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The Expedition of the Research Vessel "Polarstern" to the Antarctic in 2008 (ANT-XXIV/3)

Edited by
Eberhard Fahrbach and Hein de Baar
with contributions of the participants

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10 February - 16 April 2008

Cape Town - Punta Arenas
Weddell Sea, Drake Passage

Chief Scientist: Eberhard Fahrbach

Koordinator / Coordinator

Eberhard Fahrbach

This report is dedicated to
Willem Polman and Stefan Winter
who lost their lives by the helicopter accident at the Neumayer Station
on 2 March 2008.

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1. EXPEDITION ANT-XXIV/3: FAHRTVERLAUF UND ZUSAMMENFASSUNG

Eberhard Fahrbach[1)], Hein de Baar[2)]

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Von Kapstadt zur Neumayer-Station

Die Reise sollte am 6. Februar 2008 in Kapstadt beginnen. Der Hafenaufenthalt stand im Zeichen des Besuchs der Bundesministerin für Bildung und Forschung Frau Dr. Annette Schavan. Sie kam mit südafrikanischen Ministerkollegen, Würdenträgern und Wissenschaftlern sowie unseren Kollegen vom französischen Forschungsschiff *Marion Dufresne* zu Gesprächen, einem Workshop und einem gelungenen Empfang an Bord. Das Ereignis war sorgfältig vorbereitet worden und die gute Stimmung der 150 Gäste war ein sicheres Zeichen für den Erfolg dieser Bemühungen.

Der anhaltend stürmische Wind verhinderte, dass ein noch ausstehender CO_2-Container in Kapstadt angelandet werden konnte. Schließlich wurde das Schiff mit unserem Container nach Port Elizabeth umgeleitet, und so traf er erst in der Nacht zum 10. Februar auf der *Polarstern* ein. Unverzüglich wurde seeklar gemacht und so begann unsere Reise am 10. Februar endlich mit dreieinhalb Tagen Verspätung. Die Fahrtroute ist in Abb. 1.1 dargestellt.

Als Erstes wurden die Messungen vom fahrenden Schiff aus aufgenommen. Der akustische, profilierende Strömungsmesser (Akustischer-Doppler-Profilstrommesser, ADCP) und der Thermosalinograph lieferten Daten und die Pumpen förderten Wasser für Analysen. Entweder durch einen Schnorchel im Kiel in das bordeigene Leitungsnetz oder, um besonders reines Wasser zu erhalten, aus einem Schleppfisch, der Wasser neben dem Schiff einsaugte.

Die erste Station diente zur Aufnahme eines sogenannten PIES (Pressure Inverted Echosounder), der an dieser Position verankert war und die Schwankungen der Meeresoberfläche und der Schallgeschwindigkeit in der Wassersäule erfasst hat.

Nach Abschluss der Aufnahme begann eine Station zur Erprobung eines Wasserbeprobungssystems, der sogenannten Ultraclean-CTD, die besonders dafür ausgelegt ist, Wasserproben zu nehmen, um die Konzentration des im Ozean gelösten Eisens zu bestimmen. Die Messung minimaler Konzentrationen von Eisen im Meerwasser stellt unvorstellbare Ansprüche an die Probennahme, da das Schiff überwiegend aus Eisen besteht. Um diesen Einfluss des Schiffes zu vermeiden, wurde im Niederländischen Meeresforschungsinstitut (NIOZ) ein spezieller Probennehmer gebaut. Er besteht aus Titan und wird an einem Kevlardraht gefiert, um alles Eisen im Bereich der Probennahme zu vermeiden. Zur Erfüllung dieser hohen

Anforderungen entstand ein System aus Winde, Stromversorgung und Reinraum-Container, das das Arbeitsdeck nahezu ausfüllt. Der Test verlief erfolgreich.

Am 11. Februar 2008 kreuzte sich unser Kurs mit dem des norwegischen Forschungsschiffes *G.O. Sars*, das auf dem Weg nach Kapstadt war und sein Programm beendet hatte. Zwei deutsche Kollegen waren an Bord. Obwohl wir an einem gemeinsamen Programm mit im Ozean verankerten PIES arbeiten, musste sich das Treffen auf ein Winken von Schiff zu Schiff, dem Blasen der Hörner und dem anschließenden Austausch von Fotos per Email beschränken, da wir bei der gegebenen Verzögerung keine weitere Zeit verlieren wollten.

Die nächste Teststation galt dem Hauptarbeitsmittel der Ozeanographen, der CTD (Conductivity, Temperature, Depth), die uns die Vertikalverteilung von Temperatur, Salzgehalt, Sauerstoff, Trübung und Fluoreszenz an Bord anzeigt. Zusätzlich wurde das Strömungsprofil mit zwei Akustischen-Doppler-Profilstrommessern (ADCP) erfasst, die an der CTD befestigt waren. Auch hier war der Erfolg zu vermelden, so dass die Probestation schon für die Forschung verwendbares Wasser und Daten lieferte und man zu Routine übergehen konnte. Diese wurde allerdings durch das Wetter unterbrochen, da uns ein Tief mit 10 Windstärken streifte und unseren Weg nach Süden verzögerte.

Am 15. Februar überquerten wir die ozeanische Polarfront und am 25. Februar den 60. Breitengrad. Damit erreichten wir die Antarktis und das nördliche Stromband des Weddellwirbels. Dieses großräumige, nierenförmige Strömungssystem füllt den gesamten antarktischen Sektor des Atlantiks aus. Östlich des Meridians von Greenwich strömt warmes, salzreiches Wasser aus dem Antarktischen Zirkumpolarstrom, das Zirkumpolare Tiefenwasser, nach Süden. Im Westen fließt in der Tiefe das neu gebildete Weddellmeer-Bodenwasser nach Norden. Im Süden folgt der Antarktische Küstenstrom als südlicher Randstrom dieses Wirbels dem Verlauf des Kontinentalabhangs und der Schelfeiskante.

Die Lufttemperaturen sanken auf etwas über 0°C mit leichtem Schneefall. Der Wind pendelte zwischen 6 und 8 Windstärken hin und her. Zahlreiche Eisberge trieben im nördlichen Stromband des Weddellwirbels von der Antarktischen Halbinsel in unseren Bereich. Allerdings waren es nur stark verwitterte Reste und nicht die für die Antarktis typischen Tafeleisberge.

Der Stationsabstand von anfänglich 100 Seemeilen wurde auf 30 Seemeilen verringert, da unser Hauptarbeitsgebiet im Weddellwirbel lag. Der nördliche Teil des Schnitts wurde von der *Marion Dufresne* abgedeckt. An jeder Station wurde eine CTD-Sonde eingesetzt. An sogenannten „Superstationen“ kam das ganze Spektrum der Probennahme zum Einsatz. Auf dem Meridian von Greenwich führten wir 7 dieser Superstationen durch, bei denen in mehrfacher Folge mit dem Kranzwasserschöpfer, dem Ultraclean-CTD und den *in-situ* Pumpen Wasserproben für die GEOTRACES-Probennahme genommen wurden, was etwa 20 Stunden dauerte.

Die Spurenstoff (GEOTRACES) – Gruppe befasste sich hauptsächlich mit der Messung von im Meerwasser gelösten Spurenmetallen. Dazu zählt das Eisen, das für den Ablauf biologischer Prozesse von besonderer Bedeutung ist. Es wird von allen lebenden Organismen benötigt und damit auch von Algen, die wiederum die Grundlage der Nahrungskette im antarktischen Ozean darstellen. Allerdings ist Eisen nur in äußerst geringen Konzentrationen von etwa einem Hundertstel von einem Millionstel Gramm in einem Liter Meerwasser (10 Nanogramm pro Liter = 10 ng/L = 10^{-8} Gramm pro Liter) vorhanden. Im Gegensatz dazu ist das Schiff *Polarstern* eine unvorstellbare Konzentration von Eisen und die Probennahme zur Messung der Eisenkonzentration im Meerwasser benötigt einen "ultra-reinen" Probennehmer mit 24 Schöpfern. Wenn dieses Gerät zurück an Deck ist, wird es sofort in einen ultra-reinen Container gebracht, um jede Berührung mit dem Eisen des Schiffs zu vermeiden. Damit ist es erstmals möglich, vollständige Vertikalschnitte bis in 5 Kilometer Tiefe im Südlichen Ozean zu vermessen. Auf dem Meridian von Greenwich fanden wir sehr geringe Eisenkonzentrationen von nur 5 ng/L im Oberflächenwasser, die auf 30 ng/L in größerer Tiefe zunahmen. Im südlichen Teil des Schnittes zwischen der Maudkuppe und der Schelfeiskante waren die Werte (sogar) mit 3 ng/L im Oberflächenwasser und 20 ng/L in der Tiefe sogar noch geringer.

Kennt man erst einmal die auch geringen Konzentrationen, so stellt sich die Frage, woher dieses Eisen überhaupt kommt? Wurde es durch Stürme, die Staub aufwirbeln, vom Land ins Meer eingetragen? Alle Böden an Land enthalten viel natürliches Eisen. Der Anteil von Eisen in den Böden beträgt etwa 4 %. Da Böden auch reichlich Aluminium (Al) enthalten, messen wir Aluminium als Nachweis für den Staubeintrag. Die Konzentrationen des im Meerwasser gelösten Aluminiums waren auf dem Schnitt entlang dem Meridian von Greenwich sehr gering. Es waren die geringsten Konzentrationen, die man bisher im Ozean fand. Diese geringen Konzentrationen von 6 ng/L im Oberflächenwasser sagen uns, dass der Staubbeitrag, wenn es ihn überhaupt gibt, sehr gering ist. Daher muss das Eisen also von einer anderen Quelle stammen.

Im Sediment sind die Bedingungen günstiger, das Eisen von den Teilchen zu lösen, mit denen es in den Ozean eingebracht wurde. Also könnte dort die Quelle des Eisens im Meerwasser liegen. Wir wissen von einem anderen Element, Mangan (Mn), dass es ebenfalls in den Sedimenten gelöst werden kann. Also nutzen wir Mangan als Hinweis darauf, dass das Eisen aus dem Sediment stammt. Aber auch die Konzentrationen des gelösten Mangans sind äußerst gering, zwischen 3 ng/L im Oberflächenwasser und in etwa 10 ng/L in den tieferen Schichten. Nur über den mittelozeanischen Rücken findet man im tiefen Ozean höhere Mangan- und Eisenkonzentrationen, die durch unterseeischen Vulkanismus hervorgerufen werden. Dies lässt vermuten, der unterseeische Vulkanismus könne eine der bedeutendsten Quelle für Eisen in der Tiefsee sein. Aber auch weitere Metalle, (wie z. B. Zink) werden untersucht. So sind zum Beispiel Zink und Kupfer für Lebewesen von größter Bedeutung und auch sie kommen nur in ganz geringen Konzentrationen vor.

Auf der Strecke wurden vertikal-profilierenden Driftkörper (Argo-Floats) ausgelegt. Ein großer Teil der Floats wurden von Stephen Riser von der Universität von

Washington zur Verfügung gestellt. Sie sollen im Antarktischen Zirkumpolarstrom in den Indischen Ozean driften. In diesem Gebiet haben wir auch eine Serie von 6 Bodendruckmessern mit nach oben gerichteten Echoloten (PIES) aufgenommen und 5 davon wieder ausgelegt. Leider ging ein Gerät bei der Aufnahme verloren. Aus den Messungen dieser Geräte können die Schwankungen des Antarktischen Zirkumpolarstroms abgeleitet werden.

Die Verankerungsarbeiten begannen mit der erfolgreichen Aufnahme von drei Verankerungen im Übergangsgebiet zwischen dem Zirkumpolarstrom und dem Weddellwirbel, mit denen der Austausch zwischen diesen Strömungssystemen erfasst wurde. Leider war aus finanziellen Gründen eine Neuauslegung dieser Geräte nicht mehr möglich.

Der Unfall

Am 2. März erreichten wir die Atkabucht am frühen Sonntagmorgen, nachdem wir am 28. Februar unser Arbeitsgebiet am Meridian von Greenwich verlassen hatten. Nach grauen und zum Teil stürmischen Tagen wurden wir mit Sonntagswetter im wörtlichsten Sinne empfangen. Alle freuten sich darauf, nach Tagen der anstrengenden Stationsroutine, einen Tag auf dem Eis mit all den Eindrücken zu genießen, die Antarktisforschung so besonders faszinierend machen. Zwar mussten die Wissenschaftler sich darauf einstellen, auch bei den Lade- und Pumparbeiten mit Hand anzulegen, doch sollte genügend Zeit bleiben, sich am Aufenthalt auf dem Eis zu erfreuen.

Als wir um 8:30 Uhr die Nachricht erhielten, dass ein Helikopter beim Personentransport zur Neumayer-Station abgestürzt war, verwandelte sich Vorfreude und Erwartung in Bestürzung und Trauer. Schnell erreichten die Hilfsmannschaften von der Neumayer-III-Baustelle und der Neumayer-Station die Absturzstelle und mussten den Tod eines unserer Kollegen, Willem Polman aus dem NIOZ und des Piloten Stefan Winter vermelden. Zwei weitere Insassen, Alice Renault und Maarten Klunder waren schwer und der Helikopter-Techniker Carsten Möllendorf leicht verletzt. Trotz seiner Verletzungen war es Carsten Möllendorf gelungen, die anderen Verletzten aus dem Helikopter zu bergen und per Funk Hilfe anzufordern. Wir bewundern seine Umsicht und Besonnenheit. Die Verletzten wurden so schnell wie möglich mit dem zweiten Helikopter in das Hospital der *Polarstern* gebracht und dort versorgt.

Sofort wurde im AWI ein Krisenstab eingesetzt, der eine umfassende Unterstützungsaktion einleitete und die Information der Angehörigen und der Öffentlichkeit sowie den Rücktransport der Verletzten und Verstorbenen in beispielhafter internationaler Zusammenarbeit organisierte.

An Bord haben wir uns am 3. Februar zu einer Trauerfeier auf dem Helikopterdeck versammelt und von den beiden Kollegen Abschied genommen. Willem Polman und Stefan Winter verloren ihr Leben beim schwersten Unfall, den wir während des 25jährigen Einsatzes der *Polarstern* zu beklagen haben. Mit dieser Feier wollten wir den Angehörigen der Opfer unser tiefes Mitgefühl ausdrücken, uns gegenseitig Trost geben, und unsere hohe Wertschätzung der beiden Opfer bekunden. Unermesslich sind der Schmerz, der Verlust und die Ängste der betroffenen Familien, bei denen wir immer mit unseren Gedanken waren. Eine Flut von Beileidsbekundungen traf aus der ganzen Welt an Bord, im AWI und im NIOZ ein. Wir möchten uns auch auf diesem Wege für das weltweite Mitgefühl bedanken, das uns die Stärke verliehen hat, diese schwierige Situation durchzustehen. Wir möchten uns auch bei allen bedanken, die dazu beigetragen haben, dass die Verletzten schnell gefunden, geborgen und behandelt werden konnten und dass unsere verstorbenen Kollegen ihre letzte Reise in die Heimat in Würde antreten konnten. Weiterhin möchten wir all denen danken, die in vielfältiger Weise dazu beigetragen haben, dass die Verletzten optimal versorgt wurden und nach Kapstadt und in die Heimat gebracht wurden. Nur wer vor Ort war, kann wirklich empfinden, welche Leistung die Stationsmannschaften von Neumayer und der Baustelle, Besatzungsmitglieder der *Polarstern*, Piloten, medizinisches Personal, Meteorologen, Logistiker und Organisatoren vollbracht haben, um das Ausmaß der Katastrophe zu begrenzen.

Am 4. März nahmen wir noch einmal im kleinsten Kreise der unmittelbar Betroffenen an der Unfallstelle Abschied von den Opfern. Die Baumannschaft hatte zwei Kreuze am Unfallort errichtet. Als wir uns dort zum Stillen Gedenken trafen, erhob sich die Basler BT-67 mit den Särgen an Bord über unsere Köpfe hinweg zum Flug nach Novolazarevskaja, von wo aus der Weitertransport nach Kapstadt erfolgte. Als Abschiedsgruß neigten die Piloten die Tragflächen zu den Kreuzen hin. Ein würdigerer Abschied eines Polarforschers in die andere Welt lässt sich kaum vorstellen.

Am 5. März erfolgte der Transport der Verletzten nach Kapstadt. Am frühen Morgen erschien die Wetterlage hoffnungslos. Es herrschte Schneetreiben. Die Verletzten mussten einer Geduldsprobe entgegen sehen. Doch dann erreichte uns die Mitteilung der Meteorologen: es werde besser und die Basler sei von Novolazarevskaja gestartet. Wir bewundern den Mut der Piloten und die Kompetenz der Meteorologen, denn es wurde besser. Bei Schneefall startete ein Transport mit Pistenbullies vom Schiff zum Flugfeld. Mit Schmerz über die Trennung und Freude über die Aussicht, diese bald in Kapstadt und bei ihren Verwandten zu wissen, nahmen wir von den Verletzten Abschied. Die Piloten nutzten die kurze Phase der Wetterbesserung, landeten, nahmen die Verletzten an Bord und starteten im letzten Moment, bevor die Bedingungen einen Flug nicht mehr zugelassen hätten.

Als uns der erfolgreiche Start gemeldet wurde, legten wir von der Schelfeiskante ab, und nahmen in der Atkabucht die Forschung wieder auf. Die Ironie des Schicksals bescherte uns bei unserer Fahrt durch die Atkabucht einen sonnigen Nachmittag mit den stimmungsvollen Eindrücken, die für die Antarktis typisch sind. Schönheit und Zauber standen in unmittelbarer Nähe von Schrecken und Trauer. Der entschlossene Wille, unsere Arbeit im Sinne und zum Gedenken an unsere umgekommenen Kollegen fortzusetzen, half uns, unseren Schmerz zu überwinden und wieder zur Forschungsroutine zurück zu finden.

Unser Aufenthalt an der Station diente der Versorgung. Wir haben vor allem Treibstoff und Verpflegung angeliefert. Gleichzeitig haben wir aber auch die wertvollen Eiskerne, die an der Kohnen-Station erbohrt wurden, gebrauchtes Material und Abfall an Bord genommen. Ferner mussten Container an Bord umgestaut werden, um wieder Platz zu schaffen und Material zur Verfügung zu haben, das erst während des folgenden Teils der Reise benötigt wurde. Dazu mussten Frachtcontainer von der Ladeluke auf das Eis gestellt werden, die Luken geöffnet und Laborcontainer aus den Laderäumen herausgepackt werden. Nachdem alles auf Schlitten auf dem Eis stand, um es aus dem Ladebereich auf dem Eis entfernen zu können, wurde es in neuer Folge mitsamt der zusätzlichen Fracht wieder herangefahren und eingeladen. Ein Verschiebebahnhof auf dem Schelfeis. Gleichzeitig wurde Treibstoff in Tankcontainer umgepumpt. Das gute Wetter erleichterte die Arbeiten, die zügig voran gingen.

Nach Abschluss der Bergungs- und Ladearbeiten nahmen wir die Einladung des Stationsleiters gerne an, die Neumayer-Station zu besuchen und einen Eindruck von der Arbeit der Überwinterer zu gewinnen. Sie erklärten geduldig die Eigenschaften und die Funktion der Station. Die Verabschiedung der Überwinterer erfolgte dieses Mal mit einem kurzen Innehalten an der Station.

Der Abschluss der Arbeiten am Meridian von Greenwich

Eine längere Phase mit relativ schwachem Wind begünstigte den Fortschritt der Arbeiten auf dem Greenwich Meridian. Mit 7 „Superstationen“ im Rahmen des GEOTRACES-Programmes, 25 Ultraclean-CTDs und 73 „normalen“ CTD-Profilen haben wir alle hydrographischen Regionen auf dem Meridian von Greenwich zufriedenstellend mit allen geplanten Parametern erfasst. Wir haben 9 Verankerungen aufgenommen und 5 wieder ausgelegt. Das Netz der vertikal profilierenden Driftkörper wurde um 38 Floats erweitert.

Bei der Aufnahme der letzten Verankerung etwa 12 Meilen vor der Kante des Fimbul-Schelfeises wurden wir auf eine besondere Probe gestellt. Als wir versuchten mit dem POSIDONIA-System Kontakt zu den akustischen Auslösern aufzunehmen, erhielten wir keinerlei Rückmeldung. Also lösten wir blind aus und warteten ab. Doch keiner der Auftriebskörper erschien an der Oberfläche. Auch der Funkpeiler, der Signale von einem Satellitensender empfangen sollte, der an der Spitze der Verankerung sitzt, empfing nichts. Wir begannen mit dem Schiff Suchkurse zu fahren und schickten den Helikopter los. Kein Erfolg. Als uns klar war, dass die Verankerung nicht mehr vor Ort sein konnte, nahmen wir die Arbeiten mit CTD und Wasserprobennahme wieder auf und arbeiteten uns weiter nach Süden vor. Doch dann kam die große Überraschung von OPTIMARE aus Bremerhaven. Dort werden die Signale der Satellitensender Tag und Nacht überwacht. Wir erhielten die Meldung, dass der Sender kurz nach der Auslösung aufgetaucht sei, allerdings 9 km von der Sollposition entfernt. Sofort kehrten wir um, der Helikopter stieg auf und konnte wenig später die genaue Position der Verankerung in einem Eisfeld in wenigen Seemeilen Entfernung melden. Mit der genauen Position ging es dann schnell. Die Verankerung wurde vollständig geborgen. Sie zeigte Beschädigungen, die klar erkennen ließen, dass sie von einem Eisberg verschleppt worden sein musste. Dadurch lag sie in einer Entfernung von der Sollposition, in der unser akustisches Signal zwar stark genug war, um die Auslöser zu aktivieren, das schwächere Bestätigungssignal des Auslösers uns aber nicht mehr erreichte. Der Satellitensender war so tief in den Auftriebskörper hineingedrückt, dass er in Bodennähe durch die Eisfelder abgeschattet war. Er konnte aber vom Satelliten mit dem Blick von oben erkannt werden. Wir sind glücklich über den guten Ausgang. Allerdings sind beim Verschleppen durch den Eisberg am Eisecholot solche Schäden aufgetreten, dass die aufgezeichneten Daten verloren gingen.

Am 12. März waren die Arbeiten am Meridian von Greenwich beendet und wir dampften in Richtung Weddellmeer.

Die vorläufige Betrachtung der hydrographischen Aufnahme zeigt, dass die Abkühlung des Warmen Tiefenwasser nach einer früheren Erwärmung zu Ende ist, und es sich gegenwärtig wieder erwärmt. Es handelt sich also um eine dekadische Fluktuation. Wir können jetzt das Verhalten der atmosphärischen Antriebskräfte mit dem in den 80ziger Jahren vergleichen, um damit eine Erklärung der Antriebsmechanismen dieser Veränderungen zu finden. Die Temperatur und der Salzgehalt des Weddellmeer-Bodenwassers haben in den letzten drei Jahren weiter zugenommen. Damit setzt sich eine Entwicklung, die wir seit der Mitte der Neunziger Jahre beobachten, weiter fort und die Frage stellt sich noch klarer: Hat die globale Erwärmung die Tiefsee erreicht, oder handelt es sich um eine Fluktuation über den Zeitraum von Jahrzehnten? Da von unseren australischen Kollegen berichtet wird, dass der Salzgehalt des Bodenwassers im Rossmeer und vor dem Adelieland weiter abnimmt, fordert auch dieser Gegensatz eine Erklärung, die wir im westlichen Weddellmeer gefunden haben.

Im Weddellmeer

Die Eisverhältnisse im östlichen Weddellmeer waren durch eine ausgeprägte Meereiszunge geprägt. Da aufgrund der Ereignisse bei der Neumayer-Station Zeit eingespart werden musste, wurde der östliche Teil des Schnitts von Kapp Norvegia nach Joinville Island aufgegeben. Alternativ war geplant, die Zunge nördlich zu umfahren, um durch im Vergleich zum Stationsbetrieb zügiges Fahren Zeit zu gewinnen. Doch die Aussicht auf sehr schlechtes Wetter führte zur Entscheidung, doch in die Zunge einzudringen. Es stellte sich heraus, dass das Eis sehr leicht war, und wir so gut vorankamen, dass wir uns am 14. März entschieden, nach Süden abzudrehen, um noch einen größeren Teil des Schnittes abdecken können. Doch bald wurde das Eis sehr schwer befahrbar, so dass wir diesen Plan nur zu einem kleinen Teil umsetzen konnten. Der Stationsabstand musste auf 45 sm vergrößert werden. Die erste Station auf dem Schnitt erfolgte am 15. März bei 69°22'S 16°21'W.

Am 18. März fand die Beerdigung von Willem Polman und am 19. März die Trauerfeier für Stefan Winter statt. Gleichzeitig mit den Feiern an Land stellten wir an Bord die Forschungsarbeiten ein und trafen uns zum gemeinsamen Gedenken. Auch wenn es schwer fiel, den Schmerz zu überwinden, so gingen die Forschungsarbeiten weiter. Die tiefen Lücken, die die Verstorbenen und die Verletzen in unseren Herzen und bei der Arbeit hinterlassen haben, wurden, so gut es ging, überbrückt. So wurde aus einem Helikoptertechniker ein Windenfahrer für die Ultraclean-CTD. Mit Solidarität und noch weiter verstärkter Anstrengung wurde das Programm im Sinne und zur Würdigung der Verstorbenen fortgeführt.

Wie auf dem Meridian von Greenwich war das Programm von der Routine des Fierens und Hievens der „normalen“ und der Ultraclean-CTD und der Aufarbeitung des nicht versiegenden Stroms von Probenwasser geprägt. Meist gingen die Profile bis zum Meeresboden, häufig wurden aber auch kurze Profile (200 bis 300 m) eingefügt, um große Mengen Wasser zu Experimenten oder zur Extraktion der untersuchten Spurenstoffe zu erhalten. Eine besondere Herausforderung stellten immer wieder die Verankerungen dar, die wir aufnahmen und auslegten.

Für unser Programm spielte die Auslegung von Schallquellen eine besondere Rolle. Um Messungen im Winter und auch unter dem Eis zu bekommen, wurden Driftkörper entwickelt, die in der Tiefe von 800 m ihre Bahnen ziehen. Nach jeweils 10 Tagen tauchen sie zuerst auf 2000 m Tiefe ab und steigen dann an die Oberfläche auf, wobei sie ein Temperatur- und Salzgehaltsprofil messen. Dort angekommen erfahren sie mit Satellitennavigation ihren Ort und geben die Messdaten ab. Soweit das weltweite Argo-System, in dessen Rahmen etwa 3000 derartiger Floats im offenen Ozean unterwegs sind, und zu dem auch wir unseren Beitrag leisten. Unter dem Eis funktioniert dieses Verfahren aber nicht, da die Floats die Oberfläche nicht erreichen können. Deshalb orientieren sich unsere Floats mit Hilfe von Schallquellen und der Laufzeit, der von ihnen ausgestrahlten Signale. Befinden sich die Floats unter dem Eis, so erkennen sie dies, da sich die Wassertemperatur in der Nähe des Gefrierpunkts bewegt, und brechen den Aufstieg an die Oberfläche ab. Erreichen sie das nächste Mal offenes Wasser, so geben sie den gesamten gemessenen Datensatz ab. Leider mussten wir feststellen, dass zwei von den aufgenommenen Schallquellen defekt waren und deshalb ihre Funktion nicht erfüllt hatten.

Bei zwei Verankerungen, die wir aufgenommen haben, wurden wir mit einem besonderen Phänomen konfrontiert. Um die Verankerungsleine mit den Geräten senkrecht im Wasser zu halten, sind Auftriebskörper daran befestigt, die in der Tiefsee aus Glaskugeln in Plastikhalterungen bestehen. Nun haben wir bei den beiden letzten Verankerungen von den tiefsten Auftriebskörpern nur noch mit Glasbrei gefüllte, zerfetzte Plastikhüllen vorgefunden. Diese Reste sind eine eindrucksvolle Darstellung der Wirkung des Wasserdrucks nach einer Implosion der Glaskugeln in über 4500 m Tiefe. Das Rätseln über die Gründe ist allerdings noch nicht abgeschlossen.

Im westlichen Teil des Weddellmeeres fanden wir ebenfalls wesentlich härtere Eisverhältnisse vor als erwartet. Deshalb wurden wir, was den Abschluss des Schnittes anbetrifft auf erhebliche Geduldsproben gestellt. Die Eisbedingungen im Weddellmeer sind in diesem Sommer ungewöhnlich hart. Während des Sommers haben sich zwei große Eiszungen aus dem südlichen ins nordöstliche und nordwestliche Weddellmeer gehalten. Damit wurde ein Trend deutlich bestätigt, gemäß dem das Meereis in der Antarktis im Sommer über die letzten Jahrzehnte zugenommen hat. Allerdings bedeutet das keine wirkliche Zunahme der Eisbedeckung, sondern nur ein geringeres Abschmelzen im Sommer. Im Winter blieb die Eisdecke nahezu konstant. Für uns folgte aus dieser Entwicklung nicht nur die Frage nach einer Erklärung, sondern sie hatte auch direkte Konsequenzen für den Fahrtverlauf. Die herbstliche Eisbildung bescherte uns unerwartet schwere Eisverhältnisse, die eher für den Winter typisch sind. Schwere Eisverhältnisse bedeuten langsamere Fahrt und damit Zeitverlust im Vergleich zu einer Planung, die von mittleren Eisverhältnissen ausgegangen war. Dieser Zeitverlust musste durch die Reduktion von Stationszeit ausgeglichen werden. Sie erfolgte durch die Vergrößerung des Stationsabstands und damit der Fehlergrenzen bei der Abschätzung längerfristiger Veränderungen. Trotzdem gelang es, die dominierenden Wassermassen so ausreichend zu erfassen, dass der Anschluss an die Veränderungen, die wir auf dem Meridian von Greenwich gesehen hatten, gefunden werden konnte. Der Gehalt von Spurenstoffen ist in bisher nicht erreichter Qualität erfasst worden.

Eine besondere Herausforderung stellte die Aufnahme von Verankerungen bei schweren Eisverhältnissen dar. Bei der letzten Verankerung, die wir im Weddellmeer aufzunehmen hatten, führte das Zusammentreffen von hoher Professionalität, die sich mit der Erfahrung von Jahrzehnten (25 Jahre *Polarstern*) gebildet hat und dem Quäntchen Glück, dass man immer braucht, um erfolgreich zu sein, zur glücklichen Aufnahme bei fast 100 % Eisbedeckung. Da die Verankerungen schon drei Jahre lagen und die nächste Möglichkeit erst wieder in 3 Jahren bestanden hätte (wenn die Batterien der Auslöser erschöpft sein würden), gab es keine wirkliche Alternative, als den Versuch zu wagen. Der Erfolg erfüllte uns alle mit Freude und auch Stolz. Damit konnten wir die Bilanz ziehen, dass nach der erstmaligen Verankerungsdauer von 3 Jahren alle Verankerungen wieder aufgenommen werden konnten. Leider ist aber die Gerätetechnik noch nicht so ausgreift wie unsere Verankerungstechnik. Trotz 100 % Aufnahmerate liegt die Datenrate auf Grund von Geräteausfällen niedriger.

Die Auswertung der Daten, die in den verankerten Geräten gespeichert wurden, begann schon an Bord. Ein erster Blick zeigte, dass die Folge von Erwärmungs- und Abkühlungsvorgängen, die wir in unseren CTD-Schnitten mit großem zeitlichem Abstand sehen, keine Zufallsergebnisse darstellen, sondern dass sie durch die dazwischen liegenden Messungen mit verankerten Geräten voll bestätigt wurden. Eine besondere Herausforderung wird nun darin bestehen, die extremen Eisverhältnisse in Beziehung zu den Wassermasseneigenschaften zu setzen, die neben den atmosphärischen Verhältnissen für die Veränderungen verantwortlich sein können.

Am 29. März wurden die Arbeiten im Weddellmeer abgeschlossen. Mit 1 „Superstation“ im Rahmen des GEOTRACES-Programmes, 15 ultraclean-CTDs und 45 „normalen“ CTD-Profilen haben wir das zentrale und das westliche Weddellmeer zufriedenstellend mit allen geplanten Parametern erfasst; im östlichen Weddellmeer ist leider eine Lücke geblieben. Wir haben 3 Verankerungen aufgenommen und 8 wieder ausgelegt. Das Netz der vertikal profilierenden Driftkörper wurde um 16 Floats erweitert.

King George Island und die Drakestraße

Am 30. März erreichten wir King George Island nachdem wir an der Nordspitze der Antarktischen Halbinsel noch einmal mit schweren Eisverhältnissen zu kämpfen hatten. An der Maxwellbucht im Potter Cove liegt die argentinische Station Jubany, der das deutsche Dallmann-Labor angeschlossen ist. Von hier und von den Stationen Frei und Artigas aus sollte die Übernahme von Fracht stattfinden. Eine Gruppe von sieben französischen und einer chilenischen Wissenschaftler/innen wartete bei der russischen Station Bellingshausen und 2 koreanische Wissenschaftler bei der koreanischen Station King Sejong, um an zu Bord kommen. Ihr Interesse bestand in den Arbeiten in der Drake-Passage. Da der Flug von King George Island nach Punta Arenas gestrichen worden war, musste die Gruppe, die aussteigen wollte, um den Zusteigenden Platz zu machen, bis zum Ende der Reise an Bord bleiben. Nach einer sonnigen Anfahrt kam aber in der Bucht Nebel auf und eine Zeit des Wartens begann, bis der Flugbetrieb endlich möglich war.

Nach mehreren Versuchen bei jeweils kurzfristigen Wetterverbesserungen, gelang es am 31. März die neuen Fahrtteilnehmer an Bord zu bringen und die Ladung, die bei den Stationen Jubany und Frei auf uns wartete, aufzunehmen. Wir mussten aber die Übernahme von Ladung von Artigas aufgeben. Der Nebel war zu dicht geworden und eine Wetterbesserung, die weitere Flüge ermöglicht hätte, war nicht abzusehen. In der Nacht dampften wir in die Drake-Passage und setzten die Aufnahme der hydrographischen Bedingungen und der Spurenstoffverteilung fort.

Am 3. April überquerten wir 60° S und verließen damit die Antarktis.

Im Vordergrund der Arbeiten in der Drake-Passage stand die Aufnahme und Auslegung von französisch/koreanischen Verankerungen. Es sollten 10 Verankerungen aufgenommen und 5 wieder ausgelegt werden. Während die ersten beiden Verankerungen der koreanischen Arbeitsgruppe in der südlichen Drake-Passage trotz sehr schlechtem Wetters erfolgreich aufgenommen werden konnten, hatten wir – trotz wesentlich besserem Wetter – große Schwierigkeiten mit den französischen Verankerungen. Bei den aufzunehmenden Verankerungen ergaben sich Probleme mit dem Auftrieb, der zum Teil dem Druck nicht stand gehalten hatte. Bei den meisten von ihnen reichte der verbleibende Auftrieb noch aus. Da sie aber zum Teil nur sehr langsam an die Oberfläche kamen, wurde viel Geduld gefordert. Beruhigend war, dass ihr Aufstieg mit POSIDONIA überwacht werden konnte. Zwei Verankerungen lösten sich zwar vom Boden, erreichten aber die Oberfläche nicht. Mit zeitaufwändigen Manövern versuchten wir zwar, sie einzufangen, indem wir etwa 5000 m Draht in Schleifen über den Grund um sie herum zogen. Aber unsere Bemühungen blieben leider ohne Erfolg. Wie immer wir unsere Schleifen legten, was bei 6 bis 7 Windstärken nicht einfach war, die driftenden Verankerungen konnten uns wieder entweichen, so dass wir beide Dredge-Aktionen enttäuscht abbrechen mussten. Die verlorene Zeit konnte nur durch die Einschränkung des CTD-Programms ausgeglichen werden. Trotzdem haben wir viel Glück gehabt, da sich die Drake-Passage mit dem berüchtigten Kap Hoorn uns gegenüber sehr zurückhaltend gezeigt hat. Richtig schlechtes Wetter sollte uns erst am 13. April erwischen. Daher beschlossen wir, nicht mehr weiter nach Süden zu fahren, um die ausgelassenen CTD-Stationen nachzuholen, sondern beendeten bei 56°1,07'S 64°0,59'W am 13. April mit einer letzten CTD das Forschungsprogramm und dampften vor dem Wind in Richtung Le-Maire-Straße.

Mit 5 „Superstationen“ im Rahmen des GEOTRACES-Programmes, 12 ultraclean-CTDs und 46 „normalen“ CTD-Profilen haben wir die Drake-Passage nicht ganz zufriedenstellend mit allen geplanten Parametern erfasst. Wir haben 8 Verankerungen aufgenommen und 5 wieder ausgelegt. Das Netz der vertikal profilierenden Driftkörper wurde um 14 Floats erweitert.

Am Mittwoch, dem 16. April 2008 endete die Reise plangemäß in Punta Arenas.

Wissenschaftliche Hintergründe

Unsere Reise war vor allem der Untersuchung der ozeanischen Zirkulation und den davon abhängenden Stoffkreisläufen mit ihrem Einfluss auf das Leben im Meer gewidmet. Das Hauptprogramm der Reise erfolgt im Rahmen des Internationalen Polarjahres 2007/2008 (IPY). Es steht unter der Schirmherrschaft der ICSU und der WMO und soll durch eine weltweite Koordination der Kräfte und die Intensivierung der Aktivitäten zu einer quasi-synoptischen Aufnahme der Bedingungen in beiden Polargebiete führen, die als Grundlage der Bewertung der gegenwärtig ablaufenden Veränderungen dienen wird. Im GEOTRACES-Projekt wurden Spurenstoffe und biogeochemische Prozesse untersucht. Das CASO-Projekt (Climate of Antarctica and the Southern Ocean) setzte Arbeiten des früheren WECCON-Projekts (Weddell Sea Convection CONtrol) fort. Es begann mit dem World Ocean Circulation Experiment (WOCE) als von 1989 bis 2001 Untersuchungen im Weddellmeer ausgeführt wurden, die zum besseren Verständnis der Wassermassentransformation und Zirkulation beigetragen haben. Diese Messungen wurden anschließend im Climate Variability and Predictability (CLIVAR) Programm des World Climate Research Programme (WCRP) der UNESCO fortgesetzt. Die Arbeiten in der Drake-Passage erfolgten im Rahmen des französischen DRAKE-Projekts, das ebenfalls ein Beitrag zum IPY-Projekt CASO ist. Die globale Bedeutung der regionalen Prozesse wird im IPY-Projekt BIAC (Bipolar Atlantic Thermohaline Circulation) berücksichtigt. Im Norden schließen die Messungen an die Arbeiten des BONUS-GOODHOPE-Projektes an. Die Untersuchungen bei der Maudkuppe und im Antarktischen Küstenstrom fanden im Rahmen des von SCOR (Scientific Committee of Oceanographic Research) betreuten iAnzone Programms statt, das einen Beitrag zum Climate and Cryosphere (CLIC) Programm des WCRP liefert und im IPY mit dem Projekt SASSI Synoptic Antarctic Shelf Slope Interactions Study vertreten ist. In diesem Programm ist besonders die Ausbringung der Upward Looking Sonars (ULS) und der Verankerungen an der Küste von Bedeutung. Die ULS sind ein Beitrag zum Antarctic Sea Ice Thickness Projects (AnSITP). Das Ausbringen der Floats erfolgte im Rahmen des internationalen Argo-Programms, das zum Gobal Ocean Observing System (GOOS) beiträgt. Im Rahmen der internationalen Programme erfolgt besonders enge Zusammenarbeit mit dem Bjerknes Centre in Bergen, Norwegen, und dem British Antarctic Survey (BAS), der am Verankerungsprogramm beteiligt ist. Die gesamte Expedition ist ein Beitrag zum MARCOPOLI-Programm der Hermann von Helmholtz-Gemeinschaft Deutscher Forschungszentren (HGF).

Ziel der Reise war es, Meeresströmungen und die Temperatur-, Salzgehalts- und Spurenstoffverteilungen im Südlichen Ozean zu erfassen. Die Absinkbewegungen im Südlichen Ozean stellen den südlichen Teil der globalen Umwälzbewegung im Ozean dar. Sie bestimmen seine Rolle im Klimageschehen und sind für den Spurenstoffkreislauf von Bedeutung. Unsere Messungen werfen die Frage auf, ob die tief reichende Umwälzbewegung der ozeanischen Wassermassen in der Antarktis nach einer Phase der Schwächung wieder zunimmt. Seit mehr als einem Jahrzehnt konnte beobachtet werden, dass die Temperatur in der Tiefsee im Weddellmeer kontinuierlich zunahm, was darauf schließen ließ, dass die tief reichenden Absinkbewegungen am Rand der Antarktis abgenommen haben. Nun sinken die Temperaturen wieder. Diese Entwicklung der Wassermassen erfolgt zu einer Zeit, zu der das Meereis in der Antarktis im Sommer zunimmt. Dies macht deutlich, dass der Einfluss der globalen Erwärmung vor dem Hintergrund jahrzehntelanger Schwankungen nicht eindeutig zu identifizieren ist.

Besondere Aufmerksamkeit erregt die Tatsache, dass nach Auswertungen von Satellitenaufnahmen durch das NSIDC klar geworden ist, dass der Antarktische Sommer 2007/2008 der eisreichste Sommer war, den es seit dem Beginn der Satellitenaufnahmen gab. Dieser Trend, der im atlantischen Teil des Südlichen Ozeans besonders ausgeprägt ist, steht im Gegensatz zur Entwicklung in der Arktis, wo eine deutliche Abnahme des Meereises im Sommer zu verzeichnen ist. Die gegensätzlichen Entwicklungen in Antarktis und Arktis zu verstehen, ist ein wesentliches Ziel dieser Reise. Da sie aber im Laufe von Jahrzehnten verlaufen und merkliche räumliche Unterschiede aufweisen, reichen die *Polarstern*-Reisen nicht aus, um sie mit ausreichender Sicherheit zu verfolgen. Deshalb muss eine umfassende Erfassung mit Hilfe autonomer Mess-Systeme erfolgen, die entweder verankert oder frei treibend sind. Sie stellen eine Komponente des Südlichen-Ozean-Observations-Systems (SOOS) dar, das zur Zeit entwickelt wird. Als Beitrag zu diesem System wurden in internationaler Zusammenarbeit 18 verankerte Beobachtungsstationen ausgelegt und 20 geborgen. Mit 3 Jahren Einsatzdauer stellen die jetzt aufgenommenen Systeme einen Rekord auf. Mit der Auslegung von 67 Floats, von denen die im Weddellmeer ausgelegten auch unter dem Meereis Daten erfassen können und bis zu 5 Jahren aktiv bleiben, wurde ein bisher nicht erreichtes Messnetz in diesem Teil der Erde erstellt.

Im Internationalen Polarjahr sollten nicht nur neue Erkenntnisse über die Rolle der Polargebiete im System Erde gewonnen werden. Es war ein zentrales Anliegen, die Öffentlichkeit und insbesondere den Nachwuchs in die aktuelle Forschung einzubeziehen und umfassend zu informieren. Aus diesem Grund waren zwei Lehrer an Bord. Sie haben aktiv an den Forschungsarbeiten teilgenommen und ihren

Schülern, Kollegen und auch Zeitungen ihre Erlebnisse regelmäßig über Telefon und Internet vermittelt. Ihre Erfahrungen werden im Rahmen eines Lehrernetzwerks auch in den Unterricht weiterer Schulen und hoffentlich auch in Schulbücher einfließen.

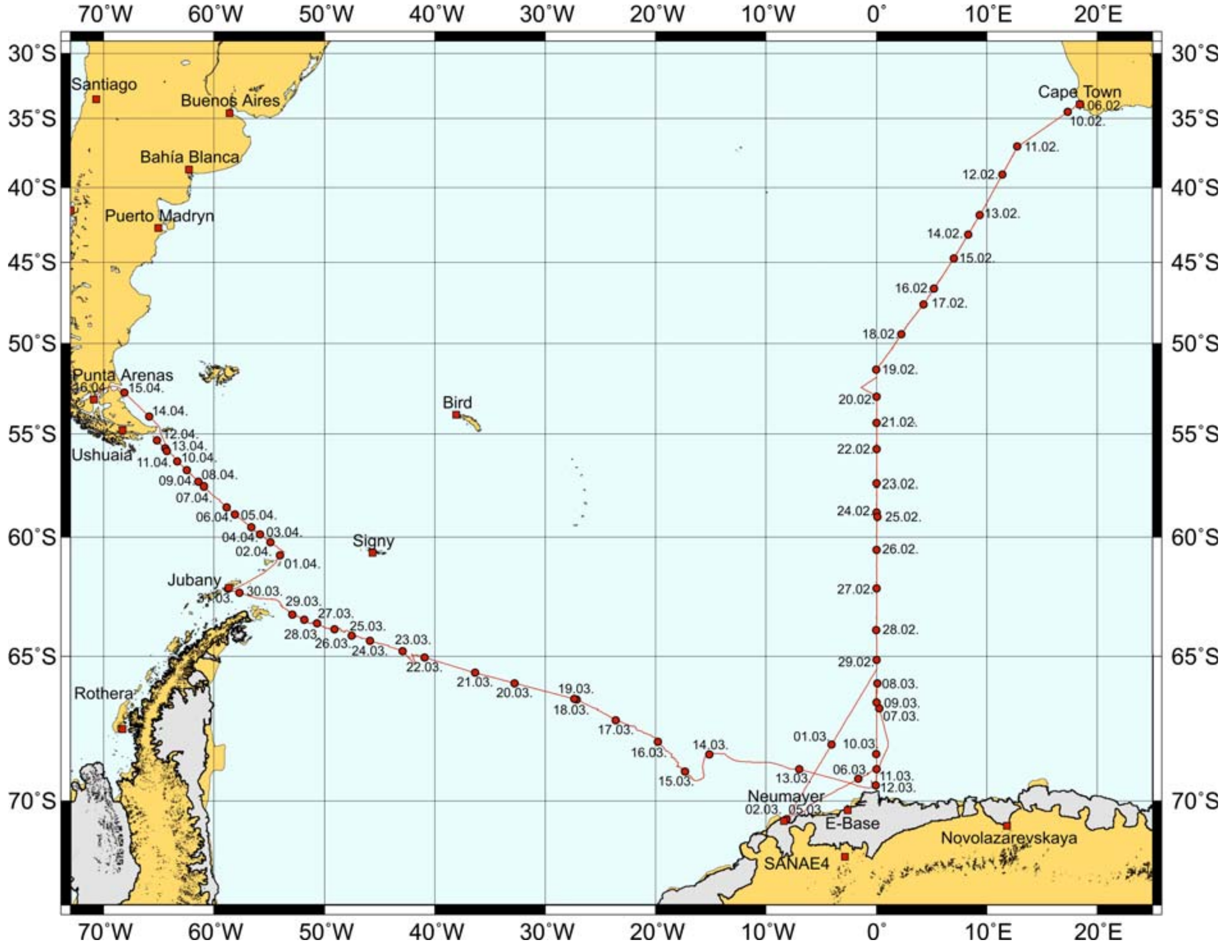

Abb. 1.1: Die Fahrtroute der Polarstern während der Reise ANT-XXIV/3 vom 6. Februar bis zum 16. April 2008
Fig. 1.1: Cruise track during Polarstern leg ANT-XXIV/3 from 6 February to 16 April 2008

ITINERARY AND SUMMARY

From Cape Town to Neumayer Station

The call to port in Cape Town was marked by a visit of the German Federal Minister of Education and Research, Dr. Annette Schavan. She came on board with South African Ministerial colleagues, dignitaries and scientists in addition to a group of our colleagues from the French research vessel *Marion Dufresne*. During the visit talks were held along with a workshop and a reception. The event was carefully prepared and the good mood of the 150 guests proved it as a success.

We were supposed to leave on 6 February 2008, but strong winds prevented a container for the CO_2 programme to arrive Cape Town in time. Then, the container ship was diverted to Port Elizabeth and the container was finally loaded onto *Polarstern* in the night to 10 February. We immediately prepared to depart and our journey could finally start on 10 February with three and a half days of delay. The cruise track is displayed in Fig. 1.1.

Observations started with instruments which are applied from the moving ship with the acoustic profiling current meter (ADCP) and the thermosalinograph. Pumps started to inject seawater from a snorkel in the keel of the ship into the pipes to the labs for analysis and for those who need particularly clean water a fish was used to pump seawater from a certain distance onto the ship.

The first stop was dedicated to recover a PIES (Pressure inverted echosounder) which moored on the sea floor recorded variations in the sea level elevation and the sound velocity in the water column. It was the first one of a set of those instruments to be recovered and moored again.

Then, a test station for the ultraclean CTD followed. It was brought on board by a group from the Netherlands Institute of Sea Research (NIOZ). It was supposed to take samples which enable scientists to measure the concentration of dissolved iron in the water. It was understood that it is highly challenging to measure iron in very faint concentrations on a ship which is mainly made out of iron. To avoid interference with the ship the NIOZ group had built a special sampling system from titanium lowered with a Kevlar wire which avoids any iron parts in the vicinity of the sampling process. To meet this requirement a huge device was installed which fills up large parts of the deck consisting of a huge winch, a power station and a clean room container. The tests were successful and proved that the system was mechanically and electronically fully operational.

On 11 February we crossed the course of the Norwegian research vessel G.O. *Sars*, which was on its way back to Cape Town from a cruise on which two German colleagues participated. In spite of having a common programme with PIES in the Southern Ocean, we had to restrict ourselves to waving the arms, blowing the horns and a subsequent email exchange of slides taken of each of us, since we could not afford to loose further time on our way to the South.

The next test station aimed on the main work horse of the physical oceanographers, the CTD probe (conductivity, temperature, depth) with the rosette water sampler. It is lowered to depth to measure the vertical profiles of temperature, salinity, oxygen, transmissivity and fluorescence. The data are transmitted on board, displayed and stored. In addition a current profile is obtained from the lowered acoustic Doppler current profiler (LADCP) which is mounted on the CTD frame. Here, as well, the test was performed successfully and water samples and data could be used for the programme. Weather slowed us down when a low pressure system passed nearby providing us with winds of up to 10 Bft.

In this northern part of our operation area station work and steaming alternated with a distance of almost 100 nm, weather and sea permitting. Since the focus of our work was south of the Polar Front the distance between the stations decreased to about 30 nm after we have passed this point. However, the gaps in the North were closed via cooperation with the scientists on the French research vessel *Marion Dufresne* whose focus was on the northern part of the region. Our cooperation in the context of the International Polar Year 2007/2008 resulted in a comprehensive survey of the sea area between South Africa and Antarctica.

On 15 February we crossed the Polar Front and reached Antarctica on 25 February when crossing 60°S. We arrived at our main operation area when entering the northern limb of the Weddell gyre, the large-scale bean-shaped current system which covers the Antarctic sector of the Atlantic Ocean. East of the Greenwich meridian warm and salty water from the Antarctic Circumpolar Current, the Circumpolar Deep Water, flows to the south. In the west newly formed Weddell Sea Bottom Water returns at great depth to the north. In the south the Antarctic Coastal Current and the Antarctic Slope Current follow as the southern boundary current of the gyre the continental slope and the ice shelf front from east to west.

Air temperatures decreased to near to 0°C and scattered snowfall occurred. The wind fluctuated from 6 to 8 Bft. Significant numbers of icebergs were encountered which drifted with the northern limb of the Weddell gyre from the Antarctic Peninsula into our operation area. However, so far we have only met highly weathered remnants and not the impressive table icebergs for which Antarctica is famous.

At super stations a full suite of water sampling devices with at times more than 10 casts was operated including the CTD/rosette water sampler, the ultraclean sampler and *in-situ* pumps. They all are needed to fulfil the requirements of the GEOTRACES community and take up to 20 hours per station.

The aim of the GEOTRACES group was to measure the concentration and distribution of a variety of trace substances. Dissolved trace metals in seawater were the focus of their research. Iron is a very important trace metal for biological processes in the Antarctic Ocean. It is essential for all living organisms, and thus for the algae also. These algae are the basis of the food-chain of the Antarctic region and are in turn dependent on the availability of iron. However, iron is only found in extremely low concentrations of circa one hundredth of one millionth of a gram per litre seawater (10 nanogram per litre = 10 ng/L = 10^{-8} gram per litre). In contrast *Polarstern* is a strong ship of steel, iron is everywhere on the ship, iron is the ship. Therefore the sampling of seawater is done with the special ultraclean frame holding 24 samplers. Once this frame is back on the deck, it is immediately placed in its own laboratory container, so as to rule out direct contact with the iron of the ship. This allows us to collect the first-ever complete vertical sections, from surface to circa 5 km deep bottom, in the Southern Ocean. Along the Greenwich meridian section we found dissolved iron is very low from 5 ng/L in surface waters increasing to 30 ng/L at great depth. In the southern part of the Weddell gyre, between Maud Rise and the ice shelf of Antarctica, the values are even lower, from 3 ng/L in surface waters to 20 ng/L in deep waters.

It is one thing to know how much, or how little, iron there is in the seawater, but in addition we wonder where this iron has come from. Has it been blown into the ocean in dust storms carrying soil dust from land to sea? After all, soil on land contains much natural iron, about 4 percent of soils is iron. Soil also contains much aluminium (Al). Therefore we also measure dissolved Al as a source tracer for dust. Along the Greenwich meridian the concentration of dissolved aluminium in seawater is extremely low, the lowest found thus far in the world oceans. Very low levels of 6 ng/L in surface waters tell us that dust input from land is very small, if any.

Therefore the dissolved iron must come from somewhere else. In the sediments the conditions are better for iron to dissolve from the sediment particles and then enter into the bottom waters. So, perhaps that is the source of iron to the sea. We know that another element, manganese (Mn), can also be dissolved in the sediments. Consequently we use manganese as a source tracer for iron coming from below, from the bottom sediments. However the concentrations of dissolved manganese also are extremely low, from 3 ng/L in surface waters to some times about 10 ng/L in deeper layers. Only over the mid-ocean ridge, formed by deep-sea volcanism, we find more manganese, and also more iron, in the deep waters. Hydrothermal circulation associated with deep-sea volcanism, is perhaps the most important source of iron in the ocean waters. Others in the team search for their favourite metal. Zinc and copper are also necessary for all organisms and occur in very low concentrations as well. Overall the dark secrets of the deep unknown waters of the Antarctic Ocean are now being discovered for the first time.

Deployment of vertically profiling floats (Argo floats) continued to add to the world wide network with a significant part of the floats being provided by Stephen Riser from the University of Washington. These floats were supposed to drift with the Antarctic Circumpolar Current into the Indian Ocean. Underway we recovered 6 and redeployed 5 PIES. One of the instruments was lost upon recovery. These instruments measured the fluctuations of the Antarctic Circumpolar Current.

The mooring work started with the successful recovery of three moorings in the transition zone from the Antarctic Circumpolar Current to the Weddell gyre, which were supposed to measure the exchanges between the two current systems. These moorings could not be redeployed because of funding reasons.

The accident

On 2 March we reached the Atka Bight in the early hours of Sunday morning, after we had left the operation area on the Greenwich meridian on 28 February. After greyish and partly stormy days we were greeted with Sunday weather in the most literal sense of the word. Everybody was excited, after days of tiring station routine, to enjoy one day on the ice with all the impressions that renders Antarctic research so particularly fascinating. Despite the fact that the scientists had to take into account that they must assist with the loading and pumping work there should still be sufficient time to enjoy the stay on the ice.

However when we received at 8.30 am, the news that a helicopter has crashed during the transport of personnel to the Neumayer Station the pleasure of anticipation and expectation altered to shock and grief. The rescue teams from the Neumayer III construction site and the Neumayer station quickly arrived at the crash site and had to report the deaths of one of our colleagues from NIOZ, Willem Polman and of the pilot Stefan Winter. The two other passengers Alice Renault and Maarten Klunder were seriously and the helicopter technician Carsten Möllendorf was moderately injured. Inspite of his injuries, the helicopter technician succeeded in removing the other injured persons from the helicopter and radioed for help. We admire his cool head and bravery. The injured persons were transported as quickly as possible with the second helicopter to the hospital on *Polarstern* where they were cared for.

As soon as the news of the terrible event reached AWI, a crisis centre was established at once that was responsible for the organisation and coordination of comprehensive support measures necessary for an immediate return transport of the casualties, the notification of the next of kin and a public statement. Within the shortest period of time an exceptional and unparalleled international cooperation was set up providing the logistical support for the accident victims' instant trip home via Cape Town.

On board we gathered together on 3 March for a memorial on the helicopter deck on Monday to bid farewell to our two colleagues. Willem Polman and Stefan Winter lost their lives in the most terrible accident which ever happened in the 25 years of operation of *Polarstern*. With this ceremony we wanted to express our deepest sympathies to the relatives of the victims and comfort each other and express our highest appreciation of the two deceased to the whole world. The pain, the loss and the fear of the affected families is beyond belief; they are always in our thoughts. A flood of condolences arrived on board, at the AWI and at the NIOZ from all around the world. With this report, we wish to express our thanks for the worldwide sympathy, which provided us with the strength to carry on and get through this difficult situation. As well we want to thank all those who have contributed so that the injured were discovered fast, rescued and taken care of and that our deceased colleagues could begin their last journey with dignity. In addition, we would like to thank all of those who ensured that the injured receive optimal care and could return from Cape Town to their home countries shortly. Only those who were at the location know what it was like for the crews of the station of Neumayer and the construction site and the crew members of *Polarstern*, pilots, medical personnel, meteorologists, logistical officers, and managers to do all what was needed to limit the extent of this disaster.

On 4 March we once again bid farewell with a small group of the most closely affected at the place of the accident. The construction team had built and placed two crosses at the place of the accident. As we held a moment of silence in remembrance, the Basler BT-67 with the bodies on board flew overhead on their flight to Novolazarevskaja, from where the further transport to Cape Town occurred. As a farewell the pilots dipped their wings towards the crosses. It is difficult to imagine a more dignified farewell for a Polar researcher leaving for another world.

On 5 March the injured were transported to Cape Town. In the early morning the weather situation seemed to be hopeless. There was continuous snowfall. The injured had to prove further patience. However, we then received the message of the meteorologists: it will improve and the Basler BT-67 has departed from Novolazarevskaja. We admire the courage of the pilots and the skill of the meteorologists because weather really improved. With snow still falling the transport by the PistenBullies from the ship to the airfield began. With pain because of the separation and pleasure of the expectation to know that our friends would soon be in Cape Town and with their relatives we bid farewell to the injured. The pilots took advantage of the short period of better weather, landed, and got the injured on board and started in the last moments before the conditions would not permit the flight anymore.

When we were informed about the successful takeoff, we left the shelf ice front and restarted research in Atka Bight. The irony of fate provided us with a sunny afternoon with glorious impressions that are typical for Antarctica during out travel across Atka Bight. It is strange to think that beauty and enchantment could so closely follow horror and grief. However, the decided will to continue our work in the spirit and in remembrance of our deceased colleagues, helped us, to overcome our pain and to return to the routine of research.

Our stay at the Station was aimed at supply; we mainly had to supply fuel and food. Additionally, the valuable ice cores, which were drilled at the Kohnen Station, used material and garbage, came on board. Furthermore containers had to be rearranged, to provide space and material, which was used during the next part of the cruise. For this purpose, freight containers had to be moved from the hatch onto the ice, the hatches then had to be opened and lab containers had to be offloaded. Once all these containers were on sledges on the ice, to remove them from the loading area, they were, together with the additional freight containers, then carried back and reloaded in a new sequence. A shunting yard on the shelf ice. Simultaneously, fuel was pumped into the tank containers. The good weather facilitated the work.

After the end of the rescue and loading operation we were pleased to accept the invitation of the Station leader to visit the Neumayer Station and to get an impression of the work of the over wintering team. Patiently they explained the properties and function of the station. The farewell of the over wintering team occurred this time only with a short break at the station.

The completion of the work on the Greenwich meridian

The work on the Greenwich meridian was determined by an alternating sequence of casts with the oceanographic and the *ultraclean* CTD every 30 nautical miles. Slowly the hydrographic structure of the Weddell gyre appeared in our observations, which we had crossed until the time of leaving to the Neumayer Station up to the foot area of Maud Rise at 65˚30'S. A longer phase with relatively weak winds was favourable to this progress. We completed 7 „Super stations“ in the context of the GEOTRACES-Programme, 25 ultraclean CTDs and 73 normal CTD stations to cover all hydrographic regions on the Greenwich meridian with all the relevant parameters. We have recovered 9 moorings and redeployed 5 of them. Two sound sources were recovered and redeployed. The grid of vertically profiling floats was extended by 38 and these drifted under the sea ice of the forthcoming autumns and winters.

At the last mooring at about 12 nm north of the edge of the Fimbul Ice Shelf, we encountered a new challenge. When we tried to interrogate the acoustic releases with the POSIDONIA system on board *Polarstern* no reply was received. So we released blindly and waited for the mooring to show up at the surface. However no float was sighted and no signal was detected with the radio receiver on board from the satellite transmitter, which is mounted on the uppermost part of the mooring. We started to search with the ship and with the helicopter, but with no result. When we were sure that the mooring was not longer at its position, we stopped searching and resumed water sampling stations towards the ice shelf edge. However, shortly after, we were surprised by a message from OPTIMARE in Bremerhaven who are surveying for us the satellite transmitters of the moorings. They informed us that the transmitter had reached the surface shortly after the release signal, though 9 km away from the expected position. We turned immediately towards the indicated position, the helicopter started again and was able to identify the mooring in an ice field in a few miles distance. With this information from the helicopter it was easily possible to approach the mooring with the ship and to recover it quickly. It had damages which clearly indicated that it was removed by an iceberg to a position which was still within the reach of the POSIDONIA transmitter on board to receive the release command, but too far distant for the reply from the less powerful releaser to be received on board. The satellite beacon was pushed by the iceberg so deep into the float assembly that it was hidden for the quasi horizontal view from a distance on the ship, but still visible to the satellite which was on top of it. We were glad about the happy end of the recovery. However, the upward looking sonar was damaged by the iceberg so that the recorded data were lost. Still, it is a great success that all moorings on the Greenwich meridian were recovered after the first 3-year-mooring period, which proves that our mooring technology has reached a standard which allows us to plan such long deployment periods in future.

Despite the fact that the data requires comprehensive processing and calibration work, the quality of our instruments is so high, that a first look on the preliminary data from the hydrographic survey indicated that the cooling of the Warm Deep Water which was observed since the mid 90ties has come to a halt. Together with the observation of an earlier warming until the mid 90ties this suggests that decadal fluctuations dominate the variability. Now we can compare the atmospheric forcing during the last years with the one in the early nineties to better understand the forcing mechanism of the fluctuations. The temperature and the salinity of the Weddell Sea Bottom Water increased further during the last three years. This observation provides evidence of the evolution that we have followed since the mid 90s and raised the question even clearer: did global warming reach the deep sea or is it only a fluctuation on a timescale of decades. Because our Australian colleagues report that the salinity of the bottom water in the Ross Sea and off Adelie Land keeps on decreasing, this regional contrast requires an explanation to which we obtained a hint from the data which were obtained in the western Weddell Sea. There the Weddell Sea Bottom Water descends into the deep sea.

On 12 March the work on the Greenwich meridian was terminated and we steamed towards the Weddell Sea.

In the Weddell Sea

The sea ice conditions in the eastern Weddell Sea were determined by a pronounced tongue of sea ice emerging from the South. Since we needed to save time due to the events at the Neumayer Station, we omitted the eastern part of the transect from Kapp Norvegia to Joinville Island. As an alternative it was planned to circumnavigate the ice tongue in the North to gain by easier conditions and omitting station work the required time. However, the forecast of bad weather led us to the decision to enter the ice. It appeared that the ice was rather easy to break and we proceeded so fast that we decided on 14 March to turn further to the south to be able to begin with the section further to the southeast. However the ice conditions became much more serious and this plan was only partially successful. We had to increase the station distance to 45 nm. The first station on the transect occurred on 15 March at 69°22'S 16°21'W.

On 18 March the funeral of Willem Polman took place and on 19 March the obsequies for Stefan Winter. Simultaneously with the ceremonies on land we stopped the work on board and came together for a commemoration. In the solemn company of our ceremonies we were with our thoughts near to the deceased and their families. Even if it was hard for us to overcome our pain, the work on board had to go on. The deep gaps which are left by the deceased and injured colleagues in our hearts and at work have to be bridged as adequately as possible. In this sense a helicopter technician became a winch driver for the ultraclean CTD. With solidarity and even more enhanced efforts we continued the programme in the sense and as an appreciation of the victims.

As on the Greenwich meridian, the rhythm of the programme was given by the sequence of lowering and hoisting of the „normal“ and ultraclean CTD and the processing of the never ending flow of sampled water. Most of the profiles reached to the sea bottom, but frequently shallow casts (200 to 300 m) were needed to provide large quantities of water for experiments or for extraction of trace substances to be sampled. The moorings which we recovered and deployed were always a particular challenge.

In our programme the deployment of sound sources is of particular interest. To obtain measurements in the winter and under the ice, floats were developed which drift at 800 m depths. Once every 10 days they descend first to 2000 m depth and then return to the surface. If there, they are informed of their position and they transfer the measured data by satellites. So far, this is the global Argo system, in the context of which about 3,000 such floats operate in the open ocean and to which we are contributing. However, under the ice this procedure does not work because the floats are not able to reach the surface. For this reason our floats are located by means of the sound sources and the travel times of the signals they transmit. They recognize that they are under the ice because the near surface water temperature is close to the freezing point. Then they stop their ascent and return to depth again. When they reach open water again, they transmit the full recorded data set.

In two moorings we have recovered, we encountered a particular phenomenon. The moorings contain buoyancy elements (floats) which are supposed to keep the mooring wire upright in the water column. They consist of glass spheres in plastic housings. In the two last moorings which we recovered we found only remnants of the deepest floats which consisted of the smashed plastic housings which contained sand like glass flour. Those remnants are an impressive demonstration of the impact of the implosion of a glass sphere in about 4,500 m water depth. The discussion on the potential causes is not yet finished.

A special challenge is the recovery of moorings under heavy ice conditions. At the last mooring we were due to recover in the Weddell Sea, the great skill built up during decades of experience (25 years *Polarstern*) and the grain of luck which is always required to be successful, resulted in the recovery at almost 100 % in ice cover. Since the mooring had already been in place for three years and the next opportunity for recovery would be three years later (when the batteries of the releases will be most likely exhausted) there was no alternative but to give it a try. The success fills our hearts with joy and pride. Now we can summarize that after our first deployment period of three years, we were able to recover all moorings. Unfortunately the instruments technology is not as far developed as our mooring technology. Therefore in spite of a 100 % recovery rate, we did not achieve a 100 % data rate.

The evaluation of the data stored in the moored instruments has already begun on board. A first glance showed evidence that the sequence of longer term cooling and warming events detected in the CTD transect repeated in large time intervals were confirmed by the time series from the moored instruments. A particular challenge will now be to find out if there is a relationship between the extreme ice conditions and the water mass properties that together with the atmospheric conditions could result in such changes.

To finalize the transect across the Weddell Sea, we needed a lot of patience since the sea ice conditions in the Weddell Sea were extreme. Over the summer two large ice tongues stretched from the southern to the northeastern and the northwestern Weddell Sea. This wider than normal ice extent is consistent with a trend visible in the time series of NSIDC derived from satellite images of increasing sea ice extent in summer during the last decades. However, this does not mean a real increase but only a weaker melting in summer because the winter sea ice extent remained basically constant. For us, this situation was not only a challenge to be explained but it had direct consequences on the cruise. The onset of ice formation in autumn gave rise to unexpected heavy ice conditions very similar to winter conditions. Heavy ice resulted in lower speed and less station time available, as the original plan was based on mean sea ice conditions. The loss of time had to be compensated through reduction of station times by increasing the station distances. Increasing station distance increases the uncertainty of the estimates of the intensity of variations. In spite of the restrictions, it was possible to probe the relevant water masses sufficiently to detect the correlation of long-term variations in the Weddell Sea and those at the Greenwich meridian. The concentrations of trace substances were measured in an unprecedented manner.

In the Weddell Sea we completed 1 „Super station“ in the context of the GEOTRACES-Programme, 15 ultraclean CTDs and 45 normal CTD stations which covered the central and the western part. We have recovered 3 moorings and redeployed 8 of them. Three sound sources were recovered and 4 deployed. Unfortunately we had to take note that two of the recovered sound sources had failed. The grid of vertically profiling floats was extended by 16 and these will now drift under the sea ice of the forthcoming autumns and winters.

King George Island and Drake Passage

On 30 March we arrived at King George Island after having crossed serious ice conditions north of Joinville Island. The German Dallmann-Labor is run in cooperation at the Argentinean station of Jubany, located at Maxwell Bay on Potter Cove. We were supposed to take freight on board, both here and from the stations Frei and Artigas. A group of seven French and one Chilean scientist were waiting at the Russian station Bellingshausen and two Korean scientists were waiting at the Korean station King Sejong to come on board for the rest of the cruise. They are interested in investigations in Drake Passage. Since the flight from King George Island to Punta Arenas was cancelled, the group who was supposed to return from there had to stay on board until the end of the cruise. After a sunny start in the morning the bay was immersed in fog and we had to wait until flight conditions would prevail for the ship's helicopter to take on board the new scientists and to transfer some equipment as well.

On 31 March we left King George Island with a new French/Korean group on board. In addition it was possible to load material from Jubany and Frei stations. However the bad weather conditions, which showed no hope of improvement, forced us to give up our final task of loading material from Artigas. Dense fog prevented any further flights for an unforeseeable future. During the night, we steamed to Drake Passage where an intensive mooring programme took place in addition to the continuation of our measurements of water mass properties and concentration of trace substances.

The work was focussed on the French/Korean mooring programme. We intended to recover 10 moorings and redeploy 5 of them. The first two moorings of the Korean group in the southern Drake Passage could be recovered in spite of the unfavourable weather conditions with no problems. Unfortunately there was a problem with the flotation of the following moorings we needed to recover. Most of them had still enough buoyancy to ascend to the surface. However, some of them did so at a rather slow rate. In spite of the fact that they could be monitored by POSIDONIA, this required a lot of patience. Two of the moorings ascended but did not reach the surface. With time consuming operations we tried to dredge them, by paying out about 5000 m of wire which we towed in loops around them. Still, our efforts were not successful. No matter which way we placed our loops (which was not easy with 6 to 7 Bft) the moorings escaped and, disappointed, we had to give up the recovery.

In Drake Passage we completed 5 „Super stations“ in the context of the GEOTRACES-Programme, 12 ultraclean CTDs and 46 normal CTD stations. We have recovered 8 moorings and redeployed 5 of them. The grid of vertically profiling floats was extended by 14. The time lost to the problems with the moorings had to be regained by the reduction of the CTD work which resulted in a coarser resolution. Still we were lucky because Drake Passage with famous Cape Hoorn did not show us its most uncomfortable side. Really bad weather only reached us only at the end of the mooring work when we returned to the south to fill in omitted CTD stations. To avoid the bad weather the final CTD station occurred at 56°1.07'S 64°0.59'W on 13 April 2008. When the bad weather arrived we were already steaming towards Le Maire Strait with the wind at our back.

On 3 April, we had left Antarctica, when we passed 60°S. On 16 April, the cruise ended according to the plan in Punta Arenas.

Scientific background

Our cruise was mainly dedicated to the investigation of the oceanic circulation and the biogeochemical processes with their influence on life that depends on them. The main programmes occurred in the context of the International Polar Year 2007/2008 (IPY). The IPY was established under the auspices of ICSU and WMO. It aims to coordinate forces globally to achieve a quasi-synoptic survey of the conditions in both polar areas to obtain a benchmark for future changes. In the GEOTRACES project the role of traces substances in the context of biogeochemical cycles is investigated. The CASO project (Climate of Antarctica and the Southern Ocean) takes up work which had started in the WECCON project (Weddell Sea Convection CONtrol). It aims to investigate processes which occur in the Atlantic Sector of the Southern Ocean and Drake Passage in cooperation with the Bjerknes Centre for Climate Research in Bergen, Norway and the British Antarctic Survey (BAS). In the framework of iAnZone, a programme associated to SCOR (Scientific Committee of Oceanographic Research) and its IPY SASSI project (Synoptic Antarctic Shelf Slope Interactions Study) observations occurred in the area of Maud Rise and the Antarctic Coastal Current. The observations occurred jointly with the IPY GOOD-HOPE project which covers the northern part of the Atlantic sector of the Southern Ocean. The part of the cruise in Drake Passage is part of the French programme DRAKE. The global impact of the regional Processes will be considered in the BIAC (Bipolar Atlantic Thermohaline Circulation) IPY project. The cruise occurs in the context of the MARCOPOLI programme of the Hermann von Helmholtz Association of German Research Centres (HGF). It is a contribution to the Climate Variability and Predictability (CLIVAR) and the Climate and Cryosphere (CliC) projects of the World Climate Research Programme (WCRP). The ULSs are a contribution to the Antarctic Sea Ice Thickness Project (AnSITP). The deployment of floats occured in the framework of the international Argo programme which contributes to the Global Ocean Observing System (GOOS).

As a contribution to the International Polar Year 2007/2008 the cruise was part of the CASO - (Climate of Antarctica and the Southern Ocean) and the GEOTRACES projects. It was the aim to measure ocean currents, temperature, salinity and concentrations of many trace substances in the Southern Ocean. The descending motions in the Southern Ocean are part of the world wide oceanic overturning circulation. They affect the role of the ocean in climate change and biogeochemical cycles. Our measurements raise the question as to whether the deep reaching, descending motion of the overturning, increases again after a phase of slackening. For more than a decade we have observed that the temperatures in the deep Weddell Sea were rising which suggested the reduction of the deep reaching water mass formation in the Antarctic Ocean. Now the temperature is decreasing again. This occurs at a time when sea ice extent in summer is increasing and shows clearly that the potential influence of global warming is not simply to identify from the background of decadal variations.

It is of special interest, that the evaluation of satellite data by NSIDC indicated clearly that the Antarctic summer 2007/2008 was the one with the largest ice extent on record. This trend which is particularly strong in the Atlantic sector of the Southern Ocean is in clear contrast to the Arctic where a strong decrease of the summer ice extend is observed. To understand the opposing trends in the Antarctic and the Arctic is an obvious aim of our cruise. Because those changes occur over decades and are subject to significant spatial variations ships cruises like the one of *Polarstern* are not enough to track them with sufficient accuracy. Therefore we need comprehensive autonomous observing systems which can be moored or feely drifting. They are a component of the Southern Ocean Observing System (SOOS) which is under development these days. As a contribution to such a system we deployed, in international cooperation, 18 moored systems and recovered 20 of them. With the recording period of three years we have reached a record length. We deployed 67 floats, the ones which were deployed in the Weddell Sea are able to operate under the ice. They have an operation period of up to five years and form a network of unprecedented coverage of this part of the earth.

During the International Polar Year 2007/2008 we expected not only to provide new knowledge on the role of the polar areas in the earth system, but in addition, it was an aim of high priority to include the public and, in particular, the younger generation in actual research and instruct them comprehensively. For this purpose, we had two teachers on board. They participated actively in the research work and transmitted their experiences on a regular basis to their students, colleagues and newspapers by telephone, email and internet. Their experiences will reach other schools via an IPY teacher's network and hopefully school books too.

2. CASO - (CLIMATE OF ANTARCTICA AND THE SOUTHERN OCEAN)

The CASO project (*Climate of Antarctica and the Southern Ocean*) takes up work which had started in the WECCON project (*Weddell Sea Convection CONtrol*). It aims to investigate processes which occur in the Atlantic Sector of the Southern Ocean and Drake Passage in cooperation with the Bjerknes Centre for Climate Research in Bergen, Norway and the British Antarctic Survey (BAS). In the framework of iAnZone, a programme associated to SCOR (*Scientific Committee of Oceanographic Research*) and its IPY SASSI project (*Synoptic Antarctic Shelf Slope Interactions Study)* observations occur in the area of Maud Rise and the Antarctic Coastal Current. The observations occur jointly with the IPY GOOD-HOPE project which covers the northern part of the Atlantic sector of the Southern Ocean. The global impact of the regional Processes will be considered in the BIAC (*Bipolar Atlantic Thermohaline Circulation*) IPY project. The cruise occurs in the context of the MARCOPOLI programme of the Hermann von Helmholtz Association of German Research Centres (HGF). It is a contribution to the *Climate Variability and Predictability* (CLIVAR) and the *Climate and Cryosphere* (CliC) projects of the *World Climate Research Programm*e (WCRP). The ULS are a contribution to the *Antarctic Sea Ice Thickness Project* (AnSITP). The deployment of floats occurs in the framework of the international *Argo* programme which contributes to the *Global Ocean Observing System (*GOOS).

2.1 Decadal variations of water mass properties in the Atlantic sector

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Objectives

The densest bottom waters of the global oceans originate in the Southern Ocean. Production and export of these dense waters constitute a vital component of the global climate system. The formation of dense water in polar areas is controlled to a large extent by the delicate balance between supply of fresh water through precipitation and melt of continental and sea ice and the extraction of freshwater by sea ice formation and evaporation. Therefore the Southern Ocean's part of the global freshwater cycle links continental and oceanic conditions. It consists of the transport of freshwater from the continent through melting of ice shelf and icebergs and is strongly mediated by redistribution of freshwater through the highly variable and moving sea ice cover on which snow is accumulated as well as by the oceanic circulation. Coupled models predict an intensification of the freshwater cycle in the context of global warming. Observations of the freshening of Subantarctic Mode, intermediate and deep waters suggest that the intensification is ongoing. Therefore the better understanding of the Southern Ocean freshwater balance is urgently needed. It can only be achieved by a quasi-simultaneous comprehensive circumpolar assessment by multi-platform observations and modelling.

The influence of Southern Ocean waters can be traced far into the northern hemisphere. As deep and bottom waters, they represent the deepest layer of the global overturning circulation. The conditions in the Southern Ocean are largely controlled by the Antarctic Circumpolar Current (ACC), the world´s most powerful current system, which transports about 140 Sv (10^6 m^3 s^{-1}) of water at all depths. It connects the three ocean basins and forms an isolating water ring around the Antarctic continent. South of the ACC, in the subpolar region, warm and salty water masses are carried in the subpolar gyres to the continental margins of Antarctica. The most prominent are the Weddell and Ross gyres. In the subpolar gyres, water mass modifications occur through ocean-ice-atmosphere interactions and mixing with adjacent water masses. The ACC is dynamically linked to meridional circulation cells, formed by southward ascending flow in intermediate depth feeding into northward flow above and below. In the deep cell water sinking near the continental water spreads to the adjacent ocean basins, in the shallow cell the northward flow occurs in the near surface layers. Dense waters are produced at several sites near the continental margins of Antarctica. Quantitatively the most important region for dense water formation may well be the Weddell Sea, however other areas provide significant contributions as well.

The basic mechanism of dense water generation involves upwelling of Circumpolar Deep Water which is relatively warm and salty into the surface layer where it comes into contact with the atmosphere and sea ice. The newly formed bottom water is significantly colder and slightly fresher than the initial Circumpolar Deep Water which indicates heat loss and the addition of freshwater. Since freshwater input in the upper oceanic layers is prohibitive to sinking through increasing stability of the water column, it has to be compensated by salt gain through fresh water extraction. The upwelled water is freshened by precipitation and melting of glacial and sea ice. Freshwater of glacial origin is supplied from the ice shelves or melting icebergs. Ice shelves melt at their fronts and undersides related to the oceanic circulation in the cavity. Iceberg melting depends highly on the iceberg drift and can supply freshwater to areas distant from the shelves as the Antarctic frontal system. Due to the spatial separation of major freezing and melting areas of sea ice, cooling and salt release during sea-ice formation cause the compensation of the freshwater gain and subsequently the density increase which is needed for bottom water formation. Significant parts of the salt accumulation occur on the Antarctic shelves in coastal polynyas. Since extreme heat losses can only occur in ice free water areas, the polynyas are areas of intense sea ice formation. Offshore winds compress the newly formed sea ice and keep an open sea surface in the polynyas.

The cold and saline water accumulated on the shelves can descend the continental slope and mix with water masses near the shelf edge or it circulates under the vast ice shelves, where it is further cooled below the surface freezing point and freshened by melting of the ice shelf. The resulting Ice Shelf Water spills over the continental slope and mixes with ambient waters to form deep and bottom water. For both mechanisms relatively small scale processes at the shelf front, topographic features and the nonlinearity of the equation of state of sea water at low temperatures are of special importance to induce and maintain the sinking motion. The different processes, topographic settings and atmospheric forcing conditions lead to variable spatial characteristics of the resulting deep and bottom water masses which than spread along a variety of pathways to feed into the global oceanic circulation. Climate models suggest that dense water formation is sensitive to climate change. However, since the relatively small scale formation processes are poorly represented in the models further improvement is needed. The overturning affects as well the biogeochemical cycles and consequently its change can have a significant impact on ocean carbon uptake.

The properties and volume of the newly formed bottom water underlies significant variability on a wide range of time scales, which are only poorly explored due to the large efforts needed to obtain measurements in ice covered ocean areas. As for the atmospheric driving forces, the sea ice and upper ocean layers, seasonal variations are partly known and normally exceed in intensity the other scales of variability. However the spatial distribution pattern of the variability is only poorly resolved e.g. seasonal cycles of sea ice thickness are only available at a few sites. An estimate of the sea ice mass as a baseline to detect change is still not possible due to the missing measurements of sea ice thickness. Longer term variations of the atmosphere-ice-ocean system as the Antarctic Circumpolar Wave, the Southern Hemispheric Annular Mode and the Antarctic Dipole are only poorly observed and understood. Their influence on or interaction with oceanic conditions are only guessed on the basis of models which are only superficially validated due to lack of appropriate measurements.

The extreme regional and temporal variability represents a large source of uncertainty when data sets of different origin are combined. Therefore circumpolar data sets are needed of sufficient spatial and temporal coverage. At present such data sets can only be acquired satellite remote sensing. However, to penetrate into the ocean interior and to validate the remotely sensed data, an ocean observing system is needed, which combines remotely sensed data of sea ice and surface properties with *in-situ* measurements of atmospheric, sea ice and oceanic properties.

To achieve further progress significant steps occurred in the development of appropriate technology and logistics. Oceanic properties are measured under the sea ice which required the development of under-ice acoustic ranging and data transmitting systems. To construct from the achievable observations a comprehensive circumpolar view, model assimilations have to be done which require the development of appropriate models.

During the International Polar Year 2007/2008 a set of meridional transects was occupied in one season to provide the first synoptic snapshot of the circulation, stratification and biogeochemical status of the Southern Ocean. It included each of the “chokepoint” sections between Antarctic and the southern hemisphere continents. ANT-XXIV/3 covered the African chokepoint in the Atlantic Sector of the Southern Ocean, the Weddell Sea and Drake Passage. The northern part of the section south of Africa was taken care by BONUS-GOODHOPE.

Work at sea

The *Polarstern* cruise ANT-XXIV/3 complemented the efforts during the International Polar Year 2007/2008 to obtain *in-situ* observations in the Atlantic sector of the Southern Ocean in order to allow a circumpolar view. Time series stations with moored instruments provided measurements in the deep and the surface layers and of ice thickness. For this purpose moorings with current meters, temperature and salinity sensors as well as upward looking sonars were recovered and redeployed. The cruise concentrated to three major areas: the Greenwich meridian, the Weddell Sea and Drake Passage.

Measurements occurred along the Greenwich meridian, across the Weddell Sea and Drake Passage (Fig. 2.1). The ship borne surveys in summer are imbedded in the time series measurements with moorings, drifters and floats to derive the effect of the seasonal variability on transfer processes and to avoid the aliasing effect on longer term observations. Moorings were recovered (Fig. 2.1b) and redeployed (Fig. 2.1c). The details of the moored instruments are summarized in Tab. 2.5 to 2.6. The spreading of floats is able to extend the data from the sections over larger parts of the area. Ship borne meridional transects were obtained to determine water mass properties including tracer concentrations (Fig. 2.1.d).

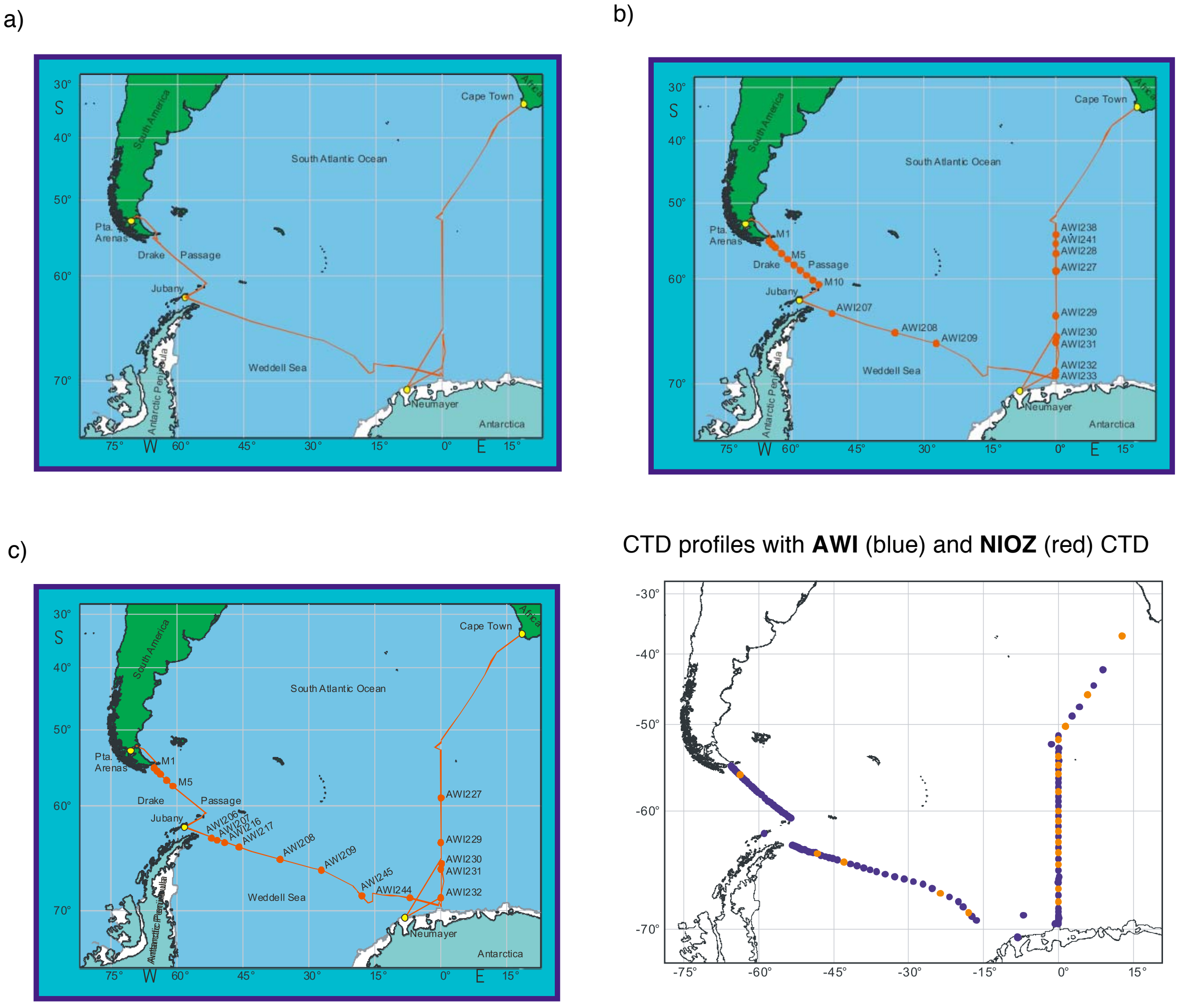

Fig. 2.1: The cruise track of ANT-XXIV/3 (a) and the locations of moorings recovered (b) deployed (c) and the CTD stations (d)

Profiling floats were deployed. The float system has to complement *Argo* in ice-fee and under-ice condition to reach a global coverage. Moorings with sound sources for under ice navigation were recovered and redeployed. The IPY set the goal of achieving at least the 3° X 3° sampling of the global array throughout the southern hemisphere oceans south of 30°S, for the full duration of the IPY (March 2007 to March 2009). Acoustically tracked floats will provide profiles and current velocities from key ice-covered seas. The floats are programmed to continue to profile and store data beneath ice. Once the floats detect open water, the stored profiles are transmitted. While the position of the sub-ice profiles is not known without acoustic navigation, the floats can survive the winter and the stored profiles provide a statistical description of winter stratification.

Preliminary results

Despite the fact that the data requires comprehensive processing and calibration work, the quality of our instruments is so high, that a first look on the preliminary data from the hydrographic survey indicated that the cooling of the Warm Deep Water which was observed since the mid 90ties has come to a halt. Together with the observation of an earlier warming until the mid 90ties this suggests that decadal fluctuations dominate the variability. Now we can compare the atmospheric forcing during the last years with the one in the early nineties to better understand the forcing mechanism of the fluctuations. The temperature and the salinity of the Weddell Sea Bottom Water increased further during the last three years at the Greenwich meridian. This observation provides evidence of the evolution that we have followed since the mid 90s and raised the question even clearer: did global warming reach the deep sea or is it only a fluctuation on a timescale of decades. Because our Australian colleagues report that the salinity of the bottom water in the Ross Sea and off Adelie Land keeps on decreasing, this regional contrast requires an explanation to which we obtained a hint from the data which were obtained in the western Weddell Sea where the data from the moored instruments showed cooling of the Weddell Sea Bottom Water.

The descending motions in the Southern Ocean are part of the world wide oceanic overturning circulation. They affect the role of the ocean in climate change and biogeochemical cycles. Our measurements raise the question as to whether the deep reaching, descending motion of the overturning, increases again after a phase of slackening. For more than a decade we have observed that the temperatures in the deep Weddell Sea were rising which suggested the reduction of the deep reaching water mass formation in the Antarctic Ocean. Now the temperature near the formation area in the western Weddell Sea is decreasing again. This occurs at a time when sea ice extent in summer is increasing and shows clearly that the potential influence of global warming is not simply to identify from the background of decadal variations.

2.1.1 CTD transects

Hydrographic surveys were carried out along the Greenwich meridian, from Kapp Norvegia to the northern end of the Antarctic Peninsula and across Drake Passage with a CTD (Conductivity/Temperature/Depth) probe and a rosette water sampler (Fig. 2.1d). Samples were taken to measure the components of the CO_2 system, oxygen, nutrients, and tracers.

A total number of 217 CTD stations were carried out during the cruise. Two independent systems were used. The standard CTD/water sampler (here indicated as “AWI CTD”) consists of a SBE911plus CTD system in combination with a carousel water sampler SBE32 with 24 12-l bottles. Bottle number 1 and 2 were not used because of up- and down looking ADCPs which have been installed at the carousel frame. To determine the distance to the bottom we used an altimeter from Benthos.

In addition to this a transmissometer from Wetlabs, a SBE43 oxygen sensor from Seabird Electronics and a Dr. Haardt Fluorometer has been used.

The second system was the ultraclean water sampler (here indicated as "NIOZ CTD") from the GEOTRACES group (See 3.1.9). This water sampler was also equipped with a SBE911plus CTD. In addition the following external sensors were installed at the NIOZ CTD: I) a SBE43 oxygen sensor from Seabird, II) a Seapoint OBS, and III) a Chelsea Aquatracka fluorometer. A high precision thermometer SBE35 was used to check the CTD temperature sensors. A mechanical bottom switch with 10 m rope length was used. The altimeter did not work reliably.

Both CTD systems were equipped with two independent CT sensor pairs. Each senor pair has its own pump to flush the cell at a constant flow of water. The oxygen sensor was integrated in the first pair. The serial numbers, the type of each sensor and the calibration dates of each device can be taken from Tab. 2.1 and 2.2.

