Gliders: Excellent New Tools for Observing the Ocean

GENTOO

RRS James Clark Ross
cruises
JR255A and JR255B

January-March 2012

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1 GENTOO Cruise Narrative

1.1 Introduction

The objectives of the GENTOO project are:

(i) to quantify and understand the possible new source of dense water overflow and its variability; to determine the outflow's potential as an early indicator of Antarctic climate change; to assess the impact of changing dense overflows on the locations and strengths of the surface currents and frontal jets; to provide valuable constraints for climate models that describe how changes in ocean circulation feedback on and regulate climate change in polar latitudes.

(ii) to determine the krill biomass distribution and (temporal and spatial) variability to the east of the Antarctic Peninsula and its likely impact on the circumpolar krill ecosystem; to assess the impact of any variations in the location of the frontal jets (from objective i) on the krill biomass distribution; to alleviate a severe regional lack of field data on krill, a key species in the Antarctic food web.

To achieve the two objectives, our technological deliverable is a critical evaluation of our ability to measure (i) current velocity from a glider and (ii) krill biomass from a glider.

The GENTOO fieldwork in the Weddell Sea was accomplished through a Seaglider campaign in early 2012. A glider deployment cruise (JR255A) was the primary data gathering exercise; as well as deploying three Seagliders, a hydrographic survey was undertaken together with nets and underway biological, chemical and physical measurements. The recovery of the three gliders was to have taken place on the recovery cruise, which immediately followed, JR255B. This document reports on both JR255A and JR255B, but not on the other projects that shared the voyage with the glider recovery team.

1.2 Cruise Participants

1.2.1 Glider deployment cruise JR255A

| Karen Heywood | k.heywood@uea.ac.uk | UEA | Chief scientist |

Physical oceanography team (responsible for CTD, ADCP, LADCP, shiptrack file, met and underway file, salt mine, gliders, drifters and helping with krill nets)

Sunke Schmidtko	s.schmidtko@uea.ac.uk	UEA	(+ Seagliders)
Andy Thompson	andrewt@caltech.edu	Caltech	(+ Seagliders)
Alan Jamieson	aj395@cam.ac.uk	DAMTP	
Céline Heuzé	c.heuze@uea.ac.uk	UEA	
Jim Jordan	jamrda26@bas.ac.uk	BAS	
Ben Webber	b.webber@uea.ac.uk	UEA	
Jenny Graham	j.graham@uea.ac.uk	UEA	
Liz Creed	ecreed@irobot.com	iRobot	
Herbert Huppert	heh1@cam.ac.uk	DAMTP	

Dissolved oxygen team (responsible for dissolved oxygen Winkler titrations, also helping out with gliders, krill nets and chlorophylls)

Chris Brown	c.brown3@uea.ac.uk	UEA	(+ Seagliders)
Bastien Queste	b.queste@uea.ac.uk	UEA	(+ Seagliders)
Imke Grefe	I.Grefe@uea.ac.uk	UEA	(+ N isotopes)

Biological Oceanography team (responsible for acoustics, krill and phytoplankton)

Jill Peloquin	jill.peloquin@gmail.com	VIMS	(chlorophyll)
Danny Kaufman	dekaufman@vims.edu	VIMS	(phytoplankton)
Sophie Fielding	sof@bas.ac.uk	BAS	(acoustics, krill)
Damien Guihen	damaoi@nerc.ac.uk	BAS	(acoustics, krill)

1.2.2 Glider recovery cruise JR255B

For glider recovery and undertaking dissolved oxygen and chlorophyll calibration CTDs.

Gareth Lee	g.a.lee@uea.ac.uk	UEA
Douglas Hamilton	Douglas.Hamilton@uea.ac.uk	UEA
Céline Heuzé	c.heuze@uea.ac.uk	UEA

1.2.3 Images of Participants

Andrew Thompson	Bastien Queste	Ben Webber	Celine Heuze
Christopher Walker-Brown	Herbert Huppert	Imke Grefe	Jennifer Graham
Jill Peloquin	Karen Heywood	Liz Creed	Sunke Schmidtko
Missing images: Jim Jordan and Jeremy Robst	Alan Jamison	Damien Guihen	Sophie Fielding
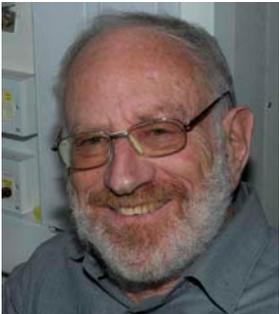
1.3 Cruise Daily Summary

1.3.1 Friday 20th January
Set sail from Port Stanley at 8 am. Anchored in the harbour for boat drill for several hours.

1.3.2 Saturday 21st January
Steaming south across Drake Passage.

1.3.3 Sunday 22nd January
Steaming south across Drake Passage

1.3.4 Monday 23rd January
Arrived at the tip of the Peninsula. Sea ice maps showed large amounts of ice at the outer half of the ADELIE section, so we decided to start at the shelf break and work offshore while we could. Deployed Seagliders. SG546 (iRobot glider) deployed first, but it had a problem with ballasting and had to be recovered and redeployed. Test RMT net. Deployed SG522 and SG539. CTD station 01 near glider deployment location (ADELIE station 16).

1.3.5 Tuesday 24th January
CTD stations working offshore repeating ADELIE stations until we reached the sea ice. Decision to work back inshore since sea ice covered the outer end of the ADELIE CTD section. Deployment of two Argo floats. Deployment of 21 surface drifters returning along section towards shelf. Recovery of SG546. CTD yoyo for several hours between surface and 450 m.

1.3.6 Wednesday 25th January
RMT net. CTD stations to complete the on-shelf end of the ADELIE section.

1.3.7 Thursday 26th January
Acoustic calibration. Commence ADCP sections on- and off-shelf. Deploy remaining surface drifters. Attempted to deploy remaining Argo float but it was faulty.

1.3.8 Friday 27th January
CTD station near giant iceberg. CTD section across continental slope in Powell Basin. SG546 deployed. RMT net.

1.3.9 Saturday 28th January
Completed CTD section across slope (final station CTD28 in ~850 m of water). CTD29 close to the iceberg for Herbert Huppert to investigate ice melt processes (closest approach ~300 m). CTD at 500 m isobath. Steamed to eddy just south of Clarence Island. Commenced CTD stations across eddy.

1.3.10 Sunday 29th January
Completed CTD section across eddy (CTD stations 31-39) and then returned south across eddy, doing krill nets north of the eddy (at CTD station 39), in the middle of the eddy (CTD 35) and south of the eddy (CTD 31). Steamed east towards location of SG546. Saw orcas around the ship, as well as penguins and seals.

1.3.11 Monday 30th January
Recovery of SG546. CTD station 40. Deployment of SG546. CTD station 41.

1.3.12 Tuesday 31st January
Steaming across Drake Passage

1.3.13 Wednesday 1st February
Steaming across Drake Passage

1.3.14 Thursday 2nd February
Steaming across Drake Passage. Arrival Falkland Islands.

1.3.15 Friday 3rd February
Disembarked Mare Harbour, Falkland Islands

1.4 Cruise Track and CTD location plots
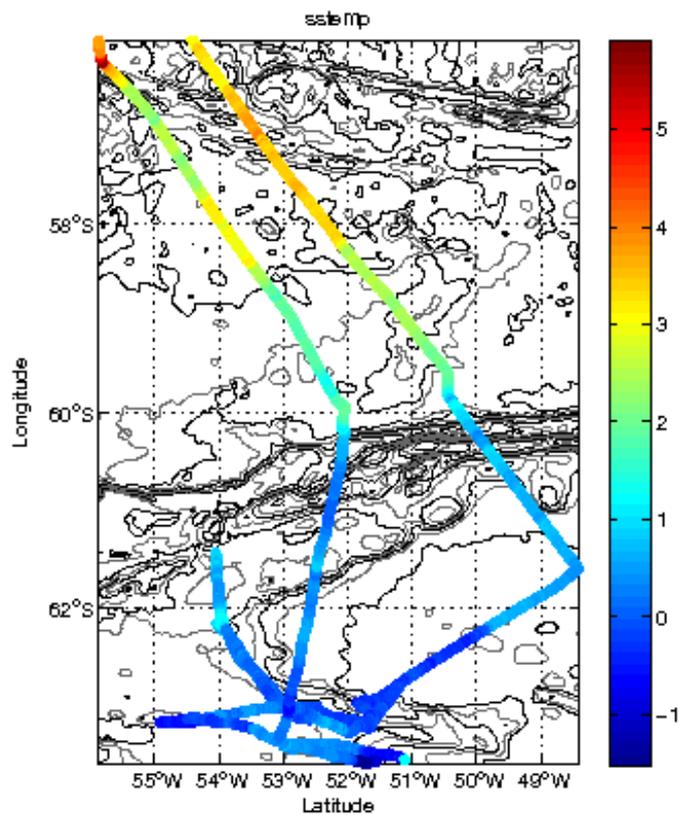
Figure 1 Cruise track with Sea Surface Temperature (SST) as from shipboard thermosalinograph.
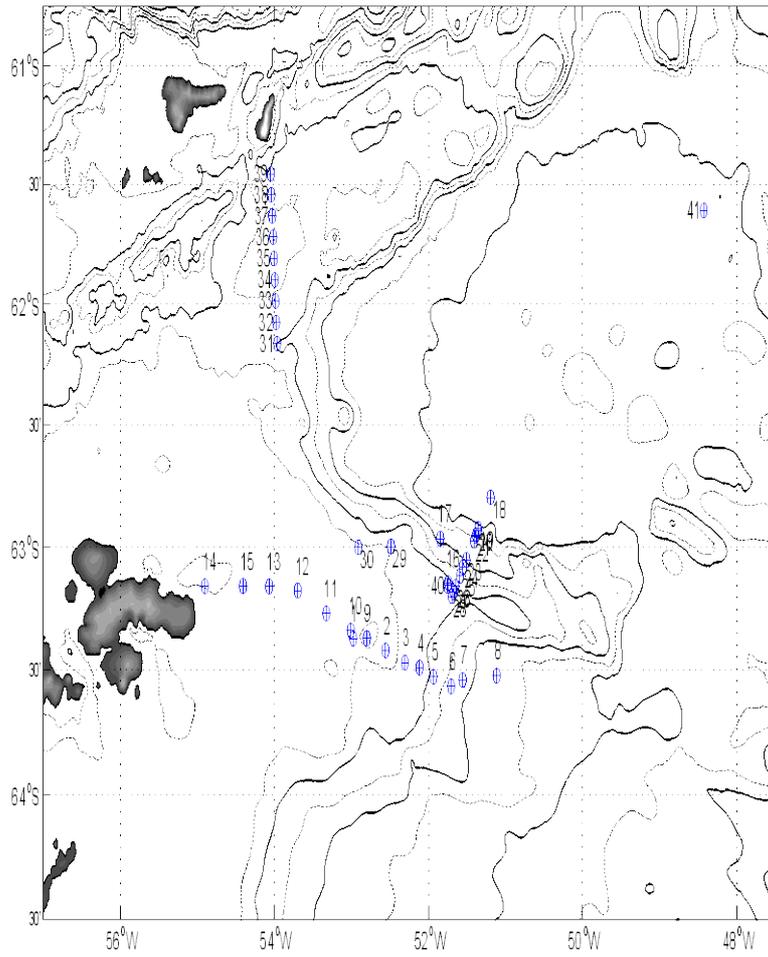
Figure 2: CTD cast locations during GENTOO.
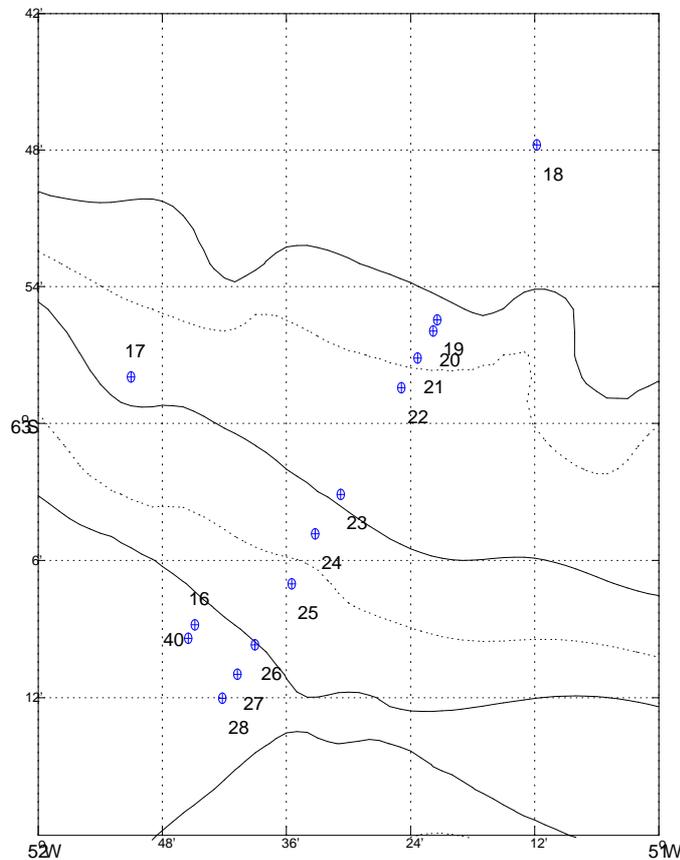
Figure 3: CTD cast location on section into Powell Basin, enlarged from figure 2.

1.5 Sea Ice

(Jennifer Graham)

In order to plan routes for the gliders, their latest locations were plotted along with sea ice concentration contours. Sea ice concentration was downloaded on to the JCR network daily (SSMIS hdf files from PolarView), from 25th January, and then found in the legwork/seaice directory, with file names of the format antarctic_SSMIS_[yyyymmdd].hdf. Corresponding latitude and longitude grids can also be found in the same directory. These hdf files can be read using the MatLab function hdfread.

The sea ice concentration and glider paths were plotted using sgicemap.m, which can be found in the legdata/jr255/sg_ice_plots directory. The sea ice data was initially on an equal area grid, and was interpolated on to a latitude-longitude grid for plotting. Various maps were produced, to assess the movement of the ice edge, and large iceberg (named Big Bird), from day to day, and also to consider the difference in extent between 0% or 15% concentrations. Although the gliders were initially steered clear of ice, it was later decided that concentrations <15% were probably safe to venture into.

1.5.1 Problems with sea ice data

As the sea ice concentration is determined from satellite imagery, the resulting values are dependent on cloud cover. This became most evident when the Big Bird iceberg would vanish from the concentration maps one day, only to reappear the next. As we were sitting next to it at the time, we could be certain that the iceberg itself had not vanished for the day. Therefore, satellite images of sea ice from the bridge were also used to trace the path of Big Bird, and assess safe routes for the gliders to take.

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2 CTD Measurements

(Sunke Schmidtko)

2.1 CTD Operations

The 24 bottle SeaBird (SBE) rosette equipped with 24 Niskin water bottles was used for all casts on cruise JR255A. Standard SeaBird Software Version Seasave V 7.21d was used for data collection and conductivity cell thermal mass correction (The SBE-11plus manufacturer recommended values were used: thermal anomaly amplitude, α=0.03, thermal anomaly time constant 1/β=7.0)

Sensors installed on the CTD SBE 11plus V 5.0 include the following with their respective calibrations used in this set up. The actual calibration profiles can be found in the headers of the respective profiles.

Pressure Sensor, SerialNumber: 0771, CalibrationDate: 25/06/2010
The pressure sensor is believed to be good and calibrated. A deck offset in the order of 1.5 dbar was recorded before each CTD deployment and thus afterwards corrected by this amount.

Temperature Sensor 1, SerialNumber: 4874, CalibrationDate: 25/06/2010
Temperature Sensor 2 SerialNumber: 2191, CalibrationDate: 23/06/2010
The temperature sensors show a pressure dependent divergence in the order of $0.5*10^{-3}°C$ / 3500 dbar. This is small but noticeable; there was no way of correcting this divergence. Notification was sent to BAS that post cruise factory calibration is needed for these sensors, to determine ultimately which of these sensors or both were affected.

Conductivity Sensor 1, Serial Number 3248, Calibration Date: 25/06/2010
Conductivity Sensor 2, Serial Number 1912, Calibration Date: 25/06/2010
Both conductivity sensors showed an offset when calibrated against bottle samples taken on the cruise. (See Calibration chapter). Otherwise both seem to be stable. The slight pressure dependence of CS2 is most likely due to the pressure drift of TS2 and too small to correct. All CS will be recalibrated when the post cruise TS calibration is in.

PAR_BiosphericalLicorChelseaSensor, Serial Number 7235, Calibration Date 12/07/2010
PAR sensor is taken as it is and not calibrated by us.

FluoroChelseaAqua3Sensor, Serial Number 088-249, Calibration Date 13/11/2007
Fluorometer samples were taken by bottle and are still due to be analysed. Eventually this value will be calibrated. Not calibrated with samples taken during the cruise as of today.

WET_LabsCStar Sensor, Serial Number CST-1279DR, Calibration Date 26/08/2009
Backscatter measurements were not calibrated.

Oxygen Sensor, Serial Number 0242, Calibration Date 21/01/09
The oxygen sensor was calibrated against bottle samples. Final calibration pending.
(See section 2.6)

Altimeter Sensor, Serial Number 2130.27001, Calibration Date 10/11/2006
The altimeter was working fine for most of the profiles. A few profiles the altimeter showed extreme sensitivity picking up many double reflections, thus making the altimeter dater very noisy. Never the less the bottom approach was always detectable. The noisy data could create problems in an algorithm picking up the distance to bottom using those profiles. However a manual analysis should immediately reveal the right bottom depth.

Data quality in general was good. No major malfunction of any instrument on the CTD was recorded. No obvious spikiness found in the data. Apart cast 41, wakes did not affect CTD casts, due to very little swell in the lee of the Antarctic Peninsula (see section 2.2 and figure 2).

2.2 CTD Data processing
(Sunke Schmidtko)

The recommended standard Seabird correction via a reverse filter to conductivity is applied to both sensors to correct effects of conductivity cell thermal mass in sharp thermoclines. This is likely negligible for all casts of this cruise with a maximum thermocline below 2°C, but applied to adjust theoretically known errors. The SBE-11plus manufacturer recommended values were used: thermal anomaly amplitude, α=0.03, thermal anomaly time constant 1/β=7.

In the following the standard UEA CTD handling MatLab scripts were used, as on previous cruises. Minor changes are described in detail below:

Ctdcal.m
Is used to read in the SeaBird data format.

Offpress.m
Is used to correct the profiles for the deck pressure offset.

Spike.m
Is used to remove high frequency fluctuations in all measurements, resulting from various sources, spanning from organic material being pumped in the conductivity cell to data transmission noise via the sea cable.
Conductivity is despiked with a threshold of 0.03, temperature with 0.04. A final salinity despiking is applied with a threshold of 0.009. Oxygen is despiked with a threshold 2, the transmissionmeter with 0.4 and the fluorometer with 0.01. Despiking allows data point to data point variations (within 1/24th of a second, sampled at 24Hz) smaller or equal to the threshold. Larger changes are eliminated by setting them to 'NaN'.

Interpol.m
Is used to interpolate across the gaps from spike.m . They are usually in the order of 1-5 data points, equivalent to a loss of up to 1/5th of a second data.

Makebot.m
Is used to create MatLab readable code from the bottle data captures.

newvar_cal.m
is used to apply the conductivity calibration derived from salinometer measurements (see CTD conductivity calibration section 2.5 and Salinometer section 3.1) and compute salinity from corrected conductivity.

Splitcast.m
The cast is further split into a up and down cast. Since the water sampler has significant water drag, only the downcast is used in the following. Cast 41 will be treated different and is not ideally processed due to large swell during the CTD cast, resulting in mixing around the CTD that was lowered slowly.

ctd2db.m; ctd1dbup.m; ctd1dbdn.m and ctd05dbdn.m
The cast is finally subsampled onto a vertical 2, 1 and 0.5 dbar grid with respective m-files. This is done by using the median in each property within each depth interval. (0.5 to 1.5 dbar for the 1dbar grid point).

2.3 CTD Cast locations

We were planning to sample the WOCE section SR4 again as during the ADELIE cruise. Unfortunately sea ice required us to retreat early. Thus only the shelf and shelf break of the WOCE section got sampled up to the 2300m isobath (CTD cast 1 to 15, see figure 2+3 and table 1). We focussed on the more northern section more perpendicular to the WOCE section into the Powell Basin in the following days, realizing a high resolution CTD section between the 800m isobaths and the 3500m isobaths (CTD cast 16, 18 to 28 and 40). A third section was sampled across a eddy feature sampled on previous cruises and seen in drifter displacements (cast 31 to 39). A few CTD stations were taken during deployment and or recovery of Seagliders.

Table 1: CTD cast locations and times:

Cast	Lat. °N	Long. °E	Max pres.	Max depth	Date (at bottom)	Time (bottom)	Julian Day
1	-63.372	-52.980	448	443	2012-01-23	20:09:29	23.840
2	-63.420	-52.559	508	503	2012-01-23	22:43:29	23.947
3	-63.470	-52.308	718	710	2012-01-24	0:47:23	24.033
4	-63.490	-52.120	930	919	2012-01-24	4:23:41	24.183
5	-63.526	-51.937	1136	1122	2012-01-24	6:47:03	24.283
6	-63.565	-51.710	1587	1565	2012-01-24	9:00:26	24.375
7	-63.539	-51.558	2025	1995	2012-01-24	11:58:03	24.499
8	-63.522	-51.117	2286	2252	2012-01-24	15:11:59	24.633
9	-63.370	-52.803	452	448	2012-01-25	0:27:15	25.019
10	-63.340	-53.011	442	437	2012-01-25	4:56:16	25.206
11	-63.270	-53.328	399	395	2012-01-25	6:54:05	25.288
12	-63.177	-53.699	282	279	2012-01-25	9:15:15	25.386
13	-63.160	-54.071	205	203	2012-01-25	11:01:25	25.459
14	-63.159	-54.904	329	325	2012-01-25	13:53:38	25.579
15	-63.158	-54.409	217	214	2012-01-25	15:44:58	25.656
16	-63.147	-51.748	124	122	2012-01-25	23:35:33	25.983
17	-62.966	-51.851	2034	2005	2012-01-26	23:04:14	26.961
18	-62.796	-51.197	3398	3338	2012-01-27	5:44:45	27.239
19	-62.924	-51.357	3252	3196	2012-01-27	9:28:54	27.395
20	-62.932	-51.364	3015	2965	2012-01-27	13:29:24	27.562
21	-62.952	-51.389	2532	2492	2012-01-27	18:38:16	27.777
22	-62.974	-51.415	2240	2207	2012-01-27	21:24:45	27.892
23	-63.052	-51.513	1985	1956	2012-01-28	0:56:25	28.039
24	-63.081	-51.554	1743	1719	2012-01-28	3:37:22	28.151
25	-63.117	-51.592	1488	1469	2012-01-28	6:10:22	28.257
26	-63.162	-51.651	1256	1240	2012-01-28	8:17:43	28.346
27	-63.183	-51.679	986	974	2012-01-28	10:34:23	28.441
28	-63.200	-51.703	842	832	2012-01-28	12:12:44	28.509
29	-62.998	-52.488	713	705	2012-01-28	15:34:08	28.649
30	-63.001	-52.912	496	490	2012-01-28	17:26:48	28.727
31	-62.164	-53.968	835	825	2012-01-29	0:24:13	29.017
32	-62.076	-53.980	585	579	2012-01-29	2:11:25	29.091
33	-61.986	-53.987	574	567	2012-01-29	3:45:12	29.156
34	-61.898	-53.999	383	379	2012-01-29	5:07:51	29.214
35	-61.809	-54.009	298	295	2012-01-29	6:23:05	29.266
36	-61.720	-54.019	398	394	2012-01-29	7:45:32	29.323
37	-61.632	-54.032	460	455	2012-01-29	9:02:42	29.377
38	-61.544	-54.043	927	916	2012-01-29	10:25:57	29.435
39	-61.457	-54.051	833	823	2012-01-29	12:02:17	29.502

40	-63.157	-51.758	968	956	2012-01-30	8:30:03	30.354
41	-61.609	-48.430	3174	3120	2012-01-31	0:22:44	31.016

2.4   CTD Temperature calibration

Analysing the first set of temperature data during cruise JR255A indicated a slight pressure effect. This was detected by comparing the two separate temperature sensors. Although small, it was noticeable in preliminary salt profiles. The deck offset between the sensors was (-0.49 ± 0.004)*10-3 °C and a pressure effect in the same order, (+0.47 ± 0.006) *10-3 °C, for every 3000 dbar. Thus there was no measurable difference between the two sensors in depths below 3000m. This pressure effect is surprising, since thermistors are generally not known to be effected by pressure. Since it was not possible to determine which of the sensors was effected a high precision thermometer (SBE-35 SN:0045) was used for all following dives, recording the temperature on closure of any of the 24 bottles, that were subsequently all used on each deep cast following cast 18, evenly spread throughout the water column. 24 temperature readings (cycles) were taken during each bottle closure, providing a mean and a difference reading, for the raw thermistor reading for each bottle. The difference readings can be regarded as a measure of the amount of variation during the measurement. The accuracy of the SBE-35 is given with 0.001°C with a maximum temporal drift of 0.001°C per year. In a thermally quiet environment temperature noise standard deviation is given with 29·10-6 · (8/cycles)$^{\frac{1}{2}}$ °C, which leads to an idealized standard deviation in the order 10-6 °C of for our 24 cycle measurements. This accuracy leads to the assumption that the significant larger variation we record results from temperature gradients within the patch of water measured. The last calibration was 15th July 2010 providing new slope and offset coefficients, but confirming the 10th October 2003 calibration for the four linearization coefficients. Due to a possible temporal drift in the SBE-35 since the last calibration, it is only used to remove the pressure effect not the absolute offset.
Unfortunately the number of data points was limited and thus no statistically significant offset of either temperature sensor could be applied. Data indicate that Temperature Sensor 2 is showing the pressure effect, but a correction was not applied. We strongly recommend a post cruise temperature sensor calibration to determine the origin of this pressure dependence.

