RRS James Clark Ross

Cruise JR311

Surface Mixed Layer Evolution at Submesoscales: SMILES

April 21st to May 22nd 2015

Phil Hosegood et al.

A SMILES cruise led by Plymouth University with participants from University of Cambridge, Plymouth Marine Laboratory and LOCEAN

MARINE SCIENCE & ENGINEERING WITH PLYMOUTH UNIVERSITY

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1. SUMMARY

JR311 was the research cruise conducted as the observational element of the NERC Standard Grant, Surface Mixed Layer Evolution at Submesoscales (SMILES). The project aims to improve our understanding of submesoscale dynamics in regions characterised by strong fronts and where they impact on water mass transformation. For this reason, the field site was chosen to be the subantarctic front (SAF) to the east of Drake Passage where the Antarctic Circumpolar Current generates a pronounced front between the warmer subantarctic water to the north and the subpolar water to the south. To the north of the SAF, subantarctic mode water is formed through a process previously considered to be governed by air-sea interaction alone. SMILES aims to investigate the extent to which submesoscale dynamics at the SAF and the surrounding region may impact on, and potentially govern, this process of water mass transformation.

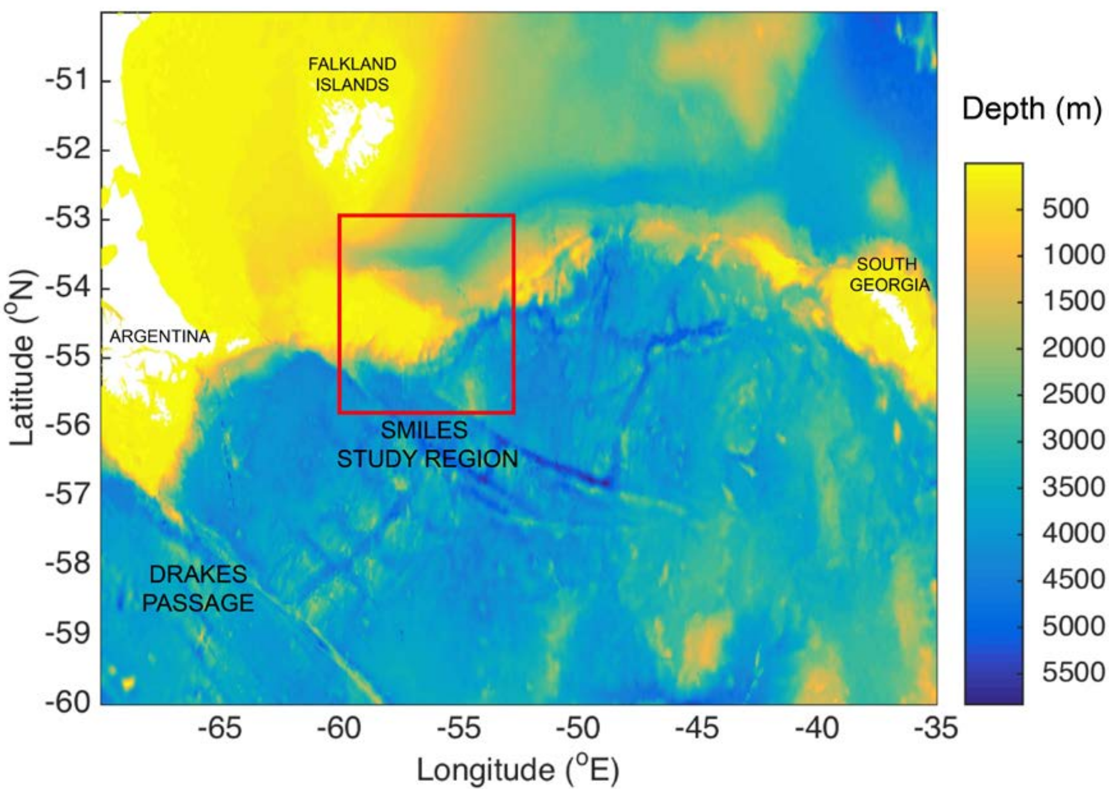

Figure 1.1. The SMILES study region occupied during JR311.

2. INTRODUCTION

2.1 SHIP PERSONNEL

1	BURGAN, Michael JS	Master
2	PAGE, Timothy S	Chief Officer
3	BOWDEN, Philippa Ann	2nd Officer
4	JOHNSTON, Greg GJ	3rd Officer
5	WHITE, Alexander K	Extra 3rd
6	GLOISTEIN, Michael EP	ETO Comms
7	MACDONALD, Neil C	Ch Engineer
8	BEHRMANN, Gert	2nd Engineer
9	LAUGHLAN, Marc	3rd Engineer
10	MANNION, Christopher J	4th Engineer
11	THOMAS, Craig GL	Deck
12	AMNER, Stephen P	ETO
13	TURNER, Richard J	Purser
14	PECK, David J	Bosun/Sci'
15	BOWEN, Albert Martin	Bosun
16	DALE, George A	Bosun's Mate
17	SMITH, Sheldon T	SG1A
18	ROBINSON, Richard G	SG1A
19	HERNANDEZ, Francisco J	SG1A
20	ENGLISH, Samuel	SG1A
21	JONES, Allan D	SG1A
22	HENRY, Glyndor Neil	MG1
23	WALE, Gareth M	MG1
24	PRATT, John	Chief Cook
25	COCKRAM, Colin C	2nd Cook
26	JONES, Lee J	Snr Steward
27	GREENWOOD, Nicholas R	Steward
28	RAWORTH, Graham	Steward
29	SAVAGE, Christian P	Steward
30	EDMONSTON, Johnnie GR	BAS IT
31	HUNT, Julie	Ship's doctor
32	THOMAS, Seth	BAS

2.2 Scientific Personnel

1	HOSEGOOD, Philip J	Plymouth University
2	ADAMS, Katherine	Plymouth University
3	AYRES, Holly C	Plymouth University
4	SCHWARZ, Jill N	Plymouth University
5	WARING, Zoe E	Plymouth University
6	ZANACCHI, Marcus M	Plymouth University
7	MILLAR, Ross R	Plymouth University
8	SALLEE, Jean-Baptiste B	LOCEAN, Paris
9	PELLICHERO, VIOLAINE	LOCEAN, Paris
10	TAYLOR, John R	Cambridge University
11	BACHMAN, Scott D	Cambridge University
12	CRAWFORD, Thomas J	Cambridge University
13	STAMPER, Megan A	Cambridge University
14	DILLON Anna L	Affiliated to Plymouth
15	GALLIENNE, Christopher P	Plymouth Marine Laboratory
16	PROVOST, Paul G	National Marine Facilities,
17	MOUNTIFIELD, Dougal	National Marine Facilities,
18	CAMERON, Candice A	National Marine Facilities,
19	WOOD, Julie E	National Marine Facilities,

2.3 Watch Keepers

Watches were organised on the basis of 8 hours on, 16 hours off. The watch pattern was rotated mid way through the cruise.

Watch	Scientific personnel			
00.00 – 08.00	Scott Bachman*	Chris Gallienne	Violaine Pellichero	
08.00 – 16.00	Kate Adams*	John Taylor	Marcus Zanacchi	Holly Ayres
16.00 – 00.00	Jean-Baptiste Sallee*	Megan Stamper	Thomas Crawford	

* Watch leader

2.4 BIOGEOCHEMISTRY SAMPLING

In addition to the physical oceanographic element of the cruise, a small team of biogeochemists sampled the underway system and CTD rosette (at the times of CTD profiles) around the clock.

WATCH	SCIENTIFIC PERSONNEL
22.00 – 06.00	Jill Schwarz
06.00 – 14.00	Ross Millar
14.00 – 22.00	Zoe Waring

2.5 CRUISE TRACK

Scientific activities during JR311 occupied two regions to the southeast of the Falklands; the first half of the cruise studied the evolution of a weakly strained filament that intruded westwards into the warmer water found north of the subantarctic front. The second half of the cruise targeted a meander, which subsequently formed a closed-core eddy, within the Antarctic Circumpolar Current (ACC). The track for the whole cruise is indicated in Figure 2.1 and for each 24 hour period in the following section alongside the narrative.

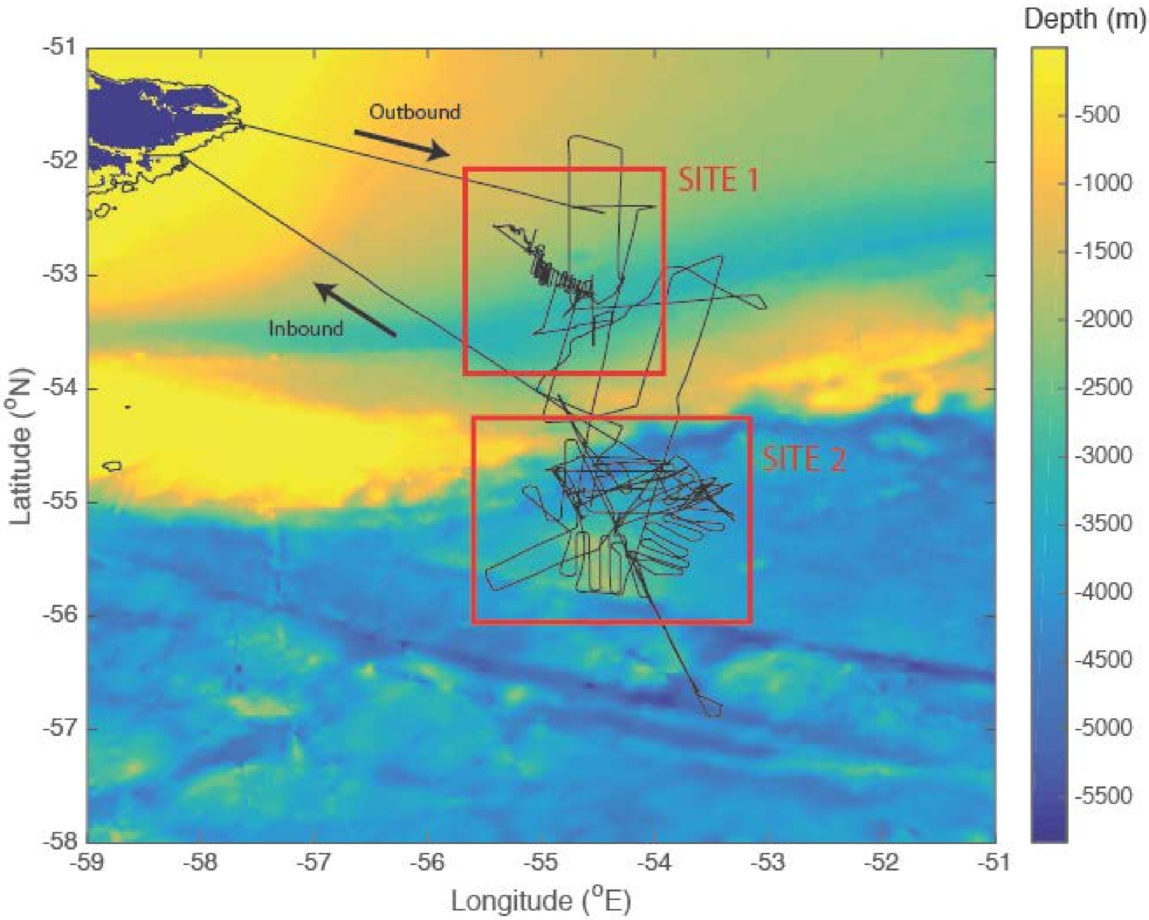

Figure 2.1. Cruise track for JR311 plotted over bathymetry.

At Site 1 a cold water filament was selected using the operational model supplied by the Met Office and that indicated the filament to be intruding into the warmer subantarctic water to the west. To the east of the Falklands, the subantarctic front turns northwards such that the front is aligned from north to south; cross-front excursions are therefore to the west or east. Due to extensive and persistent cloud coverage, only a very few SST images were available. The most extensive coverage of the study site was afforded by the AVHRR pass on May 3rd at 02.19, 2 days after our work on the filament had concluded. By this stage, the filament had wrapped up into a vortex and degenerated into a series of streaks and smaller filaments (Figure 2.5.2). Analysis of the sea surface height anomaly suggests that the filament resulted from the strain generated by two counter-rotating eddies to the north.

Throughout this portion of the cruise we focussed our effort on the northern edge of the filament where colder water was observed south of the front separating the colder water from the water, subantarctic water to the north. The majority of our effort was devoted to repeated Moving Vessel Profiler (MVP) sections across the front whilst following Lagrangian drifters.

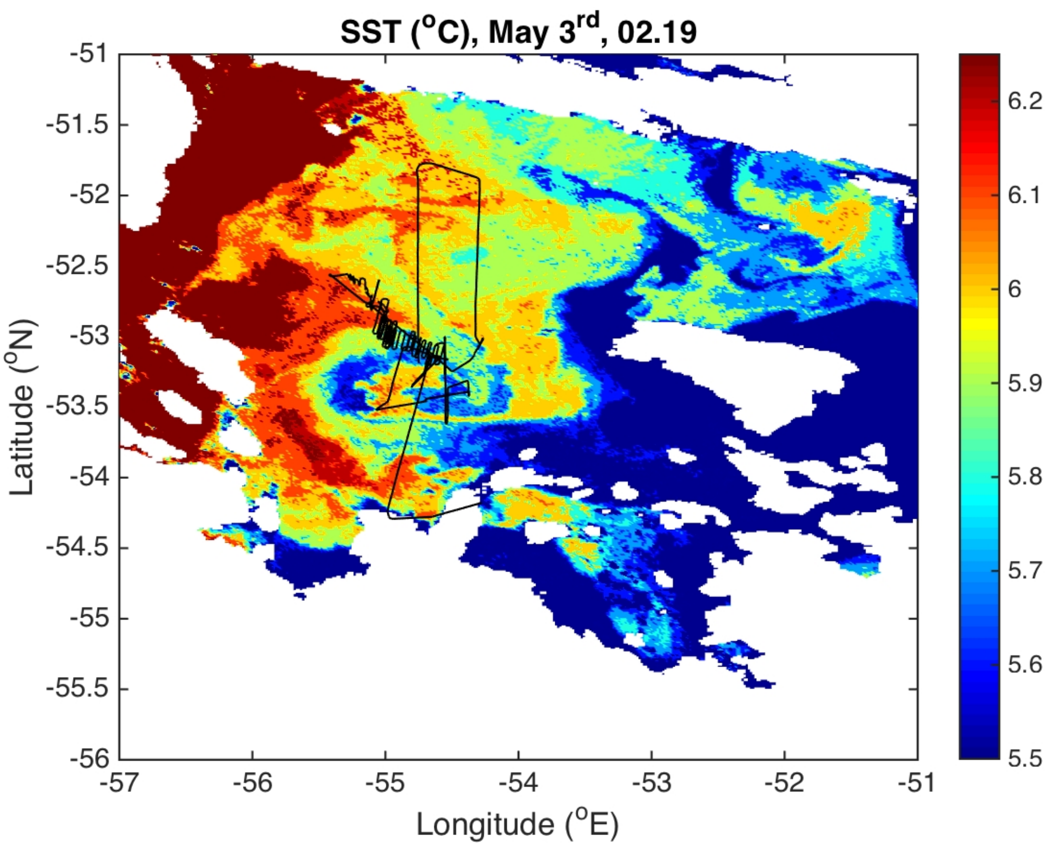

Figure 2.2. AVHRR SST from May 3rd over the site where the first half of the cruise was conducted. The black lines correspond to the cruise track between yeardays 115-123, April 25th – May 3rd.

Site 2 targeted a meander in the ACC that we had traversed during the first SeaSoar survey at the beginning of the cruise. On reaching the site to the south of Burwood Bank, we released three drifters with the intention of tracking them during their transit around the meander. However, at the precise time that we released the drifters, the meander closed off to become a closed-core eddy. As a consequence the drifters continued to circle within a filament that defined the outer edge of the eddy interior. Good weather further enabled a Seasoar transect around the eddy periphery whilst following drifters and a complete CTD and MSS transect across it.

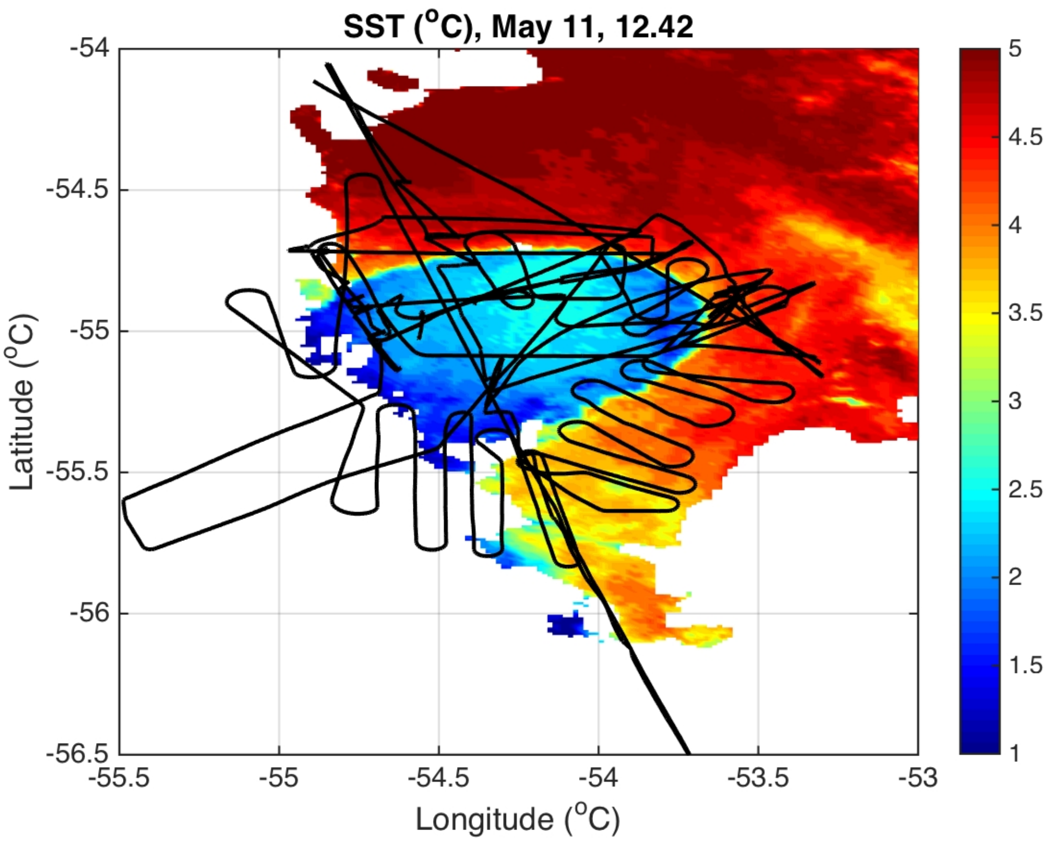

Figure 2.3. AVHRR SST from May 11th over the site where the second half of the cruise was conducted. The black lines correspond to the cruise track between yeardays 126 - 140, May 6th – May 20th.

2.6 DAILY ACTIVITY DIARY

The primary activities conducted during JR311 were towed CTD and Vessel-mounted acoustic Doppler current profiler (VMADCP) measurements but additional deployments included MSS turbulence profiling and drifter releases.

Table 2.1. List of activities conducted aboard the JCR during JR311, Seasoar and Moving Vessel Profiler (MVP) are towed CTDs, the Microstructure Sensing System (MSS) is a turbulence profiler and the CTD refers to standard CTD rosette casts.

DATE	YEARDAY	EXPERIMENT	ACTIVITY
21/4/2015	111		Transit
22/4/2015	112	Regional Survey 1	MSS (5), Seasoar
23/4/2015	113	“	Seasoar
24/4/2015	114	“	Seasoar
25/4/2015	115	Lagrangian 1 (LE1)	Seasoar, Wave buoy, MVP
26/4/2015	116	“	Drifters, Dye, MVP
27/4/2015	117	“	MVP
28/4/2015	118	“	MVP
29/4/2015	119	MSS inertial	MVP, MSS (inertial)
30/4/2015	120	“	
1/5/2015	121	Filament survey	CTD, Argo
2/5/2015	122	“	Seasoar
3/5/2015	123		VMADCP
4/5/2015	124		Hove to
5/5/2015	125	Meander survey	MSS
6/5/2015	126	“	Seasoar, CTD BioArgo
7/5/2015	127	“	CTD
8/5/2015	128	Eddy front survey 1 (LE2)	Seasoar, dye, drifters
9/5/2015	129	“	Seasoar
10/5/2015	130	“	Seasoar
11/5/2015	131	“	Seasoar
12/5/2015	132	“, Eddy CTD transect	Seasoar, CTD, MSS
13/5/2015	133	Eddy CTD transect	CTD, MSS
14/5/2015	134	“	CTD, MSS
15/5/2015	135	“, Eddy front slice (LE3)	CTD, MSS, MVP
16/5/2015	136	Eddy front time series (LE3)	MVP
17/5/2015	137	Eddy front survey 2	MVP, drifters
18/5/2015	138	“	MVP
19/5/2015	139	“	MVP
20/5/2015	140	“	MVP

2.7 CRUISE METEOROLOGY

Wind forcing during the JR311 cruise was unseasonably calm. The strongest wind events came from the west and occurred on 23rd April and at the end of the cruise, 22nd May.

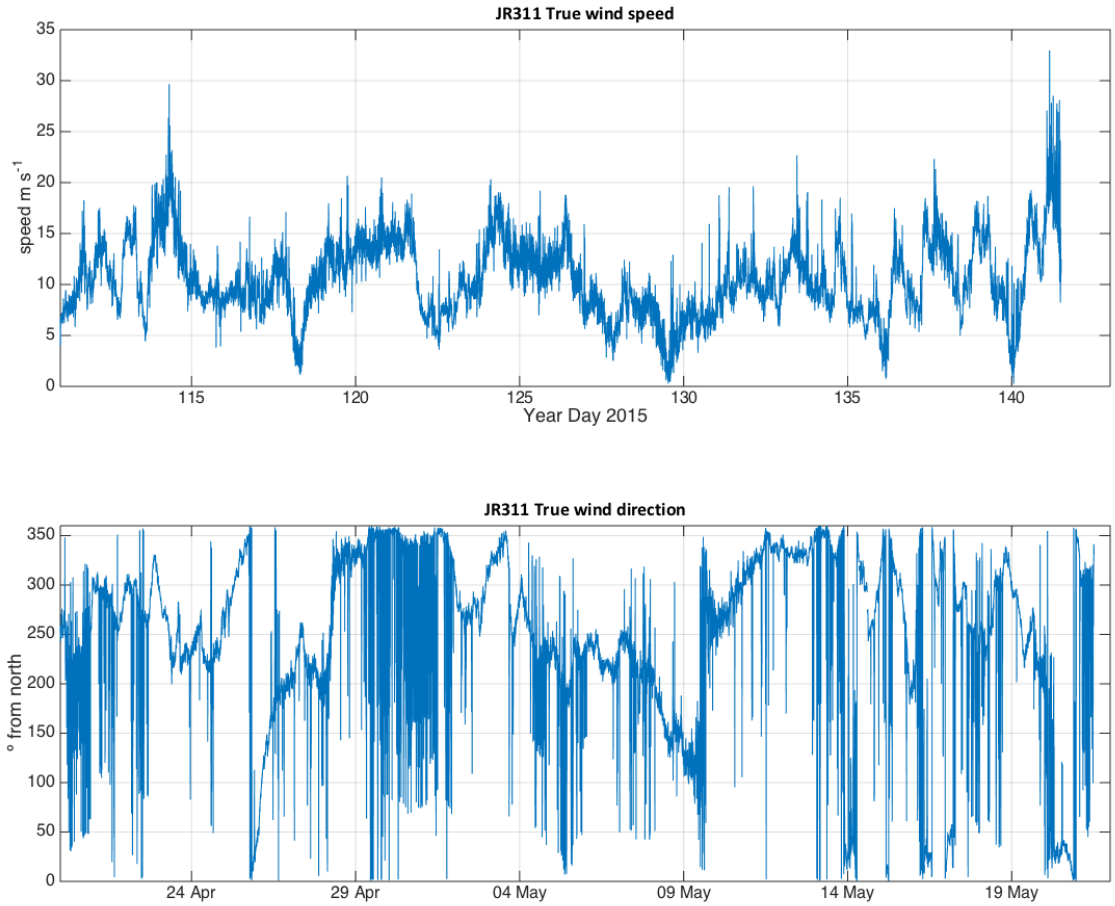

Figure 2.4. (top) Wind speed and (bottom) direction measured aboard the JCR during JR311. The lower panel indicates the date and the upper panel the corresponding decimal yearday.

The air temperature decreased before the 23rd April storm. Air and water temperatures decrease when the ship traversed southward passed the Polar Front, 23rd April and 5th – 22nd May.

Figure 2.5. (top) Air temperature and (bottom) sea temperature during JR311. Sea temperature is measured at the intake at approximately 4 m depth by the thermosalinograph located just inside the intake. The fluctuations in water temperature are indicative of the repeated crossing of the polar and subantarctic fronts during the second half of the cruise.

3. NARRATIVE

Phil Hosegood, Plymouth University, PSO

Monday 20th April

Mobilisation continued throughout the morning until the vessel's departure from the FIPASS terminal at 13.00 after which it anchored in Port William. Following routine drills, tests were performed on the Wirewalker drifter and various other components of the cruise instrumentation. NMF encountered problems with the MVP connections that appear to have become wet during transport. The starting position of the cruise (52° 24.000' S, 54° 39.4667' W) has been passed to the bridge and departure will take place on Tuesday once the Seasoar termination has been completed as the cable faring was finished this evening. Weather for the forthcoming week seems poor, with heavy swells and high winds forecast to build to a peak on Friday. However, the following period from Monday 28th onwards appears to be settled.

Tuesday 21st April

We departed Port William at 15.00 after completion of the Seasoar terminations. Conditions are good with winds 20 knots and wave heights 2-3 m. We will transit overnight to the starting position and plan to deploy Seasoar at 07.00. The weather forecast suggests that conditions will be unfavourable in the morning but by the afternoon improving.

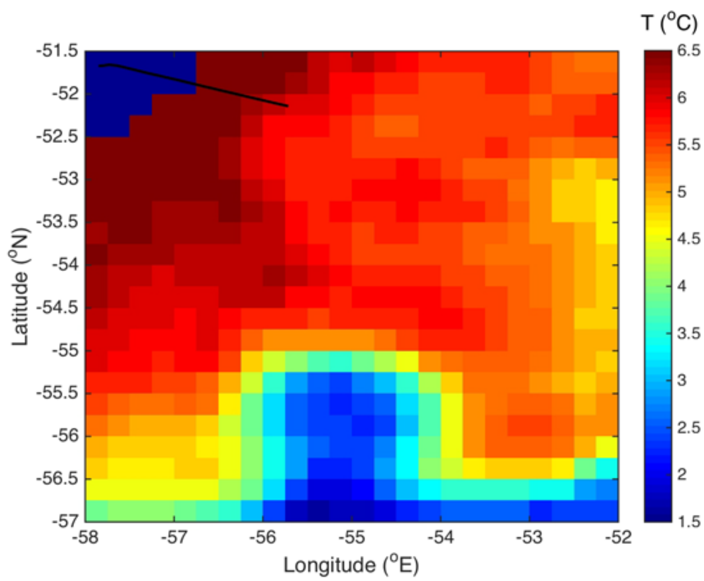

Figure 3.1. Cruise track to 23.59, 21st April overlain on 25 km horizontal resolution microwave SST for the respective day.

Wednesday 22nd April

Conditions were better than expected in the morning. Whilst waiting for the final mechanical Seasoar termination we conducted 5 MSS profiles to establish the mixed layer depth which is reassuringly deep at 100 m. Seasoar was launched at 13.00 for a trial deployment and recovery before launching on its first science tow shortly after 14.00. The weather forecast proved to be worse than that which actually arose, with winds around 20 knots from the west and swell no more than 2-3 m from the southwest. To reduce rolling a heading of 190° was chosen for the long transect that was designed to traverse a filament in the front and continue to 55°S where we plan to cross the subantarctic and polar fronts. Throughout the night winds increased to 30-35 knots and waves approached 3-4 m but nonetheless excellent progress was made.

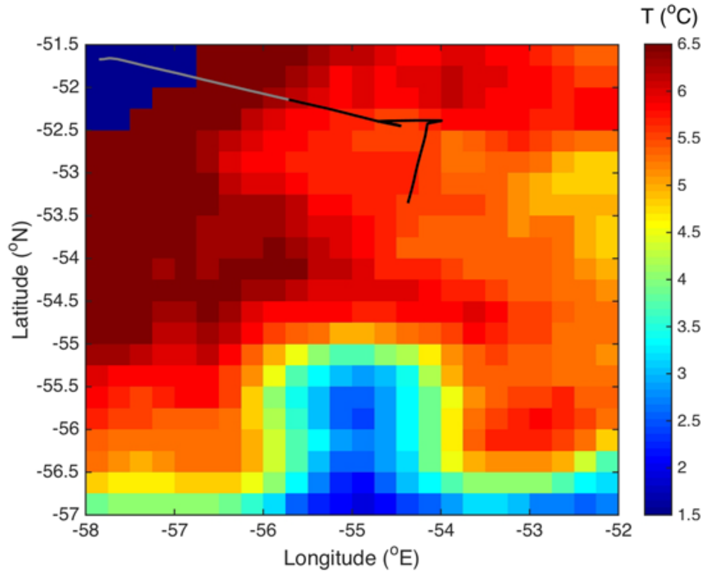

Figure 3.2. Cruise track to 23.59, 22nd April.

Thursday 23rd April

We continued with the first leg of the Seasoar survey, passing through the filament and onto the subantarctic and polar fronts. SeaSoar performed perfectly and we crossed the fronts with no issues despite a 1.5 m s^{-1} frontal jet coming from the west. After passing the front we turned to the east and made plans for a return transect north to pass beyond the northern

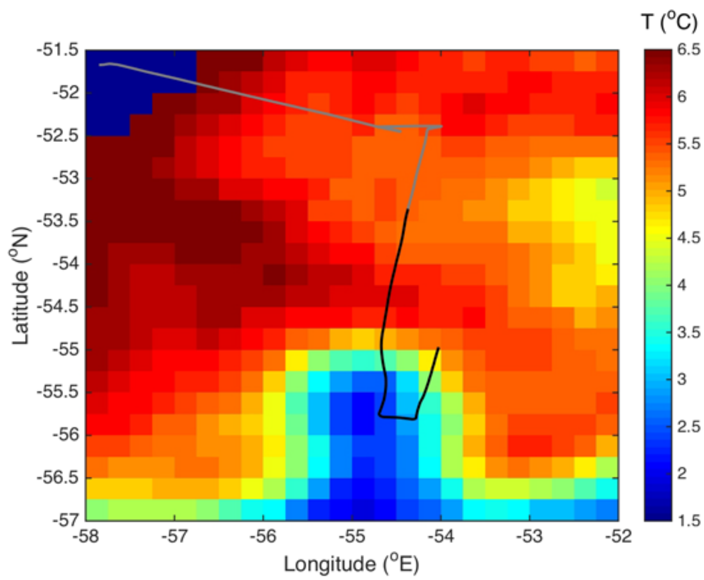

Figure 3.3. Cruise track to 23.59, 23rd April.

edge of the filament. Data from the first leg were worked up in the evening and showed the subduction of oxygenated water down the northern flank of the polar front and strong evidence of a strained front on the northern edge of the filament. Over the coming days we will target the filament in order to identify the location of the tracer release on Saturday. Throughout the night conditions deteriorated, with winds reaching 55 knots and waves in excess of 5 m. Rolls exceeded 20° and made for an uncomfortable nights sleep.

Friday 24th April

Conditions were poor throughout the morning but we nonetheless completed leg 2 of the SeaSoar survey during late morning. With the 3-5m swell approaching from the port quarter and our need to turn back onto a reciprocal course, we continued north before executing a turn back to the south. Now heading back into the swell we began Leg 3 of the survey at around 11.00 before turning for the final time today to a northerly heading at 22.00. On the basis of the TSG, the filament has a width of approximately 14 km and has a sharper front on its northern edge compared to the south. The wind dropped throughout the day and sea state improved. During the evening we prepared the sensors for mounting on the drifters with the aim of recovering Seasoar late morning tomorrow and starting the small-scale surveys shortly thereafter.

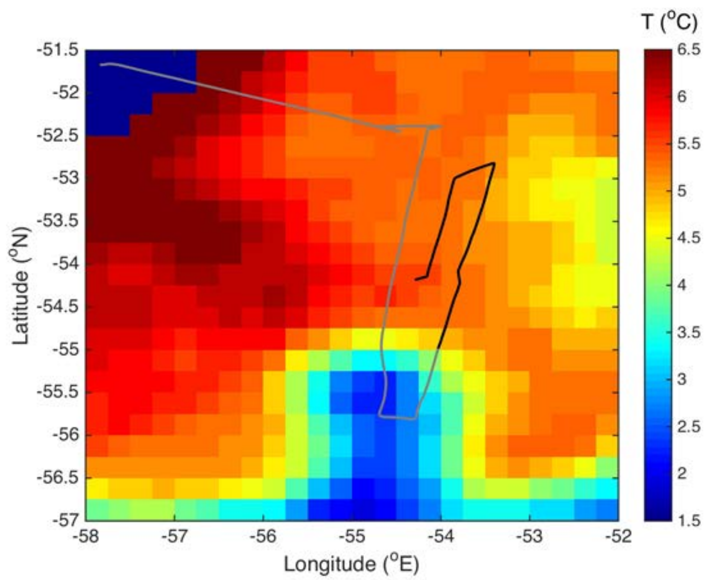

Figure 3.4. Cruise track to 23.59, 24th April.

Saturday 25th April

Seasoar was recovered at 11.30 after which we steamed towards the site identified as most suitable for the Lagrangian survey. On route to the deployment site we deployed the wave buoy on a tethered drogue. Our goal on reaching the deployment site was to conduct an initial survey to identify the front and to then release the tracer and drifters. After two MVP legs the location of the front was unclear; it appeared that the front had moved north from its previous locations and with daylight fading it was decided to postpone the tracer release until the morning so that a complete MVP survey could be undertaken throughout the night in order to locate the front in readiness for the tracer release on Sunday morning.

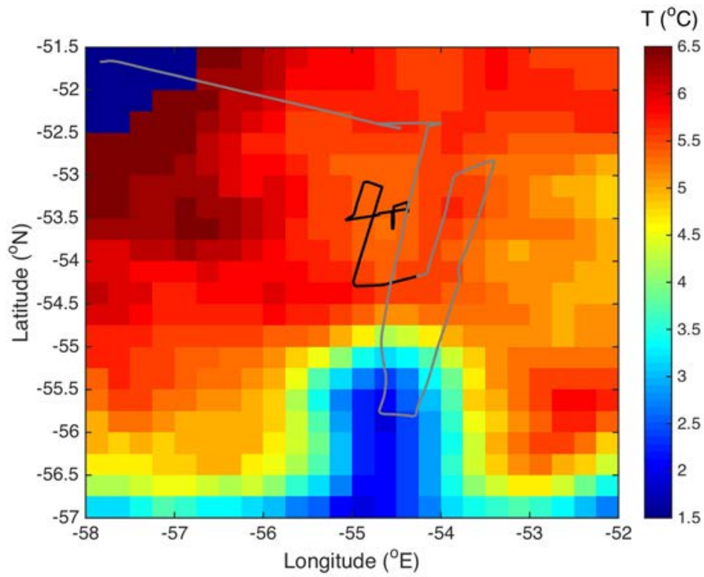

Figure 3.5. Cruise track to 23.59, 25th April.

Sunday 26th April

The front was resolved throughout the night with a high resolution MVP survey; as suspected the front had been to the north but with a clear indication of its structure, we were able to mobilise the tracers and drifters for a morning deployment. After orienting the ship on the north side of the front, we positioned the hose at a depth of 80 m to account for the drag and began our approach to the front at 1.2 knots. The initial drifter was released and the dye

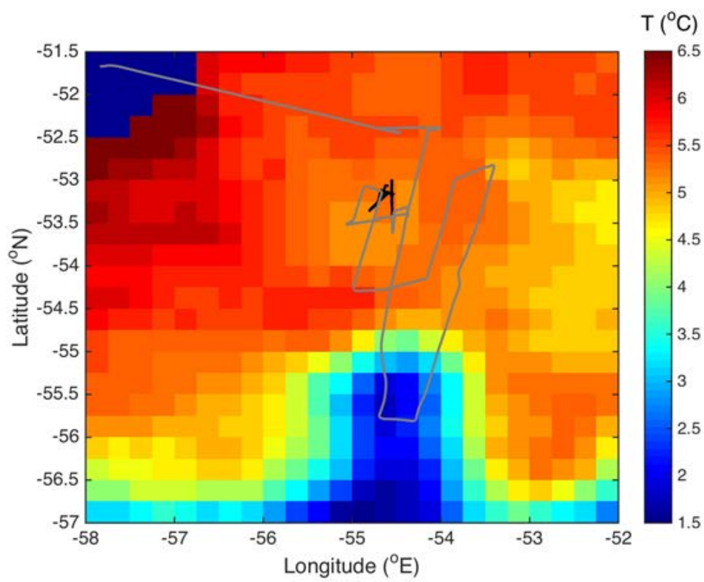

Figure 3.6. Cruise track to 23.59, 26th April.

pumped along a streak of approximately 2 km extent. The Wirewalker drifter was deployed in the middle of the tracer release and the ADCP drifter shortly thereafter. On recovery of the release hose it became apparent that the Wirewalker was not transmitting its position, and neither was the wave buoy deployed the day before. We searched for the Wirewalker without success but found the wave buoy after a one hour transit. Returning to the tracer release site we began MVP surveys across the front and continued through the night.

Monday 27th April

MVP surveying of the front continued throughout the day without any issues. Weather is good with winds less than 20 knots and waves no more than 2m. The drifters are moving westwards along the front and we are capturing the dye occasionally. We plan to continue for another couple of days until the conditions worsen on Wednesday.

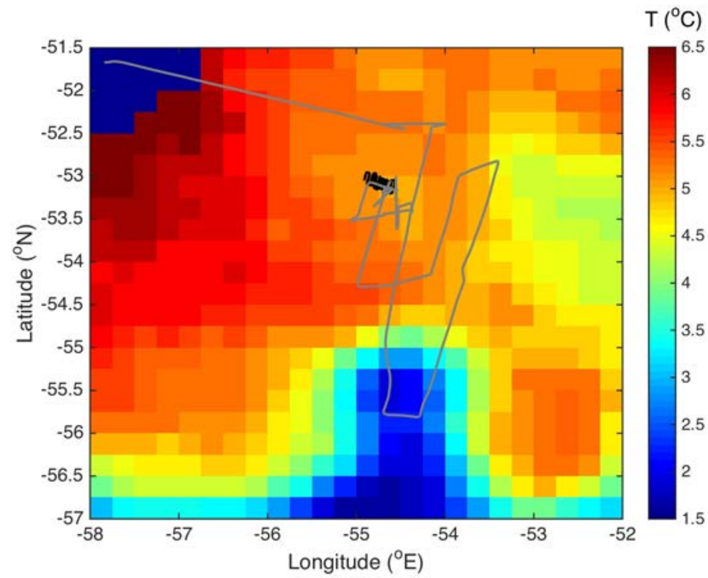

Figure 3.7. Cruise track to 23.59, 27th April.

Tuesday 28th April

We continued to survey the front with MVP as the weather continues to be favourable. The drifters continue to move westwards with the front but after passing by the ADCP drifter late in the afternoon it was noticed that the second buoy was no longer visible. It was decided to recover the buoy in the morning weather permitting, with northerly winds expected to increase throughout Wednesday.

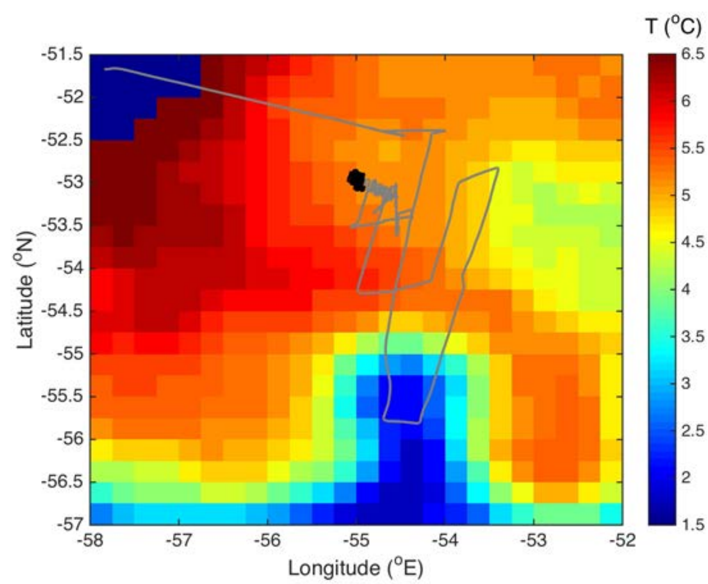

Figure 3.8. Cruise track to 23.59, 28th April.

Wednesday 29th April

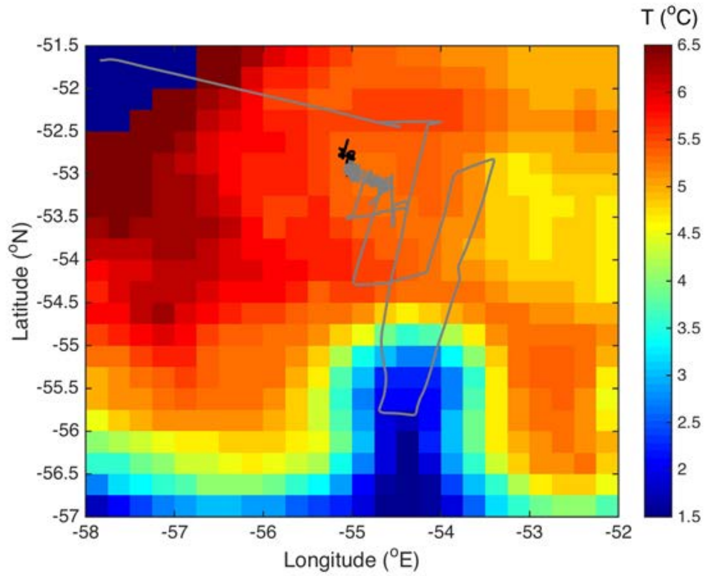

Figure 3.9. Cruise track to 23.59, 29th April.

Conditions deteriorated throughout the night and MVP became impossible as the tow cable began getting caught on the transom. By 3am MVP operations ceased and we began MSS profiling around 5am. A number of profiles were completed until 9.30am before it became clear that the break in MVP operations had caused us to lose our understanding of the frontal orientation. It was decided to return to MVP operations around 11am as the weather improved but after recovering the ADCP drifter. However, on recovering the drifter it became apparent that the secondary buoy had sunk whilst attached to the primary buoy and the entire drifter assembly beneath the buoy had been lost. On inspection it was clear that the shackle that attached the drifter to the upper swivel had failed for unknown reasons, which was particularly puzzling given the good weather. After searching for the remainder of the drifter we completed an MVP transect to the south to establish the orientation of the front. As the northerly winds picked up we were unable to continue with MVP and decided to conduct a 15 hour MSS survey of the front to understand the impact of near inertial oscillations. Winds increased to 25 knots and air temperature to 3C, making the profiling difficult for extended periods.

Thursday 30th April

On concluding the MSS station shortly after midday we proceeded to recover the drogued drifter that had marked our reference point for the preceding 20 hours and the primary drifter deployed several days earlier. On recovering the first drifter, it was discovered that the two floats that would have remained at the top of the ADCP drifter lost the day before had been spotted within 100m of the buoy that we had recovered. A search was made for several hours to locate the ADCP drifter but no further trace was found and at 4pm with daylight fading and conditions worsening considerably we proceeded to recover the primary drifter. On recovery we discovered that the steel wire had snapped at 45 m depth where a Microcat had been attached. Later analysis that evening showed that the wire snapped at 3am that morning. The poor weather required us to heave to for the night as northerly winds reached 40 knots and swells getting up to 4m.

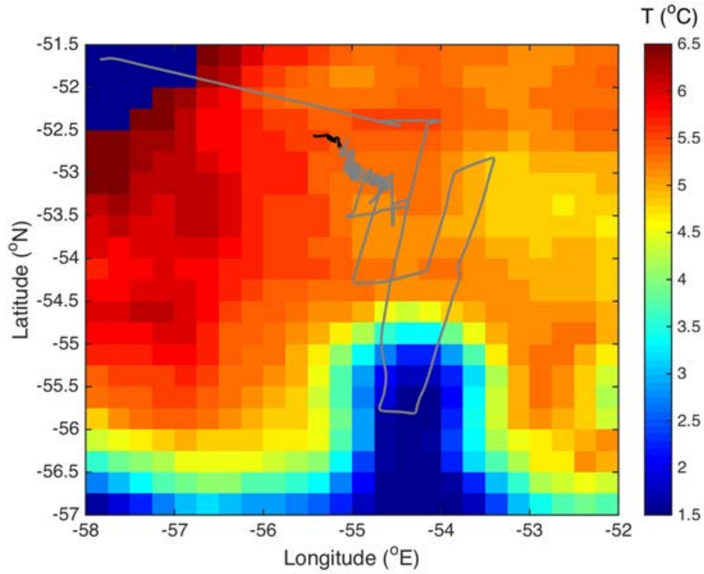

Figure 3.10. Cruise track to 23.59, 30th April.

Friday 1st May

With conditions still poor we headed back to the starting point of our survey several days previously to complete 3 CTD profiles and deploy Argo floats and drifters. On reaching the front, which was now some distance to the north of its position days earlier, conditions had abated to allow CTDs, which proceeded throughout the afternoon and night. 5 Argo floats and 9 drifters were deployed in considerably improved conditions.

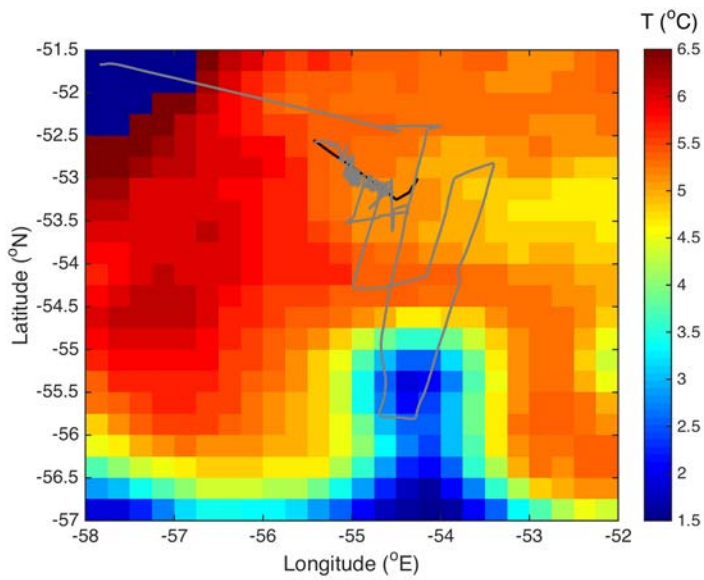

Figure 3.11. Cruise track to 23.59, 1st May.

Saturday 2nd May
After completing the 3rd CTD and drifter/Argo release shortly after midnight, Seasoar was deployed for a survey of the eddy before a storm forecast for Sunday arrived. After the issuing of a gale warning Seasoar was instructed to be recovered at 21.00. Conditions remained calm throughout the night during which the ship was effectively hove to.

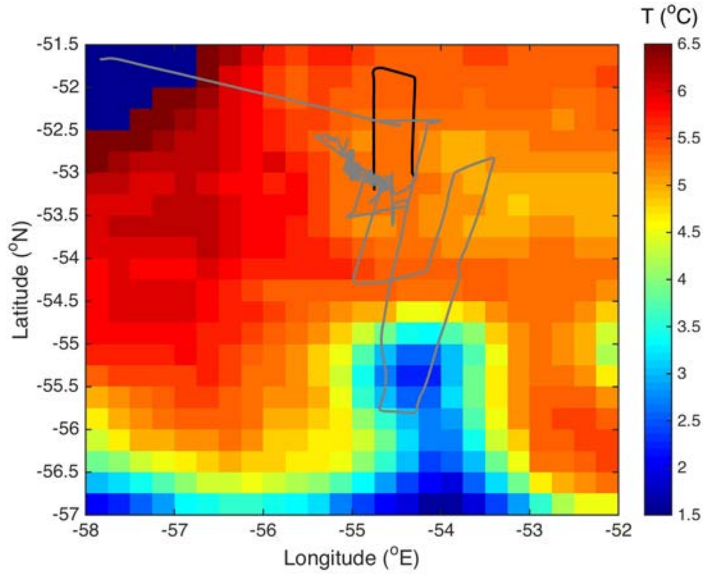

Figure 3.12. Cruise track to 23.59, 2nd May.

Sunday 3rd May
With conditions remaining relatively calm an ADCP survey of the eddy was continued whilst the ship remained north of Burdwood Bank prior to the strong winds and swell arriving on Sunday evening. Throughout the day winds started to increase as atmospheric pressure dropped to 973mb and winds backed to the west.

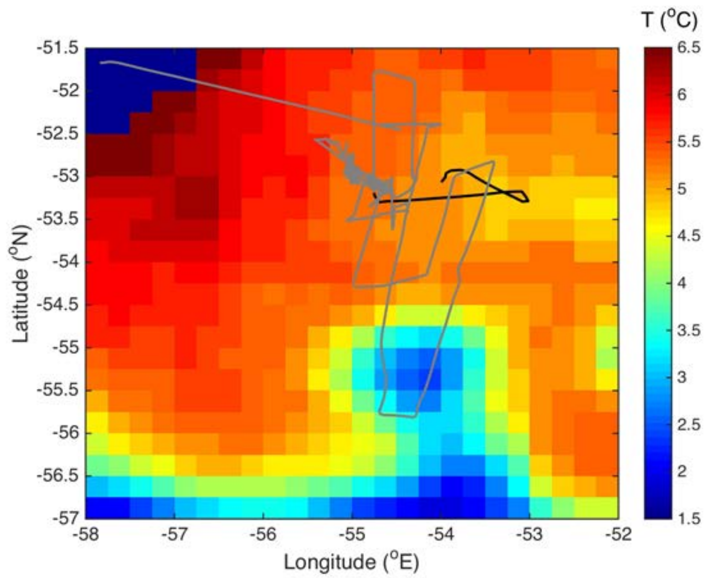

Figure 3.13. Cruise track to 23.59, 3rd May.

Monday 4th May
The storm arrived overnight and we are hove to whilst the winds and swell drop. Atmospheric pressure is increasing and winds dropping to 20 knots but the swell is still pitching the ship.

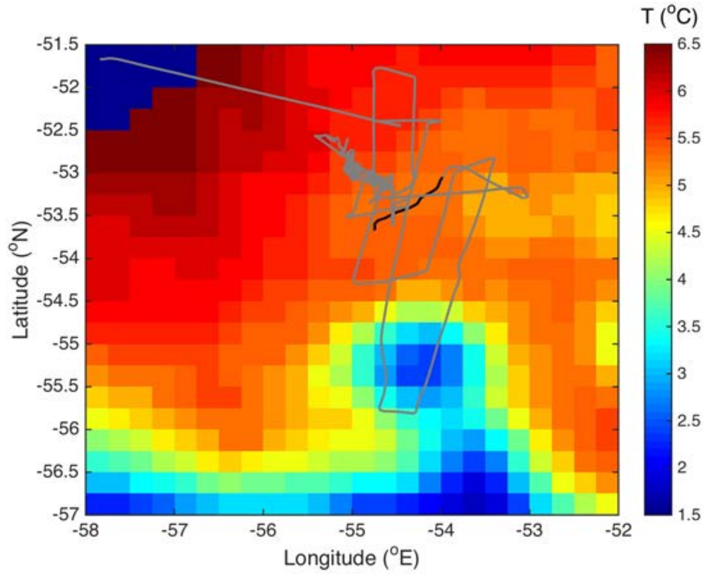

Figure 3.14. Cruise track to 23.59, 4th May.

Tuesday 5th May
Winds decreased to 20 knots but a heavy sea persisted making it impossible to deploy Seasoar. Setting up north of the meander in the ACC targeted for the next site we began an MSS transect (MSS group 3) across the front on the northern edge of the meander in the polar front until midnight at which point the sea had dropped sufficiently to attempt a Seasoar tow which proceeded successfully.

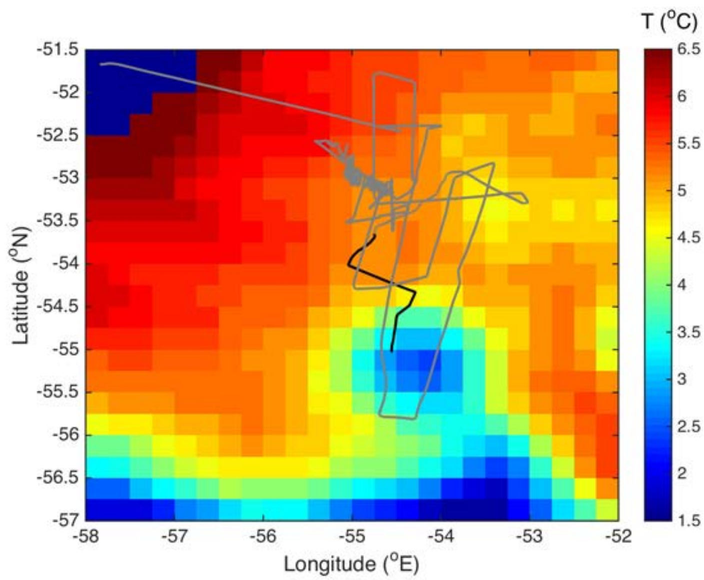

Figure 3.15. Cruise track to 23.59, 5th May.

Wednesday 6th May

Despite winds exceeding 30 knots during the morning we continued with Seasoar until 4pm, mapping the frontal structure across 3 portions of the meander. After recovering the fish we proceeded to the north-eastern sector of the meander for a CTD transect, during which the two BioArgo and four conventional Argo floats were deployed. The front was revealed to be complex in horizontal structure whilst distinctly elevated chlorophyll, the highest we've seen so far, was observed throughout the interior of the meander.

