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RRS *James Clark Ross* Cruise JR16005

17 MAR – 08 MAY 2017

The Dynamics of the Orkney Passage Outflow
(DynOPO)

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ABSTRACT

The RRS *James Clark Ross* JR16005 expedition (Punta Arenas, 17 March 2017 – Montevideo, 8 May 2017) was the primary fieldwork element of the Dynamics of the Orkney Passage Outflow (DynOPO) project. The cruise had two main goals: (1) to conduct measurements of the hydrographic properties, velocity and turbulent processes of the Antarctic Bottom Water outflow along its pathway through the Orkney Passage region; and (2) to turn around a set of long-term moorings deployed in the area by BAS and LDEO scientists, including recovery of additional instruments on some of the moorings deployed by DynOPO investigators 2 years previously. Operations were generally successful. With regard to goal (1), a total of 120 hydrographic and / or microstructure stations were occupied across the study region; 3 focussed surveys of two major sills in the area were performed with the autonomous underwater vehicle Autosub Long Range; and an array of moored sensors measuring turbulent processes at high spatio-temporal resolution was deployed for the duration of the cruise, with partial instrument failures. In respect of goal (2), all moorings were successfully recovered and re-deployed, and the return of additional DynOPO instruments was close to 100%.

KEYWORDS

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ABSTRACT

The RRS *James Clark Ross* JR16005 expedition (Punta Arenas, 17 March 2017 - Montevideo, 8 May 2017) was the primary fieldwork element of the Dynamics of the Orkney Passage Outflow (DynOPO) project. The cruise had two main goals: (1) to conduct measurements of the hydrographic properties, velocity and turbulent processes of the Antarctic Bottom Water outflow along its pathway through the Orkney Passage region; and (2) to turn around a set of long-term moorings deployed in the area by BAS and LDEO scientists, including recovery of additional instruments on some of the moorings deployed by DynOPO investigators 2 years previously. Operations were generally successful. With regard to goal (1), a total of 120 hydrographic and / or microstructure stations were occupied across the study region; 3 focussed surveys of two major sills in the area were performed with the autonomous underwater vehicle Autosub Long Range; and an array of moored sensors measuring turbulent processes at high spatio-temporal resolution was deployed for the duration of the cruise, with partial instrument failures. In respect of goal (2), all moorings were successfully recovered and re-deployed, and the return of additional DynOPO instruments was close to 100%.

1 INTRODUCTION

The RRS *James Clark Ross* JR16005 expedition (Punta Arenas, 17 March 2017 - Montevideo, 8 May 2017) was the primary fieldwork element of the Dynamics of the Orkney Passage Outflow (DynOPO) project. The project seeks to investigate the dynamics controlling the flow of Antarctic Bottom Water (AABW) through the Orkney Passage (Figure 1), a deep cleft in the South Scotia Ridge that channels a substantial fraction of the AABW export from the polar Southern Ocean. The project is motivated by (i) widespread observations of warming and contraction in volume of AABW across much of the Atlantic Ocean in recent decades, and (ii) the recently put forward, observation-based hypothesis that climatic variations in the basin-scale properties of AABW downstream of its South Atlantic sources are primarily controlled by wind-forced changes in export, via a mechanism involving the modulation of small-scale turbulent mixing in the Orkney Passage. DynOPO seeks to test the hypothesis in (ii) by measuring turbulent mixing and its underpinning physical processes in the passage for the first time, and by assessing the climatic significance of those processes with an enhancement of the BAS-supported mooring array deployed at the site.

The cruise had two main goals: (1) to conduct measurements of the hydrographic properties, velocity and turbulent processes of the AABW outflow along its pathway through the Orkney Passage region; and (2) to turn around the long-term moorings deployed in the area by BAS and LDEO scientists, including recovery of the additional instruments on some of the moorings deployed by DynOPO investigators 2 years previously. Operations were generally successful, aided by relatively benign weather and the absence of sea ice. With regard to goal (1), a total of 120 hydrographic and / or microstructure stations were occupied across the study region; 3 focussed surveys of two major sills in the area were performed with the autonomous underwater vehicle Autosub Long Range (ALR); and an array of moored sensors measuring turbulent processes at high spatio-temporal resolution was deployed by WHOI scientists for the duration of the cruise, with partial instrument failures. In respect of goal (2), all moorings were successfully recovered and re-deployed, and the return of additional DynOPO instruments was close to 100%.

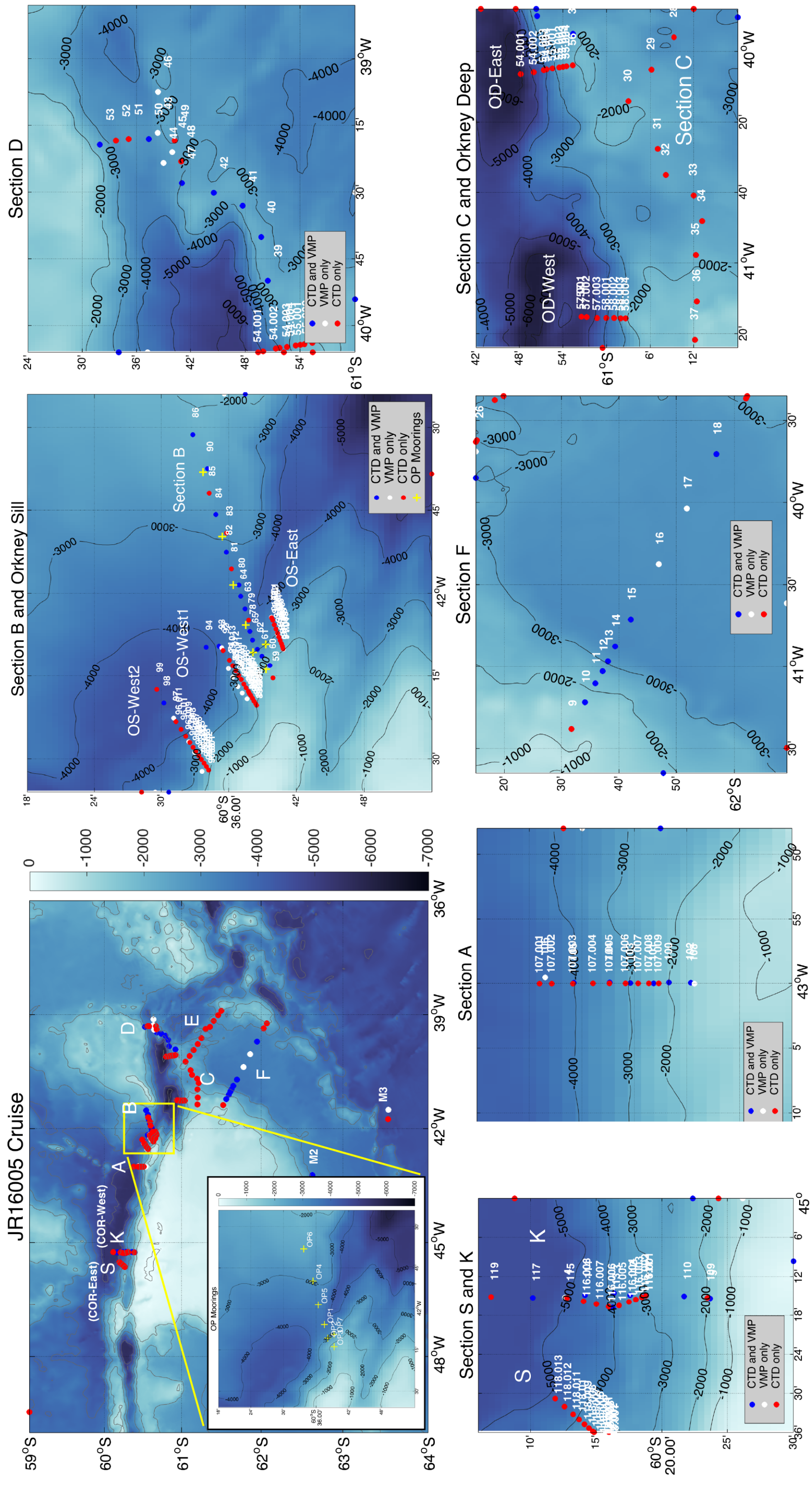

Figure 1: Station locations and sections for cruise JR16005

2 NARRATIVE

2.1 PSO's Diary

Friday 17th March (Julian day 76) We set sail from Punta Arenas at 20:00 UTC and steamed eastward toward the Patagonian shelf, in fair weather. Upon arrival at the ship, we had learned of a significant challenge: our crew included only one fully trained CTD winch operator. As this would make 24-hour CTD operations impossible, it was decided that training of a second CTD winch operator would be undertaken as promptly as possible in the initial stages of the expedition.

Saturday 18th March (Julian day 77) We steamed into northern Drake Passage with all underway systems switched off, as we sailed through Argentinian waters with favourable weather conditions. Most scientists and technicians were busy preparing instrumentations and systems for upcoming deployments.

Sunday 19th March (Julian day 78) We steamed across central Drake Passage in fair weather. We deployed Argo float SN7591 in the evening (20:39 UTC) on behalf of the U.K. Met Office, and continued steaming toward the Orkney Passage region.

Monday 20th March (Julian day 79) We steamed across southern Drake Passage in good weather. At 11:30 UTC, we conducted station 1, involving tests of the two VMP-6000s (both tethered and untethered tests) and the CTD system. All tests were successful, with the caveat of the USBLs on the VMP-6000s being undetectable. To address this issue, we conducted station 2 at 22:00 UTC, deploying the CTD with the USBLs clamped on. The problem remained unresolved for one of the USBLs. We deployed Argo float SN7590 at the station location (at 23:30 UTC) on behalf of the U.K. Met Office, and continued sailing toward the Orkney Passage area.

Tuesday 21st March (Julian day 80) We arrived at the site of the WHOI mooring at 13:30 UTC, and occupied station 3 with CTD and VMP-6000. Upon concluding the cast, we initiated the mooring deployment, which we successfully completed at 23:10 UTC. We subsequently triangulated the mooring position, which matched the target position closely. As weather conditions had gradually deteriorated during mooring operations, we were unable to carry out over-the-side work for the remainder of the evening.

Wednesday 22nd March (Julian day 81) As weather conditions improved in the early hours, we conducted station 4 with VMP-6000 north of the WHOI mooring site at 05:02 UTC, followed by station 5 with CTD and VMP-6000 south of the WHOI mooring site at 11:56 UTC. On concluding station 5, we steamed to Signy Island to meet the RRS *Ernest Shackleton* at 18:00 UTC, to transfer one of her ABs to our crew. Approximately one hour later, we commenced our 12-hour transit to the LDEO M2 mooring site.

Thursday 23rd March (Julian day 82) We successfully recovered the M2 mooring from 9:00 UTC, and steamed for 6 hours to the LDEO M3 mooring site. After recovering the M3 mooring, we conducted station 6 at the site. The station was occupied with CTD only, as the presence of icebergs in the area raised concerns about the risk of VMP-6000 operations.

Friday 24th March (Julian day 83) We conducted a VMP-6000 station overnight (station 7) a few miles off the M3 mooring site, and successfully re-deployed the M3 mooring at 01:46 UTC. After steaming 6 hours to the M2 mooring site, we re-deployed the M2 mooring at 18:30 UTC, and conducted a CTD / VMP-6000 station at the site (station 8) at 20:24 UTC. Following triangulation of the M2 mooring, we steamed to the start of transect F overnight.

Saturday 25th March (Julian day 84) We arrived at transect F at 09:00 UTC. We conducted the first station in the transect (station 9) with CTD only, as the VMP-6000's weight retainer cable broke when the system was about to be deployed. We subsequently occupied stations (stations 10-12) along transect F with CTD / VMP-6000 for the remainder of the day, until the fully trained CTD winch operator had to go off watch. We conducted two VMP stations (stations 13-14) overnight.

Sunday 26th March (Julian day 85) We re-occupied stations 13-14 with CTD from 09:06 UTC, and subsequently conducted station 15 with CTD / VMP-6000 from 15:20 UTC. Once the fully trained CTD winch operator's watch had ended, we occupied stations 16-17 with VMP-6000 through the night.

Monday 27th March (Julian day 86) This was a testing day. A significant incident occurred as we conducted station 18 with CTD / VMP-6000 in the early hours. The VMP-6000 (SN016) profiled all the way to the seafloor (seemingly as a result of an incorrect reading of water depth prior the cast), and became stuck at the bottom at 05:59 UTC. After waiting in vain for the instrument to return to the surface, we moved on to station 19, which we completed with CTD at 15:15 UTC. We then returned to the site of station 18 to assess whether the VMP-6000 had dislodged itself from the seafloor, with no luck. As weather conditions were deteriorating, we steamed to the last station in transect F (station 20), which we conducted with CTD at 22:20 UTC. As these events unfolded, we conducted two short test casts of our other VMP-6000 (SN107), which had been experiencing electronic issues that rendered the data useless. The tests were unsuccessful. At the end of the day, we steamed back to the site of station 18 to monitor the status of the stuck VMP-6000, as stormy seas grew around us and halted our work.

Tuesday 28th March (Julian day 87) The storm persisted well into the afternoon, while we continued to monitor the trapped VMP-6000's status without any change. As weather conditions started to subside, we steamed toward the southeastern end of transect E to re-start work.

Wednesday 29th March (Julian day 88) We conducted the first four stations in transect E (stations 21-24) with CTD only, as the sea state was too rough for VMP-6000 operations. Conditions worsened in the evening, and we were forced to interrupt over-the-side work once again.

Thursday 30th March (Julian day 89) Weather conditions began to moderate in the morning, and we resumed CTD work with stations 25-27. At the end of station 27, we conducted a further trial of VMP-6000 SN107. As this was unsuccessful, we continued to occupy the remaining stations along transects E-C with CTD only.

Friday 31st March (Julian day 90) As weather conditions held on, we worked relentlessly until completing transects E-C at 20:36 UTC, with station 37. We then steamed overnight to the site of the stuck VMP-6000, to make a last attempt at recovering it before proceeding northward for the remainder of the expedition.

Saturday 1st April (Julian day 91) We commenced dragging for VMP-6000 SN016 at approximately 10:00 UTC. The dredging operation proceeded slowly until the VMP-6000's USBL beacon indicated that the instrument was starting to ascend, at 18:10 UTC. Three hours later, we recovered the instrument without any visible damage, and the day finished on an uplifting note.

Sunday 2nd April (Julian day 92) We steamed overnight toward transect D. As the sea state had deteriorated around us, we were forced to delay the start of the transect until 9:00 UTC. We subsequently conducted the first 5 stations in the transect (stations 38-42) with CTD / VMP-6000, through the day and well into the early hours of 3rd April.

Monday 3rd April (Julian day 93) We commenced preparations for the first deployment of Autosub Long Range (ALR) at 9:00 UTC, amongst modest winds and swell. After two aborted attempts to initiate its mission, ALR successfully dived to near the seafloor and commenced its first survey at 19:39 UTC.

Tuesday 4th April (Julian day 94) We conducted two VMP stations (stations 43-44) overnight at sites along the ALR track. We then attended a pre-arranged rendezvous with ALR halfway through its mission, re-positioned the vehicle via acoustic communication, and sent it off to complete the mission. We occupied two further VMP stations (stations 45-46) along the ALR track, and steamed to the end location of the mission. The ALR was absent from the area, and acoustic tracking of its USBL suggested that it had terminated its mission 8 km to the west. We recovered the ALR at that location. Preliminary investigation suggested that the vehicle had experience a mechanical malfunction that had caused it to dive into the seafloor and consequently abort its mission. Upon recovery, damage was apparent only in the ALR Microrider.

Wednesday 5th April (Julian day 95) We continued working along section D by conducting a CTD / VMP station (47) overnight. Weather conditions rapidly deteriorated during the station, making the recovery of VMP-6000 impossible. We spent approximately 8 hours tracking the VMP-6000, waiting for a recovery opportunity that arrived in the afternoon. After recovering the VMP-6000 in more moderate weather, we occupied stations 48-49 with CTD only.

Thursday 6th April (Julian day 96) We completed the last four stations in transect D with CTD / VMP (stations 50 and 53) and CTD only (stations 51-52). We subsequently steamed westward into the Orkney Deep, and conducted a 10-hour CTD tow-yo station (54) up the South Orkney Plateau slope. The two-yo was paused at the end of the day to charge up the LADCP on the CTD rosette.

Friday 7th April (Julian day 97) Weather conditions deteriorated rapidly overnight, to an extent not captured by the forecasts. High seas and 50-60 knot winds prevented us from working for much of the day. As conditions moderated in the late afternoon, we resumed the previous day's CTD tow-yo transect (stations 55-56).

Saturday 8th April (Julian day 98) We commenced a second CTD tow-yo transect (station 57) across the southern edge of Orkney Deep in the early hours, in calm seas. We deployed Argo float SN7592 during the transect on behalf of the U.K. Met Office. At 14:00 UTC, we interrupted the tow-yo to attempt to recover a <French float> deployed in the preceding RRS *James Clark Ross* expedition (JR16004), located approximately 40 miles to the northeast at the time. We successfully recovered the float at 18:25 UTC, and steamed back to our CTD tow-yo transect via several sites without previous multibeam topographic measurements. On arrival at the tow-yo site, a fault was discovered in the CTD winch system that took approximately 4 hours to fix.

Sunday 9th April (Julian day 99) Weather conditions deteriorated rapidly while the CTD winch was being fixed, and prevented over-the-side work overnight. The tow-yo transect was resumed at 11:00 UTC (station 58), and completed at 18:00 UTC in rising seas. We subsequently steamed to the main sill of the Orkney Passage in rough weather.

Monday 10th April (Julian day 100) We commenced the transect across the main sill of the Orkney Passage at 9:00 UTC with CTD station 59, as a large iceberg nearby prevented deployment of the VMP-6000. We continued the transect with three further CTD / VMP-6000 stations (60-62) in calm seas. Our progress was disrupted when the large iceberg started drifting over the lower western slope of the transect. In response, we provisionally skipped the three subsequent planned station locations.

Tuesday 11th April (Julian day 101) We continued occupying CTD / VMP-6000 stations along the transect overnight: two stations (63-64) to the northeast, and one of the three stations that we had skipped to avoid the large iceberg (65). At first light, we commenced preparations for the deployment of ALR for its second mission. Deployment was successfully completed at 15:30 UTC, and we spent the remainder of the day monitoring ALR's progress while conducting two VMP-6000 stations (66-67) along its track.

Wednesday 12th April (Julian day 102) We continued to monitor ALR periodically at selected waypoints, in marginal weather conditions. In the intervening periods, we conducted three VMP-6000 stations (68-70) along or in the close vicinity of ALR's track.

Thursday 13th April (Julian day 103) At 05:17 UTC, ALR began an unplanned ascent toward the surface near the southernmost point on its track, after completing sin 100 km of its mission. We monitored ALR's rise, and subsequently recovered the vehicle in challenging wind and swell conditions at 20:20 UTC. We conducted a further three VMP-6000 stations (72-74) in the evening and overnight.

Friday 14th April (Julian day 104) As wind and swell had subsided through the night, we spent daylight hours recovering four of the Orkney Passage sill moorings: OP5 (recovery completed at 09:34 UTC), OP6 (12:36 UTC), OP4 (15:02 UTC) and OP2 (17:33 UTC). We conducted the two further VMP-6000 stations (74-75) on the western slope of the Passage in the evening and overnight.

Saturday 15th April (Julian day 105) We recovered the remaining three Orkney Passage sill moorings in fair seas: OP1 (recovery completed at 10:28 UTC), OP3 (14:43 UTC) and OP7 (17:20 UTC). On completion of mooring recovery, we occupied the last VMP-6000 station (76) on the western slope of the Passage.

Sunday 16th April (Julian day 106) We resumed the CTD / VMP-6000 transect across the Orkney Passage sill in the early hours with station 78, during which we commenced clamping of the moorings' Microcats to the CTD rosette for calibration purposes. Strong winds built up rapidly during the station, and caused the VMP-6000 to be adrift for several hours before recovery. We continued the transect with two CTD stations (79 and 81) and a CTD / VMP-6000 station (80).

Monday 17th April (Julian day 107) We continued the CTD / VMP-6000 transect across the Orkney Passage sill with two further CTD stations (83 and 85) and two CTD / VMP-6000 stations (82 and 84). At 16:00 UTC, we commenced deployment of ALR on its third mission. The deployment was completed at 22:30 UTC, but the vehicle experienced technical problems and had to be recovered shortly afterwards.

Tuesday 18th April (Julian day 108) We completed the CTD / VMP-6000 transect across the Orkney Passage sill with a last CTD / VMP-6000 station (86) at the eastern edge of the Passage overnight. We subsequently steamed to the OP1 mooring site to commence re-deployment of the long-term mooring array at the sill. We deployed mooring OP1 at 12:44 UTC, and proceeded to deploy mooring OP2 at 17:37 UTC, in fair seas. We then returned to the launch site of ALR's third mission, and commenced the vehicle's deployment. This was completed at 20:54 UTC.

Wednesday 19th April (Julian day 109) After monitoring ALR for several hours as far as its first waypoint, we conducted two VMP-6000 stations (87 and 88) on the western slope of the Orkney Passage. We re-deployed mooring OP3 in the morning (10:38 UTC) and mooring OP5 in the afternoon (16:46 UTC), and triangulated the positions of all moorings deployed to that point. In the evening (20:00 UTC), we commenced a CTD tow-yo transect (station 89) across the Passage's western slope, between stations 67 and 77.

Thursday 20th April (Julian day 110) We completed the CTD tow-yo at 10:00 UTC, and proceeded to deploy the OP6 mooring at the eastern edge of the Orkney Passage. After triangulating the mooring's position, we conducted a CTD / VMP-6000 station (90) at the site. We subsequently steamed to the Passage's western slope to monitor ALR's mission and commence a further CTD tow-yo transect (station 91).

Friday 21st April (Julian day 111) We concluded the CTD tow-yo at 13:30 UTC, and steamed to the OP4 mooring site to re-deploy that mooring. OP4 mooring deployment was completed at 15:30 UTC, and was followed by triangulation of the OP4 and OP5 mooring positions. We then steamed to the northern edge of the Orkney Passage sill, where we were due to meet ALR at the end of its third mission.

Saturday 22nd April (Julian day 112) We successfully recovered ALR at 2:00 UTC, and commenced occupation of a CTD station (92) in the close vicinity of the recovery site. However, the station was aborted at 23:17 m due to a technical issue, and marginal weather conditions prevented further overnight work. After addressing the technical issue with the CTD (replacement of pump), we resumed over-the-side activity in the morning with two CTD / VMP-6000 stations (93 and 94) near the ALR recovery site. On completion of these stations, in the evening (17:30 UTC), we repositioned downstream of the Orkney Passage sill to conduct a CTD tow-yo transect there.

Sunday 23rd April (Julian day 113) Our first attempt at commencing the CTD tow-yo transect (station 95) was aborted during the first downcast due to unfavourable weather conditions. We resumed the transect (station 96) in the morning (9:00 UTC). The transect was concluded at midnight.

Monday 24th April (Julian day 114) On concluding the CTD tow-yo transect, we conducted a VMP-6000 station (97) at the transect's end position. We subsequently occupied a CTD / VMP-6000 station (98) and a CTD station (99) to extend the transect of measurements into deeper waters. We steamed away from the Orkney Passage, westward to transect A, and commenced occupation of CTD / VMP-6000 stations there. The two initial stations (100 and 101) were conducted by the end of the day.

Tuesday 25th April (Julian day 115) We progressed through transect A with four further CTD / VMP-6000 stations (102-105) and one VMP-6000 station (106).

Wednesday 26th April (Julian day 116) After waiting for weather conditions to settle for several hours, we conducted a CTD tow-yo transect (station 107) along section.A. On concluding the tow-yo at 17:30 UTC, we repeated station 102 with the VMP-6000 (station 108), as the instrument had dived with faulty probes on the station's previous occupation. We conducted a further unsuccessful test of VMP-6000 SN107 at the same location, and subsequently steamed for 6 hours to section K.

Thursday 27th April (Julian day 117) We arrived at section K in the early hours, and readily commenced occupation of stations on the transect. The first station (109), located in the proximity of Coronation Island, was conducted with CTD only, due to the presence of some bergy bits. The next four stations (110-113) were occupied with CTD and VMP-6000. At 16:20 UTC, we deployed the final U.K. Met Office Argo float (SN7593).

Friday 28th April (Julian day 118) We conducted a further CTD / VMP-6000 station (114) along transect K overnight. Weather conditions deteriorated during the station, and made it difficult to recover the VMP-6000. Recovery was eventually completed at 11:00 UTC. After occupying a further CTD station (115), we commenced a CTD tow-yo transect (station 116) between the locations of stations 111 and 115 at 19:30 UTC.

Saturday 29th April (Julian day 119) We concluded the CTD tow-yo at 9:00 UTC, and steamed to the WHOI mooring site for recovery operations. The mooring was successfully recovered by 12:03 UTC. We subsequently occupied a CTD / VMP-6000 station (117) at the northern end of section K, and steamed westward to a small ridge north of Coronation Island to conduct a CTD tow-yo transect (station 118) there. We started the CTD tow-yo at 00:12 UTC.

Sunday 30th April (Julian day 120) We conducted the CTD tow-yo transect overnight, and concluded it at 14:28 UTC. We then carried out a (successful!) test of VMP-6000 SN107 at the site of the tow-yo's end. We steamed to a site beyond the northern end of transect K to attempt to encompass the entire deep boundary current, and conducted a further test dive of VMP-6000 SN107 while we waited for the LADCP battery to charge. On completion of this cast, we occupied a CTD / VMP-6000 station (119). The VMP-6000 (SN016) aborted its dive shortly after deployment. The CTD cast was concluded at 23:45 UTC.

Monday 1st May (Julian day 121) We steamed eastward for approximately 6 hours to a site beyond the northern end of transect A, to attempt to encompass the deep boundary current there too. We conducted a final CTD station (120). At 10:55 UTC, we concluded fieldwork operations and commenced transit to Montevideo.

Tuesday 2nd May (Julian day 122) – Friday 5th May (Julian day 125) As we approached the northern edge of the Scotia Sea, we encountered stormy weather conditions. These delayed our progress considerably, and made living conditions uncomfortable for four days.

Saturday 6th May (Julian day 126) – Sunday 7th May (Julian day 127) Weather conditions subsided in the early hours of Saturday, and we resumed rapid progress toward Montevideo in calm conditions.

2.2 Event Logs – *Christian Buckingham*

Here, we document events that took place on the ship. This list represents a select set of events documented by the research scientist and cross-checked with the ship event log. A more complete record of events is available upon request. Events generally correspond to anytime something happens on the ship (e.g., an instrument going into and coming out of the water). This includes mooring recovery. Also, note that VMPs and CTDs generally share the same station number; if a VMP is done without a CTD cast, it will still receive a station number. In this portion of the cruise report, VMP/CTD or TowYo sections labelled "OD-East" and "OD-West" correspond to those stations further east and west in Orkney Deep. Sections labelled "OS-East", "OS-West1" and "OS-West2" correspond to those stations near Orkney Sill–that is, where the long-term OP moorings were deployed and recovered. Lastly, sections labelled "COR-East" and "COR-West" correspond to those stations near Coronation Island (i.e., where the short-duration WHOI mooring was deployed and recovered). See Figures 1 to **??** below. In addition to the aforementioned events conducted as part of JR16005, three (3) German floats were deployed at the completion of the cruise and during our transit to Uruguay.

Event Type	Colour
Weather	(grey)
Float	(pink)
Mooring	(green)
Tow-Yo	(cyan)
VMP, CTD	
Autosub Long Ranger (ALR)	(yellow)
Other	(red)

Table 1: Key to event log colours (cf. Table 2).

Event	Stn.	Sec.	Date	Time (UTC)	MOR	VMP	CTD	Comments
1			19-Mar-17	20:38				APEX float deployed (SN7591)
2			20-Mar-17	11:42		X		VMP107 deployed to test buoyancy
3			20-Mar-17	12:06		X		VMP016 deployed to test buoyancy
4			20-Mar-17	12:48		X		VMP 016 tethered deployed to 150m tethered
5			20-Mar-17	13:24		X		VMP 107 tethered deployed to Test buoyancy
6			20-Mar-17	14:12		X		VMP 016 deployed to 500m

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Table 2 – *continued from previous page*

Event	Stn.	Sec.	Date	Time (UTC)	MOR	VMP	CTD	Comments
7			20-Mar-17	15:00		X		VMP deployed
8	001		20-Mar-17	16:15			X	
9	002		20-Mar-17	22:11			X	
10			20-Mar-17	23:30				APEX float deployed (Serial Number Unrecorded)
11	003		21-Mar-17	13:48		X		
12	003		21-Mar-17	14:29			X	
13	004		22-Mar-17	05:02		X		
14	004		22-Mar-17	11:56			X	
15	005		22-Mar-17	11:25		X		
16	005		22-Mar-17	11:56			X	
17			23-Mar-17	07:45	X			M2 recovery
18			23-Mar-17	17:20	X			M3 recovery
19	006		23-Mar-17	19:53			X	CTD to 4300m
20	007		24-Mar-17	01:46		X		VMP only
21			24-Mar-17	09:00	X			M3 deployment
22			24-Mar-17	18:18	X			M2 deployment
23	008		24-Mar-17	20:24		X		Near new mooring M2 deployment
24	008	F	24-Mar-17	20:39			X	Near new mooring M2 deployment
25	009	F	25-Mar-17	09:00		X		
26	009	F	25-Mar-17	09:40			X	
27	010	F	25-Mar-17	11:57		X		
28	010	F	25-Mar-17	12:12			X	
29	011	F	25-Mar-17	14:43		X		
30	011	F	25-Mar-17	15:03			X	
31	012	F	25-Mar-17	17:43		X		
32	012	F	25-Mar-17	18:03			X	
33	013	F	25-Mar-17	21:20		X		VMP only
34	014	F	26-Mar-17	01:09		X		VMP only
35	013	F	26-Mar-17	09:06			X	CTD only (went to station we missed in the night)
36	014	F	26-Mar-17	12:02			X	CTD only (went to station we missed in the night)
37	015	F	26-Mar-17	15:20		X		
38	015	F	26-Mar-17	15:38			X	
39	016	F	26-Mar-17	20:20		X		VMP only
40	017	F	27-Mar-17	01:07		X		VMP only
41	018	F	27-Mar-17	05:59		X		VMP (stuck in seabed)
42	018	F	27-Mar-17	09:06			X	CTD
43		F	27-Mar-17	12:14		X		VMP 500-m test cast
44	019	F	27-Mar-17	15:15			X	CTD only
45		F	27-Mar-17	19:39		X		VMP tethered
46	020	F	27-Mar-17	22:20			X	
			27-Mar-17					Assessing Weather
47	021	E	29-Mar-17	09:18			X	
48	022	E	29-Mar-17	11:46			X	
49	023	E	29-Mar-17	14:45			X	
50	024	E	29-Mar-17	17:58			X	
51	025	E	30-Mar-17	09:06			X	
52	026	E	30-Mar-17	12:32			X	

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Table 2 – *continued from previous page*

Event	Stn.	Sec.	Date	Time (UTC)	MOR	VMP	CTD	Comments
53	027	E	30-Mar-17	15:39			X	
54	027	E	30-Mar-17	17:54		X		VMP 500-m test cast
55	028	E	30-Mar-17	19:36			X	
56	029	E	30-Mar-17	22:50			X	
57	030	C	31-Mar-17	03:43			X	
58	031	C	31-Mar-17	06:34			X	
59	032	C	31-Mar-17	08:54			X	
60	033	C	31-Mar-17	11:22			X	
61	034	C	31-Mar-17	13:44			X	
62	035	C	31-Mar-17	16:11			X	
63	036	C	31-Mar-17	18:36			X	
64	037	C	31-Mar-17	20:36			X	
65								Dredging for VMP (full day)
66								VMP recovery from seabed
67	038	D	02-Apr-17	10:02		X		
68	038	D	02-Apr-17	10:22			X	
69	039	D	02-Apr-17	13:45		X		
70	039	D	02-Apr-17	13:55			X	
71	040	D	02-Apr-17	17:31		X		
72	040	D	02-Apr-17	17:44			X	
73	041	D	02-Apr-17	22:09		X		
74	041	D	02-Apr-17	22:42			X	
75	042	D	03-Apr-17	02:29		X		
76	042	D	03-Apr-17	03:01			X	
77	AS01		03-Apr-17	11:54				ALR Deployed (#1) -- on station at 07:42, recovered at 17:28
78	AS02		03-Apr-17	19:39				ALR Deployed (#2) -- on station at 18:06, recovered at xxx
79	043-test	D	04-Apr-17	02:54		X		VMP 500-m test cast
80	043	D	04-Apr-17	04:15		X		
81	044	D	04-Apr-17	08:15		X		
78	AS02		04-Apr-17	11:42				Rendezvous with ALR (halfway point; came off station at 13:52)
82	045	D	04-Apr-17	14:26		X		
83	046	D	04-Apr-17	18:06		X		
78	AS02		04-Apr-17	11:42				Recovery of ALR
84	047	D	05-Apr-17	04:16		X		
85	047	D	05-Apr-17	04:29			X	
86	048	D	05-Apr-17	18:43			X	CTD (dead time before this; recovering VMP)
87	049	D	05-Apr-17	21:29			X	
88	050	D	06-Apr-17	00:39		X		
89	050	D	06-Apr-17	00:54			X	
90	051	D	06-Apr-17	04:44			X	
91	052	D	06-Apr-17	07:32			X	
92	053	D	06-Apr-17	10:30		X		

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Table 2 – *continued from previous page*

Event	Stn.	Sec.	Date	Time (UTC)	MOR	VMP	CTD	Comments
93	053	D	06-Apr-17	10:40			X	
94	054-001	OD-East	06-Apr-17	16:07			X	Tow-Yo (no USBL; issues with swath multi-beam depth sounder)
94	054-002	OD-East	06-Apr-17	19:17			X	Tow-Yo
94	054-003	OD-East	06-Apr-17	21:36			X	Tow-Yo
	054-004		06-Apr-17	23:36			X	Removed at 02:12 UTC due to inclement weather
95	055-001	OD-East	07-Apr-17	19:48			X	Tow-Yo (better depth penetration, trusting altimeter)
95	055-002	OD-East	07-Apr-17	21:41			X	Tow-Yo
95	055-003	OD-East	07-Apr-17	22:44			X	Tow-Yo
95	055-004	OD-East	07-Apr-17	23:30			X	Tow-Yo
96	056		08-Apr-17	01:15			X	
97	057-001	OD-West	08-Apr-17	06:32			X	Tow-Yo
97	057-002	OD-West	08-Apr-17	09:20			X	Tow-Yo
97	057-003	OD-West	08-Apr-17	11:45			X	Tow-Yo
98			09-Apr-17	11:33				ARGO float (SN7592) deployed
99			09-Apr-17	18:26				French float (PROVOR) recovered
100			09-Apr-17	18:47		X		VMP test cast
101	058-001	OD-West	09-Apr-17	11:49			X	Tow-Yo
101	058-002	OD-West	09-Apr-17	13:58			X	Tow-Yo
101	058-003	OD-West	09-Apr-17	15:27			X	Tow-Yo
101	058-004	OD-West	09-Apr-17	16:43			X	Tow-Yo
102	059	B	10-Apr-17	09:22			X	OP-CTD04, CTD only
103	060	B	10-Apr-17	11:43		X		OP-CTD05
104	060	B	10-Apr-17	11:53			X	OP-CTD05
105	061	B	10-Apr-17	14:14		X		OP-CTD06
106	061	B	10-Apr-17	14:22			X	OP-CTD06
107	062	B	10-Apr-17	17:29		X		OP-CTD07 (OP2 mooring)
108	062	B	10-Apr-17	17:44			X	OP-CTD07 (OP2 mooring)
109	063	B	10-Apr-17	22:20		X		OP-CTD11
110	063	B	10-Apr-17	22:31			X	OP-CTD11
111	064	B	11-Apr-17	02:46		X		OP-CTD12
112	064	B	11-Apr-17	02:56			X	OP-CTD12

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Table 2 – *continued from previous page*

Event	Stn.	Sec.	Date	Time (UTC)	MOR	VMP	CTD	Comments
113	065	B	11-Apr-17	07:12		X		OP-CTD08
114	065	B	11-Apr-17	07:22			X	OP-CTD08
115								ALR Deployed (#3) (longer mission)
116	066		11-Apr-17	15:30		X		ALR1
117	067		11-Apr-17	21:06		X		ALR2
118	068		12-Apr-17	15:21		X		ALR6
119	069		12-Apr-17	21:52		X		ALR7
120	070		13-Apr-17	02:04		X		ALR3
121	071		13-Apr-17	05:17		X		ALR8.1
115			13-Apr-17					ALR Recovery 3 (talk & recover)
122	072		13-Apr-17	20:20		X		ALR9.1
123	073		14-Apr-17	01:00		X		ALR4
124	074		14-Apr-17	04:43		X		ALR10
125			14-Apr-17	09:34	X			MOORING RECOVERY (OP5) (time corresponds to at surface)
126			14-Apr-17	12:36	X			MOORING RECOVERY (OP6) (time corresponds to at surface)
127			14-Apr-17	15:02	X			MOORING RECOVERY (OP4) (time corresponds to at surface)
128			14-Apr-17	17:33	X			MOORING RECOVERY (OP2) (time corresponds to at surface)
129	075		14-Apr-17	21:52		X		ALR5
130	076		15-Apr-17	01:10		X		ALR11
131			15-Apr-17	xxx		X		ALR12 (FAILED VMP)
132			15-Apr-17	10:28	X			MOORING RECOVERY (OP1) (time corresponds to at surface)
133			15-Apr-17	14:43	X			MOORING RECOVERY (OP3) (time corresponds to at surface)
134			15-Apr-17	17:20	X			MOORING RECOVERY (OP7) (time corresponds to at surface)
135	077		15-Apr-17	21:16		X		ALR12
136	078	B	16-Apr-17	02:03		X		OP-CTD09
137	078	B	16-Apr-17	02:18			X	OP-CTD09
138	079	B	16-Apr-17	14:18			X	OP-CTD10 (CTD only)
139	080	B	16-Apr-17	18:13		X		OP-CTD13
140	080	B	16-Apr-17	18:23			X	OP-CTD13
141	081	B	16-Apr-17	22:34			X	OP-CTD14 (CTD only)
142	082	B	17-Apr-17	01:49		X		OP-CTD15
143	082	B	17-Apr-17	02:08			X	OP-CTD15
144	083	B	17-Apr-17	05:25			X	OP-CTD16 (OP4),(CTD only)
145	084	B	17-Apr-17	08:42		X		OP-CTD17
146	084	B	17-Apr-17	08:50			X	OP-CTD17

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Table 2 – *continued from previous page*

Event	Stn.	Sec.	Date	Time (UTC)	MOR	VMP	CTD	Comments
147	085	B	17-Apr-17	11:41			X	OP-CTD18 (CTD only)
148			17-Apr-17	22:20				ALR Deployed (#4); time corresponds to in water
149	086	B	18-Apr-17	05:59		X		OP-CTD20
150	086	B	18-Apr-17	06:14			X	OP-CTD20
151			18-Apr-17	12:44	X			Mooring Deployment (OP1); start_time 12:44, anchor_drop 15:18
152			18-Apr-17	17:37	X			Mooring Deployment (OP2); start_time 17:37, anchor_drop 19:19
153			18-Apr-17	20:54				ALR Deployed (#5) -- in water at 20:54
154	087		19-Apr-17	02:29		X		VMP1
155	088		19-Apr-17	06:04		X		VMP2
156			19-Apr-17	10:38	X			Mooring Deployment (OP3); start_time 10:38, anchor_drop 12:08 Triangulation of Moorings (12:42 to 16:12 UTC)
157			19-Apr-17	16:46	X			Mooring Deployment (OP5); start_time 16:46, anchor_drop 17:33
153			19-Apr-17	19:00				ALR Rendezvous; 1900 in water; 1933 out of water
158	089-001	OS-West1	19-Apr-17	20:12			X	Tow-Yo
158	089-002	OS-West1	19-Apr-17	21:18			X	Tow-Yo
158	089-003	OS-West1	19-Apr-17	22:00			X	Tow-Yo
158	089-004	OS-West1	19-Apr-17	22:42			X	Tow-Yo
158	089-005	OS-West1	19-Apr-17	23:30			X	Tow-Yo
158	089-006	OS-West1	20-Apr-17	00:29			X	Tow-Yo
158	089-007	OS-West1	20-Apr-17	01:25			X	Tow-Yo
158	089-008	OS-West1	20-Apr-17	02:29			X	Tow-Yo
158	089-009	OS-West1	20-Apr-17	03:36			X	Tow-Yo
158	089-010	OS-West1	20-Apr-17	04:39			X	Tow-Yo
158	089-011	OS-West1	20-Apr-17	05:52			X	Tow-Yo
158	089-012	OS-West1	20-Apr-17	07:12			X	Tow-Yo
158	089-013	OS-West1	20-Apr-17	08:36			X	Tow-Yo (recovered at 10:42)

Continued on next page

Table 2 – *continued from previous page*

Event	Stn.	Sec.	Date	Time (UTC)	MOR	VMP	CTD	Comments
159			20-Apr-17	13:17	X			Mooring Deployment (OP6) (start_time 13:17, anchor_drop 14:13)
160	090		20-Apr-17	16:07		X		OP-CTD19
161	090		20-Apr-17	16:26			X	OP-CTD19
153			20-Apr-17	21:54				ALR Rendezvous (off station at 00:42)
162	091-001	OS-East	21-Apr-17	01:53			X	Tow-Yo
162	091-002	OS-East	21-Apr-17	03:47			X	Tow-Yo
162	091-003	OS-East	21-Apr-17	05:12			X	Tow-Yo
162	091-004	OS-East	21-Apr-17	06:34			X	Tow-Yo
162	091-005	OS-East	21-Apr-17	07:55			X	Tow-Yo
162	091-006	OS-East	21-Apr-17	09:06			X	Tow-Yo
162	091-007	OS-East	21-Apr-17	10:11			X	Tow-Yo
162	091-008	OS-East	21-Apr-17	11:09			X	Tow-Yo
162	091-009	OS-East	21-Apr-17	12:03			X	Tow-Yo
162	091-010	OS-East	21-Apr-17	12:47			X	Tow-Yo
163			21-Apr-17	15:58	X			Mooring Deployment (OP4) (start_time 15:58, anchor_drop 17:21)
			21-Apr-17					Triangulation of Moorings (OP4,OP5,17:42 to 20:12 UTC)
153			21-Apr-17	20:48				Recovery of ALR (Completed at 01:55)
164	092		22-Apr-17	09:28			X	CTD (dead time before this; waiting on weather; decided to stop at 2317 lineout due to bad CTD sensor data)
165	093		22-Apr-17	12:04		X		
166	093		22-Apr-17	12:16			X	
167	094		22-Apr-17	17:12		X		
168	094		22-Apr-17	17:30			X	
169	095		23-Apr-17	01:29			X	CTD (single cast due to WX; LADCP slave not recording correctly)
170	096-001	OS-West2	23-Apr-17	09:31			X	Tow-Yo
170	096-002	OS-West2	23-Apr-17	10:37			X	Tow-Yo

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Table 2 – *continued from previous page*

Event	Stn.	Sec.	Date	Time (UTC)	MOR	VMP	CTD	Comments
170	096-003	OS-West2	23-Apr-17	11:32			X	Tow-Yo
170	096-004	OS-West2	23-Apr-17	12:34			X	Tow-Yo
170	096-005	OS-West2	23-Apr-17	13:35			X	Tow-Yo
170	096-006	OS-West2	23-Apr-17	14:41			X	Tow-Yo
170	096-007	OS-West2	23-Apr-17	15:53			X	Tow-Yo
170	096-008	OS-West2	23-Apr-17	17:15			X	Tow-Yo
170	096-009	OS-West2	23-Apr-17	18:49			X	Tow-Yo
170	096-010	OS-West2	23-Apr-17	20:40			X	Tow-Yo
170	096-011	OS-West2	23-Apr-17	22:44			X	Tow-Yo
171	097	OS-West2	24-Apr-17	01:25		X		VMP only
172	098	OS-West2	24-Apr-17	05:51		X		
173	098	OS-West2	24-Apr-17	06:05			X	
174	099	OS-West2	24-Apr-17	11:44			X	CTD only
			24-Apr-17	16:08				Swath survey (completed at 20:30)
175	100	A	24-Apr-17	21:40		X		
176	100	A	24-Apr-17	21:49			X	
177	101	A	25-Apr-17	00:17		X		
178	101	A	25-Apr-17	00:29			X	
179	102	A	25-Apr-17	04:19		X		
180	102	A	25-Apr-17	04:39			X	
181	103	A	25-Apr-17	07:44		X		
182	103	A	25-Apr-17	08:02			X	
183	104	A	25-Apr-17	11:08		X		
184	104	A	25-Apr-17	11:16			X	
185	105	A	25-Apr-17	15:31		X		
186	105	A	25-Apr-17	15:47			X	
187	106	A	26-Apr-17	20:26		X		
188	107-001	A	26-Apr-17	03:17			X	Tow-Yo
188	107-002	A	26-Apr-17	05:49			X	Tow-Yo
188	107-003	A	26-Apr-17	07:51			X	Tow-Yo
188	107-004	A	26-Apr-17	09:51			X	Tow-Yo
188	107-005	A	26-Apr-17	11:29			X	Tow-Yo

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Table 2 – *continued from previous page*

Event	Stn.	Sec.	Date	Time (UTC)	MOR	VMP	CTD	Comments
188	107-006	A	26-Apr-17	13:00			X	Tow-Yo
188	107-007	A	26-Apr-17	14:12			X	Tow-Yo
188	107-008	A	26-Apr-17	15:14			X	Tow-Yo
188	107-009	A	26-Apr-17	16:09			X	Tow-Yo (recovered at 17:22)
189	108		26-Apr-17	17:57		X		
190	108		26-Apr-17	19:40		X		test VMP
191	109	COR-East	27-Apr-17	07:36			X	CTD only (no VMP due to iceberg bits)
192	110	COR-East	27-Apr-17	10:07		X		
193	110	COR-East	27-Apr-17	10:20			X	
194	111	COR-East	27-Apr-17	13:33		X		
195	111	COR-East	27-Apr-17	13:48			X	
196			27-Apr-17	16:20				ARGO float (SN7593) deployment
197	112	COR-East	27-Apr-17	17:24		X		
198	112	COR-East	27-Apr-17	17:40			X	
199	113	COR-East	27-Apr-17	22:05		X		
200	113	COR-East	27-Apr-17	22:21			X	
201	114	COR-East	28-Apr-17	03:47		X		
202	114	COR-East	28-Apr-17	04:06			X	
203	115	COR-East	28-Apr-17	12:42			X	CTD only
204	116-001	COR-East	28-Apr-17	18:54			X	Tow-Yo
204	116-002	COR-East	28-Apr-17	20:27			X	Tow-Yo
204	116-003	COR-East	28-Apr-17	21:43			X	Tow-Yo
204	116-004	COR-East	28-Apr-17	23:14			X	Tow-Yo
204	116-005	COR-East	29-Apr-17	00:52			X	Tow-Yo
204	116-006	COR-East	28-Apr-17	02:33			X	Tow-Yo
204	116-007	COR-East	28-Apr-17	04:30			X	Tow-Yo
204	116-008	COR-East	29-Apr-17	09:53			X	Tow-Yo

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Table 2 – *continued from previous page*

Event	Stn.	Sec.	Date	Time (UTC)	MOR	VMP	CTD	Comments
205			29-Apr-17	12:03	X			Mooring Recovery (WHOI) (release 11:42; fully recovered 15:31)
206	117		29-Apr-17	17:02		X		
207	117		29-Apr-17	17:25			X	
208	118-001	COR-West	30-Apr-17	00:12			X	Tow-Yo
208	118-002	COR-West	30-Apr-17	01:26			X	Tow-Yo
208	118-003	COR-West	30-Apr-17	02:12			X	Tow-Yo
208	118-004	COR-West	30-Apr-17	03:02			X	Tow-Yo
208	118-005	COR-West	30-Apr-17	03:56			X	Tow-Yo
208	118-006	COR-West	30-Apr-17	04:51			X	Tow-Yo
208	118-007	COR-West	30-Apr-17	05:52			X	Tow-Yo
208	118-008	COR-West	30-Apr-17	06:52			X	Tow-Yo
208	118-009	COR-West	30-Apr-17	08:02			X	Tow-Yo
208	118-010	COR-West	30-Apr-17	09:21			X	Tow-Yo
208	118-011	COR-West	30-Apr-17	10:52			X	Tow-Yo
208	118-012	COR-West	30-Apr-17	12:35			X	Tow-Yo
208	118-013	COR-West	30-Apr-17	14:28			X	Tow-Yo
209			30-Apr-17	17:25		X		VMP test cast
210	119		30-Apr-17	21:35		X		VMP test cast
211	119		30-Apr-17	22:30		X		VMP (failed)
212	119	COR-East	30-Apr-17	23:45			X	After recovering VMP, did CTD only
213	120	A	01-May-17	10:55			X	Redid one station at end of line
214			02-May-17	07:12				ARGO float (AL2500-16DE001) deployment
215			03-May-17	19:04				ARGO float (AL2500-16DE003) deployment
216			06-May-17	04:34				ARGO float (AL2500-16DE004) deployment

Table 2: Scientific events on the cruise JR16005, 19 March – 1 May 2017. Key to colour coding given in Table 1.

3 Conductivity, Temperature, Depth (CTD) Operations

3.1 AME CTD Operations – *Carson McAfee.*

CTD Instrumentation

The CTD performed well during the cruise, and suffered only minor issues. There were occasional issues caused by the winch/spooling, but these were limited to select events.

Instrument	S/N	Comments
Deck unit 1 SBE11plus	0458	Whole Cruise
Underwater unit SBE9plus	0771	Whole Cruise
Temp1 sensor SBE3plus	5623	Whole Cruise
Temp2 sensor SBE3plus	4874	Whole Cruise
Cond1 sensor SBE 4C	4087	2813: Casts 001-003 / 4087: Casts 004-End
Cond2 sensor SBE 4C	3248	Whole Cruise
Pump1 SBE5T	7966	7966: Casts 001-092 / 2400: Casts 093-End
Pump2 SBE5T	1807	Whole Cruise
Standards Thermometer SBE35	0051	Whole Cruise
Transmissometer C-Star	CST-1505DR	Whole Cruise
Oxygen sensor SBE43	0242	0620: Casts 001-039 / 0242: Casts 040-End
PAR sensor	70636	Whole Cruise
Fluorimeter	12-8513-003	Whole Cruise
Altimeter PA200	26993	Whole Cruise
LADCP Master	14443	Whole Cruise
LADCP Slave	14897	Whole Cruise
CTD swivel linkage	1961018	Whole Cruise
Pylon SBE32	1106	Whole Cruise
Notes on any other part of CTD e.g. faulty cables, wire drum slip ring, bottles, swivel, frame, tubing etc		Reterminated the sea cable on the 24/04/2017.

Table 3: Serial numbers of CTD instruments used on cruise JR16005.

Layout

The standard layout of the CTD was modified to suit the requirements of the cruise science. Four ChiPod instruments were installed (two facing up, and two facing down) on the CTD frame. These instruments are discussed in their own section. The majority of the niskin bottles (1-6, and 13-24) were removed from the CTD frame in order to reduce the turbulence caused by the CTD, and therefore improve the data quality of the ChiPods. In addition to this the LADCP cables were re-routed in an attempt to reduce noise from the LADCP on the ChiPods. Other than these changes, the CTD layout remained the same as the previous cruise JR16004.

Operation

The CTD casts were managed by two scientists and a winch operator. Three scientists in each of the three work shifts were trained to manage the CTD casts. Importance was placed on consistent operation between the scientists, so that the data quality and management would remain the same throughout the cruise (regardless of the operator).

This cruise also used the CTD in a new way: 'Tow-Yo'. The CTD is left in the water for extended periods of time being lowered and raised in the water (Yo-Yo), while being towed by the ship at a slow speed (typically 0.5 kt). The CTD is generally raised to a depth of 1000 m, and then lowered again. The benefit of this method is that the CTD can profile (especially with the LADCP) over a larger area. It also saves time by focusing only on the range of depths being studied, and also removes the wasted time during recovery and deployment. Additionally the CTD spends less time transitioning through the surface, which is where most of the damage to instruments occurs. The Tow-Yo's performed on this cruise have been reported as a great success by the scientists, and may become more popular in the future.

Initially there was some anxiety about moving the CTD through the water while the ship was moving, however we found that the altimeter still operated correctly, and therefore gave adequate warning about seafloor levels/proximity. However given the geometry and wire angle, it is often possible to have more line out than depth. This poses a problem if the ship stops, and the CTD swings towards the seafloor. I would recommend keeping the CD at least 40 m from the seafloor to allow some safety margin in an emergency.

Instrument Changes and Repairs

21/03/2017 Conductivity cell 1 failed and was replaced (042813->044087). It failed during cast 003, and suspect damage was caused during recovery on cast 002.

02/04/2017 The dissolved oxygen sensor started producing noisy data (0620->0242).

22/04/2017 The instruments on line 1 (T1, C1, DO) started producing bad data. Pump 1 was replaced (7966->2400), however no problem could be found with the original pump.

24/04/2017 An inspection of the CTD wire (near the swivel) showed the beginning of birdcaging. This did not indicate an immediate problem, however in an effort to reduce the chance of future damage, the call was made to remove 20 m of the CTD cable, and re-terminate. Table 4 shows the insulation resistance of the sea cable termination. After the re-termination the cable was load tested and checked by the Deck Engineer, Winch Operator and Chief Mate.

		250 V (MΩ)	500 V (MΩ)	1000 V (MΩ)
Start of Cruise	19/03/2017	7.3	6.3	4.7
Before Termination	24/04/2017	2.4	6 .0	3.8
After Termination	24/04/2017	65.0	50.0	40.0
End of Cruise	05/05/2017	170.0	130.0	99.0

Table 4: The insulation resistance of the CTD sea cable termination.

Technical Cast Summary

This section lists comments made during the casts that may offer insight into the technical performance of the CTD.

001 Stopped at 200 m on upcast for a USBL test. +-15 min.

002 USBL test cast. BAS beacons only start working at approximately 480 m, and loose signal at approximately same depth while returning. Surface level problem. Could not get NMF Beacons to communicate. CTD also bumped the side of the ship during recovery (bad sea state).

003 Conductivity Sensor 1 (C1) is bad during this cast. Decide to continue regardless. Waited at bottom for EdgeTech Acoustic release testing. Left bottom at 16:03.

005 New Conductivity Cell (C1) installed. T1 and C1 show consistent data blips. Possibly a pump issue?

006 Quick Stop at 4300m Full depth of 4600m was not reached due to a 4000m Rated USBL beacon attached to the frame. Bas beacon works from ˜480 m, to ˜1500m. The NMF beacons are working fine now.

008 Bottle 12 not fired due to noisy readings at 30 m.

010 At 55 m there was a pulse on T1, C1, and DO. Suspect a problem with the pump.

013 At 925 m, there was a step/spike in C1. Bottle 7 failed to fire.

014 Interleaving at about 2000 m.

015 Temperature difference showed a negative offset. PC time was incorrect by ˜20 s.

018 Updated clock on the SBE35 after the cast.

022 Pulse seen at 820 m on upcast for both lines.

024 LADCP startup script was not sent to the master. Therefore no LADCP data for this cast.

033 Problem with conductivity cell 1 from 600-300 m on upcast. Flushing cells after cast resolved issues.

035 Seasave started at the 10m stop.

037 Incorrect naming of LADCP Files.

038 Dissolved Oxygen has shifted during cast.

039 Dissolved Oxygen is 258 at surface. Problem with sensor.

040 New DO sensor installed before this cast.

041 There was a delay (10 min) at the start of the cast while checking the traction winch room. CTD left at 30 m while checking. Cast was restarted at scan 18000. Noisy DO and Salinity data between 558-1120 m on the downcast. Appears to be something stuck in pump.

047 Big spike in DO at 510 m during downcast. Bottle 12 did not fire. Unsure if this was operator error, or equipment issue.

049 DO sensor developed a negative offset during the upcast from ˜2650 dbm.

053 Niskin 9 may have a leak.

054 Tow-Yo Cast. ˜10 Hours.

- **001** At 17:16 UTC changed ship speed from 0.8 kt to 0.5 kt. Stopped CTD before altimeter values kicked in.
- **002** Stopped at 4476 m. Still no altimeter readings. Spooling problems at 1500 m during upcast.
- **003** Vessel stopped to resolve spooling issue. From 22:53 UTC ship started moving again.
- **004** Ship stopped when winch was at 1013 m line out (3832 m on CTD).

055 Tow-Yo Cast. ˜5 Hours.

- **001** USBL Beacon 5 attached to CTD. Vessel started moving at 19:58. 20:41 Ship slows to a stop, with CTD at 2833 m. 20:44 Winch is stopped and restarted. Altimeter is correctly reading the bottom. 20:58 Ship is started again.

057 Tow-Yo Cast. ˜8 Hours.

- **001** Vessel is stationary while on downcast, and moved south during upcast. There was a mistake made during the naming of the casts files, which were corrected after the cast.

058 Tow-Yo Cast. ~6 Hours.

- **001** Rough weather during entire casts.

061 Conductivity value difference appears to be increasing.

063 At 22:45 UTC / 372 m, the CTD was paused to check the wire on the drum.

078 Microcat instruments attached to CTD frame. CTD held for 5 min at each bottle stop.

079 Microcat instruments attached to CTD frame. CTD held for 5 min at each bottle stop.

080 Microcat instruments attached to CTD frame. CTD held for 5 min at each bottle stop.

081 Slave LADCP failed to record during the cast. First time this problem has occurred.

083 Microcat instruments attached to CTD frame. CTD held for 5 min at each bottle stop.

085 Suspect that T and C difference is increasing. No microcat sensors. Tested acoustic releases at the bottom.

086 Microcat instruments attached to CTD frame. CTD held for 5 min at each bottle stop. Tested acoustic releases at bottom.

089 Tow-Yo Cast. ~15 Hours.

- **001** T and C sensors take a while to stabilise, and were lowered to 20 m for surface soak. Vessel started moving at 0.4 kt, at 20:58 UTC.
- **002** Stopped at the bottom for release test, abd restarted at 21]39.
- **005** Erroneously closed file at bottom of cast. Upcast is recored in 087_005_1.
- **012** Conductivity difference has changed from ~0.002 -> ~0.006 at ~2900 m. Suspect a problem with conductivity sensor 1.
- **013** Still a problem with C1 during start of this cast component, however it improves at 400 m during the upcast. USBL stopped for approximately 2 hours during the cast.

090 Microcat instruments attached to CTD frame. CTD held for 5 min at each bottle stop.

091 Tow-Yo Cast. ~12 Hours.

- **001** Vessel started moving at 03:00 UTC.
- **010** DO sensor produced bad data at 680 m on upcast.

092 Microcat instruments attached to CTD frame. Line 1 sensors developed issues at 1340 m during downcast. Cast was cancelled at 2316 line out, and brought to surface for repair. Suspect the pump on line 1, and changed it after recovery.

094 Pumps took a lot longer to turn on this time. Suspect that there may have been freezing on T+C ducts. Paused on downcast at 950 m (~ 2 min). Going slowly over poorly spooled portion of the cable drum. Also paused on upcast at ~3990 m to check drum.

095 Initially started as a Tow-Yo, but recovered on first upcast due to bad weather. The LADCP slave also failed to record again.

096 Tow-Yo Cast. ~15.5 Hours.

- **001** Ship started moving from the start of the downcast. There is a big spike in T2 at 600m.
- **004** C1 values looked incorrect from 1850 m on downcast, but imporved on the upcast. Suspect that it may have had biological matter pulled through cell.
- **006** C1 looks bad at the start, but settels after 1100 m during downcast.
- **011** Ship stopped moving after the CTD reached the bottom, and remained stationary for the upcast.

098 There was a spooling issue during recovery (gap on the drum). CDT had to be stopped at 4298 m, 3810 m, 3707 m, 3698 m, 3397 m, 3352 m and 3300 m. Between these depths the CTD moved slowly. After 3300 m, the CTD continued as normal.

107 Tow-Yo Cast. ~14 Hours.

- **001** Ship was stationary during downcast, but started moving at 0.4 kt after reaching the bottom. C1 had a spike at 1890 m during downcast. Following this spike the data does not settle as expected. From 4236 m on downcast the data from C1 seems to improve, and decision is made to continue cast as normal.
- **003** Problem with the wire on the upcast at 4075 m line out. Ship stopped moving while an issue with the compensator was sorted out. Ship started moving again after CTD reached ~4000 m.

115 Conductivity difference is increasing. Started at 0.005 at the start of the cast, but increased to 0.006 at the end. The difference is still stable, and therefore it may be better to keep the instruments.

116 Tow-Yo Cast. ~13 Hours.

- **008** During upcast (at 3642 m), a decision was made to return down to the bottom again to collect a water sample. This cast will have a short upcast+downcast in the middle of the data set.

117 Conductivity difference is still 0.005.

118 Tow-Yo Cast. ~17 Hours.

- **005** Had to stop at the top of the cast for winch tension. Restarted at 04:03.

Improvements and Recommendations

ICT have created a backup disk of the CTD PC. This is installed inside the PC for a quick change over in an emergency.

Preliminary review of the CTD data shows that C2 is drifting. May be worth changing on the next cruise. There are no spare DO sensors on board, and the current one is showing signs of deterioration. May be worth hand carrying a sensor to the ship.

More screws have been breaking off the CTD bottle brackets. Spare screws need to be sourced. As a last resort it may be possible to use the A2 grade screws on board, but the original ones are titanium.

LADCP

The LADCP had the same problems as the last cruise. Occasionally the slave/master would stall while sending the command scripts (not predeployment scripts). This problem resolves itself by sending the 'Break' command to both Master and Slave terminals periodically. There is no need to power cycle the battery case.

The newest versions of BBTalk and WinADCP have been installed on the CTD PC. Unfortunately the stalling issue persists. However no data has been affected by this issue, and is therefore not a critical problem.

A more concerning issue is that the slave has had three instances where it failed to record data after receiving its command file. I believe that this is caused by a break/short circuit on the synchronisation lines that link the master and the slave (part of the wiring harness). The first time this happened, I incorrectly thought that it was due to operator error, however it happened two more times on the 22/04/2017. After this, I removed the cable connectors from both master and slave, and cleaned them up. I then applied fresh silicone grease, and reinstalled the connectors. The slave record failures happened on casts 81 (16/04/2017), 92 (22/04/2017) and 95 (22/04/2017). The 25 casts following cast 95 had no faults or failures on the slave or master.

As reported in the previous cruise report, the batteries in the LADCP battery pack need replacing (due to age, and long operational life). Additionally the available spares have been damaged due to no charge/discharge cycling over the years. The battery pack operated well until the 25/04/2017. It was noted that the voltage after charge was dropping from the expected 51.7 V, to 48.5 V before a cast. I performed a basic load test by starting the LADCP's, and monitoring the voltage. Initially the voltage was 51.5 V, and would dip by 0.5 V every second (roughly corresponding to pings). After 10 minutes the voltage had dropped to 48.5 V. This indicated a problem with one of the internal batteries in the case. Normally the voltage would not drop (after settling from the charge value), and would only dip by a maximum of 0.01 V. I then decided to remove the battery tray from the case, and quickly found that one of the 8 batteries dropped voltage under load (1 kΩ). The battery pack is made up of 8 batteries connected in series, so one failure could cause the rest to fail. I replaced the damaged battery with the last remaining spare, and reinstalled everything.

The new battery performed well on the casts that followed (107-115), however the 13 hour Tow-Yo on cast 116 appears to have depleted the batteries, and caused damage. This was made worse by the 17 hour Tow-Yo on cast 118, where the battery voltage dropped to 42.6 V (should aim for 48 V). Nothing was done to the battery tray, due to the lack of spares. Even in this damaged state the battery pack still performed well on casts 119 and 120.

In its current state the battery pack should be capable of lasting one more cruise, however new batteries need to be installed as soon as possible. If possible new batteries should be sourced in Montevideo (next port of call).

3.2 CTD Processing and Calibration – *Tiago S. Dotto & Carl P. Spingys*

A total of 85 profiles and 10 tow-yo sections were collected with the CTD911+ on the cruise JR16005. The CTD processing was performed using the MEXEC software developed by Brian King (NOC). [For details of the instrumentation see Section 3.1].

Seabird processing

Data were recorded and viewed using Seasave version 7.22.3. For each cast 4 files were created (Table 5).

JR16005_nnn.hex	hexadecimal (raw) ascii data file
JR16005_nnn.XMLCON	ascii configuration file with calibration information
JR16005_nnn.hdr	ascii header file containing sensor information
JR16005_nnn.bl	file containing bottle fire information

Table 5: CTD SeaBird processing files.

After every deployment, a batch script was run to copy the raw data to the network drives and do some preliminary processing with SBE Data Processing version 7.22.3. This included creating a sound velocity profile for updating the EM122 and a coarser resolution copy of the data for sending to the Met Office. Once data have been backed up to the network drive, the .hex file is passed through the Align CTD and Cell Thermal Mass modules of SBE Data processing. Align CTD corrects the temporal offsets between the sensors on the CTD; in this case, the oxygen measurements were advanced by five seconds. Cell thermal mass corrects the effects of the conductivity cell thermal mass. Once complete the following three files were transferred to the network drive ‘Legdata’.