2.5   CTD Conductivity calibrations

All samples acquired by the CTD during the closing of the Niskin bottle (the '.ros' file) are used. This gives a good representation of the water properties and its variability within the depth of the water sample. The median and inter quartile range are computed for each property and bottle. The inter quartile range gives a good indication of the homogeneity of the water properties and is used later in the weighting of the calibration offset.
Salinometer conductivities, that were corrected by salinometer drift as detailed in section 3.1 about the salinometer, and bath temperature are used to determine the bottle salinities, and to compute the conductivity expected to be measured by the CTD with in-situ temperature and pressure for each water sample.
The difference for each sensor and the salinometer derived values are shown in figure 4. The outliers are removed manually. More than half of these outliers could be traced back to missing surface tight seals in the bottle probes as referenced in the salinometer protocol. The other outliers are of unknown cause, but most likely due to some sort of not completely sealed bottles. This assumption is supported by the fact that all outliers show higher conductivities. We feel confident that they do not represent any trend or bias, thus can be removed.
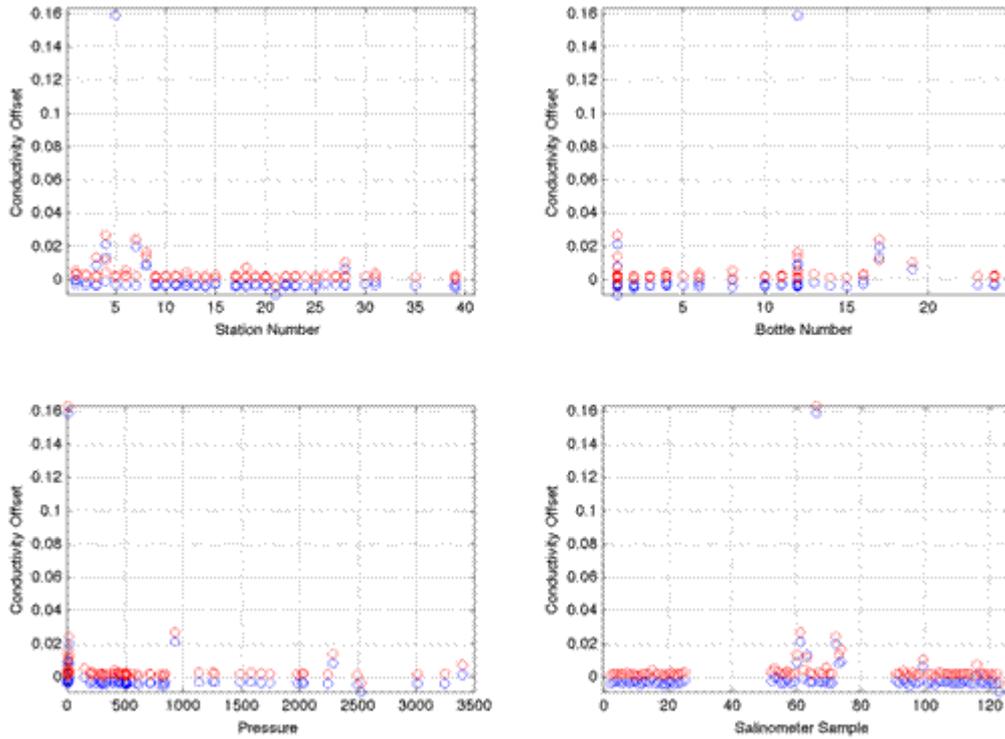
Figure 4. Difference between CTD values and bottle measured salinometer data (blue sensor 1, red sensor 2), versus station number, bottle number, pressure and salinometer sample number.
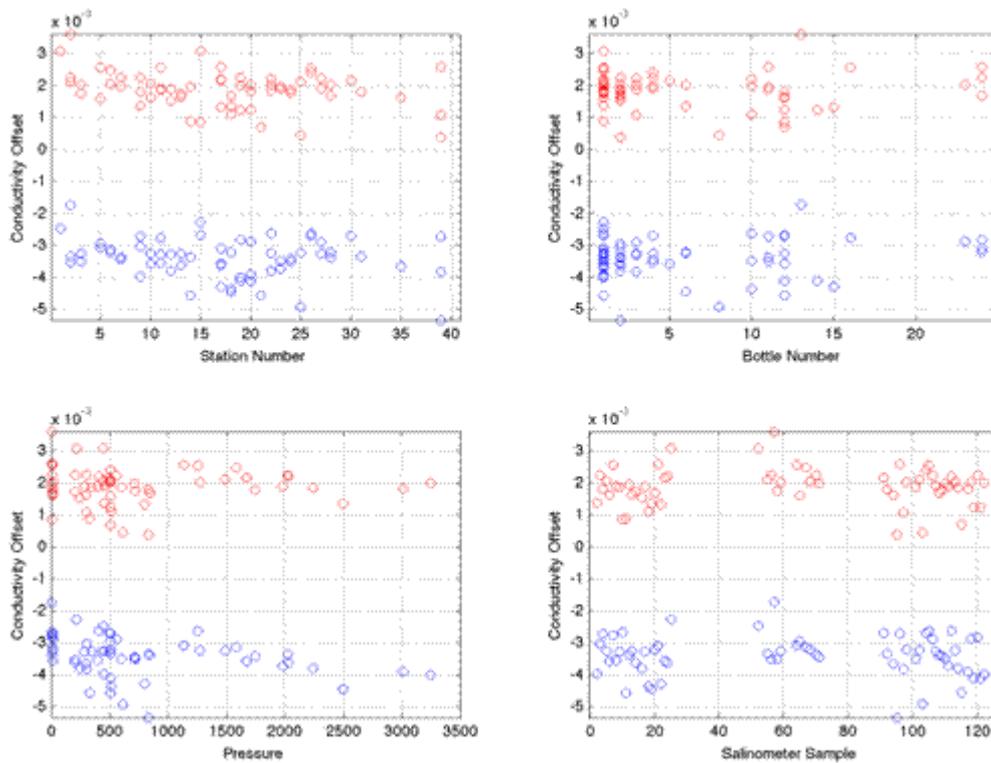
Figure 5. Difference between CTD values and bottle measured salinometer data after the manual removal of outliers (blue sensor 1, red sensor 2), versus station number, bottle number, pressure and salinometer sample.
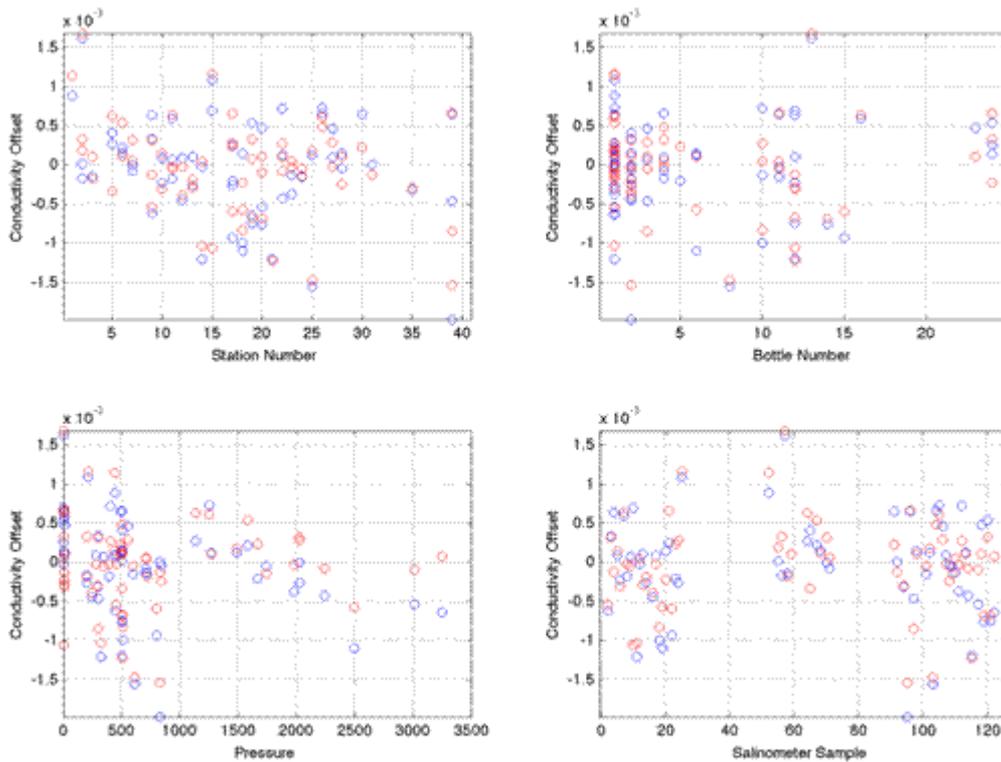
Figure 6. Difference between CTD values and bottle measured salinometer data after offset for both C sensors is applied, to minimize residuals.
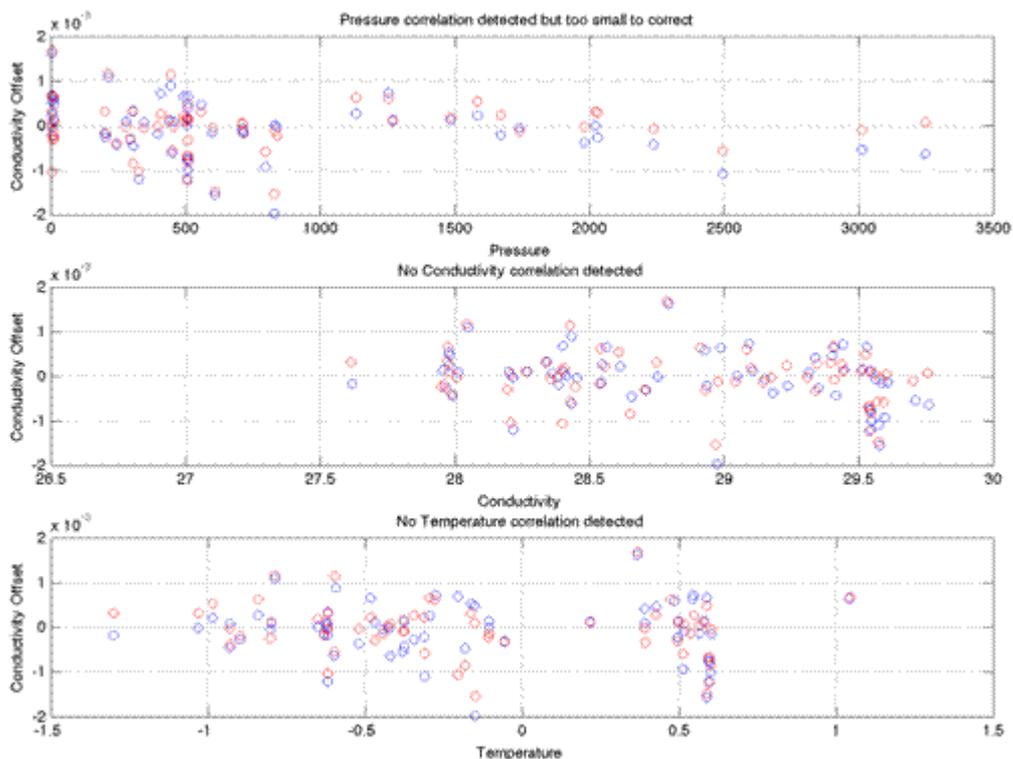
Figure 7. Test plots of difference between CTD values and bottle measured salinometer data versus pressure, conductivity and temperature.
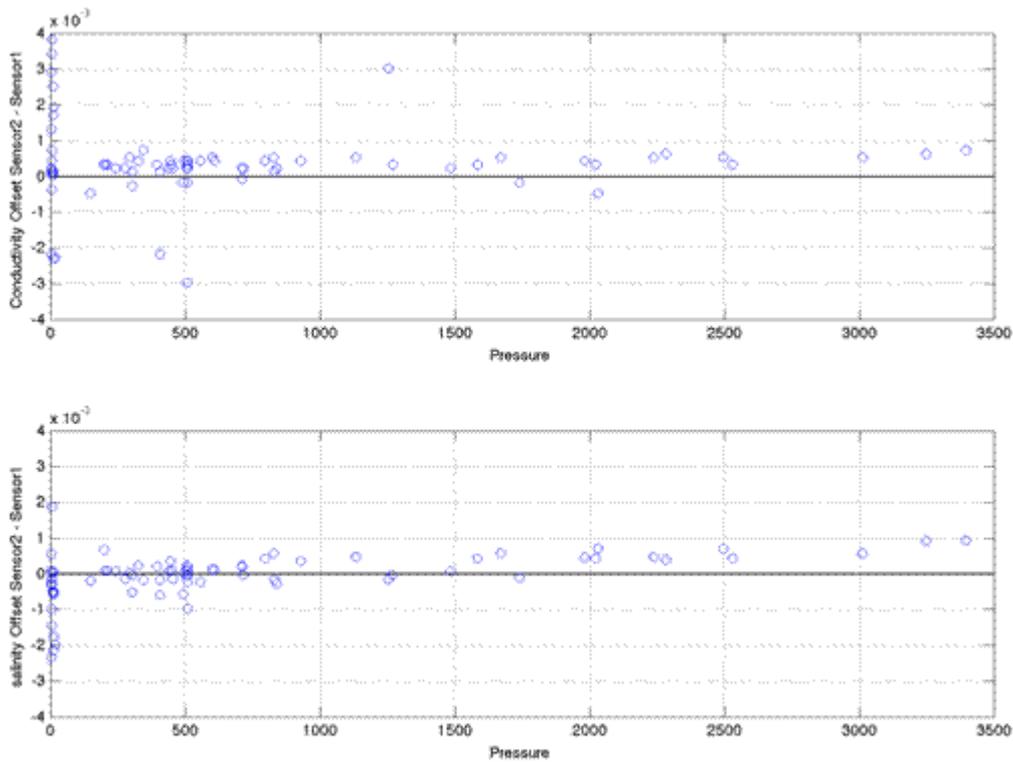
Figure 8. Difference between sensors in conductivity and salinity versus pressure.

Figure 5 shows the identical plot without the outliers. No trend is obvious, neither in sensor 1 nor sensor 2, thus first an offset calibration is applied.
For each sensor this is done by applying an inter quartile range filter, using only data within half the IQR range below the first and half the IQR range above the third quartile. The offset is determined by solving a least squares problem with weights for each data point. The weights are computed by using a Gaussian with normalization scale using CTD IQR range (0.0025).
The offset computed is:
Conductivity sensor 2 has an offset of -0.00336 (mS/cm)
Conductivity Sensor 1 has an offset of +0.00191 (mS/cm)

Figure 8 shows the test of these calibrations against other properties. There is a slight pressure dependence in Sensor 2, likely resulting from a pressure bias in the respective temperature sensor. Since we are waiting for a post cruise calibration of the temperature sensors and the marginal effect, this is not corrected.

We are confident that we managed to calibrate the CTD to an accuracy of 0.001 in salinity, with noise on the order of 0.001 below the mixed layer. (see figure 8).

2.6 Dissolved oxygen
(Christopher W. Brown, Imke Grefe, Bastien Queste, Jan Kaiser)

Note: This section is preliminary. The calibration of the thiosulphate solution is not final. Do not use the results from this section without consulting Jan Kaiser.

Oxygen is a useful tracer for biogeochemical processes (e.g., photosynthesis, respiration) and for the identification of water masses.
Winkler O_2 titrations were performed to provide in-situ calibration data for the SBE 43 O_2 sensor (Sea-Bird Electronics) mounted on the rosette and the Aanderaa 4330F O_2 optode sensors mounted on Seagliders SG533 and SG546. Even though all O_2 sensors are pre-calibrated by their

manufacturers, previous experience has shown that in-situ calibrations are required for high accuracy and precision to WOCE standards (maximum standard deviation for duplicate measurements of 0.5 µmol kg^{-1}; reproducibility between cruises and laboratories of better than 2.0 µmol kg^{-1}).

SBE 43 O_2 concentrations were processed using the standard Sea-Bird Software (Seasave V 7.21d), with temperature, salinity and depth corrections applied by the Seasave program. Median values from ±1 s around the bottle firing times during the upcast were then compared against the Winkler results.

193 samples (including replicates) at 28 stations were collected over 5 days from a representative sample of different depths. These samples were analysed by whole-bottle Winkler titration with photometric endpoint detection, using a custom-built system with a computer-controlled automatic burette. A thiosulphate solution at concentration 0.2 mol dm^{-3} was used; standardised by iodometry against a 2.225 mmol dm^{-3} KIO$_3$ solution (prepared using gravimetrically at UEA prior to the cruise, and shipped as a solution; Fluka 60386 potassium iodate, certified standard titrimetric substance, w (±2u) = 0.9990±0.0012, Lot&Filling code 1137457 13804001). The bottle volume was corrected to the temperature of the sea water sample, measured with a calibrated electronic thermometer during the transfer of water from the Niskin bottles to the titration flasks. Calibration was carried out in accordance with WOCE procedures (Dickson, 1996). The reagent blank was measured using MilliQ water and found to be (3.1±1.3) mm^3 (n = 10). The O_2 content of the reagents (1 cm^3 4 M MnCl$_2$ solution, 1 cm^3 4 M NaI + 8 M NaOH solution) was assumed to be 76 nmol.

Triplicate samples were taken from each sample depth, pickled immediately with MnCl and NaI/NaOH, and shaken vigorously. All sample bottles were stored in the dark and under water (to avoid leaks) for 9 to 44 h before titration. The median standard deviation of a triplicate analysis was 0.8 µmol kg^{-1}.

Figure 9 shows a linear regression of the Winkler results versus the SBE 43 output in the corresponding bottle file, converted to µmol kg^{-1}. The mean of the triplicate Winkler samples was used, after outlier removal. The calibration function was then applied to the raw SBE 43 dat. The residual difference to the Winkler results was 1.7 µmol kg^{-1}, disregarding the last 3 stations, which showed a drift of the SBE 43 sensor (Figure 10).
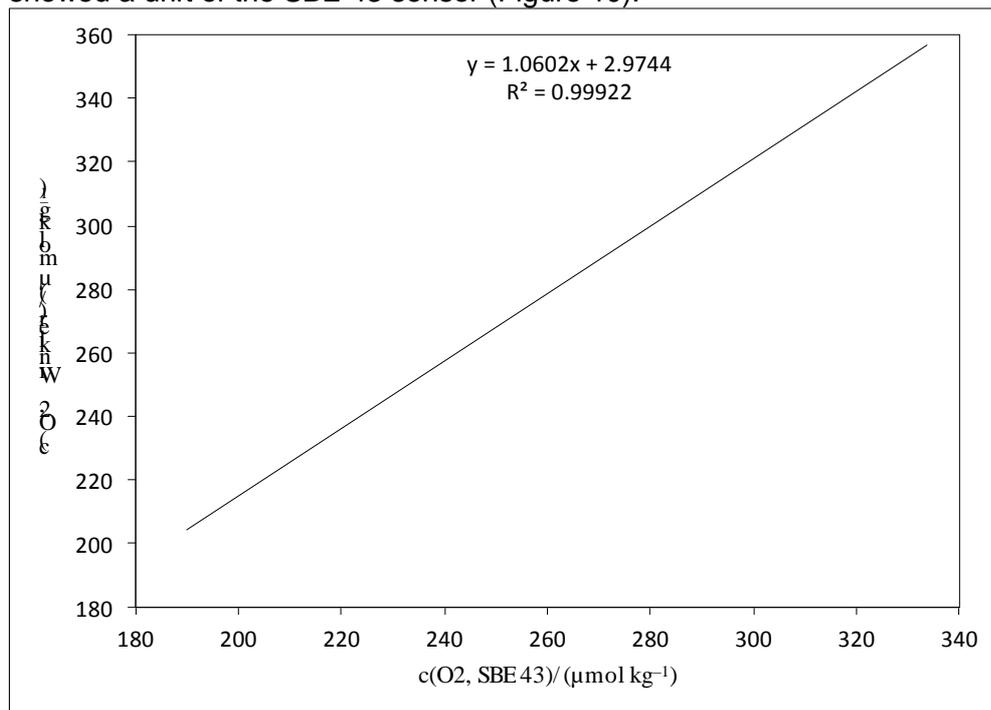
Figure 9: Linear regression of Winkler O_2 measurements versus SBE 43 CTDO$_2$ measurements. The regression line represents a linear fit to the data, as described by the equation near the top. Stations 31, 35 and 39 (red points) have been excluded because the SBE 43 sensor started to drift.
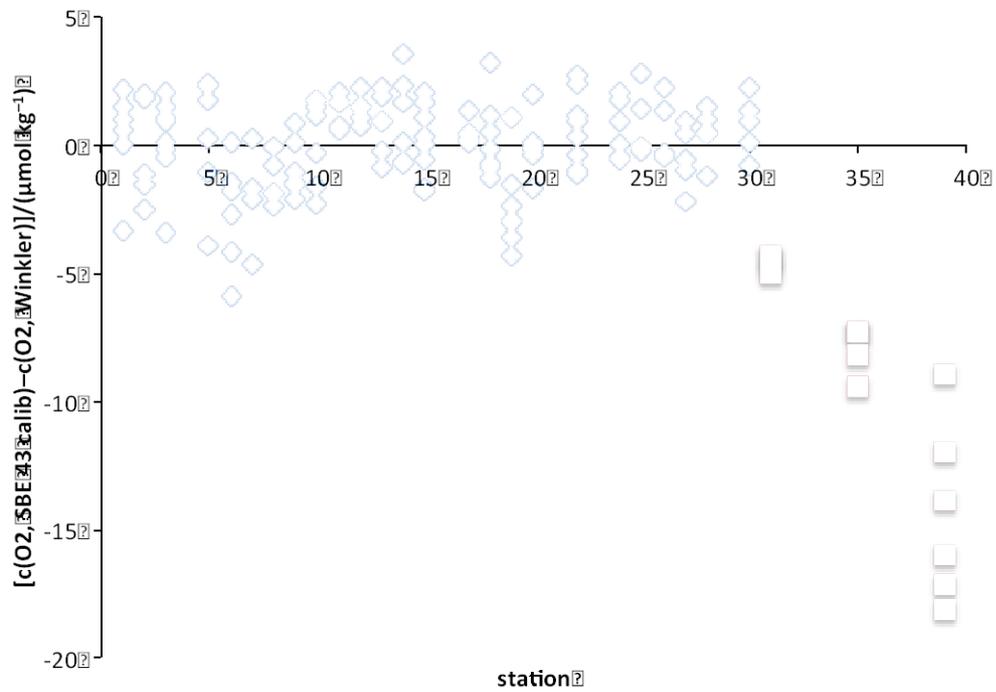
Figure 10: Residual difference between calibrated SBE 43 and Winkler O_2 concentrations versus station number. At stations 31, 35 and 39, the SBE 43 O_2 sensor started to drift.

2.7 Observed hydrographic properties and sections
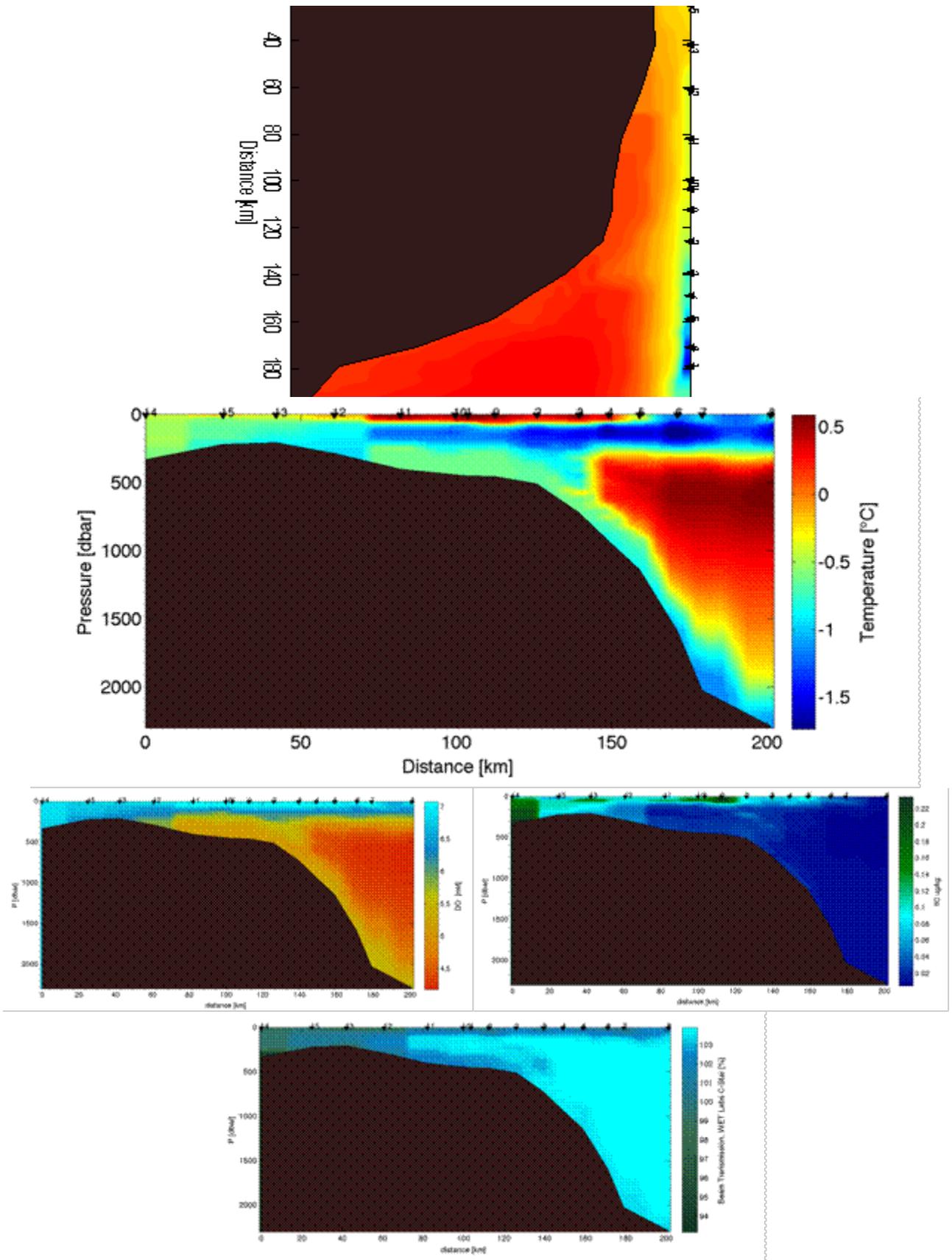
Figure 11: Repeat of the first 200km, the shelf and shelf-break, of the WOCE SR4 section during JR255A – CTD casts 1-15. Section plots of (a) theta, (b) salinity, (c) dissolved oxygen (DO), (d) chlorophyll, (e) transmission.
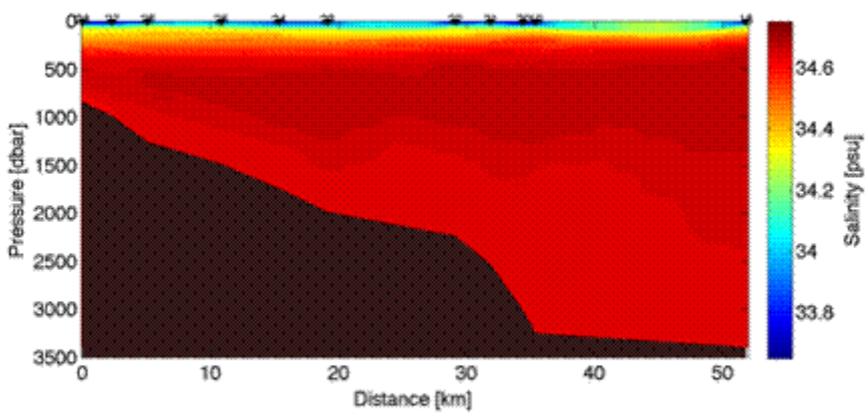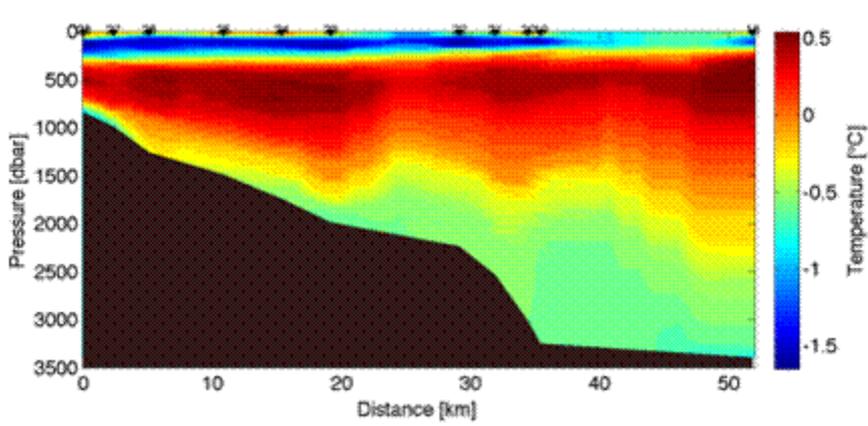
Figure 12: Second section during GENTOO cruise JR255A – CTD casts 18-28, from the shelf into the Powel basin. Section plots of (a) theta, (b) salinity.
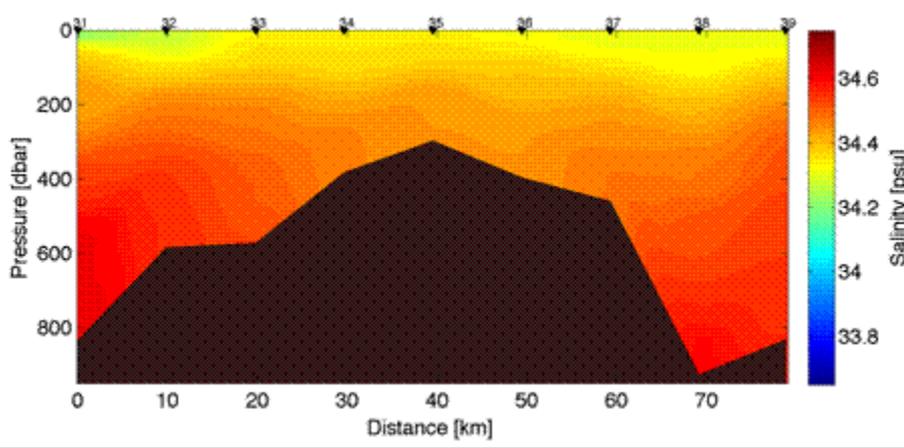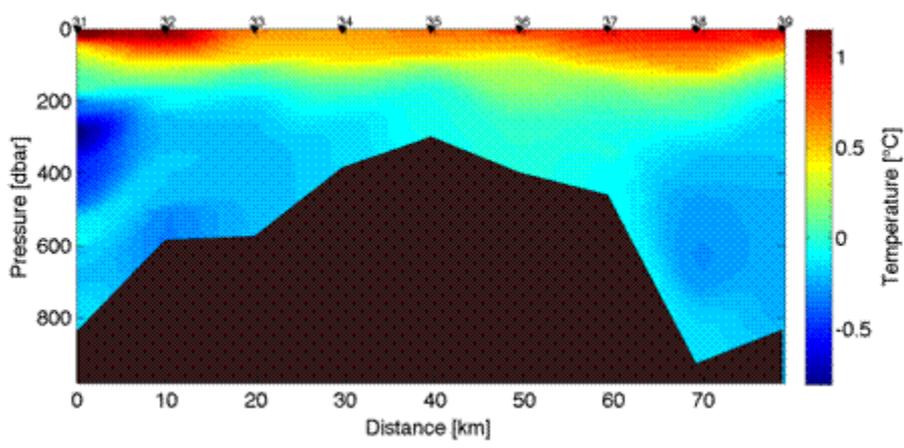
Figure 13: Third section during GENTOO cruise JR255A – CTD casts 31-39, across a seamount on the ridge north of the Powell basin. Section plots of (a) theta, (b) salinity.

