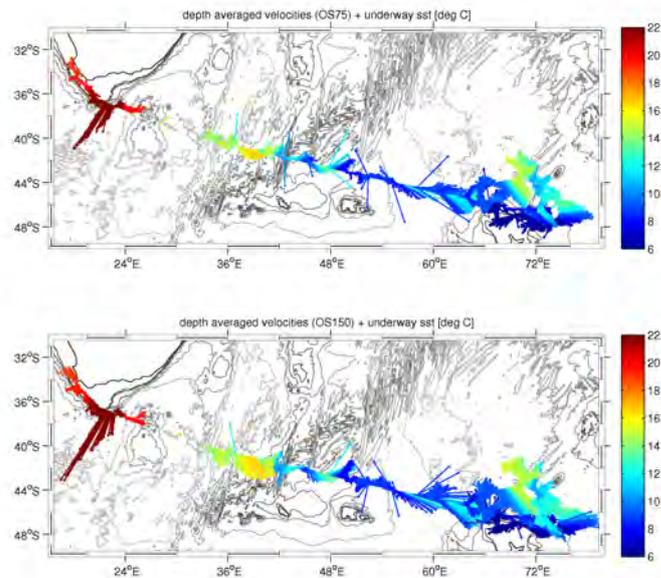
Figure 31: Depth averaged velocities (upper plot: OS75, lower plot: OS150) for the transit to the survey region. Colors indicate the SST measured by the underway system.

9.8.3 Comparison of ADCP-derived velocities with geostrophic velocities from SSH

Depth averaged ADCP velocities can be compared with geostrophic velocities calculated from SSH fields (courtesy Stephanie Waterman) and show good agreement (see figure 32). Note also that the meander of the jet visible in the geostrophic velocities on November 15th has moved eastward by the time we were there a couple of days later.
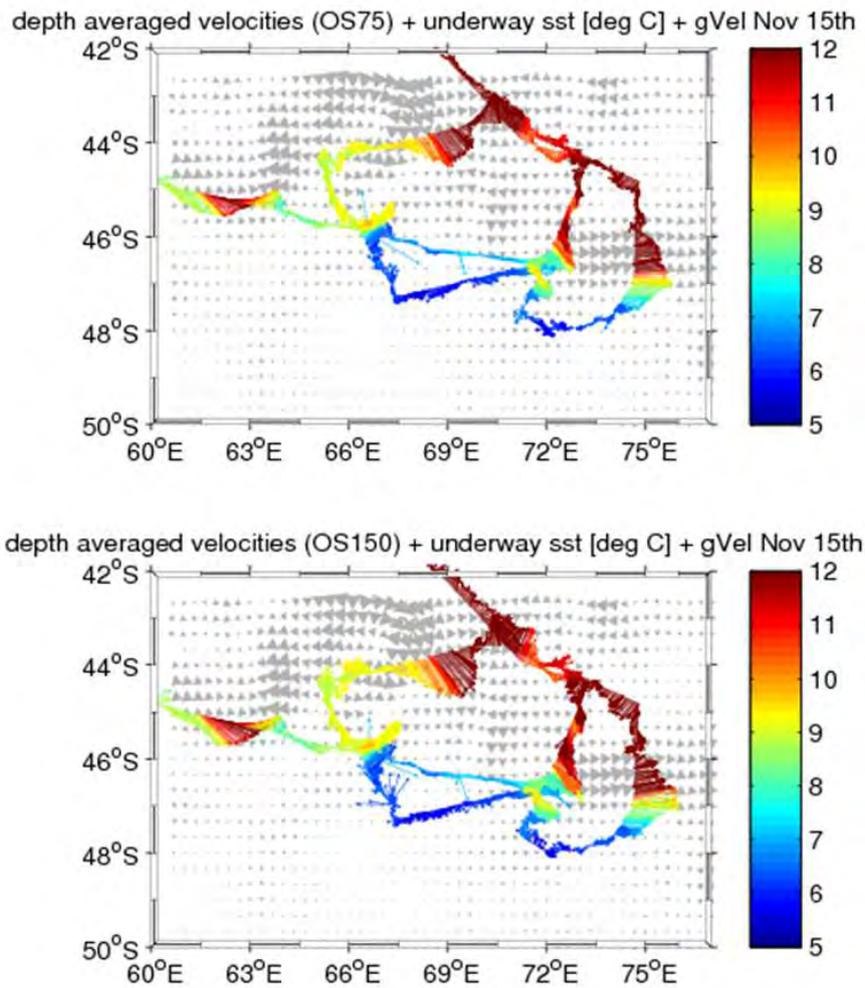
Figure 32: Depth averaged velocities (upper plot: OS75, lower plot: OS150) in the survey region. Colors indicate the SST measured by the underway system. The grey arrows in the background are geostrophic velocities calculated from SSH - courtesy Stephanie Waterman.

154

9.8.4 Inertial oscillations near the ridge

On Julian Day 318 and 319 after a stromy day we picked up some oscillations in the top 100 m of the water column and weaker ones in the 100 m below (see figure 33). Power spectral analysis shows that the oscillation in the upper 100 m has a period of approximately 17 hours which is the period of inertial motions ont the latitude we were at at that time (see figure 34, courtesy to Alex Forryan!). The oscillation below 100 m turns out to have peak periods at approximately 12 hours (tides?) and 2f.
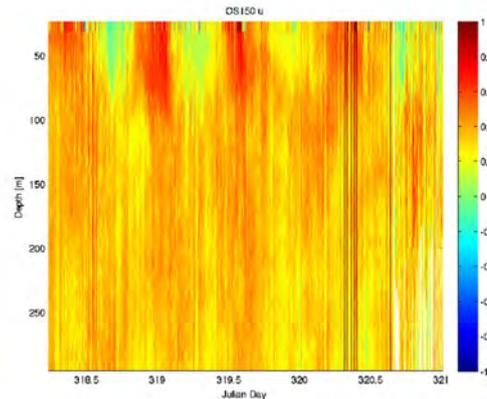
Figure 33: OS150 zonal velocity with inertial oscillation.
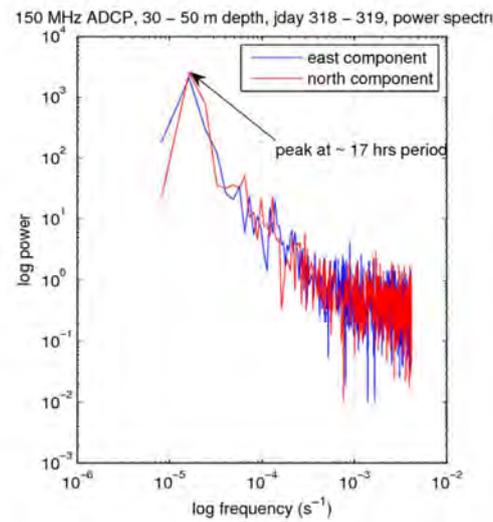
Figure 34: Power density spectrum for OS150 showing a peak at the inertial period. Courtesy Alex Forryan

9.9 VmDas Commands

9.9.1 Overview of available commands

(from JR133 report)

	Command	*	Description
Control	CRn		Retrieve Parameters (0=User, 1=Factory)
	CBnnn	1	Serial Port Control (Baud Rate, Parity, Stop Bits)
Narrow Bandwidth Water Profiling	NPnnn		Number of Pings (0 to 999 pings; 0=disable)
	NNnnn		Number of Bins (0 to 128 bins)
	NSnnnn		Bin size (800 to 3200 cm)
	NFnnnn		Blanking Distance (0 to 99999cm)
	NDnnnnn0000		Data out (velocity, power, echo intensity, percent good, status)
Broad Bandwidth Water Profiling	WPnnn		Number of pings (0 to 999 pings; 0=disable)
	WNnnn		Number of Bins (0 to 128 bins)
	WSnnnn		Bin size (40 to 3200 cm)
	WFnnnn		Blanking Distance (0 to 9999cm)
	WVnnn	6	Ambiguity Velocity (0 to 390 cm/s)
	WDnnnnn0000		Profile data out (velocity, correlation, echo intensity, percent good, status)
Bottom Track	BPn		Number of Pings (0 to 999 pings; 0=disable)
	BXnnnn		Maximum Tracking Depth (0 to 9999dm)
Timing	TPmmssff	2	Time between pings (mm=mins, ss=secs, ff=hundredths of secs)
	TEhhmmssff	3	Time per Ensemble (hours, mins, secs, hundredths of secs)
Environment	EZcdhprst		Sensor Source (speed of sound, depth, heading, pitch, roll, salinity, temperature); (0=manual, 1=transducer, 2=synchro)
	EXnnnnn	4	Coordinate transformations
	EA±nnnn	5	Heading Alignment (-179.99 to 180.00 degrees) (100ths of degrees)
	EDnnnnn		Depth of Transducer (0 to 65535 decimeters)
	ESnn		Salinity (0 to 40 ppt)
Control	CK		Keep parameters as user defaults (i.e. save this setup to non-volatile memory in the ADCP)

* Notes

1. VmDas sends baud rate change command (CB) after all other commands in this file, so that it is not made permanent by a CK command.

2. TP is the minimum time berween pings (independent of the type of ping), used to make sure the previous ping is "dead", i.e. there is no more echo, before the following ping is sent.

3. Since VmDas uses manual pinging, TE is ignored by the ADCP. You must set the time between ensembles in the VmDas Communication options.

4. Output beam data (rotations are done in software).

5. Set transducer misalignment (EA). Note: contrary to the manual, this is given in hundredths of degrees NOT degrees.

6. Don't touch ambiguity velocity (WV), it is the max speed ADCP can measure.

9.9.2 Command files

OS75NB_BT_off_JC29.txt

```
  ;-------------------------------------------------
; ADCP Command File for use with VmDas software.
;
; ADCP type: 75 Khz Ocean Surveyor
; Setup name: NB, BT off
; Setup type: Low resolution, long range profile(narrowband)
;
; NOTE: Any line beginning with a semicolon in the first
; column is treated as a comment and is ignored by
; the VmDas software.
;
; NOTE: This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 01November2008 for JC29 (SOFINE)
;-------------------------------------------------/

; Restore factory default settings in the ADCP
cr1

; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE: VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb611

; Set for narrowband single-ping profile mode (NP), sixty (NN) 16 meter bins (NS),
; 8 meter blanking distance (NF)

WP0
NN060
NP00001
NS1600
NF0800

; Enable single-ping bottom track (BP),
; Set maximum bottom search depth to 1200 meters (BX)
BP00
BX12000

; output velocity, correlation, echo intensity, percent good
ND111100000

; One and a half seconds between bottom and water pings
TP000150

; Three seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000300

; Set to calculate speed-of-sound, no depth sensor, external synchro heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ1020001

; Output beam data (rotations are done in software)
```

157

```
EX00000

; Set transducer misalignment (hundredths of degrees)
EA00900

; Set transducer depth (decimeters)
ED00097

; Set Salinity (ppt)
ES35

; save this setup to non-volatile memory in the ADCP
CK
```

OS75NB_BT_off_JC29_noangle.txt

```
  ;--------------------------------------------------
; ADCP Command File for use with VmDas software.
;
; ADCP type: 75 Khz Ocean Surveyor
; Setup name: NB, BT off
; Setup type: Low resolution, long range profile(narrowband)
;
; NOTE: Any line beginning with a semicolon in the first
; column is treated as a comment and is ignored by
; the VmDas software.
;
; NOTE: This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 01November2008 for JC29 (SOFINE)
;--------------------------------------------------/

; Restore factory default settings in the ADCP
cr1

; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE: VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb611

; Set for broadband single-ping profile mode (NP), sixty (WN) 16 meter bins (NS),
; 8 meter blanking distance (NF)

WP0
NN060
NP00001
NS1600
NF0800

; Enable single-ping bottom track (BP),
; Set maximum bottom search depth to 1200 meters (BX)
BP00
BX12000

; output velocity, correlation, echo intensity, percent good
ND111100000

; One and a half seconds between bottom and water pings
TP000150

; Three seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000300

; Set to calculate speed-of-sound, no depth sensor, external synchro heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ1020001

; Output beam data (rotations are done in software)
EX00000
```

```
; Set transducer misalignment (hundredths of degrees)
EA00000

; Set transducer depth (decimeters)
ED00097

; Set Salinity (ppt)
ES35

; save this setup to non-volatile memory in the ADCP
CK
```

OS75NB_BT_on_JC29.txt

```
 ;------------------------------------------------
; ADCP Command File for use with VmDas software.
;
; ADCP type: 75 Khz Ocean Surveyor
; Setup name: NB, BT on
; Setup type: Low resolution, long range profile(narrowband)
;
; NOTE: Any line beginning with a semicolon in the first
; column is treated as a comment and is ignored by
; the VmDas software.
;
; NOTE: This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 01November2008 for JC29 (SOFINE)
;-----------------------------------------------/

; Restore factory default settings in the ADCP
cr1

; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE: VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb611

; Set for broadband single-ping profile mode (NP), sixty (NN) 16 meter bins (NS),
; 8 meter blanking distance (NF)

WP0
NN060
NP00001
NS1600
NF0800

; Enable single-ping bottom track (BP),
; Set maximum bottom search depth to 1200 meters (BX)
BP01
BX12000

; output velocity, correlation, echo intensity, percent good
ND111100000

; One and a half seconds between bottom and water pings
TP000150

; Three seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000300

; Set to calculate speed-of-sound, no depth sensor, external synchro heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ1020001

; Output beam data (rotations are done in software)
EX00000
```

159

```
; Set transducer misalignment (hundredths of degrees)
EA00900


; Set transducer depth (decimeters)
ED00097


; Set Salinity (ppt)
ES35


; save this setup to non-volatile memory in the ADCP
CK
```

OS75NB_BT_off_JC29_keelup.txt

```
  ;-------------------------------------------------
; ADCP Command File for use with VmDas software.
;
; ADCP type: 75 Khz Ocean Surveyor
; Setup name: NB, BT off
; Setup type: Low resolution, long range profile(narrowband)
;
; NOTE: Any line beginning with a semicolon in the first
; column is treated as a comment and is ignored by
; the VmDas software.
;
; NOTE: This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 01November2008 for JC29 (SOFINE)
;-------------------------------------------------/

; Restore factory default settings in the ADCP
cr1

; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE: VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb611

; Set for narrowband single-ping profile mode (NP), fifty five (NN) 16 meter bins (NS),
; 8 meter blanking distance (NF)
WP0 NN055 NP00001
NS1600
NF0800

; Disable single-ping bottom track (BP),
; Set maximum bottom search depth to 1200 meters (BX) (decimeters)
BP000
BX12000

; output velocity, correlation, echo intensity, percent good
ND111100000

; One and a half seconds between bottom and water pings
TP000150

; Three seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000300

; Set to calculate speed-of-sound, no depth sensor, external synchro heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ1020001

; Output beam data (rotations are done in software)
EX00000

; Set transducer misalignment (hundredths of degrees)
EA00900

; Set transducer depth (decimeters)
```

```
ED00069


; Set Salinity (ppt)
ES35


; save this setup to non-volatile memory in the ADCP
CK
```

OS75NB_BT_off_JC29_keelup_noangle.txt

```
  ;--------------------------------------------------
; ADCP Command File for use with VmDas software.
;
; ADCP type: 75 Khz Ocean Surveyor
; Setup name: NB, BT off
; Setup type: Low resolution, long range profile(narrowband)
;
; NOTE: Any line beginning with a semicolon in the first
; column is treated as a comment and is ignored by
; the VmDas software.
;
; NOTE: This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 01November2008 for JC29 (SOFINE)
;--------------------------------------------------/

; Restore factory default settings in the ADCP
cr1


; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE: VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb611


; Set for narrowband single-ping profile mode (NP), fifty five (NN) 16 meter bins (NS),
; 8 meter blanking distance (NF)
WP0 NN055 NP00001
NS1600
NF0800


; Disable single-ping bottom track (BP),
; Set maximum bottom search depth to 1200 meters (BX) (decimeters)
BP000
BX12000


; output velocity, correlation, echo intensity, percent good
ND111100000


; One and a half seconds between bottom and water pings
TP000150


; Three seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000300


; Set to calculate speed-of-sound, no depth sensor, external synchro heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ1020001


; Output beam data (rotations are done in software)
EX00000


; Set transducer misalignment (hundredths of degrees)
EA00000


; Set transducer depth (decimeters)
ED00069


; Set Salinity (ppt)
ES35
```

```
; save this setup to non-volatile memory in the ADCP
CK
```