SBE35 high precision thermometer

Once the CTD was on deck and secured, data from the SBE35 were uploaded using Seaterm version 1.59. The procedure for this was to switch the deck unit on, open the software, click ’connect’, and then ’upload’. Once the data had been uploaded the sample history was cleared by entering the command ’samplenum=0’. A status command (ds) was used before and after upload to ensure that the sample numbers matched the log records for each cast. The process batch script transferred across the file and its nomenclature was: **SBE35_JR16005_nnn.asc**. More information on the SBE35 is found in the CTD calibration section.

CTD MSTAR Processing

Modified from the cruise report JR15007 by Carl Spingys.

The initial SeaBird data conversion, align, and cell thermal mass corrections (alpha = 0.03, tau = 7.0000 on both primary and secondary) were performed using SBE Data Processing, Version 7.22.3 software. The network data drive, legdata, was linked to ctd/ASCII_FILES/jcrfs_ctd and ctd_linkscript was used to copy files to fola and set up additional symbolic links to filenames following mstar convention. The tow-yo stations were renamed as nnnxxx, where nnn is the station number and xxx is the cast number. At the beginning of processing, empty sample files sam_jr16005_nnn.nc for all casts were generated using msam_01. For each cast, the following m-files were then run, using wrapper script ctd_all_part1: mctd_01, mctd_02a, mctd_02b, mctd_03, mdcs_01, mdcs_02. The processes completed by these scripts include:

- read ASCII cnv data from ctd/ASCII FILES/ctd_jr16005_nnn.cnv
- convert variable names from SBE names to mexec names using jr16005_renamelist.csv in data/templates/ctd/ directory.
- copy raw file to 24hz file
- average to 1hz
- calculate derived variables psal, potemp
- extract information from bottom of cast identified by maximum pressure.

Subsequently, mdcs_03g was run to inspect the profiles and hand-select cast start and end times. The way oxygen time lag is handled in the SBE align algorithm, and the weak dependence of oxygen calculation on salinity, means that when air is ingested into the conductivity cell at the end of the cast, the oxygen becomes biased a few seconds earlier than the psal. Care should therefore be taken to select a cast end time for which all the important variables are free from bias. The start, bottom and end data cycles are stored in files with names like dcs_jr16005_nnn.nc. After selecting the limits for start and end, ctd_all_part2 was then run, executing mctd_04, mfir_01, mfir_02, mfir_03, mfir_04, mwin_01, mwin_03, mwin_04. The processes completed by these scripts include:

- Extract downcasts and upcasts using scan numbers stored in dcs_jr16005_nnn, and average into 2 dbar files (2db and 2up)
- Read the data/ctd/ASCII_FILES/ctd_jr16005_nnn.bl file and extract scan numbers corresponding to bottle firing events.
- Add time from CTD file, merging on scan number
- Add CTD upcast data (P, T1, T2, S1, S2, etc) corresponding to bottle firing events
- Paste these data into the master sample file data/ctd/sam_jr16005_nnn.nc
- Load winch telemetry data from winch SCS file
- Add winch wireout data to the fir_jr16005_nnn file
- Paste winch wireout data into the master sample file

Processed data could then be examined using mctd_checkplots to view sensor and up-down cast differences as well as compare nearby profiles, with particular attention paid to any drift in deep temperature or salinity (expected to be relatively stable) over time. The 24-Hz data were checked for spikes in either of the temperature or conductivity sensors using mctd_rawshow and, if necessary, edited using mctd_rawedit. A variety of extra steps is available after other processing has been carried out; these steps can be run in any order.

After navigation data processing has been completed, the file bst_jr16005_01 will be available. mdcs_04 will generate files dcs_jr16005_nnn_pos.nc which include position at start, bottom and end of profiles. The script mdcs_05, which paste the position at the bottom of the cast into the header of all relevant files in data/ctd, was not run during the cruise. The tow-yo 087, casts 001 to 013, was renamed to 089.

When temperature and conductivity calibrations are available, they are applied to the 24hz files using mctd_tempcal and mctd_condcal, as described below. A subset of scripts should now be rerun, specifically mctd_02b, mctd_tempcal with senscal = 1, mctd_tempcal with senscal = 2, mctd_condcal with senscal = 1, mctd_condcal with senscal = 2, mctd_03, mctd_04, mfir_03, mfir_04, msam_updateall. This collection of calls can usefully be put in a script like smallscript.m, modified in this cruise to smallscript_JR16005.m where msam_updateall was not performed. Selection of data cycle start and end points is preserved by smallscript, as well as edits to the raw file made using mctd_rawedit. Water depth and position data will also be preserved and do not need to be re-entered after conductivity calibration.

CTD Calibrations

Temperature field calibrations

A high-accuracy SBE35 was installed on the stainless steel CTD frame during JR16005. This instrument was used to carry out field calibrations of the pair of CTD911+ sensors. The SBE35 was automatically triggered each time a bottle was fired. During JR16005, six bottle stops were typically chosen at the bottom, in the surface mixed layer, and in four additional regions of low gradients (in temperature or salinity) spaced throughout the water column. At each firing, the SBE35 was automatically triggered. It takes 8 temperature samples over a span of 10 seconds, which are averaged and returned as a single measurement.

Data are stored internally and must be downloaded at the CTD deck unit as a separate process from the CTD data transfer. The SBE35 data are then transferred as a collection of ASCII files. On JR16005, these were found in data/ctd/ASCII_FILES/SBE35. msbe35_01 reads the data from a single station, and the script works in data/ctd/SBE35/. The script requires a list of all available SBE35 data files, so on JR16005 the list was called lsbe. msbe35_01 reads all ascii files in the lsbe list file and extracts data cycles for the station, based on the start and end times with a 15-minute extra window in case the SBE35 clock timestamps are not perfectly accurate. For some reason, msbe35_01 did not work for tow-yos profiles 057_001 and 096_005 to 096_011. msbe35_02 is then run and pastes the SBE35 data from one station into the master sample file sam_jr16005_nnn.nc. msam_update_all could be used to paste the data into the appended sample file sam_jr16005_all, however this process was not done during this cruise.

Temperature offsets between SBE35 and 911.

The offsets between the SBE35 and the temperature sensors of the CTD911+ were calculated based on the median difference for each measurement collected during the bottle stops. A threshold of +/- 0.1°C was used to exclude outliers following by the exclusion of data that were lower/higher than the median minus/plus one standard deviation for each sensor. Finally, the new median value for the differences in each sensor was calculated, which was used as the offset between instruments. The offset between the SBE35 and the CTD was less than 1 milli-degree for the primary sensor and ca. 1 milli-degree for the secondary sensor (Figure 2). Based on the median values of the differences between SBE35 and the CTD, the offset applied was +0.00004°C to the primary temperature sensor, and +0.00120°C to the secondary sensor (Figure 2). These offsets were applied as a constant correction, given that no drift in depth (Figure 3) or time (Figure 4) was observed. These offset values were entered in the script temp_apply_call and run via smallscript_JR16005. After the corrections, the median differences for both sensors were close to 0.

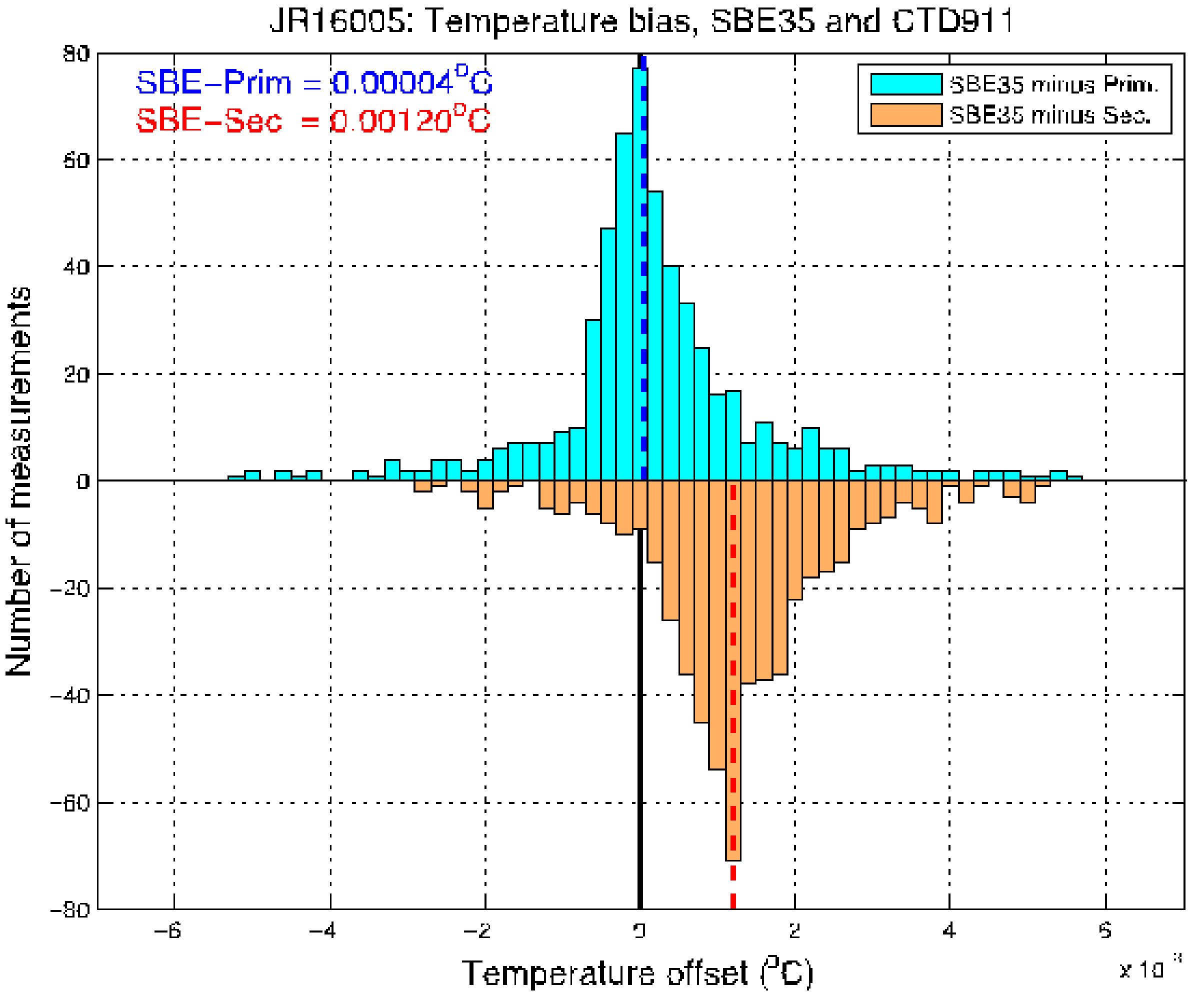

Figure 2: Temperature offset between the SBE35 and the sensor pair of CTD911+ on JR16005. The overall differences (SBE35 minus CTD) in °C for primary (cyan) and secondary (orange). The median offsets of the differences are shown on the left upper part of the figure and as the dashed lines for the primary (blue) and secondary (red) sensors.

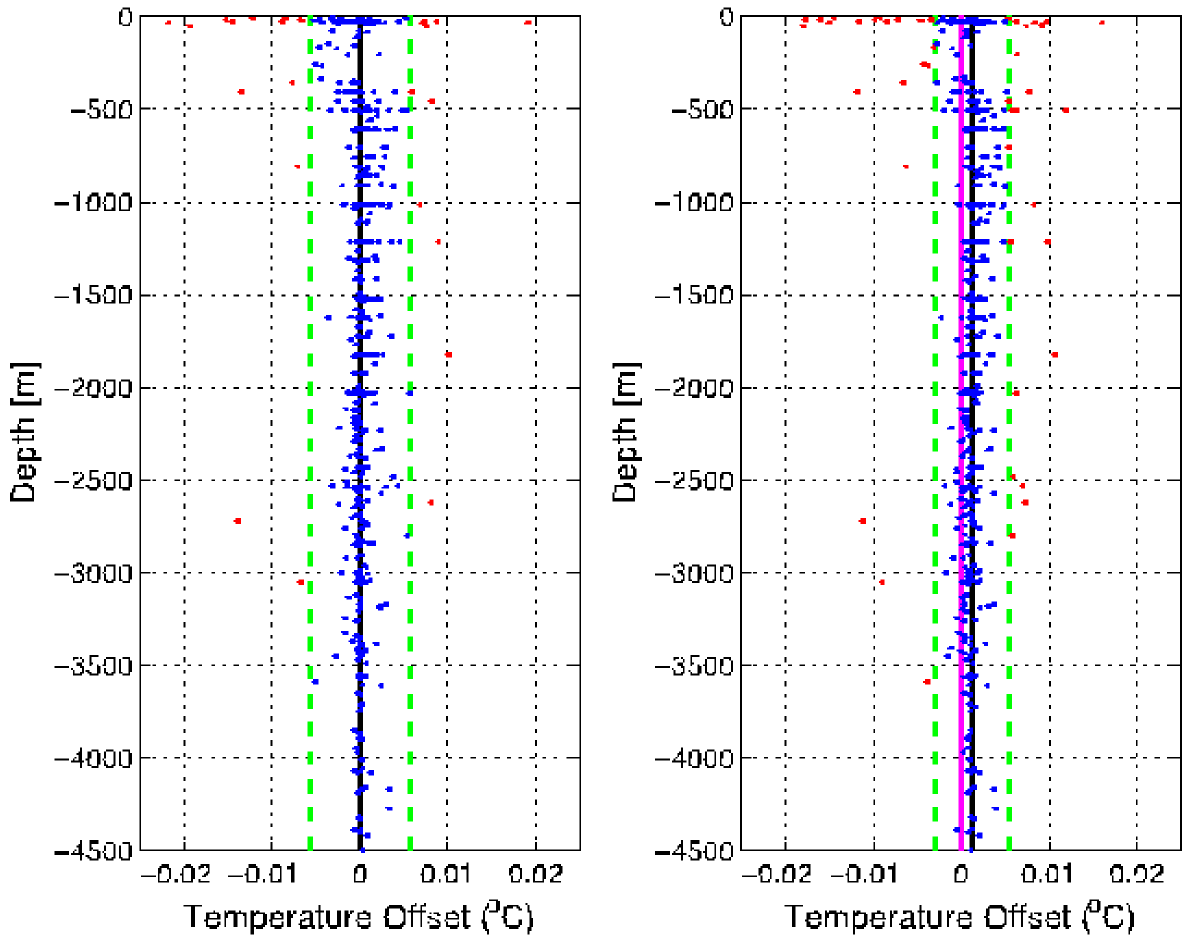

Figure 3: Temperature difference between the SBE35 and the sensor pair of CTD911+ on JR16005 along the depth. (A) Differences between SBE35 and the primary sensor in °C. (B) Differences between SBE35 and the secondary sensor in °C. Blue dots are the measurements within one standard deviation (green dashed lines) from the median (black solid line) used to calculate the offset. Red dot fall outside the threshold and were not used. Magenta solid line corresponds to the zero difference.

Conductivity field calibrations

Typically, six water samples were taken from each CTD cast during the JR16005 cruise. The water samples were analysed for conductivity through a Guildline Autosal 8400B salinometer in the controlled temperature lab. The Guildline Autosal 8400B measures the conductivity of a water sample with very high precision, in a water bath of 24°C constant during the whole cruise. The readout is given as twice the conductivity ratio between the sample and standard seawater with salinity 35 PSU at 20ºC, and 1 atmospheric pressure (known as the Vienna Standard). The instrument (S/N 68533) was standardised at the beginning of the cruise and set to a reading of 638. Once the instrument had been standardised, it was left like this for the duration of the cruise. All crates of salinity samples were left in the salinometer room for at least 24 hours before being analysed, to give them time to acclimatise to the room temperature.

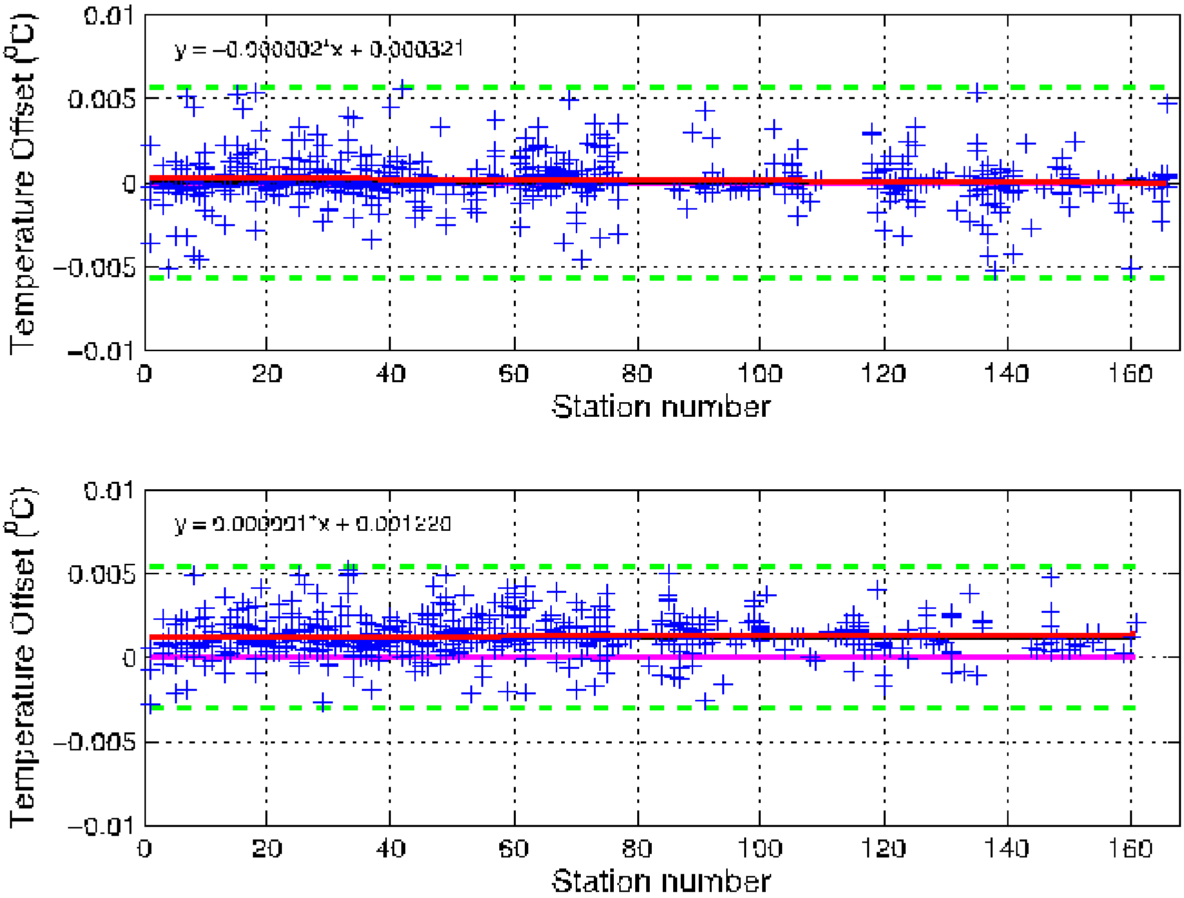

Figure 4: Temperature difference between the SBE35 and the sensor pair of CTD911+ on JR16005 along stations. (A) Differences between SBE35 and the primary sensor in °C. (B) Differences between SBE35 and the secondary sensor in °C. Blue plus markers are the differences measured within one standard deviation (green dashed lines) from the median (black solid line) used to calculate the offset. Magenta solid line corresponds to the zero difference. Red solid line is the temporal trend of the difference, equations are written on the left upper part of the panels. Station number is presented as a linear increase, not the real station number.

Ocean Scientific International Ltd (OSIL) standard seawater (batch number P160) was used to provide calibration readings before and after each crate of 24 salt samples, thus that corrections could be applied to the intermediate measurements. Measurements were taken from each sample/standard until three readings with a standard deviation <0.00002 were achieved. The mean reading was then taken as the accepted value. From these conductivity ratios, the practical salinity of the sample could be calculated using the equation of state from UNESCO (1978). The measurements were typed into a spreadsheet named sal_jr16005_01.csv and saved on data/ctd/BOTTLE_SAL. One spreadsheet was created for the whole cruise with all readings.

These conductivity measurements were then used to calculate practical salinity within the script msal_01 for each depth of the bottle samples. Salinities were then converted back to conductivities at the bottle depths using the measured pressure and SBE35 temperatures. Using SBE35 temperatures meant that the bottle conductivity estimates were independent from the CTD911+ conductivity measurements for the comparison and calibration of the CTD sensors.

Salinometer drift evaluation

Since the salinometer was not re-standardized during the cruise, the standards run before and after each crate were used to determine a drift in the salinometer. This drift was computed using the evaluate_standards.m script in the mstar routines, after creating the sal_jr16005_01.csv spreadsheets with the data from the bottle salts. Offsets were applied during the mstar processing in the function msal_01.m (see CTD processing section).

Conductivity comparison and calibration

All the conductivity sensors deployed showed a large amount of scatter near the surface, where there were also large vertical gradients in salinity. As the water collected by the Niskin bottle had been taken from a range between a few tens centimetres above the sensor to over a metre it is likely that strong vertical gradients will bias the bottle samples relative to the CTD. Thus, this analysis was performed for depths higher than 300 m, where the data did not show large scatter. The first primary sensor (used from station 1 to 3) was not included in this analysis because it was not viable to compute an equation with the small amount of data collected during the time we were using it, but it was corrected with the same equations presented here. It was also evidenced that the sensors drifted with the time, showing step-like changes (Figure 5). Thus, to correct the data, we identified the stations that these changes occurred and split the data in three groups that were different according to the sensor (Figure 5). While the primary sensor slightly recovered to the end of the cruise, the secondary sensor continued to drift. We assumed the pressure dependent correction is linear with pressure. This has been applied by least squares fitting an equation of the form:

$$y = A * p + B$$

where y is the offset to be applied to the salinity, p is the pressure and A and B are constants to be fitted (Figs. 5 and 6). The constants derived are given in Table 1. Using the equations generated, the offsets were added to the script cond_apply_cal and run via smallscript_JR16005 for the respective range of stations identified for each equation.

The calibration considerably improved the differences between the bottle conductivity and CTD conductivity (Figure 8). The general spread and the standard deviations were reduced, and the new median of the difference between the data is now close to zero.

After the calibrations, we recommend to use the secondary sensors for temperature and conductivity. The exceptions are station 117 and tow-yo profiles 089_012 and 089_013, where conductivity or conductivity and temperature were bad. The oxygen sensor was coupled to the primary sensors, so the results are based on the measurements of the primary sensors during the whole cruise.

Sensor	**A**	**B**
Primary [Stn. 1-37]	-1.5807688e-08	0.99999868
Primary [Stn. 38-112]	-1.1787023e-08	0.99985408
Primary [Stn. 113-120]	-7.0372210e-09	0.99993059
Secondary [Stn. 1-37]	-9.7207000e-10	0.99996579
Secondary [Stn. 38-86]	-1.1461378e-08	0.99983899
Secondary [Stn. 90-120]	+0.2.44248e-09	0.99971216

Table 6: The constants derived from the least-squares fitting of the conductivity ratio. In brackets are the range of stations covered by each equation. Note that Figure 5 shows the station number as linearly increasing numbers, whereas here the real station number is shown.

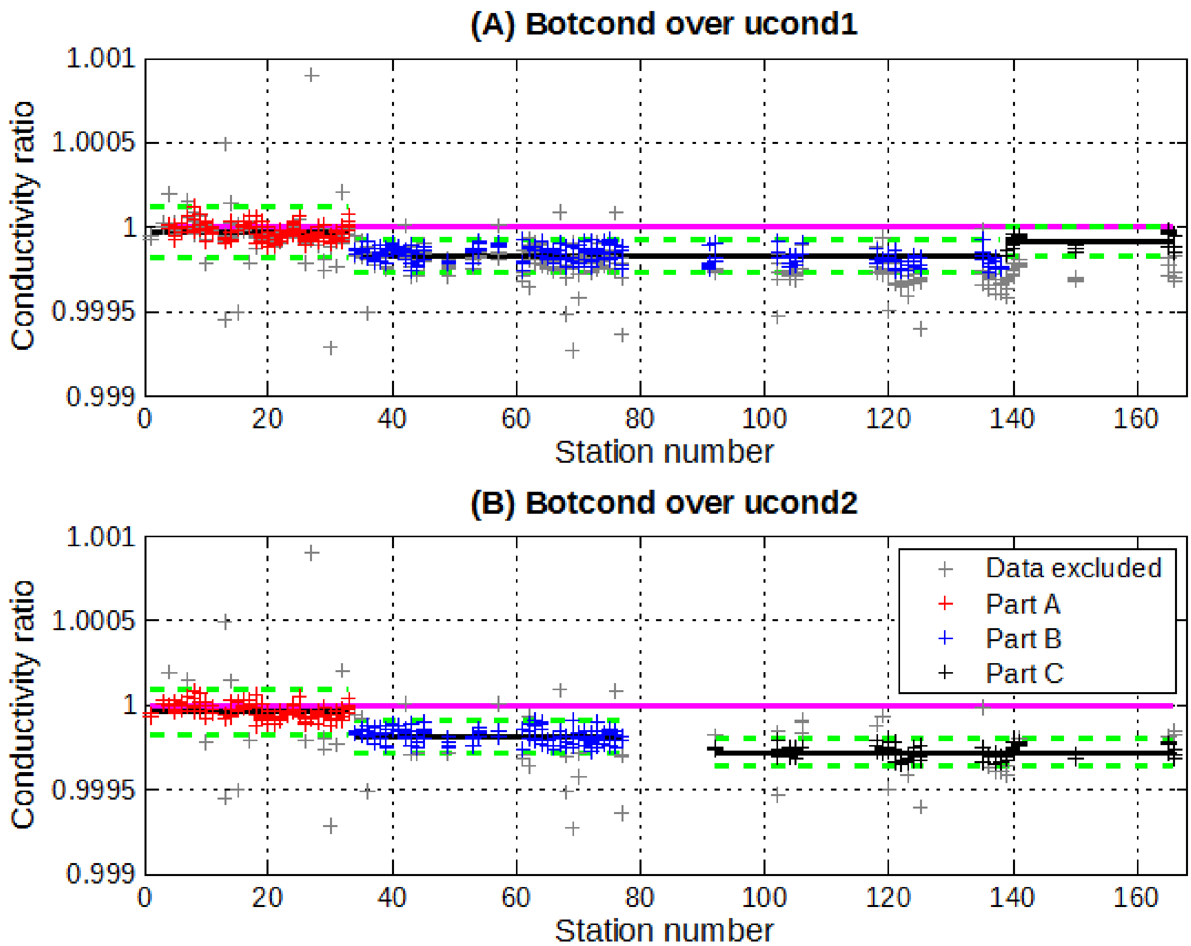

Figure 5: Ratio between the conductivity given from bottle samples and the CTD sensors along the stations. (A) Primary conductivity and (B) secondary conductivity. Because of the steps presented, the correction was done considering groups of stations. Red is the first group, blue second group and black third group. Magenta is the ratio equal to 1. Green dashed lines are the standard deviations from the median for each group. Black solid lines are the median of each group. Gray are the data outside the one stardard deviation of the median value for each group. Station number is presented as a linear increase, not the real station number.

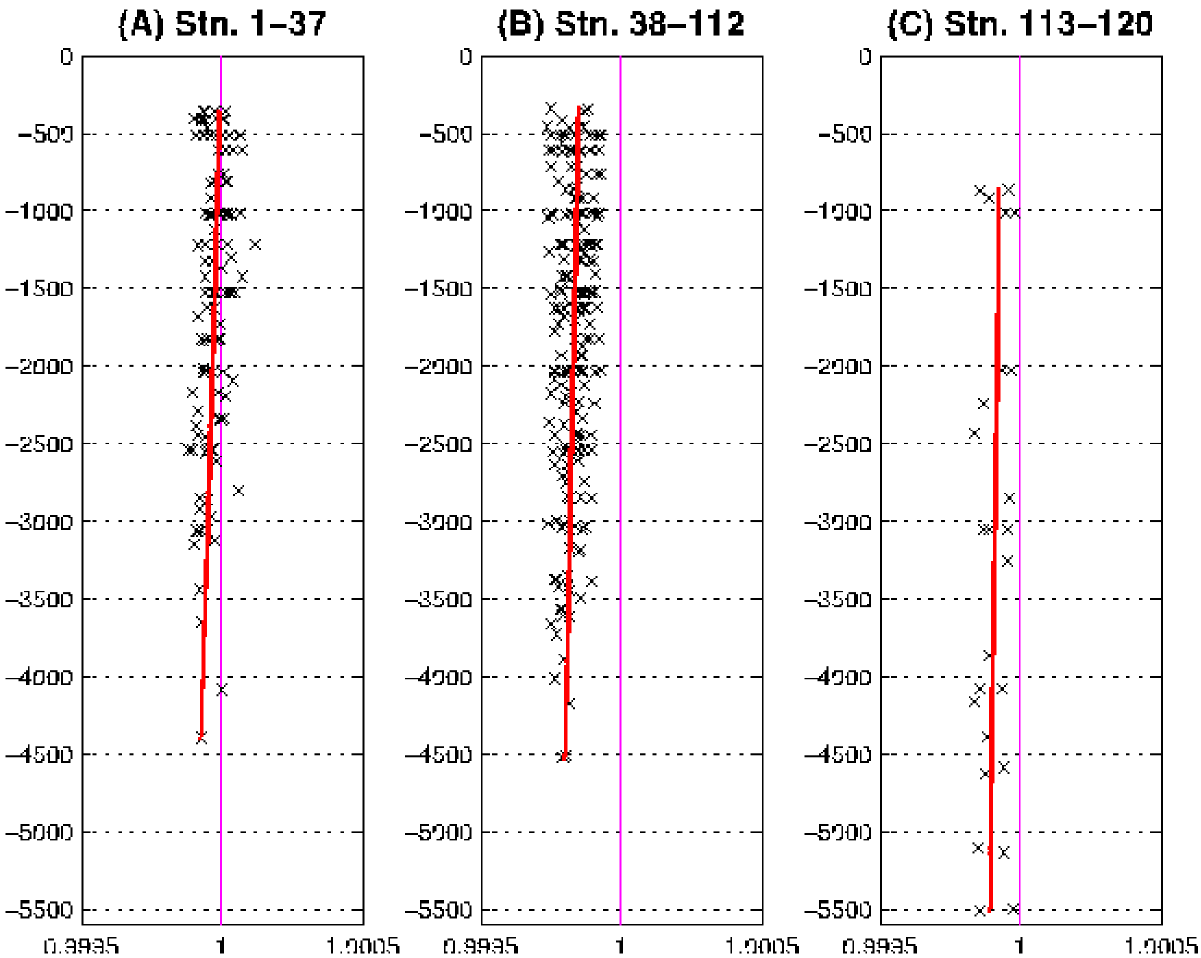

Figure 6: Vertical profile of the ratio between the conductivity given from bottle samples and the primary sensor. The least-squares fitting used for calibration is show in red. Magenta is the ratio equal to 1. The constants of the least-squares fitting are in the Table 6.

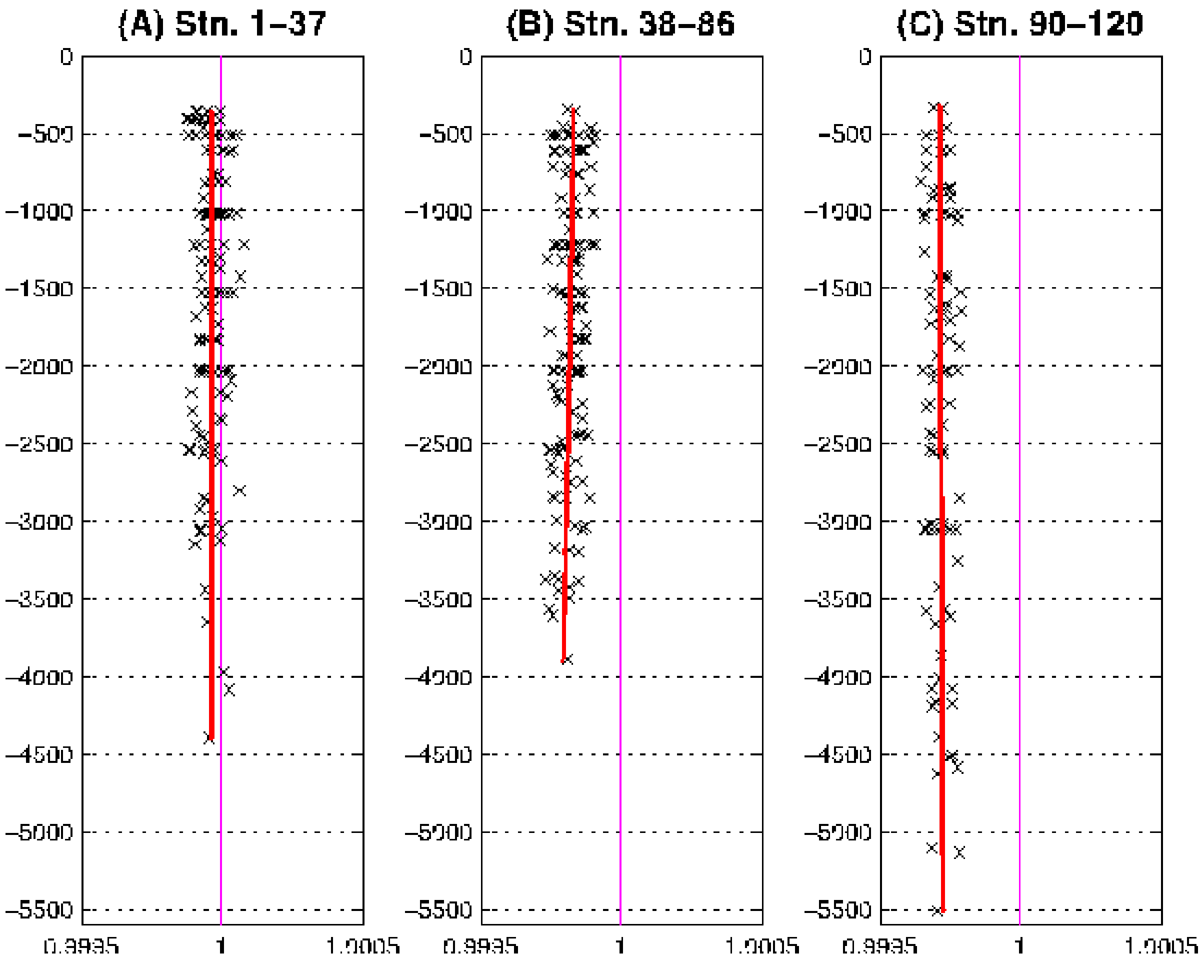

Figure 7: Vertical profile of the ratio between the conductivity given from bottle samples and the secondary sensor. The least-squares fitting used for calibration is show in red. Magenta is the ratio equal to 1. The constants of the least-squares fitting are in the Table 6.

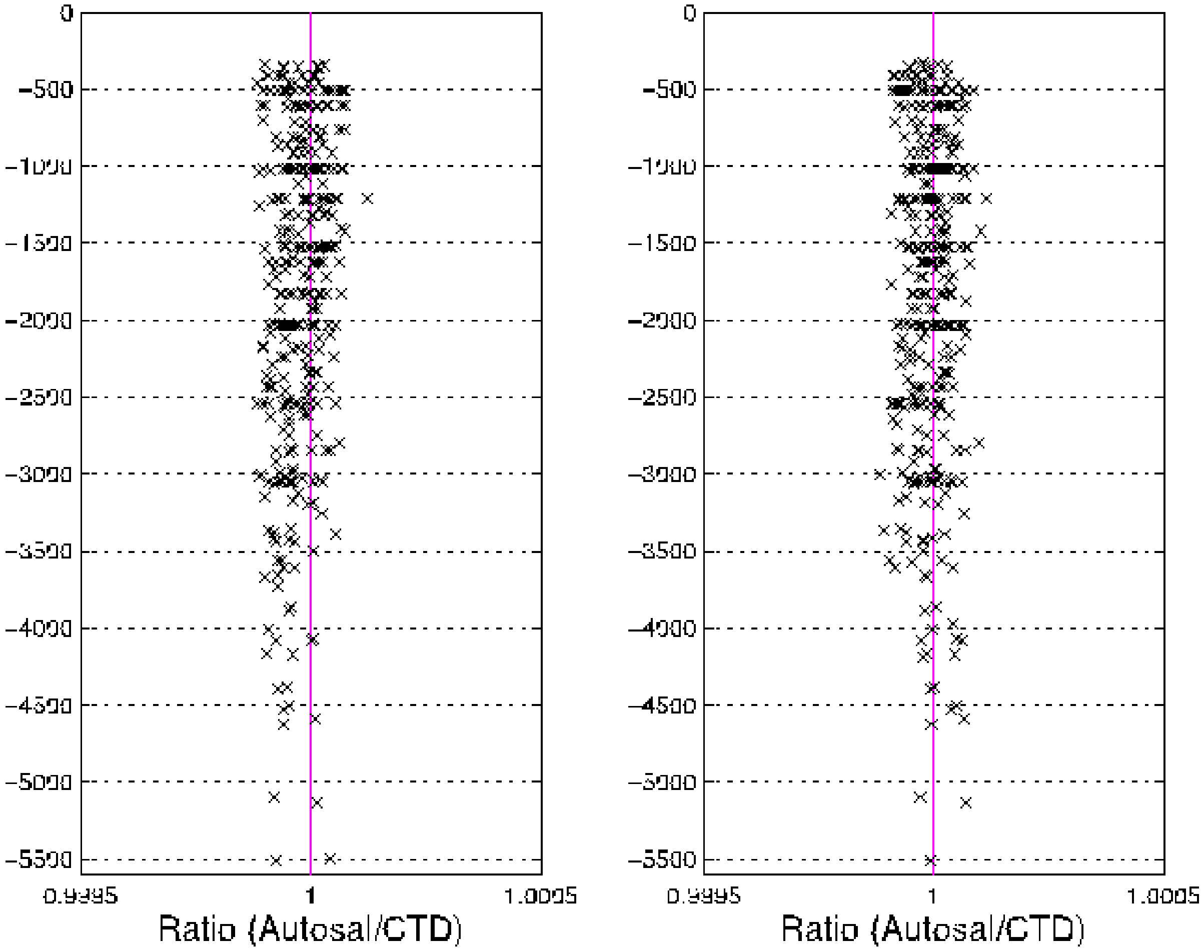

Figure 8: Vertical profile of the ratio between the conductivity given from bottle samples and the primary sensor post-calibration (A) and the secondary sensor post-calibration (B). First 300m depth were removed and data higher than one standard deviation was removed. Magenta is the ratio equal to 1.

3.3 Lowered Acoustic Doppler Current Profiler (LADCP) – *Jack Hooley*

Instrument and Configuration

For all CTD casts, two RDI 300kHz Workhorse LADCP units were fitted to the CTD frame one in a downward-looking orientation the other upward-looking. Each LADCP was configured to have 25 x 8 m bins, a 0 m blank-to-surface, one ping per ensemble, and two ensembles per burst in narrowband mode. Data were collected in beam coordinates.

Parameter	**D**escription
WM15	water mode 15 (LADCP)
TC2	ensembles per burst
LP1	pings per ensemble
TB 00:00:02.80	time per burst
TE 00:00:01.30	time per ensemble
TP 00:00.00	time between pings
LN25	number of depth cells
LS0800	bin size [cm]
LF0	blank after transmit [cm]
LW1	narrow bandwidth LADCP mode
LV400	ambiguity velocity [cm/s]
SB0	disable hardware-break detection on Channel B (ICN118)
EZ0011101	Sensor source: - manual speed of sound (EC) - manual depth of transducer (ED = 0 [dm]) - measured heading (EH) - measured pitch (EP) - measured roll (ER) - manual salinity (ES = 35 [psu]) - measured temperature (ET)
EX00100	Coordinate transformation: - radial beam coordinates (2 bits) - use pitch/roll (not used for beam coords?) - no 3-beam solutions - no bin mapping
CF11101	Flow control: - automatic ensemble cycling (next ens when ready) - automatic ping cycling (ping when ready) - binary data output - disable serial output - enable data recorder

Table 7: LADCP parameter settings.

LADCP Deployments

Stn	CTD	Date	Time (GMT)	Lat. (°S)	Lon. (°W)	Dpth (m)	RDI file	Comments
1	1	20/03/17	16:22	58 31.87	50 56.62	596	JR16005_M_001	Test station.
2	2	20/03/17	22:16:00	58 59.95	49 27.41	602	JR16005_M_002	Test station – USBL.
3	3	21/03/17	14:35:00	60 16.36	45 14.58	3898	JR16005_M_003	WHOI mooring sitete.
5	5	22/03/17	12:01:00	60 23.68	45 15.37	2137	JR16005_M_005	WHOI shallow station
6	6	23/03/17	22:53:00	63 32.16	41 45.21	4308	JR16005_M_006	M3 mooring
8	8	24/03/17	20:38:43	62 37.63	43 13.53	3050	JR16005_M_008	M2 mooring
9	9	25/03/17	09:40:33	61 31.72	41 22.85	1398	JR16005_M_009	Transect F Start
10	10	25/03/17	12:10:48	61 34.10	41 13.14	1833	JR16005_M_010	
11	11	25/03/17	14:58:49	61 35.90	41 06.17	2197	JR16005_M_011	
12	12	25/03/17	18:02:53	61 37.15	41 01.66	2611	JR16005_M_012	
13	13	26/03/17	09:09:29	61 38.10	40 58.12	3209	JR16005_M_013	
14	14	26/03/17	11:59:53	61 39.34	40 52.58	3637	JR16005_M_014	
15	15	26/03/17	15:37:53	61 42.04	40 42.75	3595	JR16005_M_015	
18	18	27/03/17	09:06:10	61 56.95	39 42.32	3393	JR16005_M_018	
19	19	27/03/17	15:17:04	62 01.98	39 21.92		JR16005_M_019	
20	20	27/03/17	22:20:52	62 04.17	39 13.62	2088	JR16005_M_020	Transect F End
21	21	29/03/17	09:13:15	61 30.19	38 53.87	2320	JR16005_M_021	Transect E Start
22	22	29/03/17	11:44:10	61 27.89	39 00.61	2765	JR16005_M_022	
23	23	29/03/17	14:43:45	61 24.45	39 09.99	3020	JR16005_M_023	
24	24	29/03/17	17:57:14	61 21.71	39 19.18	3108	JR16005_M_024	
25	25	30/03/17	09:06:26	61 18.31	39 22.51	3019	JR16005_M_025	
26	26	30/03/17	12:30:47	61 15.17	39 37.26	2908	JR16005_M_026	
27	27	30/03/17	15:37:30	61 46.65	39 46.65	2872	JR16005_M_027	
28	28	30/03/17	19:36:05	61 9.29	39 56.02	3085	JR16005_M_028	
29	29	30/03/17	22:53:10	61 06.15	40 05.19	2436	JR16005_M_029	

Continued on next page

Table 8 – *continued from previous page*

Stn	CTD	Date	Time (GMT)	Lat. (°S)	Lon. (°W)	Dpth (m)	RDI file	Comments
30	30	31/03/17	03:34:29	61 03.0	40 14.11	2246	JR16005_M_030	Transect E End
31	31	31/03/17	16:32:41	61 07.01	40 27.54	2328	JR16005_M_031	Transect C Start
32	32	31/03/17	08:53:27	61 08.15	40 35.04	2261	JR16005_M_032	
33	33	31/03/17	11:21:35	61 11.99	40 40.87	2573	JR16005_M_033	
34	34	31/03/17	13:43:14	61 13.13	40 48.17	2362	JR16005_M_034	
35	35	31/03/17	16:12:24	61 12.29	41 57.76	1997	JR16005_M_035	
36	36	31/03/17	18:34:21	61 12.43	41 10.93	1659	JR16005_M_036	
37	37	31/03/17	20:35:44	61 12.16	41 21.78	1273	JR16005_M_037	Transect C End
38	38	02/04/17	10:20:30	60 55.38	39 55.05	2247	JR16005_M_038	Transect D Start
39	39	02/04/17	13:53:07	61 50.46	39 49.95	2609	JR16005_M_039	
40	40	02/04/17	17:42:21	60 49.77	39 40.12	2722	JR16005_M_040	
41	41	02/04/17	22:42:39	60 47.73	39 33.08	2707	JR16005_M_041	
42	42	03/04/17	03:01:48	60 44.57	39 30.16	2676	JR16005_M_042	
47	47	05/04/17	04:29:45	60 41.03	39 27.98	2990	JR16005_M_047	
48	48	05/04/17	18:34:43	60 40.96	39 23.10	3005	JR16005_M_048	
49	49	05/04/17	21:26:27	60 40.27	39 18.46	2991	JR16005_M_049	
50	50	06/04/17	00:53:15	60 37.36	39 18.10	3405	JR16005_M_050	
51	51	06/04/17	04:44:14	60 35.12	39 18.08	3144	JR16005_M_051	
52	52	06/04/17	07:33:11	60 33.74	39 18.46	3318	JR16005_M_052	
53	53	06/04/17	10:39:37	60 31.95	39 19.33	2480	JR16005_M_053	Transect D End
54	54_001	06/04/17	16:07:00	60 48.19	40 06.39	5620	JR16005_M_054_001	Tow-Yo 1 Start
54	54_002	06/04/17	19:17:00	60 49.97	40 05.83	4569	JR16005_M_054_002	
54	54_003	06/04/17	21:36:00	60 51.37	40 05.21	4200	JR16005_M_054_003	
54	54_004	06/04/17	23:36:00	60 51.76	40 05.05	3870	JR16005_M_054_004	Tow-Yo 1 End
55	55_001	07/04/17	19:48:00	60 52.56	40 04.81	3450	JR16005_M_055_001	Tow-Yo 2 Start
55	55_002	07/04/17	21:41:00	60 53.51	40 04.51	2610	JR16005_M_055_002	

Continued on next page

Table 8 – *continued from previous page*

Stn	CTD	Date	Time (GMT)	Lat. (°S)	Lon. (°W)	Dpth (m)	RDI file	Comments
55	55_003	07/04/17	22:44:00	60 54.04	40 04.34	2160	JR16005_M_055_003	
55	55_004	07/04/17	23:30:00	60 54.47	40 04.20	2085	JR16005_M_055_004	Tow-Yo 2 End
56	56	08/04/17	01:15:00	60 55.36	40 03.92	2090	JR16005_M_056	
57	57_001	08/04/17	06:32:00	60 56.55	41 15.17	5400	JR16005_M_057_001	Tow-Yo 3 Start
57	57_002	08/04/17	09:20:00	60 57.23	41 15.33	5240	JR16005_M_057_002	
57	57_003	08/04/17	11:45:00	60 58.71	41 15.59	4670	JR16005_M_057_003	Tow-Yo 3 End
58	58_001	09/04/17	11:49:00	60 59.99	41 15.60	3839	JR16005_M_058_001	Tow-Yo 4 Start
58	58_002	09/04/17	13:58:00	61 00.99	41 15.60	3550	JR16005_M_058_002	
58	58_003	09/04/17	15:27:00	61 01.88	41 15.62	2860	JR16005_M_058_003	
58	58_004	09/04/17	16:43:00	61 02.65	41 15.65	2327	JR16005_M_058_004	Tow-Yo 4 End
59	59	10/04/17	09:22:00	60 39.93	42 15.37	1510	JR16005_M_059	Section B Start
60	60	10/04/17	11:52:00	60 39.65	42 13.09	1720	JR16005_M_060	
61	61	10/04/17	14:22:00	60 38.96	42 11.40	2525	JR16005_M_061	
62	62	10/04/17	17:44:00	60 38.55	41 10.15	3130	JR16005_M_062	
63	63	10/04/17	22:35:00	60 37.46	42 02.84	3500	JR16005_M_063	
64	64	11/04/17	02:55:00	60 37.08	42 00.56	3430	JR16005_M_064	
65	65	11/04/17	07:25:00	60 38.12	42 00.50	3385	JR16005_M_065	
78	78	16/04/17	02:19:00	60 37.90	42 06.91	3550	JR16005_M_078	
79	79	16/04/17	14:18:00	60 37.78	42 04.88	3400	JR16005_M_079	
80	80	16/04/17	18:28:00	60 36.92	41 58.52	3370	JR16005_M_080	
81	81	16/04/17	22:33:00	60 36.25	41 55.59	3310	JR16005_M_081	No slave file
82	82	17/04/17	02:06:00	60 35.79	41 52.57	3120	JR16005_M_082	
83	83	17/04/17	05:25:00	60 35.83	41 49.14	2930	JR16005_M_083	
84	84	17/04/17	18:49:00	60 34.87	41 45.80	2640	JR16005_M_084	
85	85	17/04/17	11:44:00	60 34.28	41 41.88	2440	JR16005_M_085	
86	86	18/04/17	06:14:00	60 32.81	41 31.29	2140	JR16005_M_086	Section B End

Continued on next page

Table 8 – *continued from previous page*

Stn	CTD	Date	Time (GMT)	Lat. (°S)	Lon. (°W)	Dpth (m)	RDI file	Comments
89	89_001	19/04/17	20:13:00	60 38.48	42 20.34	1980	JR16005_M_089_001	Tow-Yo 5 Start
89	89_002	19/04/17	21:18:00	60 38.40	42 20.04	2050	JR16005_M_089_002	
89	89_003	19/04/17	22:00:00	60 35.26	42 19.56	2110	JR16005_M_089_003	
89	89_004	19/04/17	22:42:00	60 38.12	42 19.07	2240	JR16005_M_089_004	
89	89_005	19/04/17	23:32:00	60 37.95	42 18.58	2440	JR16005_M_089_005	
89	89_006	20/04/17	00:29:00	60 37.75	42 17.82	2550	JR16005_M_089_006	
89	89_007	20/04/17	01:25:00	60 37.56	42 17.16	2660	JR16005_M_089_007	
89	89_008	20/04/17	02:29:00	60 37.33	42 16.42	2770	JR16005_M_089_008	
89	89_009	20/04/17	03:36:00	60 37.11	42 15.66	2650	JR16005_M_089_009	
89	89_010	20/04/17	04:39:00	60 36.89	42 14.93	2870	JR16005_M_089_010	
89	89_011	20/04/17	05:52:00	60 36.64	42 14.08	3120	JR16005_M_089_011	
89	89_012	20/04/17	07:12:00	60 36.69	42 13.16	3350	JR16005_M_089_012	
89	89_013	20/04/17	08:36:00	60 36.07	42 12.15	3660	JR16005_M_089_013	Tow-Yo 5 End
90	90	20/04/17	16:24:00	60 34.11	42 37.39	2200	JR16005_M_090	
91	91_001	21/04/17	01:53:00	60 39.83	42 04.42	3500	JR16005_M_091_001	Tow-Yo 6 Start
91	91_002	21/04/17	03:47:00	60 39.90	42 04.88	3330	JR16005_M_091_002	
91	91_003	21/04/17	05:12:00	60 40.04	42 05.15	3280	JR16005_M_091_003	
91	91_004	21/04/17	06:34:00	60 40.20	42 06.47	3200	JR16005_M_091_004	
91	91_005	21/04/17	07:55:00	60 40.34	42 07.24	2950	JR16005_M_091_005	
91	91_006	21/04/17	09:06:00	60 40.46	42 07.91	2810	JR16005_M_091_006	
91	91_007	21/04/17	10:11:00	60 40.57	42 08.54	2600	JR16005_M_091_007	
91	91_008	21/04/17	11:09:00	60 40.67	42 09.09	2400	JR16005_M_091_008	
91	91_009	21/04/17	12:03:00	60 40.77	42 09.60	2210	JR16005_M_091_009	
91	91_010	21/04/17	12:47:00	60 40.84	42 10.03	1970	JR16005_M_091_010	Tow-Yo 6 End
92	92	22/04/17	09:29:00	60 35.51	42 10.39	3960		Aborted Cast
93	93	22/04/17	12:18:00	60 35.14	42 09.57	3933	JR16005_M_093	

Continued on next page

Table 8 – *continued from previous page*

Stn	CTD	Date	Time (GMT)	Lat. (°S)	Lon. (°W)	Dpth (m)	RDI file	Comments
94	94	22/04/17	17:29:00	60 33.97	42 09.73	4110	JR16005_M_094	
95	95	22/04/17	01:29:00	60 34.23	42 32.05	2010	JR16005_M_095	No slave file
96	96_001	23/04/17	09:31:00	60 34.24	42 32.05	2090	JR16005_M_096_001	Tow-Yo 7 Start
96	96_002	23/04/17	10:37:00	60 34.02	42 31.40	2340	JR16005_M_096_002	
96	96_003	23/04/17	11:32:00	60 33.82	42 30.79	2650	JR16005_M_096_003	
96	96_004	23/04/17	12:34:00	60 33.58	42 30.11	2720	JR16005_M_096_004	
96	96_005	23/04/17	13:35:00	60 33.35	42 29.41	2820	JR16005_M_096_005	
96	96_006	23/04/17	14:41:00	60 33.10	42 29.68	2910	JR16005_M_096_006	
96	96_007	23/04/17	15:53:00	60 32.84	42 27.89	3100	JR16005_M_096_007	
96	96_008	23/04/17	17:08:00	60 32.55	42 27.04	3490	JR16005_M_096_008	
96	96_009	23/04/17	18:49:00	60 32.18	42 25.91	3870	JR16005_M_096_009	
96	96_010	23/04/17	20:40:00	60 31.77	42 24.68	4250	JR16005_M_096_010	
96	96_011	23/04/17	22:44:00	60 31.32	42 23.27	4180	JR16005_M_096_011	Tow-Yo 7 End
98	98	24/04/17	06:06:00	60 30.25	42 19.89	4410	JR16005_M_098	
99	99	24/04/17	11:45:00	60 29.61	42 17.37	4430	JR16005_M_099	
100	100	24/04/17	21:48:00	60 31.31	42 59.94	2000	JR16005_M_100	Section A Start
101	101	25/04/17	00:29:00	60 30.72	42 59.99	2340	JR16005_M_101	
102	102	25/04/17	04:39:00	60 32.15	42 59.95	1510	JR16005_M_102	
103	103	25/04/17	08:03:00	60 29.85	42 59.97	2970	JR16005_M_103	
104	104	25/04/17	11:16:00	60 29.06	42 59.93	3540	JR16005_M_104	
105	105	25/04/17	15:47:00	60 27.69	40 59.95	4090	JR16005_M_105	Section A End
107	107_001	26/04/17	03:15:00	60 26.39	43 00.03	4670	JR16005_M_107_001	Tow-Yo 8 Start
107	107_002	26/04/17	15:49:00	60 26.85	43 00.02	4320	JR16005_M_107_002	
107	107_003	26/04/17	07:51:00	60 27.64	43 00.03	4090	JR16005_M_107_003	
107	107_004	26/04/17	09:51:00	60 28.40	43 00.01	3710	JR16005_M_107_004	
107	107_005	26/04/17	11:29:00	60 29.05	42 59.99	3490	JR16005_M_107_005	

Continued on next page

Table 8 – *continued from previous page*

Stn	CTD	Date	Time (GMT)	Lat. (°S)	Lon. (°W)	Dpth (m)	RDI file	Comments
107	107_006	26/04/17	13:00:00	60 29.65	42 59.99	2990	JR16005_M_107_006	
107	107_007	26/04/17	14:12:00	60 30.12	42 59.99	2710	JR16005_M_107_007	
107	107_008	26/04/17	15:14:00	60 30.55	42 59.99	2430	JR16005_M_107_008	
107	107_009	26/04/17	16:09:00	60 30.91	42 59.99	2180	JR16005_M_107_009	Tow-Yo 8 End
109	109	27/04/17	07:37:00	60 23.50	42 15.30	2230	JR16005_M_109	Section K Start
110	110	27/04/17	10:19:00	60 21.73	45 15.08	2500	JR16005_M_110	
111	111	27/04/17	13:47:00	60 18.77	45 15.00	2960	JR16005_M_111	
112	112	27/04/17	17:41:00	60 17.60	45 14.89	3500	JR16005_M_112	
113	113	27/04/17	22:18:00	60 16.28	45 16.79	4080	JR16005_M_113	
114	114	28/04/17	04:07:00	60 14.15	45 14.85	4530	JR16005_M_114	
115	115	28/04/17	12:45:00	60 12.79	45 15.29	5024	JR16005_M_115	Section K End
116	116_001	28/04/17	18:45:00	60 18.79	45 14.99	2980	JR16005_M_116_001	Tow-Yo 9 Start
116	116_002	28/04/17	20:27:00	60 18.49	45 15.21	3141	JR16005_M_116_002	
116	116_003	28/04/17	21:43:00	60 18.04	45 15.56	3390	JR16005_M_116_003	
116	116_004	28/04/17	23:14:00	60 17.53	45 15.92	3700	JR16005_M_116_004	
116	116_005	29/04/17	00:52:00	60 16.76	45 16.49	3880	JR16005_M_116_005	
116	116_006	29/04/17	02:32:00	60 15.97	45 16.65	4230	JR16005_M_116_006	
116	116_007	29/04/17	04:30:00	60 15.05	45 16.27	4330	JR16005_M_116_007	
116	116_008	29/04/17	06:33:00	60 14.08	45 15.85	4720	JR16005_M_116_008	Tow-Yo 9 End
117	117	29/04/17	17:27:00	60 10.18	45 15.31	5380	JR16005_M_117	
118	118_001	30/04/17	00:12:00	60 16.19	45 38.39	2530	JR16005_M_118_001	Tow-Yo 10 Start
118	118_002	30/04/17	01:26:00	60 16.08	45 38.19	2570	JR16005_M_118_002	
118	118_003	30/04/17	02:12:00	60 15.85	45 37.79	2600	JR16005_M_118_003	
118	118_004	30/04/17	03:02:00	60 15.60	45 37.35	2680	JR16005_M_118_004	
118	118_005	30/04/17	03:56:00	60 15.33	45 36.87	2770	JR16005_M_118_005	
118	118_006	30/04/17	14:51:00	60 15.06	45 35.40	2970	JR16005_M_118_006	

Continued on next page

Table 8 – *continued from previous page*

Stn	CTD	Date	Time (GMT)	Lat. (°S)	Lon. (°W)	Dpth (m)	RDI file	Comments
118	118_007	30/04/17	05:52:00	60 18.77	45 35.89	3080	JR16005_M_118_007	
118	118_008	30/04/17	06:52:00	60 14.46	45 35.34	3270	JR16005_M_118_008	
118	118_009	30/04/17	08:02:00	60 14.27	45 34.77	3524	JR16005_M_118_009	
118	118_010	30/04/17	09:21:00	60 13.75	45 34.10	3980	JR16005_M_118_010	
118	118_011	30/04/17	10:52:00	60 13.28	45 33.29	4420	JR16005_M_118_011	
118	118_012	30/04/17	12:35:00	60 12.58	45 32.15	4620	JR16005_M_118_012	
118	118_013	30/04/17	14:28:00	60 11.87	45 30.82	4923	JR16005_M_118_013	Tow-Yo 10 End
119	119	30/04/17	22:46:00	60 06.91	45 15.34	5370	JR16005_M_119	Extra station on Section K
120	120	01/05/17	10:43:00	60 23.09	45 00.10	4990	JR16005_M_120	Extra Station on Section A

Table 8: JR16005 LADCP Deployments.

LADCP Data Processing

RDI format binary files, recorded by the instrument, were downloaded after each cast and stored with the corresponding pre-deployment test log files. All data were processed using the latest version of the Lamont-Doherty Earth Observatory (ldeoIX) software which calculates velocities using an inverse method. This package was also used to monitor the health of the beams on the instrument.

Navigation data, for use in the processing, were extracted from the SCS data stream for the ship's primary GPS positional system the Seatex Seapath 320+ (seatex-gga.ACO). Data from the ship mounted ADCP was averaged in into station mean profiles for all casts. CTD data was extracted from the raw SeaBird .hex files, corrected for cell thermal mass, filtered to remove noise, and averaged into one second bins.

Parameters changed from the ldeoIX default values were set in the set_cast_params.m script and are given below:

Parameter Setting	Description
p.cut = 20;	Ignore data above 20 db
p.edit_mask_dn_bins = [1]; p.edit_mask_up_bins = [1];	Disregard data from 1st bin as blank-to-surface is set to zero
fname = ['Pos-times/postime' stnstr];	
postime = load(fname); autocat = 1; intlat = postime(4); intlon = postime(6); p.drot = magdev(intlat,intlon);	Calculate magnetic deviation using matlab script magdev.m using lat. lon. from postime file constructed from CTD NMEA data.
p.nav_error = 30	Allowable error in navigation (30 m)
p.navtime_av = 2/60/24	Average navigation data into 2 minute bins
ps.shear = 1	Calculate a shear solution
ps.std_weight = 1	Use super ensemble to weight data
ps.sadcpfac = 1	Give equal weight to vmadcp
ps.shear_stdf = 2	Average shear over two standard deviations
ps.dz = 8	8 m vertical resolution for profiles
ps.outlier = 1	Remove 1% of outlier data after solution

Table 9: LADCP processing parameters.

LADCP Command Files

Master

```
CR1
RN JR15007M
WM15
TC2
LP1
TB 00:00:02.80
TE 00:00:01.30
TP 00:00.00
LN25
LS0800
LF0
LW1
LV400
SM1
```

```
SA011
SB0
SW5500
SI0
EZ0011101
EX00100
CF11101
CK
CS
$l
```

Slave

```
CR1
RN JR15007S
WM15
LP1
TP 00:00.00
TE 00:00:00.00
LN25
LS0800
LF0
WB1
LW1
LV400
SM2
SA011
SB0
EZ0011101
EX00100
CF11101
CK
CS
$l
```

4 Microstructure

4.1 NMF Vertical Microstructure Profiler (VMP) Operations – *Jeff Benson, Dougal Mountifield, Billy Platt, & Jez Evans*

Equipment used

- VMP 6000 S/N 016
- VMP 6000 S/N 107

Deployments and recoveries

Both VMP 6000's were deployed and recovered the same way. Deployments were made using the hydraulic LARS which launches the VMP from the VMP trolley. A quick release pin was inserted through a bight in the rope around the bale. Recovery was made using the same system in reverse. The LARS upright in the launch/recover position with the line paid out going over the sheave of the trolley, around the stern of the JCR and as far up the starboard deck as it would reach. The line was then attached to a hook with on an extendable pole. Once the VMP was 'hooked' the pole would detach from the hook and the VMP would be floated around the stern to the LARS and winched up and into the trolley.

Initial setup

Both VMP fish were fitted with the following recovery aids:

- Sonardyne WMT 6G USBL beacon
- Novatech Zenon strobe flasher with pressure sensor switch
- Novatech RF beacon
- Novatech Iridium beacon
- Bright orange homemade flag

Both VMP S/N 016 and S/N 107 were assembled in the same fashion and with the same recovery aids. Each pressure housing was opened up to connect the release battery as it is stored disconnected. S/N 107, recently returned from Rockland to resolve 'bad buffer' issues, was found to have its release battery still connected with the battery measuring only 2volts and thus being dead. A new release battery was installed. The release 'Faith' was fitted to S/N 016 and release 'Hope' fitted to S/N 107. Both release units were tested by simulating a short cast of three minutes. This allowed a quick bench test of sensors installed, the LED and finally the release unit. Both VMP's and releases passed this test although it should be noted that neither of them carried out their release sequence in the exact manner described in the manual. They should fire the solenoid in the release for 2seconds, pause for 6seconds and repeat 16 times. Both releases/VMP units fired for an extended period on the first repetition (anywhere from 30-60 seconds) and then fired for 2seconds and paused for 6seconds 13-15 times across multiple tests on both units. It was agreed that the releases were working sufficiently well so as to enable weight releasing during a dive. A1 galvanic timed releases (GTR) were used for all deployments. Pre-burning was carried out for the first dozen or so casts by soaking 4-6 GTR's in a pot of seawater in the fridge at 6°C so as to reduce the overall lifetime of the links to approximately 18 hours instead of 24. It was found that the links were not lasting for a further 18 hours, sometimes much less. Due to this, and as there had been no issues with releases not firing, the procedure of pre-burning was discontinued. No issues arose from this decision.

Initially both VMP's were float tested to ensure they were sufficiently buoyant. Then an approximately 150m tethered cast was carried out to ensure the weight release worked correctly and that the units were able to float to the surface. Both tests on both VMP's were successful and they were then each deployed to 500metres. This also provided an opportunity to test the LARS (Launch And Recovery System), the two VMP trollies (one was brand new) and the recovery method for both ship crew and the technical team.

Both 500m test casts proved successful and the data from the shear sensors and the thermistors looked good. There was doubt about the quality of the micro C data for both fish even though they both had brand new micro C sensors fitted so these were swapped for previously used good sensors.

The initial fall rate of the two VMP's was 0.7 m/s for S/N 107 and 0.8-0.9 m/s for S/N 016 using three 7kg weights (65mm diameter X 280mm steel). This was slightly faster than the ideal fall rate of 0.6 m/s so some weights were cut in half to allow approximately 17.5kgs of weight (2.5 weights) to be fitted. This reduced the fall rate to approximately 0.66 m/s. After one failed launch with the new weight configuration where the weights slipped out of the brackets a small modification was made to one of the weight brackets to so that it sat slightly higher than the other two. This one was then used to hold the half weight as it ensured that the weight retaining strap would correctly hold the weight around its centre and ensure that it didn't lose tension and thus fall out of position too early. This weight configuration was used successfully for the rest of the cruise.

