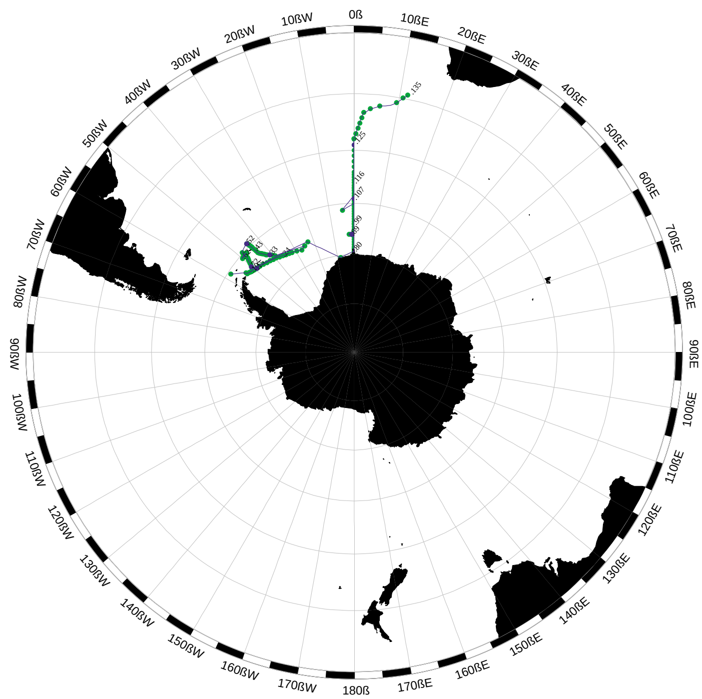
1. CRUISE NARRATIVE: SR04

(Updated MAY 2005)



1.1. HIGHLIGHTS

Cruise Summary Information

WOCE section designation	**SR04**
Expedition designation (ExpoCode)	**06AQANTXV_4**
Chief Scientist / affiliation*	**Eberhard Fahrbach / AWI**
Dates	28 MAR 1998 – 23 MAY 1998
Ship	*R/V POLARSTERN*
Ports of call	Punta Arenas Cape Town
Station geographic boundaries	39° 23.5' S 57° 35' W 11° 49.6' E 70° 29.3' S
Stations	151 CTD-Stations
Floats and drifters deployed	0
Moorings deployed or recovered	Greenwich Meridian: 6 deployed, 7 recovered Western Weddell Sea: 10 deployed, 5 recovered

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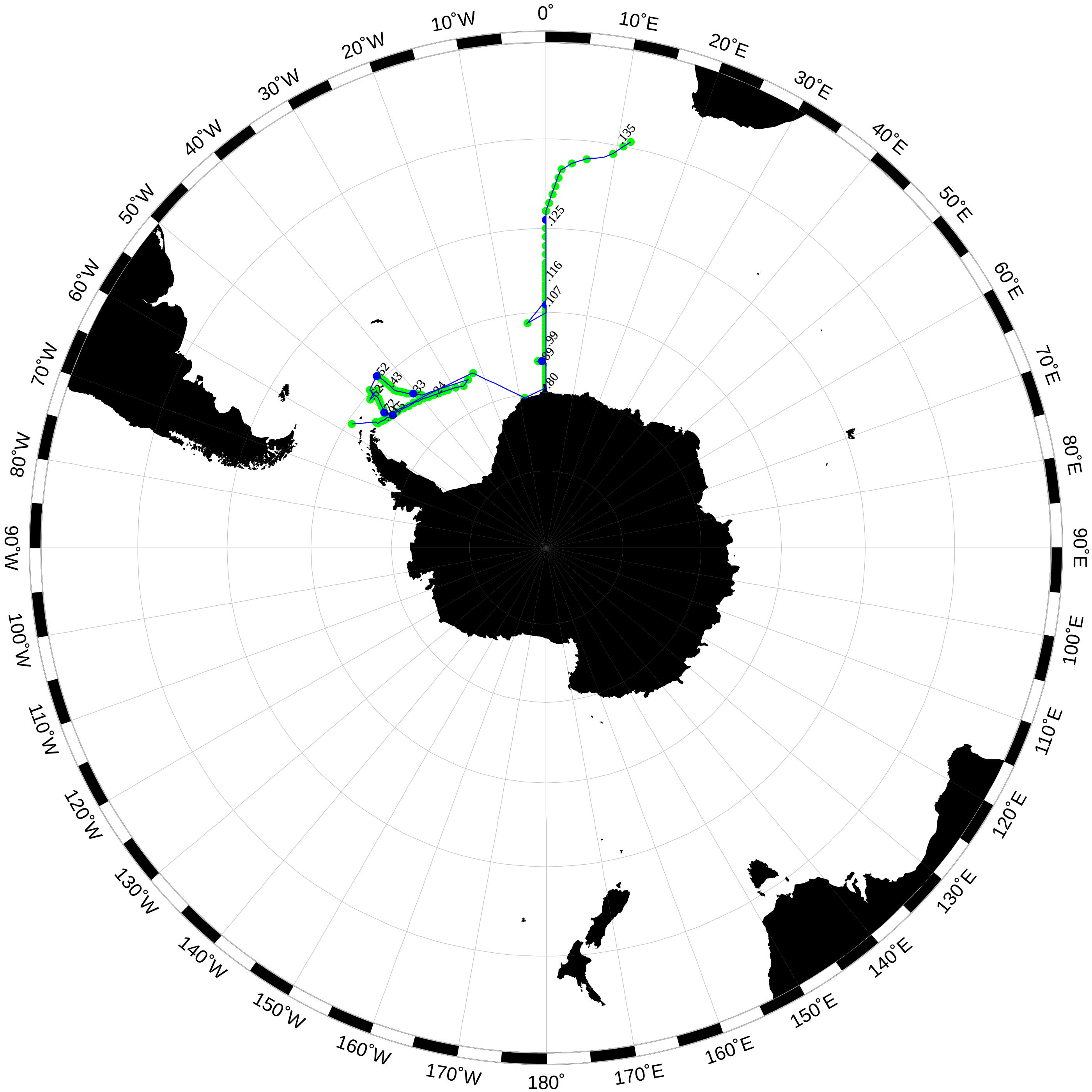
Cruise and Data Information

Links to text locations. Shaded items are not relevant to this cruise or were not available when this report was compiled

Cruise Summary Information	Hydrographic Measurements
Description of Scientific Program	**CTD Data: Introduction**
Geographic Boundaries	**Calibration**
Cruise Track: WHPO-Generated PI-Generated	Salinity Pre-Cruise Post-Cruise
Description of Stations	Temperature Pre-Cruise Post-Cruise
Description of Parameters Sampled	Pressure Pre-Cruise Post-Cruise
Bottle Depth Distributions (Figure)	Oxygen Pre-Cruise Post-Cruise
	Bottle Data
Floats and Drifters Deployed	Salinity
Moorings Deployed or Recovered	Oxygen
	Nutrients
Principal Investigators for All Measurements	CFCs
Cruise Participants	CO_2 System Parameters
	Helium Tritium
Problems and Goals Not Achieved	Radiocarbon
Other Incidents of Note	Other Parameters (Marine Biology)
Underway Data Information	**DQE Reports**
Navigation Bathymetry	CTD
Acoustic Doppler Current Profiler (ADCP)	S/O_2/Nutrients
Thermosalinograph and Related Measurements	CFCs
XBT and/or XCTD	^{14}C
Meteorological Observations	
Atmospheric Chemistry Data	
Acknowledgments	**Data Processing Notes**
References	

Station Locations for SR04 • Fahrbach • *R/V Polarstern* • 1988



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1.2. SUMMARY AND ITINERARY

Cruise Track

See Figure 1a (WHPO Station Location Map) and Figure 1b (AWI Cruise Track)

Number of Stations

151 CTD-Stations were occupied. See section 1.3 for a complete breakdown of stations and the work done at each.

Sampling

Water samples measurements included Salinity and Oxygen, as well as tracers that include: Tritium, Helium and CFCs (Freon-11 and Freon-12, Freon-113, CCL4). Nutrients: (Silicate, Nitrate, Nitrite, Phosphate), Total Carbon, Partial Pressure of CO_2 and Neon were also collected

Moorings

To obtain time series, 12 moorings were recovered and 16 were deployed (Appendix 1). 10 of the deployed moorings were conventional ones and 6 were expendable. Regionally these operations focused on four components:

1. To measure the outflow from the northwestern Weddell Sea into the Weddell-Scotia Confluence, a hydrographic section, consisting of 28 stations, extended from Joinville Island to the southeast (Figures 7a and 8). This section is termed Joinville section. It represents the fifth repeat since 1989. 5 moorings were recovered and 3 were deployed along this section (Figures 7b and 17; Appendix 1, Tables 1 and 2).
2. To determine the water mass properties in the Weddell-Scotia Confluence, two quasi-meridional hydrographic sections with 39 stations were carried out, one east of the South Orkneys and the other one west of the islands (Figures 7a, 9, 10). These sections are called South-Orkney-east and South-Orkney-west sections. A section with 7 CTD-stations was carried out across the northern boundary of the Powell Basin, extending west-east along the South Scotia Ridge towards the Scotia Sea (Figures 7a and 11). This section is called Powell-Basin-boundary section. 6 expendable and 1 conventional mooring were deployed along this section (Figures 7b and 18; Appendix 1, Table 2).
3. To measure the exchanges between the eastern and the western Weddell Sea, a hydrographic section with 38 stations was carried out along the Greenwich Meridian. This section extended northward from the ice shelf front at 69°38.5'S to 55°S (Figures 7a and 12), and was previously measured in 1992 and 1996. Along this section 7 moorings were recovered and 6 deployed (Figures 7b and 19, Appendix 1, Tables 3 and 4).
4. To determine the structure and transport of the Antarctic Circumpolar Current, a hydrographic section was carried out along the Greenwich Meridian from the northern boundary of the Weddell Gyre (55°S) to the Subtropical Front (48°S; Figures 7a and 12). At 48°S the section turns to the northeast and ends at 39°25'S, 11°48'E. For simplicity the complete section will be called Greenwich-Meridian section, despite its deviation from that longitude. To resolve the frontal system, XBTs were launched between CTD stations at approximately 10 nm distance from 57°S on northward.

Investigations of Acoustic Location of Moorings

(Alexeij Iaremtchouk/AAI)

Objectives

Acoustic methods are used to locate and release moorings. However, only rarely signals from the deployed instruments can be received by the ship, whereas the releases receive the transmitted signals and operate properly. The extent, to which the ship's noise or natural perturbations affect the sound propagation, were investigated.

Work at sea

The tests indicated that all used positioning systems exhibit similar behaviour, mainly determined by the parameters of the sounding signals. The vessel noise was found to have the most significant impact on performance of the acoustic instruments.

During the cruise special measurements of the arriving beacon signal and of the vessel noise in the close-field zone were conducted. The collected data made it possible to evaluate the actual signal-to-noise ratio and operating range of the transponder systems. See the final report for details.

Preliminary results

1 The impact of currents on operation of ranging systems is negligible: practically, currents do not deflect rays neither cause extra attenuation of the signal; the Doppler shift of frequency is also very small.

2 Stratification of water has no influence on deep transponders, but may cause a significant extra attenuation of a signal coming to the vessel from a beacon floating underneath the ice at a depth of 50 to 100 m. Extra attenuation occurs when a beacon happens to be inside of an acoustic channel, i.e. in layers with small sound velocity. Actual attenuation may be estimated with the aid of computer programs (see the final report).

3 The vessel noise is the main factor limiting the operating range of a transponder system. Its level at the depth of 10 to 20 m amounts to about 0.1 to 0.3 Pa/ $\sqrt{Hz}$ when "Polarstern" is at rest, and probably about 25 dB more when she moves. The noise is produced by turbulent eddies and air bubbles clouding around the body of the vessel, the decrease in level is only expected at distances large enough in comparison with 100 m (no accurate estimate is available). The working range of the transponder systems with the short transducer cable is expected to be about 300 m. When the system is operated from an ice floe far from the vessel, the range is expected to increase up to 5-8 km (depending on frequency).

4 On average the ambient noise does not exceed the level of -55 dB relative to Pa/ $\sqrt{Hz}$ and is small in comparison with the vessel noise. See the description of computer programs for prediction of the ambient noise level in the final report.

5 Because of possible multi-path arrivals of the beacon signal, the vessel transducer should not be placed closer than 8 m to the water surface or the body of the ship (MORS and EG&G systems). The Benthos system with its long (two seconds) messages must always suffer from multi-paths arrivals which can additionally reduce the operating range.

Recommendations

1 In order to protect the deck receiving transponder from the vessel noise, one may try to construct a baffle. The transducer size is about the wavelength, and this implies that the far field zone starts approximately at distances of 20 to 50 cm from the transducer. A baffle in the far field zone appears to be unacceptably large (about 1 m in radius), even for a deep transducer. Constructing a close field baffle is very complicated and must be controlled by measurements. Also, an effective baffle will make the hydrophone looking strictly downwards. Therefore, the use of a baffle is not feasible.

2 The most promising, realistic, and cost effective way to improve the situation is to change the shape and duration of the signal transmitted by the beacon. Increasing duration of the signal to 1-4 s will result in an increase of the signal-to-noise ratio by 20-25 dB, and consequently the operating range will reach at least 36 km. The frequency of the signal should not be kept constant but should be linearly increased with time. Then, scanning through the range of 1 kHz formally results in ranging accuracy of 1.5 m which is enough for mooring search. The working frequency band should be set to 8-12 kHz (a tradeoff between sound absorption and the vessel noise). With the spatial step of 1.5 m, about 8000 bins are needed to cover the range of 12 km; therefore, there will be no problems with digital processing.

3 For ranging purposes it seems advantageous to periodically send signals from the beacon without synchronizing clocks with the deck unit. This results in an extra measurement, but also makes it possible to achieve the maximum allowed accuracy. Improper clock synchronization may explain the discrepancy of 55 m of the MORS ranging system against geometrical evaluation of distance.

1.3. PRINCIPAL INVESTIGATORS AND PROGRAMS

Institute	Scientist	No.	Unit	Type of Measurements	Comments
AWI	Fahrbach, E	28	stations	Current meters	6 moorings deployed on the Greenwich Meridian 7 moorings recovered on the Greenwich Meridian 10 moorings deployed in the western Weddell Sea 5 moorings recovered in the western Weddell Sea
AWI	Fahrbach, E	5000	n miles	Current profiler	VM-ADCP-profiles
AWI	Fahrbach, E	136	stations	Water bottle stations	GO rosette 21x12l bottles
AWI	Fahrbach, E	151	stations	CTD-Stations	
AWI	Fahrbach, E	196	drops	Bathythermograph drops	
AWI	Fahrbach, E	136	stations	Oxygen	GO rosette 21x12l bottles
AWI	Fahrbach, E	136	stations	Phosphates, Nitrates, Nitrites, Silicates, Ammonia	Samples were analyzed by NIOZ an board with Technicon TRAACS Autoanalyser system
AWI	Fahrbach, E	5000	n miles	Surface measurements underway	Thermosalinograph (T, S)
DWDSWA	Hartig,	55	day (s)	Upper air observations	Synoptic met obs and radiosondes
DWDSWA	Hartig,	55	day (s)	Routine standard measurements	Synoptic met obs and radiosondes
GEOMAR	Heeschen,	119	stations	Other dissolved gases	Methane
GEOUNB	Roether, W.	106	stations	Geochemical tracers	Freon-11, -12, -113, CCL4, tritium, helium
IUHB	Hoppema, M	136	stations	Alkalinity Carbon dioxide	Partial pressure of CO_2, total CO_2
UFT	Heuchert,	38	stations	Dissolved organic matter	Water samples to sample bacteria (e.g. DOC)
UFT	Heuchert,	16	stations	Pelagic bacteria / microorganisms	Water samples to sample bacteria
UFT	Heuchert,	38	stations	Particulate organic matter	Water samples to sample bacteria (e.g. POC, PON)

1.4. SCIENTIFIC PROGRAMMES AND METHODS

The "Polarstern" cruise ANT XV/4 started on 28 March 1998 in Punta Arenas and lead to the Weddell Sea (Figure 1). The major scientific aim of the cruise was to investigate the role of the Weddell Sea in the global climate system. The cruise consisted of two parts - the first took place in the western Weddell Sea and the Weddell-Scotia Confluence, the second concentrated on the Southern Ocean between the coast of Antarctica and the Subtropical Front off South Africa, mostly along the Greenwich Meridian.

A major part of the deep and bottom waters of the global ocean are ventilated by water mass formation in the Weddell Sea. Its intensity controls the global thermohaline circulation and consequently the effect of the ocean on large scale climate variations. Water mass formation in the Weddell Sea is driven by cooling in winter and consequent sea ice formation, as well as by the interaction between the ocean and the ice shelves. On the shelf, water masses dense enough to sink to the bottom of the Weddell Basin can be generated. During their descent they mix with ambient water masses and are carried with the cyclonic Weddell Gyre circulation to the north, where they partly leave the Weddell Sea towards the Antarctic Circumpolar Current and partly recirculate.

The outflow in the western Weddell Sea consists of near surface, intermediate, and deep components. The near surface water is, to a large extent, shelf water from the Weddell Sea which, in the area of the Weddell-Scotia Confluence, encounters water from the Antarctic Circumpolar Current. The confluence gives rise to a system of two fronts, the Weddell and the Scotia Front. These fronts enclose a water mass whose properties result from the mixing of the converging water masses and the local atmosphere-ice-ocean interaction. If this water crosses the South Scotia Ridge at intermediate depth and sinks along the front, it may contribute to the ventilation of the deep global ocean without ever having been bottom water in the Weddell Sea, the traditionally assumed ventilation area. The deep components of the Weddell Sea water flow along the South Scotia Ridge to the east and pass through gaps to the north to fill the deep basins of the Atlantic and Indian Oceans.

At the Greenwich Meridian water masses modified in the eastern Weddell Sea by injection of circumpolar water masses flow westward in the southern part of the gyre. At the gyre's northern rim modified deep water and newly formed bottom water recirculate to the east. During the past years the Warm Deep Water, injected from the Antarctic Circumpolar Current, became warmer and saltier. The bottom water in the Weddell Basin increased its temperature by approximately 0.01 K per year since 1989. The present data set indicates significant regional differences of these variations. In the Western Weddell Sea the warming of the Warm Deep Water and Weddell Sea Bottom Water continued in the interior of the gyre cooling occurred. The transition from the Antarctic Circumpolar Current to the Weddell Gyre is shifted south from 1996 to 1998, which might indicate a new warming event for the interior. The regional displacement of these variations may indicate if and how local atmosphere-ice-ocean interaction and the inflow of water masses from the north affect the bottom water formation.

Of particular interest are variations affecting the stability of the water column and the atmosphere-ice-ocean interaction west of Maud Rise. In this area a large open ocean polynya was observed in the seventies, leading to open ocean formation of deep water. The transition of water mass formation processes occurring on the continental slope to those in the open ocean can cause abrupt changes and may affect the global thermohaline circulation.

Objectives:

The operations concentrated on four regional components: The outflow from the southern Weddell Sea into the Weddell-Scotia Confluence, the exchange between the Weddell Sea and the Antarctic Circumpolar Current within the Weddell-Scotia Confluence, the exchange of water masses between the eastern and the western Weddell Sea across the Greenwich Meridian, and the structure of the Antarctic Circumpolar Current at the Greenwich Meridian. For this purpose, the water mass properties and currents were measured with a CTD-probe (Conductivity/ Temperature/Depth) combined with a rosette water sampler and an ADCP (Acoustic Doppler Current Profiler) along hydrographic sections. From the water samples measurements of the following tracers were carried out: CFCs (Freon-11 and Freon-12, Freon-113, CCL4), tritium, 3He and He. CFCs were measured on board by gas chromatography. The other tracers were collected for subsequent analyses on shore. Salinity was measured from the water bottles to calibrate the CTD and to control the water samplers. Current meter moorings were recovered and redeployed along the Greenwich Meridian and in the western Weddell Sea off Joinville Island, and deployed along the South Scotia Ridge west of the South Orkney Islands.

The physical oceanography programme onboard is part of the international DOVETAIL project (Deep Ocean VEntilation Through Antarctic Intermediate Layers), a contribution to the SCOR affiliated iAnzone programme (Scientific Committee on Oceanic Research). In this context the instruments at the moorings in the western Weddell Sea were provided by the Universitat Politecnica de Catalunya in Barcelona, Spain.

A project of sea ice investigations with remote sensing techniques aimed to develop a new algorithm for cloud masking with infrared images. For this purpose in-situ data, e.g. observations of clouds and surface conditions, weather charts and radiosonde measurements, were collected to validate the analyses.

Measurements of the CO_2 system and nutrients were performed to investigate the processes which determine the potential of the Weddell Sea to take up atmospheric CO_2. For this purpose the total inorganic carbon content, TCO_2, and the partial pressure of CO_2 (pCO_2) were measured.

A geochemistry programme aimed to investigate the potential of methane as a water mass tracer. Its concentration is influenced by the atmospheric content, as well as by production and consumption within the ocean. The $^{12}C/^{13}C$ ratio of the dissolved CH_4 provides an indication on the methane decrease in the water column due to oxidation, since this process preferentially consumes the lighter isotope. The comparison with the distribution of other tracers is used to develop a model for the methane circulation in higher latitudes.

The microbiology programme aimed to estimate the contribution of the microbial community to the biological activity within the sea ice and the water column during autumn, and its role in the carbon cycle. For this purpose samples were collected to measure bacterial elemental diversity with X-ray microanalysis (XRMA), and to determine dissolved organic carbon (DOC) production and degradation in reference to the algal standing stock. The colonization of sinking particles was investigated with water samples from which pure strains of attached heterotrophic bacteria were isolated. The bacterial cells of the water column as well as the bacteria attached to particles will be counted after return.

Laboratory experiments on silicon uptake and release of sponges and sponge needle mats took place in the framework of the benthos programme to establish a benthic silicon budget.

Itinerary:

The fieldwork began with XBT-deployments across Drake Passage. On 1 April we reached the operation area in the northwestern Weddell Sea. Following the recovery of a mooring we starlet a

CTD-section. In the evening a search and rescue message for three missing members of the Argentinean Station "Orcadas" was received. They had not returned from a trip around the island by boat. At that time we were too far away to reach the South Orkneys in time and participate in the search. On 11 April a new message was received, saying that the boat was found on the shore. At this time we were near the island and our helicopter participated in the ongoing search of the missing persons. The helicopter could operate from the Argentinean icebreaker "Almirante Irizar", permitting us to continue the research. Bad weather obliged us to finish the search without any positive result.

The work in the western Weddell Sea and the Weddell-Scotia Confluence, was finished on 22 April. The ice conditions were appropriate, to the autumn situation. Multi-year ice floes, surrounded by newly formed ice, were advected northward from the southern Weddell Sea. However, the predominant southwesterly winds and the currents of the Weddell Gyre generated enough leads in the ice field, that no pressure was built up and work could proceed without serious restrictions.

During the passage to the Neumayer Station the wind increased to 10 Bft. The waves flushing on the deck damaged the door of the nutrient laboratory container. In spite of serious damages the container could be repaired and the nutrient measurements could be continued. Southerly winds advected cold air from the continent and new ice formed quickly. On 26 April we crossed the ice edge at 66°10'S, 21°00'W, further north than expected. However, strong winds kept the ice field open and we could reach the coast without problems.

On 28 April we reached Atka Bay. The bay was covered with a sheet of young ice broken by leads. Strong winds and bad visibility prohibited the supply operations in the morning. By the afternoon winds had calmed down sufficiently to permit helicopter flights. The station's physician from the last overwintering crew came on board after a prolonged stay at the station, and spare parts and food supplies were dispatched. The in-between fair weather permitted helicopter flights, so that the cruise participants could visit the station and the overwintering crew could come on board.

Research continued at the Greenwich Meridian on 29 April. The first station of the meridional transect was carried out in a polynya next to the ice shelf front. The ice consisted of small floes of young ice and heavily grinded multi-year floes. The floe sizes were too small to deploy the two sea ice buoys which we had on board. The northern ice edge at 69°15'S was reached on 30 April.

Despite of strong winds, the CTD and mooring work along the meridional transect occurred without significant delay. Seven moorings were recovered and six moorings were deployed during rough weather. The deployment of the mooring on top of Maud Rise had to be cancelled because of ongoing bad weather. At 60°S a section to the southeast was planned to identify a northward branch of the Weddell Gyre flow. This branch was deduced from earlier measurements, resulting in a much stronger gyre transport at the Greenwich Meridian than off Kapp Norvegia. Due to bad weather this plan had to be abandoned. To resolve the frontal system XBTs were launched between CTD stations from 57°S on northward.

During ANT XV/4 the Weddell Front was located further south than during earlier surveys. The progress of circumpolar water induced a significant warming at the level of the Warm Deep Water, in contrast to the cooling observed at the southern part of the transect. Compared to earlier cruises, few icebergs were observed along the transect; none of the few was suited to deploy a buoy as planned.

The section continued along the Greenwich Meridian as far as 48°S. There, it turned to the northeast. The last station (No. 136) was carried out at the Subtropical Front at 39°25'S, 11°48'E. XBTs were launched and ADCP data were recorded up to the 200-sm zone of South Africa. The cruise ended on 23 May 1998 in Cape Town.

Preliminary Results

The measurements along the Joinville section, spanning the outflow from the southern Weddell Sea into the Weddell-Scotia Confluence, display features comparable to those observed during earlier surveys (Figures 7a and 8). The surface waters are relatively warm, in accordance with the autumnal situation. The thermocline from the Winter Water to the Warm Deep Water is deeper than in 1996, resulting in a temperature decrease at 500 m depth. The depression of the thermocline at the boundary of the gyre corresponds to an intensification of the boundary current. The temperature of the Warm Deep Water above the upper continental slope increased by as much as 0.1 K since 1996. This warming trend is not evident between stations 16 and 19, where the complete water column, except the surface water, is colder than in 1996. This is consistent with an intensification of the boundary current which, in this area, is deflected into the Powell Basin. On the slope the Weddell Sea-Bottom-Water layer is subject to strong spatial variation. Therefore, a trend analysis requires further effort.

The quasi-meridional sections east and west of the South Orkneys across the Weddell-Scotia Confluence (Figures 7a, 9 and 10) indicate that the band of Warm Deep Water with temperatures above 0.6°C penetrates into the Powell Basin and recirculates along the continental slope of the South Orkneys to the southeast. The temperature increase of the Warm Deep Water is clearly visible between stations 19 and 21. Here, the section reaches the southern part of the boundary current which has made its way through the Powell Basin and follows the southern continental slope. At the South-Orkneys-east section the current band is located between stations 34 and 38 (Figure 9).

Across the ridge extending from Joinville Island to the east, Weddell Sea Bottom Water enters the Powell Basin and fills the near-bottom layers with water colder than -1°C (Figure 10). Comparable temperatures occur at the Joinville section on the continental slope below 1000 m, but are not observed at the South-Orkney-east section. There, the coldest temperatures of -0.8°C appear at the foot of the continental slope. At the boundary of the Powell Basin to the Soctia Sea near-bottom water at a depth of approximately 1500 m reaches temperatures of only -0.3°C (Figs. 7a and 11). We conclude that shallower parts of the bottom water enter and leave the Powell Basin before the western end of the Powell Basin-boundary section. Consequently, there is direct outflow of bottom water into Bransfield Strait.

Bottom water colder than -1.0°C, observed at the Joinville-Island section between 1500 and 3000 m (i.e. at a depth greater than the sill depth), is not observed further to the north or to the east. To cross the sill, this water must be modified through mixing. The spreading of the isolines on the slope of the Powell Basin (Figure 10) suggests that the bottom water, injected into the Basin along the slope, mixes with adjacent water masses. Consequently, the water with temperatures around -0.3°C, found in the Powell Basin, contains a significant amount of Weddell Sea Bottom Water. Since this water mass fills the southern slope of the trench north of the Powell Basin to a depth of 5000 m, a significant amount of Weddell Sea Bottom Water must be mixed, so that it can leave the Weddell Sea through the Powell Basin as a relatively shallow water mass. It is still dense enough, however, to fill the deep basins of the South Scotia Trench. Since in this area the temperature of the Warm Deep Water decreases towards north, it must have originated in the Weddell Sea.

The meridional section along the Greenwich Meridian, extending from the ice shelf front at 69°38.5'S to 55°S, shows the well known structure of the Weddell Gyre: a central dome of cold water and descending isotherms towards the northern and southern edges (Figs. 7a and 12). Compared to 1996 the flanks of the dome became steeper. North of Maud Rise the slope is particularly steep, corresponding to a strong current to the west. The geostrophic currents and the results from current meter mooring 229 agree well in that sense. Within a band of 100 km width a volume transport of about 20 Sv to the west was derived. Further contribution to the westward transport results from a less intensive current band south of Maud Rise, and from the Antarctic

Coastal Current. The steepening of the slope of the isotherms north of Maud Rise leads to a cooling of the southern part of the gyre.

