Report of
R/V *Laurence M. Gould* Cruise LMG02-01A
to the
Western Antarctic Peninsula
6 February to 3 March 2002

United States Southern Ocean
Global Ocean Ecosystems Dynamics Program
Report Number 4

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We especially want to thank Captain Robert Verret II and the officers and crew of the *R/V Laurence M. Gould* for their superb assistance in the recovery and deployment of the Woods Hole Oceanographic Institution (WHOI) and Scripps Institution of Oceanography (SIO) moorings during LMG02-01A, and in the marine mammal survey work. Some of the mooring operations occurred during difficult conditions, including working in sea ice, and the Captain and mates were able to maneuver the ship to make the stern deck a safe and efficient working area during these operations. It was especially helpful to have Captain Robert driving the ship from the aft control room with Fernando Naraga or Efren Prado controlling the A-frame during all mooring recoveries.

Special thanks to Randy Sliester of Raytheon Polar Services (RPS) for coordinating the various activities during the cruise and, in general, making the cruise run smoothly. The WHOI mooring team was lead by Scott Worrilow with assistance from Ryan Schrawder and Jim Ryder. They deserve great credit for the successful mooring planning, design, recoveries, and deployments made on this cruise. The SIO mooring team was led by John Hildebrand, with assistance from Sean Wiggins, Ana Sirovic, and Mark McDonald. They also deserve great credit for the success of the bio-acoustics moorings. Randy Sliester and Josh Spillane (RPS) were on deck for all mooring operations and provided excellent support running the mooring winch, knuckle crane, A-frame, etc., while keeping an eye on safety. They also provided excellent Zodiac support during the whale sighting and sampling work. In addition to his job as cruise Electronics Technician, Andy Nunn (RPS) collected all the CTD and XBT data during the cruise and provided processed data for our analysis. Andy also oversaw the collection of meteorological and underway data and jumped in to correct problems when they arose. Sara Disick (RPS) kept the shipboard scientific equipment working, and collected and processed all the water samples collected with the CTD rosette sampler.

The WHOI and SIO work conducted on this cruise is sponsored by the National Science Foundation research grants OPP-99-10092 and OPP-99-10007, respectively. The marine mammal survey work is supported by the International Whaling Commission. All data and results in this report are to be considered preliminary.

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1. 0 Purpose of the Cruise

The primary objectives of *R/V Laurence M. Gould* cruise LMG02-01A were to: 1) recover a Woods Hole Oceanographic Institution (WHOI) array of six current meter moorings deployed near Marguerite Bay and redeploy three moorings, 2) recover and redeploy a Scripps Institution of Oceanography (SIO) moored array of eight whale acoustic recording packages (ARPs) along the West Antarctic Peninsula, 3) deploy six near-surface satellite-tracked drifters and twelve satellite-tracked isobaric floats, and 4) conduct a marine mammal survey of the Marguerite Bay region. This report summarizes the events that occurred during cruise LMG02-01A.

A central hypothesis of the U.S. Southern Ocean Global Ocean Ecosystems Dynamics (SO GLOBEC) collaborative research program is that a unique combination of physical and biological factors contributes to the enhanced growth, reproduction, recruitment and survivorship of Antarctic krill (*Euphausia superba*) on the central West Antarctic Peninsula (WAP) shelf. In particular, it was thought that this region provides the following conditions that are especially favorable to winter survival of larval and adult krill: a) a clockwise shelf circulation that retains the krill population in a favorable environment for extended periods of time; b) an early and long-lasting ice cover that provides dependable food and protection for larval krill to grow and survive over winter; and c) on-shelf intrusions of warm, salty, nutrient-rich Upper Circumpolar Deep Water which affects hydrographic and sea ice properties and enhances biological production. To begin to investigate these ideas, the WHOI moored array, drifter and float component was designed to investigate shelf circulation processes and their spatial and temporal variability using long-term moorings and satellite-tracked Lagrangian drifters and isobaric floats. Supporting data on the surface forcing (wind stress and heat flux) will also be obtained and the combined data set used to describe the shelf circulation and water property variability on vertical scales of 10s of meters and time scales from hourly to seasonal.

Other components of the U.S. SO GLOBEC program have been designed to investigate the relationships between krill and their predators, including marine mammals. The SIO moored array was deployed to record sounds made by whales and other marine mammals in the study area over the last year. This information will be used to identify the existence of different types of whales in the West Antarctic Peninsula area, their spatial and temporal distribution, and some sense of their population density. The SIO moored array effort was augmented by a visual marine mammal survey conducted during the cruise by two International Whaling Commission (IWC) observers and the deployment of sonobuoys to identify the presence of whales during the IWC survey to hopefully collect simultaneous acoustic and visual data on the same whale.

2.0 Accomplishment Summary

After conducting an Expendable Bathythermograph (XBT)/Expendable Conductivity-Temperature-Depth (XCTD)/Acoustic Doppler Current Profiler (ADCP) transect across Drake Passage, the *L.M. Gould* left Palmer Station (64º 46′S, 64º 04′W) Monday, 11 February 2002 and headed south to recover and redeploy WHOI and SIO moorings deployed in the study area in March 2001 on cruise LMG01-03. With good working weather for the next eight days and skilled personnel, the mooring work proceeded quite smoothly, with seven of the eight SIO ARPs recovered and five redeployed. With the exception of the S8 instrument, which failed to surface after many release commands were sent, the other SIO instruments worked well, with most returning a full data set. During this same period, five of the six WHOI moorings were also recovered and two new moorings deployed along the C-line (Figure 1). The three WHOI moorings on the northern A-line had no noticeable damage. On the southern B-line roughly across the mouth of Marguerite Bay, the two southern most moorings B2 and B3 were recovered in patchy sea ice, with damage to the upper instruments due to passing icebergs. The B1 mooring was lost with no trace. On 19 February 2002, the first of several storms with high winds curtailed mooring operations and the *L.M. Gould* steamed into Marguerite Bay to conduct marine mammal survey work in the protected waters east of Adelaide Island (Figure 1). The remaining one WHOI mooring and two SIO ARPs were successfully deployed during short windows of good weather, while the marine mammal survey work was reduced to just a few short periods of conditions suitable for visual search. Despite these limitations, the main concentration of whales was found along the northern ice edge in Marguerite Bay and five biopsies were collected from humpbacks there. Two additional humpbacks were also sampled on Tuesday, 26 February 2002 after the *L.M. Gould* docked at Palmer Station. In addition, a total of six satellite-tracked surface drifters and eight isobaric floats were deployed, and nine conductivity-temperature-depth (CTD) casts made at the WHOI mooring sites.

The cruise track for LMG02-01A is shown in Figure 1, and the mooring recovery and deployment and drifter and float launch positions are listed in Table 1.

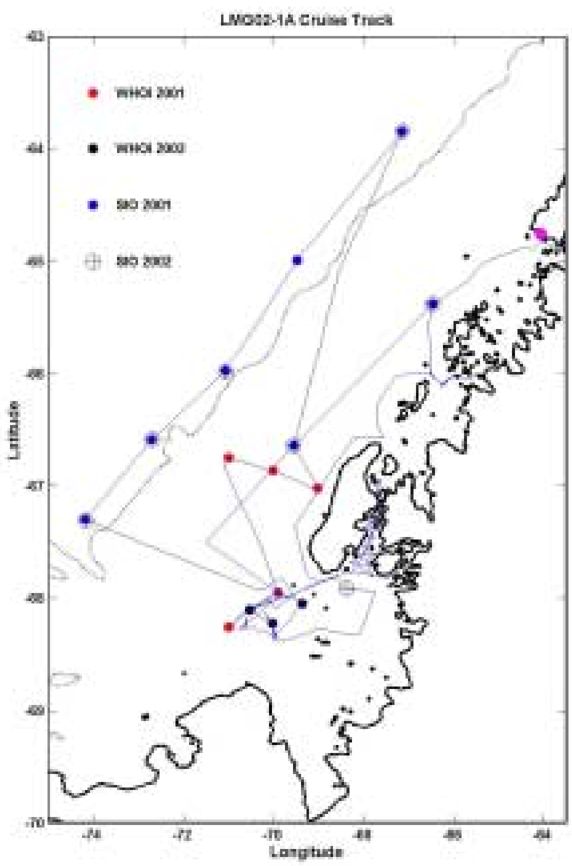

Figure 1. Cruise track for LMG02-01A from Palmer Station (11 February 2002) to Palmer Station (26 February 2002). The red dots show the positions of the WHOI A-line and B-line moorings deployed in 2001, the black dots the three new WHOI moorings deployed on the 2002 cruise, the blue dots the SIO mooring positions used in 2001, and the black circle with cross the positions where SIO ARPs were deployed on this cruise. Not shown is SIO S1, located north of Palmer Station, which was recovered and redeployed. Marguerite Bay is the indentation in the coastline between 68ºS and 69ºS and Adelaide and Alexander Islands are located on the north and south of the Bay, respectively.

Table 1. LMG02-01A mooring, float, drifter, and CTD station locations. Notes: 1) Time for mooring recovery is when the release command was sent, and the mooring started up to the surface (* means time is +/- 5 minutes, otherwise, time is accurate to the minute). 2) Time and position for CTD is the time and position when the CTD/Rosette reached the bottom of the cast. Depth is the reading at the start of cast. 3) Float times and positions as recorded on the bridge as the instrument was launched. 4) Time and mooring position for mooring deployment is when the anchor is released as recorded on the bridge. 5) Topography at C1 is very rugged, so the actual depth where C1 anchor landed could be between about 450 m and 395 m (worst case). Depth at the drop site was 450 m; however, fallback may cause the actual depth to be less.

Station	Date	Time UTC	Latitude (S)	Longitude (W)	Depth (m)
Recover S1 Mooring	02/9/02	2339	62° 16.470′	62° 10.000′	1651
Recover S7 Mooring	02/12/02	0752	65° 22.620′	66° 28.210′	450
Deploy Drifter 25180	02/12/02	1503	66° 04.01′	68° 07.92′	388
Deploy Float 138	02/12/02	1505	66° 04.01′	68° 07.92′	388
S8 Mooring	02/12/02		66° 38.241′	69° 33.095′	407
Deploy Drifter 24477	02/13/02	0221	66° 40.150′	69° 30.010′	
Deploy Float 139	02/13/02	0222	66° 40.190′	69° 29.940′	
CTD 1 (A1)	02/13/02	0742	67° 01.249′	69° 00.959′	455
Recover A1 Mooring	02/13/02	0830*	67° 01.134′	69° 01.217′	450
CTD 2 (A2)	02/13/02	1321	66° 51.583′	79° 00.250′	562
Recover A2 Mooring	02/13/02	1352	66° 51.883′	70° 00.683′	564
CTD 3 (A3)	02/13/02	1859	66° 44.428′	71° 00.720′	490
Recover A3 Mooring	02/13/02	1947	66° 45.002′	70° 59.991′	490
Deploy Float 137	02/14/02	0249	67° 26.726′	70° 22.950′	
CTD 4 (B1)	02/14/02	0737	67° 56.603′	69° 54.586′	522
CTD 5 (B3)	02/14/02	1355	68° 15.145′	70° 59.332′	462
Recover B3	02/14/02	1503	68° 15.345′	70° 59.853′	450
CTD 6 (B2)	02/14/02	1911	68° 05.573′	70° 31.157′	822
Recover B2	02/14/02	1944	68° 06.091′	70° 31.675′	811
Recover S6	02/15/02	1535	67° 17.900′	74° 10.800′	3057
Deploy S6A	02/15/02	1648	67° 18.250′	74° 10.150′	3099
Recover S5	02/15/02	2348	66° 35.197′	72° 42.311′	3450
Deploy S5A	02/16/02	0039	66° 34.990′	72° 41.430′	3421
Recover S4	02/16/02	0834	65° 58.400′	71° 04.100′	2962
Deploy S4A	02/16/02	0936	65° 58.730′	71° 03.640′	2944
Recover S3	02/16/02	1902	64° 59.406′	69° 28.795′	2521
Recover S2	02/17/02	0721	63° 50.799′	67° 08.829′	3056
Deploy S2A	02/17/02	0842	63° 50.460′	67° 07.840′	3047
Deploy Float 110	02/18/02	1007	67° 30.000′	71° 30.100′	430
Deploy Float 112	02/18/02	1229	67° 42.990′	70° 41.950′	778
Deploy Float 142	02/18/02	1450	67° 56.850′	69° 54.470′	442
Deploy C1	02/18/02	2122	68° 02.940′	69° 21.790′	450++
CTD 7 (C1)	02/18/02	2243	68° 02.599′	69° 19.855′	515
Deploy Float 111	02/18/02	2332	68° 03.190′	69° 21.940′	401
Deploy Drifter 25120	02/18/02	2333	68° 03.200′	69° 22.000′	401
Deploy Drifter 24476	02/19/02	0037	68° 11.600′	69° 38.710′	827
Deploy Float 124	02/19/02	0039	68° 11.710′	69° 38.740′	828
Deploy C2	02/19/02	1132	68° 13.331′	70° 01.730′	850
Deploy Drifter 25119	02/19/02	1144	68° 14.040′	70° 01.060′	868
CTD 8 (C2)	02/19/02	1231	68° 14.606′	69° 59.954′	890
Deploy C3	02/21/02	2344	68° 06.006′	70° 31.799′	815

CTD 9 (C3)	02/22/02	0037	68° 05.8493′	70° 30.529′	818
Deploy Drifter 25181	02/22/02	0115	68° 05.630′	70° 30.400′	867
Deploy S9	02/23/02	1848	67° 54.499′	68° 23.003′	687
Deploy S7A	02/25/02	2338	65° 22.620′	66° 28.150′	470
Deploy S1A	02/28/02	0748	62° 16.420′	62° 10.040′	1658

3.0 Mooring, Drifter and Float Measurements

3.1 Bathymetric Surveys

Digital depth data were collected with a Knudsen fathometer using a sound speed of 1500 m s^{-1} from Punta Arenas, Chile to Palmer Station. At Palmer Station, the sound speed was changed to 1456 m s^{-1} about 1800 UTC on 11 February 2002. This value was the depth-averaged sound speed computed using CTD profile data collected at the Long-Term Ecological Research (LTER) stations 200.000, 200.020, and 200.040 located west of the southern tip of Adelaide Island in water greater than 500 m deep during the January 2002 LTER cruise. This value was checked against depth-averaged sound speed values computed using CTD data collected on this cruise, and found to be within a few m s^{-1}. The sound speed was changed back to 1500 m s^{-1} at Palmer Station on 26 February 2002 for the trip north to Punta Arenas, Chile.

Small-scale depth surveys were made prior to the deployment of the three new WHOI moorings. The original objective of the C-line moorings was to monitor the in-flow and out-flow across the month of Marguerite Bay. The C1 and C2 moorings were located along the northern part of a line between the tips of Adelaide and Alexander Islands to investigate inflow, while C3 was located on the western edge of the Marguerite Trough to investigate outflow. Sites C2 and C3 were located too far south in the sea ice to be reached, and an initial pass over the C1 target showed it to be too bumpy and deep to deploy a mooring. Using the high-resolution SO GLOBEC digital data base to pick new sites, we chose to deploy C1 and C2 close to the line between the two islands and C3 at the B2 site, roughly 90^o to C1-C2, thus forming a L. All three mooring sites were located within the multi-beam data area, which made it easier to pick smoother sites. Since the SO GLOBEC depth data were not corrected for local sound speed, we made full depth surveys at C1 and C2, and merged the new C3 data collected during the C3 deployment with data collected last year during the B2 deployment. Plots of the depth surveys are shown in Appendix A.

3.2 Mooring Operations

One primary objective of LMG02-01A was to recovery the 6 WHOI current meter moorings and the 8 SIO ARP moorings deployed in March 2001 on LMG01-03, refurbish the 8 ARPs and redeploy them, and deploy 3 new WHOI moorings. To accomplish this, the cruise track was designed with the following sequence of mooring operations: 1) recover S1 on south transit to Palmer Station; 2) steam south from Palmer Station to recover S7 and S8; 3) recover WHOI A1, A2, A3; 4) recover WHOI B1, B2, B3; 5) steam north along the outer line of SIO ARPs, recover S6, S5, S4, S3, and S2 and deploy refurbished ARPs from earlier recoveries at these sites; 6) deploy WHOI C1, C2, C3; 7) deploy refurbished ARPs at S8 and S7 on the way to Palmer Station, and S1 on the northbound transit to Punta Arenas, Chile. This plan was chosen to minimize steaming time between mooring operations plus provide adequate time between ARP recoveries to turn these instruments around for redeployment and sufficient time between the WHOI recoveries and deployment of the new moorings for two "workhorse" ADCPs and two SeaGauges (bottom pressure, temperature, conductivity recorders) to be downloaded, checked, and made ready for redeployment on the new moorings.

Overall, this sequence was followed during the cruise with a few modifications. The ARP at S8 responded to acoustic interrogation but did not lift off the bottom despite repeated lease commands being sent and acknowledged. It was left and not replaced. There was no response at B1 to any commands sent by the deck unit. The ARP at S3 was recovered but not replaced, so there would be one unit to deploy at a new site (S9) located in Rothera Channel. The C3 mooring was deployed at the old B2 site since the intended C3 site was deep into the sea ice pack south of the ice edge. Figure 2 shows the location of the ice edge in southern Marguerite Bay on 13 February 2002.

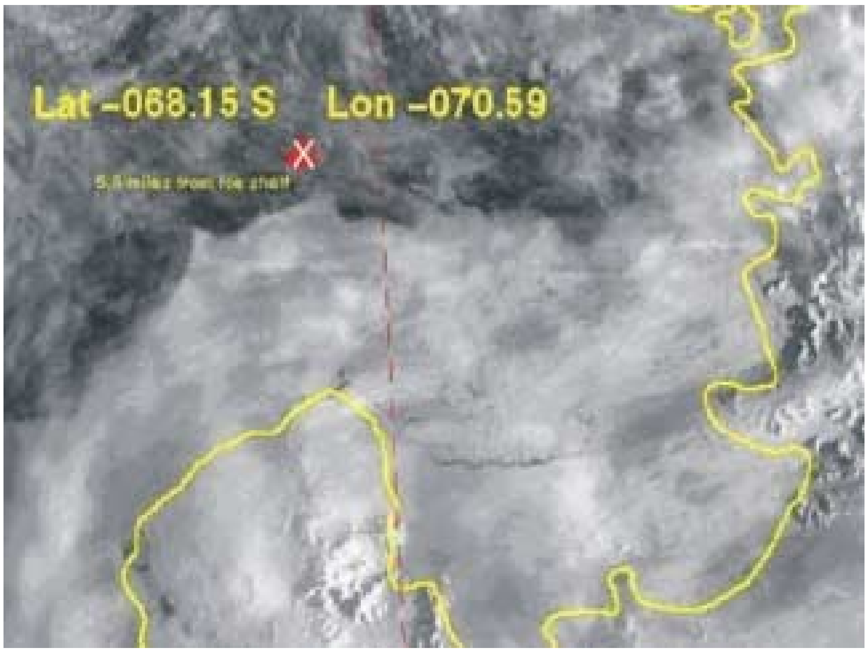

Figure 2. Satellite image of southern Marguerite Bay, showing the extent of pack ice on February 13. The B3 and original C3 mooring locations were south of the ice edge. The X indicates a position roughly 3 nm south of B2 mooring and 6 nm north of B3 mooring.

Fortunately, eight straight days of good working weather prevailed after leaving Palmer Station, and with skilled personnel and excellent equipment, the mooring work went quickly and smoothly. During this period, all of the ARPs were recovered except S8 and 5 were redeployed, 5 of the 6 WHOI moorings were recovered (including B3 in the sea ice), and the new C1 and C2 moorings deployed. Mooring operations were then suspended due to rough weather, and the rest of the mooring work was done during a few brief windows of good working weather. A more detailed description of the mooring operations is given in the Chief Scientist's Cruise Narrative (section 6). The positions, time and water depth of all mooring recoveries and deployments are listed in Table 1.

The success of the mooring operations on LMG02-01A was due to the following factors. The combination of the new RPS mooring winch, knuckle crane, and stern A-frame with highly skilled personnel on deck made for efficient and safe mooring operations. The ship handling was excellent, with Captain Robert Verrett at the helm in the aft control room with a clear view of the aft deck during all mooring recoveries. The depth survey grids and mooring deployment approaches were done skillfully by the mate on watch at the bridge.

3.3 Moored Data Return

The 6 WHOI current moorings were deployed during LMG01-03 along two transects, the A-line located west off central Adelaide Island, and the B-line located towards the southwest of the southern tip of Adelaide Island (Figure 1). The 3 moorings along the A-line were called A1, A2, and A3, with A1 being closest to Adelaide Island. The 3 moorings in the B-line were called B1, B2, and B3, with B3 located closest to Alexander Island. The positions and depths of these 6 moorings are given in Table 1.

The A-line moorings were recovered with no apparent damage to any instrument or mooring equipment. The B1 mooring was never recovered. The B2 mooring was recovered with the flotation collar on the upper-most instrument (ice profiler) broken off. The data from SEACAT 1457 (file B2sc050m900s) indicates that the B2 ice profiler lost its buoyancy on 14 July 2001 at 19:29:36 GMT - Bastille Day. Instruments on B2 above 100 m are affected. The B3 mooring was recovered with the top flotation sphere flooded. The metal bracket for the ARGOS beacon was bent, which had apparently created a small leak which allowed water to fill the sphere. All instruments on the B3 mooring except the deep SeaGauge sank to a different deeper depth on 19 June 2001 at 16:00 GMT.

A preliminary summary of the data return from the different instruments is given in Table 2. A draft copy of a moored data report is included in Appendix C.

