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The Expedition of the Research Vessel "Polarstern" to the Antarctic in 2012/2013 (ANT-XXIX/2)

Edited by
Olaf Boebel
with contributions of the participants

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ANT-XXIX/2

30 November 2012 - 18 January 2013

Cape Town – Punta Arenas

Chief scientist
Olaf Boebel

Coordinator
Rainer Knust

Contents

1. ZUSAMMENFASSUNG UND FAHRTVERLAUF

Olaf Boebel AWI

Der Fahrtabschnitt 2 der Antarktisexpedition ANT-XXIX (Abbildung 1.1) führte von Kapstadt über Neumayer in das Weddellmeer nach Punta Arenas und diente der Durchführung logistischer und wissenschaftlicher Vorhaben, die sich in stationsgebundene, vom fahrenden Schiff aus durchführbare, sowie helikoptergestützte Arbeiten unterteilen lassen. Folgende stationsgebundene Aufgaben wurden durchgeführt:

- Ausbringen von 10 OBS am Südwest-Indischen-Rücken;
- Aufnahme von 10 Verankerungen; 4 weitere Verankerung konnten wegen Eisganges nicht erreicht werden, ein erneuter Versuch ist für den Südsommer 2014/15 geplant;
- Ausbringen von 17 Verankerungen;
- Ausbringen von 50 Argo Floats;
- Versorgung der Neumayer Station;
- Fahren von 47 CTD Stationen mit Rosette und l-ADCP;
- Kalibration von 8 RAFOS Schallquellen.

Folgende Arbeiten wurden vom fahrenden Schiff aus durchgeführt:

- Erfassung des Vorkommens von Vögeln, Robben und Walen mittels visueller Sichtungsmethoden von der Brücke aus;
- Erfassung des Vorkommens und des Verhaltens von Walen mittels eines automatischen Waldetektionssystems.

Weitere Arbeiten nutzten die Helikopter als Plattform bzw. zur logistischen Unterstützung:

- Erfassung der Verbreitung von marinen Warmblütern (7 Flüge);
- Medienflüge (20 Flüge);
- Flüge zur Unterstützung der ozeanographischen Arbeiten (11 Flüge);
- Weitere Flüge erfolgten zur Eiserkundung sowie zu logistischen Zwecken bei der Neumayer Station.

Die Reise begann am 30. November 2012, 20:00 LT in Kapstadt. Die zunächst anstehenden Tests der OBS Auslöser verliefen problemlos. 10 OBSe wurden wegen des hohen Seegangs im Zielgebiet im freien Fall ausgelegt. Begünstigt durch eine sich um den Maud Rise herum schnell öffnende Polynja war der Reisefortschritt entlang des 0° Schnittes zügig. Am südlichsten Ende dieses Schnittes jedoch hatten wir mit starkem Eisgang zu kämpfen, weshalb die südlichste Verankerung nicht aufgenommen werden konnte und das Schiff für längere Zeit festsaß. Dennoch konnte das aus logistischen Gründen angestrebte Anlaufen der Neumayer-Station wie geplant umgesetzt werden. Die Löscharbeiten begannen am 22. Dezember, 14:00 am „Nordanleger" der trotz des nun vorgelagerten Eisberges gut zu erreichen war. Aufgrund der umsichtigen Planung und des bemerkenswerten Einsatzes von sowohl Stations- als auch Schiffspersonal konnten die Löscharbeiten trotz eines erhöhten Volumens innerhalb von 2 Tagen abgeschlossen werden. Das Ablegen erfolgte am 24. Dezember 15:00.

Der weitere Reiseverlauf führte uns im Zick-Zack Kurs durch das Weddellmeer um ein Array von Verankerungen mit ozeanographischen und bioakustischen Messgeräten im Rahmen des HAFOS Projektes aufzunehmen und neu auszulegen. Aufgrund des eingeschränkten Zeitrahmens wurde vorsorglich auf das Anlaufen einer in dichtem Eis gelegenen Aufnahmeposition verzichtet. Zwei weitere Aufnahmen nahe der Halbinsel mussten aus ebendiesem Grund fallen gelassen werden. Entlang der Fahrtroute wurden in regelmäßigen Abständen Argo Floats ausgesetzt und an Schlüsselpositionen tiefe CTDs gefahren. Die Reise endete am 18. Januar 2013 8:00 LT in Punta Arenas. Zusammenfassend ist festzustellen, dass trotz der erheblichen Probleme aufgrund des ungewöhnlichen dicken und flächigen Eisganges die wesentlichen Teile der Vorhaben umgesetzt werden konnten, für die kommende Reise jedoch ein späterer Reisebeginn unbedingt notwendig ist, um sicherzustellen, dass die nun liegengelassenen Verankerungen aufgenommen werden können.

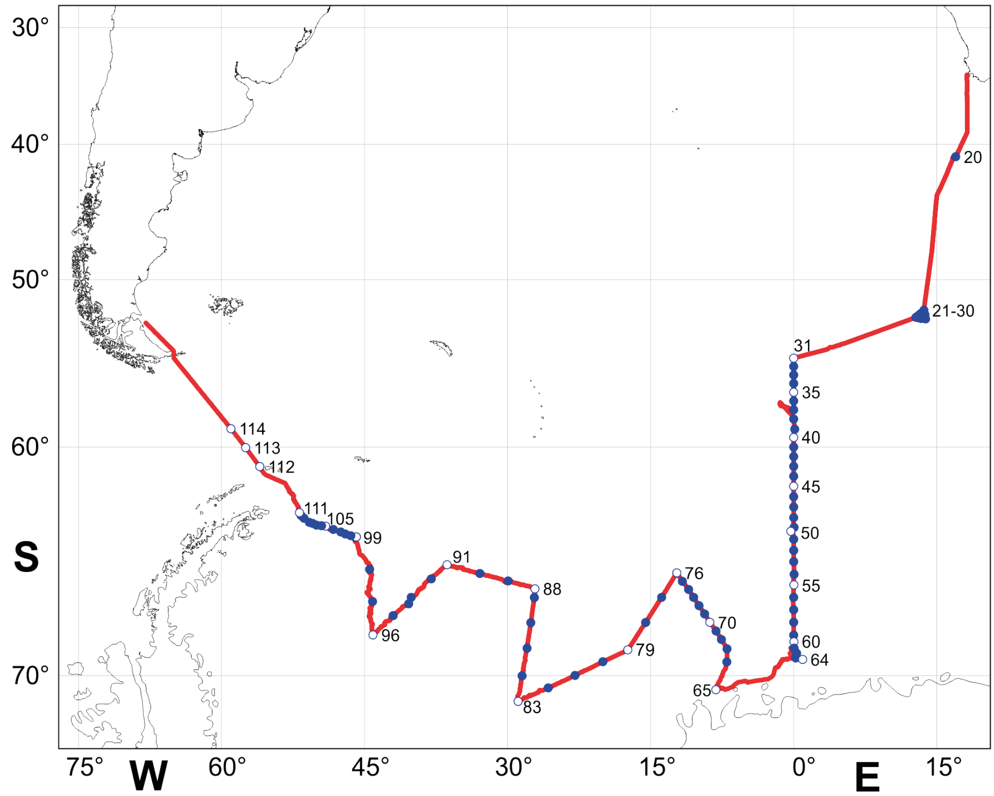

Abb. 1.1: Fahrtverlauf der Antarktis Expedition ANT-XXIX/2. Beginn der Reise war in Kapstadt, Ende in Punta Arenas. Punkte und Kreise geben die Orte von Station an, mit Kreisen assoziierte Zahlen die jeweilige Stationsnummer (s. auch Liste aller Stationen im Appendix 4).

Fig. 1.1: Cruise plot of expedition ANT-XXIX/2 to the Antarctic, starting in Cape Town and ending in Punta Arenas. Dots and circles represent locations of stations, labels the corresponding station number (see Appendix 4 for a listing of stations).

ITINERARY AND SUMMARY

Leg 2 of the Antarctic expedition ANT-XXIX (Figure 1.1) operated in the Weddell Sea and served both logistic and scientific objectives, which can be grouped as station-bound, *enroute* and helicopter borne activities. The following station-bound activities were conducted:

- Deployment of 10 OBS at the South-West Indian Ridge;
- Recovery of 10 moorings; 4 additional moorings were inaccessible due to the ice-cover, a second attempt is planned for austral summer 2015/16;
- Deployment of 17 moorings;
- Deployment of 50 Argo Floats;

- Logistic operations at Neumayer station;
- 47 CTD casts (including rosette sampler) and l-ADCP;
- Calibration of 8 RAFOS sound sources.

The following research was conducted on transit:

- Visual observation of the occurrence of birds, seals and whales;
- Automatic detection of whales using a thermographic scanner.

Additional studies were conducted from the helicopters directly or by using the helicopter for logistic support:

- Distribution of marine endotherms (7 flights);
- Flights for media purposes (20 flights);
- Flights in support of oceanographic activities (11 flights);
- Additional flights for ice recognition logistic purposes at Neumayer station.

The cruise commenced on 30 November 2012, 20:00 LT in Cape Town. The scientific work started with testing the OBS releases, followed by the deployment of 10 OBS at the South-West Indian Ridge. Due to high waves, the OBS were deployed in free-fall from the sea surface rather than lowered by cable. Thereafter we quickly proceeded south along the Greenwich meridian, facilitated by a rapidly opening polynya around Maud Rise. However, close to the Antarctic continent, heavy ice cover prohibited the release of the southernmost mooring, while the ship got stuck in the ice for a lengthy period. Nevertheless, we were able to reach Neumayer Station as scheduled to commence the resupply operation on 22 December, 14:00 at the "Nordanleger", which could be readily accessed, even with the large ice berg that had stranded nearby in 2012. Due to the careful planning and the remarkable efforts by the station's and ship's personnel, the discharge operations proceeded rapidly in spite of an increased volume, allowing us to depart on 24 December, 15:00.

The expedition then crossed the Weddell Sea in a zigzag course to recover and deploy an array of oceanographic and bioacoustic moorings as part of the HAFOS project. Due to heavy ice, we relinquished steaming towards a mooring scheduled for recovery in the central Weddell Sea. Two further recoveries had also to be dropped from the schedule due to heavy ice in the western Weddell Sea near the Antarctic Peninsula. Along the entire transect we deployed Argo floats at regular distances and casted deep CTDs at key positions. The expedition ended on 18 January 2013, 8:00 LT in Punta Arenas.

Summarizing, we can state that in spite of the unusually thick and widespread sea ice, the essential parts of our scientific projects were accomplished . However, the next cruise should be scheduled for later in the season, to ensure the recovery of the moorings that we could not access this time due to the ice situation.

2. WEATHER CONDITIONS

Harald Rentsch, Juliane Hempelt and Andreas Raeke DWD

Leaving Cape Town harbour on Friday, 30 Nov. 2012, *Polarstern* immediately met south-easterly trade winds of up to 11 Bft, with average wave heights of 5 m, peaking at 7 m. Throughout the following weekend, wind and waves decreased steadily, slackening to weak south-easterly winds of up to 3 Bft on Sunday, 2 Dec. At this time, weather was dominated by a ridge of high surface pressure, with some hours of sunshine and a nearly clear sky for some periods. Due to high sea-surface temperatures of 21°C, the air temperature rose up to 19° C.

On 3 Dec. we reached the Westerlies at about 42°S, with winds around 6 Bft and waves up to 3.5 m dominating thereafter. Shortly after crossing the Subtropical Front, air temperature decreased rapidly to 10°C.

During the following days, until 6 Dec., strong north-westerly winds carried some drizzle along the edge of a depression located in the central Weddell Sea, with winds often reaching Bft 8 and waves up to 5 m. On 7 Dec., shortly after passing Bouvet Island near 54.4°S, a ridge of high pressure caused winds to blow from westerly directions. During extended sunny periods, the *Wave and Surface Current Monitoring System*, WaMoS, measured swells of up to 5 m height.

On the following day, air masses of the warm front of a secondary low approached the ship while the sea remained calm and north-westerly winds did not exceed 6 Bft. The flow of warm air over the cold sea surface caused some rain and drizzle and the visibility to drop below 5 km for most of the time.

On Sunday 9 Dec., the 30th anniversary of the commissioning of *Polarstern,* a very strong depression, featuring a minimal pressure of 947.8 hPa in its centre, approached. The system, located to the South-West of our ship's track, weakened until Monday noon. Rain persisted for extended periods, including a mixture of snow and rain together with stormy winds of up to Bft 11 from north-easterly - later westerly – directions. This caused very rough seas of up to 8 m and, because of different wind-sea and swell directions, a dangerous and unpleasant sea state.

After attending a mooring at 59°S, 0°E, our southward journey resumed on 11 Dec. Pushed by increased winds from North-West and exploiting favourable sea state conditions of only 3.5 m, we quickly proceeded towards the sea ice edge, which was located near 60.5°S.

During the following days the sea calmed while we steamed in between several surrounding lows. Scattered snow showers and a mostly covered sky allowed using the helicopters only in the immediate vicinity of the ship.

Beginning with 13 Dec., sunny periods prevailed increasingly, with winds blowing from the North-East, reaching not more than 5 to 6 Bft. These conditions were caused by a strengthening ridge of high pressure. On 16 and 17 Dec., another strong depression influenced our weather conditions, with its lowest central pressure at 955 hPa and its south-western fronts grazing our path. This caused heavy snowfalls and showers, along with winds of 8 to 9 Bft from the South-East. Thereafter, the ice situation was highly variable, yet significant enough to reduce the maximum wave height to 2.5 m.

On Tuesday 18 Dec., we entered nearly 3 m thick pack ice fields, covered by a snow layer of nearly 1 m; this significantly reduced the ship's speed and repeatedly stopped the ship altogether on our course to the Neumayer III Station. Meteorologically, a new ridge of high pressure developed with south-easterly winds not exceeding more than 4 Bft. In spite of some light snow showers, this allowed flights for ice reconnaissance and to the Neumayer station for logistic purposes.

On 22 Dec., we docked at the „Nordanleger" on the shelf ice edge near the Neumayer III Station. Dry easterly winds provided us with good meteorological flight conditions. One day later low stratus clouds influenced the weather, impairing the use of the ship's helicopters.

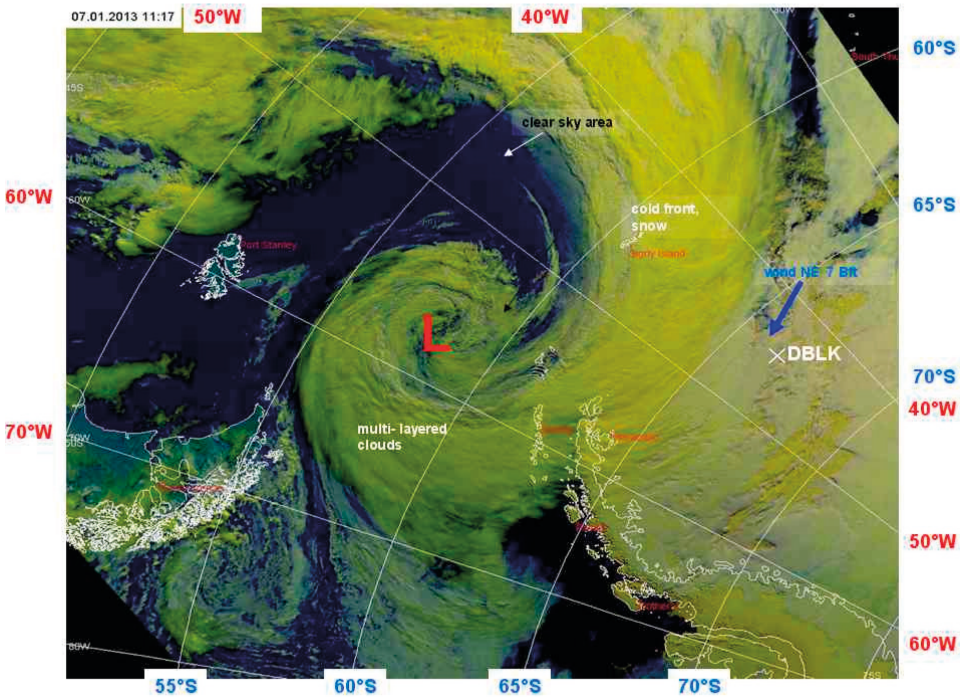

Fig. 2.1: RGB-satellite picture NOAA 16 for 07.01.2013 11:17 UTC. The position of the research vessel Polarstern is marked by its call sign DBLK.

On Christmas Eve we continued our expedition across the Weddell Sea while fronts and snowfall reached the ship with weak south-westerly winds. This low-pressure gradient situation prevailed until Boxing Day. Thereafter, a high pressure system strengthened in the central Weddell Sea, causing south-easterly winds of up to 4 Bft and frequent sunny periods. After 29 Dec., weather conditions worsened with low clouds and partly foggy conditions near an intensified high pressure system, causing south-westerly winds.

Our transect of the eastern Weddell Sea was characterized by thin, often broken sea ice coverage, permitting a swift voyage. Until Sunday, 6 Jan. 2013, weak winds dominated and the cloudiness changed frequently between overcast and broken, with some sporadic light snowfalls.

Thereafter, the last strong low-pressure system of this expedition approached from Antarctic Peninsula, causing winds of up to Bft 8-9 (gusts up to 10 Bft) from North-East on 7 Jan (Figure 2.1). Concurrently, snow, rain and partly low clouds led to weather conditions insufficient for the save conduction of helicopter flights. The high wind speed from North-East increased the pressure within the sea-ice field, causing a rather difficult ice-situation in northern Weddell Sea, which repeatedly stalled our progress.

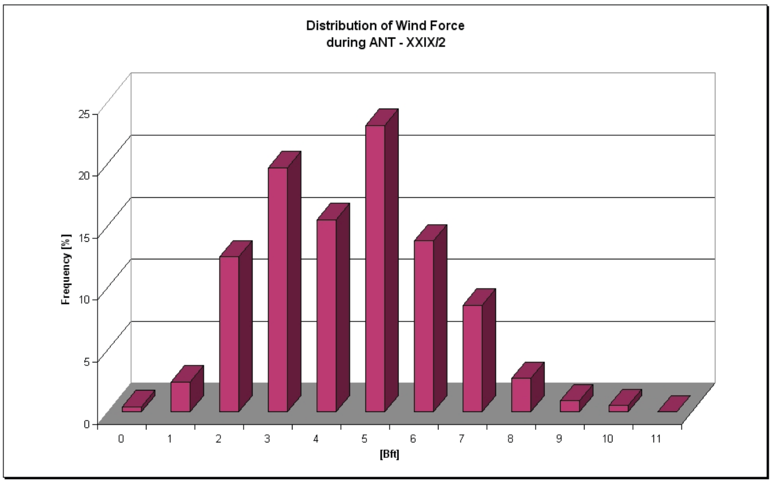

Fig. 2.2: Distribution of wind force during ANT-XXIX/2

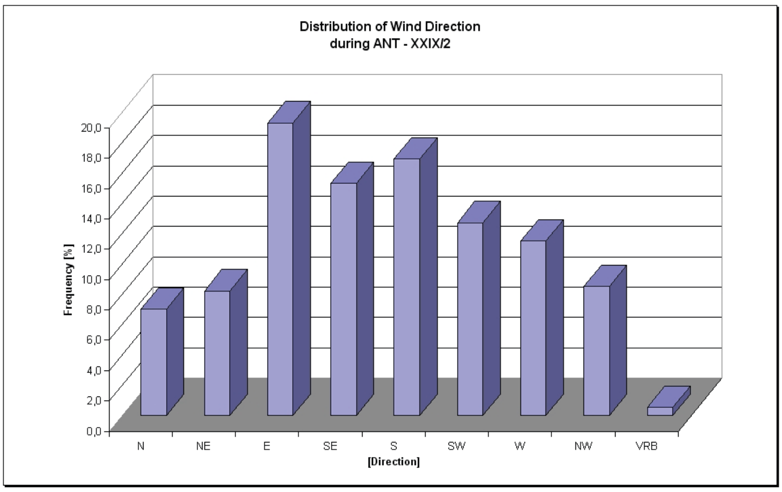

Fig. 2.3: Distribution of wind directions during ANT-XXIX/2

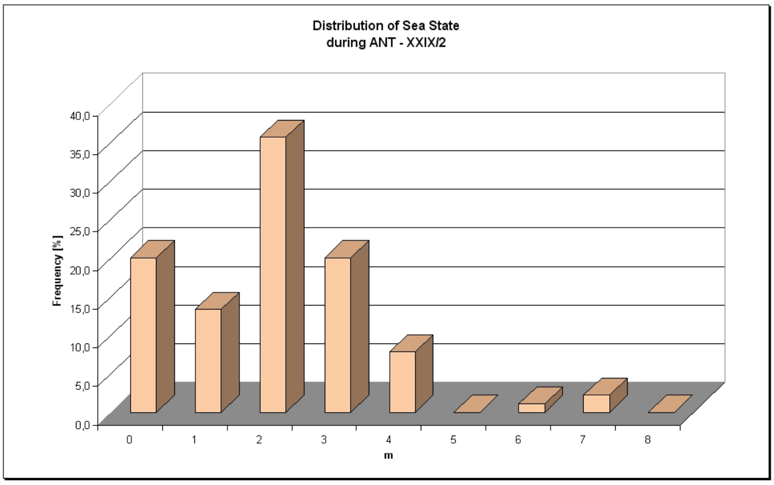

Fig. 2.4: Distribution of sea state during ANT-XXIX/2

Two days later we reached the back side of this low, featuring isolated showers and weak southerly winds. This low-pressure influence persisted until 12 Jan., characterized by changing wind directions, wind speeds up to 6 Bft and occasional light snowfalls.

With the beginning of the last week of this expedition, on 14 Jan., we sailed through an area influenced by a ridge of high pressure, where south-westerly to westerly winds of up to 5, later 6 Bft, dominated. On 15 Jan. we reached the sea ice edge and the wave height increased to 2m. Later, in the Drake Passage, wave hights did not exceed a moderate 3 m, allowing a quick passage to South America. Until the end of the cruise, on 18 Jan., steady winds from west-southwest prevailed with 5-6 Bft, with broken clouds and rain and sunshine present at equal parts. Temperature reached values around 3°C while at the sea, and 17°C at our destination in Punta Arenas.

Figures 2.2. through 2.4 depict this expedition's statistics of wind force, direction and sea state, clearly showing the dominance of winds of 5 Bft and sea states of 2 m.

3. OCEANOGRAPHY

3.1 Implementation of the HAFOS observation system in the Antarctic

Olaf Boebel[1], Katerina Lefering[1], Raúl Guerrero[2], Nina Machner[1], Sebastian Menze[1], Matthias Monsees[1], Eva Nowatzki[1], Loretta Preis[1], Stefanie Rettig[1], Friederike Rohardt[1], Gerd Rohardt[1], Karolin Thomisch[1], Ilse Van Opzeeland[1], Wei Wei[1], Rainer Graupner[3], Sabine Brosch[4], Wolfgang Zahn[5]

[1]AWI
[2]INIDEP
[3]OPTIMARE
[4]Schickhardt-Gymnasium
[5]FZ-Jülich

Overall objectives

The densest bottom waters of the global oceans originate in the Southern Ocean. Production and export of these dense waters constitute an important component of the global climate system. The formation of dense water in polar areas is controlled by the balance between supplies of fresh water through precipitation, the melting of sea and continental ice and the extraction of freshwater by sea ice formation and evaporation. As Deep and Bottom Waters, these waters represent the deepest layer of the global overturning circulation. The influence of Southern Ocean waters can be traced far north of the Antarctic Circumpolar Current (ACC) into the Northern Hemisphere. The ACC is the world´s most powerful current system, transporting about 140 Sv (10^6 m^3 s^{-1}) of water. It connects the Pacific, Atlantic and Indian Oceans and forms a 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 of which being the Weddell and Ross Gyres. In the subpolar gyres, water mass modification occurs 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 at intermediate depth and feeding into northward flow above and below. In the deep cell, water sinking near the continental water spreads to the adjacent ocean basins whereas in the shallow cell, the northward flow occurs in the 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 relatively warm and salty Circumpolar Deep Water into the surface layer, where it interacts 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 would impede sinking due to increased stratification 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 bases in response 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, such as the Antarctic frontal system. Due to the spatial separation of major sea-ice freezing and melting areas, cooling and salt release during sea-ice formation also help compensating the freshwater gain. Significant parts of salt accumulation occur on the Antarctic shelves in coastal polynyas. With extreme heat losses occurring only over ice free waters, 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. Alternatively, it may circulate under the vast ice shelves, where it experiences cooling (below the surface freezing temperature) and freshening through entrainment of melt water from 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 is of particular importance to induce and maintain the sinking motion. The various processes, topographic settings and the atmospheric forcing conditions lead to variable spatial characteristics of the resulting deep and bottom water masses which then 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 to be able to quantify their current contribution and to be able forecast their response to a changing environment.

The properties and volume of the newly formed bottom water underlies significant variability on a wide range of time scales, which are only scarcely explored due to the large efforts needed to obtain measurements in ice covered ocean areas. Seasonal variations of the upper ocean layers generally exceed in intensity the variability on other scales, but are known only partially. Impacts of longer term variations of the atmosphere-ice-ocean system, such as the Southern Hemispheric Annular Mode and the Antarctic Dipole, are only poorly observed and understood. Their influence on or interaction with oceanic conditions are merely guessed on the basis of models which as yet could be validated only superficially 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 of sufficient spatial and temporal coverage are needed. At present, such data sets can only be acquired by satellite remote sensing. However, to penetrate into the ocean interior and to validate the remotely sensed data, an ocean observing system is required, which combines remotely sensed data of sea ice and surface properties with *in-situ* measurements of atmospheric, sea ice and the ocean interior.

Significant progress towards this goal already occurred in the development of appropriate technology and logistics. Now the *Hybrid Antarctic Float Observing System* (HAFOS) observing system, which shall be installed during this expedition, aims to capitalize on these advances to investigate the ocean interior in the Atlantic Sector of the Southern Ocean, thereby extending the international *Argo* program into the Weddell Sea and making an important step towards a *Southern Ocean Observing System* (SOOS).

3.1.1 Hydrographic moorings

Olaf Boebel[1], Katerina Lefering[1], Matthias Monsees[1], Loretta Preis[1], Stefanie Rettig[1], Friederike Rohardt[1], Gerd Rohardt[1], Rainer Graupner[2]

[1]AWI
[2]OPTIMARE

Objectives

To determine trends and fluctuations in the characteristics of the various Antarctic water masses, a set of more than a dozen hydrographic moorings (Figure 3.1) has been maintained and expanded throughout the past 30 years. Moorings host temperature, salinity and velocity sensors as well as RAFOS sound sources to support the use of RAFOS-tracked, under-ice Argo floats throughout the Weddell Gyre. Most recently, the suite of hosted sensor was complemented by passive acoustic recorders to monitor underwater acoustics with biotic and abiotic applications. One major goal of ANT-XXIX/2 was to recover and redeploy these mooring to be able continue these observations for another 2-3 years.

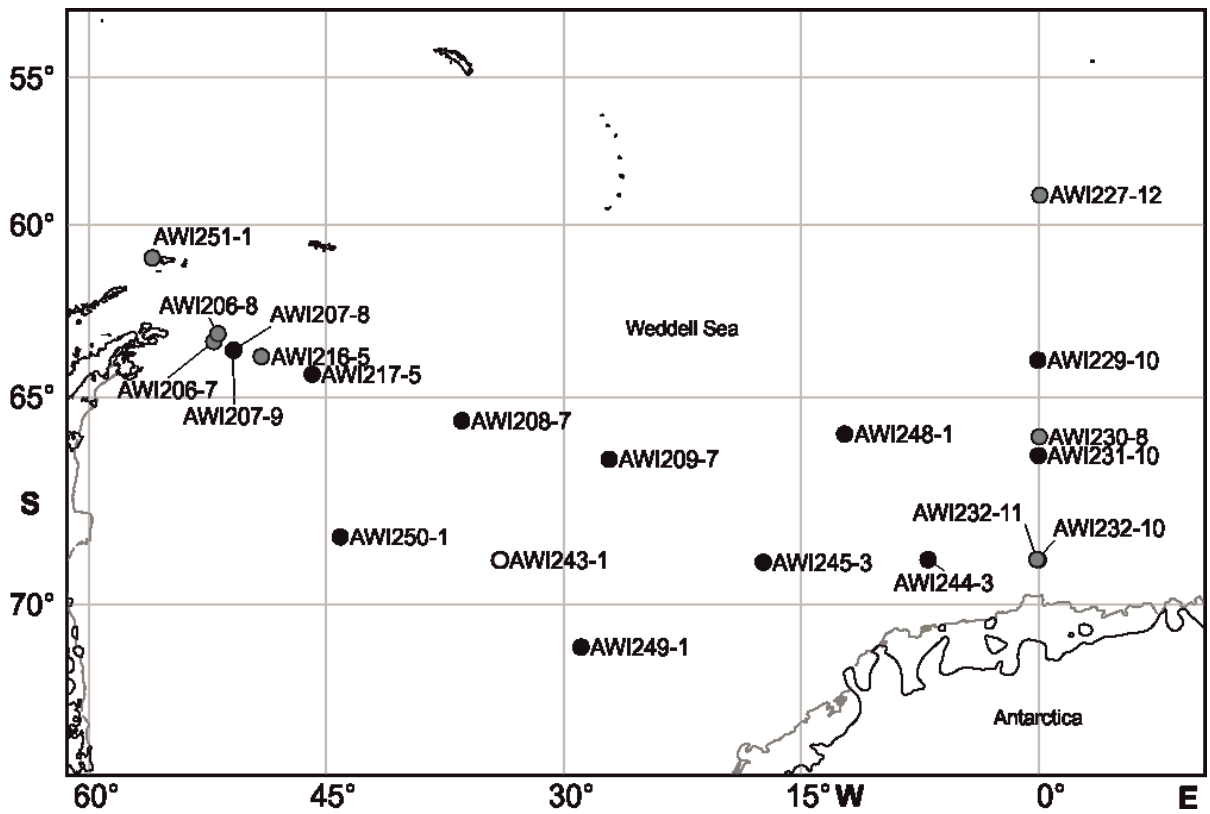

Fig. 3.1: Map of mooring locations occupied since ANT-XXIX/2 or earlier. Black dots indicate moorings hosting RAFOS sources.

Work at sea

Overview

During this expedition, a total of 10 moorings were recovered (Table 3.1, Figures 3.2 and 3.4). An attempt to recover mooring “MARU #2”, which had already been considered lost in 2011 (Kattner, 2012), failed again, as its release did (expectedly) not respond to the acoustic commands issued. This mooring must now definitely be considered lost. Four additional moorings, scheduled for recovery during this expedition, were inaccessible due to the heavy ice coverage; Their recovery will be reattempted during an upcoming cruise (Table 3.2). A total of 17 moorings were deployed (Table 3.3, Figures 3.3 and 3.5).

Tab. 3.1: Recoveries during ANT-XXIX/2

Mooring	Latitude	Longitude	Depth [m]	Deployment		Recovery	
AWI227-11	59°03.02’ S	00°06.63’ W	4600	11.12.2010	18:28	11.12.2012	06:28
AWI229-9	63°59.56’ S	00°02.65’ W	5170	15.12.2010	16:28	14.12.2012	05:40
Maru #2	64°04.84’ S	00°05.36’ W	5193	14.12.2008	08.54	failed, mooring lost	
AWI230-7	66°01.90’ S	00°03.25’ E	3540	16.12.2010	20:00	15.12.2012	07:45
AWI231-9	66°30.71’ S	00°01.54’ W	4524	17.12.2010	12:00	16.12.2012	05:28
AWI244-2	69°00.30’ S	06°58.89’ W	2900	23.12.2010	10:27	25.12.2012	08:37
AWI245-2	69°03.52’ S	17°23.05’ W	4740	27.12.2010	11:00	28.12.2012	13:15
AWI209-6	66°36.70’ S	27°07.31’ W	4830	29.12.2010	15:15	01.01.2013	09:35
AWI208-6	65°37.06’ S	36°25.28’ W	4740	01.01.2011	17:49	03.01.2013	08:35
AWI217-4	64°23.88’ S	45°51.95’ W	4416	04.01.2011	17:57	09.01.2013	07:29
AWI216-4	63°53.66’ S	49°05.20’ W	3500	05.01.2011	15:57	10.01.2013	21:48

Tab. 3.2: Pending recoveries

Mooring	Latitude	Longitude	Depth [m]	Deployment	
AWI232-10	69° 00.11’ S	00° 00.11’ W	3370	19.12.2010	10:20
AWI243-1	68° 00.67’ S	34° 00.15’ W	4443	31.01.2007	06:15
AWI207-8	63° 43.20’ S	50° 49.54’ W	2500	06.01.2011	12:26
AWI206-7	63° 28.93’ S	52° 05.87’ W	950	06.01.2011	20:52

Tab. 3.3: Overview of mooring deployments during ANT-XXIX/2

Mooring	Latitude	Longitude	Depth [m]	Deployment	
AWI227-12	59° 02.57’S	00° 04.91’ E	4600	11.12.2012	14:41
AWI229-10	63° 59.66’ S	00° 002.67’ W	5172	14.12.2012	12:34
AWI230-8	66° 02.12’ S	00° 02.98’ E	3552	15.12.2012	14:39
AWI231-10	66° 30.93’ S	00° 00.65’ W	4456	16.12.2012	11:30
AWI232-11	68° 59.86’ S	00° 06.51’ W	3319	18.12.2012	06:00
AWI244-3	69° 00.39’ S	06° 58.97’ W	2900	25.12.2012	14:24
AWI248-1	65° 58.09’ S	12° 15.12’ W	5011	27.12.2012	08:50

Mooring	Latitude	Longitude	Depth [m]	Deployment	
AWI245-3	69° 03.47' S	17° 23.32' W	4746	28.12.2012	21:04
AWI249-1	70° 53.55' S	28° 53.47' W	4364	30.12.2012	12:41
AWI209-7	66° 36.45' S	27° 07.26' W	4830	01.01.2013	15:05
AWI208-7	65° 37.23' S	36° 25.32' W	4732	03.01.2013	13:20
AWI250-1	68° 28.95' S	44° 06.67' W	4100	05.01.2013	14:53
AWI217-5	64° 22.94' S	45° 52.12' W	4410	09.01.2013	14:16
AWI216-5	63° 53.61' S	49° 05.17' W	3513	10.01.2013	00:17
AWI207-9	63° 43.57' S	50° 51.64' W?	2500	12.01.2013	08:23
AWI206-8	63° 15.51' S	51° 49.59' W	917	14.01.2013	05:06
AWI251-1	61° 00.88' S	55° 58.53' W	319	15.01.2013	02:11

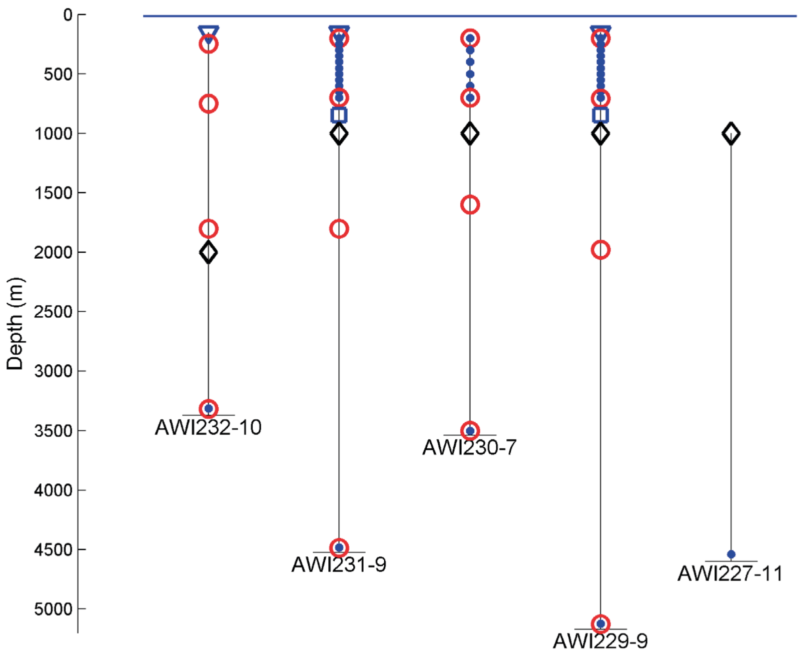

Fig. 3.2: Schematic of instrument distribution as hosted by moorings recovered (except for AWI232-10, which remained in place) along the Greenwich meridian. Left to right corresponds to South to North. Red circles: Current meters; blue dots: CTD recorders; black open diamonds: passive acoustic recorders; blue open squares: RAFOS sound sources; blue open triangles: upward looking sonars (ULS).