OS150NB_BToff_JC29.txt

```
  ;--------------------------------------------------
; ADCP Command File for use with VmDas software.
;
; ADCP type: 150 Khz Ocean Surveyor
; Setup name: default
; Setup type: Low resolution, long range profile(narrowband)
;
; NOTE: Any line beginning with a semicolon in the first
; column is treated as a comment and is ignored by
; the VmDas software.
;
; NOTE: This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 01November2008 for JC29 (SOFINE)
;--------------------------------------------------/

; Restore factory default settings in the ADCP
cr1

; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE: VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb611

; Set for narrowband single-ping profile mode (NP), sixty (NN) 8 meter bins (NS),
; 6 meter blanking distance (NF)
WP0
NN060
NP00001
NS0800
NF0600

; Disable single-ping bottom track (BP),
; Set maximum bottom search depth to 800 meters (BX)
BP000
BX08000

; output velocity, correlation, echo intensity, percent good
ND111100000

; 1 seconds between bottom and water pings
TP000100

; Two seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000200

; Set to calculate speed-of-sound, no depth sensor, external synchro heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ1020001

; Output beam data (rotations are done in software)
EX00000

; Set transducer misalignment (hundredths of degrees)
EA00000

; Set transducer depth (decimeters)
ED00096

; Set Salinity (ppt)
ES35

; save this setup to non-volatile memory in the ADCP
```

CK

OS150NB_BToff_JC29_keelup.txt

```
;--------------------------------------------------
; ADCP Command File for use with VmDas software.
;
; ADCP type: 150 Khz Ocean Surveyor
; Setup name: default
; Setup type: Low resolution, long range profile(narrowband)
;
; NOTE: Any line beginning with a semicolon in the first
; column is treated as a comment and is ignored by
; the VmDas software.
;
; NOTE: This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 01November2008 for JC29 (SOFINE)
;---------------------------------------------------/

; Restore factory default settings in the ADCP
cr1

; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE: VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb611

; Set for narrowband single-ping profile mode (NP), sixty (NN) 8 meter bins (NS),
; 6 meter blanking distance (NF)
WP0
NN060
NP00001
NS0800
NF0600

; Disable single-ping bottom track (BP),
; Set maximum bottom search depth to 800 meters (BX)
BP000
BX08000

; output velocity, correlation, echo intensity, percent good
ND111100000

; 1 seconds between bottom and water pings
TP000100

; Two seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000200

; Set to calculate speed-of-sound, no depth sensor, external synchro heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ1020001

; Output beam data (rotations are done in software)
EX00000

; Set transducer misalignment (hundredths of degrees)
EA00000

; Set transducer depth (decimeters)
ED00068

; Set Salinity (ppt)
ES35

; save this setup to non-volatile memory in the ADCP
CK
```

OS150NB_BTon_JC29.txt

```
  ;-------------------------------------------------
; ADCP Command File for use with VmDas software.
;
; ADCP type: 150 Khz Ocean Surveyor
; Setup name: default
; Setup type: Low resolution, long range profile(narrowband)
;
; NOTE: Any line beginning with a semicolon in the first
; column is treated as a comment and is ignored by
; the VmDas software.
;
; NOTE: This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 01November2008 for JC29 (SOFINE)
;-------------------------------------------------/

; Restore factory default settings in the ADCP
cr1

; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE: VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb611

; Set for narrowband single-ping profile mode (NP), sixty (NN) 8 meter bins (NS),
; 6 meter blanking distance (NF)
WP0
NN060
NP00001
NS0800
NF0600

; Enable single-ping bottom track (BP),
; Set maximum bottom search depth to 800 meters (BX)
BP001
BX08000

; output velocity, correlation, echo intensity, percent good
ND111100000

; 1 seconds between bottom and water pings
TP000100

; Two seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000200

; Set to calculate speed-of-sound, no depth sensor, external synchro heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ1020001

; Output beam data (rotations are done in software)
EX00000

; Set transducer misalignment (hundredths of degrees)
EA00000

; Set transducer depth (decimeters)
ED00096

; Set Salinity (ppt)
ES35

; save this setup to non-volatile memory in the ADCP
CK
```

OS150BB_BTon_JC29.txt

```
  ;-------------------------------------------------
; ADCP Command File for use with VmDas software.
;
```

```
; ADCP type: 150 Khz Ocean Surveyor
; Setup name: default
; Setup type: High resolution, short range profile(broadband)
;
; NOTE: Any line beginning with a semicolon in the first
; column is treated as a comment and is ignored by
; the VmDas software.
;
; NOTE: This file is best viewed with a fixed-point font (e.g. courier).
; Modified Last: 01November2008 for JC29 (SOFINE)
;------------------------------------------------/

; Restore factory default settings in the ADCP
cr1

; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE: VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb611

; Set for narrowband single-ping profile mode (NP), fifty-five (NN) 8 meter bins (NS),
; 6 meter blanking distance (NF)
NP00000
NN055
NS0800
NF0600

; Set for broadband single-ping profile mode (WP), forty-five (WN) 4 meter bins (WS),
; 6 meter blanking distance (WF), 390 cm/s ambiguity vel (WV)
WP00001
WN055
WS0400
WV390
WF0400

; Enable single-ping bottom track (BP),
; Set maximum bottom search depth to 800 meters (BX)
BP001
BX08000

; output velocity, correlation, echo intensity, percent good
ND111100000

; 1 seconds between bottom and water pings
TP000100

; Two seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000200

; Set to calculate speed-of-sound, no depth sensor, external synchro heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ1020001

; Output beam data (rotations are done in software)
EX00000

; Set transducer misalignment (hundredths of degrees)
EA00000

; Set transducer depth (decimeters)
ED00096

; Set Salinity (ppt)
ES35

; save this setup to non-volatile memory in the ADCP
CK
```

9.10 File sequences during SOFINE (JC29)

Table 16: List of file sequences and files recorded during JC29 - OS150

seq.	First and last $PADCP lines	Files	Config.	comments
001	discarded test file (01/11/08)			
002	discarded test file (01/11/08)			
003	$PADCP,1,20081101,171421.99,0.08	OS150_JC29003_000000-2.ENR	NB, BT on[1]	
	$PADCP,17659,20081102,061603.51,0.09	OS150_JC29003_000000-2.ENS		
		OS150_JC29003_000000-2.ENX		
		OS150_JC29003_000000-1.N1R		
		OS150_JC29003_000000-1.N2R		
004	discarded (02/11/08)			wrong setting
005	$PADCP,1,20081102,062217.00,0.10	OS150_JC29005_000000-2.ENR	BB, BT on[2]	
	$PADCP,16310,20081102,152650.89,0.09	OS150_JC29005_000000-2.ENS		
		OS150_JC29005_000000-2.ENX		
		OS150_JC29005_000000-1.N1R		
		OS150_JC29005_000000.N2R		
006	$PADCP,1,20081102,152736.00,0.09	OS150_JC29006_000000.ENR	NB, BT on[1]	
	$PADCP,5304,20081102,194051.15,0.08	OS150_JC29006_000000.ENS		
		OS150_JC29006_000000.ENX		
		OS150_JC29006_000000.N1R		
		OS150_JC29006_000000.N2R		
007	$PADCP,1,20081102,194124.99,0.09	OS150_JC29007_000000-3.ENR	NB, BT off[3]	stn 001
	$PADCP,32064,20081103,133011.01,0.09	OS150_JC29007_000000-4.ENS		
		OS150_JC29007_000000-4.ENX		
		OS150_JC29007_000000-2.N1R		
		OS150_JC29007_000000-1.N2R		
***	KEEL UP	03/11/08, 13:35		***
008	$PADCP,1,20081105,070040.00,0.09	OS150_JC29008_000000-7.ENR	NB, BT off[4]	
	$PADCP,58893,20081106,154344.01,0.09	OS150_JC29008_000000-7.ENS		
		OS150_JC29008_000000-7.ENX		
		OS150_JC29008_000000-3.N1R		
		OS150_JC29008_000000-3.N2R		
009	$PADCP,1,20081106,154853.00,0.08	OS150_JC29009_000000-4.ENR	NB, BT off[4]	
	$PADCP,33062,22081107,101055.00,0.08,	OS150_JC29009_000000-4.ENS		
		OS150_JC29009_000000-4.ENX		
		OS150_JC29009_000000-2.N1R		
		OS150_JC29009_000000-1.N2R		
***	KEEL DOWN	07/11/08, 10:36		***
010	$PADCP,1,20081107,102702.00,0.09	OS150_JC29010_000000.ENR	NB, BT off[5]	changed transducer depth
	$PADCP,6196,20081107,135226.50,0.09	OS150_JC29010_000000.ENS		in command file
		OS150_JC29010_000000.ENX		9.1 to 9.7 m
		OS150_JC29010_000000.N1R		stn 002
		OS150_JC29010_000000.N2R		
***	KEEL UP	07/11/08, 13:55		***
011	$PADCP,1,20081107,141235.00,0.09	OS150_JC29011_000000-6.ENR	NB, BT off[6]	transducer depth
	$PADCP,51689,22081108,185530.99,0.08,	OS150_JC29011_000000-6.ENS		set to 6.9 m
		OS150_JC29011_000000-6.ENX		stns 003-004
		OS150_JC29011_000000-3.N1R		
		OS150_JC29011_000000-3.N2R		
012	$PADCP,1,20081108,185605.99,0.09	OS150_JC29012_000000-8.ENR	NB, BT off[6]	transducer depth
	$PADCP,71632,22081110,104348.00,0.09,	OS150_JC29012_000000-9.ENS		set to 6.9 m
		OS150_JC29012_000000-9.ENX		stn 005

Continued on next page

Table 16 – continued from previous page

seq.	First and last $PADCP lines	Files	Config.	comments
		OS150_JC29012_000000-4.N1R		
		OS150_JC29012_000000-4.N2R		
—	—	—	—	—
***	KEEL DOWN	10/11/08, 10:48		***
—	—	—	—	—
013	$PADCP,1,20081110,105330.00,0.10 $PADCP,95457,20081112,155521.99,0.09,	OS150_JC29013_000000-11.ENR OS150_JC29013_000000-12.ENS OS150_JC29013_000000-12.ENX OS150_JC29013_000000-6.N1R OS150_JC29013_000000-5.N2R	NB, BT off[5]	transducer depth set back to 9.7 m stn 006
014	$PADCP,1,20081112,155554.01,0.09 $PADCP,15454,20081113,003059.99,0.08,	OS150_JC29014_000000-2.ENR OS150_JC29014_000000-2.ENS OS150_JC29014_000000-2.ENX OS150_JC29014_000000.N1R OS150_JC29014_000000.N2R	NB, BT off[5]	EM120 survey
015	$PADCP,1,20081113,003133.99,0.09 $PADCP,114088,20081115,155428.00,0.09	OS150_JC29015_000000-15.ENR OS150_JC29015_000000-16.ENS OS150_JC29015_000000-16.ENX OS150_JC29015_000000-7.N1R OS150_JC29015_000000-6.N2R	NB, BT off[5]	no of bins changed from NN055 to NN060 EM120 survey moorings stns 007-011
016	$PADCP,1,20081115,155530.00,0.09 $PADCP,52591,20081117,162309.76,0.09	OS150_JC29016_000000-7.ENR OS150_JC29016_000000-8.ENS OS150_JC29016_000000-8.ENX OS150_JC29016_000000-5.N1R OS150_JC29016_000000-5.N2R	NB, BT on[7]	steaming against strong winds stns 012-014
017	$PADCP,1,20081117,162355.00,0.08 $PADCP,111547,20081120,062207.00,0.09	OS150_JC29017_000000-14.ENR OS150_JC29017_000000-15.ENS OS150_JC29017_000000-15.ENX OS150_JC29017_000000-7.N1R OS150_JC29017_000000-6.N2R	NB, BT off[5]	stns 015-022
018	$PADCP,1,20081120,062217.02,0.09 $PADCP,29582,20081120,224819.00,0.09	OS150_JC29018_000000-3.ENR OS150_JC29018_000000-4.ENS OS150_JC29018_000000-4.ENX OS150_JC29018_000000-1.N1R OS150_JC29018_000000-1.N2R	NB, BT off[5]	stns 023-024
019	$PADCP,1,20081120,224832.01,0.09 $PADCP,140761,20081124,050032.01,0.09	OS150_JC29019_000000-18.ENR OS150_JC29019_000000-20.ENS OS150_JC29019_000000-20.ENX OS150_JC29019_000000-9.N1R OS150_JC29019_000000-8.N2R	NB, BT off[5]	EK500 on at some point stns 025-029
020	$PADCP,1,20081124,050039.99,0.09 $PADCP,86982,20081126,052002.13,0.09	OS150_JC29020_000000-11.ENR OS150_JC29020_000000-12.ENS OS150_JC29020_000000-12.ENX OS150_JC29020_000000-5.N1R OS150_JC29020_000000-5.N2R	NB, BT off[5]	EK500 on at some point stns 029-034
021	$PADCP,1,20081126,052017.01,0.09 $PADCP,50341,20081127,091817.01,0.10	OS150_JC29021_000000-6.ENR OS150_JC29021_000000-7.ENS OS150_JC29021_000000-7.ENX OS150_JC29021_000000-3.N1R OS150_JC29021_000000-3.N2R	NB, BT off[5]	EK500 on at some point stns 035-037
022	$PADCP,1,20081127,091825.99,0.10 $PADCP,163753,20081201,041650.00,0.09	OS150_JC29022_000000-21.ENR OS150_JC29022_000000-23.ENS OS150_JC29022_000000-23.ENX OS150_JC29022_000000-10.N1R OS150_JC29022_000000-9.N2R	NB, BT off[5]	stns 038-049
023	$PADCP,1,20081201,041717.00,0.09 $PADCP,25839,20081202,031131.41,0.10	OS150_JC29023_000000-3.ENR OS150_JC29023_000000-3.ENS OS150_JC29023_000000-3.ENX	NB, BT on[7]	stns 050-056

Table 16 – continued from previous page

seq.	First and last $PADCP lines	Files	Config.	comments
024	$PADCP,1,20081202,031141.00,0.11 $PADCP,20067,20081202,210843.89,0.09	OS150_JC29023_000000-2.N1R OS150_JC29023_000000-2.N2R OS150_JC29024_000000-2.ENR OS150_JC29024_000000-3.ENS OS150_JC29024_000000-3.ENX OS150_JC29024_000000-1.N1R OS150_JC29024_000000-1.N2R	NB, BT on[7]	stn 057
		stn 057 (CTD/VMP), 02/12/08, 16:47-19:51		
025	$PADCP,1,20081202,210919.00,0.09 $PADCP,164972,20081206,1164821.00,0.09	OS150_JC29025_000000-22.ENR OS150_JC29025_000000-23.ENS OS150_JC29025_000000-23.ENX OS150_JC29025_000000-10.N1R OS150_JC29025_000000-9.N2R	NB, BT off[5]	mooring recoveries during 03/12 stns 058-067
026	$PADCP,1,20081206,164841.31,0.09 $PADCP,57000,20081208,002838.01,0.10	OS150_JC29026_000000-7.ENR OS150_JC29026_000000-8.ENS OS150_JC29026_000000-8.ENX OS150_JC29026_000000-3.N1R OS150_JC29026_000000-3.N2R	NB, BT off[5]	stns 068-071
027	$PADCP,1,20081208,002852.01,0.10 $PADCP,61161,20081209,102732.00,0.09	OS150_JC29027_000000-8.ENR OS150_JC29027_000000-8.ENS OS150_JC29027_000000-8.ENX OS150_JC29027_000000-3.N1R OS150_JC29027_000000-3.N2R	NB, BT off[5]	calibration cross
—	—	—	—	—
***	KEEL UP	09/12/08, 10:30		***
—	—	—	—	—
028	$PADCP,1,20081209,105147.00,0.09 $PADCP,195027,20081213,231239.01,0.08	OS150_JC29027_000000-24.ENR OS150_JC29027_000000-26.ENS OS150_JC29027_000000-25.ENX OS150_JC29027_000000-12.N1R OS150_JC29027_000000-11.N2R	NB, BT off[6]	
		The software crashed during the night, no apparent reason.		
029	$PADCP,1,20081214,032230.00,0.08 $PADCP,230484,20081219,112516.02,0.09	OS150_JC29027_000000-28.ENR OS150_JC29027_000000-30.ENS OS150_JC29027_000000-30.ENX OS150_JC29027_000000-15.N1R OS150_JC29027_000000-13.N2R	NB, BT off[6]	stn 072

Table 17: List of file sequences and files recorded during JC29 - OS75

seq.	First and last $PADCP lines	Files	Config.	comments
001	$PADCP,1,20081101,171238.01,0.09	OS75_JC29001_000000-2.ENR	NB, BT on[8]	
				Continued on next page

---

[1]OS150NB_BTon_JC29.txt with transducer depth set to 9.1 m

[2]OS150BB_BTon_JC29.txt with transducer depth set to 9.1 m

[3]OS150NB_BToff_JC29.txt with transducer depth set to 9.1 m

[4]OS150NB_BToff_JC29_keelup.txt with transducer depth set to ??