Tab. 2.1a: Configuration of the AWI CTD

CTD SBE911plus SN 0287 with rosette SBE 32		
Pressure (Type/SN, Cal.-date)	***Digiquartz 419K-105/SN 51197, 20.11.1992***	
Sensors in pair:		
	Pair 1	Pair 2
Temperature (Type/SN, Cal.-Date)	SBE 03P/2929, 10.04.07	SBE 03P/1373, 10.05.07
Conductivity (Type/SN, Cal.-Date)	SBE 04C/3173, 26.04.07	SBE 04C/2470, 10.04.07

Tab. 2.2a: Additional sensors of the AWI CTD:

Sensor	Type	Cal.-date	Analog channel (Voltage)
Altimeter	Benthos PSA 916D SN 208	-	6
Transmissiometer	WET labs C-Star SN CST-814DR	23.07.99	0
Fluorometer	Dr Haardt Mod. 1101.3 SN 8060	-	2
Oxygen (Type/SN)	SBE43 SN 0743	28.02.06	4

Tab. 2.1b: Configuration of the NIOZ CTD

CTD SBE911plus SN 0230 with Ultraclean Water Sampler		
Pressure (Type/SN, Cal.-date)	***Digiquartz 419K-105/SN 43517, 28.02.2006***	
Sensors in pair:		
	Pair 1	Pair 2
Temperature (Type/SN, Cal.-Date)	SBE 03P/2118, 09.11.07	SBE 03P/1360, 28.11.07
Conductivity (Type/SN, Cal.-Date)	SBE 04C/3035, 09.11.07*	SBE 04C/3385, 09.01.08
	SBE 04C/0776, 29.11.07**	

*: used from station 97 cast 2 until station 135 cast 1
**: used from station 138 cast 1 until station 252 cast 1

Tab. 2.2b: Additional sensors of the NIOZ CTD:

Sensor	Type	Cal.-date	Analog channel (Voltage)
Altimeter	unknown	-	-
Transmissiometer	Seapoint OBS SN 1066	-	-
Fluorometer	Chelsea Aquatracka MKIII SN 092	-	-
Oxygen (Type/SN)	SBE43 SN 0654	22.11.07	-

The salinity is given in Practical Salinity Units (PSU). Salinity samples were analysed with an Autosal salinometer 8400B from Guildline Instruments to check and probably correct the conductivity measurements of the CTD. Therefore once per day double samples were taken from 6 depth levels which show no significant gradient in the salinity differences. The salinity measurements were directly compared with the CTD measurements. The water samples were measured in reference to Standard water batch no P149 (K15=0.99984) from 10. May 2007.

AWI CTD

The difference between conductivity from sensor pair 1 and 2 showed an increasing drift of the primary conductivity sensor from the first to the last profile. This was confirmed by the post-calibration of the sensors carried out after the cruise. Therefore the secondary sensor pair was taken for the final data set. 21 deep casts were made with both, the AWI- and the NIOZ CTD. These profiles were used to compare all temperature sensors against each other resulting in a temperature correction of -0.00065°C for the secondary temperature sensor.

The pre- and post-calibration of the secondary conductivity sensor shows no drift but the evaluation of the Autosal measurements indicated a pressure dependent correction, which is in the order less than the sensor specification (see Fig. 2.2).

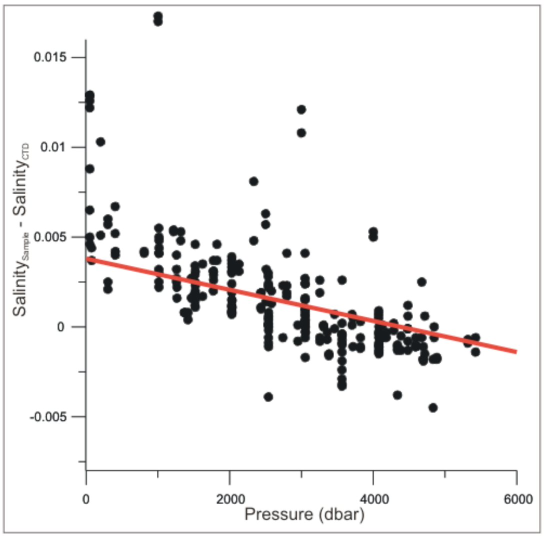

Fig. 2.2 : Salinity differences of AWI CTD plotted versus pressure.

The uncorrected salinity is in the range of the sensor specification, see Fig. 2.3 below. The applied correction based on the Autosal measurements and the pre- and post-calibration from the manufacturer.

$S_{corr} = S_{CTD} + \Delta S$ with $\Delta S = a + b * P$

P:= Pressure (dbar)

$a := 3.8 * 10^{-3}$

$b := -8.6667 * 10^{-7}$

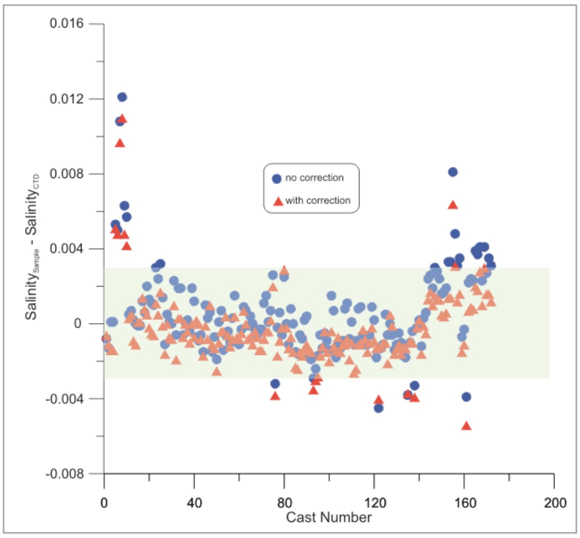

Fig. 2.3: Salinity differences of AWI CTD before and after correction from Autosal measurements taken from deep samples (greater 2,000 m) only. The shaded region indicates the range of the sensor specification.

NIOZ CTD

The secondary sensor pair was influenced by a strong noisy signal. The reason is still unclear. The same feature was already observed during the *Polarstern* cruise ARK-XXII/3. Therefore the primary sensor pair was taken for the final data set in spite of a sensor exchange due to a broken conductivity cell which happened at station 135, cast 1. No correction must be applied for the secondary temperature, which results from comparison between the secondary and primary sensors. This result was confirmed by the pre- and post-calibration and the comparison between AWI- and NIOZ CTD (see 21 deep casts).

No correction must be applied for the conductivity carried out with SN 3035; see Fig. 2.4. Data measured with the spare sensor SN 0776 need to be corrected with a constant offset of -0.00137.These correction could be confirmed with the help of the pre- and post-calibration results.

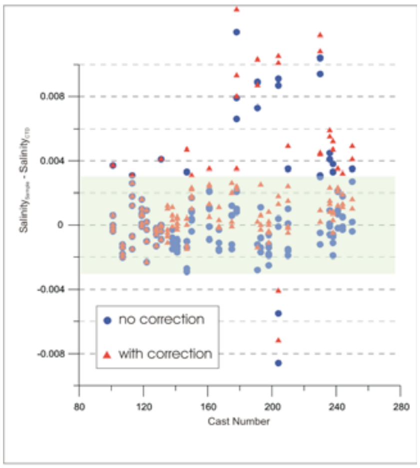

Fig. 2.4: Salinity differences of NIOZ CTD before and after correction from Autosal measurements taken from deep samples (greater 2,000 m) only. The shaded region indicates the range of the sensor specification.

After each single correction step temperature and salinity were checked using the T/S relation including all available profiles from AWI and NIOZ CTD and in addition data from previous cruises were taken into account. This method was used to correct the different performance of the two systems which was finally controlled by contour plots (Fig. 2.5).

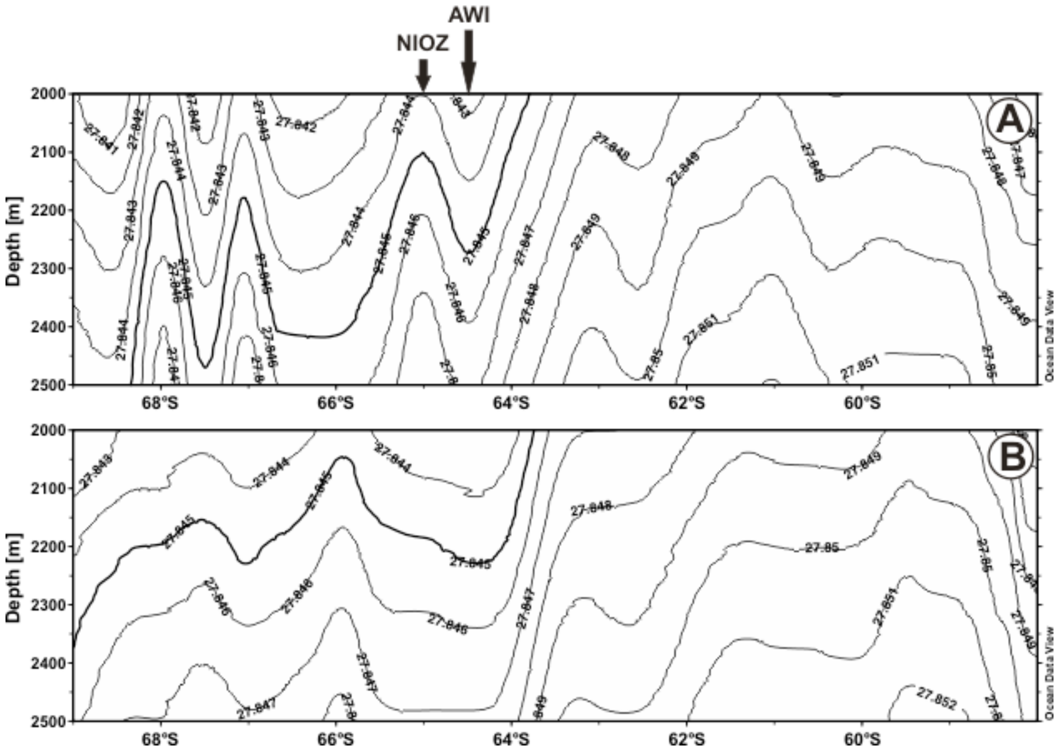

Fig. 2.5: Example of the density contour plot from the layer 2,000 to 2,500 m along the Greenwich meridian, which demonstrates the influence by the use of two independent CTD systems before and after the final processing. A) is the uncorrected and B) the corrected density contour plot. The arrows in the upper panel showed the location of the neighbouring CTD casts carried out with the AWI and NIOZ CTD.

The data quality for salinity is better than ± 0.002 and for temperature better than ± 0.001 K.

The temperature and salinity data are presented as vertical sections in Fig. 2.6 to 2.8.

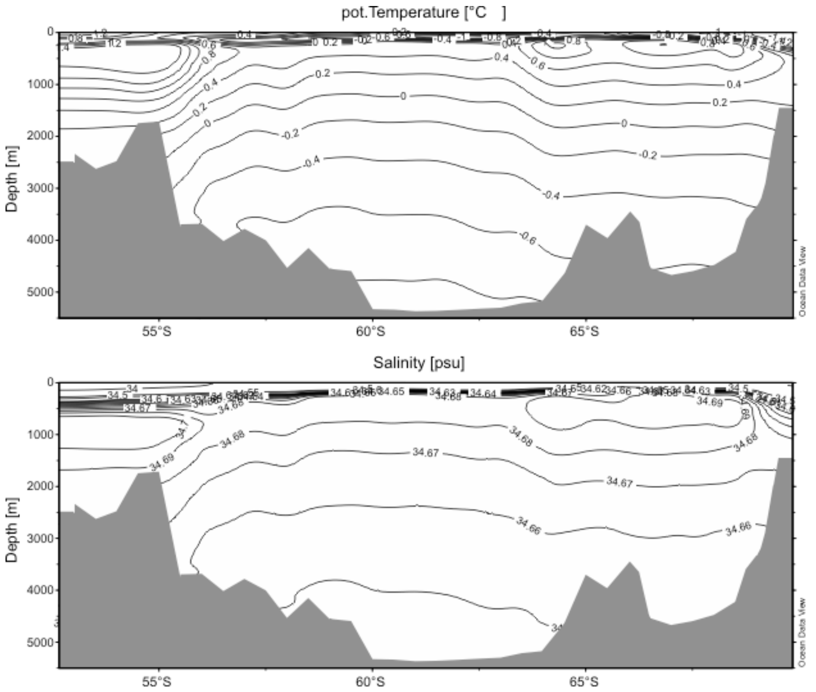

Fig. 2.6: Vertical transect of potential temperature (top panel) and salinity (bottom panel) along the Greenwich meridian

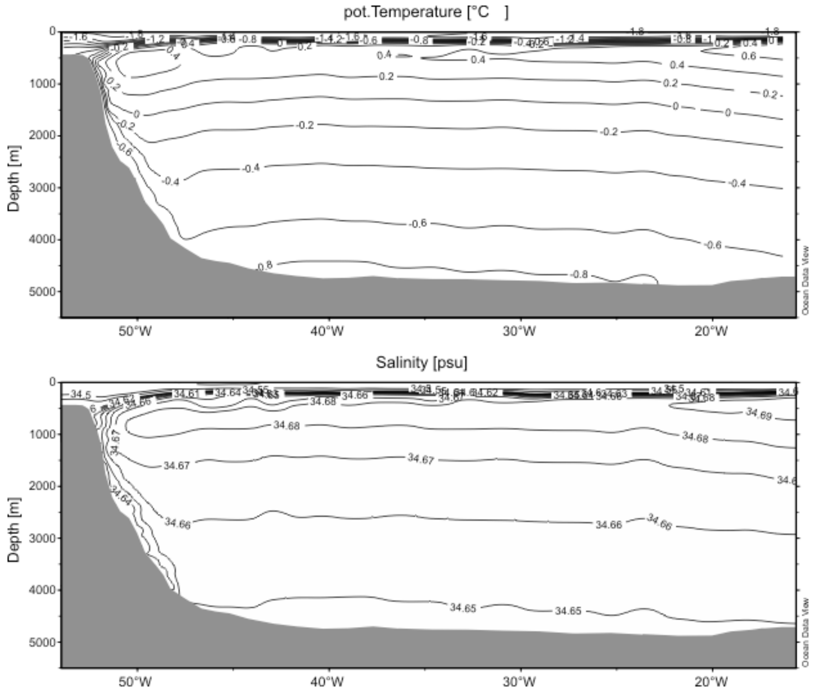

Fig. 2.7: Vertical transect of potential temperature (top panel) and salinity (bottom panel) across the Weddell Sea from Kapp Norvegia (right) to Joinville Island (left)

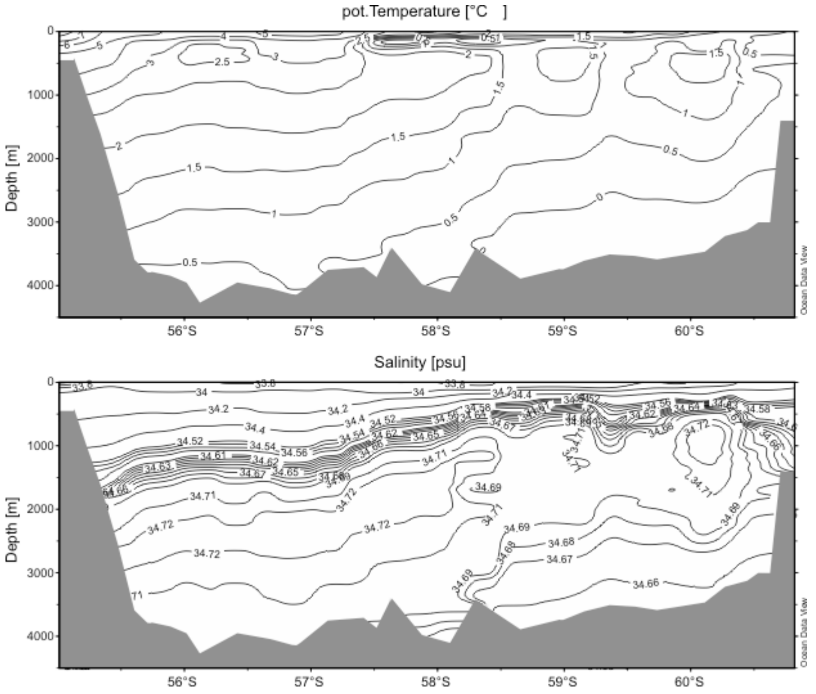

Fig. 2.8: Vertical transect of potential temperature (top panel) and salinity (bottom panel) across the Drake Passage from South America (left) to the Antarctic continent (right)

2.1.2 Underway measurements

Underway measurements with a vessel mounted 150 kHz-Ocean Surveyor ADCP from RD Instruments and two SBE21 thermosalinographs from Seabird Electronics were conducted along the whole track to supply temperature, salinity and current data at a high spatial resolution (Figs. 2.9, 2.10, and 2.11). The intakes of the thermosalinographs are mounted in 5 m depth in the bow thruster tunnel (TSB) and in 11 m depth in the keel (TSK). Both instruments were controlled by taking water samples each day which were measured on board with the Autosal 8400B.

The final corrected and verified thermosalinograph data can be retrieved from the AWI database using:

http://www.awi.de/de/infrastruktur/schiffe/polarstern/bordwetterwarte/continuous_measurements/

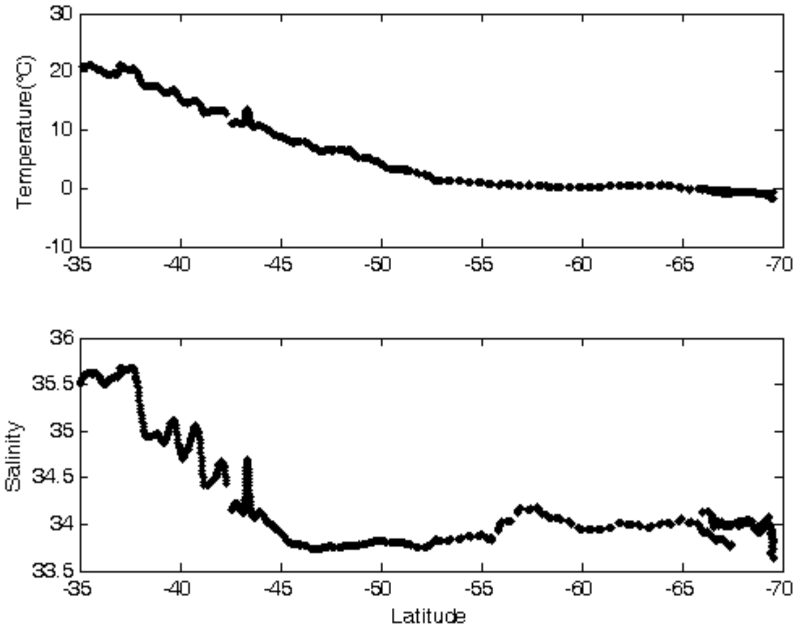

Fig. 2.9: Near surface temperature and salinity from the thermosalinograph (keel) along the trackline from South Africa (left) to the Antarctic continent (right)

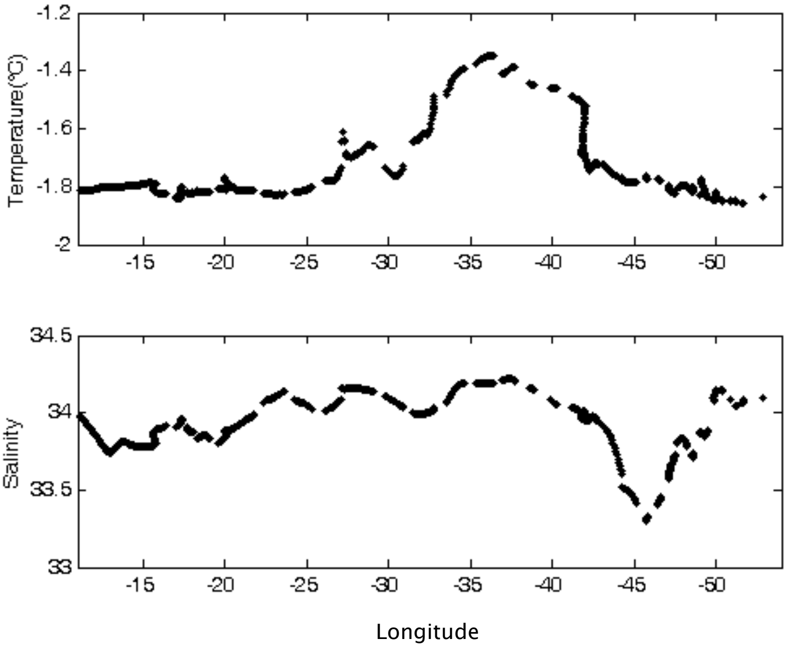

Fig. 2.10: Near surface temperature and salinity from the thermosalinograph (keel) across the Weddell Sea from Joinville Island (right) to Kapp Norvegia (left)

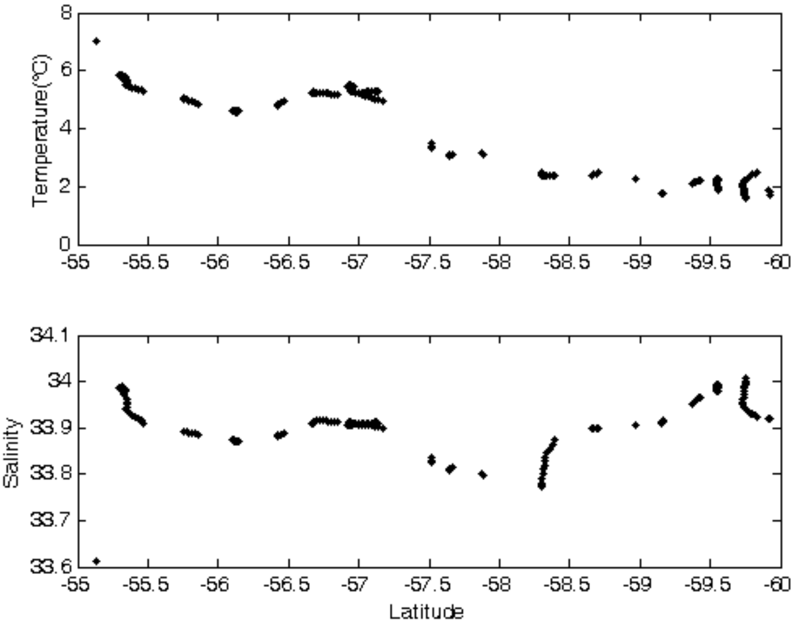

Fig. 2.11: Near surface temperature and salinity from the thermosalinograph (keel) across Drake Passage from South America (left) to the Antarctic continent (right)

2.1.3 LADCP (Lowered acoustic Doppler profiler)

Objectives

Full depth profiles of horizontal ocean currents were measured with two lowered acoustic Doppler profilers (LADCP) attached to the AWI CTD Rosette. CTD/LADCP stations were performed along the three transects (the Greenwich meridian, the Weddell Sea and the Drake Passage, Fig. 2.1), in order to complement the mooring arrays. The LADCP data along these transects in the Atlantic sector of the Southern Ocean will contribute to a better understanding of the Southern Ocean in the Atlantic sector including the Weddell Sea. The Antarctic Circumpolar Current (ACC), is a key element of the global climate system. The LADCPs data will provide a picture of the ACC transport across Drake Passage within a period of approximately 12 days. With a high resolution CTD/LADCP station section, the LADCP data will help to document the current structure.

Work at sea

The measurements were done with two RDI Workhorse 300 kHz ADCPs. An external battery case was used to supply power to the two LADCPs. Between two consecutive stations, the data from the two LADCPs were downloaded from their internal memory card and the power supply was checked. A Master/Slave configuration was used in which the Master ADCP was downward looking and the Slave ADCP was upward looking. Unfortunately the signal could not be synchronised between the two LADCPs and a unique configuration was used for each LADCP. The LADCP measurements are summarized in Tab. 2.3 and 2.4.

On the Greenwich meridian section we did a total of 24 profiles with the LADCPs. For 13 of them both upward and downward looking LADCPs worked, and for the others only the downward -looking LADCP could get data. On the Weddell Sea section we did a total of 52 profiles. On six of them, only the downward-looking LADCP was working properly and could acquire data.

Tab. 2.3: LADCP measurements during ANT-XXIV/3

Transect	Greenwich meridian	Weddell Sea	Drake Passage
Number of CTD/LADCP stations	24	52	31
Downward looking profile alone	11	6	12
Upward and downward looking profiles	13	46	31

Expected results

Processing was not completed on board. The quality of the data has to be tested in order to validate the raw data. The second step consists in the computation of the currents over the whole water column. The data coming from vessel mounted ADCP (VADCP) will be used to better constraint the first 300 meters. The profiles through the whole Drake Passage will allow the computation of the ACC transport across the section.

Tab. 2.4: Location of the LADCP profiles

Station	Date	Lat	Lon	Depth [m]	LADCP	
					Down	Up
PS71/099-2	13.02.08	41° 8.71' S	9° 58.28' E	4761.0	1	1
PS71/101-3	13.02.08	42° 21.36' S	8° 59.93' E	4640.0	1	1
PS71/102-2	15.02.08	44° 39.56' S	7° 5.77' E	4606.0	1	0
PS71/104-6	17.02.08	47° 39.05' S	4° 16.20' E	4544.2	1	0
PS71/106-1	18.02.08	48° 54.71' S	2° 47.88' E	4094.3	1	0
PS71/108-2	19.02.08	51° 29.95' S	0° 0.02' W	2775.4	1	0
PS71/112-1	20.02.08	52° 30.20' S	1° 22.26' W	2811.4	1	0
PS71/113-3	20.02.08	52° 59.75' S	0° 2.30' E	2522.4	1	0
PS71/115-2	21.02.08	53° 30.95' S	0° 0.30' E	2657.7	1	0
PS71/118-2	21.02.08	54° 30.19' S	0° 1.76' E	1718.8	1	0
PS71/121-1	22.02.08	55° 29.76' S	0° 0.34' W	3837.3	1	0
PS71/124-1	22.02.08	56° 30.34' S	0° 1.22' E	4055.3	1	1
PS71/125-1	23.02.08	57° 0.11' S	0° 0.17' W	3837.3	1	1
PS71/127-1	23.02.08	57° 29.91' S	0° 1.20' E	4056.7	1	1
PS71/130-1	24.02.08	58° 29.96' S	0° 0.03' W	4184.8	1	0
PS71/131-1	24.02.08	59° 0.06' S	0° 0.17' E	4584.2	1	1
PS71/134-1	25.02.08	59° 30.98' S	0° 1.77' E	4710.8	1	1
PS71/137-1	26.02.08	60° 29.99' S	0° 0.04' E	5355.5	1	1
PS71/140-1	27.02.08	61° 29.91' S	0° 0.35' W	5378.0	1	1
PS71/141-2	27.02.08	61° 59.98' S	0° 0.04' E	5359.2	1	1
PS71/143-1	27.02.08	62° 30.58' S	0° 0.56' W	5337.7	1	1
PS71/146-1	28.02.08	63° 30.01' S	0° 0.03' W	5236.3	1	0
PS71/149-1	29.02.08	64° 29.99' S	0° 0.04' E	4660.9	1	1
PS71/152-1	29.02.08	65° 30.04' S	0° 0.34' E	3972.6	1	1
PS71/157-5	08.03.08	66° 28.60' S	0° 1.85' W	4493.2	1	0
PS71/158-1	08.03.08	66° 14.73' S	0° 1.07' W	3683.5	1	1
PS71/159-4	08.03.08	66° 1.41' S	0° 7.93' E	3547.5	1	0
PS71/161-4	09.03.08	66° 29.93' S	0° 0.20' E	4536.5	1	0
PS71/165-1	10.03.08	67° 30.01' S	0° 0.08' E	4625.5	1	0
PS71/169-1	10.03.08	68° 30.02' S	0° 0.12' E	4256.2	1	1
PS71/171-1	10.03.08	68° 45.02' S	0° 0.00' W	3627.7	1	0
PS71/173-1	10.03.08	69° 11.89' S	0° 1.61' E	2905.2	1	0
PS71/174-1	11.03.08	69° 5.96' S	0° 0.24' W	3223.5	1	0
PS71/175-1	11.03.08	69° 0.72' S	0° 0.05' E	3374.5	1	0
PS71/177-1	11.03.08	69° 18.08' S	0° 0.31' W	2457.2	1	1
PS71/178-1	11.03.08	69° 24.07' S	0° 0.18' W	2000.5	1	1
PS71/179-1	12.03.08	69° 30.98' S	0° 3.14' W	1519.2	1	1
PS71/181-1	12.03.08	69° 36.58' S	0° 0.34' W	1506.2	1	1
PS71/183-1	12.03.08	69° 36.55' S	0° 40.05' W	2264.5	1	1

Station	Date	Lat	Lon	Depth [m]	LADCP	
					Down	Up
PS71/184-1	13.03.08	69° 0.00' S	6° 58.33' W	2942.5	1	1
PS71/185-1	15.03.08	69° 21.69' S	16° 25.87' W	4737.5	1	1
PS71/186-1	15.03.08	69° 3.86' S	17° 21.38' W	4766.5	1	1
PS71/188-1	16.03.08	68° 23.60' S	19° 4.19' W	4826.7	1	1
PS71/189-1	16.03.08	67° 56.57' S	20° 0.04' W	4905.0	1	1
PS71/190-1	17.03.08	67° 35.95' S	21° 47.96' W	4905.2	1	1
PS71/192-1	17.03.08	66° 56.84' S	25° 17.27' W	4852.0	1	1
PS71/193-1	18.03.08	66° 37.26' S	27° 4.85' W	4865.0	1	1
PS71/194-1	19.03.08	66° 24.72' S	29° 1.09' W	4827.7	1	1
PS71/195-1	20.03.08	66° 13.02' S	30° 55.42' W	4810.2	1	1
PS71/196-1	20.03.08	66° 0.50' S	32° 46.46' W	4789.7	1	1
PS71/197-1	20.03.08	65° 48.54' S	34° 37.55' W	4787.0	1	1
PS71/198-1	21.03.08	65° 36.82' S	36° 23.82' W	4771.2	1	1
PS71/199-1	21.03.08	65° 27.20' S	37° 42.46' W	4730.5	1	1
PS71/200-1	22.03.08	65° 16.95' S	39° 1.32' W	4766.2	1	1
PS71/201-1	22.03.08	65° 7.01' S	40° 19.31' W	4774.5	1	1
PS71/202-1	22.03.08	64° 56.89' S	41° 39.90' W	4733.2	1	1
PS71/205-1	23.03.08	64° 33.97' S	44° 13.71' W	4592.7	1	1
PS71/206-1	24.03.08	64° 28.19' S	45° 11.21' W	4484.5	1	1
PS71/207-3	24.03.08	64° 23.03' S	45° 55.50' W	4442.5	1	1
PS71/208-1	24.03.08	64° 17.84' S	46° 38.62' W	4392.2	1	1
PS71/209-1	25.03.08	64° 11.42' S	47° 31.81' W	4200.2	1	1
PS71/211-1	26.03.08	63° 54.58' S	48° 39.48' W	3725.0	1	1
PS71/212-1	26.03.08	63° 54.37' S	49° 4.69' W	3520.2	1	1
PS71/213-1	26.03.08	63° 53.45' S	49° 35.38' W	3304.2	1	1
PS71/214-1	27.03.08	63° 51.31' S	50° 0.28' W	2938.0	1	1
PS71/215-1	27.03.08	63° 46.68' S	50° 25.67' W	2660.2	1	1
PS71/216-5	28.03.08	63° 41.47' S	50° 50.39' W	2536.7	1	1
PS71/217-1	28.03.08	63° 42.09' S	51° 18.52' W	2255.5	1	1
PS71/218-1	28.03.08	63° 36.85' S	51° 40.05' W	1786.5	1	1
PS71/219-1	28.03.08	63° 32.70' S	51° 53.33' W	1230.0	1	1
PS71/220-2	28.03.08	63° 28.17' S	52° 6.35' W	939.5	1	0
PS71/221-1	28.03.08	63° 24.11' S	52° 32.23' W	514.5	1	0
PS71/222-1	29.03.08	63° 21.19' S	52° 51.24' W	444.5	1	1
PS71/223-1	29.03.08	63° 17.20' S	53° 13.97' W	431.0	1	1
PS71/224-1	31.03.08	62° 12.28' S	58° 56.04' W	90.5	1	1
PS71/225-1	01.04.08	60° 42.41' S	53° 36.97' W	1496.2	1	0
PS71/226-3	02.04.08	60° 37.63' S	53° 49.88' W	2777.2	1	1
PS71/227-1	02.04.08	60° 32.15' S	54° 5.65' W	2971.0	1	1
PS71/228-1	02.04.08	60° 26.44' S	54° 19.42' W	3185.0	1	1
PS71/229-1	02.04.08	60° 16.28' S	54° 47.76' W	3265.2	1	1

Station	Date	Lat	Lon	Depth [m]	LADCP Down	Up
PS71/231-2	03.04.08	59° 55.50' S	55° 44.52' W	3577.5	1	1
PS71/232-1	03.04.08	59° 45.59' S	56° 14.98' W	3629.2	1	1
PS71/233-2	04.04.08	59° 33.51' S	56° 40.24' W	3578.2	1	0
PS71/234-1	05.04.08	59° 21.48' S	57° 8.42' W	3556.5	1	1
PS71/235-1	05.04.08	59° 9.49' S	57° 37.99' W	3651.2	1	1
PS71/236-6	06.04.08	58° 59.99' S	58° 8.69' W	3790.2	1	0
PS71/237-1	06.04.08	58° 39.12' S	58° 47.30' W	3928.5	1	0
PS71/238-3	06.04.08	58° 17.02' S	59° 28.18' W	3543.0	1	0
PS71/239-1	07.04.08	58° 5.85' S	60° 0.16' W	4082.7	1	1
PS71/240-1	07.04.08	57° 52.39' S	60° 27.14' W	3898.2	1	1
PS71/241-1	07.04.08	57° 38.36' S	60° 53.81' W	3500.7	1	0
PS71/242-1	08.04.08	57° 30.13' S	61° 6.39' W	3911.2	1	0
PS71/243-1	08.04.08	57° 23.94' S	61° 24.32' W	3731.0	1	0
PS71/244-6	09.04.08	56° 51.50' S	62° 30.20' W	4146.2	1	1
PS71/246-1	10.04.08	57° 6.96' S	61° 58.54' W	3774.0	1	1
PS71/247-1	10.04.08	56° 39.70' S	62° 48.94' W	4065.0	1	1
PS71/248-1	10.04.08	56° 25.00' S	63° 18.63' W	3982.5	1	1
PS71/250-8	12.04.08	55° 43.96' S	64° 25.68' W	3822.2	1	1
PS71/251-1	12.04.08	55° 20.63' S	65° 9.19' W	1762.7	1	1
PS71/252-2	12.04.08	55° 7.49' S	65° 29.44' W	468.2	1	1
PS71/253-1	12.04.08	55° 13.66' S	65° 20.74' W	1061.2	1	1
PS71/254-1	13.04.08	55° 27.98' S	64° 56.91' W	2563.2	1	0
PS71/255-1	13.04.08	55° 35.35' S	64° 44.01' W	3619.0	1	0
PS71/256-1	13.04.08	55° 53.30' S	64° 15.31' W	3878.0	1	0
PS71/258-1	13.04.08	56° 0.24' S	64° 0.56' W	3987.7	1	**0**
				TOTAL	**106**	**73**
				ZERO	**39**	**20**
				Weddell	**36**	**34**
				DRAKE	**31**	**19**
					106	**73**

2.1.4 Moorings

Work at sea

In order to detect variations with sufficient time resolution to avoid the effect of aliasing and to be able to separate processes of a wide range of time scales quasi-continuous measurements from moored instruments are needed.

Recovery and deployment of moorings

Since the previous cruise ANT-XXII/3 moorings were maintained along two sections. The first are a set of 9 moorings on the Greenwich meridian. The other section crosses the Weddell Sea from Kapp Norvegia towards Joinville Island at the tip of the Antarctic Peninsula.

Greenwich meridian moorings

The moored observing system on the Greenwich meridian is maintained since 1996. Current meter moorings were exchanged in 1998, 1999, 2001, 2003 and 2005. But three moorings AWI229, AWI231 and AWI232 were already exchanged in 2006 because of the high sample rate of the ADCPs in these moorings. Some mooring positions were modified and additional ones were added during this period. During the present leg the moorings deployed in 2005 (Figs. 2.1b, 2.12 and Tab. 2.5) were recovered and a new reduced set was deployed (Figs. 2.1c, 2.14 and Tab. 2.6).

The two southernmost moorings covered the area of the coastal and slope current. West of Maud Rise there are three moorings equipped with temperature-conductivity recorders from approximately 250 to 750 meters depth to monitor the stratification in the transition from the Winter Water to the Warm Deep Water. These data should indicate the potential pre-conditioning for the occurrence of a polynya. Three of the northernmost moorings were not redeployed and the remaining northern mooring was continued with a near bottom CT recorder only. The southernmost mooring was not redeployed neither. The observations along the Greenwich meridian are concentrated on Maud Rise and the continuation of the sea ice thickness measurements with the Upward Looking Sonars (ULS) in combination with the ADCP.

Two sound sources were exchanged in moorings AWI229 and AWI231 to locate floats. Further details are given in 2.1.5.

Weddell Sea moorings

The first mooring section across the Weddell Sea began 1989 and was continued until 1995 and 1997 with one single mooring respectively. 2005 three of the longest continued mooring sites were deployed again in the same year (Figs. 2.1b, 2.13 and Tab. 2.7). The redeployed moorings AWI208 and AWI209 showed increasing temperature of the Weddell Sea Bottom Water (WSBW) in the central Weddell Sea. For this reason these mooring locations were continued. The instruments were focussed on the WSBW layer. Sea ice draft measurements with ULS were also continued at AWI208 and AWI207. Due to the weak currents in the centre of the Weddell gyre a RDI Longranger ADCP was installed in AWI208 at 300 m depth to support the estimates of the sea ice volume transport. All these moorings were equipped with sound sources at approximately 800 m depth – further details concerning the sound sources see section 2.1.6.

The volume transport of the WSBW which flows northward along the continental slope has been previously calculated from moored records. After the break off from the Larsen Ice Shelf in 2002 the calculation should be repeated since significant changes might have occurred. For this reason additional moorings were deployed in the out flowing branch of the Weddell gyre from 900 m depth down the continental slope. Locations of these moorings were selected at the same sites as previous moorings (Fig. 2.16 and 2.15, Tab. 2.8).

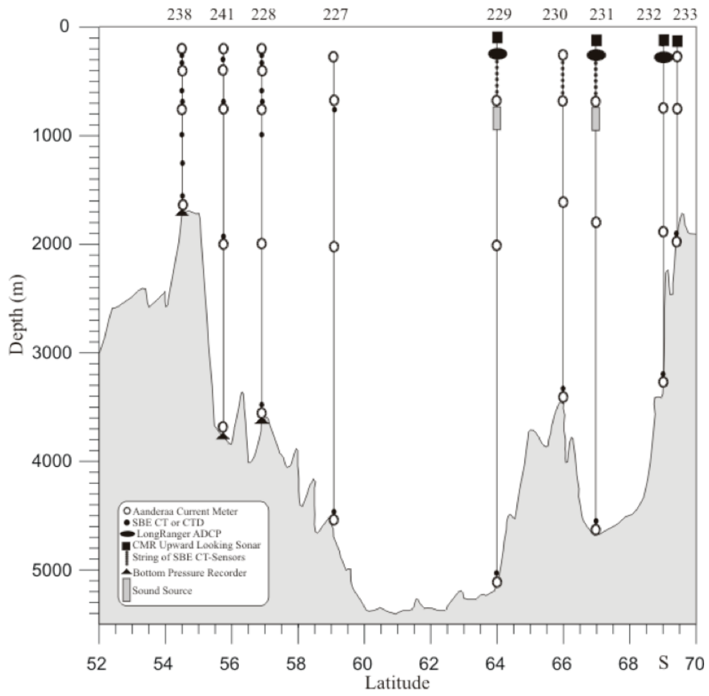

Fig. 2.12: Moorings recovered on the Greenwich meridian

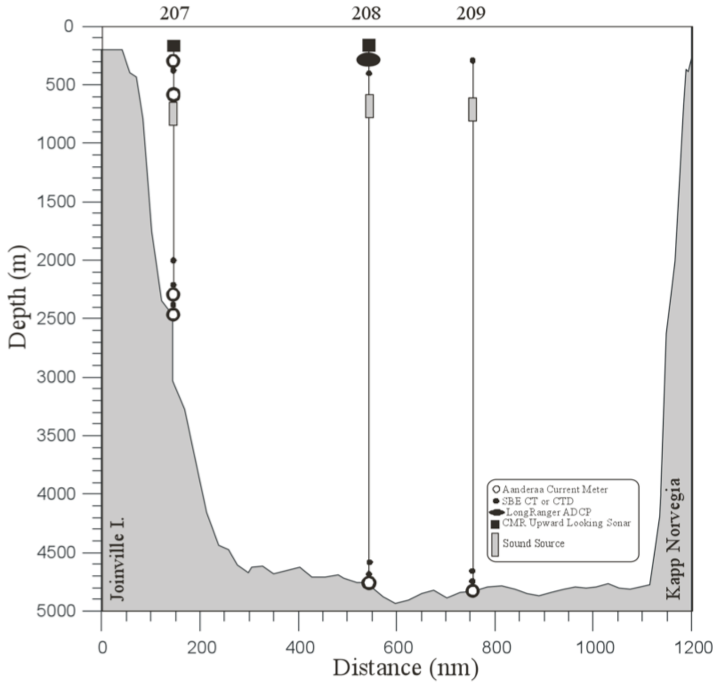

Fig. 2.13: Moorings recovered in the Weddell Sea

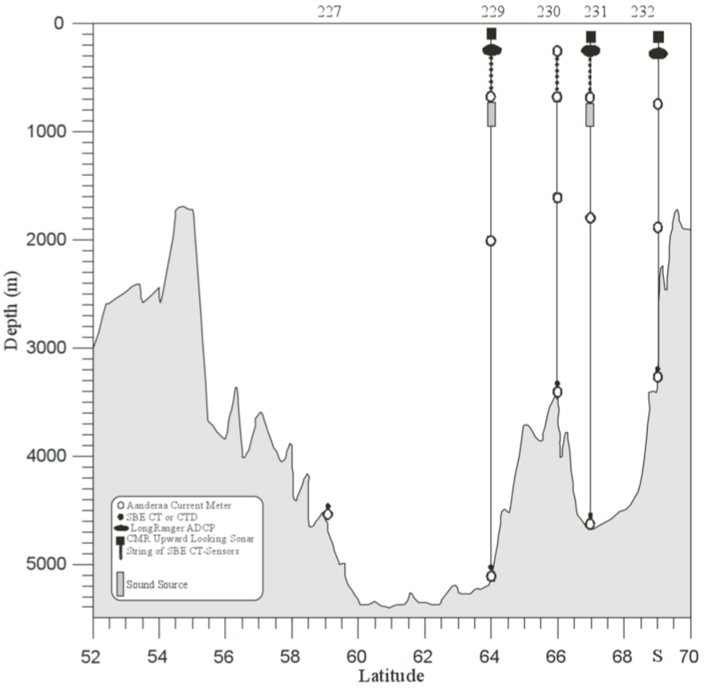

Fig. 2.14: Moorings deployed on the Greenwich meridian

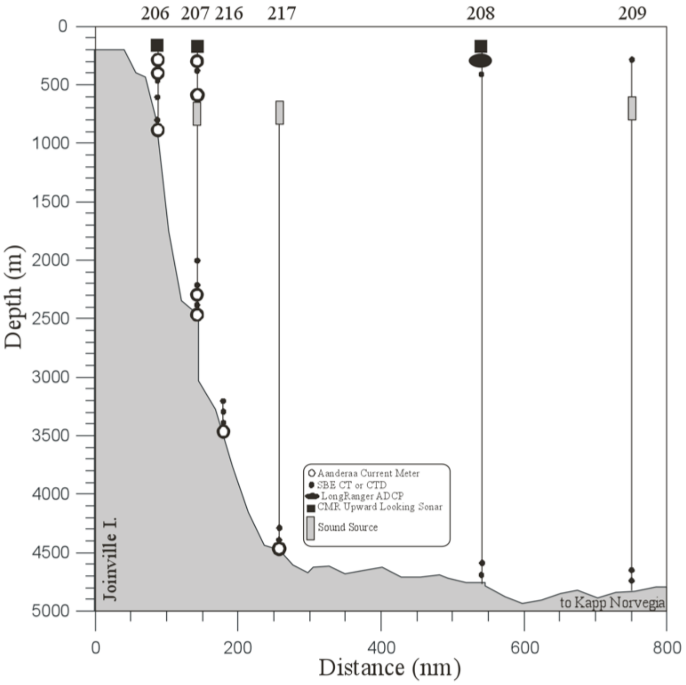

Fig. 2.15: Moorings deployed in the Weddell Sea

Tab. 2.5: Moorings recovered on the Greenwich meridian

Mooring	Latitude Longitude	Water Depth (m)	Date Time 1. Record last Record	Instrument Type	Serial Number	Instr. Depth (m)	Record Length (days)
AWI233-7	69° 23.60' S	1950	17.02.2005	ULS	46	150	(2)
	00° 04.29' W		22:00	AVTP	11890	202	1117(2)
			12.03.2008	RCM 11	100	699	1117
			06:00	POD	W402	1700	(1)
				SBE37	3810	1903	683
				RCM 11	146	1904	1117
AWI232-8	68° 59.75' S	3370	19.12.2005	ULS	50	125	(1)
	00° 00.16' W		20:00	ADCP		466	(1)
			11.03.2008	AVTP	10492	745	812
			04:00	AVT	6856	1804	812
				SBE37	211	3312	812
				AVT	9179	3313	812
AWI231-7	66° 30.67' S	4517	18.12.2005	ULS	41	119	(1)
	00° 01.90' W		13:00	SBE37	249	150	810
			07.03.2008	SBE37	2382	250	716
			14:00	ADCP	385	309	(1)
				SBE37	2383	350	699
				SBE37	2235	450	638
				SBE37	2385	550	707
				SBE37	2384	650	705
				AVTP	9212	675	810
				SQ	W2-c30	865	
				AVT	9184	1777	810
				SBE37	214	4472	810
				AVT	9194	4473	810
AWI230-5	66° 00.66' S	3450	08.02.2005	AVTP	9204	194	1123
	00° 11.28' E		21:00	SBE37P3	243	200	1123
			08.03.2008	SBE37	233	300	1123
			06:00	SBE37	232	400	1123
				SBE37	235	500	1123
				SBE37	236	600	(2)
				SBE37P3	2721	700	1123
				AVTP	9214	701	(2)
				POD	A401	1560	
				AVTP	9998	1597	1123
				SBE37	238	3403	1123
				RCM 11	25	3404	1123
AWI229-7	63° 57.17' S	5180	16.12.2005	ULS	49	146	(1)
	00° 00.17' W		16:00	SBE37	2611	190	441
			28.02.2008	SBE37	2386	290	733
			10:00	ADCP	5848	373	(1)
				SBE37	1605	390	679
				SBE37	2388	490	729
				SBE37	2389	590	702
				SBE37	1564	680	600
				AVTP	9997	684	803
				SQ	W1-c29	832	
				AVT	9185	1982	803
				SBE37	215	5135	803
				AVT	9187	5136	803

Mooring	Latitude Longitude	Water Depth (m)	Date Time 1. Record last Record	Instrument Type	Serial Number	Instr. Depth (m)	Record Length (days)
AWI227-9	59° 04.11' S	4627	04.02.2005	AVTP	10003	231	1115
	00° 04.92' E		20:00	AVTPC	10926	723	1115
			25.02.2008	SBE37PP10	1234	724	1113
			12:00	AVT	11937	2019	1115
				SBE37Pu	1603	4581	1113
				AVT	9767	4582	1115
AWI228-7	56° 57.56' S	3700	03.02.2005	AVTP	9763	191	1114
	00° 01.07' E		16:00	SBE37PuP3	1232	197	1114
			23.02.2008	SBE37	441	247	1114
			04:00	SBE37	442	297	1114
				SBE37PuP3	1233	347	1114
				AVTP	10539	401	1114
				SBE37	447	403	1114
				SBE37P3	247	582	1114
				AVTP	8037	747	1114
				SBE37PuP3	1230	749	1114
				SBE37	444	998	1114
				SBE37	440	1247	1114
				RCM 11	214	2003	1114
				RCM 11	26	3654	1114
				SBE37Pu	1607	3656	1114
				SBE26	257	3700	(1)
AWI241-1	55° 31.94' S	3810	02.02.2005	AVTPC	9200	212	11(2)
	00° 00.05' W		16 :00	SBE37P3	246	317	1114
			22.02.2008	AVTP	9785	424	1114
			06:00	AVT	10532	770	1114
				SBE16P3	245	772	1114
				RCM 11	216	2017	1114
				SBE37	269	2000	(2)
				RCM 11	219	3744	1114
				SBE26	228	3810	(1)
AWI238-5	54° 30.76' S	1700	01.02.2005	AVTP	10541	201	1114
	00° 01.39' E		20:00	SBE16PuP3	1235	208	1114
			21.02.2008	SBE37P3	244	257	1114
			12 :00	SBE37	218	306	1114
				SBE37PP35	2719	356	1114
				AVTP	9211	402	1114
				SBE37PP35	2720	403	1114
				SBE37	225	573	1114
				AVTP	7727	748	1114
				SBE37PP35	2722	750	1114
				SBE37PP35	2723	1000	1114
				SBE37	437	1250	1114
				RCM 11	215	1644	1114
				SBE37PP35	3811	1646	1114
				SBE26	227	1700	(1)

Tab. 2.6: Moorings deployed on the Greenwich meridian

Mooring	Latitude Longitude	Water Depth (m)	Date Time 1. Record	Instrument Type	Serial Number	Instrument Depth (m)
AWI232-9	68° 59.74' S	3419	11.03.2008	ULS	57	150
	00° 00.17' E		14:00	AURAL	085	216
				ADCP	6240	450
				AVT	9782	750
				RCM 11	144	1800
				SBE37	2086	3300
				RCM 11	486	3300
AWI231-8	66° 30.68' S	4546	07.03.2008	ULS	56	150
	00° 01.81' W		22:00	SBE37	1236	200
				SBE37	449	300
				SBE37	2088	400
				ADCP	825	450
				SBE37	2089	500
				SBE37	2090	600
				SBE37Pu	1237	700
				AVTP	10928	700
				SQ	30	850
				AVT	9180	1800
				SBE37	237	4500
				AVT	9186	4500
AWI230-6	66° 01.13' S	3577	08.03.2008	AURAL	086	200
	00° 04.77' E		14:00	AVTP	3517	200
				SBE37Pu	1229	200
				SBE37	2091	300
				SBE37	2092	400
				SBE37	2093	500
				SBE37	2094	600
				SBE37Pu	2237	700
				RCM 11	295	700
				AVTP	9188	1600
				SBE37	2099	3400
				RCM 11	504	3400
AWI229-8	63° 58.03' S	5195	28.02.2008	ULS	64	150
	00° 003.10' W		18:00	SBE 37	2098	200
				SBE37	2096	300
				ADCP	5373	350
				SBE16	2416	400
				SBE37	2099	500
				SBE37	2100	600
				SBE37Pu	2396	700
				AVTP	10925	704
				SQ	29	850
				AVT	9390	2000
				SBE37	2101	5150
				AVT	10499	5150
AWI227-10	59° 04.10'S	4630	25.02.2008	SBE37P10	1565	4580
	00° 04.88' W		14:00			

Tab. 2.7: Moorings recovered along transect from Kapp Norvegia towards Joinville Island

Mooring	Latitude Longitude	Water Depth (m)	Date Time 1. Record last Record	Instrument Type	Serial Number	Instr. Depth (m)	Record Length (days)
AWI209-4	66° 37.08' S	4860	01.03.2005	SBE37	3814	282	675
	27° 06.29' W		12:00	SQ	W4	1840	
			18.03.2008	SBE16	319	4799	1113
			12:00	SBE37	226	4848	1113
				RCM 11	101	4849	1113
AWI208-4	65° 37.14' S	4740	05.03.2005	ULS	42	154	(1)
	36° 23.53' W		21:00	ADCP	5691	291	(1)
			21.03.2008	SBE37	241	296	1111
			08:00	SQ	W5/19	2014	
				SBE37	228	4678	1111
				SBE37	1606	4728	1111
				AVT	9182	4729	1111
AWI207-6	63° 42.20' S	2500	14.03.2005	ULS	36	148	(1)
	50° 52.22' W		04:00	AVTP	9193	246	(2)
			27.03.2008	SBE37	3812	248	681
			14:00	AVT	10929	757	1109
				POD	C403	1457	(1)
				SQ	W6/17	2000	
				SBE37	239	2099	1109
				SBE37	3813	2297	688
				AVT	10497	2303	1109
				SBE37	2097	2488	1109
				AVT	10496	2489	1109

Tab. 2.8: Moorings deployed along transect from Kapp Norvegia towards Joinville Island

Mooring	Latitude Longitude	Water Depth (m)	Date Time 1. Record	Instrument Type	Serial Number	Instrument Depth (m)
AWI244-1	68° 59.70' S	2927	13.03.2008	SQ	23	850
	06° 56.70' W		16:00			
AWI245-1	69° 03.68' S	4466	15.03.2008	SQ	24	850
	17° 25.89' W		16:00			
AWI209-5	66° 36.89' S	4864	18.03.2008	SBE 16	2415	300
	27° 07.08' W		20:00	SQ	34	800
				SBE37P	220	4800
				SBE37	230	4850
AWI208-5	65° 36.85' S	4770	21.03.2008	ULS	62	150
	36° 24.43' W		16:00	ADCP	3813	300
				SBE16	1979	300
				SBE37	435	4680
				SBE37	2234	4730
AWI217-3	64° 23.63' S	4456	24.03.2008	SQ	32	850
	45° 52.38' W		14:00	SBE37	250	4150
				SBE37	240	4350
				RCM 11	296	4351

Mooring	Latitude Longitude	Water Depth (m)	Date Time 1. Record	Instrument Type	Serial Number	Instrument Depth (m)
AWI216-3	63° 54.03' S	3516	26.03.2008	SBE37	2392	3350
	49° 04.68' W		16:00	SBE37	2393	3400
				SBE37	439	3450
				RCM 11	298	3451
AWI207-7	63° 42.74' S	2500	27.03.2008	ULS	60	150
	50° 50.55' W		20:00	AVTP	10872	250
				SBE 16	2414	251
				AVT	10503	750
				SQ	36	850
				SBE37	2610	2100
				SBE37	2297	2200
				AVT	10530	2300
				SBE37	436	2490
				RCM 11	619	2490
AWI206-6	63° 28.77' S	950		ULS	61	150
	52° 05.77' W			AVTP	9206	250
				SBE37	1228	500
				AVT	9201	501
				SBE16	2422	700
				SBE37	438	900
				RCM 11	508	901

Abbreviations:

ADCP	RD-Instruments, Self Contained Acoustic Doppler Current Profiler
AURAL	AURAL-Underwater Acoustic Recorder
AVTCP	Aanderaa Current Meter with Temperature-, Conductivity- and Pressure Sensor
AVTP	Aanderaa Current Meter with Temperature- and Pressure Sensor
AVT	Aanderaa Current Meter with Temperature Sensor
RCM 11	Aanderaa Doppler Current Meter
SBE16	SeaBird Electronics Self Recording CTD to measure Temperature, Conductivity and Pressure
ULS	Upward looking sonar from Christian Michelsen Research Inc. to measure the ice draft
SBE37	SeaBird Electronics, Type: MicroCat, to measure Temperature and Conductivity
SQ	Sound Source for SOFAR-Drifter

Remarks:
Blank field: passive instrument with not data recording
(1) Data recorded but not processed
(2) Complete or partly missing data due to instrument failure

Location and recovering of moored instruments

Since ANT-XX/2 (2002) POSIDONIA has been proved as a reliable system to locate transponders or acoustic releases in moorings. POSIDONIA is an ultra short base line positioning system manufactured by iXSEA (France). The POSIDONIA signals can be detected even under unfavourable conditions, e.g. the high background noise created by *Polarstern* itself. Another advantage is the POSIDONIA transducer array which is installed in the moon pool. There the commands are transmitted from a fixed and stable platform resulting in a longer distance over which the signal can be received by the releaser because a handheld transducer lowered over the side vibrates while it is dragged through the water. It was observed that a mooring could not be released with the handheld transducer if the slant range is larger than 4,000 m while the same mooring was released with one single release ping only being sent via the POSIDONIA transponder array. During this cruise POSIDONIA was only able to display the relative target position because of a failure in the main electronic unit.

Under good weather and sea ice conditions 11 of 12 moorings were recovered without any serious difficulties. The first try to recover the southernmost mooring AWI233-7 at the Greenwich section failed. One of the double releasers and an additional transponder in the mooring top were equipped with POSIDONIA-option but both could not be located while *Polarstern* was exactly at the estimated mooring position. Therefore the handheld transducer and the standard deck unit TT301 were used to interrogate the second releaser. This operation failed also. Several release commands were sent with POSIDONIA and TT301. An intensive search occurred from the bridge and with the helicopter downstream according to the observed sea ice drift. After 8 hours of searching the mooring was assumed as lost and *Polarstern* took course to the next working area.

All moorings were equipped with an ARGOS satellite transmitter which is supposed to send the position if a mooring would surface unplanned. These messages were automatically checked by OPTIMARE and forwarded by email. By this we were informed that the ARGOS transmitter with the ID 10574 which was installed in AWI233-7 has sent one reliable position message. The position was about 9 km downstream off the deployed mooring location. Two additional locations obtained from OPTIMARE confirmed the position given in the email and indicated a slow westward drift. The time of the first message received by ARGOS agreed with the time when the release commands have been sent.

Polarstern returned to the mooring guided by the helicopter in a field of ice floes. Later the direction-finder detected the ARGOS signal too. Finally AWI233-7 was recovered completely. The upper instruments and the mooring rope showed clearly the trace left by an iceberg. The rotor of the upper current meter was lost and the antenna of the ARGOS transmitter was pushed down through the fitting clamps. Therefore the antenna could not be stick out sufficiently of the water and only the satellite could receive the signal from above. The mooring had been hit and dragged off by an iceberg over a distance of more than 9 km and the release command was successfully received over a distance of about 10 km.

Altogether the 12 moorings were equipped with 119 instruments. Five of them were sound sources. The instruments were recovered in good conditions. The data from 105 data memories were transferred to PC. The data processing occurred for 91 instruments on board. The processing of the remaining 14 data records from ULS, Bottom Pressure Recorder and ADCP could not finished on board but the data seemed to be in good condition. Six instruments failed which results in a data recovery rate of 94 %.

It was the first time moorings were deployed for a period of three years. Tab. 2.5 and 2.7 indicate that most of the instruments have measured and stored during the complete mooring period. While all Aanderaa current meter contained the full data rate the Seabird SBE37 have recorded approximately 80 % only. This is surprising because it happened for the moorings which have been exchanged in 2006 already. In the past SBE37 were working correctly for a period of two years with the same sampling setup. Therefore a bad quality of the batteries is the most probable reason. Another problem was related with SBE37 instruments with SN38##. These instruments are a new design which have internal pumps in contrast to the former ones with external pumps. Probably the internal pump needs more power. In future SBE37 sample rates should be 60 minutes for old and new design.

2.1.5 Argo in the Southern Ocean

Objectives

The international Argo project maintains in the order of 3,000 profiling floats distributed throughout the world ocean, to establish a real-time operational data stream of mid- and upper (< 2,000 m) ocean temperature and salinity profiles. In addition, the array provides the mid-depth oceanic circulation pattern. During the past years, AWI achieved technological developments to extend the operational range of Argo floats into seasonally ice-covered regions. To this end and with additional support by the EU project MERSEA and the BMBF Project German Argo, the NEMO float (Navigating European Marine Observer) was developed and tested, which is now fully operational (Klatt et al., 2007). NEMO floats are equipped with ISA-2, an ice-sensing algorithm which triggers the abort of a floats' ascent to the sea surface, when the presence of sea ice is likely as determined from the existence of a layer of near surface winter water. To nevertheless be able to (retrospectively) track the floats that actively remained under the sea ice, acoustic tracking via RAFOS (Rossby et al., 1986) (Ranging And Fixing Of Sound) is used. All NEMO floats are equipped with RAFOS-receivers and an array of 10 moored sound sources has been installed.

Work at sea

Deployment of Argo floats

During ANT-XXIV/3 a total of 15 NEMO floats (Navigating European Marine Observer, produced by OPTIMARE, Germany) and one refurbished APEX float (produced by Webb Research Corporation, USA) were deployed in the Weddell Sea. In addition, 38 APEX floats – also equipped with RAFOS and ISA - provided by Steve Riser, University of Washington (UW), were deployed. The instruments were launched at quasi-regular intervals along the Greenwich meridian and within the central and western part of the Weddell Sea proper, with preference given to undersampled regions and boundary currents (Fig. 2.16, Tab. 2.9 and 2.10). All of the float launches were preceded by a CTD cast.

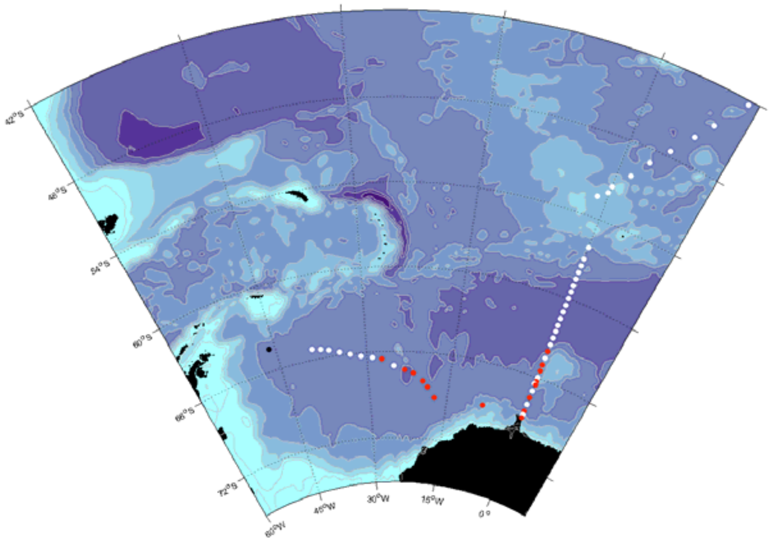

Fig. 2.16: Deployment positions of Argo floats. (White dots – APEX floats (University of Washington), red dots – NEMO floats (AWI), black dot – APEX float (AWI))

All APEX floats (UW and AWI) are equipped with RAFOS Navigation System and with Ice Sensing Algorithm (ISA; abort-temperature -1.79°C). The AWI APEX and nine of the UW floats using the ARGOS system for communication (marked with an A in Tab. 2.9), the remaining 29 UW are capable of using IRIDIUM. The UW (AWI) floats were ballasted to drift at a depth of 1,000 m (800 m) and will acquire profiles from 2,000 m to the surface.

Tab. 2.9: University of Washington APEX float launch positions and times. All floats (excluding the first) are equipped with Aanderaa optodes for oxygen measurements.

Float Serial Number	Station [PS71/]	Latitude	Longitude	Date (UTC)	Time (UTC)	Depth [m]
A 0051	101-6	42° 20.74' S	8° 59.73' E	14.02.08	03:42	4576
A 5171	102-1	44° 39.64' S	7° 05.43' E	15.02.08	11:05	4614
A 5285	103-2	45° 59.86' S	5° 52.86' E	16.02.08	04:05	3322
A 5287	104-10	47° 38.44' S	4° 16.56' E	17.02.08	14:41	4548
A 5281	106-2	48° 54.72' S	2° 47.90' E	18.02.08	06:30	4094
A 5283	107-4	50° 16.98' S	1° 27.98' E	18.02.08	22:39	3804
A 5282	108-4	51° 29.97' S	0° 00.02' W	19.02.08	11:52	2784
A 5280	110-2	51° 56.75' S	0° 00.84' E	19.02.08	17:45	2858
A 5288	112-3	52° 30.23' S	1° 23.75' W	20.02.08	03:28	2799
5326	122-2	56° 00.65' S	0° 00.96' E	22.02.08	16:50	3495
5327	125-3	56° 58.03' S	0° 01.02' E	23.02.08	08:33	3774
5323	127-2	57° 29.90' S	0° 01.20' E	23.02.08	14:45	4059
5313	128-2	58° 00.49' S	0° 00.12' W	23.02.08	23:07	4528
5318	130-2	58° 29.92' S	0° 00.09' W	24.02.08	07:36	4187
5307	132-4	59° 04.30' S	0° 05.60' E	25.02.08	14:04	4662
5302	134-2	59° 31.00' S	0° 02.03' E	25.02.08	20:49	4780
5320	135-2	60° 00.46' S	0° 00.21' W	26.02.08	04:19	5344
5321	137-2	60° 29.93' S	0° 00.04' W	26.02.08	11:18	5355
5308	138-2	61° 00.13' S	0° 00.48' E	26.02.08	18:47	5379
5298	140-2	61° 29.88' S	0° 00.48' W	27.02.08	01:43	5377
5325	141-3	61° 59.97' S	0° 00.03' E	27.02.08	09:27	5358
5324	143-3	62° 30,58' S	0° 00,54' W	27.02.08	17:31	5337
5301	144-2	63° 00,06' S	0° 00,28' E	28.02.08	00:34	5302
5295	146-2	63° 29,97' S	0° 00,20' E	28.02.08	07:40	5236
5331	149-2	64° 30.10' S	0° 00.12' E	29.02.08	04:35	4659
5303	157-6	66° 28.31' S	0° 01.73' W	08.03.08	00:45	4493
5310	159-5	66° 01.43' S	0° 07.81' E	08.03.08	15:10	3549
5300	163-2	67° 00.03' S	0° 00.11' E	09.03.08	17:09	4702
5329	167-3	68° 00.00' S	0° 00.06' W	10.03.08	07:30	4506
5330	171-2	68° 45.11' S	0° 00.09' E	10.03.08	18:27	3622
5317	192-2	66° 56.75' S	25° 17.07' W	17.03.08	22:03	4852
5316	194-2	66° 24.79' S	29° 1.05' W	19.03.08	20:39	4827
5304	195-2	66° 13.03' S	30° 55.86' W	20.03.08	04:49	4810
5311	196-2	66° 0.48' S	32° 46.68' W	20.03.08	12:55	4789
5305	197-2	65° 48,54' S	34° 37,55' W	20.03.08	21:01	4787
5306	198-6	65° 36,63' S	36° 22,87' W	21.03.08	14:51	4770
5299	199-2	65° 27.20' S	37° 42.44' W	21.03.08	21:47	4731
5309	200-2	65° 16.92' S	39° 1.09' W	22.03.08	04:05	4766

All NEMO floats are equipped with RAFOS Navigation System, an adjustable Ice Sensing Algorithm (ISA-2), set to -1.79°C with a ‘retarded‘ response: Once activated, ISA-2 will need to detect ‘surfacing conditions‘ (i.e. the lack of ‘abort conditions‘) for two consecutive ascent cycles, before giving the float permission to completely ascend to the surface on the second cycle. An interim data storage (iStore) stores any profiles that could not be transmitted in real time due to ISA aborts and transmits these profiles during ice-free condition. The floats were ballasted to drift at a drift depth of 800 m and will acquire profiles from 2,000 m to the surface.

Tab. 2.10: AWI float launch positions and times. All floats were equipped with Ice Sensing Algorithm ISA-2, set to -1.79°C. Floats #120 – 134 are NEMO floats, float #135 is an APEX float.

AWI – number	Float Serial Nr.	ARGOS-DEC	WMO-Number	Station [PS71/]	Latitude [S]	Longitude	Date (UTC)	Time (UTC)	Water depth [m]
120	55	10120	7900232	147-4	63° 58.04'	00° 02.44' W	28.02.08	21:33	5196
121	49	08064	7900226	150-3	64° 59.99'	00° 00.01' E	29.02.08	11:00	3726
122	46	29223	7900224	152-3	65° 29.97'	00° 00.36' E	29.02.08	17:22	3972
123	25	27983	7900218	158-2	66° 14.72'	00° 01.22' W	08.03.08	04:39	3684
124	50	08067	7900227	161-7	66° 30.07'	00° 00.01' E	09.03.08	10:27	4546
125	54	09728	7900231	165-2	67° 30.03'	00° 00.10' E	10.03.08	00:18	4625
126	40	08060	7900223	169-2	68° 30.05'	00° 00.14' E	10.03.08	13:56	4256
127	36	28037	7900222	175-5	68° 59.82'	00° 00.14' E	11.03.08	13:29	3413
128	27	27985	7900219	184-3	68° 59.59'	06° 56.73' W	13.03.08	14:29	2924
129	58	08058	7900234	186-4	69° 03.80'	17° 26.53' W	15.03.08	15:24	4766
130	51	09354	7900228	188-2	68° 23.55'	19° 04.26' W	16.03.08	08:48	4827
131	31	28013	7900221	189-2	67° 56.47'	19° 59.98' W	16.03.08	17:53	4905
132	52	09355	7900229	190-2	67° 35.84'	21° 47.97' W	17.03.08	03:13	4904
133	56	10454	7900233	191-4	67° 18.96'	23° 38.27' W	17.03.08	14:10	4874
134	53	09363	7900230	193-12	66° 34.66'	27° 25.22' W	19.03.08	13:28	4861
135	2552	9356	7900235	207-4	64° 23.06'	45° 55.58' W	24.03.08	16:13	4442

2.1.6 Installation of RAFOS Sound sources

During this cruise, 5 sound sources were recovered and 7 sound sources deployed (Fig. 2.17, Tab. 2.11 and 2.12).

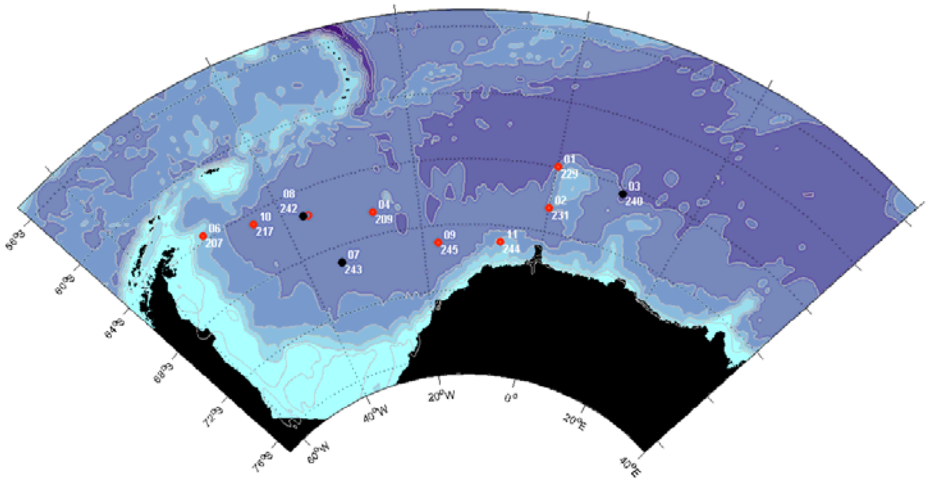

Fig. 2.17: Current state of the Weddell Sea RAFOS array. Red dots depict positions where sound sources were deployed or redeployed during ANT-XXIV/3. The black dots represent positions of sound sources deployed during earlier cruises.

At locations W1 and W2, the recovered sources were immediately redeployed after a battery and clock check and the exchange of shackles and chains. At locations W4 and W6 the recovered sound sources (tuned to a deployment depth of 2,000 m) have been replaced by two new sources (tuned to a deployment depth of 800 m). Sound source W5 was flooded and has not been replaced. Finally, on three locations (W9, W10, and W11) sound sources have been deployed for the first time.

Tab. 2.11: Sound sources recovered

[1] Note that for R29 and R30 the sources internal software attempts to compensate for the noted clock drift by adjusting the pong schedule. To be able to determine the effective drift of the pongs, this adjustment needs to be accounted for. The necessary information can only be retrieved after the next recovery of the sources by reading the operations log file as stored on board the source. Note the difference between GPS and UTC times.

site / mooring pong time	position water depth recovery date	sound source status
W1c / 229 00:30 GPS	63° 57.17'S 00° 00.17'W 5180 m 28 Feb 2008 12:07 UTC	R29 @ 832 m; piggy-back, aluminum resonator RTC 12:28:16 @ GPS 12:35:00 → 392s late[1] general status at recovery: ok Vbat-2 = 8.56 Vdc High Voltage = 19.24 Vdc Internal Pressure = 203.48 hPa
W2c / 231 01:00 GPS	66° 30.67'S 00° 01.90'W 4517 m 07 Mar 2008 16:50 UTC	R30 @ 865 m; piggy-back, aluminum resonator RTC 17:04:34 @ GPS 17:08:00 → 206s late[1] general status at recovery: ok Vbat-2 = 8.57 Vdc High Voltage = 19.67 Vdc Internal Pressure = 294.60 hPa
W4a / 209 01:30	66° 37.08'S 27° 06.29'W 4860 m 18 Mar 2008 16:09 UTC	R16 @ 1840 m; in-line design, steel resonator status: flooded Vbat-2 = - High Voltage = - Internal Pressure = -
W5a / 208 00:30	65° 37.14'S 36° 23.53'W 4740 m 21 Mar 2008 08:20 UTC	R19 @ 2014 m; in-line design, steel resonator RTC 10:59:24 @ GPS 10:57:00 →144s early general status at recovery: dry, CPU ok, no pongs Vbat-2 = 7.7 (with Voltmeter, 1? puck) High Voltage = 3.7 (with Voltmeter, 5 pucks) Internal Pressure = ok, but no pressure gauge
W6a / 207 01:00	63° 42.20'S 50° 52.22'E 2500 pending Pending	R17 @ 2000m; in-line design, steel resonator RTC: pending general status at recovery: pending Vbat-2 = pending High Voltage = pending Internal Pressure = pending

Tab. 2.12: Sound source moorings of ANT-XXIV/3. Sound source depths are nominal depths according to preliminary mooring protocols. Note the difference between GPS and UTC times.

site / mooring pong time	position water depth deployment date	sound source status
W1d / 229 00:30 GPS	63° 58.03'S 00° 03.10'W 5170 m 28-02-2008 17:31	R 29 @ 820 m; piggy-back design, aluminum resonator t offset = 0s Vbat-2 = 8.56 Vdc High Voltage = 19.24 Vdc Internal Pressure = 203.48 hPa
W2d / 231 01:00 GPS	66° 30.68'S 00° 01.81'W 4517 m 07-03-2008 21:24	R 30 @ 869 m; piggy-back design, aluminum resonator Vbat-2 = 8.57 Vdc High Voltage = 19.67 Vdc Internal Pressure = 294.60 hPa
W11a / 244 00:40 GPS	68° 59.70'S 06° 56.70'W 2927m 13-03-2008 14:14	W 23 @ 790 m; piggy-back design, aluminum resonator Bat=+00439dV Vac=+00044
W9a / 245 01:10 GPS	69° 03.68'S 17° 25.89'W 4766 m 15-03-2008 14:49	W 24 @ 800m; piggy-back design, aluminum resonator Bat=+00441dV Vac=+00041
W4b / 209 01:30 GPS	66° 36.89S 27° 07.08'W 4860 m 18-03-2008, 19:48	R 34 @ 837 m; piggy-back design, aluminum resonator Vbat-2 = 8.11 Vdc High Voltage = 20.39 Vdc Internal Pressure = 661.86 hPa
W10 / 217 00:40 GPS	64° 23.36'S 45° 52.38'W 4400 m 24-03-2008 12:37	R 32 @ 836 m; piggy-back design, aluminum resonator Vbat-2 = 8.49 Vdc High Voltage = 27.49 Vdc Internal Pressure: 991.15 hPa (sensor faulty, manual vacuum check ok.)
W6 / 207 01:00 GPS	63° 45.10'S 50° 54.30'E 2500 m depl. pending	R 36 @ 857 m (as planned) with electronics R 19 Vbat-2 = 8.98 Vdc (as measured by #36) High Voltage = 20.55 Vdc (as measured by #36) Internal Pressure = no sensor. (Manual vacuum check ok)

Preliminary and expected results

The deployment 54 ARGOS floats into the Weddell Gyre increases significantly the number of active floats from 32 to 86. Thus, for the first time the requirements of the Argo project (floats spaced every 3°) are met (Fig. 2.18).

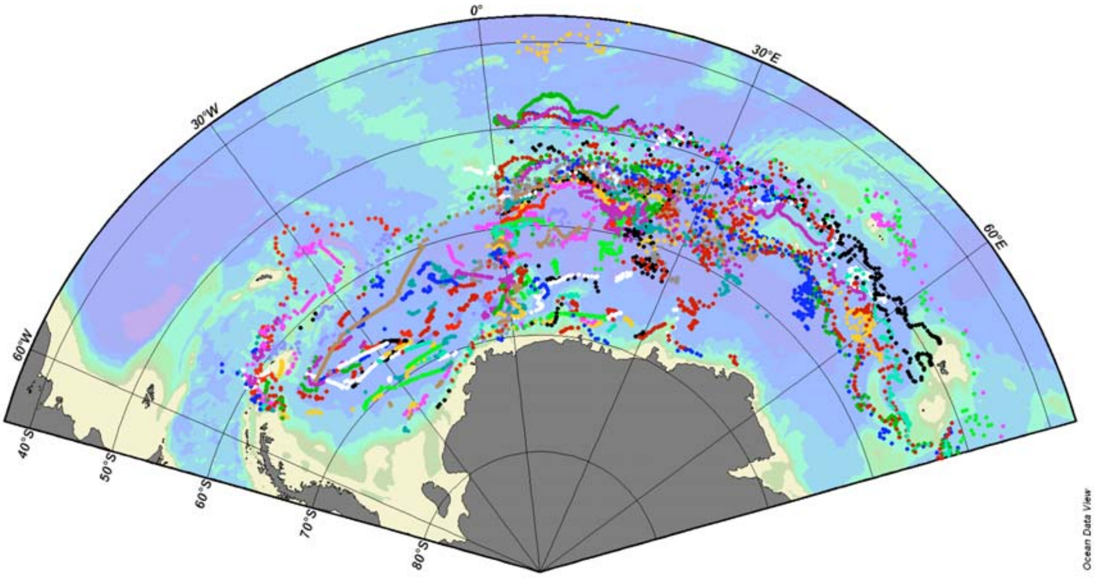

Fig. 2.18: Current distribution of Argo floats in the area of the Weddell gyre

References

Klatt, O., Olaf Boebel, and E. Fahrbach, 2007: A profiling float's sense of ice. *Journal of Atmospheric and Oceanic Technology*, **24,** 1301-1308. DOI: 10.1175/JTECH2026.1

Rossby, T., D. Dorson, and J. Fontaine, 1986: The RAFOS-System. *Journal of Atmospheric and Oceanic Technology*, **3,** 672-679.

2.1.7 Iceberg tracking

To estimate the fresh water transport by icebergs, satellite tracked transmitters were deployed since cruise ANT-XVI/2 as iceberg markers. The project was supposed to end with a last deployment during cruise ANT-XXII/2 but one remaining transmitter was deployed during this cruise.

The marker determines its position once per day at noon with a GPS receiver. The positions are transmitted via satellite using the ARGOS system. The ARGOS transmitter is switched on for 6 hours once a week, to send the positions from the past seven days. The transmitter's on-time lasts long enough to ensure that all data can be received by CLS in Toulouse, France. This weekly transmission mode was chosen to save CLS service costs. The iceberg markers are designed to operate for up to two years. Due to environmental aspects, the housing is slightly enlarged compared to previous versions. Thus the new markers have positive buoyancy. Markers from melted icebergs are likely to leave the Antarctic Ocean by drifting northwards and being entrained into the Antarctic Circumpolar Current. Tilt sensors are installed to detect when an iceberg begins to capsize. The ARGOS transmitter will switch into a continuous mode as soon as the tilt exceeds a fixed limit.

The markers were deployed on icebergs by helicopter. A digital photograph was taken to describe the shape of the iceberg. The length and width was measured with the GPS, flying along and across the iceberg. The height above sea level is taken from the radar altimeter of the helicopter. Tab. 2.13 gives of the marked iceberg.

OPTIMARE, Bremerhaven, is assigned to collect the data from CLS via direct computer link and to process and validate the data.

Tab. 2.13: Deployment of iceberg tracking ARGOS transmitter

Transmitter				*Iceberg*		
ARGOS ID	*Date*	*Time (UTC)*	*Latitude* *Longitude*	*length (m)*	*width (m)*	*Free board (m)*
9802	24.3.08	13:00	64° 32.4’ S 45° 47.6’ W	500	330	30

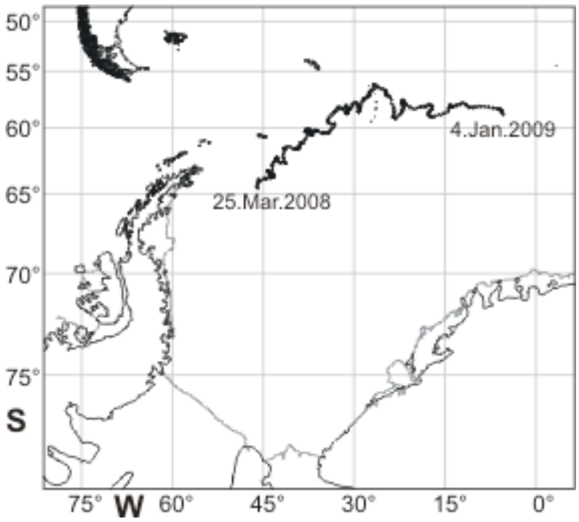

Fig. 2.19: Track of the iceberg with marker Id 9802

2.1.8 Sea ice observations

Sea ice observations were conducted on an hourly basis by the CTD watch from the bridge of *Polarstern* from 2 March to 29 March 2008 during daylight conditions (ca. from 05:00 to 21:00 UTC) when the ship was steaming. They are a contribution to the Antarctic Sea Ice Processes and Climate (ASPeCt) programme, which aims at an improved understanding of the role of Antarctic sea ice in the global climate system.

The sea ice thickness data collected in this framework form the only circumpolar ice thickness dataset available for the Southern Ocean and have been used for model validation studies. According to the ASPeCt protocol, total ice concentration, and the thickness, concentration and morphology (ridge height, areal fraction of ridged ice, floe size; snow thickness) of the three dominant ice types within a 1 km radius from the ship were recorded while the ship moved through the pack ice. The observations were complemented by records of sea surface temperature, near-surface air temperature, wind speed and direction, and total cloud cover. All together 236 observations were carried out, at 167 of them ice was encountered. All data collected were sent to the ASPeCt database immediately after the cruise.

As the cruise was conducted in austral summer, during the time of minimum ice extent, rather little sea ice was encountered. On our way to Neumayer Station no significant ice cover was encountered until we reached the coast.

However, the sea ice conditions in the Weddell Sea were extreme. Over the summer two large ice tongues stretched from the southern to the northeastern and the northwestern Weddell Sea (Fig. 2.20). This wider than normal ice extent is consistent with a trend visible in the time series of NSIDC derived from satellite images of increasing sea ice extent in summer during the last decades. However, this does not mean a real increase but only a weaker melting in summer because the winter sea extent remained basically constant.

It is of special interest, that the evaluation of satellite data by NSIDC indicated clearly that the Antarctic summer 2007/2008 was the one with the largest ice extent on record. This trend which is particularly strong in the Atlantic sector of the Southern Ocean is in clear contrast to the Arctic where a strong decrease of the summer ice extend is observed. To understand the opposing trends in the Antarctic and the Arctic is an obvious aim of our cruise.

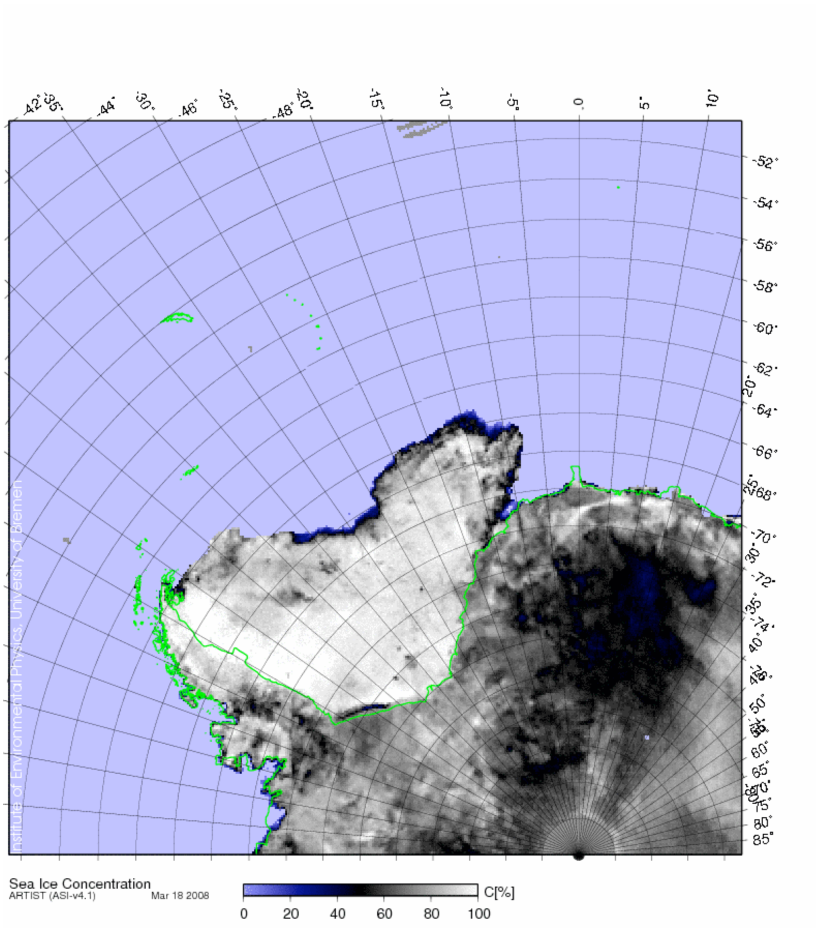

Fig. 2.20: Regional sea ice distribution in the Weddell Sea on 18 March 2008 (www.seaice.de)

2.2 Transport variations of the Antarctic Circumpolar Current

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Objectives

Pressure Inverted Echo Sounders (PIES) deliver bottom pressure, bottom temperature and travel times of sound signals from the bottom to the sea surface, effectively providing a measure of average temperatures, bottom temperature and pressure variations and sea surface height.

PIES data are used to extract transport variations of the ACC as part of the AWI programme to observe the decadal variability of the Antarctic Circumpolar Current (ACC). PIES are placed along the GoodHope section between South Africa and Antarctica, which in large parts coincides with satellite ground track # 133 of the Jason (previously TOPEX/Poseidon) satellite mission to allow direct comparison with altimetry data. PIES to PIES distances are selected to allow resolution of the major oceanic fronts of this region.

In addition, the same PIES data is used in the context of the GRACE satellite mission (Gravity Recovery And Climate Experiment), to validate monthly mean ocean bottom pressure anomalies as derived from the GRACE geoid variations. As the typical length scale inherent to GRACE data is about 1,000 km, the broad spatial coverage of the GoodHope PIES array (spanning nearly 2,000 km) is well suited to determine the accuracy of the GRACE measurements in this region. Additional PIES complement the array to the northwest.

Work at sea

Several of the PIES deployed from *Polarstern* in 2005/6 required an exchange in 2008 to prevent the loss of the instruments due to a hardware error which was discovered only after the instruments' deployment and which would lead to early battery depletion. While 6 positions of the GoodHope and Grace PIES arrays were served by *Polarstern*, the 3 remaining sites were covered by the *G.O. Sars* during the 2007/8 AKES cruise.

Tab. 2.14: PIES recovery. Clock offsets are positive if early with regard to UTC/GMT. *) PIES release/checkout from helicopter

mooring	station book (rel.)	PIES Sn.	start date & time [UTC]	launch date & time [UTC]	launch lat & lon	release date & time [GPS]	surface date & time [GPS]	surface lat & lon	depth [m]	Clock offset
ANT-3-1	PS 71/ 097-1	189	25.08.06 15:06	26.08.06 15:13	37°05.56' S 12°46.16' E	11.02.08 09:42*	11.02.08 11:25	37°04.09' S 12°48.79' E	4977	-165 sec 11.02.08 13:52:15
ANT-5-1	PS 71/ 099-3	113	26.01.05 16:12:56	26.01.05 19:20	41°08.12' S 09°56.62' E	13.02.08 03:43	13.02.08 05:35	41°08.56' S 09°57.18' E	4650	+99 sec 16.02.08 16:16:21
ANT-7-2	PS 71/ 102-3	135	26.01.05 22:50:59	27.01.05 20:37	44°39.86'S 07°04.96'E	15.02.08 07:57	15:02.08 09:45	44°39.48'S 07°05.71'E	4536	+113 sec 15.02.08 12:36:00
ANT-9-1	PS 71/ 104-7	125	29.01.05 17:06:12	30.01.05 02:29	47°39.30' S 04°15.70' E	17.02.08 11:32	17.02.08 13:14	47° 39.23' S 4° 16.11' E	4536	+78 sec 17.02.08 15:29:00
ANT-11-2	PS 71/ 107-2	185	24.10.06 17:46:47	24.10.06 20:24	50°15.73' S 01°25.95' E	18.02.08 18:15*	18.02.08 19:48	50° 15.47' S 1° 26.31' E	3888	Lost
ANT-13-1	PS 71/ 112-2	069	22.10.06 14:58:12	24.10.06 06:17	52°30.47' S 01°25.12' W	20.02.08 02:09	20.02.08 02:52	52°30.24' S 01°22.27' W	2736	-65 sec 20.02.08 11:30:30

During ANT-XXIV/3, 5 of 6 PIES were successfully recovered (Tab. 2.14) while one was lost during recovery. This PIES (#185 of mooring ANT-11.2) was lost after it had successfully surfaced. It floated next to the ship to be retrieved when it drifted astern and probably got smashed under the ships stern due to wave action.

Tab. 2.15: Helicopter assisted PIES recoveries. Sonobuoys were dropped from a helicopter from a height of 1000 ft and acoustic data recorded via radio link. Data dropouts are probably due to shielding of the antenna by the helicopter's fuselage. 12 and 12.5 kHz pings are generated by the PIES and release units.

mooring site	Sonobuoy launch lat & lon	launch date & time [GPS]	Sonobuoy	records	water depth [m]
ANT-3-1	37°05.56' S 12°46.16' E	11.02.08 09:42	channel 5 (received)	none (user error)	4977
ANT-5-1	41°08.12' S 09°56.62' E	12.02.08 17:17	channel 7 (received)	17:17 – 17:42	4650
ANT-11-2	50°15.73' S 01°25.95' E	18.02.08 18:04	channel 5 (failed) channel 8 (ok)	18:04 – 18:29	3888

At two sites, PIES releases were executed some 20 nm ahead of *Polarstern* via an hydrophone lowered from a helicopter hovering above the water. During these, and on a third site, the PIES acoustic activity was monitored previous to and during release via sonobuoys, kindly provided by the Forschungsanstalt für Wasserschall und Geophysik, Kiel, Germany, dropped from the helicopter (Tab. 2.15). Details of this procedure are described in the cruise report of ANT-XXII/3. In this context it was particularly useful to have the PIES transmission schedules set to 10 minutes intervals for rather than half hourly, for acoustic verification.