3.4 Hydrographic Data

Hydrographic data were collected during LMG02-01A using several different approaches. Both XBT probes and XCTD probes were used to collect profiles of temperature and conductivity during the southward ADCP transect conducted across Drake Passage. XBTs were also used to obtain temperature profiles at each of the SIO bio-acoustic moorings, in order to estimate sound speed profiles needed to help process the moored data. CTD profiles were taken at each of the WHOI mooring sites, both prior to mooring recovery and after mooring deployments, so that the CTD data can be used to check the temperature/conductivity calibrations of the moored instruments. In addition, water samples were collected at all CTD stations for filtration for later chlorophyll a analysis at Palmer Station. Twelve Niskin bottles were fired at each station, with two at the surface, one at the standard depths of 10, 25, 50, 75, 100, 150, 200, 300 m, and two at the bottom of the cast. Three water samples for salinity comparisons were drawn from each surface and bottom bottle at the last four CTD stations. A brief description of the CTD, its operation during the cruise, and the processed profiles will be given next. The XBT and XCTD data are available on the cruise data CD.

The ship's CTD system consisted of a Sea-Bird Electronics Model 9Plus CTD sampling at 24 Hz with a DigiQuartz quartz crystal pressure transducer, a primary and secondary pair of Sea-Bird temperature and conductivity sensors, a Chelsea fluorometer sensor, and a WET Labs light transmissometer. The CTD package was lowered at between 20 and 40 m min^{-1} and the data were logged using a Sea-Bird 11Plus deck unit and DOS Seabird Electronics software. The CTD data were averaged into 1-m bins and the averaged downcast data is presented in this report. Andy Nunn collected and processed all the CTD data, Breck Owens did final processing and plotting, and Sara Disick collected the water samples, did the filtration, and determined the sample salinities using the ship's Guildline AutoSal salinometer.

Table 2. Moored data summary showing good data (blue), unprocessed data (gray), and lost data (red).

3.4.1 Calibration

Two tests were conducted to determine how well the CTD temperature and conductivity sensors worked on this cruise. The first test consisted of comparing the primary and secondary temperature and conductivity profiles at each station. The results (Table 3) show that the two sensor pairs exhibited a consistent offset, with a mean difference between the primary and secondary temperature sensors of -0.00088 +/- 0.00024°C and between the primary and secondary conductivity sensors of 0.00250 +/- 0.00040 mS cm^{-1}. These are quite small differences, which would cause a difference in salinity at 30 mS cm^{-1}, 1°C, 500 m of only 0.0010 psu due to the temperature offset and 0.0032 psu due to the conductivity offset, or a combined difference of about 0.004 psu.

Table 3. Comparison of CTD primary (1) and secondary (2) temperature and conductivity sensors for the nine CTD casts made on LMG02-01A. Shown for each cast is the mean and standard deviation for the difference temperature and conductivity, computed over the entire cast (upper value) and over the deeper part beneath 300 m (lower value). Units are milli-°C and milli-S m^{-1}. The mean and standard deviation of the nine entire cast values are given at the bottom.

Station	T1-T2	STD	C1-C2	STD
A1	-0.96	3.17	0.194	0.283
	-0.89	0.13	0.189	0.009
A2	-0.73	1.26	0.250	0.136
	-0.86	0.34	0.229	0.028
A3	-1.10	6.13	0.229	0.603
	-0.92	0.30	0.228	0.027
B1	-1.19	5.46	0.248	0.510
	-0.97	0.25	0.260	0.022
B2	-0.80	4.14	0.234	0.376
	-0.88	0.58	0.218	0.055
B3	-1.17	3.53	0.203	0.377
	-0.87	0.24	0.232	0.028
C1	-0.56	4.68	0.302	0.367
	-0.86	0.11	0.266	0.011
C2	-0.62	3.18	0.295	0.274
	-0.84	0.16	0.268	0.014
C3	-0.76	4.98	0.293	0.485
	-0.82	0.14	0.278	0.013
Mean	-0.88	0.24	0.250	0.040

The second test was a comparison of the bottle salinity S_{AS} (as determined using the AutoSal) with the CTD salinity S_{CTD} computed using the primary temperature and conductivity values and pressure recorded when the Niskin bottle was fired. A total of 48 water samples were taken and processed, three were discarded as clear outliers, and the remaining 45 bottle salinities used to compare with the CTD values. The salinity difference between bottle and CTD (S_{AS} - S_{CTD}) is shown in Figure 3 as a function of sample number, with squares denoting the surface samples and the circles denoting the bottom samples. There is a tendency for the difference to be of order – 0.010 psu for the first two groups of bottom samples, however, this trend changes at later stations as does the initial trend of the surface samples. The mean difference over the 45 samples was S_{AS} - S_{CTD} = -0.0067 +/- 0.0050 psu, with the CTD reading higher salinity than the AutoSal. The first sensor test indicated that the primary salinity would be roughly 0.004 psu higher than the secondary salinity. The results of both tests suggest that the CTD primary salinity reads roughly 0.005 psu high, and that the secondary salinity is accurate to within +/- 0.002 psu. The processed CTD data include both primary and secondary values, so subsequent analysis should use the secondary temperature and salinity data as the more accurate. However, the difference is relatively small, and the CTD profile data presented in this report were taken with the primary sensor pair.

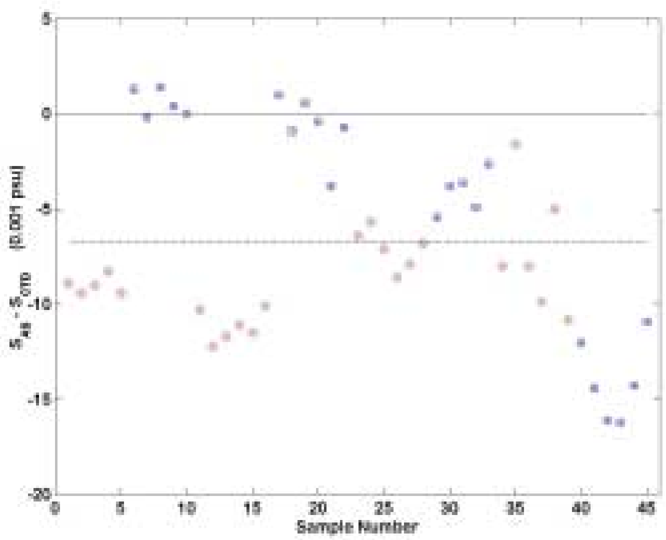

Figure 3. Difference between the *in situ* water sample salinity S_{AS} and the primary CTD salinity S_{CTD} versus sample number. The squares represent surface samples, and the circles bottom samples. The dashed line is the mean difference.

3.4.2 CTD Data

Plots of temperature, salinity, density, sound speed, dissolved oxygen, fluorescence, beam transmission, and T/S correlation are shown next for the 9 CTD casts made during LMG02-01A (Figures 4-12). Note that the depth-averaged sound speeds are all close to the LTER-based 1456 m s^{-1} value used to set the ship's sounder for this cruise.

A relatively warm (>0.5°C) surface layer overlying cold winter water (<-0.5°C) was observed at the three A-line moorings (Figures 4-6). The warmest surface water occurred at A1 while the freshest surface water (about 33.45 psu) was found at A2. The surface waters had the lowest light transmission and highest fluorescence, which peaked near 2 volts at A3. Along the B-line (Figures 7-9), the upper water column structure was more complex. A clear core of cold winter water occurred at B1 and B2, but was less distinct at B3. The surface waters above this cold layer showed interleaving of warm and cool layers. The surface salinity was less than along the A-line, with the water getting fresher southwestward from B1 towards B3. The mooring B3 was recovered in patchy sea ice, and the surface water there was the coldest (-1.6°C) and freshest (33.05 psu) water found at any of the nine CTD stations. Fluorescence was high along the B-line, exceeding 4 volts at B1 and B2, and 2 volts at B3.

The upper water column structure was also complex at the three C moorings (Figures 10-12). The surface salinity decreased from C1 to C2 to C3, while surface fluorescence increased from C1 (1.5 volts) to C2 and C3 (3.5 volts). Thus the highest fluorescence waters were found at B1, B2 (C3), with intermediate values at A3, B3, and C1.

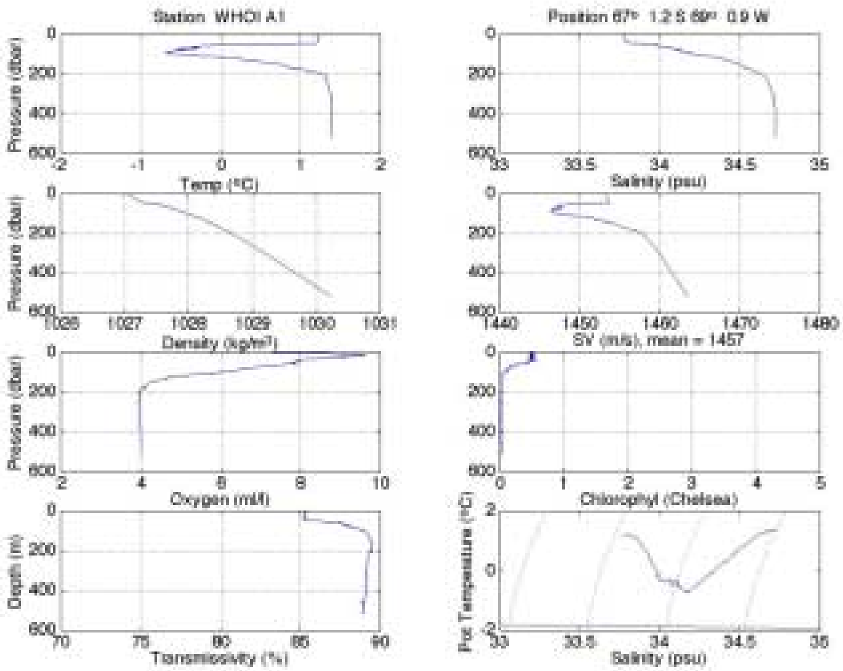

Figure 4. CTD profile data at WHOI mooring site A1.

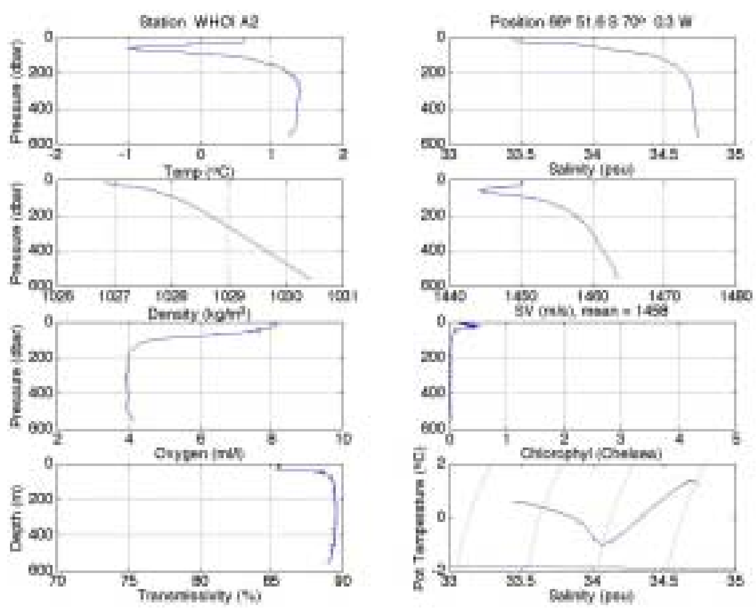

Figure 5. CTD profile data at WHOI mooring site A2.

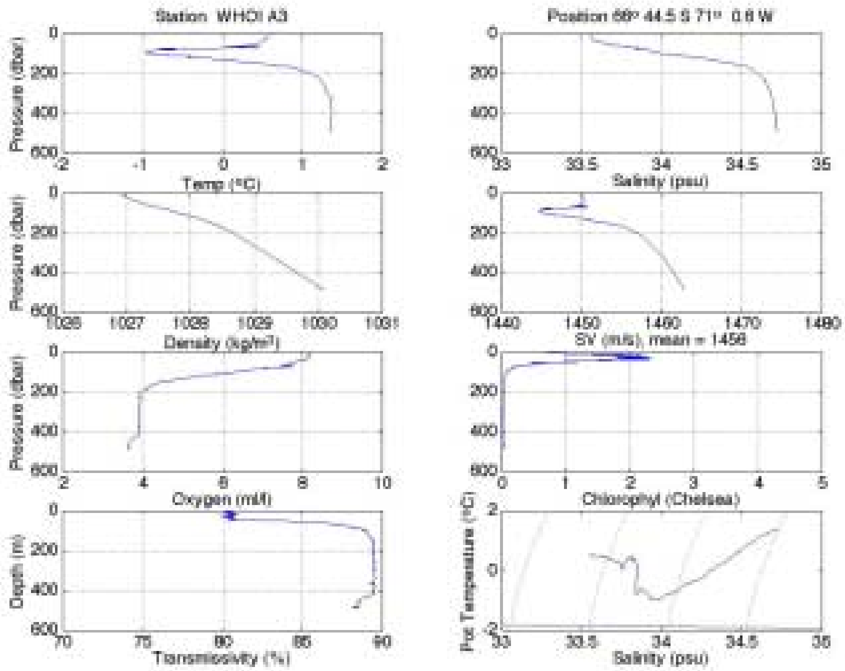

Figure 6. CTD profile data at WHOI mooring site A3.

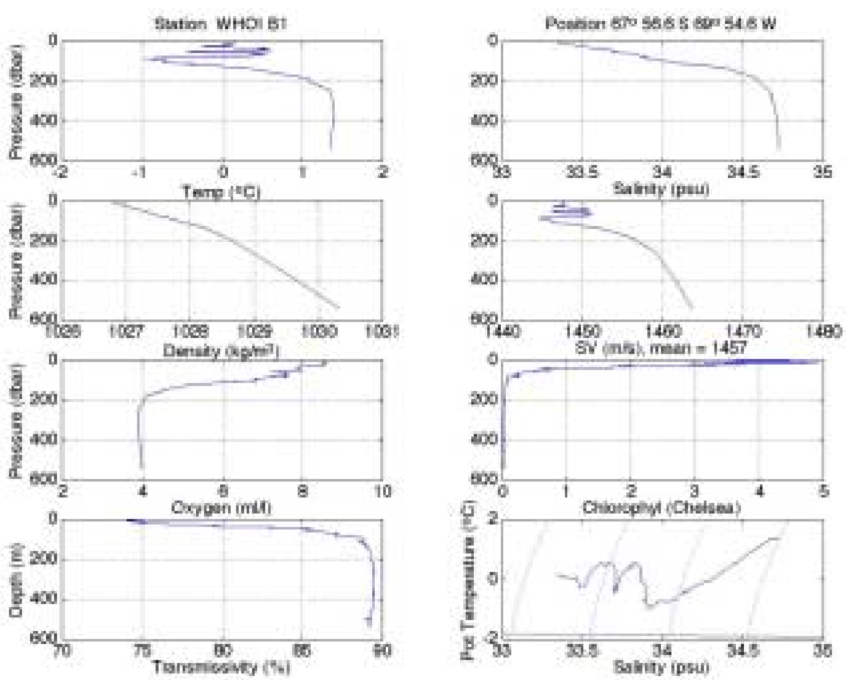

Figure 7. CTD profile data at WHOI mooring site B1.

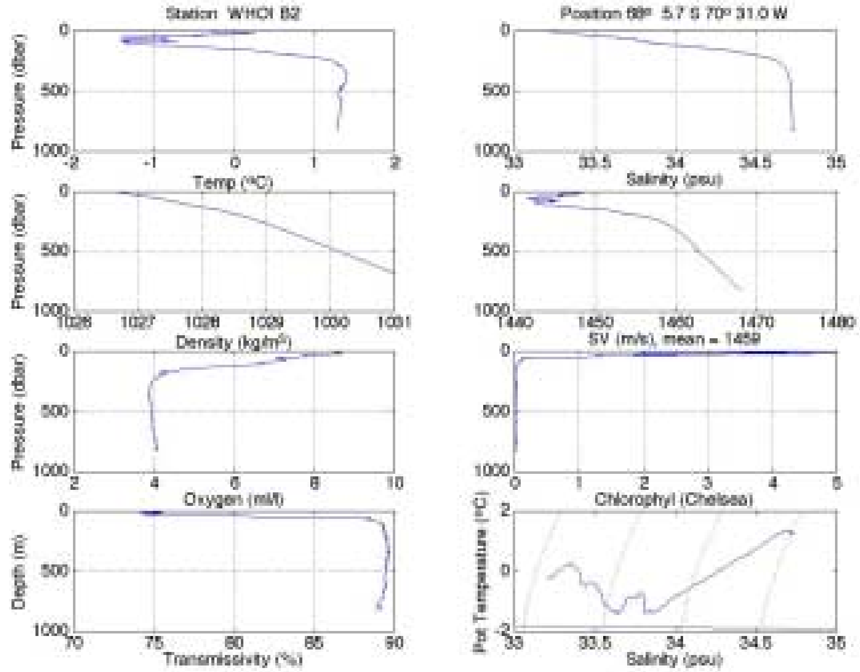

Figure 8. CTD profile data at WHOI mooring site B2.

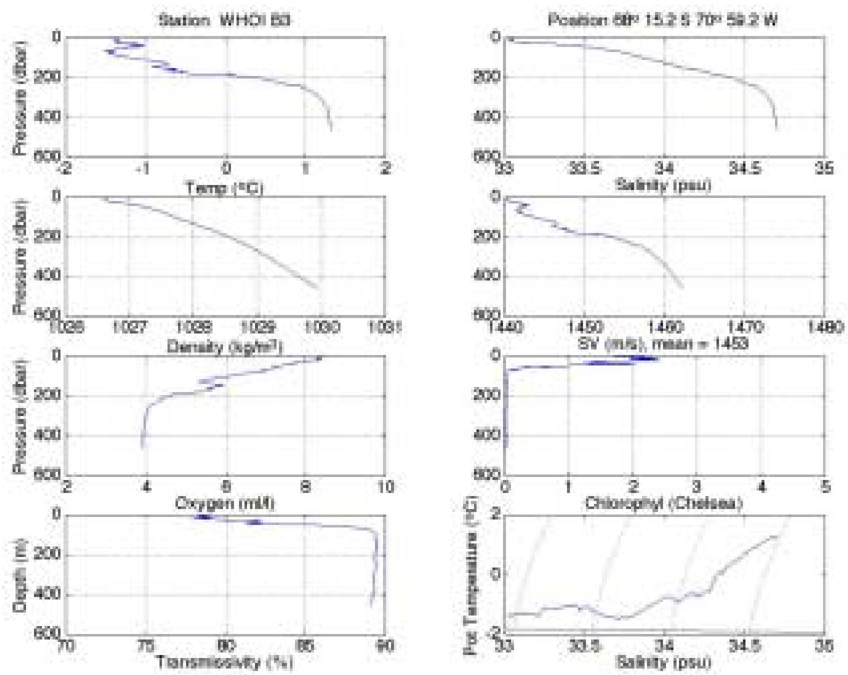

Figure 9. CTD profile data at WHOI mooring site B3.

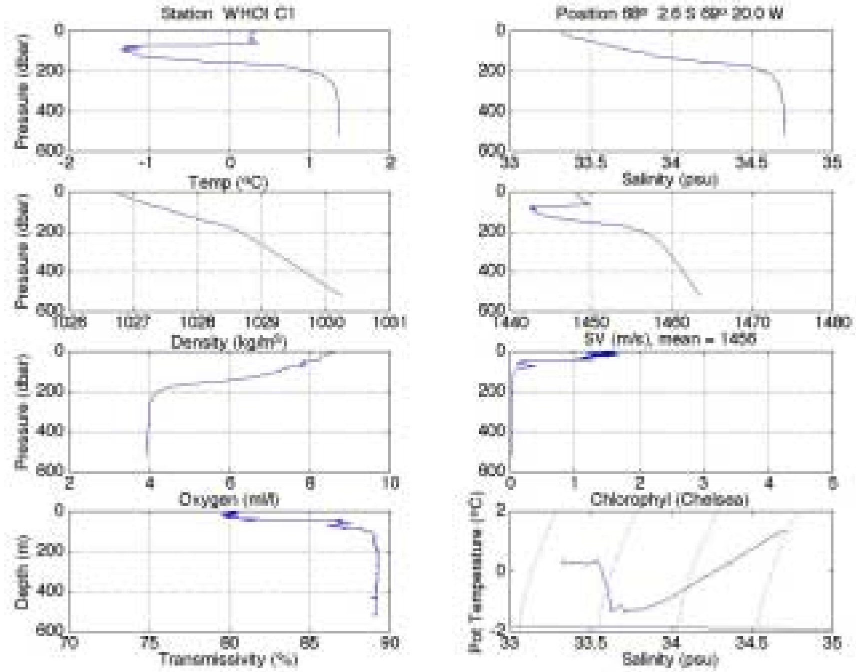

Figure 10. CTD profile data at WHOI mooring site C1.

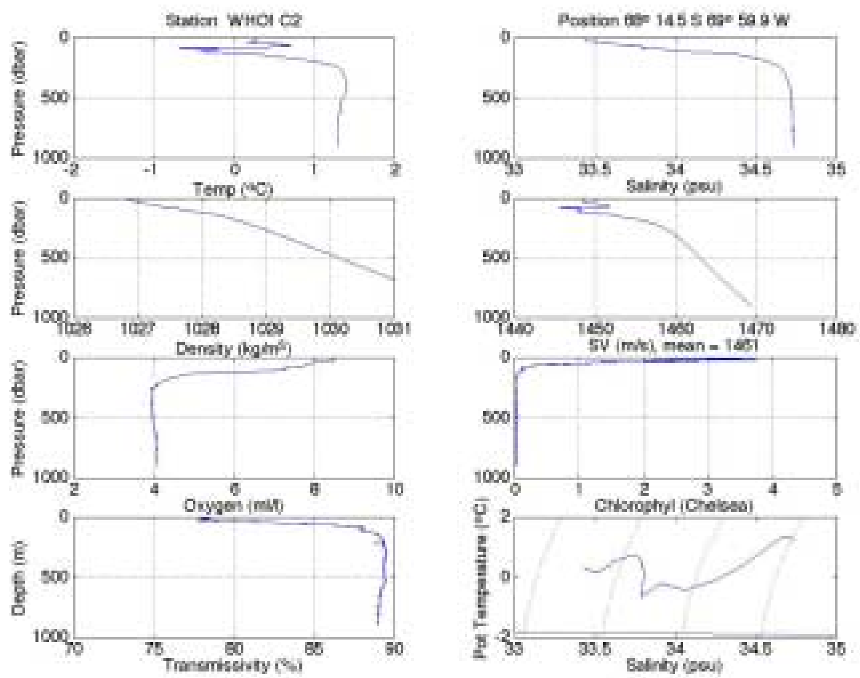

Figure 11. CTD profile data at WHOI mooring site C2.