[5]OS150NB_BToff_JC29.txt

[6]OS150NB_BToff_JC29_keelup.txt

[7]OS150NB_BTon_JC29.txt

Table 17 – continued from previous page

seq.	First and last $PADCP lines	Files	Config.	comments
	$PADCP,21467,20081102,170609.03,0.08	OS75_JC29001_000000-3.ENS		
		OS75_JC29001_000000-3.ENX		
		OS75_JC29001_000000-2.N1R		
		OS75_JC29001_000000-2.N2R		
002	$PADCP,1,20081102,170837.99,0.09	OS75_JC29002_000000.ENR	NB, BT on[8]	
	$PADCP,2014,20081102,193855.98,0.09	OS75_JC29002_000000.ENS		
		OS75_JC29002_000000.ENX		
		OS75_JC29002_000000.N1R		
		OS75_JC29002_000000.N2R		
003	$PADCP,1,20081102,193931.99,0.09	OS75_JC29003_000000-3.ENR	NB, BT off[9]	stn 001
	$PADCP,26733,20081103,133006.58,0.10	OS75_JC29003_000000-3.ENS		
		OS75_JC29003_000000-3.ENX		
		OS75_JC29003_000000-2.N1R		
		OS75_JC29003_000000-1.N2R		
—	—	—	—	—
***	KEEL UP	03/11/08, 13:35		***
—	—	—	—	—
004	$PADCP,1,20081104,065942.00,0.08	OS75_JC29004_000000-6.ENR	NB, BT off[10]	
	$PADCP,48802,20081106,153508.64,0.09	OS75_JC29004_000000-6.ENS		
		OS75_JC29004_000000-6.ENX		
		OS75_JC29004_000000-3.N1R		
		OS75_JC29004_000000-3.N2R		
005	$PADCP,1,20081106,154024.00,0.10	OS75_JC29005_000000-3.ENR	NB, BT off[10]	
	$PADCP,27725,20081107,101107.41,0.08	OS75_JC29005_000000-3.ENS		
		OS75_JC29005_000000-3.ENX		
		OS75_JC29005_000000-2.N1R		
		OS75_JC29005_000000-1.N2R		
—	—	—	—	—
***	KEEL DOWN	07/11/08, 10:36		***
—	—	—	—	—
006	$PADCP,1,20081107,102702.00,0.09	OS75_JC29006_000000.ENR	NB, BT off[11]	changed transducer depth
	$PADCP,5126,20081107,135229.99,0.09	OS75_JC29006_000000.ENS		in command file
		OS75_JC29006_000000.ENX		from 9.1 to 9.7 m
		OS75_JC29006_000000.N1R		stn 002
		OS75_JC29006_000000.N2R		
—	—	—	—	—
***	KEEL UP	07/11/08, 13:55		***
—	—	—	—	—
007	$PADCP,1,20081107,141031.99,0.09	OS75_JC29007_000000-5.ENR	NB, BT off[12]	transducer depth
	$PADCP,43034,20081108,185405.58,0.10	OS75_JC29007_000000-5.ENS		set to 6.9 m
		OS75_JC29007_000000-5.ENX		stns 003-004
		OS75_JC29007_000000-3.N1R		
		OS75_JC29007_000000-3.N2R		
008	$PADCP,1,20081108,185510.99,0.09	OS75_JC29008_000000-4.ENR	NB, BT off[12]	transducer depth
	$PADCP,35017,20081109,181730.73,0.09	OS75_JC29008_000000-4.ENS		set to 6.9 m
		OS75_JC29008_000000-4.ENX		stn 005
		OS75_JC29008_000000-2.N1R		
		OS75_JC29008_000000-2.N2R		
009	$PADCP,1,20081109,182024.01,0.09	OS75_JC29009_000000-3.ENR	NB, BT off[13]	transducer depth
	$PADCP,24555,20081110,104346.91,0.08	OS75_JC29009_000000-3.ENS		set to 6.9 m
		OS75_JC29009_000000-3.ENX		misalignment set
		OS75_JC29009_000000-1.N1R		in command file
		OS75_JC29009_000000-1.N2R		EA00900
—	—	—	—	—
***	KEEL DOWN	10/11/08, 10:48		***
—	—	—	—	—
010	$PADCP,1,20081110,105747.99,0.10	OS75_JC29010_000000-9.ENR	NB, BT off[14]	stn 006
	$PADCP,79313,20081112,155422.68,0.10	OS75_JC29010_000000-10.ENS		
		OS75_JC29010_000000-10.ENX		

Table 17 – continued from previous page

seq.	First and last $PADCP lines	Files	Config.	comments
		OS75_JC29010_000000-6.N1R		
		OS75_JC29010_000000-5.N2R		
011	$PADCP,1,20081112,155518.99,0.08	OS75_JC29011_000000-1.ENR	NB, BT off[14]	no of bins changed
	$PADCP,11900,20081113,003134.71.00,0.09	OS75_JC29011_000000-1.ENS		from NN055
		OS75_JC29011_000000-1.ENX		to NN060
		OS75_JC29011_000000.N1R		EM120 survey
		OS75_JC29011_000000.N2R		
012	$PADCP,1,20081113,003359.00,0.09	OS75_JC29012_000000-11.ENR	NB, BT off[14]	moorings
	$PADCP,87622,20081115,155532.85,0.08	OS75_JC29012_000000-12.ENS		stns 007-011
		OS75_JC29012_000000-12.ENX		
		OS75_JC29012_000000-7.N1R		
		OS75_JC29012_000000-6.N2R		
013	$PADCP,1,20081115,155609.01,0.08	OS75_JC29013_000000-5.ENR	NB, BT on[15]	steaming against
	$PADCP,35466,20081117,192803.61,0.09	OS75_JC29013_000000-5.ENS		strong winds
		OS75_JC29013_000000-5.ENX		stns 012-015
		OS75_JC29013_000000-5.N1R		
		OS75_JC29013_000000-5.N2R		
014	$PADCP,1,20081117,193001.00,0.09	OS75_JC29014_000000-10.ENR	NB, BT off[14]	stns 016-022
	$PADCP,81429,20081120,062259.16,0.10	OS75_JC29014_000000-11.ENS		
		OS75_JC29014_000000-11.ENX		
		OS75_JC29014_000000-6.N1R		
		OS75_JC29014_000000-6.N2R		
015	$PADCP,1,20081120,062308.00,0.10	OS75_JC29015_000000-3.ENR	NB, BT off[14]	stns 023-024
	$PADCP,22712,20081120,224830.79,0.10	OS75_JC29015_000000-3.ENS		
		OS75_JC29015_000000-3.ENX		
		OS75_JC29015_000000-1.N1R		
		OS75_JC29015_000000-1.N2R		
016	$PADCP,1,20081120,224840.01,0.10	OS75_JC29016_000000-5.ENR	NB, BT off[14]	stn 025
	$PADCP,37524,20081122,015643.62,0.08	OS75_JC29016_000000-5.ENS		
		OS75_JC29016_000000-5.ENX		
		OS75_JC29016_000000-3.N1R		
		OS75_JC29016_000000-2.N2R		
—	—	—	—	—

OS75 PC crashed at 01:56, 22/11, due to loss of serial ports (loosened card). Restored the ports, restarted PC and VmDas.

seq.	First and last $PADCP lines	Files	Config.	comments
—	—	—	—	—
017	$PADCP,1,20081122,023153.00,0.71	OS75_JC29017_000000-9.ENR	NB, BT off[14]	stns 026-029
	$PADCP,69748,20081124,050015.18,0.09	OS75_JC29017_000000-9.ENS		
		OS75_JC29017_000000-9.ENX		
		OS75_JC29017_000000-5.N1R		
		OS75_JC29017_000000-5.N2R		
018	$PADCP,1,20081124,050032.01,0.09	OS75_JC29018_000000-8.ENR	NB, BT off[14]	
	$PADCP,66796,20081126,052040.02,0.08	OS75_JC29018_000000-9.ENS		
		OS75_JC29018_000000-9.ENX		
		OS75_JC29018_000000-5.N1R		
		OS75_JC29018_000000-5.N2R		
019	$PADCP,1,20081126,052054.00,0.10	OS75_JC29019_000000-5.ENR	NB, BT off[14]	stns 035-037
	$PADCP,38612,20081127,091727.38,0.09	OS75_JC29019_000000-5.ENS		
		OS75_JC29019_000000-5.ENX		
		OS75_JC29019_000000-3.N1R		
		OS75_JC29019_000000-3.N2R		
020	$PADCP,1,20081127,091737.00,0.09	OS75_JC29020_000000-16.ENR	NB, BT off[14]	stns 038-049
	$PADCP,125208,20081201,035427.15,0.09	OS75_JC29020_000000-17.ENS		
		OS75_JC29020_000000-17.ENX		
		OS75_JC29020_000000-10.N1R		
		OS75_JC29020_000000-9.N2R		
021	$PADCP,1,20081201,035502.99,0.09	OS75_JC29021_000000-2.ENR	NB, BT on[15]	stns 050-056
	$PADCP,125208,20081202,031102.11,0.10	OS75_JC29021_000000-2.ENS		
		OS75_JC29021_000000-2.ENX		
		OS75_JC29021_000000-2.N1R		

Table 17 – continued from previous page

seq.	First and last $PADCP lines	Files	Config.	comments
022	$PADCP,1,20081202,031113.00,0.10 $PADCP,12951,20081202,210917.02,0.10	OS75_JC29021_000000-2.N2R OS75_JC29022_000000-1.ENR OS75_JC29022_000000-1.ENS OS75_JC29022_000000-1.ENX OS75_JC29022_000000-2.N1R OS75_JC29022_000000-1.N2R	NB, BT on[15]	stn 057
023	$PADCP,1,20081202,210942.01,0.10 $PADCP,126746,20081206,164841.31,0.09	OS75_JC29023_000000-16.ENR OS75_JC29023_000000-18.ENS OS75_JC29023_000000-18.ENX OS75_JC29023_000000-10.N1R OS75_JC29023_000000-9.N2R	NB, BT off[14]	mooring recoveries during 03/12 stns 058-067
024	$PADCP,1,20081206,164905.00,0.09 $PADCP,43767,20081208,002755.00,0.09	OS75_JC29024_000000-5.ENR OS75_JC29024_000000-6.ENS OS75_JC29024_000000-6.ENX OS75_JC29024_000000-3.N1R OS75_JC29024_000000-3.N2R	NB, BT off[14]	stns 068-071
025	$PADCP,1,20081208,002804.00,0.09 $PADCP,47006,20081209,102727.34,0.10	OS75_JC29025_000000-6.ENR OS75_JC29025_000000-6.ENS OS75_JC29025_000000-6.ENX OS75_JC29025_000000-3.N1R OS75_JC29025_000000-3.N2R	NB, BT off[14]	calibration cross
—	—	—	—	—
***	KEEL UP	09/12/08, 10:30		***
—	—	—	—	—
026	$PADCP,1,20081209,105106.00,0.10 $PADCP,206650,20081215,044753.77,0.08	OS75_JC29026_000000-25.ENR OS75_JC29026_000000-27.ENS OS75_JC29026_000000-27.ENX OS75_JC29026_000000-16.N1R OS75_JC29026_000000-14.N2R	NB, BT off[13]	
027	$PADCP,1,20081215,044807.99,0.10 $PADCP,153758,20081219,112605.33,0.08	OS75_JC29027_000000-19.ENR OS75_JC29027_000000-20.ENS OS75_JC29027_000000-20.ENX OS75_JC29027_000000-11.N1R OS75_JC29027_000000-11.N2R	NB, BT off[13]	stn 072

[8]OS75NB_BTon_JC29.txt with misalignment set to 0

[9]OS75NB_BToff_JC29_noangle.txt

[10]OS75NB_BToff_JC29_keelup_noangle.txt with transducer depth set to ??

[11]OS75NB_BToff_JC29_noangle.txt

[12]OS75NB_BToff_JC29_keelup_noangle.txt

[13]OS75NB_BToff_JC29_keelup.txt

[14]OS75NB_BToff_JC29.txt

[15]OS75NB_BTon_JC29.txt

10 Underway Measurements

Maria Broadbridge, Jennifer Graham and Chris Barnard

10.1 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. Also this cruise the new transmissometers have been installed which replace the old Seatech model. This brand of transmissometer became unsupportable and so recently were uncalibrated. By adding the new CStar's we hope to gather more accurate and calibrated data.

The Surfmet system had its Transmissometer and Fluorimeter windows cleaned at least once per week when time allowed during watches. The Met Platform sensors were also cleaned once a week during the cruise and the whole system was cleaned prior to sailing as it had not been running prior to the cruise which allowed fouling to occur. The system was run from JDay 308 9:02 GMT.

A list of instruments is provided in Table 18.

Table 18: Surfmet instrument details

Instrument	Type	Serial No.	Field Name and Notes
Sea Temperature	Falmouth Scientific OTM	1370	SSTemp, remote (temp_r)
Thermosalinograph	Falmouth Scientific OTM and OCM	1376, 1333	TSG Temp, housing (temp_h) and Conductivity (uncalibrated)
Flourometer	Wetlabs WETStar	WS3S-246	Fluorometer
Air Temperature and Humidity	Vaisala HMP45A	D1330038	Air Temp and Humidity
PAR Sensor	Skye SKE 510	28563,28558	PPAR and SPAR, port and starboard
TIR Sensor	Kipp and Zonen CM6B	047462, 047463	PTIR and STIR, port and starboard
Barometer	Vaisala BAROCAP	RO45005	Air Press
Wind Speed and Direction	Gill Windsonic (Option 3)	064537	Wind speed and direction (uncalibrated)
Transmissometer	WetLabs C-Star	CST1132PR	Trans
Voltage Converters	Nudam 6017 and 6018 ± 5V		NA
Thermosalinograph (SBE)	SBE 45 MicroTSG		Temporary install on trial

10.2 Routine Processing

The underway data was read into daily files using the Unix script, get_underway. This would produce a pstar file, with a filename format of surfmetJJJ.pstar, where JJJ is the corresponding jday. These pstar files were then converted into an mstar format within Matlab, using the script, pstar_to_mstar_wrap.m. This uses a previous pstar_to_mstar routine, as well as setting the cruise details within the header. To be able to use this script, m_setup must be run first to set the required path names. The resulting netcdf files were then added to a master file, surfmetall.nc. This was done using mapend.m, producing a file for the entire cruise duration. Some spikes were noted in the data in the first couple of days of the cruise, and were set to NaN values when plotting the data. Spike values were also noticed in wind speed during the times of high winds.

10.3 Thermosalinograph Samples

Salinity samples were taken from the thermosalinograph roughly every 4 hours during the cruise track. 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 P149. 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 with the sampling times and ship positions and then further transferred into the Unix system. A problem with the TSG occurred on 23rd Nov, so there is no temperature or conductivity data for 24 hours between 08:56 GMT (last valid sample) on 23rd Nov and 09:04 GMT (first valid sample) on 24th Nov. In total 150 underway salinity samples were taken.

10.4 Comparison of Salinity Sensors

From comparing the salinity data done on the Autosal 8400B with the SBE45 and FSI datasets we can see the high variability and large offsets that exist for the FSI Sensors. There is almost a 3PSU over reading of Salinity by the FSI sensors. Where as the Seabird

has a $20 - 35$ miliPSU offset.

Figure 35 shows that there is a large variability in the dataset from the FSI which does not correlate well with the Autosal data. There is a $2.9 - 3$ PSU offset in the data however the trend of the data does follow despite this. The variability is a lot higher than that of the SBE which you can see, in Figure 36, has a very small distribution.
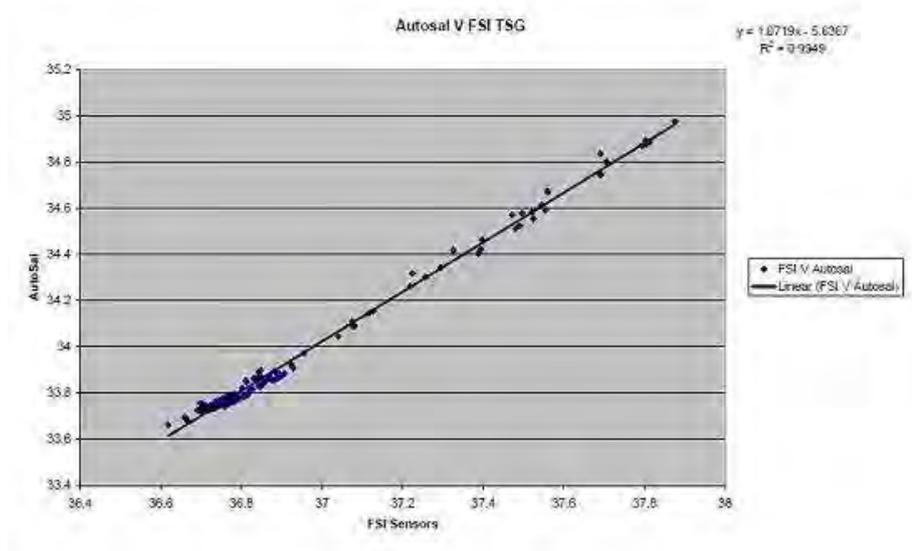
Figure 35: Comparison of FSI with the Autosal data.