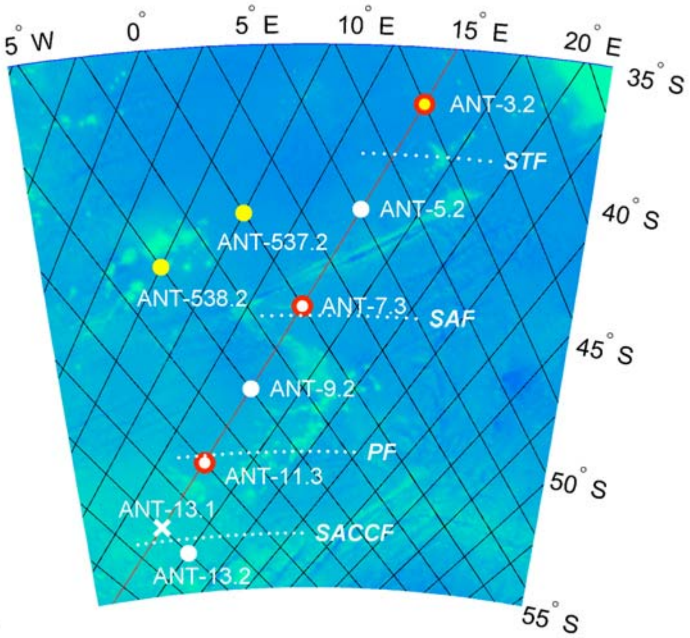

Fig. 2.21: Positions of PIES deployments during Polarstern cruise ANT-XXIV/3 (white dots) and G.O. Sars cruise AKES 2 (yellow dots). Red circles indicate PIES with PopUp buoys attached. Red line: ground track #133 of Jason satellite mission (previously TOPEX/Poseidon). White dotted lines: nominal positions of fronts: STF = Subtropical Front, SAF = Subantarctic Front, PF = Polar Front, SACCF = Southern Antarctic Circumpolar Current Front. White cross: recovery site of PIES at position ANT-13.1, re-deployment at position ANT-13.2 on Greenwich meridian.

Three of the PIES were re-deployed after refurbishment on board (exchange of batteries, software upgrades and hardware fixes). Along with additional deployments of two new PIES, a total of 5 PIES was deployed across the ACC (Tab. 2.16 and Figs 2.21 and 2.22) at sites ANT-5, 7, 9, 11, and 13. At site ANT-3, a PIES (#192) with two PopUps was successfully deployed by *G.O.Sars*, only hours after *Polarstern* recovered the mooring ANT-3.1 at the same position.

Tab. 2.16: PIES deployments

mooring	Station book (deploy)	PIES S/N	start date & time [GPS]	launch date & time [GPS]	launch lat & lon	POSIDONIA: bottom date & time [GPS]	POSIDONIA: bottom lat & lon	POS. ID	depth [m]	PopUp	Auto release date & time [UTC]
ANT-5-2	PS 71/99-1	062	10.02.08 15:29	13.02.08 01:50	41°07.35' S 9°57,.32' E	13.02.08 02:10	41°07.4'S 09°57.70'E	470	4675	-	12.02.12 12:00
ANT-7-3	PS 71/102-1	184	13.02.08 15:54	15.02.08 05:37	44°38..90' S 7°05..91' E	no reception	44° 39,65' S 7° 06..2' E	387	4616	#5 #19	14.02.12 04:15
ANT-9-2	PS 71/104-5	113	16.02.08 16:20	17.02.08 09:42	47°39.41' S 4°15.69' E	no reception	47°39.35' S 04°15.70' E	388	4538	-	17.02.12 02:00
ANT-11-3	PS 71/107-2	189	18.02.08 20:55	18.02.08 19:20	50°15.47' S 01°26.33' E	18.02.08 20:08	50°16.12'S 01°.26.72'E	386	3844	#14 #18	18.02.12 02:00
ANT-13-2	PS 71/115-1	125	19.02.08 14:37	21.02.08 01:13	53°31.25' S 00°00.09' E	21.02.08 01:45	53°31.19'S 00°00.23'E	471	2632	-	20.02.12 02:00

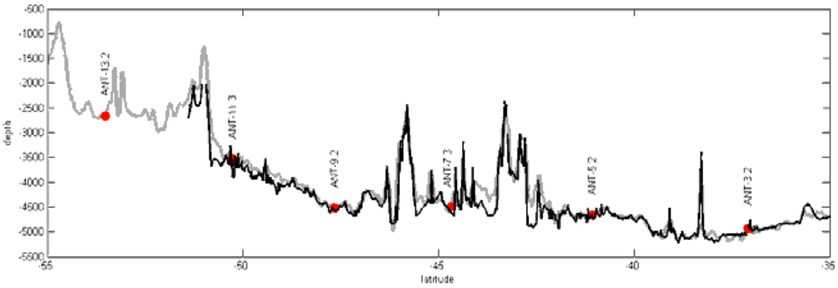

Fig. 2.22: Hydrosweep depth profile (black) along ground track #133 (obtained during ANT-XXII/3) with a resolution of 1,000 m. Red dots indicate PIES positions ANT-3, -5, -7, -9, -11, and -13. The grey curve indicates topography according to Smith and Sandwell TOPEX/Poseidon analysis.

Preliminary results

From four of the five successfully recovered PIES continuous time series with half hourly data were obtained. PIES #189, recovered at site ANT-3, shows data gaps of a few cycles (up to days) in the beginning of the measurement and has a large gap of one and a half month starting in the middle of December 2006. Examination of the log-file revealed unknown problems to have caused repeated self-resets of the instruments CPU. After 4 May 2007 however, the PIES operated flawlessly and provided half hourly measurements until its recovery on 11 February 2008. PIES #185, which had been lost during recovery, had fortunately previously transmitted some of its data via a PopUp buoy, so 6 data-months of the 18 data-months record are available.

Pressure time series of all instruments show a clear tidal signal and the fortnightly modulation of the tides (Fig. 2.23). On a monthly time scale, the variability of the pressure time series measured at positions south of ANT-3 is of about 0.05 to 0.1 dbar, decreasing from North to South. This range compares well with the range of variability as derived from (satellite based) GRACE solutions. The highest bottom pressure variability of about 1 dbar was found at site ANT-3, and is caused by the substantial sea surface height difference of more than 1 m between cyclonic and anti-cyclonic eddies, which are omnipresent in the Cape Basin. Three of the bottom pressure time series, however, show conspicuous drifts, which have not yet been removed and need to be analysed in more detail in the lab.

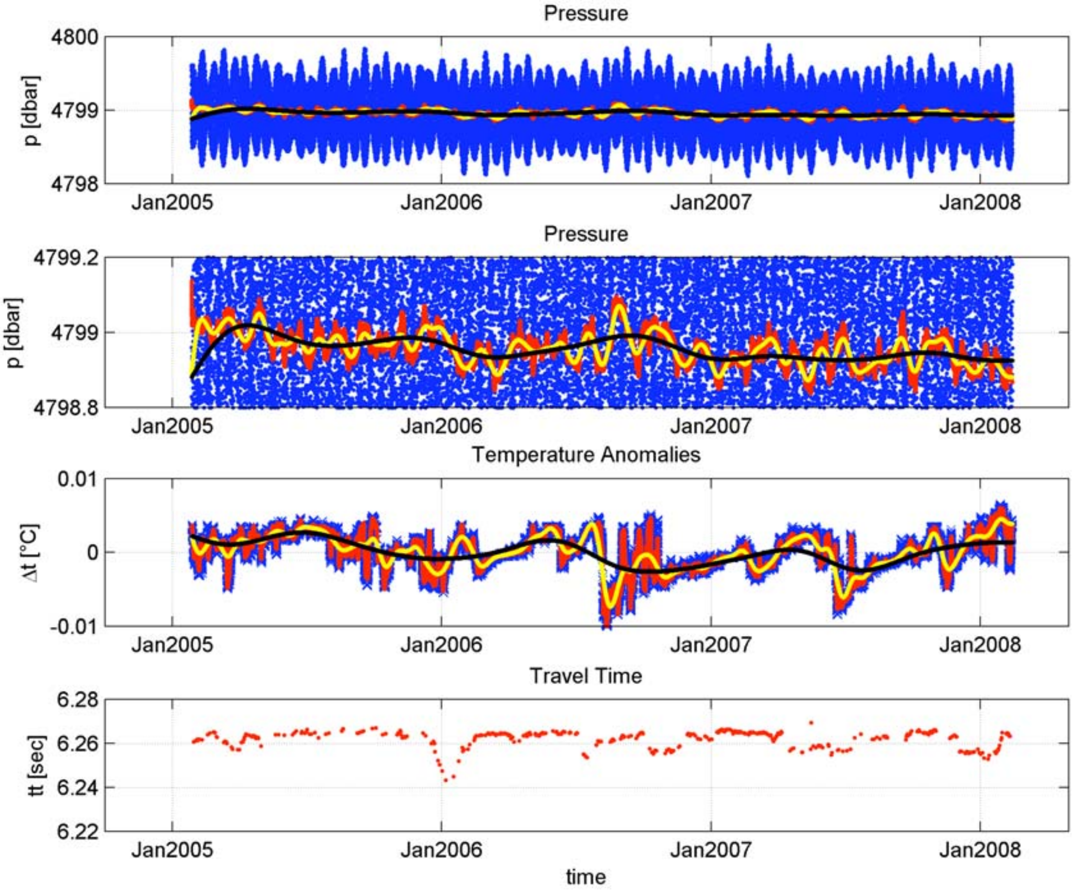

Fig. 2.23: Absolute pressure, temperature anomalies and travel time measured by PIES #113 at ANT-5.1. Blue: unfiltered 30-min values. Red: 2-day low pass filter. Yellow: 30-day low pass filter. Black: 180-day low pass filter.

The observed range of the bottom temperature anomalies is, on a daily time scale, ± 0.01°C. On longer time scales, the time series show a period of 10 - 14 months and about half the amplitude.

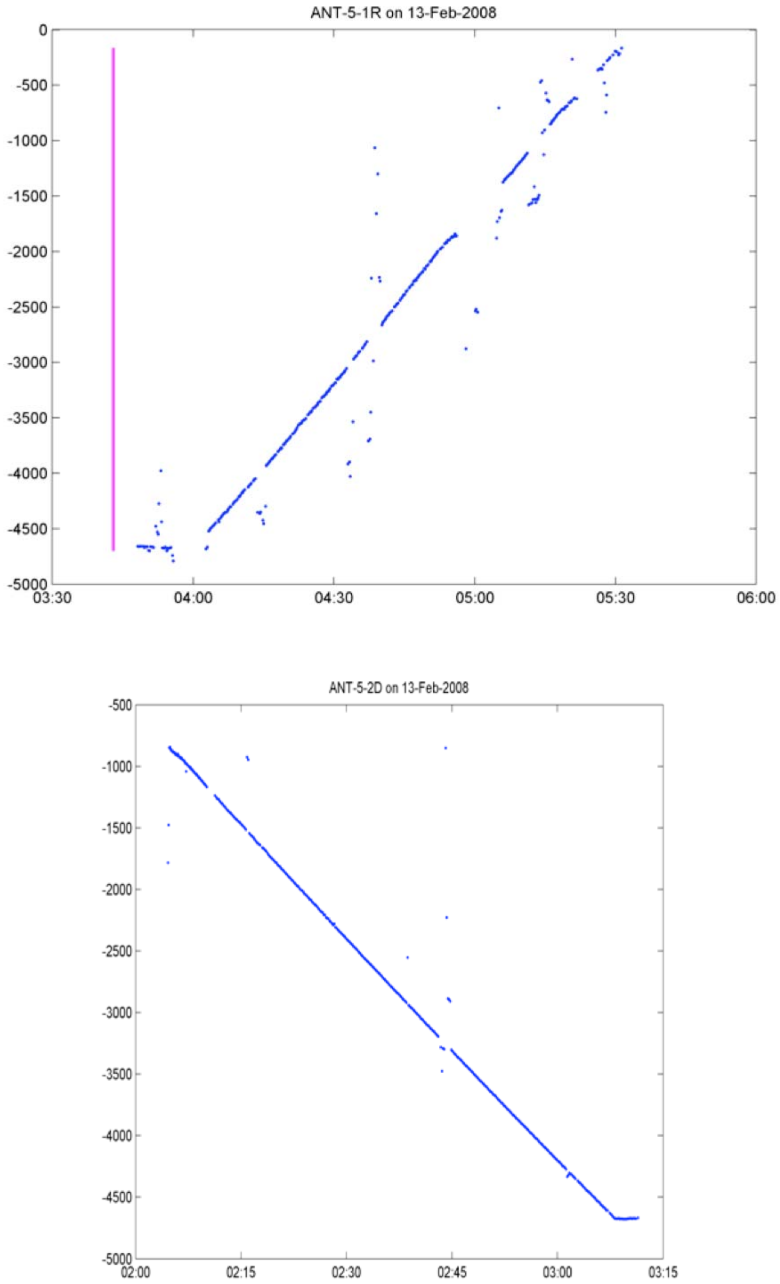

Fig. 2.24: Blue dots indicate the position of the POSIDONIA transponder during the recovery (top) and deployment (bottom) at ANT-5. Red line: release signal sent.

The acoustic travel time varies by up to 0.02 sec on time scales typical for mesoscale features. Those instruments moored at depths of 4000-5000 m showed clear travel time signals (and did hence well receive the acoustic pings), while PIES #69, moored at a depth of 2736 m, provided a diffuse travel time signal only. Further analysis of this instrument will be needed to resolve if this was due to the PIES electronics or rather a depth-related issue.

Tab. 2.17: PIES ascent or descent and buoyancy information

Position	R/D	PIES S/N	Posidonia S/N	Posidonia data	w [m/s]	release sent	release	Anderaa DCS	Floatation	Buoyancy
ANT-3-1	R	189	470	n				n	j	19
ANT-5.2	D	62	470	j	1.01			n	j	-35.34
ANT-5.1	R	113	387	j	-0.84	13.02.2008 03:43:00	13.02.2008 04:00:00	n	n	16
ANT-7.3	D	184	387	j	1.12			S/N 753	j	-45.34
ANT-7.2	R	135	388	j	-0.8	15.02.2008 07:57:00	15.02.2008 08:13:00	n	n	16
ANT-9.1	R	125	386	n				n	n	16
ANT-9.2	D	113	388	j	1.26			n	n	-60.34
ANT-11.2	R	185	462	n				n	n	16
ANT-11.3	D	189	386	j	1.38			n	n	-70.34
ANT-13.1	R	69	471	j	not valid	20.02.2008 02:09:00	not valid	n	n	16
ANT-13.2	D	125	471	j	1.36			n	n	-60.34

Critical to the planning of helicopter assisted PIES releases, but also to the overall expedition planning, are times of ascent and descent when instruments are deployed and recovered, respectively. To obtain quantitative estimates of these times for the various PIES/PopUp configurations used, range information (Fig. 2.24) from POSIDONIA transponders (which are part of all PIES moorings) have been analyzed in detail (Tab. 2.17)), showing descent speeds to range from 1 to 1.4 ms^{-1}. A generalized approach, showing the descent speed as a function of system weight (Fig. 2.25 upper left corner) allows prediction of descent time for future deployments of variable total weight. Released PIES without additional floatation attached showed an ascent speed of 0.8 to 0.84 m s^{-1}.

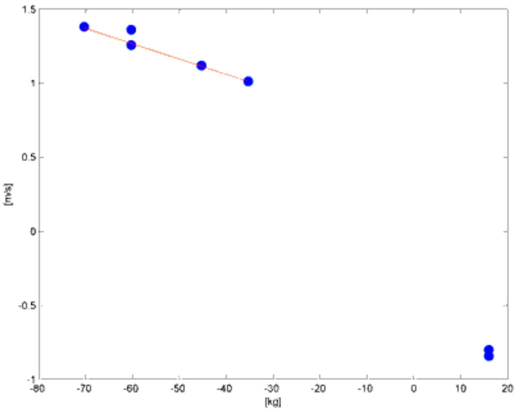

Fig. 2.25: Speed of ascent and descent and of PIES' as a function of system configuration

2.3 Monitoring the ACC transport through Drake Passage

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Objectives

The Antarctic Circumpolar Current (ACC), the world largest current, is a key element of the global climate system. The ACC is constricted to its narrowest extent (700 km) in Drake Passage thus a convenient place for observations. Monitoring the transport and water mass characteristics of the ACC is essential for understanding the coupling of this major current with climate change. It is not an easy matter since the current is concentrated in highly variable narrow bands of swifts currents and energetic eddies of all sizes are numerous.

Our experimental set up is designed to use the complementarity between satellite and *in-situ* observations. Satellite altimetry measures the sea level of the ocean along tracks every 10 days with horizontal resolution of 7 km. The *in-situ* measurements will provide information on the vertical structure of the ocean, information that cannot be obtained by satellites.

During ANT-XXII/3, in January-February 2006, we deployed an array of 10 current meter moorings along a ground track of Jason altimetric satellite (Fig. 2.26).

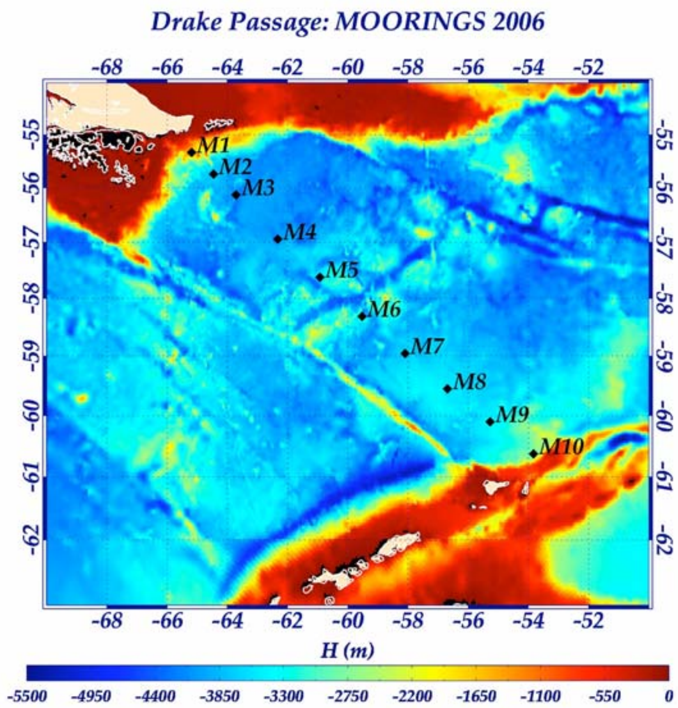

Fig. 2.26: Location of the 10 moorings deployed during ANT-XII/3 in January February 2006. Background is bottom topography (in m). The narrow ridge to the south west of M6-M7, part of the Shackleton Fracture Zone, constrains the ACC flow.

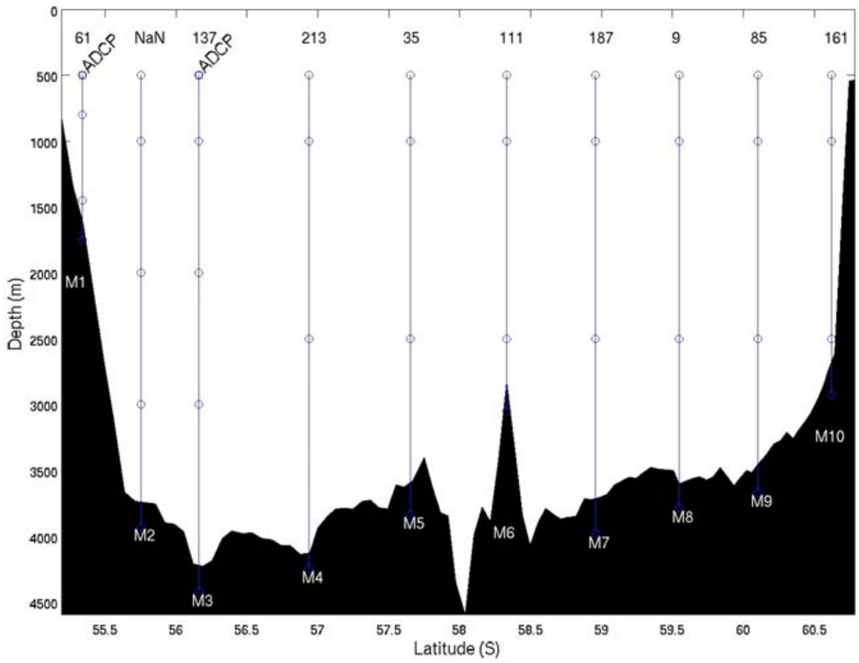

Fig. 2.27: Mooring section deployed in 2006

Work at sea

The work at sea included: recovery of the moorings deployed in 2006 (Tab. 2.18), deployment of 5 new moorings (Fig. 2.27 and 2.28, Tab. 2.19) at the locations M1 through M5 where the Antarctic Circumpolar Current is canalized due to the steep and narrow ridge of the Shackleton Fracture Zone and realization of a refined array of CTD stations with LADCP along the satellite ground track.

The two moorings to the south M10 and M9 which were equipped with double benthos releases were safely recovered. The remaining 8 moorings carried a transducer equipped with POSIDONIA (M1 through M8) and could be located readily. However two of them M2 and M8 could not be recovered. They were released, the acoustic transducers went up from their moored positions (respectively 3,070 m for M2, 2,600 m for M8) and then stabilized around 1,200 m at M2 and 1,600 m at M8. In both cases, the moorings, once stabilized, began to drift with the current. In spite of dredging efforts (1 full day for M8, and more than half a day for M2) the two moorings could not be recovered. During the two attempts wind and sea surface state conditions were rather poor.

M7 slowly went up to the surface. We recovered it and discovered that part of the foam flotation had imploded. M6, M5, M4, M3 and M1 were fully recovered. The instruments were read on board.

Tab. 2.18: Data recovered

Mooring	Instrument	Depth	record	CTD / LADCP stations
M1	ADCP	200 m	26 months	PS71/252 PS71/253
	Aquadopp	500 m	26 months	
	RCM8	500 m	26 months	
	Microcat	1000 m	26 months	
	RCM11	1000 m	26 months	
M2 lost				
M3	ADCP	400 m	26 months	PS71/248 PS71/249
	microcat	400 m	26 months	
	Aquadopp	900 m	26 months	
	RCM8	900 m	26 months	
	RCM8	1950 m	26 months	
	MORS	3100 m	26 months	
M4	RCM8	400 m	26 months	PS71/244
	Microcat	400 m	26 months	
	Aquadopp	950 m	26 months	
	RCM7	950 m	26 months	
	RCM8	2450 m	26 months	
M5	Aquadopp	500 m	0 (head lost)	PS71/241
	MORS	550 m	26 months	
	Microcat	1070 m	26 months	
	RCM7	1070 m	26 months	
	RCM8	2640 m	26 months	
M6	Aquadopp	300 m	26 months	PS71/237
	MORS	300 m	26 months	
	microcat	800 m	26 months	
	RCM7	800 m	26 months	
	RCM8	2440 m	26 months	
M7	Aquadopp	450 m	0 (crushed)	PS71/236
	RCM7	450 m	21 months	
	microcat	950 m	21 months	
	RCM8	950 m	21 months	
	RCM8	2540 m	26 months	
M8 Lost				
M9	RCM-8	500 m	0 (leak)	PS71/230
	RCM-11	1000 m	26 months	
	RCM-11	2500 m	26 months	
M10	RCM-11	500 m	14 months	PS71/226
	RCM-11	1000 m	26 months	
	RCM-11	1500 m	11 months	

Tab. 2.19: Moorings deployed

Mooring	Instrument	Depth	CTD/LADCP stations
M1-2 : 12/04/2008 18 :00 UTC Lat : 55° 10.16’S Lon : 65° 11.22’W Depth : 1600 m	ADCP	500 m	PS71/252 PS71/253
	microcat	500 m	
	Aquadopp	500 m	
	microcat	1000 m	
	Aquadopp	1000 m	
M2-2 : 13/04/2008 15 :50 UTC Lat : 55°43.135’ Lon : 64°24.100’W Depth : 3816 m	microcat	500 m	PS71/256
	Aquadopp	500 m	
	microcat	1000 m	
	Aquadopp	1000 m	
	RCM-8	2000 m	
	RCM-8	3000 m	
M3-2 : 10/04/2008 20 :18 UTC Lat : 56°06.05’ Lon : 63°43.93’ Depth : 4275 m	ADCP	500 m	PS71/248 PS71/249
	microcat	505 m	
	Aquadopp	510 m	
	microcat	1000 m	
	RCM-7	1000 m	
	RCM-8	2000 m	
	RCM-8	3000 m	
M4-2 08/04/2008 22.24 UTC Lat 56°55.55S Lon: 62°22.03W Depth : 4093 m	RCM-11	500 m	Super station DRAKE-4 PS71/244
	RCM-11	1500 m	
	RCM-11	2500 m	
M5-2 07/04/2008 15 :36UTC Lat : 57°37.53S Lon: 60° 55.01W Depth: 3445 m	RCM-11	500 m	Super station DRAKE-3 PS71/241
	RCM-11	1500 m	
	RCM-11	2500 m	

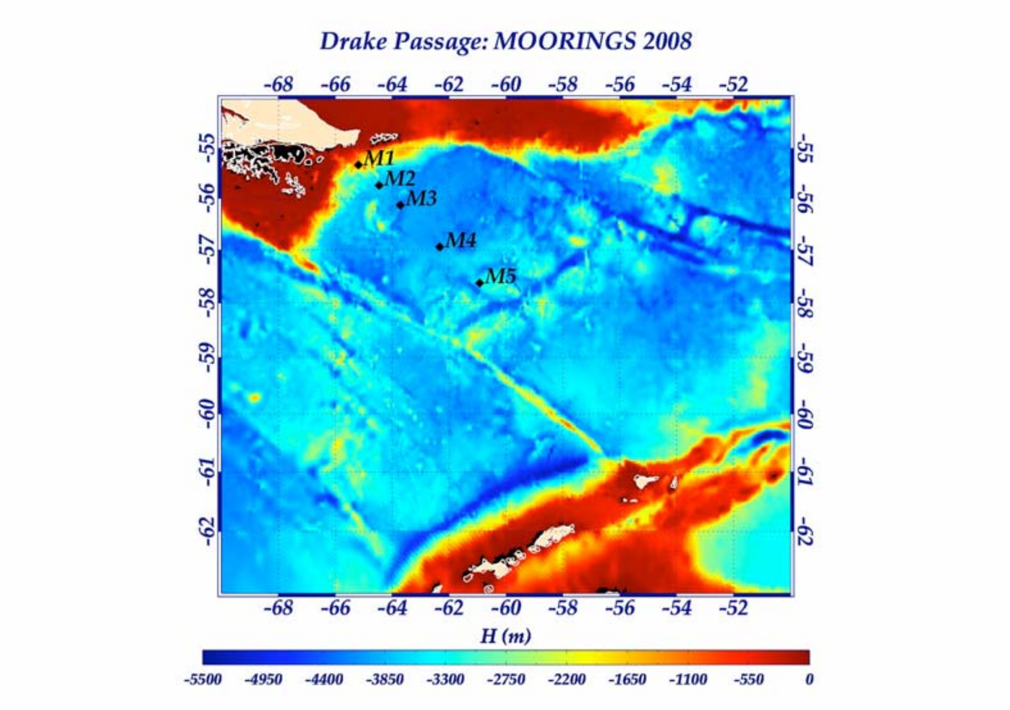

Fig. 2.28: Moorings deployed in Drake Passage

2.4 Measurements of trace gases: chlorofluorocarbons, helium isotopes & neon

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Objectives

The Weddell Sea is a major supplier for Antarctic Bottom Water to the World Ocean. There, Weddell Sea Deep and Bottom Water (WSDW and WSBW) are formed by interaction of mid-depth water masses with several shelf water types (e.g., Ice Shelf Water, ISW, or glacial melt water) and by entrainment of external water masses. Modifications in its composition and formation rates – caused by environmental changes (e.g., decay of ice shelves, warming mid-depth water) – could modify the strength of the Meridional Overturning Circulation (MOC) and, thus, affect climate and climate change. Changes in the formation processes and in the amount of formed deep and bottom water might also influence the uptake and storage of carbon in the interior of the Southern Ocean.

The major aims of our tracer measurements are:

- To assess the formation rates and its variability of WSDW and WSBW.
- To consider correlations to changing environmental conditions (i.e. degradation of ice shelves, enhanced melting, warming, freshening) that might lead to varying deep and bottom water composition, distribution, and formation rates

- To determine the variability of deep and bottom water export and import from easterly sources across the Greenwich meridian.
- To assess the contribution and variability of Southeast Pacific Deep Slope Water (SPDSW) through Drake Passage to the total transport of the Circumpolar Current.

The deep and bottom water formation and its variability in the Weddell Sea will be studied by using chlorofluorocarbon (CFC) inventories and CFC based transit time distributions (TTDs, ore age spectra), inferred from this cruise and from historical data. The combined hydrographic, CFC and noble gas data will allow to distinguish different source water masses, that contribute to deep and bottom water formation, and how they reflect changing environmental conditions. From the continuation of the CFC time series along the Greenwich meridian, further insight regarding the variability of the export of deep and bottom water out of the Weddell gyre and through the South Scotia Ridge system as well as the import from easterly sources is expected. The role of the SPDSW in the Atlantic Circumpolar Current will be studied by the repeated noble gas, CFC, and velocity observations across Drake Passage.

Work at sea

During the cruise a total of 1620 samples on 97 CTD/water bottle stations were collected for chlorofluorocarbons (CFC-11 and CFC-12); 32 stations were occupied along the Greenwich meridian section, 37 stations along the Weddell Sea section, and 28 stations across the Drake Passage. The water samples from the CTD/rosette system were collected into 100 ml glass ampoules and sealed off after a CFC free headspace of pure nitrogen had been applied. The CFC samples will be analysed in the CFC-laboratory at the IUP in Bremen. The determination of CFC concentration will be accomplished by purge and trap sample pre-treatment followed by gas chromatographic (GC) separation on a capillary column and electron capture detection (ECD). The amount of CFC degassing into the headspace will be accounted for during the measurement procedure in the lab. The system will be calibrated by analyzing several different volumes of a known standard gas. Additionally the blank of the system will be analyzed regularly.

Furthermore, 480 samples from 41 stations were collected for helium isotopes (^{3}He, ^{4}He) and neon (Ne); 10 stations along the Greenwich meridian section, 14 stations along the Weddell Sea section, and 17 stations across the Drake Passage. The water samples from the water bottles were stored in clamped off copper tubes. They will be analysed with the IUP-Bremen noble gas mass spectrometer (combined quadrupole and sector field mass spectrometer), after the gases were extracted from the sea water samples and separated from other gaseous components by several cooling traps.

Additionally, 50 samples from 6 stations (on the southern part of the Greenwich meridian section and above the northwestern slope along the Weddell Sea section) were collected for tritium (^{3}H). The water samples were collected into water vapour tight glass bottles. Since tritium is part of the water molecule, all gasses will be extracted from the water sample, and the remaining water will be stored for at least half a year. During that time a sufficient part of the ^3H has decayed to ^3He. Finally, the ^3He is measured with the same IUP-Bremen mass spectrometer as described above.

Expected results

Chlorofluorocarbons (CFCs) are gaseous, anthropogenic tracers that enter the ocean by gas exchange with the atmosphere. The evolution of these transient tracers in the ocean interior is determined by their temporal increase in the atmospheric and by the formation and mixing processes of intermediate, deep and bottom water. The total inventories of CFCs in deep and bottom water reflect the accumulation of CFCs carried by its surface near source water masses. Together with the known atmospheric CFC evolution, CFC inventories allow, thus estimating the renewal or formation rates of recently formed bottom water. Furthermore, the availability of time series from various sections allows to assess the temporal variability of the formation rates, and possibly, its relation to changing environmental (boundary) conditions (ice shelf decay, surface water warming, etc.).

Other methods using CFCs as age tracers include transit time distributions (TTDs, or age spectra). By applying a “mean age”, a “width of the age”, and, if appropriate, a tracer free (i.e. “old”) component, this dating method accounts for advection and mixing, other than the “CFC-ratio age” approach, which accounts – as a first approach – for advection and tracer free dilution only. This improves the estimates of ventilation time scales, mixing parameters, and ventilation or formation rates significantly. To constrain the parameters of the TTD well, it is valuable to use transient tracers from different observation times (e.g. CFC time series). Furthermore, the derived TTDs can be used to estimate the input, internal transfer, and storage of anthropogenic CO_2.

Using stable tracers like helium isotopes and neon, additional to temperature and salinity, allow one to carry out an Optimum Multiparameter (OMP) analysis to estimate the contributions of the parent source water masses to the formation of deep water masses. Herein helium and neon are ideal tracers to detect smallest fractions of glacial melt water or ISW, and the $^3He/^4He$ isotope ratio is a tracer for deep water from the Pacific (SPDSW).

2.5 Oxygen measurements

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Oxygen measurements from samples

To calibrate the oxygen profiles measured with the optode sensor of both CTDs, from AWI and NIOZ, water samples of the Niskin bottles of both CTDs were taken from station 97 to station 251. One sample of water was taken at the surface, one at the ocean bottom and one at the oxygen minimum. Additional samples were taken along the water column: one sample each thousand meters. In most of the cases, 5 or 6 water samples were taken from each cast. In shallow stations only 2 or 3 samples were taken. Every sixth CTD cast, replicas were taken (i.e., at least 15 % of the all the samples are replicas). In total, 651 samples were taken.

The oxygen was measured using the Winkler method, according to the manual "WOCE operation and methods" (C.H. Culberson, July, 1991). Immediately after the sampling, the dissolved oxygen was fixed with 1 ml of $MnCl_2.4H_2O$ and 1 ml of NaOH+NaI. Then, the bottles were stored under water and their caps were attached with a rubber band to prevent intrusion of air. To measure the dissolved oxygen, 1 ml of Sulphuric Acid 50 % (H_2SO_4) was added to the samples and a solution of Sodium Thiosulfate ($Na_2S_2O_3 \cdot 5H_2O$) was titrated with a Dosimat Metrohm automatic pipette provided with a transmissiometer. Potassium iodate (KIO_3) was used as standard. Preliminary results of these measurements show an accuracy of 0.028 ml l^{-1} (based on the standard deviation of 22 replicas).

While the AWI CTD sensor seems to be relatively stable (constant offset), the NIOZ CTD sensor drifted with time, measuring less oxygen every day, see Fig. 2.29. Due to problems with the Dosimat (failure of the device to measure some samples, bubbles in the pipette, etc.), the first half of the expedition (up to 10 March, i.e., station 163) results of the titration were not completely satisfactory: imprecise outcome of the titration resulted in a large dispersion of the offset around a straight line. After various attempts of improving the measuring process, on 10 March, the titer bottle and the pipette were changed; new titer was prepared, added to the bottle and standardized. After this, the titration results matched the CTD profiles along the vertical considerably better.

Monitoring of the offset between CTD and titration results ruled the sampling frequency of each CTD, depending on the dispersion of the off-set around the straight line. Because of this, the first half of the expedition, samples were taken from every cast of both CTDs. After the offset seemed to be stable, and considering that the AWI CTDs occurred with a large frequency, samples were taken only from one cast per day. Since casts of the NIOZ CTD occurred every second or third day, every cast of the NIOZ CTD has been sampled.

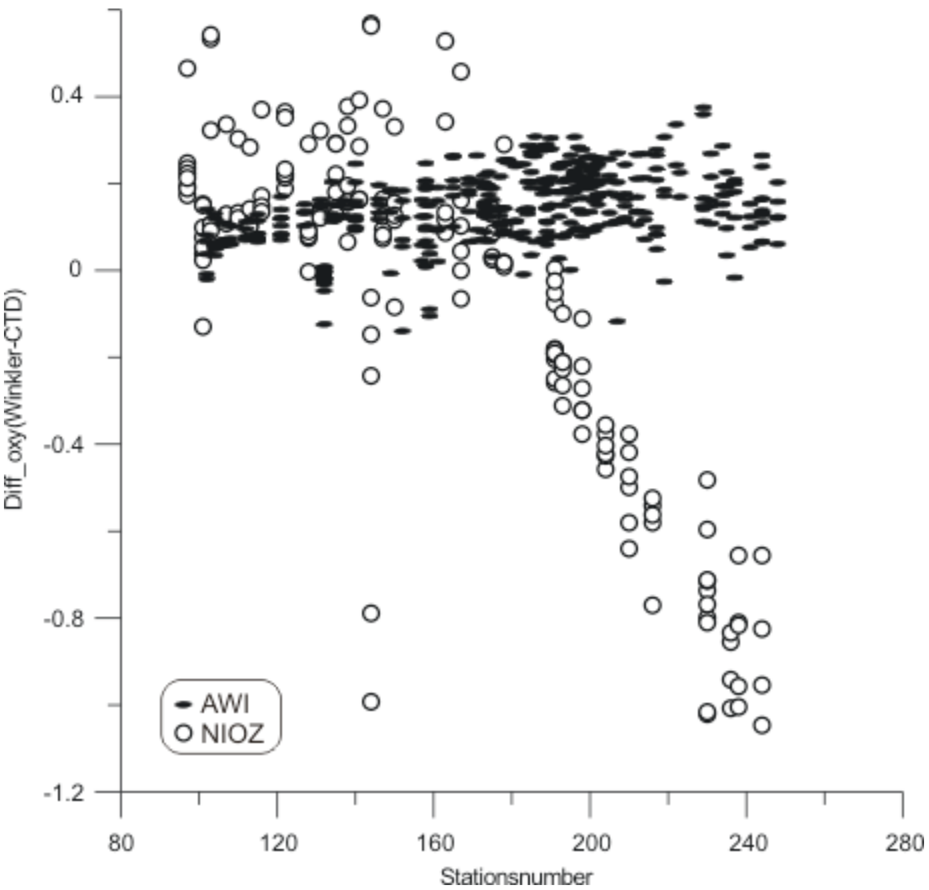


Fig. 2.29: Oxygen difference between the measured samples and the reading from the CTD's oxygen sensor versus station number for the AWI and NIOZ system

Three individual steps of correction were applied for the AWI CTD oxygen sensor:

1. Step: Linear correction of the CTD oxygen reading

$$OXY1 = a + b * OXY$$

with:

a = -0.02291300577

b = 1.029883905

2. Step: Linear correction of the oxygen sensor drifts

with:

a = -0.14125

b = 0.0008125

$$OXY2 = OXY1 + \Delta OXY1$$

3. Step: High order polynomial fit to correct the pressure effect of the oxygen sensor

a: In upper water column; 0 to 2370 dbar:

$$\Delta OXY2 = a + b * PRES$$

with:
a = -0.04598245614
b = 2.336842105E-005
and pressure given in decibar.

b: In the deep water column; pressure > 2370 dbar:

$$\Delta OXY2 = a + b * PRES + c * PRES^2 + d * PRES^3 + e * PRES^4 + f * PRES^5 + g * PRES^6$$

with:
a = 0.01938375746
b = -0.0001436734808
c = 7.707321788E-008
d = 1.241336138E-011
e = -1.460247804E-014
f = 3.065354609E-018
g = -2.023542164E-022
and pressure given in decibar.

The final corrected CTD oxygen reading is:

$$OXY_{corr} = OXY2 + \Delta OXY2$$

The correction of the NIOZ CTD oxygen sensor was made for two separated parts due to the sensor drift which can be clearly identified in Fig. 2.29.Two individual steps of correction were applied for the first part from station number 97 to 178:

1. Step: Correction of the oxygen sensors pressure effect

$$\Delta OXY1 = a + b * \log(pressure)$$

with:
a = 0.5972460117
b = -0.05964890171
and pressure given in decibar.

2. Step: Linear correction of the oxygen sensor drifts

with:
a = 0.242
b = -0.0019

The final corrected CTD oxygen reading for station 97 to 178 is:

$$OXY_{corr} = OXY + \Delta OXY1 + \Delta OXY2$$

The following correction was applied for the second part form station number 187 to 252:

1. Step: Linear correction of the oxygen sensor drifts

with:
a = 2.975
b = -0.01625

2. Step: High order polynomial fit to correct the pressure effect of the oxygen sensor

$$\Delta OXY2 = a + b * PRES + c * PRES^2 + d * PRES^3 + e * PRES^4 + f * PRES^5 + g * PRES^6$$

with:
a = -0.1744698393
b = 0.0007819713073
c =-8.445337449E-007
d = 3.882443376E-010
e = -9.007417652E-014
f = 1.034638749E-017
g = -4.679330148E-022
and pressure given in decibar.

The final corrected CTD oxygen reading for station 187 to 252 is:

$$OXY_{corr} = OXY + \Delta OXY1 + \Delta OXY2$$

Fig. 2.30 shows the remaining oxygen difference between the measured samples and the corrected reading from the CTD oxygen sensor. The sensor from the NIOZ CTD shows a little higher noise than the AWI CTD oxygen sensor which reflects the sensor problems which were already visible in the plot of the uncorrected data.

The standard deviation for the AWI CTD is 0.04 and 0.07 for the NIOZ CTD. From there the accuracy for all CTD oxygen is better than ±0.1 ml/l.

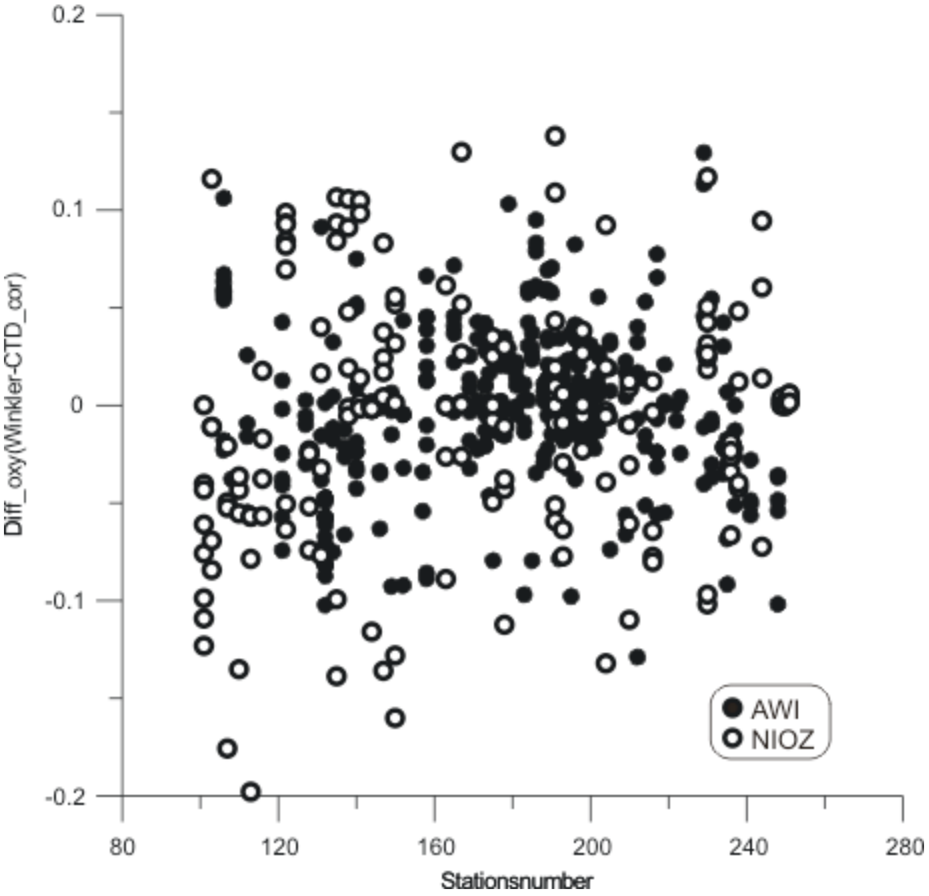


Fig. 2.30: Oxygen difference between the measured samples and the reading from the CTD's oxygen sensor after applied corrections versus station number for the AWI and NIOZ system.

The oxygen profiles of the CTD were constantly compared with the results of the titration along the expedition. The profiles were roughly corrected by shifting them horizontally (adding or subtracting an offset) until they optimally matched the titration results by minimal quadratic differences (Fig. 2.31 shows station 244 as an example). Fig. 2.32 shows the offset between each CTD profile and the corresponding titration values against the station number.

The authors of this report wrote also an succinct manual about oxygen sampling and measuring. This manual is available under request.

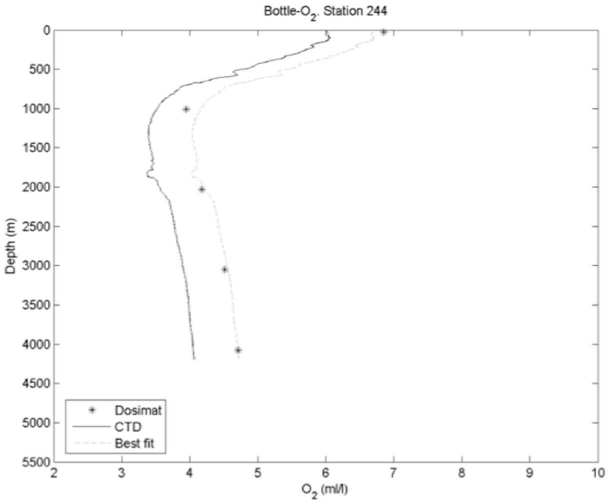


Fig. 2.31: Comparison of the oxygen profile of the CTD sensor of Station 244 (black continuous line) and the titration values (stars). To monitor the results (and not as calibration procedure), the CTD profile has been shifted adding an offset until it matched by minimum quadratic differences the titration values (grey dashed line).

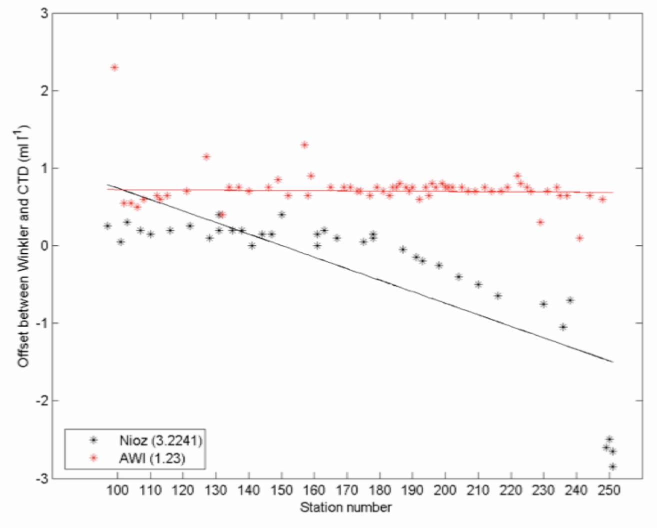


Fig. 2.32: Offset between the CTD oxygen profiles and the titration results for the AWI CTD (red) and the NIOZ CTD (black) as a function of the station number. The offset is defined as the amount of oxygen added or subtracted to the profile as to match the titration values by minimum quadratic differences.

3. GEOTRACES IN THE INTERNATIONAL POLAR YEAR DURING ANT-XXIV/3 EXPEDITION

General objectives

One major aim of international GEOTRACES (http://www.geotraces.org) is:

> "To determine global ocean distributions of selected trace elements and isotopes, including their concentration, chemical speciation, and physical form, and to evaluate the sources, sinks, and internal cycling of these species to characterise more completely the physical, chemical and biological processes regulating their distributions".

The International Polar Year (IPY) is an excellent opportunity to study Trace Elements and Isotopes in the Arctic and Antarctic Oceans. An international suite of vertical sections in the polar oceans is integrated in the IPY project No. 35 (http://www.ipy.org/development/eoi/proposal-details.php?id=35) entitled: "International Polar Year GEOTRACES: An international study of the biogeochemical cycles of Trace Elements and Isotopes in the Arctic and Southern Oceans". In context of this IPY-GEOTRACES, two *Polarstern* cruises have been implemented, in the Arctic Ocean (ARK-XXII/2; 2007) and the current expedition in the Antarctic Ocean (ANT-XXIV/3; 2008), respectively.

Organization

The GEOTRACES research of ANT-XXIV/3 pivots around three research teams of Royal NIOZ, IFM-GEOMAR and AWI led by Principal Investigators (PI) Hein de Baar, Peter Croot and Michiel Rutgers van der Loeff, respectively. Moreover there are several participants of other institutes CNRS-LEGOS, Stanford University and University of Groningen taking part in one or another of these teams.

Data management

All data of Isotopes and Trace Metals will be reported into the worldwide database of the GEOTRACES programme. Within the GEOTRACES Scientific Steering Committee, Dr. Reiner Schlitzer (AWI) is the SSC-member responsible for the database, and will be able to correspond regularly with the other SSC members Michiel Rutgers van der Loeff (AWI) and Hein de Baar (NIOZ) which had organized the ANT-XXIV/3 GEOTRACES component.

3.1 Trace elements during ANT-XXIV/3 expedition: NIOZ team

Anne-Carlijn Alderkamp[3], Hein de Baar1), Babette Bontes2), Loes Gerringa1), Maarten Klunder1), Patrick Laan1), Rob Middag1),), Ika Neven2), Sven Ober1), Jan van Ooijen1), Willem Polman†1), Cornelis van Slooten2), Charles-Edouard Thuroczy1)

1)NIOZ
2)University of Groningen
3)Stanford University/University of Groningen

In GEOTRACES we have defined 6 key trace metals (Tab. 3.1) which, together with additional metals Co, Ni, Ag will be investigated in IPY-GEOTRACES subprojects. The distribution and biological availability of Fe (3.1.1) is strongly controlled by its physical-chemical speciation (3.1.2) within seawater, where colloids and Fe-organic complexes are dominant actors. The external sources of Fe into the oceans are either from above (dust) and below (sediments) and will be constrained by Al and Mn (3.1.3) for aeolian dust input and sedimentary redox cycling sources, respectively. For phytoplankton growth, Cu (3.1.4) at the cell wall acts in reductive dissociation of Fe-organic complexes, hence facilitates Fe uptake. This may partly explain the nutrient-type distribution of Cu in the oceans. The Fe enhances phytoplankton growth, which in turn strongly controls the biological pump for uptake of CO_2 from the atmosphere into polar oceans (4.). The increasing CO_2 in polar ocean waters may affect phytoplankton ecophysiology (3.1.7), with key links of metals Fe (3.1.1) in the overall photosynthetic apparatus and Zn (3.1.4) in carbonic anhydrase and respectively, where Cd and Co (3.1.4) may substitute for Zn in the latter carbonic anhydrase.

Tab. 3.1: The 6 trace metals with high priority in GEOTRACES. Many more trace metals are measured during GEOTRACES, yet these 6 were measured or sampled on all sections. Moreover Co, Ni, Ag of subproject 3.1.4.

Fe Iron	Most important essential micronutrient
Al Aluminium	Tracer of Fe inputs (from mineral dust and elsewhere)
Zn Zinc	Second important micronutrient; co-factor in carbonic anhydrase; toxic at high concentrations; environmental pollutant worldwide
Mn Manganese	Tracer of Fe inputs and redox cycling; Fe-Mn in superoxide dismutase
Cd Cadmium	Essential micronutrient; paleoproxy for phosphate in seawater; toxic at high concentrations; environmental pollutant worldwide
Cu Copper	Essential micronutrient (toxic at high concentrations); toxic at high concentrations; environmental pollutant worldwide
Co Cobalt	Essential micronutrient; co-factor vitamin B12
Ni Nickel	Essential micronutrient; in urease
Ag Silver	Analog of both Cu and Si; paleoproxy for nutrient silicate; environmental pollutant

3.1.1 Distributions, sources, sinks of dissolved Fe in Polar Oceans

Patrick Laan, Maarten Klunder
NIOZ

Very little data exists on Fe in waters of the Antarctic Ocean. There is some data for Fe (or other trace metals) in surface waters of the Arctic Ocean, and very little at depths below ca. 1000 metres. Since the 1988 European *Polarstern* Study the role of Fe in ecology of the Southern Ocean has been investigated, including the Fe distributions, speciation, sources and sinks. Nevertheless in an exhaustive synthesis of all then existing ocean Fe data uncertainty remained as to the actual, correct, concentration of Fe in ocean waters. Therefore total dissolved Fe is a top priority in GEOTRACES. ANT-XXIV/3 aimed for two complete sections on distributions of Fe (and other trace metals) in the Antarctic Ocean.

Work at sea

Dissolved iron was measured directly on board by Flow Injection Analysis (FIA) after De Jong et al. 1998 in a cleanroom container. In a continuous FIA system the acidified pH 1.8, filtered (0.2 μm) seawater is buffered to pH 4.0. The iron is concentrated on a column which contains the column material iminodiacetic acid (IDA). This material binds only transition metals and not the interfering salts. After washing of the column with ultra pure water (MQ) the column is eluted with diluted acid. After mixing with luminol, peroxide and ammonium the oxidation of luminal with peroxide is catalysed by iron and a blue light is produced and detected with a photon counter. The amount of iron is calculated using a standard calibration line, where a known amount of iron is added to low iron containing seawater. Using this calibration line a number of counts per nM iron is obtained.

All 23 stations on the prime meridian and corresponding depths have been analyzed on board. The values of DFe measured varied from below 50 pM in the surface waters up to more then 2 nM. The standard deviation varied between 0 % and 7 % (exceptional), but was generally lower than 4 %. The standard deviation of the values is determined of a triplicate measurement of the same sample bottle. To correct for contamination during the process or in the sample bottle a duplicate sample was taken of every station depth. The daily consistency of the system was verified using a drift standard. Regularly a certified SAFe standard (Johnson et al. 2007) for the long term consistency and absolute accuracy was measured.

Next to the 23 stations also the amount of dissolved iron in the 1000 kDa filtered fraction was measured for 7 casts. The corresponding 0.2 μm filtered fraction of the same casts was also measured. The 1,000 kDa filtered fraction generally contained a lower amount of dissolved iron.

Although all ultraclean CTD casts were sampled for the determination of dissolved iron on board only the samples from the prime meridian were measured. Due to the accident at Neumayer station we were not able to measure all the station taken and all the primary goal was to finish the prime meridian.

Preliminary results

The preliminary data shown in Fig. 3.1, show that the concentrations of dissolved iron in South Atlantic Sector of the Southern Ocean are comparable to the concentrations found in the North Atlantic Deep Waters, 0.6 - 0.7 nM. (Martin et al., 1993).

Elevated DFe values were observed around 55°S and are most probably related to hydrothermal activity from the area where the Mid Atlantic, the Southwest Indian and the America-Antarctic Ridges meet. The lowest DFe concentrations were observed in the surface of the most southerly located stations. Fig. 3.2 shows a typical profile of the DFe as observed in the Southern Ocean.

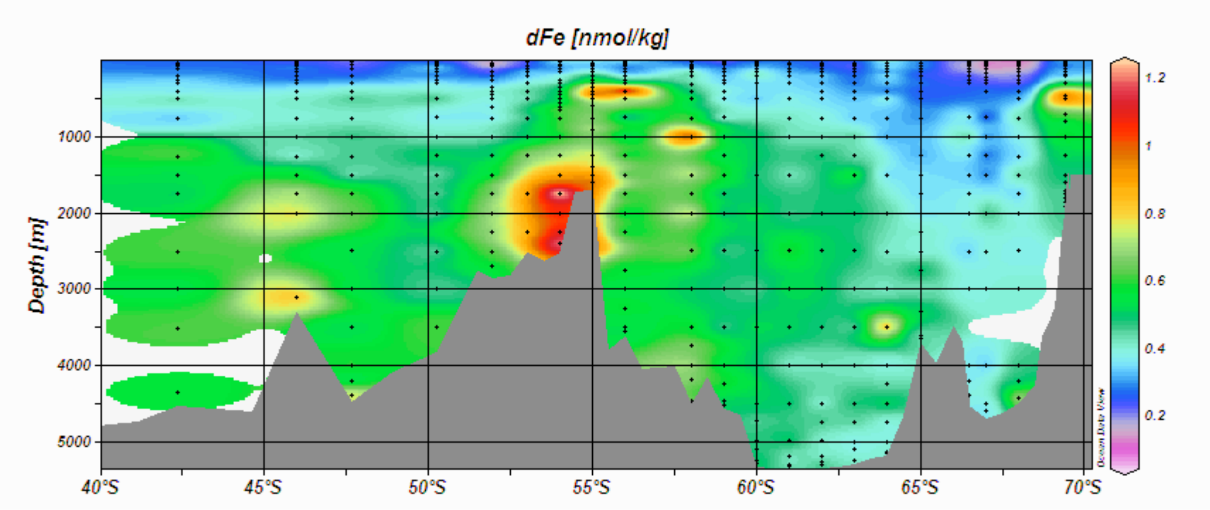
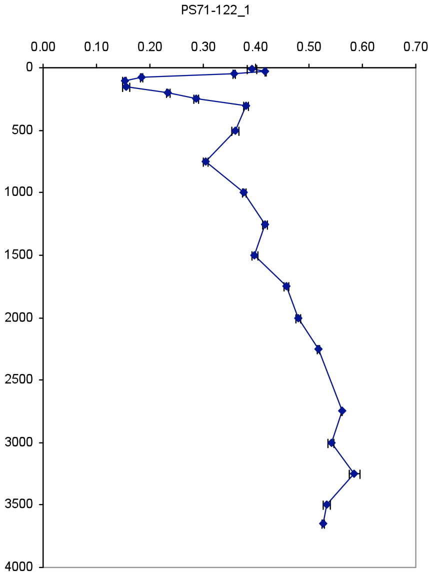


Fig. 3.1: Distribution of DFe on a section along the Greenwich meridian for

Fig. 3.2: Depth profile of dissolved Iron



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3.1.2 Physical and chemical speciation of iron in seawater

Charles-Edouard Thuroczy and Loes Gerringa
NIOZ

Objectives

The distribution and biological availability of Fe is strongly controlled by its physical-chemical speciation within seawater, where colloids and Fe-organic complexes are dominant factors. In order to study the distribution and the biological availability of Fe the natural Fe organic complexes over the whole water depth were determined in three different size fractions. Special attention was given that distinct water masses present were sampled as well.

Samples were collected by an ultraclean sampling system using 24 Go Flo bottles fixed on an all-titanium frame and with a Kevlar cable. The concentration of iron binding ligands (organic compounds which strongly bind Fe) and their binding strength (conditional stability constant) are studied in 3 size classes here: unfiltered water, 0.2 μm filtered water and smaller than 1,000 KDa ultra-filtrated water.

Methods

General

Under ultraclean conditions the 0.2 μm filtered seawater was ultra-filtrated using polyethylene hollow-fiber filters as to make an operational defined distinction between large colloidal and small colloidal Fe including the "truly dissolved" Fe (1,000 KDa nominal weight, Stereapore, Mitsubishi-rayon Co. Ltd, Nishioka and al., 2005). The dissolved organic iron (0.2 μm filtered) as well as the truly dissolved iron (< 1000 KDa) were analysed by Maarten Klunder and Patrick Laan using a chemo luminescence method (FIA) with acidified samples (pH 1.8). Total iron will be measured 6-12 months after the acidification of the unfiltered sample. The natural ligand characteristics were determined by doing a complexing ligand titration with addition of iron (between 0 and 8 nM of Fe added) in buffered seawater (mixed NH_3/NH_4OH borate buffer, 5 mM). The competing ligand 'TAC' (2-(2-Thiazolylazo)-p-cresol) with a final concentration of 10 μM was used and the complex $(TAC)_2$-Fe was measured after equilibration (> 15 h) by cathodic stripping voltammetry (CSV) (Croot and Johansson, 2000). The electrical signal recorded with this method (nA) was converted as a concentration (nM), then the ligand concentration and the binding strength were estimated using the non-linear regression of the Langmuir isotherm (Gerringa and al., 1995).

The voltammetric equipment consisted of a μAutolab potentiostat (Type I, II and III, Ecochemie, The Netherlands), a mercury drop electrode (model VA 663 from Metrohm). All equipment was protected against electrical noise by a current filter (Fortress 750, Best Power).

Extra experiment
Instability with time of the unfiltered seawater was observed during the ARK-XXII/2 cruise in 2007 and made the estimation of the ligand characteristics difficult. This raised the question how long samples could be kept before analysis (“expiration”) because life (algae, bacteria, viruses) modified the equilibrium in the sample.

Three experiments were performed in order to establish the “expiration date” of the unfiltered seawater samples. These experiments want to explain what causes the perturbations in the samples.

For this, four size fractions were analysed after different conditions of conservation (temperature and light). The four fractions were unfiltered water, 1 μm filtered water (without the big algae), 0.2 μm filtered water (without the pico-eucaryotes) and 1,000 KDa filtered water. With the collaboration of Claire Evans and Erwin Frijling, the total chlorophyll fluorescence of the algae was measured by Phyto-PAM (Pulse Amplitude Modulation) and followed in time (between 5 and 10 days), as well as the amount of living small algae (pico-eucaryotes) measured by flow-cytometry. Samples for bacteria analyses were also taken and will be analysed at NIOZ. The dissolved iron concentration was measured by FIA and the ligand concentrations and binding strength were measured on board by voltammetry.

Another experiment was performed in order to establish a mass balance of the ligands before and after the ultrafiltration. Four classes of size were then analyzed, the unfiltered fraction, the 0.2 μm filtered fraction the 1,000 KDa ultrafiltered fraction, but also the fraction left after the ultrafiltration (size between 0.2 μm and 1,000 KDa).

Sampling statistics
Seven stations were sampled on the Greenwich meridian transect with a maximal depth of 4,500 m. A total of 140 samples on 56 depths were sampled (28 of unfiltered, 56 of 0.2 μm filtered and 56 of 1,000 KDa ultra-filtered). Among them, 11 depths characterizing the most important water-masses were sampled twice and kept frozen for later analyses while back at NIOZ (for the study of kinetic exchange between the different forms of iron).

Two profiles were sampled in the Weddell Sea for a total of 46 samples (8 of unfiltered, 19 of 0.2 μm filtered and 19 of 1000 KDa ultra-filtered). 8 depths were also sampled twice to characterize important water-masses. Two other depths were also taken on a third station to start the mass balance experiment.

In the Drake Passage one station was sampled for a total of 30 samples (10 depths). A second station was used to continue the masse balance experiment.

Preliminary results

Only results of the fraction smaller than 0.2 μm could be calculated at the time of this report. The following figures (3.3, 3.4 and 3.5) show the vertical profiles of iron and of the ligands in the fraction smaller than 0.2 μm. These 3 profiles are 3 stations along the Greenwich meridian. The concentration of the ligand is expressed in nanoequivalents of mol Fe (nEq of MFe), meaning sites present at the ligand molecules at which Fe can be bound in such a way as described by the determined binding strength (conditional stability constant). The conditional stability constant ranged from $10^{21.87}$to $10^{23.35}$, and a mean value of $10^{22.44}$.

The excess ligand concentration is calculated by subtracting the dissolved Fe concentration from total ligand concentration, resulting in the concentration of empty ligand sites (not filled with Fe) of the sample. In all samples, except one, the excess ligand concentration was larger than zero, implicating that more than 99 % of the dissolved Fe was bound to the ligands. It is possible that the sample in station 107 at 2,500 m depth (Fig. 3.5) was contaminated with Fe.

The results of the extra experiments indicate that unfiltered samples stored correctly (4° C) can be kept for 1 or 2 days before changes occur. However, as soon as the algae die, changes occur in the ligand concentration as well as in the binding strength of the ligand.

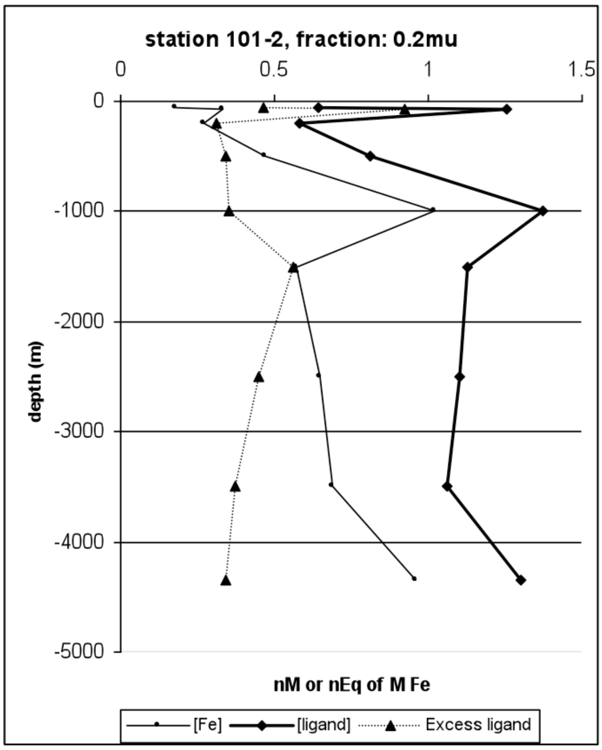

Fig. 3.3: Station PS 71-101/2, concentration of iron and ligands with the depth

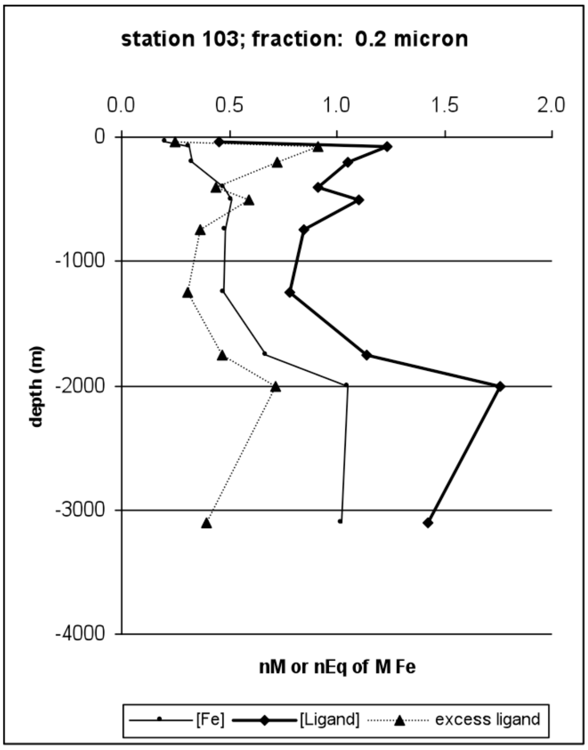

Fig. 3.4: Station PS 71-103/1, concentration of iron and ligands with the depth

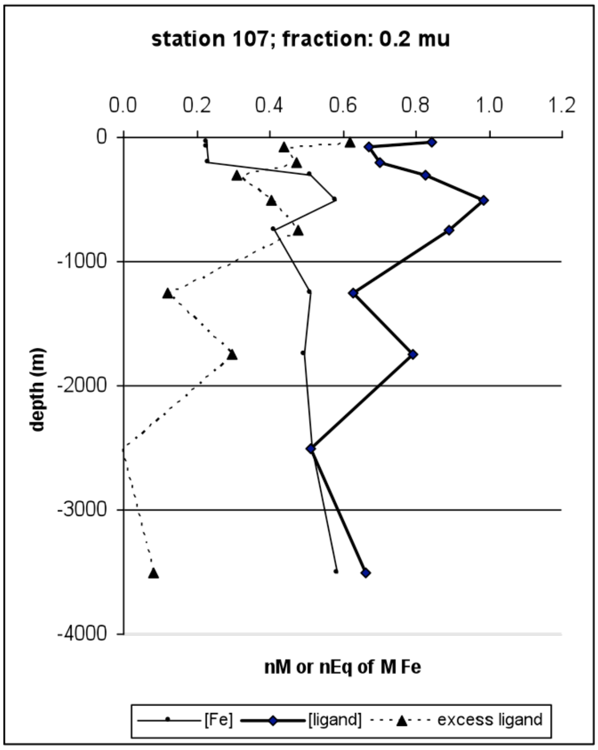

Fig. 3.5: Station PS 71-107/3, concentration of iron and ligands with the depth

References

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Gerringa, L.J.A., P.M.J. Herman, T.C.W. Poortvliet (1995). Comparison of the linear Van den Berg/Ruzic transformation and a non-linear fit of the Langmuir isotherm applied to Cu speciation data in the estuarine environment. Marine Chemistry. 48, 131-142.

3.1.3 Dissolved Al and Mn as source tracers for iron

Rob Middag and Cornelis van Slooten
NIOZ

Objectives

For the world oceans, the initial hypothesis of Fe coming from above has been challenged by upwelling supply from below where reducing marine sediments are the ultimate Fe source. Dissolved Al in surface waters is a tracer of aeolian dust input and indeed very high in the Mediterranean where dissolved Fe is also high due to dust supply from the adjacent Sahara and Egypt arid regions. The dissolved Al and dissolved Fe also co-vary on a transect from the Canary Basin to Gibraltar. Data of Al is scarce in polar seas, and IPY GEOTRACES aims to fill this gap for better assessment of dust input. Elevated dissolved Mn and Fe in reducing environments render dissolved Mn a source tracer for Fe from below, i.e. from reducing sediments. Our combined Mn-Fe data, also with natural radiotracers will quantify the Fe 'from below' source.

Work at sea

Dissolved Al and dissolved Mn were measured directly using shipboard FIA measurements. In a continuous FIA system, the acidified pH 1.8, filtered (0.2 μm) seawater is buffered to pH 5.5 and 8.5 for Al and Mn, respectively. The metals are concentrated on a column which contains the column material iminodiacetic acid (IDA). This material binds only transition metals and not the interfering salts. After washing of the column with ultra pure water (MQ) the column is eluted with diluted acid.

The Al is determined using lumogallion after Brown and Bruland (2008). Lumogallion is a fluorometric agent and reacts with aluminium. The change in the fluorescence detected by a fluorometer is used as a measure for the dissolved Al concentration.

In order to verify the consistency of the analysis, every day a sample was measured from a 25 liter tank that was filled in the beginning of the cruise. Also a duplicate sample was taken every cast and this sample was analysed with the samples of the next cast to further check for inter daily variation. Furthermore, SAFe seawater samples were analysed daily and the values are consistent with those found by Brown and Bruland (2008).

The Mn is detected using the chemoluminescence method of Doi et al. (2004). The oxidation of luminol by hydrogen peroxide produces a blue light. This oxidation reaction is catalyzed by manganese and the increase in the production of blue light is detected by a photon counter and used as a measure for the dissolved Mn concentration.

Also for Mn similar consistency checks as for Al have been performed with samples from the 25 liter tank and duplicate samples. Also SAFe seawater was analysed which was consistent with the values found previously in the lab and by Mendez (pers. com). The daily consistency of the system was verified using a so-called drift standard.

Preliminary results

The preliminary data shows that the values in the surface for dissolved aluminium are low over the Greenwich meridian (Figs. 3.6 and 3.7). The increase of Al with depth as observed in the Arctic and North Atlantic oceans is far less profound in the Southern Ocean. Higher deep values of up to 6 nM were found closest to the African continent while close to the Antarctic continent the deep values were below 2 nM. The section over the Greenwich meridian consisted of 22 stations and a total of 486 samples were analysed for dissolved Al over the Greenwich meridian. Another 8 stations were sampled in the Weddell Sea and 10 more in the Drake Passage bringing the total number of samples to 915. The Weddell Sea bottom water appears to be somewhat enriched in dissolved Al and some elevated values were found just under the surface going into the Drake Passage.

The Mn values are quite low throughout the water column (Figs. 3.8 and 3.9), except for areas with suspected hydrothermal input enriching the deep waters with Mn. Going from deep to surface the Mn values start to increase towards the surface as is generally observed for Mn, but the values drop sharply in the last 25 to 50 metres indicating a depleted surface layer. The section over the Greenwich meridian consisted of 22 stations and a total of 496 samples were analysed for dissolved Mn. Another 8 stations were sampled in the Weddell Sea and 10 more in the Drake Passage bringing the total number of samples to 926. These sections showed Mn input from the Peninsula and Antarctic islands.

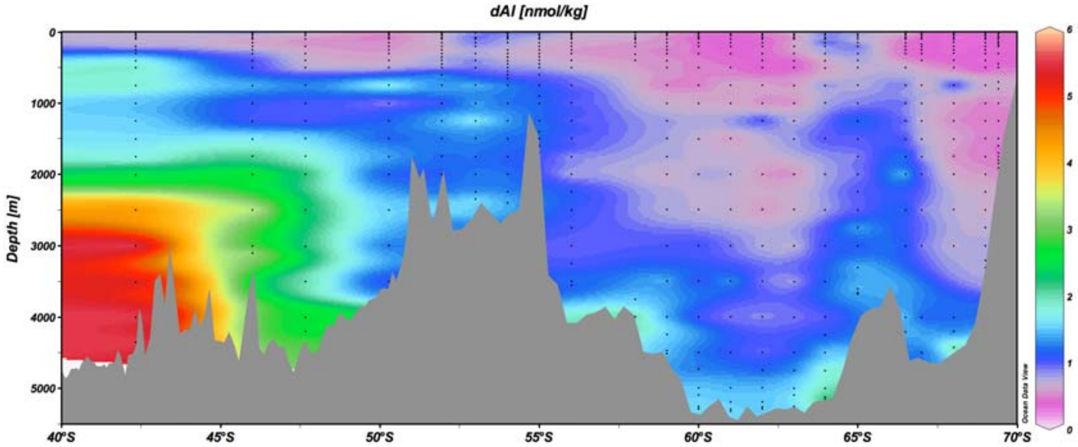

Fig. 3.6: Distribution of dissolved Al on a section along the Greenwich meridian

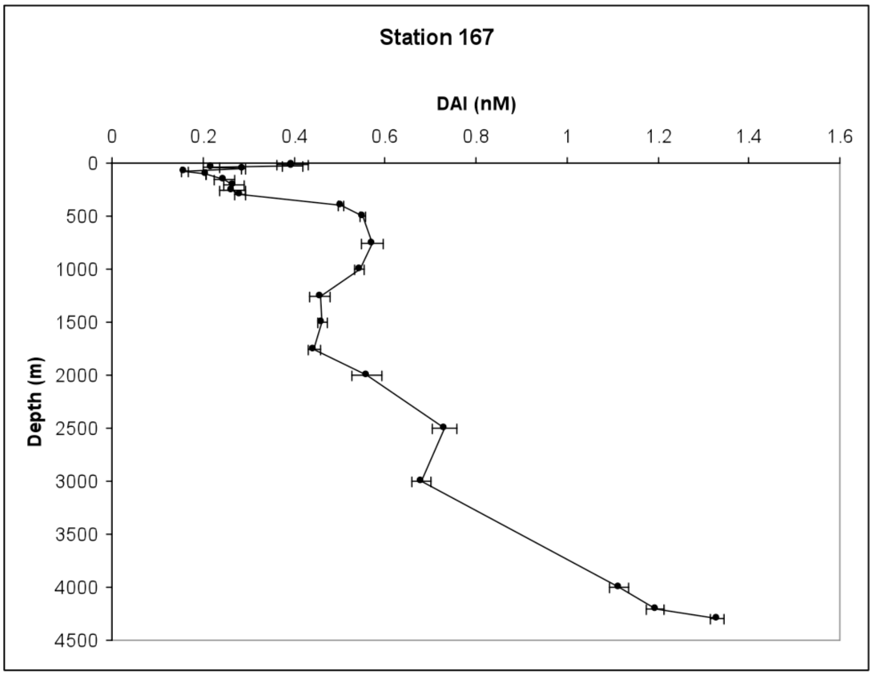

Fig. 3.7: DAl profile station 167 Greenwich meridian

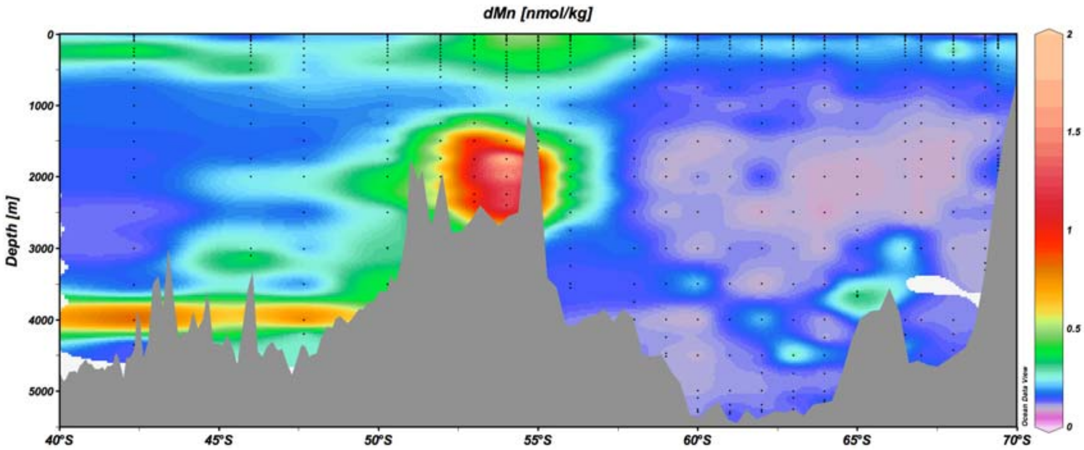

Fig. 3.8: Distribution of dissolved Mn on a section along the Greenwich meridian

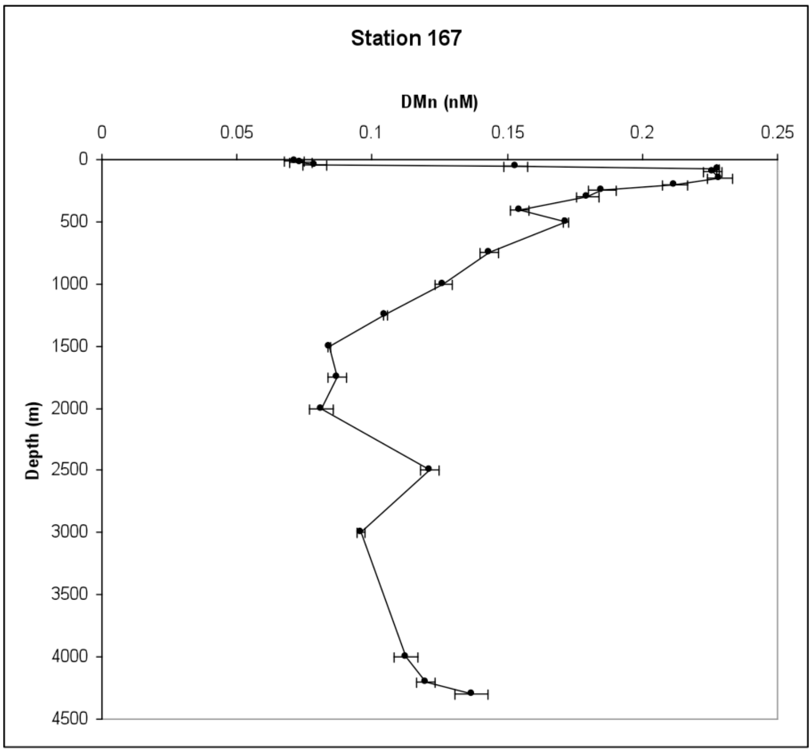

Fig. 3.9: DMn profile station 167 Greenwich meridian

References

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3.1.4 Involvement of Co, Ni, Cu, Zn, Ag, Cd in biological cycles in Polar Oceans

Patrick Laan, NIOZ
not on board: E. Achterberg, NOC

Objectives

The first row of transition metals (Mn, Fe, Co, Ni, Cu, Zn) are essential for every living cell, in the sea and on land. Co is co-factor in vitamin B12, which most phytoplankton cannot synthesize hence needs to be provided in ocean waters. Zinc is in carbonic anhydrase for CO_2 fixation by algae. Substitution of cobalt Co or cadmium Cd in carbonic anhydrase may occur under Zn deficiency stress. Also a specific Cd-based carbonic anhydrase exists in a certain diatom. These enzyme functions may partly explain the co-variance in the oceans of Zn with silicate (see 3.1.5), and Cd with phosphate. Also nickel Ni co-varies with both phosphate and silicate, and copper Cu resembles silicate, albeit less due to deep ocean Cu removal (akin to deep ocean Fe removal, see 3.1.2). The second row metal silver (Ag), despite having no biological function, also correlates with silicate. The thus far small (Cd, Ni, Cu) or very small (Zn, Ag) ocean data sets suggest interaction of Zn and Ag with the diatoms-and-Si cycle, and all (Ni, Cu, Zn, Ag, Cd) with the general ocean carbon cycle. The parallel measurements of nutrients (nitrate, phosphate, silicate) and alkalinity allows our study of metal-nutrient co-variances. With regards to the trace metals Cd, Cu, Ni and Zn this allows synergy and internal consistency with the project of Dr. Peter Croot (IfM-GEOMAR).

Work at sea

At each ultraclean station cast sample bottles of one litre each were filled with filtered seawater for measurements afterwards in the home laboratory of Co, Ni, Cu, Zn, Cd as well as dissolved Fe. Latter dissolved Fe as a duplication hence confirmation/verification of the direct shipboard detection. The home laboratory measurement of this suite of trace metals will be done by High-Resolution Inductively Coupled Plasma Mass Spectrometry (HR-ICP-MS) with preceding in-line column pre-concentration of the metal elements from seawater. Another set of small 60 ml bottles was collected and stored for measurements afterwards of dissolved silver Ag in the laboratory of collaborator Dr. Eric Achterberg, National Oceanography Centre, Southampton, UK.

Expected results

Within two years we hope to have analysed in all samples the first row of transition metals. With these results we hope to get a better understanding of the trace metal distributions throughout the world oceans and especially in the “High Nutrient Low Chlorophyll” region of the Southern Ocean.

3.1.5 Fractionations of the stable isotopes of cadmium

Patrick Laan, Rob Middag, Cornelis van Slooten, Charles-Edouard Thuroczy, Hein de Baar, NIOZ
not on board: Wafa Abouchami (MPI Chemie, Mainz), Mark Rehkamper (DESE, London)

Objectives

Within the oceans the trace metal cadmium (Cd) exhibits a close correlation with the nutrient phosphate. This suggests an involvement of Cd in the ocean biological cycle. This in turn has been suggested to serve as a paleoceanographic indicator of past concentrations of phosphate in the oceans. Here the elemental ratio of cadmium versus calcium (Cd/Ca ratio) in the calciumcarbonate of microfossils, notably foraminifera, would serve as a proxy tracer for paleo-phosphate. One implicit assumption of this paleo-application is that the Cd/PO_4 proportions in seawater do not change significantly when the ocean changes, for example from a glacial period ocean into an interglacial period ocean.

The involvement of Cd in the ocean biological cycle (de Baar et al., 1994; Loscher et al., 1998) may be due to two different processes. On the one hand Cd may have true biological uptake in plankton, and a true biological function inside the living cell. Until recently Cd was deemed to have no biological functionality. However now there is evidence of Cd sometimes serving as substitute for zinc (Zn) in the enzyme carbonic anhydrase. Moreover there is another line of evidence suggesting a truly Cd-based carbonic anhydrase enzyme in some diatoms. On the other hand Cd may become adsorbed by, in principle abiotic, chemical processes, on the outside of plankton material. When this plankton becomes debris and settles into the deep oceans where it is remineralized by bacterial consumption, the Cd may be released again and return into seawater solution in the deep sea.

In general a true involvement in biological processes implies involvement in a large sequence of many biochemical reactions. Each reaction giving rise to slight mass fractionation, heavier isotopes tend to be left behind somewhat. The overall suite of many biochemical reactions will give rise to a significant, detectable, isotopic fractionation. This is well known for isotopes of biological elements carbon (C) and nitrogen (N). Similarly a significant isotopic fractionation of Cd isotopes in marine biota would cause major variation of the Cd isotope signal in the seawater from which the biota had derived its Cd. Therefore the Cd isotope ratio in various water masses will serve to indicate whether or not Cd is truly involved in biochemical processes. Moreover once Cd isotope ratio values can indeed be measured accurately in seawater, this will also serve as a tool for enhancing our understanding of the use of Cd as a paleo-indicator of phosphate.

Work at sea

Samples of seawater were collected both with the ultraclean CTD system for vertical profiles and with the clean torpedo and pumpline system for underway surface waters. Both type of samples were filtered over 0.2 micron nominal size cutoff filter cartridges and collected into pre-cleaned bottles. Sample volumes ranged from 1 L for deep waters (where Cd concentrations are deemed to be high), to 5 L in intermediate waters, 10 L in upper water column, and 20 L for water collected from 3-5 m depth with the torpedo.

At the Greenwich meridian we obtained four vertical profiles of 8-10 sampling depths each at stations and hydrocasts PS71-104-2, PS71-113-2, PS71-138-2 and PS71-163-1 as well as 25 underway samples of 20 L each with the IFISH torpedo. In the Weddell Sea two vertical profiles were obtained at stations and hydrocasts PS71-198-2 and PS71-216-4, due to sea ice cover it was impossible to sample with the torpedo. In Drake Passage one vertical profile was obtained at station and hydrocast PS71-249-3 and one underway sample of 20 L with the IFISH torpedo. See the corresponding hydrocast sheets of A.1. Ultraclean CTD for depths etc. of the vertical profile samples, and the Zero & Drake folder H. Iron Fish Cd Isotopes for fact sheets of the 26 underway surface samples with positions, S, T, and nutrients values.

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3.1.6 Trace metal input by aerosols

Maarten Klunder, Charles-Edouard Thuroczy and Rob Middag
NIOZ
not on board: Alex Baker, University of East Anglia

Objectives

The input of airblown dust particles (aerosols) into surface waters is known to be a source of trace metals in seawater. In order to be able to quantify this source an aerosol collector from Dr Alex Baker (University of East Anglia) was placed on top of *Polarstern*'s Peildeck. Shipboard collection of the aerosols was done by Maarten Klunder, Charles-Edouard Thuroczy and Rob Middag. Dr. Alex Baker will analyse the aerosols for trace metals in his laboratory.

There is a close link with 3.1.3 where distributions of Al in surface waters are determined as independent tracer for aerosol input.

Work at sea

Every 50 to 72 hours a new filter was placed in the aerosol collector, depending on daylight and weather conditions. Unfortunately some sampling days were lost due to breaking down of the engine of the aerosol collector which had to be replaced. In total 21 filters were collected. The filters stayed on *Polarstern* till Bremerhaven in the -20°C freezer room.

3.1.7 The effect of dynamic light conditions and iron limitation on phytoplankton abundance

Anne-Carlijn Alderkamp
University of Groningen, Stanford University
not on board: Kevin R. Arrigo, Stanford University

Objectives

The DYNALIFE project is funded by the US-IPY programme and focuses on the interactions between DYNAmic light conditions and Fe limitation experienced by Antarctic phytoplankton. In addition to the availability of iron, light plays a major role in defining where and when the different phytoplankton taxa bloom. The light climate phytoplankton experience can be highly dynamic, as a result of diel cycles, changes in cloud cover and wind driven mixing of the upper layer of the ocean. These alternations between low and high light require regulation and acclimation of light harvesting, photosynthesis, and photoprotective pigments in the phytoplankton. In response to low light algae maximize their light harvesting capacity and photosynthetic efficiency. Yet, high light may cause damage to the photosystems leading to photoinhibition and therefore requires synthesis of protective pigments. Southern Ocean ecosystem model results indicate taxon-specific differences in photoinhibition may be a key factor in determining the distribution of a taxon. And, indeed, experiments with Antarctic phytoplankton in the laboratory have identified taxon-specific differences in photoacclimation and photoinhibition at different light conditions that contribute to explaining the observed distribution. In addition, iron (Fe) limitation of the algal communities in the Southern Ocean is now well documented, and directly affects the quantity and efficiency of the photosystems. Thus, Fe-limitation directly affects photoacclimation and photoinhibition.

The objective of the ANT-XXIV/3 cruise is to determine 1) if Antarctic phytoplankton experience photoinhibition when residing near te surface, 2) if photoinhibition is related to the depth of the mixed layer, and 3) the importance of repair of photodamage versus photoprotection.

Work at sea

To assess the ratio of photoprotective and light harvesting pigments, at 10 stations on the Greenwich meridian and 5 stations on the Weddell Sea transect, samples from the upper 100 m of the water column were filtered onto GF/F filters under low vacuum pressure, *in-situ* temperature and low light levels. Filters were snap-frozen in liquid nitrogen and stored at -80°C for pigment analysis by HPLC at the University of Groningen.

To assess the extent of photoinhibition Antarctic phytoplankton receive when residing near the surface, short-term deck incubations were carried out at 9 stations on the meridian of Greenwich, 8 stations on the Weddell Sea and 5 stations on the Drake Passage transect. The depth of the mixed layer was determined based on the CTD profile. Samples containing *in-situ* phytoplankton were collected from surface water and the chlorophyll maximum. Subsamples were fixed for microscopic analysis of phytoplankton species and samples were filtered and stored at -80°C for analysis of photosynthetic and –protective pigments as described above. The photosynthetic efficiency of phytoplankton (Fv/Fm) was analyzed with a PAM fluorometer. Samples were incubated for 20 mins at incident light levels in deck incubators. The effect on the photosynthetic efficiency was determined by PAM fluorometer and subsequently, recovery of photosynthetic efficiency was measured during incubation at *in-situ* temperatures and low light levels. In parallel experiments the repair of photodamage was prevented by addition of the inhibitor lincomycin. Lincomycin inhibits transcription of chloroplast encoded proteins, such as the D1 protein, which is a crucial component of photosystem II and one of the first proteins to become damaged by high light.

Preliminary data

Significant photoinhibition was observed as a decrease in efficiency of photosynthesis (Fv/Fm) after incubating *in-situ* phytoplankton samples in deck incubators at incident light levels (see Fig. 3.10 for a typical example), both for samples from the surface as well as the chlorophyll maximum. Part of the decrease in photosynthetic efficiency was reversible during 120 mins of recovery under low light conditions. The inhibition of repair by the addition of lincomycin did not affect the decrease in photosynthetic efficiency during the *in-situ* incubation, but reduced the recovery in almost all experiments. Experiments conducted early in the morning, or at low incident light levels showed the least photoinhibition, which was rapidly reversed. Experiments conducted at higher light levels showed strong photoinhibition, that was not (completely) reversed during 120 mins of recovery. In these cases, lincomycin prevented recovery completely, as shown in Fig. 3.10.

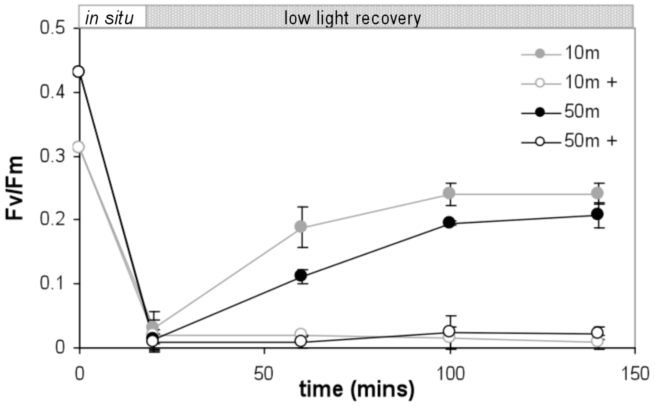

Fig. 3.10: A typical example of photosynthetic efficiency (Fv/Fm) dynamics during a deck incubation followed by recovery under low light conditions. Means and standard deviations are shown for triplicate incubations of water collected at 10 m and 50 m depth, without and with (+) the addition of lincomycin, an inhibitor of repair of photosystem II.

Future work

The characteristics of photoinhibition and recovery observed during incubation experiments will be related to species composition (microscopy), the ratio of photosynthetic and –protective pigments (HPLC analysis, University of Groningen), the characteristics of the mixed layer and the incident irradiance in the experiments.

3.1.8 Southern Ocean primary productivity in a high-CO_2 world

Babette Bontes[1)], Ika Neven[1)], Steven van Heuven[1)], Hans Slagter[1)], Jan van Ooijen[2)]

[1)]University of Groningen
[2)]NIOZ

Objectives

Since the beginning of the Anthropocene, atmospheric CO_2 levels have risen from 280 ppm to 370 ppm. This is higher than any CO_2 concentration experienced on Earth in at least 400,000 years and a further increase up to 750 ppm by the year 2050 becomes increasingly inevitable. Along with rising atmospheric CO_2 comes a continuing invasion of CO_2 into the world oceans (particularly in polar areas), which is predicted to cause a drop of pH by 0.3 – 0.4 units. As a result only half of the pre-industrial carbonate ion concentration $[CO_3^{2-}]$ might remain (Feely et al. 2004). With the biological pump overriding CO_2 outgassing from upwelling deep waters, the Southern Ocean is an important sink for anthropogenic CO_2. Thus, making the local phytoplankton community an important player within the global climate system.

