ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR-
UND MEERESFORSCHUNG

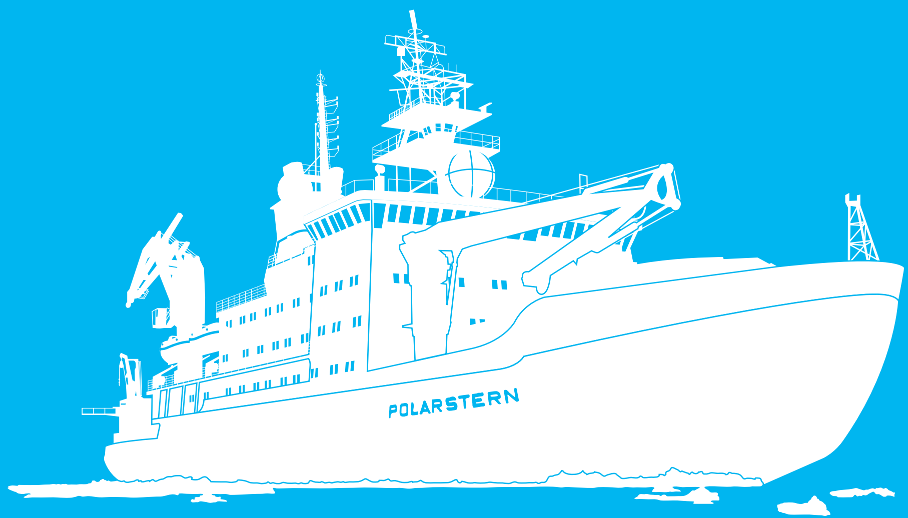
EXPEDITION PROGRAMME PS129

Polarstern

PS129
Cape Town - Cape Town
3 March 2022 - 28 April 2022

Coordinator: Ingo Schewe

Chief Scientist: Mario Hoppema



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The Expedition Programme *Polarstern* is issued by the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI) in Bremerhaven, Germany.

The Programme provides information about the planned goals and scientific work programmes of expeditions of the German research vessel *Polarstern*.
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PS129

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Cape Town – Stanley

Chief scientist
Mario Hoppema

Coordinator
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1. ÜBERBLICK UND FAHRTVERLAUF

Mario Hoppema DE.AWI

Die Expedition PS129 des deutschen Forschungsschiffs *Polarstern* soll Beiträge zu wissenschaftlichen Projekten aus den Bereichen physikalische Ozeanografie, Meeresbiologie und Meereschemie liefern; die Arbeiten zielen darauf ab, die Entwicklung der Wassermassen des Weddellmeers und der benachbarten Regionen zu verstehen sowie deren ökologischen und chemischen Kreisläufen. Diese Expedition ist eine Fortsetzung der langfristigen Zeitreihenarbeit im Rahmen des HAFOS Projekts (Hybrid Antarctic Float Observation System). HAFOS ist dem Klima, dem Ozean und der Ökosystem-Dynamik im Weddellwirbel gewidmet. Die HAFOS-Zeitreihe geht zurück bis auf die 1980/1990 er Jahre, insbesondere bezüglich der Hydrografie, der Nährstoffe, des gelösten Sauerstoffs und des CO_2-Systems. Ein weiterer Teil von PS129 befasst sich mit dem Eastern Weddell Sea Observation System (EWOS); das koordinierte und systematische Beobachtungen des sympagischen, pelagischen und benthischen Teils des Ökosystems des Weddellmeers umfasst. Die Expedition beinhaltet folgende Zielsetzungen und Subprojekte, die während der Expedition durchgeführt werden:

- HAFOS erforscht die Zirkulation und die Entwicklung des Warmen Tiefenwassers (WDW) und des Weddellmeer Bodenwassers (WSBW) mittels ozeanografischer Tiefseeverankerungen, hydrografischer Schnitte mit Messungen von chemischen Variablen, und autonomer Floats; mit letzteren wird das internationale Argo-Projekt bis in die polaren Meere erweitert.
- Wichtiges Ziel ist es die HAFOS-Verankerungen, die 2018/19 ausgelegt worden sind, aufzunehmen und neue Verankerungen auszulegen. Es sollen auch meereisbelastbare Floats ausgesetzt werden. Hydrografische Daten werden gesammelt, um die Verankerungsdaten und Floatdaten zu kalibrieren.
- Die Wiederholungsschnitte entlang des Nullmeridians und quer durch das Weddellmeer sollen erneut besetzt werden für die Messung von Temperatur, Salzgehalt, gelöstem Sauerstoff, Gesamt-CO_2, Alkalinität und Nährstoffen.
- Biologische Aspekte von HAFOS betreffen die akustische Ökologie des Weddellmeers und dessen Fauna; die Verankerungen sind zu dem Zweck mit autonomen Aufzeichnungsgeräten ausgerüstet. Ziel ist es, regionale Geräusch-Budgets für das Weddellmeer zu erstellen.
- Teil von HAFOS ist auch das Abschätzen der ökologischen Adaption und der dynamischen Reaktion von marinen Säugetieren auf anthropogene Störungen, einschließlich Klimawandel und Lärm.
- Für EWOS-I wird auf dem Schelf und im Einstromgebiet vor Kapp Norvegia im östlichen Weddellmeer gearbeitet. Dabei wird es eine quantitative Abschätzung der biogeochemischen Flüsse zwischen Phytoplankton- und Zooplankton-Gemeinschaften, sowie den lebenden Meeresressourcen, wie Krill und Antarktischem Seehecht, in Beziehung zu den treibenden Umweltkräften, und den dazugehörenden passiven und

trophischen Kohlenstoff-Flüssen von der Oberfläche in die Tiefsee liefern. EWOS-II erforscht die Schlüsselvariablen und treibenden Kräfte, die die Hauptkompartimente des Ökosystems strukturieren; obendrein werden die Zusammensetzung und die Biodiversität der eis-assoziierten pelagischen und benthischen Biota untersucht. EWOS-III wird die benthischen Biodiversitätsmuster, den Sauerstoffverbrauch und die Nährstoffflüsse in den inneren und äußeren Schelfregionen vor Kapp Norvegia mittels optischer und akustischer Meeresbodenabbildungen, Probennahme von Makrobenthos (mit Agassiz-Trawl und Multigrab) und *ex-situ* Inkubationsexperimenten von Sedimentkernen untersuchen. Dabei sollen historische Stationen, unter anderem solche des Störungsexperiments BENDEX, erneut beprobt werden

- COMA (Chemical controls on Organic Matter Aggregation / Chemische Regulierung von Aggregation organischen Materials) erforscht die Übergänge zwischen gelösten, kolloidalen und partikulären organischen Stoffen im Ozean. Es befasst sich mit der Frage, ob bestimmte chemische Klassen innerhalb des Pools von organischen Molekülen im Südpolarmeer die Aggregation und die Metallkomplexierung bestimmen.
- DEFIANT (Drivers and Effects of Fluctuations in sea Ice in the ANTarctic/Antrieb und Effekte von Fluktuationen im Meereis in der Antarktis) soll neue mechanistische Kenntnisse des Antriebs und des Einflusses der Meereisvariabilität liefern, wobei es die dramatische Meereisabnahme von 2016 mit einschließt. Dies soll erreicht werden durch miteinander gekoppelte Programme bezüglich Beobachtungen, Modelentwicklung und Modelevaluierung.

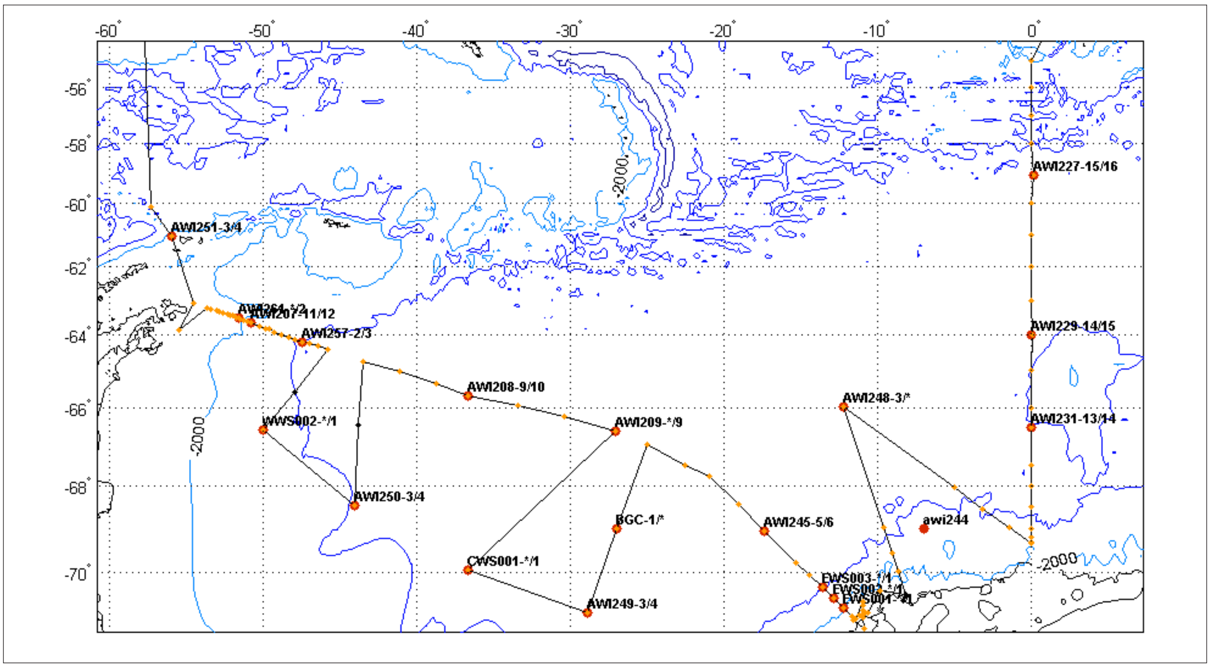

Abb. 1.1: Übersichtskarte des Untersuchungsgebietes mit geplanter Expeditionsroute. Rote Kreise mit Beschriftungen: Standorte und Namen der zu bergenden ozeanographischen Verankerungen (Beschriftungen mit Ziffern vor dem Schrägstrich) und neu zu verankernde Verankerungen (Beschriftungen mit Ziffern nach dem Schrägstrich). Orange Punkte: Standorte geplanter Stationen

Fig. 1.1: Overview chart of the study area with planned expedition track. Red circles with labels: Locations and names of oceanographic moorings to be recovered (labels featuring numerals preceding slash) and redeployed (labels featuring numerals following slash). Orange dots: Locations of planned stations

Um diese Vorhaben und Ziele umzusetzen, wird die *Polarstern* am 3. März 2022 von Kapstadt, Südafrika, auslaufen (Abbildung 1.1). Die Fahrt führt durch das Südpolarmeer bis zum Antarktischen Kontinent und zurück, um am 28. April 2022 in Stanley, Falkland-Inseln, zu enden. Wir werden Kapstadt mit südwestlichem Kurs verlassen, um wenige Tage später den Nullmeridian bei etwa 51° S, nahe der Polarfront, zu erreichen. Dem Nullmeridian wird südwärts bis zum Erreichen des Antarktischen Kontinents gefolgt, um daraufhin Atka Seaport anzulaufen. Von hier aus werden wir in die Region vor Kapp Norvegia fahren, wo ein mehrtägiges biologisches Programm ausgeführt wird. Hier schließt sich eine Querung des Weddellmeers im Zickzackkurs zur Nordspitze der Antarktischen Halbinsel bei Joinville Island an, wo einer der hydrografischen Schwerpunkte liegt. Schlussendlich queren wir die Drakestraße, und fahren entlang der Küste Südamerikas, um im Zielhafen unserer Expedition, Stanley, am 28. April 2022 einzulaufen.

SUMMARY AND ITINERARY

Mario Hoppema DE.AWI

The expedition PS129 of the German research vessel *Polarstern* seeks to provide contributions to scientific projects encompassing physical oceanography, marine biology and marine chemistry, with the aim to investigate the water masses of the Weddell Sea and adjacent oceanic regions, and the ecological and chemical cycles within the regions. This expedition is another continuation of the long-term time series work in the framework of Hybrid Antarctic Float Observation System (HAFOS). HAFOS work is dedicated to climate, the ocean and ecosystem dynamics in the Weddell Gyre. The time series exists since the 1980–90s for hydrography, nutrients, oxygen and carbon system. An additional substantial part of PS129 is concerned with the Eastern Weddell Sea Observation System (EWOS), which includes coordinated and systematic observations of the sympagic, pelagic and benthic part of the ecosystem of the Weddell Sea. Specific scientific projects conducted throughout the expedition are:

- HAFOS investigates the circulation and evolution of Warm Deep Water and Weddell Sea Bottom Water by means of oceanographic deep-sea moorings, hydrographic sections with measurements of chemical species, and autonomous floats, the latter of which also extend the international Argo Project to the polar seas.
- To service the HAFOS mooring array (as deployed in 2018/19) by recovery and redeployment of deep-sea moorings, deployment of ice-resilient floats and collection of hydrographic data for calibration of moored data loggers and validation of float data.
- To prolong the repeated section work by occupation of the full Prime Meridian and Weddell Sea crossing lines for temperature, salinity, dissolved oxygen, total CO_2, alkalinity, nutrients.
- Biological aspects of HAFOS concern the acoustic ecology of the Weddell Sea and its fauna, for which moorings are equipped with autonomous recorders; to establish regional noise budgets for the Weddell Sea.
- To assess ecological adaptation and dynamic responses of marine mammals to anthropogenic perturbation, incl. climate change and noise.
- EWOS-I will work on the shelf and inflow region off Kapp Norvegia in the Eastern Weddell Sea and provide a quantitative assessment of the biogeochemical fluxes between phytoplankton and zooplankton communities as well as marine living resources such as krill and Antarctic toothfish in relation to environmental drivers, and associated

passive and trophic carbon fluxes from the surface into the deep ocean. EWOS-II will investigate key variables and drivers that structure the main ecosystem compartments, and study the composition and biodiversity of ice-associated, pelagic and benthic biota. EWOS-III will investigate benthic biodiversity patterns, oxygen consumption and nutrient fluxes at the inner and outer shelf regions off Kapp Norvegia, by means of optical and acoustic seabed imaging, sampling of macrobenthos (Agassiz trawl and Multi grab) and *ex-situ* sediment core incubation experiments. Historical stations, including those of the BENDEX disturbance experiment, will be re-sampled.

