1. Physical Oceanography and Underway Environmental Observations; submitted by Derek Needham(Leg I), Marcel van den Berg(Legs I&II) and Johan Kritzinger(Leg II).

1.1 Objectives: Objectives were to 1) collect and process physical oceanographic data in order to identify hydrographic characteristics and map oceanographic frontal zones; and 2) collect and process underway environmental data in order to describe sea surface and meteorological conditions experienced during the surveys

1.2 Accomplishments:

1.2.1 Hydrographic Data Collection: A total of 224 CTD/carousel casts were completed, 99 of these as part of Leg I (Survey A) and 115 as part of Leg II (65 as part of Survey D and 50 casts in the South Orkney Island Area). Eight additional casts were done (See Figure 2 in the Introduction for station locations). Two CTD casts were also completed during acoustic calibrations in Admiralty Bay at the beginning and end of the cruise.

A total of 73 Expendable Bathy Thermographs (XBT's) were deployed to compliment the data collected from the CTD casts (57 during Survey A, 16 during Survey D and the South Orkney Island area). These were mainly deployed during transits between stations and at cancelled stations. Three XBT transects (60 casts) were completed during the Drake Passage crossings (two transects from North to South, and one from South to North during Leg II).

Four stations (A11-05; A11-03; A02-02 and A02-04) were cancelled during Leg I due to bad weather. One additional station (A03-14) was added to the existing survey area at the most southern point reached in the Joinville Island Area. During Leg II, two stations (SO-001 and SO-010) were cancelled due to bad weather.

Water samples were collected at 11 discrete depths on all casts and used for salinity and phytoplankton analysis. These were drawn from Niskin bottles by the Russian scientific support team. Salinity calibration samples from all stations were analyzed on board, using a Guildline Portasal salinometer. Close agreements between CTD measured salinity and the Portasal values were obtained, with an average error of 0.0016 %. The final CTD/Portasal correlation produced an r^2=0.9964 (n= 1069) during the cruise. Comparisons of dissolved oxygen levels in the carousel water samples and the levels measured during the casts (via the O_2 sensor) were not attempted during the survey.

Underway comparisons of the Sea-Bird SBE-21 thermosalinograph (TSG) with CTD data were undertaken during the main survey. Salinity data compared with 5m CTD salinity data showed that the TSG salinity reading were on average 0.051ppt (n=216) lower than the CTD, while the sea temperature showed the TSG to be on average 0.529°C (n=216) higher than the CTD 7m temperature data. This can be attributed to the heating effects of positioning the temperature sensor downstream of the seawater pump.

1.2.2 Underway Environmental Data Collection: Environmental and vessel positional data was collected for a total of 61 days (30 days and 31 days during Legs I and II respectively) via the Scientific Computer System (SCS) software package. The data collected covered surface environmental conditions encountered over the South Shetland Islands and South Orkney Islands for the duration of the cruise, as well as transits to and from Punta Arenas, Chile.

1.3 Methods:

1.3.1 Hydrographic Data Collection:

Water profiles and samples were collected with a Sea-Bird SBE 911plus CTD system and Sea-Bird SBE 32 carousel water sampler equipped with eleven 101itre sampling bottles. A Sea-Bird SBE 43 dissolved oxygen probe, SBE pump, Chelsea Instruments Aquatracka III fluorometer, Wetlabs C-Star red transmissometer and a Wetlabs C-Star blue transmissometer were added to the CTD system. A Biospherical QCP-2300 2pi PAR sensor was also added. The QCP200L PAR sensor, used on previous cruises, was retained on the system to obtain a cross calibration between the two (Table 1.1). Scan rates were set at 24 scans/second during both down and up casts. Sample bottles were triggered during the up casts. Profiles were limited to a depth of 750m or 5m above the sea bottom when shallower than 750m. A Data Sonics altimeter was used to stop the CTD descent 5 to 7m from the seabed during shallow casts. Standard sampling depths were 750m, 200m, 100m, 75m, 50m, 40m, 30m, 20m, 15m, 10m and 5m.

The SCS software (SCS Version 3.3a) used to record and compare data ran on a Windows XP based Pentium IV Dell PC with an Edgeport-8 USB serial port expander. A Coastal Environmental Company Weatherpak system, a Licor quantum PAR sensor and a Biospherical 4PI QSR-2100 PAR sensor were installed on the port side of the forward A-frame in front of the bridge and were used as the primary meteorological data acquisition system.

Plots of the down and up traces were generated and stored with the CTD cast log sheets. Various phytoplankton groups received copies of the data, together with CTD mark files (reflecting data from the cast at bottle triggering depths) and processed down traces in Ocean Data View (ODV) format. Data from casts were averaged over 1m bins and saved separately as up and down traces during post processing. The data was logged and bottles triggered using Sea-Bird Seasave Win32 Version 5.30a software and the data processed using SBE Data Processing Version 5.30a software. Downcast data was re-formatted using a SAS script and then imported into ODV for further analysis.

Before leaving port and during Leg I, various tests were undertaken to compare the performance of the CTD's two PAR sensors against the two masthead PAR sensors. An extended-period cross calibration of the PAR sensors was undertaken in port between Legs I and II.

1.3.2 Underway Environmental Data Collection: Weather data inputs were provided by the Coastal Environmental Systems Company Weatherpak via a serial link. Data included relative wind speed and direction, barometric pressure, air temperature and irradiance (PAR). A Biospherical 4PI QSR-2100 PAR sensor (RS232 output version) was installed on the forward gantry, near the Weatherpak, and interfaced to the Scientific Computer System (SCS). The relative wind data were converted to true speed and true direction by the internally derived functions of the SCS logging software. Measurements of sea surface temperature and salinity were received by the SCS, in serial format, from the Sea-Bird SBE 21 thermosalinograph (TSG) and integrated into the logged data. Ship position and heading were provided in NMEA format via a Trimbol GPS Navigator and Guiys Gyro, respectively. Serial data lines were interfaced to the Pentium 4 (Windows XP Professional based) logging PC via an Edgeport 8 serial RS232 to USB interface.

1.4 Results and Tentative Conclusions:

1.4.1 Oceanography:

The position of the polar frontal zone, identified by pronounced sea surface temperature and salinity change, was located from the logged SCS data during the two transits from and to Punta Arenas and the South Shetland Islands Survey Area. This frontal zone is normally situated between 57-58° S.

During the south-bound transit of Leg I, a narrow front was defined between 58° 05'S and 58°' 15'S, with sea surface temperature (SST) changing from 4.5°C to 3.1°C. During the north-bound transect the front was located between 57°15'S and 56°50'S, with a change in SST from 3.4°C to 4.3°C. During the south-bound transit of Leg II the front was found to have moved further south and broadened when compared to the north bound transect of Leg I, laying between 57° 30' S and 58° 55' S, with the SST changing from 6.7°C to 3.1°C. On the return (north-bound) transit, at the end of Leg II, the zone was located between 57° 20' S and 58° 15' S, with the SST changing from 4.0°C to 6.5°C. (Figure 1.1) Two of the three XBT transects across the Drake Passage were plotted for comparison reasons for the North to South transects for Legs I and II respectively. The 1.8°C temperature isotherm was highlighted to show the Polar fronts, which coincide with the data obtained from the logged SCS data (Figure 1.2).