Surface ocean pH and CO_2 changes in turn might have large impact on representatives of the major bloom forming taxonomic classes: diatoms, nanoflagellates, and haptophytes (mainly Phaeocystis antarctica) in the Antarctic Ocean proper (> 50°S), and coccolithophorids in the sub-Antarctic region (< 50°S) of the Southern Ocean. We are going to study the effects of different pCO_2 in Southern Ocean seawater on the growth, vitality and carbon metabolism of the *in-situ* algal community.

Work at sea

CO_2 manipulation experiments

Five CO_2 manipulation experiments were conducted. The first examined the influence of CO_2 under Fe limited and Fe replete conditions; in the following experiments, CO_2 was alternated only under Fe replete conditions. Seawater inoculums were collected from the chlorophyll maximum by the NIOZ ultraclean CTD and incubated in 10 L Polycarbonate carboys (Nalgene) at ambient temperature under 50 µEinstein m^2 s^{-1}, 16h: 8h light: dark cycle in a laboratory container. The following CO_2 scenarios were mimicked in a semi-continuous set-up and monitored for 10 days

- 190 ppm (Last Glacial Maximum)
- 370 ppm (Present)
- 750 ppm (Future 2050 A.D)

Phytoplankton were daily enumerated and identified using flow cytometry, for species smaller than 20 μm, and microscope counts for large species. Algal viability and photosystem II (PS II) efficiency was measured daily on dark-adapted samples by the PhytoPAM fluorometer. In addition, nutrient dynamics have been monitored every day. On T0, T 5 days, T 7 days and T 10 days samples were collected for Fe, determination of particulate organic carbon (POC), dissolved organic carbon (DOC) and pigment composition. Dissolved inorganic carbon (DIC) and total alkalinity were monitored every other day throughout the experiments with methods described in sections 3.4.1 and 4.1. of this report.

Short-term $^{14}CO_2/H^{14}CO_3^-$ disequilibrium experiments (Elzenga et al. 2000) were carried out on T0, T 5 days and T 10 days of the experiments to measure the extent external carbonic anhydrase (eCA), an enzyme which catalyses the dehydration of bicarbonate (HCO_3^-) to CO_2 and vice versa in the boundary layer of phytoplanktonic cells, contributes to the uptake of inorganic carbon. In this way it was possible to distinguish between the inorganic carbon species taken up by cells.

Transect

To estimate the extent of bicarbonate uptake and the role of eCA in inorganic carbon uptake of Southern Ocean phytoplankton, short-term $^{14}CO_2/H^{14}CO_3^-$ disequilibrium experiments were carried out. In total 9 stations were assessed on the Greenwich meridian transect, 10 on the Weddell Sea transect and 6 on the Drake Passage transect.

Preliminary results

Measurements of DIC revealed that it took approximately 2 days of continuous aeration to reach the required levels of pCO_2 in the experimental vessels. Subsequently the pCO_2 remained reasonably stable during the experiment (data not shown).

Fluorescence parameters, growth (Fig. 3.11), viability and photosynthetic efficiency (Fig. 3.12) were not affected by the different CO_2 or Fe treatments. The dynamics of phosphate, silicate and nitrate (Fig. 3.13) suggest that neither Fe addition nor differences in CO_2 concentration affected the nutrient uptake rates of the algae.

^{14}C disequilibrium experiments revealed that communities cultured under 190 ppm make extensive use of the bicarbonate pool by eCA-mediated conversion to CO_2. This distinct pattern decreased under present CO_2 conditions and ceased totally under future high CO_2 conditions. Differences were already visible after the short incubation time of 5 days (Fig. 3.14). After analysis of pigment composition, POC and microscope samples a quantitative approach will be possible.

In consistence with the experimental data, preliminary results of the Greenwich meridian and Weddell Sea transect suggest that the majority of phytoplankton makes only modest use of the bicarbonate pool under present CO_2 conditions.

The existence of a Carbon Concentrating Mechanism such as eCA that is quickly induced under low CO_2 conditions implies that the majority of phytoplankton is well adapted to changing CO_2 conditions. External CA-mediated conversion of bicarbonate to CO_2 may have been beneficial in the past during changes in CO_2 concentrations over geological timescales as well as during fast occurring CO_2 shifts, for example during a phytoplankton bloom. However, under future high CO_2 scenarios this once evolutionary advantageous trait might become redundant.

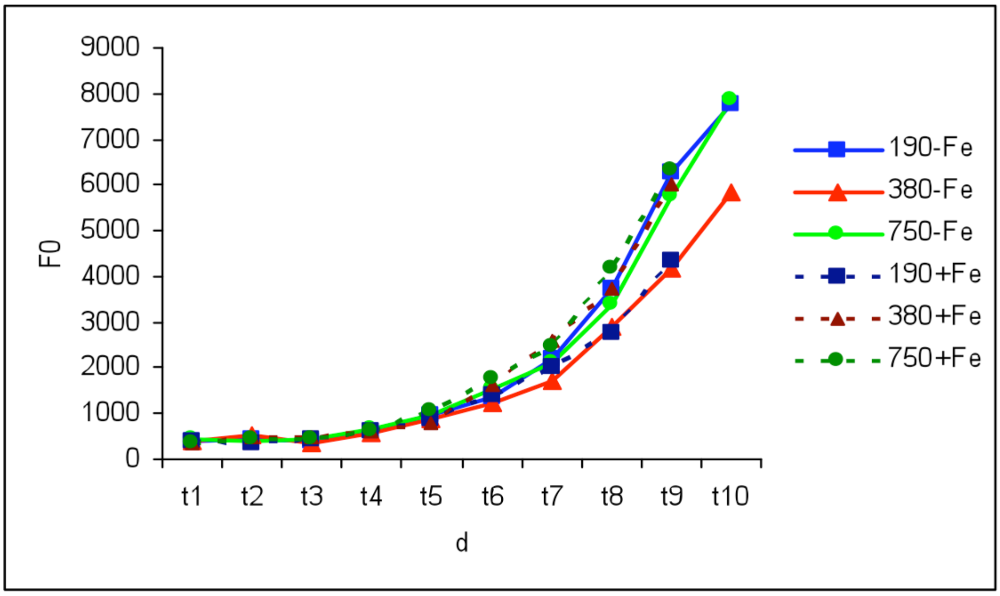

Fig. 3.11: Phytoplanktonic growth during experiment 1

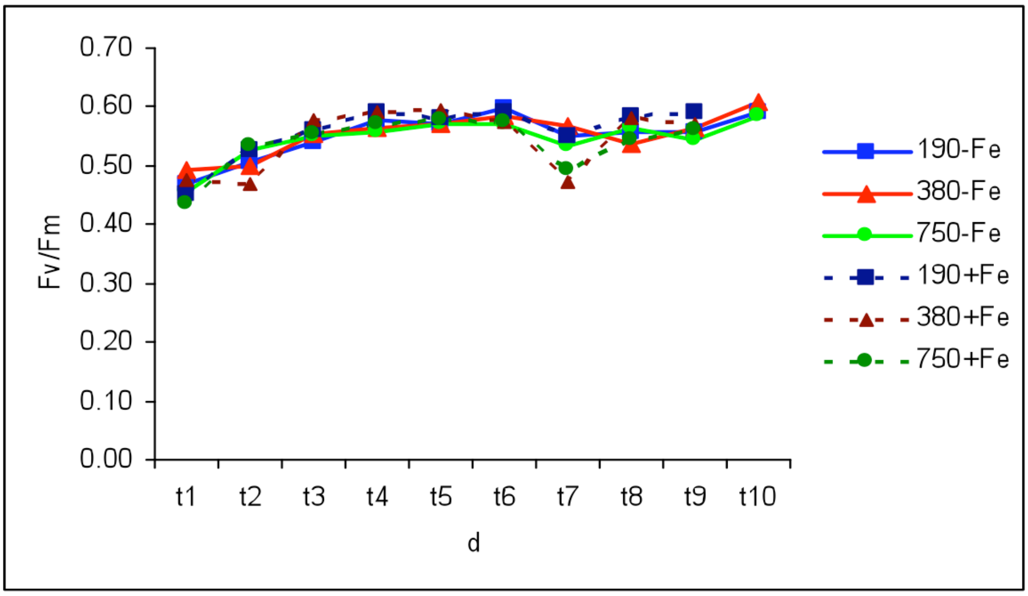

Fig. 3.12: Photosynthetic efficiency of phytoplankton during experiment 1

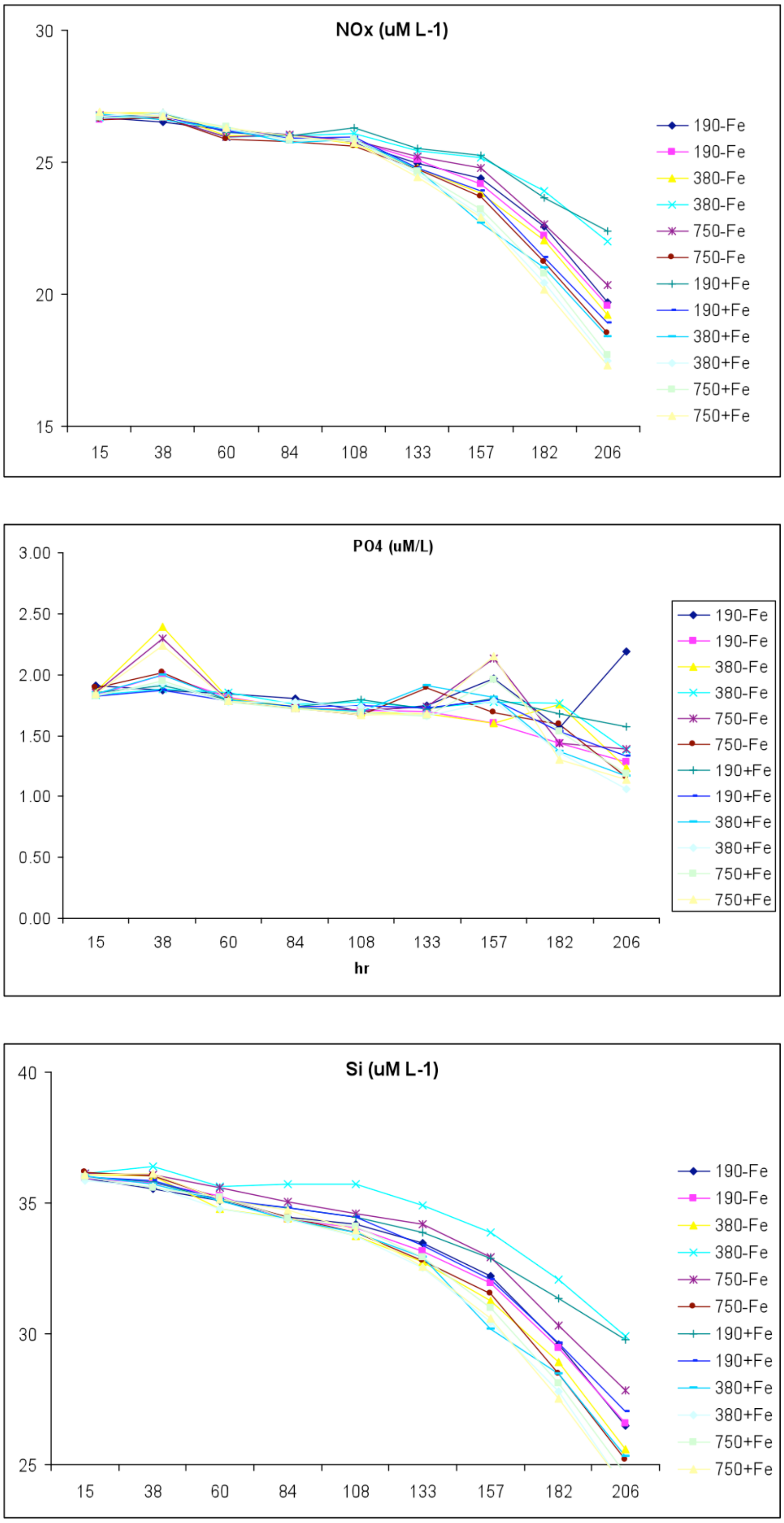

Fig. 3.13: Dynamics of nitrate, phosphate and silicate during experiment 1

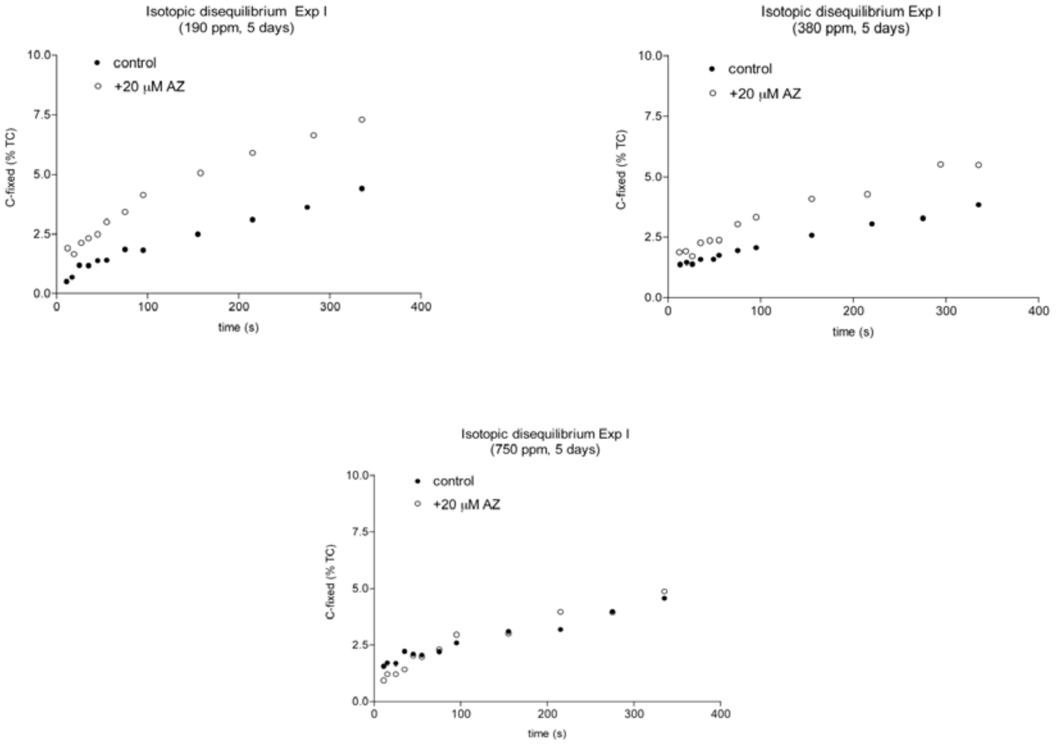

Fig. 3.14: Differences in bicarbonate utilization by the in-situ phytoplankton community cultured for 5 days under different pCO_2 conditions (190ppm, 380ppm, 750ppm)

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3.1.9 Ultraclean CTD and sampling system

Sven Ober1), Willem Polman1) (deceased 2 March 2008), Mihael Stimac2)
1)NIOZ
2) Heli Service

This CTD and sampling system was operated by Sven Ober (CTD operator and electronics) and Willem Polman (winch operator and overall mechanics). Due to the tragic loss of Willem Polman, the kind offer of Mihael Stimac to continue as winch operator was gratefully accepted. This and the much appreciated extra support of the shipboard CTD team allowed the system to be operational again from 9 March onwards.

During the cruise a special CTD system was used to sample for trace elements and isotopes. This CTD system consists of 3 major modules: a winch with a super-aramide CTD cable, a box-shaped titanium CTD frame and a clean air container that is designed to hold the CTD frame in order to enable subsampling and filtration under clean air conditions. The CTD frame is made of pure titanium and was equipped with a Seabird SBE9+ CTD underwater unit, a double SBE3/SBE4 temperature-conductivity-sensor set each with a separate SBE5 underwater pump, an SBE43 DO-sensor, a Chelsea MK-III fluorometer, a Seapoint OBS and a special sampling system. This sampling-system consists of a Multivalve hydraulic multiplexer and 24 GoFlo sampling bottles each with its own hydraulic release unit. (De Baar et al, 2008 and Ober et al, 2002). The temperature sensors were *in-situ* calibrated with an SBE35 reference thermometer. Salinity samples were analysed using an Guildline Autosal 8400B for the calibration of the conductivity sensors (See 2.1.1). The pressure sensor, mounted inside the SBE9+, was monitored using Electronic Reversing Pressure Meters, (Brand SIS, type 6000X). Winkler titrations were carried out in order to calibrate the SBE43 DO-sensor.

In total 56 casts were carried out with the Ultraclean CTD system (Type A1: 41, type B2: 7, type D: 2, type G: 5, type F: 1) including an intercalibration cast with the CTD system operated by AWI. This cast proved that both systems had a sufficient level of data quality enabling interchangeability during the cruise.

Throughout the whole cruise the system worked very reliable, although some technical problems occurred. The primary conductivity sensor had to be exchanged after station 135, cast 1 for a spare because of erratic behavior due to a broken cell and the secondary sensor pair showed for still unknown reasons a noisy signal. The DO-sensor showed some drift in time and some depth dependency.

As part of the processing of the CTD all available pre-cruise, post-cruise and *in-situ* calibration data were used to correct for the sensor imperfections. The way how the calibration values are obtained and processed are described in detail in chapter 2.1.1 of this report. Overall the data quality of the salinity is better than +/- 0.002 and for temperature better than +/- 0.001 K. The accuracy of the CTD oxygen is better than +/- 0.1 ml/l.

The hydraulic bottle control system worked perfectly (100%) and the GoFlo samplers worked very well (better than 99%). The analysis of dissolved Fe and dissolved Al showed very low concentrations in the surface water. The concentrations of dissolved Mn were very low at depth. These low concentrations proved that the sampling system did not contaminate the samples. The status of "Ultraclean" was confirmed conclusively.

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3.1.10 Ultraclean sub-sampling and filtrations

Patrick Laan[1], Maarten Klunder[1], Rob Middag[1], Cees van Slooten[1], Charles-Edouard Thuroczy[1], Oliver Baars[2]

[1]NIOZ
[2]IFM-GEOMAR

Upon the evacuation of Maarten Klunder from Neumayer station, Oliver Baars kindly joined the team during the remaining period of subsampling from 9 March onwards to the end of the expedition.

Once the ultraclean frame with 24 GOFLO samplers was placed inside the clean laboratory van an extensive programme of sub-sampling and filtrations was done, typically lasting 3 - 4 hours.

Unfiltered seawater samples have been collected into various pre-cleaned bottles for the projects 3.1.8, 3.2.5, 3.3.6 (Barium only), 3.4.1, 5.1, as well as by the respective analists themselves for projects 2.5 and 4.1.

Filtrations have been done with a 0.2μm Sartorius Sartobran 300 cartridge filter for the projects 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5; 3.2.1, 3.2.2, 3.2.3; 3.3.6 (Rare Earths only) and 3.3.7.

Moreover filtrations have been done for project 3.3.7 in another approach over a suite of two filter membranes of 5 micron and 0.45 micron nominal size cutoff respectively, placed in-line such that the first 5 micron filter takes out the larger size class marine particles, and next the finer 0.45 micron filter removes the smaller size class particles. In this manner not only the filtered seawater is collected, but also the filters for later analysis of the particles on the filters.

3.2 Trace elements during ANT-XXIV/3 expedition: IFM-GEOMAR team

Peter Croot[1)] and Rob Sherrell[2)]
[1)]IfM-GEOMAR
[2)]Rutgers University

Background and general objectives

In the High Nutrient Low Chlorophyll waters of the Southern Ocean the supply of iron controls primary productivity and thus the cycling of other key bio-elements (Co, Ni, Cd and Zn). While recent work has focused on the role of iron, it is now clear, mostly through at sea incubation experiments and laboratory studies, that other elements may also play a role in controlling the species composition of the phytoplankton and importantly the rates at which macronutrients are consumed by phytoplankton. These changes in rates of uptake are then reflected as differences in the nutrient ratios, or metal to nutrient ratios, of the phytoplankton themselves. A further complicating factor is that the chemical speciation and bioavailability of these bio-elements may also undergo changes as a function of phytoplankton growth fuelled by the supply of iron. Understanding of these processes is then critical for investigations into primary productivity of the Southern Ocean and the sources and sinks for major nutrients. Unfortunately at the present time there have been only a limited number of studies on the distribution of these elements in the Southern Ocean, and even less studies examining the chemical speciation of these elements. Recent studies have also indicated that sub-optimal Zn concentrations may greatly influence Si and N uptake rates by phytoplankton while the Co containing vitamin B_{12} may be present in the Southern Ocean at potentially limiting concentrations for some diatom species – however for both elements direct evidence is still missing. Thus presently we urgently require a comprehensive study encompassing the chemical speciation and distribution of the already identified key bio-elements (Co, Ni, Cd and Zn) over a range of different Fe and macronutrient conditions. Overall such a study will not only improve our understanding of trace metal biogeochemical cycling in the Southern Ocean but also greatly increase our understanding as a whole of nutrient biogeochemistry in this key climatic region.

As part of the GEOTRACES contribution to ANT-XXIV/3 the IfM-GEOMAR Aqueous Trace Oxidant and Metal Speciation Laboratory (ATOMSLab) has 3 main research areas funded by the DFG:

1. Does Fe control the biogeochemical cycling, speciation and distribution of Cd, Zn, Ni and Co in the Southern Ocean?
2. Development of a budgetary scheme for Cd, Zn, Ni and Co in the Southern Ocean, including both concentrations of various inorganic and organic pools, size ranges and the fluxes between them.
3. What controls trace metal solubility (Fe, Al and Ti) in the ocean?

The overall aim of this work is to combine the results of the objectives listed above into a comprehensive model of the key processes affecting the biogeochemistry of the Cd, Zn, Co, Ni and Ti in the Southern Ocean.

3.2.1 Cadmium, cobalt, nickel and zinc speciation in the Southern Ocean

Oliver Baars and Peter Croot
IfM-GEOMAR

Objectives

Our main objective during ANT-XXIV/3 was to examine the speciation and biogeochemistry of other bio-relevant elements (Cd, Co, Ni and Zn) in the iron limited Southern Ocean. While Fe is the primary control for phytoplankton productivity in this region, the elements we are investigating have also been identified as being important for structuring the phytoplankton community and the macronutrient drawdown during bloom situations. The interplay between the Fe biogeochemical cycle and the physical oceanography of the region with the elements we are studying is important for understanding their global cycling. By comparison of the chemistries and distributions of Cd, Zn, Co and Ni this IPY GEOTRACES study is aiming to improve our knowledge of the processes effecting trace metal distributions in the ocean with emphasis on the iron limited Southern Ocean.

Introduction

Zn Biogeochemistry – zinc is an element that is required for many enzymatic processes and from a marine prospective chief amongst these are its role in carbonic anhydrase (Lane and Morel, 2000b) and in zinc finger proteins for DNA transcription(Armbrust et al., 2004). Vertical profiles of Zn show a strong nutrient like profile (Bruland et al., 1979; Nolting and De Baar, 1994), with strong similarity to silicate. In surface waters Zn is present as weak organic complexes (Bruland, 1989; Ellwood, 2004; Ellwood and van den Berg, 2000) that lower the free zinc concentrations to sub pM levels which based on laboratory studies could be potentially limiting for phytoplankton (Brand et al., 1983; Buitenhuis et al., 2003; Shaked et al., 2006; Sunda and Huntsman, 1992; Sunda and Huntsman, 1995; Sunda and Huntsman, 2005). However deckboard incubation experiments in HNLC regions (Coale, 1991; Coale et al., 2003; Crawford et al., 2003) have yet to clearly show any strong effect on productivity but have shown differences in N and Si assimilation rates (Franck et al., 2003).

There have been a few published studies on Zn distributions in the Southern Ocean; Ross Sea (Fitzwater et al., 2000), Drake Passage and Gerlache Strait (Martin et al., 1990) and in the Weddell Sea (Nolting and De Baar, 1994; Westerlund and Öhman, 1991). There have been no studies of Zn speciation reported yet from Southern Ocean waters.

Cd Biogeochemistry – It is yet to be demonstrated that cadmium is an essential element for phytoplankton growth and normally it is toxic at levels just above ambient seawater (Brand et al., 1986). However recently it has been shown that there is a cadmium containing isoform, found in some marine diatoms, of the usual zinc containing enzyme carbonic anhydrase (Lane and Morel, 2000a; Lane et al., 2005). This apparent biological utilization of Cd (Lee and Morel, 1995; Lee et al., 1995; Price and Morel, 1990) may explain why this element has a strong nutrient like profile in seawater with strongest similarity to phosphate. The Cd-phosphate relationship in the global ocean has been studied extensively particularly with regard to the Southern Ocean (Frew and Hunter, 1992; Löscher et al., 1998; Nolting and De Baar, 1994). The true nature of the relationship between Cd and phosphate in the Southern Ocean is an important area of study as Cd:Ca ratios in forams are commonly used as a paleotracer for PO_4^{3-} (Boyle, 1988; Boyle et al., 1995).

Iron and Zn bioavailability along with CO_2 concentrations may influence the Cd:P ratio in phytoplankton (Cullen et al., 2003; Cullen et al., 1999; Cullen and Sherrell, 2005). During the Southern Ocean iron enrichment experiments SOIREE (Frew et al., 2001) and EIFeX (Croot in prep.) there was a considerable conversion of dissolved Cd into particulate forms with an apparently high Cd:P ratio, while Zn remained mostly in the dissolved phase. This phenomena is currently difficult to explain though it may be due to differences in the bioavailabilty of Cd compared to Zn, due to weak Cd organic complexation (Bruland, 1992; Ellwood, 2004).

There have been no published studies to date of Cd speciation in the main Southern Ocean water masses, with studies limited to the coastal Ross Sea (Biesuz et al., 2006; Capodaglio et al., 1991; Capodaglio et al., 2002) and the subantarctic waters close to New Zealand (Ellwood, 2004). None of the studies published so far have included the important effects of Fe limitation on the Cd speciation.

Co Biogeochemistry - Cobalt is present in seawater at low pM concentrations (Jickells and Burton, 1988) and shows depletion in surface waters with typically a maximum in intermediate waters. Recent work has shown that Co can replace Zn in carbonic anhydrase (Lane and Morel, 2000b; Price and Morel, 1990; Yee and Morel, 1996) and that this Co-Zn inter-replacement may determine the dominance of either diatoms or coccolithophorids (Sunda and Huntsman, 1995), though other studies have shown that not all phytoplankton can utilise Co instead of Zn (Timmermans et al., 2001). Co is also the central metal atom in several key vitamins such as B12, but not all phytoplankton apparently require B12 (Swift, 1981). In surface seawater Co(II) is believed to be strongly organically complexed (Ellwood and Berg, 2001; Ellwood et al., 2005; Saito and Moffett, 2001; Zhang et al., 1990) though a recent study suggested that some of this apparently complexed Co(II) may be inert Co(III) (van Leeuwen et al., 2005) based on the expected dissociation kinetics for Co(II) complexes.

Only one speciation study has been carried out in the vicinity of the Antarctic Polar Front (APF) on samples obtained during the *Polarstern* cruise ANT-XVI/3 (Ellwood et al., 2005). In this study Co speciation was found to be dominated by inorganic complexes north of the APF, while to the south organic complexation was more important, giving rise to a large gradient in the free Co concentration in the southern surface waters. How this change in Co bioavailability may affect phytoplankton productivity or community structure was not immediately clear though the authors noted that south of the APF the system was dominated by diatoms who may have a lower Co requirement than other phytoplankton species.

There are few measurements of Co from the Southern Ocean: low levels for Co (20-40 pM) in the Drake Passage (Martin et al., 1990) with similarly low levels (20-40 pM) in the adjacent Weddell Sea (Westerlund and Öhman, 1991) and in the Ross Sea (Fitzwater et al., 2000) though a more recent study found elevated levels close to the Antarctic Peninsula and Deception Island in the Weddell Sea (Sañudo-Wilhelmy et al., 2002).

Ni Biogeochemistry – nickel is a required element for the enzyme urease, which phytoplankton use to break down urea into ammonia. Laboratory studies have shown that Ni deficiency can affect N uptake in the form of urea (Price and Morel, 1991). Ni also has a nutrient like vertical distribution in the ocean and studies (Donat and Bruland, 1988; Donat et al., 1994; van den Berg and Nimmo, 1987) have indicated it to be weakly organically complexed with up to 20 % in some unreactive form (Wen et al., 2006). The kinetics of Ni(II) water loss are slow (Hudson and Morel, 1993; Morel et al., 1991) and so equilibrium with organic complexes can take many hours to come to completion, much longer than the duration of many of the published experiments leaving the possibility that the “unreactive” Ni is only very slowly exchangeable but not necessarily inert.

There are no published reports on Ni speciation from the Southern Ocean and only a handful of studies on its distribution; high levels for Ni (4-8 nM) in the Ross Sea (Fitzwater et al., 2000) with similar levels in the Weddell Sea (Nolting and De Baar, 1994; Westerlund and Öhman, 1991).

Work at sea

Water Sampling

In the present work we obtained vertical profiles for these elements along the transects in the different regions of the Southern Ocean surveyed during ANT-XXIV/3 as part of the IPY GEOTRACES ZERO and DRAKE research programme (Fig. 3.15). Depth resolved sampling was performed using water collected with the NIOZ ultraclean (A1 cast) winch.

Trace metal sampling for zinc and cadmium speciation

Samples for zinc (Bruland, 1989) and cadmium (Bruland, 1992) speciation were measured at sea in the IfM-GEOMAR Class 100 Clean room container using anodic stripping voltammetry (ASV) with a mercury film electrode plated on a rotating disk electrode (MFE-RDE). Pseudopolarograms were also made from selected stations to examine the Zn and Cd speciation further.

Trace metal sampling for total zinc, cadmium, nickel and cobalt

Samples were collected for total dissolved concentration and acidified on board for later analysis in Kiel using standard methods for trace metals.

Speciation sampling for nickel and cobalt

Samples were collected for dissolved speciation analysis of Ni and Co for later in Kiel. Samples were immediately frozen and will be thawed only immediately prior to analysis. Laboratory work will focus on kinetic aspects of the speciation of these elements at the ambient temperatures found in Southern Ocean waters. These measurements were not made at sea due to the slow kinetics of these two metals which then requires several days of experimental time to make the required measurements.

Preliminary results

During ANT-XXIV/3 we sampled 15 stations at sea for Cd and Zn speciation and an equal number for total dissolved metal concentrations (Cd, Co, Cu, Fe, Ni, Zn) which will be analysed later in the laboratory in Kiel. Samples from 6 stations were also frozen for later analysis for Ni and Co speciation. At all stations we observed strong gradients in electroactive (labile) Zn and Cd, by which the labile metal concentration increased with depth (Fig. 3.16). It also appeared that Cd and Zn ligands were present mostly in the surface waters and were not so abundant at depth with Cd ligands more important in controlling the speciation. Pseudopolarography also confirmed this interpretation as for zinc only a single inorganic wave was observed while for Cd two distinct waves could be seen suggesting the presence of a reducible organic species in the seawater. Further laboratory work should help to confirm these original findings. Later work will also involve examining the metal:nutrient ratios found in the different water masses during ANT-XXIV/3.

Acknowledgments

The authors would like to show their deep thanks and appreciation to the crew of the *Polarstern*, for all their efforts in helping us throughout ANT-XXIV/3. Thanks to the winch operating and tapping crew of the Ultraclean A1 cast who provided all the samples for this study – in particular Mihael Stimac for taking on a second job at short notice. Thanks also to the Chief Scientist, Dr Eberhard Fahrbach and to the AWI Logisitics Department for making this cruise possible. Funding for participation in this cruise was provided by the DFG (CR145/10) and IfM-GEOMAR.

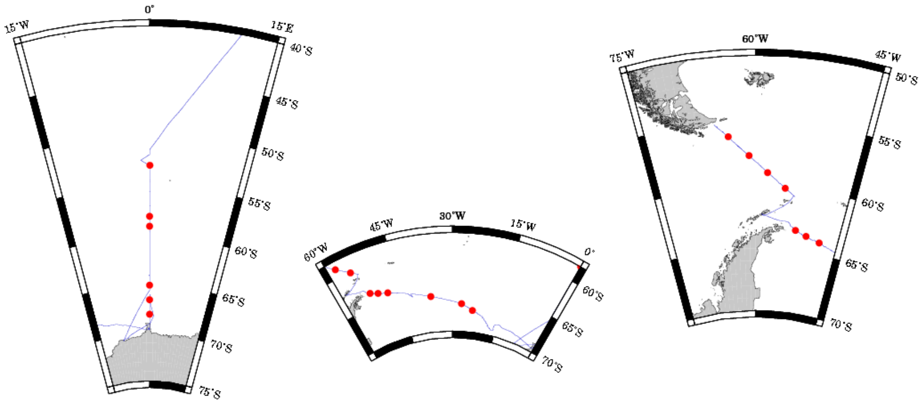

Fig. 3.15: Location of the stations during ANT-XXIV/3 where measurements were made for Cd and Zn speciation. (left) Greenwich meridian, (centre) Weddell Sea and (right) in Drake Passages.

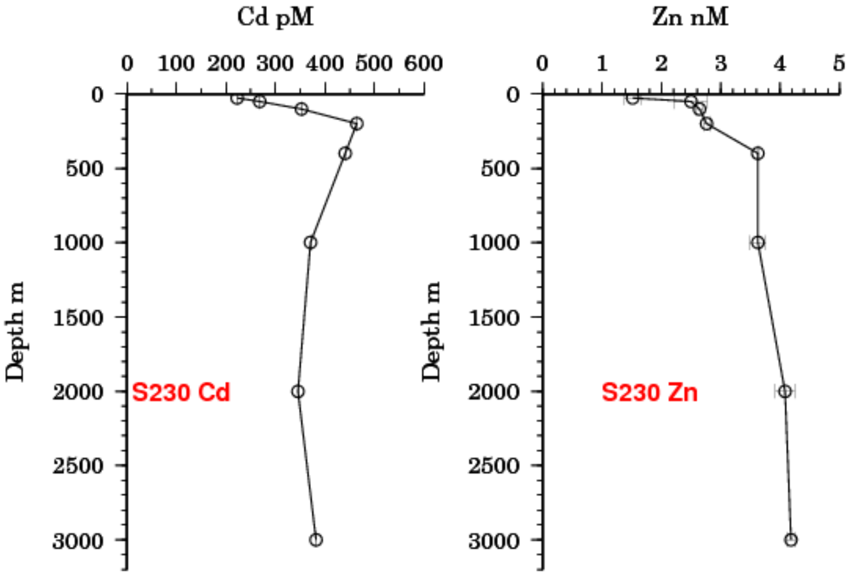

Fig. 3.16: Cd and Zn vertical profiles from the Drake Passage (Station 230)

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3.2.2 Copper speciation in the Southern Ocean: Implications for reactions with superoxide

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Objectives

Our primary objective during ANT-XXIV/3 was to examine the chemical speciation of copper in the water column of the Southern Ocean and to determine whether Cu speciation played a significant role in superoxide reactivity. Superoxide is difficult to measure in the ocean because it is extremely reactive, particularly with trace metals, and has a short half-life. It is however important in metal cycling as it can shuttle metals between different redox states with differing biogeochemical properties. This is most evident in the case of Cu and Fe where the oxidized forms are thermodynamically favored in seawater but are less soluble and less reactive than the reduced forms – thus Fe(II) is more bioavailable and soluble than Fe(III). Amongst the biogeochemically important trace metals Cu has the fastest kinetic reactivity and is thus the main candidate for controlling superoxide reactivity in seawater.

Introduction

Importance of copper to oceanic productivity

Copper is an important component of respiratory proteins and oxidases (Baron et al., 1995) and as such is a required element for phytoplankton. However even at the low level of free copper ($Cu^{2+}{}_{f}$) concentrations found in the environment (pM to nM), cell division rates of phytoplankton in culture have been shown to be dramatically reduced, particularly for cyanobacteria (Brand et al., 1986). Elevated free Cu^{2+} in phytoplankton cells can decrease photosynthetic rates (Baron et al., 1995), competitively inhibit the uptake of other essential metals such as Mn (Sunda et al., 1981; Sunda and Huntsman, 1983; Sunda and Huntsman, 1998) and disrupt enzyme function through binding to thiol groups(-SH) or from reactions with oxygen species to from the damaging hydroxyl radical (Stauber and Florence, 1987).

Copper speciation in seawater
Dissolved copper in seawater has been found to be efficiently complexed by strong organic ligands, of unknown functionality, but believed to be biologically produced (Coale and Bruland, 1988; Moffett et al., 1990; van den Berg, 1984). This organic complexation of Cu greatly reduces the free copper concentration to below 1 pM in most open ocean waters and unpolluted coastal waters (Moffett, 1995; Moffett et al., 1997), a level at which most phytoplankton are not Cu stressed (Brand et al., 1986).

Copper redox speciation
In oxygenated seawater the thermodynamically favoured redox state of Cu is Cu(II), however there are several important redox reactions involving Cu(II) that could see cycling between Cu(I) and Cu(II) with significant concentrations of Cu(I) present in surface waters (Moffett and Zika, 1988). Most notably Cu(I) could be produced by processes including:

(i) Photochemical reduction of Cu organic complexes (Ferraudi and Muralidharan, 1981; Wu et al., 2000).
(ii) Reduction of Cu(II) by H_2O_2 (Moffett and Zika, 1987; Moffett and Zika, 1988).
(iii) Biologically mediated reduction of Cu(II) to Cu(I) (Hassett and Kosman, 1995; Jones et al., 1987; Jones et al., 1985).

There have been several studies into the oxidation of Cu(I) in seawater (Moffett and Zika, 1987; Sharma and Millero, 1988a; Sharma and Millero, 1988b; Sharma and Millero, 1989) and in general Cu(I) oxidation in the open ocean is controlled through oxidation by O_2 as the reaction with H_2O_2 is significantly slower under typical open ocean conditions.

A generalised mechanism for the oxidation of Cu(I) has been proposed:

$$Cu^{+} + O_2 \rightarrow Cu^{2+} + O_2^{-}$$ slow

$$Cu^{+} + O_2^{-} \rightarrow Cu^{2+} + H_2O_2$$ fast

$$Cu^{+} + H_2O_2 \rightarrow Cu^{2+} + OH^{\bullet} + OH^{-}$$ slow

$$Cu^{+} + OH^{\bullet} \rightarrow Cu^{2+} + OH^{-}$$ fast

For the reduction of Cu(II) by H_2O_2 the following mechanism has also been proposed:

$$H_2O_2 \leftrightarrow H^+ + HO_2^- \qquad \text{fast}$$

$$Cu^{2+} + HO_2^- \rightarrow Cu^+ + HO_2 \qquad \text{slow}$$

$$HO_2 \rightarrow H^+ + O_2^- \qquad \text{fast}$$

$$Cu^{2+} + O_2^- \rightarrow Cu^+ + O_2 \qquad \text{fast}$$

The Cu(II) reduction rate increases in the presence of strong Cu(I) binding ligands. At low concentrations of Cu, the O_2^- formed may react via different pathways, notably that of reactions with Fe(II/III) and CDOM (Goldstone and Voelker, 2000; Voelker et al., 2000).

Superoxide

Superoxide is produced in seawater by predominantly photochemical pathways, though biological production may also be important. Model studies suggest that superoxide would be found in seawater at sub nM levels due to its rapid reactions with metals (Cu, Fe) and organic matter. However at present there are no direct measurements of superoxide in seawater published to confirm this and initial reports suggest steady state superoxide levels may be in the tens of nMs in sunlit open ocean seawater. The half-life of superoxide is relatively short (Millero, 1987) due to a combination of the dismutation reaction to form peroxide and reactions with metals such as Cu and Fe. In the present work we examined the influence of Cu speciation on superoxide half-lifes in seawater as a tool to probe metal redox reactivity in seawater.

Water sampling

In the present work we obtained vertical profiles for total Cu along the transects in the different regions of the Southern Ocean surveyed during ANT-XXIV/3 as part of the IPY GEOTRACES ZERO and DRAKE research programme. Depth resolved sampling was performed using water collected with the NIOZ Ultraclean (A1 cast) winch. Speciation measurements were only performed in the Weddell Sea and in the Drake Passage (Fig. 3.17).

Copper speciation determination

Copper speciation measurements were made using the ligand Salicylaldoxime (SA) with the voltametric method of Campos and van den Berg (1994). For each station 6 samples from throughout the water column were analysed using two detection windows (1 μM and 2 μM SA). The data was analysed using a non-linear optimization of a Langmuir isotherm (Gerringa et al., 1995).

Superoxide determination using MCLA

In order to determine superoxide at nM concentrations in seawater we employed the reagent MCLA ([2-methyl-6-(4-methoxyphenyl)-3,7-dihydroimidazo[1,2-a]pyrazin-3-one, HCl]) which is a commonly used chemiluminescent technique for the determination of superoxide in aqueous solutions. A FIA (Waterville Analytical – Maine, USA) system was used to follow the reaction of the MCLA with an addition of an aliquot of superoxide to seawater samples from different depths, which had been amended with either DTPA (to observe only the superoxide dismutation reaction), Fe or Cu (both added at nM levels).

Preliminary results

Speciation measurements for Cu were made at 8 stations during ANT-XXIV/3. In general we found stronger complexation in surface waters than in deeper waters. This relationship was also reflected in the superoxide reactivity experiments where deep samples had reduced superoxide lifetimes and this was further reduced upon addition of Cu (Fig. 3.18) and to a lesser extent Fe. Surface water samples had an excess of metal complexing ligands and no change in superoxide reactivity was seen for the metal additions. The complete data set will be analysed once the samples for Total Cu are analysed in the laboratory in Kiel.

Acknowledgements

The authors would like to show their deep thanks and appreciation to the crew of the *Polarstern*, for all their efforts in helping us throughout ANT-XXIV/3. Thanks also to the Chief Scientist, Dr Eberhard Fahrbach and to the AWI Logistics Department for making this cruise possible. Funding for participation in this cruise was provided by the DFG (CR145/15) and IfM-GEOMAR.

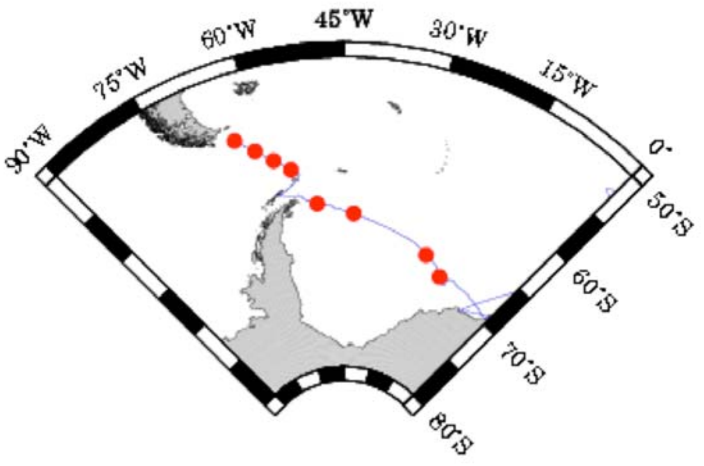

Fig. 3.17: Map of the station locations at which samples were analysed for Cu speciation and reactivity with superoxide

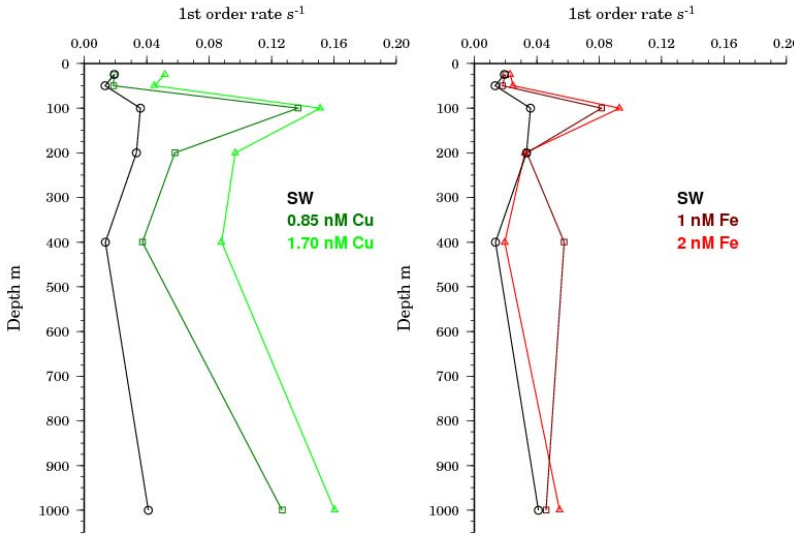

Fig. 3.18: Depth profiles of superoxide kinetics in seawater. (left) 1st order rate constants for the destruction of superoxide in seawater amended with Cu. (right) 1st order rate constants for the destruction of superoxide in seawater amended with Fe.

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3.2.3 Iron solubility in the Southern Ocean

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Objectives

In collaboration with the group of Hein de Baar from NIOZ we examined the solubility of iron in water samples from the Southern Ocean. This study seeks to determine the processes (complexation, scavenging, redox state) that contribute to the distribution of iron in deep waters and in the long term transport of iron through the deep ocean. The main goal of this work is to determine what controls the solubility of dissolved iron in deep waters.

Introduction

Iron is poorly soluble in seawater and careful laboratory measurements of inorganic iron solubility (cFe_S) by Byrne et al. (2005), Kuma et al. (1996) and a Fe solubility model of Liu and Millero (1999; 2002) suggest that cFe_S depends on salinity, temperature, pH, with higher concentrations of soluble Fe possible at lower temperatures, lower pHs, and higher salinities. Fe solubility in both UV irradiated and artificial seawater (i.e. seawater containing no dissolved organic matter (DOM)), at 0.01 nM between pH 7.5 and 9, has been shown to be lower than in untreated seawater (cFe_S = 0.5 nM) (Liu and Millero, 2002). This difference can be explained by the existence of natural organic ligands (Kuma et al., 1996; Liu and Millero, 2002) which enhance the Fe solubility in seawater by organic complexation of the trace metal.

More recently iron solubility in deep waters has been found to be linearly correlated to the concentrations of macronutrients (e.g., NO_x) (Kuma, 2002; Tani et al., 2003) possibly due to the release of organic ligands during the microbial decomposition of sinking particulate organic matter (POM). The regeneration of fluorescent humic substances has been observed during organic matter decomposition (and consistent with the correlation of nutrients and apparent oxygen utilization (AOU)) in the water column (Hayase and Shinozuka, 1995; Hayase et al., 1988). Some humic substances, such as humic acid, can function as Fe binding ligands, increasing Fe solubility at pH 8 by organic complexation. Alternatively, Fe binding ligands are released by bacteria (Haygood et al., 1993; Martinez et al., 2000; McCormack et al., 2003), and could be associated with the growth of the population of heterotrophic bacteria decomposing the organic matter. In the present work we undertook to examine Fe solubility in deep waters from the Southern Ocean for the first time to see if the same apparent processes were occurring there as in the North Pacific (Studies of Kuma et al., 2002). This work also follows up previous work conducted during ANT-XXIII/9 which focused solely on surface waters.

Work at sea

Sampling of subsurface seawater

Seawater samples were obtained throughout the water column using the NIOZ ultraclean rosette during ANT-XXIV/3 (Fig. 3.19). The seawater was filtered through 0.2 µm membrane filters (Sartorius) under nitrogen overpressure (0.2 – 0.3 bar) into

125 mL acid cleaned LDPE bottles (Kartell). All sample handling was performed under Class 100 Clean room conditions. The samples were frozen at -20°C and transported back with *Polarstern* to Germany for later analysis in the laboratory in Kiel.

Sample treatment

Fe solubility measurements will be performed on thawed aliquots of the previously frozen samples using the radioisotope ^{55}Fe (Hartmann Analytics, Braunschweig, Germany). The experimental setup (described below) is adapted from Kuma et al. (2002) and is briefly described: An addition of 20 nM ^{55}Fe (t_0 = 0h; pH 7.9) is made to each sample, and a small subsample (roughly 9 mL) is filtered through a 0.02 μm Anotop syringe filter (Whatman) previously flushed and rinsed with MQ water. The first 6 – 7 mL of the filtrate is discarded in order to avoid dead volume artifacts. The next 1 – 2 mL of filtrate is placed in a 60 mL acid cleaned Teflon bottle and acidified with QD-HCl, to keep the Fe from adsorbing to the bottle walls (Fischer et al., 2007).

Duplicates of unfiltered and 0.02 μm filtered samples (400 μL) are transferred into 6 mL counting vials to which 4.5 mL of scintillation fluid (Lumagel Plus®) are then added. The same procedure is repeated for subsamples taken after 3, 6, 24, 48 and 72h. After filtration and cocktail addition, vials are capped and placed in a liquid scintillation counter (Packard, Tri-Carb 2900TR) where each sample is counted for 30 minutes. Counts per minute are then converted to soluble Fe concentrations, taking into account the activity of the added isotope solution and the dissolved Fe concentration of each sample.

Preliminary results

There are no results at present as the samples still need to be analysed in the laboratory in Kiel. We anticipate however that the results will be complementary to data recently obtained during ANT-XXIII/9 in the Weddell Sea and Kerguelen Plateau. Using this approach we will obtain information about iron solubility in this region and data on the kinetics of Fe exchange between soluble and particulate forms. This study is a comparison study with work performed within the BMBF project SOPRAN (D-SOLAS) which examines iron cycling in the surface ocean under the Saharan dust plume.

Acknowledgements

The authors would like to show their deep thanks and appreciation to the officers and crew of *Polarstern*, for all their efforts in helping us throughout the duration of ANT-XXIV/3. Thanks also to the Chief Scientist, Dr Eberhard Fahrbach and to the AWI for making this cruise possible. Special thanks to our GEOTRACES colleagues from the Netherlands who operated and performed the sampling programme with the Ultraclean winch during this cruise. This work was made possibly specifically through funding from the DFG (CR145/10 and CR145/15) and IfM-GEOMAR.

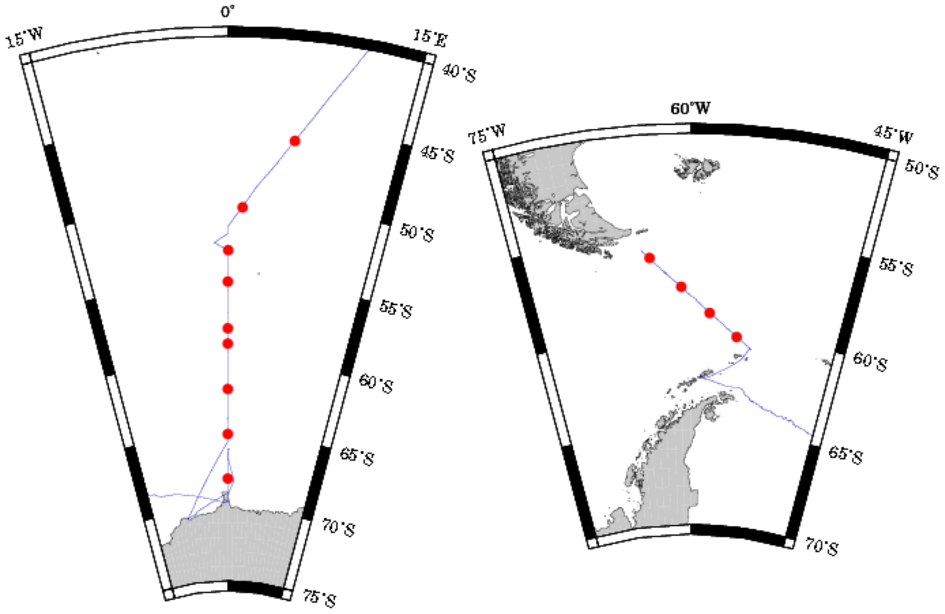

Fig. 3.19: Locations during ANT-XXIV/3 where vertical profiles were taken for iron solubility measurements (left) Greenwich meridian and (right) Drake Passage. One further station was sampled in the centre of the Weddell Sea.

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3.2.4 Titanium in the Southern Ocean

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IfM-GEOMAR

Objectives

As part of the IPY GEOTRACES ZERO and DRAKE programme we planned to take the first deep water measurements of titanium from the Southern Ocean. This information should allow us to better constrain the residence time of Ti in the ocean and to examine the fluxes and important processes occurring between the different oceanic basins.

Introduction

While it is established now that Fe can be a (co)limiting nutrient for phytoplankton in High Nutrient Low Chlorophyll (HNLC) regions of the world we still know little about the processes by which Fe is supplied to the ocean and how processes in the ocean scavenge/uptake or remineralize dissolved Fe. In many cases examination of other elements similar in chemistry to iron reveals more information on the key processes involved – such elements include Ti(IV), Al(III) and Mn(II). By comparison of the concentrations of these strongly hydrolysed elements in the soluble, dissolved and particulate phases we hope to be able to better understand the processes affecting dust dissolution and particle scavenging in the surface ocean.

Titanium biogeochemistry in seawater has been studied very little in the open ocean, with only a single deep-water profile from the Pacific (Orians and Boyle, 1993; Orians et al., 1990) which showed picomolar concentrations in surface waters and increasing to ~300 pM in deep waters. There have been a few more studies in enclosed seas (van den Berg et al., 1994) and estuaries (Skrabal, 1995; Skrabal and Terry, 2002; Skrabal et al., 1992) but overall there is little information on the global Ti distribution in the ocean. Based on the work of Orians et al. (1990) Ti has a short residence time in the ocean and is enriched with depth due to remineralisation processes, there are presently no measurements from the Southern Ocean. For the Southern Ocean, the small data set from other regions hints that there may be significant differences in Ti concentrations between the different water masses present. In the present study, through the use of a new voltametric technique, developed at IfM-GEOMAR, that allows shipboard determination of pM levels of Ti, we were set to test this hypothesis.

By comparison of the chemistries and distributions of Ti, Al, Mn and Fe this GEOTRACES study in cooperation with NIOZ colleagues is aiming to improve our knowledge of the processes effecting trace metal distributions in the ocean with emphasis on dust deposition. The work performed during ANT-XXIV/3 was part of the German contribution for GEOTRACES and is also a continuation of similar earlier work performed on the *Polarstern* (ANT-XVIII/1 and ANT-XXIII/1) (Bowie et al., 2003; Sarthou et al., 2003) and the Meteor (M55) (Croot et al., 2004).

Work at sea

Water sampling

In the present work we obtained vertical profiles for Ti along the transects in the different regions of the Southern Ocean surveyed during ANT-XXIV/3 as part of the IPY GEOTRACES ZERO and DRAKE research programme. Depth resolved sampling was performed using water collected with both the regular CTD (B1 cast) and the NIOZ Ultraclean (A1 cast) winch.

Trace metal sampling – analysis and examination of storage protocols

Samples were analysed for Ti(IV) using a new voltametric method developed at IfM-GEOMAR (Croot, in preparation). All samples were analyzed unfiltered and within 24 hours of collection. Archive samples were also taken for later analysis in the laboratory in Kiel to examine possible storage artefacts as Ti is a ubiquitous component of the conventional trace metal sampling bottles as it is used a whitening agent (TiO_2) or as a catalyst in the preparation of plastics (similar problems exist for Al).

Preliminary results

During ANT-XXIV/3 we made on board analysis of 15 stations for Titanium (Fig. 3.20) with 3 in the Drake Passage and 12 along the Greenwich meridian. Problems were encountered with the 3 stations taken from the ultraclean rosette, presumably due to its titanium construction but this may also have been due to sampling artefacts. The normal CTD (B1 cast) seemed to be fine for Ti sampling as was found in past cruises on the *Polarstern*. In general Ti increased with depth at all stations (Fig. 3.21) and further work will examine if there are discernable differences in the Ti content between the different deep water masses present along the transects.

Acknowledgements

The authors would like to show their deep thanks and appreciation to the crew of the *Polarstern*, for all their efforts in helping us throughout ANT-XXIV/3. Thanks also to the Chief Scientist, Dr. Eberhard Fahrbach and to the AWI Logistics Department for making this cruise possible. Funding for participation in this cruise was provided by the DFG (CR145/15) and IfM-GEOMAR.

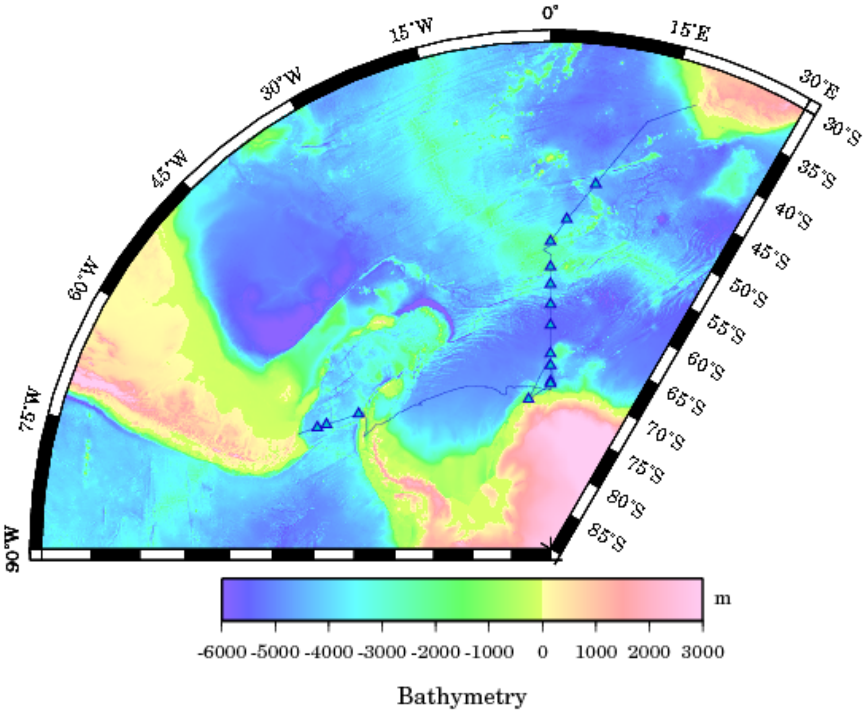

Fig. 3.20: Bathymetrical map of the Atlantic sector of the Southern Ocean showing the location of stations sampled (blue triangles) during ANT-XXIV/3, the cruise track is also shown as a thin blue line.

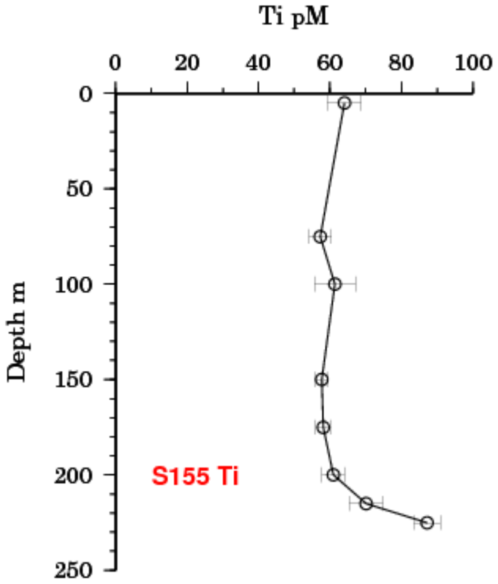

Fig. 3.21: Profile of labile Ti in the water column near the shelf edge close to Neumayer Station

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3.2.5 Elemental ratios in particulate samples from the Atlantic sector of the Southern Ocean

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[2)]Rutgers University

Objectives

Our goal during ANT-XXIV/3 was to obtain samples for particulate metals from along the surveyed transects in order to have material from a variety of different oceanic environments in the Southern Ocean. Particulate samples were taken simultaneously, and in cooperation with the Dutch and German teams on board sampling in the dissolved phase in order to facilitate interpretation of the collected samples.

Introduction

Trace element ratios in particulate matter from surface waters reflect the nature of the particles themselves and can provide information on the processes that formed them. In particular in regions of high productivity the content of the mostly organic particles reflect the concentrations of the bioavailable fraction of the metals in seawater; this may include changes in the Cd:P or Zn:P ratio or in the Fe:P ratio. In contrast in shallow coastal regions, the particles may reflect more the inorganic/crustal signature of the nearby land or underlying sediments. The Rutgers group of Prof. Rob Sherrell have a strong history of developing and applying ICPMS techniques to the problem of element ratios in particulate matter (Berman-Frank et al., 2001; Cullen and Sherrell, 1999; Cullen et al., 1999; Cullen et al., 2003; Field et al., 1999; Sterner et al., 2004).

By measuring elemental ratios in particles collected during ANT-XXIV/3 we hope to gather further information on the way in which particle supply and production, scavenging and dissolution controls dissolved metal concentrations in the open ocean and in turn how this may affect primary productivity.

Work at sea

Sampling Methodology

In the present work we obtained surface and near surface samples along the transects in the different regions of the Southern Ocean surveyed during ANT-XXIV/3 as part of the IPY GEOTRACES ZERO and DRAKE research programme. Sampling was conducted in two modes:

(i) Occasional surface sampling from the Iron-FISH. This involved collecting 24 L of seawater into a trace metal clean carboy and filtering through either 13 mm quartz or polycarbonate filters. All sample manipulations and filtration took place in a class 100 laminar flow bench. The filters were then later frozen and stored until shipping for later analysis at Rutgers.

(ii) Depth resolved sampling was performed using water collected with the NIOZ ultraclean roseetteA1 cast. This involved filtering in duplicate 2 L aliquots of seawater through; (1) a sandwiched pair of 13 mm ~1.0 μm pore size quartz fiber filter (QMA) and (2) a sandwiched pair of 25 mm 0.45 μm and 5.0 μm Supor and Poretics plastic filters fibre filters. All filtering was performed with a gentle vacuum over pressure in a Class 100 laminar flow bench. Typically samples were obtained from 25, 50, 100 and 200 m. The filters were then frozen and stored until shipping for later analysis at Rutgers.

The collected samples will be analysed by ICP-MS in the laboratory at Rutgers. The present study is an extension of a pilot study examining the feasibility of combining this type of sampling with work on the dissolved metals in the water column carried out by the trace metal group at the IfM-GEOMAR. This is an ongoing international collaboration between Germany and the USA as a contribution to GEOTRACES.

Work at sea

During ANT-XXIV/3 we collected over 60 samples from along the Greenwich meridian, in the Weddell Sea and through the Drake Passage for particulate metals from the A1 casts and from the fish.

Preliminary results

As analysis of the collected samples is yet to be performed we have no preliminary results at this time.

Acknowledgements

The authors would like to show their deep thanks and appreciation to the crew of the *Polarstern*, for all their efforts in helping us throughout ANT-XXIV/3. Special thanks to the ultraclean winch team from NIOZ for their help with the sampling. Thanks also to the Chief Scientist, Dr Eberhard Fahrbach and to the AWI Logistics Department for making this cruise possible. Funding for participation in this cruise was provided by the DFG (CR145/10) and IfM-GEOMAR.

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3.2.6 The distribution of H_2O_2 in surface and deep waters of the Southern Ocean

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Objectives

H_2O_2 is a short lived photochemically produced trace oxidant found throughout the water column but predominantly in sunlit surface waters. Information on H_2O_2 concentrations allows us to constrain the oxidation time of reduced metal species (e.g. Cu(I), Fe(II)) in the ocean where H_2O_2 can be the principal oxidant, this information is important for understanding the biogeochemical cycling of these metals. Furthermore H_2O_2 can be used as a tracer for vertical mixing in surface waters and/or a tracer of recent (last few days) rain or snow events. For ANT-XXIV/3 our objective was to make a synoptic survey of H_2O_2 throughout the Atlantic sector of the Southern Ocean and examine the influence of different biogeochemical provinces on its formation and decay.

Introduction

Hydrogen peroxide (H_2O_2) is the most stable intermediate in the four-electron reduction of O_2 to H_2O and may function as an oxidant or a reductant. H_2O_2 is principally produced in the water column by photochemical reactions involving dissolved organic matter (DOM) and O_2 (Cooper et al., 1988; Scully et al., 1996; Yocis et al., 2000; Yuan and Shiller, 2001). Open ocean H_2O_2 concentrations show a distinct exponential profile with a maximum at the surface consistent with the photochemical flux. Concentrations can reach up to 300 nmol L^{-1} in Equatorial and Tropical regions with high DOM concentrations such as in the Amazon plume in the Atlantic (Yuan and Shiller, 2001). In regions with low DOM and low sunlight, surface H_2O_2 levels are much lower with values in the Southern Ocean of 10-20 nmol L^{-1} (Sarthou et al., 1997). Rainwater is a major potential source for H_2O_2 to surface seawater as it is preferentially removed from the atmosphere, relative to other peroxides, during convective events (Croot et al., 2004b). Due to its high solubility in water, scavenging of H_2O_2 in deep convection is around 55 - 70 % (Cohan et al., 1999). Mixing ratios of H_2O_2 in the marine troposphere show a strong latitude dependence with a maximum over the equator, suggesting that the air to surface flux at the equator should be high (Weller and Schrems, 1993).

H_2O_2 is also produced by biological processes in the ocean with observations from the Sargasso Sea (Palenik and Morel, 1988) and in phytoplankton cultures (Palenik et al., 1987) of production in the dark. Most studies to date have suggested that the major production pathway in the water column for H_2O_2 is from photochemical production, however in a few cases in the Southern Ocean, distinct H_2O_2 maxima at depth, corresponding to the chlorophyll maximum, suggest a significant biological source of H_2O_2 (Croot et al., 2004a). The ‘dark decay life-time’ of H_2O_2 can vary from hours to weeks in the ocean (Petasne and Zika, 1997), but typically may be around 4 days in the open ocean (Plane et al., 1987). Overall the decay rate of H_2O_2 is apparently controlled by several factors: H_2O_2 concentration, colloid concentration, bacteria/cyanobacteria numbers and temperature (Wong et al., 2003; Yuan and Shiller, 2001).

Methods

H_2O_2 measurements in surface waters

Seawater samples were obtained using Niskin bottles on a standard CTD rosette. Samples were drawn into 100 mL low density brown polyethylene bottles which were impervious to light. Samples were analyzed within 1-2 hours of collection where possible and were not filtered. In the present work H_2O_2 was measured using a flow injection chemiluminescence (FIA-CL) reagent injection method (Yuan and Shiller, 1999). In brief, the chemiluminescence of luminol is catalysed by the reaction of H_2O_2 present in the sample with Co^{2+} at alkaline pH. H_2O_2 standards were made by serial dilution from a primary stock solution (30 % Fluka - Trace Select). The concentration of the primary standard was determined by direct spectrophotometry of the solution ($\varepsilon = 40.9$ mol L^{-1} cm^{-1}, (Hwang and Dasgupta, 1985)). Secondary standards were analysed with a spectrophotometric method using Cu(II) and 2,9-dimethyl-1,10-phenanthroline (Kosaka et al., 1998). Seawater samples were measured directly by FIA-CL, while rainwaters were diluted, up to 1:100, with ultrapure water (18 MΩ). Sample concentrations were corrected for a small reagent blank (Yuan and Shiller, 1999). Samples were analyzed using 5 replicates: typical precision was 2-3 % through the concentration range 1-100 nM, the detection limit (3σ) was typically 0.2 nmol L^{-1}.

Work at sea

During ANT-XXIV/3 samples were taken for H_2O_2 throughout the water column in connection with the normal B1 hydrocast as part of the IPY GEOTRACES ZERO & DRAKE programme. H_2O_2 profiles were measured at 38 stations during the course of ANT-XXIV/3 from a wide range of upper ocean environments (Fig. 3.22). On previous research cruises we have concentrated exclusively on surface waters, however during ANT-XXIV/3 we undertook full depth profiles to examine more closely the concentration of H_2O_2 in deep waters. As H_2O_2 is a short lived chemical species all sample analysis was performed at sea.

Preliminary results

Results gathered from ANT-XXIV/3 showed in general surface water concentrations of H_2O_2 were relatively low (20 - 40 nM) with one interesting exception in a high productivity region between 65° and 67° S (see Fig. 3.23). Where a major phytoplankton bloom was occurring, in this area H_2O_2 concentrations were elevated in the surface waters up to 90 nM which is more typical of values found in Tropical regions. The possible reasons for this include (1) release of large amounts of photo-labile DOC by the phytoplankton due to senescence or (2) direct biological production of H_2O_2 by phytoplankton cells. Deep water profiles often showed the presence of two distinct regions of elevated H_2O_2: at approximately 300 and 1,000 m and it is thought that these may be related to enzymatic reactions associated with the remineralization of organic matter that occurs at this depth.

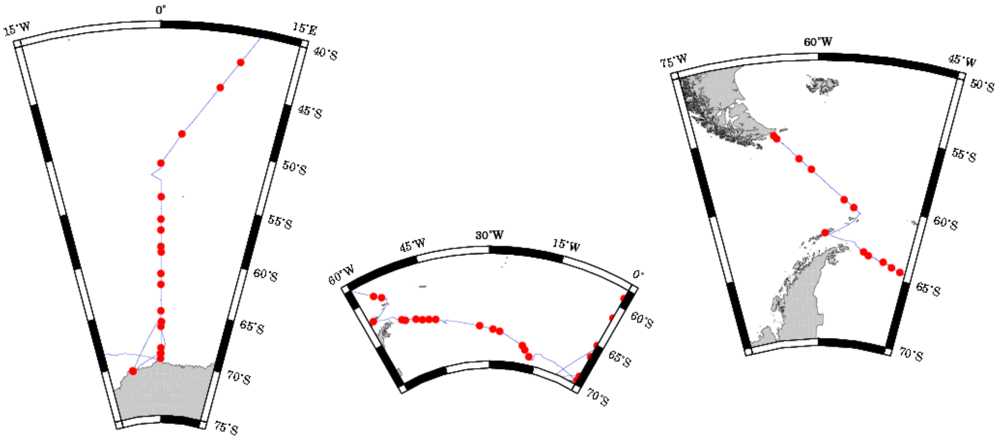

Fig. 3.22: The location of stations sampled for H_2O_2 during ANT-XXIV/3: (left) Greenwich meridian, (centre) Weddell Sea and (right) Drake Passage.

Later work will include comparing the H_2O_2 profiles with measurements of other chemical and physical parameter made at each station. Using this approach it should be possible to determine the major processes (e.g. active mixing, rain inputs of H_2O_2, production via photolysis or phytoplankton production of H_2O_2) controlling the distribution of H_2O_2 in both the surface and deep waters in the Southern Ocean along the ANT-XXIV/3 transects.

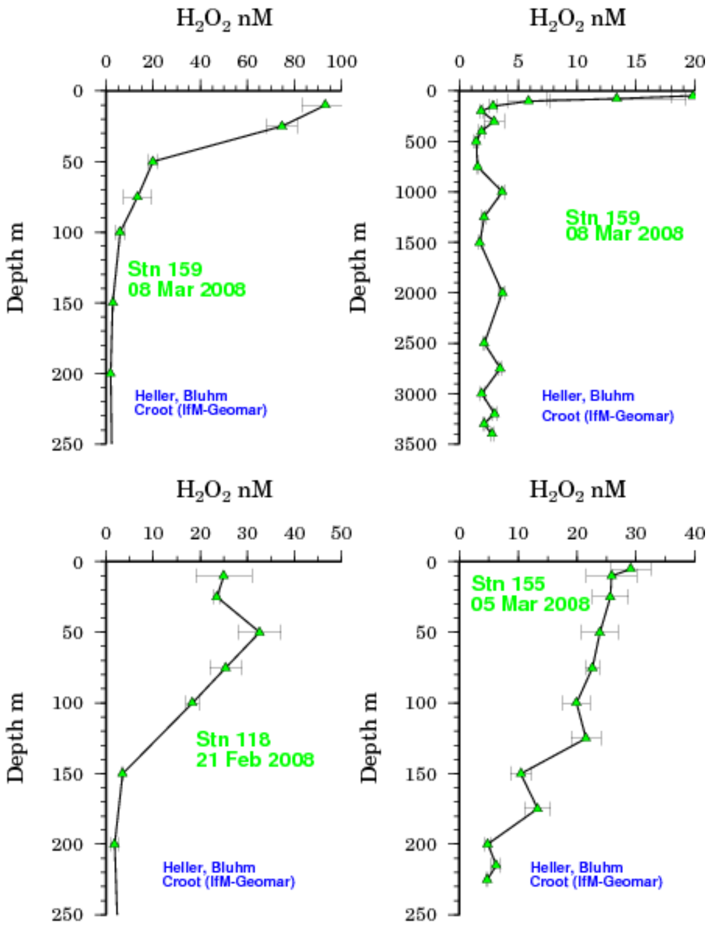

Fig. 3.23: The vertical distribution of H_2O_2 from some representative stations during ANT-XXIV/3: top left: Near surface distribution of H_2O_2 along the Greenwich meridian in a region impacted by a large phytoplankton bloom. Top right: Full water column profile from the same station. Bottom left: Typical profile for Polar waters not impacted by phytoplankton blooms. Bottom right: H_2O_2 profile from the edge of the ice shelf showing the deeper mixing that occurs here.

Acknowledgements

The authors would like to show their deep thanks and appreciation to the crew of the *Polarstern*, for all their efforts in helping us throughout ANT-XXIV/3. Thanks also to the Chief Scientist, Dr. Eberhard Fahrbach and to the AWI Logistics Department for making this cruise possible. Funding for participation in this cruise was provided by the DFG.

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3.2.7 Iodide and iodate speciation in the Southern Ocean

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IfM-GEOMAR

Objectives

Iodine is potentially a key element for climate change as iodine emissions from the ocean strongly influence the formation of new aerosol particles with impacts on cloud formation and radiative balances. The source and mechanism of iodine emissions from the ocean is poorly understood, as are other more fundamental aspects of iodine biogeochemistry in seawater such as the cycling between the major iodine species; iodate and iodide. In the proposed work we will investigate the biogeochemistry of iodine in the poorly studied waters of the Southern Ocean. Central to this work will be investigations into the underlying mechanism behind the distribution and speciation of iodine species in the Atlantic sector of the Southern Ocean. During the *Polarstern* cruise ANT-XXIV/3 ZERO&DRAKE the speciation and distribution of iodine species were examined across gradients of iron concentration and phytoplankton abundance in seawater; ranging from an open ocean region along the prime meridian, the Weddell Sea and Drake Passage and near several Antarctic islands.

Introduction

Dissolved iodine is ubiquitous and quasi-conservative in seawater and exists predominantly as iodide (I^-) and iodate (IO_3^-), with a total dissolved concentration of about 470 nM (Salinity 35). In fully oxygenated seawater (pH 8.0, p€ 12.5) IO_3^- is the thermodynamically stable form of iodine (Wong, 1991). Molecular iodine (I_2) is only a transient species due to its fast reactivity with organic matter (Truesdale, 1974) and loss to the atmosphere (Leblanc et al., 2006). In surface waters I^- concentrations reach 50-150 nM, probably through biological reduction of IO_3^- and this occurs to the greatest extent in tropical and subtropical waters (Jickells et al., 1988). In deep waters, below the euphotic zone, iodide decreases to low levels (< 5 nM), while iodate increases to a relatively constant level of about 450 nM. Attempts to explain iodate reduction in the euphotic zone have linked it to phytoplankton growth, microbial respiration (Truesdale and Bailey, 2002), photochemistry (Spokes and Liss, 1996), and sediment- water interactions (Anschutz et al., 2000).

The biogeochemistry of iodine in the Southern Ocean is relatively unknown at present with only a single published study from the Weddell Sea (Campos et al., 1999) which ran along the WOCE A23 transect from the Weddell Sea at 75°S to about 25°S in March-May 1995. In this work Campos et al. (1999) found a systematic increase in iodide in surface waters (0-100 m) from south to north. The lowest values of about 20 nM iodide in surface waters were observed at stations south of the Polar Front. North of the Polar and Subtropical Front values increased up to 100 nM of iodide, where at depth greater than 100 m iodide concentrations dropped down again to less than 20 nM and continue to decrease rapidly with depth until the detection limit of the method (0.08 nM with a precision better than ±5 %).

Campos et al. (1999) interpreted their results from north to south as a lower iodide production south of the Polar Front where surface waters contained high nitrate concentrations, a surprisingly similar conclusion to McTaggart et al. (1994) made for the Tropics, this is however based on the assumption that iodate reduction is related to nitrate reduction via the action of nitrate reductase. They also suggested that the cycling of iodine was different in the various sectors of the Southern Ocean resulting in different nitrate: iodide ratios in the surface waters. Unfortunately Campos et al. had no supporting productivity or chlorophyll data for their work.

Truesdale et al. (2003) followed the iodate and total iodine concentrations in a mesocosm experiment in Antarctica. They only found little or no change in the iodate concentrations and their results do not support the belief that changes in iodine speciation is only due to phytoplankton growth. These results are somewhat contradictory to laboratory studies made by Wong et al. (2002) and Chance et al. (2007) in which both researchers found a change in iodine speciation during the growth of Antarctic species. Globally iodide production has been suggested as both an indicator of new production (Campos et al., 1996) and of regenerated production (Tian et al., 1996) and the interpretation hinges on whether iodide production is related to nitrate uptake as suggested by Wong (Wong, 2001) or is related to other decomposition processes. It is thus unclear at present exactly what processes control iodate biogeochemistry in the Southern Ocean.

The presence of iodide in seawater is a necessary precursory for the production of iodinated organic compounds, many of which are volatile. Iodine chemistry in the atmosphere is also important as iodine released from the ocean is believed to be a major source of new particles to the atmosphere (O´Dowd et al., 2002) which may alter the radiative forcing in the atmosphere by acting as cloud condensation nuclei. The main flux from the ocean is from the air-sea gas exchange of iodinated organic compounds such as methyl iodide (CH_3I) or diodomethane (CH_2I_2). These iodinated compounds may be formed in seawater by reactions between organic compounds and iodine species via photolysis reaction (Moore, 2006; Richter and Wallace, 2004) or bacterial action (Amachi et al., 2001; Manley, 2002). Gases such as CH_3I and CH_2I_2 are relatively short-lived in the atmosphere as sunlight readily breaks the C-I bond producing I radicals (Martino et al., 2006) which form particulate aerosol iodine species (Baker et al., 2000). Thus there has been considerable interest in the flux of methyl iodide from Southern Ocean waters with this area being identified as a major source to the atmosphere (Cox et al., 2005) with large fluxes being observed at the Antarctic Peninsula (Reifenhauser and Heumann, 1992) and more recently in the Weddell Sea (Carpenter et al., 2007). Enhanced production of some iodinated gases was also observed during the recent Southern Ocean iron enrichment experiments: EisenEx (Chuck et al., 2005) and SOFeX (Wingenter et al., 2004).

Work at sea

Analytical Measurements

Seawater samples (unfiltered) were obtained using Niskin bottles on the standard CTD rosette from all depths during the B1 cast of the IPY GEOTRACES ZERO &

DRAKE programme. Samples were drawn into 100 mL low density brown polyethylene bottles which were impervious to light. Samples for iodide were analyzed by cathodic stripping square wave voltammetry (Luther et al., 1988), using a μAutolab III (Ecochemie) combined with a VA663 electrode (Metrohm), within 3-4 hours of collection. Iodate was analyzed by spectrophotometry (Truesdale, 1978; Truesdale and Smith, 1979), by conversion to I_3^-, using 10 cm cells with an Ocean Optics USB4000 spectrophotometer. All analysis was performed under clean conditions in the Class 5 clean room container from the IfM-GEOMAR.

Iodide profiles were measured at 30 stations during the course of ANT-XXVI/3 (Fig. 3.24). This included 15 stations on the transect to and along the Greenwich meridian, 2 stations in the coastal waters close to Neumayer, 6 in the Weddell Sea and 7 in the Drake Passage. Sea ice samples were also collected in the coastal waters close to Neumayer, melted and analysed on board. All sample analysis was performed at sea.

Preliminary results

Iodide concentrations were relatively low (0-40 nM) along the Greenwich meridian, and a typical profile for this region is shown in Fig. 3.25. The highest concentrations for iodide during this cruise were found along the coastal shelf of South America at the end of the transect across the Drake Passage. Initial comparisons with macronutrient data suggest that iodide was weakly related to primary production and that physical mixing appeared to play a strong role in shaping the iodide profile. Of most interest however, was the discovery of elevated iodide at depths below the euphotic layer, which strongly suggests that regeneration processes are responsible for the iodide production at these depths. The iodate data gathered on board also supported this view and indicated that overall iodine was conservative in these waters.

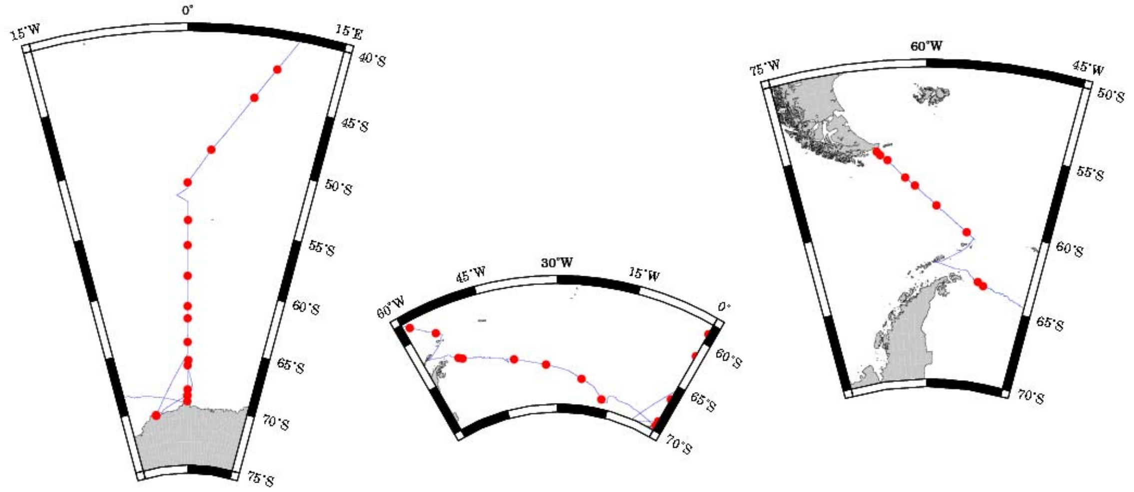

Fig. 3.24: The location of stations sampled for iodine speciation (iodide & iodate) during ANT-XXIV/3: (left) Greenwich meridian, (centre) Weddell Sea and (right) Drake Passage

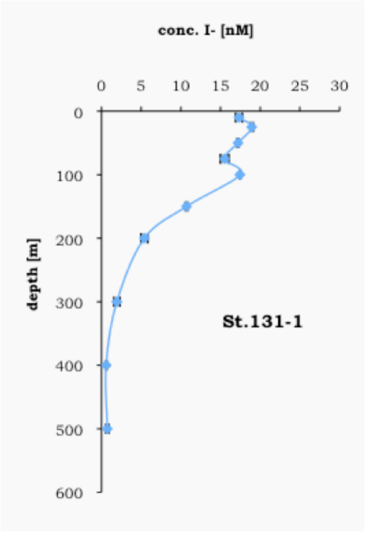

Fig. 3.25: A representative profile for iodide in Polar waters from along the Greenwich meridian

Acknowledgments

The authors would like to show their deep thanks and appreciation to the crew of the *Polarstern*, for all their efforts in helping us throughout ANT-XXIV/3. Thanks also to the Chief Scientist, Dr Eberhard Fahrbach and to the AWI Logistics Department for making this cruise possible. Funding for participation in this cruise was provided by the DFG and IfM-GEOMAR.

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3.2.8 Measurements of AOT (Aerosol Optical Thickness) over the Southern Ocean

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Objectives

There is a currently a lack of ground truth information for measurements of AOT (Aerosol Optical Thickness) from the Southern Ocean. While satellite measurements of AOT are possible at present through a number of dedicated satellites (MODIS AQUA and TERRA) data interpretation is reduced due to persistent cloud cover and reflections from sea ice and waves. Direct measurements of AOT from the surface using the sun as a light source are possible using small handheld devices such as the MICROTOPS and provide a useful dataset to validate retrieval algorithms for satellite estimation of AOT as well as providing instantaneous information for shipboard users. For ANT-XXIV/3 we undertook measurements of AOT when the weather permitted to provide baseline data for improving satellite retrievals and for assessment of any contribution from Patagonian dust to the aerosol loading over the Southern Ocean.

Transport of airborne dust from the continents provides a route by which Fe and other trace elements can enter remote surface ocean waters. This transport can be of particular importance for supplying iron to HNLC regions where Fe is the limiting nutrient. For the Atlantic sector of the Southern Ocean and the Weddell Sea it is suspected that much of the iron supplied to surface waters originates from Patagonia but the supply is extremely episodic (Erickson Iii et al. 2003; Gaiero et al. 2004; Gasso and Stein 2007).

Work at sea

During ANT-XXIV/3 discrete AOT measurements were made using a MICROTOPS II kindly loaned by the NASA/Goddard Space Flight Centre as part of the AERONET Maritime Aerosol Network programme (http://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html).

The MICROTOPS II is a handheld instrument that is well characterised for AOT measurements (Ichoku et al. 2002) and is capable of being used on moving platform such as a ship at sea (Porter et al. 2001), though the data does require some corrections because of ship movement (Knobelspeisse et al. 2003).

Over 1400 individual measurements were collected during the course of ANT-XXIV/3 corresponding to the periods when the sun was visible and not obscured by clouds. Problems were encountered with rough sea states and high winds but in general observations were easily made.

Preliminary results

The preliminary data indicated extremely low AOT over the course track most of the time suggesting there was little dust encountered during the cruise as might be expected for this remote region. Slightly elevated AOT was found along the Greenwich meridian at the location of the phytoplankton bloom and this may be due to increased biogenic aerosol production during the bloom though this must be confirmed by later comparison with satellite data collected at the same time. Further Satellite data relayed to us during the cruise (Santiago Gasso - NASA) indicated that there were some minor dust events from Patagonia occurring during the duration of ANT-XXIV/3 but back trajectories indicated a mostly easterly course which did not intersect with the ships position at any time. The collected AOT data will be further processed before release to the web.

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3.3 Isotopes during ANT-XXIV/3 expedition: AWI team

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Not on board: Michiel Rutgers van der Loeff[1)] Martin Frank[2)], Michael Staubwasser (Univ. Cologne), Christina de la Rocha[1)], Dieter Wolf-Gladrow[1)]

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Background and general objectives

Uranium-series radionuclides are powerful tracers for the rate of transport processes in the ocean. We wish to measure the distribution of U-series isotopes along the Greenwich meridian and in the Drake Passage. The sampling will be coordinated with sampling of other trace elements. This joint sampling allows us to directly apply the information on particle dynamics (aggregation, disaggregation and particle sinking rates) and terrigenous input that we will obtain from the distribution of thorium isotopes and ^{231}Pa, to the transport of other tracers. Similarly, we will be able to confront the results on water mass ventilation and upwelling, as we will derive from ^{230}Th/^{231}Pa and ^{227}Ac distributions, with hydrographic data and the conclusions drawn from other tracers described in parallel proposals (Nd/Hf isotopes; freons). The data will be interpreted along with other tracer data in (inverse) GCM models. We expect that this approach will improve our ability to use a set of tracers as more reliable proxies for past ocean climate.

3.3.1 ^{234}Th as tracer of export production of POC

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Objectives

The objectives of the project are:

1) to acquire accurate estimates of upper ocean POC export fluxes in the Southern Ocean;
2) to infer the export fluxes of some particle-reactive elements/compounds (i.e., Fe, Al, Mn, Cu, Cd, Ni, Zn, and Ag) that will be measured by other researchers in the same regions (see section on trace metals above; and
3) to carry out the intercomparison of POC export studies between ^{234}Th/^{238}U and ^{210}Po/^{210}Pb methods.

Work at sea

1) A total of 20 depth profiles of total ^{234}Th in 4-L water samples have been collected with the CTD.
2) Deployment of *in-situ* pumps in order to obtain size-fractionated samples of suspended particles and determine the POC/^{234}Th ratio in those size fractions.

In parallel to the sampling in Rosette casts we have used our automated ^{234}Th analyser to obtain the distribution of particulate and dissolved ^{234}Th in the surface water at higher spatial resolution. Samples were drawn every 4 hours from the ships seawater supply.

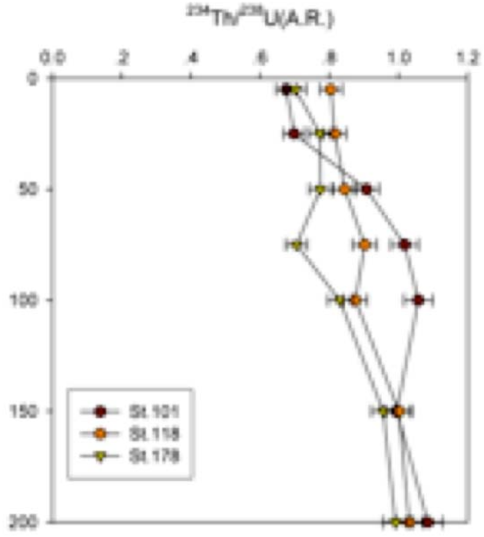
The distribution of particulate ^{234}Th gave a consistent picture. We have the experience that particulate ^{234}Th is an indirect representation of the suspended load in seawater. Plankton blooms are e.g. usually reflected in an increase of particulate ^{234}Th. As we approached the shelf ice a prominent drop in particulate ^{234}Th showed the presence of very clear water.

The automated analysis of dissolved ^{234}Th involves a coprecipitation of Th with MnO_2. The efficiency of this coprecipitation has been monitored by a continuous intercalibration programme with the manual 4-L method described above. The results of this programme will only be available after the measurement of a ^{230}Th yield tracer at AWI. Dissolved and total ^{234}Th data from the automated analysis were therefore not yet available on board.

Preliminary results

The depth profiles of total ^{234}Th show that ^{234}Th deficit varied substantially over the upper Southern Ocean (Fig. 3.26). This indicates remarkable variations in POC export in the Southern Ocean.

Fig. 3.26: Depth profiles of total ^{234}Th at Station 101, 118 and 178 in the Southern Ocean. Note that the recovery for ^{234}Th is yet to be determined.



3.3.2 Analysis of multiple thorium isotopes and ^{231}Pa

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Objectives

^{230}Th and ^{231}Pa are both the decay products of soluble and conservatively distributed uranium isotopes (^{234}U and ^{235}U). Th and Pa are produced at a fixed known rate in the ocean and are both sensitive to scavenging. The distributions of ^{231}Pa and ^{230}Th are controlled by particle flux and boundary scavenging. Thus, changes in the water column distribution of these isotopes can be interpreted as indication of changes in water mass ventilation and in particle flux. If no scavenging and/or recent ventilation of water masses occurs, the production rate of Th and Pa along the water column is constant, resulting in a distribution that increases with increasing depth. With a residence time of of ~ 50 years, ^{230}Th is more reactive than ^{231}Pa (residence time in seawater of approximately 200 years) and will trace more rapid and recent processes.

We wish to determine ^{231}Pa and ^{230}Th in filtered seawater and suspended particulate matter along the Greenwich meridian and in the Drake Passage.

The distribution of multiple Th isotopes over particulate and dissolved phase can be used to derive adsorption and desorption rates. When the particles are separated according to grain size before analysis (e.g. with a 50 μm screen), then the isotopes can be used to constrain the settling velocity of small and large particles in the upper 1000 m of the water column. If the distribution of Th isotopes is obtained over various size fractions it is possible to derive aggregation and disaggregation rates.

