The Expeditions

ANTARKTIS-XXII/4

and

ANTARKTIS-XXII/5

of the Research Vessel "POLARSTERN" in 2005

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Ber.Polarforsch.Meeresforsch.

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ANT-XXII/4

8 April 2005 - 21 May 2005

Punta Arenas - Bahia Blanca

ZENSUR 2005

(**Zen**trales **S**cotiameer: **Ur**sprung und Rolle
bei der Öffnung der Drake-Passage)

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1. ZUSAMMENFASSUNG UND FAHRTVERLAUF

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Die *Polarstern*-Fahrt ANT-XXII/4 führte über die Drake-Passage und die Süd-Orkney-Insel in das zentrale Scotiameer, wo in einem ausgewählten Gebiet ein umfangreiches geophysikalisches und marin-geodätisches Vermessungsprogramm, ergänzt durch sedimentechographische Kartierungen und Sedimentbeprobungen, durchgeführt wurde. Wissenschaftliches Ziel dieser Fahrt war es, durch eine systematische, flächendeckende Aufnahme der Meeresbodentopographie, des Geopotentialfeldes (Schwere und Magnetik) und der Struktur der Oberflächensedimente einen Beitrag zur Beantwortung der mit dem Öffnungsprozess der Drake-Passage Passage zusammenhängenden Fragen zu liefern. Das Vermessungsprogramm konzentrierte sich auf ein Gebiet im zentralen Scotiameer zwischen Südgeorgien und den Süd-Orkney-Inseln, in dem Daten der Satellitenaltimetrie und der Magnetik sehr komplexe Strukturen der oberen Erdkruste aufweisen und daher eine vollständige Interpretation der geologischen Entstehung dieses Gebietes nicht erlauben. Die durchgeführte flächenhafte, hochauflösende Vermessung der Meeresbodentopographie (multi-beam MB), Gravimetrie und Magnetik liefert die Datengrundlage für eine weiter führende Interpretation und die zukünftige Forschungsplanung in diesem Gebiet.

Das marin-geodätische Programm befasst sich mit der Geoidbestimmung im Untersuchungsgebiet. Kenntnisse über das Geoid werden für geophysikalische Untersuchungen im oberen Erdmantel und für die Bestimmung der dynamischen Meeresoberflächentopographie benötigt. Die auf dieser Expedition gewonnenen Daten der Bathymetrie, Seegravimetrie und die 3D-Schiffpositionierung liefern die Grundlage für eine genaue Geoidberechnung.

Im Rahmen des meeresgeologischen Programmes wurden im Gebiet der Süd-Orkney-Inseln und im zentralen Untersuchungsgebiet Kernproben mit dem Multicorer und dem Kolbenlot genommen, auf deren Basis Untersuchungen des Antarktischen Zirkumpolarstroms während der glazialen und interglazialen Perioden im Hinblick auf die Sedimentablagerungen und den damit verbundenen Veränderungen durchgeführt werden.

Wesentliches Ziel des meeresbiologischen Programmes war es, auf der Grundlage eines umfangreichen Phytoplankton-Beprobungprogrammes die Verbreitung des *Phaeocystis Antarctica* im Scotiameer und dessen Randgebiete zu untersuchen.

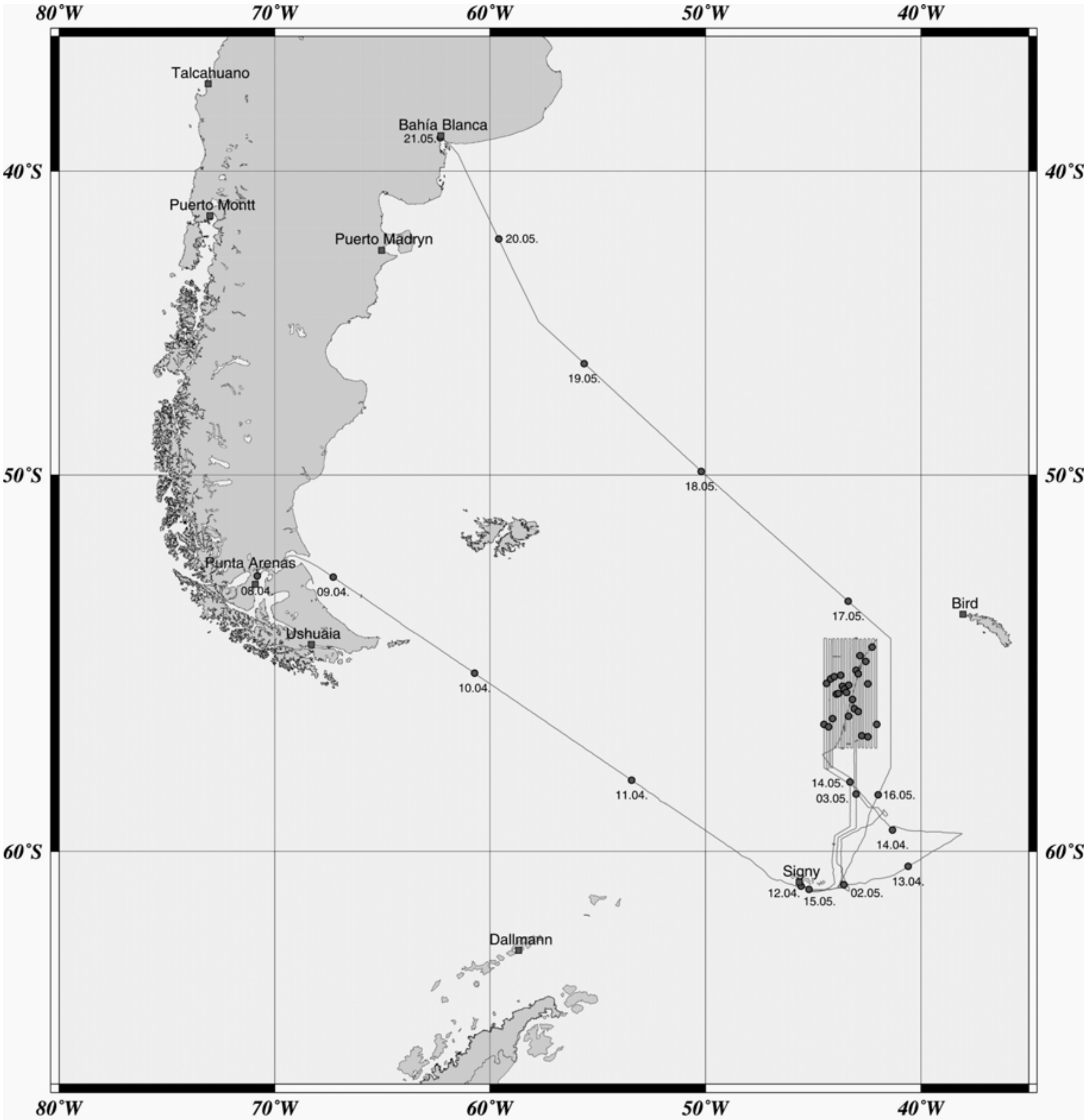

Abb. 1.1: Kursplot der gesamten Polarstern-Expedition ANTXXII/4
Fig.1.1: Trackplot of the Polarstern Expedition ANTXXII/4

Die Expedition ANT-XXII/4 begann am 8. April 2005 in Punta Arenas, Chile, und führte zunächst durch die Magellan-Straße (Abb. 1.1). An Bord waren 29 Wissenschaftler und 43 Besatzungsmitglieder. Das wissenschaftliche Messprogramm der Bathymetrie, Gravimetrie, Magnetik und Sedimentechographie erstreckte sich auch auf die Ausschließlichen Wirtschaftszonen (AWZ) von Argentinien und Chile. Aus diesem Grund nahmen zwei offizielle wissenschaftliche Beobachter der betroffenen Regierungen an der Expedition teil. Beide Beobachter beteiligten sich an den laufenden wissenschaftlichen Arbeiten an Bord. Die profilierenden Vermessungen der Bathymetrie, Gravimetrie, Magnetik und Sedimentechographie wurden, sobald geeignete Bedingungen vorlagen, unmittelbar nach dem Auslaufen begonnen. Für das hydroakustische Messprogramm wurde ein Arbeitsplan für einen 24-Stunden Operateurbetrieb organisiert. Auf dem der Insel Feuerland vorgelagertem Kontinentalschelf wurden zur Eichung der Schiffsmagnetik zwei Kreisprofile gegenläufig in Form einer Acht durchfahren. Die Daten dienen zur Kompensation des schiffseitigen Magnetfeldes. Die guten Wetterbedingungen während der Fahrt über die Drake-Passage zu den Süd-Orkney-Inseln erlaubten die Durchführung von Erprobungs- und Kalibrierungsflügen für das Helikoptermagnetik-Programm (Helimag).

Nach dem Erreichen der Süd-Orkney-Inseln wurde Signy-Island angelaufen, auf der die englische Sommerstation *Signy* liegt. Die Station war wenige Wochen zuvor von den englischen Wissenschaftlern winterfest gemacht und verlassen worden. Das British Antarctic Survey (BAS) hatte im Voraus die Zustimmung erteilt, in der Nähe der Station eine *Field Party* mit zwei GFK-Iglus aufzubauen, um dort GPS-Referenzmessungen für die 3D-Positionsbestimmung und für die Magnetik durchzuführen. Für Notfälle standen Räume im Stationsbereich zur Verfügung.

Für die Geoidberechnung und die Ableitung der Meeresoberflächentopographie im Untersuchungsgebiet ist eine präzise dreidimensionale Positionsbestimmung des FS *Polarstern* mit hoher zeitlicher Auflösung erforderlich. Zu diesem Zweck wurde auf Signy-Island auf dem 1995 im Rahmen des Geodetic Antarctic Program (GAP) eingerichteten geodätischen Referenzpunktes SIG1 eine GPS-Landstation eingerichtet. Die Vermarkung des 1995 eingerichteten Vermessungspunktes wurde in einem sehr guten Zustand aufgefunden. Das verwendete Vermarkungsmaterial (Messing) hat den extremen Witterungsbedingungen in der Antarktis sehr gut widerstanden. Dieser mit höchster Genauigkeit im International Terrestrial Reference Frame (ITRF) Epoche 2000 bestimmte Punkt liegt ca. 500 km vom Zentralpunkt des Messgebietes entfernt. Die für das Differential-GPS Verfahren benötigten Phasenmessungen wurden im Ein-Sekundentakt auf der Landstation und auf FS *Polarstern* während des gesamten Vermessungsprogrammes durchgeführt. Die Geoidberechnung auf der Basis der Seegravimetrie und der Bathymetrie wird im Rahmen weiterer Auswertungen am AWI erfolgen.

Neben der GPS-Station wurde eine Landstation zur Kalibrierung der Magnetikmessungenen eingerichtet. Die Registrierung der Magnetik-Referenzdaten dient unter anderem dazu, die kurz- und langperiodischen Schwankungen des Erdmagnetfeldes zu registrieren und bei den Auswertungen der Schiffs- und Helikopter-Messungen als Korrekturen anzubringen. Die Arbeiten auf Signy-Island wurden von zwei Wissenschaftlern durchgeführt. Die *Field Party* wurde mit allen notwendigen Verpflegungs- und Kommunikationsmitteln ausgestattet.

Das logistische und technische Material, die Iglus und die Messeinrichtungen wurden mit Unterstützung beider Helikopter in wenigen Stunden aufgebaut. Die Kommunikation und Abstimmung erfolgte täglich über ein Iridium-Telefon, das sich als zuverlässige Satellitenverbindung erwies. Die GPS- und Magnetik-Aufzeichnungen begannen am 12. April 2005. Die Daten wurden täglich von den Rechnern auf CD kopiert und gesichert.

Auf dem Süd-Orkney-Plateau südlich der Coronation-Insel wurde von der russischen Arbeitsgruppe ein bathymetrisches und sedimentechographisches Vermessungsprogramm mit Beprobung glazialer Erosionsrinnen durchgeführt. Der größte Gletscher auf der Coronation-Insel, der Sunshine Glacier, hat im Laufe der Vereisungsgeschichte auf dem Schelf ausgeprägte Spuren in Form von Abtragungen und Ausschürfungen von mehr als 100 Meter Tiefe am Meeresboden hinterlassen. Nach einer Übersichtsvermessung mit Hydrosweep und Parasound wurde ein Sedimentkern mit einer Länge von über 18 Metern gezogen. Ein Multicorer auf dieser Position vervollständigte das Beprobungsprogramm. Weitere Daten wurden im Zusammenhang mit der Erweiterung der russischen bathymetrischen Karten südlich und westlich der Süd-Orkney-Inseln gewonnen.

Die bathymetrischen Vermessungen im Gebiet des Süd-Orkney-Plateaus konzentrierten sich entlang der Versegelungsstrecke zum Arbeitsgebiet im zentralen Scotiameer zunächst auf den über 5,000 m tiefen South Scotia Graben. Hier wurde das Fahrtprofil diagonal in nordöstlicher Richtung über die Verbindung zwischen dem South Scotia Ridge und dem South Orkney Trough gelegt. Die Fahrtroute führte über den Bruce Rise, einer markanten submarinen Erhebung nordöstlich des Süd-Orkney-Plateaus. Im Verlauf der Anfahrt in das Hauptarbeitsgebiet wurden in der Tiefsee östlich und westlich des Bruce Rise zwei geologische Kernstationen beprobt. Beide Stationen liefern ergänzende Informationen zu Sedimentkernen, die in diesem Gebiet auf früheren *Polarstern*fahrten (ANT-X/5 und ANT-XI/2) gezogen wurden. Nach Analyse der vorliegenden Hydrosweep- und Sediment-Echolotdaten wurden zwei lange Kerne von 22,6 m und 23,90 m erzielt. Sie sollen Auskunft über die paläozeanographische und paläoklimatische Geschichte des Scotiameeres geben. Der weitere Verlauf der Anreise wurde mittels Daten aus der Satellitenaltimetrie und auf der Basis von FS *Polarstern*-Fahrten durchgeführt. Auf diesen Profilen wurden mehrere neue submarine Strukturen entdeckt.

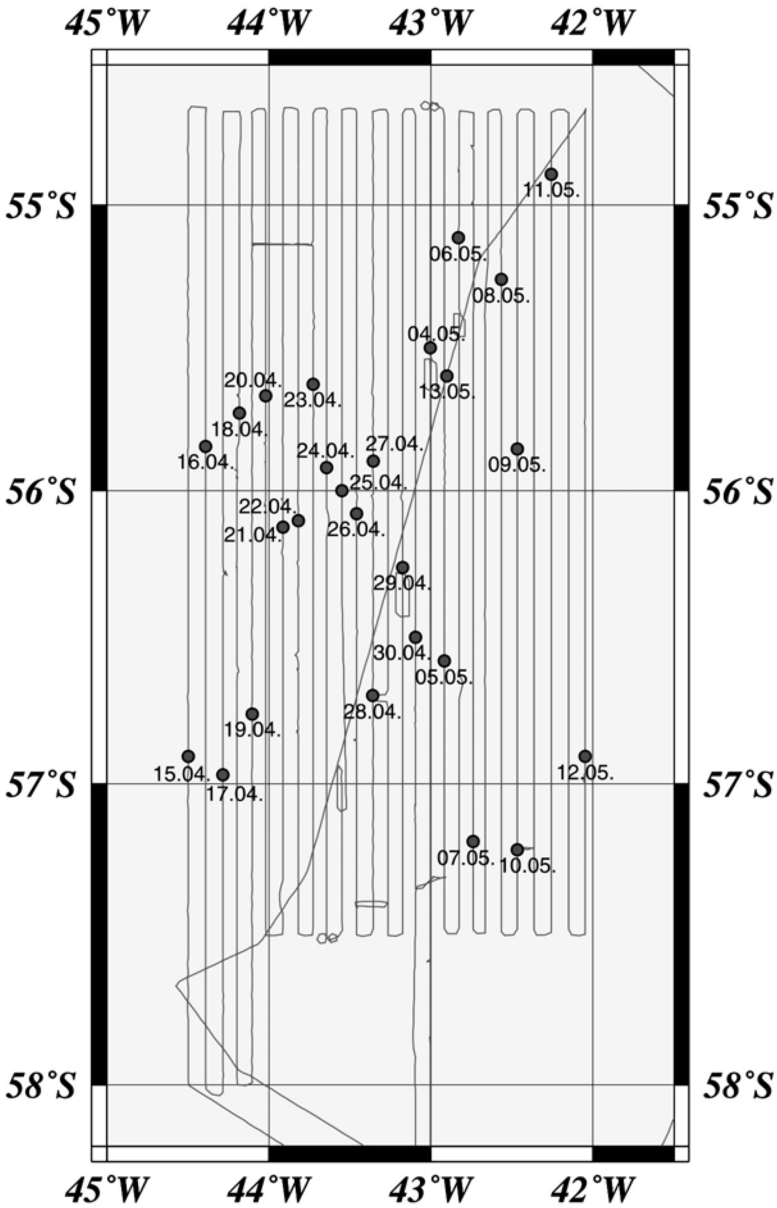

Abb. 1.2: Fahrtprofile des geophysikalisch-bathymetrischen Vermessungsprogramms im zentralen Scotiameer
Fig. 1.2: Survey profiles of the geophysical-bathymetrical survey programme in the central Scotia Sea

Das flächenhafte bathymetrisch-geophysikalische Vermessungsprogramm (Abb. 1.2) begann am 14. April auf der Position 58°S und 44°30'W mit Profilen in N-S Richtung. Es beinhaltet Messungen der Meeresbodentopographie mit dem Tiefseefächerlot Hydrosweep DS-2, des Magnetfeldes mit dem Fluxgate Schiffsmagnetometersystem (PS-Mag) und des Erdschwerefeldes mit dem Bodenseewerke KSS-31 Seegravimeter. Zur kontinuierlichen Vermessung der oberen Sedimentschichten wurde das parametrische Sedimentecholot Parasound DS-2 eingesetzt.

Das Vermessungsprogramm der Meeresbodentopographie war ein Schwerpunkt der Expedition. Profil- und Zeitplanung der Expedition wurden vorrangig an den Zielen der bathymetrischen Vermessung ausgerichtet. Um Datenlücken im Messgebiet zu vermeiden, wurden die Messprofile wurden so angeordnet, dass auch in den Gebieten geringster Wassertiefe eine volle Überdeckung aller Fächersonarstreifen sicher gestellt wurde. Es ergaben sich dadurch Profilabstände zwischen 6 und 7 km. Durch diesen Profilabstand wird gleichzeitig erreicht, dass mit der gravimetrischen Vermessung auch Schwereanomalien unterhalb der Auflösung der Satelliten-Radaraltimetrie erfasst werden können. Verzögerungen und Kursänderungen entstanden während der Messfahrt im Zusammenhang mit der Helikopter-Magnetik. Bei Start- und Landevorgängen musste FS *Polarstern* in eine günstige Windrichtung eingedreht werden. In der Regel wurden bei diesen Manövern Vollkreise gefahren, so dass keine Datenlücken entstanden.

Die Berechnung der Refraktionskorrekturen der Fächersonardaten erfolgte auf der Basis gemessener Schallgeschwindigkeitsprofile, die mit einer Seabird Speicher-CTD in Verbindung mit dem Kolbenlot oder dem MUC auf allen Kernstationen gemessen wurden. Zur Verdichtung der Wasserschallgeschwindigkeitsdaten im Vermessungsgebiet wurden in einem Raster von ca. 40 km Temperatursonden (Expendable Bathythermograph XBT) eingesetzt, mit deren Messdaten im Rahmen des späteren Postprocessing ein räumliches Wasserschallmodell für das Arbeitsgebiet bestimmt werden soll. Die XBT-Messungen liefern Wassertemperatur und -tiefe, aus denen mittels bekanntem Salzgehalt (ODV-Datenbank) aktuelle Wasserschallprofile berechnet werden können. Die CTD-Messungen wurden zur Überprüfung und Kalibrierung der XBT-Messungen herangezogen.

Die Fächersonarmessungen wurden im 24-Stundenbetrieb während der gesamten Expedition, einschließlich der Versegelungsabschnitte zwischen den Arbeitsgebieten durchgeführt. Die gewonnenen Daten tragen zur Erweiterung der globalen geophysikalischen und bathymetrischen Datenbanken bei und liefern einen Beitrag zur Fortführung kleinmaßstäblicher Kartenwerke, unter anderem für das neue Kartenwerk der International Bathymetric Chart of the Southern Ocean (IBCSO). Insgesamt wurde ein Gebiet mit einer Ausdehnung von 320 km (N-S) mal 160 km (E-W) vermessen, das entspricht einer überdeckten Fläche von 52.000 km^2. Von großem Vorteil ist die sofortige Auswertung der Fächersonardaten an Bord, denn die Ergebnisse werden zumeist von anderen Forschungsgruppen zur Planung eigener Arbeiten und zur Interpretation benötigt.

Die Ergebnisse der Meeresbodenvermessung ergaben völlig neue Erkenntnisse über die Morphologie des zentralen Scotiameeres. Die hier entdeckten submarinen Strukturen unterscheiden sich erheblich von der Topographie des westlichen und östlichen Scotiameeres, in denen Tiefseerücken und Bruchzonen vorherrschen. Das südliche Gebiet ist von einem zum Teil über 4.000 m tiefen und 60 km breiten Graben gekennzeichnet, dessen nördliche Flanke Steilstufen von über 30° Neigung aufweist. Im nördlichen Vermessungsgebiet wurden zahlreiche Unterseeberge (seamounts) entdeckt, die teilweise vulkanischen Ursprungs sind. Der größte und eindrucksvollste Seamount wurde am 8. Mai auf der Position 55°06'S und 42°35'W entdeckt. Der kreisrunde Vulkan hat eine relative Höhe von 1200 m gegenüber dem umgebenden Meeresboden in 3500 m Tiefe. Die überwiegend flache Kuppe ist von einem 200 m tiefen Krater mit einem Durchmesser von 1 km durchbrochen. Die Flanken des Seamounts haben teilweise Hangneigungen von über 20°. Die Basis hat einen Durchmesser von 12 km und ist von einer etwa 100 m tiefen Ringmulde umgeben. Vulkanische Aktivitäten konnten mit den an Bord vorhandenen Mitteln nicht detektiert werden. Weitergehende Interpretationen der Morphologie und Topographie erfolgen im Rahmen der späteren Auswertung. Aussagen über die geologische Entwicklungsgeschichte dieses Teils des Scotiameeres können erst auf Basis zukünftiger seismischer und petrologischer Daten gemacht werden.

Zur Messung der Parameter des lokalen Erdmagnetfeldes wurden das Schiffsmagnetometer und das Helimag-System eingesetzt. Die für diese Jahreszeit relativ guten Wetterverhältnisse ermöglichten die gleichzeitige Durchführung eines umfangreichen Helimag-Programmes. Die Flugprofile wurden orthogonal zu den Profilen des FS *Polarstern* in einem Abstand von 5 km angelegt. Durch Kreuzungspunkt-Ausgleichung der Schiffs- und Helikopter-Magnetik kann ein fehlerminimiertes homogenes Feld der Magnetikanomalien abgeleitet werden. Die zurückgelegte Flugstrecke aller Helimag-Flüge auf dieser Expedition beträgt 10.122 km.

Im Rahmen des meeresgeologischen Programmes wurden im Hauptarbeitsgebiet an ausgewählten Lokationen fünf Sedimentkerne (Multicorer, Kolbenlot) mit Längen von meistens über 20 m gezogen. Die Auswahl der Kernstationen erfolgte auf Grundlage der aktuellen bathymetrischen und sedimentechographischen Daten. Das im bathymetrischen Vermessungsprogramm über das gesamte Arbeitsgebiet angelegte System von Parallelprofilen ermöglicht für die Parasound-Kartierung eine flächendeckende, qualitative und quantitative Bestimmung der Sedimentechotypen. Hiermit können Rückschlüsse auf vergangene Ablagerungsprozesse und Paläoströmungen bzw. deren Entwicklung gezogen werden. Die Visualisierung und Interpretation erfolgt mit Hilfe eines Geographischen Informationssystems.

Das meeresbiologische Programm konzentrierte sich auf die Beprobung und Analyse der *Phaeocystis Antarctica*, einer grünen antarktischen koloniebildenden Algenart mit nahezu globaler Verteilung. Mithilfe des Planktonnetzes und des bordseitigen Membranpumpensystems wurde eine große Anzahl an Proben gewonnen, die am AWI weiter analysiert werden. Neben Sondierungen mit Planktonnetz und Pumpensystem wurden auf Signy-Island auch Proben von Land genommen. Insgesamt konnten während der Fahrt 51 marine Phytoplanktonproben gewonnen werden.

In Zusammenarbeit mit dem Woods Hole Oceanographic Institute (WHOI) wurden an unterschiedlichen Lokationen im Scotiameer vier SOLO-Tiefendrifter (buoyant floats) ausgesetzt. Diese Tiefendrifter sind Teil eines globalen Programms zur Messung ozeanographischer Daten, die zur Modellierung der Ozeanzirkulation oder Beobachtung der Ausbreitung von Wassermassenanomalien benötigt werden. Die Floats wurden zwischen 55°S und 58°S ausgesetzt und driften im Zirkumpolarstrom in östliche Richtung. Die profilierenden Floats driften in vorprogrammierten Wassertiefen mit der Strömung und steigen in definierten zeitlichen Abständen an die Meeresoberfläche, wobei ein vertikales Profil der Leitfähigkeit (Salzgehalt), Temperatur und Druck (Tiefe) gemessen wird. Die gespeicherten Daten werden nach dem Auftauchen über Satellit an die Monitorstationen abgesetzt. Die neuen WHOI SOLO-Floats verfügen über eine verbesserte Satellitenkommunikation und

Datenübertragung bei optimiertem Energieverbrauch, wodurch die Lebensdauer des Drifters verlängert wird. Die SOLO-Drifter sind mit einem neuen akustischen Messsystem ausgerüstet, das eine genauere Messung der Strömungsgeschwindigkeit erlaubt. Alle vier ausgesetzten Tiefendrifter wurden etwa 24 Stunden nach dem Aussetzen von der Überwachungsstation als operationell gemeldet.

Vom 30. April bis zum 3. Mai musste das Vermessungsprogramm wegen eines besonders starken Orkans unterbrochen werden. Aufgrund der erwarteten Wellenhöhen von 15 m versegelte FS *Polarstern* zu den Süd-Orkney-Inseln. Die Planung der Versegelungsstrecken erfolgte wie immer auf der Basis vorhandener Trackdaten von FS *Polarstern* und anderen Schiffen. Die neuen Routen wurden durchweg parallel zu vorhandenen Profilen angelegt, um die Flächenüberdeckung zu erweitern. Nach dem Ende des Sturms am 3. Mai 2005 wurde das Vermessungsprogramm fortgesetzt.

Am 13. Mai wurde nach Beendigung des 27. Nord-Süd-Profils das Vermessungsprogramm auf der Position 54°40'S, 42°03'W beendet. Von diesem Punkt an der nordöstlichen Ecke wurde zur Überprüfung und Kalibrierung der Messdaten ein Diagonalprofil durch das Vermessungsgebiet gefahren. Durch Ausgleichungsverfahren kann mit Hilfe dieser Messdaten die Genauigkeit der gravimetrischen und magnetischen Daten im Postprocessing verbessert werden. Hydrosweep- und Parasound-Daten lassen sich mit Hilfe dieses Diagonalprofils validieren und dienen zur Detektierung eventuell vorhandener systematischer Fehler. Das Profil kreuzte auch den neu entdeckten Vulkan. Um eine besonders hohe Datendichte für die Herstellung einer großmaßstäblichen Karte der *Seamounts* zu erzielen, wurde in dem Gebiet mit stark verminderter Geschwindigkeit gefahren.

Am 15. Mai wurde die *Field Party* auf *Signy* abgerüstet. Die Planung der An- und Abfahrtprofile nach *Signy* erfolgten erneut auf der Basis vorhandener Daten. Das Ablaufprofil nach Norden wurde 30 km östlich des Vermessungsgebietes über eine aus der ETOPO2-Karte bekannte topographische Anomalie gelegt, die sich als ein etwa 1500 m hoher Seamount mit einem Durchmesser von fast 30 km erwies. Die Rückreise nach Bahia Blanca, Argentinien führte in nordwestlicher Richtung über den Nord-Scotia-Rücken und das Falkland-Plateau nach Bahia Blanca, das am 20. Mai 2005 erreicht wurde. In Bahia Blanca endete die Expedition mit der Durchführung von Anschlußschweremessungen an Land zur Kalibrierung der Seegravimetrie.

CRUISE NARRATIVE AND SUMMARY

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Main task of the RV *Polarstern* expedition ANT-XXII/4 was the accomplishment of a geophysical and bathymetric survey in conjunction with sub-bottom profiling and sediment sampling in a geologically complex region of the central Scotia Sea between South Georgia Island and the South Orkney Plateau. Scientific goal was to create a topographic data basis from a detailed multibeam (MB) sonar survey and to measure the parameters of the Earth's geopotential field (magnetics and gravity) in order to study the structure and formation of the upper Earth crust and to assess the role of this part of the Drake-Passage Passage within the break-up of Gondwana. The systematic survey programme was focussed on the region between 58°S, 44°30'W and 54°40'S, 42°W which is characterized by pronounced free-air gravity anomalies, derived from satellite radar altimetry and by anomalously trending magnetic pattern.

The new data which are of high precision and high resolution will be used for a detailed geoscientific interpretation but also for the planning of future research programmes. The marine-geodetic programme comprises mainly the navigation and positioning of RV *Polarstern* and the geoid determination of the boxed survey. Beyond this programme an experiment for the derivation of the sea-surface topography was conducted. For this purpose the precise measurement of the ship's ellipsoidal height is required. This was realized using Differential- GPS techniques and a land-based GPS station on the South Orkney Islands. A two-frequency geodetic GPS receiver and a land magnetometer were installed on Signy Island in order to track the required reference data. The observations were carried out over a period of four weeks by two scientists. During the time of installation of the field party on Signy Island a small geological survey and sampling programme was conducted by the Russian working group in order to investigate the morphology and the sediment structures on the South Orkney Plateau.

In the frame of the marine geological programme seven sediment cores (piston corer and multicorer) were taken in the region of Pirie Rise and in the main survey area. The analysis of the sediment cores will provide data and information to model the impact of the Antarctic Circumpolar Current (ACC) during the past glacial/interglacial periods for instance on the sedimentation processes and its variability. Sub-Bottom-Profiling (SBP) with the parametric echosounder Parasound is an indispensable tool for selecting sediment coring locations and surveying the structure along the ship's track. Due to the dense survey with track line spacing of 6 to 7 km, spatial 3D-information about sediment thickness and distribution may be evaluated.

The major task of the marine-biological programme is to assess the distribution of the *phaeocystis antarctica* in the Scotia Sea and its surrounding areas along the Northern and the Southern Scotia Ridges. More than 50 samples were taken during the entire cruise by using the plankton net for surface samples, the ship-borne membrane pumping system and the bucket.

In co-operation with the Woods Hole Oceanographic Institute (WHOI) four buoyant floats type SOLO were launched in the region between 55°S and 58°S in the central Scotia Sea. After successful launch all floats were reported operational within 24 hours.

RV *Polarstern* left Punta Arenas, Chile, on 8 April 2005 at 20:00 h with 43 crew members and 29 scientists from 5 countries for the fourth leg of the expedition ANT-XXII (Fig. 1.1). As usual at the beginning of a geoscientific cruise and before leaving the port, the calibration of the ship gravity meter was performed by connection measurements between RV *Polarstern* and the nearest gravity reference point of the International Gravity Standardization Net 1971 (IGSN), located at the harbour of Punta Arenas. The bathymetric, gravimetric and magnetic measurements as well as the sub-bottom profiling were started right after the departure from Punta Arenas. For the Hydrosweep and Parasound measurements a 24 h operation in watches of 4 hours was initiated in order to collect data during the entire cruise. The measurements within the national Exclusive Economic Zones (EEZ) of Chile and Argentina were approved by the authorities of both countries. Two national observers from Argentina and Chile were appointed by their governments to participate in the expedition. They were well integrated into the scientific work on board.

The scientific programme was started on the continental shelf off Terra del Fuego. A magnetometer calibration loop was performed in order to compensate the raw magnetic measurements for the ship’s interfering magnetic field. The calibration loop has the form of an eight, two loops with a diameter of 6 nautical miles were sailed with RV *Polarstern* in opposite direction. From this calibration procedure a set of correction coefficients was determined and applied later to the raw magnetic data. Due to the excellent weather conditions during the transit across the Drake-Passage, it was possible to perform several test and calibration flights with the helicopter magnetic system (Helimag). Only a small number of icebergs were observed in the southern Scotia Sea. But the situation changed at the arrival on the South Orkney Plateau. Several hundreds of icebergs were clustered south of Coronation Island, the largest one on the South Orkney Plateau. Many of the icebergs were obviously grounded. RV *Polarstern* arrived at Signy Island on 12 April 2005. The British summer base *Signy* is located on Signy Island. The research station was winterized and left by the British team few weeks before our arrival. Our work programme and the installation of a field party near *Signy* Base was approved by the British Antarctic Survey (BAS) beforehand. Permission was granted that in case of emergency the facilities of the British station could be used. The work programme of the field party included the installation and operation of a GPS-tracker and a magnetometer reference station.

Due to the expedition schedule, the reference station was set up for a 5-weeks operation period. The housing for the scientists was realized by two weather resistant igloos made of fibreglass. The power supply for the field party, and especially for the operation of the scientific equipment was realized by a system of portable generators. The igloos were transported by helicopter from RV *Polarstern* to the place of the field party, about 30 m beneath the geodetic reference marker. Both igloos were anchored to the surrounding rocks to protect against strong winds. The GPS antenna was installed on the existing geodetic reference point SIG1, which was established during the international Geodetic Antarctic Campaigns (GAP) in 1995 and 1998. SIG1 is a point of the GPS-network to measure plate kinematics on the southern hemisphere. High precision coordinates in the International Terrestrial Reference Frame (ITRF) Epoch 2000 were determined from the GAP campaigns and now used as reference coordinates for this expedition. The geodetic reference marker, made of brass, was in excellent physical condition. The metal did not show any damage or corrosion. The work programme of the field party comprised primarily the continuous tracking of GPS phase data in a one-second recording rate and the registration of magnetometer measurements during the entire working period of RV *Polarstern* in the central Scotia Sea. The high GPS data sampling rate realized on both, RV *Polarstern* and the reference station, is required for the high precision kinematic 3d-positioning of RV *Polarstern*. The scientific goal of this experiment is to investigate possibilities to determine the ellipsoidal height of the ship and subsequently the sea-surface topography in the investigation area.

The land magnetometer was installed in a short distance from the igloos in order to collect magnetic reference data used for the correction of long and short periodical variations in the magnetic field. The GPS- and magnetic data recording started on 12 April. The observations were recorded and daily downloaded on a laptop. The GPS data were quality controlled to assure a good data quality. The communication between RV *Polarstern* and the field camp was realized by the Iridium telephone system.

During the installation of the field party RV *Polarstern* carried out a marine-geological survey and sampling programme in the outflow and calving area of the Sunshine Glacier, the largest of its kind on Coronation Island. During the course of various glacial periods the glacier has produced deep abrasives and glacial valleys on the seafloor. Sediment and rafted material are deposited in this region. In order to study these structures a short survey programme including bathymetry, sub-bottom profiling and sediment sampling was conducted by the Russian expedition team. A large number of traces and scours of more than 100 m depth relative to the surrounding on the seafloor were discovered by multibeam. After a reconnaissance survey with Hydrosweep and Parasound a sediment core of 18 m length was recovered using the piston corer, a multicorer (MUC) combined with a CTD concluded the sampling work in this region.

The subsequent bathymetric survey programme at the northern slope of the South Scotia Trench was also conducted by the Russian research group. The transit tracks of RV *Polarstern* covered the transition zone between the South Scotia Ridge and the South Orkney Trough. The new track lines were located in areas where no bathymetric data exist. A major goal of this part of the expedition was to map regions without any bathymetric information. Thus the track line of RV *Polarstern* to the Bruce Rise, which is a major submarine structure northeast of South Orkney Plateau, traversed unknown regions. On the transit to the first marine geological sampling station RV *Polarstern* crossed the top of the Bruce Rice in north-eastern direction. Two major tops were picked up with multibeam in the south-western (700 m) and in the north-eastern area (580 m) of this extended submarine feature. East of Bruce Rise in the deep sea, a sediment core of 22.6 m was taken by piston corer. At this site also a multicorer was used to take surface sediment samples. The transit to the subsequent geological core station followed an E-W profile at 59°30'S across the northern slope of Bruce Rise where a least depth of 1480 m was encountered. The third sediment core in the course of our cruise was taken in the deep sea west of Bruce Rise. Following the pre-survey with Parasound and Hydrosweep, a 23.9 m long core was gathered with the piston corer. These two sediment cores, which are located close to earlier coring sites from the RV *Polarstern* expeditions ANT-X/5 and ANT-XI/2, will be used to investigate the paleoceanographic and paleoclimatical history of the Scotia Sea.

In general, the planning of the transit routes was based on existing RV *Polarstern* track lines, on data from international archives for example from the IHO Data Centre on Digital Bathymetry (DCDB), and on predicted bathymetry and free-air anomalies derived from satellite radar altimetry (ETOPO2). A number of new seamounts and other submarine features were discovered in the course of the transits between core sites and survey areas.

RV *Polarstern* reached the main investigation area at location 58°S and 44°30'W on 14 April 2005, where the systematic survey was taken up with north-south going lines (Fig. 1.2). The work programme included the survey of the seafloor topography (multibeam sonar system Hydrosweep DS-2), the magnetic field (Fluxgate ship's magnetometer PS-Mag), and the gravity field (Bodenseewerke KSS-31). The continuous survey of the upper sediment layers was realized using the parametric sub-bottom-profiler Parasound DC-2. The ship-borne magnetic observations were complemented and expanded by an aeromagnetic programme using the air-borne Helimag sensor on the helicopter. The flight lines were placed orthogonal to the ship's profiles in a spacing of 5 km.

The systematic survey programme of the seafloor topography in combination with the observation of the Earth's potential field data was the main work programme of the expedition. The multibeam technology permits the continuous survey of the seafloor with a swath width of more than the double of the water depth underneath the ship. Thus, in order to avoid gaps in the multibeam survey, the spacing of the track lines was pre-estimated on the base of the depth data taken for the previous profile. The least observed depth determines the spacing of the multibeam tracks. The line spacing utilized in this area varied between 6 and 7 km, which is also an advantage for the determination of the marine gravity model. The relatively dense distribution of gravity measurements will permit to determine Free-air and Bouguer anomaly models of a shorter wave length than available from satellite radar altimetry.

Delays and deviations from the pre-determined tracks occurred only during the start and landing operations of the helicopter or when sailing to selected coring locations. For the safety of helicopter starts and landings, RV *Polarstern* had to be positioned into an optimal wind direction. In this situation, RV *Polarstern* made a full circle over 360°.

For the precise determination of the water depth, a refraction correction must be applied to all slant sonar beams. The determination of the refraction coefficients requires the measurement of a sound velocity profile (SVP). This was realized by measuring conductivity, temperature and depth (pressure) in the water column by using a memory CTD sonde, which was hooked to the MUC. Thus CTD profiles were measured only in connection with the geological coring programme. In order to determine a spatial model for the SVP in the entire survey area and to increase the distribution of sample points, Expendable Bathythermographs (XBTs) probes were launched in a raster of 40-50 km. XBT measure the temperature and depth, the salinity was partly taken from the Ocean Data View archive. The CTD measurements were further used for the calibration and verification of the XBT measurements.

The multibeam survey programme was carried out in watches of 4 hours. Also during the transits between working areas the MB system was operated. The data was immediately checked and post-processed on board RV *Polarstern*. Since bathymetric data in this region of the globe is very rare, the new data will considerably contribute to the extension of the global bathymetric data base, and it will update the small scale bathymetric charts, like the General Bathymetric Chart of the Oceans (GEBCO). In particular, this new data will be incorporated into the new Bathymetric Chart of the Southern Ocean (IBCSO). During the period of the survey from 14 April until 13 May 2005, an area with the extension of 320 km (N-S) times 160 km (E-W) was surveyed, which represents an area of 52,000 km^2. A big technical advancement is the immediate post-processing of the multibeam data on-board. Most of the results are badly needed by other scientific working groups as planning tool and for the interpretation of related scientific observations. With this kind of uninterrupted work programme, the bathymetric working group substantially contributes to all expeditions.

All multibeam data were post-processed during the expedition using the MB data editing software CARIS-HIPS. A set of four preliminary bathymetric maps (scale 1:400,000 and 1:250,000) were compiled. The morphological structures, discovered during this expedition are of great visual impact. The submarine relief explored in the central Scotia Sea significantly differs from the previously existing bathymetric information. Differences of over 1600 m between predicted bathymetry (ETOPO2) or GEBCO Digital Atlas and the new bathymetry were observed in many regions. In general, the multibeam bathymetry is less deep than the existing bathymetric DTMs and maps.

In the centre of the survey area a wide deep sea graben was discovered. The central graben shows a depth of more than 4,000 m, the width of the graben is more than 60 km. Most impressive and imposing is the northern slope, which proceeds in E-W direction and turns in a circular curve into nearly N-S direction. This slope in some parts has inclinations of more than 30°. A number of submarine volcanoes were discovered in the northern region of the survey area. The largest and most spectacular seamount was discovered on 8 May at the location 55°06'S and 42°35'W. The circular shaped seamount has a height of 1,200 m relative to the surrounding water depth of 3,500 m. The basis of the seamount has a diameter of 12 km and is surrounded by a 100 m deep moat. The flat top of the volcano is foraminated by a 200 m deep crater of 1 km diameter. Sampling or dredging at this volcano was not possible, volcanic activities were not observed. Detailed morphological and geological interpretation will be performed in the frame of the post-processing at the AWI. Detailed geoscientific interpretations of the history of this part of the Scotia Sea can only be done on the base of additional seismic profiling and petrologic sampling.

The Earth's magnetic field was observed during the entire cruise using the ship-borne Fluxgate magnetometer system (PS-Mag) and the helicopter magnetic system Helimag. Due to the unexpected good weather conditions an extensive air-borne magnetic programme was realized. All flight lines were placed orthogonal to the ship's tracks. Nearly 30 sailed profiles and over 40 helicopter flight lines resulted in more than 1,200 cross-over points, useful for the adjustment of observations. In total 10,122 km profiling lines were measured, the total length of the ship's track in the main surveying area was 10,500 km. At the end of the survey a diagonal profile was measured, sailing from the north-eastern corner to the south-western corner of the survey area in order to calibrate the gravity and magnetic measurements and to validate the multibeam and SBP data.

The marine geological sampling programme in the main survey area in the central Scotia Sea was performed by AWI. Five core locations were selected for coring in this region on the basis of the actual multibeam and sub-bottom profiles. The core sampling programme comprises the deployment of the piston corer (KOL) and the multicorer (MUC), whereas the latter always was combined with the Seabird Memory-CTD. Sediment cores were successfully taken at all five locations in the main survey area. Three cores were obtained in the northern area of the Pirie Rise, one coring site was placed in the central graben and another core was taken in the north-western part of the survey area, approx. 50 km south of the North Scotia Ridge. The samples will be utilized to study the impact of the Antarctic Circumpolar Current (ACC) during the past glacial and interglacial periods, for instance on the sedimentation processes and its variability.

Sub-bottom-profiling (SBP) using the parametric echo sounder PARASOUND is an integral part of the marine geological research and survey programmes. The accomplishment of a systematic areal survey with parallel track lines made it possible to analyze and visualize the quantitative and qualitative structures and distribution of sediment layers in three-dimensional form. Conclusions can be drawn about past sediment deposition, accumulation processes and paleocurrent development. Furthermore, SBP is extremely useful to select geological sampling sites. Sediment structures as well as the composition of the upper surface layers and the seafloor topography are the critical parameters to choose the right coring location. It was again demonstrated in the course of this expedition that the combination of multibeam survey data and sub-bottom-profiling comprises a perfect procedure for the selection of marine geological sampling sites.