On the northern side of the gyre intensive mesoscale structures were found. The correlation with the bottom topography and the northeastward direction of the currents suggests topographically induced meanders. During earlier surveys along the Greenwich Meridian no mesoscale structures of that intensity were found. On average the structures give origin to a warming on the section since 1996. The southward shift of the transition zone from the Antarctic Circumpolar Current to the Weddell Gyre from 1996 to 1998 might indicate the start of a new warming event for the interior.

The section across the Antarctic Circumpolar Current, from the Weddell to the Subtropical Front at 39°25'S, 11°48'E, indicates that both the Weddell and the Polar Front were shifted towards the south. In 1996 these two fronts were already further south than in 1992. This southward shift may be due to inter-annual or seasonal variability or both. Since 1992 a significant warming of 0.25 K of the deep water near the bottom above the northern slope of the Southwest Indian Ridge was observed.

1.5. PROBLEMS

During the first half of the cruise the data were significantly better than during the second half. This was caused by bad temperature conditions in the lab container after the container door had been blown away. However, after four days, the lab container temperature was stable again, thanks to the successful repairing of the air-conditioning system by the technicians of the crew.

1.6. OTHER OBSERVATIONS OF NOTE

none

2. UNDERWAY MEASUREMENTS

The programme consisted of measurements from the ship using the CTD probe (Conductivity and Temperature with Depth) connected to a water sampler, XBTs (eXpendable BathyThermographs), and both ship-borne and lowered

2.1. NAVIGATION AND BATHYMETRY

Navigational data was continuously analyzed. Stable heading data with an accuracy of 0.10 was provided by the MINS (Marine Inertial Navigational System), a combined navigation equipment based on a laser ring gyro. In order to get information about the drift and to calculate the course made good, a "Sky Fix System" GPS (Global Positioning System) was used. This differential GPS uses the communication satellites of the Inmarsat system to correct the absolute position. For navigational use and in combination of the bathymetric survey with the hydrosweep-system the two navigational aids (Gyro and GPS) are combined by use of a filter. Failures or position jumps of GPS were filtered and smoothed out. By this means a reliable and good description of the ship's movement is achieved. The accuracy of the ship's position in the 1 -second values is better than 50 m.

2.2. ADCPS (ACOUSTIC DOPPLER CURRENT PROFILER) (See Appendix 2)

A self-contained narrow band ADCP (Acoustic Doppler Current Profiler) from RD Instruments, San Diego, with 153.6-kHz transducers was mounted on the CTD. The instrument was lowered with the CTD, and every 300 m a current profile was measured. From the sequence of individual profiles, one full-depth profile was constructed. Near-bottom measurements were disturbed by bottom reflections. Towards the end of the cruise the instrument failed, and a close inspection of the instrument by RDI was required. Altogether 131 LADCP profiles were obtained.

These were processed with a program supplied by the Institut for Meereskunde Kiel (J. Fischer and M. Visbeck, Deep Velocity Profiling with self-contained ADCPs, Journal of Atmospheric and Oceanic Technology, 10(5), 764-773, 1993). The vessel-mounted narrow band ADCP from RD Instruments, San Diego, with 153.6-kHz transducers worked continuously. The data will be processed in Bremerhaven by means of CODAS.

2.3. XBTS

During the crossing of Drake Passage, along the transect from 62°28'S, 36°38'W to 65°45'S, 22°17' W, and along the transect at the Meridian of Greenwich starting at 57°S up to the 200-nm zone of South Africa 196 XBT-7 from Sparton of Canada ltd., London, Ontario were launched (Abb. 13, 14, 15 and 16, Appendix 3). The data were directly transmitted by satellite into GTS.

2.4. WEATHER CONDITIONS

Rüdiger Hartig, Herbert Köhler (DWD)

"Polarstern" left Punta Arenas on 28 March 1998, heading towards the Antarctic Peninsula. The Drake Passage, known for frequent gale activity, was crossed under fair weather conditions. Winds from the west to northwest and occasional sunshine were observed. "Polarstern" reached the Antarctic Peninsula on 1 April.

1 to 11 April 1998, section from the Antarctic Peninsula into the central Weddell Sea at 66°S, 25°W

Low pressure systems, developing leeward of the Antarctic Peninsula and moving east across the northern Weddell Sea, dominated the synoptic situation in the northwestern Weddell Sea. These lows had only minor weather activity over sea ice, but intensified with moderate snowfalls over open water. The wind reached gale force on 10 and 11 April. Otherwise westerly winds around force 5 prevailed. The temperature ranged from -2 to -12°C. The region between 50° and 40°W was up to 80% ice covered; 50% consisted of multi-year ice up to 3 m thick.

Few climatological data are available for this region. Meteorological measurements at the stations on the Antarctic Peninsula are influenced by orographic effects. Measurements taken at the South Orkneys are affected by the westerly wind regime, and may not be representative for the weather near the Peninsula. A rough idea about the weather conditions is given in "The Antarctic Pilot, 4. Edit. 1974, Part C, Chap.1, 66ff". Based on this report, we expected an equal amount of easterly and westerly winds with forces smaller than 5 Bft. The mean temperature rises only a little above freezing in summer and drops to -15°C in winter. Although nearly no easterly winds occurred during ANT XV/4, no significant differences from the climatological values were evident.

12 April to 21 April 1998, Weddell-Scotia Confluence

At the beginning of this period polar air with temperatures around -1O°C was advected by winds from the south and southwest with forces 4 to 7. Fields of broken sea ice with rapid development of nilas between the flows prevailed south of 61°S. The area around the South Orkneys was sea-ice free, except for some icebergs. From 16 to 19 April the weather changed to a strong northwesterly regime. Air with temperatures slightly above freezing was advected by winds of force 7. The warm air over colder water induced mist, fog, and drizzle. Three days with fog were observed, corresponding to 50% of the expected value according to the climate table of the station "Islas Orcadas Sur" (period 1971-1980). Towards the end of this period cold air was advected from the southwest.

Wind measurements recorded during ANT XV/4 by "Polarstern" are displayed in Figure 2. From 12 to 21 April northwesterlies with force around 6 Bft prevailed. The "Polarstern" data were compared with climatological data (April) of the "Islas Orcadas Sur" weather station (Figure 3). Winds from the south, southwest, and west were observed more frequently than expected, and the average wind speeds were higher. The occurrence of northerlies was comparable to the climatological data. Easterlies were exceptional and are not displayed.

22 to 28 April 1998, sailing to Neumayer Station

Southwestly winds with force around 6 prevailed. In the night from 25 to 26 April the low pressure system intensified rapidly as it moved from the sea ice to open water. Wind speeds increased to force 10, with gusts of force 12. With this southwesterly flow continental cold air (between -10 and -15°C) was advected far to the north. The sky varied between fair and cloudy. The ice coverage was about 90%: 70% of first-year ice and 20% of multi-year ice.

29 April to 21 May 1998, section along the Greenwich Meridian

In the vicinity of the Antarctic coastline winds from the east and southeast with force around 7 prevailed, inducing a 3-m swell in the open water. The ice edge was encountered at 69°S. Temperatures ranged from -6 to -11°C. Progressing northward, westerly and northwesterly winds dominated (Figure 4). Wind speeds increased to force 8 and more. No heavy gales (stronger than Bft 10) occurred. The winds produced an average swell of 6 m, but periods with gales lasting for several hours increased the swell to 10 m. North of 60°S both the water and air temperatures reached positive values. A few icebergs were observed as far north as 55°S.

21 to 23 May 1998, sailing to Cape Town

On the way to Cape Town "Polarstern" reached the subtropical high pressure zone. Fair weather, westerly winds between forces 4 and 7, and temperatures gradually rising to 17°C were observed. "Polarstern" reached Cape Town on 23 May.

Validation and Application of a Cloud Masking Algorithm

Norbert Schlüter (IUPF)

During ANT XV/4 data were collected for the HYPAM C (remote sensing of hydrometeorological parameters by microwave radiometry in polar regions) project. This project is funded by the Deutsche Forschungsgemeinschaft and aims to develop a new algorithm for cloud masking using infrared and microwave data. First versions of the algorithm were tested during the cruise.

Satellite data of the two satellite series DMSP (Defense Meteorological Satellite Program) and NOAA (National Oceanographic and Atmospheric Administration) were received to analyze atmospheric profiles. The DMSP satellites consist of the sensors OLS (Operational Line-scan System, two channels in the infrared and visible spectral range), SSM/I (Special Sensor Microwave Imager, 7 channels in the microwave range), and the microwave sounders SSM/T1 (Special Sensor Microwave Temperature) and SSM/T2 (Special Sensor Microwave Water Vapor). The NOAA satellites are equipped with an AVHRR (Advanced Very High Resolution Radiometer) with 5 channels in the visible and infrared spectral range. A total of 230 DMSP passes and 160 NOAA passes were stored. In order to overview this large data set (ca. 20 GByte), a catalogue with visible and infrared images, as well as images showing the sea ice concentrations were generated. Examples for the sea ice concentrations from a microwave sensor are given in Figs. 5 and 6.

Meteorological data were collected to improve the analysis of the satellite data. The daily radiosonde measurements were supplemented by 37 additional launches. Because of the high temporal variability of the atmosphere they had to coincide with the DMSP passes. The radiosondes measure profiles of air temperature, relative humidity, and wind in heights up to 33 km. In order to validate the radiosonde measurements, the cloud top and bottom levels were observed with helicopters. The weather charts and the hourly synoptic observations (clouds, precipitation, sea ice, wind) were stored.

The analysis focused on the application of an algorithm for cloud masking with infrared data. Ice concentration and the location of the ice edge were estimated using microwave data and an algorithm developed in IUPF. An iceberg, recently formed near the Larsen Ice Shelf, was monitored using cloud-free scenes from infrared and visible satellite images. The radiosonde data were compared with infrared satellite images. The cloud top level temperatures were in good agreement, especially in cases of homogeneous cloud cover.

To fully exploit the potential of the obtained data set, more analyses are necessary. Selected infrared images will be visually classified and used to train a neural network for automatic classification. In addition, sequences of images will be analyzed to take advantage of the different dynamics of sea ice and clouds. The radiosonde measurements will be used to analyze the data of the SSM/T1 and SSM/T2 sensors.

3. PHYSICAL OCEANOGRAPHY: DEEP AND BOTTOM WATER FORMATION IN THE WEDDELL SEA

Eberhard Fahrbach, Martin Frenzel, Sabine Harms, Antonio Härter Fetter, Alexeij Iaremtchouk, Jens Langreder, Sven Loske, Katrin Meissner, Carlos Mir Casanovas, Matthias Monsees, Adriene Pereira, Gerd Rohardt, Michael Schröder, Andreas Wisotzki, Hannelore Witte (AWI, FURG, 1CM, IUPT)

Objectives

A major part of the deep and bottom waters of the global ocean are ventilated by the injection of waters from the Weddell Sea. Cooling in winter, sea ice formation, as well as the interaction between the ocean and the ice shelves induce water mass modifications, and water masses dense enough to sink to the bottom of the Weddell basin may be formed. During their descent they mix with ambient water masses and are carried with the cyclonic Weddell Gyre circulation to the north, where they partly leave the Weddell Sea towards the Antarctic Circumpolar Current and partly recirculate.

The outflow in the western Weddell Sea consists of near surface, intermediate, and deep components. The near surface water is, to a large extent, shelf water from the Weddell Sea which, in the area of the Weddell-Scotia Confluence, encounters waters from the Antarctic Circumpolar Current. The confluence gives rise to a system of two fronts, the Weddell and the Scotia Front. These fronts enclose a water mass whose properties result from the mixing of the converging water masses and the local atmosphere-ice-ocean interaction. If this water crosses the ridge system at intermediate depth and sinks along the front, it may contribute to the ventilation of the deep global ocean without ever having been bottom water in the Weddell Sea, the traditionally assumed ventilation area. The intermediate components consist of the upper part of the Weddell Sea Deep Water found in the central Weddell Sea below 1250 m. At this depth outflow may occur over large parts of the South Scotia and North Weddell Ridges. The deep components of the Weddell Sea water flow along the South Scotia Ridge to the east and escape through gaps to the north, where they fill the deep basins of the Atlantic and Indian Oceans.

At the Greenwich Meridian the water masses, modified in the eastern Weddell Sea by injection of circumpolar waters, flow westward in the southern part of the gyre. In the north water modified in the gyre and newly formed bottom water recirculate to the east. During the past years the water coming from the Antarctic Circumpolar Current and the bottom water in the central Weddell Sea became gradually warmer. The regional distribution of the variations are used to examine if and how local variations of the atmosphere-ice-ocean interaction and the inflow from the north affect the bottom water formation. of particular interest are variations affecting the stability of the water column and the atmosphere-ice-ocean interaction west of Maud Rise. Here, a large open ocean polynya was observed in the seventies, leading to open ocean formation of deep water. The transition of water mass formation processes over the continental slope to those in the open ocean could cause abrupt changes with effects on the global thermohaline circulation.

The physical oceanography programme onboard is part of the international DOVETAIL project (Deep Ocean VEntilation Through Antarctic Intermediate Layers), a contribution to the SCOR affiliated iAnzone programme (Scientific Committee on Oceanic Research). In this context the instruments on the moorings in the western Weddell Sea are provided by the Universitat Politecnica de Catalunya in Barcelona, Spain. The cruise track in the Weddell-Scotia Confluence is partly a repeat of a survey carried out with the U.S. ice breaker "Nathaniel B. Palmer" in August 1997.

3.1. BOTTLE DATA TECHNIQUES AND CALIBRATION

3.1.1. Nutrient distributions in Antarctic waters

Karel Bakker (NIOZ)

Equipment and methods

Nutrients were analyzed by standard photometric methods on a Technicon TRAACS 800 rapid flow autoanalyser. The sample rate was set to 60 samples per hour, measuring about 3000 samples during the cruise. Measurements were made simultaneously on four channels: phosphate, silicate, nitrate and nitrite together, and nitrite separately. All measurements were calibrated with standards diluted in low nutrient sea water (LNSW). Subsamples from the CTD-Rosette were collected in 100-ml polyethylene sample bottles. The samples were kept cool and dark, and were generally analyzed within 12 hours. Sample statistics for stations 001 and 099/02 where all bottles were fired at one depth.

	Station 001			Station 099/2		
	aver. µmol/l	std. dev. µmol/l	%	aver. µmol/l	std.dev. µmol/l	%
PO_4	2.2895	0.0037	0.16	2.366	0.0043	0.18
$Si0_2$	131.86	0.72	0.55	128.03	0.297	0.23
$N0_3$+NO_2	no data			34.48	0.065	0.19

Measuring ranges

In order to increase the accuracy of the measurements, an attempt was made to scale in the range for the nutrients to be measured so that the maximum was always at a level of 80-90% of full scale.

This resulted in acceptable percentage standard deviations for reproducibility of 0.18% for PO_4, 0.23% for $Si0_2$ and 0.19% for $N0_3$+NO_2 as a percentage of those levels.

Calibration and standards

Nutrient primary stock standards were prepared at the home lab. The calibration standards were prepared daily by diluting the stock standards, using three electronic pipettes, into four volumetric 100-ml PP flasks (calibrated at the lab) filled with low nutrient sea water (LNSW). The values of the LNSW were measured on board and added to the calibration values to get the absolute nutrient values.

Cocktail standard

This standard acts as a reference. It is made in the home lab containing phosphate, silicate and nitrate in a solution containing 40 mg H92CI2 per litre as a preservative. Every time it was used, it was diluted 100 times with the same 1-ml pipette and the same volumetric 100-ml flask.

In inter-calibration exercises like ICES and Quasimeme our standards were within the obtainable limits to the mean of the better laboratories. There is still no absolute reference standard available, so an onboard comparison was made (to gain accuracy) with the stock standards of Ocean Scientific International OSI. Our results listed in the next table are given as 100%.

	ANT XV/4	OSI
PO_4	100.0%	99.8%
$Si0_2$	100.0%	100.3%
$N0_3$	100.0%	99.6%

The other stocks compared well with OSI stocks. Another comparison was carried out by measuring deep water from the Weddell Sea sampled in 1996 and the cocktail standard used in that year.

Comparison with Weddell Sea water of 1996 and the cocktail of 1996:

	PO_4 µmol/l		$Si0_2$ µmol/l		$N0_3$ µmol/l	
	1996	1998	1996	1998	1996	1998
Weddell Sea.	2.39	2.34	126.6	126.35	34.1	34.2
Cocktail 1996	2.92	2.84	83.0	83.1	35.8	35.7

1998/1996			
Weddell Sea	98.0%	99.8%	100.3%
Cocktail 1996	97.3%	100.1%	99.7%

The data for $Si0_2$ and $N0_3$ for 1998 compare well with those of 1996. However, the PO_4 data of 1996 must be corrected with a factor 0.98 due to the fact that the calibration standard used in 1996 was only 98%. This was independently confirmed by an intercomparison (Quasimeme) and by calibrating against 100% pure potassium dihydrogen phosphate.

Cocktail standard statistics

To obtain cross run statistical values for a limited number of stations, analyses were carried out twice on the same sample from the bottle closed in the bottom layer. This gives the possibility to estimate the precision from station to station. Analyses of these "real" (cross runs) duplicates show the absolute differences for PO_4 to be 0.013 pM, for $Si0_2$ to be 0.80 pM and for $N0_3$+NO_2 to be 0.20 pM in the raw data set.

During all runs an independent "reference" standard (the cocktail) was measured as a triplicate. From all of these measurements the average value was recorded. If we assume that on this level the value of the cocktail does not change during the different cruises, then, by dividing the average of the end by the average of the different runs, we obtain a factor for all three parameters which can be multiplied with the data of that particular run to obtain corrected data. As a check on the data we again looked at the absolute differences between the "real" 96 duplicates with the following results:

	µmol/l		C.V.% (of average value sample)	
	original	corrected	original	corrected
PO_4	0.0131	0.0097	0.60%	0.44%
$Si0_2$	0.80	0.57	0.70%	0.47%
$N0_3$+NO_2	0.197	0.158	0.60%	0.48%

Clearly, there is a significant improvement for phosphate, silicate and nitrate.

The cocktail standard is a reference standard with the three nutrients mixed into one bulk, giving for each run an idea of how the machine is performing. It is also an instrument to correct data from run to run for producing better data quality, especially in an area like the Weddell Sea where nutrient gradients in deep water are very small.

3.1.2. CFCs, Helium and Tritium

Klaus Bulsiewicz, Gerhard Fraas, Oliver Huhn, Olaf Klatt and Christian Rodehacke (IUPT)

Objectives and methods

CFCs, Tritium and partially 3 He are transient tracers of anthropogenic origin. Measured distributions of these tracers provide information on the renewal of subsurface water from the ocean surface layer on yearly to decadal time scales. Sections investigated during ANT X/4 (1992) and ANT XIII/4 (1996) were repeated to evaluate the increase of the tracer concentrations in time. The comparison between the atmospheric and the in-situ increase will be used to study transport processes. The natural tracers 3 He and He will also be used to identify the water mass ventilation from the surface layer and the contribution of Ice Shelf Water.

Along the sections, the CFCs Freon-11, Freon-12, Freon-113 and CCL4 were measured on board by ECID gas chromatography. In addition to the analyses on board, water samples for CFC were stored in flame-sealed ampoules which will be analyzed in the laboratory. Water samples for Helium and Tritium were also taken. They will be extracted after the cruise and analyzed with a mass spectrometer. All gases will be extracted from the Tritium samples which will then be stored for half a year. After this time a sufficient amount of Tritium will have decayed to 3He, that it can be measured by the mass spectrometer.

Work at sea

At the hydrographic section in the western Weddell Sea, water samples for CFCs and CCL4 were taken from the rosette water sampler using flow-through containers. Along the Greenwich Meridian, from the ice-shelf edge at 69°24'S to 50°S, only the CFCs Freon-11 and Freon-12 could be measured. Water had intruded into the freon system and damaged the capillary column of the gas chromatograph. With a new column (however, a different type as the old one) it was not possible to measure Freon-113 and CCL4. Helium (copper tubes) and Tritium (glass bottles) were also taken from the water sampler rosette. In addition to the helium samples in copper tubes, water samples were stored in flame-sealed ampoules. These samples will also be analyzed in the laboratory and will provide reference measurements for the water samples in copper tubes.

In total, 106 stations were sampled and 1600 water samples for the CFCs were analyzed during this cruise. In addition, 850 gas and blank measurements were taken with constant time intervals. Air samples were frequently analyzed to establish the atmospheric CFC and CCL4 concentrations. They will be used to calculate the CFC and CCL4 saturation of the surface water. In total, 1850 water samples were collected for analyses in the laboratory, including 350 CFC water samples in glass ampoules (collected at 28 stations), 667 water samples for Helium in copper tubes (collected at 66 stations), 260 water samples in glass ampoules (collected at 33 stations) and 571 samples for Tritium (at 60 stations).

At a test station at the Greenwich Meridian at 64°30'S no CFC-free water was found, so that the blank levels of the bottles could not be established. These samples (all in the same depth of 1300 m) and replicate samples frequently drawn throughout the cruise do not exhibit any suspicious variability. Therefore, we are confident that the bottles did not contaminate the CFC samples. Another test station was made in the Cape Basin at 42°S, 6°5'E (all bottles in the same depth of

3000 m). These samples were stored in flame-sealed ampoules for analyses ashore. The water obtained at this depth is very old (Freon-11 < 0.05 pmol/kg) still above the detection limit of 2 to 3 fmol/kg. Therefore, the measurement of this samples gives additional information about the variability due to contamination of the bottles.

Preliminary Results

The section across the southern Weddell Gyre, extending from the Antarctic Peninsula (Joinville Island) to 25°W, is shown in Figure 20 (top). The layer of the high CFC concentration along the slope of the Antarctic Peninsula indicates newly formed bottom water which flows to the north. Relatively old water, enclosed by the 0.15 pmol/kg isoline, is located at a depth between 500 and 2000 m as found during ANT XIII/4 (1996).

The section from Antarctica (69°24'S) along the Greenwich Meridian to 50°S is shown in Figure 20 (bottom). Observations along this section can be compared with data from previous cruises (ANT X/4 in 1992 & ANT XIII/4 in 1996). In the centre of the Weddell Gyre (62°30'S) water with less than 0.2 pmol/kg reaches to a depth of 2000 m. In 1996 it reached to 2500 m and in 1992 to 3500 m. The increase of the tracer concentration in the interior from below is consistent with upwelling in the Weddell Gyre. On the continental slope, a core of young water (0.75 pmol/kg) occurs at 3300 m. This was also found during ANT XIII/4. The source of this water is further to the east. The core of young water, leaning against the southern flank of the Southwest Indian Ridge, shows the flow of Bottom Water moving from the western Weddell Sea to the east. The relatively high CFC concentrations (> 0.6 pmol/kg) on the southern and northern slope of Maud Rise were higher in comparison to the previous cruises. The cause of the increase of the CFC concentration is not clear at this time.

The section extending from the Weddell Basin at 65°S across the South Orkney Plateau to 59°30'S is shown in Figure 21 (top). In the Weddell Basin, at depths deeper than 4500 m at approximately 64°S, we found CFC concentrations with Freon-11 > 2.0 pmol/kg. Similar CFC concentrations occurred in the Jane Basin at depths deeper than 3500 m. The source area of this well ventilated bottom water is near the northern part of the Antarctic Peninsula.

The section across the Powell Basin is presented in Figure 21 (bottom). Near the centre of the Powell Basin (62°30'S) a maximum in Freon-11 concentration (> 2.0 pmol/kg) occurs at a depth of more than 3000 m. This is also newly formed bottom water from the Antarctic Peninsula which follows the topography and spreads into the Powell Basin. North of the South Scotia Ridge we found, on the slope and at the bottom, Freon-11 concentrations > 1 pmol/kg. This bottom water circulated counterclockwise around the South Orkney Plateau and has been mixed with "older" water with lower CFC concentrations.

3.1.3. The carbon dioxide system in Antarctic waters

Mario Hoppema/IUPB and Richard Bellerby (PML)

Objectives

Modifications of the global carbon cycle, by the burning of fossil fuel and changes in land use, have led to an increase in atmospheric carbon dioxide (CO_2), which has the potential to increase the greenhouse effect of the atmosphere. The deep oceans are, in principle, able to take up almost all of this excess CO_2, but only on a time scale which is much longer than the one associated with the anthropogenic perturbations. This is related to the typical mixing and residence times of the deep and bottom waters of the oceans, which are of the order of 1000 years. Thus studies in areas where interactions between the deep and the surface ocean occur, such as the Weddell Sea, are vital for the study of CO_2 uptake and its distribution.

The objective of this project is to gain knowledge of the CO_2 distribution in the Weddell Sea, where the initial properties of a major part of the abyssal world oceans are generated. Another objective is to determine the potential of Antarctic waters to take up atmospheric CO_2. This is especially important for the frontal regions of the Antarctic Circumpolar Current (ACC) and for the regions with seasonal ice cover. Data from this cruise will be combined with data of previous cruises to address those questions

Work at sea

CO_2 parameters have been investigated along sections across the Weddell Sea, two sections across the Weddell-Scotia Confluence, and a long section from the Antarctic continent to the African continent largely following the prime meridian. Parameters that were measured include the total inorganic carbon content (TCO_2) and the partial pressure of CO_2 (pCO_2). Vertical TCO_2 profiles of the entire water column were determined from discrete water samples taken from the Rosette sampler. The pCO_2 was determined quasi-continuously from the sailing ship, only in the surface water.

TCO_2 was determined by a high-precision coulometric method using an automated sample stripping system. Briefly, the method is as follows. A sample of seawater is acidified with phosphoric acid and stripped with high purity N_2 gas. The extracted CO_2 is, with a carrier gas (pure N2), passed through a solution containing ethanolamine and an indicator. This solution is electrochemically back-titrated to its original colour and the amount of Coulombs generated is equivalent to the amount of CO_2 in the sample. The measurements are calibrated and corrected against an internationally recognized TCO_2 standard (Dickson).

Continuous measurements of the pCO_2 in water and marine air were done using an infrared analyzer (Li-Cor). A continuous water supply is passed through an equilibrator where approximately every 4 to 5 minutes the headspace gas is analyzed for its CO_2 content, thus giving pCO_2 in the surface water. Marine air was pumped continuously from the crow's nest into the laboratory and subsampled after every fourth equilibrator reading. The measurements are calibrated with reference gases, traceable against NOAA standard gases. Final data will be available after re-calibration of the reference gases ashore.

Preliminary Results

Total carbon dioxide

In Figure 22 the section across the Weddell Sea between Joinville Island (near the tip of the Antarctic Peninsula) and the central Weddell Sea is shown for TCO_2. A general feature of the TCO_2 distribution is that, although the TCO_2 values in the Weddell Sea surface water are high compared to other surface ocean regions, they are low in comparison with the deep and bottom water. The TCO_2 minimum in the surface water is due to phytoplankton which utilises CO_2. Below the thermocline, a TCO_2 maximum is found, associated with the temperature maximum of the Warm Deep Water. Near the bottom, where Weddell Sea Bottom Water is present, relatively low TCO_2 values were measured. This water mass originates partly from the shelf waters of the Weddell Sea, which are low in TCO_2. The large water volume of Weddell Sea Deep Water, which lies between the bottom water and the Warm Deep Water, is merely a mixture of these two source waters with corresponding TCO_2 values.

Over the. continental slope of the Antarctic Peninsula a thin layer of recently formed bottom water was observed, recognizable by its low TCO_2 values. This coldest Weddell Sea Bottom Water of the Weddell region also has the lowest TCO_2 values. Towards the coastline the isolines fall precipitously indicative of a sharp frontal feature. This is the Antarctic Slope or Shelfbreak Front, which separates the Warm Deep Water and Antarctic Surface Water from the coastal and shelf waters.

The TCO_2 maximum is the highest towards the central part of the Weddell Sea. In fact, the values observed here are higher than those of the Warm Deep Water that enters the Weddell circulation near 25°E. This implies that in the central Weddell Sea CO_2 enrichment of the Warm Deep Water occurs, which is most probably caused by the decomposition of organic material at that depth.

Partial pressure of CO_2

The measurement of pCO_2 during the entire cruise period resulted in a large, high spatial resolution data set. Only modest under- and supersaturation were observed in the area of investigation. The spatial variability in this time of the year was found to be relatively small, which is probably related to the low level of biological activity in the surface layer. The only exception being the shelf area of the South Orkney Plateau.

Frontal structures were generally reflected in the pCO_2 distribution. As an example the pCO_2 across the Sub-Antarctic Front on the prime meridian is shown in Figure 23. South of the front in the Polar Frontal Zone the pCO_2 is relatively constant and above saturation. On passing the front a clear pCO_2 change from supersaturation to under-saturation was observed on a small spatial scale. Also shown in Figure 23 is the surface temperature along this transect. Clearly, the pCO_2 signal is strongly negatively correlated with the temperature change across the front. Note that in general the correlation between the pCO_2 and the surface temperature is very high.