- COMA (Chemical controls on Organic Matter Aggregation) investigation on the transitions between dissolved, colloidal and particulate organic matter in the ocean. It addresses the question whether certain chemical classes within the pool of organic molecules in the Southern Ocean predominantly drive aggregation and metal complexation.
- DEFIANT (Drivers and Effects of Fluctuations in sea Ice in the ANTarctic) will deliver a new mechanistic understanding of the drivers and impacts of Antarctic sea-ice variability, including the dramatic decline in 2016. This is achieved through an interlinked programme of observations, model development and model evaluation.

To realize these projects and objectives, *Polarstern* will depart from Cape Town, South Africa, on 3 March 2022 (Fig. 1.1), taking us across the Southern Ocean to Antarctica and back, to end on 28 April 2022 in Stanley, Falkland Islands. We will leave Cape Town on a southwesterly course, heading for the Prime Meridian which we should reach several days later at about 51° S close to the Polar Front. Sailing straight south until reaching the Antarctic continent, we will then veer west for the Atka Seaport. From there, we will sail to the Kapp Norvegia region where a multi-day biological programme will be carried out. Thereafter we will zig-zag across the Weddell Sea from Kapp Norvegia to the tip of Antarctic Peninsula near Joinville Island, where one of the hydrographic foci is. Finally, we cross Drake Passage and along the South American coast we course to the call at Stanley, the final destination of this expedition, on 28 April.

2. HAFOS: MAINTAINING THE AWI'S LONG-TERM OCEAN OBSERVATORY IN THE WEDDELL SEA

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Grant-No. AWI_PS129_00

Outline

The ocean is a key element of the global climate system due to its ability to store and transport large amounts of heat, to act as a sink of carbon dioxide, and due to the sea ice ocean albedo effect providing a positive feedback to sea ice melting. The response of the ocean to changes in the radiative and wind-driven forcing is controlled by its stratification as governed by the vertical structure of temperature and salinity. Until recently, ship-borne observations provided the only means to obtain sufficiently accurate vertical profiles of water mass properties. However, automated systems gained importance during the last decade. The current backbone of the oceanic observing system is Argo, an internationally financed and organized array of >3000 autonomous profiling floats with public, near-real time data access. However, Argo is by and large restricted to oceanic regions that are ice free year-round, as the floats need to surface regularly to be localized and to transmit their data. Furthermore, Argo does not access the deep ocean.

In an effort to overcome the observational constraints posed by high latitudes and the deep ocean, the Hybrid Antarctic Float Observing System (HAFOS) builds on vertically profiling, custom developed ice-resilient floats (Klatt et al. 2007) and a set of deep sea moorings deployed throughout the Weddell Gyre to record oceanographic data at selected sites. HAFOS also includes an ecological component using passive hydroacoustic recording devices embedded in each of the deep-sea moorings to collect data on the acoustic environment as shaped by manifold biotic and abiotic acoustic sources.

HAFOS was first established in its full extent in 2012/13 during *Polarstern* expedition ANT-29/2, yet subsets of the system existed in various configurations since 2002, allowing for the development and testing of components. The goal of this expedition is to service HAFOS by maintaining the mooring array to allow localizing ice-resilient floats deployed in 2018/19 and in preparation for the deployment of additional ice-resilient floats next year, and to recover and continue the deep temperature und salinity long-term time series monitoring the state of Antarctic Bottom Water.

Objectives

Being the physical oceanography core project of this expedition, HAFOS intends to investigate the role of the Southern Ocean in the global climate system with focus on the Atlantic sector, including the Weddell Sea, where the densest bottom waters of the global oceans originate

(Behrendt et al. 2011; Fahrbach et al. 2011; Fahrbach et al. 2007). The production of these dense water is controlled by the balance between:

- supplies of fresh water through precipitation,
- the melting of continental and sea ice,
- the extraction of freshwater by sea ice formation and evaporation, and
- a supply of warm and salty water masses as transported by the subpolar gyres towards the continental margins of Antarctica, with the gyres of the Weddell and Ross Seas being their most prominent expressions.

The basic mechanism of dense water generation involves upwelling of Circumpolar Deep Water (CDW), which is relatively warm and salty, into the surface layer where CDW comes into contact with the atmosphere and sea ice, becoming cooled and freshened. The newly formed bottom water formed hereby 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 increasing stratification of the water column, it has to be compensated by salt gain through freshwater extraction. Significant parts of salt accumulation occur on the Antarctic shelves in coastal polynyas. With extreme heat losses occurring over ice-free water areas, the polynyas are areas of intense sea ice formation. Offshore winds compress the newly formed sea ice and keep an open sea surface in the polynyas.

The properties and volume of the newly formed bottom water are subject to significant variability on a wide range of time scales, which can only scarcely be explored due to the large efforts needed to obtain measurements in ice-covered ocean areas. Seasonal variations of the upper ocean layers are only partially known and normally exceed other scales of variability in intensity. 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 monitored and understood. Their influence on or interaction with oceanic conditions are merely guessed on the basis of models, which are only superficially validated due to lack of appropriate measurements.

This 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 required and until recently could only be acquired for surface or integral properties by satellite remote sensing. However, to penetrate into the ocean interior and validate the remotely sensed data, an ocean observing system is required, which combines remotely sensed data of sea ice and surface properties with long-term *in-situ* measurements of ocean interior properties, i.e., HAFOS.

Work at sea

The oceanographic studies during *Polarstern* expedition PS129 will concentrate on two major areas, the Greenwich Meridian and the Weddell Sea, continuing more than 30 years of *in-situ* observations in the Atlantic sector of the Southern Ocean. Employing moored instruments, we seek to obtain time series of water mass properties throughout the deep and the surface layers. For this purpose, moorings featuring current meters, temperature and salinity sensors, sound sources and passive acoustic recorders, will be recovered and redeployed (Tables 2.1 and 2.2). While, during the previous expeditions ANT-29/2, ANT-30/2 (PS89), PS103 and PS117, the recovery of moorings in ice-covered areas was facilitated significantly using the ultra-short line positioning system (POSIDONIA), it nevertheless was not possible to retrieve some moorings due to the ice conditions. For this reason, a ROV has been acquired and developed to recover moorings directly by hooking a recovery rope to the mooring rope.

Tab. 2.1: Scientific instrumentation of planned moorings recoveries during PS129

Mooring	Latitude Longitude	Decimal Lat Decimal Lon	Water Depth [m]	Date Time	Instrument Type	Instrument S/N	Instrument Depth [m]
AWI 227-15	59° 03.02' S	-59.0503	4648	31.12.2018	PAM	1006	300
	00° 06.44' E	0.1073		10:10	SBE37	12479	4597
AWI 229-14	64° 01.26' S	-64.0210	5193	01.01.2019	SBE37	9494	50
	00° 00.83' E	0.0138		22:38	SBE37	9495	100
					SBE37	9496	150
					SBE37	9497	200
					AquaD	12654	230
					SBE37	9492	231
					PAM	1060	300
					SBE37	2098	330
					SBE37	2385	430
					SBE37	2382	530
					SBE37	2396	630
					SBE37	3811	734
					AquaD	12658	735
					SBE37	12481	5152
AWI 231-13	66° 31.03' S	-66.5172	4612	27.12.2018	PAM	1056	300
	00° 04.48' W	-0.0747		18:34	SBE37	10944	4534
AWI 244-6	69° 00.08' S	-69.0013	2984	05.01.2019	PAM	1049	300
	07° 01.65' W	-7.0275		20:01	SBE37	8122	2903
AWI 248-3	65° 58.12' S	-65.9687	5048	07.01.2019	PAM	1012	300
	12° 13.84' W	-12.2307		10:37	SBE37	8123	5003
AWI 245-5	69° 03.64' S	-69.0607	4773	08.01.2019	PAM	1014	300
	17° 23.49' W	-17.3915		14:20	SBE37	8124	4693
BGC-1	69° 00.07'S	-69.0012	4717	24.03.2021	LOC	NaN	40
	27° 00.07'W	-27.0012		13:14	ISUS	NaN	40
					CO2	219	40
					RAS-500	12073	40
					Ecotriplet	17c	40
					SBE37	21026	40
					ADCP WH	12667	40
					SBE 56	7824	60
					SBE 37	2100	80

Mooring	Latitude Longitude	Decimal Lat Decimal Lon	Water Depth [m]	Date Time	Instrument Type	Instrument S/N	Instrument Depth [m]
					SBE 56	7825	120
					SBE 37	386	147
					Octopus	NA	156
					Suna	1122	156
					Vp6	7LP	156
					SBE 56	6513	158
					Sedimenttrap	2009404	511
					SonoVault	1024	918
					Sedimenttrap	2009406	1525
AWI 249-3	70° 53.22’ S	-70.8870	4407	20.01.2019	PAM	1010	300
	28° 56.97’ W	-28.9495		12:00	SBE37	8126	4357
AWI 208-9	65° 41.78’ S	-65.6963	4766	23.01.2019	PAM	1020	300
	36° 41.01’ W	-36.6835		16:01	AquaD	12685	806
					SBE37	3812	807
					SBE37	9841	4758
AWI 250-3	68° 28.85’ S	-68.4808	4141	24.01.2019	PAM	1048	300
	44° 05.94’ W	-44.0990		20:28	AquaD	12718	819
					SBE37	3813	820
					SBE37	9839	4094
AWI 257-2	64° 12.94’ S	-64.2157	4215	27.01.2019	PAM	1033	3001
	47° 29.38’ W	-47.4897		17:50	RCM	11888	813
					SBE37	10944	814
					SBE37	9493	4285
AWI 207-11	63° 39.36’ S	-63.6560	2555	29.01.2019	SBE37	10934	250
	50° 48.66’ W	-50.8110		17:08	ADCP QM150	23548	291
					PAM	1032	300
					AquaD	12745	802
					SBE37	6928	803
					SBE37	10937	2200
					AVT	3517	2248
					SBE39	8641	2259
					SBE39	8642	2305

Mooring	Latitude Longitude	Decimal Lat Decimal Lon	Water Depth [m]	Date Time	Instrument Type	Instrument S/N	Instrument Depth [m]
					SBE39	8643	2355
					SBE37	10943	2406
					ADCP QM150	24053	2545
					SBE37	9847	2545
AWI 251-3	61° 01.38' S	-61.0230	335	01.02.2019	PAM	AU0085	179
	55° 58.68' W	-55.9780		18:30	PAM	1002	181
					AZFP	55037	288
					ADCP QM150	5373	322
					SBE37	2096	322

Tab. 2.2: Scientific instrumentation of planned mooring deployments during PS129

Mooring	Latitude Longitude	Decimal Lat Decimal Long	Water Depth [m]	Date Time	Instrument Type	Instrument S/N	Instrument Depth [m]
AWI 227-16	59° 03.02' S	-59.0503	4648		SonoVault		300
	00° 06.44' E	0.1073			SBE37	10933	800
					SBE37	...	4562
AWI 229-15	64° 01.26' S	-64.0210	5193		SBE37	10929	256
	00° 00.83' E	0.0138			SonoVault	...	300
					SBE37	10930	355
					SBE37	2092	455
					SBE37	10931	555
					SBE37	2093	655
					SBE37	10932	755
					SBE37	...	5016
AWI 231-14	66° 31.03' S	-66.5172	4612		SonoVault	...	300
	00° 04.48' W	-0.0747			SBE37	9848	800
					SBE37	...	4536
EWS 001-01	70° 47.87' S	-70.7978			SBE 37	7729	19
	12° 13.05' W	-12.2175			SBE56	...	150
					SBE56	...	300
					ADCP QM150	23807	341

Mooring	Latitude Longitude	Decimal Lat Decimal Long	Water Depth [m]	Date Time	Instrument Type	Instrument S/N	Instrument Depth [m]
					SBE 37	7730	346
					SBE56	...	400
					SBE56	...	460
					SBE 37	7731	520
					SBE56	...	580
					ADCP WH600	1002	652
					SBE56	...	652
					SBE 37	10928	693
EWS 002-01	70° 35.17' S	-70.5861			SBE 37	7733	18
	12° 51.46' W	-12.8576			SBE56	...	100
					SBE56	...	200
					ADCP QM150	22283	341
					SBE 37	8122	346
					SBE56	...	500
					SBE56	...	600
					SBE56	...	700
					SBE 37	9490	800
					SBE56	...	900
					SBE56	...	1000
					SBE 37	10949	1100
					SBE56	...	1200
					ADCP WH300	951	1302
					SBE 37	...	1393
EWS 003-01		-70.3464			SonoVault	...	290
		-13.5746			SoSo	...	794
					Aquadopp	...	795
					SBE 37	3814	795
					SBE 37	224	2959
AWI 245-06	69° 03.64' S	-69.0607	4773		SonoVault	...	300
	17° 23.49' W	-17.3915			SoSo	...	841
					Aquadopp	...	841
					SBE37	9838	841
					SBE37	218	4691