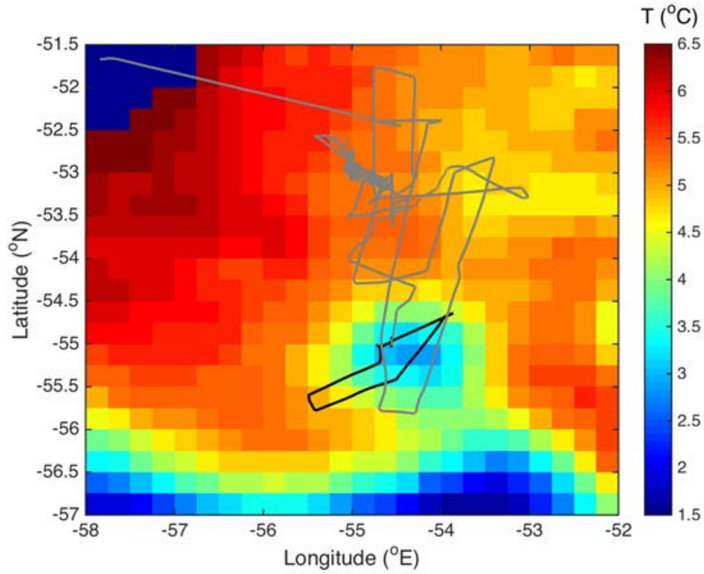

Figure 3.16. Cruise track to 23.59, 6th May.

Thursday 7th May

CTDs continued throughout the day in improving conditions. Wind speeds were less than 10 knots for the majority day but some southerly swell remained. CTDs were completed across the main front and into the northern region beyond but into which the sloping isopycnals, along which AIW is subducted, extend. After the final CTD cast, the MVP wire was streamed to remove twisting before the release of the dye but during streaming the scroller on the MVP winch broke. The only remaining option was to deploy Seasoar while the problem was investigated. Seasoar transects began shortly after midnight and continued through the night.

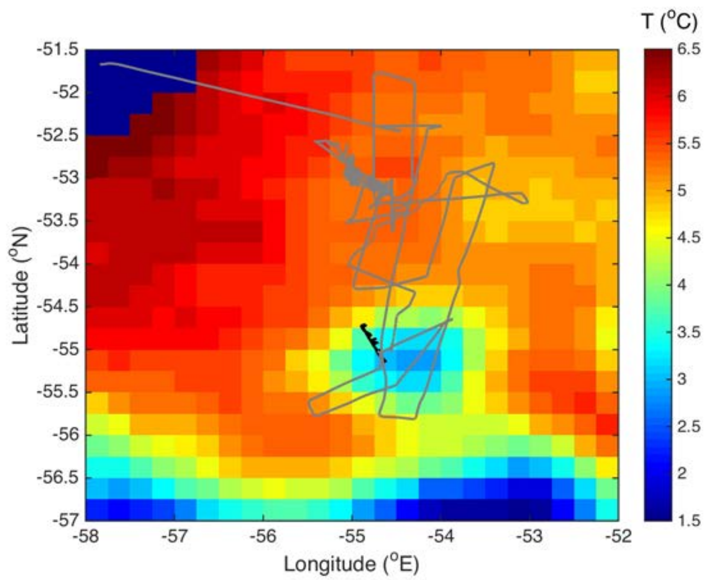

Figure 3.17. Cruise track to 23.59, 7th May.

Friday 8th May

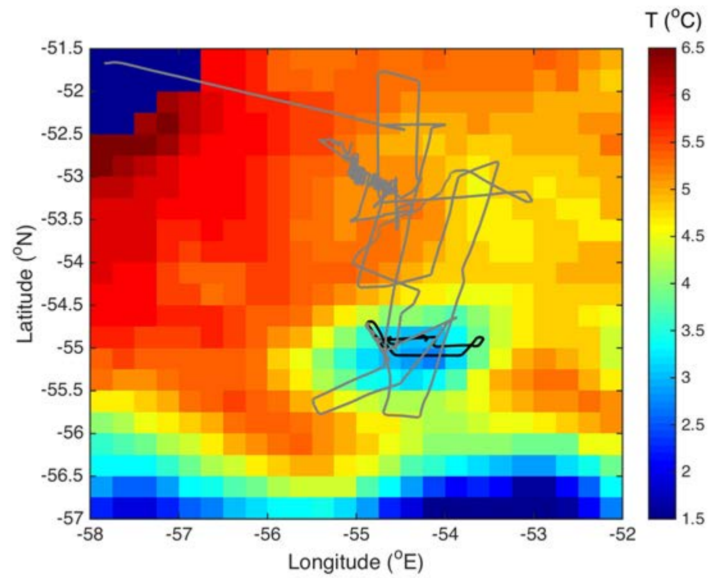

Figure 3.18. Cruise track to 23.59, 8th May.

The problems with MVP necessitated the use of Seasoar for the Lagrangian experiment in the cold filament on the southern side of the meander. The vehicle was recovered at midday with the aim of redeploying after the tracer had been injected but a wiring issue caused a delay until 6pm by which time the dye had been released at a depth of 47m alongside a triplet of drifters. The drifters began a perfect circular trajectory around the meander to the east and we began repeating cross front transects whilst following the drifters.

Saturday 9th May

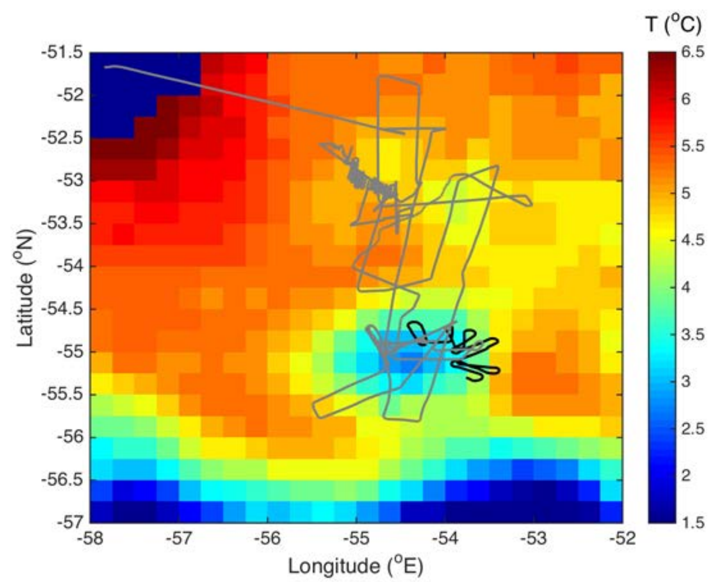

Figure 3.19. Cruise track to 23.59, 9th May.

The weather is perfect, with virtually no wind or swell, enabling us to maintain our strategy of traversing the front whilst following the drifters. By the end of the day the drifters, which were still within 1km of each other despite having already travelled over 100km in the frontal jet, were on the eastern side of the meander which it was now clear was located immediately adjacent to another meander with the opposite orientation to the east. Our aim over the coming days is to continue following the drifters until they either become detrained from the front or weather prohibits our cross front heading.

Sunday 10th May
The drifters are continuing their path and remain closely spaced despite the emergence in the morning of significant submesoscale structure in the front. Winds remained less than 10 knots and the sea flat calm, providing a somewhat unprecedented opportunity to sample the meander/eddy front in this way given the time of year when heading would normally be constrained by sea conditions.

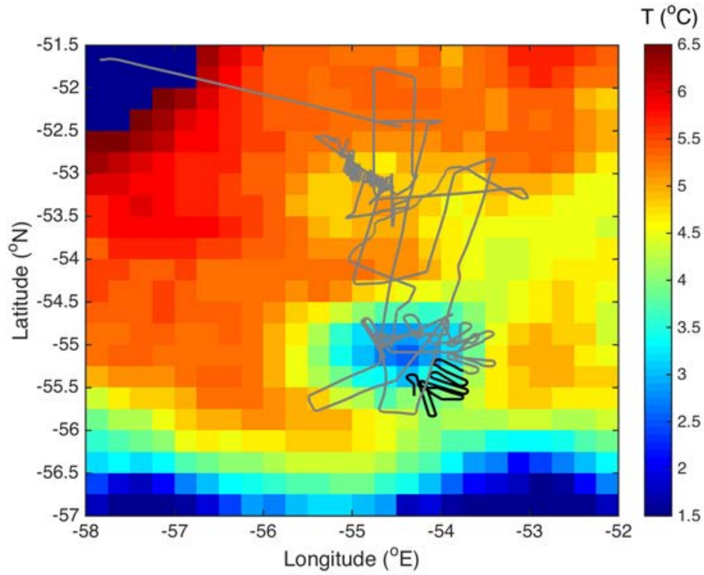

Figure 3.20. Cruise track to 23.59, 10th May.

Monday 11th May
Wind is picking up from the north and the ship starting to move around a little, something that we've missed the last couple of days. Seasoar continued throughout the night and into the morning as the drifters made their way back to their starting point in the northwestern sector.

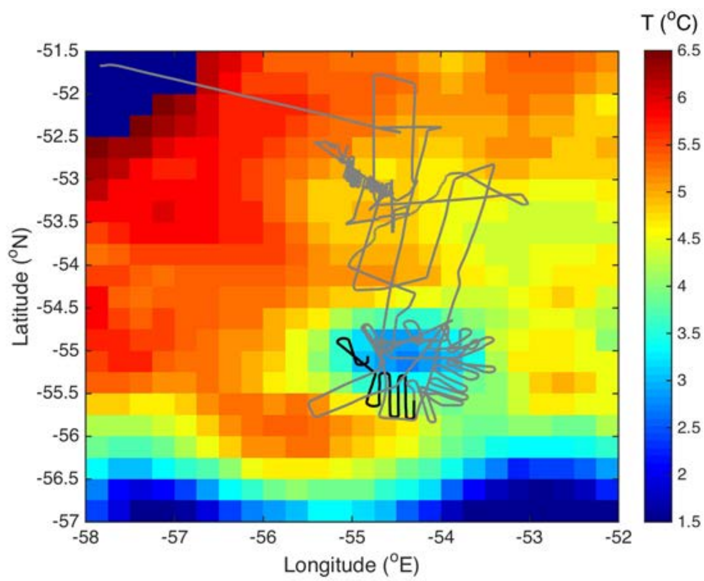

Figure 3.21. Cruise track to 23.59, 11th May.

Tuesday 12th May
After completing the circuit around the eddy the swell started to increase from the north, prohibiting a westward transect across the edge of the eddy. Seasoar was recovered without incident at 19.15 after having crossed the subpolar front and we immediately started a return CTD section to capture the deep structure associated with the eddy and its formation.

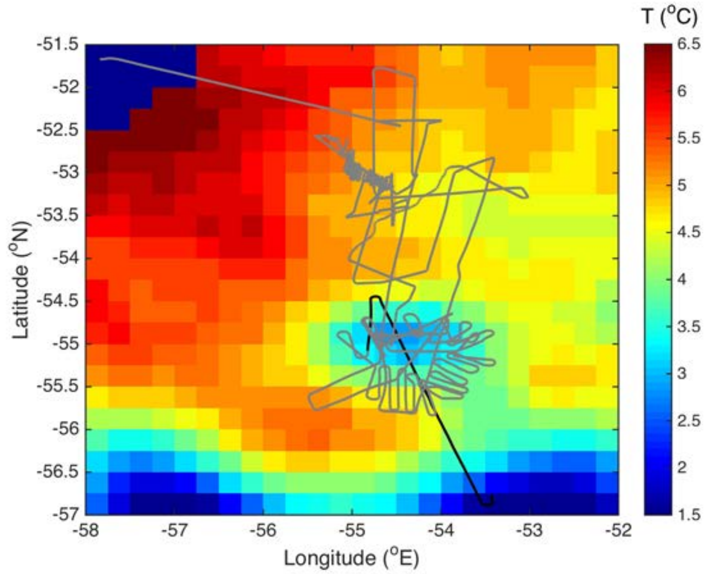

Figure 3.22. Cruise track to 23.59, 12th May.

Wednesday 13th May
The CTD transect continued through the day in a lumpy northerly Force 6, grey mist and accompanying swell. We decided to supplement the CTDs with MSS profiles around and inside the eddy to avoid having to come back and do them later. As a result the decision was made to extend the section to Friday morning at which time we plan to undertake the final Lagrangian survey.

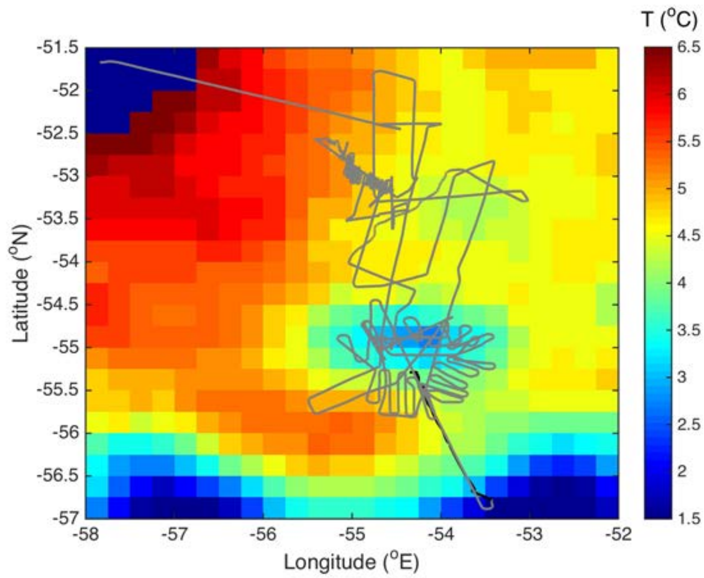

Figure 3.23. Cruise track to 23.59, 13th May.

Thursday 14th May
The CTD transect was extended towards the north to capture the subducting isopycnals associated with the subantarctic front. Conditions are still good, the sea calm and winds light.

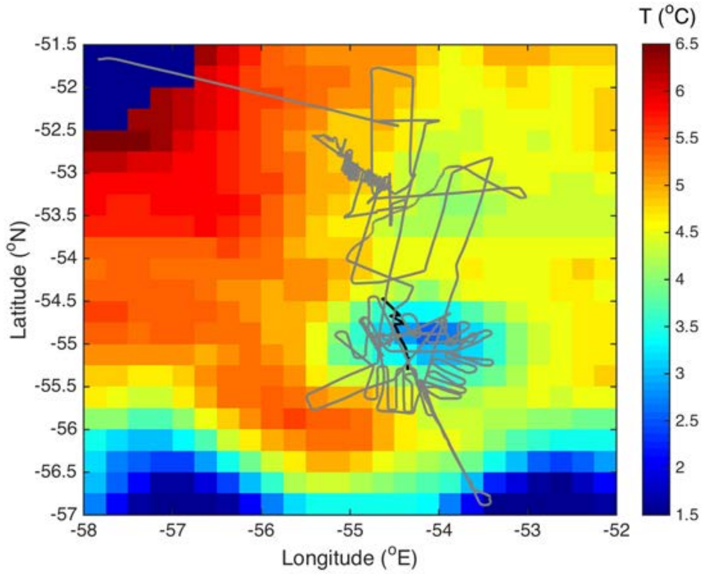

Figure 3.24. Cruise track to 23.59, 14th May.

Friday 15th May
The final CTD was completed at 05.00 and we returned south to the front to undertake a survey of the submesoscale instabilities we'd seen in the only SST pass we have available from May 11th. We chose the strategy of cross-frontal transects with MVP, which after some testing in the morning was shown to have been successfully repaired by the NMFSS technicians.

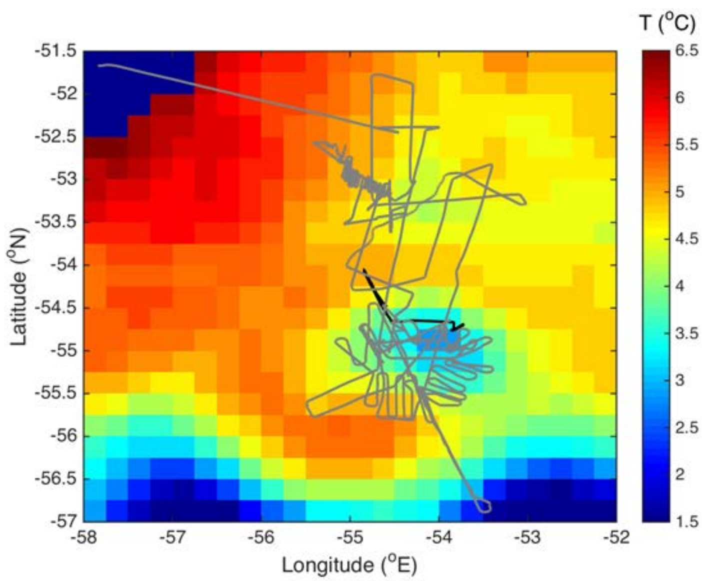

Figure 3.25. Cruise track to 23.59, 15th May.

We took up position on the north-eastern sector of the eddy and commenced short (6km) cross-stream transects after checking the fish wasn't trailing under the vessel. By the evening the results already revealed the sampling of the isopycnal undulations as they passed along the front. Our plan is to continue throughout the night and into tomorrow, weather depending. Currently conditions are good, with light winds and a gentle swell from the north.

Saturday 16th May
The sea built throughout the night and was surprisingly marginal by 09.00. The dye release (3) was postponed and we decided to recover the wave buoy in the centre of the eddy before conditions worsened with the end of the cruise approaching. The buoy was recovered without issue and the wind died a little on our return back to the front where we arrived around 17.00 after deploying a further 2 drogued drifters half way from the eddy centre. By 19.00 we started MVP profiling whilst holding station in the frontal jet, driving the fish down rather than allowing it to free fall. Wind is light in the evening but expected to be 30 knots+ by the morning.

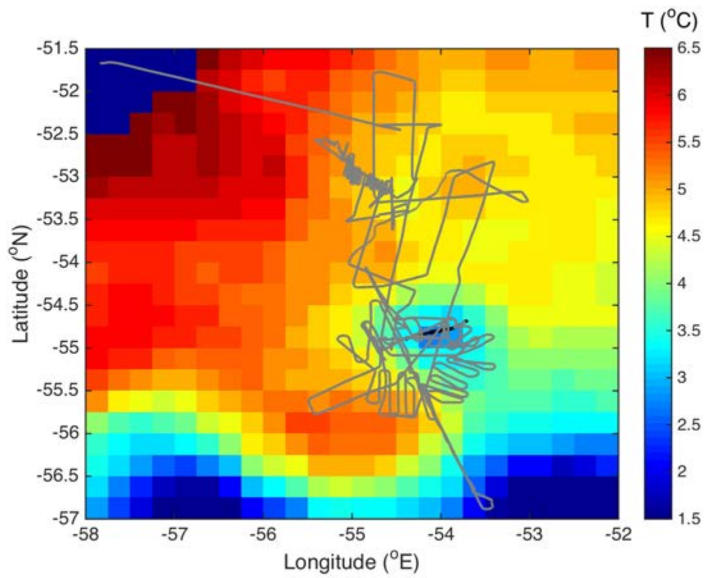

Figure 3.26. Cruise track to 23.59, 16th May.

Sunday 17th May
MVP was recovered at 05.30am due to worsening conditions, which had reached 30+knots by breakfast. The westerly wind built the sea up so there was little chance of profiling throughout the day. The final three drifters were equipped with a single temperature sensor and deployed on the northwestern sector of the eddy at 17.00 - 18.00 and the final dye

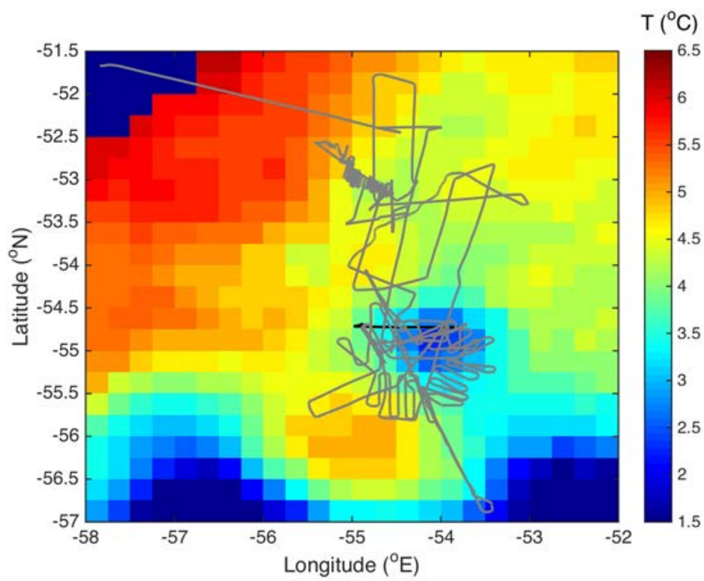

Figure 3.27. Cruise track to 23.59, 17th May.

release at 19.00. We were hove to throughout the night whilst the wind dropped although the swells rolled the ship continuously.

Monday 18th May
A number of transects were completed with MVP across the front in the northeastern sector of the eddy and several efforts were made to hold station. Winds increased throughout the day from the southwest, different to the otherwise northerlies we've encountered throughout the cruise. By the end of the day we'd made our way round to the eastern edge of the eddy where the three drifters we'd recovered the temperature sensors from the previous day had left the eddy to the south.

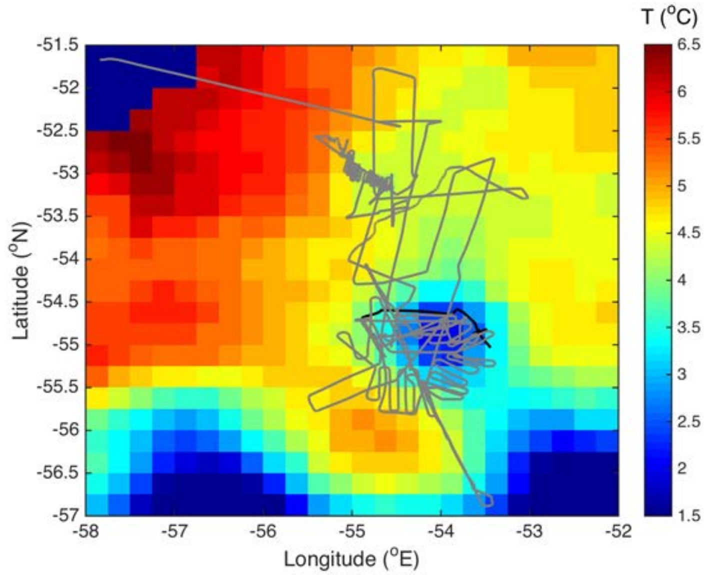

Figure 3.28. Cruise track to 23.59, 18th May.

Tuesday 19th May
MVP was recovered at 05.30 due to deteriorating conditions. Winds reached 40 knots and swells were developing that led to the wire trailing underneath the ship and the ship being unable to hold station in the wind and current. We eventually steamed westward to the southern edge of the eddy to attempt a northward MVP transect that began around 21.00 following issues with the brake that were resolved. The transect was completed throughout the night in good conditions.

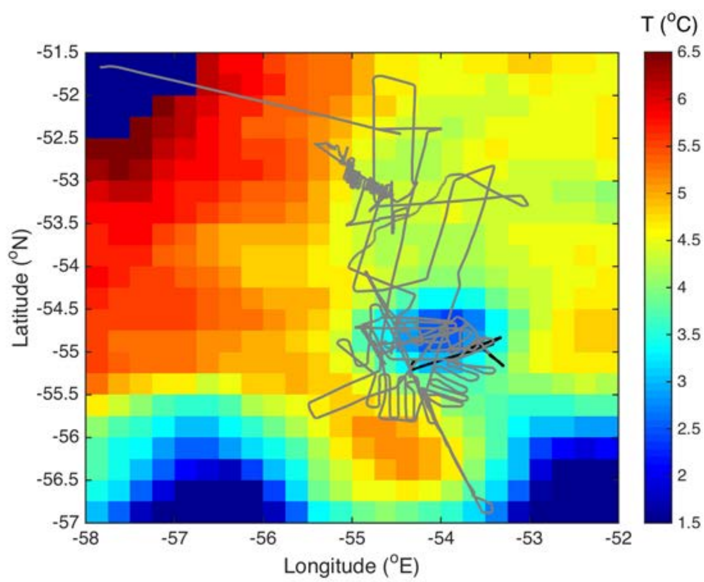

Figure 3.29. Cruise track to 23.59, 19th May.

Wednesday 20th May
After completing the northward MVP transect overnight we continued to the southeast corner of the eddy which was completed at 11.00, at which point we streamed the wire before recovering the fish and heading north. This was the end of science operations.

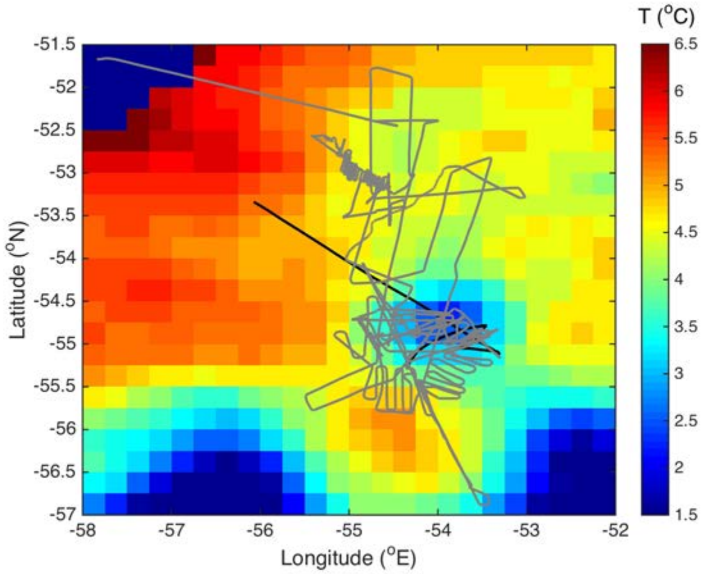

Figure 3.30. Cruise track to 23.59, 20th May.

4. SEASOAR SURVEYS

Dougal Mountifield, National Marine Facilities

4.1 SUMMARY

The new Seasoar 2012 system, first deployed on JC097, was used to implement a large area survey of a meander in the polar front, and subsequently the evolving meso-scale eddy, which was shed from the meander. 213 hrs (~9 days) was spent undulating on survey, covering over 1900 nm and completing nearly 1500 dives.

The SeaSoar package was towed at ~9knts with approximately 750m of flexnose faired 8.3mm conducting wire deployed in the water. Turn rates were limited to 5°/min to maintain undulation, or 10°/min to reduce turn times, and hence line separation, at the expense of good flight. Occasionally due to weather and sea-state, much higher turn rates were required. However, this is not recommended as operational practice, where avoidable, due to the increased risk of the wire fouling the vessel, or jumping a sheave.

Figure 4.1. Seasoar vehicle during deployment from the JCR

There were no operational, or instrumentation, issues during the cruise. The WETLabs DH4 data handler was configured to produce hourly data-files to minimise the risk of potential data loss. The core hourly datasets produced by the DH4 were extracted, converted, and merged using the WETlabs archive processing (WAP) software.

Three sets of merge files were produced by WAP for each hour: Main, Radiometers and Biolum. The 4Hz final merged pairs were copied to a separate area for clarity. Note that the GPS data and UBAT data are 1Hz. WAP copies lower rate 1Hz data through the 4Hz records until new data is available, hence there are 4 identical data lines for these fields in the data-files. WAP was used to calculate density and oxygen concentration. The algorithms used are not confirmed or validated, so it is recommended that these fields are re-calculated from raw data.

In addition to the main DH4/WAP archives, additional separate data products were produced by Seabird Seasave (16Hz raw hex secondary SBE49 FastCAT CTD data), CTG Fastpro (~0.25Hz CTG Fasttracka-II FRRF data) and Rolls-Royce ODIM LOPC host software (2Hz LOPC-660 data).

During the cruise an opportunity was taken to test a new version of the Rolls-Royce ODIM LOPC host software at our risk. The new version provides numerous additional features that we have requested from the manufacturers. The new version, which is currently in beta test, was tested extensively prior to deployment to develop sufficient confidence. No problems were encountered with the beta test version, and the additional pressure data which is now present in the LOPC data files will significantly reduce the burden of processing them. Prior to Tow 5, a CTG Unilux fluorescein fluorimeter was integrated into the SeaSoar vehicle. The Unilux was fitted to the BB channel, hence for Tow 5, a different DH4 and WAP configuration was used to log, extract and merge CTG Unilux data and thus no BB data is available.

4.2 Tow Distances & Time On-Survey

No trial-towing opportunities were available due to time constraints. The deployment time from system power-up, to first dive on survey, was approximately 40 minutes. The recovery time was of similar duration. Hence, each tow had a nominal overhead of 1 hour 20 minutes not profiling. For the five tows, a total of ~7hrs was incurred in deployment and recovery, a total of 3% of total Seasoar operation time.

Note that start and end survey times are for the start of first dive and end of last dive respectively. For start of deployment, time in water, time out of water and on deck times, please consult Bridge logs.

Tow	Start Survey	End Survey	Time on Survey /hrs	Distance on Survey /nm	Dive Depth /m	Dives
1	22/04/2015 18:01	25/04/2015 14:16	68.25	600	300 (224 dives) 200 (205 dives)	429
2	02/05/2015 04:54	03/05/2015 00:10	19.25	170	250	124
3	06/05/2015 02:43	06/05/2015 19:35	17	151	250	120
4	08/05/2015 03:32	08/05/2015 16:01	12.5	112	300	70
5	08/05/2015 21:46	12/05/2015 22:12	96.5	868	150 (30 dives) 175 (5 dives) 200 (618 dives) 350 (76 dives)	729

Table 4.1. Summary of key statistics relating to each of the Seasoar tows completed during JR311.

Figure 4.2. Deck set-up for Seasoar tow cable.

4.3 PROFILES AND DIVE DEPTHS AND PERIODS

A total of 1472 dive profiles were obtained, 2944 instrument profiles if dives and climbs are treated separately. As indicated in the table above, various dive depths were used throughout the tows, the maximum depth obtained was ~350m.

Dive Depth /m	Dives per Hour	Dive Period /min	Horizontal Resolution @ 9knts /m
200	8.25	7.27	2020
250	7	8.57	2381
300	5.5	10.91	3031
350	4.25	14.11	3920

Table 4.2. Summary of performance statistics from each of the Seasoar tows.

4.4 HYDROPLANE TRIM

The wing-trim was left as set since D369 with a 1 degree up-wing bias set on the push rods. This yields a range of 16 degrees up to 14 degrees down wing angle. Since the addition of the Rolls- Royce ODIM BOT LOPC-660 instrument, maximum dive depths have decreased from ~400m to 350m. This suggests that returning to neutral wing bias may be appropriate in the future. The future introduction into the NMEP of a new SeaSoar tow-body with newer style hydraulic units will be a good opportunity to re-assess hydroplane trim.

4.5 WINCH, WIRE AND FAIRING

In December 2014 a new tow-wire was installed on the SeaSoar winch, the existing serviceable fairing was installed by sliding on existing 2m sections and swaging new ferrules on. The 7 conductors in the core were insulation and continuity tested ok. In the New Year after the Christmas holiday, the conductors were tested once more in preparation for splicing on electrical cable tails at both ends of the wire. Two conductors failed insulation test to armour and to each other as a dead short at 250VDC. Low voltage tests indicated a shunt of the order of 10's to 100's of kΩ with a standard multi-meter.

The whole drum was visually inspected, but no sign of damage was seen. A few metres were removed from each end, but the problem remained. The inboard mechanical termination clamps were removed, but no improvement was observed.

The conductors were tested with a Time Domain Reflectometer (TDR) to estimate the location of the damaged insulation. The TDR tests were completed in bonded and floating conductor configuration with all TDR settings and filter configurations available. No clear reflection was observed as TDR and it was subsequently established that TDR cannot resolve the location of high impedance shunts.

The damaged wire was removed from the drum and chopped up to remove faring sections to retain for future use. A second new wire was installed, but new fairing was built on the wire during installation onto the drum. 90% of fairing was installed before the winch had to be shipped. The remaining 85m was installed during mobilisation in Port Stanley, FI. The second wire subsequently passed electrical tests and cable tail was spliced on the inboard end for junction box termination and the sea-cable tail spliced on to connect to the PENGUIN 2012 unit in SeaSoar.

A new oil cooler to cool the winch HPU was fitted prior to JR311. Due to the small tank, even in cold ambient temperatures, the winch requires seawater cooling to moderate system temperature.

A new load-cell panel meter display and repeater was fitted into the winch electrical control box prior to the cruise to replace a failed unit. The Vishay load-

cell amp and the panel meters were configured for 4-20mA output with a full-scale range of 3000 kg. The existing load-cell calibration coefficients were used with a spot check of the weight in air of the tow-fish to confirm validity.
The winch scrolled the faired cable perfectly, but the plough requires a very small adjustment to prevent it from striking the aluminium ferrules on the wire. Some sections of fairing were lost during the 5 deployments and recoveries, but the majority remained in-tact. Most fairing lost was near the surface with the full length deployed and was probably damaged by the sea in rough weather.

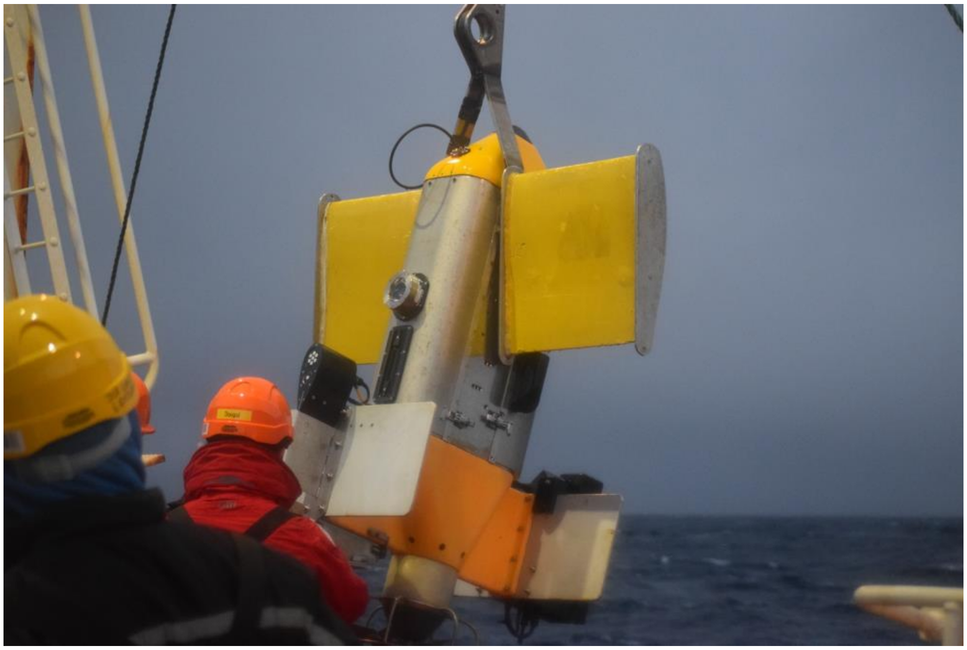

Figure 4.3. Seasoar during deck recovery

4.6 SEASOAR TOW-FISH CONFIGURATION

The current SeaSoar system architecture centres on the in-house PENGUIN 2012 unit. PENGUIN provides:

- 150VDC to 12/24/48V DC-DC power conversion (Vicor VIPAC array)
- 6 channels of switchable relay power (Moxa Iologik E1214 ethernet remote IO)
- SHDSL telemetry (Westermo DDW-120 g.SHDSL.bis ethernet modem)
- 3 axis MRU accelerometer, gyro and magnetometer (XSens MTi-300 AHRS)
- 8 port serial multiplexing (2 off Moxa IA-5450AI-T ethernet device servers)
- A bridge of the Moog servo-valve topside control current from Seacable to Hydraulic Unit

The SeaSoar fish was assembled with the hydraulic unit, PENGUIN 2012 (unit s/n PENGUIN 2012-2, with MRU s/n 03700034), WETLabs DH4 Data Handler (unit s/n 202) and the SeaSoar 2012 instrument suite.

Manufacturer	Model	Description	Serial Number	Mounting Position
Seabird	SBE50	Digital Oceanographic Pressure Sensor F Control Feedback	50-0242	Forward, centre top, beneath SBE5T
Seabird	SBE49	FastCAT CTD Integral Pump Primary Instrument	49-71842-0293	Forward, beneath wings, port-side
Seabird	SBE49	FastCAT CTD Integral Pump Secondary Instrument	49-72136-0292	Forward, beneath wings, startboard-side
Seabird	SBE43	Dissolved Oxygen Sensor Profiling Membrane Primary Instrument	43-2539	Forward, port- side top
Seabird	SBE43	Dissolved Oxygen Sensor Profiling Membrane Secondary Instrument	43-2540	Forward, starboard-side, top
Seabird	SBE5T	Submersible Pump For both SBE43s 3000rpm	5T-6877	Forward, centre top, above SBE50
WETLabs	FL3	Triplet Fluorimeter Chlorophyll 0.025-50ug/l Excitation 470nm (Blue) Emission 695nm (Red) Phycoerythrin 0.09-175ppb Excitation 540nm (Green) Emission 570nm (Green/Yellow) CDOM 0.28-375ppb Excitation 370nm (UV) Emission 460nm (Blue)	2956	Centre, underside optics gondola, aft aperture, beams pointing aft
WETLabs	FLNTU rtd	Combined Chlorophyll Fluorimeter and Turbidity Sensor Du Sources Single Detector 140° Acceptance Angle Chlorophyll 0.025-50ug/l Excitation 470nm (Blue) Emission 695nm (Red) Turbidity 0.01 – 100NTU 700nm (Red)	2952	Centre, underside optics gondola, port-side aperature, beams pointing to port
WETLabs	BB rtd	Backscatter Sensor 117° Acceptance Angle 650nm 0.003-5m^{-1}	1026	Centre, underside optics gondola,

				starboard-side aperture, beam pointing to starboard
WETLabs	BAM	Beam Transmissometer 650nm 10cm Path-length ~1° Acceptance Angle Temperature Compensated	172R	Aft, Top through cover aperture.
WETLabs	UBAT	Underwater Bioluminescence Assessment Tool	029	Forward centre with flow from centre of SeaSoar nose.
Satlantic	Digital PAR	400-700nm Cosine Response, Linear Amplifier, 24bit ADC	0384	Aft, top in optics fairing on SeaSoar tail-fin.
Satlantic	OCR507 ICSW	7 Band Irradiance Radiometer Cosine Response 412/443/490/510/ 560/620/665nm	0235	Aft, top in optics fairing on Seasoar tail-fin
Satlantic	OCR507 R10W	7 Band Radiance Radiometer 10° Half-angle 412/443/490/510/ 560/665/683nm	0104	Centre, underside optics gondola, forward aperture.
Rolls-Royce ODIM BOT	LOPC-660	Laser Optical Plankton Counter 70x70mm Sampling Aperture 35 Element 1mm Width Laser Diode Linear Detector Array 128 Size Classes – 2Hz	10693	Aft, underside, slung below bottom tail-plane
Chelsea Technologies Group (CTG)	Fasttrack a -II	Fast Repetition Rate Fluorimeter 1cm^3 Sample Volume Ex/Em 470nm/685nm	07-6480-002	Centre, top, through cover aperture, forward of BAM

Table 4.3. Sensors mounted on Seasoar as deployed during JR311.

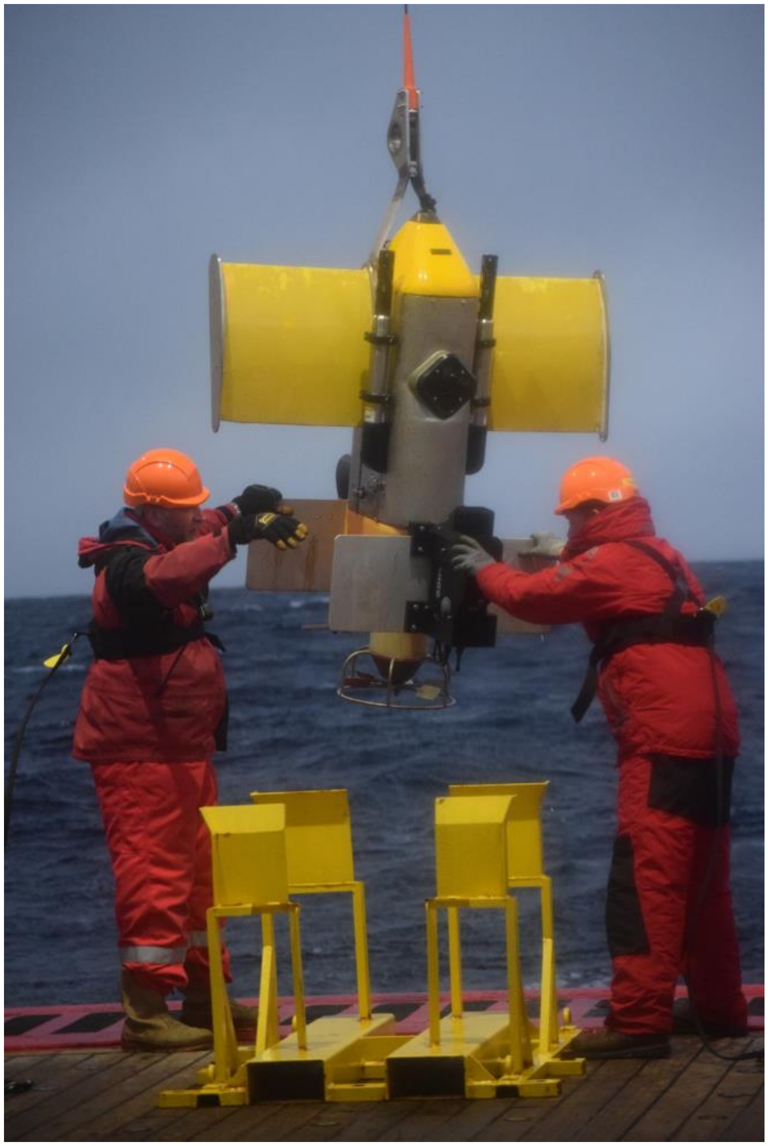

Figure 4.4. Seasoar deck cradle

4.7 PENGUIN 2012 INSTRUMENT CONFIGURATION

Instruments with complex data formats or which cannot be directly connected to the DH4 are multiplexed to the topside using the 8 serial ports in PENGUIN.

The Seabird SBE50 Digital Oceanographic Pressure Sensor is provided solely for flight control purposes and serves no scientific purpose. However it is a useful additional check on the validity of the pressure sensors in the two SBE49 FastCAT CTD instruments.

The DH4 can only log up to 4Hz with the attached suite, so the secondary CTD is logged by Seasave at 16Hz to provide a separate high resolution CTD data set which can be processed using the standard Seabird software suite. Real-time graphics displays are used in Seasave to show time- series, profiles and T-S plots of data for monitoring and data quality purposes. The Seasave Serial Out function is also used to subsample the 16Hz secondary CTD data to 4Hz for merging with the DH4 archive files using the PC Logger function in the DH4 Host Software.

The Rolls-Royce ODIM BOT LOPC and CTG Fasttracka-II data formats are too complex to log with the DH4, so the manufacturers host software is used to control, monitor and log these instruments. Hence separate data archives in manufacturer's proprietary format are provided for these two instruments.
The WETlabs UBAT is controlled and visualised using the manufacturer's provided software BLINC, but is logged by the DH4 Host Software PC Logger function.

The Satlantic Digital PAR is visualised by the manufacturer's software Satview, but is logged by the DH4 Host Software PC Logger function.

Logical COM Port	Virtual COM Port	Serial Port Settings	Instrument	Software Consumer
1	COM 11	RS-232 9600,8,n,1 CR-LF delimiter	Seabird SBE50 Digital Oceanographic Pressure Sensor	NMF-SS Seasoar Controller v1.3
2	COM 12	RS-232 115200,8,n,1 No delimiter Force Transmit 1ms	WETlabs DH4 Data Handler	WETLabs DH4 Host Software
3	COM 13	RS-232 9600,8,n,1 CR-LF delimiter	Secondary Seabird SBE49 FastCAT CTD 16Hz Raw Hex	Seabird Seasave v7.23.2
4	COM 14	RS-232 19200,8,n,1 CR-LF delimiter	Satlantic Digital PAR	WETLabs DH4 Host PC Logger In
5	COM 3	RS-232 115200,8,n,2 No delimiter Force Transmit 1ms	XSens MTI-300 AHRS MRU	WETLabs DH4 Host PC Logger In
6	COM 4	RS-232 19200,8,n,1 CR-LF delimiter	WETLabs UBAT Bioluminescence Sensor	WETLabs DH4 Host PC Logger In
7	COM 5	RS-422 115200,8,n,1 No delimiter	Rolls Royce ODIM LOPC-660 Plankton Counter	ODIM LOPC Host

		Force Transmit 1ms		
8	COM 6	115200,8,n,1 No delimiter Force Transmit 1ms	CTG Fasttracka-II Fast Repetition Rate Fluorimeter	CTG Fastpro Host

Table 4.4. Communication settings for Seasoar during JR311.

4.8 WETLabs DH4 Data Handler Instrument Configuration

The WETLabs DH4 interfaces with the core SeaSoar 2012 instrument suite to integrate these into the DH4 archive files via the DH4 Host software. These instruments along with additional ones integrated at the top-side with the DH4 Host software PC Logger function are logged in binary format with a ms resolution clock. These binary files are later extracted into separate instrument data files, converted into engineering units and merged into final data files using the WETLabs Archive Processing (WAP) software.

DH4 Physical Port	WAP DH4 Logger Port ID	Port Settings	Instrument	Measurand	Data Rate
1	21	ASCII 9600,8,n, 1	Primary Seabird SBE49 FastCAT CTD Converted Decimal Output	Temperature °C Conductivity S/m Pressure dbar Salinity PSU	4Hz
2	22	PORT NOT FITTED	N/A	N/A	N/A
3	23	ASCII 19200,8,n ,1	WETLabs FL3 Triplet	Chlorophyll CDOM Phycoerythrin	4Hz
4	24	ASCII 19200,8,n ,1	WETLabs FLNTUrtd	Chlorophyll Turbidity	4Hz
5	25	ASCII 19200,8,n ,1	WETLabs BAM	Beam attenuation coefficient	4Hz
6	26	ASCII, 19200,8,n ,1	WETLabs BBrtd	Backscatter	4Hz
7	27	BINARY 57600,8,n ,1	Satlantic OCR-507-ICSW Irradiance Radiometer	7 band Ed Irradiance	4Hz
8	28		Satlantic OCR-507-	7 band Lu	

		BINARY 57600,8,n ,1	R10W Radiance Radiometer	Radiance	4Hz
9A	29	Analogue 0-5VDC	Primary Seabird SBE43 Dissolved Oxygen Sensor	Dissolved Oxygen Saturation	4Hz
9B	29	Analogue 0-5VDC	Secondary Seabird SBE43 Dissolved Oxygen Sensor	Dissolved Oxygen Saturation	4Hz

Table 4.5. Wetlabs DH4 settings and sensor inputs

4.9 WETLABS DH4 HOST PC LOGGER CONFIGURATION

The WETLabs DH4 Host Software provides a PC Logger function to enable the integration of further instruments into the DH4 archive files via top-side serial data feeds. The PC Logger function can also be configured to provide additional top-side serial data outputs of instruments that are physically connected to the DH4 in the SeaSoar tow body. These outputs can be used in conjunction with manufacturer's software to provide a real-time display of key instruments for monitoring and data quality control purposes.

PC Logger Virtual Port	PC Logger Direction	WAP DH4 Logger Port ID	Serial Port Settings	Instrument	Measurand	Data Rate
1	OUTPUT to Satview for Data Display via Topside MOXA	27	Topside MOXA COM 15 Binary 57600,8,n, 1	Satlantic OCR-507-ICSW Irradiance Radiometer	7 band Ed 24-bit raw ADC counts	4Hz
2	OUTPUT to Satview for Data Display via Topside MOXA	28	Topside MOXA COM 17 Binary 57600,8,n, 1	Satlantic OCR-507-R10W Radiance Radiometer	7 band Lu 24-bit raw ADC counts	4Hz
3	INPUT Direct from PENGUI N	13	PENGUIN MOXA B COM 3 ASCII 115200,8,n ,2	XSens MTI-300 AHRS $PRDID	Roll Pitch Heading	4Hz

4	INPUT Vessel Provided via Topside MOXA	14	Topside MOXA COM 9 ASCII 9600,8,n,1	Vessel GPS Navigation Feed $GPRMC	UTC Time Latitude Longitude SMG CMG Date	1Hz
5	INPUT From Seasave Serial Out via Topside MOXA	15	Topside MOXA COM 26 ASCII 9600,8,n,1	Seabird SBE49 FastCAT CTD Converted Data Output Averaged from 16Hz	Temperature °C Conductivity S/m Pressure dbar Salinity PSU	4Hz
6	INPUT Direct from PENGUIN	16	PENGUIN MOXA A COM 14 ASCII, 19200,8,n,1	Satlantic Digital PAR	400-700nm PAR µmol m^{-2} s^{-1}	4Hz
7	INPUT Direct from PENGUIN	17	PENGUIN MOXA B COM 4 ASCII 19200,8,n,1	WETLabs UBAT Underwater Bioluminescence Assessment Tool	Pump & Flow-meter rpm, Raw 60Hz PMT detector ADC Counts & 1Hz Average Bioluminescence Photons s^{-1}	1Hz
8	OUTPUT to Ecoview for Display via Topside MOXA	18	Topside MOXA COM 27 ASCII 19200,8,n,1	WETLabs FLNTU	Chlorophyll Fluorescence Turbidity	4Hz
9	INPUT	19	Internal feature in DH4 Host Software	PC UTC Time NTP Synchronised with Meinberg NTP Client	UTC Time/Date	4Hz

Table 4.6. PC logging details for WETlabs DH4 host.

4.10 Top-side MOXA Nport 5650-16 Configuration

The Top-side MOXA is a 16-port RS-232/422/485 ethernet serial device server. It is used in the SeaSoar 2012 system to redistribute and patch various instrument data feeds for display and monitoring purposes. It is also used to connect vessel provided GPS Navigation, Gyro, Speed log and echo-sounder NMEA streams and broadcast them on the SeaSoar private VLAN network for use by many software programs used in the SeaSoar system. On JR311 the UDP broadcast was also used for the MVP-300 system by connecting the MVP PC to the SeaSoar private VLAN during MVP work. At present all 16 ports are configured in RS-232 mode. Where CR-LF termination characters are not present, force transmit is set to 1ms to minimise packetisation latency.

Moxa Physical Port	Mapped RealCOM Port	Moxa Port Identifier	Moxa Port Settings	Description
1	COM 15	PCLoggerOut1	57600,8,n,1	DH4 Host PC Logger Output of OCR-507 ICSW Linked to Port 2 for Satview
2	COM 16	ICSW_Satview	57600,8,n,1	OCR-507 ICSW Feed to Satview
3	COM 17	PCLoggerOut2	57600,8,n,1	DH4 Host PC Logger Output of OCR-507 R10W Linked to Port 4 for Satview
4	COM 18	R10W_Satview	57600,8,n,1	OCR-507 R10W Feed to Satview
5	COM 19	NAV_LISTEN1	9600,8,n,1	UDP Listen for GPS Navigation from Port 10. Linked to port 6 for LOPC Host GPS Nav Feed
6	COM 9	$GPRMC_OUT	9600,8,n,1	GPS Navigation feed to LOPC Host Software
7	COM 21	NAV_LISTEN2	9600,8,n,1	UDP Listen for GPS Navigation from Port 10. Linked to port 8 for Seasave Nav Feed
8	COM 22	$GPRMC_OUT	9600,8,n,1	GPS Navigation feed to Seasave
9	COM 23	$SDDBS	9600,8,n,1	RS-232 PES Feed from Vsl Moxa UDP Broadcast on SeaSoar Private Network
10	COM 24	$GPRMC_IN	9600,8,n,1	RS-232 Nav Feed from Vsl Moxa UDP Broadcast on SeaSoar Private Network
11	COM 25	Seasave_Out	9600,8,n,1	Secondary CTD Serial Out from Seasave at 4Hz Linked to Port 12 for DH4 Host PC Logger In
12	COM 26	SEASAVE_IN	9600,8,n,1	Secondary CTD feed for

				DH4 PC Logger In
13	COM 27	PCLoggerOut8	19200,8,n,1	DH4 Host PC Logger Output of FLNTU 15 for Ecoview
14	COM 28	$HEHDT	9600,8,n,1	RS-232 Gyro Feed from Vsl Moxa UDP Broadcast on SeaSoar Private Network
15	COM 29	FLNTU_Ecoview	19200,8,n,1	FLNTU Feed to Ecoview
16	COM 30	$VMVBW	9600,8,n,1	RS-232 Log Feed from Vsl Moxa UDP Broadcast on SeaSoar Private Network

Table 4.7. Topside MOXA settings

4.11 SeaSoar 2012 Instrumentation Suite

There follows below a brief description of individual instruments in the SeaSoar instrument suite, along with configuration details and comments on data fields. For further information, please refer to the manufacturer's data sheets, manuals, and other technical documentation included in the main cruise data archive.

Seabird SBE50 Digital Oceanographic Pressure Sensor

The SBE50 is used solely for the feedback control system in the NMF-SS SeaSoar Controller software. The instrument was configured to output converted ASCII pressure in dbar at 1Hz.

SBE 50 V 1.0d SERIAL NO. 0242
number of scans to average = 16
start sampling on power up = yes
output format = decibars, 2 decimals

Seabird SBE49 FastCAT CTD (Primary & Secondary Instruments)

The primary unit was attached to the WETLabs DH4 and was configured to output converted ASCII data at 4Hz for direct incorporation in the DH4 archive files. The converted data was configured to have temperature and conductivity correction for temperature advance (for aligning temperature and conductivity in the flow), and cell thermal mass.

SBE 49 FastCAT V 1.3a SERIAL NO. 0293
number of scans to average = 4
pressure sensor = strain gauge, range = 1450.0
minimum cond freq = 3000, pump delay = 30 sec
start sampling on power up = yes
output format = converted decimal

output salinity = yes, output sound velocity = no
temperature advance = 0.0625 seconds
celltm alpha = 0.03
celltm tau = 7.0
real-time temperature and conductivity correction enabled for converted data

The secondary unit was attached to PENGUIN 2012 and was configured to output raw hex data at 16Hz for logging via Seabird Seasave software. Seasave was configured to output converted ASCII data at 4Hz for indirect incorporation into the DH4 archive via the DH4 Host Software PC Logger function. No corrections can be applied to this data by Seasave, hence advance and cell thermal mass corrections are not present in the secondary data in the DH4 archive. Further investigation is required to establish whether Seasave averages or sub-samples the 16Hz data when down-sampling to 4Hz in the Serial Out function.