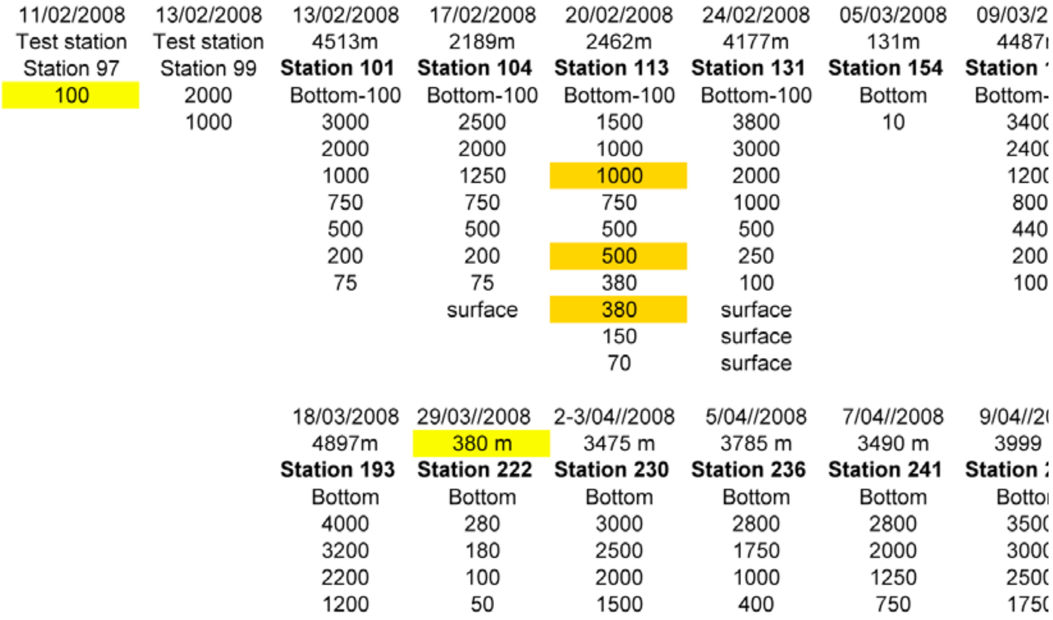
Work at sea

Dissolved

^{231}Pa and ^{230}Th analysis requires collection of 20 L of filtered (<1 μm) seawater. 20 L were collected using the Niskin bottles into acid-cleaned collapsible cubitainers, filtered through a 142 mm diameter Supor®-450 filter of 0.45 μm pore size (Pall). Then, all seawater samples were stored acidified (with concentrated distilled HNO_3), without addition of any tracers. The Supor®-450 filters were stored wet in special plastic bags and stored at 4°C. All the samples will be further processed at the home laboratory (addition of the tracers, coprecipitation, chromatographic extraction and spectrometric measurements).

About 8 - 11 samples were collected at each super station, giving a full water column profile with a good resolution. Therefore, 13 profiles were realised: 6 along the Greenwich meridian (Fig. 3.27), 2 in the Weddell Sea (Tab. 3.2) and 5 at Drake Passage. At some stations, duplicates were achieved. Thus, in the scope of GEOTRACES intercalibration and the BONUS-GOODHOPE expedition, 3 duplicates were collected at Station 113 (20/02/08, at 1,000 m, 500 m and 380 m for the ^{231}Pa and ^{230}Th analysis that will be achieved at LEGOS in Toulouse (Catherine Jeandel and Matthieu Roy-Barman). Three duplicates, which will be analysed at AWI, were also collected at the same location (on 12/03/08 at 52°59'S and 0°0'E) by the BONUS-GOODHOPE expedition. An extra station was realised near the ice shelf at 70°34’S and 8°7’E on 5/03/08. Surface samples were collected with the IFISH and filtered like the other samples on Supor®-450 filters.

Tab. 3.2: List of all the 20 L samples collected for the Nd, Th and Pa analysis at the different stations with the indicated depths (from 10 Feb. 08 to 16 Apr. 08). Highlighted in orange are the duplicated samples for the GEOTRACES intercomparison and in green, the duplicated depth/samples.



11/02/2008	13/02/2008	13/02/2008	17/02/2008	20/02/2008	24/02/2008	05/03/2008	09/03/2
Test station	Test station	4513m	2189m	2462m	4177m	131m	4487
Station 97	Station 99	**Station 101**	**Station 104**	**Station 113**	**Station 131**	**Station 154**	**Station**
100	2000	Bottom-100	Bottom-100	Bottom-100	Bottom-100	Bottom	Bottom-
	1000	3000	2500	1500	3800	10	340
		2000	2000	1000	3000		240
		1000	1250	1000	2000		120
		750	750	750	1000		800
		500	500	500	500		440
		200	200	500	250		200
		75	75	380	100		100
			surface	380	surface		
				150	surface		
				70	surface		

18/03/2008	29/03//2008	2-3/04//2008	5/04//2008	7/04//2008	9/04//2
4897m	380 m	3475 m	3785 m	3490 m	3999
Station 193	**Station 222**	**Station 230**	**Station 236**	**Station 241**	**Station**
Bottom	Bottom	Bottom	Bottom	Bottom	Botto
4000	280	3000	2800	2800	350
3200	180	2500	1750	2000	300
2200	100	2000	1000	1250	250
1200	50	1500	400	750	175

So far, 119 samples were collected for the dissolved ^{231}Pa and ^{230}Th analysis. 13 super stations have been realised, 2 test stations, a small station close to the Antarctic ice shelf and some surface samples collected from the IFISH.

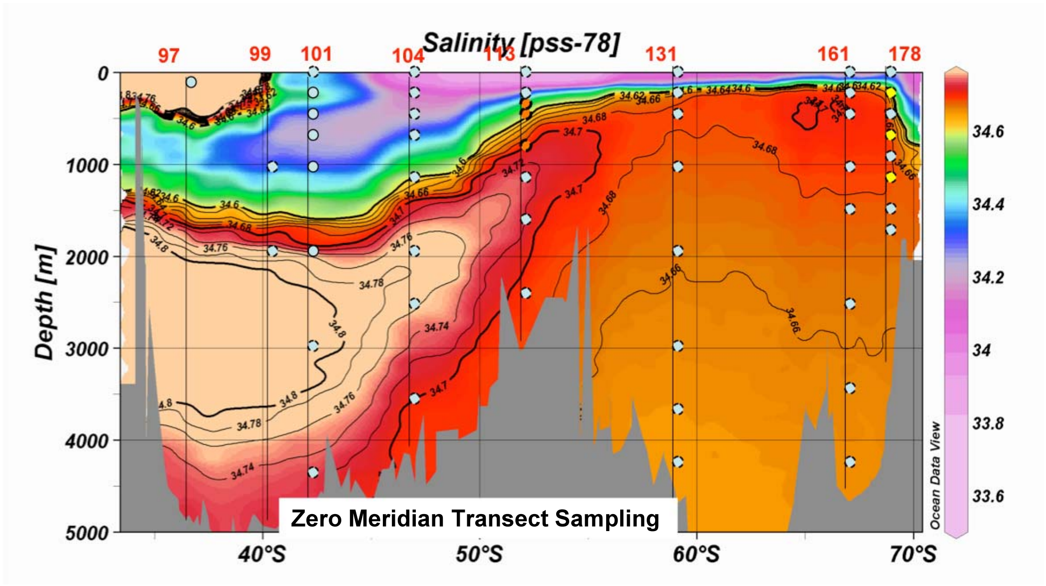


Fig. 3.27: Sampling location and depths along the Zero meridian

Particulate

Due to the ^{231}Pa and ^{230}Th low concentrations in particles (10 times less than in the dissolved phase), their analysis requires large volumes of filtered seawater of about 500 -1,000 L.

Size-fractionated particulate material sampling was achieved using 6 "Challenger" *in-situ* pumps. The filter holders of these pumps are set up with a stack of 3 different filters of 142 mm diameter and separated by grids. The lower filter is a Supor®-800 filter (Pall) of 0.80 μm pore size on which the small particle fraction (0.8 - 10 μm) is collected. Then, above the Supor®-800, a Nitex filter of 10 μm pore size is mounted and will allow the recovery of the intermediate size particles (10 - 50 μm). Another Nitex filter of 50 μm pore size is added on the upper part to collect the large particle fraction (> 50 μm). This size-fractionated particulate study was always achieved at 100 m depth for the on board ^{234}Th analysis with beta counting. Then, 5 other samples were collected for ^{231}Pa and ^{230}Th analysis at different depths so as to get a full water column profile. The on-board ^{234}Th analysis was further extended during the cruise to other depths of the profile, so as to combine both information on the export with ^{234}Th and ^{230}Th. The ^{231}Pa, ^{230}Th and ^{232}Th analysis in the 3 size-fractionated particles requiring clean-lab chemistry and high resolution mass spectrometry measurements will be realised at the home laboratory.

The pumping time was ca. 3 hours for most of the deep stations and the entire procedure (deployment and recovery) ranged from 5 to 7 hours. In 3 hours about 400 - 500 L of seawater were typically filtered at very high particle flux stations and between 600-800 L at stations with lower biological productivity.

Briefly, once collected on the Nitex filters, the size-fractionated particulate material (> 50 and 10 - 50 μm) was recovered by sonication (leaching in ultrasonic bath with

100 - 200 ml of 0.2 μm filtered bottom seawater) and the resulting solution filtered through a 47 mm Supor®-450 filter. The 47 mm filters, representing both size-fractionated particles (> 50 and 10 - 50 μm), were then stored in clean petri dishes. If any sample has to be counted for ^{234}Th, the 47 mm was dried at 50°C in the oven and then folded in order to be measured with beta counting. Otherwise they were stored wet in the fridge at 4°C. In this latter case, a part of the Supor®-800 filter (small particles) was cut under clean conditions (flow hood in clean container, cleaned material) and punched (with a 22 mm diameter punch) to enable a ^{234}Th counting for the small fraction size particles. The other part of the Supor®-800 filter was folded in half and stored in special plastic bags at 4° C.

Tab. 3.3 sums up the particulate sampling, realised with the ISP, during the expedition. For stations 131, 161 and 178, the ^{234}Th was counted on the large and intermediate size-fractionated particles. At stations 193, 222 (Weddell Sea), 230 and 241 (Drake Passage), a part of the Supor®-800 filters was cut and punched to allow ^{234}Th beta counting for the small particle fraction as well. Therefore, at these 4 stations, a full particulate ^{234}Th profile was achieved. The major part of the filters was then stored in special plastic bags and frozen.

Tab. 3.3: Summary of the size-fractionated particulate samples (50 μm, 10 μm and 0.8 μm) collected with the *in-situ* pumps from 10.02.08 to 16.04.08. Highlighted in green the 100 m sample for Pinghe Cai. The low filtered volumes (when not enough water to analyse was filtered) are noted in red.

Depth (m)	**Volume (L)**	**Depth (m)**	**Volume (L)**	**Depth (m)**	**Volume (L)**	**Depth (m)**	**Volume (L**
13/02/2008		17/02/2008		20/02/2008		24/02/2008	
Station 101		**Station 104**		**Station 113**		**Station 131**	
100	did not work	**100**	2831	**100**	1731	**100**	2406
200	358	**200**	did not work	**50**	282	**250**	719
500	494	**500**	631	**200**	453	**500**	658
750	537	**750**	1932	**500**	547	**1000**	666
1000	90	**1250**	79	**750**	374	**2000**	1278
2000	524	**2500**	517	**1000**	1352	**3800**	634
09/03/2008		11/03/2008		18/03/2008			
Station 161		**Station 178**		**Station 193**		**Station 222**	
100	953	**100**	762	**100**	840	**100**	532
200	416	**200**	354	**200**	409	**180**	271
440	419	**500**	1123	**500**	482	**280**	481
1200	596	**800**	445	**1200**	631	**380**	281
2400	450	**1000**	321	**3200**	182		
3400	568	**1500**	425	**bottom**	503		
02/04/2008		05/04/2008		07/04/2008		07/04/2008	
Station 230		**Station 236**		**Station 241**		**Station 244**	
100	733	**100**	584	**100**	336	**100**	160
250	1251	**250**	1392	**120**	162	**200**	325
500	417	**400**	386	**750**	421	**750**	499
1000	636	**1000**	644	**1250**	634	**1250**	702
2000	440	**2800**	279	**2800**	1551	**2400**	663
3000	483	**3500**	397	**3300**	413	**3500**	391
11/04/2008							
Station 250							
100	378						
150	222						
500	382						
900	606						
2200	466						
3700	368						

Sediment

Activities stored in marine sediments can help to reconstruct particle flux patterns in the past and surface sediments to evaluate patterns of particle flux and boundary scavenging. Therefore, it is a required complementary study to investigate the particle dynamics and the winnowing and focusing processes occurring on the seafloor in an area submitted to strong currents as the Drake Passage.

In this frame, sediment cores were collected with the minicorer (Fig. 3.28) at three super stations in the Drake Passage (241, 244 and 250). The minicorer was deployed under the normal AWI CTD, 20 m below the CTD frame. The altimeter signal gave an estimate of the moment when the minicorer had reached the bottom. Enough sediment cores were obtained with the minicorer at Station 241 and were sliced and stored in plastic containers. At first sight, it seems that this sediment was constituted of clays or silts, with a sandy aspect and overlied by numerous Mn crusts (Fig. 3.29).

Fig. 3.28: Minicorer deployment during ANT-XXIV/3

Fig. 3.29: Mn crust at station 241

Further analyses

In the vicinity of the Antarctic Peninsula, Ra samples, ^{228}Th and further ^{227}Ac samples were included in the analyses.

Preliminary results

Since the ^{231}Pa and ^{230}Th analysis requires clean-room work and further processes such as mass spectrometric techniques that could not be realized on board no preliminary results could be achieved. The evaluation of the collected data will be performed at the home laboratory.

However, the ^{234}Th counting on the particles was achieved on board. Thus, figures 3.30 and 3.31 represent the coarse profiles obtained for the ^{234}Th for the large and intermediate size particles at stations 131, 161 and 178 and for the total particulate phase at stations 193, 222, 230 and 241.

On Fig. 3.30, even without the small fraction size particle measurement, a “normal” ^{234}Th pattern can be clearly noticed with decreasing particulate ^{234}Th with depth at most of the stations, except the maximum observed at station 178 at 1000 m. Close to the bottom, at stations 222 and 230, the particulate ^{234}Th, as expected, increases, likely due to sediment re-suspension.

Moreover, the range of the ^{234}Th particulate concentrations in both fractions is in agreement with what can be expected (personal comm. Pinghe Cai) confirming that the sonication step efficiently worked.

Fig. 3.31 displays the total particulate ^{234}Th at 4 stations: 193 and 222 in the Weddell Sea, 230 and 241 in the Drake Passage. On most of these profiles, the characteristic trend of the particulate ^{234}Th can be seen with higher concentrations at the surface and near the bottom. To the exception of some surface values, all along the water column, the mean total particulate ^{234}Th concentrations are ca. 0.05 dpm/L. The maximum values are found at the surface and for the station 222 near the Antarctic Peninsula where the profile follows once more the general pattern with a high value near the surface, decreasing with depth and increasing again close to the seafloor.

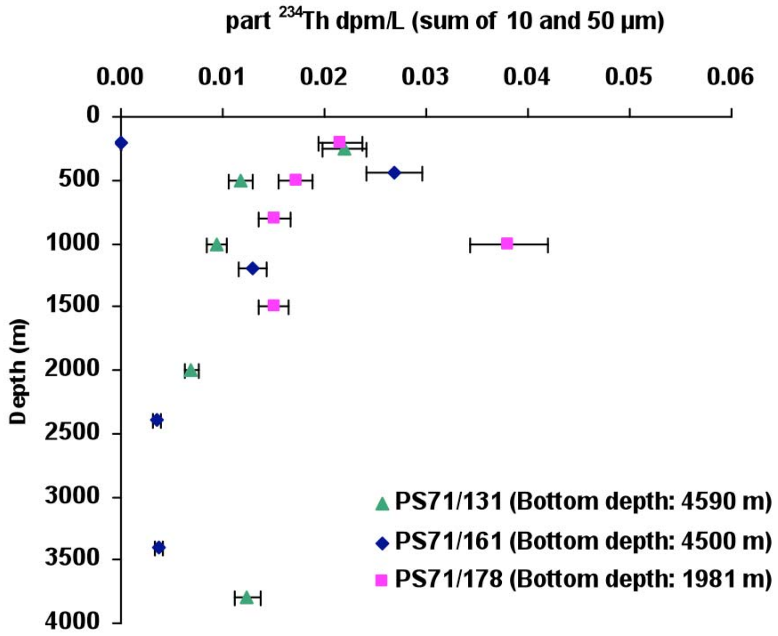


Fig. 3.30: ^{234}Th concentrations (in dpm/L) in 10 and 50 µm combined particle size fractions, i.e. for particles >10 µm. The error bars represent a 10 % error on the final value.

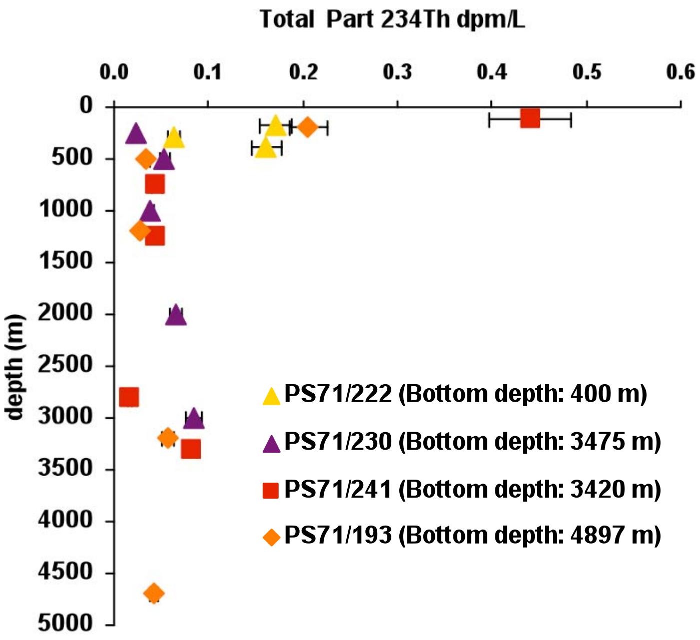


Fig. 3.31: Total particulate ^{234}Th concentrations (in dpm/L), i.e. sum of the 3 particle size fractions (i.e. particles > 0.8 µm). The error bars represent a 10 % error on the final value.

3.3.3 Importance of marine polysaccharides for radionuclides cycling

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Background

Dissolved organic matter (DOM) forms the largest pool of material in the marine environment. The colloidal fraction of the DOM is highly reactive and thus, plays a large role in biological, physical and chemical processes. Due to their high molecular weight, polysaccharides belong to the colloidal organic matter (COM). These substances are mainly released by marine phytoplankton and bacteria. Some of these exopolymers can abiotically aggregate to form particles called transparent exopolymer particles (TEP). TEP are very sticky and consequently a key controlling factor in vertical fluxes as they glue together diverse particles. This occurs via aggregation and leads to the formation of large marine aggregates. The sticky nature of TEP is linked to the presence of a high fraction of acidic polysaccharides with sulphate ester groups, which give the ability to form cations bridges and hydrogen bounds, especially with trace elements.

Thorium-234 (^{234}Th), lead-210 (^{210}Pb) and polonium-210 (^{210}Po) are produced by radioactive decay of uranium-238 in seawater. ^{234}Th (24 days half life), ^{210}Po (138 days half life) and ^{210}Pb (22.3 years half life) are known for their high affinities to particles and aggregates. In seawater these radionuclides occur both in dissolved form and adsorbed onto particles. In the COM pool, the polonium (Po) distribution differs from thorium (Th) and lead (Pb). Whereas Th and Pb seem to have a higher partitioning coefficient in polysaccharide-enriched COM than in the bulk COM, Po seems to have a much higher partitioning coefficient in bulk COM than in polysaccharide-enriched COM. This selective complexation points out the importance of the chemical composition of marine particles in controlling the scavenging of particle reactive radionuclides in particular and trace elements in general in the ocean.

Objectives

During the GEOTRACES activities of ANT-XXIV/3 we want to:

1) get a better insight into binding affinities of Th, Pb and Po for polysaccharide-like particles and protein-like particles.
2) Investigate to which extend TEP can play a role in extending ^{210}Po as a proxy for particulate organic carbon (POC) transport.

Work at sea

1) At the superstations ^{210}Po and ^{210}Pb have been sampled at different depths in the water column (25, 100, 200, 500, 750, 1000 m) on the three transects (from CTD rosette Niskin bottles) in 30-40 L samples for particulate and dissolved fractions (over 1μm and truly dissolved respectively). Additional samples (10-20 L) were used to determine the concentrations of TEP and protein-like particles (CSP) in the

particulate and dissolved fractions (filtration over 1 µm then through 0.4 µm respectively). POC has also been sampled at each depth studied (filtration onto precombusted GF/F filters). The filters retaining the particulate phase for the radionuclides have been measured on board in order to determine the ^{234}Th/^{238}U ratio. Back at the AWI, the same filters will be analyzed for ^{210}Pb/^{210}Po determination.

So far, 7 depths profiles have been sampled.

2) Whenever high volumes of water (ca. 100 L from the chlorophyll maximum depth) have been available from the CTD, aggregation experiments have been conducted. After determination of the same parameters as described above, the seawater is incubated in 5 L container that are maintained in rotation (3 rpm) in the dark, at 2°C, for different time scale (from 24 h up to 15 days). These experiments aim at monitoring the transfer of radionuclides (^{234}Th, ^{210}Po, ^{210}Pb) between the dissolved and he particulate fractions and try to correlate these changes to those that could be observed for POC, DOC, TEP and /or CSP.

So far, 3 aggregation experiments have been conducted.

Preliminary results

All the samples will be later analyzed either in the Geochemie or the Biogeochemie groups of the AWI.

In Fig. 3.32, the ^{234}Th profiles show different ^{234}Th deficit patterns.

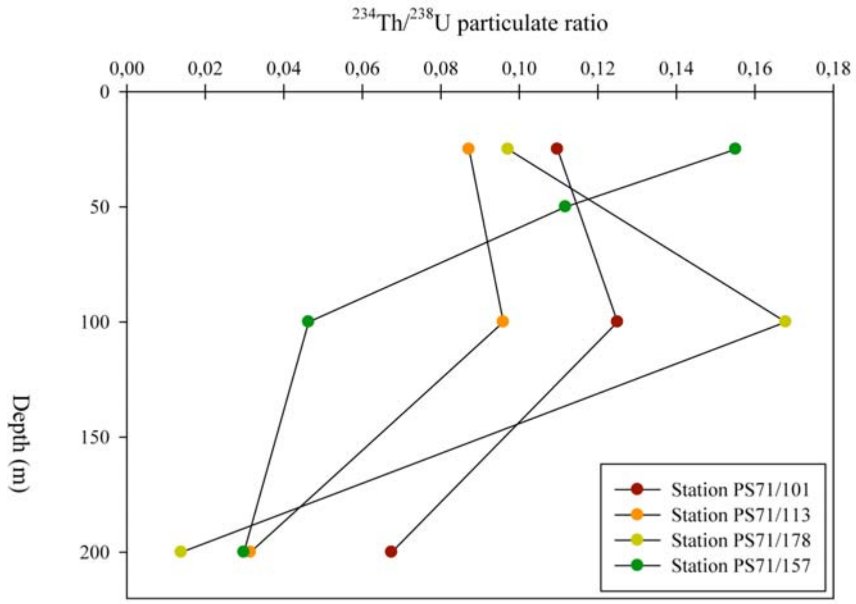

Fig. 3.32: Profile of 234Th in the particulate phase (over 1µm) for the 200 upper meters N.B.: Errors bars have not been calculated yet. The error can vary from ca. 5 to 10 %.

3.3.4 Radium isotopes and ^{227}Ac

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Objectives

Four radium isotopes are supplied to the ocean by contact with the continent or (deep-sea)-sediments: ^{223}Ra, (half-life 11.4 d); ^{224}Ra (3.7 d), ^{226}Ra (1620 y) and ^{228}Ra (5.8 y). The distribution of these isotopes in seawater has been shown to be most helpful to evaluate shelf-basin exchange and water residence times. On the Greenwich meridian we expected extremely low concentrations of all but the long-lived ^{226}Ra. We have concentrated the Radium sampling programme in the area around the Antarctic Peninsula where Ra isotopes are most informative on shelf-water interaction (Hanfland, PhD thesis 2002; Dulaiova, pers. comm.). Like Ra isotopes, ^{227}Ac is released from sea sediments, but its main source is in deep-sea sediments. This tracer is therefore especially useful to study deep water mixing and ventilation.

Work at sea

Radium

During 13 deployments of *in-situ* pumps a set of two MnO_2 –coated polypropylene fiber cartridges was used to adsorb dissolved radionuclides. (On station 279 loose MnO_2-fiber was used instead to allow immediate measurement of ^{224}Ra with the RaDeCC system, but the adsorption efficiency turned out to be unsatisfactory). The ^{228}Ra/^{226}Ra isotope ratio will be quantified in the home laboratory by Soxhlet acid leaching and subsequent gamma spectroscopy; ^{226}Ra will be derived from the relationship established on earlier expeditions between ^{226}Ra and dissolved silicate.

For the analysis of short-lived radium isotopes, surface water from the ship's seawater intake was cartridge-filtered at 31 stations and transferred into 250 L tanks in the fishlab. At four shelf stations (154, 155, 216, and 221) additional 60-L subsurface samples were collected with the Rosette and treated similarly. Each sample was pumped at max.1 L/min through MnO_2-impregnated acrylic fiber to scavenge radium isotopes. Fibers were dried using compressed air, and short-lived ^{223}Ra and ^{224}Ra measured at-sea using RaDeCC detectors.

Actinium

^{227}Ac has been sampled in two ways. First, it is collected along with radium on the MnO_2-coated cartridges during *in-situ* pump deployments. Due to the absence of a second isotope that could serve as yield tracer to correct for insufficient absorption of Ac on the fiber, this procedure leaves an appreciable uncertainty. The second procedure used the discrete approx. 60-L samples from Rosette casts collected in cooperation with Torben Stichel for the combined analysis of Hf isotopes and ^{227}Ac (see section on Nd and Hf isotopes). Samples were filtered and Hf and Ac were coprecipitated with $Fe(OH)_3$. After return to Germany these samples will be separated with ion-exchange procedures and analysed in the Kiel and Bremerhaven labs.

Expected Results

From the analysis of radium isotopes we expect to derive signals of shelf input which can be related to parallel studies on trace metals (Mn, Al: Rob Middag; Fe: Maarten Klunder) and ^{232}Th (Celia Venchiarutti). The ^{227}Ac data will enlarge the very sparse dataset of this isotope. After correction for activity that is supported by production from ^{231}Pa in the water column (from the study of Celia Venchiarutti) the excess concentrations ($^{227}Ac_{xs}$) will be used to estimate upwelling rates of deep water.

3.3.5 Neodymium (Nd) and hafnium (Hf) isotopes

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Objectives

The subject of our study is a detailed investigation of the distribution of neodymium (Nd) and hafnium (Hf) isotopes in dissolved and particulate form in the water column and in the seawater-derived fraction of surface sediments of the Atlantic sector of the Southern Ocean. Nd isotopes have been shown to be a powerful geochemical tracer for present and past water mass mixing and source provenance tracing in the ocean. The combination with Hf isotopes was applied successfully for the characterization of continental weathering regimes, i.e. it has been suggested that coupled Nd-Hf isotope analyses of Hf and Nd allow to distinguish weathering regimes dominated by chemical weathering from those dominated by physical weathering (van de Flierdt et al., 2002). Both isotope systems have been used for the reconstruction of water masses in the Southern Ocean on various time scales in the past from marine sediments. So far there are, however, nearly no data for the water column of the Southern Ocean, which severely restricts the reliable application of this combination of tracers for present day studies and reconstructions of the past. In the frame of the international GEOTRACES programme we collected large volume water samples from the surface ocean and from depth profiles at selected stations during ANT-XXIV/3.

Work at sea

Greenwich meridian

On the Greenwich meridian we have collected 25 samples (8 surface samples taken with the towed fish and 17 deep samples by the CTD rosette; Tab. 3.4) with a total volume of about 1500 liters for Nd and Hf isotope measurements. The samples were collected under trace metal free conditions in acid cleaned 20 liter holding collapsible cubitainers. The Hf concentration in seawater ranges from 0.2 to 1 pmol/kg and is thus very low (Godfrey et al., 1996; McKelvey and Orians, 1998). For meaningful Hf isotope measurements on a multi collector inductively coupled mass spectrometer

(MC-ICPMS) in the home laboratory, Hf from at least 50-60 liters (≈5-10 nanograms Hf) were needed for each sample taken below 100-200 meter. Due to the even lower Hf concentration in the surface waters, samples taken by the towed fish, had to be even larger (100-120 liters). After collection, the samples were filtered through a filter of 0.45 μm mesh width, which was kept for later particle analysis. In order to avoid adsorption of Nd and Hf onto the walls of the cubitainers, the samples were acidified to pH 2 by addition of double distilled concentrated acid. For every large volume sample we filtered, acidified, and stored a 2 liter aliquot to determine the concentration of Nd and Hf by isotope dilution in the home lab. To the rest of each sample 0.5 ml of a $FeCl_3$ solution containing ~200 mg Fe per ml were added to each 20 liter sample. After this step the pH was titrated back to 7-8 by addition of a suprapure ammonia solution to co-precipitate FeOOH, which scavenged the dissolved trace metals in the sample. After 24-48 h most of the supernatant was discarded. Afterwards the samples were transferred into 2 liter acid cleaned wide mouth bottles. Additionally, at each Super Station shared 20 liter samples were taken for Nd, thorium (Th), and protactinium (Pa) isotope measurements (see subsection 3.3.2) to have a total of 59 Nd samples inclusive duplicates.

Tab. 3.4: List of samples from hydro-casts (a) and surface waters (b) with corresponding depths in meters for each station.

a)

Stat.:	71/101	71/104	71/131	71/161	71/181
LAT:	42°20.3' S	47°39.3' S	58°59' S	66°30' S	69°36' S
LONG:	8°59.6' E	4°16.2'E	0° E	0° E	0° E
	750	400	400	440	1465
		750	900	800	
		1200	1500	1200	
		2000	2500	2400	
		4500	4070	3400	

b)

Stat.:	I	II	71/105	71/116	71/133
LAT:	34°53.1' S	38°38' S	47°39.3' S	54°21' S	59°14.4' S
LONG:	16°40.7' E	11°35.8' E	4°16.16' E	0°01' E	0°02.9' E

b) continued

Stat.:	71/142	71/151	GvN-Fish	71/156
LAT:	62°20' S	65°19' S	68°31.8' S	67°08' S
LONG:	0° E	0° E	4°39' W	0°24' E

Weddell Sea and Drake Passage

On the transect from Neumayer Station (Atka Bay, Antarctica) to Punta Arenas (Chile) a total of 39 water samples for Hf and Nd analyses were collected in the Weddell Sea and the Drake Passage. 12 of these samples were taken from surface waters and 27 samples from hydro cast CTD profiles (Tab. 3.5). In addition, 50 shared samples in total were taken for Nd, Th and Pa isotope measurements on all Super Stations (see subsection 3.3.2).

Tab. 3.5: List of samples from hydro-casts (a) and surface samples (b) recovered in the Weddell Sea and the Drake Passage with corresponding depths in meters.

a)

Stat.:	71/193	71/222	71/236	71/241	71/250
LAT:	66°36'S	63°21'S	59°00'S	57°38'S	55°45'S
LONG:	27°17'W	52°51'W	58°09'W	60°53'W	64°26'W
	500	450	500	480	500
	1200		1000	750	900
	2200		1500	1250	1600
	3200		2500	2800	2500
	4800		3700	3550	3800

b)

Stat.:	III	71/186	71/191	IV	V	VI
LAT:	60°02'S	69°03'S	67°21'S	65°34'S	64°59'S	64°20'S
LONG:	15°42'W	17°25'W	23°38'W	36°46'W	42°00'W	46°04'W

Stat.:	71/210	71/222	VII	71/223	VIII	71/244
LAT:	64°03'S	63°21'S	62°08'S	63°17'S	60°03'S	56°53'S
LONG:	48°15'W	52°51'W	57°31'W	53°14'W	55°24'W	62°31'W

Expected results and further processing

We will determine the isotope composition of Nd and, for the first time of Hf, in both dissolved and particulate form to characterize the isotopic composition of the different Southern Ocean water masses, their sources, and mixing relationships. This will enable new insights into the influence of weathering processes of the Antarctic continental landmass on the geochemical composition of the Southern Ocean, as well as a detailed isotopic characterization of the water masses prevailing in the Atlantic sector of the Southern Ocean and the Weddell Sea. The new data will allow a more reliable application of the Nd/Hf isotope systems for reconstructions of past weathering regimes and ocean circulation.

In the home laboratory, the FeOOH precipitates of the samples will be centrifuged and separated from the remaining supernatant. To remove most of the organic matrix, the samples will be treated with aqua regia after drying. The next step will be the separation of the Hf and Nd from Fe of the FeOOH-precipitate, which will either be carried out by backextraction* or large volume (40 ml resin) cation separation columns. “Hf” and “Nd” cuts will then be collected separately. The “Nd” cuts will be further purified through additional cation column steps to separate the REEs from Ba and achieve a pure rare-earth-element (REE) cut. To separate Nd from other REEs, a Ln-SPEC resin will be used. The "Hf" cut will be further purified by a one step column chemistry modified after (Münker et al., 2001). The isotopic composition will then be measured on a Nu-Instruments multi-collector-inductively coupled plasma mass spectrometer (MC-ICPMS). For the measurements of the Nd and Hf concentrations of each sample, a Nd and Hf spike will be added to each 2 L aliquot to determine the concentrations by the isotope dilution method on the MC-ICPMS.

*: Trace elements, which are adsorbed on the FeOOH-precipitate, are dissolved in 6M HCl together with the precipitate. Iron forms a $HFeCl_4$-complex which is taken up by di-ethylether (Nachtrieb and Conway, 1948; Nachtrieb and Fryxell, 1948). T he residual trace elements stay in the aqueous solution and can be separated.

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3.3.6 Rare earth elements and barium

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Objectives

The varying REE-pattern is transferred to the ocean via processes such as riverine inputs, dust inputs, or leaching of shelf sediments and ice drifted sediments. In addition to selective weathering, elemental fractionation may also occur during aqueous transport, where natural particles and colloids are of great importance. The REE concentrations coupled with the Nd isotopic ratios (subproject 3.3.5) are powerful tracers to investigate scavenging processes and to predict the fate of elements brought from the continent. The REE's residence times on the order of

1000 years make them ideal tracers for water masses as it allows for long distance transport while preventing complete homogenisation.

The geochemistry of barium is closely linked to that of radium. For the interpretation of our measurements of radium it is important to know the barium and silicate as well.

Work at sea

Samples were collected for REE in dissolved and particulate form. For dissolved REE 1 L of seawater was collected in surface waters and at deep stations using the NIOZ Titanium-Rosette. Such samples were obtained at all superstations along with the sampling for ^{231}Pa and ^{230}Th and barium.

Particulate REE in surface waters has been collected by the ship's seawater pump and a continuous flow centrifuge. At each superstation, 2,500 - 5,800 L of seawater was centrifuged at a rate of about 500 - 1,000 L per hour at 16,000 g. The combined centrifugate, a brown-green paste with a high content of phytoplankton and sea-salt, was stored frozen. It will be freeze dried and analyzed for its elemental composition at AWI.

3.3.7 Iron isotopic fractionation near the Antarctic Peninsula

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Objectives

On the occasion of approaching the Antarctic Peninsula towards Jubany the objective is to collect seawater samples to complement the IPY project ClicOPEN (Doris Abele; EoI#193; full proposal #34) on the issue of iron stress on near-shore ecosystems of the Antarctic Peninsula. Briefly it is planned to assess the ratio of stable isotopes of iron (Fe) to link the high coastal Fe concentrations with semi continuous surface-water profiles to the growth-limiting concentrations far offshore. Such a transect is especially interesting for studies of Fe isotopic composition, which can be measured at far better precision at these elevated concentrations and thus will allow to identify any isotope fractionation during early Fe uptake. Samples for Fe isotopic composition studies are to be collected (cooperation with Michael Staubwasser, University Köln).

Work at sea

We have done five shallow casts with the ultraclean Rosette, at overall five stations on the approach towards the Antarctic Peninsula. At three to five depth horizons samples of 20 to 50 liters were collected for iron isotope analysis. The seawater samples were all filtered, some on membrane filters, others over a filter cartridge (0.2 micron Sartorius Sartobran 300). Moreover filtrations have been done in another approach over a suite of two filter membranes of 5 micron and 0.45 micron nominal size cutoff respectively, placed in-line such that the first 5 micron filter takes out the larger size class marine particles, and next the finer 0.45 micron filter removes the smaller size class particles. The membrane filters were stored in the freezer for isotope analyses as well. In parallel for selected stations and selected depths the distribution of dissolved trace metals Fe, Mn and Al was sampled, and analyzed in context of projects 3.1.1. and 3.1.3, respectively. For exact information on sampling, filtrations and ancilliary samples for Fe, Mn Al, see the Excel sheet of each station hydrocast G1 to G5.

3.3.8 δ ^{13}C of particulate organic material in the Southern Ocean

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Objectives

The Southern Ocean may have been essential for the drawdown of atmospheric CO_2 during glacial periods. In order to reconstruct the state of the Southern Ocean during glacial periods and the processes responsible for altered states various paleo-proxies including $\delta^{13}C_{org}$, $\delta^{15}N$, $\delta\ ^{30}Si$, have been proposed and applied. A major problem for the application of $\delta\ ^{13}C_{org}$, as a paleo-proxy is its large variation in the Southern Ocean and the unknown origin of isotopically very light organic material ($\delta^{13}C_{org}$ below -30‰). Our goal is to identify the phytoplankton species responsible for this light material, to look for variations under various growth conditions, and to investigate the relationships between $\delta\ ^{13}C_{org}$ to other paleo-proxies based on consistent data sets. The work will contribute to the international programme GEOTRACES (2006).

Work at sea

Samples containing *in-situ* phytoplankton were collected from the chlorophyll maximum at 5 stations and 6 super stations on the Greenwich meridian transect. The depth of the mixed layer was determined based on the CTD profile and where no clear chlorophyll maximum peak was present, a depth of 50 m was used as a standard depth.

In order to separate different plankton groups the suspended particulate material was fractionated sequentially into 5 size classes: 0.2 – 1.2 μm, 1.2 – 5 μm, 5 - 20 μm, 20 - 100 μm and > 100 μm. The particulate material collected from each size fraction was resuspended immediately after sampling in 0.2 μm filtered sea water from the previous station. To evaluate the collected species composition and further characterize the particulate material sampled 20 ml of the suspension were transferred into a 25 ml screw capped scintival and chemically fixed for later microscopic investigation. The remaining suspension was filtered through a precombusted glass fibre filter (GF/F 25 mm diameter) for the four larger size fractions and through a precombusted silver filter (25 mm diameter) for the 0.2 μm size fraction. These filters were frozen for isotopic analysis, which will be conducted at the Alfred Wegener Institute.

The large diatoms (Corethron sp., Fragilariopsis kerguelensis) common in the Southern Ocean will be collected in the > 100 μm fraction, whereas the smaller diatoms like Pseudonitzschia sp. and many protozoa will be collected in the 20 – 100 μm fraction. Copepods caught in the large size fractions will be hand picked off the filters. Flagellates of Phaeocystis antarctica and other flagellates will dominate the 5 - 20 μm fraction. Bacterio-plankton (0.2 -1.2 μm) and picoplankton (1.2 – 5 μm) will dominate the two respective smallest fractions.

A minimum of 50 - 80 μg of carbon per filter is required for the measurement of $\delta^{13}C_{Corg}$. At a chlorophyll concentration of 0.5-2 μg L^{-1} and a carbon: chlorophyll ratio of 40 g g^{-1} filtration of 20 to 40 L of seawater will collect enough material for $\delta\ ^{13}C_{Corg}$ measurements of samples fractionated into 5 size classes. This has been confirmed by measurements performed within an earlier fractionation experiment. The amount of water filtered was determined at each station according to the chlorophyll concentration, which is measured online as fluorescence and the amount of particulate material present in the sample during filtration. Smaller volumes of water were required for filtration through the smaller size fractions.

Preliminary results

Isotopically extremely light values ($\delta^{13}C_{org}$ < -28 ‰) were consistently observed at stations south of the Polar Front, with values $\delta^{13}C_{org}$ < -30 ‰ in at least one size fraction at 4 stations. The fractionations ε_p indicate that the produced organic carbon was appreciably lighter (+ 14 to 20 ‰) than the source DIC implying that biology is a key factor responsible for the isotope ratios.

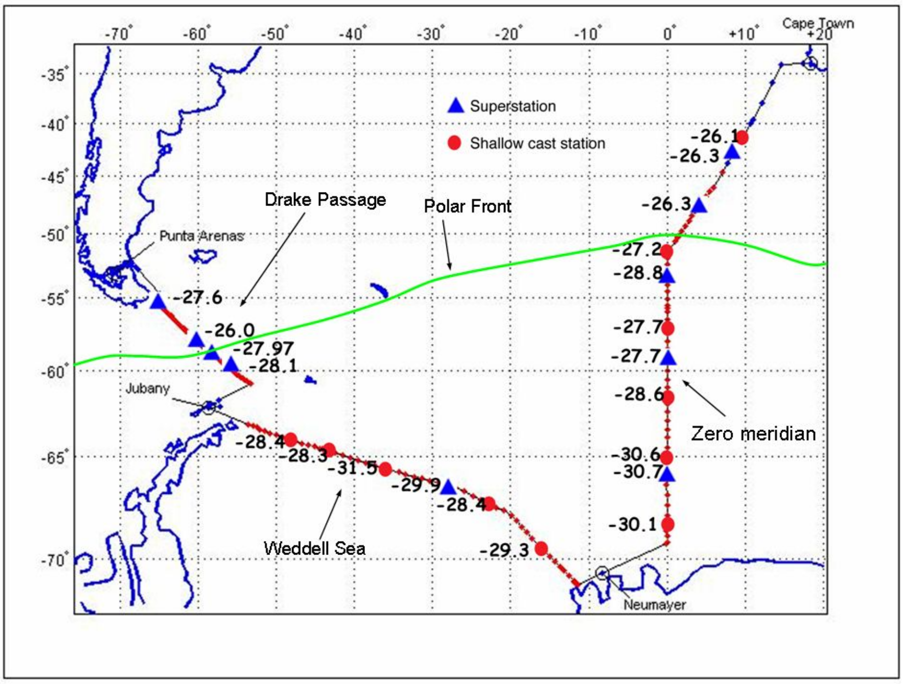

Fig. 3.33: Location of stations sampled and the most isotopically light $\delta^{13}C$ signal at each station. Extremely light values (< -28 ‰) were observed in the Southern Ocean, south of the Polar Front, indicated by the green line.

3.3.9 Mapping the distribution of Si isotopes in Southern Ocean waters

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Objectives

The Silicon isotopic composition of sedimentary diatoms is a key proxy for reconstructing nutrient cycling in the Southern Ocean and its impact on atmospheric CO_2 over past climate cycles. It is considered to reflect the extent to which the nutrient, silicic acid, is removed from the euphotic zone in support of primary production. The extent of CO_2 uptake during primary production relative to the upwelling of CO_2-rich deep waters in the Southern Ocean, in turn, has a strong influence on atmospheric concentrations of CO_2.

To date paleoceanographic reconstructions of silicic acid draw down in the Southern Ocean, south of the present day Antarctic Polar Front (APF), has produced conflicting results with that of nitrate draw down. The Si isotopic composition of diatoms has suggested that silicic acid is more completely consumed during interglacials, and is utilized to a significantly lesser extent during glacials, especially the last glacial maximum (LGM) and the maximum of the penultimate glacial cycle. The nitrogen isotopic composition of organic matter trapped within the siliceous framework of diatoms, however, suggests the opposite pattern for nitrate utilization.

The objective of this work is to map both the distribution of Si isotopes in dissolved nutrients in surface waters in the Southern Ocean, providing information as to the range and variability of the variations (especially of the isotopic composition of nutrients) over a fine spatial scale and to examine the Si and composition of seawater and diatoms in the Southern Ocean.

Work at sea

Samples were collected at 4 stations on the Greenwich meridian transect and 2 on the Weddell Sea transect. 16 depths per cast were sampled to construct a complete depth profile on these stations from depths ranging from 10 meters at the shallowest down to 5000 meters at the deepest (although most sites were shallower than this). At Station PS71/115-2 a reduced 7 depth profile was sampled to enable an intercalibration with the *Marion Dufresne*:

Once the samples were collected the water was filtered throught 0.6 μm polycarbonate filters to obtain biogenic (BSi) and lithogenic (LSi) silica concentrations; and δ^{30}Si of dissolved silicon. The parameters sampled for will be measured back at the AWI.

Preliminary results

70 depths were sampled from 6 different CTD casts on the first part of the cruise ANT-XXIV/3. These samples fall along a cruise track that covered temperate to polar regimes, crossed over the Antarctic Divergence, the Antarctic Polar Front, and the

Subantarctic Front, regions of low Fe availability as well as those (down wind of land masses or on the Kerguelen Plateau) where Fe may be abundant, and both open and coastal waters. The samples taken should allow for documentation of shifts in isotope values over a broad range of conditions. This will help us to improve Si isotope-based paleoceanographic reconstructions of nutrient utilization and CO_2 removal. The data sets produced, in addition to enhancing our understanding of a proxy fundamental to reconstructions of Southern Ocean paleoceanography, falls under the auspices of the IPY umbrella project, BIPOMAC, and will also contribute to the trace metal and isotope mapping efforts of GEOTRACES.

3.3.10 Uranium isotopes

Ingrid Stimac1), Hein de Baar2)
not on board: B. Moran3), M. Rutgers van der Loeff1)

1)Alfred-Wegener-Institut
2)NIOZ
3)University of Rhode Island

Objectives

New methods are now available for more accurate determination of the isotopic composition of uranium (U) in seawater. This allows better insight in the geochemistry of U in the oceans. One important aspect is to be able to distinguish the U isotopic signal of different water masses.

Work at sea

In an effort to capture the core water masses of Antartic Intermediate Water (AAIW), the underlying water of North Atlantic Deep Water origin, and the Antarctic Bottom Water, 10 samples of 4 L each have been collected at a station situated north of the Polar Front, as to be able to sample AAIW which forms at the Polar Front, and does not exist South of the Polar Front. The station positioned at 44°39.69'S, 7°5.59'E (PS71-102-2 at 15.02.2008) was sampled at depths of 300, 400, 500, 750, 1,000, 1,500, 2,000, 2,500, 4,000 and 4,500 m. Each sample was acidified with 1 ml/liter of Seastar 12M HCl baseline grade (this acid was available in context of project 3.15. on Cd isotopes) and then stored for future analysis by Brad Moran.

3.4 Nutrient measurements during ANT-XXIV/3

Jan van Ooijen
NIOZ

Background

On this cruise samples were analysed on phosphate, silicate, nitrate and nitrite.

At the end of the cruise there will be about 18,000 analysis (4,500 samples) accomplished on a Bran and Luebbe Traacs800 Autoanalyser connected to an autosampler. The different nutrients were determined colorimetrical as described by Grashoff (1983).

Methods

Samples were obtained from a CTD rosette sampler, an ultraclean CTD and of algae growth experiments. All samples were obtained in a polyethylene vial and the samples of the algae growth experiment were filtered over a 0.20 μm acrodisc filter. They were all stored dark at 4°C. CTD samples were analysed within 12 hours all other samples within 24 hours on a Technicon TrAAcs 800 autoanalyzer.

Standards were prepared fresh every day by diluting the stock solutions of the different nutrients in nutrient depleted surface ocean water. This water is also used as baseline water. Each run of the system ha,d a correlation coefficient for 9 calibrant points of at least 0.9999. The samples were measured from the lowest to the highest concentration in order to keep the carry over effects as small as possible.

In every run a mixed nutrient standard containing silicate, phosphate and nitrate in a constant and well known concentration, a so called antarctic nutrient-cocktail, was measured in duplicate. This cocktail is used as a guide to check the performance of the analysis and used to make a correction at the end of a transect obtaining the final data.

Over the last 20 years this cocktail has proven to be stable for at least 10 years and has also been used and monitored in many intercomparisment tests (ICES, Quasimeme). The reduction efficiency of the cadmium column on the NO_x manifold was as least 97 % and measured in each run.

Chemistry
Silicate reacts with ammoniummolybdate to a yellow complex, after reduction with ascorbic acid the obtained blue silica-molybdenum complex was measured at 800 nm. Oxalic acid was used to prevent formation of the blue phosphate-molybdenum.

Phosphate reacts with ammoniummolybdate at pH 1.0, and potassiumantimonyl-tartrate was used as an inhibitor. The yellow phosphate-molybdenum complex was reduced by ascorbic acid and measured at 880 nm.

Nitrate plus nitrite (NOx) was mixed with a buffer imidazol at pH 7.5 and reduced by a copperized cadmium column to nitrite. This was diazotated with sulphanylamide and naphtylethylenediamine to a pink colored complex and measured at 550 nm.

After subtracting the nitrite value of the nitrite channel the nitrate value was achieved.

Nitrite was diazotated with sulphanylamide and naphtylethylenediamine to a pink colored complex and measured at 550 nm.

Statistics after corrections for the Greenwich meridian transect
The standard deviation of reference material within a run:

PO_4:	0.006 uM	0.16 % of full scale value
Si :	0.084 uM	0.06 % of full scale value
NO_x:	0.063 uM	0.13 % of full scale value

NO_2:	0.001 uM	0.05 % of full scale value

The standard deviation of reference material between the runs are:

PO_4:	0.009 uM	0.27 % of full scale value
Si :	0.464 uM	0.33 % of full scale value
NO_x:	0.222 uM	0.24 % of full scale value
NO_2:	0.006 uM	0.39 % of full scale value

Suspicious bottles

Bottles which seem not to have closed at the right depth at the Greenwich meredian transect are:

CTD 106-1-1
CTD 127-1-2
CTD 134-1-4 or CTD 134-1-1

Preliminary results

An overlook of the results of the nutrient analysis on the Greenwich meridian transect is plotted in ODV (Fig. 3.34).

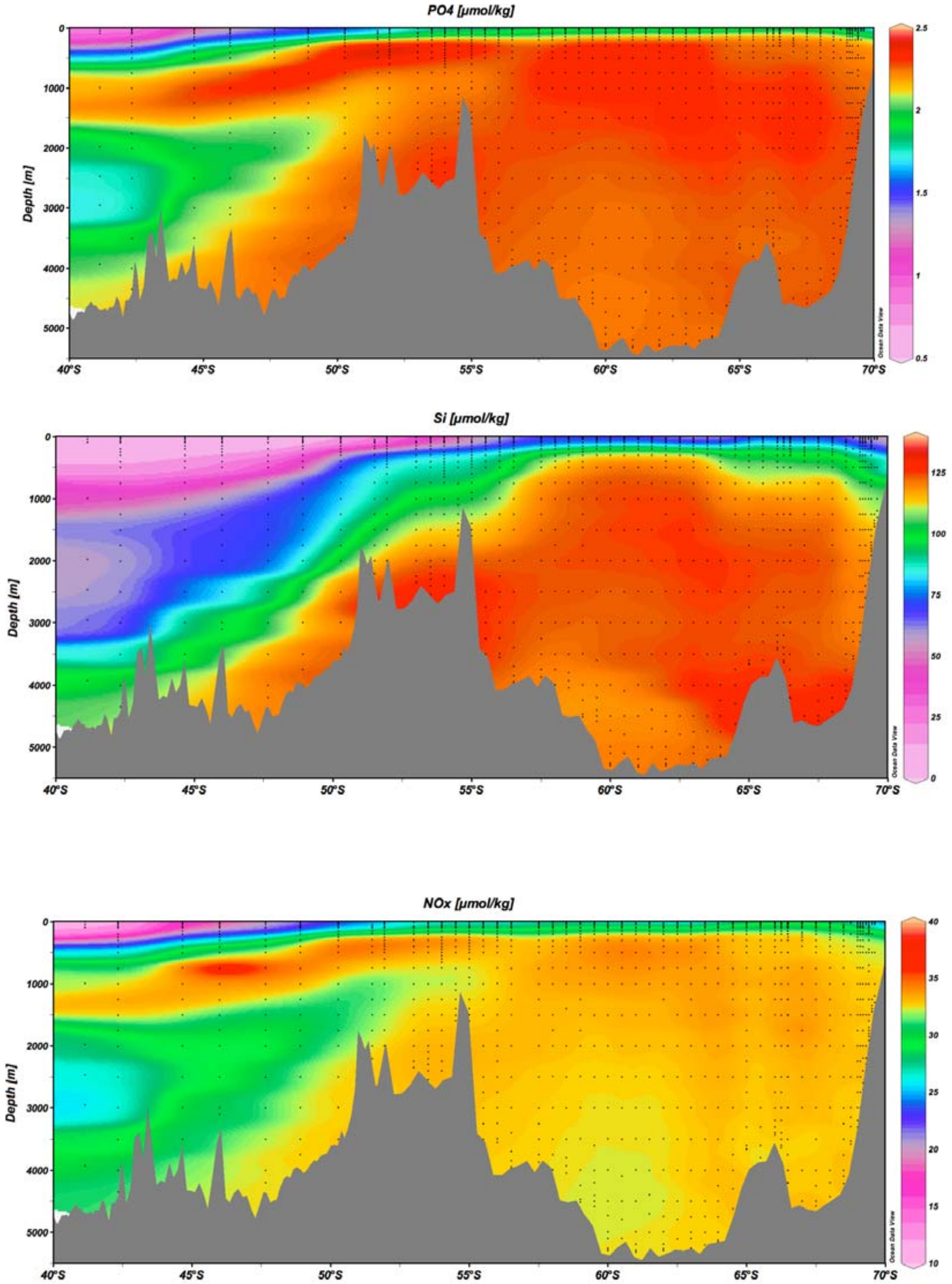

Fig. 3.34: Vertical transects of PO_4, SIO_4 and NO_x along the Greenwich meridian

3.5 Silicate measurements with cyclic voltammetry

Marielle Lacombe and Veronique Garçon
CNRS/LEGOS

Background and General Objectives

Real time, long-term *in-situ* monitoring of the ocean, leading to the acquisition of repeated measurements without having a ship at sea permanently, constitutes a crucial step to increase our knowledge of the ocean. Chemicals in the ocean play an essential role and particularly nutrients controlling photosynthesis. Electrochemistry seems a well adapted method for *in-situ* measuring of bioactive components in extreme conditions found in the ocean. The potentialities of the voltammetric methods for the analysis of various chemical species in the marine environment have already been demonstrated. They allow to measure several species simultaneously and this down to very low concentrations and without reagent (Luther et al., 2007). Moreover, microelectrode techniques are particularly adapted to high pressure environments. In this context, we developed a new method for silicate determination in the ocean using no reagent (Lacombe et al., 2008). Silicates are non-electroactive species. The method involves complexing molybdenum salt in acidic medium with silicate to make it electroactive. This method was compared during Drake ANT-XXIII/3 Cruise (*Polarstern*, PI C. Provost) with the classical colorimetric one in Drake Passage, and showed excellent results (Lacombe et al., 2007). The variability of the different water masses of this key passage was also studied using hydrographic parameters.

The Drake Passage is an important entry point for several water masses from the Pacific into the Atlantic Ocean. They are carried by the Antarctic Circumpolar Current (ACC) around the Antarctic continent and thus can enter in the South Atlantic and the Weddell Sea. Our objective is to compare the present picture of water mass mixing with that of the Drake Cruise in 2006 (ANT-XXIII/3), and in particular the SPDW (South Pacific Deep Waters) spreading. We will also document water mass mixing along the Greenwich meridian.

Work at sea

We sampled for silicate determination along Greenwich meridian-Drake transects (along the Greenwich meridian and in the Weddell Sea). The samples were analyzed on board by cyclic voltammetry with a glassy carbon electrode, with an Ag/AgCl reference electrode and a carbon counter electrode. The detection method was developed on new working electrodes to avoid the manual polishing that is required with the glassy carbon one for a complete autonomous measurement. Electrochemical measurements were carried out with a Metrohm potentiostat and with a newly developed autonomous submersible potentiostat.

Preliminary results

The new electrochemical detection method was developed and tested on board on gold and platinum electrodes during the Greenwich meridian transect, and the Weddell Sea section allowed us to test the stability of the response. The oxide formed at the electrode surface appears not to be very stable and more experiments are needed to yield a fully satisfying method. The autonomous submersible potentiostat had electronic problems and was out of use. One of the mains problem encountered was the leaking of the measurement cell. This problem will be easily solved back in the laboratory.

The profiles obtained will be compared with the classical silicate determination carried out by colorimetry by the NIOZ team along the Weddell Sea transect. The study of the stability of the measurements will allow us to conclude on the potentialities to adapt this new method on a autonomous *in-situ* sensor.
The distribution of silicate concentrations will document the different water masses along the Greenwich meridian and in the Weddell Sea.

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3.6 Intercomparison of GEOTRACES variables with BONUS-GOODHOPE

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not on board: M. Rutgers van der Loeff[1)], C. de la Rocha[1)]
On board *Marion Dufresne*: Marie Boye[3)], Frank Dehairs[4)], Matthieu Roy-Barman[6)], Damien Cardinal[5)],
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For the sections from Cape Town to the Greenwich meridian, and from there along Greenwich meridian to Antarctica, the CASO-GEOTRACES programme of *Polarstern* ANT-XXIV/3 was complementary to the BONUS-GOODHOPE programme aboard *Marion Dufresne*. Towards an overall integrated database of both expeditions, some intercomparison between both programmes had been envisioned.

Before departure from Cape Town, where *Marion Dufresne* was also in port, there had been a meeting on board *Polarstern* for organizing the intercomparison. This had to be modest for following reasons:

- departure of both vessels from Cape Town was delayed with many days for various reasons, at expense of scientific stations time,
- adverse weather conditions in the Southern Ocean caused more time losses,
- the extensive research objectives of both expeditions were very ambitious,
- the number of pre-cleaned sample bottles on board both ships was limited.

The agreed strategy was twofold. Firstly the initial cruise tracks of *Polarstern* and *Marione Dufresne* had been scheduled to be overlapping, and that, in principle, allowed the positioning of stations and sampling depths at the same place. That was the strategy of choice for intercomparison of CO_2 system measurements, see further section 4.3, and for major nutrients. Secondly for a limited number of variables, it had been decided that both ships would take a small number of duplicate samples to be exchanged after the expeditions were completed, for final analyses at the home laboratories. These variables are barium, dissolved trace metals, neodymium / thorium-Isotopes / protactinium (Nd/Th/Pa), and silicon isotopes.

Once at sea, *Polarstern,* due to its earlier departure, was further south than *Marion Dufresne*. On 26 February the positions and sampling depths of *Polarstern* stations completed up to then (then until 59°S, 0°W) were communicated to *Marion Dufresne* to allow their re-occupation of selected mutual stations, their overall research programme, weather permitting.

Moreover 12 duplicate samples (Ingrid Stimac) for barium at 46°S, 5°53' E (PS71-103-1 at 16.02.2008) were collected on *Polarstern,* 10 duplicate filtered seawater samples (Patrick Laan) for trace metals at 47°40' S, 4°17' E (PS71-104-2 at 16.02.2008); 3 duplicate samples (Celia Venchiarutti) for Nd/Th/Pa at 52°59.58'S 0°2.39'E (PS71/113-4 at 20.02.08); and 7 duplicates (Elizabeth Sweet) for Si isotopes at 53°31' S, 0°0.30'E (PS71-115-2 at 21.02.2008).

Similarly the BONUS-GOODHOPE team aboard *Marion Dufresne* collected several replicate samples (Marie Boye) for trace metals at 10 depths at 43°33.16' S, 4°22.36 E (their station GF-19 cast S3 on 04.03.2008), and 3 replicate samples (Matthieu Roy-Barman) for Nd/Th/Pa at 52°59'S, 0°E. Damien Cardinal agreed to take replicates for Si isotopes at same location as above for such replicates taken on *Polarstern*, actual sampling yet to be confirmed.

4. DISSOLVED CARBON DIOXIDE IN THE SOUTHERN OCEAN

4.1 Deep-ocean carbondioxide chemistry (DIC, TAlk)

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[3)]AWI

Objectives

In the last 250 years large amounts of CO_2 have been emitted to the atmosphere as a result of human activity. A significant fraction (~50%) of this 'anthropogenic' CO_2 has subsequently been taken up by the oceans, which by doing so, are having a dampening effect on the speed of the climate change predicted to result from the increasing atmospheric CO_2 concentration.

The total amount of anthropogenic CO_2 taken up, current and past rates of uptake, the potential decline in uptake due to 'saturation' of the surface ocean and the deleterious effect on marine life resulting from the acidification associated with the increasing amount of dissolved inorganic carbon (DIC) of the oceans are current focusing points of the fields of marine chemistry, biogeochemistry and biology.

Next to laboratory and field studies aimed at conceptual and mechanistic understanding of the many processes involved, a large effort is being made to investigate the state of the carbonate system in the world's oceans. This is performed almost exclusively through research cruises since no remote sensing or automated profiling systems are currently available for this task.

In order to be able to calculate the exact state of the carbonate system (i.e., the precise concentrations of all substances constituting DIC), one additional of the four measurable parameters of the carbonate system (pH, pCO_2, DIC, total alkalinity) must be determined. The setup that was used here measures TAlk and DIC of each sample simultaneously.

Work at sea

High-precision measurements were made of the dissolved inorganic carbon (DIC) content and total alkalinity (TAlk) of samples collected at 126 oceanographic stations. This yielded at total of 2,400 unique samples of which a subset (400) was analyzed on VINDTA instsruments to allow for intercalibration.

Analysis of DIC was performed using the coulometric method (Johnson et al., 1993; DOE, 1994). TAlk analysis was carried out with acid titration (Gran, 1952; Bradshaw et al., 1981; DOE, 1994). Both analyses were performed using a single integrated system: the VINDTA (Versatile Instrument for Determination of Titration Alkalinity; MARIANDA: Marine Analytics and Data, Kiel, Germany). Drift control and accuracy of the analyses were maintained through extensive use of labstandards and certified reference material (CRM, supplied by Dr. A. Dickson, Scripps Institution of Oceanography).

Technical details on methods used

Two VINDTA setups were used concurrently, often running a sample ‘together’ - drawing from the same sample bottle at the same moment. These ‘duplicates’ are used to ensure system intercomparability.

As to the determination of DIC by coulometry: a precisely known amount of sample (~20 ml) is dispensed from an automated, thermostated pipette into a stripper. The sample is acidified here, converting the two carbonate species into dissolved $CO_{2(aq)}$. The evolving CO_2 is rapidly removed from the sample by sparging with N_2. The CO_2-enriched N_2 stream is led through the solution in the coulometric cell, which absorbs the CO_2 and becomes more transparent. The coulometer subsequently electrically titrates the solution back to its original opacity. The required amount of charge is a linear measure of the amount of CO_2 absorbed.

Total alkalinity is mathematically derived from a titration curve, fitted in an electrochemically consistent manner along data of electrode potential derived from an acid-titration of an accurately known amount of sample (~100 ml), dispensed with an automated, thermostated pipette. Titration is performed in a thermostated cell. With knowledge of the sample's volume and density, the concentrations of the DIC and total alkalinity in the sample are easily calculated.

Samples, collected without headspace in 600 ml Duran bottles, where brought to analysis temperature (25 °C) by flowing through a heat exchanger on their way from the sample bottle to the VINDTAs. Samples were injected into the system under a slight overpressure (~0.4 bar), which fully suppressed the bubble formation often associated with the drawing of sample into the VINDTA using a peristaltic pump.

Lab standard was prepared on board in batches of 60 L by filtering and poisoning water collected with the CTD from around 2,000 m deep, or simply from the ship’s surface water tap. For the later batches, the pCO_2 of the batch was, prior to use, brought to 1.4 times the atmospheric value (thus ~550 μatm) by sparging, so that upon headspace pressurization no significant CO_2 exchange with the lab standard headspace would occur. The sparging process was monitored with a LiCor 7000 infrared gas analyzer.

Approximately every 5th analysis was followed by analysis of this labstandard, and CRM was analyzed 3 or 4 times per day in order to set accuracy and to detect and be able to correct for measurement drift. Every CRM-sample was run on both machines at the same time. A definitive way of application of corrections is still to be decided upon.

Measurements were performed in a thermostated container, with the components most sensitive to sudden temperature drops (caused by the turning on of the air conditioning unit), being thermally insulated in order to smooth out those peaks.

Examples of the obtained data are displayed in figures 4.1 and 4.2.

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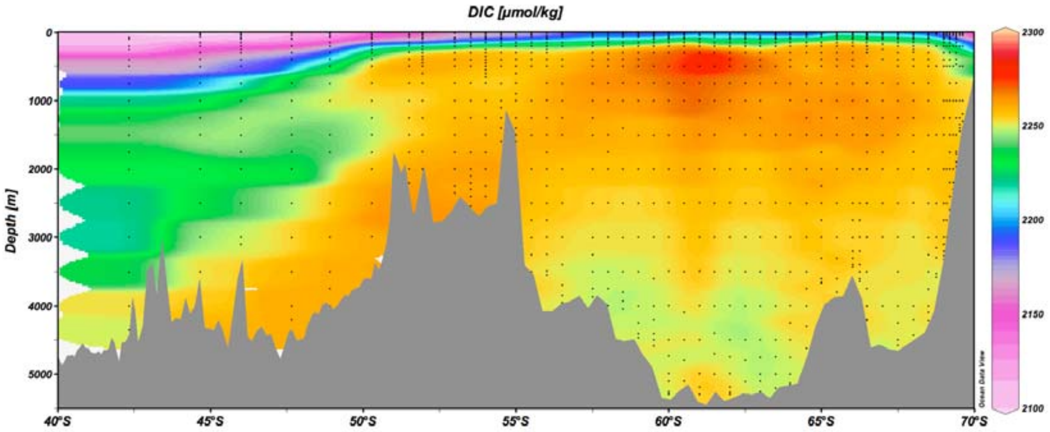

Fig. 4.1: Preliminary results for the section along the Greenwich meridian for DIC. These data are quite close to being final.

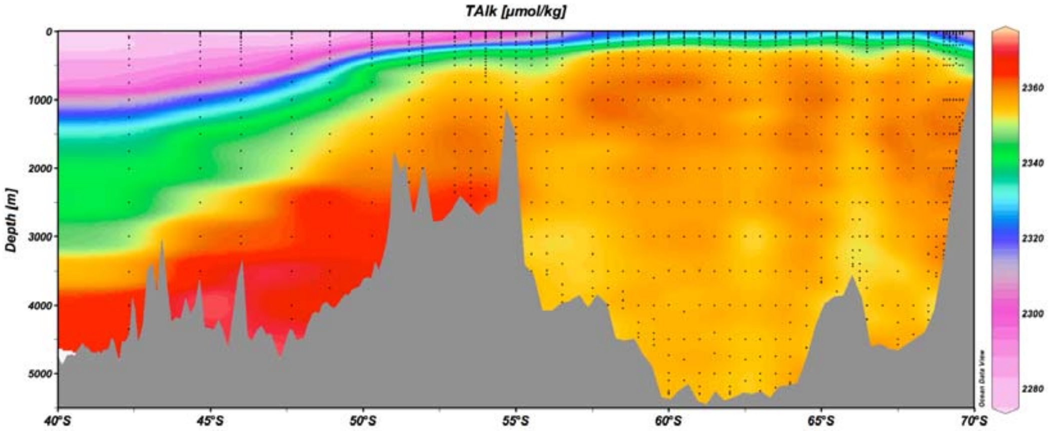

Fig. 4.2: Preliminary results for the section along the Greenwich meridian for TAlk. Please note that additional correction of these data has yet to be performed.

4.2 Surface water carbondioxide chemistry (DIC, pCO_2)

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Objectives

The increase in the atmospheric CO_2 content is not equal to the cumulative emissions from human activities because about half of these emissions are taken up by the world's oceans. This leads to the increase in DIC which is the subject of the research described in the previous paragraph (deep-ocean carbonate chemistry). However, these oceanic inventory changes are not the only measure of the processes involved in the distribution of this anthropogenic CO_2 between the ocean and atmosphere. Since exchange of CO_2 between these two compartments necessarily takes place across the sea surface, global quantification and (temporal and spatial) integration of these fluxes should yield an independent measure of DIC accumulation in the world's oceans.

Quantification of these fluxes requires accurate knowledge of the partial pressure of CO_2 (pCO_2) of both the atmosphere and surface ocean. Determination of the atmospheric concentrations is now common practice around the world, but the determination of the highly variable sea surface pCO_2 has historically proven to be much more complicated. However, several research groups around the world are involved in major efforts to fill in this gap, using highly specialized (though now standardized) equipment. Already these investigations have resulted in global, seasonal pCO_2 maps, from which, with information of wind speed and atmospheric pCO_2 fields, fluxes can be calculated with reasonable accuracy. The monitoring of the sea-surface carbonate system will contribute to this effort.

Work at sea

A fully autonomous, continuous surface water pCO_2 system has been permanently installed on *Polarstern* since 2007. This system draws water from the ship's seawater supply. A steady flow of this water is led through a plastic 'equilibrator' vessel, filling it almost halfway before flowing out into the ship's drain. The air in the headspace of this equilibrator is circulated through a LiCor 7000 infrared gas analyzer. Because the air after a short while takes on the pCO_2 value of the water, the pCO_2 of the analyzed air is identical to that of the water. By using several sensors and methods, all measurements are corrected for vapour pressure and temperature effects, which may cause significant deviations of the equilibrated pCO_2. Four calibration gases (0, 175, 350 and 700 μatm) are available for hourly recalibration of the gas analyzer. Atmospheric air is measured every hour. pCO_2 values as well as diagnostic and auxiliary data (mainly GPS and meteorological observations), are logged and automatically sent to the home laboratory through email. Operation of the pCO_2 system consisted of little more that turning it on and keeping an eye on reference gas availability and the different diagnostic indicators.

In order to fully determine the state of the carbonate system in the surface ocean, a second of the four measurable parameters of the carbonate systems (DIC, TAlk, pCO_2 and pH) has to be determined. From the work done by Craig Neill during the previous cruise leg ANT-XXIV/2, a continuous surface water DIC analyzer was available, which we have used to continue his work. This system is built up around the heart of the SOMMA system, but now equipped with an automatic intake and the capacity to measure continuously, unattended, until the coulometer chemicals need to be replenished. This setup allowed for the determination of 3 - 4 samples every hour, for a cruise-leg total of 4500, which should allow us to determine the exact state of the carbonate system to an exacting degree.

The ~20 ml sampling pipette was thermostated to the temperature of the sample, using a second line from the sea water tap. This means that the pipette volume changes with the sample temperature, as does - of course - the sample's density. Corrections for all these effects will be applied after the cruise.

For the calibration of the SOMMA system (and as a means of checking the pCO_2 system as well), the VINDTA-analyses (see 'deep-ocean carbonate chemistry') of the uppermost samples of the regular hydrocasts (from circa 10 meters depth) were used. Whenever no hydrocasts were being performed for a significant amount of time, samples tapped from the ship's seawater supply (from which the SOMMA get its water as well) were analyzed. The assumption that the water from 10 m depth resembles the water from 5 m depth (at the ships sea water supply inlet) will be tested for validity.

4.3 Intercomparison of carbondioxide variables with BONUS-GOODHOPE

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For the sections from Cape Town to the Greenwich meridian, and from there along zero meridian to Antarctica, the CASO-GEOTRACES programme of *Polarstern* ANT-XXIV-3 was complementary to the BONUS-GOODHOPE programme aboard *Marion Dufresne*. Towards an overall integrated database of both expeditions, some intercomparison between both programmes had been envisioned.

The initial cruise tracks of *Polarstern* and *Marione Dufresne* had been scheduled to be overlapping, and that in principle allowed the positioning of stations and sampling depths at the same place. This was the strategy of choice for intercomparison of CO_2 system measurements, which had already been calibrated routinely on both ships by the shipboard use of certified reference material (CRM, supplied by Dr. A. Dickson, Scripps Institute of Oceanography).

Once at sea, *Polarstern,* due its earlier departure, was further south than *Marion Dufresne*. On 26 February 2008 the positions and sampling depth horizons (pressure, salinity, temperature at 22 - 24 depths per station) of 21 stations with CO_2 system data aboard *Polarstern* (then until 59°S, 0°) which had been completed up to then were communicated to *Marion Dufresne*. These were twenty-one (21) ANT-XXIV/3 stations PS71-101 until PS71-131 from positions 42.3379°S, 8.9946°E (101) to 59.00°S, 0.00° (131). This allowed re-occupation of selected same stations by BONUS-GOODHOPE, its overall research programme, weather permitting. Indeed BONUS-GOODHOPE was able to occupy sixteen (16) stations BGH-44 to BGH-78 from 46.0242°S, 5.865°E (BGH-44) to 57.5°S, 0.0365°E (BGH-78) with their respective CTD hydrocast numbers CTD-57 to CTD-106. Among these BONUS-GOODHOPE stations were ten (10) stations within 5 nautical miles of most nearby ANT-XXIV/3 stations of *Polarstern*. The listing of exact stations positions is available in an excel sheet.

5. MARINE BIOLOGY

In addition to the marine biological projects 5.1. and 5.2. described below, one is referred to two other projects with strong biological focus:

3.1.7. The effect of dynamic light conditions and iron limitation on phytoplankton abundance
3.1.8. The Southern Ocean in a high-CO_2 World

5.1 The significance of viruses for polar marine ecosystem functioning

Claire Evans, E. Frijling, NIOZ
not on board: C. Brussaard, NIOZ

Background and Objectives

Microbial communities (phytoplankton, bacteria, Achaea, heterotrophic protozoa and viruses) comprise the majority of the biomass in the oceans and drive nutrient and energy cycling, and are thereby important components of polar food webs. With the emergent awareness that viruses are major players influencing biodiversity and biogeochemical processes the need to elucidate their role in polar ecosystems has been underlined as, despite their likely importance, their quantitative significance has barely been studied. We aimed to complete a comprehensive study of the viruses and viral mediated processes of the Antarctic marine habitats encountered during ANT-XXIV/3. The objectives of this study were; 1) To examine the abundance and composition of viruses and their prokaryotes and eukaryotic hosts, 2) To determine viral induced mortality on both prokaryotic and eukaryotic microbial hosts alongside host growth rates and mortality due to grazing. 3) To gather a data set allowing comparison of the viruses and viral mediated processes of the Southern and Northern Polar regions. 4) To collect sample from which viruses might be isolated and therefore available for laboratory experiments.

Work at sea

Daily profiles were made of algal abundances (cyanobacteria, picoeukaryotes and nanoeukaryotes) by flow cytometry of fresh samples. Additionally samples for viral and bacterial abundance were fixed with glutaraldehyde, snap frozen and stored at -80 ºC for later analysis at NIOZ by flow cytometry and SYBR Green. On experimental stations measurements of abundance, growth rate, diversity, grazing rate and viral-induced mortality were performed on the bacterial community at surface, chlorophyll maximum and 200 m or both the algal and bacterial community at the chlorophyll maximum. Details of the stations sampled are given in table one. At all experimental stations, samples were taken for viral diversity by concentrating 10 l volumes by 30 kDa ultrafiltration. These samples will be stored at -80 ºC until analysis by pulse field gel electrophoresis at the NIOZ. Samples for algal and bacterial diversity were collected by filtration of approximately 1 L volumes of whole seawater onto 1 and 0.2 µm polycarbonate filters respectively which were snap frozen and stored at -80 °C and will be analyzed at the NIOZ by denaturing gradient gel electrophoresis.

Growth rates, viral lysis and grazing of the cyanobacteria, picoeukaryote, and nanoeukaryote communities present were determined by a dilution technique whereby whole water is combined with either 30 kDa filtered water (virus and grazer-free) or 0.4 um filtered water (grazer-free) in triplicate over a dilution series and incubated at *in-situ* temperature and light conditions (deck incubator). Samples for algal enumeration were taken from all incubations at the start of the assay and after 24 h, allowing the calculation of growth rate. By plotting observed growth rate against the level of dilution the theoretical growth rate in the absence of mortality was calculated along with coefficients of grazing and viral induced mortality.

Rates of viral induced mortality of bacteria were determined by viral reduction assay. Briefly, the bacterial community was concentrated by tangential flow filtration and resuspended in viral free water generated by 30 kDa ultrafiltration. The production of viruses was followed by sampling for bacterial and viral abundance over a 12 h period (subsampling every 3 h). Rates of lysogenic infection of the bacteria were determined in identical experiments with the addition of Mitomycin C, inducing lytic production of any lysogenic phage. In addition, rates of viral infection of bacteria will be elucidated by determining the frequency of infected cells which will be performed at the NIOZ on samples preserved with glutaradehyde. Grazing of bacteria was assessed by an exclusion assay whereby bacterial numbers within incubations filtered to remove grazers 0.8 um were compared with whole water incubations containing grazers. Secondary production was determined using the radiolabelling Leucine incorporation technique. Live and dead (fixed) subsamples of whole water were incubated for 4 hours in the dark at *in-situ* temperature the presence of 20 µCi. After the incubation period the samples will be killed with the addition of formalin and stored until later analysis by liquid scintillation at the NIOZ.

Samples for virus isolation were collected from the chlorophyll maximum and will be screened against potential hosts at the NIOZ.

Tab. 5.1: Stations sampled

Station Type	Station	Date	Time	Lat	Long	Depth [m]	Gear
Abundance	PS71/101-2	13.02.08	16:02	42° 20.22' S	8° 59.88' E	4543.0	CTD, Ultra Clean
Algal Bacterial	PS71/101-5	14.02.08	02:49	42° 20.54' S	8° 59.54' E	4560.0	CTD/rosette water sampler
Abundance	PS71/102-2	15.02.08	07:55	44° 39.62' S	7° 5.82' E	4619.0	CTD/rosette water sampler
Bacterial	PS71/102-4	15.02.08	10:33	44° 39.51' S	7° 5.62' E	4618.0	CTD/rosette water sampler
Abundance	PS71/104-2	16.02.08	22:44	47° 39.58' S	4° 16.95' E		CTD, Ultra Clean
Algal Bacterial	PS71/104-8	17.02.08	14:13	47° 38.45' S	4° 16.43' E	4549.2	CTD/rosette water sampler
Bacterial	PS71/106-1	18.02.08	03:48	48° 54.68' S	2° 48.11' E	4101.4	CTD/rosette water sampler
Abundance	PS71/107-3	18.02.08	19:57	50° 16.13' S	1° 26.71' E	3855.0	CTD, Ultra Clean
Abundance	PS71/108-2	19.02.08	10:41	51° 29.91' S	0° 0.21' E	2771.7	CTD/rosette water sampler
Abundance	PS71/113-2	20.02.08	11:02	52° 59.90' S	0° 0.89' E	2530.3	CTD, Ultra Clean
Algal Bacterial	PS71/113-4	20.02.08	13:27	52° 59.58' S	0° 2.39' E	2544.2	CTD/rosette water sampler
Abundance	PS71/116-1	21.02.08	06:44	54° 0.07' S	0° 0.01' W	2529.5	CTD, Ultra Clean
Bacterial	PS71/121-2	22.02.08	05:02	55° 30.01' S	0° 0.03' E	3750.3	CTD/rosette water sampler
Abundance	PS71/122-1	22.02.08	14:05	56° 0.03' S	0° 0.23' E	3682.3	CTD, Ultra Clean
Algal Bacterial	PS71/125-1	23.02.08	06:06	57° 0.11' S	0° 0.17' W	3837.3	CTD/rosette water sampler
Abundance	PS71/127-1	23.02.08	12:05	57° 30.02' S	0° 0.30' E	3936.8	CTD/rosette water sampler
Abundance	PS71/131-4	24.02.08	17:49	59° 0.04' S	0° 0.07' W	4600.7	CTD/rosette water sampler
Algal Bacterial	PS71/131-10	25.02.08	09:05	58° 59.99' S	0° 0.22' E	4608.6	CTD/rosette water sampler
Abundance	PS71/137-1	26.02.08	08:06	60° 30.00' S	0° 0.08' W	5355.5	CTD/rosette water sampler
Abundance	PS71/141-1	27.02.08	05:34	62° 0.01' S	0° 0.02' W	5359.5	CTD, Ultra Clean
Bacterial	PS71/141-2	27.02.08	09:00	61° 59.96' S	0° 0.05' E	5359.5	CTD/rosette water sampler
Abundance	PS71/147-3	28.02.08	18:03	63° 57.99' S	0° 0.81' W	5193.2	CTD, Ultra Clean
Algal Bacterial	PS71/150-1	29.02.08	08:11	64° 59.94' S	0° 0.27' E	3721.8	CTD/rosette water sampler
Abundance	PS71/150-2	29.02.08	08:34	64° 59.93' S	0° 0.12' E	3723.0	CTD, Ultra Clean
Abundance	PS71/157-5	07.03.08	22:04	66° 28.57' S	0° 1.95' W	4495.0	CTD/rosette water sampler
Abundance	PS71/159-4	08.03.08	12:59	66° 1.88' S	0° 8.68' E	3460.5	CTD/rosette water sampler
Abundance	PS71/163-1	09.03.08	14:04	66° 59.94' S	0° 0.18' W	4701.5	CTD, Ultra Clean
Algal Bacterial	PS71/167-2	10.03.08	07:09	68° 0.04' S	0° 0.00' W	4506.7	CTD/rosette water sampler
Abundance	PS71/171-1	10.03.08	16:13	68° 44.96' S	0° 0.06' W	3629.5	CTD/rosette water sampler
Abundance	PS71/175-3	11.03.08	08:34	68° 59.77' S	0° 0.23' E	3418.2	CTD, Ultra Clean
Abundance	PS71/178-1	11.03.08	18:34	69° 23.98' S	0° 0.05' W	2011.7	CTD/rosette water sampler
Abundance	PS71/184-1	13.03.08	10:54	69° 0.09' S	6° 59.81' W	2954.5	CTD/rosette water sampler
Abundance	PS71/186-1	15.03.08	10:00	69° 5.27' S	17° 17.22' W	4763.5	CTD/rosette water sampler
Algal Bacterial	PS71/186-3	15.03.08	15:03	69° 3.76' S	17° 26.03' W	4766.2	CTD/rosette water sampler
Abundance	PS71/187-1	15.03.08	20:38	68° 48.20' S	17° 57.61' W	4791.5	CTD, Ultra Clean
Bacterial	PS71/191-2	17.03.08	10:05	67° 21.18' S	23° 38.85' W	4871.2	CTD/rosette water sampler
Abundance	PS71/191-3	17.03.08	10:32	67° 20.95' S	23° 38.21' W	4871.7	CTD, Ultra Clean
Abundance	PS71/193-6	18.03.08	20:30	66° 36.44' S	27° 9.39' W	4864.7	CTD, Ultra Clean
Bacterial	PS71/193-10	19.03.08	11:44	66° 35.16' S	27° 20.59' W	4863.5	CTD, Ultra Clean

Preliminary results

Flow cytometry of the algal populations revealed that with increasing latitude there was a change in the composition of the phytoplankton community shifting away from a dominance of cyanobacteria towards picoeukaryote cells. In addition, overall abundance of the microbial community was observed to decrease. Preliminary interpretation of the dilution experiments indicated that prior to crossing the Polar Front, viral lysis was a significant factor in the control of the picophytoplankton community (Fig. 5.1). However, viral lysis was not detected on any of the stations examined after this point, indicating that viruses play only a minor role or are not implicated in the control of these polar communities. Whereas, significant rates of grazing were routinely recorded indicating that in the Southern Ocean herbivory is a major process controlling primary production. Further work will be needed to finalize this data set and it is expected that this will be completed by the end of 2008.

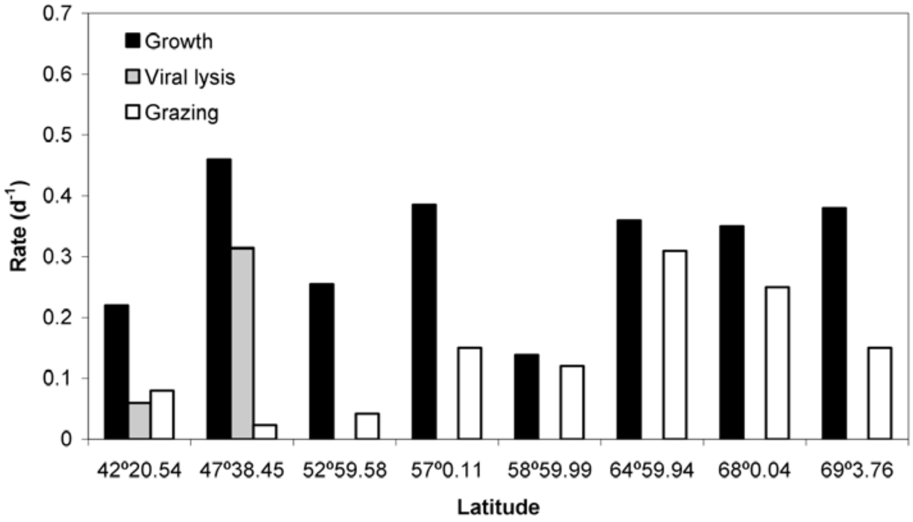

Fig. 5.1: Growth grazing and viral lysis rate of the dominate components of picophytoplankton community as determined by preliminary interpretation of the dilution experiments.

5.2 Phytoplankton measurements

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Objectives

The ocean is getting acidified in response to atmospheric CO_2 increase. The impact of such an acidification on primary producers is usually investigated through laboratory experiments or coupled physical/biogeochemical modeling. What is the *in-situ* state of the ocean with respect to pH conditions and distribution of the various phytoplanktonic groups? This knowledge is a prerequisite for both carrying out proper models outputs validation, and establishing the present state.

We are interested in the Polar frontal region of Drake Passage by two major phytoplanktonic functional types: diatoms (siliceous phytoplankton) and coccolithophorids (calcareous phytoplankton). Our main objective is to investigate the relationship between the variations of acidification level (pH and alkalinity) and distribution of these two groups.

Work at sea

We have sampled across the Polar Front from the upper six Niskin bottles of all B1 CTD stations casts. Depths sampled were 10, 25, 50, 75, 100 and 150 m. Two liters (for pigments determination) and one liter sample (for phytoplankton speciation) were collected and then filtered on board right after in the cold container. Filters for pigments are stored in the -80°C freezer, membrane filters for speciation were dried at 50°C for a couple of hours and stored in a dry place. Duplicates were performed all along the section. A total of 27 CTDs stations were sampled and 324 filters collected. All filters will be analyzed back in the laboratory for further determination of pigments composition by HPLC and for further identification and quantification of diatoms and coccolithophorids biomass by microscopy.

Expected results

The distribution of the two phytoplanktonic groups will be established in the Polar Frontal region. By comparing with the pH and alkalinity conditions of the surface water masses, it will be possible to derive a relationship linking chemistry of seawater and the phytoplanktonic speciation.

6. AUTOMATIC DETECTION OF MARINE MAMMALS

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Objectives

The automated detection of marine mammals has a broad range of applications. Population ecologists focussing on whale distributions and migratory patterns are interested in effective methods for conducting marine mammal censuses. Users of hydroacoustic instruments are interested in implementing reliable and effective mitigation methods in case adverse reactions of marine mammals are to be apprehended. Whales spend considerable periods of time at the surface as well as submerged. Diving, vocalizing mammals may be detected by passive sonar while surfaced whales might be recognized by means of their warm blow, which stands out against the cold Antarctic environment. The objectives of this cruises' projects were to:

a) determine the range at which the new IR lenses are capable of detecting marine mammals;
b) deploy and recover acoustic recorders (PODs and Aurals) for the detection of whale and seal vocalizations to be used in the context of environmental suitability models;
c) test the technology and deployment procedure of a mobile, automated listening station, PALAOA-S.

Work at sea

Infrared Cameras

Two infrared (IR) cameras and a visual camera, contained in protective housings are mounted in the crow's nest of *Polarstern* (Tab. 6.1). The cameras are oriented co-axially but view different angular segments due to different lenses. The IR cameras provide a resolution of 320 x 240 pixels with 25 frames per second. The visual camera operates at 640x480 pixels. The cameras are connected to two PCs in the scientific work room via an optical FireWire link. The image stream is displayed on the PCs and 10 second long snippets are stored every 3 minutes (typically) by the Matlab ™ based programme WalBlas.

Tab. 6.1: Camera system configuration

CAMERA	label in video	lense	location
visual	VIS	24°	top (+0.4 m)
FLIR ThermoVision A40M	CAM1	12°	middle (28.5 above water)
FLIR ThermoVision A40V	CAM3	7°	bottom (-0.4 m)

When preparing the system in Bremerhaven during *Polarstern's* docking time, a power supply cable for the A40V camera was identified as broken. Temporal constraints prohibited an immediate exchange of this cable (which involves significant efforts to open and reseal two water tight feedthroughs). To solve this problem in the highly exposed area of the crow's nest prior to *Polarstern's* departure from Cape Town, two of us arrived early to use the time in port for an exchange of this cable. The work was finished successfully before *Polarstern* left port.

The camera system was modified with regard to its previous configuration as to be able to rotate it in the horizontal to be able to point it in the direction of whales which might eventually be sighted visually. Generally, however, the system was fixed, pointing in the direction 10° starboard from the ships heading.

Starting on 13 March 2008 the IR system was operated almost continuously for 360 hours, until 28 March 2008, generating some 80 GByte of video data. Interruptions resulted mainly from hang-ups of the video stream, all of which could simply be solved by rebooting the computer or cameras. On a daily basis, both IR cameras' video data of the previous day were searched manually for events such as whale blows, seals, icebergs or birds. Interesting events were noted in event log files.

Data Loggers (PODs Aurals and PALAOA-S)

During a previous expedition, ANT-XXII/3, three autonomous data loggers, PODs (Porpoise Detectors by Chledonia Inc.) had been deployed as part of 3 oceanographic deep sea moorings. The instruments were to record click events in the frequency bands around 9, 22, 41 and 70 kHz which most probably constitute the centre of frequency bands of echolocation clicks of toothed whales. The three devices were successfully recovered with the moorings after an operation period of over 3 years (Tab. 6.2).

Tab. 6.2: Recovery of PODs

POD ID	Mooring ID	Position Lat	Position Lon	Deployment Date	Recovery Date	Water Depth	POD Depth
A401	AWI 230-5	66° 00.66' S	00° 11.28' E	08.02.2005 21:00	08.03.2008 8:25	3450 m	1557 m
B402	AWI 233-7	69° 23.60' S	00° 04.29' W	17.02.2005 21:06	12.03.2008 14:54	1950 m	1700 m
C403	AWI 207-6	63° 42.20' S	50° 52.22' W	14.03.2005 02:47	pending	2500 m	1457 m

While PODs are designed to record the high frequency clicks of odontocetes, many marine mammals vocalize in the 10 Hz to 20 kHz range. Detection and identification of such vocalizations requires broadband audio recordings. To complement such recordings from the PALAOA listening station north of Neumayer (Boebel et al., 2008), two underwater recorders (AURAL-M2 by Multi Electronique, Canada) and a PALAOA-S (Satellite) listening station were deployed (Tab. 6.3). The two Aural-M2s are incorporated in oceanographic deep sea moorings and are programmed to record the first 5 minutes out of sound every 4 hours (starting at midnight of each day).

Tests prior to deployment however showed that the system will skip every 48th record (i.e. the last record of every 8th day).

By contrast, PALAOA-S is designed to collect continuous sound records, but for a period of one day only. In a first sea-trial (that is in open waters), PALAOA-S was placed on an ice floe of about 2 m freeboard, close to the ice shelf edge in the south-western corner of Atka Bay. The hydrophone was lowered over the floe's edge into the water to a depth of an estimated 5 m. During the course of the day, the floe drifted seawards with the prevailing wind driven and tidal currents away from the ice shelf edge. Upon recovery during the next day, PALAOA-S had drifted some 3.66 nm, to a location east of *Polarstern's* berthing site at the ice shelf (70°34.12'S, 008°08.21'W).

Tab. 6.3: Deployments of Aural-M2s and PALAOA-S. For the PALAOA-S deployment, the top row indicates the deployment position, the bottom row the recovery position.