Mooring	Latitude Longitude	Decimal Lat Decimal Long	Water Depth [m]	Date Time	Instrument Type	Instrument S/N	Instrument Depth [m]
AWI 249-04	70° 53.22' S	-70.8870	4407		SonoVault	...	300
	28° 56.97' W	-28.9495			SoSo	...	809
					Aquadopp	...	809
					SBE37	9832	809
					SBE37	...	4319
CWS 001-01	69° 57.55' S	-69.9592	4243		Aural		291
	36° 43.87' W	-36.7312			SonoVault		293
					SoSo		795
					AquaD		819
					SBE37	7727	797
					SBE37	233	4200
AWI 209-09	66° 36.45' S	-66.6075			SonoVault	...	300
	27° 07.29'W	-27.1215			SoSo	...	809
					AquaD	...	809
					SBE37	9832	809
					SBE37	...	4319
AWI 208-10	65° 41.78' S	-65.6963	4766		PAM		300
	36° 41.01' W	-36.6835			AquaD		806
					SBE37		807
					SBE37		4758
AWI 250-04	68° 28.85' S	-68.4808	4141		PAM		294
	44° 05.94' W	-44.0990			SoSo		795
					AquaD		797
					SBE37	2101	797
					SBE37		4057
WWS 002-01	66° 34.62' S	-66.5770	3517		Aural		291
	44° 00.91' W	-50.0152			SonoVault		293
					SoSo		792
					AquaD		795
					SBE37	9488	795
					SBE37	232	4057
AWI 257-03	64° 12.94' S	-64.2157	4215		PAM		311
	47° 29.38' W	-47.4897			SoSo		811
					AquaD	11330	811
					SBE37	7690	811

Mooring	Latitude Longitude	Decimal Lat Decimal Long	Water Depth [m]	Date Time	Instrument Type	Instrument S/N	Instrument Depth [m]
					SBE37		4279
AWI 207-12	63° 39.36’ S	-63.6560	2555	29.01.2019	SM37	8131	249
	50° 48.66’ W	-50.8110		17:08	QM150	23456	290
					SonoVault		300
					SM37	10951	805
					SM37	8129	2200
					AquaD	11348	2203
					SBE39		2210
					SBE39		2260
					SBE39		2310
					SBE39	8643	2355
					SM37	2234	2410
					QM150	24052	2500
					SBE37	2009	2500
AWI 261-02	63° 30.87’ S	-63.5145	1726		PAM		290
	50° 38.20’ W	-51.6367			SBE37	9840	790
					SBE56		1150
					SBE37	2092	1200
					SBE56		1250
					SBE37	2093	1291
					SBE56		1350
					SBE37	9834	1400
					SBE56		1450
					SBE37	12478	1491
					ADCP QM150	14088	1491
AWI 251-04	61° 01.38’ S	-61.0230	335		PAM		179
	55° 58.68’ W	-55.9780			PAM		181
					AZFP		288
					ADCP LR 075	22858	322
					SBE37	2395	322

Abbreviations:

ADCP LR075	*RD Instruments Doppler Current Profiler, Type Long Ranger 75 kHz*
ADCP QM150	*RD Instruments Doppler Current Profiler, Type Quarter Master 150 kHz*
ADCP WH600	*RD Instruments Doppler Current Profiler, Type Workhorse 600 kHz*
AquaD	*Nortek Aquadopp Acoustic Current Meter*
Aural	*Multi-Electronique (MTE) Aural Passive Acoustic Recorder*
AVT	*Aanderaa Current Meter with Temperature Sensor*
AZFP	*ASL Environmental Sciences Acoustic Zooplankton and Fish Profiler*
PAM	*Passive Acoustic Monitor (Type: AURAL or SONOVAULT)*
RCM11	*Aanderaa Doppler Current Meter (acoust.)*
SBE37	*SeaBird Electronics MicroCat Conductivity and Temperture Logger*
SBE39	*SeaBird Electronics Temperature Logger*
SBE56	*SeaBird Electronics Temperature Logger*
SonoVault	*Develogic SonoVault Passive Acoustic Recorder*
SOSO	*Develogic RAFOS Sound Source*

Ecotriplet	*Fluorescence sensor*
ISUS	*Nitrate Sensor*
LOC	*Lab on Chip sensors*
RAS-500	*Remote Access Sampler RAS-48-500*
Sedimenttrap	*KUM sediment traps*
Suna	*Nitrate Sensor*
VVP6	*Underwater Vision Profiler 6*

To enhance the vertical resolution and to calibrate moored sensors, CTD stations will be occupied at the mooring locations. The CTD / water sampler consists of a SBE911plus CTD system in combination with a carousel water sampler SBE32 with 24 12L bottles. To determine the distance to the bottom, an altimeter from Benthos is mounted. A transmissometer from Wetlabs, a SBE43 oxygen sensor from Seabird Electronics and a fluorometer will be incorporated in the sensor package. Additionally, two RDI-150 kHz ADCPs, one pointing upward, one pointing downward are attached to the rosette sampler to measure the current velocity profile.

Moorings will contain sound sources, providing RAFOS signals for retrospective under-ice tracking of 23 NEMO floats deployed during PS129 (Table 2.3, Fig. 2.2) and passive acoustic recorders to record ambient (biotic and abiotic) sounds. During PS129, 5 Argo floats will be deployed for the Bundesamt für Seeschifffahrt und Hydrographie (BSH, Table 2.4) across the ACC throughout the Weddell Sea. Further 9 biogeochemical Argo floats shall be deployed for Scripps Institution of Oceanography (Table 2.5). A CTD / I-ADCP section shall be conducted between mooring 217-5 (near 45° E) and the tip of the Antarctic Peninsula (Fig. 2.1) aiming at delineating the export plume of Antarctic Bottom Water.

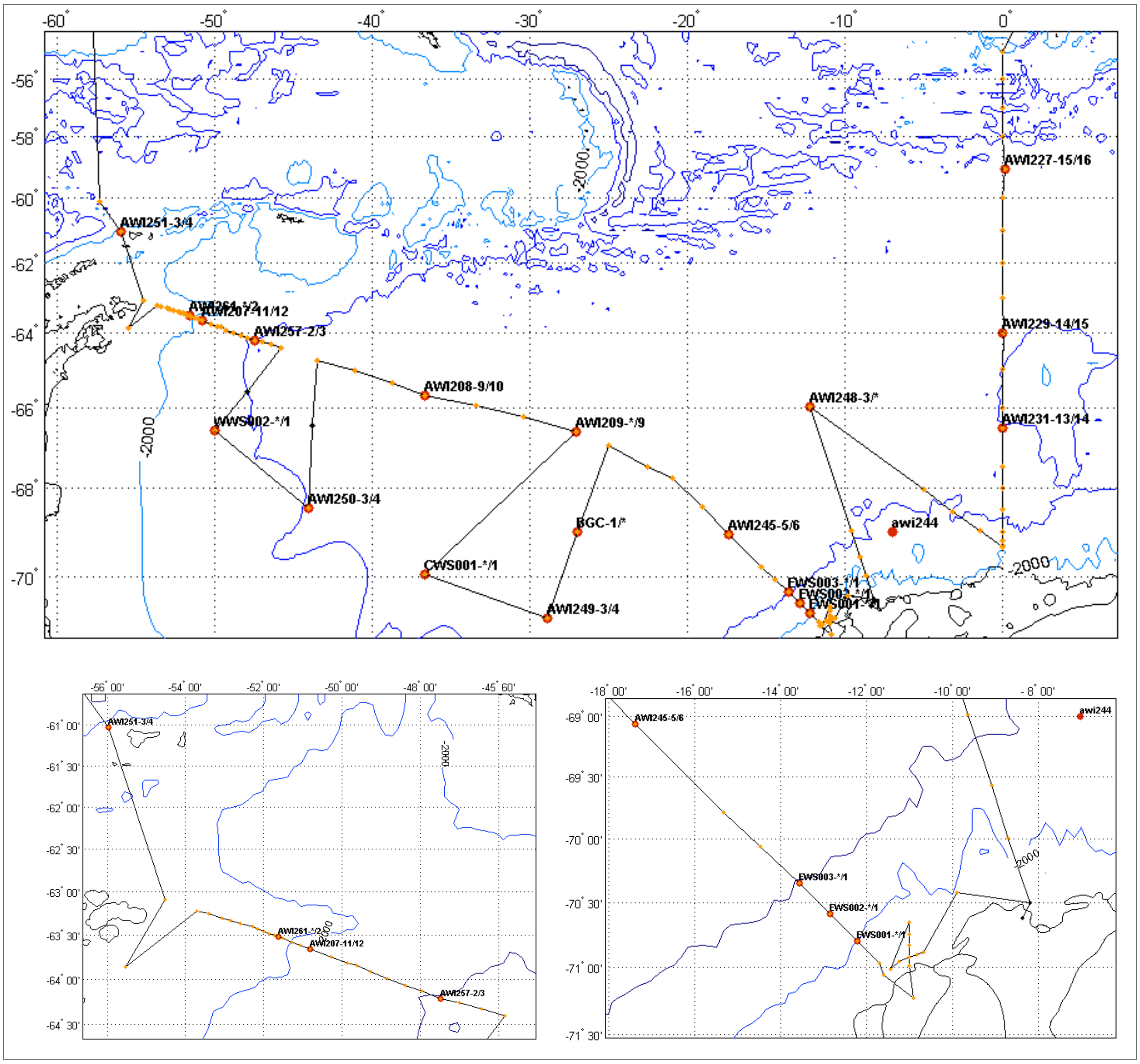

Fig. 2.1: Overview (top) and zoomed-in (bottom left: Antarctic Peninsula; bottom right: Kapp Norvegia) charts of the study area with planned expedition track. Red circles with labels: Locations and names of oceanographic moorings to be recovered (labels featuring numerals preceding slash) and redeployed (labels featuring numerals following slash). Orange dots: Locations of planned stations

Tab. 2.3: List of planned ice-resilient Argo float deployments during PS129. All floats are of type APEX by Teledyne Webb Research and their planned deployments have been registered with www.ocean-ops.org.

AWI-ID	Apex float S/N	WMO	IMEI	Deployment latitude	Deployment longitude	Water depth [m]
PS129-1	8878	7900971	300125061811150	68° 00.00’ S	0° 00.00’ E	4522
PS129-2	8879	7900972	300125061814250	69° 00.00’ S	0° 00.00’ E	3421
PS129-3	8886	7900979	300125061326710	69° 21.84’ S	0° 00.00’ E	2303
PS129-4	8887	7900980	300125061324710	68° 59.75’ S	1° 27.67’ W	3031

AWI-ID	Apex float S/N	WMO	IMEI	Deployment latitude	Deployment longitude	Water depth [m]
PS129-5	8888	7900981	300125061323740	68° 32.69’ S	3° 10.23’ W	4087
PS129-6	8889	7900982	300125061326720	68° 02.47’ S	5° 01.47’ W	4421
PS129-7	8890	7900983	300125061321650	68° 59.12’ S	9° 37.84’ W	4297
PS129-8	8891	7900984	300125061321740	69° 34.18’ S	9° 04.82’ W	3397
PS129-9	8892	7900985	300125061810140	69° 59.33’ S	8° 42.40’ W	2855
PS129-10	8893	7900986	300125061813240	70° 25.19’ S	9° 53.30’ W	1696
PS129-11	9212	7900987	300125061140800	70° 57.93’ S	11° 42.32’ W	752
PS129-12	9213	7900988	300125061142720	70° 47.87’ S	12° 13.05’ W	1810
PS129-13	9214	7900989	300125061756090	70° 35.17’ S	12° 51.46’ W	2198
PS129-14	9215	7900990	300125061143710	70° 20.78’ S	13° 34.48’ W	3234
PS129-15	9216	7900991	300125061163760	70° 03.61’ S	14° 28.25’ W	4755
PS129-16	9217	7900992	300125061246210	69° 47.26’ S	15° 20.49’ W	4755
PS129-17	9218	7900993	300125061165760	69° 03.64’ S	17° 23.49’ W	4774
PS129-18	9219	7900994	300125061148800	70° 53.22’ S	28° 56.97’ W	4367
PS129-19	9220	7900995	300125061144830	70° 53.22’ S	28° 56.97’ W	4367
PS129-20	9221	7900996	300125061167760	69° 57.55’ S	36° 43.87’ W	4243
PS129-21	9222	7900997	300125061163750	69° 57.55’ S	36° 43.87’ W	4243
PS129-22	9223	7900998	300125061162770	68° 28.85’ S	44° 05.94’ W	4081
PS129-23	9224	7900999	300125061162760	66° 34.62’ S	50° 00.91’ W	3517

Table 2.4: List of planned standard Argo float deployments during PS129. All floats provided by BSH.

BSH-ID	Apex float S/N	WMO	IMEI	Deployment latitude	Deployment longitude	
PS129-BSH1				45° 0’ S	10° 30.00’ E	
PS129-BSH2				47° 0’ S	9° 00.00’ E	
PS129-BSH3				50° 0’ S	6° 30.00’ E	
PS129-BSH4				58° 30.00’ S	0° 30.00’ E	
PS129-BSH5				59° 30.00’ S	0° 00.00’ E	

Tab. 2.5: List of planned biogeochemical Argo float deployments during PS129. All floats provided by Scripps Institution of Oceanography.