The marine-biological programme focussed on surface sampling and analysis of the colony-forming and ecologically important genus *phaeocystis antarctica* which is part of the marine phytoplankton. The biological sampling programme fitted well into the general geoscientific work. Samples were taken at geological coring sites and at other stops during the survey programme, and at various locations of the Antarctic coastal waters. The sampling was carried out by using the plankton net, the ship-borne membrane pumping system and a bucket for water surface samples in coastal waters (South Orkney Islands). In total more than 50 marine phytoplankton probes were collected and prepared during this expedition.

In cooperation with the Wood Hole Oceanography Institute (WHOI) four SOLO floats were launched in the region of the central Scotia Sea. These technically highly developed buoyant floats are part of the global programme to measure physical oceanographic parameters which will be utilized to model ocean circulation or to observe and monitor the propagation of water mass anomalies in the water column. The floats were launched in the region between 55°S and 58°S in the centre of the Drake-Passage. The buoyant floats will drift with the Antarctic Circumpolar Current into eastern direction in a pre-defined water depth. After a given time period the float emerges to the surface and measures a vertical CTD profile. At the sea surface all recorded data are transferred via satellite to land-based monitor stations, from were the data are forwarded to archiving facilities. The launched SOLO buoys are equipped with an improved data communication and transfer technology by reduced power consumption, which may extend the life time of the floats. All four SOLO floats were reported fully operational about 24 hours after deployment.

From 30 April to 3 May, 2005 the survey programme was interrupted due to a very strong gale, which approached to the working area from westerly direction. The expected wave heights of more than 15 m, predicted by the board meteorologists, gave a good reason for RV *Polarstern* to take course to the South Orkney Islands. The transit lines were placed parallel to the existing tracks in order to cover a larger region with multibeam data. This procedure will lead over years to a higher coverage of the ocean floor with multibeam data. After the end of the storm the survey programme was continued on 3 May.

On 13 May after finishing the 27th N-S profile the survey programme was terminated on the position 54°40'S and 42°03'W. Starting from this point at the north-eastern corner of the working area, a diagonal calibrating profile intersecting all 27 lines was measured. With the help of least squares adjustment methods the accuracy and the precision of the magnetic and gravimetric measurements can be significantly improved. Bathymetric and SBP-data can be validated and checked against systematic and random errors by making use of the data form the diagonal profile. This profile also crossed the newly discovered volcano with the crater. In order to yield a high data density for large scale modelling and mapping, the speed of RV *Polarstern* was reduced to five knots at this location.

On 15 May RV *Polarstern* arrived at Signy Island in order to close and dismantle the field party. As good practice, the track lines again were located next to existing profiles. The weather condition required a rapid salvage work of equipment and expedition material. All material, which was needed to run the field party and the human waste were transported back to RV *Polarstern*. Nothing was left on Signy Island from this operation. The transit to Bahia Blanca, Argentina was also planned according to existing track lines. The north going profile was placed 30 km east of the survey area in order to cross a large topographic and gravimetric anomaly, taken from the ETOPO2 data base. This anomaly turned out to be a huge 1,500 m high seamount with a diameter of 30 km. The last part of the transit to Bahia Blanca was placed in north western direction, crossing the North Scotia Ridge and the Falkland Plateau. RV *Polarstern* arrived in Bahia Blanca on 20 May 2005. The last scientific task was the accomplishment of the gravity measurement to link the ship-borne data to the absolute gravity value of the IGSN 71 reference point in Bahia Blanca. This was performed with the kind support of the ship's crew.

2. LARGE SCALE BATHYMETRY OF THE CENTRAL SCOTIA SEA

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Introduction

Precise depth measurements are necessary to provide seafloor morphology and structure as basic information for marine sciences. High resolution digital elevation models of the seafloor enable the spatial allocation of physical, chemical and biological processes in the transition zone of geosphere and hydrosphere. The information about the seafloor topography and its physical properties is crucial for morphogenetic analyses trying to clarify geological formation and for the interpretation of geophysical surveys.

During the ANT-XXII/4 expedition an area of about 52,000 km^2 has been surveyed in the central Scotia Sea. 27 profiles were placed parallel in north – south direction each covering a length of about 170 nm. The survey was conducted within 30 days (14 April – 13 May 2005).

Equipment

The depth measurements were performed using ATLAS Hydrosweep DS-2, a deep-sea multibeam echo sounding system especially designed for operation in ice covered waters. It is a permanent installation on RV *Polarstern* and also records the echo amplitudes of the transmitted acoustic pulses. Hydrosweep DS-2 operates at 15.5 kHz and transmits sound pulses perpendicular to the ships longitudinal axis. The echo amplitudes can be converted into multibeam sidescan and angular backscatter data. The main application of sidescan is to detect small scale features which cannot be clearly recognised in the bathymetry (e. g. shallow channels or iceberg plough marks). Angular backscatter data supply additional information about the physical properties of the seafloor (surface- and volume roughness).

During this cruise, Hydrosweep was operated using the 120° transmitting and 100° receiving swath width mode. In the basic mode, Hydrosweep uses 59 physical pre-formed beams (PFB), but 240 so-called soft-beams are available in the HDBE (High Definition Bearing Estimation) mode. In the HDBE mode, the received 100° swath width is divided into 240 soft beams by mathematical functions. In general, the accuracy of the depth measurements is approximately 1 % of the water depth. The refraction correction of the sonar beams is carried out using measured sound velocity profiles (SVP), but when available, existing SVP were utilized. Single station GPS was used for the navigation of RV *Polarstern*.

Methods

Data acquisition

During the survey, all relevant sensor data are processed by the data acquisition software Hydromap-Online. This programme is used for operating the multibeam system as well as for visualisation and first data analyses. Furthermore, the planning of adjacent track lines was done by basically using this software. Because of geometrical constraints due to the swath width, the ensonified area varies between and within profiles depending on the local water depth. One objective of this expedition was the complete coverage of the study area. Therefore, the spacing of neighboured track lines was determined based on the minimum depth of the previous profile. In order to realize a high data accuracy within the entire area an overlap of at least 10% between adjacent depth profiles was realised. The measured depth data are directly visualised on the monitor. Thus it was possible to validate the data quality and adjust planned track lines (for example around seamounts). In order to assure precise depth measurements sound velocity profiles were applied using the Hydromap-Online software.

Data processing

The recorded depth and positioning data were stored in 8 hour intervals in a sensor-independent raw data format (SURF). During the post processing at first the position data was analysed, using the Hydromap-Offline position editor. The aim is to detect data gaps and to correct positioning errors by interpolation. Within the subsequent step, the SURF data are transferred via the RV *Polarstern* network into the data storage area for further processing. The subsequent cleaning of the multibeam data was carried out using the Caris HIPS.

The data cleaning with Caris is the most time-consuming part of the post processing. Using various view directions of depth profiles, for example rear and side view, the operator can check all depth values separately for plausibility and identifies whether for example a depth value represents an erroneous echo. Echoes considered by the operator as erroneous are not deleted but flagged and will not be used for further calculations. The judgement whether the depth measurements are correct or wrong is mainly based on the comparison to the general relief of sea floor and the standard deviation of the multibeam system. For this purpose, previous and successive depth profiles are also considered. As final step, the computation of a digital terrain model (DTM) is performed. The grid size of the DTM depends directly on the resolution of the multibeam data. Especially the outer beams have a reduced accuracy since their footprints are larger than those from the central beams. Due to the ping rate of about 15 seconds and the vessel speed of about 10 kn, the point spacing is approximately 75 m in along track and 25 m in across track direction. Given this geometric conditions, a grid size of 100 m was utilized for primary DTM modelling. This provides a good representation of the seafloor. The grids were used to check the data quality and for data cleaning. A comparison of depth data before and after data cleaning is shown in figure 2.1. It is obvious that a large amount of the erroneous data are in the centre of the MB swath. This effect was often observed while using the HDBE mode. Other sources of systematic errors or blunders are noise at the outer beams and erroneous ship's attitude data. After data cleaning, the errors were removed from the data set. Figure 2.2 shows characteristic errors of the nadir region in one single depth profile.

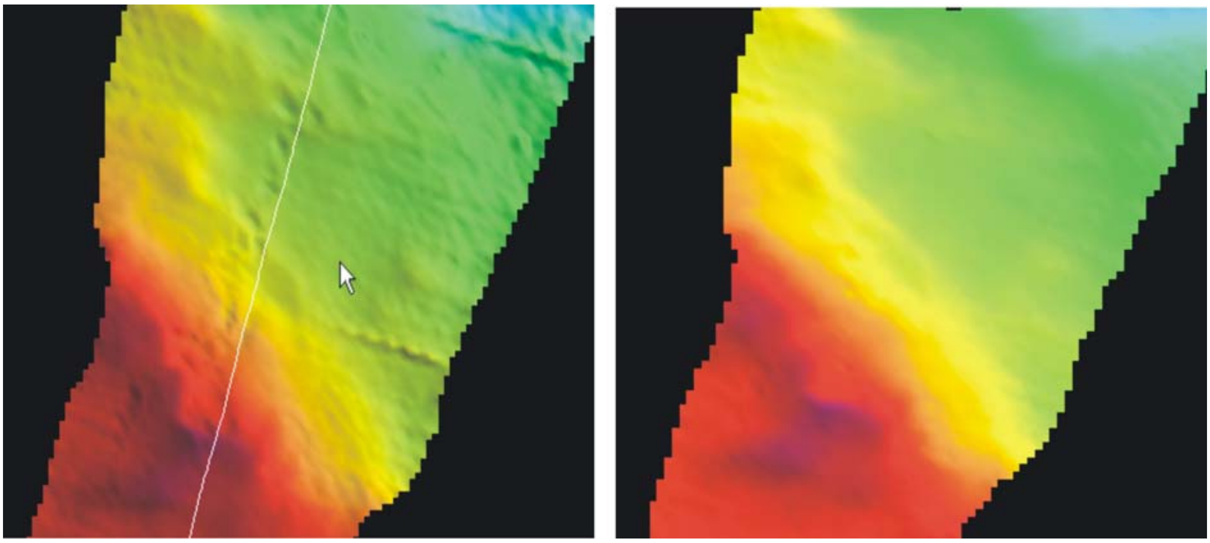

Fig. 2.1: Depth grid before and after data cleaning

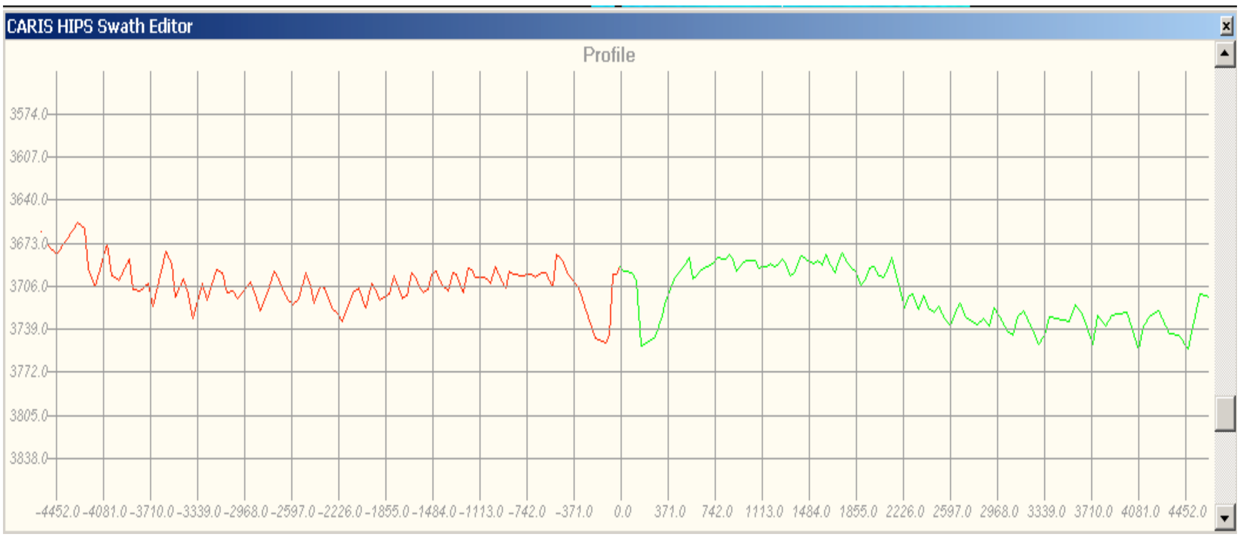

Fig. 2.2: Erroneous depth data in the nadir region in the HDBE mode

The final step in the post processing is the export of the bathymetric data into a defined ASCII-format (longitude, latitude, depth; optional: line, line number, profile, time). Thereafter, the cleaned data are available for the preparation of bathymetric maps. During this cruise the map preparation was done using the Generic Mapping Tools (GMT).

Assessment of the multibeam data

The standard deviation of data from the ATLAS Hydrosweep multibeam system as claimed by the manufacturer is <1% of the water depth. The average water depth of the Scotia Sea in the study area is about 3500 m. Therefore, the standard deviation can be expected to be better than 35 m. This value was used as constraint for data editing with HIPS. After the post processing it turned out that the average value of rejected beams was 8%. In bad weather situation this value increased up to 20%. Reduced quality of ship's attitude data and probably aeration under the ships hull and in the water column in rough sea are the suspected sources.

General bathymetric programme

The bathymetric long term programme focusses on recording systematically in poorly investigated areas. The depth data were recorded continuously during transits from Punta Arenas towards the main investigation area in the central Scotia Sea and on the way back to Bahia Blanca. The track covers the areas of the South American continental shelf east of Tierra del Fuego, the Yaghan Basin, the West Scotia Ridge, the Ona Basin, the North Scotia Ridge, the Falkland Plateau and the Argentine Abyssal Plain. Some tracks during the transit were planned in accordance to existing tracks in order to expand the covered area during successive cruises.

Table 2.1 includes bathymetric features which were discovered using the Hydrosweep multibeam system during the transit from Punta Arenas to the Scotia Sea. The list includes seamounts, moats, and channel-like structures.

Table 2.1: Summary of some outstanding morphological structures detected during the approach to the Scotia Sea

Date of discovery	Time (UTC) of crossing	Position	Feature description
10.04.05	12:00	60° 45' W 55° 35' S	small scale seamount and channel, height above the surrounding seafloor: 500 m
11.04.05	8:20	54° 22' W 57° 55' S	seamount, height above the surrounding seafloor: 900 m
11.04.05	23:15	49° 50' W 59° 35' S	meandering depression, possibly a channel
14.04.05	22:00	43° 20' W 58° 25' S	moats

Bathymetry of the central Scotia Sea

The currently acquired bathymetry will contribute to the understanding of the morphology of the central Scotia Sea. Morphological analyses will permit first indications to the origin of various segments of the investigation area. It also supplies essential data for the interpretation of gravity and magnetic data, which where also recorded during this cruise.

The multibeam data of the investigation area was recorded during 30 days. This data comprise more than 35 million individual depth values within the main investigation area. 27 parallel lines were surveyed. In order to assure complete coverage of adjacent survey lines, their spacing was determined based on the depth information from previous lines.

The velocity of sound in seawater is an oceanographic variable that varies with temperature, salinity and depth. Local sound velocity profiles measured during the cruise have been applied to the recorded multibeam data. Nevertheless, after applying the refraction correction to the multibeam data all swath data were transformed into soundings (normalized depths) assuming a mean sound velocity of the water column of 1500 m/s. This approach provides consistency with all data obtained during this and previous cruises.

For visualizing the sea floor topography, grids were computed based on the cleaned depth data using the Generic Mapping Tools (GMT) software and the Caris-Hips surface tool respectively. The on-board processing was done continuously. By this way it was possible to produce an updated bathymetric chart of the survey area on a daily basis. The actual chart was used for the planning discussion and the selection of sampling stations. Based on the DTM, contour line maps with colour coded depth ranges were produced. By this way, high-resolution bathymetric maps were produced on board within few hours after recording and editing the data.

However, further processing of the manually cleaned data will be required for the final bathymetric product in order to eliminate other systematic artefacts, which are still visible in the grids. Particularly, the centre beam area and the overlapping outer beams are affected by systematic errors, caused by reduced data quality visible as systematic artefacts along the survey lines. Figure 2.3 shows the bathymetry and the slope data of the area in the central Scotia Sea. This map is based on a 200 m grid. A part of the Tehuelche Fracture Zone (TFZ) is visible in the north west corner. The TFZ is the northern limit of the first survey lines. The south western corner of the map covers the northern extension of the Pirie Rise. The depths within the survey area ranges between 5,000 m to 2,000 m. The southern part is dominated by a huge graben which has a maximum depth of about 4,500 m. The surface of the graben is affected and formed by sediment transport. Sediment transport and current activity is also indicated in the northern part. The central area shows a plateau with pronounced structures. This feature has an almost circular shape and some of the ridges reach 1,000 m relative to the surrounding. The southern flank towards the graben has the steepest slopes with inclination up to 35°. However, most of the surface slope over the whole area is within a range of 0° to 5°. A number of four distinctive circular seamounts which are likely volcanos were discovered in the eastern area. They reach heights of about 1000 m and are lined almost along a north-south axis.

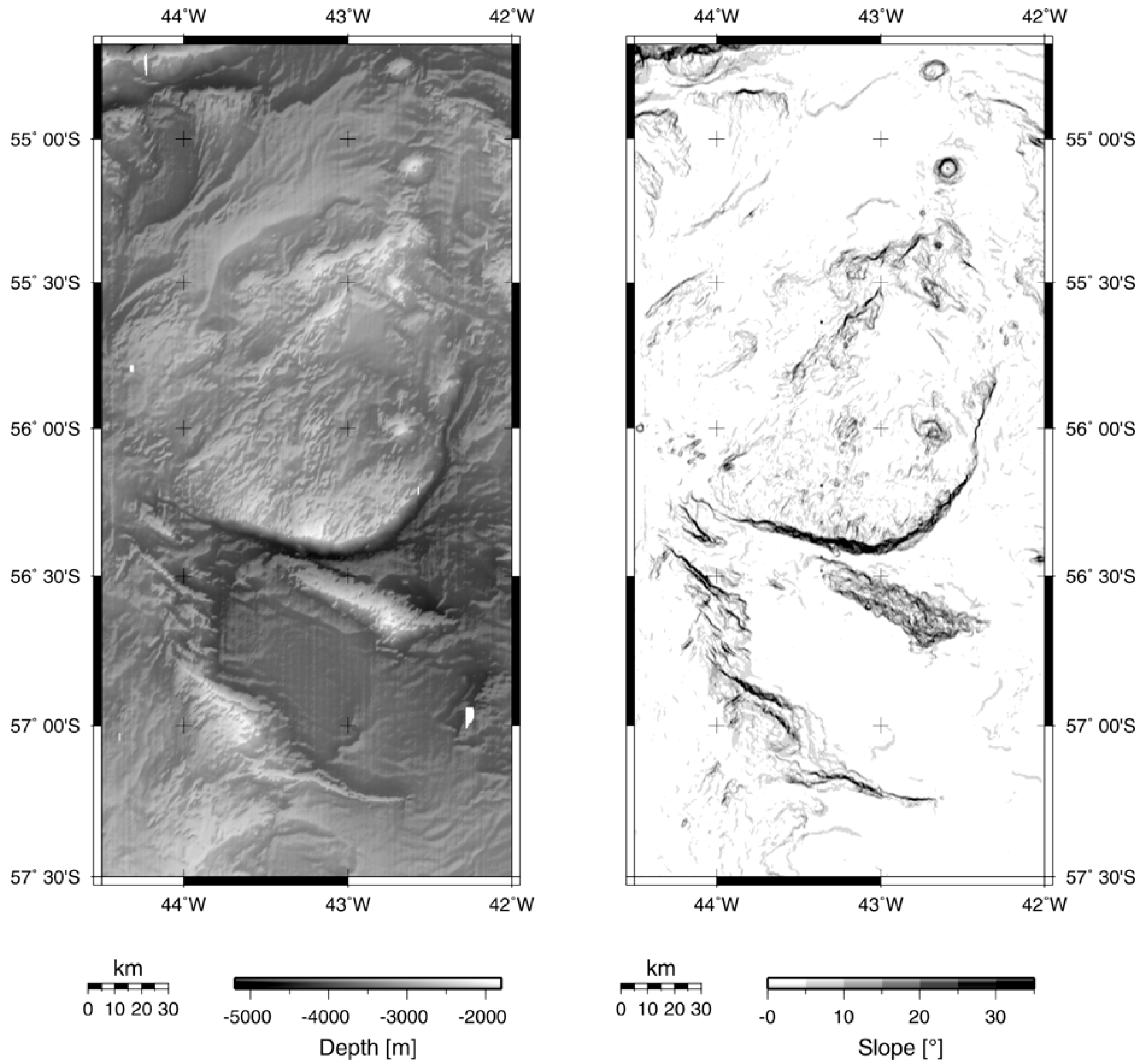

Fig. 2.3: Bathymetry (left hand side) and slope (right hand side) of the central Scotia Sea

In order to demonstrate the high resolution of the acquired data and the improvement of the terrain model of the central Scotia Sea, the existing global data set ETOPO2 (2-minute global relief data base) was compared to the data set acquired during this cruise. Figure 2.4 and figure 2.5 show three-dimensional mesh plots of the same sector of the investigation area. Both mesh plots were computed using identical adjustments for altitude, azimuth, map projection and vertical scaling. It is obvious that the ANT-XXII/4 grid model contains significantly more details compared to the ETOPO2 grid. Beyond this, the new model resolves and exactly identifies small-scale features with a horizontal spatial extend of a few hundred meters. ETOPO2, for example, does not even indicate, that there may be a seamount, even not a volcano at 55°07'S 42°35'W as shown in figure 2.4. The volcano has a spatial extend of 10 km and a height of 1200 m. The mesh plot shown in figure 2.5 based on the ANT-XXII/4 data set indicates a more distinct morphology at the steep flanks of the graben compared the ETOPO2 based mesh plot.

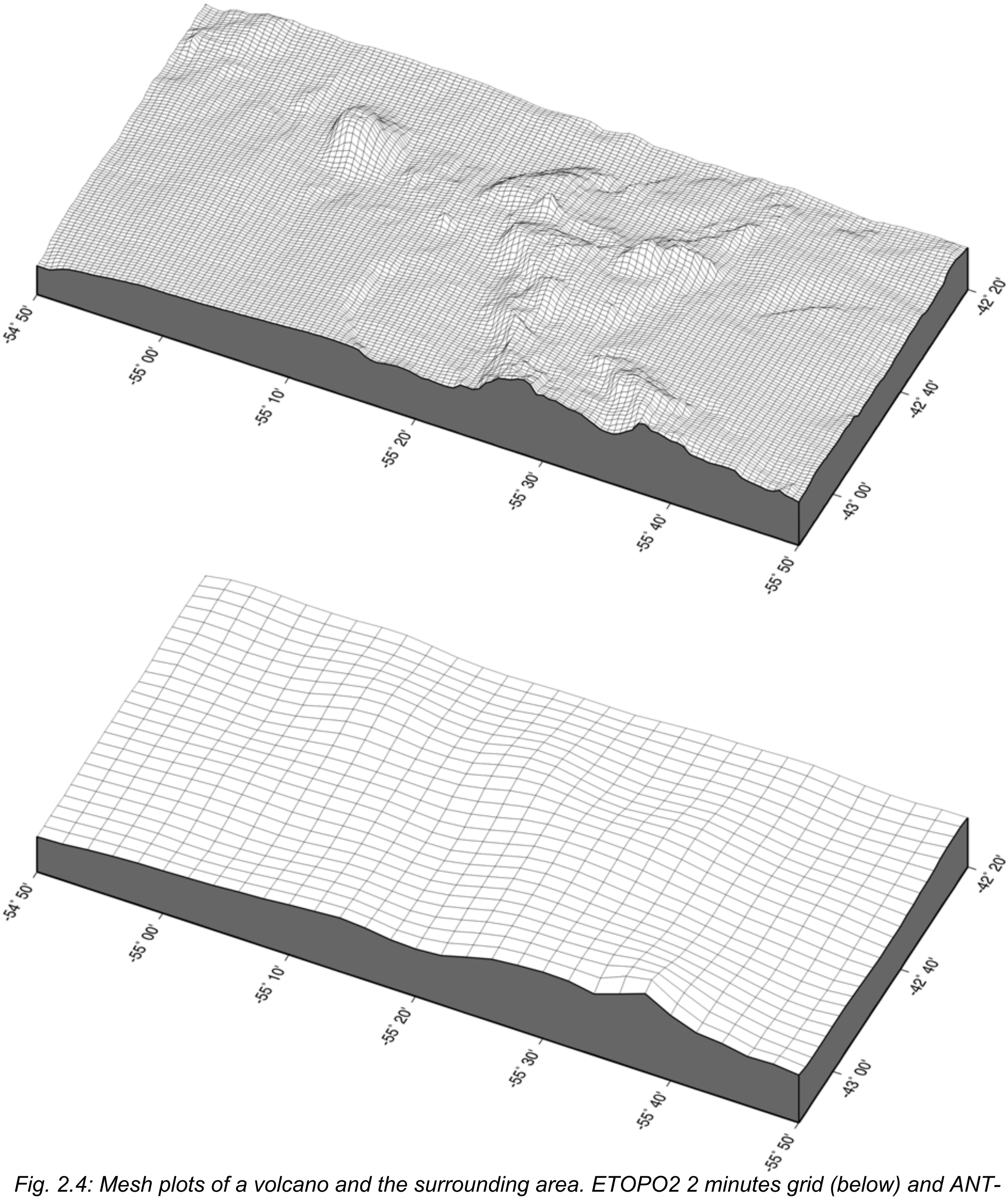

Fig. 2.4: Mesh plots of a volcano and the surrounding area. ETOPO2 2 minutes grid (below) and ANT-XXII/4 data set 0.5 minutes grid (above)

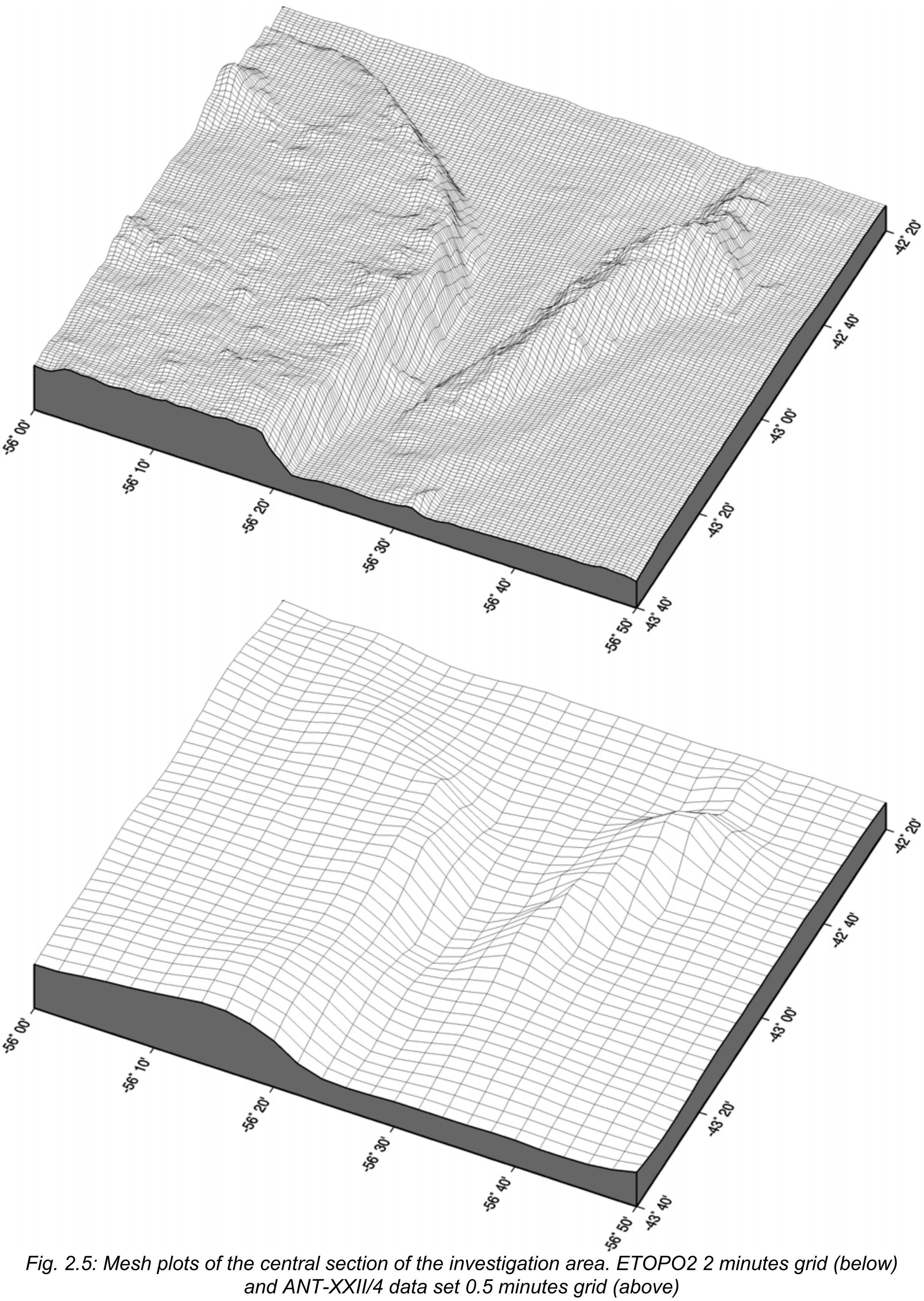

Fig. 2.5: Mesh plots of the central section of the investigation area. ETOPO2 2 minutes grid (below) and ANT-XXII/4 data set 0.5 minutes grid (above)

Based on the currently obtained data set, small-scale morphological features were detected and mapped within the main investigation area with an accuracy and resolution as never before. Small scale features observed within the central Scotia Sea are listed in table 2.2. Some seamounts show heights of about 1,000 m above the surrounding area. Crater like structures indicate a volcanic origin. Others have a smaller height of about 500 m. Distinctive moats are typical morphological features around the seamounts.

Table 2.2: Summary of distinct morphological structures observed within the central Scotia Sea and not yet identified in existing bathymetric charts

Date of crossing	Time (UTC) of crossing	Position	Feature description
15.04.05	13:10	44° 32' W 56° 44' S	elongated hill, height above the surrounding seafloor: ca. 500 m
15.04.05	18:35	44° 27' W 56° 00' S	hill, height above the surrounding seafloor: ca. 300 m
19.04.05	15:00	44° 05' W 56° 22' S	combination of ridges, height above the surrounding seafloor: ca. 900 m
19.04.05	14:00	44° 09' W 56° 29' S	elongated seamount, above the surrounding seafloor: ca. 900 m
07.05.05	23:25	42° 40' W 56° 01' S	seamount, height above the surrounding seafloor: 1200
08.05.05	07:05	42° 40' W 54° 45' S	seamount, height above the surrounding seafloor: ca. 800 m
08.05.05	10:40	42° 35' W 55° 07' S	volcano, height over the surrounding seafloor: ca. 1200 m
10.05.05	2:50	42° 24' W 55° 52' S	volcano, height over the surrounding seafloor: ca. 600 m

After further post processing and adjusting the sound velocity model of the water column, a grid size of 100 m will be determined for the final terrain model. It will be used to generate the AWI Bathymetric Chart of Central Scotia Sea with a contour interval of 20 m. A preliminary set of map sheets of the central Scotia Sea was prepared during the cruise. It covers the area between 58°30'S to 54°30'S and 44°40'W to 41°50'W and is divided into four map sheets each covering 1° latitude.

XBT and CTD programme for sound velocity modelling

The basic parameter to determine the depth of the seafloor by sonar is the travel time of the acoustic signal. This is the time in which an acoustic pulse travels through the water column from the transducer to the seafloor and back. The application of the precise water sound velocity is therefore required to convert travel time into depth and to account for the refraction of slant sonar beams. An incorrect sound velocity model would result for example in a deformation of the depth profiles, meaning that the profiles show a bending and the depth is shifted up or down in case of applied lower or higher sound velocity, respectively.

Temperature, salinity and pressure are the main quantities that affect the sound velocity. These physical properties of the water column vary with depth and geographical location. Temperature and pressure influence the water sound velocity in majority, whereas changes of salinity have a minor influence of the variation of the sound velocity.

A CTD probe (Conductivity, Temperature, Depth) was deployed to determine the sound velocity based on temperature and salinity measurements. Seven CTD stations were conducted during ANT-XXII/4 (Tab. 2.3). In connection with the geological programme, the CTD probes were attached 20 metres above each multicorer. However, due to time constraints additional CTD stations were replaced by XBT´s (Expendable Bathymetric Thermographs) which can be deployed from the sailing vessel. The locations of the XBT and CTD sites are shown figure 2.6.

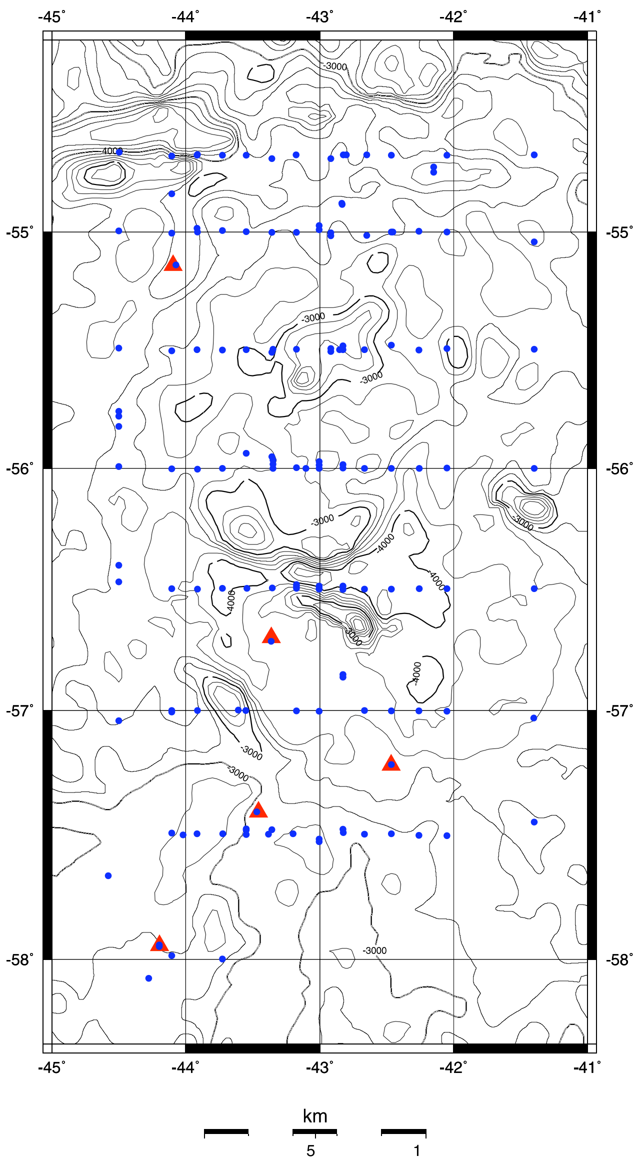

Fig. 2.6: Overview of XBT (circles) and CTD (triangles) stations during ANT-XXII/4

Table 2.3: Summary of the CTD stations during ANT-XXII/4

No.	Station	Date	UTC	Latitude (S)	Longitude (W)	Water Depth [m]	CTD Depth [m]
1	ctd_ps67_182-02	12.04.05	17:29	60:47.77	45:29.64	363	320
2	ctd_ps67_185-01	13.04.05	21:42	59:35.10	38:05.80	2944	2841
3	ctd_ps67_197-04	23.04.05	22:44	55:08.59	44:05.64	3822	3735
4	ctd_ps67_205-04	28.04.05	13:32	56:42.08	43:21.64	3787	3684
5	ctd_ps67_206-03	28.04.05	22:54	57:24.62	43:27.51	3212	3094
6	ctd_ps67_219-03	10.05.05	14:20	57:13.22	42:28.07	3616	3512
7	ctd_ps67_224-03	14.05.05	07:09	57:56.66	44:11.73	2867	2764

XBTs are free-falling one-way temperature probes. The probe is connected to measurement electronics on board by a thin copper wire, which tears off at a maximum depth of 1830 m. A number of 83 XBTs have been launched successfully within the study area at regular intervals (Tab. 2.4).

Table 2.4: Summary of the XBT stations during ANT-XXII/4. T7: XBT type T-7

No.	Station	Date	UTC	Latitude (S)	Longitude (W)	Water Depth [m]	XBT Depth [m]
1	xbt_ps67_184-01	13.04.05	20:58	59:35.10	38:05.60	N/A	1826
2	xbt_ps67_187-01	15.04.05	03:46	58:04.47	44:16.68	2789	1794
3	xbt_ps67_188-04	15.04.05	11:06	57:02.48	44:30.00	3459	1574
4	xbt_ps67_xxx-01	15.04.05	20:32	55:45.71	44:30.02	N/A	1731
5	xbt_ps67_188-11	16.04.05	02:04	54:59.69	44:30.00	3594	1664
6	xbt_ps67_192-02	19.04.05	03:23	57:59.02	44:06.28	2876	1652
7	xbt_ps67_192-04	19.04.05	10:09	57:00.34	44:06.29	3340	1722
8	xbt_ps67_192-06	19.04.05	14:00	56:30.00	44:06.30	2985	1826
9	xbt_ps67_192-08	19.04.05	17:32	56:00.13	44:06.32	3340	1568
10	xbt_ps67_192-10	19.04.05	23:45	55:00.28	44:06.29	3834	1258
11	xbt_ps67_192-11	20.04.05	00:48	54:50.09	44:06.28	4064	1501
12	xbt_ps67_192-12	20.04.05	01:48	54:40.35	44:06.32	4352	1490
13	xbt_ps67_194-02	21.04.05	01:41	57:29.93	43:54.98	2556	1762
14	xbt_ps67_194-04	21.04.05	09:08	56:30.16	43:54.89	3598	1722
15	xbt_ps67_194-06	21.04.05	16:20	55:30.10	43:54.90	3229	1530
16	xbt_ps67_194-07	21.04.05	19:33	54:59.98	43:54.88	3846	1560
17	xbt_ps67_196-02	23.04.05	00:02	57:29.94	43:43.52	2790	1427
18	xbt_ps67_196-03	23.04.05	03:09	57:59.90	43:43.60	2438	1450
19	xbt_ps67_197-05	23.04.05	21:42	55:08.39	44:04.39	3815	1796
20	xbt_ps67_196-07	23.04.05	23:57	54:59.60	43:43.61	3456	1506
21	xbt_ps67_196-08	24.04.05	02:01	54:40.16	43:43.62	3312	1653
22	xbt_ps67_202-02	25.04.05	08:50	56:29.96	43:32.63	3834	1513
23	xbt_ps67_202-03	25.04.05	12:22	55:56.24	43:32.97	3345	1530
24	xbt_ps67_202-06	25.04.05	20:26	54:40.11	43:33.01	3698	1450
25	xbt_ps67_204-02	27.04.05	01:50	57:28.90	43:21.38	3216	1527
26	xbt_ps67_204-03	27.04.05	11:41	55:57.11	43:21.51	3218	1472

No.	Station	Date	UTC	Latitude (S)	Longitude (W)	Water Depth [m]	XBT Depth [m]
27	xbt_ps67_204-07	27.04.05	19:43	54:41.01	43:21.50	3883	1541
28	xbt_ps67_205-06	28.04.05	14:31	56:43.00	43:21.77	3782	1495
29	xbt_ps67_206-04	28.04.05	23:43	57:24.56	43:28.20	3236	1736
30	xbt_ps67_210-03	03.05.05	19:45	57:31.21	43:00.29	3366	1608
31	xbt_ps67_210-05	03.05.05	23:38	56:30.10	43:00.32	3832	1637
32	xbt_ps67_212-03	04.05.05	22:05	55:00.14	42:55.02	3397	758[T-7]
33	xbt_ps67_212-04	04.05.05	22:10	55:00.93	42:54.99	3405	1622
34	xbt_ps67_212-05	05.05.05	01:21	55:29.76	42:55.01	2886	757[T-7]
35	xbt_ps67_212-06	05.05.05	01:27	55:30.58	42:55.01	3018	1610
36	xbt_ps67_213-04	05.05.05	23:09	56:51.81	42:49.60	3720	1580
37	xbt_ps67_213-12	06.05.05	13:43	54:52.54	42:50.06	3665	1826
38	xbt_ps67_213-13	06.05.05	13:48	54:52.85	42:50.03	3658	757[T-7]
39	xbt_ps67_213-14	06.05.05	15:08	54:40.07	42:49.52	3876	1580
40	xbt_ps67_213-15	06.05.05	15:14	54:40.02	42:48.02	3871	758[T-7]
41	xbt_ps67_215-02	07.05.05	14:28	57:29.99	42:40.00	3193	1490
42	xbt_ps67_215-03	07.05.05	17:30	56:59.99	42:39.99	3734	1465
43	xbt_ps67_215-04	07.05.05	20:33	56:30.07	42:39.98	4043	1530
44	xbt_ps67_215-05	07.05.05	23:31	56:00.04	42:40.01	2740	1548
45	xbt_ps67_215-06	08.05.05	02:31	55:30.07	42:39.99	2713	1502
46	xbt_ps67_215-07	08.05.05	05:30	55:00.85	42:38.99	3390	1447
47	xbt_ps67_215-08	08.05.05	07:26	54:40.04	42:39.01	3922	1485
48	xbt_ps67_217-02	09.05.05	01:55	57:29.88	42:27.97	3213	1488
49	xbt_ps67_217-03	09.05.05	04:48	57:00.07	42:27.99	3830	1304
50	xbt_ps67_217-04	09.05.05	07:57	56:30.13	42:27.99	4100	1469
51	xbt_ps67_217-05	09.05.05	11:06	56:00.02	42:27.99	3766	1485
52	xbt_ps67_217-06	09.05.05	14:14	55:28.87	42:28.02	3274	1472
53	xbt_ps67_217-07	09.05.05	17:16	54:59.96	42:27.99	3553	1479
54	xbt_ps67_217-08	09.05.05	19:22	54:40.11	42:28.00	3798	1518
55	xbt_ps67_219-04	10.05.05	15:31	57:13.12	42:27.90	3619	1518
56	xbt_ps67_220-02	10.05.05	17:36	57:30.24	42:15.65	3353	1587
57	xbt_ps67_220-03	10.05.05	20:54	57:00.05	42:15.51	3949	1541
58	xbt_ps67_220-04	11.05.05	00:24	56:29.99	42:15.49	4100	1635
59	xbt_ps67_220-05	11.05.05	04:08	56:00.01	42:15.48	3838	1672
60	xbt_ps67_220-06	11.05.05	07:49	55:30.14	42:15.50	3470	1826
61	xbt_ps67_220-07	11.05.05	11:47	54:59.78	42:15.51	3335	1555
62	xbt_ps67_221-03	11.05.05	14:23	54:44.52	42:09.00	3929	1390
63	xbt_ps67_222-02	12.05.05	06:47	57:30.33	42:03.04	3395	1826
64	xbt_ps67_222-03	12.05.05	10:35	57:00.12	42:03.00	3833	1624
65	xbt_ps67_222-04	12.05.05	15:02	56:30.01	42:02.98	4134	1672
66	xbt_ps67_222-05	12.05.05	18:40	55:59.98	42:02.99	3425	1770
67	xbt_ps67_222-06	12.05.05	22:32	55:29.79	42:02.99	2848	1718
68	xbt_ps67_222-07	13.05.05	02:02	54:59.93	42:03.02	3238	1552
69	xbt_ps67_222-08	13.05.05	04:13	54:40.10	42:03.00	3701	1675
70	xbt_ps67_223-02	13.05.05	06:57	54:59.97	42:27.27	3524	1408
71	xbt_ps67_223-03	13.05.05	11:23	55:30.05	42:51.18	2649	1389
72	xbt_ps67_223-04	13.05.05	14:22	56:00.02	43:06.14	3380	1399

No.	Station	Date	UTC	Latitude (S)	Longitude (W)	Water Depth [m]	XBT Depth [m]
73	xbt_ps67_223-05	13.05.05	17:25	56:29.84	43:21.21	3991	1443
74	xbt_ps67_223-06	13.05.05	20:38	56:59.85	43:36.58	1946	1474
75	xbt_ps67_223-07	14.05.05	00:02	57:30.14	44:01.17	2638	1479
76	xbt_ps67_223-08	14.05.05	02:15	57:40.03	44:34.79	2982	1546
77	xbt_ps67_223-10	14.05.05	04:39	57:56.93	44:11.92	2868	1826
78	xbt_ps67_226-02	16.05.05	17:20	57:27.03	41:23.97	3585	978
79	xbt_ps67_226-04	16.05.05	19:09	57:01.78	41:24.02	3586	1530
80	xbt_ps67_226-05	16.05.05	21:22	56:29.98	41:23.99	3590	977
81	xbt_ps67_226-06	16.05.05	23:29	56:00.03	41:24.01	3308	1040
82	xbt_ps67_226-07	17.05.05	01:38	55:29.99	41:24.01	3343	1014
83	xbt_ps67_226-10	17.05.05	05:14	54:40.01	41:24.01	3398	1027

The XBT measurements were evaluated straight away after launch using the ODV-programme (Ocean Data View) to compare the water sound profiles with the current profile used in Hydromap-Online. Salinity data, necessary for the determination of the sound velocity were taken from a nearby station. These stations were selected either from current CTD measurements or from data of similar season of the World Ocean Database 2001. In case of temperature changes an updated water sound velocity was calculated and imported to Hydromap-Online.