As in previous years, an attempt was made to group stations with similar temperature and salinity profiles into five Water Zones as defined in Table 1.2. The tentative Water Zone classifications according to the criteria in Table 1.2 were sometimes prone to ambiguity, particularly in the coastal regions around King George & Livingston Islands and in the south and southeast of Elephant Island. Classifications of Zone IV (Bransfield Strait) and V (Weddell Sea) waters in these areas could change if other oceanographic data such as density are considered. For the purpose of this report, in which only tentative conclusions are reported, only the criteria contained in Table 1.2 were used. This was done to ensure consistency with past cruises and only serves as a first attempt field classification.

During Leg I, there was a defined distinction of Zone I (ACC) water at the offshore stations of the West area (63% of stations), with the inshore stations being Zone IV (Bransfield Strait) water. The Fracture Zone, in the Elephant Island Area, was classified as containing ACC water, or Water Zone I (transects 09; 08 and 07), with Zone II (Transition) water in the northeastern part of the Area. The southern extent of the Elephant Island Area was classified as Water Zone IV (Bransfield Strait), with 3 stations towards the south east of the area being Water Zone V (Weddell Sea). Ten stations were occupied in the Joinville Island area, with 80% of these stations being classified as Water Zone V (Weddell Sea). In the South Area the stations along the Peninsula was classified as Water Zone V (Weddell Sea) with the remainder of the stations (74%) in the area being classified as Water Zone IV (Bransfield Strait) (Figure 1.3).

During Leg II the West Area was not sampled; only the Elephant Island and South Areas were completed as part of survey D. Comparing data from these two areas with Leg I data shows that the water located along the northern extent of the Elephant Island Area had become more Zone II (Transition) waters, with 40% of stations being classified as Zone II (transition) compared to 28% during Leg I. The southern extent of the Elephant Island Area was still mainly classified as Zone IV (Bransfield Strait) waters, with 3 stations on the eastern side of the area classified as Zone V (Weddel Sea) waters. The South Area was, as with Leg I of the survey, mainly classified as Zone IV (Bransfield Strait) water (83% of stations) (Figure 1.3).

The stations completed around the South Orkney Islands were found to be mainly Transition water, or Water Zone III (Figure 1.4); although very low surface salinities were observed at the stations in the area, this was mainly due to ice melt.

Three vertical temperature transects - identical to transects from previous years, for comparative value - were plotted using ODV software from the main survey (Figure 1.5). These transects are W05 in the West Area and EI03 and EI07 in the Elephant Island Area of the survey. Transect W05 in the West Area was not sampled during Leg II.

1.4.2 Underway Data: Environmental data were recorded for the duration of the surveys and during the transits between Punta Arenas and the survey area. Processed data were averaged and filtered over 1-minute and 5-minute intervals. (Figures 1.6; 1.7 and 1.8: Leg I, the South Orkney Islands and Leg II respectively).

Summary tables of the underway data collected during the survey were created (Tables 1.3 and 1.4) using 5-minute average values. Mean PAR values was calculated using *mid-day* values only (10:00 – 14:00).

Using PAR results obtained, which indicate levels of photosynthetic radiation, it can be observed that cloud cover during Survey A was less (t=12.6, p=0.000) than during Survey D. Air temperature was higher for Survey A compared to Survey D (2.3°C and 2.1°C respectively; t=3.9, p=0.000).

Wind direction during Survey A was predominately west to northwest (45% and 36% respectively) with wind speeds averaging 19 knots. During Survey D the average wind speed was lower (17.8 knots; t=7.0, p=0.000), with wind direction still mainly from the west and northwest (24% and 26% respectively).

1.5 Problems and Suggestions

In general the CTD systems performed well during the cruise; only the usual maintenance to leaking underwater connectors was required. A continuous check was done on CTD performance by frequently processing data and checking for signs of sensor drift. Only one SBE 9plus underwater unit (and its auxiliary instruments) was used for both legs of the cruise. The SBE 43 Oxygen Sensor was replaced with a spare unit during Leg II due to malfunction. Four sampling bottles were damaged beyond repair during the cruise. The process of replacing the existing sampling bottles should be started before the next cruise.

There is an ongoing problem with the ship's clean seawater supply and the TSG debubbler plumbing system that was not resolved during the cruise. The pump is too powerful and cavitates, causing excessive bubbles that the debubbler cannot clear fast enough. This causes spiking on the salinity trace. Continual cleaning and monitoring of the pump was required by ship staff to reduce the amount of bubbles. It is suggested that the pump and debubbler system be replaced by the ship and that a new Sea-Bird SBE 45 TSG be bought to be used as the operational unit and the existing SBE 21 TSG be used as the spare, as there is no spare TSG at present. This practice of gradual upgrading and replacement of instruments and systems is recommended to phase out old equipment and keep abreast of new oceanographic technology.

A field calibration was done on the Chelsea Instruments submersible fluorometer. Results provided in the phytoplankton section (Chapter 2).

There is a discrepancy between the calibration of the four PAR sensors on the ship (two submersible and two mast mounted). It is suggested that all four sensors be post-cruise calibrated together.

Besides the technical support for the oceanographic operation, general technical support was given to assist in solving a number of equipment related problems (electronic, software, mechanical and operational).

1.6 Disposition of Data: Data are available from Christian Reiss, Southwest Fisheries Science Center, 8604 La Jolla Shores Drive, La Jolla, CA, 92037; phone/fax (858) 546-5603/(858) 546-5608; email: Christian.Reiss@noaa.gov.

1.7 Acknowledgements: The co-operation and assistance of the Russian technical support and deck staff was once again outstanding. All requests for assistance were dealt with effectively and in a professional manner.

1.8 References:

Schlitzer, R., Ocean Data View, http://www.awi.bremerhaven.de/GEO/ODV, 2001.

Table 1.1. CTD/Sensor installation summary (AMLR2008)

Description	**Manufacture**	**Model**	**LEG I**	**LEG II**
Deck Unit	Sea-Bird	SBE 11	11P13966-0434	11P13966-0434
U/W Unit	Sea-Bird	SBE 9plus	09P13966-0454	09P13966-0454
Temperature Sensor	Sea-Bird	SBE 3plus	3P2234	3P2234
Conductivity Sensor	Sea-Bird	SBE 4C	041815	041815)
Pressure Sensor	DigiQuartz 410K-105	Internal	64268	64268
Circulation Pump	SeaBird	SBE 5T	051654	051654
SBE Carousal	Sea-Bird	SBE 32	3235861-0509	3235861-0509
O_2 Sensor	Sea-Bird	SBE 43	430908 (Voltage 0)	430908/430912 (Voltage 0)[1]
PAR (new)	Biospherical	QCP-2300	4744 (Voltage 2)[2]	
Altimeter	Datasonics	PSA-900	508 (Voltage 3)	508 (Voltage 3)
PAR (old)	Biospherical	QCP200L	4264 (Voltage 4)[3]	4264 (Voltage 2)
Transmissometer	Wetlabs	C-Star (Blue)	CST-421DB (Voltage 5)	CST-421DB (Voltage 5)
Fluorometer	Chelsea	Aqua 3	05-5173-001 (Voltage 6)	05-5173-001 (Voltage 6)
Transmissometer	Wetlabs	C-Star (Red)	CST-882DB (Voltage 7)	CST-882DB (Voltage 7)

[1] Change O2 sensor after Station SO-012 from SN#430908 to SN#430918 due to malfunction (New configuration file – 09p-0454_AMLR2008_Leg2a)

[2]Remove and change to PAR(old) – SN#4264 - after station A03-08

[3] Remove PAR sensor after station A11-01 ; Transmissometer (voltage 5) moved to voltage 4 (new confile 09p-0454_AMLR2008_leg1C)

Table 1.2. Water Zone definitions applied for AMLR 2007/08.