3.1.4. Geochemistry

Katja Heeschen und Karin Fürhaupter (GEOMAR)

Objectives and methods

The atmospheric trace gas methane has increased in the last 150 years from about 700 to 1800 ppbV. At the sea surface the concentration is in equilibrium with the atmospheric content of methane. Changing atmospheric gas concentrations result in a time dependent increase of methane in the ocean. This signature should be observed in recently formed deep waters. The pattern in the water column should be similar to those of transient tracers (e.g. Tritium, CFCs). Methane is influenced by the atmospheric content as well as by production and consumption within the ocean. The measurement of the $^{12}C/^{13}C$ ratio of the dissolved CH_4 Will provide an indication of the extent of the methane decrease in the water column that is due to oxidation, because this process preferentially consumes the lighter isotope. On the other hand, the carbon isotope ratio of methane in the atmosphere has remained nearly constant over time.

The goal of this investigation is to separate the effects of uptake from the atmosphere and microbial oxidation on the distribution of dissolved methane. For this purpose we determined the methane content and the stable carbon isotopic ratio in the younger bottom water of the Weddell Sea and in the water masses of the Weddell-Scotia Confluence. This will lead to a larger data base of methane concentrations in the Weddell Sea and will also be used for comparison with the distribution of common transient tracers to develop a model for the methane budget in higher latitudes.

In order to measure the dissolved methane, water from the bottles is drawn into a 200-ml glass syringe two times without contact to the air. The syringe is then connected to an evacuated 500-ml bottle. As the water is drawn into this bottle from the syringe, most of the dissolved gas separates from the liquid phase. The gas is then led into an evacuated burette and compressed to atmospheric pressure by injecting a degassed brine into the bottom of the sample through a sidearm. Subsequently, 1 ml of gas is extracted and injected into a gas chromatograph equipped with a flame ionization detector (FID) to determine the mole fraction of methane in the extracted gas. The gas remaining in the burette is collected in an evacuated vial for isotopic analysis by mass spectrometry ashore.

2188 samples were taken at 4 hydrographic sections and 119 rosette stations to measure the methane content in the water column on board. The accuracy of the method (4%) was determined at two test stations where all bottles were closed at the same depth. The accuracy of the gas chromatograph (3%) was determined by using a CH_4 standard in synthetic air which was calibrated to ±0.1% (methane concentration. 1.936; Department for Environmental Physics in Heidelberg) for 375 times. 1306 gas samples were taken from the extracted gas of the discrete water samples in order to measure the isotopic signal of methane after the cruise in a shorebased mass spectrometry laboratory. The samples are stored in evacuated gas-tight vials (5 ml). Those samples can be determined much faster than water samples which leads to a larger data base. Because this method is expected to be less exact than immediate extraction from water samples before analysis, 84 double samples were stored in 100-ml gas-tight headspace vials. Those specimen will be extracted ("purge and trap" method) and measured with the GC-C-IRMS method (Gas Chromatography-Combustion- Isotopic Ratio Mass Spectrometry method) at the lab for comparison with the gas samples extracted on board. The water samples are stored at temperatures of 4°C.

Preliminary results

A vertical transect from the Antarctic Peninsula to 25°W (Section 1, Figure 24) shows high values of methane (up to 2 ppbV and more) at the continental slope of the Antarctic Peninsula up to a depth of 3000 m. They can be correlated with the ventilated water from the southwestern shelves of the Weddell Sea which is transported northwards along the slope. Due to the relative new Weddell Sea Bottom Water, higher contents of methane can also be seen at the bottom of the Weddell Basin (0.6250.894 ppbV) in comparison with the concentration measured in the central part (0.395-0.679 ppbV). Where Warm Deep Water is dominant, methane concentrations of the Bottom Water are much lower than the ones at the slope. In contrast, Warm Deep Water shows enhanced methane concentrations compared with very old water masses in the South Shetland Trench (0.4 ppbV; measured on ANT XV/2). Contents of about 3 ppbV of methane in the surface water confirmed the assumption that the concentration of methane in the surface water in higher latitudes is controlled by the partial pressure of methane in the atmosphere.

East of the South Shetland Islands (Section 2, Figure 25) higher concentrations of methane occur north and south of the Endurance Ridge (Jane and Weddell Basin). Near the bottom, values of 1.467-1.718 ppbV are observed in a few hundred meters thick layer. It results from recently ventilated water from the western Weddell Sea transported northwards. Slightly higher concentrations (1.269 ppbV) occur at the bottom in the trench north of the South Orkney Plateau which is more than 5000 m deep. An unexplained feature was found in the subsurface water above and north of the plateau. Local concentrations of methane are up to 5.336 ppbV at a depth of 100 m. Anoxic mircohabitates in particles and microorganisms could be a reason for this subsurface maximum.

In the trench north of the South Scotia Ridge with depths of more than 5000 m relatively high values (up to 1.301 ppbV) of methane are found (Section 3, Figure 26). Even in shallower areas concentrations above 1.2 ppbV were measured. A water mass with up to 1.823 ppbV at the bottom of the Powell Basin indicates recently ventilated water from the continental shelf of the Antarctic Peninsula. It is transported northward through the basin. South of the Powell Basin this water mass can be found with values of 1.95 ppbV in 2000 nm depths. The central basin contains an older water mass low in methane up to 1000 m depth with a core value of more than 0.6 ppbV. As seen in section 2 there is some oversaturated surface water with maximae in 50 m depth at a few stations.

Transect 4 along the Greenwich Meridian is not yet processed completely. However, preliminary results show methane concentrations up to 1 ppbV at bottom of the Antarctic continental slope. During the continuation of the transect a rather uniform distribution of methane (0.5 to 0.8 ppbV) was observed. Difficulties with the equipment require the correction of the data. Values at the sea surface are in equilibrium with the atmosphere.

3.2. CTD MEASUREMENTS AND CALIBRATION

Equipment

The hydrographic work was carried out using CTD probes and water bottle release mechanisms built by Falmouth Scientific Instruments (FSI). Two instruments of the type Triton ICTD, SN 1347 and SN 1360 were used. The water samples were taken with a 21-(12-1)-bottle rosette from General Oceanics Inc.

The accuracy of the data set is determined by laboratory calibrations both before and after the cruise. Each CTD is equipped with two temperature sensors. The stability of these sensors is controlled by comparing both readings. For both instruments the calibrations before and after the cruise were performed by the Scripps Institution of Oceanography. For both sensors the temperature drift in the relevant temperature range was less than 1 mK. Thus, the pre-cruise calibration coefficients were used. Quality control onboard the ship was performed using 7 electronic thermometers from SIS (SIS Sensoren Instruments Systeme GmbH, Kiel), calibrated by the manufacturer. Deviations from the sensor readings occurred due to scatter in the thermometer readings. If noise is taken into account the sensors' accuracy amounts to 2 mK.

For both CTDs pressure calibrations were performed before and after the cruise at Scripps. No change was recorded between the pre- and post-cruise calibrations. The accuracy of the pressure readings is better than 2 db. Quality control onboard the ship was performed using 7 electronic pressure gauges from SIS (SIS Sensoren Instruments Systeme GmbH, Kiel). The instruments were calibrated by the manufacturer.

The conductivity was corrected using salinity measurements from water samples. IAPSO Standard Seawater from the P-series P133 was used. A total of 2649 water samples were measured using a Guildline Autosal 8400B. On the basis of the water sample correction, salinity is measured to an accuracy of 0.002.

To determine distance above the sea floor, the CTD was equipped with an altimeter from Benthos Undersea Systems Technology Inc. Two transmissometers with a 25cm light path from SeaTech Inc. were used, but after a few stations both were damaged by water leaking.

At all stations oxygen samples were taken from the entire water column (in total 2915 samples). The determination of oxygen was carried out according to WOCE standards for O_2 measurement (Carpenter, 1965). Two radiation counters from SIS (SIS Sensoren Instruments Systeme GmbH, Kiel) were used. 346 double samples, amounting to 10% of the samples and covering the entire range of O_2 values (180-350 µmol/l), were taken. Using these data, a percentage error of 0.1%

was obtained. Oxygen profiles were not measured because oxygen sensors fail under freezing conditions.

Calibration: CTD Measurements during 06AQANTXV/4

Instruments: Falmouth Scientific ICTD, Sn: 1360 and Sn: 1347

```
Fallmouth Scientific Reference Grade
Platinum Resistance Thermometer
range      : -2  -  32  deg C
accuracy   : +/- 0.003  deg C
stability  : +/- 0.0005 deg C/month
resolution :     0.0001 deg C

Falmouth Scientific Thermistor Sensor
range      : -2  -  32  deg C
accuracy   : +/- 0.010  deg C
stability  : +/- 0.001  deg C / month
resolution : 0.0001     deg C

Falmouth Scientific Titanium Pressure Sensor
range      : 0 - 7000 dbar
accuracy   : +/- 2.1  dbar
stability  : +/- 0.7  dbar/month
resolution :     0.08 dbar

Falmouth Scientific Inductive Conductivity Sensor
range      :   0 - 65   mmho/cm
accuracy   : +/- 0.003  mmho/cm
stability  : +/- 0.0005 mmho/cm/month
resolution :     0.0002 mmho/cm

Each CTD has two Platinum Resistance Thermometer

Software   : FSI Software for data aquisition
             CTD postprocessing in analogy to Version 1.12

Time lag   : 0.10 s
```

```
ICTD-SN 1347; Cal_date: AUG.98
   Calibration: post-cruise no pre-cruise calibration used
  #PT1
   a1 = 0.00179275
   a2 = 0.000367769
   a3 = 5.98102E-06
   a4 =-1.73705E-06
   a5 = 3.92021E-08
  #PT2
   a1 =-0.00296646
   a2 = 0.000105862
   a3 = 1.00638E-05
   a4 =-1.12480E-06
   a5 = 2.20040E-08

   temperature post-cruise calibration
   the temperature data are used only from PT2
   T(corrected) = T(reading) + dT
   with dT = a1 +a2*T +a3*T**2 +a4*T**3 +a5*T**4
        ai : T(calibrated)-T(reading)

  #PRES
   a1 = 1.6215
   a2 = 0.000766727
   a3 =-2.36597E-07
   a4 =-5.02071E-11
   a5 = 8.88206E-15
  #UNLOAD PRES
    0.0

   pressure post-cruise calibration
   p(corrected) = p(reading) + dp
   with dp = a1 +a2*p +a3*p**2 +a4*p**3 +a5*p**4
        ai : p(calibrated)-p(reading)


ICTD-SN 1360; Cal_date: AUG.98
   Calibration: post-cruise no pre-cruise calibration used
```

```
#PT1
 a1 = 0.00448876
 a2 =-4.55829E-05
 a3 = 3.83954E-05
 a4 =-2.45250E-06
 a5 = 4.40105E-08

#PT2
 a1 =-0.00332538
 a2 =-0.000208227
 a3 = 3.21668E-05
 a4 =-1.67948E-06
 a5 = 2.77787E-08

 temperature post-cruise calibration
 the temperature data are used only from PT2
 T(corrected) = T(reading) + dT
 with dT = a1 +a2*T +a3*T**2 +a4*T**3 +a5*T**4
      ai : T(calibrated)-T(reading)

#PRES
 a1 =-0.641264
 a2 =-0.000848878
 a3 = 3.51877E-07
 a4 =-7.04156E-11
 a5 = 4.47779E-15
#UNLOAD PRES
  0.0

 Pressure post-cruise calibration
 p(corrected) = p(reading) + dp
 with dp = a1 +a2*p +a3*p**2 +a4*p**3 +a5*p**4
      ai : p(calibrated)-p(reading)


 after calibration the platinum temperature is summed with
 the fast thermistor as follows:
  F(t)  = F(t-dt)*W2+Fi(t)*(1-W2) filtered fast thermistor
```

```
 F'(t) = Fi(t)-F(t)              high pass filtered fast temperature
 T(t)  = Ti(t)+F'(t)             summed platinum and fast thermistor

 with W2= exp(-dt/TtauF)  dt is the CTD observations intervall in seconds
                          dt = 48ms
                          TtauF is the Platinum thermometer time constant
                                in seconds relative to the fast thermistor
                          TtauF = 400 ms
      Ti is the unfiltered platinum temperature = T(corrected)
      Fi is the unfiltered fast thermistor
```

The CTD-temperature is IPTS-68

Correction of the CTD-conductivity data with the bottle-samples

COND(corrected) = COND(CTD) - COND(delta)

with COND(delta)= average(COND(CTD)-COND(WATERSAMPLE))

Station/Cast	COND(delta)
00101 to 00601	-0.0149
00703	-0.0138
00801 to 00901	-0.0136
01001	-0.0130
01102 to 01106	-0.0129
01201	-0.0131
01301	-0.0130
01401	-0.0133
01501 to 01502	-0.0129
01601	-0.0131
01701	-0.0132
01801	-0.0128
01901	-0.0134
02001 to 02002	-0.0135
02101	-0.0136
02201 to 02801	-0.0134
02901	-0.0138

03001 to 03101	-0.0140
03201	-0.0135
03301 to 03401	-0.0134
03501	-0.0135
03601	-0.0134
03701	-0.0130
03801	-0.0128
03901	-0.0127
04001	-0.0126
04101	-0.0129
04201	-0.0124
04301	-0.0121
04401	-0.0130
04501	-0.0127
04601	-0.0133
04701 to 04702	-0.0117
04801	-0.0116
04901	-0.0113
05001	-0.0115
05101	-0.0120
05201 to 05301	-0.0121
05401	-0.0119
05501	-0,0168
05601 to 05701	-0.0158
05801	-0.0145
05901	-0.0140
06001	-0.0137
06101	-0.0140
06201	-0.0141
06301	-0.0143
06501	-0.0141
06601	-0.0144
06701 to 06802	-0.0140
06901	-0.0139
07001 to 07101	-0.0142
07201 to 07301	-0.0144
07401	-0.0142
07501	-0.0144

07601	-0.0145
07701 to 07702	-0.0146
07802 to 07804	-0.0147
07901	-0.0149
08001	-0.0148
08101	-0.0150
08201	-0.0149
08301	-0.0151
08401	-0.0149
08501	-0.0150
08601	-0.0153
08701 to 08901	-0.0149
09001	-0.0147
09101	-0.0145
09201	-0.0143
09301	-0.0150
09401 to 09601	-0.0151
09701	-0.0153
09801	-0.0152
09902 to 09905	-0.0150
10001	-0.0151
10101	-0.0153
10201	-0.0150
10301	-0.0148
10401	-0.0150
10501 to 10601	-0.0151
10702 to 10704	-0.0150
10801	-0.0152
10901	-0.0150
11001	-0.0151
11101	-0.0150
11201	-0.0149
11301	-0.0150
11402 to 11404	-0.0148
11501	-0.0149
11601 to 11701	-0.0150
11801	-0.0148
11901	-0.0142

12001 to 12101	-0.0144
12201 to 12202	-0.0148
12301 to 12401	-0.0140
12501 to 12601	-0.0147
12701	-0.0148
12801	-0.0146
12901	-0.0144
13001	-0.0141
13101	-0.0144
13201	-0.0145
13301 to 13401	-0.0149
13501	-0.0154
13601	-0.0147

```
CTD Files column 5 : transmissiometer raw data
                     range between 0 and 5 Volt
                     these data are not controlled
```

4. MARINE BIOLOGY

4.1. DECOMPOSITION OF SINKING PARTICLES

Anja Heuchert (UFT)

Objectives

Macroscopic aggregates (marine snow) are the dominant fraction involved in the transport of biogenic carbon from surface water to the deep-sea bottom. Rapidly sinking particles in the water column, so called "marine snow", consist of dissolved and colloidal organic matter which aggregates together, e.g. phytoplankton aggregates, fecal pellets and detritus. Bacteria and protozoa seem to play an important role in decomposing "marine snow", because the main decomposition takes place in the mesopelagic zone.

In this investigation, single strains of bacteria attached to "marine snow" will be isolated. By means of these isolates, the microbial decomposition of "marine snow" by different species of bacteria will be investigated. In addition, preparations for light and electron microscopy will be made. Moreover, the fixed material has to be examined with a scanning electron microscope to determine the colonization with attached bacteria. The results will be compared with those of two cruises in the equatorial Atlantic in 1996 and 1997.

Work at sea

In order to investigate the colonization of sinking particles in the water column, ("marine snow") samples from different water depths were taken with bottles at 16 stations. Pure strains of attached heterotrophic bacteria were isolated from samples which were filtered through 5-µm or 10-µm pore-size filters to increase particle concentration.

Water samples from sediment trap 227-4 were taken to investigate bacterial density. Furthermore samples are filtered through 0.2-µm and 5-µm or 10-µm pore-size filters and fixed for 30 min in 3.7% formalin. This fixed material will be used for the in-situ identification of microorganisms. Fluorescently labeled rRNA-targeted nucleic acid probes allow an in-situ identification of individual microbial cells in their natural habitat.

In order to quantify the bacteria, samples taken by the ship's pump and filtered through 11-µm pore-size filters were fixed with formalin (2% v/v). Later the samples will be treated with the epifluorescence dye DAPI in order to count the bacterial cells of the free water column as well as the attached bacteria.

Preliminary results

The filtered particles were rather small in most of the cases and hardly visible on the filter itself. However, five different strains of bacteria have been distinguished with respect to colony- and cell morphology. Two of the strains were found at one particular station only, whereas the others occurred at various stations during the cruise. All of the obtained bacteria are rods, some of them are motile rods. It is intended to investigate the metabolism of the isolates and characterize them thoroughly. As has been stated before, a quantitative count of bacterial cells will have to be performed at the lab using the epifluorescence dye DAPI. Furthermore, there will be an in-situ identification of the bacteria at the lab.

4.2. MICROBIAL COMMUNITY CHARACTERISTICS IN AUSTRAL AUTUMN FROM ICE AND SEA WATER.

Kjell Magne Fagerbakke (IM)

Objectives

The role of sea ice as an environment for growth and survival of microorganisms in the Weddell Sea is characterized by measuring Chlorophyll a and DOC/POC (Dissolved organic carbon/particulate organic carbon) concentrations in ice and sea water. Measurements of DOC may increase our knowledge of the biological input in CO_2 sequestering from the atmosphere. A large contribution to it may come from the POC produced in sea ice.

Elemental compositions of microorganisms are shown to reflect their growth. If this is the case for microorganisms living in nutrients, excess (N, P) is explored by X-ray microanalysis (XRMA). From XRMA a physiological characteristic can also be made. Variation within and among the microbial communities in sea water and ice may be discovered.

Work at sea

The sampling routine was to make one station each day (in total 48). Samples of chlorophyll from 0, 20 and 100 m have been taken. Samples of POC and DOC were made from the same stations as Chi. a. All Chi a, POC, and DOC samples were frozen to be analyzed later. When sea ice was present, ice samples were taken. From the ice Chi a, POC, and DOC were also taken (in total 10 stations). The communities present, both in sea water and ice, were characterized by fluorescence microscope.

Preliminary results

The brown layers of first-year sea ice consist mostly of particular matter and only occasionally algae were observed. Variation in species composition indicated that different algae had different strategies for the life in ice. The dominating species in compact ice were *Stellarima microtrias* and *Dactyliosolen antarctica*, indicating that these algae are staying until the ice melt. Occasionally observations of *Corethron criophilum* in ice, and always in porous ice, indicate that this specie may easier leave the ice than the former. From the structure of ice it seems that large holes may be created during the melting period and due to this, the algae may migrate easily to the open water. Possibly algae influence the ice melting, and species found in winter ice, but not in spring ice are more effective in the melting process than *C. criophium. C. criophilum* was also observed as one of the dominating species to occupy the new ice, when it is formed. During growth of artificial sea ice, phosphorus was not incorporated, and at the time of incorporation the organisms may explore phosphorus depletion. Nitrate and silicate levels decreased during the ice formation also. However, the level of 20 to 30 µM silicate and 10 µM nitrate may be sufficient for biological activity based on this as limiting factors.

4.3. THE ROLE OF SPONGES IN CARBON AND SILICON FLUXES IN THE WEDDELL SEA

Susanne Gatti (AWI)

Objectives

Flow of carbon: Antarctic sponges are supposed to grow very slowly due to low ambient water temperatures and scarce, seasonally strongly varying food supply. As sponges do not build any permanent hard skeleton parts it is impossible to assess their age by analyzing such structures. Turn over rates for spicules in Antarctic sponges are not known and as for now no method exists that utilises the siliceous sponge spicules for age analysis. It is therefore impossible to assess growth or age via direct methods as for example in some mollusks, echinoderms, or fishes. To provide a rough estimate of growth rates and the age of sponges, mass specific respiration rates will be established. After conversion, these will provide estimates of consumption and production rates.

Flow of silicon: In the Antarctic the silicon cycle in the water column has been studied extensively. Thus, the role of diatoms, radiolarians, and silicoflagellates is quite well understood. But so far no effort has been made to study the role of sponges in the silicon cycle. Frequently, up to 90% of the wet weight of siliceous sponges (Demospongia and Hexactinellida) consist of opal (biologically synthesized silica) (Barthel, 1995). As methods for age determination in sponges are lacking it is impossible to assess how long it takes for a sponge to accumulate these enormous amounts of opal.

Work at sea

Most of the animals were collected during the previous leg (ANT XV-3). Additionally, two Agassiz trawls (AGTs) were used off Kapp Norvegia during this leg to collect fresh sponges for analysis of activity of the electron transport system (ETS).

Long term (more than three months) life maintenance of the collected sponges was successful. Individuals collected during the previous leg were in good condition. Meanwhile, most have been used for respiration experiments. Only individuals of *Monosyringa longispina* and some little hexactinellid sponges will be carried back to Bremerhaven.

Respiration experiments were carried out with unfiltered sea water in a closed but intermittently opened (whenever oxygen saturation was below 80-85%) system. Oxygen saturation in the water was determined by micro optodes (Holst et al., 1997). Constant mixing in the respiration chambers was assured using peristaltic pumps which pumped the water from the chambers to the measuring optodes and back to the chambers. An additional empty chamber (i.e. containing water but no animal) was used in every run to compensate for bacterial respiration. During this cruise ten respiration experiments, lasting for two to three days each, were carried out. Nine individuals of *Cinachyra Antarctica*, 14 individuals of *Stylocordyla borealis*, and four little specimens of hexactinellid sponges were measured. For these sponges only dripping wet weight (ww) has been determined on board. Specimens were frozen for later determination of dry weight and ash free dry weight.

To support findings of the respiration experiments the analysis of ETS was carried out with newly caught sponges and those taken from the aquaria. As ETS is based on enzyme activity and as it takes some time to assimilate or decompose enzymes, there is little or no change in ETS levels to be expected within the first hours after a catch. ETS measurements will give an estimate of maximum capacities of oxygen consumption and changes that are caused by taking sponges from their natural habitat to aquaria. It should thus be possible to assess whether or not respiration rates measured on board are a good estimate of in-situ respiration rates.

Silicate uptake: Prior to freezing, sponges coming from respiration experiments were transferred into silicate-uptake experiments. For these nalgene bottles were filled with 750 ml of filtered sea water and an additional supply of liquid food (4-5 drops of Liquifry per 10 l water). As silicate uptake is an energy consuming process food limitation could limit silicate-uptake rates even when silica is present in excess. Constant bubbling with air supplied oxygen and assured mixing within the bottles. Again a control was run (nalgene bottle without an animal). Silicate levels in the water were monitored by taking 20-ml samples every six to ten hours. Analyses followed the Koreleff method described by Grasshof et al (1983). Dissolution experiments with spicule mats and dead sponges will be carried out in the AWL

Preliminary Results

All specimens examined tolerated being transferred from the aquarium to a respiration chamber and later to a nalgene bottle for silicate-uptake experiments apparently without problems. After an initial phase of slight construction of the oscula all sponges opened their oscula (exhalant openings), thus showing active water transport through their systems.

It was possible to cover a good size range for both species. Individuals of *Stylocordyla borealis* and *Cinachyra Antarctica* varied between 2 to 75g and 1.5 to 64g of ww, respectively.

From the oxygen and silicate decrease in the water respiration rates and silicate uptake rates will be calculated once dry weight and ash free dry weight have been determined at the AWL

5. REFERENCES

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Hoist G. et al. (1997)- "A microoptode array for fine-scale measurement of oxygen distribution" in Sensors and Actuators B Vol. 38-39 pp 122-129.

6. ACKNOWLEDGEMENTS

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7. PARTICIPATING INSTITUTIONS

	Address	Participants	Leg
Brazil			
FURG	Department of Physics University of Rio Grande Rio Grande RS CEP 96201-900	2	4
Federal Republic of Germany			
AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung Columbusstraße D-27568 Bremerhaven	12	4
DWD	Deutscher Wetterdienst Seewetteramt Postfach 301190 D-20304 Hamburg	2	4
HSW	Helicopter-Service Wasserthal GmbH Kätnerweg 43 D-22393 Hamburg	3	4
UFT	Zentrum für Umweltforschung und Technologie (UFT) Abt. Marine Mikrobiologie Universität Bremen Postfach 330 440 D-28334 Bremen	1	4
IUPT	IUP - Institut für Umweitphysik Abt. Tracer-Ozeanographie Universität Bremen, FB 1 Postfach 330 440 D-28334 Bremen	6	4
IUPF	IUP - Institut für Umweltphysik Abt. Fernerkundung Universität Bremen, FB 1 Postfach 330 440 D-28334 Bremen	1	4

7. PARTICIPATING INSTITUTIONS (Continued)

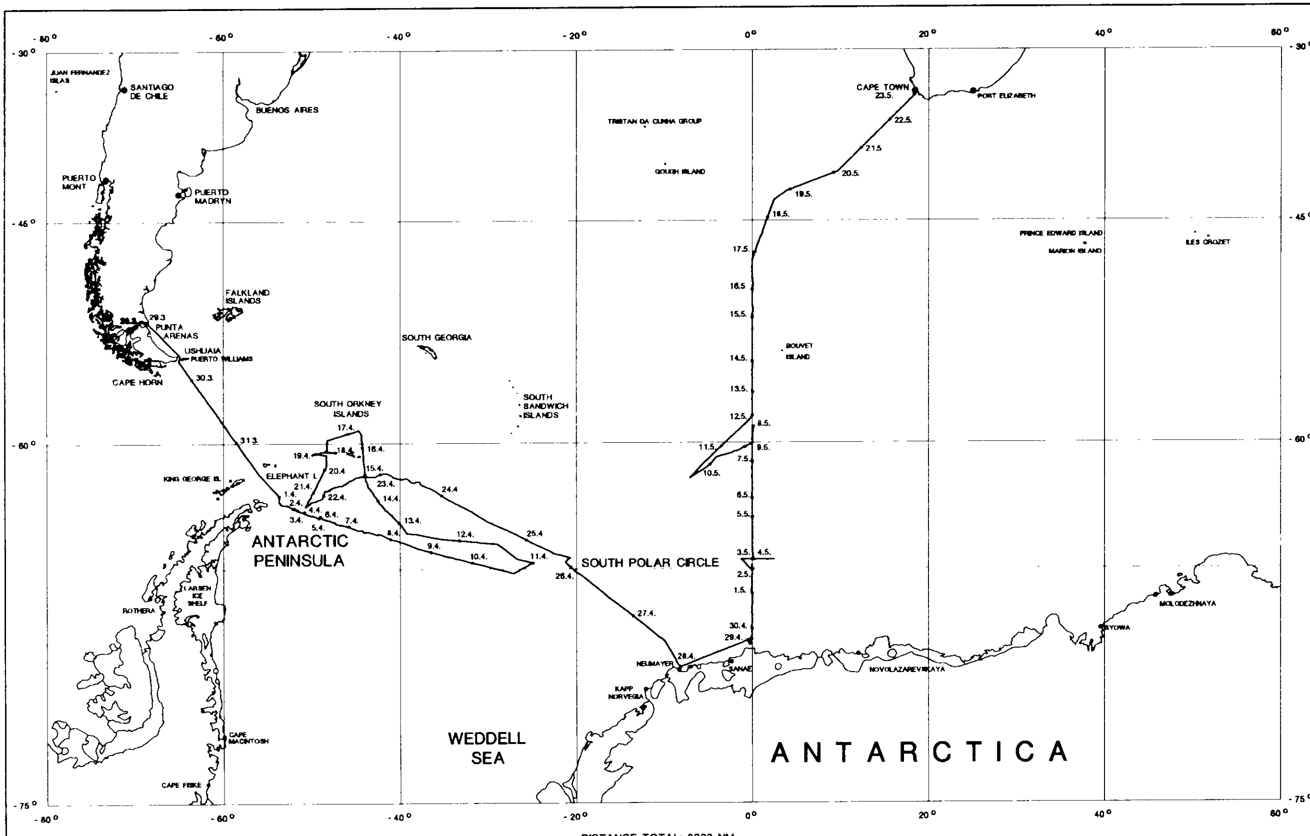
	Address	Participants	Leg
The Netherlands			
NIOZ	Netherlands Institute for Sea Research P.O. Box 59 1790 Ab den Burg Texel	1	4
Norway			
IM	Institutt for Mikrobiologi Jahnebakken 7 N-5020 Bergen	1	4
Spain			
ICM	Instituto de Ciencias del Mar Paseo Juan De Boron S/N 08039 Barcelona	1	4
LEM	Laboratori d'Engiyeria Maritima Universtat Politecnica de Catalunya C/Gran Capita s/n, Modul D-1 08034 Barcelona		4
Russia			
AAI	Andreyev Acoustics Institute Shvernika 117034 Moscow	1	4
United Kingdom			
PML	Plymouth Marine Laboratory West Hoe, Plymouth Devon, PL1 3DH	1	4