SBE 49 FastCAT V 1.3a SERIAL NO. 0292
number of scans to average = 1
pressure sensor = strain gauge, range = 1450.0
minimum cond freq = 3000, pump delay = 30 sec
start sampling on power up = yes
output format = raw HEX
temperature advance = 0.0625 seconds
celltm alpha = 0.03
celltm tau = 7.0
real-time temperature and conductivity correction enabled, not applied to raw data

The general settings used for Seasave for the Secondary SBE49 FastCAT CTD were:

Scans to average: 1
NMEA position data added: Yes
NMEA device connected to PC: Yes
NMEA time added: Yes

The serial port settings used for Seasave were:

CTD serial port: COM 13
Serial Data Out port: COM 25
NMEA serial port: COM 22

The settings used for the Seasave 4Hz Serial Out data feed to DH4 PC Logger function were:

XML format: No

Serial Out time between updates: 0.25s
Temperature (ITS-90 deg C): 4 digits
Conductivity (S/m):   5 digits
Pressure, Strain Gauge (db:) 3 digits
Salinity, Practical (PSU): 4 digits

Seabird SBE43 Dissolved Oxygen (Primary & Secondary Instruments)
The SBE43 is a clark-cell electro-chemical polargraphic type with integral temperature sensor within the cell. The SBE43 is permanently polarised by a battery within the instrument. The instruments are fitted with a 0.5mil Teflon membrane for fast-response profiling applications. It produces an analogue 0-5VDC output which is proportional to temperature corrected oxygen current. Therefore the output is directly proportional to oxygen saturation. The SBE43 is fitted with a flow-through plenum chamber for use in a pumped system.

The two SBE43 oxygen sensors are mounted in the top forward end of the SeaSoar body directly behind the nose section. The intakes for the sensors penetrate the nose moulding either side of the tow-cable entry to the vehicle. Due to space constraints, the sensor exhausts are connected via balanced tubing lengths and a T-fitting to a single SBE5T pump which is factory configured to pump at 3000rpm (winding #3) which will induce a flow of approximately 25ml/s through each SBE43 plenum chamber.

Due to space constraints it was not possible to mount the SBE43's in-line with the SBE49 FastCAT CTD flow-through plumbing. When calculating oxygen concentration from the SBE43 oxygen saturation output, one of the two SBE49 CTD data sets must be selected to establish oxygen concentration at saturation in-situ. At the normal tow-speed of SeaSoar, the flow over the vehicle will introduce errors in oxygen concentration in high thermal gradients due to the physical separation of the intakes for the CTDs and oxygen sensors. Further investigation and analysis is required to establish the most appropriate CTD to use for each oxygen sensor to minimise errors in oxygen in the thermocline.

Figure 4.5. Seabird 43 Oxygen sensor

WETLabs FL3 Triplet Fluorimeter

The WETLabs FL3 is a 'Triplet' fluorimeter with a separate LED light source and detector for each of its three channels from a single optical face. The channels are Chlorophyll (Blue), CDOM (UV) and Phycoerythrin PE (Green). The instrument produces an ASCII serial output with raw 12-bit ADC counts for each channel. Later conversion by WAP produces concentration estimates for Chlorophyll in µg/l with CDOM and PE in ppb. The FL3 is configured to sample at 4Hz.

Figure 4.6. Wetlabs triplet fluorimeter

WETLabs FLNTU Combined Chlorophyll Fluorimeter and Turbidity Sensor
The WETLabs FLNTU is a two channel instrument that has a separate LED light source for each channel, but a single shared detector. The channels are Chlorophyll fluorescence and Turbidity. The instrument produces an ASCII serial output with raw 12-bit ADC counts for each channel. Later conversion by WAP produces a Chlorophyll concentration estimate in µg/l and Turbidity in NTU. The FLNTU is configured to sample at 4Hz.

WETLabs BB Backscatter Sensor
The WETLabs BB is a single channel LED light-source backscatter instrument. The instrument produces an ASCII serial output of raw 12-bit ADC counts. Later conversion by WAP extracts total and particle only estimates for Volume Scattering and Backscattering Coefficients. The BB is configured to sample at 4Hz.

WETLabs BAM Beam Attenuation Meter
The WETLabs BAM is a compact, temperature corrected, 10cm path-length beam transmissometer. The BAM employs an LED light source. The instrument produces an ASCII serial output of raw 14-bit ADC counts for source-reference, signal, temperature corrected signal, calculated beam attenuation coefficient c, and internal thermistor raw count. Later extraction by WAP leaves the calculated beam attenuation coefficient c in the final data files. The BAM is configured to sample at 4Hz.

WETLabs UBAT Underwater Bioluminescence Assessment Tool
The WETLabs UBAT is an instrument for measuring light flux in a dark chamber due to bioluminescent emission. It consists of a reflective integrating measurement chamber with a photo- multiplier tube (PMT) as the detector. The inlet to the chamber is an S shaped light baffle with a pump inducing flow and acting as an agitator to the bioluminescent material. The outlet features a calibrated flow meter and a helical light-baffled exhaust. The instrument samples at 60Hz and produces an serial ASCII data output at 1Hz. The raw PMT 60Hz ADC values, pump speed, flow- meter speed and current PMT gain value are included in the data output along with an integrated calibrated 1Hz average of the 60Hz raw data. As the flow meter is calibrated and the sample volume is known, applying the volume flow-rate to the photon flux yields Bioluminescent Potential with units of photons l^{-1} s^{-1}. The UBAT data is integrated into the DH4 archive files with the PC Logger function and is latter extracted by WAP to form a 'Biolum' data set including CTD and PAR data.

Satlantic Digital PAR
The Satlantic Digital PAR sensor has a cosine response detector and is produces a unity sensitivity from 400-700nm. The sensor has a 24-bit ADC which has sufficient dynamic range to enable the use of a linear detector amplifier. The instrument has an RS-232 ASCII output and produces raw ADC detector counts as the output. Later conversion by WAP produces PAR in μmol $m^{-2}s^{-1}$ in the data files. The Digital PAR is configured to sample at 4Hz.

At the start of Tow 5 the Digital PAR sensor spontaneously changed its serial number from 0384 to 4278190464. Whether this is a firmware bug or a more serious problem with this unit is not known, but it continued to work well and aside from having to re-create a new .cal file for Satview, it was only a minor annoyance. No data was lost and the data quality did not deteriorate. The instrument will be returned to the manufacturer for assessment post-cruise.

Satlantic OCR-507 Radiometers
The OCR-507 Radiometers have 7 detectors with 10nm bandwidths.

ICSW – Cosine Response Water Corrected Irradiance Meter
The ISCW instrument is mounted in an up-looking orientation to measure down-

welling irradiance. The instrument outputs Ed Irradiance raw ADC detector counts at each of the 412, 443, 490, 510, 560, 620 and 665nm wavelengths. The ICSW is configured to sample at 4Hz. Later conversion by WAP produces Ed for each channel in μW cm^{-2} nm^{-1}.

R10W – 10 degree half-angle Water Corrected Radiance Meter
The R10W instrument is mounted in a down-looking orientation to measure upwelling radiance. The instrument outputs Lu Radiance raw ADC detector counts at each of the 412, 443, 490, 510, 560, 665 and 683nm wavelengths. The R10W is configured to sample at 4Hz. Later conversion by WAP produces Lu for each channel in μW cm^{-2} $nm^{-1}sr^{-1}$.

Rolls-Royce Naval Marine (ODIM BOT) LOPC-660 Laser Optical Plankton Counter
The instrument had firmware version 2.48 and DSP version 2.32. LOPC host software version 1.39 was used for Tow 1 only. LOPC host software version 1.40.1B Beta was trialled on Tow 2, and following the confirmation that no errors had been experienced, the Beta software was used for the remainder of the cruise (Tows 2-5). The beta software expands the number of serial ports available, allows integration of a CTD data feed into the LOPC data file at topside to allow depth binning and profiling. The 1.40.1B Beta software also allows periodic cycling of files.

We integrated the secondary CTD at 2Hz into the LOPC feed using the TCP/IP Out function in Seasave using the following settings in Seasave:

XML format: No
TCP/IP Out time between updates: 0.5s
Temperature (ITS-90 deg C): 4 digits
Conductivity (S/m): 5 digits
Pressure, Strain Gauge (db:) 3 digits
TCP/IP Converted Data Out Port: 49161

The following settings were used in the LOPC Host Software:

Serial Port Configuration
Main Serial Interface to LOPC: Port 5, 115200,8,n,1, no handshaking
Aux GPS/NMEA Input: Port 9, 9600,8,n,1, no handshaking
NMEA Sentence Logging: Sentence ID1 $GPRMC, CR, LF
Set Survey Latitude
Allow GPS Input to override: Yes
LOPC Firmware Version: 2.48
Installed Tunnel: Standard Tunnel
Instrument Input (CTD)
Select External Instrument: SBE49 FastCAT (Sea-Bird) 16Hz
Expected Output Format: OUTPUTFORMAT=3

Instrument Input Source: Input via TCP/IP
TCP/IP Connection
Host IP Address: 10.20.12.1
Host Port: 49161

Lat/long Parsing Configuration
Sentence ID: $GPRMC
Latitude: Field 4
Lat N/S Indicator: Field 5
Longitude: Field 6
Long E/W Indicator: Field 7
Time (UTC): Field 2

Data File Cycling
Use Automatic File Cycling: Yes
Cycle Files after Elapsed Time: 60 minutes

The LOPC Host data files are provided separately from the WAP archives as .bin binary files and .dat ASCII files.

CTG FASTtracka-II Fast Repetition Rate Fluorimeter
The FASTtracka-II is the short-lived mark II version of the long-serving and very obsolete FASTtracka. It is considerably smaller, more reliable and easier to use than the mark I. It has now been superceeded by the mark III or FASTOcean. The FASTOcean is very similar to the FASTtracka-II but adds an additional 2 wavelengths of light sources, green and orange. In the future the FASTOcean will be integrated into SeaSoar, but for the present, the FASTtracka-II is in use. Version (2.5.1) of the CTG FASTpro software was used. FASTpro was configured to output hourly files. PMT eht (receiver sensitivity) and LED drive (lamp intensity) were occasionally adjusted to suite the in-situ conditions. A PMT eht value of 500V and an LED drive of 35 offered good dynamic range through most of the chlorophyll conditions encountered. No PAR sensor was directly attached to the FASTtracka-II. The hourly FASTpro data files are provided separately from the WAP archives as .fnp files.

The protocol used in FASTpro was:

Sequences per acq: 64
Sequence interval: 30ms
Acquisition pitch: 0s
Saturation Fets: 100
Saturation interval: 1µs

This yielded 6400 flashes per acquisition which took 1.9s. Once the instrument had processed and telemetered the data, the period between curve-fits increased to ~4s. This was the only selected protocol.

FASTpro settings used were:

FRR COM Port: 6
FRR COM Baud rate: 115200
Dark chamber installed: No
Output synopsis data: Yes
FRR direct archive: Enabled
FRR direct archive: Duration (h) 1
Synchronise Time: Yes

Files and protocols were synchronised, then acquisition was started under instrument control with continuous acquisition with all active protocols.

At the end of each tow FASTpro does not write a time/date named .fnp file as normal in the Direct Archive function. Hence the DA.fnp buffer file was renamed in the same format as the Direct Archive files with the time/date in the filename. If this is not done, when the next acquisition is started up to one hour of data will be lost from the end of the previous acquisition.

CTG Unilux Fluorescein Fluorimeter

The CTG Unilux was provided by the PI as a dye tracing fluorimeter for the Rolls-Royce ODIM BOT MVP-300 system. However a the CTG Unilux was integrated into the SeaSoar instrument suite prior to Tow 5. The instrument had a range of 0-100ug/l and the Unilux serial output was used on the existing BB DH4 Channel having been set to sample at 3Hz. A new instrument cable was spliced, and a bracket made to mount the Unilux in a forward facing orientation underneath the bottom SeaSoar tail-plane beside the LOPC. The DH4 Host configuration was modified and a new.cal file was written for WAP to parse the data. Hence for the main WAP archives of Tow 5 only, column 20 is Fluorescein(ug/l), not bb(650).

XSens MTi-300 AHRS Motion Reference Unit (MRU)

Following a recent firmware update release by XSens to stabilise the heading of the MTI-300 AHRS, firmware version 1.4.1 of the MRU was applied during mobilisation. The MRU in PENGUIN was integrated into the DH4 dataset, for the first time, during the cruise, by configuring the MTI-300 to produce a $PRDID roll, pitch, heading NMEA message. The $PRDID message was parsed and recorded by the DH Host PC Logger function. This data is currently for engineering trial and development only and has not been extracted in the WAP archives provided. The intention is to use the MRU for correcting the radiometer data for sensor attitude in the future. ‘MT Manager’ from the XSens Software Suite 4.3 was used to visualise SeaSoar vehicle attitude in real-time for flight analysis. The data-logging feature of MT Manager was not used.

4.12 SYSTEM OPERATION

4.12.1 Tow-cable Electrical Characteristics

The tow-cable has a 7 core conducting bundle of 22AWG conductors. Two cores (one red, one clear) are used in parallel for the positive power feed, and one core (black) in addition to the armour as GND return. These leaves 4 cores remaining, one pair for SHDSL telemetry and one pair for the hydro-plane servo-valve control current loop.

The resistance of the power conductor loop in the tow cable was approximately 30 Ω including the deck cable. Total power supply current was found to be 0.6 A with 750m of wire streamed and the all systems switched on, inducing a tow-cable voltage drop of ~20V. The topside PSU voltage was set at 150VDC to yield approximately 130VDC at the fish end.

One possible future development includes increasing the tow-cable voltage to ~300VDC by replacing the VIPAC DC-DC converter module in PENGUIN with a different VIPAC model. This would reduce the load current and hence variability in voltage-drop in the tow-cable with changing electrical load.

4.12.2 Flight Control System

The in-house NMF-SS Seasoar Controller Topside Interface system and software developed in 2011 was used for the fourth time during JR311.
As before, peak control currents were <2mA and most of the time the current was of the order of 0.1mA. Tow cable tensions where smooth, and due to the shallower dive depths, peak tension was approx 1000kg, apart from in higher seas where vessel pitching created occasional peak loads of ~1300kg.
A new version of the control software is now being developed to significantly improve the user interface and to automatically create dive statistics for reporting use. The new version will also address a few known minor bugs.

4.12.3 PENGUIN 2012 and Instrument Suite Power-up

Once deployed in the water and whilst the tow-cable was being veered, PENGUIN 2012 was powered up by switching the main output of the Glassman LPC power supply on with a pre-set 150VDC line voltage.

After approximately 1 minute the SHDSL modems initiated line negotiation, and within another 30 secs the communications link is established. Pressure data from the SBE50 pressure sensor could then be confirmed to be streaming to the NMF-SS SeaSoar Controller software and MRU data streaming to MT Manager as these instruments have hard-wired power within PENGUIN 2012.
Occasionally the link negotiation would fail, but this was easily resolved by power-cycling both PENGUIN 2012 and the Top-side Interface Unit. Once the link was established the noise margin was of the order of 10db.

The PENGUIN 2012 instrument ports were then powered up using the web-interface to the MOXA Iologik relay module in PENGUIN 2012. Instruments were powered up in the following order:

1. Seabird SBE49 FastCAT CTD (Secondary)
2. Satlantic PAR

3. WETLabs UBAT
4. WETLabs DH4
5. Rolls-Royce ODIM LOPC
6. CTG Fasttracka-II FRRF2

All is now powered apart from the instruments which are connected to the WETLabs DH4. These get power from the DH4 later, when it is put into sampling mode, with the DH4 Host Software.

The WETLabs Blinc software was then connected to the UBAT instrument for monitoring purposes. Note that if the UBAT is run on deck for any reason, Blinc must be used to turn off the UBAT internal pump and the PMT detector to prevent damage to the pump and ageing of the PMT.

Sea-bird Seasave was then set to acquire and log data from the Secondary SBE49 FastCAT CTD, which also enables the Serial Output to the DH4 Host PC Logger function, and the TCP/IP output to the LOPC Host Software. The CTD data was then checked for validity.

The DH4 Host Software was then connected to the DH4 and the DH4 set to begin sampling. All DH4 instruments are now powered up and the Glassman load current was checked to be ~0.6A. Once running in sampling mode, all DH4 channels were checked for correct data format and rate and logging to hourly files was started. Note that if the DH4 is run on deck for any reason, the analogue channel 9 must be disabled to prevent damage to the SBE5T pump being incurred whilst running in air. If DH4 ports are disabled, the port does not receive power.

The LOPC host software is then used to start the instrument and log the data to disk, followed by the CTG Fastpro software for the Fasttracka-II FRRF. Data validity and rates are then confirmed for these instruments.

Finally, the PAR and OCR Radiometer data is checked in Satview.

4.13 SeaSoar Deck Deployment Notes

The Lebus deployment snatch-block was hung from the articulated arm on the after gantry of the RRS James Clark Ross. The articulated arm was positioned to give maximum headroom during deployment without the wire jumping off the top of the winch scrolling sheave. Once the SeaSoar vehicle was outboard the arm was repositioned to give maximum clearance from the transom during deployment and recovery.

Prior to deployment the Top-side Interface Unit was switched into over-ride to saturate the servo- valve in full hydroplane up position. Vessel speed was set to 4 knots through the water for deployment. Once the fish was in the water, about 50-100m of wire was payed out to clear the fish from prop wash. Whilst veering, the PENGUIN 2012 and instrument suite was powered up and logging started. Then vessel speed was increased to 6 knts to increase drag on the tow-cable. Once the full tow-cable had been deployed, with 5 turns left remaining on the drum, vessel speed was increased to a survey speed of 9 knts. Once at survey speed, the Top-side Interface Unit was switched into run and the NMF-SS SeaSoar Controller software set to undulate.

Prior to recovery, undulation was stopped with the NMF-SS SeaSoar Controller software and the Top-side Interface Unit was switched into over-ride to bring the fish to the surface. Once the fish was at the surface, the vessel speed was reduced to a 4knt recovery speed. Once outboard tow-cable tension was confirmed to be below 400kg, hauling was commenced. When 100m of tow-cable was left outboard, vessel speed was reduced to 2knts to reduce snatching and PENGUIN 2012 and instrument suite powered down. When the fish was close in sight hauling was stopped and vessel speed reduced to 0.5knt. When the wire was leading nearly vertically from the block, the fish was hauled out of the water and recovered to deck.

In heavy weather when deployment head to sea caused too much pitching of the vessel, deployments and recoveries were done stern to sea. The final haul out of the water was done at an increased speed of 1knt to prevent the wire leading under the transom, and was carefully timed to prevent a wave-induced strike of the SeaSoar vehicle against the transom.

4.14 FURTHER DOCUMENTATION

For further information please refer to the following NMF-SS provided documentation, that was included in the main cruise archive (JCR legwork):

1- ☐ JR311 Seasoar Sensor Information
2- ☐ JR311 Seasoar Configuration May 2015
3- ☐ SEASOAR 2012 System Notes DRAFT Feb 2014
4- ☐ Wetlabs DH4 Data Handler Data Files and Wetlabs Archive Easter SundayProcessing (WAP) Files
5- ☐ JR311 Seasoar Data Processing and Backup Checklist

5. MOVING VESSEL PROFILER AND LAGRANGIAN EXPERIMENTS

Kate Adams, Plymouth University

5.1 INTRODUCTION

During JR311 three Lagrangian Experiments were conducted. Each Lagrangian Experiment, hereafter LE, consisted of a fluorescein dye release streak at approximately 50-m water depth, a deployment of drogued drifters and a towed instrument survey. LE1 focused on a warm filament while LE2 and LE3 took place along a mesoscale meander/eddy feature in the ACC south of the Scotia Ridge (Figure 5.1).

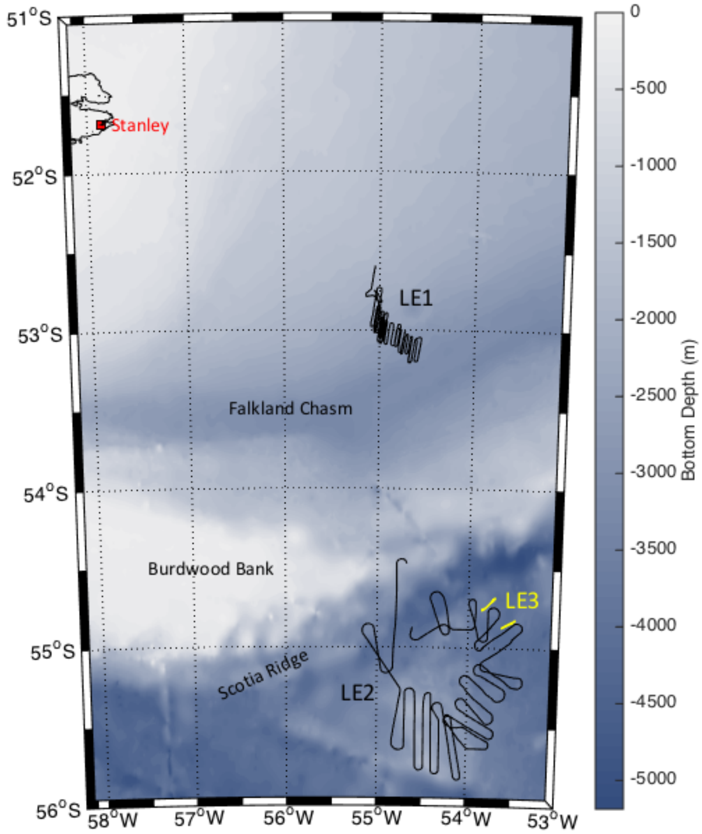

Figure 5.1. JR311 ship track map of Lagrangian Experiments located in the Southern Ocean southeast of the Falkland Islands with bottom bathymetry in background.

The two towed instruments used during JR311 included a Brooke Ocean Moving Vessel Profiler (MVP 300-1700) and SeaSoar (Figure 5.2) both supplied and operated by National Marine Facilities technicians. The MVP was deployed during LE1 and LE3. Due to a cable spooling issue, SeaSoar was used during

LE2. Metadata and sensor information for the SeaSoar legs is presented in Section 4.

Instrumentation installed on the MVP during JR311 is detailed in Table 5.1. Time, latitude and longitude variables are only collected at the beginning of each dive/climb pair.

A total of 1390 dives were completed during JR311.

Table 5.1. Details of MVP sensors during JR311

MANUFACTURER	MODEL	SN
Brooke Ocean Moving Vessel Profiler	MVP300-1700	10112
Small Multi Sensor Free-fall Fish	MSFFF-I	10114
Data Telemetry Module	DTM MUX	10217
AML	CTD	7027
Wetlabs	Flash Lamp Fluorometer	FLF-370S
Chelsea Technologies Group	Minitracka II Fluorimeter	175222
Chelsea Technologies Group	Unilux Fluoroscein	021
Satlantic	OCR507 R10W Radiometer	074
Satlantic	OCR507 ICSW Radiometer	136
PML Tilt & Roll	-	PMLTR02

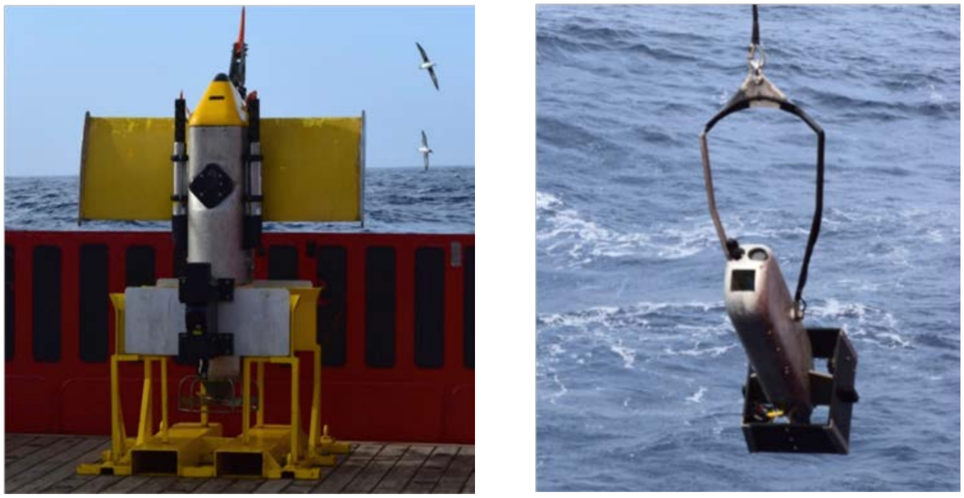

Figure 5.1. Towed instruments deployed for the Lagrangian Experiments during JR311, SeaSoar (left) and MVP (right).

5.2 LAGRANGIAN EXPERIMENT 1 (LE1)

The LE1 dye release occurred between 26 April 2015 13:05 and 14:25 GMT. During the dye release, instrumented drifters D01, D02 and D03 were deployed (see Section 8). The LE1 MVP survey began at 26 April 2015 22:30 GMT after the recovery of the wave buoy (Section 8). LE1 consisted of 33 MVP legs across a warm filament, Figure 5.3. MVP legs were organized into groups with the intention of each group representing a frozen field or 'snap shot' of water properties. The MVP groups followed the D01 and D03 drifters, however individual legs centered on the front.

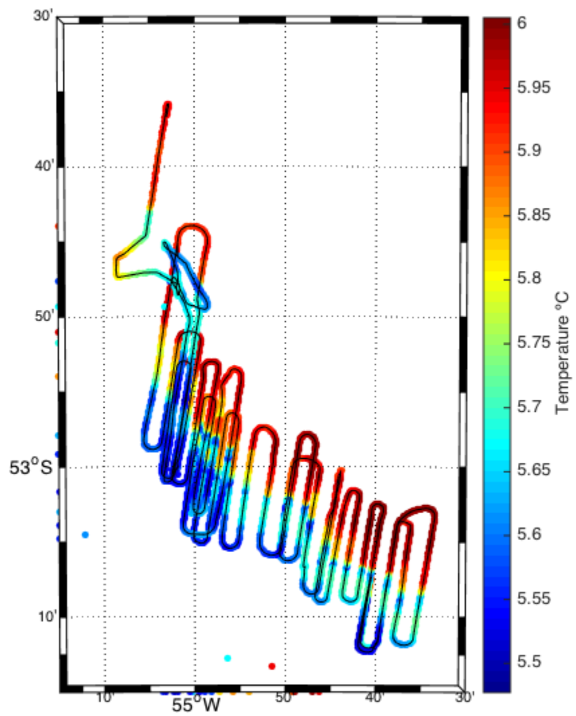

Figure 5.2. LE1 ship tracks with underway (4-m) temperature in color.

The MVP survey legs measured water properties across the front from 10 to 160 m of the water column (Figure 5.4). Measured quantities included temperature, conductivity, pressure, chlorophyll fluorescence, and fluorescein fluorescence. Radiometric data was also collected (see NMF technical report).

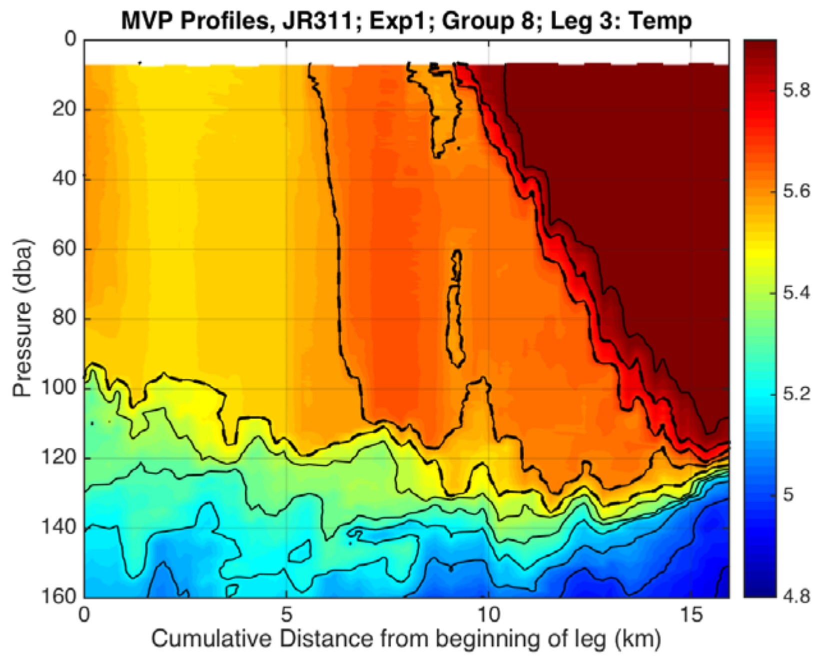

Figure 5.3. Vertical MVP cross-front temperature (ºC) leg during LE1.

5.3 Lagrangian Experiment 2

Measurements of an ACC meander/eddy were collected in LE2 (Figure 5.5). Due to a problem with the MVP winch spooling mechanism, SeaSoar was deployed during LE2 with the MVP fluorescein sensor installed. The dye release for LE2 occurred on 08 May between 18:21 and 18:37 GMT (54.9186ºS, 54.6868ºW). Un-instrumented drifters D01, D13 and D16 (see Section 7) were deployed during the dye release and subsequently used as Lagrangian markers for SeaSoar sections 17 to 46. See Section 4 for individual SeaSoar section information during LE2.

The start location for LE2 was chosen at the northwest edge of a cold meander in the ACC, however during LE2 this meander pinched off and became a closed cold-core eddy (Figure 5.6). The Lagrangian drifters tracks show a nearly-closed path indicating closed streamlines expected in an eddy. At the time of formation the eddy was approximately 60 km x 100 km.

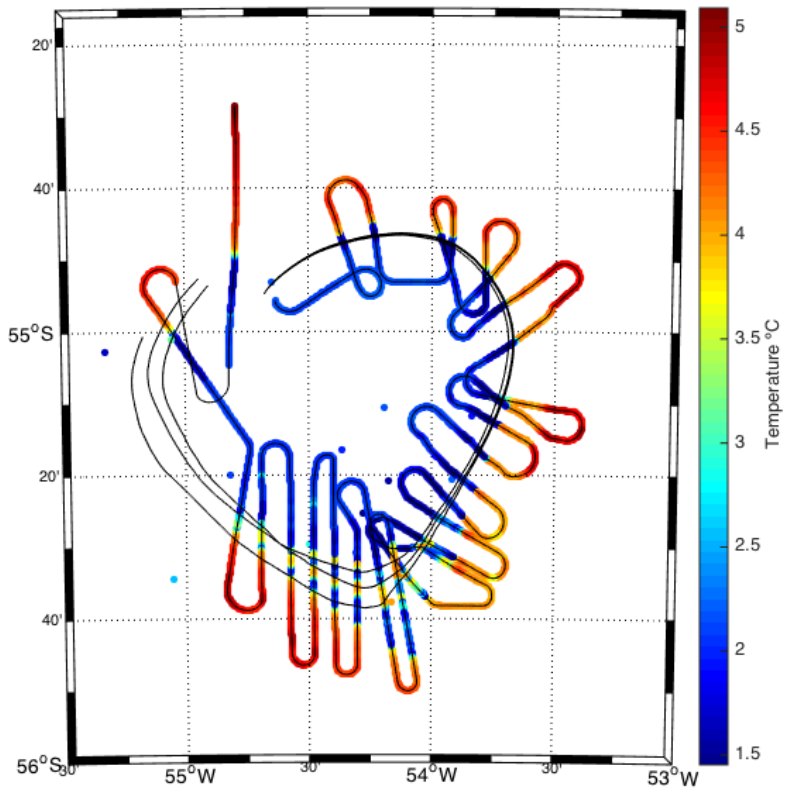

Figure 5.5. LE2 drifter tracks (black) and underway temperature ship track (colour) around a cold-core eddy.

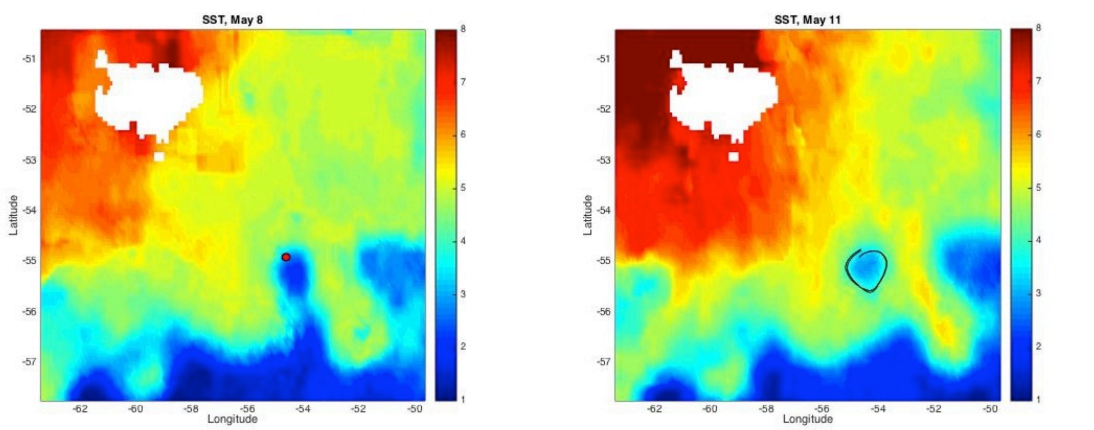

Figure 5.4. Microwave SST (ºC) images from 8 May (left) and 11 May (right). LE2 began on the edge of a cold ACC meander on 8 May (red circle). Drifter tracks (black) show the meander closed off to a cold-core eddy by the end of LE2.

5.4 LAGRANGIAN EXPERIMENT 3

The LE3 dye release occurred on 17 May between 22:18 and 23:07 GMT (54.6997ºS, 54.9048ºW) on the northeast side of the eddy sampled in LE2. Three drifters (D19, D20, D21) were deployed before the dye, each with a thermistor attached 1 m below the surface (Section 8). Due to sea conditions, deployment of the MVP was delayed. After one section the MVP was recovered due to a cable issue. Five MVP legs were completed following the tracks of the three drifters before conditions worsened and the MVP was recovered.

Prior to the third dye release (LE3), 20 cross-front MVP legs were collected at the northeast edge of the eddy sampled in LE2 (Figure 5.1). Due adverse weather conditions a NE (SW reciprocal) heading was required. These cross-frontal sections were repeated along the same line nearly hourly from 15 May 16:18 and 16 May 10:55 GMT (Figure 5.7).

Additionally, a stationary MVP survey of 98 casts was completed on the northeast edge of the eddy between 16 May 21:15 and 17 May 08:38 GMT. The purpose of this survey was to capture the temporal evolution, in an Eulerian reference frame, of small-scale frontal features on the eddy periphery. Drifter throughout the survey was less than 30m. Figure 5.8 shows the vertical temperature time series of the top 200 m of the water column with fluctuations of isotherms at the base of the surface mixed layer on the order of 3 hours and 30 m. The survey ended due to worsening weather conditions.

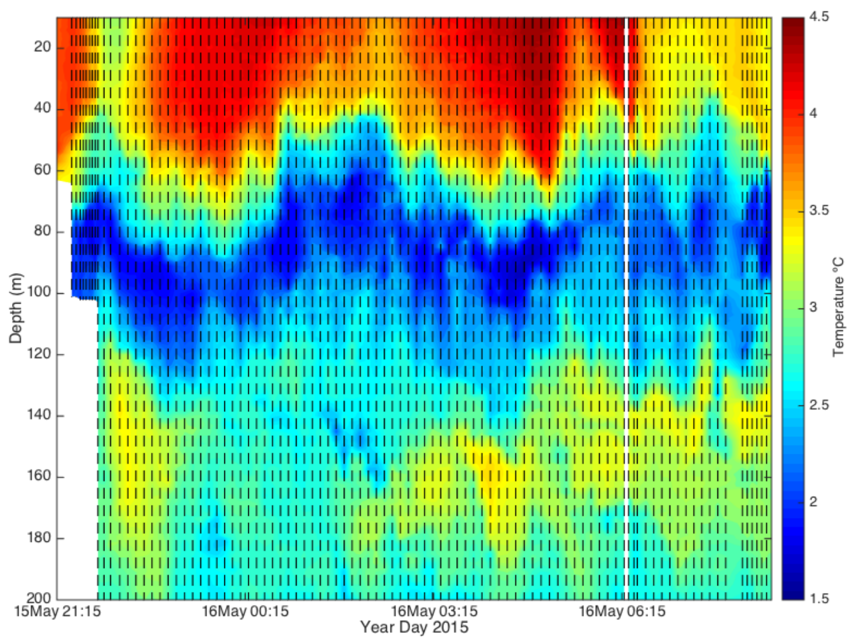

Figure 5.5. Vertical time series of temperature during the stationary MVP survey prior to LE3. Individual MVP casts are shown as dashed lines.

Note: all MVP data files during LE3 were named “Exp2” (Table 5.2) during the cruise since this was the second MVP Lagrangian survey.

Table 5.1. JR311 MVP survey information.

MVP line filename	mo	day	hour	min	sec	start lat	start lon	end lat	end lon
JR311_Exp1_Section1	4	25	21	24	46	53.6087	54.5552	53.0088	54.5357
JR311_Exp1_Section2	4	26	4	57	26	53.2557	54.5526	53.0092	54.5495
JR311_Exp1_Section3	4	26	8	9	27	53.2653	54.5549	53.1133	54.5542
JR311_Exp1_Section4	4	26	16	53	32	53.1587	54.6427	53.1473	54.5520
JR311_Exp1_Group1_Leg1	4	26	21	46	3	53.1826	54.6920	53.1226	54.6742
JR311_Exp1_Group1_Leg2	4	26	22	46	17	53.1880	54.6604	53.0784	54.6299
JR311_Exp1_Group1_Leg3	4	27	0	7	47	53.1749	54.6302	53.0718	54.6028
JR311_Exp1_Group1_Leg4	4	27	1	39	34	53.1871	54.5957	53.0781	54.5635
JR311_Exp1_Group2_Leg1	4	27	3	21	54	53.1946	54.6637	53.0659	54.6269
JR311_Exp1_Group2_Leg2	4	27	5	6	22	53.1909	54.6969	53.0609	54.6577
JR311_Exp1_Group2_Leg3	4	27	6	49	20	53.1422	54.6994	53.0488	54.6736
JR311_Exp1_Group2_Leg4	4	27	8	5	58	53.1364	54.7268	53.0526	54.7021
JR311_Exp1_Group3_Leg1	4	27	9	23	39	53.1314	54.7519	53.0345	54.7185
JR311_Exp1_Group3_Leg2	4	27	10	46	17	53.1391	54.7768	53.0396	54.7423
JR311_Exp1_Group4_Leg1	4	27	13	7	5	53.1244	54.7683	53.0159	54.7332
JR311_Exp1_Group5_Leg1	4	27	16	0	50	53.0970	54.7965	53.0145	54.7722
JR311_Exp1_Group5_Leg2	4	27	17	20	40	53.0808	54.8409	53.0015	54.8201
JR311_Exp1_Group6_Leg1	4	27	18	45	0	53.0920	54.8097	52.9836	54.7789
JR311_Exp1_Group6_Leg2	4	27	20	9	1	53.0802	54.8373	52.9722	54.8068
JR311_Exp1_Group6_Leg3	4	27	21	45	9	53.0814	54.8801	52.9826	54.8531
JR311_Exp1_Group6_Leg4	4	27	23	15	40	53.0782	54.9181	52.9642	54.8889
JR311_Exp1_Group7_Leg1	4	28	0	50	8	53.0751	54.9493	52.9609	54.9206
JR311_Exp1_Group7_Leg2	4	28	2	26	2	53.0699	54.9748	52.9476	54.9421
JR311_Exp1_Group7_Leg3	4	28	4	4	28	53.0708	55.0015	52.9365	54.9624
JR311_Exp1_Group7_Leg4	4	28	5	41	40	53.0536	55.0189	52.9277	54.9838
JR311_Exp1_Group8_Leg1	4	28	7	40	38	53.0615	54.9614	52.9166	54.9173
JR311_Exp1_Group8_Leg2	4	28	9	50	26	53.0383	54.9800	52.9219	54.9489
JR311_Exp1_Group8_Leg3	4	28	11	22	54	53.0403	55.0023	52.8988	54.9581
JR311_Exp1_Group8_Leg4	4	28	13	24	43	53.0003	55.0101	52.9048	54.9844
JR311_Exp1_Group9_Leg1	4	28	14	49	57	53.0067	55.0410	52.8993	55.0085
JR311_Exp1_Group9_Leg2	4	28	16	19	8	52.9887	55.0573	52.8922	55.0333
JR311_Exp1_Group10_Leg1	4	28	19	58	49	52.9909	55.0297	52.8739	54.9921
JR311_Exp1_Group10_Leg2	4	28	21	33	4	52.9648	55.0585	52.8631	55.0303

JR311_Exp1_Group10_Leg3	4	28	23	2	45	52.9644	55.0925	52.7650	55.0344
JR311_Exp1_Group10_Leg4	4	29	1	47	6	53.0082	55.0558	52.7585	54.9785
JR311_Exp1_Group11_Leg1	4	29	4	28	7	53.0010	55.0537	52.8420	55.0095
JR311_Exp1_Group12_Leg1	4	29	15	42	6	52.7567	55.0928	52.6107	55.0504
JR311_Exp2_Group1_Leg1	5	15	16	18	38	54.7412	53.8086	54.7196	53.7736
JR311_Exp2_Group1_Leg2	5	15	17	8	8	54.7475	53.8179	54.7121	53.7570
JR311_Exp2_Group1_Leg3	5	15	18	7	14	54.7436	53.8100	54.7088	53.7533
JR311_Exp2_Group1_Leg4	5	15	18	51	34	54.7554	53.8325	54.7092	53.7497
JR311_Exp2_Group1_Leg5	5	15	20	10	44	54.7450	53.8187	54.7064	53.7503
JR311_Exp2_Group1_Leg6	5	15	21	6	16	54.7459	53.8115	54.7094	53.7477
JR311_Exp2_Group1_Leg7	5	15	21	55	24	54.7465	53.8182	54.6995	53.7286
JR311_Exp2_Group1_Leg8	5	15	22	50	35	54.7416	53.8037	54.7046	53.7381
JR311_Exp2_Group1_Leg9	5	15	23	41	57	54.7417	53.8095	54.6973	53.7433
JR311_Exp2_Group1_Leg10	5	16	0	42	8	54.7428	53.8069	54.6976	53.7313
JR311_Exp2_Group1_Leg11	5	16	1	36	28	54.7473	53.8177	54.6967	53.7359
JR311_Exp2_Group1_Leg12	5	16	2	33	48	54.7336	53.7917	54.6947	53.7244
JR311_Exp2_Group1_Leg13	5	16	3	29	47	54.7325	53.7920	54.6911	53.7245
JR311_Exp2_Group1_Leg14	5	16	4	18	23	54.7463	53.8149	54.6897	53.7152
JR311_Exp2_Group1_Leg15	5	16	5	32	30	54.7482	53.8217	54.6895	53.7218
JR311_Exp2_Group1_Leg16	5	16	6	30	25	54.7473	53.8141	54.6872	53.7102
JR311_Exp2_Group1_Leg17	5	16	7	47	46	54.7500	53.8240	54.6948	53.7336
JR311_Exp2_Group1_Leg18	5	16	8	45	37	54.7387	53.7970	54.6935	53.7176
JR311_Exp2_Group1_Leg19	5	16	10	3	7	54.7415	53.8066	54.6912	53.7285
JR311_Exp2_Group1_Leg20	5	16	10	55	12	54.8251	54.1031	54.6891	53.7138
JR311_Exp2_Section1	5	16	10	55	12	54.8251	54.1031	54.6891	53.7138
JR311_Exp2_Section2	5	16	16	51	5	54.8829	54.3930	54.7334	53.8032
JR311_Exp2_Section3	5	16	21	15	54	54.7258	53.7838	54.7256	53.7835
JR311_Exp2_Section4	5	18	12	53	37	54.6316	53.8679	54.6029	53.8374
JR311_Exp2_Group2_Leg1	5	18	18	30	5	54.8664	53.6296	54.8379	53.5403
JR311_Exp2_Group2_Leg2	5	18	19	26	6	54.8687	53.6198	54.8424	53.5251
JR311_Exp2_Group2_Leg3	5	18	20	17	7	54.8702	53.6307	54.8277	53.5100
JR311_Exp2_Group2_Leg4	5	18	21	23	2	54.8593	53.5915	54.8292	53.4958
JR311_Exp2_Section5	5	18	22	40	49	54.9987	53.5867	54.8501	53.4685
JR311_Exp2_Section6	5	19	2	36	30	55.1022	53.4214	55.0597	53.3620
JR311_Exp2_Section7	5	20	0	55	5	55.2264	54.3239	54.7860	53.4909
JR311_Exp2_Section8	5	20	9	53	57	55.0871	53.7262	55.0512	53.3508

Table 5.3. Times of start and end of MVP tows and corresponding number of dive cycles.

TOW NUMBER	NO. OF DIVE CYCLES	START TIME	END TIME
1	14	25/4/2015, 18:40:58	25/4/2015, 19:29:26
2	119	25/4/2015, 21:24:46	26/4/2015, 04:43:23
3	50	26/4/2015, 04:57:26	26/4/2015, 07:56:31
4	27	26/4/2015, 08:09:27	26/4/2015, 09:47:00
5	10	26/4/2015, 16:53:32	26/4/2015, 17:26:38
6	170	26/4/2015, 21:46:03	27/4/2015, 11:48:01
7	18	27/4/2015, 13:07:05	27/4/2015, 14:15:18
8	314	27/4/2015, 16:00:50	28/4/2015, 17:21:48
9	122	28/4/2015, 19:58:49	29/4/2015, 05:51:32
10	24	29/4/2015, 15:42:07	29/4/2015, 17:10:06
11	216	15/5/2015, 16:18:38	16/5/2015, 13:57:35
12	37	16/5/2015,16:51:06	16/5/2015, 20:11:05
13	98	16/5/2015, 21:15:54	17/5/2015, 08:38:53
14	6	18/5/2015, 12:45:27	18/5/2015, 13:14:09
15	53	18/5/2015, 18:30:05	18/5/2015, 23:50:18
16	6	19/5/2015, 02:36:30	19/5/2015, 03:00:31
17	80	20/5/2015, 00:55:06	20/5/2015, 07:38:34
18	26	20/5/2015, 09:53:57	20/5/2015, 11:56:56

6. CTD REPORT

Jean-Baptiste Sallée, LOCEAN

6.1 INTRODUCTION AND AIMS

Twenty-four Conductivity-Temperature-Depth (CTD), 24-bottle rosette stations were occupied during cruise JR311 (See table below). This 24-cast survey had three main goals for the SMILES program:

- Give the hydrologic deep and wide water mass context, for analysis of the other components of the program, which mostly focused on surface-layer observations, e.g. SeaSoar, MSS, MVP.
- Provide calibration profiles for 11 floats (2 Bio-Argo, and 9 Argo) that have been deployed at CTD stations.
- Provide in-situ water measurement of the biological activity.

Table 6.1. CTD station locations and times during JR311

Cast nb	Longitude	Latitude	Time	Max Pressure
1	-54.3075	-53.0885	01/05/2015	3009.6887
2	-54.3005	-53.0752	01/05/2015	3003.2741
3	-54.2888	-53.0617	02/05/2015	2029.7061
4	-54.7202	-55.0207	07/05/2015	2029.0183
5	-54.6333	-55.1418	07/05/2015	2029.4257
6	-54.7637	-54.9398	07/05/2015	2027.4833
7	-54.7915	-54.8987	07/05/2015	2029.2435
8	-54.8173	-54.8565	07/05/2015	2031.0315
9	-54.8975	-54.7218	07/05/2015	2029.3207
10	-54.77	-54.9382	07/05/2015	2013.0163
11	-53.4248	-56.7785	12/05/2015	2019.608
12	-53.6455	-56.668	13/05/2015	2029.6258
13	-53.923	-56.1008	13/05/2015	2029.6666
14	-54.1343	-55.6673	13/05/2015	2027.3499
15	-54.2122	-55.433	13/05/2015	2029.3655
16	-54.2817	-55.2872	13/05/2015	1971.6195
17	-54.3318	-55.1635	14/05/2015	2029.7755
18	-54.3688	-55.0663	14/05/2015	2029.2978
19	-54.4262	-54.949	14/05/2015	2029.8731
20	-54.4933	-54.7685	14/05/2015	1992.1318
21	-54.5448	-54.6713	14/05/2015	1979.5022
22	-54.6343	-54.469	14/05/2015	1887.732
23	-54.7583	-54.2122	15/05/2015	1621.5809
24	-54.843	-54.0537	15/05/2015	1927.815

6.2 General comments significant events

- The Conductivity sensor 2 was very spiky on the first profile. After the first profile it was much more stable. In general the two conductivity and temperature sensors have been very stable (except for this first profile for conductivity 2).
- The line allowing firing the Niskins on Niskin 8 broke and was replaced.

6.3 Instruments and system specification

See appendix for the full list of instruments and calibration coefficient.

6.4 Sensor Failures

There were no CTD sensor failures during the cruise.

6.5 Salinity sampling

Discrete salinity samples were taken throughout the cruise for two purposes: the calibration of CTD salinity profiles and the calibration of underway TSG data (see section 10). These were then analysed using a salinometer on board.

All samples were taken using 200 ml glass sample bottles with plastic lids, in cases of 24 bottles. Each bottle was labelled with a unique number, and in a uniquely numbered case. Log sheets were used to note the case number and bottle number of each sample taken. Bottles were filled in order to leave minimal air for evaporation to occur whilst leaving enough air to allow for adequate mixing of the sample before sampling, in order to counteract any stratification that may have developed. The bottle necks and lids were dried thoroughly before plastic caps, were placed inside the bottle necks immediately after sampling in order to seal the air within the bottles to counteract evaporation. Obviously the small amount of air sealed in the bottle will have caused a slight salty bias in all samples.

The CTD instrument contains a rosette of 24 niskins, closed at various depths during deployment in order to capture samples of water at those depths. For each CTD cast, the niskins to sample for salinity were decided in order to provide the best coverage of the salinity profile measured by the conductivity probe on the CTD. In practice, this normally meant sampling from the deepest niskins, the shallowest niskins, and some in the middle.

When sampling, the sample bottles were first rinsed a minimum of three times using the water from the niskin to be sampled. This was to minimise contamination of the sample from anything on the inside surface of the bottle. The bottle was then filled as described above, capped and replaced in the relevant case.

6.6 SALINITY SAMPLE PROCESSING

Once a case of sample bottles was full, it was transferred to the temperature-controlled laboratory, where it remained a minimum of 24 hours before being sampled. This was to ensure that all samples were at the same temperature on sampling for consistency of measurements. The temperature of the room was monitored and logged every ~4 hours as part of the underway data logging procedure. Salinity measurements were taken using a Guildline AutoSal Salinometer, model 8400B, s/n 65763. At the beginning of the processing, the machine was standardised using a bottle of IAPSO Standard Seawater, batch P157, conductivity ratio K15 = 0.99985, provided by OSIL. At the beginning and end of each sampling run, the standardisation was checked using a bottle of IAPSO Standard Seawater, batch P157, conductivity ratio K15 = 0.99985.

The salinometric analysis was carried out as per the manufacturers recommendations. The sample bottle to be measured was gently agitated by inversion 3 times to remove any stratification. Before any measurements were taken, the measurement cell was filled using the peristaltic pump and flushed three times with the relevant sample in order to avoid any contamination from previous samples. The analyst ensured that no bubbles were present in the cell before measuring the sample. The cell was flushed, filled and then measured a further two times in order to have a total of three measurements for each sample. This was repeated for each sample in the relevant crate. Once all samples in the crate had been analysed, another bottle of IAPSO Standard Seawater was analysed in the same way as a sample, in order to ascertain whether the Salinometer precision had remained the same throughout the sampling. All recorded measurements were converted into salinity using the Unesco algorithm for practical salinity (Unesco, 1980).

The accuracy of the results gained is improved by the time averaging and the three separate measurements for each sample. The standardisation check at the beginning and end of the crate gave an idea of how consistent the salinometer precision had been, which should be taken into account in error analysis. The temperature of the water bath in the Salinometer was kept at 24 degrees Celsius throughout the cruise. The temperature of the lab remained fairly constant throughout the cruise, although slight diurnal variations and the effect of the analyst being in the lab during the sampling process could not be avoided. This is not expected to affect the results as the water bath in the salinometer ensures consistency of sampling.

6.7 DATA PROCESSING: INITIAL PROCESSING USING SEABIRD PROGRAMS

The files output by Seasave (version 7.22) have appendices: .HEX, .HDR, .BL, .CON. The .CON files for each cast contain the calibration coefficients for the instrument. The .HDR files contain the information in the header of each cast file. The .HEX files are the data files for each cast, and are in hex format. The .BL files contain information on bottle firings of the rosette.

Initial data processing was performed on a PC using the Seabird processing software SBE Data Processing, Version 7.22. We used the following options in the given order:
• Data Conversion
• Cell Thermal Mass

Data Conversion turns the raw data into physical units. It takes the .CON and .HEX files and outputs a file called JR311nnn.cnv, where JR311 is a reference to the cruise, and nnn is the station number.

Cell Thermal Mass takes the .cnv files output from Data Conversion and makes corrections for the thermal mass of the cell, in an attempt to minimise salinity spiking in steep vertical gradients due to temperature/conductivity mismatch.