You can see above that there is a very good fit with our given dataset. The dataset has had a drift correction applied in the image above (Figure 36) and the offset between datasets has been reduced to 18 miliPSU by removal of the drift calculated.

You can see the offset in Figure 37, including the drift and the offset with the removal of the drift applied. Figure 37 shows the original offset and the trend line used to remove the drift. The Drift was calculated using the trendline above as being 14.50 miliPSU between JDay 317 and JDay 343, this is possibly being affected by the spikes seen in the offsets however they are possibly not bad samples and have been included in the calculations. The Lower line is the offset with the drift removed across the dataset based on the date. As you can see the R2 value has moved towards 0 which is what we would hope to achieve by accounting for the drift.

Figure 38 shows the temperature data for the 2 temperature sensors present in the TSG System. The Purple one being the new SBE45. The data (despite the offset) does
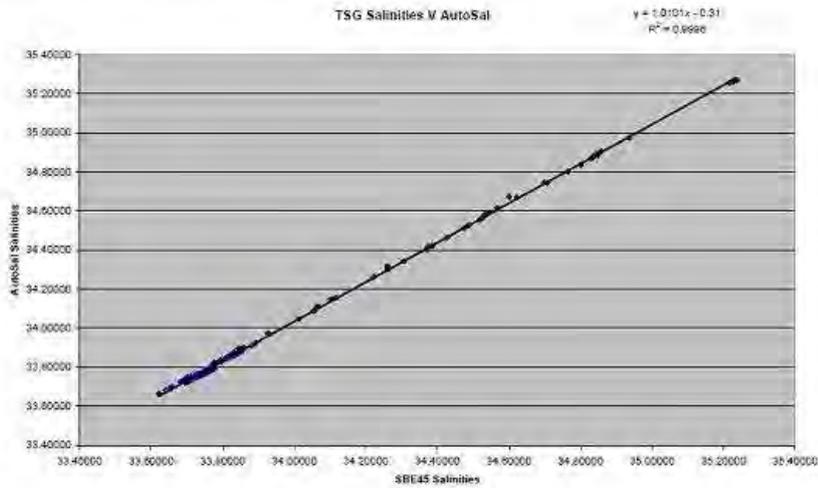
Figure 36: Comparison of Seabird TSG Salinities with Autosal data.

follow the same distinct pattern however one noticeable thing is the SBE 45 data has spikes every few hours in the data. I believe this is due to air entering the SBE when the TSG samples were taken which is possibly due to its installation location within the system. This will not occur once the TSG takes the place of the FSI TSG when the SBE45 has been integrated fully into the Surfmet System.
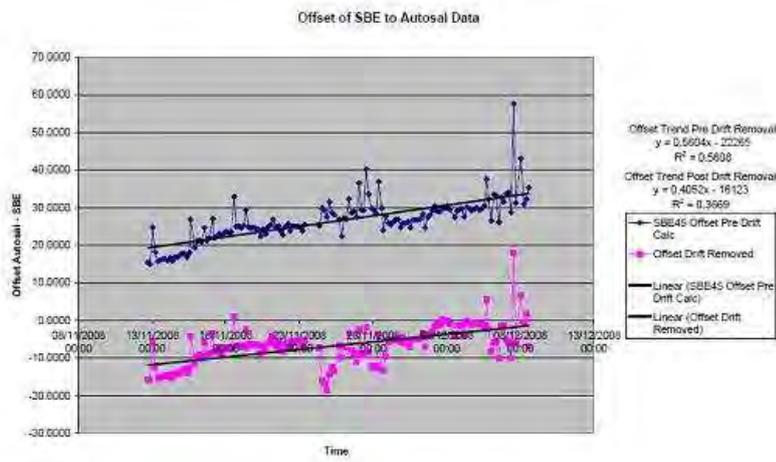
Figure 37: Offset between Seabird and Autosal Data
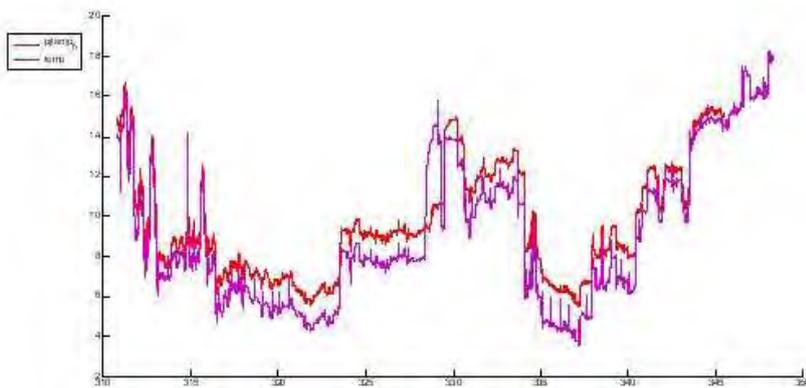
Figure 38: Comparison between Seabird and FSI temperature data.

11   The RRS *James Cook* Bathymetry Suite

Christopher Barnard

The RRS *James Cook* is fitted with a number of acoustic systems for ocean bottom mapping and depth sounding.

Kongsberg Simrad EM-120 Multibeam Echo Sounder Kongsberg Simrad EM-710 Multibeam Echo Sounder Kongsberg Simrad EA600 Single Beam Echo Sounder Kongsberg SBP-120 Sub Bottom Profiler Kongsberg EK-60 Fish Finding Echo Sounder

During this cruise the EM-120 and EA600 were used.

Kongsberg Simrad EM-120

The EM-120 is a Kongsberg Multibeam Echo Sounder capable of 191 beams at 12 KHz. The echo returned to the receiver on the hull is then processed by the transceiver hardware and the Seafloor Information System (SIS) software and displayed as a track beneath the ship displaying the various heights that each ping was returned. The swath pings once every 30 seconds and is capable of full ocean depth survey with a nominal coverage span of 3 to 6 times the water depth. The system is fully integrated into the ships systems however does not rely upon any other external references with exception of the POSMV system which provides Pitch Heave and Roll data which is visible in the Time Series window and is used in real time by SIS to compensate for ships movement when transmitting. The transmit array is split up into sections that are coded with different frequencies ranging from 11.25 to 12.6 KHz. The System installed on the *James Cook* is a 1 x 1 which means it has 48 TX Modules and 16 TX Modules. The 1 x 1 system is the highest resolution of the EM-120 series currently available.

The diagram on the left displays the positioning of the Transmit and Receive Transducers. All measurements in of position are indicated with the POSMV Motion Reference Unit being the central point.

	TX	RX
X	1.832	0.954
Y	19.199	14.092
Z	-6.944	-6.926

All measurements expressed in meters and are the centre points of the arrays. Z measured as negative being below the MRU

Data Output
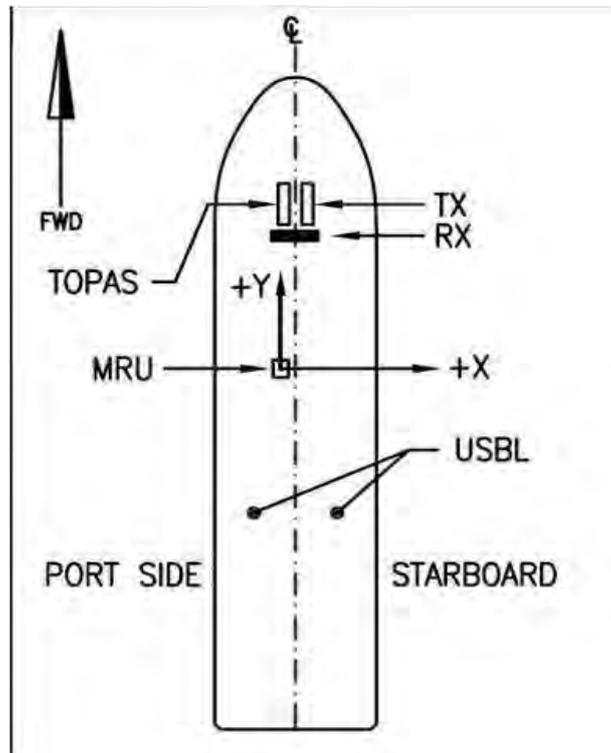
The swath system itself produces IX1, IX2 and all file formats directly on to the machine that SIS runs upon. This data can then be used by programs such as Replay and Caris Hips and Sips for processing. During the cruise there was a requirement to process data for the Moorings sites, this was not possible at the time as a day earlier the Kongsberg Neptune processing computer suffered a corruption in its System Registry and despite attempts to recover the corrupt registry, access to the OS of the hard disk was not possible. Luckily however we could access the files on the hard drive to retrieve the license information from the computer. Kongsberg were contacted and the software downloaded via FTP however the system was not up and running until the evening following the first 2 mooring deployments. Some data was processed through the cruise as the cruise went on with most of the data remaining raw and to be processed post cruise.

Kongsberg Simrad EA600

The Kongsberg EA600 is a single beam echo sounder using a 12 KHz transducer. The EA600 is built into the port drop keel which was deployed for most of the cruise. The

Echo Sounder produces data output in a Depth below surface format which is sent to the TECHSAS System and recorded on a ping by ping basis. The time between pings is dependant on the depth of water that we are in.

EA600 Position X 0.054 Y 4.412 Z -6.943

Both the EA600 and EM120 were used throughout the cruise with the requirement that they be turned off during VMP Deployments and during Mooring Triangulation. They were turned on sporadically during VMP Casts to allow the CTD Operator to receive a depth for bottom approach. Both EM120 and EA600 were updated with the same Sound Velocity profiles. These were taken at opportune moments during the cruise. In total 6 casts were performed throughout the cruise with some casts being reused when we re-entering area's where they were taken originally.

	Filename	Time	Changed
1	JC029_081108	09/11/08	07:37
2	JC029_121108	12/11/08	16:22
3	JC029_171108	17/11/08	22:40
4	JC029_211108	21/11/08	08:39
5	JC029_251108	25/11/08	03:57
6	JC029_011208	01/12/08	23:36

Upon starting the SWATH Survey at the end of the moorings we re used JC029_121108 as it was close to the moorings site. This was done at 04/12/08 06:00 due to the data not being recorded properly on the SVP that was deployed on the previous CTD Cast. It is unknown why that SVP failed. The SVP was not put back on the frame after that and so no testing could be done.

12 Mooring Operations

Bernadette Sloyan, Stephanie Waterman, Paul Provost, Daniel Comben

Prior to the beginning of the mooring operations a 12 hour swath survey was completed of a ridge that extended northward from the Kerguelen Plateau between 46.5° - 47°S and 71.75° - 72°E. From the swath data, the ridge extends with a smooth, but steep slope from 2100 m to 1300 m at its shallowest point. Locations of the mooring sites were determined from the swath data. It was noted that a depth error in the swath of approximately 50 m (greater than actual) was estimated by comparison of the CTD depth and swath at station 006.

The SOFINE mooring array consisted of five moorings designed to measure veloc-ity, temperature, salinity and pressure. Three highly instrumented short-term (approx-imately 25 days) moorings and two long-term (2 year) moorings were deployed. The three short-term moorings were located with approximately 1 km of each other, and the long-term moorings were a further 3 km (2000 m mooring) and 5 km (2500 m) from the short-term central mooring position (Figure 39; Table 19).

12.1 Mooring Deployment

Mooring deployment operations began at 02:45 UTC on 13 November 2008 with the deployment of the northern short-term mooring (UK mooring 2) and were completed at 13:41 UTC on 15 November 2008 with the deployment of the 2500 m long-term moor-ing (AU mooring 2). All moorings were deployed from the aft-deck of the RRS *James Cook* by Paul Provost and Daniel Comben, National Oceanographic Centre, Southamp-ton (NOCS), UK, with assistance from the ships deck crew. Additional assistance was provided by Phil Adams and Bernadette Sloyan, CSIRO, Australia.

All moorings were deployed using a NOCS double barrel winch (electro-hydraulic) and reeling winch system which was load tested prior to commencement of operations. 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 the mooring deployment.

The anchors for the three UK moorings consisted of a 550 kg mushroom anchor and 2200 kg of eight inch chain. This was designed to be deployed such that as it reached the seabed the mushroom anchor would land first, and the chain would land on the seabed to provide as much scope and drag as possible due to the anticipated high energies.
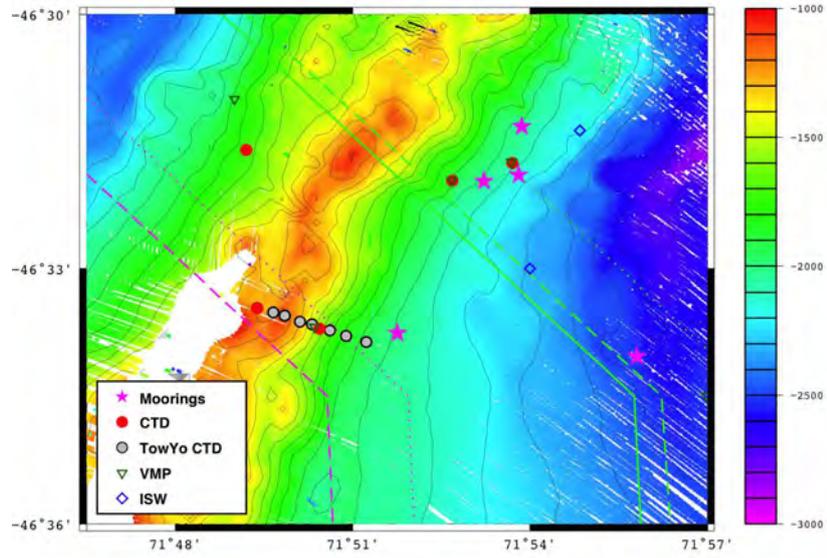
Figure 39: Position of mooring array (pink stars). Mooring array is shown in relation to VMP, CTD, ISW and Tow-yo stations in the vicinity of the ridge spur of the Kerguelen Plateau.

Table 19: Distance (km) between moorings sites. Distance is calculated from estimated anchor position.

	Short Term North	Short Term Central	Short Term East	Long Term 2000 m
Short Term Central	1.44			
Short Term East	1.06	0.76		
Long Term 2000 m	5.23	3.49	4.32	
Long Term 2500 m	5.59	5.04	4.70	5.18

12.1.1 Northern short-term mooring (UK mooring 2)

The short-term northern mooring nominal target position was 46° 31.301′ S, 71° 53.608′ E in 1900m of water. The mooring consisted of seven single point current meters of various types, a RDI 75 kHz Long-Range Acoustic Doppler Current Profiler (ADCP) and a McLane Moored Profiler (MMP) (Figure 40).

The mooring operation began at 02:45 UTC on 13 November 2008. Originally the mooring was designed for a water depth of 2100m. To obtain the required depth a 200 m wire length was removed from the mooring just below the steel sphere flotation. Attachment of in-line current meters, upward-looking ADCP and MMP continued until 05:03 UTC (Table 20). At this time the ship was still some distance from the nominal position. Subsequently the mooring was towed behind the ship for approximately one hour (Table 20). The mooring anchor was released at 06:13 UTC, 46° 31.266′S 71° 53.62′E in 1840 m water depth (time and position from aft-deck hand-held GPS device). This was approximately 160 m past the intended anchor position to allow for fall back of the mooring during release and decent. Fall back had been estimated at 300 m but at the suggestion of the bridge the mooring anchor was released early.

After anchor release from the vessel, the acoustic releases were ranged until the anchor was confirmed to be on the seabed and remained as such. The ranging allowed a decent rate for the mooring of 170 m/min to be measured.

An estimated mooring location of 46° 31.301′ S, 71° 53.608′ E was determined from three independent ranging locations (triangulation) to the acoustic release. 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 41).

The wind speed and sea state had increased dramatically by the completion of the range estimates and mooring operations were halted for the day. As the winds abated overnight a CTD tow-yo was completed over the crest of the ridge.