3 Rosette Water Sample Analysis

(Sunke Schmidtko)

Figure 14 shows the pressures of water samples taken for each cast. Due to an new science crew a few samples taken for Salinity and Oxygen Isotopes the sample bottle number was not recorded. The four salinity samples without recorded bottle number could be assigned by conductivity comparisons. They were cast 18, Niskin bottle 1, 6, 10 and 24. An assignment of the oxygen isotopes sample by salinity comparisons is still to come, probably with less confidence.
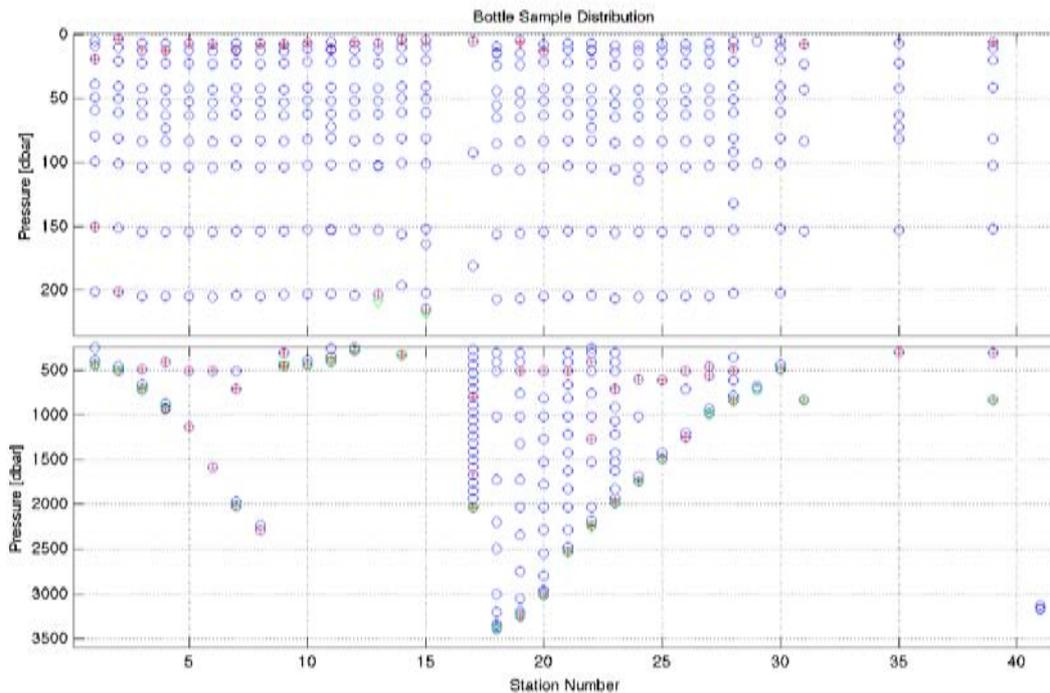
Figure 14: bottle sample distribution (blue circles) . The green triangles mark the bottom as seen by the CTD altimeter when available. The red crosses mark the salinity samples taken.

3.1 Salinometry

(Ben Webber, Sunke Schmidtko)

The salinometer that we used was a Guildline Autosal. The functioning of this is described in detail in the manual, currently located in the top drawer in the bio lab, where the salinometer is also located. The basic functioning of the salinometer depends on measuring the conductivity of the sample through four coils located in the cell. The cell needs to be flushed three times before reading, and then is flushed in between each reading. At least three readings are taken, and the final conductivity ratio used for conversion to salinity is taken to be the median of these readings. The autosal should be set up on the bench in the "bio lab" at least 24 hours before use to allow time for the water bath to equilibrate to room temperature and to perform checks. On this cruise an Autosal was set up, but a replacement was needed (see below).
The de-ionised water supply should be connected to the tank fill/drain nozzle, and a tube connected to the overflow into a drain or sink. Fill the chamber until water runs out of the overflow – this requires around 18 litres of water. Turn off the water supply then turn off the cell drain using

the knob at the bottom left and remove the tubing from the nozzle. Make sure the function knob is set to standby and turn on the unit at the mains.

Set the bath temperature 2-3°C above the lab temperature (this was set to 24°C on this cruise, with the lab temperature around 21-22°C). Both heating lamps should come on until the water reaches the desired temperature; after this, one lamp should remain on and the other will cycle between on and off to maintain the correct temperature. The 'check heater' light will flash occasionally, but if it remains lit then there is a lamp problem.

A short length of tubing should be connected to the cell drain valve. Ideally this should drain into an isolated bucket that it does not touch. It must not provide an electrical path to the ground, nor must it be long enough to cause a siphoning effect out of the conductivity cell.

Initial issues and zeroing

The Guildline Autosal salinometer that was set up in the bio lab at the start of JR255A, s/n 68533, was found to be badly calibrated, as indicated by the zero reading, which was -0.00007. This is a sign of electronic drift; given that the acceptable range is stated as +/- 0.00005, it was decided that the replacement unit located in the scientific hold should be set up alongside, even though both were within a year of their last service and alignment. This unit, s/n 65763 had a zero reading which remained steady within the range 0.00000 to 0.00001. We therefore used this salinometer throughout. Note that this salinometer was used without the addition of a peristaltic pump, which is commonly added when the air pump fails to work effectively. The set up used on this cruise requires a tight air seal to be formed around the neck of the sample bottle. The use of a peristaltic pump negates this requirement and causes the cell to fill more quickly, but can lead to issues with bubbles being drawn into the cell which can cause significantly affect the salinity reading.

Keeping the lab temperature stable is an issue on board the JCR, since the bio lab is not a constant temperature lab. There is a thermostat in the lab, and an external thermostat in the CTD hanger. The external thermostat regulates temperatures in the chemistry lab, but the hot air duct runs through the bio lab and can cause the temperature to rise in there uncontrollably. If turning the external thermostat down does not work, ask the engineers to adjust the A/C in that part of the accommodation.

Standardisation

The salinometer was standardized following the manual guidelines, using IAPSO standard seawater from batch P153, with a conductivity ratio of K15 = 0.99979. The salinometer was thus standardized such that the 2 x conductivity ratio displayed was 2 x K15 = 1.99958. The standard seawater was measured in the normal way (see analysis procedure section below) – flushed three times and then repeated readings taken until three consecutive identical readings were achieved. The standardisation dial was then turned until the reading was 1.99958. The standardisation dial (Rs offset) was set to 9.5, and this remained constant throughout the measurements. The difference between the measured standard 2 x conductivity ratio and their stated values was less than 0.000005 for all standards run, apart from one, which was assumed to have been contaminated by a salt crystal. Another standard was run immediately afterwards which gave a very good reading. Standards were run at the start and end of each measurement session, and in between each crate, or between each 24 bottles when partial crates were analysed. The conductivity readings of the standards should be within ±20 in the last two digits compared to 2 x K15. If it is more than this then the Rs knob may need adjusting, but this should be avoided if at all possible – it is best to keep the same Rs trim value throughout a cruise.

The values for the standards, standby and zero readings were as follows:

Table 2. Standards, standby readings and zero readings for the crates processed in the salinometer. Note that crates 10 and 3 were processed sequentially, as were crates 3, 7, 4, 2, 23 and A. Crates 4, 2, and 23 were processed as a single batch as they were all partial crates – the total number of bottles in these three crates was 24.

Jday	Crate	End-start	SSW start	SSW end	Stndby start	Stndby end	Zero start	Zero end
030	Standardisation	n/a	199958	n/a	246011	n/a	0	n/a
030	10	0	199958	199958	246011	246011	0	0
030	3	0.000005	199958	1999575	246011	246010	0	0
031	7	0.00002	199960	199962	246010	246010	0.00001	0.00001
031	4,2,23	-0.00001	199962	199961	246010	246010	0.00001	0.00001

031	A		0	199961	199961	246010	246009	0.00001	0

Analysis procedure

- Before running any samples, they should be left in the bio lab (where the salinometer is located) for at least 24 hours to equilibrate to the lab temperature. The date and time that each crate is placed in the bio lab should be noted to ensure that samples are not analysed before this time has elapsed (it is fine to leave them for longer).
- Start a new log sheet for every batch. Record the cruise number, your name, the date, and the cell temperature (i.e., 21, 24, 27 or 30°C).
- Record the lab temperature; on this cruise, the first two readings on the computer screen above the salinometer were used. This should be a couple of degrees below the cell temperature.
- Record the serial number of the salinometer used, and the Rs offset.
- Check that the heating lamps are flashing frequently (indicates stable temperature) and that the water bath is being stirred (look for particles in the water).
- Ensure that the function knob is in the standby position, and record the display next to SBY (start) on the log sheet.
- Turn the function switch to the zero position and record this next to zero (start) on the log sheet.
- Before using a standard, it is a good idea to flush the cell with seawater from the ships underway supply, or from previously measured salinity samples, to minimise contamination of the standard seawater with de-ionised water (the cell should be left full of de-ionised water if idle for any length of time).
- Take a bottle of IAPSO standard seawater. Record the batch number (Pnnn) and K15 value on the logsheet. A new standard bottle should be used each time; leaving a standard bottle for an hour was found to generate errors of as much as 0.01 psu.
- Gently agitate the bottle of standard seawater to remove any salinity gradients – do not shake too hard, since bubbles formed may contaminate the reading.
- Remove the previous bottle; wipe the collection tube and the top of the standard bottle with a clean tissue or blue roll.
- Insert the collection tube into the bottle, adjusting the platform height so that the neck of the bottle is flush with the rubber bung and a secure air seal is created.
- Flush the cell three times with the standard.
- Allow the cell to refill before turning the knob to the read position (never switch the knob to read if the cells are not full of water).
- If the display flashes, adjust the suppression knob. Turn clockwise if the display shows a negative sign, and anti-clockwise if it is flashing with a positive sign.
- Wait briefly for the reading to stabilise (but not too long, otherwise the cell heats up and the reading starts to drift), then record this on the log sheet.
- Repeat steps 12-15 twice more. If the readings differ by more than 0.00002, then repeat until a stable reading is achieved.
- When removing the standard bottle from the collection tube, it is good to flush the cell one final time, thus allowing the remaining water to be removed before the next sample is introduced.
- Repeat steps 10-17 for the sample bottles. The platform height will need to be adjusted for the first sample to ensure an airtight fit to the rubber bung.
- Note any problems with the sample, e.g. missing inserts,
- Run a standard seawater sample between crates of samples and at the end of a session. Record these as K15 on the log sheet.
- Fill a sample bottle with de-ionised water and flush the conductivity cell three times with this de-ionised water. Leave the cell full, and leave the bottle in place.
- Switch off the salinometer's air pumps, but not the salinometer itself.
- Empty the waste bucket if needed (on this cruise, a tube was fed directly into the sink).

Conversion to salinities

Conversion from the conductivity ratio readings and salinities was done using the MatLab function sw_salt.m in the seawater toolbox. This divides the measured conductivity by 2 times the conductivity of standard seawater measured at standard temperature and pressure, and then multiplies by the salinity of standard seawater. The small drift (around 0.00003) in the measured standard seawater conductivities is removed by linear interpolation from the measurements before conductivity calibration is carried out for the CTD and the underway salinities (see respective chapters).

3.2 Dissolved Oxygen Measurements

Oxygen is discussed in detail in section 2.6.

3.3 Oxygen Isotope Measurements

50 samples were taken, but not analysed on board. There may be a problem with the first set of samples since the sample containers were not sealed with additional paraffin foil. However they were sealed tightly with the corresponding bottle caps. This got discovered a few days after the first station.

4 Lowered Acoustic Doppler Current Profiler (LADCP)

(Ben Webber)

4.1 Technical information about ladcp unit used and installation

One Down-looking 300 kHz WorkHorse (WH) LADCP installed, model number WHM300-1-UG301, serial number 15060. The use of just one down-looking LADCP, as opposed to one downlooker (master) and one up-looker (slave), is believed to be standard practice due to the regularity of failures with LADCP units; using just one at a time means that a replacement is available and minimises the chances of both LADCPs failing.

LADCP deployment and recovery procedures

Before starting any deployments, the pre-deployment test script (stored in C:\LADCP\Scripts\ 01PreDeployTest.rds) was run. This contained the following commands:

```
;----------------------------------------------------------------------
;                          PRE_DEPLOY.RDS
; Script file for pre deployment RD Instruments WorkHorse
; ADCP with the BBTalk program
;----------------------------------------------------------------------
;----------------------------------------------------------------------
; RDI - WH ADCP pre deployment script file:
; FILE name = "pre_deploy.rds"
; Date: 11 February 2010
; Author: Julian Klepacki
; Version: 1.0
; Modified by on:
$L
$B
$W62
$P ************************************************************************
PA
$W62
$P ************************************************************************
PT200
$W62
$P ************************************************************************
PC2
$W62
$P ************************************************************************
RS
$W62
$T

$W62
$P ************************************************************************
$P Type 're ErAsE' to erase data if necessary?
$P Hit Return for Command Prompt
$P************************************************************************
$L
```

Communication with the WH LADCP during deployment and recovery was accomplished via the BBTALK software package on a dedicated laptop set up in the chemistry lab. This location was chosen as it was the easiest point to connect the cables to the LADCP. The battery pack was recharged in between each station, and was able to maintain a high level of charge throughout the cruise, partly due to the predominantly shallow nature of the CTD sections occupied. Thus it was not necessary to use a backup battery pack, although this has been done in the past. The command sequence for deployment (contained in the deployment script stored in C:\LADCP\Scripts\SingleLADCP_script.txt) was as follows:

```
;
$P **************************************************************************
$P ******* LADCP Deployment with one ADCP. Usually looking down **********
$P **************************************************************************
; Send ADCP a BREAK
$B
; Wait for command prompt (sent after each command)
$W62
;**Start**
; Display real time clock setting
tt?
$W62
; Set to factory defaults
CR1
$W62
; use WM15 for firmware 16.3
WM15
$W62
; Save settings as User defaults
CK
$W62
; Name data file
RN JR255A
$W62
; Set transducer depth to zero
ED0000
$W62
; Set salinity to 35ppt
ES35
$W62
; Set system coordinate.
EX11111
$W62
; Set one ensemble/sec
TE00000100
$W62
; Set one second between pings
TP000100
$W62
; Set LADCP to output Velocity, Correlations, Amplitude, and Percent Good
LD111100000
$W62
; Set one ping per ensemble. Use WP if LADCP option is not enabled.
LP1
$W62
; Set to record 25 bins. Use WN if LADCP option is not enabled.
LN025
$W62
; Set bin size to 400 cm. Use WS if LADCP option is not enabled.
LS400
$W62
; Set blank to 176 cm (default value) Use WF if LADCP option is not enabled.
LF0176
$W62
; Set max radial (along the axis of the beam) water velocity to 176 cm/sec.
; Use WV if LADCP option is not enabled.
LV170
$W62
; Set ADCP to narrow bandwidth and extend range by 10%
LW1
$W62
; Set to use a fixed speed of the sound
EZ0111111
$W62
; Set speed of sound value. 1500 m/sec is default.
EC1500
$W62
; Heading alignment set to 0 degrees
EA00000
$W62
; Heading bias set to 0 degrees
EB00000
$W62
; Record data internally
CF11101
$W62
```

```
; Save set up
CK
$W62
; Start pinging
CS
; Delay 3 seconds
$D3
$p ***********************************************************************
$P Please disconnect the ADCP from the computer.
$P ***********************************************************************
; Close the log file
$l
```

For a description of their effect see RDI's 'WorkHorse Commands and Output Data Format' manual.

4.2 Deployment

Make sure that battery pack and communication cables are connected to the WH.
From BBTALK, wake up the WH, using the blue 'B' button on the top panel of the window, which sends a break signal. You should get a command prompt (>), indicating that the WH is listening. This is done automatically whenever BBTALK is launched.
Press <F3> to start a log file and select an appropriate filename. The naming convention used for this cruise was jr255nnn.txt, where nnn is the three-digit station number. Check the status bar in the bottom right-hand corner to see that logging is ON.
Send 'ts?' command to check internal clock time against the ship's clock. It is important that this is accurate, otherwise the combination of the LADCP data with data for navigation, CTD, SADCP etc. will be hindered. If it does not match the scientific clock time, reset it using 'tsYYMMDDhhmmss'.
Send command 'rs?' to check that there is enough space left in the PCMCIA card for storing the cast data. A 4000 metre cast should use around 5 MB of space. If more space is needed, use the 're ErAsE' command (but be sure to have backed up all files first!).
Send command 'pa' to run pre-deployment tests. Note that the Receive Loop-Back and Wide Bandwidth tests may fail because the WH is not in water (check notes for tests PT3 and PT6 in the command manual). On this cruise, the 'Transmit' test also failed, but this was also believed to be due to testing the WH in air.
Measure the battery voltage and record this.
Press <F2> to read the command file (contents of this file listed above). The WH will start pinging when the 'cs' command is sent. At this point, data is being recorded and BBTALK does not return a prompt.
Check that logging is off. If not, press <F3> to turn it off.
Disconnect the comms cable and replace with a dry plug. The WH is now ready for deployment.
Data recovery
Remove dry plug and reconnect comms cable to the WH.
Send a break signal to stop data connection.
Check battery voltage and switch on the power supply.
Send command 'ra?' to check number of deployments.
Send command 'cb811' to switch the WH baud rate to 115200 (fastest). The corresponding setting in BBTALK has to be changed. (The version used on this cruise did this automatically).
Press <Ctrl>+<Page Down> to download cast data. Make sure you select only the cast you wish to download and do not select 'download all data' unless you want to! Data download takes around 10-20 minutes depending on cast depth.
When data transfer is finished, switch back to the default baud rate ('cb411') and power down the WH ('cz'). Note that the WH will automatically power down if left idle for some time, but the baud rate will not be changed.
Rename the data file (if required) and copy it (and the log file) to backup storage on the ship's file server jrua (U:/data/ on the laptop – this had to be set up by Jeremy Robst, the Computer Technician). For this cruise, the file naming convention was JR255nnn.000
As a safeguard, open the file with BBLIST and write down the file size and number of ensembles recorded.

```
JR255A GENTOO LADCP Deployment / Recovery Log Sheet
Station number (nnn) ………………….. Date(dd/mm/2012) …………………………. Jday …………………
Latitude ……………………………. Longitude …………………………. Water depth (m) ………………………
LADCP instrument: RDI WorkHorse 300 kHz S/N 1855 (downlooking)
```

```
Pre-deployment (Comms and Charge leads should be in place)
In BBTALK:
Log File name (F3)   j255A……………………….. .txt
Time check (ts?)      GMT ……………………….
Time correction made, if necessary? (TSYYMMDDhhmmss) Y/N
Memory used (rs?)      ……………………………. MB
Erase if necessary (RE ErAsE). Erased?                    Y/N
Run tests (PA)                                           Y/N
Battery Voltage. Measure across charger ………………………… V
Deployment
Command file (F2)
Master deployment time (start pinging), from master clock. GMT …………………………………..
Check logging is now off (if not, press F3).
At bottom of cast   Time …………………. Lat ……………………. Long …………………………………
CTD depth ………………… m Seabed …………………………………….m
Recovery (in BBTALK)
Time of stopping MASTER logging/pinging.      GMT …………………………………..
Battery Voltage, across charger              …………………………………….. V
Data Transfer (in BBTALK)
Number of deployments (ra?)                  ……………………………………..
Set baud rate to 115200 (cb811)
Download data (<ctrl> + <page down>). Filename: …………………………………….
Set baud rate to 9600 (cb411) and power down (cz)
In BBLIST (right click file and open with BBLIST, on desktop)
File size            ……………………………………………… b
Number of ensembles …………………………………………….
Copy station data and log files to U:\data          Y/N
Comments ……………………………………………….....................................
```

4.3 Data Processing

On board data processing was performed using the Lamont Doherty Earth Observatory (LDEO) software, downloaded from the website at www.ldeo.columbia.edu/~ant/LADCP/. It is also common to use the University of Hawaii (UH) software as a point of comparison, but this was not available on board, so it is intended that this software be used after the cruise before the final data set is published.

The LDEO software includes shipboard ADCP data into the processing of the LADCP by default. Although this provides the most accurate profiles, it was decided to keep the SADCP and LADCP data separate initially, to allow the two independent data sets to be compared to each other and thus to assess their accuracy. The LDEO software was therefore modified where necessary to stop the incorporation of the SADCP data (the code was commented wherever this happened with the line 'Comment by BGM WEBBER:', and the initial code was commented out, rather than deleted). In addition, it was necessary to modify the data input, since the processing of the input CTD and navigation data was done in MatLab, and not using the standard seabird software as is the default. These modifications were simple changes to the data loading, and were also commented. The software was run using MatLab 2011a, on the ship's Sun Linux computer. The scripts in initial_dir/ also need to be edited at the start of each cruise to check that paths, parameters and names are correct. It is possible to enter specific parameters for the cruise into cruise_params.m, and specific parameters for individual casts into cast_params.m.

After the modifications to the various scripts (all stored in L:\ladcp\jr255a\m\), the processing of the data was simply carried out using the following two commands:

prepare_cast(nnn)

process_cast(nnn),

where nnn is the station number (the code accounts for this being entered as an integer without leading zeros).

The processing worked well for most casts. One concerning station was number 3, where the software returned the warning 'weak beam 4'. However, this warning was not repeated, so it was assumed that the problem was not critical. Many of the later casts had the warning 'high error due to shear – inverse difference'. It is not clear how much of a concerning factor this is, but it should be borne in mind when comparing the results to SADCP data and the output of the UH processing software.

Results

All the plots so far are stored in the cruise report folder. The following are the u and v components of the measured velocity profiles for the eddy. These are interesting in that they do not show a purely rotational velocity profile; indeed, there is a very substantial south-eastwards current that

crosses the centre of the eddy. A preliminary look at the SADCP data suggests that this is real, but it remains to be seen whether or not it is a tidal signal.
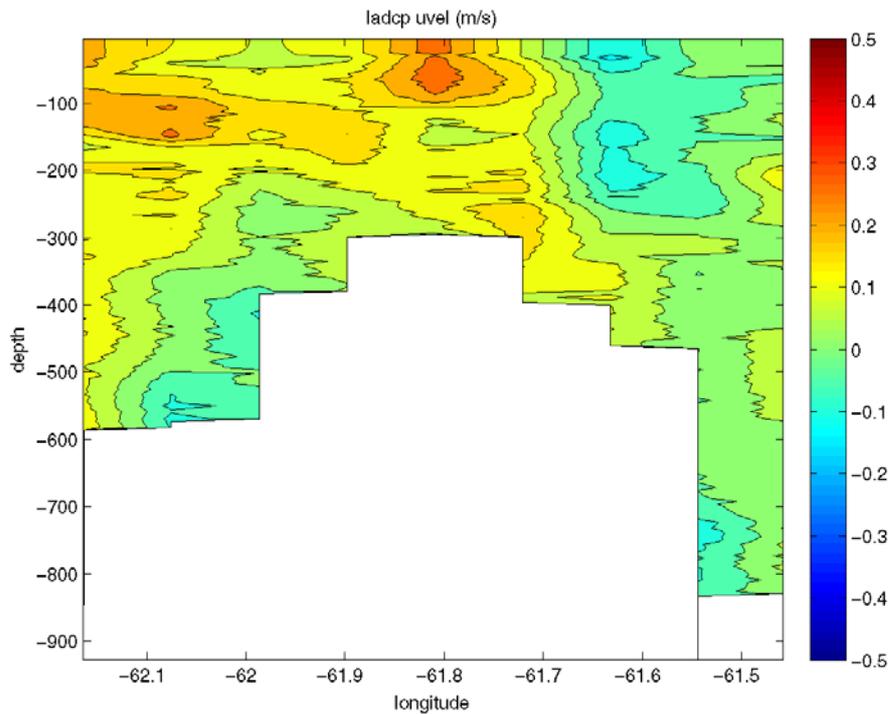
Figure 15: Northward velocities of lADCP section
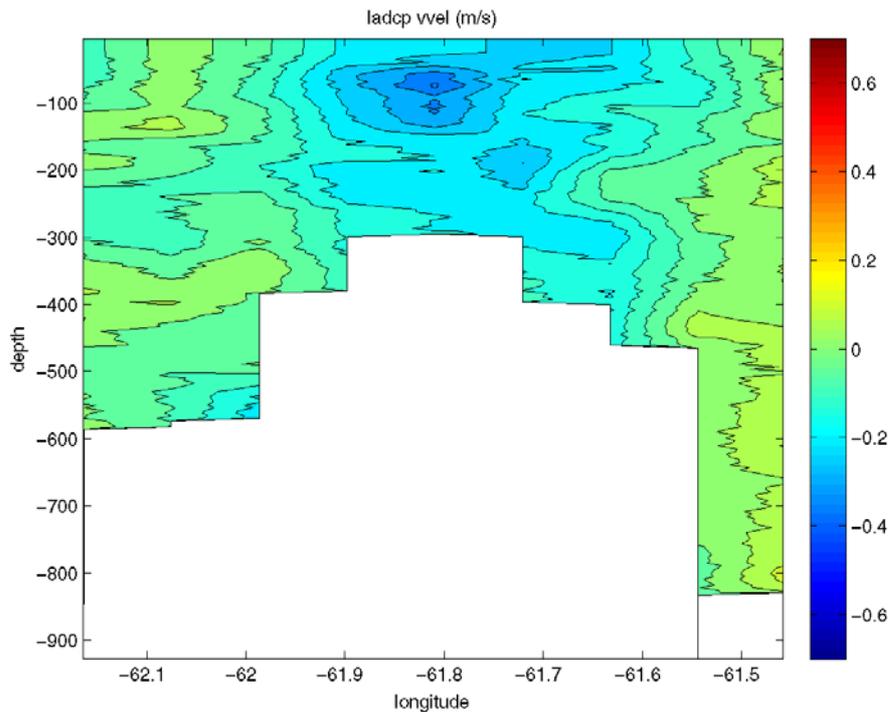
Figure 16: Eastwards velocities of lADCP section.