ID	Mooring ID	Position Lat	Position Lon	deployment date	water depth	instrument depth
PALAOA-S	-	70°37.70'S 70°34.08'S	008°08.19'W 008°08.23'W	02.03.2008 08:35 03.03.2008 10:20	~ 200m	5 m
#086	AWI 230-6	66°01.13'S	00°04.77'E	08.03.2008	3450 m	189 m
#085	AWI 232-9	68°59.74'S	00°00.17'E	11.03.2008	3370 m	206 m

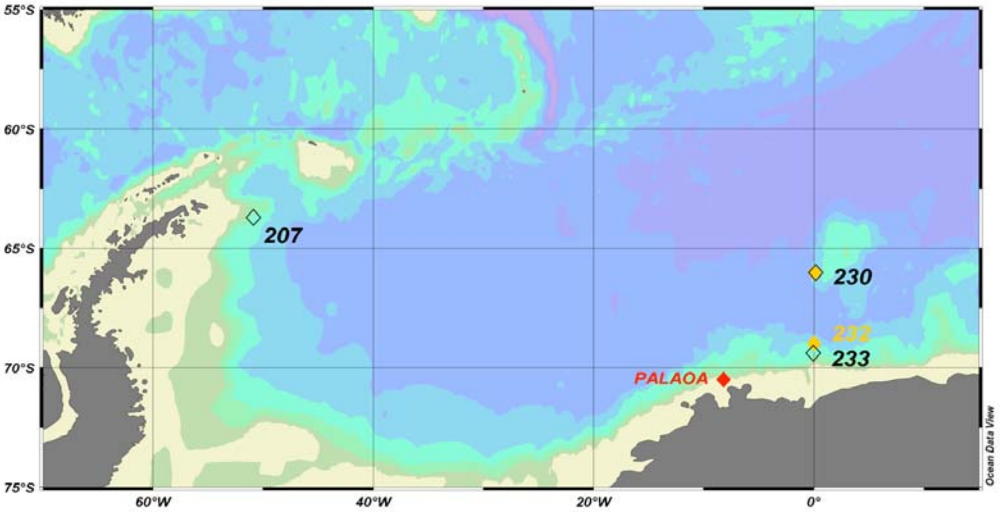

Figure 6.1: Positions of AURAL deployments (yellow) and POD recoveries (black). A red diamond indicates the position of the PALAOA station and the two-day deployment of PALAOA-S (at a distance of approximately 6 miles to PALAOA).

Preliminary and expected results

Infrared Cameras

While unobserved (i.e. not directed manually towards a sighted whale), the system recorded a few whale blows, seals and birds simply by chance, as records are taken in limited angular segments and only every 10 s out of 3 minutes. On 15 March 2008, several whales were observed swimming ahead of the ship while following a lead through the ice. Then, the camera system was pointed manually towards the lead and whales. In this way, 15 whale blow events were recorded. A similar event occurred on 24 March 2008 with *Polarstern* on station and whales present in a lead portside-astern of the ship.

Overall, the 12° camera recorded 27 snippets showing blowing whales (as identified by manually browsing the data), while the 7° camera recorded 10 blows. These whales were identified as Minke whales. Earlier experiences had showed that Minke whales are difficult to detect with a 24° lense due to their tendency to keep some distance from the ship and their relatively small and faint blow. However, the new high resolution (7° and 12°) lenses clearly revealed the blows, even at a distance of order 1 km (Fig. 6.2).

The distance d between the ship and an event (at the sea surface) was estimated from the number of pixels N, between the horizon and the event, avoiding detailed knowledge of the cameras orientation (including the ship's pitch, roll and heave).

$$d = h \cdot \tan\left(\arctan\left(\frac{r_H}{h}\right) - N \cdot \varphi\right)$$

and $r_H = \sqrt{2 r_E h + h^2}$

i.e. the distance to the horizon as a function of camera height $h \approx 28.5\ m$, r_E the earth radius, and φ the instant field of view (or angular segment of a single pixel). Errors are estimated by assuming an uncertainty in the camera height of ± 1 m.

Analysis of the images showed, that seals and whale blows are detectable up to distance of 1.5 km with both the 12° and 7° lenses.

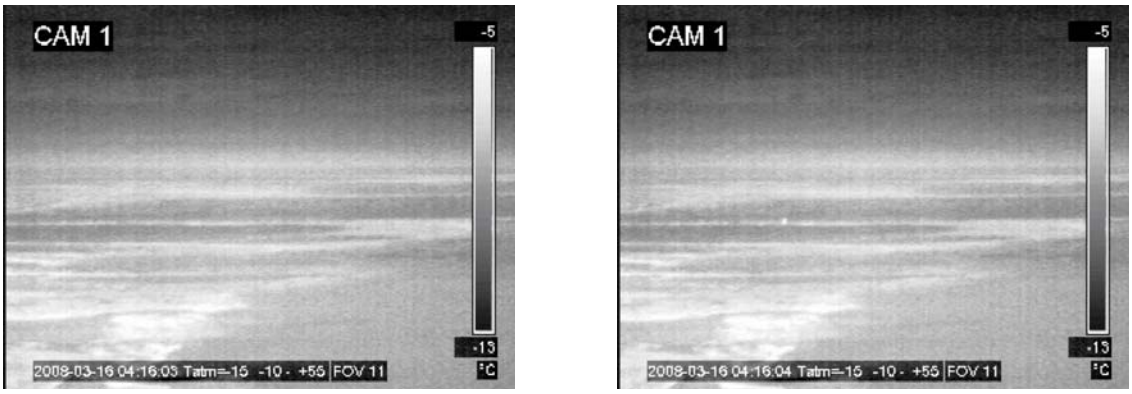

Fig. 6.2: IR images by FLIR Thermacam A40M with 12° lense prior (left) and during peak (right) of Minke whale blow. The image to the right was taken 0.24 s after image to the left. The blow was visible for the duration of 8 frames, which corresponds to about 0.56 s. The distance to the blow is estimated to be 1164 ± 40 m. Dark areas are covered by sea ice, brighter areas represent (partially) open water.

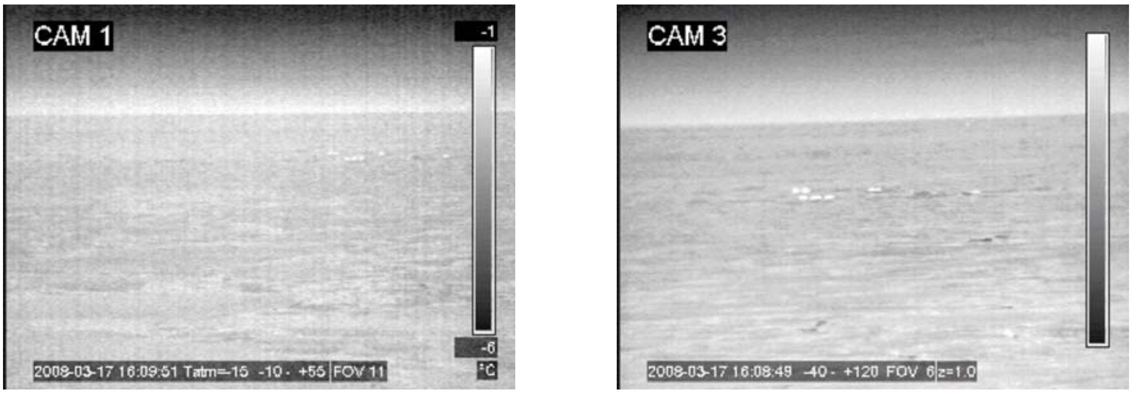

Fig. 6.3: Infrared images showing a group of seals in the far distance. Left: IR CAM1 with 12° lense, the distance is estimated to 1590.4 ± 53 m. Right IR camera with 7°, the distance is estimated to 1588.9 ± 53 m.

Further analysis will use the collected set of IR snippets to further develop automatic pattern recognition algorithm while avoiding false positives.

Data Loggers (PODs, Aurals, and PALAOA-S)
The recovered three PODs appear to be in good shape and are internally dry, even though this was the first deployment of such instruments at depths greater than 1500 m. The data will however only be accessible in Bremerhaven. Until then the instruments are stored upside down in “idle” mode.

Both pressure cases of the new Aural units have been successfully tested to a depth of 300 m prior to the instruments deployment at around 200 m depth. The deployment of PALAOA-S proceeded without complications, though it is advisable to mark every 1 m of the hydrophone cable to be able to estimate the deployment depth in the field. The collected acoustic data will be analysed in Bremerhaven in conjunction with recording from PALAOA.

References

Boebel, O., Kindermann, L., Klinck, H., Bornemann, H., Plötz, J., Steinhage, D., Riedel, S., Burkhardt, E.(2006).Acoustic Observatory Provides Real-Time Underwater Sounds from the Antarctic Ocean, EOS, 87, 361-372.

7. WEATHER SITUATION DURING THE CRUISE LEG ANT-XXIV/3

Wolfgang Seifert and Klaus Bult
Deutscher Wetterdienst

Between 5 and 9 February a strong south-easterly gale situation, well known as “Cape Doctor”, influenced the Cape region. As a consequence the loading activities had to be postponed. This was one reason why *Polarstern* finally sat sail not before 10 February.

After crossing the subtropical high we reached the Subtropical Front at 40°S with westerly winds force 6 Bft. During the following days several secondary lows as part of polar frontal system crossed our course with south-westerly gales force 8 - 9 Bft and waves up to 7 m (Fig. 7.1a).

With the beginning of the following week the frontal zone developed in a more meridional shape with two dominant low pressure systems: an upper level trough with a surface low southwest of the Antarctic Peninsula and a steering low pressure system east of 30°E. Between these two systems especially close to the Greenwich meridian – our course track – a flat high pressure ridge developed and caused wind forces less than 5 - 6 Bft with wave heights under 2 - 3 m (Fig. 7.1b).

During the following days a new low developed near 20°W with secondary lows moving from its northern flank southeast, where theses systems came in a slow dipolar rotation. Firstly, near the core afterwards on its southern flank *Polarstern* approached the ice shelf at Atka Bay on 2 March. During this day moderate winds were observed (Fig. 7.1c and Fig. 7.1d).

At this morning a helicopter accident happened in good flight conditions as described in a special report[1].

On 5 March *Polarstern* left the Atka region in fair weather conditions. During the following days two polar lows influenced our course with stormy weather of wind force 8 - 9 Bft and increasing waves of about 4 m. This was observed several times during the expedition when a cold upper low produced some vorticity centres with sheering wind systems at the surface (Fig. 7.2a).

Operating along the Greenwich meridian again *Polarstern* sailed at the western flank of a dominant low east of 15°E with mostly south-eastern winds forces 6 - 7 Bft (Fig. 7.2b). By 13 March, we headed west through the Weddell Sea.

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[1] Report about weather conditions on the occasion of a flight accident for LBA

New low pressure systems north and northeast of our track showed that we were on the cold side of the frontal zone with mostly southerly or south-easterly winds force 6 - 7 Bft (Fig. 7.2c). Sailing along the northern ice edge weather improved temporarily. After 18 March a new low pressure system moved from northwest in south-eastern direction and caused winds from northeast to east up to force 7 Bft. Without the shelter of the ice the ship would have experienced the effect of higher waves (Fig. 7.2d).

The circulation changed during the following days because of a more unstable frontal zone with an increasing wave number from 4 to 5. That's why a new cyclone could establish close to 65°N and 30°W with a secondary low moving on its eastern flank southwards. *Polarstern* was affected by several trough centres which caused surface lows with wind forces 7 - 9 Bft. However waves only increased up to 3 m because of the short fetch. At the western side of this system mainly southerly to southeasterly winds with force 5 - 7 Bft prevailed but the pacific system developed secondary lows near the northern part of the Antarctic Peninsula so that *Polarstern* was influenced some days by easterly to north-easterly winds which affected a compression of the northern ice edge (Fig. 7.3a). On 30 March *Polarstern* approached Jubany Station as scheduled. By then moderate winds were observed.

Because of strong windward-effects at the South-Shetlands the cloud base lowered to 300 ft and fog prevailed at times with strong variations of visibility and cloud base. Nevertheless most of the planned flight operations could be done. However, the flight to Artigas Station (Uruguay) had to be cancelled dew to impossible flight conditions with a cloud base of 100 ft and visibility under 300 m. *Polarstern* left King George Island in the afternoon of 31 March heading northeast.

During the following days we reached the frontal zone between two dominant long wave systems in an area between 100°W und east of 45°W (Fig. 7.3b). The wind situation then was relatively moderate with an average wind force of about Bft 6 - 7. Only occasionally westerly storms with force 8 - 9 Bft were observed. Because of the relatively long fetch the sea state was more influenced by swell than by wind sea with significant heights up to 4 m.

In the beginning of the two last weeks at sea *Polarstern* sailed at the southern flank of a low pressure zone reaching from the Bellingshausen Sea to the Malvinas and South Georgia (Fig. 7.3c).

Therefore the predominant wind direction was northeast with wind speed about 20 kn. This situation remained until 13 April while the ship was heading towards Cabo San Diego. At the end of the research operations on 14 April the frontal zone established and intensified from the eastern Pacific to southern Patagonia (Fig. 7.3d). On board *Polarstern* a strong wind field from southwest with force up to 8 - 9 Bft and waves up to 5 m were observed. The last two days in lee of the continent were not influenced by any meteorological event so that *Polarstern* arrived at Punta Arenas on 16 April as scheduled.

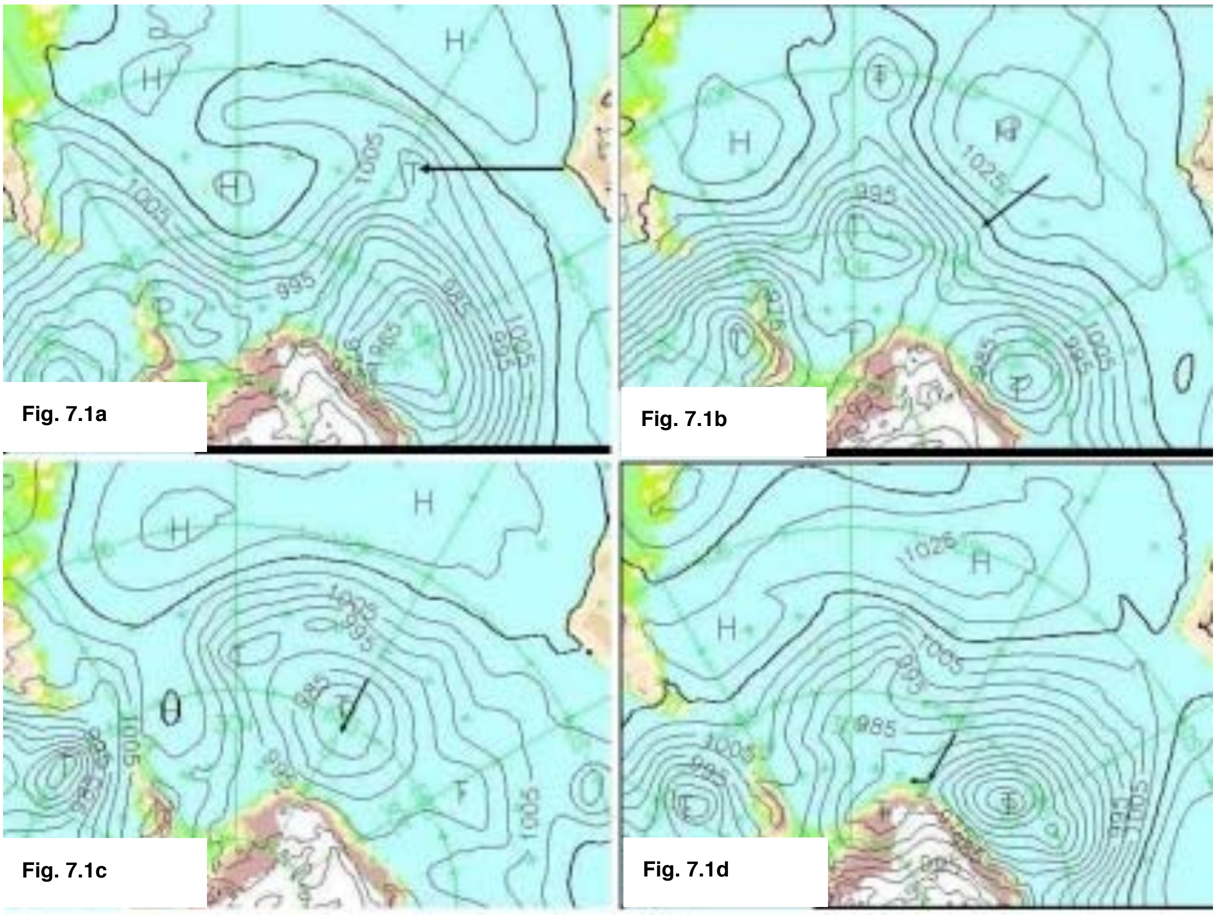
Fig. 7.1a

Fig. 7.1b

Fig. 7.1c

Fig. 7.1d

Fig. 7.1: Sea surface and air pressure distribution for the periods
a: 10 - 17 Feb 2008
b: 18 - 22 Feb 2008
c: 23 - 27 Feb 2008
d: 28 - 03 Mar 2008

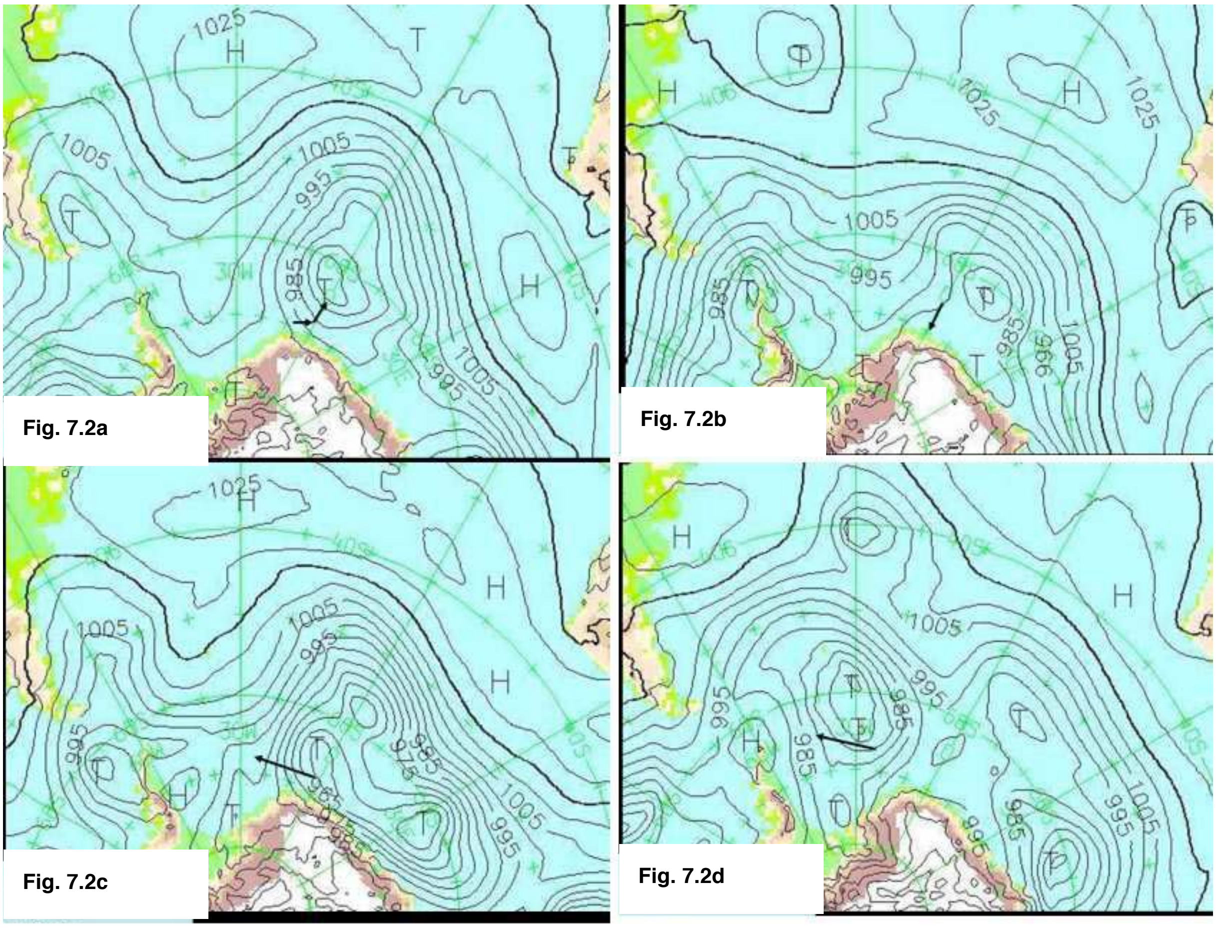
Fig. 7.2a

Fig. 7.2b

Fig. 7.2c

Fig. 7.2d

Fig. 7.2: Sea surface and air pressure distribution for the periods
a: 04 - 08 Mar 2008
b: 09 - 12 Feb 2008
c: 13 - 17 Feb 2008
d: 18 - 23 Mar 2008

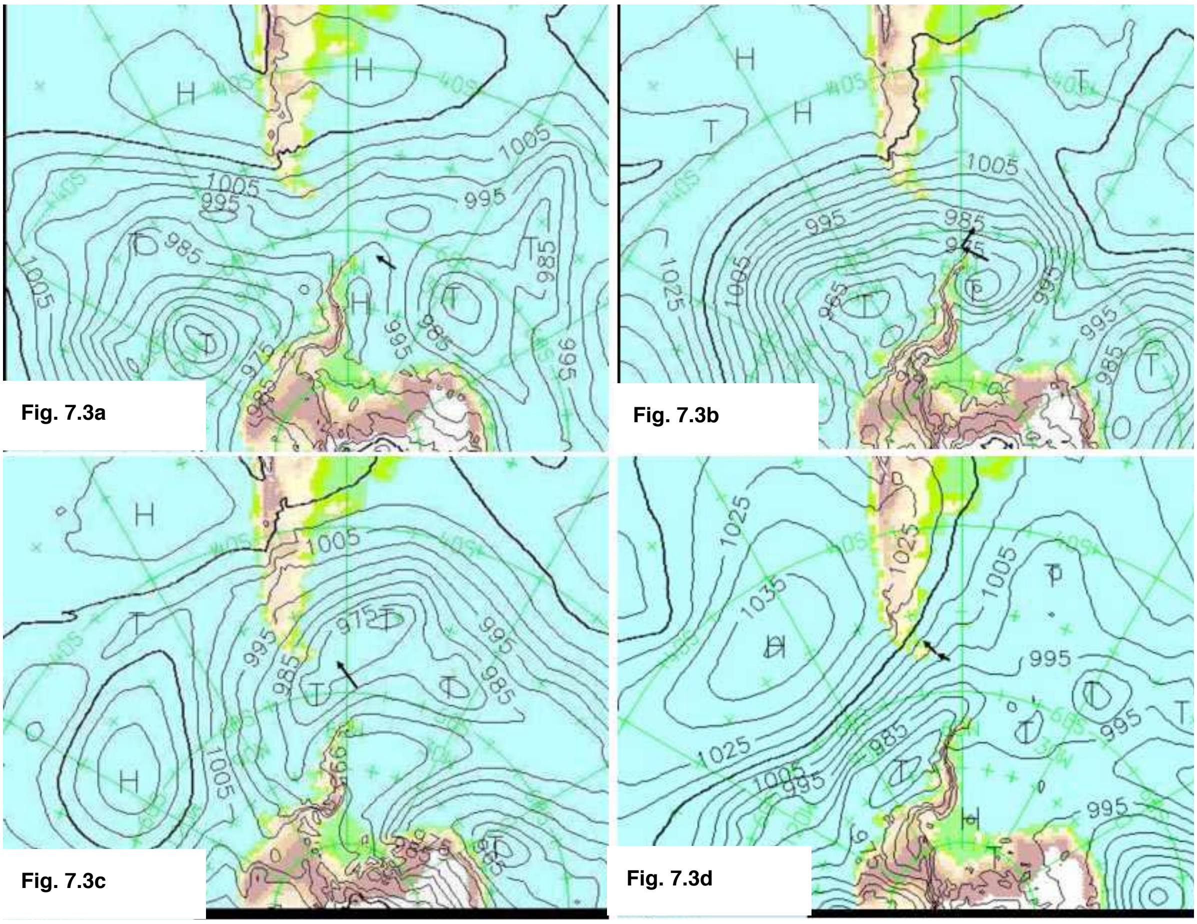

Fig. 7.3a

Fig. 7.3b

Fig. 7.3c

Fig. 7.3d

Fig. 7.3: Sea surface and air pressure distribution for the periods
a: 24 - 28 Mar 2008
b: 29 - 04 Apr 2008
c: 05 - 09 Apr 2008
d: 10 - 14 Apr 2008

8. ACKNOWLEDGEMENTS

ANT-XXVII/3 was the most difficult cruise for all of us. In the course of the helicopter accident on 2 March 2008 two cruise participants lost their lives and three were injured so that they had to be evacuated. Although overshadowed by that dramatic event, we were able to collect extensive data sets and outstanding samples during that cruise and we achieved our logistic tasks. This was a further proof of the exceptional professionalism and the never ending commitment of the *Polarstern* crew. For that we would like to express our heartfelt and sincere thanks to Master Schwarze and his entire crew. We want to thank as well all those, even if we are not able to state them all by name, who contributed to the success of the cruise by their support on shore during planning, preparation and while we had been at sea.

APPENDIX

A.1 PARTICIPATING INSTITUTIONS

A.2 CRUISE PARTICIPANTS

A.3 SHIP'S CREW

A.4 STATION LIST PS-71

A. 1 BETEILIGTE INSTITUTE/ PARTICIPATING INSTITUTES ANT-XXIV/3

	Adresse Address
AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft Am Handelshafen 12 27570 Bremerhaven / Germany
CNRS LEGOS	LEGOS Laboratoire d'Etudes en Géophysique et Océanographie Spatiales Unité Mixte de Recherche CNRS, UPS, CNES, IRD 18 avenue Edouard Belin 31055 Toulouse / France
DESE	Dept. of Earth Science & Engineering Imperial College London SW7 2AZ / UK (participating, but not on cruise)
DWD	Deutscher Wetterdienst Geschäftsbereich Wettervorhersage Seeschifffahrtsberatung Bernhard Nocht Str. 76 20359 Hamburg / Germany
Heli Service	Heli Service International GmbH Im Geisbaum 2 63329 Egelsbach / Germany
IFM-GEOMAR	Leibniz-Institut für Meereswissenschaften IFM-GEOMAR Düsternbrooker Weg 20 24105 Kiel / Germany
IGM	Institut für Geologie und Mineralogie Universität zu Köln Zülpicher Strasse 49 a/b 50674 Köln / Germany

	Adresse **Address**
IUP	Institut für Umweltphysik (IUP) Ozeanographie Institute of Environmental Physics Oceanography Otto-Hahn-Allee 1 D-28359 Bremen / Germany
KORDI	Korean Ocean Research and Development Institute 1270 Sa-dong Sangrok-gu, Asan Kyunggi-do PO Box 29 425-600 Korea
Laeisz	Reederei F. Laeisz (Bremerhaven) GmbH Brückenstrasse 25 27568 Bremerhaven / Germany
LEMAR	Laboratoire des Sciences de l'Environnement Marin (LEMAR), CNRS-UMR 6539 Institut Universitaire Européen de la Mer (IUEM) Technopole Brest-Iroise Place Nicolas Copernic 29280 Plouzané / France
LOCEAN	LOCEAN (Laboratoire d’Océanographie et du Climat: Expérimentation et Analyses Numériques) Unité Mixte de Recherche CNRS, UPMC, MNHN, IRD Université Pierre et Marie Curie Tour 45-55 5^{E} 4 place Jussieu 75252 Paris cedex 05 / France
LSCE	Laboratoire des Sciences du Climat et de l'Environnement / Institut Pierre Simon Laplace Domaine du CNRS Bât 12 - avenue de la Terrasse F - 91198 Gif-sur-Yvette Cedex / France
MPI Chemie	Max-Planck-Institut für Chemie Abteilung Geochemie Postfach 3060 55020 Mainz / Germany

	Adresse **Address**
NIOZ	Koninklijk Nederlands Instituut vor Onderzoek der Zee Department of Biological Oceanography P.O. Box 59 1790 AB Den Burg / The Netherlands
OPTIMARE	OPTIMARE Am Luneort 15a 27572 Bremerhaven / Germany
RMfCA	Section of Mineralogy and Geochemistry Department of Geology Royal Museum for Central Africa Leuvensesteenweg, 13 B-3080 Tervuren / Belgium
University Brussels	Vrije Universiteit Brussel Analytical and Environmental Chemistry Pleinlaan 2 B-1050 Brussels / Belgium
University Las Palmas	Departamento de Química Universidad de Las Palmas de Gran Canaria Campus de Tafira 35017 Las Palmas /Spain
University Liège	Chemical Oceanography Unit Astrophysics, Geophysics and Oceanography Department Université de Liège, Belgium Allée du 6 Août, 17 4000 Liège / Belgium
University of Groningen	Faculteit Wiskunde en Natuurwetenschappen University of Groningen Nijenborgh 4 9747 AG Groningen / The Netherlands
XU	XU Research Center for Environmental Science Xiamen University Xiamen 361005 / China

A.2 FAHRTTEILNEHMER / PARTICIPANTS

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession	
Alderkamp	Anne-Carlijn	University of Groningen	Biologist	
Baars	Oliver	IFM-GEOMAR	PhD student, geochemistry	
Beauverger	Mickael	LOCEAN	Engineer, oceanography	From K.G.I.
Bluhm	Katrin	IFM-GEOMAR	PhD student, biology	
Boebel	Olaf	AWI	Physicist	
Boening	Carmen	AWI	PhD student, oceanography	
Bontes	Babette	NIOZ	PhD student, biology	
Bult	Klaus	DWD	Technician, weather station	
Cai	Pinghe	XU	Geochemist	
Cristini	Luisa	AWI	Physicist	
Croot	Peter	IFM-GEOMAR	Marine chemist	
de Baar	Hein	NIOZ	Geochemist	
Evans	Claire	NIOZ	Biologist	
Fahrbach	Eberhard	AWI	Oceanographer	
Frijling	Erwin	NIOZ	Chemist	
Garçon	Veronique	CNRS LEGOS	Oceanographer	From K.G.I.
Gebler	Madlen	IUP	Student, physics	
Gerringa	Loes	NIOZ	Chemist	
Gremlowski	Lars	AWI	Student, chemistry	
Gronholz	Alexandra	IUP	Student, physics	
Heckmann	Hans-Hilmar	HeliService	Pilot	
Heller	Maija	IFM-GEOMAR	PhD student, chemistry	
Huhn	Oliver	IUP	Physicist	
Hwang	San Chui	KORDI	Oceanographer	From K.G.I.
Kartavsteff	Annie	LOCEAN	Engineer, oceanography	From K.G.I.
Klatt	Olaf	AWI	Physicist	
Laan	Patrick	NIOZ	Engineer, chemistry	
Lacombe	Marielle	CNRS LEGOS	PhD student, oceanography	
Lee	Jae-Hak	KORDI	Oceanographer	From K.G.I.
Legoff	Hervé	LOCEAN	Engineer, oceanography	From K.G.I.
Lohse	Charlotte	IPY teacher programme	Teacher	
Middag	Rob	NIOZ	PhD student, biology/geochemistry	
Monglon	Thierry	LOCEAN	Technician, oceanography	From K.G.I.
Monsees	Matthias	OPTIMARE	Technician, oceanography	
Neven	Ika	University Groningen	PhD student, geochemistry	
Nunez-Ribuni	Ismael	AWI	Physicist	
Ober	Sven	NIOZ	Engineer, chemistry	
Paz Martinez	Andrea		Observer	From K.G.I.
Provost	Christine	LOCEAN	Oceanographer	From K.G.I.

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession	
Robert	Maya	AWI	PhD student, biology	
Rohardt	Gerd	AWI	Oceanographer	
Sander	Hendrik	OPTIMARE	Physicist	
Seifert	Wolfgang	DWD	Meteorologist	
Sennechael	Nathalie	LOCEAN	Oceanographer	From K.G.I.
Slagter	Hans	NIOZ	MSc student, chemistry	
Spadone	Aurelie	LOCEAN	PhD student, oceanography	
Stichel	Torben	IFM-GEOMAR	PhD student, geochemistry	
Stimac	Mihael	HeliService	Helicopter mechanic	
Strothmann	Olaf	AWI	Technician, oceanography	
Sudre	Joel	LEGOS	Engineer, oceanography	
Sweet	Elizabeth	AWI	PhD student, geochemistry	
Theisen	Stefan	IPY teacher programme	Teacher	
Thuroczy	Charles-Edouard	NIOZ	PhD student, geochemistry	
Van Heuven	Steven	NIOZ	PhD student, biology	
Van Ooijen	Jan	NIOZ	Engineer, chemistry	
Van Slooten	Cornelis	NIOZ	PhD student, biology	
Venchiarutti	Celia	AWI	Chemist	
Stimac	Ingrid	AWI	Technician, chemistry	

Two cruise participants lost their lives during the helicopter accident on 2 March 2008:
Willem Polman, NIOZ, Technician, geochemistry
Stefan Winter, HeliService, Pilot

Three cruise participants had to return home from Neumayer station after being injured during the helicopter accident on 2 March 2008:
Maarten Klunder, NIOZ, PhD student, geochemistry
Carsten Möllendorf, HeliService, Helicopter mechanic
Alice Renault, LOCEAN, PhD student, oceanography

A.3 SCHIFFSBESATZUNG / SHIP'S CREW

No.	Name	Rank
1.	Schwarze, Stefan	Master
2.	Spielke, Steffen	1.Offc. from Neumayer
3.	Fallei, Holger	1.Offc to Neumayer
4.	Farysch, Bernd	Ch.Eng.
5.	Becker, Tilo	2.Offc.
6.	Peine Lutz	2.Offc.
7.	Dugge, Heike	3.Offc.
8.	Sokoll, Herbert	Doctor
9.	Hecht, Andreas	R.Offc
10.	Minzlaff, Hans-Ulrich	2.Eng.
11.	Sümnicht, Stefan	2.Eng.
12.	Schäfer, Marc	3.Eng.
13.	Scholz, Manfred	Elec.Tech.
14.	Fröb Martin	Electron.
15.	Himmel, Frank	Electron.
16.	Muhle, Helmut	Electron.
17.	Nasis, Ilias	Electron.
18.	Loidl, Reiner	Boatsw.
19.	Reise, Lutz	Carpenter
20.	Bäcker, Andreas	A.B.
21.	Guse, Hartmut	A.B.
22.	Hagemann, Manfred	A.B.
23.	Schmidt, Uwe	A.B.
24.	Stutz, Hein-Werner	A.B.
25.	Vehlow, Ringo	A.B.
26.	Wende, Uwe	A.B.
27.	Winkler, Michael	A.B.
28.	Preußner, Uwe	Storekeep.
29.	Elsner, Klaus	Mot-man
30.	Hartmann, Ernst-Uwe	Mot-man
31.	Ipsen, Michael	Mot-man
32.	Pinske, Lutz	Mot-man
33.	Voy, Bernd	Mot-man
34.	Müller-Homburg, Ralf-Dieter	Cook
35.	Martens, Michael	Cooksmate
36.	Silinski, Frank	Cooksmate
37.	Jürgens, Monika	1.Stwdess
38.	Hölger, Irene	Stwdss/KS
39.	Czyborra, Bärbel	2.Stwdess
40.	Gaude, Hans-Jürgen	2.Steward
41.	Huang, Wu-Mei	2.Steward
42.	Möller, Wolfgang	2.Steward
43.	Silinski, Carmen	2.Stwdess
44.	Wu, Chi Lung	Laundryman

A. 4 STATION LIST PS-71

POLARSTERN ANT XXIV-3
PS71/097-2 is Polarstern cruise 71, station 097, Cast 2.

THIS IS FINAL VERSION OF STATION NUMBERS AND CAST NUMBERS
WARNING: THESE NUMBERS MAY DIFFER FROM PROVISIONAL STATION/CAST NUMBERS ON YOUR SAMPLE BOTTLES

		Cast Leader
	CTD/RO is regular CTD Rosette with 22 NISKIN-type samplers	
B1	**CTD/RO Deep Hydrocasts for ALK, DIC, CFC's, 234Th, Silicon-isotopes are yellow highlighted**	**Oliver Huhn**
C	**CTD/RO Deep Hydrocasts for eight (8) large 20 Litre samples for 231Pa/230Th/Nd (plus 60 L for Hf) is purple highlighted**	**Celia Venciarutti**
D	**CTD/RO hydrocasts to 200m and to 1000m are for 210Po/210Pb and are red highlighted**	**Maya Robert**
F	**CTD/RO Hydrocast for four (4) large volumes (circa 60 L) samples for Hafnium**	**Torben Stichel**
A2	**CTD/RO shallow hydrocast for virus exps., phyto exps., fast-equilbr.exps., 234Th, Si-isotopes, (Hafnium)**	**Anne-Carlijn Alderkamp**
	PS71-132-3 is special hydrocast for testing dissolved O2 method	**Ismael Nunez-Riboni**
	PS71-154-1 and PS71-155-1 are two special hydrocasts in Atka Bay, near Neumayer station	
	CTD/UC is Ultraclean Titanium frame with 24 GOFLO samplers used for trace metals	
A1	**CTD/UC Deep Hydrocasts for Trace Metals (often also for DIC, ALK) are lightblue highlighted**	**Patrick Laan / Hein de Baar**
B2	**One large volume of 240 L for start biological experiment**	**Babette Bontes**
G	**Ultraclean shallow 300-400m depth casts G1 through G5 for Iron Isotopes when approaching Antarctic Peninsula**	**Hein de Baar**

Major nutrients are analysed for each sampler of deep hydrocasts A1 and B1 (silicate, phosphate, nitrite, nitrate+nitrite)
Date and time is UCT (formerly called GMT, Greenwich Mean Time, in old days when Brittania still thought it ruled the waves)

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment
	PS71/096-1	10.02.08	15:05	34° 51.99' S	16° 42.72' E	3401.6	Iron Fish	IFISH	surface	
	PS71/097-1	11.02.08	11:25	37° 4.09' S	12° 48.79' E	4967.5	Pressure In	PIES	Surface	Signal auf Ch 77 empfangen ca 3 Strich stb.
	PS71/096-1	11.02.08	11:37	37° 3.78' S	12° 46.15' E	4886.7	Iron Fish	IFISH	on deck	
	PS71/097-1	11.02.08	11:44	37° 3.69' S	12° 45.69' E	4904.4	Pressure In	PIES	on Deck	
A1	PS71/097-2	11.02.08	12:00	37° 3.46' S	12° 45.59' E	4876.9	CTD, Ultra	CTD/UC	into Water	TestStation; 3 sets of 8 samplers
A1	PS71/097-2	11.02.08	14:21	37° 0.99' S	12° 45.29' E	4921.5	CTD, Ultra	CTD/UC	on Depth	TestStation; 3 sets of 8 samplers
A1	PS71/097-2	11.02.08	15:56	36° 59.81' S	12° 45.28' E	4966.1	CTD, Ultra	CTD/UC	on Deck	TestStation; 3 sets of 8 samplers
	PS71/097-3	11.02.08	16:04	36° 59.76' S	12° 45.39' E	4971.7	Test	TEST	surface	EL31 Draht
	PS71/097-3	11.02.08	18:13	36° 57.59' S	12° 45.71' E	4999.1	Test	TEST	at depth	
	PS71/097-3	11.02.08	18:18	36° 57.56' S	12° 45.74' E	4998.7	Test	TEST	information	hieven
	PS71/097-3	11.02.08	20:21	36° 55.58' S	12° 46.06' E	4992.2	Test	TEST	on deck	
	PS71/098-1	12.02.08	09:55	38° 45.92' S	11° 37.17' E	4935.4	Iron Fish	IFISH	surface	
	PS71/098-1	13.02.08	01:41	41° 7.27' S	9° 57.20' E	4730.0	Iron Fish	IFISH	on deck	
	PS71/099-1	13.02.08	01:49	41° 7.32' S	9° 57.27' E	4730.0	Pressure In	PIES	Start deployment	
	PS71/099-2	13.02.08	02:10	41° 8.07' S	9° 56.77' E	4732.0	CTD/rosett	CTD/RO	surface	
	PS71/099-1	13.02.08	03:09	41° 8.24' S	9° 57.50' E	4737.0	Pressure In	PIES	End deploy	Posidonia Position B= 41°07,4 L= 009°57,700 dezimal
	PS71/099-2	13.02.08	03:39	41° 8.35' S	9° 57.73' E	4744.0	CTD/rosett	CTD/RO	at depth	EL 31 4589 m
	PS71/099-3	13.02.08	03:44	41° 8.37' S	9° 57.76' E	4742.0	Pressure In	PIES	Release	Aufnahme ANT 5-1
	PS71/099-2	13.02.08	04:49	41° 8.71' S	9° 58.28' E	4761.0	CTD/rosett	CTD/RO	on deck	
	PS71/099-3	13.02.08	05:35	41° 8.56' S	9° 57.18' E	4777.0	Pressure In	PIES	Surface	
	PS71/099-3	13.02.08	05:56	41° 8.26' S	9° 56.93' E	4738.0	Pressure In	PIES	on Deck	
B2	PS71/099-4	13.02.08	06:09	41° 8.28' S	9° 57.00' E	4735.0	CTD, Ultra	CTD/UC	into Water	
B2	PS71/099-4	13.02.08	06:16	41° 8.38' S	9° 57.04' E	4737.0	CTD, Ultra	CTD/UC	on Depth	SL147m
B2	PS71/099-4	13.02.08	06:37	41° 8.58' S	9° 57.09' E	4734.0	CTD, Ultra	CTD/UC	on Deck	
	PS71/100-1	13.02.08	06:48	41° 9.11' S	9° 56.54' E	4732.0	Iron Fish	IFISH	surface	
	PS71/100-1	13.02.08	15:13	42° 18.82' S	9° 0.66' E	4467.0	Iron Fish	IFISH	on deck	
	PS71/101	**START SUPERSTATION**								
D	PS71/101-1	13.02.08	15:33	42° 19.96' S	8° 59.96' E	4524.0	CTD/rosett	CTD/RO	surface	
D	PS71/101-1	13.02.08	15:41	42° 19.97' S	8° 59.97' E	4527.0	CTD/rosett	CTD/RO	at depth	EL 31 194 m
D	PS71/101-1	13.02.08	15:55	42° 20.15' S	8° 59.91' E	4539.0	CTD/rosett	CTD/RO	on deck	
A1	PS71/101-2	13.02.08	16:02	42° 20.22' S	8° 59.88' E	4543.0	CTD, Ultra	CTD/UC	into Water	
A1	PS71/101-2	13.02.08	17:17	42° 20.33' S	8° 59.61' E	4546.0	CTD, Ultra	CTD/UC	on Depth	SL 4350m
A1	PS71/101-2	13.02.08	18:55	42° 20.27' S	8° 59.54' E	4538.0	CTD, Ultra	CTD/UC	on Deck	
C	PS71/101-3	13.02.08	19:04	42° 20.26' S	8° 59.52' E	4535.0	CTD/rosett	CTD/RO	surface	

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment		
C	PS71/101-3	13.02.08	20:33	42° 20.74' S	8° 59.60' E	4569.0	CTD/rosett	CTD/RO	at depth	4513 m		
C	PS71/101-3	13.02.08	21:55	42° 21.36' S	8° 59.93' E	4640.0	CTD/rosett	CTD/RO	on deck			
	PS71/101-4	13.02.08	22:26	42° 20.22' S	8° 59.37' E	4532.0	In situ pum	ISP	into water	Gewicht		
	PS71/101-4	13.02.08	22:33	42° 20.28' S	8° 59.41' E	4534.0	In situ pum	ISP	Information	Pumpe 1		
	PS71/101-4	13.02.08	22:54	42° 20.45' S	8° 59.50' E	4550.0	In situ pum	ISP	Information	Pumpe 2		
	PS71/101-4	13.02.08	23:02	42° 20.52' S	8° 59.52' E	4554.0	In situ pum	ISP	Information	Pumpe 3		
	PS71/101-4	13.02.08	23:10	42° 20.59' S	8° 59.55' E	4563.0	In situ pum	ISP	Information	Pumpe 4		
	PS71/101-4	13.02.08	23:21	42° 20.68' S	8° 59.59' E	4567.0	In situ pum	ISP	Information	Pumpe 5		
	PS71/101-4	13.02.08	23:25	42° 20.72' S	8° 59.61' E	4581.0	In situ pum	ISP	pump at depth			
	PS71/101-4	14.02.08	01:40	42° 21.39' S	8° 59.04' E	4612.0	In situ pum	ISP	Information	hieven		
	PS71/101-4	14.02.08	02:33	42° 21.49' S	8° 58.96' E	4617.0	In situ pum	ISP	on deck			
D	PS71/101-5	14.02.08	02:49	42° 20.54' S	8° 59.54' E	4560.0	CTD/rosett	CTD/RO	surface			
D	PS71/101-5	14.02.08	03:16	42° 20.65' S	8° 59.58' E	4569.0	CTD/rosett	CTD/RO	at depth	EL 31 995 m		
D	PS71/101-5	14.02.08	03:39	42° 20.72' S	8° 59.67' E	4574.0	CTD/rosett	CTD/RO	on deck			
	PS71/101-6	14.02.08	03:42	42° 20.74' S	8° 59.73' E	4576.0	FLOAT	FLOAT	into water			
	PS71/101	**END SUPERSTATION**										
	PS71/102-1	15.02.08	05:35	44° 38.89' S	7° 5.97' E	4642.0	Mooring	MOR	surface			
	PS71/102-1	15.02.08	05:37	44° 38.90' S	7° 5.96' E	4634.0	Mooring	MOR	slipped			
B1	PS71/102-2	15.02.08	06:17	44° 39.69' S	7° 5.59' E	4615.0	CTD/rosett	CTD/RO	surface			
B1	PS71/102-2	15.02.08	07:55	44° 39.62' S	7° 5.82' E	4619.0	CTD/rosett	CTD/RO	at depth			
	PS71/102-3	15.02.08	07:55	44° 39.62' S	7° 5.82' E	4619.0	Mooring	MOR	Hydrophone into the water			
	PS71/102-3	15.02.08	07:57	44° 39.62' S	7° 5.85' E	4618.0	Mooring	MOR	released			
	PS71/102-3	15.02.08	08:03	44° 39.63' S	7° 5.85' E	4620.0	Mooring	MOR	Hydrophone on Deck			
B1	PS71/102-2	15.02.08	09:22	44° 39.56' S	7° 5.77' E	4606.0	CTD/rosett	CTD/RO	on deck			
	PS71/102-3	15.02.08	09:48	44° 39.48' S	7° 5.71' E	4620.0	Mooring	MOR	on the surface			
	PS71/102-3	15.02.08	10:00	44° 39.64' S	7° 5.69' E	4613.0	Mooring	MOR	on deck			
A2	PS71/102-4	15.02.08	10:33	44° 39.51' S	7° 5.62' E	4618.0	CTD/rosett	CTD/RO	surface			
A2	PS71/102-4	15.02.08	10:45	44° 39.53' S	7° 5.65' E	4623.0	CTD/rosett	CTD/RO	at depth			
A2	PS71/102-4	15.02.08	10:59	44° 39.59' S	7° 5.59' E	4625.0	CTD/rosett	CTD/RO	on deck			
	PS71/102-5	15.02.08	11:05	44° 39.64' S	7° 5.43' E	4614.0	FLOAT	FLOAT	into water			
A1	PS71/103-1	16.02.08	01:44	46° 0.13' S	5° 52.80' E	3288.0	CTD, Ultra	CTD/UC	into Water		12 Ba calibration duplicates for Dehairs	
A1	PS71/103-1	16.02.08	02:38	45° 59.97' S	5° 52.87' E	3330.0	CTD, Ultra	CTD/UC	on Depth	auf Tiefe 3100 m	12 Ba calibration duplicates for Dehairs	
A1	PS71/103-1	16.02.08	04:01	45° 59.88' S	5° 52.91' E	3318.1	CTD, Ultra	CTD/UC	on Deck		12 Ba calibration duplicates for Dehairs	
	PS71/103-2	16.02.08	04:05	45° 59.86' S	5° 52.86' E	3322.5	FLOAT	FLOAT	into water			
	PS71/104	**START SUPERSTATION**										
D	PS71/104-1	16.02.08	22:09	47° 39.34' S	4° 16.03' E	4540.0	CTD/rosett	CTD/RO	surface			
D	PS71/104-1	16.02.08	22:21	47° 39.36' S	4° 16.48' E	4547.1	CTD/rosett	CTD/RO	at depth			
D	PS71/104-1	16.02.08	22:32	47° 39.47' S	4° 16.77' E	4555.0	CTD/rosett	CTD/RO	on deck			
A1	PS71/104-2	16.02.08	22:44	47° 39.58' S	4° 16.95' E	0.0	CTD, Ultra	CTD/UC	into Water		10 calibration duplicate samples for MarieBoye	**Cd isotopes**
A1	PS71/104-2	17.02.08	00:03	47° 40.31' S	4° 17.36' E	4545.8	CTD, Ultra	CTD/UC	on Depth	4400 m	10 calibration samples for MarieBoye	**Cd isotopes**
A1	PS71/104-2	17.02.08	01:55	47° 39.54' S	4° 17.66' E	4550.1	CTD, Ultra	CTD/UC	on Deck		10 calibration samples for MarieBoye	**Cd isotopes**
C	PS71/104-3	17.02.08	02:20	47° 39.43' S	4° 16.17' E	4541.7	CTD/rosett	CTD/RO	surface			
C	PS71/104-3	17.02.08	03:09	47° 39.37' S	4° 16.22' E	4542.1	CTD/rosett	CTD/RO	at depth	2189 m		
C	PS71/104-3	17.02.08	03:46	47° 39.31' S	4° 15.86' E	4536.6	CTD/rosett	CTD/RO	on deck			
	PS71/104-4	17.02.08	03:56	47° 39.30' S	4° 15.74' E	4536.4	In situ pum	ISP	into water			
	PS71/104-4	17.02.08	05:30	47° 39.35' S	4° 15.69' E	4534.7	In situ pum	ISP	pump at depth			
	PS71/104-4	17.02.08	08:20	47° 39.37' S	4° 15.70' E	4545.3	In situ pum	ISP	Information	Beginn Hieven / 6 Pumpen		
	PS71/104-4	17.02.08	09:18	47° 39.37' S	4° 15.71' E	4536.6	In situ pum	ISP	on deck			
	PS71/104-5	17.02.08	09:41	47° 39.41' S	4° 15.69' E	4538.0	Mooring	MOR	slipped	PIES -ANT-9-2		
	PS71/104-6	17.02.08	09:56	47° 39.46' S	4° 15.90' E	4538.3	CTD/rosett	CTD/RO	surface			
	PS71/104-7	17.02.08	11:30	47° 39.45' S	4° 16.06' E	4541.2	Mooring	MOR	Hydrophone into the water			
	PS71/104-6	17.02.08	11:38	47° 39.44' S	4° 16.06' E	4542.9	CTD/rosett	CTD/RO	at depth			
	PS71/104-7	17.02.08	11:39	47° 39.43' S	4° 16.06' E	4543.9	Mooring	MOR	Hydrophone on Deck			
	PS71/104-6	17.02.08	12:53	47° 39.05' S	4° 16.20' E	4544.2	CTD/rosett	CTD/RO	on deck			
	PS71/104-7	17.02.08	13:15	47° 39.23' S	4° 16.11' E	4542.5	Mooring	MOR	on the surfa	ch 77		
	PS71/104-7	17.02.08	13:30	47° 38.69' S	4° 16.05' E	4546.5	Mooring	MOR	on deck			
D	PS71/104-8	17.02.08	13:50	47° 38.48' S	4° 16.18' E	4547.0	CTD/rosett	CTD/RO	surface			

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment	
	PS71/104-9	17.02.08	13:59	47° 38.50' S	4° 16.23' E	4552.3	Hand net	HN	surface		
	PS71/104-9	17.02.08	14:09	47° 38.47' S	4° 16.39' E	4551.9	Hand net	HN	on deck		
D	PS71/104-8	17.02.08	14:13	47° 38.45' S	4° 16.43' E	4549.2	CTD/rosett	CTD/RO	at depth	EL 31 997 m	
D	PS71/104-8	17.02.08	14:36	47° 38.40' S	4° 16.55' E	4549.8	CTD/rosett	CTD/RO	on deck		
	PS71/104-10	17.02.08	14:41	47° 38.44' S	4° 16.56' E	4548.7	FLOAT	FLOAT	into water		
	PS71/104	**END SUPERSTATION**									
	PS71/105-1	17.02.08	14:48	47° 38.73' S	4° 16.36' E	4547.6	Iron Fish	IFISH	surface		
	PS71/105-1	18.02.08	03:33	48° 54.23' S	2° 48.52' E	4114.4	Iron Fish	IFISH	on deck		
B1	PS71/106-1	18.02.08	03:48	48° 54.68' S	2° 48.11' E	4101.4	CTD/rosett	CTD/RO	surface		
B1	PS71/106-1	18.02.08	05:12	48° 54.69' S	2° 48.07' E	4100.3	CTD/rosett	CTD/RO	at depth		
B1	PS71/106-1	18.02.08	06:27	48° 54.71' S	2° 47.88' E	4094.3	CTD/rosett	CTD/RO	on deck		
	PS71/106-2	18.02.08	06:30	48° 54.72' S	2° 47.90' E	4094.9	FLOAT	FLOAT	into water		
	PS71/107-1	18.02.08	18:16	50° 9.50' S	1° 32.36' E	3642.1	Mooring	MOR	released	by Heli	
	PS71/107-2	18.02.08	19:18	50° 15.47' S	1° 26.31' E	3864.2	Mooring	MOR	surface		
	PS71/107-2	18.02.08	19:19	50° 15.47' S	1° 26.33' E	3864.5	Mooring	MOR	slipped		
	PS71/107-1	18.02.08	19:29	50° 15.60' S	1° 26.37' E	3865.1	Mooring	MOR	on the surface		
	PS71/107-1	18.02.08	19:46	50° 16.06' S	1° 26.56' E	3860.5	Mooring	MOR	on deck		
A1	PS71/107-3	18.02.08	19:57	50° 16.13' S	1° 26.71' E	3855.0	CTD, Ultra	CTD/UC	into Water		
A1	PS71/107-3	18.02.08	20:59	50° 16.29' S	1° 27.02' E	3840.6	CTD, Ultra	CTD/UC	on Depth	3700 m	
A1	PS71/107-3	18.02.08	22:33	50° 16.94' S	1° 27.83' E	3816.0	CTD, Ultra	CTD/UC	on Deck		
	PS71/107-4	18.02.08	22:39	50° 16.98' S	1° 27.98' E	3804.9	FLOAT	FLOAT	into water		
A2	PS71/108-1	19.02.08	08:44	51° 29.96' S	0° 0.19' E	2768.2	CTD/rosett	CTD/RO	surface		
A2	PS71/108-1	19.02.08	08:53	51° 29.95' S	0° 0.43' E	2761.6	CTD/rosett	CTD/RO	at depth		
A2	PS71/108-1	19.02.08	09:08	51° 30.01' S	0° 0.57' E	2761.0	CTD/rosett	CTD/RO	on deck		
B1	PS71/108-2	19.02.08	09:38	51° 29.84' S	0° 0.31' E	2758.5	CTD/rosett	CTD/RO	surface		
	PS71/108-3	19.02.08	09:53	51° 29.88' S	0° 0.34' E	2761.0	Hand net	HN	surface		
	PS71/108-3	19.02.08	10:01	51° 29.89' S	0° 0.37' E	2761.4	Hand net	HN	on deck		
B1	PS71/108-2	19.02.08	10:41	51° 29.91' S	0° 0.21' E	2771.7	CTD/rosett	CTD/RO	at depth	2704m	
B1	PS71/108-2	19.02.08	11:48	51° 29.95' S	0° 0.02' W	2775.4	CTD/rosett	CTD/RO	on deck		
	PS71/108-4	19.02.08	11:52	51° 29.97' S	0° 0.02' W	2784.1	FLOAT	FLOAT	into water		
	PS71/109-1	19.02.08	11:56	51° 30.19' S	0° 0.17' W	2793.1	Iron Fish	IFISH	surface		
	PS71/109-1	19.02.08	15:38	51° 56.55' S	0° 0.72' E	2846.0	Iron Fish	IFISH	on deck		
A1	PS71/110-1	19.02.08	15:44	51° 56.66' S	0° 0.65' E	2852.8	CTD, Ultra	CTD/UC	into Water		
A1	PS71/110-1	19.02.08	16:32	51° 56.76' S	0° 0.77' E	2856.5	CTD, Ultra	CTD/UC	on Depth	sl 2700m	
A1	PS71/110-1	19.02.08	17:42	51° 56.75' S	0° 0.84' E	2858.3	CTD, Ultra	CTD/UC	on Deck		
	PS71/110-2	19.02.08	17:45	51° 56.75' S	0° 0.84' E	2858.9	FLOAT	FLOAT	into water		
	PS71/111-1	19.02.08	17:51	51° 56.97' S	0° 0.36' E	2861.4	Iron Fish	IFISH	surface		
	PS71/111-1	20.02.08	00:55	52° 30.28' S	1° 23.96' W	2794.2	Iron Fish	IFISH	on deck		
B1	PS71/112-1	20.02.08	01:07	52° 30.38' S	1° 23.91' W	2801.2	CTD/rosett	CTD/RO	surface		
B1	PS71/112-1	20.02.08	02:06	52° 30.30' S	1° 23.03' W	2852.2	CTD/rosett	CTD/RO	at depth	2800 m	
	PS71/112-2	20.02.08	02:07	52° 30.30' S	1° 23.02' W	2852.6	Pressure In	PIES	information hydrofon zu wasser		
	PS71/112-2	20.02.08	02:09	52° 30.29' S	1° 22.99' W	2853.9	Pressure In	PIES	Release		
	PS71/112-2	20.02.08	02:17	52° 30.30' S	1° 22.87' W	2860.6	Pressure In	PIES	information hydrofon an deck		
	PS71/112-2	20.02.08	02:52	52° 30.24' S	1° 22.27' W	2816.3	Pressure In	PIES	Surface		
B1	PS71/112-1	20.02.08	02:59	52° 30.20' S	1° 22.26' W	2811.4	CTD/rosett	CTD/RO	on deck		
	PS71/112-2	20.02.08	03:24	52° 30.24' S	1° 23.67' W	2803.5	Pressure In	PIES	on Deck		
	PS71/112-3	20.02.08	03:28	52° 30.23' S	1° 23.75' W	2799.8	FLOAT	FLOAT	into water		
	PS71/113	**START SUPERSTATION**									
D	PS71/113-1	20.02.08	10:28	53° 0.03' S	0° 0.43' E	2525.5	CTD/rosett	CTD/RO	surface		
D	PS71/113-1	20.02.08	10:55	52° 59.92' S	0° 0.81' E	2529.5	CTD/rosett	CTD/RO	at depth	994m	
	PS71/113-2	20.02.08	11:02	52° 59.90' S	0° 0.89' E	2530.3	Hand net	HN	surface		
	PS71/113-2	20.02.08	11:09	52° 59.89' S	0° 0.98' E	2529.5	Hand net	HN	on deck		
D	PS71/113-1	20.02.08	11:19	52° 59.88' S	0° 1.11' E	2539.3	CTD/rosett	CTD/RO	on deck		
A1	PS71/113-3	20.02.08	11:25	52° 59.87' S	0° 1.19' E	2522.4	CTD, Ultra	CTD/UC	into Water		**Cd isotopes**
A1	PS71/113-3	20.02.08	12:06	52° 59.81' S	0° 1.70' E	2520.9	CTD, Ultra	CTD/UC	on Depth	2351 m	**Cd isotopes**
A1	PS71/113-3	20.02.08	13:14	52° 59.75' S	0° 2.30' E	2522.4	CTD, Ultra	CTD/UC	on Deck		**Cd isotopes**
C	PS71/113-4	20.02.08	13:27	52° 59.58' S	0° 2.39' E	2544.2	CTD/rosett	CTD/RO	surface		3 duplicates to compare with BonusGoodHope

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment	
C	PS71/113-4	20.02.08	14:27	52° 59.55' S	0° 2.72' E	2517.3	CTD/rosett	CTD/RO	at depth	EL 31 2462 m	3 duplicates to compare with BonusGoodHope
C	PS71/113-4	20.02.08	15:17	52° 59.67' S	0° 2.65' E	2506.1	CTD/rosett	CTD/RO	on deck		3 duplicates to compare with BonusGoodHope
	PS71/113-5	20.02.08	15:23	52° 59.70' S	0° 2.66' E	2504.2	In situ pum	ISP	into water	Ankerstein	
	PS71/113-5	20.02.08	15:29	52° 59.73' S	0° 2.68' E	2503.5	In situ pum	ISP	into water	1.Pumpe	
	PS71/113-5	20.02.08	15:36	52° 59.76' S	0° 2.69' E	2502.9	In situ pum	ISP	into water	2.Pumpe	
	PS71/113-5	20.02.08	15:42	52° 59.77' S	0° 2.69' E	2503.2	In situ pum	ISP	into water	3.Pumpe	
	PS71/113-5	20.02.08	15:51	52° 59.77' S	0° 2.67' E	2505.3	In situ pum	ISP	into water	4. Pumpe	
	PS71/113-5	20.02.08	15:55	52° 59.78' S	0° 2.67' E	2504.9	In situ pum	ISP	into water	5. Pumpe	
	PS71/113-5	20.02.08	16:00	52° 59.79' S	0° 2.67' E	2505.3	In situ pum	ISP	into water	6. Pumpe	
	PS71/113-5	20.02.08	16:01	52° 59.79' S	0° 2.67' E	2505.3	In situ pum	ISP	pump at de	SI 1020	
	PS71/113-5	20.02.08	19:33	53° 1.09' S	0° 3.19' E	2454.4	In situ pum	ISP	on deck	Pumpe 6	
	PS71/113-5	20.02.08	19:36	53° 1.12' S	0° 3.19' E	2455.7	In situ pum	ISP	on deck	Pumpe 5	
	PS71/113-5	20.02.08	19:39	53° 1.14' S	0° 3.19' E	2456.1	In situ pum	ISP	on deck	Pumpe 4	
	PS71/113-5	20.02.08	19:46	53° 1.19' S	0° 3.20' E	2458.8	In situ pum	ISP	on deck	Pumpe 3	
	PS71/113-5	20.02.08	19:53	53° 1.23' S	0° 3.24' E	2456.1	In situ pum	ISP	on deck	Pumpe 2	
	PS71/113-5	20.02.08	20:01	53° 1.27' S	0° 3.28' E	2448.5	In situ pum	ISP	on deck	Pumpe 1	
	PS71/113-5	20.02.08	20:03	53° 1.27' S	0° 3.29' E	2442.8	In situ pum	ISP	on deck		
B2	PS71/113-6	20.02.08	20:15	53° 1.33' S	0° 3.33' E	2434.8	CTD, Ultra	CTD/UC	into Water		
B2	PS71/113-6	20.02.08	20:22	53° 1.37' S	0° 3.35' E	2429.9	CTD, Ultra	CTD/UC	on Depth	152m	
B2	PS71/113-6	20.02.08	20:42	53° 1.42' S	0° 3.36' E	2422.0	CTD, Ultra	CTD/UC	on Deck		
D	PS71/113-7	20.02.08	20:53	53° 1.44' S	0° 3.36' E	2423.4	CTD/rosett	CTD/RO	surface		
D	PS71/113-7	20.02.08	21:04	53° 1.49' S	0° 3.44' E	2361.6	CTD/rosett	CTD/RO	at depth	195m	
D	PS71/113-7	20.02.08	21:17	53° 1.57' S	0° 3.54' E	2350.9	CTD/rosett	CTD/RO	on deck		
	PS71/113	**END SUPERSTATION**									
	PS71/114-1	20.02.08	21:19	53° 1.57' S	0° 3.63' E	2347.7	Iron Fish	IFISH	surface		
	PS71/114-1	21.02.08	01:06	53° 31.21' S	0° 0.04' E	2630.3	Iron Fish	IFISH	on deck		
	PS71/115-1	21.02.08	01:13	53° 31.24' S	0° 0.04' E	2631.7	Pressure In	PIES	Start deployment		
	PS71/115-1	21.02.08	01:13	53° 31.24' S	0° 0.04' E	2631.7	Pressure In	PIES	End deployment		
B1	PS71/115-2	21.02.08	01:19	53° 31.25' S	0° 0.10' E	2631.4	CTD/rosett	CTD/RO	surface		7 duplicates Si isotopes to compare with BonusGoodHope
	PS71/115-1	21.02.08	01:47	53° 31.19' S	0° 0.23' E	2630.2	Pressure In	PIES	information	PIES am Grund	
B1	PS71/115-2	21.02.08	02:17	53° 31.12' S	0° 0.37' E	2643.9	CTD/rosett	CTD/RO	at depth	2590 Meter	7 duplicates Si isotopes to compare with BonusGoodHope
B1	PS71/115-2	21.02.08	03:07	53° 30.95' S	0° 0.30' E	2657.7	CTD/rosett	CTD/RO	on deck		7 duplicates Si isotopes to compare with BonusGoodHope
A1	PS71/116-1	21.02.08	06:44	54° 0.07' S	0° 0.01' W	2529.5	CTD, Ultra	CTD/UC	into Water		
A1	PS71/116-1	21.02.08	07:28	53° 59.99' S	0° 0.02' W	2521.9	CTD, Ultra	CTD/UC	on Depth	SL 2400m	
A1	PS71/116-1	21.02.08	08:42	53° 59.97' S	0° 0.01' E	2513.2	CTD, Ultra	CTD/UC	on Deck		
	PS71/117-1	21.02.08	08:51	54° 0.25' S	0° 0.06' W	2464.6	Iron Fish	IFISH	surface		
	PS71/117-1	21.02.08	12:43	54° 30.71' S	0° 2.39' E	1743.0	Iron Fish	IFISH	on deck		
	PS71/118-1	21.02.08	12:45	54° 30.77' S	0° 2.30' E	1743.0	Mooring	MOR	released	Rec 238-5	
	PS71/118-1	21.02.08	13:15	54° 30.43' S	0° 1.60' E	1735.5	Mooring	MOR	action	Toppeinheit	
	PS71/118-1	21.02.08	13:22	54° 30.41' S	0° 1.70' E	1738.4	Mooring	MOR	action	1 Benthospaket + Strömungsmesser	
	PS71/118-1	21.02.08	13:25	54° 30.41' S	0° 1.69' E	1740.4	Mooring	MOR	action	CTD Rekorder	
	PS71/118-1	21.02.08	13:28	54° 30.42' S	0° 1.66' E	1737.4	Mooring	MOR	action	CTD Rekorder	
	PS71/118-1	21.02.08	13:31	54° 30.41' S	0° 1.71' E	1737.2	Mooring	MOR	action	Benthospaket + Strömungsmesser	
	PS71/118-1	21.02.08	13:37	54° 30.42' S	0° 1.70' E	1738.4	Mooring	MOR	action	CTD-Rekorder	
	PS71/118-1	21.02.08	13:41	54° 30.39' S	0° 1.58' E	1735.5	Mooring	MOR	action	Strömungsmesser + Auftriebspaket	
	PS71/118-1	21.02.08	13:49	54° 30.36' S	0° 1.55' E	1733.1	Mooring	MOR	action	CTD-Rekorder	
	PS71/118-1	21.02.08	13:55	54° 30.38' S	0° 1.55' E	1733.8	Mooring	MOR	action	CTD-Rekorder	
	PS71/118-1	21.02.08	14:09	54° 30.39' S	0° 1.56' E	1734.2	Mooring	MOR	on deck	Mooring komplett	
B1	PS71/118-2	21.02.08	14:29	54° 30.35' S	0° 2.37' E	1728.3	CTD/rosett	CTD/RO	surface		
B1	PS71/118-2	21.02.08	15:16	54° 30.20' S	0° 2.24' E	1750.5	CTD/rosett	CTD/RO	at depth	1714m	
B1	PS71/118-2	21.02.08	15:58	54° 30.19' S	0° 1.76' E	1718.8	CTD/rosett	CTD/RO	on deck		
A1	PS71/119-1	21.02.08	20:01	55° 0.00' S	0° 0.05' E	1714.4	CTD, Ultra	CTD/UC	into Water		
A1	PS71/119-1	21.02.08	20:32	55° 0.14' S	0° 0.00' W	1729.3	CTD, Ultra	CTD/UC	on Depth	1652m	
A1	PS71/119-1	21.02.08	21:35	55° 0.02' S	0° 0.15' E	1708.5	CTD, Ultra	CTD/UC	on Deck		
	PS71/120-1	21.02.08	21:46	55° 0.34' S	0° 0.36' E	1670.0	Iron Fish	IFISH	surface		
	PS71/120-1	22.02.08	01:27	55° 29.17' S	0° 0.47' E	3642.0	Iron Fish	IFISH	on deck		
B1	PS71/121-1	22.02.08	01:46	55° 29.96' S	0° 0.31' E	3758.2	CTD/rosett	CTD/RO	surface		

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment
B1	PS71/121-1	22.02.08	02:59	55° 29.72' S	0° 0.07' E	3841.3	CTD/rosett	CTD/RO	at depth	3722m
B1	PS71/121-1	22.02.08	04:02	55° 29.76' S	0° 0.34' W	3837.3	CTD/rosett	CTD/RO	on deck	
A2	PS71/121-2	22.02.08	05:02	55° 30.01' S	0° 0.03' E	3750.3	CTD/rosett	CTD/RO	surface	
A2	PS71/121-2	22.02.08	05:12	55° 30.00' S	0° 0.04' E	3753.2	CTD/rosett	CTD/RO	at depth	SL 194m
A2	PS71/121-2	22.02.08	05:24	55° 30.01' S	0° 0.03' E	3750.6	CTD/rosett	CTD/RO	on deck	
	PS71/121-3	22.02.08	06:32	55° 31.69' S	0° 0.46' W	3849.7	Mooring	MOR	released	Aufnahme AWI 241-1
	PS71/121-3	22.02.08	06:44	55° 31.91' S	0° 0.07' W	3838.6	Mooring	MOR	on the surface	
	PS71/121-3	22.02.08	08:03	55° 32.59' S	0° 1.68' E	3831.2	Mooring	MOR	action	Flasher ob
	PS71/121-3	22.02.08	08:14	55° 32.63' S	0° 1.99' E	3762.6	Mooring	MOR	action	SN 9200 ob
	PS71/121-3	22.02.08	08:24	55° 32.73' S	0° 1.81' E	3817.0	Mooring	MOR	action	SN 9785 ob
	PS71/121-3	22.02.08	08:32	55° 32.83' S	0° 2.02' E	3781.5	Mooring	MOR	action	SN 10532 ob
	PS71/121-3	22.02.08	08:59	55° 32.99' S	0° 2.14' E	3753.2	Mooring	MOR	action	SN 216 ob
	PS71/121-3	22.02.08	09:42	55° 32.97' S	0° 2.31' E	3641.1	Mooring	MOR	mooring on	Mooring komplett
A1	PS71/122-1	22.02.08	14:05	56° 0.03' S	0° 0.23' E	3682.3	CTD, Ultra	CTD/UC	into Water	
A1	PS71/122-1	22.02.08	15:03	56° 0.18' S	0° 0.40' E	3695.3	CTD, Ultra	CTD/UC	on Depth	3550 m
A1	PS71/122-1	22.02.08	16:50	56° 0.65' S	0° 0.96' E	3495.8	CTD, Ultra	CTD/UC	on Deck	
	PS71/122-2	22.02.08	16:50	56° 0.65' S	0° 0.96' E	3495.8	FLOAT	FLOAT	into water	
	PS71/123-1	22.02.08	16:58	56° 0.90' S	0° 0.75' E	3442.8	Iron Fish	IFISH	surface	
	PS71/123-1	22.02.08	21:00	56° 30.10' S	0° 0.30' E	4022.3	Iron Fish	IFISH	on deck	
B1	PS71/124-1	22.02.08	21:07	56° 30.22' S	0° 0.51' E	4030.1	CTD/rosett	CTD/RO	surface	
B1	PS71/124-1	22.02.08	22:28	56° 30.47' S	0° 0.95' E	4074.8	CTD/rosett	CTD/RO	at depth	3987m
B1	PS71/124-1	22.02.08	23:42	56° 30.34' S	0° 1.22' E	4055.3	CTD/rosett	CTD/RO	on deck	
A2	PS71/125-1	23.02.08	03:53	57° 0.09' S	0° 0.04' E	3625.8	CTD/rosett	CTD/RO	surface	
A2	PS71/125-1	23.02.08	05:06	56° 60.00' S	0° 0.04' E	3840.1	CTD/rosett	CTD/RO	at depth	
	PS71/125-2	23.02.08	05:45	57° 0.01' S	0° 0.13' W	3835.5	Mooring	MOR	released	
A2	PS71/125-1	23.02.08	06:06	57° 0.11' S	0° 0.17' W	3837.3	CTD/rosett	CTD/RO	on deck	
	PS71/125-2	23.02.08	06:31	56° 58.45' S	0° 1.85' E	3742.1	Mooring	MOR	on the surfa	Aufnahme AWI 228-7
	PS71/125-2	23.02.08	07:01	56° 57.58' S	0° 1.28' E	3745.2	Mooring	MOR	action	SN9763 ob
	PS71/125-2	23.02.08	07:10	56° 57.69' S	0° 1.35' E	3747.9	Mooring	MOR	action	SN 10539 ob
	PS71/125-2	23.02.08	07:23	56° 57.80' S	0° 1.63' E	3753.5	Mooring	MOR	action	SN 8037 ob
	PS71/125-2	23.02.08	07:29	56° 57.86' S	0° 1.63' E	3758.0	Mooring	MOR	action	SN 1230 ob
	PS71/125-2	23.02.08	07:47	56° 57.85' S	0° 1.18' E	3759.2	Mooring	MOR	action	SN 214 ob
	PS71/125-2	23.02.08	08:05	56° 57.88' S	0° 1.02' E	3760.7	Mooring	MOR	action	4 Benthos
	PS71/125-2	23.02.08	08:20	56° 57.94' S	0° 1.04' E	3768.3	Mooring	MOR	action	4 Benthos, 1 Strömungsmesser (SN26) , 1 Seacat (SN1607)
	PS71/125-2	23.02.08	08:29	56° 58.01' S	0° 1.07' E	3773.4	Mooring	MOR	on deck	Mooring komplett
	PS71/125-3	23.02.08	08:33	56° 58.03' S	0° 1.02' E	3774.7	FLOAT	FLOAT	into water	
	PS71/126-1	23.02.08	08:36	56° 58.19' S	0° 0.78' E	3781.2	Iron Fish	IFISH	surface	
	PS71/126-1	23.02.08	11:55	57° 29.82' S	0° 0.37' E	3921.1	Iron Fish	IFISH	on deck	
B1	PS71/127-1	23.02.08	12:05	57° 30.02' S	0° 0.30' E	3936.8	CTD/rosett	CTD/RO	surface	
B1	PS71/127-1	23.02.08	13:25	57° 29.98' S	0° 0.87' E	4075.9	CTD/rosett	CTD/RO	at depth	3970 m
B1	PS71/127-1	23.02.08	14:39	57° 29.91' S	0° 1.20' E	4056.7	CTD/rosett	CTD/RO	on deck	
	PS71/127-2	23.02.08	14:45	57° 29.90' S	0° 1.20' E	4059.2	FLOAT	FLOAT	into water	
A1	PS71/128-1	23.02.08	20:14	58° 0.09' S	0° 0.14' E	4520.6	CTD, Ultra	CTD/UC	into Water	
A1	PS71/128-1	23.02.08	21:25	58° 0.12' S	0° 0.28' W	4533.8	CTD, Ultra	CTD/UC	on Depth	4470m
A1	PS71/128-1	23.02.08	23:00	58° 0.46' S	0° 0.07' W	4529.9	CTD, Ultra	CTD/UC	on Deck	
	PS71/128-2	23.02.08	23:07	58° 0.49' S	0° 0.12' W	4528.7	FLOAT	FLOAT	into water	
	PS71/129-1	23.02.08	23:18	58° 0.87' S	0° 0.62' W	4528.5	Iron Fish	IFISH	surface	
	PS71/129-1	24.02.08	04:31	58° 30.06' S	0° 0.63' E	4212.6	Iron Fish	IFISH	on deck	
B1	PS71/130-1	24.02.08	04:46	58° 29.90' S	0° 0.68' E	4122.8	CTD/rosett	CTD/RO	surface	
B1	PS71/130-1	24.02.08	06:15	58° 30.00' S	0° 0.02' W	4189.0	CTD/rosett	CTD/RO	at depth	SL 4109m
B1	PS71/130-1	24.02.08	07:33	58° 29.96' S	0° 0.03' W	4184.8	CTD/rosett	CTD/RO	on deck	
	PS71/130-2	24.02.08	07:36	58° 29.92' S	0° 0.09' W	4187.6	FLOAT	FLOAT	into water	
	PS71/131	**START SUPERSTATION**								
B1	PS71/131-1	24.02.08	13:57	58° 59.92' S	0° 0.39' E	4584.3	CTD/rosett	CTD/RO	surface	
	PS71/131-2	24.02.08	15:02	58° 59.99' S	0° 0.53' E	4577.1	Hand net	HN	surface	
	PS71/131-2	24.02.08	15:08	59° 0.02' S	0° 0.57' E	4585.8	Hand net	HN	on deck	
B1	PS71/131-1	24.02.08	15:23	59° 0.06' S	0° 0.59' E	4585.4	CTD/rosett	CTD/RO	at depth	4518 m

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment
B1	PS71/131-1	24.02.08	16:37	59° 0.06' S	0° 0.17' E	4584.2	CTD/rosett	CTD/RO	on deck	
	PS71/131-3	24.02.08	16:46	58° 59.99' S	0° 0.01' E	4590.7	Test	TEST	surface	Test pressure case
	PS71/131-3	24.02.08	16:58	58° 59.99' S	0° 0.03' W	4597.7	Test	TEST	at depth	SL 300m / 0,5h auf Tiefe
	PS71/131-3	24.02.08	17:30	59° 0.00' S	0° 0.05' E	4583.0	Test	TEST	information	start hieven
	PS71/131-3	24.02.08	17:41	59° 0.00' S	0° 0.07' W	4603.8	Test	TEST	on deck	
D	PS71/131-4	24.02.08	17:49	59° 0.04' S	0° 0.07' W	4600.7	CTD/rosett	CTD/RO	surface	
D	PS71/131-4	24.02.08	17:58	59° 0.08' S	0° 0.08' E	4595.2	CTD/rosett	CTD/RO	at depth	SL 195m
D	PS71/131-4	24.02.08	18:11	58° 59.99' S	0° 0.10' E	4564.9	CTD/rosett	CTD/RO	on deck	
A1	PS71/131-5	24.02.08	18:21	59° 0.01' S	0° 0.10' E	4594.2	CTD, Ultra	CTD/UC	into Water	
A1	PS71/131-5	24.02.08	19:37	59° 0.02' S	0° 0.03' E	4596.9	CTD, Ultra	CTD/UC	on Depth	SL 4518m
A1	PS71/131-5	24.02.08	21:23	58° 59.96' S	0° 0.09' E	4592.6	CTD, Ultra	CTD/UC	on Deck	
C	PS71/131-6	24.02.08	21:32	58° 59.99' S	0° 0.03' W	4594.7	CTD/rosett	CTD/RO	surface	
C	PS71/131-6	24.02.08	22:55	58° 59.98' S	0° 0.03' E	4595.0	CTD/rosett	CTD/RO	at depth	EL31 4177m
C	PS71/131-6	25.02.08	00:10	59° 0.07' S	0° 0.05' E	4598.9	CTD/rosett	CTD/RO	on deck	
	PS71/131-7	25.02.08	00:20	59° 0.12' S	0° 0.01' W	4598.9	In situ pum	ISP	into water	
	PS71/131-7	25.02.08	00:23	59° 0.13' S	0° 0.03' W	4600.2	In situ pum	ISP	Information	1 Pumpe
	PS71/131-7	25.02.08	00:57	59° 0.19' S	0° 0.21' W	4604.1	In situ pum	ISP	Information	2. pumpe bei 1820 m
	PS71/131-7	25.02.08	01:19	59° 0.11' S	0° 0.40' W	4611.5	In situ pum	ISP	Information	3. pumpe bei 2820 m
	PS71/131-7	25.02.08	01:30	59° 0.08' S	0° 0.46' W	4615.1	In situ pum	ISP	Information	4. Pumpe bei 3325m
	PS71/131-7	25.02.08	01:37	59° 0.06' S	0° 0.52' W	4612.4	In situ pum	ISP	Information	5. Pumpe bei 3570 m
	PS71/131-7	25.02.08	01:43	59° 0.04' S	0° 0.55' W	4613.5	In situ pum	ISP	Information	6. Pumpe bei 3720m
	PS71/131-7	25.02.08	01:46	59° 0.02' S	0° 0.57' W	4607.9	In situ pum	ISP	pump at de	GE 52.1 3820 m Pumpen bis 05:20
	PS71/131-7	25.02.08	05:04	59° 0.03' S	0° 0.01' W	4596.9	In situ pum	ISP	Information	start hieven
	PS71/131-7	25.02.08	05:07	59° 0.01' S	0° 0.01' W	4598.5	In situ pum	ISP	on deck	6.Pumpe
	PS71/131-7	25.02.08	05:12	58° 60.00' S	0° 0.04' E	4594.0	In situ pum	ISP	on deck	5.Pumpe
	PS71/131-7	25.02.08	05:18	58° 59.99' S	0° 0.02' E	4601.5	In situ pum	ISP	on deck	4.Pumpe
	PS71/131-7	25.02.08	05:29	59° 0.01' S	0° 0.02' E	4596.0	In situ pum	ISP	on deck	3.Pumpe
	PS71/131-7	25.02.08	05:48	59° 0.00' S	0° 0.02' E	4595.8	In situ pum	ISP	on deck	2.Pumpe
	PS71/131-7	25.02.08	06:23	58° 60.00' S	0° 0.02' E	4593.4	In situ pum	ISP	on deck	1.Pumpe
	PS71/131-7	25.02.08	06:25	59° 0.00' S	0° 0.03' E	4600.0	In situ pum	ISP	on deck	Grundgewicht ob
F	PS71/131-8	25.02.08	06:32	59° 0.01' S	0° 0.05' E	4597.4	CTD/rosett	CTD/RO	surface	
F	PS71/131-8	25.02.08	07:19	59° 0.01' S	0° 0.00' W	4579.7	CTD/rosett	CTD/RO	at depth	SL 2487m
F	PS71/131-8	25.02.08	08:02	58° 59.97' S	0° 0.10' E	4570.7	CTD/rosett	CTD/RO	on deck	
	PS71/131-9	25.02.08	08:06	58° 59.97' S	0° 0.17' E	4579.5	Test	TEST	surface	
	PS71/131-9	25.02.08	08:17	58° 59.96' S	0° 0.08' E	4595.8	Test	TEST	at depth	SE32-2 300m, 30min auf Tiefe
	PS71/131-9	25.02.08	08:59	58° 59.98' S	0° 0.15' E	4565.5	Test	TEST	on deck	
D	PS71/131-10	25.02.08	09:05	58° 59.99' S	0° 0.22' E	4608.6	CTD/rosett	CTD/RO	surface	
D	PS71/131-10	25.02.08	09:35	59° 0.00' S	0° 0.03' E	4601.7	CTD/rosett	CTD/RO	at depth	EL31 997m
D	PS71/131-10	25.02.08	09:59	59° 0.01' S	0° 0.11' W	4598.5	CTD/rosett	CTD/RO	on deck	
	PS71/131	**END SUPERSTATION**								
	PS71/132-1	25.02.08	10:42	59° 4.28' S	0° 4.82' E	4668.3	Mooring	MOR	released	AWI227-9
	PS71/132-1	25.02.08	10:45	59° 4.22' S	0° 4.41' E	4791.5	Mooring	MOR	on the surface	
	PS71/132-1	25.02.08	11:16	59° 4.11' S	0° 5.11' E	4667.2	Mooring	MOR	on deck	Toppboje
	PS71/132-1	25.02.08	11:20	59° 4.17' S	0° 5.00' E	4666.2	Mooring	MOR	on deck	Strömungsmesser RCM8 Transponder ET861G
	PS71/132-1	25.02.08	11:32	59° 4.19' S	0° 5.34' E	4664.1	Mooring	MOR	on deck	4 Floats, Strömungsmesser RCM7, Seacat SBE37
	PS71/132-1	25.02.08	11:55	59° 3.96' S	0° 5.64' E	4661.4	Mooring	MOR	on deck	2 Float, Strömungsmesser RCM8
	PS71/132-1	25.02.08	12:19	59° 3.83' S	0° 5.46' E	4661.4	Mooring	MOR	on deck	3 Float
	PS71/132-1	25.02.08	12:33	59° 3.79' S	0° 5.63' E	4659.8	Mooring	MOR	on deck	5 Benthos
	PS71/132-1	25.02.08	12:38	59° 3.78' S	0° 5.68' E	4657.9	Mooring	MOR	mooring on	SBE 37, RCM 8, Doppelauslöser an Deck
	PS71/132-2	25.02.08	12:53	59° 4.14' S	0° 4.88' E	4666.7	Mooring	MOR	action	Auslegung AWI 227-10
	PS71/132-2	25.02.08	12:54	59° 4.13' S	0° 4.85' E	4667.2	Mooring	MOR	surface	Ankerstein
	PS71/132-2	25.02.08	13:05	59° 4.07' S	0° 4.89' E	4665.5	Mooring	MOR	surface	DW AR 61 RT 861, Doppelauslöser, RCM 8 Strömungsmesser
	PS71/132-2	25.02.08	13:08	59° 4.07' S	0° 4.88' E	4667.7	Mooring	MOR	surface	8 Floats (o,y,y,y) (o,o,o,o)
	PS71/132-2	25.02.08	13:14	59° 4.10' S	0° 4.88' E	4666.4	Mooring	MOR	slipped	
	PS71/132-3	25.02.08	13:28	59° 4.21' S	0° 5.16' E	0.0	CTD/rosett	CTD/RO	surface	start special cast for testing O2 determinations; Ismael
	PS71/132-3	25.02.08	13:40	59° 4.10' S	0° 5.30' E	4650.1	CTD/rosett	CTD/RO	at depth	495 m
	PS71/132-2	25.02.08	13:44	59° 4.11' S	0° 5.35' E	4663.2	Mooring	MOR	at depth	mit Posidonia verfolgt, am Grund 4637 m, Verankerungsposi=Slipposition

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment	
	PS71/132-3	25.02.08	13:54	59° 4.06' S	0° 5.49' E	4662.1	CTD/rosett	CTD/RO	on deck	end special cast for testing O2 determinations; Ismael	
	PS71/132-4	25.02.08	14:04	59° 4.30' S	0° 5.60' E	4662.5	FLOAT	FLOAT	into water		
	PS71/133-1	25.02.08	14:11	59° 4.76' S	0° 5.48' E	4674.7	Iron Fish	IFISH	surface		
	PS71/133-1	25.02.08	14:35	59° 6.58' S	0° 4.89' E	4666.8	Iron Fish	IFISH	on deck	Fisch kaputt	
	PS71/133-1	25.02.08	15:06	59° 10.32' S	0° 3.74' E	4993.6	Iron Fish	IFISH	surface		
	PS71/133-1	25.02.08	17:33	59° 29.20' S	0° 0.15' E	4617.6	Iron Fish	IFISH	on deck		
B1	PS71/134-1	25.02.08	17:46	59° 30.10' S	0° 0.03' W	4642.7	CTD/rosett	CTD/RO	surface		
B1	PS71/134-1	25.02.08	19:16	59° 30.54' S	0° 0.83' E	4603.1	CTD/rosett	CTD/RO	at depth	SL 4595m	
B1	PS71/134-1	25.02.08	20:42	59° 30.98' S	0° 1.77' E	4710.8	CTD/rosett	CTD/RO	on deck		
	PS71/134-2	25.02.08	20:49	59° 31.09' S	0° 2.03' E	4780.4	FLOAT	FLOAT	into water		
A1	PS71/135-1	26.02.08	00:37	60° 0.21' S	0° 0.43' E	5357.4	CTD, Ultra	CTD/UC	into Water		
A1	PS71/135-1	26.02.08	02:06	60° 0.33' S	0° 0.24' W	5343.6	CTD, Ultra	CTD/UC	on Depth	5300 m	
A1	PS71/135-1	26.02.08	04:12	60° 0.43' S	0° 0.47' W	5342.2	CTD, Ultra	CTD/UC	on Deck		
	PS71/135-2	26.02.08	04:19	60° 0.46' S	0° 0.21' W	5344.3	FLOAT	FLOAT	into water		
	PS71/136-1	26.02.08	04:22	60° 0.57' S	0° 0.23' E	5349.5	Iron Fish	IFISH	surface		
	PS71/136-1	26.02.08	07:51	60° 29.28' S	0° 0.00' W	5358.1	Iron Fish	IFISH	on deck		
B1	PS71/137-1	26.02.08	08:06	60° 30.00' S	0° 0.08' W	5355.5	CTD/rosett	CTD/RO	surface		
B1	PS71/137-1	26.02.08	09:43	60° 30.04' S	0° 0.02' W	5355.2	CTD/rosett	CTD/RO	at depth	EL31 5306m	
B1	PS71/137-1	26.02.08	11:13	60° 29.99' S	0° 0.04' E	5355.5	CTD/rosett	CTD/RO	on deck		
	PS71/137-2	26.02.08	11:18	60° 29.93' S	0° 0.04' W	5355.5	FLOAT	FLOAT	into water		
A1	PS71/138-1	26.02.08	15:25	61° 0.11' S	0° 0.24' W	5378.0	CTD, Ultra	CTD/UC	into Water		**Cd isotopes**
A1	PS71/138-1	26.02.08	16:46	61° 0.04' S	0° 0.44' W	5378.2	CTD, Ultra	CTD/UC	on Depth	SL 5327m	**Cd isotopes**
A1	PS71/138-1	26.02.08	18:39	61° 0.03' S	0° 0.02' W	5378.2	CTD, Ultra	CTD/UC	on Deck		**Cd isotopes**
	PS71/138-2	26.02.08	18:47	61° 0.13' S	0° 0.48' E	5379.0	FLOAT	FLOAT	into water		
	PS71/139-1	26.02.08	18:49	61° 0.23' S	0° 0.46' E	5378.7	Iron Fish	IFISH	surface		
	PS71/139-1	26.02.08	22:32	61° 30.06' S	0° 0.38' E	5378.5	Iron Fish	IFISH	on deck		
B1	PS71/140-1	26.02.08	22:36	61° 30.04' S	0° 0.40' E	5379.7	CTD/rosett	CTD/RO	surface		
B1	PS71/140-1	27.02.08	00:15	61° 29.91' S	0° 0.08' W	5377.5	CTD/rosett	CTD/RO	at depth	el 31 5344m	
B1	PS71/140-1	27.02.08	01:37	61° 29.91' S	0° 0.35' W	5378.0	CTD/rosett	CTD/RO	on deck		
	PS71/140-2	27.02.08	01:43	61° 29.88' S	0° 0.48' W	5377.5	FLOAT	FLOAT	into water		
A1	PS71/141-1	27.02.08	05:34	62° 0.01' S	0° 0.02' W	5359.5	CTD, Ultra	CTD/UC	into Water		
A1	PS71/141-1	27.02.08	07:01	62° 0.00' S	0° 0.01' E	5359.5	CTD, Ultra	CTD/UC	on Depth	SL 5300m	
A1	PS71/141-1	27.02.08	08:53	61° 59.94' S	0° 0.03' E	5360.2	CTD, Ultra	CTD/UC	on Deck		
B2	PS71/141-2	27.02.08	09:00	61° 59.96' S	0° 0.05' E	5359.5	CTD/rosett	CTD/RO	surface		
B2	PS71/141-2	27.02.08	09:11	62° 0.06' S	0° 0.08' E	5359.5	CTD/rosett	CTD/RO	at depth	EL31 196m	
B2	PS71/141-2	27.02.08	09:23	61° 59.98' S	0° 0.04' E	5359.2	CTD/rosett	CTD/RO	on deck		
	PS71/141-3	27.02.08	09:27	61° 59.97' S	0° 0.03' E	5358.7	FLOAT	FLOAT	into water		
	PS71/142-1	27.02.08	09:50	62° 1.96' S	0° 0.02' E	5359.2	Iron Fish	IFISH	surface		
	PS71/142-1	27.02.08	14:26	62° 29.75' S	0° 0.25' E	5336.4	Iron Fish	IFISH	on deck		
B1	PS71/143-1	27.02.08	14:36	62° 30.21' S	0° 0.02' W	5339.0	CTD/rosett	CTD/RO	surface		
B1	PS71/143-1	27.02.08	16:09	62° 30.26' S	0° 0.82' W	5336.7	CTD/rosett	CTD/RO	at depth	SL 5303m	
	PS71/143-2	27.02.08	16:16	62° 30.32' S	0° 0.88' W	5336.6	Hand net	HN	surface		
	PS71/143-2	27.02.08	16:22	62° 30.37' S	0° 0.96' W	5334.8	Hand net	HN	on deck		
B1	PS71/143-1	27.02.08	17:27	62° 30.58' S	0° 0.56' W	5337.7	CTD/rosett	CTD/RO	on deck		
	PS71/143-3	27.02.08	17:31	62° 30.58' S	0° 0.54' W	5337.4	FLOAT	FLOAT	into water		
A1	PS71/144-1	27.02.08	21:09	62° 60.00' S	0° 0.30' E	5302.3	CTD, Ultra	CTD/UC	into Water		
A1	PS71/144-1	27.02.08	22:34	63° 0.06' S	0° 0.15' E	5301.8	CTD, Ultra	CTD/UC	on Depth	5253m	
A1	PS71/144-1	28.02.08	00:27	62° 59.90' S	0° 0.32' E	5303.8	CTD, Ultra	CTD/UC	on Deck		
	PS71/144-2	28.02.08	00:34	63° 0.06' S	0° 0.28' E	5302.8	FLOAT	FLOAT	into water		
	PS71/145-1	28.02.08	00:37	63° 0.28' S	0° 0.24' E	5298.7	Iron Fish	IFISH	surface		
	PS71/145-1	28.02.08	04:00	63° 30.00' S	0° 0.13' W	5236.6	Iron Fish	IFISH	on deck		
B1	PS71/146-1	28.02.08	04:16	63° 30.02' S	0° 0.04' W	5237.0	CTD/rosett	CTD/RO	surface		
B1	PS71/146-1	28.02.08	05:49	63° 30.01' S	0° 0.02' W	5236.0	CTD/rosett	CTD/RO	at depth	SL 5193m	
B1	PS71/146-1	28.02.08	07:35	63° 30.01' S	0° 0.03' W	5236.3	CTD/rosett	CTD/RO	on deck		
	PS71/146-2	28.02.08	07:40	63° 29.97' S	0° 0.20' E	5236.5	FLOAT	FLOAT	into water		
	PS71/147-1	28.02.08	10:53	63° 57.12' S	0° 0.72' W	5192.6	Mooring	MOR	released	AWI229-7	
	PS71/147-1	28.02.08	11:00	63° 57.11' S	0° 0.75' W	5194.8	Mooring	MOR	on the surface		