Figure 2.5 shows temperature and sound velocity profiles at two XBT stations. A higher variability of temperature and sound velocity is obvious for the most northern XBT (red graph, station PS-67-222-02) compared to the most southern XBT (blue graph, station PS-67-222-07) in the upper level of the water column. The mean temperature at station PS-67-222-02 is approximately 1°C warmer compared to station PS-67-222-07. This results in an increase of sound velocity of about 4 m/s.

It is planned to combine all XBT and CTD measurements to prepare a sound velocity model of the central Scotia Sea for the period of this expedition. An improvement of the multibeam data can be achieved by applying the local water sound velocity determined using this model. Therefore, depth data are optimal adjusted to the local sound velocity.

At the end of the expedition all recorded XBT data were supplied to the “Deutsches Ozeanisches Datenzentrum” (DOD) and to the “Bundesamt für Seeschifffahrt und Hydrographie” (BSH).

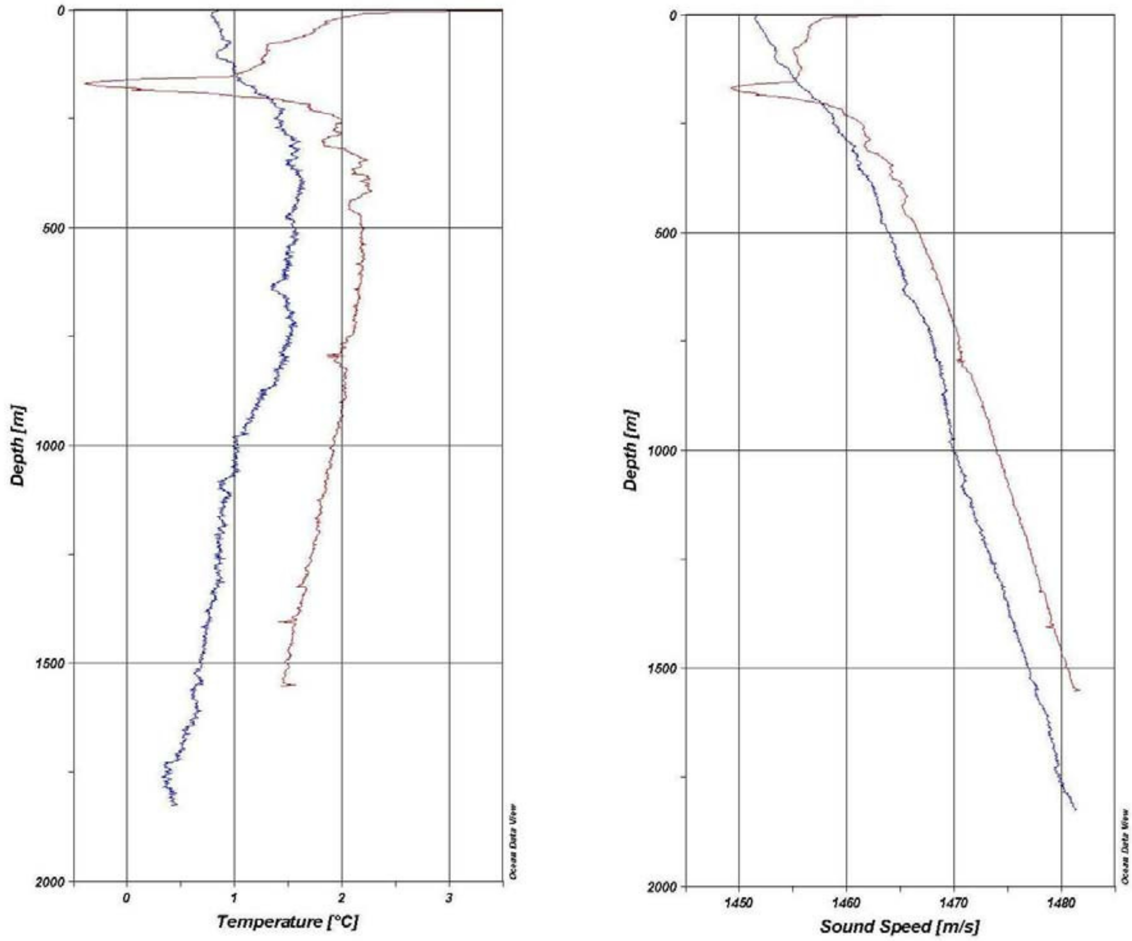

Fig. 2.5: Depth profiles of temperature (left side) and sound velocity (right side) at the stations PS-67-222-02 (grey) and PS-67-222-07 (dark)

3. MARINE GEOPHYSICS

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General purpose

Although the opening of the Drake Passage is well studied in general and is discussed in many publications there are still some remaining questions concerning details about the precise age of the development of an effective deep water connection between South America and Antarctica and the role of the different crustal blocks in the Scotia Sea. A key to these questions is the structure and age of the ocean floor in the central Scotia Sea. This region was the area of special investigation during the expedition ANT-XXII/4. There is doubt about the origin and age of this central part of the Scotia Sea. Interpretations of east-west oriented magnetic anomalies, bordering this region to the east, vary in their ages from the Miocene (~5 – 26 Ma) to the Mesozoic (~118 – 146 Ma), resulting in completely different implications for paleoceanography and paleobiogeography. In the west there are identified north-south striking magnetic anomalies corresponding to the spreading system along the west Scotia Ridge. The area of detailed investigation during the cruise ANT-XXII/4 was chosen to cover a region where the above mentioned 2 types of perpendicular magnetic anomalies exist in close spatial vicinity.

3.1 Ship-based magnetics

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The ship-mounted magnetometer system was used to measure the variations of the geomagnetic field along the ship's track during the complete cruise (Fig. 3.1). The magnetometer system comprises 2 three-component digital fluxgate sensors and is installed on an aluminium platform at the aft of the crow's nest platform about 6 m above the uppermost deck. Data were acquired with a sampling rate of 1 sec and stored in the POlarstern Data Acquisition System (PODAS). In the survey area, a set of 29 north-south oriented profiles was acquired having an overall length of about 10,000 km and covering an area of about 48,000 km^2.

In order to compensate the raw data for the ship's interfering field calibration loops were performed repeatedly during the cruise. In table 3.1 all calibration loops are listed including date, position and shape of the individual loops.

Table 3.1: Calibration loops performed during the cruise ANT-XXII/4

Date	Start [UTC]	End [UTC]	Longitude [°]	Latitude [°]	Description
09.04.2005	16:06:27	16:51:21	-65.97433	-53.46623	figure of an eight
13.04.2005	00:51:43	02:35:39	-43.59680	-60.81833	figure of an eight
24.04.2005	22:02:04	23:56:23	-43.67194	-57.51699	figure of an eight
14.05.2005	23:15:15	01:05:47	-44.07760	-59.83343	figure of an eight

The shape of an eight was chosen for each calibration loop in order to account for the influence of semi-permanent magnetic field effects which can largely influence the quality of the compensation results. The average speed during the calibration loops was set to 6.5 kn and a radius of 1 nm was chosen for each loop. For each calibration site a set of coefficients was calculated which is used to compensate the raw magnetometer data acquired along the profiles.

The following list shortly describes the principal steps of preliminary data processing:

- Compensation of raw magnetometer data using a set of compensation coefficients
- correcting the data for the international geomagnetic reference field (IGRF)
- filtering of high frequency noise using a low-pass with a cut-off frequency of 0.03 Hz
- removal of spikes and unusable data caused by fast course changes of the ship. This occurred for example during the departure and/or landing of the helicopter when the ship had to be aligned with the wind.
- Data were split and arranged into north-south profiles according to the ship's track. Each profile line has been corrected for any residual offset and trend.

The result, after performing these processing steps, is shown in figure 3.1 as a wiggle plot.

Data quality, i.e. high frequency noise, strongly depends on the state of the sea at which the data were acquired. During rough seas high frequency noise of up to 40 nT is still existent in the data. At moderate seas this is reduced to less than 30 nT. Space domain filtering before or during the gridding process can further reduce this noise.

No major problems were encountered during data acquisition. Data storage suffered a few short breaks due to PODAS maintenance but caused no essential data gaps. As already experienced during former cruises, the magnetometer system worked properly without any maintenance throughout the complete expedition.

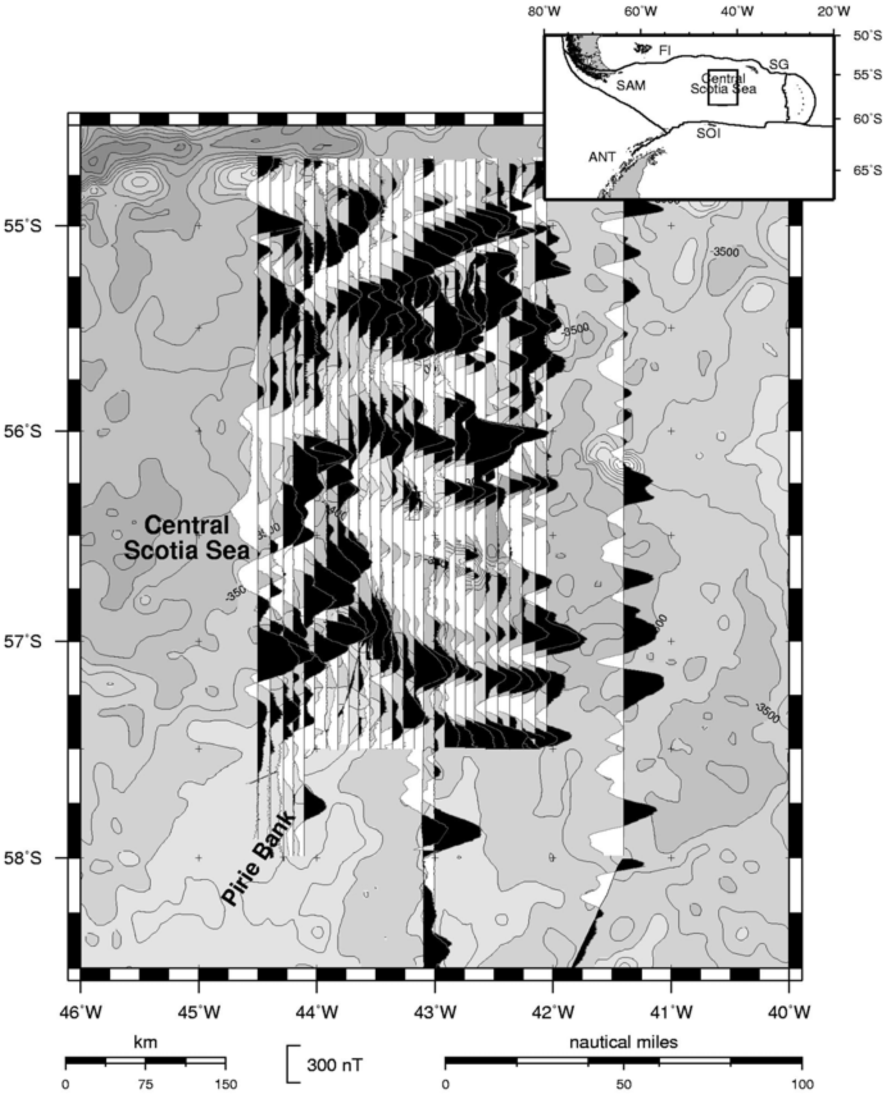

Fig. 3.1: *Wiggle plot of the shipborne magnetic data. Black colour represents positive magnetic anomalies*

3.2. Helicopter magnetics

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Originally, helicopter magnetics were aimed to support the ship borne magnetic survey and to extend the survey area in places. Due to good weather conditions, especially during the first half of the cruise, finally, an almost complete pattern of closely spaced (5 km line spacing) flight lines was flown between 44.5° W – 41.8° W and 57° S – 55.2° S (Fig. 3.2).

The flight lines are mainly oriented east – west across the complete survey area, perpendicular to the ship's track. Thus, adding detailed information especially about north-south oriented magnetic anomalies which are crossed perpendicular in this way. During 29 days of operation in the survey area a total sum of 35 flights with more than 10,000 km of flight lines were flown at a total time of 61 hours 3 minutes and 8 seconds (Tab. 3.2). During the second half of the cruise (after 30 April 2005) after a heavy storm the weather conditions changed to low wind but dense fog which strongly reduced the flight operations. This becomes apparent in figure 3, showing the total flight time per day throughout the cruise.

Table 3.2: HELIMAG flight statistics for ANT-XXII/4

HELIMAG flight statistics for ANT-XXII/4								
TEXT FILENAME	Binary data files	LINE #	FIDUCIAL START	FIDUCIAL END	Time START	Time END	Flight #	ASCII RAW-FILENAME
050411								
S5041100.T09	Test flight 05041						**1**	**0504111.raw**
S0541102.T01	Test flight 05041						**2**	**0504112.raw**
S0541102.T47	Test flight 05041						**3**	**0504113.raw**
050415								
S5041511.T58	S5041511.B59	560.0E	1	3327	11:59:16	12:54:43	**1**	**0504151.raw**
	S5041512.B55	550.0E	3328	3721	12:55:17	13:01:51		
S5041513.T02	S5041513.B0A	550.0W	1	189	13:02:41	13:05:50		
S5041513.T08	S5041513.B08	550.0W	1	4062	13:08:58	14:16:40		**174 km**
050417								
S5041711.T15	S5041711.B20	550.0W	1	729	11:20:54	11:33:03	**1**	**0504171.raw**
								31 km
050418								
S5041811.T14	S5041811.B19	290.0E	1	2850	11:19:30	12:07:00	**1**	**0504181.raw**
	S5041812.B07	300.0W	2851	7235	12:07:10	13:20:15		**335 km**
S5041813.T46	S5041813.B48	350.0E	1	2905	13:48:59	14:37:24	**2**	**0504182.raw**
	S5041814.B37	360.0W	2906	6853	14:37:29	15:43:18		
	S5041815.B43	370.0E	6854	7823	15:43:22	15:59:32		
	S5041815.B59	360.0W	7824	7824	15:59:32	15:59:34		
	S5041815.B5J	350.0W	7825	7825	15:59:34	15:59:36		**371 km**
S5041816.T39	S5041816.B40	410.0E	1	2966	16:40:25	17:29:51	**3**	**0504183.raw**
	S5041817.B30	420.0W	2967	6299	17:30:04	18:25:37		
	S5041818.B25	420.0E	6300	6306	18:25:38	18:25:45		**325 km**
050419								
S5041913.T21	S5041913.B22	460.0W	1	260	13:22:28	13:26:48	**1**	**050419.raw**
	S5041913.B26	450.0W	261	331	13:26:48	13:28:00		**16 km**
050420								
S5042011.T08	S5042011.B12	270.0E	1	1188	11:12:12	11:32:01	**1**	**0504201.raw**
	S5042011.B32	260.0E	1189	2239	11:32:01	11:49:33		
	S5042011.B49	280.0W	2240	6309	11:49:37	12:57:27		
	S5042012.B57	270.0E	6310	7819	12:57:30	13:22:40		**361 km**

HELIMAG flight statistics for ANT-XXII/4								
TEXT FILENAME	**Binary data files**	**LINE #**	**FIDUCIAL START**	**FIDUCIAL END**	**Time START**	**Time END**	**Flight #**	**ASCII RAW-FILENAME**
S5042014.T06	S5042014.B11	310.0E	1	753	14:11:19	14:23:52	**2**	**0504202.raw**
	S5042014.B23	320.0W	754	3066	14:23:55	15:02:28		
	S5042015.B02	310.0E	3067	4689	15:02:36	15:29:39		**218 km**
050421								
S5042111.T09	S5042111.B14	400.0E	1	2178	11:14:17	11:50:36	**1**	**0504211.raw**
	S5042111.B50	390.0W	2179	5304	11:50:50	12:42:56		
								265 km
050422								
S5042211.T03	S5042211.B06	370.0E	1	2060	11:06:57	11:41:17	**1**	**0504221.raw**
	S5042211.B41	380.0W	2061	5271	11:41:20	12:34:51		
	S5042212.B34	390.0E	5272	6740	12:34:56	12:59:25		**313 km**
S5042213.T39	S5042213.B40	430.0E	1	1956	13:40:19	14:12:55	**2**	**0504222.raw**
	S5042214.B13	440.0W	1957	5213	14:13:09	15:07:26		
	S5042215.B07	430.0E	5214	6878	15:07:38	15:35:23		**323 km**
S5042216.T08	S5042216.B10	490.0E	1	206	16:10:44	16:14:10	**3**	**0504223.raw**
	S5042216.B14	500.0E	207	1869	16:14:13	16:41:56		
	S5042216.B42	490.0W	1870	5206	16:42:00	17:37:38		
	S5042217.B37	500.0E	5207	6945	17:37:42	18:06:41		**317 km**
050423								
S5042311.T08	S5042311.B14	260.0E	1	2028	11:14:23	11:48:11	**1**	**0504231.raw**
	S5042311.B48	250.0W	2029	4952	11:48:13	12:36:58		
	S5042312.B37	260.0E	4953	7017	12:37:01	13:11:26		**332 km**
S5042313.T29	S5042313.B32	200.0E	1	1884	13:32:45	14:04:09	**2**	**0504232.raw**
	S5042314.B04	190.0W	1885	4851	14:04:12	14:53:39		
	S5042314.B53	200.0W	4852	5016	14:53:39	14:56:25		
	S5042314.B56	190.0E	5017	5224	14:56:27	14:59:56		
	S5042314.B59	200.0E	5225	7895	14:59:59	15:44:30		**363 km**
S5042316.T30	S5042316.B33	170.0E	1	2748	16:33:40	17:19:28	**3**	**0504233.raw**
	S5042317.B19	180.0W	2749	5752	17:19:42	18:09:46		
	S5042318.B09	170.0E	5753	7817	18:09:54	18:44:19		**361 km**
050424								
S5042410.T59	S5042411.B03	330.0W	1	165	11:03:12	11:05:57	**1**	**0504241.raw**
S5042411.T06	S5042411.B07	330.0E	1	1918	11:07:03	11:39:01		
	S5042411.B39	340.0W	1919	4765	11:39:04	12:26:31		
	S5042412.B26	330.0E	4766	6105	12:26:33	12:48:53		**277 km**
050426								
S5042611.T12	S5042611.B14	430.0E	1	1795	11:14:08	11:44:04	**1**	**0504261.raw**
	S5042611.B44	350.0E	1796	1821	11:44:18	11:44:44		
	S5042611.B4E	450.0W	1822	3584	11:44:59	12:14:22		**174 km**
S5042615.T15	S5042615.B19	450.0W	1	1605	15:19:53	15:46:38	**2**	**0504262.raw**
	S5042615.B46	460.0E	1606	3282	15:46:45	16:14:42		
	S5042616.B14	470.0W	3283	5219	16:14:49	16:47:06		
	S5042616.B47	480.0E	5220	6966	16:47:08	17:16:15		**321 km**
S5042617.T40	S5042617.B44	510.0W	1	1835	17:44:14	18:14:49	**3**	**0504263.raw**
	S5042618.B14	520.0E	1836	3292	18:14:51	18:39:08		
	S5042618.B39	540.0E	3293	3901	18:39:12	18:49:21		**185 km**

HELIMAG flight statistics for ANT-XXII/4

TEXT FILENAME	Binary data files	LINE #	FIDUCIAL START	FIDUCIAL END	Time START	Time END	Flight #	ASCII RAW-FILENAME
050427								
S5042710.T58	S5042711.B02	320.0W	1	610	11:02:14	11:12:24	**1**	**0504271.raw**
	S5042711.B12	310.0E	611	2842	11:12:26	11:49:38		
	S5042711.B49	340.0W	2843	4221	11:49:55	12:12:55		
	S5042712.B12	330.0E	4222	5183	12:12:57	12:28:58		
	S5042712.B29	320.0W	5184	8264	12:29:01	13:20:22		**391 km**
S5042714.T13	S5042714.B16	220.0W	1	6411	14:16:37	16:03:28	**2**	**0504272.raw**
								330 km
050429								
S5042911.T31	S5042911.B31	240.0W	1	6874	11:31:17	13:25:51	**1**	**0504291.raw**
								325 km
S5042914.T55	S5042914.B56	230.0W	1	4234	14:56:30	27:44:00	**2**	**0504292.raw**
	S5042916.B07	220.0W	4235	7155	16:07:07	16:55:49		**316 km**
050430								
S5043011.T32	S5043011.B36	450.0W	1	651	11:36:29	11:47:19	**1**	**0504301.raw**
	S5043011.B47	460.0E	652	2903	11:47:22	12:24:53		
	S5043012.B24	450.0W	2903	4843	12:24:55	12:57:16		
	S5043012.B57	470.0W	4844	5812	12:57:20	13:13:30		
	S5043013.B13	480.0E	5813	6936	13:13:33	13:32:17		**323 km**
S5043014.T06	S5043014.B10	540.0W	1	2633	14:10:27	14:54:21	**2**	**0504302.raw**
	S5043014.B54	550.0E	2634	5080	14:54:23	15:35:10		
	S5043015.B35	530.0E	5081	5082	15:35:12	15:35:14		
	S5043015.B3F	540.0W	5083	7000	15:35:17	16:07:15		**326 km**
S5043016.T38	S5043016.B39	550.0E	1	9336	16:39:50	19:15:26	**3**	**0504303.raw**
								415 km
050503								
S5050317.T02	S5050317.B07	550.0E	1	6530	17:07:43	18:56:33	**1**	**05045031.raw**
								319 km
050504								
S5050411.T05	S5050411.B12	210.0W	1	3535	11:12:19	12:11:14	**1**	**0505041.raw**
	S5050412.B11	160.0E	3536	6550	12:11:24	13:01:39		**297 km**
S5050414.T41	S5050413.B45	150.0E	1	94	13:45:55	13:47:30	**2**	**0505042.raw**
	S5050413.B47	140.0W	95	3264	13:47:32	14:40:22		
	S5050414.B40	150.0E	3265	5995	14:40:24	15:25:55		**276 km**
050506								
S5050611.T49	S5050611.B57	160.0E	1	1654	11:57:53	12:25:27	**1**	**0505061.raw**
	S5050612.B25	170.0W	1655	2869	12:25:29	12:45:44		
	S5050612.B45	180.0E	2870	3814	12:45:46	13:01:31		
	S5050613.B01	150.0W	3812	5857	13:01:37	13:35:40		**293 km**
S5050616.T19	S5050616.B20	130.0E	1	1754	16:20:57	16:50:11	**2**	**0505062.raw**
	S5050616.B50	140.0W	1755	3758	16:50:14	17:23:38		
	S5050617.B23	150.0E	3759	5577	17:23:45	17:54:04		**267 km**
050508								
S5050811.T01	S5050811.B07	190.0W	1	6539	11:07:12	12:56:11	**1**	**0505081.raw**
								301 km

HELIMAG flight statistics for ANT-XXII/4								
TEXT FILENAME	**Binary data files**	**LINE #**	**FIDUCIAL START**	**FIDUCIAL END**	**Time START**	**Time END**	**Flight #**	**ASCII RAW-FILENAME**
050510								
S5051011.T11	S5051011.B13	290.0E	1	4510	11:13:41	12:28:51	**1**	**0505101.raw**
								213 km
050512								
S5051211.T04	S5051211.B09	290.0E	1	4327	11:09:30	12:21:27	**1**	**0505121.raw**
								213 km
050516								
S5051613.T30	S5051613.B3F	290.0E	1	5787	13:33:39	15:10:06	**1**	**0505161.raw**
								301 km

Total flight time	61:03:08	hh:mm:ss
Total distance along profiles	10122	km
Days with flight operations	21	d
Days in survey area	29	d
No. of flights	35	d

The wiggle plot shown in figure 3.2 summarizes the data gathered during this expedition. The data were corrected for spikes caused by radio transmissions between the helicopter and the ship, the international geomagnetic reference field (IGRF) was removed and finally the lines were split into single profiles and a systematic adjustment was applied.

During the complete cruise there were no problems with the sensor system and/or the data acquisition computer. It should be noted that, contrasting to helicopter magnetic operations in the Arctic and Antarctic regions, here, the Caesium sensor had to be oriented in an upright position to receive the appropriate signal strength. Test flights carried out at the beginning of the cruise resulted in heading errors of up to 120 nT using a more inclined position of the sensors head.

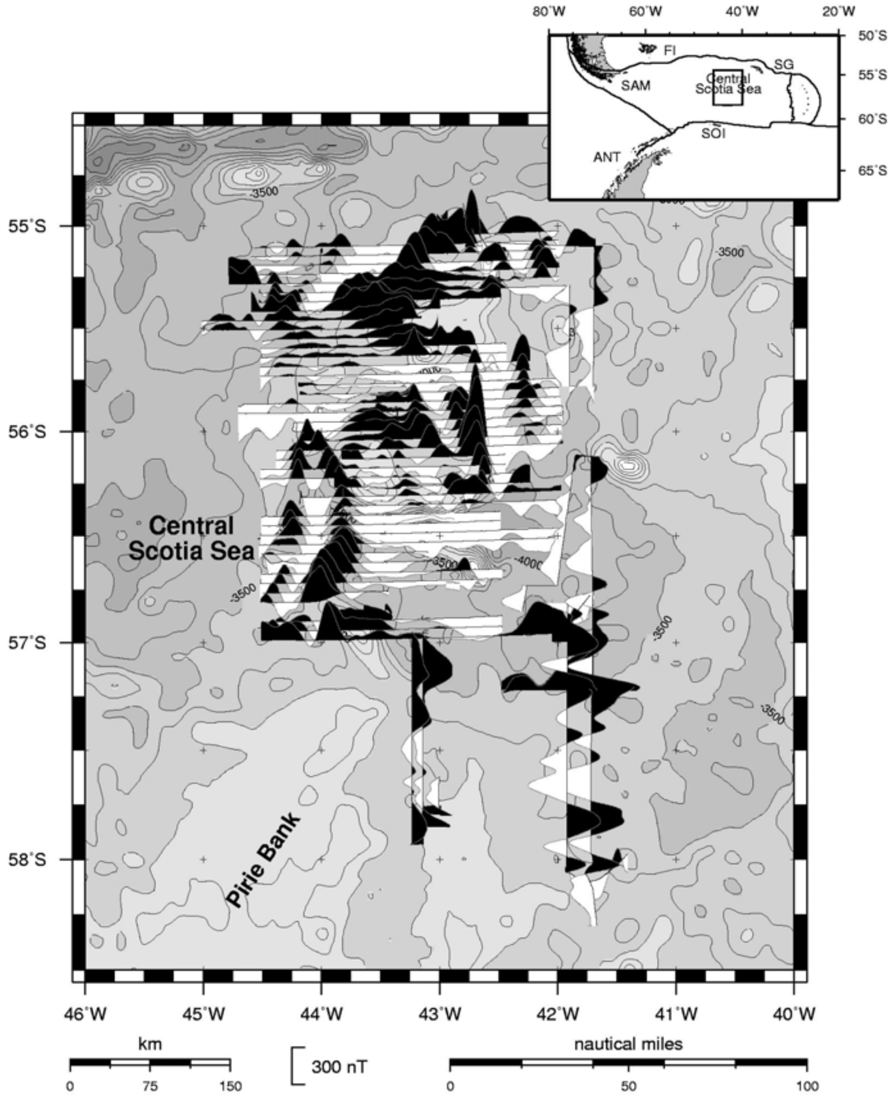


Fig.3.2: Wiggle plot of all helicopter flights. Black colour represents positive magnetic anomalies

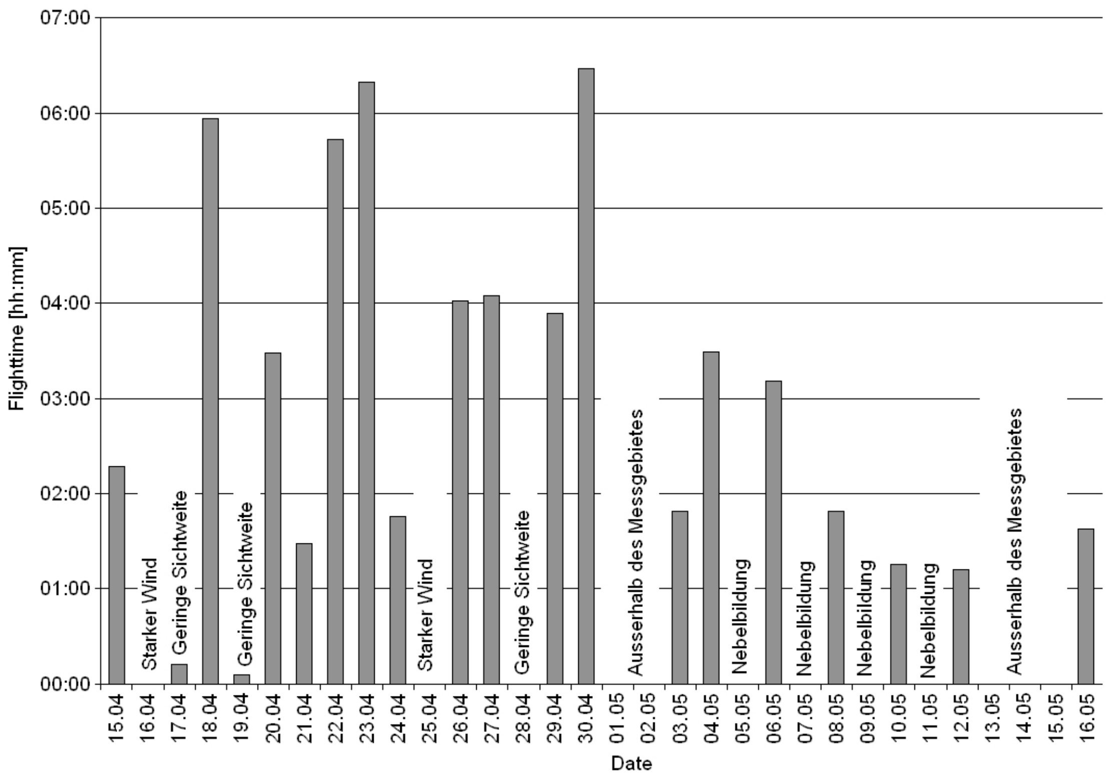


Fig. 3.3: Total time of flight operations per day

3.3 Magnetic base station (Signy)

Mathias König, Julia Lindner Volker Leinweber
Alfred Wegener Institute, Bremerhaven

A magnetic base station has been deployed on Signy Island, South Orkney Islands, near the British summer station *Signy* (60° 43' S, 45° 36'W) about 500 km distant from the survey area. A proton magnetometer from Geometrics Inc., model G856, was used to continuously record the daily variations of the geomagnetic field. These data are later used to correct the magnetic measurements carried out by helicopter and ship during the 4 weeks in the survey area.

Due to uncertainties about the proper functionality of the external data storage device a daily routine has been set up to manually copy the data from the internal memory of the magnetometer to a laptop by serial data transmission. Since no solar panel was available the base station had to be run only by battery. Due to a sampling rate of 10 sec and cold and stormy weather conditions the batteries had to be recharged several times during the field work.

Data acquisition started on 12 April 2005 and ended on 15 May 2005. During this time data acquisition was only interrupted for data transfer for about 30 minutes each day. Additional distortions were caused by a break down of the power supply due to low batteries. These break downs caused data gaps of several hours.

At the end of the expedition a first analysis of the data showed that for unknown reasons almost 40% of the data are distorted by severe spikes. Thus, only parts of the data can be used for the correction of the helicopter and ship borne magnetic data.

However, in figure 3.4 there are 2 examples shown for days without spikes. The variations shown for 21 April 2005 are representative for a magnetically quiet day. Maximum peak to peak amplitudes of less than 25 nT occur at about noon each day. Although 20 April 2005, is magnetically one of the most disturbed days during the 4 weeks in the survey area, amplitudes are still less than 50 nT. No strong magnetic variations or storms occurred throughout the complete cruise, which reduces the amplitude of the corrections to be applied to the helicopter and ship data to less than 50 nT.

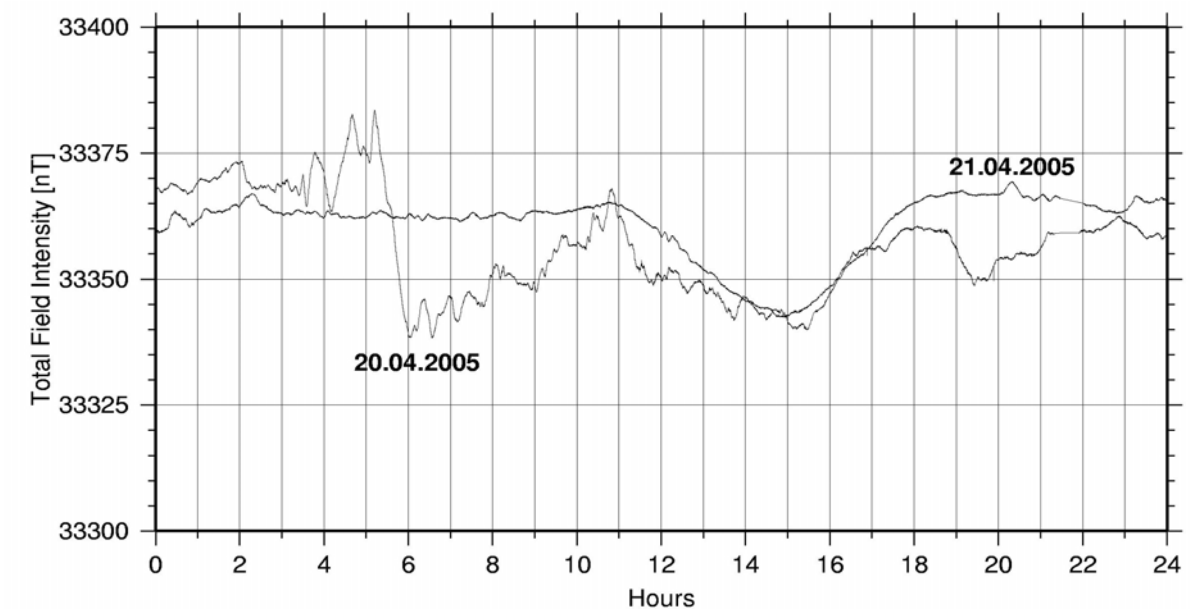


Fig. 3.4: Examples for the daily variations of the geomagnetic field during the expedition ANT-XXII/4

3.4 Shipborne gravity

Mathias König[1)], Julia Lindner[1)], Volker Leinweber [1], Vladimir Udintsev[2)]),

[1)]Alfred Wegener Institute, Bremerhaven,
[2)] Vernadsky Institute of Geochemistry and Analytical Chemistry

To tie the gravity measurements carried out at sea to the international gravity standardisation network (IGSN) and for quality control calibration measurements at known absolute gravity points have been made in Punta Arenas, Chile, and Bahia Blanca, Argentina, at the beginning and the end of the cruise. The onboard gravity meter consists of a KSS 31 sea gravity meter by Bodenseewerke and the calibration measurements were performed using LaCoste & Romberg land gravity meters (model no. G-877, G-1031).

In Punta Arenas an international gravity point exists in front of the harbour administration building (Administracion del Puerto) of the old harbour next to the town, called Puerto del Estrecho (Fig. 3.5). This point is marked by a metal blade labelled IGM 196. Its absolute gravity value is 981320.87 mgal.

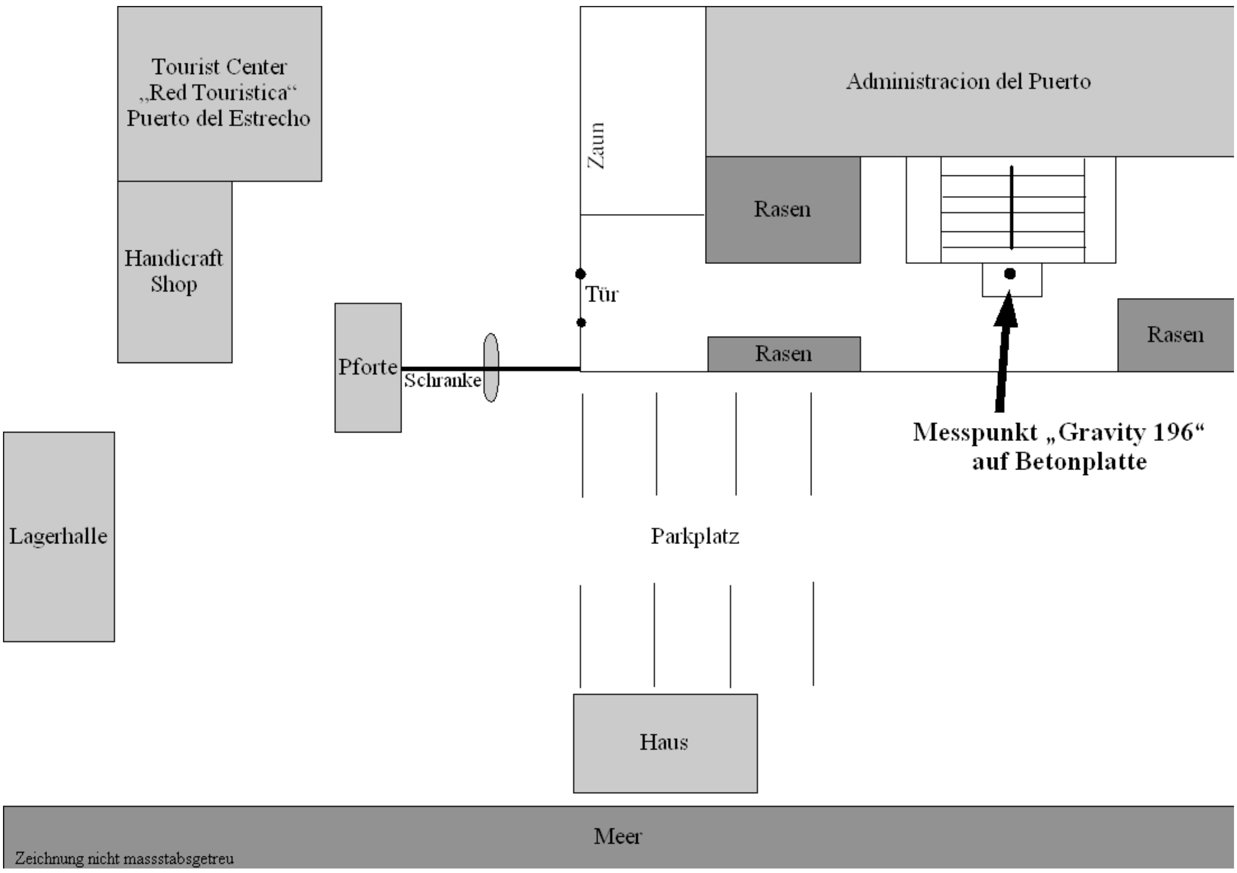
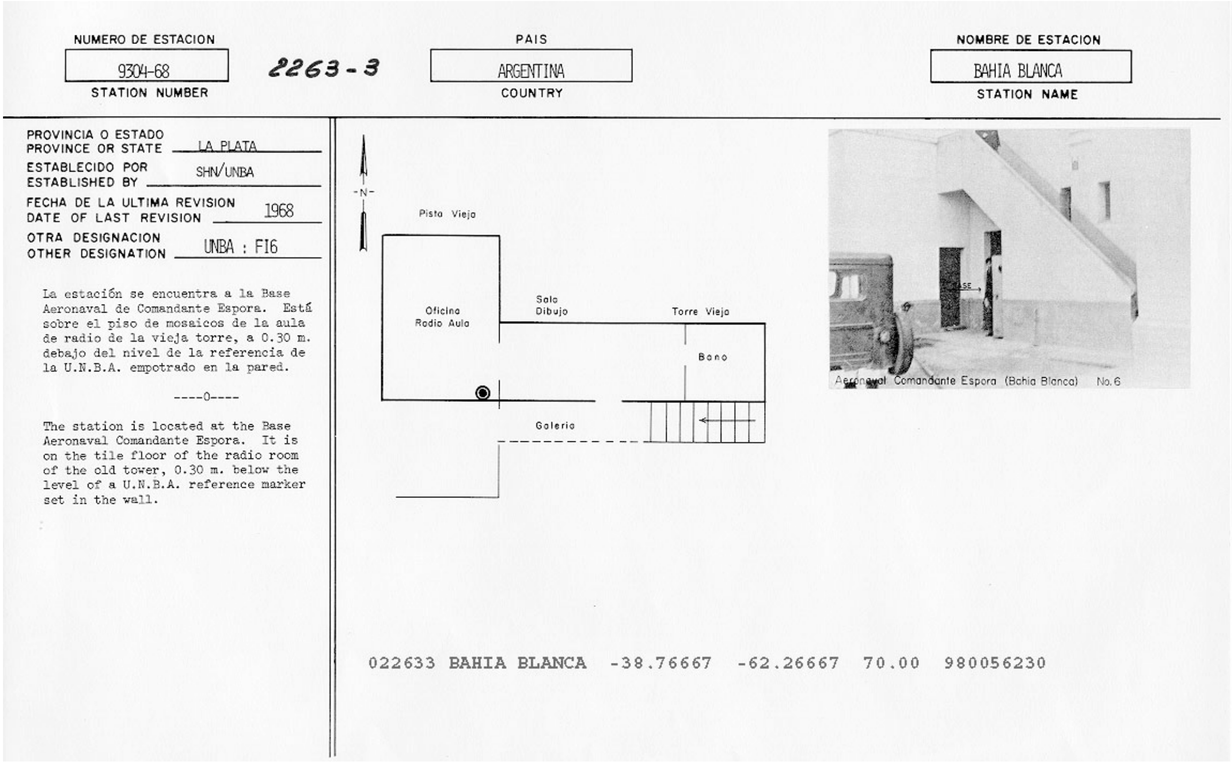


Fig. 3.5: Principal map of buildings and places around gravity point IGM 196 in Punta Arenas



NUMERO DE ESTACION 9304-68 STATION NUMBER

2263 - 3

PAIS ARGENTINA COUNTRY

NOMBRE DE ESTACION BAHIA BLANCA STATION NAME

PROVINCIA O ESTADO / PROVINCE OR STATE: LA PLATA
ESTABLECIDO POR / ESTABLISHED BY: SHN/UNBA
FECHA DE LA ULTIMA REVISION / DATE OF LAST REVISION: 1968
OTRA DESIGNACION / OTHER DESIGNATION: UNBA : FI6

La estación se encuentra a la Base Aeronaval de Comandante Espora. Está sobre el piso de mosaicos de la aula de radio de la vieja torre, a 0.30 m. debajo del nivel de la referencia de la U.N.B.A. empotrado en la pared.