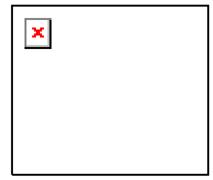
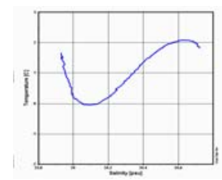
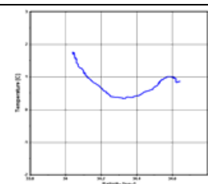
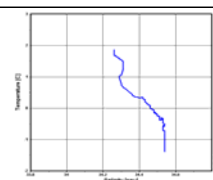
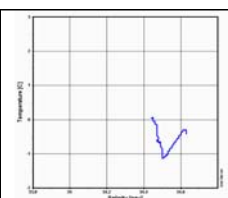
	T/S Relationship			
	Left	**Middle**	**Right**	**Typical TS Curve (from 2002)**
Water Zone I (ACW)	**Pronounced V shape with V at <0ºC**			
Warm, low salinity water, with a strong subsurface temperature minimum, Winter Water, approx. -1ºC, 34.0ppt salinity) and a temperature maximum at the core of the CDW near 500m.	2 to >3ºC at 33.7 to 34.1ppt	<0ºC at 33.3 to 34.0 ppt	1 to 2ºC at 34.4 to 34.7ppt (generally >34.6ppt)	
Water Zone II (Transition)	**Broader U-shape**			
Water with a temperature minimum near 0ºC, isopycnal mixing below the temperature minimum and CDW evident at some locations.	1.5 to >2ºC at 33.7 to 34.2ppt	-0.5 to 1ºC at 34.0 to 34.5ppt (generally >0ºC)	0.8 to 2ºC at 34.6 to 34.7ppt	
Water Zone III (Transition)	**Backwards broad J-shape**			
Water with little evidence of a temperature minimum, mixing with Type 2 transition water, no CDW and temperature at depth generally >0ºC	1 to >2ºC at 33.7 to 34.0ppt	-0.5 to 0.5ºC at 34.3 to 34.4ppt (note narrow salinity range)	< 1ºC at 34.7ppt	
Water Zone IV (Bransfield Strait)	**Elongated S-shape**			
Water with deep temperature near -1ºC, salinity 34.5ppt, cooler surface temperatures.	1.5 to >2ºC at 33.7 to 34.2ppt	-0.5 to 0.5 ºC at 34.3 to 34.45ppt (T/S curve may terminate here)	<0ºC at 34.5ppt (salinity < 34.6ppt)	
Water Zone V (Weddell Sea)	**Small fish-hook shape**			
Water with little vertical structure and cold surface temperatures near or < 0ºC.	1ºC (+/- some) at 34.1 to 34.4ppt	-0.5 to 0.5ºC at 34.5ppt	<0ºC at 34.6ppt	

Table 1.3. Mean environmental variables (5-minute average values) by survey and area. Mean PAR calculated using mid-day values only (10:00- 14:00).

Survey	**A**					**D**			**South Orkneys**
Area	**Elephant**	**Joinville**	**South**	**West**	**Total**	**Elephant**	**South**	**Total**	
N / N for PAR	2503 / 402	474 / 96	804 / 144	951 / 174	4732 / 816	1929 / 336	815 / 108	2787 / 480	2798 / 456
Wind Speed (knots)	22.0	13.4	13.6	18.2	19.0	19.9	12.8	17.8	21.1
Air Temp (°C)	2.8	-0.4	1.9	2.7	2.3	2.2	2.1	2.1	1.4
Barometric Pressure (mb)	997.6	989.5	992.8	991.9	994.8	1005.0	991.4	1001.0	987.3
Humidity (%)	91.7	91.3	90.9	91.3	91.5	90.0	93.1	91.0	91.8
Water Temp (°C)	1.7	0.2	1.4	1.8	1.5	2.0	1.3	1.8	0.8
Salinity (ppt)	34.0	34.3	34.1	34.0	34.1	34.0	34.1	34.1	33.5
PAR (μEin/m²/s)	538.0	336.6	603.4	343.3	484.3	273.3	239.7	259.1	388.7

Table 1.4. Percent wind direction by survey and area (from 5-minute average values).

Survey	**A**					**D**			**South Orkneys**
Area	**Elephant**	**Joinville**	**South**	**West**	**Total**	**Elephant**	**South**	**Total**	
E	1%	3%	0%	0%	**1%**	8%	8%	**8%**	2%
N	7%	4%	8%	11%	**8%**	6%	13%	**8%**	8%
NE	1%	0%	1%	0%	**0%**	20%	13%	**17%**	5%
NW	32%	25%	22%	64%	**36%**	23%	27%	**24%**	31%
S	0%	28%	0%	0%	**3%**	6%	0%	**5%**	2%
SE	0%	12%	1%	0%	**2%**	9%	0%	**6%**	1%
SW	6%	12%	8%	0%	**6%**	8%	2%	**6%**	14%
W	53%	15%	59%	24%	**45%**	20%	37%	**26%**	36%