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment
	PS71/147-1	28.02.08	11:32	63° 57.49' S	0° 1.31' W	5193.2	Mooring	MOR	action	10 Floats, Sonar CMR-ULS, MuFuKo SMM
	PS71/147-1	28.02.08	11:42	63° 57.57' S	0° 1.34' W	5193.8	Mooring	MOR	action	Mikrocat SBE37
	PS71/147-1	28.02.08	11:45	63° 57.57' S	0° 1.33' W	5193.7	Mooring	MOR	action	Mikrocat SBE37
	PS71/147-1	28.02.08	11:48	63° 57.60' S	0° 1.36' W	5192.9	Mooring	MOR	action	ADCP, Transponder ET861G, Mikrocat SBE37
	PS71/147-1	28.02.08	11:56	63° 57.67' S	0° 1.56' W	5193.5	Mooring	MOR	action	Mikrocat SBE37
	PS71/147-1	28.02.08	11:59	63° 57.70' S	0° 1.59' W	5193.9	Mooring	MOR	action	4 Floats, Strömungsmesser RCM8, Mikrocat SBE37
	PS71/147-1	28.02.08	12:07	63° 57.78' S	0° 1.65' W	5192.5	Mooring	MOR	action	2 Floats & Schallquelle an Deck
	PS71/147-1	28.02.08	12:23	63° 57.87' S	0° 1.48' W	5192.9	Mooring	MOR	action	3 Floats, 1 Strömungsmesser
	PS71/147-1	28.02.08	12:46	63° 57.80' S	0° 2.06' W	5196.6	Mooring	MOR	action	3 Floats an Deck
	PS71/147-1	28.02.08	13:09	63° 58.04' S	0° 2.28' W	5193.8	Mooring	MOR	action	5 Floats an deck
	PS71/147-1	28.02.08	13:14	63° 58.09' S	0° 2.26' W	5194.2	Mooring	MOR	mooring on	Doppelauslöser, alles komplett geborgen
	PS71/147-2	28.02.08	15:10	63° 59.89' S	0° 9.36' W	5185.7	Mooring	MOR	surface	ULS
	PS71/147-2	28.02.08	15:13	63° 59.84' S	0° 9.15' W	5186.4	Mooring	MOR	surface	Argos+12 Float`s
	PS71/147-2	28.02.08	15:17	63° 59.79' S	0° 8.93' W	5188.4	Mooring	MOR	surface	ADCP, STrömungsmesser, Transponder
	PS71/147-2	28.02.08	15:26	63° 59.64' S	0° 8.40' W	5187.6	Mooring	MOR	surface	Microcat
	PS71/147-2	28.02.08	15:38	63° 59.49' S	0° 7.91' W	5187.2	Mooring	MOR	surface	Strömungsmesser+6 Float´s
	PS71/147-2	28.02.08	15:49	63° 59.39' S	0° 7.66' W	5188.6	Mooring	MOR	surface	Schallquelle
	PS71/147-2	28.02.08	15:59	63° 59.23' S	0° 7.16' W	5190.0	Mooring	MOR	surface	RCM8VT / SN 9390
	PS71/147-2	28.02.08	16:42	63° 58.59' S	0° 4.79' W	5192.8	Mooring	MOR	surface	3 Floats
	PS71/147-2	28.02.08	17:15	63° 58.14' S	0° 3.02' W	5194.6	Mooring	MOR	surface	5 Floats
	PS71/147-2	28.02.08	17:23	63° 58.11' S	0° 3.09' W	5195.1	Mooring	MOR	surface	SN 2101/10499 & SN 544/344
	PS71/147-2	28.02.08	17:31	63° 58.03' S	0° 3.10' W	5195.2	Mooring	MOR	slipped	Ankerstein
A1	PS71/147-3	28.02.08	18:03	63° 57.99' S	0° 0.81' W	5193.2	CTD, Ultra	CTD/UC	into Water	
A1	PS71/147-3	28.02.08	19:44	63° 58.04' S	0° 0.58' W	5194.4	CTD, Ultra	CTD/UC	on Depth	SL 5156m
A1	PS71/147-3	28.02.08	21:29	63° 58.08' S	0° 2.33' W	5195.2	CTD, Ultra	CTD/UC	on Deck	
	PS71/147-4	28.02.08	21:33	63° 58.04' S	0° 2.44' W	5196.0	FLOAT	FLOAT	into water	
	PS71/148-1	28.02.08	21:40	63° 58.19' S	0° 3.27' W	5194.7	Iron Fish	IFISH	surface	
	PS71/148-1	29.02.08	01:20	64° 29.36' S	0° 0.02' W	4560.5	Iron Fish	IFISH	on deck	
B1	PS71/149-1	29.02.08	01:31	64° 29.95' S	0° 0.06' E	4660.7	CTD/rosett	CTD/RO	surface	
B1	PS71/149-1	29.02.08	02:54	64° 29.99' S	0° 0.11' E	4660.1	CTD/rosett	CTD/RO	at depth	4610 m
B1	PS71/149-1	29.02.08	04:28	64° 29.99' S	0° 0.04' E	4660.9	CTD/rosett	CTD/RO	on deck	
	PS71/149-2	29.02.08	04:35	64° 30.10' S	0° 0.12' E	4659.2	FLOAT	FLOAT	into water	
A2	PS71/150-1	29.02.08	08:11	64° 59.94' S	0° 0.27' E	3721.8	CTD/rosett	CTD/RO	surface	
A2	PS71/150-1	29.02.08	08:18	64° 59.91' S	0° 0.21' E	3721.6	CTD/rosett	CTD/RO	at depth	EL31 96m
A2	PS71/150-1	29.02.08	08:26	64° 59.92' S	0° 0.18' E	3722.0	CTD/rosett	CTD/RO	on deck	
A1	PS71/150-2	29.02.08	08:34	64° 59.93' S	0° 0.12' E	3723.0	CTD, Ultra	CTD/UC	into Water	
A1	PS71/150-2	29.02.08	09:31	64° 59.99' S	0° 0.10' W	3728.3	CTD, Ultra	CTD/UC	on Depth	3672m
A1	PS71/150-2	29.02.08	10:56	65° 0.00' S	0° 0.08' E	3725.5	CTD, Ultra	CTD/UC	on Deck	
	PS71/150-3	29.02.08	11:00	64° 59.99' S	0° 0.01' E	3726.7	FLOAT	FLOAT	into water	
	PS71/151-1	29.02.08	11:04	65° 0.09' S	0° 0.39' E	3723.4	Iron Fish	IFISH	surface	
	PS71/151-1	29.02.08	14:48	65° 29.97' S	0° 0.16' E	3978.9	Iron Fish	IFISH	on deck	
B1	PS71/152-1	29.02.08	14:50	65° 29.98' S	0° 0.16' E	3980.0	CTD/rosett	CTD/RO	surface	
	PS71/152-2	29.02.08	15:34	65° 30.10' S	0° 0.12' W	3992.5	Hand net	HN	surface	
	PS71/152-2	29.02.08	15:42	65° 30.11' S	0° 0.21' W	3993.7	Hand net	HN	on deck	
B1	PS71/152-1	29.02.08	16:06	65° 30.19' S	0° 0.25' W	3999.9	CTD/rosett	CTD/RO	at depth	SL 3932m
B1	PS71/152-1	29.02.08	17:19	65° 30.04' S	0° 0.34' E	3972.6	CTD/rosett	CTD/RO	on deck	
	PS71/152-3	29.02.08	17:22	65° 29.97' S	0° 0.36' E	3972.4	FLOAT	FLOAT	into water	
	PS71/153-1	29.02.08	17:28	65° 30.04' S	0° 1.00' E	3913.4	Iron Fish	IFISH	surface	
	PS71/153-1	01.03.08	15:58	68° 46.04' S	5° 2.10' W	3021.5	Iron Fish	IFISH	on deck	
	TRANSIT TO ATKA BAY; NEUMAYER STATION									
		02.03.08		ARRIVAL ATKA BAY ICE SHELF						
		05.03.08		DEPARTURE ATKA BAY ICE SHELF						
	TWO HYDROCASTS & ICE SAMPLING IN THE BAY									
	PS71/154-1	05.03.08	13:39	70° 34.32' S	8° 7.20' W	140.2	CTD/rosett	CTD/RO	surface	
	PS71/154-1	05.03.08	13:53	70° 34.50' S	8° 7.37' W	134.2	CTD/rosett	CTD/RO	at depth	131 m
	PS71/154-1	05.03.08	14:02	70° 34.62' S	8° 7.53' W	134.7	CTD/rosett	CTD/RO	on deck	
	PS71/154-2	05.03.08	14:20	70° 34.40' S	8° 6.96' W	136.7	Eisfischen	EF	start	

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment
	PS71/154-2	05.03.08	14:47	70° 34.76' S	8° 6.79' W	130.5	Eisfischen	EF	End	
	PS71/155-1	05.03.08	15:40	70° 31.21' S	8° 10.96' W	230.7	CTD/rosett	CTD/RO	surface	PALAOA
	PS71/155-1	05.03.08	15:54	70° 31.21' S	8° 11.09' W	232.2	CTD/rosett	CTD/RO	at depth	225 m
	PS71/155-1	05.03.08	16:07	70° 31.21' S	8° 11.23' W	232.7	CTD/rosett	CTD/RO	on deck	
	END OF BAY STATIONS									
	TRANSIT RETURNING TO ZERO MERIDIAN									
	PS71/156-1	07.03.08	09:00	67° 22.37' S	0° 34.13' E	4648.2	Iron Fish	IFISH	surface	
	PS71/156-1	07.03.08	14:48	66° 30.99' S	0° 3.27' W	4582.7	Iron Fish	IFISH	on deck	
	START SUPERSTATION									
D1	PS71/157-1	07.03.08	14:54	66° 30.99' S	0° 3.40' W	4585.2	CTD/rosett	CTD/RO	surface	
D1	PS71/157-1	07.03.08	15:06	66° 31.00' S	0° 3.35' W	4584.7	CTD/rosett	CTD/RO	at depth	195m
D1	PS71/157-1	07.03.08	15:16	66° 31.00' S	0° 3.25' W	4584.2	CTD/rosett	CTD/RO	on deck	
	PS71/157-2	07.03.08	15:41	66° 30.66' S	0° 2.31' W	4560.2	Mooring	MOR	released	ANT 231-7 Recovering
	PS71/157-2	07.03.08	15:45	66° 30.68' S	0° 2.39' W	4561.0	Mooring	MOR	on the surface	
	PS71/157-2	07.03.08	16:17	66° 30.75' S	0° 1.63' W	4531.2	Mooring	MOR	action	CMR-ULS on deck
	PS71/157-2	07.03.08	16:21	66° 30.77' S	0° 1.71' W	4534.7	Mooring	MOR	action	SB 37 on deck
	PS71/157-2	07.03.08	16:30	66° 30.77' S	0° 1.94' W	4545.7	Mooring	MOR	action	ADCP on deck
	PS71/157-2	07.03.08	16:41	66° 30.68' S	0° 1.97' W	4548.7	Mooring	MOR	action	SN 9212 on deck
	PS71/157-2	07.03.08	16:46	66° 30.70' S	0° 2.08' W	4554.0	Mooring	MOR	action	2 Floats on deck
	PS71/157-2	07.03.08	16:51	66° 30.71' S	0° 2.18' W	4556.7	Mooring	MOR	action	Schallquelle on deck
	PS71/157-2	07.03.08	17:06	66° 30.63' S	0° 2.14' W	4554.5	Mooring	MOR	action	SN9184 on deck
	PS71/157-2	07.03.08	17:09	66° 30.62' S	0° 2.17' W	4555.0	Mooring	MOR	action	3 Floats on deck
	PS71/157-2	07.03.08	17:32	66° 30.57' S	0° 2.33' W	4559.5	Mooring	MOR	action	5 Floats on deck
	PS71/157-2	07.03.08	17:37	66° 30.54' S	0° 2.37' W	4560.5	Mooring	MOR	mooring on	SN9194 & Releaser on deck
D2	PS71/157-3	07.03.08	17:56	66° 30.45' S	0° 2.54' W	4564.5	CTD/rosett	CTD/RO	surface	
D2	PS71/157-3	07.03.08	18:06	66° 30.42' S	0° 2.53' W	4564.5	CTD/rosett	CTD/RO	at depth	SL 148m
D2	PS71/157-3	07.03.08	18:14	66° 30.44' S	0° 2.43' W	4561.0	CTD/rosett	CTD/RO	on deck	
	PS71/157-4	07.03.08	18:41	66° 30.68' S	0° 1.93' W	4548.0	Mooring	MOR	surface	Ankerstein
	PS71/157-4	07.03.08	18:48	66° 30.68' S	0° 1.91' W	4547.5	Mooring	MOR	surface	Releaser & SN 9186 &SN 237
	PS71/157-4	07.03.08	18:56	66° 30.68' S	0° 1.96' W	4548.0	Mooring	MOR	surface	5 Floats
	PS71/157-4	07.03.08	19:24	66° 30.66' S	0° 1.86' W	4544.7	Mooring	MOR	surface	3 Floats
	PS71/157-4	07.03.08	19:56	66° 30.64' S	0° 1.88' W	4546.0	Mooring	MOR	surface	3 Floats & Strömungsmesser
	PS71/157-4	07.03.08	20:20	66° 30.67' S	0° 1.72' W	4538.7	Mooring	MOR	surface	Schallquelle W2-2
	PS71/157-4	07.03.08	20:34	66° 30.70' S	0° 1.81' W	4544.5	Mooring	MOR	surface	6 Floats, Strömungsmesser RCM7, Microcat
	PS71/157-4	07.03.08	20:40	66° 30.69' S	0° 1.87' W	4544.5	Mooring	MOR	surface	Microcat
	PS71/157-4	07.03.08	20:44	66° 30.71' S	0° 1.91' W	4545.7	Mooring	MOR	surface	Microcat
	PS71/157-4	07.03.08	20:50	66° 30.69' S	0° 1.90' W	4546.0	Mooring	MOR	surface	Microcat
	PS71/157-4	07.03.08	20:54	66° 30.67' S	0° 1.84' W	4543.5	Mooring	MOR	surface	Transponder ET861G, ADCP
	PS71/157-4	07.03.08	21:06	66° 30.69' S	0° 1.90' W	4546.2	Mooring	MOR	surface	Microcat
	PS71/157-4	07.03.08	21:13	66° 30.66' S	0° 1.81' W	4542.0	Mooring	MOR	surface	Toppkugel SB37, MuFuKu, CMR-ULS
	PS71/157-4	07.03.08	21:24	66° 30.67' S	0° 1.81' W	4542.2	Mooring	MOR	slipped	
B1	PS71/157-5	07.03.08	22:04	66° 28.57' S	0° 1.95' W	4495.0	CTD/rosett	CTD/RO	surface	
B1	PS71/157-5	07.03.08	23:24	66° 28.58' S	0° 1.86' W	4493.0	CTD/rosett	CTD/RO	at depth	EL31 4430m
B1	PS71/157-5	08.03.08	00:39	66° 28.60' S	0° 1.85' W	4493.2	CTD/rosett	CTD/RO	on deck	
	PS71/157-6	08.03.08	00:45	66° 28.31' S	0° 1.73' W	4493.7	FLOAT	FLOAT	into water	
	END SUPERSTATION									
B1	PS71/158-1	08.03.08	02:16	66° 14.95' S	0° 0.02' W	3687.7	CTD/rosett	CTD/RO	surface	
B1	PS71/158-1	08.03.08	03:30	66° 14.78' S	0° 0.27' W	3685.2	CTD/rosett	CTD/RO	at depth	EL 31 3628m
B1	PS71/158-1	08.03.08	04:34	66° 14.73' S	0° 1.07' W	3683.5	CTD/rosett	CTD/RO	on deck	
	PS71/158-2	08.03.08	04:39	66° 14.72' S	0° 1.22' W	3684.2	FLOAT	FLOAT	into water	
	PS71/159-1	08.03.08	06:36	66° 0.72' S	0° 11.11' E	3475.7	Mooring	MOR	released	Moor Rec AWI 230-5
	PS71/159-1	08.03.08	06:51	66° 0.67' S	0° 10.44' E	3486.5	Mooring	MOR	released	
	PS71/159-1	08.03.08	07:00	66° 0.48' S	0° 10.43' E	3483.5	Mooring	MOR	Hydrophone into the water	
	PS71/159-1	08.03.08	07:00	66° 0.48' S	0° 10.43' E	3483.5	Mooring	MOR	released	
	PS71/159-1	08.03.08	07:06	66° 0.53' S	0° 10.29' E	3485.5	Mooring	MOR	Hydrophone on Deck	
	PS71/159-1	08.03.08	07:17	66° 0.68' S	0° 11.18' E	3474.5	Mooring	MOR	released	
	PS71/159-1	08.03.08	07:21	66° 0.64' S	0° 11.10' E	3474.2	Mooring	MOR	on the surface	

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment
	PS71/159-1	08.03.08	07:55	66° 0.69' S	0° 10.92' E	3479.0	Mooring	MOR	action	Top Boje, Multifunktionskopf, Strömungsmesser RCM8, Transponder ET801P
	PS71/159-1	08.03.08	07:59	66° 0.70' S	0° 10.78' E	3481.0	Mooring	MOR	action	Microcat
	PS71/159-1	08.03.08	08:01	66° 0.68' S	0° 10.75' E	3481.5	Mooring	MOR	action	Microcat
	PS71/159-1	08.03.08	08:03	66° 0.65' S	0° 10.75' E	3480.2	Mooring	MOR	action	Microcat
	PS71/159-1	08.03.08	08:05	66° 0.63' S	0° 10.74' E	3480.0	Mooring	MOR	action	Microcat
	PS71/159-1	08.03.08	08:07	66° 0.60' S	0° 10.74' E	3479.5	Mooring	MOR	action	Microcat
	PS71/159-1	08.03.08	08:08	66° 0.59' S	0° 10.73' E	3479.5	Mooring	MOR	action	Microcat
	PS71/159-1	08.03.08	08:09	66° 0.58' S	0° 10.73' E	3479.2	Mooring	MOR	action	Microcat
	PS71/159-1	08.03.08	08:10	66° 0.57' S	0° 10.72' E	3479.2	Mooring	MOR	action	3 Floats, Strömungsmesser RCM8, Microcat
	PS71/159-1	08.03.08	08:25	66° 0.57' S	0° 10.92' E	3475.7	Mooring	MOR	action	Walhydrophon POD
	PS71/159-1	08.03.08	08:28	66° 0.58' S	0° 10.94' E	3475.2	Mooring	MOR	action	4 Floats, Strömungsmesser RCM8
	PS71/159-1	08.03.08	08:54	66° 0.48' S	0° 10.68' E	3478.5	Mooring	MOR	action	5 Floats
	PS71/159-1	08.03.08	08:59	66° 0.43' S	0° 10.55' E	3480.0	Mooring	MOR	action	Microcat SBE37, Strömungsmesser RCM11, Releaser
	PS71/159-1	08.03.08	09:00	66° 0.42' S	0° 10.52' E	3481.0	Mooring	MOR	mooring on	Verankerung komplett
	PS71/159-2	08.03.08	09:35	66° 0.74' S	0° 11.04' E	3477.0	CTD, Ultra	CTD/UC	Information	Windentest ohne CTD-Gerät
	PS71/159-3	08.03.08	10:50	66° 0.84' S	0° 0.05' E	3421.5	Mooring	MOR	surface	MuFuKo, Top boje, Walsonar, Strömungsmesser, Transponder, Microcat
	PS71/159-3	08.03.08	11:05	66° 0.65' S	0° 0.92' E	3499.0	Mooring	MOR	surface	Microcat
	PS71/159-3	08.03.08	11:08	66° 0.65' S	0° 1.08' E	3484.5	Mooring	MOR	surface	Microcat
	PS71/159-3	08.03.08	11:10	66° 0.66' S	0° 1.18' E	3465.7	Mooring	MOR	surface	Microcat
	PS71/159-3	08.03.08	11:12	66° 0.67' S	0° 1.30' E	3498.5	Mooring	MOR	surface	Microcat
	PS71/159-3	08.03.08	11:18	66° 0.69' S	0° 1.60' E	3653.0	Mooring	MOR	surface	Microcat, 3 Float, Strömungsmesser
	PS71/159-3	08.03.08	11:38	66° 0.83' S	0° 2.63' E	3674.0	Mooring	MOR	surface	4 Float, Strömungsmesser
	PS71/159-3	08.03.08	12:08	66° 1.06' S	0° 4.90' E	3601.0	Mooring	MOR	surface	5 Float
	PS71/159-3	08.03.08	12:25	66° 1.17' S	0° 5.25' E	3579.0	Mooring	MOR	surface	Strömungsmesser,Microcat Releaser
	PS71/159-3	08.03.08	12:31	66° 1.22' S	0° 5.19' E	3577.5	Mooring	MOR	slipped	AWI 230-6 Ankerstein geslipt
B1	PS71/159-4	08.03.08	12:59	66° 1.88' S	0° 8.68' E	3460.5	CTD/rosett	CTD/RO	surface	
	PS71/159-3	08.03.08	13:15	66° 1.86' S	0° 8.68' E	3465.0	Mooring	MOR	at depth	Sender aus
B1	PS71/159-4	08.03.08	14:05	66° 1.72' S	0° 8.47' E	3489.5	CTD/rosett	CTD/RO	at depth	EL 31 3430 m
B1	PS71/159-4	08.03.08	15:06	66° 1.41' S	0° 7.93' E	3547.5	CTD/rosett	CTD/RO	on deck	
	PS71/159-5	08.03.08	15:10	66° 1.43' S	0° 7.81' E	3549.5	FLOAT	FLOAT	into water	
	PS71/160-1	08.03.08	15:40	66° 1.16' S	0° 4.59' E	3605.7	Iron Fish	IFISH	surface	
	PS71/160-1	08.03.08	18:36	66° 29.89' S	0° 0.21' E	4533.2	Iron Fish	IFISH	on deck	
	PS71/161	**BEGIN SUPERSTATION**								
	PS71/161-1	08.03.08	18:47	66° 29.83' S	0° 0.39' E	4532.0	CTD, Ultra	CTD/UC	into Water	Testreihe mit Gewicht 500kg
	PS71/161-1	08.03.08	18:52	66° 29.82' S	0° 0.33' E	4531.2	CTD, Ultra	CTD/UC	on Depth	100m
	PS71/161-1	08.03.08	18:59	66° 29.85' S	0° 0.20' E	4531.5	CTD, Ultra	CTD/UC	on Deck	
	PS71/161-1	08.03.08	19:12	66° 29.90' S	0° 0.08' W	4527.2	CTD, Ultra	CTD/UC	into Water	Test 2
	PS71/161-1	08.03.08	19:15	66° 29.93' S	0° 0.08' W	4535.2	CTD, Ultra	CTD/UC	on Depth	50m
	PS71/161-1	08.03.08	19:20	66° 29.97' S	0° 0.07' W	4531.2	CTD, Ultra	CTD/UC	on Deck	
F	PS71/161-2	08.03.08	19:27	66° 29.92' S	0° 0.41' W	4525.0	CTD/rosett	CTD/RO	surface	
F	PS71/161-2	08.03.08	20:14	66° 30.06' S	0° 0.21' W	4540.0	CTD/rosett	CTD/RO	at depth	EL31 2401m
F	PS71/161-2	08.03.08	20:58	66° 30.05' S	0° 0.08' E	4543.2	CTD/rosett	CTD/RO	on deck	
B2.	PS71/161-3	08.03.08	21:13	66° 29.97' S	0° 0.19' W	4530.5	CTD, Ultra	CTD/UC	into Water	
B2.	PS71/161-3	08.03.08	21:19	66° 29.95' S	0° 0.24' W	4527.2	CTD, Ultra	CTD/UC	on Depth	52m
B2.	PS71/161-3	08.03.08	21:39	66° 30.01' S	0° 0.09' W	4535.2	CTD, Ultra	CTD/UC	on Deck	
C	PS71/161-4	08.03.08	21:59	66° 30.00' S	0° 0.15' W	4532.0	CTD/rosett	CTD/RO	surface	
C	PS71/161-4	08.03.08	23:36	66° 30.03' S	0° 0.11' W	4536.2	CTD/rosett	CTD/RO	at depth	EL31 4487m
C	PS71/161-4	09.03.08	00:48	66° 29.93' S	0° 0.20' E	4536.5	CTD/rosett	CTD/RO	on deck	
	PS71/161-5	09.03.08	00:54	66° 29.89' S	0° 0.15' E	4530.7	In situ pum	ISP	into water	Ankerstein
	PS71/161-5	09.03.08	01:02	66° 29.84' S	0° 0.10' E	4529.0	In situ pum	ISP	into water	1. Pumpe bei 21 m
	PS71/161-5	09.03.08	01:24	66° 29.85' S	0° 0.36' E	4532.5	In situ pum	ISP	into water	2. Pumpe bei 1020m
	PS71/161-5	09.03.08	01:48	66° 29.90' S	0° 0.30' E	4533.2	In situ pum	ISP	into water	3. Pumpe 2220m
	PS71/161-5	09.03.08	02:05	66° 29.85' S	0° 0.26' E	4531.2	In situ pum	ISP	into water	4. Pumpe bei 2981 m
	PS71/161-5	09.03.08	02:11	66° 29.82' S	0° 0.21' E	4529.7	In situ pum	ISP	into water	5. Pumpe bei 3171 m
	PS71/161-5	09.03.08	02:17	66° 29.82' S	0° 0.22' E	4529.2	In situ pum	ISP	into water	6. Pumpe 3320 m
	PS71/161-5	09.03.08	02:20	66° 29.81' S	0° 0.22' E	4529.0	In situ pum	ISP	pump at de	GE 52.1 3421 m
	PS71/161-5	09.03.08	05:37	66° 30.08' S	0° 0.08' E	4544.5	In situ pum	ISP	on deck	6.Pumpe

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment	
	PS71/161-5	09.03.08	05:42	66° 30.05' S	0° 0.02' W	4547.5	In situ pum	ISP	on deck	5.Pumpe	
	PS71/161-5	09.03.08	05:49	66° 29.97' S	0° 0.19' W	4558.2	In situ pum	ISP	on deck	4.Pumpe	
	PS71/161-5	09.03.08	06:05	66° 30.00' S	0° 0.07' W	4547.5	In situ pum	ISP	on deck	3.Pumpe	
	PS71/161-5	09.03.08	06:29	66° 30.05' S	0° 0.05' E	4541.5	In situ pum	ISP	into water	2.Pumpe	
	PS71/161-5	09.03.08	06:48	66° 30.02' S	0° 0.06' W	4537.0	In situ pum	ISP	on deck	1.Pumpe	
	PS71/161-5	09.03.08	06:49	66° 30.01' S	0° 0.06' W	4537.2	In situ pum	ISP	on deck	Hinkelstein	
A1	PS71/161-6	09.03.08	07:07	66° 30.00' S	0° 0.14' W	4533.2	CTD, Ultra	CTD/UC	into Water		
A1	PS71/161-6	09.03.08	08:23	66° 30.06' S	0° 0.01' W	4543.7	CTD, Ultra	CTD/UC	on Depth	4380m	
A1	PS71/161-6	09.03.08	10:24	66° 30.06' S	0° 0.02' E	4543.0	CTD, Ultra	CTD/UC	on Deck		
	PS71/161-7	09.03.08	10:27	66° 30.07' S	0° 0.01' E	4546.0	FLOAT	FLOAT	into water		
	PS71/161	**END SUPERSTATION**									
	PS71/162-1	09.03.08	10:33	66° 30.27' S	0° 0.17' E	4542.2	Iron Fish	IFISH	surface		
	PS71/162-1	09.03.08	13:53	66° 59.49' S	0° 0.30' W	4702.5	Iron Fish	IFISH	on deck		
A1	PS71/163-1	09.03.08	14:04	66° 59.94' S	0° 0.18' W	4701.5	CTD, Ultra	CTD/UC	into Water		**Cd isotopes**
A1	PS71/163-1	09.03.08	15:25	67° 0.04' S	0° 0.12' E	4701.2	CTD, Ultra	CTD/UC	on Depth	4600m	**Cd isotopes**
A1	PS71/163-1	09.03.08	17:04	67° 0.04' S	0° 0.02' E	4701.7	CTD, Ultra	CTD/UC	on Deck		**Cd isotopes**
	PS71/163-2	09.03.08	17:09	67° 0.03' S	0° 0.11' E	4702.0	FLOAT	FLOAT	into water		
	PS71/164-1	09.03.08	17:13	67° 0.25' S	0° 0.54' E	4701.7	Iron Fish	IFISH	surface		
	PS71/164-1	09.03.08	21:20	67° 29.99' S	0° 0.06' E	4624.7	Iron Fish	IFISH	on deck		
B1	PS71/165-1	09.03.08	21:28	67° 30.04' S	0° 0.20' E	4624.2	CTD/rosett	CTD/RO	surface		
B1	PS71/165-1	09.03.08	22:51	67° 29.96' S	0° 0.12' W	4626.2	CTD/rosett	CTD/RO	at depth	EL31 4570m	
B1	PS71/165-1	10.03.08	00:14	67° 30.01' S	0° 0.08' E	4625.5	CTD/rosett	CTD/RO	on deck		
	PS71/165-2	10.03.08	00:18	67° 30.03' S	0° 0.10' E	4625.2	FLOAT	FLOAT	into water		
	PS71/166-1	10.03.08	00:22	67° 30.18' S	0° 0.26' E	4623.0	Iron Fish	IFISH	surface		
	PS71/166-1	10.03.08	03:38	67° 59.28' S	0° 0.40' W	4510.7	Iron Fish	IFISH	on deck		
A1	PS71/167-1	10.03.08	04:02	67° 59.96' S	0° 0.13' W	4506.5	CTD, Ultra	CTD/UC	into Water		
A1	PS71/167-1	10.03.08	05:22	67° 60.00' S	0° 0.00' E	4507.2	CTD, Ultra	CTD/UC	on Depth	SL 4430m	
A1	PS71/167-1	10.03.08	06:56	68° 0.01' S	0° 0.05' E	4507.0	CTD, Ultra	CTD/UC	on Deck		
A2	PS71/167-2	10.03.08	07:09	68° 0.04' S	0° 0.00' W	4506.7	CTD/rosett	CTD/RO	surface		
A2	PS71/167-2	10.03.08	07:17	68° 0.02' S	0° 0.06' W	4506.2	CTD/rosett	CTD/RO	at depth	SL 124m	
A2	PS71/167-2	10.03.08	07:26	68° 0.02' S	0° 0.06' W	4507.7	CTD/rosett	CTD/RO	on deck		
	PS71/167-3	10.03.08	07:30	68° 0.00' S	0° 0.06' W	4506.7	FLOAT	FLOAT	into water		
	PS71/168-1	10.03.08	07:33	68° 0.09' S	0° 0.13' E	4507.2	Iron Fish	IFISH	surface		
	PS71/168-1	10.03.08	10:55	68° 29.99' S	0° 0.13' W	4258.5	Iron Fish	IFISH	on deck		
B1	PS71/169-1	10.03.08	11:00	68° 30.04' S	0° 0.31' W	4258.2	CTD/rosett	CTD/RO	surface		
B1	PS71/169-1	10.03.08	12:39	68° 30.02' S	0° 0.13' W	4257.5	CTD/rosett	CTD/RO	at depth	EL 31 4200m	
B1	PS71/169-1	10.03.08	13:55	68° 30.02' S	0° 0.12' E	4256.2	CTD/rosett	CTD/RO	on deck		
	PS71/169-2	10.03.08	13:56	68° 30.05' S	0° 0.14' E	4256.5	FLOAT	FLOAT	into water		
	PS71/170-1	10.03.08	14:02	68° 30.52' S	0° 0.21' E	4251.2	Iron Fish	IFISH	surface		
	PS71/170-1	10.03.08	16:02	68° 44.25' S	0° 0.02' E	3736.7	Iron Fish	IFISH	on deck		
	PS71/171-1	10.03.08	16:13	68° 44.96' S	0° 0.06' W	3629.5	CTD/rosett	CTD/RO	surface		
B1	PS71/171-1	10.03.08	17:21	68° 45.03' S	0° 0.03' W	3627.0	CTD/rosett	CTD/RO	at depth	SL 3576m	
B1	PS71/171-1	10.03.08	17:22	68° 45.03' S	0° 0.05' W	3627.0	CTD/rosett	CTD/RO	Information	Hieven	
B1	PS71/171-1	10.03.08	18:22	68° 45.02' S	0° 0.00' W	3627.7	CTD/rosett	CTD/RO	on deck		
	PS71/171-2	10.03.08	18:27	68° 45.11' S	0° 0.09' E	3622.5	FLOAT	FLOAT	into water		
	PS71/172-1	10.03.08	18:32	68° 45.57' S	0° 0.14' E	3572.2	Iron Fish	IFISH	surface		
	PS71/172-1	10.03.08	21:05	69° 11.11' S	0° 3.38' E	3043.0	Iron Fish	IFISH	on deck		
B1	PS71/173-1	10.03.08	21:18	69° 11.79' S	0° 3.40' E	2990.2	CTD/rosett	CTD/RO	surface		
B1	PS71/173-1	10.03.08	22:20	69° 11.90' S	0° 2.33' E	2925.2	CTD/rosett	CTD/RO	at depth	EL31 2878m	
B1	PS71/173-1	10.03.08	23:17	69° 11.89' S	0° 1.61' E	2905.2	CTD/rosett	CTD/RO	on deck		
B1	PS71/174-1	11.03.08	00:26	69° 5.77' S	0° 0.05' E	3234.0	CTD/rosett	CTD/RO	surface		
B1	PS71/174-1	11.03.08	01:26	69° 5.99' S	0° 0.06' W	3226.5	CTD/rosett	CTD/RO	at depth	3176 m	
B1	PS71/174-1	11.03.08	02:20	69° 5.96' S	0° 0.24' W	3223.5	CTD/rosett	CTD/RO	on deck		
B1	PS71/175-1	11.03.08	03:34	69° 0.58' S	0° 0.03' E	3378.7	CTD/rosett	CTD/RO	surface		
B1	PS71/175-1	11.03.08	04:43	69° 0.73' S	0° 0.05' W	3372.2	CTD/rosett	CTD/RO	at depth	SL 3307m	

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment
B1	PS71/175-1	11.03.08	05:40	69° 0.72' S	0° 0.05' E	3374.5	CTD/rosett	CTD/RO	on deck	
	PS71/175-2	11.03.08	06:06	68° 59.79' S	0° 0.30' E	3419.2	Mooring	MOR	released	AWI 232-8
	PS71/175-2	11.03.08	06:11	68° 59.76' S	0° 0.43' E	3420.7	Mooring	MOR	on the surface	
	PS71/175-2	11.03.08	06:41	68° 59.71' S	0° 0.73' W	3399.0	Mooring	MOR	action	ULS on deck
	PS71/175-2	11.03.08	06:44	68° 59.74' S	0° 0.80' W	3396.5	Mooring	MOR	action	Topboye & mfkopf
	PS71/175-2	11.03.08	06:50	68° 59.77' S	0° 0.84' W	3392.7	Mooring	MOR	action	Transponder on deck
	PS71/175-2	11.03.08	06:55	68° 59.82' S	0° 0.80' W	3391.2	Mooring	MOR	action	ADCP on deck
	PS71/175-2	11.03.08	07:02	68° 59.88' S	0° 0.71' W	3390.2	Mooring	MOR	action	RCM7 VTP14MPa on deck
	PS71/175-2	11.03.08	07:18	68° 60.00' S	0° 0.43' W	3395.5	Mooring	MOR	action	4 Floats & Strömungsmesser on deck
	PS71/175-2	11.03.08	07:38	69° 0.11' S	0° 0.56' W	3384.0	Mooring	MOR	action	5 Floats / Microcat/ Releaser/ Ström ms. on deck
	PS71/175-2	11.03.08	07:39	69° 0.11' S	0° 0.53' W	3384.2	Mooring	MOR	mooring on deck	
A1	PS71/175-3	11.03.08	08:34	68° 59.77' S	0° 0.23' E	3418.2	CTD, Ultra	CTD/UC	into Water	
A1	PS71/175-3	11.03.08	09:37	68° 59.75' S	0° 0.12' E	3418.0	CTD, Ultra	CTD/UC	on Depth	3300m
A1	PS71/175-3	11.03.08	10:57	68° 59.77' S	0° 0.16' E	3417.0	CTD, Ultra	CTD/UC	on Deck	
	PS71/175-4	11.03.08	11:07	68° 59.74' S	0° 0.32' E	3420.5	Mooring	MOR	surface	AWI232-9 Ankerstein
	PS71/175-4	11.03.08	11:13	68° 59.75' S	0° 0.25' E	3419.5	Mooring	MOR	surface	Doppel-Releaser, Strömungsmesser RCM8, Microcat SBE37
	PS71/175-4	11.03.08	11:20	68° 59.75' S	0° 0.19' E	3418.7	Mooring	MOR	surface	5Float
	PS71/175-4	11.03.08	11:56	68° 59.76' S	0° 0.26' E	3419.2	Mooring	MOR	surface	Strömungsmesser RCM11, 4Floats
	PS71/175-4	11.03.08	12:27	68° 59.75' S	0° 0.26' E	3420.0	Mooring	MOR	surface	4 Floats(y,y,y,o) & RCM 7 VT
	PS71/175-4	11.03.08	12:38	68° 59.73' S	0° 0.15' E	3419.0	Mooring	MOR	surface	ADCP
	PS71/175-4	11.03.08	12:44	68° 59.73' S	0° 0.22' E	3420.2	Mooring	MOR	surface	Transponder ET 801 G
	PS71/175-4	11.03.08	12:58	68° 59.74' S	0° 0.18' E	3418.7	Mooring	MOR	surface	Unterwasserrekorder Aural N 2
	PS71/175-4	11.03.08	13:02	68° 59.75' S	0° 0.19' E	3419.0	Mooring	MOR	surface	Toppkugel SBE 37, Flasher SMM,
	PS71/175-4	11.03.08	13:11	68° 59.74' S	0° 0.17' E	3418.5	Mooring	MOR	surface	ULS-CMR upward looking sonar
	PS71/175-4	11.03.08	13:16	68° 59.74' S	0° 0.16' E	3418.5	Mooring	MOR	on the ground	
	PS71/175-4	11.03.08	13:17	68° 59.74' S	0° 0.16' E	3419.0	Mooring	MOR	slipped	
	PS71/175-4	11.03.08	13:19	68° 59.75' S	0° 0.17' E	3418.5	Mooring	MOR	on deck	Releaser
	PS71/175-4	11.03.08	13:28	68° 59.81' S	0° 0.18' E	3414.0	Mooring	MOR	action	10 minuten gewartet, alles i.o
	PS71/175-5	11.03.08	13:29	68° 59.82' S	0° 0.14' E	3413.5	FLOAT	FLOAT	into water	
	PS71/176-1	11.03.08	13:40	69° 0.87' S	0° 0.00' E	3368.5	Iron Fish	IFISH	surface	
	PS71/176-1	11.03.08	14:12	69° 4.61' S	0° 0.11' E	3272.2	Iron Fish	IFISH	on deck	frozen
B1	PS71/177-1	11.03.08	16:02	69° 17.98' S	0° 0.10' W	2466.2	CTD/rosett	CTD/RO	surface	
B1	PS71/177-1	11.03.08	16:53	69° 17.97' S	0° 0.22' W	2458.0	CTD/rosett	CTD/RO	at depth	SL 2403m
B1	PS71/177-1	11.03.08	17:39	69° 18.08' S	0° 0.31' W	2457.2	CTD/rosett	CTD/RO	on deck	
	PS71-178	**BEGIN SUPERSTATION**								
B1	PS71/178-1	11.03.08	18:34	69° 23.98' S	0° 0.05' W	2011.7	CTD/rosett	CTD/RO	surface	
B1	PS71/178-1	11.03.08	19:20	69° 24.01' S	0° 0.18' W	2008.7	CTD/rosett	CTD/RO	at depth	SL 1959m
B1	PS71/178-1	11.03.08	20:00	69° 24.07' S	0° 0.18' W	2000.5	CTD/rosett	CTD/RO	on deck	
	PS71/178-2	11.03.08	20:08	69° 24.08' S	0° 0.03' E	2005.0	In situ pum	ISP	into water	Grundgewicht
	PS71/178-2	11.03.08	20:11	69° 24.06' S	0° 0.09' E	2007.0	In situ pum	ISP	into water	1. Pumpe 20m
	PS71/178-2	11.03.08	20:24	69° 23.98' S	0° 0.03' W	2011.2	In situ pum	ISP	into water	2. Pumpe
	PS71/178-2	11.03.08	20:30	69° 23.97' S	0° 0.10' W	2010.7	In situ pum	ISP	into water	3. Pumpe 700m
	PS71/178-2	11.03.08	20:39	69° 23.98' S	0° 0.11' W	2010.7	In situ pum	ISP	into water	4. Pumpe 1000m
	PS71/178-2	11.03.08	20:47	69° 23.95' S	0° 0.15' W	2012.7	In situ pum	ISP	into water	5. Pumpe 1300m
	PS71/178-2	11.03.08	20:52	69° 23.93' S	0° 0.18' W	2015.0	In situ pum	ISP	into water	6. Pumpe 1400m
	PS71/178-2	11.03.08	20:53	69° 23.93' S	0° 0.18' W	2015.5	In situ pum	ISP	pump at de	1500m
	PS71/178-2	12.03.08	00:23	69° 24.03' S	0° 0.06' E	2007.5	In situ pum	ISP	Information	Hieven
	PS71/178-2	12.03.08	00:27	69° 24.03' S	0° 0.01' W	2006.2	In situ pum	ISP	on deck	6. Pumpe 1400m
	PS71/178-2	12.03.08	00:30	69° 24.02' S	0° 0.07' W	2006.2	In situ pum	ISP	on deck	5. Pumpe 1320m
	PS71/178-2	12.03.08	00:36	69° 23.99' S	0° 0.18' W	2007.2	In situ pum	ISP	on deck	4. Pumpe 1020m
	PS71/178-2	12.03.08	00:43	69° 23.97' S	0° 0.22' W	2009.7	In situ pum	ISP	on deck	3. Pumpe 720m
	PS71/178-2	12.03.08	00:47	69° 23.95' S	0° 0.24' W	2012.7	In situ pum	ISP	on deck	2. Pumpe 520m
	PS71/178-2	12.03.08	00:58	69° 23.95' S	0° 0.20' W	2012.5	In situ pum	ISP	on deck	1. Pumpe 20 m
	PS71/178-2	12.03.08	01:00	69° 23.95' S	0° 0.19' W	2013.0	In situ pum	ISP	on deck	Ankerstein
C	PS71/178-3	12.03.08	01:06	69° 23.95' S	0° 0.20' W	2011.7	CTD/rosett	CTD/RO	surface	
C	PS71/178-3	12.03.08	01:50	69° 23.79' S	0° 0.47' W	2026.7	CTD/rosett	CTD/RO	at depth	1981 m
C	PS71/178-3	12.03.08	02:26	69° 23.77' S	0° 0.42' W	2029.2	CTD/rosett	CTD/RO	on deck	

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment
A1	PS71/178-4	12.03.08	02:41	69° 23.98' S	0° 0.09' E	2012.7	CTD, Ultra	CTD/UC	into Water	
A1	PS71/178-4	12.03.08	03:19	69° 24.03' S	0° 0.24' W	2004.5	CTD, Ultra	CTD/UC	on Depth	1910 m
A1	PS71/178-4	12.03.08	04:22	69° 24.01' S	0° 0.60' W	2005.7	CTD, Ultra	CTD/UC	on Deck	
D	PS71/178-5	12.03.08	04:42	69° 23.90' S	0° 0.24' W	2020.0	CTD/rosett	CTD/RO	surface	
D	PS71/178-5	12.03.08	05:00	69° 23.86' S	0° 0.25' W	2024.5	CTD/rosett	CTD/RO	at depth	SL 1002
D	PS71/178-5	12.03.08	05:34	69° 23.70' S	0° 1.13' W	2033.0	CTD/rosett	CTD/RO	on deck	
	PS71/178-6	12.03.08	06:08	69° 23.39' S	0° 4.13' W	1994.2	Mooring	MOR	released	AWI 233-7, kein signal
	PS71/178-6	12.03.08	06:17	69° 23.41' S	0° 4.55' W	1990.0	Mooring	MOR	Hydrophone into the water	
	PS71/178-6	12.03.08	06:22	69° 23.45' S	0° 4.70' W	1983.0	Mooring	MOR	released	kein signal
	PS71/178-6	12.03.08	06:27	69° 23.50' S	0° 4.80' W	1977.5	Mooring	MOR	Hydrophone on Deck	
	PS71/178-6	12.03.08	07:35	69° 23.62' S	0° 4.32' W	1968.2	Mooring	MOR	Hydrophone into the water	
	PS71/178-6	12.03.08	07:37	69° 23.63' S	0° 4.34' W	1967.0	Mooring	MOR	released	
	PS71/178-6	12.03.08	07:38	69° 23.64' S	0° 4.35' W	1967.0	Mooring	MOR	Hydrophon	2. Hydrophon
	PS71/178-6	12.03.08	07:41	69° 23.65' S	0° 4.37' W	1964.7	Mooring	MOR	released	
	PS71/178-6	12.03.08	07:51	69° 23.69' S	0° 4.42' W	1961.7	Mooring	MOR	Hydrophon	alle Hydrophone
	PS71/178-6	12.03.08	07:51	69° 23.69' S	0° 4.42' W	1961.7	Mooring	MOR	action	Abbruch, da kein Signal
D	PS71/178-7	12.03.08	08:17	69° 23.76' S	0° 5.04' W	1956.5	CTD/rosett	CTD/RO	surface	
D	PS71/178-7	12.03.08	08:27	69° 23.77' S	0° 5.14' W	1957.2	CTD/rosett	CTD/RO	at depth	EL31 197m
D	PS71/178-7	12.03.08	08:39	69° 23.76' S	0° 5.29' W	1970.2	CTD/rosett	CTD/RO	on deck	
B2	PS71/178-8	12.03.08	08:55	69° 23.44' S	0° 5.85' W	2004.2	CTD, Ultra	CTD/UC	into Water	
B2	PS71/178-8	12.03.08	09:00	69° 23.44' S	0° 5.90' W	2004.0	CTD, Ultra	CTD/UC	on Depth	100m
B2	PS71/178-8	12.03.08	09:22	69° 23.35' S	0° 6.01' W	2018.0	CTD, Ultra	CTD/UC	on Deck	
	PS71-178	**END SUPERSTATION**								
B1	PS71/179-1	12.03.08	10:45	69° 30.95' S	0° 0.72' W	1464.0	CTD/rosett	CTD/RO	surface	
B1	PS71/179-1	12.03.08	11:28	69° 31.00' S	0° 2.66' W	1495.0	CTD/rosett	CTD/RO	at depth	EL31 1463m
B1	PS71/179-1	12.03.08	12:02	69° 30.98' S	0° 3.14' W	1519.2	CTD/rosett	CTD/RO	on deck	
	PS71/180-1	12.03.08	14:17	69° 23.08' S	0° 26.37' W	2003.2	Mooring	MOR	action	Recover AWI 233-7
	PS71/180-1	12.03.08	14:26	69° 22.92' S	0° 26.68' W	2015.5	Mooring	MOR	on deck	MUFOKO, SM,
	PS71/180-1	12.03.08	14:28	69° 22.91' S	0° 26.70' W	2016.5	Mooring	MOR	on deck	ULS
	PS71/180-1	12.03.08	14:38	69° 22.92' S	0° 26.89' W	2018.0	Mooring	MOR	on deck	4 Floats, 1 Strömungsmesser
	PS71/180-1	12.03.08	14:55	69° 22.88' S	0° 27.10' W	2020.7	Mooring	MOR	on deck	Walvoicerekorder
	PS71/180-1	12.03.08	14:58	69° 22.88' S	0° 27.10' W	2021.2	Mooring	MOR	surface	5 Floats
	PS71/180-1	12.03.08	15:03	69° 22.89' S	0° 27.20' W	2020.2	Mooring	MOR	surface	microcat, Stömungsmesser, Dopplereleaser
	PS71/180-1	12.03.08	15:03	69° 22.89' S	0° 27.20' W	2020.2	Mooring	MOR	on deck	AWI 233-7 komplett geborgen
B1	PS71/181-1	12.03.08	17:09	69° 36.61' S	0° 0.07' E	1505.0	CTD/rosett	CTD/RO	surface	
B1	PS71/181-1	12.03.08	17:54	69° 36.59' S	0° 0.23' W	1503.5	CTD/rosett	CTD/RO	at depth	EL31 1461 m ausgesteckt
B1	PS71/181-1	12.03.08	18:27	69° 36.58' S	0° 0.34' W	1506.2	CTD/rosett	CTD/RO	on deck	
	PS71/182-1	12.03.08	18:35	69° 36.30' S	0° 0.26' E	1520.0	Iron Fish	IFISH	surface	
	PS71/182-1	12.03.08	19:09	69° 34.45' S	0° 16.78' W	1985.5	Iron Fish	IFISH	on deck	
B1	PS71/183-1	12.03.08	20:08	69° 36.51' S	0° 40.40' W	2268.0	CTD/rosett	CTD/RO	surface	
B1	PS71/183-1	12.03.08	21:04	69° 36.54' S	0° 40.16' W	2266.2	CTD/rosett	CTD/RO	at depth	EL31 2203m
B1	PS71/183-1	12.03.08	21:49	69° 36.55' S	0° 40.05' W	2264.5	CTD/rosett	CTD/RO	on deck	
	END OF ZERO MERIDIAN SECTION									
	BEGIN OF TRANSIT INTO WEDDELL SEA									
B1	PS71/184-1	13.03.08	10:54	69° 0.09' S	6° 59.81' W	2954.5	CTD/rosett	CTD/RO	surface	
B1	PS71/184-1	13.03.08	11:52	68° 59.97' S	6° 59.18' W	2953.7	CTD/rosett	CTD/RO	at depth	EL31 2903m
B1	PS71/184-1	13.03.08	12:49	69° 0.00' S	6° 58.33' W	2942.5	CTD/rosett	CTD/RO	on deck	
	PS71/184-2	13.03.08	12:57	68° 59.99' S	6° 58.19' W	2939.2	Mooring	MOR	surface	Deploy AWI 244-1 SoSo#11
	PS71/184-2	13.03.08	12:58	68° 59.99' S	6° 58.18' W	2938.5	Mooring	MOR	surface	Ankerstein
	PS71/184-2	13.03.08	13:02	68° 59.99' S	6° 58.11' W	2937.0	Mooring	MOR	surface	EG&G Swivel, Releaser
	PS71/184-2	13.03.08	13:55	68° 59.78' S	6° 57.09' W	2929.5	Mooring	MOR	surface	5 Float (y,y,y,y,y)
	PS71/184-2	13.03.08	14:02	68° 59.75' S	6° 56.98' W	2928.5	Mooring	MOR	surface	Schallquelle
	PS71/184-2	13.03.08	14:10	68° 59.72' S	6° 56.87' W	2927.7	Mooring	MOR	surface	6 Floats (o,o,o,o,y,o) & Benthos Transponder(y)XT 6000
	PS71/184-2	13.03.08	14:13	68° 59.71' S	6° 56.83' W	2927.5	Mooring	MOR	surface	6 Floats (y,o,o,y,y,y,)
	PS71/184-2	13.03.08	14:14	68° 59.70' S	6° 56.82' W	2927.2	Mooring	MOR	slipped	
	PS71/184-2	13.03.08	14:18	68° 59.70' S	6° 56.70' W	2924.7	Mooring	MOR	on the grou	mittels DWS das Aufsetzen beobachtet
	PS71/184-3	13.03.08	14:29	68° 59.59' S	6° 56.73' W	2924.5	FLOAT	FLOAT	into water	

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment
B1	PS71/185-1	14.03.08	23:42	69° 22.04' S	16° 22.95' W	4739.0	CTD/rosett	CTD/RO	surface	
B1	PS71/185-1	15.03.08	01:03	69° 21.76' S	16° 24.52' W	4738.2	CTD/rosett	CTD/RO	at depth	4710 m
B1	PS71/185-1	15.03.08	02:15	69° 21.69' S	16° 25.87' W	4737.5	CTD/rosett	CTD/RO	on deck	
B1	PS71/186-1	15.03.08	10:00	69° 5.27' S	17° 17.22' W	4763.5	CTD/rosett	CTD/RO	surface	
B1	PS71/186-1	15.03.08	11:28	69° 4.38' S	17° 18.96' W	4765.7	CTD/rosett	CTD/RO	at depth	EL31 4850m
B1	PS71/186-1	15.03.08	12:52	69° 3.86' S	17° 21.38' W	4766.5	CTD/rosett	CTD/RO	on deck	
	PS71/186-2	15.03.08	13:14	69° 3.75' S	17° 25.82' W	4766.0	Mooring	MOR	action	Deploy AWI 245-1 SoSo
	PS71/186-2	15.03.08	13:15	69° 3.75' S	17° 25.84' W	4766.0	Mooring	MOR	surface	Ankerstein
	PS71/186-2	15.03.08	13:20	69° 3.70' S	17° 25.80' W	4766.2	Mooring	MOR	surface	EG&G Swivvel Releaser
	PS71/186-2	15.03.08	13:28	69° 3.67' S	17° 25.80' W	4766.2	Mooring	MOR	surface	3 Float(o,o,o)
	PS71/186-2	15.03.08	13:53	69° 3.68' S	17° 25.67' W	4766.2	Mooring	MOR	surface	3 Floats(o,o,o)
	PS71/186-2	15.03.08	14:17	69° 3.66' S	17° 25.73' W	4766.5	Mooring	MOR	surface	3 Floats (o,o,o)
	PS71/186-2	15.03.08	14:37	69° 3.65' S	17° 25.82' W	4766.5	Mooring	MOR	surface	Schallquelle-Soundsoucre
	PS71/186-2	15.03.08	14:46	69° 3.67' S	17° 25.87' W	4766.5	Mooring	MOR	surface	Transponder(y) XT 6000, 6 Floats(y,y,y,o,o,o)
	PS71/186-2	15.03.08	14:49	69° 3.68' S	17° 25.89' W	4766.5	Mooring	MOR	surface	6 Floats (o,y,y,o,y,o,)
	PS71/186-2	15.03.08	14:49	69° 3.68' S	17° 25.89' W	4766.5	Mooring	MOR	slipped	
A2	PS71/186-3	15.03.08	15:03	69° 3.76' S	17° 26.03' W	4766.2	CTD/rosett	CTD/RO	surface	
A2	PS71/186-3	15.03.08	15:09	69° 3.82' S	17° 26.09' W	4766.2	CTD/rosett	CTD/RO	at depth	EL 97 m
A2	PS71/186-3	15.03.08	15:18	69° 3.81' S	17° 26.14' W	4766.0	CTD/rosett	CTD/RO	on deck	
	PS71/186-4	15.03.08	15:24	69° 3.80' S	17° 26.53' W	4766.2	FLOAT	FLOAT	into water	
A1	PS71/187-1	15.03.08	20:38	68° 48.20' S	17° 57.61' W	4791.5	CTD, Ultra	CTD/UC	into Water	
A1	PS71/187-1	15.03.08	21:58	68° 48.04' S	17° 56.75' W	4791.5	CTD, Ultra	CTD/UC	on Depth	4720m
A1	PS71/187-1	15.03.08	23:31	68° 47.21' S	17° 56.08' W	4793.7	CTD, Ultra	CTD/UC	on Deck	
B1	PS71/188-1	16.03.08	05:57	68° 24.11' S	19° 3.37' W	4823.0	CTD/rosett	CTD/RO	surface	
B1	PS71/188-1	16.03.08	07:25	68° 23.88' S	19° 4.12' W	4825.5	CTD/rosett	CTD/RO	at depth	SL 4776m
B1	PS71/188-1	16.03.08	08:40	68° 23.60' S	19° 4.19' W	4826.7	CTD/rosett	CTD/RO	on deck	
	PS71/188-2	16.03.08	08:48	68° 23.55' S	19° 4.26' W	4827.0	FLOAT	FLOAT	into water	
B1	PS71/189-1	16.03.08	14:25	67° 59.20' S	20° 2.06' W	4901.0	CTD/rosett	CTD/RO	surface	
B1	PS71/189-1	16.03.08	15:30	67° 58.39' S	20° 1.33' W	4902.2	CTD/rosett	CTD/RO	Information	stop wegen Rechnerproblem
B1	PS71/189-1	16.03.08	16:03	67° 57.93' S	20° 0.98' W	4903.2	CTD/rosett	CTD/RO	at depth	SL 5023m
B1	PS71/189-1	16.03.08	17:46	67° 56.57' S	20° 0.04' W	4905.0	CTD/rosett	CTD/RO	on deck	
	PS71/189-2	16.03.08	17:53	67° 56.47' S	19° 59.98' W	4905.0	FLOAT	FLOAT	into water	
B1	PS71/190-1	17.03.08	00:00	67° 37.72' S	21° 47.68' W	4906.0	CTD/rosett	CTD/RO	surface	
B1	PS71/190-1	17.03.08	01:37	67° 36.73' S	21° 48.14' W	4905.7	CTD/rosett	CTD/RO	at depth	4908 m
B1	PS71/190-1	17.03.08	03:02	67° 35.95' S	21° 47.96' W	4905.2	CTD/rosett	CTD/RO	on deck	
	PS71/190-2	17.03.08	03:13	67° 35.84' S	21° 47.97' W	4904.5	FLOAT	FLOAT	into water	
	PS71/191-1	17.03.08	09:45	67° 21.20' S	23° 39.05' W	4871.5	CTD, Ultra	CTD/UC	into Water	Winchtest mit Stein
	PS71/191-1	17.03.08	09:48	67° 21.20' S	23° 39.02' W	4871.2	CTD, Ultra	CTD/UC	on Depth	60m
	PS71/191-1	17.03.08	09:52	67° 21.21' S	23° 39.02' W	4871.2	CTD, Ultra	CTD/UC	on Deck	
A2	PS71/191-2	17.03.08	10:05	67° 21.18' S	23° 38.85' W	4871.2	CTD/rosett	CTD/RO	surface	
A2	PS71/191-2	17.03.08	10:15	67° 21.10' S	23° 38.63' W	4871.5	CTD/rosett	CTD/RO	at depth	EL31 199m
A2	PS71/191-2	17.03.08	10:25	67° 21.01' S	23° 38.38' W	4872.5	CTD/rosett	CTD/RO	on deck	
A1	PS71/191-3	17.03.08	10:32	67° 20.95' S	23° 38.21' W	4871.7	CTD, Ultra	CTD/UC	into Water	
A1	PS71/191-3	17.03.08	11:58	67° 20.26' S	23° 36.77' W	4872.7	CTD, Ultra	CTD/UC	on Depth	4800 m
A1	PS71/191-3	17.03.08	13:41	67° 19.89' S	23° 36.72' W	4873.2	CTD, Ultra	CTD/UC	on Deck	
	PS71/191-4	17.03.08	14:10	67° 18.96' S	23° 38.27' W	4874.5	FLOAT	FLOAT	into water	
B1	PS71/192-1	17.03.08	19:06	66° 57.33' S	25° 19.21' W	4850.0	CTD/rosett	CTD/RO	surface	
B1	PS71/192-1	17.03.08	20:34	66° 57.19' S	25° 18.54' W	4851.0	CTD/rosett	CTD/RO	at depth	EL31 4823m
B1	PS71/192-1	17.03.08	21:58	66° 56.84' S	25° 17.27' W	4852.0	CTD/rosett	CTD/RO	on deck	
	PS71/192-2	17.03.08	22:03	66° 56.75' S	25° 17.07' W	4852.0	FLOAT	FLOAT	into water	
	PS71/193	**START SUPERSTATION**								
B1	PS71/193-1	18.03.08	03:05	66° 37.11' S	27° 6.26' W	4864.2	CTD/rosett	CTD/RO	surface	
B1	PS71/193-1	18.03.08	04:36	66° 37.35' S	27° 5.75' W	4863.7	CTD/rosett	CTD/RO	at depth	SL 4814m
B1	PS71/193-1	18.03.08	05:58	66° 37.26' S	27° 4.85' W	4865.0	CTD/rosett	CTD/RO	on deck	
	PS71/193-2	18.03.08	08:03	66° 36.79' S	27° 5.96' W	4864.7	Test	TEST	information	Posidonia & Releaser
	PS71/193-2	18.03.08	08:52	66° 36.46' S	27° 6.22' W	4865.0	Test	TEST	surface	Gewicht u Releaser

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment
	PS71/193-2	18.03.08	09:41	66° 36.57' S	27° 6.98' W	4865.0	Test	TEST	at depth	GE52.1 3000m
	PS71/193-2	18.03.08	10:31	66° 36.81' S	27° 8.05' W	4864.2	Test	TEST	information	2500m
	PS71/193-2	18.03.08	11:01	66° 37.00' S	27° 8.82' W	4863.2	Test	TEST	information	500m
	PS71/193-2	18.03.08	11:18	66° 37.07' S	27° 8.90' W	4863.2	Test	TEST	on deck	alle Releaser haben ausgelöst
D1	PS71/193-3	18.03.08	11:32	66° 36.95' S	27° 9.04' W	4863.7	CTD/rosett	CTD/RO	surface	
D1	PS71/193-3	18.03.08	11:41	66° 36.93' S	27° 9.07' W	4863.2	CTD/rosett	CTD/RO	at depth	EL31 200m
D1	PS71/193-3	18.03.08	11:51	66° 36.90' S	27° 9.06' W	4863.5	CTD/rosett	CTD/RO	on deck	
	PS71/193-4	18.03.08	14:20	66° 37.16' S	27° 6.45' W	4863.7	Mooring	MOR	action	Recover AWI-209-4
	PS71/193-4	18.03.08	14:27	66° 37.27' S	27° 6.68' W	4863.7	Mooring	MOR	released	
	PS71/193-4	18.03.08	14:30	66° 37.29' S	27° 6.78' W	4863.5	Mooring	MOR	on the surface	
	PS71/193-4	18.03.08	15:27	66° 37.07' S	27° 6.32' W	4863.7	Mooring	MOR	on deck	MUFUKO; Toppboje
	PS71/193-4	18.03.08	15:34	66° 37.07' S	27° 6.31' W	4863.7	Mooring	MOR	on deck	Transponder Microcat
	PS71/193-4	18.03.08	15:44	66° 36.97' S	27° 6.44' W	4864.2	Mooring	MOR	on deck	3 Floats
	PS71/193-4	18.03.08	16:01	66° 36.80' S	27° 6.66' W	4864.7	Mooring	MOR	on deck	3 Floats & 4Floats
	PS71/193-4	18.03.08	16:09	66° 36.72' S	27° 6.64' W	4864.5	Mooring	MOR	on deck	Schallquelle
	PS71/193-4	18.03.08	16:29	66° 36.54' S	27° 6.71' W	4865.0	Mooring	MOR	on deck	3 Floats
	PS71/193-4	18.03.08	16:48	66° 36.49' S	27° 6.65' W	4865.0	Mooring	MOR	on deck	1 Float, 4 verschollen
	PS71/193-4	18.03.08	16:52	66° 36.47' S	27° 6.73' W	4865.2	Mooring	MOR	on deck	Strömungsmesser
	PS71/193-4	18.03.08	16:56	66° 36.46' S	27° 6.83' W	4865.0	Mooring	MOR	on deck	Microcat, Doppelrelaser, komplett geborgen
	PS71/193-5	18.03.08	17:44	66° 37.11' S	27° 6.20' W	4864.5	Mooring	MOR	surface	AWI 209-9, Ankerstein & Releaser
	PS71/193-5	18.03.08	17:48	66° 37.10' S	27° 6.24' W	4864.5	Mooring	MOR	surface	1 Microcat
	PS71/193-5	18.03.08	17:51	66° 37.09' S	27° 6.26' W	4864.7	Mooring	MOR	surface	1 Microcat
	PS71/193-5	18.03.08	17:55	66° 37.09' S	27° 6.28' W	4864.7	Mooring	MOR	surface	5 Floats
	PS71/193-5	18.03.08	18:25	66° 37.09' S	27° 6.26' W	4864.7	Mooring	MOR	surface	3 Floats
	PS71/193-5	18.03.08	18:58	66° 37.03' S	27° 6.64' W	4865.0	Mooring	MOR	surface	3 Floats
	PS71/193-5	18.03.08	19:23	66° 37.06' S	27° 6.55' W	4864.7	Mooring	MOR	surface	Schallquelle
	PS71/193-5	18.03.08	19:28	66° 37.05' S	27° 6.52' W	4865.0	Mooring	MOR	surface	3+4 Floats
	PS71/193-5	18.03.08	19:40	66° 37.01' S	27° 6.88' W	4865.0	Mooring	MOR	surface	1 Seacat & Transponder
	PS71/193-5	18.03.08	19:48	66° 36.95' S	27° 6.95' W	4864.7	Mooring	MOR	surface	Topboje & BUFOCO
	PS71/193-5	18.03.08	19:55	66° 36.89' S	27° 7.05' W	4865.0	Mooring	MOR	Hydrophone into the water	
	PS71/193-5	18.03.08	19:56	66° 36.89' S	27° 7.08' W	4865.2	Mooring	MOR	slipped	
	PS71/193-5	18.03.08	19:56	66° 36.89' S	27° 7.08' W	4865.2	Mooring	MOR	Hydrophone on Deck	
	PS71/193-5	18.03.08	20:00	66° 36.85' S	27° 7.17' W	4865.2	Mooring	MOR	releaser on deck	
A1	PS71/193-6	18.03.08	20:30	66° 36.44' S	27° 9.39' W	4864.7	CTD, Ultra	CTD/UC	into Water	
A1	PS71/193-6	18.03.08	21:50	66° 36.43' S	27° 10.82' W	4864.5	CTD, Ultra	CTD/UC	on Depth	4800m
A1	PS71/193-6	18.03.08	23:16	66° 36.19' S	27° 13.00' W	4864.2	CTD, Ultra	CTD/UC	on Deck	
C	PS71/193-7	18.03.08	23:30	66° 36.32' S	27° 14.31' W	4863.5	CTD/rosett	CTD/RO	surface	
C	PS71/193-7	19.03.08	01:03	66° 36.26' S	27° 16.89' W	4863.0	CTD/rosett	CTD/RO	at depth	4897 m
C	PS71/193-7	19.03.08	02:16	66° 36.13' S	27° 19.50' W	4862.5	CTD/rosett	CTD/RO	on deck	
	PS71/193-8	19.03.08	02:48	66° 36.79' S	27° 8.79' W	4864.0	In situ pum	ISP	into water	Ankerstein
	PS71/193-8	19.03.08	02:55	66° 36.77' S	27° 8.77' W	4864.0	In situ pum	ISP	into water	1. Pumpe 20 m
	PS71/193-8	19.03.08	03:26	66° 36.65' S	27° 9.36' W	4864.2	In situ pum	ISP	into water	2. Pumpe bei 1520 m
	PS71/193-8	19.03.08	04:05	66° 36.49' S	27° 10.06' W	4864.2	In situ pum	ISP	into water	3. Pumpe bei 3520 m
	PS71/193-8	19.03.08	04:20	66° 36.44' S	27° 10.40' W	4864.2	In situ pum	ISP	into water	4. Pumpe bei 4220 m
	PS71/193-8	19.03.08	04:29	66° 36.43' S	27° 10.55' W	4864.0	In situ pum	ISP	into water	5. Pumpe bei 4520 m
	PS71/193-8	19.03.08	04:33	66° 36.43' S	27° 10.60' W	4864.2	In situ pum	ISP	into water	6. Pumpe bei 4620 m
	PS71/193-8	19.03.08	04:34	66° 36.43' S	27° 10.61' W	4864.5	In situ pum	ISP	pump at de	4720 m
	PS71/193-8	19.03.08	07:52	66° 35.72' S	27° 14.32' W	4864.7	In situ pum	ISP	Information	start hieven
	PS71/193-8	19.03.08	07:55	66° 35.69' S	27° 14.43' W	4865.0	In situ pum	ISP	on deck	6. Pumpe
	PS71/193-8	19.03.08	08:00	66° 35.64' S	27° 14.59' W	4865.2	In situ pum	ISP	on deck	5. Pumpe
	PS71/193-8	19.03.08	08:07	66° 35.58' S	27° 14.77' W	4864.5	In situ pum	ISP	on deck	4. Pumpe
	PS71/193-8	19.03.08	08:20	66° 35.49' S	27° 14.91' W	4865.2	In situ pum	ISP	on deck	3. Pumpe
	PS71/193-8	19.03.08	08:57	66° 35.34' S	27° 15.68' W	4864.7	In situ pum	ISP	on deck	2. Pumpe
	PS71/193-8	19.03.08	09:24	66° 35.49' S	27° 16.21' W	4864.0	In situ pum	ISP	on deck	1. PUMPE
	PS71/193-8	19.03.08	09:26	66° 35.50' S	27° 16.28' W	4864.0	In situ pum	ISP	on deck	Ankerstein an Deck
F	PS71/193-9	19.03.08	09:36	66° 35.48' S	27° 16.61' W	4864.2	CTD/rosett	CTD/RO	surface	
F	PS71/193-9	19.03.08	10:38	66° 35.59' S	27° 18.17' W	4864.2	CTD/rosett	CTD/RO	at depth	EL31 3208m

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment	
F	PS71/193-9	19.03.08	11:31	66° 35.38' S	27° 19.28' W	4863.5	CTD/rosett	CTD/RO	on deck		
B2	PS71/193-10	19.03.08	11:44	66° 35.16' S	27° 20.59' W	4863.5	CTD, Ultra	CTD/UC	into Water		
B2	PS71/193-10	19.03.08	11:56	66° 35.11' S	27° 21.09' W	4862.2	CTD, Ultra	CTD/UC	on Depth	200m	
B2	PS71/193-10	19.03.08	12:11	66° 35.06' S	27° 21.74' W	4862.2	CTD, Ultra	CTD/UC	on Deck		
D2	PS71/193-11	19.03.08	12:21	66° 34.90' S	27° 22.65' W	4862.0	CTD/rosett	CTD/RO	surface		
D2	PS71/193-11	19.03.08	13:01	66° 34.78' S	27° 24.07' W	4861.5	CTD/rosett	CTD/RO	at depth	1018 m	
D2	PS71/193-11	19.03.08	13:21	66° 34.65' S	27° 24.75' W	4860.7	CTD/rosett	CTD/RO	on deck		
	PS71/193-12	19.03.08	13:28	66° 34.66' S	27° 25.22' W	4861.5	FLOAT	FLOAT	into water		
	PS71-193	**END SUPERSTATION**									
B1	PS71/194-1	19.03.08	17:25	66° 24.87' S	29° 1.95' W	4825.0	CTD/rosett	CTD/RO	surface		
B1	PS71/194-1	19.03.08	19:00	66° 24.87' S	29° 1.97' W	4824.5	CTD/rosett	CTD/RO	at depth	SL 4786m	
B1	PS71/194-1	19.03.08	20:29	66° 24.72' S	29° 1.09' W	4827.7	CTD/rosett	CTD/RO	on deck		
	PS71/194-2	19.03.08	20:39	66° 24.79' S	29° 1.05' W	4827.5	FLOAT	FLOAT	into water		
	PS71/194-3	19.03.08	20:45	66° 24.83' S	29° 0.93' W	4827.7	FLOAT	FLOAT	into water	Weatherbuoy 1	
B1	PS71/195-1	20.03.08	01:51	66° 12.60' S	30° 54.49' W	4810.5	CTD/rosett	CTD/RO	surface		
B1	PS71/195-1	20.03.08	03:14	66° 12.58' S	30° 55.19' W	4810.2	CTD/rosett	CTD/RO	at depth	4758 m	
B1	PS71/195-1	20.03.08	04:43	66° 13.02' S	30° 55.42' W	4810.2	CTD/rosett	CTD/RO	on deck		
	PS71/195-2	20.03.08	04:49	66° 13.03' S	30° 55.86' W	4810.7	FLOAT	FLOAT	into water		
B1	PS71/196-1	20.03.08	10:07	66° 0.47' S	32° 46.22' W	4791.0	CTD/rosett	CTD/RO	surface		
B1	PS71/196-1	20.03.08	11:34	66° 0.41' S	32° 46.18' W	4791.5	CTD/rosett	CTD/RO	at depth	EL31 4738m	
B1	PS71/196-1	20.03.08	12:49	66° 0.50' S	32° 46.46' W	4789.7	CTD/rosett	CTD/RO	on deck		
	PS71/196-2	20.03.08	12:55	66° 0.48' S	32° 46.68' W	4789.2	FLOAT	FLOAT	into water		
B1	PS71/197-1	20.03.08	18:14	65° 48.49' S	34° 37.86' W	4787.0	CTD/rosett	CTD/RO	surface		
B1	PS71/197-1	20.03.08	19:37	65° 48.64' S	34° 37.59' W	4787.2	CTD/rosett	CTD/RO	at depth	SL 4735m	
B1	PS71/197-1	20.03.08	19:39	65° 48.64' S	34° 37.57' W	4787.7	CTD/rosett	CTD/RO	Information	hieven	
B1	PS71/197-1	20.03.08	21:01	65° 48.54' S	34° 37.55' W	4787.0	CTD/rosett	CTD/RO	on deck		
	PS71/197-2	20.03.08	21:01	65° 48.54' S	34° 37.55' W	4787.0	FLOAT	FLOAT	into water		
B1	PS71/198-1	21.03.08	02:31	65° 36.93' S	36° 23.81' W	4770.7	CTD/rosett	CTD/RO	surface		
B1	PS71/198-1	21.03.08	03:53	65° 36.81' S	36° 23.90' W	4770.2	CTD/rosett	CTD/RO	at depth	4715 m	
B1	PS71/198-1	21.03.08	05:10	65° 36.82' S	36° 23.82' W	4771.2	CTD/rosett	CTD/RO	on deck		
A1	PS71/198-2	21.03.08	05:21	65° 36.84' S	36° 23.65' W	4771.2	CTD, Ultra	CTD/UC	into Water		**Cd isotopes**
A1	PS71/198-2	21.03.08	06:40	65° 36.89' S	36° 24.09' W	4771.5	CTD, Ultra	CTD/UC	on Depth	SL 4700m	**Cd isotopes**
A1	PS71/198-2	21.03.08	08:09	65° 36.80' S	36° 23.93' W	4772.2	CTD, Ultra	CTD/UC	on Deck		**Cd isotopes**
	PS71/198-3	21.03.08	08:55	65° 37.02' S	36° 22.68' W	4771.5	Mooring	MOR	released	AWI 208-4	
	PS71/198-3	21.03.08	09:05	65° 37.09' S	36° 23.02' W	4771.0	Mooring	MOR	on the surface		
	PS71/198-3	21.03.08	09:28	65° 37.46' S	36° 23.02' W	4770.2	Mooring	MOR	on deck	ULS an deck	
	PS71/198-3	21.03.08	09:31	65° 37.50' S	36° 22.99' W	4769.7	Mooring	MOR	on deck	Topboje	
	PS71/198-3	21.03.08	09:39	65° 37.57' S	36° 22.87' W	4770.2	Mooring	MOR	on deck	ADCP, Transponder, 1 Microcat	
	PS71/198-3	21.03.08	09:54	65° 37.70' S	36° 22.50' W	4770.0	Mooring	MOR	on deck	3 Floats	
	PS71/198-3	21.03.08	10:12	0° 0.00' N	0° 0.00' E	0.0	Mooring	MOR	on deck	7 Floats	
	PS71/198-3	21.03.08	10:20	0° 0.00' N	0° 0.00' E	0.0	Mooring	MOR	on deck	Schallquelle W5	
	PS71/198-3	21.03.08	10:40	0° 0.00' N	0° 0.00' E	0.0	Mooring	MOR	on deck	3 Floats	
	PS71/198-3	21.03.08	11:00	0° 0.00' N	0° 0.00' E	0.0	Mooring	MOR	on deck	5 kaputte Floats	
	PS71/198-3	21.03.08	11:05	0° 0.00' N	0° 0.00' E	0.0	Mooring	MOR	on deck	Microcat	
	PS71/198-3	21.03.08	11:10	0° 0.00' N	0° 0.00' E	0.0	Mooring	MOR	on deck	Microcat, Strömungsmesser	
	PS71/198-3	21.03.08	11:10	0° 0.00' N	0° 0.00' E	0.0	Mooring	MOR	releaser on deck		
	PS71/198-3	21.03.08	11:16	65° 38.16' S	36° 21.94' W	4767.7	Mooring	MOR	mooring on	Verankerung komplett geborgen	
A2	PS71/198-4	21.03.08	11:20	65° 38.17' S	36° 21.90' W	4768.0	CTD/rosett	CTD/RO	surface		
A2	PS71/198-4	21.03.08	11:30	65° 38.16' S	36° 21.87' W	4768.0	CTD/rosett	CTD/RO	at depth	EL31 196m	
A2	PS71/198-4	21.03.08	11:43	65° 38.14' S	36° 21.88' W	4767.7	CTD/rosett	CTD/RO	on deck		
	PS71/198-5	21.03.08	12:22	65° 35.98' S	36° 17.85' W	4774.0	Mooring	MOR	surface	AWI208-5 ULS	
	PS71/198-5	21.03.08	12:27	65° 35.99' S	36° 17.88' W	4774.2	Mooring	MOR	surface	MoFuKo + Toppboje	
	PS71/198-5	21.03.08	12:34	65° 36.05' S	36° 18.07' W	4773.7	Mooring	MOR	surface	ADCP, Transponder, Strömungsmesser	
	PS71/198-5	21.03.08	12:43	65° 36.15' S	36° 18.42' W	4773.5	Mooring	MOR	surface	4 Floats	
	PS71/198-5	21.03.08	13:01	65° 36.39' S	36° 19.87' W	4772.0	Mooring	MOR	surface	2 Floats	
	PS71/198-5	21.03.08	13:26	65° 36.60' S	36° 22.07' W	4771.0	Mooring	MOR	surface	3 Floats	
	PS71/198-5	21.03.08	13:51	65° 36.85' S	36° 24.20' W	4770.5	Mooring	MOR	surface	5 Floats	

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment	
	PS71/198-5	21.03.08	13:53	65° 36.86' S	36° 24.28' W	4770.5	Mooring	MOR	surface	Microcat	
	PS71/198-5	21.03.08	14:07	65° 36.85' S	36° 24.43' W	4770.7	Mooring	MOR	slipped	Microcat, Doppelreleaser,Ankerstein	
	PS71/198-6	21.03.08	14:51	65° 36.63' S	36° 22.87' W	4770.7	FLOAT	FLOAT	into water		
B1	PS71/199-1	21.03.08	19:02	65° 26.90' S	37° 42.32' W	4731.5	CTD/rosett	CTD/RO	surface		
B1	PS71/199-1	21.03.08	20:25	65° 27.18' S	37° 42.55' W	4731.7	CTD/rosett	CTD/RO	at depth	SL 4681m	
B1	PS71/199-1	21.03.08	21:45	65° 27.20' S	37° 42.46' W	4730.5	CTD/rosett	CTD/RO	on deck		
	PS71/199-2	21.03.08	21:47	65° 27.20' S	37° 42.44' W	4731.2	FLOAT	FLOAT	into water	#52	
B1	PS71/200-1	22.03.08	01:16	65° 16.99' S	39° 1.12' W	4766.2	CTD/rosett	CTD/RO	surface		
B1	PS71/200-1	22.03.08	02:42	65° 16.96' S	39° 0.85' W	4766.2	CTD/rosett	CTD/RO	at depth	EL31 4712m	
B1	PS71/200-1	22.03.08	04:02	65° 16.95' S	39° 1.32' W	4766.2	CTD/rosett	CTD/RO	on deck		
	PS71/200-2	22.03.08	04:05	65° 16.92' S	39° 1.09' W	4766.2	FLOAT	FLOAT	into water		
B1	PS71/201-1	22.03.08	07:29	65° 7.01' S	40° 19.35' W	4774.0	CTD/rosett	CTD/RO	surface		
B1	PS71/201-1	22.03.08	08:52	65° 7.02' S	40° 19.41' W	4774.5	CTD/rosett	CTD/RO	at depth	SL 4721m	
B1	PS71/201-1	22.03.08	10:17	65° 7.01' S	40° 19.31' W	4774.5	CTD/rosett	CTD/RO	on deck		
B1	PS71/202-1	22.03.08	13:54	64° 56.91' S	41° 38.30' W	4733.7	CTD/rosett	CTD/RO	surface		
B1	PS71/202-1	22.03.08	15:21	64° 56.63' S	41° 39.93' W	4732.7	CTD/rosett	CTD/RO	at depth	4708 m	
B1	PS71/202-1	22.03.08	16:41	64° 56.89' S	41° 39.90' W	4733.2	CTD/rosett	CTD/RO	on deck		
G1	PS71/202-2	22.03.08	16:48	64° 56.94' S	41° 39.82' W	4733.7	CTD, Ultra	CTD/UC	into Water		iron isotopes
G1	PS71/202-2	22.03.08	17:04	64° 56.93' S	41° 40.02' W	4732.0	CTD, Ultra	CTD/UC	on Depth	400 m	iron isotopes
G1	PS71/202-2	22.03.08	17:28	64° 56.91' S	41° 40.18' W	4732.2	CTD, Ultra	CTD/UC	on Deck		iron isotopes
	PS71/202-3	22.03.08	17:35	64° 57.17' S	41° 40.49' W	4731.7	Drifter, long	LD	surface		
	PS71/203-1	22.03.08	17:46	64° 57.20' S	41° 43.78' W	4729.0	Iron Fish	IFISH	surface		
	PS71/203-1	22.03.08	18:19	64° 56.66' S	41° 56.41' W	4719.5	Iron Fish	IFISH	on deck		
	PS71/203-1	22.03.08	19:02	64° 56.15' S	42° 3.96' W	4714.7	Iron Fish	IFISH	surface		
	PS71/203-1	22.03.08	19:46	64° 57.89' S	42° 1.61' W	4717.5	Iron Fish	IFISH	on deck		
A2	PS71/204-1	23.03.08	12:07	64° 48.03' S	42° 54.10' W	4677.0	CTD/rosett	CTD/RO	surface		
A2	PS71/204-1	23.03.08	12:18	64° 47.97' S	42° 53.86' W	4676.0	CTD/rosett	CTD/RO	at depth	EL31 196m ausgesteckt	
A2	PS71/204-1	23.03.08	12:29	64° 47.98' S	42° 53.61' W	4675.5	CTD/rosett	CTD/RO	on deck		
A1	PS71/204-2	23.03.08	12:40	64° 47.96' S	42° 53.23' W	4676.0	CTD, Ultra	CTD/UC	into Water		
A1	PS71/204-2	23.03.08	14:04	64° 47.39' S	42° 51.50' W	4678.5	CTD, Ultra	CTD/UC	on Depth	4600m ausgesteckt	
A1	PS71/204-2	23.03.08	15:36	64° 46.84' S	42° 49.65' W	4685.0	CTD, Ultra	CTD/UC	on Deck		
B1	PS71/205-1	23.03.08	19:35	64° 36.13' S	44° 13.51' W	4573.7	CTD/rosett	CTD/RO	surface		
B1	PS71/205-1	23.03.08	21:04	64° 35.04' S	44° 13.63' W	4587.2	CTD/rosett	CTD/RO	at depth	EL31 4639m ausgesteckt	
B1	PS71/205-1	23.03.08	22:22	64° 33.97' S	44° 13.71' W	4592.7	CTD/rosett	CTD/RO	on deck		
B1	PS71/206-1	24.03.08	01:14	64° 29.14' S	45° 11.50' W	4504.0	CTD/rosett	CTD/RO	surface		
B1	PS71/206-1	24.03.08	02:34	64° 28.51' S	45° 11.49' W	4479.2	CTD/rosett	CTD/RO	at depth	EL 31; 4445 m	
B1	PS71/206-1	24.03.08	03:55	64° 28.19' S	45° 11.21' W	4484.5	CTD/rosett	CTD/RO	on deck		
	PS71/207-1	24.03.08	06:13	64° 24.62' S	45° 46.19' W	4455.0	Test	TEST	information	Austörnen Draht EL 31 0,7m/s	
	PS71/207-1	24.03.08	08:05	64° 23.52' S	45° 44.04' W	4462.5	Test	TEST	at depth	SL 4200m	
	PS71/207-1	24.03.08	08:18	64° 23.36' S	45° 43.85' W	4464.7	Test	TEST	information	Hieven mit 0,7m/s	
	PS71/207-1	24.03.08	10:06	64° 21.90' S	45° 43.07' W	4482.5	Test	TEST	on deck		
	PS71/207-2	24.03.08	11:11	64° 24.36' S	45° 51.98' W	4452.2	Mooring	MOR	surface	AWI-217-3, Ankerstein	
	PS71/207-2	24.03.08	11:19	64° 24.34' S	45° 52.09' W	4452.5	Mooring	MOR	surface	Doppelreleaser, Strömungsmesser RCM11, Microcat	
	PS71/207-2	24.03.08	11:22	64° 24.30' S	45° 52.09' W	4452.7	Mooring	MOR	surface	Microcat	
	PS71/207-2	24.03.08	11:27	64° 24.24' S	45° 52.10' W	4453.2	Mooring	MOR	surface	5 Float	
	PS71/207-2	24.03.08	11:55	64° 23.93' S	45° 52.05' W	4456.2	Mooring	MOR	surface	2 Floats	
	PS71/207-2	24.03.08	12:32	64° 23.67' S	45° 52.41' W	4456.0	Mooring	MOR	surface	2 Floats	
	PS71/207-2	24.03.08	12:38	64° 23.61' S	45° 52.34' W	4456.0	Mooring	MOR	surface	Schallquelle	
	PS71/207-2	24.03.08	12:45	64° 23.63' S	45° 52.37' W	4456.0	Mooring	MOR	surface	Transponder, 6 Floats	
	PS71/207-2	24.03.08	12:47	64° 23.63' S	45° 52.38' W	4456.0	Mooring	MOR	surface	6 Floats	
	PS71/207-2	24.03.08	12:47	64° 23.63' S	45° 52.38' W	4456.0	Mooring	MOR	slipped		
B1	PS71/207-3	24.03.08	13:20	64° 22.99' S	45° 54.95' W	4444.5	CTD/rosett	CTD/RO	surface		
B1	PS71/207-3	24.03.08	14:47	64° 22.81' S	45° 55.63' W	4445.2	CTD/rosett	CTD/RO	at depth	EL31 4394m	
B1	PS71/207-3	24.03.08	16:10	64° 23.03' S	45° 55.50' W	4442.5	CTD/rosett	CTD/RO	on deck		
	PS71/207-4	24.03.08	16:13	64° 23.06' S	45° 55.58' W	4442.7	FLOAT	FLOAT	into water		