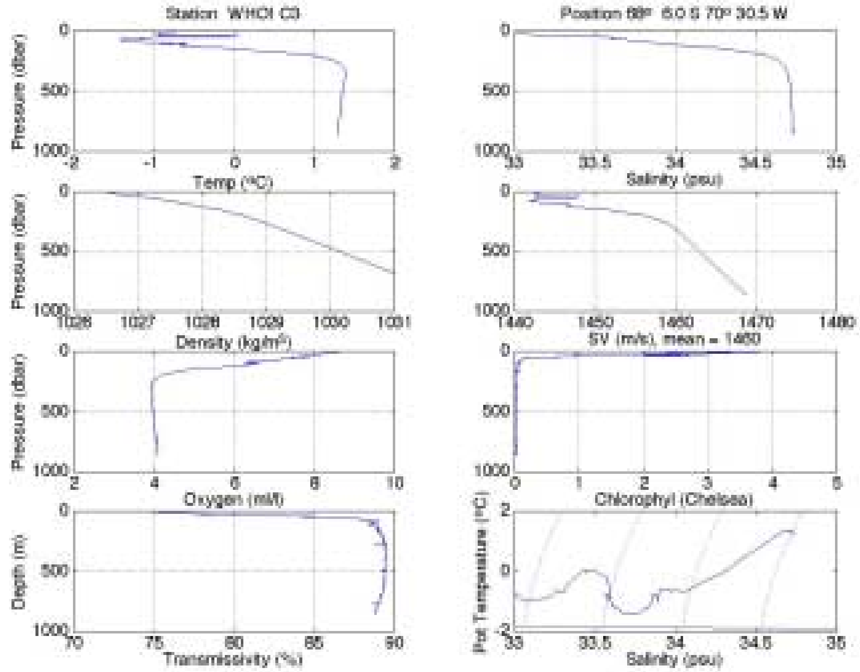

Figure 12. CTD profile data at WHOI mooring site C3.

3.5 Drifter Measurements

A total of 6 World Ocean Circulation Experiment (WOCE)-style, near-surface drifters (Sybrandy, A.S. and P.P. Niiler, 1991, WOCE/TOGA Lagrangian drifter construction manual, Report 91/6, Scripps Institution of Oceanography, La Jolla, CA; Brink, K.H, R. Limeburner, and R.C. Beardsley, 2002, Properties of flow and pressure over Georges Bank as observed with near-surface drifters, *Journal of Geophysical Research*, accepted) were deployed in the waters near Marguerite Bay (see Table 1 for their launch positions and time). Each drifter was equipped with a holey sock drogue centered at 15 m, and reported its position via Service ARGOS roughly 20 times per day. Tracks for the first few days after deployment are shown in Figure 13.

3.6 Float Deployments

The original plan for this cruise was to launch 12 profiling floats in the inflow, outflow, and central areas of Marguerite Bay. These floats are a new version of the design used in previous experiments, such as WOCE and the Argo float program. The basic concept is for the float to descend to a depth, here 250 m, drift with the ocean current, then descend quickly to a deeper depth, here the bottom or 600 m, and make a profile of temperature and salinity to the surface of the ocean. At the surface the floats are tracked by satellite, transmit data back to shore, and then descend for another cycle. In the past, these floats have used the ARGOS satellite system for positioning and transferring the data back to shore. The floats deployed on this cruise use GPS for positioning and the ORBCOMM satellite system, which has two-way communications, for data transfer. This configuration allows for at least an order of magnitude increase in bandwidth and two orders of magnitude decrease in the time on the surface. It is presently being used successfully in the subtropical North Atlantic.

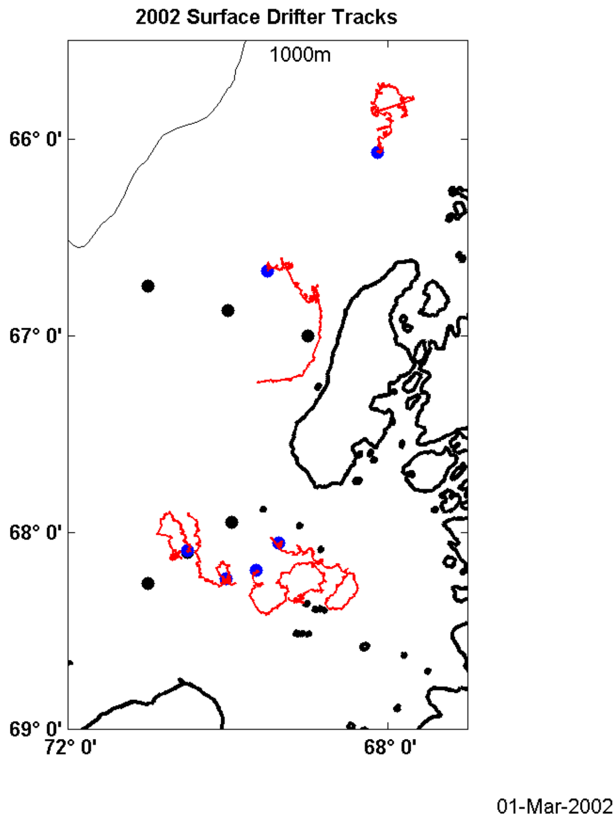

Figure 13. Initial tracks through March 1 for the six surface drifters deployed during LMG02-01A.

The profiling floats were programmed for a 5-day repeat cycle. Prior to the cruise, the number of polar orbiting ORBCOMM satellites had been reduced to only two, greatly limiting the time window for communications. The software in the float limited the time on the surface to only two and one-half hours, which meant that if the time estimates for taking the profiles to the surface were off, the floats would miss the satellites or only have partial data transfer. The first three floats were launched on 12-14 February 2002. When the floats surfaced for the first time, there were limited communications from only two of the three floats. At this time, the R/V *L.M. Gould* had arrived on location for the deployment of the next set of floats. These next 5 floats were deployed. Upon further discussion with J. Valdes who was monitoring the reception of data at Woods Hole Oceanographic Institution, it was determined that the float data was not getting through the ORBCOMM system effectively. The remaining four floats were not deployed and will be reprogrammed and deployed on the 2003 SO GLOBEC mooring recovery cruise.

4.0 Meteorological Measurements

4.1 Introduction

A good knowledge of the surface meteorological conditions during the SO GLOBEC program is essential to understand the role of surface wind stress and heat flux forcing on the regional circulation and upper ocean properties. The surface meteorological data are also useful in interpreting other physical and biological data collected during the program. The primary sources of surface meteorological data during SO GLOBEC include the data collected aboard the *L.M. Gould* and the *N.B. Palmer* during their cruises in the study area and two Automated Weather Stations (AWSs) that were deployed on small islands in the mouth of Marguerite Bay in May 2001 during NBP01-03 (see SO GLOBEC Report Number 2). This section provides a preliminary description of the meteorological data collected on LMG02-01A.

The *L.M. Gould* left Punta Arenas, Chile on 6 February 2002 and arrived at Palmer Station on 11 February 2002 (Leg 1). The *L.M. Gould* left Palmer Station on the next day and returned to Palmer Station from the SO GLOBEC area to the south on 26 February 2002 (Leg 2). The *L.M. Gould* left Palmer Station the next day for Punta Arenas, Chile and arrived there on 3 March 2002 (Leg 3).

A full suite of meteorological and underway data was collected during the cruise with two exceptions. Sea surface temperature (SST), sea surface salinity (SSS), and fluorometer data were not collected while the ship was docked at Palmer Station. The ship's meteorological data acquisition system (DAS) was turned off for 41 minutes on 18 February 2002 between 1339 and 1419 GMT. This was done in a successful attempt to reduce some high frequency noise present in some of the variables (e.g., shortwave radiation, air temperature). The ship uses GMT year day (yd) as given by GPS for time. Leg 2 corresponds to yd = 42.8007 to 57.4000. The description here will focus on the surface forcing during Leg 2, when the *L.M. Gould* was working in the study area.

4.2 Instrumentation

The meteorological sensors are mounted on the ship's main mast (Figure 14). The sensors include a pair of wind monitors and other sensors to measure air temperature (AT), relative humidity (RH), barometric pressure (BP), incident shortwave (SW) and long-wave (LW) radiation, and photosynthetically active radiation (PAR). The SST was measured using a remote sensor in the intake manifold, and SSS, fluorescence (Fluor), and light transmission (Trans) were measured using a thermosalinograph, fluorometer, and transmissometer placed in the wet lab. The different sensors and their calibration history and installation dates are given in Table 4.

Figure 14. Meteorological sensors mounted on platform railing on top of the mast on the *L.M. Gould*.

Table 4. LMG02-01A meteorological and underway sensors, their calibration history, and time of installation. The last column indicates if the sensor is to be re-calibrated every year (A) or every two years (BA).

Variable	Sensor	Serial Num.	Last Cal.	Next Cal.	Installed	Cal. Inv.
Star. Wind	RM Young 5106	WM 28394	04/15/01	04/15/02	06/7/01	A
Port Wind	RM Young 5106	WM 35061	04/15/01	04/15/02	04/15/01	A
AT, RH	RM Young 41372LC	6133	10/31/01	10/31/02	12/1/01	A
BP	RM Young 61201	BP 01150	11/7/00	11/7/02	After LMG01-04	BA
PAR	Biosp. Inst. QSR-240P	6394	06/5/01	06/5/03	07/19/01	BA
SW	Eppley PSP	31701F3	06/1/01	06/1/02	07/19/01	A
LW	Eppley PIR	32031F3	06/1/01	06/1/02	07/19/01	A
SST	Sea-Bird 3-01/S	031619	06/2/01	06/2/02	07/20/01	A
SSS	Sea-Bird 21	219209-1577	11/10/01	11/10/02	Prior to LMG01-08C	A
Trans	WET Labs C-Star 25cm	CST-168R	12/20/01		Prior to 2002 LTER	
Fluor	Turner 10AU-005-CE	6046 RTD				

4.3 Data Acquisition and Processing

The raw *L.M. Gould* shipboard meteorological and underway data were collected using the ship's DAS. A 1-minute processed subset of the raw data was saved at the end of each day in a flat ASCII text file on the ship's data drive Q:\.geopdata\JGOF\. This 1-minute time series was produced using a JGOFS code that merged the meteorological data with navigation and other data and combined the ship's motion and the measured (relative to the ship) wind speed and direction data to make "true" wind speed and direction relative to the ground. The light transmission data is not included in the JGOFS subset.

The daily 1-minute data were obtained from drive Q, converted into standard variables using the MATLAB m-file read_lmg_met1m(yd), and after simple editing, stored as MATLAB mat files (e.g., the file for yd 50 is jg050a.mat). These files were then merged into a composite file lmg_met1m.mat for the entire cruise using merge_lmg_met1m. A subset of the 1-minute cruise data (called cruise_met.mat) was created to cover Leg 2, when the *L.M. Gould* was working in the study area south of Palmer Station. This cruise_met data were then used to estimate the surface wind stress and heat flux using create_lmg_wshf1m and stored back in cruise_met. For further analysis, 1-hour averaged wind stress and heat flux time series were constructed and saved as part of cruise_met. Copies of these MATLAB files, the m-files used to construct them, the edited daily JGOFS mat-files, summary figures, and document are included in the cruise data CD.

Overall, the data quality of the meteorological and underway data looks good with one important exception. The shortwave radiation time series exhibits a negative bias during the night-time which is both large and variable in time (Figure 15). Unlike the PAR record which exhibits a clean day/night transition from nearly 0 to much larger values, the day/night transition in the shortwave radiation is difficult to determine due to the low values on insolation and the large variable bias. It is not clear if this bias is in the sensor itself or in the electronics between the sensor and the ship's DAS. An initial attempt was made to remove this bias by subtracting from the raw SW data a line which connects the lowest value before sunrise and the lowest value after sunset, and setting the SW values between sunset and sunrise to 0. This corrected series (called swnf in cruise_met) was used to compute the short-wave heat flux component.

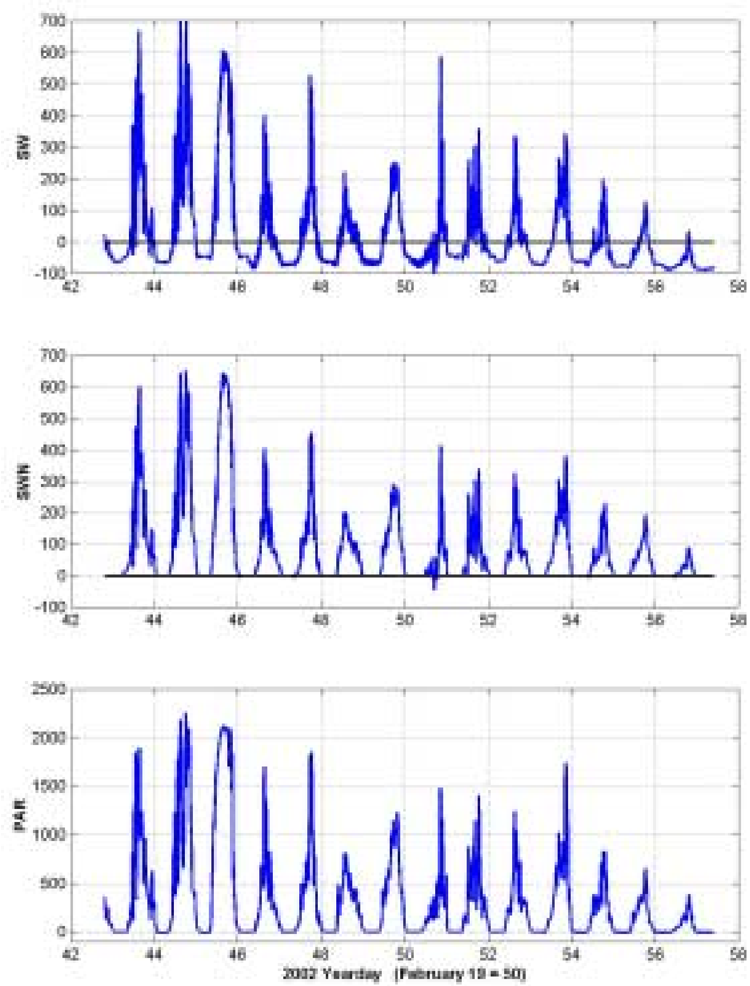

Figure 15. Raw shortwave radiation SW (SW, top panel), "corrected" shortwave radiation with the nighttime bias removed (SWN, middle panel), and raw PAR (bottom panel). These data have been averaged over 10 minutes for plotting.

4.4 Description of Cruise Weather

Time series of the 10-minute averaged surface meteorological data during Leg 2 are shown in Figure 16. Winds were generally moderate (less than 25 kts) and oriented primary towards and from the northeast for most of the first 8 days of this leg. The air and sea surface temperatures reached their lowest values on yd 45, when the *L.M. Gould* was working in the edge of the ice recovering the B3 mooring. The winds during this day were from the southwest, and the air was both cold and relatively dry. The first major storm arrived on yd 50, with a quick drop in the barometric pressure, winds from the north and northeast, reaching over 40 kts as the *L.M. Gould* stopped its mooring work and steamed into Marguerite Bay near the British base, Rothera, on Adelaide Island. This storm continued to bring warm air and strong winds as the *L.M. Gould* conducted marine mammal survey work inshore east of Adelaide Island. As the winds weakened over the next several days, the *L.M. Gould* was able to resume mooring work, and on the afternoon and evening of yd 53, conditions were prefect (very weak winds, good sunlight) for the marine mammal work conducted along the ice edge in southern Marguerite Bay. The desire to continue to work the ice edge evaporated the next morning (yd 54) when the second major storm hit Marguerite Bay. High winds persisted for most of the rest of this leg, reaching over 40 kts from the northeast on yd 56 during a rapid drop in barometric pressure. Part of this period was spent working in Pendleton Pass, where the ship was partially sheltered from the high winds over the shelf. The winds did drop sufficiently for the SIO S7 mooring to be deployed just before returning to Palmer Station.

4.5 Description of Surface Fluxes

The surface wind stress and heat flux components for Leg 2 are shown in Figure 17. The two major storms produced peak wind stresses of about 1.0 N m^{-2}, with much weaker stresses (less than 0.2 N m^{-2}) for about 70% of this leg. These two storms dominate the mean stress, which has a magnitude of 0.10 N m^{-2} directed towards the south-southwest (-97^{o}CCW wrt E). Table 5 gives simple statistics for the east (Tx) and north (Ty) wind stress and the heat flux components for Leg 2.

Table 5. Wind stress and heat flux statistics for LMG02-01A Leg 2. Heat flux components are: net heat flux–Q_{net}; shortwave radiation–Q_{sw}; longwave radiation–Q_{lw}; sensible heat flux–Q_{sen}; and latent heat flux–Q_{lat}. Units for wind stress are N m^{-2}; those for heat flux are W m^{-2}.

Variable	Mean	St. Dev.	Mininum	Maximum
Tx	-0.013	0.146	-0.661	0.534
Ty	-0.097	0.166	-0.970	0.279
Qnet	-27.7	101.5	-236.1	331.5
Qsw	71.1	113.7	0	589.6
Qlw	-102.0	27.7	-194.5	-69.3
Qsen	8.1	15.8	-41.4	73.8
Qlat	-4.9	12.8	-53.7	25.4

The mean net heat flux into the ocean during Leg 2 was -28 W m^{-2}. The generally overcast and cloudy conditions limited the incident shortwave flux to relatively low daily values, but also caused a decrease in the longwave heat loss. The resulting net radiation flux was -31 W m^{-2}, roughly comparable with the mean net heat flux. The weak mean sensible heat flux gain and latent heat flux loss tend to counterbalance, so that the net air-sea flux was only $Q_{sen} + Q_{lat} = 3$ W m^{-2}, which is not significantly different from 0.

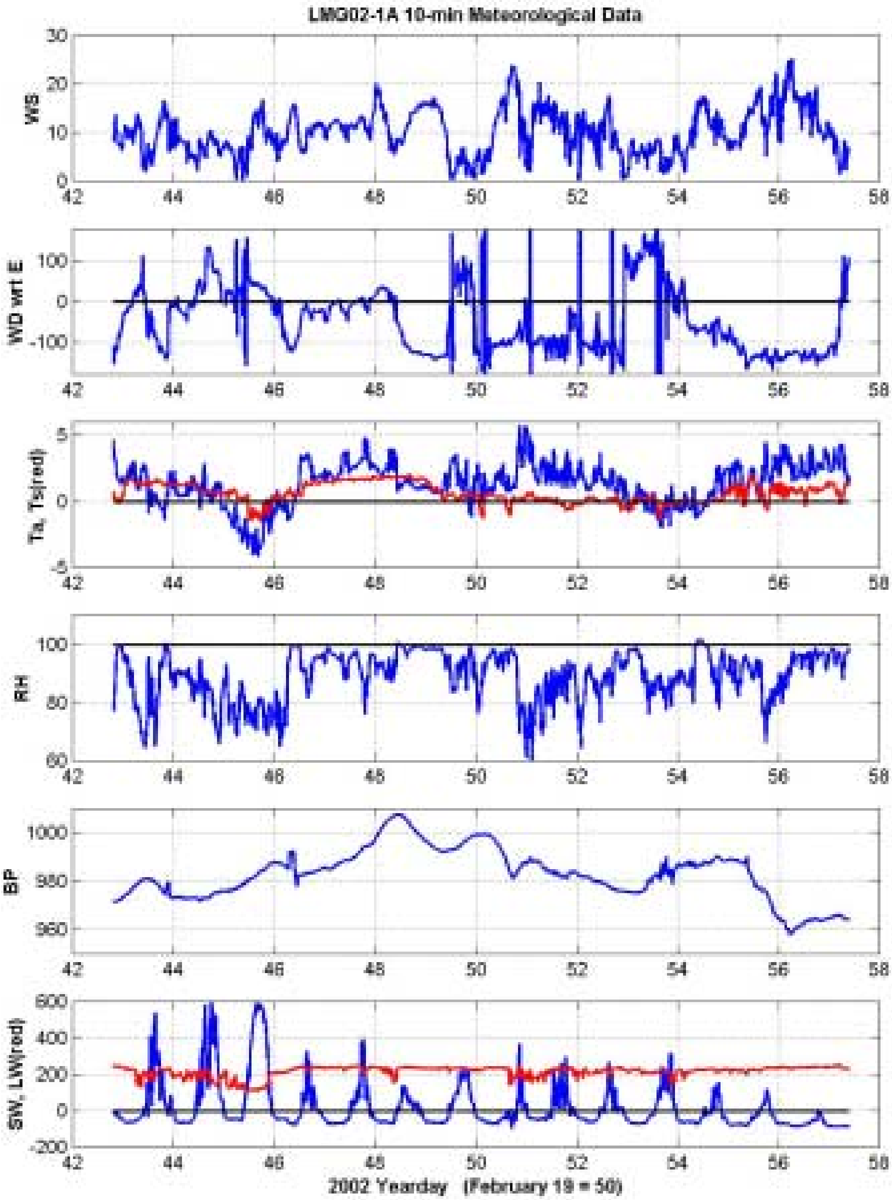

Figure 16. Surface meteorological measurements during Leg 2 of LMG02-01A. The wind direction plotted is the direction the wind vector is pointing with respect to east (e.g., a wind blowing towards the south = -90^o, an eastward wind = 0^o). Units are: wind speed, m s^{-1}; temperature, ^{o}C; relative humidity, %; barometric pressure, mb; short- and longwave radiation, W m^{-2}.