12.1.2 Central short-term mooring (UK mooring 3)

The short-term central mooring nominal target position was 46° 31.85′ S, 71° 53.22′ E in 1900m of water. The mooring consisted of seven single point current meters of various

JC029 Mooring 2
LATERAL 1
White tape

75 m	1Benthos	5/8 Shac
	#1 15m 1/2" Polyprop	5/8 Shac
91 m	48" Steel sphere	5/8 Shac
	#2 1.5m chain–13	

Argos beacon   (I.D. 23829)
Novatech Xenon light (s/n W06-007)

		shac–link–shac
94 m		shac–link–shac
	#3 100m 3/16" ins	shac–link–shac
196 m		shac–link–shac
	#4 200m 3/16" ins	shac–link–shac
398 m		shac–link–shac
	#5 200m 3/16" ins	shac–link–shac
600 m		shac–link–shac
	#6 200m 3/16" ins	shac–link–shac
802 m		shac–link–shac
	#7 100m 3/16" ins	shac–link–shac
903 m	ADCP+66"Streamline	shac–link–swiv-shac
	#8 2.5m chain–13	shac–link–shac
910 m		shac–link–shac
	#9 top 950m 1/4" ins	Stopper
921 m	MMP	
	#10 bottom	
1864 m	14Benthos	Stopper sRs
		sRs
1869 m		shac–link–swiv-shac
	#10 5m chain–13	

RCM 7 (s/n 9069)

SEAGUARD (s/n 69)
SBE 37SMP (s/n 3276)

RCM 8 (s/n 9440)

SEAGUARD (s/n 70)
SBE 37SMP (s/n 3481)

RCM 8 (s/n 11215)

RDI 75kHz LR-ADCP (s/n 10583)

RCM 11   (s/n 425)
RBR XR-CTD (s/n 17025)

McLane MMP (s/n 11794-03)

NORTEK Aquadopp (s/n 1404)
SBE 37SI (frame)   (s/n 3145)

Figure 40: Diagram of Northern short-term mooring (UK mooring 2).

Table 20: Instruments, time and position (latitude and longitude) of deployment on northern short-term mooring on 13/11/2008. The position was obtained from a hand-held global positioning system (GPS) device operated from the aft deck of the RRS *James Cook*. Difference in GPS location, for given UTC time, between ships navigation and hand-held GPS device reflects the different location on the ship of the two instruments and the relative accuracy of the hand-held device.

Instrument and Equipment	Serial Number	Time (UTC) Overside	Latitude Overside	Longitude Overside
Argos Beacon	I.D 23829	2:54	S 46 33.102	E 71 56.335
Novatech Xenon	W06-007	2:54	S 46 33.102	E 71 56.335
RCM 7	9069	2:54	S 46 33.102	E 71 56.335
Seaguard	69	3:09	S 46 33.006	E 71 56.208
SBE 37SMP	3276	3:09	S 46 33.006	E 71 56.208
RCM 8	9440	3:16	S 46 32.954	E 71 56.122
Seaguard	70	3:26	S 46 32.837	E 71 55.957
SBE 37SMP	3481	3:26	S 46 32.837	E 71 55.957
RCM 8	11215	3:35	S 46 32.743	E 71 55.817
RDI 75 kHz	10583	4:02	S 46 32.543	E 71 55.520
RCM 11	425	4:02	S 46 32.543	E 71 55.520
RBR XR-CTD	17025	4:02	S 46 32.543	E 71 55.520
MMP	11794-03	4:10	S 46 32.514	E 71 55.485
14 Benthos		4:47	S 46 31.952	E 71 54.657
Nortek Aquadopp	1404	5:03	S 46 31.875	E 71 54.548
SBE37SI (frame)	3145	5:03	S 46 31.875	E 71 54.548
IxSea AR861	683	6:13	S 46 31.266	E 71 53.626
Sonardyne DORT	238773-002	6:13	S 46 31.266	E 71 53.626
Anchor (2750 kg)		6:13	S 46 31.266	E 71 53.626
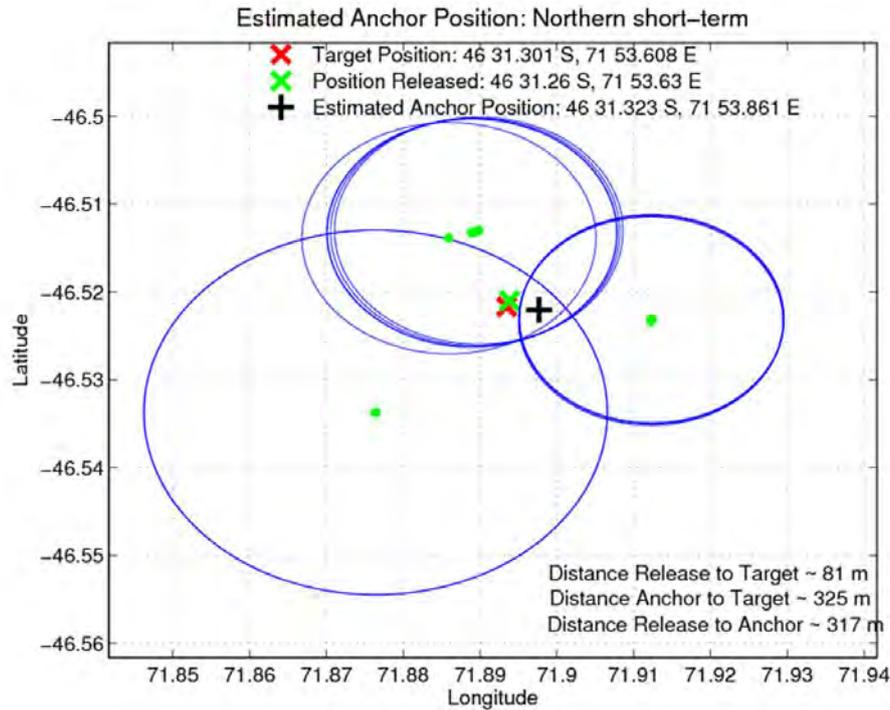
Figure 41: Triangulation estimate of position of the Northern short-term mooring. Green dots mark the position of the ship and the blue circles the horizontal range calculated from the slant (direct) range and water depth. Estimated position of mooring (black cross), target or nominal position of mooring location (red x) and release position of mooring (green x) are also shown.

types, a RDI 75 kHz Long-Range ADCP and, a McLane Moored Profiler (MMP) (Figure 42).

The mooring operation began at 01:32 UTC on 14 November 2008. Originally the mooring was designed for a water depth of 2100m. To obtain the required depth a 200 m wire length was removed from the mooring just below the steel sphere flotation. Attachment of in-line current meters, upward-looking ADCP and MMP continued until 04:34 UTC (Table 21). At this time the ship was a short distance from the nominal target depth. Subsequently the mooring towed behind the ship for approximately 30 minutes (Table 21). The mooring anchor was released at 05:04 UTC, 46° 31.976′ S 71° 52.774′ E in 1824 m water depth (time and position from aft-deck hand-held GPS device). The mooring was ranged to the seabed and descended with a speed of 170 m/min.

An estimated mooring location of 46° 31.85′ S, 71° 53.22′ E was determined from triangulation of the mooring location (Figure 43).
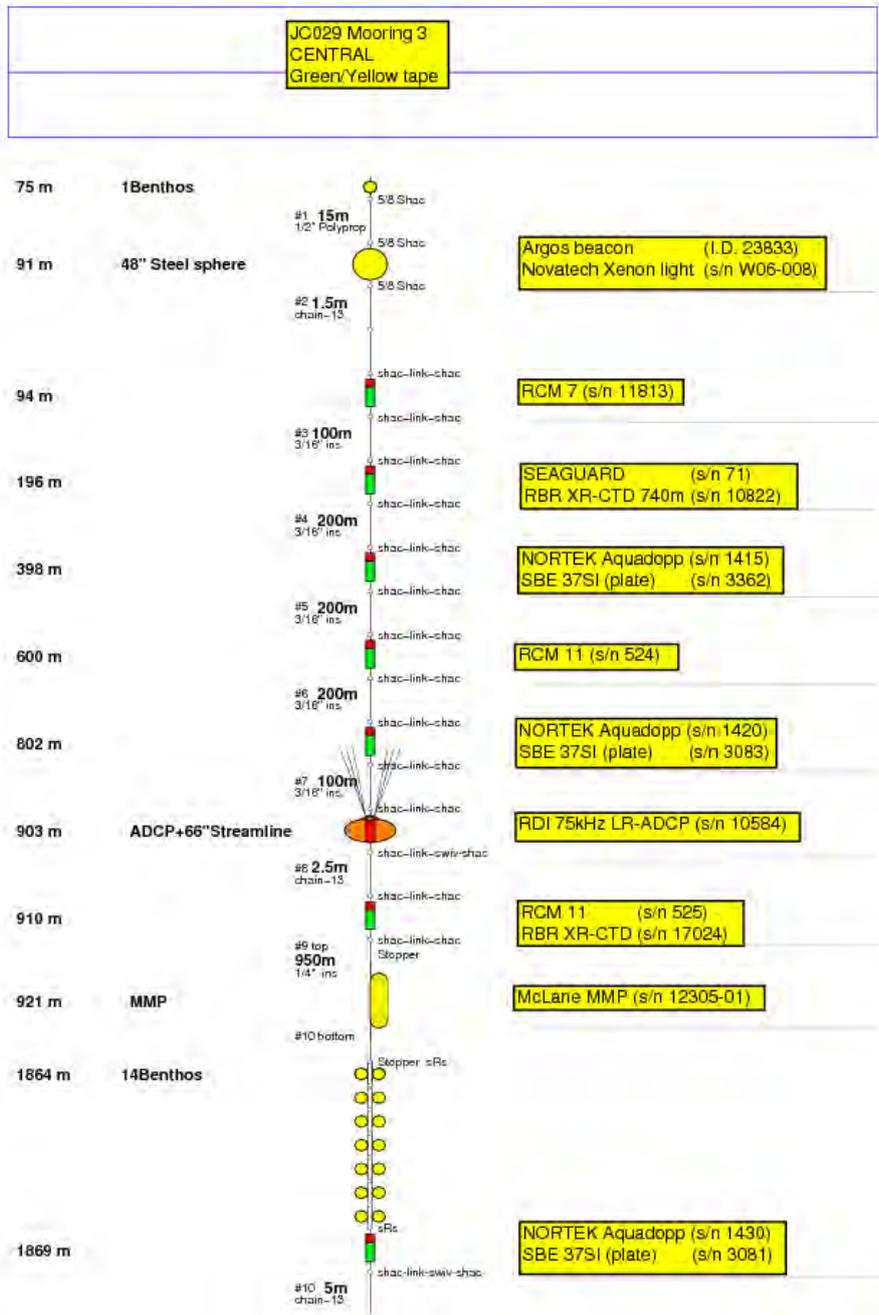
Figure 42: Diagram of Central short-term mooring (UK mooring 3).

Table 21: Instruments, time and position (latitude and longitude) of deployment on central short-term mooring on 14/11/2008. The position was obtained from a hand-held global positioning system (GPS) device operated from the aft deck of the RRS *James Cook*. Difference in GPS location, for given UTC time, between ships navigation and hand-held GPS device reflects the different location on the ship of the two instruments and the relative accuracy of the hand-held device.

| Instrument and Equipment	Serial Number	Time (UTC) Overside	Latitude Overside	Longitude Overside
Argos Beacon	I.D 23833	1:32	S 46 32.422	E 71 55.121
Novatech Xenon	W06-008	1:32	S 46 32.422	E 71 55.121
RCM 7	11813	1:32	S 46 32.422	E 71 55.121
Seaguard	71	1:53	S 46 32.376	E 71 54.875
RBR XR-CTD 740m	10822	1:53	S 46 32.376	E 71 54.875
Nortek Aquadopp	1415	2:01	S 46 32.358	E 71 54.784
SBE37SI (frame)	3362	2:01	S 46 32.358	E 71 54.784
RCM 11	524	2:30	S 46 32.312	E 71 54.571
Nortek Aquadopp	1420	2:37	S 46 32.299	E 71 54.491
SBE37SI (frame)	3083	2:37	S 46 32.299	E 71 54.491
RDI 75kHz LR-ADCP	10584	2:56	S 46 32.281	E 71 54.390
RCM 11	525	2:56	S 46 32.281	E 71 54.390
RBR XR-CTD 740m	17024	2:56	S 46 32.281	E 71 54.390
MMP	11794-03	3:06	S 46 32.248	E 71 54.264
14 Benthos		4:34	S 46 32.022	E 71 53.043
Nortek Aquadopp	1404	4:34	S 46 32.022	E 71 53.043
SBE37SI (frame)	3145	4:34	S 46 32.022	E 71 53.043
IxSea AR861	683	5:04	S 46 31.976	E 71 52.774
Sonardyne DORT	238773-002	5:04	S 46 31.976	E 71 52.774
Anchor (2750 kg)		5:04	S 46 31.976	E 71 52.774
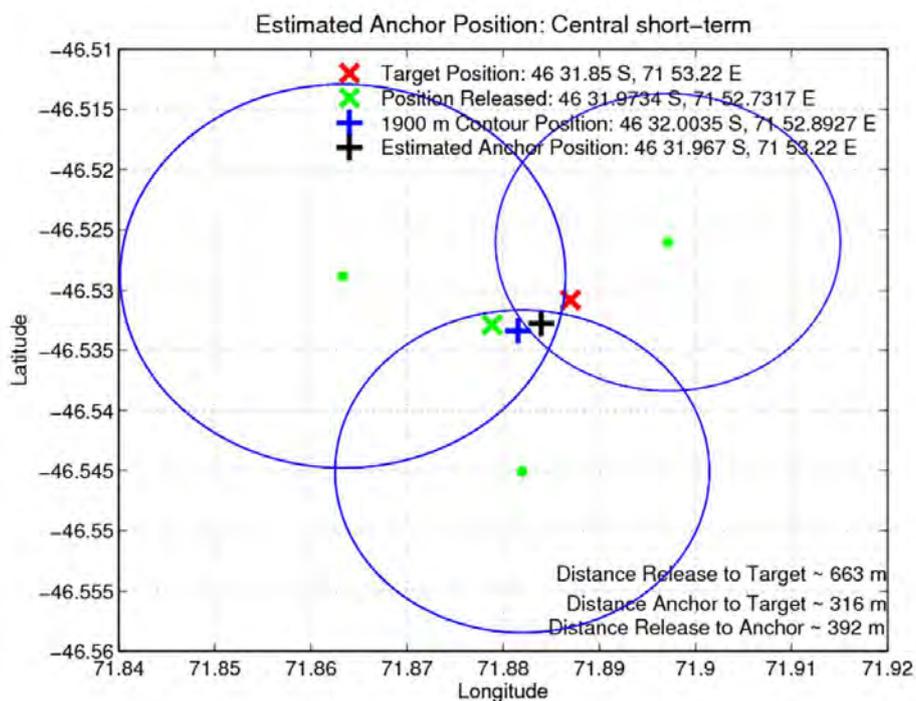
Figure 43: Triangulation estimate of position of the Central short-term mooring. Green dots mark the position of the ship and the blue circles the horizontal range calculated from the slant (direct) range and water depth. Estimated position of mooring (black cross), target or nominal position of mooring location (red x) and release position of mooring (green x) are also shown.

12.1.3 Eastern short-term mooring (UK mooring 1)

The short-term central mooring nominal target position was 46° 31.866′ S, 71° 53.6040′ E in 2050m of water. The mooring consisted of seven single point current meters of various types, a RDI 75 kHz Long-Range ADCP and a McLane Moored Profiler (MMP) (Figure 44).

The mooring operation began at 08:22 UTC on 14 November 2008. Originally the mooring was designed for a water depth of 2100m. To obtain the required depth and position of instrumentation of the mooring a 200 m wire length was removed from the mooring just below the steel sphere flotation and 100 m of spare CSIRO wire added to the bottom of the mooring below the deepest RCM8/RBR XR-CTD instrument. Attachment of in-line current meters, upward-looking ADCP and MMP continued until 04:34 UTC (Table 22). At this time the ship was some distance from the nominal target depth. Subsequently the mooring was towed behind the ship for approximately 1 hour 30 minutes (Table 22). The mooring anchor was released at 11:39 UTC, 46° 31.821′S

71° 53.492′ E in 1992 m water depth (time and position from aft-deck hand-held GPS device). The mooring was ranged to the seabed to confirm bottom contact and descended at a rate of 170 m/min.

An estimated mooring location of 46° 31.894′ S, 71° 53.808′ E was determined from triangulation of the mooring position (Figure 45).

12.1.4   2000m long-term mooring (AUS mooring 1)

Mooring operations resumed on the 15 November 2008 with the deployment of the 2000m long-term mooring. The nominal target position was 46° 33.780′ S, 71° 53.0314′ E in 2000m of water. The mooring consisted of six Aanderaa RCM 8 current meters and six SBE 37 microcats (Figure 46).

The mooring operation began at 03:27 UTC on 15 November 2008. Attachment of in-line current meters and SBE 37 microcats continued until 04:34 UTC (Table 23). At this time the ship was some distance from the nominal target depth. Subsequently the mooring towed behind the ship for approximately 1 hour 30 minutes (Table 23). The mooring anchor was released at 05:58 UTC, 46° 33.789′ S 71° 51.505′ E in 1950 m water depth (time and position from aft-deck hand-held GPS device). The mooring was ranged to the seabed to confirm bottom contact.