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment
B1	PS71/208-1	24.03.08	20:14	64° 18.09' S	46° 39.73' W	4388.5	CTD/rosett	CTD/RO	surface	
B1	PS71/208-1	24.03.08	21:34	64° 17.99' S	46° 38.93' W	4393.0	CTD/rosett	CTD/RO	at depth	SL 4338m
B1	PS71/208-1	24.03.08	22:49	64° 17.84' S	46° 38.62' W	4392.2	CTD/rosett	CTD/RO	on deck	
B1	PS71/209-1	25.03.08	09:49	64° 11.48' S	47° 31.02' W	4201.0	CTD/rosett	CTD/RO	surface	
B1	PS71/209-1	25.03.08	11:15	64° 11.50' S	47° 31.32' W	4201.0	CTD/rosett	CTD/RO	at depth	EL31 4149m
B1	PS71/209-1	25.03.08	12:30	64° 11.42' S	47° 31.81' W	4200.2	CTD/rosett	CTD/RO	on deck	
B2	PS71/210-1	25.03.08	18:41	64° 2.76' S	48° 15.51' W	4018.7	CTD, Ultra	CTD/UC	into Water	
B2	PS71/210-1	25.03.08	18:46	64° 2.75' S	48° 15.56' W	4018.5	CTD, Ultra	CTD/UC	on Depth	100 m
B2	PS71/210-1	25.03.08	19:04	64° 2.71' S	48° 15.76' W	4017.2	CTD, Ultra	CTD/UC	on Deck	
A2	PS71/210-2	25.03.08	19:12	64° 2.70' S	48° 15.84' W	4016.7	CTD/rosett	CTD/RO	surface	
A2	PS71/210-2	25.03.08	19:21	64° 2.68' S	48° 15.93' W	4016.5	CTD/rosett	CTD/RO	at depth	SL 195m
A2	PS71/210-2	25.03.08	19:31	64° 2.65' S	48° 16.02' W	4016.2	CTD/rosett	CTD/RO	on deck	
A1	PS71/210-3	25.03.08	19:56	64° 2.59' S	48° 16.23' W	4016.5	CTD, Ultra	CTD/UC	into Water	
A1	PS71/210-3	25.03.08	21:02	64° 2.33' S	48° 16.72' W	4023.5	CTD, Ultra	CTD/UC	on Depth	Seillänge 3945m
A1	PS71/210-3	25.03.08	22:21	64° 1.82' S	48° 17.00' W	4079.7	CTD, Ultra	CTD/UC	on Deck	
B1	PS71/211-1	26.03.08	02:51	63° 55.44' S	48° 38.73' W	3753.0	CTD/rosett	CTD/RO	surface	
B1	PS71/211-1	26.03.08	04:00	63° 54.94' S	48° 39.15' W	3737.2	CTD/rosett	CTD/RO	at depth	3722 m
B1	PS71/211-1	26.03.08	05:03	63° 54.58' S	48° 39.48' W	3725.0	CTD/rosett	CTD/RO	on deck	
B1	PS71/212-1	26.03.08	12:00	63° 56.14' S	49° 5.61' W	3553.7	CTD/rosett	CTD/RO	surface	
B1	PS71/212-1	26.03.08	13:24	63° 55.13' S	49° 4.85' W	3535.0	CTD/rosett	CTD/RO	at depth	EL31 3543m
B1	PS71/212-1	26.03.08	14:29	63° 54.37' S	49° 4.69' W	3520.2	CTD/rosett	CTD/RO	on deck	
	PS71/212-2	26.03.08	14:33	63° 54.31' S	49° 4.68' W	3520.0	Mooring	MOR	surface	Ankerstein AWI 216-3
	PS71/212-2	26.03.08	14:41	63° 54.19' S	49° 4.59' W	3520.7	Mooring	MOR	surface	Doppelreleaser, Strömungsmesser RMC11VT, Mirocat SBE
	PS71/212-2	26.03.08	14:44	63° 54.14' S	49° 4.57' W	3520.5	Mooring	MOR	surface	Microcat
	PS71/212-2	26.03.08	14:49	63° 54.08' S	49° 4.61' W	3518.5	Mooring	MOR	surface	Microcat
	PS71/212-2	26.03.08	14:50	63° 54.08' S	49° 4.63' W	3518.2	Mooring	MOR	surface	12 Floats
	PS71/212-2	26.03.08	14:56	63° 54.03' S	49° 4.68' W	3516.0	Mooring	MOR	slipped	MW= + 6,9° Oooooost
G2	PS71/212-3	26.03.08	15:11	63° 53.84' S	49° 4.67' W	3509.0	CTD, Ultra	CTD/UC	into Water	
G2	PS71/212-3	26.03.08	15:29	63° 53.68' S	49° 4.73' W	3505.5	CTD, Ultra	CTD/UC	on Depth	400 m
G2	PS71/212-3	26.03.08	15:54	63° 53.39' S	49° 4.76' W	3499.5	CTD, Ultra	CTD/UC	on Deck	
B1	PS71/213-1	26.03.08	19:02	63° 54.21' S	49° 36.65' W	3311.7	CTD/rosett	CTD/RO	surface	
B1	PS71/213-1	26.03.08	20:13	63° 53.91' S	49° 36.08' W	3308.5	CTD/rosett	CTD/RO	at depth	3248 m EL31
B1	PS71/213-1	26.03.08	21:15	63° 53.45' S	49° 35.38' W	3304.2	CTD/rosett	CTD/RO	on deck	
B1	PS71/214-1	27.03.08	01:16	63° 52.60' S	50° 1.27' W	2938.5	CTD/rosett	CTD/RO	surface	
B1	PS71/214-1	27.03.08	02:26	63° 51.84' S	50° 0.58' W	2939.7	CTD/rosett	CTD/RO	at depth	EL31 2894m
B1	PS71/214-1	27.03.08	03:21	63° 51.31' S	50° 0.28' W	2938.0	CTD/rosett	CTD/RO	on deck	
B1	PS71/215-1	27.03.08	06:38	63° 46.93' S	50° 26.21' W	2614.5	CTD/rosett	CTD/RO	surface	
B1	PS71/215-1	27.03.08	07:31	63° 46.90' S	50° 25.97' W	2656.5	CTD/rosett	CTD/RO	at depth	SL 2598m
B1	PS71/215-1	27.03.08	08:23	63° 46.68' S	50° 25.67' W	2660.2	CTD/rosett	CTD/RO	on deck	
G3	PS71/216-1	27.03.08	13:36	63° 42.46' S	50° 52.45' W	2705.7	CTD, Ultra	CTD/UC	into Water	
G3	PS71/216-1	27.03.08	13:49	63° 42.37' S	50° 52.38' W	2620.2	CTD, Ultra	CTD/UC	on Depth	300m
G3	PS71/216-1	27.03.08	14:10	63° 42.22' S	50° 52.26' W	2600.2	CTD, Ultra	CTD/UC	on Deck	
	PS71/216-2	27.03.08	15:36	63° 42.40' S	50° 52.18' W	2681.0	Mooring	MOR	Hydrophone into the water	
	PS71/216-2	27.03.08	15:37	63° 42.39' S	50° 52.17' W	2601.0	Mooring	MOR	action	280 m Transponder
	PS71/216-2	27.03.08	15:39	63° 42.37' S	50° 52.15' W	2685.0	Mooring	MOR	released	Rec AWI 207-6
	PS71/216-2	27.03.08	15:41	0° 0.00' N	0° 0.00' E	0.0	Mooring	MOR	on the surface	
	PS71/216-2	27.03.08	16:10	63° 42.17' S	50° 52.15' W	2619.0	Mooring	MOR	on deck	mufuko
	PS71/216-2	27.03.08	16:14	63° 42.14' S	50° 52.08' W	2600.7	Mooring	MOR	on deck	ULS
	PS71/216-2	27.03.08	16:18	63° 42.11' S	50° 52.06' W	2600.7	Mooring	MOR	on deck	Transponder,Str.messer, seacat
	PS71/216-2	27.03.08	16:32	63° 42.06' S	50° 52.03' W	2601.5	Mooring	MOR	on deck	2 Floats+Strömungsmesser
	PS71/216-2	27.03.08	16:39	63° 42.01' S	50° 52.02' W	2610.2	Mooring	MOR	on deck	Walhorchgerät POD
	PS71/216-2	27.03.08	16:54	63° 41.91' S	50° 52.03' W	2601.0	Mooring	MOR	on deck	6 Floats
	PS71/216-2	27.03.08	17:00	63° 41.88' S	50° 52.04' W	2602.0	Mooring	MOR	on deck	Schallquelle

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment
	PS71/216-2	27.03.08	17:06	63° 41.86' S	50° 52.04' W	2603.2	Mooring	MOR	action	Seacat SBE 37 lost
	PS71/216-2	27.03.08	17:11	63° 41.83' S	50° 52.05' W	2603.0	Mooring	MOR	on deck	Knäul 2 Seacat SBE 37 Strömungsmesser 3+5 Floats
	PS71/216-2	27.03.08	17:17	63° 41.80' S	50° 52.06' W	2601.0	Mooring	MOR	on deck	Releaser, Strömungsmesser, Secat SBE 37
	PS71/216-3	27.03.08	18:19	63° 43.08' S	50° 50.36' W	2537.5	Mooring	MOR	surface	AWI 207-7, Ankerstein, Doppelauslöser+Strömungsmesser+Microcat, MW=+7,8 Ooooost
	PS71/216-3	27.03.08	18:28	63° 43.04' S	50° 50.38' W	2537.5	Mooring	MOR	surface	5 Floats(o,o,o,o,o)
	PS71/216-3	27.03.08	18:34	63° 43.01' S	50° 50.40' W	2537.2	Mooring	MOR	surface	Strömungsmesser+3Float`s(o,o,o)
	PS71/216-3	27.03.08	18:36	63° 43.00' S	50° 50.40' W	2537.5	Mooring	MOR	surface	Seacat SBE 37
	PS71/216-3	27.03.08	18:43	63° 42.97' S	50° 50.42' W	2537.2	Mooring	MOR	surface	Seacat SBE 37
	PS71/216-3	27.03.08	19:14	63° 42.86' S	50° 50.48' W	2537.0	Mooring	MOR	surface	Schallquelle
	PS71/216-3	27.03.08	19:18	63° 42.84' S	50° 50.48' W	2537.0	Mooring	MOR	surface	Str.messer, 8 Stck Floats
	PS71/216-3	27.03.08	19:34	63° 42.79' S	50° 50.52' W	2537.2	Mooring	MOR	surface	Seacat, Str.messer, Transponder
	PS71/216-3	27.03.08	19:38	63° 42.78' S	50° 50.53' W	2537.0	Mooring	MOR	surface	Topkugel, MuFuKo
	PS71/216-3	27.03.08	19:46	63° 42.75' S	50° 50.54' W	2537.0	Mooring	MOR	surface	ULS
	PS71/216-3	27.03.08	19:46	63° 42.75' S	50° 50.54' W	2537.0	Mooring	MOR	surface	Releaser
	PS71/216-3	27.03.08	19:51	63° 42.74' S	50° 50.55' W	2537.0	Mooring	MOR	action	Geslippt
	PS71/216-3	27.03.08	19:52	63° 42.73' S	50° 50.56' W	2537.0	Mooring	MOR	on deck	Releaser
A1	PS71/216-4	27.03.08	21:04	63° 42.10' S	50° 50.66' W	2536.7	CTD, Ultra	CTD/UC	into Water	**Cd isotopes**
A1	PS71/216-4	27.03.08	21:54	63° 41.95' S	50° 50.70' W	2536.5	CTD, Ultra	CTD/UC	on Depth	SL 2450m **Cd isotopes**
A1	PS71/216-4	27.03.08	22:53	63° 41.78' S	50° 50.67' W	2536.2	CTD, Ultra	CTD/UC	on Deck	**Cd isotopes**
B1	PS71/216-5	27.03.08	23:03	63° 41.76' S	50° 50.66' W	2536.2	CTD/rosett	CTD/RO	surface	
B1	PS71/216-5	28.03.08	00:08	63° 41.58' S	50° 50.55' W	2536.0	CTD/rosett	CTD/RO	at depth	EL31 2478m
B1	PS71/216-5	28.03.08	00:54	63° 41.47' S	50° 50.39' W	2536.7	CTD/rosett	CTD/RO	on deck	
B1	PS71/217-1	28.03.08	04:14	63° 42.11' S	51° 18.65' W	2254.2	CTD/rosett	CTD/RO	surface	
B1	PS71/217-1	28.03.08	05:04	63° 42.09' S	51° 18.52' W	2255.5	CTD/rosett	CTD/RO	at depth	2199 m
B1	PS71/217-1	28.03.08	05:44	63° 42.08' S	51° 18.43' W	2256.7	CTD/rosett	CTD/RO	on deck	
B1	PS71/218-1	28.03.08	09:05	63° 36.96' S	51° 40.04' W	1789.5	CTD/rosett	CTD/RO	surface	
B1	PS71/218-1	28.03.08	09:46	63° 36.92' S	51° 40.04' W	1788.2	CTD/rosett	CTD/RO	at depth	SL 1736m
B1	PS71/218-1	28.03.08	10:23	63° 36.85' S	51° 40.05' W	1786.5	CTD/rosett	CTD/RO	on deck	
B1	PS71/219-1	28.03.08	12:32	63° 33.07' S	51° 53.22' W	1238.0	CTD/rosett	CTD/RO	surface	
B1	PS71/219-1	28.03.08	13:05	63° 32.87' S	51° 53.25' W	1234.2	CTD/rosett	CTD/RO	at depth	EL31 1191m
B1	PS71/219-1	28.03.08	13:34	63° 32.70' S	51° 53.33' W	1230.0	CTD/rosett	CTD/RO	on deck	
	PS71/220-1	28.03.08	15:47	63° 29.17' S	52° 5.67' W	967.2	Mooring	MOR	surface	Ankerstein AWI 206-6 MW=+8,4 Ooost
	PS71/220-1	28.03.08	15:52	63° 29.13' S	52° 5.62' W	967.2	Mooring	MOR	surface	Doppelreleaser+Strömungsmesser
	PS71/220-1	28.03.08	15:55	63° 29.11' S	52° 5.61' W	967.0	Mooring	MOR	surface	1 Microcat
	PS71/220-1	28.03.08	16:07	63° 29.02' S	52° 5.66' W	964.7	Mooring	MOR	surface	5 Floats(o,o,o,o,o)+ 1Seacat
	PS71/220-1	28.03.08	16:17	63° 28.96' S	52° 5.65' W	963.7	Mooring	MOR	surface	Strömungsmesser+Microcat
	PS71/220-1	28.03.08	16:30	63° 28.87' S	52° 5.70' W	961.5	Mooring	MOR	surface	Transponder, strömungsmesser, 7 Floats (o) Mufuko
	PS71/220-1	28.03.08	16:36	63° 28.83' S	52° 5.73' W	960.5	Mooring	MOR	surface	ULS, Releaser
	PS71/220-1	28.03.08	16:44	63° 28.77' S	52° 5.77' W	959.0	Mooring	MOR	slipped	
B1	PS71/220-2	28.03.08	17:03	63° 28.44' S	52° 6.21' W	946.5	CTD/rosett	CTD/RO	surface	
B1	PS71/220-2	28.03.08	17:36	63° 28.27' S	52° 6.30' W	942.0	CTD/rosett	CTD/RO	at depth	907 m
B1	PS71/220-2	28.03.08	17:56	63° 28.17' S	52° 6.35' W	939.5	CTD/rosett	CTD/RO	on deck	
B1	PS71/221-1	28.03.08	20:58	63° 24.14' S	52° 31.95' W	519.2	CTD/rosett	CTD/RO	surface	
B1	PS71/221-1	28.03.08	21:17	63° 24.14' S	52° 32.11' W	518.7	CTD/rosett	CTD/RO	at depth	SL 496m
B1	PS71/221-1	28.03.08	21:33	63° 24.11' S	52° 32.23' W	514.5	CTD/rosett	CTD/RO	on deck	
G4	PS71/221-2	28.03.08	21:44	63° 24.09' S	52° 32.36' W	517.0	CTD, Ultra	CTD/UC	into Water	
G4	PS71/221-2	28.03.08	22:02	63° 24.10' S	52° 32.55' W	515.2	CTD, Ultra	CTD/UC	on Depth	SL 493m
G4	PS71/221-2	28.03.08	22:32	63° 24.03' S	52° 32.90' W	513.5	CTD, Ultra	CTD/UC	on Deck	
B1	PS71/222-1	29.03.08	01:12	63° 21.19' S	52° 51.39' W	444.2	CTD/rosett	CTD/RO	surface	
B1	PS71/222-1	29.03.08	01:32	63° 21.19' S	52° 51.24' W	444.5	CTD/rosett	CTD/RO	at depth	EL31 431m
B1	PS71/222-2	29.03.08	01:54	63° 21.21' S	52° 51.03' W	444.7	CTD, Ultra	CTD/UC	into Water	
A1	PS71/222-2	29.03.08	01:54	63° 21.21' S	52° 51.03' W	444.7	CTD, Ultra	CTD/UC	into Water	
A1	PS71/222-2	29.03.08	02:11	63° 21.23' S	52° 50.83' W	445.2	CTD, Ultra	CTD/UC	on Depth	425m

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment	
A1	PS71/222-2	29.03.08	02:41	63° 21.23' S	52° 50.46' W	453.5	CTD, Ultra	CTD/UC	on Deck		
	PS71/222-3	29.03.08	02:53	63° 21.20' S	52° 50.34' W	446.7	In situ pum	ISP	into water	Ankerstein	
	PS71/222-3	29.03.08	03:00	63° 21.20' S	52° 50.24' W	446.7	In situ pum	ISP	into water	1. Pumpe	
	PS71/222-3	29.03.08	03:10	0° 0.00' N	0° 0.00' E	0.0	In situ pum	ISP	into water	2. Pumpe 120m	
	PS71/222-3	29.03.08	03:15	63° 21.19' S	52° 50.06' W	447.0	In situ pum	ISP	into water	3.pumpe	
	PS71/222-3	29.03.08	03:18	63° 21.19' S	52° 50.03' W	447.0	In situ pum	ISP	into water	4. Pumpe	
	PS71/222-3	29.03.08	03:20	63° 21.19' S	52° 50.00' W	447.0	In situ pum	ISP	pump at de	400m	
	PS71/222-3	29.03.08	05:33	63° 21.19' S	52° 48.11' W	448.5	In situ pum	ISP	Information	Hieven	
	PS71/222-3	29.03.08	05:34	63° 21.19' S	52° 48.10' W	448.5	In situ pum	ISP	on deck	4 .Pumpe	
	PS71/222-3	29.03.08	05:38	63° 21.18' S	52° 48.04' W	449.2	In situ pum	ISP	on deck	3.pumpe	
	PS71/222-3	29.03.08	05:42	63° 21.18' S	52° 47.99' W	449.7	In situ pum	ISP	on deck	2.Pumpe	
	PS71/222-3	29.03.08	05:45	63° 21.17' S	52° 47.95' W	450.0	In situ pum	ISP	on deck	1. Pumpe	
	PS71/222-3	29.03.08	05:49	63° 21.17' S	52° 47.90' W	450.5	In situ pum	ISP	on deck	Gewicht	
C	PS71/222-4	29.03.08	06:00	63° 21.16' S	52° 47.77' W	449.5	CTD/rosett	CTD/RO	surface		
C	PS71/222-4	29.03.08	06:18	63° 21.14' S	52° 47.56' W	451.5	CTD/rosett	CTD/RO	at depth	434 m	
C	PS71/222-4	29.03.08	06:32	63° 21.12' S	52° 47.40' W	451.2	CTD/rosett	CTD/RO	on deck		
B1	PS71/223-1	29.03.08	14:51	63° 17.42' S	53° 13.87' W	428.0	CTD/rosett	CTD/RO	surface		
B1	PS71/223-1	29.03.08	15:09	63° 17.28' S	53° 13.80' W	430.5	CTD/rosett	CTD/RO	at depth	420m	
B1	PS71/223-1	29.03.08	15:24	63° 17.20' S	53° 13.97' W	431.0	CTD/rosett	CTD/RO	on deck		
G5	PS71/223-2	29.03.08	15:30	63° 17.17' S	53° 14.04' W	431.0	CTD, Ultra	CTD/UC	into Water		
G5	PS71/223-2	29.03.08	15:48	63° 17.10' S	53° 14.26' W	431.5	CTD, Ultra	CTD/UC	on Depth	420 m	
G5	PS71/223-2	29.03.08	16:10	63° 17.00' S	53° 14.44' W	431.0	CTD, Ultra	CTD/UC	on Deck		
	END OF WEDDELL SEA SECTION										
	BEGIN TRANSIT TO KING GEORGE ISLAND										
	ONE HYDROCAST IN THE BAY OF KING GEORGE ISLAND:										
A2	PS71/224-1	31.03.08	18:35	62° 12.30' S	58° 55.95' W	95.2	CTD/rosett	CTD/RO	surface		
A2	PS71/224-1	31.03.08	18:42	62° 12.27' S	58° 56.01' W	91.7	CTD/rosett	CTD/RO	at depth	75 m	
A2	PS71/224-1	31.03.08	18:52	62° 12.28' S	58° 56.04' W	90.5	CTD/rosett	CTD/RO	on deck		
	BEGIN TRANSIT TO FIRST STATION OF DRAKE PASSAGE TRANSECT										
B1	PS71/225-1	01.04.08	15:10	60° 42.54' S	53° 36.52' W	1414.2	CTD/rosett	CTD/RO	surface		
B1	PS71/225-1	01.04.08	15:46	60° 42.49' S	53° 36.93' W	1463.2	CTD/rosett	CTD/RO	at depth	1386 m	
B1	PS71/225-1	01.04.08	16:15	60° 42.41' S	53° 36.97' W	1496.2	CTD/rosett	CTD/RO	on deck		
	PS71/225-2	01.04.08	16:33	60° 42.11' S	53° 36.31' W	1365.7	Test	TEST	surface	UC Winch mit Gewicht	
	PS71/225-2	01.04.08	16:35	60° 42.11' S	53° 36.26' W	1262.2	Test	TEST	at depth	200 m	
	PS71/225-2	01.04.08	16:42	60° 42.13' S	53° 36.14' W	1239.5	Test	TEST	on deck		
	PS71/225-3	01.04.08	16:45	60° 42.15' S	53° 36.08' W	0.0	Drifter, long	LD	surface		
	PS71/226-1	01.04.08	18:30	60° 37.90' S	53° 47.83' W	2728.5	Mooring	MOR	Hydrophon	Recovery M 10	
	PS71/226-1	01.04.08	18:37	60° 37.93' S	53° 47.70' W	2726.0	Mooring	MOR	released		
	PS71/226-1	01.04.08	18:38	60° 37.94' S	53° 47.69' W	2727.0	Mooring	MOR	Hydrophone on Deck		
	PS71/226-1	01.04.08	18:39	60° 37.94' S	53° 47.67' W	2726.5	Mooring	MOR	Hydrophone into the water		
	PS71/226-1	01.04.08	18:42	60° 37.96' S	53° 47.61' W	2724.5	Mooring	MOR	released		
	PS71/226-1	01.04.08	18:47	60° 37.99' S	53° 47.54' W	2725.0	Mooring	MOR	Hydrophone on Deck		
	PS71/226-1	01.04.08	18:53	60° 37.90' S	53° 47.90' W	2728.0	Mooring	MOR	Hydrophone into the water		
	PS71/226-1	01.04.08	19:02	60° 37.92' S	53° 47.86' W	0.0	Mooring	MOR	released		
	PS71/226-1	01.04.08	19:03	60° 37.92' S	53° 47.83' W	0.0	Mooring	MOR	released		
	PS71/226-1	01.04.08	19:10	60° 37.93' S	53° 47.95' W	2729.7	Mooring	MOR	on the surface		
	PS71/226-1	01.04.08	19:36	60° 38.04' S	53° 48.07' W	2732.0	Mooring	MOR	on deck	7 Bentos + 1MuFuKo	
	PS71/226-1	01.04.08	19:41	60° 38.09' S	53° 47.96' W	2730.7	Mooring	MOR	on deck	Strömungsmesser	
	PS71/226-1	01.04.08	19:51	60° 38.16' S	53° 47.86' W	2728.0	Mooring	MOR	on deck	8 Floats	
	PS71/226-1	01.04.08	20:00	60° 38.19' S	53° 47.75' W	2726.7	Mooring	MOR	on deck	Strömungsmesser	
	PS71/226-1	01.04.08	20:23	60° 38.23' S	53° 47.71' W	2725.7	Mooring	MOR	on deck	6 Floats	
	PS71/226-1	01.04.08	20:27	60° 38.23' S	53° 47.67' W	2724.7	Mooring	MOR	mooring on	4 Floats + 1 Releaser	
A1	PS71/226-1	01.04.08	20:55	60° 37.64' S	53° 49.79' W	2775.0	CTD, Ultra	CTD/UC	into Water		
A1	PS71/226-2	01.04.08	21:33	60° 37.60' S	53° 49.82' W	2776.7	CTD, Ultra	CTD/UC	Information	SL 1060m Kabel aus dem Block, wird gehievt	CABLE DAMAGE AT 1050 METER OUT
A1	PS71/226-2	01.04.08	21:47	60° 37.61' S	53° 49.75' W	2775.0	CTD, Ultra	CTD/UC	Information	Probenentnahme von SL 900m aufwärts	
A1	PS71/226-2	01.04.08	22:37	60° 37.58' S	53° 49.88' W	2778.0	CTD, Ultra	CTD/UC	on Deck		
B1	PS71/226-3	01.04.08	22:50	60° 37.59' S	53° 49.88' W	2778.7	CTD/rosett	CTD/RO	surface		

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment
B1	PS71/226-3	01.04.08	23:46	60° 37.57' S	53° 49.84' W	2777.2	CTD/rosett	CTD/RO	at depth	EL31 2707m
B1	PS71/226-3	02.04.08	00:37	60° 37.63' S	53° 49.88' W	2777.2	CTD/rosett	CTD/RO	on deck	
B1	PS71/227-1	02.04.08	02:00	60° 31.79' S	54° 5.48' W	3046.7	CTD/rosett	CTD/RO	surface	
B1	PS71/227-1	02.04.08	03:23	60° 32.04' S	54° 5.41' W	2977.7	CTD/rosett	CTD/RO	at depth	2988 m
B1	PS71/227-1	02.04.08	03:58	60° 32.15' S	54° 5.65' W	2971.0	CTD/rosett	CTD/RO	on deck	
B1	PS71/228-1	02.04.08	05:07	60° 26.88' S	54° 19.42' W	3181.7	CTD/rosett	CTD/RO	surface	
B1	PS71/228-1	02.04.08	06:07	60° 26.71' S	54° 19.12' W	3177.7	CTD/rosett	CTD/RO	at depth	3105 m
B1	PS71/228-1	02.04.08	07:09	60° 26.44' S	54° 19.42' W	3185.0	CTD/rosett	CTD/RO	on deck	
B1	PS71/229-1	02.04.08	09:13	60° 16.23' S	54° 47.57' W	3267.0	CTD/rosett	CTD/RO	surface	
B1	PS71/229-1	02.04.08	10:25	60° 16.19' S	54° 47.79' W	3268.5	CTD/rosett	CTD/RO	at depth	SL 3192m
B1	PS71/229-1	02.04.08	11:26	60° 16.28' S	54° 47.76' W	3265.2	CTD/rosett	CTD/RO	on deck	
	PS71/230	**START SUPERSTATION DRAKE-1**								
	PS71/230-1	02.04.08	13:46	60° 6.14' S	55° 15.89' W	3513.7	Mooring	MOR	Hydrophon	Verankerung M-9
	PS71/230-1	02.04.08	13:49	60° 6.10' S	55° 16.06' W	3515.2	Mooring	MOR	released	
	PS71/230-1	02.04.08	14:01	60° 6.06' S	55° 16.01' W	3514.5	Mooring	MOR	on the surface	
	PS71/230-1	02.04.08	14:32	60° 5.83' S	55° 16.96' W	3516.0	Mooring	MOR	on deck	6 Floats, 1 Strömungsmesser
	PS71/230-1	02.04.08	14:53	60° 5.91' S	55° 16.79' W	3515.7	Mooring	MOR	on deck	6 Floats
	PS71/230-1	02.04.08	15:13	60° 6.06' S	55° 16.87' W	3517.7	Mooring	MOR	on deck	1 Strömungsmesser+ 9 Floats+MUFUKO
	PS71/230-1	02.04.08	15:30	60° 6.18' S	55° 17.09' W	3519.0	Mooring	MOR	on deck	9 Floats+ Strömungsmesser
	PS71/230-1	02.04.08	15:40	60° 6.19' S	55° 16.92' W	3521.5	Mooring	MOR	on deck	6 Floats+Doppelrelaser
A2	PS71/230-2	02.04.08	15:53	60° 6.23' S	55° 16.75' W	3518.7	CTD/rosett	CTD/RO	surface	
A2	PS71/230-2	02.04.08	16:02	60° 6.27' S	55° 16.65' W	3518.0	CTD/rosett	CTD/RO	at depth	197 m
A2	PS71/230-2	02.04.08	16:12	60° 6.31' S	55° 16.64' W	3525.5	CTD/rosett	CTD/RO	on deck	
B2	PS71/230-3	02.04.08	16:25	60° 6.41' S	55° 16.86' W	3519.2	CTD, Ultra	CTD/UC	into Water	
B2	PS71/230-3	02.04.08	16:31	60° 6.46' S	55° 16.93' W	3518.2	CTD, Ultra	CTD/UC	on Depth	150 m
B2	PS71/230-3	02.04.08	16:48	60° 6.50' S	55° 16.85' W	3518.0	CTD, Ultra	CTD/UC	on Deck	
C	PS71/230-4	02.04.08	16:58	60° 6.48' S	55° 16.63' W	3517.5	CTD/rosett	CTD/RO	surface	
C	PS71/230-4	02.04.08	17:07	60° 6.46' S	55° 16.62' W	3518.5	CTD/rosett	CTD/RO	at depth	200 m
C	PS71/230-4	02.04.08	17:22	60° 6.44' S	55° 16.46' W	3516.2	CTD/rosett	CTD/RO	Information	fieren weiter bis zum Grund
C	PS71/230-4	02.04.08	18:24	60° 6.38' S	55° 16.23' W	3515.2	CTD/rosett	CTD/RO	at depth	3458 m
C	PS71/230-4	02.04.08	19:22	60° 6.20' S	55° 16.21' W	3516.0	CTD/rosett	CTD/RO	on deck	
	PS71/230-5	02.04.08	19:24	60° 6.20' S	55° 16.24' W	3515.7	In situ pum	ISP	into water	Gewicht
	PS71/230-5	02.04.08	19:40	60° 6.13' S	55° 16.44' W	3516.7	In situ pum	ISP	into water	Pumpe 1 SL 20m
	PS71/230-5	02.04.08	20:06	60° 6.01' S	55° 16.36' W	3516.5	In situ pum	ISP	into water	Pumpe 2 SL 1021m
	PS71/230-5	02.04.08	20:27	60° 6.00' S	55° 16.30' W	3517.0	In situ pum	ISP	into water	Pumpe 3 SL 2020m
	PS71/230-5	02.04.08	20:39	60° 6.03' S	55° 16.36' W	3516.5	In situ pum	ISP	into water	Pumpe 4 SL2521m
	PS71/230-5	02.04.08	20:48	60° 6.04' S	55° 16.27' W	3516.0	In situ pum	ISP	into water	Pumpe 5 SL2771m
	PS71/230-5	02.04.08	20:55	60° 6.01' S	55° 16.19' W	3515.5	In situ pum	ISP	into water	Pumpe 6 SL2920m
	PS71/230-5	02.04.08	20:58	60° 6.01' S	55° 16.16' W	3514.7	In situ pum	ISP	pump at de	Ausgesteckte Seillänge 3021m
	PS71/230-5	02.04.08	23:54	60° 6.06' S	55° 16.39' W	3515.2	In situ pum	ISP	on deck	6. Pumpe
	PS71/230-5	03.04.08	00:00	60° 6.02' S	55° 16.41' W	3515.5	In situ pum	ISP	on deck	5. Pumpe
	PS71/230-5	03.04.08	00:06	60° 5.98' S	55° 16.39' W	3515.0	In situ pum	ISP	on deck	4. Pumpe
	PS71/230-5	03.04.08	00:16	60° 5.92' S	55° 16.42' W	3515.5	In situ pum	ISP	on deck	3. Pumpe
	PS71/230-5	03.04.08	00:38	60° 5.92' S	55° 16.46' W	3514.5	In situ pum	ISP	on deck	2. Pumpe
	PS71/230-5	03.04.08	00:58	60° 6.02' S	55° 16.53' W	3515.5	In situ pum	ISP	into water	1. Pumpe
	PS71/230-5	03.04.08	01:00	60° 6.04' S	55° 16.52' W	3516.5	In situ pum	ISP	on deck	Ankerstein
A1	PS71/230-6	03.04.08	01:20	60° 6.03' S	55° 16.16' W	3514.5	CTD, Ultra	CTD/UC	into Water	
A1	PS71/230-6	03.04.08	03:33	60° 6.12' S	55° 16.35' W	3515.2	CTD, Ultra	CTD/UC	on Depth	3420 m
A1	PS71/230-6	03.04.08	04:56	60° 6.06' S	55° 16.93' W	3517.7	CTD, Ultra	CTD/UC	on Deck	
	PS71/230	**END SUPERSTATION DRAKE-1**								
	PS71/231-1	03.04.08	08:12	59° 54.90' S	55° 44.57' W	3574.7	Test	TEST	information	Zugtest EL 31, 1,9t
	PS71/231-1	03.04.08	08:14	59° 54.89' S	55° 44.62' W	3574.7	Test	TEST	information	beendet
B2	PS71/231-2	03.04.08	08:44	59° 54.88' S	55° 44.71' W	3575.7	CTD/rosett	CTD/RO	surface	
B2	PS71/231-2	03.04.08	10:09	59° 54.95' S	55° 44.76' W	3575.7	CTD/rosett	CTD/RO	at depth	SL 3495m

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment
B2	PS71/231-2	03.04.08	11:17	59° 55.50' S	55° 44.52' W	3577.5	CTD/rosett	CTD/RO	on deck	
B2	PS71/232-1	03.04.08	13:47	59° 43.99' S	56° 12.89' W	3628.5	CTD/rosett	CTD/RO	surface	
B2	PS71/232-1	03.04.08	15:15	59° 45.02' S	56° 14.20' W	3636.2	CTD/rosett	CTD/RO	at depth	EL31 3601m
B2	PS71/232-1	03.04.08	16:25	59° 45.59' S	56° 14.98' W	3629.2	CTD/rosett	CTD/RO	on deck	
	PS71/233-1	03.04.08	19:02	59° 33.08' S	56° 41.03' W	3571.2	Mooring	MOR	Hydrophon	Verankerung M8
	PS71/233-1	03.04.08	19:04	59° 33.06' S	56° 41.01' W	3571.2	Mooring	MOR	Hydrophone on Deck	
	PS71/233-1	03.04.08	19:53	59° 32.93' S	56° 41.03' W	3571.2	Mooring	MOR	released	
	PS71/233-1	03.04.08	21:47	59° 33.12' S	56° 40.97' W	3572.2	Mooring	MOR	action	Abbruch
B1	PS71/233-2	03.04.08	23:02	59° 33.47' S	56° 39.81' W	3579.2	CTD/rosett	CTD/RO	surface	
B1	PS71/233-2	04.04.08	00:13	59° 33.50' S	56° 39.91' W	3579.5	CTD/rosett	CTD/RO	at depth	EL31 3505m
B1	PS71/233-2	04.04.08	01:17	59° 33.51' S	56° 40.24' W	3578.2	CTD/rosett	CTD/RO	on deck	
	PS71/233-1	04.04.08	10:43	59° 33.39' S	56° 38.34' W	3578.0	Mooring	MOR	action	Start aussetzen Dredgegewicht (600kg)und Draht
	PS71/233-1	04.04.08	10:47	59° 33.39' S	56° 38.38' W	3578.0	Mooring	MOR	surface	Ankerstein 600kg
	PS71/233-1	04.04.08	10:55	59° 33.37' S	56° 38.27' W	3577.5	Mooring	MOR	surface	1 draggen, 80m SL
	PS71/233-1	04.04.08	11:08	59° 33.36' S	56° 38.22' W	3577.5	Mooring	MOR	surface	2 Draggen, 580m
	PS71/233-1	04.04.08	11:22	59° 33.34' S	56° 38.12' W	3577.0	Mooring	MOR	surface	2 Draggen, 1080m
	PS71/233-1	04.04.08	11:42	59° 33.31' S	56° 38.12' W	3576.2	Mooring	MOR	surface	2 dragger, SL 1555m
	PS71/233-1	04.04.08	12:03	59° 33.34' S	56° 38.22' W	3576.5	Mooring	MOR	surface	1 Draggen, 2100m
	PS71/233-1	04.04.08	15:20	59° 33.39' S	56° 38.02' W	3572.2	Mooring	MOR	action	Beginnen Mooring einzukreisen
	PS71/233-1	04.04.08	17:30	59° 33.27' S	56° 37.66' W	3577.5	Mooring	MOR	action	stoppen nach 2 Törn`s auf Posidonia Position
	PS71/233-1	04.04.08	18:07	59° 33.25' S	56° 37.81' W	3576.5	Mooring	MOR	action	neuer Kreis
	PS71/233-1	04.04.08	19:43	59° 33.56' S	56° 36.60' W	3588.2	Mooring	MOR	action	start hieven
	PS71/233-1	04.04.08	21:01	59° 33.61' S	56° 36.82' W	3586.2	Mooring	MOR	on deck	3500m Keflar Line & 1 Draggen
	PS71/233-1	04.04.08	21:25	59° 33.61' S	56° 36.80' W	3586.5	Mooring	MOR	on deck	2. Draggen
	PS71/233-1	04.04.08	21:42	59° 33.59' S	56° 36.71' W	3587.2	Mooring	MOR	action	Draht gekappt
B1	PS71/234-1	05.04.08	00:36	59° 21.56' S	57° 8.50' W	3556.7	CTD/rosett	CTD/RO	surface	
B1	PS71/234-1	05.04.08	01:42	59° 21.47' S	57° 8.61' W	3557.2	CTD/rosett	CTD/RO	at depth	EL31 3483m
B1	PS71/234-1	05.04.08	02:43	59° 21.48' S	57° 8.42' W	3556.5	CTD/rosett	CTD/RO	on deck	
	PS71/234-2	05.04.08	02:44	59° 21.48' S	57° 8.41' W	3557.7	Drifter, long	LD	surface	wetterboje
B1	PS71/235-1	05.04.08	05:28	59° 9.49' S	57° 37.45' W	3649.2	CTD/rosett	CTD/RO	surface	
B1	PS71/235-1	05.04.08	06:38	59° 9.42' S	57° 37.90' W	3647.5	CTD/rosett	CTD/RO	at depth	3586 m
B1	PS71/235-1	05.04.08	07:44	59° 9.49' S	57° 37.99' W	3651.2	CTD/rosett	CTD/RO	on deck	
	PS71/236	**START SUPERSTATION DRAKE-2**								
D	PS71/236-1	05.04.08	10:02	58° 57.81' S	58° 5.81' W	3772.7	CTD/rosett	CTD/RO	surface	
D	PS71/236-1	05.04.08	10:14	58° 57.82' S	58° 5.93' W	3772.2	CTD/rosett	CTD/RO	at depth	SL 196m
D	PS71/236-1	05.04.08	10:28	58° 57.79' S	58° 6.05' W	3773.0	CTD/rosett	CTD/RO	on deck	
	PS71/236-2	05.04.08	10:37	58° 57.45' S	58° 5.49' W	3768.2	Mooring	MOR	released	Moor M7
	PS71/236-2	05.04.08	15:11	58° 58.13' S	58° 7.37' W	3780.2	Mooring	MOR	on deck	6 Floats,Releaser
	PS71/236-2	05.04.08	15:15	58° 58.14' S	58° 7.41' W	3779.5	Mooring	MOR	on deck	1 Strömungsmesser
	PS71/236-2	05.04.08	15:20	58° 58.17' S	58° 7.39' W	3779.7	Mooring	MOR	on deck	14 Floats
	PS71/236-2	05.04.08	15:49	58° 58.21' S	58° 7.65' W	3781.7	Mooring	MOR	on deck	Strömungsmesser+Microcat-1 Float eliptic
	PS71/236-2	05.04.08	15:55	58° 58.23' S	58° 7.66' W	3781.5	Mooring	MOR	on deck	Float, spheric
	PS71/236-2	05.04.08	16:10	58° 58.27' S	58° 7.73' W	3782.2	Mooring	MOR	on deck	Strömungsmesser, Aquadopp, eliptic Float
A1	PS71/236-3	05.04.08	16:31	58° 58.27' S	58° 7.92' W	3783.0	CTD, Ultra	CTD/UC	into Water	
A1	PS71/236-3	05.04.08	17:54	58° 58.23' S	58° 8.32' W	3787.7	CTD, Ultra	CTD/UC	on Depth	3700 m
A1	PS71/236-3	05.04.08	19:10	58° 58.04' S	58° 8.87' W	3790.7	CTD, Ultra	CTD/UC	on Deck	
	PS71/236-4	05.04.08	19:32	58° 57.54' S	58° 5.86' W	3771.2	In situ pum	ISP	into water	Gewicht
	PS71/236-4	05.04.08	19:36	58° 57.52' S	58° 5.83' W	3770.5	In situ pum	ISP	into water	1.Pumpe Sl 20m
	PS71/236-4	05.04.08	19:51	58° 57.53' S	58° 5.75' W	3769.2	In situ pum	ISP	into water	2. Pumpe, SL 725m
	PS71/236-4	05.04.08	20:24	58° 57.51' S	58° 5.99' W	3772.0	In situ pum	ISP	into water	3. Pumpe, SL 2520m
	PS71/236-4	05.04.08	20:36	58° 57.53' S	58° 6.03' W	3772.0	In situ pum	ISP	into water	4. Pumpe, SL 3120m
	PS71/236-4	05.04.08	20:41	58° 57.53' S	58° 6.04' W	3772.0	In situ pum	ISP	into water	5. Pumpe SL 3271m
	PS71/236-4	05.04.08	20:45	58° 57.54' S	58° 6.04' W	3772.2	In situ pum	ISP	into water	6. Pumpe SL 3420m
	PS71/236-4	05.04.08	20:48	58° 57.54' S	58° 6.03' W	3771.7	In situ pum	ISP	pump at de	SL 3520m, hoist 2120LT
	PS71/236-4	06.04.08	00:12	58° 58.38' S	58° 7.38' W	3780.2	In situ pum	ISP	on deck	6. Pumpe
	PS71/236-4	06.04.08	00:16	58° 58.41' S	58° 7.42' W	3780.2	In situ pum	ISP	on deck	5. Pumpe

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment
	PS71/236-4	06.04.08	00:21	58° 58.45' S	58° 7.46' W	3779.7	In situ pum	ISP	on deck	4. Pumpe
	PS71/236-4	06.04.08	00:34	58° 58.56' S	58° 7.56' W	3779.7	In situ pum	ISP	on deck	3. Pumpe
	PS71/236-4	06.04.08	01:08	58° 58.88' S	58° 7.76' W	3780.5	In situ pum	ISP	on deck	2. Pumpe
	PS71/236-4	06.04.08	01:22	58° 58.99' S	58° 7.84' W	3782.0	In situ pum	ISP	on deck	1. Pumpe
	PS71/236-4	06.04.08	01:25	58° 59.01' S	58° 7.84' W	3782.0	In situ pum	ISP	on deck	Ankerstein
F	PS71/236-5	06.04.08	01:42	58° 58.42' S	58° 7.35' W	3778.7	CTD, Ultra	CTD/UC	into Water	
F	PS71/236-5	06.04.08	02:46	58° 59.22' S	58° 7.89' W	3782.5	CTD, Ultra	CTD/UC	on Depth	2500m
F	PS71/236-5	06.04.08	03:38	58° 59.48' S	58° 8.17' W	3784.5	CTD, Ultra	CTD/UC	on Deck	
C	PS71/236-6	06.04.08	03:50	58° 59.56' S	58° 8.21' W	3784.2	CTD/rosett	CTD/RO	surface	
C	PS71/236-6	06.04.08	05:02	58° 59.91' S	58° 8.30' W	3785.7	CTD/rosett	CTD/RO	at depth	3712 m
C	PS71/236-6	06.04.08	06:04	58° 59.99' S	58° 8.69' W	3790.2	CTD/rosett	CTD/RO	on deck	
	PS71/236	**END SUPERSTATION DRAKE-2**								
B1	PS71/237-1	06.04.08	09:02	58° 39.19' S	58° 47.43' W	3934.0	CTD/rosett	CTD/RO	surface	
B1	PS71/237-1	06.04.08	10:26	58° 39.20' S	58° 47.45' W	3933.7	CTD/rosett	CTD/RO	at depth	SL 3869m
B1	PS71/237-1	06.04.08	11:33	58° 39.12' S	58° 47.30' W	3928.5	CTD/rosett	CTD/RO	on deck	
	PS71/237-2	06.04.08	11:42	58° 38.99' S	58° 47.14' W	3923.7	FLOAT	FLOAT	into water	
	PS71/238-1	06.04.08	14:42	58° 19.13' S	59° 31.47' W	3152.0	Mooring	MOR	released	Verankerung M6
	PS71/238-1	06.04.08	15:03	58° 18.93' S	59° 31.21' W	3130.0	Mooring	MOR	on the surface	
	PS71/238-1	06.04.08	15:24	58° 18.26' S	59° 30.38' W	3129.7	Mooring	MOR	on deck	eliptic Bouy+Argos 2 Strömungsmesser
	PS71/238-1	06.04.08	15:32	58° 18.20' S	59° 30.39' W	3118.2	Mooring	MOR	on deck	ecliptic Float
	PS71/238-1	06.04.08	15:37	58° 18.22' S	59° 30.32' W	3135.0	Mooring	MOR	on deck	ecliptic Float+Microcat Strömungsmesser
	PS71/238-1	06.04.08	16:04	58° 18.16' S	59° 29.56' W	3154.5	Mooring	MOR	on deck	14 Float+
	PS71/238-1	06.04.08	16:10	58° 18.13' S	59° 29.37' W	3120.0	Mooring	MOR	on deck	1 Strömungsmesser
	PS71/238-1	06.04.08	16:13	58° 18.13' S	59° 29.29' W	3010.5	Mooring	MOR	on deck	6 Floats+Releaser
A1	PS71/238-2	06.04.08	16:28	58° 18.14' S	59° 28.87' W	2994.0	CTD, Ultra	CTD/UC	into Water	
A1	PS71/238-2	06.04.08	17:21	58° 18.10' S	59° 28.62' W	3077.0	CTD, Ultra	CTD/UC	on Depth	2950 m
A1	PS71/238-2	06.04.08	18:29	58° 17.81' S	59° 28.79' W	3156.0	CTD, Ultra	CTD/UC	on Deck	
B1	PS71/238-3	06.04.08	18:40	58° 17.75' S	59° 28.86' W	3147.7	CTD/rosett	CTD/RO	surface	
B1	PS71/238-3	06.04.08	19:52	58° 17.31' S	59° 28.69' W	3378.5	CTD/rosett	CTD/RO	at depth	SL 3390m
B1	PS71/238-3	06.04.08	20:56	58° 17.02' S	59° 28.18' W	3543.0	CTD/rosett	CTD/RO	on deck	
	PS71/238-4	06.04.08	21:00	58° 16.98' S	59° 28.20' W	3539.5	FLOAT	FLOAT	into water	
B1	PS71/239-1	06.04.08	22:56	58° 5.92' S	60° 0.13' W	4104.5	CTD/rosett	CTD/RO	surface	
B1	PS71/239-1	07.04.08	00:16	58° 5.93' S	60° 0.24' W	4069.5	CTD/rosett	CTD/RO	at depth	EL31 4073m
B1	PS71/239-1	07.04.08	01:25	58° 5.85' S	60° 0.16' W	4082.7	CTD/rosett	CTD/RO	on deck	
	PS71/239-2	07.04.08	01:28	58° 5.89' S	60° 0.19' W	4127.2	FLOAT	FLOAT	into water	
B1	PS71/240-1	07.04.08	03:45	57° 52.57' S	60° 28.44' W	4032.0	CTD/rosett	CTD/RO	surface	
B1	PS71/240-1	07.04.08	04:59	57° 52.55' S	60° 27.94' W	3986.5	CTD/rosett	CTD/RO	at depth	3955 m
B1	PS71/240-1	07.04.08	06:08	57° 52.39' S	60° 27.14' W	3898.2	CTD/rosett	CTD/RO	on deck	
	PS71/240-2	07.04.08	06:11	57° 52.31' S	60° 27.24' W	3895.0	FLOAT	FLOAT	into water	LOCEAN 3
	PS71/241	**BEGIN SUPERSTATION DRAKE-3**								
B1	PS71/241-1	07.04.08	08:25	57° 38.33' S	60° 53.87' W	3446.5	CTD/rosett	CTD/RO	surface	
B1	PS71/241-1	07.04.08	09:38	57° 38.29' S	60° 53.93' W	3435.5	CTD/rosett	CTD/RO	at depth	SL 3373m
	PS71/241-2	07.04.08	10:16	57° 38.32' S	60° 53.83' W	3448.5	Mooring	MOR	released	M5
	PS71/241-2	07.04.08	10:24	57° 38.30' S	60° 53.83' W	3443.7	Mooring	MOR	on the surfa	Argossignal received SP 330°-1nm
B1	PS71/241-1	07.04.08	10:40	57° 38.36' S	60° 53.81' W	3500.7	CTD/rosett	CTD/RO	on deck	
	PS71/241-2	07.04.08	10:50	57° 37.87' S	60° 54.80' W	3416.2	Mooring	MOR	on the surfa	optisch
	PS71/241-2	07.04.08	11:14	57° 37.67' S	60° 54.59' W	3428.7	Mooring	MOR	on deck	6 Benthos, Releaser
	PS71/241-2	07.04.08	11:19	57° 37.71' S	60° 54.56' W	3420.0	Mooring	MOR	on deck	1 Strömungsmesser, 14 Floats
	PS71/241-2	07.04.08	12:00	57° 37.68' S	60° 54.56' W	3421.5	Mooring	MOR	on deck	1 Strömungsmesser, 1 Microcat, 1 Float
	PS71/241-2	07.04.08	12:04	57° 37.66' S	60° 54.54' W	3424.0	Mooring	MOR	on deck	1 Float
	PS71/241-2	07.04.08	12:16	57° 37.67' S	60° 54.43' W	3420.7	Mooring	MOR	on deck	2 Strömungsmesser, 1 Toppauftrieb, Argussender
	PS71/241-2	07.04.08	12:18	57° 37.68' S	60° 54.42' W	3416.7	Mooring	MOR	mooring on	Verankerung M5 komplett geborgen
D	PS71/241-3	07.04.08	12:24	57° 37.70' S	60° 54.39' W	3415.0	CTD/rosett	CTD/RO	surface	
D	PS71/241-3	07.04.08	12:40	57° 37.67' S	60° 54.48' W	3421.0	CTD/rosett	CTD/RO	on deck	EL31 199m
D	PS71/241-3	07.04.08	12:52	57° 37.63' S	60° 54.42' W	3415.7	CTD/rosett	CTD/RO	on deck	
	PS71/241-4	07.04.08	13:41	57° 38.63' S	61° 0.54' W	3472.5	Mooring	MOR	action	Verankerung M5-2
	PS71/241-4	07.04.08	13:42	57° 38.63' S	61° 0.49' W	3473.5	Mooring	MOR	surface	MuFuKo, 9 Floats (3x3)

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment	
	PS71/241-4	07.04.08	13:44	57° 38.65' S	61° 0.40' W	3456.5	Mooring	MOR	surface	1 Strömungsmesser	
	PS71/241-4	07.04.08	13:51	57° 38.63' S	61° 0.04' W	3444.0	Mooring	MOR	surface	9 Floats (3x3)	
	PS71/241-4	07.04.08	13:59	57° 38.54' S	60° 59.68' W	3452.0	Mooring	MOR	surface	6 Floats	
	PS71/241-4	07.04.08	14:09	57° 38.39' S	60° 59.30' W	3452.5	Mooring	MOR	surface	1 Strömungsmesser	
	PS71/241-4	07.04.08	14:29	57° 38.28' S	60° 58.43' W	3368.2	Mooring	MOR	surface	6 Floats	
	PS71/241-4	07.04.08	14:49	57° 38.12' S	60° 57.37' W	3287.0	Mooring	MOR	surface	1 Strömungsmesser	
	PS71/241-4	07.04.08	14:54	57° 38.08' S	60° 57.24' W	3289.0	Mooring	MOR	surface	6 Floats	
	PS71/241-4	07.04.08	15:10	57° 37.95' S	60° 57.06' W	3309.2	Mooring	MOR	surface	Doppelreleaser	
	PS71/241-4	07.04.08	15:23	57° 37.73' S	60° 56.49' W	3345.5	Mooring	MOR	surface	Ankerstein mit Fallschirm	
	PS71/241-4	07.04.08	15:23	57° 37.73' S	60° 56.49' W	3345.5	Mooring	MOR	slipped	Verankerung M5-2	
	PS71/241-4	07.04.08	15:36	57° 37.53' S	60° 55.01' W	3444.7	Mooring	MOR	action	Sender aus	
B1	PS71/241-5	07.04.08	15:38	57° 37.50' S	60° 54.76' W	3421.0	CTD/rosett	CTD/RO	surface		
B1	PS71/241-5	07.04.08	15:47	57° 37.48' S	60° 54.47' W	3418.0	CTD/rosett	CTD/RO	at depth	EL31 99m	
B1	PS71/241-5	07.04.08	15:54	57° 37.49' S	60° 54.38' W	3399.0	CTD/rosett	CTD/RO	on deck		
A1	PS71/241-6	07.04.08	16:00	57° 37.51' S	60° 54.33' W	3407.5	CTD, Ultra	CTD/UC	into Water		
	PS71/241-7	07.04.08	16:11	57° 37.56' S	60° 54.26' W	3417.2	Hand net	HN	surface		
	PS71/241-7	07.04.08	16:17	57° 37.57' S	60° 54.22' W	3417.0	Hand net	HN	on deck		
A1	PS71/241-6	07.04.08	17:02	57° 37.63' S	60° 53.80' W	3424.2	CTD, Ultra	CTD/UC	on Depth	3350 m	
A1	PS71/241-6	07.04.08	18:14	57° 37.87' S	60° 53.47' W	3442.7	CTD, Ultra	CTD/UC	on Deck		
C	PS71/241-8	07.04.08	18:28	57° 37.92' S	60° 53.18' W	3493.5	CTD mit Kr	CTD/RO/M	MIC in water		PLUS MINICORER
C	PS71/241-8	07.04.08	18:34	57° 37.95' S	60° 53.06' W	3493.5	CTD mit Kr	CTD/RO/M	CTD/RO to water		PLUS MINICORER
C	PS71/241-8	07.04.08	19:44	57° 38.16' S	60° 52.70' W	3491.5	CTD mit Kr	CTD/RO/M	MIC at bott	SL 3423m	PLUS MINICORER
C	PS71/241-8	07.04.08	20:55	57° 38.06' S	60° 52.41' W	3492.7	CTD mit Kr	CTD/RO/M	CTD/RO on deck		PLUS MINICORER
C	PS71/241-8	07.04.08	20:59	57° 38.06' S	60° 52.40' W	3493.0	CTD mit Kr	CTD/RO/M	MIC on deck		PLUS MINICORER
	PS71/241	**END SUPERSTATION DRAKE-3**									
	PS71/241-9	07.04.08	21:30	57° 37.92' S	60° 53.42' W	3479.2	In situ pum	ISP	into water	Grundgewicht	
	PS71/241-9	07.04.08	21:32	57° 37.92' S	60° 53.42' W	3481.5	In situ pum	ISP	into water	1.Pumpe SL 21m	
	PS71/241-9	07.04.08	21:52	57° 37.85' S	60° 53.30' W	3484.0	In situ pum	ISP	into water	2. Pumpe SL 521m	
	PS71/241-9	07.04.08	22:25	57° 37.75' S	60° 52.85' W	3489.2	In situ pum	ISP	into water	3.Pumpe SL 2070m	
	PS71/241-9	07.04.08	22:44	57° 37.80' S	60° 52.72' W	3490.2	In situ pum	ISP	into water	4.Pumpe SL 2571m	
	PS71/241-9	07.04.08	22:58	57° 37.87' S	60° 52.62' W	3490.7	In situ pum	ISP	into water	5.Pumpe SL 3201m	
	PS71/241-9	07.04.08	23:04	57° 37.87' S	60° 52.56' W	3491.2	In situ pum	ISP	into water	6.Pumpe SL 3221m	
	PS71/241-9	07.04.08	23:06	57° 37.87' S	60° 52.55' W	3492.2	In situ pum	ISP	pump at de	GE52.2 3320m	
	PS71/241-9	08.04.08	02:10	57° 37.70' S	60° 52.37' W	3495.0	In situ pum	ISP	on deck	6. Pumpe	
	PS71/241-9	08.04.08	02:13	57° 37.68' S	60° 52.40' W	3494.2	In situ pum	ISP	on deck	5. Pumpe	
	PS71/241-9	08.04.08	02:26	57° 37.65' S	60° 52.43' W	3493.2	In situ pum	ISP	on deck	4. Pumpe	
	PS71/241-9	08.04.08	02:36	57° 37.68' S	60° 52.39' W	3493.7	In situ pum	ISP	on deck	3. Pumpe	
	PS71/241-9	08.04.08	03:07	57° 37.62' S	60° 52.42' W	3492.0	In situ pum	ISP	on deck	2. Pumpe	
	PS71/241-9	08.04.08	03:17	57° 37.54' S	60° 52.48' W	3487.2	In situ pum	ISP	on deck	1 . Pumpe	
	PS71/241-9	08.04.08	03:19	57° 37.51' S	60° 52.50' W	3485.5	In situ pum	ISP	on deck	Anker	
F	PS71/241-10	08.04.08	03:26	57° 37.42' S	60° 52.57' W	3476.7	CTD/rosett	CTD/RO	surface		
F	PS71/241-10	08.04.08	04:38	57° 37.18' S	60° 52.56' W	3447.7	CTD/rosett	CTD/RO	at depth	2799 m	
F	PS71/241-10	08.04.08	05:22	57° 37.32' S	60° 52.06' W	3483.2	CTD/rosett	CTD/RO	on deck		
	PS71/241-11	08.04.08	05:25	57° 37.31' S	60° 52.23' W	3477.5	FLOAT	FLOAT	into water	KORDI 2	
B1	PS71/242-1	08.04.08	07:04	57° 31.09' S	61° 9.27' W	3722.2	CTD/rosett	CTD/RO	surface		
B1	PS71/242-1	08.04.08	08:25	57° 30.57' S	61° 7.78' W	3900.5	CTD/rosett	CTD/RO	at depth	SL 3834m	
B1	PS71/242-1	08.04.08	09:31	57° 30.13' S	61° 6.39' W	3911.2	CTD/rosett	CTD/RO	on deck		
	PS71/242-2	08.04.08	09:37	57° 30.12' S	61° 6.39' W	3905.0	FLOAT	FLOAT	into water	Locean 4	
B1	PS71/243-1	08.04.08	11:15	57° 24.97' S	61° 24.68' W	3760.2	CTD/rosett	CTD/RO	surface		
B1	PS71/243-1	08.04.08	12:38	57° 24.38' S	61° 24.12' W	3739.2	CTD/rosett	CTD/RO	at depth	EL31 3694m	
B1	PS71/243-1	08.04.08	13:44	57° 23.94' S	61° 24.32' W	3731.0	CTD/rosett	CTD/RO	on deck		
	PS71/243-2	08.04.08	13:49	57° 23.89' S	61° 24.27' W	3729.7	FLOAT	FLOAT	into water		
	PS71/243	**BEGIN SUPERSTATION DRAKE-4**									
	PS71/244-1	08.04.08	17:27	56° 56.69' S	62° 19.40' W	4065.0	Mooring	MOR	action	M 4 Recover	
	PS71/244-1	08.04.08	17:42	56° 56.44' S	62° 19.64' W	4071.2	Mooring	MOR	released		
	PS71/244-1	08.04.08	18:12	56° 56.41' S	62° 20.32' W	4077.7	Mooring	MOR	action	aufgeschwommen	
	PS71/244-1	08.04.08	18:19	56° 56.25' S	62° 20.79' W	4089.0	Mooring	MOR	action	14+6 Floats aufgeschwommen	

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment	
	PS71/244-1	08.04.08	18:29	56° 56.08' S	62° 21.36' W	4094.7	Mooring	MOR	on deck	6 Floats+Releaser	
	PS71/244-1	08.04.08	18:31	56° 56.06' S	62° 21.38' W	4092.2	Mooring	MOR	on deck	Strömungsmesser	
	PS71/244-1	08.04.08	18:37	56° 56.00' S	62° 21.50' W	4091.5	Mooring	MOR	on deck	14 Floats	
	PS71/244-1	08.04.08	18:59	56° 55.81' S	62° 22.04' W	4091.0	Mooring	MOR	on deck	Strömungsmesser, Microcat, Float	
	PS71/244-1	08.04.08	19:03	56° 55.78' S	62° 22.14' W	4090.0	Mooring	MOR	on deck	Float	
	PS71/244-1	08.04.08	19:12	56° 55.73' S	62° 22.37' W	4090.5	Mooring	MOR	mooring on	2 Strömungsmesser, Microcat, Topboje, Argossender(beschädigt)	
	PS71/244-2	08.04.08	20:30	56° 57.69' S	62° 15.66' W	4011.0	Mooring	MOR	surface	M4 10 Bentos, 1 MUFUKO	
	PS71/244-2	08.04.08	20:35	56° 57.58' S	62° 15.93' W	4016.5	Mooring	MOR	surface	1 Strömungsmesser	
	PS71/244-2	08.04.08	20:43	56° 57.41' S	62° 16.35' W	4027.7	Mooring	MOR	surface	8 Floats	
	PS71/244-2	08.04.08	20:54	56° 57.22' S	62° 17.06' W	4043.5	Mooring	MOR	surface	1 Strömungsmesser	
	PS71/244-2	08.04.08	21:13	56° 56.94' S	62° 18.07' W	4067.5	Mooring	MOR	surface	6 Floats	
	PS71/244-2	08.04.08	21:35	56° 56.62' S	62° 19.22' W	4067.0	Mooring	MOR	surface	1 Strömungsmesser	
	PS71/244-2	08.04.08	21:35	56° 56.62' S	62° 19.22' W	4067.0	Mooring	MOR	surface	4 Floats	
	PS71/244-2	08.04.08	21:59	56° 56.33' S	62° 20.51' W	4083.7	Mooring	MOR	surface	Doppelreleaser	
	PS71/244-2	08.04.08	22:12	56° 56.22' S	62° 21.15' W	4099.7	Mooring	MOR	surface	Ankerstein mit Fallschirm	
	PS71/244-2	08.04.08	22:13	56° 56.22' S	62° 21.18' W	4099.0	Mooring	MOR	slipped	Verankerung M04-2	
	PS71/244-2	08.04.08	22:24	56° 55.55' S	62° 22.03' W	4092.5	Mooring	MOR	at depth	Argossender abgetaucht	
A1	PS71/244-3	08.04.08	22:40	56° 55.15' S	62° 22.73' W	4106.7	CTD, Ultra	CTD/UC	into Water		
A1	PS71/244-3	08.04.08	23:55	56° 55.16' S	62° 23.72' W	4095.5	CTD, Ultra	CTD/UC	on Depth	4000m	
A1	PS71/244-3	09.04.08	01:14	56° 55.14' S	62° 24.13' W	4091.5	CTD, Ultra	CTD/UC	on Deck		
	PS71/244-4	09.04.08	01:52	56° 54.89' S	62° 21.25' W	4129.7	Test	TEST	surface	Kabeltest EL31	
	PS71/244-4	09.04.08	03:47	56° 54.20' S	62° 22.02' W	4151.0	Test	TEST	at depth	4000 m	
	PS71/244-4	09.04.08	05:41	56° 53.22' S	62° 23.76' W	4155.2	Test	TEST	on deck		
	PS71/244-5	09.04.08	05:50	56° 53.12' S	62° 23.83' W	4155.2	In situ pum	ISP	into water	Ankergewicht	
	PS71/244-5	09.04.08	05:55	56° 53.07' S	62° 23.89' W	4155.5	In situ pum	ISP	into water	1. Pumpe bei 20 m	
	PS71/244-5	09.04.08	06:17	56° 52.90' S	62° 24.22' W	4156.7	In situ pum	ISP	into water	2. Pumpe bei 1120 m	
	PS71/244-5	09.04.08	06:39	56° 52.70' S	62° 24.50' W	4159.0	In situ pum	ISP	into water	3. Pumpe bei 2270 m	
	PS71/244-5	09.04.08	06:54	56° 52.60' S	62° 24.78' W	4158.5	In situ pum	ISP	into water	4 pumpe bei 2770 m	
	PS71/244-5	09.04.08	07:05	56° 52.57' S	62° 25.05' W	4157.5	In situ pum	ISP	into water	5.Pumpe, SL 3320m	
	PS71/244-5	09.04.08	07:10	56° 52.54' S	62° 25.18' W	4157.5	In situ pum	ISP	into water	6.Pumpe, SL 3421m	
	PS71/244-5	09.04.08	07:15	56° 52.52' S	62° 25.28' W	4157.2	In situ pum	ISP	pump at de	SL 3520m	
	PS71/244-5	09.04.08	10:40	56° 51.45' S	62° 27.65' W	4164.0	In situ pum	ISP	on deck	6.Pumpe	
	PS71/244-5	09.04.08	10:43	56° 51.44' S	62° 27.68' W	4164.2	In situ pum	ISP	on deck	5.Pumpe	
	PS71/244-5	09.04.08	10:55	56° 51.38' S	62° 27.83' W	4164.0	In situ pum	ISP	on deck	4.Pumpe	
	PS71/244-5	09.04.08	11:06	56° 51.34' S	62° 27.91' W	4165.5	In situ pum	ISP	on deck	3. Pumpe	
	PS71/244-5	09.04.08	11:06	56° 51.34' S	62° 27.91' W	4165.5	In situ pum	ISP	on deck	2. Pumpe	
	PS71/244-5	09.04.08	11:47	56° 51.14' S	62° 27.99' W	4169.7	In situ pum	ISP	on deck	1. Pumpe	
	PS71/244-5	09.04.08	11:52	56° 51.13' S	62° 28.02' W	4169.2	In situ pum	ISP	on deck	Ankerstein	
B1	PS71/244-6	09.04.08	11:57	56° 51.12' S	62° 28.08' W	4169.0	CTD/rosett	CTD/RO	surface		
B1	PS71/244-6	09.04.08	13:22	56° 51.30' S	62° 29.00' W	4158.5	CTD/rosett	CTD/RO	at depth	EL31 4152m	
B1	PS71/244-6	09.04.08	14:35	56° 51.50' S	62° 30.20' W	4146.2	CTD/rosett	CTD/RO	on deck		
D	PS71/244-7	09.04.08	14:45	56° 51.48' S	62° 29.98' W	4147.0	CTD, Ultra	CTD/UC	into Water		
D	PS71/244-7	09.04.08	14:54	56° 51.50' S	62° 30.07' W	4146.5	CTD, Ultra	CTD/UC	on Depth	200m	
D	PS71/244-7	09.04.08	15:13	56° 51.46' S	62° 29.95' W	4147.5	CTD, Ultra	CTD/UC	on Deck		
C	PS71/244-8	09.04.08	15:57	56° 53.23' S	62° 28.50' W	4174.2	CTD mit Kr	CTD/RO/M	MIC in water		PLUS MINICORER
C	PS71/244-8	09.04.08	16:03	56° 53.23' S	62° 28.46' W	4174.0	CTD mit Kr	CTD/RO/M	CTD/RO to water		PLUS MINICORER
C	PS71/244-8	09.04.08	17:29	56° 53.34' S	62° 29.22' W	4172.5	CTD mit Kr	CTD/RO/M	MIC at bott	4133m	PLUS MINICORER
C	PS71/244-8	09.04.08	18:45	56° 53.31' S	62° 30.15' W	4157.0	CTD mit Kr	CTD/RO/M	CTD/RO on deck		PLUS MINICORER
C	PS71/244-8	09.04.08	18:51	56° 53.28' S	62° 30.20' W	4158.0	CTD mit Kr	CTD/RO/M	MIC on deck		PLUS MINICORER
D	PS71/244-9	09.04.08	19:00	56° 53.19' S	62° 30.21' W	4163.0	CTD, Ultra	CTD/UC	into Water		
D	PS71/244-9	09.04.08	19:05	56° 53.14' S	62° 30.20' W	4166.2	CTD, Ultra	CTD/UC	on Depth	SL 140m	
D	PS71/244-9	09.04.08	19:25	56° 53.00' S	62° 30.63' W	4163.5	CTD, Ultra	CTD/UC	on Deck		
F	PS71/244-10	09.04.08	19:38	56° 52.94' S	62° 31.03' W	4164.2	CTD/rosett	CTD/RO	surface		
F	PS71/244-10	09.04.08	19:40	56° 52.93' S	62° 31.07' W	4165.2	CTD/rosett	CTD/RO	at depth	SL 33m	
F	PS71/244-10	09.04.08	19:47	56° 52.85' S	62° 31.17' W	4161.7	CTD/rosett	CTD/RO	on deck		
	PS71/244-11	09.04.08	19:52	56° 52.86' S	62° 31.25' W	4162.5	FLOAT	FLOAT	into water	KORDI 3	
	PS71/244	**END SUPERSTATION DRAKE-4**									

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment	
	PS71/245-1	09.04.08	19:55	56° 53.09' S	62° 31.25' W	4163.0	Iron Fish	IFISH	surface		
	PS71/245-1	09.04.08	22:25	57° 7.94' S	61° 56.92' W	3787.5	Iron Fish	IFISH	on deck		
B1	PS71/246-1	09.04.08	22:31	57° 7.97' S	61° 57.07' W	3791.7	CTD/rosett	CTD/RO	surface		
B1	PS71/246-1	09.04.08	23:53	57° 7.09' S	61° 58.32' W	3773.2	CTD/rosett	CTD/RO	at depth	EL31 3781m	
B1	PS71/246-1	10.04.08	01:07	57° 6.96' S	61° 58.54' W	3774.0	CTD/rosett	CTD/RO	on deck		
	PS71/246-2	10.04.08	01:11	57° 6.95' S	61° 58.60' W	3774.7	FLOAT	FLOAT	into water		
	PS71/246-3	10.04.08	01:12	57° 6.98' S	61° 58.54' W	3774.5	FLOAT	FLOAT	into water		
	PS71/246-4	10.04.08	01:12	57° 6.98' S	61° 58.54' W	3774.5	Drifter, long	LD	surface	Wetterboje	
B1	PS71/247-1	10.04.08	04:50	56° 40.74' S	62° 49.49' W	4077.0	CTD/rosett	CTD/RO	surface		
B1	PS71/247-1	10.04.08	06:08	56° 40.17' S	62° 49.13' W	4069.2	CTD/rosett	CTD/RO	at depth	4062 m	
B1	PS71/247-1	10.04.08	07:15	56° 39.70' S	62° 48.94' W	4065.0	CTD/rosett	CTD/RO	on deck		
	PS71/247-2	10.04.08	07:22	56° 39.46' S	62° 48.83' W	4064.5	FLOAT	FLOAT	into water		
B1	PS71/248-1	10.04.08	09:22	56° 25.10' S	63° 18.12' W	3983.5	CTD/rosett	CTD/RO	surface		
B1	PS71/248-1	10.04.08	10:40	56° 25.06' S	63° 18.26' W	3983.5	CTD/rosett	CTD/RO	at depth	SL 3932m	
B1	PS71/248-1	10.04.08	11:51	56° 25.00' S	63° 18.63' W	3982.5	CTD/rosett	CTD/RO	on deck		
	PS71/248-2	10.04.08	11:55	56° 24.92' S	63° 18.62' W	3982.0	FLOAT	FLOAT	into water		
	PS71/249-1	10.04.08	13:52	56° 7.96' S	63° 42.22' W	4295.5	Mooring	MOR	released	Verankerung M03	
	PS71/249-1	10.04.08	14:17	56° 7.99' S	63° 42.64' W	4296.2	Mooring	MOR	on the surface		
	PS71/249-1	10.04.08	15:13	56° 7.02' S	63° 42.55' W	4280.7	Mooring	MOR	on deck	12 Benthos	
	PS71/249-1	10.04.08	15:31	56° 6.62' S	63° 42.99' W	4277.2	Mooring	MOR	on deck	1 Strömungsmesser, 1 Auftrieb	
	PS71/249-1	10.04.08	15:39	56° 6.47' S	63° 43.23' W	4277.2	Mooring	MOR	on deck	1 Strömungsmesser	
	PS71/249-1	10.04.08	15:41	56° 6.43' S	63° 43.29' W	4277.5	Mooring	MOR	on deck	1 Auftrieb	
	PS71/249-1	10.04.08	15:47	56° 6.31' S	63° 43.46' W	4277.0	Mooring	MOR	on deck	6 Floats, 1 Releaser	
	PS71/249-1	10.04.08	16:04	56° 5.99' S	63° 43.95' W	4275.2	Mooring	MOR	on deck	2 Strömungsmesser, Microcat, Float	
	PS71/249-1	10.04.08	16:16	56° 5.74' S	63° 44.22' W	4274.2	Mooring	MOR	on deck	Toppauftrieb, Argos, Microcat	
	PS71/249-2	10.04.08	17:27	56° 6.17' S	63° 44.21' W	4278.2	Mooring	MOR	action	Mooring M 3 - 2 Deploy	
	PS71/249-2	10.04.08	17:35	56° 6.15' S	63° 44.15' W	4279.5	Mooring	MOR	surface	eliptic Float, red, ADCP, Argos, Strömungsmesser, Microcat	
	PS71/249-2	10.04.08	17:56	56° 6.31' S	63° 43.99' W	4280.2	Mooring	MOR	surface	10 Floats(y,y,y,o,y,o,o,y,o,o) Microcat, Strömungsmesser	
	PS71/249-2	10.04.08	18:24	56° 6.48' S	63° 44.04' W	4289.7	Mooring	MOR	surface	18 Floats+ Strömungsmesser	
	PS71/249-2	10.04.08	18:48	56° 6.52' S	63° 43.99' W	4290.0	Mooring	MOR	surface	12 Floats (6 x y,6 x o)	
	PS71/249-2	10.04.08	18:54	56° 6.44' S	63° 43.98' W	4289.2	Mooring	MOR	surface	Strömungsmesser	
	PS71/249-2	10.04.08	18:59	56° 6.34' S	63° 44.05' W	4288.2	Mooring	MOR	surface	6 Floats(y)+Releaser	
	PS71/249-2	10.04.08	19:28	56° 6.62' S	63° 43.81' W	4294.2	Mooring	MOR	slipped	Ankerstein mit Fallschirm	
A1	PS71/249-3	10.04.08	19:47	56° 7.32' S	63° 45.38' W	4304.7	CTD, Ultra	CTD/UC	into Water		**Cd isotopes**
	PS71/249-2	10.04.08	19:48	56° 7.32' S	63° 45.38' W	4301.2	Mooring	MOR	action	Argos Sender aus	
	PS71/249-2	10.04.08	20:18	56° 7.20' S	63° 45.42' W	4301.7	Mooring	MOR	on the grou	Pos via Posidonia 56°06,05S - 063°43,93W	
A1	PS71/249-3	10.04.08	21:00	56° 7.16' S	63° 45.44' W	4302.0	CTD, Ultra	CTD/UC	on Depth	SL 4250m	**Cd isotopes**
A1	PS71/249-3	10.04.08	22:28	56° 6.89' S	63° 45.35' W	4299.2	CTD, Ultra	CTD/UC	on Deck		**Cd isotopes**
	PS71/249-4	10.04.08	22:35	56° 7.02' S	63° 45.63' W	4302.0	FLOAT	FLOAT	into water	LOCEAN 10	
	PS71/250	**START SUPERSTATION DRAKE-5**									
C	PS71/250-1	11.04.08	01:29	55° 45.29' S	64° 26.10' W	3798.7	CTD mit Kr	CTD/RO/M	MIC in water		
C	PS71/250-1	11.04.08	02:57	55° 45.27' S	64° 25.09' W	3814.7	CTD mit Kr	CTD/RO/M	MIC at bott	3775	
C	PS71/250-1	11.04.08	04:16	55° 45.16' S	64° 24.27' W	3827.2	CTD mit Kr	CTD/RO/M	MIC on deck		
	PS71/250-2	11.04.08	04:31	55° 45.35' S	64° 25.11' W	3811.5	In situ pum	ISP	into water	gewicht	
	PS71/250-2	11.04.08	04:32	55° 45.35' S	64° 25.09' W	3811.5	In situ pum	ISP	into water	1. pumpe	
	PS71/250-2	11.04.08	04:32	55° 45.35' S	64° 25.09' W	3811.5	In situ pum	ISP	into water		
	PS71/250-2	11.04.08	05:02	55° 45.33' S	64° 25.02' W	3812.7	In situ pum	ISP	into water	2. Pumpe bei 1520 m	
	PS71/250-2	11.04.08	05:26	55° 45.27' S	64° 24.87' W	3818.7	In situ pum	ISP	into water	3. Pumpe 2820 m	
	PS71/250-2	11.04.08	05:36	55° 45.36' S	64° 24.98' W	3812.5	In situ pum	ISP	into water	4. Pumpe bei 3220 m	
	PS71/250-2	11.04.08	05:45	55° 45.33' S	64° 24.83' W	3815.7	In situ pum	ISP	into water	5. Pumpe 3570 m	
	PS71/250-2	11.04.08	05:53	55° 45.31' S	64° 24.71' W	3815.2	In situ pum	ISP	into water	6. und letzte Pumpe bei 3620 m	
	PS71/250-2	11.04.08	05:56	55° 45.32' S	64° 24.69' W	3814.2	In situ pum	ISP	pump at de	3720 m	
	PS71/250-2	11.04.08	09:20	55° 44.67' S	64° 22.74' W	3841.7	In situ pum	ISP	on deck	6. Pumpe	
	PS71/250-2	11.04.08	09:24	55° 44.66' S	64° 22.78' W	3843.5	In situ pum	ISP	on deck	5.Pumpe	
	PS71/250-2	11.04.08	09:34	55° 44.64' S	64° 22.87' W	3841.2	In situ pum	ISP	on deck	4.Pumpe	
	PS71/250-2	11.04.08	09:43	55° 44.67' S	64° 22.97' W	3840.5	In situ pum	ISP	on deck	3.Pumpe	
	PS71/250-2	11.04.08	10:08	55° 44.64' S	64° 22.85' W	3841.7	In situ pum	ISP	on deck	2.Pumpe	

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment		
	PS71/250-2	11.04.08	10:36	55° 44.62' S	64° 22.83' W	3841.5	In situ pum	ISP	on deck	1. Pumpe		
	PS71/250-2	11.04.08	10:38	55° 44.62' S	64° 22.83' W	3842.0	In situ pum	ISP	on deck	Gewicht		
D1	PS71/250-3	11.04.08	10:47	55° 44.62' S	64° 22.83' W	3842.7	CTD/rosett	CTD/RO	surface			
D1	PS71/250-3	11.04.08	11:21	55° 44.61' S	64° 22.73' W	3843.7	CTD/rosett	CTD/RO	at depth	SL 995m		
D1	PS71/250-3	11.04.08	11:43	55° 44.55' S	64° 22.42' W	3848.2	CTD/rosett	CTD/RO	on deck			
	PS71/250-4	11.04.08	12:19	55° 44.46' S	64° 27.32' W	3798.2	Mooring	MOR	released	Verankerung M2		
D2	PS71/250-5	11.04.08	14:04	55° 43.80' S	64° 26.79' W	3818.0	CTD/rosett	CTD/RO	surface			
D2	PS71/250-5	11.04.08	14:14	55° 43.74' S	64° 26.60' W	3818.7	CTD/rosett	CTD/RO	at depth	EL31 194m		
D2	PS71/250-5	11.04.08	14:25	55° 43.85' S	64° 26.58' W	3819.0	CTD/rosett	CTD/RO	on deck			
A1	PS71/250-6	11.04.08	14:54	55° 42.49' S	64° 25.95' W	3808.2	CTD, Ultra	CTD/UC	into Water			
A1	PS71/250-6	11.04.08	15:57	55° 42.06' S	64° 25.67' W	3798.0	CTD, Ultra	CTD/UC	on Depth	3725m		
A1	PS71/250-6	11.04.08	17:13	55° 41.72' S	64° 24.70' W	3799.5	CTD, Ultra	CTD/UC	on Deck			
D1	PS71/250-7	11.04.08	17:47	55° 43.99' S	64° 26.45' W	3817.5	CTD/rosett	CTD/RO	surface			
D1	PS71/250-7	11.04.08	18:05	55° 43.92' S	64° 26.19' W	3819.0	CTD/rosett	CTD/RO	at depth	497 m		
D1	PS71/250-7	11.04.08	18:15	55° 43.87' S	64° 26.05' W	3819.5	CTD/rosett	CTD/RO	on deck			
	PS71/250-4	11.04.08	18:42	55° 45.29' S	64° 25.79' W	3801.7	Mooring	MOR	action	Ankerstein Dredgegeschirr zu Wasser		
	PS71/250-4	11.04.08	18:45	55° 45.31' S	64° 25.82' W	3800.7	Mooring	MOR	surface	1. Draggen bei 50 m		
	PS71/250-4	11.04.08	18:49	55° 45.33' S	64° 25.86' W	3799.7	Mooring	MOR	surface	2. Draggen bei 100m		
	PS71/250-4	11.04.08	18:55	55° 45.35' S	64° 25.89' W	3798.7	Mooring	MOR	surface	3. Draggen bei 150 m		
	PS71/250-4	11.04.08	19:06	55° 45.36' S	64° 25.80' W	3799.5	Mooring	MOR	surface	4. Draggen bei 500m		
	PS71/250-4	11.04.08	19:25	55° 45.44' S	64° 25.64' W	3800.2	Mooring	MOR	surface	Releaser und darüber 5. Draggen bei 1000 m		
	PS71/250-4	11.04.08	21:40	55° 44.13' S	64° 25.62' W	3822.7	Mooring	MOR	action	start hieven dredge 5000m		
	PS71/250-4	11.04.08	22:21	55° 44.19' S	64° 26.77' W	3813.5	Mooring	MOR	action	ausstecken und einholen verschiedener längen		
	PS71/250-4	11.04.08	23:24	55° 44.10' S	64° 26.88' W	3813.0	Mooring	MOR	action	start einholen 5150m		
	PS71/250-4	12.04.08	00:46	55° 44.13' S	64° 26.85' W	3814.5	Mooring	MOR	on deck	5. Draggen und Releaser		
	PS71/250-4	12.04.08	01:02	55° 44.15' S	64° 26.83' W	3814.0	Mooring	MOR	on deck	4. Draggen		
	PS71/250-4	12.04.08	01:15	55° 44.15' S	64° 26.86' W	3814.7	Mooring	MOR	on deck	3. Draggen		
	PS71/250-4	12.04.08	01:19	55° 44.15' S	64° 26.86' W	3814.0	Mooring	MOR	on deck	2. Draggen		
	PS71/250-4	12.04.08	01:23	55° 44.15' S	64° 26.88' W	3814.7	Mooring	MOR	on deck	1. Draggen		
B1	PS71/250-8	12.04.08	01:51	55° 44.36' S	64° 27.61' W	3794.7	CTD/rosett	CTD/RO	surface			
B1	PS71/250-8	12.04.08	03:20	55° 44.30' S	64° 26.44' W	3816.0	CTD/rosett	CTD/RO	at depth	EL31 3764m		
B1	PS71/250-8	12.04.08	04:27	55° 43.96' S	64° 25.68' W	3822.2	CTD/rosett	CTD/RO	on deck			
F	PS71/250-9	12.04.08	05:24	55° 44.58' S	64° 27.88' W	3788.7	CTD/rosett	CTD/RO	surface			
F	PS71/250-9	12.04.08	06:13	55° 44.41' S	64° 28.19' W	3786.5	CTD/rosett	CTD/RO	at depth	2492 m		
F	PS71/250-9	12.04.08	06:55	55° 44.33' S	64° 28.13' W	3787.7	CTD/rosett	CTD/RO	on deck			
	PS71/250	**END OF SUPERSTATION DRAKE 5**										
B1	PS71/251-1	12.04.08	10:15	55° 21.16' S	65° 11.45' W	1704.7	CTD/rosett	CTD/RO	surface			
B1	PS71/251-1	12.04.08	11:05	55° 20.95' S	65° 10.24' W	1752.0	CTD/rosett	CTD/RO	at depth	SL 1702m		
B1	PS71/251-1	12.04.08	11:53	55° 20.63' S	65° 9.19' W	1762.7	CTD/rosett	CTD/RO	on deck			
	PS71/251-2	12.04.08	12:08	55° 20.27' S	65° 10.88' W	1626.0	Mooring	MOR	released	Verankerung M1		
	PS71/251-2	12.04.08	12:12	55° 20.27' S	65° 10.80' W	1634.0	Mooring	MOR	on the surface			
	PS71/251-2	12.04.08	14:30	55° 18.18' S	65° 7.83' W	1655.7	Mooring	MOR	on deck	4 Floats, 1 Releaser		
	PS71/251-2	12.04.08	14:33	55° 18.06' S	65° 7.75' W	1655.5	Mooring	MOR	on deck	2 Strömungsmesser, 1 Auftrieb		
	PS71/251-2	12.04.08	14:39	55° 17.90' S	65° 7.57' W	1664.5	Mooring	MOR	on deck	1 Strömungsmesser, 1 Microcat, 1 Auftrieb		
	PS71/251-2	12.04.08	14:58	55° 17.50' S	65° 6.96' W	1690.7	Mooring	MOR	on deck	Toppboje mit ADCP		
	PS71/251-2	12.04.08	14:58	55° 17.50' S	65° 6.96' W	1690.7	Mooring	MOR	mooring on	Verankerung M1 komplett geborgen		
A1	PS71/251-3	12.04.08	15:35	55° 20.29' S	65° 11.22' W	1589.0	CTD, Ultra	CTD/UC	into Water			
A1	PS71/251-3	12.04.08	16:07	55° 20.01' S	65° 10.68' W	1631.0	CTD, Ultra	CTD/UC	on Depth	1550 m		
A1	PS71/251-3	12.04.08	16:53	55° 19.64' S	65° 9.79' W	1682.0	CTD, Ultra	CTD/UC	on Deck			
	PS71/251-4	12.04.08	17:07	55° 19.95' S	65° 10.87' W	1605.5	Mooring	MOR	action	M1-2 Deploy, MW= + 11,7 ° E		
	PS71/251-4	12.04.08	17:20	55° 19.93' S	65° 10.90' W	1601.7	Mooring	MOR	surface	Toppauftrieb (red eliptic) Float+ ADCP, Argos, Microcat,+4 Nautilus Float`s (o,y,o,y)		
	PS71/251-4	12.04.08	17:32	55° 20.06' S	65° 10.80' W	1618.0	Mooring	MOR	surface	Microcat, Strömungsmesser,		
	PS71/251-4	12.04.08	17:39	55° 20.02' S	65° 10.82' W	1615.5	Mooring	MOR	surface	6 Nautilus Float`s (all orange)+ Releaser		
	PS71/251-4	12.04.08	17:55	55° 20.16' S	65° 10.98' W	1601.2	Mooring	MOR	slipped	Ankerstein		
	PS71/251-4	12.04.08	18:00	55° 20.16' S	65° 11.22' W	1582.0	Mooring	MOR	action	Argos Sender aus		
A1	PS71/252-1	12.04.08	19:54	55° 7.77' S	65° 32.39' W	405.2	CTD, Ultra	CTD/UC	into Water		FINAL 55th ULTRACLEAN HYDROCAST	CD ISOTOPES AT 3 DEPTHS
A1	PS71/252-1	12.04.08	20:08	55° 7.70' S	65° 32.00' W	408.5	CTD, Ultra	CTD/UC	on Depth	SL 375m	FINAL 55th ULTRACLEAN HYDROCAST	CD ISOTOPES AT 3 DEPTHS

	Station	Date	Time	PositionLat	PositionLon	Depth [m]	Gear	Gear Abbr	Action	Comment		
A1	PS71/252-1	12.04.08	20:35	55° 7.63' S	65° 31.31' W	414.5	CTD, Ultra	CTD/UC	on Deck		FINAL 55th ULTRACLEAN HYDROCAST	CD ISOTOPES AT 3 DEPTHS
B1	PS71/252-2	12.04.08	20:50	55° 7.47' S	65° 30.55' W	433.0	CTD/rosett	CTD/RO	surface			
B1	PS71/252-2	12.04.08	21:06	55° 7.44' S	65° 29.81' W	462.7	CTD/rosett	CTD/RO	at depth	SL 461m		
B1	PS71/252-2	12.04.08	21:19	55° 7.49' S	65° 29.44' W	468.2	CTD/rosett	CTD/RO	on deck			
B1	PS71/253-1	12.04.08	22:16	55° 14.02' S	65° 22.12' W	1037.5	CTD/rosett	CTD/RO	surface			
B1	PS71/253-1	12.04.08	22:45	55° 13.83' S	65° 21.29' W	1053.5	CTD/rosett	CTD/RO	at depth	SL 1022m		
B1	PS71/253-1	12.04.08	23:09	55° 13.66' S	65° 20.74' W	1061.2	CTD/rosett	CTD/RO	on deck			
B1	PS71/254-1	13.04.08	01:18	55° 28.50' S	64° 57.77' W	2578.5	CTD/rosett	CTD/RO	surface			
B1	PS71/254-1	13.04.08	02:28	55° 28.21' S	64° 57.20' W	2576.7	CTD/rosett	CTD/RO	at depth	EL31 2532m		
B1	PS71/254-1	13.04.08	03:16	55° 27.98' S	64° 56.91' W	2563.2	CTD/rosett	CTD/RO	on deck			
B1	PS71/255-1	13.04.08	04:35	55° 36.34' S	64° 44.82' W	3658.2	CTD/rosett	CTD/RO	surface			
B1	PS71/255-1	13.04.08	05:44	55° 35.61' S	64° 44.55' W	3619.7	CTD/rosett	CTD/RO	at depth	3569 m		
B1	PS71/255-1	13.04.08	06:46	55° 35.35' S	64° 44.01' W	3619.0	CTD/rosett	CTD/RO	on deck			
B1	PS71/256-1	13.04.08	09:21	55° 53.42' S	64° 15.53' W	3877.5	CTD/rosett	CTD/RO	surface			
B1	PS71/256-1	13.04.08	10:50	55° 53.33' S	64° 15.52' W	3877.2	CTD/rosett	CTD/RO	at depth	SL 3823m		
B1	PS71/256-1	13.04.08	12:02	55° 53.30' S	64° 15.31' W	3878.0	CTD/rosett	CTD/RO	on deck			
	PS71/257-1	13.04.08	13:32	55° 43.51' S	64° 23.68' W	3829.2	Mooring	MOR	action	Auslegung Verankerung M02-2		
	PS71/257-1	13.04.08	13:34	55° 43.51' S	64° 23.71' W	3829.0	Mooring	MOR	surface	1 Argus-Sender, 1 Toppboje, 1 Microcat, 1 Strömungsmesser		
	PS71/257-1	13.04.08	13:54	55° 43.58' S	64° 23.99' W	3828.7	Mooring	MOR	surface	10 Floats, 1 Microcat, 1 Strömungsmesser		
	PS71/257-1	13.04.08	14:19	55° 43.68' S	64° 24.47' W	3827.5	Mooring	MOR	surface	16 Floats, 1 Strömungsmesser		
	PS71/257-1	13.04.08	14:40	55° 43.74' S	64° 24.86' W	3826.7	Mooring	MOR	surface	12 Floats		
	PS71/257-1	13.04.08	14:46	55° 43.72' S	64° 24.84' W	3826.0	Mooring	MOR	surface	1 Strömungsmesser		
	PS71/257-1	13.04.08	14:51	55° 43.64' S	64° 24.67' W	3826.7	Mooring	MOR	surface	6 Floats, 1 Releaser		
	PS71/257-1	13.04.08	15:13	55° 43.50' S	64° 24.55' W	3826.5	Mooring	MOR	surface	Ankerstein mit Fallschirm		
	PS71/257-1	13.04.08	15:14	55° 43.48' S	64° 24.53' W	3825.7	Mooring	MOR	slipped	Verankerung M02-2		
	PS71/257-2	13.04.08	15:15	55° 43.48' S	64° 24.55' W	3826.0	FLOAT	FLOAT	into water			
	PS71/257-3	13.04.08	15:15	55° 43.48' S	64° 24.55' W	3826.0	Drifter, long	LD	surface	Wetterboje		
	PS71/257-1	13.04.08	16:00	55° 43.09' S	64° 24.00' W	3816.5	Mooring	MOR	action	Posidonia-Position		
B1	PS71/258-1	13.04.08	19:06	56° 1.07' S	64° 0.59' W	3979.2	CTD/rosett	CTD/RO	surface		**bottle 24 gelbstoffe in ethanol**	
B1	PS71/258-1	13.04.08	20:23	56° 0.67' S	64° 0.51' W	3985.2	CTD/rosett	CTD/RO	at depth	SL 3936m	**bottle 24 gelbstoffe in ethanol**	
B1	PS71/258-1	13.04.08	21:33	56° 0.24' S	64° 0.56' W	3987.7	CTD/rosett	CTD/RO	on deck	Forschungsende	**bottle 24 gelbstoffe in ethanol**	

END OF DRAKE PASSAGE SECTION
END OF ALL DEPLOYMENT AND RECOVERY OPERATIONS ANT XXIV-3 EXPEDITION
TRANSIT TO PUNTA ARENAS

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