8. CRUISE PARTICIPANTS

Name	Institution
Bakker, Karel	NIOZ
Bellerby, Richard	PML
Bulsiewicz, Klaus	IUPT
Büchner, Jürgen	HSW
Fagerbakke, Kjell Magne	IM
Fahrbach, Eberhard	AWI
Feldt, Oliver	HSW
Frenzel, Martin	AWI
Fraas, Gerhard	IUPT
Fürhaupter, Karin	GEOMAR
Gatti, Susanne	AWI
Harms, Sabine	AWI
Härter, F.F. Antonio	FURG
Hartig, Rüdiger	DWD
Heeschen, Katja	GEOMAR
Heuchert, Anja	UFT
Hoppema, Mario	IUPT
Huhn, Olliver	IUPT
Iaremtchouk, Alexei	AAI
Klatt, Olaf	IUPT
Köhler, Herbert	DWID
Krause, Peter	HSW
Langreder, Jens	AWIAUPT
Meissner, Katrin	AWI
Mir Casanovas, Carlos	ICM/LEM
Monsees, Matthias	AWI/IUPT
Pereira Ferreira, Adriene	AWI/FURG
Rodehacke, Christian	IUPT
Rohardt, Gerd	AWI
Schlüter, Norbert	IUPF
Schodlok, Michael	AWI
Schröder, Michael	AWI
Schuster, Fritz	AWI (ab Neumayer Station)
Wisotzki, Andreas	AWI
Witte, Hannelore	AWI

9. SHIP'S CREW

Position	Name
Kapitän	Keil, Jürgen
1. nautischer Offizier	Schwarze, Stefan
Leitender techn. Offizier	Schulz, Volker
2. nautischer Offizier	Block, Michael
2. nautischer Offizier	Malz, Ingo
2. nautischer Offizier	Peine, Lutz
Arzt	Bennemann, Jürgen
Funkoff izier	Hecht, Andreas
2. technischer Offizier	Delff, Wolfgang
2. technischer Offizier	Folta, Henryk
2. technischer Offizier	Simon, Wolfgang
Elektroniker	Dimmler, Werner
Elektroniker	Fröb, Martin
Elektriker	Holtz, Hartmut
Elektroniker	Pabst, Helmar
Elektroniker	Piskorzynski, Andreas
Schiffbetriebsmeister	Loidl, Reiner
Zimmermann	Neisner, Winfried
Facharbeiter/Deck	B&cker, Andreas
Facharbeiter/Deck	Bindernagel, Knuth
Facharbeiter/Deck	Bohne, Jens
Facharbeiter/Deck	Hagemann, Manfred
Facharbeiter/Deck	Hartwig, Anderas
Facharbeiter/Deck	Moser, Siegfried
Facharbeiter/Deck	Schmidt, Uwe
Facharbeiter/Deck	Winckler, Michael
Storekeeper	Beth, Detlef
Facharbeiter/Maschine	Arias Iglesias, Enr.
Facharbeiter/Maschine	Dinse, Horst
Facharbeiter/Maschine	Fritz, Günter
Facharbeiter/Maschin	Giermann, Frank
Facharbeiter/Maschine	Krüsche, Eckard
Koch	Silinski, Frank
Kochsmaat	Beck, Walter
Kochsmaat	Tupy, Mario
1. Stewardess	Dinse, Petra
1. Stewardess	Wöckener, Martina
2. Stewardess	Klemet, Regine
2. Stewardess	Schmidt, Maria
2. Stewardess	Silinski, Carmen
2. Steward	Tu, Jian-Min
2. Steward	Wu, Chi Lung
Wäscher	Yu, Chung Leung



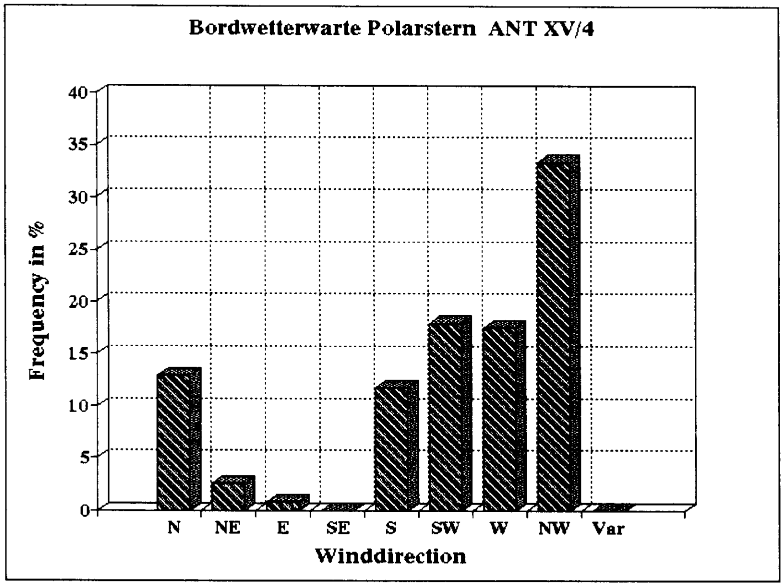
PFS POLARSTERN

CRUISE ANTXV/4

PUNTA ARENAS - NEUMAYER - CAPETOWN

MARCH 28th TO MAY 23rd, 1998

Alfred Wegener Institute for Polar and Marine Research D-27568 Bremerhaven, FRG



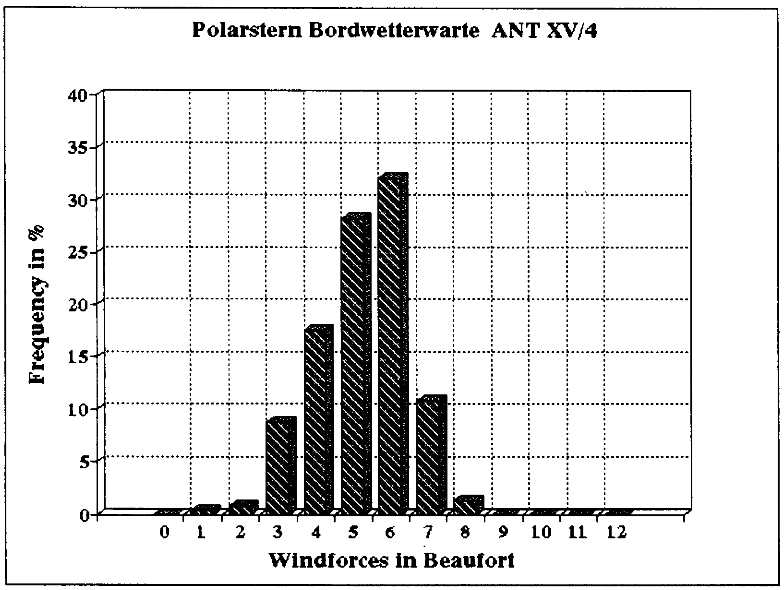
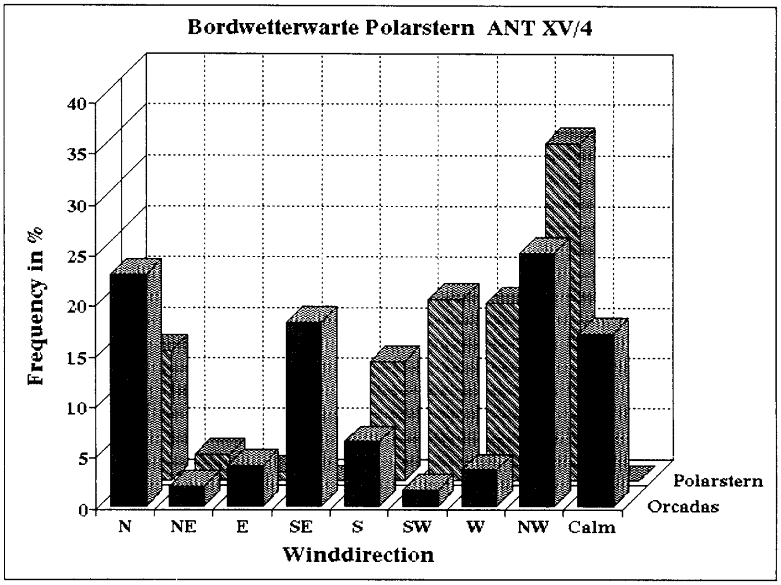


Fig. 2: Frequency distribution of wind direction and force. "Polarstern" observations from 12 to 21 April 1998.



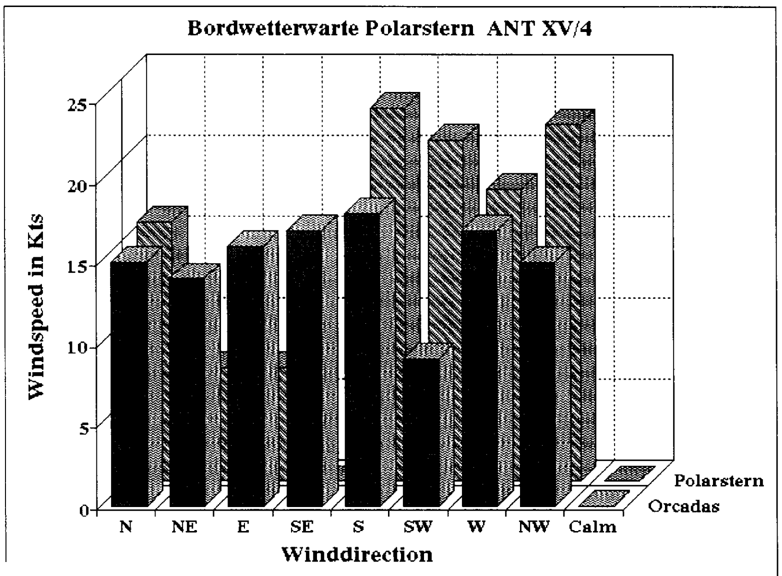
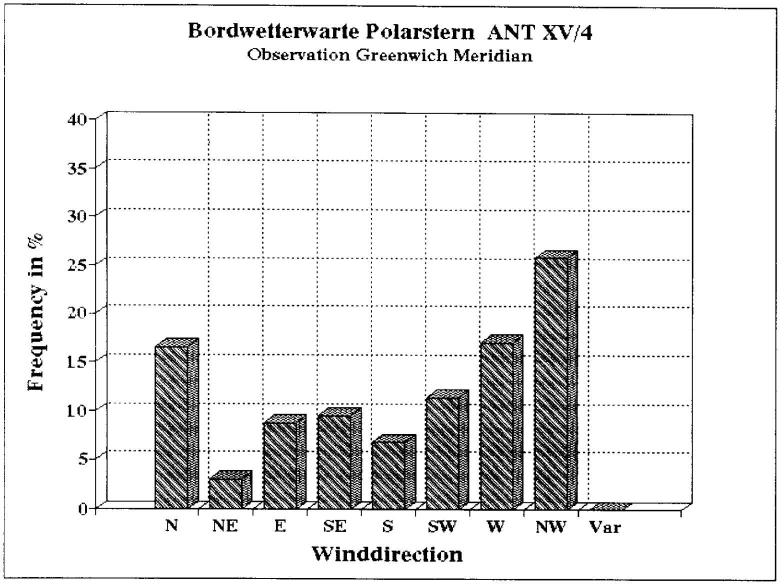


Fig.-3: Correlation between wind direction and wind speed. Comparison of "Polarstern" observations (12 to 21 April 1998) versus climatological data of the "Islas Orcadas Sur" weather station (period 1971 to 1980) for April.



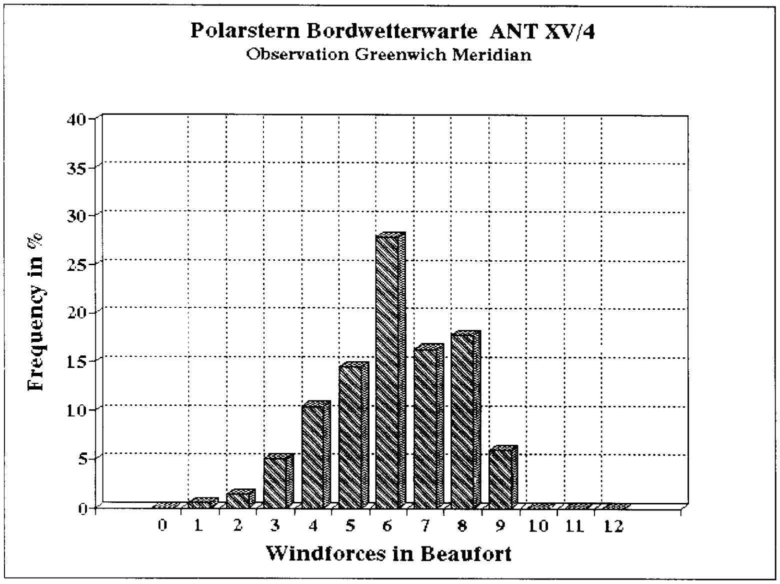


Fig. 4: Frequency distribution of wind direction and force. Observations of "Polarstern" from 29 April to 18 May 1998 along the Greenwich Meridian between 50° and 70°S.

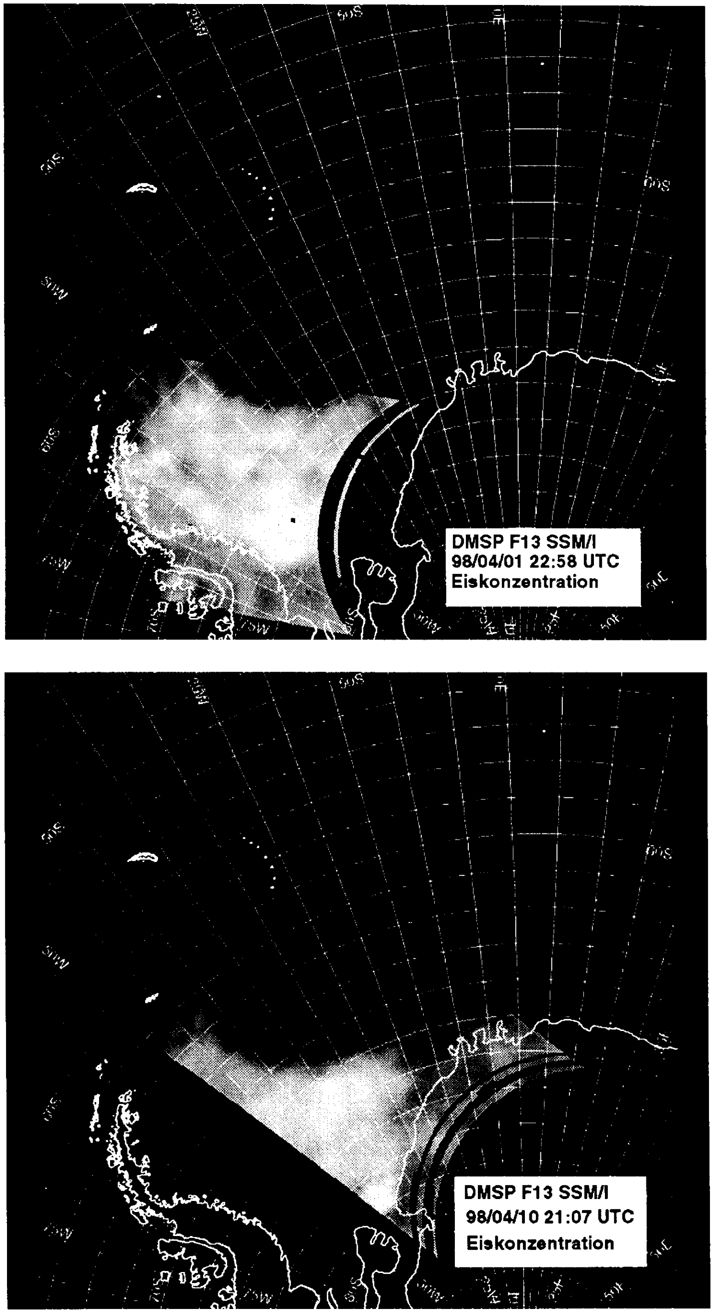


Fig. 5: Ice coverage of the Weddell Sea on 1 April 1998 (top) and on 10 April 1998 (bottom), calculated using data of the microwave radiometer SSIVIA.

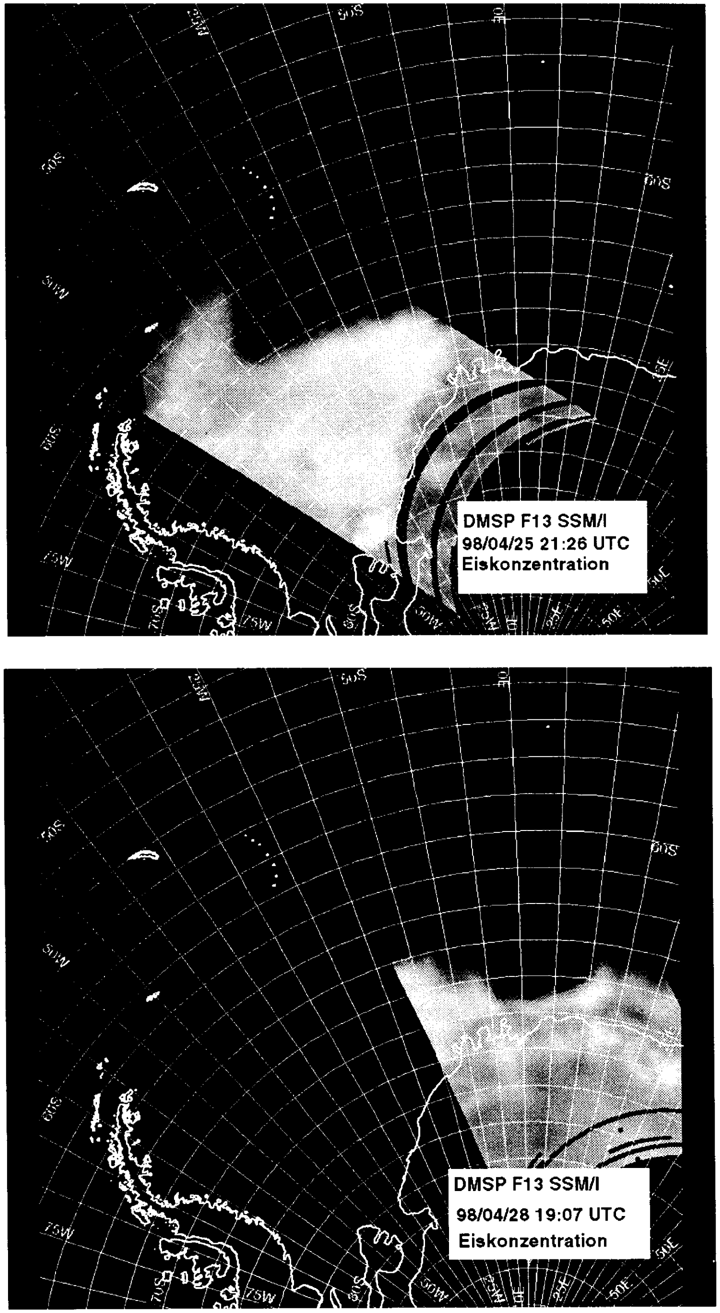


Fig. 6: Ice coverage of the Weddell Sea on 25 April 1998 (top) and on 28 April 1998 (bottom), calculated using data of the microwave radiometer SSM/I.

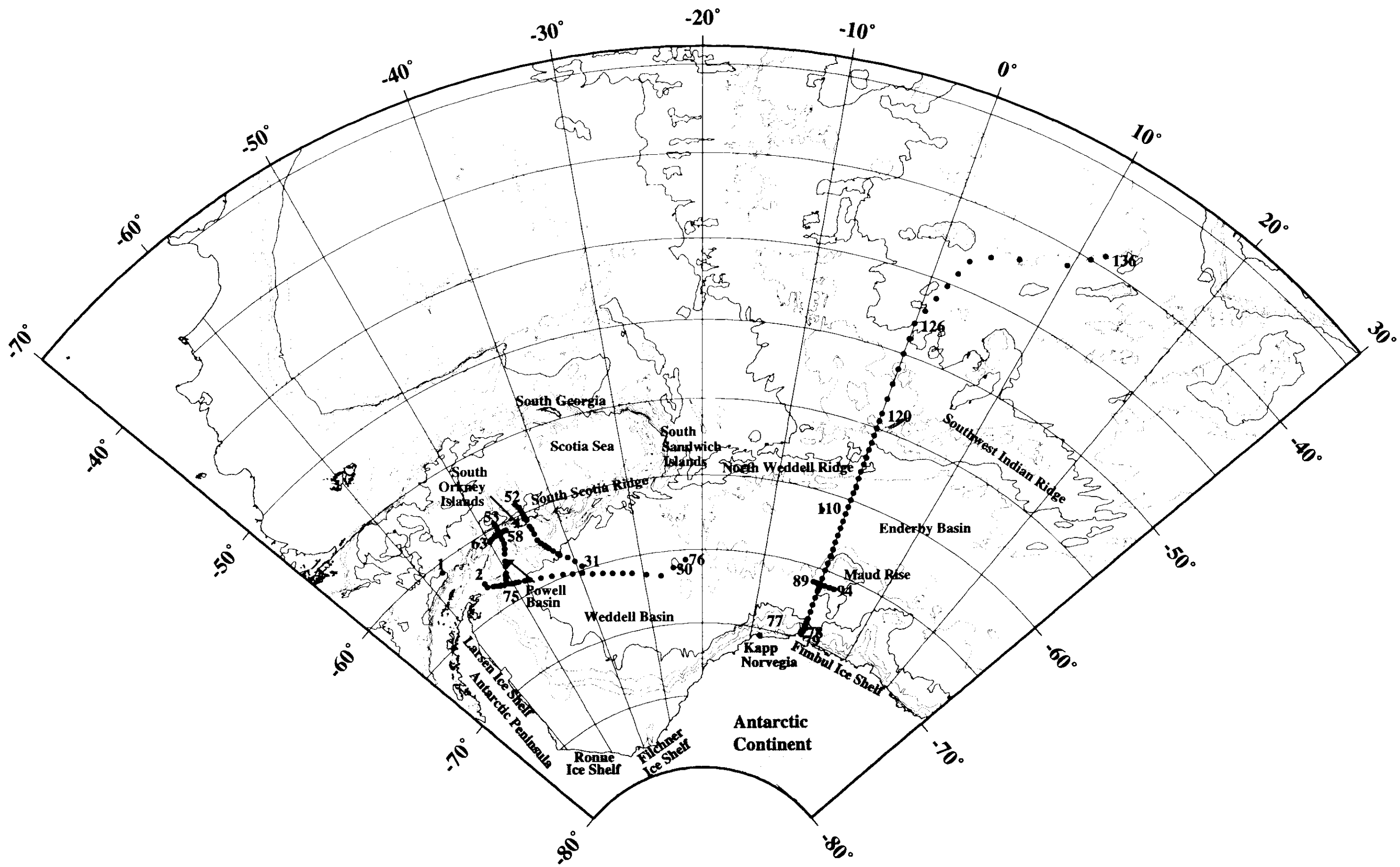


Fig. 7a: Location of the hydrographical stations in the Weddell Sea.

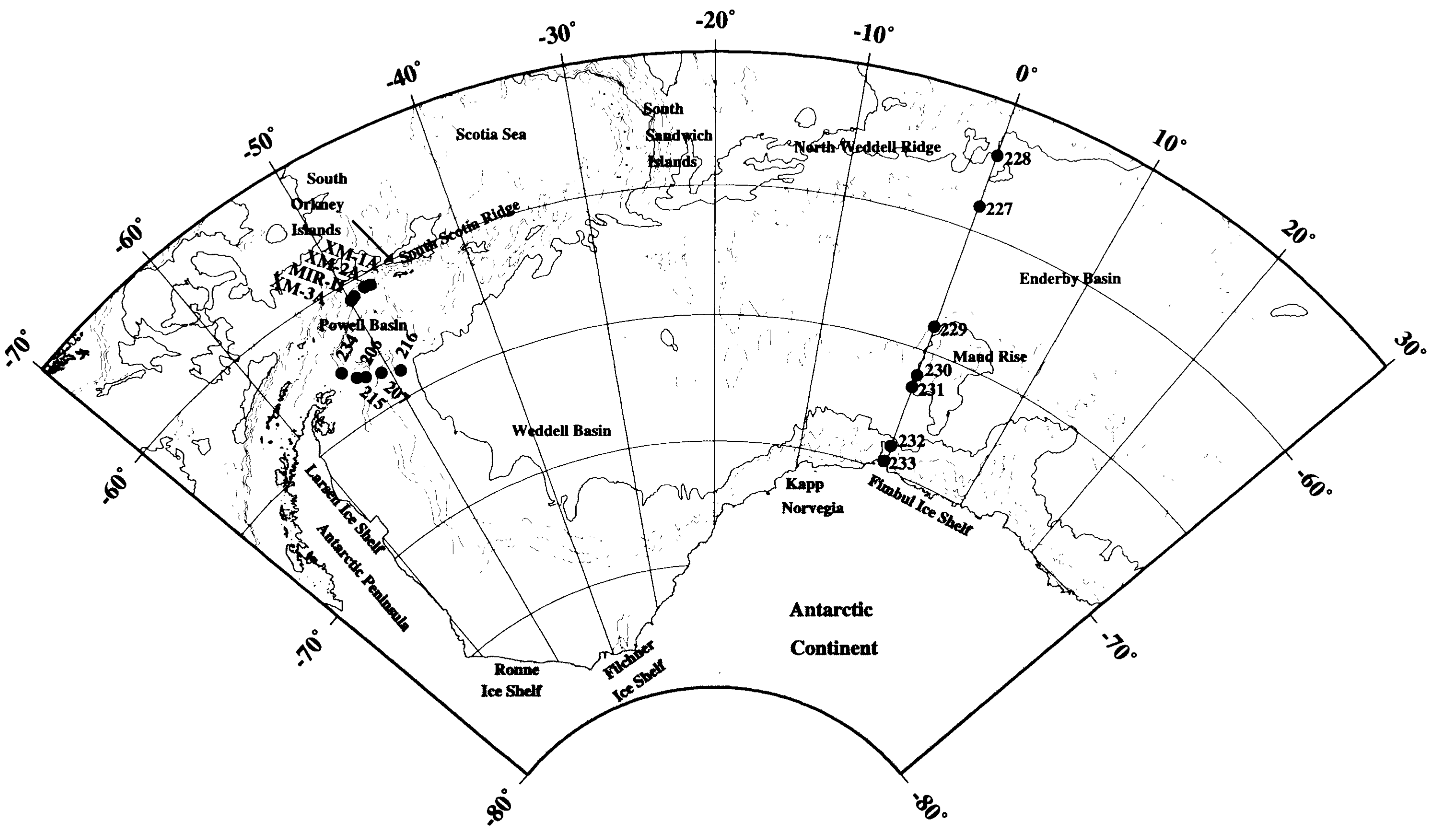


Fig. 7b: Location of the moorings in the Weddell Sea.