----0----

The station is located at the Base Aeronaval Comandante Espora. It is on the tile floor of the radio room of the old tower, 0.30 m. below the level of a U.N.B.A. reference marker set in the wall.

022633 BAHIA BLANCA -38.76667 -62.26667 70.00 980056230

Fig.3.6: IGSN station description for absolute gravity point in Bahia Blanca

In Bahia Blanca the IGSN station no 9304-68 at the Base Aeronaval Comanande Espora has been used as reference (Fig. 3.6). Its absolute gravity value is 980056.230 mgal.

At both locations shipside measurements on the pier were performed with the LaCoste & Romberg gravity meters in order to connect the measurements made at the absolute gravity points with the gravity measurements onboard the ship.

Data acquisition with the shipboard gravity meter started on 8 April 2005 in Punta Arenas while conducting the calibration measurements in the harbour and ended on 23 May 2005 after the final measurements have been made in Bahia Blanca. Sampling rate was 1 Hz.

Problems with the gravity meter occurred in the time between 14 April 2005 and 16 April 2005. For several times the gravity sensor system completely shut down due to malfunctions of the stabilisation platform. The pitch gyro for stabilising the platform in cross direction appeared to be unstable. Maybe the gyro gets too old and should be changed during the next time in the shipyard.

After 16 April 2005 the sea state filter was set to 4 (normally a sea state of 2 is used when sailing on open water) until the end of the cruise. No further problems were experienced with the gravity meter during the rest of the cruise.

Initial data processing of the 1 Hz raw data was performed during the cruise. A wiggle plot of the free-air gravity anomaly after performing an Eötvös and normal field correction is shown in figure 3.7. For this figure the data were low-pass filtered using a 2 km median filter.

A more detailed analysis and estimation on the accuracy of the gravity meter system was made with raw data using only every 10th data point (0.1 Hz). In a first step erroneous values were deselected from the raw data using the following criteria and algorithm. Data were discarded if

- the first derivative of the Eötvös acceleration was larger than 0.03 mgal/sec and/or if
- the deviation of ship's course was larger than 13°.

  Course deviation (*cdev*) was calculated using the following formula:

$$cdev_i = \sqrt{\frac{\sum_{j=-n}^{n}(course_{i+j} - course_{i-1+j})^2}{2n+1}}$$

$$n = 5$$

Applying these criteria to the raw data about 14 % of all data were discarded as shown in table 3.3.

Table 3.3: Data selection

Eötvös	Course deviation	Discarded points n.	%
Yes	Yes	2109	0.65
Yes	No	18559	5.73
No	Yes	24484	7.56
Not discarded		278765	86.06
Total		323917	100.00

Data accuracy was determined from the evaluation of repeated crossings of the same points during the cruise. This cross point analysis was performed once with the raw and once with the selected data. Cross points were defined by a distance between the measurements along different tracks of less than 100 meters and a difference in time of more than 12 hours between the individual crossings. If more than one point satisfied these criteria the point nearest to the initial points was used. Using this selection scheme 137 cross points were found in the raw data and 75 were found after discarding the raw data. According to this the mean cross point error and thus data accuracy is about 6.74 mgal before and 2.20 mgal after data cleaning. figure 3.8 shows the distribution of the cross point errors through time.

The selected 0.1 Hz data were used to calculate a free-air gravity anomaly grid. This has been filtered by a Boxcar 10 kilometre filter and calculated on a cell size of 30 x 30 sec. Figure 3.9 shows a grey shaded relief map of the calculated grid.

A Bouger anomaly grid was calculated by using smoothed bathymetry data (Gaussian 20 km filter) and a rock density of 2.67 g/cm^3 and a water density of 1.03 g/cm^3 for reduction. This is shown as a shaded relief in figure 3.10.

Finally, a topographic reduction was calculated. Therefore the field of thin vertical cylinders has been integrated over an area twice as large as the survey area. The formula used to calculate the topographic effect is shown below:

$$\Delta g = \sum_{i,j} G \cdot \rho \cdot Sij \frac{1}{\sqrt{r_{ij}^2 + z_{ij}^2}}$$

$$\Delta g = 6.67 \cdot (\rho_{rock} - \rho_{water})(\sum_{i,j} Sij \frac{1}{\sqrt{r_{ij}^2 + z_{ij}^2}} - \sum_{i,j} Sij \frac{1}{\sqrt{r_{ij}^2 + 1}}) - 41.9$$

The following variables are used:

S	Area in square kilometres
r	Distance in kilometres
z	Depth in kilometres
ρ	Density of water and rock in g/cm^3

The topographically corrected gravity anomaly grid is shown in figure 3.11.

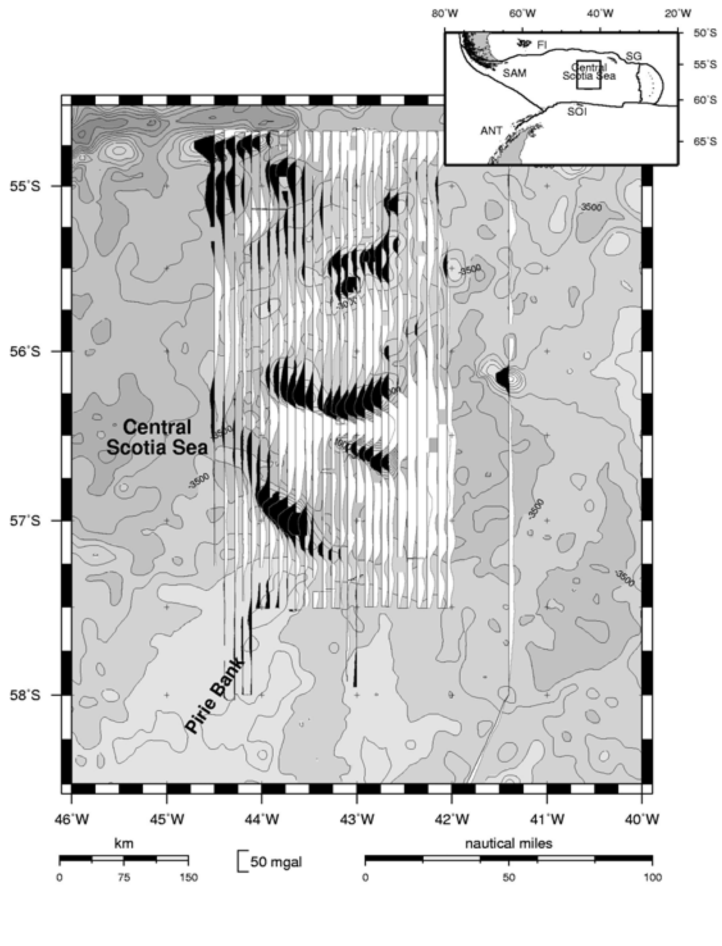


Fig. 3.7: Wiggle plot of the free-air gravity anomaly. Black colour denotes positive anomalies.

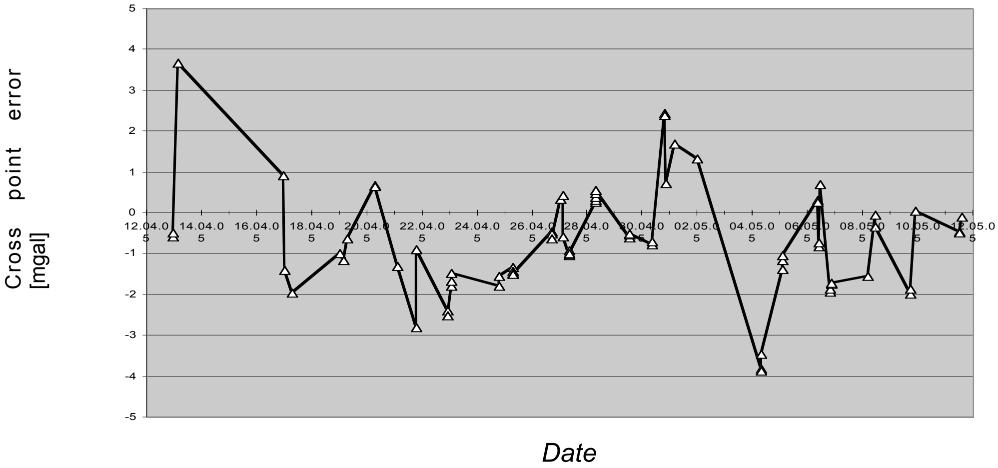


Fig. 3.8: Cross point errors after cleaning the data for bad values

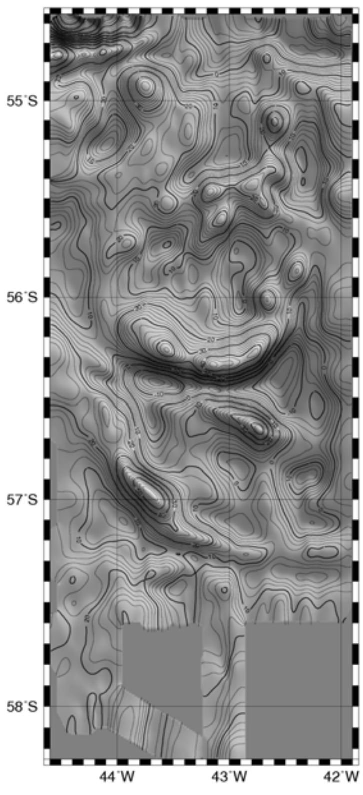


Fig. 3.9: Free-air gravity anomaly map

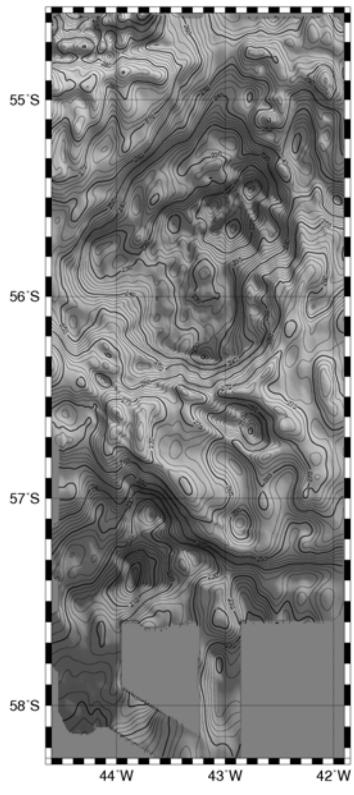


Fig. 3.10: Bouger anomaly map

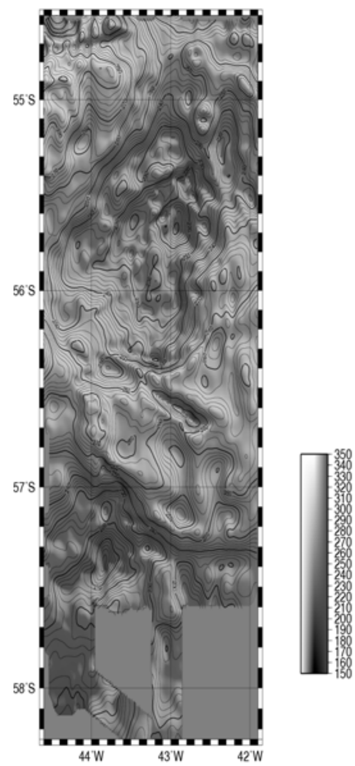


Fig. 3.11: Topographically corrected Bouger anomaly map

4. MARINE GEOLOGY

Gerhard Kuhn, Andreas Borchers, Patrycj Gregorowicz, Dietmar Penshorn, Patrick Simundic
Alfred Wegener Institute, Bremerhaven

4.1 Objectives of marine geological mapping and sampling

Gerhard Kuhn
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The main goal of our long-term study is the reconstruction of the paleoclimatic and paleoceanographic development of the late Quaternary south polar ocean and adjacent continental areas in high temporal and spatial resolution. In this context the Scotia Sea represents a key area of the Southern Ocean for understanding climate-regulating factors. The evolution, spatial, and temporal variations of the Antarctic Circumpolar Current (ACC) should leave their signals in the sedimentary record of this area, which forms a gateway for the ACC. Grain size variations in the sediment column could be a record of intensity changes of paleocurrent velocities. In addition the study area allows monitoring of past variability of the eolian import of dust from Patagonia and terrigenous material from both Patagonia and Antarctic Peninsula. This will point to the question of natural iron fertilization and its impact on Southern Ocean productivity regimes and related removal and burial of organic compounds (e.g. organic carbon, biogenic opal). Past changes of sea ice seasonality and extent, which exerts major control on the formation of water masses, biological productivity and ocean/atmosphere gas and heat exchange, will be investigated.

Previous studies have demonstrated that Holocene and Pleistocene sediments have been deposited in parts of the Scotia Sea at high sedimentation rates allowing reconstructions of past climate and Southern Ocean conditions at up to centennial resolution. Such sedimentary sequences are ideal oceanic climate archives to be compared with continental ice core records (e.g. EPICA ice cores).

As a goal of this expedition the sedimentary budget of biogenic and terrigenous components and their variability will be investigated. We like to get answers on the relationships between production of biogenic components and input of terrigenous components and involved fertilization. Therefore in addition to the surface samples we took long sediment cores (Tab. 4.1) for the following investigations:

- high resolution stratigraphy of the obtained sediment sections (isotope stratigraphy, AMS 14C age determinations, magnetic susceptibility),
- terrigenous sediment supply and paleocurrent reconstructions (high-resolution granulometry, bulk and clay mineralogy, heavy minerals, geochemical tracers),

- variations and budgets of biogenic and terrigenous components during glacial and interglacial,
- correlation of marine sediment sequences with Antarctic ice core.

Most important tool on board for identification, characterization and quantification of seafloor sediments is the PARASOUND sub-bottom echosounder. For the period of the cruise ANT-XXII/4 an area of more than 15,000 nm^2 was mapped systematically with the Parasound system. All together 9500 nm have been profiled in total distance. Parasound is a high-resolution sub-bottom echosounder, which operates with two primary frequencies that generate a parametric frequency in the water column. With this effect a variable resulting secondary frequency at 2.5 to 5.5 kHz can be used for sub-bottom profiling, depending on the scientific question. During the whole leg the following settings were used: PAR Frequency 4 kHz, 2 Periods/Pulse length, A/D frequency 50 kHz and a frequency filter at 2 - 6 kHz. Sensor operation mode was PAR-Pilot, in case of wrong or missing water depth data NBS-PAR was used.

During the first three weeks, the system was running quite stable. After that time failures increased (up to three crashes per week) and system restores were indispensable.

Based on two channels, Parametric and NBS signals were recorded and saved on different data storage units as *.asd and *.ps3 files. After real-time recording on a local hard disk, all files were copied to the main server and a second PC for post-processing, followed by recording on LTO-Tapes containing 200 GB storage capacity. Approximately 460 GB of data were stored. In addition to that, PS3-Files were burned on DVD for mapping the sediment echo types and penetration depths within the scope of a diploma cartography (by Andreas Borchers, University of Leipzig) using a Geographical Information System (GIS).

Sub-buttom profiling is not only a tool for gathering information about sediment accumulation and erosion areas but it is also used for locating drilling positions. The sediment acoustic information from Parasound at each location can be compared after piston coring with data received by measuring physical parameters on the sediment cores with the multi-sensor core logger (MSCL). Out of these examinations it is possible to correlate reflectors with sediment boundaries from the cores.

In the investigation area four accumulation centres occur with penetration depths up to 130 m (Fig. 4.1). Drift sediments are quite common. Sediment slumps of multiple events appear in regions with steep morphologies and low to high sedimentation rates.

Stations for taking geological samples from the seafloor could be planned only with the information from PARASOUND data. The echosounding data recovered during transit between stations are very important for new input for the following goals and targets:

- to map sediment distribution patterns on transects across the Polar Frontal Zone (areas of non deposition and high accumulation),

- to interpolate sediment budget and figure out transport processes of terrigenous and biogenic components to the sea-floor during past climate periods,
- to discover areas with sediments of high temporal resolution,
- to provide information for the selection of core locations (site surveys for future expeditions).

Sites for sampling the seafloor were selected according to the PARASOUND data. All together 7 surface samples were collected with the Multicorer (MUC) and 8 long sediment cores with the piston corer (Tab. 4.1). Due to effective PARASOUND pre-site survey none of the sampling attempts failed.

4.2 Micropaleontological sampling

Patrycj Gregorowicz
Alfred Wegener Institute

To collect surface sediments and water from directly above the sea-floor the Multicorer device (MUC) with 12 tubes (each 6 cm Ø) was used. These short cores, together with long sediment records obtained from piston cores will provide complete data sequence for reconstructions of palaeoenvironmental conditions in the Scotia Sea area.

59 MUC cores at 7 stations have been taken (Tab. 4.2). Only at 1 position all of the tubes were filled with sediment, while at 6 stations the core amount ranged between 7 and 11.

Surface sediments were sampled as follows:

- one core every 1 cm for micropaleontological studies,
- two cores from 0 to 6 cm every 1 cm, then in 4 cm intervals one-cm-thick samples were taken for sedimentological analyses,
- one complete core deep frozen immediately for geochemical examinations.

Sampling contained also core surface water and the topmost, thin sediment layers (so-called “fluff” layers) recovered as additional information source for micro-paleontological studies.

At 4 core positions surface water samples for opal isotopes analyses were collected, using membrane pumping system and 10-micromesh size gaze (Tab. 4.3).

In addition as a part of the geological tasks 208 surface-water samples were collected in the work area, using a ship born membrane-pumping system (water depth ca. 7 m).

At each station (Fig. 4.3) two samples were taken, one filtered with 10-micromesh size gaze and second with 41-micromesh size gaze. Water filtration process lasted at least 15 minutes. After this time micro nets were transferred to the 100 ml Kautex bottles and 0.5 ml of formalin was added for preservation. Further information was noted at the sampling positions: date, hour, coordinates, water flow rate, salinity, water temperature, water depth, and general weather conditions.

Those surface water samples contain information about modern distribution pattern of siliceous microplankton (e.g. diatoms) in the Scotia Sea and their environmental and ecological demands. On this basis it will be possible to define indicative species and assemblages – an useful tool in palaeoenvironmental and palaeoclimatological reconstructions.

4.3 Physical properties of the sediment cores

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Sediment cores were taken with a piston corer (KOL) on 8 stations during the cruise (Tab. 4.1). Physical properties like sediment density, p-wave velocity, and magnetic susceptibility were measured on the collected sediment cores with a GEOTEK multi-sensor core logger (MSCL). For calculation of these values core diameter and temperature were measured in addition (Tab. 4.1).

For calibration the following parameter were used in the logger settings of the MSCL software (version 6) or afterwards.

- Temperature sensor calibrated with Hg-thermometer.
- Core thickness (displacement) calibrated with distance pieces.
- P-wave travel time calibrated with a water core of known temperature and theoretical sound velocity.
- PTO offset for piston corer (KOL) 8.24 µs (Tab. 4.2)
- Gamma ray attenuation measurement and density calculation with equation type $y=-Ax^2+Bx+C$.

The coefficients A, B, and C were determined with measurements on calibration cores with defined density steps (GEOTEK calibration software) for the piston corer $y = 0.0004x^2 - 0.0725x + 8.8914$, $R^2 = 0.9998$. A and B, the linearity of the detector, were constant during the cruise. C, the sensitivity of the detector (I0 drift), was variable (Fig. 4.4) and determined with a constant attenuation measurement (PVC-core) before each sediment core measurement. The values are stored in the calibration files for each core and the variability of ln (Io) for the piston corer (Fig. 4.4) reached maximum –1% deviation (PS67/206-1).
Magnetic susceptibility

- Data were stored as sensor units and calculated for volume magnetic susceptibility (Tab. 4.4). Corrections for sensor drift during measurement and recalculation of core top and bottom data were applied.
  Piston corer sensor units times 6.926.

All data were graphically controlled and bad values at core section boundaries were removed.The data will be stored in the database PANGAEA (www.pangaea.de).

First results and comparison with studied sediment cores show nicely recorded cycles in magnetic susceptibility variations in core PS67/185-3, low resolution, and core PS67/224-1 higher resolution sediment record. Low values are characteristic for warm climate periods (Holocene, marine isotope stage 5) with high accumulation of biogenic silicate. During cold climate periods accumulation of terrigenous material was higher and increases magnetic susceptibility values (Fig. 4.5).

References

Spiess, V., Digitale Sedimentechographie- Neue Wege zu einer hochauflösenden Akustostratigraphie, Berichte aus dem Fachbereich Geowissenschaften der Universität Bremen, 35, 1-199, 1992.

Table 4.1: List of surface sediment samples and sediment cores from ANT-XXII/4

CORE_ID	DATE	TIME	LONG W	LAT S	WATER DEPTH (m)	RECOVERY (m)	REMARKS
PS67/182-1 KOL	12.04.2005	16:36:00	45°15.72	60°65.44	364	18.43	TC 0.69
PS67/182-2 MUC	12.04.2005	17:29:00	45°15.72	60°65.44	363	11 x 0.42	
PS67/185-1 MUC	13.04.2005	21:42:00	37°52.22	59°30.83	2944	7 x 0.34	
PS67/185-3 KOL	13.04.2005	23:32:00	37°52.22	59°30.83	2932	22.58	TC 0.59
PS67/186-1 KOL	14.04.2005	12:00:00	40°87.11	59°16.47	3671	23.93	no TC
PS67/197-1 KOL	23.04.2005	18:25:00	43°50.78	54°56.22	3837	23.37	TC 1.00
PS67/197-4 MUC	23.04.2005	20:44:00	43°50.78	54°56.22	3822	12 x 0.37	
PS67/205-2 KOL	28.04.2005	11:17:00	42°92.92	56°50.31	3790	19.27	TC 1.07
PS67/205-4 MUC	28.04.2005	13:32:00	42°93.45	56°50.22	3787	7 x 0.34	
PS67/206-1 KOL	28.04.2005	20:45:00	43°09.75	57°01.72	3206	23.67	TC 0.73
PS67/206-3 MUC	28.04.2005	22:45:00	43°09.75	57°01.86	3212	8 x 0.37	
PS67/219-1 KOL	10.04.2005	12:28:00	42°11.17	56°70.06	3619	20.71	TC 0.86
PS67/219-3 MUC	10.04.2005	14:20:00	42°11.31	56°70.06	3616	7 x 0.30	
PS67/224-1 KOL	14.04.2005	5:20:00	43°66.08	57°90.47	2868	22.01	TC 0.93
PS67/224-3 MUC	14.04.2005	7:09:00	43°65.89	57°90.72	2887	7 x 0.33	

Table 4.2: List of multicorer sampling during ANT-XXII/4

Station number	Latitude	Longitude	Water Depth (m)	Amount	Lenght (cm)	Amount of sampled cores DF	MicroPal	Sed
PS 67/182-2	60°47.55	45°29.64	363.4	11	0-41.5	1	1	2
PS 67/185-1	59°35.10	38°05.80	2944	7	0-34	1	1	2
PS 67/197-4	55°08.59	44°05.64	3822	12	18-37	1	1	2
PS 67/205-4	56°42.08	43°21.64	3787	7	0-33.5	1	1	2
PS 67/206-3	57°24.62	43°27.51	3212	8	0.36-5	1	1	2
PS 67/219-3	57°43.22	42°28.07	3616	7	0-30	1	1	2
PS 67/224-3	57°56.66	44°11.73	2867	7	0-33	1	1	2

DF: deep-frozen
MicroPal: for micropaleontological analyses
Sed: for sedimentological analyses

Table 4.3: List of filtrate from surface water samples for opal isotopes analyses

Nr	Date	Hour UTC	Latitude	Longitude	Salinity [psu]	Water temp. [°C]	Water depth [m]	Flow rate [ml/sec]	Gaze [µm]
1	23.04.2005	17:39	55 08.354 S	44 06.244 W	33.73	2.45	3835	380/30	10
2	28.04.2005	11:35	56 42.129 S	43 21.464 W	33.04	1.24	1790	150/30	10
3	10.05.2005	11:47	57 13.222 S	42 28.127 W	33.98	1.09	3618	250/30	10
4	14.05.2005	8:11	57°58.451 S	44°05.204 W	34.17	0.58	2896	230/30	10

Table 4.4: Sensors and parameter settings for measurements with the GEOTEK multi-sensor core logger during ANT-XXII/4

P-wave velocity and core diameter plate-transducers diameter: 4 cm transmitter pulse frequency: 500 kHz pulse repetition rate: 1 kHz recorded pulse resolution: 50 ns gate: 2800 delay: 10 ms P-wave travel time offset: 8.24 µs (KOL, 2*2.7 mm liner thickness) temperature = 20 °C, salinity = 35 psu, not corrected for water depth and in situ temperature.
Temperature bimetal sensor
Density gamma ray source: Cs-137 activity: 356 MBq energy: 0.662 MeV aperture diameter: 5.0 mm (SL+KOL) gamma ray detector: Gammasearch2, Model SD302D, Ser. Nr. 3047, John Caunt Scientific Ltd.; count time 10 s
Fractional porosity Mineral grain density = 2.75, water density = 1.026
Magnetic susceptibility coil sensor: BARTINGTON MS-2C, Ser. Nr. 207 (KOL) nominal inner coil diameter: 10 cm coil diameter: 10.8 cm alternating field frequency: 565 Hz, count time 10 s, precision 0.1 * 10^{-5} (SI) magnetic field strength: ca. 80 A/m RMS Krel: 1.44 (KOL, 8.46 cm Kern-ø) coil sensor correction factor: 6.926 (KOL) for 10^{-6} (SI)
Core thickness measurement Penny + Giles, Type HLP 190…, Ser #. 92730147

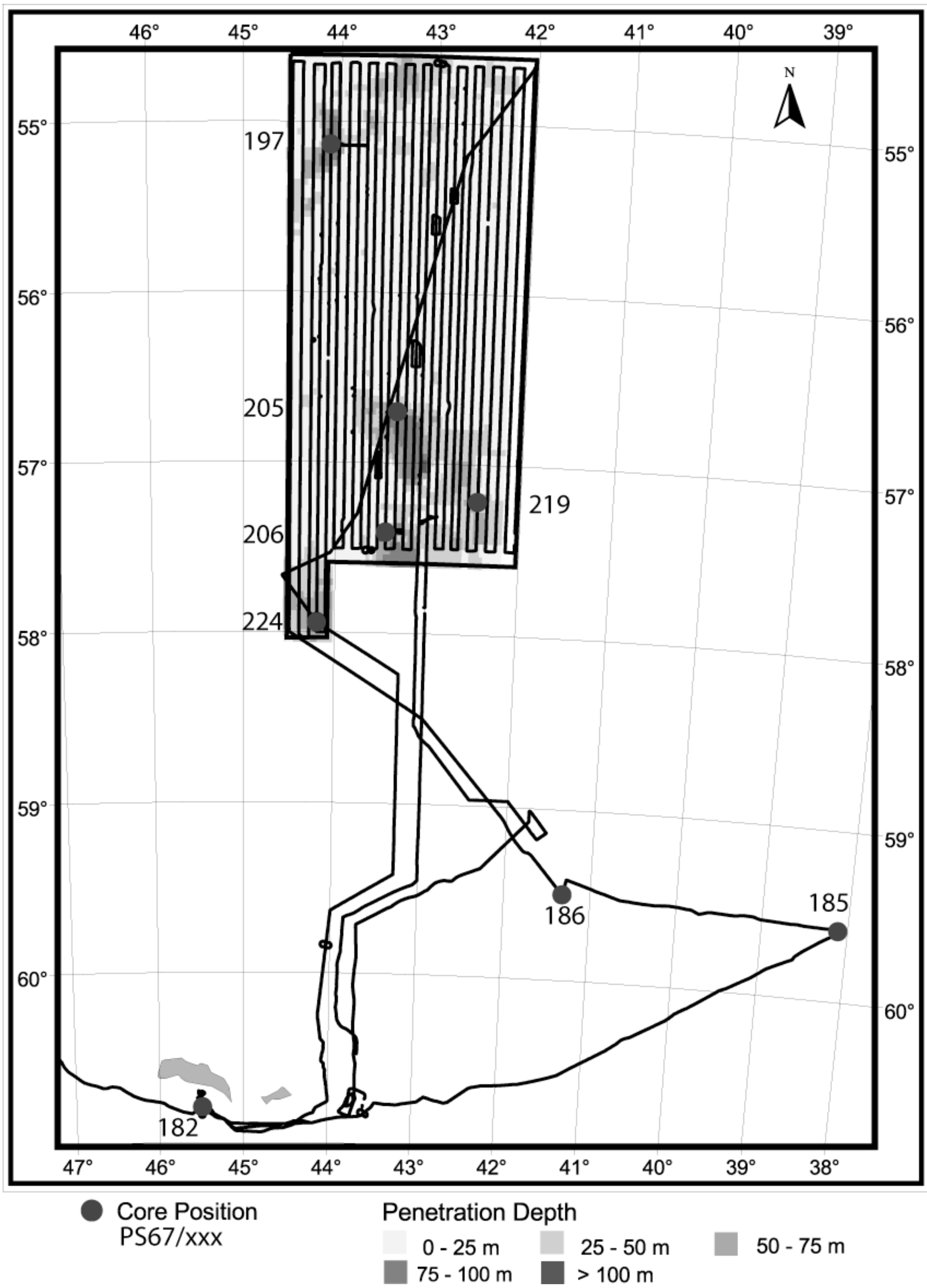

Fig. 4.1: Cruise track, sampling positions, and Parasound sediment penetration depths in the central Scotia Sea area

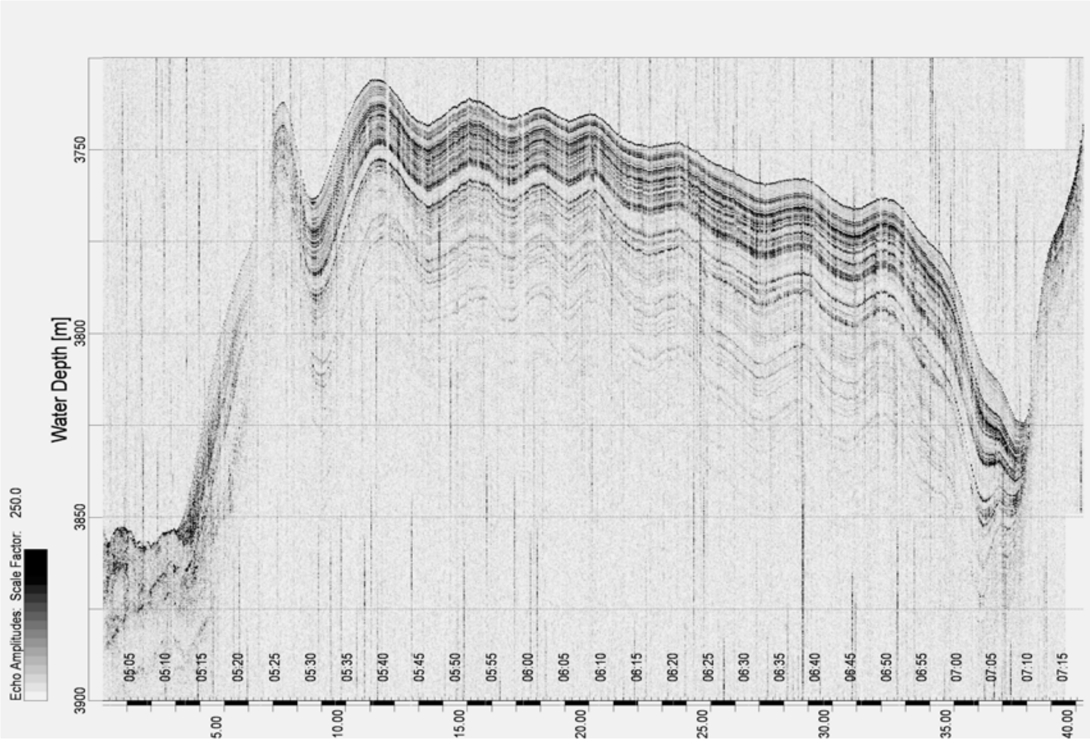

Fig. 4.2: Parasound profile from 27.04.2005 at 57°S 43°21'W to 56°37'S 43°21'W with sampling position (PS67/205) at 6:45 UTC

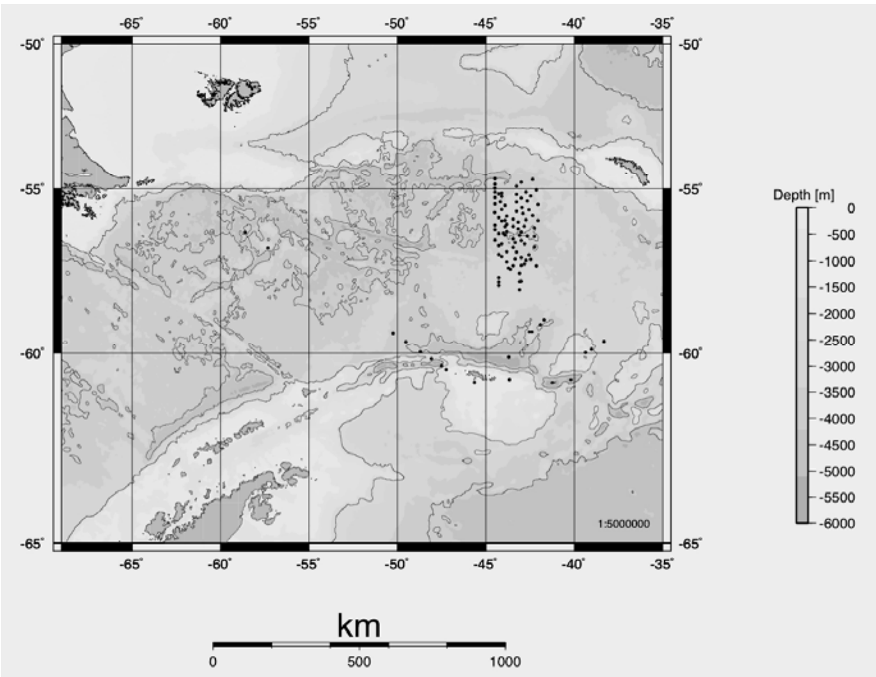

Fig. 4.3: Stations for filtrate from surface water samples for micro-paleontological investigations

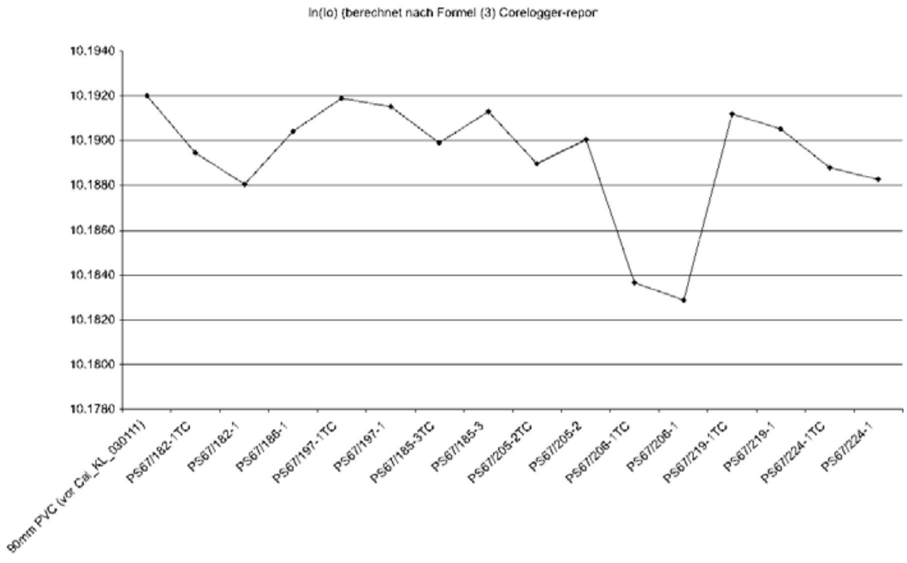

Fig. 4.4: Stability of the I0-gamma attenuation measured during the cruise before measuring the piston corer sediment cores

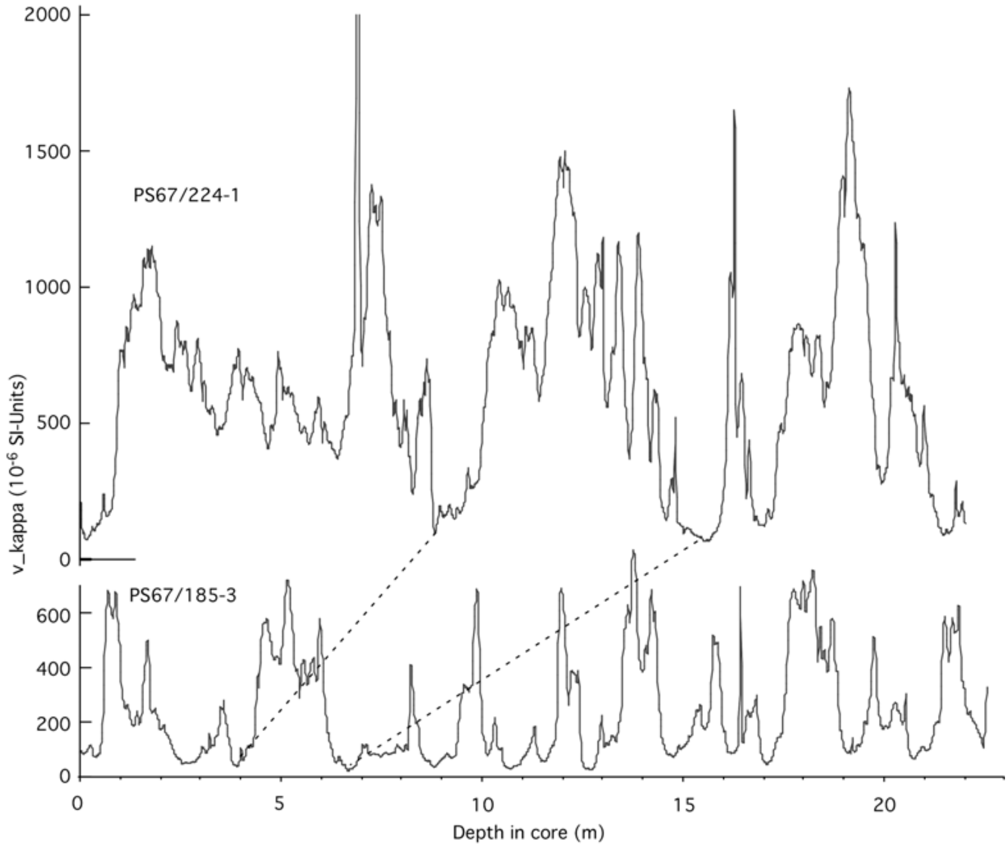

Fig.4 5: Volume corrected magnetic susceptibility values from sediment cores PS67/185-3 and PS67/224-1 and possible correlation

5. MARINE BIOLOGY

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The prymnesiophyte *Phaeocystis* is a cosmopolitan, ecologically important genus that contains also two colony-forming cold water species, *Ph. pouchetii* in the Arctic and *Ph. antarctica* in the Antarctic. First results about their genetic diversity have been obtained by molecular biological analyses, showing substantial inter- and intraspecific diversity and first attempts have been made to trace the biogeographical history of strains in Antarctic coastal waters. A more detailed analysis of the population structure of *Ph. antarctica* is necessary to study the genetic diversity inside populations from different locations and the gene flow between them. For this analysis, microsatellite markers (short: highly polymorphic repetitive sequences) will be developed and used to analyse the genetic diversity in a large number of clones from different locations at Antarctic coastal waters. The main purpose of the biological programme on this cruise was to obtain of these isolates of *Ph. antarctica* from different locations in the Antarctic region. This was done by using a 21 µm plankton net (surface samples) and the ship-borne membrane pumping system (water depth ca. 7 m). While the membrane pumping system could be used at any time of the day, the plankton net sampling was only done if the ship was not moving. After taking the surface samples with the plankton net these samples were first filtered through a 41 µm gauze and then through a 10 µm gauze. The filtrate obtained was reverse filtered to the top of a 3 µm filter (millipore) and resuspended in K- media and 0,2 µm filtrated seawater (1:1). The top of the two different gauzes were carefully examined by using a microscope at 25 and 40 x magnifications. Several *Phaeocystis* stages could be isolated under a binocular microscope at 10 x magnification into 12 well plates or Petri dishes filled up with K- media and filtered seawater (1:1). A colony of the species is shown in figure 5.1 A. This work was carried out in a 15 °C lab container with immediate access to the 0 °C culture room. If the membrane pumping system was used, two samples were usually taken, one filtered with 10 µm gauze and the second with 41 µm gauze. The water filtration process lasted at least 15 minutes. Afterwards the gauzes were transferred into ceramic bowls and microscopically searched through for *Phaeocystis*. The filtrate of the 10 µm gauze was also reversely filtrated on the top of a 3 µm filter and resuspended as shown in the workflow scheme in figure 5.1 B. All sample locations are shown below in table 5.1 and figure 5.2.