General proceedings and notable events

S/N 107 encountered bad buffers and noise contamination that meant it wasn't able to be used for collecting good scientific data. Multiple test casts were done with it to try to rectify this. It is believed that the very last test has identified at least one source of noise contamination but there was no time to conduct a second test with everything connected. See below for more details.

S/N 016 was generally working well and was used for most deployments due to the issues encountered with S/N 107.

A USBL beacon (6G) was used to track the VMP whilst it was under water which allowed the bridge to maintain a record of where it was drifting and enabled scientists/technicians to confirm that the VMP had started its ascent after releasing its weights. It was also used to identify bottom contacts as the USBL beacon would have a prolonged period at its maximum depth. This was useful as a quick bench test could be done before the next deployment to confirm the status of the probes that had contacted the seabed. The USBL notes in the appendix show the setup of the USBL beacon and the ships transducer for use on the JCR. Note this will be different to use on NMF ships as the head on the JCR is an older version.

Both VMP's experienced some bad buffers on multiple casts although this was deemed, by the scientists, not to be so bad as to make the data unusable and a MatLab process called 'patch_odas' was used to correct this. On multiple occasions the processing showed evidence of bad/noisy shear/temperature probes. This was sometimes due to seabed strikes which happened several times throughout the cruise. Whenever a suspected bad probe was identified it was swapped for a replacement probe. The sensor list in the appendix reflects this. There was continued uncertainty over the quality of the micro conductivity data. Swapping probes or micro C boards failed to rectified this throughout the cruise.

Station S005 VMP S/N 107 - noise contamination on both shear channels, micro C was duff, Temperature 2 appeared to be dead and bad buffers encountered. After consultation with Rockland the ASTP board was replaced. This did not fix the issue.

Station S008 VMP S/N 107 – A 1kHz noise was seen which rendered the microstructure data unusable. This had been seen on the previous cruise (JR15-006 Ridgemix) and quickly identified as being caused by the LED. Subsequent test casts with this VMP were done with the LED blank installed instead of the LED probe. This removes the 1kHz signal.

Station S018 VMP S/N 016 failed to ascend as it had hit the seabed. Several hours were spent watching it on the USBL to see if it would dislodge itself. It is assumed that it had sunk sufficiently into the seabed so as to cause the weights to be pinned against the weight brackets as even long after the galvanic link would have corroded it failed to surface. It spent a total of 5 days stuck on the seabed before dragging operations commenced to recover it. During this period the ship moved onto other locations where CTD's and test casts of VMP S/N 107 took place whilst a constant vigil was kept on the iridium system for evidence of S/N 016 surfacing.

The safety margin left to ensure that the VMP doesn't hit the bottom has been ~50m. It has been suggested that this is increased to 75-80m if there is less certainty in the terrain or if the terrain is changing, on the side of a slope for example. There is a variance in the safety margin being left depending on which scientist is on watch and choosing the maximum pressure to be input to the setup.cfg file.

Station S047 VMP S/N 016 – Hit the seabed without getting stuck. A visual inspection suggests that both thermistors have been broken, at least one shear probe is broken and the micro C sensor is broken. All probes replaced.

Station S070 VMP S/N 016 – Hit the seabed without getting stuck breaking shear one. Only S1 was changed.

Station S073 VMP S/N 016 – SBE conductivity sensor blocked/frozen until 1000m. Suggest not rinsing in Milli-Q whilst outside temperatures are so cold, ~-6C.

15/04/17 test VMP S/N 107 – Test with micro C board disconnected. Surfaced after 10-15 mins after deployment. After looking at the pressure record and the logfile it is believed that the pressure port had frozen over shortly after deployment thus triggering a 'fall rate release'. The instrument had been sat outside in temperatures below 0°C for several days prior to deployment.

Station S090 VMP S/N 016 – Repeating, aperiodic noise seen on the micro C and both shear channels.

Station S094 VMP S/N 016 – Hit seabed breaking T1.

Station S102 VMP S/N 016 – Whilst there is no evidence it has hit the seabed since S094 T2, S1 and S2 are all broken. The ends were missing from the two shear probes and the connector has come out of the back of one of them. It appears to have received an impact but this can't be supported in the logfile (shear/accelerometer plots).

Station S119 VMP S/N 016 – Surfaced 10-15 mins after deployment. After looking at the pressure record and the logfile it is believed that the pressure port had frozen over shortly after deployment thus triggering a 'fall rate release' at approximately 180m. In the 10-12 hours prior to deployment the instrument had been sat outside in temperatures of -11°C and was only brought into the container for 1hour before deployment due to testing of S/N 107. This had a heatsink effect which caused seawater to freeze around it upon deployment.

Problems with S/N 107

Prior to this cruise VMP S/N 107 experienced issues with bad buffers. After a long email conversation with Rockland during the cruise the issues were still unresolved. As a result S/N 107 was returned to Rockland for analysis and repair. Whilst there it had a new micro C board fitted, a new micro magnetometer board fitted and a new CF2 persistor board fitted. This was reported, by Rockland, to have fixed the issues causing the bad buffers.

The data from the test station, 500m cast, showed bad buffers, temperature 1 was dead and the mirco C data didn't look good. The mirco C probe was a brand new probe, both shear and temperature probes were the ones last used in S/N 107 during the previous cruise, as, after consultation with the science team, they were believed to be good then it was reasoned they should still be good now.

The next cast, S005, showed bad buffers, both shear contaminated with 'noise', micro C data was no good and temperature 2 was dead. The only data that looked acceptable was from temperature 1. The micro C probe used for this cast was the last one used in this instrument on the previous cruise but still the data was no good. After communication with Rockland the recommendation was that the ASTP board (Acceleration, Shear, Temperature and Pressure) had a fault on it that was causing all the contamination and should be replaced with another board. The ASTP board was changed for a new, unused one.

The next cast for this instrument, S008, had multiple bad buffers again, and the micro data was unusable due to a 1kHz noise contamination, Figure 9. This noise was seen on all of the channels.

It was quickly identified as coming from the LED as this has a flash rate of once every second and this problem was encountered on the previous cruise also. Replacing the LED with either the LED blank or a shear blank removed the 1kHz noise. Note that T and C blanks can't be used for this purpose due to the resistors inside them.

Even with the 1kHz noise removed the data still looked contaminated on all channels, including the x axis of the accelerometer except for temperature 1 which looked fine throughout. The noise had a particular aperiodic repeating pattern, see Figure 10. It was noticed that the noise signal was not reproducible during a dry bench test in the VMP container but noise could be seen if seawater was poured over the LED or micro C probe. For this reason it believed to be water. Several inspections of the SMC cables, nose cone and inside the pressure housing showed no sign of any water leakage.

Data plots were sent to Rockland in the hope that they may be able to help resolve this issue. RSI suggested part 1 and part 2 of things to do. Part 1 was a list of things to check for mechanical noise including ensuring there were no loose parts of the fish, o-rings were correctly in connectors, cables looked ok, recovery aids were not loose, etc. These had already been checked but were re-checked and nothing out of the ordinary was found. Part 2 included installing dummy plugs, isolating Sea-Bird sensors, testing the micro conductivity probe and sending detailed schematics of the boards after requests for these and test procedures from NMF staff. Time was not found during the cruise to do a full and systematic analysis of the boards to try and identify the source of contamination.

Multiple tests were done to try and rectify the problem. The list below is the various 500m test casts that were carried out.

- All probes as usual
- LED probe blanked using shear blank after using the LED as confirmation that recording had started.
- LED probe blanked.
- ASTP board switched.
- Micro C probe blanked.
- All probes blanked
- All probes blanked, micro C SMC cable disconnected at micro C board
- Micro C board removed from instrument, matrix in setup.CFG changed.
- Sea-Bird sensors isolated.

The following plots show the noise signal plotted in the shear probes after various tests were carried out. It appears to show that whilst some noise contamination is removed the underlining source of the contamination has not yet been found.

After the test with the Sea-Bird sensors isolated the data looked better. Another test was carried out with a new Sea-Bird cable and the Sea-Bird instruments reconnected to the instrument. The data again looked good and the noise contamination appeared to have disappeared.

There wasn't sufficient time left during the cruise to carry out another test with all the boards and sensors fully installed and connected.

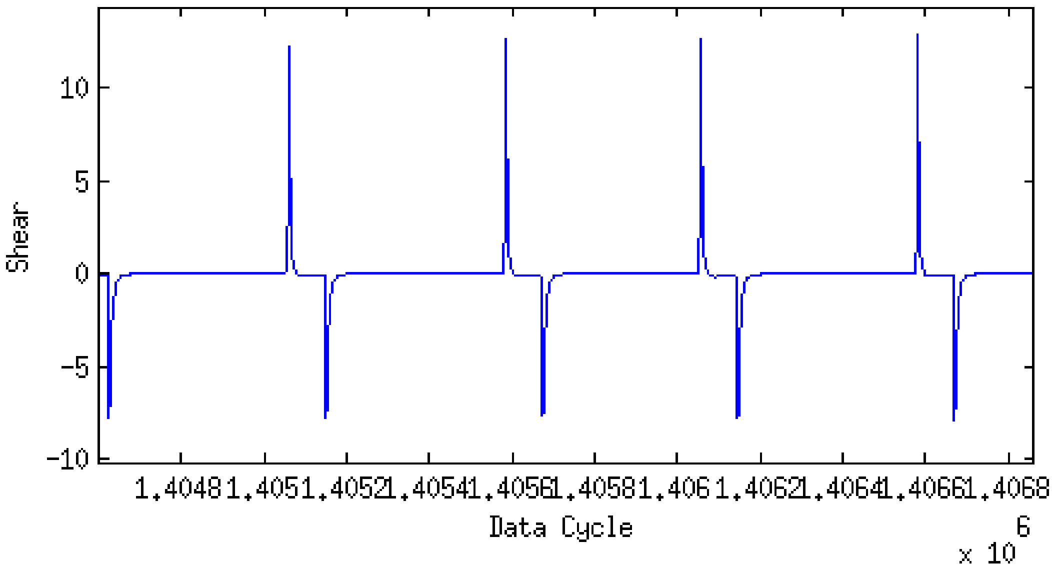

Figure 9: Setup in standard configuration for a dive. LED 1kHz noise.

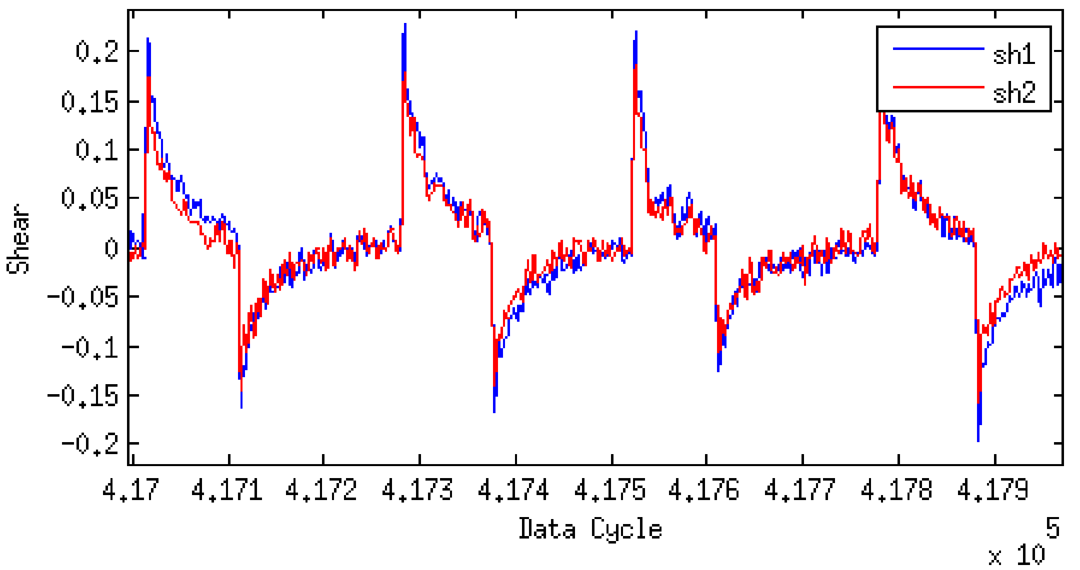

Figure 10: LED removed, noise contamination signal.

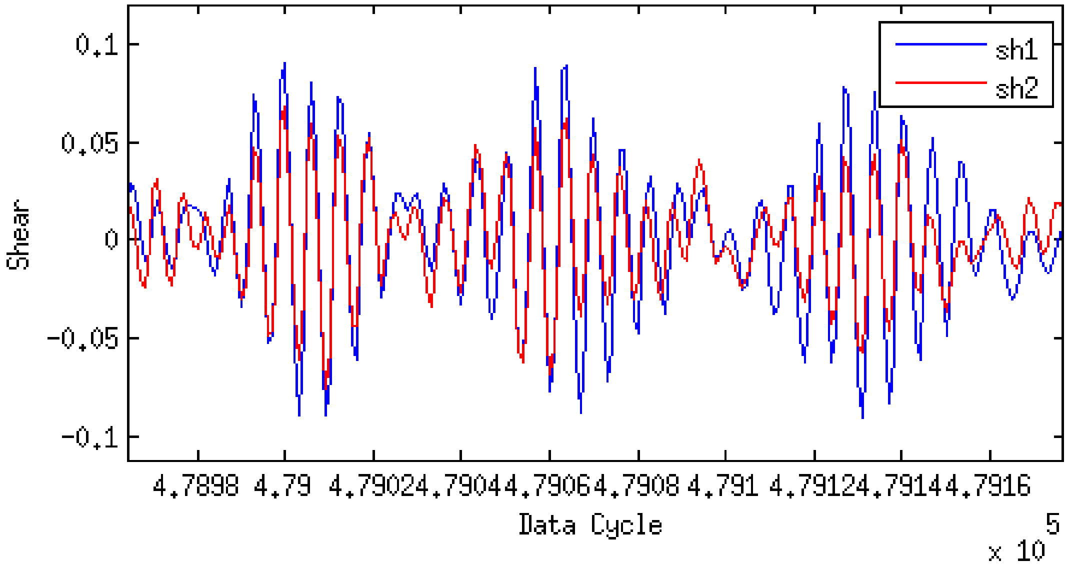

Figure 11: The noise signal after a new ASTP board had been installed with new T and S probes and the micro C and LED had their blanks in place.

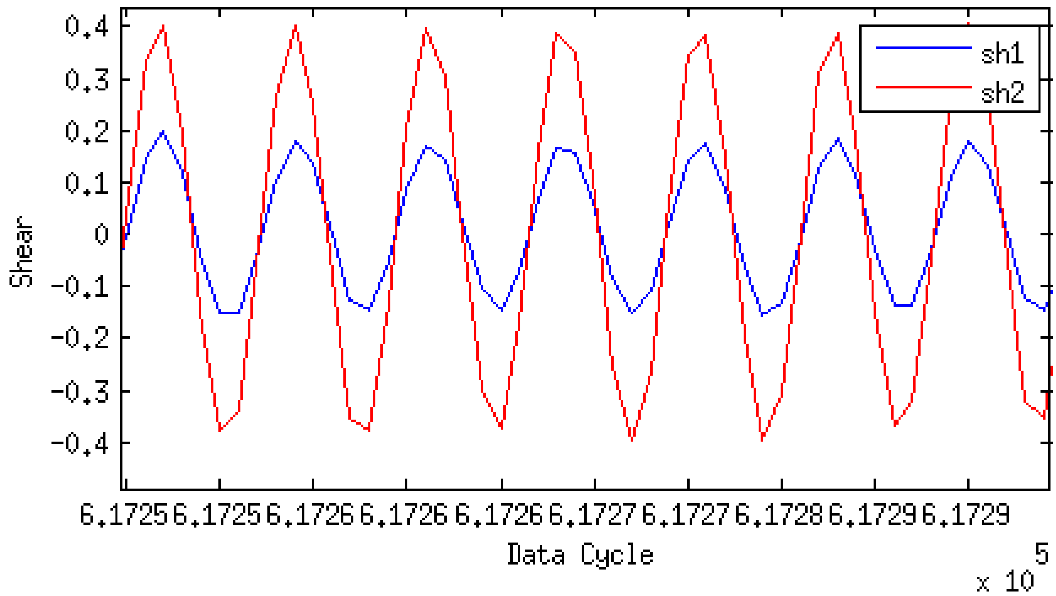

Figure 12: The noise after the micro C board has been removed.

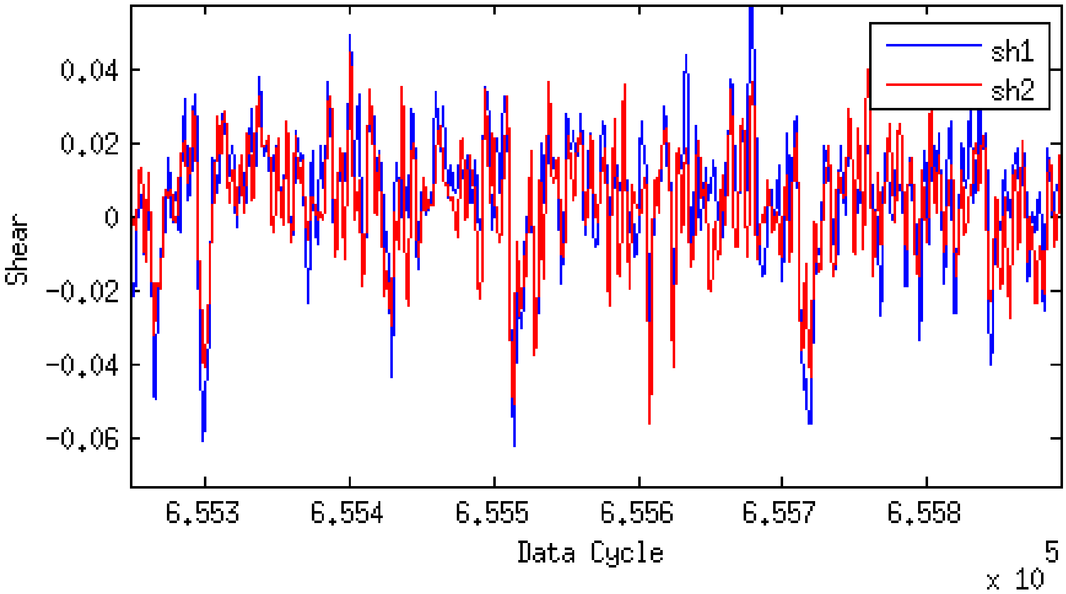

Figure 13: Noise when the Sea-Bird sensors are fitted but electrically disconnected.

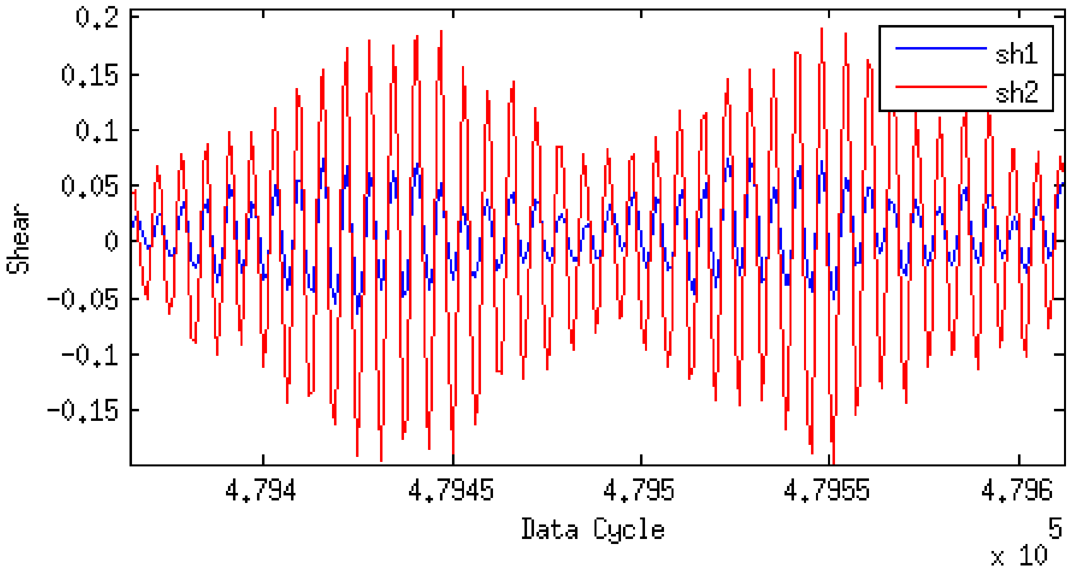

Figure 14: Noise when a new Sea-Bird cable has been connected.

General notes

1. Care should be taken with the cable layout of the iridium beacon as twice during recoveries the cable loop between the head and the battery pack was hooked by mistake. One of these caused possible damage to the bulkhead connector which led to the head being swapped for the spare.

2. In the icy conditions that were experienced most days of the cruise the ramps used to get the VMP and trolley in and out of the container slipped many times. Whilst this never caused a serious issue it easily could if the ramps slipped with the trolley on them. It is suggested that a method of securing the ramps in place be found to mitigate this risk. It should be easy to quickly secure and remove the ramps to allow closing of the container door in high seas/exceptionally cold weather.

3. A new material needs to found for the flag pole to reduce the amount of breakages that occurred due to the VMP going under the JCR fantail. A springier pole would be better.

JR16-005 DynOPO VMP 6000 probe record

Summary of Probes Used

Micro conductivity 8 plus 2 on ALR-1

Micro shear 19 plus 2 on ALR-1

Micro temperature 14 plus 4 on ALR-1

Date	**S**1	**S**2	**T**1	**T**2	**u**C	**S**BE 3	**S**BE 4	**C**omments
15/03/17	M390	M395	T617	T383	C201	5916	3490	
20/03/17				T382				T2 broken
21/03/17	M395	M390			C098			uC saturating S2 noisy
23/03/17	M396							S1 noisy
06/04/17								S1 &T2 broken
10/04/17	M399	M400	T859	T860	C162			
11/04/17	M401							S1 noisy, S2 broken
13/04/17		M1043						
15/04/17			T861					S1, S2, & T1 Broken
15/04/17			T861					
15/04/17	M1086	M1087	T862					
22/04/17			T765					
25/04/17	M543	M544		T863				

Table 10: Probe Serial numbers for VMP S/N 016

Date	**S**1	**S**2	**T**1	**T**2	**u**C	**S**BE 3	**S**BE 4	**C**omments
15/03/17	M713	M722	T1165	T1166	C100	4634	4245	
20/03/17			T765		C097			
29/03/17				Blank				
02/04/17	M1039	M1042	T1183	T1355	Blank			
03/04/17					C203			
08/04/17								uC isolated at PCB
09/04/17								uC PCB removed, C fitted
10/04/17				T1166				

Table 11: Probe Serial numbers for VMP S/N 107

JR16-005 DynOPO VMP 6000 Installed board serial numbers

Board	**P**art Number	**S**erial Number	**C**alibration date
Persistor		13505	N/A
CF2 interface	P040R01	072	N/A
LP-PS	P050R02	110	N/A
Release	P031R02	017	N/A
Pressure Sensor		87770	05/01/16
ASTP	P049R02	090	13/11/15
uC	P059R01	037 then 058	02/04/15 then 19/09/16
Magnetometor	P032R01	032	05/01/16

Table 12: Board Serial numbers for VMP S/N 016

Board	Part Number	Serial Number	Calibration date
Persistor		13236	N/A
CF2 interface	P040R01	128	N/A
LP-PS	P050R02	068	N/A
Release	P031R02	019	N/A
Pressure Sensor		143451	04/01/16
ASTP	P049R02	076 then 111	16/11/16 then 16/03/15
uC	P059R01	042	10/12/15
Magnetometor	P032R01	002	25/10/15

Table 13: Board Serial numbers for VMP S/N 107

JR16-005 DynOPO Microstructure Profiler Locator Beacons

Type	Model	Serial Number	Channel	Comments
Acoustic	Sonardyne 6G Type 8190 WMT USBL Transponder	305950-002	Unit ID: 004E5E Address: 2704 [5401]	Submerged only Config: 7212
Visual	Novatech ST-400A Strobe	C01-021	Double burst flash - white	Surface only in darkness
Radio DF	Novatech RF-700A1 RDF	X04-061	156.625 MHz CH.72	18" whip antenna 2 sec on, 4 sec off
GPS Iridium	Novatech iBCN MMI-7500RH	M00PTL	IMEI 300434060131010	GPS fix and Iridium update every 10 minutes

Table 14: Locator beacons for VMP S/N 016

Type	Model	Serial Number	Channel	Comments
Acoustic	Sonardyne 6G Type 8190 WMT USBL Transponder	306855-001	Unit ID: 004E64 Address: 2707 [5901]	Submerged only Config: 7212
Visual	Novatech ST-400A Strobe	C01-019	Double burst flash - white	Surface only in darkness
Radio DF	Novatech RF-700A1 RDF	V03-040	160.725 MHz CH.C	15" whip antenna 2 sec on, 4 sec off
GPS Iridium	Novatech iBCN MMI-7500RH	M00PQX	IMEI 300434060134020	GPS fix and Iridium update every 10 minutes

Table 15: Locator beacons for VMP S/N 107

Type	Model	Serial Number	Channel	Comments
Visual	Novatech ST-400A Strobe	U03-042	Double burst flash – white	Surface only in darkness
Visual	Novatech ST-400A Strobe	W06-137	Double burst flash – white	Surface only in darkness
Visual	Novatech ST-400A Strobe	W10-030	Double burst flash – white	Surface only in darkness
GPS Iridium Beacon	Novatech iBCN MMI-7500RH	M00PWL	IMEI 300434060132020	GPS fix and Iridium update every 10 minutes
GPS Iridium Beacon	Novatech IR-7300	J06863	IMEI 300234062982050	GPS fix and Iridium update every 1hr
GPS Iridium Beacon	Novatech IR-7300	J06908	IMEI 300234062988050	GPS fix and Iridium update every 1hr
Argos Beacon	Novatech AS-900A	X04-060	Argos ID: 95449 Argos Alerts: 95449?	1 hr between fixes
Argos Beacon	Novatech AS-900A	V01-052	Argos ID: 95925 Argos Alerts: 74853?	1 hr between fixes

Table 16: Spare Locator beacons.

4.2 Vertical Microstructure Profiler (VMP) Processing – *Carl P. Spingys*

Two untethered microstructure profilers were used during JR16005 manufactured by Rocklands Scientific International (VMP 6000's SN016 and SN107). These types of instruments measured profiles of temperature and velocity microstructure (i.e. on the length scales of dissipation of turbulent flows, typically a few millimetres to tens of centimetres), from which the rates of dissipation of turbulent kinetic energy (ε) and temperature variance (χ) are estimated using methodology based on Oakey (1982); and finescale temperature, salinity and pressure with a Seabird CTD mounted on each instrument. The aim of the DYNOPO VMP operations was to observe the mixing occurring within Orkney Passage with a particular focus on the dense deep water transported from the Weddell Sea to the Scotia Sea, which is a significant source of AABW. To achieve this a series of sections were performed across the passage supported by a series of short sections focussed on the western slope of the passage, where much of the transport is strongest, particularly around the main sill.

VMP 6000 stations

On JR16005 a total of 72 VMP profiles were collected (69 using SN016 and 3 using SN107). VMP SN107 was not used after station S008 due to technical difficulties with the instrument that was not resolved during the cruise. A number of intended stations were missed due to bad weather, the charging requirements of the VMP, and the VMP becoming stuck at the bottom on station S018.

Stn.	**Lat (°S)**	**Lon (°W)**	**Date/Time (GMT)**	**Max Press. (dbar)**	**File name**	**VMP No.**	**Comments**
Test	58 31.52	50 57.56	20/03/17 00:00	564	TEST_01	SN107	Bad buffers, T1 dead MicroC ? Fall rate 0.7 dbar
	58 31.52	50 57.56	20/03/17 00:00	566	TEST_01	SN016	T2 dead fall rate 0.8 – 0.9 dbar
S003	60 16.372	45 14.738	21/03/17 13:48	3970	S003_001	SN016	Swapping she1 / she2 for next dip changing microC
S004	60 12.609	45 15.258	22/03/17 05:02	5074	S004_001	SN016	she1 noisy – replace for next cast, microC duff (replace before next cast) 4 bad buffers – sigh
S005	60 23.790	45 15.470	22/03/17 11:25	2041	S005_001	SN107	Fall rate 0.7 – 0.75 where to begin – both shear contaminated, microC duff T2 dead (to be replaced). Bad buffers. ASTP board to be replaced

Continued on next page

Table 17 – *continued from previous page*

Stn.	Lat (°S)	Lon (°W)	Date/Time (GMT)	Max Press. (dbar)	File name	VMP No.	Comments
S007	63 33.023	41 26.129	24/03/17 01:46	4555	S003_003	SN016	no bad buffers – no probes to change (though eps1 lower than eps2 so needs watching).
S008	63 37.711	43 13.366	24/03/17 20:01	3119	S008_001	SN107	microdata unusable – 1Hz contamination. Multiple bad buffers
S010	61 34.06	41 13.00	25/03/17 11:50	1690	S010_01	SN016	1 bad buffer
S011	61 35.833	41 05.847	25/03/17 14:39	2185	S011_001	SN016	7 bad buffers
S012	61 37.1	41 01.4	25/03/17 17:30	2626	S012_001	SN016	2 bad buffers. MicroC questionable.
S013	61 38.051	40 57.899	25/03/17 21:12	3144	S013_001	SN016	3 bad buffers. No contemporary CTD cast.
S014	61 39.345	40 52.550	26/03/17 00:50	3654	S014_001	SN016	9 bad buffers. MicroC questionable. No contemprary CTD cast.
S015	61 42.14	40 42.95	26/03/17 14:58	3627	S015_001	SN016	3 bad buffers.
S016	61 46.892	40 22.387	26/03/17 19:48	3488	S016_001	SN016	8 bad buffers.
S017	61 51.865	40 2.172	27/03/17 00:38	3472	S017_001	SN016	6 bad buffers. MicroC as before – may not be responding correctly. Tracks seabird C to some extent doesn't appear as sensitive.
S018	61 56.99	39 42.227	27/03/17 05:45	3441	S018_001	SN016	5 bad bufferson downcast. Parked on seabed for a week.
S038	60 55.379	39 55.163	02/04/17 09:22		S038_001	SN016	No bad buffers. Sensors as for S018 – no problems.
S039	61 50.436	39 49.850	02/04/17 13:30		S039_001	SN016	No bad buffers. Sensors as for S018 – no problems.
S040	60 49.774	39 39.860	02/04/17 16:56		S040_001	SN016	No bad buffers.
S041	60 47.702	39 32.877	02/04/17 22:09	2678	S041_001	SN016	
S042	60 44.564	39 39.099	03/04/17 02:29	2672	S042_001	SN016	
S043	60 38.38	39 16.175	04/04/17 03:40	3310	S043_001	SN016	No bad buffers

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Table 17 – *continued from previous page*

Stn.	Lat (°S)	Lon (°W)	Date/Time (GMT)	Max Press. (dbar)	File name	VMP No.	Comments
S044	60 39.018	39 23.469	04/04/17 07:47	3479	S044_001	SN016	No bad buffers. Fall rate release.
S045	60 40	39 21	04/04/17 14:14	3084	S045_001	SN016	
S046	60 38.4	39 7.4	04/04/17 17:59	3131	S046_001	SN016	
S047	60 40.960	39 28.247	05/04/17 03:47	3075	S047_001	SN016	Bounced of seabed.
S050	60 37.329	39 18.116	05/04/17 23:59	3313	S050_001	SN016	T2 dead. All other sensors looked ok.
S053	60 31.928	39 19.349	06/04/17 10:22	2224	S053_001	SN016	
S060	60 39.639	42 13.083	10/04/17 11:20	1700	S060_001	SN016	
S061	60 38.948	42 11.357	10/04/17 14:01	2488	S061_001	SN016	
S062	60 38.538	42 09.967	10/04/17 17:00		S062_001	SN016	
S063	60 37.401	42 02.887	10/04/17 21:46	3550	S063_001	SN016	
S064	60 37.038	-42 0.594	11/04/17 02:23	3446	S064_001	SN016	sh1 looks a bit noisy
S065	60 38.171	-42 08.759	11/04/17 06:48	3260	S065_001	SN016	all probes look ok. Spike in both sh1 & sh2 at ˜1400 m maybe noise.
S066	60 34.200	42 32.115	11/04/17 15:06	2015	S066_001	SN016	sh1 noisy again
S067	60 38.487	42 20.349	11/04/17 20:30	1889	S067_001	SN016	sh1 swapped out
S068	60 33	42 28.8	12/04/17 14:21	2921	S068_001	SN016	
S069	60 36.818	42 16.967	12/04/17 20:53	2969	S069_001	SN016	
S070	60 40.811	42 10.199	13/04/17 01:38	1953	S070_001	SN016	
S071	60 40.312	42 07.424	13/04/17 04:41	2913	S071_001	SN016	
S072	60 39.822	42 04.417	13/04/17 19:59	3520	S072_001	SN016	
S073	60 37.647	42 19.182	14/04/17 00:31	2609	S073_001	SN016	seabird conductivity blocked/frozen surface 1000 m
S074	60 35.974	42 13.647	14/04/17 04:04	3570	S074_001	SN016	3 bad buffers. Seabird conductivity frozen to 800m. Noise in sh2
S075	60 33.625	42 32.275	14/04/17 21:24	2449	S075_001	SN016	1 bad buffer. T2 broken

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Table 17 – *continued from previous page*

Stn.	Lat (°S)	Lon (°W)	Date/Time (GMT)	Max Press. (dbar)	File name	VMP No.	Comments
S076	60 32.452	42 26.899	15/04/17 00:41	3481	S076_001	SN016	Hit seabed all sensors except microC & T2 broken.
S077	60 35.363	42 09.847	15/04/17 20:42	4031	S077_001	SN016	
S078	60 37.922	42 06.819	16/04/17 01:39	3533	S078_001	SN016	5 bad buffers
S080	60 36.785	41 58.655	16/04/17 17:46	3380	S080_001	SN016	5 bad buffers
S082	60 35.842	41 52.604	17/04/17 01:26	3120	S082_001	SN016	'10s data timeout acquisition stopped' during recovery. 2 bad buffers.
S084	60 34.841	41 45.824	17/04/17 08:15	2607	S084_001	SN016	No bad buffers.
S086	60 32.849	41 31.031	18/04/17 05:32	2100	S086_001	SN016	
S087	60 37.230	42 17.950	19/04/17 02:10	2940	S087_001	SN016	Bounced off seabed. No broken probes
S088	60 36.374	42 15.248	19/04/17 05:32	3088	S088_001	SN016	4 bad buffers
S090	60 34.108	41 37.578	20/04/17 15:33	2323	S090_001	SN016	
S093	60 35.123	42 09.675	22/04/17 11:41	4130	S093_001	SN016	
S094	60 33.888	42 09.668	22/04/17 16:29	4207	S093_001	SN016	Hit seabed T1 broken.
S097	60 31.108	42 22.622	24/04/17 00:48	4139	S094_001	SN016	
S098	60 30.146	42 19.845	24/02/17 05:19	4450	S098_001	SN016	
S100	60 31.315	42 59.977	24/04/17 00:00		S100_001	SN016	
S101	60 30.669	43 00.123	25/04/17 00:00	2332	S101_001	SN016	
S102	60 32.155	42 59.965	25/04/17 03:45	1365	S102_001	SN016	Replaced sh1/sh2 & T2 – no inidcation of hitting seabed but both sh visibly broken during dive. Both sh1/sh2 & T2 channels duff.
S103	60 29.906	42 59.750	25/04/17 06:53	2730	S103_001	SN016	
S104	60 28.978	42 59.958	25/04/17 10:34	3497	S104_001	SN016	
S105	60 27.802	43 00	25/04/17 14:54	3942	S105_001	SN016	

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Table 17 – *continued from previous page*

Stn.	Lat (°S)	Lon (°W)	Date/Time (GMT)	Max Press. (dbar)	File name	VMP No.	Comments
S106	60 26.608	42 59.546	25/04/17 19:59	4694	S106_001	SN016	
S108	60 32.280	43 00.0033	26/04/17 17:50	1385	S108_001	SN016	
S110	60 21.666	45 15.186	27/04/17 09:38		S110_001	SN016	
S111	60 18.704	45 15.125	27/04/17 13:03	3008	S111_001	SN016	
S112	60 17.572	45 15.084	27/04/17 16:51	3475	S112_001	SN016	
S113	60 16.207	45 16.880	27/04/17 21:31	4130	S113_001	SN016	
S114	60 14.098	45 14.988	28/04/17 03:05	4543	S114_001	SN016	1x bad buffer
S117	60 10.035	45 15.262	29/04/17 16:45	5440	S117_001	SN016	

Table 17: Summary of VMP station on JR16005.

Processing

All processing scripts used on this cruise were adaptations of those used in previous VMP cruises by the University of Southampton group. A summary of the processing steps are given below:

1. **vmp_firstlook4** Produces a series of diagnostic plots for the raw un-calibrated VMP data (from XXX.P, produces XXX.mat) and calibrates data (XXX_cal.mat)

2. **vmp_process_seabird4** Processes the VMP seabird data and applies various corrections (despike, filter, . . .). Output is saved as a separate matlab file, XXX_dCTD.mat. Upgraded on JR16005 by Alex Forryan.

3. **vmp_process_micro4** Processes the VMP microstructure shear, temperature and conductivity are calibrated by regressing against the processed VMP seabird temperature and conductivity. Output saved as a separate matlab file, XXX_micro.mat.

4.3 Dragging Operation for VMP-5500 S/N 016 at Station 18 – *Povl Abrahamsen*

On 1 April we returned to the site of the stuck VMP to drag for it, at a depth of approx. 3400 m. The coring wire was brought up to the aft deck and led through the A-frame. A 400-kg locomotive wheel (spare LDEO mooring anchor) was used as the end weight, shackled onto a length of 13-mm long-link chain, which was attached to the wire through a weak link held together with shear bolts. After paying out 400 m of wire, a depressor weight, consisting of two 280-kg railway wheels (BAS mooring anchors), attached via a length of chain and another weak link to a length of lashing wire, was attached to the wire using wire clamps. At 1000 m wire out, 600 m above the depressor, a BAS USBL beacon (ID 2) was attached to the wire. The wire was then paid out until the first weight landed on the seabed about 120 m from the VMP. At this stage the ship started moving slowly northeast on DP, continuing to pay out wire until the depressor weight also landed on the seabed. Communications were lost with the USBL beacon shortly after the end weight landed, but before the depressor did. This could have been caused by an increasing tilt of the USBL beacon – though we would expect that any tilt would be toward the ship. After the depressor landed, the ship started steaming slowly to the WNW, into the wind, while paying out wire. The ship came to a stop with the transom 1375 m from the VMP position, and 5526 m of wire out. The slant distance from the transom to the end weight via the depressor (assuming both at 3400 m) was 4000 m, while the distance from the transom to the end weight via the VMP was around 3785 m. The wire was then hauled in at a rate of 10 m/min, starting at 15:16. The tension on the wire increased around 18:03, indicating that the depressor weight was being dragged along the seabed, with 4118 m of wire out. At 18:16 the VMP started rising, with 4016 m of wire out. The wire was then hauled in, USBL beacon and weights removed, and the VMP recovered. The lack of damage, or any signs of contact with the wire, on the VMP indicate that only a slight nudge with the wire was enough to dislodge the VMP. While the initial hauling rate probably could have been increased until the wire out was closer to the slant range to the weight positions (plus some leeway for the catenary), the slow haul rate at the time of contact with the VMP likely contributed to the success of the dragging, and the lack of damage to the VMP.

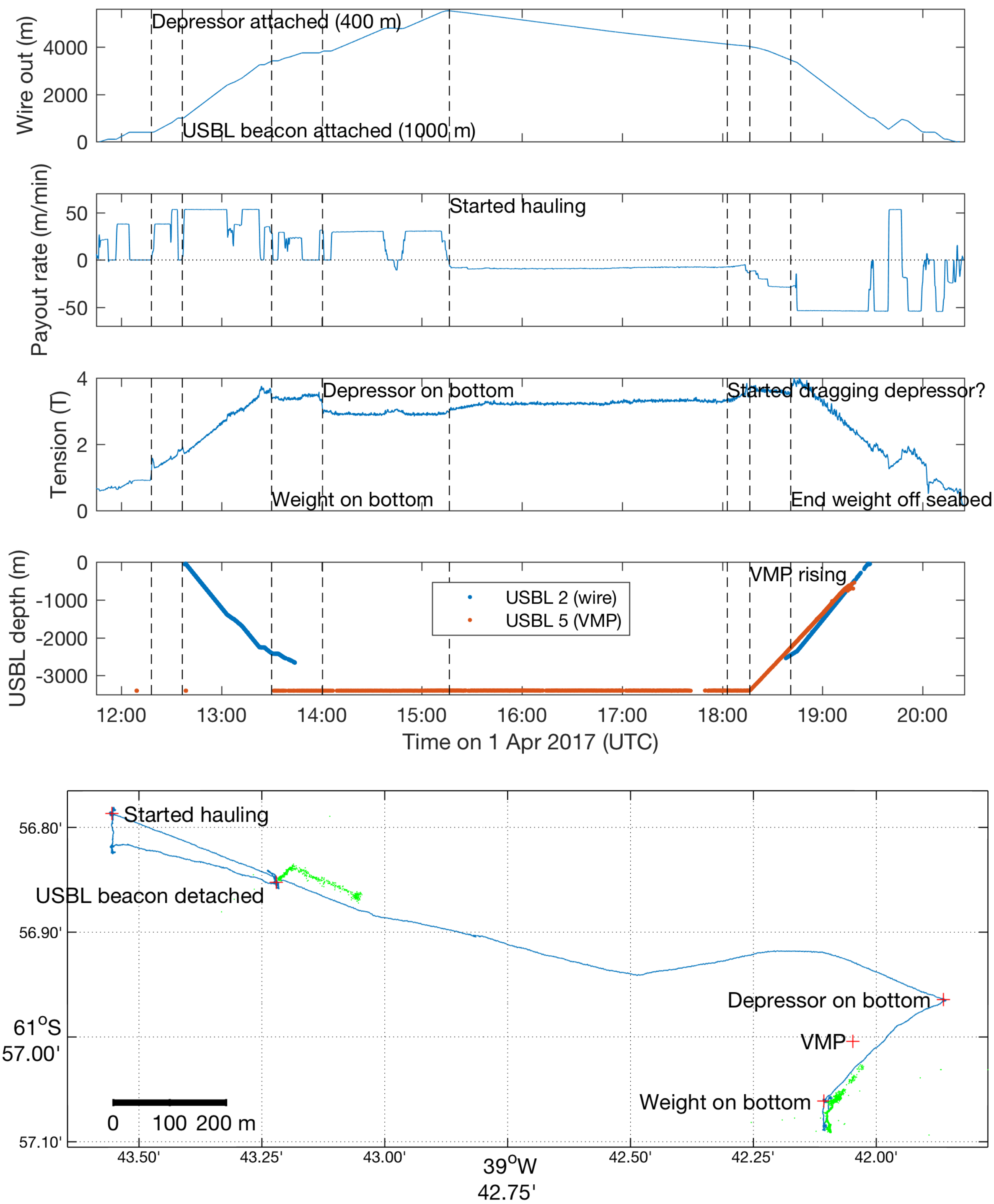

Figure 15: Winch data from the dragging operation on 1 Apr 2017. The payout rates and tensions have been low-pass filtered to remove the signal from the ship's heave; this made it difficult to judge when the weights had reached or left the bottom while performing the operation. The USBL depths of the beacon on the wire (blue) and on the VMP (red) are shown in the fourth panel. The path of the ship's transom is shown in the map in blue (with key points in red). The positions from the USBL beacon on the wire are shown in green.

4.4 ChiPods – *Kurt L. Polzin, Carl P. Spingys & Carson McAfee*

ChiPods are self-contained devices that estimate small scale temperature variability using fast response FP07 thermistors sampled at about 100 Hz. They are built, maintained and provided by the Ocean Mixing group at Oregon State University. A ChiPod unit consists of a small pressure case with sensing unit containing the thermistor connected to the pressure case with cable. The units are continuously recording as long as the thermistor cable is connected. Data downloads were conducted about once a day for a status check on the sensor and electronics. Quality control was done visually by plotting the temperature records. This subsection reports on those quality estimates and links the resulting files to the corresponding CTD station.

ChiPod Installation

There were four ChiPod instrumentation sets installed on the CTD frame. Two faced up (set 1 and 2), and two faced down (set 3 and 4).

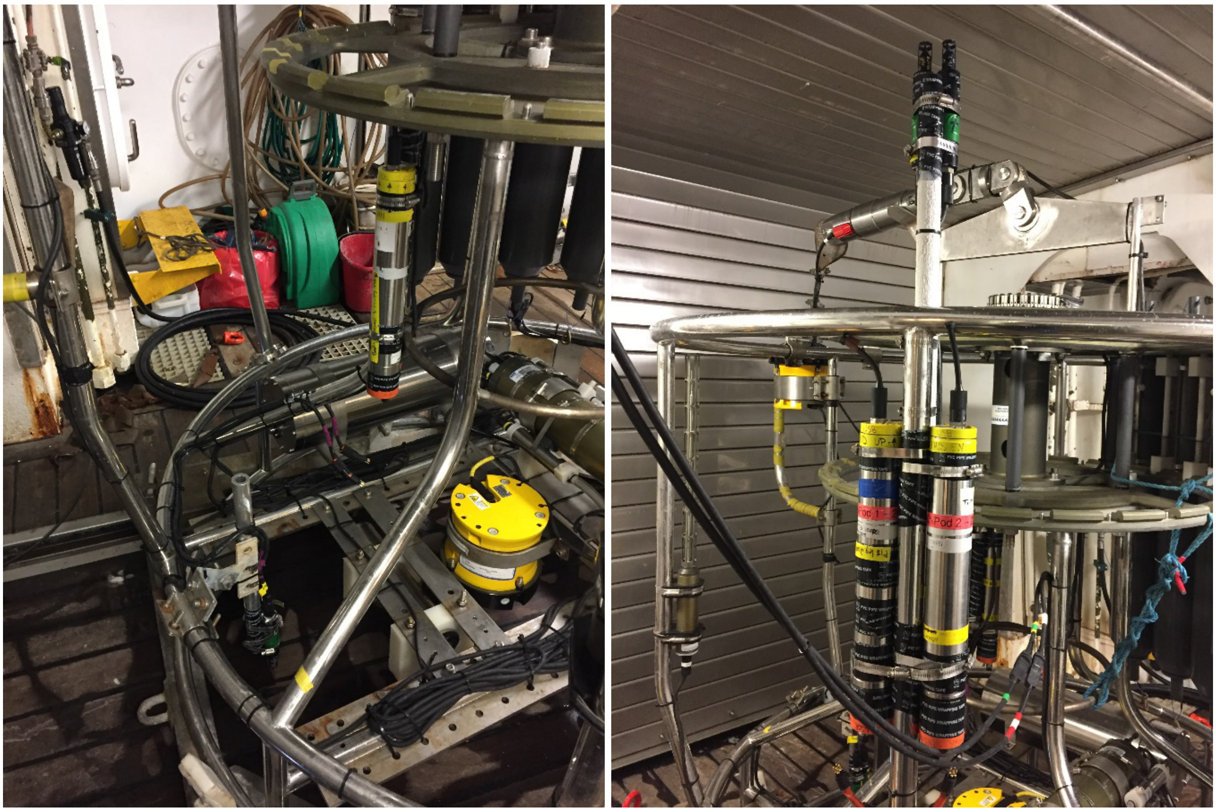

Figure 16: ChiPod loaction on CTD frame for JR16005.

Each instrumentation set consists of a number of smaller elements: Data Logger, SD Card, Pressure Case, Sensor Holder, Thermistor and Cable. This section will discuss the installation and initial configuration of these instrument sets.

Set 1 (Upward Facing)		Set 2 (Upward Facing)	
Data Logger SN:	2013	Data Logger SN:	2018
Pressure Case SN:	TI44-7	Pressure Case SN:	TI44-3
Sensor Holder:	8	Sensor Holder:	17
Thermistor:	10-08	Thermistor:	14-36D
Cable:	24-4-1/SM183571-07	Cable:	24-4-6/SM183571-02
Files:	47	Files:	112
Last Used:	02/02/2017	Last Used:	02/02/2017

Table 18: Upward facing ChiPod serial numbers

Upward Sets

Installation notes for Set 1

- Opened pressure case. Cleaned and lubricated both O-Rings.
- No visible problems with Cables.
- Visual inspection of sensor holder (did not open). Bad corrosion on base (near connector). Two big pits. Should not affect pressure seal.
- Thermistor appears fine. Lubricated o-rings.
- Bench Test 01 (File 52):
  - 01:44 Cold Water
  - 01:46 Ambient Temp
  - 01:48 Warm Water
  - 01:50 Ambient
  - 01:50 Rotate axis 1 of housing
  - 01:51 Rotate axis 2 of housing
  - 01:52 Test Over
- Bench Test 01 (File 52), had an issue with some of its time points, and indicated samples in 1970. I decide to rerun the test.
- Bench Test 02 (File 53):
  - 15:12:00 Cold Water
  - 15:13:00 Warm Water
  - 15:14:00 Cold Water
  - 15:14:30 Warm Water
  - 15:15:00 Ambient
  - 15:15:30 Axis 1 pendulum
  - 15:16:00 Axis 2 pendulum
  - 15:16:30 Test Over
- Bench Test 02 looks good.
- At 18:17 UTC on 19/03/2017 the set is installed on the CTD frame, and started.

Installation notes for Set 2

- Started with USB communication test. With sensor cable attached the battery voltage read 0.6 v. No good. However initial thermistor test ('SA' command) looks good.
- Opened pressure case. Cleaned and lubricated the o-rings.
- Found that battery wire had broken off of its connector pin (at the pint of solder). Re-soldered original pin. No spares available. No visible issues with internal components.
- No corrosion damage on the sensor holder 17.
- Time of the logger is synced to PC time. And PC time is synced to ship NTP server.
- Bench Test 01 (File 115):
  - 17:37:00 Cold Water
  - 17:38:00 Warm Water
  - 17:39:00 Cold Water
  - 17:39:30 Warm Water
  - 17:40:00 Ambient
  - 17:40:30 Axis 1 pendulum
  - 17:41:00 Axis 2 pendulum
  - 17:41:30 Test Over
- Bench Test 01 looks good.
- At 18:17 UTC on 19/03/2017 the set is installed on the CTD frame, and started.

Downward Sets

Set 1 (Downward Facing)		Set 2 (Downward Facing)	
Data Logger SN:	2016	Data Logger SN:	1014
Pressure Case SN:	TI44-6	Pressure Case SN:	TI44-1
Sensor Holder:	16	Sensor Holder:	6
Thermistor:	14-27D	Thermistor:	14-26D
Cable:	24-4-7/SM183571-05	Cable:	24-4-5/SM189862-04
Files:	23	Files:	79
Last Used:	02/02/2017	Last Used:	17/01/2017

Table 19: Downward facing ChiPod serial numbers

Installation notes for Set 3

- Opened pressure case. Looks good. No clear problems with internal components. Cleaned and lubricated o-rings.

- Sensor Holder 16 looks good. No significant damage.
- Preliminary testing looks good. Synced Time.
- Bench Test 01 (File 24):
  - 19:17:00 Cold Water
  - 19:18:00 Warm Water
  - 19:19:00 Cold Water
  - 19:19:30 Warm Water
  - 19:20:00 Ambient
  - 19:20:30 Axis 1 pendulum
  - 19:21:00 Axis 2 pendulum
  - 19:21:30 Test Over
- Bench Test 01 had the 1970 time error on sample pints again. Decide to redo the test.
- Bench Test 02 (File 25):
  - 20:27:00 Cold Water
  - 20:28:00 Warm Water
  - 20:29:00 Cold Water
  - 20:29:30 Warm Water
  - 20:30:00 Ambient
  - 20:30:30 Axis 1 pendulum
  - 20:31:00 Axis 2 pendulum
  - 20:31:30 Test Over
- Bench Test 02 looks good. I am happy with the instrument.
- At 22:06 UTC on 19/03/2017 the set is installed on the CTD frame, and started.

Initial installation notes for set 4

- Started by doing preliminary testing with the 'SA' command. Thermistor responds to hot and cold breath test. Tilt values seem strange. The third column of data normally has a value of ˜26000 while flat, and ˜30000 while vertical. However this unit shows the reverse. May indicate a problem?
- A note on the case says: 'Bad. Removed 01-17-17'. I have no clue why. There is no obvious problem with physical condition of the equipment, or the communication with the logger. Only issue may be the tilt values in the accelerometer. I will use this set as is until a problem becomes clear.
- Opened pressure case. Cleaned and lubricated o-rings. Note that the internal layout was wrong (battery first then the board). This was different from the other units. I changed this back to a consistent layout. Also note that the battery cable broke loose from its connector (at point of solder). This is the second time I have seen this, and may indicate a problem with the components/wire. I re-soldered using the original pin.
- Sensor Holder 6 seems fine. Minor corrosion on the connector end. Cleaned and lubricated the o-rings on the thermistor.
- Bench Test 01 (File 82)

- 21:33:00 Cold Water
- 21:34:00 Warm Water
- 21:35:00 Cold Water
- 21:35:30 Warm Water
- 21:36:00 Ambient
- 21:36:30 Axis 1 pendulum
- 21:37:00 Axis 2 pendulum
- 21:37:30 Test Over

- Bench Test 01 looks good. I am happy with the instrument.
- At 22:06 UTC on 19/03/2017 the set is installed on the CTD frame, and started.

Daily checks and data management

A daily check on each of the instruments would involve:

1. Connect to instrument and establish communication.
2. Interrupt logging: 'qqq'.
3. Check system information: 'si'.
4. Check the time of both clocks: 'gt'.
5. Check the battery voltage: 'bv'.
6. Check recorded files: 'di'.
7. Download new files.
8. Start logging and disconnect: 'sl'.

The critical information from these checks can be found in the following logs. These can be used to explain and understand gaps in the data. These logs also indicate when problems were found during the daily checks. Each of these problems are discussed in the next section 'General Maintenance'.

Chipod Daily Logs

Date	Start Time	Battery Voltage (V)	Files	End Time	Problem?
21/03/2017	18:16	6.8	56	18:37	
24/03/2017	16:09		60	16:38	
25/03/2017	14:34	6.76	62	14:43	
27/03/2017	13:35	6.83	65	13:52	
30/03/2017	18:26	6.73	69	18:54	
01/04/2017	00:01	6.8	72	00:12	
02/04/2017	12:29	6.72	74	12:42	
03/04/2017	13:35	6.85	76	13:43	
04/04/2017	11:58	6.8	78	12:06	
05/04/2017	12:43	6.81	80	12:52	

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Table 20 – *continued from previous page*

Date	**Start Time**	**Battery Voltage (V)**	**Files**	**End Time**	**Problem?**
06/04/2017	12:30	6.6	82		Yes
07/04/2017	16:38	6.88	8	16:39	Yes
08/04/2017	15:40	6.8	10	16:00	
09/04/2017	18:34	6.63	12	18:44	
11/04/2017	11:52	6.82	15	12:05	
12/04/2017	12:18	6.88	17	12:27	
13/04/2017	12:16	6.88	19	12:27	
14/04/2017	13:34	6.88	21	13:44	
15/04/2017	13:53	6.82	23	14:03	
16/04/2017	11:03	6.81	25	11:11	
17/04/2017	14:26	6.73	27	14:37	
18/04/2017	12:56	6.82	29	13:04	
19/04/2017	12:43	6.92	31	12:52	
20/04/2017	11:31	6.66	33	11:40	
21/04/2017	15:16	6.77	35	15:27	
22/04/2017	16:27	6.72	37	16:37	
24/04/2017	15:09	6.69	40	20:45	Yes
25/04/2017	14:03	6.77	43	14:10	Yes
26/04/2017	17:37	6.73	45	17:48	
27/04/2017	12:47	6.76	47	12:54	
28/04/2017	17:57	6.77	49	18:07	
29/04/2017	15:55	6.89	51	16:03	
30/04/2017	17:32	6.72	53	17:45	
01/05/2017	16:25	6.8	55	End	

Table 20: ChiPod daily log instrument Set 1. Initially Data logger 2013, then 0102

Date	**Start Time**	**Battery Voltage (V)**	**Files**	**End Time**	**Problem?**
21/03/2017	18:38	6.84	118	18:56	
24/03/2017	16:39	6.88	112	17:05	
25/03/2017	14:44	6.78	124	14:53	
27/03/2017	13:53	6.87	127	14:12	
30/03/2017	18:53	6.78	131	19:16	Yes
01/04/2017	00:13	6.84	135	00:29	
02/04/2017	12:43	6.82	137	12:56	
03/04/2017	13:44	6.95	139	13:53	
04/04/2017	12:06	6.88	141	12:14	
05/04/2017	12:53	6.91	143	13:02	

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Table 21 – *continued from previous page*

Date	Start Time	Battery Voltage (V)	Files	End Time	Problem?
06/04/2017	12:43	6.71	145	12:45	
07/04/2017	16:04	6.82	147	16:51	
08/04/2017	16:00	6.76	149	16:05	Yes
09/04/2017	18:45	6.62	151	18:55	
11/04/2017	12:06	6.7	154	12:20	
12/04/2017	12:27	6.7	156	12:38	
13/04/2017	12:27	6.55	158	12:37	
14/04/2017	13:44	6.31	160	13:54	Yes
15/04/2017	14:04	5.06	162	14:32	Yes
16/04/2017	11:12	6.95	165	11:20	
17/04/2017	14:37	6.88	167	14:49	
18/04/2017	13:06	6.98	169	13:14	
19/04/2017	12:55	7.05	171	13:02	
20/04/2017	11:41	6.92	173	11:49	
21/04/2017	15:28	6.94	175	15:39	
22/04/2017	16:37	6.91	177	16:47	
24/04/2017	15:53	6.9	180	20:45	Yes
25/04/2017	14:11	6.88	2	14:18	
26/04/2017	17:49	6.85	4	17:59	
27/04/2017	12:55	6.87	6	13:02	
28/04/2017	18:08	6.85	8	18:19	
29/04/2017	16:04	6.98	10	16:13	
30/04/2017	17:46	6.83	12	17:55	
01/05/2017	16:34	6.92	14	End	

Table 21: ChiPod daily log instrument Set 2. Data logger 2018.

Date	Start Time	Battery Voltage (V)	Files	End Time	Problem?
21/03/2017	18:58	6.81	28	19:15	
24/03/2017	17:07	6.88	32	19:24	Yes
25/03/2017	14:11	6.74	34	14:22	
27/03/2017	14:14	6.86	37	14:33	
30/03/2017					
31/03/2017	22:31	6.76	42	23:12	
02/04/2017	15:49	6.74	46	16:03	
03/04/2017	13:54	6.9	48	14:05	Yes
04/04/2017	12:15	6.85	52	12:25	Yes
05/04/2017	13:11	6.87	54	13:20	

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Table 22 – *continued from previous page*

Date	**Start Time**	**Battery Voltage (V)**	**Files**	**End Time**	**Problem?**
06/04/2017	12:58	6.73	56	13:07	
07/04/2017	16:52	6.82	58	17:03	
08/04/2017	16:25	6.8	60	16:33	Yes
09/04/2017	18:57	6.75	64	19:07	
11/04/2017	12:21	6.83	67	12:37	
12/04/2017	12:39	6.91	69	12:47	Yes
13/04/2017	12:39	6.89	72	12:52	Yes
14/04/2017	13:55	6.91	74	14:04	
15/04/2017	14:12	6.84	76	14:21	
16/04/2017	11:22	6.81	78	11:30	
17/04/2017	14:50	6.75	80	15:01	
18/04/2017	13:15	6.86	82	13:24	
19/04/2017	13:02	6.9	84	13:13	
20/04/2017	11:50	6.73	86	12:00	
21/04/2017	15:39	6.72	88	15:51	
22/04/2017	16:48	6.65	90	16:57	
24/04/2017	16:16	6.67	93	16:34	
25/04/2017	14:18	6.59	95	14:28	
26/04/2017	18:00	6.56	97	18:10	Yes
27/04/2017	13:03	6.76	101	13:11	
28/04/2017	18:20	6.74	103	18:32	
29/04/2017	16:13	6.84	105	16:23	
30/04/2017	17:56	6.7	107	18:08	Yes
01/05/2017	16:44	6.81	109	End	

Table 22: ChiPod daily log instrument Set 3. Data logger 2016.

Date	**Start Time**	**Battery Voltage (V)**	**Files**	**End Time**	**Problem?**
21/03/2017	19:17	6.85	85	19:35	
24/03/2017	17:38	6.89	89	19:24	Yes
25/03/2017	14:24	6.78	91	14:32	
27/03/2017	14:34	6.9	94	14:52	
30/03/2017					
31/03/2017	23:13	6.84	99	23:59	
02/04/2017	16:04	6.78	104	16:31	
03/04/2017	14:06	6.93	107		Yes
04/04/2017	12:26	6.87	109	12:34	
05/04/2017	13:21	6.89	111	13:31	

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Table 23 – *continued from previous page*

Date	Start Time	Battery Voltage (V)	Files	End Time	Problem?
06/04/2017	13:08	6.75	113	13:18	
07/04/2017	17:04	6.84	115	17:16	
08/04/2017	16:34	6.84	117		Yes
09/04/2017	19:07	6.73	3	19:18	
11/04/2017	12:38	6.83	6	12:53	
12/04/2017	12:48	6.89	8	12:57	
13/04/2017	12:55	6.89	10	13:11	
14/04/2017	14:05	6.88	12	14:15	
15/04/2017	14:22	6.82	14	14:31	
16/04/2017	11:31	6.77	16	11:40	
17/04/2017	15:02	6.72	18	15:12	
18/04/2017	13:25	6.82	20	13:35	
19/04/2017	13:14	6.83	22	13:23	
20/04/2017	12:01	6.63	24	12:10	
21/04/2017	15:51	6.58	26	16:02	
22/04/2017	16:58	6.32	28	17:08	
24/04/2017	16:35	6.85	33	16:51	
25/04/2017	14:29	6.81	35	14:38	
26/04/2017	18:10	6.78	37	18:22	
27/04/2017	13:11	6.79	39	13:19	
28/04/2017	18:32	6.8	41	18:44	
29/04/2017	16:23	6.89	43	16:34	
30/04/2017	18:09	6.78	45	18:19	
01/05/2017	16:53	6.85	47	End	

Table 23: ChiPod daily log instrument Set 4. Data logger 1014.

ChiPod General Maintenance

Set 1

30/03/2017 15:31 UTC: Noise Reported on data files. Insulated the upright pole holding the sensor heads to see if noise improves.

05/04/2017 Insulated pressure case, and vertical support bar (CTD). No more direct electrical contact. Done in an effort to reduce noise from LADCP's.

06/04/2017 File 82 failed to download during data check. Afterwards the data logger failed to communicate correctly (even after a power cycle). Pressure case was removed from the CTD for inspection. I repeatedly tested USB communication with the standard daily check, however the logger fails to reply or acknowledge commands. It will start up with system information, but will not do anything else. I replaced the data logger board with SN:0102.

Set 1 (Before)		Set 1 (After)	
Data Logger SN:	2013	Data Logger SN:	0102
Pressure Case SN:	TI44-7	Pressure Case SN:	TI44-7
Sensor Holder:	8	Sensor Holder:	8
Thermistor:	10-08	Thermistor:	10-08
Cable:	24-4-1/SM183571-07	Cable:	24-4-1/SM183571-07
Files:	47	Files:	47
Last Used:	02/02/2017	Last Used:	02/02/2017

Table 24: ChiPod set 1 changed serial numbers

Two bench tests were performed on the unit, however both failed. Due to casts, testing was stopped.

07/04/2017 The reason for the failed bench tests (on the 6th) were traced to a broken battery connector cable. The original connector pin was re-soldered to the cable. A third bench test was run. Bench Test 03 (File 7):

- 16:01:00 Cold Water
- 16:02:00 Warm Water
- 16:03:00 Cold Water
- 16:03:30 Warm Water
- 16:04:00 Ambient
- 16:04:30 Axis 1 pendulum
- 16:05:00 Axis 2 pendulum
- 16:05:30 Test Over

Bench Test 03 looks good. New instrumentation setup is installed on the CTD.

24/04/2017 File 38 failed to download during data check.

24/04/2017 Due to a failure with ChiPod Set 2, I began further testing on the 2013 logger board. I found that removing and reinstalling the SD card re-established USB communication, and allowed all the files to be seen. However I removed and reinstalled the SD card once more, and afterwards no files could be seen. The communication software requested that I format the card, and I chose not to. It may still be possible to extract the original file data from the card, which is in the 2013 data logger.

25/04/2017 An additional file was made during the day. I expected 2 files and found 3 (41, 42 and 43). However file 41 had a 0 data file. No clue why this happened.

Set 2

30/03/2017 15:31 UTC: Noise Reported on data files. Insulated the upright pole holding the sensor heads to see if noise improves

30/03/2017 File 129 failed to download during data check.

05/04/2017 Insulated pressure case, and vertical support bar (CTD). No more direct electrical contact. Done in an effort to reduce noise from LADCP's.

08/04/2017 File 148 and 149 failed to download during data check.

14/04/2017 Battery voltage is low. Will leave for one more day.

15/04/2017 Battery voltage dropped too low in the night, and logging stopped. Replaced batteries after the data download. Also did a short logging test, so files will increment by 1. No need for a bench test.