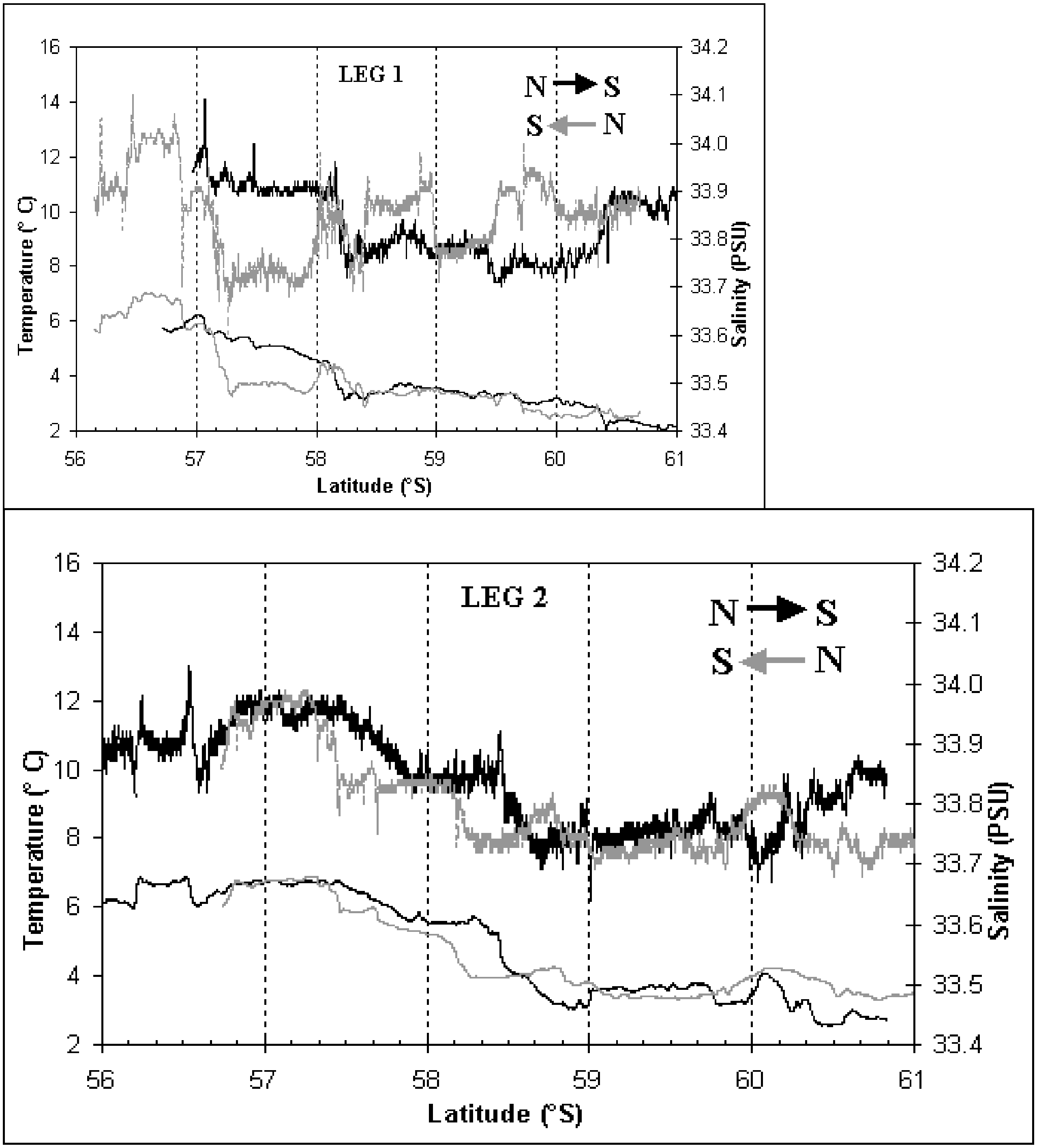


Figure 1.1. The position of the polar fronts as determined for AMLR 2007/08 Legs I (top) and II (bottom), from measurements of sea surface temperature (solid line) and salinity (broken line) for the south and north transits to and from the South Shetland Islands Survey area.

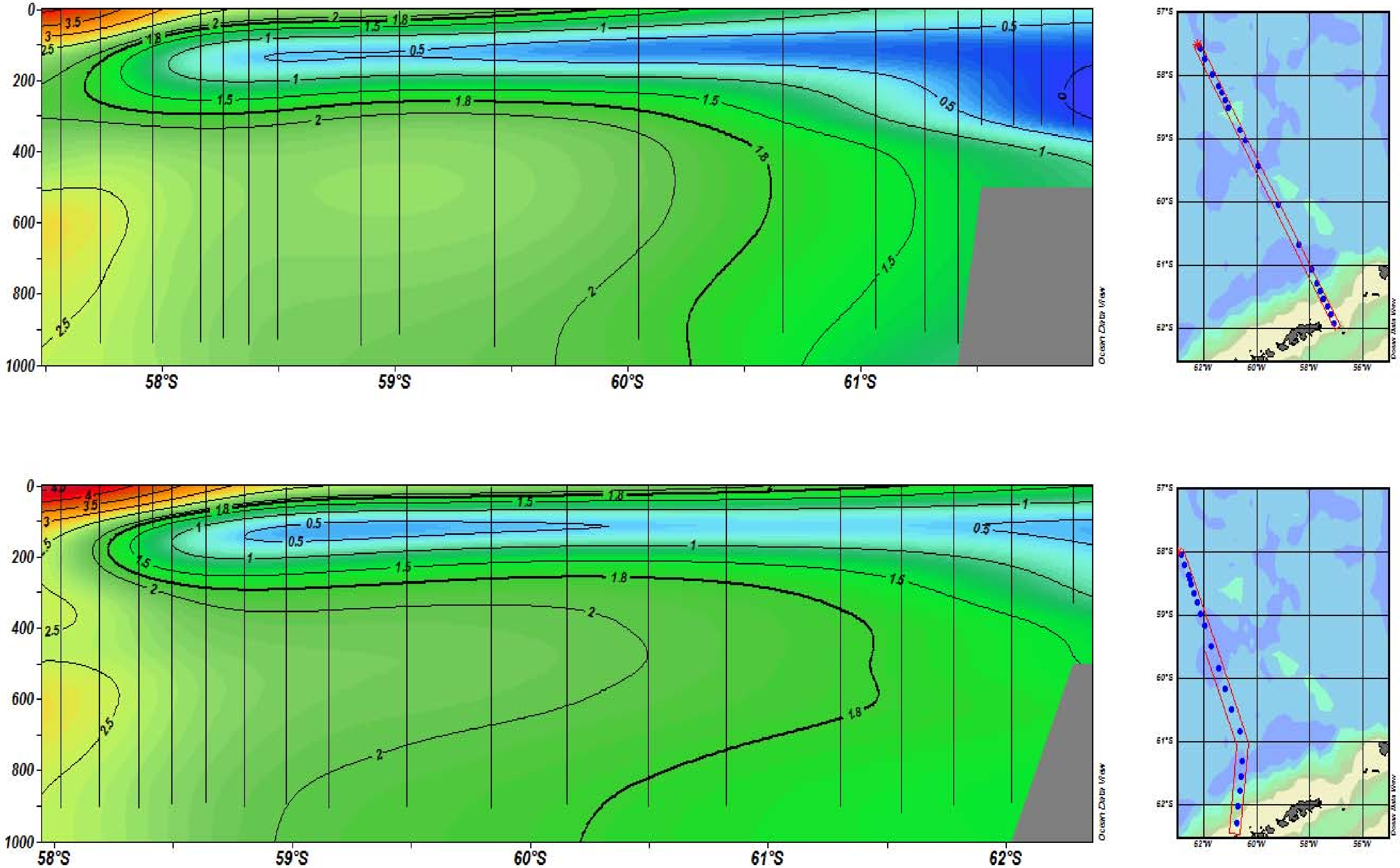


Figure 1.2. XBT (Expendable Bathy Thermograph) temperature data for AMLR 2006/07: North/South transect (top) and South/North transect (bottom).