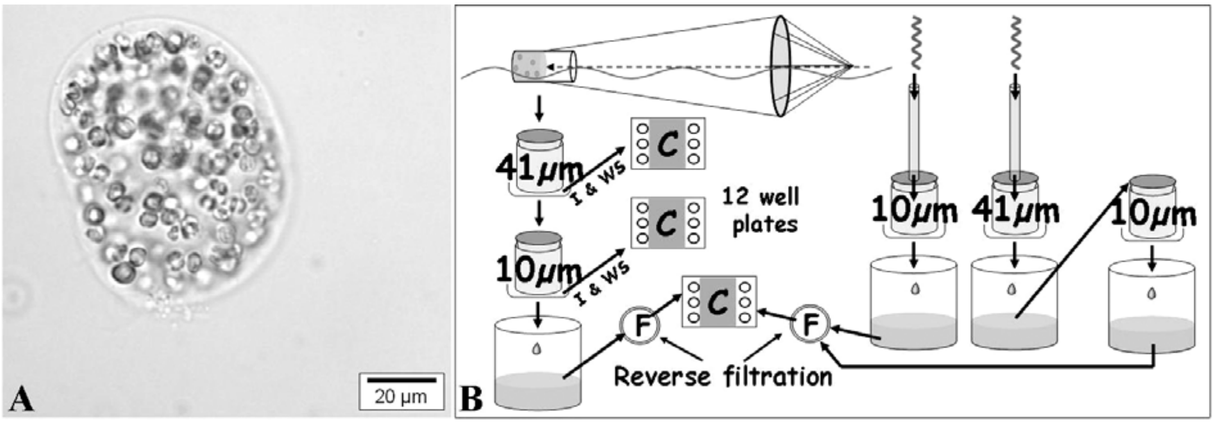

Fig. 5.1: A) Colony of Phaeocystis antarctica, *B) Work flow scheme of the carried out sampling methods on board of RV Polarstern in the Antarctic Region.*
Left: plankton net sampling, Right: ship-borne membrane pumping system,
I = isolates, WS = water samples, G = gauze, F = 3 µm filter, C = cultures

Table 5.1: Sampling overview

No.	Date	Gaze, filtriert (f), Top (T)	(P), (N), (E)	Flow rate ml/sec	latitude (S) start	longitude (W) start	latitude (S) end	longitude (W) end	Water temp. (°C) start-end	Water depth (m) start-end	3 µm Filter	Water sample	Isolate
1	10.04.05	10 µm(f)	P	560/30	56°54.209	57°19.240	56°54.209	57°14,774	4,98-4,75	2383-3347	1	0	0
2	11.04.05	41 µm (f)	P	300/30	59°25,626	50°14.889	59°27.513	50°09.450	1.19-1.22	3786-3789	3	0	0
3	11.04.05	10 µm (f)	P	230/30	59°40.770	49°31.202	59°42.727	49°25.525	1.24-1.18	3885-3906	1	0	0
4	11.04.05	41 µm (f)	P	180/30	59°57.485	48°42.567	59°59.105	48°37.750	0.00-(-0.07)	4268-4307	0	1	0
5	12.04.05	10 µm (f)	P	140/30	60°09.594	48°05.327	60°10.917	47°57.969	0,05	2827-2753	0	1	0
6	12.04.05	5 µm (T)	P	90/30	60°10.917	47°57.969	60°19.705	47°37.260	0.05-0.09	2753-4727	1	3	14
7	12.04.05	10 µm (f; T)	N; E		60°42.500	45°38.500			0,06	2-5	5	9	0
8	12.04.05	5 µm (T)	P	220/30	60°53.400	45°01.550	60°53.418	44°27.030	-0.22-(-0.24)	223-258	1	1	0
9	13.04.05	10 µm (f; T)	N; E		59°35.100	38°05.600			1	2944	3	4	0
10	14.04.05	10 µm (f; T)	N; E		59°29.740	41°19.400			1.03	3684	6	0	0
11	15.04.05	10 µm (f; T)	N; E		57°59.340	44°29.970			1.05	2836	4	0	0
12	19.04.05	10 µm (f; T)	N; E		56°34.279	44°06.318			2.02-2.05	3433	3	5	2
13	19.04.05	10 µm (f)	P	150/30	56°00.255	44°06.309	55°59.246	44°06.277	2.36-2.35	3340-3296	1	1	0
14	19.04.05	10 µm (f)	P	90/30	55°38.277	44°06.339	55°36.879	44°06.313	2.54-2.65	3346-3405	1	1	0
15	21.04.05	10 µm (f)	P	250/30	56°12.715	43°55.078	56^10.341	43°54.883	2.51-2.52	3351-3236	1	1	0
16	21.04.05	5 µm (T)	P	270/30	55°56.822	43°54.893	55°47.062	43°54.865	2.23-2.10	3348-3129	1	1	0
17	22.04.05	10 µm (f; T)	N; E		56°15.823	43°49.135			2,2	3262	0	3	6
18	23.04.05	10 µm (f; T); 41 µm (T)	N; E		55°08.325	44°06.330			2,39	3833	1	1	11
19	24.04.05	41 µm (T)	P	250/30	57°03.266	43°38.593	57°05.995	43°38.619	1.34-1.27	2111-2705	0	1	2
20	24.04.05	10 µm (T); 41 µm (T)	P	190/30	57°31.900	43°36.611	57°30.634	43°38.818	1.15-1.21	3206-3209	0	2	3
21	26.04.05	10 µm (T); 41 µm (T)	P	200/30	56°35.497	43°27.496	56°37.563	43°27.510	1.14-1.07	3814-3848	0	1	8
22	27.04.05	10 µm (f; T); 41 µm (T)	N; E		55°31.296	43°21.657			2,18	3103	3	3	50
23	28.04.05	10 µm (T); 41 µm (T)	N; E		56°42.101	43°21.610			1,27	3789	1	2	0
24	27.04.05	5 µm (T)	P	260/30	54°42.336	43°15.987	54°51.871	43°15.979	2.46-2.15	3872-3982	0	0	0
25	28.04.05	10 µm (T); 41 µm (T)	N; E		57°25.030	43°27.317			1,12	3196	1	2	0

No.	Date	Gaze, filtriert (f), Top (T)	(P), (N), (E)	Flow rate ml/sec	latitude (S) start	longitude (W) start	latitude (S) end	longitude (W) end	Water temp. (°C) start-end	Water depth (m) start-end	3 µm Filter	Water sample	Isolate
26	29.04.05	10 µm (T)	P	290/30	56°16.940	43°10.505	56°14.436	43°10.516	1.50-1.52	2822-3046	0	0	0
27	30.04.05	10 µm (T)	P	420/30	56°29.262	43°06.243	56°29.887	43°05.766	2.13-2.12	4363-4105	0	0	0
28	01.05.05	10 µm (T)	P	250/30	59°02.138	41°42.531	59°01.381	41°44.992	0.5-0.31	3434-3609	0	0	0
29	01.05.05	10 µm (T)	P	300/30	59°10.667	41°55.813	59°12.608	41°59.443	0.39-0.41	4088-4067	0	0	0
30	01.05.05	10 µm (T)	P	140/30	59°26.853	42°43.290	59°33.142	43°05.794	0.34-0.10	4109-4287	0	0	0
31	01.05.05	10 µm (T), 41 µm (T)	P	350/30; 330/30	60°07.095	43°42.736	60°09.630	43°42.245	-0.83-(-0.93)	4908-5213	0	0	0
32	02.05.05	10 µm (T), 41 µm (T)	P	300/30; 280/30	60°45.152	43°40.864	60°46.641	43°41.995	-1.35-(-1.27)	285-263	0	0	0
33	03.05.05	10 µm (T)	P	320/30	57°24.856	43°00.308	57°22.778	43°00.299	1.10-1.11	3148-3195	0	1	15
34	04.05.05	10 µm (T), 41 µm (T)	P	180/30ß; 300/30	56°38.690	43°00.319	56°34.351	43°00.319	1.23-1.12	3266-2785	0	0	0
35	04.05.05	10 µm (T), 41 µm (T)	P	200/30; 180/30	55°36.490	42°57.985	55°33.931	42°57.987	1.53-1.51	2862-2842	0	0	0
36	04.05.05	10 µm (T), 41 µm (T)	P	320/30; 300/30	54°46.941	43°00.288	54°43.410	43°00.307	2.55-2.38	3911-3874	0	0	0
37	07.05.05	10 µm (T), 41 µm (T)	P	400/30; 290/30	56°30.238	42°39.980	56°27.094	42°39.993	1.15-1.37	4047-4172	0	1	8
38	08.05.05	10 µm (T), 41 µm (T)	P	300/30; 270/30	55°30.410	42°34.016	55°37.500	42°33.994	1.31-1.34	3294-3141	2	3	15
39	09.05.05	10 µm (T), 41 µm (T)	P	240/30; 305/30	55°24.556	42°27.998	55°17.493	42°27.972	1.36-1.51	3494-3564	2	3	2
40	09.05.05	5 µm (T)	P	220/30	55°10.267	42°27.999	55°00.529	42°28.016	1.70-1.70	3426-3533	0	1	2
41	09.05.05	10 µm (T)	P	250/30	54°41.492	42°21.810	54°44.295	42°21.807	1.81-1.80	3872-3900	0	1	4
42	10.05.05	10 µm (T), 41 µm (T)	E		57°13.213	42°28.083			1,3	3618	3	0	0
43	11.05.05	10 µm (T), 41 µm (T)	P	300/30; 360/30	55°01.954	42°08.986	55°05.697	42°08.999	1.88-1.79	3217-3416	0	2	1
44	11.05.05	10 µm (T), 41 µm (T)	P	350/30; 335/30	55°42.637	42°08.999	56°13.949	42°09.010	1.39-1.31	3440-3809	1	2	0
45	14.05.05	10 µm (T), 41 µm (T)	N		57°56.565	44°11.789			0,3	2866	1	2	0
46	14.05.05	10 µm (T), 41 µm (T)	P	360/30; 390/30	58°43734	43°17.008	58°52.807	43°16.999	-0.56-(-0.47)	3248-3521	1	2	0
47	14.05.05	10 µm (T), 41 µm (T)	P	300/30; 260/30	59°37.949	43°59.865	59°47.414	44°02.052	-0.85-(-1.08)	3986-4552	1	2	0

No.	Date	Gaze, filtriert (f), Top (T)	(P), (N), (E)	Flow rate ml/sec	latitude (S) start	longitude (W) start	latitude (S) end	longitude (W) end	Water temp. (°C) start-end	Water depth (m) start-end	3 µm Filter	Water sample	Isolate
48	15.05.05	10 µm (T), 41 µm (T)	P	300/30; 260/30	59°59.719	44°04.681	60°09.777	44°06.882	-1.63-(-1.31)	4777-5091	1	2	0
49	15.05.05		Ice		60°41.965	45°32.359			-1.33	219	0	0	0
50	15.05.05	10 µm (T; f), 41 µm (T)	N		60°41.952	45°32.453			-1.18	215	1	2	0
51	15.05.05	10 µm (f, T)	P	190/30	60°43.660	45°27.006	60°50.309	45°21.149	-1.28-(-1.30)	270-214	1	1	0
										S=	52	68	143

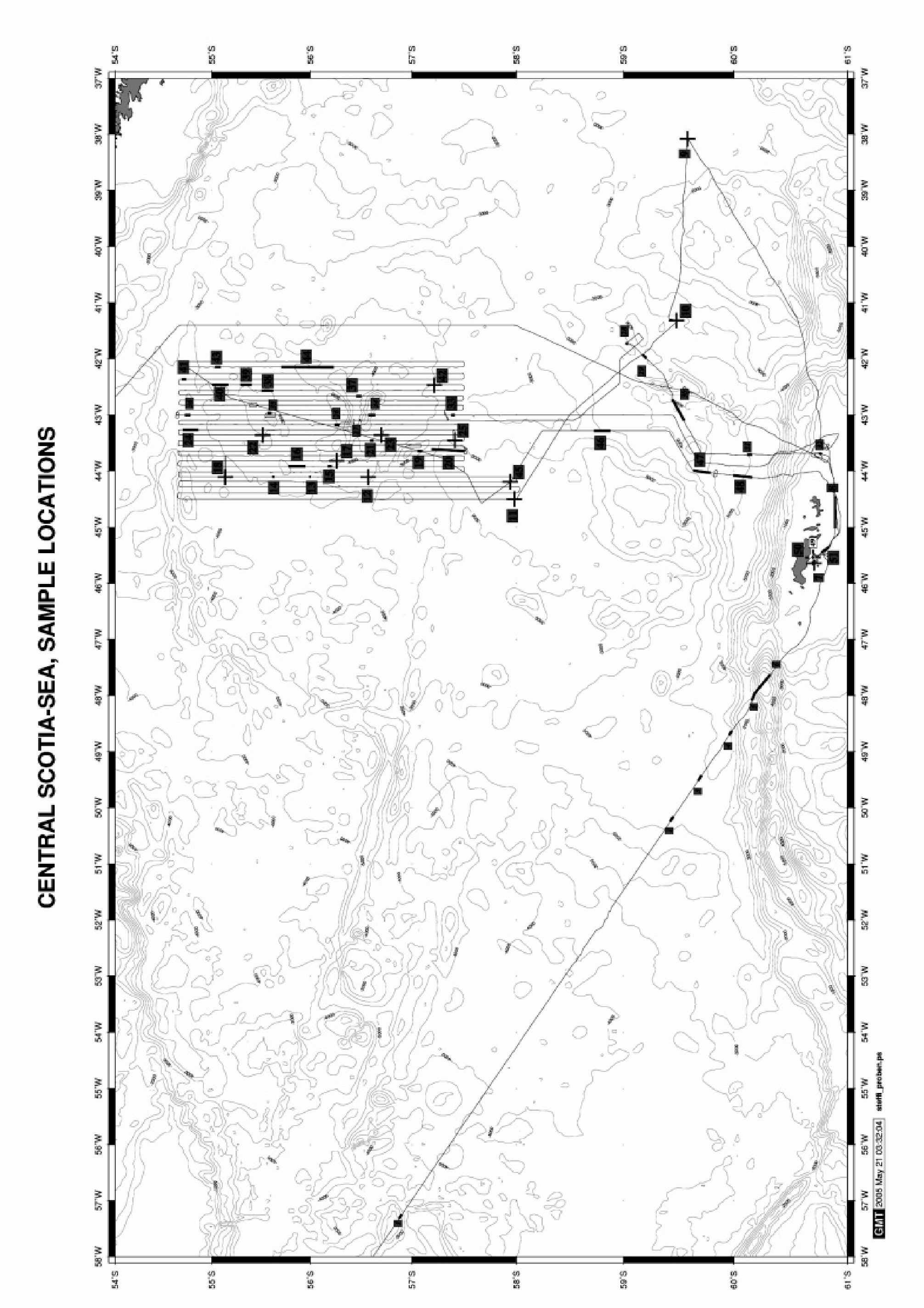

Figure 5.2: Sample locations on the ship track in the Scotia Sea, plankton net sampling (cross), membrane pumping system sampling (prominent line)

6. THE MORPHOLOGY OF THE SOUTH SCOTIA SEA

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Objectives

1) To survey the South Scotia Ridge, using the opportunity of transits between Signy Island and the area of main, detailed survey to the north. The underway, geophysical data complements previous bathymetry to yield additional information on the morphology of the South Orkney Trench and Orkney Deep.
2) To obtain additional bathymetry of the Scotia Sea Central Plate, southern region, in order to more fully describe the morphology of the Pirie Rise, the Dove Basin, and the Bruce Rise.
3) To examine the detailed topography in the area of the main survey for clues to the genesis of the Central Plate.

All three of these objectives were successfully met.

Observations

1. Bathymetry of the South Scotia Ridge

Analysis of the detailed bathymetry revealed errors in the interpretations of previously prepared maps. The eastern end of the South Orkney Trench is about 20 nautical miles (nm) south of the western end of the Orkney Deep. The two ends of the deeps are connected by a N-S trending trough with an axial depth of 4,000 meters (m), 400 m below the regional depth of 3,600 m. To the south, the floor of the South Orkney Trench is as deep as 5,613 m, while to the north, the Orkney deep reaches a depth of 5,545 m.

2. Morphology of the southern Central Plate of the Scotia Sea

The submarine elevation capped with Pirie Bank has been regarded as the Pirie Rise, based on previous surveys. The northern extension of the Rise was inferred from a seismic profile along 59°S. That extension was confirmed with the results of the ANT-XXII/4. The Rise reaches depths of less than 500 m, in its southern region, with a surface smoothed by sedimentation and possibly erosion. The Pirie Rise is bounded on the south by a steep escarpment into the South Orkney Trench. The northern extent of the Rise is an inclined slope with hilly topography, having tens of meters of relief. This slope continues to a depth of about 3,100 m at 58°40'S, and exhibits a sinuous extension to the north.

The eastern slope of the Pirie Rise drops into the Dove Basin at a marginal depth of 3,300-3,800 m. The subdued topography of the Dove Basin lies between the Pirie

Rise and the western slope of the Bruce Rise. A symmetrical, linear ridge rises near the centre of the Basin from a depth of 4,150 m to a crestal depth of 1,670 m. The ridge has a width of 6 nm and a length of 30 nm, with its axis aligned on an azimuth of N5°E, from 59°37'S to 59°07'S. Northeast of this ridge lies another small ridge with crestal depths of 3,400-3,565 m. This ridge is asymmetrical with a steep, highly linear southeast face aligned along N45°E dropping to 4,000 m. The northwest slope is both less steep and less linear.

The Dove Basin is bounded on the north by a swell with depths of less than 3,500 m, extending from the Pirie Rise to the Bruce Rise.

The asymmetric Bruce Rise has a steeper western slope rising to a minimum depth of 1,089 m and a gentler eastern slope descending from 1,566 to 1,775 m. The eastern slope of the Bruce Rise transitions into a hilly plain with a depth of about 2,700-2,800 m, which extends to the Discovery Rise. This plain is shallower than the Dove Basin and is regarded as the Bruce-Discovery Platform.

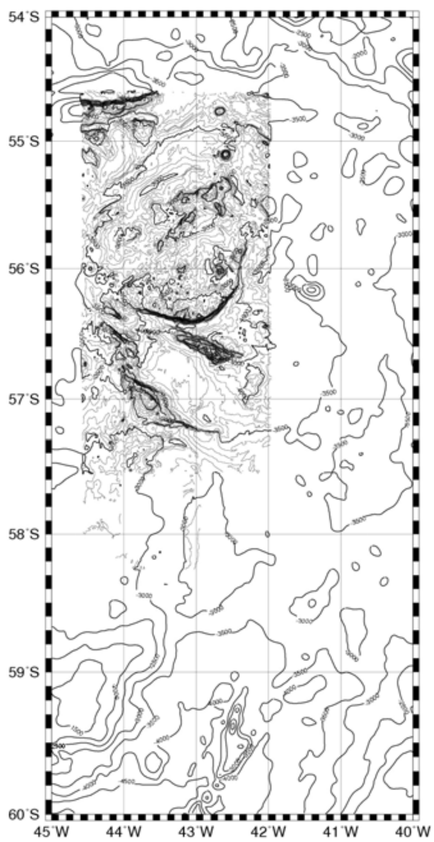


Fig. 6.1: Detailed bathymetry survey in context of generalized regional contours

3. Detailed topography of the Central Scotia Plate

The detailed bathymetric survey of the Central Scotia Sea showed a shallow seafloor that appears to be a northern continuation of the Pirie Rise, suggesting a larger feature, here, in whole, proposed to be the Pirie Plateau. Such a large topographic form in the central part of the Scotia Sea is a significant discovery, one that advances the study of the structure and evolution of the Scotia Sea.

This large morphological province bridges the space between the two prominent features of the Scotia Arc: The North and South Scotia Ridges. The plateau is bounded on the north by a large fracture zone passing near the Shag Rocks, here named the Shag Trench. On the south, the plateau is bounded by the South Orkney Trench and the South Orkney Deep. In a larger sense, the plateau is bounded by the continental structures of the North and South Scotia Ridges.

4. Regional Analysis of major features of the Pirie Plateau

Three major features of the Pirie Plateau bear thought and analysis: the major E-W lineated trenches, a large central graben, and an associated circular basin structure. The major E-W lineated trenches are the Shag Trench and the South Orkney Trench, and the associated North and South Scotia Ridges. These define the overall character of the Pirie Plateau.

The central graben is a morphological trough bounded by very steep, almost 30°, walls, which are evidently normal faults, yielding the appearance of a typical graben. The graben is about 2,000 m deep and 30-40 nm wide. We propose the name, RV *Polarstern* Graben, for such a large and significant feature. The bases of the bounding walls are considerably deeper than the centre of the graben. The foot of the north wall is about 4,500 m deep while that of the southern wall is about 4,000 m, while the central depth of the graben is only 3,700-3,800 m. The overall morphology suggests a genesis by means of a large domal uplift with tensional failure and collapse at the center. Detailed bathymetry shows a small transverse ridge inside the northern part of the graben and 2,000-2,500 m depths on the crests of the northern and southern walls. This hypothesis would lead to the interpretation of the Pirie Plateau as containing relic structures of the uplifted and collapsed dome.

The third major feature is a subtle, large circular depression to be found in the pattern of the 3,500 m isobath. The basin is about 80-90 nm in diameter with a central depth (at 56°45'S, 42°10'W) of about 4,400 m, a total of about 900 m of relief. The rim of the feature rises above the surrounding seafloor by about 50 m, which would suggest a crater-like structure, as opposed to a simple basin. We propose to name this feature either the RV *Polarstern* Crater or the Scotia Crater.

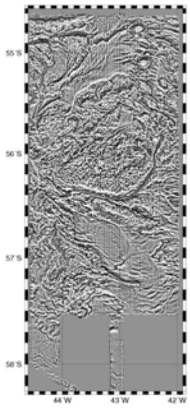


Fig. 6.2: Shaded relief short wavelength slope distribution analysis

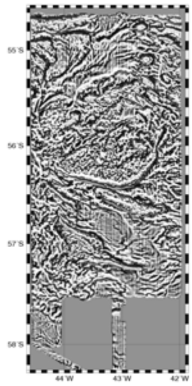


Fig. 6.3: Shaded relief long wavelength slope distribution analysis

5. Analysis of detailed, small scale features of the Pirie Plateau

The surface of the Pirie Plateau is characterized by an irregular, hilly topography, which upon analysis shows three sets of lineated fabric: north, northeast, and northwest, resulting in an orthogonal net of lineations. Such a pattern is suggestive to brittle fracture of the basement beneath the sediment that would contribute to the surface topography. Analysis of the previously collected seismic profile along 59°S shows clear evidence of fracturing and displacement of acoustic basement, lending further support to this hypothesis.

A second, notable characteristic of the detailed topography of the Pirie Plateau is the detailed distribution of seafloor depths, which shows clustering at several discrete depth intervals (Fig. 6.4). The figure shows the distribution of relatively planar topography at depths of (1) 3,800-4,000 m, (2) 3,200-3,400 m, and (3) 2,700-2,900 m. The distribution of slopes is highly skewed toward very low angles, suggesting dominant, low-relief, planar surfaces, the hilly plains that characterize the Pirie Plateau.

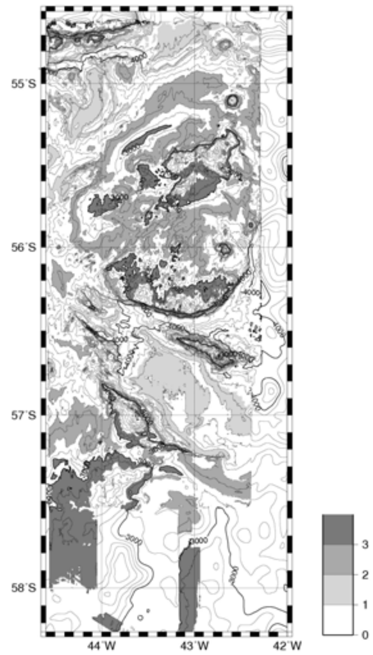


Fig. 6.4: Depth distribution of planar averaged surfaces of the Pirie Plateau

The Pirie Plateau appears to be a geomorphological province of low-relief plains. Such morphology is generated through long-term sedimentation on a rough basement, where the relief of the basement is subdued by differential sedimentation, resulting in a smoothed topography of hilly plains. This type of smoothed topography, or hilly plains, is characteristic of the Pirie Plateau and Bruce-Discovery Platform, their marginal slopes, and their almost horizontal apronic plains. The average sediment thickness for the whole area is roughly constant, with rare exceptions of steep and abrupt slopes.

The exceptions to these generalities are several seamounts with the characteristic volcanic topography of conical, flat-topped form. One such a seamount is located at 55°06'S, 42°37'W with a peak depth of 2,287 m and a remarkable central crater structure on the summit, suggesting a very young age. We propose this seamount be named in honor of Professor Eugen Seibold. This seamount aligns with two others, one at 56°09'S, 41°23'W with a peak depth of 1,550 m, and the second at 54°46'S, 42°42'W with a peak depth of 3,000 m to suggest a linear trend similar to four, linearly aligned seamounts on the western margin of the Discovery Rise.

7. GPS AND MAGNETIC REFERENCE STATION SIGNY ISLAND

Tobial Krömer, René Käker
Alfred Wegener Institute

Location: Base Signy, Borge Bay, Signy Island, South Orkney Islands, Scotia Sea, Antarctica
Activity: GPS-tracking and magnetic reference station

RV *Polarstern* arrived at Signy Island in the morning of 12 April, 2005. A first visit of the island and the scheduled site for the field party was carried out with the ship's helicopter. The weather conditions were almost perfect. After the reconnaissance of the research base and the vicinity of the GPS marker, a horizontal plateau located 30 m away from the GPS-marker SIG1 was selected as the base camp for the field party. As arranged during the preparation of the expedition, the operators of Base *Signy* had left sufficient drinking water in the tanks for use. A chemical container for the chemical toilets was also made available for the field party.
At first the two igloo cabins were transported by the helicopter to the station, followed by the scientific instruments (GPS, magnetometer, PC, laptop, etc.) and finally the technical equipment like generators, fuel and food.

Fig. 7.1: Helicopter transport of the igloos at Signy

Installation
The two igloo cabins („Tomatoes“) were carefully anchored in the bedrock in order to withstand strong storm. The transport of the complete equipment and material to *Signy* was due to a perfect organization finished until noon. This goes on the account of the ship's crew and the helicopter team.

After finishing the securing of the igloos and the storing of the provisions the installation of the field party was finished and the field party was on its own. One tomato was used for housing, the other for storage and kitchen.

Fig.7.2: Trimble GPS-Antenna installed on the geodetic reference point SIG1 at Signy

Power supply

In order to power the GPS receiver and the magnetometer, a 12 Volt truck battery was used, which was recharged using the three generators. At the beginning, three power generators were available. One Knurtz 5 kW generator and two small 1kW Honda generators. The Honda generators were planned as backup and for short period power supply for the notebooks and other small utilities. The Knurtz generator was scheduled for battery recharging and heating of the tomatoes and thus planned for nearly continuous power supply periods. Unfortunately the Knurtz generator failed after short operation time of 4 hours. Trials to repair the generator with advise and support form RV *Polarstern* were not successful. Because of this outage, the recharging of the batteries had to be done with the Honda generators. Due to the weather conditions this took 20-30 hours by alternating using both Hondas for a period of 9 hours. The warming of the igloos was achieved by using the gas heaters.

Scientific work

After the installation of the magnetometer, which was conducted by the geophysicists, the field party members were instructed into its functionality and the operation of the recording system and magnetometer. The major tasks were the daily data download and the checking and recharging of the batteries.

The primary task of the field party on Signy Island was the operation of the GPS receiver on the precisely coordinated geodetic reference station SIG1. The coordinates result from two international GPS campaigns in 1995 and 1998, conducted mainly by a German group of universities and research institutions within the SCAR programme GIANT. They are defined in the International Terrestrial Reference Frame (ITRF) Epoch 2000.

The GPS marker, established in 1995, was in excellent condition, so were the reference markers in the vicinity. The tracked GPS phase data will be used for the precise 3D-positioning of RV *Polarstern* in differential kinematic mode (D-GPS).

Two Trimble 4000 SSI GPS receivers (one as back-up) from the „Bundesamt für Kartographie und Geodäsie“ (BKG) were available for this project. The Trimble antenna (L1/L2 microcentered with ground plate) using a Zeiss-antenna adapter was levelled with a Zeiss-tripod. The receivers had a very limited storage capacity, thus the data had to be downloaded three times a day. The data backup took about 40 minutes. The data collection was carried out in a recording interval of one second, an elevation mask of 0° was used. In order to avoid longer interruptions in the data collection, both receivers were used in an alternating mode. Only small data gaps of two to three minutes occurred during the receiver exchange. Due to a broken cable adapter, which could not be replaced or repaired, the originally planned „direct“ data collection on a notebook was waived on the second day. Thus the receiver had to be installed approx. 10 meters away from the GPS antenna in a specially prepared and isolated box, and the data downloads were performed off-line.

Handling Waste
In accordance with the Protocol for the Antarctic Environmental Protection, human waste and all other garbage were handled by RV *Polarstern* at the end of the campaign.

Dismantling of the field party
After 34 days, the field party was picked up by RV *Polarstern* on 15 May 2005. The difficult weather conditions delayed the helicopter transfer but finally the entire equipment including the igloos was transported back to RV *Polarstern* on the same day.

As a preliminary subsumption, it can be stated that the scientific objectives were achieved and the data required for the D-GPS experiment were completely tracked and the magnetic reference measurements were collected successfully.

Fig. 7.3: Igloos and expedition material at the end of the campaign

8. MINS INVESTIGATION PROGRAMME

Sebastian Albrecht
FIELAX

The technical investigation programme of positioning data provided by the Marine Inertial Navigation System (MINS) on board RV *Polarstern* consisted of two main parts:

The first part was the evaluation of the reduction of MINS positioning data compared to the built-in position of the system at different operational states of the vessel.

The second part dealt with a problem that has been noticed during former expeditions when sailing on the 0° or +6° meridians north- or southward: the MINS longitude position jumped six degrees east- or westward while crossing the meridian.

Overview

The MINS is a precise attitude and heading reference system built for surface and submarine naval forces by Raytheon Marine GmbH in Kiel (Germany). It includes three inertial accelerometers and a platform of three ring laser gyros for measuring rotational and translational accelerations of the vessel. The system's outputs are the heading, roll and pitch angles of the vessel, its speed and its latitude and longitude position.

Two of these inertial systems (MINS 1 and MINS 2) are installed in the gravimeter room on deck F on board RV *Polarstern* though only one of them can be connected at the same time to the data acquisition system. Each of these MINS gets additional navigation information from Trimble GPS antennas and an electromagnetic LOG.

For analysing the positioning data of the MINS it is necessary to relate it to other positioning sensors' data. Three GPS antennas on board RV *Polarstern* (Trimble 1, Trimble 2 and Ashtech) were included in the analysis to obtain reference positions. They all have defined built-in positions (two are located on the observation deck, one on the mast) which can be related to the actual received GPS positions as shown in figure 8.1.

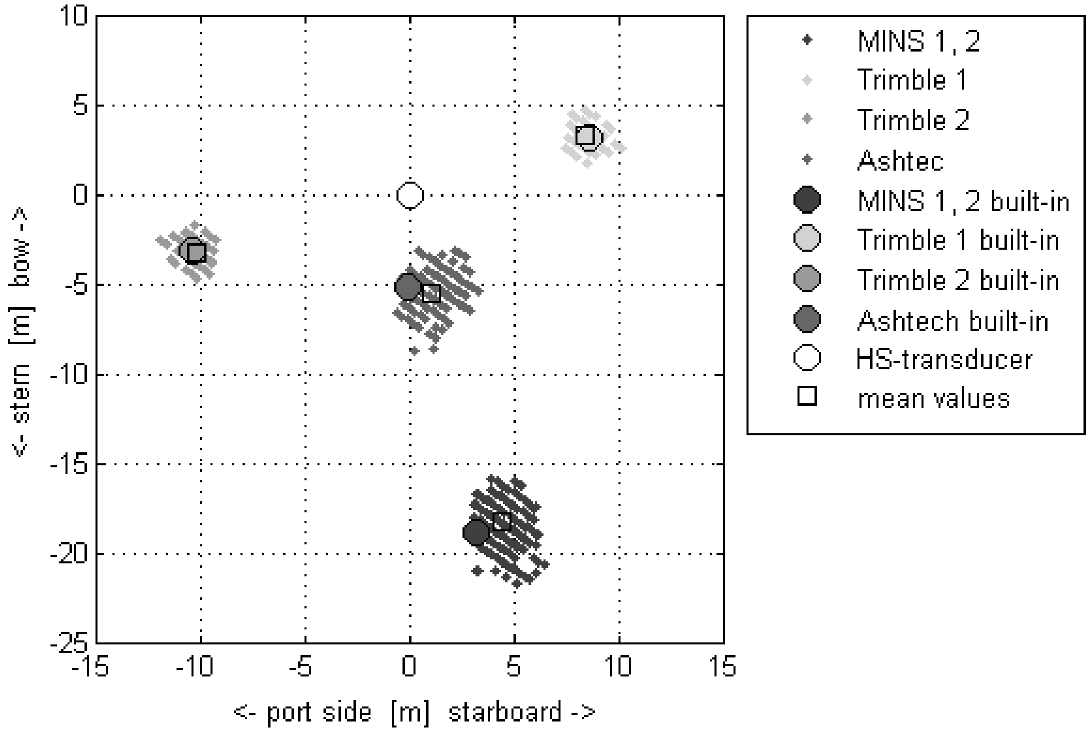


Fig. 8.1: Positioning sensors on board RV Polarstern and their relative positioning data

Investigation of the centering of MINS positioning data

The investigation of the centering of MINS positioning data was taken up in Punta Arenas when RV *Polarstern* was still alongside the pier. To prove a correct reduction of the MINS positioning data to its built-in position the vessel was turned around 180° at the pier. In these tests the positions matched to the built-in position of each MINS in a tolerable way even after turning the vessel (Fig. 8.1).

Furthermore positioning data from different speed and course conditions at sea were processed and compared to each other. The matching of the positioning data decreased at sea while sailing with different speeds as shown in figure. 8.2. The faster the vessel sailed the farther the position data of the MINS drifted to the bow of the vessel. At a speed of 15 kn the mean values of the positioning data reached a distance of 23 m to the actual location of the MINS in direction to the bow.

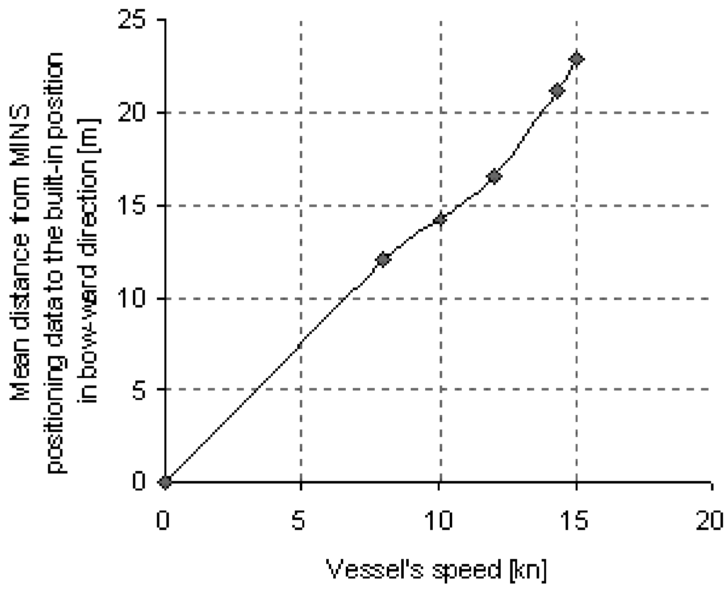


Fig. 8.2: The distance between the built-in position of the MINS and the mean value of the positioning data recorded increases towards the bow the higher the vessel's speed is.

Investigation of the six-degree-longitude-jumping problem

A problem has been noticed during former expeditions concerning the MINS positioning data when sailing north- or southward on the meridians 0° and +6°: The MINS' longitude position jumped six degrees in east- or westward direction when the vessel sailed close to those longitudes. It was assumed this failure would occur at every degree of longitude that is a multiple of six degrees. During our expedition RV *Polarstern* passed the following multiple-6 meridians: -66°, -60°, -54°, -48° and -42°.

The MINS positioning data failures occurred at -66° longitude (during a magnetic turn circle as shown in figure 8.3) and while sailing northward on -48° longitude on our way back to Bahia Blanca. The failure did not occur at the other meridians because the vessel just crossed them at a high speed instead of sailing on them directly.

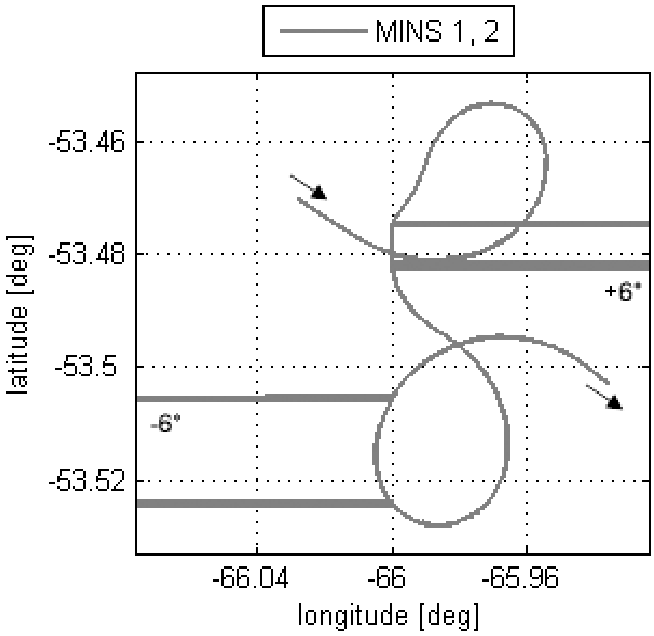


Fig. 8.3: The MINS' longitude position jumped in east- and westward direction by six degrees during a magnetic turn circle at -66° longitude.

Results

First results of the investigation were sent to Raytheon Marine GmbH in Kiel (Germany) during the expedition. In reply they suggested different changes of the MINS' configuration parameters in order to improve a correct reduction of the positioning data. These changes will be performed soon. In addition Raytheon will deliver a software update to fix the six-degree-longitude-jumping problem.

9. METEOROLOGY

Hans-Joachim Möller, Klaus Mader, Klaus Buldt,
Deutscher Wetterdienst

The RV *Polarstern* left Punta Arenas on 8 April 2005 at 20:00 local time.

A deep low in the centre of Scotia Sea caused south westerly to westerly winds about 6 to 7 Bft in the Magellan Channel and east of Tierra del Fuego. Because of a short fetch the sea state remained low. Southeast of Cape Horn the sea state increased clearly. Due to a new low development just west of the Falkland Islands the ship sailed a short and steep cross-sea about 3 to 4 m. This low moved to the northeast but remained dominant with southerly winds about 4 to 5 Bft at first during our crossing to Signy Island.

With the approaching wedge from South America its influence decreased on 11 April. The air temperatures cooled down from 6 °C to 1 °C. The same happened to water temperatures which decreased from 9 °C to 2 °C.

We reached Signy Island on 12 April in the afternoon. Hundreds of icebergs were drifting around South Orkney Islands.

The second half of April was dominated by a few lows developing in the Drake Passage and crossing our area with their frontal systems. They caused mainly north-westerly winds with 8 Bft in maximum. After weaker wedges had passed a new well defined low development approached from the Drake Passage. It was expected to become a low with hurricane-force. Due to this the course was changed out of the working area on 30 April. We sailed towards South Orkney Islands to remain south of the strongest wind fields. Due to a short fetch about only 60 sm the sea state was limited to 7 to 8 m. After the storm passed we sailed back to the working area with winds up to 9 Bft.

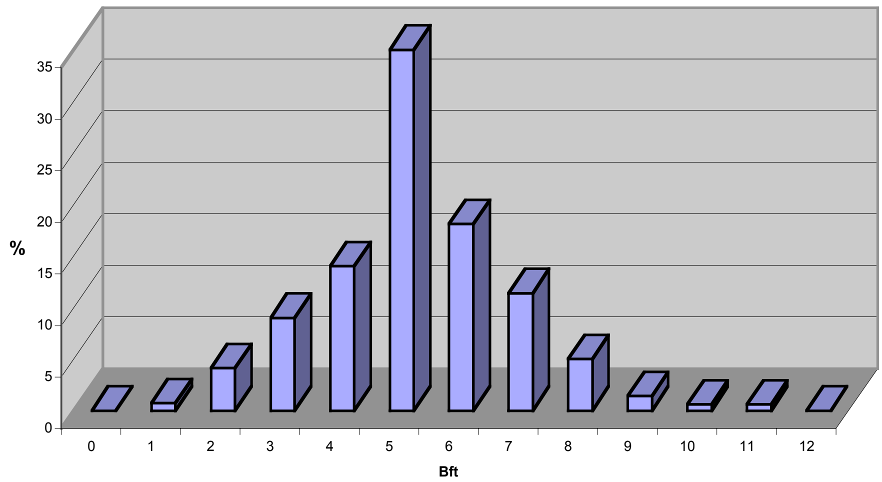
Due to low developments near the Antarctic Peninsula and western part of the Weddell Sea south-westerly winds were predominating. Cold air masses from Weddell Sea let temperatures drop from 2 °C in the morning of 6 May 2005 to -8 °C next morning. This resulted in the change of precipitation from rain to snow. The snowfall remained the whole day with south-westerly winds about 6 Bft. A wedge of a high over Rio de la Plata terminated the cold period with north-westerly winds.

Embedded secondary lows and a new low development on 10 May 2005 over Tierra del Fuego changed the weather situation. North-westerly winds with 6 Bft and frequent rain dominated the next two days. On 13 May 2005 a new central low moved northeast with its centre just south of us. It organized many secondary lows around the centre. Due to multiplied vertical exchanges the low grew old rapidly. Sailing to Signy Island we approached colder waters. Simultaneously air temperatures cooled down from 0 °C on 14 May to -5 °C on the next day with widespread snowfall.

Wide-spreading pressure strengthening between Falkland Islands and Western Weddell Sea caused an intense high over Scotia Sea on 16 May. With a south-westerly air flow cold air masses came in from the Weddell Sea and caused post cold-frontal weather with good visibilities and snow showers.

On our transit to Bahia Blanca a deep low over Tierra del Fuego escorted us to the north. During the coldfront passage on May 18, the northerly winds increased from to 9 Bft for a short time.

Wind statistics to the cruise are shown in figure 9.1.



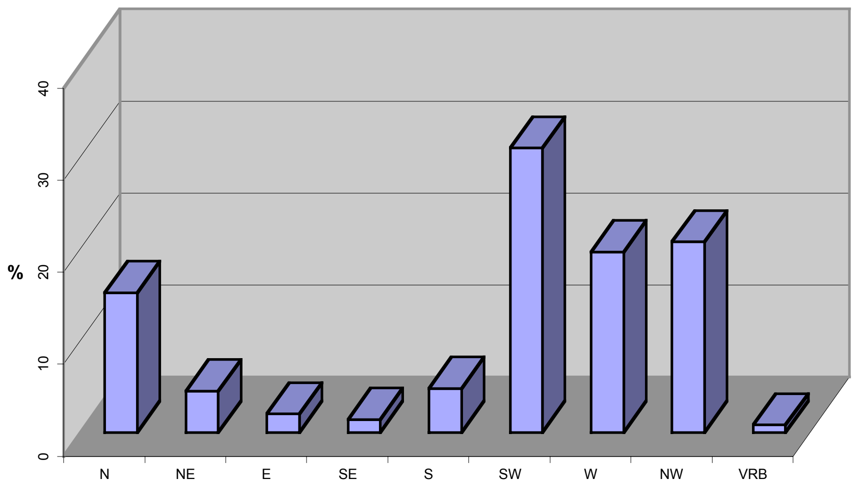


Fig. 9.1: Distribution of wind force during and direction during ANT-XXII/4 (12 April to 17 May 2005)

APPENDIX

A.1 Participating Institutions

A.2 Participants

A.3 Ship's Crew

A.4 Station list

A.1 PARTICIPATING INSTITUTIONS

AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft Postfach 120161 27515 Bremerhaven Germany
BAS	British Antarctic Survey High Cross, Madingley Road Cambridge, CB3 0ET UK
DWD	Deutscher Wetterdienst Geschäftsfeld Seeschifffahrt Bernhard-Nocht-Str. 76 20359 Hamburg Germany
GEOKHI	Vernadsky Institute of Geochemistry and Analytical Chemistry Russian Academy of Sciences 19, Kosygin Street Moscow 119991 Russia
HeliTransair	HeliTransair GmbH Am Flugplatz 63329 Egelsbach Germany
SHOA	Servicio Hidrografico y Oceanografico Armada de Chile Errázuriz 254 Playa Ancha Valparaíso Chile
SHN	Servicio de Hidrografia Naval Armada Argentina Av. Montes de Oca 2124 C1270ABV Buenos Aires Argentina

A.2 PARTICIPANTS

Name	**Institution**
Schenke, Hans-Werner	AWI
Albrecht, Sebastian	FIELAX
Beyer, Andreas	AWI
Borchers, Andreas	AWI
Brauer, Jens	HeliTransair
Büchner, Jürgen	HeliTransair
Buldt, Klaus	DWD
Federowitz, Marcus	HeliTransair
Friedrich, Stephan	AWI
Gäbler, Steffi	AWI
Gregorowicz, Patrycj	AWI
Käker, René	AWI
König, Matthias	AWI
Krömer, Tobias	AWI
Kuhn, Gerhard	AWI
Leinweber, Volker	AWI
Linder, Julia	AWI
Mader, Klaus	DWD
Möller, Hans-Joachim	DWD
Mondzech, Juliane	AWI
Penshorn, Dietmar	AWI
Rybinski ,Paul	AWI
Simundic, Patrick	AWI
Udintsev, Gleb	GEOKHI
Udintsev, Vladimir	GEOKHI
Viétor, Follrich	AWI
Yousif, Khalaf	HeliTransair
Adaro, Martin P.C.	SHN
Viel, Gonzalez Matias	SHOA

A.3 SHIP'S CREW

Punta Arenas – Bahia Blanca

Name	Vorname	Rank	Nation
Pahl	Uwe	Master	German
Ziemann	Olaf	2. Eng.	German
Kotnik	Herbert	2. Eng.	Austria
Simon	Wolfgang	2. Eng.	German
Gerchow	Peter	Electron	German
Fröb	Martin	Electron.	German
Muhle	Helmut	Electron.	German
Feiertag	Thomas	Electron.	German
Holtz	Hartmut	Elec. Tech.	German
Beth	Detlef	Storekeep.	German
Fritz	Günter	Mot-man	Austria
Schwarz	U		
Toeltl	S		
Krösche	Eckard	Mot-man	German
Dinse	Hhorst	Mot-man	German
Spielke	Steffen	1. Offc.	German
Bratz	Herbert	3. Offc.	German
Peine	Lutz	2. Offc.	German
Grimm	S		
Clasen	Burkjard	Boatsw.	German
Neisner	Winfried	Carpenter	German
Schultz	Ottomar	A.B.	German
Darr	K D		
Schröder	Norbert	A.B.	German
Burzan	G.-Ekkelard	A.B.	German
Kreis	Reinhard	A.B.	German
Pousada Martinez	S.	A.B.	Spain
Moser	Siegfried	A.B.	German
Sandmann	R		
Riess	F		
Kohlberg	Eberhard	Doctor	German
Koch	Georg	R. Offc.	German
Fischer	Matthias	Cook	German
Martens	Michael	Cooksmate	German
Tupy	Mario	Cooksmate	German
Dinse	Petra	1. Stwdess	German
Wöckener	Martina	Stwdss/KS	German
Schmutzler	G		
Schmidt	Maria	2. Stwdess	German
Streit	Christina	2. Stwdess	German
Wu	Chi Lung	2. Steward	German
Tu	Jian Min	2. Steward	China
Sun	Y.S	2. Stw / Laundrym.	