24/04/2017 Initial parts of the daily check went smoothly, and then files 179/180 failed to download. I power cycled the unit as usual, however afterwards the data logger board failed to communicate properly. These were the same symptoms seen on the 2013 data logger board (06/04/2017) in Set 1. I removed and opened the pressure case, and extracted the data logger PCB. I removed the SD card, and installed a new one. This seems to have solved the issues with communication. I did a short logging test (File 0), and then reinstalled the instrument on the CTD.

Set 3

24/03/2017 File 31 failed to download during data check.

30/03/2017 15:31 UTC: Noise Reported on data files. Insulated the upright pole holding the sensor heads to see if noise improves

03/04/2017 File 48 failed to download during data check.

04/04/2017 File 49 and 50 had a '-1' file size. I have no explanation for this. It is also worth noting that I expected 2 additional files during the data check (as seen on the other units), however I had four: 49, 50, 51 and 52.

05/04/2017 Insulated pressure case, and vertical support bar (CTD). No more direct electrical contact. Done in an effort to reduce noise from LADCP's.

08/04/2017 The data from this instrument looks questionable. A request was made to change the thermistor. At 20:43 a new thermistor (13-01) was installed on the sensor housing.

Bench Test 03 (File 62):

- 20:51:03 Cold Water
- 20:52:00 Warm Water
- 20:53:00 Cold Water
- 20:53:30 Warm Water
- 20:54:30 Axis 1 pendulum
- 20:55:00 Axis 2 pendulum
- 20:55:30 Test Over

Set 1 (Before)		Set 1 (After)	
Data Logger SN:	2016	Data Logger SN:	2016
Pressure Case SN:	TI44-6	Pressure Case SN:	TI44-6
Sensor Holder:	16	Sensor Holder:	16
Thermistor:	14-27D	Thermistor:	13-01
Cable:	24-4-7/SM183571-05	Cable:	24-4-7/SM183571-05
Files:	23	Files:	23
Last Used:	02/02/2017	Last Used:	02/02/2017

Table 25: ChiPod set 3 changed serial numbers 1

12/04/2017 File 68 failed to download during data check.

13/04/2017 Found an extra file in the daily check. I expected two file, but found three: 70, 71 and 72. Looking at the file size, I suspect that file 70 is actually a copy of file 69.

26/04/2017 The data from this instrument still looks questionable. A new thermistor will be installed, and the batteries will be replaced (getting low). At 19:38 a new thermistor (14-18D) was installed.

Set 1 (Before)		Set 1 (After)	
Data Logger SN:	2016	Data Logger SN:	2016
Pressure Case SN:	TI44-6	Pressure Case SN:	TI44-6
Sensor Holder:	16	Sensor Holder:	16
Thermistor:	13-01	Thermistor:	14-18D
Cable:	24-4-7/SM183571-05	Cable:	24-4-7/SM183571-05
Files:	23	Files:	23
Last Used:	02/02/2017	Last Used:	02/02/2017

Table 26: ChiPod set 3 changed serial numbers 2

Bench Test 04 (File 99):

- 20:14:00 Cold Water
- 20:15:00 Warm Water
- 20:16:00 Cold Water
- 20:16:30 Warm Water
- 20:17:30 Axis 1 pendulum
- 20:18:00 Axis 2 pendulum
- 20:18:30 Test Over

Bench Test 04 looks good. Unit reinstalled at 20:23.

29/04/2017 16:27 UTC: The data from the new thermistor does not look good. A request was made to reinstall the original thermistor (13-01). No bench test was done.

Set 1 (Before)		Set 1 (After)	
Data Logger SN:	2016	Data Logger SN:	2016
Pressure Case SN:	TI44-6	Pressure Case SN:	TI44-6
Sensor Holder:	16	Sensor Holder:	16
Thermistor:	14-18D	Thermistor:	13-01
Cable:	24-4-7/SM183571-05	Cable:	24-4-7/SM183571-05
Files:	23	Files:	23
Last Used:	02/02/2017	Last Used:	02/02/2017

Table 27: ChiPod set 3 changed serial numbers 3

30/04/2017 File 106 failed to download during data check.

Set 4

24/03/2017 File 88 failed to download during data check.

30/03/2017 15:31 UTC: Noise Reported on data files. Insulated the upright pole holding the sensor heads to see if noise improves.

03/04/2017 Extra file found during daily check. No explanation.

05/04/2017 Insulated pressure case, and vertical support bar (CTD). No more direct electrical contact. Done in an effort to reduce noise from LADCP's.

08/04/2017 Initial parts of the daily check went smoothly, and then files failed to download. I power cycled the unit as usual, however afterwards the data logger board failed to communicate properly. These were the same symptoms seen on the 2013 data logger board (06/04/2017) in Set 1. I removed and opened the pressure case, and extracted the data logger PCB. I removed the SD card, and installed a new one (21:53). This seems to have solved the issues with communication. I did a short logging test (File 0), and then reinstalled the instrument on the CTD.

22/04/2017 Replaced batteries before a failure. Did a short logging test, and should increment files by at least 1.

ChiPod Instrument Removal

After science was completed, all of the instrumentation sets were removed and washed in clean water.

None of the pressure cases showed any damage or corrosion. For transportation reasons the batteries were removed from each pressure case.

Sensor Holder 8 Minor corrosion starting on the top surface (thermistor end), but not critical. On the bottom (connector end) these is a big pit, and continued corrosion damage. This unit is still good for use.

Sensor Holder 17 No corrosion damage. Unit is still good for use.

Sensor Holder 16 Minor corrosion damage on the bottom. Good for use.

Sensor Holder 6 Minor pitting on the bottom edges. Unit good for use.

The upward facing support bar suffered from high levels of corrosion, however the downward facing support bar did not.

Equipment Review

1. In general there were 4 instanced where the battery cables had broken loose from their connectors (at point of solder on the pins in the connectors). This is definitely a weak point in the internal design, and may lead to failure in the future.
2. There were a number of instances where communication was established with the logger boards, however files failed to download. When this happened the logger would not re-establish communication unless the power is removed from the logger (IE, the sensor cable is removed, and then reinserted). This is not a critical fault given that the units typically continue to operate. However it does limit the immediate access to the data.
3. Thermistor 10-02 had a damaged o-ring. No spares with equipment. Used an alternative thermistor.
4. Sensor Holder 1 and 4 had significant corrosion damage/pitting on the inside edge of the thermistor entry point. This damage is deep enough to reach the first o-ring of the thermistor. This risks the pressure seal of the holder. I recommend that both units are repaired or retired.
5. Data logger 2013 had an issue with its SD card (see the note in Set 1 General Maintenance). The SD card in the logger may still contain historic data.
6. On 26/04/2017 I dropped a thermistor while preparing it for installation. The serial number is: 14-19D. It was immediately placed in the box with a note indicating possible damage. This unit needs to be tested before deployment.
7. The SD cards in data loggers 2018 and 1014 were changed during the cruise. On the 24/04/2017 for logger 2018 (Set 2), and 08/04/2017 for logger 1014 (Set 4). These SD cards contain historic data which may be recovered. They have been labelled and kept separate.
8. Data logger 2010 is completely unresponsive. I suspect a problem with its FDTI USB chip. I have kept it stored inside one of the spare pressure cases.

ChiPod Data Processing

We found that locating cable runs along those of the lowered ADCP transducers resulted in electronic noise. Repositioning cables alieviated many, but not all of the symptoms. A bit of experimentation suggests that the 'minor electrical spikes' noted below can be removed with Rockland Scientific International's despike routine:

$$[y, spike, pass\_count, ratio] = despike(dat', 6, 0.5, 100, 4) .$$

Quality codes akin to 'SPIKES!' indicate data that are likely non-usable.

File No.	CTD	Date on Plot Title	Notes
3	n/a	19-Mar-2017 21:35:15	bench test
4	n/a	19-Mar-2017 23:06:39	bench test
5	1-2	20-Mar-2017 12:00:00	test stations - SPIKES!
6	3	21-Mar-2017 09:38:24	SPIKES
7	no CTD	21-Mar-2017 21:47:29	VMP only at station #4
8	5	22-Mar-2017 12:00:00	SPIKES
	6		could not download
9	no CTD	24-Mar-2017 08:49:23	VMPs only today
10	8	24-Mar-2017 21:43:07	changed wire routing/appears functional
11	9-10	25-Mar-2017 07:12:03	appears functional
12	11-12	25-Mar-2017 19:16:12	appears functional
13	13-15	26-Mar-2017 12:00:00	appears functional
14	18	27-Mar-2017 07:17:13	appears functional
15	19-20	27-Mar-2017 19:26:05	appears functional
16	no CTD	28-Mar-2017 12:00:00	no station
17	21-14	29-Mar-2017 12:00:00	appears functional
18	25-29	30-Mar-2017 12:00:00	appears functional
19	29-37	31-Mar-2017 11:36:51	appears functional
20	no CTD	31-Mar-2017 23:59:57	very short
21	no CTD	01-Apr-2017 12:00:00	no station
22	38-39	02-Apr-2017 08:02:16	functional
23	40-41	02-Apr-2017 20:15:30	functional
24	41-42	03-Apr-2017 07:03:02	functional
25	no CTD	03-Apr-2017 07:03:12	no station
26	no CTD	04-Apr-2017 06:13:09	no station
	n/a		could not download ??
27	no CTD	04-Apr-2017 18:17:30	no station
28	47	05-Apr-2017 06:40:42	good
29	48-49	05-Apr-2017 18:45:53	good
30	50-53	06-Apr-2017 06:34:01	good
31	54-ty	06-Apr-2017 18:39:13	great
32	54-ty	07-Apr-2017 08:32:08	good
33	55-ty	07-Apr-2017 20:38:20	good

Continued on next page

Table 28 – *continued from previous page*

File No.	CTD	Date on Plot Title	Notes
	56-57		missing
34		08-Apr-2017 23:03:31	no station
35	58-ty	09-Apr-2017 09:33:56	good
36	no CTD	09-Apr-2017 21:39:09	no station
37	59-63	10-Apr-2017 12:00:00	
38	63-65	11-Apr-2017 06:19:07	good
39	-	11-Apr-2017 18:26:49	no station
40	-	12-Apr-2017 06:24:00	no station
41	-	12-Apr-2017 18:28:57	no station
42	-	13-Apr-2017 06:27:37	no station
43	-	13-Apr-2017 18:34:39	no station
44	-	14-Apr-2017 07:02:51	no station
45	-	14-Apr-2017 19:07:32	no station
46	-	15-Apr-2017 07:11:08	no station
47	-	15-Apr-2017 19:15:38	no station
48	78	16-Apr-2017 05:45:44	good
49	79-18	16-Apr-2017 17:50:14	good
50	81-85	17-Apr-2017 07:31:18	good
51	no CTD	17-Apr-2017 19:36:18	no station
52	86	18-Apr-2017 06:42:31	good
53	-	18-Apr-2017 18:49:19	no station
54	-	19-Apr-2017 06:37:03	no station
55	89-ty	19-Apr-2017 18:41:33	good
56	89-ty	20-Apr-2017 06:00:29	good
57	90	20-Apr-2017 18:05:27	good
58	91-ty	21-Apr-2017 07:55:57	good
59	-	21-Apr-2017 20:01:08	no station
60	92-93	22-Apr-2017 08:29:01	good
61	94	22-Apr-2017 20:40:22	some spikes, but generally ok
62	95 96-ty	23-Apr-2017 12:00:00	ok, but keep eye on
63	96-ty 98-99	24-Apr-2017 08:17:37	okay
64	100	24-Apr-2017 20:25:51	good
65	101-104	25-Apr-2017 07:14:47	good
66	105	25-Apr-2017 19:19:08	good
67	107-ty	26-Apr-2017 09:05:25	good
68	-	26-Apr-2017 21:11:03	no station
69	109-110	27-Apr-2017 06:35:46	good
70	111-113	27-Apr-2017 18:39:57	good
71	113-115	28-Apr-2017 09:16:20	good
72	116-ty	28-Apr-2017 21:22:08	good
73	116-ty	29-Apr-2017 08:11:47	good
74	117	29-Apr-2017 20:16:58	good

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Table 28 – *continued from previous page*

File No.	CTD	Date on Plot Title	Notes
75	118-ty	30-Apr-2017 09:04:52	good
76	119	30-Apr-2017 21:09:57	good
77	119-120	01-May-2017 08:26:47	good

Table 28: Chipod 1014, Down Look, casts and files.

File No.	CTD	Date on Plot Title	Notes
3	n/a	19-Mar-2017 17:39:14	bench test
4	n/a	19-Mar-2017 18:24:29	bench test
5	n/a	19-Mar-2017 21:10:59	no station
6	1-2	20-Mar-2017 12:00:00	test stations - SPIKES!
7	3	21-Mar-2017 09:19:09	SPIKES
8	no CTD	21-Mar-2017 21:28:24	VMP only at station #4
9	5	22-Mar-2017 12:00:00	SPIKES
10	6	23-Mar-2017 12:00:00	SPIKES
11	no CTD	24-Mar-2017 08:19:33	VMPs only today
12	8	24-Mar-2017 20:32:54	changed wire routing/minor electrical noise
13	9-10	25-Mar-2017 07:22:06	minor electrical noise
14	11-12	25-Mar-2017 19:26:47	minor electrical noise
15	13-15	26-Mar-2017 12:00:00	minor electrical noise
16	18	27-Mar-2017 06:56:43	minor electrical noise
17	19-20	27-Mar-2017 19:05:59	minor electrical noise
	no CTD		could not download
18	21-24	29-Mar-2017 12:00:00	minor electrical noise
19	25-27	30-Mar-2017 09:26:42	minor electrical noise
20	28-29	30-Mar-2017 21:38:54	minor electrical noise
21	29-37	31-Mar-2017 12:00:00	minor electrical noise
22	no CTD	01-Apr-2017 00:06:44	very short
23	no station	01-Apr-2017 12:14:55	
24	38	02-Apr-2017 06:40:03	2035 year date, last 9 points
25	39-41	02-Apr-2017 18:28:05	functional
26	41-42	03-Apr-2017 06:52:07	functional
27	no CTD	03-Apr-2017 18:56:36	no station
28	no CTD	04-Apr-2017 06:03:15	no station
29	no CTD	04-Apr-2017 18:07:29	no station
30	47	05-Apr-2017 06:26:40	minor spikes
31	48-49	05-Apr-2017 18:31:11	minor spikes
32	50-53	06-Apr-2017 06:21:43	minor spikes
33	54-ty	06-Apr-2017 18:27:04	minor spikes
34	54-ty	07-Apr-2017 08:20:03	minor spikes missing

Continued on next page

Table 29 – *continued from previous page*

File No.	CTD	Date on Plot Title	Notes
			missing
35		08-Apr-2017 20:02:39	no station
36	58-ty	09-Apr-2017 09:22:37	minor spikes
37	no CTD	09-Apr-2017 21:27:56	no station
38	59-63	10-Apr-2017 12:00:00	minor spikes
39	63-65	11-Apr-2017 06:03:12	minor spikes
40	-	11-Apr-2017 18:10:50	no station
41	-	12-Apr-2017 06:13:51	no station
42	-	12-Apr-2017 18:19:00	no station
43	-	13-Apr-2017 06:13:44	no station
44	-	13-Apr-2017 18:18:44	no station
45	-	14-Apr-2017 06:52:18	no station
46	-	14-Apr-2017 18:57:15	no station
47	-	15-Apr-2017 01:47:15	no station
48	-	15-Apr-2017 19:16:24	no station
49	78	16-Apr-2017 05:36:03	significant spikes
50	79-81	16-Apr-2017 17:40:27	minor spikes
51	81-85	17-Apr-2017 07:18:47	minor spikes
52	no CTD	17-Apr-2017 19:24:39	no station
53	86	18-Apr-2017 06:32:58	minor spikes
54	-	18-Apr-2017 18:37:20	no station
55	-	19-Apr-2017 06:26:44	no station
56	89-ty	19-Apr-2017 18:31:04	minor spikes
57	89-ty	20-Apr-2017 05:50:35	minor spikes
58	90	20-Apr-2017 17:54:59	minor spikes
59	91-ty	21-Apr-2017 07:44:03	good
60	-	21-Apr-2017 19:49:34	no station
61	92-93	22-Apr-2017 08:18:52	minor spikes
62	94	22-Apr-2017 20:23:38	nfg
63	95 96-ty	23-Apr-2017 12:00:00	minor spikes
	96-ty 98-99	-	missing
64	100	24-Apr-2017 22:26:58	minor spikes
65	101-104	25-Apr-2017 07:05:48	minor spikes
66	105	25-Apr-2017 19:09:05	minor spikes
67	107-ty	26-Apr-2017 08:54:48	minor spikes
68	-	26-Apr-2017 20:59:47	no station
69	109-110	27-Apr-2017 06:27:44	minor spikes
70	111-113	27-Apr-2017 18:31:26	minor spikes
71	113-115	28-Apr-2017 09:04:13	minor spikes
72	116-ty	28-Apr-2017 21:09:53	minor spikes
73	116-ty	29-Apr-2017 08:02:12	minor spikes
74	117	29-Apr-2017 20:06:32	spikes
75	118-ty	30-Apr-2017 08:53:14	spikes

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Table 29 – *continued from previous page*

File No.	CTD	Date on Plot Title	Notes
76	119	30-Apr-2017 20:57:50	spikes
77	119-120	01-May-2017 08:17:11	spikes

Table 29: Chipod 2018, Up Look, casts and files.

File No.	CTD	Date on Plot Title	Notes
3	n/a	13-May-1999 21:08:20	bench test with 1970 date
4	n/a	19-Mar-2017 20:29:19	bench test
5	n/a	19-Mar-2017 23:06:37	no station
6	1-2	20-Mar-2017 12:00:00	test stations - SPIKES!
7	3	21-Mar-2017 09:29:11	SPIKES
8	no CTD	21-Mar-2017 21:37:52	VMP only at station #4
9	5	22-Mar-2017 12:00:00	SPIKES
-	6	-	missing file
10	no CTD	24-Mar-2017 08:04:45	VMPs only today
11	8	24-Mar-2017 21:42:26	changed wire routing/minor electrical noise
12	9-10	25-Mar-2017 07:05:35	minor electrical noise
13	11-12	25-Mar-2017 19:11:26	minor electrical noise
14	13-15	26-Mar-2017 12:00:00	minor electrical noise
15	18	27-Mar-2017 07:07:01	minor electrical noise
16	19-20	27-Mar-2017 19:16:31	minor electrical noise
17	no CTD	28-Mar-2017 12:00:00	no station
18	21-24	29-Mar-2017 12:00:00	minor electrical noise
19	25-29	30-Mar-2017 12:00:00	minor electrical noise
20	29-37	31-Mar-2017 11:15:31	minor electrical noise
21	no CTD	31-Mar-2017 23:36:29	minor electrical noise
22	no station	01-Apr-2017 12:00:00	taped Rosette
23	38-39	02-Apr-2017 07:54:30	minor spikes
24	40-41	02-Apr-2017 20:01:58	good
-	41-42??	03-Apr-2017	missing file ???
25	no CTD	04-Apr-2017 15:31:42	no station + 2095 year date
26	no CTD	04-Apr-2017 06:07:58	no station
27	no CTD	04-Apr-2017 18:12:44	no station
28	47	05-Apr-2017 06:35:51	noisy - keep eye on
29	48-49	05-Apr-2017 18:40:17	noisy / spiky at depth
30	50-53	06-Apr-2017 22:47:34	2035 year date / noisy
31	54-ty	06-Apr-2017 18:33:31	noisy!
32	54-ty	07-Apr-2017 08:26:04	noisy!
33	55-ty	07-Apr-2017 20:31:45	replaced tip - good
34	56;57-ty	08-Apr-2017 08:12:35	not good
35	-	08-Apr-2017 22:33:25	no station

Continued on next page

Table 30 – *continued from previous page*

File No.	CTD	Date on Plot Title	Notes
36	58-ty	09-Apr-2017 09:28:33	-
37	no CTD	09-Apr-2017 21:33:38	no station
38	59-63	10-Apr-2017 12:00:00	poor quality
39	63-65	11-Apr-2017 06:10:38	barf
-	-	12-Apr-2017	missing file
40	-	12-Apr-2017 06:19:30	no station
41	-	12-Apr-2017 18:26:24	no station
42	-	13-Apr-2017 06:19:30	no station
43	-	13-Apr-2017 18:26:17	no station
44	-	14-Apr-2017 06:57:38	no station
45	-	14-Apr-2017 19:02:23	no station
46	-	15-Apr-2017 07:06:14	no station
47	-	15-Apr-2017 19:10:52	no station
48	78	16-Apr-2017 05:41:01	BARF
49	79-81	16-Apr-2017 17:45:23	ok
50	81-85	17-Apr-2017 07:25:00	unconvincing
51	no CTD	17-Apr-2017 19:30:59	no station
52	86	18-Apr-2017 06:37:47	ok
53	-	18-Apr-2017 18:42:11	no station
54	-	19-Apr-2017 06:31:23	no station
55	89-ty	19-Apr-2017 18:36:46	minor spikes
56	89-ty	20-Apr-2017 05:55:28	minor spikes
57	90	20-Apr-2017 18:00:09	good
58	91-ty	21-Apr-2017 07:49:57	good
59	-	21-Apr-2017 19:55:32	no station
60	92-93	22-Apr-2017 08:24:09	unclear
61	94	22-Apr-2017 20:28:43	spikes/bad
62	95 96-ty	23-Apr-2017 12:00:00	not obviously nfg
63	96-ty 98-99	24-Apr-2017 08:08:28	noisy w/ ok spots?
64	100	24-Apr-2017 20:17:07	unimpressive
65	101-104	25-Apr-2017 07:09:30	gack!
66	105	25-Apr-2017 19:14:32	thpppt
67	107-ty	26-Apr-2017 09:00:15	yes/no?
68	-	26-Apr-2017 22:15:37	no station
69	109-110	27-Apr-2017 06:31:54	???
70	111-113	27-Apr-2017 18:35:30	nfg
71	113-115	28-Apr-2017 09:10:08	nfg
72	116-ty	28-Apr-2017 21:15:59	spikes / nfg
73	116-ty	29-Apr-2017 08:06:54	???
-	117	29-Apr-2017	no file
74	118-ty	30-Apr-2017 08:58:18	spikes
75	119	30-Apr-2017 21:04:28	crap
76	119-120	01-May-2017 08:22:02	spikes

Table 30: Chipod 2016, Down Look, casts and files.

File No.	CTD	Date on Plot Title	Notes
3	n/a	22-Mar-2014 03:20:12	bench test with 1970 year date
4	n/a	19-Mar-2017 15:09:06	bench test
5	n/a	19-Mar-2017 18:26:55	bench test
6	n/a	19-Mar-2017 21:11:02	no station
7	1-2	20-Mar-2017 12:00:00	test stations / appears functional
8	3	21-Mar-2017 09:09:22	appears functional
9	no CTD	21-Mar-2017 21:18:40	VMP only at station #4
10	5	22-Mar-2017 12:00:00	appears functional
11	6	23-Mar-2017 12:00:00	appears functional
12	no CTD	24-Mar-2017 08:49:23	VMPs only today
13	8	24-Mar-2017 20:19:11	changed wire routing/minor electrical noise
14	9-10	25-Mar-2017 07:16:57	minor electrical noise
15	11-12	25-Mar-2017	minor electrical noise
16	13-15	26-Mar-2017 12:00:00	minor electrical noise
17	18	27-Mar-2017 06:47:48	minor electrical noise
-	19-20	27-Mar-2017	missing file
18	-	28-Mar-2017 12:00:00	no station
19	21-14	29-Mar-2017 12:00:00	minor electrical noise
20	25-27	30-Mar-2017 09:13:05	minor electrical noise
21	28-29	30-Mar-2017 21:26:20	minor electrical noise
22	29-37	31-Mar-2017 12:00:00	minor electrical noise
23	no CTD	01-Apr-2017 00:00:52	no station + very short
24	no CTD	01-Apr-2017 12:06:14	taped Rosette
25	38	02-Apr-2017 06:14:37	repeat with below
26	38	02-Apr-2017 06:14:37	repeat with above
27	39-41	02-Apr-2017 18:21:21	functional
28	41-42	03-Apr-2017 06:47:22	functional
29	no CTD	03-Apr-2017 18:51:56	no station
30	no CTD	04-Apr-2017 05:59:01	no station
31	no CTD	04-Apr-2017 18:03:02	no station
32	47	05-Apr-2017 06:21:56	good!
33	48-49	05-Apr-2017 18:26:26	minor spikes

Table 31: Chipod 2013, Up Look, casts and files.

File No.	CTD	Date on Plot Title	Notes
3	n/a	06-Apr-2017 15:37	bench test
4	n/a	07-Apr-2017 16:26:39	shorty / bench test?
5	56; 57-ty	08-Apr-2017 07:50:08	
6	-	08-Apr-2017 19:56:59	no station

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Table 32 – *continued from previous page*

File No.	CTD	Date on Plot Title	Notes
7	58-ty	09-Apr-2017 09:17:15	good
8	no CTD	09-Apr-2017 21:22:18	no station
9	59-63	10-Apr-2017 12:00:00	good!
10	63-65	11-Apr-2017 05:55:56	good
11	-	11-Apr-2017 18:02:53	no station
12	-	12-Apr-2017 06:09:02	no station
13	-	12-Apr-2017 18:13:35	no station
14	-	13-Apr-2017 06:08:19	no station
15	-	13-Apr-2017 18:13:25	no station
16	-	14-Apr-2017 06:46:55	no station
17	-	14-Apr-2017 18:52:01	no station
18	-	15-Apr-2017 06:56:54	no station
19	-	15-Apr-2017 19:01:39	no station
20	78	16-Apr-2017 05:31:48	nfg
21	79-18	16-Apr-2017 17:35:40	good
22	81-85	17-Apr-2017 07:13:21	good!
23	-	17-Apr-2017 19:18:28	no station
24	86	18-Apr-2017 06:27:53	ok
25	-	18-Apr-2017 18:32:16	no station
26	-	19-Apr-2017 06:21:47	no station
27	89-ty	19-Apr-2017 18:26:23	good
28	89-ty	20-Apr-2017 05:45:48	good
29	90	20-Apr-2017 17:50:14	good!
30	91-ty	21-Apr-2017 07:38:18	some parts noisy
31	-	21-Apr-2017 19:43:44	no station
32	92-93	22-Apr-2017 08:13:47	good!
-	94	22-Apr-2017	missing file
33	95 96-ty	23-Apr-2017 12:00:00	good!
34	96-ty 98-99	24-Apr-2017 07:34:41	good
35	100	24-Apr-2017 22:26:51	good!
36	101-104	25-Apr-2017 07:01:35	good
37	105	25-Apr-2017 19:05:15	good
38	107-ty	26-Apr-2017 08:48:29	good!
39	-	26-Apr-2017 20:54:27	no station
40	109-110	27-Apr-2017 06:23:49	good
41	111-113	27-Apr-2017 18:27:25	good
42	113-115	28-Apr-2017 08:58:56	good
43	116-ty	28-Apr-2017 21:03:54	good
44	116-ty	29-Apr-2017 07:57:41	good
45	117	29-Apr-2017 20:01:56	good
46	118-ty	30-Apr-2017 08:46:11	good
47	119	30-Apr-2017 20:52:52	good
48	119-120	01-May-2017 08:12:34	good

Table 32: Chipod 102, Up Look, casts and files.

5 Underway Systems

5.1 AME Ship Systems – *Carson McAfee.*

Instrument Serial Numbers

Instrument	S/N	Comments
LAB Instruments		
AutoSal	68533	
Scintillation Counter	N	
Magnetometer STCM1	N	
XBT	N	
ACOUSTIC		
ADCP	Y	
PES	N	
EM120	Y	
TOPAS	N	
EK60	N	
SSU	N	
USBL	Y	See Below
10kHz IOS pinger	N	
Benthos 12kHz pinger S/N 1316 + bracket	N	
Benthos 12kHz pinger S/N 1317 + bracket	N	
MORS 10kHz transponder	N	
OCEANLOGGER		
Barometer1(UIC)	Y	
Barometer1(UIC)	Y	
Foremast Sensors		
Air humidity & temp1	6138 / 6609	
Air humidity & temp2	6137 / 6752	
TIR1 sensor (pyranometer)	161952	Not Working
TIR2 sensor (pyranometer)	161953	
PAR1 sensor	150813	Different values to PAR2
PAR2 sensor	150814	Different values to PAR1
PREP. LAB		
Thermosalinograph SBE45	4524698-0018	

Continued on next page

Table 33 – *continued from previous page*

Instrument	**S/N**	**Comments**
Transmissometer	527DR	
Fluorometer	6456RTX	
Flow meter	811950	
Seawater temp 1 SBE38	0767	
Seawater temp 2 SBE38	0771	
AME UNSUPPORTED INSTRUMENTS BUT LOGGED		
EA600	Yes	
Anemometer	Yes	
Gyro	Unsure	
DopplerLog	Unsure	
EMLog	Unsure	

Table 33: Serial numbers of instruments used on cruise JR16005.

pCO2

This system was started on the 22/03/2017 at 18:00 UTC, and requires constant manual adjustment. This is normally done by an electronic control valve, however it was damaged before the start of the previous cruise (see JR16004 cruise report), and there are no spares on the ship.

The only change made to the system, is the removal of the inline filter (installed on the previous cruise). This filter would prevent biological matter entering the equilibrator tanks, and prevent blockages in the water jets. The negative aspect is that the filter would require multiple daily cleaning, however the system requires constant adjustment anyway.

The following table shows the dates and times when the flow rate was changed during the cruise. Note that the flow rates indicate the values after the change was made, and not before. Ideally the Equilibrator should be 1.6 L/min (0.8 L/30 sec), and the Pre-Equilibrator should be between 1-1.4 L/min (0.5-0.7 L/30 sec). Adjusting these values was often necessary due to pressure changes, and biological blockages.

Date	**Start Time**	**Name**	**Pre-Equi Flow Rate (L/30 sec)**	**Equilibrator Flow Rate (L/30 sec)**	**End Time**	**Notes**
17/04/2017	17:50	SMG	0.59	0.79	17:53	
18/04/2017	04:41	NB	0.57	0.78	04:47	RHS was 0.62
18/04/2017	08:50	NB	0.63	0.80		LHS was 0.35
18/04/2017	13:04	SMG	0.64	0.81	13:09	RHS was 0.84
18/04/2017	15:26	SMG	0.63	0.79	15:33	

Continued on next page

Table 34 – *continued from previous page*

Date	Start Time	Name	Pre-Equi Flow Rate (L/30 sec)	Equilibrator Flow Rate (L/30 sec)	End Time	Notes
18/04/2017	18:41	SMG	0.60	0.82	18:44	
19/04/2017	03:55	NB	0.62	0.16	03:59	LHS Blocked
19/04/2017	08:51	TD	0.60	0.80	08:54	LHS was 0
19/04/2017	13:11	EFW	0.57	0.79	13:13	
19/04/2017	15:58	SMG	0.57	0.80	16:02	RHS was 0.89
19/04/2017	17:50	EFW	0.57	0.80	17:53	
19/04/2017	19:47	CS	0.58	0.79	19	
19/04/2017	22:36	CS	0.57	0.79	22:38	
20/04/2017	02:34	CS	0.58	0.80	02:38	
20/04/2017	06:43	TD	0.59	0.80	06:48	RHS was 0.63
20/04/2017	11:22	EFW	0.57	0.81	11:25	
20/04/2017	13:27	SMG	0.58	0.83	13:31	
20/04/2017	15:30	SMG	0.58	0.81	13:33	RHS was 0.83
20/04/2017	17:35	SMG	0.60	0.82	17:38	
20/04/2017	20:40	CS	0.58	0.81	20:42	
21/04/2017	02:48	CS	0.59	0.81	02	RHS was 0.42
21/04/2017	07:16	TD	0.58	0.79	07:18	
21/04/2017	11:29	CB	0.55	0.84	11:31	RHS was 0.80
21/04/2017	14:21	SMG	0.57	0.80	14:23	
21/04/2017	17:10	EFW	0.57	0.80	12:12	
21/04/2017	19:13	CS	0.59	0.80	19:16	
22/04/2017	04:51	NB	0.56	0.81	04:54	
22/04/2017	19:15	NB	0.56	0.80	09:16	
22/04/2017	13:00	CB	0.62	0.80	13:05	RHS was 0.95
22/04/2017	19:00	CB	0.62	0.80	19:02	
23/04/2017	01:05	JH	0.60	0.79		LHS was 0.05, RHS was 0.74
23/04/2017	04:37	NB	0.61	0.77	04:45	LHS was 0.69
23/04/2017	08:24	TD	0.61	0.79	08:28	RHS was 0.76
23/04/2017	12:42	PA	0.60	0.79	12:44	
23/04/2017	14:33	PA	0.60	0.81	14:38	RHS was 0.77
23/04/2017	17:01	EFW	0.59	0.79	17:02	
23/04/2017	18:46	EFW	0.59	0.81	18:49	RHS was 0.87
23/04/2017	23:04	CS	0.61	0.80	23:17	LHS was 0.65, RHS was 0.95
24/04/2017	01:46	CS	0.59	0.81	01:49	
24/04/2017	03:32	NB	0.62	0.60		LHS was 0.26. RHS is blocked.
24/04/2017	10:03	NB	0.64	0.80	10:07	

Continued on next page

Table 34 – *continued from previous page*

Date	Start Time	Name	Pre-Equi Flow Rate (L/30 sec)	Equilibrator Flow Rate (L/30 sec)	End Time	Notes
24/04/2017	11:48	SMG	0.62	0.81	11:55	
24/04/2017	14:06	PA	0.63	0.82	14:08	
24/04/2017	16:12	PA	0.63	0.82	14:14	
24/04/2017	18:45	PA	0.62	0.82	18:47	
25/04/2017	02:35	CS	0.60	0.79	20:38	
25/04/2017	07:55	TD	0.60	0.82	07:58	
25/04/2017	11:37	EFW		0.78		LHS was 0.1. Cant reset.
25/04/2017	12:05	CM	0.58	0.80	12:25	Cleaned both chambers. Shrimp blocking both jets.
25/04/2017	13:39	CB	0.60	0.80	13:40	
25/04/2017	15:55	SMG	0.59	0.80	15:57	
25/04/2017	23:03	CS	0.59	0.80		
26/04/2017	05:41	TD	0.59	0.80	05:44	RHS was 0.65
26/04/2017	09:46	NB	0.64	0.27	09:48	RHS has a blockage.
26/04/2017	12:02	EFW	0.62	0.80	12:06	RHS flow was very low.
26/04/2017	14:05	CB	0.60	0.80	14:07	RHS was 0.77
26/04/2017	16:01	PA	0.62	0.80	16:04	
26/04/2017	18:04	PA	0.62	0.80	18:07	RHS was 0.85
26/04/2017	21:30	KN	0.63	0.82	21:32	
27/04/2017	00:31	CS	0.63	0.81	00:35	RHS was 0.67
27/04/2017	08:25	TD	0.60	0.80		
27/04/2017	12:45	CB	0.60	0.78	12:47	
27/04/2017	14:40	CB	0.60	0.79	14:41	
27/04/2017	16:34	PA	0.60	0.80	16:36	
27/04/2017	18:43	PA	0.61	0.81		
27/04/2017	20:49	KN	0.60	0.81		
28/04/2017	00:11	CS	0.61	0.80		LHS was 0, and RHS was 0.62
28/04/2017	03:09	NB	0.61	0.34	03:12	RHS has a blockage
28/04/2017	06:37	NB	0.61	0.35	06:39	
28/04/2017	10:23	TD	0.60	0.80		Blockage cleared.
28/04/2017	12:44	PA	0.60	0.80	12:46	RHS was 0.78

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Table 34 – *continued from previous page*

Date	Start Time	Name	Pre-Equi Flow Rate (L/30 sec)	Equilibrator Flow Rate (L/30 sec)	End Time	Notes
28/04/2017	14:34	EFW	0.60	0.80	14:36	
28/04/2017	18:58	PA	0.60	0.80	19:00	
28/04/2017	20:50	CS	0.61	0.79		
28/04/2017	23:34	CS	0.60	0.79	23:37	
29/04/2017	03:18	TD	0.60	0.79	03:20	
29/04/2017	08:36	TD	0.61	0.80	08:38	
29/04/2017	12:39	EFW	0.60	0.79	12:43	RHS was 0.9
29/04/2017	14:52	EFW	0.61	0.78	14:54	
29/04/2017	19:13	CS	0.61	0.79		
30/04/2017	02:05	CS	0.60	0.79	02:07	
30/04/2017	06:00	TD	0.60	0.80	06:01	
30/04/2017	10:46	TD	0.60	0.80	10:47	
30/04/2017	12:43	PA	0.61	0.81	12:47	RHS was 0.61
30/04/2017	15:00	PA	0.60	0.80	15:04	RHS was 0.86
30/04/2017	18:04	SMG	0.59	0.81		RHS was 0.73
01/05/2017	05:19	NB	0.60	0.83	05:21	
01/05/2017	09:17	SL	0.62	0.88	09:23	RHS was 0.3
01/05/2017	12:06	SMG	0.60	0.81		
01/05/2017	17:11	SMG	0.60	0.79		RHS was 0.7

Table 34: pCO2 flow rate adjustments on cruise JR16005.

The PI for this system is Ian Brown (iaian2@pml.ac.uk) from PML. He has indicated that he will be visiting the ship in June to upgrade and repair the system.

Acoustic Cabinet

During the previous cruise (JR16004), UPS 1 started to show signs of failure, and during this cruise it failed. On the 27/04/2017 there was a distinct burning smell (chemical rather than melting plastic) coming from the cabinet. This was traced to UPS 1, which was hot. A quick inspection showed that the battery bank inside the UPS was overheating. Four of the eight internal batteries were swollen, and hot enough to melt the batteries together. All the batteries were removed from the UPS, and left to cool. Fortunately none of the batteries leaked. They have been stored in the cage for disposal in the UK.

The UPS hardware still appears to operate correctly (providing a stable supply to the Seapath monitor), and may be fine if new batteries are installed. Pete Lens (ICT) has ordered a new UPS for the ship, however it may be worth upgrading the batteries in this unit, and keeping it as a spare.

The semi-critical (NMEA splitter, and Labview Server) equipment that were on UPS1, have been moved to UPS 2 by using a multi-plug extension lead with an IEC connector attached. This is a temporary solution that will last until the spare UPS is brought to the ship.

Salinometer

No major problems have been reported on this system. At the beginning of the cruise one of the internal heating light bulbs failed, and was replaced. Spare bulbs and a peristaltic pump have been ordered.

USBL

Initial Problems

There were two problems at the beginning of the cruise.

1. We could not get the NMF beacons to work, and the BAS beacons only worked between 480-1220 m. After contacting Sonardyne, we found that the transmit power of the Hull transducer (USBL head) was set too high. This is configured in the transducer settings of Ranger. The default power is 'High', and needs to be changed to 'Low'. After this both BAS and NMF beacons began operating.

2. If a beacon lost communication after 2000 m, it would not regain a location fix until it was raised above this depth again. This was caused by the range setting under the 'Environmental' option in Ranger.

A NMF WMT USBL setup guide has been created in the Wiki, and details all the required settings for using an NMF beacon with our system. This should simplify matters on future cruises, and contains information relevant to the BAS beacons.

Improvements

The Deck Engineer and AME Engineer fitted a new three light display to indicate the position of the USBL pole. This indicator is installed on the back wall (top right corner) of the UIC, near the door that exits onto the back deck.

The motivation for this display is due to the repeated tests that failed due to poor communication between the UIC and the bridge. There have been multiple cases where the USBL is being tested with little or no results, and the cause has been that the pole was not lowered into the water. This display helps to eliminate the problem.

This system is a simple three light display that is driven by relays in the USBL distribution box in the transducer space. This is then connected to the UIC via 4 conductors in the 'H' JB's of the scientific wiring. This has been documented in the on board scientific wiring notes (AME Office).

System State

Individual NMF beacons (WMT) operate well with the JCR USBL system. As long as the beacon is in the operational angle, the system is capable of tracking from 50 m, to deeper than 5000 m. The operating angle (defined by depth and radial distance of the beacon) changes depending on the location of the USBL pole. When flush the angle is 20° off perpendicular (40° full beam), and when extended the angle of 60° off perpendicular (120° full beam). The beam angle is important when trying to track a beacon that is close to the surface, and far from the ship (past the beam angle). Beyond these angles tracking will not work.

Unfortunately the BAS beacons do not work as well as the NMF beacons. They work from 50 m, down to approximately 2500 m. I cannot explain why this is happening. I have tested different power/gain settings on the beacon, and changed the power level of the hull transponder (in Ranger). Neither of these allowed the beacon to track down to its maximum depth of 4000 m. The testing of the BAS beacons was limited by the depths of the casts/tow-yo's (often deeper than 4000 m), and the fact that there would be a VMP in the water during most casts (which would take priority on the USBL system).

This highlights another problem with the system. When tracking an individual beacon the system would operate quite well (fast and stable). However when attempting to track two or more beacons the system would take a lot longer to gain a fix on location. The locations would also be more spread out, and occasionally erratic. The system would also go into a loop of gaining a fix, and then losing it for all beacons (almost like constructive/destructive interference). There is definitely interference happening, but the exact cause is unclear.

Even with these problems, the system is mostly reliable, and safe for use. It was used repeatedly on VMP deployments, as well as Autosub operations.

UWIA

This system performed well during the cruise, and required minimal intervention. There were a number of instances where the room temperature dropped due to external temperatures, doors left open, and heating failures. Most of the time the system would dry itself out, and continue operating. There was one case where the drierite had become saturated, and needed changing.

System Work Log

What follows is a daily log of work completed on the system. These logs also discuss problems found, as well as the conclusions and solutions arrived at during the cruise.

Time	Comments
21/03/2017	
20:02	Replaced peristaltic pump tube. Filter looks good. No change.
20:03	PC system started. Water started.
31/03/2017	
11:56	Data looks bad. Something went wrong last night.
02/04/2017	
11:55	At some time during the night the water stopped. H2O values start to drop at 08:00 UTC.
05/04/2017	

Continued on next page

Table 35 – *continued from previous page*

Time	Comments
11:56	System running well.
11:56	Change Peristaltic pump tube, and filter.
12:00	Done.
06/04/2017	
12:09	18.7° in the cabinet. Temperature dropped in the night, and condensation formed on the inside of the air supply pipes. H2O values are erratic.
07/04/2017	
12:06	Pipes are still wet. Internal condensation. Ambient temperature is low. Pipes nee dto dry out.
12:07	Bypass the membrane, and attached the drierite source.
08/04/2017	
12:07	Something went wrong. Yesterday the pipes were wet, so I decided to use dry air (drierite source, with membrane bypassed) to dry out the pipes. After a few hours the H2O value was down to ˜2000 ppm. It should be lower so I left it to continue drying. However this morning the H2O value had increased to ˜4300 ppm. This may indicate a problem with the drierite.
12:11	I connect the drierite source directly to the source input (with a filter).
12:31	H2O is at 4190 ppm. Did not drop significantly. Therefore the drierite is definitely wet, and needs to be replaced.
12:32	Switched to ambient air.
13:06	Switched back to direct drierite test (with new drierite).
13:40	H2O is at 707 ppm. Probably will drop more. I am happy with the new drierite.
13:43	Switched back to the standard drierite pipe configuration (bypassed membrane).
14:15	H2O is 890 ppm. Standard drierite test looks good.
14:16	Reconnect membrane. System running normally again.
18/04/2017	
12:52	Opened the fridge, and shifted (not replaced) the peristaltic tube.
12:54	Replaced filter.
22/04/2017	
	Data looks bad. Temperature dropped, and there is condensation in pipes.
23/04/2017	
	System corrected itself. Data looks good.
26/04/2017	

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Table 35 – *continued from previous page*

Time	Comments
12:38	Temperature dropped again. Condensation in pipes and bad data.
28/04/2017	
18:04	Temperature dropped again. Wet pipes, and bad data.
29/04/2017	
	System still recovering from yesterday as temperature increases.
31/04/2017 and 01/05/2017	
	Low temperature. Bad data and condensation on inside of pipes.
04/05/2017	
	Water supply was stopped at approximately 12:00 UTC.
05/05/2017	
	Water supply restarted during the morning.

Table 35: Work log on UWIA system during cruise JR16005.

Recommendation

This system is very susceptible to small changes in temperature, and its current location is in a passageway which is used throughout the day. The constant opening/closing of the passage doors allows heat to escape, and the temperature to drop. Additionally it is located directly next to a door that is exposed to outside temperatures for long periods of the day. The obvious solution is to move the instrument to a lab with a more stable temperature.

I would recommend using the MIC. RADIO' lab, which is attached to the current passageway location. It has a sea water supply and sink, and has a location for the installation (where the fridge is currently located). This lab is not used often, and has a more stable temperature.

Seapath GPS

The Seapath GPS failed twice during the cruise (unrelated to the UPS issues). The first time, both the deck unit and PC needed to be restarted. The second time only the PC needed to be restarted. This system needs to be monitored in case these failures begin happening more often.

It would also be a good idea to test both the spare Seapath units. Given the re-wiring required, and the importance of the GPS to the ship and science, it was decided not to attempt a test during the cruise. I would recommend testing the GPS during a refit/drydock period.

ChiPods

ChiPods are standalone instruments that were attached to the CTD during the cruise. The instruments are property of Oregon State University (College of Earth, Ocean, and Atmospheric Sciences), and are managed by June Marion (jmarion.ceoas@gmail.com). The ChiPods can be described as: 'Self contained devices that estimate small scale temperature variability using fast response FP07 thermistors sampled at 100 Hz'.

AME were involved with the daily maintenance and data management of these devices. A separate document detailing this work is available on request, but is not directly relevant in this report.

Ocean Logger

At the end of the last cruise (JR16004), scientists reported that the transmissometer was producing bad data, and could be caused by a dirty lens. On the 22/03/2017 at 18:00 UTC, the lens was cleaned.

Swath

No major issues with this system. It was used intermittently with the VMP casts. There was a suspicion that the Swath would interfere with the VMP data.

Ship ADCP

Used throughout the cruise. The scientists have reported that the swath does not appear to create noise on the ADCP data, as reported by the scientists on JR16004. The general consensus is that the data quality is good, and there are no problems with the system. A possible reason for problems reported in the past is that VMDAS appears to plot the data incorrectly (partially processed). The recorded data is however fine.

5.2 Vessel Underway Systems Processing – *Alex Forryan & Nikki Brown*

Raw data from the ship SCS system underwent a series of post processing programs from the mexec suite as follows;

mday_00_get_all(day) Retrieves data from from ship SCS system.
mday_02_run_all(day) Appends the days file to the running logs.
mbest_all(day) Calculates the 'best' position by combining the different navigation streams.
mtruewind_01 Calculate true wind data.

Running logs of the whole cruise were updated daily using the mday_02 command. The files must be added sequentially in order. The true wind direction was calculated by combining the measured relative wind speed and direction with the calculated 'best' navigation data. No calibrations were applied to the underway data.

Thermosalinograph

A SBE45 MicroTSG, fitted in the wet lab, draws on seawater supplied from an inlet situated in the hull of the ship and takes temperature and conductivity measurements. Throughout the cruise salinity samples were taken from the non-toxic supply located upstream of the SBE45 every 6 hours. A basic ratio calibration is to be calculated and applied to the TSG conductivity using the measured conductivity from the bottle samples post cruise.

5.3 Swath Bathymetry – *Povl Abrahamsen*

The multi-beam sonar on the JCR, a Kongsberg Simrad EM122, was running during most of the cruise, from after leaving the Chilean and Argentine exclusive economic zones, until shortly before entering the Argentine EEZ en route to Montevideo. The data have been split into four surveys. The first, JR16005_a covers the transit to Coronation Island, through Lewthwaite Strait south to M2 and M3 and up to the start of section F (station 9). JR16005_b covers the work south of Orkney Passage from station 9 to the Autosub recovery position on 4 Apr. JR16005_c covers the rest of the science, from 4 Apr up to 1 May; logging was disabled for much of that time, as the region has been extensively surveyed on JR235/6/9, JR252, and JR310. However, when crossing areas that had gaps in our known swath coverage, we did log data. The final survey, JR16005_d, covers the transit from the northern end of section A (station 120) to the edge of the Argentine EEZ en route to Montevideo. The division into surveys is shown in Figure 17.

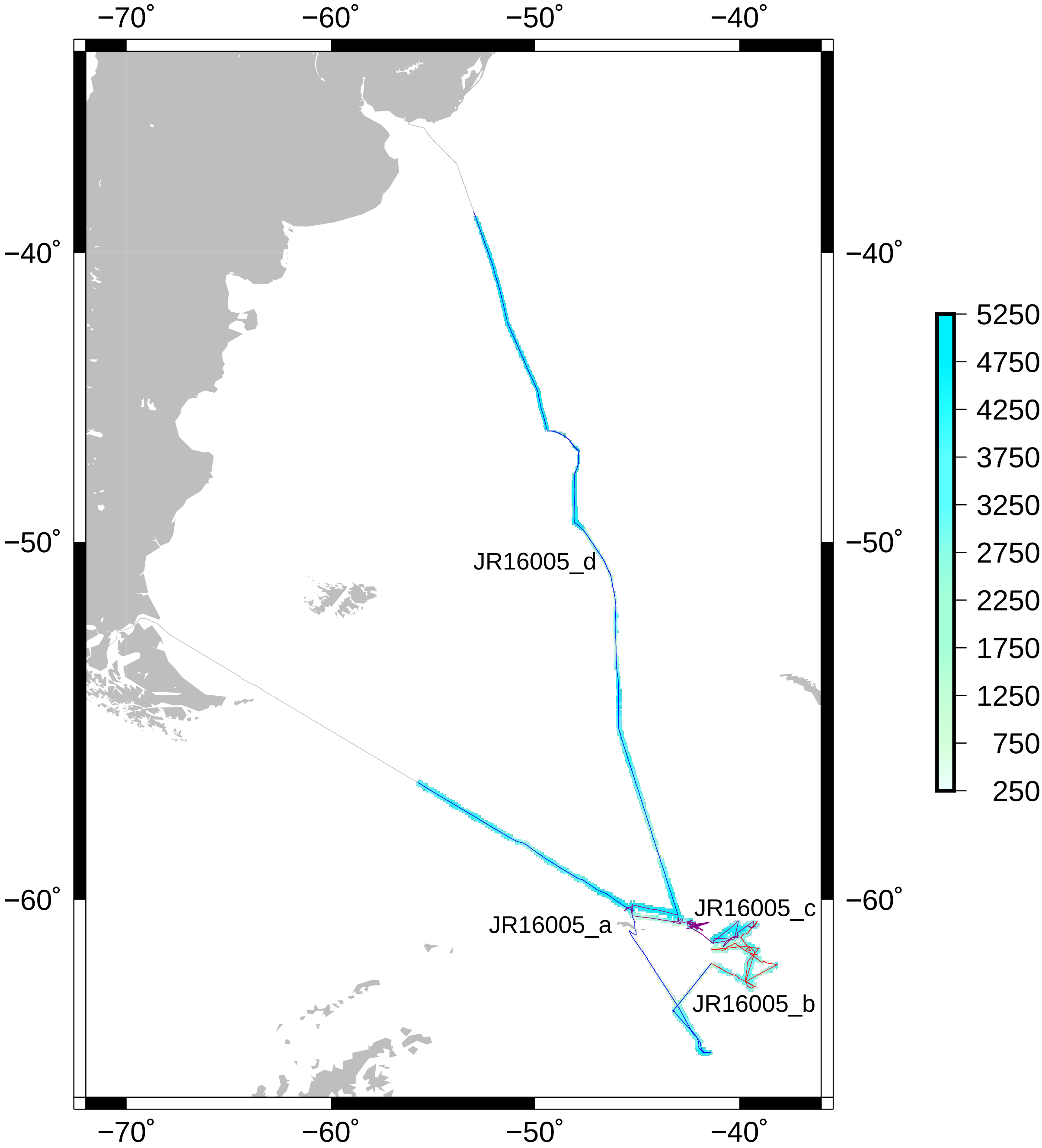

Figure 17: Overview of the swath bathymetry data from JR16005, with track colours alternating between blue, red, magenta, and blue.

Instruments and methods

Data acquisition was performed on a Windows 7 workstation, em122, running Simrad's SIS software. The default settings, as described in the notes "Using the EM122 multibeam on an opportunistic basis", by Gwen Buys and Alex Tate, version 3.0 dated 28/4/2013, were used – with varying maximum beam angles, depending on the depth and sea state. For most of the cruise a beam angle of 65 degrees was used. CTD casts were imported regularly as sound velocity profiles, to represent local conditions. The details of the profiles used at different points in the cruise are in the table below. After crossing North Scotia Ridge, a representative XBT cast from the Argentine Basin from JR206 was used.

Data from this cruise have not been cleaned and processed on board. Generally the data appears to be of good quality, though some manual cleaning will be required. During the rough weather encountered on 28/3, 9-10/4, and 3/5 many data were missing because of poor returns from the seabed, possibly exacerbated by bubbles beneath the transducers.

When running the EM122, the EA600 was in passive mode, synchronised by the KSync. A problem was occasionally encountered in the second half of the cruise, where the KSync computer said that the EM122 timed out; at this stage the trace for the EM122 went gray (inactive). The EA600 was then triggered; the EM122 trace went green, and shortly afterwards both the EM122 and EA600 were triggered, causing the EA600 to record the transmit pulse from the EM122. This problem was not fully explained or solved, but seems to be cured by reducing the beam angle (receive time) and/or reducing the depth range on the EM122. This was first encountered on 6 April, and then appeared periodically afterwards. Most of the time both instruments were working correctly.

Survey	Note	Lines	Date	Time	XBT/CTD for SVP file name	Location/ station
JR16005_a		0	19/3	22:47	JR16004 CTD 128	
		2	19/3	22:57	JR16004_128_thinned	
		3	19/3	22:58	JR16004 CTD 175	
		15	20/3	11:28	JR16004_175_thinned	1
		16	20/3	17:28	JR16004 CTD 175	1
		20	20/3	22:12	JR16004_175_thinned	2
		21	20/3	23:35	JR16004 CTD 175	2
		35	21/3	14:16	JR16004_175_thinned	3 (WHOI)
		36	21/3	23:45	JR16005 CTD 3	WHOI
		36	22/3	00:17	JR16005_003_thinned	WHOI R1
		37	22/3	00:23	JR16005 CTD 3	WHOI R1
		37	22/3	00:40	JR16005_003_thinned	WHOI R2
		38	22/3	00:47	JR16005 CTD 3	WHOI R2
		38	22/3	00:54	JR16005_003_thinned	
		39	22/3	01:25	JR16005 CTD 3	WHOI R3
	1	39	22/3	01:45	JR16005_003_thinned	
		40	22/3	02:07	JR16005 CTD 3	
		40	22/3	02:24	JR16005_003_thinned	WHOI R4
		41	22/3	14:38	JR16005 CTD 3	5
		48	22/3	21:58	JR16005_003_thinned	
		49	22/3	21:58	JR310 CTD 1	
		58	23/3	07:41	JR310_CTD001_thinned	M2

Continued on next page

Table 36 – *continued from previous page*

Survey	Note	Lines	Date	Time	XBT/CTD for SVP file name	Location/ station
		59	23/3	11:21	JR310 CTD 1	M2
		64	23/3	17:14	JR310_CTD001_thinned	6 (M3)
		65	23/3	23:21	JR310 CTD 1	6
		65	24/3	00:18	JR310_CTD001_thinned	7
		66	24/3	11:27	JR310 CTD 1	M3 R1
		67	24/3	11:44	JR310_CTD001_thinned	M3 R2
		67	24/3	11:51	JR310 CTD 1	M3 R2
		67	24/3	12:07	JR310_CTD001_thinned	M3 R3
		68	24/3	13:16	JR310 CTD 1	M3 R3
		74	24/3	19:41	JR310_CTD001_thinned	M2
		75	24/3	23:35	JR16005 CTD 8	VMP 8
		75	24/3	23:52	JR16005_008_thinned	M2 R2
		76	25/3	00:18	JR16005 CTD 8	M2
		85	25/3	09:43	JR16005_008_thinned	9
JR16005_b		0	25/3	10:51	JR16005 CTD 8	9
		1	25/3	11:52	JR16005_008_thinned	10
		2	25/3	13:38	JR16005 CTD 8	10
		2	25/3	14:26	JR16005_008_thinned	11
		3	25/3	16:53	JR16005 CTD 8	11
		3	25/3	17:40	JR16005_008_thinned	12
		4	25/3	20:11	JR16005 CTD 8	12
		4	25/3	20:32	JR16005_008_thinned	13
		5	26/3	00:01	JR16005 CTD 8	13
		7	26/3	02:58	JR16005_008_thinned	14
		8	26/3	11:22	JR16005 CTD 8	13
		8	26/3	11:57	JR16005_008_thinned	14
		9	26/3	14:18	JR16005 CTD 8	14
		9	26/3	14:59	JR16005_008_thinned	15
		10	26/3	18:44	JR16005 CTD 8	15
		11	26/3	19:52	JR16005_008_thinned	16
		12	27/3	00:07	JR16005 CTD 8	16
		12	27/3	00:38	JR16005_008_thinned	17
		13	27/3	04:15	JR16005 CTD 8	17
		14	27/3	04:16	JR16005_008_thinned	
		15	27/3	05:30		18
		16	27/3	08:59	JR16005 CTD 8	18
		16	27/3	09:03	JR16005_008_thinned	18
		17	27/3	13:58	JR16005 CTD 8	18
		17	27/3	14:56	JR16005_008_thinned	19
		18	27/3	17:16	JR16005 CTD 8	19
		18	27/3	17:58	JR16005_008_thinned	18
		19	27/3	20:48	JR16005 CTD 8	18
		21	27/3	22:13	JR16005_008_thinned	20
		22	28/3	00:04	JR16005 CTD 8	20
		25	28/3	02:32	JR16005_008_thinned	18
		26	28/3	17:22	JR16005 CTD 8	18
	2	30	28/3	21:41	JR16005_008_thinned	
		41	29/3	09:11		21
		42	29/3	11:09	JR16005 CTD 8	21
		42	29/3	11:37	JR16005_008_thinned	22

Continued on next page

Table 36 – *continued from previous page*

Survey	Note	Lines	Date	Time	XBT/CTD for SVP file name	Location/ station
		43	29/3	13:13	JR16005 CTD 8	22
		43	29/3	14:32	JR16005_008_thinned	23
		44	29/3	16:42	JR16005 CTD 8	23
		45	29/3	18:02	JR16005_008_thinned	24
		46	29/3	19:52	JR16005 CTD 8	24
		47	29/3	21:08	JR16005_008_thinned	25
		48	30/3	06:05	JR16005 CTD 8	25
		49	30/3	07:26	JR16005_008_thinned	25
		50	30/3	07:56	JR16005 CTD 8	
		50	30/3	07:59	JR16005_008_thinned	
		51	30/3	11:05	JR16005 CTD 8	25
		52	30/3	12:27	JR16005_008_thinned	26
		53	30/3	14:42	JR16005 CTD 8	26
		53	30/3	15:31	JR16005_008_thinned	27
		54	30/3	18:41	JR16005 CTD 8	27
		54	30/3	19:41	JR16005_008_thinned	28
		55	30/3	21:38	JR16005 CTD 8	28
		56	30/3	22:37	JR16005_008_thinned	29
		57	31/3	05:40	JR16005 CTD 8	29
		57	31/3	06:19	JR16005_008_thinned	30
		58	31/3	08:21	JR16005 CTD 8	31
		58	31/3	09:06	JR16005_008_thinned	32
		59	31/3	10:24	JR16005 CTD 8	32
		59	31/3	11:14	JR16005_008_thinned	33
		60	31/3	12:58	JR16005 CTD 8	33
		60	31/3	13:40	JR16005_008_thinned	34
		61	31/3	15:20	JR16005 CTD 8	34
		61	31/3	16:04	JR16005_008_thinned	35
		62	31/3	16:36	JR16005 CTD 8	35
		63	31/3	18:36	JR16005_008_thinned	36
		64	1/4	19:48	JR16005 CTD 8	36
	3	68/69	1/4	00:25	JR16005_008_thinned	
		77	1/4	08:59		18
		78	1/4	21:36	JR16005 CTD 8	18
		89	2/4	09:27	JR16005_008_thinned	38
		90	2/4	11:59	JR16005 CTD 8	38
		91	2/4	13:19	JR16005_008_thinned	39
		92	2/4	15:47	JR16005 CTD 8	39
		93	2/4	17:00	JR16005_008_thinned	40
		94	2/4	21:26	JR16005 CTD 8	40
		94	2/4	21:52	JR16005_008_thinned	41
		95	3/4	01:31	JR16005 CTD 8	41
		95	3/4	02:25	JR16005_008_thinned	42
		96	3/4	06:38	JR16005 CTD 8	42
		98	3/4	08:50	JR16005_008_thinned	ALR dep 1
		99	4/4	02:12	JR16005 CTD 8	ALR dep 2
		103	4/4	06:15	JR16005_008_thinned	43
		104	4/4	07:20	JR16005 CTD 8	43
	4	104	4/4	07:58	JR16005_008_thinned	44
		106	4/4	11:18	JR16005 CTD 8	44
		106	4/4	11:45	JR16005_008_thinned	ALR rdvz

Continued on next page

Table 36 – *continued from previous page*

Survey	**Note**	**Lines**	**Date**	**Time**	**XBT/CTD for SVP file name**	**Location/ station**
JR16005_c		0	5/4	02:35	JR16005 CTD 8	ALR rec
		1	5/4	04:27	JR16005_008_thinned	47
		2	6/4	04:17	JR16005 CTD 8	50
		2	6/4	04:40	JR16005_008_thinned	51
		3	6/4	12:56	JR16005 CTD 8	53
	5	12	6/4	21:37	JR16005_008_thinned	54 (TY)
		13	6/4	22:06	JR16005 CTD 8	54 (TY)
	1	13	6/4	22:11	JR16005_008_thinned	54 (TY)
		14	6/4	22:23	JR16005 CTD 8	54 (TY)
		17	7/4	02:12	JR16005_008_thinned	54 (TY)
		18	7/4	14:40	JR16005 CTD 8	
		28	8/4	01:02	JR16005_008_thinned	56
		29	8/4	02:47	JR16005 CTD 8	56
		33	8/4	07:37	JR16005_008_thinned	57 (TY)
		34	8/4	08:20	JR16005 CTD 8	57 (TY)
		44	8/4	18:43	JR16005_008_thinned	Fr float
		45	8/4	19:37	JR16005 CTD 8	Fr float
		50	9/4	00:45	JR16005_008_thinned	58 (TY)
		51	9/4	18:02	JR16005 CTD 8	58 (TY)
	6	51	9/4	18:55	JR16005_008_thinned	
	6	52	10/4	03:07	JR16005 CTD 8	
		59	10/4	10:26	JR16005_008_thinned	59
		60	11/4	14:29	JR16005 CTD 61	ALR dep 2
		60	11/4	15:03	JR16005_061_thinned	ALR wpt 2
	7	61	14/4	00:33	JR16005 CTD 61 JR16005_061_thinned	
	7	62	14/4	14:18	JR16005 CTD 61 JR16005_061_thinned	
		63	20/4	01:45	JR16005 CTD 61	89 (TY)
		65	20/4	04:31	JR16005_061_thinned	89 (TY)
		66	21/4	13:55	JR16005 CTD 61	91
		66	21/4	14:36	JR16005_061_thinned	OP4
		67	24/4	14:54	JR16005 CTD 98	99
		73	24/4	21:37	JR16005_098_thinned	100
		74	25/4	10:25	JR16005 CTD 98	102
		74	25/4	10:36	JR16005_098_thinned	103
		75	25/4	14:48	JR16005 CTD 98	105
		75	25/4	15:30	JR16005_098_thinned	105
		76	25/4	18:47	JR16005 CTD 98	105
		76	25/4	19:32	JR16005_098_thinned	106
		77	26/4	21:02	JR16005 CTD 98	108
		90	27/4	10:35	JR16005_098_thinned	109
		91	27/4	13:16	JR16005 CTD 98	110
		91	27/4	13:54	JR16005_098_thinned	111
		92	28/4	16:41	JR16005 CTD 98	115
		93	28/4	17:46	JR16005_098_thinned	116
		94	1/5	03:05	JR16005 CTD 98	119
		101	1/5	10:52	JR16005_098_thinned	120
JR16005_d		0	1/5	14:01	JR16005 CTD 98	120
		59	4/5	01:47	JR16005_098_thinned	
		60	4/5	01:48	JR206 XBT 17	
		140	7/5	10:46	jr206_xbt17_thinned	

Table 36: Summary of swath data and speed of sound profiles used. All times UTC. Stops for science stations have not been included; a full table is available and has been saved on the legwork drive.

Notes

1. Restarted SIS
2. Turned into the wind; data noticeably degraded.
3. Helmsman had stopped displaying coverage; stopping, then restarting logging appears to have fixed it.
4. SIS crashed; there appears to be no line 105. After this point, the survey grid stopped updating, and some zoom levels are corrupted.
5. EM122 appears to have stopped pinging. SIS was restarted, then EM122 hardware and workstation rebooted. Occasionally EM122 goes gray on K-sync, EA600 is triggered separately, then EM122 fires.
6. Rough weather, not getting usable data.
7. Started, then stopped logging – clicked button by mistake. There doesn't appear to be a line 62.