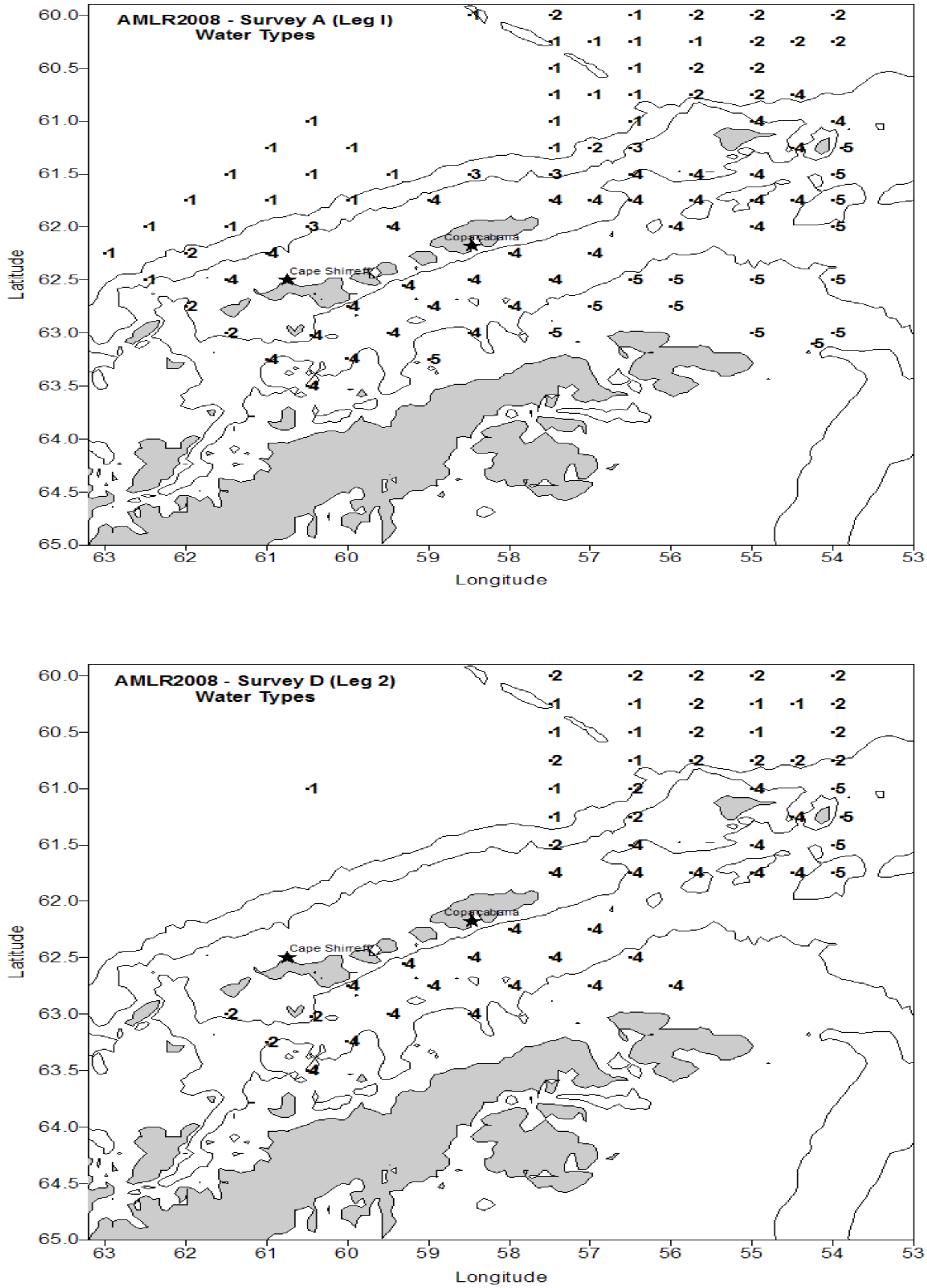


Figure 1.3. Classification of water zones for Leg I & II (top and bottom panels, respectively) for AMLR 2007/08, as defined in Table 1.1 (Water Zone definitions).

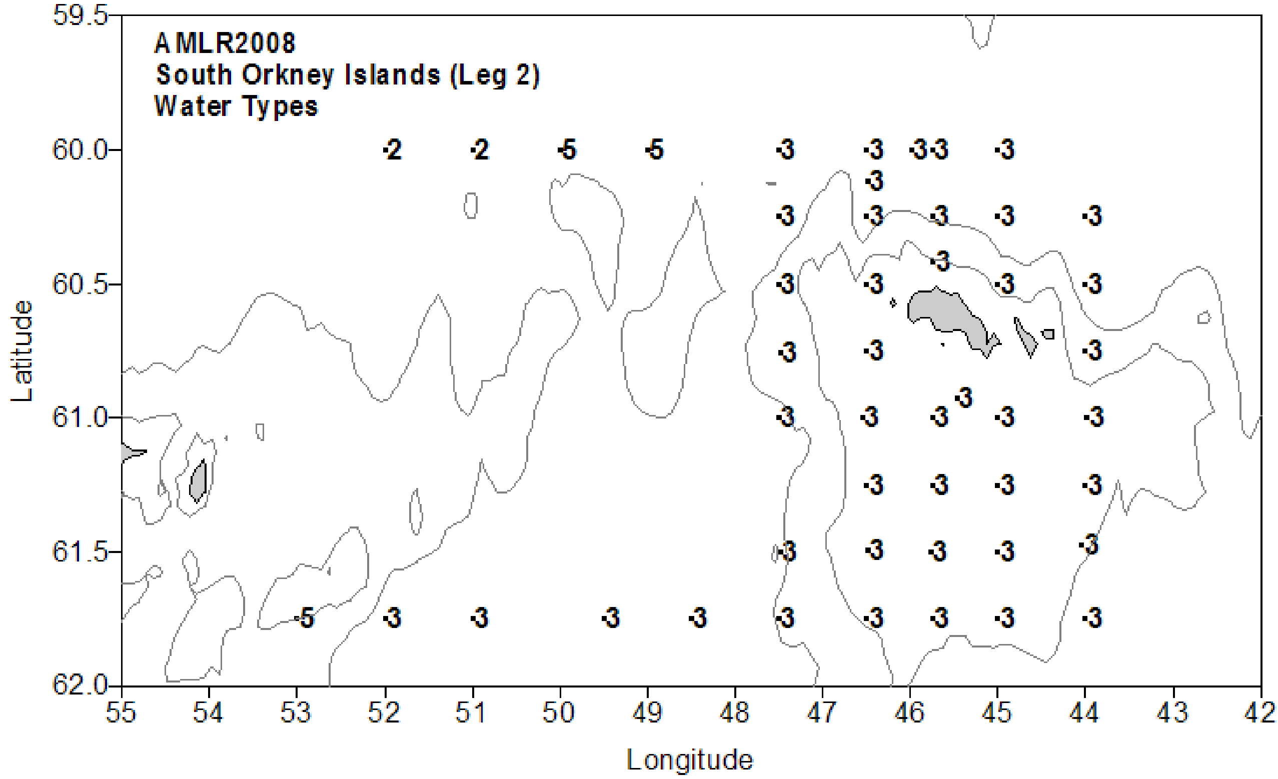


Figure 1.4. Classification of water zones for the South Orkneys Islands (Leg II) for AMLR 2007/08, as defined in Table 1.1 (Water Zone definitions).