Estimated mooring location of 46° 33.753′ S, 71° 51.760′ E was determined from tri-angulation of the mooring position (Figure 47).

12.1.5   2500m long-term mooring (AUS mooring 2)

The nominal target position and depth was 46° 34.500′ S, 71° 56.9529′ E in 2500m of water. The mooring consisted of six Aanderaa RCM 8 current meters and six SBE 37 microcats (Figure 48).

The mooring operation began at 09:59 UTC on 15 November 2008. Attachment of in-line current meters and SBE 37 microcats continued until 11:17 UTC (Table 24). At this time the ship was nearly directly over the nominal target position, but the bottom depth was deepening. On closer inspection of the swath bathymetry it appeared that the nominal position was close to a depression in which the maximum depth was 2570m. A decision was made to continue with the ships northwest heading until the 2500m isobath was encountered. Consequently the mooring was towed behind the ship for approximately 2 hour 20 minutes (Table 24). The mooring anchor was released at 13:41 UTC, 46° 33.952′ S 71° 51.508′ E in approximately 2490 m water depth (time and
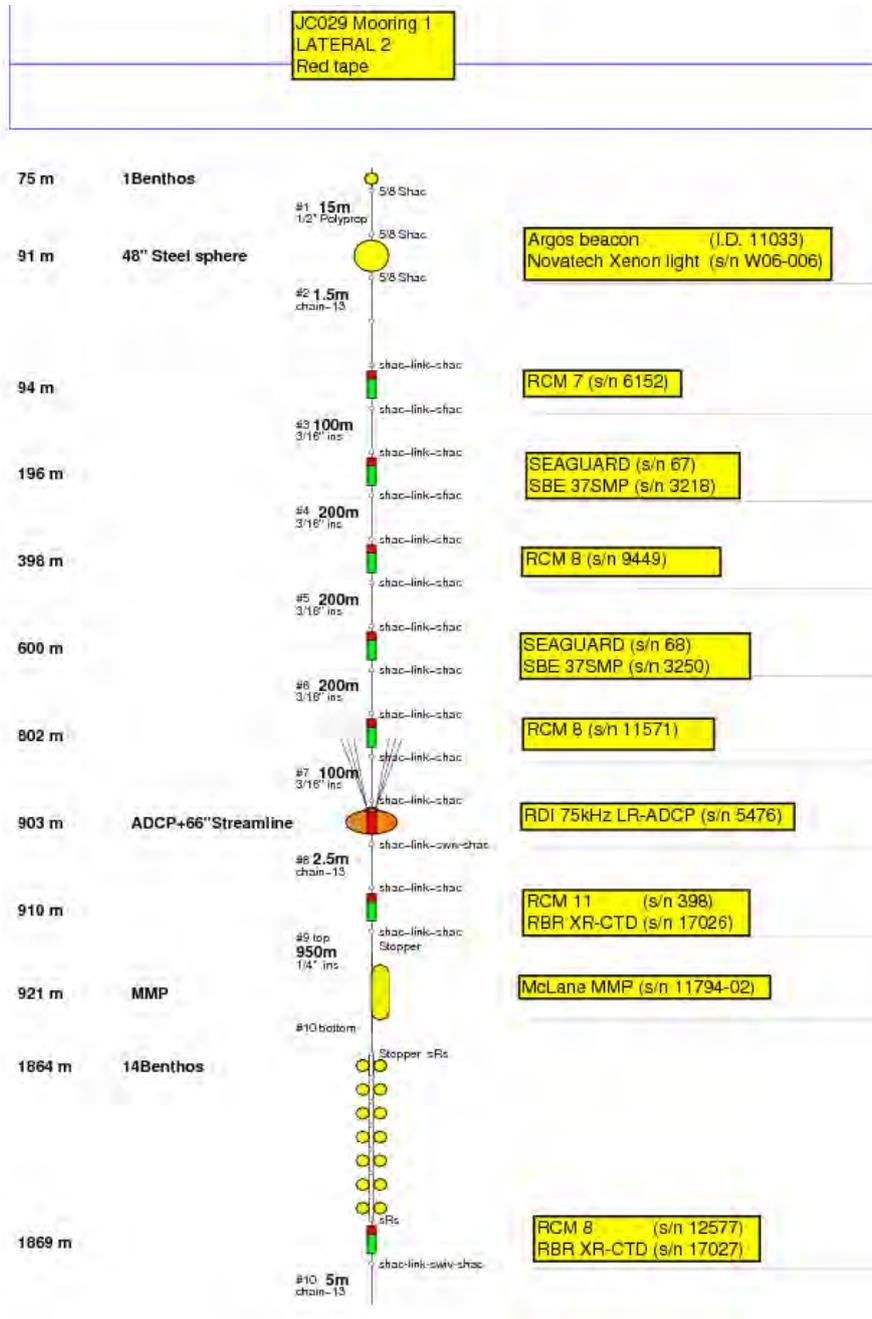
Figure 44: Diagram of Eastern short-term mooring (UK mooring 1).

Table 22: Instruments, time and position (latitude and longitude) of deployment on eastern short-term mooring on 14/11/2008. The position was obtained from a hand-held global positioning system (GPS) device operated from the aft deck of the RRS *James Cook*. Difference in GPS location, for given UTC time, between ships navigation and hand-held GPS device reflects the different location on the ship of the two instruments and the relative accuracy of the hand-held device.

Instrument and Equipment	Serial Number	Time (UTC) Overside	Latitude Overside	Longitude Overside
Argos Beacon	I.D 11033	8:22	S 46 32.163	E 71 55.039
Novatech Xenon	W06-006	8:22	S 46 32.163	E 71 55.039
RCM 7	6152	8:22	S 46 32.163	E 71 55.039
Seaguard	67	8:45	S 46 32.156	E 71 54.997
SBE 37SMP	3281	8:45	S 46 32.156	E 71 54.997
RCM 8	9449	8:52	S 46 32.156	E 71 54.997
Seaguard	68	9:02	No satellite	No satellite
SBE 37SMP	3250	9:07	S 46 32.117	E 71 54.853
RCM 8	11571	9:07	S 46 32.117	E 71 54.853
RDI 75 kHz LR-LADCP	5476	9:22	S 46 32.086	E 71 54.751
RCM 11	398	9:22	S 46 32.086	E 71 54.751
RBR XR-CTD	117026	9:22	S 46 32.086	E 71 54.751
MMP	11794-02	9:31	S 46 32.071	E 71 54.698
14 Benthos		10:06	S 46 31.937	E 71 54.139
RCM 8	12577	10:06	S 46 31.937	E 71 54.139
RBR XR-CTD	17027	10:06	S 46 31.937	E 71 54.139
IxSea AR861	315	11:39	S 46 31.821	E 71 53.492
Sonardyne DORT	238773-001	11:39	S 46 31.821	E 71 53.492
Anchor (2750 kg)		11:39	S 46 31.821	E 71 53.492

Table 23: Instruments, time and position (latitude and longitude) of deployment on eastern short-term mooring on 15/11/2008. The position was obtained from a hand-held global positioning system (GPS) device operated from the aft deck of the RRS *James Cook*. Difference in GPS location, for given UTC time, between ships navigation and hand-held GPS device reflects the different location on the ship of the two instruments and the relative accuracy of the hand-held device.

Instrument and Equipment	Serial Number	Time (UTC) Overside	Latitude Overside	Longitude Overside
Aanderaa RCM8	10869	3:27	S 46 33.870	E 71 53.665
SBE37SMP	4299	3:27	S 46 33.870	E 71 53.665
Aanderaa RCM8	10998	3:48	S 46 33.863	E 71 53.494
SBE37SM	4907	3:48	S 46 33.863	E 71 53.494
Aanderaa RCM8	10996	4:07	S 46 33.844	E 71 53.137
SBE37SMP	4300	4:07	S 46 33.844	E 71 53.137
Aanderaa RCM8	10992	4:15	S 46 33.835	E 71 52.979
SBE37SMP	4301	4:15	S 46 33.835	E 71 52.979
Aanderaa RCM8	10990	4:25	S 46 33.825	E 71 52.827
SBE37SMP	5721	4:25	S 46 33.825	E 71 52.827
Aanderaa RCM8	10919	4:34	S 46 33.818	E 71 52.681
SBE37SMP	6263	4:34	S 46 33.818	E 71 52.681
Acoustic Release	30554	5:58	S 46 33.786	E 71 51.505
Acoustic Release	24587	5:58	S 46 33.786	E 71 51.505
Anchor (1.5 tonne)		5:58	S 46 33.786	E 71 51.505
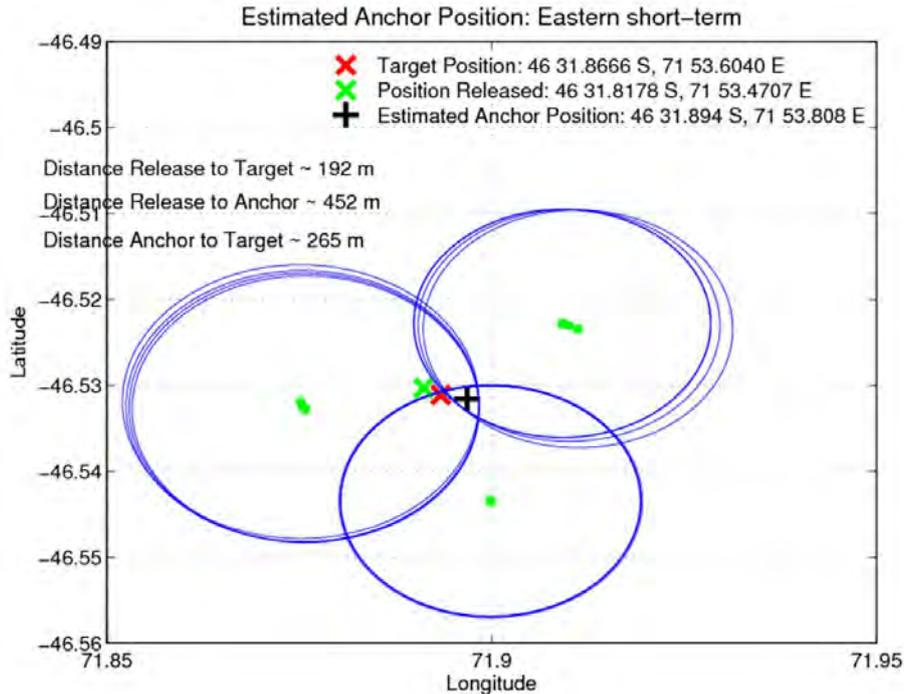
Figure 45: Triangulation estimate of position of the Eastern short-term mooring. Green dots mark the position of the ship and the blue circles the horizontal range calculated from the slant (direct) range and water depth. Estimated position of mooring (black cross), target or nominal position of mooring location (red x) and release position of mooring (green x) are also shown.

position from aft-deck hand-held GPS device). The mooring was ranged to the seabed to confirm bottom contact.

Estimated mooring location of 46° 34.029′ S, 71° 55.807′ E was determined from triangulation of the mooring position (Figure 49).

12.2 Mooring Recovery

The recovery of the three short-term moorings began at 1:53 UTC on the 3 December 2008. The moorings were recovered in the following order: Northern; Central and; Eastern. Recovery operations were completed at 15:38 UTC on the 3 December 2008.

Kerguelen Mooring 1 19–May–2008 16:17:36

Wire/chain	Length[m]		Element	Depth[m]
			1 10in PanthP	163.69
16mm Polyprop	30.00		8 Benthos	196.26
			Aanderaa RCM–8	199.02
			SBE–37	199.71
7mm wire/jack	120.00			
			8 Benthos	321.89
7mm wire/jack	270.00			
			8 Benthos	596.96
			Aanderaa RCM–8	599.72
			SBE–37	600.54
7mm wire/jack	595.00			
			6 Benthos	1197.31
			Aanderaa RCM–8	1199.47
7mm wire/jack	0.50		SBE–37	1200.18
8mm Kevlar	295.00			
			4 Benthos	1497.11
			Aanderaa RCM–8	1498.67
7mm wire/jack	0.50		SBE–37	1499.29
8mm Kevlar	197.00			
			4 Benthos	1698.20
			Aanderaa RCM–8	1699.77
7mm wire/jack	0.50		SBE–37	1700.29
8mm Kevlar	194.00			
			8 Benthos	1897.52
			Aanderaa RCM–8	1900.29
			SBE–37	1900.92
7mm wire/jack	77.00			
			double 8242	1978.28
8tonne strop	15.00			
1/2 chain SL	5.00			
			R/way 1.50 tonne	2000.00

Figure 46: Diagram of 2000m long-term mooring (AUS mooring 1). The mooring was designed and built by CSIRO Marine and Atmospheric Research, Hobart, Australia.

195

Table 24: Instruments, time and position (latitude and longitude) of deployment on eastern short-term mooring on 15/11/2008. The position was obtained from a hand-held global positioning system (GPS) device operated from the aft deck of the RRS *James Cook*. Difference in GPS location, for given UTC time, between ships navigation and hand-held GPS device reflects the different location on the ship of the two instruments and the relative accuracy of the hand-held device.

| Instrument and Equipment	Serial Number	Time (UTC) Overside	Latitude Overside	Longitude Overside
Aanderaa RCM8	10868	9:59	S 46 34.827	E 71 57.885
SBE37SMP	6264	9:59	S 46 34.827	E 71 57.885
Aanderaa RCM8	10916	10:21	S 46 34.732	E 71 57.611
SBE37SM	6265	10:21	S 46 34.732	E 71 57.611
Aanderaa RCM8	10766	10:46	S 46 34.620	E 71 57.296
SBE37SMP	6266	10:46	S 46 34.620	E 71 57.296
Aanderaa RCM8	10914	10:58	S 46 34.587	E 71 57.203
SBE37SMP	6267	10:58	S 46 34.587	E 71 57.203
Aanderaa RCM8	10918	11:07	S 46 34.564	E 71 57.139
SBE37SMP	6268	11:07	S 46 34.564	E 71 57.139
Aanderaa RCM8	10917	11:17	S 46 34.532	E 71 57.053
SBE37SMP	6269	11:17	S 46 34.532	E 71 57.053
Acoustic Release	32485	13:41	S 46 33.952	E 71 55.508
Acoustic Release	24653	13:41	S 46 33.952	E 71 55.508
Anchor (1.5 tonne)		13:41	S 46 33.952	E 71 55.508
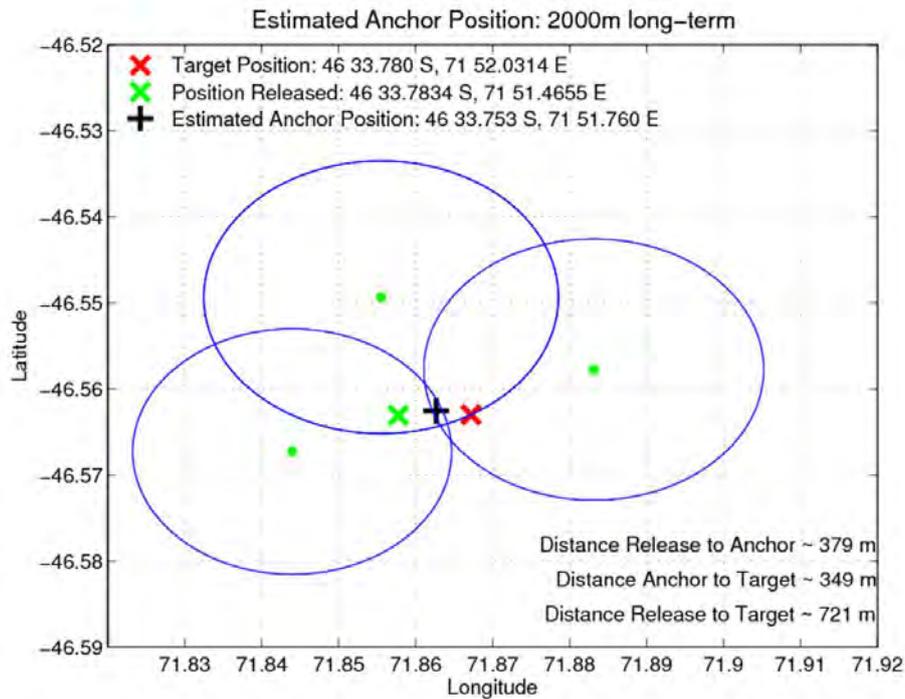
Figure 47: Triangulation estimate of position of the 2000m long-term mooring. Green dots mark the position of the ship and the blue circles the horizontal range calculated from the slant (direct) range and water depth. Estimated position of mooring (black cross), target or nominal position of mooring location (red x) and release position of mooring (green x) are also shown.