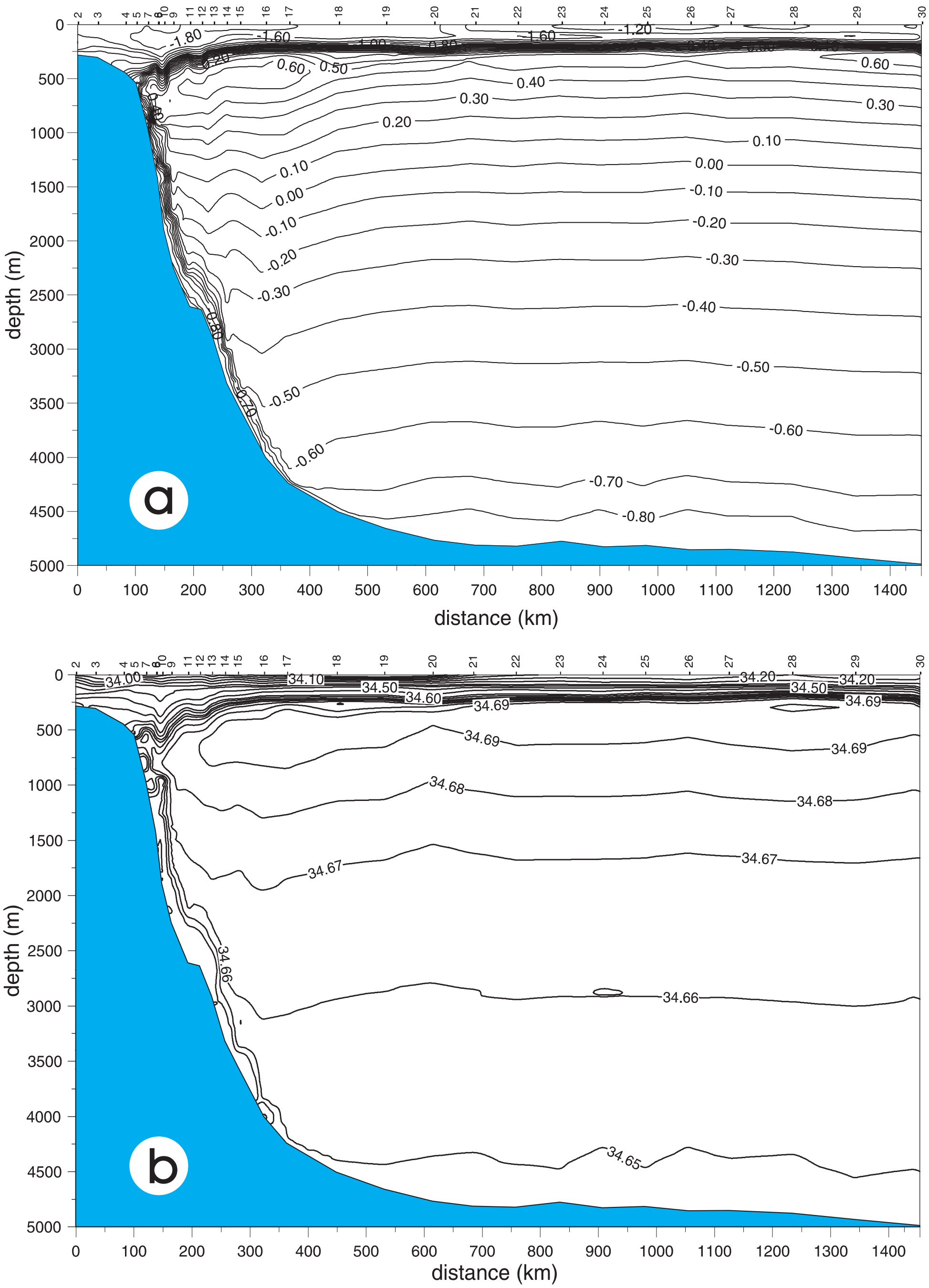
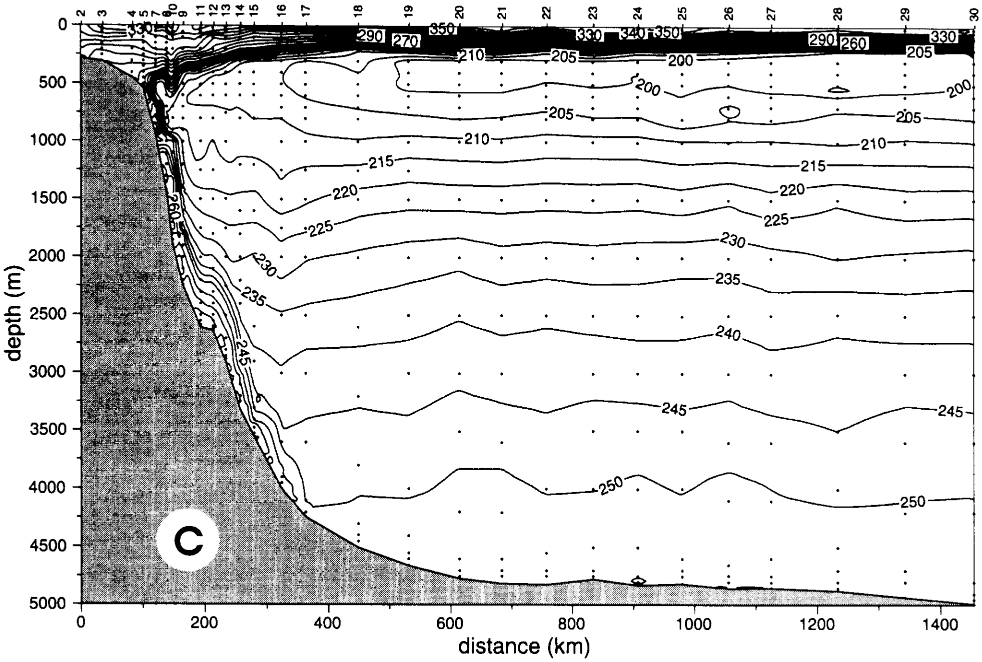
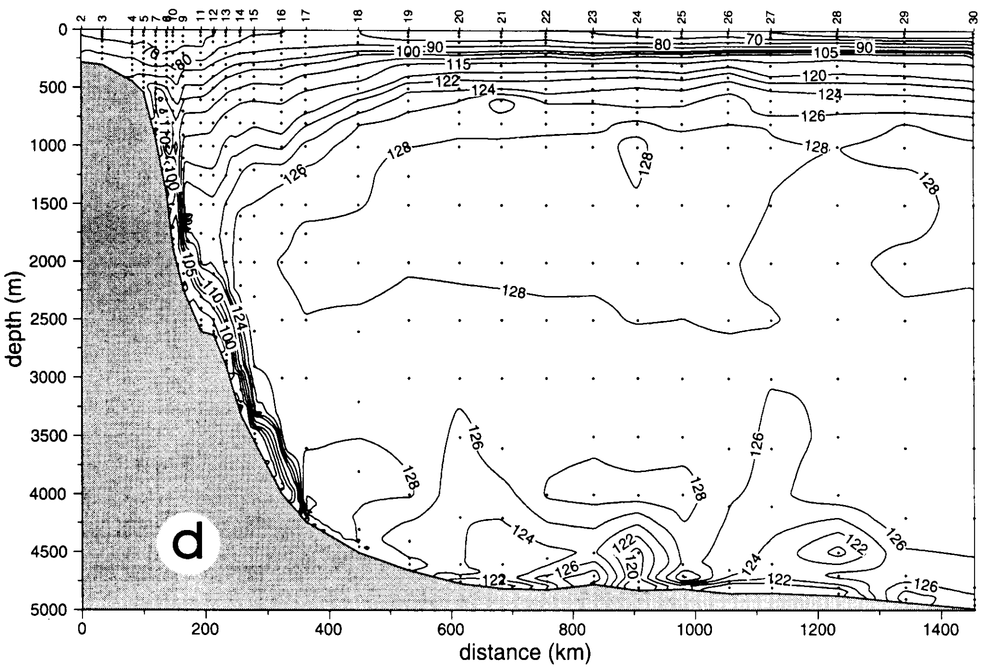


Fig. 8: Vertical section of potential temperature (a), salinity (b), oxygen in µmol/l (c) and silicate in µmol/l (d) across the northwestern Weddell Sea from Joinville Island to the southeast.


c
depth (m)
distance (km)


d
depth (m)
distance (km)

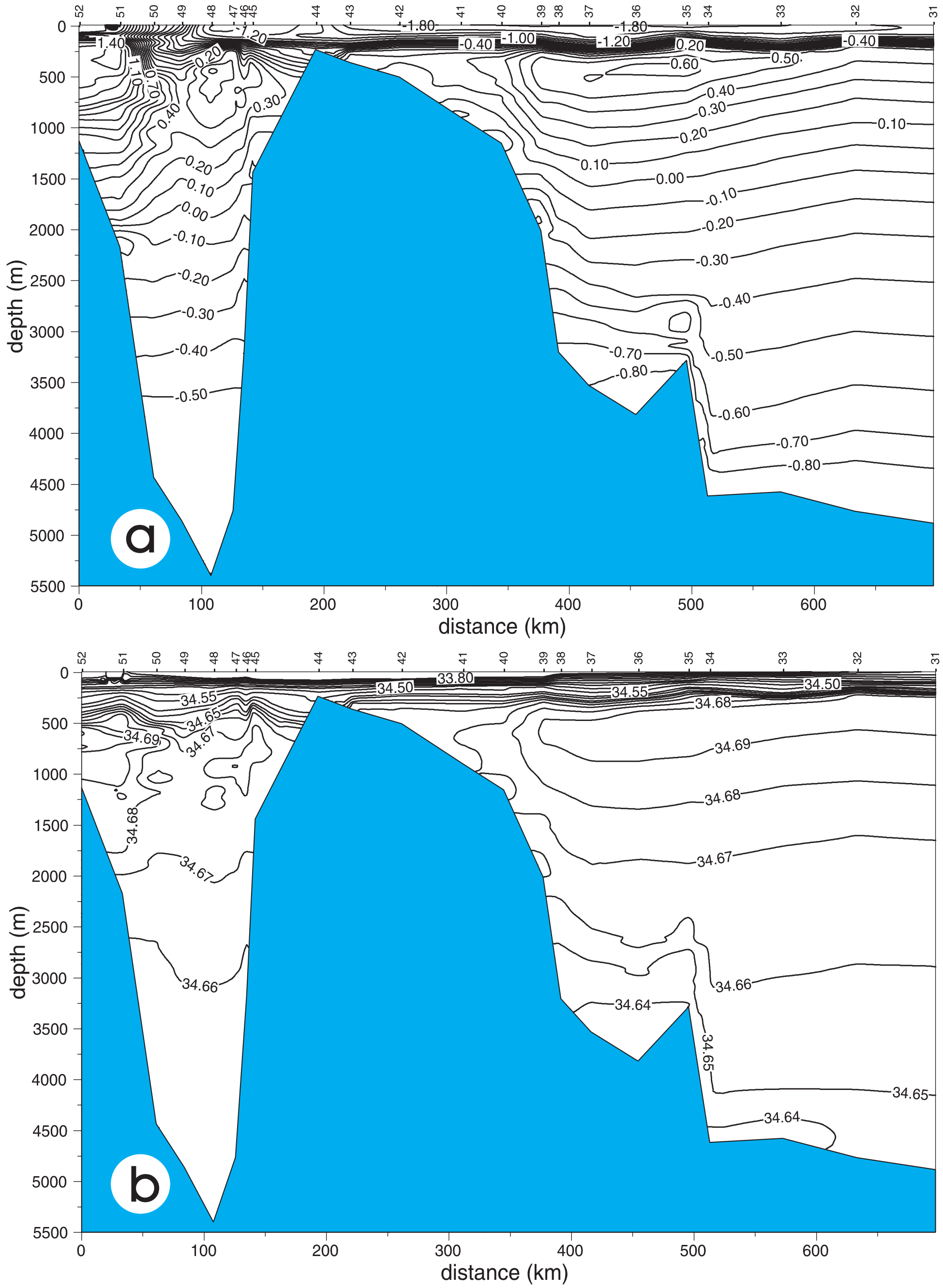
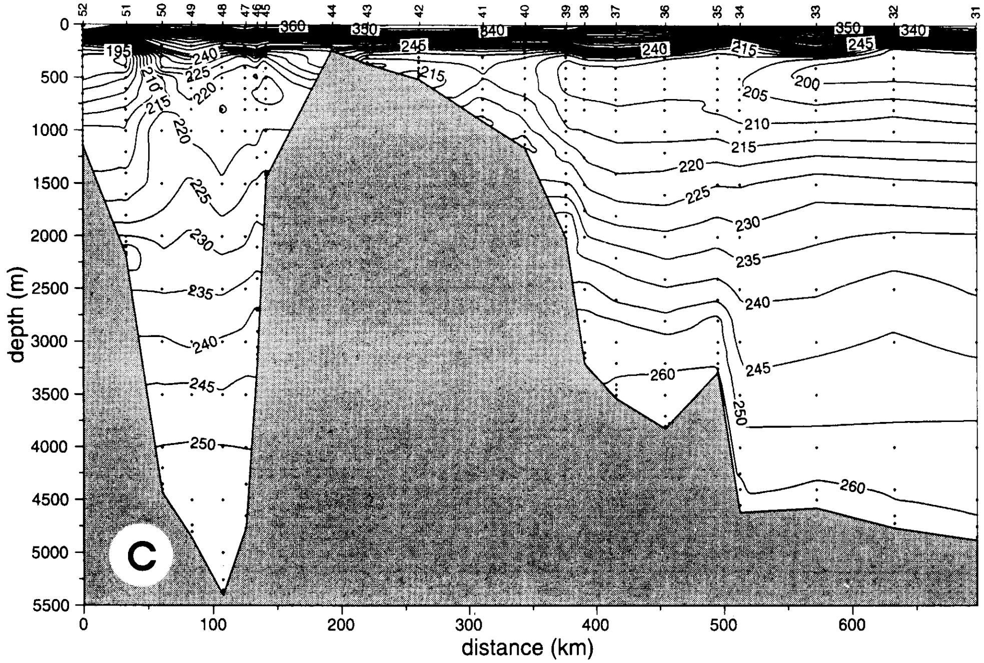


Fig. 9: Vertical section of potential temperature(a), salinity (b), oxygen in µmol/kg (c) and silicate in µmol/kg (d) across the Weddell-Scotia Confluence from 64°44'S, 39°15'W to 59°15'S, 44°40'W.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360
350
340
350
340
195
240
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220
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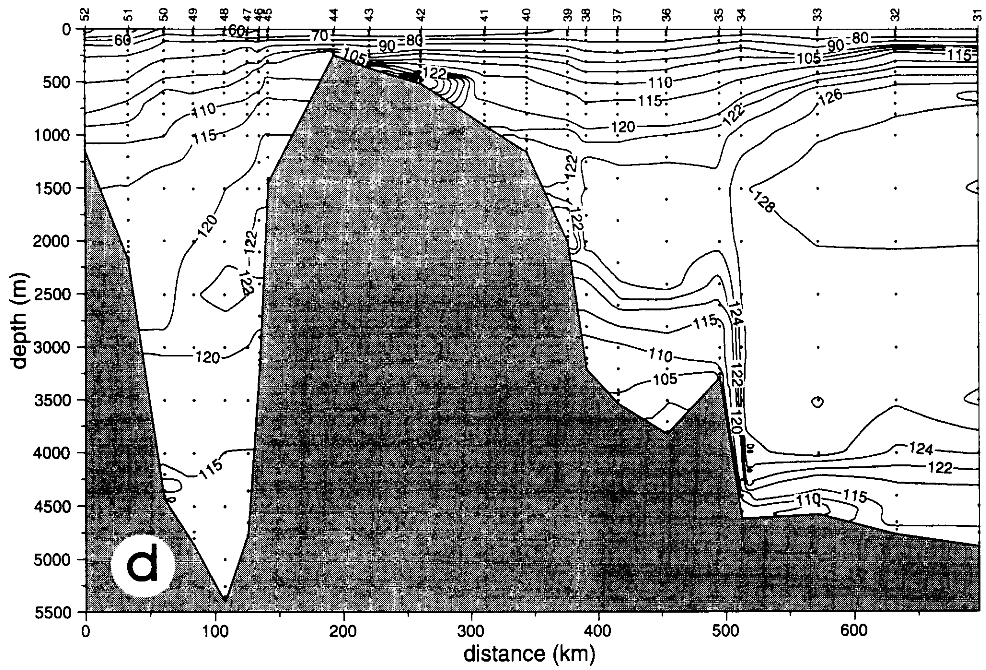
245
215
240
215
245
200
205
210
215
220
225
230
235
240
245
250
260
260
depth (m)
distance (km)
c


52 51 50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31
60
60
70
90
80
105
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90
80
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110
115
120
122
126
128
120
122
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122
124
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105
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120
120
124
122
115
110
115
depth (m)
distance (km)
d

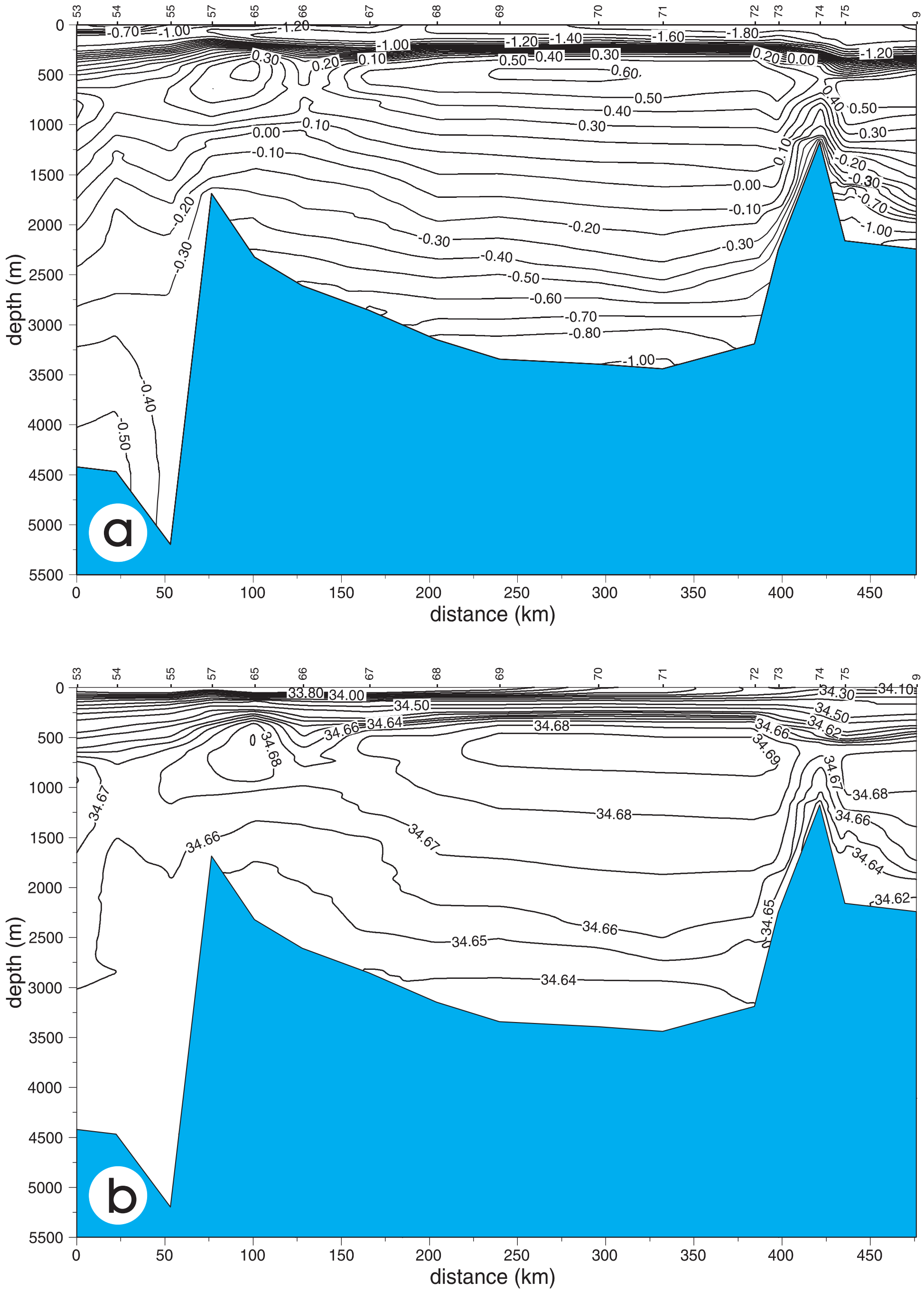
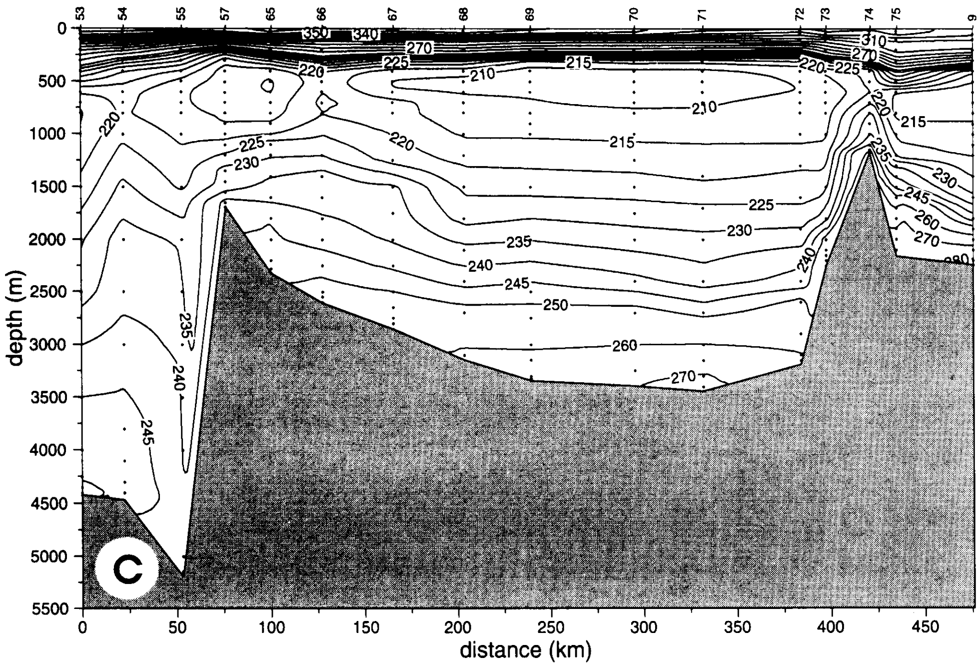


Fig. 10: Vertical section of potential temperature (a), salinity (b), oxygen in µmol/kg (c) and silicate in µmol/kg (d) across the Weddell-Scotia Confluence from 59°49'S, 48°13.5'W to 63°16'S, 50°26'W.



53 54 55 57 65 66 67 68 69 70 71 72 73 74 75 9
350
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215
225
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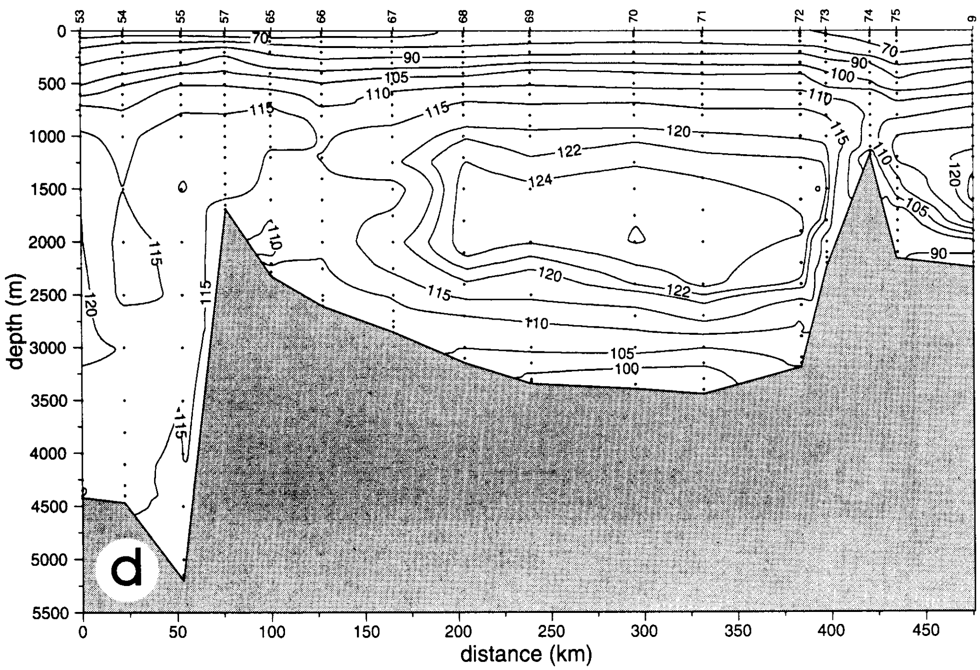
210
230
235
240
245
250
260
280
depth (m)
distance (km)
c



53 54 55 57 65 66 67 68 69 70 71 72 73 74 75 9
70
90
100
105
110
115
120
122
124
depth (m)
distance (km)
d

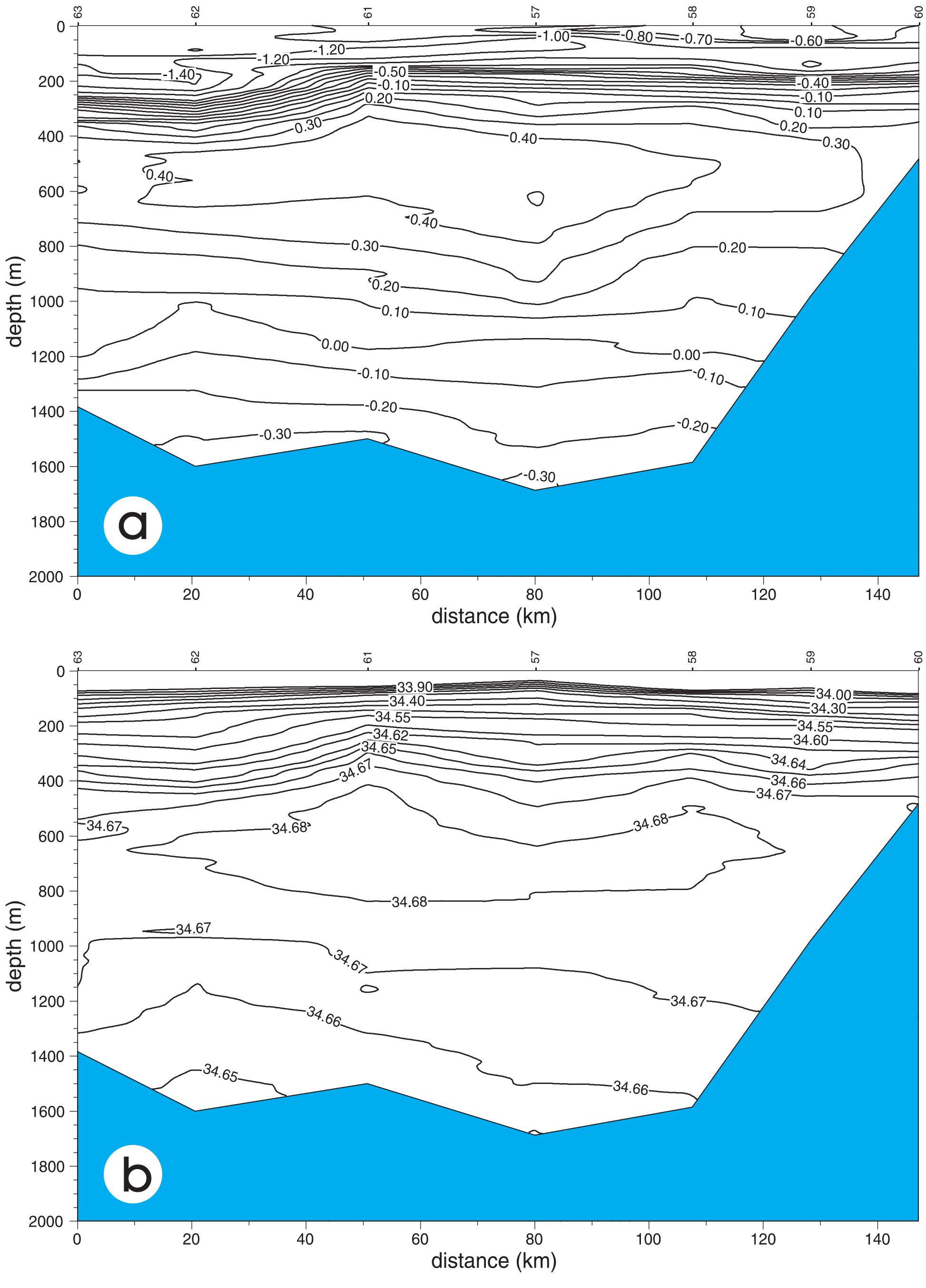
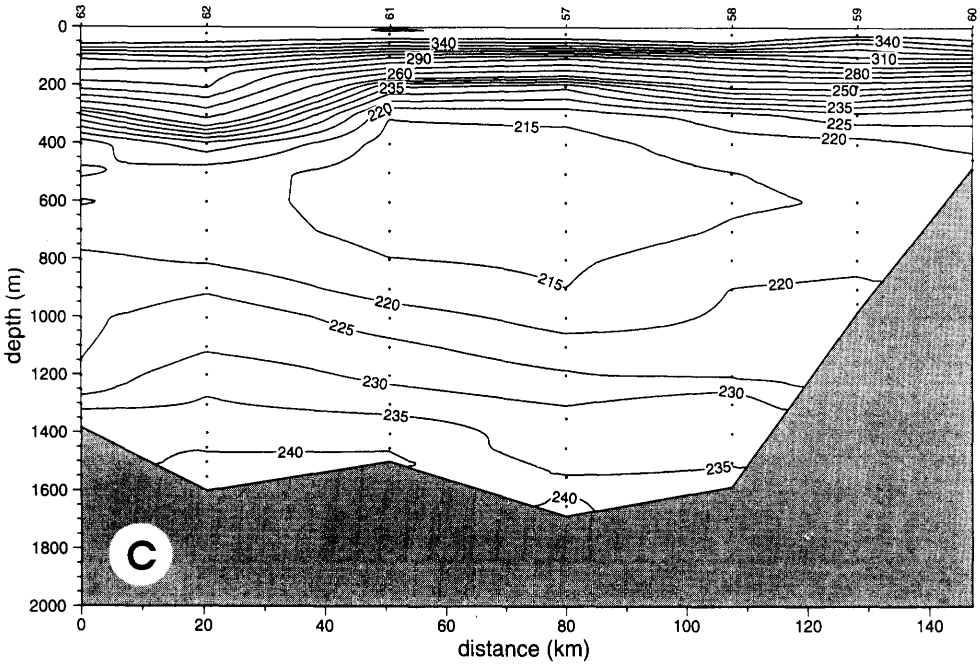


Fig. 11: Vertical section of potential temperature (a), salinity (b), oxygen in µmol/l (c) and silicate in µmol/l (d) along the northern edge of the Powell Basin from 60°30'S, 47°25'W to 60°38'S, 50°00'W.