4.4 Next steps

The next steps will be to remove any tidal signals from the LADCP (and SADCP) data. Then it will be necessary to analyse the ladcp casts using the UH software as a comparison. In addition, comparison with the SADCP data will give an insight into the quality of the LADCP profiles. If these are found to be good, then the analysis can proceed using any method desired, with the estimation

errors informed by the agreement between the methods. If not, then more careful merging of the SADCP and LADCP data sets will be required, and an estimation of the uncertainty involved in this must be produced.

5 Drifters and Floats (Andy Thompson)

5.1 Surface Drifters

Forty surface drifters were deployed during the GENTOO cruise. Twenty Clearsat-15 Minidrogue drifters with a GPS navigation option were purchased from Clearwater Instrumentation, Inc. Another twenty Clearsat-15 SVP Minidrogue drifters with Argos data telemetry, also from Clearwater, were generously provided by NOAA's Global Drifter Program. These additional drifters were originally meant to include barometers (SVPB drifters), but were replaced just before the cruise due to faulty batteries in the SVPB drifters. Gary Williams (wgwill@clearsat.net) has been the contact at Clearwater while Shaun Dolk (shaun.dolk@noaa.gov) and Mayra Pazos (mayra.pazos@noaa.gov) have been the contacts at AOML in Miami.

All drifters are drogued at 15 m depth and employ a holey sock technique to track the surface currents and minimize slip due to wind forcing on the buoy. Communication is through the Argos satellite system and the data is obtained from NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML).

The drifters came packed in cardboard boxes from Clearwater and were individually wrapped in plastic. We removed the drifters from boxes and plastic and stored them in the scientific workshop during the steam. Similar to what was done on ADELIE, we decided to test a few drifters by removing the magnet that initiates the drifter program. We then planned to leave them on the back deck during the crossing of Drake Passage. Six SVP and six SVPG drifters were selected for this. Similar to ADELIE, although the drifters were brought out in clear and sunny skies, eventually spray getting on the back deck required us to move the drifters back inside. The activation of these test drifters began at approximately 18:30 GMT (Julian day 020) at 51.67S and 58.80W. Most of the drifters began giving Argos fixes.

Following correspondence prior to the ADELIE research cruise in 2007, we were told that ideal conditions for deploying the drifters requires the ship to turn into the wind and reduce its speed to 2-3 knots. The drifter should be deployed over the stern from the lowest deck in order to avoid tangling with the screws and having the wind blow the drifter back onto the hull. This advice seemed to contradict the instructions provided by Clearwater which suggested that drifters could simply be heaved over the side at speeds up to 25 knots. Due to calm weather during both deployments we were able to deploy the drifters off the stern while the JCR was underway travelling at a speed of roughly 10 knots.

The original plan was to deploy the forty surface drifters along the ADELIE section to repeat the 2007 experiment, however this was not possible due to high sea ice concentrations at the deep end of the ADELIE section. We chose to deploy 21 of the 40 drifters across the continental slope and shelf break on the return steam on the 24th of January using a combination of SVP and SVPG drifters. The remaining 19 drifters were deployed across the continental shelf and slope along our iceberg section to the north of Joinville Ridge (see Figure 17). Both drifter deployment legs were carried out over a period of roughly three hours.

We obtained surface drifter fixes from AOML's anonymous FTP site. Files are posted daily with the data obtained from Argos. To obtain the data:

ftp ftp.aoml.noaa.gov
username: anonymous
password: your e-mail address
cd /phod/pub/pazos/data/thompson

This same method for obtaining data can be continued following the cruise.

The data is in Argos format, which for each entry consists of one line of transmitter identification and multiple lines of data collection messages. The data has the form:
Transmitter ID
1. programme no. (for us this is 06129)
2. Drifter ID no. (all SVPG drifters start with 03 or 04, all SVP drifters start with 1010)
3. No. of lines in entry (includes both transmitter ID and data collection lines)
4. No. of sensors (we have 3 for SVP drifters and 31 for SVPG drifters)
5. Satellite ID (this is a single character)
6. Location class obtained
7. Date (yyyy-mm-dd)
8. Time (HH:MM:SS)
9. Latitude (-90 to 90)
10. Longitude (0 - 360)
11. Location altitude (usually zero)
12. Calculated frequency

Due to the time spent piloting gliders during the cruise we have not had the opportunity to look at sensor data from the drifters. Information about sensors can be found in the ADELIE cruise report, although at this time it is uncertain if the sensor format has changed.

As of 3 February, 38 of the 40 drifters were still responding with Argos fixes (SVPG drifters have both GPS fixes and Argos fixes). Gary Williams sent along the first batch of GPS fixes this afternoon. In general the lag between first fix and deployment was better than on the ADELIE cruise. This is most likely because magnets were removed manually before deploying rather than waiting for the cardboard to dissolve. Figure 17 below shows drifter positions and tracks as of the morning of February 3. Blue and red tracks denote SVP and SVPG drifters respectively. The position of the Big Bird iceberg is also marks at times when we had good satellite images.

The difference between the ADELIE drifter tracks and these early GENTOO drifter tracks is remarkable! During ADELIE the drifter tracks strongly conformed to isobaths and separated into a number of frontal currents, the most dominant being the Antarctic Slope Front found between the 800 and 1000 m isobath. In this case however, a large portion of the drifters have exhibited substantial cross-isobath motion. Big Bird is traveling rapidly along the path of the ASF where the ADELIE drifters congregated and to this point, very few GENTOO drifters have followed in its wake. There also seems to be a larger group of drifters that are following the path around the Powell Basin towards the Orkney Plateau. Despite the greater sea ice extent this year, we hope that the earlier deployment will enable more drifters to escape the Weddell Sea.

GENTOO: Drifter Log Sheet (positions given in degrees, decimal minutes)

Table 3: Drifter Log Sheet (First deployment)

ID	Date (Jday)	Time (GMT)	Latitude S	Longitude W	Depth (m)	Deployer
43552	24	16:28	63 31.13	51 07.50	2300	Andy
42479	24	16:42	63 29.74	51 11.85	2300 (?)	Ben
42488	24	16:55	63 29.01	51 17.66	2300 (?)	Jenny
42495	24	17:07	63 28.60	51 23.05	2300 (?)	Alan
101530	24	17:16	63 28.31	51 27.49	1960	Mark
41413	24	17:26	63 28.00	51 32.03	1853	Bastien
101956	24	17:38	63 27.61	51 37.65	1808	Andy
41410	24	17:48	63 27.13	51 42.38	1659	Alan
101898	24	18:00	63 26.11	51 47.17	1285	Andy
43554	24	18:11	63 25.04	51 52.14	1126	Karen

101870	24	18:21	63 24.37	51 57.10	1033	James
101823	24	18:33	63 23.75	52 02.10	938	Sophie
43555	24	18:44	63 23.11	52 07.30	832	James (Doc)
101983	24	18:56	63 22.80	52 13.04	718	Herbert
101535	24	19:06	63 22.72	52 17.42	634	Celine
42487	24	19:17	63 22.64	52 22.85	559	Liz
101537	24	19:26	63 22.58	52 27.07	532	Sunke
101985	24	19:37	63 22.49	52 31.96	509	Jill
41400	24	19:48	63 22.46	52 37.13	487	Andy
101954	24	19:58	63 22.53	52 41.79	471	Andy
43557	24	20:09	63 22.64	52 47.05	467	Andy

Table 4: Drifter Log Sheet (Second deployment)

ID	Date (Jday)	Time (GMT)	Latitude S	Longitude W	Depth (m)
101527	26	09:46	62 47.90	51 11.86	3447
42513	26	09:57	62 49.41	51 13.79	3047
101531	26	10:05	62 50.51	51 15.12	3387
43353	26	10:13	62 51.67	51 16.54	3387
101900	26	10:21	62 52.82	51 17.97	3384
39759	26	10:29	62 54.05	51 19.45	3375
101949	26	10:38	62 55.40	51 21.2	3130
41399	26	10:45	62 56.49	51 22.52	2860
101768	26	11:21	62 58.75	51 25.30	2140
41402	26	11:28	62 59.90	51 26.87	2270
101647	26	11:33	63 00.81	51 27.91	2165
41408	26	11:41	63 02.19	51 29.66	2109
101867	26	11:49	63 03.52	51 31.30	1928
40881	26	11:56	63 04.70	51 32.79	1774
101979	26	12:07	63 06.01	51 34.55	1620
41414	26	12:12	63 07.00	51 35.58	1508
101766	26	12:20	63 08.30	51 37.32	1479
41412	26	12:27	63 09.49	51 38.80	1346
101758	26	12:40	63 12.23	51 42.11	850
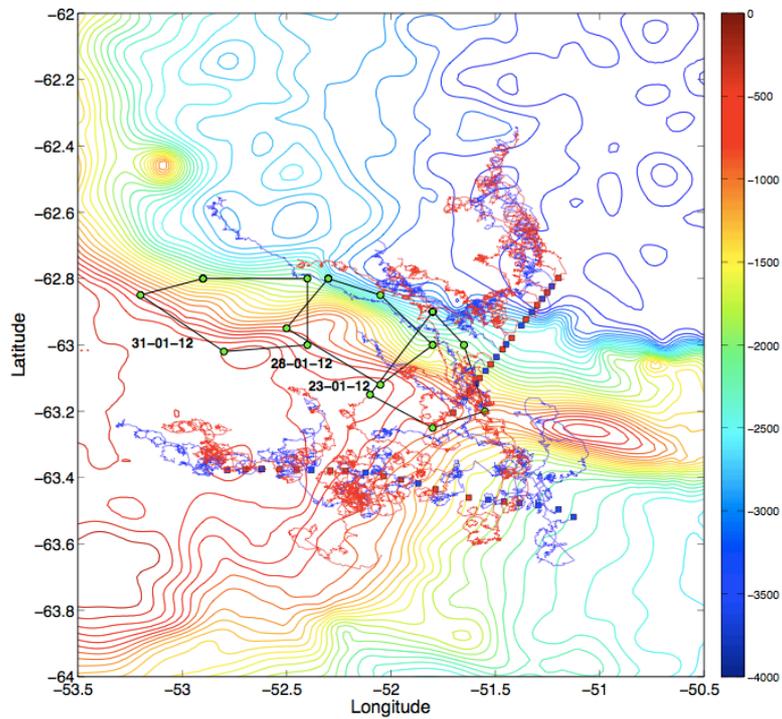
Figure 17. Drifter positions as of the morning of February 3. The colored squares indicate deployment locations and the curves indicate tracks as plotted using the raw Argos fixes. Blue and red squares/curves indicate SVPG and SVP drifters respectively. The colored contours indicate the bathymetry. The polygons represents the positions of the Big Bird iceberg on at the dates indicated on the figure (as determined from ENVISAT SAR pictures downloaded from PolarView).

Figure 18: Drifter deployment from first section (start of WOCE SR04)

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5.2 ARGO Float Deployments
(Jim Jordan)

Three Argo floats were deployed during this cruise. They are APEX-SBE profilers produced by Webb Research Corporation USA that are programmed to drift with the current at a depth of 1000m. The floats are equipped with temperature and conductivity sensors and a pressure gauge. Every 10 days they descend to 2000m and then measure temperature, conductivity and pressure on the way up. At the surface they transmit their locations and vertical hydrographic profiles back to the Argo data centre via ARGOS satellite before sinking to a parking depth and repeating the cycle again. Floats are designed to make roughly 150 such cycles.

Argo floats were shipped to the deployment site in hibernation mode. The floats were activated approximately one hour before deployment by holding a magnet for 6 seconds over the RESET location marked on the float. After 10 seconds the float sent six ARGOS transmissions at 8 second intervals. This transmission can be detected by placing the ARGOS receiver/beeper close to the antenna. The hydraulic piston pump began to move to full extension and the oil bladder expanded. It took approximately 12 minutes for the oil bladder to reach full inflation. The float then started sending a test transmission every 45 seconds. The instructions supplied with the floats said that there would be a 90 second gap between tests transmissions, but as all the floats had a 45 second gap this was assumed to be a mistake with the instructions rather than the floats themselves. It was at this stage that one of the four floats (4869) was found to have been damaged in transmitting, sending a very long and drawn out signal compared to the sharp pings of the other floats. As such it was not deployed. The remaining three floats were deployed off the aft deck with the ship being stationary. During deployment the sea was fairly calm, with a small amount of sea ice in the vicinity.
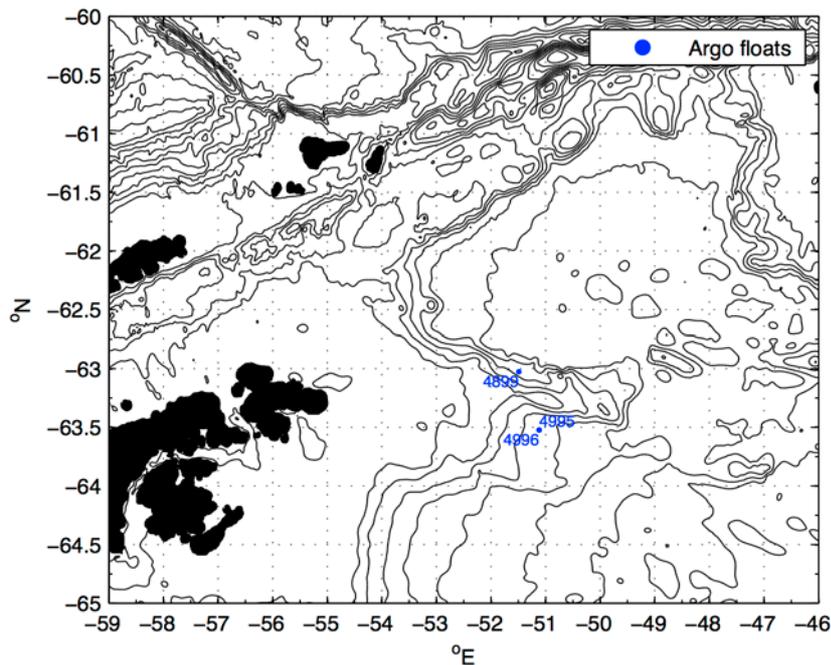
Figure 19: location of the Argo float deployments

All three deployed Argo floats reported back at the Argo Information center and took up the routine of one profile every 10 days. They managed to sample between 6 and 10 profiles before being caught under the seasonal winter sea ice. All three are expected to work under the ice and report their profiles next austral spring/summer.

Table 5: Argo float deployment locations and times

Float Reference	Argo number	Julian Day	Date	Time (GMT)	Latitude (°S)	Longitude (°W)
4995	1901286	025	25/01/2012	13:00	63 31.26	51 07.19
4996	1901287	025	25/01/2012	13:30	63 31.26	51 07.19
4899	1901288	026	26/01/2012	13:55	63 01.483	51 29.69
4869	-/-	Not deployed, failed pre-deployment test. (no reaction of float)				

6 Seagliders

(Bastien Queste, Andrew Thompson, Liz Creed)

6.1 Launch and recovery procedures

Of the five gliders taken aboard the RRS James Clark Ross for the GENTOO 2012 cruise, three were launched (SG522, 539 and 546). SG503 was run through several self tests and sim dives but was never launched due to undetermined issues (most likely GPS or TT8). SG502 was considered unfit for the mission due to a diminished VBD pump remaining from the GOVARS Ross Sea mission.
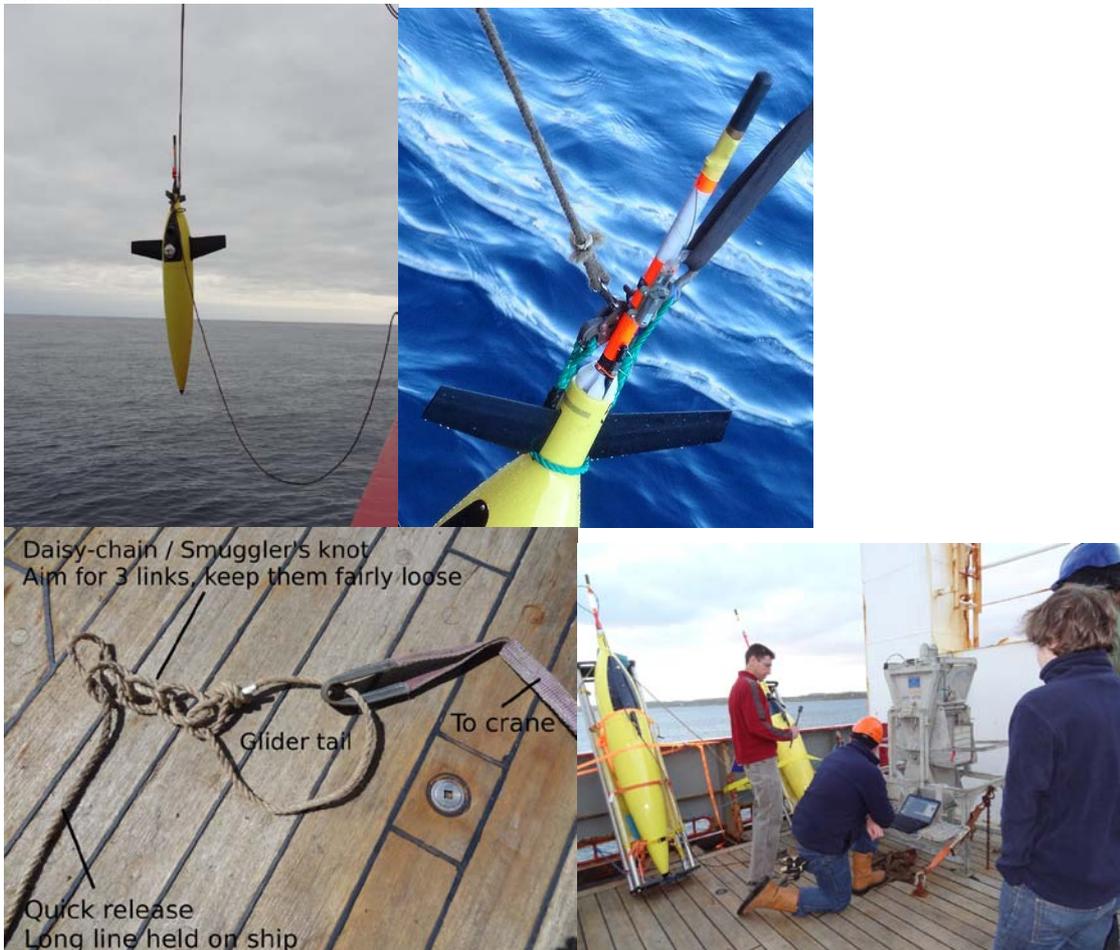
Figure 20: Glider deployment procedures

6.2 Self tests / Sim dives

Self tests and sim dives were performed on the aft deck. Care was taken to maximise sky visibility but little difference was noticed between different areas. Positioning the glider cradle flat in the centre of the aft deck did not seem to hinder GPS acquisition or Iridium connection. Excessive roll and movement from the ship seemed to cause more frequent disconnections.

6.3 Launch method

Six launches and three recoveries were performed on this cruise. All were done from the starboard side using the starboard-aft crane. The first launch (SG546) was performed using a large metallic quick release clip (pictured), which was tied to a strap, in turn attached to the crane. The glider was held by a small length of line with loops spliced at either end. One loop was fitted into the quick release while the other was anchored to the strap. The long line was maintained used to release the glider after its buoyancy had been assessed. A loop and peg system was not use as testing the buoyancy would remove the necessary strain on the rope to keep the Seaglider attached. Although it has been confirmed this type of antenna has a defective shoe, we believe strain caused by bashing against the fairly large and heavy clip contributed to the antenna breaking.

SG546 was recovered nearly immediately with a broken antenna as it was not diving. After replacement of the antenna, SG546 was launched a second time using a daisy-chain/smuggler's knot. Several variations of this method were attempted during all the launches before finally settling on the set-up pictured here.
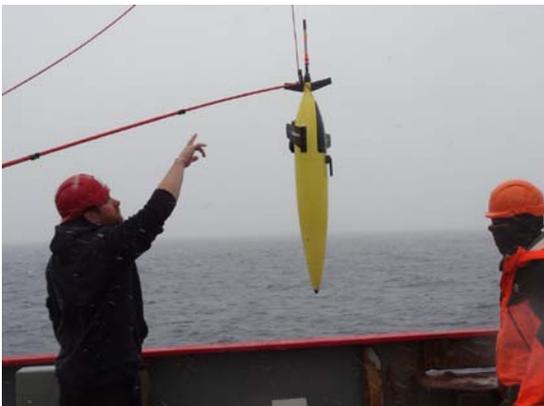
Figure 21: Glider deployment photo

The strap was cinched onto the crane to shorten it sufficiently for the glider to clear the railing. A long line (20m +) was used for the release. On one end, a loop was spliced (not pictured here) to prevent it catching in the rudder. The long-line's loop was passed through the strap's loop as opposed to tied on so that the glider would not end up suspended on a long line going from the ship to the crane. The long-line was passed around the aft end of the glider below the rudder and a bight pulled through the loop. Another bight was then pulled through this newly created one from the long-line to create another link. This was repeated 3 to 4 times to create a series links. The link closest to the glider gets pulled tight by the weight so it is important to leave the following links fairly loose (as pictured). The final link can be tightened more to prevent the bight from slipping out. This was only ever a risk when the winds were slightly stronger and cause the glider to spin, catching the rope on the wings and pulling at the release.

We found that in cases where we had to test the buoyancy, it was easier to keep the glider on a static line, pull it back out, change the lines then release it using the smuggler's knot. Although possible in one go, the long-line would often tangle around the antenna or the rudder while waiting to test the buoyancy. This is a major hazard as it is very difficult to remove without putting stress on fragile bits of the glider. This way, the glider can also be released without being entirely in the water; the extra weight on the glider loop makes it easier to pull the quick release.

6.4 Recovery method

Figure 22: Glider recovery sling

Recovery was performed in the same fashion for all instances, recovery with this method was simple and only required three pairs of hands. One with the pole guiding it over the glider, one to pull the rope tight, and the third to hold a safety line on the pole so it didn't end up over the side. We used a 10-12 m extendable pole, a Streamline Ecoline pole, with a machined end (as pictured) bolted onto the pole. The rope used was slightly negatively buoyant so as to sink around the glider. In addition we had threaded wire through the end to hold the noose out. The last 15 cm or so did not have wire so as to can cinch around the glider lifting point below the rudder. A few cms of the wire/rope was already threaded through the hole so that after looping around the glider we could pull the rope tight around the lifting point. Once the rope was cinched around the glider at midships we dragged it to the aft of the ship, put a knot in the line and hooked onto the starboard-aft crane. We then used the crane to pull the glider away from the ship before raising out of the water so it didn't bump into the side of the ship also using the pole to steady the glider coming in and then lay it in the cradle.

6.5 Seaglider 503

Preparations for the launch of SG503 began on the 20th of January 2012. During the sim-dive routine, it was noted the Seaglider was unable to communicate with the GPS unit.

Battery state:
24V – 27.05V 1.737AmpHrs
10V – 10.55V 1.939AmpHrs
Comms confirmed at 13:13 UTC / 18.01.2012
Both phones set to 441603597331, password gentooJCR

A sim-dive was begun on the 20.01.2012 at 16:44 UTC. SG503 was unable to communicate with the GPS unit. This was assumed to be due to a faulty wire inside or a defect in the GPS unit. The antenna was ruled out as a single element is shared between the iridium and the GPS, the former functioned correctly. This was not confirmed by switching antennas. No log file was created at this point but files were transferred to the basestation from the following self test. A superficial test of the GPS unit was then done:

```
Version 66.08/2769M starting up Jul 13 2011 15:29:41
Seaglider operating software developed and maintained by
Applied Physics Laboratory, University of Washington
Copyright 2003-2010, University of Washington
Built without SCENARIO, with ICE, with RAFOS, without KERMIT,
 without ARS, without MMODEM, without PAAM, without MIB, with AQUADOPP, with SAILCT,
 without DEEPGLIDER, without HEAP RECYCLE, with REV_C, without LUA
with serial and logger device sensor integration facilities
developed by Integrative Observational Platforms Group, APL-UW
_mtop = 0x2fefff, _mbot = 0x29af50, _mcur = 0x29c000
glmalloc_init: glmalloc_data_init = 0x0
glmalloc_init: avail_bytes = 376831, requested_bytes = 358400
glmalloc_init: Allocated 358400 bytes.
-536870911.973,SSENSOR,N,assigned SBE_CT to sensor slot 1 (p = 2)
-536870910.062,SSENSOR,N,assigned AA4330 to sensor slot 2 (p = 101)
```

```
-536870910.152,SSENSOR,N,assigned WL_BB2F to sensor slot 3 (p = 39)
-536870906.213,SPOWER,N,no CURRENTS file
-536870906.306,HCOMPASS,N,Active compass is SP3003
-536870906.514,SSYS,N,Changing capture file
-536870906.998,SUSR,N,WARNING! $R_PORT_OVSHOOT,204.0000: Recommended range is between -100.0000 and
100.0000!
HPITCH DEBUG BOTH
HPHONE DEBUG BOTH
-536870898.457,SUSR,N,Glider 503, mission 9, dive 357, booted Sat Dec 27 05:11:42 1952
, boot #125
-536870897.344,HXPDR,N,max range = 82.500000 m, timeout = 110 ms
-536870897.610,SSURF,N,Hit CR within 1 minute to start, otherwise will go to recovery ...
Set current date and time
<CR> for default [07/13/2011 15:29:41]

Are you running on external (bench) power? [N]

param/surface
------ Parameters (current value in [])-------
 1) $D_SURF [2] Surface depth (m)
 2) $D_FINISH [9] Dive finish depth (m)
 3) $D_PITCH [1.75] Depth to achieve before surface maneuver pitch (m)
 4) $D_CALL [3] Depth to achieve before antenna is assumed to be out of water (m)
 5) $SURFACE_URGENCY [2] Number of dives to accumulate before trying extra surfacings
 6) $SURFACE_URGENCY_TRY [2] Dive number modulo for extra surfacing attempts
 7) $SURFACE_URGENCY_FORCE [4] Dive number modulo for forced extra surfacing attempts
 8) $USE_ICE [0] Use ice map for surfacing decisions (0 - no, +/-nnn - file number)
 9) $ICE_FREEZE_MARGIN [0.0099999998] Margin (degC) in freezing point check for surfacing
 10) $SM_CC [150] VBD volume for surfacing (cc)
 11) $N_FILEKB [8] File segment size for upload (KBytes <=16, 0=no split, negative=no gzip)
 12) $FILEMGR [2] File management aggressiveness: 0=none, 1=only store compressed, 2=delete splits
on failed phone call
 13) $CALL_NDIVES [1] # of dive/climb cycles before calling
 14) $COMM_SEQ [0] Comm sequence to use (0-default, 1-ctl only, 2-no loggers)
 15) $PROTOCOL [0] file transfer protocol (bits 0-2 data protocol, bits 3-5 control protocol, 0 -
xmodem, 1 - raw, 2 - kermit, 3 - kermit batch (data only))
 16) $N_NOCOMM [1] # dives without communications before max surface
 17) $N_NOSURFACE [0] modulo for dives to finish under surface
 18) $UPLOAD_DIVES_MAX [5] maximum # of dives to upload at each surfacing (-1 = all available)
 19) $CALL_TRIES [5] # of calls to try at each surfacing
 20) $CALL_WAIT [60] Delay between phone tries (sec)
 21) $CAPUPLOAD [1] Upload capture file (0=no/1=yes)
 22) $CAPMAXSIZE [100000] Maximum capture file size to upload (before compression)
 23) $T_GPS [15] GPS timeout (min)
 24) $N_GPS [20] Max # valid GPS readings
 25) $T_GPS_ALMANAC [0] Time to wait to reacquire the GPS almanac (mins)
 26) $T_GPS_CHARGE [-23281.406] How long to trickle charge the GPS (secs)
 27) $T_RSLEEP [3] Sleep interval during recovery (min)
$STROBE [0] Strobe control (0=never, 1=recovery, 2=surface)
param/config/gps
24.806,SUSR,N,Current GPS is Garmin_GPS15H on port 0, TPU00/TPU01, nominally 'GPS'
hw/gps/version
48.282,HGPS,N,DeviceUp: No data from device Garmin_GPS15H on TPU0 after 5000 msecs!
48.395,HTT8,N,Updating parameter $T_GPS_CHARGE to -23286.516
48.743,HGPS,N,No traffic from GPS - trying to reset it 0
51.093,HTT8,N,Updating parameter $T_GPS_CHARGE to -23288.783
56.176,HGPS,N,DeviceUp: No data from device Garmin_GPS15H on TPU0 after 5000 msecs!
56.289,HTT8,N,Updating parameter $T_GPS_CHARGE to -23293.893
56.367,HGPS,N,No traffic from GPS - trying to reset it 1
58.717,HTT8,N,Updating parameter $T_GPS_CHARGE to -23296.16
59.339,SPOWER,N,powerOFF (10,GPS) without corresponding powerON!
59.467,HTT8,N,trying to close unopened port 0
hw/gps/direct
78.003,HGPS,N,DeviceUp: No data from device Garmin_GPS15H on TPU0 after 5000 msecs!
78.116,HTT8,N,Updating parameter $T_GPS_CHARGE to -23301.27
78.463,HGPS,N,No traffic from GPS - trying to reset it 0
80.813,HTT8,N,Updating parameter $T_GPS_CHARGE to -23303.537
85.896,HGPS,N,DeviceUp: No data from device Garmin_GPS15H on TPU0 after 5000 msecs!
86.008,HTT8,N,Updating parameter $T_GPS_CHARGE to -23308.646
86.086,HGPS,N,No traffic from GPS - trying to reset it 1
90.417,HTT8,N,Updating parameter $T_GPS_CHARGE to -23310.914
90.522,HGPS,N,Opening GPS port despite error from GPSOn
90.656,SUSR,N,Starting breakable loop - Ctrl-Q to end
99.079,HTT8,N,Updating parameter $T_GPS_CHARGE to -23319.33
```

Further testing was abandoned until SG522, 539 and 546 were in the water. We communicated with Jason Gobat and Fritz Stahr. Jason suggested monitoring the voltage and lowlevel I/O to verify if the unit was still connected and rule out any baud rate problems. Issues with TT8 channels were also suggested. Fritz said he'd never seen a failed GPS unit and in his experience all issues were due to cables; he also said that TT8 issues happen across all channels and rarely single out only one channel.