Scripps ID	float S/N	WMO	IMEI	Deployment latitude	Deployment longitude	Water depth [m]
				-37.5000	14.9200	
				-40.5000	13.3000	
				-62.0000	0.0000	
				-65.0006	0.0237	
				-69.0057	-6.9823	
				-65.9682	-12.2520	
				-66.6075	-27.1210	
				-65.6205	-36.4220	
				-64.3321	-46.4369	

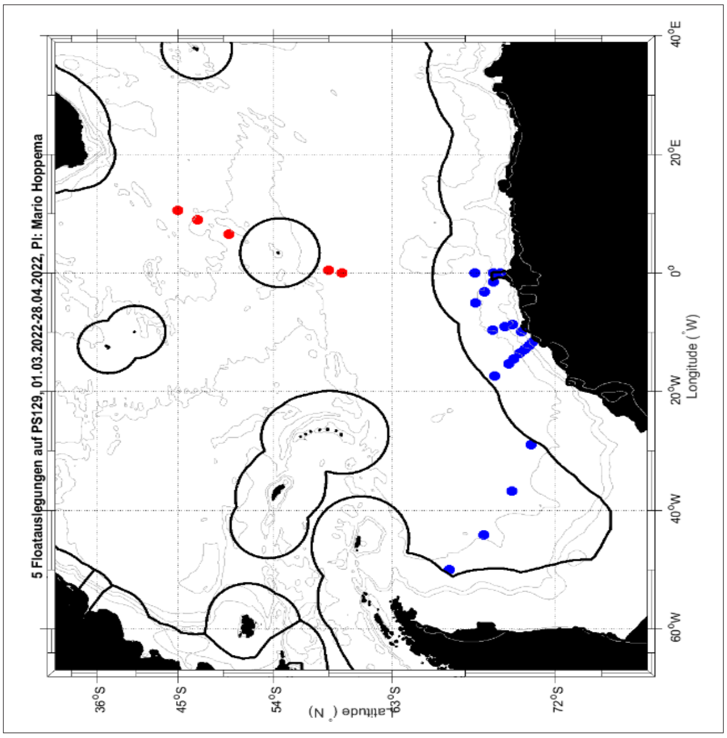

Fig. 2.4: Map of deployments sites for ice-resilient (blue) and standard (red) Argo floats during PS129. Graphics courtesy of Birgit Klein, BSH

Expected results

We expect to secure data from a large proportion of the instruments currently moored, together with ship-based CTD- and lowered ADCP data.

Data management

Environmental data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (https://www.pangaea.de) within two years after the end of the cruise at the latest. By default, the CC-BY license will be applied.

Metadata of recoded data will be made available through the expedition report. Mooring and CTD data will be made available after validation through the PANGAEA database. Float data will be made available through the Argo System and PANGAEA (Reeve et al., 2016). The processing of the lowered ADCP will last several months but as soon as these data were processed and documented they will be available in PANGAEA too. Results will be published in international journals.

In all publications, based on this cruise, the grant no. AWI_PS129_00 will be quoted and the following *Polarstern* article will be cited:

Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (2017) Polar Research and Supply Vessel POLARSTERN Operated by the Alfred-Wegener-Institute. Journal of large-scale research facilities, 3, A119. http://dx.doi.org/10.17815/jlsrf-3-163.

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Fahrbach E, Hoppema M, Rohardt G, Boebel O, Klatt O, Wisotzki A (2011) Warming of deep and abyssal water masses along the Greenwich meridian on decadal time scales: The Weddell gyre as a heat buffer. Deep-Sea Research II, 58, 2509-2523, https://doi.org/10.1016/j.dsr2.2011.06.007.

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Appendix 1

Current planning of stations to be occupied during PS129

Station	Cast	Latitude	Longitude	Water Depth [m]	Instrument	Comment
WP	none	-32.699	17.9331	22	Cape Town(sf)	
1	1	-55	0	2008	CTD/RO	
2	1	-56	0	3597	CTD/RO	
3	1	-57	0	3852	CTD/RO	
4	1	-58	0	4010	CTD/RO	
5	1	-59.0503	0.1073	4777	MOOR/R	Recovery AWI227-15
5	2	-59.0503	0.1073	4777	CTD/RO	Attention keep 2 nm off mooring
5	3	-59.0503	0.1073	4777	MOOR/D	Deployment AWI227-16
6	1	-60	0	5149	CTD/RO	
6	2	-60	0	5149	MN	
6	3	-60	0	5149	RMT	
6	4	-60	0	5149	ICAM	
7	1	-61	0	5437	CTD/RO	
8	1	-62	0	5177	CTD/RO	
8	2	-62	0	5177	MN	
8	3	-62	0	5177	RMT	
8	4	-62	0	5177	ICAM	
9	1	-63	0	5293	CTD/RO	
10	1	-64.021	0.0138	5056	MOOR/R	Recovery AWI229-14
10	2	-64.021	0.0138	5056	CTD/RO	Attention keep 2 nm off mooring
10	3	-64.021	0.0138	5056	MOOR/D	Deployment AWI229-15
11	1	-65	0	3856	CTD/RO	
11	2	-65	0	3856	MN	
11	3	-65	0	3856	RMT	
11	4	-65	0	3856	ICAM	
12	1	-66	0	3490	CTD/RO	
12	2	-66	0	3490	MN	
12	3	-66	0	3490	RMT	
12	4	-66	0	3490	ICAM	
12	5	-66	0	3490	TRAPS	
13	1	-66.5172	-0.0747	4543	MOOR/R	Recovery AWI231-13
13	2	-66.5172	-0.0747	4543	CTD/RO	Attention keep 2 nm off mooring
13	3	-66.5172	-0.0747	4543	MOOR/D	Deployment AWI231-14
14	1	-67.5	0	4667	CTD/RO	
15	1	-68	0	4522	CTD/RO	

Station	Cast	Latitude	Longitude	Water Depth [m]	Instrument	Comment
15	2	-68	0	4522	FLOAT	
16	1	-68.5	0	4255	CTD/RO	
17	1	-69	0	3421	CTD/RO	
17	2	-69	0	3421	FLOAT	
18	1	-69.224	0	2784	CTD/RO	
18	2	-69.224	0	2784	SUIT	
18	3	-69.224	0	2784	MN	
18	4	-69.224	0	2784	RMT	
18	5	-69.224	0	2784	ICE	
18	6	-69.224	0	2784	ICAM	
19	1	-69.329	0	2437	CTD/RO	
20	1	-69.364	0	2303	CTD/RO	
20	2	-69.364	0	2303	FLOAT	
21	1	-68.9958	-1.4612	3031	FLOAT	
22	1	-68.5448	-3.1705	4087	FLOAT	
23	1	-68.0412	-5.0245	4421	FLOAT	
24	1	-65.9687	-12.2307	5022	MOOR/R	Recovery AWI248-3
24	2	-65.9687	-12.2307	5022	CTD/RO	Attention keep 2 nm off mooring
25	1	-68.9854	-9.6307	4297	FLOAT	
26	1	-69.5697	-9.0803	3397	FLOAT	
27	1	-69.9888	-8.7067	2855	FLOAT	
WP	none	-70.504	-8.2	258	waypoint	
WP	none	-70.6166	-8.3666	282	Neumayer arrival	
WP	none	-70.6166	-8.3666	282	Neumayer departure	
WP	none	-70.504	-8.2	258	waypoint	
28	1	-70.4198	-9.8883	1696	FLOAT	
29	1	-70.883	-10.663	281	SUIT	
29	2	-70.883	-10.663	281	MN	
29	3	-70.883	-10.663	281	RMT	
29	4	-70.883	-10.663	281	ICE	
29	5	-70.883	-10.663	281	ICAM	
29	6	-70.883	-10.663	281	TRAPS	
29	7	-70.883	-10.663	281	ROV	
29	8	-70.883	-10.663	281	TVMUC	
29	9	-70.883	-10.663	281	TVMUC	
29	10	-70.883	-10.663	281	MG	
29	11	-70.883	-10.663	281	OFOS	
30	1	-70.9	-10.835	308	LANDER	
30	2	-70.9	-10.835	308	MG	

Station	Cast	Latitude	Longitude	Water Depth [m]	Instrument	Comment
30	3	-70.9	-10.835	308	OFOS	
31	1	-70.921	-11.016	360	SUIT	
31	2	-70.921	-11.016	360	MN	
31	3	-70.921	-11.016	360	RMT	
31	4	-70.921	-11.016	360	ICE	
31	5	-70.921	-11.016	360	ROV	
31	6	-70.921	-11.016	360	LANDER	
31	7	-70.921	-11.016	360	TVMUC	
31	8	-70.921	-11.016	360	TVMUC	
31	9	-70.921	-11.016	360	MG	
31	10	-70.921	-11.016	360	OFOS	
32	1	-70.954	-11.247	357	LANDER	
32	2	-70.954	-11.247	357	TVMUC	
32	3	-70.954	-11.247	357	MG	
32	4	-70.954	-11.247	357	OFOS	
33	1	-71.009	-11.435	433	LANDER	
33	2	-71.009	-11.435	433	TVMUC	
33	3	-71.009	-11.435	433	MG	
33	4	-71.009	-11.435	433	OFOS	
34	1	-70.651	-11	1432	AGT	
34	2	-70.651	-11	1432	AGT	
34	3	-70.651	-11	1432	LL	
34	4	-70.651	-11	1432	LL	
35	1	-70.743	-11	1133	LANDER	
35	2	-70.743	-11	1133	AGT	
35	3	-70.743	-11	1133	AGT	
35	4	-70.743	-11	1133	LL	
35	5	-70.743	-11	1133	LL	
35	6	-70.743	-11	1133	TVMUC	
35	7	-70.743	-11	1133	MG	
35	8	-70.743	-11	1133	OFOS	
36	1	-70.831	-11	474	SUIT	
36	2	-70.831	-11	474	MN	
36	3	-70.831	-11	474	RMT	
36	4	-70.831	-11	474	ICE	
36	5	-70.831	-11	474	ICAM	
36	6	-70.831	-11	474	TRAPS	
36	7	-70.831	-11	474	ROV	
36	8	-70.831	-11	474	LANDER	
36	9	-70.831	-11	474	AGT	

Station	Cast	Latitude	Longitude	Water Depth [m]	Instrument	Comment
36	10	-70.831	-11	474	AGT	
36	11	-70.831	-11	474	LL	
36	12	-70.831	-11	474	LL	
36	13	-70.831	-11	474	TVMUC	
36	14	-70.831	-11	474	MG	
36	15	-70.831	-11	474	OFOS	
37	1	-70.988	-11	377	LANDER	
37	2	-70.988	-11	377	TVMUC	
37	3	-70.988	-11	377	MG	
37	4	-70.988	-11	377	OFOS	
38	1	-71.2307	-10.9097	606	MOOR/D	
38	2	-71.2307	-10.9097	606	CTD/RO	
39	1	-71.056	-11.597	344	SUIT	
39	2	-71.056	-11.597	344	MN	
39	3	-71.056	-11.597	344	RMT	
39	4	-71.056	-11.597	344	ICE	
39	5	-71.056	-11.597	344	ICAM	
39	6	-71.056	-11.597	344	TRAPS	
39	7	-71.056	-11.597	344	ROV	
39	8	-71.056	-11.597	344	LANDER	
39	9	-71.056	-11.597	344	TVMUC	
39	10	-71.056	-11.597	344	TVMUC	
39	11	-71.056	-11.597	344	MG	
39	12	-71.056	-11.597	344	OFOS	
40	1	-70.9655	-11.7053	752	MOOR/D	
40	2	-70.9655	-11.7053	752	CTD/RO	
40	3	-70.9655	-11.7053	752	FLOAT	
41	1	-70.7978	-12.2175	1810	MOOR/D	EWS001-1 Deploy
41	2	-70.7978	-12.2175	1810	CTD/RO	
41	3	-70.7978	-12.2175	1810	FLOAT	
42	1	-70.5861	-12.8576	2198	MOOR/D	EWS002-1 Deploy
42	2	-70.5861	-12.8576	2198	CTD/RO	
42	3	-70.5861	-12.8576	2198	FLOAT	
43	1	-70.3464	-13.5746	3234	MOOR/D	EWS003-1 Deploy
43	2	-70.3464	-13.5746	3234	CTD/RO	
43	3	-70.3464	-13.5746	3234	FLOAT	
44	1	-70.0602	-14.4709	4755	CTD/RO	
44	2	-70.0602	-14.4709	4755	FLOAT	
45	1	-69.7877	-15.3415	4755	CTD/RO	
45	2	-69.7877	-15.3415	4755	FLOAT	

Station	Cast	Latitude	Longitude	Water Depth [m]	Instrument	Comment
46	1	-69.0607	-17.3915	4774	MOOR/R	Recovery AWI245-5
46	2	-69.0607	-17.3915	4774	CTD/RO	Attention keep 2 nm off mooring
46	3	-69.0607	-17.3915	4774	MOOR/D	Deployment AWI245-6
46	4	-69.0607	-17.3915	4774	FLOAT	
47	1	-68.4464	-19.0801	4839	CTD/RO	
48	1	-67.7429	-20.9806	4915	CTD/RO	
49	1	-67.476	-22.5503	4907	CTD/RO	
50	1	-66.9705	-25.0575	4876	CTD/RO	
50	2	-66.9705	-25.0575	4876	MN	
50	3	-66.9705	-25.0575	4876	RMT	
50	4	-66.9705	-25.0575	4876	ICAM	
50	5	-66.9705	-25.0575	4876	TRAPS	
51	1	-69.0012	-27.0012	4708	MOOR/R	BGC-1 Recovery
51	2	-69.0012	-27.0012	4708	CTD/RO	
52	1	-70.887	-28.9495	4367	MOOR/R	Recovery AWI249-3
52	2	-70.887	-28.9495	4367	CTD/RO	Attention keep 2 nm off mooring
52	3	-70.887	-28.9495	4367	MOOR/D	Deployment AWI249-4
52	4	-70.887	-28.9495	4367	SUIT	
52	5	-70.887	-28.9495	4367	ICE	
52	6	-70.887	-28.9495	4367	FLOAT	
52	7	-70.887	-28.9495	4367	FLOAT	
53	1	-69.9592	-36.7312	4243	CTD/RO	
53	2	-69.9592	-36.7312	4243	MOOR/D	Deploy CWS001-1
53	3	-69.9592	-36.7312	4243	SUIT	
53	4	-69.9592	-36.7312	4243	ICE	
53	5	-69.9592	-36.7312	4243	FLOAT	
53	6	-69.9592	-36.7312	4243	FLOAT	
54	1	-66.6075	-27.1215	4844	MOOR/D	Deployment AWI209-9
54	2	-66.6075	-27.1215	4844	CTD/RO	Attention keep 2 nm off mooring
55	1	-66.2488	-30.435	4823	CTD/RO	
56	1	-65.9374	-33.4566	4800	CTD/RO	
57	1	-65.6963	-36.6835	4701	MOOR/R	Recovery AWI208-9
57	2	-65.6963	-36.6835	4701	CTD/RO	Attention keep 2 nm off mooring
57	3	-65.6963	-36.6835	4701	MOOR/D	Deployment AWI208-10
58	1	-65.3545	-38.7161	4723	CTD/RO	
59	1	-65.0407	-41.1417	4716	CTD/RO	
60	1	-64.7425	-43.522	4600	CTD/RO	