12.2.1   Northern short-term mooring (UK mooring 2)

The northern mooring was ranged and released at 1:57 UTC. The ascent rate was measured as approximately 80 m/min. Recovery of the mooring started at 2:55 UTC. Instruments were recovered on board as listed in Table 25.

During recovery the 3/16" wire directly above the syntactic ADCP flotation parted as a result of twisting and exceeding the minimum bend radius of the wire under load. The ship repositioned and recovery of the ADCP flotation continued. As the Benthos spheres were recovered, the quarter inch wire was tangled around the chain, this was untangled as the package was brought aboard. The MMP was free-running on the wire but was found to be against the top stopper on recovery.

Kerguelen Mooring 2 19–May–2008 16:06:37

Wire/chain	Length[m]		Element	Depth[m]
			1 10in PanthP	169.85
16mm Polyprop	50.00			
			8 Benthos	196.42
			Aanderaa RCM-8	199.19
			SBE-37	199.77
7mm wire/jack	118.00			
			8 Benthos	320.05
7mm wire/jack	270.00			
			2 Benthos	593.32
			8 Benthos	596.32
			Aanderaa RCM-8	599.08
			SBE-37	599.90
7mm wire/jack	895.00			
			8 Benthos	1496.88
			Aanderaa RCM-8	1499.05
			SBE-37	1499.60
7mm wire/jack	0.50		RBR DR-1050	1499.75
8mm Kevlar	395.00			
			4 Benthos	1896.88
			Aanderaa RCM-8	1898.43
7mm wire/jack	0.50		SBE-37	1899.04
8mm Kevlar	297.00			
			4 Benthos	2198.14
			Aanderaa RCM-8	2199.71
7mm wire/jack	0.50		SBE-37	2200.53
8mm Kevlar	244.00			
			8 Benthos	2447.57
			Aanderaa RCM-8	2450.34
			SBE-37	2450.97
7mm wire/jack	27.00			
			double 8242	2478.28
8tonne strop	15.00			
1/2 chain SL	5.00			
			R/way 1 50 tonne	2500.00

Figure 48: Diagram of 2500 m long-term mooring (AUS mooring 2). The mooring was designed and built by CSIRO Marine and Atmospheric Research, Hobart, Australia.
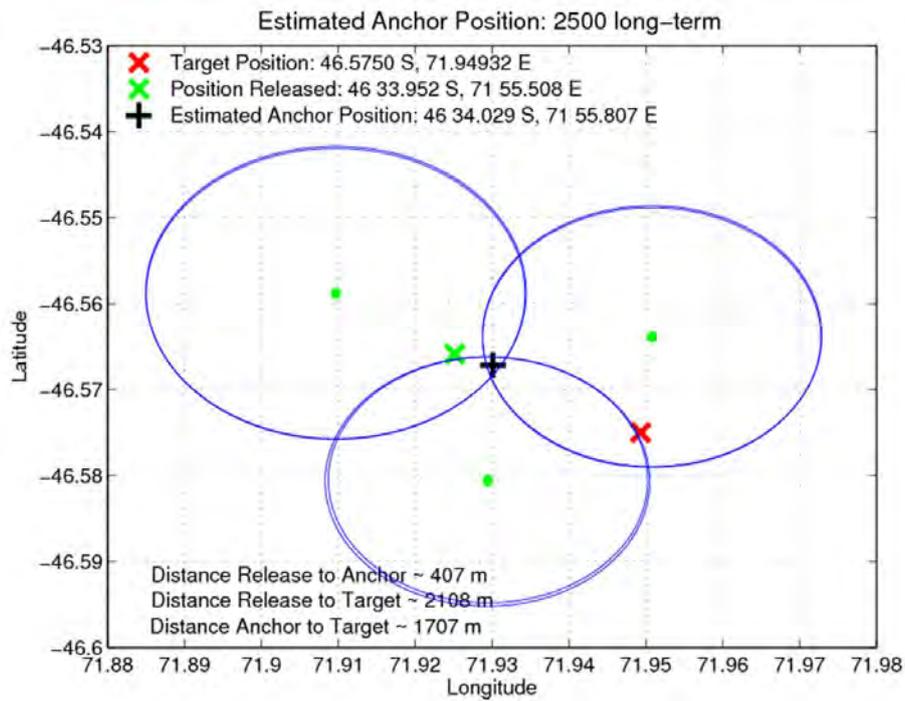
Figure 49: Triangulation estimate of position of the 2500m long-term mooring. Green dots mark the position of the ship and the blue circles the horizontal range calculated from the slant (direct) range and water depth. Estimated position of mooring (black cross), target or nominal position of mooring location (red x) and release position of mooring (green x) are also shown.

Table 25: Instruments and time of recovery for northern short-term mooring on 3/12/2008.

Instrument and Equipment	Serial Number	Time (UTC) On Board
RCM 7	9069	3:07
Seaguard	69	3:15
SBE 37SMP	3276	3:15
RCM 8	9440	3:23
Seaguard	70	3:29
SBE 37SMP	3481	3:29
RCM 8	11215	3:35
RDI 75 kHz	10583	4:13
RCM 11	425	4:14
RBR XR-CTD	17025	4:14
MMP	11794-03	4:46
Nortek Aquadopp	1404	4:40
SBE37SI (frame)	3145	4:40

12.2.2 Central short-term mooring (UK mooring 3)

The central mooring was ranged and released at 5:45 UTC. The ascent rate was measured as approximately 80 m/min. Recovery of the mooring started at 6:31 UTC. Instruments were recovered on board as listed in Table 26.

During recovery the sphere containing the ADCP was banged into the ship's stern. As for the northern short-term mooring, the quarter inch wire was twisted around the chain of the syntactic sphere upon recovery. The sixth pair (i.e. two individual) of Benthos glass spheres had imploded. As for the northern mooring, the MMP was free-running on the wire but found to be at the top stopper on recovery.

### 12.2.3 Eastern short-term mooring (UK mooring 1)

The eastern mooring was ranged and released at 8:53 UTC. The ascent rate was measured as approximately 80 m/min. Recovery of the mooring started at 9:20 UTC. Instruments were recovered on board as listed in Table 27.

The ACM -X arm on the MMP was broken during recovery when it came into contact with the 17" Benthos sphere package. This occurred as the package was lifted clear of

Table 26: Instruments and time of recovery for central short-term mooring on 3/12/2008.

Instrument and Equipment	Serial Number	Time (UTC) On Board
RCM 7	11813	6:34
Seaguard	71	6:42
RBR XR-CTD 740m	10822	6:42
Nortek Aquadopp	1415	6:48
SBE37SI (frame)	3362	6:48
RCM 11	524	6:54
Nortek Aquadopp	1420	6:59
SBE37SI (frame)	3083	6:59
RDI 75kHz LR-ADCP	10584	7:07
RCM 11	525	7:07
RBR XR-CTD 740m	17024	7:07
MMP	11794-03	7:38
Nortek Aquadopp	1404	7:38
SBE37SI (frame)	3145	7:38

Table 27: Instruments and time of recovery for eastern short-term mooring on 3/12/2008.

Instrument and Equipment	Serial Number	Time (UTC) On Board
RCM 7	6152	9:31
Seaguard	67	9:47
SBE 37SMP	3281	9:47
RCM 8	9449	9:55
Seaguard	68	10:01
SBE 37SMP	3250	10:01
RCM 8	11571	10:07
RDI 75 kHz LR-LADCP	5476	10:14
RCM 11	398	10:15
RBR XR-CTD	117026	10:15
MMP	11794-02	10:38
RCM 8	12577	10:38
RBR XR-CTD	17027	10:38

the water in swell at the stern of the vessel. The MMP was free-running on the wire but approximately mid-way along the wire when the mooring was recovered.

12.2.4 Instrument Condition

Many of the recovered instruments showed signs of wear suggestive of a highly energetic environment. Many of the SBE37s had screws loose or missing (SBE37 3250: 2 screws missing on guard, 3rd screw loose; SBE37 3276: 1 screw loose on guard; SBE37 3218 3 screws missing on guard, SEB3481: all ok). The frames of all Nortek Aquadopps/ SBE37SIs looked stretched with some loose screws on SBE37SIs. All cowlings on the MMPs were scratched, but this was thought to have happened during deployment from deck.

There was one instrument failure: RBR XR-CTD S/N 17027 (1869 m depth on the eastern short-term mooring) which leaked at the sensor end (possibly temperature). Water drained to the battery end bottom down causing damage. Both end O-rings were inspected and looked fine. There was no data retrieval from this instrument.

12.2.5 Data Recovery

Data was downloaded and processed into physical units when applicable for all instruments except the Aanderee RCM current meters which require post-calibrating to be done back at NOCS. At the time of writing, the ADCP data had been viewed in the WinADCP software but still required export to Matlab format.

During downloading of the Nortek Aquadopps, two of the instruments (S/N 1415 = 398 m depth on the central short-term mooing and S/N 1430 = 1869 m depth on the central short-term mooring) produced an error regarding missing two records. These instruments were downloaded a second time (names of the raw data files were appended with v2) but this produced the same error. As a result, the two copies of raw data files for the instrument are identical. In addition, one of the Aanderaa Seaguards (S/N 71 = 196 m depth on the central short-term mooring) experienced a battery failure resulting in the screen not responding. It was switched off at the switch. This instrument returned a total of 14840 records the last at 03/12/2008 at 00:42:00 UTC, thus the battery failure resulted in a loss of only about 6 hours of data.

The downloaded data was inspected for completeness and data quality. As part of this process, data from all instruments (with the exception of the MMPs and the ADCP) were stored in the form of a Matlab structure in a .mat file named by the instrument name

Table 28: Variables in Processed Data Files

Instrument	Variables Measured
Seaguard	voltage, memory used, interval, pressure, temperature, absolute speed, direction, velocity north, velocity east heading, tilt x, tilt y, SP std, strength, ping count
SBE 37SMP	temperature, conductivity, pressure, rtc
RBR XR-CTD	temperature, conductivity, pressure
McLane MMP	current, voltage, pressure, conductivity, temperature, TX, TY, HX, HY, HZ, VPAB, VPCD, VPEF, VPGH*
NORTEK	error code, status code,
Aquadopp	velocity east, velocity north, velocity up,
SBE 375I	amplitude beam 1 east, amplitude beam 2 north, amplitude beam 3 up, battery voltage, sound speed, heading, pitch, roll, pressure, temperature, analog input1, conductivity, salinity, speed, direction

and serial number. These .mat files were backed up with the raw data files. A summary of the variables contained in these records for each of the various instruments that were processed is given in Table 28. Note that in the MMP records, TX, TY, HX, HY, HZ, VPAB, VPCD, VPEF, VPGH are raw acoustic path velocity measurements logged in the ACM data files. These require conversion to velocities in the local Cartesian earth frame. Instructions are provided in Chapter 8 of the MMP manual (MMP-Manual-RevD.pdf), a copy of which is saved in the raw mooring data MMP directory. Information on the sampling interval and strategy for all the instruments is given in Table 29.

With the exception of the MMPs, the failed RBR-XR-CTD S/N 17027, and the six missing hours on the Seaguard S/N 71, all instruments returned full records. A summary of the instrument records are given in Tables 30, 31, 32, 33, 34 and 35.

Unfortunately, the MMPs had problems. The MMP on the central mooring (S/N 12305-01) never profiled and remained stuck at the starting pressure (993 dB) for the entire deployment. For each profile attempt, the instrument would backtrack and restart due to a "Pressure Rate Zero" status a total of six times before the profile was terminated. During these attempts, data was logged so the MMP record can be considered as a stationary current meter record with a sample rate of approximately 90 minutes. This was the first deployment of this McLane MMP as it was newly acquired for the project. Prior to deployment the MMP passed all deck tests. After investigation, it has been found that the motor works, but there is no power coming from the electronic board

Table 29: Sampling intervals by instrument type

Instrument	Sampling Interval
RCM 7/8	5 minutes
RCM 11	2 minutes, 600 pings standard (not burst) mode
Seaguard	2 minutes, 300 pings, burst mode
NORTEK Aquadopp	120 s, averaged over 120 s
SBE 37SI	120 s, averaged over 4 measurements
SBE 37SMP	60 s, averaged over 2 measurements
RBR XR-CTD	10 s shallow, 5 s deep
RDI 75kHz LR-ADCP	5 minute ensembles

to the motor connection, however the processor states that it is supplying 10.4v and a current is being drawn. The instrument will be returned to the manufacturer after the cruise.

The MMP on the northern mooring (MMP11794-03) made near complete profiles for the first 11 profiles and then, similar to the MMP on the central mooring, remained near the its starting pressure ($\sim$ 1055 dB) for the remainder of the deployment. Again for each profile attempt, it would time out after six unsuccessful restarts in response to the "Pressure Rate Zero" status.

The MMP on the eastern mooring was the most successful, making near complete profiles some of the time. In general, the instrument was successful profiling up the wire but often had problems in the profile down, again restarting the maximum number of times due to the "Pressure Rate Zero" status before terminating the profile early. A summary of the profiling behaviour during the deployment of all three instruments is shown in Figure 50.

Table 30: Summary of Data Return: Northern short-term mooring

| Instrument	S/N	nominal depth	record start	record end	number of records	data file names
RCM 7	9069	94	11/12/2008 10:00	12/5/2008 11:03	39966 words	rcm9069.dsu
Seaguard	69	196	11/12/2008 10:02	12/6/2008 10:40	17300	seaguard 69.TXT, seaguard 69.mat
SBE 37SMP	3276		11/12/2008 10:00	12/4/2008 11:11	31752	sbe37smp 3276data.asc, sbe37smp 3276.mat
RCM 8	9440	398	11/12/2008 10:00	12/5/2008 11:03	65520 words	rcm9440.dsu
Seaguard	70	600	11/12/2008 10:02	12/6/2008 10:40	17300	seaguard 70.TXT, seaguard 70.mat
SBE 37SMP	3481		11/12/2008 10:00	12/4/2008 11:11	31752	sbe37smp 3481data.asc, sbe37smp 3481.mat
RCM 8	11215	802	11/12/2008 10:00	12/5/2008 11:05	39966 words	rcm11215.dsu
RDI 75kHz LR-ADCP	10583	903	11/12/2008 10:00	12/5/2008 14:15	6676 ensembles	5476K000.000
RCM 11	425	910	11/12/2008 13:30	12/6/2008 09:06	3:5047 words	rcm11 425.dsu
RBR XR-CTD	17025		11/12/2008 10:00	12/5/2008 05:01	393886	rbr 17026.dat, rbr 17026.mat
McLane MMP	11794-03	921	11/13/2008 17:00	3/12/2008 03:26	342 profiles	342 Engineering files (E*.TXT), 342 CTD files (C*.TXT), 342 ACM files (A*.TXT)
NORTEK Aquadopp	1404	1869	11/12/2008 10:00	12/5/2008 05:30	16426	1404K01.HDR, 1404K01.DAT
SBE 37SI	3145					Nortek 1404.mat
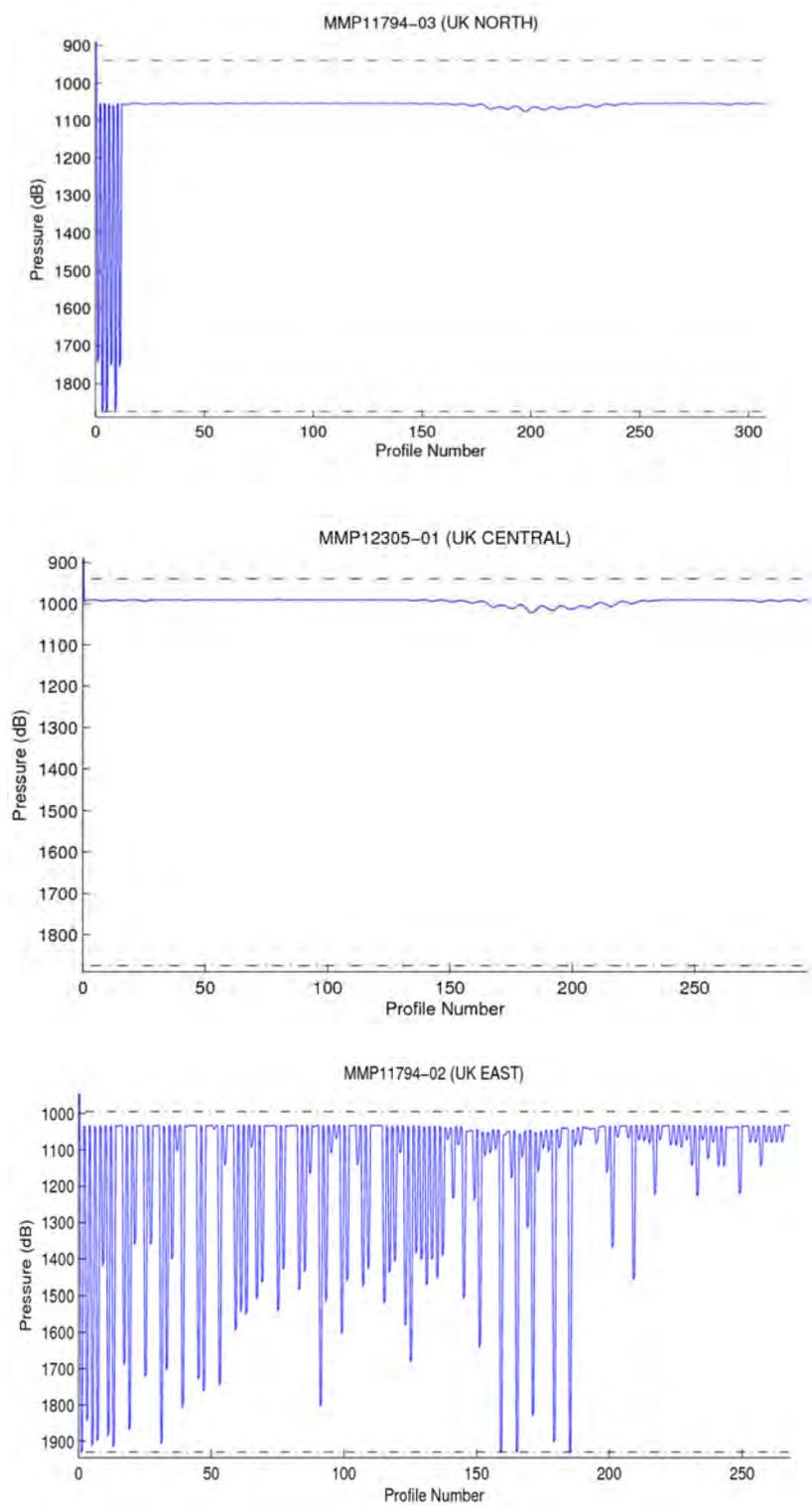
Figure 50: Profiling behaviour of the MMPs on the northern (top), central (middle) and eastern (bottom) short-term moorings.