5.4 Vessel Mounted Acoustic Doppler Current Profiler (VMADCP) – *Alex Forryan & Nikki Brown*

Instrument and configuration

The ADCP mounted on the JCR is a 75 kHz RD Instruments Ocean Surveyor (OS75, model 71A- 1029- 00, SN 2088), which can measure water velocity down to roughly 1000 m below the surface. However, in practice, usable measurements on this cruise typically reached up to 500 m below the surface. The OS75 uses a phased array transducer that produces all four beams from a single aperture at specific angles. Because of the way that the beams are formed, horizontal velocities can be estimated independently from the speed of sound (this is not true for vertical velocities, which still require sound speed). The OS75 unit on the JCR (installed in August 2005) is located in the transducer space in the hull; the typically assumed value for the transducer depth, used on JR16005, is 6.3 m. Configuration of the VMADCP was set using one of the JCR standard VMADCP command files, included in Appendix 1, using the VmDas ADCP control software. The VMADCP was configured with a maximum depth of 1000 m, 100 x 8 m bins, 8 m surface-blanking distance and, ping rate set independently from the SIMRAD Synchronization Unit (SSU), i.e. the OS75 was set to use its own internal ping rate. The misalignment angle was set to 60.08°.

VmDas creates data files containing ship navigation data, raw instrument data, and other logging information. The nine different types of file produced by VmDas are:

- .VMO VmDas configuration file (ASCII)
- .LOG log of ADCP communication and VmDas error (ASCII)
- .ENR beam coordinate single-ping raw data (binary)
- .ENX Earth coordinate single-ping data (binary)
- .LTA Earth coordinate long-term averaged data (binary)
- .STA Earth coordinate short-term averaged data (binary)
- .NMS navigation and attitude data (binary)
- .N1R navigation data from the ship's Seatex GPS system (ASCII) [2028?]

VmDas uses the same file naming convention for each file type: CRUISExxx_000nnn.aaa, where CRUISE is the cruise name (in this case, JR16005), 'xxx' is the ensemble number, 'nnn' the file sequence number, and 'aaa' is the file format (e.g. N1R, LOG). A new set of files is created each time VmDas is started and the ensemble number incremented; a new file is also created if the file size goes above 10 Mb when the sequence number is incremented.

Parameter	Description
CR1	Restore the ADCP to factory default settings
CB611	Set the data collection baud rate to 38400, no parity, 1 stop bit, 8 data bits
NP1	Switch on narrowband mode
NN100	When in narrowband mode, use 100 bins
NS0800	When in narrowband mode, use 8 m bins
NF0800	When in narrowband mode, use 8 m blanking depth
W*	Broadband options [not used on this cruise]
BP00	Disable bottom tracking
BX10000	Set maximum bottom search depth to 1000 m (only used when bottom tracking is on)
WD111100000	Tells VmDas to output velocity, correlation, echo intensity, and percent good
TP000050	Allow half a second between bottom and water pings
TE00000100	Allow one second between ensembles (this is overridden by VmDas)
EZ1020001	Calculate the speed of sound, no depth sensor, external synchro heading sensor, no pitch or roll used, no salinity sensor, use internal transducer temperature sensor
EX00000	Tells VmDas to output beam coordinate data (rotations are done in software)
EA6008	Set transducer misalignment to 60.08°
ED00063	Set transducer depth (6.3 m on the JCR)
ES0	Set salinity (ppt) [salinity is zero in the transducer well]
CX0,0	Disable external trigger (e.g. from K-Sync or SSU)

Table 37: JR16005 VMADCP parameter settings.

VMADCP File Summary

Date	Time (GMT)	Filename	Seq. No.	Comments
19/03/17		JR16005003	000 to 001	Without tilt/pitch/roll transform
20/03/17	18:10	JR16005004	000 to 000	Stations 001 and 002 Tilt/pitch/roll transform now enabled

Continued on next page

Table 38 – *continued from previous page*

Date	Time (GMT)	Filename	Seq. No.	Comments
20/03/17	23:21	JR16005005	000 to 000	Restarted after USBL tests
20/03/17	23:45	JR16005006	000 to 004	Station 003
21/03/17	16:05	JR16005007	000 to 011	Stations 004 and 005
23/03/17	06:20	JR16005008	000 to 007	Stations 006 and 007
24/03/17	07:08	JR16005009	000 to 006	Station 008
25/03/17	04:03	JR16005010	000 to 007	Stations 009 to 012 and VMP stations 013 and 014
26/03/17	05:13	JR16005011	000 to 006	CTD stations 013 and 014, and stations 015 to 017
27/03/17	03:57	JR16005012	000 to 006	Stations 018 to 020
28/03/17	03:03	JR16005013	000 to 007	
29/03/17	03:01	JR16005014	000 to 007	Stations 021 to 024
30/03/17	03:00	JR16005015	000 to 007	Stations 025 to 029
31/03/17	03:11	JR16005016	000 to 007	Stations 030 to 037
01/04/17	03:43	JR16005017	000 to 007	
02/04/17	03:13	JR16005018	000 to 008	Stations 038 to 042
03/04/17	05:58	JR16005019	000 to 007	Station 043
04/04/17	07:03	JR16005020	000 to 006	Stations 044 to 046
05/04/17	03:03	JR16005021	000 to 007	Stations 047 to 050
06/04/17	03:31	JR16005022	000 to 007	Stations 051 to 054
07/04/17	03:31	JR16005023	000 to 007	Stations 055 and 056
08/04/17	02:59	JR16005024	000 to 007	Station 057
09/04/17	03:01	JR16005025	000 to 007	Station 058
10/04/17	02:53	JR16005026	000 to 008	Stations 059 to 064
11/04/17	05:32	JR16005027	000 to 006	Stations 065 to 067
12/04/17	03:05	JR16005028	000 to 007	Stations 068 to 070
13/04/17	03:31	JR16005029	000 to 007	Stations 071 to 073
14/04/17	03:03	JR16005030	000 to 008	Stations 074 to 076
15/04/17	06:38	JR16005031	000 to 008	Stations 077 and 078
16/04/17	09:12	JR16005032	000 to 005	Stations 079 to 082
17/04/17	04:59	JR16005033	000 to 006	Stations 083 to 085
18/04/17	03:02	JR16005034	000 to 008	Stations 086 to 088
19/04/17	08:44	JR16005035	000 to 008	Station 089
20/04/17	11:32	JR16005036	000 to 012	Stations 090 and 091
22/04/17	03:28	JR16005037	000 to 007	Stations 092 to 095
23/04/17	04:34	JR16005038	000 to 007	Stations 096 and 097
24/04/17	05:52	JR16005039	000 to 006	Stations 098 to 101
25/04/17	03:09	JR16005040	000 to 009	Stations 102 to 107-003

Continued on next page

Table 38 – *continued from previous page*

Date	Time (GMT)	Filename	Seq. No.	Comments
26/04/17	09:51	JR16005041	000 to 005	Stations 107-004 to 108
27/04/17	02:33	JR16005042	000 to 008	Stations 109 to 114
28/04/17	07:33	JR16005043	000 to 008	Stations 115 and 116
29/04/17	11:06	JR16005044	000 to 011	Stations 117 to 119
01/05/17	05:24	JR16005045	000 to 008	Station 120

Table 38: VMADCP file ensembles recorded during JR16005.

VMADCP Data Processing

The data recorded by OS75 via VmDas software are post-processed through a set of Matlab scripts to quality check the data and to calibrate the ADCP misalignment angle and amplitude factors. A brief description of what the Matlab code does during post-processing is given below. (For more detailed descriptions of each m-file, refer to cruise report JR235/236/239.)

1. Read the selected .ENX files (Earth coordinate single-ping data; binary) and .N1R files (navigation data; ASCII) into Matlab.
2. Remove missing data and data with bad navigation.
3. Merge single-ping ADCP data with Seapath attitude data.
4. Correct for transducer misalignment and velocity scaling error.
5. Derive ship velocity from Seapath navigation data.
6. Perform quality control, such that only the four-beam solution is permitted. Quality control also screens data based on maximum heading change between pings, maximum velocity change between pings, and the error velocity.
7. Average the data into ensembles (120 seconds for JR16005).
8. Calculate transducer misalignment and velocity scaling error.
9. Discard velocities from depths deeper than 86% of the bottom-tracking depth (i.e. set to missing).
10. Determine water velocities (referred to as 'absolute velocities') from either bottom-track ship velocity or Seapath GPS (usually the latter).
11. Plot eastward and northward velocities.

The final data are stored in Matlab format (*.mat). Below is a brief description of the output files:

File name	Description
JR16005_cal_pts_wt.mat	Contains misalignment angle (phi) and amplitude scaling statistics
JR16005xxx_000nnnd_att.mat	Contains ship's attitude data
JR16005xxx_000nnn_raw.mat	Contains ensemble-averaged data and absolute velocities
JR16005xxx_000nnn_sgl_ping.mat	Contains single-ping data in a structured array
JR16005xxx_bad_nav.mat	Contains counts of bad navigation points
JR16005xxx_bad_heading.mat	Contains counts of bad heading points
JR16005000_000000_xxx_abs.mat	Contains absolute horizontal velocity (i.e. water velocity) navigation data and bin depths.

Table 39: Description of VMADCP processing output files for JR16005

Misalignment angle and amplitude factors were estimated using water track calibration over the duration of the cruise (approximately 43 days). The estimated values for both misalignment angle and amplitude factors appeared to be stable through time; consequently only a single value was used for each parameter during the processing (-0.9482 degrees for misalignment; 1.023 for amplitude).

Parameters	Mean	Median	Standard Deviation
Misalignment angle	-0.9482	-0.9715	0.9452
Amplitude factor	1.023	1.019	0.032

Table 40: Calibration parameters estimated using water track for JR16005

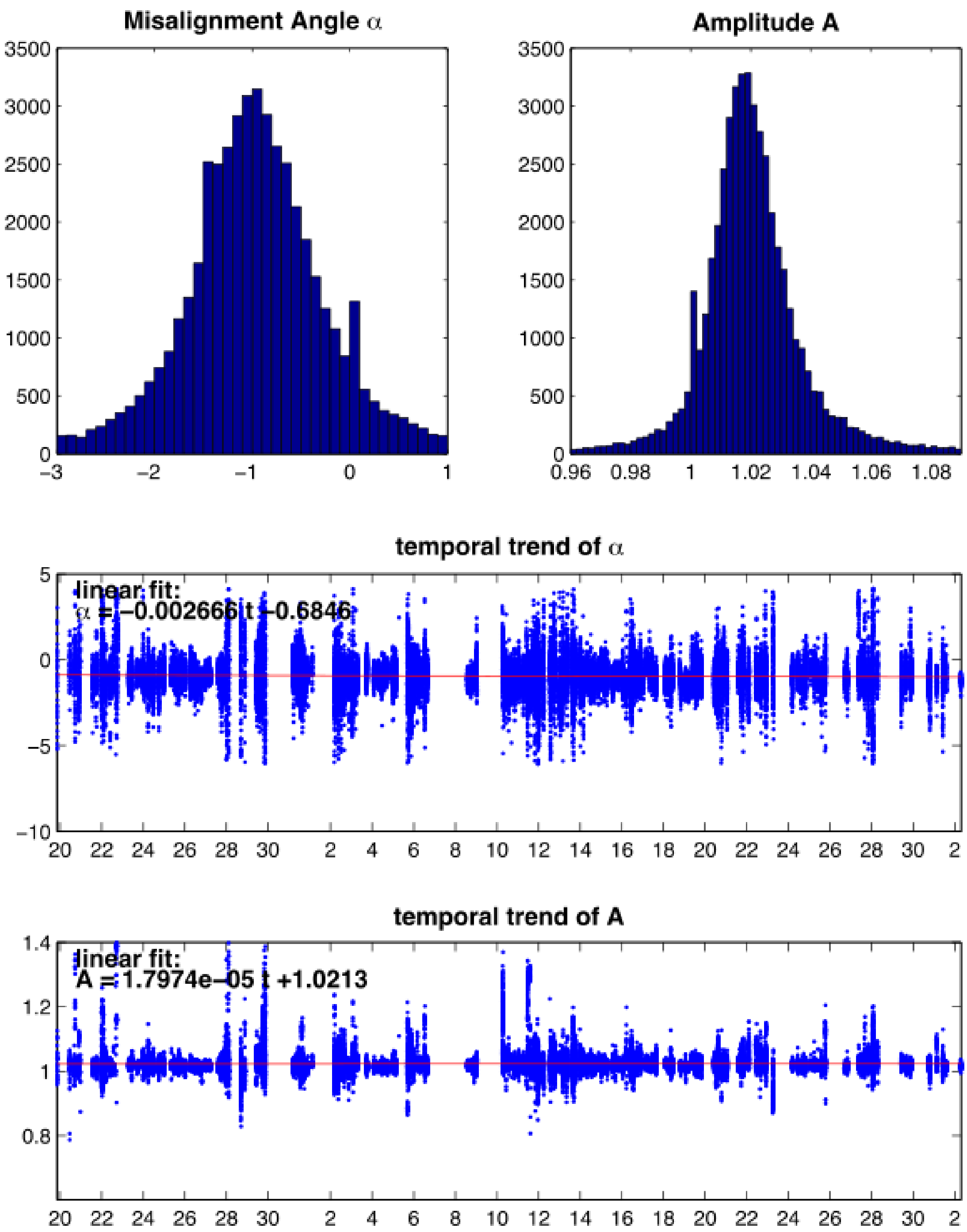

Figure 18: Statistics and temporal trend for VMADCP misalignment angle and amplitude factor estimated using water track calibration during JR16005.

VMADCP Results

The performance of the VMADCP was seen to be heavily weather dependent. During periods when windspeeds were low and the sea state relatively calm, at least for the area of operation, percentage good values exceeded 50% to depths below 500 m and reasonable results were obtained. At times of rough weather, performance deteriorated, and data quality issues prevented processing.

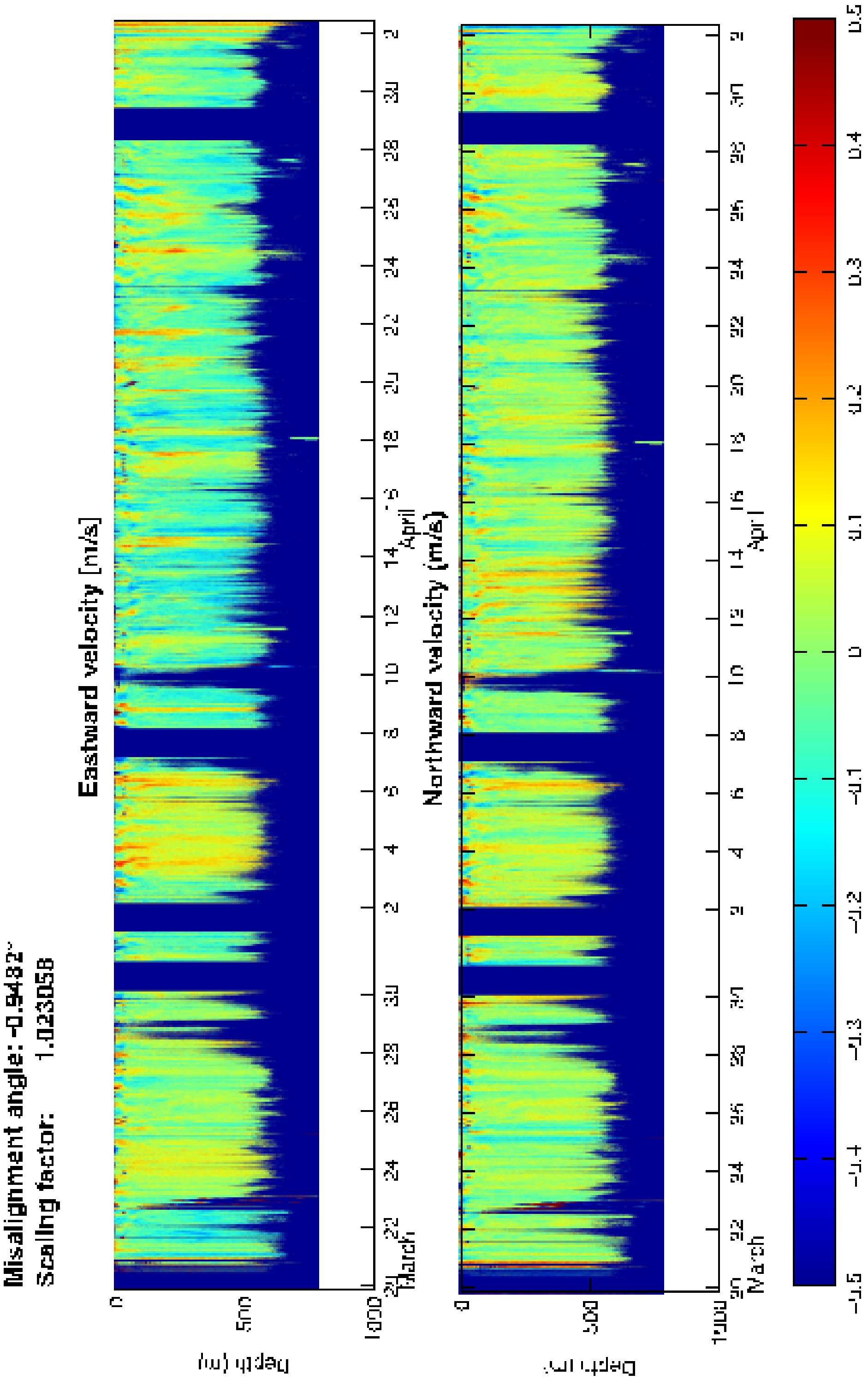

Figure 19: VMADCP velocities (ms^{-1}) recorded during JR16005.