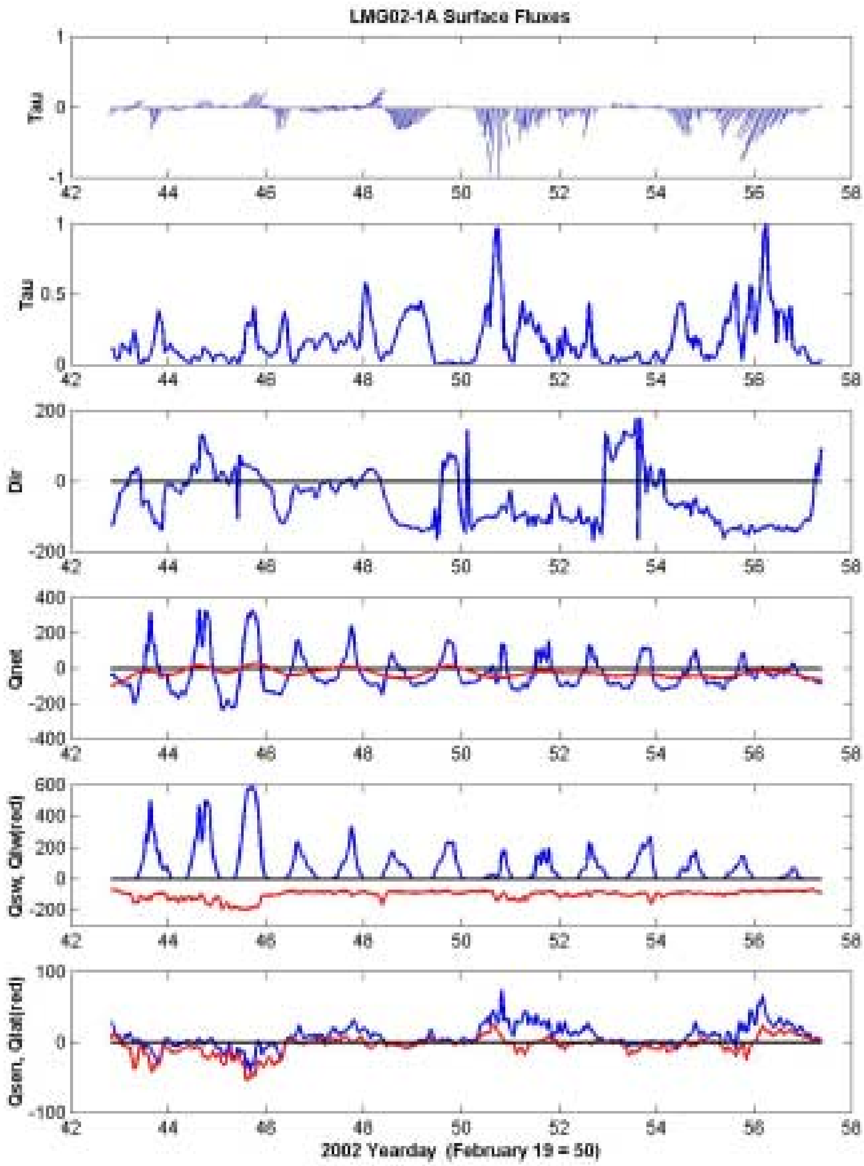

Figure 17. Surface wind stress and heat flux during LMG02-01A. Units of wind stress are N m^{-2} and those for heat flux are W m^{-2}.

5.0 Marine Mammal Observations

5.1 Acoustic Census of Mysticete Whales

The primary goal of this project is to determine the minimum population estimates, distribution and seasonality of mysticete whales within the west Antarctic Peninsula region. These data will be integrated with the rest of the SO GLOBEC data set to improve the understanding of Antarctic krill ecology in the area. Because the vocalizations of most baleen whales are species specific and easily recognizable, passive acoustic techniques can be used to determine long-term, seasonal presence of a species in the area. The species of interest are blue (*Balaenoptera musculus*), fin (*B. physalus*), humpback (*Megaptera novaeangliae*) and minke (*B. bonaerensis*) whales. Southern right whale (*Eubalaena australis*) and sperm whale (*Physeter macrocephalus* – an odontocete) calls may also be detected but are expected less frequently.

The primary purpose of this cruise was to recover and redeploy 8 bottom-mounted ARPs. The ARPs consist of a data logging system with 2 18-gigabyte hard disks, an acoustic release, and a hydrophone component floating 10 m above the mooring. The sampling has been conducted continuously at 500 samples over the 11 months of the deployment. Also during this cruise, sonobuoys were deployed opportunistically to supplement the information obtained from the visual observations, as well as the ARP data. Sonobuoys are expendable underwater listening devices. Four main components of a sonobuoy are a float, radio transmitter, saltwater battery, and hydrophone. The hydrophone detects underwater sounds, which are transmitted to the underway ship using radio waves. These sounds can be reviewed for whale calls in real-time and simultaneously recorded onto a digital audio tape (DAT). We deployed 3 types of sonobuoys: 41B and 57B omni-directional sonobuoys that cannot determine the location of the sound source, and 53B DiFAR (Directional Fixing And Ranging) sonobuoys that can be used to determine the exact bearing of the sound from the sonobuoy.

Seven of the eight ARPs were recovered successfully. Most instruments came back in fairly good condition. There was evidence of crevice corrosion on the shallow water instrument (S7) and corrosion due to a connector leak in one of the deeper instruments (S3). The other shallow water instrument (S8) never surfaced even though we were able to talk to it acoustically and send the release command. Four instruments (S1, S2, S3, and S4) appear to have complete, high quality data sets. The other three instruments (S5, S6, and S7) had problems that resulted in partial data return. We have been unable to read one of the hard disks from the leaky instrument. The other disk is full with good data, so we are hoping to recover the first disk upon return to land and thus retrieve all data for that site.

All of the recovered instruments were serviced, parts in question were replaced and we were able to redeploy them. The deployments of all 7 instruments were successful. Six of the 7 instruments were deployed at the original sites, and one was deployed at a new site within Marguerite Bay (S9). Old site S3 was not repopulated, and no new instrument was deployed on S8. (See Figure 1 for ARP locations.)

Preliminary analysis of the ARP data shows high numbers of calls on all instruments. Blue whale calls (Figure 18) seem to be present in numbers greater than expected, and there is evidence of the presence of calling blue whales year round. Also, initial blue whale call analysis indicates the possibility of higher source levels than have been reported for the species previously. Blue whale calls seemed stronger on the shelf break than on the shallow water instruments. Fin whales (Figure 19) seem to be present seasonally, with stronger fin whale calls heard on the instruments from the shelf break. A few minke whale calls were seen in the preliminary analysis. Seal calls were heard on S7, they are mostly likely crabeater seals (Figure 20). Two types of unidentified calls (Figure 21) were seen frequently on all instruments, showing higher call presence during the ice-covered periods. The source of these sounds is not known at this time, but the two possibilities are a fish species or minke whales. No southern right or humpback whale calls were seen in the preliminary analysis.

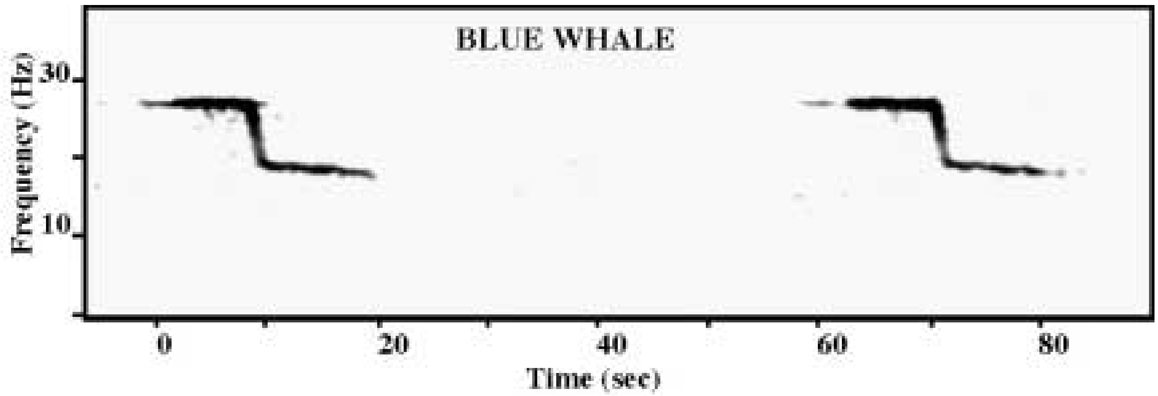

Figure 18. Antarctic blue whale calls recorded on the ARPs. The call is a 28 Hz tone of 10 seconds duration, followed by a 1 second down-sweep (28-19 Hz) and a 10 second slightly down-swept tone (19-18 Hz).

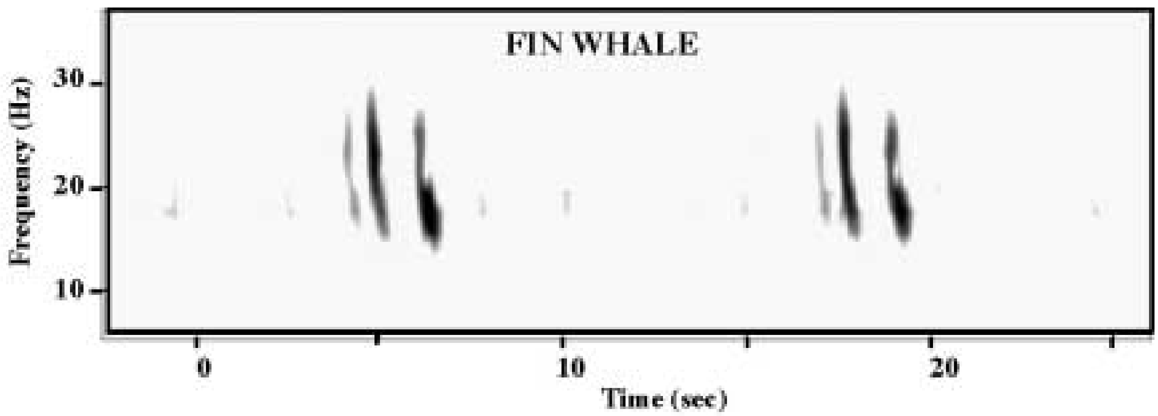

Figure 19. Antarctic fin whale calls recorded on the ARPs. The call produced by the whale is a single down-swept pulse (30-15 Hz). Multipath propagation produced 2 additional pulses.

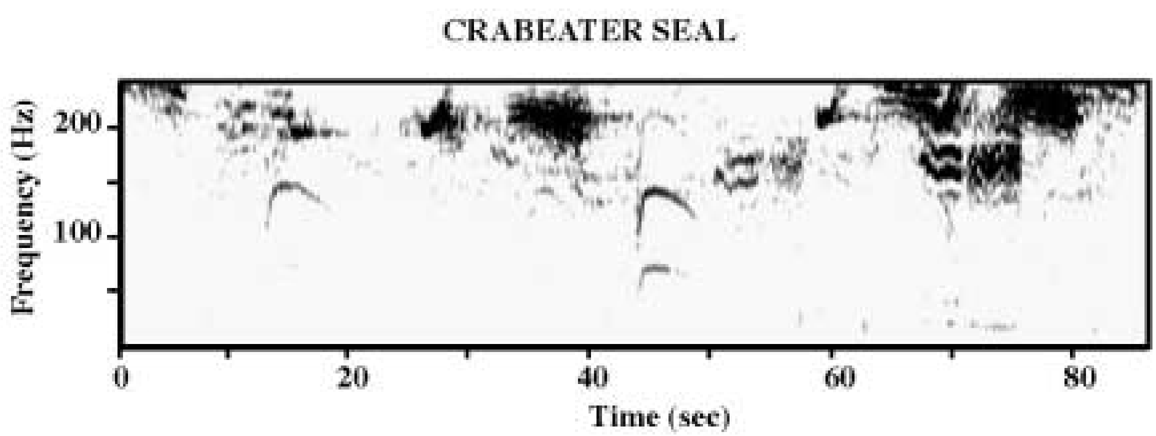

Figure 20. Seal calls recorded on ARPs, most likely crabeater seals. Complex tones and pulses are produced. Some of the original energy might have been above 250 Hz (the Nyquist frequency for ARPs).

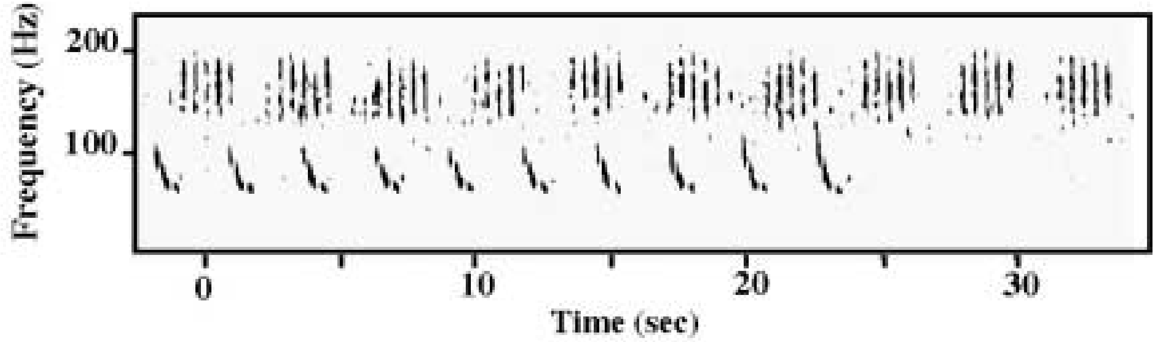

Figure 21. Unidentified calls recorded on the ARPs. Sets of 5 down-swept pulses are produced by one animal, and a set of single down-sweeps (110-60 Hz) by a different animal.

Sonobuoys were deployed both when marine mammals were visually detected and also randomly throughout the cruise. A total of 39 sonobuoys was deployed – 34 omnidirectionals (19 of type 41B and 15 of type 57B) and 5 DiFARs (53B). The locations of all the deployments are shown in Figure 22 and given in the cruise event log (Appendix 2). Species heard on the sonobuoys were blue whales, minke whales, and possibly a fin whale (Figure 22). Sperm whales clicks, as well as unidentified beaked whale species (possibly Hector's beaked whale) whistles were heard on sonobuoys deployed in Drake Passage.

5.2 International Whaling Commission Cetacean Sighting and Biopsy Summary

Visual survey was conducted throughout the cruise in suitable weather conditions and commenced off the east coast of Chile on the southward journey to the western Antarctic Peninsula study area. Few sightings were made until reaching the Boyd Strait and Gerlache Strait area on 10 February 2002. Humpback whales were numerous in this area (28 sightings/59 animals). Throughout the first mooring deployment phase of the cruise (11–18 February 2002), small numbers of humpback, sei, minke, killer and unidentified whale sightings were made. After weather conditions deteriorated at B2 mooring site on 19 February 2002, the ship headed for Porquois Pas to conduct cetacean survey in calmer waters until weather cleared in Marguerite Bay. Weather conditions were not good, and only small numbers of humpback and minkes were sighted. Mooring deployments commenced in Marguerite Bay the evening of 21 February 2002.

Cetacean surveying continued on the afternoon of 22 February 2002 on a track to the ice edge. Humpback whales were concentrated near the ice edge (10 sightings/30 animals) at the southern end of Marguerite Bay. Two biopsy trips were made using the Zodiac, resulting in five biopsies (skin and blubber) from two groups. Plans to continue the survey along this ice edge to the east were cancelled due to worsening weather the next morning.

The ship again headed for the protected east coast of Adelaide Island and Matha Strait. Matha Strait was reached on the morning of 24 February 2002. The sea ice edge here extended out into the mouth of the Strait, precluding survey. A large number of seals were evident here throughout the sea ice. The ship headed further north to Pendleton Straits and cetacean surveying was conducted throughout this area. Humpback whales were concentrated in the Pendleton Strait/Mudge Passage area. Single minke whales were also sighted throughout the passage.

Palmer Station was reached on 26 February 2002. Two pairs of humpbacks were sighted off Cormorant Island by Palmer Station personnel and a Zodiac trip to obtain biopsies resulted in two samples from one pair and individual photo-identification records for all four animals. Humpback whales were also numerous during the transit through Dallman Bay on 27 February 2002 (20 sightings/42 animals). Calm conditions across Drake Passage on 28 February 2002 provided good sightings of three groups of Mesoplodon, hourglass dolphins and a sperm whale. The total time on effort up to 28 February 2002 was 148 hours and 40 minutes, and the summary of the cetacean sightings is given in Table 6. Figure 23 shows the distribution of the cetacean sightings in the study area.

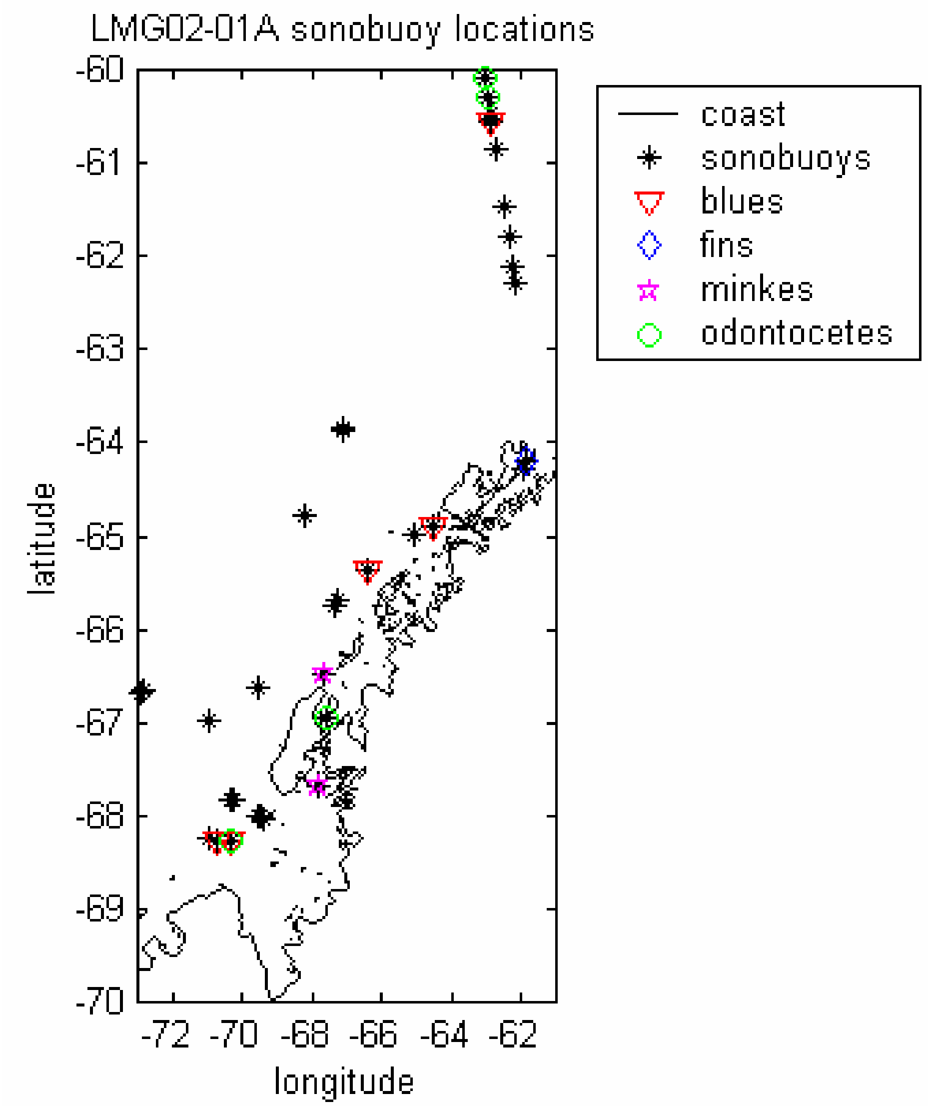

Figure 22. Sonobuoy deployment locations with species heard on the sonobuoy marked. Calling whales can be heard at large distances from the sonobuoy so a detected call does not necessarily indicate vicinity of whales.

Table 6. Summary of cetacean sightings during LMG02-01A (to end 28 February 2002).

Cumulative species	Cumulative sightings/animals
Unidentified large whale	7/10
Hourglass dolphin	2/14
Humpback	75/168
Undetermined minke	13/18
Unidentified whale	11/62
Killer whale	1/25
Sei	1/8
Unidentified small whale	1/2
Unidentified cetacean	2/3
Like minke	2/2
Mesoplodont	3/13
Sperm whale	1/1
Cumulative TOTAL	117/322

6.0 Chief Scientist's Cruise Narrative

Wednesday, 02/06 (yd=37)

The start of LMG02-01A was delayed one day while we waited for a shipment of lithium batteries for the SIO moorings to arrive. The original air shipment of three containers got split en route, with one container making it to Santiago, Chile and the other two eventually arriving in Mexico. Once they were found, these two containers were sent to Miami, FL and then Santiago, Chile, where AGUNSA hired a plane to fly all three containers to Punta Arenas, Chile, where they were delivered to the ship at 1500, just two hours before we were to steam. These batteries are considered "hazardous material", and can not be air shipped on an airplane with passengers, thus the need to hire an empty commercial jet for the Santiago to Punta Arenas leg.

The ship left Punta Arenas with a pilot aboard at 1700 (Local Time = GMT-3). Strong winds from the west at ~25 kts, with scattered clouds. Andy Nunn (RPS) fixed the connection on the long-wave (PIR) sensor, so that it seems to be working fine. After dinner, the Chief Mate gave us a safety briefing, and we all donned our survival suits, and entered the rescue boat. Then we held a brief science meeting with all the science crew and Raytheon staff.

The ship left Punta Arenas with a pilot aboard at 1700 (Local Time = GMT-3). Strong winds from the west at ~25 kts, with scattered clouds. Andy Nunn (RPS) fixed the connection on the long-wave (PIR) sensor, so that it seems to be working fine. After dinner, the Chief Mate gave us a safety briefing, and we all donned our survival suits, and entered the rescue boat. Then we held a brief science meeting with all the science crew and Raytheon staff.