Example of configuration (cast 1) for the seabird program:

```
* Sea-Bird SBE 9 Data File:
* FileName = D:\Data\JR311\Raw Data\JR311_001.hex
* Software Version Seasave V 7.22.3
* Temperature SN = 5043
* Conductivity SN = 3491
* Number of Bytes Per Scan = 37
* Number of Voltage Words = 4
* Number of Scans Averaged by the Deck Unit = 1
* System UpLoad Time = May 01 2015 19:04:58
* NMEA Latitude = 53 05.31 S
* NMEA Longitude = 054 18.45 W
* NMEA UTC (Time) = May 01 2015 19:04:56
* Store Lat/Lon Data = Append to Every Scan
** Vessel: James Clark Ross
** Cruise: JR311
** Station Number:  001
** Lat 53 05.306 S
** Long 54 18.449 W
** Depth (EA60):  3001
** PSO: PH
** Operator: ST
* System UTC = May 01 2015 19:04:58
# nquan = 13
# nvalues = 179426
# units = specified
# name 0 = t090C: Temperature [ITS-90, deg C]
# name 1 = sal00: Salinity, Practical [PSU]
# name 2 = prDM: Pressure, Digiquartz [db]
# name 3 = c0S/m: Conductivity [S/m]
# name 4 = c1S/m: Conductivity, 2 [S/m]
```

name 5 = t190C: Temperature, 2 [ITS-90, deg C]
name 6 = sal11: Salinity, Practical, 2 [PSU]
name 7 = sbeox0Mm/Kg: Oxygen, SBE 43 [umol/Kg]
name 8 = flC: Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]

name 9 = timeS: Time, Elapsed [seconds]
name 10 = par: PAR/Irradiance, Biospherical/Licor
name 11 = scan: Scan Count

6.8 DATA PROCESSING: INITIAL PROCESSING USING MATLAB

Once pre-processed with the Seabird programs, we applied a series of processing steps using Matlab. Below is a list of CTD and bottle processing we applied to each cast:

1. Read CTD data from the cnv file and convert into mat file (read_cnv.m)
2. Average to 1hz, calculate practical salinity, and identify bottom, start and end of the cast (Average1hz.m)
3. Visually check 1Hz profiles using plots (profiles versus time) to detect any possible anomaly, and flag bad data, e.g. spikes (deskipe.m)
4. Extract downcast data from the “1Hz flagged file”, sort, interpolate gaps and average to 2dbar (Average2db.m)
5. Read the .BL file from seabird, merge time from ctd onto a bottle file using scan number, and compute each measured variable at fired bottle. Save into bottle files (ReadBottle.m)
6. Once salinity from the bottles were analyzed, data were copied into a file: Salinometer.csv
7. Salinity from Salinometer.csv were then paste into our bottle files (MergeBottleSalinometer.m)
8. Once chlorophyll from the bottles were analyzed, data were copied into a file: Fluorometer.csv
9. Analysed chlorophyll from Fluorometer.csv were then paste into our bottle files (MergeBottleFluorometer.m)
10. CTD chlorophyll and salinity were plotted against analysed salinity and chl to investigate possible calibration to apply to CTD measurements (PlotCTDvsSalinometer.m and PlotCTDvsFluorometer.m)
11. Calibration for Salinity and Chlorophyll were applied to 1hz_flagged files (ApplyOffsetSalinity.m ApplyOffsetFluorometer.m)
12. The series of function of steps 4, 5, 7, 9 were gone over again to apply offset to all appropriate files.
13. Once all station were processed, a unique Cruise file were created with the 2db version of profiles (Concat2db.m)

In a number of casts, localized small spikes have been detected on the salinity/conductivity profiles. As mentioned earlier, conductivity 2 of cast 1 was particularly spiky (see Figure 6.1).

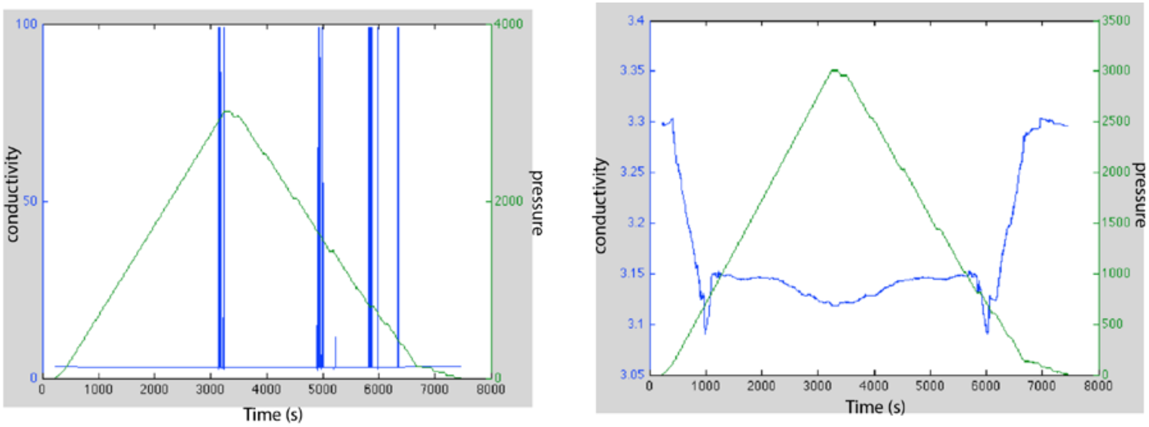

Figure 6.1. (left panel) example of spikes on the conductivity sensor (cast 1, conductivity sensor 2). (right panel) same profile once despiked.

6.9 CALIBRATION OF SALINITY

Between three and eight Niskins were sampled at all stations for salinity measurements. The salinity differences between bottle salinity and sensors 1 show a constant offset of 0.046 psu (see Figure 6.2). In contrast, sensor 2 has behaved very well all along the 24 casts. The salinity differences between bottle salinity and sensor 2 fall within +/- 0.002 psu with a median less than 0.001 (See Figure 6.2). We looked for pressure dependence and/or time dependence, but no clear trend pattern emerged.

We therefore chose to use data from sensor 2. We also applied an offset of +0.046 to sensor 1, though the data from sensors one were not used in the 2db profiles.

NB: the calibration was applied to salinity, not conductivity.

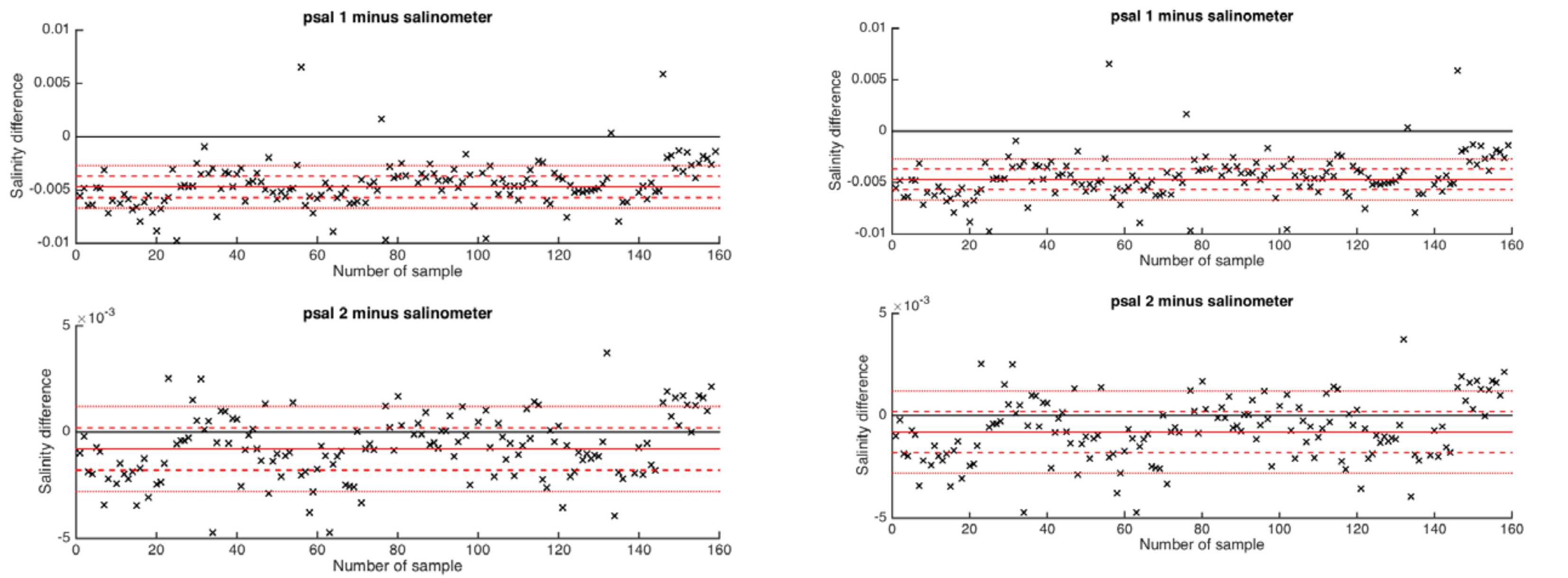

Figure 6.2. Salinity calibration: (upper left) CTD psal sensor 1 minus salinometer salinity versus sample number; (bottom left) CTD psal sensor 2 minus salinometer salinity versus sample number; (upper right) CTD psal sensor 1 minus salinometer salinity versus pressure; (bottom right) CTD psal sensor 2 minus salinometer salinity versus pressure. In all figure. Black lines show the zero offset line; plain red line show the median offset; dashed red lines show the ±0.001 psu deviation from median; and dotted red line show the ±0.002 psu deviation from median.

6.10 CALIBRATION OF CHLOROPHYLL FLUOROMETER

Between three and five niskins were sampled at all stations for chlorophyll measurements (see Section 11 for details about chlorophyll sampling and analysis). The chlorophyll differences between analysed chlorophyll and chlorophyll from the CTD sensor show a bias, which appears to have a temperature dependence. For instance, for sample with temperature above 3ºC, CTD chlorophyll appear lower by about 40% compared to analysed chlorophyll (correlation of 0.9); for sample with temperature lower than 3ºC, CTD chlorophyll appear lower by about 13% compared to analysed chlorophyll (correlation of 0.9) [See Figure 6.3]. In order to investigate possible temperature dependence in the calibration we repeated linear fits for subsets of the samples based on their temperature: we explored temperature of samples going from 0 to 5 degrees (every 0.1ºC) within a temperature range of ±1ºC (e.g. first subset was all samples with temperature ranging from -1 to 1ºC; second subset: temperature ranging from -0.9 to 1.1ºC; third subset: temperature ranging from -0.8 to 1.2ºC; etc.). For each of these subsets we fitted linear trend between CTD chlorophyll and analysed chlorophyll, and reported the slope of the trend, and the correlation (see Figure 6.3, right panel).

The value of the slope (Analysed chlorophyll)/(CTD chlorophyll) has a clear temperature dependence, which we extracted by linear fit (using only the temperature ranges when more than 15 samples where available).

We found that the slope C = (Analysed chlorophyll)/(CTD chlorophyll), has a temperature dependence following: $C(T) = 0.11*T+0.94$. We applied this correction by multiplying all CTD chlorophyll by C(T), which we computed from the CTD temperature.

In order to check the calibration procedure, we repeated the comparison with analysed chlorophyll once calibration was applied to the CTD data. After calibration, the agreement between CTD chlorophyll and analysed chlorophyll is very good (Figure 6.5)

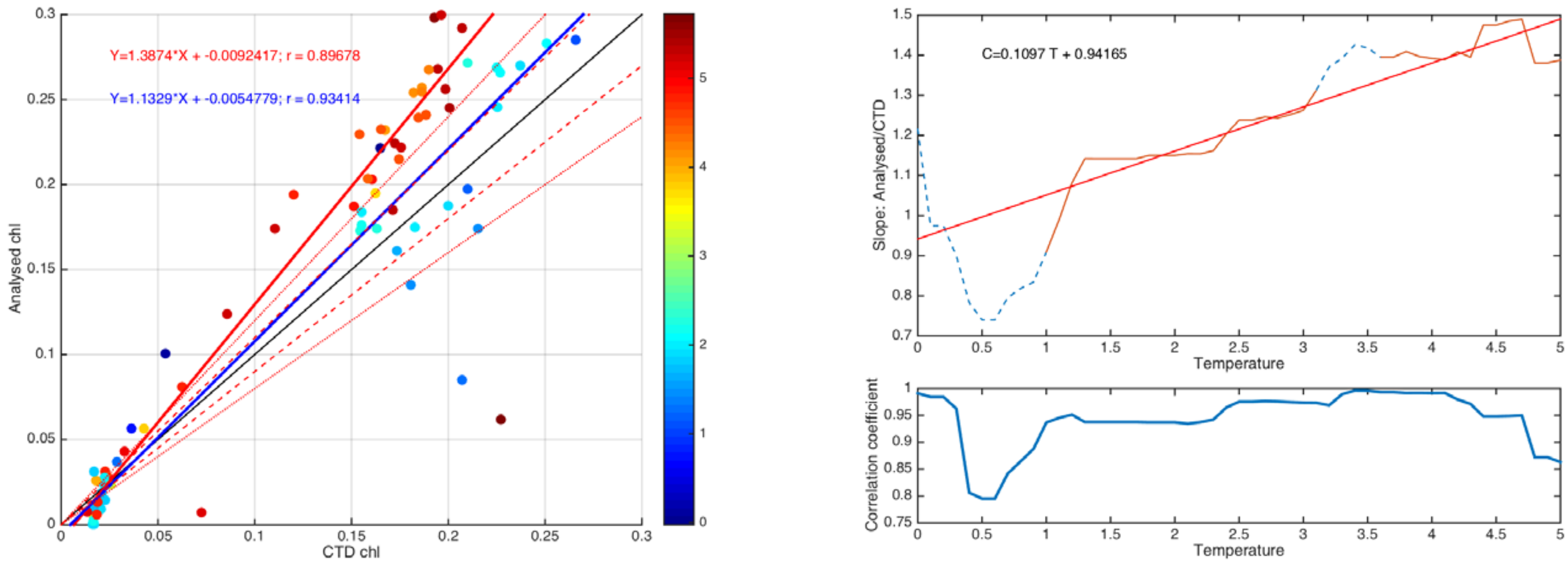

Figure 6.3. Chlorophyll calibration: (left panel) Analysed chlorophyll versus CTD chlorophyll. Color of dots represent temperature. The black line is the one:one relationship. Dashed red line represents 10% deviation and dotted red line represents 20% deviation. Linear fit for all samples were temperature were less than 3ºC is shown in blue (line and equation). Linear fit for all samples were temperature were more than 3ºC is shown in red (line and equation). (upper right panel) Slope of linear fit versus temperature of the samples (in bins of 1ºC). Corresponding correlation coefficient are shown in the bottom right panel. The dashed line represents temperature bins were less than 15 sample were available. The red line represent the best linear fit of the temperature dependence relationship.

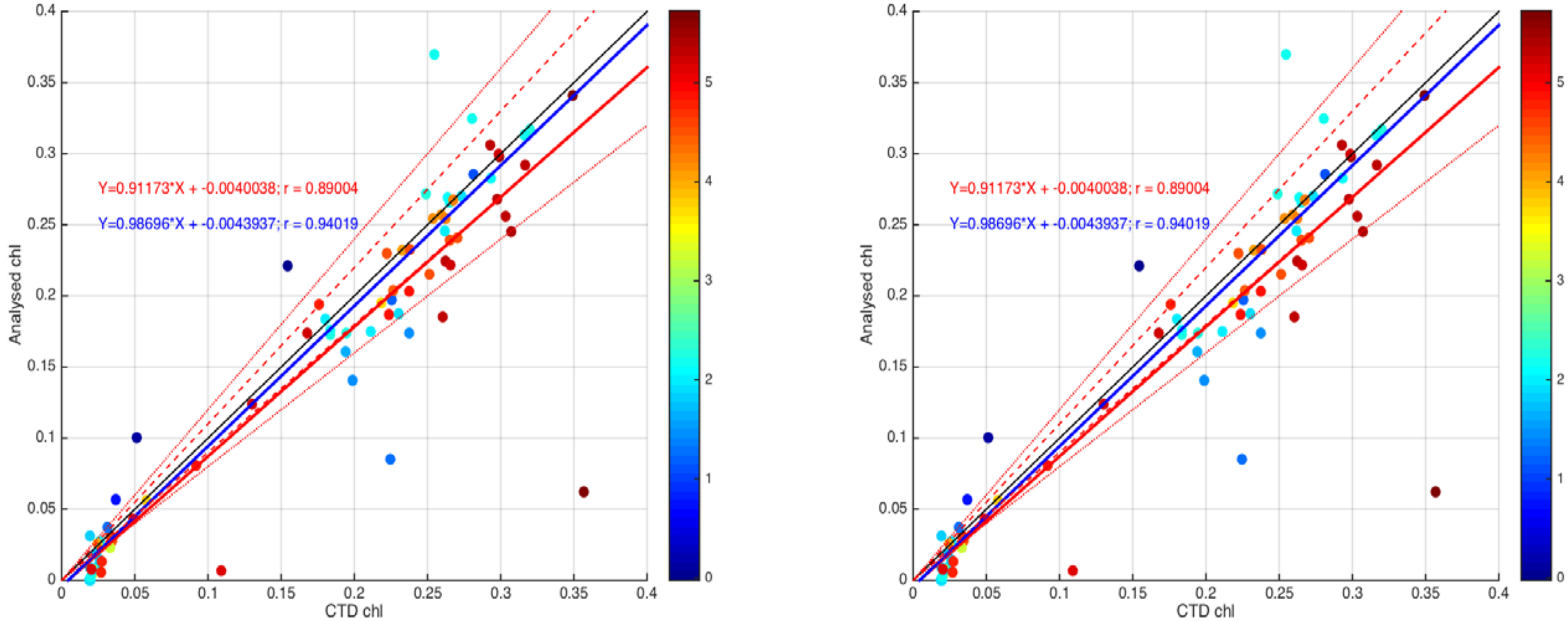

Figure 6.5. Same as above once the calibration of CTD chlorophyll is applied.

6.11 DATA

Below are figures showing examples of data obtained from the CTD: one section across the eddy of "Experiment 2" showed in comparison to a collocated SeaSoar section (figure 6.6); T-S plot of all the CTD profiles during the cruise (Figure 6.7).

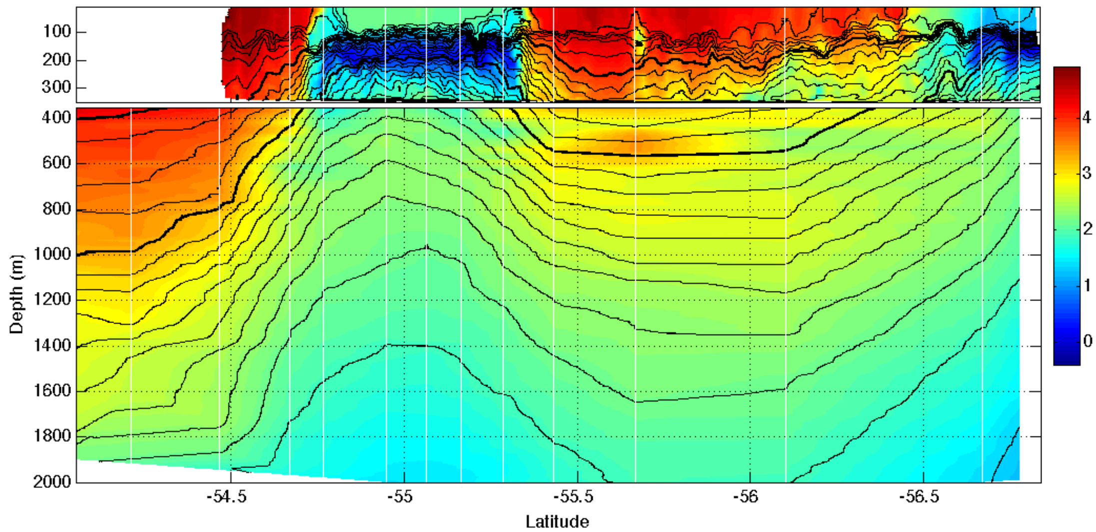

Figure 6.6. Example of CTD section (station 11 to 24) across the ACC and the eddy structure, done to complement a Seasoar section. The high resolution first 300 m from the SeaSoar survey is shown on the top panel (from 0 m to 350 m). The lower resolution but much deeper-reaching CTD section is shown on the bottom panel (from 350 m to 2000 m)

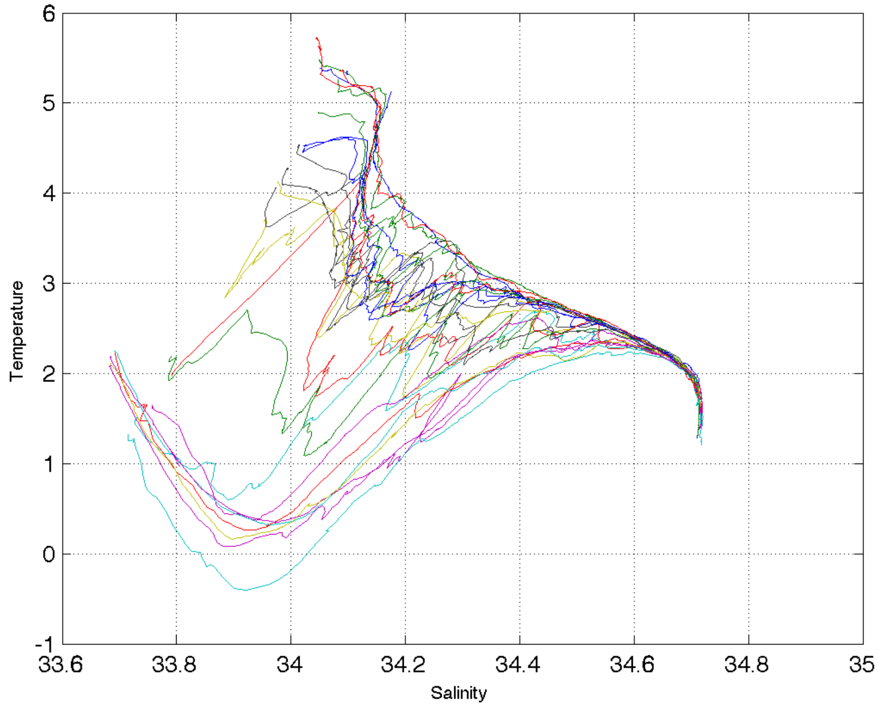

Figure 6.7. Temperature/Salinity plot of the 24 casts done during JR311

7. DRIFTERS

Holly Ayres, Plymouth University

7.1 INTRODUCTION AND AIMS

During JR311 19 drogued drifters were released with the intention of tracking water movement during and beyond the time of the cruise itself. The drifters were constructed at Plymouth University using a variety of components. The hulls and drogues were acquired from Pacific Gyre but the internal electronics were designed and built by Technical Specialist Peter Ganderton from Plymouth University. The buoys consisted of a 12V battery, a magnetic Reed switch to turn the electronics on and off, a ROCKBlock Iridium board, an Arduino microprocessor unit and a GPS chip. The drifters were programmed to transmit their position every 10 minutes for the first 2000 transmissions (equating to approximately 2 weeks) and to then step down to 60 minute intervals. The reason for the change in sample frequency was to conserve battery power after a period of time when the clusters of drifters had become dispersed and independent of each other.

7.2 DRIFTER PREPARATION

The drogues used to ensure the drifters followed the currents as opposed to the wind were constructed onboard the JCR prior to departure from Stanley. They consisted of a 10 m holey sock supplied from Pacific Gyre, with ten plastic hoops at one meter intervals inside. The lowest hoop at the bottom of the drogue was weighted with lead to ensure that the drogue maintained a vertical orientation and was stretched out in the water column. Holes were drilled in each pipe, in order for them to fill with water and reduce buoyancy when deployed.

Figure 7.1. Drogue construction on deck prior to departure for JR311

Figure 7.2. Drifter Arduino controller unit.

The drogues were attached to the buoys via a 35m Dyneema 3.5mm diameter tether, which centred the drogues at 40 meters depth. The rope was first flaked out to avoid getting tangled or knotted on deployment and attached via a 12mm stainless steel jaw-to-jaw swivel to the drogue and a 10 mm stainless steel shackle to the buoy. The shackles were tightened with pliers then secured with wire to prevent them from coming loose after deployment.

Figure 7.3. 12mm Swivel and 3.5mm Dyneema tether attached to each buoy.

7.3 Drifter deployment 1

The first drifter deployment occurred on 1st - 2nd May and was focussed on the location of a front. The drifters were released in triplets following each of three CTD casts taken during a transect that aimed to monitor the change in hydrographic properties across the front on the northern edge of the filement at Site 1. The first triplet was released in the cold water on the southern side of the front, the second in the centre of the front and the last triplet in the warm water to the north of the front. The times and locations of each drifter release is indicated in Table 7.1. The drifters were numbers D04 to D12 sequentially. During the drifter deployment the ship moved slowly forward and the drifters were dispatched one after the other from the port and starboard side of the stern, approximately ten meters apart. Each drifter took approximately two minutes with a slight variation to deploy.

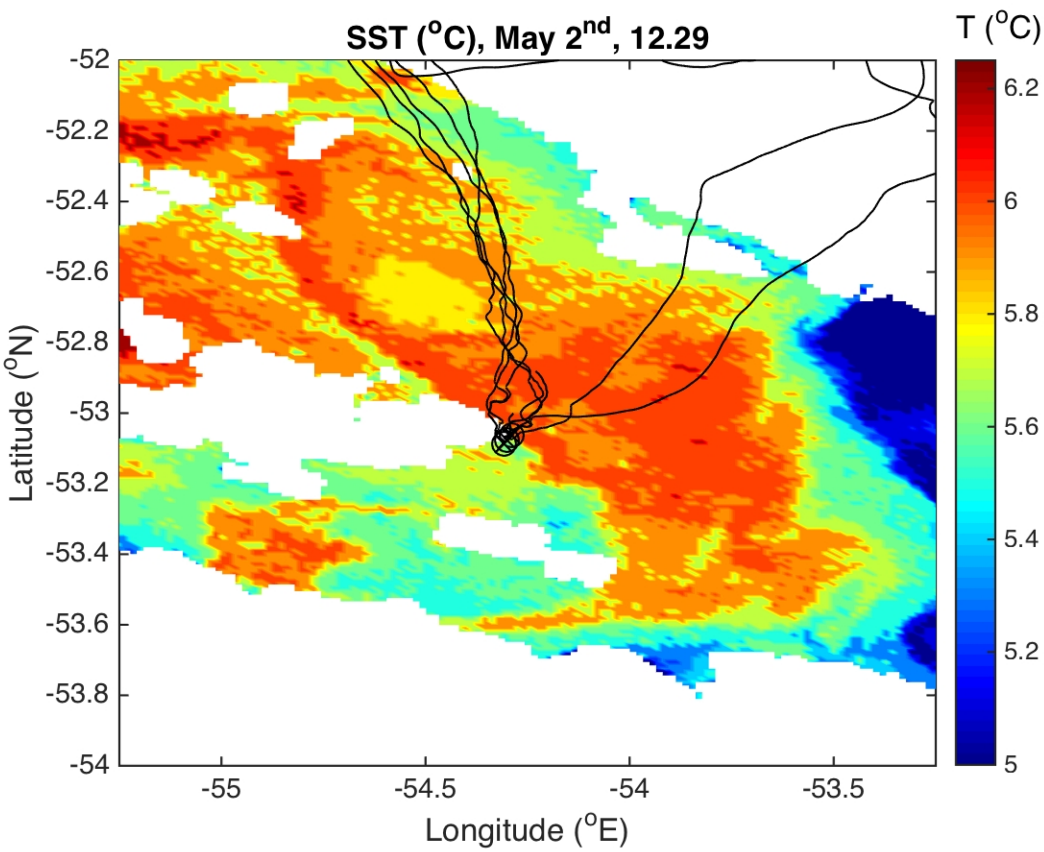

Figure 7.4. SST field on May 2nd 2015 at the time of the drifter release during Lagrangian 1. The black lines indicate the drifter trajectories after release.

Drifters D07 and D10 stopped transmitting within three to four days of the survey on the 3rd and 4th of May. Drifters D04, D05, D08, D09, D11 and D12 all lost their drogues throughout the survey making data after that point unusable. The loss of drogues was identified by the sudden change in direction of the drifters after the onset of a northerly wind. The reason that they lost their drogues is unknown.

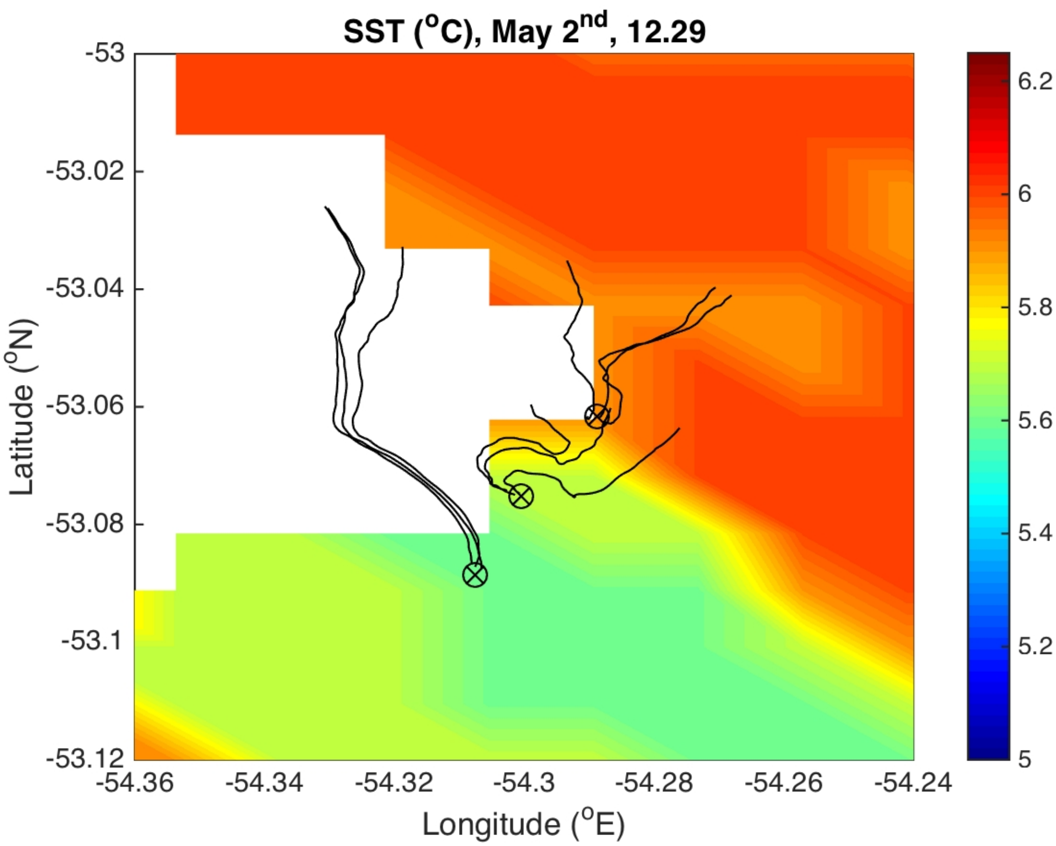

Figure 7.5. Trajectory of drifters during the 24 hours following release of the first drifter, D04.

Table 7.1. Details for Drifter deployment 1 release at the northern Site 1.

CTD CAST	DRIFTER ID	LATITUDE (°N)	LONGITUDE (°E)	RELEASE TIME	COMMENTS
1	D04	-53° 05.02	-54° 18.47	21:24, 01/05/2015	Lost drogue- 13/05/15, 2:00-3:00 -51°N 10.47, -55°E 09.29
1	D05	-53° 05.17	-54° 18.53	21:27, 01/05/2015	Lost drogue- 17/05/15, 0:00-1:00 -50°N 10.68, -54°E 99.54
1	D06	-53° 05.02	-54° 18.47	21:24, 01/05/2015	
2	D07	-53° 04.44	-54° 18.15	00:45, 02/05/2015	Last transmitted- 03/05/15, 22:45 -53°N 00.10, -54°E 17.13

2	D08	-53° 04.48	-54° 18.09	00:41, 02/05/2015	Lost drogue-13/05/15, 6:00-7:00 -51°N 47.35, -54°E 33.76
2	D09	-53° 04.45	-54° 18.13	00:44, 02/05/2015	Lost drogue- 04/05/15, 13:00 -52°N 57.68, -54°E 07.30
3	D10	-53° 03.68	-54° 17.36	04:08, 02/05/2015	Last transmitted- 04/05/15, 19:23 -52°N 52.90, -54°E 13.76
3	D11	-53° 03.63	-54° 17.43	04:11, 02/05/2015	Lost drogue- 16/05/15, 16:00-17:00 -51°N 15.55, -55°E 00.17
3	D12	-53° 03.61	-54° 17.47	04:13, 02/05/2015	Lost drogue- 03/05/15, 22:00-23:00 -53°N 00.62, -54°E 14.08

7.4 DRIFTER DEPLOYMENT 2

The second drifter deployment was performed to define the circulation around a mesoscale eddy that had formed on our arrival at the subantarctic front during the second half of the cruise. The deployment followed a dye release at 50 m depth at the mesoscale front, on the 8th of May, using drifters DO1, D13 and D16. The drifter triplet release began at 18:22 UTC -54°54.45 -54°40.30 and was completed within 6 minutes.

Table 7.2. Details for Drifter deployment 2 release at the northern Site 2.

DRIFTER ID	LATITUDE (°N)	LONGITUDE (°E)	RELEASE TIME
D16	-54°N 54.44	-54°E 40.30	18:22, 08/05/2015
D13	-54°N 59.40	-54°E 39.43	18:26, 08/05/2015
D01	-54°N 54.38	-54°E 40.23	18:28, 08/05/2015

The triplet stayed together as a group and demonstrated the formation of a cyclonic mesoscale eddy from the meander. On the 19th of May the drifters left the eddy in the southeastern sector of the eddy and transited to the east with the ACC, dispersing from each other during their passage.

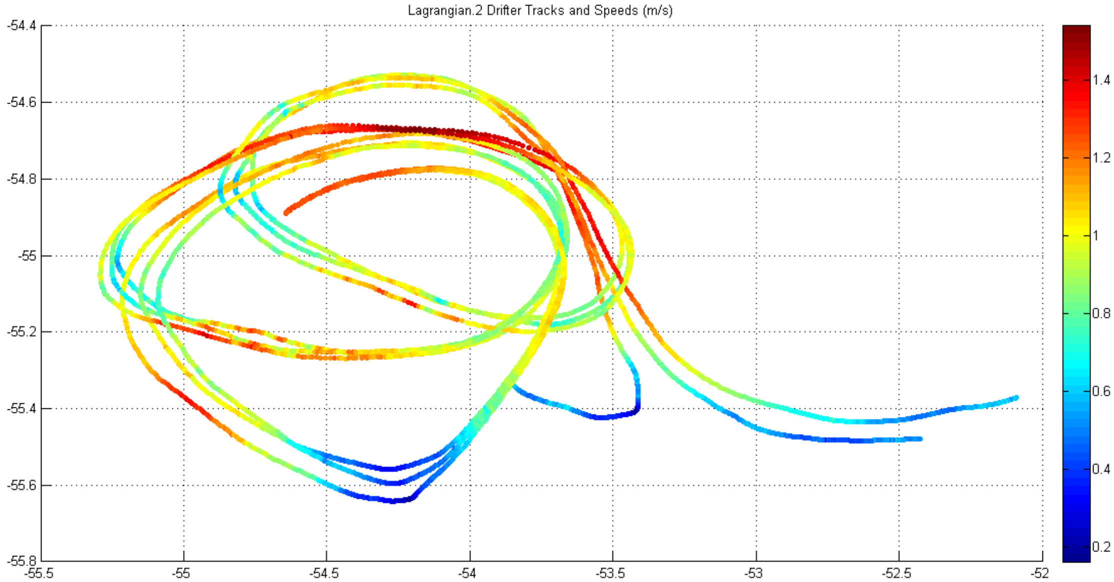

Figure 1.6. Drifter tracks and speeds up to 21/05/15 for Drifter deployment 2.

7.5 DRIFTER DEPLOYMENT 3

The third drifter deployment aimed to supplement the drifters deployed during Lagrangian 2 by releasing additional drifters within the eddy. The wave buoy, which was put in the middle of the eddy, appeared to be going in a square motion around the centre. This is believed to have happened due to an inertial oscillation rotating anticlockwise in the middle of the cyclonic clockwise rotating eddy, whereby the opposing vorticity had caused the wave buoy to travel in a square as oppose to a circle in the centre of the eddy. The wave buoy had not lost its drogue, which was present on recovery

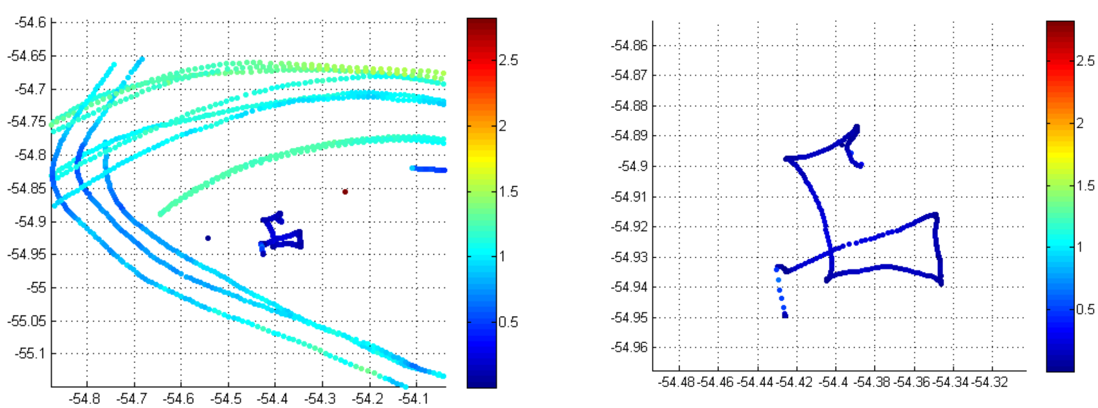

Figure 7.7. Wave buoy inside the eddy (right) and close up (left).

Two drifters, D15 and D18 were deployed at the centre of the eddy at 15:36 UTC on the 16th of May at -54°53.88 -54°23.31, to survey the inner eddy circulation.

Table 7.3. Details for Drifter deployment 3 release at the northern Site 2.

DRIFTER ID	LATITUDE (°N)	LONGITUDE (°E)	RELEASE TIME
D15	-54°N 53.88	-54°E 23.31	15:37, 16/05/2015
D18	-54°N 53.88	-54°E 23.31	15:36, 16/05/2015

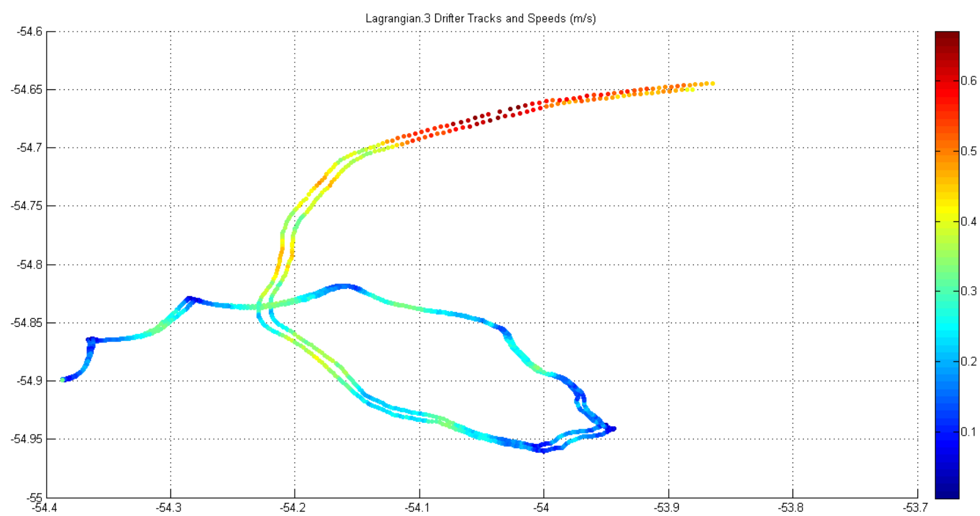

Figure 7.8. Drifter tracks and speeds up to 21/05/15 during Drifter deployment 3.

7.6 DRIFTER DEPLOYMENT 4

The fourth drifter deployment occurred on the 16th of May, at 18:25 UTC, at -54°49.14 -54°06.66. Two drifters were deployed, D14 and D17 on the northern side of the eddy.

Table 7.4. Details for Drifter deployment 4 release at the northern Site 2.

DRIFTER ID	LATITUDE (°N)	LONGITUDE (°E)	RELEASE TIME
D14	-54°N 49.14	-54°E 06.66	18:25, 16/05/2015
D17	-54°N 49.09	-54°E 06.69	18:27, 16/05/2015

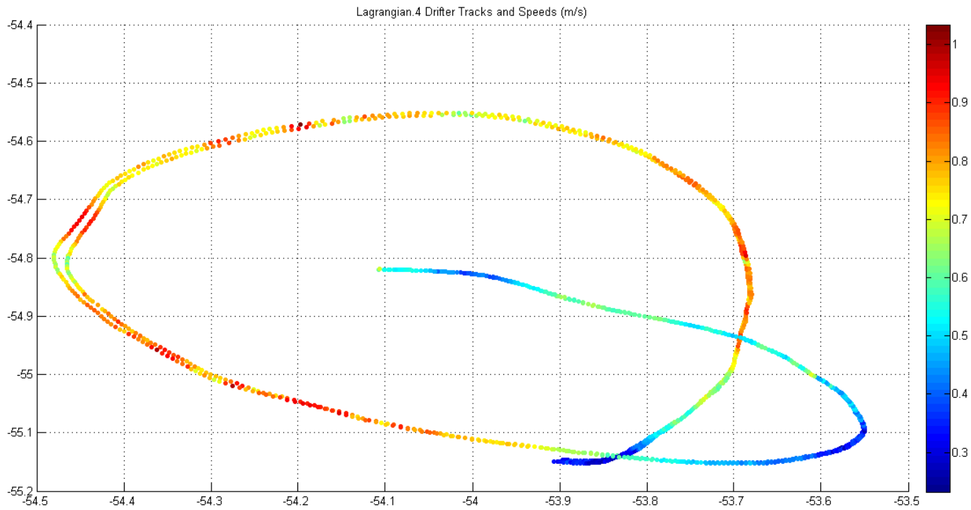

Figure 7.9. Drifter tracks and speeds up to 21/05/15 during Drifter deployment 4.

7.7 Drifter deployment 5

The fifth drifter deployment occurred on the 17th of May at 20:12 UTC, at -54°42.14 -54°54.38. Three drifters were deployed, D19, D20 and D21. The drifters were released to go around the outside of the eddy, encountering the smaller features to see how they affected the speed of the drifters. Attached to the drifters were SeaBird Electronics, Inc., SBE56 temperature sensors. The drifters were then collected and sensors removed before being redeployed. Recovery and redeployment took less than 5 minutes during which time the drifters continued to transmit their position. As the drifters were released in the same position as they were recovered for the purpose of removing the temperature sensor (the drogues were not taken from the water), we consider there to have no break in the drifter trajectories arising from the temporary recovery.

Table 7.5. Details for Drifter deployment 5 release at the northern Site 2.

Drifter ID	Latitude (°N)	Longitude (°E)	Release Time
D19	-54°N 42.11	-54°E 54.41	20:27, 17/05/2015
D20	-54°N 42.10	-54°E 54.42	20:42, 17/05/2015
D21	-54°N 42.14	-54°E 54.38	20:12, 17/05/2015

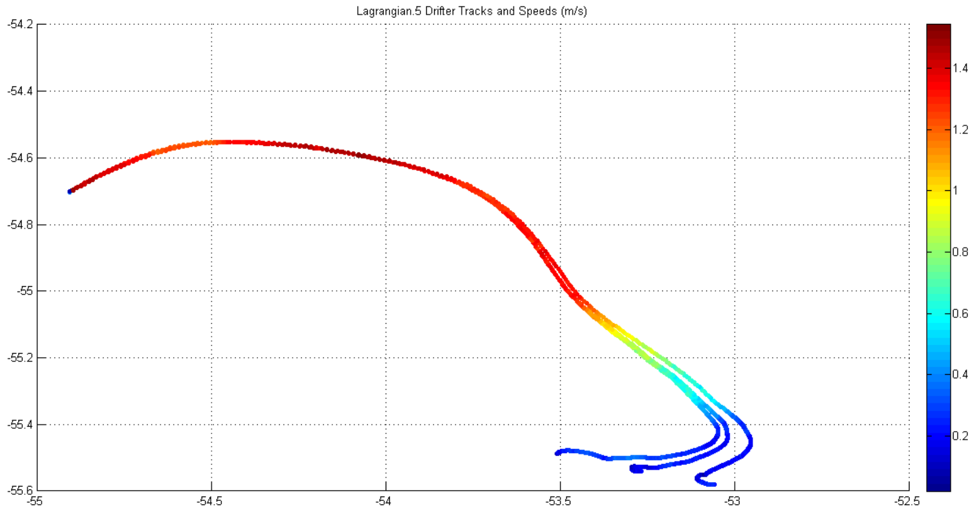

Figure 7.10. Drifter tracks and speeds up 21/05/15 during Drifter deployment 5.

8. INSTRUMENTED DRIFTERS

Kate Adams, Plymouth University

Drifters with attached oceanographic instrumentation were deployed during Lagrangian Experiment 1 and 3 on the JR311 cruise. No instrumented drifters were deployed in Lagrangian Experiment 2.

8.1 WAVE BUOY

Plymouth University's Fugro OCEANOR Seawatch Mini II Buoy, serial number SWM053, was deployed twice during JR311 to collect wave field measurements such as wave height and directional wave spectra. The wave buoy (Figure 8.1) was equipped with a flashing light, radar reflector, GPS, and a Rock Seven RockBLOCK satellite communications card. The GPS and satellite communications cards were powered by the wave buoy and attached externally.

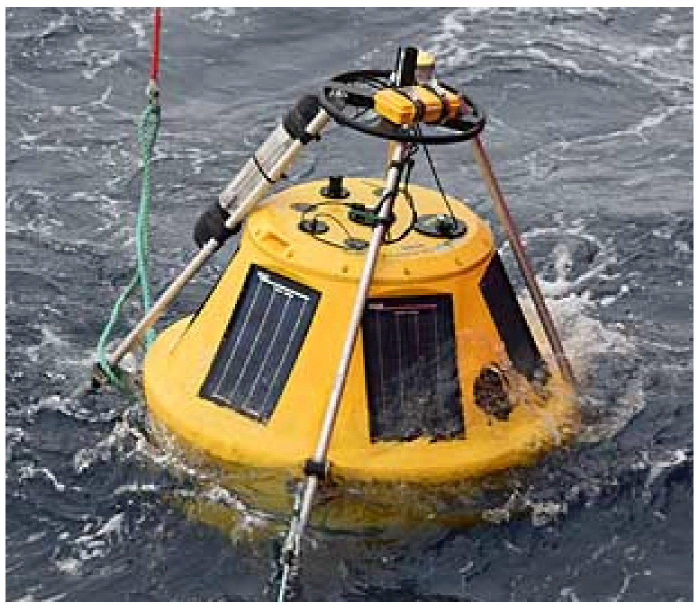

Figure 8.1. Wave buoy with externally-mounted radar reflector, light and waterproof case containing GPS and satellite communication cards.

The wave buoy was first deployed on 25 April 2015, one day before Lagrangian Experiment 1. During this deployment the wave buoy was not moored, tethered or drogued but a length of chain approximately 5 m in length was attached to the bottom for ballast. Emails containing GPS information from the wave buoy were received approximately every 10 minutes from 25 April 15:59:33 until 26 April 11:59:54 (GMT) when communications ceased due to a faulty RockBLOCK card (D22). A successful recovery location (Table 8.1) was calculated by extrapolating the wave buoy trajectory from the last known positions and speed.

Table 8.1. Wave buoy deployment information from JR311 event log.

DATE	TIME (GMT)	LATITUDE °S	LONGITUDE °W	EVENT	BUOY ID
25/04/2015	16:47	53.44999	54.69992	Deployment 1	D22
26/04/2015	19:36	53.35607	54.80073	Recovery 1	D22
14/05/2015	12:09	54.93109	54.43171	Deployment 2	D03 (D14)
16/05/2015	15:29	54.89846	54.38765	Recovery 2	D03 (D14)

The second wave buoy deployment took place between 14 May 12:09 and 16 May 15:29 (GMT) in the center of a mesoscale eddy. For this deployment, the wave buoy containing RockBLOCK card D03 was connected to a second buoy containing RockBLOCK card D14. A 10 m drogue centered at 40-m depth was also connected to the second buoy. The wave buoy was recovered on 16 May due to incoming inclement weather.

Hourly data was successfully recorded and recovered from the wave buoy for both deployments. Average wave height and wave period during each deployment are shown in Figure 8.2. A full list of output parameters are listed below in Table 8.2. Latitude and longitude were not recorded onboard the wave buoy during JR311.

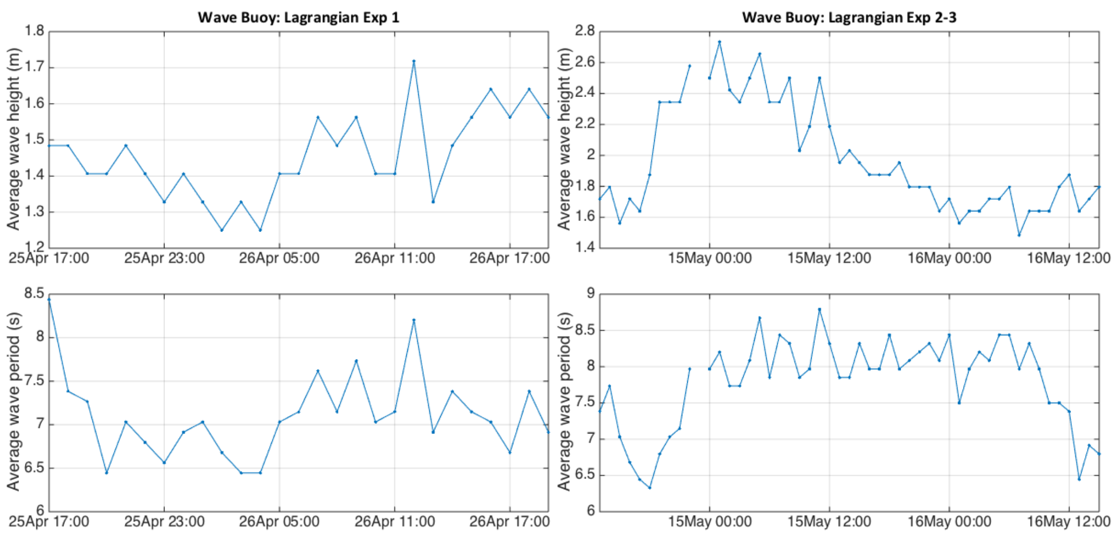

Figure 8.2. Average wave height (top) and wave period (bottom) for the two wave buoy deployments during JR311.

Table 8.2. Wave buoy output parameter names and descriptions.

PARAMETER	DESCRIPTION	UNITS
hspec	Heave spectrum	
dspec	Mean direction spectrum	
sprspec	Directional spread spectrum	
heave	Heave series	
north	Slope in the east direction	
east	Slope in the north direction	
batteryVoltage	Battery voltage	V
cardNo	Memory card number	
hm0	Estimate of hs = $4(m0)^{-0.5}$	m
hm0lf	Lower frequency significant wave height	m
hmax	Height of highest wave	m
hmean	Average height of individual waves	m
hs	Average of third highest waves	m
hs1max	Height of steepest wave	m
latitude	Latitude	degrees
longitude	Longitude	degrees
m0	Moments of the spectrum about origin	
m1	Moments of the spectrum about origin	
m2	Moments of the spectrum about origin	
m3	Moments of the spectrum about origin	
m4	Moments of the spectrum about origin	
mdir	Mean spectral wave direction	
qp	Spectrum width parameter	
rb	Width of spectrum peak	
s1hmax	Steepness of highest wave	
s1max	Steepness of steepest wave	
s1mean	Average wave steepness	
s2	Steepness based on Hs and tz	
s3	Steepness based on Hs and ts	
sfp	Maximum spectral density	
sigs1	Standard deviation of individual steepness	
sm02	Estimate of wave steepness	
sprtp	Wave spreading at spectral peak period	
thhf	High frequency mean wave direction	degrees
thlf	Low frequency mean wave direction	degrees
thmax	Period of highest wave	s
thtp	Mean wave direction at spectral peak	degrees
tl	Lower wave period of significance	degrees
tm01	Estimate of Tz	s

tm02	Estimate of Tz	s
tm24	Estimate of Tc	s
tmm10	Estimate of Ts	s
tmm20	Estimate of Ts	s
tp	Period of spectral peak	s
tz	Average wave period	s

8.2 LAGRANGIAN EXPERIMENT 1

On 26 April 2015, three instrumented, drogued drifters were deployed as part of Lagrangian Experiment 1 (Figure 8.3,Table 8.3). Each of the drifter assemblies included two communications buoys: one 39 cm buoy with satellite and radio communications from Plymouth Marine Lab and one 46 cm buoy with satellite only communications from Plymouth University. Each buoy was programmed to report the latitude and longitude of the drifter every 10 minutes. Pacific Gyre drogue socks 10 m in length were centered at 55-m water depth for both the temperature and CTD chain and Wirewalker drifters and 65-m depth for ADCP drifter. The internal drifter rings were constructed from 20 and 25 mm diameter MPDE. Lead weights were inserted into the bottom two rings of each drogue, approximately 3 kg in total. Additional lead plates, 10 - 30 kg, were attached to the bottom of the drogues.

Table 8.3. Lagrangian Experiment 1 instrumented drifter deployment information on 26 April 2015.

Drifter	Buoy IDs	Deployment time (GMT)	Deployment Latitude (°S)	Deployment Longitude (°W)
Temperature & CTD Chain	R02,D01	13:42	53.14694	54.5537
Wirewalker	R01,D02	13:46	53.14816	54.5537
ADCP	R03,D03	15:01	53.15691	54.5537

The temperature and CTD chain drifter was the first of three instrumented drifters to be deployed on 26 April 2015. Figure 8.3 below depicts the drifter design. Instrumentation secured to the drifter line included 20 SBE56 thermistors and three SBE37 CTDs. Table 8.4 includes the serial numbers and depths of each instrument. The thermistors and CTDs sampled at 1 Hz and 60 Hz, respectively.

Both buoys on this drifter reported locations as expected, approximately every 10-20 minutes, until the day of recovery. D01 failed to report between 30 April 2015 at 2:24:06 AM and 5:46:46 AM GMT. R02 missed calls between 6:25:00 and 7:04:40 AM GMT and again between 7:44:21 and 8:24:07 AM GMT.