For further testing, we started the Seaglider on a power supply and indoors and checked whether or not the GPS worked. Running GPS functions led to a current draw, but there were still no

communications. We then tested the lowlevel I/O. Baud rates were tested successively (300, 600, 1200, 2400, 4800, 9600, 19200 and 38400). Nothing on 300 or 600, then a single character showed up at 1200. At this point tried the normal baud rate (4800) and observed nothing. Retried at 1200, and illegible strings began appearing (wrong baud rate). At this point, GPS output began appearing at 4800:

```
$GPRMC,230116,V,6258.4478,S,05124.8629,W,,,270112,007.5,E*6D
$GPGGA,230116,6258.4478,S,05124.8629,W,0,00,,,M,,M,,*54
$GPRMC,230117,V,6258.4478,S,05124.8629,W,,,270112,007.5,E*6C
$GPGGA,230117,6258.4478,S,05124.8629,W,0,00,,,M,,M,,*55
```

A lot of noise was observed in the 4800 readings at random intervals. Similar noise was observed during the final sim dives (see further below).

```
$GPGGA,203801,6258.4609,s<05124î87=9,_,0,00,,,O,,M,,*59ý
þ□ú
ñðš801<þü6þõø.4öðùéÅþª|>"#Ÿ7Î ÿ,,>#ŠŠòâþ,7¹â*©ö0
$GP□GPI,šÂ01ì625r¢ö0ù<ß,05|&" _Óþú  b,,bbbj±,M,,*59ý
þÒ□èù0óðæñþú8þò0óðÿÿþþ?üþÿõñ?2üðúîþÿ=ß□ÿÒÁ#ÿ□ìðÿ8ò~þ>7î<>0ùü_,07Ì&"#úÿNé ùb,,ì‰©ñü}ü<œ
õú□ßø>ðÿ ú,ñ□Ÿøü ö9 ú,ýLæÿ ù°þì~þúð□þâ,,ú¯<Ç'óÿú$GPÿA,þú,šùþ ÿø>4>Êþ Ó,0ýþ4?~ÿü<ð0b~ê ¿ì},ì¿ò=
üÿþî±,ó8<Ïÿ"ŸÂ ÒŸ²,úbS,0M'¢r÷7~þÿ<,Š#Š12ì007.õ,□*öõ
$GPGÿA<2ð3,¢b²'ªÂ>"#Êbs,0=124>8_s,W0,00,,,M,,M,,.õ□ýúäÿ=Õý<&šÂð5ÉÅò'ª8î"#Îbš±05124.87MNéñ,,270112,00
7.5,E*64
$GPGGA,203805,6258.4609,S,05124.8759,W,0,00,,,M,,M,,*5D
ÒAIÏ□I0?806,V,"ªþr¢609,S,0õ124>8÷79ì_%□Iú,ŠŠ'b,,°rªb*©6÷
$GPGGA,203806,6258.4609,S,05124.87õ9,W,0,00,,,M,,M,,*5E
$GPR}C,ò03807ìV,ö258.460ù,:   ª124.8?=9,W,,,27ŠŠ'b,,°.?,E*6ö
$GPGGA,203807,6258>4609,S,05124.8759,_,0,00,,,M,,M,,*5F
$GPRMC,203808,V,6258î4ö09<Ó,07□¢rþ°êÊb°±<,270112,007.5,E*69
```

There was never any acquisition (A instead of V on the GPRMC lines) as the glider was indoors. I/Os selected on hw/lowlevel/io then observed on hw/lowlevel/terminal:
A4: GPS Vaux control
A7: GPS power
B5: GPS RF relay select
Of these three, only A7 displayed anything. We also opened the E5: WL_BB2F power channel to identify potential issues with the 4800 baud rate but nothing showed on the terminal. Going through the Wetlabs self test (hw/sensors/wlbb2f/selftest) showed only normal values.

We then ran a self test outdoors with no power supply. The GPS took a very long time to acquire a position (most likely an almanac issue) but eventually got a fix. Some strange readings, plus roll errors, were observed on the self test:
84.010,SUSR,N,internal pressure 0.263682 psia
84.110,SUSR,N,internal pressure is too low

Another hw/gps/selftest was run later to verify if issues had returned and fixes were obtained rapidly with no time outs. More communications with Jason and Fritz led to the decision to cycle the GPS for long periods. The following command was run repeatedly for 5 hours from picoDOS:
menu hw/gps/selftest

lpsleep 60

lpsleep 60

menu hw/gps/capture seconds=120

Data came back spotless, with rapid fixes. At this point we considered launching the Seaglider as issues seemed to have disappeared and we considered that all had been needed was for the GPS to be kicked back into normal functioning. Pre-launch sim-dives were run as a safety measure and found strange warnings during the GPS fix:

```
17251109.001,HGPS,N,sync sentence
$GPRMC,072809,A,6143.2279,S,05401.1984,W,000.7,017.4,290112,008.2,E*71
17251109.132,HGPS,N,set 2012/01/29 07:28:10
17251111.579,HGPS,N,confirm $GPRMC,072810,A,6143.2272,S,05401.1982,W,000.8,012.1,290112,008.2,E*7B
17251111.713,SPOWER,N,Bogus seconds (-53687.089844) for TT8_Sampling; ignored!
```

Noise also began appearing when the call dropped:

```
17252189.220,SSURF,N,No acknowledgment of sector, aborting
17252189.295,SSURF,N,Transmission failed...
17252189.734,HPHONE,D,sent [echo 0:0:3:0:9:131:-1 logout >> comm.log
], got [aw³ËC3G?^\!.?I^B6g¯^Olf?
^]sçFÃ;^Bx^]Ã^CÛXçdQ
\sg503= ]
17252189.908,SSURF,N,logout...
17252190.965,HPHONE,D,sent [logout
], got [!.?I^B6g¯^Olf?
^]sçFÃ;^Bx^]^CÛXçdQ³
\sg503= [h^^k!~^WUÍàw^L»$f¬ß£R¯!Ûä¡¹Í:Pó¶sÛÌRÍÉày^LºX±Gª
f^B6gç^HÅ&?^GW"2ª{^P|aw³ËC3G?^\^\!.?I^B6g¯^Olf?
^]sçFÃ;^Bx^]^CÛX
\sg503= çdQ³[h^^k!~^WUÍàw^L»$f¬ß£R¯!Ûä¡¹Í:Pó¶sÛsent [&&&], got [:Pó¶sÛÌRÍÉày^LºX±Gª
f^B6gç^HÅ&?^GW"2ª{^P|aw³ËC3G?echo 0:0:3:0:9:131:-1 logout >> comm.log
M^[M^SM-*9M-[M-dM-!M-9M-M: Event not found.
\sg503= logout
```

The glider also attempted to send a very very large .cap file (over 100 blocks) during the sim dives. The glider had been wanded off and did not have a backlog of files to send.
Compressing THISDIVE.KAP to sg0000kl.x...

```
17252568.352,SSURF,N,Sending cmd lrx -y -c -t150 sg0000kl.x
17252570.175,HPHONE,D,sent [lrx -y -c -t150 sg0000kl.x
], got [lrx -y -c -t150 sg0000kl.x
lrx: ready to receive]
17252570.332,SSURF,N,Sending sg0000kl.x...
17252570.517,SSURF,N,block: 1, size: 1024, blkSize: 1024, attempt: 1...
[...]
17253131.579,SSURF,N,block: 100, size: 128, blkSize: 128, attempt: 10...
17253131.950,SSURF,N,No acknowledgment of sector, aborting
17253132.025,SSURF,N,Transmission failed...
```

At this point we decided not to launch the Seaglider and abandon further attempts.

6.6 Argos tags Programming
(Christopher Walker-Brown)

Programming
The Argos tags on SG522 and SG546 were programmed in accordance with the recommended settings from iRobot and Wildlife computers. Identical transmission settings were also used on SG510 (deployed in the North Sea), SG537 (deployed in the Indian Ocean) and SG539 (deployed as part of Gentoo).
Each tag was set to attempt to broadcast a signal 10 s after the wet/dry sensor detected a surfacing manoeuvre, and then subsequently every 50 s after this initial transmission, assuming the tag remained above the waters surface. A maximum of 150 transmission attempts per day were permitted, to conserve battery life (which typically extends to a maximum of 80 000 broadcast cycles).
The Argos tags on SG522 and SG539 were also programmed to record and broadcast 'haul-out' statistics, providing an estimate of the time spent at the surface. This enabled us to assess the performance of the wet/dry sensor. Recording haul-out statistics slightly reduces the total number of transmissions an Argos tag can send before the internal battery becomes exhausted (Wildlife Computers manual).

Location accuracy
The Argos geolocation accuracy was in line with previous studies, with 63rd percentile location errors in classes 3, 2 and 1 all within a 2 km radius of the Seagliders' GPS coordinates (Table 1). Geolocation accuracy was further improved using CLS' elliptical error definitions. We found that the Argos tags deployed in the Weddell Sea performed within the CLS prescribed accuracies, with 64 % of elliptical error radii proving correct, compared to an expected accuracy of 63 % (personal communication, Yann Bernard, CLS).

Table 6: Argos tag isotropic geolocation errors (distance between Argos geolocations and corresponding GPS coordinates) for our data (Indian Ocean and Weddell Sea) and 8 comparable studies for the 5 different grades of location classes (LC). All errors are at the 63th percentile, except Soutullo et al. (2008) who solely stated the 50th percentile error.

Location class	Geolocation error (in metres)					
	LC-3	LC-2	LC-1	LC-0	LC-A	LC-B
CLS location class accuracy	<250	250-500	500-1500	>1500	Not quoted	Not quoted
Indian Ocean (this study)	453	989	1780	4300	6700	12900
Weddell Sea (this study)	430	1021	1670	4100	7200	11500
Costa et al. (2010)	490	1010	1200	4180	6190	10280
Keating et al. (1991)	361	903	1188	N/A	N/A	N/A
Vincent et al. (2002)	226	372	757	N/A	N/A	N/A
White & Sjoberg (2002)	N/A	1022	2238	3792	N/A	N/A
McKeown & Westcott (2012)	1001	847	1950	2467	1722	13120
Soutullo et al. (2008)	300	1300	900	7400	12700	35000
Dubinin et al. (2009)	500	700	1500	4600	2100	18300
Witt and Hawkes (2008)	400	700	800	2300	1400	18000
Average	462	886	1398	4142	5430	21105

Transmission timestamps

During Gentoo's data collection stage, SG522 completed non-stop consecutive dives 24 h a day. This resulted in both the Seaglider and associated Argos tag spending the majority of their time underwater, and hence unable to transmit geolocations. Any time that the Seaglider surfaced, the Argos tag attempted to transmit a signal, with the result that a histogram of Argos tag transmission times shows that transmissions are received throughout the day (Figure 23). This would indicate that a transmission limit of 150 messages per day is sufficient for a Seaglider maintaining a normal daily dive cycle. However, after SG522 and SG546 went into recovery, and remained on the surface 24 h a day, this 150 message per day limit was found to be inadequate with the daily message quotas being used in the first 6 h of the day. Therefore, for future deployments, message limit values of 600-1000 would be more suitable for these situations.

The tag on SG522 was still broadcasting as of June 2012. The tag on SG539 was broadcasting up until that particular Seaglider was removed from the water.

Processing of haul-out data indicated that the wet/dry sensors performed reliably on both SG522 and SG539, correctly identifying all surfacing manoeuvres. Therefore, as the tag on SG546 stopped broadcasting completely as of 18 April 2012, we assume with a reasonable degree of confidence that this tag is held underwater.
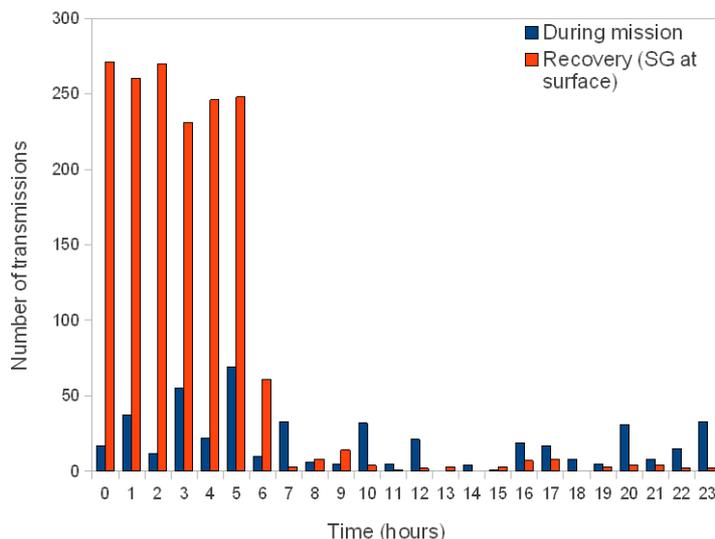
Figure 23: Total number of Argos tag transmissions from SG522 received by CLS during the Gentoo mission (blue) and Seaglider recovery (red), plotted against hour of day.
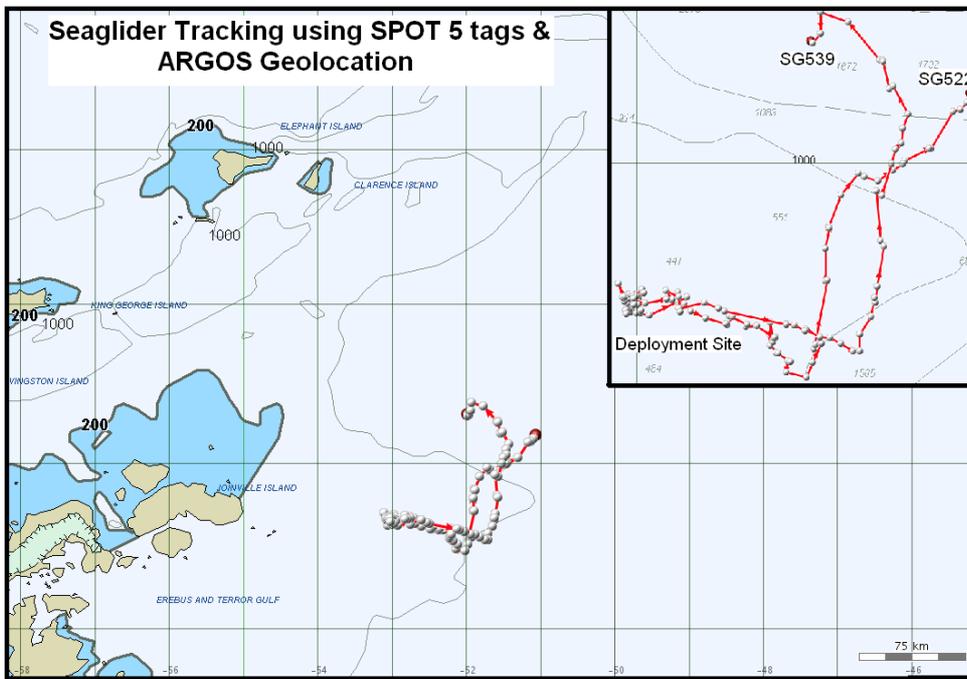
Figure 24: Tracking SG 522 and SG539 solely using the onboard Wildlife Computers SPOT 5 Argos geolocation. Plotted from 19:00UTC 23/1/2012 (deployment) to 19:00UTC 1/2/2012.

7   Vessel-Mounted Acoustic Doppler Current Profiler

(Herbert Huppert)

A 75 kHz RD Instruments Ocean Surveyor (OS75) ADCP was installed onboard RRS James Clark Ross in August 2005. It is capable of profiling to comparatively deep water levels of up to 800 m depth in the type of conditions the JCR is likely to encounter. Under ideal conditions, i.e. bubble-free water, low noise, good scattering, it should even be able to reach 1000 m. It can be run in broadband or narrowband modes, providing the choice of very high-resolving shallow profiles or less resolving deep profiles.

7.1   Instrument and software

The OS75 is sited in the transducer well in the hull of the JCR. The well is flooded with 90% de-ionised water and 10% monopropylene glycol. The transducer is at a depth of 6.3 m, but that value can change slightly depending on ship load. It is aligned at approximately 60 degrees, thus differing from the recommended 45 degrees. The instrument is controlled using the RDI VmDas v. 1.42 software, which is installed on the ADCP-PC in the UIC.
Further detail can be obtained from there.

7.2   Data

We were not able to process shipboard ADCP data on board, due to changes within the ADCP data format that were previously not encountered. The data it self does look good, though in a different format. This was likely due to changes in the ship hydrographic Krill survey undertaken.

8 Underway Observations

8.1 Bathymetry
(Alan Jamison)

There are 2 streams for bathymetry: sim500 and prodep. Prodep is an old piece of software and so we had to ask IT to set it up for us everyday to download, this meant we had to wait around a day afterwards to use the prodep stream. The sim500 was much faster and so could be downloaded everyday.

Using the scripts "get_sim500" and "sim500" and entering the required Julian day allowed us to download the data for that particular day, they were automatically saved as "(pro)bathy.julianday". The data was then converted into MatLab files using the programs "loadbathy.m" and "loadprodep.m" which would put the data in the work space, from there it was saved as "(pro)bathy.julianday.mat". Once all data from all days had been collected they were combined using the programs "saveall(pro)bathy2012". The complete data was then saved as "(pro)bathymetry.mat" and contained newtime, big time and depth. Unlike the ADELIE cruise the sim500 data could not be corrected using a linear relationship, instead the average speed of sound was used to correct data.

In order to use the bathymetry to get the CTD stations we first despiked the data using the program "grapheditbath2012", after running this operation the new data was saved as "despiked(pro)bath.mat". Using the new despiked data meant we could then run "getdepthsctd(_pro)2012" which required the times of descent and ascent of the CTD. This program would output "CTDdepths" and "CTDdeploytimes" and save them under "depthsCTD.mat". The CTD depths could also be calculated using the program "sw_dpth" which used the pressure and latitude at the CTD station, this information was stored in "CTDstnpressnlat".

Using data collected from navigation we combined the bathymetry and navigation into the one MatLab file. The latitude and longitude are saved as "specific" to correspond with the times of bathymetry, navigation ran a bit before we set sail so the data had to be cut a bit.

9 Oceanlogger
(Celine Heuze)

The "/users/jr255/oceanlogger/JR255_oceanlogging.m" script on the JRLC server (written by Bastien Queste) was run automatically every hour at quarter past to update the file "JR255_oceanlogger.mat".
This routine first creates the query file "transects.csv" which contains a GMT start and end time. It takes either the first date recorded by the oceanlogger (18:36 17/01/2012) or the last date stored in the "JR255_oceanlogger.mat" file (if present) as a start time. It takes the current time as an end time. It also specifies the output file for the raw extracted data in CSV format (jr255.csv).

The file "transects.csv" is then used by BAS IT Jeremy Robst's perl script "/packages/dps/current/utils/dps.pl" to obtain the variables from the oceanlogger, the ship's navigation and the anemometer defined in the file "jr255.xml", with data1 and data2 both being measured on the mast (data2 is measured in case data1 is wrong):
Timestamp: date and GMT time of the measure
lat: latitude in decimal degrees North
lon: longitude in decimal degrees East
speed: speed of the ship in Nm

heading: heading of the ship in decimal degrees
airtemp1 and airtemp2: air temperature in Celsius degrees
humidity1 and humidity2: humidity in RH%
par1 and par2: photosynthesis active radiation in µmol/s.m²
tir1 and tir2: solar radiation in W/m²
baro1 and baro2: barometric pressure in hPa
tstemp: salinity sample temperature in Celsius degrees
conductivity: conductivity of the water in S/m
salinity: salinity of the water in psu
sound_velocity: velocity of the sound in m/s
chlorophyll: chlorophylle deduced from the measure of the fluorescence, in µg/L
sampletemp: fluorometer sample temperature in Celsius degrees
flowrate: flowrate in L/mn of the underway sampling system, set to 0.6L/mn
sstemp: sea surface temperature in Celsius degrees
anemometer-wind_dir: direction of the wind relative to the ship in degrees
 anemometer-wind_speed: speed of the wind relative to the ship in Nm
The routine JR255_oceanlogging.m then calculates the "true wind", i.e relative to the ground. All those data are saved in JR255_oceanlogger.mat.

Before mapping the results, the outliers are removed from the data: choosing a big enough threshold T (e.g. 20), for each parameter we calculate x1 –value of the parameter corresponding to the Tth percentile- and x2 –for the 100-T th percentile. With SF being the scaling factor, set to 7 after testing different ones, we consider as an outlier and set to NaN each value x such as :

$$x < x_1 - SF*(x_2 - x_1)$$
$$OR \quad x > x_2 + SF*(x_2 - x_1)$$

Data points where the flow rate was inferior to 0.55 L/mn were discarded. Finally, all the parameters (without the outliers) are plotted on a map of the region, also including the bathymetry, called Figures/XXX_map.png (with the name of the parameter instead of XXX), while their timeseries are plotted on Figures/XXX_plot.png (see example as figure 1).

10 Ocean Chemistry Measurements

10.1 Nitrous oxide N$_2$O: Sampling for stable isotope analysis and continuous concentration measurements in the surface ocean

(Imke Grefe)
Supervisors: Jan Kaiser, Paul Dennis, Alina Marca (UEA, UK), Thomas Röckmann (University Utrecht, Netherlands)

10.1.1 Background and Objective
Nitrous oxide N2O is an important greenhouse gas and precursor of ozone depleting substances in the stratosphere. Natural sources of this trace gas are bacterial nitrification and denitrification. Stable isotope signatures can be useful tracers of biological cycling and the excess of the heavy oxygen isotope 17O (Δ17O) in N2O is a potential tracer of bacterial sources. Measuring the Δ17O signal in marine samples could help constraining the contribution of the ocean to the global N2O budget. The Southern Ocean is a highly dynamic area of the global overturning circulation where older water masses are upwelled and new deepwater is generated. Those settings allows for sampling of various water masses, which can then be compared for their N2O stable isotope composition.

Another approach of investigating the role of the oceans is comparing concentrations of dissolved N2O in the surface ocean with the background signal in the marine air. Air-sea gas exchange calculations give insight in the amount of flux in- and out of the ocean.

10.1.2 Sampling and Measurements

The work from the previous cruise (JR260B) was continued. Water samples for stable isotope analysis were taken from CTD casts on and off the shelf (table 7, figure 25). It was also attempted to samples stations close to the Antarctic Coastal Current, the Antarctic Slope Front and the Weddell Front as described in Thompson and Heywood (2008). Furthermore, samples were taken from a cast at the edge of the eddy forming off the tip of the Antarctic Peninsula. Three to five depths were sampled, focussing on changes in the oxygen profile. Enhanced N2O production from nitrification is expected in zones of lower oxygen concentrations. Isotope signatures of those production regions will be compared to surface samples from 10 m depths which are expected to be in equilibrium with the atmosphere. It was also tried to sample different water masses, identified by changes in temperature and salinity. Samples were drawn bubble-free from Niskin bottles in 550 ml glass flasks, allowing the water to overflow three times the sample volume to avoid contamination from the atmosphere. Sample flasks were closed gas-tight with a butyl rubber stopper and aluminium crimp seals. To stop biological activity until analysis, 1 ml of mercuric chloride were added. 1 ml of helium was injected to avoid potentially compromising the seal when water warms up and expands. The gas headspace expands and compresses without building up as much pressure as a liquid.
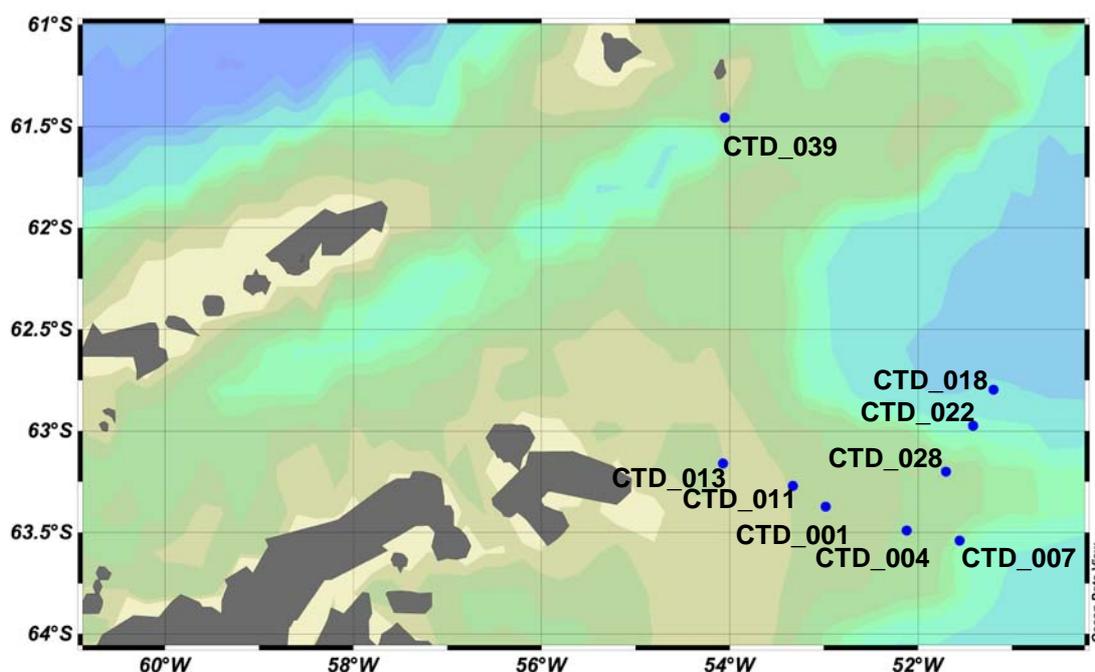
Figure 25: Map of CTD stations sampled for N2O stable isotope analysis.