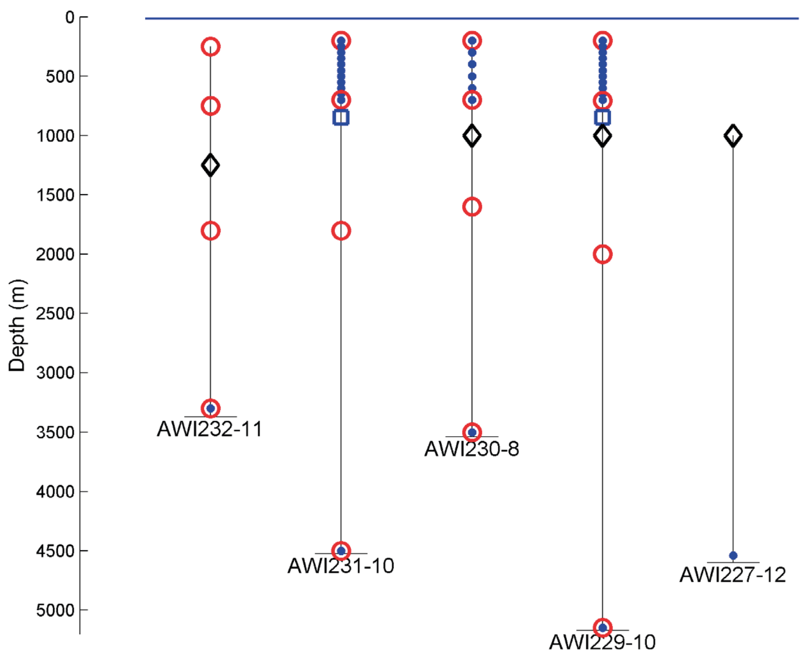

Fig. 3.3: Schematic of instrument distribution as hosted by moorings deployed along the Greenwich meridian. Legend as in Figure 3.2.

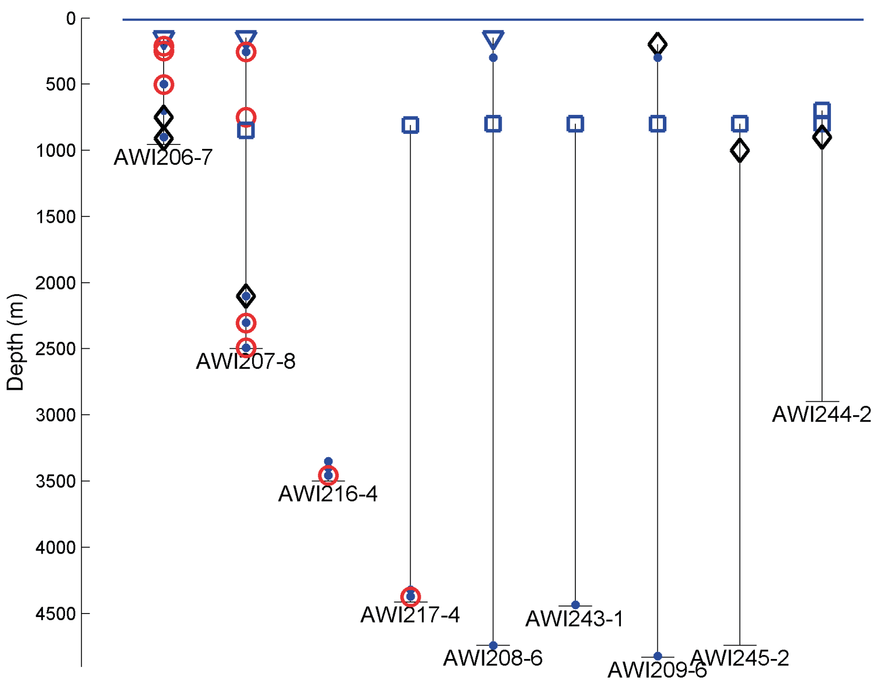

Fig. 3.4: Schematic of instrument distribution as hosted by moorings recovered across the Weddell Sea (except for AWI206-7 and AWI 207-8, which remained in place). Left to right corresponds approximately to West to East. Legend as in Figure 3.2.

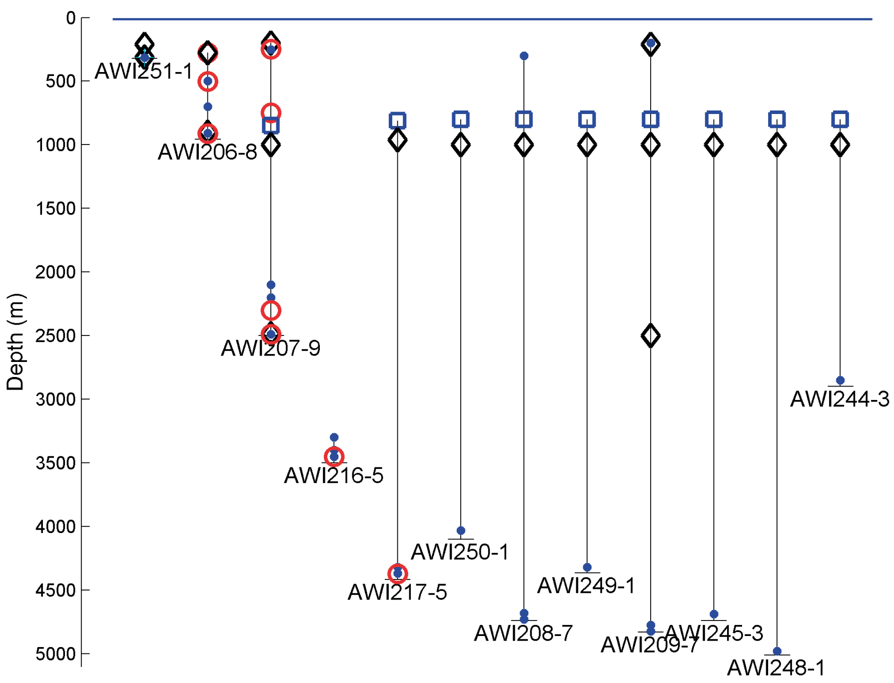

Fig. 3.5: Schematic of instrument distribution as hosted by moorings deployed across the Weddell Sea. Legend as in Figure 3.2; cyan cross: ADCP.

Details regarding the instrumentation of the moorings deployed are listed in Table 3.4.

Tab. 3.4: Instrumentation of moorings deployed during ANT-XXIX/2

Mooring	Latitude Longitude	Water Depth [m]	Date Time(UTC) deployed	Instru-ment Type	Serial Number	Instrument Depth [m]
AWI232-11	68° 59.86’ S	3319	18.12.2012	AVT	10925	250
	00° 06.51’ W		06:00	RCM11	469	750
				PAM	1011	1250
				RCM 11	512	1800
				SBE37	7727	3300
				AVT	10499	3300
AWI231-10	66° 30.93’ S	4456	16.12.2012	AVT	10541	200
	00° 00.65’ W		11:30	SBE37	2096	200
				SBE37	2098	250
				SBE37	2099	300
				SBE37	2100	350
				SBE37	2101	400
				SBE37	2385	450

Mooring	Latitude Longitude	Water Depth [m]	Date Time(UTC) deployed	Instru-ment Type	Serial Number	Instrument Depth [m]
				SBE37	2234	500
				SBE37	2386	550
				SBE37	2389	600
				SBE37	2391	650
				SBE37	3813	700
				AVT	9184	700
				SOSO	0024	850
				RCM11	509	1800
				SBE37	7726	4500
				AVT	9180	4500
AWI230-8	66° 02.12′ S	3552	15.12.2012	AVT	10491	200
	00° 02.98′ E		14:39	SBE37	2088	200
				SBE37	2090	300
				SBE37	2091	400
				SBE37	2092	500
				SBE37	2093	600
				SBE37	2094	700
				AVT	6856	700
				PAM	1009	1000
				AVT	9213	1600
				SBE37	2095	3500
				AVT	9179	3500
AWI229-10	63° 59.66′ S	5172	14.12.2012	AVT	8050	200
	00° 002.67′ W		12:34	SBE37	9834	200
				SBE37	447	250
				SBE37	237	300
				SBE16	240	350
				SBE37	435	400
				SBE37	9838	450
				SBE37	438	500
				SBE37	439	550
				SBE37	2086	600
				SBE37	449	650
				SBE37	245	700
				RCM 11	452	704
				SOSO	0026	850
				PAM	1010	1000
				RCM 11	475	2000
				SBE37	9833	5150
				RCM 11	144	5150
AWI227-12	59° 02.57′S	4600	11.12.2012	PAM	1025	1000
	00° 04.91′ E		14:41	SBE16	319	4540

Mooring	**Latitude Longitude**	**Water Depth [m]**	**Date Time(UTC) deployed**	**Instru-ment Type**	**Serial Number**	**Instrument Depth [m]**
AWI244-3	69° 00.39’ S	2900	25.12.2012	SOSO	29	800
	06° 58.97’ W		14:24	PAM	0001	1000
				SBE16	2419	2850
AWI248-1	65° 58.09’ S	5011	27.12.2012	SOSO	0028	800
	12° 15.12’ W		08:50	PAM	1013	1000
				SBE37	9841	4980
AWI245-3	69° 03.47’ S	4746	28.12.2012	SOSO	16/30	800
	17° 23.32’ W		21:04	PAM	1012	1000
				SBE37	9839	4690
AWI249-1	70° 53.55’ S	4364	30.12.2012	SOSO	0030	800
	28° 53.47’ W		12:41	PAM	1014	1000
				SBE37	9847	4320
AWI209-7	66° 36.45’ S	4830	01.01.2013	SBE16	2420	200
	27° 07.26’ W		15:05	PAM	1027	210
				SOSO	0025	800
				PAM	1028	1000
				PAM	1029	2500
				SBE37	7728	4775
				SBE37	7729	4825
AWI208-7	65° 37.23’ S	4732	03.01.2013	SBE16	1167	300
	36° 25.32’ W		13:20	SOSO	0029	800
				PAM	1030	1000
				SBE37	7730	4680
				SBE37	7731	4730
AWI250-1	68° 28.95’ S	4100	05.01.2013	SOSO	23	800
	44° 06.67’ W		14:53	PAM	1031	1000
				SBE37	9848	4030
AWI217-5	64° 22.94’ S	4410	09.01.2013	SOSO	29/34	810
	45° 52.12’ W		14:16	PAM	1020	960
				SBE37	9496	4320
				SBE37	9497	4370
				RCM 11	135	4372
AWI216-5	63° 53.61’ S	3513	10.01.2013	SBE37	9493	3300
	49° 05.17’ W		00:17	SBE37	9494	3400
				SBE37	9495	3450
				RCM 11	215	3451
AWI207-9	63° 43.57’ S	2500	12.01.2013	PAM	1032	200
	50° 51.64’ W?		08:23	AVT	11888	250
				SBE16	2413	251
				RCM 11	474	750
				SOSO	27	850
				PAM	1033	1000

Mooring	Latitude Longitude	Water Depth [m]	Date Time(UTC) deployed	Instru-ment Type	Serial Number	Instrument Depth [m]
				SBE37	7732	2100
				SBE37	7733	2200
				AVT	10530	2300
				SBE37	9492	2490
				PAM	1034	2490
				AVT	10498	2490
AWI206-8	63° 15.51’ S	917	14.01.2013	AVTP	11889	276
	51° 49.59’ W		05:06	PAM	232LE	277
				SBE16	1975	500
				RCM 11	508	501
				SBE16	1976	700
				PAM	0002	900
				SBE16	1977	910
				RCM 11	100	912
AWI251-1	61° 00.88’ S	319	15.01.2013	PAM	231LF	210
	55° 58.53’ W		02:11	PAM	1008	500
				ADCP	5848	314
				SBE16	1973	316

Abbreviations:

AVT Aanderaa Current Meter with Temperature Sensor
PAM Passive Acoustic Monitor (Type: AURAL or SONOVAULT)
RCM 11 Aanderaa Doppler Current Meter
SBE16 SeaBird Self Recording CTD measuring Temperature, Conductivity and Pressure
SBE37 SeaBird Electronics, Type: MicroCat, to measure Temperature and Conductivity
SOSO Sound Source for SOFAR-Drifter
ULS Upward looking sonar from Christian Michelsen Research Inc. to measure the ice draft

Mooring recoveries under heavy sea-ice conditions

Most of the moorings scheduled for recovery during this expedition were at locations covered by heavy sea ice, requiring rather complex recovery procedures. These require concurrent availability of acoustic tracking and mobility of the ship. If mobility is hampered, as it frequently was the case during this expedition, the ensuing wait times prohibit the timely use of opportunities resulting from natural patches of open water, rendering recoveries most difficult. Essential requirements for in-ice mooring recoveries are:

- Verified, reliable positioning of the mooring prior and during its ascent.
- Prediction of the sea ice drift for the period between release and sighting of the mooring.
- Timing of the mooring release, such that it surfaces within a natural or “ship prepared” patch of open water, or
- tracking of the presumed surface location of the mooring while it is trapped under the sea ice in conjunction with the ship’s ability to break the ice around/at this location to allow the mooring to surface.

- Ability to keep *Polarstern* within a 45° to 60° cone above the mooring's transponder to allow acoustic tracking.

Commonly, an in-ice mooring recovery would follow the following scheme:

- Localization of the mooring.
- Eventually preparing a patch of open water upstream (allowing for tidal and wind-driven currents) of the mooring.
- Issuing of the release command at a time commensurate with the mooring's projected surfacing in a patch of open water.
- Acoustic acknowledgement of the release.
- Acoustic tracking the mooring's ascent.
- Visual marking of the last known reliable acoustic position.
- Search for mooring in open water or breaking of ice to allow surfacing.
-

However, during ANT-XXIX/2, multifold compounding complications compromised our ability to proceed accordingly:

- The presence of heavy, multiyear sea ice conditions (up to 3 m thickness even in unridged floes) with substantial snow cover (up to 1 m thickness), limiting the ship's maneuverability if not stopping it altogether.
- Tidal motion displacing the ship when entrapped in sea-ice, making it impossible to maintain a position.
- Unreliable positioning of moorings by Posidonia when used with the "fixed" antenna (see section "Posidonia" below).
- Delays when having to install the "mobile" Posidonia antenna.
- Limited maneuverability with the "mobile" Posidonia antenna installed.
- Clotted release hooks resulting in possibly retarded mechanical response of the release to acoustic release commands.

At mooring AWI232-10, while having reached and successfully contacted the mooring acoustically, ice conditions prohibited attaining a location suitable for recovery. Hence, AWI232-10 was not recovered. Its instrumentation is expected to run out of battery within the first half of 2013. To ensure continuation of this time series, a second mooring, AWI232-11, was deployed about 2 nm west of AWI232-10, at about the same water depth (Figure 3.6); Recovery of both moorings is now planned for 2014/15.

Accessing mooring AWI243-1, which was scheduled for recovery only (i.e. not for redeployment), was cancelled due to time constraints resulting from the severe sea ice conditions predicted for the remainder of the expedition.

Dense sea ice was again encountered at mooring AWI207-8. While the mooring's location was reached, the ship could not be maneuvered into a position suitable for recovery (Figure 3.7). Again, to ensure continuation of the time series, a second mooring, AWI207-9, was deployed nearby.
Attempting to access the position of mooring AWI206-7 (Figure 3.8) had to cancelled, due to limitations in ship time paired with heavy sea-ice conditions which made reaching the position in time unrealistic. Along the direct course towards the

last planned mooring, AWI251-1, a "sister mooring" to AWI206-7, AWI206-8 was deployed when crossing the 950 m depth contour.

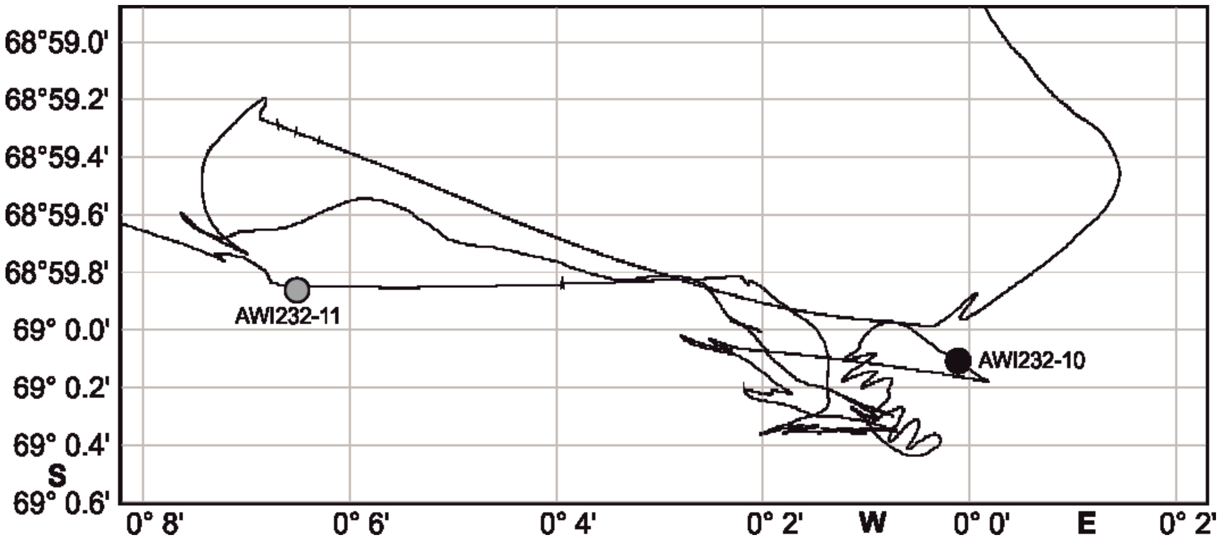

Fig. 3.6: Polarstern's track throughout the attempted recovery of mooring AWI232-10 (black dot). The new mooring AWI232-11 (gray dot) was deployed ca. 2 nm west of the location of AWI232-10.

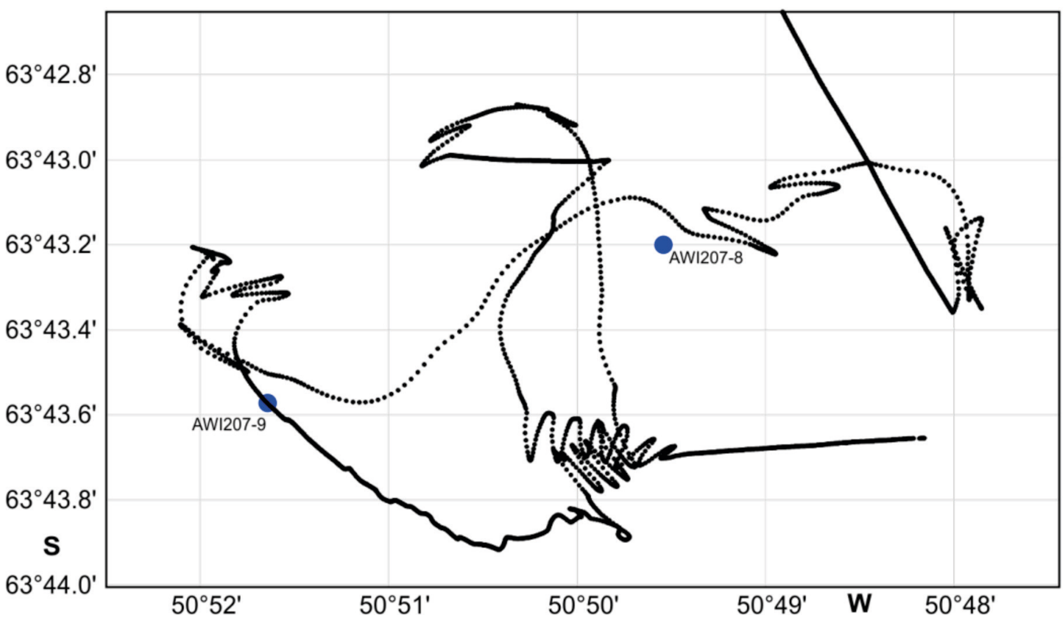

Fig. 3.7: Attempts to reach mooring AWI207-8i

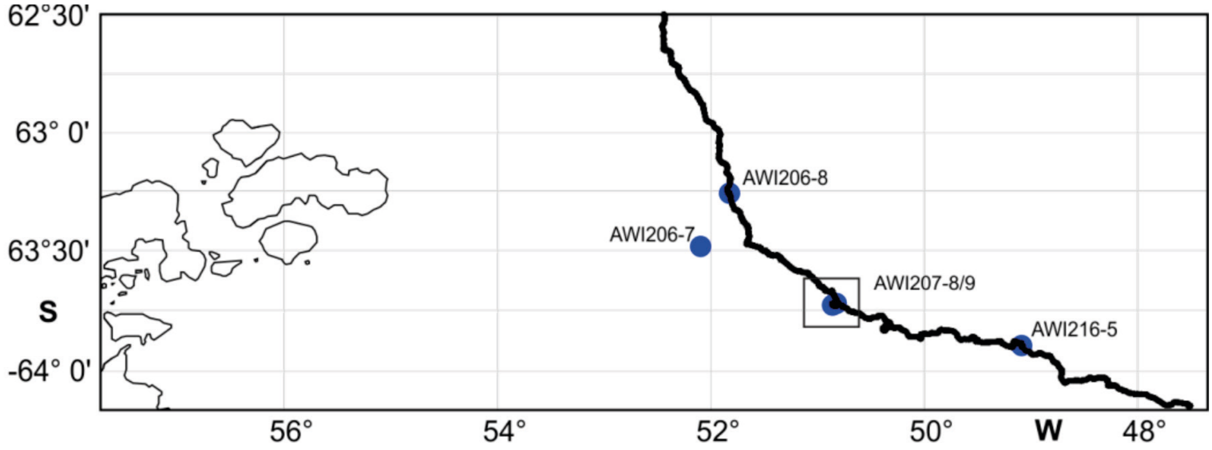

Fig. 3.8: Location of moorings near the tip of the Antarctic Peninsula

A successful implementation of the above recovery approach under difficult conditions is exemplified by the recovery of AWI216-4 (now AWI216-5, Figure 3.8). This unusually short mooring of only 250 m total length resided in 3,500 m water depth. Once released it would take about 30 minutes to reach the surface. During this period it was expected to drift with the ocean's interior currents, and hence differently than the sea ice at the surface. Therefore, breaking ice over the mooring position to open up a suitable patch of open water prior to installing the mobile Posidonia antenna to release and track the mooring, appeared an unfeasible approach. For this reason the recovery of AWI216-4 was planned and executed as follows:

- Verification of Posidonia communication with the releaser/transponder using the fixed antenna, with the ship positioned right over the mooring.
- Concurrent determination of the sea-ice drift vector.
- Repositioning of *Polarstern* to a suitable position (45 min times the sea ice drift) upstream of the mooring location.
- Installation of the mobile antenna (45 min). During this period *Polarstern* drifted with the sea ice towards the mooring position.
- Re-localization of the mooring via Posidonia using the mobile antenna.
- Change to Posidonia's release mode immediately after first successful positioning.
- Commanding the release of the mooring primary release unit 3 times. (Due to the Posidonia software's inability to process acoustic acknowledgments of the reception of the release command, release commands were repeated for redundancy).
- Concurrent, independent issuing of release commands for the second releaser of the double releaser unit using an iXsea TT801 deck unit.
- Return to Posidonia's navigation mode and monitoring of the mooring's ascent/position.
- Stop of commanding releases via TT801 as soon as a decreasing depth was indicated by Posidonia.

- Tracking of the ascending mooring as long as possible. Positioning becomes unreliable once the transponder is outside of the antenna's 60° view angle.
- Forwarding the last reliable position to the helicopter team, which is on stand-by.
- Placement of a conspicuous, floatable marker (mooring floatation elements) by the helicopter on the ice floe at the last reliable Posidonia fix. The mooring is expected to surfaced under ice near this location and to then drift with the sea ice.
- Return of the helicopter.
- Removal of the mobile antenna and closing of the ship's well (45 min) while visually tracking the marker.
- Breakup of the marked ice floe by *Polarstern* while the entire system drifts with the sea-ice.

The described method resulted in a successful recovery even under these very difficult conditions (compact sea-ice, fast drift and short mooring assembly rising from deep water). We spotted the mooring at a 100 m range off the marked ice floe.

Performance of the Posidonia tracking system

Moorings usually are located using *Polarstern*'s short baseline navigation system Posidonia. Posidonia may be used in conjunction with two different acoustic receiver arrays (antennas):

- The "fixed" antenna is permanently installed in the ship's box keel. It is protected by a "shutter" from passing chunks of ice. For Posidonia to be operational, this shutter must be opened by remote command from the bridge. Opening or closing takes about 2 minutes. With the shutter closed, *Polarstern* is fully maneuverable in ice; If open, only limited (slow speed, no ramming) maneuverability is available.
- The "mobile" antenna, which usually is not installed, is mounted on demand in the ship's well. Installation or removal both require about 45 minutes, during which *Polarstern* has to be stationary. Once installed *Polarstern*'s maneuverability in ice is limited; In particular, ramming of thicker ice flows or ridges is not possible, as the unprotected mobile antenna is in risk of damage from passing chunks of ice.

The fixed antenna had been used during the previous Arctic expedition, lacking any notable differences between the manually logged deployment locations and the positioning by Posidonia. However, during the installation of a new shutter prior to ANT-XXIX, a damaged pin of the antenna's connector had been noted, prompting the replacement of the fixed antenna array. While the antenna's functionality had been subsequently verified by the manufacturer (iXsea), a detailed calibration of the orientation of this new antenna was not performed due to time constraints.
During ANT-XXIX/2 it was noticed that the moorings did not surface at the position indicated by Posidonia. Therefore test were carried out by tracking the transponder of a mooring while it was deployed anchor first. The fixed antenna consistently indicated a large unrealistic horizontal displacement which increased with depth. While Posidonia indicated a relative direction towards the stern, the mooring wire actually stood exactly vertical. A second test alternated between both antennas,

while the ship did a full circle turn around the lowered transponder. At all times, the mobile antenna indicated realistic horizontal displacement, while the fixed antenna indicated widely scattered, unrealistic displacements. Finally, software tests using Posidonia 6000 and the new electronic unit called "USBL Box" were conducted. These test indicated that the observed results are independent of the electronic units and software and hence are likely to originate from the antenna hardware. Details of these tests were reported by the FIELAX technician and directly forwarded to iXsea for further evaluation.

Preliminary results

Details of the moorings scheduled for recovery, their instrumentation and the length of each associated data record are listed in Table 3.5. See section 5.3 regarding the performance of passive acoustics recorders (PAM).

Tab. 3.5: Details of instrumentation hosted by moorings recovered during ANT-XXIX/2

Mooring	Latitude Longitude	Water Depth [m]	Date Time deployed recovered	Instru ment Type	Serial Number	Instru-ment Depth [m]	Number of Days recorded
AWI232-10	69° 00.11′ S	3370	19.12.2010	ULS	69	150	(1)
	00° 00.11′ W		10:20	AVTP	8400	250	
			not	AVT	9219	750	
			recovered	PAM	1003	1250	
				RCM 11	212	1800	
				POD	403	2000	
				SBE37	441	3300	
				RCM 11	216	3300	
AWI231-9	66° 30.71′ S	4524	17.12.2010	ULS	68	150	729
	00° 01.54′ W		12:00	AVTP	8367	200	729
			16.12.2012	SBE37	249	200	729
			05:28	SBE37	232	250	729
				SBE37	233	300	729
				SBE37	235	350	729
				SBE37	236	400	729
				SBE37	1230	450	729
				SBE37	238	500	729
				SBE37	239	550	729
				SBE37	2388	600	729
				SBE37	437	650	729
				SBE37	1232	700	729
				RCM 11	145	700	729
				SOSO	29	850	729
				PAM	1002	1000	729
				AVT	9212	1800	729
				SBE37	440	4500	729
				RCM 11	146	4500	729
AWI230-7	66° 01.90′ S	3540	16.12.2010	AVTP	10539	200	729 (2)

Mooring	Latitude Longitude	Water Depth [m]	Date Time deployed recovered	Instru ment Type	Serial Number	Instru-ment Depth [m]	Number of Days recorded
	00° 03.25′ E		20:00	SBE37	8125	200	729
			15.12.2012	SBE37	227	300	729
			07:45	SBE37	246	400	729
				SBE37	228	500	729
				SBE37	229	600	729
				SBE37	247	700	729
				RCM 11	102	700	729
				PAM	1001	1000	729
				AVTP	9211	1600	729 (2)
				SBE37	231	3500	729
				RCM 11	133	3500	692
AWI229-9	63° 59.56′ S	5170	15.12.2010	ULS	67	150	729
	00°002.65′ W		16:28	AVTP	10926	200	729
			14.12.2012	SBE37	2719	200	729
			05:40	SBE37	241	250	729
				SBE37	215	300	729
				SBE16	216	350	729
				SBE37	218	400	729
				SBE37	2720	450	729
				SBE37	224	500	729
				SBE37	225	550	729
				SBE37	226	600	729
				SBE37	2382	650	729
				SBE37	2722	700	729
				AVTP	8037	704	729
				SOSO	17	850	729
				PAM	1000	1000	729
				RCM 11	501	2000	729
				SBE37	2383	5150	729
				RCM 11	134	5150	693
AWI227-11	59° 03.02′S	4600	11.12.2010	PAM	0002	1000	
	00° 06.63′ W		18:28	SBE16	630	4540	730
			11.12.2012				
			06:28				
AWI244-2	69° 00.30′ S	2900	23.12.2010	SOSO	02	700	
	06° 58.89′ W		10:27	SOSO	30	800	
			25.12.2012	PAM	1005	900	
			08:37				
AWI245-2	69° 03.52′ S	4740	27.12.2010	SOSO	24	800	
	17° 23.05′ W		11:00	PAM	1004	1000	
			28.12.2012				
			13:15				
AWI209-6	66° 36.70′ S	4830	29.12.2010	PAM	086	200	
	27° 07.31′ W		15:15	SBE37	1233	300	733
				SOSO	23	800	

Mooring	**Latitude Longitude**	**Water Depth [m]**	**Date Time deployed recovered**	**Instru ment Type**	**Serial Number**	**Instru-ment Depth [m]**	**Number of Days recorded**
				SBE37	1603	4775	733
				SBE37	442	4825	733
AWI243-1	68° 00.67’ S	4443	31.01.2007	SOSO	31	800	(1)
	34° 00.15’ W		06:15	SBE37	217	4436	
AWI208-6	65° 37.06’ S	4740	01.01.2011	ULS	66	150	
	36° 25.28’ W		17:49	SBE37	1234	300	732
			03.01.2013	SOSO	29/34	800	
			08:35	SBE37	1606	4680	732
				SBE37	444	4730	732
AWI217-4	64° 23.88’ S	4416	04.01.2011	SOSO	28/27	810	
	45° 51.95’ W		17:57	SBE37	1564	4320	736
			09.01.2013	SBE37	2087	4370	736
			07:29	RCM 11	217	4372	648
AWI216-4	63° 53.66’ S	3500	05.01.2011	SBE37	2395	3300	735
	49° 05.20’ W		15:57	SBE37	448	3400	735
			10.01.2013	SBE37	2611	3450	735
			21:48	RCM 11	219	3451	666
AWI207-8	63° 43.20’ S	2500	06.01.2011	ULS	63	150	(1)
	50° 49.54’ W		12:26	RCM 11	294	250	
				SBE37	1235	251	
				AVT	8405	750	
				SOSO	32	850	
				POD	845	2100	
				SBE37	2235	2100	
				SBE37	1605	2200	
				RCM 11	297	2300	
				SBE37	1607	2490	
				RCM 11	311	2490	
AWI206-7	63° 28.93’ S	950	06.01.2011	ULS	65	150	(1)
	52° 05.87’ W		20:52	AVTP	8417	250	
				SBE37	2723	500	
				RCM 11	312	501	
				SBE16	2418	700	
				POD	844	750	
				SBE37	2097	900	
				PAM	1006	910	
				RCM 11	313	912	

Abbreviations:

AVT	Aanderaa Current Meter with Temperature Sensor
PAM	Passive Acoustic Monitor (Type: AURAL or SONOVAULT)
RCM 11	Aanderaa Doppler Current Meter
SBE16	SeaBird Self Recording CTD to measure Temperature, Conductivity and Pressure
SBE37	SeaBird Electronics, Type: MicroCat, to measure Temperature and Conductivity
SOSO	Sound Source for SOFAR-Drifter
ULS	Upward looking sonar from Christian Michelsen Research Inc. to measure the ice draft

Data management

The final records from moored instruments (CTD-recorders and current meters) will be processed after post-expedition calibrations were finished. All data will be stored and available through the PANGAEA data base. P.I.: Olaf Boebel and Gerd Rohardt.

References

Kattner, G. (2012). The expedition of the research vessel "Polarstern" to the Antarctic in 2011/12 (ANT-XXVIII/2), Berichte zur Polar- und Meeresforschung = Reports on polar and marine research, Bremerhaven, Alfred Wegener Institute for Polar and Marine Research, 646 , 97 p., hdl:10013/epic.39675

3.1.2 CTD and l-ADCP observations

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Objectives

To continue the spatially highly resolved repeat CTD section along the Greenwich meridian and to collect temperature and salinity data at mooring positions for estimation of drifts of the sensors moored, a set of deep CTD casts was planned. However, time constraints did not allow to repeat deep CTDs every 30 nm as during previous expeditions. Rather, deep CTDs were cast only every 60 nm, and supplemented by Argo floats deployed in between at the 30 nm mark. Float missions were modified to execute the first profile immediately after launch (rather than after 10 days), to maintain a synoptic approach.

Work at sea

Hydrographic profiles

During this expedition, data from 42 full ocean depth CTD/l-ADCP profiles were collected (Table 3.6). In addition, 5 shallow (typically 300 m) CTD casts were taken. Locations of full ocean depth casts are depicted as black dots in Figure 3.9, with labels given in the format "station number - cast number. Locations of shallow casts are indicated by circles.