63
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290
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215
310
280
250
225
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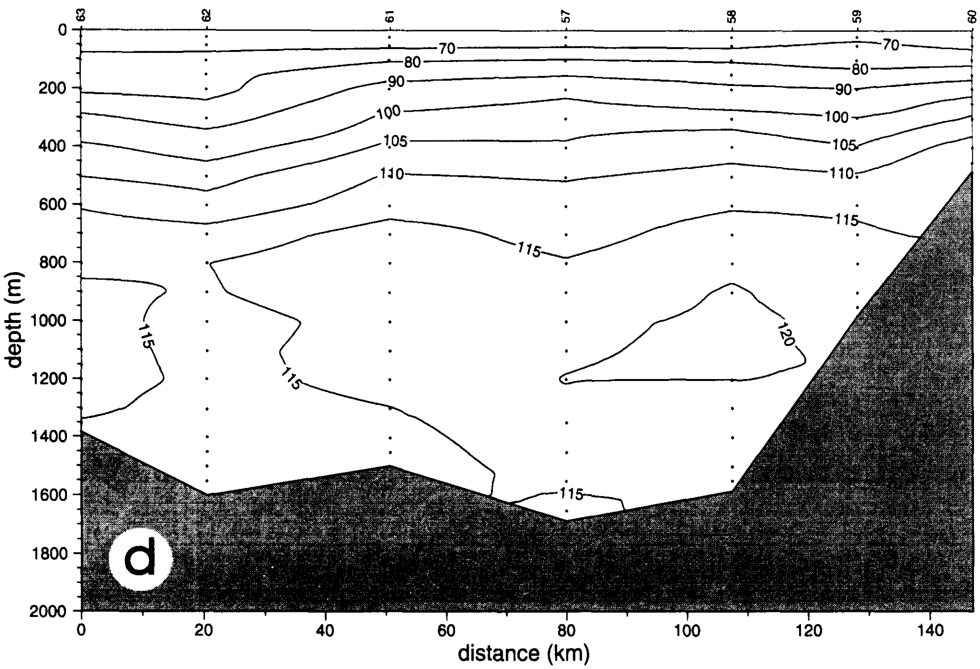
215
220
225
230
235
240
240
230
235
depth (m)
distance (km)
c



63
62
61
57
58
59
60
70
80
90
100
105
110
115
115
115
120
115
depth (m)
distance (km)
d

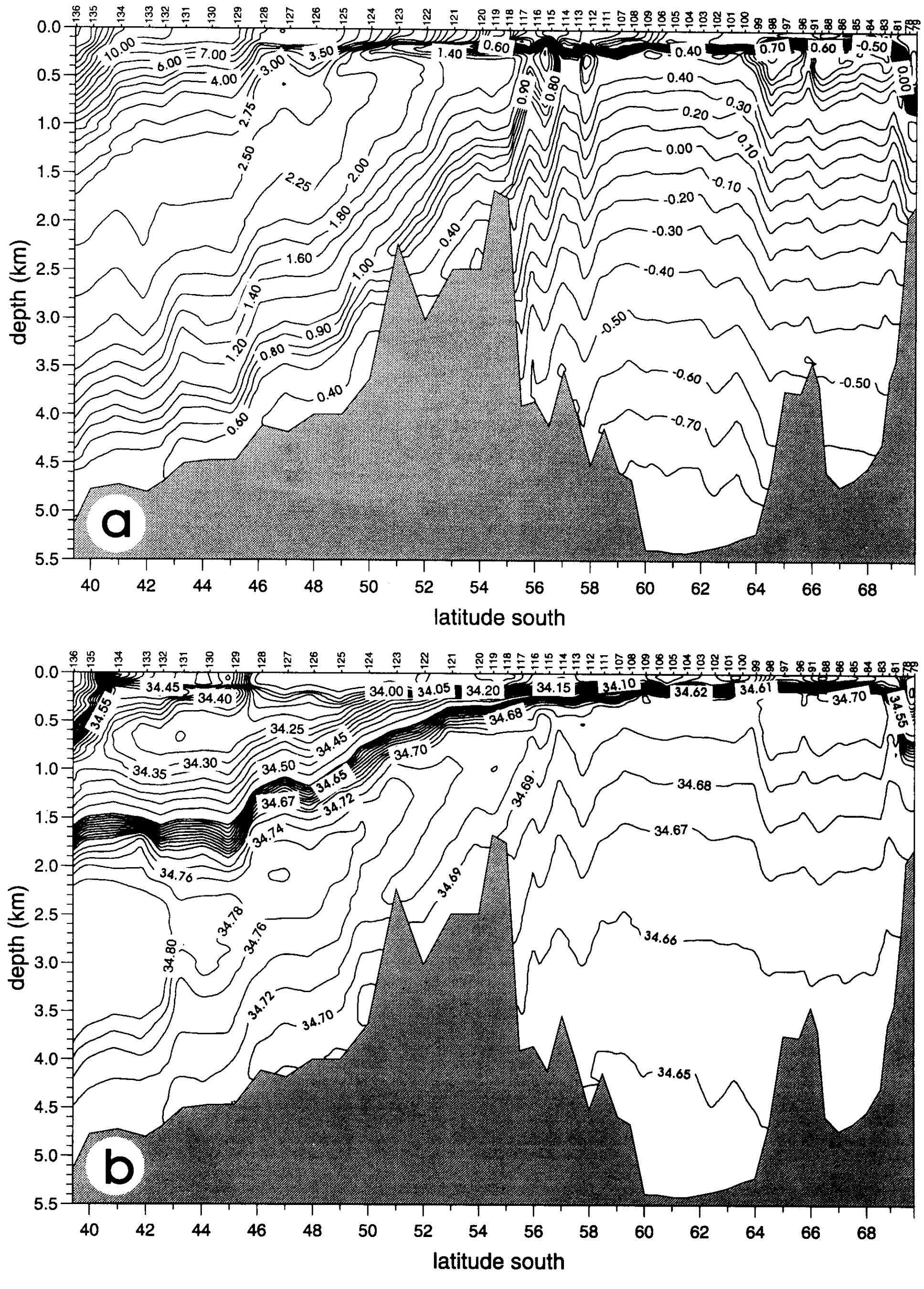
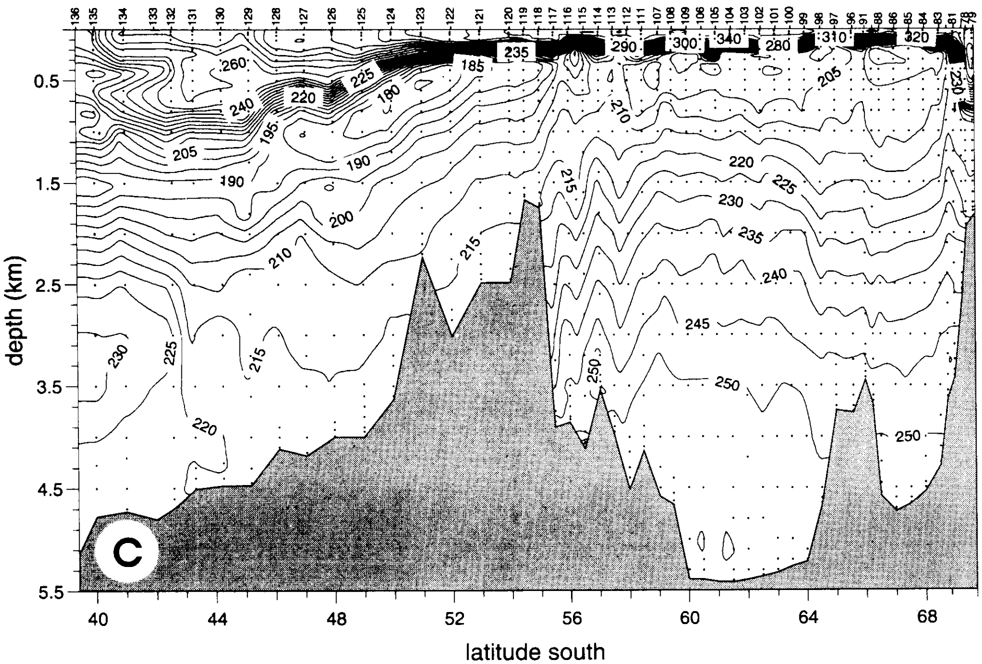
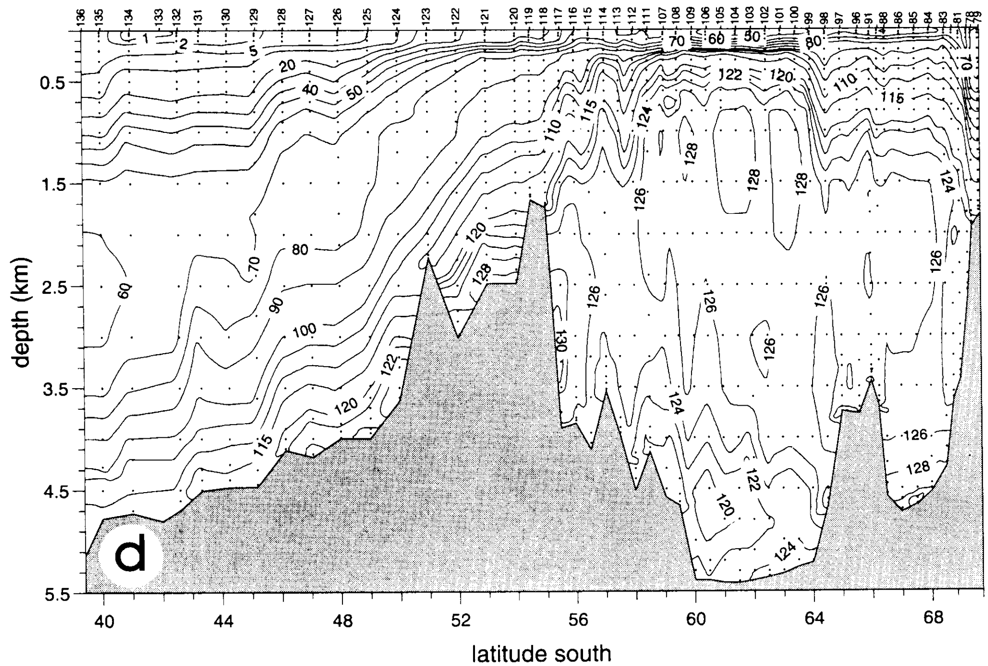


Fig. 12: Vertical section of potential temperature (a), salinity (b), oxygen in µmol/kg (c) and silicate in µmol/kg (d) across the Southern Ocean 39°24.5'S, 11°48'E to 69°38.5'S.


depth (km)
0.5
1.5
2.5
3.5
4.5
5.5
40
44
48
52
56
60
64
68
latitude south
c


depth (km)
0.5
1.5
2.5
3.5
4.5
5.5
40
44
48
52
56
60
64
68
latitude south
d

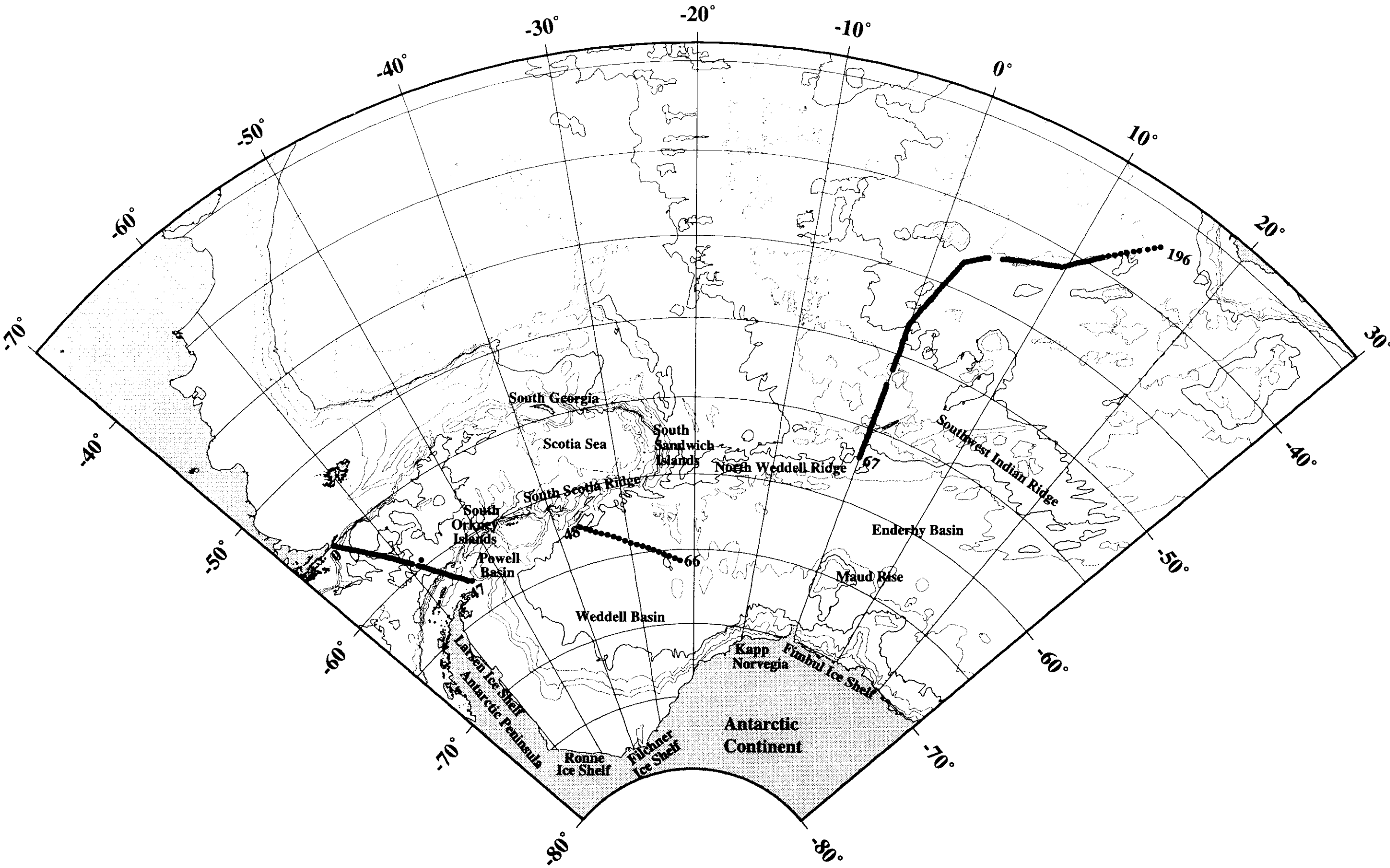


Fig. 13: Location of the XBT sections.

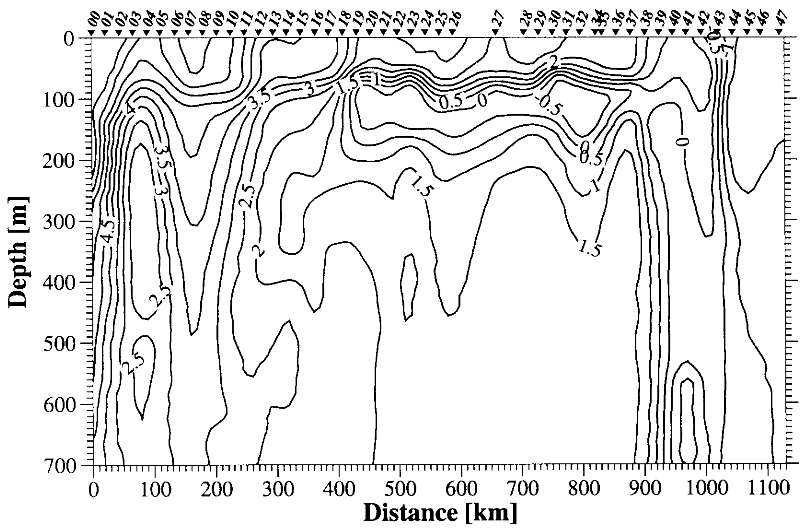


Fig. 14: XBT section across the Antarctic Circumpolar Current at Drake Passage.

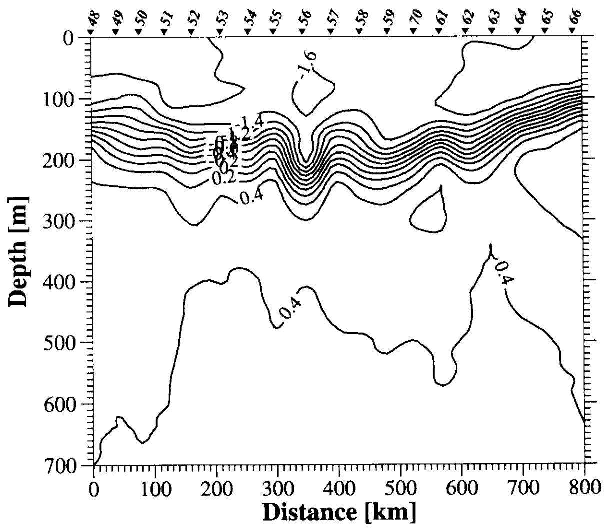


Fig. 15: XBT section across the Weddell gyre from 62°28'S, 36°38'W to 65°45'S, 22°17' W.

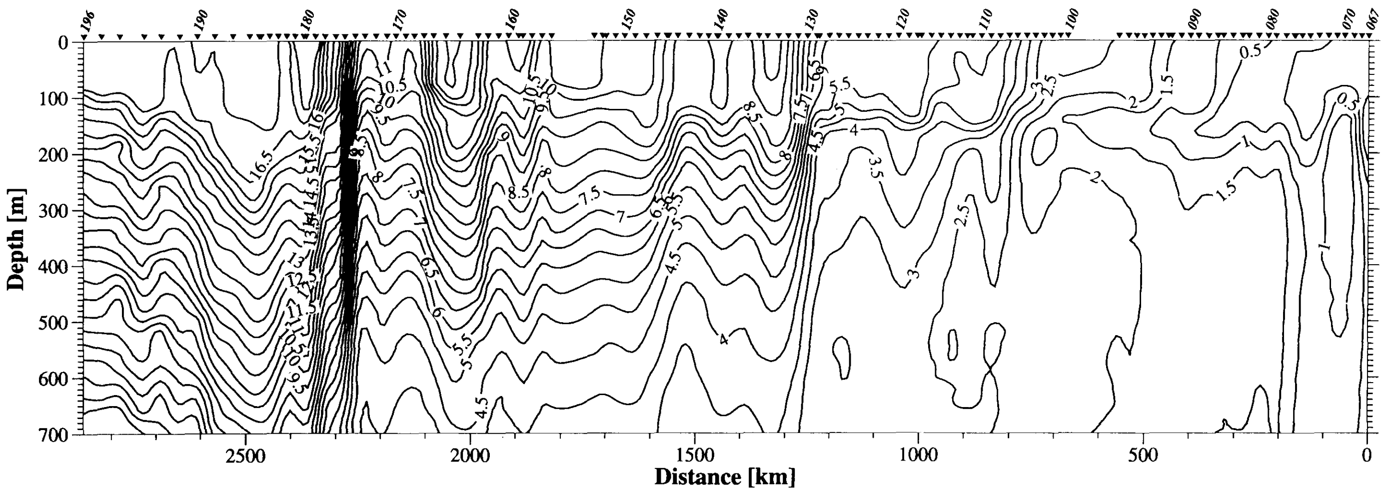


Fig. 16: XBT section across the Antarctic Circumpolar Current from 57°S, 0° to the boundary of the 200-sm zone of South Africa.

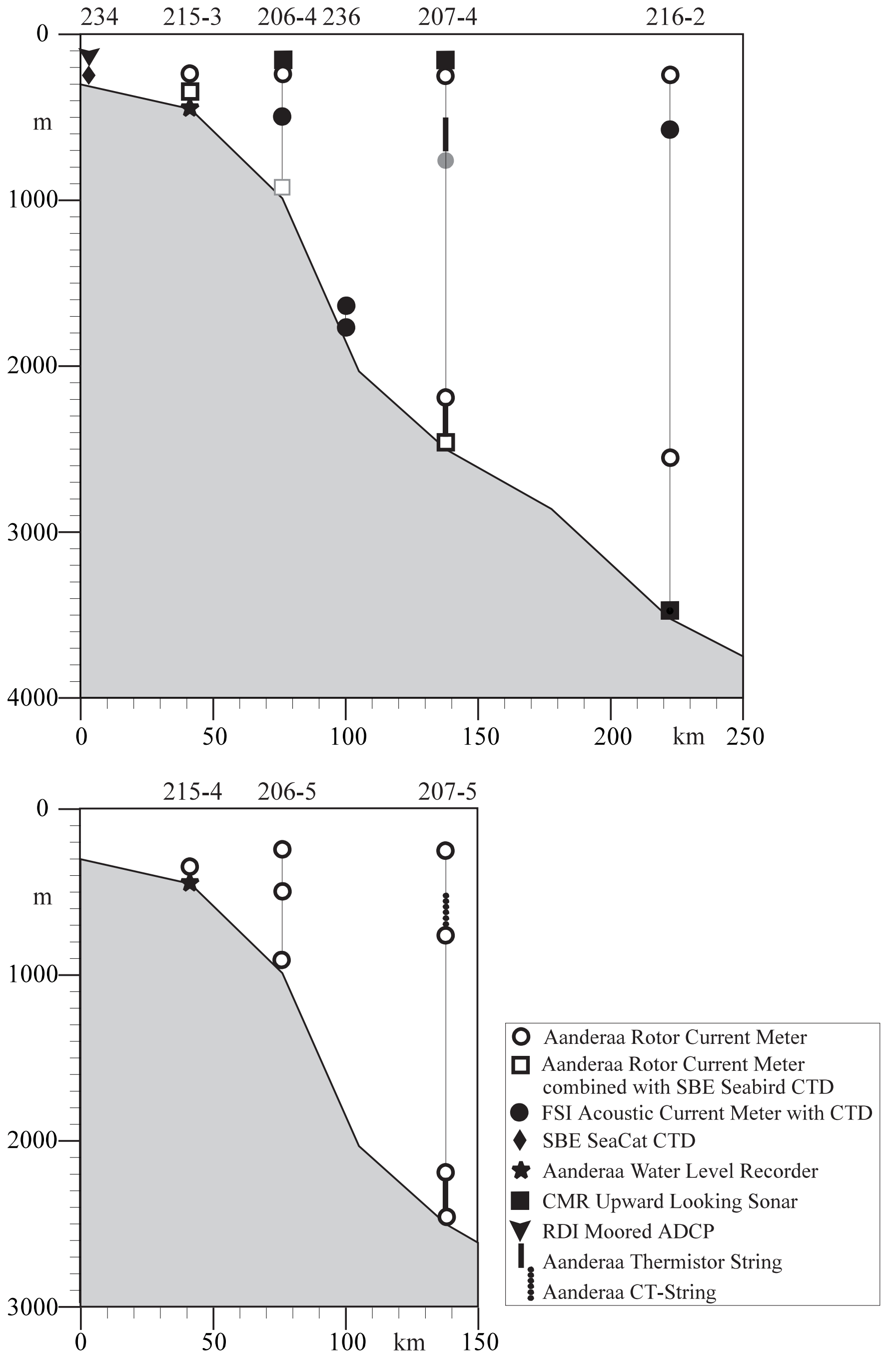


Fig. 17: Vertical section across the southern Weddell Sea off Joinville Island with the recovered moorings (top) and the deployed moorings (bottom).

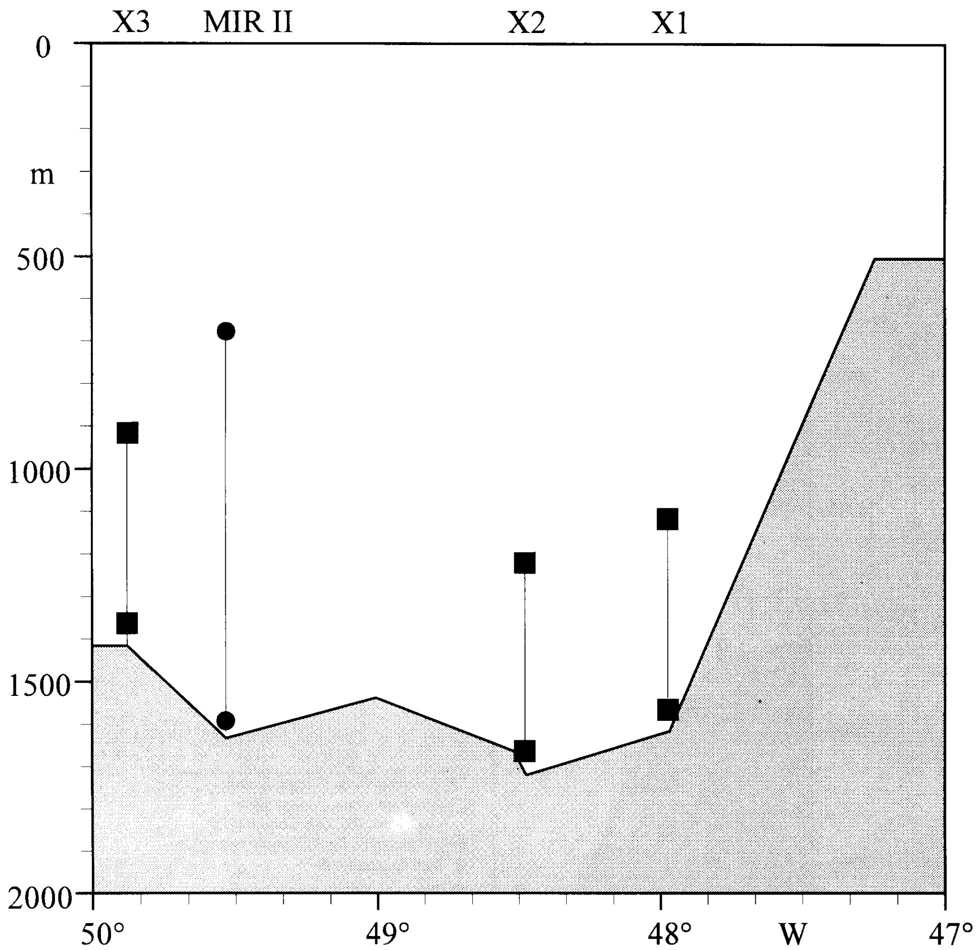


Fig. 18: Vertical section along the northern boundary of the Powell Basin from 60°30'S, 47°25'W to 60°38'S, 50°00'W with the deployed moorings.