Station	Cast	Latitude	Longitude	Water Depth [m]	Instrument	Comment
WP	none	-66.4528	-43.8719	4295	waypoint	
61	1	-68.4808	-44.099	4081	MOOR/R	Recovery AWI250-3
61	2	-68.4808	-44.099	4081	CTD/RO	Attention keep 2 nm off mooring
61	3	-68.4808	-44.099	4081	MOOR/D	Deployment AWI250-4
61	4	-68.4808	-44.099	4081	ICE	
61	5	-68.4808	-44.099	4081	SUIT	
61	6	-68.4808	-44.099	4081	SOSOCAL	
61	7	-68.4808	-44.099	4081	SOSOCAL	
61	8	-68.4808	-44.099	4081	FLOAT	
62	1	-66.577	-50.0152	3517	MOOR/D	
62	2	-66.577	-50.0152	3517	SOSOCAL	
62	3	-66.577	-50.0152	3517	SOSOCAL	
62	4	-66.577	-50.0152	3517	FLOAT	
WP	none	-65.5845	-47.9297	3987	waypoint	
63	1	-64.4098	-45.8455	4400	CTD/RO	
63	2	-64.4098	-45.8455	4400	SUIT	
63	3	-64.4098	-45.8455	4400	MN	
63	4	-64.4098	-45.8455	4400	RMT	
63	5	-64.4098	-45.8455	4400	ICE	
64	1	-64.3321	-46.4369	4400	CTD/RO	
65	1	-64.2574	-47.0054	4289	CTD/RO	
66	1	-64.2157	-47.4897	4171	MOOR/R	Recovery AWI257-2
66	2	-64.2157	-47.4897	4171	CTD/RO	Attention keep 2 nm off mooring
66	3	-64.2157	-47.4897	4171	MOOR/D	Deployment AWI257-3
67	1	-64.1342	-47.9651	4082	CTD/RO	
68	1	-64.0665	-48.3813	3926	CTD/RO	
69	1	-63.9874	-48.8512	3675	CTD/RO	
70	1	-63.9173	-49.2678	3407	CTD/RO	
71	1	-63.8471	-49.6199	3161	CTD/RO	
72	1	-63.816	-49.8579	2984	CTD/RO	
73	1	-63.7427	-50.2799	2600	CTD/RO	
74	1	-63.656	-50.811	2494	MOOR/R	Recovery AWI207-11
74	2	-63.656	-50.811	2494	CTD/RO	Attention keep 2 nm off mooring
74	3	-63.656	-50.811	2494	MOOR/D	Deployment AWI207-12
75	1	-63.6163	-51.0719	2320	CTD/RO	
76	1	-63.58	-51.2986	2165	CTD/RO	
77	1	-63.5395	-51.5014	1993	CTD/RO	

Station	Cast	Latitude	Longitude	Water Depth [m]	Instrument	Comment
78	1	-63.5148	-51.6367	1730	CTD/RO	
78	2	-63.5148	-51.6367	1730	MOOR/D	Deployment AWI261-2
79	1	-63.4972	-51.7338	1453	CTD/RO	
80	1	-63.4783	-51.8732	1210	CTD/RO	
81	1	-63.4527	-51.9968	1016	CTD/RO	
82	1	-63.4283	-52.1555	882	CTD/RO	
83	1	-63.4033	-52.2868	678	CTD/RO	
84	1	-63.3654	-52.5998	500	CTD/RO	
85	1	-63.3349	-52.8537	457	CTD/RO	
86	1	-63.3064	-53.0668	424	CTD/RO	
87	1	-63.2553	-53.4056	400	CTD/RO	
88	1	-63.22	-53.7067	332	CTD/RO	
88	2	-63.22	-53.7067	332	MOOR/D	
89	1	-63.862	-55.5333	298	TVMUC	
90	1	-63.0882	-54.5248	405	CTD/RO	
91	1	-61.023	-55.978	264	MOOR/R	Recovery AWI251-3
91	2	-61.023	-55.978	264	CTD/RO	Attention keep 2 nm off mooring
91	3	-61.023	-55.978	264	MOOR/D	Deployment AWI251-4
92	1	-60.119	-57.3267	3879	SOSOCAL	
92	2	-60.119	-57.3267	3879	SOSOCAL	
WP	none	-51.7	-57.8333	1	Stanley	

3. HAFOS-NUTRIENTS

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Grant-No. AWI_PS129_03

Objectives

The determination of nutrients and biogeochemical parameters is closely connected with the physical and planktological investigations. The development of phytoplankton blooms is especially dependent on the available nutrients. Nutrients are also well suited as tracers for the identification of water masses. Our interests on this expedition are focussed on the nutrient distribution in the upper water layer and the interactions between phytoplankton and nutrients during the development of phytoplankton blooms. During the CTD-transects all inorganic nutrients (nitrate, nitrite, ammonium, silicate and phosphate) will be measured in the samples drawn from the rosette bottle system. In addition, the stable isotope ratios of nitrogen and carbon for biogenic substances in the surface layers will be investigated to describe the isotopic structure of the Antarctic ecosystem and to trace the flow of sea ice-derived matter contributing substantially to the suspended pelagic biomass especially during the late season.

Work at sea

From water samples drawn from the rosette sampler at different depths, the nutrients phosphate (Murphy & Riley 1962), silicate (Strickland & Parsons 1968), nitrite and nitrate (Grasshoff et al. 1983) and ammonium (Kerouel & Aminot 1997) are determined immediately on board using a Seal 500 auto-analyser system according to standard methods. Particulate organic matter for bulk stable isotope analysis of ^{13}C and ^{15}N isotopes will be obtained by standard methods after filtration onto precombusted GF / F filters.

Expected results

This work will be carried out to continue the investigation of the seasonal as well as the interannual variability of the Antarctic Circumpolar Current (ACC) and the Weddell Gyre. With the help of the nutrient data, that will be available approximately within two days after sampling, we will get an overview of water masses, biological activity and functioning of the sampling system. Later, the nutrient data will be used for many studies related to the cruise to indicate a diversity of physical and biological processes. Analysis of $\delta^{13}C$ / $\delta^{15}N$-POM will highlight the interaction between sympagic and pelagic communities.

Data management

Environmental data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (https://www.pangaea.de) within two years after the end of the cruise at the latest. By default, the CC-BY license will be applied.

We will sample a large variety of interconnected parameters. We plan that the full data set will be available at least one year after the cruise. Most of the samples, which will not be analyzed immediately, will be stored at AWI and be available to other colleagues. Data will be made available to the public via the PANGAEA repository after.

In all publications, based on this cruise, the grant no. AWI_PS129_03 will be quoted and the following *Polarstern* article will be cited:

Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (2017) Polar Research and Supply Vessel POLARSTERN Operated by the Alfred-Wegener-Institute. Journal of large-scale research facilities, 3, A119. http://dx.doi.org/10.17815/jlsrf-3-163.

This expedition was supported by the Helmholtz Research Programme "Changing Earth – Sustaining our Future" Topic 6, Subtopics 6.1 and 6.2.

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4. THE CARBON SYSTEM OF THE WEDDELL SEA

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Grant-No. AWI_PS129_02

Objectives

The Southern Ocean is a key region in our understanding of the global carbon cycle and how it will respond under predicting future climate change. Recent studies have suggested that the Southern Ocean is taking up around 30 to 40 % of the anthropogenic excess CO_2 (Cant) followed also by an important and efficient transport of this Cant by intermediate and deep-water formation in this area. The uptake and accumulation of Cant is mainly controlled by the ocean circulation and water mass mixing, in particular the deepest penetrations associated with convergence zones. This is why the Southern Ocean is one of the most conspicuous places of the global ocean. The formation of intermediate, deep and bottom water masses together with the upwelling of old waters takes place through complex dynamical processes, that will be one of the main objectives of the HAFOS project and PS129. This cruise will provide a new set of carbon dioxide data for this area that will increase our knowledge of the amount of anthropogenic carbon being incorporated by the different water masses and will be compared with previous results for this area to compute anthropogenic carbon inventory, the concentration in deep and bottom layers and its storage and evolution (Panassa et al. 2018). Moreover, after PS89 and PS117, to study the tidal effect on polynyas in the Antarctic area and their effects on the carbon chemistry will be of special interest for the group. During the call at *Neumayer Station III* or in a site where we spend more than a day in a well-established polynya, we plan to carry out a tidal cycle with a 2 hour-resolution to see the tidal carbon pumping at the polynya (first 100 m of water column). If it is possible, during work in sea ice we would like to have samples taken below the ice to compare values in the open water, at the polynya and below the sea ice.

To achieve these objectives, the Marine Chemistry group (QUIMA) from the Instituto de Oceanografía y Cambio Global (IOCAG) at the Universidad de Las Palmas de Gran Canaria will measure for each CTD cast two carbon dioxide parameters along the water column at all locations: the total alkalinity (AT) and the total dissolved inorganic carbon concentration (CT), making the value traceable to the highest standards by using Certified Reference Material for CO_2 analyses. During the cruise, the QUIMA group will also be in charge of analyzing the concentration of dissolved oxygen by using the potentiometry Winkler method.

Work at sea

Two variables of the carbonate system will be measured along the water column on board *Polarstern* to achieve the highest level of data quality and resolution and to account for the objectives proposed above. The QUIMA group of ULPGC owns a coulometric system for total dissolved inorganic carbon, the VINDTA 3C system (MARIANDA™). Other carbonate system variables will be computed for the *in situ*-conditions.

Total Alkalinity and Dissolved Inorganic Carbon: A VINDTA 3C system (Mintrop et al. 2000) (www.MARIANDA.com), is used for the potentiometric titration of total alkalinity and for total dissolved inorganic carbon with coulometer determination after phosphoric acid addition, with a usual precision of ± 1.0 µmol kg^{-1}. For alkalinity determination, 100 ml of seawater is titrated by adding HCl to the seawater past the carbonic acid end point. For the CT determination, a calibrated pipette of 20 ml of seawater is filled automatically by pumping and the seawater is injected in a scrubber containing 20 drops of phosphoric acid (10 % v/v) and the CO_2 released is trapped in a cathodic solution that is titrated coulometrically until the photometric end point. Each analysis takes about 20 minutes and a titration cell usually is valid for around 60 samples. The titration of CRMs for both parameters is used to test the performance of the equipment after the preparation of each titration cell.

Dissolved Oxygen: A titrator Titrino 804 (Metrohm™) with a platinum electrode will be computed-controlled to titrate a calibrated volume of seawater for dissolved oxygen concentration following the Winkler method according to https://cchdo.github.io/hdo-assets/documentation/manuals/pdf/91_1/dickson2.pdf. Samples of 120 ml of seawater will be used calibrated to 0.01 ml and titrated with $Na_2S_2O_3$ daily titrated against KIO_3 standard solution.

Sampling procedure: 500 ml glass bottles are used for the determination of both alkalinity and inorganic carbon. A 100 ml glass bottle will be used to analyze the dissolved oxygen concentration. The bottles are rinsed twice with seawater and over-filled with seawater. Samples are preserved in the dark and will be analyzed between the stations. In shallow stations and in case the samples are not possible to be analyzed for CT in less than 5 hours after sampling, they are poisoned with $HgCl_2$ solution. Our group will use around 1 liter of seawater for the full procedure. For samples at the polynya and below the sea ice, the samples can be taken by the QUIMA group or by groups working on the sea ice.

Expected results

We expect to get 100 % of each carbon dioxide system variables and oxygen data from each CTD cast, and a high-resolution data set for surface carbonate variables at the polynya.

Data management

Metadata of recorded data will be made available through the cruise report. CTD sampling data for carbon system variables and oxygen will be made available after validation through the PANGAEA database. Results will be used for publication in a high impact international journal in a collaborative AWI-ULPGC paper including the ULPGC members M. González-Dávila, J. M. Santana-Casiano (both at the ship) and D. González-Santana (on land).

Environmental data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (https://www.pangaea.de) within two years after the end of the cruise at the latest. By default, the CC-BY license will be applied.

In all publications, based on this cruise, the Grant No. AWI_PS129_02 will be quoted and the following *Polarstern* article will be cited:

Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (2017) Polar Research and Supply Vessel POLARSTERN Operated by the Alfred-Wegener-Institute. Journal of large-scale research facilities, 3, A119. http://dx.doi.org/10.17815/jlsrf-3-163.

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Panassa E, Santana-Casiano JM, González-Dávila M, Hoppema M, van Heuven SMAC, Völker C, Wolf-Gladrow D, Hauck J (2018) Variability of nutrients and carbon dioxide in the Antarctic Intermediate Water between 1990 and 2014. Ocean Dynamics, 68, 295-308.