Tab. 3.6: List of CTD profiles taken during ANT-XXIX/2

File name	Date /time	Latitude	Longitude	Water depth [m]	max pres. [dbar]
20-3	02-Dec-2012 14:25:00	41 2.058 S	16 48.108 E	4900	304
31-1	08-Dec-2012 04:56:00	54 59.970 S	0 0.222 E	1750	1715
32-1	08-Dec-2012 09:54:00	55 29.952 S	0 0.108 E	3797	304
33-1	08-Dec-2012 19:12:00	56 0.000 S	0 0.438 E	3660	3670
35-1	09-Dec-2012 04:13:00	57 0.018 S	0 0.048 E	3671	3667

File name	Date /time	Latitude	Longitude	Water depth [m]	max pres. [dbar]
37-1	09-Dec-2012 15:00:00	58 0.150 S	0 0.258 E	4547	4563
39-2	11-Dec-2012 10:40:00	59 3.090 S	0 6.780 E	4647	4686
41-1	11-Dec-2012 23:11:00	60 0.030 S	0 0.072 E	5362	5443
43-1	12-Dec-2012 09:28:00	60 59.910 S	0 0.870 E	5389	5472
45-1	12-Dec-2012 23:29:00	62 0.210 S	0 1.170 E	5371	5453
47-1	13-Dec-2012 09:17:00	63 0.030 S	0 0.588 E	5312	5392
49-1	14-Dec-2012 03:14:00	63 57.558 S	0 3.120 E	5210	5279
52-1	14-Dec-2012 21:45:00	64 59.898 S	0 0.258 E	3739	3752
54-2	15-Dec-2012 10:59:00	66 1.752 S	0 3.120 E	3617	3623
55-1	16-Dec-2012 03:24:00	66 28.788 S	0 1.212 E	4495	4530
56-1	16-Dec-2012 16:22:00	66 59.700 S	0 1.482 E	4712	4762
58-1	17-Dec-2012 01:25:00	67 59.592 S	0 0.630 E	4522	4554
59-1	17-Dec-2012 07:39:00	68 29.988 S	0 0.150 E	4270	4295
60-1	17-Dec-2012 14:29:00	68 44.910 S	0 4.140 E	3460	3442
61-3	18-Dec-2012 08:45:00	68 59.142 S	0 14.340 E	3382	3376
62-1	18-Dec-2012 20:53:00	69 10.872 S	0 19.932 E	2752	2728
63-1	19-Dec-2012 03:30:00	69 21.498 S	0 15.132 E	2052	2025
64-5	20-Dec-2012 13:38:00	69 24.798 S	1 1.710 W	2632	304
65-1	24-Dec-2012 15:24:00	70 29.988 S	8 9.438 W	270	255
67-3	25-Dec-2012 15:49:00	69 0.552 S	6 56.172 W	2886	2870
73-1	26-Dec-2012 11:48:00	66 59.940 S	10 29.838 W	4980	307
76-1	27-Dec-2012 04:46:00	65 58.350 S	12 14.928 W	5051	5111
79-3	28-Dec-2012 23:09:00	69 4.272 S	17 30.468 W	4776	4827
83-2	30-Dec-2012 14:50:00	70 51.462 S	28 55.302 W	4422	4455
88-1	01-Jan-2013 07:07:00	66 38.760 S	27 9.150 W	4873	4923
90-5	02-Jan-2013 14:32:00	65 59.988 S	32 52.830 W	4799	303
91-1	03-Jan-2013 04:45:00	65 37.272 S	36 20.430 W	4779	4823
94-1	04-Jan-2013 09:44:00	67 15.570 S	40 21.960 W	4510	912
96-2	05-Jan-2013 16:49:00	68 30.042 S	44 2.940 W	4151	4168
99-1	09-Jan-2013 01:37:00	64 24.588 S	45 57.468 W	4475	4506
100-1	09-Jan-2013 18:02:00	64 19.308 S	46 27.588 W	4429	4456
101-1	09-Jan-2013 23:44:00	64 14.922 S	47 1.308 W	4317	4349
102-1	10-Jan-2013 04:43:00	64 9.258 S	47 29.808 W	4218	4237
103-1	10-Jan-2013 11:40:00	64 2.760 S	48 16.560 W	4016	4029
104-3	11-Jan-2013 01:55:00	63 52.782 S	49 8.052 W	3473	3467
105-1	11-Jan-2013 06:19:00	63 52.470 S	49 30.780 W	3345	3333
106-1	11-Jan-2013 12:13:00	63 50.868 S	50 1.788 W	2918	2903
107-1	11-Jan-2013 21:10:00	63 46.362 S	50 25.812 W	2673	2653
108-1	12-Jan-2013 02:28:00	63 43.690 S	50 49.330 W	2565	2546
109-1	13-Jan-2013 03:58:00	63 31.788 S	51 20.772 W	2178	2145
110-1	13-Jan-2013 20:21:00	63 24.390 S	51 39.012 W	1604	1580
111-1	14-Jan-2013 04:03:00	63 15.702 S	51 49.662 W	940	922

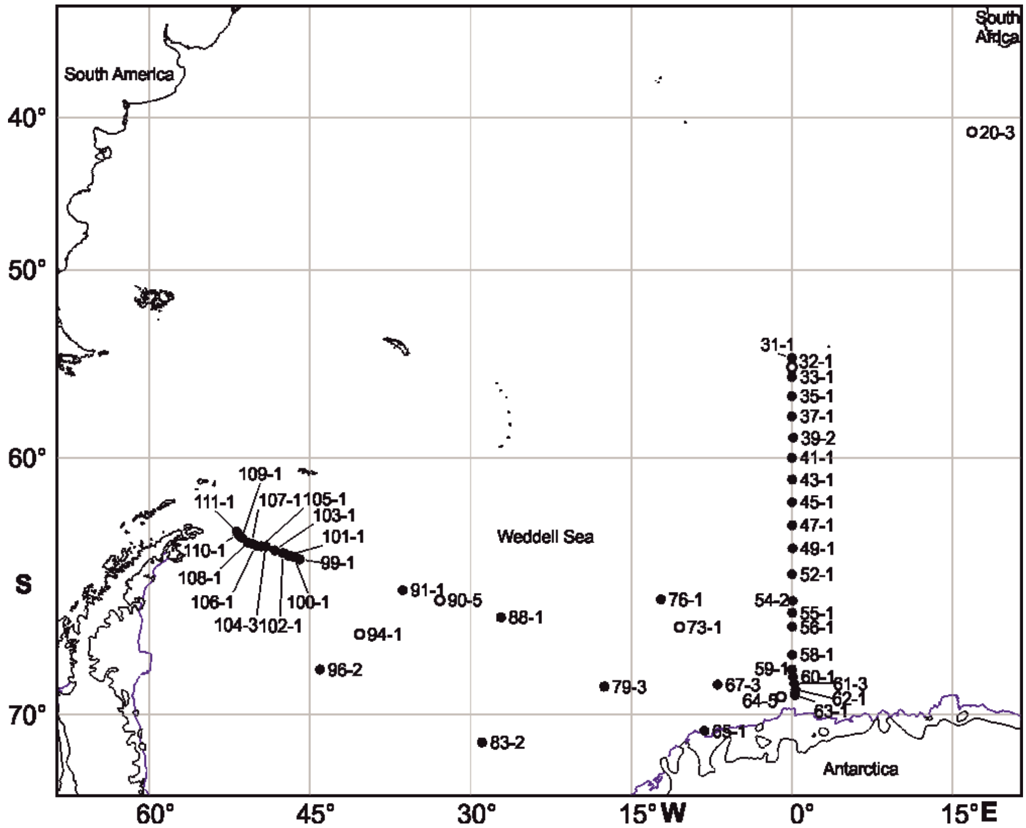

Fig. 3.9: Map of locations of CTD stations. Labels indicate station and cast numbers as given in the station list. Dots indicate full ocean depth CTD- and l-ADCP profiles. Circles indicate shallow CTD profiles (usually to 300 m depth).

The rosette assembly comprises a SBE 911plus CTD system, combined with a carousel type SBE32 for Niskin water samplers of 12 liter volume, with 4 samplers installed. Additionally, the assembly was equipped with a C-Star transmissometer (wave length 650 nm; path length 25 cm) and a Benthos/DataSonics altimeter type PSA 916D.

CTD data was logged with Seabird's *SeaSaveV7* data acquisition software to a local PC in raw format. *ManageCTD*, a Matlab™ based script developed at AWI, was employed to execute Seabird's SBEDataProcessing software, producing CTD profiles adjusted to 1-dbar intervals. *ManageCTD* further embedded metadata (header) information extracted from the DShip-Electronic Station Book before conducting a preliminary de-spiking and data validation of the profile data.

Preprocessed data were saved in OceanDataView compatible format, to provide near real-time visualization of e.g. potential temperature and salinity, particularly to provide *en route* (i.e. during the expedition) visualization of the unfolding hydrographic section.

The CTD was equipped with double sensors for temperature (SBE3plus) and conductivity (SBE4C). These sensors were calibrated prior to the expedition. *Enroute* comparison of the calibrated sensors nevertheless revealed differences of about of 0.0001°C in temperature and 0.001 mS·cm^{-1} in conductivity for *in-situ* measurements between the sensors.

Enroute comparisons between *in-situ* CTD data and salinometer based salinity measurements of water samples indicated that the conductivity sensors (SBE4c #3290 and # 3585) used in the secondary sensor pair (Table 3.7, Fig. 3.10) featured the higher accuracies (see section *Salinometer* for more details). In addition, their drifts were smaller than that of the primary sensor for the duration of the expedition.

A definitive determination of sensors' drifts however requires post-expedition lab calibrations, for which the sensors will be returned to Seabird Electronics after leg ANT-XXIX/3. Hence all results reported hereinafter must be considered preliminary.

Tab. 3.7: CTD-Sensor configuration

SN of Sensors for Station PS81/20-1 to PS81/35-1		
	#1 (primary)	#2 (secondary)
Temperature (SBE3plus)	2929	5027
Conductivity (SBE4c)	2470	3290
SN of Sensors for Station PS81/37-1 to PS81/111-1		
	#1 (primary)	#2 (secondary)
Temperature (SBE3plus)	2929	5027
Conductivity (SBE4c)	2470	3585

Salinometer measurements

To monitor the accuracy and precision of the CTD's conductivity sensors, salinity/conductivity of selected water samples was determined using an Optimare Precision Salinometer (OPS) for 22 CTD stations (Tab. 3.8) between 08.12.2012 and 13.01.2013. Duplicate water samples (bottles) were drawn from Niskin water samplers closed in homogeneous water layers at full ocean depth (sample #1, 40 probes) and predominantly near 1,500 m (sample #2, 38 probes), which allows identifying possible pressure dependencies of the sensors' accuracy. Water probes were measured in reference to Standard Water batch no. P154; K15 = 0.9999, valid until date: 2014-10-10.

Tab. 3.8: Salinity samples taken

Nr.	**Station Number**	**Sample #1 Depth (m)**	**Sample #2 Depth (m)**
1	PS81/31-1	1713	865
2	PS81/37-1	4460	1518
3	PS81/39-1	4683	1520
			255
4	PS81/43-1	5471	1522
5	PS81/47-1	5391	1419

Nr.	Station Number	Sample #1 Depth (m)	Sample #2 Depth (m)
6	PS81/54-2	3557	1497
7	PS81/56-1	4661	1500
8	PS81/59-1	4208	1497
9	PS81/60-1	3374	1499
10	PS81/64-5		300
11	PS81/67-3	2822	1500
12	PS81/76-1	5000	1500
13	PS81/79-3	4724	1500
14	PS81/83-2	4364	1500
15	PS81/88-1	4818	1500
16	PS81/91-1	4722	1500
17	PS81/96-2	4086	1500
18	PS81/100-1	4366	1500
19	PS81/103-1	3802	1964
20	PS81/105-1	3174	
21	PS81/107-1	2611	
22	PS81/105-1	1950	

Preliminary results

Averaging the first 15 duplicate water samples (i.e. 30 probes) resulted in a mean salinity correction of 0.00085 $g \cdot kg^{-1}$ (Figure 3.10). Using all duplicate water probes taken throughout the expedition (i.e. 78 probes from 39 bottles), the overall *enroute* salinity correction averages to a similar value of 0.00092 $g \cdot kg^{-1}$.
Such an early correction (after only a few salinity measurements rather than hundreds of water samples when using a Guildline Autosal 8400B) now appears possible due to the unprecedented precision of the Optimare Precision Salinometer. In particular, the majority of the duplicate samples showed exactly the same salinity value within $1 \cdot 10^{-4}$ $g \cdot kg^{-1}$. A temporary offset of 0.00085 $g \cdot kg^{-1}$ was applied to salinity data derived from the secondary sensor, and used for preliminary results as presented hereinafter.

First results (Figures 3.11 and 3.12) show an overall thermal structure resembling that of earlier cruises, but indicate a warming of the deep water masses, continuing the general trend as documented in this long term time series for some 20 plus years.

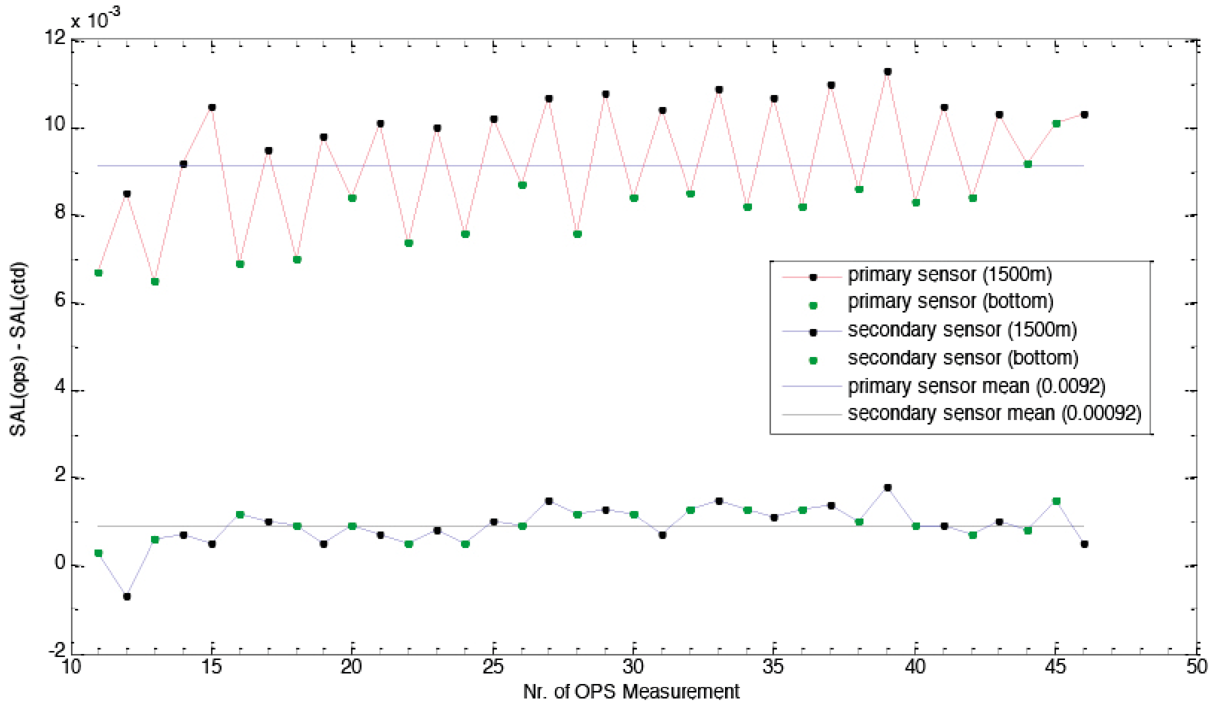

Fig. 3.10: Salinity deviations between OPS measurements and in-situ CTD measurements. The correction for the secondary sensor (black dashed line) is about 0.0009 g·kg⁻¹, and lacked any discernible pressure dependency.

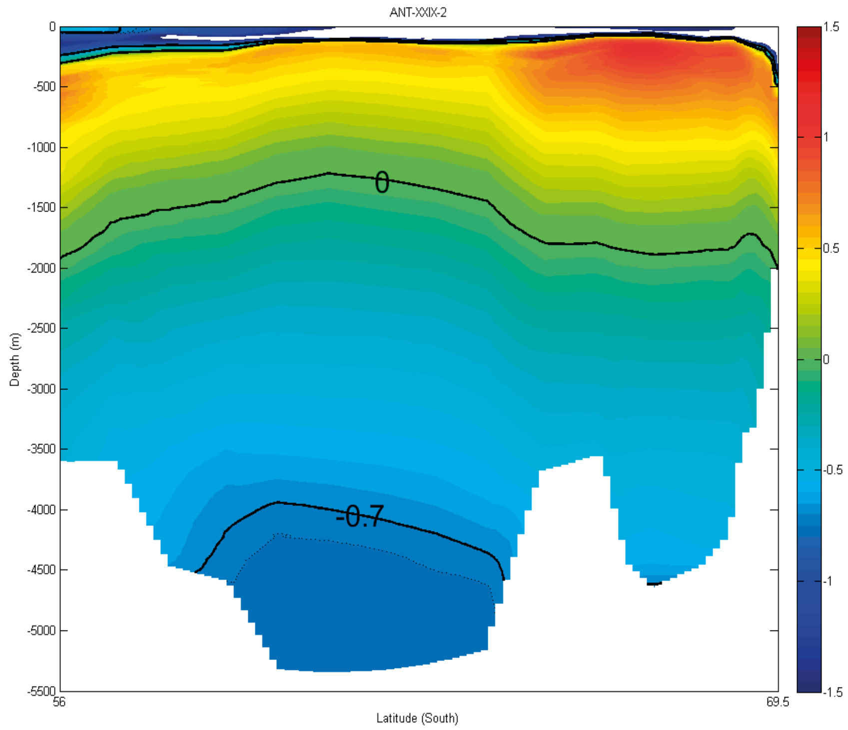

Fig. 3.11: Temperature section along the Greenwich Meridian

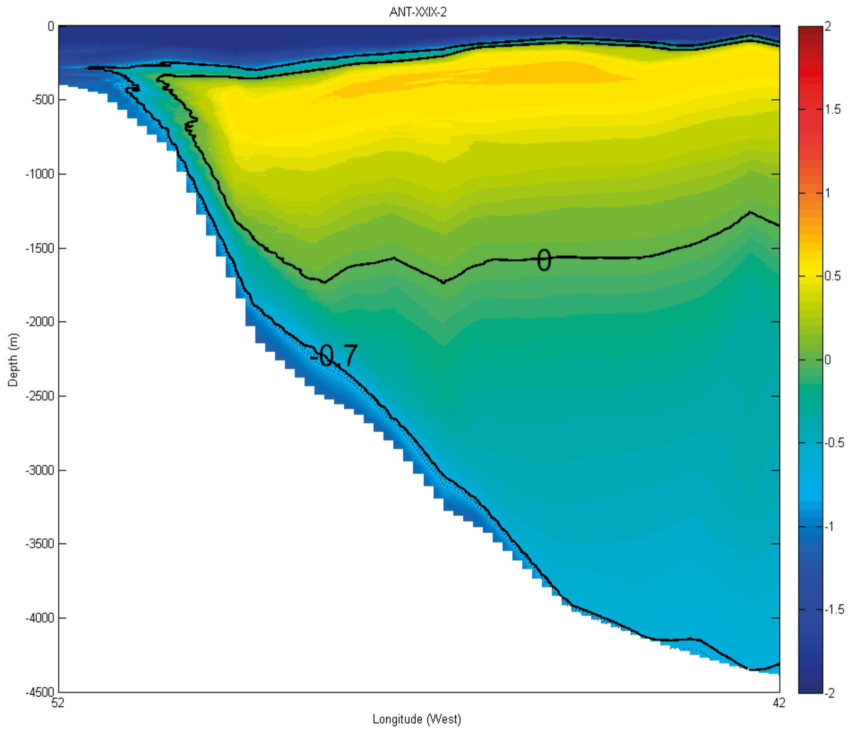

Fig. 3.12: Temperature section approaching the Antarctic Peninsula

l-ADCP

Current velocities between the sea surface and the ocean floor were recorded using a lowered acoustic Doppler current profiler (l-ADCP), consisting of an upward/ downward looking pair of RDI *Workhorse Sentinels* 300 kHz attached to the rosette frame (Figure 3.13).

While the l-ADCP was mounted on the rosette for the duration of the expedition, it was inactivate during some casts, in particular the shallow CTD profiles. A total of 42 l-ADCP profiles were obtained.

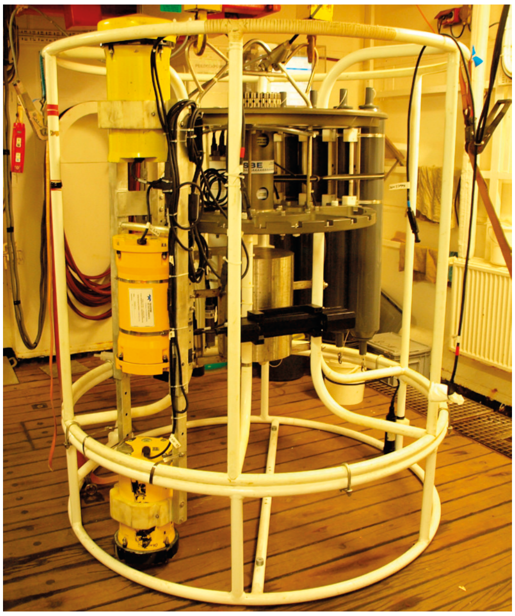

Fig. 3.13: CTD and SBE32 carousel with RDI Workhorse Sentinels 300 kHz ADCP attached at the frame. The upward looking instrument (light yellow) is placed at the top, the downward looking instrument (dark yellow) at the bottom. The (slightly orange)unit in between is the housing for the extended battery pack.

Data management

The final processing of CTD-data will be conducted after post-expedition calibrations are finished. All data will be stored and available through the PANGAEA data base. L-ADCP data have not been processed on board. Post-cruise data processing and evaluation will be conducted under the auspicious of Volker Strass, AWI. P.Is.: Gerd Rohardt and Volker Strass.

3.1.3 Argo float deployments

Olaf Boebel, Sebastian Menze, Gerd Rohardt AWI

Objectives

The international Argo-project maintains order of 3,000 profiling floats, distributed throughout the world ocean to establish a real-time operational data stream of mid- and upper (< 2,000m) ocean temperature and salinity profiles. In addition, the array provides the mid-depth oceanic circulation pattern. During the past years, the AWI pushed 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 projects MERSEA and EURO-ARGO as well as the BMBF Project German Argo, the NEMO float (Navigating European Marine Observer) had been 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 be able to (retrospectively) track the floats that continued their mission under sea ice, RAFOS [Rossby et al., 1986] (Ranging And Fixing Of Sound) technology is used, based on an array of currently 12 moored RAFOS sound sources.

Work at sea

During ANT-XXIX/2, a total of 50 NEMO floats (Navigating European Marine Observer), produced by Optimare Sensorsyteme, Germany, were deployed. A total of 48 floats had been appropriated by AWI, while 2 floats were provided by Bundesamt für Seeschifffahrt und Hydrographie (BSH). The floats differed with respect to some of their technical features as listed in Table 3.9.

Table 3.9: Number and characteristic of Argo floats deployed during ANT-XXIX/2.

Quantity Deployed	Trade Name	Satellite Communication	RAFOS	appropriated by
12	NEMO	Iridium	-	AWI
35	NEMO	Iridium	Y	AWI
1	NEMO	ARGOS	Y	AWI
2	NEMO	ARGOS	Y	BSH

A total of 47 floats use Iridium SBD for data transmission, while 3 floats are equipped with ARGOS-2 transmitters. All NEMO floats are equipped with an adjustable Ice Sensing Algorithm (ISA-2), set to -1.65°C between 40 and 15 dbar, with a surfacing response retarded by 1 profile. Interim data storage (iStore) internally saves all profiles that could not be transmitted in real-time due to ISA aborts and transmits these profiles during ice-free conditions. The floats were ballasted to drift at a drift depth of 800m and acquire profiles from 2,000m depth upwards every 10 days. The deployment positions are plotted in Figure 3.14.

Float identification information is given in Table 3.10, sorted by time of deployment. One additional Nemo float (S/N 173) was not deployed as it failed the internal battery and GPS tests during checkout.

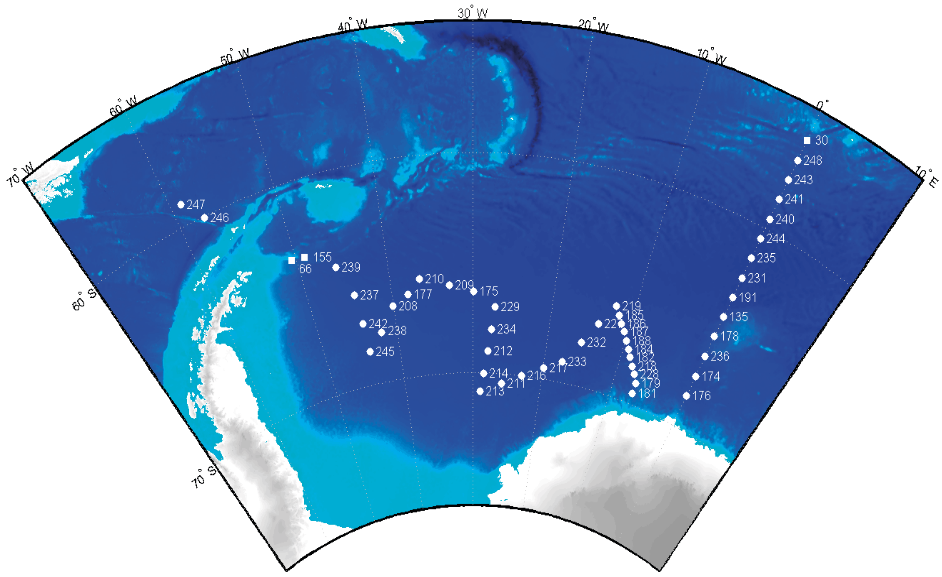

Fig. 3.14: Positions of NEMO float deployments. Numbers indicate each NEMO's S/N.

RAFOS sources have been deployed as part of the oceanographic mooring activities described above. Tables 3.11 and 3.12 list the addition information as relevant for the tracking of NEMO floats.

Tab 3.10: Identification information of deployed floats during ANT-XXIX/2

AWI ID	S/N	IMEI/ARGOS ID	WMO ID	Test ok	RAFOS receiver	Deploy date	Magnet sweep @	Deployed @	Sea ice	Lat	Lon
AWI_171	30	35989	7900399	1	1	08.12.2012	08:35	14:35	0	55°29,70‘S	000°00,44‘E
AWI_172	248	300234011429370	7900411	1	0	08.12.2012	22:04	23:23	0	56°29,83‘S	000°00,01‘E
AWI_173	243	300234011425370	7900406	1	0	09.12.2012	07:52	09:04	0	57°30,06‘S	000°00,06‘E
AWI_174	241	300234011424370	7900404	1	0	11.12.2012	22:08	01:40	0	58°29,84‘S	000°00,08‘E
AWI_175	240	300234011423390	7900403	1	0	11.12.2012	16:00	18:15	0	59°29,92‘S	000°00,06‘E
AWI_176	244	300234011427370	7900407	1	0	12.12.2012	01:17	04:08	0	60°30,00‘S	000°00,04‘E
AWI_177	235	300234011421390	7900384	1	1	12.12.2012	14:42	18:18	0	61°30,00‘S	000°00,01‘E
AWI_178	231	300234011423380	7900380	1	1	13.12.2012	20:18	04:11	1	62°29,99‘S	000°00,02‘E
AWI_179	191	300034013648160	7900368	1	1	13.12.2012	15:14	22:22	1	63°30,14‘S	000°00,21‘W
AWI_180	135	300034012395640	6900885	1	1	14.12.2012	14:04	16:38	1	64°29,98‘S	000°00,08‘W
AWI_181	178	300034013640160	7900359	1	1	15.12.2012	20:12	01:58	1	65°29,52‘S	000°00,00‘W
AWI_182	236	300234011422470	7900385	1	1	16.12.2012	09:22	11:47	0	66°30,91‘S	000°00,48‘W
AWI_183	174	300034013640150	6900887	1	1	16.12.2012	15:00	20:49	0	67°30,14‘S	000°00,12‘W
AWI_184	176	300034013643150	7900357	1	1	17.12.2012	05:20	08:59	1	68°29,97‘S	000°00,01‘W
AWI_185	181	300034013646150	7900361	1	1	25.12.2012	23:20	01:48	1	69°30,09‘S	007°00,15‘W
AWI_186	179	300034013642160	7900360	1	1	25.12.2012	14:31	16:46	1	69°00,69°S	006°56,69°W
AWI_187	228	300234011428460	7900378	1	1	25.12.2012	17:42	20:25	1	68°39,92‘S	007°34,58‘W
AWI_188	218	300234010982870	7900375	1	1	25.12.2012	19:08	23:38	1	68°20,04‘S	008°08,62‘W
AWI_189	182	300034013648150	7900362	1	1	26.12.2012	19:11	03:09	1	67°59,78‘S	008°47,66‘W
AWI_190	184	300034013641180	7900363	1	1	26.12.2012	19:10	05:50	1	67°40,11‘S	009°19,86‘W
AWI_191	188	300034013644150	7900367	1	1	26.12.2012	06:45	08:40	1	67°20,04‘S	009°55,86‘W
AWI_192	187	300034013642150	7900366	1	1	26.12.2012	07:11	16:35	1	66°58,82‘S	010°30,02‘W
AWI_193	186	300034013641160	7900365	1	1	26.12.2012	12:08	19:49	1	66°40,09‘S	011°06,85‘W
AWI_194	185	300034013647150	7900364	1	1	26.12.2012	18:54	23:11	1	66°20,07‘S	011°39,46‘W
AWI_195	219	300234010981890	7900376	1	1	27.12.2012	13:14	09:05	1	65°57,98‘S	012°15,12‘W
AWI_196	227	300234011424380	7900377	1	1	27.12.2012	13:39	19:07	1	67°00,04‘S	013°50,84‘W

AWI ID	S/N	IMEI/ARGOS ID	WMO ID	Test ok	RAFOS receiver	Deploy date	Magnet sweep @	Deployed @	Sea ice	Lat	Lon
AWI_197	232	300234011426380	7900381	1	1	28.12.2012	19:14	03:58	1	68°00,57'S	015°31,79'W
AWI_198	233	300234011422390	7900382	1	1	29.12.2012	13:54	00:37	1	69°04,25'S	017°31,96'W
AWI_199	217	300234010922880	7900374	1	1	29.12.2012	00:47	07:21	1	69°29,98'S	019°59,82'W
AWI_200	216	300234010988760	7900373	1	1	29.12.2012	09:42	16:02	1	69°59,82'S	022°55,78'W
AWI_201	211	300234010988870	7900369	1	1	30.12.2012	17:58	00:11	1	70°26,36'S	025°43,61'W
AWI_202	213	300234010983890	7900371	1	1	30.12.2012	11:36	21:05	1	70°50,48'S	028°55,82'W
AWI_203	214	300234010989880	7900372	1	1	31.12.2012	17:18	02:52	1	70°00,54'S	028°28,92'W
AWI_204	212	300234010987880	7900370	1	1	31.12.2012	21:51	09:47	1	68°59,61'S	027°57,71'W
AWI_205	234	300234011426370	7900383	1	1	31.12.2012	10:52	18:04	1	68°01,03'S	027°33,74'W
AWI_206	229	300234011423360	7900379	1	1	01.01.2013	19:05	02:06	1	67°00,14'S	027°11,75'W
AWI_207	175	300034013649160	6900888	1	1	02.01.2013	12:10	01:24	1	66°19,15'S	029°56,20'W
AWI_208	209	300234010983880	7900413	1	1	02.01.2013	23:05	14:43	1	65°59,88'S	032°52,86'W
AWI_209	210	300234010988880	7900414	1	1	03.01.2013	07:57	13:26	1	65°37,24'S	036°25,29'W
AWI_210	177	300034013645160	7900358	1	1	03.01.2013	08:22	20:59	1	66°13,75'S	037°59,96'W
AWI_211	208	300234010980690	7900412	1	1	04.01.2013	20:49	06:52	1	66°59,86'S	040°05,86'W
AWI_212	238	300234011421380	7900401	1	0	04.01.2013	09:22	23:24	1	67°44'06'S	041°59'95'S
AWI_213	245	300234011427380	7900408	1	0	05.01.2012	08:18	18:31	1	68°29,77'S	044°02,93'W
AWI_214	242	300234011425350	7900405	1	0	07.01.2013	22:55:00 on 05.01.2013	00:45	1	67°10,22'S	044°09,06'W
AWI_215	237	300234011420380	7900400	1	0	08.01.2013	08:27	11:15	1	65°49,39'S	044°27,59'W
AWI_216	239	300234011422380	7900402	1	0	09.01.2013	08:06	14:27	1	64°22,81'S	045°52,13'W
BSH_001	155	40850	7900290	1	1	11.01.2013	18:14	03:08	1	63°52,68'S	049°07,86'W
BSH_002	66	35779	6900586	1	1	12.01.2013	19:37:00 on 11.01.2013	19:53	1	63°40,17'S	050°52,22'W
AWI_217	246	300234011428350	7900409	1	0	16.01.2013	02:32	07:26	0	60°02,43'S	057°27,19'W
AWI_218	247	300234011428370	7900410	1	0	16.01.2013	07:28	12:44	0	59°01,61'S	059°00,36'W

Tab. 3.11: Sound sources recovered during ANT-XXIX/2

Mooring / SoSo site	Water depth [m]	Position [LAT LON]	Deployment date	Recovery date	depth [m]	Pong time [GPS]	Drift [s/day]	Unit	Comments
229-9/W1e	5170	63° 59.56′ S 000° 02.65′ W	2010-12-15	2012-12-14	807	00:40	--	R19E18	Electronics flooded, Lid open
231-9/W2e	4524	66° 30.71′S 000° 01.51′ W	2010-12-17	2012-12-16	811	01:10	-0.4973	R29E29	Electronics active, redeployed in AWI244-3[1]
244-2a/W11b	2900	69° 00.30′ S 006° 58.89′ W	2010-12-23	2012-12-25	801	00:50	-0.2678	R30E23	Electronics active, redeployed in AWI245-3[1]
244-2b/W11b	2900	69° 00.30′ S 006° 58.89′ W	2010-12-24	2012-12-25	708	00:30	-5.3251	D02E02	Electronics active[3]
245-2/W9b	4740	69° 03.52′ S 017° 23.05′ W	2010-12-27	2012-12-28	808	01:10	0.0150	W24W24	Electronics active[2] at recovery, but became defect during tests
209-6/W4c	4830	66° 36.70′ S 027° 07.31′ W	2010-12-29	2013-01-01	808	01:00	-0.0054	W23W23	Electronics active, redeployed in AWI250-1[1,2]
208-6/W5b	4740	65° 37.04′ S 036° 25.28′ W	2011-01-01	2013-01-03	861	00:40	0.3834	R34E29	Electronics active
207-6/W6c	2500	63° 43.07′ S 050° 49.91′W	2010-01-06	--	807	01:10	--	R32E19	100% ice coverage, left in position
217-4/W10b	4416	64° 23.52′ S 045° 51.95′ W	2010-01-04	2013-01-09	836	00:50	0.2500	R27E28	Electronics active, redeployed in AWI207-7[1,2]

1) Batteries changed;
2) Resonator together with Electronics of W23 and 2 new battery packs used for redeployment in AWI250-1;
3) Self-tuning sound source
Time drift: seconds per day, '-' sound source too late, '+' sound source too fast

Tab. 3.12: Sound sources deployed during ANT-XXIX/2

Mooring / SoSo site	Water depth [m]	LAT	LON	Deployment date	depth [m]	Schedule [GPS time]	Unit	Comments
229-10/W1f	5172	63° 59.66′ S	000° 02.65′ W	2012-12-14	807	12:30*	D26E40	1st sweep 1012-12-15 [2]
231-10/W2f	4456	66° 30.93′ S	000° 00.65′ W	2012-12-16	830	13:00	D24E33	1st sweep 2012-12-17 [2]
244-3/W11c	2900	69° 00.35′ S	006° 58.97′ W	2012-12-25	806	12:40	R29E29	1st sweep 2012-12-26 [1]
248-1/W12a	5011	65° 58.09′ S	012° 15.12′ W	2012-12-27	839	14:00	D28E31	1st sweep 2012-12-27 [2]
245-3/W9c	4746	69′ 03.48′ S	017° 23.32′ W	2012-12-28	822	13:10	R30E23	1st sweep 2012-12-30 [1]
249-1/W13a	4364	70° 53.55′ S	028° 53.47′ W	2012-12-30	843	13:50	D30E39	1st sweep 2012-12-31 [2]
209-7/W4d	4830	66° 36.45′ S	027° 07.26′ W	2013-01-01	805	13:30	D25E37	1st sweep 2013-01-02 [2]
208-7/W5c	4732	65° 37.23′ S	036° 25.32′ W	2013-01-03	856	12:40	D29E36	1st sweep 2013-01-04 [2]
250-1/W14a	4100	68° 28.95′ S	044° 06.67′ W	2013-01-05	798	13:10	W24W23	1st sweep 2013-01-05 [3]
217-5/W10c	4410	64° 22.94′ S	045° 52.12′ W	2013-01-09	807	13:50	R34E29	1st sweep 2013-01-10 [1]
207-9/W6d	2500	63° 42.09′ S	050° 49.61′ W	2013-01-12	807	14:10	R27E28	1st sweep 2013-01-13 [1]

* UTC was used to set times: GPS= UTC +16s; All sources contain new batteries; All sources use piggy back design, aluminum resonator tubes
1) date of first full power sweep, one low power sweep the day before;
2) Tuning for resonance frequency during ANT-XXIX/2, Firmware V2.03;
3) 16 sweeps to full power, one sweep on deck successfully completed

Preliminary results

As of now, data return of the floats deployed met our expectations. Floats first executed a "start profile" immediately after launch, followed by 3 profiles at 3-day intervals (to allow immediate bidirectional communication with the float in case adjustment of mission parameters is needed) before continuing with the standard 10-day profiling intervals (Figure 3.15).