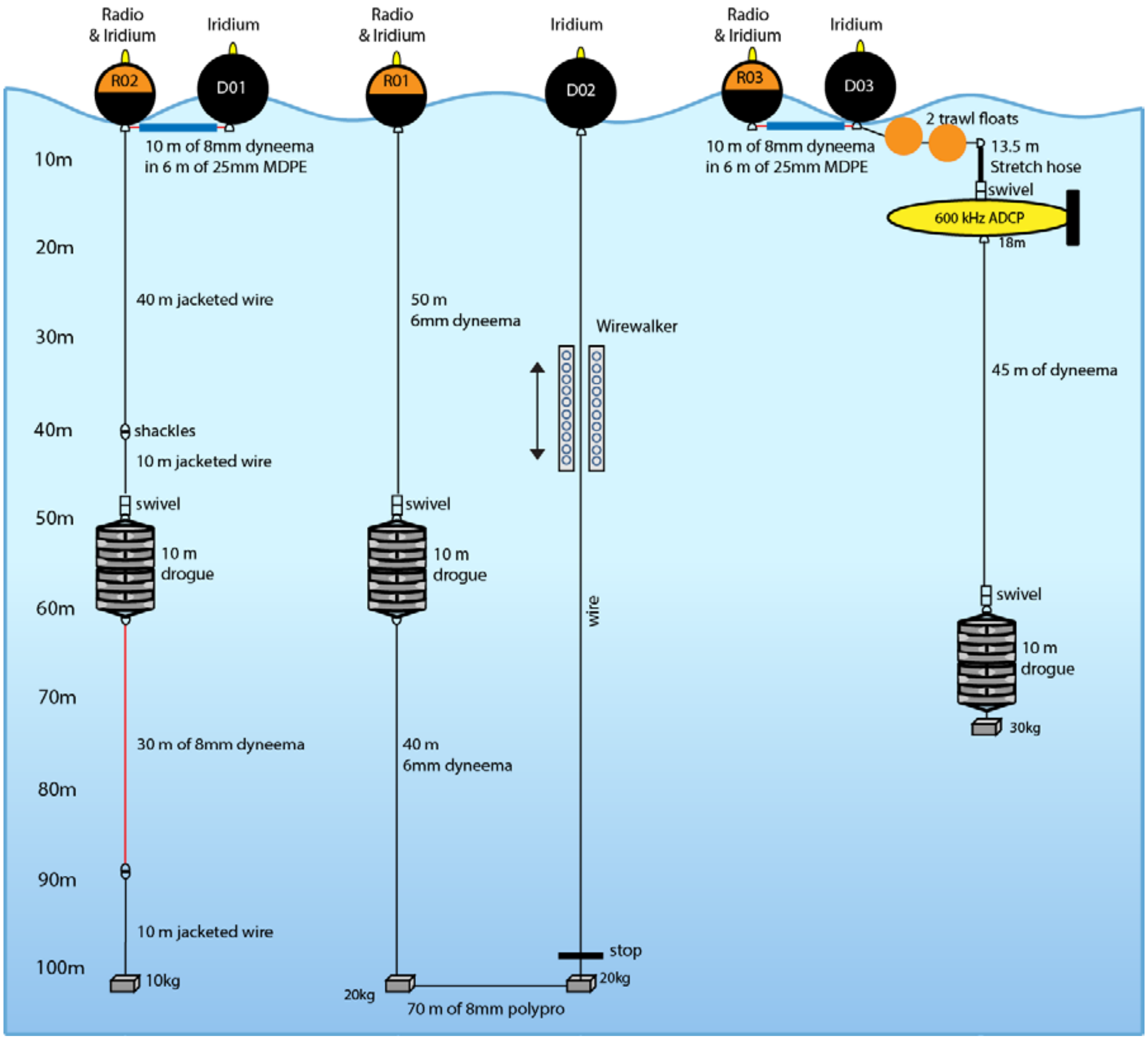

Figure 8.3. Instrumented drifter configuration for Lagrangian Experiment 1.

Recovery of the first drifter occurred on 30 April 2015 20:00 GMT at 52.56831°S, 55.4194°W. Only the top 50 m of the drifter configuration was recovered. At the 50-m depth mark the jacketed wire was severed (Figure 8.4) presumably from prolonged bending and twisting. Several twists were observed in the line connecting the surface drifters. A plausible failure scenario is that the SBE37sm clamped at 50-m depth became entangled with the drogue bridle straps. This would have bent the jacketed wire at exactly 50-m depth and prohibited the swivel above the drogue to remove turns in the top 50 m of wire.

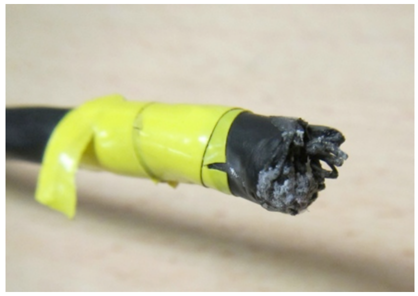

Figure 8.4. Severed end of jacketed wire at approximately 50 m from the surface.

The drifter components below 50-m depth were not recovered and are not connected to any buoyancy. Remaining components include eight SBE56 thermistors (Plymouth University), two SBE37 CTDs (National Marine Facilities), one 10-m drogue, and one 10 kg lead weight attached to the bottom of the drogue.

Table 8.4. Depth and recovery status for the instruments secured to the primary drifter.

Instrument	Serial Number	Depth (m)	Recovered?
SBE37sm	9250	1	√
SBE56	3355	3	√
SBE56	3369	5	√
SBE56	4814	7	√
SBE56	4815	9	√
SBE56	4807	11	√
SBE56	3368	15	√
SBE56	4812	20	√
SBE56	3364	25	√
SBE56	3365	30	√
SBE56	4808	35	√
SBE56	4811	40	√
SBE56	3363	45	√
SBE37sm	9248	50	X
SBE56	4809	53	X
SBE56	4816	60	X
SBE56	3367	65	X
SBE56	4813	70	X
SBE56	3371	75	X
SBE56	4810	80	X
SBE56	3370	85	X
SBE56	3366	90	X
SBE37sm	9249	91	X

Pressure data from the recovered SBE37sm clearly shows a sharp decrease at 30 April 2015 around 06:00 AM GMT (Figure 8.5), specifying the exact time when the jacketed wire was severed from the bottom drifter components. Also at this time communications were restored with the D01 buoy. Speculatively, the D01 buoy may have been submerged during the period of time when the wire was bending and twisting and then resurfaced once the wire yielded.

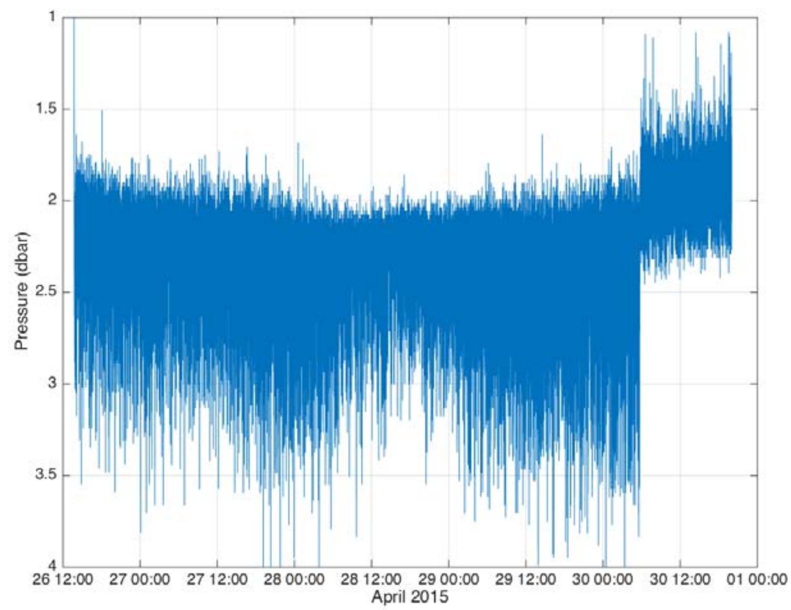

Figure 8.5. Time series of pressure (dbar) from the recovered SBE37sm CTD showing a sharp pressure decrease at 06:00 GMT on 30 April 2015.

Temperature data recovered from the top 12 thermistors is interpolated to show a vertical time series during the drift track (Figure 8.6).

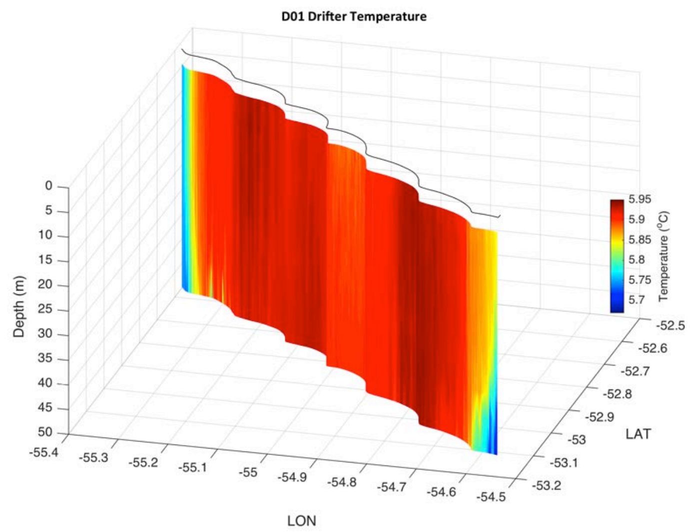

Figure 8.6. Vertical spatial series of temperature from the top 50 m of the first drifter. The drifter path, shown in black, progressed to the northwest.

The second drifter deployed on 26 April 2015 included a Brooks Instruments Wirewalker, property of Plymouth Marine Lab. Two Plymouth University instruments were attached to the Wirewalker: a RBR concerto CTD with a Uniflux fluorescein fluorometer and a 100-m rated Nortek Aquadopp ADCP (Figure 8.7). Additional buoyancy was attached to the Wirewalker frame after a buoyancy test on 25 April 2015.

Figure 8.7. Wirewalker with attached CTD, Aquadopp and extra buoyancy.

Communications from D02 failed shortly after deployment. Communications from R01 were not working properly at the time of deployment. An unsuccessful search was conducted after the deployment of the third drifter. It is likely that a flooded buoy or a tangle in the wire sank the other components.

The ADCP drifter was deployed third on 26 April 2015 (Figure 8.8). Initially a 10 kg weight was attached below the drogue which was not enough to sink the ADCP sub unit containing a Teledyne RDI Workhorse Sentinel 600 kHz ADCP (NOC) and two hardball floats. The drifter was recovered and an additional 20 kg of weight was added below the drogue. A length of polypro line was also added between the trawl floats and ADCP sub to remove the necessity of recovering via the stretchy hose. After these two modifications were made, the ADCP drifter was redeployed on 26 April 2015 15:41 GMT at -53.15696°S, -54.56398°W. At the time of the deployment, communications were not working properly on buoy R03 however messages from D03 were successfully received.

Figure 8.8. ADCP sub component of the third drifter.

The drifter was recovered on 29 April 2015 12:40 GMT at 52.8099°S, 55.03085°W. Upon recovery, only the two communications buoys were recovered and R03 was found flooded due to a missing screw. The pin of the stainless ‘D’ shackle connecting the two trawl floats and the stretchy hose either failed or loosened during the deployment. Remaining buoyancy on the unrecovered drifter include the two hardball floats inside the ADCP sub and an additional two trawl floats.

The drift tracks of the temperature and CTD drifter (D01) and the ADCP drifter (D03) both show periodic oscillations (Figure 8.9). The time series of drifter speed (Figure 8.10) shows an approximate 15 hour signal which corresponds to the inertial period at this latitude, $T = 2\pi f^{-1}$, of 15.1 hours.

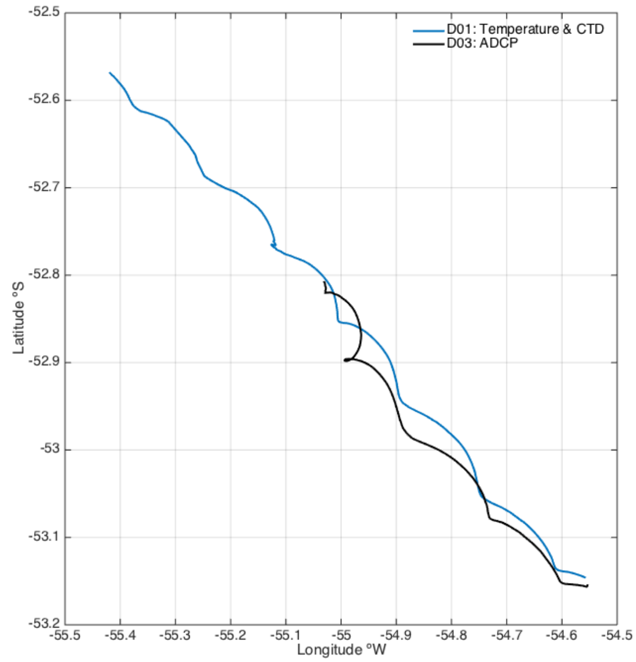

Figure 8.9. Drift track from position data received from D01 and D03 buoys on the temperature and CTD and ADCP drifters, respectively.

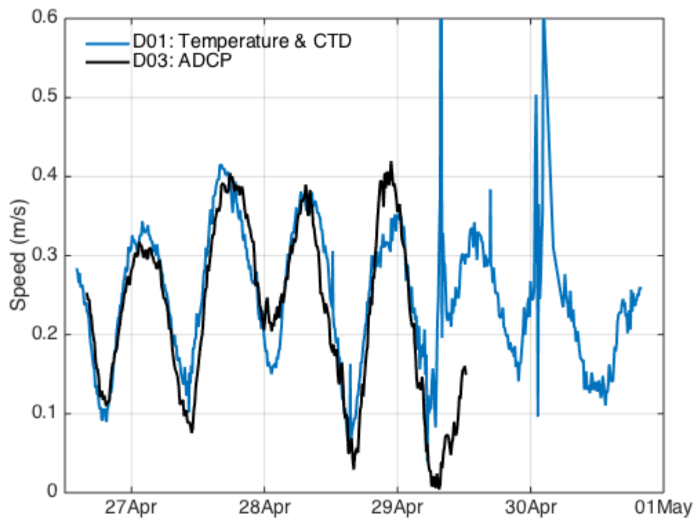

Figure 8.10. Drifter speed time series during Lagrangian Experiment 1.

8.3 Lagrangian Experiment 3

On 17 May 2015, three drogued drifters were deployed each with a SBE56 thermistor attached 1 m below a ‘pick-up’ buoy (Figure 8.11). Each drifter was deployed with one Plymouth University buoy (D19, D20, D21) with a RockBLOCK satellite communications card. The 10-m drogues were centered at 35-m water depth.

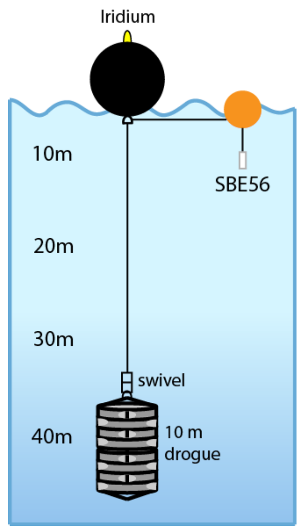

Figure 8.11. Instrumented drifter configuration in Lagrangian Experiment 3 (corresponding to Drifter Deployment 5 in Section 7).

The three thermistors attached to the buoys (Table 8.5) were programmed to sample at 1 Hz.

Table 8.5. Instrumented drifter deployment information for Lagrangian Experiment 3 (corresponding to Drifter Deployment 5 in Section 7).

Buoy ID	SBE56 sn	Deployment time (GMT)	Deployment latitude (°S)	Deployment longitude (°W)
D20	3363	20:42	54.70166	54.90714
D19	3364	20:27	54.70183	54.90689
D21	3365	20:12	54.70231	54.90633

The three drifters were placed in an eastward current +1 m s^{-1} at the northern edge of a mesoscale eddy in the ACC (Figure 8.12). Data from the thermistors shows variation of SST along the drifter tracks.

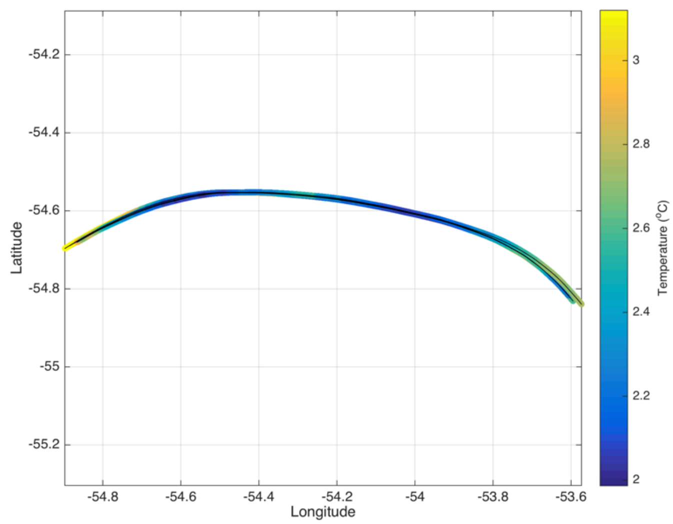

Figure 8.12. Map of drifter tracks during Lagrangian Experiment 3 with temperature data shown in colour.

The time series of temperature also shows variation between the three thermistors (Figure 8.13).

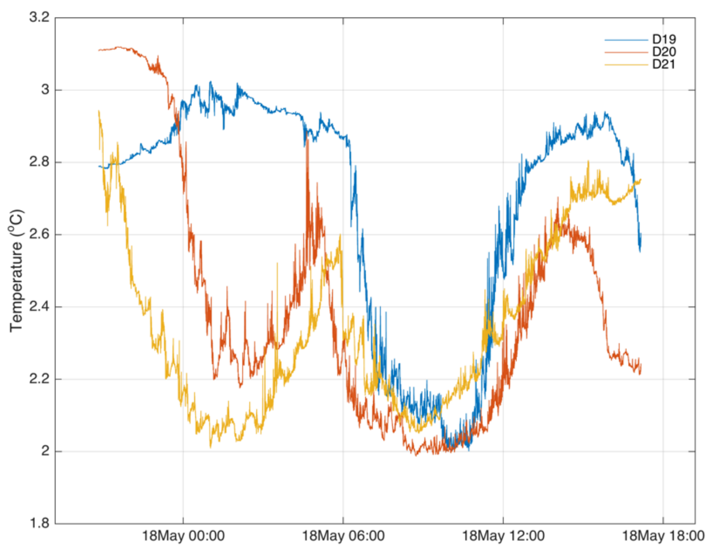

Figure 8.13. Time series of temperature from the thermistors deployed on three drogue drifters in Lagrangian Experiment 3.

On 18 May 2015 at 17:44 GMT the three drifters were recovered to remove the thermistors and were subsequently redeployed.

9. VESSEL MOUNTED ADCP

Marcus Zanacchi, Plymouth University

9.1 INTRODUCTION

A 75 kHz RD Instruments Ocean Surveyor (OS75, – model 71A-1029-00, SN 2088) ADCP operating at a system frequency of 76.8 kHz was used during JR311. This has also been used on JR139 (in Dec 2005, Chief Scientist Stansfield), JR161 (Oct-Dec 2006, Shreeve), JR165 (Feb 2007, Shoosmith), JR193 (Dec 2007, Quartly), JR177 (Jan 2008, Tarling), JR218 (Oct 2008, Woodward) and JR200 (Mar 2009, Korb), JR265 (Dec 2011, Yelland), JR276 (April 2011, Watson), JR281 (March 2013, Sallee) and JR299 (March 2014, Meijers). Note that this isn't a complete list. The OS75 is capable of profiling to deeper levels in the water column than the previous 150 kHz ADCP and can also be configured to run in either narrowband or broadband modes.

9.2 INSTRUMENTATION

The OS75 unit is sited in the transducer well in the hull of the JCR. This is flooded with a mixture of 90% de-ionised water and 10% monopropylene glycol. With the previous 150 kHz unit, the use of a mixture of water/antifreeze in the transducer chest required a post-processing correction to derived ADCP velocities. However, the new OS75 unit uses a phased array transducer that produces all four beams from a single aperture at specific angles. A consequence of the way the beams are formed is that horizontal velocities derived using this instrument are independent of the speed of sound (vertical velocities, on the other hand, are not), hence this correction is no longer required.

The OS75 transducer on the JCR is aligned at 60.08 degrees relative to the centre line. This differs from the recommended 45 degrees. The instrument was used in an unsynchronised mode because there was no evidence of any interference between the OS75, the EK60 and EK600. The heading feed to the OS75 is the heading from the Seapath GPS unit.

9.3 CONFIGURATION

The OS75 was linked to the RDI proprietary software VmDAS, version 1.42. The OS75 was run in narrowband for days 111.97-127.07 and then in broadband for days 127.07-141.6, both in water tracking mode. At no point during the cruise was it shallow enough to use bottom tracking. Vessel positioning was used to geo-reference the data. There were 100 bins each with a bin length of 8 metres. The transducer depth had been previously calculated to be 6.3 m for JR139. This is the value assumed for JR311, but note that the ship was very heavily laden during cruise JR139, and for other cruises it may be shallower. Salinity at the transducer was set to zero.

Specific configuration parameters are indicated in Table 9.1 below (except for the bandwidth employed, settings were identical for the narrowband and broadband setup).

Pings per ensemble	1
Depth cells	100
Bin size	8 m
Blanking distance	8 m
Ambiguity velocity	3.9 m s^{-1}
Time between pings	0.5 seconds
Time per ensemble	1 second

Table 9.1. ADCP settings used for both broadband and narrowband operation during JR311.

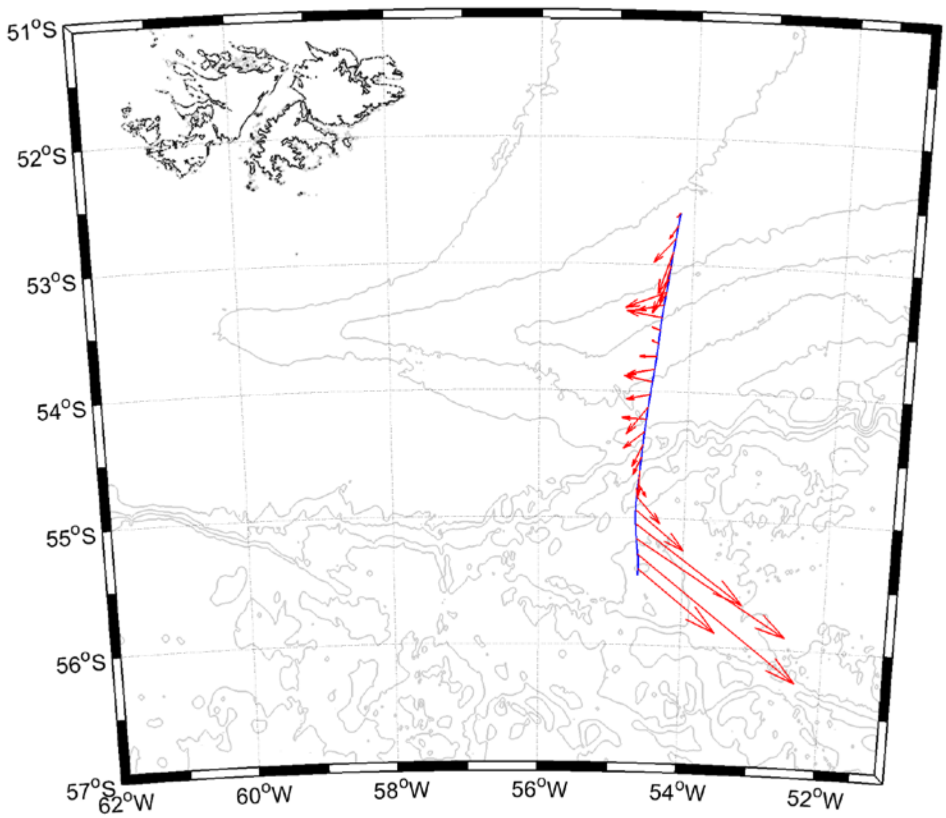

Figure 9.1: Map showing VM-ADCP velocities of the upper 200m of the water column for a large-scale transect to the south-east of the Falkland Islands. Strong easterly currents associated with the Polar and Antarctic circumpolar front is seen in the lower part of the transect.

9.4 RAW OUTPUT

The ADCP data was written to the samba-mounted 'legwork' and 'legdata' drive. File structure for the output files created by VmDAS have the general structure; JR311_XXXXX_YYYYYY.END. Where XXXXX refers to the number set at the start of each recording. YYYYYY is the number that VmDAS automatically increments when the file size reaches its maximum size and a new file is created. END is the file extension (See Summary Table for extension details).

The short-term average interval in VMDAS was set to be 2 minutes and 10 minutes for the long-term averaged data (the .STA and .LTA files, respectively).

System Frequency	76.8 kHz
.N1R	NMEA telegram + ADCP timestamp (ASCII)
.ENR	Beam co-ordinate single-ping data (binary)
.VMO	VmDas configuration (ASCII)
.ENX	Earth co-ordinate single-ping data (binary)
.STA	Earth co-ordinate short-term averaged data (binary)
.LTA	Earth co-ordinate long-term averaged data (binary)

Table 9.2. File extensions created by VMDAS

9.5 PROCESSING OF RAW OUTPUT (WINADCP & OS75)

A 'quick&easy' method processing the ADCP data was conducted during the cruise using WinADCP on the '.STA' raw output and saved as Mat files for interim use during the cruise.

A more thorough method of processing was conducted in Matlab utilizing a bespoke Matlab script created and maintained by a number of contributors from previous cruises aboard the JCR. The routines were developed to convert the raw '.ENX' files to temporally averaged '.mat' output which included removing the bad data points and transforming to absolute velocities in Earth coordinates. The main script used for JR311 was called 'OS75_JCR_jr311.m' and calls a number of specifically created subroutines. The main script requires a number of user-defined inputs including directory path and filenames that are required for processing.

The script is run twice in order to extract and then use calculated instrument misalignment and amplitude factors. Firstly a default instrument misalignment and amplitude factors of 0 and 1 respectively is used. On the second run, misalignment and amplitude values that are calculated in the first run are inputted and used to calculate the output absolute velocities. These values wee found to be -0.0418° for the misalignment angle and 1.018 for the amplitude factor.

The OS75 script calculates the time using a decimal day which represents noon on the 1st January as 0.5 whereas other instrumentation aboard the JCR measures time in Julian days, or year day, which represents noon on the 1st of January as 1.5. Care must therefore be taken when comparing datasets. The data was processed using water track and not bottom track as water depths were greater than the maximum achievable bottom track depth of 800m.

9.6 GENERAL COMMENTS

1. During the cruise there were instances when the VM-ADCP system would freeze and require restarting. During these periods there were no data collected and hence gaps in the dataset are present. In some instance the VM-ADCP system was out of operation for several hours.

2. It was noticed during the cruise that the VM-ADCP velocity magnitudes of both the u and v components were sensitive to ship heading alterations – which we termed as banding. For example, reciprocal tracks would show a slight deviation in velocity magnitude and subsequent current heading. Additionally, the two components of velocity were affected differentially depending on the ship's heading. Banding was especially pronounced when the raw '.STA' data was processed in a 'quick&easy' method using WinADCP, exported as a '.mat' file and plotted in Matlab. When the more thorough processing (OS75) was conducted on the raw '.ENX' files, the variability was reduced but not removed.

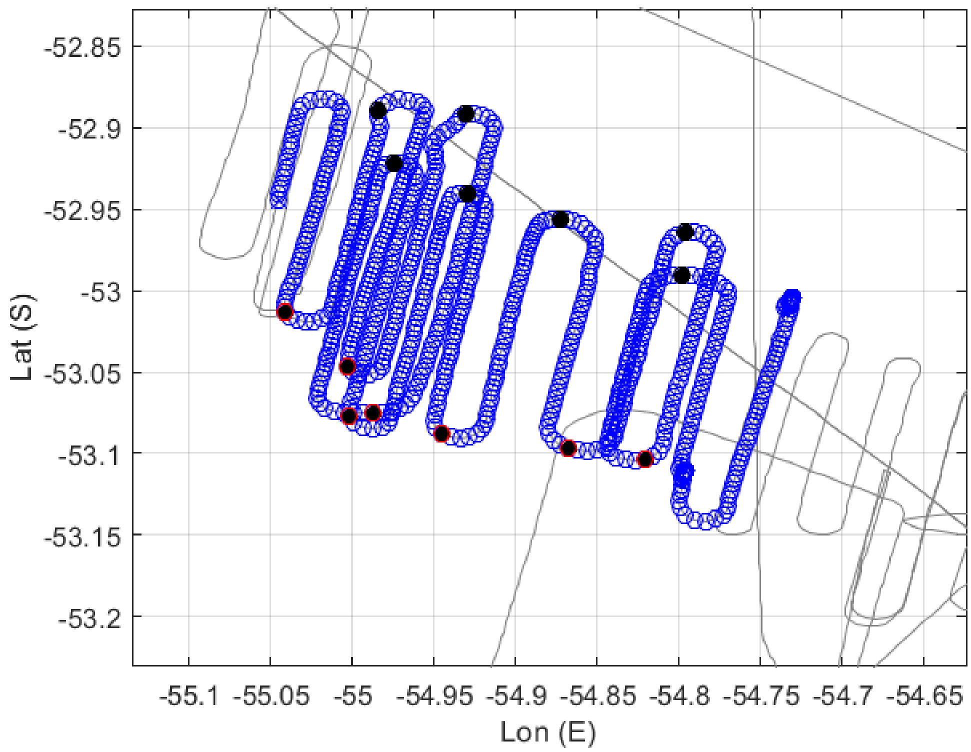

Figure 9.2. Map showing transect legs used to illustrate banding in the VM-ADCP data. Transects were started from the east and were run in an approximately north-south direction with subsequent transects westward of the start point. Black and red-circled points show location of corresponding black and red vertical lines in velocity time series depicted in Figure 9.3.

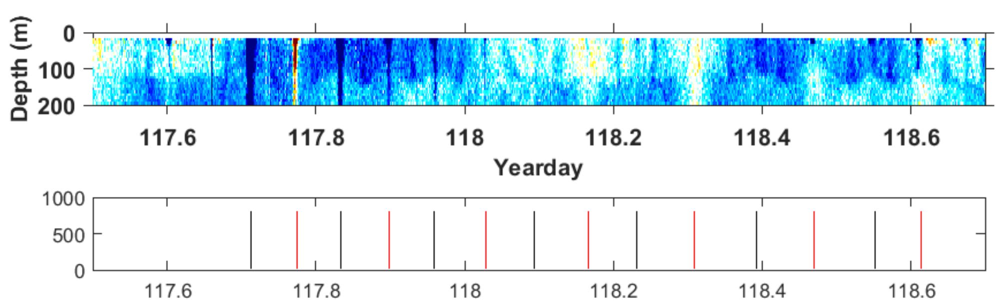

Figure 9.3. Above: u-velocity from WinADCP showing banding of stronger blue (westward velocities). Below: showing the black and red points corresponding to the map shown in the previous figure. These points give an indication in the time series when the ship was turning between transects. East-west banding is seen to occur during these turns. As a result, stronger westward velocities are seen when the ship is turning westwards.

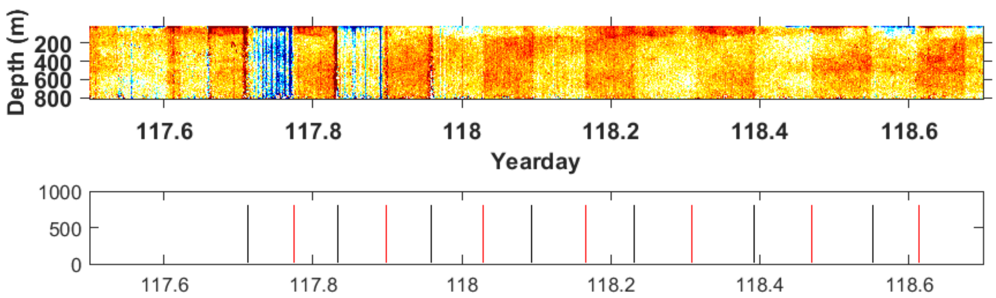

Figure 9.4. Above: v-velocity from WinADCP showing extended banding of stronger red (northward velocities). Below: Black and red points as shown on the map (Figure 9.2). As can be seen, the banding occurs in extended sections, compared to the U velocity, during the approximately north-south transects.

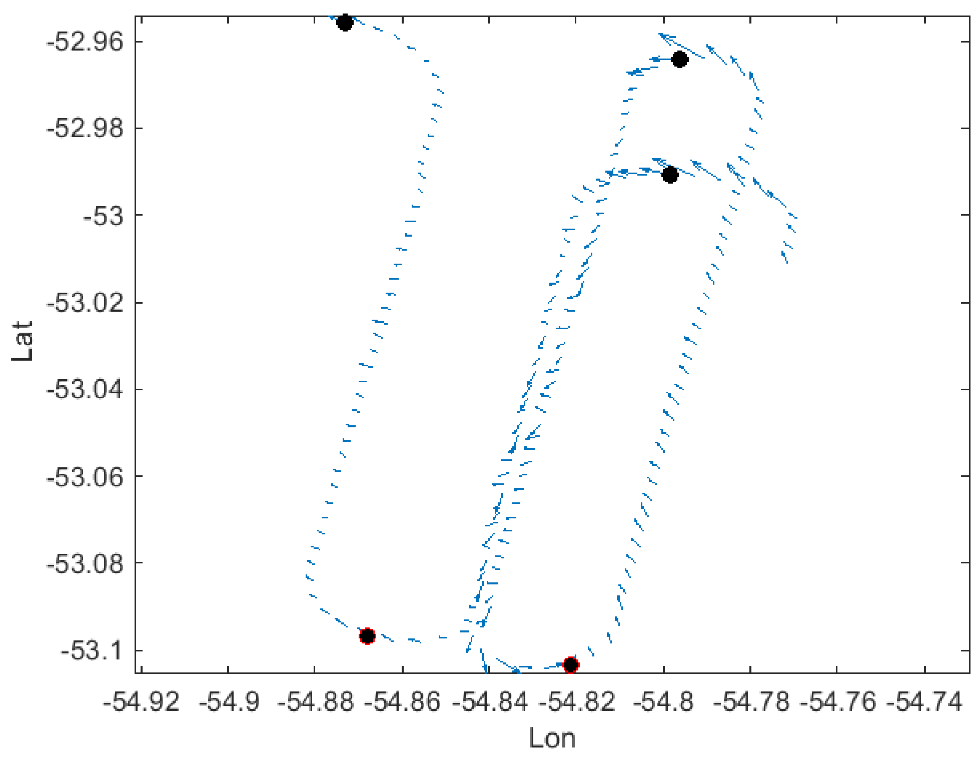

Figure 9.5. Current vectors showing the results of the banding in WinADCP data. The middletwo transects are recorded while the ship was heading southwards and show more variability in current direction in relation to the outer two transects where the ship was heading northwards. Additionally, whilst turning between transects a stronger u-component of velocity is recorded. The southern most sector of the first transect shows eastward currents during the turn. This could be a result of the banding or it could be a bona fide eastward current – this cannot be distinguished without further analysis

9.7 COMPARISON BETWEEN OS75 PROCESSING MATLAB SCRIPT AND WINADCP OUTPUT

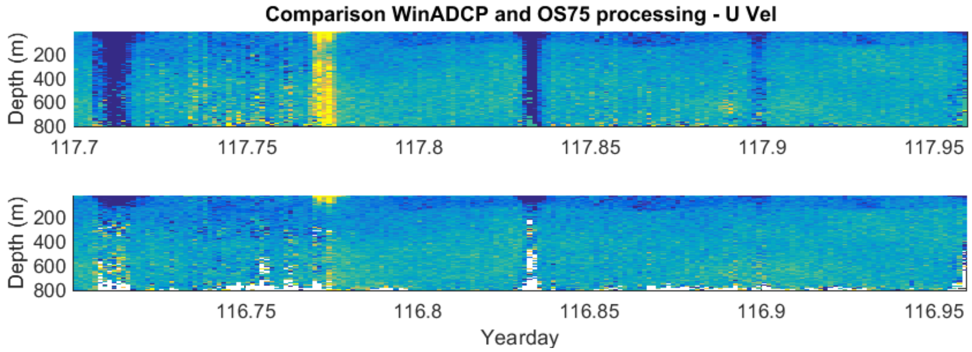

Figure 6. (top) Timeseries of u-velocity from a 'quick&easy' process with WinADCP, and (below) the same section of u-velocity although processed using the OS75 Matlab scripts. The banding is reduced in the OS75 processing. Note: the top panel x-axis (yearday) shows the Julian day (+1) for WinADCP whereas the OS75 processing outputs in decimal days (bottom panel).

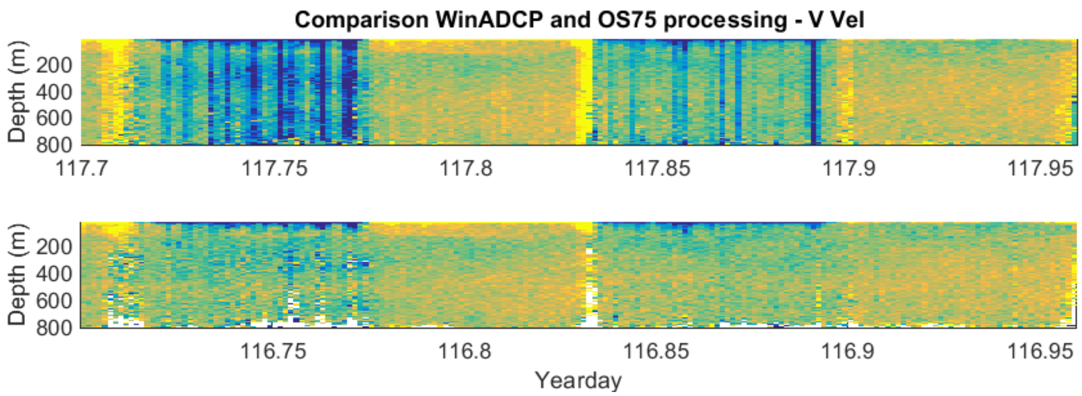

Figure 7. Showing the same comparison as in Figure 6 but for the v-component of velocity. Similarly, the banding is reduced in the OS75 processing (bottom panel). Note: the top panel x-axis (yearday) shows the Julian day (+1) for WinADCP whereas the OS75 processing outputs in decimal days (bottom panel)

10. UNDERWAY MEASUREMENTS: OCEANLOGGER

Megan Stamper, University of Cambridge

10.1 NAVIGATION

On the RRS James Clark Ross, navigational data are logged using the Seapath 200 system. Data are stored in ascii files at 1Hz under the path *legdata/scs/Raw/seatex*.Raw*. Longitude and latitude data are stored in files named *seatex-gll*.Raw* and heading data in files named *seatex-hdt*.Raw*.

To allow the ease of use in matlab of this dataset, seatex-gll and seatex-hdt data were compiled by scripts contained within *legwork/Underway_processing_scripts* named *seatex_gll_read.m* and *seatex_hdt_read.m* into daily .mat files stored in *legwork/Seatex*. For speed this data was stored at a coarsened resolution giving one data point per minute.

Removal of erroneous data points from seatex-gll and seatex-hdt data is done manually using the scripts *despike_seatex_gll.m* and *despike_seatex_hdt.m* located within *legwork/Underway_processing_scripts*. Data points marked for removal are flagged in files named *seatex_gll_*_flags.mat* and seatex_hdt_*_flags.mat. In these files, for each parameter, we set **_flag = 1* for good data and *_flag = 9 for bad data.

Finally data are concatenated into cruise-long .mat files using the script *concat_seatexdata.m* located in *legwork/Operational*. The concatenated navigation for the entire cruise can then be found in the following two .mat files with variables as listed (Table 10.1).

Table 10.1. Filenames and variables of recorded Seatex data.

DIRECTORY	FILENAME	VARIABLES
legwork/Seatex	JR311_concat_seatex_gll.mat	time tii longitude latitude longitude_flags latitude_flags
.legwork/Seatex	JR311_concat_seatex_hdt.mat	time tii heading heading_flags

10.2 OCEANLOGGER AND ANEMOMETER

10.2.1 Instrumentation

There are a number of meteorological and near-surface oceanographic sensors on board the RRS James Clark Ross measuring; air temperature (T), humidity (H), photosyntheticly active radiation (PAR), short wave radiation (TIR), sea-surface temperature (SST), salinity, conductivity, fluorescence and barometric pressure (BAR). These are logged using the oceanlogger system at 5 second intervals and stored in files *legwork/scs/Raw/oceanlogger*.Raw*.

In addition, anemometer readings give wind direction and wind speed relative to the ship at 2 second intervals. These are stored in files *legwork/scs/Raw/anemometer*.Raw*.

Meteorological instruments are located on the JCR's foremast with estimated heights: sonic anemometer, 0.65m, air temperature and humidity sensor, 0.25m, irradiance sensors, 0.2m. Barometers are located in the oceanlogger display cabinet in the UIC. The thermosalinograph (TSG), flowmeter, fluorometer and transmissometer are located in the prep-lab and the thermometer for calculating underway SST is, downstairs from there, in the transducer room.

The difference in location between the TSG and underway SST measurements has resulted in a 3 minute lag between SST measurements and the salinity and conductivity measurements in the oceanlogger data. These data sets will therefore need to have their time vectors adjusted accordingly before use.

Table 10.2. Serial numbers and types of all instrumentation used during the underway sampling.

INSTRUMENT	SERIAL NUMBER	TYPE
Thermometer	0767	Sea-bird Electronics (SBE) 38
Thermometer	0771	Sea-bird Electronics (SBE) 38
Digital Barometer	V1450002	Vaisala PTB210 Class B
Digital Barometer	V1450003	Vaisala PTB210 Class B
Transmissometer	CST-1279DR	Web Labs, C-Star (CST)
Flowmeter	05/811950	Litremeter, 05SPRA40CE
PAR1	110127	Kipp & Zonen, PQS 1
PAR2	110126	Kipp & Zonen, PQS 1
Temperature & humidity (port side)	0060743898	Rotronic, MP402H-050300
Temperature & humidity (starboard side)	0060743896	Rotronic, MP402H-050300
TIR1	112993	Kipp & Zonen, SP Lite2
TIR2	112992	Kipp & Zonen, SP Lite2
Fluorometer	1100243	Turner designs, 10AU

10.2.2 Data processing

The oceanlogger and anemometer datasets were compiled daily into .mat files by the scripts *underway_read.m* and *anemometer_read.m* located in *legwork/Underway_processing_scripts* and stored in *legdata/Underway_Data/Oceanlogger* and *legdata/Anemometer*, respectively. Again, for speed, this data was stored at the coarsened resolution of one data point per minute.

The seatex-gll navigation data (latitude and longitude) are interpolated onto the same grid as the oceanlogger data by the script *oceanlogger_latlon.m* located in *legwork/Underway_processing_scripts* and stored in *legdata/Underway_Data/Oceanlogger* in files named *oceanlogger_pos_*.mat*. This interpolated data is included in the final concatenated .mat files described below, also including the calculation of the distance travelled between each lat / lon data point.

Removal of erroneous data points from anemometer and oceanlogger data is done manually using the scripts *despike_underway.m* and *despike_anemometer.m* located under *legwork/Underway_processing_scripts*. Data points marked for removal are flagged in files named anemometer_*_flags.mat and *oceanlogger_*_flags.mat, located in legdata/Underway_Data/Oceanlogger* and *legdata/Anemometer*, respectively. In these files, for each parameter, we set **_flag = 1* for good data and *_flag = 9 for bad data. These flags are added so that we need not actually remove data points from the data set i.e. all original data can be recovered.

Finally data are concatenated into cruise-long .mat files using the scripts *concat_underwaydata.m* and *concat_winddata.m* located in *legwork/Operational*. The concatenated datasets for the entire cruise can then be found in the following .mat files with variables as listed.

Table 10.3. Filenames of .mat files created from underway data and the variables contained within each file.

DIRECTORY	FILENAME	VARIABLES
./Underway_Data	JR311_concat_underway_data.mat	time tii, T1, T1_flags, H1, H1_flags, PAR1, PAR1_flags, TIR1, TIR1_flags, T2, T2_flags, H2, H2_flags, PAR2, PAR2_flags,

		TIR2, TIR2_flags, BAR1, BAR1_flags, BAR2, BAR2_flags, salinity, salinity_flags, conductivity, conductivity_flags, fluorometer, fluorometer_flags, SST1, SST1_flags, SST2, SST2_flags, lat, lat_flags, lon, lon_flags, dist, dist_flags
./Anemometer	JR311_concat_wind_data.mat	time wspd, wspd_flags, wdirection, wdirection_flags

11. NUTRIENT AND CHLOROPHYLL BIOGEOCHEMISTRY

Jill Schwarz, Ross Millar, Zoe Waring, Plymouth University

Sampling for biogeochemical parameters was carried out semi-continuously between 22nd April and 20th May, with two breaks during rough weather. Water samples were collected from the uncontaminated seawater supply in the Main Lab, and from 3 or 4 Niskin bottles on each CTD cast (surface, approximate centre of the fluorescence maximum/mixed layer, sub-pycnocline and for some stations, 2000 m). The estimated time delay between the main lab and the underway-system water supply, where the Turner fluorometer was based, was < 20 s. We chose the Main Lab for underway sampling as it was the clearest space to set up the underway FRRF and had a clear view to a UTC time display. Methods are detailed below. Table 1 lists the CTD locations, chlorophyll results and number of samples taken for nutrient, absorption, HPLC and flow cytometric analysis. Table 2 provides this information for the underway samples.

11.1 CHLOROPHYLL-A

Water samples were taken every 40 minutes to 2 hours from the ship's uncontaminated seawater supply (intake at approximately 5 m depth). Chlorophyll-a was determined fluorometrically using a Turner Trilogy fluorometer, with a non-acidifying chlorophyll-a module, after gentle filtration of 0.9 to 1.5 litres through GF/F filters. The fluorometer was calibrated against Turner chl-a standard solution prior to the cruise (data kindly provided by Andy Rees, PML):

$$chl = 0.2506 \cdot F - 0.04 \ \ (mg\ m^{-3})$$

Fluorometer stability was checked using pre- and post-cruise measurements of a stock chl-a solution in 90% acetone (Sigma Aldrich; rmse 0.17%), as well as of a solid standard. Triplicate chl-a measurements were taken every 10 samples.

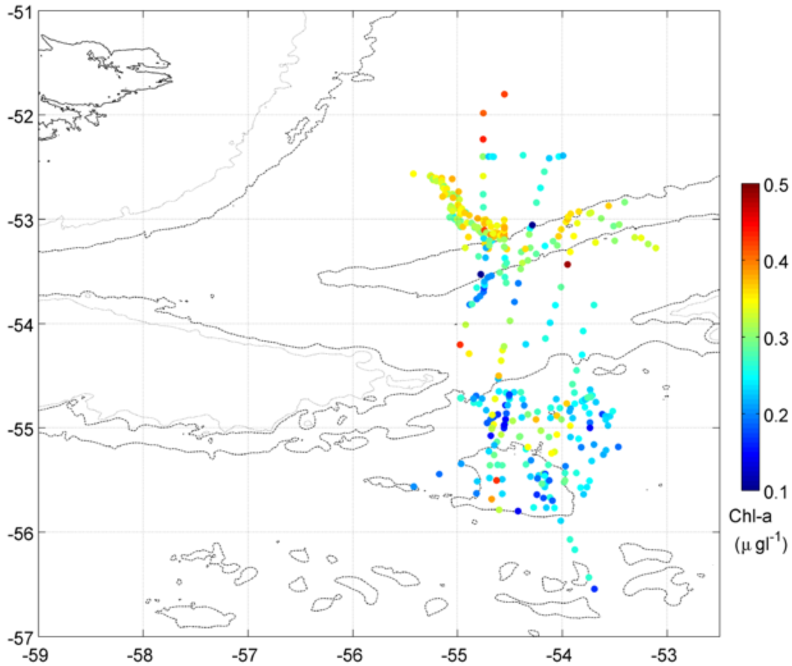

Figure 11.1. Chl-a discrete sampling map.

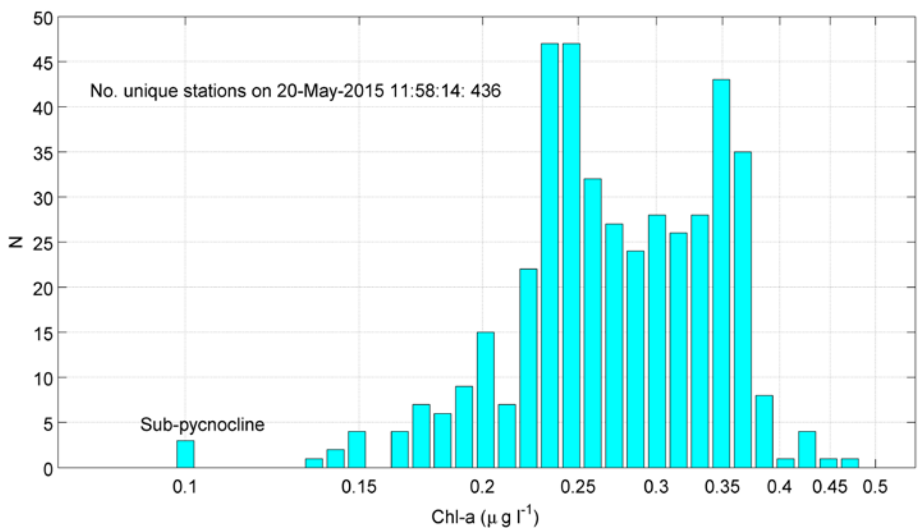

Figure 11.2. Chl-a discrete sampling distribution.

Spectral fluorescence of the extract was measured using a 405 nm LED lamp, delivered via a 0.2 mm diameter optical fibre to a 4-way, 1 cm cuvette holder in which the sample was held. A second 0.2 mm diameter optical fibre positioned at right angles to the cuvette-lamp plane collected light. Measurements were made using an Ocean Optics USB2000 spectrometer in the range 300 to 1000 nm at 0.2 nm intervals.

20 fluorescence emission spectra were averaged and smoothed using a 3rd order, 25 nm Savitsky-Golay filter. Chl-a was estimated as the ratio between the excitation peak intensity at 404 nm (Ex404) and peak emission intensity at 670 nm (Em670). Phaeopigments were estimated by repeating this procedure after acidifying the sample with 1 % HCl, using Ex404/Em672. Fluorescence Ex/Em values will be validated using results from high performance liquid chromatography (Section 11.2).

Calibration of the Turner AU10 fluorometer plumbed into the uncontaminated seawater supply and running continuously was hindered by the low gain of the AU10 and low range of chlorophyll values. Some means of a) cleaning this system and b) diverting the input to the system to enable calibration standards to be run through it would facilitate accurate calibration of this system.

Although fluorescence efficiency was found to be temperature dependent, there remained high uncertainty in the fluorometer calibration and no clear relationship was found between water mass and chl-a range with which to refine the underway fluorometer data (see figures below). Calibration of the CTD fluorometer was successful because of the higher range of calibration sample values spanning deep to surface waters (section 6.10).

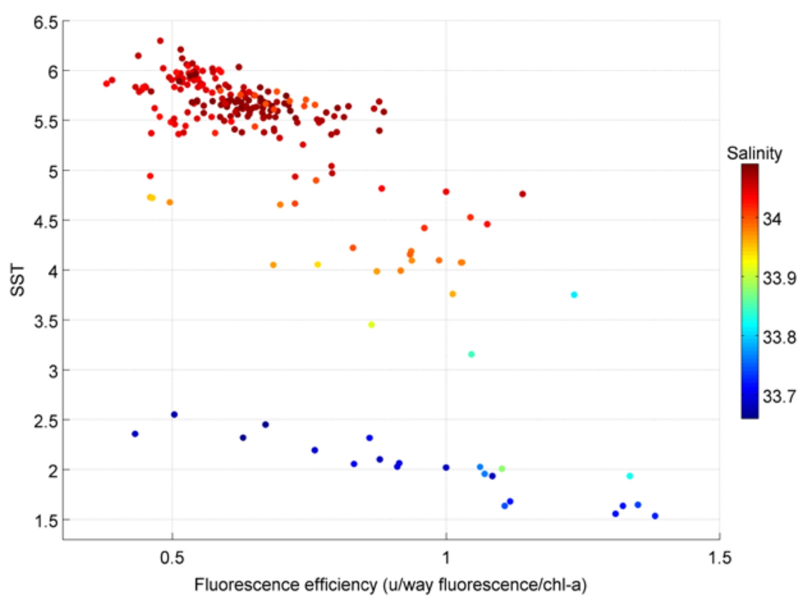

Figure 11.3. Underway fluorescence normalised to discrete surface chl-a values, in relation to surface temperature and salinity.

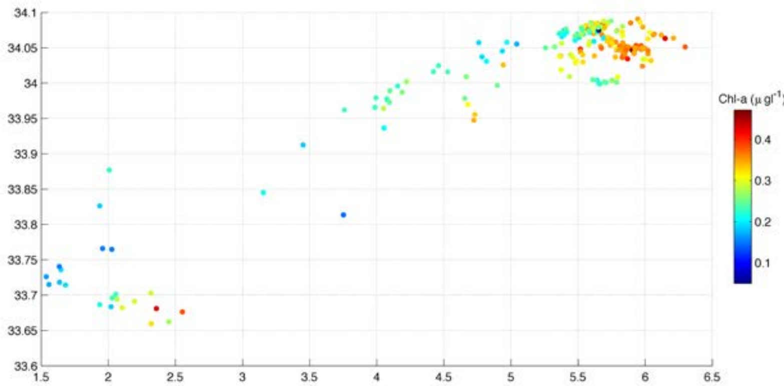

Figure 11.4. Discrete surface chl-a values relative to SST (x-axis) and salinity (y-axis).

11.2 PHYTOPLANKTON PIGMENTS

Additional filtrations of 1 to 1.5 litres were carried out in triplicate, every 20th chl-a sample. Filters were stored at -80 C prior to analysis by high performance liquid chromatography at PML.

11.3 PHYTOPLANKTON IDENTIFICATION AND ENUMERATION

50 ml aliquots of seawater were preserved with glutaraldehyde at a concentration of 0.5 %, and stored at 4 C prior to microscopy analysis - as requested by Amy Leventer at Colgate University, New York. For additional qualitative analysis, GF/F filters used for absorption measurements were stored at -80 C for examination with an inverted microscope.

11.4 CELL SIZE AND ABUNDANCE

Aliquots of 1.9 ml, taken from the same water samples used for chl-a measurements, were pipetted into 2 ml vials, preserved with glutaraldehyde at a final concentration of 0.5 % and stored at -20 C prior to flow cytometry analysis. Triplicate samples were taken every 10th station. Vials were pre-spiked with glutaraldehyde prior to sailing and stored at -20 C.