A.4 STATION LIST

Station	Date	Time	Latitude	Longitude	Depth	Gear	Remark
177-1	09.04.05	16:03	53° 28,55' S	66° 00,85' W	93,0	MTC	end portside
177-1	09.04.05	17:57	53° 29,93' S	65° 56,70' W	91,9	MTC	end starboard
178-1	11.04.05	14:13	58° 32,60' S	52° 45,60' W	4000,0	HELIMAG	take-off
178-1	11.04.05	14:44	58° 36,10' S	52° 37,70' W	4000,0	HELIMAG	landing
179-1	11.04.05	16:16	58° 45,70' S	52° 09,90' W	3800,0	HELIMAG	take-off
179-1	11.04.05	16:30	58° 47,00' S	52° 08,60' W	3800,0	HELIMAG	landing
180-1	11.04.05	17:03	58° 50,20' S	51° 59,20' W	3800,0	HELIMAG	take-off
180-1	11.04.05	17:34	58° 52,10' S	51° 51,70' W	3800,0	HELIMAG	landing
181-1	12.04.05	12:00	60° 48,40' S	45° 33,64' W	195,5	HS_PS	start profile
181-1	12.04.05	12:24	60° 47,15' S	45° 27,09' W	278,3	HS_PS	change course
181-1	12.04.05	12:37	60° 45,47' S	45° 28,06' W	302,6	HS_PS	change course
181-1	12.04.05	12:50	60° 45,88' S	45° 31,44' W	201,6	HS_PS	change course
181-1	12.04.05	13:30	60° 42,69' S	45° 28,08' W	272,6	HS_PS	change course
181-1	12.04.05	14:03	60° 45,54' S	45° 29,92' W	343,6	HS_PS	change course
181-1	12.04.05	14:15	60° 47,40' S	45° 29,67' W	363,6	HS_PS	change course
181-1	12.04.05	14:33	60° 50,07' S	45° 27,91' W	316,0	HS_PS	change course
181-1	12.04.05	15:29	60° 47,55' S	45° 29,62' W	364,2	HS_PS	end profile
182-1	12.04.05	16:21	60° 47,55' S	45° 29,64' W	364,4	PC	start cast
182-1	12.04.05	16:36	60° 47,56' S	45° 29,66' W	363,9	PC	at depth
182-1	12.04.05	17:01	60° 47,56' S	45° 29,64' W	363,8	PC	end cast
182-2	12.04.05	17:18	60° 47,56' S	45° 29,59' W	363,7	MUC/CTD	start cast
182-2	12.04.05	17:29	60° 47,55' S	45° 29,64' W	363,4	MUC/CTD	at depth
182-2	12.04.05	17:41	60° 47,57' S	45° 29,48' W	360,8	MUC/CTD	end cast
183-1	13.04.05	00:52	60° 50,03' S	43° 34,96' W	266,9	MTC	start portside
183-1	13.04.05	01:43	60° 50,05' S	43° 35,29' W	266,5	MTC	end portside
183-1	13.04.0	01:48	60° 49,68' S	43° 34,33' W	266,6	MTC	start starboard

Station	Date	Time	Latitude	Longitude	Depth	Gear	Remark
	5						
183-1	13.04.05	02:35	60° 49,13' S	43° 33,23' W	263,1	MTC	end starboard
184-1	13.04.05	20:58	59° 35,10' S	38° 05,60' W	N/A	XBT	start cast
185-1	13.04.05	20:59	59° 35,10' S	38° 05,60' W	2942,0	MUC/CTD	start cast
185-2	13.04.05	21:05	59° 35,10' S	38° 05,60' W	2942,0	HN	start cast
185-2	13.04.05	21:26	59° 35,10' S	38° 05,70' W	2944,0	HN	end cast
185-1	13.04.05	21:42	59° 35,10' S	38° 05,80' W	2944,0	MUC/CTD	at depth
185-1	13.04.05	22:19	59° 35,10' S	38° 06,10' W	2945,0	MUC/CTD	end cast
185-3	13.04.05	22:49	59° 35,20' S	38° 06,40' W	2945,0	PC	start cast
185-3	13.04.05	23:32	59° 35,10' S	38° 06,80' W	2932,0	PC	at depth
185-3	14.04.05	00:33	59° 34,80' S	38° 07,90' W	2939,0	PC	end cast
186-1	14.04.05	10:56	59° 29,94' S	41° 19,30' W	3672,0	PC	start cast
186-2	14.04.05	11:43	59° 29,92' S	41° 19,27' W	3670,0	HN	start cast
186-1	14.04.05	12:00	59° 29,93' S	41° 19,36' W	3671,0	PC	at depth
186-2	14.04.05	12:37	59° 29,74' S	41° 19,40' W	3677,0	HN	end cast
186-1	14.04.05	13:07	59° 29,58' S	41° 19,56' W	3684,0	PC	end cast
187-1	15.04.05	03:46	58° 04,47' S	44° 16,68' W	2789,0	XBT	start cast
188-3	15.04.05	04:52	58° 00,02' S	44° 29,89' W	2845,0	HS_PS	start profile
188-1	15.04.05	04:59	57° 59,34' S	44° 29,97' W	2836,0	BUCKET	start cast
188-1	15.04.05	05:00	57° 59,26' S	44° 29,95' W	2836,0	BUCKET	end cast
188-2	15.04.05	05:01	57° 59,17' S	44° 29,93' W	2835,0	HN	start cast
188-2	15.04.05	05:02	57° 59,09' S	44° 29,91' W	2838,0	HN	end cast
188-4	15.04.05	11:06	57° 02,48' S	44° 30,00' W	3459,0	XBT	start cast
188-11	16.04.05	02:04	54° 59,69' S	44° 30,00' W	3594,0	XBT	start cast
188-3	16.04.05	04:13	54° 39,46' S	44° 29,91' W	4972,0	HS_PS	end profile
189-1	16.04.05	04:43	54° 39,87' S	44° 23,36' W	4935,0	HS_PS	start profile
189-1	17.04.05	01:34	58° 00,15' S	44° 23,58' W	2826,0	HS_PS	end profile
190-1	17.04.0	02:26	58° 00,05' S	44° 17,08' W	2827,0	HS_PS	start profile

Station	Date	Time	Latitude	Longitude	Depth	Gear	Remark
	5						
190-1	18.04.05	04:28	54° 40,22' S	44° 16,98' W	4877,0	HS_PS	end profile
191-1	18.04.05	04:52	54° 40,23' S	44° 10,44' W	4819,0	HS_PS	start profile
191-1	18.04.05	11:14	55° 40,14' S	44° 11,00' W	3316,0	HS_PS	break profile
191-1	18.04.05	11:34	55° 40,12' S	44° 10,96' W	3313,0	HS_PS	continue profile
191-1	18.04.05	13:19	55° 55,94' S	44° 11,79' W	3222,0	HS_PS	break profile
191-1	18.04.05	13:36	55° 55,62' S	44° 11,72' W	3240,0	HS_PS	continue profile
191-1	18.04.05	13:46	55° 57,12' S	44° 11,77' W	3221,0	HS_PS	break profile
191-1	18.04.05	13:58	55° 57,09' S	44° 11,69' W	3224,0	HS_PS	continue profile
191-1	18.04.05	15:59	56° 16,12' S	44° 12,02' W	3907,0	HS_PS	break profile
191-1	18.04.05	16:09	56° 15,74' S	44° 11,78' W	3914,0	HS_PS	continue profile
191-1	18.04.05	18:25	56° 36,80' S	44° 11,80' W	3451,0	HS_PS	break profile
191-1	18.04.05	18:38	56° 37,32' S	44° 11,54' W	3453,0	HS_PS	continue profile
191-1	19.04.05	02:58	57° 59,86' S	44° 11,74' W	2833,0	HS_PS	end profile
192-1	19.04.05	03:17	57° 59,85' S	44° 06,32' W	2852,0	HS_PS	start profile
192-2	19.04.05	03:23	57° 59,02' S	44° 06,28' W	2876,0	XBT	start cast
192-4	19.04.05	10:09	57° 00,34' S	44° 06,29' W	3340,0	XBT	start cast
192-5	19.04.05	13:20	56° 34,98' S	44° 06,27' W	3345,0	HN	start cast
192-5	19.04.05	13:23	56° 34,85' S	44° 06,22' W	3370,0	HN	end cast
192-6	19.04.05	14:00	56° 30,00' S	44° 06,30' W	2985,0	XBT	start cast
192-7	19.04.05	16:59	56° 04,59' S	44° 06,32' W	3540,0	ARGOS	deployed
192-8	19.04.05	17:32	56° 00,13' S	44° 06,32' W	3340,0	XBT	start cast
192-10	19.04.05	23:45	55° 00,28' S	44° 06,29' W	3834,0	XBT	start cast
192-11	20.04.05	00:48	54° 50,09' S	44° 06,28' W	4064,0	XBT	start cast
192-12	20.04.05	01:48	54° 40,35' S	44° 06,32' W	4352,0	XBT	start cast
192-1	20.04.05	01:50	54° 40,02' S	44° 06,32' W	4721,0	HS_PS	end profile
193-1	20.04.05	02:14	54° 39,91' S	44° 01,31' W	4301,0	HS_PS	start profile
193-1	20.04.0	11:10	55° 35,89' S	44° 01,19' W	3328,0	HS_PS	break profile

Station	Date	Time	Latitude	Longitude	Depth	Gear	Remark
	5						
193-1	20.04.05	11:26	55° 36,28' S	44° 01,56' W	3304,0	HS_PS	continue profile
193-1	20.04.05	13:21	55° 50,29' S	44° 01,20' W	3194,0	HS_PS	break profile
193-1	20.04.05	13:34	55° 50,15' S	44° 01,15' W	3204,0	HS_PS	continue profile
193-1	20.04.05	14:09	55° 54,50' S	44° 01,25' W	3159,0	HS_PS	break profile
193-1	20.04.05	14:22	55° 54,22' S	44° 01,13' W	3150,0	HS_PS	continue profile
193-1	20.04.05	15:30	56° 03,25' S	44° 01,71' W	3469,0	HS_PS	break profile
193-1	20.04.05	15:40	56° 02,99' S	44° 01,13' W	3440,0	HS_PS	continue profile
193-1	21.04.05	01:15	57° 29,89' S	44° 01,23' W	2627,0	HS_PS	end profile
194-1	21.04.05	01:41	57° 29,93' S	43° 54,98' W	2556,0	HS_PS	start profile
194-2	21.04.05	01:41	57° 29,93' S	43° 54,98' W	2556,0	XBT	start cast
194-4	21.04.05	09:08	56° 30,16' S	43° 54,89' W	3598,0	XBT	start cast
194-1	21.04.05	12:40	56° 02,03' S	43° 54,90' W	3384,0	HS_PS	break profile
194-1	21.04.05	12:57	56° 02,07' S	43° 54,90' W	3387,0	HS_PS	continue profile
194-6	21.04.05	16:20	55° 30,10' S	43° 54,90' W	3229,0	XBT	start cast
194-7	21.04.05	19:33	54° 59,98' S	43° 54,88' W	3846,0	XBT	start cast
194-1	21.04.05	21:43	54° 40,11' S	43° 54,90' W	3978,0	HS_PS	end profile
195-1	21.04.05	22:12	54° 39,98' S	43° 49,20' W	4250,0	HS_PS	start profile
195-2	22.04.05	13:02	56° 14,80' S	43° 49,25' W	3265,0	HN	start cast
195-2	22.04.05	13:10	56° 14,94' S	43° 49,51' W	3283,0	HN	end cast
195-1	22.04.05	16:12	56° 36,88' S	43° 49,45' W	4063,0	HS_PS	break profile
195-1	22.04.05	16:22	56° 36,63' S	43° 49,08' W	4085,0	HS_PS	continue profile
195-1	22.04.05	18:07	56° 49,64' S	43° 49,19' W	3717,0	HS_PS	break profile
195-1	22.04.05	18:20	56° 49,11' S	43° 49,57' W	3697,0	HS_PS	continue profile
195-1	22.04.05	23:41	57° 30,33' S	43° 49,15' W	2698,0	HS_PS	end profile
196-1	23.04.05	00:01	57° 30,10' S	43° 43,52' W	2787,0	HS_PS	start profile
196-2	23.04.05	00:02	57° 29,94' S	43° 43,52' W	2790,0	XBT	start cast
196-3	23.04.0	03:09	56° 59,89' S	43° 43,60' W	2438,0	XBT	start cast

Station	Date	Time	Latitude	Longitude	Depth	Gear	Remark
	5						
196-1	23.04.05	15:20	55° 08,66' S	43° 43,59' W	3776,0	HS_PS	break profile
197-1	23.04.05	17:25	55° 08,28' S	44° 06,33' W	3834,0	PC	start cast
197-2	23.04.05	17:53	55° 08,33' S	44° 06,21' W	3833,0	HN	start cast
197-2	23.04.05	18:01	55° 08,32' S	44° 06,27' W	3835,0	HN	end cast
197-3	23.04.05	18:02	55° 08,32' S	44° 06,29' W	3833,0	BUCKET	start cast
197-3	23.04.05	18:03	55° 08,32' S	44° 06,30' W	3835,0	BUCKET	end cast
197-1	23.04.05	18:25	55° 08,24' S	44° 06,28' W	3837,0	PC	at depth
197-1	23.04.05	19:40	55° 08,32' S	44° 06,02' W	3832,0	PC	end cast
197-4	23.04.05	19:53	55° 08,40' S	44° 05,98' W	3828,0	MUC/CTD	start cast
197-4	23.04.05	20:44	55° 08,59' S	44° 05,64' W	3822,0	MUC/CTD	at depth
197-4	23.04.05	21:30	55° 08,57' S	44° 05,37' W	3821,0	MUC/CTD	end cast
197-5	23.04.05	21:42	55° 08,39' S	44° 04,84' W	3815,0	XBT	start cast
196-1	23.04.05	23:04	55° 08,28' S	43° 43,53' W	3766,0	HS_PS	continue profile
196-7	23.04.05	23:57	54° 59,60' S	43° 43,61' W	3456,0	XBT	start cast
196-8	24.04.05	02:01	54° 40,16' S	43° 43,62' W	3312,0	XBT	start cast
196-1	24.04.05	02:02	54° 40,00' S	43° 43,62' W	3344,0	HS_PS	end profile
198-1	24.04.05	02:38	54° 39,75' S	43° 38,47' W	3487,0	HS_PS	start profile
198-1	24.04.05	21:54	57° 29,86' S	43° 38,60' W	2910,0	HS_PS	end profile
199-1	24.04.05	22:00	57° 30,84' S	43° 38,63' W	2958,0	MTC	start starboard
199-1	24.04.05	22:58	57° 30,88' S	43° 38,38' W	2972,0	MTC	end starboard
199-1	24.04.05	23:00	57° 31,09' S	43° 38,34' W	2996,0	MTC	start portside
199-1	24.04.05	23:52	57° 31,04' S	43° 38,24' W	2993,0	MTC	end portside
200-1	25.04.05	00:13	57° 30,25' S	43° 33,08' W	3156,0	HS_PS	start profile
200-1	25.04.05	03:45	56° 56,31' S	43° 33,21' W	3545,0	HS_PS	end profile
201-1	25.04.05	03:50	56° 56,29' S	43° 34,42' W	3245,0	HS_PS	start profile
201-1	25.04.05	04:54	57° 05,40' S	43° 34,63' W	2763,0	HS_PS	end profile
202-1	25.04.0	05:05	57° 05,49' S	43° 31,57' W	2907,0	HS_PS	start profile

Station	Date	Time	Latitude	Longitude	Depth	Gear	Remark
	5						
202-2	25.04.05	08:50	56° 29,96' S	43° 32,63' W	3834,0	XBT	start cast
202-1	25.04.05	09:52	56° 20,14' S	43° 32,97' W	2891,0	HS_PS	change course
202-3	25.04.05	12:22	55° 56,24' S	43° 32,97' W	3345,0	XBT	start cast
202-6	25.04.05	20:26	54° 40,11' S	43° 33,01' W	3698,0	XBT	start cast
202-1	25.04.05	20:26	54° 40,11' S	43° 33,01' W	3698,0	HS_PS	end profile
203-1	25.04.05	20:52	54° 39,76' S	43° 27,49' W	3831,0	HS_PS	start profile
203-1	26.04.05	17:18	56° 42,33' S	43° 27,51' W	3800,0	HS_PS	break profile
203-1	26.04.05	17:30	56° 42,01' S	43° 27,56' W	3804,0	HS_PS	continue profile
203-1	26.04.05	18:50	56° 51,07' S	43° 27,50' W	3803,0	HS_PS	break profile
203-1	26.04.05	19:06	56° 50,95' S	43° 27,53' W	3801,0	HS_PS	continue profile
203-1	27.04.05	01:17	57° 29,98' S	43° 27,55' W	3204,0	HS_PS	end profile
204-1	27.04.05	01:44	57° 29,88' S	43° 21,47' W	3218,0	HS_PS	start profile
204-2	27.04.05	01:50	57° 28,90' S	43° 21,38' W	3216,0	XBT	start cast
204-1	27.04.05	11:00	56° 01,50' S	43° 21,50' W	3150,0	HS_PS	break profile
204-1	27.04.05	11:15	56° 01,22' S	43° 21,36' W	3183,0	HS_PS	continue profile
204-3	27.04.05	11:41	55° 57,11' S	43° 21,51' W	3218,0	XBT	start cast
204-1	27.04.05	13:21	55° 40,31' S	43° 21,49' W	3244,0	HS_PS	break profile
204-1	27.04.05	13:31	55° 39,49' S	43° 21,62' W	3211,0	HS_PS	continue profile
204-1	27.04.05	14:16	55° 32,04' S	43° 21,49' W	3072,0	HS_PS	break profile
204-4	27.04.05	14:18	55° 31,77' S	43° 21,58' W	3091,0	HN	start cast
204-4	27.04.05	14:23	55° 31,60' S	43° 21,78' W	3099,0	HN	end cast
204-1	27.04.05	14:29	55° 31,06' S	43° 21,55' W	3100,0	HS_PS	continue profile
204-7	27.04.05	19:43	54° 41,01' S	43° 21,50' W	3883,0	XBT	start cast
204-1	27.04.05	19:49	54° 40,05' S	43° 21,50' W	3882,0	HS_PS	end profile
205-1	27.04.05	20:13	54° 39,91' S	43° 15,93' W	3879,0	HS_PS	start profile
205-1	28.04.05	09:45	56° 41,74' S	43° 15,99' W	3788,0	HS_PS	break profile
205-2	28.04.0	10:19	56° 42,01' S	43° 21,56' W	3787,0	PC	start cast

Station	Date	Time	Latitude	Longitude	Depth	Gear	Remark
	5						
205-2	28.04.05	11:17	56° 42,11' S	43° 21,45' W	3790,0	PC	at depth
205-3	28.04.05	11:35	56° 42,13' S	43° 21,45' W	3771,1	HN	start cast
205-3	28.04.05	11:48	56° 42,12' S	43° 21,56' W	3788,0	HN	end cast
205-2	28.04.05	12:28	56° 42,00' S	43° 21,75' W	3791,0	PC	end cast
205-4	28.04.05	12:36	56° 41,98' S	43° 21,78' W	3788,0	MUC/CTD	start cast
205-4	28.04.05	13:32	56° 42,08' S	43° 21,64' W	3787,0	MUC/CTD	at depth
205-4	28.04.05	14:19	56° 42,08' S	43° 21,71' W	3789,0	MUC/CTD	end cast
205-5	28.04.05	14:20	56° 42,08' S	43° 21,71' W	3789,0	ARGOS	deployed
205-6	28.04.05	14:31	56° 43,00' S	43° 21,77' W	3782,0	XBT	start cast
205-1	28.04.05	14:52	56° 43,61' S	43° 15,87' W	3775,0	HS_PS	continue profile
205-1	28.04.05	19:03	57° 24,49' S	43° 15,98' W	3192,0	HS_PS	break profile
206-1	28.04.05	20:00	57° 24,64' S	43° 27,69' W	3214,0	PC	start cast
206-1	28.04.05	20:45	57° 24,67' S	43° 27,51' W	3206,0	PC	at depth
206-1	28.04.05	21:45	57° 25,07' S	43° 27,29' W	3195,0	PC	end cast
206-2	28.04.05	21:47	57° 25,05' S	43° 27,40' W	3197,0	HN	start cast
206-2	28.04.05	22:03	57° 24,46' S	43° 27,70' W	3221,0	HN	end cast
206-3	28.04.05	22:06	57° 24,45' S	43° 27,72' W	3220,0	MUC/CTD	start cast
206-3	28.04.05	22:54	57° 24,62' S	43° 27,51' W	3212,0	MUC/CTD	at depth
206-3	28.04.05	23:34	57° 24,68' S	43° 27,65' W	3214,0	MUC/CTD	end cast
206-4	28.04.05	23:43	57° 24,56' S	43° 28,20' W	3236,0	XBT	start cast
205-1	29.04.05	00:28	57° 23,79' S	43° 16,08' W	3172,0	HS_PS	continue profile
205-1	29.04.05	01:07	57° 30,05' S	43° 15,97' W	3251,0	HS_PS	end profile
207-1	29.04.05	01:30	57° 29,86' S	43° 10,41' W	3285,0	HS_PS	start profile
207-1	29.04.05	09:19	56° 17,38' S	43° 10,49' W	2773,0	HS_PS	change course
207-1	29.04.05	09:28	56° 17,00' S	43° 12,28' W	2870,0	HS_PS	change course
207-1	29.04.05	10:22	56° 25,61' S	43° 13,00' W	4602,0	HS_PS	change course
207-1	29.04.0	10:37	56° 26,01' S	43° 08,93' W	4559,0	HS_PS	change course

Station	Date	Time	Latitude	Longitude	Depth	Gear	Remark
	5						
207-1	29.04.05	11:33	56° 18,57' S	43° 08,13' W	2515,0	HS_PS	change course
207-1	29.04.05	11:51	56° 17,20' S	43° 10,20' W	2780,0	HS_PS	change course
207-1	29.04.05	23:12	54° 40,19' S	43° 10,52' W	3871,0	HS_PS	end profile
208-1	29.04.05	23:34	54° 39,95' S	43° 05,82' W	3871,0	HS_PS	start profile
208-1	30.04.05	11:37	56° 29,01' S	43° 05,80' W	4457,0	HS_PS	break profile
208-1	30.04.05	11:50	56° 28,91' S	43° 05,75' W	4465,0	HS_PS	continue profile
208-1	30.04.05	13:36	56° 44,89' S	43° 05,79' W	3757,0	HS_PS	break profile
208-1	30.04.05	13:51	56° 44,63' S	43° 05,69' W	3763,0	HS_PS	continue profile
208-1	30.04.05	14:21	56° 47,72' S	43° 05,80' W	3771,0	HS_PS	continue profile
208-1	30.04.05	16:08	57° 04,30' S	43° 05,79' W	3757,0	HS_PS	break profile
208-1	30.04.05	16:18	57° 04,04' S	43° 06,19' W	3745,0	HS_PS	continue profile
208-1	30.04.05	16:40	57° 07,29' S	43° 05,81' W	3789,0	HS_PS	break profile
208-1	30.04.05	16:50	57° 07,10' S	43° 05,88' W	3799,0	HS_PS	continue profile
208-1	30.04.05	18:19	57° 21,10' S	43° 05,82' W	3113,0	HS_PS	break profile
208-1	30.04.05	20:13	57° 20,87' S	43° 05,82' W	3122,0	HS_PS	continue profile
208-1	01.05.05	03:22	58° 32,41' S	43° 05,81' W	2979,0	HS_PS	change course
208-1	01.05.05	06:33	58° 57,92' S	42° 26,64' W	3960,0	HS_PS	change course
208-1	01.05.05	07:56	58° 58,00' S	42° 00,45' W	3798,0	HS_PS	change course
208-1	01.05.05	09:37	59° 10,76' S	41° 39,40' W	4000,0	HS_PS	change course
208-1	01.05.05	10:07	59° 08,67' S	41° 32,93' W	3982,0	HS_PS	change course
208-1	01.05.05	11:21	59° 01,16' S	41° 44,29' W	3579,0	HS_PS	end profile
209-1	01.05.05	11:48	59° 04,94' S	41° 45,13' W	3610,0	HS_PS	start profile
209-1	01.05.05	14:10	59° 21,83' S	42° 16,73' W	3871,0	HS_PS	change course
209-1	01.05.05	16:06	59° 27,58' S	42° 47,28' W	4093,0	HS_PS	change course
209-1	01.05.05	19:38	59° 42,80' S	43° 41,54' W	3900,0	HS_PS	change course
209-1	02.05.05	03:00	60° 45,70' S	43° 41,29' W	271,8	HS_PS	end profile
210-1	03.05.0	06:30	59° 27,03' S	43° 00,40' W	4181,0	HS_PS	start profile

Station	Date	Time	Latitude	Longitude	Depth	Gear	Remark
	5						
210-1	03.05.05	17:06	57° 50,86' S	43° 00,30' W	2953,0	HS_PS	break profile
210-1	03.05.05	17:19	57° 50,73' S	43° 00,35' W	2955,0	HS_PS	continue profile
210-1	03.05.05	18:58	57° 35,68' S	43° 00,31' W	3302,0	HS_PS	break profile
210-1	03.05.05	19:16	57° 35,55' S	43° 00,26' W	3314,0	HS_PS	continue profile
210-3	03.05.05	19:47	57° 31,21' S	43° 00,29' W	3366,0	XBT	start cast
210-5	03.05.05	23:38	56° 59,44' S	43° 00,32' W	3832,0	XBT	start cast
210-1	04.05.05	09:37	55° 32,78' S	43° 00,28' W	2590,0	HS_PS	change course
210-1	04.05.05	09:47	55° 32,51' S	43° 02,00' W	2870,0	HS_PS	change course
210-1	04.05.05	10:32	55° 38,72' S	43° 02,51' W	2845,0	HS_PS	change course
210-1	04.05.05	10:47	55° 39,10' S	42° 58,77' W	2908,0	HS_PS	change course
210-1	04.05.05	11:28	55° 33,55' S	42° 58,02' W	2844,0	HS_PS	change course
210-1	04.05.05	11:41	55° 32,74' S	42° 59,96' W	2657,0	HS_PS	change course
210-1	04.05.05	17:26	54° 40,05' S	43° 00,34' W	3828,0	HS_PS	end profile
211-1	04.05.05	17:34	54° 38,81' S	43° 00,19' W	3861,0	MTC	start
211-1	04.05.05	19:22	54° 38,48' S	43° 00,13' W	3847,0	MTC	end
212-1	04.05.05	19:33	54° 38,22' S	42° 59,14' W	3841,0	HS_PS	start profile
212-3	04.05.05	22:05	55° 00,14' S	42° 55,02' W	3397,0	XBT	start cast
212-4	04.05.05	22:10	55° 00,93' S	42° 54,99' W	3405,0	XBT	start cast
212-5	05.05.05	01:21	55° 29,76' S	42° 55,01' W	2886,0	XBT	start cast
212-6	05.05.05	01:27	55° 30,58' S	42° 55,01' W	3018,0	XBT	start cast
212-1	05.05.05	18:45	57° 29,88' S	42° 54,95' W	3127,0	HS_PS	end profile
213-1	05.05.05	19:03	57° 29,79' S	42° 49,50' W	3090,0	HS_PS	start profile
213-4	05.05.05	23:09	56° 51,81' S	42° 49,60' W	3720,0	XBT	start cast
213-1	06.05.05	00:10	56° 42,47' S	42° 49,58' W	3898,0	HS_PS	break profile, iceb.
213-1	06.05.05	00:46	56° 37,21' S	42° 49,51' W	2656,0	HS_PS	continue profile
213-1	06.05.05	08:48	55° 23,35' S	42° 49,58' W	2556,0	HS_PS	change course
213-1	06.05.0	08:56	55° 23,03' S	42° 50,90' W	2872,0	HS_PS	change course

Station	Date	Time	Latitude	Longitude	Depth	Gear	Remark
	5						
213-1	06.05.05	09:33	55° 27,73' S	42° 51,50' W	2546,0	HS_PS	change course
213-1	06.05.05	09:46	55° 27,99' S	42° 48,08' W	2532,0	HS_PS	change course
213-1	06.05.05	10:11	55° 24,12' S	42° 47,49' W	2386,0	HS_PS	change course
213-1	06.05.05	10:21	55° 23,30' S	42° 49,30' W	2466,0	HS_PS	change course
213-1	06.05.05	11:56	55° 07,34' S	42° 49,59' W	3357,0	HS_PS	break profile
213-1	06.05.05	12:09	55° 07,22' S	42° 49,54' W	3372,0	HS_PS	continue profile
213-1	06.05.05	13:37	54° 52,88' S	42° 49,59' W	3640,0	HS_PS	break profile
213-12	06.05.05	13:43	54° 52,54' S	42° 50,06' W	3665,0	XBT	start cast
213-13	06.05.05	13:48	54° 52,85' S	42° 50,03' W	3658,0	XBT	start cast
213-1	06.05.05	13:50	54° 52,73' S	42° 49,74' W	3653,0	HS_PS	continue profile
213-14	06.05.05	15:08	54° 40,07' S	42° 49,52' W	3876,0	XBT	start cast
213-1	06.05.05	15:08	54° 40,07' S	42° 49,52' W	3876,0	HS_PS	end profile
213-15	06.05.05	15:14	54° 40,02' S	42° 48,02' W	3871,0	XBT	start cast
214-1	06.05.05	15:27	54° 40,02' S	42° 44,47' W	3932,0	HS_PS	start profile
214-1	06.05.05	16:19	54° 47,54' S	42° 44,20' W	3865,0	HS_PS	break profile
214-1	06.05.05	16:33	54° 47,55' S	42° 44,25' W	3866,0	HS_PS	continue profile
214-1	06.05.05	17:54	54° 59,58' S	42° 44,21' W	3349,0	HS_PS	break profile
214-1	06.05.05	18:10	54° 59,71' S	42° 44,28' W	3340,0	HS_PS	continue profile
214-1	07.05.05	14:14	57° 29,93' S	42° 44,36' W	3153,0	HS_PS	end profile
215-2	07.05.05	14:28	57° 29,99' S	42° 40,00' W	3193,0	XBT	start cast
215-1	07.05.05	14:28	57° 29,99' S	42° 40,00' W	3193,0	HS_PS	start profile
215-3	07.05.05	17:30	56° 59,99' S	42° 39,99' W	3734,0	XBT	start cast
215-4	07.05.05	20:33	56° 30,07' S	42° 39,98' W	4043,0	XBT	start cast
215-5	07.05.05	23:31	56° 00,04' S	42° 40,01' W	2740,0	XBT	start cast
215-6	08.05.05	02:31	55° 30,07' S	42° 39,99' W	2713,0	XBT	start cast
215-7	08.05.05	05:30	55° 00,85' S	42° 38,99' W	3390,0	XBT	start cast
215-1	08.05.0	07:31	54° 40,04' S	42° 39,01' W	3922,0	HS_PS	end profile

Station	Date	Time	Latitude	Longitude	Depth	Gear	Remark
	5						
215-8	08.05.05	07:31	54° 40,04' S	42° 39,01' W	3922,0	XBT	start cast
216-1	08.05.05	07:52	54° 39,91' S	42° 34,03' W	3766,0	HS_PS	start profile
216-1	08.05.05	11:12	55° 08,98' S	42° 34,23' W	3180,0	HS_PS	break profile
216-1	08.05.05	11:19	55° 09,72' S	42° 34,15' W	3480,0	HS_PS	continue profile
216-1	09.05.05	01:32	57° 29,96' S	42° 34,00' W	3236,0	HS_PS	end profile
217-1	09.05.05	01:54	57° 30,04' S	42° 27,99' W	3219,0	HS_PS	start profile
217-2	09.05.05	01:55	57° 29,88' S	42° 27,97' W	3213,0	XBT	start cast
217-3	09.05.05	04:48	57° 00,07' S	42° 27,99' W	3830,0	XBT	start cast
217-4	09.05.05	07:57	56° 30,13' S	42° 27,99' W	4100,0	XBT	start cast
217-5	09.05.05	11:06	56° 00,02' S	42° 27,99' W	3766,0	XBT	start cast
217-6	09.05.05	14:14	55° 28,87' S	42° 28,02' W	3274,0	XBT	start cast
217-7	09.05.05	17:16	54° 59,96' S	42° 27,99' W	3553,0	XBT	start cast
217-8	09.05.05	19:22	54° 40,11' S	42° 28,00' W	3798,0	XBT	start cast
217-1	09.05.05	19:23	54° 39,96' S	42° 28,01' W	3791,0	HS_PS	end profile
218-1	09.05.05	19:47	54° 40,00' S	42° 21,84' W	3913,0	HS_PS	start profile
218-1	10.05.05	10:49	57° 12,91' S	42° 21,79' W	3612,0	HS_PS	break profile
219-1	10.05.05	11:30	57° 13,25' S	42° 28,20' W	3619,0	PC	start cast
219-1	10.05.05	12:28	57° 13,22' S	42° 28,02' W	3619,0	PC	at depth
219-2	10.05.05	12:36	57° 13,22' S	42° 28,01' W	3618,0	WSB	start cast
219-2	10.05.05	12:51	57° 13,19' S	42° 28,02' W	3616,0	WSB	start cast
219-1	10.05.05	13:31	57° 13,18' S	42° 27,94' W	3617,0	PC	end cast
219-3	10.05.05	13:38	57° 13,22' S	42° 28,00' W	3620,0	MUC/CTD	start cast
219-3	10.05.05	14:20	57° 13,22' S	42° 28,07' W	3616,0	MUC/CTD	at depth
219-3	10.05.05	15:02	57° 13,13' S	42° 27,92' W	3619,0	MUC/CTD	end cast
219-4	10.05.05	15:05	57° 13,12' S	42° 27,90' W	3619,0	XBT	start cast
218-1	10.05.05	15:31	57° 13,11' S	42° 21,82' W	3604,0	HS_PS	continue profile
218-1	10.05.0	17:14	57° 30,03' S	42° 21,86' W	3284,0	HS_PS	end profile

Station	Date	Time	Latitude	Longitude	Depth	Gear	Remark
	5						
220-2	10.05.05	17:36	57° 30,24' S	42° 15,65' W	3353,0	XBT	start cast
220-1	10.05.05	17:37	57° 30,12' S	42° 15,49' W	3357,0	HS_PS	start profile
220-3	10.05.05	20:54	57° 00,05' S	42° 15,51' W	3949,0	XBT	start cast
220-4	11.05.05	00:24	56° 29,99' S	42° 15,49' W	4100,0	XBT	start cast
220-5	11.05.05	04:08	56° 00,01' S	42° 15,48' W	3838,0	XBT	start cast
220-6	11.05.05	07:49	55° 30,14' S	42° 15,50' W	3470,0	XBT	start cast
220-7	11.05.05	11:17	54° 59,78' S	42° 15,51' W	3335,0	XBT	start cast
220-1	11.05.05	13:30	54° 40,02' S	42° 15,48' W	3952,0	HS_PS	end profile
221-1	11.05.05	13:56	54° 39,93' S	42° 08,96' W	3825,0	HS_PS	start profile
221-3	11.05.05	14:23	54° 44,52' S	42° 09,00' W	3929,0	XBT	start cast
221-1	12.05.05	06:24	57° 29,93' S	42° 09,01' W	3370,0	HS_PS	end profile
222-2	12.05.05	06:47	57° 30,33' S	42° 03,04' W	3395,0	XBT	start cast
222-1	12.05.05	06:50	57° 30,02' S	42° 02,91' W	3397,0	HS_PS	start profile
222-3	12.05.05	10:25	57° 00,12' S	42° 03,00' W	3833,0	XBT	start cast
222-1	12.05.05	10:35	56° 58,81' S	42° 02,98' W	3829,2	HS_PS	break profile
222-1	12.05.05	11:18	56° 59,63' S	42° 02,75' W	3849,0	HS_PS	continue profile
222-4	12.05.05	15:02	56° 30,01' S	42° 02,98' W	4134,0	XBT	start cast
222-5	12.05.05	18:40	55° 59,98' S	42° 02,99' W	3425,0	XBT	start cast
222-6	12.05.05	22:32	55° 29,79' S	42° 02,99' W	2848,0	XBT	start cast
222-7	13.05.05	02:02	54° 59,93' S	42° 03,02' W	3238,0	XBT	start cast
222-8	13.05.05	04:13	54° 40,10' S	42° 03,00' W	3701,0	XBT	start cast
222-1	13.05.05	04:14	54° 39,94' S	42° 03,00' W	3717,0	HS_PS	end profile
223-1	13.05.05	04:25	54° 39,95' S	42° 02,96' W	3726,0	HS_PS	start profile
223-2	13.05.05	06:57	54° 59,97' S	42° 27,27' W	3524,2	XBT	start cast
223-1	13.05.05	07:21	55° 03,23' S	42° 31,23' W	3575,3	HS_PS	change course
223-1	13.05.05	09:25	55° 11,16' S	42° 41,80' W	3394,9	HS_PS	change course
223-3	13.05.0	11:23	55° 30,05' S	42° 51,18' W	2649,3	XBT	start cast

Station	Date	Time	Latitude	Longitude	Depth	Gear	Remark
	5						
223-4	13.05.0 5	14:22	56° 00,02' S	43° 06,14' W	3380,0	XBT	start cast
223-5	13.05.0 5	17:25	56° 29,84' S	43° 21,21' W	3991,0	XBT	start cast
223-6	13.05.0 5	20:38	56° 59,85' S	43° 36,58' W	1946,0	XBT	start cast
223-1	13.05.0 5	22:32	57° 17,80' S	43° 45,91' W	2895,0	HS_PS	change course
223-7	14.05.0 5	00:02	57° 30,14' S	44° 01,17' W	2638,0	XBT	start cast
223-1	14.05.0 5	00:10	57° 31,20' S	44° 02,52' W	2705,0	HS_PS	change course
223-1	14.05.0 5	02:13	57° 39,83' S	44° 34,36' W	2979,0	HS_PS	change course
223-8	14.05.0 5	02:15	57° 40,03' S	44° 34,79' W	2982,0	XBT	start cast
223-1	14.05.0 5	04:26	57° 56,62' S	44° 11,91' W	2868,0	HS_PS	break profile
223-10	14.05.0 5	04:32	57° 56,65' S	44° 11,89' W	2868,0	XBT	start cast
224-1	14.05.0 5	04:39	57° 56,63' S	44° 11,92' W	2868,0	PC	start cast
224-2	14.05.0 5	04:45	57° 56,60' S	44° 11,91' W	2866,0	HN	start cast
224-2	14.05.0 5	04:55	57° 56,59' S	44° 11,89' W	2868,0	HN	end cast
224-1	14.05.0 5	05:20	57° 56,57' S	44° 11,79' W	2868,0	PC	at depth
224-1	14.05.0 5	06:13	57° 56,60' S	44° 11,76' W	2867,0	PC	end cast
224-3	14.05.0 5	06:26	57° 56,62' S	44° 11,77' W	2865,0	MUC/CTD	start cast
224-3	14.05.0 5	07:09	57° 56,66' S	44° 11,73' W	2867,0	MUC/CTD	at depth
224-3	14.05.0 5	07:44	57° 56,85' S	44° 11,72' W	2868,0	MUC/CTD	end cast
223-1	14.05.0 5	07:47	57° 56,88' S	44° 11,72' W	2866,0	HS_PS	continue profile
223-1	14.05.0 5	11:17	58° 14,39' S	43° 17,35' W	3174,0	HS_PS	change course
223-1	14.05.0 5	19:05	59° 24,65' S	43° 17,01' W	4127,0	HS_PS	change course
223-1	14.05.0 5	21:53	59° 37,86' S	43° 59,53' W	3991,0	HS_PS	change course
223-1	14.05.0 5	23:11	59° 49,70' S	44° 02,51' W	4640,0	HS_PS	break profile
225-1	14.05.0 5	23:12	59° 49,85' S	44° 02,56' W	4647,0	MTC	start starboard
225-1	15.05.0 5	00:09	59° 50,12' S	44° 02,76' W	4664,0	MTC	start portside
223-1	15.05.0 5	00:59	59° 49,66' S	44° 02,32' W	4640,0	HS_PS	continue profile
225-1	15.05.0	01:08	59° 50,56' S	44° 02,92' W	4690,0	MTC	end portside

Station	Date	Time	Latitude	Longitude	Depth	Gear	Remark
	5						
223-1	15.05.05	03:40	60° 15,04' S	44° 08,01' W	5517,0	HS_PS	change course
223-1	15.05.05	07:14	60° 45,14' S	44° 00,26' W	201,2	HS_PS	change course
223-1	15.05.05	09:34	60° 54,77' S	44° 31,68' W	232,9	HS_PS	change course
225-2	15.05.05	15:48	60° 41,98' S	45° 32,32' W	225,9	HN	start cast
225-2	15.05.05	16:05	60° 41,96' S	45° 32,48' W	208,4	HN	end cast
223-1	15.05.05	16:05	60° 41,96' S	45° 32,48' W	208,4	HS_PS	end profile
226-1	16.05.05	15:03	57° 59,94' S	41° 24,05' W	3254,0	HS_PS	start profile
226-2	16.05.05	17:20	57° 27,03' S	41° 23,97' W	3585,0	XBT	start cast
226-4	16.05.05	19:09	57° 01,78' S	41° 24,02' W	3586,0	XBT	start cast
226-3	16.05.05	19:11	57° 01,51' S	41° 24,00' W	3584,0	ARGOS	deployed
226-5	16.05.05	21:22	56° 29,98' S	41° 23,99' W	3590,0	XBT	start cast
226-6	16.05.05	23:29	56° 00,03' S	41° 24,01' W	3308,0	XBT	start cast
226-7	17.05.05	01:38	55° 29,99' S	41° 24,01' W	3343,0	XBT	start cast
226-9	17.05.05	03:45	55° 00,76' S	41° 23,98' W	3230,0	ARGOS	deployed
226-10	17.05.05	05:14	54° 40,01' S	41° 24,01' W	3398,0	XBT	start cast
226-1	17.05.05	05:14	54° 40,01' S	41° 24,01' W	3398,0	HS_PS	change course
226-1	18.05.05	03:49	51° 07,90' S	47° 59,98' W	2670,0	HS_PS	break profile
226-1	18.05.05	04:10	51° 05,82' S	48° 03,87' W	2690,0	HS_PS	continue profile

ANT-XXII/5

24 May - 21 June 2005

Bahia Blanca - Bremerhaven

Fahrtleiter / Chief Scientist:
Dr. W. Zenk

Koordinator / Coordinator:
Prof. Dr. P. Lemke

CONTENTS

1. FAHRTVERLAUF UND ZUSAMMENFASSUNG

Walter Zenk
Institut für Meereskunde, Kiel (IFM-GEOMAR)

Die Fahrt begann in Bahia Blanca, Argentinien, und führte nach Bremerhaven. Sie dauerte vom 24. Mai bis 21. Juni 2005. Der Schwerpunkt der wissenschaftlichen Arbeiten während des Fahrtabschnitts ANT-XXII/5 lag im Bereich des Vemakanals bei etwa 31°S, 39°W. Dort wurden neben CTD-Sondierungen zwei Kieler Verankerungen an den Flanken des Kanals ausgetauscht. Diese dienten der Aufzeichnung von Strömungs- und Temperaturschwankungen an der wichtigsten Durchlassstelle für Antarktisches Bodenwasser zwischen dem Argentinischen und dem Brasilianischen Becken. 13 von 14 ausgelegten Messgeräten haben Daten von sehr guter Qualität geliefert. Auf der langen Transitstrecke nach Norden wurden ferner sechs Argo-Drifter zwischen 35° - 23°S ausgelegt. Beobachtungen zu äquatorialen Strombändern mit dem akustischen Doppler-Strommesser (ADCP) auf 23°W ergänzen den in Kiel gepflegten Satz von äquatornahen Aufzeichnungen dieser Art. Ferner wurden während der gesamten Fahrt bathymetrische sowie luftchemische Daten gesammelt und alle acht Stunden Proben zur späteren Bestimmung des gelösten CO_2-Gehalts genommen.