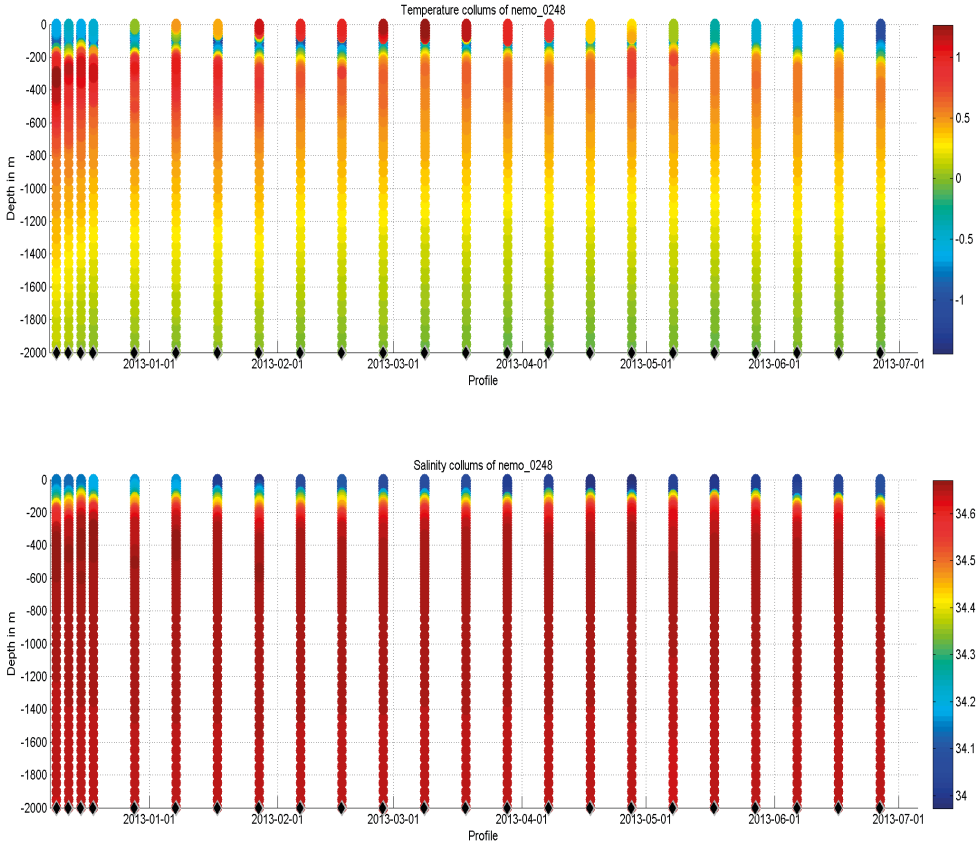

Fig. 3.15: Color coded temperature (top) and salinity (bottom) profiles from NEMO float S/N 248, approximately 7 months into its mission (profiles 1-23).

Data return from RAFOS receivers was most satisfying as well, confirming the functioning of the RAFOS sources deployed. Figure 3.16 depicts the expected estimated ranges of RAFOS signals as based on prior experiences. However, the newly developed Develogic RAFOS source proved rather effective in that many floats received good quality signals from sources farther away than expected. NEMO float S/N 214 for example persistently received 5 presumably neighboring RAFOS sources (Figure 3.16) until 10 March 2013 (after which no more profiles were received due to the expanding sea ice prohibiting the float from surfacing).

An exploratory 3-band optical sensor provides red, green and blue light intensities, yet a logarithmic rather than linear response would be highly desirable to properly capture the full range of illumination; the current implementation frequently runs into saturation or is too insensitive for the lowest light levels.

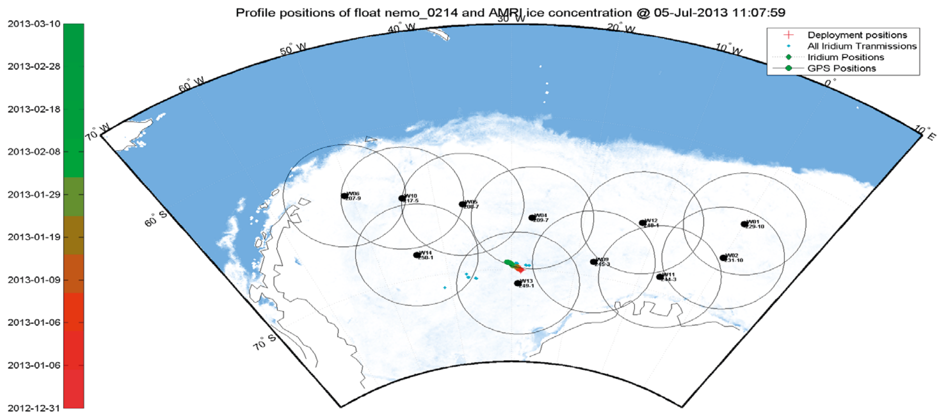

Fig. 3.16: Map of surfacing locations (red and green dots) of NEMO float S/N 214 deployed during ANT-XXIX/2 and ranges of RAFOS sound sources.

Data management

Floats have been registered with Argo (see Table 3.10, column WMO ID) and data is distributed in near real-time through the Argo System (Figure 3.17). P.I.: Olaf Boebel.

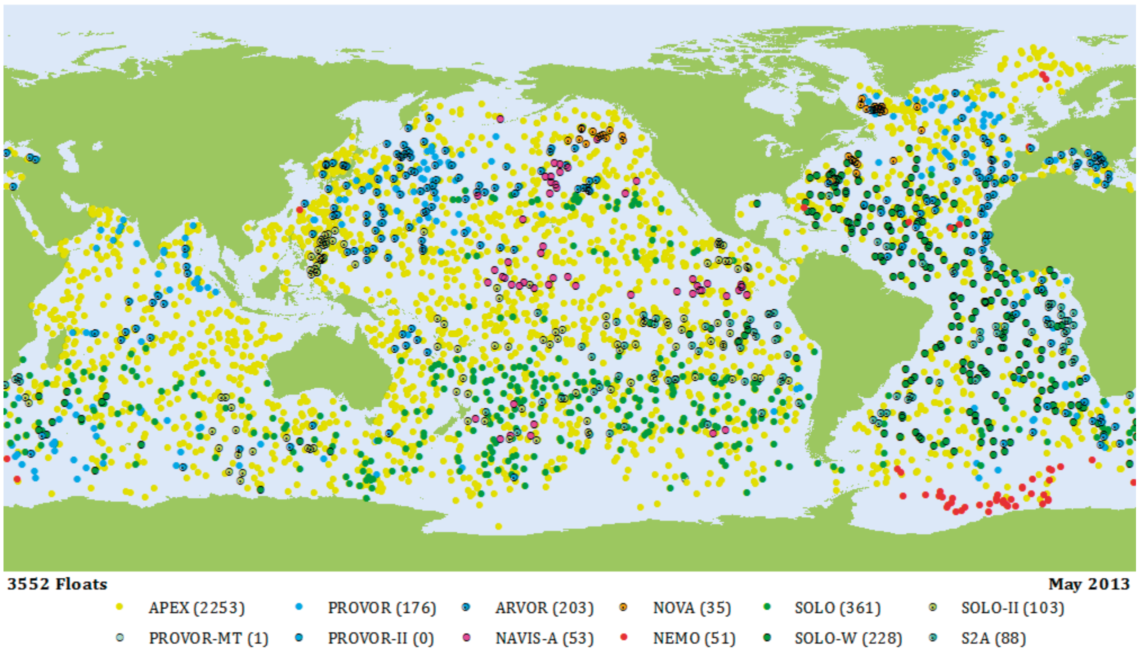

Fig 3.17: Currently active Argo floats. The units deployed during ANT-XXIX/2 are represented by the bright red dots in the Southern Ocean.

References

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

3.1.4 Sea ice observations

Sabine Brosch[3], Raul Guerrero[2], Nina Machner[1], Eva Nowatzki[1], Gerd Rohardt[1], Wei Wei[1], Wolfgang Zahn[4]

[1]AWI
[2]INIDEP
[3]Schickhardt-Gymnasium
[4]FZ-Jülich

Objectives

Sea ice observations were primarily conducted as a contribution to the Antarctic Sea Ice Thickness Project (AnSITP) but also to collect data for the development of new sea ice mapping technology using the onboard infrared scanner.

Work at sea

Observations were conducted by the CTD watch from the ship's bridge every 30 minutes, starting on 12 Dec. 2012 at 20:15 UTC. A high temporal resolution of 30 minutes (instead of hourly records) aimed at increasing the data volume for comparison with observations by the onboard infrared camera. During stations, ice observations were stopped. During periods of slow ship motion (e.g. during ramming) ice observations were executed less frequently (at intervals of 4 to 6 hours) while maintaining the distance between observations (about 4 nm). Ice observation stopped on 15 January 2013 at 20:30 UTC when reaching of the sea ice edge.

Observations (date, time, location and sea ice types, etc.), were logged on a PC, using a software package (SEAICE) provided by the Australian Antarctic Division and Antarctic CRC, Hobart. All parameters entered were instantly verified by the software for consistency, reducing input errors. (For example, specified ice types were checked for consistency with related entries of ice thickness, ridge heights and snow cover, issuing an alert in case of any inconsistencies.)

Preliminary results

The number of observations obtained until December 2012 (when berthing at Atka Bay) was 372. Until 15 Jan. 2013 (leaving the sea ice zone), 722 observations were obtained in total. On the Greenwich meridian, first sea ice was encountered at 61.8°S, and was observed *enroute* all the way to 61.3°S 54.55°W. During the first part of the expedition (before arriving at Neumayer station), approximately 52% of the track was covered with ice with an average ice thickness of 0.81 m (Figure 3.18). After December 24, 2012, the average ice thickness was 0.70 m with large differences between observations. The average ice coverage was approximately 65 %.

Possible uncertainties in ice observations are due to the limited accuracy of the logged position, which only allows use of full minutes for longitude and latitude without decimals. Additionally, minor discrepancies might be found in the position records as the program often prohibited the correction of typing mistakes once the observation was recorded. In such cases, comments were added. Certain (realistic) combinations of ice observation (e.g. melt puddles on first-year ice) are rejected by the program, which might result in further discrepancies with infrared based analyses.

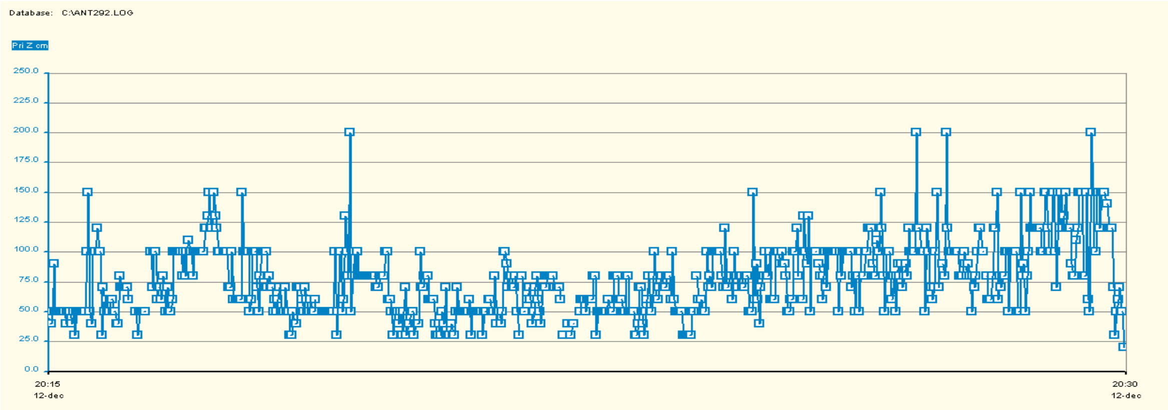

Fig. 3.18: Sea ice thickness in centimeters over time (not to scale) from the first to the last observation.

Data management

The data file was submitted to the Australian Antarctic Division and Antarctic CRC, Hobart for further evaluation. P.I.: Gerd Rohardt.

3.1.5 Thermosalinograph and vm-ADCP

Gerd Rohardt AWI
Not on board: Volker Strass

Objectives

Please refer to overall objectives.

Work at sea

Enroute (starting on 30 Nov 2012 00:00:00UTC at 33.91186°S 18.43460°E; ending on 18 Jan 2013 00:00:00UTC at 53.14470°S 70.90910°) surface temperature/ salinity and near-surface current velocity profiles were acquired with the ship's thermosalinograph and the vessel mounted acoustic Doppler current profiler (vm-ADCP), respectively. On request from the onboard Argentinean observer, vm-ADCP measurements were extended throughout the Argentinean EEZ and terminated when reaching the Chilean waters at the entry of Magellan Strait. Both instruments were maintained throughout the expedition by FIELAX scientific data services. Data were stored directly in the DShip system.

Thermosalinograph

To minimize the risk of data loss due to blocking of the thermosalinograph's intake by ice particles, *Polarstern* features two SBE21 thermosalinographs (TSG) with intakes at 11 m (in the box keel) and at 5 m (in the bow-thruster tunnel) depth (Table 3.13), respectively.
Water samples were taken once daily from both bow and keel TSGs by FIELAX. Salinity of these samples was determined using the Optimare Precision Salinometer at least once every two weeks to determine the salinity correction and to identify possible sensor faults.

Tab. 3.13: Sensor specification for the SBE21 as given by Seabird Electronics www. seabird.com

	Temperature SBE38 remote	Temperature	Conductivity
Range	-5 to 35 °C	-5 to 35 °C	0 to 70 mS/cm
Accuracy	0.001 °C	0.01 °C	0.001 mS/cm
Resolution	0.0003 °C	0.001 °C	0.0001 mS/cm

vm-ADCP

The vessel mounted ADCP transducer (Table 3.14) is installed in the box keel at 11 m depth. An acoustic window protects the transducer against damage when *Polarstern* is operating in sea ice.

Tab. 3.14: Instrument specification given by RD Instruments for the 150 kHz Ocean Surveyor

Velocity range:	-5 to 9 m/s
Velocity accuracy:	±1.0 %; 0.5 cm/s
Max. profile depth:	375 – 400 m
Max. altitude in bottom track:	600 m

The vm-ADCP acquired data autonomously. The CTD-watch regularly checked the instrument's proper operating. Throughout this expedition, the vm-ADCP worked reliable and without interruption.

Preliminary results

Figure 3.19 depicts the *enroute* temperature from Cape Town to Punta Arenas as observed at 11 m depth (i.e. by the keel TSG).

Data management

At the end of the expedition, the recorded data were directly transferred to AWI by the system manager. Final processing of TSG data occurred in Bremerhaven by FIELAX post expedition. TSG data is readily available at: http://doi.pangaea.de/10.1594/PANGAEA.808838.

Please refer to this data set rather than data retrieved from the DShip data base directly. vm-ADCP data will be processed in Bremerhaven later in 2013. Processed data will be made available through the PANGAEA data base. P.I.: Gerd Rohardt and Volker Strass.

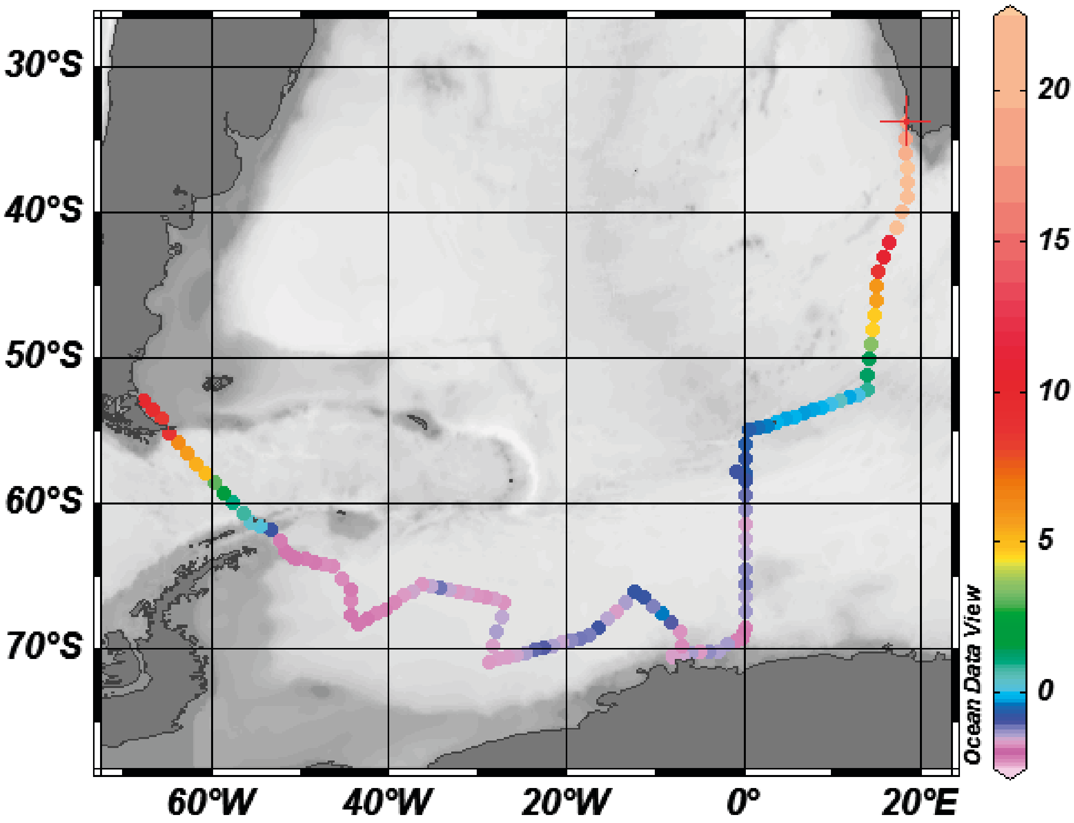

Fig. 3.19: Enroute temperature at 11 m depth retrieved from the PANGAEA data base

3.1.6 Sound source tuning

Olaf Boebel[1], Rainer Graupner[2], Sebastian Menze[1], Matthias Monsees[1], Stefanie Rettig[1]

[1]AWI
[2]OPTIMARE

Objectives

RAFOS sound sources comprise two elements: a) an electronic module generating a high voltage signal to drive a hydroacoustic transducer which is b) suspended in a resonator tube that needs to be adjusted in length such that the system resonates at the desired target frequency (about 260 Hz for common RAFOS systems). To determine the resonance frequency of a given tube by hydroacoustic measurements, order of 10 m distance are required between the sound source and the hydrophone for it to be in the acoustic far field, as the RAFOS signal's wavelength is of about 5.8 meters. Furthermore, as the signal has to be of several seconds duration to allow the electronics to properly function, any (impedance) boundary (e.g. sea-surface, sea floor, piers) should be at distances such that – at the hydrophone's location - any reflected signals are significantly quieter than the direct signal.

Attempts by the sound source manufacturer Develogic to tune their RAFOS sources in the shallow waters of Hamburg harbor provided only inconclusive results, presumably as the waters were too shallow, resulting in multiple reflections compromising the detectability of a clear resonance. Hence we had to resort to tuning newly acquired Develogic RAFOS sound sources *enroute*, as the expedition schedule did not allow pursuing other alternatives (i.e. taking the sources to deep coastal waters in Norway) prior to our departure from Cape Town.

Work at sea

The frequency response of each sound sources was measured repeatedly. Successively, each of the 8 Develogic sound sources was tuned (i.e. length-adjusted) to a resonance frequency near 260 Hz, typically employing 4 steps:

1. Determination of frequency response "as delivered".
2. 1st cut of 50% of estimated length reduction to reach target frequency.
3. Determination of frequency response after cut 1.
4. 2nd cut of 50% of estimated length reduction to reach target frequency.
5. Determination of frequency response after cut 2.
6. 3rd cut of 50% of estimated length reduction to reach target frequency.
7. Determination of frequency response after cut 3.
8. Final cut to reach target frequency.
9. Determination of frequency response of final length (Table 3.15, column resonance frequency.)

For each run, an assembly of a Sonovault passive acoustic recorder (recording 1 Hz-5.3 kHz) tethered 40 m below a sound source (suspended vertically at first, horizontally later) were lowered to 200 m (occasionally 800 m) sound source depth (Figure 3.20). For each session (i.e. set of multiple consecutive runs comprising different sound sources) a CTD was cast to determine the oceanic sound speed and density profiles.

Sonovaults recorded continuously throughout each session (i.e. also during hauling or when placed on deck awaiting the next run). Sonovault data (saved internally as 10-minute files) were copied from SD-Card to harddisk after the tuning procedure. Using Adobe Audition®, sweeps belonging to a specific sound source were manually extracted on the basis of their spectrogram representation and saved as single files before being merged into one file representing the successive (8 (1st step) to 6 (last step)) tuning sweeps (each spanning 5 Hz with interruptions of 120 s to allow dissipation of heat) of a single run (Figure 3.21). A custom Matlab™ routine was then used to find the highest amplitude (current resonance frequency) in this sweep which, along with current tube length and environmental parameters (sound velocity at tuning depth, density) entered the calculation of the optimal tube length for the deployment conditions (i.e. at typically 800 m depth). Shortening the tube by only about ½ of the calculated cut, all newly acquired 8 Develogic sound sources were iteratively cut to optimal length.

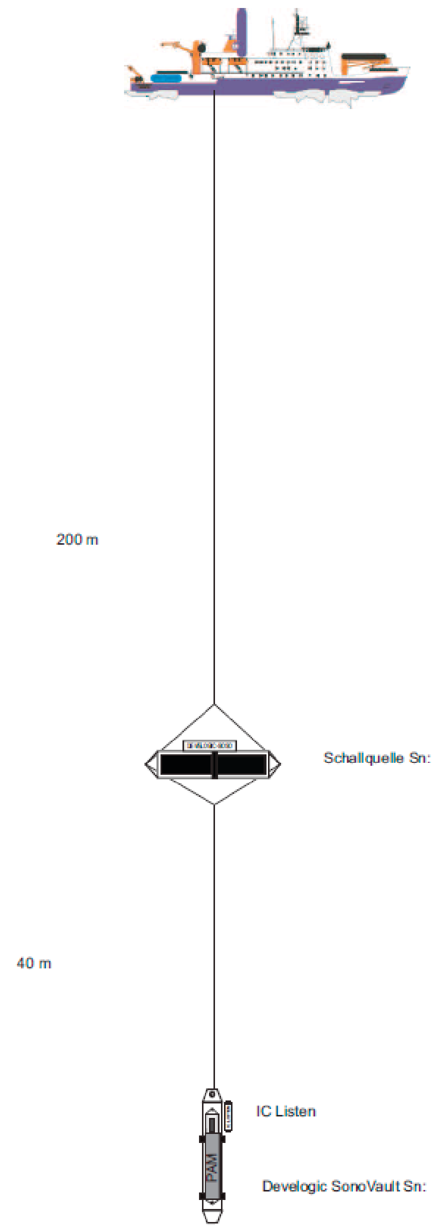

Fig. 3.20: Schematic (not to scale) of setup of enroute *resonance frequency measurements of sound sources.*

During tuning activities, a marine mammal watch was conducted from the ship's bridge to shut down tuning activities in case marine mammals were to approach the ship closer than 1,000 m. This was not the case except for three incidents:

a) 2 whales approached the ship and were expected to enter the mitigation radius. With the whales at > 1,000 m distance, tuning was interrupted and the ship was relocated to a position away from the projected path of these whales. Tuning was resumed after relocation of the ship while the whales maintained their course, not entering the mitigation radius.

b) Twice, during the period between two tuning runs (i.e. while the source was being hauled up/down without being active), a single whale was noted to surface within a patch of open water close by. However, both whales have not been sighted again for at least 15 minutes prior to the deployment of the next source.

However, the acoustic measurements revealed that the sound sources are about 14 dB quieter than the ship itself (a fact not known before), raising the question of the necessity of mitigation during tuning activities.

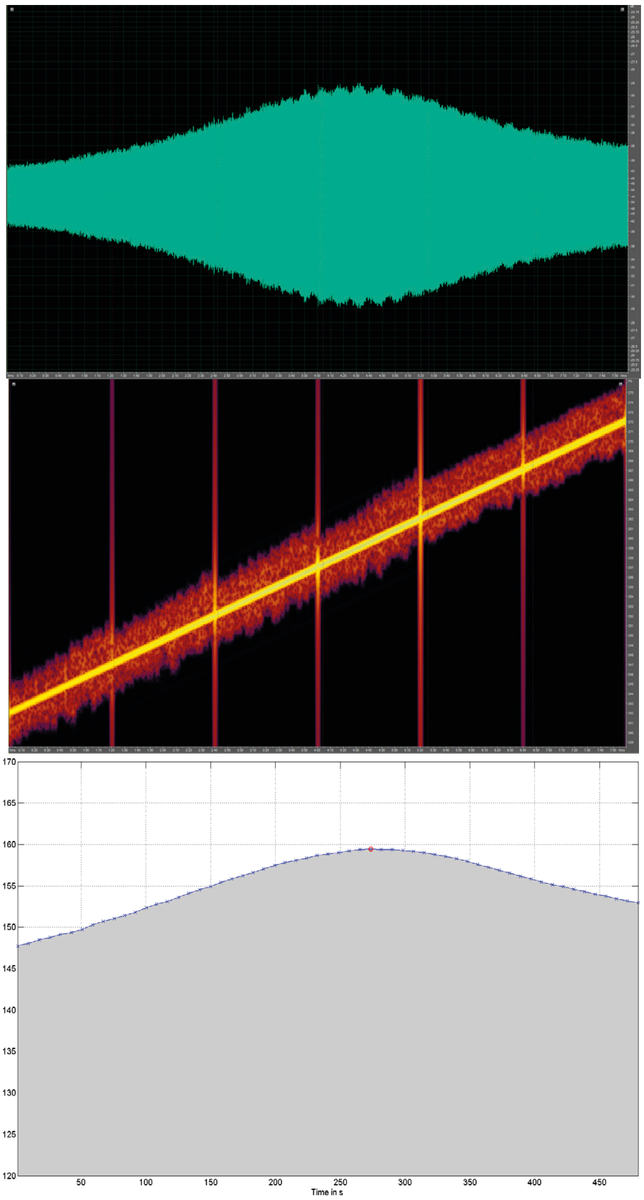

Fig. 3.21: Frequency response of a RAFOS sound source. In each plot, the x-axis represents time in seconds since sweep start, being linearly related to sweep frequency. Top: Waveform of 6 collated 5-Hz sweeps. Middle: Spectrogram of collated waveform (broadband lines representing artifacts from the merging of files). Bottom: Relative sound pressure levels (arbitrary units) as function time (i.e. source frequency).

Tab. 3.15: Determination of frequency response of RAFOS sources to tune pipe length to target frequency.

Nr	Unit	Electronic board	Firmware	Measurement				Resonance frequency	Deployed in	c.f.
				#1	#2	#3	#4	Hz	Mooring #	
1	D26	40	V2.03	2012-12-02	2012-12-08	2012-12-12	2012-12-13	259.6	AWI229-10	1
2	D24	33	V2.03	--	2012-12-08	2012-12-12	2012-12-13	261.1	AWI231-10	
3	D27	34	V2.03	2012-12-08	2012-12-26	2012-12-30	2013-01-02	260.2	Not deployed	2
4	D28	31	V2.03	2012-12-08	2012-12-12	2012-12-13	2012-12-15	261.2	AWI248-1	3
5	D30	39	V2.03	2012-12-12	2012-12-13	2012-12-15	2012-12-20	259.4	AWI249-1	4
6	D25	37	V2.03	2012-12-15	2012-12-20	2012-12-26	2012-12-30	260.3	AWI209-7	
7	D29	36	V2.03	2012-12-20	2012-12-26	2012-12-30	2013-01-02	259.2	AWI208-7	
8	D23	32	V2.03	2012-12-26	2012-12-30	2013-01-02	2013-01-04	259.0	Not deployed	5
9	D15	38		2012-12-26					Not deployed	6
10	RD	10	V1.00	2012-12-13	15.12.2012				Not deployed	7
11	R29		V3.00	2012-12-20					AWI244-3	
12	W24	24	N/A	2012-12-30	2013-01-02	2013-01-04			Not deployed	8
13	R34	29	V3.00	2013-01-04					AWI217-5	9

1 Measured in both vertical and horizontal positions.
2 A small leak was detected in the resonator assembly after the 1st measurement, fixed before 2nd measurement.
3 Measurement #3: 200m and 800m
4 After 20 Oct 2012, all sound sources suspended horizontally.
5 Measurement #4: @800m, 1 sweep at 95%, 1 sweep at 100% power.
6 Equipped with a resonator tube tuned previously by develogic in Hamburg harbor.
7 Measurement #2: suspended horizontally, Rossby resonator driven by Develogic electronics.
8 Measurement #1: source did not sweep for unknown reasons; Measurement 3: 800m
9 Measurement #1: 800m

Preliminary results

The acoustic soundscape below the ship is – apart from natural sounds - composed of the ship's noise and the sound source's signal. Obviously, the deeper the sound source/PAM assembly is lowered, the less the loudness of the ship at the recording site will be. The amplitude of the ship noise's at 240 m distance is slightly less than the of RL of the RAFOS source at 40 m distance (Figure 3.22, upper left panel) with a signal to noise ratio (SNR) of only 1.5 dB. (This implies the ship being about 14 dB louder than the source.) Nevertheless, the RAFOS signal is discernible in the broadband spectrogram (Figure 3.22, lower left panel), allowing to cut out the respective portions of the acoustic recordings for further analysis. Filtering to the RAFOS band (260±1 Hz, (Figure 3.22, lower right panel) improves the SNR to 21dB, while "filtering" using Audition®'s lasso tool increases the SNR to nearly 28dB (Figure 3.22, upper right panel), allowing a quantitative analysis of the amplitude of the RAFOS signal in spite of the noisy broadband background.

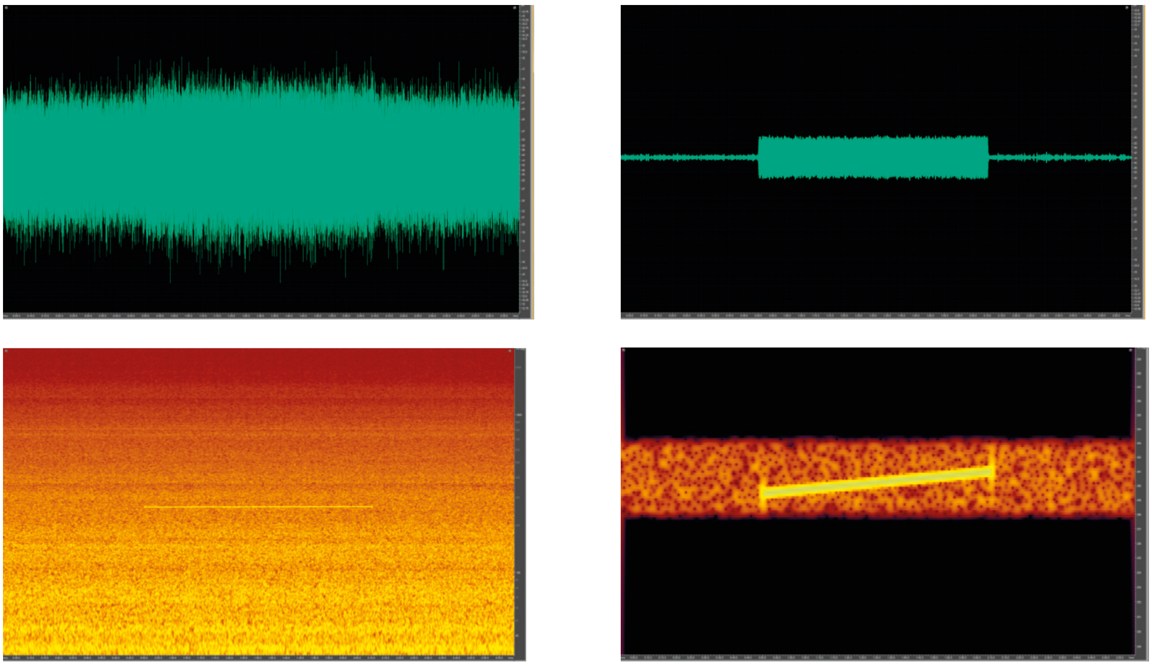

Fig. 3.22: Waveforms and spectrograms recorded at 240 m depth of a RAFOS sweep produced by RAFOS sound source SN29 at 200 m depth.

A technical complication arose from the fact that the system is suspended from the ship, which, at least in open waters, rolls and pitches throughout the measurements and hence heaves the PAM up and down through the water column at a frequency of about 0.1 Hz. Without high pass filtering, the vertical displacement of a hydrophone by merely 1 m however corresponds to an acoustic signal of 200dB:

$$20 \log (1 \text{ dbar} / 1 \mu\text{Pa}) = 20 \log (10^{10} \mu\text{Pa} / 1 \mu\text{Pa}) = 200 \text{ dB re. } 1 \mu\text{Pa}.$$

Even if a relatively steep filter of 6 dB per octave with a cutoff frequency of 5 Hz is implemented, a near DC signal of 160 dB re. 1 μPa is superposed to the acoustic signals of interest. This might saturate the range of the acoustic recorder's AD converter and render results unusable. To minimize such effects, calibration runs should be conducted during fair weather with little swell and using an order of Hertz high pass filter prior to signal digitization.

The final analysis revealed a relatively liner relation between tube length and resonance frequency (Figure 3.23). While the overall sensitivity (shift of resonance frequency per cm tube length) results in about 0.6Hz cm^{-1}, the resonance's overall broadness suggest that the source will be not too misgiving with regard to slight (< 1cm) deviations from the optimal length.

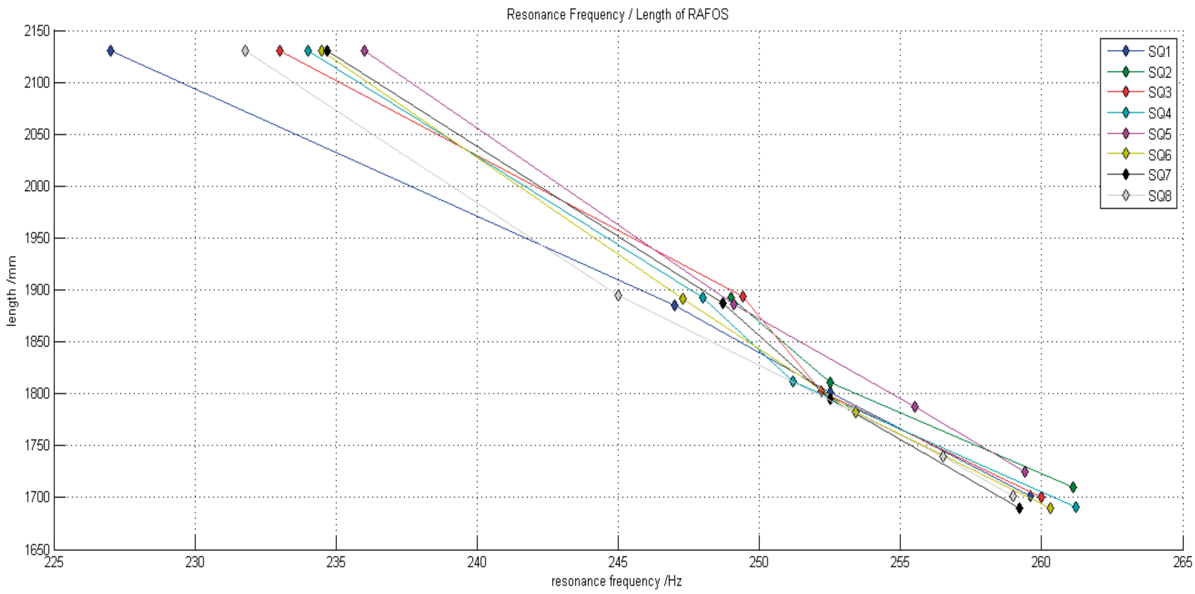

Fig. 3.23: Relation between resonance frequency and tube length for RAFOS sources.

In summary, during this expedition 8 RAFOS sources were tuned to resonate at target conditions. Six of these have subsequently been deployed (moored), all of which were clearly detected by RAFOS receiver equipped Argo floats that drifted in their wider (several hundreds of kilometers) environment.

Data management

No data was recorded for scientific purposes. P.I.: Olaf Boebel.

4. GEOSCIENCES: SEISMICITY OF THE ULTRASLOW-SPREADING SOUTHWEST-INDIAN RIDGE

Vera Schlindwein, Edith Korger, Jürgen Gossler; AWI
Not on board: Norbert Lensch

Objectives

Microearthquakes image the active tectonic and magmatic processes at mid-ocean ridges and therefore help to understand crustal generation. At ultraslow-spreading ridges the microseismicity is hardly explored. In our current project, we want to compare the seismicity and structure of a site of magmatic crustal production and a site of amagmatic crustal production. For the magmatic site, we chose a recently active submarine volcano at the eastern SWIR. It was instrumented in October 2012 during a cruise with *Marion Dusfresne* with 8 ocean bottom seismometers (OBS). This expedition was part of a large international collaboration to image the hotspot underlying the island of La Reunion.