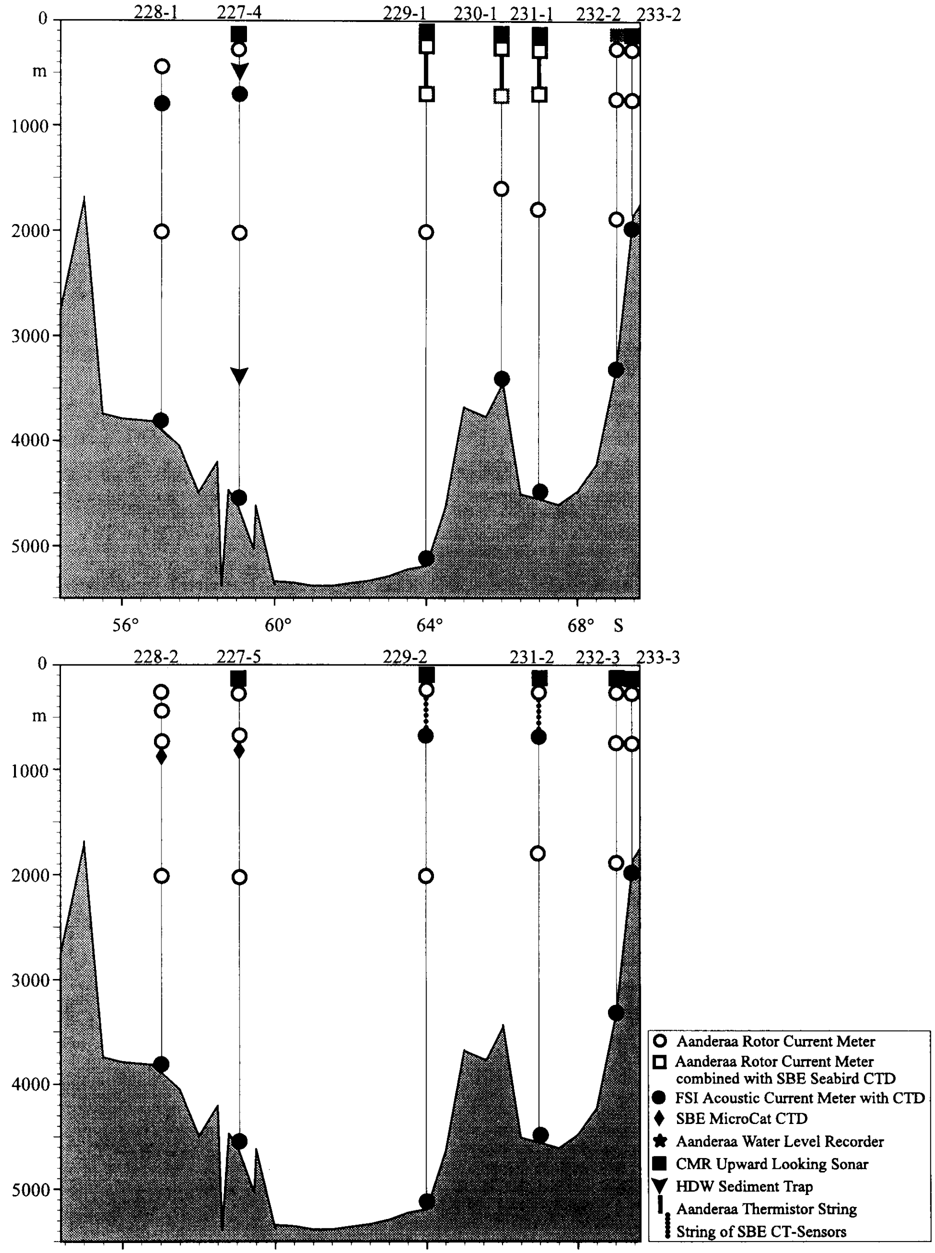


Fig. 19: Vertical section across the Weddell Sea along the Greenwich Meridian from 55°S to 69°38.5'S with the recovered (top) and the deployed moorings (bottom).

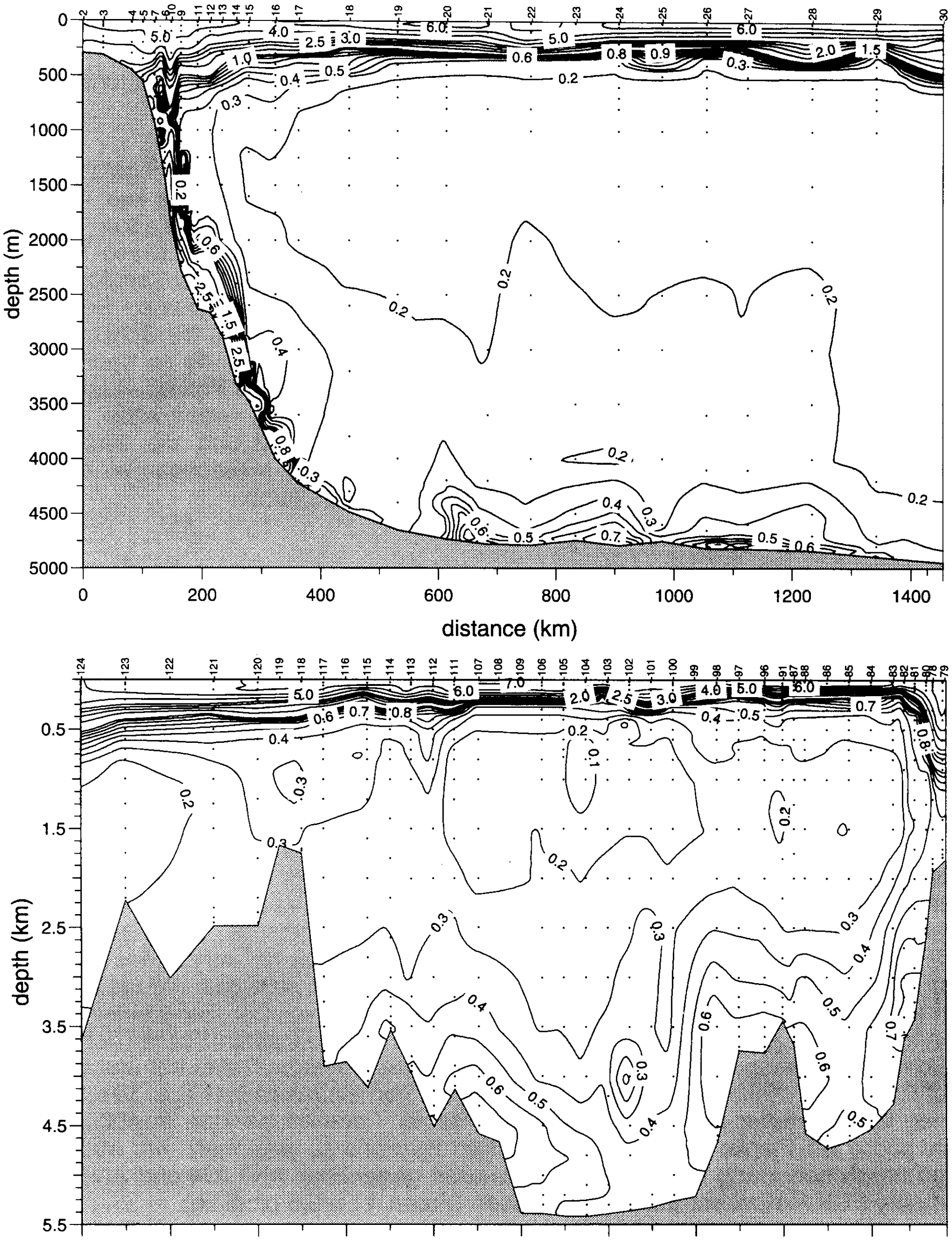


Fig. 20: Vertical section of the tracer Freon-11 in pmol/kg across the southern Weddell Sea from Joinville Island (top) and across the Weddell Sea along the Greenwich Meridian from 69°24'S to 50°S (bottom).

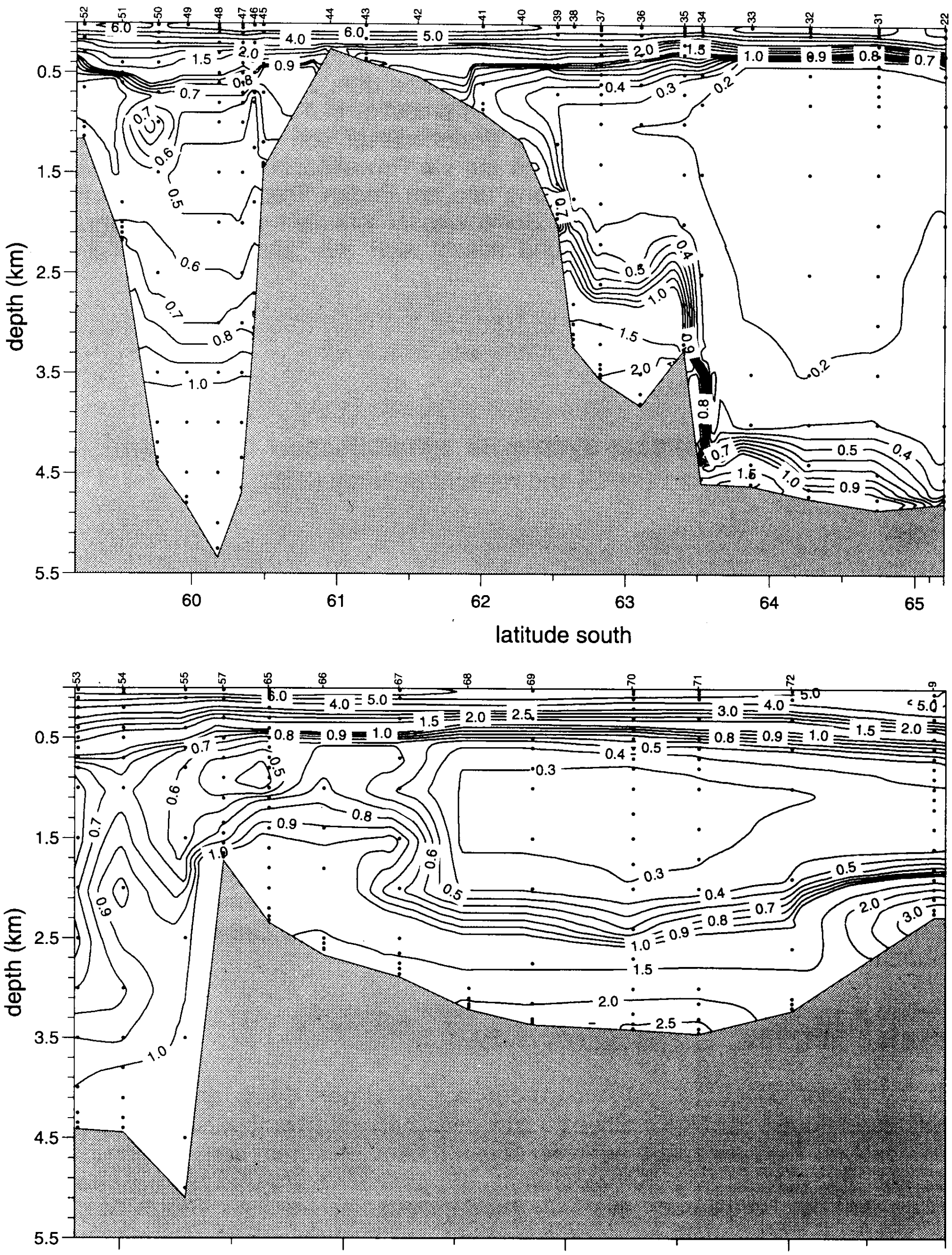


Fig. 21: Vertical section of the tracer Freon-11 in pmol/kg across the Weddell Basin from 65°12.1'S over the South Orkney Plateau to 59°15.5'S (top) and across the Powell Basin from 59°48.7'S to 63°38.9'S (bottom).

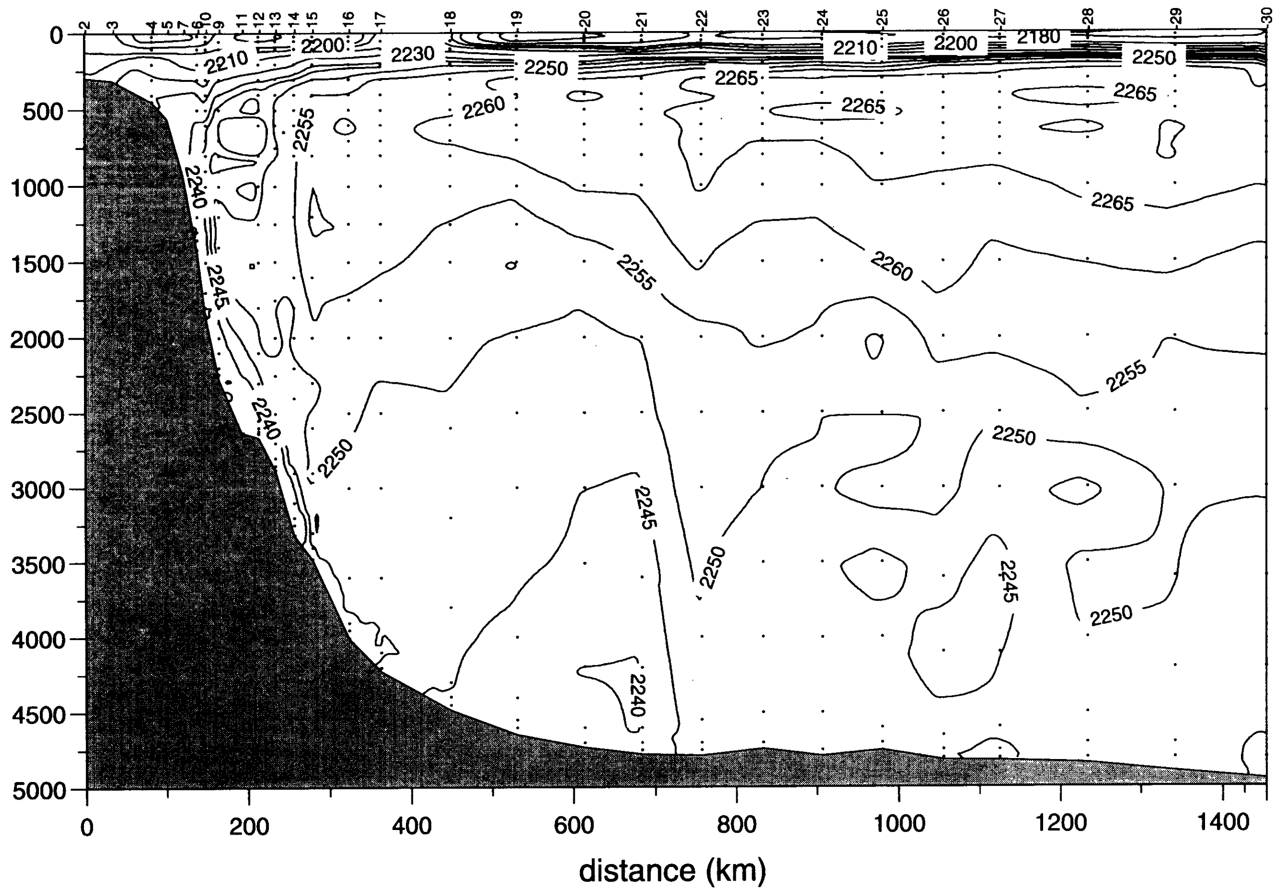


Fig. 22: TCO_2 section (µmol/kg) between Joinville Island and the central Weddell Sea.

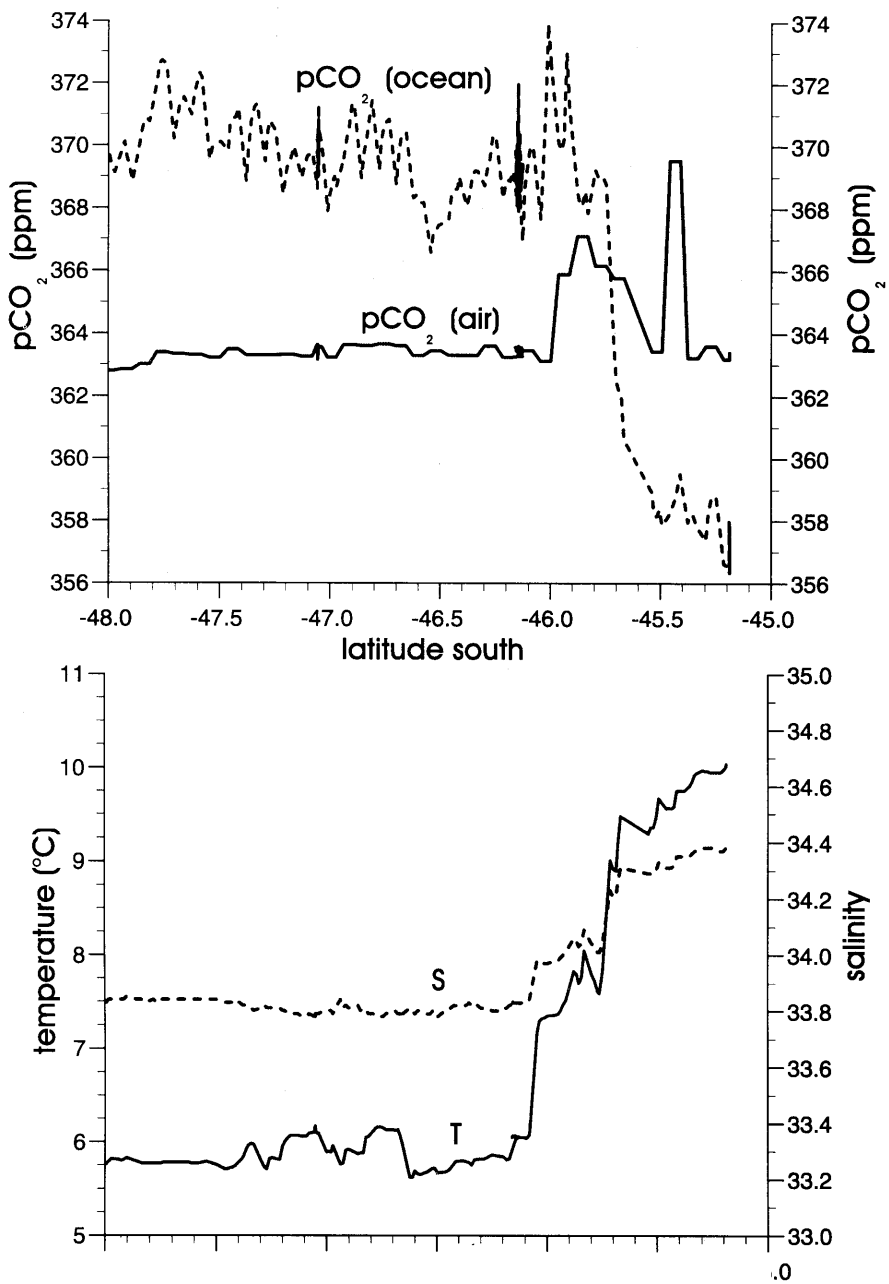


Fig. 23: Distribution of the partial pressure Of CO_2 in surface water and in air and the sea surface temperature from the ship's thermosalinograph across the Subantarctic Front.

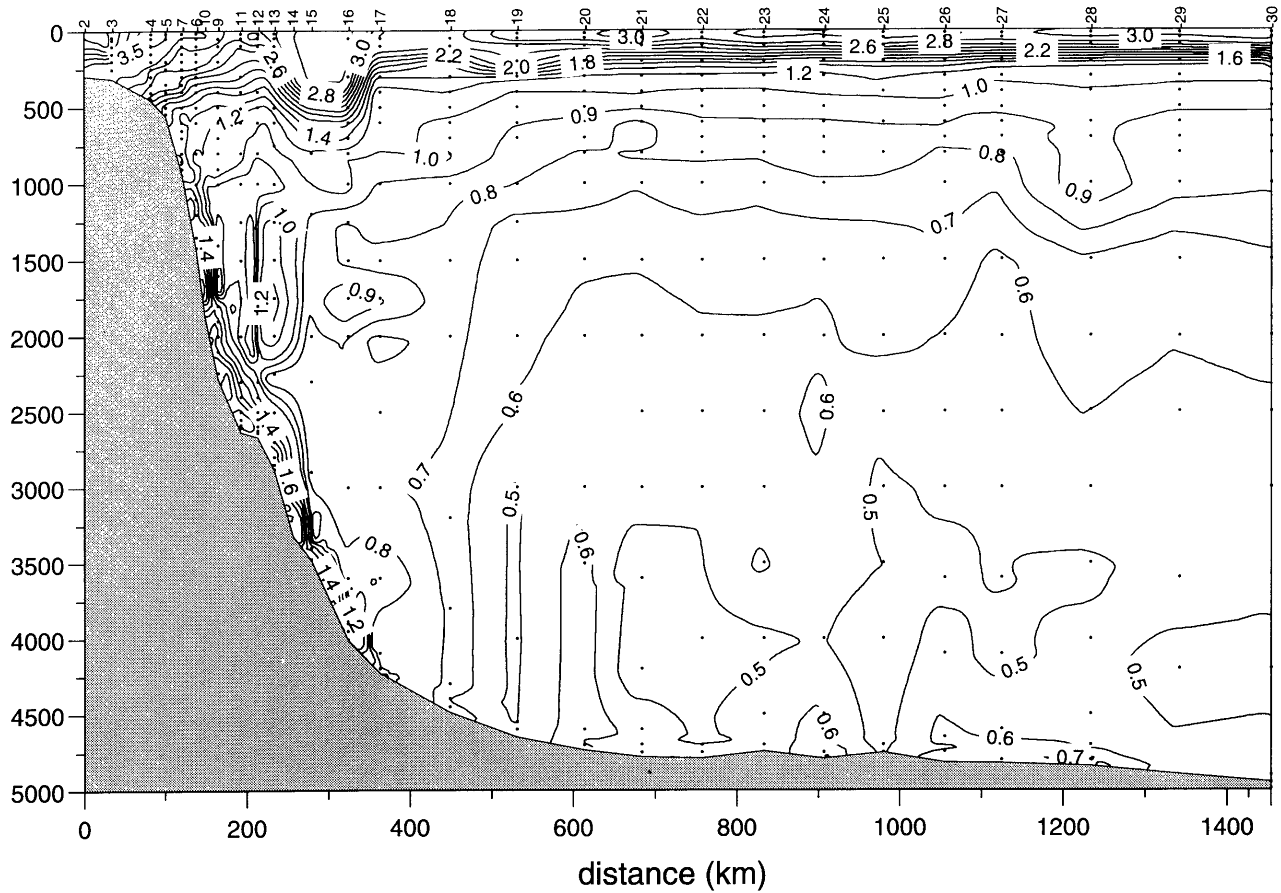


Fig. 24: Vertical section of the methane concentration in ppbV across the southern Weddell Sea from Joinville Island to 25°W.

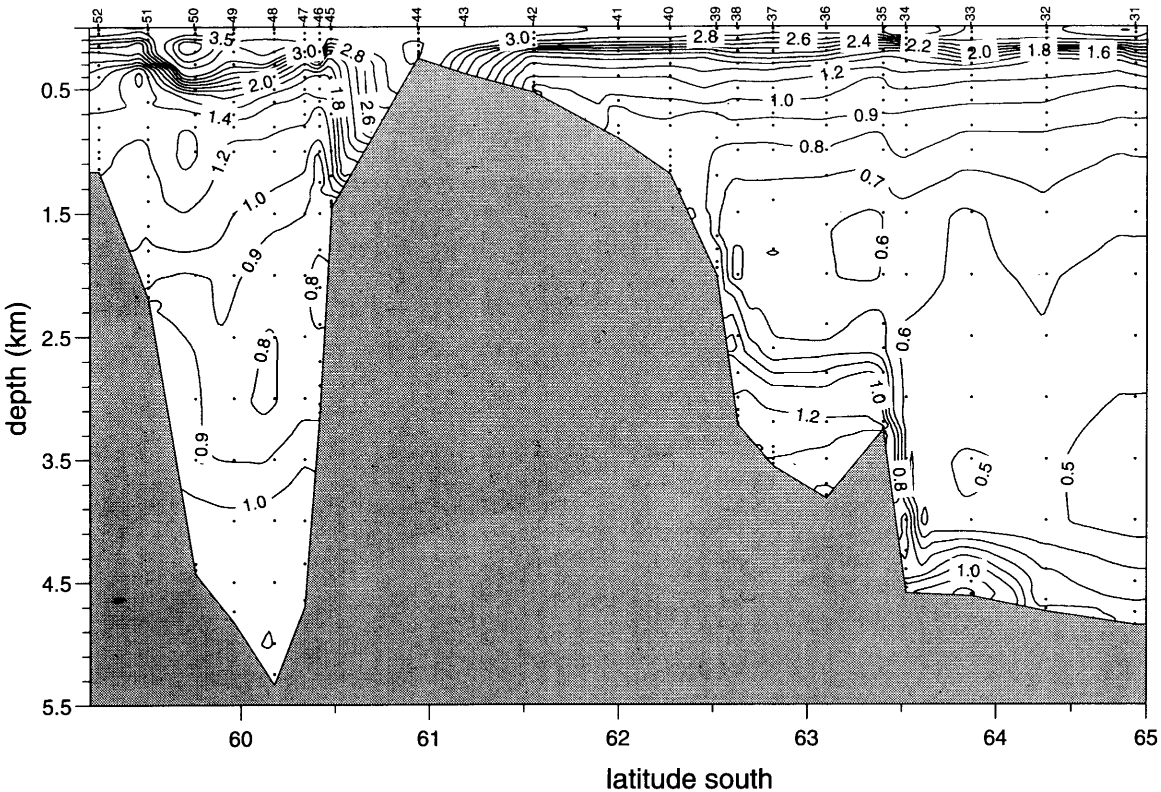


Fig. 25: Vertical section of the methane concentration in ppbV through the Weddell-Scotia Confluence east of the South Orkney Islands from 64°44'S to 59°15'S.

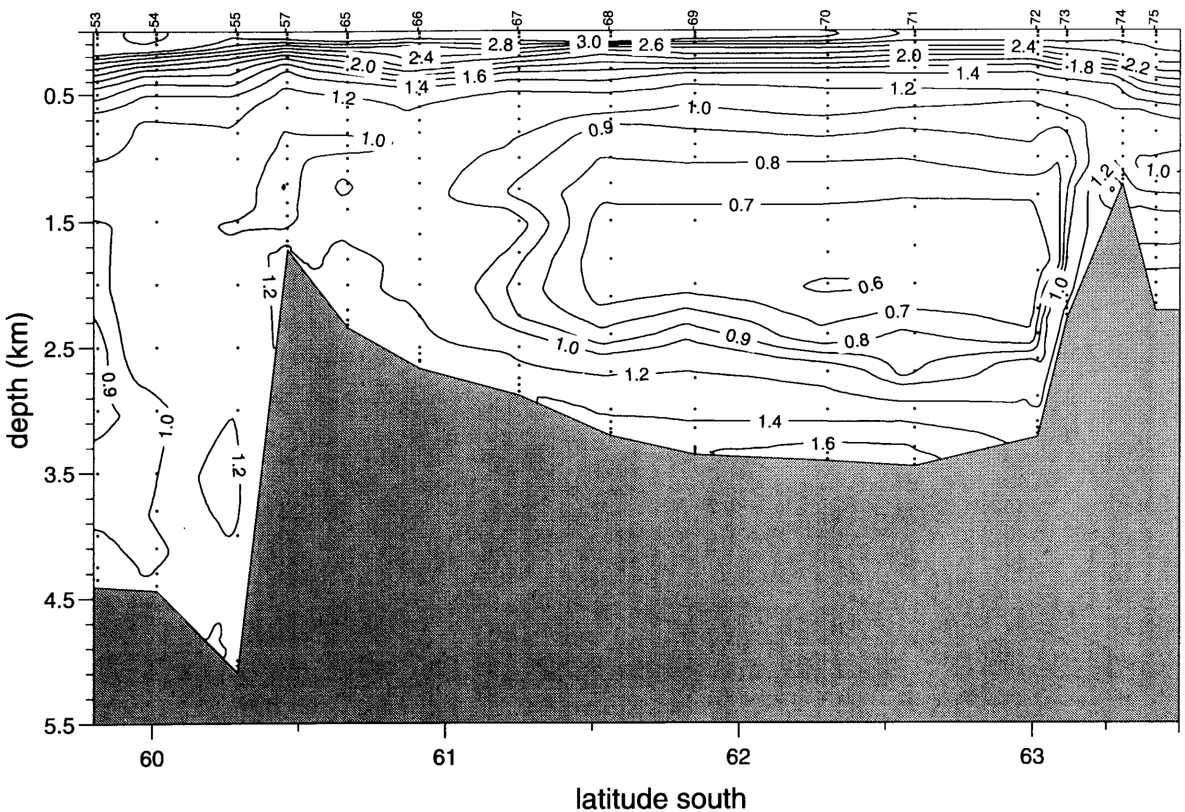


Fig. 26: Vertical section of the methane concentration in ppbV through the Weddell-Scotia Confluence west of the South Orkney Islands from 59°49'S to 63°16'S.

APPENDIX 1: MOORINGS

Table 1: Moorings recovered in the western Weddell Sea.

Mooring	Latitude Longitude	Date Time (UTC) (1. Record)	Water Depth (m)	Type	SN	Depth (m)	Record length (days)
AW1216-	63°57.6'S	06-05.96	3520	AVTP	11926	262	699
	49°08.8'W	18-00		ACM-CTD	1403	573	[1]
				AVT	11885	2549	699
				AVT	11886	3474	699
				Sc	631	3475	699 [2]
AW1207-	63°43.3'S	07.05.96	2510	ULS	08	174	[3]
	50°49.2'W	22:00		AVTPC	9207	270	695
				TC250	2299	505 [5]	695
				ACM-CTD	1402	762	464 [4]
				AV7	9767	2187	695
				TC250	2371	2198 [5]	695
				AVT	9206	2454	695
				Sc	1979	2455	695 [2]
AW1206-	63°29.6'S	08.05.96	952	ULS	09	150	[3]
	52°06.1'W	20:00		AVTP	11890	246	693
				ACM-CTD	1409	491	463 [6]
				AVT	9401	906	[7]
				SC	1977	907	693 [2]
AW1215-	63°19.6'S	09.05.96	465	AVTP	11892	259	692
	52°46.9'W	00:00		AVT	9402	459	692
				Sc	1974	460	692 [2]
				WLR	1154	465	692
AW1234-	62°51.4'S	09.05.96	284	ADCP	378	275	[3]
	53°40.3'W	17:00		Sc	1975	280	691

Remarks:

[1] found water inside - memory destroyed

[2] found intense marine growth - destroyed conductivity measurements

[3] data not processed but could retrieve complete memory contents

[4] instruments stopped recording on August 1997

[5] upper level of 11 temperature sensors with 25m spacing

[6] only CTD recorded until August 1997

[7] no data recorded

Table 2: Moorings deployed in the western Weddell Sea.