Appendix: VMADCP command file

```
;--------------------------------------------------------------------------------\
; ADCP Command File for use with VmDas software.
;
; ADCP type:     75 Khz Ocean Surveyor
; Setup name:    default
; Setup type:    High resolution, short range profile(broadband)  500 m
;
; 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: 13January2006 (for JR141: routing through the SSU)
;-------------------------------------------------------------------------------/

; 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 (WP), one hundred (WN) 8 meter bins (WS)
; 8 meter blanking distance (WF), 390 cm/s ambiguity vel (WV)

; Switch off Narrowband NP0
NP1
nn100
ns800
nf0800

; Switch on Broadband  WP1

WP000
WN100
WS800
WF0800

WV390

; Enable single-ping bottom track (BP),
; Set maximum bottom search depth to 1000 meters (BX)
```

```
BP00
BX10000

; output velocity, correlation, echo intensity, percent good
WD111100000

; Two seconds between bottom and water pings
TP000050

; 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
TE00000100

; 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)
EA6008

; Set transducer depth (decimeters) [= 6.3m on JCR]
ED00063

; Set Salinity (ppt) [salinity in transducer well = 0]
ES0

; Set Trigger In/Out [ADCP run through SSU]
CX0,0

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

6 Float Deployment and Recovery – *Jack Hooley, Nikki Brownn & Tiago S. Dotto*

During the course of the cruise, four ARGO floats (Serial Nos: 7590, 7591, 7592, 7593) were deployed and one Deep Arvor float (Serial No: AD17-22-16FR-003) was recovered. The details of the deployment/recovery locations and times are shown in Table 6.

Serial No	Date	Time (UTC)	Lat (S)	Lon (W)	Depth (m)
7590	20/03/17	2340	56° 59.90′	049° 27.40′	3975
7591	19/03/17	2039	56° 59.95′	045° 45.86′	3755
7592	08/04/17	1133	60° 58.59′	041° 15.59′	4868
7593	27/04/17	1620	60° 18.50′	045° 16.50′	3150
AD17-22-16FR-003	02/04/17	1826	60° 30.66′	040° 03.55′	N/A

Table 41: Summary of the deployment and recovery events of the ARGO floats and Deep Arvor float during the cruise JR16005.

ARGO float deployments

The ARGO floats are pressure-activated floats which turn on upon entering the water; they do not require pre-launch activation. They were deployed from the stern of the ship and gently lowered into the water by a rope attached to the strong point on the side of the hull. Once at the surface it took a few minutes for the hull to flood with water before the float sat upright in the water. Correspondence with the UK Met Office confirms that this isn't a problem and that the floats have since begun their data gathering cycle, as expected.

Deep Arvor float recovery

On the previous cruise, JR16004, two Deep Arvor floats equipped with Nortek Signature 500 AD2CP current profilers were deployed. One of these floats malfunctioned after deployment, and on 24 March the PSO received a request from JB Sallée to recover it. The serial number of the float was AD17-22-16FR-003, with AD2CP serial no. 10301; it had been deployed on 8 Mar 2017 at 02:49. Once the float malfunctioned, it was parked at the surface, and after 30 Mar it sent positions back to Ifremer at intervals of 20 minutes (with decreasing position quality during rough weather). The positions were made available to the ship through a website, enabling us to follow the progress of the float. On 2 April we were close to the position of the float, but the weather was unsuitable for a recovery, and on 3 April we were unable to recover the float because of Autosub operations. We notified Ifremer, and they increased the position intervals to save batteries. However, on 8 April the weather was suitable, so we attempted a recovery. Ifremer changed the position interval to 15 minutes. During the previous interval of high-frequency positions we noticed that the float was moving northward at around 1.5 knots, decreasing to a standstill twice a day, implying a tidal or inertial cycle. Fortunately, at the time of the recovery the float was moving around 0.1 knots, and conditions were almost flat calm. Approaching the float slowly, it was spotted at a range of just under 1 km, at 18:09 UTC. In line with recommendations in Ifremer document G601026, 'Deep Arvor Wapiti Recovery Procedure' by Serge Le Reste, a lasso was lowered over the float. One end went under the syntactic foam flotation, while the other ended up against the base of the bulkhead connector for the cable connecting the float to the AD2CP. This was considered safe for lifting, and using the ship's 10-tonne crane the float was lifted on board at 18:26 in position 60° 30.66′S 040° 03.55′W. In line with guidance from Ifremer the float was left on deck, mounted vertically, until it could be switched off remotely.

On 12 April we received an e-mail from Ifremer notifying us that the float had been disabled, and including instructions for disassembling the float: G600614A, 'Disassembly instruction of Deep Arvor WAPITI float' by Corentin Renaut. The float was promptly disassembled; the bottom frame with the AD2CP and external battery case was placed into its original crate, which had been retained on the JCR, while a crate for a Teledyne Webb Apex float was modified to fit the main buoy, with the ballast hull sticking out through the end. Once additional Apex floats had been deployed, another Apex crate was sawed up to extend the crate, fully enclosing the float. Both cases will be shipped back to Ifremer for investigation.

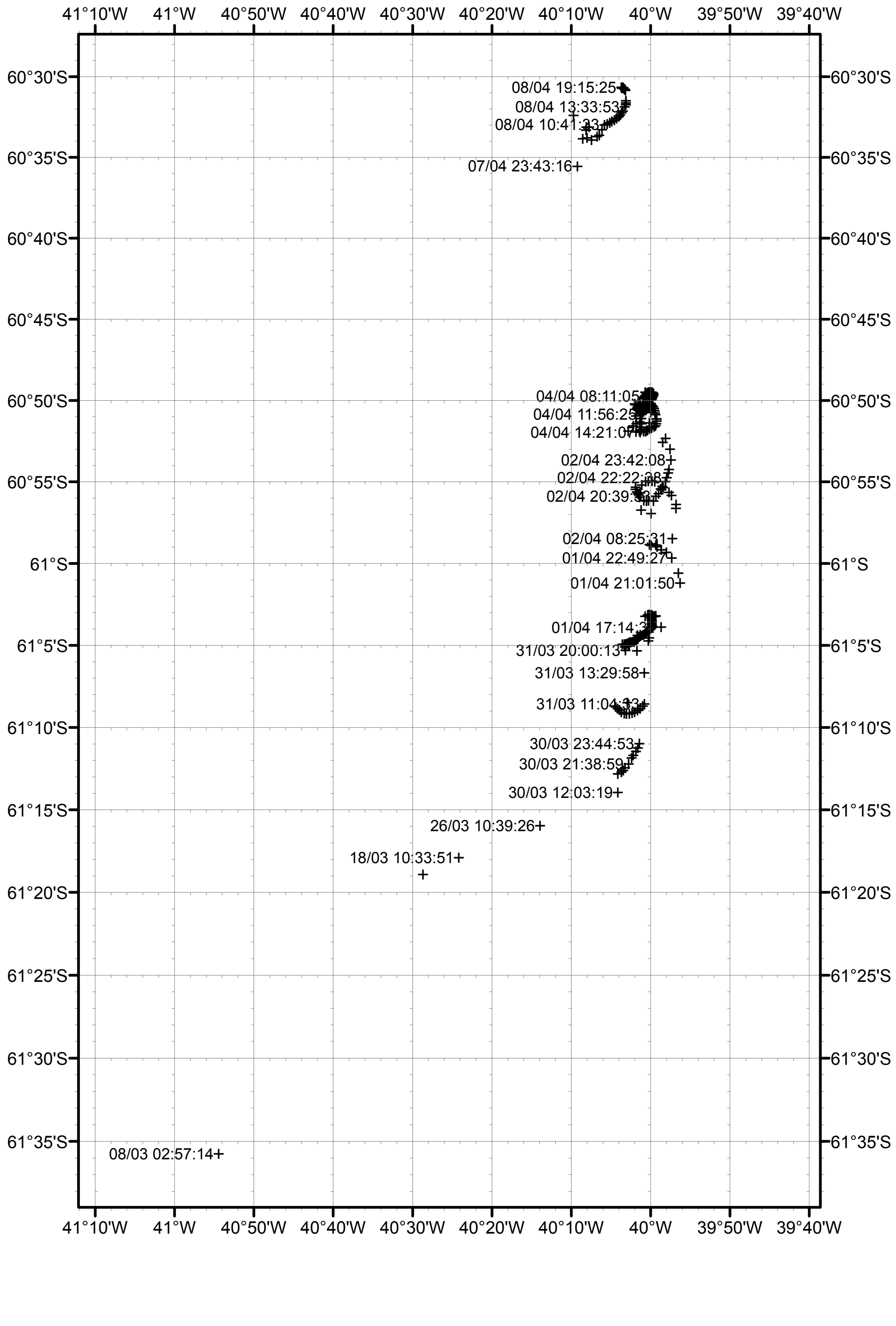

Figure 20: Track of Deep Arvor float AD17-22-16FR-003 from deployment to recovery.

7 Mooring Operations

7.1 British Antarctic Survey (BAS) Mooring Operations – *Povl Abrahamsen & Christian Buckingham*

A total of nine previously deployed moorings were recovered on JR16005. Eight moorings were deployed for recovery in 2019. In addition, the WHOI mooring was deployed for the duration of the cruise; this is described in a separate chapter. The triangulated positions of the moorings are given in the table below, along with the times the anchors were dropped or the moorings were released.

Mooring	**Dep.**	**Rec.**	**Lat. (°S)**	**Lon. (°W)**	**Depth**
M2 (1517)	18/03/15 20:35	23/03/17 08:46	62° 33.320′	042° 57.353′	3024
M3a (1417)	05/04/14 21:12	23/03/17 17:19	63° 31.998′	041° 46.656′	4622
M2 (17XX)	24/03/17 19:37		62° 36.854′	043° 14.475′	3052
M3 (17XX)	24/03/17 10:30		63° 31.963′	041° 46.299′	4573
OP1 (1517)	05/04/15 20:05	15/04/17 10:02	60° 37.522′	042° 05.761′	3644
OP2 (1517)	04/04/15 15:54	14/04/17 17:11	60° 38.173′	042° 10.714′	3036
OP3 (1517)	03/04/15 20:25	15/04/17 14:28	60° 39.322′	042° 13.801′	1738
OP4 (1517)	07/04/15 15:59	14/04/17 14:29	60° 35.434′	041° 49.752′	2972
OP5 (1517)	06/04/15 18:36	14/04/17 09:03	60° 36.424′	041° 58.531′	3423
OP6 (1517)	06/04/15 13:08	14/04/17 12:34	60° 33.727′	041° 38.033′	2338
OP7 (1517)	09/04/15 13:38	15/04/17 16:59	60° 39.289′	042° 09.248′	3060
OP1 (17XX)	18/04/17 15:17		60° 38.048′	042° 05.090′	3693
OP2 (17XX)	18/04/17 19:19		60° 38.746′	042° 10.766′	3058
OP3 (17XX)	19/04/17 12:07		60° 39.428′	042° 13.766′	1737
OP4 (17XX)	21/04/17 17:20		60° 35.398′	041° 49.615′	2949
OP5 (17XX)	19/04/17 17:33		60° 36.721′	041° 58.517′	3387
OP6 (17XX)	20/04/17 14:13		60° 33.806′	041° 38.041′	2310

Table 42: Mooring deployment and recovery times and locations. Approximate anchor depths are also shown.

A brief description of the mooring operations is given below, with details for each mooring as required. Mooring recoveries and deployments were done using the storage drum of the BAS mooring winch, without the traction winch. All of the mooring deployments were performed buoy first (anchor last).

Both moorings M2 and M3a were recovered on 23 Mar. Some instruments that had been recovered from M2 were redeployed, but most have been returned to LDEO for calibration. M2 and M3 were redeployed on 24 Mar, without any problems to note.

In Orkney Passage, OP4, OP5, and OP6 were the first moorings to be recovered on 14 Apr, followed by OP2. OP5, OP6, and OP2 all went quite smoothly; the bottom section of OP4 came up slightly tangled, but without major problems. On 15 Apr the remaining three moorings were recovered. OP1 came up without major problems – it took 1 $\frac{1}{2}$ hours to recover all the instruments once the first mooring elements had been brought on board. OP3 was slightly more tangled, with both the middle and bottom buoyancy tangled with nearby instruments.

When we recovered OP7, release 1617 was first released, but the mooring did not rise. Release 1616 was then fired, and the mooring rose. Both releases were found to have opened, but the hook of release 1617 is stiff, and it has not been redeployed. The chain and release links were not recovered. When OP7 was recovered, it was severely tangled: when the ship attempted to stream out the mooring after it had been grappled, the releases got tangled in the upper syntactic foam float. When this was brought on board, the releases, bottom buoyancy, and lowest two instruments were removed from the wire. The loose end of the wire was then released and allowed to stream out; the rest of the recovery was uneventful.

To help calibrate the Microcats (SBE-37SM and SBE-37SMP), all of the Microcats from the recovered OP moorings (from BAS, LDEO, NMEP, and those purchased by the University of Southampton for DynOPO) were deployed in groups of 5-10 on CTD casts 78, 79, 80, 83, 86, 90, and 93, by attaching them to spare OTE Niskin bottle frames using hose clamps (90-110 mm size on the sensor end, 77-95 mm on the instrument housing), and inserting them in the rosette in empty Niskin bottle slots. They logged data at an interval of 10 s; the resulting data will be calibrated against the final CTD data, once the temperatures and salinities in these files have been corrected against salinity samples and the SBE-35 standard thermometer.

Moorings OP1-OP6 were redeployed on 18-21 Apr. During the deployment of OP1, the threads on the clamp for SBE-39 s/n 4409 were stripped; to secure the instrument to the wire, a jubilee clip (hose clamp) was placed over the clamp. Apart from this, the redeployments were all done without incident. To locate clamp-on instruments on the wire, measurements were made either from the manufacturer's marks on the wire (for some 350-m segments), or measuring from the ends of the wire using the 1-m grid on the aft deck.

Mooring Instrumentation

The Orkney Passage and M2/M3 moorings all use 3/16" (5 mm) 3x19 plastic-jacketed galvanized wire, supplied by Mooring Systems Inc. (MSI), with an outer diameter of 6.5 mm, and swaged sockets to fit 1/2" shackles. All of the instrumentation deployed on the OP and M moorings were clamped onto the mooring wire; only the ADCPs and RCM11 current meters, which were not redeployed, were installed in line. The table below gives an overview of the instrument types deployed, and the tools required to remove them from the mooring wire.

The instruments generally performed well on their deployment. One Aquadopp from NMEP (s/n 6212) leaked; the electronics appeared to be undamaged, and data were downloaded from the deployment – though it stopped after only two days in the water. The leak appeared to have been through the bulkhead connector on the endcap. Another NMEP Aquadopp (s/n 6275) had a pin from the blanking plug break off inside the bulkhead connector; data from this instrument were downloaded using the endcap from another instrument.

All of the Seabird instruments were logging as expected. Two of the RBRsoloT temperature loggers stopped logging before they were deployed. The problem in both instruments appeared to be with the battery spring in the end of the instrument: it was not in contact with the battery, and had been fully depressed. All of these instruments should be checked carefully before they are redeployed.

One of the ADCPs, s/n 3301 (from NMEP), had leaked in the transducer end. This

Model	**P**aram.	**T**ools req.	**C**onnect	**S**erial nos.
SBE-39	T & P	3/8" socket	internal	All M2/M3 except 0229 (M2)
SBE-39	T only	3/8" socket	internal	0083 (OP2) and 0229 (M2)
SBE-39	T only	3/16" Allen key	4-pin / internal	Remaining OP instruments
SBE-37SM	T & C only	3/8" socket	4-pin	8267 (OP6)
SBE-37SM	T, C, P	3/8" socket	3-pin	2678 (OP4)
SBE-37SM	T, C, P	3/8" socket	4-pin	Remaining instruments
Aquadopp DW (6000 m)	U, V, W, T, P	17 mm socket & spanner	Round	Instruments on OP1, OP2, and OP4
Aquadopp DW (6000 m)	U, V, W, T, P	9/16" socket & spanner	Square/ round	all M2/M3
Aquadopp DW (6000 m)	U, V, W, T, P	13 mm socket & spanner	Square	5424 (OP3)
Aquadopp DW (6000 m) – short housing	U, V, W, T, P	13 mm socket & spanner	Round	8556 (OP3)
Aquadopp DW (6000 m)	U, V, W, T, P	13 mm socket & spanner	Round	Instruments on OP5 and OP6

Table 43: Details of mooring instrumentation.

instrument had been disassembled to install a memory card during JR310 (it was supplied by NMF with the memory card removed), and during reassembly it appears that the backing ring behind the upper o-ring was pinched in the case, blocking one or both of the o-rings and causing a leak. The two lower circuit boards and the memory card appear heavily corroded, while the upper board, the capacitors, and the batteries appear unharmed.

The other two ADCPs, s/n 22182 and 22183, were both logging on recovery. However, the data from both appear to have serious interference from other instruments: the bins corresponding to the locations of Aquadopp/Microcat pairs have high backscatter (intensity) in all four beams. ADCP 22182 has slightly positive vertical speeds in the affected bins, and near-zero error velocity. ADCP 22813 has much more strongly positive vertical velocity, strongly negative error velocity in the bin before (above) the affected bin, and strongly positive error velocity in the bin itself. While the data in the affected bins are clearly invalid, currents in the neighbouring bins appear to be good, and using suitable filtering/interpolation (Figure 21) it should be possible to recover usable data from the ADCPs. The figure below shows preliminary corrections using a median filter. Nevertheless, it is unusual that the instruments would be affected this way; the specification for the ADCPs claims a beam width of 4°, with an angle of 20°. If this was the case, the beams should have been well clear of the mooring wire and instrumentation.

The Iridium beacon on OP1 was damaged after recovery: one or more of the batteries appeared to have leaked, and after recovery it appears that leaked electrolyte spread into the upper part of the beacon. We are uncertain if any positions were received from the beacon before it was removed from the frame and disabled.

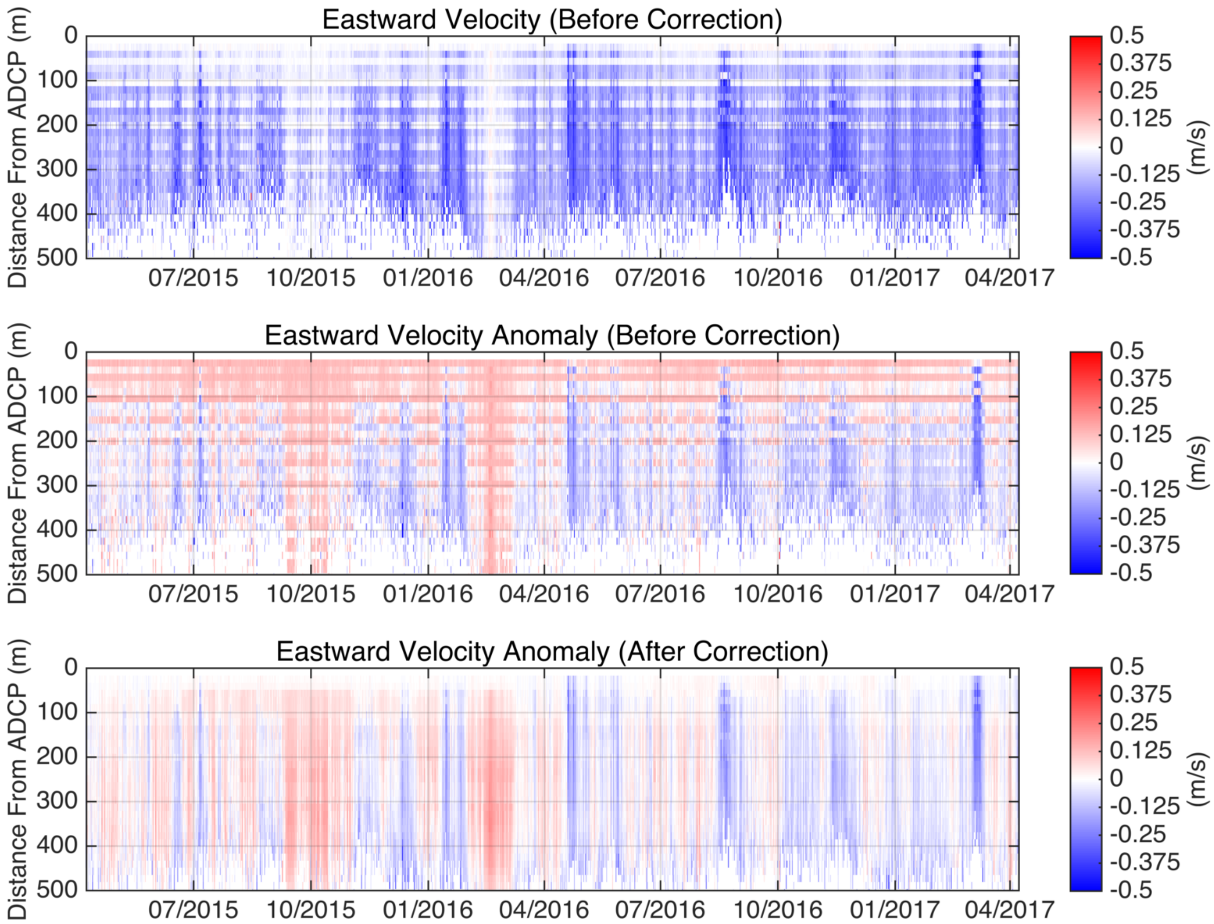

Figure 21: Preliminary corrections applied to the RDI ADCP (S/N22182) on OP1. (a) Raw eastward velocity, (b) velocity minus a global mean and (c) recovered velocity anomaly obtained by (1) subtracting from each bin the time-average of measurements in that bin and (2) applying a 3x3 median filter to the resulting data.

All three RCM11 current meters were logging on recovery; while two of the three had brief gaps in their records, all have logged most of the time, and the data appear to be of good quality.

The times in the tables below are relative to GPS time. On both the deployment and recovery cruises, clocks were synchronized with server "jrlb.jcr.nerc-bas.ac.uk", which is accessible on the JCR's public network. In turn, this machine is synchronized with the ship's Galleon NTP-4000 GPS time server, which is on the data network only.

Mooring Recoveries

M2 (2015-2017)

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start/stop time UTC	Clock drift	First good/ Last good record Comments
532	2492	Novatech RF-700A1 W08-053 VHF radio beacon (159.480 MHz)					On triangular McLane top float
532	2492	Novatech ST-400A V08-057 Xenon flash beacon (daylight off disabled)					
511	2513	Aquadopp 9380	U, V, W, T, P	30	01/04/2015 12:00:00 23/03/2017 11:50:24	+00:01:38	18/03/2015 21:30:00 23/03/2017 08:30:00
466	2558	SBE-37SM 2678	T, C, P	15	02/04/2015 00:00:01 23/03/2017 11:57:45	+00:05:50	18/03/2015 21:15:00 23/03/2017 08:45:01
341	2683	SBE-39 4602	T, P	15	02/04/2015 00:00:00 23/03/2017 12:02:42	+00:02:59	18/03/2015 21:15:00 23/03/2017 08:45:00
239	2785	SBE-39 1235	T, P	15	02/04/2015 00:00:00 23/03/2017 12:20:45	-00:03:04	18/03/2015 21:14:59 23/03/2017 08:30:03
164	2860	SBE-39 1231	T, P	15	02/04/2015 00:00:00 23/03/2017 12:15:22	-00:02:46	18/03/2015 21:15:00 23/03/2017 08:30:00
19	3005	SBE-37SMP 6557	T, C, P	15	02/04/2015 00:00:01 21/08/2016 12:45:01 (23/03/2017 12:42:10)	-00:00:30	18/03/2015 21:15:01 21/08/2016 12:45:01 Stopped – low battery
16	3008	Aquadopp 2807	U, V, W, T, P	30	01/04/2015 12:00:00 23/03/2017 12:06	+00:02:22	18/03/2015 21:30:00 23/03/2017 08:30:00
8	3016	Release: ORE 8242xs 49027					

Table 44: Details of M2 (2015-2017) mooring recovery. First good/last good record times are instrument times uncorrected for drift

M3a (2014-2017)

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start/stop time UTC	Clock drift	First good/ Last good record Comments
534	4088	Novatech RF-700A1 U08-058 VHF radio beacon (159.480 MHz)					On triangular McLane top float Some pitting on upper o-ring groove
534	4088	Novatech ST-400A U08-060 Xenon flash beacon					Batteries leaked, damage to case
515	4107	Aquadopp 2796	U, V, W, T, P	60	05/04/2014 18:00:00 24/03/2017 14:39	+00:03:42	05/04/2014 23:00:00 23/03/2017 17:00:00
470	4152	SBE-37SM 5490	T, C, P	15	05/04/2014 17:00:01 24/03/2017 15:33:38	+00:07:24	05/04/2014 22:15:00 23/03/2017 17:15:01
345	4277	SBE-39 6315	T, P	15	05/04/2014 17:00:00 24/03/2017 14:50:20	+00:03:09	05/04/2014 22:15:00 23/03/2017 17:15:00
241	4381	SBE-39 4896	T	15	05/04/2014 17:00:00 24/03/2017 14:37:47	+00:03:16	05/04/2014 22:15:00 23/03/2017 17:15:00
116	4506	SBE-39 6314	T	15	05/04/2014 17:00:00 24/03/2017 14:58:20	+00:02:31	05/04/2014 22:15:00 23/03/2017 17:15:00
21	4601	SBE-37SMP 10172	T, C, P	15	05/04/2014 17:00:01 24/03/2017 15:24:40	+00:00:30	05/04/2014 22:15:01 23/03/2017 17:15:01
18	4604	Aquadopp 5424	U, V, W, T, P	60	05/04/2014 18:00:00 24/03/2017 14:21	+00:00:55	05/04/2014 23:00:00 23/03/2017 17:00:00
9	4613	Releases: ORE 8242xs 33614 & 33758					

Table 45: Details of M3a (2014-2017) mooring recovery. First good/last good record times are instrument times uncorrected for drift

OP1 (2015-2017)

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start/stop time UTC	Clock drift	First good/ Last good record Comments
1800	1844	Aquadopp 6273	U, V, W, T, P	10	01/04/2015 12:00:00 16/04/2017 12:42:50	+00:01:50	05/04/2015 20:50:00 15/04/2017 10:00:00 Shows large pitch/roll at start of time series, gradually decreasing. Could be sensor problem, rather than a tilted instrument.
1799	1845	SBE-37SMP 7308	T, C, P	20	02/04/2015 00:00:01 15/04/2017 19:37:04	+00:00:33	05/04/2015 21:00:01 15/04/2017 10:00:01
1725	1919	SBE-39 4716	T	10	02/04/2015 00:00:00 16/04/2017 14:22:15	+00:03:07	05/04/2015 20:50:00 15/04/2017 10:00:00
1650	1994	Aquadopp 8351	U, V, W, T, P	10	01/04/2015 12:00:00 16/04/2017 12:42:55	+00:01:37	05/04/2015 20:50:00 15/04/2017 10:00:00
1649	1995	SBE-37SMP 7309	T, C, P	20	02/04/2015 00:00:01 15/04/2017 17:43:35	+00:00:47	05/04/2015 21:00:01 15/04/2017 10:00:01
1575	2069	SBE-39 4413	T	10	02/04/2015 00:00:00 16/04/2017 13:21:05	+00:02:46	05/04/2015 20:50:00 15/04/2017 10:00:00
1500	2144	Aquadopp 12020	U, V, W, T, P	10	02/04/2015 12:00:00 16/04/2017 01:33:30	+00:01:30	05/04/2015 20:50:00 15/04/2017 10:00:00
1499	2145	SBE-37SMP 9394	T, C, P	10	02/04/2015 00:00:01 15/04/2017 19:46:20	+00:00:46	05/04/2015 20:50:01 15/04/2017 10:00:01
1425	2219	RBRsoloT 72251	T	10 s	02/04/2015 00:00:00 23/04/2017 15:56:28	+00:00:20	05/04/2015 20:50:00 15/04/2017 10:02:10
1350	2294	Aquadopp 6182	U, V, W, T, P	10	02/04/2015 12:00:00 16/04/2017 12:30:00	+00:01:48	05/04/2015 20:50:00 15/04/2017 10:00:00

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Table 46 – *continued from previous page*

Height (above bottom) **(m)**	**Depth** (Nominal) **(m)**	**Instrument**	**Param.**	Sample int. (min)	**Start/stop time UTC**	**Clock drift**	**First good/ Last good record Comments**
1349	2295	SBE-37SMP 7313	T, C, P	20	02/04/2015 00:00:01 15/04/2017 19:53:10	+00:01:12	05/04/2015 21:00:01 15/04/2017 10:00:01
1275	2369	RBRsoloT 72253	T	10 s	02/04/2015 00:00:00 23/04/2017 16:06:22	+00:00:47	05/04/2015 20:50:00 15/04/2017 10:02:40
1200	2444	Aquadopp 8355	U, V, W, T, P	10	01/04/2015 12:00:00 16/04/2017 12:29:45	+00:01:48	05/04/2015 20:50:00 15/04/2017 10:00:00
1199	2445	RBRsoloT 72252	T	10 s	02/04/2015 00:00:00 23/04/2017 15:58:58	+00:00:33	05/04/2015 20:50:00 15/04/2017 10:02:30
1150	2494	RBRsoloT 72274	T	10 s	02/04/2015 00:00:00 23/04/2017 16:47:15	-00:00:40	05/04/2015 20:50:00 15/04/2017 10:01:20
1116	2528	Novatech MMI-7500 M00QMQ Iridium beacon					Battery leaked, damaging beacon
1116	2528	RDI Longranger ADCP 22182	U, V, W (profile), T, P	60	05/04/2015 00:00:00 16/04/2017 12:29:40	-00:09:23	05/04/2015 21:00:00 15/04/2017 09:00:00 12 pings per ensemble, 48 16-m depth cells Mounted in MSI SB47-3000 buoy 10-14 SN 128
1100	2544	SBE-37SMP 7307	T, C, P	20	02/04/2015 00:00:01 15/04/2017 20:00:50	+00:00:25	05/04/2015 21:00:01 15/04/2017 10:00:01
1050	2594	RBRsoloT 72265	T	10 s	02/04/2015 00:00:00 23/04/2017 16:09:34	-00:00:10	05/04/2015 20:50:00 15/04/2017 10:01:50
1000	2644	Aquadopp 6178	U, V, W, T, P	10	01/04/2015 12:00:00 16/04/2017 12:15:31	+00:01:22	05/04/2015 20:50:00 15/04/2017 10:00:00 Hit transom during deployment

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Table 46 – *continued from previous page*

Height (above bottom) **(m)**	**Depth** (Nominal) **(m)**	**Instrument**	**Param.**	Sample int. (min)	**Start/stop time UTC**	**Clock drift**	**First good/ Last good record Comments**
999	2645	SBE-37SMP 9379	T, C, P	10	02/04/2015 00:00:01 15/04/2017 20:10:05	+00:00:55	05/04/2015 20:50:01 15/04/2017 10:00:01
950	2694	RBRsoloT 72266	T	10 s	02/04/2015 00:00:00 23/04/2017 16:11:24	+00:00:06	05/04/2015 20:50:00 15/04/2017 10:02:00
900	2744	Aquadopp 5883	U, V, W, T, P	10	01/04/2015 12:00:00 16/04/2017 11:57:40	+00:00:29	05/04/2015 20:50:00 15/04/2017 10:00:00 Appears to have large compass offset
899	2745	RBRsoloT 72267	T	10 s	02/04/2015 00:00:00 23/04/2017 16:13:16	-00:00:19	05/04/2015 20:50:00 15/04/2017 10:01:40
850	2794	RBRsoloT 72268	T	10 s	02/04/2015 00:00:00 23/04/2017 16:14:56	+00:00:01	05/04/2015 20:50:00 15/04/2017 10:02:00
800	2844	Aquadopp 8088	U, V, W, T, P	10	01/04/2015 12:00:00 16/04/2017 12:00:15	+00:01:50	05/04/2015 20:50:00 15/04/2017 10:00:00
799	2845	SBE-37SMP 7302	T, C, P	20	02/04/2015 00:00:01 15/04/2017 20:18:40	+00:01:40	05/04/2015 21:00:01 15/04/2017 10:00:01
750	2894	RBRsoloT 72269	T	10 s	02/04/2015 00:00:00 23/04/2017 16:31:44	+00:00:00	05/04/2015 20:50:00 15/04/2017 10:02:00
700	2944	Aquadopp 8352	U, V, W, T, P	10	02/04/2015 12:00:00 16/04/2017 11:34:51	+00:00:57	05/04/2015 20:50:00 15/04/2017 10:00:00
699	2945	SBE-37SMP 7310	T, C, P	20	02/04/2015 00:00:01 15/04/2017 20:25:15	+00:00:34	05/04/2015 21:00:01 15/04/2017 10:00:01
650	2994	RBRsoloT 72270	T	10 s	02/04/2015 00:00:00 23/04/2017 16:32:56	+00:00:03	05/04/2015 20:50:00 15/04/2017 10:02:00

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Table 46 – *continued from previous page*

Height (above bottom) **(m)**	**Depth** (Nominal) **(m)**	**Instrument**	**Param.**	**Sample int. (min)**	**Start/stop time UTC**	**Clock drift**	**First good/ Last good record Comments**
600	3044	Aquadopp 6275	U, V, W, T, P	10	01/04/2015 12:00:00 16/04/2017 12:57:30	+00:01:05	05/04/2015 20:50:00 15/04/2017 10:00:00
599	3045	SBE-37SMP 8076	T, C, P	20	02/04/2015 00:00:01 15/04/2017 20:32:27	+00:00:49	05/04/2015 21:00:01 15/04/2017 10:00:01
550	3094	RBRsoloT 72231	T	10 s	02/04/2015 00:00:00 23/04/2017 14:13:55	-00:00:01	05/04/2015 20:50:00 15/04/2017 10:01:50
500	3144	Aquadopp 11997	U, V, W, T, P	10	01/04/2015 12:00:00 16/04/2017 01:08:50	+00:02:33	05/04/2015 20:50:00 15/04/2017 10:00:00
499	3145	SBE-37SMP 7311	T, C, P	20	02/04/2015 00:00:01 15/04/2017 17:31:05	+00:00:57	05/04/2015 21:00:01 15/04/2017 10:00:01
450	3194	RBRsoloT 72235	T	10 s	02/04/2015 00:00:00 23/04/2017 14:32:58	-00:00:08	05/04/2015 20:50:00 15/04/2017 10:01:50
400	3244	Aquadopp 6244	U, V, W, T, P	10	01/04/2015 12:00:00 16/04/2017 11:16:00	+00:00:34	05/04/2015 20:50:00 15/04/2017 10:00:00
399	3245	SBE-37SMP 7294	T, C, P	20	02/04/2015 00:00:01 15/04/2017 17:27:20	+00:00:27	05/04/2015 21:00:01 15/04/2017 10:00:01
350	3294	RBRsoloT 72233	T	10 s	02/04/2015 00:00:00 23/04/2017 14:27:31	-00:00:38	05/04/2015 20:50:00 15/04/2017 10:01:20
300	3344	Aquadopp 6203	U, V, W, T, P	10	02/04/2015 12:00:00 16/04/2017 11:11:50	+00:01:25	05/04/2015 20:50:00 15/04/2017 10:00:00
299	345	SBE-37SMP 7299	T, C, P	20	02/04/2015 00:00:01 15/04/2017 17:18:50	+00:00:26	05/04/2015 21:00:01 15/04/2017 10:00:01
250	3394	RBRsoloT 72234	T	10 s	02/04/2015 00:00:00 23/04/2017 14:29:04	-00:00:14	05/04/2015 20:50:00 15/04/2017 10:01:40

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Table 46 – *continued from previous page*

Height (above bottom) **(m)**	**Depth** (Nominal) **(m)**	**Instrument**	**Param.**	Sample int. (min)	**Start/stop time UTC**	**Clock drift**	**First good/ Last good record Comments**
200	3444	Aquadopp 11979	U, V, W, T, P	10	02/04/2015 00:00:00 16/04/2017 00:54:40	+00:01:57	05/04/2015 20:50:00 15/04/2017 10:00:00
199	3445	SBE-37SMP 7314	T, C, P	20	02/04/2015 00:00:01 15/04/2017 17:15:40	+00:01:17	05/04/2015 21:00:01 15/04/2017 10:00:01
150	3494	RBRsoloT 72273	T	10 s	02/04/2015 00:00:00 23/04/2017 16:46:20	-00:00:28	05/04/2015 20:50:00 15/04/2017 10:01:30
100	3544	Aquadopp 6260	U, V, W, T, P	10	01/04/2015 12:00:00 16/04/2017 02:47	+00:00:56	05/04/2015 20:50:00 15/04/2017 10:00:00
99	3545	SBE-37SMP 7297	T, C, P	20	02/04/2015 00:00:01 15/04/2017 17:06:40	+00:00:53	05/04/2015 21:00:01 15/04/2017 10:00:01
20	3524	Aquadopp 8111	U, V, W, T, P	10	02/04/2015 12:00:00 16/04/2017 02:16	+00:00:52	05/04/2015 20:50:00 15/04/2017 10:00:00
19	3625	SBE-37SMP 7316	T, C, P	20	02/04/2015 00:00:01 15/04/2017 16:58:05	+00:00:18	05/04/2015 21:00:01 15/04/2017 10:00:01
7	3637	RBRsoloT 72248	T	10 s	02/04/2015 00:00:00 23/04/2017 15:46:15	-00:00:13	05/04/2015 20:50:00 15/04/2017 10:01:40 Mounted between releases using cable ties; bent sensor and shield
Releases: IXSEA AR861 1615 & 1618							

Table 46: Details of OP1 (2015-2017) mooring recovery. First good/last good record times are instrument times uncorrected for drift

OP2 (2015-2017)

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start/stop time UTC	Clock drift	First good/ Last good record Comments
1500	1536	Aquadopp 8362	U, V, W, T, P	10	02/04/2015 12:00:00 14/04/2017 23:53	+00:02:04	04/04/2015 16:40:00 14/04/2017 17:10:00
1499	1537	SBE-37SM 7387	T, C, P	10	02/04/2015 00:00:01 15/04/2017 01:13:07	+00:00:10	04/04/2015 16:40:01 14/04/2017 17:10:01
1350	1686	Aquadopp 6213	U, V, W, T, P	10	02/04/2015 12:00:00 14/04/2017 23:36	-00:00:09	04/04/2015 16:40:00 14/04/2017 17:10:00
1349	1687	SBE-37SM 7382	T, C, P	10	02/04/2015 00:00:01 15/04/2017 01:32:06	+00:00:43	04/04/2015 16:40:01 14/04/2017 17:10:01
1200	1836	Aquadopp 6242	U, V, W, T, P	10	02/04/2015 12:00:00 14/04/2017 23:40	+00:00:59	04/04/2015 16:40:00 14/04/2017 17:10:00
1199	1837	SBE-37SMP 7303	T, C, P	20	02/04/2015 00:00:01 15/04/2017 04:44:16	+00:00:22	04/04/2015 16:40:01 14/04/2017 17:00:01
1125	1911	SBE-39 4713	T	10	02/04/2015 00:00:00 16/04/2017 13:31:55	+00:03:10	04/04/2015 16:40:00 14/04/2017 17:10:00
1050	1986	Aquadopp 8093	U, V, W, T, P	10	02/04/2015 12:00:00 14/04/2017 23:48	+00:00:58	04/04/2015 16:40:00 14/04/2017 17:10:00
1049	1987	SBE-37SMP 8075	T, C, P	20	02/04/2015 00:00:01 15/04/2017 04:54:25	+00:00:40	04/04/2015 16:40:01 14/04/2017 17:00:01
975	2061	RBRsoloT 72243	T	10 s	02/04/2015 00:00:00 23/04/2017 14:57:14	+00:00:11	04/04/2015 16:40:00 14/04/2017 17:11:10
900	2136	Aquadopp 12053	U, V, W, T, P	10	02/04/2015 12:00:00 14/04/2017 22:55	+00:01:59	04/04/2015 16:40:00 14/04/2017 17:10:00
899	2137	SBE-37SMP 7295	T, C, P	20	02/04/2015 00:00:01 15/04/2017 05:08:20	+00:00:24	04/04/2015 16:40:01 14/04/2017 17:00:01

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Table 47 – *continued from previous page*

Height (above bottom) **(m)**	**Depth** (Nominal) **(m)**	**Instrument**	**Param.**	**Sample int. (min)**	**Start/stop time UTC**	**Clock drift**	**First good/ Last good record Comments**
825	2211	RBRsoloT 72242	T	10 s	02/04/2015 00:00:00 23/04/2017 14:55:36	+00:00:32	04/04/2015 16:40:00 14/04/2017 17:11:30
750	2286	Aquadopp 6181	U, V, W, T, P	10	02/04/2015 12:00:00 14/04/2017 23:19	+00:01:11	04/04/2015 16:40:00 14/04/2017 17:10:00
749	2287	SBE-37SMP 7293	T, C, P	20	02/04/2015 00:00:00 15/04/2017 06:16:40	+00:00:13	04/04/2015 16:40:01 14/04/2017 17:00:01
675	2261	RBRsoloT 72244	T	10 s	02/04/2015 00:00:00 23/04/2017 14:59:04	+00:00:03	04/04/2015 16:40:00 14/04/2017 17:11:00
600	2436	Aquadopp 8360	U, V, W, T, P	10	02/04/2015 12:00:00 14/04/2017 23:17	+00:02:03	04/04/2015 16:40:00 14/04/2017 17:10:00
599	2437	SBE-37SMP 7292	T, C, P	20	02/04/2015 00:00:01 15/04/2017 06:04:20	-00:00:20	04/04/2015 16:40:01 14/04/2017 17:00:01
550	2486	RBRsoloT 72275	T	10 s	02/04/2015 00:00:00 23/04/2017 16:58:17	+00:00:29	04/04/2015 16:40:00 14/04/2017 17:11:20
500	2536	Aquadopp 1404	U, V, W, T, P	10	02/04/2015 00:00:00 15/04/2017 00:07	+00:02:12	04/04/2015 16:40:00 14/04/2017 17:10:00 Hit transom during deployment
499	2537	RBRsoloT 72246	T	10 s	02/04/2015 00:00:00 23/04/2017 15:41:55	+00:00:04	04/04/2015 16:40:00 14/04/2017 17:11:00
450	2586	RBRsoloT 72245	T	10 s	02/04/2015 00:00:00 23/04/2017 15:39:50	+00:00:25	04/04/2015 16:40:00 14/04/2017 17:11:20
415	2621	Novatech RF-700A1 W02-085 VHF radio beacon (159.480 MHz)					
415	2621	Novatech ST-400A W02-089 Xenon flash beacon (daylight off disabled)					

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Table 47 – *continued from previous page*

Height (above bottom) **(m)**	**Depth** (Nominal) **(m)**	**Instrument**	**Param.**	**Sample int. (min)**	**Start/stop time UTC**	**Clock drift**	**First good/ Last good record Comments**
415	2621	RDI Longranger ADCP 22183	U, V, W (profile), T, P	60	02/04/2015 00:00:00 15/04/2017 01:09:45	-00:14:41	04/04/2015 17:00:00 14/04/2017 16:00:00 12 pings per ensemble, 26 16-m depth cells Mounted in MSI SB47-3000 buoy 10-14 SN 119
399	2637	SBE-37SMP 7289	T, C, P	20	02/04/2015 00:00:01 15/04/2017 05:47:57	+00:00:59	04/04/2015 16:40:01 14/04/2017 17:00:01
350	2686	RBRsoloT 72247	T	10 s	02/04/2015 00:00:00 23/04/2017 15:43:43	+00:10:48	04/04/2015 16:40:00 14/04/2017 17:21:40
300	2736	Aquadopp 6262	U, V, W, T, P	10	01/04/2015 12:00:00 14/04/2017 23:07	+00:00:32	04/04/2015 16:40:00 14/04/2017 17:10:00
299	2737	SBE-37SMP 7291	T, C, P	20	02/04/2015 00:00:01 15/04/2017 05:38:55	+00:00:05	04/04/2015 16:40:01 14/04/2017 17:00:01
250	2786	RBRsoloT 72249	T	10 s	02/04/2015 00:00:00 23/04/2017 15:52:15	+00:00:36	04/04/2015 16:40:00 14/04/2017 17:11:30
200	2836	Aquadopp 1415	U, V, W, T, P	10	02/04/2015 00:00:00 15/04/2017 00:21	+00:10:10	04/04/2015 16:40:00 14/04/2017 17:10:00
199	2837	SBE-37SMP 7290	T, C, P	20	02/04/2015 00:00:01 15/04/2017 05:15:50	+00:01:22	04/04/2015 16:40:01 14/04/2017 17:00:01
150	2886	RBRsoloT 72250	T	10 s	02/04/2015 00:00:00 23/04/2017 15:53:10	+00:00:40	04/04/2015 16:40:00 14/04/2017 17:11:30
100	2936	Aquadopp 8097	U, V, W, T, P	10	02/04/2015 12:00:00 14/04/2017 23:05	+00:01:52	04/04/2015 16:40:00 14/04/2017 17:10:00 Appears to have large compass offset

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Table 47 – *continued from previous page*

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start/stop time UTC	Clock drift	First good/ Last good record Comments
99	2937	RBRsoloT 72232	T	10 s	02/04/2015 00:00:00 23/04/2017 14:23:51	-00:00:13	04/04/2015 16:40:00 14/04/2017 17:10:40
17	3019	Aquadopp 1430	U, V, W, T, P	10	02/04/2015 00:00:00 15/04/2017 00:49	+00:02:56	04/04/2015 16:40:00 14/04/2017 17:10:00
16	3020	SBE-37SMP 7288	T, C, P	20	02/04/2015 00:00:01 15/04/2017 09:51:40	+00:00:30	04/04/2015 16:40:01 14/04/2017 17:00:01
7	3028	Releases: IXSEA AR861 565 & 1942					

Table 47: Details of OP2 (2015-2017) mooring recovery. First good/last good record times are instrument times uncorrected for drift

OP3 (2015-2017)

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start/stop time UTC	Clock drift	First good/ Last good record Comments
530	1208	Novatech RF-700A1 V08-056 VHF radio beacon (159.480 MHz)					On triangular McLane top float
530	1208	Novatech ST-400A W02-088 Xenon flash beacon (daylight off disabled)					
508	1230	SBE-39 4897	T, P	10	02/04/2015 00:00:00 16/04/2017 14:31:13	+00:02:07	03/04/2015 21:00:00 15/04/2017 14:30:00
300	1438	Aquadopp 9392	U, V, W, T, P	10	02/04/2015 12:00:00 16/04/2017 00:40:50	+00:01:50	03/04/2015 21:00:00 15/04/2017 14:30:00
299	1439	SBE-37SM 7383	T, C, P	10	02/04/2015 00:00:01 15/04/2017 23:12:30	+00:00:14	03/04/2015 21:00:01 15/04/2017 14:20:01
50	1688	Aquadopp 9378	U, V, W, T, P	10	01/04/2015 12:00:00 16/04/2017 00:27:20	+00:02:06	03/04/2015 21:00:00 15/04/2017 14:30:00
16	1722	SBE-37SM 7386	T, C, P	10	02/04/2015 00:00:01 15/04/2017 23:18:20	+00:00:18	03/04/2015 21:00:01 15/04/2017 14:20:01
7	1731	Release: Edgetech 8242XS 33147					

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Table 48 – *continued from previous page*

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start/stop time UTC	Clock drift	First good/ Last good record Comments

Table 48: Details of OP3 (2015-2017) mooring recovery. First good/last good record times are instrument times uncorrected for drift

OP4 (2015-2017)

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start/stop time UTC	Clock drift	First good/ Last good record Comments
1132	1840	Novatech RF-700A1 W02-086 VHF radio beacon (160.725 MHz)					On triangular McLane top float
1132	1840	Novatech ST-400A W02-087 Xenon flash beacon (daylight off disabled)					
1116	1856	RCM-11 521	U, V, T, C	60	05/04/2015 14:00:00 22/04/2017 13:55 DSU word count incremented from 130158 to 130165 at 13:52:53	-00:27:23	07/04/2015 17:00 14/04/2017 13:25 DSU 15236; battery pack consisted of 6 new SAFT LSH 20 cells
1109	1863	SBE-37SM 2707	T, C, P	10	02/04/2015 00:00:01 15/04/2017 02:22:05	+00:04:14	07/04/2015 16:30:01 14/04/2017 14:30:01
760	2212	RCM-11 532	U, V, T, C	60	05/04/2015 14:00:00 22/04/2017 14:43 DSU word count incremented from 130070 to 130077 at 14:15:32	-00:12:51	07/04/2015 17:00 14/04/2017 14:02 DSU 15238; battery consisted of 5 new SAFT LSH 20 cells and 1 partly used Electrochem BCX85-LMS cell
753	2219	SBE-39 4418	T, C, P	10	02/04/2015 00:00:00 16/04/2017 13:51:25	+00:01:53	07/04/2015 16:30:00 14/04/2017 14:30:00

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Table 49 – *continued from previous page*

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start/stop time UTC	Clock drift	First good/ Last good record Comments
54	2918	RCM-11 592	U, V, T, C	60	05/04/2015 14:00:00 22/04/2017 14:32 DSU word count incremented from 130068 to 130075 at 14:17:35	-00:27:22	07/04/2015 17:00 14/04/2017 13:50 DSU 15239; battery consisted of 4 new SAFT LSH 20 cells and 2 partly used Electrochem BCX85-LMS cells
16	2956	SBE-37SM 2956	T, C, P	10	02/04/2015 00:00:01 15/04/2017 01:47:13	+00:04:27	07/04/2015 16:30:00 14/04/2017 14:30:02
7	2965	Release: IXSEA AR861 562					

Table 49: Details of OP4 (2015-2017) mooring recovery. First good/last good record times are instrument times uncorrected for drift

OP5 (2015-2017)

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start/stop time UTC	Clock drift	First good/ Last good record Comments
934	2489	Novatech RF-700A1 Y07-010 VHF radio beacon (160.725 MHz)					On rectangular McLane top float
934	2489	Novatech ST-400A Y07-011 Xenon flash beacon (daylight off disabled)					
900	2523	Aquadopp 6226	U, V, W, T, P	10	02/04/2015 00:00:00 14/04/2017 22:00	+00:01:52	06/04/2015 19:20:00 14/04/2017 09:00:00
899	2524	SBE-37SMP 12473	T, C, P	10	02/04/2015 00:00:00 16/04/2017 00:43:00	+00:00:24	06/04/2015 19:20:01 14/04/2017 09:00:01
825	2598	RBRsoloT 72225	T	10 s	02/04/2015 00:00:00 23/04/2017 13:44:26	+00:00:16	06/04/2015 19:20:00 14/04/2017 09:03:10
750	2673	Aquadopp 6198	U, V, W, T, P	10	02/04/2015 00:00:00 14/04/2017 22:13	+00:00:35	06/04/2015 19:20:00 14/04/2017 09:00:00

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Table 50 – *continued from previous page*

Height (above bottom) **(m)**	**Depth** (Nominal) **(m)**	**Instrument**	**Param.**	Sample int. (min)	**Start/stop time UTC**	**Clock drift**	**First good/ Last good record Comments**
749	2674	SBE-37SMP 12475	T, C, P	10	02/04/2015 00:00:00 16/04/2017 00:35:05	-00:00:23	06/04/2015 19:20:01 14/04/2017 09:00:01 Conductivities bad
675	2748	RBRsoloT 72224	T	10 s	02/04/2015 00:00:00 23/04/2017 13:38:05	+00:00:35	06/04/2015 19:20:00 14/04/2017 09:03:30
600	2823	Aquadopp 6180	U, V, W, T, P	10	02/04/2015 00:00:00 14/04/2017 22:05	+00:00:16	06/04/2015 19:20:00 14/04/2017 09:00:00