During the current *Polarstern* expedition, we deployed 10 OBSs at an amagmatic site at the western SWIR. Here, at about 13°E and 52°S in about 4,000 m water depth (Fig. 1), we wanted to explore the processes that bring mantle rocks to the seafloor forming an entirely amagmatic crust. In addition, hydrothermal discharge into the water column has been discovered in this area. Microearthquakes are able to track circulating fluids and therefore can help to understand amagmatic hydrothermal systems. We will visit this site again in one year time during ANT-XXIX/8 and recover our OBSs. ANT-XXIX/8 will mainly be dedicated to the exploration of the hydrothermal system and *Polarstern* will remain in the survey area for many days, such that we will have good chances to recover the OBS in favorable weather conditions. By then the seismometers will have stored in their internal data logger several thousands of small earthquakes, the location of which will tell us for example about the maximal depth of faulting and thus the thermal structure of the lithosphere.

Work at sea

From 28 November 2012 until the evening of 30 November 2012, we assembled our OBSs while *Polarstern* was still in the harbor of Cape Town. We placed the OBSs by crane on their steel anchor weights and fixed then seismometers and hydrophones to the titanium OBS frames. Lithium battery supply for 12 months recording time was inserted into the solid titanium pressure tubes along with the recorders that take 32 GB of data. They were programmed to digitize the signals of seismometer and hydrophone at a rate of 100 Hz. All instruments were tested.

When at sea, we tested the releasing units by strapping them onto a frame and winching them down to 2,500 m water depth. We ran two tests with 7 releasers in each go. Deployment started on December 5th, 2012 (Table 4.1). We programmed the recorders and synchronized the internal OBS clocks with GPS time. Flag, flash light and radio beacon were mounted onto the OBS frame and checked for functionality. All 10 OBSs carried as pay-load a biological colonization experiment. Five of the instruments had additionally a temperature sensor fixed to the frame. Figure 4.1 shows the position of these instruments in a transect along and across-axis of the rift valley. Furthermore, 5 OBSs were equipped with ARGOS transmitter, allowing to track the OBS by satellite once it has surfaced.

Weather conditions on the 5th and 6th of December did not allow to lower the OBSs with the winch. There was a swell of about 4 m height, moving the ship up and down. We therefore dropped the instruments from the crane and let them fall freely to their planned position. On an existing high resolution bathymetry map of the rift valley, we had selected areas with a slope of less than 20° in an area of about 2 km diameter surrounding the targeted OBS position. The bathymetry of these chosen OBS sites agreed well with data acquired by the *Polarstern's* hydrosweep system during the deployment. We could therefore use all pre-selected OBS positions without having to search for suitable deployment sites The entire OBS deployment including all transit times could therefore be accomplished in only 16 hours (Table 4.1).

Tab. 4.1: Deployment sites and times of all 10 OBS. Stations with „T" in their name carry a temperature sensor. Stations marked with „A" are equipped with an ARGOS transmitter

Deploy-ment No	Deployment Longitude °E	Deployment Latitude °S	Water depth (m)	Station number	Deployment Date	Deploy-ment Time (UTC)
1	13.6490	52.0190	3422	S10-00	05.12.2012	10:58
2	13.7636	52.2950	3818	S09-A0	05.12.2012	13:20
3	13.5554	52.3110	3974	S08-0T	05.12.2012	14:54
4	13.8400	52.5806	2708	S07-00	05.12.2012	16:55
5	13.3618	52.5508	3695	S06-AT	05.12.2012	19:30
6	13.2628	52.3936	4395	S04-AT	05.12.2012	21:00
7	13.3112	52.2433	2977	S03-AT	05.12.2012	22:27
8	13.0703	52.3636	3310	S02-00	06.12.2012	00:10
9	13.0627	52.4982	4227	S05-AT	06.12.2012	01:20
10	12.8354	52.4729	4426	S01-00	06.12.2012	02:42

Expected results

We expect to record several thousands of earthquakes of small magnitudes. However, the data will only be accessible after the recovery cruise in 2013. Therefore, the present cruise did not yield any data for immediate use.

Data management

Our seismic data will be archived in a common data repository for all data acquired with the OBSs of the DEPAS instrument pool. This archive is currently being developed and implemented at AWI and will be available by 2013. After 3 years of restricted access, the data will be made publicly available through the GEOFON seismic data request system. P.I.: Vera Schlindwein.

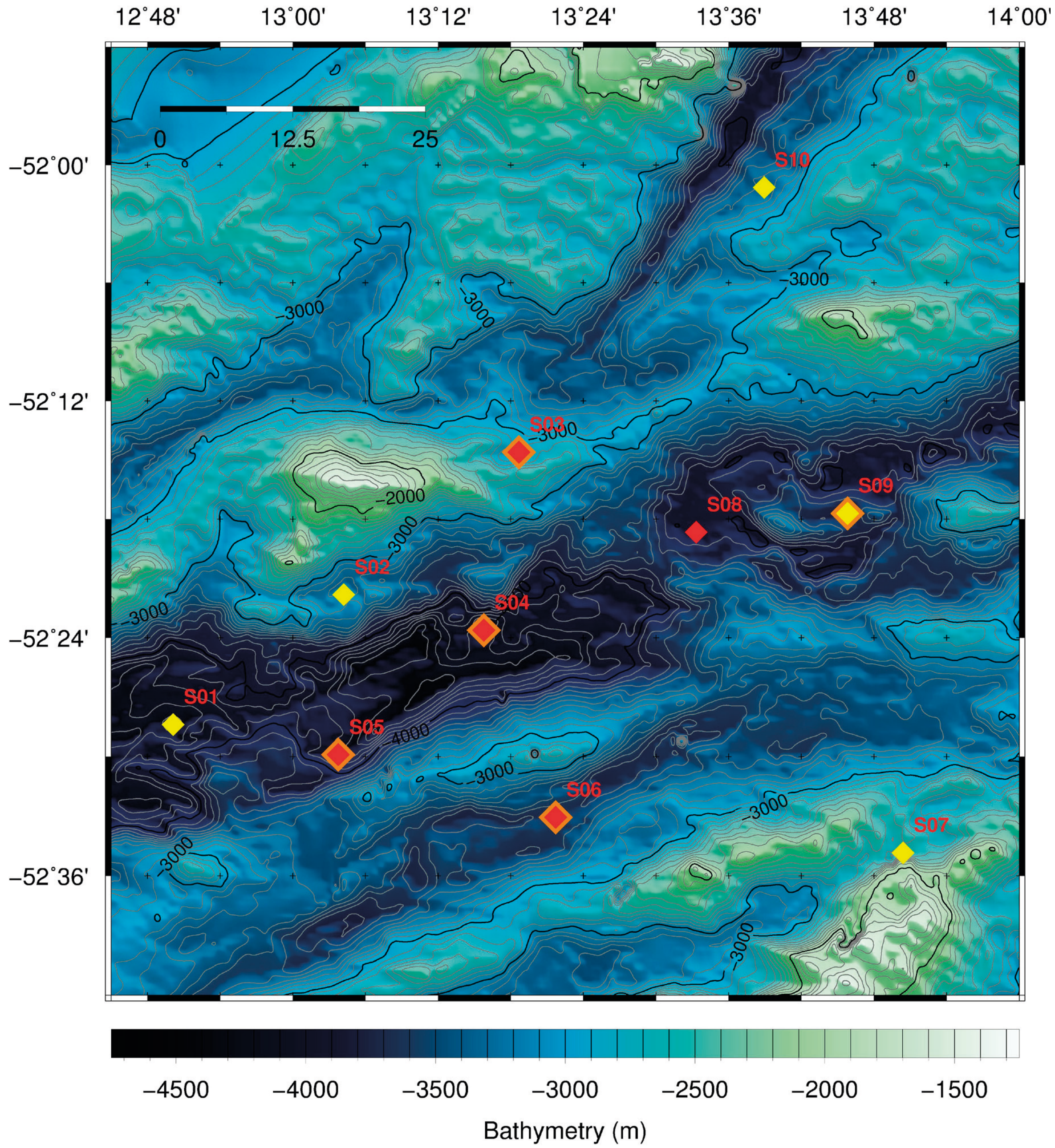

Fig. 4.1: Deployment sites of the OBS at the Orthogonal Supersegment of the Southwest Indian Ridge. Diamonds mark the deployment sites. Red diamonds: OBS carries temperature sensor; Orange outline: OBS is equipped with ARGOS transmitter.

5. BIOLOGY

5.1 Higher trophic levels: at-sea distribution of seabirds and marine mammals in the Southern Ocean (Atlantic sector)

Dominique Verbelen, Diederik D'Hert, Raphaël Lebrun;
Not on board: Claude Joiris

PolE

Objectives

Seabirds are well studied worldwide, primarily at the breeding colonies. The at-sea distribution of pelagic species, however, is less well known, as most of the feeding grounds are extensive, remote and difficult to access for systematic surveys. This is even more so the case for polar regions, as very few ships venture into the pack-ice. Hence, *Polarstern* offers a unique opportunity to survey the distribution and densities of seabirds in these areas, rarely visited by ornithologists and marine mammal observers.

In the framework of our long-term studies in polar marine ecosystems, the main aims are:

- to study the hydrological factors influencing the distribution and densities of seabirds and marine mammals;
- to detect temporal and spatial changes with special attention to possible effects caused by global warming.

Since the distributional information of many species is scarce south of 60°S, all data collected provide a valuable contribution to this, while - combined with oceanographic data (derived from D-ship) - they could help to understand the reasons behind distributional patterns and densities.

During ANT-XXIX/2 all data collected on the transect from Cape Town to Neumayer Station will be compared to the data obtained during 4 previous expeditions, both on board of *Polarstern* and *Ivan Papanin* (Joiris & Debroyer, in prep.). Data obtained in the Weddell Sea during the EPOS 1 expedition will serve as a baseline for a comparison with those obtained on ANT-XXIX/2.

Work at sea

The basic methodology consists in transect counts performed from the bridge of *Polarstern*. The transect did not follow a systematic survey layout but was determined by necessities of the other scientific programs, resulting in an inhomogeneous coverage of the area. Each observer scanned the sea surface using regular binoculars and naked eye, from 90° port to 90° starboard side (with 0° dead ahead). Observations of birds and marine mammals were made without any width limitation.

Counts were performed on a continuous basis, light and weather conditions permitting. If needed, species were further investigated with high quality binoculars (Swarovski 10X42) and spotting scopes (Leica Trinovid 30X, Swarovski ATM 80, zoom 25x-50x) to identify them to species level, to age and/or sex them. As the identification and ageing of some species (birds as well as marine mammals) is not always straightforward, the most recent literature was always at hand. Additionally professional cameras were used to validate identifications and/or document our observations. Valid counts lasted half an hour and were performed when the ship had a speed above 5 knots.

Complementary helicopter flights were used to survey off track transects (e.g. transect along the ice edge, transect along the ridge northwest of Elephant Island).

Preliminary results

On 13 January 2013, 00:00 UTC, a total of 1.077 transect counts had been performed, each lasting half an hour. Due to the heavy ice conditions (primarily in the western part of the Weddell Sea) *Polarstern* proceeded at a speed of less than 5 knots for prolonged periods of time. Nonetheless transect counts were made, adding valuable information, mainly on the occurrence of pinnipeds and Antarctic minke whales (*Balaenoptera bonaerensis)*. Out of the 1,077 counts, 843 were valid (*i.e.* performed at a speed of 5 knots or more), resulting in 421.5 counting hours (Figure 5.1). No counting was done during hours of darkness, mandatory meetings, etc..

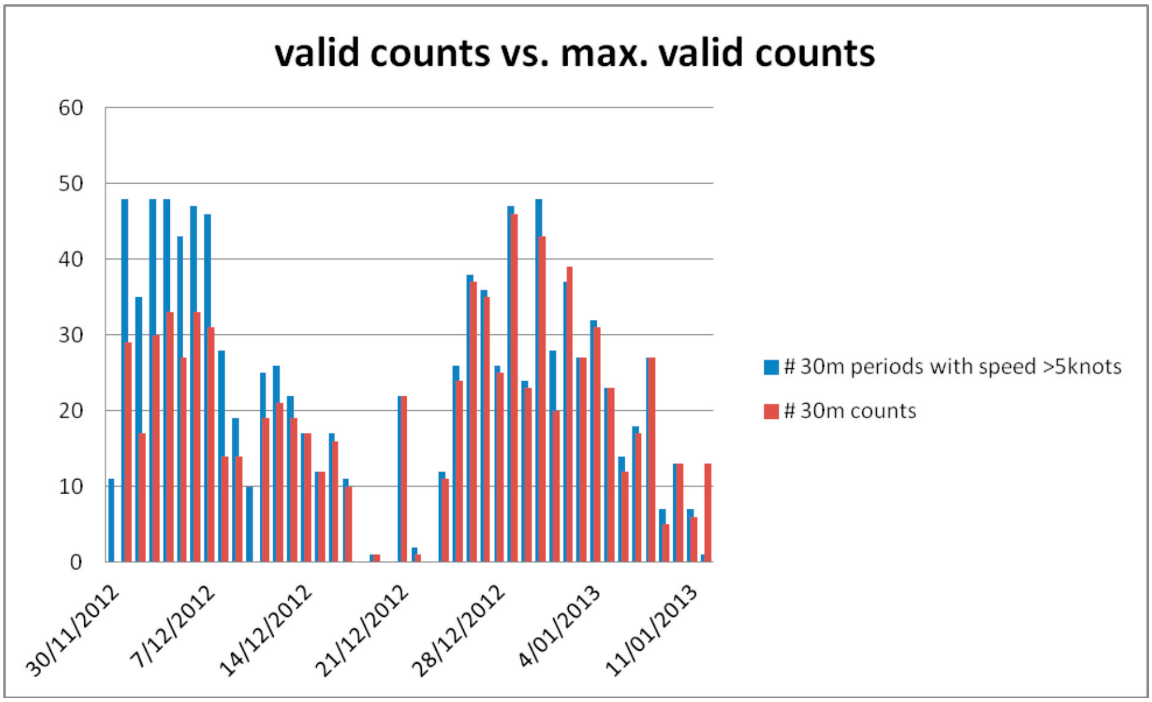

Fig. 5.1: Periods of 'valid' 30 minute counts (red) in relation to the number of 30 minute periods during which Polarstern cruised at a speed of at least 5 knots (blue).

During ANT-XXIX/2, 38 bird species were observed, totaling 20,538 birds. Some genera (especially the prions) pose major identification problems at sea, and even when good photographic documentation was available, the vast majority could not be identified to species level. A list of all bird species observed from 1 December 2012 up untill 13 January 2013 is presented in Table 5.1. This list follows the taxonomy as proposed by the International Ornithological Committee (Gill & Donsker, 2012). Strikingly, out of the 38 species seen, 6 are listed as 'Near Threatened', 5 are listed in the category 'Vulnerable' and 4 are 'Endangered', clearly illustrating that seabirds in the Southern Ocean are highly threatened (IUCN, 2012).

Tab. 5.1: Birds species recorded during ANT-XXIX/2 38: English name, scientific name, Red List category (LC: Least Concern, NT: Near Threatened, VU: Vulnerable, EN: Endangered), number seen of each species

SPECIES	SCIENTIFIC NAME	IUCN	#
Emperor penguin	*Aptenodytes forsteri*	NT	802
Adelie penguin	*Pygoscelis adeliae*	NT	4089
Chinstrap penguin	*Pygoscelis antarcticus*	LC	595
Macaroni penguin	*Eudyptes chrysolophus*	VU	4
penguin sp.	/	/	9
Wandering albatross	*Diomedea exulans*	VU	40
Southern royal albatross	*Diomedea epomophora*	VU	12
royal/wandering albatross	/	/	7
Sooty albatross	*Phoebetria fusca*	EN	4
Light-mantled albatross	*Phoebetria palpebrata*	NT	119
Black-browed albatross	*Thalassarche melanophris*	EN	46
Shy albatross	*Thalassarche cauta*	NT	24
Grey-headed albatross	*Thalassarche chrysostoma*	VU	15
Atlantic yellow-nosed albatross	*Thalassarche chlororhynchos*	EN	6
Indian yellow-nosed albatross	*Thalassarche carteri*	EN	3
yellow-nosed albatross sp.	*Thalassarche chlororhynchos/carteri*	/	6
Southern giant petrel	*Macronectes giganteus*	LC	138
Northern giant petrel	*Macronectes halli*	LC	27
giant petrel sp.	*Macronectes sp.*	/	10
Southern fulmar	*Fulmarus glacialoides*	LC	728
Antarctic petrel	*Thalassoica antarctica*	LC	2236
Cape petrel	*Daption capense*	LC	369
Snow petrel	*Pagodroma nivea*	LC	2156
Blue petrel	*Halobaena caerulea*	LC	1588
Broad-billed prion	*Pachyptila vittata*	LC	11
Antartic/Salvin's prion	*Pachyptila desolata/salvini*	/	46
Slender-billed prion	*Pachyptila belcheri*	LC	5
prion sp.	*Pachyptila sp.*	/	2363
Kerguelen petrel	*Aphrodroma brevirostris*	LC	372
Great-winged petrel	*Pterodroma macroptera*	LC	276
White-headed petrel	*Pterodroma lessonii*	LC	74
Soft-plumaged petrel	*Pterodroma mollis*	LC	494
Grey petrel	*Procellaria cinerea*	NT	18
White-chinned petrel	*Procellaria aequinoctialis*	VU	348
Cory's shearwater	*Calonectris borealis*	LC	76

SPECIES	SCIENTIFIC NAME	IUCN	#
Sooty shearwater	*Puffinus griseus*	NT	9
Great shearwater	*Puffinus gravis*	LC	7
Little shearwater	*Puffinus assimilis*	LC	35
Wilson's storm petrel	*Oceanites oceanicus*	LC	106
Black-bellied storm petrel	*Fregetta tropica*	LC	1013
storm petrel sp.	/	/	7
diving petrel sp.	*Pelecanoides sp.*	/	12
Red phalarope	*Phalaropus fulicarius*	LC	57
Arctic tern	*Sterna paradisaea*	LC	2160
tern sp.	*Sterna sp.*	/	6
South Polar skua	*Stercorarius maccormicki*	LC	6
Brown skua	*Stercorarius antarcticus*	LC	4
Total			**20538**

The data collected during the expedition largely confirm the present knowledge on the spatial distribution of seabirds in this area. However, some data might help to fill in the gaps in the current knowledge. Indian yellow-nosed albatrosses (*Thalassarche carteri)* and Atlantic yellow-nosed albatrosses (*Thalassarche chlororhynchos*), for instance, have recently been recognized as full species on the basis of differences in breeding ecology, vocalizations, genetics and morphology. The knowledge about the at-sea distribution of the former in the Atlantic sector of the Southern Ocean is still rather scant. The data collected on this species during ANT-XXIX/2 might help to better understand the spatial distribution of this endangered species.

The data obtained on the subantarctic form of little shearwater (*Puffinus assimilis elegans*) show a presumed extension of the known range. In total 35 individuals were observed, all on 3 December 2012, all between 42°80' S - 15°76' E and 44°92' S - 14°88' E (Figure 5.2). According to Shirihai (2008), the species has never been recorded in this area.

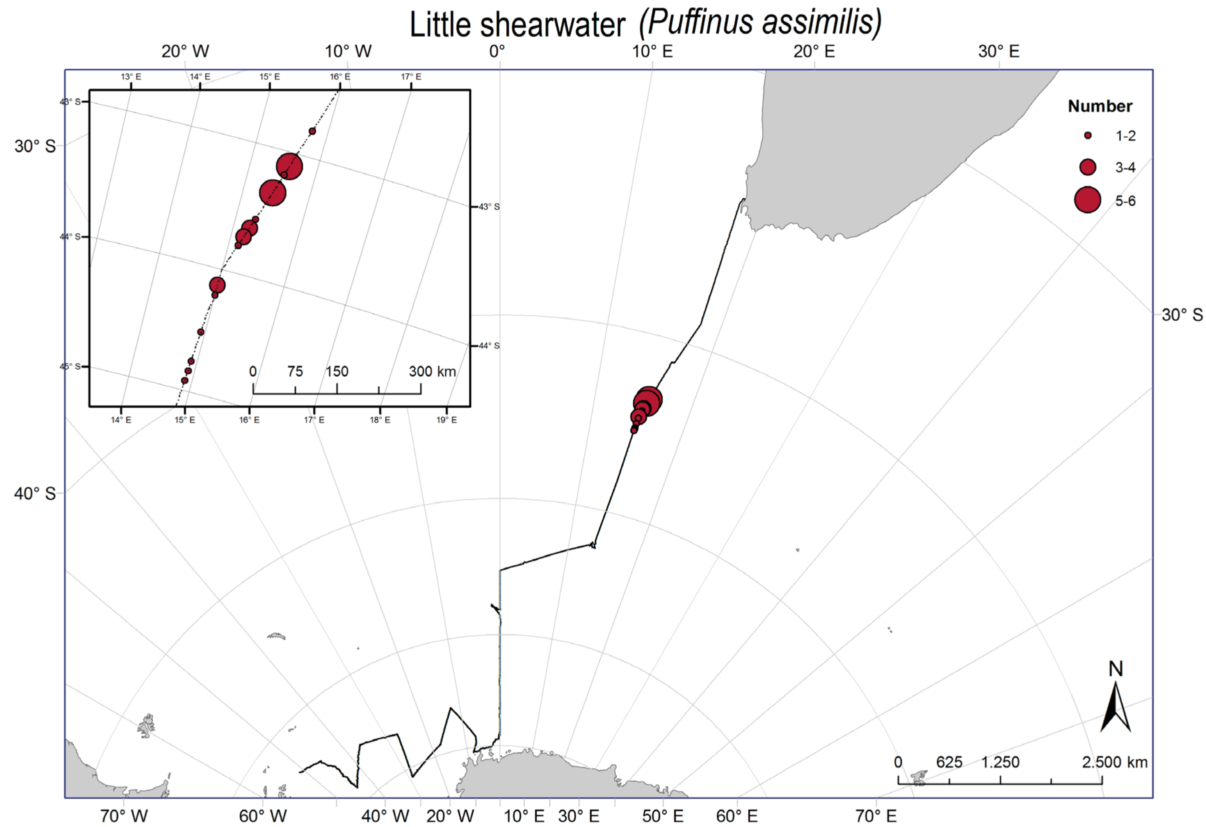

Fig. 5.2: Observations of the subantarctic form of little shearwater (Puffinus assimilis elegans) during ANT-XXIX/2

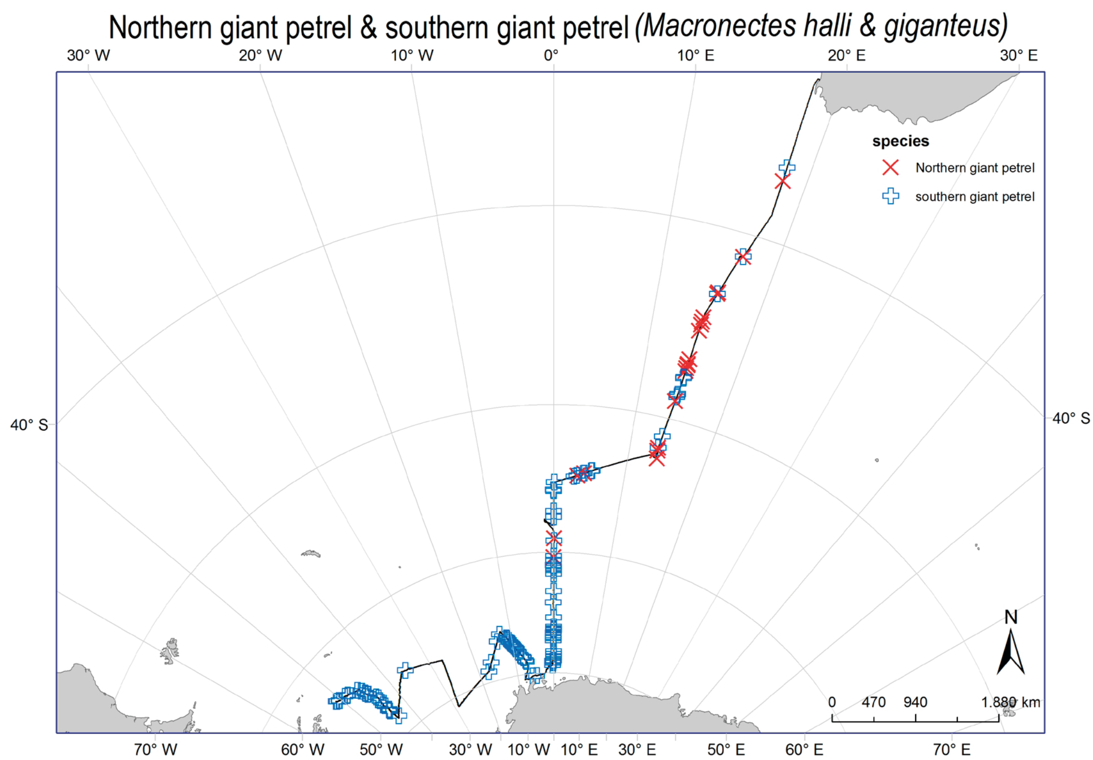

Fig. 5.3: Observations of northern giant petrel (Macronectes halli) and southern giant petrel (Macronectes giganteus) during ANT-XXIX/2

The provisional data clearly illustrate how so-called twin-species hardly overlap, hence avoiding competition for food. Figure 5.3 presents the observations of northern giant petrel (*Macronectes halli*) and southern giant petrel (*Macronectes giganteus*) during the expedition, clearly illustrating that the former mainly occurs north of the subantarctic convergence whereas the latter was mainly south of the Antarctic convergence. Similar maps could be produced for other twin species (e.g. Sooty albatross vs. Light-mantled albatross). On December 7th, *Polarstern* passed by Bouvet Island. Located at 54°25'S 03°21'E, 1,600 km from the nearest land of the Antarctic continent, 2,600 km southwest of South Africa and 4,800 km east of Cape Horn, Bouvet Island is the most isolated island in the world and is amongst the most rarely visited places on Earth. Its avifauna is in consequence not well-known. A heliflight around the volcanic island rendered most of the species known to occur here, with several gentoo penguins (*Pygoscelis papua*) being of special interest since this species has not been noted frequently on the island during four recent summer expeditions (Shirihai, 2008).

Some data show that the spatial distribution as shown in most of the literature might need some nuance. Arctic Tern (*Sterna paradisea*) is said to winter off South Africa and southern South America and in subantarctic and Antarctic waters (Birldife International, 2013). Yet, during this expedition alone, 1 was seen on the transect from Cape Town to Neumayer whereas 2.159 were noted in the Weddell Sea, suggesting that the spatial distribution might be more patchy than generally assumed (Figure 5.4).

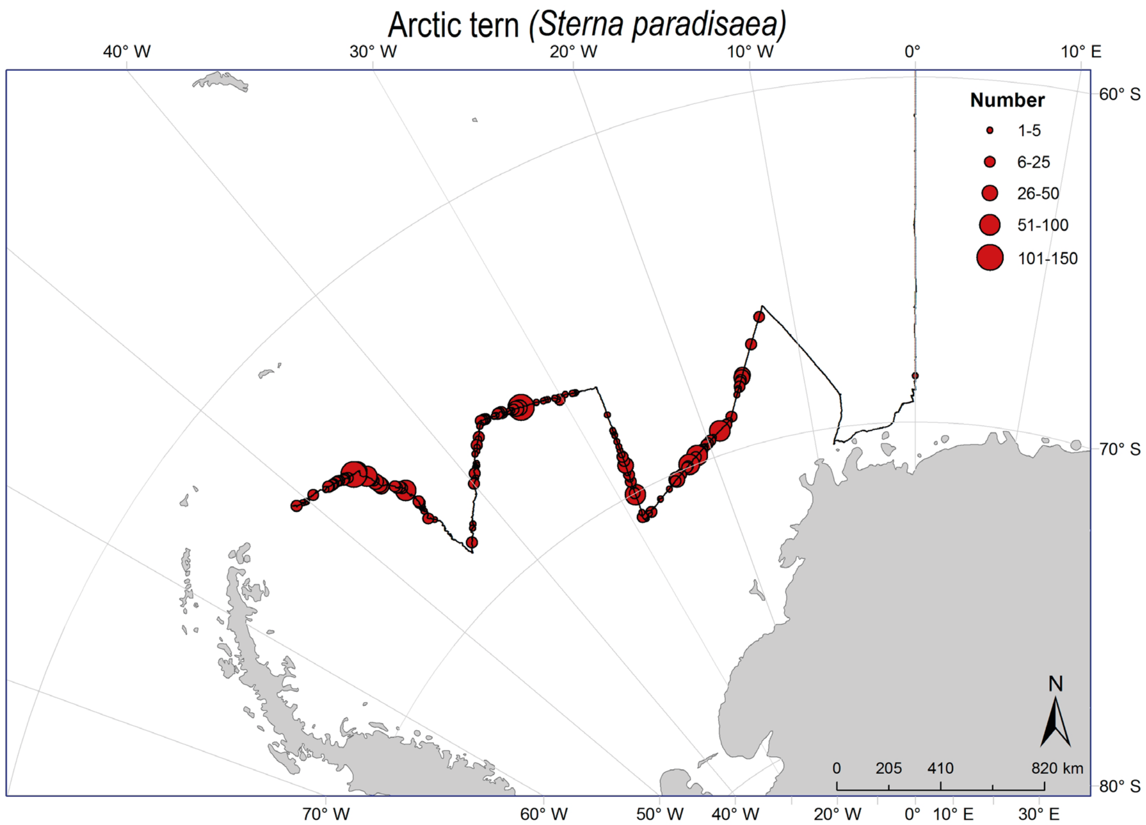

Fig. 5.4: observations of Arctic tern (Sterna paradisaea) during ANT-XXIX/2

All data will be further examined and correlated with some determining oceanographic parameters, collected by D-Ship and Ferrybox on board of *Polarstern*, as the water masses and especially the different convergences determine to a large extent the boundaries of the distribution of various species.

In addition to seabirds, records of pinnipeds and cetaceans were documented. During ANT-XXIX/2, 12 species of marine mammals were observed, totaling 885 individuals (Table 5.2). As expected, crabeater seal (*Lobodon carcinophaga*) was the most common species. Leopard seal (*Hydrurga leptonyx*) was seen on 11 occasions. The observations of 8 Ross seals (*Ommatophoca rossii*) are of interest. First discovered in 1840, it still is among the least-known pinnipeds in the world. All our sightings do confirm that the species favors very dense pack ice. Visual records of Ross seal in the Weddell Sea are scarce and they do add up to the acoustic observations, confirming their presence in the Weddell Sea during the austral summer. Surprisingly, 50 Weddell seals (*Leptonychotes weddellii*) were seen in the central Weddell Sea (Figure 5.5). The species is circumpolar in distribution, being most abundant near the Antarctic coast, mainly inhabiting fast ice. All 50 were immature individuals. All were seen in heavy pack ice and most often they were in couples, with a maximum of 5 together. Exact GPS positions were taken so that the data obtained could be used for more detailed studies.

Tab. 5.2: Marine mammals recorded during ANT-XXIX/2: English name, scientific name, Red List category (LC: Least Concern, DD: Data Deficient, VU: Vulnerable, EN: Endangered, CR: Critically Endangered), number seen of each species

SPECIES	SCIENTIFIC NAME	IUCN status	#
fur seal sp.	/	/	9
Leopard seal	*Hydrurga leptonyx*	LC	16
Weddell seal	*Leptonychotes weddellii*	LC	56
Crabeater seal	*Lobodon carcinophaga*	LC	544
Ross seal	*Ommatophoca rossii*	LC	7
seal sp.	/	/	38
Long-finned pilot whale	*Globicephala melas*	DD	3
Killer whale	*Orcinus orca*	DD	11
Sperm whale	*Physeter macrocephalus*	VU	2
Southern bottlenose whale	*Hyperoodon planifrons*	LC	4
Antarctic Minke whale	*Balaenoptera bonaerensis*	DD	45
smaller whale sp.	/	/	2
Southern blue whale	*Balaenoptera musculus intermedia*	CR	5
Fin whale	*Balaenoptera physalus*	EN	25
Humpback whale	*Megaptera novaeangliae*	LC	47
larger whale sp	/	/	70
Total			**885**

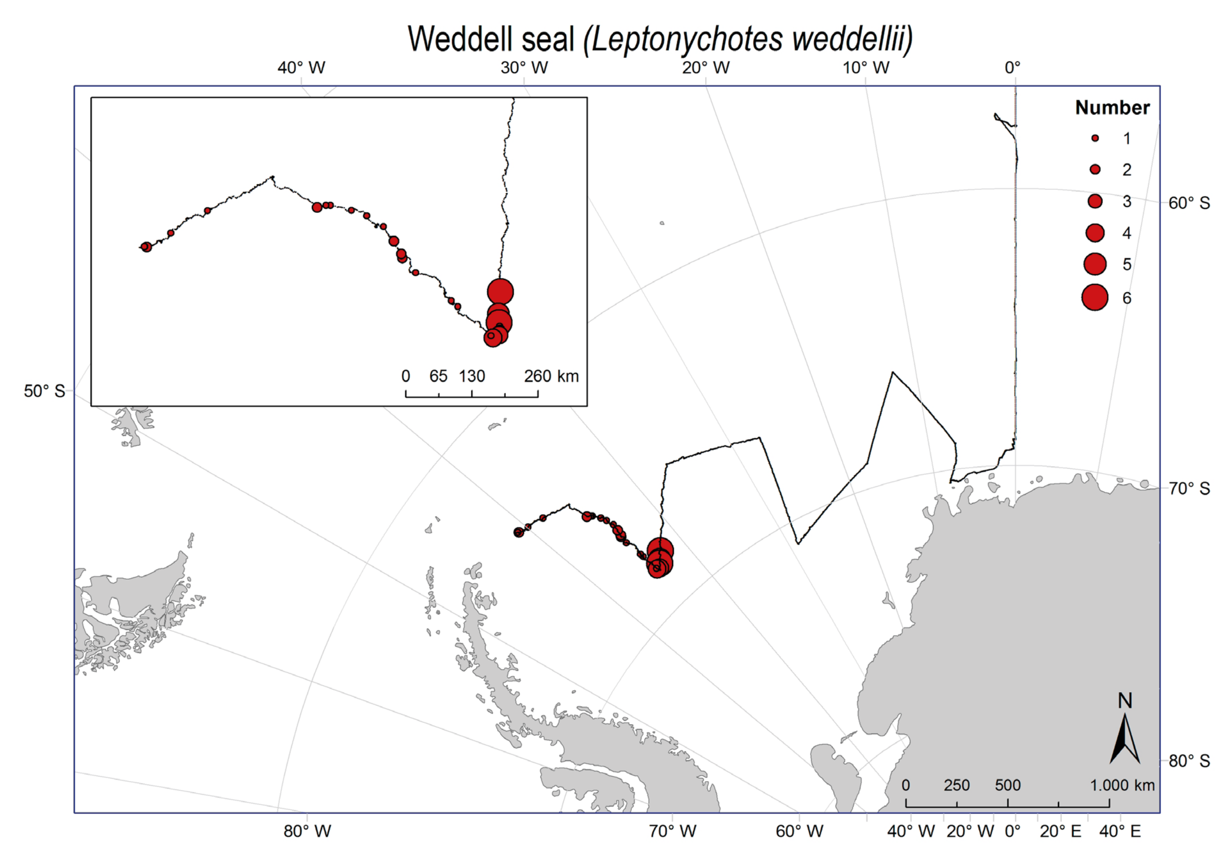

Fig. 5.5: Observations of Weddell seals (Leptonychotes weddellii) during ANT-XXIX/2

Cetaceans were observed in good numbers. Especially the transect from Cape Town to Neumayer proved very productive with fin whale (*Balaenoptera physalus*) (n=25) and humpback whale (*Megaptera novaeangliae*) (n=47) being the most numerous. Rather surprisingly, at least 2 Pacific humpback whales were seen. Atlantic and Pacific humpback whales have differently colored flippers, with the former usually having largely white flippers on both sides and only some black markings, while those in the Pacific have a black upperside and white underside. Shirihai (2008) notes that the two might perhaps occasionally meet in Antarctic waters.

Data management

Please contact C. Joiris for data availability. P.I.: Claude Joiris.