Thursday, 02/07 (yd=38)

Sky was most clear all day, with some scattered clouds. Held meeting with Captain and all mooring folks, to explain what operations would be done, and how the different groups would work together. I analyzed the CTD data taken at 3 deep stations just west of the southern tip of Adelaide Island on the LTER cruise LMG02-01 to compute a mean sound speed for our bathymetry work. The mean value was 1456 $m\ s^{-1}$. The original (default) value 1500 $m\ s^{-1}$ will be changed to this new value at Palmer Station. Andy held a short class on using the new automatic XBT launcher at 1900, and the XBT/XCTD/ADCP section across Drake Passage was started about 2148.

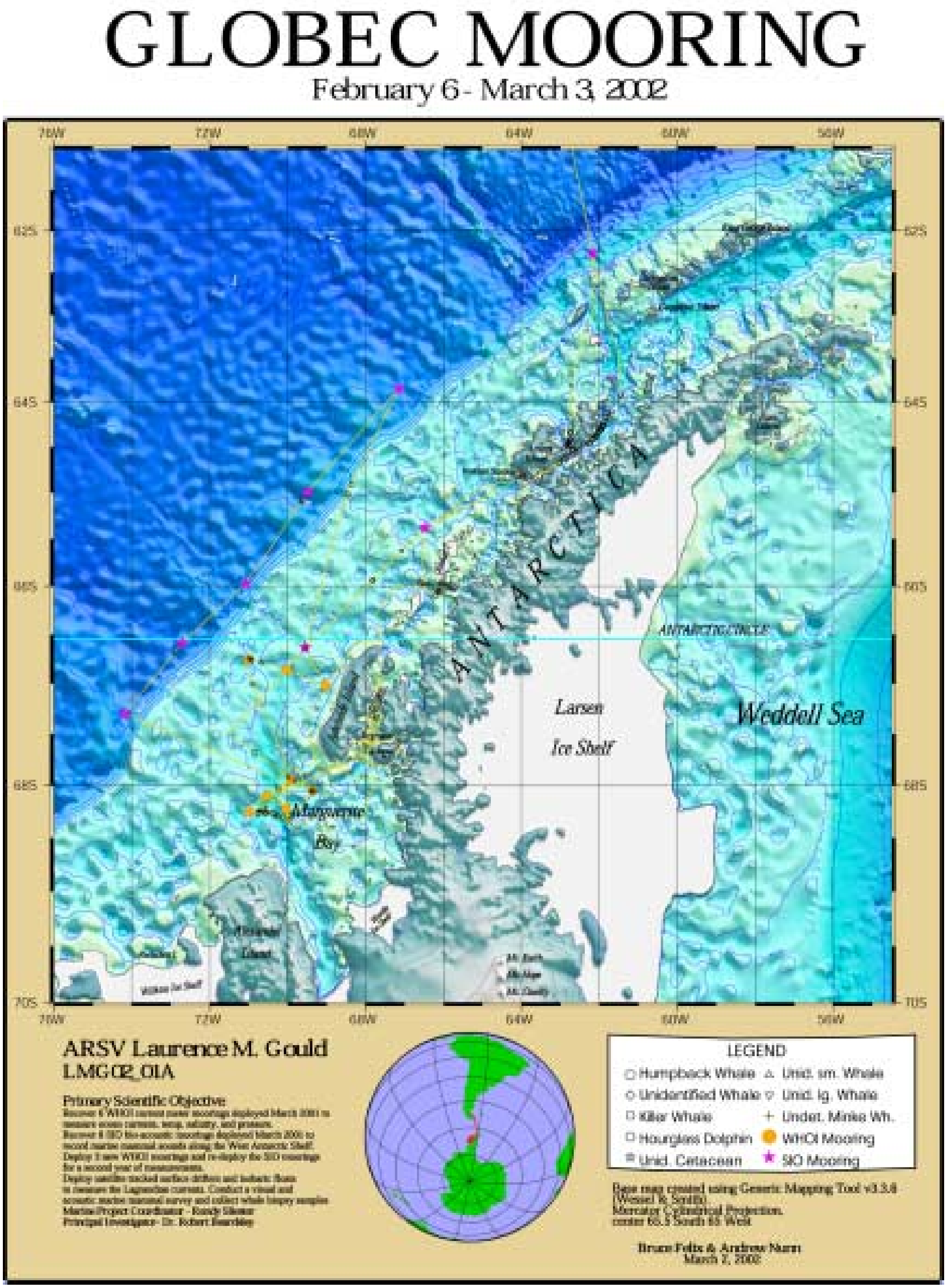

Figure 23. Map of cetacean sightings in study area.

Friday, 02/08 (yd=39)

Continued the XBT/XCTD/ADCP section across Drake Passage. The auto XBT launcher is working well. Winds strong all day, about 25-30 kts from the N and NW. Overcast occurred all day, causing very low shortwave readings from the PSP. Because these values were so low, I processed the JGOFS met data collected on LMG02-01, and found that during the last five days when the LMG was steaming back to Punta Arenas, the PSP values ranged from ~800 W m^{-2} on clear days to lows around 200 W m^{-2} on cloudy days. The long-wave sensor PIR values also ranged from ~ 180 to 320 W m^{-2}, with a mean value of ~260 W m^{-2}, over the last 4 days of LMG02-01. The initial PIR values on our cruise seem a little low in comparison, but okay. Andy checked that the PIR and PSP calibration coefficients were correctly entered in the ship's DAS software.

Saturday, 02/09 (yd=40)

Clear sky in morning, with bright sun, distinct shadows on deck, lower winds, 10-20 kts from W and NW, with air temperatures now down to roughly 5°C. The XBT/XCTD/ADCP section was continued, with surface ARGOS drifters deployed at some specified XBT sites. Deb Thiele (IWC) spotted several whales, and Mark McDonald deployed several sonobuoys, catching blue whale calls that identified the whales as belonging to the Antarctic group. We started the SO GLOBEC cruise event log with Deb's whale watch (decided not to include the XBT/XCTD deployments in the event log since that data will be sent to Teri Chereskin (SIO) as part of her research effort). During the day, the sky remained most clear, with PSP readings reaching up to roughly 600 W m^{-2}, which seems more normal. Will want to check on the PIR and PSP values collected today by processing today's JGOFS met data tomorrow morning.

Afternoon marked more clouds, some overcast developing. ETA to the first SIO mooring S1 is about 1800, just after dinner. Approached S1 about 1840, then waited while the hydraulic hose on the knuckle crane was repaired. A XCTD cast was made at 1855, providing a clean cast to about 550 m. S1 release command first sent 1913, then resent. S1 surfaced about 2020 and was onboard by 2039. S1 was taken directly to Baltic room and secured, and deck secured, we continued the XBT/XCTD section towards Palmer Station.

Sunday, 02/10 (yd=41)

Entered Gerlache Strait in very early morning, some low clouds and overcast, but still bright, winds down to 5-10 kts, from the SE. Deb and Rebecca Pirzl started their marine mammal survey early, and saw some whales before 0850, when first sonobuoy was launched. The initial reading of S1 indicates blue, humpback, and fin whale calls, plus a periodic loud noise in the last few days, suggesting some ship had passed using an air gun. Met the NBP during final approach to Palmer Station.

The LMG docked at Palmer Station at 1645. Safety meeting with Station Manager just after docking. Off loading of gear for Palmer Station started, and once the vans were removed from the deck, Scott Worrilow and crew relocated the mooring winch and some other deck equipment. Most of the scientific party went ashore, some took the trolley to visit the small peninsula just north of the station, but only saw a few penguins and no seals, some went to the station store, and then most went to the station bar for fun and pool. The crew of the NBP came ashore after dinner, including John Anderson, the chief scientist on their geophysics cruise. We meet, and I showed him some of the SO GLOBEC multibeam data that we have collected, and he agreed to give us much of his NBP SeaBeam data except for several small regions where they have done extensive mapping as part of two students' thesis research. I assured him that this was fine. John has already told Susanna York to send us John's data once their cruise is over, and Susanna is back at Lamont-Doherty Earth Observatory. John also mentioned several maps and references to the bathymetry in the SO GLOBEC area, which we will get after the cruise. I was very glad to meet John, and obtain his cooperation.

Maria Vernet asked if we would be willing to collect water samples for chlorophyll analysis. We agreed to collect 10 bottles at standard depths during the CTD casts made at the WHOI moorings, provided this activity did not require much extra time. Maria then set up a filtration system in the dry lab, and went over the water collection and processing methods. The filters with samples will be stored in the freezer for analysis back at Palmer Station. The winds picked up during the evening, with some rain.

Monday, 02/11 (yd=42)

Awoke at 0700 to find winds up to 30-40 kts, with gusts up to 50 kts and heavy rains at times. These high winds make it too dangerous to use the main crane, so we will have to wait until the winds are down below 30 kts before the LMG hatch cover on the main hold can be opened and the van and other supplies that can not be frozen can be lifted using the main crane and transferred to shore. Also, the ship needs the winds from the W and NW to be below 30 kts to be able to steam away from the dock without danger of being pushed on the opposite rocky shore.

The winds finally dropped below 30 kts around noon, and after lunch, we all went to work on off loading the remaining van and other supplies for Palmer Station. Then got our mooring gear spotted and secured on deck and the VACMs and floats in the deck wet lab. Randy Sliester (RPS) and Josh Spillane (RPS) and others got the rest of the scientific gear and supplies in the hold organized and secured. Around 1500, Andy changed the ADCP sampling configuration file to the SO GLOBEC file. Andy also changed the sound speed in the ship's depth sounder from 1500 m s^{-1} to 1456 m s^{-1}, which we will keep fixed until our return to Palmer Station. With a bit of sun breaking through the overcast, and northeast winds of 15-25 kts, we left Palmer Station at 1600. The LMG will steam at roughly 6-8 kts to reach the SIO mooring S7 at 0400 tomorrow. We have a very tight cruise schedule, and hope to recover both S7 and S8 before heading to the WHOI A-line to start mooring recovery there.

John Hildebrand has asked that we obtain a sound speed profile at each of the SIO mooring sites. There is one case of 24 XCTDs on board, but it is unclear if these can be used (Andy is checking with RPS). There are several cases of XBTs on board, so we decided to drop a XBT at the next two mooring sites (S7 and S8), which should provide the temperature profile needed for constructing the sound speed profile. Breck Owens has also asked about making a CTD cast just before or after his float deployments. The instruments initially remain at the surface for about 30 minutes before starting their first decent. The CTD cast is to check the float temperature and conductivity sensor calibration. To save time, we decided that Breck could launch floats at the WHOI mooring sites with no time cost since we plan to make a CTD cast at each mooring site. The other floats could be launched without a CTD profile, since the water properties below 200 m are horizontally uniform enough to allow a check of the float's bottom values.

Tuesday, 02/12 (yd=43)

Arrived at S7 at 0400, and decided to wait for more light before starting the S7 recovery. While waiting, deployed one sonobuoy and made XBT cast 77. By 0445, sufficient light to start, and the release was fired at 0455, mooring spotted at 0522, and on deck by 0545. During final maneuvering to pick up instrument, the ship's DAS froze, so that the Captain did not have wind information in the aft control room. Andy had to reboot the DAS, which did not take long, so it was up as we left S7. Departed S7 for S8, with a deployment of one WHOI surface drifter and one float roughly half-way between S7 and S8.

Drifter 25180 was deployed at 1203, and float 138 deployed at 1205. Conditions are excellent, winds 10-15 kts from the NW, scattered clouds, some clear sun. The ship slowed to a few kts and both instruments launched over the port quarter. Ship then picked up speed and continued to S8. Andy has some 800-m XBTs that we can use along the outer SIO mooring line. We will continue to use XBTs at the inner SIO sites.

Arrived at S8 at 1700, having deployed a sonobuoy about 1645 and XBT cast 78 about 0.3 nm from the site. Burn command was sent 4 times with confirmation received, however, mooring appears to be stuck in the bottom. A short snow squall with increased winds passed the ship about 1745-1830, followed by moderate winds ~15 kts and clear visibility, great conditions for mooring recoveries. Decision made to wait on station until 2300, hoping that the mooring will free itself from the bottom and surface. The ship will steam a line over the mooring 1 nm on each side, and monitor the acoustic range to the mooring. At 1100, decision made to leave S8 and steam to A1. As leaving site, drifter 24477 was deployed at 2321 and float 139 deployed at 2322.

<u>Wednesday, 02/13 (yd=44)</u>

Arrived at A1 at 0400. Andy and Breck made CTD cast 1 about 0.2 nm from A1, tripping 12 bottles, doubles at surface and bottom, singles at the other standard depths. Standard procedure is for the CTD to be lowered to 10 m for approximately 10 minutes for the oxygen sensor to equilibrate with the water temperature. Andy and Sara Disick drew water samples for salt and filtration. The CTD was onboard by 0507, and the release command sent while the ship was still 0.2 nm downwind (east) of the reported position. The ship slowly headed towards the site, release command resent, and the mooring surfaced about 50 feet behind the ship at about 0530. Recovery went smoothly, although there was a wire wozzle near the ADCP. Little growth (just a slight film) on the flotation balls. The mooring was on deck by 0646, and the deck cleared by 0745. We then headed for A1, with an ETA of 0945.

Arrived A2 at 0945. Scott checked that release was there, then we did CTD cast 2 about 0.3 nm to north of A2 position. CTD cast completed by 1042, then we steamed slowly towards A2 until about 500 m from site, Scott sent the release command at 1052, and A2 popped to surface within a few minutes. The recovery went very smoothly, and all equipment looked to be in good shape except the top two microcats had one holder broken off. A2 was on deck by 1206, and after a break for lunch, equipment was put away and the deck cleared by 1400 as we headed for A3. The weather during the recovery varied from very brief snow showers to sunny skies with only a few clouds to low overcast. Winds were moderate, ~ 10 kts. The barometric pressure has been very steady at ~ 975 mb for most of the day. ETA at A3 is 1530.

Arrived at A3 at 1515, with ship stopped about 0.3 nm to the N. Scott tried but did not hear any return from the release. Even with ship declutched, no return. Checked deployment position with independent data from last year, and found that the position given in the cruise report is correct. Decided to do CTD cast 3, then try to talk to release again. CTD cast 3 was completed by 1616, and ship repositioned about 0.3 nm from A3 location, declutched, but no response. Moved ship to top of location, release did respond, giving a range of 492 m, about exactly water depth, so we were very close to top of mooring. Ship drifted back from location, and Scott sent the release command at 1647, and top float surfaced ~ 30 sec later. The rest of the recovery went smoothly, with all instruments looking good, almost no growth on any sensors. A3 mooring was on deck by 1800. After dinner, deck was cleared and ship started towards B1. ETA is 0400 tomorrow. Breck and Dick Limeburner deployed float 137 at 1049, about half-way between A3 and B1.

<u>Thursday, 02/14 (yd=45)</u>

Arrive at B1 at 0350. Scott was unable to talk with the acoustic release, from ranges of 0.3 nm to ~0 nm, so we made CTD cast 4. After CTD was completed by 0455, Scott sent fire command at 0513, with no response. At 0537, ship started a spiral visual search out to ~ 4 nm with no luck. This search stopped at 0700, and the ship headed for B2 as Deb Thiele started the marine mammal survey. Arrived at B2 at 0833, and Scott got release there confirmation. Since the ship was surrounded by significant sea ice, we decided to go to B3 and work on it, while waiting for the wind to blow away the sea ice from B2. Ice patchy on way to B3.

Weather this morning was excellent, bright sunrise, very few clouds, winds ~ 5kts, low seas (few whitecaps). Can see mountains on Adelaide and Alexander Islands. During yesterday and this morning, the barometric pressure has remained nearly constant, until 0700 when the pressure started to rise.

Arrived at B3 at 1027. Scott could talk to the release, so we did CTD cast 5 about 0.3 nm to NE of mooring location. CTD cast completed by 1110, and we decided to get an early lunch before sending the release command and starting the recovery. It is sunny, with very few clouds, excellent visibility (can see mountains on Alexander Island), winds have increased to 20-30 kts towards the SW, and ice patches with roughly half clear water. This will be a cool recovery, with air temperature about -3^{o}C, SST about -1.3^{o}C, wind chill about -20-25^{o}C.

At 1155, release command sent, from a range of about 900 m. No confirmation, so ship moved closer and release command sent again at 1200. Release confirmation came at 1203, and the red floatation sphere popped to surface by 1206. Only one glass ball was visible, and it was underwater frequently. After trying to hook into the glass balls, the Captain backed into the red sphere, and the rest of the mooring then recovered. The B3 mooring was on deck at 1315. It looks like a berg hit the uppermost (yellow) floats, catching on the sharp angles of the ARGOS/light bracket and causing a small leak at the top of the sphere. As a result, all the instrumentation about the red flow was hanging down from the red float. Hopefully this happened late in the deployment. The bottom pressure record looks fine at B3, with no indication of mooring movement over the deployment period. We cleaned the deck while the ship headed back to B2. Noticed several seals on ice floes that passed close to the ship, also one penguin.

Arrived at B2 at 1530 and completed CTD cast 6 at 1634. Moved ship to about 0.3 nm of site, and sent the release fire command at about 1644 (the yellow sphere popped up at 1646). Some ice patches were present, but did not present any problems. The entire mooring was on deck by 1815. The ice profiler had lost its entire flotation collar with 4 poly floats, i.e., the four plastic rods that attached the collar to the stainless steel frame were broken off, so the profiler was hanging down from the 100-m yellow float. The profiler has a depth recorder, so it should be easy to determine when this happened.

Then headed towards B1 and open waters and Scott conducted a box grid stopping every 2 nm to try to talk with the release. This search was started about 2030 and ended about 0200. Then the ship headed for SIO mooring S6. ETA = 1200.

<u>Friday, 02/15 (yd=46)</u>

Spent morning steaming to S6. Weather: low overcast, fog, air slightly warmer than water by about 1^{o}C, winds 15-25 kts from the NW, but variable. Barometric pressure shows a very curious short bump then depression starting about 0730 and lasting to about 0900, perhaps a mini front associated with the fog and highly variable winds.

Arrived at S6 at 1215. Sent first fire command at 1218, then sent second fire command at 1235, and received confirmation, as S6 started to rise. During the ascent of S6, got replacement unit ready to deploy. Deployed replacement at 1348, roughly 0.4 nm from original site. S6 then surfaced and was recovered and on deck by 1412. Andy then dropped an old deep-water XBT while we waited from replacement S6 to land on the bottom. Final commands sent 1500, and we headed for S5, ETA = 2030.

I realized today that Sara had been taking water samples for chlorophyll a filtration but not for salinity, a result of my miscommunication. Salinity samples were taken by Jordan Watson (RPS) on the southward Drake Passage crossing to check the new TSG just installed on the ship. Once these samples are analyzed by Sara, we can check the TSG calibration for this cruise. New primary and secondary temperature and conductivity sensors were put on the CTD just prior to this cruise, and these sensors will be shipped back to SeaBird for calibration immediately after this cruise. We will take two surface and two bottom water samples on all remaining CTD casts to check the conductivity calibrations. Hopefully, this limited check, plus the pre- and post-cruise SeaBird calibrations should be sufficient to determine the uncertainty in the CTD data.

Breck compared primary and secondary temperature and conductivity data for the first 6 CTD casts, and found very small differences, especially below 300 m. The mean differences between the two temperature and conductivity sensor sets averaged over measurements beneath 300 m are -0.90 +/- 0.04 milli-ºC and 0.226 +/- 0.023 milli-S m^{-1}. These differences are small enough that the CTD primary sensor data will be used without any adjustment.

Arrived S5 at 2030. Sent first release command at 2033, then second at 2048 and got confirmation of mooring rising from bottom. During ascent of S5, got its replacement ready and deployed S5A at 2139. Andy then did a deep XBT. S5 surfaced about 2230, and recovered on deck by 2236. Final commands to S5A sent 2300, and we started for S4. ETA = 0430. Weather overcast, winds 10-20 kts from the NW, barometric pressure slowly rising. Little light, but used the acoustic ranging to the S5 unit to steer ship to within 40 m of the ship when it was spotted from the bridge.

Saturday, 02/16 (yd=47)

Arrived S4 at 0430, proceeded to wait until 0500 to start because of darkness. Sent three release commands (last at 0534) until confirmation of mooring ascent. Then prepared replacement mooring S4A and launched it at 0636. S4 recovered and on deck by 0710. The hydrophone had an egg sack attached, Ana Sirovic took photos and saved the egg sack in a container. Final commands sent to S4A at ~0800, and Andy did a deep XBT cast as we left the site, heading for S3. ETA = 1500. Fire Drill at 1230.

Over the last few days, Dick has downloaded the SeaGauges, and made plots of the raw data. All five recovered units appear to have worked well, with a full data return. Comparisons between the SeaGauge temperature with the CTD temperature extrapolated to the SeaGauge depth just before recovery shows that the SeaGauge temperature reading is very close to the CTD value, suggesting that the SeaGauge temperature sensor is in calibration. Comparison with the SeaGauge conductivity/salinity data just before recovery shows an offset of order 0.15 psu for all units. The instrument calibration sheets from SeaBird indicate that the conductivity cells were calibrated before being cleaned, but not recalibrated after cleaning, so there could be a bias and slope offset. We may try to mount the SeaGauges to the CTD and let them soak at 10 m for several record cycles, to get a comparison point at the fresh end (33.7 psu) of the T/S range. The comparison with the deep CTD data gives a comparison at the saline end of the range (34.7 psu). This approach may provide what is needed to correct the SeaGauge data. Dick also has downloaded the work horse ADCPs, which appear to have worked correctly. Dick was able to get all three units ready to deploy on the new C moorings.

Arrived S3 at 1525, Sent three release commands (last at 1602), before getting confirmation of mooring ascent. S3 recovered and on deck by 1710, then deep XBT taken as ship heads for S2. ETA = 0400.

The decision was made to not deploy a replacement instrument at S3, so that it could be deployed at a new site S9 within Marguerite Bay. Also, there is some concern that the S4A hydrophone may be too quiet, i.e., have low gain, so at S2, John and group will decide if they want to revisit S4A and recover it and deploy a new instrument with a different hydrophone. They decided to leave S4A as is.