11.5 MACRONUTRIENTS

One set of nutrient samples was taken by storing the water filtered for chl-a analysis, after 3 rinses of the filtration rig and the GF/F filter, and storing at -20 C prior to analysis for nitrate, nitrite, phosphate and silicate. Seven sample bags were held bag to investigate potential leaching. Triplicate samples were taken approximately every 15th underway station.

A second set of nutrient samples was taken separately from Niskin bottles on the CTD. These water samples were filtered using 0.2 μm membrane syringe-cartridges and stored in plastic bottles at -80 C. Bottle samples were taken from duplicate-depth firings and filtered with GF/F filters, for comparison of the two methods, at 3 depths on 24 CTD stations (72 comparison samples). This should help us to quantify Si-leaching from the GF filters.

11.6 PHYTOPLANKTON ABSORPTION

Spectral absorption coefficients were estimated using a simple filter pad approach. Aliquots of 0.9 to 1.5 ml taken from the uncontaminated seawater supply were gently filtered through GF/F filters. The filters were placed in the beam of a white LED lamp (Ocean Optics Ltd), with the phytoplankton side facing away from the light source. Light was delivered and collected using a 4-way, collimated fibre-optic cuvette/filter holder, equipped with 0.2 mm core optical fibres. Measurements were made using an Ocean Optics USB2000 spectrometer. Blank readings were taken using a GF/F filter, wetted using 0.2 μm membrane-filtered seawater. A second measurement was taken with the filter positioned directly against the light-collecting optical fibre inlet, so that the majority of scattered light is collected.

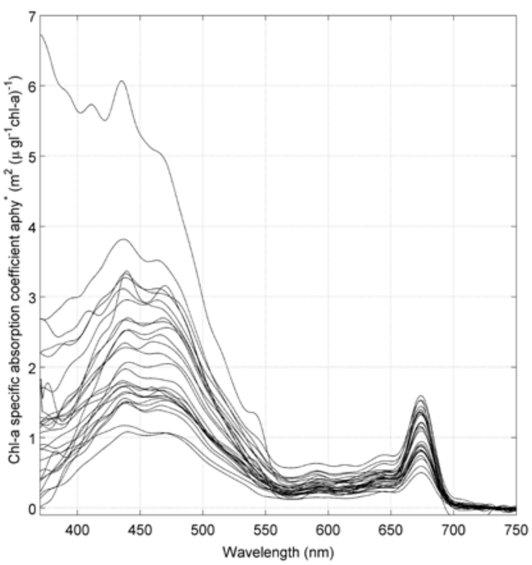

Figure 11.5. Spectral chlorophyll-specific absorption curves.

11.7 PHYTOPLANKTON PHOTOSYNTHETIC COMPETENCE AND PHOTOSYNTHETIC RATE

A Chelsea Instruments Fasttracka Mark I was plumbed into the ship's uncontaminated seawater supply and run continuously. The light chamber was switched off and the exposed sensor windows completely covered to avoid ambient light contamination of the photomultiplier detector. For the dark chamber, 100 saturation flashes of 1.1 μs duration and 0 s interval were delivered, followed by 20 relaxation flashes, also of 1.1 μs duration and 58 μs interval. The instrument was characterised according to manufacturer recommendations using milli-Q water to obtain blank readings for each detector element and rhodamine B dilutions in milli-Q water for scattering and instrument response calibrations. Data were processed for quality control using the Chelsea software FRS, prior to averaging and reprocessing using Sam Laney's v5.

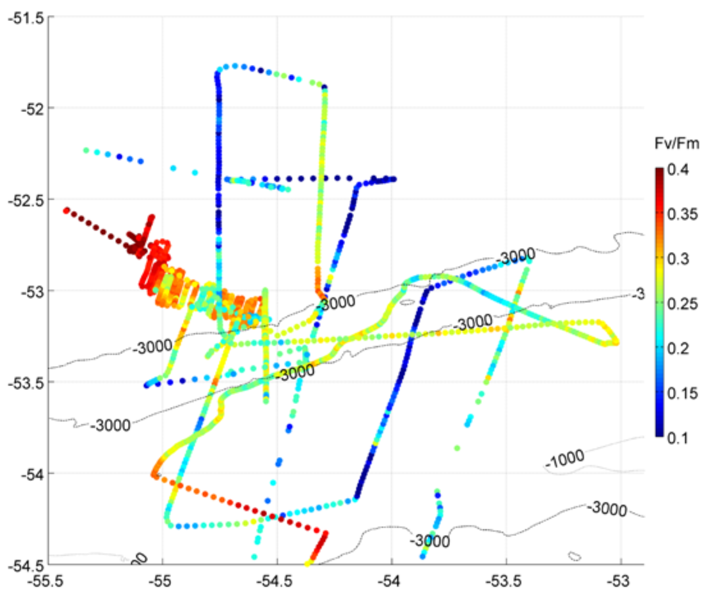

Figure 11.6. Surface Fv/Fm values for the northern front.

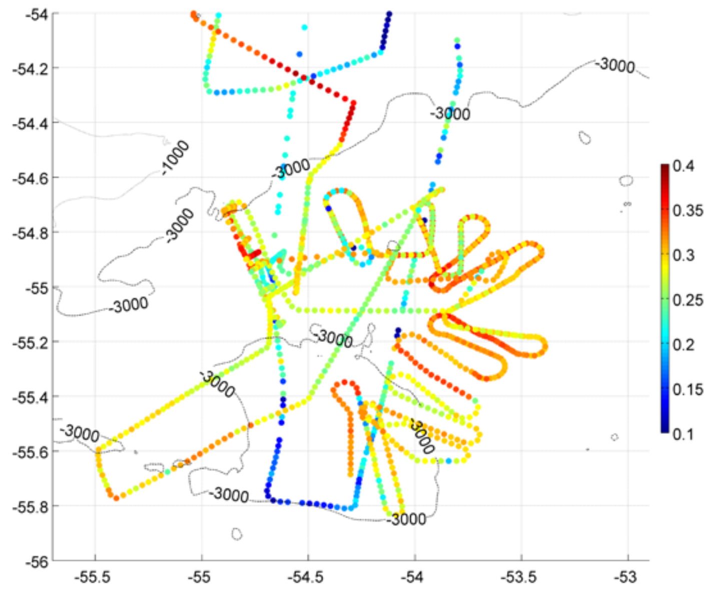

Figure 11.7. Surface Fv/Fm values for the eddy.

11.8 WATER COLOUR

Water leaving radiance, Lw(λ), was measured using a TriOS RAMSES ARC radiometer, held at approximately 40° to the vertical over the ship's side approximately 3 m above the water surface, facing as close as possible to right angles from the sun. Incident light was sampled using a Spectralon plate held horizontally beneath the sensor immediately after the Lw(λ) measurement. Ten replicate readings were taken from the water and the Spectralon plate and the pair of readings for which Lw(λ) was lowest was selected to minimise contamination by surface reflectance. No readings were taken for normalisation to solar zenith, and sampling was carried out between 13:30 and 14:30 ship time, with the Sun fairly low in the sky.

11.9 BIOGEOCHEMISTRY SAMPLE DETAILS AND DISCRETE CHL-A RESULTS.

Table 11.1. Water sample analysis for CTDs:

Mon	Day	CTD No.	Time-Start UTC	Time-End UTC	Location		Depth (m)	Sample Name	Chl-a ug/L	Flow Cyt	Nutrients	Absorb.	HPLC
					Latitude	Longitude				(No. Samples)			
5	1	1	19:08:00	21:05:00	-53.08827	-54.3078	10	J189	0.256	1	1	1	0
5							30	J190	0.268	1	1	1	0
5							62	J191	0.245	1	1	1	0
5							80	J192	0.434	1	1	1	0
5							120	J193	0.124	1	1	1	0
5							130	J194	0.007	1	1	1	0
5	1	2	22:39:00	0:30:00	-53.07512	-54.30065	10	J195	0.021	1	1	1	0
5							30	J196	0.023	1	1	1	0
5							60	J197	0.040	1	1	1	0
5							80	J198	0.043	1	1	1	0
5							110	J199	0.026	1	1	1	0
5							170	J200	0.003	1	1	1	0
5	2	3	2:26:00	3:53:00	-53.06167	-54.28888	10	J202	0.062	1	1	1	0
5							20	J203	0.341	1	1	1	0
5							38	J204	0.298	1	1	1	0
5							80	J205	0.174	1	1	0	0
5							110	J206	0.043	1	1	0	0
5							150	J207	0.031	1	1	0	0
5	7	4	1:20:00	2:56:00	-54.99927	-54.66868	90	J270	0.174	1	1	1	0
5							10	J271	0.161	1	1	1	0
5							250	J272	0.009	1	1	0	0
5	7	5	4:57:00	6:37:00	-55.12915	-54.61839	60	J273	0.283	1	1	1	0
5							10	J274	0.266	1	1	1	0
5							295	J275	0.037	1	1	1	0
5	7	6	8:42:00	10:15:00	-54.915	-54.70791	10	J276	0.173	1	1	1	0
5							60	J277	0.174	1	1	1	0
5							345	J278	0.008	1	1	0	0

5	7	7	11:33:00	nan	-54.89813	-54.79026	10	J279	0.232	1	1	1	0
5							67	J280	0.195	1	1	1	0
5							450	J281	0.005	1	1	0	0
5	7	8	14:15:00	nan	-54.85598	-54.81676	10	J282	0.194	1	1	1	0
5							49	J283	0.215	1	1	1	0
5							140	J284	0.028	1	1	0	0
5	7	9	16:45:00	18:00:00	-54.71599	-54.88268	10	J285	0.187	1	1	1	0
5							60	J286	0.203	1	1	1	0
5							130	J287	0.081	1	1	0	0
5	7	10	23:07:00	0:41:00	-54.87557	-54.18331	60	J289	0.176	1	1	1	1
5							10	J290	0.175	1	1	1	0
5							235	J291	0.024	1	1	1	0
5							350	J292	0.007	1	1	0	0
5	13	12	23:22:00	0:50:00	-56.78022	-53.4221	4	J380	0.197	1	1	1	0
5							78	J381	0.285	1	1	1	0
5							122	J382	0.221	1	1	1	0
5							300	J383	0.028	1	1	0	0
5							2000	J384	#DIV/0!	0	1	0	0
5	13	12	2:54:00	4:13:00	-56.66172	-53.61788	6	J385	0.141	1	1	1	0
5							80	J386	0.085	1	1	1	0
5							250	J387	0.009	1	1	0	0
5	13	13	9:01:00	10:26:00	-56.09875	-53.92435	6	J388	0.254	1	1	1	1
5							60	J389	0.257	1	1	1	0
5							150	J390	0.056	1	1	1	0
5							2000	J391	0.000	0	1	0	0
5	13	14	14:28:00	nan	-55.66731	-54.13448	6	J392	0.233	1	1	1	1
5							80	J393	0.230	1	1	1	0
5							130	J394	0.204	1	1	1	0
5							2000	J395	0.000	0	1	0	0
5	13	15	19:36:00	21:04:00	-55.43111	-54.24644	10	J396	0.241	1	1	1	0
5							50	J397	0.239	1	1	1	0
5							200	J398	0.026	1	1	0	0
5	13	16	nan	0:31:00	-55.28943	-54.35775	10	J399	0.187	1	1	1	1
5							75	J400	0.184	1	1	1	0
5							200	J401	0.015	1	1	0	0

5	14	17	2:44:00	4:18:00	-55.17641	-54.35904	10	J402	0.272	1	1	1	1
5							60	J403	0.270	1	1	1	0
5							300	J404	0.018	1	1	1	0
5	14	18	5:55:00	7:42:00	-55.06627	-54.36901	6	J405	0.317	1	1	1	1
5							57	J406	0.370	1	1	1	0
5							240	J407	0.031	1	1	0	0
5	14	19	9:41:00	11:01:00	-54.94891	-54.42627	6	J408	0.324	1	1	1	1
5							50	J409	0.313	1	1	1	0
5							230	J410	0.057	1	1	0	0
5	14	20	13:43:00	15:13:00	-54.76519	-54.43116	6	J411	0.269	1	1	1	0
5							50	J412	0.246	1	1	0	0
5							190	J413	0.100	1	1	0	0
5	14	21	18:59:00	20:25:00	-54.66521	-54.46118	10	J414	0.267	1	1	1	1
5							70	J415	0.254	1	1	1	0
5							200	J416	0.023	1	1	0	0
5	14	22	22:55:00	0:23:00	-54.47203	-54.58651	10	J417	0.224	1	1	1	1
5							25	J418	0.185	1	1	1	0
5							100	J419	0.008	1	1	0	0
5							2000	J420	0.002	1	1	0	0
5	15	23	3:54:00	5:03:00	-54.21222	-54.75845	14	J421	0.300	1	1	1	1
5							73	J422	0.222	1	1	1	0
5							200	J423	0.006	1	1	0	0
5	15	24	7:01:00	8:15:00	-54.05479	-54.84696	200	J424	0.013	1	1	0	0
5							85	J425	0.292	1	1	1	0
5							6	J426	0.306	1	1	1	1

Table 11.2. Underway sample locations, number samples taken and chlorophyll-a results:

Mon	Day	Time-Start UTC	Time-End UTC	Location		Depth (m)	Sample Name	Chl-a ug/L	Flow Cyt	Nutrients	Absorb.	HPLC
				Latitude	Longitude				(No. Samples)			
4	22	9:50:50	9:52:25	-54.654692	-52.40080	4	J001	0.242	0	0	0	0
4	22	11:16:40	11:17:40	-54.668801	-52.3986	4	J002	0.247	0	1	0	0
4	22	12:54:40	12:56:11	-54.703262	-52.39863	4	J003	0.227	1	1	0	0
4	22	14:14:03	14:15:15	-54.374821	-52.38688	4	J004	0.261	1	1	0	0
4	22	15:32:30	15:33:56	-53.994381	-52.39104	4	J005	0.220	1	0	0	0
4	22	16:46:55	16:48:18	-54.03419	-52.39828	4	J006	0.246	0	1	0	0
4	22	17:55:53	17:57:00	-54.125381	-52.41638	4	J007	0.229	1	1	0	0
4	22	18:54:35	18:56:23	-54.171998	-52.54465	4	J008	0.269	1	1	0	0
4	22	19:55:10	19:56:57	-54.209396	-52.69909	4	J009	0.253	1	1	0	0
4	22	20:49:25	20:53:00	-54.246355	-52.84081	4	J010A	0.273	1	1	0	0
4	22	20:49:25	20:53:00	-54.246355	-52.84081	4	J010B	0.287	0	0	0	0
4	22	20:49:25	20:53:00	-54.246355	-52.84081	4	J010C	0.279	0	0	0	0
4	22	22:44:15	22:45:55	-54.31685	-53.14454	4	J011	0.301	1	0	0	0
4	22	23:39:40	23:40:38	-54.352942	-53.28396	4	J012	0.359	3	1	1	0
4	23	0:57:16	0:57:48	-54.398699	-53.47847	4	J013	0.304	1	0	0	0
4	23	1:49:53	1:51:00	-54.421081	-53.61480	4	J014	0.197	1	1	1	0
4	23	3:00:24	3:01:05	-54.456968	-53.79347	4	J015	0.200	1	0	0	0
4	23	4:12:45	4:13:30	-54.500852	-53.97437	4	J016	0.311	1	1	1	0
4	23	5:52:31	5:53:11	-54.556612	-54.22051	4	J017	0.318	1	0	0	0
4	23	6:47:10	6:47:45	-54.583763	-54.35736	4	J018	0.344	1	0	1	0
4	23	7:44:40	7:45:15	-54.606751	-54.50214	4	J019	0.374	1	0	0	0
4	23	9:10:20	9:11:30	-54.642507	-54.72164	4	J020A	0.339	1	0	0	3
4	23	9:10:20	9:11:30	-54.642507	-54.72164	4	J020B	0.342	1	0	0	0
4	23	9:10:20	9:11:30	-54.642507	-54.72164	4	J020C	0.352	1	0	0	0
4	23	10:10:55	10:11:15	-54.667073	-54.87659	4	J021	0.342	1	0	1	0
4	23	10:56:49	10:57:50	-54.66921	-54.99973	4	J022	0.319	1	1	0	0
4	23	11:53:42	11:54:50	-54.64975	-55.16639	4	J023	0.220	1	0	1	0
4	23	12:55:40	12:56:40	-54.618325	-55.35464	4	J024	0.274	1	1	0	0
4	23	13:52:40	13:53:40	-54.627468	-55.50472	4	J025	0.426	1	0	1	0
4	23	15:02:40	15:04:10	-54.672968	-55.68284	4	J026	0.384	1	1	0	0

4	23	15:58:40	15:59:30	-54.602123	-55.78655	4	J027	0.323	1	0	1	0
4	23	16:41:40	16:42:30	-54.423527	-55.79778	4	J028	0.143	1	1	0	0
4	23	17:38:50	17:40:10	-54.274268	-55.76196	4	J029	0.254	1	0	1	0
4	23	18:45:45	18:47:45	-54.242196	-55.64082	4	J030A	0.168	1	1	0	0
4	23	18:45:45	18:47:45	-54.242196	-55.64082	4	J030B	0.168	0	0	0	0
4	23	18:45:45	18:47:45	-54.242196	-55.64082	4	J030C	0.175	0	0	0	0
4	23	19:44:40	19:45:20	-54.195248	-55.53669	4	J031	0.282	3	0	1	0
4	23	20:29:00	20:30:00	-54.166813	-55.45935	4	J032	0.249	1	1	0	0
4	23	21:23:10	21:23:55	-54.133168	-55.35423	4	J033	0.275	1	0	0	0
4	23	22:13:10	22:14:33	-54.101831	-55.24441	4	J034	0.349	1	0	1	0
4	23	23:28:17	23:29:24	-54.053046	-55.06492	4	J035	0.348	1	3	0	0
4	24	0:27:25	0:28:30	-54.008104	-54.91984	4	J036	0.301	1	0	0	3
4	24	1:28:13	1:29:05	-53.958002	-54.76600	4	J037	0.366	1	0	1	0
4	24	2:38:30	2:39:15	-53.902773	-54.58068	4	J038	0.277	1	1	0	0
4	24	3:29:00	3:29:32	-53.863459	-54.44858	4	J039	0.271	1	0	0	0
4	24	4:27:41	4:28:50	-53.810989	-54.29917	4	J040A	0.246	1	0	0	0
4	24	4:27:41	4:28:50	-53.810989	-54.29917	4	J040B	0.247	0	0	0	0
4	24	4:27:41	4:28:50	-53.810989	-54.29917	4	J040C	0.246	0	0	0	0
4	24	5:54:30	5:55:31	-53.801617	-54.07181	4	J041	0.250	3	1	1	0
4	24	7:30:12	7:30:40	-53.699441	-53.82150	4	J042	0.260	1	0	0	0
4	24	12:25:00	12:26:20	-53.457804	-53.05050	4	J043	0.305	1	1	0	0
4	24	13:37:00	13:57:52	-53.404899	-52.83644	4	J044	0.299	1	0	1	0
4	24	14:36:02	14:36:45	-53.55889	-52.87150	4	J045	0.366	1	0	0	0
4	24	15:29:10	15:29:50	-53.741197	-52.94601	4	J046	0.331	1	1	0	0
4	24	16:16:40	16:17:20	-53.858566	-53.03789	4	J047	0.342	1	0	1	0
4	24	17:06:50	17:07:45	-53.890679	-53.16192	4	J048	0.347	1	0	0	0
4	24	18:07:10	18:08:02	-53.924417	-53.31459	4	J049	0.345	1	0	1	0
4	24	18:52:40	18:53:48	-53.949142	-53.43240	4	J050A	0.482	1	3	0	0
4	24	18:52:40	18:53:48	-53.949142	-53.43240	4	J050B	0.451	0	0	0	0
4	24	18:52:40	18:53:48	-53.949142	-53.43240	4	J050C	0.483	0	0	0	0
4	24	20:17:20	20:18:00	-54.013452	-53.65051	4	J051	0.286	1	0	0	0
4	24	21:24:15	21:24:56	-54.067814	-53.82471	4	J052	0.247	1	0	1	0
4	24	22:29:56	22:30:45	-54.116694	-53.99228	4	J053	0.238	1	1	0	0
4	24	23:31:15	23:32:15	-54.161788	-54.14444	4	J054	0.259	1	0	0	0
4	25	0:19:30	0:20:10	-54.349823	-54.19795	4	J055	0.233	1	0	1	0

4	25	1:16:17	1:17:40	-54.57125	-54.25599	4	J056	0.341	1	1	0	3
4	25	2:29:00	2:29:35	-54.888639	-54.28957	4	J057	0.356	1	0	0	0
4	25	3:16:56	3:19:26	-54.976441	-54.20244	4	J058	0.430	1	0	1	0
4	25	4:31:10	4:31:30	-54.922234	-54.01134	4	J059	0.320	1	1	0	0
4	25	5:48:30	5:50:25	-54.86319	-53.81417	4	J060A	0.273	1	0	0	0
4	25	5:48:30	5:50:25	-54.86319	-53.81417	4	J060B	0.278	0	0	0	0
4	25	5:48:30	5:50:25	-54.86319	-53.81417	4	J060C	0.274	0	0	0	0
4	25	6:55:30	6:56:15	-54.816516	-53.65527	4	J061	0.257	1	0	1	0
4	25	7:48:52	7:49:22	-54.778471	-53.52860	4	J062	0.050	1	1	0	0
4	25	8:55:00	8:55:35	-54.731687	-53.36903	4	J063	0.222	1	0	0	0
4	25	9:44:20	9:45:30	-54.696887	-53.24959	4	J064	0.297	1	0	1	0
4	25	10:31:26	10:32:20	-54.662236	-53.13800	4	J065	0.341	1	3	0	0
4	25	11:22:01	11:22:36	-54.830294	-53.07291	4	J066	0.313	2	0	0	0
4	25	12:06:20	12:07:12	-54.895222	-53.16993	4	J067	0.362	1	0	1	0
4	25	12:48:21	12:49:07	-54.928046	-53.27293	4	J068	0.334	1	1	0	0
4	25	19:37:40	19:38:21	-54.392197	-53.31435	4	J069	0.292	1	0	0	0
4	25	20:23:35	20:24:40	-54.531299	-53.41851	4	J070A	0.271	1	0	0	0
4	25	20:23:35	20:24:40	-54.531299	-53.41851	4	J070B	0.293	0	0	0	0
4	25	20:23:35	20:24:40	-54.531299	-53.41851	4	J070C	0.274	0	0	0	0
4	25	21:46:58	21:47:40	-54.535686	-53.60962	4	J071	0.278	1	0	1	0
4	25	22:39:15	22:40:08	-54.548813	-53.55532	4	J072	0.266	1	1	0	0
4	25	23:50:57	23:51:40	-54.54831	-53.44573	4	J073	0.294	1	0	0	0
4	26	0:37:45	0:38:52	-54.54864	-53.37194	4	J074	0.246	1	0	1	0
4	26	1:46:12	1:46:46	-54.551593	-53.26786	4	J075	0.301	1	1	0	0
4	26	2:35:10	2:37:45	-54.555276	-53.19289	4	J076	0.311	1	0	0	3
4	26	3:50:00	3:51:05	-54.552604	-53.08539	4	J077	0.381	1	0	1	0
4	26	4:45:00	4:45:45	-54.555523	-53.00592	4	J078	0.350	1	0	0	0
4	26	5:41:40	5:42:20	-54.552157	-53.07384	4	J079	0.363	3	0	0	0
4	26	6:55:10	6:56:55	-54.550185	-53.17674	4	J080A	0.382	1	3	0	0
4	26	6:55:10	6:56:55	-54.550185	-53.17674	4	J080B	0.369	0	0	0	0
4	26	6:55:10	6:56:55	-54.550185	-53.17674	4	J080C	0.368	0	0	0	0
4	26	8:10:00	8:10:42	-54.555017	-53.26379	4	J081	0.292	1	0	0	0
4	26	8:58:35	8:59:45	-54.554687	-53.18592	4	J082	0.332	1	0	1	0
4	26	9:51:10	9:51:40	-54.554783	-53.10624	4	J083	0.354	1	1	0	0
4	26	11:06:02	11:06:42	-54.555889	-53.10824	4	J084	0.349	1	0	0	0

4	26	11:47:18	11:47:42	-54.553083	-53.17364	4	J085	0.352	1	0	0	0
4	26	12:28:50	12:24:33	NaN	NaN	4	J086	0.332	1	1	1	0
4	26	13:10:34	13:11:11	-54.553696	53.138584	4	J087	0.383	1	0	0	0
4	26	13:52:20	13:52:56	-54.553666	-53.15002	4	J088	0.375	1	0	1	0
4	26	14:32:54	14:33:36	-54.553723	-53.16154	4	J089	0.333	3	1	0	0
4	26	16:01:52	16:03:02	-54.563989	-53.15838	4	J090A	0.383	1	0	0	0
4	26	16:01:52	16:03:02	-54.563989	-53.15838	4	J090B	0.381	0	0	0	0
4	26	16:01:52	16:03:02	-54.563989	-53.15838	4	J090C	0.383	0	0	0	0
4	26	17:07:40	17:08:50	-54.589828	-53.15439	4	J091	0.347	1	0	1	0
4	26	18:00:55	18:01:40	-54.6044	-53.14495	4	J092	0.370	1	1	0	0
4	26	19:02:15	19:03:11	-54.727486	-53.27271	4	J093	0.218	1	0	0	0
4	26	19:47:30	19:48:15	-54.799905	-53.35628	4	J094	0.275	1	0	1	0
4	26	21:00:10	21:01:00	-54.69627	-53.20389	4	J095	0.290	1	3	0	0
4	26	22:01:45	22:02:27	-54.68191	-53.14925	4	J096	0.393	1	0	0	1
4	26	22:55:05	22:55:50	-54.656381	-53.17148	4	J097	0.373	1	0	1	0
4	26	23:53:30	23:54:10	-54.623548	-53.06228	4	J098	0.341	1	1	0	0
4	27	0:45:15	0:46:00	-54.616493	-53.13149	4	J099	0.366	3	0	0	0
4	27	1:36:10	1:37:28	-54.597551	-53.19238	4	J100A	0.306	1	0	1	0
4	27	1:36:10	1:37:28	-54.597551	-53.19238	4	J100B	0.318	0	0	0	0
4	27	1:36:10	1:37:28	-54.597551	-53.19238	4	J100C	0.315	0	0	0	0
4	27	2:42:00	2:42:50	-54.559752	-53.06484	4	J101	0.360	1	1	0	0
4	27	4:00:00	4:00:32	-54.643305	-53.12636	4	J102	0.367	1	0	0	0
4	27	4:50:30	4:51:00	-54.671341	-53.20344	4	J103	0.241	1	0	1	0
4	27	5:35:30	5:36:40	-54.682161	-53.14162	4	J104	0.325	1	1	0	3
4	27	7:03:30	7:04:00	-54.679317	-53.07118	4	J105	0.350	1	0	0	0
4	27	8:10:30	8:11:15	-54.724643	-53.12829	4	J106	0.318	1	0	1	0
4	27	9:10:09	9:10:56	-54.696454	-53.03149	4	J107	0.340	1	1	0	0
4	27	10:07:03	10:07:44	-54.743484	-53.10448	4	J108	0.423	1	0	0	0
4	27	10:51:18	10:52:06	-54.774142	-53.12942	4	J109	0.305	3	0	1	0
4	27	11:40:14	11:41:20	-54.743715	-53.04512	4	J110A	0.373	1	3	0	0
4	27	11:40:14	11:41:20	-54.743715	-53.04512	4	J110B	0.357	0	0	0	0
4	27	11:40:14	11:41:20	-54.743715	-53.04512	4	J110C	0.369	0	0	0	0
4	27	12:35:08	12:35:48	-54.730131	-53.00417	4	J111	0.365	1	0	0	0
4	27	13:21:46	13:22:29	-54.740834	-53.03969	4	J112	0.366	1	0	1	0
4	27	14:04:21	14:05:07	-54.763099	-53.10719	4	J113	0.320	1	1	0	0

4	27	14:59:00	14:59:30	-54.796307	-53.11019	4	J114	0.315	1	0	0	0
4	27	15:56:20	15:57:03	-54.798507	-53.10422	4	J115	0.318	1	0	1	0
4	27	17:11:10	17:11:43	-54.807948	-52.99138	4	J116	0.379	1	1	0	0
4	27	18:05:45	18:06:35	-54.837343	-53.06667	4	J117	0.317	1	0	0	0
4	27	18:51:40	18:52:40	-54.806474	-53.07899	4	J118	0.315	1	0	1	0
4	27	18:49:10	18:49:50	-54.807787	-53.08367	4	J119	0.354	3	1	0	0
4	27	21:15:40	21:16:45	-54.836824	-53.07930	4	J120A	0.293	1	0	0	0
4	27	21:15:40	21:16:45	-54.836824	-53.07930	4	J120B	0.291	0	0	0	0
4	27	21:15:40	21:16:45	-54.836824	-53.07930	4	J120C	0.295	0	0	0	0
4	27	22:10:30	22:11:20	-54.867561	-53.03631	4	J121	0.299	1	0	1	0
4	27	23:12:40	23:13:27	-54.887507	-52.96163	4	J122	0.368	1	0	0	0
4	28	0:01:25	0:02:00	-54.907765	-53.03438	4	J123	0.342	1	1	0	0
4	28	0:51:15	0:52:30	-54.948699	-53.07194	4	J124	0.363	1	0	0	3
4	28	2:18:15	2:19:00	-54.93173	-52.94029	4	J125	0.367	1	3	1	0
4	28	3:40:50	3:41:25	-54.97292	-53.06359	4	J126	0.307	1	0	0	0
4	28	4:23:06	4:23:40	-54.992237	-53.03806	4	J127	0.304	1	0	0	0
4	28	5:36:10	5:36:42	-54.976319	-52.92218	4	J128	0.347	1	1	0	0
4	28	6:28:15	6:29:01	-55.004139	-52.99956	4	J129	0.317	3	0	0	0
4	28	7:34:10	7:35:30	-54.968661	-53.07089	4	J130A	0.258	1	0	0	0
4	28	7:34:10	7:35:30	-54.968661	-53.07089	4	J130B	0.276	0	0	0	0
4	28	7:34:10	7:35:30	-54.968661	-53.07089	4	J130C	0.268	1	0	0	0
4	28	8:57:18	8:57:49	-54.922295	-52.93416	4	J131	0.272	1	1	1	0
4	28	9:50:33	9:51:13	-54.948716	-52.92261	4	J132	0.354	1	0	0	0
4	28	10:50:25	10:51:02	-54.973631	-53.01707	4	J133	0.292	1	0	0	0
4	28	11:34:01	11:34:36	-54.998554	-53.02270	4	J134	0.252	1	1	0	0
4	28	12:19:02	12:19:42	-54.976307	-52.95481	4	J135	0.353	1	0	0	0
4	28	12:56:24	12:56:59	-54.957834	-52.89743	4	J136	0.344	1	0	0	0
4	28	13:36:22	13:36:57	-54.98976	-52.92389	4	J137	0.351	1	1	1	0
4	28	14:26:00	14:26:48	-55.011001	-53.00338	4	J138	0.299	1	0	0	0
4	28	15:34:30	15:34:59	-55.018945	-52.93637	4	J139	0.354	3	0	0	0
4	28	16:41:02	16:41:59	-55.042577	-52.93070	4	J140A	0.378	1	3	0	0
4	28	16:41:02	16:41:59	-55.042577	-52.93070	4	J140B	0.371	0	0	0	0
4	28	16:41:02	16:41:59	-55.042577	-52.93070	4	J140C	0.415	0	0	0	0
4	28	17:53:35	17:54:20	-55.031937	-53.00142	4	J141	0.278	1	0	0	0
4	28	18:38:17	18:39:00	-55.030601	-52.99883	4	J142	0.292	1	0	0	0

4	28	19:39:20	19:40:20	-55.030725	-52.99893	4	J143	0.280	1	0	1	0
4	28	21:06:40	21:07:45	-54.990418	-52.86721	4	J144	0.361	1	0	0	3
4	28	22:08:37	22:09:25	-55.046186	-52.92152	4	J145	0.333	1	0	0	0
4	28	22:48:45	22:49:30	-55.075727	-52.98055	4	J146	0.282	1	1	0	0
4	28	23:47:15	23:47:55	-55.068794	-52.89667	4	J147	0.325	1	0	0	0
4	29	0:50:40	0:51:21	-55.042519	-52.79452	4	J148	0.369	1	0	0	0
4	29	1:31:45	1:32:25	-54.989061	-52.73488	4	J149	0.371	3	0	1	0
4	29	2:44:30	2:46:10	-54.999418	-52.85929	4	J150A	0.342	1	0	0	0
4	29	2:44:30	2:46:10	-54.999418	-52.85929	4	J150B	0.334	0	0	0	0
4	29	2:44:30	2:46:10	-54.999418	-52.85929	4	J150C	0.327	0	0	0	0
4	29	4:44:55	4:45:20	-55.044693	-52.96734	4	J151	0.239	1	0	0	0
4	29	5:21:35	5:22:18	-55.026368	-52.89551	4	J152	0.323	1	1	0	0
4	29	6:27:30	6:27:57	-55.042264	-52.79330	4	J153	0.340	1	0	0	0
4	29	7:55:30	7:56:02	-54.982732	-52.81107	4	J154	0.327	1	0	0	0
4	29	9:08:00	9:08:33	-55.001543	-52.79218	4	J155	0.301	1	0	0	0
4	29	10:02:06	10:02:46	-55.013372	-52.77767	4	J156	0.312	1	3	1	0
4	29	10:49:52	10:50:40	-55.024901	-52.76964	4	J157	0.305	1	0	0	0
4	29	11:45:55	11:46:25	-55.049001	-52.75816	4	J158	0.320	1	1	0	0
4	29	13:25:25	13:25:57	-55.143238	-52.78363	4	J159	0.365	3	0	0	0
4	29	14:02:00	14:02:42	-55.118546	-52.75813	4	J160A	0.353	1	0	0	0
4	29	14:02:00	14:02:42	-55.118546	-52.75813	4	J160B	0.358	0	0	0	0
4	29	14:02:00	14:02:42	-55.118546	-52.75813	4	J160C	0.368	0	0	0	0
4	29	15:43:12	15:43:50	-55.050955	-52.61312	4	J161	0.380	1	1	1	0
4	29	17:11:25	17:12:05	-55.093423	-52.75934	4	J162	0.305	1	0	0	0
4	29	18:08:55	18:09:35	-55.109906	-52.76249	4	J163	0.331	1	0	0	0
4	29	19:08:25	19:09:35	-55.103124	-52.71248	4	J164	0.355	1	1	0	3
4	29	20:13:05	20:13:40	-55.102825	-52.70588	4	J165	0.324	1	0	0	0
4	29	22:04:05	22:04:50	-55.127134	-52.70869	4	J166	0.344	1	0	0	0
4	29	23:06:57	23:07:40	-55.138257	-52.69846	4	J167	0.327	1	1	1	0
4	29	0:02:20	0:02:50	-55.063295	-52.87370	4	J168	0.316	1	0	0	0
4	30	1:16:15	1:16:50	-55.133015	-52.70353	4	J169	0.341	3	0	0	0
4	30	2:30:30	2:31:04	-55.13308	-52.68924	4	J170	0.281	1	3	1	0
4	30	3:45:45	3:47:15	-55.133076	-52.67549	4	J171A	0.343	1	0	0	0
4	30	3:45:45	3:47:15	-55.133076	-52.67549	4	J171B	0.330	0	0	0	0
4	30	3:45:45	3:47:15	-55.133076	-52.67549	4	J171C	0.338	0	0	0	0

4	30	5:03:40	5:04:10	-55.151531	-52.65567	4	J172	0.332	1	0	0	0
4	30	6:05:30	6:05:55	-55.151533	-52.62652	4	J173	0.354	1	1	0	0
4	30	6:54:00	6:54:35	-55.151478	-52.60437	4	J174	0.365	1	0	0	0
4	30	8:03:15	8:03:50	-55.198535	-52.63384	4	J175	0.320	1	0	0	0
4	30	8:59:20	8:59:59	-55.202192	-52.61845	4	J176	0.344	1	1	1	0
4	30	9:49:02	9:49:38	-55.205399	-52.60483	4	J177	0.348	1	0	0	0
4	30	11:07:27	11:07:59	-55.237636	-52.6163	4	J178	0.308	1	0	0	0
4	30	11:46:15	11:46:45	-55.240125	-52.60771	4	J179	0.331	3	1	0	0
4	30	12:36:01	12:37:12	-55.24384	-52.59682	4	J180A	0.367	1	0	0	0
4	30	12:36:01	12:37:12	-55.24384	-52.59682	4	J180B	0.370	0	0	0	0
4	30	12:36:01	12:37:12	-55.24384	-52.59682	4	J180C	0.366	0	0	0	0
4	30	13:58:25	13:58:55	-55.233769	-52.62412	4	J181	0.342	1	0	0	0
4	30	15:58:58	15:59:41	-55.238141	-52.59574	4	J182	0.334	1	1	1	0
4	30	17:28:35	17:29:10	-55.260605	-52.58586	4	J183	0.328	1	0	0	0
4	30	18:05:05	18:05:40	-55.255967	-52.58045	4	J184	0.335	1	0	0	0
4	30	18:45:57	18:47:00	-55.262454	-52.58859	4	J185	0.319	1	3	0	3
4	30	20:35:35	20:36:15	-55.422236	-52.56537	4	J186	0.345	1	0	0	0
4	30	22:10:40	22:11:15	-55.421778	-52.56523	4	J187	0.347	1	0	0	0
5	1	18:28:55	18:29:45	-54.287522	-53.05570	4	J188	0.095	1	0	1	0
4	2	4:48:40	4:49:06	NaN	NaN	4	J201	0.055	0	0	0	0
5	2	13:29:40	13:30:56	-54.553521	-51.80138	4	J208	0.419	1	1	0	3
5	2	15:30:20	15:31:10	-54.753743	-51.98291	4	J209	0.408	3	0	1	0
5	2	17:11:20	17:12:20	-54.755564	-52.23269	4	J210A	0.437	1	0	0	0
5	2	17:11:20	17:12:20	-54.755564	-52.23269	4	J210B	0.431	0	0	0	0
5	2	17:11:20	17:12:20	-54.755564	-52.23269	4	J210C	0.453	0	0	0	0
5	2	18:22:35	18:23:10	-54.757283	-52.39816	4	J211	0.306	1	1	0	0
5	2	19:46:20	19:47:03	-54.756377	-52.58560	4	J212	0.342	1	0	0	0
5	2	21:04:20	21:05:10	-54.755687	-52.76161	4	J213	0.272	1	0	0	0
5	2	21:55:50	21:56:34	-54.753832	-52.88498	4	J214	0.274	1	3	0	0
5	2	22:46:55	22:47:50	-54.753829	-53.00871	4	J215	0.355	1	0	1	0
5	2	23:58:47	23:59:25	-54.749814	-53.1828	4	J216	0.237	1	0	0	0
5	3	1:08:40	1:09:41	-54.705543	-53.28290	4	J217	0.363	1	1	0	0
5	3	2:06:40	2:07:16	-54.530099	-53.28633	4	J218	0.362	1	0	0	0
5	3	3:10:15	3:10:40	-54.30468	-53.27272	4	J219	0.295	3	0	0	0
5	3	4:23:30	4:24:35	-54.048461	-53.25254	4	J220A	0.296	1	1	0	0

5	3	4:23:30	4:24:35	-54.048461	-53.25254	4	J220B	0.306	0	0	0	0
5	3	4:23:30	4:24:35	-54.048461	-53.25254	4	J220C	0.304	0	0	0	0
5	3	6:06:00	6:06:31	-53.684832	-53.22416	4	J221	0.338	1	0	1	0
5	3	6:59:00	6:59:37	-53.49886	-53.20594	4	J222	0.303	1	0	0	0
5	3	8:14:15	8:14:51	-53.248209	-53.17882	4	J223	0.343	1	1	0	0
5	3	11:33:35	11:34:06	-53.108317	-53.27651	4	J224	0.337	1	0	0	0
5	3	12:15:26	12:15:59	-53.181422	-53.23864	4	J225	0.313	1	0	0	0
5	3	13:29:26	13:29:59	-53.309624	-53.17381	4	J226	0.329	1	3	0	0
5	3	15:28:40	15:29:30	-53.510551	-53.06530	4	J227	0.292	1	0	1	0
5	3	16:44:04	16:45:10	-53.628541	-52.99197	4	J228	0.303	1	0	0	3
5	3	17:45:10	17:45:45	-53.726315	-52.93672	4	J229	0.336	3	0	0	0
5	3	18:37:57	18:39:10	-53.842925	-52.92598	4	J230A	0.361	1	1	0	0
5	3	18:37:57	18:39:10	-53.842925	-52.92598	4	J230B	0.357	0	0	0	0
5	3	18:37:57	18:39:10	-53.842925	-52.92598	4	J230C	0.350	0	0	0	0
5	3	19:45:55	19:46:30	-53.920087	-52.94710	4	J231	0.359	1	0	0	0
5	3	21:14:55	21:15:30	-53.945806	-52.97775	4	J232	0.353	1	1	0	0
5	3	22:03:35	22:04:20	-53.948614	-52.99861	4	J233	0.370	1	0	1	0
5	3	23:05:30	23:06:00	-53.963733	-53.02516	4	J234	0.351	1	0	0	0
5	3	0:25:15	0:25:50	-54.738452	-53.23288	4	J235	0.358	1	1	0	0
5	4	1:27:00	1:27:37	-54.009503	-53.09808	4	J236	0.360	1	0	0	0
5	4	3:09:30	3:10:05	-54.036035	-53.16366	4	J237	0.369	1	0	0	0
5	4	4:31:30	4:32:20	-54.087116	-53.20998	4	J238	0.290	1	0	0	0
5	4	6:10:30	6:11:17	-54.165379	-53.25601	4	J239	0.249	3	1	1	0
5	4	9:23:30	9:24:30	-54.24877	-53.33173	4	J240A	0.284	1	0	0	0
5	4	9:23:30	9:24:30	-54.24877	-53.33173	4	J240B	0.296	0	0	0	0
5	4	9:23:30	9:24:30	-54.24877	-53.33173	4	J240C	0.292	0	0	0	0
5	4	12:08:21	12:09:58	-54.328201	-53.39569	4	J241	0.304	1	3	0	0
5	4	13:21:40	13:22:15	-54.381527	-53.41917	4	J242	0.325	1	0	0	0
5	4	17:30:40	17:31:30	-54.597583	-53.51094	4	J243	0.292	1	0	0	0
5	4	18:42:57	18:43:30	-54.675361	-53.54328	4	J244	0.203	1	0	0	0
5	4	19:34:55	19:35:45	-54.709331	-53.55764	4	J245	0.206	1	0	1	0
5	4	21:11:30	21:12:10	-54.742354	-53.59490	4	J246	0.216	1	0	0	0
5	4	22:08:45	22:09:25	-54.74574	-53.61396	4	J247	0.241	1	1	0	0
5	4	23:02:05	23:03:00	-54.741879	-53.63102	4	J248	0.241	1	0	0	3
5	5	0:07:30	0:08:10	-54.746566	-53.65905	4	J249	0.172	3	0	0	0

5	5	1:35:10	1:35:30	-54.750936	-53.69518	4	J250	0.189	1	1	0	0
5	5	3:06:40	3:07:25	-54.785786	-53.73623	4	J251	0.202	1	0	1	0
5	5	4:04:20	4:04:45	-54.817147	-53.76599	4	J252	0.199	1	0	0	0
5	5	5:52:15	5:52:46	-54.882411	-53.81730	4	J253	0.198	1	1	0	0
5	5	17:09:10	17:09:55	-54.506095	-54.68042	4	J254	0.173	1	0	0	0
5	5	17:55:10	17:55:35	-54.507937	-54.69964	4	J255	0.195	1	0	0	0
5	5	18:58:00	18:58:33	-54.520784	-54.78278	4	J256	0.219	1	3	0	0
5	5	21:02:30	21:03:15	-54.533918	-54.86180	4	J257	0.184	1	0	1	0
5	5	22:02:40	22:03:15	-54.541978	-54.91737	4	J258	0.149	1	0	0	0
5	5	23:04:25	23:05:00	-54.552314	-54.96984	4	J259	0.145	3	1	0	0
5	6	0:28:30	0:29:35	-54.55705	-55.00108	4	J260A	0.162	1	0	0	0
5	6	0:28:30	0:29:35	-54.55705	-55.00108	4	J260B	0.162	0	0	0	0
5	6	0:28:30	0:29:35	-54.55705	-55.00108	4	J260C	0.166	0	0	0	0
5	6	2:02:50	2:03:15	-54.557733	-54.97611	4	J261	0.153	1	0	0	0
5	6	3:26:30	3:27:10	-54.681861	-55.07459	4	J262	0.153	1	1	0	0
5	6	4:41:20	4:41:59	-54.700893	-55.22524	4	J263	0.232	1	0	1	0
5	6	6:12:30	6:12:59	-54.96497	-55.34394	4	J264	0.206	1	0	0	0
5	6	7:27:10	7:27:45	-55.174445	-55.44308	4	J265	0.192	1	1	0	0
5	6	8:46:21	8:46:51	-55.417607	-55.56214	4	J266	0.202	1	0	0	0
5	6	16:05:15	16:06:36	-54.328694	-55.18367	4	J267A	0.345	1	1	1	0
5	6	16:05:15	16:06:36	-54.328694	-55.18367	4	J267B	0.348	0	0	0	0
5	6	17:14:32	17:15:58	-54.204562	-55.02730	4	J268	0.316	1	0	0	3
5	6	18:07:52	18:08:31	-54.11377	-54.90539	4	J269	0.232	3	0	0	0
5	7	20:53:27	20:54:03	-54.847822	-54.72000	4	J288	0.207	3	0	0	0
5	8	6:07:16	6:08:23	-53.585574	-54.92239	4	J293	0.234	1	0	0	3
5	8	7:31:00	7:31:37	-53.736595	-55.00033	4	J294	0.148	1	0	1	0
5	8	8:25:45	8:26:16	-53.923174	-55.08821	4	J295	0.229	1	0	0	0
5	8	9:09:45	9:10:16	-54.126616	-55.08803	4	J296	0.291	1	3	0	0
5	8	10:10:50	10:11:23	-54.409467	-55.08678	4	J297	0.298	1	0	0	0
5	8	10:52:36	10:53:13	-54.583666	-55.06463	4	J298	0.325	1	0	0	0
5	8	11:31:19	11:31:50	-54.655285	-54.96900	4	J299	0.345	1	1	0	0
5	8	12:22:00	12:22:55	-54.725382	-54.83201	4	J300A	0.224	1	0	0	0
5	8	12:22:00	12:22:55	-54.725382	-54.83201	4	J300B	0.233	0	0	0	0
5	8	12:22:00	12:22:55	-54.725382	-54.83201	4	J300C	0.224	0	0	0	0
5	8	13:17:30	13:18:13	-54.821896	-54.69237	4	J301	0.193	1	0	1	0

5	8	13:58:42	13:59:24	-54.845821	-54.76100	4	J302	0.260	1	1	0	0
5	8	15:30:32	15:31:23	-54.717877	-54.95281	4	J303	0.186	3	0	0	0
5	8	16:10:53	16:11:43	-54.671132	-55.00866	4	J304	0.315	1	0	0	0
5	8	17:41:50	17:43:05	-54.68393	-54.91672	4	J305	0.190	1	1	0	0
5	8	18:30:53	18:32:30	-54.67018	-54.90601	4	J306	0.174	1	0	0	0
5	8	19:19:50	19:21:45	-54.65298	-54.8952	4	J307	0.175	1	0	1	0
5	8	20:30:10	20:32:00	-54.615365	-54.87236	4	J308	0.166	1	1	1	0
5	8	22:25:57	22:26:45	-54.541498	-54.94889	4	J309	0.296	1	0	0	0
5	8	23:18:20	23:19:30	-54.329551	-54.87037	4	J310	0.297	1	0	0	0
5	9	0:10:47	0:11:30	-54.25041	-54.91878	4	J311	0.375	1	3	0	0
5	9	1:16:15	1:16:51	-54.364581	-54.78546	4	J312	0.201	1	0	0	
5	9	2:08:40	2:10:59	-54.395231	-54.6591	4	J313	0.271	3	1	1	3
5	9	4:31:30	4:31:58	-54.052124	-54.88490	4	J314	0.363	1	0	0	0
5	9	5:23:00	5:23:05	-53.92265	-54.81494	4	J315	0.218	1	0	0	0
5	9	7:24:45	7:25:12	-53.93037	-54.84139	4	J316	0.219	1	0	0	0
5	9	7:49:02	7:50:15	-53.900556	-54.90769	4	J317	0.230	1	1	1	0
5	9	9:33:20	9:34:13	-53.784157	-54.8024	4	J318	0.245	1	0	0	0
5	9	10:14:48	10:15:24	-53.679515	-54.75431	4	J319	0.230	1	0	0	0
5	9	11:01:32	11:02:36	-53.743137	-54.86140	4	J320A	0.243	1	1	0	0
5	9	11:01:32	11:02:36	-53.743137	-54.86140	4	J320B	0.242	0	0	0	0
5	9	11:01:32	11:02:36	-53.743137	-54.86140	4	J320C	0.240	0	0	0	0
5	9	12:02:20	12:02:50	-53.92415	-54.98149	4	J321	0.345	1	0	0	0
5	9	13:05:34	13:05:59	-53.735808	-54.94930	4	J322	0.191	1	0	0	0
5	9	13:48:20	13:49:04	-53.58688	-54.88919	4	J323	0.226	3	1	1	0
5	9	15:27:15	15:27:44	-53.564827	-54.97852	4	J324	0.230	1	0	0	0
5	9	17:27:15	17:27:45	-53.697632	-55.15929	4	J325	0.208	1	0	0	0
5	9	18:20:10	18:20:40	-53.465245	-55.18248	4	J326	0.191	1	1	0	0
5	9	19:39:10	19:39:30	-53.584147	-55.21510	4	J327	0.225	1	0	0	0
5	9	21:02:15	21:02:50	-53.8456	-55.10550	4	J328	0.244	1	0	1	0
5	9	22:01:55	22:02:34	-53.820695	-55.18635	4	J329	0.199	1	3	0	0
5	9	22:55:50	22:56:45	-53.608764	-55.25653	4	J330A	0.217	1	0	0	0
5	9	22:55:50	22:56:45	-53.608764	-55.25653	4	J330B	0.220	0	0	0	0
5	9	22:55:50	22:56:45	-53.608764	-55.25653	4	J330C	0.235	0	0	0	0
5	9	23:52:05	23:52:35	-53.718575	-55.31788	4	J331	0.231	1	0	0	0
5	10	0:55:40	0:55:13	NaN	NaN	4	J332	0.256	1	0	0	0

5	10	1:55:40	1:57:17	-54.072964	-55.22874	4	J333	0.336	3	1	1	3
5	10	4:46:40	4:47:20	-53.865452	-55.43362	4	J334	0.259	1	0	0	0
5	10	5:25:20	5:25:54	-53.971221	-55.36718	4	J335	0.194	1	0	0	0
5	10	6:58:40	6:59:06	-53.973759	-55.43173	4	J336	0.266	1	1	1	0
5	10	7:57:30	7:57:57	-53.739352	-55.50872	4	J337	0.248	1	0	0	0
5	10	8:35:20	8:35:46	-53.7661	-55.57011	4	J338	0.239	1	0	0	0
5	10	9:31:30	9:32:08	-53.975523	-55.50330	4	J339	0.291	1	1	0	0
5	10	10:21:36	10:22:37	-54.162484	-55.44131	4	J340A	0.178	1	0	0	0
5	10	10:21:36	10:22:37	-54.162484	-55.44131	4	J340B	0.173	0	0	0	0
5	10	10:21:36	10:22:37	-54.162484	-55.44131	4	J340C	0.173	0	0	0	0
5	10	11:26:30	11:27:00	-54.125872	-55.50446	4	J341	0.182	1	0	0	0
5	10	12:01:38	12:02:09	-53.982774	-55.52072	4	J342	0.283	1	1	0	0
5	10	12:41:18	12:41:50	-53.825934	-55.57351	4	J343	0.246	3	0	0	0
5	10	13:19:53	13:20:35	-53.796721	-55.63657	4	J344	0.231	1	0	0	0
5	10	15:00:01	15:00:31	-54.152772	-55.52656	4	J345	0.243	1	3	0	0
5	10	16:01:51	16:02:23	-54.179649	-55.43893	4	J346	0.292	1	0	0	0
5	10	17:40:40	17:41:15	-54.093697	-55.69860	4	J347	0.182	1	0	0	0
5	10	18:21:00	18:21:35	-54.061431	-55.79763	4	J348	nan	0	3	0	0
5	10	19:13:25	19:13:50	-54.151879	-55.76393	4	J349	0.231	1	0	0	0
5	10	19:50:20	19:51:10	-54.180434	-55.67257	4	J350A	0.177	1	0	0	0
5	10	19:50:20	19:51:10	-54.180434	-55.67257	4	J350B	0.175	0	0	0	0
5	10	19:50:20	19:51:10	-54.180434	-55.67257	4	J350C	0.195	0	0	0	0
5	10	21:11:50	21:12:20	-54.236241	-55.48544	4	J351	0.190	1	1	0	0
5	10	22:21:35	22:22:00	-54.346607	-55.35084	4	J352	0.273	1	0	0	0
5	10	23:15:55	23:16:55	-54.303017	-55.46691	4	J353	0.230	3	0	0	3
5	11	9:34:03	9:34:36	-54.574322	-55.63229	4	J354	0.236	1	1	0	0
5	11	10:24:34	10:24:58	-54.573769	-55.49364	4	J355	0.228	1	0	0	0
5	11	11:15:26	11:15:58	-54.574282	-55.35812	4	J356	0.280	1	0	0	0
5	11	12:02:47	12:03:13	-54.651711	-55.26102	4	J357	0.289	1	1	0	0
5	11	12:47:55	12:48:30	-54.690133	-55.35867	4	J358	0.284	1	0	0	0
5	11	13:41:42	13:42:10	-54.694189	-55.48115	4	J359	0.233	1	0	0	0
5	11	15:19:12	15:19:52	-54.817763	-55.62874	4	J360A	0.199	1	1	0	0
5	11	15:19:12	15:19:52	-54.817763	-55.62874	4	J360B	0.205	0	0	0	0
5	11	15:19:12	15:19:52	-54.817763	-55.62874	4	J360C	0.206	0	0	0	0
5	11	15:59:21	15:59:50	-54.811898	-55.51253	4	J361	0.229	1	0	0	0