Table 7: CTD casts sampled for N2O stable isotope analysis. Each sample consists of three sub-samples, ~ 550 ml each. Samples will be analysed after return of the ship to the UK at the stable isotope lab SIL at the University of East Anglia UEA.

CTD number	Bottle number	Depth	Sample ID		
CTD_001	1	447	JR255A-1	JR255A-2	JR255A-3
	4	250	JR255A-4	JR255A-5	JR255A-6
	7	150	JR255A-7	JR255A-8	JR255A-9
	12	60	JR255A-10	JR255A-11	JR255A-12
	17	10	JR255A-13	JR255A-14	JR255A-15

CTD_004	1	914	JR255A-16	JR255A-17	JR255A-18
	4	400	JR255A-19	JR255A-20	JR255A-21
	6	200	JR255A-22	JR255A-23	JR255A-24
	11	80	JR255A-25	JR255A-26	JR255A-27
	16	20	JR255A-28	JR255A-29	JR255A-30
CTD_007	1	1990	JR255A-31	JR255A-32	JR255A-33
	5	500	JR255A-34	JR255A-35	JR255A-36
	7	150	JR255A-37	JR255A-38	JR255A-39
	9	100	JR255A-40	JR255A-41	JR255A-42
	16	10	JR255A-43	JR255A-44	JR255A-45
CTD_011	1	399	JR255A-46	JR255A-47	JR255A-48
	4	250	JR255A-49	JR255A-50	JR255A-51
	6	150	JR255A-52	JR255A-53	JR255A-54
	10	70	JR255A-55	JR255A-56	JR255A-57
	15	10	JR255A-58	JR255A-59	JR255A-60
CTD_013	1	1990	JR255A-61	JR255A-62	JR255A-63
	4	500	JR255A-64	JR255A-65	JR255A-66
	11	150	JR255A-67	JR255A-68	JR255A-69
CTD_018	5	3000	JR255A-70	JR255A-71	JR255A-72
	7	2200	JR255A-73	JR255A-74	JR255A-75
	12	300	JR255A-76	JR255A-77	JR255A-78
	15	100	JR255A-79	JR255A-80	JR255A-81
	22	10	JR255A-82	JR255A-83	JR255A-84
CTD_022	1	2240s	JR255A-85	JR255A-86	JR255A-87
	5	1500	JR255A-88	JR255A-89	JR255A-90
	9	500	JR255A-91	JR255A-92	JR255A-93
	12	250	JR255A-94	JR255A-95	JR255A-96
	17	70	JR255A-97	JR255A-98	JR255A-99
	22	10	JR255A-100	JR255A-101	JR255A-102
CTD_028	1	830	JR255A-103	JR255A-104	JR255A-105
	5	500	JR255A-106	JR255A-107	JR255A-108
	10	130	JR255A-109	JR255A-110	JR255A-111
	12	90	JR255A-112	JR255A-113	JR255A-114
	18	10	JR255A-115	JR255A-116	JR255A-117
CTD_039	2	820	JR255A-118	JR255A-119	JR255A-120
	3	300	JR255A-121	JR255A-122	JR255A-123
	4	150	JR255A-124	JR255A-125	JR255A-126
	6	100	JR255A-127	JR255A-128	JR255A-129
	10	10	JR255A-130	JR255A-131	JR255A-132

Measurements of dissolved N2O in surface waters with the N2O/CO analyser (Los Gatos Research, Inc.) was continued as described previously (JR260B cruise report. The analyser was connected to an equilibrator, as well as to an intake for marine air via a valve board. Measurements were alternated between water from the ship's pumped seawater supply, background concentrations in the air and three references, close to ambient concentrations. Saturation and air-sea gas exchange will be calculated from analyser data, temperature in the equilibrator, sea surface temperature and –salinity from the ship's sensors. Raw data from the analyser will be quality controlled (e.g. flushing time of cavity when switching between gases) and drift corrected after post-cruise calibration of the reference gases against primary standards. Discrete 20 ml samples from the pumped seawater supply were taken and preserved with 3 ml mercuric chloride for analysis with a gas chromatograph connected to an electron capture detector GC-ECD at UEA. Results will be compared to the analyser's measurements.

Table 8: Sampling times for 20 ml seawater samples from pumped supply for GC-ECD measurements and subsequent comparison to laser-based N2O analyser data.

Date	Time (GMT)		Sample ID
	start sampling	stop sampling	
22/1/12	13:18	13:24	JR255A 1a - 1d
25/1/12	21:05	21:10	JR255A 2a - 2d
28/1/12	23:39	23:42	JR255A 3a - 3d
29/1/12	18:16	18:21	JR255A 4a - 4d
30/1/12	13:28	13:32	JR255A 5a - 5d
30/1/12	19:40	19:43	JR255A 6a - 6d

11 Ocean Biology Measurements

11.1 RMT Nets Macrozooplankton
(Sophie Fielding, Damien Guihen, Jeremy Robst)

11.1.1 Gear
The RMT8 was used to characterise the macrozooplankton community in the Weddell sea during JR255a. Two types of RMT8 deployments were undertaken. Target trawls on krill layers identified from the EK60 data or stratified hauls were used where the net was opened at discrete depth horizons from the bottom upwards (200 – 100 and 100 – surface at the eddy). Target hauls were made to supply krill for live incubations, preserved for different projects in Cambridge and for length frequency.

11.1.2 Catch sorting and processing

11.1.3 Stratified and targeted hauls
For the stratified hauls the total catch was sorted and quantified. Numbers caught and total weight was obtained for each species. For some groups specific identification was not possible and identification will be verified through re-examination in the laboratory in either Cambridge or by consulting colleagues specializing in these taxa outside BAS.
The catch of targeted hauls was sorted and quantified. Krill total length was measured on 100 fresh krill, using the standard BAS measurement from the anterior edge of the eye to the tip of the telson, with measurements rounded down to the nearest mm (Morris et al. 1988). Maturity stage was assessed using the scale of Makarov and Denys with the nomenclature described by Morris et al. (1988).
Specimens of Antarctic krill found in the Weddell Sea were collected for genetic and energetic studies and preserved at -80°C or -20°C (Table) from all nets.

Table 9: RMT8 nets

Time	Latitude	Longitude	Event No	Net depth	speed	Action	Comment
23/01/2012 15:30	-63.36	-53.00	2	0.3	3	Net deployed	Test station - lots of marks <40 m
23/01/2012 15:38	-63.36	-52.99	2	25.8	2.8	Net 1 opened	
23/01/2012 15:41	-63.36	-52.99	2	32.8	2.8	Net 1 closed	
23/01/2012 15:42	-63.36	-52.99	2	44.6	2.7	Net 2 opened	
23/01/2012 15:44	-63.37	-52.98	2	0.3	2.7	Net 2 closed	Small krill
23/01/2012 15:49	-63.37	-52.98	2	0.3	2.7	Net recovered	
24/01/2012 01:57	-63.47	-52.30	9	0.6	2.6	Net deployed	Small marks <100m
24/01/2012 02:05	-63.47	-52.29	9	68.3	2.4	Net 1 opened	
24/01/2012 02:20	-63.48	-52.27	9	50	2.2	Net 1 closed	
24/01/2012 02:21	-63.48	-52.27	9	49.2	2.2	Net 2 opened	
24/01/2012 02:36	-63.48	-52.25	9	21.5	2.4	Net 2 closed	

24/01/2012 02:42	-63.48	-52.25	9	0.3	2.5	Net recovered	
25/01/2012 02:03	-63.40	-52.83	40	0.3	2.7	Net deployed	
25/01/2012 02:10	-63.40	-52.83	40	85.5	2.6	Net 1 opened	
25/01/2012 02:25	-63.39	-52.82	40	50.8	2.4	Net 1 closed	
25/01/2012 02:25	-63.39	-52.82	40	53.8	2.3	Net 2 opened	
25/01/2012 02:43	-63.38	-52.81	40	11.8	2.3	Net 2 closed	krill swarms at 0m
27/01/2012 01:34	-62.94	-51.72	70	0.3	2	Net deployed	
27/01/2012 01:40	-62.94	-51.72	70	86.3	2.1	Net 1 opened	
27/01/2012 01:52	-62.95	-51.71	70	50.8	2.1	Net 1 closed	
27/01/2012 01:52	-62.95	-51.71	70	53.8	2	Net 2 opened	
27/01/2012 02:02	-62.95	-51.71	70	39.8	2.1	Net 2 closed	
27/01/2012 02:14	-62.96	-51.71	70	0.3	2.8	Net recovered	
27/01/2012 16:13	-62.92	-51.37	74	0.6	1.8	Net deployed	
27/01/2012 16:21	-62.92	-51.38	74	59.7	1.5	Net 1 opened	
27/01/2012 16:30	-62.92	-51.39	74	45.4	2.3	Net 1 closed	
27/01/2012 16:31	-62.92	-51.39	74	40.3	2.6	Net 2 opened	
27/01/2012 16:41	-62.92	-51.40	74	31.2	2.7	Net 2 closed	
27/01/2012 16:51	-62.92	-51.42	74	0.6	2.4	Net recovered	
27/01/2012 22:44	-62.96	-51.41	78	0.3	3.1	Net deployed	
27/01/2012 22:49	-62.96	-51.40	78	51.1	2.8	Net 1 opened	
27/01/2012 22:54	-62.96	-51.40	78	48.4	2.3	Net 1 closed	
27/01/2012 22:55	-62.96	-51.40	78	48.9	2.3	Net 2 opened	
27/01/2012 22:59	-62.95	-51.40	78	41.9	2.5	Net 2 closed	
27/01/2012 23:06	-62.95	-51.39	78	0.6	2.7	Net recovered	
28/01/2012 18:00	-63.00	-52.92	87	0.6	2.8	Net deployed	
28/01/2012 18:07	-63.00	-52.93	87	100.3	2.4	Net 1 opened	
28/01/2012 18:22	-63.00	-52.95	87	49.2	2.4	Net 1 closed	
28/01/2012 18:22	-63.00	-52.95	87	54.6	2.2	Net 2 opened	
28/01/2012 18:40	-63.01	-52.97	87	11	2.3	Net 2 closed	
28/01/2012 18:47	-63.01	-52.98	87	0.6	2.7	Net recovered	
29/01/2012 12:41	-61.46	-54.04	97	0.3	2.8	Net deployed	
29/01/2012 12:50	-61.46	-54.04	97	197	2	Net 1 opened	
29/01/2012 13:20	-61.48	-54.04	97	103.2	2	Net 1 closed	
29/01/2012 13:25	-61.48	-54.04	97	103.7	2.1	Net 2 opened	
29/01/2012 13:55	-61.50	-54.04	97	12.4	1.8	Net 2 closed	
29/01/2012 14:02	-61.50	-54.04	97	0.6	1.9	Net recovered	
29/01/2012 16:26	-61.77	-54.01	98	0.3	2	Net deployed	Cleaning net
29/01/2012 16:27	-61.77	-54.01	98	14.3	2.2	Net 1 opened	
29/01/2012 16:28	-61.77	-54.01	98	25.5	2	Net 1 closed	
29/01/2012 16:29	-61.77	-54.01	98	23.7	2.2	Net 2 opened	
29/01/2012 16:30	-61.78	-54.01	98	28.8	2	Net 2 closed	
29/01/2012 16:35	-61.78	-54.01	98	0.3	2.5	Net recovered	
29/01/2012 16:48	-61.79	-54.01	99	3	2.3	Net deployed	
29/01/2012 17:00	-61.79	-54.01	99	198.6	2.3	Net 1 opened	
29/01/2012 17:30	-61.81	-54.01	99	99.7	2	Net 1 closed	
29/01/2012 17:31	-61.81	-54.01	99	101.6	2.1	Net 2 opened	
29/01/2012 18:01	-61.83	-54.00	99	14.3	2.2	Net 2 closed	
29/01/2012 18:07	-61.83	-54.00	99	0.3	2.6	Net recovered	
29/01/2012 20:19	-62.16	-53.93	100	12.6	1.6	Net deployed	
29/01/2012 20:28	-62.16	-53.94	100	199.6	1.3	Net 1 opened	
29/01/2012 20:59	-62.16	-53.97	100	100.5	1.9	Net 1 closed	
29/01/2012 21:00	-62.16	-53.98	100	107	2.1	Net 2 opened	
29/01/2012 21:28	-62.16	-54.01	100	18.3	2	Net 2 closed	
29/01/2012 21:32	-62.16	-54.01	100	5.1	2.2	Net recovered	

Table RMT8 contents

Table 10: RMT8 net content

Event	Net	Species	Weight	Total sample wt	no sampled	Storage	Comment

48

2	2	*E. superba*			50	-20	Sample not weighed as half tipped on deck
2	2	*E. superba*			100	-20	
2	1	*E. superba*					Sample discarded
9	2	*E. superba*	1.2		100	20	
9	2	*E. superba*	51.2		100	-20	
9	2	*E. superba*	25.6		50	-20	
9	2	*E. superba*	12799	12927	25250.7		Sample discarded except for 150 g subsample
9	2	*E. superba*	150		293	Formalin	
9	1	*E. superba*	26.5		100	-20	
9	1	*E. superba*	26.5		100	lf	Not kept
9	1	*E. superba*	223	276			Sample discarded
9	1	*E. superba*	109		411		
9	1	*Sagitta maxima*			1		Not kept
9	1	*Polychaeta*			2		Not kept
40	2	*E. superba*	1565	165	2558		
40	2	*E. superba*	61.1764		100	-20	
40	2	*E. superba*	61.1764		100	-20	
40	2	*E. superba*	30.5882		50	-80	
40	2	*E. superba*	156	1626.17647	255	Formalin	subsample from 1565 g
40	2	Amphipod			1	Formalin	
40	2	Ctenophore			2	-20	
40	1	*Thysonessa*			71		Sample discarded
40	1	*E. superba*			7		
40	1	Amphipod			1		
70	1	*E. superba*	26.16279		100	-20	
70	1	*E. superba*	26.16279		100	-20	
70	1	*E. superba*	26.16279		100	-20	Large krill only
70	1	*E. superba*	13.0814		50	-80	
70	1	*E. superba*	9305	9396.56976	35565.7		
70	1	*E.superba*	90		344	formalin	from 9305
70	1	*E.superba*	83			formalin	from 9305
70	2	*E.superba*	14.23611		100	-20	
70	2	*E.superba*	14.23611		100	-20	
70	2	*E.superba*	14.23611		100	-20	
70	2	*E.superba*	7.829861		55	-80	
70	2	*E.superba*	8574	8624.53819	60582.1		
70	2	*E.superba*	41		288	formalin	from 8574
70	2	*E.superba*	61			formalin	from 8574
70	2	*polychaeta*			1	formalin	
70	2	mysids			2	formalin	
74	1	*E.superba*	34.2767		100	discard for lf	
74	1	*E.superba*	34.2767		100	-20	
74	1	*E.superba*	17.1383		50	-80	
74	1	*E.superba*	109	194.691823	318	formalin	
74	1	*Polychaeta*			1	formalin	
74	1	*Spongiabranchia*			1	formalin	
74	2	*E.superba*	61		90	discarded	LF
74	2	*Polychaeta*			2	discarded	

78	1	*E.superba*	17.8010		100	-20	
78	1	*E.superba*	17.8010		100	-20	
78	1	*E.superba*	17.8010		100	-20	large krill
78	1	*E.superba*	8.90052		50	-80	
78	1	*E.superba*	4170	4232.30366	23425.5	discarded	
78	1	*E.superba*	68		382	formalin	sampled from 4170
78	1	*E.superba*	116			formalin	sampled from 4170
78	2	*E.superba*	30.7086		100	-20	
78	2	*E.superba*	30.7086		100	-20	
78	2	*E.superba*	15.3543		50	-80	
78	2	*E.superba*	622	698.771653	2025.48		
78	2	*E.superba*	78		254	formalin	sampled from 622
78	2	*E.superba*	54			formalin	sampled from 622
87	1	*Polychaeta*			4	formalin	
87	1	*Vibillia*			3	formalin	
87	1	*Cyllopus*			4	formalin	
87	1	fish (SSI)			4	-80	
87	1	fish (unknown)			1	-80	
87	1	ctenophore			1	formalin	
87	1	*E. superba*	111		163	formalin	
87	2	*E. superba*	12.9032		100	-20	
87	2	*E. superba*	12.9032		100	-20	
87	2	*E. superba*	6.45161		50	-80	
87	2	*E. superba*	556	588.258064	309	discarded	
87	2	*E. superba*	44		341	formalin	sampled from 556
87	2	*E. superba*	60			formalin	sampled from 556
87	2	*Limacina*			1	-80	
97	1	*Thysanoessa*	26		325	formalin	
97	1	*Diaphus*	20		36	formalin	
97	1	*Sagitta*			22	formalin	
97	1	*E. superba*	8		12	formalin	
97	1	*Squid*			2	formalin	
97	1	*Medusa*			2	formalin	
97	1	*Spongiabranchia*			1	formalin	
97	1	Pteropods			5	formalin	
97	2	*E. superba*	38.6666		100	-20	
97	2	*E. superba*	38.6666		100	-20	
97	2	*E. superba*	38.6666		100	-20	
97	2	*E. superba*	19.3333		50	-80	
97	2	*E. superba*	52024	52159.3333	134544.	discarded	
97	2	*E. superba*	58		150	formalin	
97	2	*E. superba*	135			formalin	
99	1	fish larvae	1		2	formalin	
99	1	*Diaphus*	28		41	formalin	
99	1	Chaetognaths	44		69	formalin	
99	1	*Calycopsis*	16		4	formalin	
99	1	*Primno macropa*			1	formalin	
99	1	*Themisto gaudichaudi*	2		5	formalin	
99	1	*E. superba*			12	formalin	
99	1	Ctenophore			3	formalin	
99	1	*Medusae*			1	formalin	
99	1	*Hyperilla*			1	formalin	

99	1	*Thysanoessa*	14		179	formalin	
99	2	*Salpa*	99			formalin	
99	2	fish larvae	2			formalin	
99	2	pteropods	1			formalin	
99	2	*Spongiabranchia*	1			formalin	
99	2	*Themisto*				formalin	
99	2	*Parandania boecki*				formalin	
99	2	*Hyperiella*				formalin	
99	2	*Orchomone*				formalin	
99	2	amphipods				formalin	
99	2	*E. superba*	5044			discarded	
99	2	*E. superba*	51			formalin	sampled from 5044
99	2	*E. superba*	45		319	formalin	sampled from 5044
100	1	*Thysanoessa*	47		487.625	formalin	8 g contain 83
100	1	*Diaphus*	16		33	formalin	
100	1	*Spongiabranchia*			4	formalin	
100	1	*Salpa*			1	formalin	
100	1	*Medusa*			2	formalin	
100	2	*E. superba*	45		63	formalin	
100	2	*Thysanoessa*	32		420.571	formalin	7 g contains 92
100	2	*Diaphus*			1	formalin	
100	2	*Medusa*			2	formalin	
100	2	*Pteropods*			5	formalin	
100	2	*Spongiabranchia*			1	formalin	
100	2	*Chaetognath*			2	formalin	
100	2	*Themistogaudic haudii*			4	formalin	
100	2	*Hyperiella*			1	formalin	
100	2	*yllopusmagellenicus*			1	formalin	
100	2	*Cyllopus lucasi*			1	formalin	
100	2	*Parandania boecki*			1	formalin	
100	2	fish larvae			1	formalin	

11.2 Krill length frequency, maturity stage and shape

11.2.1 Introduction
Antarctic krill (Euphausia superba) were sampled to determine the variation in the structure of the population in the Weddell sea and to provide parameters required in the target strength model for krill biomass estimation.
Methods
Krill samples were taken from RMT8 samples where there were sufficient numbers of krill to select 100 decent state specimens for length frequency, maturity and krill shape photographs. Krill were laid out on blue plastic boards (in pre-drilled grooves) and photographed using a Nikon DX3 with two flash guns on a stand. The same krill were then measured for length and staged. Krill total length was measured, using the standard BAS measurement from the anterior edge of the eye to the tip of the telson, with measurements rounded down to the nearest millimetre (Morris et al. 1988). Maturity stage was assessed using the scale of Makarov and Denys with the nomenclature described by Morris et al. (1988).

11.2.2 Data

Krill length frequency data were input into a spread sheet on the L drive "JR255a_krill_length_frequencies.xls. The Net event numbers from which krill were measured and whether they were photographed is identified in Table 11 with the mean length of those events and the data is displayed in Figure 26

Table 11: krill_lf

Event Number	Net Number	Photo	Mean Length (mm)
2	1	Y	25.2
2	2	Y	22.6
9	1	Y	33.0
9	2	Y	39.9
40	2	Y	40.7
70	1	Y	31.4
74	1	Y	38.6
74	2	Y	31.4
78	1	Y	26.0
78	2	Y	34.0
87	1	Y	40.6
87	2	Y	24.3
97	2	Y	41.6
99	1	Y	26.7

Krill length frequency JR255a
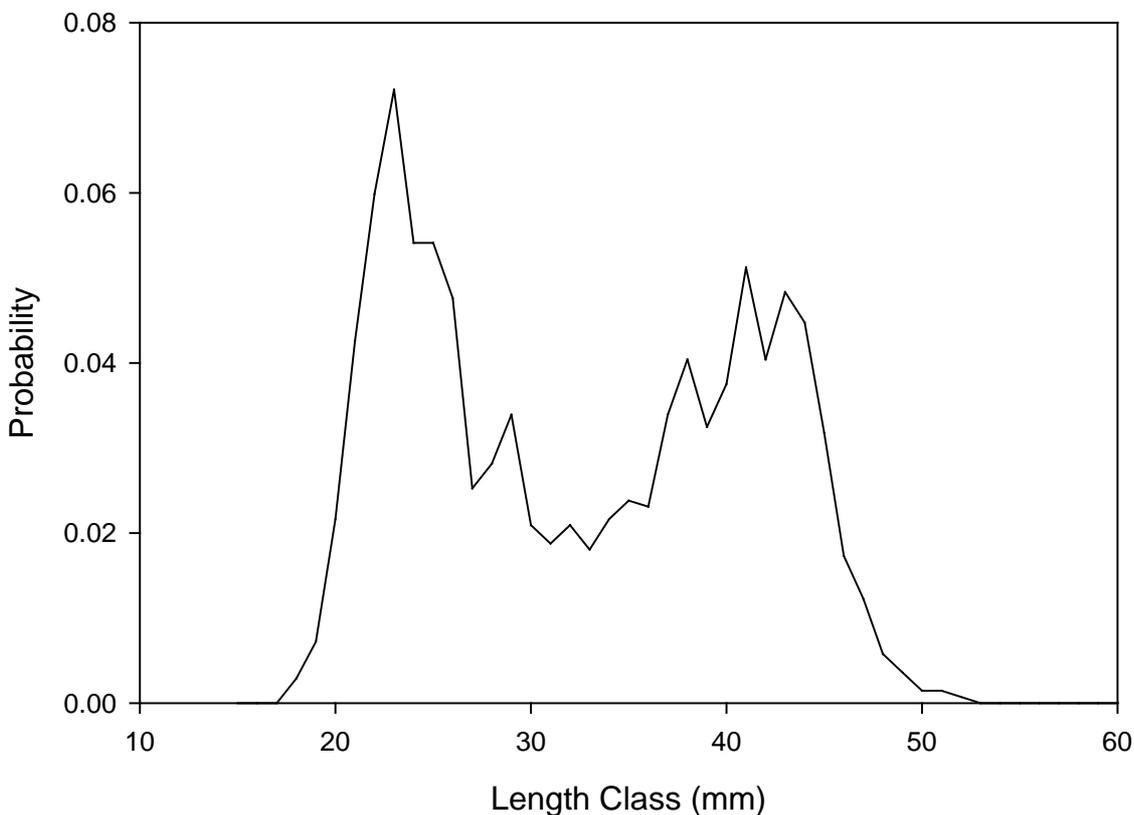
Figure 26: Krill length probability density function from all stations

11.2.3 Photography of krill samples

Photographs of krill samples were taken for use in the development in a computerised approach to calculating the shape of krill to better inform a krill target strength model.
Krill were arranged on plastic boards, typically in five rows of five. The boards were a medium to dark blue colour, intended to optimize the contrast with the krill bodies. Five grooves were

machine-melted into the boards. Melting was preferable to cutting as it reduced the scattering of light from rough edges.

A Nikon D3X with an attach Nikon 60 mm macro lens and Hoya Skylight filter was mounted level, above the board such that the board was almost filling the field of view (Figure 27a). Two magnetically mounted flash guns were positioned low, either side of the board (Figure 27b), approximately 1 m apart and connected to the camera.