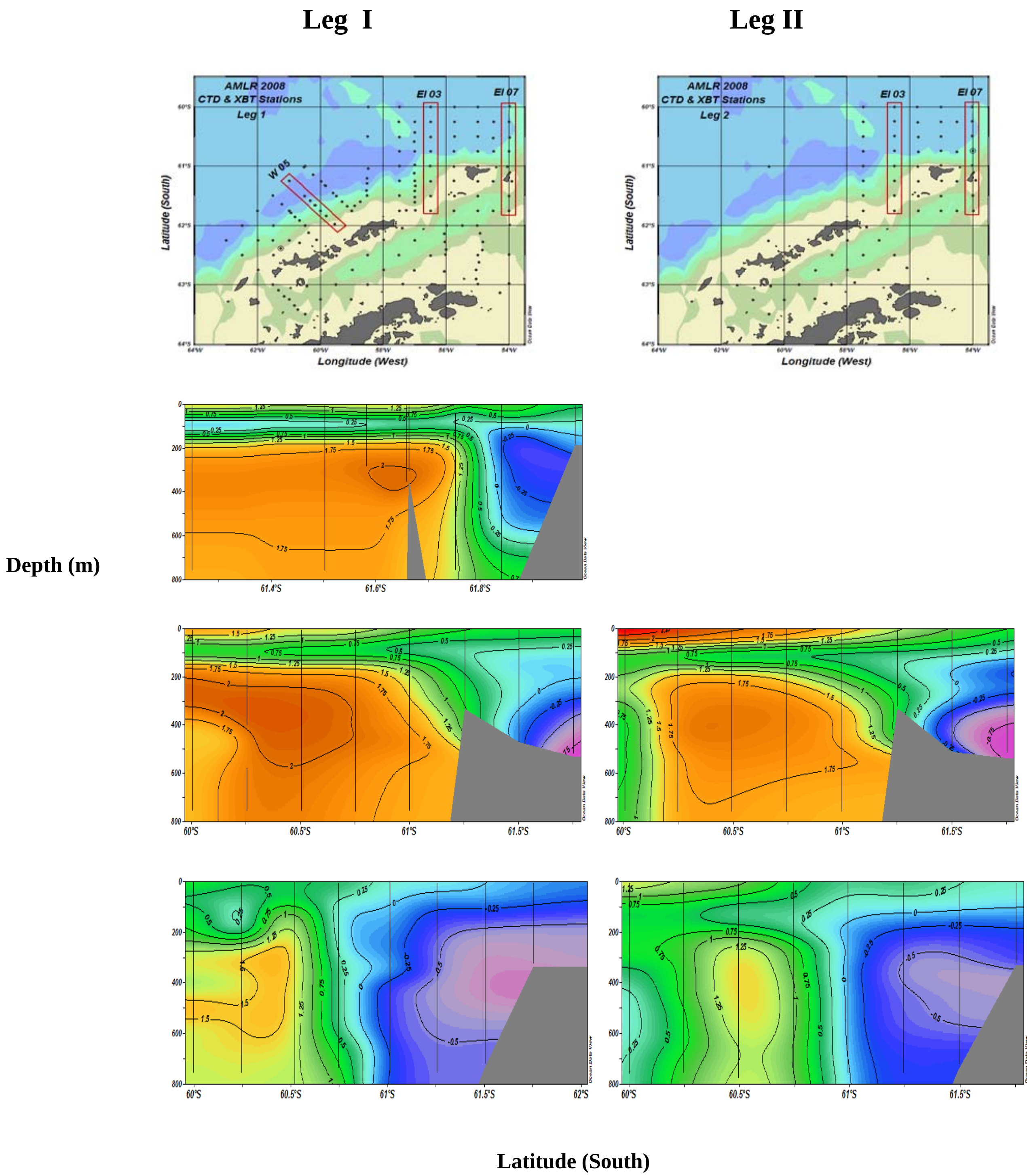


Figure 1.5. Vertical temperature profiles derived from CTD data recorded on three transects, W 05 (top), EI 03 (middle) and EI 07 (bottom), during Legs I (left column) and II (right column) of the the AMLR 2007/08 South Shetland Island survey. Transect W 05 not sampled during Leg II

AMLR 2007/08 – Leg I (Survey A)

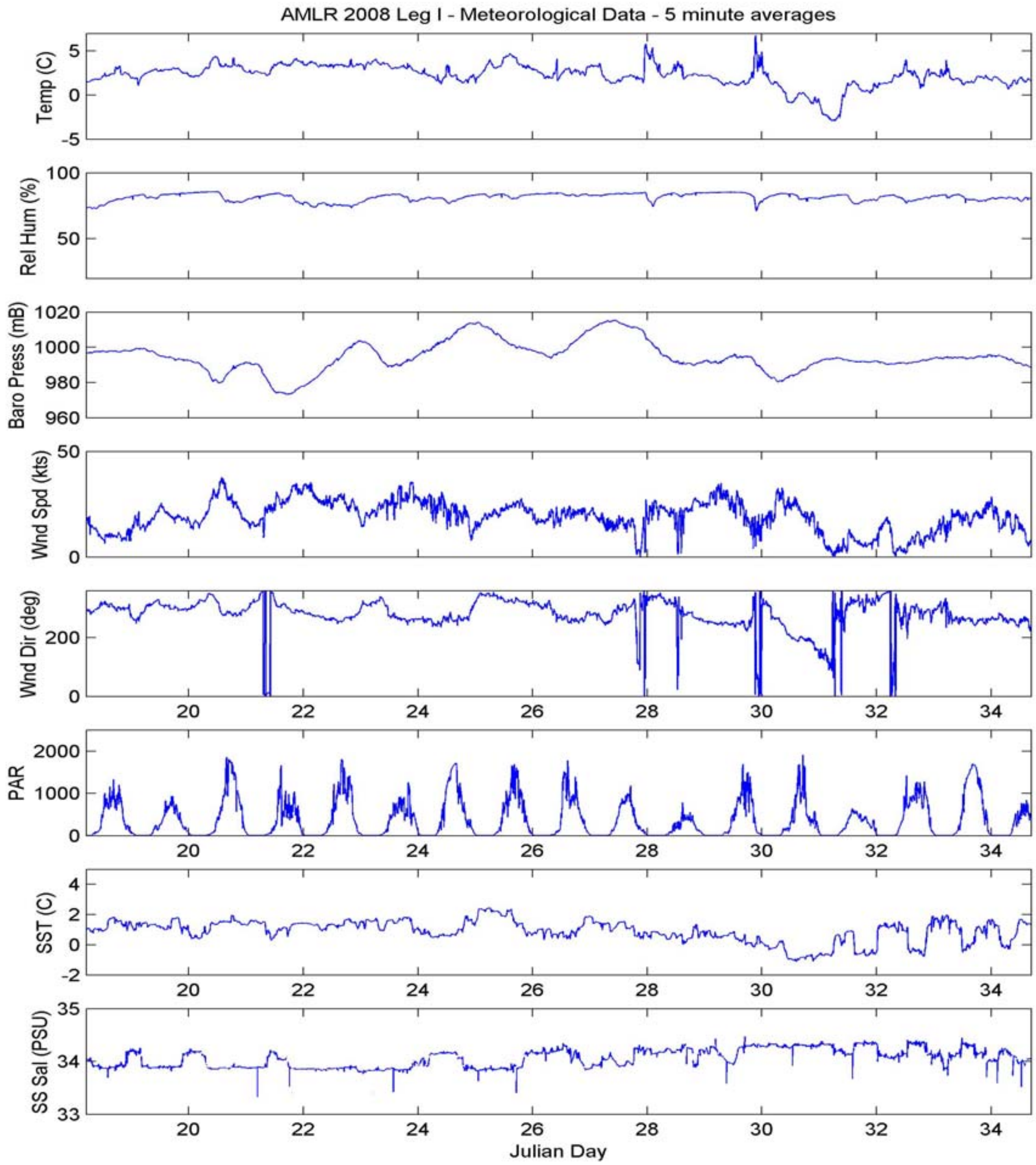


Figure 1.6. Meteorological data (5 minute averages) recorded between January 18th and February 3rd during Leg I (survey A only) of the AMLR 2007/08 cruise. (PAR is photo-synthetically available radiation).