5	12	1:51:02	1:51:46	-54.792275	-54.77112	4	J362	0.254	1	3	1	0
5	12	4:38:38	4:29:33	NaN	NaN	4	J363	0.185	1	1	1	0
5	12	5:29:01	5:30:10	-54.605774	-54.65026	4	J364	0.243	1	1	1	0
5	12	6:29:50	6:30:46	-54.542882	-54.78256	4	J365	0.162	1	1	1	0
5	12	7:37:00	7:37:54	-54.472752	-54.93183	4	J366	0.317	1	1	1	0
5	12	8:41:00	8:41:29	-54.404004	-55.08124	4	J367	0.299	1	1	1	0
5	12	9:33:00	9:34:24	-54.347202	-55.20392	4	J368	0.254	1	1	1	0
5	12	10:18:40	10:19:21	-54.298469	-55.31159	4	J369	0.200	1	1	1	0
5	12	11:21:02	11:21:43	-54.226293	-55.45569	4	J370	0.235	1	1	1	0
5	12	12:07:22	12:07:55	-54.166694	-55.56744	4	J371	0.233	1	1	1	0
5	12	12:46:55	12:47:36	-54.119583	-55.66641	4	J372	0.257	1	1	1	0
5	12	13:27:56	13:28:28	-54.075417	-55.76672	4	J373	0.245	1	1	1	0
5	12	14:19:31	14:20:06	-54.01496	-55.89063	4	J374	0.237	1	1	1	0
5	12	15:38:00	15:38:43	-53.926192	-56.06910	4	J375	0.264	1	1	1	0
5	12	16:20:59	16:22:20	-53.879719	-56.16844	4	J376	0.262	1	1	1	0
5	12	18:17:10	18:17:50	-53.747526	-56.43326	4	J377	0.265	1	1	1	0
5	12	19:07:25	19:08:15	-53.693258	-56.54423	4	J378	0.165	0	1	1	0
5	12	0:00:00	0:00:00	NaN	NaN	4	J379	0.138	1	1	1	0
5	15	11:38:48	11:39:19	-54.611538	-54.52890	4	J427	0.219	1	3	0	0
5	15	12:31:09	12:31:39	-54.538786	-54.6630	4	J428	0.253	1	0	0	0
5	15	13:35:01	13:35:51	-54.461192	-54.65921	4	J429	0.233	1	0	1	0
5	15	15:21:06	15:22:15	-53.883948	-54.66336	4	J430A	0.266	1	1	0	0
5	15	15:21:06	15:22:15	-53.883948	-54.66336	4	J430B	0.267	0	0	0	0
5	15	15:21:06	15:22:15	-53.883948	-54.66336	4	J430C	0.255	0	0	0	0
5	15	16:43:44	16:44:06	-53.758704	-54.71011	4	J431	0.276	1	0	0	0
5	15	17:23:20	17:24:00	-53.783602	-54.72799	4	J432	0.231	1	0	0	0
5	15	18:24:20	18:25:00	-53.771808	-54.72031	4	J433	0.248	1	1	0	0
5	15	19:23:30	19:24:00	-53.800456	-54.73789	4	J434	0.250	1	0	0	0
5	15	20:53:50	20:54:45	-53.725315	-54.70225	4	J435	0.273	3	0	0	3
5	15	21:56:50	21:51:45	NaN	NaN	4	J436	0.232	1	0	1	0
5	15	23:05:57	23:06:40	-53.767059	-54.72104	4	J437	0.254	1	1	0	0
5	16	0:05:26	0:06:10	-53.768759	-54.7176	4	J438	0.225	1	0	0	0
5	16	1:05:40	1:06:32	-53.774635	-54.72333	4	J439	0.248	1	1	1	0
5	16	2:23:10	2:25:13	-53.725757	-54.68632	4	J440A	0.253	1	1	1	0
5	16	2:23:10	2:25:13	-53.725757	-54.68632	4	J440B	0.249	0	0	0	0

5	16	2:23:10	2:25:13	-53.725757	-54.68632	4	J440C	0.245	0	0	0	0
5	16	5:12:30	5:13:34	-53.799843	-54.73823	4	J441	0.232	1	1	1	0
5	16	6:14:05	6:14:45	-53.728646	-54.69354	4	J442	0.263	1	3	1	0
5	16	7:07:00	7:08:07	-53.768329	-54.72006	4	J443	0.257	1	1	1	0
5	16	8:05:40	8:06:36	-53.785399	-54.72695	4	J444	0.252	1	1	1	0
5	16	8:56:00	8:56:49	-53.73335	-54.70246	4	J445	0.217	3	1	1	0
5	16	9:57:51	9:58:33	-53.811183	-54.74630	4	J446	0.231	1	0	1	0
5	16	10:54:04	10:54:49	-53.712439	-54.68852	4	J447	0.246	1	0	1	0
5	16	11:36:13	11:36:59	-53.784726	-54.73011	4	J448	0.242	1	1	1	0
5	16	12:31:39	12:32:21	-53.894418	-54.78285	4	J449	nan	1	1	1	0
5	16	13:25:58	13:27:11	-54.022866	-54.80979	4	J450A	0.256	1	1	1	0
5	16	13:25:58	13:27:11	-54.022866	-54.80979	4	J450B	0.248	0	0	0	0
5	16	13:25:58	13:27:11	-54.022866	-54.80979	4	J450C	0.250	0	0	0	0
5	16	15:21:03	15:22:12	-54.386427	-54.90020	4	J451	0.237	1	1	1	0
5	16	17:39:55	17:40:45	-54.237463	-54.84625	4	J452	0.273	1	1	1	0
5	16	18:34:30	18:35:15	-54.111019	-54.80901	4	J453	0.256	1	1	1	0
5	16	19:41:35	19:42:10	-53.879606	-54.76871	4	J454	0.249	1	1	0	0
5	16	21:10:20	21:11:50	-53.78354	-54.72587	4	J455	0.226	3	1	0	3
5	16	22:41:20	22:42:00	-53.783547	-54.72587	4	J456	0.240	1	1	0	0
5	16	23:18:30	23:19:15	-53.783562	-54.72587	4	J457	0.241	1	3	0	0
5	17	0:03:40	0:04:25	-53.783549	-54.72588	4	J458	nan	1	3	0	0
5	17	0:57:00	0:58:37	-53.783561	-54.72583	4	J459	0.254	1	1	1	0
5	17	2:37:40	2:38:08	-53.783574	-54.72586	4	J460	0.259	1	1	0	0
5	17	3:26:00	3:27:23	-53.783562	-54.72586	4	J461A	0.259	1	1	0	0
5	17	3:26:00	3:27:23	-53.783562	-54.72586	4	J461B	0.246	0	0	0	0
5	17	3:26:00	3:27:23	-53.783562	-54.72586	4	J461C	0.255	0	0	0	0
5	17	5:32:00	5:32:33	-53.78354	-54.72585	4	J462	0.238	1	1	0	0
5	17	6:37:50	6:38:34	-53.783548	-54.72582	4	J463	0.236	1	1	0	0
5	17	7:33:40	7:34:10	-53.783605	-54.72583	4	J464	0.251	1	1	0	0
5	17	8:37:00	8:37:41	-53.783756	-54.72579	4	J365	0.241	1	1	1	0
5	17	9:29:40	9:30:08	-53.783902	-54.72572	4	J466	0.244	1	1	0	0
5	17	10:16:49	10:17:21	-53.784006	-54.72571	4	J467	0.247	1	1	0	0
5	17	10:57:09	10:57:44	-53.784127	-54.72565	4	J468	0.239	1	1	0	0
5	17	12:00:22	12:00:57	-53.784148	-54.72564	4	J469	0.220	1	1	0	0
5	17	12:59:21	13:00:28	-54.058166	-54.72417	4	J470A	0.230	1	1	0	0

5	17	12:59:21	13:00:28	-54.058166	-54.72417	4	J470B	0.234	0	0	0	0
5	17	12:59:21	13:00:28	-54.058166	-54.72417	4	J470C	0.236	0	0	0	0
5	17	12:59:21	13:00:28	-54.058166	-54.72417	4	J470D	0.234	0	0	0	0
5	17	14:05:46	14:06:09	-54.378156	-54.72436	4	J471	0.238	1	1	0	0
5	17	15:33:35	15:34:22	-54.765498	-54.71925	4	J472	0.215	1	3	0	0
5	17	16:35:34	16:36:13	-54.968543	-54.71508	4	J473	0.268	1	1	0	0
5	17	14:34:50	14:35:20	-54.50524	-54.72418	4	J474	0.253	1	1	0	0
5	17	18:14:10	18:14:40	-54.970784	-54.71311	4	J475	0.252	1	1	0	0
5	17	19:27:10	19:28:10	-54.966876	-54.71222	4	J476	0.244	3	1	0	3
5	18	13:37:57	13:38:36	-53.777611	-54.60460	4	J477	0.244	1	1	0	0
5	18	14:16:40	14:17:13	-53.734741	-54.63281	4	J478	0.237	1	1	0	0
5	18	15:35:13	15:35:55	-53.734735	-54.63280	4	J479	0.228	1	1	0	0
5	18	17:54:30	17:55:25	-53.578686	-54.84832	4	J480A	nan	1	1	0	0
5	18	17:54:30	17:55:25	-53.578686	-54.84832	4	J480B	nan	0	0	0	0
5	18	17:54:30	17:55:25	-53.578686	-54.84832	4	J480C	nan	0	0	0	0
5	18	19:23:20	19:24:00	-53.519233	-54.84057	4	J481	0.254	1	1	0	0
5	18	20:05:30	20:06:00	-53.619126	-54.86852	4	J482	0.175	1	1	0	0
5	18	21:27:30	21:28:05	-53.506863	-54.83270	4	J483	0.285	1	1	0	0
5	18	22:22:22	22:23:00	-53.585071	-54.85520	4	J483	0.216	1	1	0	0
5	18	23:11:45	23:12:16	-53.534603	-54.91673	4	J484	0.224	1	1	0	0
5	19	1:40:30	1:41:52	-53.443464	-55.03596	4	J485	0.241	3	1	0	0
5	19	2:40:30	2:41:07	-53.410896	-55.06734	4	J486	0.229	1	1	0	0
5	19	3:27:15	3:28:04	-53.302588	-55.15276	4	J487	0.231	1	3	0	0
5	19	4:25:00	4:25:48	-53.300116	-55.16198	4	J488	0.235	1	1	0	0
5	19	8:02:50	8:03:37	-53.586204	-54.89835	4	J489	0.265	1	1	0	0
5	19	9:18:02	9:19:50	-53.623127	-54.93014	4	J490A	0.262	1	1	0	0
5	19	9:18:02	9:19:50	-53.623127	-54.93014	4	J490B	0.258	0	0	0	0
5	19	9:18:02	9:19:50	-53.623127	-54.93014	4	J490C	0.244	0	0	0	0
5	19	10:45:59	10:46:29	-53.578396	-54.87990	4	J491	0.243	1	1	0	0
5	19	11:35:45	11:36:10	-53.540903	-54.8536	4	J492	0.249	1	1	0	0
5	19	12:18:23	12:18:53	-53.544089	-54.86482	4	J493	0.245	1	1	0	0
5	19	13:10:47	13:11:29	-53.54681	-54.88805	4	J494	0.236	1	1	0	0
5	19	13:56:56	13:57:37	-53.489356	-54.89338	4	J495	0.258	3	1	0	0
5	19	15:25:51	15:26:30	-53.407589	-54.88105	4	J496	0.215	1	0	0	0
5	20	1:10:00	1:10:29	-54.304013	-55.19953	4	J497	0.238	1	0	0	1

5	20	1:33:00	1:36:00	-54.276037	-55.15425	4	J498	0.204	1	0	0	0
5	20	1:56:50	1:56:44	NaN	NaN	4	J499	0.230	1	0	0	1
5	20	2:33:30	2:34:22	-54.191069	-55.05990	4	J500A	0.218	3	0	0	0
5	20	2:33:30	2:34:22	-54.191069	-55.05990	4	J500B	0.231	0	0	0	0
5	20	2:33:30	2:34:22	-54.191069	-55.05990	4	J500C	0.211	0	0	0	0
5	20	3:09:40	3:10:29	-54.126132	-55.01220	4	J501	0.228	1	0	0	1
5	20	3:33:45	3:34:28	-54.077361	-54.98356	4	J502	0.241	0	0	0	0
5	20	4:00:00	4:00:33	-54.019884	-54.95370	4	J503	0.261	1	0	0	1
5	20	4:22:50	4:23:18	-53.967968	-54.92874	4	J504	0.242	1	0	0	0
5	20	4:47:20	4:48:11	-53.908524	-54.90192	4	J505	0.256	1	0	0	1
5	20	5:08:05	5:08:39	-53.859001	-54.88205	4	J506	0.240	1	0	0	0
5	20	5:31:30	5:32:20	-53.799133	-54.86053	4	J507	0.244	1	0	0	1
5	20	5:55:00	5:55:41	-53.738664	-54.84087	4	J508	0.269	1	0	0	0
5	20	6:26:02	6:27:02	-53.66289	-54.81830	4	J509	0.271	1	0	0	1
5	20	6:52:50	6:53:55	-53.598401	-54.80392	4	J510A	0.263	3	0	0	0
5	20	6:52:50	6:53:55	-53.598401	-54.80392	4	J510B	0.275	0	0	0	0
5	20	6:52:50	6:53:55	-53.598401	-54.80392	4	J510C	0.272	0	0	0	0
5	20	9:47:13	9:46:40	NaN	NaN	4	J511	0.228	1	0	0	0
5	20	9:56:42	9:57:24	-53.717821	-55.05169	4	J512	0.243	1	0	0	1
5	20	10:18:04	10:18:32	-53.658528	-55.05206	4	J513	0.275	1	0	0	0
5	20	10:27:31	10:28:11	-53.630983	-55.0537	4	J514	0.269	1	0	0	1
5	20	10:48:22	10:48:20	NaN	NaN	4	J515	0.251	1	0	0	0
5	20	11:02:50	11:03:30	-53.525176	-55.06689	4	J516	0.252	1	0	0	1
5	20	11:14:10	11:19:35	-53.482048	-55.07220	4	J517	0.235	1	0	0	0
5	20	11:29:50	11:30:35	-53.438793	-55.07716	4	J518	0.246	1	0	0	1
5	20	11:47:02	11:47:30	-53.383157	-55.08385	4	J519	0.232	1	0	0	0
5	20	11:58:14	11:58:50	-53.34545	-55.08757	4	J520A	0.221	3	0	0	0
5	20	11:58:14	11:58:50	-53.34545	-55.08757	4	J520B	0.221	0	0	0	0
5	20	11:58:14	11:58:50	-53.34545	-55.08757	4	J520C	0.222	0	0	0	0

12. MICROSTRUCTURE PROFILING

Violaine Pellichero, LOCEAN

12.1 INTRODUCTION

During JR311 we measured turbulence with the ISW Microstructure Sensing System, also called MSS-90. The instrument used is owned by Plymouth University, serial number 042. The MSS 90 is a multiparameter probe for measuring **small scale turbulence and micro-scale water stratification** in water down to ~ 300-500 m.

The measuring system is composed of the deck unit and data acquisition computer, the MSS profiler, and a powered winch. Data were acquired using the Sun & Sea Technology software, Standard Data Acquisition (SDA). Post-processing and conversion of binary data to engineering units will be performed using MSS-Pro (supplied by ISW).

The primary scientific sensor configurations of the MSS unit are:

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

12.2 SENSOR FAILURES AND OPERATIONAL ISSUES

Throughout the cruise we encountered frequent data drop–outs and pressure spiking. When the issue was at it's worst, the deck unit mounted in the UIC was unable to communicate with the profiler until the instrument was fully recovered. Rigorous checking of connections and terminations, and the complete replacement of the data cable with the spare provided by NMF failed to resolve the problem. It is thus unclear what the precise issue is and deck testing will be performed back in Plymouth, although it is noted that the careful cleaning of the wet pluggable cable connection on the MSS bulkhead reduced the issue somewhat.

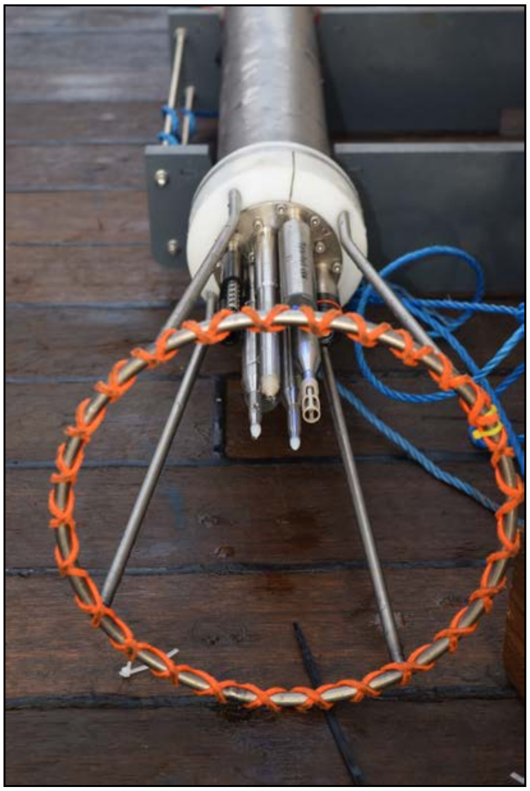

Figure 12.1: (clockwise from top left) View of various sensors on the nose of the MSS probe, the electric winch, and its location on the stern rail.

12.3 DEPLOYMENT DURING JR311

During JR311 the MSS was deployed from the stern of the ship (Figure 12.1). The winch was mounted on the aft rail to the port of the centerline and on the section between the A-frame gantry and port-side crane tower.

The strong currents and prevailing weather within which the cruise was completed required the ship to steam ahead during deployment. During the second half of the cruise when the ship was required to maintain headway against the ACC, we were often confronted with ship speeds through the water of >2 knots. As a consequence, the MSS was unable to pay out cable quickly enough to avoid tension being imparted on the cable. The MSS fall speed displayed a clear reduction under such circumstances and we will have to ignore the turbulence data given the contamination by instrument motion. There was no obvious solution to acquiring data under these conditions; as the cruise progressed and the officers became more familiar with the MSS, the ship speed through the water was reduced but the concern remained that the amount of slack cable being released presented the risk of entanglement with the ships steering gear and main propeller.

The MSS was ballasted to fall at a speed of approximately 0.6–0.8 m s^{-1}. Throughout the cruise additional weight rings were added (4 in total were used during the second half of the cruise) to increase the fall speed to 0.8 m s^{-1} with the intention of mitigating the vessel speed through the water.

12.4 JR311 PRELIMINARY RESULTS

The MSS was deployed on four separate occasions during JR311. Each deployment is considered as a group of profiles and are described in turn below.

12.4.1 MSS Group 1

Following five test profiles to check instrumentation and software, the first time series started 29th April 2015 at 07h56 (UTC) at 52°48.694 S and 54°58.923 W and carried on until 15h45, 30th April 2015 (See appendix for more details about the location of each profile). In this way, 70 profiles were collected, each one reaching a depth of 200 m to capture the mixed-layer properties (Figure 12.2).

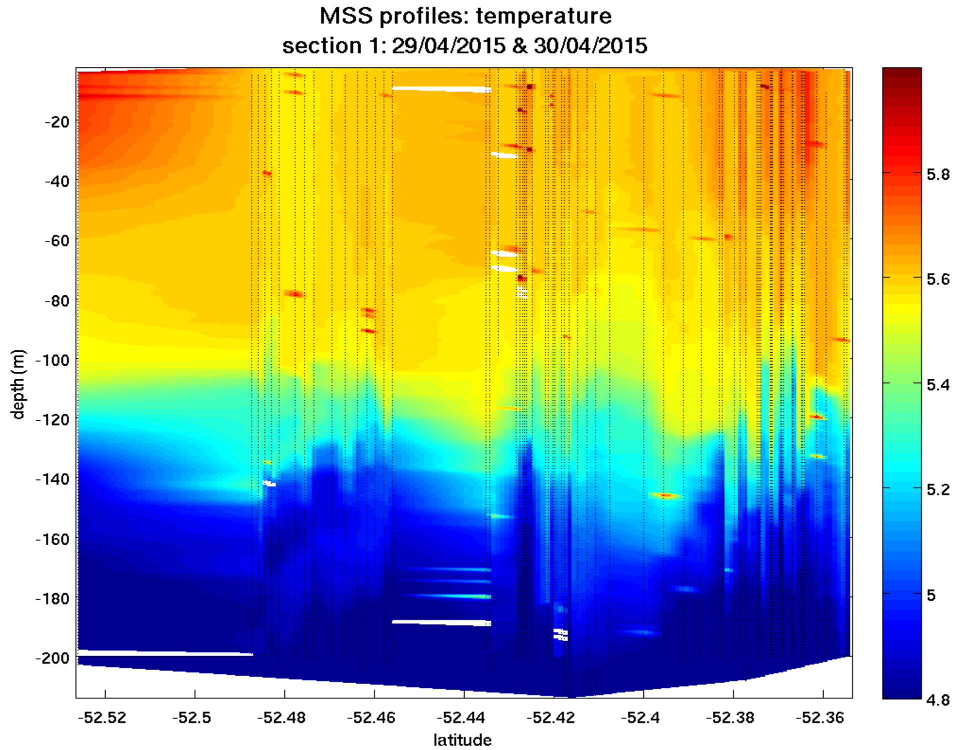

Figure 12.2. Section across the ACC front during MSS Group 1. Dashed vertical lines indicates the position of the MSS profiles.

12.4.2 MSS Group 2

The second time series started at 15h50 (UTC) on 5/5/2015 at 54°61.00S & 54°49.20 W, and finished at 01h12 on 6/5/2015. During this MSS cross-front survey, thirteen more profiles were obtained to a depth of ~150-200 m. Indeed aiming to observe the ACC front, we started this time series and carried out an ACC transect (with 8 stations). On the following figure, we can see this section with cold (left) and warm (right) part of the front (Figure 12.3).

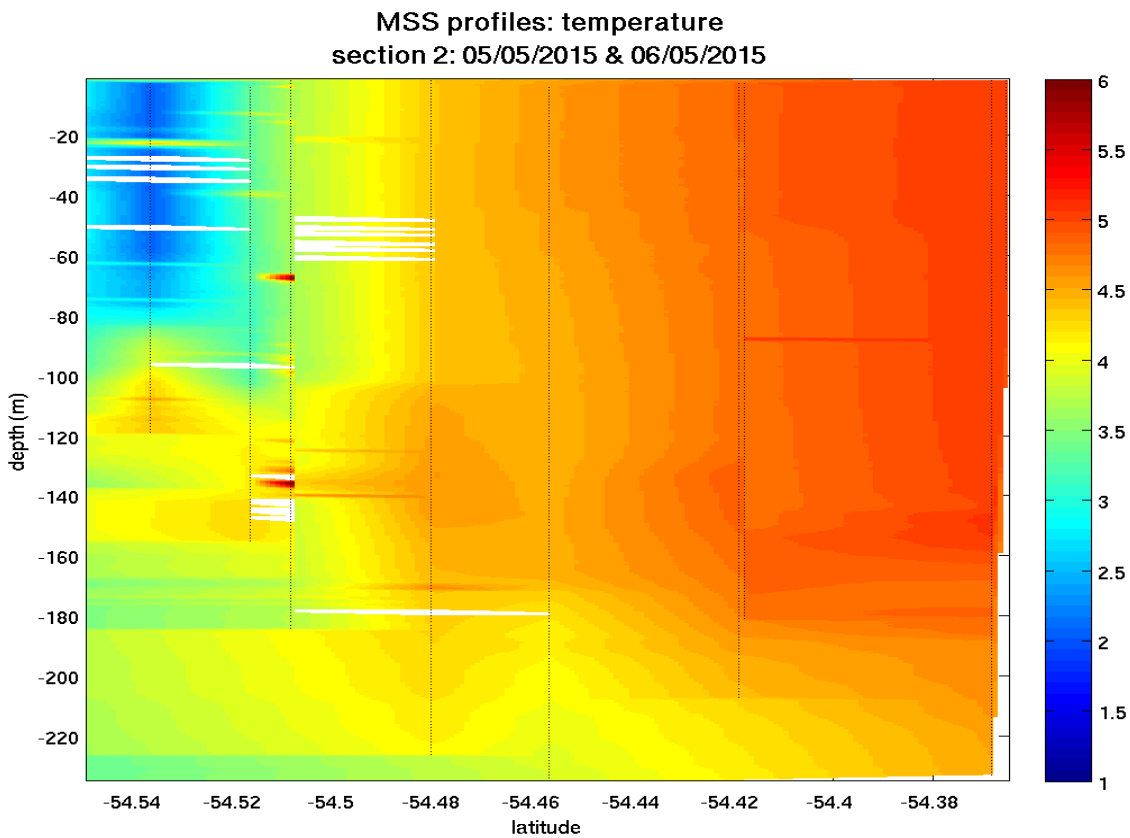

Figure 12.3. Section across the ACC front during MSS group 2

12.4.3 MSS Group 3

The third time series began at 19h10 (UTC) 8th May 2015 at 54°N and 53°70.00 W finishing at 20h43 (profiles 89 to 95). Due to a problem with the MVP's winch and because of the Sea Soar wasn't ready, we switched the chlorophyll fluorometer with the fluorescein fluorometer on the MSS and used the MSS to follow drifters and track the dye during one hour on the outer edge of the cold filament. This short time series mostly contain MSS profiles to ~100-150 m capturing the trajectory of the dye. We detected the dye twice near to the surface with the fluorescein fluorometer.

12.4.4 MSS Group 4

The final MSS group was conducted to complement a CTD survey through the eddy between 13th May 2015 and 15 May 2015 (profiles 96 to 112). Two MSS profiles were acquired following each CTD profile to provide estimates of turbulent dissipation rates that will be used to compute vertical diffusive nutrient fluxes within the eddy where enhanced chlorophyll was observed (Figure 12.4).

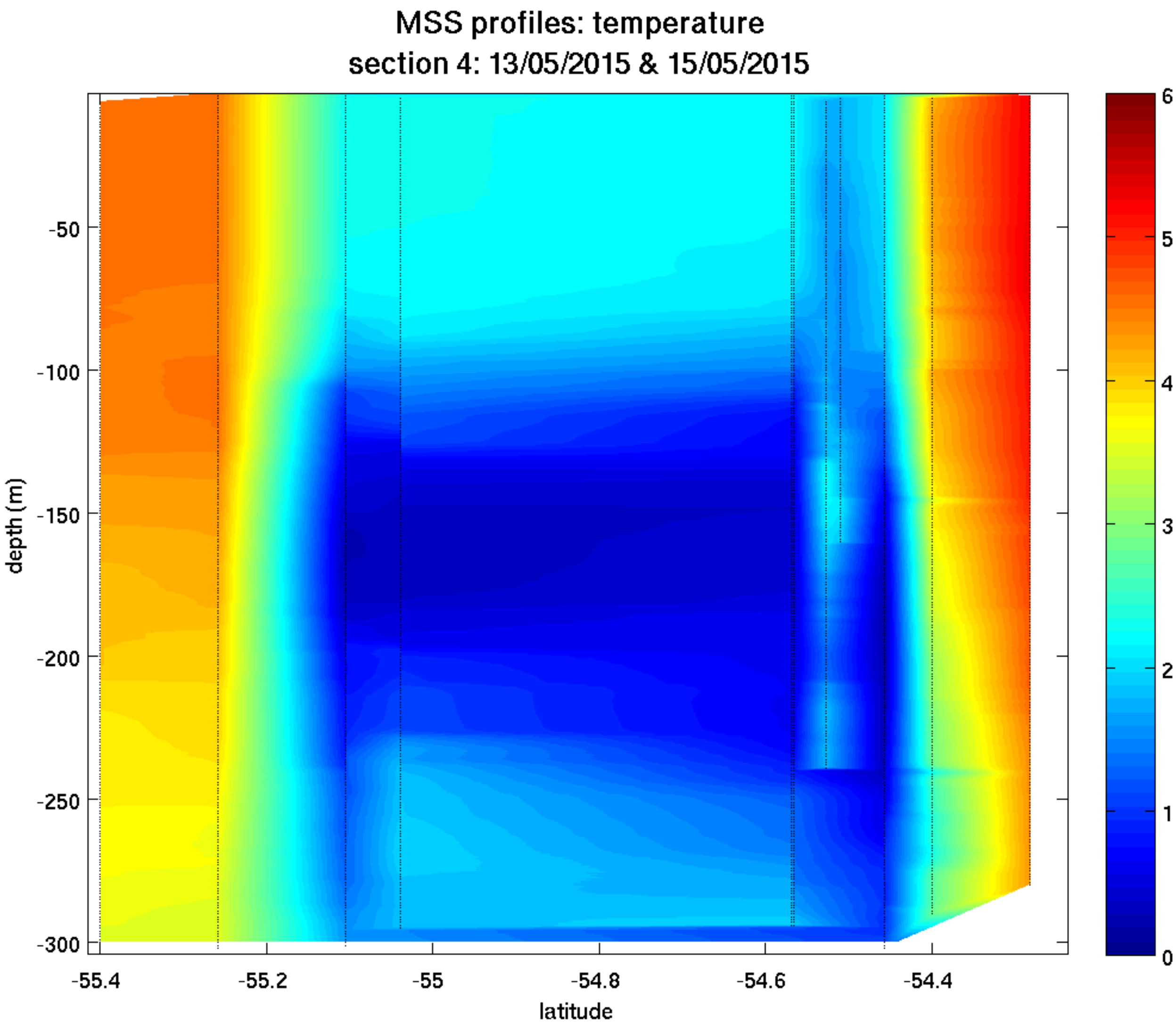

Figure 12.4. Temperature section across the eddy during MSS Group 4

Table 12.1. Time and location of MSS profiles

Profile No.	Date	Time (UTC)	Latitude (°S)	Longitude (°E)	MSS Group number	Depth of profile (m)
1	22/04/15	1144	52°39.865	-54.6773	Test	340
2	22/04/15	1150	52°39.860	-54.4852	Test	300
3	22/04/15	1213	52°39.843	-54.4941	Test	260
4	22/04/15	1228	52°39.86	-54 .7010	Test	50
5	28/04/15	1753	53°00.05	-55.0188	Test	50
6	29/04/15	0756	52°48.694	-54.5892	1	200
7	29/04/15	0800	52°48.576	-54.5905	1	200
8	29/04/15	0811	52°48.438	-54.5921	1	200
9	29/04/15	0821	52°48.298	-54.5938	1	200
10	29/04/15	0833	52°48.123	-54.5955	1	200
11	29/04/15	0854	52°47.751	-54.5981	1	200
12	29/04/15	0906	52°47.559	-55.0006	1	200
13	29/04/15	0918	52°47.339	-55.0025	1	200
14	29/04/15	0944	52°46.946	-55.0057	1	200
15	29/04/15	1017	52°46.642	-55.0080	1	200
16	29/04/15	1033	52°49.389	-55.0107	1	200
17	29/04/15	1050	52°46.170	-55.0150	1	200
18	29/04/15	1106	52°45.96	-55.0191	1	200
19	29/04/15	1121	52°45.78	-55.0231	1	200
20	29/04/15	1136	52°45.59	-55.0269	1	200
21	29/04/15	1907	52°42.70	-55.0618	1	200
22	29/04/15	1923	52°42.68	-55.0618	1	200
23	29/04/15	1940	-52.4261	-55.6178	1	200
24	29/04/15	2040	-52.4351	-55.6723	1	200
25	29/04/15	2057	-52.4331	-55.6891	1	200
26	29/04/15	2108	-52.4318	-55.7007	1	100
27	29/04/15	2147	-52.4271	-55.7425	1	200
28	29/04/15	2201	-52.4232	-55.7622	1	200
29	29/04/15	2216	-52.4237	-55.7778	1	200
30	29/04/15	2234	-52.4217	-55.7978	1	200
31	29/04/15	2249	-52.4203	-55.8129	1	200
32	29/04/15	2306	-52.4190	-55.829	1	200
33	29/04/15	2332	-52.4170	-55.8541	1	200
34	30/04/15	0106	-52.4224	-55.7976	1	200
35	30/04/15	0125	-52.4208	-55.7979	1	178
36	30/04/15	0141	-52.4192	-55.7980	1	200
37	30/04/15	0156	-52.4175	-55.7978	1	200
38	30/04/15	0212	-52.4151	-55.7977	1	200
39	30/04/15	0228	-52.4147	-55.7977	1	200
40	30/04/15	0248	-52.4120	-55.7977	1	200
41	30/04/15	0303	-52.4096	-55.7975	1	200

42	30/04/15	0333	-52.4069	-55.7974	1	200
43	30/04/15	0447	-52.3979	-55.9087	1	200
44	30/04/15	0503	-52.3935	-55.9085	1	200
45	30/04/15	0518	-52.3892	-55.9086	1	200
46	30/04/15	0533	-52.3849	-55.9086	1	200
47	30/04/15	0548	-52.3805	-55.9086	1	200
48	30/04/15	0604	-52.3761	-55.9085	1	200
49	30/04/15	0620	-52.3716	-55.9086	1	200
50	30/04/15	0635	-52.3675	-55.9084	1	200
51	30/04/15	0757	-52.3812	-55.1188	1	200
52	30/04/15	0814	-52.3784	-55.1194	1	200
53	30/04/15	0830	-52.3758	-55.1200	1	200
54	30/04/15	0845	-52.3732	-55.1207	1	200
55	30/04/15	0902	-52.3706	-55.1213	1	200
56	30/04/15	0918	-52.3680	-55.1220	1	200
57	30/04/15	0933	-52.3652	-55.1226	1	200
58	30/04/15	0949	-52.3628	-55.1239	1	200
59	30/04/15	1048	-52.3729	-55.1418	1	200
60	30/04/15	1056	-52.3713	-55.1421	1	200
61	30/04/15	1114	-52.3687	-55.1427	1	200
62	30/04/15	1130	-52.3667	-55.1432	1	200
63	30/04/15	1145	-52.3647	-55.1439	1	200
64	30/04/15	1200	-52.3627	-55.1447	1	200
65	30/04/15	1216	-52.3606	-55.1453	1	200
66	30/04/15	1231	-52.3586	-55.1460	1	200
67	30/04/15	1247	-52.3567	-55.1468	1	200
68	30/04/15	1303	-52.3546	-55.1475	1	200
69	30/04/15	1409	-52.3737	-55.1406	1	200
70	30/04/15	1425	-52.3715	-55.1408	1	200
71	30/04/15	1440	-52.3691	-55.1412	1	200
72	30/04/15	1456	-52.3668	-55.1414	1	200
73	30/04/15	1511	-52.3645	-55.1418	1	200
74	30/04/15	1531	-52.3615	-55.1422	1	200
75	30/04/15	1545	-52.3594	-55.1425	1	200
76	5/5/15	1551	-54.6100	-54.4920	2	70
77	5/5/15	1621	-54.3692	-54.2977	2	230
78	5/5/15	1730	-54.4185	-54.3041	2	158
79	5/5/15	1745	-54.4193	-54.3045	2	205
80	5/5/15	1837	-54.4574	-54.3104	2	236
81	5/5/15	1912	-54.4806	-54.3149	2	226
82	5/5/15	2008	-54.5088	-54.3189	2	180
83	5/5/15	2023	-54.5088	-54.3188	2	167
84	5/5/15	2100	-54.5170	-54.3203	2	150
85	5/5/15	2140	-54.5370	-54.3235	2	120
86	5/5/15	2228	-54.5606	-54.3284	2	135
87	5/5/15	2339	-54.1161	-54.3236	2	235

88	6/5/15	0112	-54.5576	-54.3296	2	135
89	8/5/15	1910	-54.0000	-54.0000	3	100
90	8/5/15	1919	-54.5370	-54.3918	3	120
91	8/5/15	1947	-54.5295	-54.3809	3	150
92	8/5/15	1956	-54.5295	-54.3807	3	145
93	8/5/15	2003	-54.5295	-54.3807	3	100
94	8/5/15	2026	-54.5233	-54.3692	3	120
95	8/5/15	2043	-54.5234	-54.3692	3	230
96	13/5/15	1731	-55.3976	-54.8412	4	"Very deep dive, past pressure depth rating"
97	13/5/15	2116	-55.2584	-54.1484	4	300
98	13/5/15	2127	-55.2579	-54.4869	4	300
99	14/5/15	0047	-52.3546	-54.2152	4	200
100	14/5/15	0100	-55.1706	-54.2132	4	150
101	14/5/15	0427	-55.1059	-54.2151	4	300
102	14/5/15	0442	-55.1055	-54.2143	4	300
103	14/5/15	0756	-55.3950	-54.2212	4	250
104	14/5/15	0810	-55.395	-54.2212	4	290
105	14/5/15	1121	-54.5675	-54.2563	4	300
106	14/5/15	1132	-54.5675	-54.2563	4	290
107	14/5/15	1531	-54.4580	-54.2575	4	280
108	14/5/15	1544	-54.4580	-54.2572	4	300
109	14/5/15	2039	-54.3994	-54.2703	4	280
110	14/5/15	2050	-54.3997	-54.2654	4	300
111	15/5/15	0044	-54.2829	-54.3538	4	150
112	15/5/15	0059	-54.2827	-54.3558	4	280

13. ARGO FLOATS

Jean-Baptiste Sallée, LOCEAN

13.1 INTRODUCTION

One of the responsibilities on JR311 was the preparation and launch of 9 PROVOR-type Argo floats, as well as 2 PROVBIO-type Bio-Argo floats.

PROVOR floats are equipped with an array of sensors that measure salinity/conductivity, temperature, and pressure, whilst tracking the position of the float via the contingent of ARGOS satellites orbiting the Earth. The data collected by the floats is automatically transmitted to these satellites when the float surfaces. The floats manoeuvre vertically through the water column by means of pumping fluid into and out of an external bladder. This particular type of float is designed to be neutrally buoyant at a depth of 500m (parking pressure). The float then descends to a depth of 2000m and then rises back up to the surface. This process is repeated as long as battery life remains, resulting in a continuous cycle of high quality ocean temperature and salinity profiles from 2000m depth to the surface. The profiling cycle length is programmable, and these particular floats have a cycle period of 5 days.

PROVBIO floats are equipped with the same sensors than PROVOR, as well as sensors measuring chlorophyll-A, CDOM, Backscattering. One of the two PROVBIO floats was also equipped with a sensor measuring nutrients. The data collected by the PROVBIO floats is transmitted by IRIDIUM communication, which also allows changing the programming of the floats after deployment. The PROVBIO were programmed to be drift at 500m (parking pressure). Every days, the float then descends to a depth of 1000m and then rises back up to the surface. The floats are programmed to breach surface a 12:00 local time (i.e. changes depending on their location). This process is repeated as long as battery life remains, or until they are reprogrammed differently by IRIDIUM communication.

13.2 OBJECTIVES

During this cruise, nine PROVOR and 2 PROVBIO floats were to be launched at different locations. The principal aim of this venture was to provide the hydrological and biological context at large-scale to complement the smaller-scale observations on which the cruise focused. The second aim was to increase the population of Argo floats in the South Atlantic, in order to augment the quantity and quality of ocean profile data in this location.

13.3 FLOAT IDENTIFICATION

Each float had its own unique serial number on the hull. All the information for each of the floats, including pre-deployment tests and also when the float was actually launched was recorded in a log. The main information has been compiled in the three following tables.

PROVOR Floats Launched at the site of Experience 1:

	Description	014AR51	014AR52	014AR53	014AR55	014AR56
IDENTIFICATION	Platform family	FLOAT	FLOAT	FLOAT	FLOAT	FLOAT
	Platform type	ARVOR	ARVOR	ARVOR	ARVOR	ARVOR
	Platform maker	NKE	NKE	NKE	NKE	NKE
	Type of the battery	LITHIUM	LITHIUM	LITHIUM	LITHIUM	LITHIUM
	Argos program number	2412	2412	2412	2412	2412
	Float sail ID	014AR51	014AR52	014AR53	014AR55	014AR56
	Float serial number	OIN-014-AR-51	OIN-014-AR-52	OIN-014-AR-53	OIN-014-AR-55	OIN-014-AR-56
	Float WMO number	6901712	6901713	6901714	6901716	6901717
	Float Argos Id (decimal)	140843	140844	140845	140847	140848
	Float bluetooth number	2014 01 140	2014 01 141	2014 01 142	2014 06 019	2014 06 020
DEPLOYMENT	Comment after visual inspection of the float	look good	look good	look good	look good	look good
	Comment after visual inspection of the ballast	look good	look good	look good	look good	look good
	Deployment mission name (cruise name)	SMILES	SMILES	SMILES	SMILES	SMILES
	Deployment ship name	RRS James Clark Ross	RRS James Clark Ross	RRS James Clark Ross	RRS James Clark Ross	RRS James Clark Ross
	CTD or XBT profile done during deployment (yes/no)	yes (st 3)	yes (st 2)	yes (st 2)	yes (st 2)	yes (st 1)
	Magnet removal time (dd/mm/yyyy hh:mm)	02/05/2015 03h40 GMT	02/05/2015 00h05 GMT	01/05/2015 23h58 GMT	02/05/2015 00h01 GMT	01/5/15 20h32 GMT
	5 valve actions time (dd/mm/yyyy hh:mm:ss)	10 sec after magnet rm	15 sec after magnet rm	5 sec after magnet rm	15 sec after magnet rm	15 sec after magnet rm
	CTD pump activation time (dd/mm/yyyy hh:mm:ss)	40 sec after magnet rm	70 sec after magnet rm	60 sec after magnet rm	65 sec after magnet rm	25 sec after magnet rm
	5 valve quick actions time (dd/mm/yyyy hh:mm:ss)	55 sec after magnet rm	85 sec after magnet rm	65 sec after magnet rm	85 sec after magnet rm	35 sec after magnet rm
	Pump activation time (dd/mm/yyyy hh:mm:ss)	60 sec after magnet rm	110 sec after magnet rm	80 sec after magnet rm	105 sec after magnet rm	55 sec after magnet rm
	Start time of the float internal check (dd/mm/yyyy					
	Argos transmission time (dd/mm/yyyy hh:mm:ss)					-
	Deployment time (dd/mm/yyyy hh:mm)	02/04/2015 04h06 GMT	02/04/2015 00h46 GMT	02/04/2015 00h38 GMT	02/04/2015 00h42 GMT	01/04/2015 21h23
	Deployment latitude (dd°mm,mm N/S or dd°mm'ss"	53.06133 South	53.07380 South	53.07514 South	53.07448 South	53.08738 South
	Deployment longitude (ddd°mm,mm E/W or	54.28939 West	54.30275 West	54.30072 West	54.30173 West	54.30834 West
	Buoyancy description	Floats. Anthena out of the wate	Floats. Anthena out of the wate	Floats. Anthena out of the wate	Floats. Anthena out of the wate	Floats. Anthena out of the water
	Bathymetry at deployment position(m)	2970 m	2970 m	2970 m	2970 m	2992 m
	Name of the operator in charge of the deployment	JB Sallée	JB Sallée	JB Sallée	JB Sallée	JB Sallée
	Deployment method (release box, manual,	lowered manually on a line	lowered manually on a line	lowered manually on a line	lowered manually on a line	lowered manually on a line
	Meteorology	10 knts, 1 m waves	15 knts, 1 m waves	15 knts, 1 m waves	15 knts, 1 m waves	20 knts, rain, 3 m waves
	Number of days until the first ascending profile (copy	1	1	1	1	1
	Miscellaneous comment on the deployment	all good	all good	all good	all good	all good

PROVOR Floats Launched at the site of Experience 2:

	Description	014AR48	014AR49	014AR50	014AR54
IDENTIFICATION	Platform family	FLOAT	FLOAT	FLOAT	FLOAT
	Platform type	ARVOR	ARVOR	ARVOR	ARVOR
	Platform maker	NKE	NKE	NKE	NKE
	Type of the battery	LITHIUM	LITHIUM	LITHIUM	LITHIUM
	Argos program number	2412	2412	2412	2412
	Float sail ID	014AR48	014AR49	014AR50	014AR54
	Float serial number	OIN-014-AR-48	OIN-014-AR-49	OIN-014-AR-50	OIN-014-AR-54
	Float WMO number	6901709	6901710	6901711	6901715
	Float Argos Id (decimal)	140840	140841	140842	140846
	Float bluetooth number	2014 01 137	2014 01 138	2014 01 139	2014 01 143
DEPLOYMENT	Comment after visual inspection of the float	look good			look good
	Comment after visual inspection of the ballast	look good			look good
	Deployment mission name (cruise name)	SMILES	SMILES	SMILES	SMILES
	Deployment ship name	RRS James Clark Ross	RRS James Clark Ross	RRS James Clark Ross	RRS James Clark Ross
	CTD or XBT profile done during deployment (yes/no)	yes (st 9)	yes (st 6)	yes (st8)	yes (st 7)
	Magnet removal time (dd/mm/yyyy hh:mm)	07/05/2015 18h17 GMT	07/05/2015 10h15 GMT	07/05/2015 15h42 GMT	07/05/2015 13h05 GMT
	5 valve actions time (dd/mm/yyyy hh:mm:ss)	7 sec after magnet rm	20 sec after magnet rm	5 sec after magnet rm	10 sec after magnet rm
	CTD pump activation time (dd/mm/yyyy hh:mm:ss)	80 sec after magnet rm	65 sec after magnet rm	73 sec after magnet rm	70 sec after magnet rm
	5 valve quick actions time (dd/mm/yyyy hh:mm:ss)	97 sec after magnet rm	85 sec after magnet rm	90 sec after magnet rm	80 sec after magnet rm
	Pump activation time (dd/mm/yyyy hh:mm:ss)	120 sec after magnet rm	95 sec after magnet rm	112 sec after magnet rm	100 sec after magnet rm
	Start time of the float internal check (dd/mm/yyyy hh:mm:ss)				
	Argos transmission time (dd/mm/yyyy hh:mm:ss)				
	Deployment time (dd/mm/yyyy hh:mm)	07/05/2015 18h25 GMT	07/05/2015 10h25 GMT	07/05/2015 15h52 GMT	07/05/2015 13h15 GMT
	Deployment latitude (dd°mm,mm N/S or dd°mm'ss" N/S)	54.71 South	54.91 South	54.82 South	54.87 South
	Deployment longitude (ddd°mm,mm E/W or ddd°mm'ss" E/W)	54.86 West	54.71 West	54.78 West	54.73 West
	Buoyancy description	Floats. Anthena out of the wate	Floats. Anthena out of the water	Floats. Anthena out of the water	Floats. Anthena out of the water
	Bathymetry at deployment position(m)	2939	4042	4196 m	4200
	Name of the operator in charge of the deployment	JB Sallée	JB Sallée	JB Sallée	JB Sallée
	Deployment method (release box, manual, expendable cardboard,	lowered manually on a line	lowered manually on a line	lowered manually on a line	lowered manually on a line
	Meteorology	calm, flat, 2degC	calm, flat, 2degC	10 knts, 1 m waves	calm, flat, 2degC
	Number of days until the first ascending profile (copy of the PM2	1	1	1	1
	Miscellaneous comment on the deployment	all good	all good	all good	all good

PROV-Bio Floats Launched at the site of Experience 2:

lovbio069c	
6901650	Float WMO number
Looking Good	Comment after visual inspection of the float
Looking Good (inflated)	Comment after visual inspection of the ballast
JR311 (SMILES cruise)	Deployment mission name (cruise name)
RRS James Clark Ross	Deployment ship name
yes (CTD cast 4)	CTD or XBT profile done during deployment
07 May 2015 01h51 GMT	Magnet removal time (dd/mm/yyyy hh:mm)
5 sec after magnet removal	5 valve actions time (dd/mm/yyyy hh:mm:ss)
60 sec after magnet removal	CTD pump activation time (dd/mm/yyyy hh:mm:ss)
4 min after magnet removal	5 valve quick actions time (dd/mm/yyyy hh:mm:ss)
4 min 5 sec after magnet removal	Pump activation time (dd/mm/yyyy hh:mm:ss)
	Start time of the float internal check (dd/mm/yyyy
	Argos transmission time (dd/mm/yyyy hh:mm:ss)
07 May 2015 03h15 GMT	Deployment time (dd/mm/yyyy hh:mm)
55.00 South	Deployment latitude (dd°mm,mm N/S or dd°mm'ss"
55.68 West	Deployment longitude (ddd°mm,mm E/W or
Floats wel,l anthenna out of water	Buoyancy description
3200 m	Bathymetry at deployment position(m)
JB Sallée	Name of the operator in charge of the deployment
Deployment with aft crane and quick	Deployment method (release box, manual,
calm, flat sea, 1.5 deg C	Meteorology
NA	Miscellaneous comment on the deployment

lovbio073b	
6901654	Float WMO number
Looking Good	Comment after visual inspection of the float
Looking Good (inflated)	Comment after visual inspection of the ballast
JR311 (SMILES cruise)	Deployment mission name (cruise name)
RRS James Clark Ross	Deployment ship name
yes (CTD cast 5)	CTD or XBT profile done during deployment
07 May 2015 06h37 GMT	Magnet removal time (dd/mm/yyyy hh:mm)
5 sec after magnet removal	5 valve actions time (dd/mm/yyyy hh:mm:ss)
1 min 40 sec after magnet removal	CTD pump activation time (dd/mm/yyyy hh:mm:ss)
4 min 40 sec after magnet removal	5 valve quick actions time (dd/mm/yyyy hh:mm:ss)
4 min 45 sec after magnet removal	Pump activation time (dd/mm/yyyy hh:mm:ss)
	Start time of the float internal check (dd/mm/yyyy
	Argos transmission time (dd/mm/yyyy hh:mm:ss)
07 May 2015 07h02 GMT	Deployment time (dd/mm/yyyy hh:mm)
55.13 South	Deployment latitude (dd°mm,mm N/S or dd°mm'ss"
54.62 West	Deployment longitude (ddd°mm,mm E/W or
Floats wel,l anthenna out of water	Buoyancy description
3311 m	Bathymetry at deployment position(m)
JB Sallée	Name of the operator in charge of the deployment
Deployment with aft crane and quick	Deployment method (release box, manual,
calm, flat sea, 1.5 deg C	Meteorology
NA	Miscellaneous comment on the deployment

13.4 PRE-DEPLOYMENT CHECKS

Both before the departure of the ship and prior to their deployment the floats were brought from their storage location on the aft deck and tests were run on each float to ensure that it was functioning as expected.

The following pre-deployments checks procedure for the floats sent was followed. They consisted in a series of easy steps:

- When opening the box, the float and its ballast was checked visually
- Put the float in a standing and safe position in a open area
- Remove the sensors protective plugs
- Remove the magnet to activate the floats
- Just after the float was activated, valve activates, which we checked by hearing 5 clicks
- About one minute after float is activated the CTD pump should activate, which can be checked by a slight change of the level of the water in the CTD water intake.
- About 30 sec after the CTD pump, the valves re-activates in a quicker series of five clicks, followed by sound of the inside pump of the floats.

13.5 PRE-DEPLOYMENT ISSUES

We had no pre-deployment issue. All floats consistently worked as expected during each of these checks.

13.6 DEPLOYMENT

The procedure of deployment would occur immediately after a CTD station was completed and the ship had begun steaming slowly to produce and effective speed through the water of around 0.5-1 knot. Usually about three people were present for a launch; one or two scientific staff to deploy the instrument and one of the deck crew to assist and communicate the progress of the deployment with the bridge. Due to the height weight of the Prov-bio float (compared to provor floats) different deployment procedure were used for deploying Provor and Prov-bio floats:

PROVOR deployment

The float was prepared on deck by threading a rope through the plastic damper plate. One person from the watch would lift the float over the starboard quarter. One person would then take the weight on the rope and start lowering it slowly into the water. When the float was in the water, it was allowed to stream out behind the ship and the untied end of the rope was released to run through the damper plate and let the float go. When the rope was recovered an announcement would be made to the bridge to say all lines were clear. The time and coordinates of the float deployment were recorded.

PROBIO deployment
The float was prepared on deck by threading a rope around the float, with the float being attached to a quick release. The float was slowly lowered with the aft starboard crane into the water. Once in the water, the quick release was open to release one end of the rope, which would leave the float drift away. The time and coordinates of the float deployment were recorded.

13.7 DEPLOYMENT ISSUES
We had no deployement issue.

13.8 DATA
We were not able to receive the Provor first profiles data while on the ship. However, we were notified by email from the French Coriolis Data Center that the all Provor floats works and send their data. The first profiles from the Provbio floats were received by email while on the ship. The two floats made very sensible profiles, though nitrate and chlorophyll measurements appear to have offset (Figure 13.1 and 13.2).