References

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Gill F, Donsker D (2012) IOC World Bird List (v 3.2) (http://www.worldbirdnames.org/)

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5.2 MAPS: Marine mammal perimeter surveillance

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Not on board: Elke Burkhardt[1], Lars Kindermann[1]

[1]AWI
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Objectives

Both, non-governmental organizations and governmental agencies increasingly criticize the use of air-guns for marine geophysical research due to the enhanced noise levels these instruments introduce to the aquatic environment. To remedy possible detrimental effects to the marine fauna, mitigation measures are commonly requested, which in most cases call for visual observation of the ship's perimeter and shut down of seismic operations when cetaceans are sighted within a predefined exclusion zone around the airguns. To facilitate such observations, the MAPS project aims at developing an automatic whale blow detection system on the basis of a 360° thermal imaging sensor, FIRST Navy.

Data collected with this system during seven recent *Polarstern* cruises resulted in numerous detections during retrospective human visual screening, even in relatively warm waters of up to 22°C. A robust computer based image recognition algorithm was developed and tested, which automatically processes the video stream for the occurrence of whale blows, issuing real-time alerts to the marine mammal observers and ship's crew.

To test the efficiency of this detection algorithm for various species and under varying environmental conditions, comparisons with sightings from concurrent visual observations on encounter and cue level aim at identifying false and positive auto-detections. To be able to unambiguously identify false positive (missed) events in the IR images, visual sighting information has to be recorded with high accuracy (to the second). In addition, accurately timed sightings significantly facilitate searching for a whale's blow in the thermal images during retrospective analysis as only short (5s) periods needs to be searched.

Last but not least, the visual camera system which was installed and tested during ANT-XXVII/1-2 was to be augmented during this expedition.

Work at sea

Thermographic Imaging

The FIRST system was operated continuously for a period of 30 days (726 h in total) using two sensor heads, SN001 and SN002 with a brief interruption of 4 hours.

The system (using sensor head SN001) was powered up in Cape Town on 29.11.2012 (Table 5.3). It lost its frontal alignment on 08.12.2012, presumably through degeneration sensor's slip ring. The alignment problem was temporarily overcome using a software fix. However, to prepare SN001 for return to the manufacturer, it was replaced with SN002 on 15.12.2012.

SN002 failed to operate after 11 days of operation on 26.12.2012. Manual inspection indicated a mechanical problem, as the rotational friction of the sensor was highly increased. SN002 was resubstituted with SN001 on 26.12.2012, which operated (using the software fix) until it terminated service on 31.12.2012. It should be noted though, that sensor head SN001 had already been used in previous projects for a total operation time of about 20 weeks and its failure was anticipated as the slip ring is a wear and tear element.

Between 29 Nov 2012 and 31 Dec 2012, the automatic whale detection software was operated continuously with only occasional short interruptions (<10 min) for software restarts. If a whale was sighted (visually or thermographically) we recorded the full IR data for a ship-speed dependent time-frame ΔT around the observation. This resulted in a total of 72.3h hours of thermographic video footage, which accumulates to 10.4TB of data. The temporal distribution of recorded data is represented by Figure 5.6. Additionally, beginning on 29.11.2012, a single thermal image was saved every 10 seconds to document the system performance under all occurring environmental conditions and for comparison with manual sea ice observations.

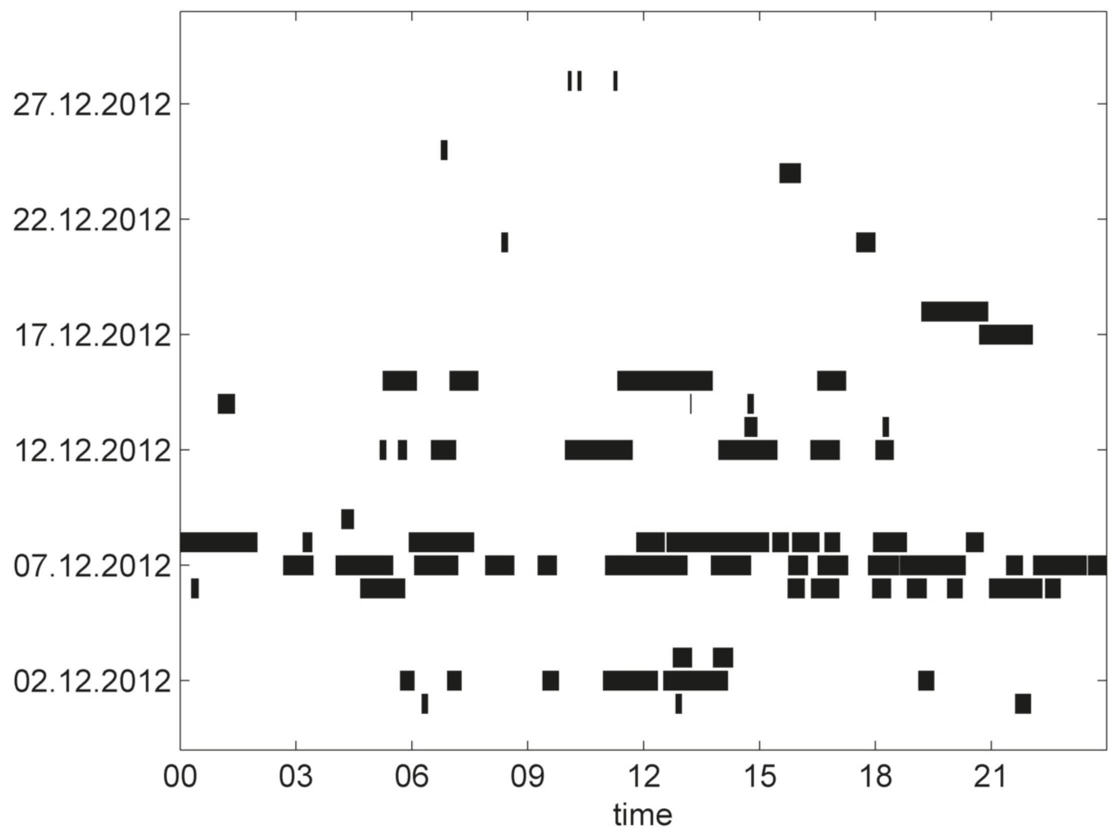

Fig. 5.6: Distribution of recorded thermographic data. Most of the data was recorded during a few days with multiple ship-whale encounters.

Tab. 5.3: Timetable showing the operation periods of the FIRST Navy.

Start	End	Hours operational [hhh:mm]	Unit Number (UN)
2012.11.29 10:00	2012.12.15 07:55	381:55	001
2012.12.15 12:36	2012.12.21 20:59	152:23	002
2012.12.22 08:00	2012.12.24 17:07	57:07	002
2012.12.25 00:21	2012.12.25 14:01	13:40	002
2012.12.25 16:47	2012.12.26 07:52	15:05	002
2012.12.26 18:02	2012.12.31 04:14	106:12	001
		∑ 726:22	

Visual whale blow logging

To test the performance of the infrared imager and the automatic detection algorithm, two dedicated observers were visually logging whale blows as accurately as possible (to the second) including time, bearing, distance, species, number of animals and comments. Visual observations were conducted for a total of 210 hours (Table 5.4). Additionally, if the thermal imaging system detected a whale, visual observations were started immediately.

For this task, an observer was searching with the naked eye or binoculars on the bridge. Once a whale was spotted, the observer focused exclusively on this animal to ensure it is not missed, while the other observer recorded the observational data via a tablet PC based, customized graphical user interface (blowlog2). If multiple whale groups surrounded the ship the observers focused on one group and did not add observations of other groups. If one group moved out of sight, the observers focused on another group. Observations were conducted under varying environmental conditions (sea state 1-5, and also during various states of visibility).

Tab. 5.4: Timetable showing the effort times of visual observations

Date	Start	End	Duration
02.12.2012	06:00:00	16:30:00	10:30:00
03.12.2012	08:00:00	11:30:00	03:30:00
	12:01:00	17:33:00	05:32:00
	18:02:00	18:28:00	00:26:00
	18:54:00	19:36:00	00:42:00
04.12.2012	07:55:00	11:33:00	03:38:00
	11:56:00	15:18:00	03:22:00
	15:35:00	17:38:00	02:03:00
	18:05:00	18:28:00	00:23:00
	18:49:00	19:50:00	01:01:00
05.12.2012	08:10:00	11:38:00	03:28:00
	12:00:00	15:15:00	03:15:00
	15:22:00	17:38:00	02:16:00

Date	Start	End	Duration
	18:00:00	18:29:00	00:29:00
	18:45:00	19:16:00	00:31:00
06.12.2012	08:11:00	11:40:00	03:29:00
	12:29:00	17:36:00	05:07:00
	17:53:00	19:25:00	01:32:00
07.12.2012	04:50:00	11:35:00	06:45:00
	12:10:00	17:36:00	05:26:00
	18:08:00	20:05:00	01:57:00
08.12.2012	13:30:00	15:30:00	02:00:00
	15:45:00	17:30:00	01:45:00
	18:00:00	18:30:00	00:30:00
	18:50:00	19:30:00	00:40:00
09.12.2012	08:06:00	08:45:00	00:39:00
12.12.2012	08:20:00	11:45:00	03:25:00
	12:02:00	15:35:00	03:33:00
	15:45:00	17:30:00	01:45:00
	18:45:00	19:28:00	00:43:00
13.12.2012	08:05:00	11:50:00	03:45:00
	12:05:00	17:45:00	05:40:00
14.12.2012	08:08:00	11:30:00	03:22:00
	11:55:00	17:30:00	05:35:00
	17:56:00	18:28:00	00:32:00
	18:45:00	19:44:00	00:59:00
15.12.2012	08:02:00	08:36:00	00:34:00
	09:35:00	11:40:00	02:05:00
	12:06:00	17:45:00	05:39:00
	18:00:00	18:50:00	00:50:00
16.12.2012	08:15:00	10:40:00	02:25:00
	10:55:00	11:42:00	00:47:00
	12:12:00	15:20:00	03:08:00
	15:34:00	16:00:00	00:26:00
	16:45:00	17:45:00	01:00:00
	18:10:00	18:30:00	00:20:00
17.12.2012	08:06:00	11:30:00	03:24:00
	12:05:00	15:30:00	03:25:00
	16:00:00	17:30:00	01:30:00
	18:05:00	19:40:00	01:35:00
	10:00:00	11:00:00	01:00:00
18.12.2012	08:20:00	11:32:00	03:12:00
	12:15:00	15:40:00	03:25:00
	16:00:00	17:30:00	01:30:00
	18:05:00	18:25:00	00:20:00

Date	Start	End	Duration
19.12.2012	10:00:00	11:35:00	01:35:00
	12:10:00	15:35:00	03:25:00
	16:05:00	17:30:00	01:25:00
	18:05:00	18:25:00	00:20:00
20.12.2012	09:30:00	11:45:00	02:15:00
	12:02:00	15:35:00	03:33:00
	16:10:00	17:30:00	01:20:00
	18:10:00	18:25:00	00:15:00
21.12.2012	08:14:00	10:00:00	01:46:00
	12:15:00	13:20:00	01:05:00
	14:20:00	17:30:00	03:10:00
	18:00:00	18:30:00	00:30:00
25.12.2012	08:35:00	10:45:00	02:10:00
	17:00:00	17:40:00	00:40:00
26.12.2012	15:20:00	16:45:00	01:25:00
27.12.2012	09:20:00	11:40:00	02:20:00
	12:15:00	15:35:00	03:20:00
	15:52:00	17:30:00	01:38:00
	18:05:00	18:25:00	00:20:00
	19:10:00	19:50:00	00:40:00
28.12.2012	08:15:00	11:30:00	03:15:00
	12:16:00	15:40:00	03:24:00
	15:50:00	17:30:00	01:40:00
	18:10:00	18:25:00	00:15:00
	18:48:00	19:55:00	01:07:00
29.12.2012	08:10:00	08:30:00	00:20:00
	09:30:00	11:30:00	02:00:00
	12:05:00	15:30:00	03:25:00
	15:50:00	17:30:00	01:40:00
	18:05:00	18:26:00	00:21:00
	18:55:00	20:00:00	01:05:00
30.12.2012	08:10:00	11:40:00	03:30:00
	12:00:00	15:30:00	03:30:00
	15:45:00	17:50:00	02:05:00
	18:10:00	20:55:00	02:45:00
02.01.2013	10:00:00	12:00:00	02:00:00
	12:15:00	14:05:00	01:50:00
04.01.2013	09:30:00	12:50:00	03:20:00
	13:10:00	15:30:00	02:20:00
			Σ 209:54

Visual Imaging

To facilitate species identification we had a second camera system installed during ANT-XXVII/1. This visual camera is mounted on a pan-tilt stage which is controlled by the IR based whale detection software and automatically pinpointed to where a whale was detected thermographically. During ANT-XXIX/2 the existing system was augmented by installing a new pan-tilt-unit featuring an enhanced internal stabilization, and by replacing the 11 Mpixel camera with a 29 Mpixel camera (Prosilica GX6600). This camera automatically acquires close-ups of objects detected by the IR scanner with a frame rate of 4 fps.

For trained marine mammal observers these photographic images may allow offline species identification of the whales of which spouts have been automatically detected by the infrared imager. During this cruise we developed the corresponding communication software and graphical user interface to operate the camera in combination with the whale detection software.

Preliminary results

Between 29 Nov and 12 Dec 2012, a total of 849 blows were visually logged. Analysis of logs of data recorded after this period is yet pending. So far, the number of confirmed (i.e. verified by human) IR detections of whale blows amounts to 887, yet only part of the automatic detections have so far been validated by human operators.

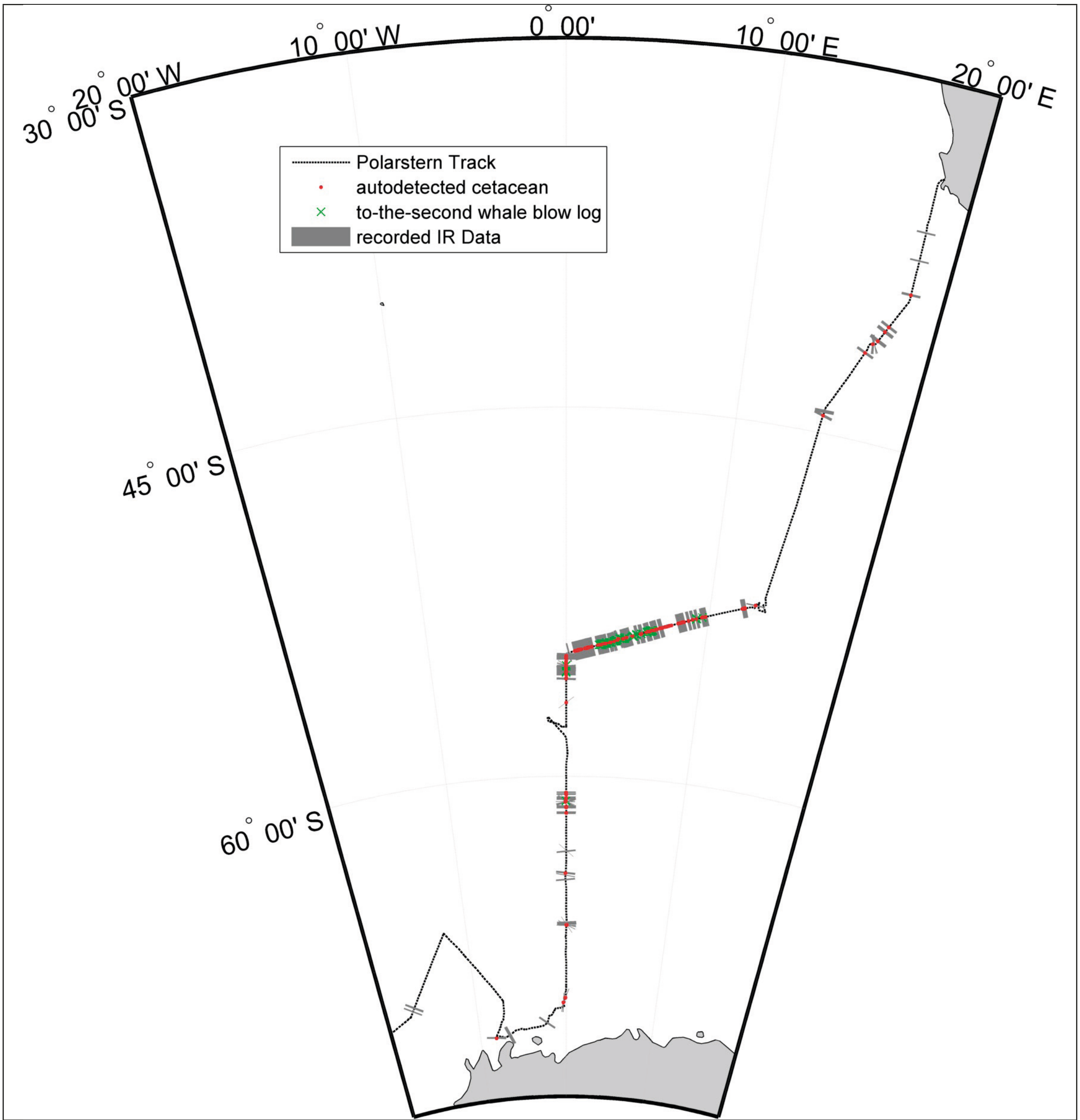

Fig. 5.7.: Location of visual sightings, IR based automatic detections, and IR data recorded.

Data management

Data description and metadata will be accessible through the PANGAEA database; however as the IR image data occupy more than 10 Terabytes, it will not be available online. PI: Daniel Zitterbart.

5.3 Ocean acoustics

Ilse van Opzeeland, Steffanie Rettig, Karolin Thomisch, Loretta Preis, Ina Lefering, Sebastian Menze, Daniel Zitterbart, Matthias Monsees, Olaf Boebel;
Not on board: Lars Kindermann

AWI

Objectives

Passive acoustic observations from moored recorders are particularly valuable as a source of information on marine mammals in areas such as the Southern Ocean, as acoustic instrumentation can collect data continuously: during summer and winter, under stormy and calm weather conditions, during day and night and over time scales up to several years. Marine mammals frequently produce sound in various behavioral contexts. The species-specific 'acoustic signatures' form a reliable basis to assess which (vocalizing) species are present in the vicinity of the recorder.

The HAFOS observing system consists of an array of oceanographic moorings to collect information on the ocean interior in the Atlantic Sector of the Southern Ocean. Passive acoustic recorders are part of the moored instrumentation, which is recovered and redeployed during ANT-XXIX/2 to recover data and to continue measurements. The acoustic recordings from the moored recorders contain information on the spatio-temporal patterns in marine mammal biodiversity at the different mooring locations. By linking marine mammal acoustic presence data to information on environmental parameters, such as depth or sea ice coverage, these provide insights in species-specific habitat usage and affinity. To date, such knowledge has been largely unavailable for most species inhabiting the Southern Ocean due to the logistic constraints of conducting long-term continuous observations in this region.

The basin-wide scale of the HAFOS observatory and the multi-year basis over which data are collected, furthermore allow unprecedented investigation of the range over which the sounds of the various marine mammal species can be detected. Information on species-specific detection ranges is important for interpretation of call rates in the context of local acoustic abundances.

Work at sea

Two types of acoustic recorders, SonoVaults (Develogic GmbH, Hamburg, Germany) and AURAL (Multi-Électronique (MTE) Inc., Quebec, Canada), which were deployed during ANT-XXVII/2, were recovered and exchanged with new recorders to continue acoustic time series data collection. In total, 6 SonoVaults and 1 AURAL were recovered, all relevant recovery information is shown in Table 5.5.

After recovery, all acoustic recorders were rinsed with freshwater. The SonoVaults require drying because of their mechanical design which causes water to easily be retained in the thread. To avoid water damage to the electronics while opening the housing, any water in the thread was removed by blowing it out using compressed air. All recorders were then left to dry overnight. To check the status of the recorder, it was connected to a laptop through a serial connection and accessed using custom-made software for the SonoVaults and the program 'AURALSetup' for the AURAL. All communication, if established, was saved in a logfile. Recorders that were still in operating mode were switched off. After opening the lid, the internal power supply was disconnected. For the SonoVault recorders, all SDHC-cards were labelled with their position in the recorder (serial number, module number and SDHC card-slot). For the AURAL recorders, the HDD was removed from the electronic board.

Unfortunately, none of the three C-PODs (POrpoise click Detectors, manufactured by Chelonia Ltd.) could be recovered due to the heavy ice cover at the mooring location. All C-PODs (IDs 844, 845 and 846) had been set to record click events continuously without limiting the number of clicks events that is logged per minute. All moorings with C-PODs (AWI232, AWI206 and AWI207) also contained an acoustic recorder.

Tab. 5.5: Overview of the recorders that were retrieved during ANT-XXIX/2

Mooring	SV	Corr. water depth /m	Position LAT LON	Deployment depth /m	Deployment date /time (UTC)	Recovery date /time (UTC)	Gain /dB	Time Signal	Comment
AWI 247-2	SV1008	4240	20° 57.80' S 005° 58.60' W	741	2011-11-25 16:56	2012-11-22 07:19	48	--	5)
AWI 227-11	SV0002	4597	59° 03.02' S 000° 06.63' E	1007	2010-12-11 16:45	2012-12-11 07:25	20	--	1),3)
AWI 229-9	SV1000	5170	63° 59.56' S 000° 02.65' W	969	2010-12-15 15:10	2012-12-14 07:35	48	00:40; daily	1),3)
AWI 230-7	SV1001	3540	66° 01.90' S 000° 03.25' E	934	2010-12-16 18:45	2012-12-15 08:34	50	--	1),3)
AWI 231-9	SV1002	4524	66° 30.71' S 000° 01.51' W	1083	2010-12-17 10:27	2012-12-16 07:05	48	01:10; daily	1),3)
AWI 232-10	SV1003	3344	69° 00.11' S 000° 00.11' W	987	2010-12-19 08:57	100% ice coverage - left on position	50	--	1), 2)
AWI 244-2	SV1005	2900	69° 00.30' S 006° 58.89' W	1003	2010-12-23 09:34	2012-12-26 00:21	50	00:50; daily	1),2)
AWI 245-2	SV1004	4740	69° 03.52' S 017° 23.05' W	1051	2010-12-27 10:40	2012-12-28 16:51	50	01:10; daily	1), 2)
AWI 209-6	AU086LF	4830	66° 36.70' S 027° 07.31' W	207	2010-12-29 12:25	2013-01-01 10:35	22	01:00; daily	4)
AWI 207-8	AU085LF	2500	63° 43.07' S 050° 49.91' W	219	2011-01-06 11:02	100% ice coverage - left on position	22	01:10; daily	4)
AWI 206-7	SV1006	950	63° 28.84' S 052° 05.77' W	909	2011-01-06 20:32	100% ice coverage - left on position	48	--	1), 2)

1) 5.3 kHz / 24bit 600s;
2) thick o-rings;
3) thin o-rings,
4) recording scheme: 4.5 min every 3 hours at 32 kHz;
5) recovered during ANT-XXIX/1

Figure 5.8 provides an overview of the acoustic recorders that were recovered during ANT-XXIX/2, showing how long they recorded and how long they were deployed. The map in Figure 5.9 shows the positions of the moorings.

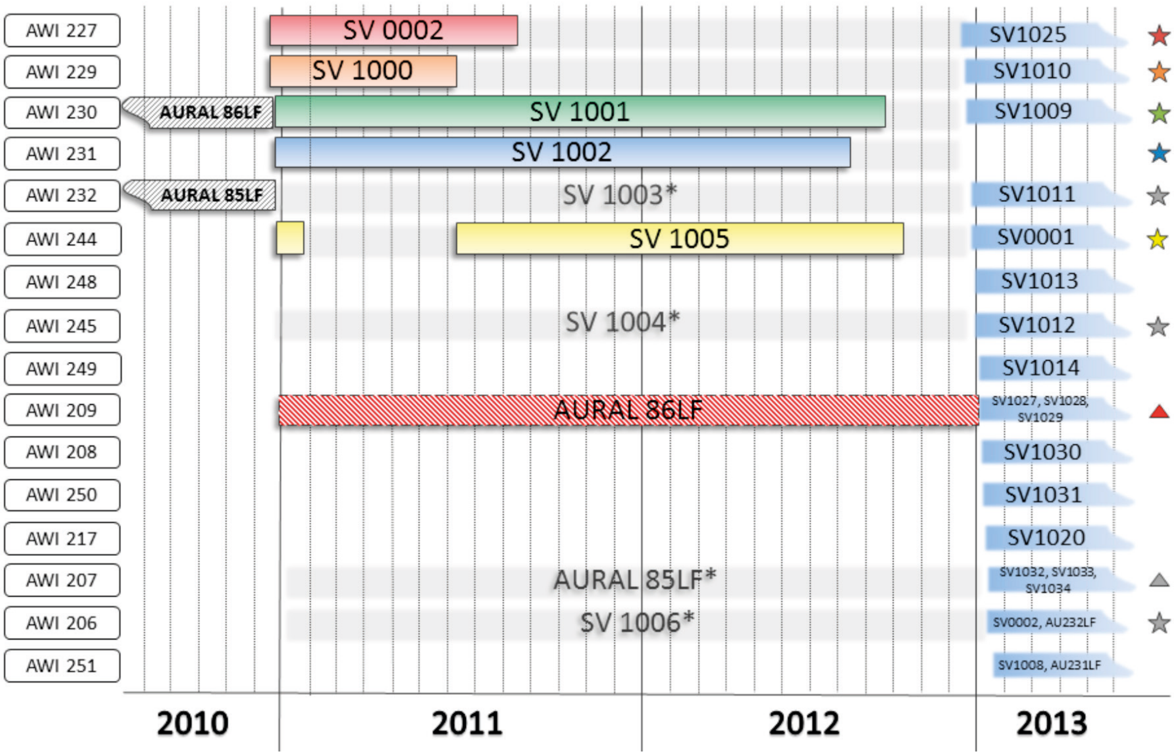

Fig.5.8: Overview of HAFOS moorings with passive acoustic recorders from 2008 until present. On the left the mooring IDs are listed, followed by the first recorders (two AURALs) that were deployed and which were recording until their recovery in 2010. The coloured bars in the middle represent the recorders which were deployed in 2010 and were successfully recovered in during ANTXXIX/2. The grey shaded bars indicate the time the recorders were deployed. The blue bars on the right show which moorings were equipped with passive acoustic recorders during ANTXXIX/2.

**) SV1003, SV1006 and AURAL85LF remained moored due to heavy ice coverage preventing the host moorings'recoveries. SV1004 had not been recording because a problem with power supply.*

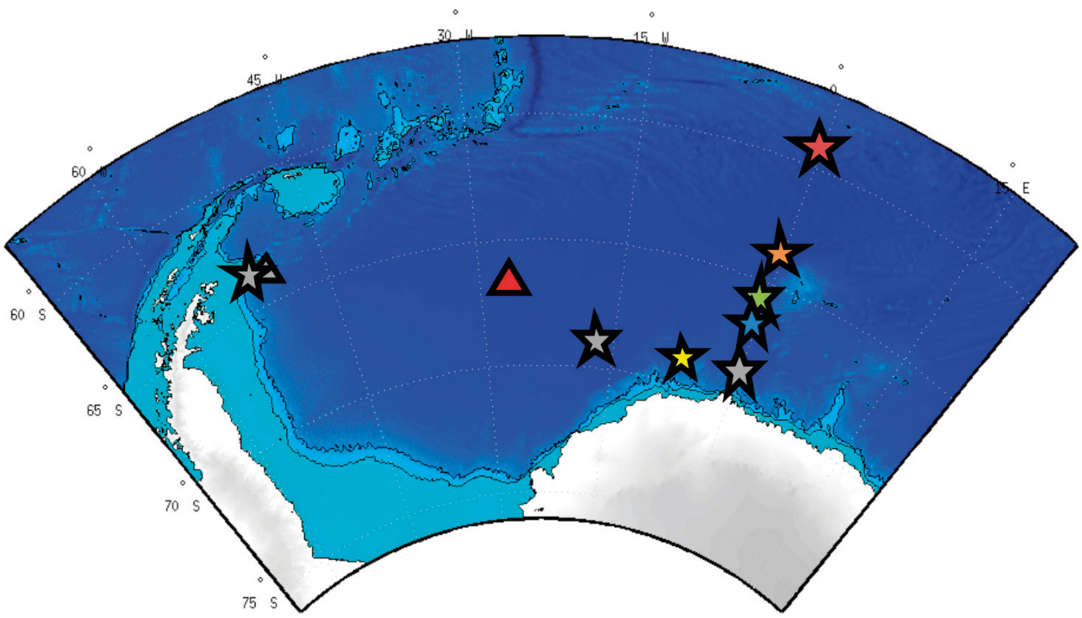

Fig. 5.9: Map showing the positions of the recorders that were retrieved during this expedition. Stars represent SonoVault recorders, triangles represent AURALs. The color-coding of the stars refers to Figure 5.8.

Data retrieval and backup

In total, 3.1 TB of acoustic data was retrieved from 5 SonoVault recorders, as well as 90 GB from the one AURAL. One SonoVault did not contain data as the power cable was damaged during deployment preparations. Recording time is represented by the colored bars in Figure 5.8. Quality of the data is further discussed in the preliminary technical results.

The AURAL recorders store acoustic data on PATA 2.5'' HDD (max. 160 GB) within the recorder. The SonoVault recorders store the acoustic data on thirty-five 32GB SDHC cards (totaling max. 1.1 TB of data storage per recorder). Upon recorder retrieval, the internal data storage was removed from the recorders and the acoustic data first copied onto an external HDD (3TB) in the original file/folder structure (Figure 5.10). After all data was secured on HDD, the acoustic data were copied once more, after file names were converted to the format 'YYYYMMDD-hhmmss_SVXXXX' by using a shell script. In addition to securing the data on HDD, all raw (i.e., unconverted) acoustic data (3.2 TB) were furthermore secured on the SILO of *Polarstern* and will be transferred to the AWI SILO in Bremerhaven in 2014. These data management procedures were the same for all recorder types.

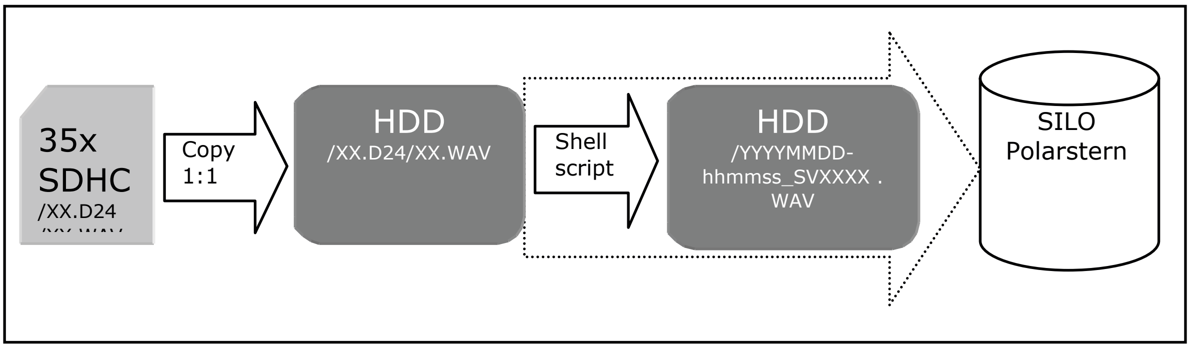

Fig. 5.10: Overview of data copying and management procedures for SonoVault. Apart from the original storage media, data management procedures were the same for the AURAL recorders.

Deployment of moored recorders

A total of 21 acoustic recorders (17 new SonoVaults, 2 refurbished SonoVaults and two AURALs) were deployed in 15 moorings. All preparations occurred on board.

The 16 new SonoVaults were equipped with batteries (LS33600) and the O-rings carefully cleaned and greased. One SonoVault (ID serial number SV1020) still contained batteries, which were installed in October 2012. The total storage capacity of each recorder is 1.1 TB (35x 32GB SDHC). Standard settings for the SonoVault recorders are 24bit sampling with a frequency of 5333 Hz, file duration is 600s with 24 files stored in each folder. In the first recorders, the gain was set to 24 dB, however after having recovered the first recorders and inspection of their audio files, the gain was increased to 30 dB, later to 48 dB.

Moorings AWI209-7 and AWI207-9 each are equipped with three SonoVaults operating at different depths along the mooring line (Figure 5.11). This set-up will allow comparing soundscapes and reception of acoustic signals at different depths of the water column. All three SonoVaults in mooring AWI 207-9 were programmed to record with a sampling rate of 10 kHz to also cover higher parts of the frequency spectrum. The three SonoVaults in mooring AWI 209-7 were programmed to record with the standard settings.

Tab. 5.6: Overview of the recorders that were deployed during ANTXXIX/2

Mooring	Device SN	Corr. water depth /m	Position LAT LON	Deployment depth /m	Deployment date	Deployment time (UTC)	Gain /dB	Time Signal	Comment
AWI 227-12	SV1025	4600	59° 02.63' S 000° 04.92' E	1020	2012-12-11	12:37	24	--	Rope shakles, 1),3)
AWI 229-10	SV1010	5172	63° 59.66' S 000° 02.65' W	969	2012-12-14	11:30	24	12:30; daily	1),3)
AWI 230-8	SV1009	3552	66° 02.12' S 000° 02.98' E	949	2012-12-15	13:55	24	--	1),3)
AWI 232-11	SV1011	3319	68° 59.86' S 000° 06.51' W	958	2012-12-18	5:30	30	--	1),3)
AWI 244-3	SV0001	2900	69° 00.35' S 006° 58.97' W	998	2012-12-25	13:58	30	12:40; daily	1),3)
AWI 248-1	SV1013	5011	65° 58.09' S 012° 15.12' W	1081	2012-12-27	8:11	30	14:00; daily	1),4)
AWI 245-3	SV1012	4746	69' 03.48' S 017° 23.32' W	1065	2012-12-28	20:40	48	13:10; daily	1),4)
AWI 249-1	SV1014	4364	70° 53.55' S 028° 53.47' W	1085	2012-12-30	12:01	48	13:50; daily	1),4)
AWI 209-7	SV1027	4830	66° 36.45' S 27° 07.26' W	226	2013-01-01	15:00	48	13:30; daily	1),4)
	SV1028	4830	66° 36.45' S 27° 07.26' W	1007	2013-01-01	14:25	48	13:30; daily	1),4)
	SV1029	4830	66° 36.45' S 27° 07.26' W	2516	2013-01-01	13:57	48	13:30; daily	1),4)
AWI 208-7	SV1030	4732	65° 37.23' S 036° 25.32' W	956	2013-01-03	12:58	48	12:40; daily	1),4)
AWI 250-1	SV1031	4100	68° 28.95' S 044° 06.67' W	1041	2013-01-05	14:21	48	13:10; daily	1),4)
AWI 217-5	SV1020	4410	64° 22.94' S 045° 52.12' W	960	2013-01-09	14:10	48	13:50; daily	1),4)
AWI 207-9	SV1032	2500	63° 42.09' S 050° 49.61' W	219	2013-01-12	8:10	48	14:10; daily	4), 5)
	SV1033	2500	63° 42.09' S 050° 49.61' W	1012	2013-01-12	7:36	48	14:10; daily	4), 5)
	SV1034	2500	63° 42.09' S 050° 49.61' W	2489	2013-01-12	6:38	48	14:10; daily	4), 5)
AWI 206-8	AU232LF	917	63° 15.51' S 051° 49.59' W	277	2013-01-14	3:07	22	--	6)
	SV0002	917	63° 15.51' S 051° 49.59' W	907	2013-01-14	4:33	48	--	2)
AWI 251-1	SV1008	320	61° 00.88' S 055° 58.53' W	212	2013-01-16	2:10	48	--	1),4)
	AU231LF	320	61° 00.88' S 055° 58.53' W	210	2013-01-16	2:10	22	--	6)

1) Sampling: 5.3 kHz/24 bit, continuously, file duration 600 s 2)96 kHz/24 bit, Subsampling: 5 minutes every 2 hours 3) CFG: Clock section setting A, 4) CFG: Clock section setting B; All: No Precision Clock; 5) sampling: 9.6 kHz/24 bit, continuously, file duration 600 s; 6) Sampling: 32 kHz/16 bit, subsampling: 5 minutes every hour

Moorings AWI 206-8 and AWI 251-1 include both an AURAL and a SonoVault (Figure 5.11). The SonoVault SV0002 in AWI 206-8 was programmed to record in duty cycle mode, recording five minutes every two hours with a sampling rate of 96 kHz. As this is the first time a SonoVault was deployed with such a high sampling rate, this set-up primarily serves as a first comparison of SonoVault recordings with those of the AURAL. Mooring AWI251-1, off Elephant Island, contains one additional SonoVault sampling with the standard settings (5.3 kHz, continuously). This set-up will allow comparison of acoustic data collected simultaneously at the same location with different recording parameters (e.g., scheduled vs. continuous recording mode). For further detailed information on deployment settings see Table 5.6.