Table 31: Summary of Data Return: Northern short-term mooring continued

Instrument	comments
RCM 7	requires calibration and processing at NOCS
Seaguard	data return good
SBE 37SMP	data return good
RCM 8	requires calibration and processing at NOCS
Seaguard	data return good
SBE 37SMP	data return good
RCM 8	logging 2 mins after other instruments
	requires calibration and processing at NOCS
RDI 75kHz LR-ADCP	data return good
RCM 11	requires calibration and processing at NOCS
RBR XR-CTD	data return good
McLane MMP	profiled for first 12 profiles
	stuck at the top for the remainder of the deployment
NORTEK Aquadopp	data return good

Table 32: Summary of Data Return: Central short-term mooring

Instrument	S/N	nominal depth	record start	record end	number of records	data file names
RCM 7	11813	94	11/12/2008 10:00	12/5/2008 11:03	39966 words	rcm11813.dsu
Seaguard	71	196	11/12/2008 10:02	12/3/2008 00:42	14841	seaguard 71.TXT, seaguard 71.mat
RBR XR-CTD	10822		11/12/2008 10:00	12/5/2008 04:03	196582	rbr 10822.dat, rbr 10822.mat
NORTEK Aquadopp	1415	398	11/12/2008 10:00	12/5/2008 05:54	16438	1415K01.HDR, 1415K01.DAT
SBE 37SI (plate)	3362					Nortek 1415.mat
RCM 11	524	600	11/12/2008 13:30	12/6/2008 09:06	3:7209 words	rcm11 524.dsu
NORTEK Aquadopp	1420	802	11/12/2008 10:00	12/5/2008 05:47	8142	1420K01.HDR, 1420K01.DAT
SBE 37SI (plate)	3083					Nortek 1420.mat
RDI 75kHz LR-ADCP	10584	903	11/12/2008 10:00	12/5/2008 13:50	6671 ensembles	10584000.000
RCM 11	525	910	11/12/2008 13:30	12/6/2008 09:06	3:6714 words	rcm11 525.dsu
RBR XR-CTD	17024		11/12/2008 10:00	12/5/2008 04:49	393735	rbr 17024.dat, rbr 17024.mat
McLane MMP	12305-01	921	11/14/2008 17:00	3/12/2008 07:03	327 profiles	327 Engineering files (E*.TXT), 327 CTD files (C*.TXT), 327 ACM files (A*.TXT)
NORTEK Aquadopp	1430	1869	11/12/2008 10:00	12/5/2008 05:30	16426	1430K01.HDR, 1430K01.DAT
SBE 37SI	3081					Nortek 1430.mat

Table 33: Summary of Data Return: Central short-term mooring continued

Instrument	comments
RCM 7	requires calibration and processing at NOCS
Seaguard	battery failure
	stopped logging 03/12/2008 00:42 UTC
	approximately 6 hours lost
RBR XR-CTD	data return good
NORTEK Aquadopp	2 missing records, 2 download attempts
SBE 37SI (plate)	
RCM 11	requires calibration and processing at NOCS
NORTEK Aquadopp	problems with conductivity and salinity
SBE 37SI (plate)	
RDI 75kHz LR-ADCP	data return good
RCM 11	requires calibration and processing at NOCS
RBR XR-CTD	data return good
McLane MMP	Never profiled.
	Stuck at starting pressure (993 dB) for entire deployment.
NORTEK Aquadopp	2 missing records, 2 download attempts
SBE 37SI (plate)	problems with conductivity and salinity

Table 34: Summary of Data Return: Eastern short-term mooring

Instrument	S/N	nominal depth	record start	record end	number of records	data file names
RCM 7	6152	94	11/12/2008 10:00	12/5/2008 11:03	39966 words	rcm6152.dsu
Seaguard	67	196	11/12/2008 10:02	06/12/08 10:40	17300	seaguard 67.TXT, seaguard 67.mat
SBE 37SMP	3218		11/12/2008 10:00	12/4/2008 14:59	31981	sbe37smp 3218data.asc, sbe37smp 3218.mat
RCM 8	9449	398	11/12/2008 10:00	12/5/2008 11:03	39966 words	rcm9449.dsu
Seaguard	68	600	11/12/2008 10:02	06/12/08 10:40	17300	seaguard 68.TXT
SBE 37SMP	3250		11/12/2008 10:00	12/4/2008 13:31	31893	sbe37smp 3250data.asc, seaguard 68.mat
RCM 8	11571	802	11/12/2008 10:00	12/5/2008 11:03	39966 words	rcm11571.dsu
RDI 75kHz LR-ADCP	5476	903	11/12/2008 10:00	12/5/2008 13:25	6666 ensembles	10583000.000
RCM 11	398	910	11/12/2008 13:30	12/6/2008 09:06	3:7264 words	rcm11 398.dsu
RBR XR-CTD	17026		11/12/2008 10:00	12/5/2008 05:01	393886	rbr 17026.dat, rbr 17026.mat
McLane MMP	11794-02	921	11/14/2008 17:00	3/12/2008 08:35	296 profiles	296 Engineering files (E*.TXT), 296 CTD files (C*.TXT), 296 ACM files (A*.TXT)
RCM 8	12577	1869	11/12/2008 10:00	12/5/2008 11:03	39966 words	rcm12577.dsu
RBR XR-CTD	17027					

Table 35: Summary of Data Return: Eastern short-term mooring

Instrument	comments
RCM 7	requires calibration and processing at NOCS
Seaguard	data return good
SBE 37SMP	data return good
RCM 8	data return good
Seaguard	data return good
SBE 37SMP	data return good
RCM 8	data return good
RDI 75kHz LR-ADCP	data return good
RCM 11	requires calibration and processing at NOCS
RBR XR-CTD	data return good
McLane MMP	Commonly had problems profiling down. Would backtrack and restart the maximum number of times then terminate the incomplete profile. Average profile range: 263 dB Performance worsens towards the end of the deployment.
NORTEK Aquadopp SBE 37SI (plate)	data return good
RCM 8	requires calibration and processing at NOCS
RBR XR-CTD	leaked, no data returned

13 Acknowledgments

A   Watches

WATCHES			
Task	**4 am - 12 pm**	**12 pm - 8 pm**	**8 pm - 4 am**
CTD	Nathan Bindoff (WL) Phil Adams	Amélie Meyer Helen Phillips	Gillian Damerell Bernadette Sloyan (WL)
LADCP	Jenny Graham	David Stevens	Andrew Dawson
SADCP + underway	Angelika Renner	Maria Broadbridge	Mirjam Glessmer
VMP - 5500	Alberto Naveira Garabato Alex Forryan	Kurt Polzin Stephanie Waterman (WL)	Bernadette Sloyan Peggy Courtois
ISW	Alex, Peggy + others		
Floats	Helen, Nathan, Amélie + others		
Salts	Peggy, Maria, Dave + others		
WL: Watch Leader			

B Sensors and Moorings BODC Document checklist

Cruise:	JC029	
Date:	17 Dec 2008	
Compiled by:	Dougal Mountifield	
Document	**Notes**	**Included**
CTD Profiling Cals	Calibration sheets of all the instruments used on the CTD package or other profiling equipment. Named by serial number, document type and date.	YES in electronic format
CTD Profiling Histories	Work and deployment history sheets of all the instruments used on the CTD package or other profiling equipment. Named by serial number. xxxx HISTORY is the latest electronic file. The old history is a pdf of the "old" paper file.	YES in electronic format
Towed Vehicle Cals	Calibration sheets of all the instruments used on the Towed vehicle. Named by serial number, document type and date.	N/A
Towed Vehicle Histories	Work and deployment history sheets of all the instruments used on the towed vehicle. Named by serial number. xxxx HISTORY is the latest electronic file. The old history is a pdf of the "old" paper file.	N/A
Salinity Data	Logsheets and any electronic files, graphs etc that have been created during or after the cruise.	Handled by science party
Cruise reports	Tech report, Sensor changes, instrumentation report, post cruise assessment et al.	Tech report.
Daily Diary		N/A
Log Sheets	Copies of all paper logsheets used.	YES - CTD/LADCP
Notes: VMP data and logsheets handled by PSO.		

C Sensor Information

SHIP: RRS *James Cook*	CRUISE: JC029

FORWARDING INSTRUCTIONS / ADDITIONAL INFORMATION:
AS SET UP ON BOARD DURING MOBILISATION D.M.
ADDITIONAL COMMENTS AT END OF CRUISE D.M.
2xSBE3p, 2xSBE4c, 1xSBE43 to be airfreighted to Seabird ex-JC029
2xRDI WH300 LADCPS to be airfreighted to RDI ex-JC029.

CHECKED BY: Dougal Mountifield DATE: 17 Dec 2008

SENSOR / SYSTEM TYPE	SERIAL No	Service / Cal	Cruise Notes
SBE 9+ CTD Underwater Unit	09P-24680-0636	Service Due 13 May 2010	Main unit on 24 way frame
SBE 9+ CTD Underwater Unit	09P-24680-0637(T)	Service Due 23 Sept 2009	Spare unit
Digiquartz Pressure sensor	83008	Last Calibrated 10 Sept 2008	Fitted to 9+ 0636 Main CTD Pressure Sensor
Digiquartz Pressure sensor	79501	Last Calibrated 22 Sept 2008	Fitted to 9+ 0637(T) Spare CTD Pressure Sensor
SBE 3P Temperature Sensor	3P-4151	Last Calibrated 3 Sept 2008	Primary Temperature Main CTD Returned for cal post-JC029
SBE 3P Temperature Sensor	3P-2919	Last Calibrated 3 Sept 2008	Secondary Temperature Main CTD (Fin Mounted) Returned for cal post-JC029
SBE 3P Temperature Sensor	3P-4105	Last Calibrated 17 Sept 2008	Spare Temperature Sensor
SBE 3P Temperature Sensor	3P-4116	Last Calibrated 3 Sept 2008	Spare Temperature Sensor
SBE 4C Conductivity Sensor	4C-2571	Last Calibrated 26 Aug 2008	Primary Conductivity Main CTD Returned for cal post-JC029
SBE 4C Conductivity Sensor	4C-2450	Last Calibrated 26 Aug 2008	Secondary Conductivity Main CTD (Fin Mounted) Returned for cal post-JC029
SBE 4C Conductivity Sensor	4C-2580	Last Calibrated 3 Sept 2008	Spare Conductivity Sensor
SBE 4C Conductivity Sensor	4C-3052	Last Calibrated 3 Sept 2008	Spare Conductivity Sensor
SBE 43 Dissolved Oxygen Sensor	43-0363	Last Calibrated 9 Sept 2008	DO Sensor on Main CTD (Primary) Returned for cal post-JC029
SBE 43 Dissolved Oxygen Sensor	43-0862	Last Calibrated 30 Sept 2008	Spare DO Sensor
SBE 5T Pump	5T-4166	Service Due 26 July 2010	Primary Pump Main CTD
SBE 5T Pump	5T-2793	Service Due 1 Sept 2010	Secondary Pump Main CTD (Fin Mounted)
SBE 5T Pump	5T-3002	Service Due June 2011	Spare Pump
SBE 5T Pump	5T-4513	Service Due 18 Sept 2011	Spare Pump
SBE 32 24-way Carousel	32-45661-0621	Last Serviced 23 Sept 2008	Main Carousel on 24-way CTD
SBE 32 24-way Carousel	32-19817-0243	Last Serviced 20 Oct 2008	Spare Carousel
SBE 11+ Deck Unit	11P-34173-0676		Main CTD Deck Unit (w/ 9600 baud uplink)
SBE 11+ Deck Unit	11P-24680-0589		Spare CTD Deck Unit (set to 9600 baud)

215

SENSOR / SYSTEM TYPE	SERIAL No	Service / Cal	Cruise Notes
Chelsea Aquatracka III Fluorimeter	088108	Last Calibrated	Fitted to Main CTD
Chelsea Aquatracka III Fluorimeter	088244	Last Calibrated	Spare Fluorimeter
Chelsea Aquatracka III Fluorimeter	088160	Last Calibrated	Spare Fluorimeter
Chelsea AlphaTracka II Transmissometer - 25cm pathlength	161045	Last Calibrated	Fitted to Main CTD
Chelsea AlphaTracka II Transmissometer - 25cm pathlength	161047	Last Calibrated	Spare Transmissometer
Chelsea AlphaTracka II Transmissometer - 25cm pathlength	07-6075-001	Last Calibrated	Spare Transmissometer
Wetlabs BBRTD Light Backscatter Sensor	115R	Last Calibrated	Fitted to Main CTD Frame
Wetlabs BBRTD Light Backscatter Sensor	182	Last Calibrated	Spare BBRTD
RDI WH300 LADCP	9192		Fitted to Main CTD Frame - Downlooking Master - Beam 3 Failure - Replaced with 9191 Returned for repair post JC029.
RDI WH300 LADCP	5415		Fitted to Main CTD Frame - Uplooking Slave - Beam 2 Failure. Data was questionable at the start of the cruise. Beam failed after 4 yo-yo casts to 2000m. Replaced with 9191. Returned for repair post JC029 Subsequently removed with BB150.
RDI WH300 LADCP	9191		Spare WH300 - Used first to replace failed slave 5415 and subsequently failed master 9192. Still on frame and all beams still good.
RDI WH300 LADCP	10629		Spare WH300 - Unused during JC029.
NMF WH300 LADCP Battery Pack (impe-rial)	WH004		Fitted to Main CTD Frame as backup for BB150 pack.
NMF WH300 LADCP Battery Pack	WH002		Spare LADCP Battery Pack
RDI BB150 LADCP	1503		Fitted to Main CTD Frame - Downlooking - Removed as data question-able. Beam $\frac{3}{4}$ receiver board replaced, HPM replaced, Power condition-ing module replaced. Redeployed, but data still bad so left on frame but not used. To be removed and boxed up at end of JC029.
NMF BB150 LADCP Battery Pack	02		Fitted to Main CTD Frame
Benthos PSA-916T Altimeter	1040		Fitted to Main CTD Frame
Benthos PSA-916T Altimeter	41302		Spare Altimeter
Sonardyne Deep HF Marker Beacon	233301-001		Fitted to Main CTD Frame
Sonardyne Deep HF Marker Beacon	245116-001		Spare CTD Beacon
NMF 10kHz Pinger	B9		24 way CTD Pinger
NMF 10kHz Pinger	B0		Spare Pinger
NMF 10kHz Pinger	B5		Spare Pinger
Guildline Autosal 8400B	68426		Main Salinometer - CT Lab
Guildline Autosal 8400A	57738		Spare Salinometer - Hold