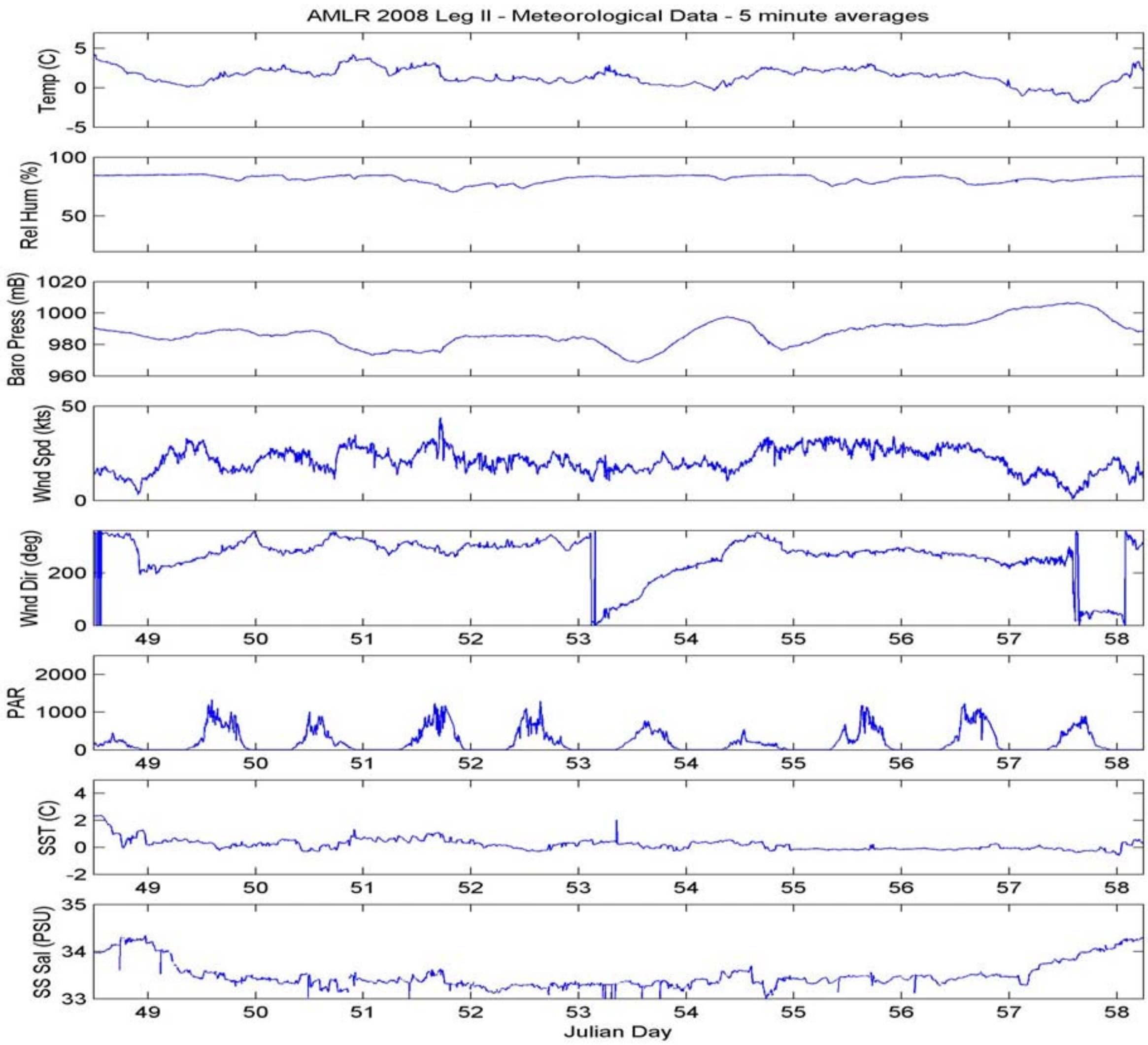


Figure 1.7. Meteorological data (5 minute averages) recorded between February 17th and February 27th during Leg II (South Orkney islands only) of the AMLR2007/08 cruise. (PAR is photo-synthetically available radiation).

AMLR 2007/08 – Leg II (Survey D)

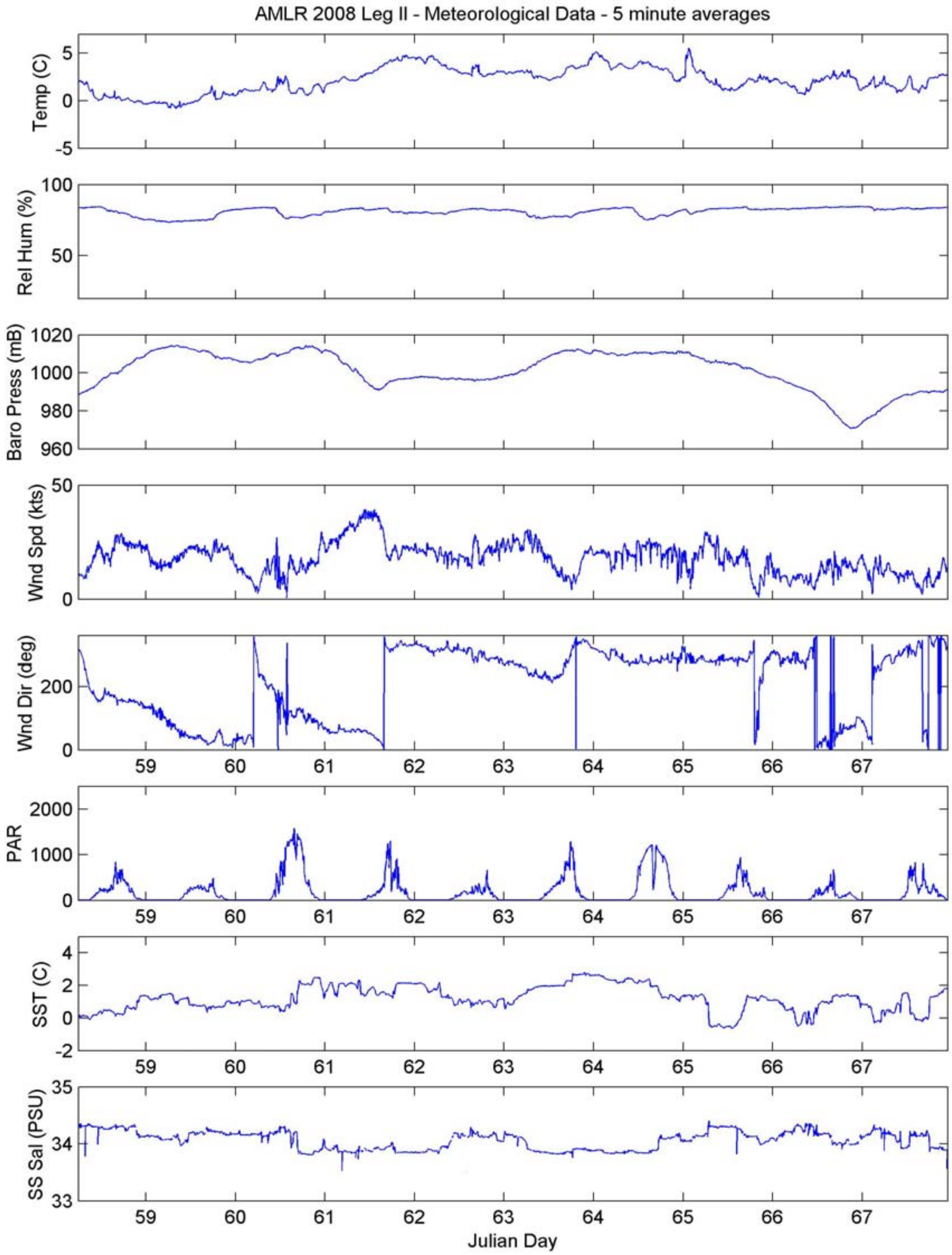
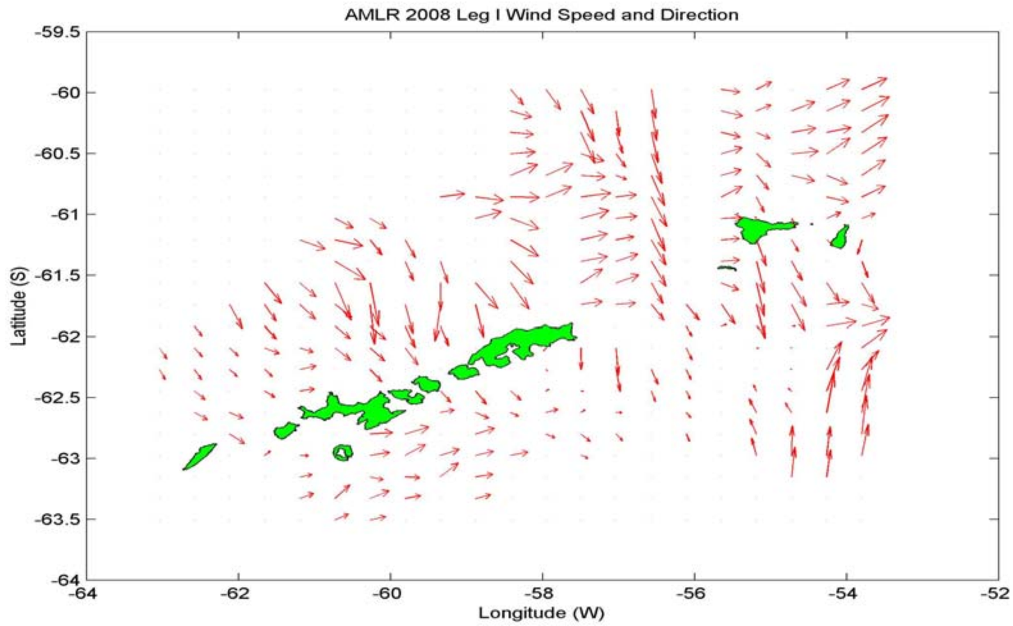