The camera was set in Manual mode with an aperture of F25 and an exposure of 1/125.
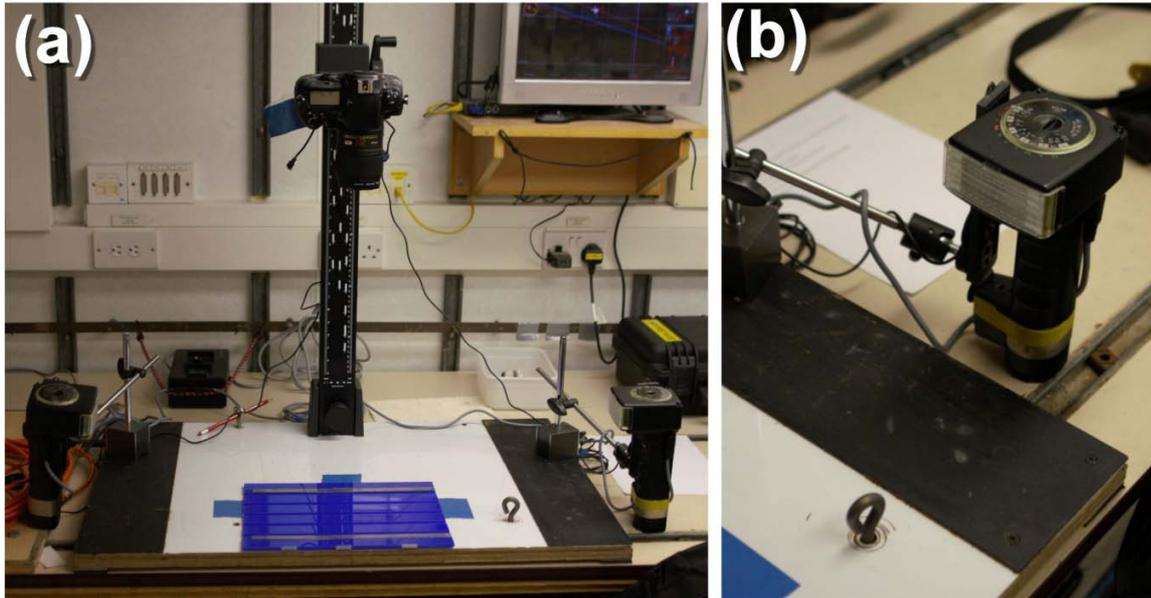
Figure 27 (a) Krill photography setup with magnetically mounted flash guns, camera stand and krill board. (b)

The photos were downloaded directly from the camera, catalogued and renamed to include the cruise number and image sequence. A list of the photographs and details of the associated event number, date etc. is included in Table krill_photos. An example photograph is shown in Figure 28.
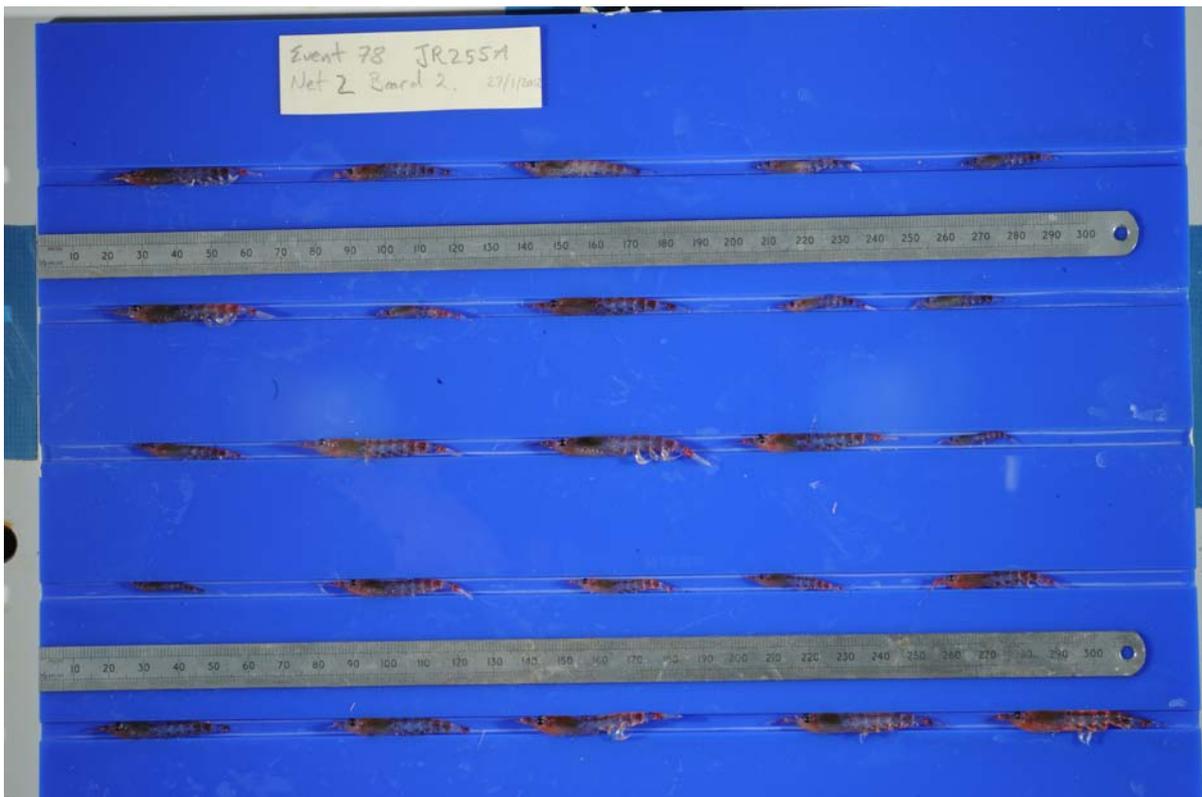
Figure 28:. Example of lateral view of a typical sample board.

Table 12: krill_photos. Details of photographs taken of krill samples.

| Image	Date	Event	Net	Board	View
JR255A_krill_image_1.JPG	23/01/2012	2	1	1	Lateral
JR255A_krill_image_2.JPG	23/01/2012	2		2	Lateral
JR255A_krill_image_3.JPG	23/01/2012	2	2	1	Lateral
JR255A_krill_image_4.JPG	23/01/2012	2	2	2	Lateral
JR255A_krill_image_5.JPG	24/01/2012	9	2	1	Dorsal
JR255A_krill_image_6.JPG	24/01/2012	9	2	1	Lateral
JR255A_krill_image_7.JPG	24/01/2012	9	2	2	Dorsal
JR255A_krill_image_8.JPG	24/01/2012	9	2	2	Lateral
JR255A_krill_image_9.JPG	24/01/2012	9	2	3	Dorsal
JR255A_krill_image_10.JPG	24/01/2012	9	2	3	Lateral
JR255A_krill_image_11.JPG	24/01/2012	9	2	4	Dorsal
JR255A_krill_image_12.JPG	24/01/2012	9	2	4	Lateral
JR255A_krill_image_13.JPG	24/01/2012	9	1	1	Dorsal
JR255A_krill_image_14.JPG	24/01/2012	9	1	1	Lateral
JR255A_krill_image_15.JPG	24/01/2012	9	1	2	Dorsal
JR255A_krill_image_16.JPG	24/01/2012	9	1	2	Lateral
JR255A_krill_image_17.JPG	24/01/2012	9	1	3	Dorsal
JR255A_krill_image_18.JPG	24/01/2012	9	1	3	Lateral
JR255A_krill_image_19.JPG	24/01/2012	9	1	4	Dorsal
JR255A_krill_image_20.JPG	24/01/2012	9	1	4	Lateral
JR255A_krill_image_21.JPG	25/01/2012	40	2	1	Dorsal
JR255A_krill_image_22.JPG	25/01/2012	40	2	1	Lateral
JR255A_krill_image_23.JPG	25/01/2012	40	2	2	Dorsal
JR255A_krill_image_24.JPG	25/01/2012	40	2	2	Lateral
JR255A_krill_image_25.JPG	25/01/2012	40	2	3	Dorsal
JR255A_krill_image_26.JPG	25/01/2012	40	2	3	Lateral
JR255A_krill_image_27.JPG	25/01/2012	40	2	4	Dorsal
JR255A_krill_image_28.JPG	25/01/2012	40	2	4	Lateral
JR255A_krill_image_29.JPG	27/01/2012	70	1	1	Dorsal
JR255A_krill_image_30.JPG	27/01/2012	70	1	1	Lateral
JR255A_krill_image_31.JPG	27/01/2012	70	1	2	Dorsal
JR255A_krill_image_32.JPG	27/01/2012	70	1	2	Lateral
JR255A_krill_image_33.JPG	27/01/2012	70	1	3	Dorsal
JR255A_krill_image_34.JPG	27/01/2012	70	1	3	Lateral
JR255A_krill_image_35.JPG	27/01/2012	70	1	4	Dorsal
JR255A_krill_image_36.JPG	27/01/2012	70	1	4	Lateral
JR255A_krill_image_37.JPG	27/01/2012	70	2	1	Dorsal
JR255A_krill_image_38.JPG	27/01/2012	70	2	1	Lateral
JR255A_krill_image_39.JPG	27/01/2012	70	2	2	Dorsal
JR255A_krill_image_40.JPG	27/01/2012	70	2	2	Lateral
JR255A_krill_image_41.JPG	27/01/2012	70	2	3	Dorsal
JR255A_krill_image_42.JPG	27/01/2012	70	2	3	Lateral
JR255A_krill_image_43.JPG	27/01/2012	70	2	4	Dorsal
JR255A_krill_image_44.JPG	27/01/2012	70	2	4	Lateral
JR255A_krill_image_45.JPG	27/01/2012	74	2	1	Dorsal
JR255A_krill_image_46.JPG	27/01/2012	74	2	1	Lateral
JR255A_krill_image_47.JPG	27/01/2012	74	2	2	Dorsal
JR255A_krill_image_48.JPG	27/01/2012	74	2	2	Lateral
JR255A_krill_image_49.JPG	27/01/2012	74	2	3	Dorsal
JR255A_krill_image_50.JPG	27/01/2012	74	2	3	Lateral
JR255A_krill_image_51.JPG	27/01/2012	74	2	4	Dorsal
JR255A_krill_image_52.JPG	27/01/2012	74	2	4	Lateral
JR255A_krill_image_53.JPG	27/01/2012	74	1	1	Dorsal
JR255A_krill_image_54.JPG	27/01/2012	74	1	1	Lateral
JR255A_krill_image_55.JPG	27/01/2012	74	1	2	Dorsal
JR255A_krill_image_56.JPG	27/01/2012	74	1	2	Lateral
JR255A_krill_image_57.JPG	27/01/2012	74	1	3	Dorsal
JR255A_krill_image_58.JPG	27/01/2012	74	1	3	Lateral
JR255A_krill_image_59.JPG	27/01/2012	74	1	4	Dorsal

JR255A_krill_image_60.JPG	27/01/2012	74	1	4	Lateral
JR255A_krill_image_61.JPG	27/01/2012	78	1	1	Dorsal
JR255A_krill_image_62.JPG	27/01/2012	78	1	1	Lateral
JR255A_krill_image_63.JPG	27/01/2012	78	1	2	Dorsal
JR255A_krill_image_64.JPG	27/01/2012	78	1	2	Lateral
JR255A_krill_image_65.JPG	27/01/2012	78	1	3	Dorsal
JR255A_krill_image_66.JPG	27/01/2012	78	1	3	Lateral
JR255A_krill_image_67.JPG	27/01/2012	78	1	4	Dorsal
JR255A_krill_image_68.JPG	27/01/2012	78	1	4	Lateral
JR255A_krill_image_69.JPG	27/01/2012	78	2	1	Dorsal
JR255A_krill_image_70.JPG	27/01/2012	78	2	1	Lateral
JR255A_krill_image_71.JPG	27/01/2012	78	2	2	Dorsal
JR255A_krill_image_72.JPG	27/01/2012	78	2	2	Lateral
JR255A_krill_image_73.JPG	27/01/2012	78	2	3	Dorsal
JR255A_krill_image_74.JPG	27/01/2012	78	2	3	Lateral
JR255A_krill_image_75.JPG	27/01/2012	78	2	4	Dorsal
JR255A_krill_image_76.JPG	27/01/2012	78	2	4	Lateral
JR255A_krill_image_77.JPG	28/01/2012	87	2	1	Dorsal
JR255A_krill_image_78.JPG	28/01/2012	87	2	1	Lateral
JR255A_krill_image_79.JPG	28/01/2012	87	2	2	Dorsal
JR255A_krill_image_80.JPG	28/01/2012	87	2	2	Lateral
JR255A_krill_image_81.JPG	28/01/2012	87	2	3	Dorsal
JR255A_krill_image_82.JPG	28/01/2012	87	2	3	Lateral
JR255A_krill_image_83.JPG	28/01/2012	87	2	4	Dorsal
JR255A_krill_image_84.JPG	28/01/2012	87	2	4	Lateral
JR255A_krill_image_85.JPG	28/01/2012	87	1	1	Dorsal
JR255A_krill_image_86.JPG	28/01/2012	87	1	1	Lateral
JR255A_krill_image_87.JPG	28/01/2012	87	1	2	Dorsal
JR255A_krill_image_88.JPG	28/01/2012	87	1	2	Lateral
JR255A_krill_image_89.JPG	28/01/2012	87	1	3	Dorsal
JR255A_krill_image_90.JPG	28/01/2012	87	1	3	Lateral
JR255A_krill_image_91.JPG	28/01/2012	87	1	4	Dorsal
JR255A_krill_image_92.JPG	28/01/2012	87	1	4	Lateral
JR255A_krill_image_93.JPG	29/01/2012	97	2	1	Dorsal
JR255A_krill_image_94.JPG	29/01/2012	97	2	1	Lateral
JR255A_krill_image_95.JPG	29/01/2012	97	2	2	Dorsal
JR255A_krill_image_96.JPG	29/01/2012	97	2	2	Lateral
JR255A_krill_image_97.JPG	29/01/2012	97	2	3	Dorsal
JR255A_krill_image_98.JPG	29/01/2012	97	2	3	Lateral
JR255A_krill_image_99.JPG	29/01/2012	97	2	4	Dorsal
JR255A_krill_image_100.JPG	29/01/2012	97	2	4	Lateral
JR255A_krill_image_101.JPG	29/01/2012	99	2	1	Dorsal
JR255A_krill_image_102.JPG	29/01/2012	99	2	1	Lateral
JR255A_krill_image_103.JPG	29/01/2012	99	2	2	Dorsal
JR255A_krill_image_104.JPG	29/01/2012	99	2	2	Lateral
JR255A_krill_image_105.JPG	29/01/2012	99	2	3	Dorsal
JR255A_krill_image_106.JP	29/01/2012	99	2	3	Lateral
JR255A_krill_image_107.JPG	29/01/2012	99	2	4	Dorsal
JR255A_krill_image_108.JPG	29/01/2012	99	2	4	Lateral

11.3 Acoustic instrumentation
(Sophie Fielding)

11.3.1 Introduction
The EK60 was run throughout JR255A to collect information on the horizontal and vertical distribution of krill and to derive estimates of krill biomass for the Weddell Sea

11.3.2 Aim
Collection of acoustic data throughout cruise to validate glider acoustics
Backup and process the acoustic data

Methods/System specification
Software versions
Simrad ER60 v. 2.2.1
Sonardata Echolog 60 v 4.10.1.6230
Sonardata Echoview v 4.20.59.8698 Live viewing
Sonardata Echoview v 4.20.59.8698 Processing

HASP Dongle BAS3 licensed for base, bathymetry, analysis export, live viewing, school detection and virtual echogram was used to run the echolog and echoview in live viewing mode. The echosounder pc AP10 and the EK60 workstation 2 are integrated into the ship's LAN. ER60 .raw data files were logged to a Sun workstation jrua, using a Samba connection, which is backed up at regular intervals. All raw data were collected to 1000 m. Echolog was run on workstation 2 and wrote compressed files also directly to the Sun workstation via a Samba connection.

11.3.3 Echolog compression settings
Final compression settings used in Echolog for all frequencies were:
Power data only (angle data is still available from the raw files)
From 0 - 500 m (38 kHz), 0 – 500 (120 kHz) and 0 – 500 (200 kHz) data only (data from greater depths are available from the raw files)
Average samples where both Sv below –100 dB and TS below –20 dB
 Maximum number of samples to average: 50
DO NOT use average samples below echosounder detected bottom unless sure of bottom detection

11.3.4 File locations
All raw data were saved in a general folder JR255A\raw, all echolog data were saved in the folder JR255A\ek6. All files were prefixed with JR255. Calibration data were additionally saved to the calibration folder.

11.3.5 EK60 (ER60) settings
The EK60 was run from the beginning of the cruise utilising the recent calibration values from Stromness 7th January calibration. In addition the EK60 was calibrated in the Weddell sea region on the ?th of January. Data were collected using the calibration settings from Stromness throughout the cruise (Table 13: default settings)

Table 13: default settings

Variable	38 kHz	120 kHz	200 kHz
Ping interval (per sec)	2	2	2
Sound velocity (m/s)	1462	1462	1462
Mode	Active	Active	Active
Transducer type	ES38	ES120-7	ES200-7
Transceiver Serial no.	009072033fa5	00907203422d	009072033f91
Transducer depth (m)	0	0	0
Absorption coef. (dB/km)	10.3802	27.7924	41.1059
Pulse length (ms)	1.024	1.024	1.024
Max Power (W)	2000	500	300
2-way beam angle (dB)	-20.70	-20.70	-19.60
Sv transducer gain (dB)	25.51	22.15	23.61
Sa correction (dB)	-0.51	-0.41	-0.22
Angle sensitivity along	22	21	23
Angle sensitivity athwart	22	21	23
3 dB Beam along	7.0	7.0	8.0
3 dB Beam athwart	7.1	7.1	7.90
Along offset	0	0	0
Athwart offset	0	0	0

The EK60 was synchronised with the other acoustic instruments through the SSU. The ADCP was run throughout the cruise pinging at a rate twice as slow as the EK60 and the EM122 was switched on occasionally to provide more correct bottom data for the CTD, also interfaced through the SSU. The groups run were in biology mode. When the EM122 was off using the group EM&EA&EK&ADCP and when the EM122 was on in deep water EM&EA EK&AD (5 EK60 pings to 1 EM ping) or EA&EM EK&AD (10 EK60 pings to 1 EM ping) depending on the ping rate required for the EM122.

SSU settings
EA600	external trigger	Fixed length 1 s
EM122	external trigger	Fixed length 1 s
EK60	external trigger	Calculated	(Set to 2 seconds in ER60 software)
ADCP	external trigger	Tx pulse	(this setting only works if the bottom tracking mode is off)

11.3.6 EK60 Calibration
There are few places in the Weddell sea suitable for calibrating the EK60. The shelf environment was quite tidal and unsuitable, in addition time constraints prevented exploration of suitable sites further south. In the end an acoustic calibration was undertaken in the lee of an iceberg in approximately 800m of water commencing at 01:30 GMT 26/01/2012. The movement of the ship was balanced by minimal use of the ships DP system. The EK60 was triggered through the SSU with a 1 second ping rate and the EA600 and ADCP were switched off. Standard ER60 calibration procedures were used as documented for previous cruises, in this case a tungsten carbide sphere was utilised so that only one sphere was required under the ship.

A CTD was undertaken immediately prior to the calibration. Temperature and salinity were averaged from 6 (depth of the transducers) to 30 m (depth of the calibration sphere) and were -0.11°C and 34.28 PSU resulting in a speed of sound constant of 1448 m/s (Kongsberg software calculation). The speed of sound was updated into the ER60 software.

Parameters from the ER60 lobes calibration were not updated onto the ER60 software (Table calibrated settings), and will only be used for processing.

Table 14: Calibrated settings

Date (dd/mm/yyyy)	26/01/2012	26/01/2012	26/01/2012
Location	In lee of Ice berg	In lee of Ice berg	In lee of Ice berg
Time (GMT)	04:30	01:30	03:30
Frequency (kHz)	38	120	200
GPT serial no	009072033fa5	00907203422d	9072033191
Comments	EA600 on	EA600 on	EA600 on
Water temperature (°C)	-0.11	-0.11	-0.11
Salinity (PSU)	34.28	34.28	34.28
Sound velocity (m/s)	1448	1448	1448
Absorption coeff (dB/km)	10.376	26.083	40.193
Ping rate (sec^{-1})	1	1	1
Transmit Power (W)	2000	500	300
Pulse length (ms)	1.024	1.024	1.024
Bandwidth (kHz)	2.43	3.03	3.09
Sample Interval (m)	0.186	0.186	0.186
Original gain (dB)	25.51	22.15	23.61
Original Sa correction (dB)	-0.51	-0.41	-0.22
Theoretical TS of sphere (dB)	-42.06	-39.87	-39.42
New gain (dB)	25.7	21.57	23.17
New Sa correction (dB)	-0.48	-0.39	-0.25

11.4 Phytoplankton Analysis

Jill Peloquin and Daniel Kaufman

Measurements relating to phytoplankton composition and variability were made by sampling of seawater from the rosette as well as the JCR's underway system. Seawater was collected via the rosette at varying depths (most commonly 5, 10, 20, 40, 50, 60, 80, 100, 150, and 200m. For specific depths collected see individual station log sheets and Table 15) down to a maximum of 200m. Samples were transferred directly from Niskin bottles to amber polycarbonate bottles and filtered at pressures between 7-10 in Hg. Measurements of biogenic silica were filtered at a higher pressure (ca. 15 in Hg). All samples stored will be run at the Virginia Institute of Marine Science.

Table 15:. Summary of sampling

Station #	Chlorophyll a	HPLC	POC/PON	Biogenic Si	Microscopy Slides
001	X	X	X	X	X
002	X	X	X	X	X
003	X	X	X	X	X
004*	X	X	X	X	X
005	X	X	X	X	X
006	X	X	X	X	X
007	X	X	X	X	X
008	X	X	X	X	X
009	X				
010	X	X	X	X	X
011	X				
012	X	X	X	X	X
013	X	X	X	X	X
014	X				
015	X	X	X	X	X
016*	X	X	X	X	X
018	X	X	X	X	X
019	X	X	X	X	X
020	X	X	X	X	X
021	X	X	X	X	X
022	X	X	X	X	X
023	X				
024	X	X	X	X	X
025	X				
026	X	X	X	X	X
027	X				
028	X	X	X	X	X
030	X	X	X	X	X
031*	X	X	X	X	X
035*	X	X	X	X	X
039*	X	X	X	X	X

* denotes collection of seawater samples at non-standard depths

11.4.1 Chlorophyll a
A proxy for total phytoplankton biomass

Seawater collected in 250 or 500 mL bottles was passed through GF/F (0.7 µm). Filters were folded in half, placed in cuvettes and were extracted with 5ml of 90% for a 24-hour at -20° C. After extraction, these samples' F0 (unaltered fluorescence) and FA (fluorescence after adding 3 drops of 10% HCl) were measured and logged using a Turner Trilogy Laboratory Fluorometer. The fluorometer was fully calibrated twice over the course of the cruise. Pure spinach extract (1 mg) was added to 50 ml of 90% acetone and a set of nine standards were made. Full calibration of the fluorometer will be completed once the stock spinach standard is read on a UV/vis

spectrophotometer. The two full calibrations compared favorably (Fig 29a) with a R2 value of > 0.99 and a slope near 1 (1.04). The mean k values for calibration 1 and 2 were 0.0017 (±0.0005) and 0.0016 (±0.0005) (Fig 30b).


$y = 1.0377x + 4471.2$
$R^2 = 0.99875$
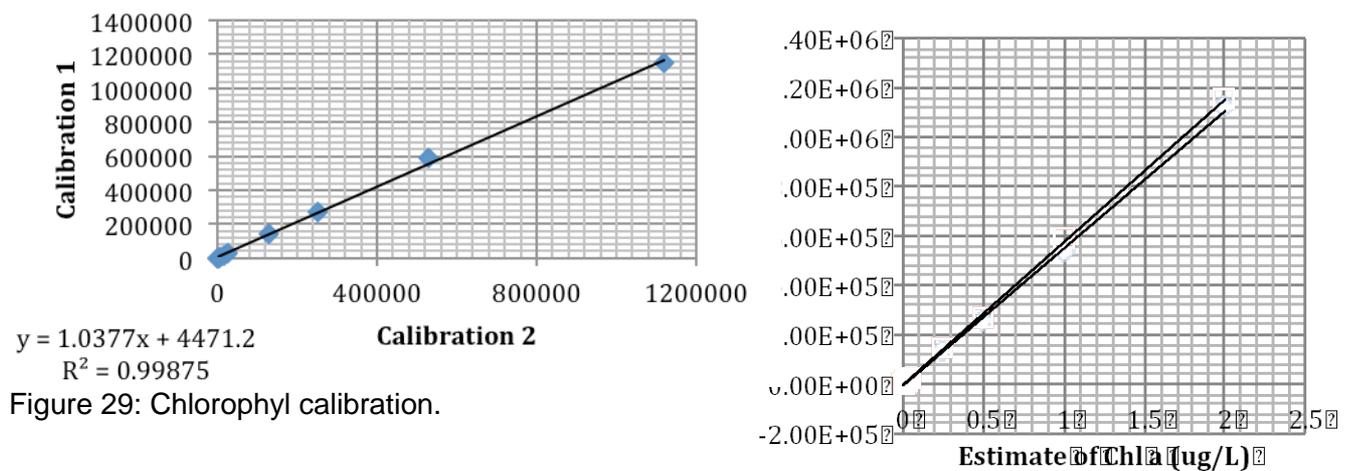
Figure 29: Chlorophyl calibration.

11.4.2 High Performance Liquid Chromatography
Samples allow us to estimate phytoplankton taxonomic composition based on broad groups (ie, diatoms, dinoflagellates)

Seawater collected in 1000 mL bottles was passed through GF/Fs (0.7 μm). These filters were folded in eighths, wrapped in aluminum foil, placed in 2.0mL cryovials, and then stored in a -80° C freezer for post-cruise analysis.

11.4.3 Particulate Organic Carbon / Particulate Organic Nitrogen
Samples allow us to know more about the quality of phytoplankton organic matter.

Seawater collected in 1000 mL bottles was passed through pre-combusted GF/Fs (0.7 μm). Filters were rinsed with 0.01N HCl before removal from the filtration frits. Blanks were created with filtered seawater (0.2 μm gravity filtered from the underway system) and 0.01N HCl through a pre-combusted GF/F filter. The sample filters and blanks were folded in half, placed in pre-combusted cuvettes and covered with pre-combusted aluminum foil. The cuvettes were then stored in a 60° C drying oven and hand carried back to VIMS.

11.4.4 Biogenic Silica
Samples indicate presence/absence of diatoms

Seawater collected in 1000 mL bottles was passed through 0.6μm polycarbonate filters. The funnels were then rinsed with filtered seawater (0.2 μm gravity filtered from the underway system). These filters were folded in quarters, placed in petri dishes, and then stored in a 60° C drying oven. Samples were hand carried back to VIMS.

11.4.5 Direct Counts for microscopy
Samples are for phytoplankton composition down to genus/species

Seawater was collected in 500 mL bottles. 140 mL was decanted into a bottle pre-spiked with 1.4 ml of 25% filtered (0.2 μm) gluteraldehyde. After at least 24 hours, replicate slides were made using a 60 ml aliquot from the sample vessel. Water was filtered onto a prestained black 0.8 μm poretics filter and seated on a pre- moistened 5 μm backing filter. The sample was filtered with low

pressure (< 5 in Hg) down to approximately 5 ml, the pressure seal was broken and 200 μl of DAPI (0.04 mg/ml) was added for two minutes. After two minutes, the sample was filtered completely down and the filter was seated on a slide with immersion oil. Slides were stored in -20˚ C.

11.4.6 PAM
Measurements tell us more about the photochemical efficiency of PSII (an indication of physiological state of the phytoplankton assemblage).

Measurements were made from the shipboard underway system (5 m) and blanked with filtered (< 0.2 μm) seawater every few days. Data collected from the day is highly impacted by solar radiation, thus night time (ca. 21:00 to 04:00) data is more effectively used to better understand photochemical efficiency.