599	2824	SBE-37SMP 12476	T, C, P	10	02/04/2015 00:00:00 16/04/2017 00:28:40	-00:00:34	06/04/2015 19:20:01 14/04/2017 09:00:01 Conductivities bad
550	2873	RBRsoloT 72221	T	10 s	02/04/2015 00:00:00 23/04/2017 13:23:28	+00:00:05	06/04/2015 19:20:00 14/04/2017 09:03:00
500	2923	RBRsoloT 72272	T	10 s	02/04/2015 00:00:00 23/04/2017 16:45:15	+00:00:15	06/04/2015 19:20:00 14/04/2017 09:03:10
450	2973	Aquadopp 6263	U, V, W, T, P	10	02/04/2015 00:00:00 14/04/2017 22:18	+00:00:53	06/04/2015 19:20:00 14/04/2017 09:00:00
449	2974	SBE-37SMP 12469	T, C, P	10	02/04/2015 00:00:00 16/04/2017 00:25:20	-00:00:23	06/04/2015 19:20:01 14/04/2017 09:00:01
400	3023	RBRsoloT 72220	T	10 s	02/04/2015 00:00:00 23/04/2017 13:17	-00:00:14	06/04/2015 19:20:00 14/04/2017 09:02:40
350	3073	RBRsoloT 72223	T	10 s	02/04/2015 00:00:00 23/04/2017 13:34:35	+00:00:42	06/04/2015 19:20:00 14/04/2017 09:03:40
300	3123	Aquadopp 6112	U, V, W, T, P	10	02/04/2015 00:00:00 14/04/2017 22:31	+00:01:18	06/04/2015 19:20:00 14/04/2017 09:00:00

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Table 50 – *continued from previous page*

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start/stop time UTC	Clock drift	First good/ Last good record Comments
299	3124	SBE-37SMP 12464	T, C, P	10	02/04/2015 00:00:01 16/04/2017 00:54:40	-00:00:23	06/04/2015 19:20:01 14/04/2017 09:00:01
250	3173	RBRsoloT 72227	T	10 s	02/04/2015 00:00:00 23/04/2017 13:54:50	+00:00:01	06/04/2015 19:20:00 14/04/2017 09:03:00
200	3223	Aquadopp 5993	U, V, W, T, P	10	02/04/2015 00:00:00 14/04/2017 22:38	+00:00:19	06/04/2015 19:20:00 14/04/2017 09:00:00
199	3224	SBE-37SMP 12455	T, C, P	10	02/04/2015 00:00:01 15/04/2017 23:35:50	-00:00:19	06/04/2015 19:20:01 14/04/2017 09:00:01 Conductivities bad
150	3273	RBRsoloT 72226	T	10 s	02/04/2015 00:00:00 23/04/2017 13:46:31	-00:00:03	06/04/2015 19:20:00 14/04/2017 09:02:50
100	3323	Aquadopp 6236	U, V, W, T, P	10	01/04/2015 12:00:00 14/04/2017 22:26	+00:00:48	06/04/2015 19:20:00 14/04/2017 09:00:00
99	3324	SBE-37SMP 12456	T, C, P	10	02/04/2015 00:00:01 15/04/2017 23:32:04	-00:00:02	06/04/2015 19:20:01 14/04/2017 09:00:01
50	3373	Aquadopp 6000	U, V, W, T, P	10	01/04/2015 12:00:00 14/04/2017 21:41	+00:01:09	06/04/2015 19:20:00 14/04/2017 09:00:00
49	3374	RBRsoloT 72229	T	10 s	02/04/2015 00:00:00 23/04/2017 14:00:25	-00:00:08	06/04/2015 19:20:00 14/04/2017 09:02:50
19	3404	SBE-37SMP 12458	T, C, P	10	02/04/2015 00:00:01 15/04/2017 23:42:10	-00:00:37	06/04/2015 19:20:01 14/04/2017 09:00:01
7	3416	Release: IXSEA AR861 1356					

Table 50: Details of OP2 (2015-2017 mooring recovery. First good/last good record times are instrument times uncorrected for drift

OP6 (2015-2017)

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start/stop time UTC	Clock drift	First good/ Last good record Comments
374	1964	Novatech RF-700A1 Y07-009 VHF radio beacon (160.725 MHz)					On triangular McLane top float
360	1978	Aquadopp 9250	U, V, W, T, P	10	02/04/2015 00:00:00 14/04/2017 22:51	+00:01:52	06/04/2015 13:40:00 14/04/2017 12:30:00
50	2288	Aquadopp 9264	U, V, W, T, P	10	02/04/2015 00:00:00 14/04/2017 22:43	+00:01:26	06/04/2015 13:40:00 14/04/2017 12:30:00
19	2319	SBE-37SM 8267	T, C	10	02/04/2015 00:00:00 15/04/2017 00:29:00	+00:00:34	06/04/2015 13:40:01 14/04/2017 12:30:01
7	2331	Release: IXSEA AR861 564					

Table 51: Details of OP6 (2015-2017) mooring recovery. First good/last good record times are instrument times uncorrected for drift

OP7 (2015-2017)

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start/stop time UTC	Clock drift	First good/ Last good record Comments
1500	1560	Aquadopp 8059	U, V, W, T, P	10	02/04/2015 12:00:00 15/04/2017 22:57:45	+00:01:08	09/04/2015 14:00:00 15/04/2017 17:00:00
1499	1561	SBE-37SMP 12463	T, C, P	10	02/04/2015 00:00:01 15/04/2017 20:40:00	-00:00:12	09/04/2015 14:00:01 15/04/2017 16:50:01
1350	1710	Aquadopp 8556	U, V, W, T, P	15	01/04/2015 12:00:00 15/04/2017 22:55:20	+00:02:15	09/04/2015 14:00:00 15/04/2017 17:00:00
1349	1711	SBE-37SM 7380	T, C, P	10	02/04/2015 00:00:01 15/04/2017 19:40:45	+00:00:51	09/04/2015 14:00:01 15/04/2017 17:00:01
1200	1860	Aquadopp 11992	U, V, W, T, P	10	02/04/2015 12:00:00 15/04/2017 23:43:30	+00:01:40	09/04/2015 14:00:00 15/04/2017 17:00:00

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Table 52 – *continued from previous page*

Height (above bottom) **(m)**	**Depth** (Nominal) **(m)**	**Instrument**	**Param.**	**Sam-ple int. (min)**	**Start/stop time UTC**	**Clock drift**	**First good/ Last good record Comments**
1199	1861	SBE-37SMP 7315	T, C, P	20	02/04/2015 00:00:01 15/04/2017 23:03:25	+00:00:51	09/04/2015 14:00:01 15/04/2017 17:00:01
1125	1935	SBE-39 4409	T	10	02/04/2015 00:00:00 16/04/2017 13:40:40	+00:02:00	09/04/2015 14:00:00 15/04/2017 17:00:00
1050	2010	Aquadopp 6212	U, V, W, T, P	10	02/04/2015 12:00:00 11/04/2015 00:00:00	Unknown	09/04/2015 14:00:00 11/04/2015 00:00:00 Instrument leaked
1049	2011	SBE-37SMP 7306	T, C, P	20	02/04/2015 00:00:01 15/04/2017 22:51:00	-00:00:05	09/04/2015 14:00:01 15/04/2017 17:00:01
975	2085	RBRsoloT 72264	T	10 s	02/04/2015 00:00:00 09/04/2015 12:35:10	Unknown	No records in water Battery loose
900	2160	Aquadopp 6225	U, V, W, T, P	10	02/04/2015 12:00:00 16/04/2017 12:57:00	+00:01:33	09/04/2015 14:00:00 15/04/2017 17:00:00
899	2161	SBE-37SMP 7305	T, C, P	20	02/04/2015 00:00:01 15/04/2017 22:38:11	+00:00:47	09/04/2015 14:00:01 15/04/2017 17:00:01
825	2235	RBRsoloT 72240	T	10 s	02/04/2015 00:00:00 23/04/2017 14:50:36	+00:00:26	09/04/2015 14:00:00 15/04/2017 16:59:20
750	2310	Aquadopp 12010	U, V, W, T, P	10	02/04/2015 12:00:00 15/04/2017 23:11:40	+00:01:33	09/04/2015 14:00:00 15/04/2017 17:00:00
749	2311	SBE-37SM 7381	T, C, P	10	02/04/2015 00:00:01 15/04/2017 20:43:18	+00:01:03	09/04/2015 14:00:01 15/04/2017 17:00:01
675	2385	RBRsoloT 72237	T	10 s	02/04/2015 00:00:00 23/04/2017 14:44:30	-00:00:02	09/04/2015 14:00:00 15/04/2017 16:58:50
600	2460	Aquadopp 8080	U, V, W, T, P	10	02/04/2015 12:00:00 16/04/2017 12:15:25	+00:01:17	09/04/2015 14:00:00 15/04/2017 17:00:00

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Table 52 – *continued from previous page*

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start/stop time UTC	Clock drift	First good/ Last good record Comments
599	2461	SBE-37SMP 7304	T, C, P	20	02/04/2015 00:00:01 15/04/2017 20:48:48	+00:01:08	09/04/2015 14:00:01 15/04/2017 17:00:01
550	2510	RBRsoloT 72241	T	10 s	02/04/2015 00:00:00 23/04/2017 14:51:54	+00:00:12	09/04/2015 14:00:00 15/04/2017 16:59:10
500	2560	Aquadopp 12047	U, V, W, T, P	10	02/04/2015 00:00:00 15/04/2017 23:26:10	+00:01:19	09/04/2015 14:00:00 15/04/2017 17:00:00
499	2561	RBRsoloT 72230	T	1 s	02/04/2015 00:00:00 18/04/2016 07:00:13 (23/04/2017 14:02:45)	+00:00:03	09/04/2015 14:00:00 18/04/2016 07:00:13 Logger was accidentally set to 1-s interval instead of 10 s! Stopped when memory full.
450	2610	RBRsoloT 72271	T	10 s	02/04/2015 00:00:00 23/04/2017 16:34:21	+00:00:19	09/04/2015 14:00:00 15/04/2017 16:59:10
415	2645	Novatech RF-700A1 W02-084 VHF radio beacon (154.585 MHz)					
415	2645	Novatech ST-400A Y07-012 Xenon flash beacon (daylight off disabled)					
415	2645	RDI Longranger ADCP 3301	U, V, W (profile), T, P	60	09/04/2015 01:00:00 Unknown	Unknown	12 pings per ensemble, 26 16-m depth cells Mounted in MSI SB47-3000 buoy 10-14 SN 120 Instrument leaked, at transducer end of pressure housing. No data recovered.
399	2661	SBE-37SMP 7312	T, C, P	20	02/04/2015 00:00:01 15/04/2017 23:06:45	+00:00:36	09/04/2015 14:00:01 15/04/2017 17:00:01
350	2710	RBRsoloT 72236	T	10 s	02/04/2015 00:00:00 09/04/2015 11:11:10	Unknown	No records in water Battery loose

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Table 52 – *continued from previous page*

Height (above bottom) **(m)**	**Depth** (Nominal) **(m)**	**Instrument**	**Param.**	**Sample int. (min)**	**Start/stop time UTC**	**Clock drift**	**First good/ Last good record Comments**
300	2760	Aquadopp 6224	U, V, W, T, P	10	01/04/2015 12:00:00 16/04/2017 02:09	+00:01:28	09/04/2015 14:00:00 15/04/2017 17:00:00
299	2761	SBE-37SM 7385	T, C, P	10	02/04/2015 00:00:01 15/04/2017 22:26:17	+00:00:21	09/04/2015 14:00:01 15/04/2017 17:00:01
250	2810	RBRsoloT 72239	T	10 s	02/04/2015 00:00:00 23/04/2017 14:46:54	-00:00:26	09/04/2015 14:00:00 15/04/2017 16:58:30
200	2860	Aquadopp 12016	U, V, W, T, P	10	02/04/2015 12:00:00 15/04/2017 20:19:27	+00:00:58	09/04/2015 14:00:00 15/04/2017 17:00:00
199	2861	SBE-37SMP 12462	T, C, P	20	02/04/2015 00:00:01 15/04/2017 22:31:05	-00:00:08	09/04/2015 14:00:01 15/04/2017 16:50:01
150	2910	RBRsoloT 72222	T	10 s	02/04/2015 00:00:00 23/04/2017 13:31:10	-00:00:02	09/04/2015 14:00:00 15/04/2017 16:58:50
100	2960	Aquadopp 11990	U, V, W, T, P	10	02/04/2015 12:00:00 16/04/2017 00:12:00	+00:01:41	09/04/2015 14:00:00 15/04/2017 17:00:00
99	2961	RBRsoloT 72238	T	10 s	02/04/2015 00:00:00 23/04/2017 14:45:15	-00:00:20	09/04/2015 14:00:00 15/04/2017 16:58:40
17	3040	Aquadopp 6276	U, V, W, T, P	10	02/04/2015 12:00:00 16/04/2017 11:40:10	+00:01:08	09/04/2015 14:00:00 15/04/2017 17:00:00
16	3041	SBE-37SMP 7298	T, C, P	20	02/04/2015 00:00:00 15/04/2017 22:44:50	+00:00:17	09/04/2015 14:00:01 15/04/2017 17:00:01
7	3053	Releases: IXSEA AR861 1616 & 1617					Release 1617 has a stiff hook, and has not been redeployed.

Table 52: Details of OP7 (2015-2017) mooring recovery. First good/last good record times are instrument times uncorrected for drift

Mooring Deployments

M2 (2017-)

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start time UTC	Comments
532	2520	Novatech RF-700A1 W08-050 VHF radio beacon (159.480 MHz)				On triangular McLane top float
532	2520	Novatech ST-400A U08-059 Xenon flash beacon (daylight off disabled)				
511	2541	Aquadopp 2807	U, V, W, T, P	30	24/03/2017 00:00:00	
466	2586	SBE-37SM 2708	T, C, P	15	24/03/2017 00:00:00	
341	2711	SBE-39 1311	T, P	15	24/03/2017 00:00:00	
239	2813	SBE-39 1232	T, P	15	24/03/2017 00:00:00	
164	2888	SBE-39 0229	T	15	24/03/2017 00:00:00	
19	3033	SBE-37SMP 14765	T, C, P	15	24/03/2017 00:00:00	
16	3036	Aquadopp 9380	U, V, W, T, P	30	24/03/2017 00:00:00	
8	3044	Releases: Edgetech 8242xs 31512 & 33152				

Table 53: Details of M2 (2017-) mooring deployment.

M3 (2017-)

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start time UTC	Comments
532	4041	Novatech RF-700A1 W08-053 VHF radio beacon (159.480 MHz)				On triangular McLane top float
532	4041	Novatech ST-400A V08-057 Xenon flash beacon				
513	4060	Aquadopp 2317	U, V, W, T, P	30	24/03/2017 00:00:00	
468	4105	SBE-37SM 1351	T, C, P	15	24/03/2017 00:00:00	
393	4180	SBE-39 1247	T, P	15	24/03/2017 00:00:00	
318	4255	SBE-39 1310	T, P	15	24/03/2017 00:00:00	
241	4332	SBE-37SMP 14764	T, C, P	15	24/03/2017 00:00:00	

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Table 54 – *continued from previous page*

Height (above bottom) **(m)**	**Depth** (Nominal) **(m)**	**Instrument**	**Param.**	Sample int. (min)	**Start time UTC**	**Comments**
116	4457	SBE-37SM 4119	T, C, P	15	24/03/2017 00:00:00	
66	4507	SBE-39 1826	T, P	15	24/03/2017 00:00:00	
21	4552	SBE-37SMP 14763	T, C, P	15	24/03/2017 00:00:00	
18	4555	Aquadopp 1752	U, V, W, T, P	30	24/03/2017 00:00:00	
9	4564	Releases: ORE 8242xs 32131 & 49027				

Table 54: Details of M3 (2017-) mooring deployment.

OP1 (2017-)

Height (above bottom) **(m)**	**Depth** (Nominal) **(m)**	**Instrument**	**Param.**	Sample int. (min)	**Start time UTC**	**Comments**
1823	1870	Six orange Vitrovex floats on 5-m Eddygrip rope				
1817	1876	Aquadopp 5993	U, V, W, T, P	10	18/04/2017 10:00:00	
1816	1877	SBE-39 4709	T	10	18/04/2017 10:00:00	Thread stripped on clamp, secured with hose clamp
1483	2210	Aquadopp 6000	U, V, W, T, P	10	18/04/2017 10:00:00	
1482	2211	SBE-37SM 7380	T, C, P	10	18/04/2017 10:00:00	
1467	2226	Four yellow Benthos floats on 5-m Eddygrip rope				
1114	2579	Three orange Vitrovex floats on 3-m Eddygrip rope				
1064	2630	SBE-39 4413	T	10	18/04/2017 10:00:00	
760	2933	Three yellow Benthos floats on 3-m Eddygrip rope				
710	2983	Aquadopp 6112	U, V, W, T, P	10	18/04/2017 10:00:00	
709	2984	SBE-37SM 7381	T, C, P	10	18/04/2017 10:00:00	
407	3286	Three orange Vitrovex floats on 3-m Eddygrip rope				
53	3640	Three orange Vitrovex floats on 3-m Eddygrip rope				

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Table 55 – *continued from previous page*

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start time UTC	Comments
47	3646	Aquadopp 6180	U, V, W, T, P	10	18/04/2017 10:00:00	
19	3674	SBE-37SM 7382	T, C, P	10	18/04/2017 10:00:00	
9	3684	Three orange Vitrovex floats on 3-m Eddygrip rope				
7	3686	Releases: IXSEA AR861 564 & 1616				

Table 55: Details of OP1 (2017-) mooring deployment.

OP2 (2017-)

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start time UTC	Comments
1526	1532	Six orange Vitrovex floats on 5-m Eddygrip rope (labelled iStar 6B)				
1520	1538	SBE-37SM 7383	T, C, P	10	18/04/2017 10:00:00	
1421	1637	Six yellow Benthos floats on 5-m Eddygrip rope (dated 2004-2005)				
1415	1643	Aquadopp 6198	U, V, W, T, P	10	18/04/2017 10:00:00	
1121	1937	SBE-39 0083	T	10	18/04/2017 10:00:00	
726	2332	Aquadopp 6226	U, V, W, T, P	10	18/04/2017 10:00:00	
725	2333	SBE-37SM 7385	T, C, P	10	18/04/2017 10:00:00	
715	2343	Six orange Vitrovex floats on 5-m Eddygrip rope (labelled iStar 6A)				
65	2993	Aquadopp 6236	U, V, W, T, P	10	18/04/2017 10:00:00	
21	3037	SBE-37SM 7386	T, C, P	10	18/04/2017 10:00:00	
10	3048	Four yellow Benthos floats on 5-m Eddygrip rope				
7	3050	Releases: Edgetech 8242XS 33147 & 33614				

Table 56: Details of OP2 (2017-) mooring deployment.

OP3 (2017-)

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start time UTC	Comments
508	1229	SBE-37SM 8540	T, C, P	10	18/04/2017 10:00:00	
308	1429	Four orange Vitrovex floats on 5-m Eddygrip rope				
300	1437	Aquadopp 5424	U, V, W, T, P	20	18/04/2017 10:00:00	Has 13mm clamp; 1 battery
53	1684	Four orange Vitrovex floats on 5-m Eddygrip rope				
47	1690	Aquadopp 8556	U, V, W, T, P	20	18/04/2017 10:00:00	Has 13mm clamp; 1 battery
19	1718	SBE-37SM 8541	T, C, P	10	18/04/2017 10:00:00	
9	1728	Two orange Vitrovex floats on 3-m Eddygrip rope				
7	1730	Release: IXSEA AR861 565				

Table 57: Details of OP3 (2017-) mooring deployment.

OP4 (2017-)

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start time UTC	Comments
1130	1819	Novatech RF-700A1 W02-084 VHF radio beacon (154.585 MHz)				On top float with Trimsyn TS2 syntactic foam float
1130	1819	Novatech ST-400A W02-088 Xenon flash beacon (daylight off disabled)				
1114	1835	Four orange Vitrovex floats on 5-m Eddygrip rope (labelled iStar 4F)				
1108	1841	Aquadopp 6263	U, V, W, T, P	10	18/04/2017 10:00:00	
1107	1842	SBE-39 4418	T, C, P	10	18/04/2017 10:00:00	
759	2190	Four orange Vitrovex floats on 5-m white Kevlar rope (labelled iStar 2C)				
750	2199	Aquadopp 9250	U, V, W, T, P	10	18/04/2017 10:00:00	
749	2200	SBE-39 4713	T, C, P	10	18/04/2017 10:00:00	
53	2896	Four orange Vitrovex floats on 5-m Eddygrip rope				

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Table 58 – *continued from previous page*

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start time UTC	Comments
47	2902	Aquadopp 9264	U, V, W, T, P	10	18/04/2017 10:00:00	
19	2930	SBE-37SM 2678	T, C, P	10	18/04/2017 10:00:00	
10	2939	Three orange Vitrovex floats on 3-m Eddygrip rope (labelled iStar 3B)				
7	2942	Release: IXSEA AR861 562 & 1615				

Table 58: Details of OP4 (2017-) mooring deployment.

OP5 (2017-)

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start time UTC	Comments
424	2963	Novatech RF-700A1 W02-085 VHF radio beacon (159.480 MHz)				On triangular McLane top float
424	2963	Novatech ST-400A W02-089 Xenon flash beacon (daylight off disabled)				
408	2979	Four yellow Benthos floats on 5-m Eddygrip rope				
400	2987	Aquadopp 12010	U, V, W, T, P	10	18/04/2017 10:00:00	
399	2988	SBE-39 4716	T	10	18/04/2017 10:00:00	
53	3334	Four yellow Benthos floats on 5-m Eddygrip rope				
46	3341	Aquadopp 12016	U, V, W, T, P	10	18/04/2017 10:00:00	
18	3369	SBE-37SM 7387	T, C, P	10	18/04/2017 10:00:00	
9	3378	Two orange Vitrovex floats on 3-m Eddygrip rope (labelled iStar 2A)				
7	3380	Release: IXSEA AR861 1618				

Table 59: Details of OP5 (2017-) mooring deployment.

OP6 (2017-)

Height (above bottom) (m)	Depth (Nominal) (m)	Instrument	Param.	Sample int. (min)	Start time UTC	Comments
400	1910	Aquadopp 12020	U, V, W, T, P	10	18/04/2017 10:00:00	
53	2257	Four yellow Benthos floats on 5-m Eddygrip rope				
46	2264	Aquadopp 12053	U, V, W, T, P	10	18/04/2017 10:00:00	
18	2292	SBE-37SM 8267	T, C	10	18/04/2017 10:00:00	
9	2301	Two orange Vitrovex floats on 3-m Eddygrip rope (labelled iStar 2C)				
7	2303	Release: IXSEA AR861 1356				

Table 60: Details of OP6 (2017-) mooring deployment.

Recovered mooring diagrams

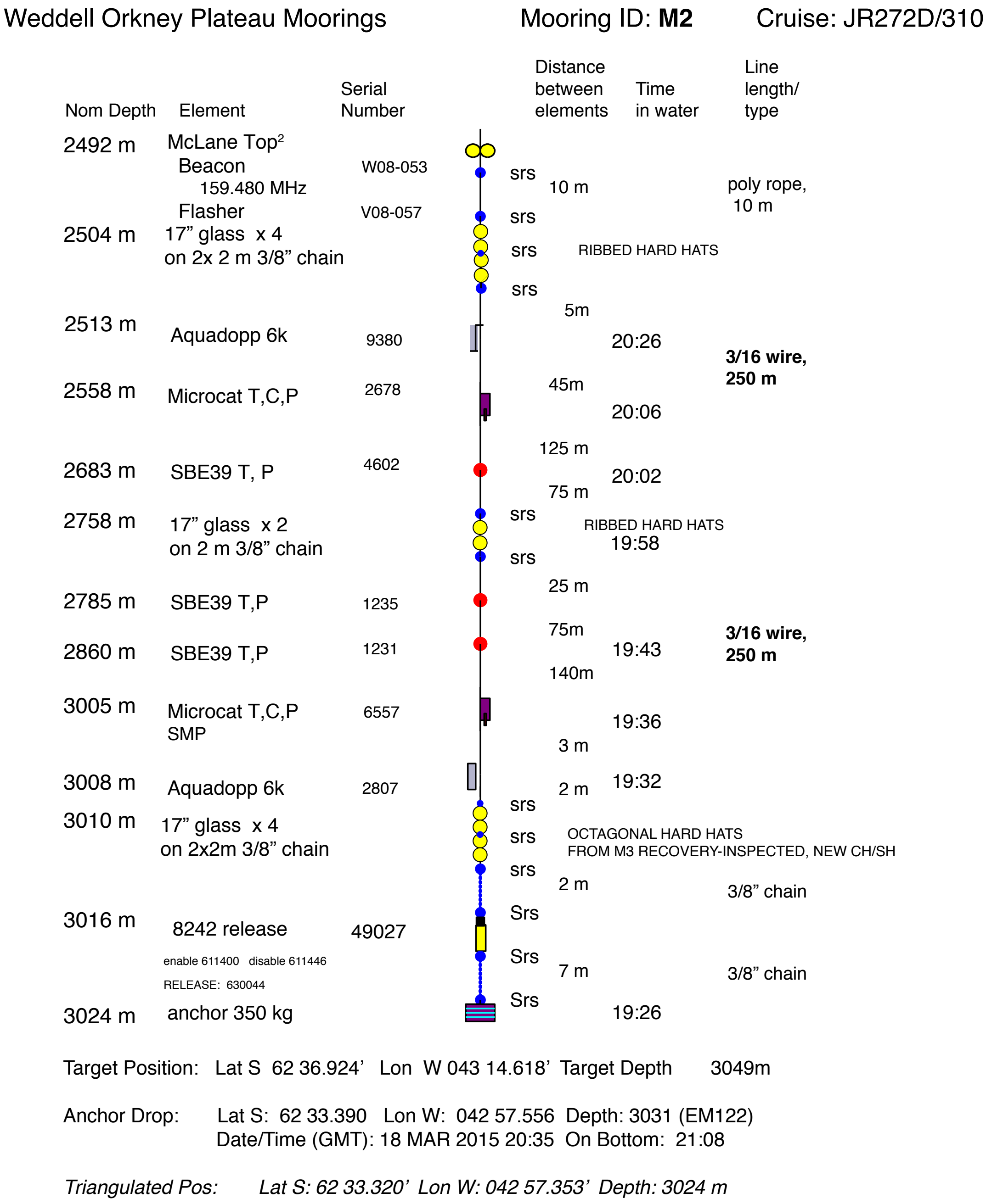
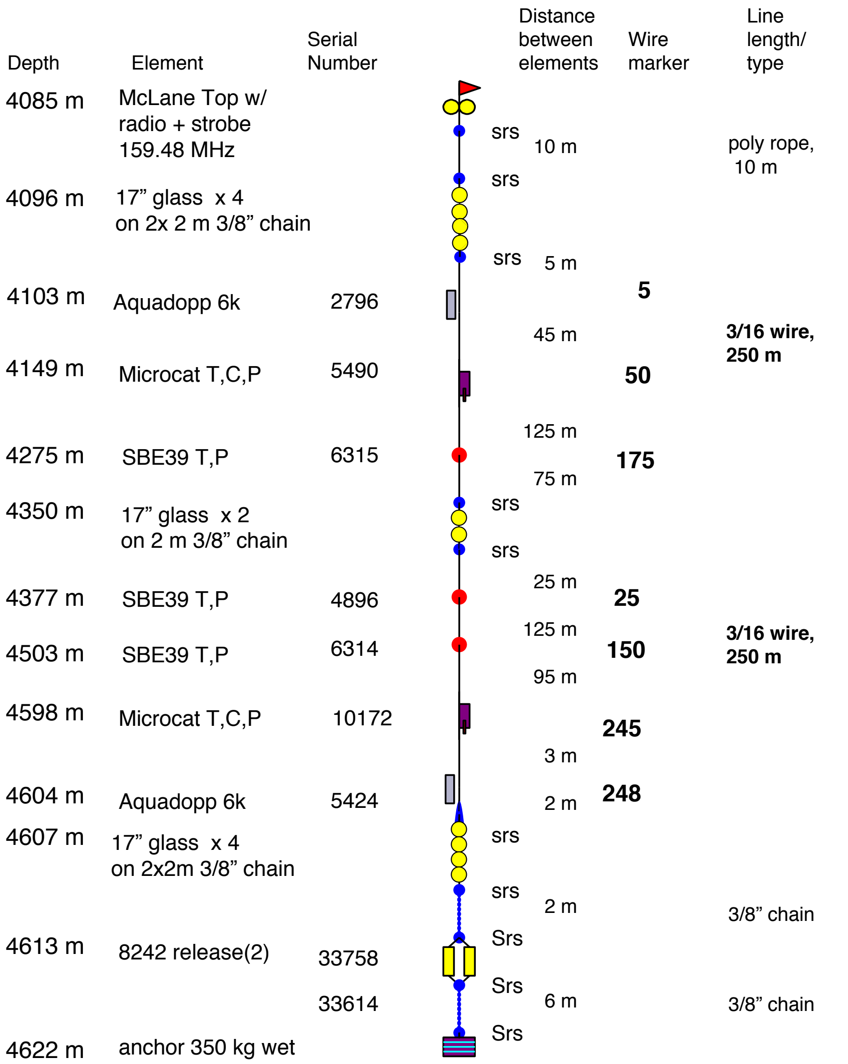


Figure 22: Mooring M2 as recovered on JR16005

Weddell Orkney Plateau Moorings   Mooring ID: M3a   Cruise: JR299



Deployed Position: Lat S 63° 31.998' Lon W 041° 46.656'
Depth 4622 m

Date/Time (GMT): 5 April 2014 21:12

notes: radio duty cycle: 2 s on, 4 off   Anchor first deployment in 9-10 tenths ice cover

Figure 23: Mooring M3a as recovered on JR16005

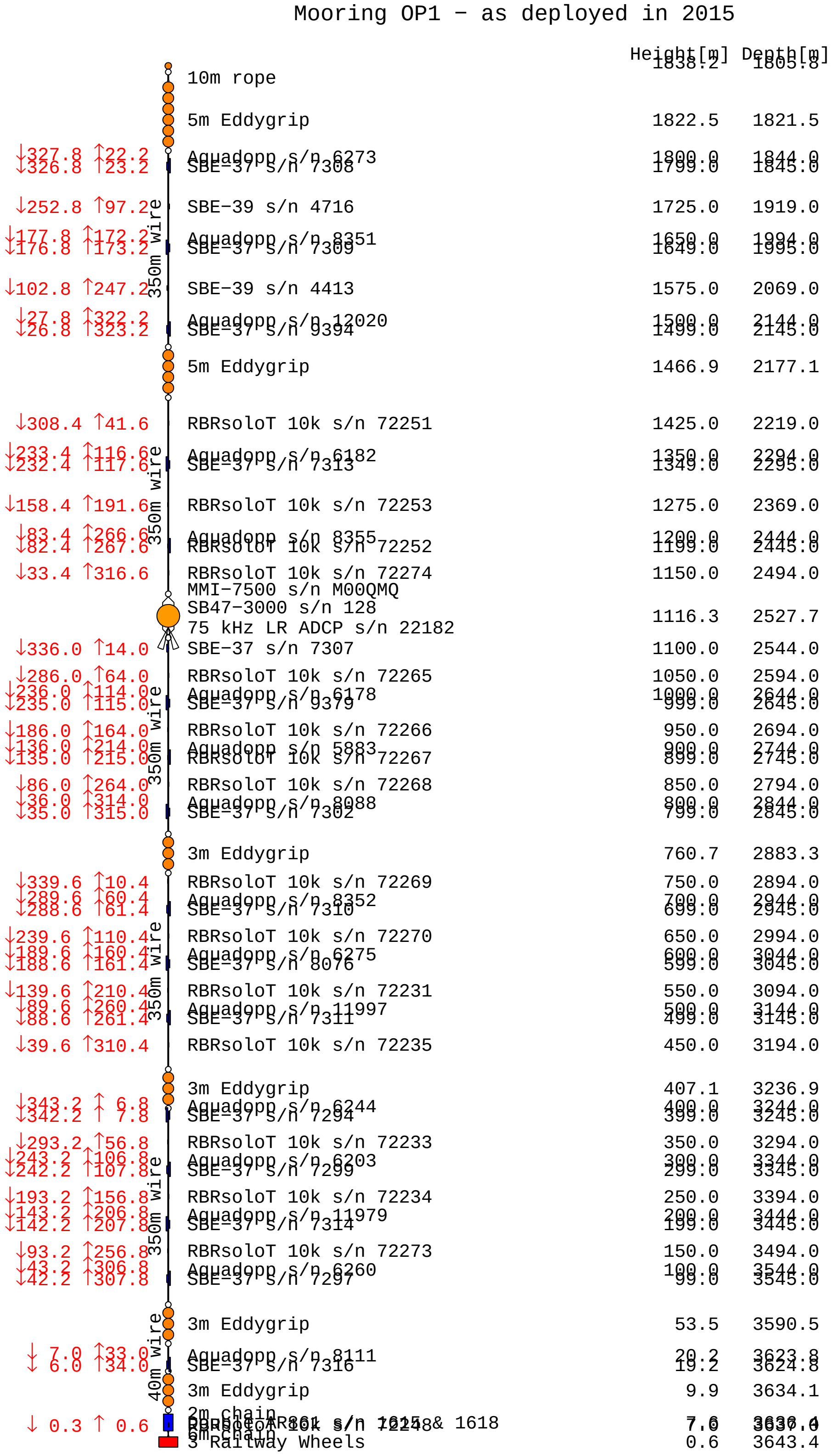


Figure 24: Mooring OP1 as recovered on JR16005

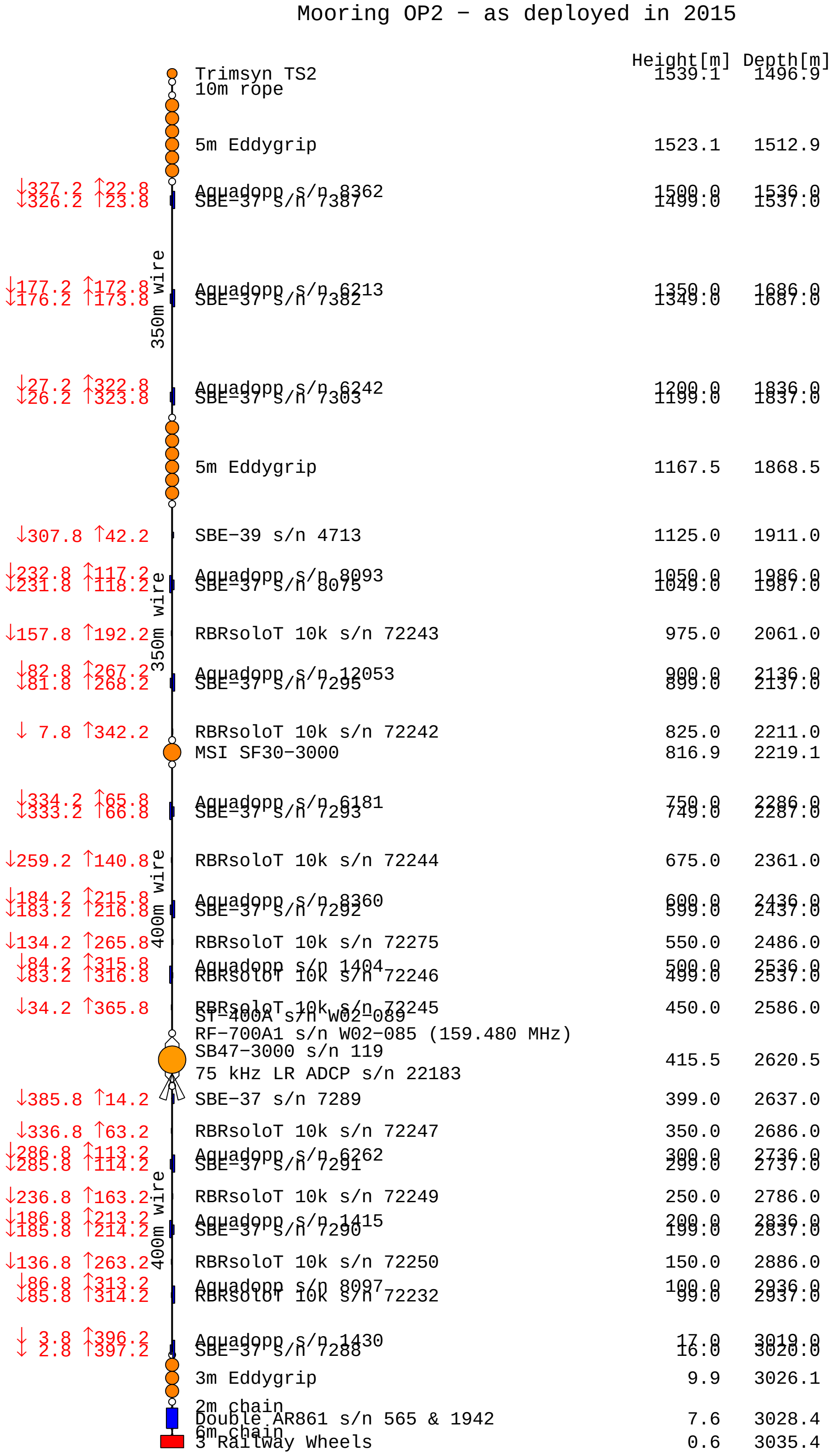


Figure 25: Mooring OP2 as recovered on JR16005

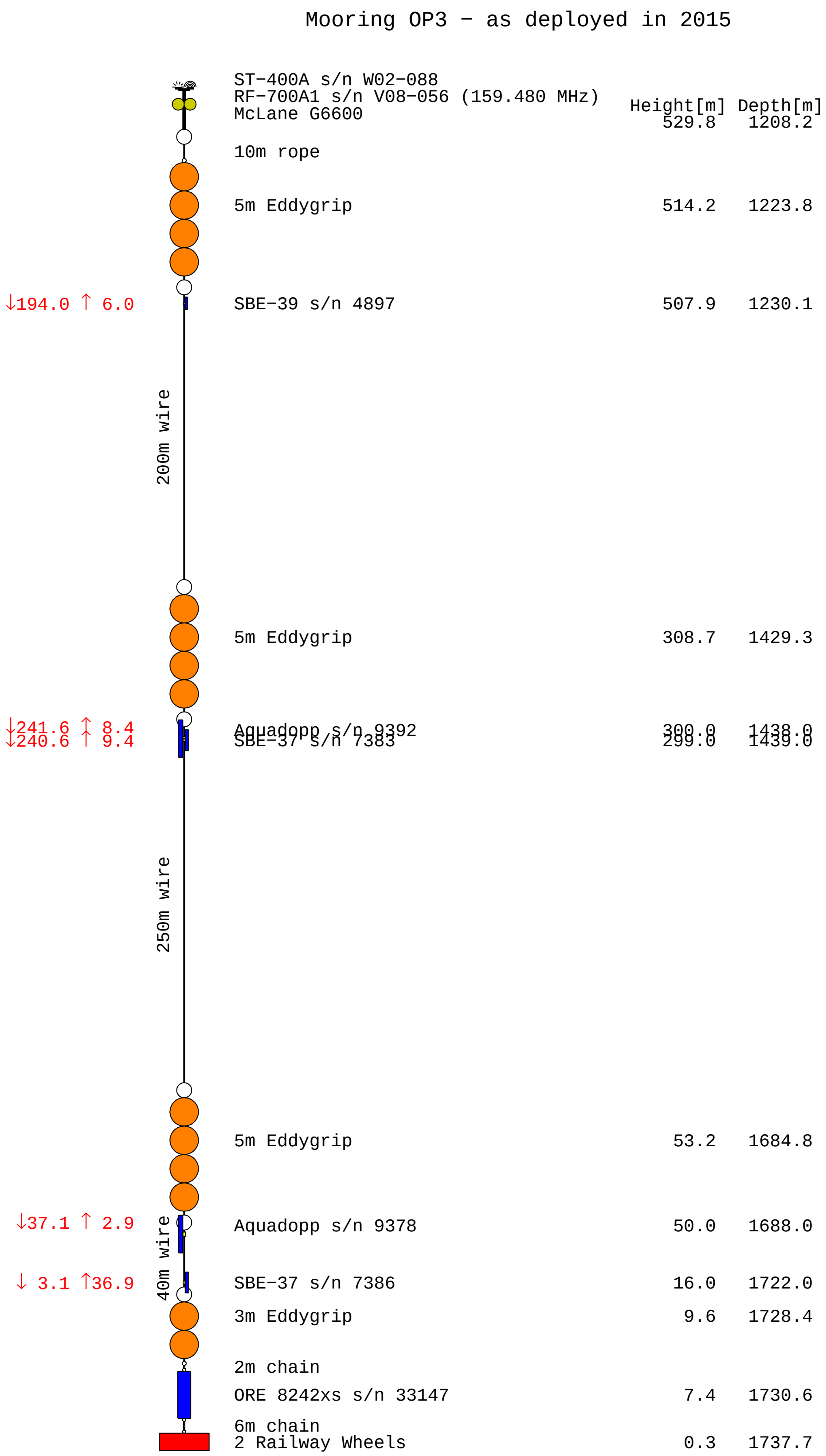


Figure 26: Mooring OP3 as recovered on JR16005

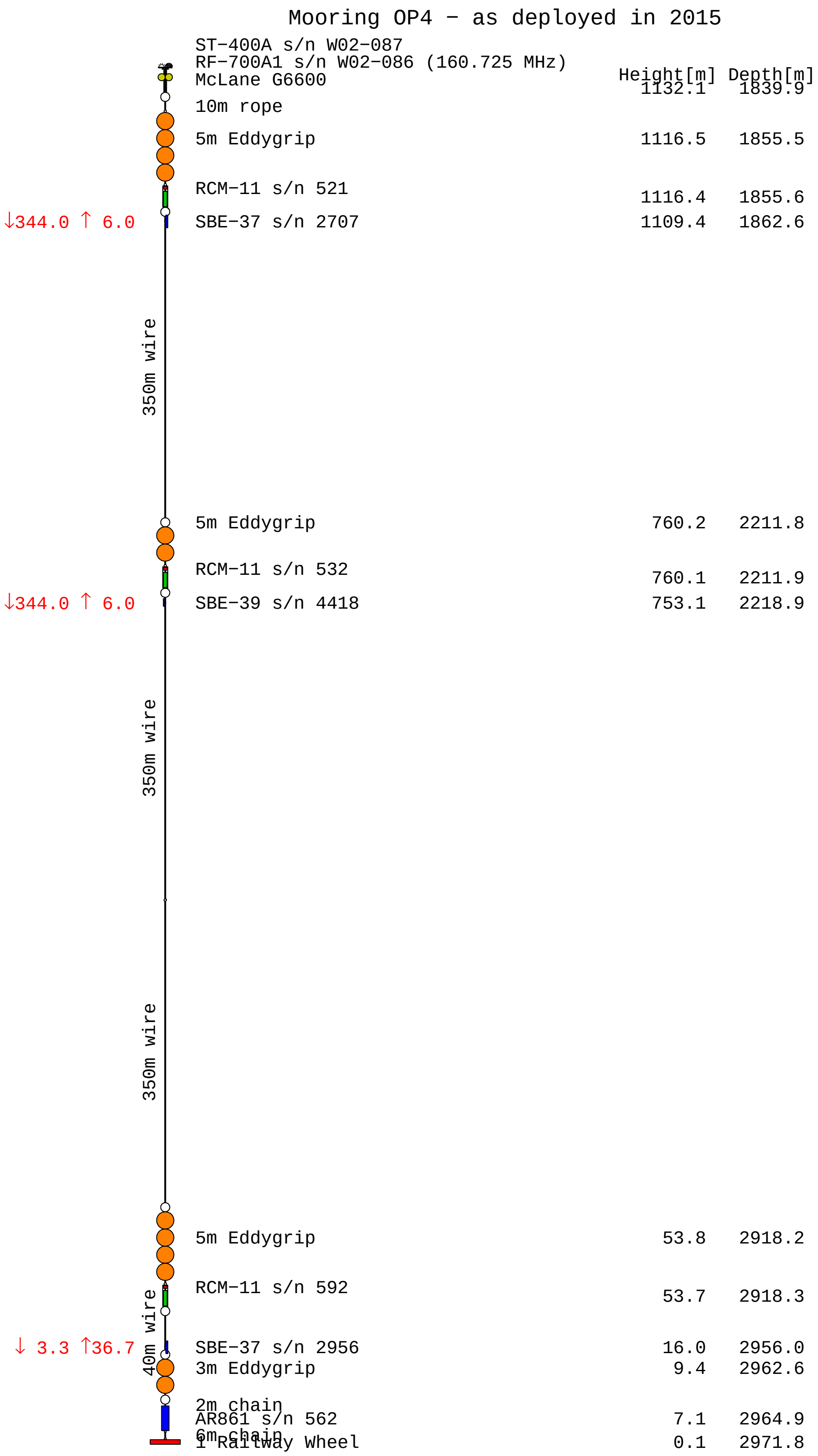


Figure 27: Mooring OP4 as recovered on JR16005

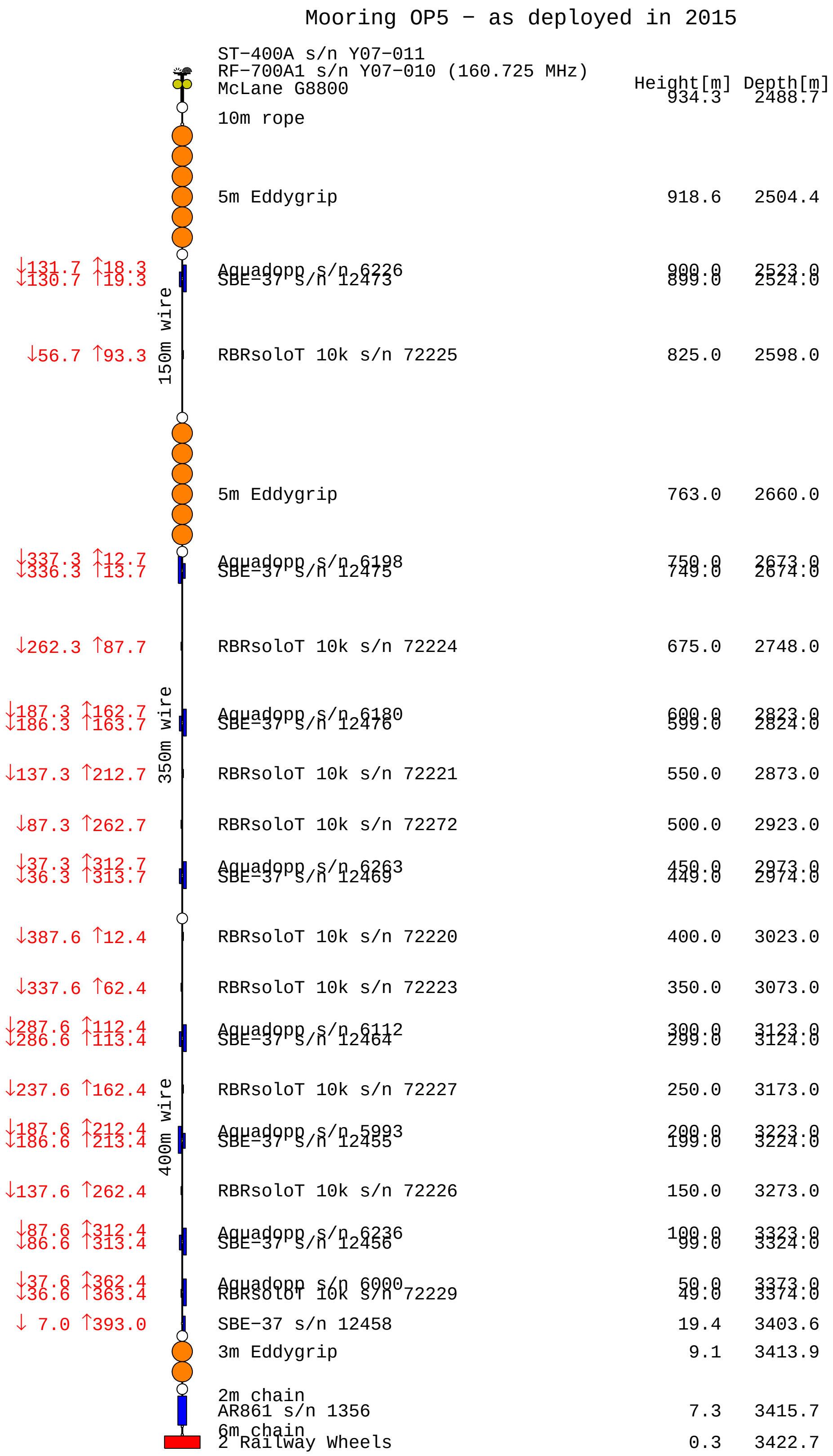


Figure 28: Mooring OP5 as recovered on JR16005

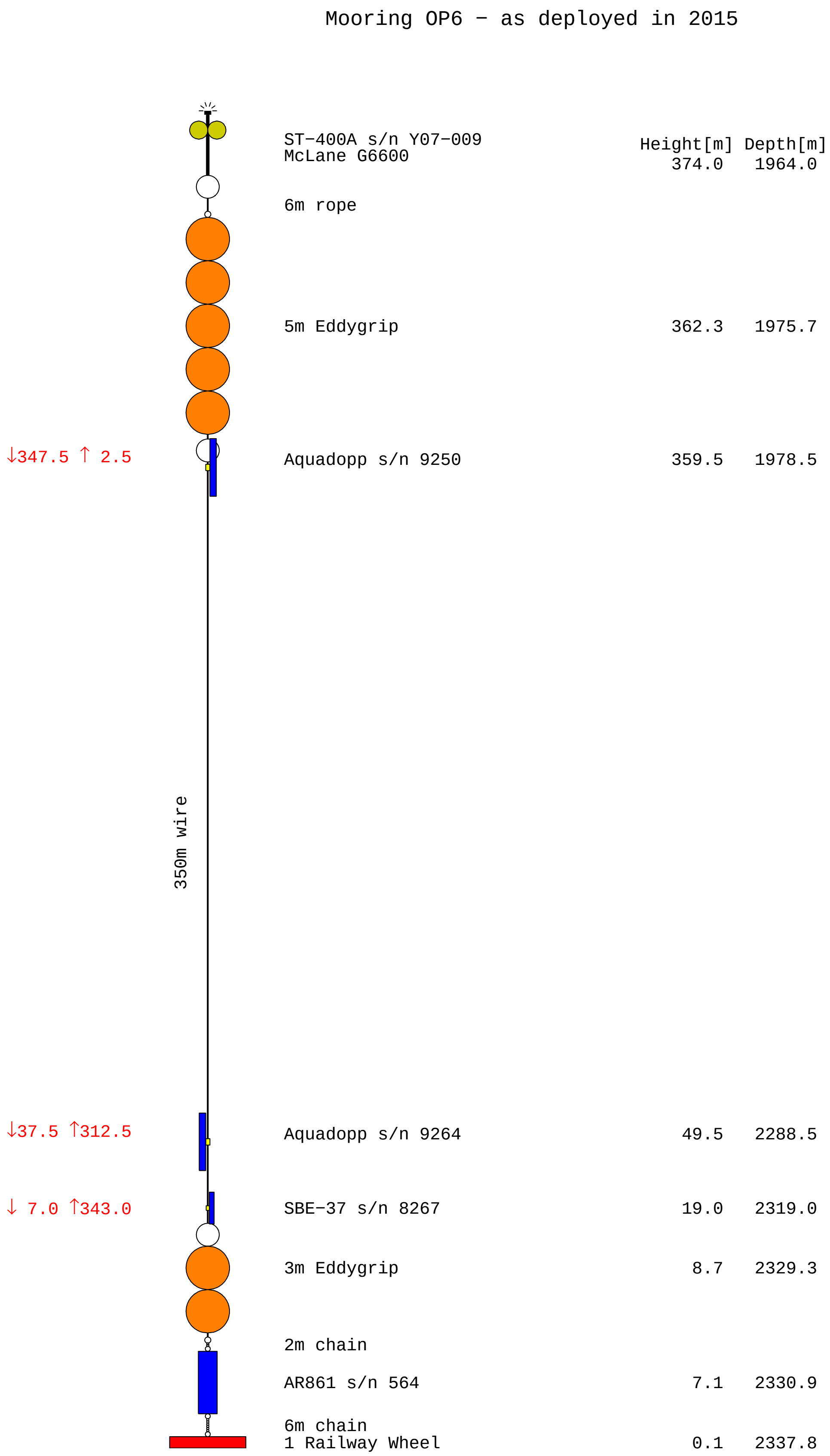


Figure 29: Mooring OP6 as recovered on JR16005

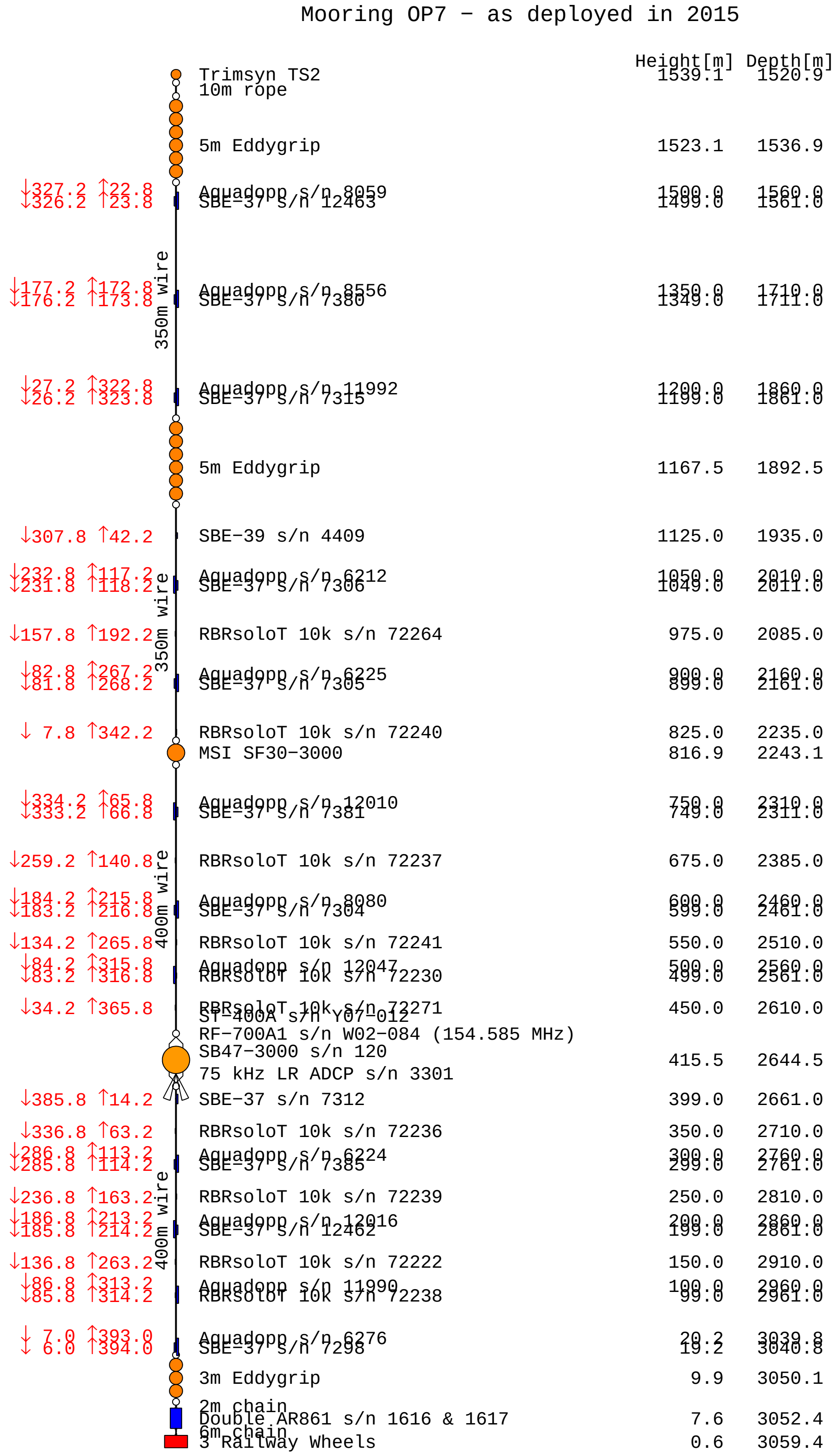


Figure 30: Mooring OP7 as recovered on JR16005

Deployed mooring diagrams

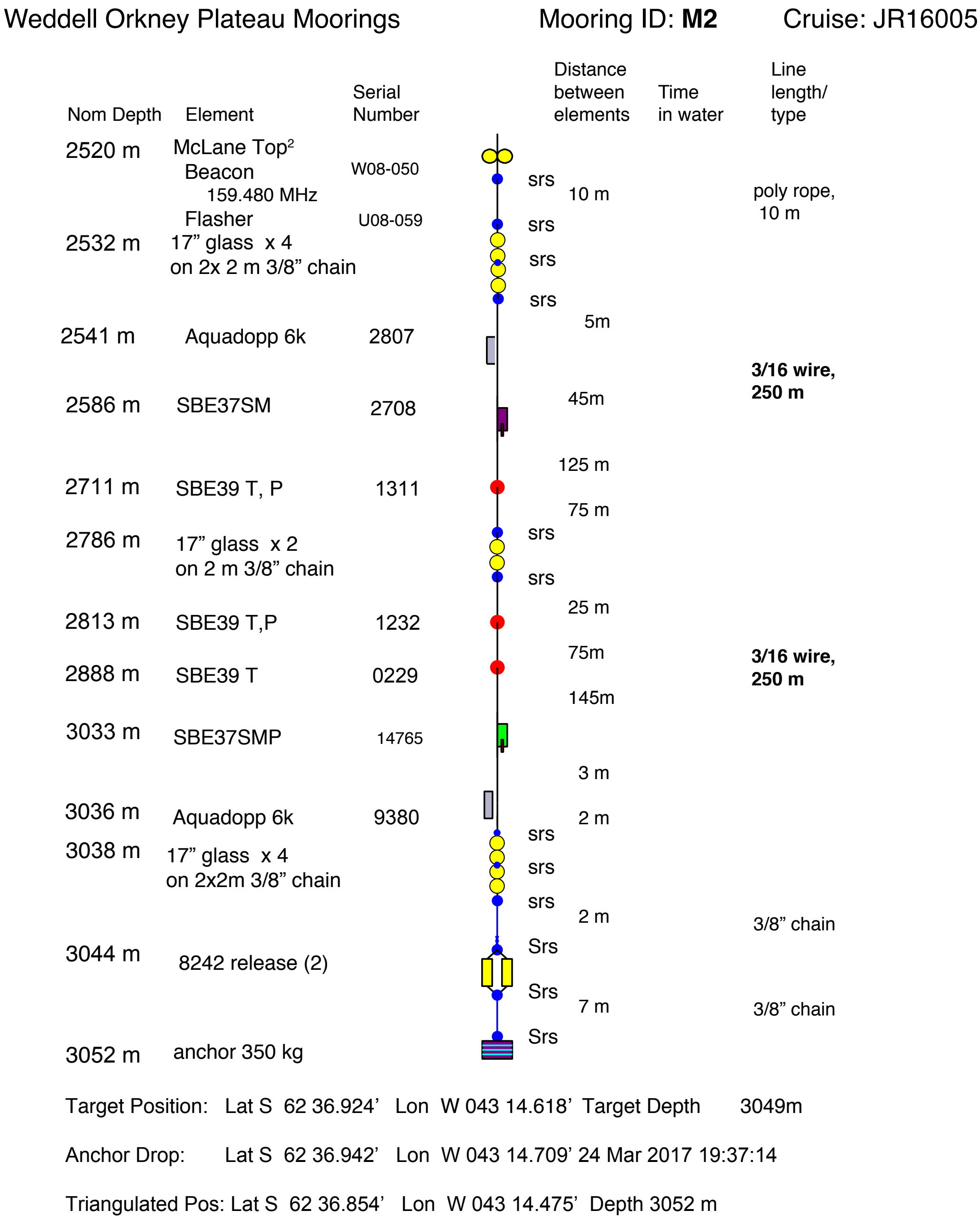
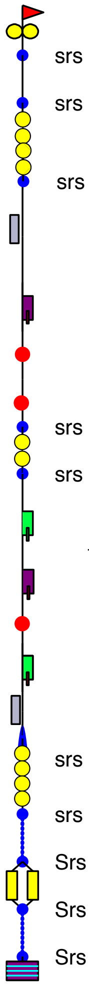


Figure 31: Mooring M2 as deployed on JR16005

Weddell Orkney Plateau Moorings Mooring ID: M3 Cruise: JR16005

Depth	Element	Serial Number	Distance between elements	Wire marker	Line length/ type
4041 m	McLane Top w/ radio + strobe 159.48 MHz	W08-053 V08-057	10 m		poly rope, 10 m
4051 m	17" glass x 4 on 2x 2 m 3/8" chain		5 m		
4060 m	Aquadopp 6k		45 m	**5**	**3/16 wire, 250 m**
4105 m	SBE37SM	1351	75 m	**50**	
4180 m	SBE39 T,P	1247	75 m	**125**	
4255 m	SBE39 T,P	1310	50 m	**200**	
4305 m	17" glass x 2 on 2 m 3/8" chain		25 m		
4332 m	SBE37SMP	14764	125 m	**25**	**3/16 wire, 250 m**
4457 m	SBE37SM	4119	50 m	**150**	
4507 m	SBE39 T,P	1826	45 m	**200**	
4552 m	SBE37SMP	14763	3 m	**245**	
4555 m	Aquadopp 6k	1752	2 m	**248**	
4557 m	17" glass x 4 on 2x2m 3/8" chain		2 m		3/8" chain
4564 m	8242 release(2)	32131 33152	7 m		3/8" chain
4573 m	anchor 350 kg wet				



Target Position: Lat S 63 31.998' Lon W 041 46.656' Target Depth 4622 m

Anchor Drop: Lat S 63 32.030' Lon W 041 46.726' 24 Mar 2017 10:30:48

Triangulated Pos: Lat S 63 31.963' Lon W 041 46.299' Depth 4573 m

notes: radio duty cycle: 2 s on, 4 off

Figure 32: Mooring M3 as deployed on JR16005

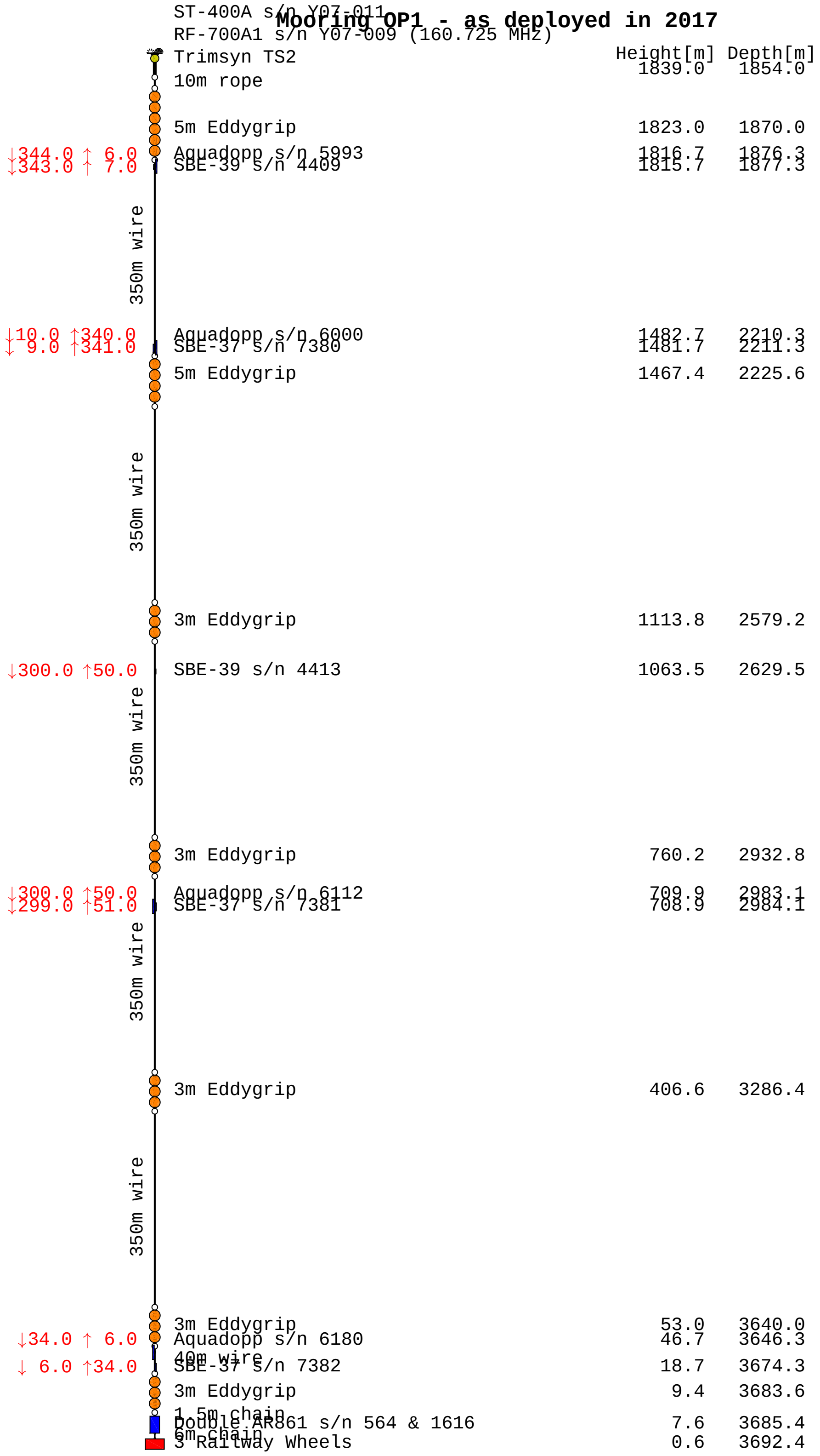


Figure 33: Mooring OP1 as deployed on JR16005

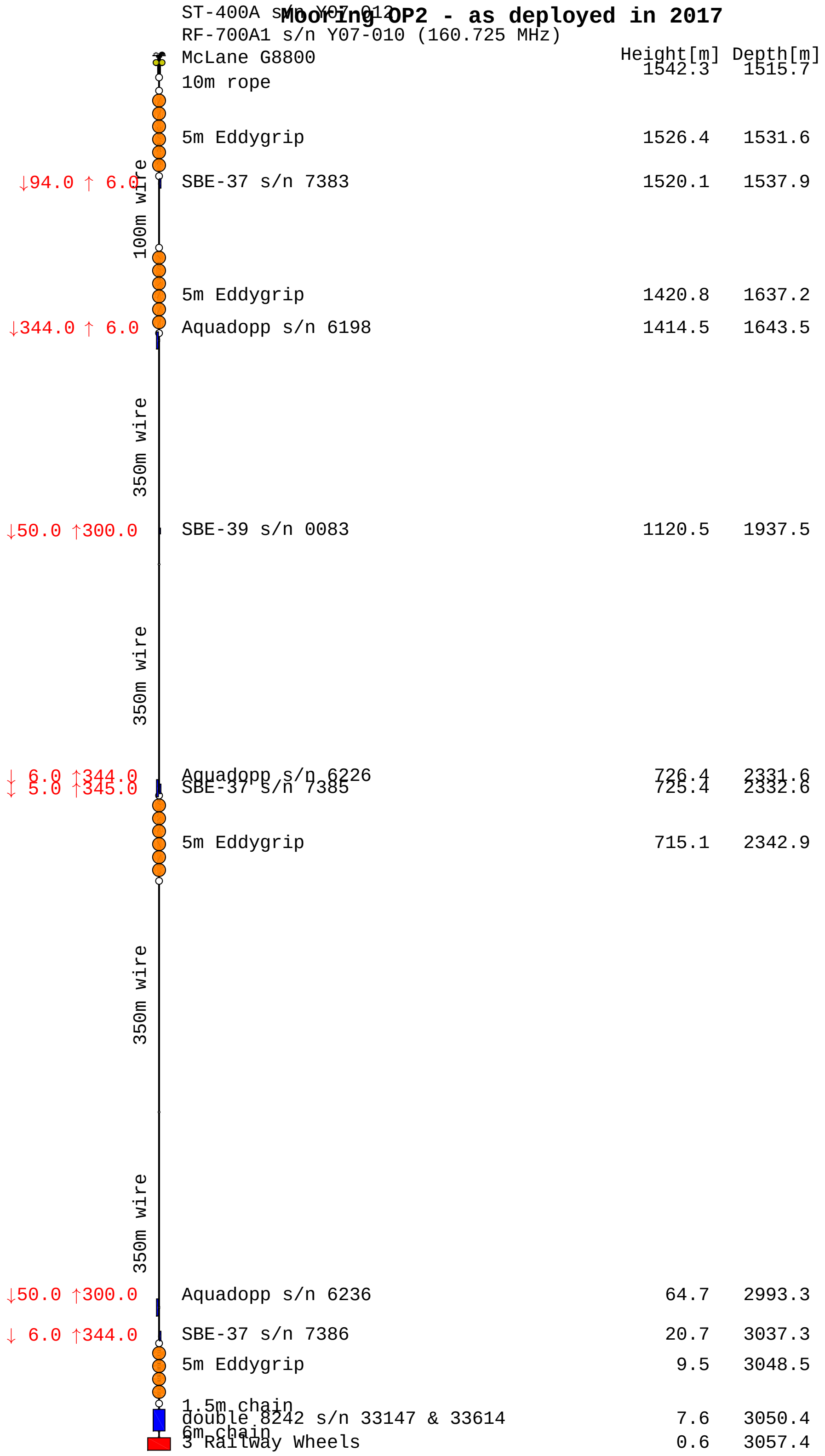


Figure 34: Mooring OP2 as deployed on JR16005

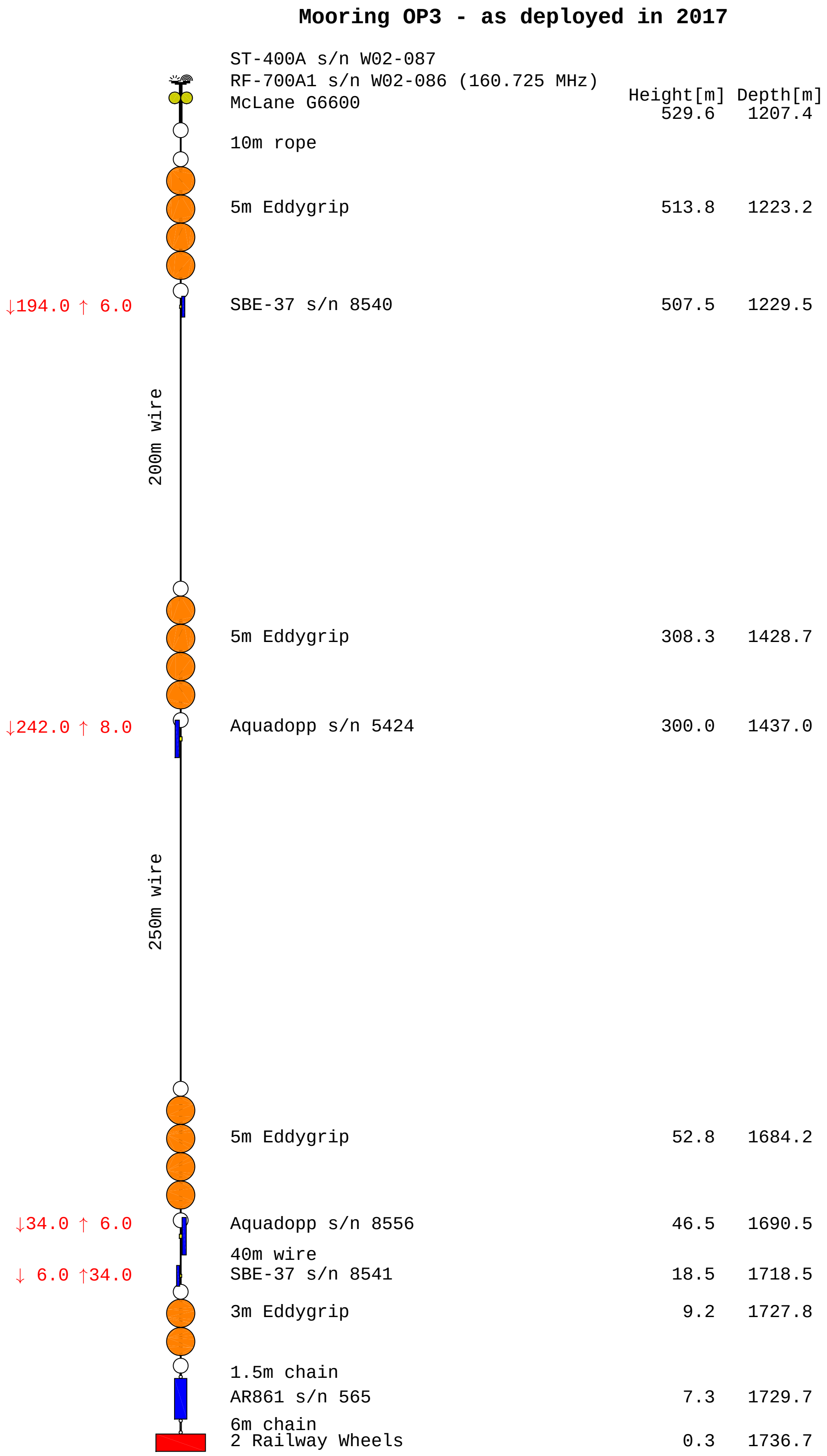


Figure 35: Mooring OP3 as deployed on JR16005

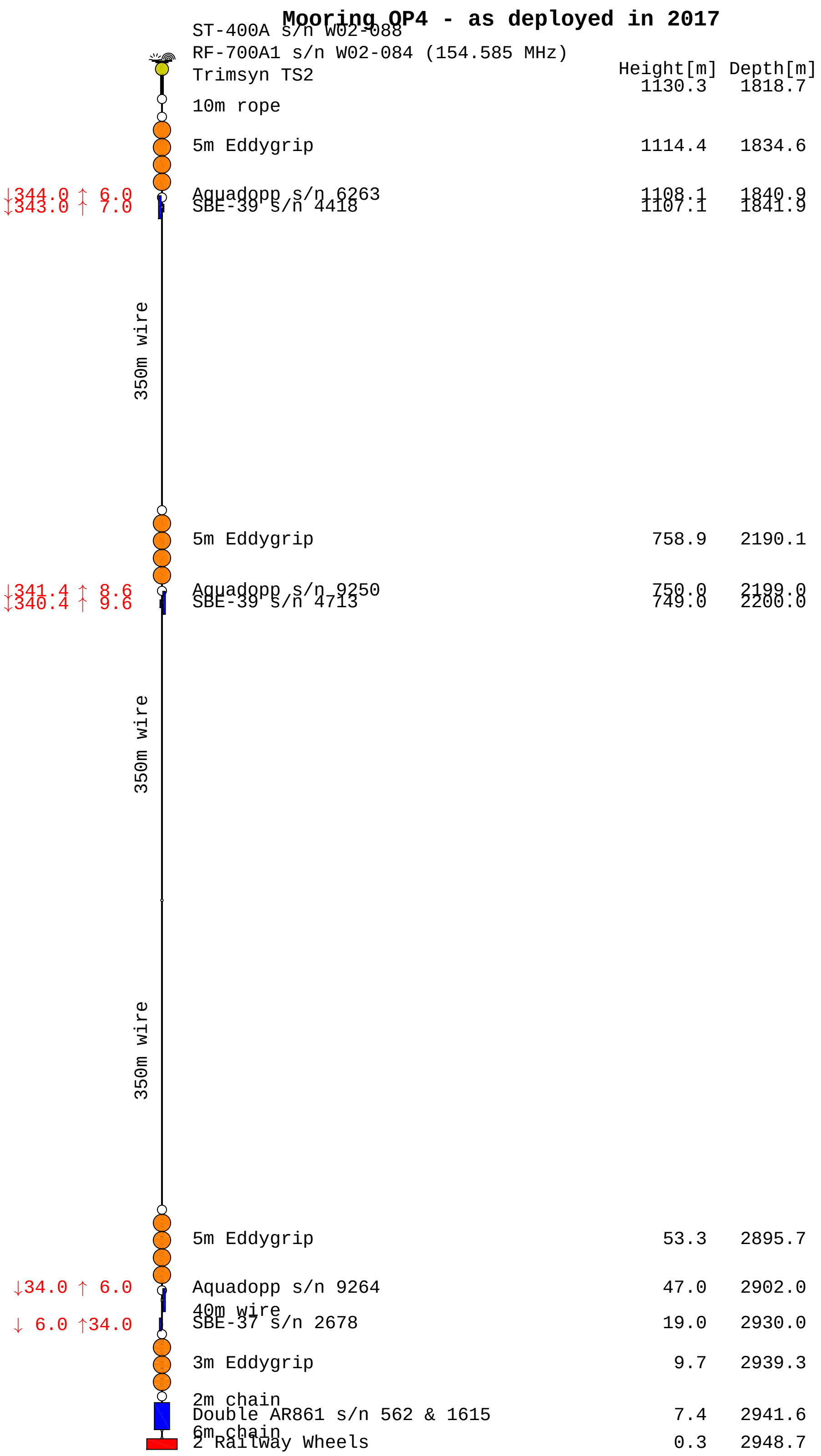


Figure 36: Mooring OP4 as deployed on JR16005

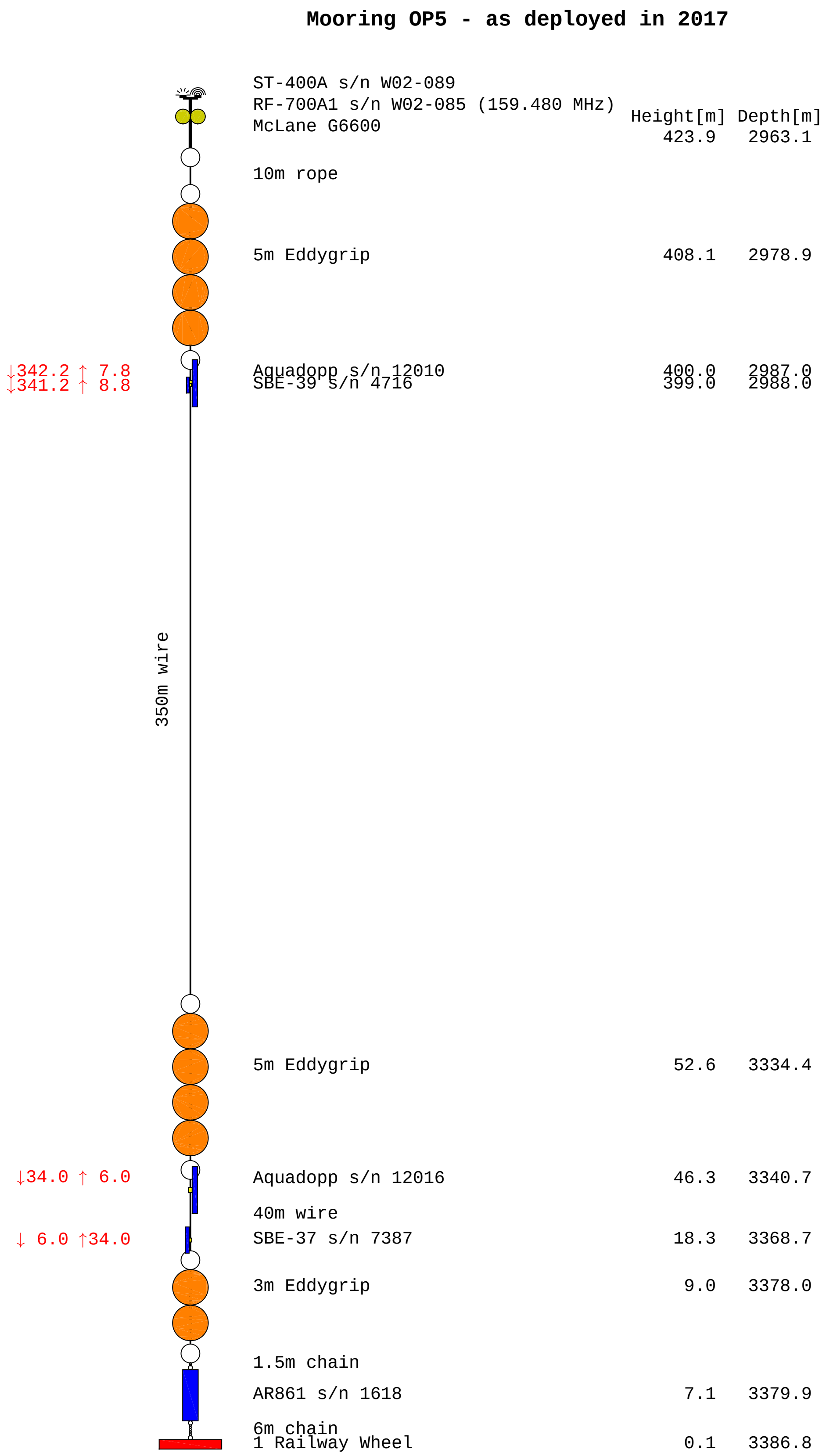


Figure 37: Mooring OP5 as deployed on JR16005

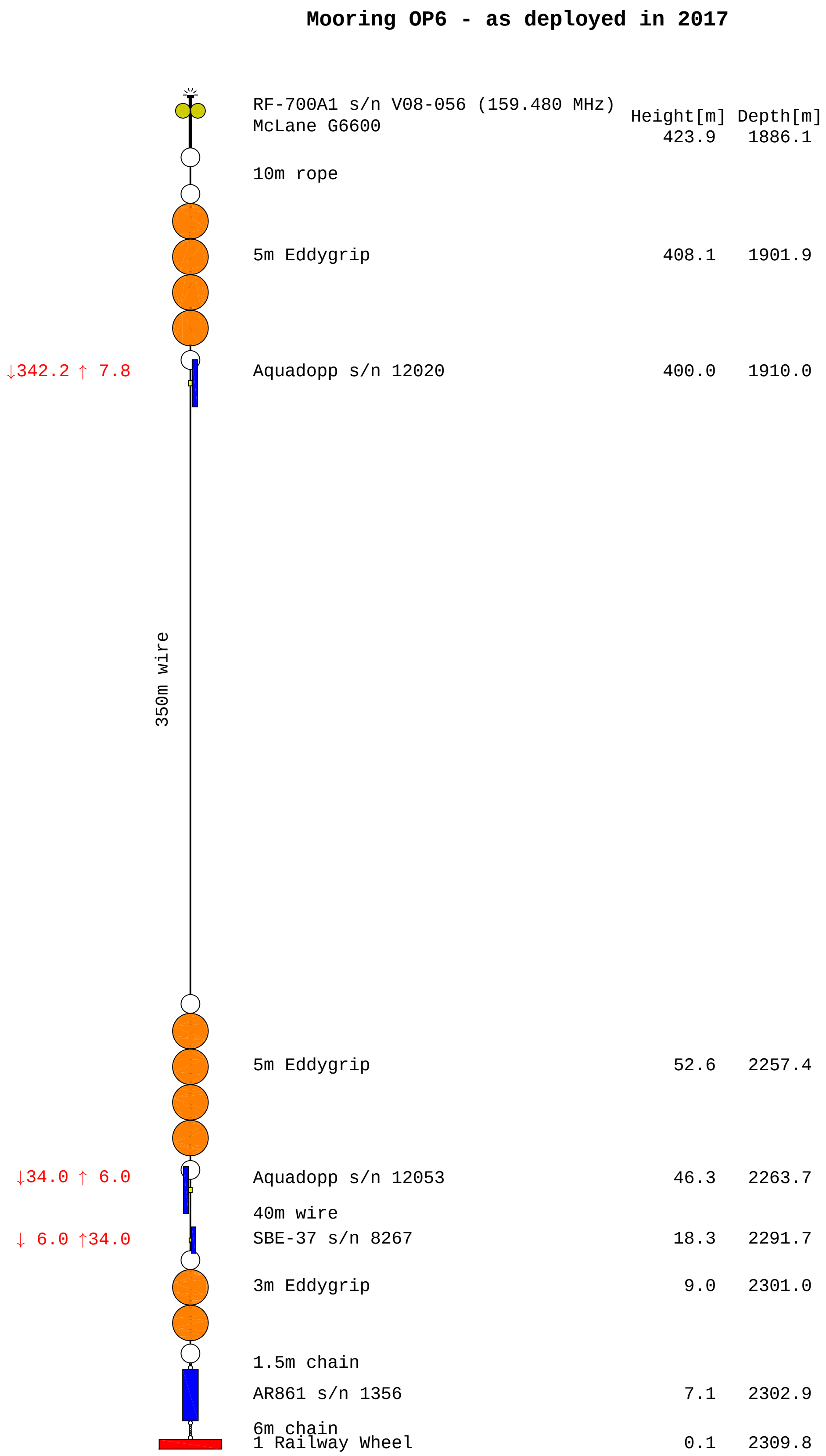


Figure 38: Mooring OP6 as deployed on JR16005

7.2 Woods Hole Oceanographic Institute (WHOI) Mooring Operations – *Andrew Davies*

Mooring Deployment

The deployment operations of the Orkney Passage (Polzin-WHOI) mooring commenced on 21 March 2017 at 1845 UTC and ran through the evening hours in deteriorating sea and weather conditions. At the start of the deployment, conditions were fair. However, as the day progressed the seas built to swells of six to seven meters with wind gusts of forty knots.

Deck set up for Deployment and Recovery Operations

The shipboard mooring winch was located on the working deck fifteen meters forward of the A-frame on the centerline of the ship. For the deployment, the 3/16" wire rope to be used was ran down the center of the ship passing under a deck-mounted sheave and up through a large block located on the swing arm of the A-frame. To deploy heavier items such as the top flotation, acoustic releases, and anchor, the ship's Gilson winch wire was passed overhead through another large sheave attached to the main A-frame and coupled to a quick release. In the working square on the back deck a cleat was bolted to the deck approximately five meters from the stern on the port side. This cleat and a deck eye located just aft were used in conjunction with a large section of Kevlar line the latter of which was passed through available pear rings to stop the mooring when needed.

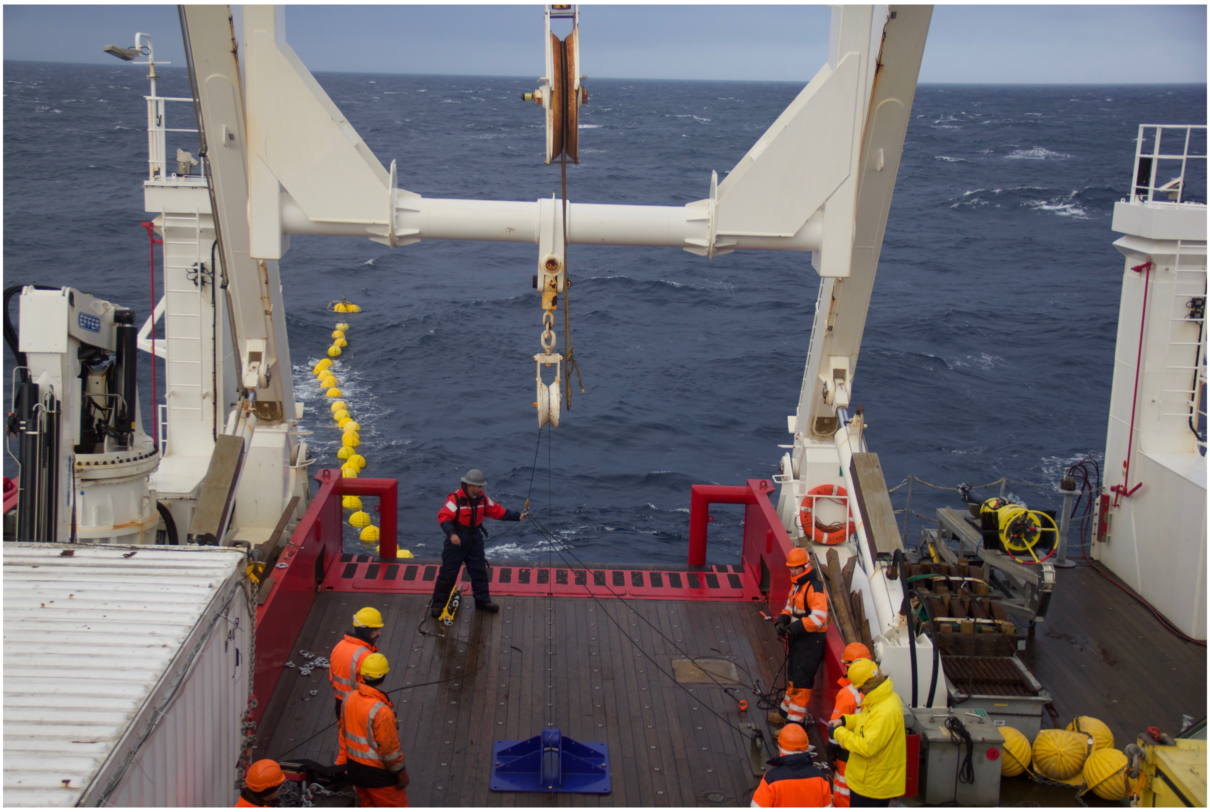


Figure 39: Deck Layout for WHOI Mooring Operations on JR16005.

Mooring Deployment Operations

The frame with Argos transmitter and strobe used as the top floatation was attached to one set of (4) glass balls and the main mooring line. Utilizing the Gilson winch, A-frame, and quick release it was hoisted outboard while the ship's winch kept the floatation at an even distance to the swing arm sheave and released into the water. The remainder of glass balls (26) located below were then deployed by stopping off with the Kevlar line to an available pear ring in sections and hoisted with the main line. The swing arm on the A-frame was then moved outboard and the glass lowered down. Once all of the glass was clear of the ship, the mooring wire was deployed and instrumentation attached in prescribed locations. To make any of the in line connections the Kevlar line was used to stop off and the swing arm of the A-frame was moved inboard closer to the deck and the frames were shackled in. Once the unit was attached, the line was slipped out and the swing arm moved outboard to clear the stern. This method was used for all of the attached instrumentation and flotation. At the end of the deployment the quick release and Gilson winch were used to hoist the acoustic releases out board and set them in the water. The ship's Effer crane then moved the anchor into position at the center of the aft deck. The anchor was then stopped off using the method described above and the load of the mooring was transferred to the anchor. The quick release and Gilson wire were attached to the anchor and it was hoisted off aft of the stern to just below the waterline preventing it from swinging around. Upon the captain's command, the anchor was dropped at the appropriate location of 60° 16.2971' S 045° 14.8893' W.

Instrumentation

The Orkney Passage (Polzin-WHOI) mooring utilizes 3/16" (5mm) 3 x 19 plastic-jacketed galvanized wire rope supplied by the WHOI Mooring Lab, with an outer diameter of 6.5 mm, and swaged sockets to fit $\frac{1}{2}$" shackles. All of the Sea-Bird 37SM CTDs and SBE 39 temperature pods were clamped onto the mooring wire with the correct sized factory Delrin clamps. The Nortek Aquadopp and Nobska MAVS current meters were installed in aluminum frames with Delrin clamps and were shackled in line with the mooring wire. At the lowest section of the mooring a newly designed rapid sampling MAVS and RBR temperature sensor duo with extended battery housing was installed. All of the SBE37s and SBE39s were set to start at 03/21/17 15:00:00 with a sample interval of six seconds. The Aquadopps were set for the same start date but with a different sample rate of 20 seconds due to the limitations of instrument memory. The eight standard MAVS were set to start on 03/21/17 16:00:00 and sample at 4Hz for two seconds and sleep for eight. The start time is different from the rest of the instrumentation due to some changes in programming prior to deployment. The MAVS with RBR attached has been specially designed for rapid sampling and was deployed to start 03/21/17 15:00:00 and sample every 0.300 seconds at 3 1/3 Hz. In order to set the correct UTC time, the lab's laptop was synced with the JCR's shipboard clock which is continuously updated via GPS signal.

Mooring Instrumentation

The table below gives an overview of the instrumentation used on the WHOI mooring according to the engineered design. The columns reflect what type of instrument was used, their actual deployed depth, and altitude from the seafloor. Also shown are the sample rates at which measurements were taken, which Parameters were measured, and what time the instruments first entered the water during the deployment.

Instrument	Serial	Depth (m)	Height (m)	Sample Interval (s)	Param.	Time Deployed (UTC)
Aquadopp	11545	2046	1992	20	U,V,W,T,P	19:15:00
SBE 37	14634	2047	1991	6	T,C,P	19:15:00
SBE 39	0630	2296	1742	6	T	19:30:00
Aquadopp	11542	2548	1490	20	U,V,W,T,P	19:46:00
SBE 37	14638	2549	1489	6	T,C,P	19:46:00
SBE 39	0626	2798	1240	6	T	19:59:00
MAVS	10290	3048	990	2 on/8 off	U,V,W,T	20:15:00
SBE 37	14635	3049	989	6	T,C,P	20:15:00
SBE 39	0695	3147	891	6	T	20:19:00
MAVS	10297	3249	789	2 on/8 off	U,V,W,T	20:29:00
SBE 37	5934	3250	788	6	T,C,P	20:29:00
SBE 39	0693	3310	728	6	T	20:32:00
MAVS	10295	3374	664	2 on/8 off	U,V,W,T	20:42:00
SBE 37	14608	3375	663	6	T,C,P	20:42:00
SBE 39	0653	3403	635	6	T	20:46:00
SBE 39	0686	3432	606	6	T	20:50:00
SBE 39	0649	3461	577	6	T	21:00:00
MAVS	10299	3493	545	2 on/8 off	U,V,W,T	21:13:00
SBE 37	14612	3494	544	6	T,C,P	21:13:00
SBE 39	0700	3526	512	6	T	21:15:00
SBE 39	0647	3556.5	481.5	6	T	21:17:00
SBE 39	0645	3587	451	6	T	21:19:00
MAVS	10289	3618	420	2 on/8 off	U,V,W,T	21:25:00
SBE 37	14644	3619	419	6	T,C,P	21:25:00
SBE 39	0688	3651	387	6	T	21:26:00
SBE 39	0701	3861.5	356.5	6	T	21:28:00
SBE 39	0789	3712	326	6	T	21:29:00
MAVS	10288	3743	295	2 on/8 off	U,V,W,T	21:36:00
SBE 37	14645	3744	294	6	T,C,P	21:36:00
SBE 39	0819	3776	262	6	T	21:38:00
SBE 39	0694	3806.5	231.5	6	T	21:39:00
SBE 39	0696	3837	201	6	T	21:41:00
MAVS	10296	3868	170	2 on/8 off	U,V,W,T	21:46:00
SBE 37	14636	3869	169	6	T,C,P	21:46:00
SBE 39	0623	3895	143	6	T	21:48:00
SBE 39	0692	3921	117	6	T	21:49:00
SBE 39	0644	3947	91	6	T	21:51:00
MAVS	10298	3973	65	2 on/8 off	U,V,W,T	22:31:00
SBE 37	14599	3974	64	6	T,C,P	22:31:00
MAVS	10355	4012	26	0.333	U,V,W,T	22:41:00
SBE 39	0690	4012.5	25.5	6	T	22:41:00

Table 61: Instrumentation used on WHOI mooring.

Post-Deployment mooring communications

After the anchor was released on 03/21/2017 23:10 UTC, the ship maintained its position over the drop site. Communication with the Edgetech 8242XS releases was enabled using the shipboard Edgetech 8011M deck unit that is connected to the Ross' hull mounted 12kHz transducer. Continuous pings were sent to follow the decent of the releases to determine their fall rate and final contact with the seafloor. Once the anchor was determined to be at rest the ship was then instructed to move one mile away to three stations 120 degrees around the drop position to survey the anchor site for a final position. Once this was completed the approximate depth and position were calculated. To be certain of this value the ship steamed back to the drop site to double check the depth. The ship then moved to a fourth position one mile away for one more measurement to ensure we had the correct calculations. The final anchor position was determined to be located at 60 S 16.212' 045 W 14.781' at depth of 4038 meters.

Mooring Recovery Operations

The recovery operations of the Polzin (WHOI) mooring commenced on 29 April 2017 at 1130 UTC and finished with the releases on board the JCR at 1530. The conditions were fair with sunny skies and light winds. The air temperature during the recovery ranged from -7 to -9 degrees C. The seas had swells of 3-4 meters and the winds gusted during the work period to 20 knots.

Pre-Recovery mooring communications

The surveyed anchor coordinates from the mooring deployment were used to determine a safe distance for the JCR to be in position for the initial acoustic communications with the mooring. Once in place, about one half mile from the anchor position with the ships heading pointed toward the mooring location, communication with the acoustic release was attempted. Using the Edgetech deck unit with the ship's transducer release # 48272 was enabled and showed a 4161m slant range. The bridge was contacted and permission to release the mooring was requested, once granted the release command was sent at 11:42:24 UTC. The mooring began to rise at a rate of 1.8 m/s and all flotation was on the surface about 40 minutes later. The acoustic communications at the mooring site were very strong and enabling, ranging, and release commands were all established on the first attempts.

Mooring Recovery

Once the mooring was spotted on the surface, the ship made its approach, keeping the top cluster of glass ball floatation to the starboard side. When the flotation was close enough the ship reduced speed and made maneuvers to place the flotation within reach of the person on the starboard rail to hook the flotation with the winch line hook. A second person at the starboard rail position was at the ready with a grappling hook in the event that the flotation was slightly out of the reach of the pick up pole and hook. After the winch hook was placed in the flotation the ship maneuvered to have the cluster move away from the hull and pass the stern of the ship. Once all of the other clusters of flotation for the mooring had cleared the stern as well the shipboard winch began to haul in the slack and move the main flotation close to the ship aft of the A-frame. The A-frame was positioned slightly outboard of the stern when the flotation was lifted out of the water to avoid swinging the weight of the cluster into the stern. The swing arm on the frame was raised to get as many balls on board as possible in the first grab. Once the cluster was hoisted to a favorable and manageable height, the angle changed and the A-frame was brought inboard while the shipboard winch kept the flotation at an even height distance to the block. The Kevlar stopper line was then ran through the lowest pear ring and secured to the deck cleat, taking the strain of the mooring trailing outboard of the stern. The winch then lowered the glass flotation sections and the top 3-ball float down to the deck where it could be disassembled from the rest of the mooring and brought out of the recovery area. When the first sections of glass flotation were cleared, the winch line was then reattached to the next section of glass flotation. The slack line was wound up onto the winch and the stopper line was gently slacked off which then transferred the mooring load back over to the winch. This method of stopping off the mooring was used during the entire recovery to remove any flotation and instrument frames, which were brought onboard. The mooring was recovered in a safe and timely manner with JCR, BAS, and WHOI personnel all taking part in the operations.

Instrument performance and data

SeaBird 37 SM Microcats

Nine of the SBE 37 SM microcats that were clamped to the mooring wire ran for the full length of the deployment and had only stopped running on the day of the recovery due to their memory being filled to capacity. The only exception was serial #5934 which had stopped running on 3 April due to its file space, this instrument is much older than the others and does not have the same file capacity. All of the instruments have full data sets of C, T, and P at a 6 second sample rate. The table below reflects each instrument's status when communications were enabled with each instrument. At this time, both the UTC time from the JCR and the instrument time were recorded and the difference between the two will show any drift in the clocks.

SeaBird 39 Temperature Loggers

The SBE 39 temperature loggers stopped operating on 11 April 2017 due to their memory having been filled to capacity. They all have full data sets and were set up for a 6 second sample rate. Of the 20 that were deployed, 19 were successfully recovered. Serial #0690 had its Delrin clamp fail and was torn off due to a tangled wire during its ascent. The table below reflects each instrument's status when communications were enabled with each instrument. At this time, both the UTC time from the JCR and the instrument time were recorded and the difference between the two will show any drift in the clocks.

Nortek Aquadopp Current Meters

The two Nortek Aquadopp current meters that were located near the top of the mooring operated for the entire deployment recording two second averages every 20 seconds. The

Serial #	**I**nstrument Time	**U**TC	**R**ecords/File Size	**S**tatus
5934	20:52:49	20:53:30	190650	Out of Memory
14599	18:43:15	18:43:20	559239	Out of Memory
14608	19:51:27	19:51:30	559239	Out of Memory
14612	19:43:40	19:43:40	559239	Out of Memory
14634	20:19:42	20:19:40	559239	Out of Memory
14635	20:10:37	20:10:40	559239	Out of Memory
14636	18:35:37	18:35:40	559239	Out of Memory
14638	20:45:58	20:46:00	559239	Out of Memory
14644	19:24:09	19:24:10	559239	Out of Memory
14645	19:17:08	19:17:10	559239	Out of Memory

Table 62: SeaBird 37 SM Microcats on WHOI Mooring.

Serial #	**I**nstrument Time	**U**TC	**R**ecords / File Size	**S**tatus
0623	22:07:00	22:07:30	299593	Out of Memory
0626	23:25:55	23:26:25	299593	Out of Memory
0630	00:18:12	00:18:20	299593	Out of Memory
0644	22:46:21	22:46:50	291661	Out of Memory
0645	23:00:01	23:00:40	299593	Out of Memory
0647	23:18:13	23:18:40	299593	Out of Memory
0649	11:17:29	11:18:10	299593	Out of Memory
0653	11:27:24	11:28:00	299593	Out of Memory
0686	11:37:07	11:37:50	299593	Out of Memory
0688	11:44:00	11:44:40	299593	Out of Memory
0690	------------	------------	----------	Lost
0692	22:43:02	22:43:40	299593	Out of Memory
0693	00:02:13	00:02:40	299593	Out of Memory
0694	23:57:40	23:58:20	299593	Out of Memory
0695	11:11:02	11:11:40	299593	Out of Memory
0696	23:41:23	23:42:00	299593	Out of Memory
0700	23:44:14	23:44:40	299593	Out of Memory
0701	00:12:47	00:13:20	299593	Out of Memory
0789	23:24:07	23:24:40	299593	Out of Memory
0819	22:13:43	22:14:20	299593	Out of Memory

Table 63: SeaBird 39 Temperature Loggers on WHOI Mooring

table below reflects each instrument's status when communications were enabled with each instrument. At this time, both the UTC time from the JCR and the instrument time were recorded and the difference between the two will show any drift in the clocks. The other columns represent what time the unit was stopped and the file size that was collected during the deployment.

Serial #	**I**nstrument Time	**U**TC	**S**top @	**R**ecords / File Size	**S**tatus
11542	11:15:40	11:15:30	11:14:20	7539072	Full Deployment
11545	11:36:37	11:36:30	11:36:20	7542006	Full Deployment

Table 64: Nortek Aquadopp Current Meters on WHOI Mooring

Nobska MAVS Current Meters

The eight standard Nobska MAVS current meters that were used on the mooring had limited success in collecting data. During the recovery it was noted that all of the instruments were coming onboard with white deposits mainly on the sensor end-caps and some on the main case as well. The anodes on the sensor post were also completely gone. Once the instruments were rinsed down in the lab post-recovery all of the areas with deposits were found to be heavily corroded sections of the anodized aluminum case. When communications were attempted, only one out of the eight had sufficient power and was still running, the others had to be connected to an external power supply to check the file sizes. Instrument #10295, still showing voltage, had run for the duration of the deployment, but the others were found to have stopped collecting data between 5 and 11 days after the deployment. Upon reviewing the data files it appears as if there was a power issue as the four channels dropped out one after another until the instrument failed. A power issue would also help explain the lack of anodes and the corrosion in the casings. Once the units were opened up to remove the compact flash cards to extract the data all of the battery voltages were tested as well and it was found that three of the units had extremely low voltages ranging from 0.1 to 0.3 v and four of the others had voltages of around 3 volts. The only unit still running was found to have a voltage of 14.20 v. All of these instruments had been recently upgraded to a CF2 system by Nobska prior to the cruise. They will be tested further upon their return to WHOI from Montevideo.

The Rapid Sampling MAVS with RBR temperature sensor worked successfully for a total of 19 days sampling every 0.3 seconds. On 9 April it appears to have had some type of issue in writing the next file and no further files were written. The unit possibly had run low on power causing it to stop, however the voltage post-recovery was still 14.20 V.