Mooring	Latitude Longitude	Date Time (UTC)	Water Depth (m)	Type	SN	Depth (m)
AW1215-	63° 19.6'S	01.04.98	450	AVT	10496	445
	52° 47.1'W	22:25		WLR	1716	450
AW1206-	63° 30.4'S	02.04.98	965	AVTP	11889	250
	52° 06.7'W	21:20		AVTPC	12462	500
				AVT	10499	921
AW1207-	63° 42.8'S	04.04.98	2500	AVTPC	209	262
	50° 52.1'W	15:44		ACT 100	85	647
				ACT100	86	748
				AVTPC	12463	752
				AVTPC	12443	2179
				TC100	2486	2340
				TC100	2485	2440
				AVTPC	12451	2445
MIR II	60° 34.5'S	19.04.98	1637	AVTPC	12452	677
	49° 30.8'W	20:46		AVTPC	12454	1593
XM1A	60° 28.3'S	18.04.98	1713	VACM	1950b4	1663
	48° 27.0'W	16:05		ARGOS	14961	
XM1B	60° 28. VS	18.04.98	1713	VACM-P	195185	1208
	48° 27.2V	15:56		ARGOS	14957	
XM2A	60" 28.5'S	18.04.98	1615	VACM	2218b0f	1565
	47° 58.2'W	20:07		ARGOS	9371	
XM2B	60° 28.3'S	18.04.98	1547	VACM-P	221700	1042
	47° 58.6'W	19:52		ARGOS	14958	
XM3A	60° 38.2'S	19.04.98	1413	VACM	221fe5e	1565
	49° 52.3'W	17:34		ARGOS	14959	
XM3B	60° 38.2'S	19.04.98	1414	VACM-P	221fdd8	909
	49° 52.3'W	17:29		ARGOS	14956	

Table 3: Moorings recovered at the Greenwich Meridian.

Mooring	Latitude Longitude	Date Time(UTC) (1. Record)	Water Depth (m)	Type	SN	Depth (m)	Record length (days)
AW1233-2	69°24.2'S	16.02.97	1985	ULS	34	139	[1]
	00° 00.0'W	20:00		AVTP	10539	236	436
				AVT	6856	736	436
				ACM-CTD	1449A	1941	436
AW1232-2	69°00.0'S	17.02.97	3409	ULS	35	191	[2]
	00° 00.0'W	04:00		AVTP	10004	297	437
				ACTP	9785	803	437
				AVT	10503	2009	437
				ACM-CTD	1454A	3366	437
AW1231-1	66°30.O'S	20.04.96	4520	ULS	26	170	[1]
	00° 00.4'W	14:00		AVTPC	9213	219	741
				SC	1976	220	[3]
				TC250	1104	236	741 [4]
				TC250	1256	512	741
				AVTP	9212	788	741
				SC	630	789	741 [5]
				AVT	9561	1815	741 [6]
				ACM-CTD	1390A	4476	121 [7]
AW1230-1	66°00.2'S	19.04.96	3450	ULS	25	51	[1]
	00°09.5'E	18:00		AVTPC	9765	91	744
				SC	1166	92	[3]
				TC250	1102	123	744 [8]
				TC250	1103	399	744 [9]
				AVTPC	9215	664	[10]
				SC	1167	665	744
				AVT	10498	1671	744
				ACM-CTD	1411A	3406	555 [7]
AW1229-1	63°59.6'S	18.04.96	5186	ULS	07	165	[1]
	00°00.30'W	14:00		AVTP	11888	215	746
				SC	1973	216	[3]
				TC250	943	240	746
				TC250	1100	515	746
				AVTPC	9786	784	746
				SC	319	785	746
				AVT	9770	2011	746
				ACM-CTD	1400A	5142	589 [7]

Table 3: Moorings recovered at the Greenwich Meridian (continued)

Mooring	**Latitude Longitude**	**Date Time (UTC) (1. Record)**	**Water Depth (m)**	**Type**	**SN**	**Depth (m)**	**Record length (days)**
AW1227-4	59°03.7'S	10.01.97	4660	ULS	37	135	[1]
	00°02.7'E	04:00		AVTPC	10872	246	483
				ST		477	[11]
				ACM-CTD	1448A	684	483
				AVT	9183	1990	483
				ST		3366	[11]
AW1228-1	57°00.0'S	13.04.96	3872	ACM-CTD	1452A	4615	483
	00°00.2'E	18:00		AVTP	11887	449	545 [12]
				ACM-CTD	1389A	810	717 [7]
				AVT	9768	2105	759
				ACM-CTD	1387A	3827	759

Remarks:

[1] data not processed but could retrieve complete memory contents
[2] instrument was lost
[3] instrument must be returned to the manufacturer to retrieve data from memory
[4] sensors 4 to 8 failed
[5] temperature sensor failed
[6] rotor lost; no speed record
[7] incomplete time series due to old firmware, and battery failures
[8] sensors 1 to 11 failed
[9] all sensors failed during the second period of the time series
[10] instrument destroyed due to blown up batteries
[11] no obvious problems found
[12] no complete time series due to empty batteries

Table 4: Moorings deployed at the Greenwich Meridian.

Mooring	Latitude Longitude	Date Time (UTC)	Water Depth (m)	Type	SN	Depth (m)
AW1233-3	69°23.9'S	29.04.98	2057	ULS	36	155
	00°00.7'W	19:57		AVTP	9763	248
				AVTPC	9783	749
				ACM-CTD	1453A	1954
AW1232-3	68°59.7'S	30.04.98	3375	ULS	39	148
	00°03.7'W	16:56		AVTPC	9201	246
				AVTPC	10492	752
				AVTPC	9214	1798
				ACM-CTD	1385A	3304
AW1231-2	66°30.0'S	02.05.98	4520	ULS	42	151
	00°01.1'W			AVTPC	9200	187
				CT500		
				ACM-CTD	1386A	698
				AVT	9391	1804
				ACM-CTD	1443A	4465
AW1229-2	63°58.5'S	05.05.98	5180	ULS	43	150
	00°04.6'E	18:51		AVTP	10002	196
				CT500		
				ACM-CTD	1391A	707
				AVT	9186	2003
				ACM-CTD	1392A	5134
AW1227-5	59°04.2'S	08.05.98	4660	ULS	40	144
	00°04.9'E	14:40		AVTP	10541	254
				AVTPC	9211	692
				SM37P	244	693
				AVT	9190	1998
				ACM-CTD	1388A	4555
AW1228-2	56°58.6'S	13.05.98	3710	AVTPC	8418	241
	00°01.3'E	14:40		AVTP	8417	447
				AVT	9179	803
				SM37P	245	804
				AVT	9180	2005
				ACM-CTD	1404A	3655

Abbreviations:

ACM-CTD	Falmouth Scientific 3-dimension acoustic current meter with CTD-sensor head (CTD=Conductivity, Temperature, Depth)
ACT 100	Aanderaa temperature/conductivity sensor string, 100 m length,5 sensor pairs
ADCP	RD[Inc. Acoustic Doppler Current Profiler
AVTPC	Aanderaa current meter with temperature, pressure, and conductivity sensors
AVTP	Aanderaa current meter with temperature and pressure sensors
AVT	Aanderaa current meter with temperature sensors
CT500	10 ea. SeaBird Electronics MicroCat CT Recorder attached at 500m mooring rope
SC	SeaBird Electronics self contained CTD, type: SeaCat
SM37	SeaBird Electronics MicroCat CT Recorder
SM37P	SeaBird Electronics MicroCat CT Recorder with 3000 psi pressure sensor
ST	Sediment trap
TC100	Aanderaa thermistor cable, 100 m length, 11 sensors, 10 m spacing
TC250	Aanderaa thermistor cable, 250 m length, 11 sensors 25 m spacing
ULS	Upward Looking Sonar Christian Michelsen Research Inc.
VACM	Oregon Environmental Instruments vector averaging current meter with temperature sensor; automatic release and ARGOS data transmission
VACM-P	Oregon Environmental Instruments vector averaging current meter with temperature sensor and pressure; automatic release and ARGOS data transmission

APPENDIX 2: STATION LIST (See .sum File)

APPENDIX 3: XBT DATA

No.	Date	Failed	Time (GMT)	Latitude	Longitude	Depth (m)
000	30.03.98		05:12	55°03.0'S	64°55.0'W	1000
001			06:07	55°13.0'S	64°43.2'W	1504
002			07:06	55°23.0'S	64°30.9'W	4757
003			08:05	55°32.9'S	64°19.7'W	3721
004			09:05	55°43.0'S	64°07.3'W	3721
005			10:05	55°52.5'S	63°55.3'W	3721
006			11:12	56°03.0'S	63°41.5'W	3721
007			12:10	56°13.0'S	63°29.0'W	4054
008			13:24	56°22.9'S	63°16.4'W	3965
009			14:30	56°33.0'S	63°03.1'W	4012
010			15:37	56°43.0'S	62°51.3'W	4084
011			16:45	56°53.0'S	62°38.1'W	4066
012			17:51	57°03.0'S	62°24.0'W	3915
013			18:56	57°13.0'S	62°10.5'W	3916
014			19:57	57°22.9'S	61°58.0'W	3929
015			20:59	57°33.0'S	61°44.7'W	3327
016			21:59	57°43.2'S	61°30.7'W	3760
017			22:56	57°53.1'S	61°17.6'W	3462
018			23:52	58°03.0'S	61°04.3'W	2882
019	31.03.98		00:52	58°13.1'S	60°50.5'W	3472
020			01:51	58°23.0'S	60°37.7'W	3621
021			02:51	58°33.0'S	60°24.6'W	3417
022			03:51	58°43.0'S	60°12.0'W	3835
023			04:51	58°53.0'S	59°57.6'W	3734
024			05:55	59°03.0'S	59°43.1'W	2916
025			06:59	59°13.0'S	59°29.7'W	3606
026			07:56	59°23.1'S	59°17.0'W	3123
027			09:01	59°33.0'S	58°04.9'W	3064
028			10:20	59°42.9'S	58°50.1'W	2426
029			11:40	59°53.0'S	58°34.7'W	1976
030			12:59	60°03.0'S	58°19.8'W	1831
031			14:13	60°13.0'S	58°06.5'W	3530
032			15:24	60°23.0'S	57°52.4'W	3740
033	f		16:36	60°33.0'S	57°38.0'W	4010
034			16:44	60°34.0'S	57°36.4'W	4150

No.	Date	Failed Time (GMT)	Latitude	Longitude	Depth (m)
035		19:37	60°38.9'S	57°32.1'W	4223
036		20:51	60°48.9'S	57°15.4'W	4676
037		22:08	60°58.9'S	57°00.0'W	2954
038		23:16	61°09.0'S	56°44.5'W	1912
039	01.04.98	00:25	61°19.0'S	56°29.0'W	4370
040		01:30	61°29.0'S	56°15.9'W	578
041		02:36	61°39.1'S	56°01.4'W	727
042		03:44	61°49.0'S	55°43.3'W	2630
043		04:59	61°59.0'S	55°22.6'W	1235
044		06:07	62°09.0'S	55°03.8'W	2750
045		07:22	62°19.1'S	54°45.0'W	3854
046		08:35	62°29.0'S	54°32.8'W	3377
047		09:50	62°38.9'S	54°03.8'W	3587
048	24.04.98	08:00	62°28.0'S	36°37.8'W	3904
049		10:00	62°38.5'S	35°56.6'W	5003
050		12:00	62°50.0'S	35°19.6'W	4813
051		14:00	63°02.1'S	34°38.9'W	4796
052		16:00	63°13.5'S	33°51.8'W	4870
053		18:00	63°24.6'S	33°02.4'W	4954
054		20:00	63°35.9'S	32°12.8'W	4545
055		22:00	63°47.6'S	31°29.9'W	4013
056	25.04.98	00:00	64°01.2'S	30°39.8'W	4888
057		02:00	64°13.4'S	29°49.7'W	4804
058		04:00	64°23.8'S	28°57.1'W	4951
059		06:00	64°33.4'S	28°05.0'W	4464
060		08:00	64°43.2'S	27°15.2'W	4754
061		10:00	64°53.3'S	26°28.6'W	4891
062		12:00	65°04.1'S	25°39.7'W	4704
063		14:00	65°14.8'S	24°51.0'W	4957
064		16:00	65°24.6'S	24°00.5'W	4964
065		18:00	65°34.9'S	23°09.8'W	4965
066	26.04.98	00:00	65°44.5'S	22°16.8'W	4969
067	13.05.98	15:41	56°59.3'S	00°01.1’W	3924
068		16:38	56°50.9'S	00°00.9’W	3975
069		17:35	56°41.5'S	00°00.0’W	4501
070		21:50	56°30.2'S	00°00.2'W	4090
071		22:50	56°20.9'S	00°00.0'W	3734
072		23:50	56°10.9'S	00°00.0'W	4168

No.	Date	Failed Time (GMT)	Latitude	Longitude	Depth (m)
073	14.05.98	03:30	55°59.2'S	00°01.2'W	3713
074		04:30	55°48.7'S	00°00.5'W	4069
075		05:30	55°38.9'S	00°00.0'W	3668
076		06:30	55°30.8'S	00°00.1'W	3774
077		09:40	55°31.4'S	00°01.8'E	3860
078		10:40	55°22.0'S	00°02.9'E	2899
079		11:40	55°09.8'S	00°01.2'E	3412
080		14:12	55°00.2'S	00°00.5'W	1750
081		15:11	54°48.9'S	00°00.7'W	1218
082		16:12	54°36.8'S	00°00.0'W	1092
083		18:22	54°29.5'S	00°00.6'W	1756
084		19:22	54°17.7'S	00°00.6'W	2584
085		20:22	54°06.2'S	00°00.3'W	2682
086		21:22	54°00.0'S	00°00.3'W	2459
087		22:58	53°59.8'S	00°00.6'W	2417
088		23:57	53°48.9'S	00°00.0'W	2673
089	15.05.98	00:59	53°37.0'S	00°00.5'E	2803
090		01:55	53°26.8'S	00°00.4'E	2550
091		02:54	53°16.1'S	00°00.6'W	2163
092		03:55	53°04.9'S	00°00.6'W	1836
093		06:35	53°00.9'S	00°00.2'E	2550
094		07:35	52°51.7'S	00°01.0'E	2670
095		08:35	52°41.2'S	00°00.4'E	2742
096		09:35	52°31.5'S	00°00.1'E	2650
097		10:35	52°22.6'S	00°00.1'W	2627
098		11:35	52°13.0'S	00°00.0'E	3148
099		18:45	52°01.6'S	00°02.3'W	3050
100	16.05.98	07:05	51°00.0'S	00°00.7'E	2359
101		08:05	50°51.1'S	00°00.4'E	2226
102		09:05	50°41.2'S	00°00.1'W	1541
103		10:05	50°31.4'S	00°00.1'E	3535
104		11:05	50°21.3'S	00°00.7'E	3653
105		12:03	50°10.8'S	00°00.3'E	3567
106		15:48	50°00.1'S	00°04.3'E	3452
107		16:48	49°50.0'S	00°04.7'E	3750
108		17:48	49°39.2'S	00°03.6'E	3965
109		18:48	49°28.6'S	00°02.2'E	4128
110		19:48	49°17.3'S	00°00.8'E	3180

No.	Date	Failed Time (GMT)	Latitude	Longitude	Depth (m)
111		20:48	49°06.2'S	00°00.3'E	3842
112	17.05.98	00:20	49°00.1'S	00°00.2'E	3970
113		01:19	48°50.8'S	00°00.2'E	3938
114		02:18	48°39.7'S	00°00.8'W	3863
115		03:19	48°28.3'S	00°00.3'W	3574
116		04:19	48°17.0'S	00°00.3'E	3246
117		05:20	48°05.2'S	00°00.4'W	3960
118		08:55	48°00.5'S	00°00.4'E	3922
119		09:55	47°50.5'S	00°05.0'E	3928
120		10:55	47°39.1'S	00°11.7'E	3868
121		11:55	47°28.0'S	00°17.9'E	3826
122		12:55	47°16.1'S	00°24.3'E	4191
123		16:50	47°03.0'S	00°29.7'E	3810
124		17:50	46°53.3'S	00°35.2'E	3370
125		18:50	46°42.3'S	00°42.2'E	4100
126		19:50	46°31.5'S	00°48.6'E	4100
127		20:50	46°20.9'S	00°54.5'E	4459
128		21:50	46°09.5'S	01°00.8'E	3776
129	18.05.98	01:14	46°08.9'S	01°04.9'E	4173
130		02:13	45°58.3'S	01°09.4'E	4456
131		03:12	45°46.9'S	01°13.6'E	4363
132		04:13	45°35.7'S	01°18.6'E	4475
133		05:13	45°24.3'S	01°24.3'E	4180
134		09:35	45°11.7'S	01°30.8'E	4226
135		10:35	45°02.0'S	01°35.5'E	3040
136		11:35	44°50.0'S	01°42.5'E	3777
137		12:33	44°39.2'S	01°48.7'E	4780
138		13:35	44°27.9'S	01°54.7'E	4672
139		14:36	44°16.4'S	02°00.5'E	4437
140		17:50	44°15.3'S	02°00.9'E	4444
141		18:50	44°05.6'S	02°05.8'E	4430
142		19:50	43°55.1'S	02°11.1'E	4633
143		20:50	43°43.6'S	02°17.7'E	4553
144		21:50	43°30.9'S	02°23.8'E	4435
145		22:50	43°20.3'S	02°29.3'E	4444
146	19.05.98	01:22	43°19.0'S	02°31.3'E	4481
147		02:21	43°12.6'S	02°44.7'E	4465
148		03:21	43°05.2'S	02°59.0'E	4460

Data Processing Notes

Date	Contact	Data Type	Data Status Summary
07/25/01	Witte	CTD/BTL/SUM	Submitted

The directory this information has been stored in is:
20010725.005322_WITTE_SR4

The format type is: ASCII

The data type is: Sum file, Bottle File, CTD File, DOC File

The Bottle File has the following parameters:
CTDPRES, CTDTMP, CTDSAL, SALNTY, OXYGEN, SILCAT, NITRAT, NITRIT, PHS, PHT

The Bottle File contains:
Cast Number, Station Number, Bottle Number

WITTE, HANNELORE would like the data PUBLIC.

And would like the following done to the data: place data on-line

Date	Contact	Data Type	Data Status Summary
12/04/01	Diggs	CTD/BTL/SUM	Website Update; Data OnLine

New cruise! Submitted by Hannalore Witte on 7/25/2001. Data are in sr04_e/original. Need information, i.e. who is the PI?

I just found a cruise that apparently has been languishing in the INCOMING area for a while, since last July 25,2001. Hannalore Witte went through the proper procedures and submitted them using the old webform.

I have hand-edited the woce_lines.txt file and added it to the RCSable lines. It's been RCS'd, and resides in the data area under sr04_e/original

The CTD files are 'close' to WOCE format, the bottle file seems dead-on, and the SUMfile is way off.

Date	Contact	Data Type	Data Status Summary
12/19/01	Hajrasuliha	STATRK	station track made

Images created for the station track map. .JPG and .GIF

Date	Contact	Data Type	Data Status Summary
12/19/01	Bartolacci	CTD/BTL/SUM	Reformatted data online

I have created an idex page for these data, reformatted all files and placed all files online. Correspondence will need to be initiated with the data PI Hannelore Witte in order to solve minor format and parameter questions, however all files are in WOCE format.

All original files reside in the original directory, a station track map still needs to be generated for this cruise.

2001.12.17 DMB

Reformatting notes for SR04_e 06AQANTXV_4. Data sent by Hannelor Witte in July, 2001.

SUM:

Added Following parameter columns to file: EXPOCODE- 06AQANTXV_4

WOCE SECT- SR04

CAST TYPE- added CTD, because original sumfile header indicated file was a list of CTD stations for this cruise, however since bottle data do exist, stations in the sumfile that contain bottle data should get ROS instead of CTD. This is a minor

Data Processing Notes

<table>
<tr><th>Date</th><th>Contact</th><th>Data Type</th><th>Data Status Summary</th></tr>
<tr><td>12/19/01</td><td>Bartolacci</td><td>CTD/BTL/SUM</td><td>Reformatted data online (continued)</td></tr>
<tr><td></td><td colspan="3">
point however (as per J. Swift) and does not affect the formatting of the file.CODE- added UN, since no cast codes were given and only one line per cast exists.

NAV- added UNK, since no nav information was given. Removed following columns, *note these should be confirmed with data PI as to relevance:

SN- this column was had a value of 1360 throughout the entire file. possibly some serial number? As per J. Swift this column can remain deleted from WHP file. Confirm what WAT. DEPTH is. Currently WAT. was removed from the DEPTH header. As per J. Swift, WAT (water) depth can be removed from header.

Realigned all columns to adhere to woce format. changed DATE from 03 31 1998 (mm<space>dd<space>yyyy) format to 033198 (mmddyy) format.

changed UTC time from hh<space>mm format to hhmm format.

Added hemisphere character designator and removed all negative signs in latitudes and longitudes.

Added ship name cruise name and leg designator to first header line. Added name/date stamp.

Ran sumchk with no errors.

Renamed file sr04_esu.txt

BOT:

Edited parameter header line to proper WOCE alignment. changed expocode 06AQANTXV/4 to 06AQANTXV_4.

Added name/date stamp.

Ran wocecvt with no errors. Several pressure inversions and duplicate depths do exist.

Renamed file sr04_ehy.txt

CTD:

Changed expocode 06AQANTXV/4 to 06AQANTXV_4 in all station files.

ran wctcvt with no errors, however TRANSMS header is unrecognized by diagnostic code. Format passed diagnostic code.

zipped up files remaning zip file to sr04_ect.zip
</td></tr>
<tr><td>03/04/02</td><td>Uribe</td><td>CTD/BTL</td><td>Website Updated: Exchange file online</td></tr>
<tr><td></td><td colspan="3">CTD and bottle have been converted to exchange and put online. Data was checked in JOA and no apparent problems were noticeable.</td></tr>
<tr><td>01/10/05</td><td>Key</td><td>TCARBN</td><td>Data Question: some lat/long values wrong?</td></tr>
<tr><td></td><td colspan="3">This is just a guess at this point based on a file I recently received from Mario Hoppema (PI for the TCO2) for this cruise.

It appears that both the WHPO SUM and exchange files have errors in the longitudes for stations which fall along the main S-N transect at the end of the cruise. I've attached a figure which shows the difference. I don't know for sure which is correct, but the ship probably went into Capetown which would favor the</td></tr>
</table>

Data Processing Notes

Date	Contact	Data Type	Data Status Summary
01/10/05	Key	TCARBN	Some lat/long values wrong? (continued)
	Hoppema file. Whichever is correct, it's just a sign change (or W to E) for the ones that are wrong. I'd appreciate a note if my guess is wrong and the WHPO locations are indeed correct. The Hoppema file also has about twice the number of bottle records as the one at WHPO. I haven't yet figured this out, but will keep you posted.		
01/10/05	Key	TCARBN	Data Update: Key has public data from Hopema
	I have recently been in contact with Mario Hoppema regarding data from this cruise. He sent me a new data file which contains TCO2 measurements which he now considers "public". He also believes that his data were submitted to WHPO quite awhile back. There is also the possibility that Roether has submitted his CFC and perhaps H3/He3 results from this cruise. Before I bother Wolfgang, could you see if you have anything which is not on-line. If you don't have the TCO2, I'll send it as soon as I've merged the values. If you don't have the CFC and/or H3/He3 let me know and I'll get in touch with Wolfgang. Since Wolfgang is now retired, we need to bump priority on these data before they're lost.		
01/11/05	Anderson	SUM	Website Updated: corrected long. indicators
	Corrected some of the longitude hemisphere indicators from W to E. Checked original .SUM file sent by H. Witte which also indicated that the stations in question should be E not W.		
01/13/05	Anderson	CTD	Data Update: New exchange file w/ corrected
	Made new exchange file for the ctd's to reflect the changes made to the longitudes in the .sum file on Jan. 11, 2005. A new NETCDF file and corrected station position map need to be generated.		
01/31/05	Roether	BTL/SUM	Updated new sum file & bot. (tracers)
	CTDPRS CTDTMP CTDSAL OXYGEN SILICAT NITRAT NITRIT PHSPHT CFC-11 CFC-12 CFC113 CCL4 TRITUM HELIUM DELHE3 NEON O18/O16 TCARBN ALKALI FCO2 PH Dear Bob (Key), Here are the tracer data that you asked for. Specifically: The first file is an ASCII table with all the bottle data of the cruise, as explained on p. 1 of the second file. I also enclose our station data for the cruise (Lat/long/water depth/date) , which might solve your problem with incoherent station information. If however the discrepancy remains unsolved, you should adress Mario because ANT 15-4 was an AWI cruise so they must have the real information. Comment: All our tracer data should have been submitted to WHPO, but the above file is the best info there is. Flags are according to WOCE requirements. There are two flag-words of 12 digits each at the end of each sample line (see table on p. 1 of the seond file what the individual flags refer to). The table includes errors for tritium and the helium/neon species, but not for the CFCs. Their errors are as follows: CFC-11, CFC-12 < 1% (all data) CFC-113 < 1.5 to 2% or O.002 pmol/kg, whichever is greater CCL4 < 2.5%, but additional uncertainty of ± 0.18 pmol (or less) for Stas. 3-6.		

Data Processing Notes

Date	Contact	Data Type	Data Status Summary
01/31/05	Roether	BTL/SUM	Submitted new sum file & bot. (tracers)
	Part of the helium samples were taken in a non-traditional way (sucking water into an evacuated ampoule), such data are denoted by a 7 as the last digit in the second flag word (regular copper samples have an 8 at that position). Intercalibrations have been made, and the errors given in the big table account for that. Part of the vaccuum samples had some air contamination, if small enough a correction was made using the neon value, in which case no neon value is given in the table.		
02/15/05	Anderson	CFCs/HeTr/CO2	Update Needed: requested data from Key
	I don't see any of that data here. Send it along and I will merge it this week.		
02/16/05	Key	CFCs/HeTr/CO2	Submitted
	The new data for this cruise are attached. I only included what you don't have. As usual, my software doesn't worry about number of decimal places and truncates trailing decimal zeros. The flags are as assigned by the data generators (Roether, Hoppema and perhaps others) and follow WOCE convention. tracer"e" are errors and tracer"f" are flags. The header is not WOCE, but I don't think you'll have any problem. You should get a 1 to 1 match to the hydro file. I did a quick check and these appear to be first class data.		
02/18/05	Anderson	CFCs/HeTr/CO2	Website Updated: Data Online
	Merged the TCO2, CFC-11, CFC-12, CFC113, CCL4, TRITUM, TRITER, HELIUM, HELIER, DELHE3, DELHER, NEON, and NEONER into the online file. Data were submitted by Bob Key on Feb. 16, 2005. There were no apparent problems.		
04/14/05	Witte	Cruise Report	Submitted summary
	as attachment I send you the summery of the cruise report of ANTXV/4. The whole cruise report is only a hard copy. If you want it also, please let me know.		
04/26/05	Witte	Cruise Report	Submitted Hard Copy
	Report is German and English. will need to be scanned and converted to text and PDF files.		
05/20/05	Kappa	STATRK	Data Update: Station Track incorrect
	I noticed that our station plot for sr04_e has an error in it. I've attached a pdf showing approximately how it should look: the northernmost leg should curve east, not west. This may mean the the values in the .sum file are incorrect, too. Can one of you fix this and send me a ps. file of the new station track?		
05/23/05	Diggs	STATRK	Website Updated: new station track online
	Updated Map on website from entries in SUMFILE corrected by S. Anderson.		
05/26/05	Kappa	STATRK	Data Update: made new station track
	I hand edited the old station track to include with the cruise report. It contains the 6 stations missing from Steve's recently generated station track. A pdf of my new statrk is attached.		

Data Processing Notes

Date	Contact	Data Type	Data Status Summary
05/26/05	Key	CFCs/HeTr/TCO2	Data Update: Key has new data files
	The bottle data file available on-line for this cruise just has T,S.O2,nuts. I have been in contact with Mario Hoppema, Wolfgang Roether and Birgit Kline. With their help, I now have values (and flags) for: CFC-11, 12, 113, CCL4 H3, He3, He-4 (with errors) Neon (with errors) TCO2 Roether says that he had previously submitted the data to WHPO and that it just hadn't been posted. Regardless, let me know what you don't have and I'll send it along. I'm still trying to verify responsible PIs for the new values. Documentation for this cruise says that C13 was collected, but I haven't been able to dig anything up on this.		
05/27/05	Kappa	Cruise Report	Assembled new pdf and text reports
	Previous online report was only CTD calibrations. New report, (PDF and Text versions) scanned from hard copy submitted by H. Witte, contains: a cruise narrative, reports on tracers, atmosphere investigations, and marine biology. Also includes figures, tables, and these data processing notes. made.		