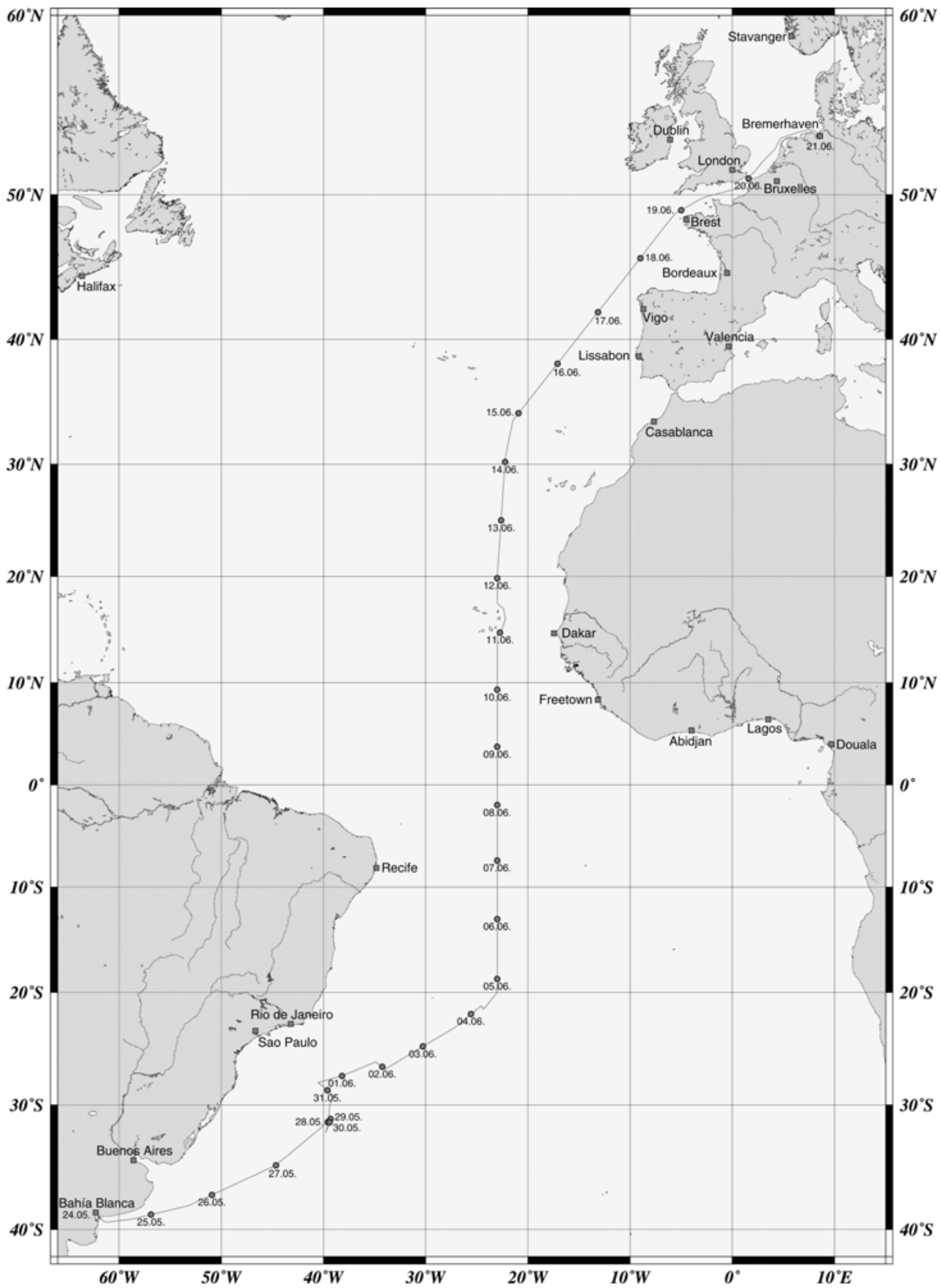


Abb.1.1: Kursplot der FS Polarstern-Expedition ANT-XXII/5
Fig. 1.1: Track chart of RV Polarstern cruise ANT-XXII/5 between Bahia Blanca and Bremerhaven, 24 May – 21 June 2005

CRUISE NARRATIVE AND SUMMARY

RV *Polarstern* left Bahia Blanca, Argentina on 24 May 2005, 08:00 (Fig. 1.1). The passage through coastal waters was used to install all scientific equipment in the laboratories. We took a direct course towards the Vema Channel. This abyssal passage is situated to the northern rim of the Argentine Basin at approximately the latitude of Santos, Brazil (~31°S). Continuously recording instruments like the multi-beam echo sounder Hydrosweep and the vessel mounted acoustic Doppler current profiling system (ADCP) had to be programmed for our needs.

During the transit time to our research site, we started to regularly transmit hydrographic data from the sea surface to the CORIOLIS data centre at the French maritime agency IFREMER in Brest. In addition, surface water samples were collected during the whole cruise leg in eight hour intervals for later analysis of their CO_2 content. The Differential Optical Absorption Spectrometer on the ship's observation deck from the University of Heidelberg continuously operated during the whole cruise. It delivers data of atmospheric trace gases for ground truth validation of satellite-based measurements (from SCIAMACHY) taken simultaneously on board of ENVISAT.

The ship reached the Vema Channel on 28 May. During daytime both near-bottom moorings V4381 on the eastern side and V4391 on the western side of the deep channel were completely recovered. Originally they were deployed on board of the Royal Research Ship *Discovery* on 17 December 2003. An early inspection of the 14 recovered recording instruments showed that all of them (with only one exception) had worked properly for the whole mooring period. The next day we saw the re-deployment of mooring V4392 on the western flank of the channel. On the following night 29/30 May a closely spaced CTD section with five stations was taken. The mooring launch work was completed with V4382 on 30 May, positioned at a deep plateau close to the eastern flank of Vema Channel. With calm weather both moorings were deployed over the starboard side with anchor first, a well approved method on RV *Polarstern*. An along-channel and another across-channel section through the Vema Extension completed the station work.

En route through all climatic zones of the Atlantic we continuously gathered bathymetric data and ocean current profiles with the ship's own ADCP. While still crossing the South Atlantic, we launched six SOLO floats at the crossings of following latitudes: 35°, 32°, 27°, 25°, 23°, and 20° S. These cycling instruments contribute to the international Argo project and were provided by both NOAA Miami (American National Oceanographic and Atmospheric Administration) and WHOI Woods Hole (Woods Hole Oceanographic Institution). The floats are expected to collect and transmit temperature and salinity profiles at ten-day intervals for a period of up to five years.

After a long pause a 16th and last CTD station was occupied on 15 June at the long-term current observatory KIEL276. Only six weeks prior to our visit, RV *Poseidon* had exchanged the full water column current meter mooring for the 25th time. The mooring site was started by IFM Kiel in 1980.

Leg 5 of cruise ANT-XXII ended on 21 June 2005, 14:10 at Lloyd's Pier in Bremerhaven.

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2. THE PHYSICAL OCEANOGRAPHY PROGRAMME

The equatorward abyssal flow of Antarctic Bottom Water represents an important branch of the global thermohaline circulation. On the western side of the South Atlantic it partly compensates for the southward-directed North Atlantic Deep Water. Fluctuations in the bottom water are therefore expected to interact with other limbs of the world-wide oceanic circulation. On its northbound flow Antarctic Bottom Water faces topographical constraints in form of submarine ridges. One of these is given by the Rio Grande Rise separating the Argentine Basin in the south from the Brazilian Basin in the north. Its zonal alignment is disrupted by a 600 meter deep gap called the Vema Channel (Fig. 2.1). This south-north channel provides a natural choke point for property fluctuations and transports of bottom waters entering the Brazil Basin.

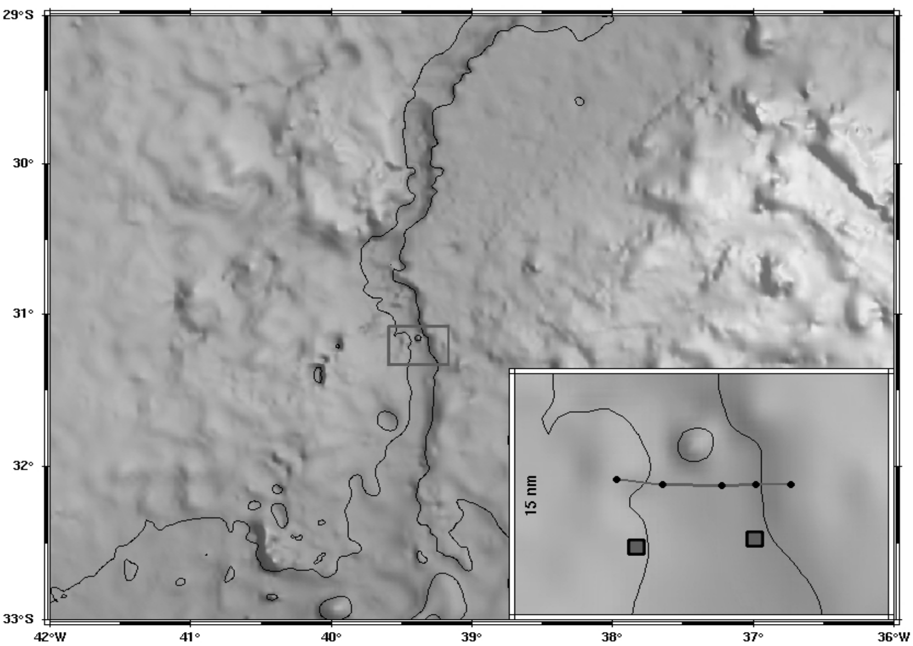

Fig. 2.1: Bottom topography of the Vema Sill according to Smith and Sandwell (1997). The CTD section and the positions of moorings V4381xx in the east and V4391xx in the west are indicated by the line and the squares. For better orientation the 4600 m isobath is drawn as a black contour line. (Figure by Chr. Begler)

Records of over thirty years in the near bottom layers in the Vema Channel depict a clear temperature increase from the beginning in the 1990. This trend has been repeatedly documented in observations from local CTD stations and moored thermometers. The prime scientific objective of cruise ANT-XXII/5 of RV *Polarstern* was to service two near-bottom moorings on the sill of the Vema Channel in continuation of this long-term time series. Originally they were launched from the

RRS *Discovery* in December 2003 on both flanks of the Vema Channel. The data obtained up to now and the ones from the redeployed instruments will be utilised to improve ocean circulation simulations.

In addition the long meridional cruise track between the Argentine Basin and the western approaches of Europe was used to collect hydrographic data with quasi-online transmission to the CORIOLIS centre of IFREMER Brest. As a contribution to the international Argo project six cycling floats were launched in the South Atlantic provided by NOAA Miami. All transmitted surface and in-situ data are implemented on land as parameters for real-time simulations of the state of the ocean. Finally, vertical profiles of ocean currents in the upper 600 metres and surface water samples were regularly collected. These observations will serve studies on the zonal structure of equatorial jets and the oceanic uptake of CO_2 from the atmosphere, respectively.

2.1 Underway activities

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Underway measurements of surface data
During the whole cruise daily surface observations of temperature and salinity series were transmitted to the French CORIOLIS Centre in Brest for operational purposes. Figure 2.2 shows the distribution of temperature and salinity between Bahia Blanca and the southern North Sea.

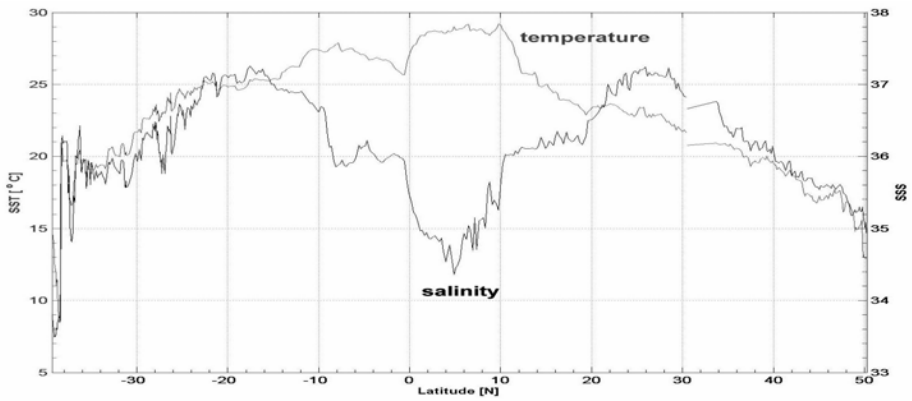

Fig. 2.2: Latitudinal distribution of Atlantic surface temperature and salinity in May/June 2005. Most of the time RV Polarstern cruised along 23° W. For details see cruise chart in Fig. 2.1.

Numerous hydrographic features like the cold Falkland-Malvinas Current (38°S), the cold equatorial upwelling region, the low-saline belt of the inter-tropical convergence zone (4-5°N), or the Azores Current (32°N) can be easily identified. As expected maximum salinities in the subtropics of both hemispheres exceeded 37.1 .

Deployment of Argo floats

During the cruise RV *Polarstern* deployed six profiling SOLO floats on request of the Woods Hole Oceanographic Institution and the American National Oceanographic and Atmospheric Administration (NOAA). They are part of the global net work of cycling buoys for the observation of the state of the ocean for operational oceanography (http://www.argo.ucsd.edu/). Table 2.1 contains an inventory of the launched floats. Most of them were deployed at full speed (14 kn) in a carton box (Fig. 2.3, 2.4). The instruments had already been started prior to our arrival in Argentina.

Table 2.1: Argo floats launched during RV *Polarstern* cruise ANT-XXII/5 on request of the Woods Hole Oceanographic Institution and of NOAA Miami

Instrument SOLO float	Sta No.	Date 2005	Longitude South	Latitude West	Depth / m
S/N° 416	227-2	27 May	35° 00.17’	44° 39.43’	4826
S/N° 417	228-1	28 May	31° 59.97’	40° 21.73’	4207
S/N° 418	244-1	01 Jun	27° 00.04’	36° 48.69’	4602
S/N° 419	248-1	03 Jun	25° 00.26’	30° 28.04’	5343
S/N° 420	249-1	04 Jun	23° 00.02’	26° 52.70’	5560
S/N° 429	250-1	05 Jun	20° 00.05’	23° 0.05’	4669

Fig. 2.3: In several cases SOLO floats for Argo were launched in their card board boxes without unpacking at full speed of 14 knots.

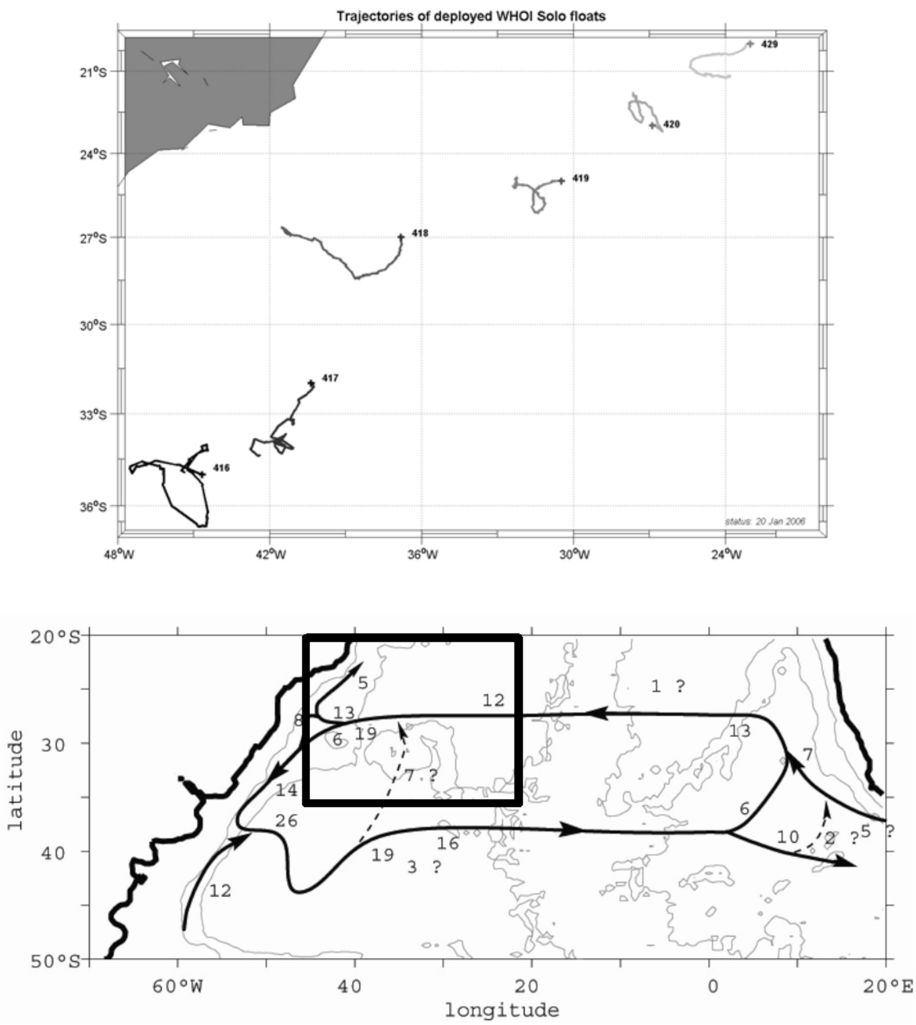

Fig. 2.4: First segments of trajectories from SOLO floats deployed during leg 5 (top) and its hydrographic frame at the level of Antarctic Intermediate Water (bottom) acc. to Schmid et al. (2000). Numbers denote transport estimates in $10^6\ m^3\ s^{-1}$. Note that all floats show a westerly drift direction as a contribution to the subtropical intermediate circulation. Argo floats return every 10 days to the surface and download their CTD profiles via satellite links.
Status: January 2006

2.2 Vessel mounted acoustic current Doppler profiler (ADCP)

Peter Brandt (not on board)
Institut für Meereskunde, Kiel (IFM-GEOMAR)

The ADCP was operated by order of Peter Brandt (IFM-GEOMAR) between the Vema Channel and the southern Canary Basin, thus completely covering the region of special interest in low latitudes of both hemispheres of the Atlantic Ocean along 23°W. These shipboard velocity measurements were carried out from 27 May to 11 June 2005. Thanks to the assistance of FIELAX GmbH, Bremerhaven, the obtained data are of high quality. The vertical measurement range increases from 200 m at

20°S towards north and south. At the equator the largest range of > 300 m was obtained. The necessary calibration of the misalignment angle of the ADCP transducer was performed using the heading from the ships-own 3D Ashtech system.

This system yields the lowest (best) standard deviation of the calibration compared to the synchro heading that is supplied to the board unit and to the digital heading from the fibre optic compass. Thus, it is recommended to always store also the heading information of the 3D Ashtech system together with the velocity data of the ADCP. A section across the equatorial current system is shown in figure 2.5

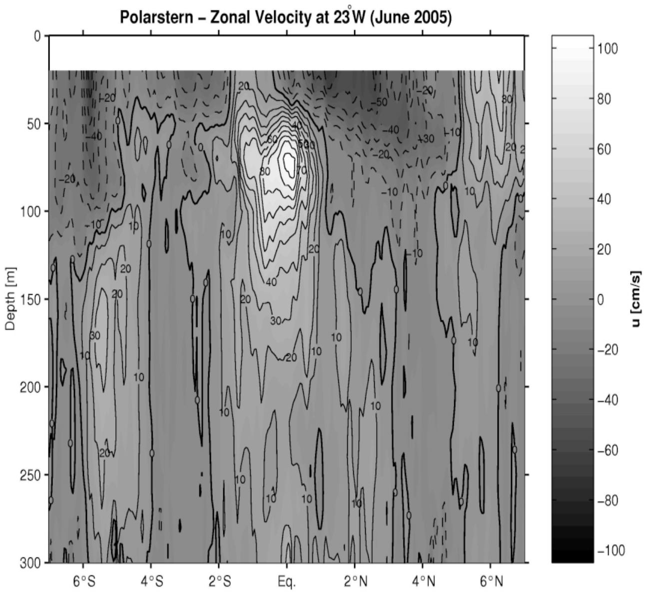

Fig. 2.5: Zonal velocity shows most paramount the Equatorial Undercurrent (EUC) with maximum velocities of > 100 cm s^{-1} in about 70 m water depth at the equator, as well as South and North Equatorial Undercurrents (NEC, SEC) in the upper 80 m of the water column between 5° and 6° of both hemispheres.

2.3 The Vema Channel Programme

Mooring works

Two near-bottom moorings were recovered and re-deployed after servicing all instruments and acoustic releases. They were and are now again located on the flanks of the Vema Sill. The geographical location of both moorings is given with the two squares in figure 2.1. A graphical presentation with the instrumented levels on opposite sides of the sill can be seen in the CTD section from the sill in figure 2.11. Nomenclature and other details like instrument types, serial numbers etc. are summarized in table 2.2.

Technically, the large majority of instruments worked well. 13 out of 14 moored devices delivered data of equal length. The 14th unit – a MTD logger at the lowest position in mooring V439108 – leaked and the included lithium batteries burned out. Substantial problems occurred with the pressure records of those two moored CTD recorders that were equipped with this option. They drifted and failed after some months of operation without any obvious reason. A gradual shift of the whole mooring rig uphill by 100 dbar per 17 months can be excluded as an explanation for the future.

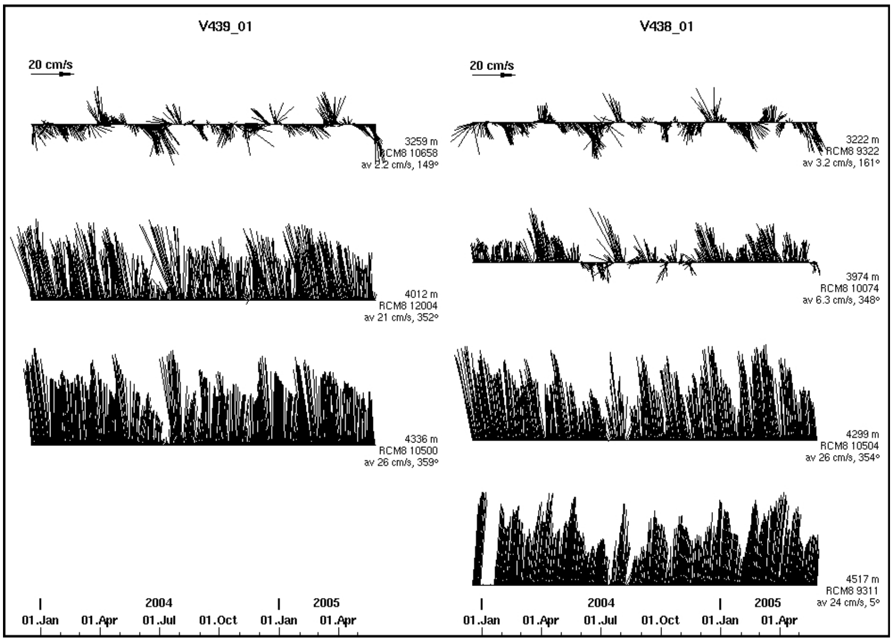

Fig. 2.6: Series of current vectors from Vema Channel moorings V4381xx (right, eastern edge) and V4391xx (left). The Aanderaa current meters recorded from December 2003 – May 2005 on the Vema Sill. Mooring positions are given in figure 2.1. Mean parameter values together with instruments serial numbers (Tab. 2.2) are shown on the right hand sides. Reference speed arrows are depicted on top. True north direction points upward.

Table 2.2: Mooring activities during RV Polarstern cruise ANT-XXII/5

IfM No.	Date 2005	Lat S	Lon W	z (m)	Instr. Type	Remarks incl. planned instr. depth
East	28 May	31°	39°	4535	Argos	ID 2264 @3178m
V 4381xx	r	15.28'	18.97'		MC	S/N 2484 @3221m
					RCM 8	S/N 9322 @3222m
					MC	S/N 2485 @3973m
					RCM 8	S/N 10074 @3974m
					MC	S/N 1284 @4298m
					RCM 8	S/N 10504 @4299m
					MC	S/N 1286 @4515m
					RCM 8	S/N 9311 @4517m
West	28 May	31°	39°	4453	Argos	ID 2262 @3217m
V 4391xx	r	15.78'	26.87'		MTD	S/N 36 @3217m
					RCM 8	S/N 10658 @3259m
					MTD	S/N 40 @3475m
					RCM 8	S/N 12004 @4012m
					RCM 8	S/N 10500 @4336m
					MTD	S/N 37 @4362m
						Instr. leaked, burned out
West	29 May	31°	39°	4449	Argos	ID 2262 @3217m
V 4392xx	d	15.60'	27.19'		MTD	S/N 36 @3217m
					RCM 8	S/N 10658 @3259m
					MTD	S/N 40 @3475m
					RCM 8	S/N 12004 @4012m
					RCM 8	S/N 10500 @4336m
East	30 May	31°	39°	4544	Argos	ID 2264 @3138m
V 4382xx	d	15.28'	18.96'		MC	S/N 2484 @3182m
					RCM 8	S/N 9322 @3183m
					RCM 11	S/N 441 @3718m
					MC	S/N 2485 @3934m
					RCM 8	S/N 10074 @3935m
					MC	S/N 1284 @4259m
					RCM 8	S/N 10504 @4260m
					MC	S/N 1286 @4478m
					RCM 8	S/N 9311 @4479m
					RCM 11	S/N 477 @4513m

Abbreviations:

IFM	Leibniz Institute of Marine Sciences, Kiel
RCM 8	Mechanical Aanderaa Current Meter RCM 8
RCM 11	Acoustic Aanderaa Current Meter RCM 11
MC	MicroCat - moored CTD logger
MTD	Mini TD - moored T-p logger
Argos	Watch dog buoy
S/N	Serial number of instrument
d	Deployment
r	Recovery
z	Depth
xx	place holder for sequential numbers of recording instruments from top to bottom

Hydrographic observations

During ANT-XXII/5 a total of 16 CTD stations were occupied. With one exception they all were located in the subtropical South Atlantic between the northern Argentine Basin and the southern Brazil Basin. The positions were chosen to trace Antarctic Bottom Water on its equatorward spreading through Vema Channel. Additional regions for CTD sections included the north side of Santos Plateau and the Vema extension (see Fig. 2.7). In case of the Santos Plateau and the extension sections (Speer & Zenk, 1993) we combine the RV *Polarstern* data with earlier surveys from the *Discovery* cruise in December 2003. The last CTD cast of the cruise was taken west of Madeira in the North Atlantic close to the ocean observatory KIEL276. Only a month prior to our arrival RV *Poseidon* had exchanged the long-term mooring for the 25th time. This full depth ocean site first was started in 1980 (Siedler et al., 2005).

Table 2.3: CTD inventory of RV *Polarstern* cruise ANT-XXII/5

Station N°	Cast N°	Date 2005	Time Start	Position Latitude ° S (-) ° N (+)	Position Longitude ° W (-)	Depth / m * Hydrosweep
227	1	27 May	12:01	-35,0010	-44,6608	4825
231	2	28 May	21:11	-31,1924	-39,4704	4145
232	3	29 May	00:13	-31,1989	-39,4182	4600
233	4	29 May	09:04	-31,1996	-39,3534	4575
234	5	29 May	14:03	-31,1984	-39,3160	4470
236	6	30 May	03:15	-32,3680	-39,7997	4480
238	7	30 May	16:12	-31,1984	-39,2752	4485
239	8	31 May	04:39	-29,2564	-38,9771	4635
240	9	31 May	16:08	-28,3225	-40,1815	4560
241	10	31 May	19:58	-28,2119	-40,3664	2485 *
242	11	31 May	22:37	-28,0796	-40,5373	2693 *
243	12	1 Jun	10:22	-27,4994	-38,1704	4474 *
245	13	2 Jun	03:38	-26,2842	-34,9321	4364 *
246	14	2 Jun	10:57	-26,6961	-34,2338	4789 *
247	15	2 Jun	16:08	-26,8836	-33,9008	3828 *
251	16	15 Jun	02:05	+33,0667	-22,0000	5277

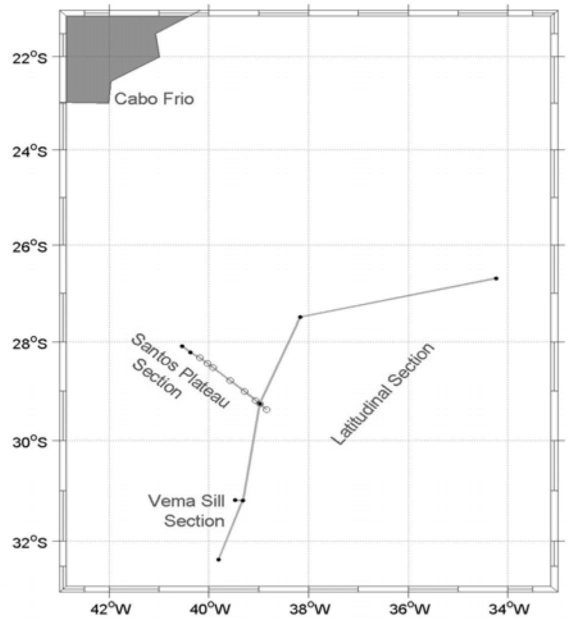

Fig. 2.7: Map of the area under investigation south-east of the Bigth of Rio de Janeiro. Three sections are indicated by solid lines. Dots indicate CTD stations occupied with RV Polarstern during ANT-XXII/5, circles denote CTD stations from December 2003 with RRS Discovery.

The backbone for our hydrographic observations consisted of a SBE 911 CTD system with a rosette sampler (see Fig. 3.7) kindly provided by AWI.

Fig. 2.8: CTD probe with rosette sampler on the working deck of RV Polarstern. In the foreground a dual-release package as used in both re-launched moorings is shown.

As later calibration checks showed, the system was in excellent condition. Immediately after each station had been finished preliminary CTD data were made available for all groups on board via intranet. Keeping the topical abyssal layers in mind we concentrated our salinometer check values from the deepest parts of the profiles. Only in two cases (Station 234, 246) we took samples from the whole water column. In figure 2.9 we display salinity differences between indicated CTD value and salinometer values as a function of station numbers. All 57 samples were analysed in one batch on 16 June 2005 after finishing the last station. After obtaining an insignificant mean deviation of roughly <0.001 we decided to apply no post-cruise salinity tuning to the obtained SBE data.

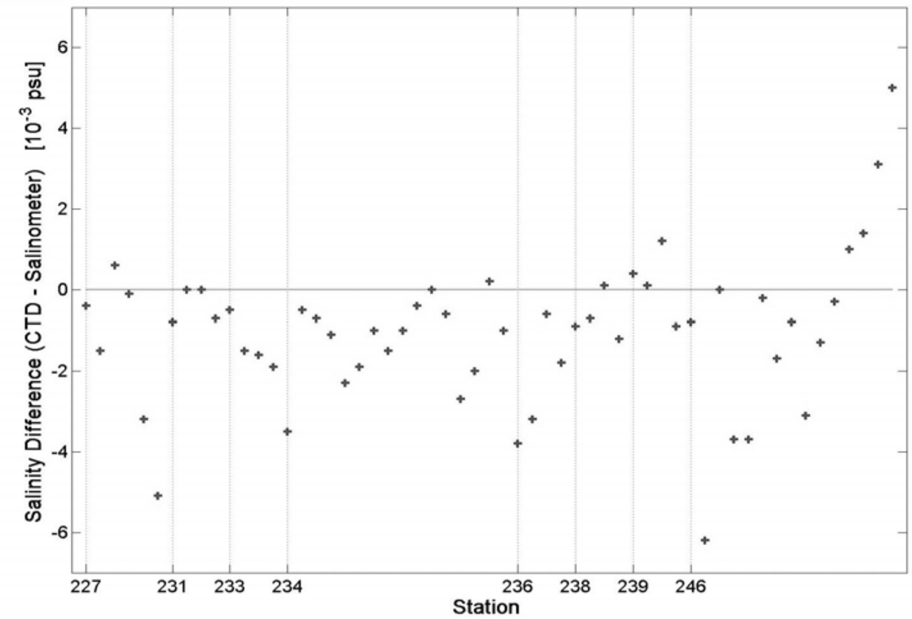

Fig. 2.9: Salinity difference [10^{-3}] between measured CTD data and check values from the rosette sampler.

Water masses

The south-western South Atlantic shows a remarkable sequence of distinct water masses stacked on top of each other. They differ in various hydrographic and chemical parameters flowing in opposite directions (Reid et al., 1977). Among the deep layers are Antarctic Bottom Water (AABW), an integral water mass first discussed by Wüst (1943) with respect to its basin-wide impact, and lower branch of Circumpolar Deep Water (CDW). In the newer literature Weddell Sea Deep Water (WSDW) can be found as the deepest abyssal water mass of the Argentine Basin (Speer & Zenk, 1993). Sometimes the terminology of the sandwiched water masses of the South Atlantic can be rather confusing as Reid et al. (1977) noted almost 30 years ago:

"The designation 'Antarctic Bottom Water' can lead to some confusion. The densest Antarctic Water is formed in the Weddell Sea and extends eastward from there as an abyssal layer that is low in temperature, salinity, and nutrients and high in oxygen. It does not extend into the Argentine Basin. Instead it is Weddell Sea Deep Water, with characteristics intermediate between those of the overlaying Circumpolar and underlying bottom water in the Weddell Sea, that extends northward into the Argentine Basin as a western boundary current and, with the lower branch of the Circumpolar Water, carries the characteristics of Antarctic waters into the abyssal Atlantic Ocean."

In the synoptic CTD section in figure 2.10 we show the step-like degradation of the bottom layer by abyssal mixing when approaching and transgressing through the Vema Channel and beyond. Its longitudinal orientation is seen in figure 2.7. Marker isolines for the upper limit of AABW (acc. Speer & Zenk, 1993) at potential temperature θ = 2.0°C and the density parameter σ_4 = 45.85 kg m^{-3} are included as white lines.

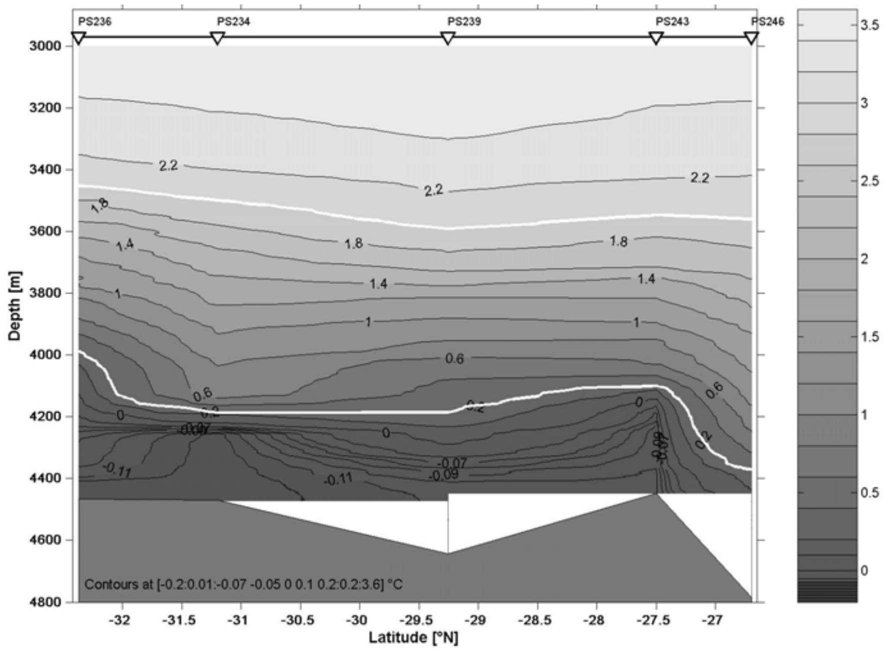

Fig. 2.10 (a): Latitudinal Section (Fig 2.7): Distribution of potential temperature [°C] as recorded during RV Polarstern cruise ANT-XXII/5. CTD casts are indicated by numbers on the upper axis.

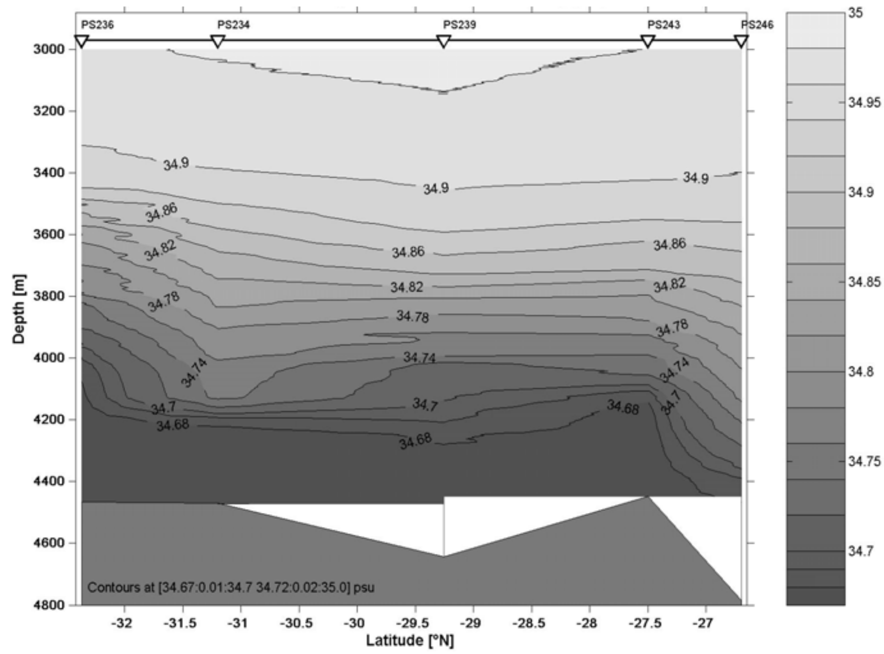

Fig. 2.10 (b): same as Fig. 2.10 (a) but for salinity

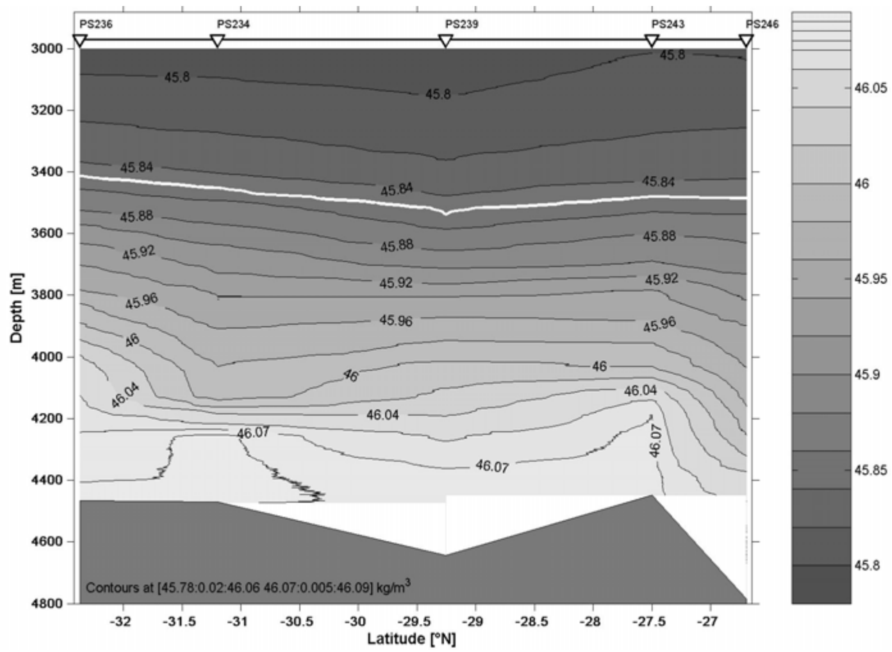

Fig. 2.10 (c): same as Fig. 2.10 (a) but for σ_4 [kg/m^3], p_{ref} = 4000 dbar

As a separator between WSDW and lower CDW we adopted θ = 0.2° C or σ_4 = 46.05 kg m^{-3}. The RV *Polarstern* section reproduces the northern most 600 km of the historical meridional section in Reid et al. (1977) that runs from the Weddell Sea towards the southern end of the Brazil Basin. The new observations will support further analysis of vertical upward fluxes from the abyss into intermediate layers (Hogg et al, 2001).

Figure 2.11 denotes a zonal section across the Vema Sill (Zenk et al., 1993). The shown bottom contour was derived directly from ship-borne Hydrosweep system operated during most of the cruise leg. For a better orientation we have further included the position of the self-contained instruments in moorings V4391xx on the western (left) banks of the Vema Channel and V4381xx on the eastern terrace (right). More details about the past and present mooring inventory are given in table 2.2.

The most notable features of the section are the pinching of isolines on the eastern wall of the channel and the coverage of almost the whole bottom with water of q < -0.12°C. The compression is a well known phenomenon of deep abyssal channels where frictional forces dominate a geostrophic equilibrium (Jungclaus & Vanicek, 1998). Measurements in earlier years have shown a systematic temperature increase of the coldest layer on the Vema Sill (Hogg & Zenk, 1997; Zenk & Hogg, 1996; Hogg, 2001). So far, the data density over the years (since 1971) has been insufficient to investigate temperature changes in the cross stream direction of the channel. This new data set will enable us to pursue this problem in more detail.