Sunday, 02/17 (yd=48)

Arrived at S2 about 0400. Sent second release command at 0721, with confirmation of instrument starting to rise. Then prepared S2A and deployed it at 0542. S2 recovered and on deck at 0616. Then a deep XBT fired at 0630, and two sonobuoys launched at 0631 (it failed) and

0636. Final commands sent to S2A at 0653, and we headed for float site F4. ETA = 0700 tomorrow.

Meet with Captain, Randy Sliester, Scott, Josh, Deb at 1230 to go over schedule for rest of cruise. We will try to deploy our three new WHOI moorings on Monday and Tuesday, then drag at B1. Then the rest of the cruise can be devoted to marine mammal work. Will determine positions for WHOI moorings this afternoon. The sea ice images, plus information coming from the NBP which is working south of us, suggests that we will not be able to get close enough to Alexander Island to deploy C3 at its intended position. The first alternative is to deploy C3 at B2, in order to get a full 2 year record there. We can do this utilizing all the spare wire rope (365 m) left over from last year's cruise.

At 1500, John suggested that we pass S8 on the way to F4, so that they can determine if the instrument is still there or not. If there, they will disable the release and plan to drag for it or use a ROV on next year's mooring cruise. Asked bridge to do this.

Talked with Dick and Breck about target positions for the C moorings. Plan is to deploy C1 at or near initial site, C2 in the George VI deep channel (Marguerite Trough), and C3 near B2. This would place the moorings in a L, with two across the month of Marguerite Bay and one offshore. One might guess that the surface flows may be coherent, but the deep flows uncoupled. These are all high risk locations, since all moorings on the B-line had sea ice damage. However, these new moorings will have the top-most float at ~100m, which should help. Also, the B2 mooring came back, so hopefully the new C3 mooring located there should also come back.

John found S8 at 2400 still on the bottom, and left it with the release disabled.

Monday, 02/18 (yd=49)

Arrived at F4 at 0700 and deployed float 110 at 0707, then headed to F5. Deployed float 112 at F5 at 0929, and float 145 at F6 (B1) at 1153.

In route, noticed that some variables in yesterday's JGOF meteorological file had considerable high frequency noise. The variables affected were SW, LW, AT, WS, and RH, all variables placed on the mast or base of the mast. Andy shut down the system around 1030 and is doing some tests to help determine and fix the problem.

Randy reported that the NBP had found a distinct ice-edge at 68º 23' S, 69º 48' W, just about 3 nm south of the proposed C2 site. Also reported winds from the east and southeast, which might push the ice towards the north. We plan to go to C2 after C1 and determine if conditions allow us to deploy at C2. If not, need to move northward.

Arrived at one mile southwest of the proposed C1 site about 1400, and started a bathymetry survey. It took almost an hour to get the MATLAB plotting program to work optimally on my PC, but Dick got it going, as we were starting with the depth survey. After finding the proposed C1 site too shallow, we moved site to west using SeaBeam data as a guide. About 1630, completed depth survey, and moved down-wind to set up for the C1 deployment. The deployment went smoothly, with the top flotation sphere going in the water at 1658 and the anchor released at 1822. Because of the difficult angle of the approach, the bumpy bottom, and the possibility of some fallback, the actual mooring depth could vary from 450 (design depth, and most likely actual depth) to the shallowest of 396 m. Then CTD 7 was completed by 2007, Scott disabled the C1 release at 2017, and float 111 and drifter 25120 were deployed at 2032 and 2033 as we left C1 and headed for C2. Drifter 24476 and float 124 were deployed at 2137 and 2139 about halfway between C1 and C2.

On our way to C2, we checked that the sound speed (1456 m s^{-1}) set in the ship's sounder was close to that computed at B2 (depth average is 1459 m s^{-1}). The difference would only make a 2 m difference in a 1000-m depth reading, so any adjustment for this in the C2 depth survey was ignored.

As we approached the proposed C2 position near midnight, it became clear that this site was several miles deep into heavy sea ice, making it an impossible place to deploy a mooring without causing heavy damage to the instruments on the mooring when it was being dragged through the surface waters.

Tuesday, 02/19 (yd=50)

Using the complete coverage of the SO GLOBEC SeaBeam data in the Marguerite Trough region, we made a high-resolution map of the channel (Marguerite Trough) as a guide, and steamed north along 70ºW until we left the ice front and found a relatively level region within the channel. Because we wanted the site to be within the deep channel (so we can learn about the deep currents in this the major cross-shelf channel) and the bottom quite irregular even in the channel, we conducted an extensive depth survey from 0030 to 0430 to locate a good site, with a design depth of 850 m. Then woke Scott 0500, redesigned the 1000-m C2 mooring to fit the 850-m site, and headed 1.75 nm to the southeast of the drop site to start deploying the mooring. The top flotation sphere was deployed at 0608 and the anchor dropped at 0832, after a long tow to the drop point. As we were deploying the mooring, the barometer and air temperature stated to fall, the wind increased to a sustained 30+ kts from the north, and the seas started to build by noon.

After CTD 8 was completed and the release disabled, we decided to steam to C3 (the original B2 site) to see if the conditions had improved enough for safe mooring operations. Heaved to at C3, the back deck was awash, and the pitching motion would put much too much strain on the mooring line, so Scott called off the C3 deployment and the ship steamed into Marguerite Bay along the southern most tip of Adelaide Island, arriving there around 1700 to start the IWC marine mammal work. Captain reported wind gusts to 60 kts, and the ship's wind sensor reported a peak gust of 106 kts. Conditions much smoother east of Adelaide Island, but winds continued to be 30 kts from the north.

Ship steamed east through Bourgeois Fjord, around Pourquoi Pas Island, reaching the main channel about midnight. A pod of orcas was seen. Captain spoke with the NBP (now located in the sea ice in the southern end of Marguerite Bay) about the weather situation, and they think a strong low will hit us tomorrow (Wednesday) and hopefully blow out by Thursday night. We need one good day to deploy the C3 mooring, and if we can not drag at B1, we will do so next year.

Wednesday, 02/20 (yd=51)

Continued on a zigzag course within the northern Marguerite Bay to look for whales and other marine life. Weather not ideal for this, with winds 20-30 kts, white caps, and scattered rain, all of which made looking for distant whale breaths very difficult. The SIO group deployed occasional sonobuoys.

Around noon, weather still not great for marine mammal operations. Ship doing a zigzag course across the channel moving slowly north towards Tickle Pass, where we hope to find calmer conditions and some whales to biopsy. Ship passing through the Gullet around 1600, and Tickle Pass around 1700.

Scott and crew have been downloading the WHOI instruments. First report is that all VACMs wrote full tapes, an excellent sign. The ice profiler that lost its flotation had many internal electrical connectors disconnected within the pressure housing, indicative of a lot of shaking (vibration).

After exploring the bay north of Tickle Pass, and finding some large ice floes there with a few whales, seals, and penguins, the Captain decided not to stay there for the night, just in case the winds got strong and started to pack ice into Tickle Pass and make it difficult for the LMG to move south again. So the LMG headed south and passed though Tickle Pass and the Gullet around 2100. Spotted a pair of humpbacks and launched the Zodiac with Randy, Mark, Rebecca Pirzl, and Sean Wiggins around 2200. Unfortunately, we lost sight of the whales from the bridge, and they were gone by the time the Zodiac reached their last known position. The Zodiac was back onboard by 2300, and the ship continued south.

Thursday, 02/21 (yd=52)

Started north from off Rothera conducting the marine mammal survey. About 0910, launched the Zodiac with the same crew close to a pair of humpbacks spotted by the bridge (this pair may have been the same pair spotted last night in this area). The Zodiac crew was able to close and look at the whales just before the whales disappeared. The Zodiac returned to the LMG and we started heading south around 1030 towards B2. ETA = 1830.

Met with Scott to modify the 450-m C3 mooring so it could be deployed at the old B2 site. By using the extra wire and the deepest VACM saved when the C2 mooring was shortened from 1000 m to 850 m, the new C3 was lengthened to 815 m, with the ADCP at 110 m, and VACMs at 250, 400, and 765 m (50 m above the bottom). We do not have sufficient microcats to put one on the bottom VACM, and cannot put a SeaGauge at 810 m on the release, since the remaining units have a maximum depth range shallower than 800 m. Therefore, the new array will have just the VACM 50 m above the bottom, and a T-pod just above the release. This will provide good temperature data near the bottom, and hopefully will be able to use the deep T-S relationship to infer salinity. Checked design with Dick after lunch, who thought it fine. Scott and crew will start winding wire on the winch then. Once at B2, we will assess whether conditions are suitable for deployment, and where to start deploying. We will want to deploy going into the wind. Also, we will aim for exactly the old B2 position, and depending on how we approach the position, will add for some fallback.

Arrived at C3 (B2) about 1815, with almost no winds (<5 kts), occasional periods of light snow, limited visibility, and swell from the west and northwest, making the seas confused. Depth at the old B2 site was close within a few meters of 811 m. With no wind, started deployment at 1.5 nm to the southeast from the drop site. Top flotation sphere deployed at 2015. Ship is about 220 feet long, roughly 70 m. Mast with the GPS antennas about mid-ship, so distance from GPS to stern about 35 m. Due to southeast approach, decided to overshoot the drop point by releasing the anchor when the ship's stern was about 100 m northwest past the drop point, so fall back will put the anchor back on the drop point. Anchor released at 2044, with water depth 815 m. CTD 9 was completed by 2200, Scott disabled the C3 release, and we headed for B1.

Friday, 02/22 (yd=53)

Arrived at B1 about midnight. Made one last attempt to communicate with the B1 release but no response. Decided to approach the site from the northwest, making a 0.2 nm half circle around the site and then steam towards the NW before stopping and hauling back. Started the first drag at 0036, first weight on bottom at 0120, depressor with pinger 30 m above in water by 0154. Started turn about 0400, and started hauling in at 0439. There was one large tension event (>5000 lbs), but nothing on the hooks. The hooks were placed at 300 m before the end (last weight) and 300 m behind the depressor weight at 700 m.

Decided to do second drag approaching the site from the south-southwest, then making a half circle around the site, and steaming south and south-southwest before hauling back, plus increasing the length of wire on the bottom from 700 to 1000 m behind the depressor weight. Started deploying at 0637, had wire on the bottom by 0650, started turn at 0745 with a total of 1900 m of wire out. Then closed the circle by steaming south-southwest and stopping at the approach line, and continued to haul back, with no success. The last weight was on deck by 0952, got gear put away, and started south for the ice edge and marine mammal work by 1000.

The dragging operations took about 10 hours, and involved Scott, Ryan Schrawder, and Jim Ryder with Randy and later Josh on the deck, Fernando Naraga on the winch and A-frame, the Captain monitoring the work from the aft control room, and myself helping the mate on watch steer the best course. This work was added to the C3 mooring deployment done yesterday evening, so everyone was extremely tired by the end of the combined mooring/dragging work. Everyone worked extremely well together and safely despite the long hours, and I want to thank them all for their effort. Both drags were well executed, and should have worked if there was any part of the B1 mooring left upright. This suggests that the mooring is not there, that it must have been struck by an iceberg and pulled and smashed, so that the release was broken or towed so far (>5-10 nm) covered in our initial acoustic search. Randy said that he saw many huge icebergs in this area during the LTER cruise this January. Hopefully, the C1 mooring will be more protected by surrounding topography and will survive this coming winter.

The weather conditions for the dragging were quite good, weak winds (<5-10 kts), old swell from the west and northwest, and sufficient light to see if any buoys surfaced. After the dragging was completed, the LMG headed south to near the ice edge, and spotted several groups of humpbacks, and launched the Zodiac for sampling. The Zodiac closed with the whales and obtained one biopsy. Around 1530, the Zodiac was recalled, and the ship headed S and W for the ice edge. The conditions have improved, with weak winds, very few whitecaps, more sunlight, making looking for whales on the bridge much easier. Around 1630, the Zodiac was launched again for biopsy work.

The Zodiac returned to the LMG about 1900. They collected a total of 5 humpback biopsies from two groups. Except for large swell which made spotting the whales more difficult in the Zodiac, conditions were excellent. After Deb came aboard, John, Deb, Randy, and myself met to decide on the schedule for the rest of the cruise. The options were to leave here about 2000 tonight to get to Rothera Station for tomorrow's visit, or stay here where the whales are and continue to work the ice-edge region to the east into Marguerite Bay, and see if Rothera would allow a visit on Sunday. After thinking about this, we concluded that we should cancel the Rothera visit (to give us the most time flexibility) and continue to work the ice edge where the whales are present. Randy called Rothera and cancelled, explaining the need to do the science when it can be done. Rothera understood, and all is fine. We will stop tonight when it is too late to see whales, then start tomorrow at 0400 to work to the east.

Saturday, 02/23 (yd=54)

Overnight, the winds have strengthened to 15-20 kts from the northwest and west, with fog and occasional snow, so visibility and sea state not good for the MM survey work. Detoured north of the Kirkwood Islands and heading back south-southeast to the ice edge at 0900. Hopefully conditions will improve for the marine mammal work.

Conditions remained poor for marine mammal survey work, with winds 20-30 kts from the north and northwest, occasionally from the west, with intermittent good visibility. Deb decided to continue steaming about east then north back towards Rothera, and about 1300 directed the ship to steam to the S9 site for the deployment of the SIO bio-acoustic mooring in the center of the Rothera deep channel. Arrived at S9 about 1515, deployed instrument at 1548, disabled it on bottom while Andy deployed a XBT. John had some initial concern about the launch, in that the glass balls were pulled under the stern rapidly. However, the instrument sink rate was normal, and the release response was normal, so the conclusion was that the instrument was ok. Left site about 1615.

Plan for the rest of today is to head west and around the outside of Adelaide Island, keeping as close to the coast as reasonable, deploy sonobuoys looking for blue whale calls, conducting visual marine mammal survey work if the conditions improve, arriving at the northern end of Adelaide Island (Matha Strait) near midnight.

Sunday, 02/24 (yd=55)

Found Matha Strait to have 10/10 sea ice, so decided to continue northeast along the shelf and try to enter Pendleton Strait. The weather has continued to worsen, with winds at 0800 reaching sustained 30-40 kts, with very limited visibility, less than 0.25 nm in snow and fog at times. Barometric pressure has started to drop since midnight.

At 1230, steaming south-southeast into Pendleton Strait, winds still 30+ kts from the northeast. Visibility has improved, but conditions still too rough for visual marine mammal survey work. Fire drill at 1240. Started into Mudge Passage, heading for Larrout Island. This area is more sheltered, winds have dropped to 15 kts, good visibility. Ran into too much sea ice at about 1500, Captain decided to reverse course and leave this area along the reciprocal track. Saw some large groups of seals on different floes. One group appeared to exceed 50 animals, others 10 and 20 animals. Small groups (2 to 6) of Adélie penguins on floes, some near seals. Saw some humpbacks and one minke whale earlier on the way north into Mudge Passage, but too windy to launch a Zodiac. Winds picked as the ship approached Pendleton Strait. Leaving the strait around 1830, ETA to S7 is 2300.

Wind and seas too rough to do mooring work, so returned to Pendleton Strait to find sheltered waters for the night. Winds remained 30+ kts.

Monday, 02/25 (yd=56)

The winds were still 30+ kts during the morning, so stayed in Pendleton Strait. Decision made to deploy S7 over the stern. The Zodiacs have already been moved to the 01 deck, leaving the fantail clear for the mooring deployment. We plan to use the knuckle boom to lift the instrument over the stern gates and lower it into the water off the stern as the ship is making 0.5 kts forward speed, so the entire instrument streams back, away from the stern. Plan is to leave here about 1800, steam to the original S7 site and deploy there. If conditions are too rough to deploy, steam to an alternative site near Palmer Station and deploy there before docking at Palmer.

Arrived at S7 about 2000, winds still 25+ kts from the northeast and large whitecaps, but conditions seem okay for a stern deployment. After getting the instrument ready, it was deployed over the stern with the ship moving ahead at about 0.5 kts so that the floats and instrument are carried away from the stern. The instrument was raised over the stern gates, and lowered with two tag lines into the water, then released. This was the smoothest deployment yet during the entire cruise. After Andy made his XBT cast and John disabled the release, we headed for Palmer Station.

Tuesday, 02/26 (yd=57)

Arrived Palmer Station 0800. Drizzle, almost no wind, overcast. Day spent shifting WHOI and SIO gear to make space for the containers and other equipment to be loaded here for the northward trip to Punta Arenas, Chile. About 1500, ship was told that some humpback whales were located near one of the Palmer Station water sampling locations, so Josh took one Zodiac out with Mark, Rebecca, Breck, Andy, Sara, John to find them and take photos and biopsies if possible. They were successful in getting biopsies from both animals. Shortly after this Zodiac left, a second Zodiac left with Dave, Bob, Barb, Jennifer, and two others. We also found a pair of humpbacks "rough-housing". They stayed with our Zodiac as it drifted for over one-half hour. Then Josh's boat arrived and continued to observe this second pair. Our boat left, then Josh's boat left after the whales were starting to display more aggressive behavior towards the boat. Being so close to these magnificent animals playing was increditable.

Palmer Station had a pizza dinner at 1730 for us, and we finished the night with a mellow party at the lounge.

Wednesday, 02/27 (yd=58)

Left Palmer Station at 1000, headed northeast on inland route (Neumeyer Passage, Dallman Bay). Conditions for a visual marine mammal survey were excellent, good light, almost no wind. Rebecca and Deb logged over 20 humpbacks, plus we saw seals and penguins in the water. ETA for S1 is 0500 tomorrow morning. There will be no XBT/XCTD survey on this northbound transit across the Drake Passage.

Thursday, 02/28 (yd=59)

Arrived at S1 around 0420, and released S1A over the stern at 0448. Andy made a deep XBT cast, and John confirmed the instrument was on the bottom, then disabled the release. Deployed one sonobuoy at S1A, then started steaming north at 0529 and dropped a second sonobuoy to listen for the blue whale heard on the first sonobuoy but with no success. Weather today has been perfect, bright sun with occasional clouds, gentle swell from the west, winds below 5 kts, frequent birds.

Friday, 03/01 (yd=60)

Back to more typical Drake Passage weather: mostly cloudy, winds from the north at 20+ kts, warm and humid.

7.0 Chief Scientist's Daily Log

Wednesday – February 6, 2002 (All times local time, GMT-3)

1700 – Depart Punta Arenas, Chile steaming eastward out the Straits of Magellan
1900 – Safety meeting with Chief Mate
2000 – Science meeting

Thursday – February 7

1000 – Mooring group meeting with Captain
1230 – Fire drill
1900 – XBT class with ET
2148 – Start XBT/XCTD/ADCP section across the Drake Passage

Friday – February 8

0000 – Continue XBT/XCTD/ADCP section across Drake Passage

Saturday – February 9

0000 – Continue XBT/XCTD/ADCP section across Drake Passage
0530 – Start IWC marine mammal survey, SO GLOBEC cruise event log
1745 – End marine mammal survey
1842 – Arrive at SIO mooring S1, make XCTD cast, recover S1
2045 – Continue XBT/XCTD/ADCP section towards Palmer Station
2319 – Finish XBT/XCTD/ADCP section, head for Palmer Station

Sunday – February 10

0500 – Start marine mammal survey, sonobuoy deployments
1530 – End marine mammal survey
1645 – Arrive at Palmer Station

Monday – February 11

1500 – Switch ADCP sampling to GLOBEC configuration
1516 – Change ship depth sounder from 1500 m s^{-1} to 1456 m s^{-1}
1600 – Depart Palmer Station, head for S7

Tuesday – February 12

0400 – Arrive S7, XBT, sonobuoy, start recovery
0600 – S7 recovery complete, steam for S8

1203 – Deploy WHOI drifter 25180
1205 – Deploy WHOI float 138
1600 – Arrive S8, sonobuoy, XBT, start recovery
2300 – Left S8 still on bottom, steam for WHOI mooring A1
2321 – Deployed drifter 24477
2322 – Deploy float 139

Wednesday – February 13
0400 – Arrive A1, make CTD cast 1
0500 – Start A1 recovery
0646 – A1 on deck, head slowly for A2 as deck is cleaned
0945 – Arrive A2, make CTD cast 2
1042 – Start A2 recovery
1206 – A2 on deck, head slowly for A3 as deck is cleaned
1515 – Arrive A3, make CTD cast 3
1616 – Start A3 recovery
1800 – A3 on deck, head slowly for B1 as decked is cleared
1049 – Deploy float 137

Thursday – February 14
0350 – Arrive B1, unable to talk to acoustic release, CTD cast 4
0700 – Depart B1, head for B2, start MM survey
0833 – Arrive B2, acoustic release responded, head for B3
1027 – Arrive B3, CDT cast 5
1130 – Start B3 recovery
1315 – B3 on deck, head for B2
1530 – Arrive B2, CTD cast 6
1635 – Start B2 recovery
1815 – B2 on deck, head for B1 to do acoustic search for B1 release

Friday – February 15
0200 – End acoustic search at B1, head for S6
1200 – Arrive at S6, send second release command 1235
1348 – Deploy S6A, XBT
1412 – S6 on deck
1500 – Confirm S6A on bottom, head for S5
2030 – Arrive S5, send second release command 2048
2139 – Deploy S5A, XBT
2236 – S5 on deck
2300 – Confirm S5A on bottom, head for S4

Saturday – February 16
0430 – Arrive at S4, send third release command 0534
0636 – Deploy S4A
0721 – S4 on deck
0800 – Confirm S4A on bottom, XBT, head for S3
1525 – Arrive at S3, sent third release command 1602
1728 – S3 on deck, XBT, head for S2

Sunday – February 17
0400 – Arrive S2, send second release command 0421

0542 – Deploy S2A
0616 – S2 on deck, XBT, sonobuoy
0653 – Confirm S2A on bottom, head for S8 and F4
2400 – Check S8

Monday – February 18
0707 – Deploy float 110
0929 – Deploy float 112
1150 – Deploy float 142
1400 – Arrive at C1, conduct bathymetric survey
1658 – Start C1 mooring deployment
1822 – C1 anchor deployed
1943 – CTD 7 at C1
2032 – Deploy float
2033 – Deploy drifter 25120, steam south towards C2
2137 – Deploy drifter 24476
2139 – Deploy float 124
2330 – Arrive at C2