Prior to deployment, all SonoVaults were fitted with the latest analog front-end electronic version V3.3. Additionally, the microprocessors of all recorders were flashed with a newer firmware V3.11. Two versions of recording modules were used in the acoustic recorders: newer SonoVaults (SV1025, SV1029-SV1034) use recording module electronics version V1.5, all other units are equipped with version V1.2, which is also supported by the new analog front-end. Firmware versions for the recording modules, V3.11_N for V1.2 and V3.11_A for V1.5, are adapted to the hardware. After flashing the microprocessors, all implemented functions (e.g., changing parameter settings, downloading the configuration and retrieve system information) were tested. Subsequently, a test recording was started in the laboratory on board. For all SonoVaults, the electronics proved functional. Before deployment all SDHC cards were formatted in FAT32. On the first SD card (S0) of the first of five recording modules (M0-M4), the recording configuration (e.g., gain setting, sample rate) was stored. Additionally, the module number was copied onto S0 of every module to make them available for storage.

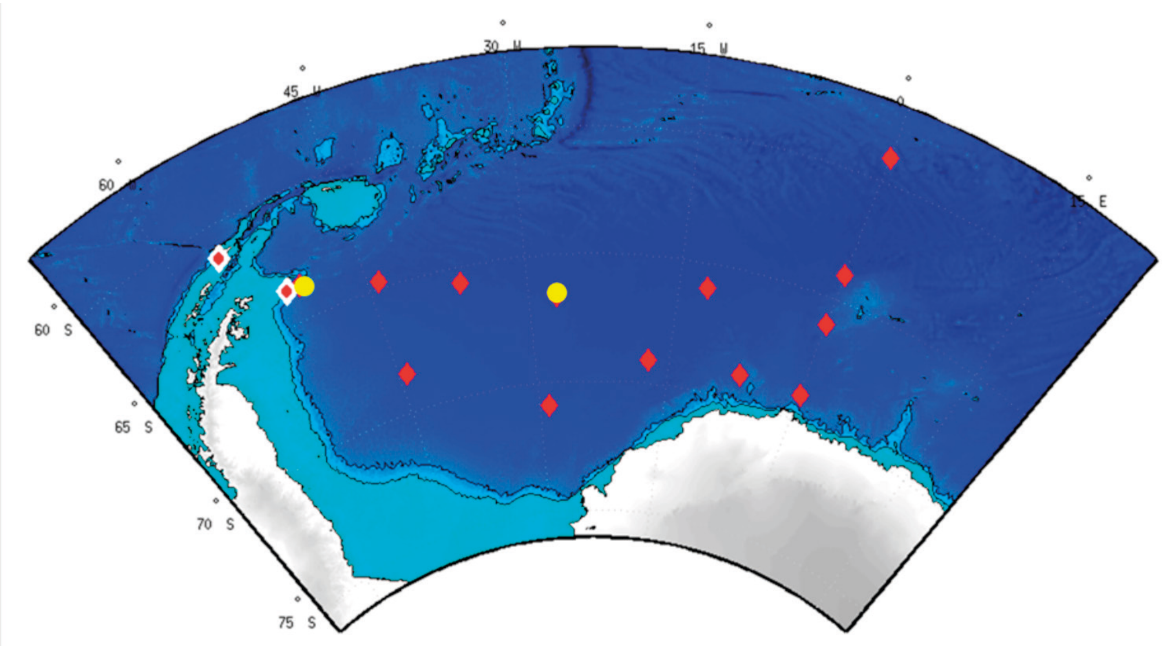

Fig. 5.11: Map showing the locations where passive acoustic recorders were deployed during ANTXXIX/2. Red diamonds indicate positions where single SonoVaults were moored, yellow dots indicate moorings with three SonoVaults and red diamonds with a white outline indicate moorings with both an AURAL and a SonoVault.

With one exemplary set of electronics a test was performed to check the transitions between SDHC cards and recording modules. It took about a week with 96kHz and 24bit sampling to reach the storage capacity of one recording module. Data were properly written to the SDHC and module transitions ran smoothly. Furthermore, some of the SonoVaults were used during sound source calibration, which served as an additional functional test. All resulting sound files were of good quality with no apparent electronic noise.

Two SonoVaults, SV1008 recovered during ANT-XXIX/1 and SV0002 recovered in the beginning of this cruise, were refurbished for redeployment and were handled the same way as the new recorders.

Two new AURAL recorders were equipped with two lithium battery packs each containing 64 LS33600. The new version of this recorder is equipped with two 320 GB hard drives, four times as much as the former version of the AURAL. The AURAL recorders were programmed to sample with 32 kHz for five minutes every hour. Test recordings were made in the lab with both AURALs. The previous version of the AURAL that we deployed in 2008 and 2010, was found to have a software bug causing regular drop-outs during recording. Dropouts occurred while files were being copied from the CF card to the HDD. Tests in the lab showed that this has been solved for the newer generation AURAL.

Preliminary results

Preliminary technical evaluation

During the ANTXXIX/2 expedition, we recovered 6 passive acoustic recorders. Unfortunately, two SonoVaults (SV1003 and SV1006), one AURAL (85LF) and three C-PODs were inaccessible due to heavy ice cover at the mooring location. These recorders will possibly be recovered in 2014. One SonoVault, SV1004, did not record as the power cable was presumably cut while closing the lid prior to deployment in 2010.

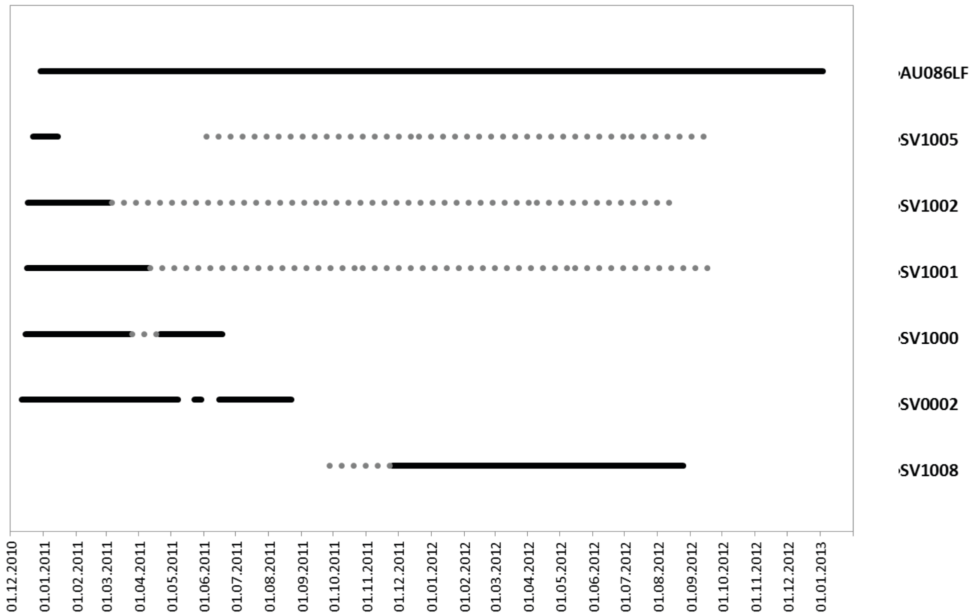

Fig. 5.12: Overview of acoustic data quality based on preliminary analysis of the recordings of the seven passive acoustic recorders. Black lines indicate good quality acoustic data, dotted lines indicate recordings with varying extent of electronic noise, blanks between lines indicate drop outs in the recordings.

None of the recovered recorders or the mooring frames showed signs of corrosion. The anodes, though, were mostly disintegrated.

The AURAL recorder was still operational upon retrieval; hence power supply and storage capacity can be concluded to be sufficient for a two year deployment in scheduled recording mode. All SonoVaults had stopped recording prior to retrieval. In most recorders (SV0002, SV1000, SV1001, SV1002), battery voltage was around 6 V upon recovery, which indicates that a problem with the power supply was the likely reason causing devices to stop recording. The cause of recording failures in SV1005 has yet to be determined.

Tab. 5.7: Overview of remarks regarding recording quality for acoustic recorders retrieved during ANTXXIX/2

Recorder	Recording period	Remarks
SV1008	2011.11.25 – 2012.08.25	Electronic noise in very last files that were recorded, likely related to battery power being too low.
SV0002	2010.12.11 – 2011.08.22	Gain 20dB too low Drop-outs: 2011.05.08 until 2011.05.22 and 2011.05.30 until 2011.06.14
SV1000	2010.12.15 – 2011.06.18	Electronic broadband noise below 20Hz (system or mooring?) Electronic pulses (0.1s interval) start 2011.03.25 until 2011.04.19
SV1001	2010.12.16 – 2012.09.17	Electronic noise (pulses 1.0s interval) start 2011.04.11 until 2012.01.04. From 2011.04.11 until end recording also irregular louder pulse sequences (frog-like sound) without clear cycle. Occur in the middle of file, sometimes several per file
SV1002	2010.12 – 2012.08	Loud electronic noise (pulses 1.0s interval) start 2011.03.06 until 2012.01.04. Louder pulse sequences (frog sound) occurs at same intervals and continues after throughout recording also after the 1.0s interval pulses have stopped. Loud electronic noise (pulses 0.1s interval) start 2011.04.24. Pulses present until end of recording (2012.08.14), only electronic noise in last recording.
SV1003	NA	No recovery; 100% ice coverage at mooring position
SV1005	2010.12.22 – 2011.01.14 2011.06.03-2012.09.18	Good sound until 2011.01.14, followed by dropout until 2011.06.03. From 2011.06.03 until end electronic noise (1.0s interval pulses), no sounds seem to have been recorded.
SV1004	NA	No recordings, power cable was damaged by lid
AU086LF	2010.12.29-2013.01.03	Recordings have regular dropouts, likely caused by an error during transition from files from CF to HDD. Dropout files contain no sounds, are 12Kb in size and occur in cycles of every 3,9,3,9 etc files.
SV1006	NA	No recovery; 100% ice coverage at mooring position
AU085LF	NA	No recovery; 100% ice coverage at mooring position

Four of the 6 recovered SonoVault recorders contained electronic noise in the form of regular pulses occurring at 1.0s and/or 0.1s intervals (SV 1000, 1001, 1002 and 1005, see Table 5.7, Figure 5.12). Furthermore, the occurrence of the pulsed noise was in some of the recorders accompanied by louder pulsed sequences which occurred irregularly throughout files (referred to as the 'frog-like-sound' in Table

5.7). It is vital to the overall usability of the data that the cause of these issues is identified and fixed, as the noise dominates recordings in some cases or recorders have failed to record any sound at all except internal electronic noise (e.g., SV1002, Table 5.7, Figure 5.12). The occurrence of electronic noise does not seem related to SDHC or module transitions as noise occur throughout the recordings without a clear pattern. Furthermore, SV1008 also contained electronic noise in the very last files that were recorded which was likely related to low battery power. However, this was a completely different type of electronic noise. This, along with the fact that the occurrence of the electronic noise did not seem to affect overall recording time of the recorders, leaves it unlikely that noise is related to issues with power supply of the recorder.

Preliminary scientific results

For the acoustic recorders retrieved during this expedition (6 recorders in total) and the SV1008 that was retrieved during the previous cruise leg, long-term spectrograms over the entire recording period were calculated in MatLab™ (Figure 5.13). These six long-term spectrograms formed the basis for a preliminary analysis of the acoustic data (totalling around 53,000 hours) to explore technical quality of the recordings and the occurrence of distinct acoustic events (e.g., temporally dominant frequency bands, repetitive loud events, Figure 5.12). More detailed information on data quality and the acoustic sources creating distinct acoustic events in the long-term spectrogram was obtained by inspecting spectrograms of single files (i.e., 5 min and 10 min files for Aural and SonoVault recorders, respectively). Selection of single files was largely balanced across the year.
For each recorder, the total number of different marine mammal species that was found acoustically present in the recordings was combined in preliminary biodiversity maps to obtain a first overview of spatial differences in species composition (Figure 5.14).

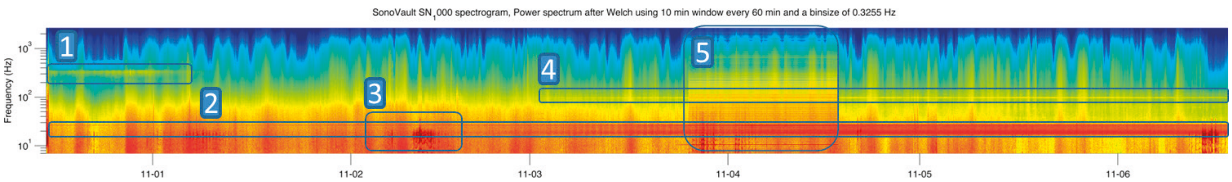

Fig. 5.13: Longterm spectrogram of SV1000 showing 1) acoustic presence of leopard seals, 2) the Antarctic blue whale chorus, 3) seismic activity, 4) fin whale chorus, 5) electronic noise. The x-axis indicates the recording period from December until June 2011.

All the recorders that were recovered in the Southern Ocean recorded leopard seals and the Antarctic blue whale chorus. The bioduck (a very characteristic repetitive pulsed sound produced by an unknown source) was present on all, but the recorder closest to the Antarctic continent. However, this recorder only recorded sounds during the first few months after deployment, the period during which the bioduck signal was also absent in the other recorders. Fin and humpback whale calls were present on almost all recorders. Calls of Ross and crabeater seals were present only on the southernmost SonoVault and the Aural recorder.

The Aural recorder that was recovered on 01.01.2013 was still operating until manually switched off on deck after retrieval. The last audio file that was still relatively devoid of the noise of *Polarstern* approaching was recorded on 01.01.2013 at 1:00AM. The recordings contained calls of leopard and Ross seals and a faint energy band at 28Hz, indicative of a distant Antarctic blue whale chorus. Leopard and Ross seals were also visually sighted hauled out on the ice in this area on 31.12.2012 and 01.01.2013. Interestingly, crabeater seals and minke whales were the species that was seen most often during these two days, but were not present in the last acoustic recordings. For crabeater seals, this might be explained by the fact that calls are likely only produced during the breeding season from August to December. Recordings from September to November from this Aural were found to contain crabeater seal calls.

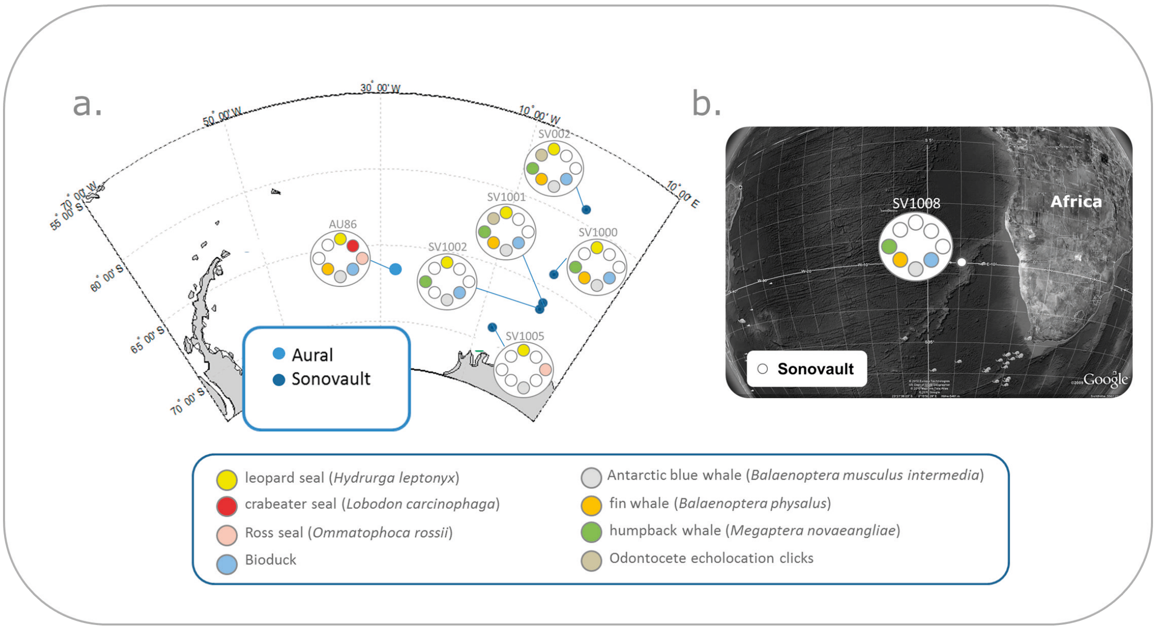

Fig. 5.14: Preliminary marine mammal acoustic biodiversity maps showing the species composition for a) the six recorders that were recovered in the Southern Ocean, and b) the recorder that was retrieved during ANTXXIX/1 on the northern edge of Walvis Ridge in the Southern Angola Basin.

For the SonoVault that recorded on the northern edge of Walvis Ridge in the Southern Angola Basin, the calls of fin, Antarctic blue and humpback whales were found to be present. Humpback whale calls occurred in structured sequences indicative of song. Interestingly, the bioduck signal was also found to be present in these recordings, which contradicts the hypothesis that the signal is produced by Antarctic minke whales (*Balaenoptera bonaerensis*) to probe ice thickness (Van Opzeeland et al., 2010). Antarctic minke whales are still a likely source producing the signal, given that this species is known to produce sounds comparable in structure in the North and no acoustic signature has as yet been attributed to these species in the Southern Ocean (Rankin & Barlow, 2005). Throughout the year, the soundscape at this recording location was furthermore dominated by airgun sounds.

We emphasize that these results base on a first very coarse analysis of the passive acoustic data and that it cannot be excluded that the maps presented here do not reflect full local marine mammal biodiversity.

Data management

All passive acoustic data will be transferred to the AWI silo and made accessible through the Pangaea database. P.I.: Ilse van Opzeeland.

References

Van Opzeeland IC, Van Parijs SM, Kindermann L, Boebel O (2010) Seasonal patterns in Antarctic blue whale (Balaenoptera musculus intermedua) vocalizations and the bioduck signal. Appendix 8, PhD Thesis, University of Bremen.

Rankin S, Barlow J (2005) Source of the North Pacific 'boing' sound attributed to minke whales. Journal of the Acoustical Society of America, 118, 3346-3351.

6. PUBLIC RELATIONS

6.1 Breaking Ice: A 6-part TV series on research ice breakers

Brian Cimagala, Marcus Lehmann Pipeline39

Objectives

Produce a 6 episode, half-hour series (6 x 30 min) for The Weather Channel that documents the work and life on board polar icebreakers. The series will feature the U.S. Coast Guard Cutter Healy and the German research vessel *Polarstern*.

Work at sea

Film the 7-week ANT-XXIX/2 research and resupply expedition from Cape Town to Neumayer Station to Punta Arenas, documenting the following:

- *Polarstern*'s journey from South Africa to Antarctica and finally to Chile, cutting through rough seas and thick ice. Our specific focus highlighted the tremendous efforts and skill necessary to overcome difficult challenges in order to accomplish the research and resupply mission for the ANT-XXIX/2 expedition.
- Our camera work included 10 hours of helicopter flights to film aerials of the journey: *Polarstern* cutting through open water and breaking sea ice; the vessel approaching the Antarctic ice shelf; shots of Neumayer Station, and other landmarks along the way, like Bouvet Island.
- Deployment of 10 Ocean Bottom Seismometers by Vera Schlindwein and her team around the Southwest Indian Ridge.
- Recovery and deployment of the moorings by Matthias Monsees, Gerd Rohardt, Olaf Boebel and the oceanography team.
- Deployment of various ARGO floats, sound sources and CTDS.
- Visual observation work being conducted by the Belgian team on birds and marine mammals, led by Dominique Verbelen.
- Continued development of automated 360-degree thermal whale detection system by Olaf Boebel's team, focusing on Daniel Zitterbart's contributions to the project.
- Visiting the Emperor Penguin colony at Atka bay with Daniel Zitterbart to see the site of his planned observation station.
- Various depictions of life on board the vessel, including the preparation of meals, the celebration of holidays, medical treatment, etc..
- The 3-day Neumayer resupply mission on the Antarctic ice shelf.

Altogether, the team filmed approximately 260 hours of footage.

Preliminary results

N/A

Data management

The film team regularly managed the digitally-recorded footage and images, downloading files onto Rugged Hard Drives; backing up onto G-Raid drives; and then converting the raw data into HD footage, which were placed on another set of G-Raid drives.

Approximately 6 TB of raw footage was collected, another 6 TB used for back up, and 6 TB of HD footage was produced. (We were unable to convert all raw materials to HD footage during the expedition due to a lack of drive space.).

Videoclips of the journey are available under:

http://www.weather.com/tv/tvshows/breaking-ice/video/icy-swim-36694?collid=/tv/shows/breaking-ice

The AWI-department of communications and media relations does have copies of the film as DVDs.

6.2 AWI photo and video archive

Lars Grübner, Folke Mehrtens AWI

Objectives

For quite some time the AWI-department of communications and media relations has been in need of photo and video files recorded at high resolution. These images are used to inform the general public about AWI's work and infrastructures, for example via the AWI homepage, the institute's Facebook website, Twitter, and the AWI YouTube channel. Other important target groups are scientific and daily journalists, political decision makers, the institute's funding agencies (Federal ministry of Education and Research, Senator for Education and Science of the State of Bremen, Ministry for Education, Science, Research and Culture of the State of Schleswig-Holstein, Ministry for Science, Research and Culture of the State of Brandenburg) and the Helmholtz Association. Furthermore the communications department supplies images for internal use, for example for presentations held by AWI staff, such as talks and posters, publications of the AWI, and by providing an adequate setting for AWI rooms and events.

Special emphasis was given on aerial shots, as a former team of photo and video journalists did not have the possibility to conduct helicopter flights during the *Polarstern* expedition ANT-XXVIII/2 in 2011/11.

The gathering of insights on work and life on board *Polarstern* and during the supply of Neumayer Station aimed at enabling the communications officers to give first hand information to journalists, artists or other future non-scientific expedition participants, who are regularly supported with detailed information.

Work at sea

The communication team produced a total of 1.5 TB of video-footage and photo material. We accompanied all scientific projects, the crew's work, and events on board taking both video and photo footage. A total of ten flights (9:59 hours) were conducted to portrait *Polarstern* in different surroundings (open water, sea ice, polynyas, icebergs, and the shelf ice edge) and under varying weather conditions (Table 6.1). One flight (1:27 hours) was conducted during the supply of Neumayer Station to portrait the station and the supply operations.

Tab. 6.1: Flights conducted by the AWI-communications-team

Date	Start [time UTC]	Duration [hours]
2012-12-07	09:45	00 :43
2012-12-13	14:45	00:37
2012-12-19	10:30	00:55
2012-12-20	10:15	01:08
2012-12-22	09:30	01:27
2012-12-29	11:00	00:54
2013-01-06	12:45	00:36
2013-01-11	07:00	01:14
2013-01-11	14:30	00:32
2013-01-15	18:45	00:53

A visit of the penguin colony near Neumayer Station on 23 December 2012 provided photos and information for a press release on the SPOT-project, which will be published in the end of January 2013.

We edited 17 time-lapse videos from photos taken by S. Menze, showing *Polarstern* breaking ice, approaching the shelf ice in Atka Bay, supplying Neumayer Station.

We already provided first packages of video-footage to the colleagues from the US film-production Pipeline 39, who we collaborated with, for example by covering certain scientific projects from different camera positions.

Preliminary results

One video produced on board and an online photo gallery of the ship's guest books were transferred to the AWI-communications department in Bremerhaven, supporting reporting on *Polarstern's* 30th anniversary as well as activities around Christmas and New Year. The communications team gave two telephone interviews to German radio stations, further interviews with the captain and scientific cruise members were arranged.

Numerous discussions with crewmembers and scientific expedition participants allowed us to gain insights in and understanding of their work. Experiencing Antarctica ourselves enables us to report much more authentically during our future work at the AWI.

Data management

The photo and video data will be stored on a 40 TB-QNAP-Server in the communications department at the AWI in Bremerhaven. Photos and videos will be provided on demand by the Digital Asset Management System Cumulus in the future. All material will be offered under the AWI terms of use (www.awi.de/de/aktuelles_und_presse/bild_film_ton/nutzungsbedingungen/).

6.3 „Coole Klassen" outreach activity for school teachers

Sabine Brosch Schickhardt Gymnasium

Objectives

A very unique chance for teachers is the vocational education by attending polar expeditions such as ANT-XXIX/2, which provides deep insights into current scientific issues. Based on these experiences and knowledge, the school will be able to develop a new and authentic science class based on polar topics. The class will be taught on an interdisciplinary basis to accustom the students with the importance of multidisciplinary research in earth and biological sciences.

Generally, many activities at the Schickhardt Gymnasium during this period revolved around my participation in ANT-XXIX/2, using it as motivation to study various aspects related to the polar environment:

- Different topics about the polar regions including the expedition were taught in grades 5, 6 and 7. This resulted in many questions by the students which I brought onboard of *Polarstern* to get them answered by the scientists in the internet blog.
- Postcards and letters were written and mailed home from *Polarstern*.
- Polar animals were molded in art classes.
- Within the module "construction" in science classes, students built Neumayer Station and *Polarstern* using paper as construction material.
- Lessons about climate issues and oceanic currents in grade 10 in combination with grade 7 as team-teaching. (The 10^{th} graders present and explain to the 7^{th} graders in small groups what they have been taught).
- Movable wall providing information about the AWI, Cool Classes, *Polarstern* and Neumayer Station III using AWI posters and information brochures, posters designed by students about polar night and day, different animals living in the Arctic and Antarctic.
- Daily update of what's happening on *Polarstern*. One of the 7th grades is in charge and takes care of this movable wall which is situated in the school's entrance hall.

Pre-cruise preparation

- Setting up of a blog on the internet (www.schickhardt.net/polarstern)
- Sharing of the URL via the school's homepage, the parent's webpage, facebook

Work at sea

Due to taking part in the CTD watch as well as ice-watch, tank- and heli-watch, I had the chance to experience different parts of the scientific work and work in general on a research vessel. I experienced working in shifts. Therefore I was quickly integrated as a team member in everyday activities and was able to get easily into contact with people. The teamwork was enriching and joyful.

Between the watches I still had enough time for the daily internet blogging including all the research that comes along with it, taking pictures and talking to people like the chief scientist, the captain, scientists, mates, the doctor, the cooks, seamen and the engineers and writing about the different scientific projects, the different working areas on the vessel and the daily routine as well as life onboard.

The scientists answered the student's questions very detailed and with pleasure. I also commented on questions in the blog and had the chance to make a phone call to the Schickhardt Gymnasium together with Vera Schlindwein. I also called the museum of natural history in Bad Dürkheim which was initiated by Monika Kallfelz, a teacher who participated last year (ANT XXVIII/2).

First results

The feedback about the daily blog was without exception very positive. Students, teachers, parents, friends, acquaintances, even some participants of the expedition as well as their relatives followed the blog enthusiastically and with great interest. The articles were talked over with some classes and used for further teaching. People are still thanking me for all the information provided and the insight they gained into an unknown but exciting and fascinating environment. Therefore the expedition was not just for me a superb experience but also for everybody else who took part indirectly from far away.

The opportunity for teachers to participate in such expeditions is a once in a lifetime experience and therefore a unique chance. Besides the personal experiences it has a highly motivating effect on the students, their parents as well as the teacher colleagues. The Schickhardt Gymnasium is ever since infected with the Antarctica fever, in a state of euphoria and excited to learn more about Antarctica and everybody is very interested in seeing more pictures and video clips which will be presented at my school within a series of events called the Kultur Café.

Starting in the following May my team of teachers and I are going to plan the upcoming school year, particularly the climate module mentioned in my application which will be partly based on materials I received from scientists during the expedition (such as instructions how to build a seismometer or hydrophone and material on meteorology). If the module turns out to be successful it is going to be integrated in the school curriculum on a long term basis.

In order to keep the direct contact to the scientific activity, even though when I am not taking part in an expedition, I hopefully will stay in tough with Barbara Fiedel (and maybe some other scientists) who is overwintering on Neumayer this year and who was born and raised in Herrenberg. I invited her to visit the Schickhardt Gymnasium after she returns from Antarctica. Maybe we even manage to call her on a regular basis at Neumayer while she is staying there. Then the students could continue blogging about what is going on in Antarctica.

My teacher colleagues, the students and the parents are highly motivated and are looking forward to the lessons about fascinating Antarctica. Therefore I judge the output of a teachers' participation on an expedition with *Polarstern* enormously high since I have never experienced such a wave of enthusiasm, positive feedback and curiosity at my school. The polar region itself plus my authentic reporting and enthusiasm, causes an intrinsic motivation by the students, about which we teachers have learned a lot in theory, but which can be experienced very rarely in everyday life. In my opinion as many teachers as possible should get the opportunity to participate together with their schools in the Cool Classes project.

With this is mind, a very warm thank you to everybody in charge at the AWI who helped to make this project happen which gives us teachers the chance to get insight into highly topical scientific work taking place at the end of the world. I will always keep the expedition in good memory and like to remind myself of the great time I had onboard of *Polarstern*.

Data management

N/A

References

Gäubote Herrenberg, 24.11.2012: Wie ein Sechser im Lotto: http://www.gaeubote.de/gb_10_110186631-24-61191_Wie-ein-Sechser-im-Lotto-.html?GBID=71737b9a44e61f93b2c96cd2f0232900

Stuttgarter Zeitung, 30.11.2012, S. 23 (Kreis Böblingen): Auf dem Schiff ins ewige Eis.

A.1 PARTICIPATING INSTITUTIONS

	Address
AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung in der Helmholtz-Gemeinschaft Am Handelshafen 12 27570 Bremerhaven / Germany
BAW	Bundesanstalt für Wasserbau, Dienststelle Hamburg Wedeler Landstraße 157 22559 Hamburg /Germany
DWD	Deutscher Wetterdienst Seeschifffahrtsberatung Bernhard-Nocht Strasse 76 20359 Hamburg / Germany
FZ-Jülich	Forschungszentrum Jülich GmbH, Außenstelle Warnemünde Seestraße 15 18119 Rostock-Warnemünde / Germany
Heliservice	HeliService International GmbH, Deutschland Am Luneort 15 27572 Bremerhaven / Germany
INIDEP	Instituto Nacional de Investigación y Desarrollo Pesquero (National Institute for Fishery Research and Development-INIDEP) Paseo Victoria Ocampo Nro.1, CC 175 Playa Grande 7600 Mar del Plata / Argentina
Laeisz	Reederei F. Laeisz (Bremerhaven) GmbH Brückenstrasse 25 27568 Bremerhaven / Germany
OPTIMARE	OPTIMARE Sensorsysteme AG Am Luneort 15A 27572 Bremerhaven / Germany
PolE	Laboratory for Ecotoxicology and Polar Ecology Free University of Brussels Pleinlaan 2 B-1050 Brussels / Belgium
Schickhardt-Gymnasium	Schickhardt-Gymnasium Im Längenholz 2 71083 Herrenberg / Germany
Pipeline 39	PIPELINE39 Entertainment 39 Broadway, 3rd floor New York, NY 10006 / USA
Uni Erlangen-Nuremberg	University Erlangen-Nürnberg Lehrstuhl fuer phys-med. Technik Henkestrasse 91 91052 Erlangen / Germany

A.2 CRUISE PARTICIPANTS

Last name	First name	Institute	Profession
Boebel	Olaf	AWI	Oceanographer
Bombosch	Annette	AWI	Biologist
Brauer	Jens	Heliservice Intl. GmbH	Inspector/Pilot
Brosch	Sabine	Schickhardt- Gymnasium	Teacher
Cammereiri	Alejandro	AWI	Biologist
Cimagala	Brian	Pipeline 39	Journalist
D‘Hert	Diederik	PolE	Biologist
Gall	Fabian	Heliservice Intl. GmbH	Mechanic
Gossler	Jürgen	AWI	Technician
Graupner	Rainer	Optimare	Technician
Grübner	Lars	AWI	Media Designer
Guerrero	Raul Alfredo	INIDEP Mar del Plata	Oceanographer
Heckmann	Hans	Heliservice Intl. GmbH	Pilot
Hempelt	Juliane	DWD	Technician
Jeppe	Thomas	BAW Hamburg	Engineer
Korger	Edith	AWI	Geophysicist
Lebrun	Raphaël	PolE	Biologist
Lefering	Katerina	AWI	Student, Geosciences
Lehmann	Marcus	Pipeline 39	Photograph
Machner	Nina	AWI	Logistician
Mehrtens	Folke	AWI	Press officer
Menze	Sebastian	AWI	BSc Maritime Technologies
Monsees	Matthias	AWI	Technician
Nowatzki	Eva	AWI	Student, Geosciences
Preis	Loretta	AWI	Student, Geosciences
Raeke	Andreas	DWD	Technician
Rentsch	Harald	DWD	Meteorologist
Rettig	Stefanie	AWI	BSc Maritime Technologies
Richter	Sebastian	Uni Erlangen	Physicist
Rohardt	Gerd	AWI	Oceanographer
Rohardt	Frederike	AWI	Student, Geosciences
Schlindwein	Vera	AWI	Geophysicist
Thomisch	Karolin	AWI	Biologist
Van Opzeeland	Ilse	AWI	Biologist
Vaupel	Lars	Heliservice Intl. GmbH	Pilot
Verbelen	Dominique	PolE	Biologist
Wei	Wei	AWI	Oceanographer
Zahn	Wolfgang	FZ-Jülich	Oceanographer
Zitterbart	Daniel	AWI	Physicist

A.3 SHIP'S CREW

Name		Rank
Pahl	Uwe	Master
Grundmann	Uwe	1.Offc.
Farysch	Bernd	Ch. Eng.
Fallei	Holger	2. Offc.
Lesch	Florian	2.Offc.
Rackete	Carola	3.Offc.
Pohl	Claus	Doctor
Hecht	Andreas	R.Offc.
Sümnicht	Stefan	2.Eng.
Minzlaff	Hans-Ulrich	2.Eng.
Holst	Wolfgang	3. Eng.
Scholz	Manfred	Elec.Tech.
Dimmler	Werner	Electron.
Hüttebräucker	Olaf	Electron.
Nasis	Ilias	Electron.
Himmel	Frank	Electron.
Loidl	Reiner	Boatsw.
Reise	Lutz	Carpenter
Scheel	Sebastian	A.B.
Brickmann	Peter	A.B.
Winkler	Michael	A.B.
Hagemann	Manfred	A.B.
Schmidt	Uwe	A.B.
Guse	Hartmut	A.B.
Wende	Uwe	A.B.
Bäcker	Andreas	A.B.
Preußner	Jörg	Storek.
Teichert	Uwe	Mot-man
Schütt	Norbert	Mot-man
Elsner	Klaus	Mot-man
Voy	Bernd	Mot-man
Pinske	Lutz	Mot-man
Müller-Homburg	Ralf-Dieter	Cook
Silinski	Frank	Cooksmate
Martens	Michael	Cooksmate
Czyborra	Bärbel	1.Stwdess
Wöckener	Martina	Stwdss/KS
Gaude	Hans-Jürgen	2.Steward
Silinski	Carmen	2.Stwdess
Arendt	Rene	2.Steward
Möller	Wolfgang	2.Steward
Sun	Yong Shen	2.Steward
Yu	Kwok Yuen	Laundrym.