5. IDENTIFYING THE CARBON THAT MATTERS: CHEMICAL CONTROLS ON ORGANIC MATTER AGGREGATION (COMA)

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Grant-No. AWI_PS129_07

Outline

The biological pump and its transport of particulate organic matter (POM) from the photic zone to the ocean floor and the formation and downwelling of CO_2 and recalcitrant dissolved organic matter (DOM) in the Southern Ocean are key regulators of the transfer of atmospheric CO_2 to long-term storage of carbon. The composition and distribution of organic matter is controlled by primary production and microbial activity, water mass mixing, physico-chemical degradation, and aggregation processes (Koch et al. 2014). DOM undergoes aggregation and binds to particles (*e.g.*, cells, fecal pellets and detritus), which contributes to deposition and sequestration of carbon and creates a major sink in the global carbon cycle. Despite the significant role of aggregation, very little is known about the accumulation rates and binding of low molecular organic matter and colloidal matter on macromolecules and particles.

Objectives

Taking advantage of the PS129 expedition, this project can address some of the central questions of the global carbon cycle, namely to derive a mechanistic understanding whether certain chemical classes within the DOM pool predominantly drive aggregation in the Southern Ocean and therefore impact the sequestration of atmospheric CO_2. The central objectives of this project therefore are to sample, isolate and structurally identify bacterially produced molecules that 1) act as coagulants and drive particle aggregation and 2) sample, isolate and structurally identify bacterially produced ligands that complex trace metals such as iron. A consequential objective is then to correlate the genetic diversity of bacteria and phytoplankton (*e.g.*, Bucklin et al. 2016) with aggregation rates and environmental parameters (iron stress, salinity and temperature).

Work at sea

The filtration and concentration of large amounts of particulate and dissolved OM is a prerequisite for the chromatographic isolation and identification of OM components as well as the exploration of the genetic diversity (DNA barcoding). Both phytoplankton species as well as clonal lines of bacterial strains will be isolated from single cells on board to be used in co-inoculation experiments in the home laboratories. To study the transition between dissolved, colloidal and particulate OM, DOM will be concentrated on functionalized solid phase extraction resins (Egbers et al. 2019) and then comparted to molecular signatures found in the POM.

Data management

Environmental data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (https://www.pangaea.de) within two years after the end of the cruise at the latest. By default, the CC-BY license will be applied.

Molecular data (DNA and RNA data) will be archived, published and disseminated within one of the repositories of the International Nucleotide Sequence Data Collaboration (INSDC, www.insdc.org) comprising of EMBL-EBI/ENA, GenBank and DDBJ).

Any other data will be submitted to an appropriate long-term archive that provides unique and stable identifiers for the datasets and allows open online access to the data.

In all publications, based on this cruise, the Grant No. AWI_PS129_07 will be quoted and the following *Polarstern* article will be cited:

Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (2017) Polar Research and Supply Vessel POLARSTERN Operated by the Alfred-Wegener-Institute. Journal of large-scale research facilities, 3, A119. http://dx.doi.org/10.17815/jlsrf-3-163.

This expedition was supported by the Helmholtz Research Programme “Changing Earth – Sustaining our Future” Topic 6, Subtopic 1, 6.2 and 6.3.

Third party funding for the following projects supporting this expedition is provided by the Priority Programme 1158 Antarctic Research with Comparable Investigations in Arctic Sea Ice Areas: “Recognition, signalling and response of the diatom Fragilariopsis to epibiotic bacterial colonization” Harder T and Tebben J; “Siderophore mediated iron acquisition of psychrophilic Antarctic marine bacteria” Tebben J, Harder T and Völker C; Identifying the carbon that matters: chemical controls on organic matter aggregation (COMA) Hoppema M, Koch B, Tebben J.

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Egbers PH, Harder T, Koch BP, Tebben J (2020) Siderophore purification with titanium dioxide nanoparticle solid phase extraction. Analyst, 145(22), 7303-7311.

Koch BP, Kattner G, Witt M, Passow U (2014) Molecular insights into the microbial formation of marine dissolved organic matter: recalcitrant or labile? Biogeosciences, 11, 4173-4190.

6. DRIVERS AND EFFECTS OF FLUCTUATIONS IN SEA ICE (DEFIANT) PROJECT

Jeremy Wilkinson[1], Povl Abrahamsen[1], Robbie Mallett[2]
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Grant-No. AWI_PS129_01

Outline

Despite global warming, Antarctic sea ice slightly expanded during most of the first four decades of satellite observations. However, in 2016 the Antarctic sea ice area plummeted, in a change far outside the range of previously observed variability. Neither the increasing trend nor the rapid decline are authentically simulated by climate models, casting doubt on their ability to represent associated processes including Southern Ocean heat and carbon uptake, melting of the Antarctic Ice Sheet, and many other aspects of the southern hemisphere climate. These recent extreme swings in Antarctic sea ice extent, and the challenge of accurately predicting, understanding and modelling them brings together UK scientists with collaborators from Australia, Canada, Germany, Norway and the Unites States as part of our project, DEFIANT (Drivers and Effects of Fluctuations in Antarctic sea Ice), to embark on one of the most ambitious observational campaigns aimed at understanding Antarctic sea ice variability.

Objectives

We focus on three areas (i) oceanography, (ii) sea ice and (iii) the deployment of four drifting buoys. We describe each, and their objectives, below:

(i) Oceanography

Performed from a) the ships' CTD / Rosette and b) on the sea ice itself.

a) CTD / Rosette additions

Seawater oxygen isotopic composition ($\delta^{18}O$)

We will assess changes in freshwater forcing (glacial, precipitation, sea ice melt) through the continuation of a long-term study of the freshwater budget derived from seawater oxygen isotopic composition ($\delta^{18}O$).

Turbulence

We will quantify turbulence within the sea ice and open-water zones through a large-scale microstructure temperature survey using the Chi-pod system to be installed on the *Polarstern*'s CTD rosette.

b) On sea ice turbulence measurements:

To utilize the helicopter to perform through-ice turbulence measurements away from the ship. These measurements will complement those made by the Chi-pod system and, importantly, allow us to obtain measurements in the uppermost water column, which is a region that is generally influenced by the ship.

(ii) Sea ice

Our sea ice measurements will be performed on the same floe as the on-ice turbulence measurements mentioned above. We have two objectives and success is reliant on access to the ship's helicopters. These are:

a) Under ice light

To perform measurements of incoming light spectra, snow / ice morphology and biological content to better understand light-extinction within Antarctic sea ice. These measurements will be made at several locations on a floe.

b) Radar

To better understand radar attenuation within the snow pack so that we can better interpret the returns from space-based sensors, such as *CryoSat2*. The radar will be a sled-based system, so that multi-location measurements can be obtained on one floe. Coincident snow and ice physics measurements will be made at each location radar where measurements are performed.

(iii) Buoy deployment

Our objective is to deploy four buoys, in sets of two. These will be deployed in the southern section of the Weddell Sea, ideally on floes as this gives them the best chance of surviving the freeze-up process. The buoys study atmosphere-ice-ocean interaction and thus monitor a number of different parameters. It is hoped that these systems will last a year.

Work at sea

Whilst at sea our work is split between

- Oceanographic work around the CTD stations which will encompass Seawater oxygen isotopic ($\delta^{18}O$) samples and turbulence measurements using the Chi-pod system which are to be installed on the *Polarstern's* CTD rosette.
- Sea-ice measurements performed from the ship's helicopter, i.e., identification of candidate floes from near real-time SAR imagery, moving team and equipment to candidate floe, performing measurements (radar, turbulence and under-ice light) on floe and coming back to the ship.
- Building up buoy systems, moving them to an open space of the ship's deck, testing systems and transmitting data to ensure all is working, and then deploying these systems.
- Helping out other teams as and when needed.

Expected results

We will use the observations we (and others) obtain from PS129 and the deployed buoys to constrain a hierarchy of numerical models and apply them to understand the processes controlling the historical decadal sea-ice expansion and 2016 decline. This will allow us to assess the short-term and decadal consequences of Antarctic sea ice variability. Through this interlinked programme of observations, model development and model evaluation, DEFIANT will deliver better understanding of the Antarctic sea ice system.

Data management

Environmental data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (https://www.pangaea.de) within two years after the end of the cruise at the latest. By default, the CC-BY license will be applied.

Any other data will be submitted to an appropriate long-term archive that provides unique and stable identifiers for the datasets and allows open online access to the data.

In all publications, based on this cruise, the Grant No. AWI_PS129_01 will be quoted and the following *Polarstern* article will be cited:

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7. EASTERN WEDDELL SEA OBSERVATION SYSTEM I (EWOS I)

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Not on board: Magnus Lucassen[1], Patricia Holm[3]

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Grant-No. AWI_PS129_04

Outline

The Weddell Sea (WS) features complex sea-ice dynamics and rich and diverse ecosystems. It plays an important role for global ocean circulation, sea-level dynamics, and carbon sequestration. Existing time series, spanning approximately 30 years, indicate that benthic community shifts in response to climate change are already underway in Southern Ocean (SO): a 1988 – 2014 record of macro- and megafauna from the north-eastern WS shelf indicated that benthic biomass decreased by two thirds and composition shifted from suspension feeders to deposit feeders (Pineda-Metz et al. 2020). To assess ecosystem diversity and functionality under a changing climate, this EWOS expedition aims to complement HAFOS with biological analyses of carbon and nutrient fluxes and cycles between atmosphere, sea ice, water column and the respective biota, including resilience analyses of marine living resources, such as Antarctic krill and Antarctic toothfish. With coordinated and systematic observations of the benthic realm on the shelf of the ecosystem in order to describe changes in the past and in the future, this study will act as a driver for the international research and monitoring activities to be carried out under the proposed Weddell Sea Marine Protected Area (WSMPA). Specifically, EWOS I will study the biodiversity as well as resilience, adaptation and acclimation capacities of benthic organisms. From a conservation perspective, we also aim to fathom direct and global human impacts on the ecosystem. Two work areas are foreseen: i) the shelf and inflow region off Kapp Norvegia, and ii) stations at the Antarctic Peninsula.

The expected results will provide valuable quantitative information on resilience of benthic and pelagic communities and ecosystem functions and stability of a rarely studied region and will also constitute an important baseline for the decision about the need for a long-term EWOS observatory.

Objectives

Environment and drivers: We will study key species responsible for the carbon and nutrient transfer – especially for carbon export to assess the role of the SO sea ice zone for global climate regulation.

Organisms and ecosystems – adaptations and biodiversity: We will determine the abundance, biomass and diversity of benthic fauna on the shelf and the shelf break in relation to organic carbon availability, seafloor substrate, and bottom current regime as a baseline to compare future change against. We aim to assess and explain taxonomic and functional biodiversity and composition of ice-associated, pelagic and benthic biota, encompassing a wide range of trophic levels (microbes to top predators) including energy flow, production and species interactions (symbioses).

We will identify key species for monitoring (ecologically important, all trophic levels), observe their stress response and assess their adaptive scope: genetic diversity, gene flow, and ecophysiological plasticity, adaptive strategies and capacities. This will result in an assessment of the robustness or sensitivity of Weddell Sea ecosystems with respect to changes in biodiversity and energy flow.

Ecosystem services: We will assess direct human impact such as the consequences of fishing pressure and indirect anthropogenic impacts such as global pollution by plastic debris – microplastic (MP, 300 µm – 5 mm) and small microplastic (SMP, 10 – 300 µm).

Work at sea

Fish and benthic ecophysiology: Information on key taxa will be collected by means of various methodological approaches. According to hydrographic, sonar and OFOBS observations along the transect from the ice edge to deep water, we will deploy benthic landers equipped with a small CTD device and carrying baited traps for benthopelagic fish and invertebrates between 250 and 1000 m depth. We will also carry out up to 8 Agassiz trawls (AGT) in areas of suitable biological diversity outside of the 'Special Protection Zone' identified in the WSMPA Phase 1 proposal. Adult specimens of the Antarctic toothfish *D. mawsoni* will be caught with long-lines deployed in depths of 500, 1000 and 1200 m in clusters of two. The design of the long-lines containing ≤ 200 baited hooks has been specifically adapted during PS117 with international collaborators (Dr. C. Jones, NOAA). Caught specimens will be measured according to CCAMLR specifications and selected individuals will be kept alive onboard for ecophysiological experiments. Up to 10 individuals will be tagged with satellite telemetry tags and released to study their migration and reproductive behaviour. All remaining living individuals will be tagged with CCAMLR standard tags and released for eventual recapture in the commercial fishery areas. We will measure and sample individuals from all catches (AGT, trap and longline catches, as well as SUIT, RMT (EWOS II)) for molecular and ecophysiological analyses. Biochemical and cell biology experiments (mitochondrial metabolism, protein synthesis) will be carried out on fish directly on board and several specimens sampled. Besides preserving tissues for future molecular studies, we will also extract high molecular weight genomic DNA as well as RNA from fresh tissues directly on board for subsequent (epi) genomic analysis in the home labs. Living individuals will be kept for further experiments onboard, as many individual fish as possible will be marked with visible implant elastomer (VIE) tags for eventual recaptures to determine field growth rate, migration behaviour and dispersal pathways.

Microplastic pollution: In addition to the samples taken for molecular biology, ecophysiology and biodiversity, EWOS also offers the opportunity to establish a monitoring baseline and follow the accumulation of microplastics in marine fish and invertebrates. These studies will be conducted by the team of the University of Basel on samples of all organism groups obtained during this cruise. More specifically, we will study (i) the occurrence of MP and SMP in abiotic samples, such as sea ice, marine snow, sediment and surface and sub-surface water, as well as deeper down in the water column (ii) gut content of zooplankton (e.g., krill), benthic organisms, as well as Antarctic fish. Water of the different layers, (i) surface, (ii) subsurface, (iii) deeper in the water column, will be sampled by (i) mobile bulk water pump, (ii) the seawater pump of *Polarstern*, and (iii) by CTD. The water sampled by all the devices will be filtered onto a sieve cascade of 300, 100, 20 and 10 µm stainless steel meshes. The further processing and analysis of MP will be done on board, as far as feasible (Burkhardt-Holm et al. 2019) while the SMP polymer analysis will be carried out by micro-FTIR and RAMAN spectroscopy, respectively, in the home laboratory and the laboratory of G. Gerdts, AWI (Mani et al. 2019).