Tuesday – February 19
0030 – Conduct bathymetric survey
0608 – Start C2 mooring deployment
0832 – C2 anchor deployed
0844 – Deploy drifter 25119
0931 – CTD 8 at C2, steam northeast towards C3 (B2)
1200 – Arrive C3, too rough for mooring work, steam towards Adelaide Island
1800 – Start inshore marine mammal survey east of Adelaide Island

Wednesday – February 20
0000 – Continue marine mammal survey east of Adelaide Island
2300 – Stop marine mammal survey near Rothera

Thursday – February 21
0000 – Continue marine mammal survey north of Rothera
1100 – Start steaming to C3 (B2)
1830 – Arrive C3, check depth
1850 – Start C3 deployment
2044 – C3 anchor released
2130 – CTD 9 at C3, steam for B1
2215 – Deploy Drifter

Friday – February 22

0000 – Arrive B1, begin dragging operations
1000 – Finish dragging operations, start steaming south
1000 – Start marine mammal survey work
2300 – Finish marine mammal survey work

Saturday – February 23
0400 – Start marine mammal survey work
1548 – Deploy S9, XBT

1630 – Confirm S9 on bottom, start for Matha Strait

Sunday – February 24
- 0000 – Found Matha Strait blocked, start for Pendleton Strait
- 0600 – Enter Pendleton Strait, start marine mammal survey work
- 1800 – Leave Pendleton Strait, stop marine mammal survey work, head for S7
- 2000 – Return to Pendleton Strait

Monday – February 25
- 1800 – Leave Pendleton Strait, head for S7
- 2038 – Deploy S7A, XBT, head for Palmer Station

Tuesday – February 26
- 0800 – Arrive Palmer Station
- 1500 – marine mammal survey work east of Palmer Station

Wednesday – February 27
- 1000 – Leave Palmer Station
- 1200 – marine mammal survey work

Thursday – February 28
- 0448 – Deploy S1A, XBT, head for Punta Arenas

Friday – March 1
- 0000 – continue to Punta Arenas, Chile

8.0 Cruise Personnel

Science Party

Robert Beardsley	Chief Scientist
Richard Limeburner	Scientist
Breck Owens	Scientist
Scott E. Worrilow	Electronics Engineer
Ryan C. Schrawder	Electronics Engineer
James R. Ryder	Mooring Engineer
Mark A. McDonald	Scientist
John Hildebrand	Scientist
Sean Wiggins	Electronics Engineer
Ana Sirovic	Graduate Student
Deborah Thiele	Scientist
Rebecca Pirzl	Scientist

<u>Southward Transit to Palmer Station</u>

Maria Vernet	Scientist
Eugene Burreson	Scientist
John Booth	Palmer Station
Timothy Brox	Palmer Station

Northward Transit from Palmer Station

Maria Vernet	Scientist
Dave Bresnahan	NSF Representative
Steffi Suhr	Palmer Station
Eugene Burreson	Scientist
Sue Cowles	Teacher
Orion Carlisle	Palmer Station
Brett Pickering	Palmer Station
Hugh MacMullan	Palmer Station

Raytheon Polar Services Staff

Randy Sliester	Marine Project Coordinator
Joshua Spillane	Marine Technician
Andrew F. Nunn	Electronics Technician
Sara Disick	Marine Science Technician
Jordan Watson	Marine Science Technician (Southward Transit)

Ship Officers and Crew

Robert Verret II	Master
Morris J Bouzigard	Chief Mate
Tracy Ruhl	2^{nd} Mate
John Synder	3^{rd} Mate
Michael L. Murphy	Chief Engineer
Gerald Tompsett	1^{st} Engineer
Noli Tamayo	2^{nd} Engineer
Joseph A. Meneses	Oiler
Donde Dasoy	Oiler
Rodolfo S. Lucas	1^{st} Cook
Luciano Albornoz	2^{nd} Cook
Rafael Sabino	Galley Hand
Fernando Naraga	Deck-Crane
Efren Prado	Deck-Crane
Donito M. Padasas	Deck
Roy G. Ninon	Deck

Appendix A. Bathymetric Surveys of the WHOI Mooring Sites

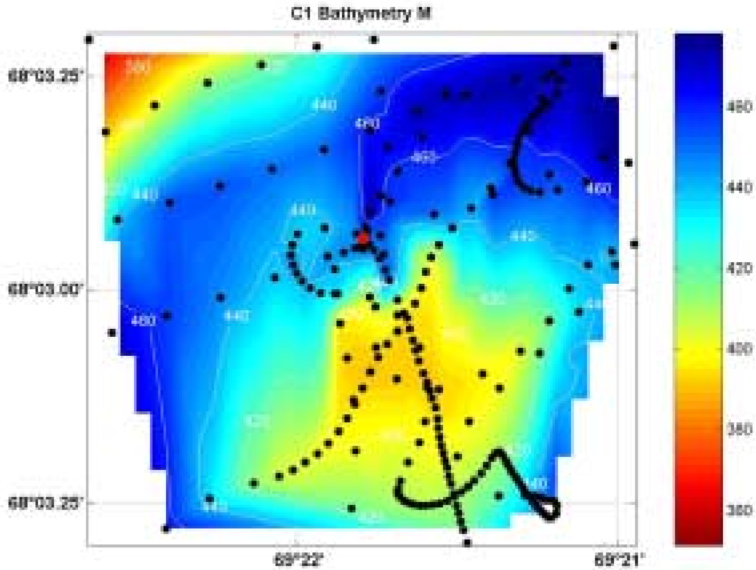

Figure A1. Bathymetry (m) at the C1 mooring site. The C1 anchor was released at the red dot located 69° 21.790′ W, 68° 02.940′ S, water depth 450 m. Fallback may make the actual anchor depth less.

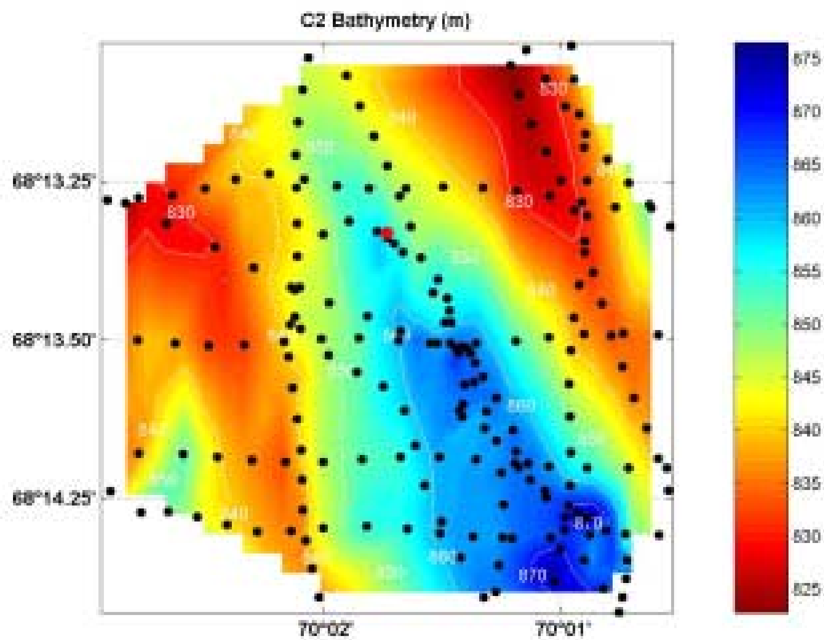

Figure A2. Bathymetry (m) at the C2 mooring site. The C2 anchor was released at the red dot located 70° 01.730′ W, 68° 13.331′ S, water depth 850 m. Fallback may make the actual anchor depth more.

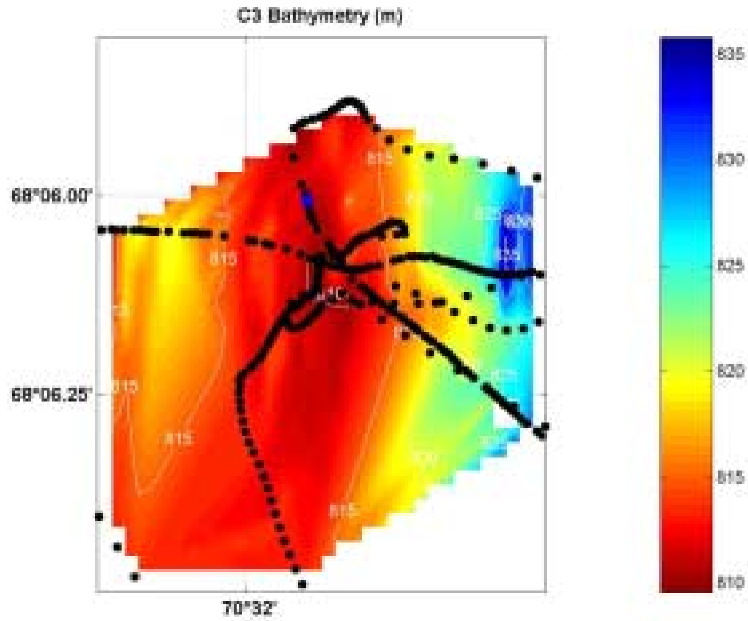

Figure A3. Bathymetry (m) at the C3 mooring site. The C3 anchor was released at the blue dot located 70° 31.799′ W, 68° 06.006′ S, water depth 815 m. Fallback may make the actual anchor depth more.

Appendix B. Surface Temperature, Salinity, and Fluorescence Maps

This appendix presents simple maps of the sea surface temperature (SST), salinity (SSS), and fluorescence (Fluor) collected with the ship's underway instrumentation. Two maps are shown for each variable, the first map includes the color code used to bin the variable, and the second map is more focused on Marguerite Bay. The SST maps (Figures B1, B2) show the coldest water (<-1°C) was found near the B3 mooring site (in the sea ice) and also just south of Palmer Station. Water near the ice edge in southern Marguerite Bay and east of Adelaide Island was generally also cold (<0°C). Water in the northern Marguerite Bay and over the shelf to the west was generally warmer (0°C < SST < 1°C), with water off the shelf break and over the shelf north of 67°S exceeding 1°C.

The freshest water (<32) was found just south of Palmer Station (Figures B3, B4). In general, the water around Pourquoi Pas Island was between 32 and 32.5, with the northeast Marguerite Bay more saline with salinities between 32.5 and 33. Surface salinities over the shelf away from the mouth of Marguerite Bay were typically above 33. The temperature-salinity plot for the surface temperature and salinity during Leg 2 (Figure B5) shows the general tendency for the water above 33 to get warmer with increasing salinity. At temperatures below about 0.5°C, there appear to be two clusters of points, with the freshest waters having temperatures between roughly -0.5°C and +0.5°C, while the coldest waters (found near the ice edge) had salinities around 33.

The along-track fluorescence pattern (Figures B6, B7) is also complex, but it is clear that the highest relative fluorescence values (given in volts) were found within Marguerite Bay, east of Adelaide Island, and along the transit from Matha Strait deep into Pendleton Strait, while the lowest values were found over the mid- and outer shelf and along the entire track north of 65.5°S. While the ship's fluorometer provides a relative measure of fluorescence, the observed fluorescence pattern supports the idea that primary production is high in Marguerite Bay.

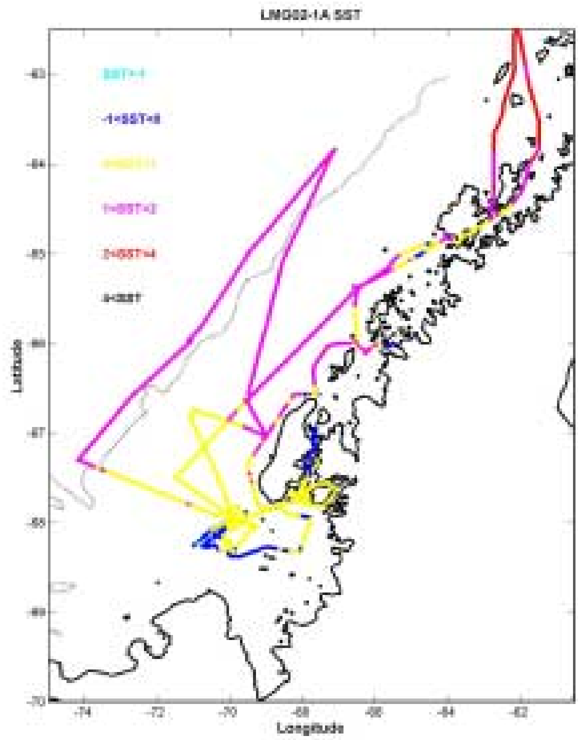

Figure B1. Large-scale map of SST. The temperature is separated into 1^{o}C bins and plotted using the color code in the upper left.

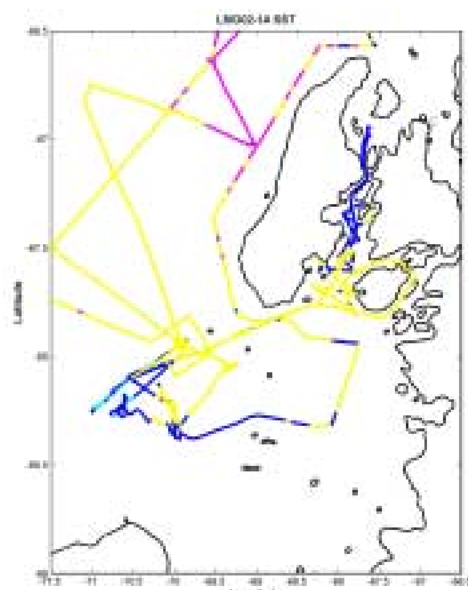

Figure B2. Small scale map of SST. Same color code as in Figure B1.

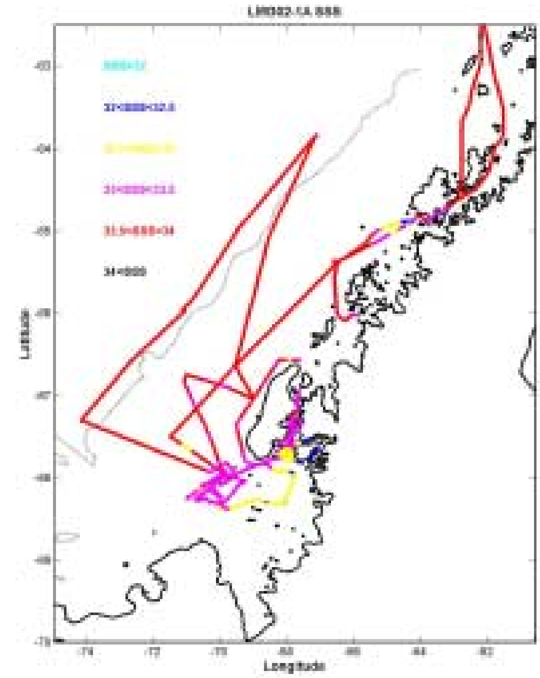

Figure B3. Large scale map of SSS. The surface salinity has been separated into 0.5 psu bins and plotted with the color code shown in the upper left.

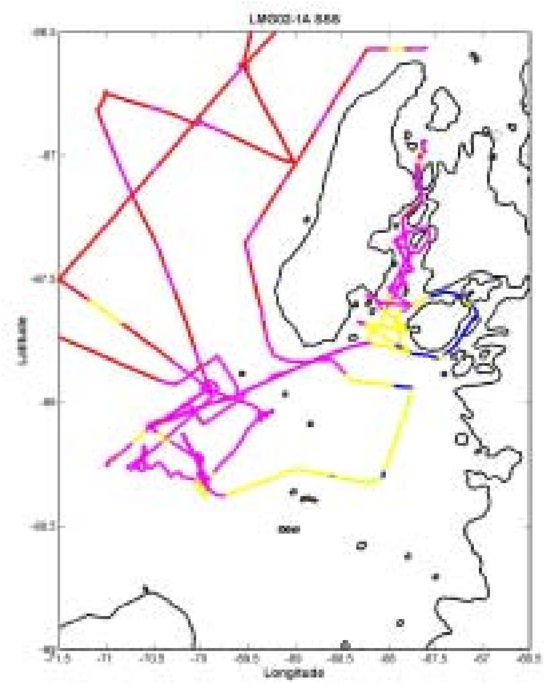

Figure B4. Small scale SSS map. Color code is same as in Figure B3.

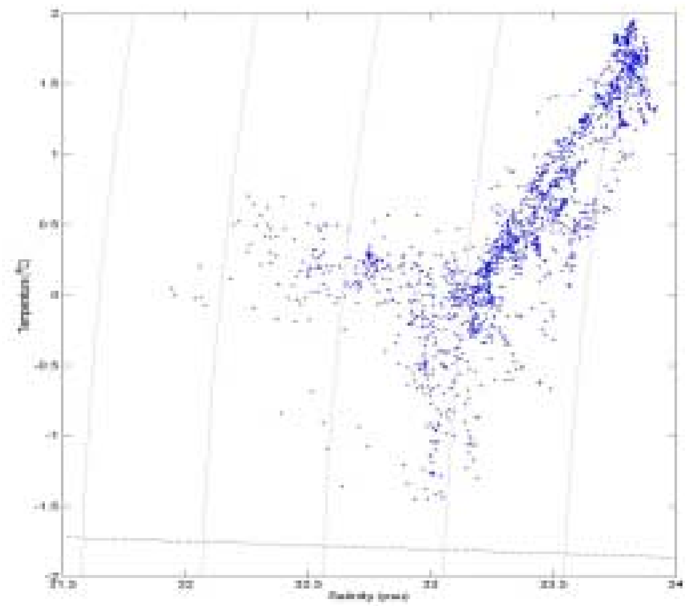

Figure B5. Temperature-salinity diagram for the surface waters during Leg 2 (Palmer Station to Palmer Station). Contours show lines of constant σ_t. Dashed line indicates the freezing point of seawater as a function of salinity.

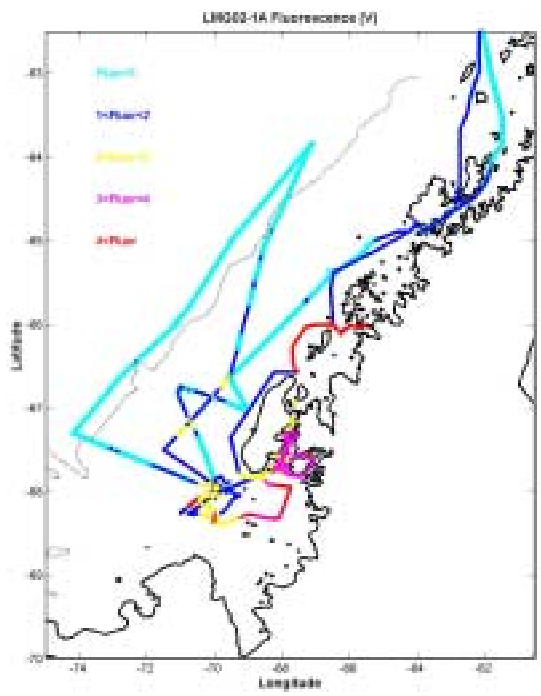

Figure B6. Large scale map of surface fluorescence (in volts). Fluorescence has been separated into 1-volt bins and plotted with the color code shown in the upper left.

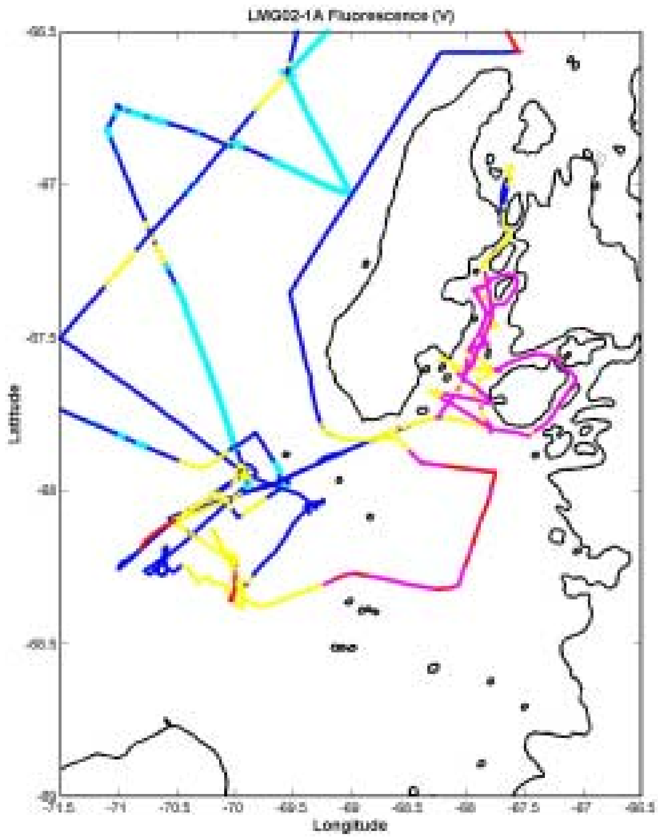

Figure B7. Small scale map of surface fluorescence. Same color code as Figure B6.

Appendix C. Cruise Event Log for LMG02-01A.