11.4.7 Early results

Three transects of chlorophyll a (uncalibrated μg/L) were analyzed. Emerging features include lower chlorophyll a within the eddy (Figure 30), high biomass on the shelf with a deep (>100 m) chlorophyll signal (Figure 31) and uniformly low biomass in the deeper water transect (Figure 32).
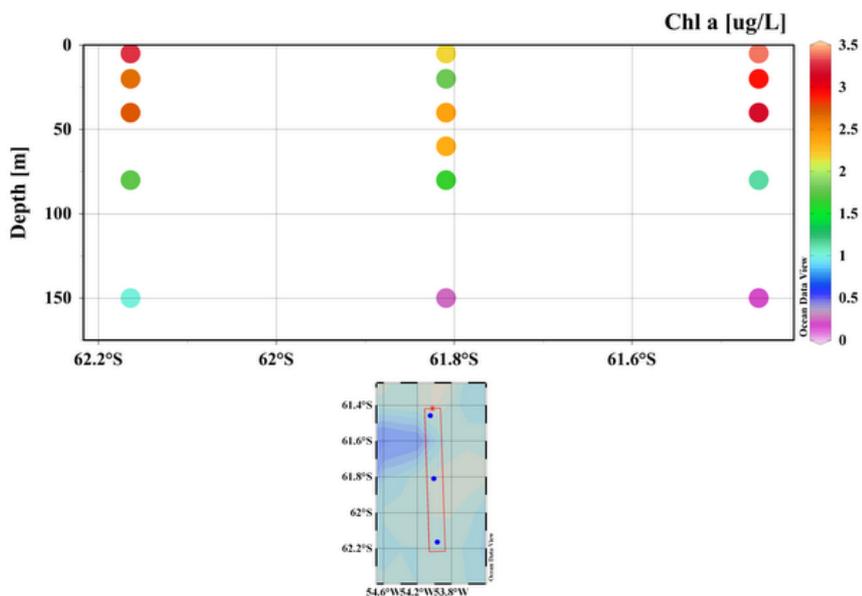
Figure 30. Chlorophyll a (estimated μg/L) for the eddy site.
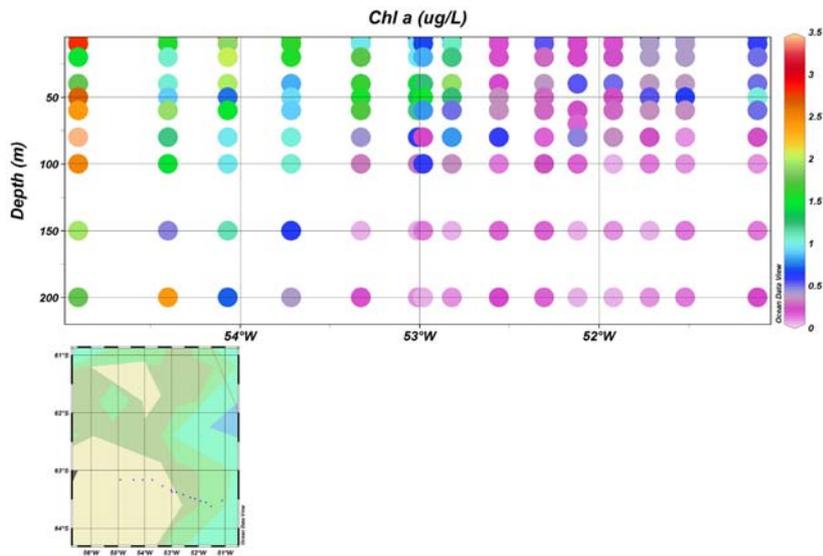
Figure 31. Chlorophyll a (estimated μg/L) for the southerly shallow transect.
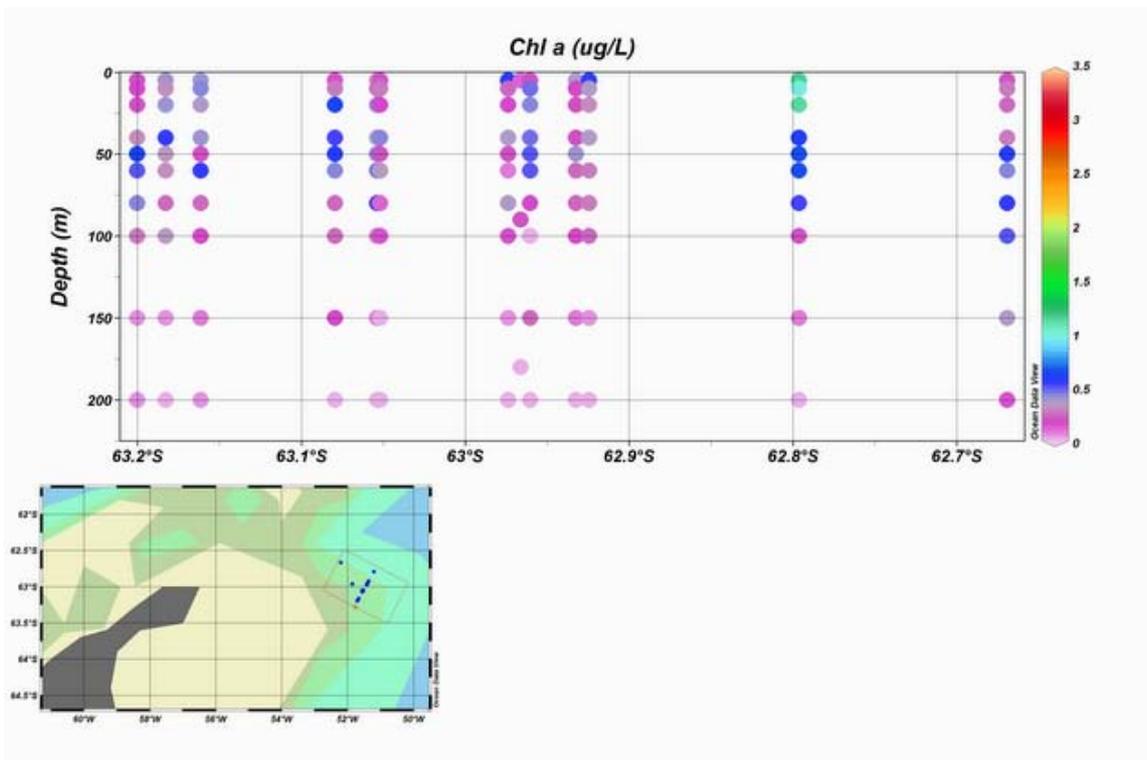
Figure 32 Chlorophyll a (estimated μg/L) for the northern deep water transect.

12 JR255B Recovery cruise

(Gareth Lee)
JR255B February 4th to March 22nd 2012

12.1 Recovery of Seagliders

Three Seagliders were deployed in the Weddell Sea in January 2012. The three gliders deployed were SG522 ('Beluga'), SG539 ('Queequeg') and SG546 ('The Flying Pig'). SG522 and SG539

were deployed on 23rd January 2012 at around midday, at 63°.37S, 52°.98W. SG546 had various faults and was re-deployed in the north-eastern region of the Powell Basin whilst the JCR was returning to Stanley, Falklands at the end of cruise. The piloting of the gliders was carried out by a team of pilots at the University of East Anglia (UEA), iRobot and California Institute of Technology (CALTECH).

The recovery of the gliders was planned as part of cruise JR275/JR259/JR255B which began on 7th February 2012 and finished on 22nd March 2012. An original schedule was released, but later rescheduled following the integration of base closure at Signy into the cruise plan. The rescheduled recovery time for the gliders was from 12th to 17th March following 5 days transit time from Halley Research station. Base closure at Signy was scheduled for 18th March 2012.

GPS/Iridium problems

SG522 and SG546 developed iridium problems during their mission meaning a total loss of communication between pilot and Seaglider. SG522 lost communication on 14th February 2012 13:15 UTC after completing 156 known dives. SG546 lost communication on 28th February 2012 17:19 UTC after completing 210 known dives. Neither Seaglider was recovered.

SG539 maintained communication throughout the entire mission and was successfully recovered on 12th March 2012 after completing 421 dives.

12.2 Recovery of SG539 'Queequeg'

Seaglider SG539 was successfully recovered, at first attempt on 12th March 2012 16:00 UTC. The position of the recovery was 60° 09.9670 S, 50° 54.2780 W. The CTD was deployed upon recovery, to a depth of 400m at the same position. Samples were taken for Salinity, Temperature, Oxygen and Chlorophyll A. This was to calibrate the onboard sensors on integrated into the Seaglider. Once recovered, the Seaglider was thoroughly rinsed with freshwater and dismantled for travel. A self test and simulated dive sequence was initiated and sent back to base-station via iridium communication. These files are for diagnostic purposes when the Seaglider is returned to irobot for battery replacement and servicing.

Recovery of SG539 12th March 2012
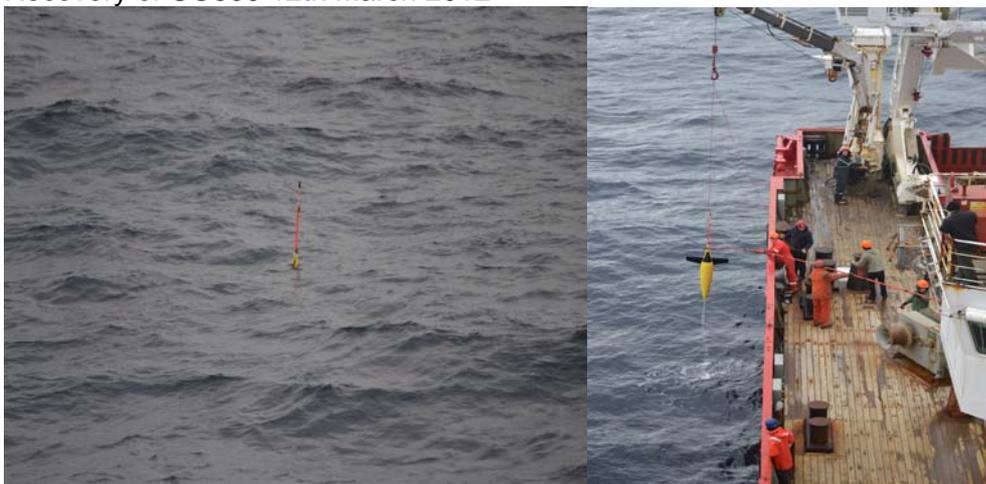
Figure 33: Photos of recovery SG539
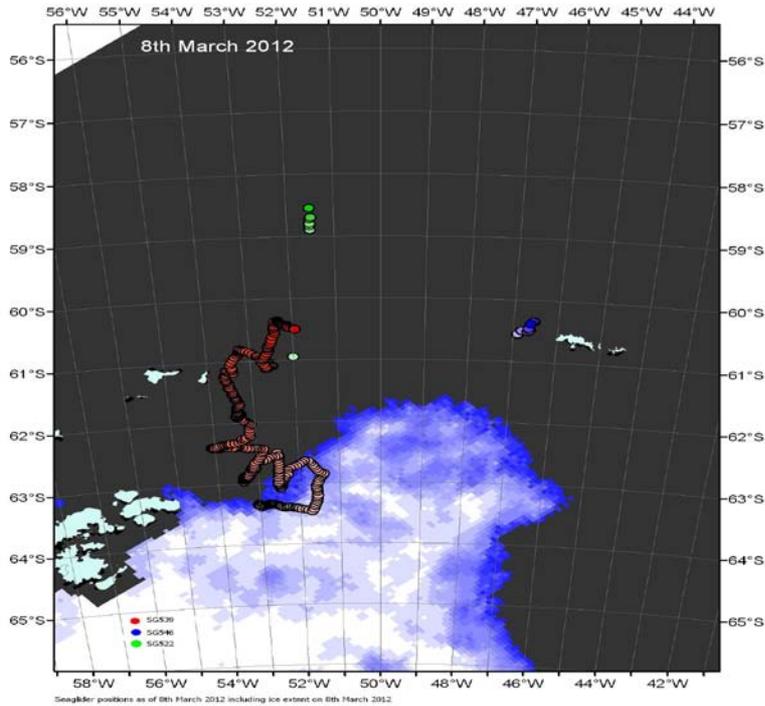
Figure 34. Seaglider positions as of 8th March 2012, with sea-ice extent on 8th March.

12.3 ARGOS positioning

After the failure of GPS positioning and communication with SG522 and SG546, we were entirely dependant on ARGOS positioning for the malfunctioning Seagliders. See section on 6.6 on Argos tags

12.4 Recovery of SG522 'BELUGA'

Recovery of SG522 was inhibited by the fact that iridium communication was lost part way throughout the mission. Recovery attempts were made using the ARGOS positioning but were unsuccessful. Recovery attempts for SG522 were aborted on 14th March 2012 at 13:00 LT (16:00 UTC)
The last command file sent to SG522 (when still communicating) is detailed below

```
Cmdfile.156
$C_ROLL_DIVE,2433
$C_ROLL_CLIMB,2210
$NAV_MODE,0
$HEADING,0
$ALTIM_PING_DEPTH,350
$ALTIM_SENSITIVITY,2
$D_TGT,990
$T_DIVE,280
$T_MISSION,400
$CALL_TRIES,5
$CALL_NDIVES,2
$UPLOAD_DIVES_MAX,1
$T_NO_W,240
$SM_CC,350
$N_NOSURFACE,2
$D_FINISH,5
$GO
```

This command file was sent to the glider to avoid drifting sea ice which was heading North West after a change in wind direction. The relevant details within this command file were

$NAV_MODE, 0 – This command switched off the glider's navigational mode, where it headed for its navigational way-points and instead used a different mode of navigation
$HEADING, 0- This command instructed the glider to head on a path Northwards at a bearing of 0° This command was intended to fly the glider to an area free of sea-ice.
$N_NOSURFACE, 2- This command instructed the glider to only surface on alternate dives. When the glider did not surface, it finished the dive at a depth of 5 meters ($D_FINISH, 5). The command was again initiated in an effort to avoid the sea-ice, potentially at the surface.
$ALTIM_PING_DEPTH, 350- This is the depth at which the glider initiated its acoustic transponder to start pinging to identify the bottom. Although irrelevant in this context this command later became relevant in that it's power consumption aided in using the battery power and putting the glider into recovery mode (in conjunction with science instruments)

In summary, from 14th February (loss of communication) the glider was now heading on a Northward bearing, diving to 1000m with the acoustic pinger switching on at 350m, all science sensors on for the full 1000m, and was only surfacing for every alternate dive. The time at the surface was minimal as the glider had no means of communication. The result of this was that we only had ARGOS positions on 18th February 2012, 26th February 2012, 27th February 2012 and 6th March 2012. On 7th March it is thought that the glider went into recovery mode, possibly due to reaching its minimum threshold for battery voltage, or maximum ampere usage. The thresholds for battery voltage are 19v for the 24v battery ($MINV_24V,19) and 8v for the 10v battery ($MINV_10V,8). The ampere usage thresholds are 150 Ah for the 24v battery ($AH0_24V,150)and 100 Ah for the 10 V battery ($AH0_10V,100). The evidence to suggest this is that the glider was now getting ARGOS fixes on a daily basis and often several times a day.

The first attempt to recover SG522 was on 13th March 2012 at 08:00 LT. The ARGOS tag had given a position of 57° 42.10 S, 50° 50.06 W (location quality B) at 05:48. The ship had been swathing overnight which meant a long steam to the position. By 12:00 the ship was still South of the position which was given 7 hours earlier. At 10:39 a new position of 57° 31.61 S, 50° 38.20 W (location quality 0) was seen and the ship steamed into this position and began a NW to SE transect along the Seagliders anticipated path. At 17:05 the new ARGOS position was 57° 28.13 S, 50° 43.86 W (location quality 0) was seen and the ship performed a N to S and E to W transect of the immediate area. By 19:00 the light level was insufficient for searching and the ship steamed North-West for overnight swathing.

On 14th March 2012 09:00 the ship had returned from overnight swathing and a second days search began. An ARGOS positional fix of 57° 15.18 S, 50° 26.33 W (location quality B) was seen at 03:11 and the ship steamed to this location and awaited another (more accurate) position. No further positions were obtained and the search was abandoned at 13:00.

Table 16: ARGOS positions and Data Quality for SG522 from 14th February 2012.

Date	Time (UTC)	Latitude	Longitude	Position Error
14.02.2012	05:59	63° 01.03 S	52° 27.65 W	2
14.02.2012	23:05	62° 56.08 S	52° 40.00 W	2
16.02.2012	03:11	62° 37.04 S	52° 55.55 W	2
17.02.2012	02:33	62° 22.01 S	53° 01.95 W	1
18.02.2012	07:23	62° 01.98 S	53° 06.68 W	1
26.02.2012	04:44	61° 06.70 S	51° 07.18 W	2
27.02.2012	06:06	60° 56.50 S	52° 00.16 W	1
06.03.2012	10:30	58° 53.88 S	51° 31.06 W	B
07.03.2012	05:29	58° 43.06 S	51° 31.08 W	0
08.03.2012	05:06	58° 32.76 S	51° 30.95 W	A
09.03.2012	18:24	58° 26.21 S	51° 39.51 W	B
10.03.2012	05:56	58° 17.25 S	51° 44.38 W	0
11.03.2012	00:38	58° 09.08 S	51° 45.66 W	B
11.03.2012	05:13	58° 10.16 S	51° 40.10 W	0
11/03/2012	09:56	58° 08.56 S	51° 39.40 W	B
11.03.2012	14:44	58° 03.61 S	51° 27.55 W	0
12.03.2012	00:01	57° 58.41 S	51° 19.11 W	B
12.03.2012	00:01	58° 05.13 S	51° 25.95 W	B
12.03.2012	00:04	58° 04.61 S	51° 17.11 W	0

12.03.2012	18:56	58° 04.51 S	51° 17.00 W	B
12.03.2012	23:45	57° 50.30 S	50° 55.88 W	Z
12.03.2012	23:46	57° 42.36 S	50° 51.45 W	A
12.03.2012	23:47	57° 43.53 S	50° 49.97 W	2
12.03.2012	23:45	57° 41.97 S	50° 40.31 W	Z
13.03.2012	05:48	57° 42.10 S	50° 50.06 W	B
13.03.2012	10:39	57° 31.61 S	50° 38.20 W	0
13.03.2012	17:05	57° 28.13 S	50° 43.86 W	0
13.03.2012	22:18	57° 25.66 S	50° 47.11 W	B
14/03/2012	03:11	57° 15.18 S	50° 26.33 W	A

The above table shows there was no accurate data from 12.03.2012 23:47 UTC
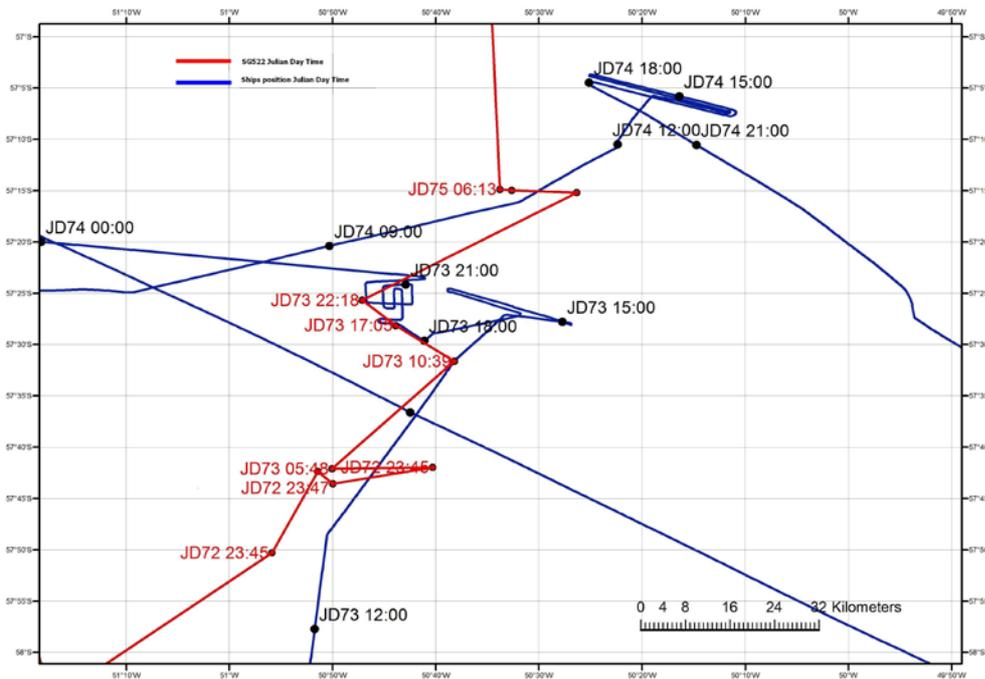
Figure 35. SG522 positional updates vs Ships position 13th/14th March 2012

12.5 Recovery of SG546 'The Flying Pig'

Initial recovery plans of SG546 were jeopardised by the fact that the Seaglider had drifted into unchartered waters to the East of the inaccessible Islands. The location of the glider SG546 on 10th March 2012 was 60° 27.2 S, 46° 29.08 W (by ARGOS, position error 3). This was an area of unchartered water with several rocky outcrops in unknown locations. However, on 11th March 2012 glider SG546 had drifted clear of this position.

The first attempt at recovering SG546 was at 08:00 LT on 11th March 2012. SG546 had given an overnight ARGOS position of 60° 22.2666 S, 46° 23.6833 W (position error 2) at 00:07 11.03.2012 which was clear of the inaccessible Islands. The ship returned from overnight swathing and was in the immediate vicinity at 09:00. A North – South grid was set up and the ship continued on this north-south trajectory in search of the glider. Having failed in the daylight search of the glider it was agreed that we would wait for the overnight position of the Seaglider and continue with a spotlight search of the area. At 23:30 LT the 00:19 position was available and the ship steamed to the immediate vicinity. A spotlight search was carried out for 1.5 hours, with no success and the search was abandoned with the intention of returning to the location on passage to Signy for the base closure. This plan of a second search time was later abandoned.

Table 17: ARGOS positions and Data Quality for SG546 from 10th March 2012.

Date	Time (UTC)	Latitude	Longitude	Position Error
10.03.2012	00:10	60° 27.55 S	46° 29.61 W	3
10.03.2012	00:12	60° 27.55 S	46° 29.60 W	2
10.03.2012	00:19	60° 27.49 S	46° 28.96 W	3

10.03.2012	00:41	60° 27.31 S	46° 29.21 W	2
10.03.2012	00:50	60° 27.20 S	46° 29.08 W	3
10.03.2012	01:00	60° 27.03 S	46° 28.51 W	2
11.03.2012	00:07	60° 22.26 S	46° 23.68 W	2
11.03.2012	00:08	60° 22.11 S	46° 23.73 W	2
11.03.2012	00:28	60° 21.65 S	46° 23.08 W	3
11.03.2012	00:30	60° 21.76 S	46° 23.83 W	2
11.03.2012	00:34	60° 21.70 S	46° 23.45 W	2
12.03.2012	00:07	60° 06.51 S	46° 47.68 W	2
12.03.2012	00:19	60° 06.33 S	46° 49.26 W	2
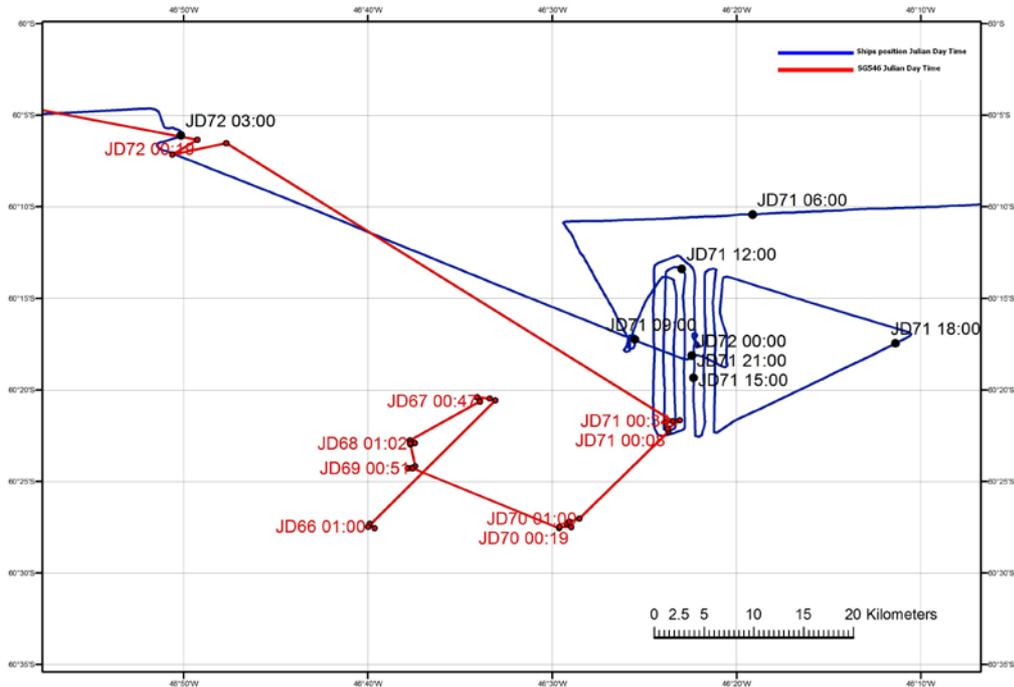
Figure 36. SG546 positional updates vs ship's position 11th/12th March 2012

Search Strategies

On each of the Seaglider search days a search strategy was adopted which made best use of the resources available. A rota was placed on the notice board allowing people to sign up for 1-2 hours slots of searching. This meant that we had teams of searchers through-out the day as opposed to everyone in the morning and none later in the day. The ship's personnel and in particular the passengers in transit from Halley were extraordinary in their willingness to help out and at times there were 20+ people on lookout duty in search of the missing gliders.
The search strategy involved a team of 8-10 people on each side of the bridge deck, with binoculars searching in a sweeping fashion their area of search. The ship would travel up and down a regular gridded search area (described above) in the vicinity of the glider's last known position. Extra persons were employed on the monkey island to add to the search personnel, gaining the advantage 360° visibility and increased height.

For night time spotlight searches the ships four spotlights were utilised to survey the ocean in a regular search pattern as advised by the captain. 10-12 people were on look out duty searching the areas illuminated by the spotlights. It was thought that the reflective tape on the antennae of the Seaglider may be effective enough to be spotted in the darkness.

A reward was also set up for the first person to spot the Seagliders to add to the incentive of actually recovering the missing Seagliders.

Acoustic pinging

The Seagliders are fitted with acoustic transponders which both receive and transmit at certain frequencies. This can be used to interrogate the Seaglider, giving some idea of depth of glider or distance away. A Benthos DS8000 deck box and acoustic transponder was used at each glider recovery attempt. The deck unit was set at the relevant transmit and receive frequency for each glider. The sensitivity was always set at 9, although the range of sensitivity (1-9) was tested to examine any increased sensitivity response. The range testing seemed to have no effect on the accuracy of the distance measurement.

SG546 TFP - RX: 12.5 - TX: 11.5 - CMD: A - Sensitivity 9

SG546 was pinged on 11th March 2012 whilst searching in the suspected vicinity of SG546. It was found that the swathing unit installed on the ship interfered with the acoustic pinging. Once the swath was switched off the results of the pinging were 4550, 8758, 9999, 9999, 1986, and 1203. These results seemed inconclusive.

SG522 'Beluga' - RX: 11.5 - TX: 12.5

SG522 was pinged on 13th March 2012. The results of the pinging, together with the pinging location is listed below. Pinging was carried out on both the port and starboard side of the ship as it was thought the beam of the ship may interfere with the transducer, whose lead was only 10m long.

```
Ping 1.                                 Ping 3.
Lat: 57° 27.3504 S                      Lat: 57° 26.1967 S
Lon: 50° 32.7797 W                      Lon: 50° 32.8368 W

Starboard          Portside            Starboard          Portside
2254                                    147
9999                                    379
9999                                    201
9999                                    2383
7289                                    5693
9999                                    9999
9999                                    9958
                                        9272
Ping 2.                                 9999
Lat: 57° 24.6922 S                      6010
Lon: 50° 38.2884 W                      8146
                                        9999
Starboard          Portside
2954
9999
4345
9999                                    Ping 4.
9101                                    Lat: 57° 29.58 S
2135                                    Lon: 50° 41.10 W
9999
                                        Starboard          Portside
                                        144
                                        190
                                        4525
                                        9999
                                        9105
                                        9999
                                        9999
                                        9999
                                        9999
                                        1040
                                        1196
                                        835
                                        7116
                                        9999
```

These results also seem inconclusive. It may be that we are seeing some sort of feedback from the glider but this is possibly inhibited by the fact that the Seaglider is at the surface and not at depth. Acoustic 'pings' are designed to use water as a medium for transport and are always much more effective going 'through' water than 'across' water. This may be the reason for the variation in the results.