Figure 1.8. Meteorological data (5 minute averages) recorded between February 27th and March 7th during Leg II (survey D only) of the AMLR2007/08 cruise. (PAR is photo-synthetically available radiation).



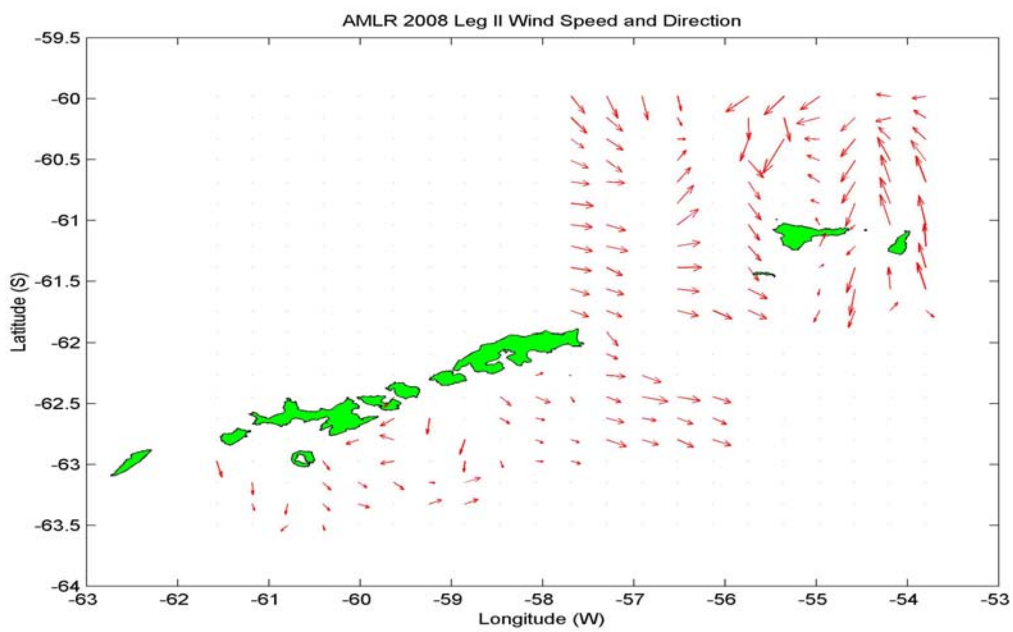


Figure 1.9. Vectors representing wind speed and direction for Legs I (top) & II (bottom), derived from data recorded by the SCS logging system during AMLR 2007/08.

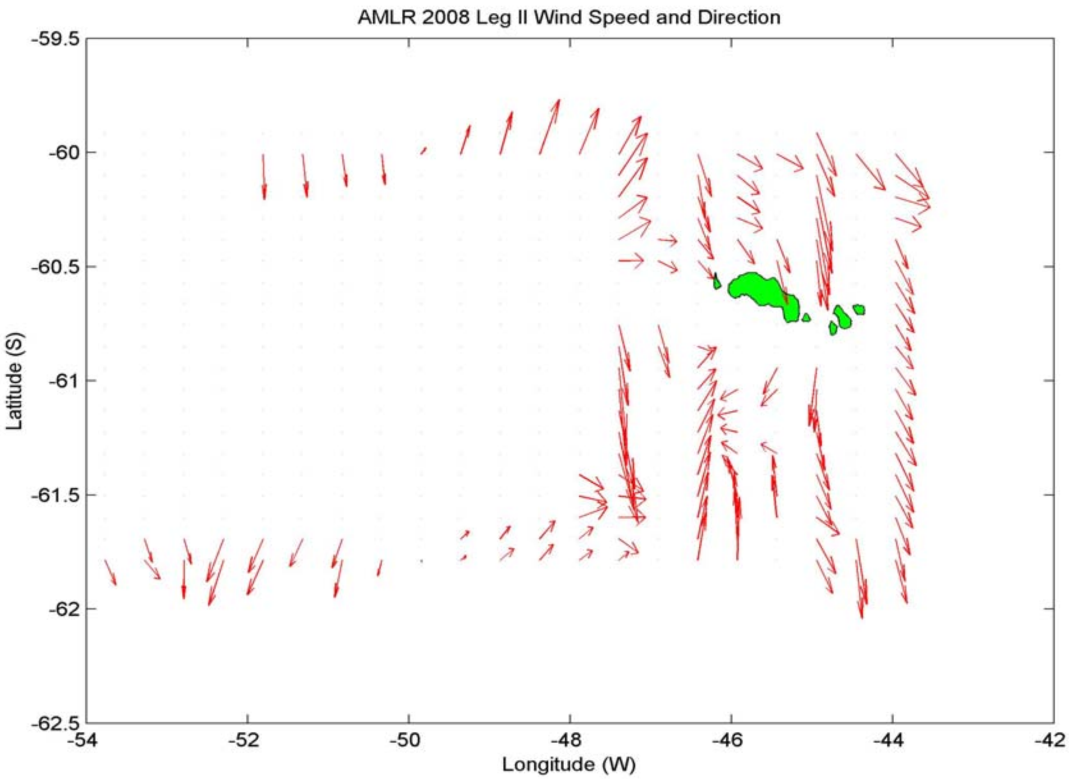


Figure 1.10. Vectors representing wind speed and direction around the South Orkney Islands (Leg II), derived from data recorded by the SCS logging system during AMLR 2007/08.

UNITED STATES

AMLR ANTARCTIC MARINE LIVING RESOURCES PROGRAM

AMLR 2007/2008 FIELD SEASON REPORT

Objectives, Accomplishments and Tentative Conclusions

Edited by
Amy M. Van Cise

October 2008

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U.S Department of Commerce
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National Marine Fisheries Service
Southwest Fisheries Science Center
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