The table below reflects when communications were attempted with each instrument. The difference between UTC and Inst. Time will show the clock drift, even though many had little battery left there is a small lithium which maintains the clock. The other columns show the date the instrument stopped running, how many total files were recorded and their size, and the main battery voltage once the instrument was opened up to remove the internal flash card. The instrument marked with (*) indicates the Rapid Sampling MAVS unit.

Serial #	**I**nstrument Time	**U**TC	**S**top	**F**iles	**S**ize (bytes)	**V**oltage
10288	17:34:14	17:35:20	3/26/17	25	1,279,450	3.24
10289	17:31:27	17:32:30	3/31/17	49	2,799,370	0.38
10290	17:46:37	17:46:45	3/30/17	45	2,547,546	0.15
10295	17:29:26	17:29:40	4/29/17	174	10,797,274	14.20
10296	17:39:40	17:40:20	4/03/17	59	3,438,090	3.19
10297	17:23:57	17:24:45	4/01/17	52	3,034,842	3.32
10298	17:27:02	17:27:50	4/01/17	54	3,121,050	3.34
10299	17:16:36	17:16:45	3/26/17	23	1,214,586	0.13
10355*	16:56:08	16:56:10	4/09/17	536	687,905 kb	14.32

Table 65: Nobska MAVS Current Meters on WHOI Mooring

Post-Deployment Anchor Survey Position

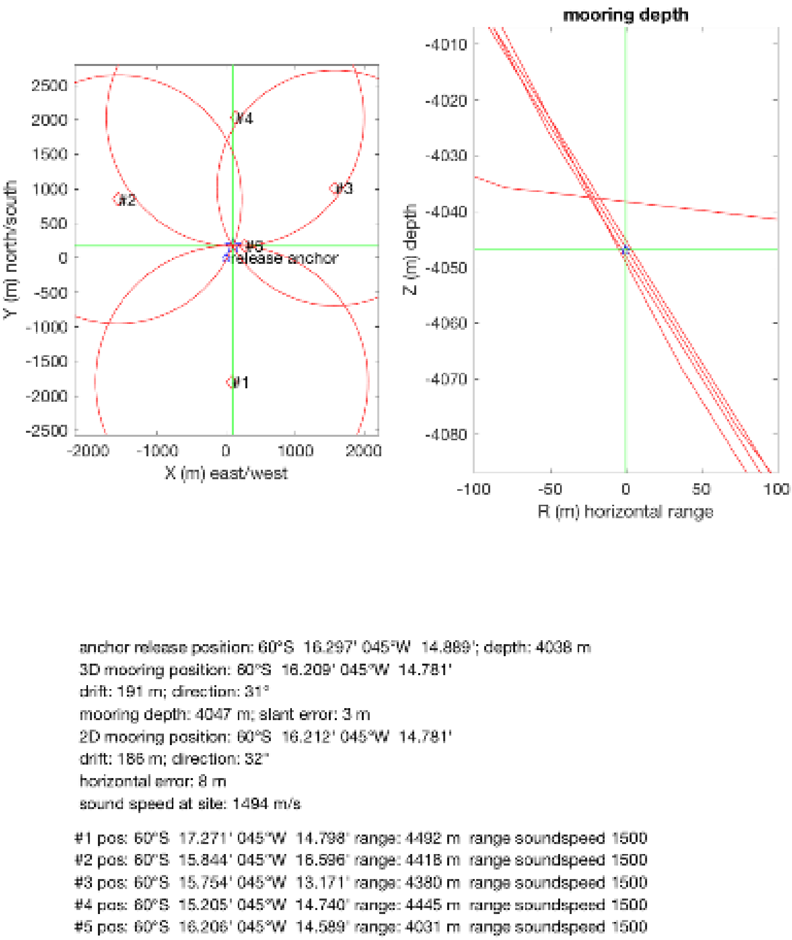


Figure 40: Post-Deployment Anchor Survey Position WHOI Mooring.

8 Autosub Long Range (ALR) – *Eleanor Frajka-Williams, Keith Nicholls, & Kurt L. Polzin.*

The overall aim of the Autosub Long Range deployments in the Orkney Passage region was to capture a spatial view of the near bottom velocities, turbulence and ocean properties. Unlike traditional CTD and LADCP measurements, or the vertical microstructure profiler, the ALR data capture fine horizontal scale structures, particularly when deployed in a radiator-like pattern.

For JR16005, the ALR vehicle was fitted with the following scientific sensors:

- RDI 300 kHz ADCP looking downwards
- RDI 300 kHz ADCP looking upwards
- Seabird 52-MP CTD system
- WETLabs ECO FLNTU(RT)D fluorometer and turbidity meter
- Rockland microRider

Mission planning

A total of two missions were planned initially: one near the section D east of the Orkney Deep and one in Orkney Passage (Figure 41). The missions were planned to have ALR travelling approximately along-isobath, rather than across isobath, in order to minimise the risk of encounters with the seabed. Mission plans were developed using available swath bathymetry for the region, and concentrating on the slope of the topography where the deep boundary current is expected to be strongest. Several regions where bottom slopes exceeded 1/3 were removed from the missions. After the early recovery of the ALR during M42, a third mission was planned in the Orkney Passage region.

Work completed and data summary

Details of the missions completed are also provided in the technical section. Of the 5 deployments of ALR, 3 produced data sets longer than 1 day in duration.

M41 The ALR was deployed on the 3rd of April and recovered roughly 30 hours later after the ALR aborted the mission early due to an issue with the stern planes (see ALR technical report). Data from this mission included the upwards and downwards looking ADCPs, the CTD and microRider. For this mission, the ADCPs were run in broadband mode at 4 m bins. In addition, the upwards looking adcp was setup with an 'heading misalignment' that was 90° out. While the bottom track data were useable for navigation, the water track bins only provided data within about 20 m of the vehicle, and showed variability that appeared to replicate the bottom track velocities–but with different magnitudes. As a consequence, the ADCP data were deemed unusable. The CTD data performed well (see ALR CTD data). The microRider data showed a lot of electrical noise which resulted in estimated turbulent dissipation that was 5 orders of magnitude larger than oceanic values. It was also determined that acoustic communications with the ALR (using the fish) interfered with the microstructure data. This appears as 2 second blips every 10 seconds, while communications were active. As a consequence, the microRider was electrically isolated from the rest of the ALR electronics prior to the next mission (see ALR Technical report) and communication frequency was reduced in future missions.

M42 The ALR was deployed on the 11th of April and recovered 2.25 days later after aborting the mission near the southeast waypoint. For this mission, the ADCPs were set to narrowband mode with 8 m bins. For this mission, the downward looking ADCP recorded both reasonable bottom track data and water track data, resulting in useable velocities within about 60 m of the vehicle. The upwards-looking ADCP recorded no data (see technical section on the ALR). The CTD data again worked well. The microRider showed very good results after the electrical isolation, with a noise floor estimated around 10^{-9} or even 10^{-10} W/kg.

M44 During M44, the ALR was sent down tight switchbacks on the western flank of Orkney Passage, making along-isobath runs approximately every 250 m change in water depth. The mission was completed successfully and without incident. Both upwards and downwards looking ADCPs recorded data, with ranges of up to 50 m. After M42, the microRider crashed and would no longer turn on. It was replaced by a second instrument with the same configuration. Microstructure data are good quality.

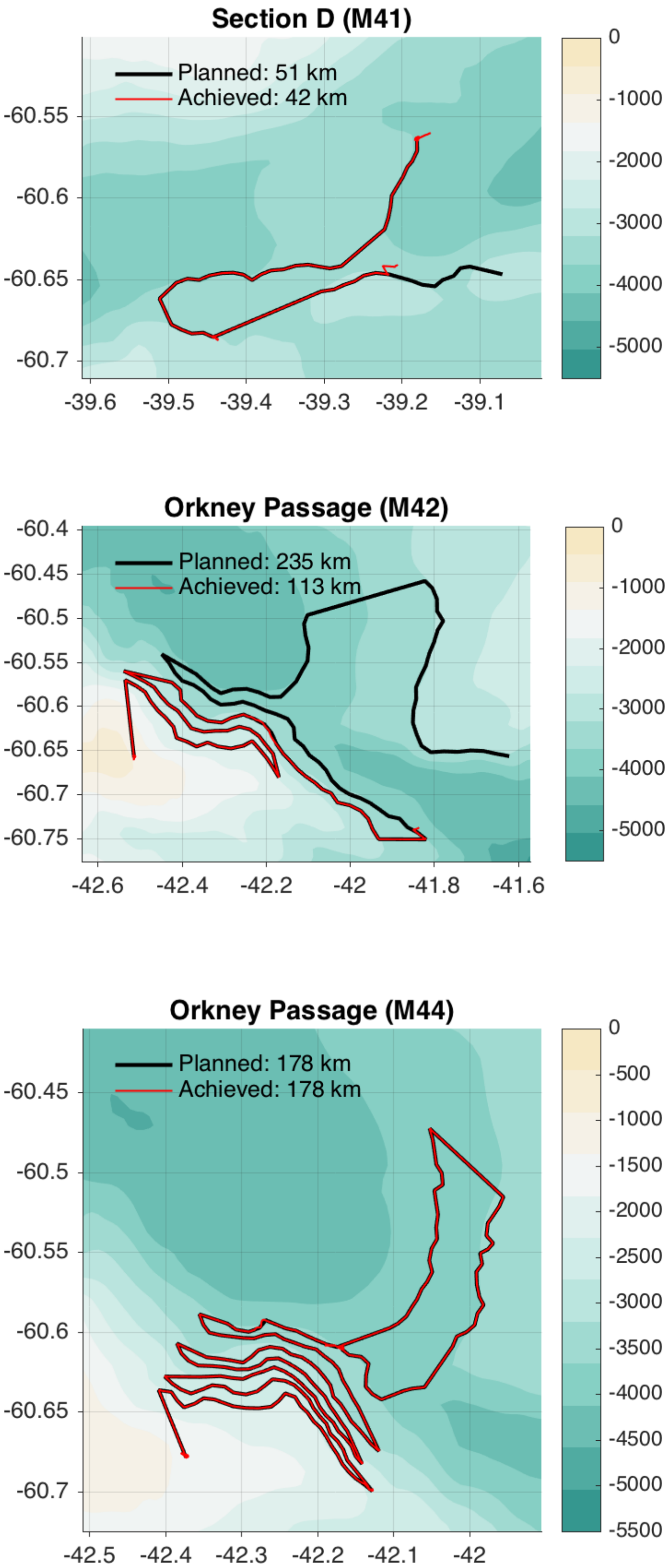


Figure 41: Map of planned missions and waypoints achieved for the ALR. Note: The 'achieved' track here is using the onboard estimate of the ALR position rather than a corrected position. Final corrections are pending.

Seabird CTD system

Instrument

The ALR was equipped with a Sea-Bird Electronics SBE 52-MP CTD instrument, serial number 52-0157. Designed for use on moored profilers, the MP52 is a lightweight, compact unit with a single, ducted pumped CT channel. The conductivity and temperature sensors are the type employed in the MicroCat (SBE 37) and the Argo float. It is housed in a 7000-m rated titanium pressure vessel, and uses a 7000 dbar, strain gauge pressure sensor. The optional DO sensor was not installed. The manufacturer's quoted resolution, accuracy and stability of each sensor are listed in Table 8, and are typical of Sea-Bird's C, T and P sensors, except for the relatively low resolution of the temperature sensor. Also less typical is the low scan rate of the MP52: 1 Hz, compared with, for example, the 24 Hz of the SBE9.

Sensor	Resolution	Accuracy	Stability
Temperature	0.001°C	± 0.002°C	0.0002°C per month
Conductivity	0.0005 mS/cm	± 0.003 mS/cm	0.003 mS/cm per month
Pressure	0.14 dbar	±7 dbar	±3.5 dbar per year

Table 66: Specifications of the SBE 52-MP, with 7000 dbar pressure sensor.

Installation

The SBE 52-MP is mounted towards the front of the ALR, with the inlet and exhaust ends of the sensor duct attached to a pair of ports in the vehicle's hull. External power is supplied by the ALR, and data are recovered and stored centrally. Data from the pressure sensor are used as one of the vehicle's navigation inputs.

Pre-cruise calibration history

The SBE 52-MP is programmed to deliver calibrated data in physical units. Calibration coefficients are therefore stored internally. The instrument was calibrated on 23rd August 2016, prior to installation in the ALR. It is not clear from Sea-Bird documentation whether there is any attempt within the 52-MP at cell thermal mass corrections or cell alignment. Although spikes in salinity are observed (see below) there is no evidence that they are a result of cell misalignment.

Overview of CTD data

The instrumented worked for each of the missions without any apparent problems. Here we give a brief overview of the quality of the time series of temperature, pressure and conductivity for the three principal missions, M41, M42 and M44.

Mission M41

Time series of the raw temperature, conductivity and pressure during M41 are shown in Figure 42. For this mission the descent was staged, according to the original plan; the ascent was different, in that the vehicle surfaced after an abort under buoyancy alone, and would have had a tail-up attitude. Noticeable in the ascent is structure in the T and C (see inset). The variations are closely correlated between the two sensors, as expected if it had been due to temperature alone. Yet the salinity signal (not shown) bears a broadly inverse character: positive T variations result in negative S variations, which is not consistent with the known T-S relation for the depths concerned. Neither is it what would be expected from salinity-spiking.

Typical noise levels on the T sensor (other than for the ascent) are as would be expected from the instrument. Most prominently in the early part of the mission, the C sensor appeared subject to spiking that was not seen in the T sensor (see second inset). The spikes were up to 0.05 mS cm-1, but were more typically around 0.002 mS cm-1; they were around 15 seconds apart. The source has not been identified. Initial suspicions were interference from the USBL beacon, but the periods of USBL activity seemed not to be well-correlated with the time periods of the interference. Between the spikes, the data-quality from the C sensor was broadly consistent with instrument specifications.

Mission M42

The time series from the CT sensors showed significantly stronger signals throughout the mission. The spiking seen in the C sensor from the previous mission is still visible near the beginning of the mission, but the strong environmental signals dominate. Figure 43 shows the overview of the time series. For this mission, the T and C signals during the ascent, for which the vehicle was normally powered, show strong, persistent and unexplained perturbations (see inset). The amplitude of the oscillation is 0.04°C and 0.05 mS cm-1, with a period of around 23 seconds. The signals are too strong for it to be a directly environmental signal (the vehicle moving through horizontal or vertical gradients).

Mission M44

As in the case of mission M42, the T and C signals are strong compared with any low-level noise from the instrument. At first sight, both descent and ascent seem to be largely free from extraneous noise.

Opportunistic calibration against ship-based CTD

The descent and ascent phases of the ALR missions gives the opportunity to compare the T and S data with the CTD casts made from the ship. Here we use two approaches, one is to compare each ascent and descent with the geographically closest cast; the other is to compare the ascents and descents in θ-S space with the full set of ship-based casts obtained from the study area during the cruise.

Figure 44 shows an example of the θ-S plot for mission M44. The salinity and temperature data have been low-pass filtered to help remove scatter and show more clearly the locus of points with respect to the aggregation of CTD data from ship casts. The colour

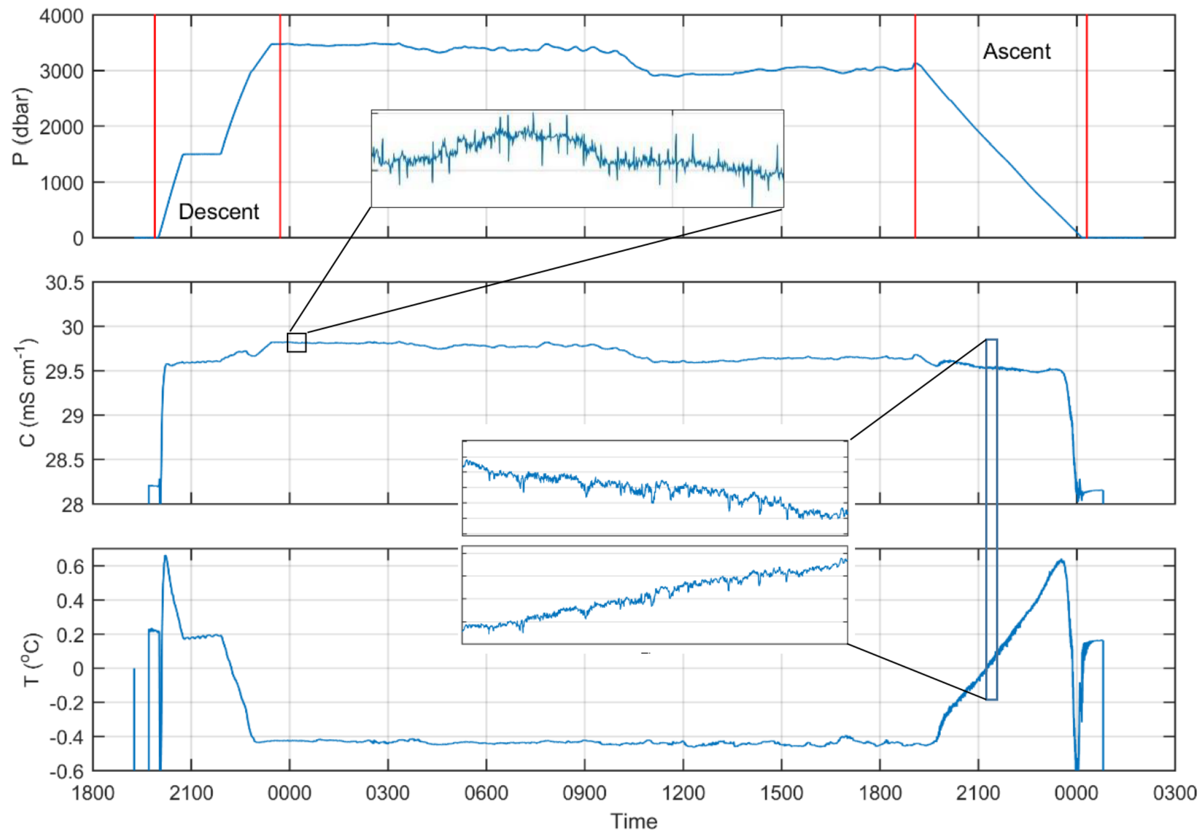


Figure 42: Overview of time series from T, C and P sensors during mission M41. The top inset shows an enlargement of a small section showing some low-level noise occurring mainly early in the mission. The lower inset shows some high-amplitude variations during the ascent, possibly related to the mode of ascent (an abort).

indicates the time during the mission, blue being early in the mission and red being the ascent. There appears to be a fresh bias of around 0.02 psu.

We plot the temperature and salinity profiles for the ascent and descent, and compare them with the nearest CTD cast. Salinity provides the dominant control on the density, and is therefore less likely to have strong horizontal variability than temperature. Salinity is therefore used for comparison, and not conductivity, which has a very strong temperature dependence. As an example, the results for the descent phase of M41 are shown in Figure 45. This also shows the effect of temperature and conductivity noise on the deeper part of the salinity record. Some of the apparent offset in salinity might be a result of the 7 km distance between the CTD cast and the descent of the ALR.

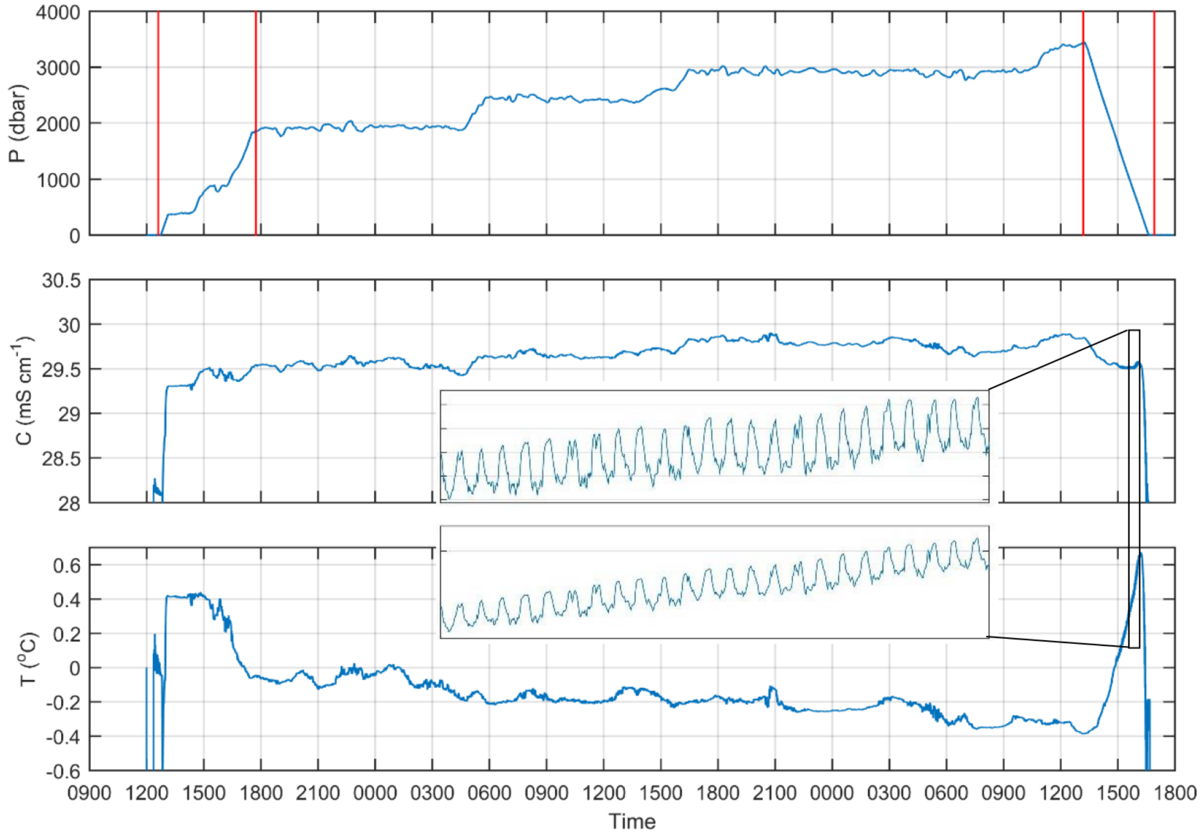


Figure 43: Overview of time series from T, C and P sensors during mission M42. The inset shows an enlargement of a small section of the ascent, showing an as-yet unexplained signal in the T and C data.

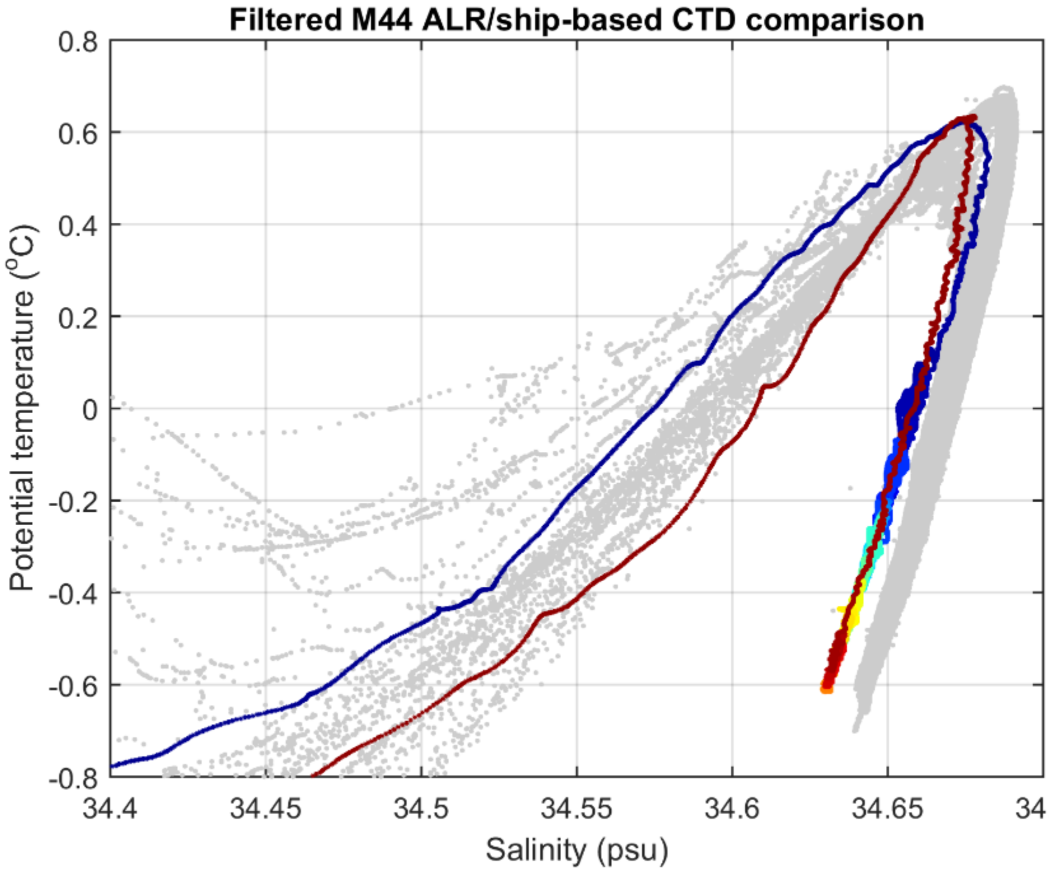


Figure 44: Filtered θ-S data from M44, plotted over the cohort of CTD casts made from the ship. There appears to be a fresh bias of around 0.02 psu. The colour indicates the time during the mission (blue=early).

Summary

The 52-MP instrument functioned correctly throughout each mission. There is evidence of contamination by occasional electronic noise spikes in M41 – a mission with relatively weak environmental signals. M42 and M44 were missions with environmental signals strong enough to dominate externally-sourced electronic noise. Generally, ascents and descents appear more prone to signals in T and C that are difficult to relate to the known hydrography – possibly a result of changing flow across the inlet and exhaust ports, or perhaps caused by slow flushing of ALR's hull. Slow flushing would mean that water with old temperatures was affecting the temperature of the conductivity cell. This, however, would be unlikely to have the observed effect on the temperature signal.

From comparison between the ship-based CTD casts and the ALR's 52-MP, it seems that there is a gross offset in the ALR's derived salinity of around -0.02 psu. The strong spatial and probably temporal variability in the study region makes it difficult to determine the relative contributions of the T and C sensors to the error. Post-cruise calibration of the SBE 52-MP should resolve most of the offsets.

The CTD data from ascents and descents of the ALR are of no great importance for the purposes of the present project – ship-based CTD casts are available for vertical profiles. After calibration, the CTD data from the mission itself will be of substantial value. Even before calibration, the signals of variability and their relation to topography will be of much interest.

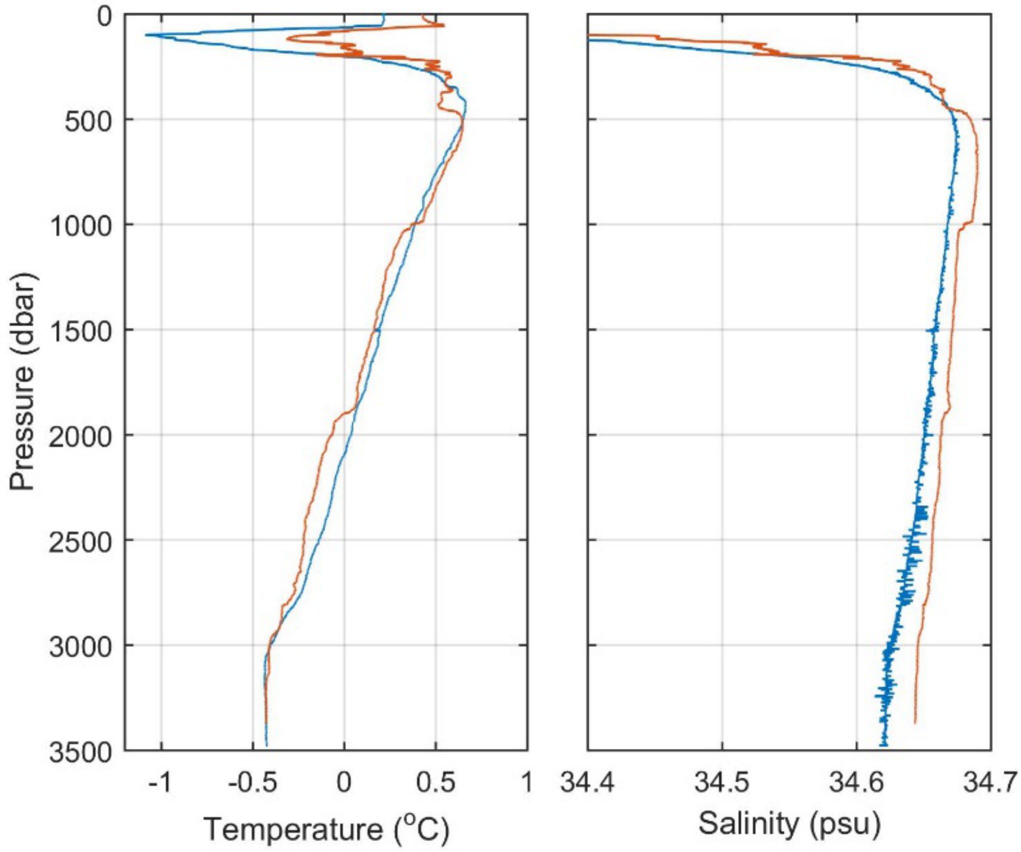


Figure 45: Temperature and salinity data (blue) from the ALR's descent during mission M41. The red lines are temperature and salinity from the geographically-nearest ship-based CTD cast.

MicroRider

This subsection reports on the processing for the Rockland Scientific International (RSI) MicroRider microstructure package that was mounted on the nose of the ALR, *Boaty*. The MicroRider has 2 shear probes for estimating millimeter scale velocity gradients, 2 fast response FP07 thermistors to estimate centimeter scale temperature gradients and a dual needle conductivity probe of higher effective resolution than that of the temperature sensors. The goal of these sensors is to provide estimates of variances on the scales at which molecular viscosity and thermal diffusivity are dynamically important. The primary use of the conductivity sensor is to define the dynamic time response of individual thermistors via an *in situ* calibration. Interpreted in the context of production - dissipation balances, these variance estimates can be related to turbulent dissipation rates, production and buoyancy flux estimates. These balances are assumption dependent, relying upon isotropic relations that obtain at high Reynolds number. The goal of the processing described below is to provide the 'best' possible estimate of the gradient variance, in which 'best' does not rely upon assumptions of the underlying dynamics.

The ALR was deployed four times.

In the first (M41), the MicroRider was electrically connected with the entire ALR electronics and this resulted in significant noise of electronic origin. Only data from the T1 temperature sensor was found to be of use, due to a combination of electronic noise and deployment of the ALR in a region hosting low signal levels. The data are sufficiently limited that they were not properly processed. See data file DYN_019.P. Boaty's nose got wacked upon recovery and needed a wholesale replacement of microstructure sensors.

In the second deployment (M42), efforts were made to electrically isolate the MicroRider electronics from the rest of the ALR. This required carving off a portion of the battery pack and severing communications. The later required independently turning on the MicroRider. It worked. This deployment results in data files DYN_025.P and DYN_026.P.

The MicroRider SN074 was used for these first two deployments. Subsequently it must have had its fill as it would not respond. Thus MicroRider SN075 was used for the remaining deployments. The calibration file SETUP.CFG could not be downloaded from the USB stick provided with SN075, so the configuration file from SN074 was altered by K. Polzin extracting the appropriate calibration coefficients from hardcopy provided by Rockland. Bench tests suggested that Ch6 was noisy and thus it was blanked off.

In the third deployment (M43), Boaty saw a cloud of krill, dropped weights and went nowhere.

In the fourth, things were good. See files M44_001.P and M44_002.P.

Platform Limitations

Processing undertaken during the cruise did not account for flow distortion associated with the stagnation point at the nose of the platform. Boaty has an elliptical nose with major axis twice the minor. The minor axis is equal to the diameter of the vehicle (80 cm) and the sensing elements of the mRider extend approximately 56 cm from Boaty's nose. Assessments based upon potential flow theory suggest a 6.45% deficit (F. Thwaites, P.C.). This impacts the microstructure sensors as follows:
shear probes: The probe response is proportional to lift generated by obliquely incident

station	channel	probe	mount	calibration
M41	Sh1 Ch8	Sx M1498	Flat Horizontal	sens=0.0693
	Sh2 Ch9	Sy M1499	Flat Vertical	sens=0.0775
	T1 Ch4	T1310		
	T2 Ch6	T1311		
	μC Ch64	C150		
M42	Sh1 Ch8	Sx M1408	Flat Horizontal	sens=0.0658
	Sh2 Ch9	Sy M1409	Flat Vertical	sens=0.0722
	T1 Ch4	T1187		
	T2 Ch6	T1188		
	μC Ch64	C230		
M43-M44	Sh1 Ch8	Sx M1408	Flat Horizontal	sens=0.0658
	Sh2 Ch9	Sy M1409	Flat Vertical	sens=0.0722
	T1 Ch4	T1187		
	T2 Ch6	Blank		
	μC Ch64	C230		

Table 67: Probes and such

currents is related to a linearized Bernoulli equation to the product of a parallel flow and an obliquely incident perturbation representing a turbulent velocity fluctuation. For vertical profiling vehicles, the parallel flow is the fall rate, W. The presence of a stagnation point implies an upstream velocity deficit and overestimate (bias) of the turbulent velocity fluctuation if the free stream velocity is used.
thermistors: the thermistor response is limited by the time for temperature fluctuations to diffuse through a viscous boundary layer. The resulting time constant scales as $W^{1/3}$, with nominal values for the FP07 of $\tau = 0.007$ s resulting in 1/2 power points of about 20 Hz for $W = 1.0$ m s^{-1}.

Processing Steps

The processing algorithms were adapted from those described in Polzin and Montgomery (1996).

- The RSI .P binary files are converted to MatLab format using odas_P2mat and a nominal fall rate of 0.7 m s^{-1}.
- The 'fall rate' is finessed using estimates of relative flow from the ADCP units. These files were provided by Dr. Eleanor Frajka-Williams. Data files were aligned using the two pressure sensors. Shear probe data were corrected by multiplying by (relative flow / 0.7 m s^{-1})^2 to account for probe response and the conversion of a time derivative to a spatial derivative. Micro T/C data were multiplied by (relative flow / 0.7 m s^{-1}) to account for the temporal / spatial conversion.
- Acoustic communications are the largest contamination of the shear probes. Visual inspection of the data (Figures 46&47) suggested communications resulted in a

response greater than a threshold of 3-5 s^{-1}. Values greater than this threshold were replaced by a NaN with the understanding that MatLab responds to a request for Fourier transforming a NaN by returning the entire spectral window as NaNs.

- Data were then despiked using RSI's despike algorithm: despike(sh1(M1:M2), 8, 0.5, 512, 4).
- Data were transformed in three half-overlapping segments of 2 second length windows.
- Boaty CTD data were used to estimate the viscosity and thermal diffusivity
- Preliminary estimates of ϵ and χ were made using variance estimates restricted to low frequency bandwidths (1) and bin averaged in logarithmic intervals, Figure 48. This process reveals noise of both vibrational and electronic origin, and these then suggest ways to structure integration endpoints (2-3) to maximize signal-to-noise ratios.
- In the next iteration, probe response functions are applied and spectra are integrated.
- Turbulence has a correlation length scale, so individual variance estimates that stand out by more than an order of magnitude from their neighbors are invariably noisy. Such incidences were rendered as NaNs.
- With redundant estimates of the same variable, a scatter plot often suggests $\epsilon_1 > a\epsilon_2$ is indicative of noise. Values of the parameter a are typically 4-6. Extreme variance estimates are replaced by NaNs using this condition.

$$\begin{aligned} test_{x1} &= 7.5\nu \int_{0.5}^{6} P_{s1} df \\ test_{x2} &= 7.5\nu \int_{0.5}^{4} P_{s2} df \\ test_{y1} &= 6\kappa \int_{0.5}^{15} P_{t1} df \\ test_{y2} &= 6\kappa \int_{0.5}^{15} P_{t2} df \\ test_{z1} &= 6\kappa \int_{0.5}^{15} P_{c1} df \end{aligned} \tag{1}$$

$$\begin{aligned} \text{if } \ test_{x1} < 2\times10^{-9} \qquad & \epsilon_1(q) = 7.5.\nu \int_{0.5}^{7} P_{s1} df \\ \text{if } \ 2\times10^{-9} < test_{x1} < 2\times10^{-8} \quad & \epsilon_1(q) = 7.5\nu \int_{0.5}^{30} P_{s1} df - 1\times10^{-10}\ \text{W/kg} \\ \text{if } \ test_{x1} > 2\times10^{-8} \quad & \epsilon_1(q) = 7.5\nu \int_{0.5}^{100} P_{s1} df - 1\times10^{-10}\ \text{W/kg} \end{aligned} \tag{2}$$

$$\text{if } test_{x2} < 5 \times 10^{-10} \qquad \epsilon_2(q) = 7.5\nu \int_{0.5}^{4} P_{s2} df$$
$$\text{if } 5 \times 10^{-10} < test_{x2} < 2 \times 10^{-8} \quad \epsilon_2(q) = 7.5\nu \int_{0.5}^{30} P_{s2} df - 3 \times 10^{-10} \text{ W/kg}$$
$$\text{if } test_{x2} > 2 \times 10^{-8} \quad \epsilon_2(q) = 7.5\nu \int_{0.5}^{100} P_{s2} df - 3 \times 10^{-10} \text{ W/kg} \qquad (3)$$

Probe Response

Shear probes are treated as a single pole transfer function, with a wavelength equal to the length of the sensor. In this case, 1 cm.

Temperature probes are treated by assuming a single pole representation for the effects of the time required for temperature fluctuations to diffusive across the viscous boundary layer. This boundary layer provides a time constant that scales as the 1/3 power of the free stream flow. Comparison of T1 and T2 temperature spectra suggested that T2 was much slower than T1 and time constants of 0.007 sec (T1) and 0.012 sec (T2) tended to return matched spectra. In the end, we found that the turbulence was sufficiently intense (average dissipations of $O(1\times10^{-7}$ W/kg) that the corresponding Batchelor scale at which temperature fluctuations are dissipated by molecular processes is sufficiently smaller than the probe's effective resolution that the variance estimates for corrected data are an order of magnitude larger than those of uncorrected data. This is not a satisfactory result and further suggested that finessing the time constants via an *in situ* calibration against the conductivity spectra was not worth the effort. Thus we have provided variance estimates over the bandwidth of 0.5 -15 Hz. Along with dissipation (ϵ) estimates, the end user can then think about χ estimates based upon assumptions of isotropic turbulence.

None of the spectral integrations corrected for RSI's anti-aliasing filters consisting of two cascaded fourth order Butterworth filters with 98 Hz roll-off frequency.

Conclusions

The end result is a data record that looks quite reasonable in a profile format, Figure 49. The segment mean dissipation rate is $\epsilon = 6 \times 10^{-8}$ W/kg and the author is confident that the sensor and platform combination works well at these signal levels. Acoustic communications are a serious impediment to obtaining quality data and thus communications should be minimized during the mission. The instrument will likely struggle to resolve mean dissipations smaller than $\epsilon = 1 \times 10^{-9}$ W/kg. Such signal levels would require greater consideration of the time variability of vibrationally induced noise.

The end result of these manipulations are the files Boaty_M42.mat and Boaty_M44.mat.

References

Polzin, K. L. and E. T. Montgomery, 1996: Deep microstructure profiling with the High Resolution Profiler. *Proceedings of the Microstructure Sensors Workshop, 23-25 October 1996, Timberline Lodge, Mt. Hood, Oregon, USA.*

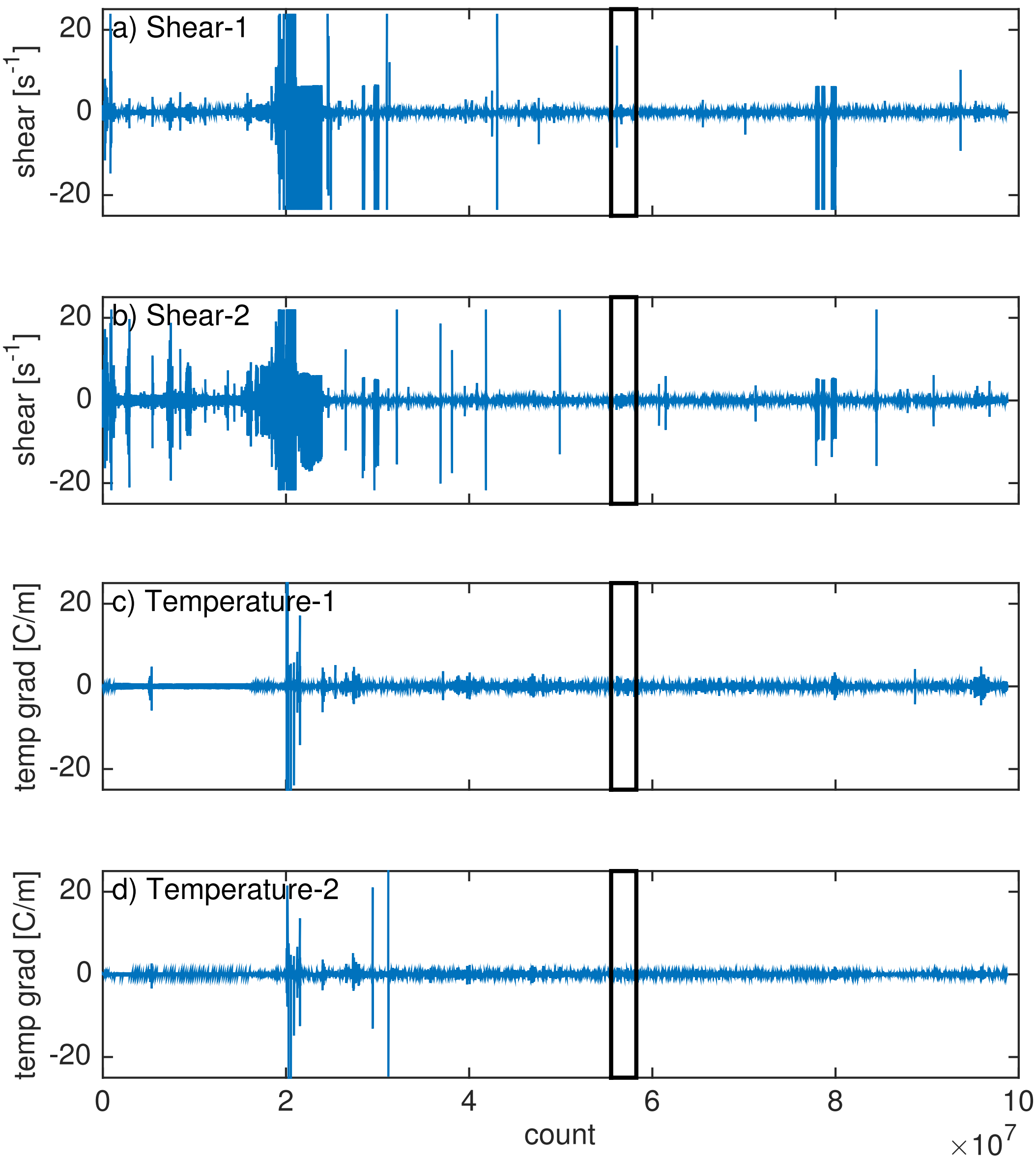


Figure 46: Scaled raw data from deployment M42, file DYN_025. The largest amplitude response in the shear probes is associated with acoustic communications. The communications appear to occur with ten second periodicity, with a duty cycle of 2 seconds one and 8 seconds off. Periods of communication appear as solid blocks of color without much feature in this densely populated figure. The much more occasional large amplitude spikes represent sensor impacts with oceanic detritus. Both need to be trimmed. Data enclosed within the thick black lines are investigated in greater detail below.

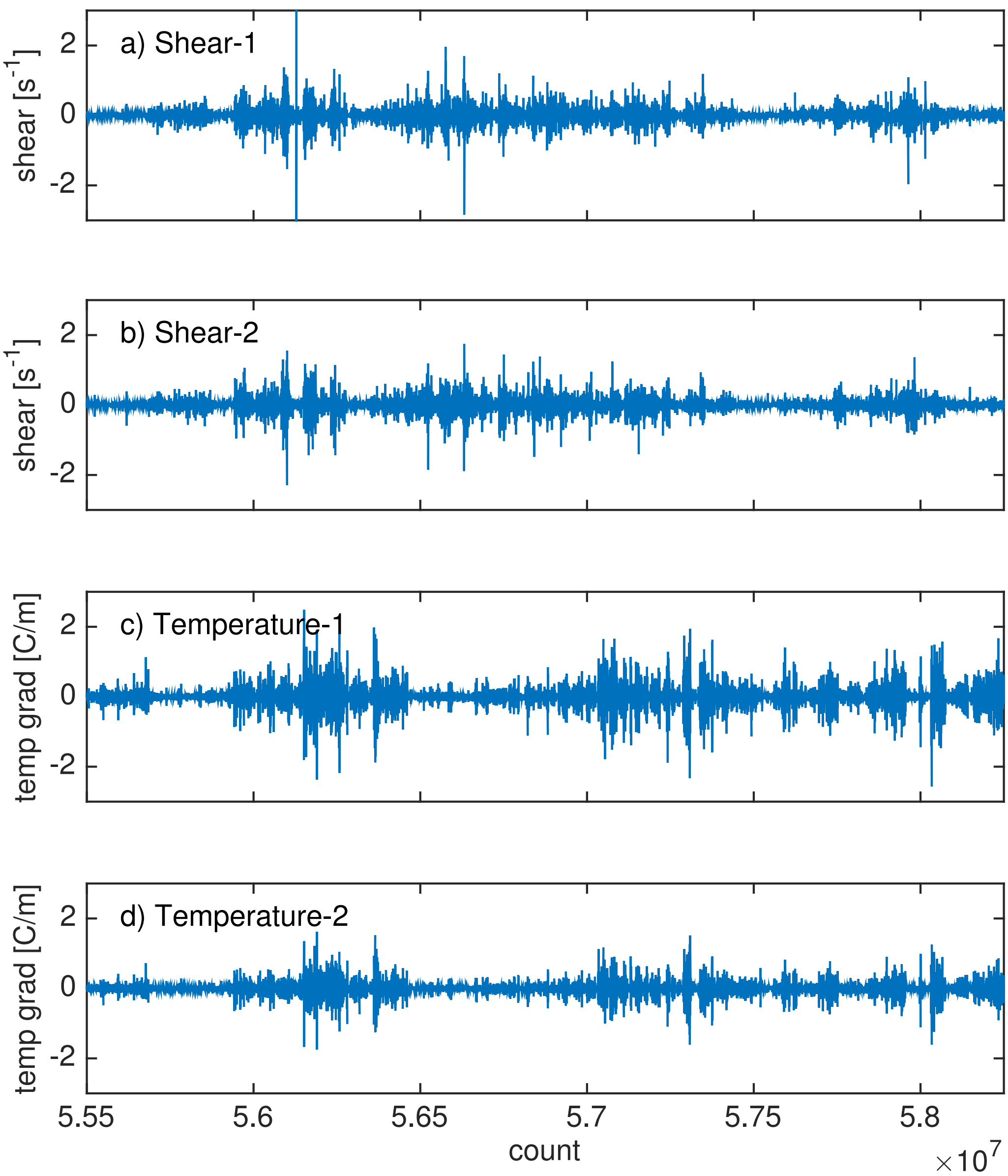


Figure 47: A blow up of the data segment delineated by the thick black line in the previous figure.

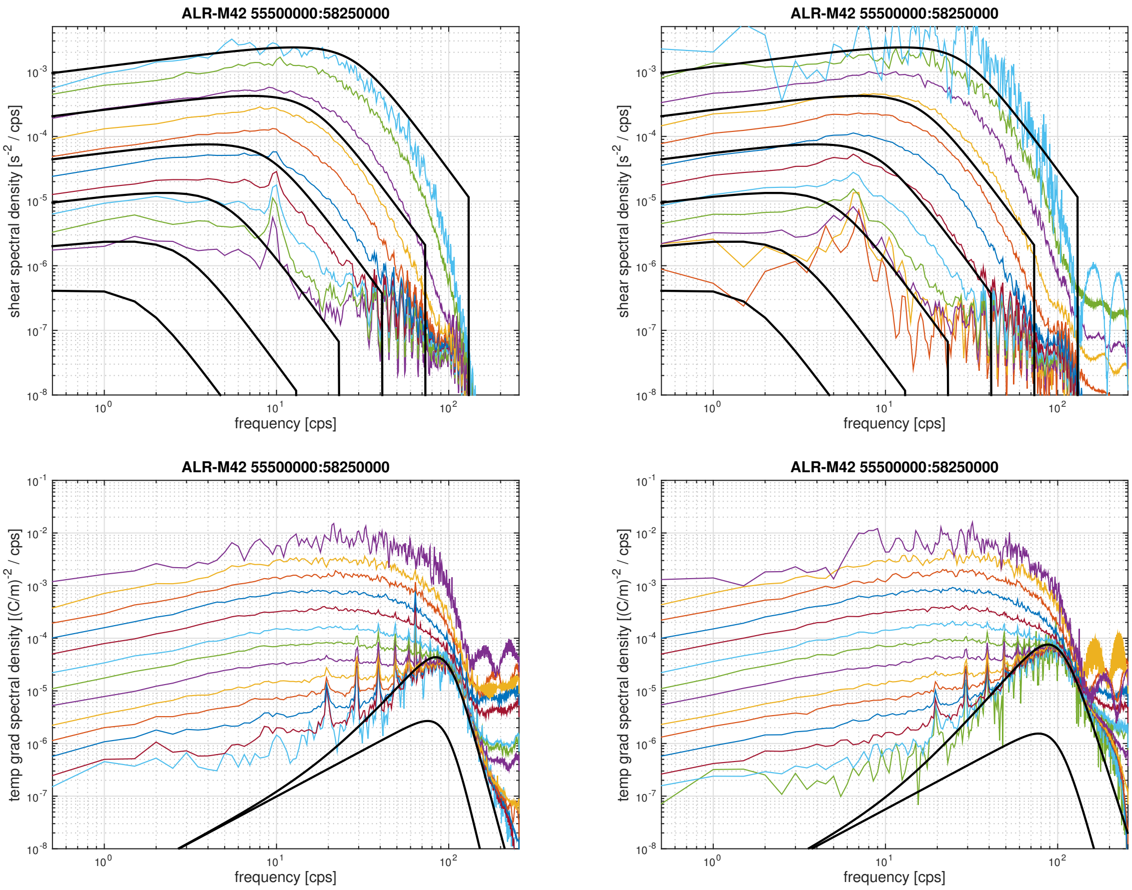


Figure 48: Microstructure spectra bin averaged in logarithmic intervals $[1-2, 2-5, 5-10...] \times 10^{-11}$, for shear-1 (upper left), shear-2 (upper right), temperature-1 (lower left) and temperature-2 (lower right). The shear spectra additionally have the Nasmyth curves superimposed at decadal intervals, starting at $\epsilon = 1 \times 10^{-11}$ W/kg. The temperature spectra have been corrected for their probe response with time constants of 0.007 and 0.012 sec. The shear spectra have not been corrected. Thick black lines in the temperature spectra are a rough estimate of electronic noise. These noise spectra are plotted in both nominal and 'corrected' forms.

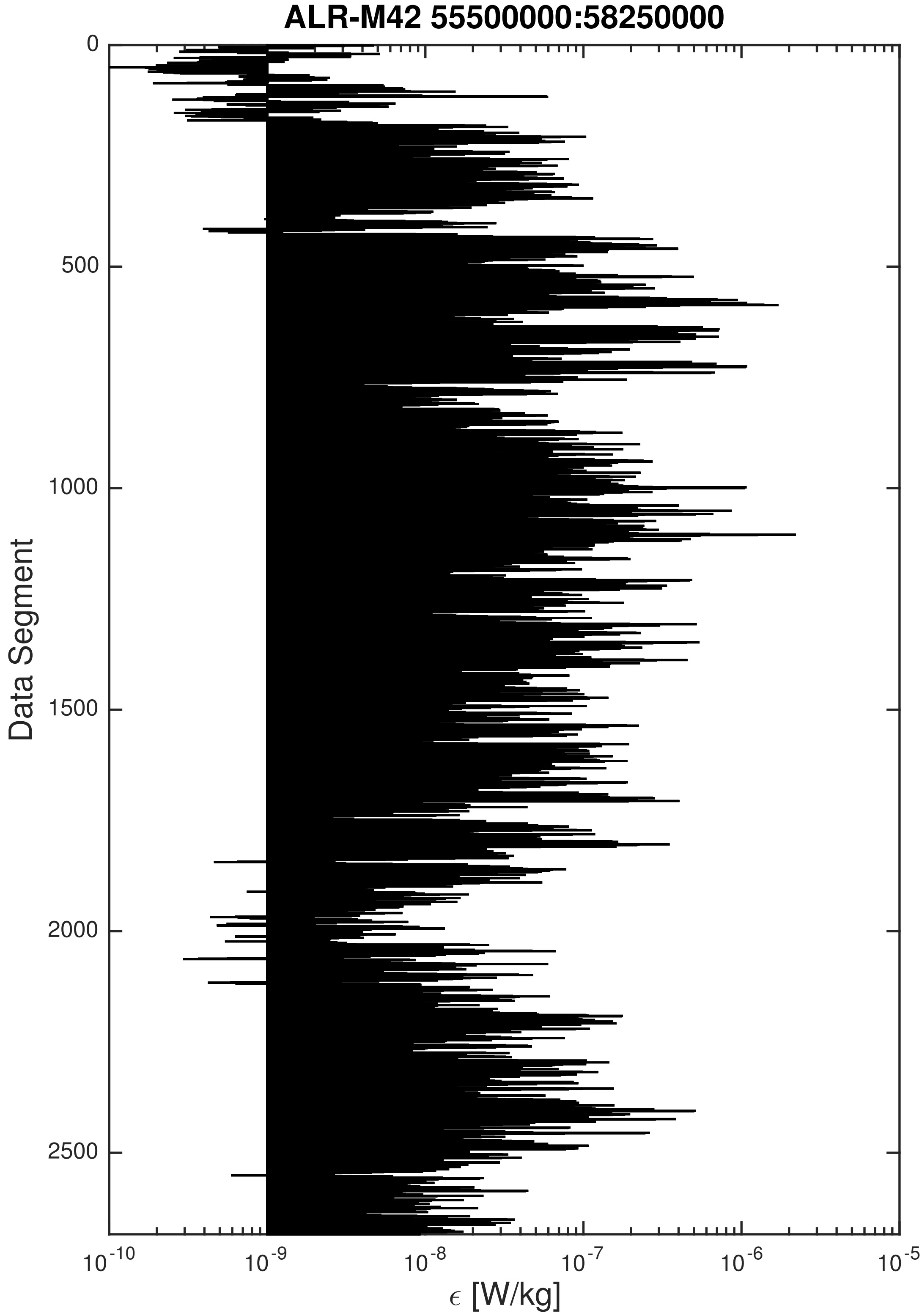


Figure 49: Post-processing dissipation estimates displayed in a profile format.

ADCP data

The ALR has two RDI ADCPs, both 300 kHz Workhorse, with one pointing downwards and one pointing upwards. The downwards pointing ADCP was run in bottom track mode and used for navigation as well as current measurements. Both ADCPs were oriented in 45 degrees relative to the ALR reference frame.

ADCP data processing

Data files from the ALR were provided in the binary ADCP `*.000` format, but were named `*.log` files. Several files were provided per mission. These were read in by the `rdradcp.m` Matlab package by R. Pawlowics.

The navigation data provided by the Autosub team was lightly edited before incorporating into the ADCP data file. This was carried out in `make_alrnav.m` where

- Latitudes and longitudes greater than −30 were removed.
- CTD data for temperature readings below −30 were removed.
- Zeros in pressure anomalies were removed and then gaps linearly interpolated over. *This could be improved for final data processing, since it is possible that rather than removing zeros, the zeros should be averaged with subsequent pressure anomalies to produce a smoother pressure transition.*
- Skips in the time interval, where time intervals varied from 0 to 2, were fixed, up to skips of 4 indices. Anything longer than this was simply removed and interpolated over using `f_regrid_time.m`.
- Large anomalies in heading were removed (heading changes exceeding 100 degrees but less than 335 degrees, which occurred over a 1 second interval).
- Leading and final `NaN`s were removed.

The cleaned up data are output into a structure called `alrnavXX.mat` where `XX` is the mission number (41, 42 or 44).

The three primary steps in processing the ADCP data are

- `load_ALR_adcp.m`: A script that requires the path to data directories and loads ADCP data. It loads in the raw ADCP files with 5-ensemble (10-second) averaging, concatenates together individual files, and outputs a Matlab file with the data called `MXX_adcp_UU.mat`, where XX is the mission number (41, 42 or 44) and UU is either ‘up’ for the upwards-looking ADCP data or ’dn’ for downwards-looking.
- `clean_adcp.m`: A script that requires the ALR navigation data to be loaded (and slightly cleaned, as above). It cleans time stamps, bad data, and regrids onto a common time interval with the ALR navigation data.
- `make_adcp.m`: A script that combines upwards and downwards looking ADCP data into the same file, calculates water velocities by subtracting the bottom track or water track data, and applies the ALR navigation heading information to rotate velocities into earth coordinates.

Additional detail is given below in Table. 8. Note that the processing focuses on the velocities when the vehicle was in bottom track mode. A minimal attempt to remove water track velocities has been made, where velocities in the bins 3–5 away from the vehicle in the downwards-looking ADCP data are removed from both downwards and upwards looking data.

Function	*Description*
`load_ALR_adcp.m`	Reads in the ADCP data from the `*.log` files and concatenates them together into a single data file per mission. This calls the `rdradcp.m` function, which was run with 5 ensemble (10-second) averaging. Output: Creates the datafiles `M44_adcp_dn.mat` and `M44_adcp_up.mat`.

Continued on next page

Table 68 – *continued from previous page*

Function	*Description*
`clean_adcp.m`	Cleans up several minor issues with the ADCP data: • Identifying and re-sorting time reversals/uneven time sampling. Occasional ensembles are marked with the same time stamp as a previous ensemble, followed by a doubling of the typical time interval. • Applying a sound speed correction based on the ALR CTD data. Onboard ADCP processing used a temperature sensor, pressure of zero and constant salinity of 35. Reprocessing applies the sound speed derived using the vehicle depth (AUVDepth, converted from meters to decibars) and the uncalibrated Seabird CTD data. *Final processing should update this for calibrated data, though the differences will be minor.* • Removing bad data. The bin nearest the vehicle in both upwards and downwards looking ADCP datasets needed to be blanked. Near the bottom in the downwards looking ADCP, there were clearly bad bins (large amplitude, large variance). To remove these, several choices were made: bins 9–12 were blanked (distance 74–98 m). Beam intensity on channels 1 and 2 was used, where a minimum threshold of 128 intensity for returns was required, otherwise velocity data were discarded. Additionally, where the percent good field for channel 4 was less than 20, and for channel 3 was greater than 80, the data were flagged as bad. • Following the removal of bad data points, the upwards and downwards looking data were regridded onto a common time grid of the same 10-second interval using nearest neighbour interpolation (`f_regrid_time_nearest.m`), and aligned with a 10-second binned version of the `alrnav` file. Note that some spikes in the velocity data still persist after this process. *Final processing may require additional editing of spikes/bad bins.*

Continued on next page

Table 68 – *continued from previous page*

Function	*Description*
	Output: Creates the files M44_adcp_clean.mat with both upwards and downwards looking ADCP data in structures alladcp_dn and alladcp_up.
make_adcp.m	Loads the ALR navigation data (e.g., alrnav44.mat) and cleaned ADCP data (e.g, M44_adcp_clean.mat). Incorporates several steps: • It bin averages the ALR Nav data (originally at 1 second time intervals) to the same time grid as the ADCP data using function stc_smooth.m. • The upwards and downwards looking ADCP data are then combined using the ranges in alladcp_dn.config.ranges and the ALR depth (converted from alrnav.AUVDepth, which is in units of pressure, by using the seawater routines). • Bottom track velocities for the forwards-aft (alladcp_dn.bt_vel(2,:)) and starboard-port (alladcp_dn.bt_vel(1,:)) directions, in the frame of reference of the AUV, are converted from units of mm/s to m/s, and then subtracted from water track velocities. • These are then rotated into earth coordinates using the function auv2earth.m. • Rotated velocities are then binned into a height above bottom coordinate using the function fgrid_height_above.m. Output: Data are saved into the structure adcp44 which incorporates the ALR navigation positions and times, the water velocities and associated depths, the bottom track ranges, and the water velocities in the height-above bottom coordinate.

Table 68: Processing steps used for the ALR ADCPs on cruise JR16005.

ADCP data

Preliminary processed data, following the steps above, for the three missions are shown in Figures 50–52. For M41, where the ADCP was set in broadband mode with 4 m bins, the bins nearest the vehicle (e.g., 0–15 m below the vehicle) show large velocities which appear to be contaminated by vehicle motion/bottom track velocities. In the end, the data were deemed unusable, and no further plots will be shown.

For M42 (Figure 51), only the downwards-looking ADCP produced data. Ranges of 20–65 m from the vehicle showed good returns.

For M44 (Figure 52), both the upwards and downwards looking ADCP data are reasonable. Data are available from 65 m below the vehicle to 65 m above the vehicle, spanning 130 m. From the initial plots, velocities are mostly barotropic (depth-independent), though shear is visible in individual profiles at some locations.

ALR data in geographic coordinates

The ALR vehicle followed a windy path down steep slopes. To put the data in geographic context, the following plots are provided for each mission: M42 (temperature and velocity, dissipation ϵ), M44 (temperature and velocity, dissipation ϵ). These plots were created by the script `plot_alr_geographic.m`, for which data are averaged into 1 km segments along the track, and then plotted in a top-down view. Data are plotted in units of distance (km) from $-60°39.38'$S and $-42°10.68'$W.

The temperature plots are in Figure 53 and 54. Temperatures are coloured evenly, but over a temperature range to highlight bottom temperatures. As the ALR progressed down the western slope of OP, temperatures cooled. Along-isobath, temperatures were cooler upstream (to the southeast). Velocity vectors show that the stronger currents in the boundary current were encountered primarily at the 3000 m isobath. The ALR aborted the mission as it was turning onto the 3500 m isobath.

The second mission in OP, M44, spans the western slope of OP from the 2000 m to 3500 m isobath at 250 m depth intervals. Here, the velocities are strongest from -5 km to 5 km, with flow roughly following isobaths. Coldest temperatures ($\theta < -0.55$°C) are observed in the deepest part of the sill.

Maps of turbulent dissipation, averaged over the 1km segments of distance along track, are shown in Figure 55 and 56. Highest dissipations are observed at the western edge of the strong currents: i.e., around -6 km (x) and 3 km (y) for M42 and along the 3250 m isobath in M44.

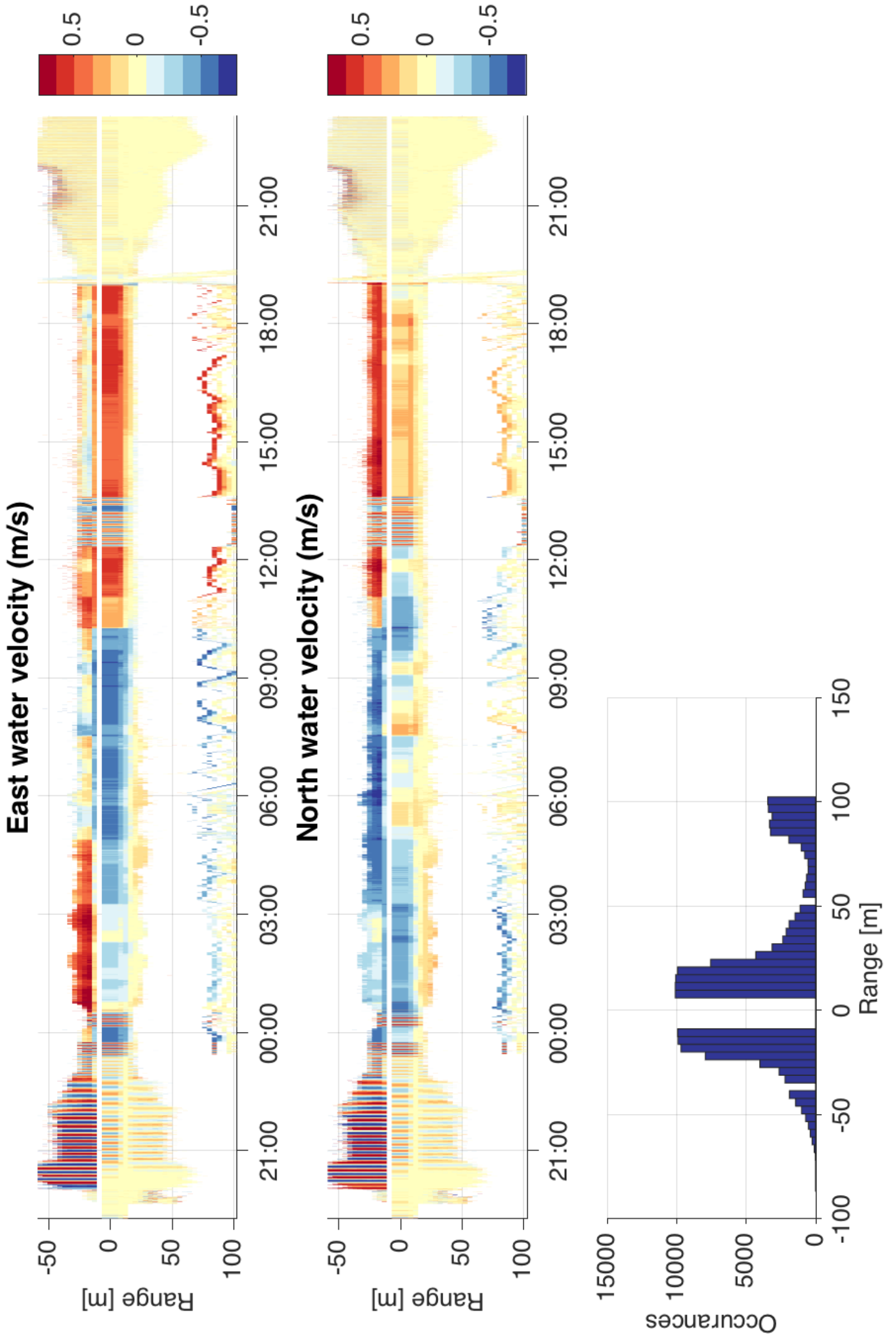


Figure 50: M41 rotated and cleaned according to the processing. (a) East water velocities from both upwards and downwards looking ADCPs as a function of range from the vehicle. (b) North water velocities. (c) Histogram of where binned ADCP data exist, as a function of range. Note both the narrow band where velocities are presumed good, and also the large shear between bins nearest the vehicle and those further away. Data were deemed unrecoverable.

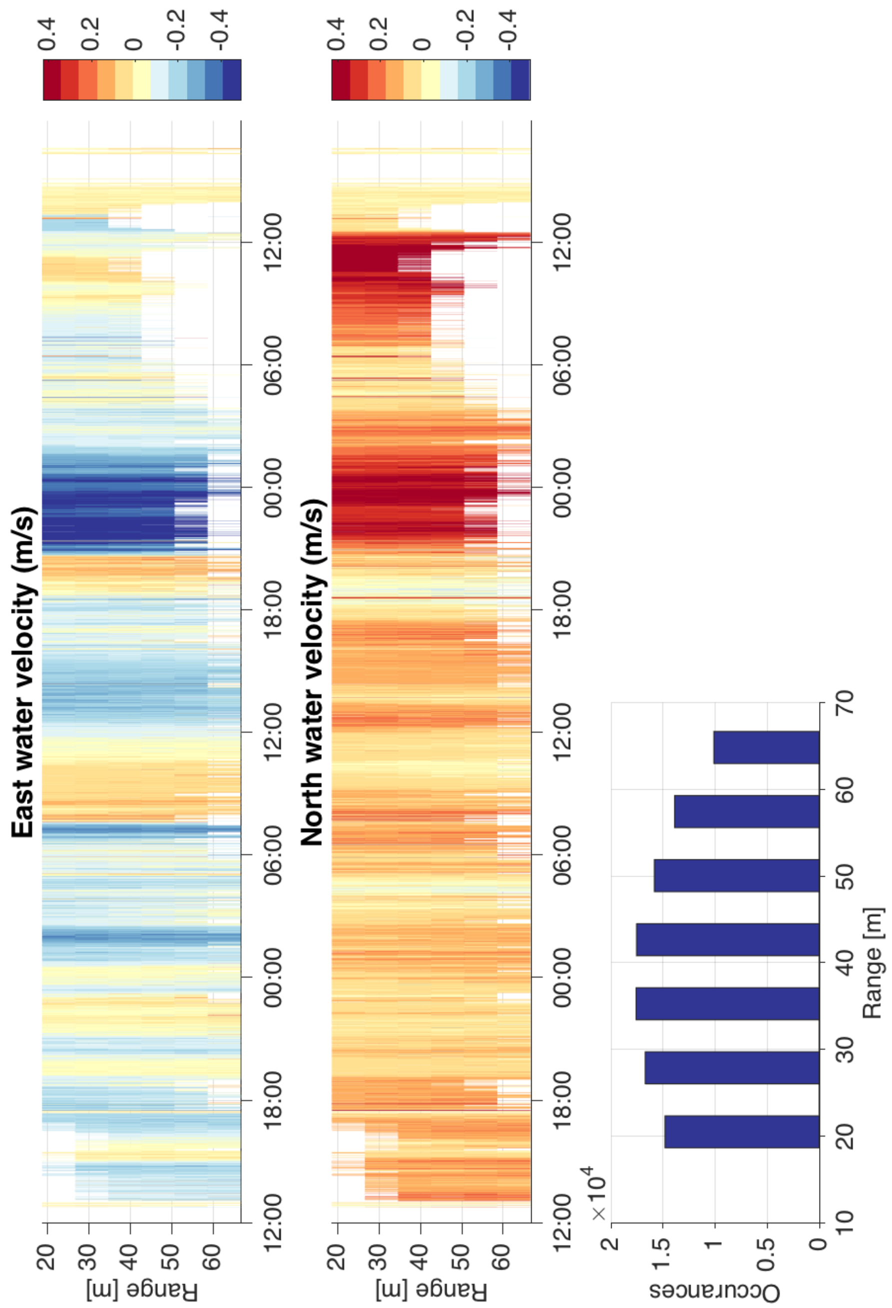


Figure 51: As for Figure 50, but for M42 which only had data from the downwards-looking ADCP.

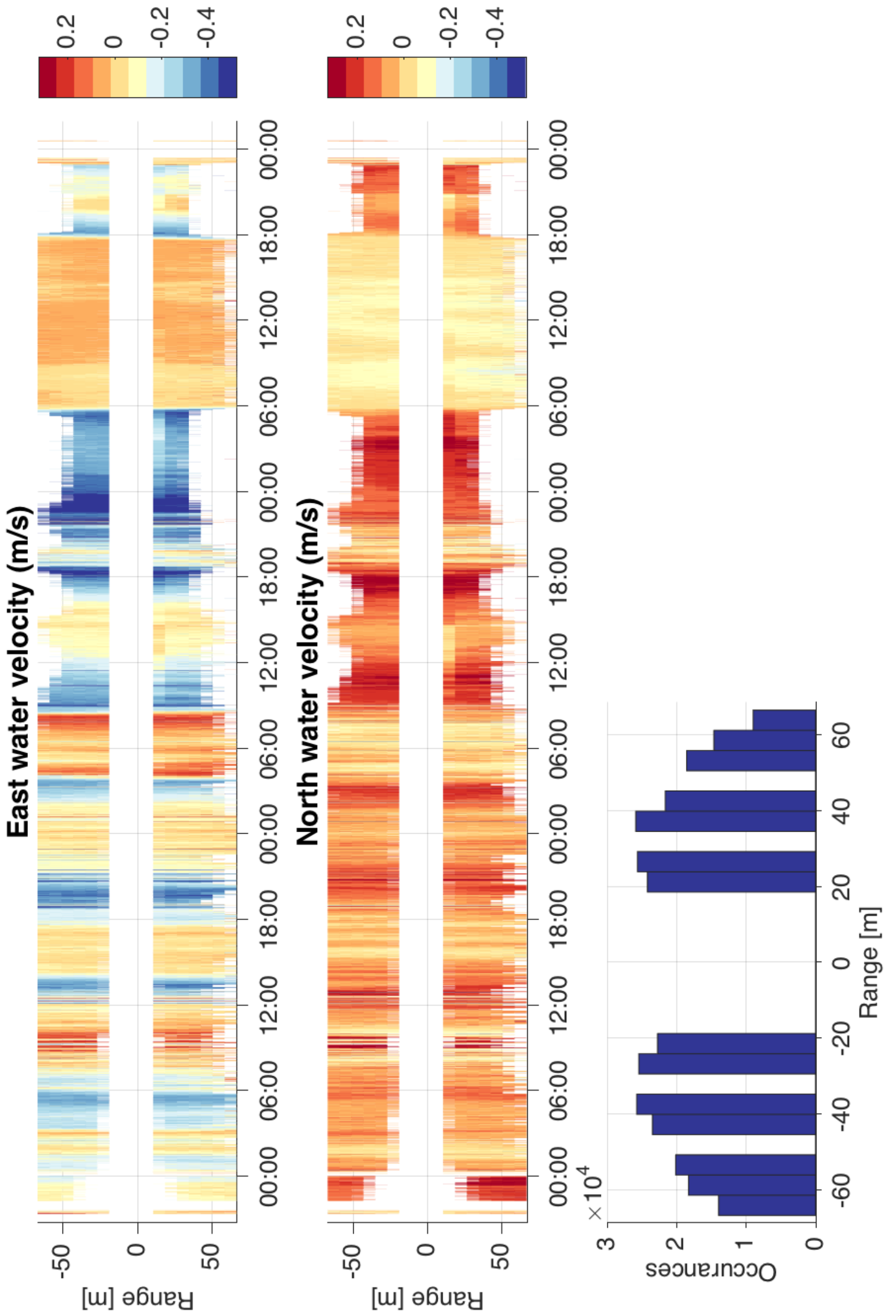


Figure 52: As for Figure 50, but for M44.

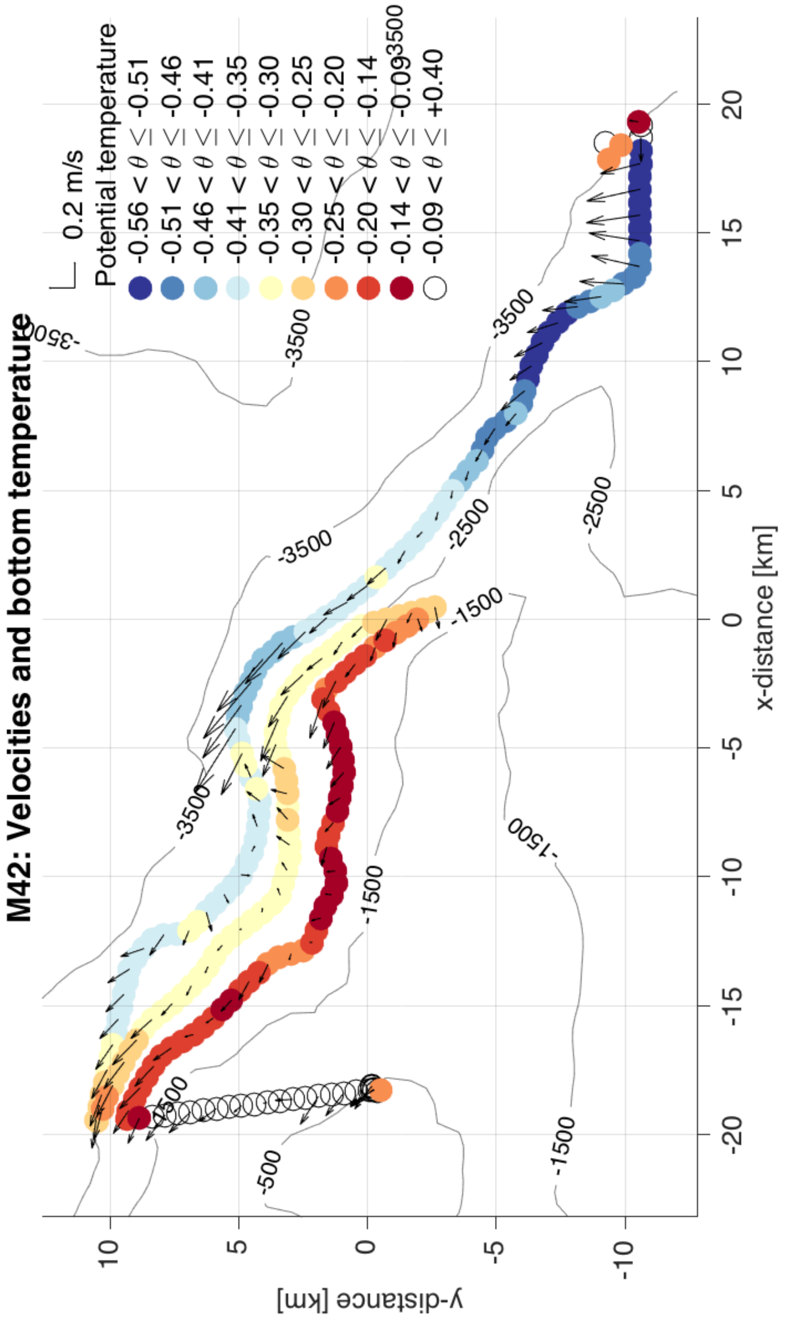


Figure 53: M42 ALR temperatures and depth-averaged velocities from the downwards looking ADCP. The ADCP data are binned in for heights above bottom between 48–64 m. Potential temperature is at the ALR depth. Data have been binned to 1 km segments along the track. Open circles indicate temperatures which are off-scale (too warm), since the colours have been selected to highlight bottom temperatures.

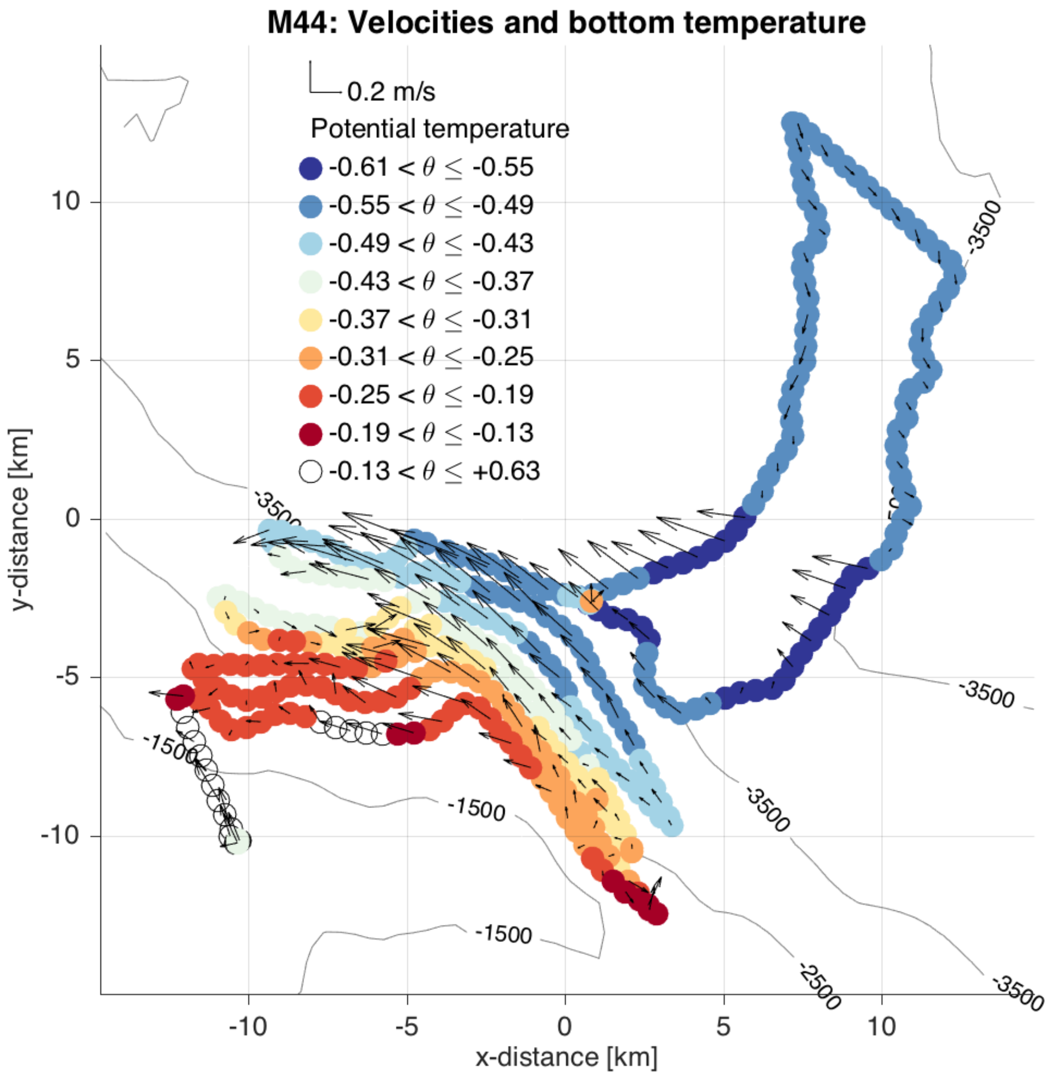


Figure 54: As Figure 53 but for M44.

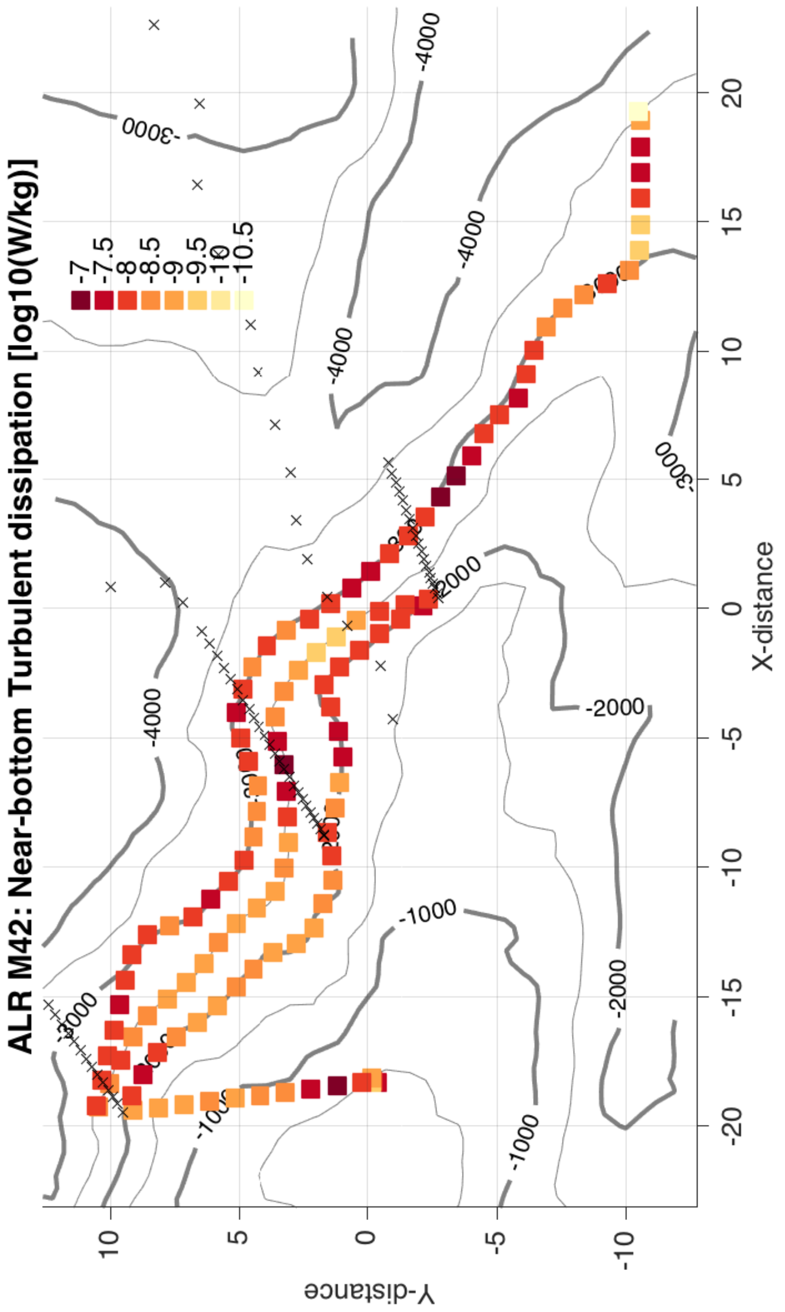


Figure 55: M42 ALR temperatures and depth-averaged velocities from the downwards looking ADCP. The ADCP data are binned in for heights above bottom between 48–64 m. Potential temperature is at the ALR depth. Data have been binned to 1 km segments along the track.

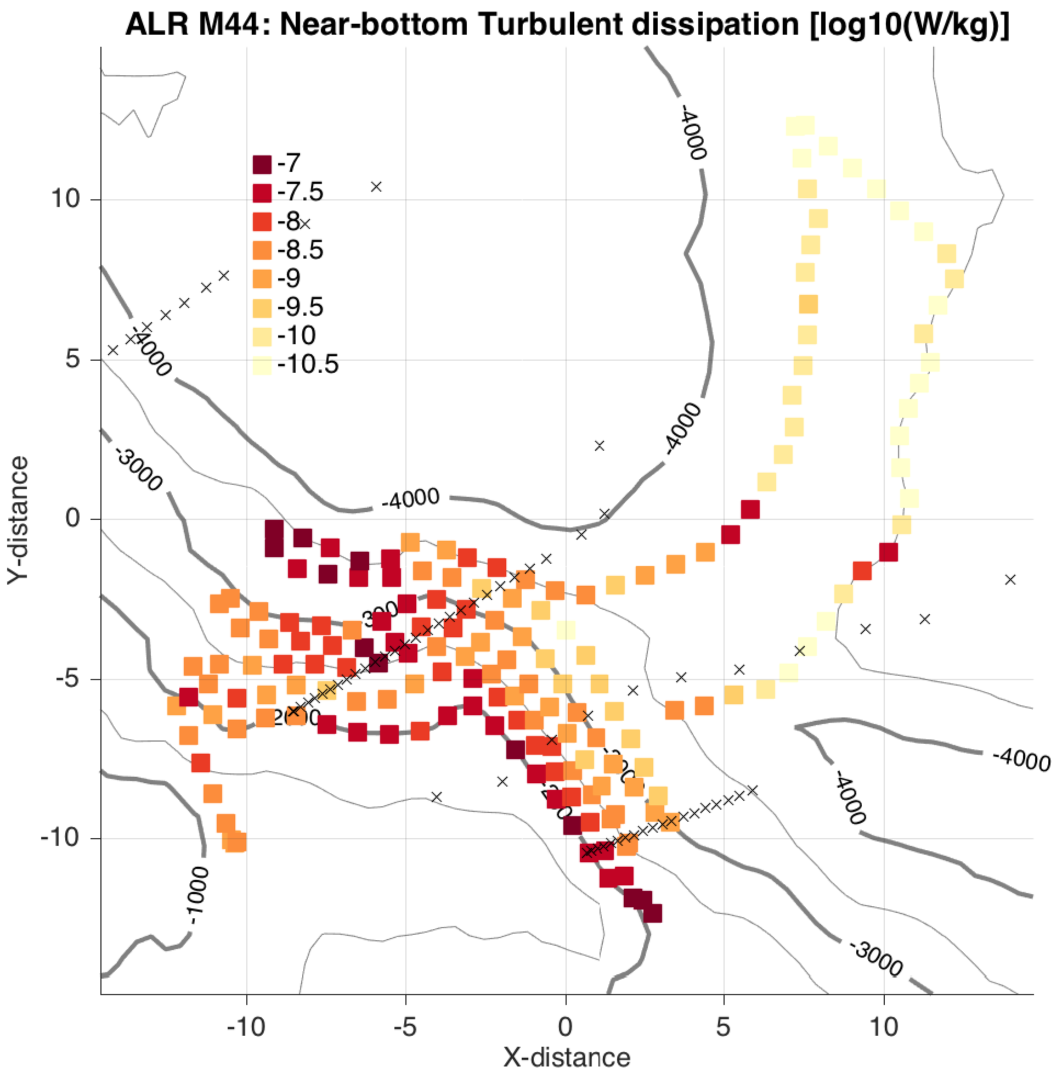


Figure 56: As Figure 55 but for M44.

Acknowledgements

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