			Consec.	Standard	Local Time			Event	Univ. Coor. Time (UCT)			Latitude (°S)	Longitude (°W)	Water	Cast		
eventno	Instr	Cast #	Sta. #	Sta. #	Mth	Day	hh mm	s/e	Mth	Day	hh mm	Deg. Min.	Deg. Min.	Depth	Depth	Science Invest.	Comments
LMG038.001	MM survey				2	7	701	s	2	7	1001	52 49.74	67 53.30			IWC	MM=marine mammal
LMG038.002	MM survey				2	7	737	e	2	7	1037	52 53.98	67 46.16			IWC	
LMG038.003	MM survey				2	7	829	s	2	7	1129	53 00.71	67 34.81			IWC	
LMG038.004	MM survey				2	7	1059	e	2	7	1359	53 21.64	67 00.15			IWC	
LMG040.001	MM survey				2	9	514	s	2	9	814	60 02.53	63 05.54			IWC	
LMG040.002	MM survey				2	9	729	e	2	9	1029	60 25.01	62 56.24			IWC	
LMG040.003	MM survey				2	9	757	s	2	9	1057	60 29.60	62 54.27			IWC	
LMG040.004	sonobuoy	1			2	9	816	s/e	2	9	1116	60 32.08	62 53.40	4047		SIO	failed
LMG040.005	sonobuoy	2			2	9	822	s/e	2	9	1122	60 32.94	62 53.11	3993		SIO	failed
LMG040.006	sonobuoy	3			2	9	827	s	2	9	1127	60 33.78	62 52.85	3932		SIO	
LMG040.007	sonobuoy	3			2	9	937	e	2	9	1237					SIO	
LMG040.008	sonobuoy	4			2	9	1012	s	2	9	1312	60 51.44	62 45.35	3925		SIO	
LMG040.009	sonobuoy	4			2	9	1025	e	2	9	1325					SIO	
LMG040.010	sonobuoy	5			2	9	1353	s	2	9	1653	61 28.77	62 29.87	3437		SIO	
LMG040.011	sonobuoy	5			2	9	1405	e	2	9	1705					SIO	
LMG040.012	sonobuoy	6			2	9	1547	s	2	9	1847	61 48.15	62 21.81	3887		SIO	
LMG040.013	sonobuoy	6			2	9	1614	e	2	9	1914					SIO	
LMG040.014	MM survey				2	9	1739	e	2	9	2039	62 07.67	62 13.72			IWC	end MM survey
LMG040.015	S1			S1	2	9	1842	s	2	9	2142	62 16.51	62 09.81			SIO	start S1 recovery
LMG040.016	XCTD	1		S1	2	9	1855	s/e	2	9	2155					SIO	
LMG040.017	S1			S1	2	9	2045	e	2	9	2345					SIO	S1 recovered
LMG041.001	MM survey				2	10	453	s	2	10	753	63 40.79	61 29.13			IWC	
LMG041.002	sonobuoy	7			2	10	814	s	2	10	1114	64 11.35	61 52.08	826		SIO	
LMG041.003	sonobuoy	7			2	10	823	e	2	10	1123					SIO	

LMG041.004	sonobuoy	8			2	10	848	s	2	10	1148	64 16.80	61 55.54	809		SIO	whales observed
LMG041.005	sonobuoy	8			2	10	1016	e	2	10	1316					SIO	
LMG041.006	MM survey				2	10	1550	e	2	10	1850	64 49.79	63 59.58			IWC	
LMG042.001	ADCP			PS	2	11	1500	s	2	11	1700	Palmer station				Andy	start GLOBEC config
LMG042.002	Sounder			PS	2	11	1516	s	2	11	1716	Palmer station				Andy	change SV = 1456 m/s
LMG042.003	MM survey			PS	2	11	1605	s	2	11	1905	Palmer station				IWC	
LMG042.004	MM survey				2	11	1930	e	2	11	2230					IWC	
LMG042.005	sonobuoy	9			2	11	1831	s	2	11	2131	64 53.41	64 31.31	478		SIO	
LMG042.006	sonobuoy	9			2	11	2030	e	2	11	2330					SIO	
LMG042.007	sonobuoy	10			2	11	2039	s/e	2	11	2339	64 58.35	65 7.11	465		SIO	
LMG043.001	S7			S7	2	12	400	s	2	12	700	65 22.62	66 28.21	450		SIO	start S7 recovery
LMG043.002	sonobuoy	11		S7	2	12	424	s	2	12	724	65 22.84	66 26.18	504		SIO	
LMG043.003	XBT			S7	2	12	427	s/e	2	12	727					SIO	
LMG043.004	S7			S7	2	12	600	e	2	12	900					SIO	S7 recovered
LMG043.005	MM survey				2	12	600	s	2	12	900	65 23.72	66 30.94			IWC	
LMG043.006	sonobuoy	11			2	12	730	e	2	12	1030						
LMG043.007	sonobouy	12			2	12	845	s/e	2	12	1145	65 41.8	67 14.4			SIO	
LMG043.008	sonobuoy	13			2	12	906	s/e	2	12	1206	65 44.07	67 19.96			SIO	
LMG043.009	drifter				2	12	1203	s/e	2	12	1503	66 04.01	68 07.92	388		WHOI	
LMG043.010	float				2	12	1205	s/e	2	12	1505	66 04.01	68 07.92	388		WHOI	
LMG043.011	sonobuoy	14		S8	2	12	1645	s	2	12	1945	66 37.59	69 31.06	402		SIO	
LMG043.012	MM survey				2	12	1650	e	2	12	1950	66 38.28	69 32.82			IWC	
LMG043.013	XBT			S8	2	12	1647	s/e	2	12	1947	66 37.860	69 31.715			SIO	
LMG043.014	S8			S8	2	12	1700	s	2	12	2000	66 38.241	69 33.095	406		SIO	start S8 recovery
LMG043.015	S8			S8	2	12	2300	e	2	13	200					SIO	S8 did not surface
LMG043.016	drifter				2	12	2321	s/e	2	13	221	66 40.150	66 40.190			WHOI	
LMG043.017	float				2	12	2322	s/e	2	13	222	66 40.290	69 29.940			WHOI	
LMG043.018	sonobuoy	14		S8	2	13	0:51	e	2	13	351					SIO	
LMG044.001	CTD	1		A1	2	13	442	s/e	2	13	742	67 01.249	69 00.959	455		RPS	
LMG044.002	A1 recovery			A1	2	13	507	s	2	13	897	67 01.134	69 01.217	450		WHOI	CTD on deck
LMG044.003	A1 recovery			A1	2	13	710	e	2	13						WHOI	A1 on deck
LMG044.004	MM survey				2	13	712	s	2	13	1012	67 00.56	69 10.43			IWC	
LMG044.005	MM survey				2	13	926	e	2	13	1226	66 52.68	69 55.78			IWC	
LMG044.006	CTD	2		A2	2	13	957	s/e	2	13	1257	66 51.883	70 00.683	564		RPS	
LMG044.007	A2 recovery			A2	2	13	1042	s	2	13	1352	66 51.883	70 00.683	564		WHOI	CTD on deck
LMG044.008	A2 recovery			A2	2	13	1206	e	2	13	1506					WHOI	A2 on deck
LMG044.009	MM survey				2	13	1212	s	2	13	1512	66 52.30	70 02.42			IWC	

LMG044.010	MM survey				2	13	1511	e	2	13	1811	66 44.73	70 59.50			IWC	
LMG044.011	CTD	3		A3	2	13	1559	s/e	2	13	1859	66 44.428	71 00.720	490		RPS	
LMG044.012	A3 recovery				2	13	1616	s	2	13	1916	66 45.002	70 59.991	490		WHOI	CTD on deck
LMG044.013	A3 recovery			A3	2	13	1800	e	2	13	2100					WHOI	A3 on deck
LMG044.014	MM survey				2	13	1920	s	2	13	2220	66 50.60	71 04.25			IWC	
LMG044.015	sonobuoy	15		A3	2	13	2035	s	2	13	2335	66 59.12	70 55.21	468		SIO	whales
LMG044.016	MM survey				2	13	2035	s	2	13	2335	67 02.49	70 51.62			IWC	
LMG044.017	float				2	13	2249	s/e	2	14	249	67 27.726	70 22.950			WHOI	
LMG045.001	CTD	4		B1	2	14	437	s/e	2	14	737	67 56.603	69 54.586	522		RPS	
LMG045.002	B1			B1	2	14	513	s/e	2	14	813					WHOI	no response from acoustic release
LMG045.003	MM survey				2	14	700	s	2	14	1000	67 57.97	69 59.90			IWC	
LMG045.004	B2			B2	2	14	833	s/e	2	14	1133	68 05.573	70 31.157	811		WHOI	acoustic release is there, go to B3
LMG045.005	CTD	5		B3	2	14	1055	s/e	2	14	1355	68 15.145	70 59.332	462		RPS	
LMG045.006	MM survey				2	14	1020	e	2	14	1320	68 15.18	70 59.35			IWC	
LMG045.007	B3 recovery			B3	2	14	1203	s	2	14	1503	68 15.345	70 59.853	450		WHOI	CTD ondeck, after lunch
LMG045.008	B3 recovery			B3	2	14	1315	e	2	14	1615					WHOI	B3 ondeck
LMG045.009	CTD	6		B2	2	14	1611	s/e	2	14	1911	68 05.573	70 31.157	822		RPS	
LMG045.010	B2 recovery			B2	2	14	1644	s	2	14	1944	68 06.091	70 31.675	811		WHOI	CTD on deck
LMG045.011	B2 recovery			B2	2	14	1815	e	2	14	2115					WHOI	B2 on deck
LMG045.012	sonobuoy	16			2	14	1344	s	2	14	1644	68 13.93	70 57.87	536		SIO	
LMG045.013	sonobuoy	16			2	14	1454	e	2	14	1754					SIO	
LMG045.014	MM survey				2	14	1830	s	2	14	2130	68 04.75	70 29.51			IWC	
LMG045.015	MM survey				2	14	2000	e	2	14	2300	68 00.68	70 06.77			IWC	
LMG045.016	B1 search			B1	2	14	2000	s	2	14	2300					WHOI	acoustic search for B1
LMG046.001	B1 search			B1	2	15	200	e	2	15	500					WHOI	
LMG046.002	MM survey				2	15	400	s	2	14	700					IWC	
LMG046.003	MM survey				2	15	450	e	2	15	750					IWC	
LMG046.004	S6			S6	2	15	1235	s	2	15	1535					SIO	release command confirmed
LMG046.005	S6A			S6	2	15	1348	s/e	2	15	1648	67 18.250	74 10.150	3099		SIO	replacement mooring launched
LMG046.006	XBT			S6	2	15		s/e	2	15						RPS	
LMG046.007	S6			S6	2	15	1412	e	2	15	1712					SIO	S6 on deck
LMG046.008	MM survey				2	15	1500	s	2	15	1800	67 17.88	74 10.35			IWC	
LMG046.009	sonobuoy	17			2	15	1856	s	2	15	2156	66 47.94	73 08.21	3442		SIO	
LMG046.010	sonobuoy	18			2	15	1941	s/e	2	15	2241	66 40.61	72 53.24			SIO	
LMG046.011	sonobuoy	19			2	15	1959	s	2	15	2259	66 39.50	72 51.19			SIO	
LMG046.012	MM survey				2	15	2003	e	2	15	2303	66 35.19	72 42.30			IWC	

LMG046.013	sonobuoy	17			2	15	2034	e	2	15	2334					SIO	
LMG046.014	S5			S5	2	15	2048	s	2	15	2348					SIO	release command confirmed
LMG046.015	sonobuoy	19			2	15	2054	e	2	15	2354					SIO	
LMG046.016	S5A			S5	2	15	2139	s/e	2	16	39	66 34.99	72 41.43	3421		SIO	replacement mooring launched
LMG046.017	XBT			S5	2	15										RPS	
LMG046.018	S5			S5	2	15		e	2	16						SIO	S5 on deck
LMG047.001	S4			S4	2	16	534	s	2	16	834	65 58.40	71 04.10	2962		SIO	release command confirmed
LMG047.002	S4A			S4	2	16	636	s/e	2	16	936	65 58.730	71 03.640	2944		SIO	replacement mooring launched
LMG047.003	S4			S4	2	16	721	e	2	16	1021					SIO	S4 on deck
LMG047.004	XBT			S4												RPS	
LMG047.005	MM survey				2	16	730	s	2	16	1030	65 58.69	71 03.76			IWC	
LMG047.006	MM survey				2	16	1525	e	2	16	1825	64 59.54	69 28.74			IWC	
LMG047.007	S3			S3	2	16	1602	s	2	16	1902	64 59.406	69 28.795	2521		SIO	release command confirmed
LMG047.008	S3			S3	2	16	1728	e	2	16	2028					SIO	S3 on deck
LMG047.009	XBT			S3				s/e	2	16						RPS	
LMG047.010	MM survey				2	16	1838	s	2	16	2138	64 53.11	69 16.22			IWC	
LMG047.011	MM survey				2	16	1945	e	2	16	2245	64 44.83	68 58.48			IWC	
LMG048.001	S2			S2	2	17	534	s	2	17	834	63 50.799	67 08.829	3056		SIO	release command confirmed
LMG048.002	S2A			S2	2	17	542	s/e	2	17	842	63 50.46	67 07.84	3047		SIO	replacement mooring launched
LMG048.003	S2			S2	2	17	616	e	2	17	916					SIO	S2 on deck
LMG048.004	sonobuoy	20		S2	2	17	625	s/e	2	17	925	63 50.70	67 07.42	3039		SIO	
LMG048.005	sonobuoy	21		S2	2	17	629	s/e	2	17	929	63 51.54	67 08.40	3035		SIO	
LMG048.006	XBT			S2	2	17	630	s/e	2	17	930					RPS	
LMG048.007	sonobuoy	22		S2	2	17	636	s	2	17	936	63 51.48	67 08.87	3039		SIO	
LMG048.008	MM survey				2	17	658	s	2	17	958	63 51.55	67 09.08			IWC	
LMG048.009	sonobuoy	22		S2	2	17	738	e	2	17	1038					SIO	
LMG048.010	sonobuoy	23			2	17	1319	s	2	17	1619	64 47.05	68 13.03	369		SIO	
LMG048.011	sonobuoy	23			2	17	1400	e	2	17	1700					SIO	
LMG048.012	MM survey				2	17	1721	e	2	17	2021	65 28.51	68 48.00			IWC	
LMG048.013	MM survey				2	17	1849	s	2	17	2149	65 44.75	68 57.47			IWC	
LMG048.014	MM survey				2	17	1920	e	2	17	2220	65 50.33	69 01.25			IWC	
LMG049.001	MM survey																
LMG049.002	float				2	18	707	s/e	2	18	1007	67 30.00	71 30.10	430		WHOI	
LMG049.003	float				2	18	929	s/e	2	18	1229	67 42.99	70 41.95	778		WHOI	
LMG049.004	sonobouy	24			2	18	1039	s/e	2	18	1339	67 50.01	70 17.85	668		SIO	
LMG049.005	sonobouy	25			2	18	1042	s	2	18	1342	67 50.34	70 16.78	637		SIO	
LMG049.006	float				2	18	1150	s/e	2	18	1450	67 56.85	69 54.47	442		WHOI	
LMG049.007	sonobouy	25			2	18	1238	e	2	18	1538					SIO	
LMG049.009	sonobouy	26			2	18	1245	s/e	2	18	1545	67 59.78	69 34.05	931		SIO	
LMG049.010	sonobouy	27			2	18	1250	s/e	2	18	1550	68 00.08	69 31.56	1031		SIO	

LMG049.011	depth survey			C1	2	18	1400	s	2	18	1700					WHOI	start depth survey
LMG049.012	sonobouy	28			2	18	1254	s/e	2	18	1554	68 00.25	69 30.18	1072		SIO	
LMG049.013	sonobouy	29		C1	2	18	1522	s	2	18	1822	68 02.85	69 22.03	443		SIO	
LMG049.014	depth survey			C1	2	18	1600	e	2	18	1900					WHOI	end depth survey
LMG049.015	mooring			C1	2	18	1658	s	2	18	1958					WHOI	start C1 deployment
LMG049.016	mooring			C1	2	18	1822	e	2	18	2122	68 02.94	69 21.79	450		WHOI	C1 deployed
LMG049.017	CTD	7		C1	2	18	1943	s/e	2	18	2243	68 02.60	69 19.86	515		RPS	
LMG049.018	float			C1	2	18	2032	s/e	2	18	2332	68 03.19	69 21.94	401		WHOI	
LMG049.019	drifter			C1	2	18	2033	s/e	2	18	2333	68 03.20	69 22.00	401		WHOI	
LMG049.020	sonobouy	29		C1	2	18	2120	e	2	19	0:20					SIO	
LMG049.021	drifter				2	18	2137	s/e	2	19	37	68 11.60	69 38.71	827		WHOI	
LMG049.022	float				2	18	2139	s/e	2	19	39	68 11.60	69 38.74	828		WHOI	
LMG049.023	MM survey																
LMG050.001	depth survey			C2	2	19	30	s	2	19	330					WHOI	
LMG050.002	depth survey			C2	2	19	430	e	2	19	730					WHOI	
LMG050.003	mooring			C2	2	19	608	s	2	19	908					WHOI	
LMG050.004	mooring			C2	2	19	832	e	2	19	1132	68 13.33	70 01.73		850	WHOI	
LMG050.005	drifter			C2	2	19	844	s/e	2	19	1144	68 14.04	70 01.06		868	WHOI	
LMG050.006	CTD		8	C2	2	19	931	s/e	2	19	1231	68 14.61	69 59.95		890	RPS	
LMG050.007	MM survey				2	19	1749	s	2	19	2049	67 47.52	68 31.90			IWC	
LMG050.008	MM survey				2	19	2224	e	2	20	124	67 36.01	67 10.27			IWC	
LMG051.001	MM survey				2	20	509	s	2	20	809	67 48.36	67 48.17			IWC	
LMG051.002	sonobuoy	30			2	20	831	s	2	20	1131	67 41.16	67 51.57			SIO	
LMG051.003	sonobuoy	30			2	20	1431	e	2	20	1731					SIO	
LMG051.004	MM survey				2	20	1756	e	2	20	2056	66 56.58	67 36.70			IWC	
LMG051.005	sonobuoy	31			2	20	1819	s	2	20	2119	66 56.53	67 37.24			SIO	
LMG051.006	MM survey				2	20	2057	s	2	20	2357	67 06.35	67 41.78			IWC	
LMG051.007	sonobuoy	31			2	20	2115	e	2	21	0:15					SIO	
LMG050.008	MM survey				2	20	2242	e	2	21	142	67 14.12	67 48.44			IWC	
LMG052.001	MM survey				2	21	529	s	2	21	829	67 34.61	67 56.77			IWC	
LMG052.002	MM survey				2	21	1121	e	2	21	1421	67 31.64	67 57.99			IWC	
LMG052.003	MM survey				2	21	1155	s	2	21	1455	67 37.52	68 01.66			IWC	
LMG052.004	MM survey				2	21	1436	e	2	21	1736	67 52.37	69 03.06			IWC	
LMG052.005	MM survey				2	21	1512	s	2	21	1812	67 55.42	69 21.44			IWC	
LMG052.006	MM survey				2	21	1656	e	2	21	1956	68 03.91	70 17.48			IWC	
LMG052.007	mooring			C3	2	21	1850	s	2	21	2150					WHOI	
LMG052.008	mooring			C3	2	21	2044	e	2	21	2344	68 06.006	70 31.799		815	WHOI	
LMG052.009	CTD		9	C3	2	21	2137	s/e	2	22	37	68 05.893	70 30.529		818	WHOI	
LMG052.010	drifter			C3	2	21	2215	s/e	2	22	115	68 05.63	70 30.40			WHOI	
LMG053.001	dragging			B1	2	22	50	s	2	22	330					WHOI	
LMG053.002	dragging			B1	2	22	1000	e	2	22	1300					WHOI	
LMG053.003	MM survey			B1	2	22	1000	s	2	22	1300					IWC	
LMG053.004	sonobuoy	32			2	22	1311	s	2	22	1611	68 16.36	70 43.74	780		SIO	

LMG053.005	sonobuoy	32			2	22	1740	e	2	22	2040					SIO	
LMG053.006	sonobuoy	33		C3	2	22	2007	s	2	22	2307	68 16.455	70 21.520			SIO	
LMG053.007	sonobuoy	33		C3	2	22	2116	e	2	22	0:16					SIO	
LMG053.008	MM survey				2	22	2125	e	2	22	43					IWC	
LMG054.001	S9			S9	2	23	1548	s/e	2	23	1848	67 54.499	68 23.003	867		SIO	
LMG055.001	sonobuoy	34			2	24	554	s	2	24	854	66 28.82	67 40.47	212		SIO	
LMG055.002	sonobuoy	34			2	24	709	e	2	24	1009						
LMG055.003	MM survey				2	24	1220	s	2	24	1520					IWC	
LMG055.004	MM survey				2	24	1739	e	2	24	2039					IWC	
LMG056.001	S7A			S7A	2	25	2038	s/e	2	25	2338	65 22.62	66 28.15	470		SIO	
LMG057.001	MM survey			PS	2	26	1600	s	2	26	1900	PS				IWC	
LMG057.002	MM survey				2	26	1900	e	2	26	2200					IWC	
LMG058.001	MM survey				2	27	1058	s	2	27	1358	64 51.34	63 51.19			IWC	
LMG058.002	MM survey				2	27	2115	e	2	28	0:15					IWC	
LMG059.001	S1A			S1A	2	28	448	s/e	2	28	748	62 16.42	62 10.04	1658		SIO	
LMG059.002	sonobuoy	35		S1A	2	28	453	s	2	28	753	62 16.41	62 10.26	1669		SIO	
LMG059.003	sonobuoy	36			2	28	621	s	2	28	921	62 07.53	62 13.60	3195		SIO	
LMG059.004	MM survey				2	28	626	s	2	28	926	62 06.53	62 14.07			IWC	
LMG059.005	sonobuoy	35		S1A	2	28	815	e	2	28	1115					SIO	
LMG059.006	sonobuoy	36			2	28	839	e	2	28	1139					SIO	
LMG059.007	sonobuoy	37			2	28	1538	s	2	28	1838	60 27.62	62 55.29	3911		SIO	
LMG059.008	sonobuoy	38			2	28	1647	s	2	28	1946	60 17.913	62 56.503			SIO	
LMG059.009	sonobuoy	37			2	28	1702	e	2	28	2002					SIO	
LMG059.010	sonobuoy	38			2	28	1747	e	2	28	2047					SIO	
LMG059.011	sonobuoy	39			2	28	1801	s	2	28	2101	60 04.74	63 02.85			SIO	
LMG059.012	sonobuoy	39			2	28	1917	e	2	28	2217					SIO	
LMG059.013	MM survey				2	28	1956	e	2	28	2256					IWC	