Expected results

We expect to obtain a comprehensive dataset of the distribution and diversity of benthic and pelagic fauna in the different areas of investigation. We will gauge the limits of the acclimation capacities of selected species in climate change scenarios from the molecular to the whole animal level.

Our results shall help protect sympagic, pelagic and benthic ecosystems as potential refugia for, inter alia, top predators (e.g., marine mammals and seabirds), commercially exploited species (e.g., krill and Antarctic toothfish), fish and other ice dependent species, in order to maintain and/or enhance their resilience and ability to adapt to the effects of climate change. We will further contribute to identify scientific reference areas to monitor the effects of climate change, human activities (fishing, pollution) in representative Antarctic ecosystems and thereby support the establishment and implementation of the WSMPA.

Data management

Environmental data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (https://www.pangaea.de) within two years after the end of the cruise at the latest. By default, the CC-BY license will be applied.

Molecular data (DNA and RNA data) will be archived, published and disseminated within one of the repositories of the International Nucleotide Sequence Data Collaboration (INSDC, www.insdc.org) comprising of EMBL-EBI/ENA, GenBank and DDBJ).

Any other data will be submitted to an appropriate long-term archive that provides unique and stable identifiers for the datasets and allows open online access to the data.

In all publications, based on this cruise, the Grant No. AWI_PS129_04 will be quoted and the following *Polarstern* article will be cited:

Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (2017) Polar Research and Supply Vessel POLARSTERN Operated by the Alfred-Wegener-Institute. Journal of large-scale research facilities, 3, A119. http://dx.doi.org/10.17815/jlsrf-3-163.

This expedition was supported by the Helmholtz Research Programme “Changing Earth – Sustaining our Future” Topic 6, Subtopics 1 and 2.

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8. EASTERN WEDDELL SEA OBSERVATION SYSTEM II (EWOS II)

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Outline

The Weddell Sea features rich and diverse ecosystems and complex sea-ice dynamics. It plays a central role for global ocean circulation, sea-level change, and carbon sequestration, which are key topics of the new Helmholtz POF-IV research programme (topics 2, 4 and 6).

Multidecadal investigations led by AWI under the umbrella of HAFOS (Hybrid Antarctic Float and Ocean Observatory) contributed significantly to the understanding of ocean circulation and quantification of decadal oceanographic variability and warming trends. We intend to investigate if the established physico-chemical perspective of HAFOS can be extended by additional bioecological long-term observations in the form of an Eastern Weddell Sea Observation System (EWOS) focussing at coordinated and systematic observations of the sympagic, pelagic and benthic part of the ecosystem. The EWOS activities proposed here are a pilot study that will act as a nucleus for the international research and monitoring activities to be carried out under the proposed Weddell Sea Marine Protected Area (WSMPA). Specifically, this EWOS expedition studies carbon and nutrient fluxes and cycles between atmosphere, sea ice, water column and the respective biota, including marine living resources, such as Antarctic krill and Antarctic toothfish. Three work areas are planned: i) along the Prime Meridian Transect; ii) the shelf and inflow region off Kapp Norvegia, and iii) the central Weddell Gyre. The expected results will provide a quantitative assessment of the biogeochemical fluxes between phytoplankton and zooplankton communities as well as marine living resources in relation to environmental drivers, and associated passive and trophic carbon fluxes from the surface into the deep ocean. The results of this EWOS campaign will already provide valuable baseline knowledge for ecosystem functions.

Objectives

- Identification of key variables and drivers that structure the main ecosystem compartments sea ice, water column, and sea floor. Study of key variables of carbon, nutrient, and trace-element fluxes and cycling within and between these compartments, as well as the key species responsible for the carbon and nutrient transfer.
- Assess and explain taxonomic and functional biodiversity and composition of ice-associated, pelagic and benthic biota, encompassing a wide range of trophic levels (microbes to top predators) including energy flow, production and species interactions.

- Quantify the carbon sink, its drivers and temporal change and the role of the EWOS region for carbon sequestration by analyzing the biologically- and physically-mediated transport of carbon to the subsurface.
- Assess sympagic, pelagic and benthic ecosystems as potential refugia for, inter alia, top predators (e.g., marine mammals and seabirds), commercially exploited species (e.g., krill and Antarctic toothfish), fish and other ice-dependent species, in order to maintain and / or enhance their resilience and ability to adapt to the effects of climate change.
- Quantify primary production and DMSP production in sympagic and pelagic ecosystems of the EWOS region. Study of taxonomic and functional biodiversity to identify the key species contributing to DMSP production within these ecosystems.

Work at sea

SUIT sampling

A Surface and Under-Ice Trawl (SUIT; van Franeker et al. 2009) will be used to sample the pelagic fauna down to 2 m under the ice and in open surface waters. During SUIT tows, data from the physical environment will be recorded, e.g., water temperature, salinity, ice thickness, and multi-spectral light transmission. Core SUIT deployments will be conducted along transects from open water into the closed pack-ice and back in a restricted survey area which will be defined based on sea-ice conditions and biological indicators. Intermediate SUIT hauls will be conducted during the passage between moorings. At the planned ice stations, SUIT hauls will be conducted on arrival and / or departure to obtain the maximum possible comparability of under-ice species composition and abundance and under-ice sensor data with data collected during the ice stations.

Pelagic sampling

We aim to also investigate deeper-dwelling key species of the pelagic food web, such as euphausiids, amphipods, and myctophids. A Multiple opening Rectangular Midwater Trawl (M-RMT) will be used at many SUIT locations. For biomarker analysis, Particulate Organic Matter (POM) will be collected from filtered seawater obtained from the CTD rosette. Chlorophyll samples will be filtered from melted ice cores and CTD rosette water samples to calibrate fluorometers built in the ship’s CTD and the SUIT. In addition, *Polarstern*’s EK60 echosounder will be running during steaming to map the distribution of resources in the water column continuously and identify potential hot spots for target hauls for SUIT and M-RMT.

Sea ice work

Biota attached to underside of floating shelf ice (cryobenthos) will be monitored and sampled using a long-range ROV with sampling capability at up to 4 stations. Owing to its low weight, deployment of the SCINI ROV can utilize night hours since no heavy equipment needs to be operated. In addition, ice cores will be collected and sections will be sampled for physical sea ice parameters, such as salinity, temperature, ice thickness, as well as for biogeochemical sea ice parameters, such as pigments, nutrients, PAM-fluorometry, particulate organic carbon (POC), and dimethylsulfoniopropionate (DMSP). Additional samples will be filtered from melted ice cores for DNA analysis of microbial sea ice communities. Primary productivity and DMSP production of the bottom sea ice communities will be investigated during stable isotope addition experiments on board.

Biomarker analysis

For later biomarker and diet analysis, samples of phytoplankton, zooplankton, sea ice POM and water column POM collected with the CTD rosette, SUIT, other nets and ice corers will be stored in formaldehyde, ethanol or frozen at –80° C on board.

Top predator censuses

During steaming, surveys of top predator densities will be conducted mainly from observation posts installed on the flying bridge. Standard band transect methods are used, with snapshot methodology for birds in flight, and line-transect methods for marine mammals. In addition, such helicopter surveys will be offered for closer inspection of the surroundings of dive holes built for the recovery of moorings, checking for the presence of leopards seals.

Expected results

We expect to obtain a comprehensive dataset of the distribution and diversity of pelagic and under-ice fauna in the different areas of investigation. Biomarker and diet samples will be analyzed in the home laboratories and will contribute to a more quantitative understanding of the role of ice algal production and sea-ice associated zooplankton in the Antarctic food web. In combination with top predator census data interdependencies of the sea ice ecosystem may be mapped from the level of physical parameters to the distribution of large mammals.

Data management

Environmental data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (https://www.pangaea.de) within two years after the end of the cruise at the latest. By default, the CC-BY license will be applied.

Molecular data (DNA and RNA data) will be archived, published and disseminated within one of the repositories of the International Nucleotide Sequence Data Collaboration (INSDC, www.insdc.org) comprising of EMBL-EBI/ENA, GenBank and DDBJ).

Any other data will be submitted to an appropriate long-term archive that provides unique and stable identifiers for the datasets and allows open online access to the data.

In all publications, based on this cruise, the Grant No. AWI_PS129_05 will be quoted and the following *Polarstern* article will be cited:

Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (2017) Polar Research and Supply Vessel POLARSTERN Operated by the Alfred-Wegener-Institute. Journal of large-scale research facilities, 3, A119. http://dx.doi.org/10.17815/jlsrf-3-163.

This expedition was supported by the Helmholtz Research Programme “Changing Earth – Sustaining our Future” Topic 2,4 and 6, Subtopics 2.1, 2.2, 4.1, 6.1, 6.2, 6.3, 6.4.

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9. SEAFLOOR HABITATS AND BENTHIC FAUNA OF THE EASTERN WEDDELL SEA

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Overarching Outline

The Weddell Sea (WS) features complex sea-ice dynamics and rich and diverse ecosystems. It plays an important role for global ocean circulation, sea-level dynamics, and carbon sequestration. Existing time series, spanning approximately 30 years, indicate that benthic community shifts in response to climate change are already underway in Southern Ocean (SO) areas of intense environmental change, such as within the waters off the western Antarctic Peninsula (Montes-Hugo et al. 2009; Sahade et al. 2015), but also in the WS. In most of the SO, sea ice coverage increased between the 1970s and 2014 before it rapidly decreased. A 1988– 2014 record of macro- and megafauna from the north-eastern WS shelf indicated that benthic biomass decreased by two thirds and composition shifted from suspension feeders to deposit feeders (Pineda-Metz et al. 2020).

EWOS III aims at coordinated and systematic observations of the benthic realm on the shelf of the ecosystem in order to describe changes in the past and in the future. Thus, this study will act as a driver for the international research and monitoring activities to be carried out under the proposed Weddell Sea Marine Protected Area (WSMPA). Specifically, the EWOS III activities aim to complement HAFOS with biological analyses of carbon and nutrient fluxes to and from the sea floor, and the respective biota. Two work areas are foreseen: i) the shelf and inflow region off Kapp Norvegia, and ii) stations at the Antarctic Peninsula. The expected results will provide valuable quantitative information on benthic communities and ecosystem functions, such as carbon export and secondary production, from a rarely studied region and will also constitute an important baseline for the decision about the need for a long-term EWOS observatory. During the PS129 cruise in 2022, the planned EWOS III field studies comprise three interrelated components:

9.1 Seafloor habitat mapping and epibenthic megafauna

Outline

Seafloor habitats and their associated epibenthic megafauna will be investigated with the Ocean Floor Observation and Bathymetry System (OFOBS). To reveal temporal changes in habitats and communities, comparisons are carried out with data from historical stations. OFOBS is a towed device capable of deployment in moderately ice-covered regions and capable of concurrently collecting acoustic as well as video and still image data from the seafloor (Purser et al. 2018). The device is the latest iteration of the camera sleds used in Antarctica for several decades, and was deployed previously in the current configuration in the Weddell Sea during PS118 and PS124.

Objectives

The objective of this project is to (1) map the habitats, and (2) describe the biodiversity, abundance and biomass of megabenthic communities and (3) assess temporal changes in habitats and communities through comparison with surveys dating back to the 1980's. For habitat mapping, OFOBS data streams will be integrated to produce high-resolution 3D spatial models (topographic maps) of the seafloor. These models will allow subsequent high-resolution analysis on a finer scale than has previously been possible of terrain variables, such as slope, aspect and rugosity, and their relationship to iceberg scour marks and the distribution of benthic fauna in the PS129 research area. For the description of megabenthic communities and the biodiversity, OFOBS images will be surveyed for the composition, abundance and distribution of megabenthic assemblages. From this data ecological indices will be derived, the community structure be described, and changes to archived community data assessed. The species composition and diversity of the megabenthic communities will be related to environmental parameters and compared with data from previous ROV transects and underwater photographs to identify changes in communities, their function and species interactions and to be able to make predictions for future environmental scenarios.

Work at sea

Habitat mapping

OFOBS is a cabled / towed system deployed ~1.5 m above the seafloor at very low ship speeds of max. 0.5 knots (for more detailed information see Purser et al. (2018)). While in operation, the exact location of the georeferenced system is determined and verified continuously by *Polarstern*'s POSIDONIA system, and refined by the new integrated Inertial Navigation System (INS) and Dynamic Velocity Logger (DVL).

In addition to collecting image data comparable with those collected from Southern Ocean waters by previous survey cruises, OFOBS will also collect in parallel high resolution topographical information from the seafloor by using a sidescan sonar system and a forward-facing acoustic camera. The sidescan system allows a ~100 m swath of seafloor to be investigated acoustically at the same time as the collection of still and video camera images.

During recent cruises the facility for this combined system to generate useful data on geological structure distribution, high-resolution topographical products and faunal distribution maps has been demonstrated.

In addition to linear transects, we plan a 2D mattress in the area of the former iceberg disturbance experiment BENDEX (Gerdes et al. 2008) to obtain a high-resolution map of the communities nearly 20 years after the original experiment.

Megabenthic communities and biodiversity

Epifaunal megabenthos will be studied using OFOBS along transects. Videos and still images will later be analyzed for composition, abundance, and distribution of megabenthic assemblages, i.e., those seafloor organisms that are large enough to be identified from seabed images. Agassiz trawls (EWOS I) will help to groundtruth the identification of species and to test for correlation models of benthic abundance and visual benthic mapping.