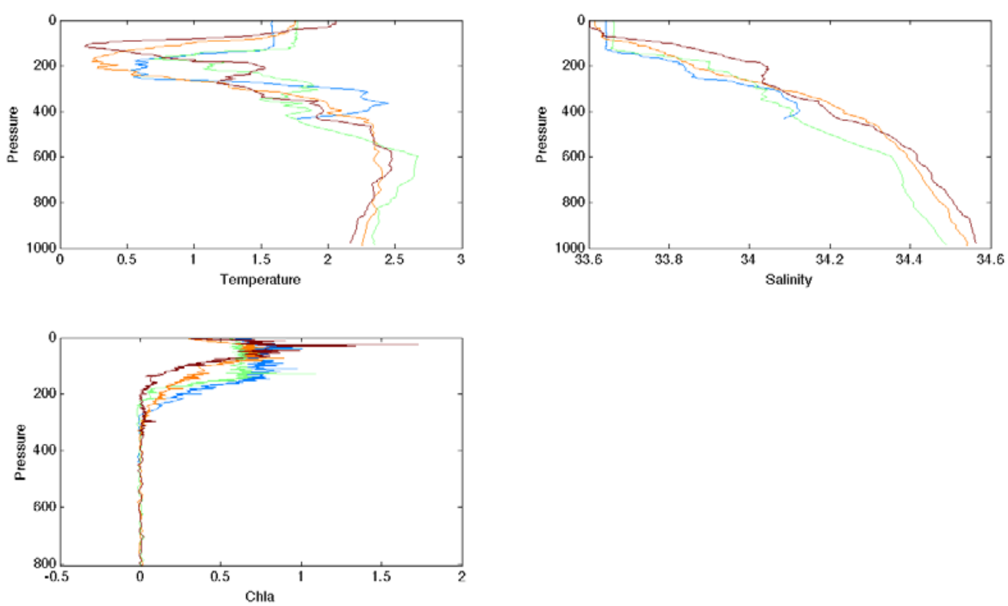

Figure 13.1. First 4 profiles of the provbio profiler lovbio069c

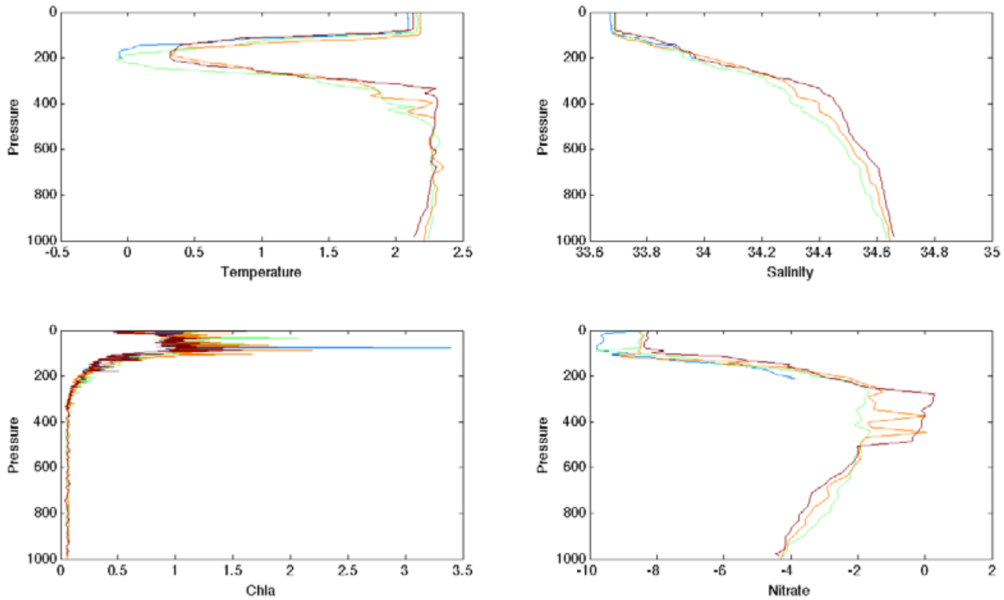

Figure 13.2. First 4 profiles of the provbio profiler lovbio073b

13.9 Calibration

We compared temperature, salinity, potential density, and chlorophyll data from the first profiles of each Provbio floats to the corresponding CTD profile (i.e. the CTD profile sampled just before deploying the Argo float; at the same station). Temperature, salinity, potential density profiles from the floats and from the CTD are in very good agreement (see Figure 13.3 and 13.4).

Salinity profile for float lovbio069c was found to have a slight offset compared to the collocated CTD profile. However, we deployed lovbio069c in a very sharp density/salinity/temperature front, and it was not clear to us whether the slight shift observed was because the front (or the ship) moved between the time of the CTD and the time of deployment of the float (typically a few hours). We therefore plotted additional profiles from the floats, and the water-mass characteristics match very well with the CTD observation (Figure 13.3). Whether the conductivity cell needed time to adapt, or the float was in one part of the front and then came back, we are not sure. But given that the following profiles had good salinity, we think, based on this analysis, that no offset should be applied to the float data.

Chlorophyll profiles were however quite highly offset (see Figure 13.3 and 13.4). We further investigated the departure from CTD and float chlorophyll by plotting them one against each other. We found for both float a clear linear relationship, the CTD measuring about 30% of the chlorophyll concentration measured by the float (28% for lovbio069c, and 31% for lovbio073c; see Figure 13.5). Correlation of the fits are high (r>0.89).

Such calibration has not been applied yet, but our analysis will be transferred and discuss with "RemOcean" to be implemented before releasing the future profiles to international databases.

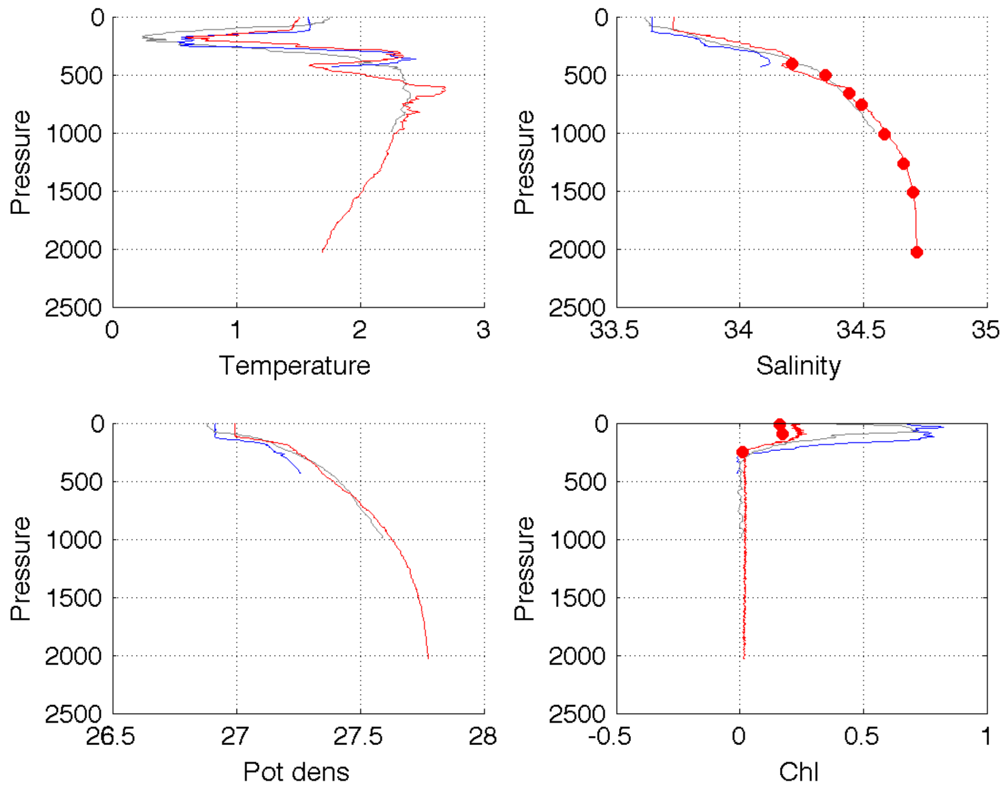

Figure 13.3. Float lovbio069c first profiles: temperature (upper left), salinity (upper right), density (bottom left), and chlorophyll (bottom right). In each panel the float's first profile is shown in blue; the corresponding CTD profile is shown in red; and the following cycle float profile is shown in gray. Red dots in salinity and chlorophyll panels show bottle measurement made on board the ship (see Section 6 and 11).

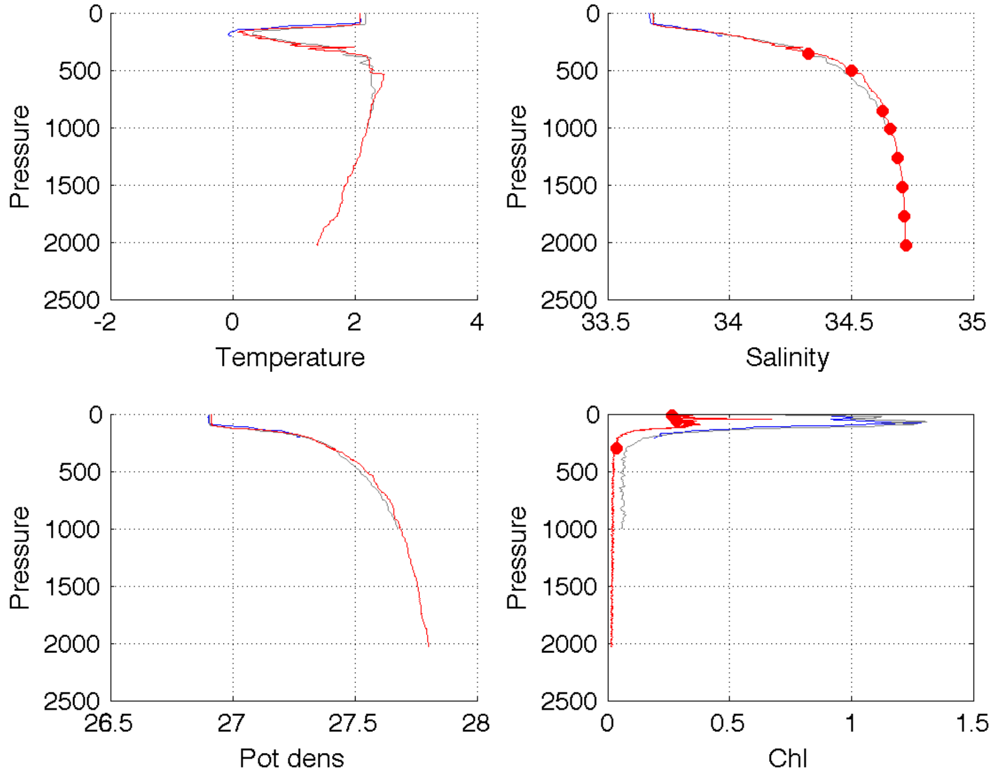

Figure 13.4. Float lovbio073b first profiles: temperature (upper left), salinity (upper right), density (bottom left), and chlorophyll (bottom right). In each panel the float's first profile is shown in blue; the corresponding CTD profile is shown in red; and the following cycle float profile is shown in gray. Red dots in salinity and chlorophyll panels show bottle measurement made on board the ship (see Section 6 and 11).

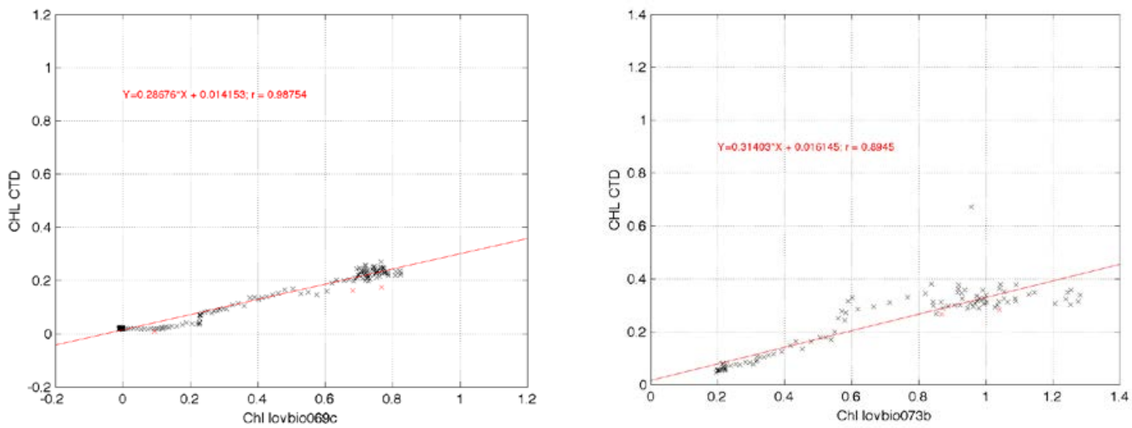

Figure 13.5. float chlorophyll versus CTD chlorophyll for (left) float lovbio069c; and (right) float lovbio073b. On each panel, the right line is the best linear fit. Equation of the fit and correlation coefficients are shown in red.

14. APPENDICES:

14.1 VESSEL MOUNTED ADCP SET-UP FILES

14.1.1 JR311 Narrowband Configuration file

Start Narrow Band Configuration File
NOTE: although header information states 'Setup Type: High resolution, short range profile(broadband) 500 m', it is infact the narrowband setup as shown in the commands highlighted in yellow.

"JR 800m WaterTrack 8mBins NotThruSSU.txt"

```
;--------------------------------------------------------------------------\
; 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

End Narrow Band Configuration File

14.1.2 JR311 Broadband Configuration file

Start Broad Band Configuration File

"JR 800m WaterTrack 8mBins NotThruSSUBband.txt"

```
;--------------------------------------------------------------------------\
; 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
NP0
nn100
ns800
nf0800
```

```
; Switch on Broadband  WP1

WP1
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

End Broad Band Configuration File

14.2 EVENT LOG

Time	Latitude	Longitude	Comment
20/05/2015 12:05	-55.09027	-53.32616	MVP out of the water
20/05/2015 09:45	-55.05326	-53.74119	MVP in the water. Exp 2 Section 8. Transect heading 050
20/05/2015 04:55	-54.89488	-53.89138	Transect of eddy complete. MVP on deck. Heading 220 for transect of separation zone.
20/05/2015 01:05	-55.2089	-54.3109	Started MVP transect. Exp 2, Section 7. Tow 17
20/05/2015 00:41	-55.2489	-54.3406	MVP in the water preparing for northward transect
19/05/2015 22:09	-55.1605	-54.3154	Try putting MVP in the water for a last cross-eddy section
19/05/2015 17:54	-54.95772	-53.55278	Crossed the front
19/05/2015 16:22	-54.8974	-53.41131	Transiting to the southwest to explore evolving eddy with TSG
19/05/2015 08:03	-54.8983	-53.5861	On station but bridge unable to hold ship in useful attitude. Hove to until conditions improve.
19/05/2015 02:31	-55.0511	-53.4329	Start MVP Exp2, Group2, Section 6: along front section toward the drifters again
19/05/2015 00:57	-55.0359	-53.4433	Cannot MVP on station because of wind and current directions. Will wait 1 hour or so for another transect toward the drifters.
19/05/2015 00:57	-55.0359	-53.4433	trouví© le dye !
18/05/2015 23:56	-55.0112	-53.4570	End of Exp2, Group2, Section 5
18/05/2015 22:43	-54.8549	-53.58271	Start of Exp2, Group2, Section 5: down front transect toward the drifters to reposition for a stationary MVP time-series
18/05/2015 22:13	-54.8633	-53.60627	Start of Exp2, Group2, Leg5
18/05/2015 22:08	-54.8634	-53.6042	End of Exp2, Group2, Leg4
18/05/2015 21:21	-54.8208	-53.49206	Start of Exp2, Group2 Leg4
18/05/2015 21:14	-54.8219	-53.49705	End of Exp2, Group2, Leg3
18/05/2015 20:15	-54.87131	-53.63353	Start of Group2 Leg3
18/05/2015 19:20	-54.83693	-53.51453	MVP leg 2 started, 0.5 miles apart from leg 1
18/05/2015 18:41	-54.85787	-53.60285	ashtec gps and time fixed
18/05/2015 18:30	-54.8665	-533.6299	MVP leg started Exp 2, Group 2, Leg 1

18/05/2015 17:44	-54.8411	-53.5851	Recovered temperature sensors from three drifters (position of scs broken)
18/05/2015 13:20	-54.59431	-53.82802	Recover MVP. NMF technicians to fix cable.
18/05/2015 12:49	-54.70166	-54.90714	MVP in water, started transect of Exp 2, Section 4
17/05/2015 23:13	-56.78022	-53.4221	Cannot MVP now. Stay in position until we can MVP
17/05/2015 23:07	-54.68862	-54.89167	Finished pump the dye
17/05/2015 22:18	-54.69969	-54.90476	ctd at 40 m: start deploying dye
17/05/2015 22:07	-54.70176	-54.90755	Start lowering the hose for dye deployment
17/05/2015 20:42	-54.70166	-54.90714	Deployment of drifter D20 with SBE56 3363
17/05/2015 20:42	-54.70166	-54.90714	Deployment of drifter D20 with SBE56 3363
17/05/2015 20:27	-54.70183	-54.90689	Deployment of D19 with SBE56 3364.
17/05/2015 20:12	-54.70231	-54.90633	Deployment of D21 with SBE56 3365.
17/05/2015 20:07	-54.70293	-54.90731	On position to deploy three drifters with SBE56
17/05/2015 16:36	-54.71495	-54.97047	Arrived at front on NW sector of eddy
17/05/2015 08:47	-54.72581	-53.78389	end of MVP Section 3
17/05/2015 08:09	-54.72586	-53.78361	Wind shift & change in vessel orientation - MVP wire uncomfortably close to ship - wire length reduced, therefore profile depth reduced to 200m.
16/05/2015 20:56	-54.72587	-53.78349	In position for on-station MVP profiling in jet
16/05/2015 20:26	-54.72722	-53.77346	In position for on-station MVP profiling in jet. MVP data named Exp2, Section 3
16/05/2015 18:26	-54.81815	-54.11154	Drifter 17 deployed
16/05/2015 18:25	-54.81899	-54.11105	Drifter 14 deployed
16/05/2015 17:37	-54.84847	-54.24694	MVP deployed, heading towards next drifter release location, named Exp2, Section 2
16/05/2015 15:37	-54.89795	-54.38849	Drifter D15 deployed
16/05/2015 15:35	-54.89795	-54.38849	Drifter D18 deployed
16/05/2015 15:29	-54.89846	-54.38765	Wave buoy recovered
16/05/2015 14:02	-54.82754	-54.11499	End of MVP transect into eddy center. Recovering MVP
16/05/2015 13:38	-54.81562	-54.0525	Transiting southwest towards center of eddy to recover wave buoy. MVP still in water and profiling. Named Exp2, Section1. (Note this data is duplicated as the final leg of Exp2, Group 1, Leg 20 and Section 1).

16/05/2015 11:59	-54.75421	-53.82773	End of Exp2, Group 1, Leg 20
16/05/2015 10:52	-54.68659	-53.70994	Start of Exp 2, Group 1, Leg 20
16/05/2015 10:47	-54.68636	-53.7099	End of Exp2, Group1, Leg19
16/05/2015 10:02	-54.74174	-53.80714	Start of Exp2, Group1, Leg19
16/05/2015 09:56	-54.7458	-53.80823	End of Exp2, Group1, Leg18
16/05/2015 09:32	-54.72162	-53.76727	Resumed normal speed
16/05/2015 08:51	-54.69972	-53.72865	Reduced speed to 3 kts to let D13 pass in front of us
16/05/2015 08:44	-54.69294	-53.71629	Start of Exp2, Group1, Leg18
16/05/2015 08:38	-54.68826	-53.71267	End of Exp2, Group1, Leg17
16/05/2015 07:49	-54.74779	-53.82033	Start Exp2, Group1, Leg17
16/05/2015 07:40	-54.75447	-53.82474	End Exp2, Group1, Leg16
16/05/2015 06:29	-54.68661	-53.70844	Start Expt. 2, Gp. 1, Leg 16
16/05/2015 06:24	-54.68153	-53.7078	End Expt. 2, Gp. 1, Leg 15
16/05/2015 05:33	-54.74683	-53.81966	Start of Exp2, Group1, Leg15
16/05/2015 05:27	-54.75192	-53.82461	End of Exp2, Group1, Leg14
16/05/2015 04:18	-54.68979	-53.71508	Start of Exp2, Group1, Leg14
16/05/2015 04:08	-54.6833	-53.71309	End of Exp2, Group1, Leg13
16/05/2015 03:33	-54.72792	-53.78391	Start of Exp2, Group1, leg 13
16/05/2015 03:20	-54.72755	-53.78327	End of Exp 2, Group1, leg 12
16/05/2015 02:32	-54.69359	-53.72227	Start Exp2 Group1 Leg12
16/05/2015 02:32	-54.69336	-53.72187	End of Exp2, Group1 Leg11
16/05/2015 01:36	-54.74782	-53.81869	Start Exp2, Group1, Leg11
16/05/2015 01:28	-54.7503	-53.81723	End of Exp2 Group1 Leg10
16/05/2015 00:43	-54.6992	-53.73415	Start Exp2 Group1 Leg10
16/05/2015 00:29	-54.68896	-53.73533	End of Exp2, Group1, Leg9
15/05/2015 23:32	-54.74844	-53.81537	Start of Exp2 Group1 Leg9
15/05/2015 22:55	-54.72268	-53.7698	Start of Exp2 Group1 Leg8

15/05/2015 22:43	-54.69717	-53.72377	End of Exp2 Group1 Leg7
15/05/2015 21:54	-54.74773	-53.82058	Start of Exp2 Group1 Leg7
15/05/2015 21:47	-54.75249	-53.82118	End of Exp2 Group1 Leg6
15/05/2015 21:05	-54.70855	-53.7455	Start of Exp 2, Group 1, Leg 6
15/05/2015 20:47	-54.69734	-53.73805	End of Exp2 Group1 Leg5
15/05/2015 20:11	-54.74445	-53.81786	Start of Group1 Leg5: We start the leg half way through the front (~3deg C) coming from the cold side of the front (~2deg C) due to way too wide turn
15/05/2015 19:48	-54.76208	-53.84401	End of Exp 2, Group 1, Leg 4
15/05/2015 18:50	-54.70894	-53.74876	Start of Exp 2, Group 1, Leg 4
15/05/2015 18:45	-54.70459	-53.73815	End of Exp 2, Group 1, Leg 3
15/05/2015 17:59	-54.05479	-54.84696	Start of Exp 2, Group 1, Leg 3
15/05/2015 16:40	-54.73566	-53.79624	End of MVP Exp 2, Group 1, Leg 1
15/05/2015 16:04	-54.75306	-53.83268	MVP in water for cross-current test at north-east sector of eddy
15/05/2015 08:15	-54.05479	-54.84696	CTD 024 on deck
15/05/2015 06:52	-54.05367	-54.84304	CTD 024 in water
15/05/2015 05:03	-54.21222	-54.75845	CTD 023 on deck
15/05/2015 03:54	-54.2122	-54.75847	CTD 023 in water
15/05/2015 00:23	-54.47203	-54.58651	CTD 22 on deck
14/05/2015 22:55	-54.46895	-54.63507	CTD22 in the water
14/05/2015 20:59	-54.66663	-54.43621	2 MSS profile done
14/05/2015 20:25	-54.66521	-54.46118	CTD21 on deck
14/05/2015 18:59	-54.67102	-54.54263	CTD21 in water
14/05/2015 16:44	-54.76275	-54.40773	CTD20 Nutrients done
14/05/2015 15:44	-54.76344	-54.42883	MSS cast 108 to 300m
14/05/2015 15:31	-54.76344	-54.42883	MSS cast 107 to 290m
14/05/2015 15:13	-54.76519	-54.43116	CTD at surface
14/05/2015 13:43	-54.76854	-54.49269	CTD 20 in water

14/05/2015 13:39	-54.76867	-54.49491	On station for CTD cast 20
14/05/2015 12:09	-54.93109	-54.43171	Wave buoy deployed - inside eddy. D03 on wave buoy. Attached to D14 deployed with drogue.
14/05/2015 11:34	-54.94271	-54.4282	Completed 2 MSS profiles to 300 & 295m
14/05/2015 11:01	-54.94891	-54.42627	CTD 019 on deck.
14/05/2015 09:41	-54.94894	-54.42627	CTD 019 in water
14/05/2015 07:56	-54.94891	-54.42627	2 x MSS profiles to 270 and 290m
14/05/2015 07:42	-55.06627	-54.36901	CTD 018 on deck
14/05/2015 05:55	-55.06625	-54.36902	CTD 018 in water
14/05/2015 04:27	-55.06602	-54.36889	2 x MSS profiles to 300m
14/05/2015 04:18	-55.17641	-54.35904	CTD 17 out of water.
14/05/2015 02:44	-55.17112	-54.34807	CTD 17 in water.
14/05/2015 01:17	-55.43306	-54.21222	Two MSS profiles done when leaving station. Fall speed on profile 100 is very low (probably towing the MSS) - unusable data.
14/05/2015 00:31	-55.28943	-54.35775	CTD 16 on deck
13/05/2015 21:15	-55.3327	-54.25717	Two MSS profiles done when leaving station, steaming northward at 1 knt
13/05/2015 21:04	-55.43111	-54.24644	CTD15 on deck
13/05/2015 19:36	-55.43306	-54.21222	CTD15 in the water
13/05/2015 14:28	-55.66731	-54.13448	CTD 14 in the water
13/05/2015 10:26	-56.09875	-53.92435	CTD 013 on deck
13/05/2015 09:01	-56.10077	-53.92318	CTD 013 in water
13/05/2015 04:13	-56.66172	-53.61788	CTD 012 on deck - continue transect.
13/05/2015 02:54	-56.66807	-53.64553	CTD 012 in water
13/05/2015 00:50	-56.78022	-53.4221	CTD 11 on deck
13/05/2015 00:50	-56.78022	-53.4221	CTD 11 on deck
13/05/2015 00:50	-56.78022	-53.4221	CTD 11 on deck
13/05/2015 00:50	-56.78022	-53.4221	CTD 11 on deck
13/05/2015 00:50	-56.78022	-53.4221	CTD 11 on deck

13/05/2015 00:50	-56.78022	-53.4221	CTD 11 on deck
13/05/2015 00:50	-56.78022	-53.4221	CTD 11 on deck
13/05/2015 00:50	-56.78022	-53.4221	CTD 11 on deck
13/05/2015 00:50	-56.78022	-53.4221	CTD 11 on deck
13/05/2015 00:50	-56.78022	-53.4221	CTD 11 on deck
13/05/2015 00:50	-56.78022	-53.4221	CTD 11 on deck
13/05/2015 00:50	-56.78022	-53.4221	CTD 11 on deck
13/05/2015 00:50	-56.78022	-53.4221	CTD 11 on deck
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13/05/2015 00:50	-56.78022	-53.4221	CTD 11 on deck
13/05/2015 00:50	-56.78022	-53.4221	CTD 11 on deck
13/05/2015 00:50	-56.78022	-53.4221	CTD 11 on deck
13/05/2015 00:50	-56.78022	-53.4221	CTD 11 on deck
12/05/2015 23:22	-56.77839	-53.425	CTD 11 deployed
12/05/2015 22:20	-56.82299	-53.42482	Seasoar recovered
12/05/2015 18:22	-56.44412	-53.74188	crossed polar front
12/05/2015 04:10	-54.46871	-54.68456	Start Leg 47
12/05/2015 03:42	-54.46995	-54.79041	End Leg 46 - Sea Soar survey of meander periphery complete.
11/05/2015 23:46	-55.11729	-54.82245	start leg 46
11/05/2015 23:01	-55.14806	-54.95084	End Leg 45
11/05/2015 21:02	-54.89652	-55.02923	Start Leg 45
11/05/2015 20:19	-54.88553	-55.16211	End of Leg 44
11/05/2015 20:19	-54.88553	-55.16211	End of Leg 44
11/05/2015 20:19	-54.88553	-55.16211	End of Leg 44
11/05/2015 20:19	-54.88553	-55.16211	End of Leg 44

11/05/2015 20:19	-54.88553	-55.16211	End of Leg 44
11/05/2015 20:19	-54.88553	-55.16211	End of Leg 44
11/05/2015 20:19	-54.88553	-55.16211	End of Leg 44
11/05/2015 20:19	-54.88553	-55.16211	End of Leg 44
11/05/2015 20:19	-54.88553	-55.16211	End of Leg 44
11/05/2015 20:19	-54.88553	-55.16211	End of Leg 44
11/05/2015 17:50	-55.22491	-54.78361	Start leg 44
11/05/2015 17:47	-55.23159	-54.77546	End of leg 43
11/05/2015 16:10	-55.48225	-54.80257	Start of leg 43
11/05/2015 14:45	-55.62216	-54.69239	End of leg 42. Turning to starboard.
11/05/2015 12:20	-55.29589	-54.69152	Start of leg 42
11/05/2015 11:44	-55.28167	-54.58175	End of leg 41. turning to port to 180
11/05/2015 08:54	-55.74135	-54.57097	Start Leg 41
11/05/2015 08:20	-55.75172	-54.47722	End Leg 40
11/05/2015 05:26	-55.34563	-54.47862	Start Leg 40
11/05/2015 04:53	-55.3025	-54.3985	End Leg 39
11/05/2015 01:53	-55.76844	-54.39033	Start Leg 39
11/05/2015 01:24	-55.7806	-54.30432	End of Leg 38
10/05/2015 23:17	-55.47024	-54.30321	Start of leg 38
10/05/2015 22:25	-55.35628	-54.36209	End of Leg 37
10/05/2015 22:25	-55.35628	-54.36209	End of Leg 37
10/05/2015 22:25	-55.35628	-54.36209	End of Leg 37
10/05/2015 22:25	-55.35628	-54.36209	End of Leg 37
10/05/2015 18:54	-55.81364	-54.13635	Start of leg 37
10/05/2015 18:46	-55.83009	-54.11776	End of leg 36
10/05/2015 16:04	-55.44426	-54.17671	Start of leg 36
10/05/2015 15:36	-55.45159	-54.24605	End of leg 35

10/05/2015 14:02	-55.63079	-53.99706	Start leg 35
10/05/2015 13:59	-55.63636	-53.97569	Turning to 312 to start leg 35
10/05/2015 13:31	-55.4365	-54.17658	Heading 270 to get back underneath drifters before starting new leg
10/05/2015 13:01	-55.60475	-53.7519	End of leg 34, starting turn to starboard
10/05/2015 11:00	-55.48504	-54.2275	Start Leg 34
10/05/2015 10:25	-55.4365	-54.17658	End Leg 33
10/05/2015 08:35	-55.57025	-53.76558	Start Leg 33
10/05/2015 08:02	-55.51459	-53.72185	End Leg 32
10/05/2015 06:23	-55.38031	-54.10357	Start Leg 32
10/05/2015 05:45	-55.32954	-54.02868	End of Leg 31
10/05/2015 04:22	-55.47541	-53.79694	Start of Leg 31
10/05/2015 03:41	-55.40998	-53.72847	End of Leg 30
10/05/2015 02:06	-55.24413	-54.0406	start leg 30
10/05/2015 01:26	-55.17525	-54.01206	End Leg 29
09/05/2015 23:29	-55.33247	-53.63049	start Leg 29
09/05/2015 22:58	-55.25932	-53.60173	End of Leg 28
09/05/2015 21:54	-55.17785	-53.84864	Start of Leg 28
09/05/2015 21:01	-55.10638	-53.84184	End of leg 27
09/05/2015 19:11	-55.24871	-53.48853	Start of leg 27
09/05/2015 19:10	-55.24894	-53.48641	End of leg 26 (need to update time)
09/05/2015 17:01	-55.14622	-53.80789	Start of leg 26
09/05/2015 16:01	-55.03527	-53.69689	Passed directly through surface dye streak. Sea soar at surface
09/05/2015 14:42	-55.16834	-53.61663	Start of leg 25
09/05/2015 14:23	-54.84252	-53.45402	End of leg 24, starting turn to starboard
09/05/2015 13:09	-54.96412	-53.91416	Dye measured with SeaSoar fluoro up to 0.4 volts (background noise 0.1 volts) down to 40m depth. Dye also visible at surface.
09/05/2015 12:28	-55.00848	-53.84886	Start of leg 24

09/05/2015 11:55	-54.96715	-53.91723	End of leg 23, starting turn to port.
09/05/2015 11:19	-54.89608	-53.7945	Dye streak observed port side at surface.
09/05/2015 10:28	-54.78911	-53.65854	Commence Leg 23 - heading 220
09/05/2015 09:47	-54.77044	-53.78421	End of Leg 22 - commence turn to starboard.
09/05/2015 08:31	-54.93772	-53.78482	Commence Leg 22 - heading 000
09/05/2015 07:55	-54.92447	-53.89492	End of leg 21 - commence turn to port.
09/05/2015 06:43	-54.73146	-53.99311	Commence Leg 21 - heading 170
09/05/2015 06:09	-54.70847	-53.9209	End of leg 20. Turning to port to pass behind buoys.
09/05/2015 04:48	-54.88477	-53.9727	Commence turn into Leg 20
09/05/2015 03:54	-54.70847	-53.9209	End leg 19, turn 090 ** According to NMF folks, everything before here is in one file (Tow 5, Leg 1). We have asked them to separate all North-South sections into separate legs from this point forward.
09/05/2015 02:15	-54.65089	-54.37205	End of Leg 18
09/05/2015 00:21	-54.9081	-54.28349	Finish the turn. Start of Leg 18
08/05/2015 23:27	-54.85844	-54.29144	end of leg 17 (along front leg catching up with the drifters), turning toward leg 18
08/05/2015 21:30	-54.85677	-54.28136	Start of leg 17
08/05/2015 21:28	-54.87677	-54.61554	Seasoar in the water
08/05/2015 21:15	-54.87237	-54.61527	Seasoar deployment
08/05/2015 19:10	-54.89523	-54.65298	MSS profiles to 100-150m, following drifters and dye.
08/05/2015 18:37	-54.90482	-54.66891	Dye release ended, hose being pulled back in
08/05/2015 18:30	-54.90635	-54.67049	Drifter D01 deployed
08/05/2015 18:27	-54.99007	-54.65714	Drifter D13 deployed
08/05/2015 18:24	-54.90749	-54.6717	Drifter D16 deployed
08/05/2015 18:21	-54.90827	-54.67258	Dye pump started
08/05/2015 18:16	-54.90935	-54.67372	Switched Chlorophyll fluorometer with Fluoroscein fluorometer on MSS. Fluoro channel wasn't working.
08/05/2015 17:30	-54.91856	-54.6868	Dye hose deployed
08/05/2015 17:23	-54.91863	-54.68691	Stopped at outer edge of cold filament, ready for dye release
08/05/2015 16:35	-54.99007	-54.65714	Recovered seasoar, turned back north to dye deployment location

08/05/2015 15:27	-54.9457	-54.71976	Front!
08/05/2015 13:40	-54.71962	-54.87236	Completed turn, start of leg 16
08/05/2015 13:08	-54.70947	-54.7978	End of leg 15, turning to port to move to center of front to start leg 16
08/05/2015 10:48	-55.07533	-54.57224	Turning to 330, Leg 15
08/05/2015 07:57	-55.06929	-53.79885	Commence turn to 270 - Leg 14.
08/05/2015 06:57	-54.91095	-53.66329	Front 2.9 degrees
08/05/2015 06:16	-54.90359	-53.57384	Commence turn to reciprocal heading - new Leg 13. SST 4.06
08/05/2015 05:28	-54.97416	-53.68411	Hit waypoint. Turning north to seek front - SST 1.868. Commencing Leg 12, heading. 018 - front at 05:50
08/05/2015 03:10	-54.89788	-54.10534	Sea Soar deployed - leg11 (1st leg of tow 4).
08/05/2015 00:41	-54.87557	-54.18331	CTD 010 at surface, recovered to deck
07/05/2015 23:07	-54.93829	-54.77	CTD 010 started profiling
07/05/2015 18:25	-54.70944	-54.86144	Argo 014AR048 deployed
07/05/2015 17:25	-54.71599	-54.88268	CTD 9 at the bottom (2000 m)
07/05/2015 17:03	-54.71968	-54.89224	CTD09 at 685m.
07/05/2015 15:52	-54.82375	-54.78111	Argo AR014050 deployed
07/05/2015 14:39	-54.84433	-54.80391	VMDAS crashed, restarted on file no. 21
07/05/2015 14:15	-54.85598	-54.81676	CTD008 starting profiling
07/05/2015 13:50	-54.85704	-54.81754	Electronics board D03 connected to wave buoy. Buoy rebooted and left running.
07/05/2015 13:15	-54.87329	-54.73378	Argo 014AR54 deployed
07/05/2015 11:33	-54.89813	-54.79026	CTD 007 started profiling
07/05/2015 10:25	-54.91496	-54.70788	Argo float 014AR049 deployed
07/05/2015 10:15	-54.915	-54.70791	CTD 006 out of water. Drifted 5 nm to the east during profile, different profile on the upcast, 2C water at surface compared to 4C on downcast
07/05/2015 08:42	-54.93997	-54.7637	CTD 006 into water
07/05/2015 07:02	-55.13303	-54.62223	Bio Argo lovbio073 deployed
07/05/2015 06:37	-55.12915	-54.61839	CTD 5 out of water
07/05/2015 04:57	-55.14182	-54.63331	CTD 5 in the water

07/05/2015 03:15	-55.00325	-54.67598	Bio Argo lovbio069 deployed
07/05/2015 02:56	-54.99927	-54.66868	CTD on deck, repositioning to CTD transect for BioArgo deployment
07/05/2015 01:40	-55.01426	-54.70899	ADCP switched to broadband, 600m range
07/05/2015 01:20	-55.02068	-54.72013	CTD 4, first station at meander, in cold filament to south of main front.
06/05/2015 20:19	-54.64787	-53.88525	seasoar on deck
06/05/2015 19:36	-54.69308	-53.96762	Seasoar recovery starting
06/05/2015 14:28	-55.41537	-54.5072	End of seasoar leg 9, turning slightly port to start leg 10
06/05/2015 10:38	-55.76002	-55.36507	Finished turn; SeaSoar still in; beginning of Leg 9
06/05/2015 09:48	-55.68703	-55.46722	Slow turn to port at end of Leg 8; considering pulling SeaSoar out
06/05/2015 02:29	-54.99264	-54.59088	Seasoar deployed
05/05/2015 23:36	-55.01934	-54.55615	MSS Station 8. ACC transect
05/05/2015 23:00	-54.96249	-54.55186	MSS Station 7. ACC transect
05/05/2015 21:26	-54.89364	-54.53774	MSS Station 6. ACC transect
05/05/2015 19:55	-54.84773	-54.53252	MSS Station 5, ACC Transect
05/05/2015 19:07	-54.8005	-54.52468	MSS Station 4, ACC Transect
05/05/2015 18:27	-54.76177	-54.51722	MSS Station 3, ACC transect
05/05/2015 17:14	-54.6928	-54.50695	Stopping ship for next MSS profile, Station 2, ACC front
05/05/2015 15:51	-54.61009	-54.49287	Starting MSS profiling. Station 1 crossing ACC front
05/05/2015 14:30	-54.48943	-54.36005	Turn to 220N to position for resumption of MSS cross-front survey
03/05/2015 11:15	-53.29182	-53.07821	Turning to 315 for VMADCP and underway TSG transect
03/05/2015 00:59	-53.26942	-54.71335	Transitting approximately 60 miles to east to wait out weather system. Heave to!
03/05/2015 00:44	-53.25511	-54.72427	Tow 2 leg 2 complete. Sea Soar recovered.
02/05/2015 14:24	-51.81504	-54.76188	Seasoar issues resolved (started diving again of its own accord). Turning to heading of 180 for Leg 3.
02/05/2015 13:51	-51.77457	-54.64867	SeaSoar has not dived for the last 10 minutes; turning south.
02/05/2015 12:40	-51.85919	-54.35662	Turned to 295N, Start of Leg 2
02/05/2015 04:26	-53.04558	-54.29612	SeaSoar deployed
02/05/2015 04:13	-53.06023	-54.29124	Drifter deployed D12

02/05/2015 04:11	-53.06064	-54.29058	Drifter deployed D11
02/05/2015 04:08	-53.06133	-54.28939	Drifter deployed D10
02/05/2015 04:06	-53.06133	-54.28939	Argo 014AR51 deployed
02/05/2015 03:53	-53.06167	-54.28888	CTD03 completed.
02/05/2015 02:26	-53.06167	-54.28886	CTD03 deployed. Starting downcast.
02/05/2015 00:46	-53.0738	-54.30275	Argo 14AR52 deployed
02/05/2015 00:45	-53.07401	-54.30246	Drifter D07 deployed
02/05/2015 00:44	-53.07417	-54.30223	Drifter D09 deployed
02/05/2015 00:42	-53.07448	-54.30173	Argo 014AR55 deployed
02/05/2015 00:41	-53.07459	-54.30155	Drifter D08 deployed
02/05/2015 00:38	-53.07514	-54.30072	Argo 014AR53 deployed
02/05/2015 00:30	-53.07512	-54.30065	CTD02 completed
01/05/2015 23:54	-53.0751	-54.30069	EK60 restarted, was not logging since 11GMT
01/05/2015 23:24	-53.07512	-54.30069	CTD 02 at bottom. Start upcast.
01/05/2015 22:39	-53.08678	-54.3086	CTD 02 deployed, start of downcast
01/05/2015 21:25	-53.08678	-54.3086	Drifter D05 deployed
01/05/2015 21:23	-53.08734	-54.30836	Drifter D04 and D06 deployed
01/05/2015 21:23	-53.08738	-54.30834	Argo 014AR56 in the water.
01/05/2015 21:23	-53.08738	-54.30834	Argo 014AR56 in the water.
01/05/2015 21:23	-53.08738	-54.30834	Argo 014AR56 in the water.
01/05/2015 21:23	-53.08738	-54.30834	Argo 014AR56 in the water.
01/05/2015 21:23	-53.08738	-54.30834	Argo 014AR56 in the water.
01/05/2015 21:23	-53.08738	-54.30834	Argo 014AR56 in the water.
01/05/2015 21:23	-53.08738	-54.30834	Argo 014AR56 in the water.
01/05/2015 21:23	-53.08738	-54.30834	Argo 014AR56 in the water.
01/05/2015 21:23	-53.08738	-54.30834	Argo 014AR56 in the water.
01/05/2015 21:23	-53.08738	-54.30834	Argo 014AR56 in the water.

01/05/2015 21:23	-53.08738	-54.30834	Argo 014AR56 in the water.
01/05/2015 21:05	-53.08827	-54.3078	CTD 01 at surface, finished upcast
01/05/2015 20:02	-53.08837	-54.30778	CTD 01 at bottom. Start upcast.
01/05/2015 19:08	-53.08844	-54.30759	Start downcast CTD 01
01/05/2015 17:50	-53.0148	-54.26359	HOVE to
01/05/2015 17:25	-52.56831	-55.41935	Intake pump tripped. Front identified sometime during subsequent 20 minutes (5.4 to 5.9 C).
01/05/2015 11:55	-52.56514	-55.42086	Begin transit towards CTD location.
30/04/2015 20:00	-52.56831	-55.41935	Recover D01/R02 drifter
30/04/2015 20:00	-52.56831	-55.41935	Recover D01/R02 drifter
30/04/2015 16:18	-52.59751	-55.25774	Recovery of D03/RO2 Buoy
30/04/2015 16:18	-52.59779	-55.25762	MSS Finished
30/04/2015 04:48	-52.66298	-55.15154	MSS sampling started again.Previous undocumented events:Ships navigation system froze, MSS taken out until fixed.
30/04/2015 00:20	-52.69172	-55.14652	Ended MSS profiling, brought in probe, moving ship south to repeat another northward section
29/04/2015 17:19	-52.76993	-55.09807	End of group 12 leg 1
29/04/2015 15:40	-52.60807	-55.04935	Starting MVP again. Beginning of Tow 10, Group 12 Leg 1
29/04/2015 12:40	-52.8099	-55.03085	Recovered drifter D03. ADCP missing. Making excursion to try to spot floats.
29/04/2015 10:13	-52.77765	-55.01342	Re-starting MSSing
29/04/2015 09:59	-52.7778	-55.01325	Stopped MSSing. Changing cable.
29/04/2015 07:53	-52.81157	-54.98214	Start MSSing
29/04/2015 06:29	-52.79331	-55.04225	MVP on deck
29/04/2015 06:15	-52.80252	-55.03342	weather picking up. MVP needs to be recovered
29/04/2015 05:53	-52.83858	-55.00872	Problem with wire. Need to bring the MVP back to the surface
29/04/2015 04:24	-53.00713	-55.05558	start Group 11 Leg 1
29/04/2015 04:14	-53.00803	-55.05585	End of Group 10 leg 4
29/04/2015 01:26	-52.73226	-55.00402	End of Group 10 leg 3, turning starboard to avoid buoy on port side
28/04/2015 23:00	-52.96755	-55.09327	Start of Group 10 leg 3

28/04/2015 22:43	-52.97523	-55.06197	End of Group 10 leg 2, turning starboard to start leg 3
28/04/2015 21:31	-52.86054	-55.02933	Start of Group 10, leg 2
28/04/2015 21:12	-52.85734	-54.98981	End of group 10 leg 1, turning to port to start group 10 leg 2
28/04/2015 20:01	-52.98614	-55.02782	MVP deployed, starting Group 10, leg 1. Start of Tow 9. Sun shield was removed from MVP fluoroscein sensor.
28/04/2015 18:57	-52.99896	-55.03067	Ashtech GPS restarted.
28/04/2015 18:02	1000.65	1000.65	Ship stopped to untwist MVP cable.
28/04/2015 17:26	1000.65	1000.65	Removed the Reed switch magnet from Drifter D04 to test comms (to replace Wavebuoy Irridium board).
28/04/2015 17:24	1000.65	1000.65	End of Group 9, Leg 2.
28/04/2015 16:18	1000.65	1000.65	Start of group 9 leg 2.
28/04/2015 16:02	1000.65	1000.65	end of group 9 leg 1
28/04/2015 14:49	1000.65	1000.65	Start of group 9 leg 1
28/04/2015 14:28	1000.65	1000.65	End of group 8 leg 4
28/04/2015 13:24	1000.65	1000.65	Start of Group 8, Leg 4.
28/04/2015 13:17	-52.91239	-54.91632	Slight excursion to look at buoy. Have not begun next MVP leg yet.
28/04/2015 13:06	-52.88386	-54.96262	End of group 8 leg3
28/04/2015 11:24	-53.03793	-55.00209	Start of Group 8, Leg 3.
28/04/2015 11:10	-53.06993	-55.01899	End of Group 8, Leg 2
28/04/2015 09:55	-52.93048	-54.94994	Start Leg 2 Group8
28/04/2015 09:10	-52.91239	-54.91632	End of Leg 1 Group8
28/04/2015 07:39	-53.06301	-54.96196	Start of Group 8 Leg 1
28/04/2015 07:16	-53.06993	-55.01899	End of Group 7 Leg 4
28/04/2015 05:42	-52.92946	-54.98412	Start of Group 7 Leg 4
28/04/2015 05:26	-52.93259	-54.96146	End of Group 7, Leg 3
28/04/2015 05:25	-52.93345	-54.96171	Problem with MVP profile Tow8_0165 - MVP dive stopped for unknown reasons.
28/04/2015 04:04	-53.07031	-55.00154	Start of Group 7 Leg 3
28/04/2015 03:50	-53.07842	-54.97687	End of Group 7 Leg 2

28/04/2015 02:25	-52.9472	-54.94183	Start Group 7 leg 2
28/04/2015 02:14	-52.94276	-54.92328	End of Group 7, leg 1 turning west
28/04/2015 00:52	-53.07073	-54.94837	Start Group 7, leg 1
28/04/2015 00:29	-53.07874	-54.91803	End of Group 6, leg 4. Turning west.
27/04/2015 23:15	-52.96431	-54.88885	Group 6, leg 4
27/04/2015 23:10	-52.9596	-54.88545	Passed D01, central drifter during turn.
27/04/2015 22:48	-52.97441	-54.85091	End Group 6, leg 3. Turning west, to port.
27/04/2015 22:38	-52.99055	-54.85506	Passed ADCP drifter, D03, on starboard side. Confirmed red lights are working!
27/04/2015 21:47	-53.07752	-54.87939	Start Group 6, leg3
27/04/2015 21:24	-53.09055	-54.83969	End of Group 6, leg 2 of tow 8. Turning starboard to start leg 3.
27/04/2015 20:29	-53.00588	-54.81545	Passed ADCP drifter to starboard
27/04/2015 20:04	-52.96621	-54.80165	Finished turn, start of leg 2 in group6
27/04/2015 19:53	-52.97078	-54.77866	end of leg 1, group6. turning to start leg 2.
27/04/2015 18:44	-53.09342	-54.81001	Start of Group 6, Leg 1.
27/04/2015 18:25	-53.09373	-54.84377	End of Group 5, Leg 2.
27/04/2015 17:21	-53.0025	-54.82022	Beginning of Group 5, Leg 2
27/04/2015 16:56	-53.00004	-54.7697	Sensitivity of Underway fluorometer changed.
27/04/2015 15:56	-53.10422	-54.79851	MVP back in water. Start of Tow 8, Group 5, Leg 1.
27/04/2015 14:46	-53.11458	-54.79792	Completed turn. Ship stopping to fix steering. MVP pulled out of water.
27/04/2015 14:22	-53.13578	-54.77162	End of Group 4, Leg 1.
27/04/2015 13:02	-53.00992	-54.73124	Ship steering problem (temporarily) tixed. MVP back in water. Start of Tow 7, Group 4, Leg 1.
27/04/2015 11:50	-53.02871	-54.73966	MVP pulled out of water; ship stopping to fix steering. End of Group 3, Leg 2.
27/04/2015 10:46	-53.13864	-54.77685	Start of Group 3 Leg 2
27/04/2015 10:33	-53.14606	-54.75611	End of Leg 1 Group 3.
27/04/2015 09:23	-53.03484	-54.71848	Start of Group 3 Leg 1
27/04/2015 09:02	-53.13534	-54.72668	End of Group 2 Leg 4 -- End of Group 2
27/04/2015 08:06	-53.13534	-54.72668	Start of Group 2 Leg 4

27/04/2015 07:50	-53.14617	-54.70075	End of Group2 Leg3
27/04/2015 06:49	-53.04898	-54.67347	Start of Group2 Leg 3
27/04/2015 06:31	-53.05256	-54.65349	End of Leg 2 Group 2, starting to turn West
27/04/2015 05:06	-53.18641	-54.69573	Start of Group 2 Leg 2.
27/04/2015 04:46	-53.19735	-54.66692	End of Group2 Leg 1, start Turning West
27/04/2015 03:36	-53.06698	-54.62713	Ocean logger flashing yellow/red. Phoned Johnnie - no problems.
27/04/2015 03:22	-53.06698	-54.62713	MVP Group 2 Leg 1 Started !
27/04/2015 02:49	-53.11849	-54.5752	MVP Group 1. End leg 4.
27/04/2015 02:14	-53.11849	-54.5752	MVP profile 52 tow 6 (leg 4) is missing data due to brake issue.
27/04/2015 01:38	-53.18936	-54.59624	MVP group 1; Starting leg 4
27/04/2015 01:19	-53.18244	-54.63254	MVP group 1; end leg 3; turning east to start leg 4
27/04/2015 00:06	-53.06995	-54.60208	MVP group 1, start leg 3. Turning south 190
26/04/2015 23:51	-53.06698	-54.62692	MVP group1, leg 2 finish. Starting turn to east.
26/04/2015 22:46	-53.18804	-54.66059	MVP group 1, leg 2, start profiling (010 degrees)
26/04/2015 22:30	-53.19585	-54.69298	MVP group1, leg 1 finish. Starting turn to east.
26/04/2015 21:44	-53.12009	-54.67326	MVP deployed
26/04/2015 21:40	-53.11552	-54.67172	Start MVP tow 6: Group 1, Leg 1 (190 degrees), Lagrangian Dye experiment 1
26/04/2015 19:36	-53.35607	-54.80073	Alongside WaveBuoy for recovery (due to buoy not updating its position).
26/04/2015 19:16	-53.31802	-54.7731	DPS stream all red. Johnnie fixed - all green. ADCP restarted.
26/04/2015 17:30	-53.14586	-54.65303	MVP recovery
26/04/2015 16:53	-53.15877	-54.55208	MVP deployed
26/04/2015 15:41	-53.15696	-54.56398	ADCP deployed
26/04/2015 15:01	-53.1552	-54.56375	ADCP recovered, D03, for more weight to be added
26/04/2015 14:29	-53.16134	-54.55371	Dye pump switched off
26/04/2015 14:25	-53.16015	-54.55371	Dye release ended
26/04/2015 14:15	-53.15691	-54.55368	ADCP drifter D03 deployed 2.41min to deploy
26/04/2015 13:46	-53.14816	-54.5537	Drifter D02 released wire walker, 11.41mins to deploy

26/04/2015 13:42	-53.14702	-54.5537	Dye pump started (time on lenovo thinkpad computer 13:43)
26/04/2015 13:42	-53.14694	-54.5537	Drogue D01, central drifter, released, 2.58min to deploy
26/04/2015 13:05	-53.13763	-54.55368	Dye release hose secured at 50m. Beginning southward transect.
26/04/2015 08:12	-53.26078	-54.55489	Turn back north (end of Leg 3; start of Leg 4)
26/04/2015 08:11	-53.26133	-54.55489	Depth of Seasoar changed from 150 m to 155 m
26/04/2015 02:44	-53.18083	-54.55455	Found the warm edge of front!
25/04/2015 22:00	-53.61503	-54.54859	Turned north. Starting MVP leg
25/04/2015 18:30	-53.40497	-54.37681	MVP test
25/04/2015 16:47	-53.44999	-54.69992	wave buoy deployed
25/04/2015 16:01	-53.46236	-54.71952	wave buoy turned on
25/04/2015 14:54	-53.5115	-55.06167	seasoar on deck
25/04/2015 14:44	-53.50676	-55.0549	Bringing in SeaSoar.
25/04/2015 11:24	-53.07293	-54.83747	Turning southwest, continuing to name as Leg 5.
25/04/2015 10:38	-53.12649	-54.67601	End of Leg 4. Turning West for a short leg to get to Leg 5
25/04/2015 02:44	-54.29037	-54.9569	Turning North (010 degrees) to run leg 4 transect. Sea Soar data continues to be called leg 4 (started earlier on westward heading).
25/04/2015 01:43	-54.27934	-54.68177	Turning west to reposition for new waypoint. Continue logging SeaSoar data as leg4.
24/04/2015 23:38	-54.15243	-54.1861	End of Leg 3, turning to 246 to start leg 4
24/04/2015 19:18	-53.49918	-53.96843	SCS fields all red, restarted. ADCP restarted.
24/04/2015 17:41	-53.25001	-53.91278	EK60 restarted after freezing for an unknown length of time
24/04/2015 14:03	-52.83038	-53.4412	Set Seasoar to 200m depth profiles
24/04/2015 13:58	-52.82507	-53.42449	Cutting SeaSave and LOPC files.
24/04/2015 13:39	-52.85586	-53.4044	End of Leg 2. Turning west for short leg before starting Leg 3.
24/04/2015 04:57	-54.22676	-53.78789	Fishing Boat on our way: we slightly turning to get around it
23/04/2015 19:34	-55.55479	-54.20286	ADCP stopped and restarted. Back to Ensemble 1
23/04/2015 19:26	-55.5683	-54.20933	DPS stream all red. Called Johnnie to fix. DPS stream now all green.
23/04/2015 19:00	-55.61608	-54.23343	ADCP stopped and restarted. Back at Ensemble 1.

23/04/2015 17:05	-55.80974	-54.33058	End of eastward short leg. Start of Tow 1 leg 2.
23/04/2015 15:27	-55.7448	-54.69416	End of Tow 1; beginning of eastward, short leg
22/04/2015 17:34	-52.40407	-54.0665	SeaSoar deployment - saved as Tow 1, Starting on heading 250 before coming round to 200
22/04/2015 16:47	-52.39817	-54.03347	Seasoar test recovery (10 minutes ago)
22/04/2015 16:12	-52.39105	-53.99437	SeaSoar test deployment
22/04/2015 12:31	-52.39863	-54.70205	MSS recovered
22/04/2015 11:44	-52.39863	-54.70221	MSS deployed
22/04/2015 10:39	-52.39869	-54.66884	Started EK60 echo sounder