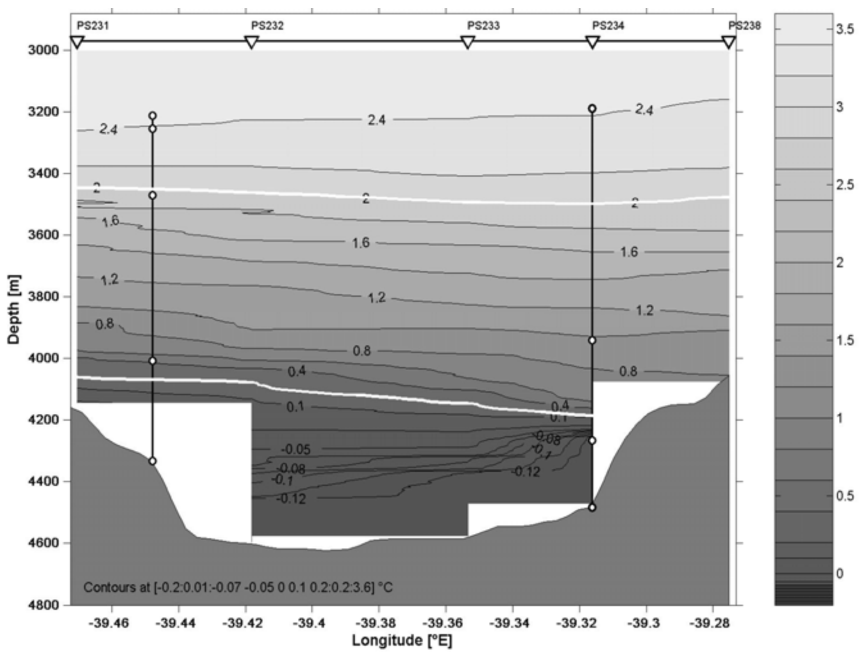

Fig 2.11 (a): Vema Sill Section (Fig. 2.7): Distribution of potential temperature [°C] as recorded during RV Polarstern cruise ANT-XXII/5. CTD casts are indicated by numbers on the upper axis. The bold vertical lines denote the moorings with recording instruments marked by circles.

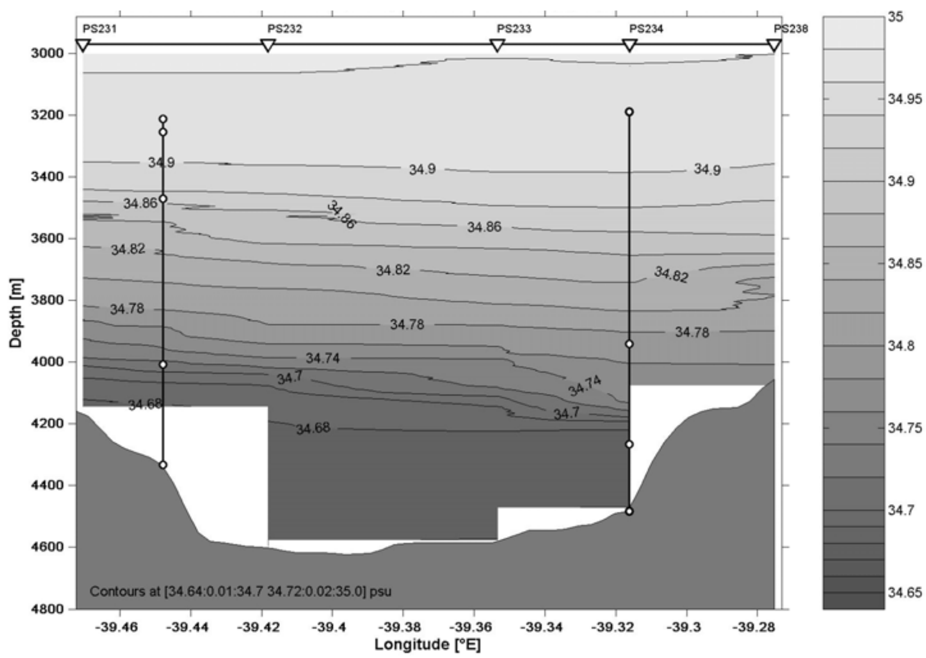

Fig 2.11 (b): same as Fig 2.11 (a) but for salinity

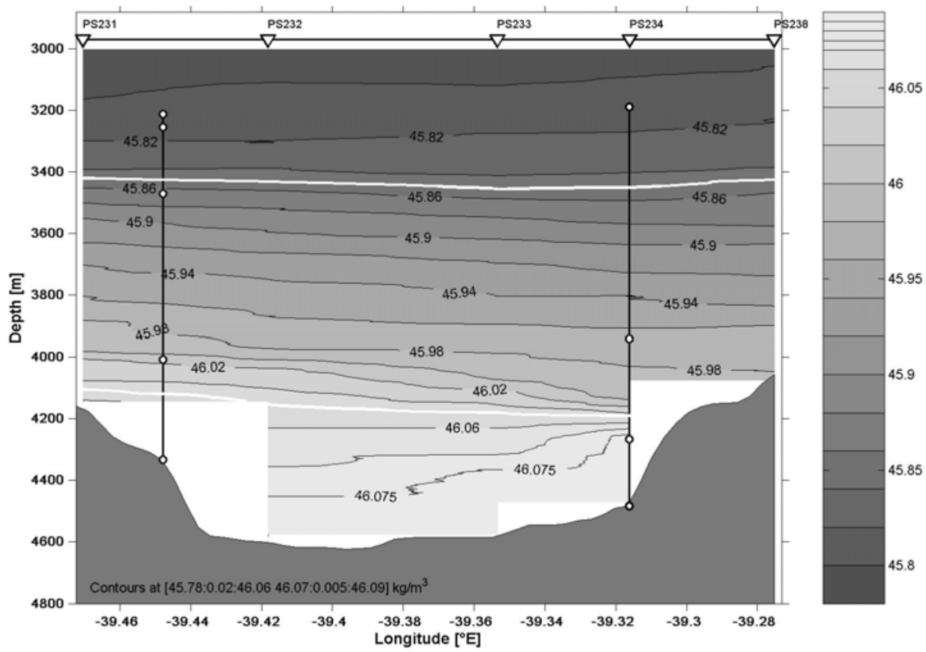

Fig. 2.11 (c): same as Fig 2.11 (a) for σ_4 [kg/m^3], p_{ref} = 4000 dbar

The third CTD section (Fig. 2.12) shows two deep channels (for position see figure 2.7): One in the west in continuation of the Santos Plateau overflow of AABW with isoline pinching at 3500 m and the other farther to the east in the direct extension of the Vema Sill region with compressed isoline as seen in figure 2.11. This section was composed from a survey in December 2003 and new data from the RV *Polarstern* cruise. The distributions of temperature and salinity on the western side are indicative for the root of the northward abyssal boundary current along the South American continental slope. The lowest temperatures on the bottom of the channel's extension on the eastern side differ barely from those seen on the Vema Sill. Obvious differences in the parameters confirm different flow paths and mixing histories farther downward in the Argentine Basin.

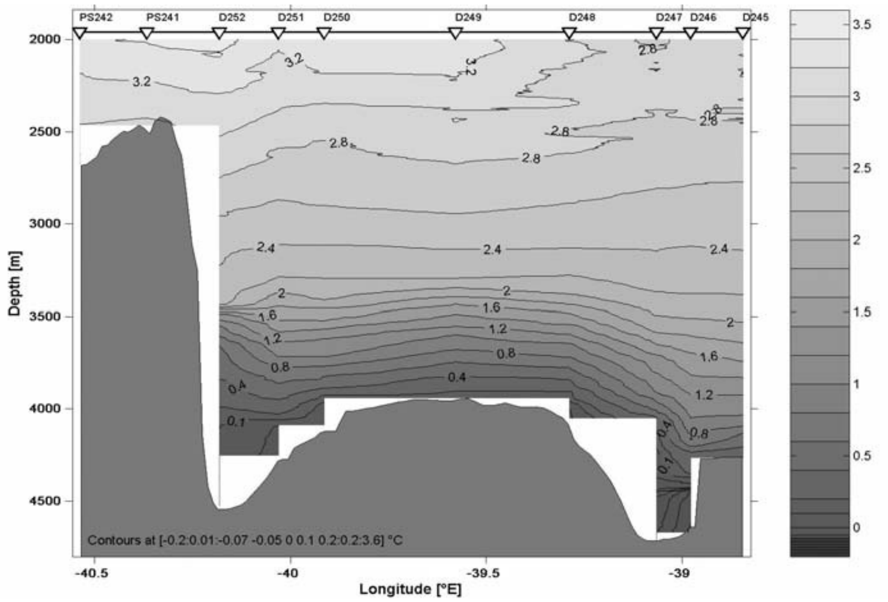

Fig. 2.12 (a): Santos Plateau Section (Fig. 2.7): Distribution of potential temperature [°C] as recorded during RV Polarstern cruise ANT-XXII/5 in May 2005 and Discovery Cruise D276b in December 2003. CTD casts are indicated by numbers on the upper axis. PSxxx stands for RV Polarstern, Dxxx for RSS Discovery.

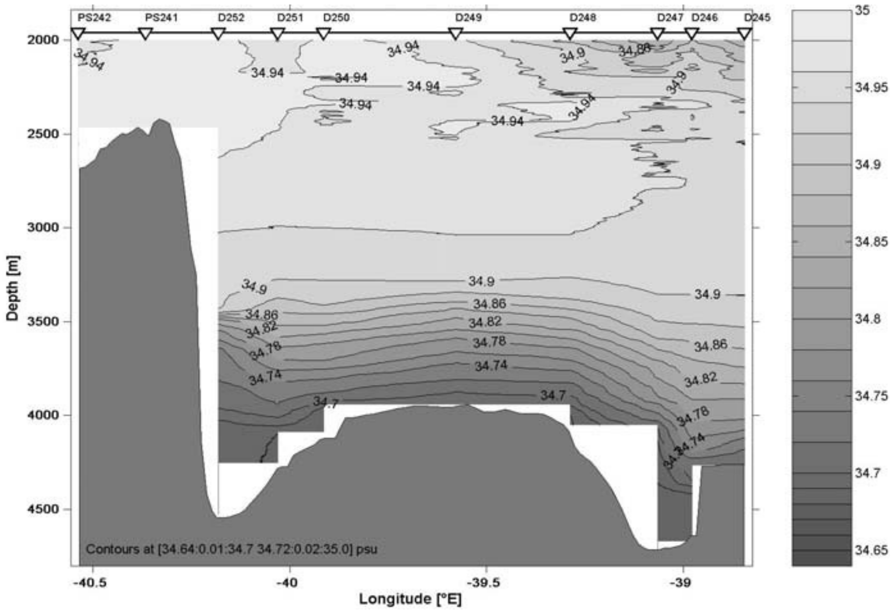

Fig. 2.12 (b): same as Fig. 2.12 (a) but for salinity

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3. SAMPLING PROGRAMME FOR SURFACE CO_2 SYSTEM PARAMETERS DURING RV POLARSTERN TRANSITS

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The primary goal of the sampling programme for parameters of the surface ocean CO_2 system is to study interannual variability and long term trends in the air-sea $\delta^{13}C$-DIC disequilibrium of surface waters in the Atlantic Ocean. The project is planned as a long-term study which involves sampling during as many RV *Polarstern* transits to/from the Southern Ocean as possible.

During each transect, surface samples for $\delta^{13}C$-DIC measurements are taken at regular spacing along the entire cruise track and measured at the Stable Isotope Laboratory of the University of Washington. For $\delta^{13}C$-DIC measurements, the CO_2 is extracted to 100 ± 0.5 % using a helium stripping technique, and the $^{13}C/^{12}C$ ratio of the extracted CO_2 is later measured on a Finnigan MAT 251 isotope ratio mass spectrometer. The overall precision of $\delta^{13}C$ analyses is typically ± 0.02 ‰ based on replicate analyses of standards and seawater samples (Quay *et al.*, 1992).

In order to enhance interpretation of the ^{13}C data (Körtzinger et al., 2003), parallel sampling for dissolved inorganic carbon (DIC) and total alkalinity (A_T) is being carried out on samples taken in parallel. Measurements of DIC and A_T are being made in Kiel using the following techniques: DIC is measured by coulometric titration following extraction of the CO_2 with an automated system known as SOMMA (Johnson et al., 1993). A_T is determined by potentiometric titration in an open cell (Mintrop et al., 2000), and references therein). DIC and A_T analyses are checked every 10–15 samples by measuring a certified reference material provided by A. Dickson (Scripps Institution of Oceanography, La Jolla, CA, U.S.A.). The estimated typical accuracy is 1.5 µmol.kg^{-1} for DIC and 2.5 µmol.kg^{-1} for A_T.

So far, samples have been collected on the following four *RV Polarstern* transits: ANT-XXI/1, ANT-XXI/5, ANT-XXII/1, ANT-XXII/5. The 135 samples from the most recent cruise ANT-XXII/5 will be measured during the second half of 2005. The d^{13}C data are currently examined with other sets to decipher the long-term Suess effect in surface waters along the Atlantic Ocean. Below data for DIC and A_T from the first three cruises are shown for illustration.

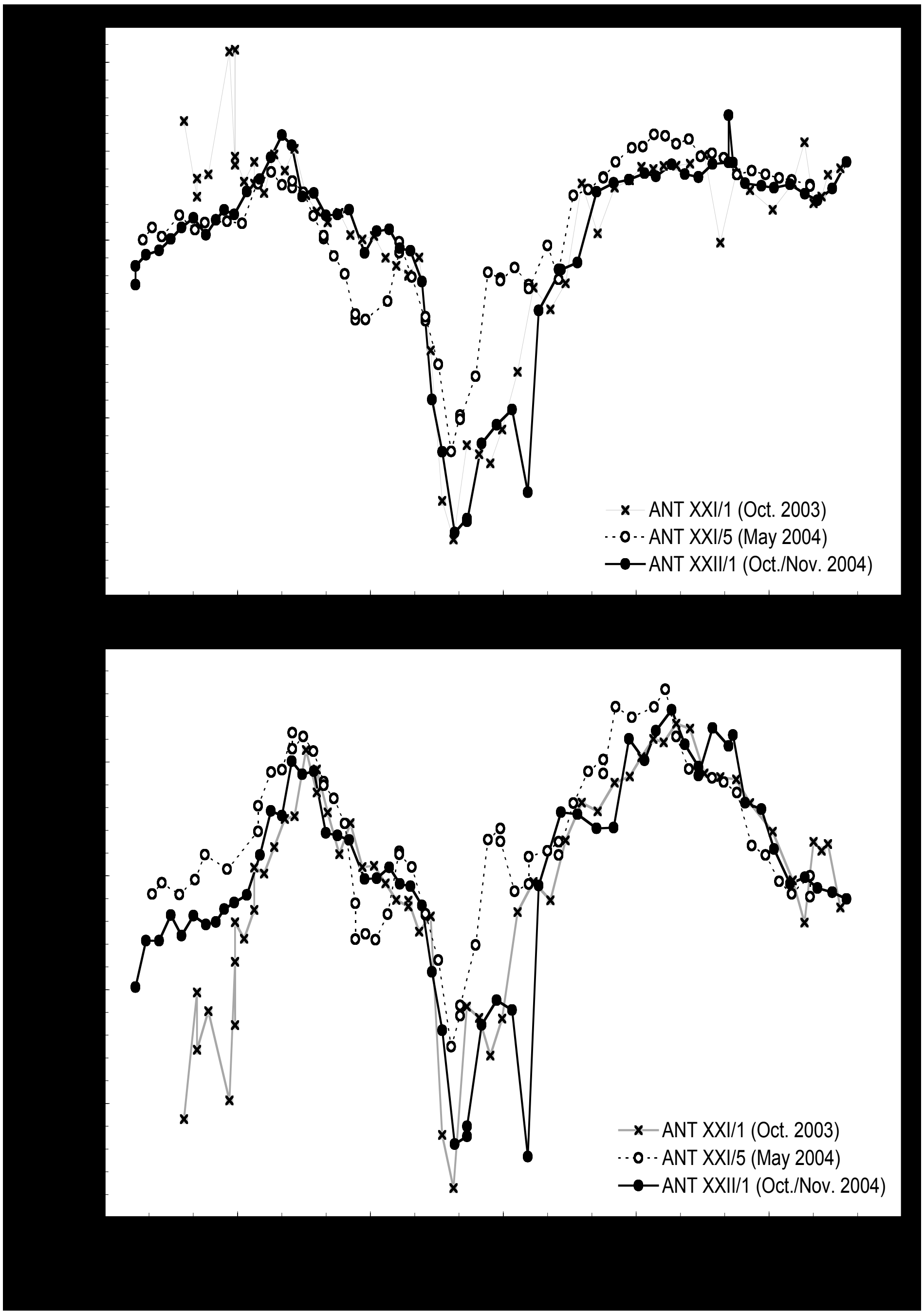

Fig. 3.1: Dissolved inorganic carbon concentrations (DIC [μmol/kg], top panel) and total alkalinity (A_T [μmol/kg], bottom panel) from surface samples taken along the ship track of RV Polarstern during the cruises ANT-XXI/1, ANT-XXI/5, and ANT-XXII/1

References

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Mintrop, L., Pérez, F.F., Gonzalez-Davila, M., Santana-Casiano, J.M., Körtzinger, A., 2000: Alkalinity determination by potentiometry – intercalibration using three different methods, *Ciencias Marinas* **26**, 23-37.

Quay, P.D., B. Tilbrook, and C.S. Wong, 1992: Oceanic uptake of fossil fuel CO_2: Carbon-13 evidence, *Science* **256**, 74-79.

4. AIR CHEMISTRY MEASUREMENTS USING DIFFERENTIAL OPTICAL ABSORPTION SPECTROSCOPY (DOAS)

Christian Frankenberg
University of Heidelberg

Objectives

The grating spectrometer deployed by the Institute of Environmental Physics of the University of Heidelberg measures stray-light in the ultraviolet and visible wavelength region. The spectrally resolved light is recorded by a CCD detector array with 2048 pixels at a spectral resolution of about 0.4 nm.

Since many trace gases in the atmosphere interact with light via electronic, vibrational and rotational transitions, each of these species exhibit a spectral signature that enables the identification and quantification by means of the Differential Optical Absorption Spectroscopy (DOAS). Applying this technique, the instrument onboard the RV *Polarstern* can measure Ozone (O_3), Nitrogen Dioxide (NO_2), Bromine Monoxide (BrO), Sulfur dioxide (SO_2) as well as Formaldehyde (CH_2O).

Work at sea

Since the instrument has been deployed onboard the RV *Polarstern* for several times already, it is now running in a nearly operational mode, i.e. the main work at sea is reduced to maintenance. Daily routine checks ensure that the measurements are not interrupted during the leg. At night, regular calibration measurements had to be performed.

Expected results

A detailed analysis of the recorded spectra in Heidelberg promises valuable insight into the distribution of the aforementioned trace gases in the remote marine atmosphere. Especially the long south-nord transect of the last leg is of importance since it covers largely varying atmospheric conditions such as solar zenith angle or ambient temperature. The air-masses are also often influenced by different geographical regions and emissions. For instance, biomass burning events in Africa or South America might influence the measurements as well as Saharan dust transported over the ocean.

5. WEATHER CONDITIONS

Hartmut Sonnabend
Deutscher Wetterdienst

On 24 May 2005 RV *Polarstern* left the harbour of Bahia Blanca. Under the influence of a ridge of high pressure spreading east-south-eastwards from the mouth of the Rio de la Plata, fresh and later on light to moderate winds from south to southwest helped RV *Polarstern* on her way towards the Vema Channel. On 26 May the ridge formed to a new high moving east-northeast. Corresponding to this development the cyclonic activity over the South Atlantic temporarily expanded north. The cold front of a low north of the Falkland Islands swung over the cruising area inducing post frontal conditions with a comfortable strong breeze nearly directly from aft. Approaching the subtropical high pressure belt that extended along the latitude of 30° south the wind shifted to northwest and decreased soon. A first CTD station could be carried out without problems.

On 28 May, when RV *Polarstern* arrived at the Vema Channel, the subtropical high was centred only a few miles southwest of the research area, dominating the feature with very fine and clear weather and only a light breeze from the northeast. A long-termed swell of about 2.5 to 3 meters came from the south-southwest. The basic conditions for the successful recovery of two moorings on the same day could not be much better. Until the next two days the subtropical high built a new centre around 600 nm east of Vema Channel. The wind increased slowly to force 4-5 on 29 May and a short maximum of force 6 beaufort in the morning of 30 May. These conditions, however, had no negative influence to the re-deployment of the two moorings and the following CTD stations in the vicinity of the moorings.

After having finished this programme RV *Polarstern* headed first a bit north-westward and later roughly north-eastward to carry out some more CTD work. As the axis of the subtropical high pressure belt remained stable along 30°S, RV *Polarstern* gradually encountered the southern hemispheric trade wind zone. Until 2 June all remaining CTD stations could have been carried out under fine weather conditions and wind forces between 3 and 5 beaufort.

Subsequently RV *Polarstern* headed directly to the waypoint 20°S, 23°W and from there northward until the final point 20°N, 23°W. Induced by a rather strong gradient between the large subtropical anticyclone with a maximum air pressure of nearly 1035 hPa and the belt of low pressure along the equator the easterly to south-easterly trade wind increased for the period from 3 June until the afternoon of 6 June. Especially on the 4 June the wind rose up to force 7 for several hours with shower squalls up to 8 beaufort associated with wave heights up to nearly 4 m. The sky was often covered with stratiform and convective clouds with scattered showers, becoming frequently on the 6 June. These bad conditions improved to more sunny weather as RV *Polarstern* approached the equator and later the Intertropical

Convergence Zone (ITCZ). The southeast wind however remained fresh with forces around 5 beaufort until RV *Polarstern* encountered the southernmost cloudband of the ITCZ a few miles north of 3°N on 9 June. The weather activities within the ITCZ were not very spectacular at all. A moderate shower in the morning of 9 June followed by some light to moderate rain and a few light showers until the early afternoon brought a total precipitation of 10.2 l m^{-2}. The wind within the ITCZ was mainly light and variable.

The northern hemispheric trade wind set in shortly after having passed 10°N. As the subtropical high in the North Atlantic was not developed as strong as its counterpart in the South Atlantic, the wind speed remained moderate and did not exceed 15 to 20 kn or wind forces from 4 to 5 beaufort. On 13 June the subtropical high started to move eastward forming a new centre until the following day between the Canary Islands and Madeira. Fading more and more in the course of 13 June, the trade wind became light and variable near the centre of the anticyclone until the next morning. The weather within that period was very fine with much sunshine and only a few clouds. The last CTD station west of Madeira could be carried out without problems during the night to the 15 June.

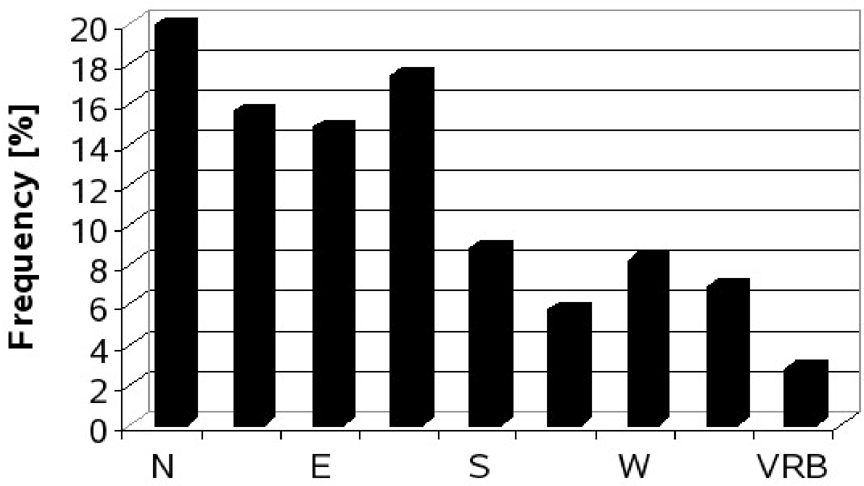

Fig. 5.1: Frequency distribution of observed wind directions during ANT-XXII/5

Soon afterwards RV *Polarstern* headed north-eastward towards the English Channel. At the same time the dominating high started to move across the north-western parts of Portugal and Spain towards the English Channel. Light to moderate winds from southwest to south and later southeast associated with continuing fair weather dominated the first two days. Off the coast lines of northwest Spain the wind shifted to north-easterly and north-westerly directions with forces of 4 to 5 beaufort. Low stratus clouds associated with bad visibilities were advected. Fresh north-westerly winds dominated when RV *Polarstern* crossed the Gulf of Biscay. Entering the English Channel near the isle of Ouessant, RV *Polarstern* encountered dense fog patches with visibilities around 100 m. These bad conditions improved as RV *Polarstern* got furthermore east along the French coast. Warm and dry continental winds favoured the passage of the Strait of Dover in the morning of 20 June with good visibilities. On the remaining way to Bremerhaven the light to moderate wind shifted from southerly directions at first to north-westerly directions later on. RV *Polarstern* reached the harbour of Bremerhaven in the early afternoon of 21 June 2005.

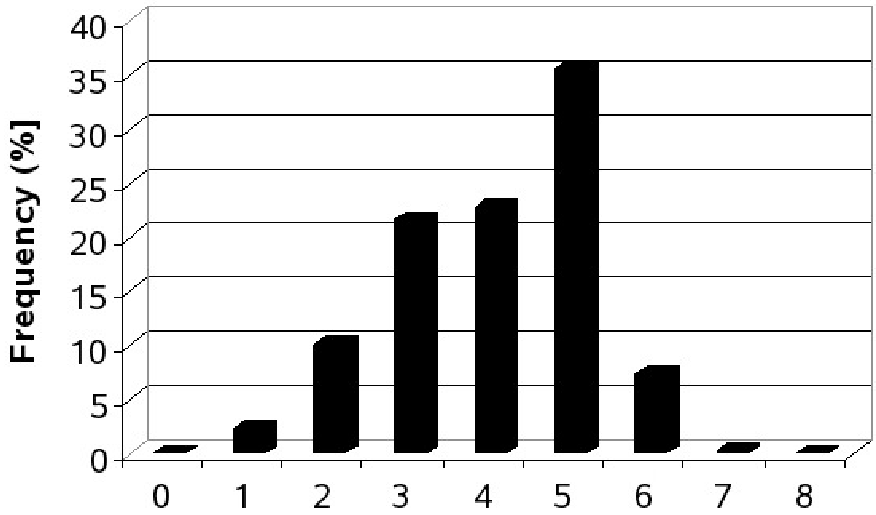

Fig. 4.2: Frequency distribution of wind forces [Bft] during leg 5

6. ACKNOWLEDGEMENTS

The chief scientist and his team would like to cordially thank Kapitän Uwe Pahl and his crew for the warm welcome and excellent co-operation on board. Financial support came from the Ministerium für Bildung und Forschung in Berlin. This cruise was a German contribution to the international climate variability and predictability (CLIVAR) programme of the World Meteorological Organisation (WMO). In Germany it is coordinated by E. Fahrbach from the Alfred Wegener Institute in Bremerhaven. Special thanks go to the cruise management committee of the Alfred Wegener Institute that enabled us to take several additional CTD casts slightly off a great circle route to the British Channel.

APPENDIX

A.1 PARTICIPATING INSTITUTIONS

A.2 PARTICIPANTS

A.3 SHIP's CREW

A.4 STATION LIST

A.1 PARTICIPATING INSTITUTIONS

DWD	Deutscher Wetterdienst Geschäftsfeld Seeschifffahrt Jenfelder Allee 70A 22043 Hamburg
IFM-GEOMAR	Leibniz-Institut für Meereswissenschaften IFM-GEOMAR Düsternbrooker Weg 20 24105 Kiel
IUPH	Universität Heidelberg Institut für Umweltphysik Im Neuenheimer Feld 229 69120 Heidelberg
NOAA	National Oceanic and Atmospheric Administration Miami U.S.A
University of Washington	University of Washington Seattle, WA 98195-7940 U.S.A.
WHOI	Woods Hole Oceanographic Institution Woods Hole, MA 02543-1050 U.S.A.

A.2 CRUISE PARTICIPANTS

Name	Institute
Frankenberg, Christian	IUPH
Neumann, Uta	IFM-GEOMAR
Niehus, Gerd	IFM-GEOMAR
Sheng, Min	IFM-GEOMAR
Sonnabend, Hartmut	DWD
Zenk, Dr. Walter	IFM-GEOMAR

A.3 SHIP'S CREW

01.	Pahl, Uwe	Master	German
02.	Spielke, Steffen	1.Offc.	German
03.	Schultz, Volker	Ch. Eng.	German
04.	Peine, Lutz G.	2.Offc.	German
05.	Bratz, Herbert	3.Offc.	German
06.	Kohlberg, Eberhard	Doctor	German
07.	Koch, Georg	R. Offc.	German
08.	Ziemann, Olaf	1. Eng.	German
09.	Kotnik, Herbert	2.Eng.	Austri
10.	Simon, Wolfgang	2.Eng.	German
11.	Bohlmann, Harald	ELO	German
12.	Feiertag, Thomas	ELO	German
13.	Fröb, Martin	ELO	German
14.	Holtz, Hartmut	Elec.	German
15.	Riess, Felix	ELO	German
16.	Clasen, Burkhard	Boatsw.	German
17.	Neisner, Winfried	Carpenter	German
18.	Burzan, Gerd-Ekkeh.	A.B.	German
19.	Darr, Klaus-Dieter	A.B.	German
20.	Kreis, Reinhard	A.B.	German
21.	Moser, Siegfried	A.B.	German
22.	Pusada Martinez, S.	A.B.	German
23.	Sandmann, Rainer	A.B.	German
24.	Schröder, Norbert	A.B.	German
25.	Schultz, Ottomar	A.B.	German
26.	Beth, Detlef	Storek	German
27.	Dinse, Horst	Mot-man	German
28.	Fritz, Günter	Mot-man	German
29.	Krösche, Eckard	Mot-man	German
30.	Schwarz, Uwe	Mot-man	German
31.	Toeltl, Siegried	Mot-man	German
32.	Fischer, Matthias	Cook	German
33.	Martens, Michael	Cooksmate	German
34.	Tupy, Mario	Cooksmate	German
35.	Dinse, Petra	1.Stwdess	German
36.	Schmidt, Maria	2.Stwdess	German
37.	Streit, Christina	2.Steward	German
38.	Tu, Jian-Min	2.Steward	China
39.	Wu, Chi Lung	2.Steward	German
40 .	Sun, Yong Sheng	Laundrym.	China

A.4 STATION LIST

Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Remarks
PS67/227-1	27.05.05	11:55	35° 0,03' S	44° 39,70' W	4824,8	CTD/RO	surface
PS67/227-1	27.05.05	12:25	35° 0,13' S	44° 39,60' W	4826,0	CTD/RO	at depth
PS67/227-1	27.05.05	12:43	35° 0,18' S	44° 39,44' W	4826,0	CTD/RO	on deck
PS67/227-2	27.05.05	12:44	35° 0,17' S	44° 39,43' W	4826,8	ArgoS	Float-N°416
PS67/228-1	28.05.05	08:19	31° 59,97' S	40° 21,73' W	4207,3	ArgoS	Float-N°417
PS67/229-1	28.05.05	13:20	31° 15,26' S	39° 18,94' W	4543,9	MOR	Hydrophone into the water
PS67/229-1	28.05.05	13:26	31° 15,25' S	39° 18,92' W	4545,4	MOR	released
PS67/229-1	28.05.05	14:53	31° 15,26' S	39° 18,80' W	4531,6	MOR	action
PS67/229-1	28.05.05	15:10	31° 13,92' S	39° 18,22' W	4468,9	MOR	Hydrophone into the water
PS67/229-1	28.05.05	15:14	31° 13,89' S	39° 18,21' W	4459,3	MOR	released
PS67/229-1	28.05.05	15:19	31° 13,88' S	39° 18,23' W	4458,2	MOR	Hydrophone on Deck
PS67/229-1	28.05.05	15:20	31° 13,88' S	39° 18,24' W	4470,5	MOR	Hydrophone into the water
PS67/229-1	28.05.05	15:25	31° 13,88' S	39° 18,32' W	4473,1	MOR	released
PS67/229-1	28.05.05	15:51	31° 13,69' S	39° 18,47' W	4488,2	MOR	Hydrophone on Deck
PS67/229-1	28.05.05	16:02	31° 13,67' S	39° 18,37' W	4490,9	MOR	on the surface
PS67/229-1	28.05.05	16:31	31° 15,20' S	39° 19,07' W	4546,6	MOR	Recover V 438-1
PS67/229-1	28.05.05	16:34	31° 15,18' S	39° 19,06' W	4545,4	MOR	Recover V 438-1
PS67/229-1	28.05.05	16:43	31° 15,13' S	39° 19,05' W	4546,4	MOR	Recover V 438-1
PS67/229-1	28.05.05	16:50	31° 15,09' S	39° 19,02' W	4546,9	MOR	Recover V 438-1
PS67/229-1	28.05.05	17:01	31° 14,90' S	39° 18,95' W	4547,6	MOR	Recover V 438-1
PS67/229-1	28.05.05	17:03	31° 14,85' S	39° 18,98' W	4550,2	MOR	Recover V 438-1
PS67/230-1	28.05.05	17:38	31° 15,79' S	39° 26,51' W	4471,4	MOR	Hydrophone into the water
PS67/230-1	28.05.05	17:49	31° 15,63' S	39° 26,59' W	4467,1	MOR	Hydrophone into the water
PS67/230-1	28.05.05	17:53	31° 15,63' S	39° 26,60' W	4464,2	MOR	released
PS67/230-1	28.05.05	17:56	31° 15,64' S	39° 26,62' W	4464,2	MOR	released
PS67/230-1	28.05.05	17:59	31° 15,64' S	39° 26,63' W	4464,0	MOR	Hydrophone on Deck
PS67/230-1	28.05.05	18:04	31° 15,58' S	39° 26,68' W	4462,3	MOR	released
PS67/230-1	28.05.05	18:11	31° 15,42' S	39° 26,76' W	4459,6	MOR	Hydrophone on Deck
PS67/230-1	28.05.05	18:34	31° 15,25' S	39° 26,66' W	4470,2	MOR	on the surface
PS67/230-1	28.05.05	18:51	31° 15,69' S	39° 26,89' W	4454,8	MOR	Recover V 439-1
PS67/230-1	28.05.05	18:52	31° 15,68' S	39° 26,89' W	4454,5	MOR	Recover V 439-1
PS67/230-1	28.05.05	18:55	31° 15,66' S	39° 26,81' W	4455,0	MOR	Recover V 439-1
PS67/230-1	28.05.05	19:00	31° 15,63' S	39° 26,71' W	4458,2	MOR	Recover V 439-1
PS67/230-1	28.05.05	19:07	31° 15,53' S	39° 26,66' W	0,0	MOR	Recover V 439-1
PS67/230-1	28.05.05	19:14	31° 15,35' S	39° 26,75' W	4461,7	MOR	Recover V 439-1
PS67/230-1	28.05.05	19:17	31° 15,26' S	39° 26,77' W	4464,2	MOR	Recover V 439-1
PS67/230-1	28.05.05	19:18	31° 15,23' S	39° 26,78' W	4466,5	MOR	surface
PS67/231-1	28.05.05	21:07	31° 11,83' S	39° 28,07' W	4151,2	CTD/RO	surface
PS67/231-1	28.05.05	22:30	31° 11,41' S	39° 28,41' W	4143,1	CTD/RO	at depth
PS67/231-1	28.05.05	23:33	31° 11,12' S	39° 28,75' W	4166,4	CTD/RO	on deck
PS67/232-1	29.05.05	00:04	31° 11,99' S	39° 25,03' W	4603,6	CTD/RO	surface
PS67/232-1	29.05.05	01:24	31° 11,91' S	39° 25,21' W	4611,4	CTD/RO	at depth
PS67/232-1	29.05.05	02:20	31° 12,01' S	39° 25,51' W	4586,6	CTD/RO	on deck

Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Remarks
PS67/233-1	29.05.05	09:03	31° 12,04' S	39° 21,15' W	4573,4	CTD/RO	surface
PS67/233-1	29.05.05	10:29	31° 12,00' S	39° 21,31' W	4577,5	CTD/RO	at depth
PS67/233-1	29.05.05	11:29	31° 11,80' S	39° 21,25' W	4561,9	CTD/RO	on deck
PS67/234-1	29.05.05	14:02	31° 11,94' S	39° 18,85' W	4464,8	CTD/RO	surface
PS67/234-1	29.05.05	15:09	31° 11,85' S	39° 18,97' W	4567,9	CTD/RO	at depth
PS67/234-1	29.05.05	17:34	31° 11,63' S	39° 19,12' W	4460,2	CTD/RO	on deck
PS67/235-1	29.05.05	19:06	31° 15,75' S	39° 26,98' W	4453,9	MOR	Deploy V439-2
PS67/235-1	29.05.05	19:10	31° 15,72' S	39° 27,01' W	4454,8	MOR	Deploy V439-2
PS67/235-1	29.05.05	19:18	31° 15,71' S	39° 27,07' W	4454,0	MOR	Deploy V439-2
PS67/235-1	29.05.05	19:29	31° 15,74' S	39° 27,15' W	4451,5	MOR	Deploy V439-2
PS67/235-1	29.05.05	19:30	31° 15,74' S	39° 27,16' W	4452,2	MOR	Deploy V439-2
PS67/235-1	29.05.05	19:41	31° 15,72' S	39° 27,17' W	4450,9	MOR	Deploy V439-2
PS67/235-1	29.05.05	19:55	31° 15,66' S	39° 27,19' W	4450,5	MOR	Deploy V439-2
PS67/235-1	29.05.05	19:59	31° 15,62' S	39° 27,17' W	4450,0	MOR	Deploy V439-2
PS67/235-1	29.05.05	20:09	31° 15,60' S	39° 27,19' W	4448,6	MOR	slipped
PS67/236-1	30.05.05	03:15	32° 22,07' S	39° 48,03' W	4469,7	CTD/RO	surface
PS67/236-1	30.05.05	04:42	32° 22,05' S	39° 48,01' W	4469,1	CTD/RO	at depth
PS67/236-1	30.05.05	05:43	32° 22,08' S	39° 47,99' W	4470,5	CTD/RO	on deck
PS67/237-1	30.05.05	14:07	31° 15,27' S	39° 18,94' W	4544,9	MOR	Deploy V438-2
PS67/237-1	30.05.05	14:31	31° 15,32' S	39° 18,91' W	4514,2	MOR	Deploy V438-2
PS67/237-1	30.05.05	14:36	31° 15,30' S	39° 18,91' W	4542,2	MOR	Deploy V438-2
PS67/237-1	30.05.05	14:45	31° 15,24' S	39° 18,97' W	4545,0	MOR	Deploy V438-2
PS67/237-1	30.05.05	14:55	31° 15,27' S	39° 18,96' W	4547,3	MOR	Deploy V438-2
PS67/237-1	30.05.05	15:13	31° 15,27' S	39° 18,95' W	4544,0	MOR	Deploy V438-2
PS67/237-1	30.05.05	15:28	31° 15,28' S	39° 18,96' W	4540,7	MOR	Deploy V438-2
PS67/237-1	30.05.05	15:34	31° 15,28' S	39° 18,96' W	4543,9	MOR	Deploy V438-2
PS67/237-1	30.05.05	15:38	31° 15,28' S	39° 18,96' W	4544,0	MOR	slipped
PS67/238-1	30.05.05	16:14	31° 11,91' S	39° 16,55' W	4077,2	CTD/RO	surface
PS67/238-1	30.05.05	17:31	31° 11,89' S	39° 16,46' W	4070,3	CTD/RO	at depth
PS67/238-1	30.05.05	18:29	31° 11,72' S	39° 16,55' W	4067,3	CTD/RO	on deck
PS67/239-1	31.05.05	04:41	29° 15,40' S	38° 58,57' W	4627,2	CTD/RO	surface
PS67/239-1	31.05.05	06:09	29° 15,38' S	38° 58,68' W	4639,9	CTD/RO	at depth
PS67/239-1	31.05.05	07:15	29° 15,40' S	38° 58,84' W	4645,7	CTD/RO	on deck
PS67/240-1	31.05.05	16:10	28° 19,36' S	40° 10,86' W	4548,6	CTD/RO	surface
PS67/240-1	31.05.05	17:36	28° 19,32' S	40° 10,85' W	4547,0	CTD/RO	at depth
PS67/240-1	31.05.05	18:37	28° 19,27' S	40° 10,88' W	4546,0	CTD/RO	on deck
PS67/241-1	31.05.05	19:58	28° 12,89' S	40° 21,87' W	2500,9	CTD/RO	surface
PS67/241-1	31.05.05	20:47	28° 12,56' S	40° 22,11' W	2479,0	CTD/RO	at depth
PS67/241-1	31.05.05	21:19	28° 12,50' S	40° 22,23' W	2480,0	CTD/RO	on deck
PS67/242-1	31.05.05	22:35	28° 4,91' S	40° 32,06' W	2678,0	CTD/RO	surface
PS67/242-1	31.05.05	23:28	28° 4,66' S	40° 32,38' W	2706,0	CTD/RO	at depth
PS67/242-1	01.06.05	00:04	28° 4,45' S	40° 32,53' W	2715,0	CTD/RO	on deck
PS67/243-1	01.06.05	10:22	27° 29,99' S	38° 10,03' W	4474,0	CTD/RO	surface
PS67/243-1	01.06.05	11:46	27° 29,91' S	38° 10,46' W	4479,0	CTD/RO	at depth
PS67/243-1	01.06.05	12:46	27° 29,85' S	38° 10,91' W	4478,0	CTD/RO	on deck
PS67/244-1	01.06.05	19:04	27° 0,04' S	36° 48,69' W	4602,0	ArgoS	Float-N°418
PS67/245-1	02.06.05	03:39	26° 16,98' S	34° 56,05' W	4359,0	CTD/RO	surface
PS67/245-1	02.06.05	05:02	26° 17,01' S	34° 55,95' W	4363,0	CTD/RO	at depth
PS67/245-1	02.06.05	06:02	26° 16,95' S	34° 55,95' W	4360,0	CTD/RO	on deck
PS67/246-1	02.06.05	10:56	26° 41,97' S	34° 13,93' W	4793,0	CTD/RO	surface
PS67/246-1	02.06.05	12:29	26° 41,58' S	34° 14,11' W	4781,0	CTD/RO	at depth
PS67/246-1	02.06.05	13:39	26° 41,22' S	34° 13,91' W	4757,0	CTD/RO	on deck
PS67/247-1	02.06.05	16:12	26° 53,10' S	33° 54,11' W	3825,0	CTD/RO	surface
PS67/247-1	02.06.05	17:23	26° 53,00' S	33° 54,05' W	3827,0	CTD/RO	at depth
PS67/247-1	02.06.05	18:11	26° 53,01' S	33° 54,01' W	3829,0	CTD/RO	on deck

Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Remarks
PS67/248-1	03.06.05	11:05	25° 0,26' S	30° 28,04' W	5343,0	ArgoS	Float-N°419
PS67/249-1	04.06.05	04:33	23° 0,02' S	26° 52,70' W	5560,0	ArgoS	Float-N°420
PS67/250-1	05.06.05	06:40	20° 0,05' S	23° 0,05' W	4669,0	ArgoS	Float-N°429
PS67/251-1	15.06.05	02:08	33° 4,00' N	22° 0,10' W	5228,0	CTD/RO	surface
PS67/251-1	15.06.05	03:45	33° 4,00' N	21° 59,90' W	5229,0	CTD/RO	at depth
PS67/251-1	15.06.05	04:48	33° 4,00' N	21° 59,90' W	5227,0	CTD/RO	on deck