A.4 STATION LIST

Station	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/20-1	02.12.2012	11:37:00	REL	on ground/ max depth	41° 0.81‘ S	16° 56.18‘ E	4677
PS81/20-2	02.12.2012	13:10:00	CAL	on ground/ max depth	41° 1.69‘ S	16° 52.61‘ E	4938
PS81/20-2	02.12.2012	13:10:01	CAL	profile start	41° 1.69‘ S	16° 52.61‘ E	4938
PS81/20-2	02.12.2012	13:45:00	CAL	profile end	41° 1.87‘ S	16° 50.63‘ E	5090
PS81/20-3	02.12.2012	14:25:00	CTD/RO	on ground/ max depth	41° 2.06‘ S	16° 48.11‘ E	4900
PS81/20-4	02.12.2012	15:44:00	REL	on ground/ max depth	41° 2.25‘ S	16° 44.38‘ E	4968
PS81/21-1	05.12.2012	10:53:59	OBS	on ground/ max depth	52° 1.14‘ S	13° 38.94‘ E	3422
PS81/22-1	05.12.2012	13:20:00	OBS	on ground/ max depth	52° 17.70‘ S	13° 45.82‘ E	3818
PS81/23-1	05.12.2012	14:53:59	OBS	on ground/ max depth	52° 18.65‘ S	13° 33.25‘ E	3972
PS81/24-1	05.12.2012	16:55:59	OBS	on ground/ max depth	52° 34.80‘ S	13° 50.33‘ E	2709
PS81/25-1	05.12.2012	19:31:59	OBS	on ground/ max depth	52° 32.96‘ S	13° 21.63‘ E	3690
PS81/26-1	05.12.2012	21:01:59	OBS	on ground/ max depth	52° 23.62‘ S	13° 15.75‘ E	4399
PS81/27-1	05.12.2012	22:25:59	OBS	on ground/ max depth	52° 14.56‘ S	13° 18.65‘ E	2973
PS81/28-1	06.12.2012	00:09:59	OBS	on ground/ max depth	52° 21.78‘ S	13° 4.18‘ E	3328
PS81/29-1	06.12.2012	01:18:59	OBS	on ground/ max depth	52° 29.82‘ S	13° 3.66‘ E	4203
PS81/30-1	06.12.2012	02:43:59	OBS	on ground/ max depth	52° 28.35‘ S	12° 50.07‘ E	4428
PS81/31-1	08.12.2012	04:56:00	CTD/RO	on ground/ max depth	54° 59.97‘ S	0° 0.22‘ E	1750
PS81/32-1	08.12.2012	09:54:00	CTD/RO	on ground/ max depth	55° 29.95‘ S	0° 0.11‘ E	3797
PS81/32-2	08.12.2012	10:25:00	CAL	on ground/ max depth	55° 29.94‘ S	0° 0.14‘ E	3772
PS81/32-2	08.12.2012	10:25:01	CAL	profile start	55° 29.94‘ S	0° 0.14‘ E	3772
PS81/32-2	08.12.2012	11:05:00	CAL	profile end	55° 29.98‘ S	0° 0.16‘ E	3767
PS81/32-3	08.12.2012	11:41:00	CAL	on ground/ max depth	55° 29.99‘ S	0° 0.06‘ E	3769
PS81/32-3	08.12.2012	11:42:00	CAL	profile start	55° 29.99‘ S	0° 0.06‘ E	3778
PS81/32-3	08.12.2012	12:16:00	CAL	profile end	55° 30.01‘ S	0° 0.07‘ E	3767
PS81/32-4	08.12.2012	12:38:00	CAL	on ground/ max depth	55° 29.96‘ S	0° 0.10‘ E	3773
PS81/32-4	08.12.2012	12:39:00	CAL	profile start	55° 29.96‘ S	0° 0.11‘ E	3768
PS81/32-4	08.12.2012	13:16:00	CAL	profile end	55° 29.95‘ S	0° 0.08‘ E	3772
PS81/32-5	08.12.2012	13:37:00	CAL	on ground/ max depth	55° 29.93‘ S	0° 0.30‘ E	3786
PS81/32-5	08.12.2012	13:38:00	CAL	profile start	55° 29.93‘ S	0° 0.30‘ E	3772

Station	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/32-5	08.12.2012	14:16:01	CAL	profile end	55° 29.75‘ S	0° 0.34‘ E	3760
PS81/32-6	08.12.2012	14:33:59	FLOAT	on ground/ max depth	55° 29.68‘ S	0° 0.41‘ E	3741
PS81/33-1	08.12.2012	19:12:00	CTD/RO	on ground/ max depth	56° 0.00‘ S	0° 0.44‘ E	3660
PS81/34-1	08.12.2012	23:23:59	FLOAT	on ground/ max depth	56° 29.83‘ S	0° 0.01‘ E	4072
PS81/35-1	09.12.2012	04:13:00	CTD/RO	on ground/ max depth	57° 0.02‘ S	0° 0.05‘ E	3671
PS81/36-1	09.12.2012	09:04:59	FLOAT	on ground/ max depth	57° 30.06‘ S	0° 0.06‘ E	3954
PS81/37-1	09.12.2012	15:00:00	CTD/RO	on ground/ max depth	58° 0.15‘ S	0° 0.26‘ W	4547
PS81/38-1	11.12.2012	01:40:59	FLOAT	on ground/ max depth	58° 29.84‘ S	0° 0.08‘ E	4131
PS81/39-1	11.12.2012	06:25:00	MOR	on ground/ max depth	59° 3.41‘ S	0° 6.37‘ E	4656
PS81/39-2	11.12.2012	10:40:00	CTD/RO	on ground/ max depth	59° 3.09‘ S	0° 6.78‘ E	4647
PS81/39-3	11.12.2012	14:41:59	MOR	on ground/ max depth	59° 2.58‘ S	0° 4.96‘ E	4651
PS81/40-1	11.12.2012	18:17:59	FLOAT	on ground/ max depth	59° 30.13‘ S	0° 0.01‘ W	4656
PS81/41-1	11.12.2012	23:11:00	CTD/RO	on ground/ max depth	60° 0.03‘ S	0° 0.07‘ E	5362
PS81/42-1	12.12.2012	04:08:59	FLOAT	on ground/ max depth	60° 30.00‘ S	0° 0.04‘ E	5367
PS81/43-1	12.12.2012	09:28:00	CTD/RO	on ground/ max depth	60° 59.91‘ S	0° 0.87‘ W	5389
PS81/43-2	12.12.2012	11:27:00	CAL	on ground/ max depth	61° 0.45‘ S	0° 2.26‘ W	5381
PS81/43-2	12.12.2012	11:28:00	CAL	profile start	61° 0.46‘ S	0° 2.27‘ W	5381
PS81/43-2	12.12.2012	11:55:00	CAL	profile end	61° 0.74‘ S	0° 2.48‘ W	5379
PS81/43-3	12.12.2012	12:14:00	CAL	on ground/ max depth	61° 0.82‘ S	0° 2.81‘ W	5378
PS81/43-3	12.12.2012	12:15:00	CAL	profile start	61° 0.82‘ S	0° 2.82‘ W	5379
PS81/43-3	12.12.2012	12:46:00	CAL	profile end	61° 0.95‘ S	0° 3.22‘ W	5378
PS81/43-4	12.12.2012	13:03:00	CAL	on ground/ max depth	61° 1.05‘ S	0° 3.39‘ W	5378
PS81/43-4	12.12.2012	13:04:00	CAL	profile start	61° 1.06‘ S	0° 3.40‘ W	5378
PS81/43-4	12.12.2012	13:46:00	CAL	profile end	61° 1.24‘ S	0° 3.69‘ W	5379
PS81/43-5	12.12.2012	14:03:00	CAL	on ground/ max depth	61° 1.25‘ S	0° 3.81‘ W	5379
PS81/43-5	12.12.2012	14:03:01	CAL	profile start	61° 1.25‘ S	0° 3.81‘ W	5379
PS81/43-5	12.12.2012	14:46:00	CAL	profile end	61° 1.31‘ S	0° 3.92‘ W	5383
PS81/44-1	12.12.2012	18:19:59	FLOAT	on ground/ max depth	61° 30.07‘ S	0° 0.03‘ E	5390
PS81/45-1	12.12.2012	23:29:00	CTD/RO	on ground/ max depth	62° 0.21‘ S	0° 1.17‘ W	5371
PS81/46-1	13.12.2012	04:12:59	FLOAT	on ground/ max depth	62° 30.05‘ S	0° 0.02‘ E	5351
PS81/47-1	13.12.2012	09:17:00	CTD/RO	on ground/ max depth	63° 0.03‘ S	0° 0.59‘ E	5312

Station	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/47-2	13.12.2012	11:25:00	CAL	on ground/ max depth	62° 59.94‘ S	0° 0.58‘ E	5312
PS81/47-2	13.12.2012	11:28:00	CAL	profile start	62° 59.93‘ S	0° 0.60‘ E	5315
PS81/47-2	13.12.2012	11:56:00	CAL	profile end	62° 59.90‘ S	0° 0.74‘ E	5313
PS81/47-3	13.12.2012	12:14:00	CAL	on ground/ max depth	62° 59.96‘ S	0° 0.65‘ E	5312
PS81/47-3	13.12.2012	12:15:00	CAL	profile start	62° 59.95‘ S	0° 0.66‘ E	5312
PS81/47-3	13.12.2012	12:51:00	CAL	profile end	63° 0.04‘ S	0° 0.52‘ E	5314
PS81/47-4	13.12.2012	13:07:00	CAL	on ground/ max depth	62° 60.00‘ S	0° 0.55‘ E	5312
PS81/47-4	13.12.2012	13:07:01	CAL	profile start	62° 60.00‘ S	0° 0.55‘ E	5312
PS81/47-4	13.12.2012	13:41:00	CAL	profile end	63° 0.13‘ S	0° 0.37‘ E	5312
PS81/47-5	13.12.2012	13:57:00	CAL	on ground/ max depth	63° 0.14‘ S	0° 0.33‘ E	5312
PS81/47-5	13.12.2012	13:57:01	CAL	profile start	63° 0.14‘ S	0° 0.33‘ E	5312
PS81/47-5	13.12.2012	14:30:00	CAL	profile end	63° 0.28‘ S	0° 0.04‘ E	5311
PS81/47-6	13.12.2012	14:49:00	CAL	on ground/ max depth	63° 0.33‘ S	0° 0.09‘ W	5311
PS81/47-6	13.12.2012	14:49:01	CAL	profile start	63° 0.33‘ S	0° 0.09‘ W	5311
PS81/47-6	13.12.2012	15:30:00	CAL	profile end	63° 0.54‘ S	0° 0.51‘ W	5312
PS81/47-7	13.12.2012	16:04:00	CAL	on ground/ max depth	63° 0.70‘ S	0° 0.82‘ W	5311
PS81/47-7	13.12.2012	16:04:01	CAL	profile start	63° 0.70‘ S	0° 0.82‘ W	5311
PS81/47-7	13.12.2012	16:04:02	CAL	profile end	63° 0.70‘ S	0° 0.82‘ W	5311
PS81/47-8	13.12.2012	17:00:00	CAL	on ground/ max depth	63° 0.70‘ S	0° 1.09‘ W	5312
PS81/47-8	13.12.2012	17:01:00	CAL	profile start	63° 0.70‘ S	0° 1.09‘ W	5311
PS81/47-8	13.12.2012	17:01:01	CAL	profile end	63° 0.70‘ S	0° 1.09‘ W	5311
PS81/48-1	13.12.2012	21:36:00	CTD	on ground/ max depth	63° 29.92‘ S	0° 0.79‘ W	5246
PS81/48-2	13.12.2012	22:22:59	FLOAT	on ground/ max depth	63° 30.14‘ S	0° 0.21‘ W	5246
PS81/49-1	14.12.2012	03:14:00	CTD/RO	on ground/ max depth	63° 57.56‘ S	0° 3.12‘ W	5210
PS81/49-2	14.12.2012	08:44:59	MOR	on ground/ max depth	63° 60.00‘ S	0° 4.08‘ W	5208
PS81/49-3	14.12.2012	12:34:00	MOR	on ground/ max depth	63° 59.66‘ S	0° 2.67‘ W	5203
PS81/50-1	14.12.2012	13:36:00	MOR	on ground/ max depth	64° 4.90‘ S	0° 5.43‘ W	5193
PS81/51-1	14.12.2012	16:38:59	FLOAT	on ground/ max depth	64° 29.98‘ S	0° 0.08‘ W	4673
PS81/52-1	14.12.2012	21:45:00	CTD/RO	on ground/ max depth	64° 59.90‘ S	0° 0.26‘ W	3739
PS81/53-1	15.12.2012	01:58:59	FLOAT	on ground/ max depth	65° 29.54‘ S	0° 0.00‘ W	3876
PS81/54-1	15.12.2012	06:57:00	MOR	on ground/ max depth	66° 1.97‘ S	0° 2.45‘ E	3630
PS81/54-2	15.12.2012	10:59:00	CTD/RO	on ground/ max depth	66° 1.75‘ S	0° 3.12‘ E	3617

Station	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/54-3	15.12.2012	14:38:00	MOR	on ground/ max depth	66° 2.12' S	0° 2.98' E	3607
PS81/54-4	15.12.2012	15:12:00	CAL	on ground/ max depth	66° 2.33' S	0° 0.85' E	3633
PS81/54-4	15.12.2012	15:13:00	CAL	profile start	66° 2.33' S	0° 0.84' E	3633
PS81/54-4	15.12.2012	15:46:00	CAL	profile end	66° 2.35' S	0° 0.70' E	3632
PS81/54-5	15.12.2012	16:03:00	CAL	on ground/ max depth	66° 2.38' S	0° 0.56' E	3631
PS81/54-5	15.12.2012	16:03:01	CAL	profile start	66° 2.38' S	0° 0.56' E	3631
PS81/54-5	15.12.2012	16:36:00	CAL	profile end	66° 2.37' S	0° 0.68' E	3631
PS81/54-6	15.12.2012	17:25:00	CAL	on ground/ max depth	66° 4.17' S	0° 0.43' E	3591
PS81/54-6	15.12.2012	17:25:01	CAL	profile start	66° 4.17' S	0° 0.43' E	3591
PS81/54-6	15.12.2012	18:01:00	CAL	profile end	66° 4.17' S	0° 0.27' E	3595
PS81/54-7	15.12.2012	18:17:00	CAL	on ground/ max depth	66° 4.17' S	0° 0.23' E	3596
PS81/54-7	15.12.2012	18:17:01	CAL	profile start	66° 4.17' S	0° 0.23' E	3596
PS81/54-7	15.12.2012	18:51:00	CAL	profile end	66° 4.22' S	0° 0.19' E	3596
PS81/55-1	16.12.2012	03:24:00	CTD/RO	on ground/ max depth	66° 28.79' S	0° 1.21' W	4495
PS81/55-2	16.12.2012	04:42:00	MOR	on ground/ max depth	66° 29.00' S	0° 1.50' W	4496
PS81/55-3	16.12.2012	11:35:59	MOR	on ground/ max depth	66° 30.91' S	0° 0.48' W	4503
PS81/55-4	16.12.2012	11:47:59	FLOAT	on ground/ max depth	66° 30.91' S	0° 0.48' W	4506
PS81/56-1	16.12.2012	16:22:00	CTD/RO	on ground/ max depth	66° 59.70' S	0° 1.48' W	4712
PS81/57-1	16.12.2012	20:49:59	FLOAT	on ground/ max depth	67° 30.14' S	0° 0.12' W	4636
PS81/58-1	17.12.2012	01:25:00	CTD/RO	on ground/ max depth	67° 59.59' S	0° 0.63' E	4522
PS81/59-1	17.12.2012	07:39:00	CTD/RO	on ground/ max depth	68° 29.99' S	0° 0.15' W	4270
PS81/59-2	17.12.2012	09:00:59	FLOAT	on ground/ max depth	68° 29.99' S	0° 0.11' E	4269
PS81/60-1	17.12.2012	14:29:00	CTD/RO	on ground/ max depth	68° 44.91' S	0° 4.14' W	3460
PS81/61-1	18.12.2012	01:46:00	MOR	on ground/ max depth	69° 0.09' S	0° 1.42' W	3387
PS81/61-2	18.12.2012	05:59:00	MOR	on ground/ max depth	68° 59.86' S	0° 6.51' W	3364
PS81/61-3	18.12.2012	08:45:00	CTD/RO	on ground/ max depth	68° 59.14' S	0° 14.34' W	3382
PS81/62-1	18.12.2012	20:53:00	CTD/RO	on ground/ max depth	69° 10.87' S	0° 19.93' W	2752
PS81/63-1	19.12.2012	03:30:00	CTD/RO	on ground/ max depth	69° 21.50' S	0° 15.13' W	2052
PS81/64-1	20.12.2012	09:30:00	CAL	on ground/ max depth	69° 24.71' S	0° 56.44' W	2598
PS81/64-1	20.12.2012	09:30:01	CAL	profile start	69° 24.71' S	0° 56.44' W	2598
PS81/64-1	20.12.2012	10:00:01	CAL	profile end	69° 24.74' S	0° 57.06' W	2599

Station	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/64-2	20.12.2012	10:19:00	CAL	on ground/ max depth	69° 24.75‘ S	0° 57.44‘ W	2602
PS81/64-2	20.12.2012	10:19:01	CAL	profile start	69° 24.75‘ S	0° 57.44‘ W	2602
PS81/64-2	20.12.2012	10:56:00	CAL	profile end	69° 24.77‘ S	0° 58.20‘ W	2605
PS81/64-3	20.12.2012	11:14:00	CAL	on ground/ max depth	69° 24.77‘ S	0° 58.56‘ W	2607
PS81/64-3	20.12.2012	11:14:01	CAL	profile start	69° 24.77‘ S	0° 58.56‘ W	2607
PS81/64-3	20.12.2012	12:05:00	CAL	profile end	69° 24.78‘ S	0° 59.65‘ W	2620
PS81/64-4	20.12.2012	12:22:00	CAL	on ground/ max depth	69° 24.78‘ S	1° 0.01‘ W	2622
PS81/64-4	20.12.2012	12:22:01	CAL	profile start	69° 24.78‘ S	1° 0.01‘ W	2622
PS81/64-4	20.12.2012	13:01:00	CAL	profile end	69° 24.79‘ S	1° 0.88‘ W	2626
PS81/64-5	20.12.2012	13:38:00	CTD/RO	on ground/ max depth	69° 24.80‘ S	1° 1.71‘ W	2632
PS81/65-1	24.12.2012	15:24:00	CTD/RO	on ground/ max depth	70° 29.99‘ S	8° 9.44‘ W	270
PS81/66-1	25.12.2012	01:48:59	FLOAT	on ground/ max depth	69° 30.09‘ S	7° 0.15‘ W	3255
PS81/67-1	25.12.2012	08:01:00	MOR	on ground/ max depth	69° 0.32‘ S	6° 58.71‘ W	2944
PS81/67-2	25.12.2012	14:25:02	MOR	on ground/ max depth	69° 0.35‘ S	6° 58.97‘ W	2947
PS81/67-3	25.12.2012	15:49:00	CTD/RO	on ground/ max depth	69° 0.55‘ S	6° 56.17‘ W	2886
PS81/67-4	25.12.2012	16:46:59	FLOAT	on ground/ max depth	69° 0.69‘ S	6° 56.69‘ W	2891
PS81/68-1	25.12.2012	20:25:59	FLOAT	on ground/ max depth	68° 39.92‘ S	7° 34.58‘ W	3001
PS81/69-1	25.12.2012	23:38:59	FLOAT	on ground/ max depth	68° 20.04‘ S	8° 8.62‘ W	4252
PS81/70-1	26.12.2012	03:08:59	FLOAT	on ground/ max depth	67° 59.78‘ S	8° 47.66‘ W	4667
PS81/71-1	26.12.2012	05:51:59	FLOAT	on ground/ max depth	67° 40.11‘ S	9° 19.86‘ W	4861
PS81/72-1	26.12.2012	08:40:59	FLOAT	on ground/ max depth	67° 20.04‘ S	9° 55.86‘ W	4938
PS81/73-1	26.12.2012	11:48:00	CTD/RO	on ground/ max depth	66° 59.94‘ S	10° 29.84‘ W	4980
PS81/73-2	26.12.2012	12:14:00	CAL	on ground/ max depth	66° 59.86‘ S	10° 29.72‘ W	4980
PS81/73-2	26.12.2012	12:15:00	CAL	profile start	66° 59.85‘ S	10° 29.72‘ W	4980
PS81/73-2	26.12.2012	12:46:00	CAL	profile end	66° 59.73‘ S	10° 29.72‘ W	4980
PS81/73-3	26.12.2012	13:01:00	CAL	on ground/ max depth	66° 59.64‘ S	10° 29.76‘ W	4980
PS81/73-3	26.12.2012	13:02:00	CAL	profile start	66° 59.64‘ S	10° 29.76‘ W	4980
PS81/73-3	26.12.2012	13:40:00	CAL	profile end	66° 59.51‘ S	10° 29.36‘ W	4982
PS81/73-4	26.12.2012	13:57:00	CAL	on ground/ max depth	66° 59.42‘ S	10° 29.32‘ W	4980
PS81/73-4	26.12.2012	13:57:01	CAL	profile start	66° 59.42‘ S	10° 29.32‘ W	4980
PS81/73-4	26.12.2012	14:36:00	CAL	profile end	66° 59.26‘ S	10° 29.52‘ W	4980
PS81/73-5	26.12.2012	14:52:00	CAL	on ground/ max depth	66° 59.17‘ S	10° 29.49‘ W	4980

Station	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/73-5	26.12.2012	14:52:01	CAL	profile start	66° 59.17‘ S	10° 29.49‘ W	4980
PS81/73-5	26.12.2012	15:30:00	CAL	profile end	66° 58.99‘ S	10° 29.89‘ W	4980
PS81/73-6	26.12.2012	15:45:00	CAL	on ground/ max depth	66° 58.93‘ S	10° 29.97‘ W	4979
PS81/73-6	26.12.2012	15:45:01	CAL	profile start	66° 58.93‘ S	10° 29.97‘ W	4979
PS81/73-6	26.12.2012	16:20:00	CAL	profile end	66° 58.82‘ S	10° 30.05‘ W	4979
PS81/73-7	26.12.2012	16:35:59	FLOAT	on ground/ max depth	66° 58.83‘ S	10° 29.99‘ W	4979
PS81/74-1	26.12.2012	19:49:59	FLOAT	on ground/ max depth	66° 40.09‘ S	11° 0.85‘ W	5004
PS81/75-1	26.12.2012	23:11:59	FLOAT	on ground/ max depth	66° 20.07‘ S	11° 39.46‘ W	5024
PS81/76-1	27.12.2012	04:46:00	CTD/RO	on ground/ max depth	65° 58.35‘ S	12° 14.93‘ W	5051
PS81/76-2	27.12.2012	08:50:59	MOR	on ground/ max depth	65° 58.09‘ S	12° 15.12‘ W	5051
PS81/76-3	27.12.2012	09:05:59	FLOAT	on ground/ max depth	65° 57.98‘ S	12° 15.12‘ W	5052
PS81/77-1	27.12.2012	19:08:59	FLOAT	on ground/ max depth	67° 0.06‘ S	13° 50.94‘ W	4984
PS81/78-1	28.12.2012	03:59:59	FLOAT	on ground/ max depth	68° 0.57‘ S	15° 31.79‘ W	4908
PS81/79-1	28.12.2012	13:03:00	MOR	on ground/ max depth	69° 3.34‘ S	17° 23.67‘ W	4777
PS81/79-2	28.12.2012	21:02:02	MOR	on ground/ max depth	69° 3.47‘ S	17° 23.32‘ W	4778
PS81/79-3	28.12.2012	23:09:00	CTD/RO	on ground/ max depth	69° 4.27‘ S	17° 30.47‘ W	4776
PS81/79-4	29.12.2012	00:37:59	FLOAT	on ground/ max depth	69° 4.25‘ S	17° 31.96‘ W	4775
PS81/80-1	29.12.2012	07:21:59	FLOAT	on ground/ max depth	69° 29.98‘ S	19° 59.82‘ W	4694
PS81/81-1	29.12.2012	16:02:59	FLOAT	on ground/ max depth	69° 59.82‘ S	22° 55.78‘ W	4506
PS81/82-1	30.12.2012	00:11:59	FLOAT	on ground/ max depth	70° 26.38‘ S	25° 43.61‘ W	4456
PS81/83-1	30.12.2012	12:41:59	MOR	on ground/ max depth	70° 53.55‘ S	28° 53.47‘ W	4406
PS81/83-2	30.12.2012	14:50:00	CTD/RO	on ground/ max depth	70° 51.46‘ S	28° 55.30‘ W	4422
PS81/83-3	30.12.2012	16:24:00	CAL	on ground/ max depth	70° 51.32‘ S	28° 55.12‘ W	4423
PS81/83-3	30.12.2012	16:24:01	CAL	profile start	70° 51.32‘ S	28° 55.12‘ W	4423
PS81/83-3	30.12.2012	16:56:00	CAL	profile end	70° 51.24‘ S	28° 55.11‘ W	4423
PS81/83-4	30.12.2012	17:11:00	CAL	on ground/ max depth	70° 51.17‘ S	28° 55.07‘ W	4424
PS81/83-4	30.12.2012	17:11:01	CAL	profile start	70° 51.17‘ S	28° 55.07‘ W	4424
PS81/83-4	30.12.2012	17:45:00	CAL	profile end	70° 51.03‘ S	28° 55.10‘ W	4425
PS81/83-5	30.12.2012	18:01:00	CAL	on ground/ max depth	70° 50.97‘ S	28° 55.11‘ W	4425
PS81/83-5	30.12.2012	18:01:01	CAL	profile start	70° 50.97‘ S	28° 55.11‘ W	4425
PS81/83-5	30.12.2012	18:36:00	CAL	profile end	70° 50.81‘ S	28° 55.12‘ W	4427

Station	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/83-6	30.12.2012	18:52:00	CAL	on ground/ max depth	70° 50.76‘ S	28° 55.15‘ W	4427
PS81/83-6	30.12.2012	18:52:01	CAL	profile start	70° 50.76‘ S	28° 55.15‘ W	4427
PS81/83-6	30.12.2012	19:26:00	CAL	profile end	70° 50.71‘ S	28° 55.27‘ W	4428
PS81/83-7	30.12.2012	19:42:00	CAL	on ground/ max depth	70° 50.71‘ S	28° 55.33‘ W	4428
PS81/83-7	30.12.2012	19:43:00	CAL	profile start	70° 50.71‘ S	28° 55.33‘ W	4428
PS81/83-7	30.12.2012	20:47:00	CAL	profile end	70° 50.60‘ S	28° 55.75‘ W	4429
PS81/83-8	30.12.2012	21:05:59	FLOAT	on ground/ max depth	70° 50.48‘ S	28° 55.82‘ W	4431
PS81/84-1	31.12.2012	02:51:59	FLOAT	on ground/ max depth	70° 0.54‘ S	28° 28.92‘ W	4602
PS81/85-1	31.12.2012	09:47:59	FLOAT	on ground/ max depth	68° 59.61‘ S	27° 57.71‘ W	4699
PS81/86-1	31.12.2012	18:04:59	FLOAT	on ground/ max depth	68° 1.03‘ S	27° 33.74‘ W	4731
PS81/87-1	01.01.2013	02:06:59	FLOAT	on ground/ max depth	67° 0.14‘ S	27° 11.75‘ W	4839
PS81/88-1	01.01.2013	07:07:00	CTD/RO	on ground/ max depth	66° 38.76‘ S	27° 9.15‘ W	4873
PS81/88-2	01.01.2013	09:35:00	MOR	on ground/ max depth	66° 36.70‘ S	27° 7.33‘ W	4877
PS81/88-3	01.01.2013	15:05:01	MOR	on ground/ max depth	66° 36.45‘ S	27° 7.26‘ W	4876
PS81/89-1	02.01.2013	01:24:59	FLOAT	on ground/ max depth	66° 19.15‘ S	29° 56.20‘ W	4820
PS81/90-1	02.01.2013	10:38:00	CAL	on ground/ max depth	65° 59.93‘ S	32° 54.35‘ W	4801
PS81/90-1	02.01.2013	10:46:00	CAL	profile start	65° 59.91‘ S	32° 54.32‘ W	4801
PS81/90-1	02.01.2013	11:18:00	CAL	profile end	65° 59.96‘ S	32° 54.14‘ W	4800
PS81/90-2	02.01.2013	11:30:00	CAL	on ground/ max depth	65° 59.96‘ S	32° 54.07‘ W	4800
PS81/90-2	02.01.2013	11:31:00	CAL	profile start	65° 59.96‘ S	32° 54.07‘ W	4800
PS81/90-2	02.01.2013	12:00:01	CAL	profile end	65° 59.94‘ S	32° 53.92‘ W	4800
PS81/90-3	02.01.2013	12:19:00	CAL	on ground/ max depth	66° 0.04‘ S	32° 53.77‘ W	4800
PS81/90-3	02.01.2013	12:20:00	CAL	profile start	66° 0.04‘ S	32° 53.77‘ W	4800
PS81/90-3	02.01.2013	12:50:00	CAL	profile end	65° 60.00‘ S	32° 53.61‘ W	4800
PS81/90-4	02.01.2013	13:09:00	CAL	on ground/ max depth	65° 59.97‘ S	32° 53.47‘ W	4800
PS81/90-4	02.01.2013	13:10:00	CAL	profile start	65° 59.97‘ S	32° 53.46‘ W	4800
PS81/90-4	02.01.2013	13:50:00	CAL	profile end	65° 59.98‘ S	32° 53.19‘ W	4800
PS81/90-5	02.01.2013	14:32:00	CTD/RO	on ground/ max depth	65° 59.99‘ S	32° 52.83‘ W	4799
PS81/90-6	02.01.2013	14:43:59	FLOAT	on ground/ max depth	65° 59.88‘ S	32° 52.86‘ W	4799
PS81/91-1	03.01.2013	04:45:00	CTD/RO	on ground/ max depth	65° 37.27‘ S	36° 20.43‘ W	4779
PS81/91-2	03.01.2013	07:00:00	MOR	on ground/ max depth	65° 36.93‘ S	36° 25.36‘ W	4782
PS81/91-3	03.01.2013	13:19:01	MOR	on ground/ max depth	65° 37.23‘ S	36° 25.32‘ W	4782

Station	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/91-4	03.01.2013	13:26:59	FLOAT	on ground/ max depth	65° 37.24‘ S	36° 25.29‘ W	4782
PS81/92-1	03.01.2013	20:59:59	FLOAT	on ground/ max depth	66° 13.75‘ S	37° 59.96‘ W	4645
PS81/93-1	04.01.2013	06:53:59	FLOAT	on ground/ max depth	66° 59.91‘ S	40° 6.02‘ W	4546
PS81/94-1	04.01.2013	09:44:00	CTD/RO	on ground/ max depth	67° 15.57‘ S	40° 21.96‘ W	4510
PS81/94-2	04.01.2013	10:40:00	CAL	on ground/ max depth	67° 15.45‘ S	40° 22.40‘ W	4510
PS81/94-2	04.01.2013	10:40:01	CAL	profile start	67° 15.45‘ S	40° 22.40‘ W	4510
PS81/94-2	04.01.2013	11:11:01	CAL	profile end	67° 15.36‘ S	40° 22.63‘ W	4511
PS81/94-3	04.01.2013	12:10:00	CAL	on ground/ max depth	67° 15.24‘ S	40° 23.16‘ W	4511
PS81/94-3	04.01.2013	12:10:01	CAL	profile start	67° 15.24‘ S	40° 23.16‘ W	4511
PS81/94-3	04.01.2013	12:45:00	CAL	profile end	67° 15.16‘ S	40° 23.52‘ W	4512
PS81/94-4	04.01.2013	13:48:00	CAL	on ground/ max depth	67° 14.98‘ S	40° 24.23‘ W	4511
PS81/94-4	04.01.2013	13:48:01	CAL	profile start	67° 14.98‘ S	40° 24.23‘ W	4511
PS81/94-4	04.01.2013	14:05:00	CAL	profile end	67° 14.93‘ S	40° 24.43‘ W	4511
PS81/94-5	04.01.2013	15:01:00	CAL	on ground/ max depth	67° 14.78‘ S	40° 25.14‘ W	4511
PS81/94-5	04.01.2013	15:01:01	CAL	profile start	67° 14.78‘ S	40° 25.14‘ W	4511
PS81/94-5	04.01.2013	15:25:00	CAL	profile end	67° 14.73‘ S	40° 25.48‘ W	4512
PS81/95-1	04.01.2013	23:24:59	FLOAT	on ground/ max depth	67° 44.06‘ S	41° 59.95‘ W	4332
PS81/96-1	05.01.2013	14:53:01	MOR	on ground/ max depth	68° 28.95‘ S	44° 6.67‘ W	4144
PS81/96-2	05.01.2013	16:49:00	CTD/RO	on ground/ max depth	68° 30.04‘ S	44° 2.94‘ W	4151
PS81/96-3	05.01.2013	18:31:59	FLOAT	on ground/ max depth	68° 29.77‘ S	44° 2.93‘ W	4152
PS81/97-1	07.01.2013	00:45:59	FLOAT	on ground/ max depth	67° 10.22‘ S	44° 9.06‘ W	4111
PS81/98-1	08.01.2013	11:15:59	FLOAT	on ground/ max depth	65° 49.39‘ S	44° 27.59‘ W	4443
PS81/99-1	09.01.2013	01:37:00	CTD/RO	on ground/ max depth	64° 24.59‘ S	45° 57.47‘ W	4475
PS81/98-2	09.01.2013	05:00:00	MOR	on ground/ max depth	64° 23.99‘ S	45° 51.39‘ W	4468
PS81/99-3	09.01.2013	14:17:00	MOR	on ground/ max depth	64° 22.94‘ S	45° 52.12‘ W	4466
PS81/99-4	09.01.2013	14:28:59	FLOAT	on ground/ max depth	64° 22.83‘ S	45° 52.28‘ W	4466
PS81/100-1	09.01.2013	18:02:00	CTD/RO	on ground/ max depth	64° 19.31‘ S	46° 27.59‘ W	4429
PS81/101-1	09.01.2013	23:44:00	CTD	on ground/ max depth	64° 14.92‘ S	47° 1.31‘ W	4317
PS81/102-1	10.01.2013	04:43:00	CTD/RO	on ground/ max depth	64° 9.26‘ S	47° 29.81‘ W	4218
PS81/103-1	10.01.2013	11:40:00	CTD/RO	on ground/ max depth	64° 2.76‘ S	48° 16.56‘ W	4016

Station	Date	Time	Gear	Action	Position Lat	Position Lon	Water depth [m]
PS81/104-1	10.01.2013	17:47:00	MOR	on ground/ max depth	63° 55.47‘ S	49° 0.08‘ W	3596
PS81/104-2	11.01.2013	00:17:59	MOR	on ground/ max depth	63° 53.61‘ S	49° 5.17‘ W	3513
PS81/104-3	11.01.2013	01:55:00	CTD/RO	on ground/ max depth	63° 52.78‘ S	49° 8.05‘ W	3473
PS81/104-4	11.01.2013	03:08:59	FLOAT	on ground/ max depth	63° 52.68‘ S	49° 7.86‘ W	3471
PS81/105-1	11.01.2013	06:19:00	CTD/RO	on ground/ max depth	63° 52.47‘ S	49° 30.78‘ W	3345
PS81/106-1	11.01.2013	12:13:00	CTD/RO	on ground/ max depth	63° 50.87‘ S	50° 1.79‘ W	2918
PS81/107-1	11.01.2013	21:10:00	CTD/RO	on ground/ max depth	63° 46.36‘ S	50° 25.81‘ W	2673
PS81/108-1	12.01.2013	02:28:00	CTD/RO	on ground/ max depth	63° 43.65‘ S	50° 46.41‘ W	2569
PS81/108-3	12.01.2013	08:23:59	MOR	on ground/ max depth	63° 43.57‘ S	50° 51.64‘ W	2542
PS81/108-2	12.01.2013	12:55:59	MOR	on ground/ max depth	63° 42.09‘ S	50° 49.61‘ W	2557
PS81/108-4	12.01.2013	19:53:59	FLOAT	on ground/ max depth	63° 40.17‘ S	50° 52.22‘ W	2537
PS81/109-1	13.01.2013	03:58:00	CTD/RO	on ground/ max depth	63° 31.79‘ S	51° 20.77‘ W	2178
PS81/110-1	13.01.2013	20:21:00	CTD/RO	on ground/ max depth	63° 24.39‘ S	51° 39.01‘ W	1604
PS81/111-1	14.01.2013	04:03:00	CTD/RO	on ground/ max depth	63° 15.70‘ S	51° 49.66‘ W	965
PS81/111-2	14.01.2013	05:06:01	MOR	on ground/ max depth	63° 15.51‘ S	51° 49.59‘ W	936
PS81/112-1	16.01.2013	02:11:59	MOR	on ground/ max depth	61° 0.88‘ S	55° 58.53‘ W	319
PS81/113-1	16.01.2013	07:26:59	FLOAT	on ground/ max depth	60° 2.43‘ S	57° 27.19‘ W	1367
PS81/114-1	16.01.2013	12:45:59	FLOAT	on ground/ max depth	59° 1.42‘ S	59° 0.36‘ W	919

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