Expected results

The expected results will provide a quantitative assessment of the megabenthic epifauna in relation to environmental drivers, and their habitats. The findings will provide valuable quantitative information on ecosystem functions, such as carbon export and secondary production, from a rarely studied region and will also constitute an important baseline for the decision about the need for a long-term EWOS observatory.

Data management

OFOBS still and video imagery, as well as acoustic data will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (https://www.pangaea.de) within two years after the end of the cruise at the latest. By default, the CC-BY license will be applied.

In all publications, based on this cruise, the Grant No. AWI_PS129_06 will be quoted and the following *Polarstern* article will be cited:

Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (2017) Polar Research and Supply Vessel POLARSTERN Operated by the Alfred-Wegener-Institute. Journal of large-scale research facilities, 3, A119. http://dx.doi.org/10.17815/jlsrf-3-163.

This expedition was supported by the Helmholtz Research Programme "Changing Earth – Sustaining our Future" Topic 6, Subtopic 1.

9.2 Macrobenthic communities and biodiversity

Outline

A 1988 – 2014 record of macro- and megafauna from the north-eastern WS shelf indicated that benthic biomass decreased by two thirds and composition shifted from suspension feeders to deposit feeders (Pineda-Metz et al. 2020). In order to reveal how climatic change affects macroinfauna, historical stations will be re-sampled. For this purpose, the methodology used in previous *Polarstern* expeditions (i.e., PS12, 48, 56, 84, 96) and the same sampling device (Multiboxcorer, MG) will be used in order to achieve comparability.

Objectives

The objective of this project is to describe the macro- and megafaunal communities and their biodiversity on the shelf and the shelf break in relation to organic carbon availability, seafloor substrate, and bottom current regime as a baseline for a possible future LTER programme. Composition, abundance and biomass of the respective taxonomic groups of the assemblages will be assessed. Taxonomic and functional biodiversity and composition of benthic biota will be linked to environmental data, compared with historical ones in order to reveal shifts in function, energy flow, production and species interactions to also allow for forecasts. Further objectives are to reveal the taxonomic identification of fauna also recorded by non-invasive benthic assessment methods (OFOBS) and thus allow for ground-truthing. The study will identify key species of macro- and megafauna for monitoring (ecologically important, all trophic levels), and assess robustness or sensitivity of Weddell Sea ecosystems with respect to changes in biodiversity and energy flow.

Work at sea

Infaunal macrobenthos will be sampled using a Multiple box corer (Mehrfachkastengreifer, MG), which allows parallel sampling of eight box-cores for adequate coverage (Pineda-

Metz et al. 2020). Samples will be sieved (0.5 mm mesh size) and preserved in 4 % buffered formaldehyde to be able to later determine macrobenthic abundance, biomass, composition, and distribution patterns.

Expected results

The expected results will provide a quantitative assessment of the benthic macroinfauna in relation to environmental drivers, and their habitats. The expected results will provide valuable quantitative information on ecosystem functions, such as carbon export and secondary production, from a rarely studied region and will also constitute an important baseline for the decision about the need for a long-term EWOS observatory.

Data management

Data on the abundance of the distinct infauna groups will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (https://www.pangaea.de) within two years after the end of the cruise at the latest. By default, the CC-BY license will be applied.

In all publications, based on this cruise, the Grant No. AWI_PS129_06 will be quoted and the following *Polarstern* article will be cited:

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This expedition was supported by the Helmholtz Research Programme “Changing Earth – Sustaining our Future” Topic 6, Subtopic 1.

9.3 Assessment of oxygen consumption, solute fluxes and particle reworking in relation to the benthic community

Outline

The intensity of interfacial solute exchange and particle reworking is related to the benthic infauna community (Renz & Forster 2013; Morys et al. 2017; Powilleit & Forster 2018). Both reflect organic matter mineralization. The latter is mirrored by the sediment depth dependent chlorophyll-*a* (Chl-*a*) decay or can be experimentally determined through the transport of particle tracers such as luminophores (Queirós et al. 2015). Both parameters together depend on the structure of distinct benthic assemblages and (habitat) conditions of the local environment, while their relation to microbial diversity has rarely been studied. These benthic processes are a missing component to estimate the overall role of benthos in potential carbon sequestration.

Objectives

The objective of this project is to quantify the short-term oxygen consumption, nutrient- and solute tracer fluxes as well as particle reworking activity at and below the sediment-water interface caused by macro- and meiobenthic communities. Bioturbation will be quantified in terms of diffusion-analogous (*Db*) and advective (*r*) transport coefficients by applying the data to a bioturbation model (Hedman et al. 2011). For the first time, the diversity of microbial communities will be assessed in parallel using amplicon sequencing. The relation of fluxes and particle reworking rates to faunal and microbial diversity, organic carbon and detritus availability and seafloor substrate will thus be determined.

Work at sea

Replicated TV-MUC cores taken at eight stations distributed in the EWOS III research area will be used to assess short-term oxygen consumption as well as nutrient- and solute tracer (Br^-) fluxes at the sediment-water interface. Measurements will use nutrient and oxygen concentrations in the water phase overlying the sediments in (dark) onboard 24 – 48 h incubation conducted in a temperature-controlled laboratory container. After incubations, macro- an meiofauna will be preserved for further analyses of biodiversity pattern (Link et al. 2013, 2016). Sediment subsamples will be taken from each core (sliced layers) to measure Chl-*a*, TOC, C/N and the solute tracer Br^- profiles. At selected stations, pore water will be extracted by use of rhizons from retrieved MUC cores. Subsamples for sediment, microbial and pore-water analyses (PO_4^{2-}, NO_3^- , SO_4^{2-}, H_2S, Br^-) will be frozen for later measurements at the University of Rostock and IOW. Furthermore, a repeated sampling of one station with the TV-MUC at the Antarctic Peninsula, successfully sampled during PS81 and PS96 is planned.

At two stations, additional cores from additional TV-MUCs will be obtained for experimental work. Experiments will test the influence of key macrobenthic species in the area on oxygen consumption and particle reworking through addition of luminophores (Queirós et al. 2015). After the experiments, MUC sediments will also be sieved (1 mm mesh size) and preserved in 4 % buffered formaldehyde for subsequent determination of macrobenthic abundance, biomass and species depth distribution. Three replicates of sediment subsamples of each core will be sliced in 1 cm layers and stored frozen until further determination of luminophore distribution at the University of Rostock.

Expected results

The expected results will reveal the oxygen consumption and nutrient fluxes at the sediment-water interface caused by macro- and meiobenthic communities in relation to organic carbon availability, seafloor substrate, and microbial diversity. Furthermore solute (Br^-) and particulate tracer (Chl-*a*, luminophores) distributions in the sediment will be used for modelling bioirrigation and bioturbation processes, which are at present scarcely available in the Weddell Sea. Results from the repeated station will allow placing EWOS III results in the larger spatial and temporal context necessary to decide on potential LTER programme sites.

Data management

Data on oxygen consumption, nutrient fluxes, particle reworking activity and community composition of the respective benthic assemblages will be archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (https://www.pangaea.de) within three years after the end of the cruise at the latest. By default, the CC-BY license will be applied.

In all publications, based on this cruise, the Grant No. AWI_PS129_06 will be quoted and the following *Polarstern* article will be cited:

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APPENDIX

A.1 TEILNEHMENDE INSTITUTE / PARTICIPATING INSTITUTIONS

A.2 FAHRTTEILNEHMER / CRUISE PARTICIPANTS

A.3 SCHIFFSBESATZUNG / SHIP'S CREW

A.1 TEILNEHMENDE INSTITUTE / PARTICIPATING INSTITUTIONS

Affiliation	Address
BE.IRSNB	Institut Royal des Sciences Naturelles de Belgique Directorate Natural Enviroment Rue Vautier 29 1000 Brussels Belgium
BE.VLIZ	Flanders Marine Institute Wandelaarkaai 7 8400 Oostende Belgium
CH.UNIBAS	Universität Basel Department Umweltwissenschaften Vesalgasse 1 4051 Basel Switzerland
DE.AWI	Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung Postfach 120161 27515 Bremerhaven Germany
DE.DWD	Deutscher Wetterdienst Seewetteramt Bernhard-Nocht-Straße 76 20359 Hamburg Germany
DE.HeliService	Heli Service International GmbH Gorch-Fock-Straße 105 26721 Emden Germany
DE.HSB	Hochschule Bremerhaven An der Karlstadt 8 27568 Bremerhaven Germany
DE.IOW	Leibniz-Institut für Ostseeforschung Seestraße 15 18119 Rostock/Warnemünde Germany

Affiliation	Address
DE.UNI-Rostock	Albert-Einstein-Str. 21 18059 Rostock Germany
ES.ULPGC	Universidad de Las Palmas de Gran Canaria Facultad de Ciencias del Mar Campus de Tafira 35017 Las Palmas de Gran Canaria Spain
GOV.NOAA	National Oceanic and Atmospheric Administration 8901 La Jolla Shores Dr. 92037 La Jolla, CA U.S.A.
IT.UNIPD	Universita Degli Studi Di Padova Via U. Bassi 58/b 35121 Padova Italy
NL.DORSSEN	M van Dorssen Metaalbewerking Schilderend 113 1791 BE Den Burg The Netherlands
NL.NIOZ	Koninklijk Nederlands Instituut voor Onderzoek der Zee P.O. Box 59 1790 AB Den Burg The Netherlands
NL.RUG	Rijksuniversiteit Groningen P.O. Box 11103 9700 CC Groningen The Netherlands
NL.WUR	Wageningen Marine Research Ankerpark 27 1781 AG Den Helder The Netherlands
UK.BAS	British Antarctic Survey High Cross, Madingley Rd. CB3 0ET Cambridge United Kingdom
UK.EBI	EMBL's European Bioinformatics Institute Wellcome Genome Campus Hinxton, Cambridgeshire CB10 1SD United Kingdom

Affiliation	Address
UK.NOTTING	University of Nottingham Sutton Bonington Campus LE12 5RD Nottingham United Kingdom
UK.UCL	University College London Centre for Polar Observation and Modelling London
UK.UNI-Liverpool-EOE	University of Liverpool Department of Earth, Ocean and Ecological Sciences 4 Brownlow Street L69 3GP Liverpool

A.2 FAHRTTEILNEHMER / CRUISE PARTICIPANTS

Name / Last name	**Vorname / First name**	**Institut / Institute**	**Beruf / Profession**	**Fachrichtung / Discipline**
Abrahamsen	Povl	UK.BAS	Scientist	Oceanography
Bach	Mareike Gabriele	NL.RUG	PhD candidate	Biology
Barnes	David	UK.BAS	Scientist	Biology
Beyer	Andrea Kerstin	DE.AWI	Technician	Biology
Boebel	Olaf	DE.AWI	Scientist	Oceanography
Chakrabarti	Lisa	UK.NOTTING	Scientist	Biology
Christensen	Jonas Overby	DE.HeliService	Pilot	Helicopter Service
Engicht	Carina	DE.AWI	Technician	Oceanography
Erni Cassola e Barata	Gabriel	CH.UNIBAS	Scientist	Biology
Feij	Bram	NL.NIOZ	Observer	Biology
Flores	Hauke	DE.AWI	Scientist	Biology
Gebhardt	Christopher	DE.UNI-Rostock	Scientist	Biology
González-Dávila	Melchor	ES.ULPGC	Scientist	Oceanography
Graeve	Martin	DE.AWI	Scientist	Chemistry
Allerholt	Jacob	DE.AWI	Technician	Oceanography
Hecken	Timo	DE.HeliService	Technician	Helicopter Service
Held	Christoph	DE.AWI	Scientist	Biology
Hoppema	Mario	DE.AWI	Scientist	Oceanography
Jones	Christopher	GOV.NOAA	Scientist	Biology
Kempf	Sarah	DE.AWI	PhD candidate	Biology
Koch	Boris	DE.AWI	Scientist	Chemistry
Koschnick	Nils	DE.AWI	Engineer	Biology
Kühn	Susanne	NL.WUR	Scientist	Biology
Leuenberger	Kevin	CH.UNIBAS	Student (Master)	Biology
Link	Heike	DE.UNI-Rostock	Scientist	Biology
Llanillo del Rio	Pedro Jose	DE.AWI	Scientist	Oceanography
Laudien	Jürgen	DE.AWI	Scientist	Biology

Name / Last name	**Vorname / First name**	**Institut / Institute**	**Beruf / Profession**	**Fachrichtung / Discipline**
Ludwichowski	Kai-Uwe	DE.AWI	Engineer	Chemistry
Mallett	Robbie	UK.UCL	PhD candidate	Oceanography
Mark	Felix	DE.AWI	Scientist	Biology
Meijboom	André	NL.WUR	Scientist	Biology
Otte	Frank	DE.DWD	Scientist	Meteorology
Pallentin	Malte	DE.AWI	Engineer	Biology
Papetti	Chiara	IT.UNIPD	Scientist	Biology
Parcerisas Serrahima	Clea	BE.VLIZ	PhD candidate	Engineering Sciences
Pinner	Ole	DE.AWI	PhD candidate	Oceanography
Piotrowski	Lukas	DE.HeliService	Pilot	Helicopter Service
Powilleit	Martin	DE.UNI-Rostock	Scientist	Biology
Purser	Autun	DE.AWI	Scientist	Biology
Roca Torrecilla	Irene	DE.AWI	Scientist	Biology
Santana Casiano	Juana Magdalena	ES.ULPGC	Scientist	Oceanography
Schröder	Henning	DE.AWI	Engineer	Engineering Sciences
Spiesecke	Stefanie	DE.AWI	Engineer	Oceanography
Stenssen	Willem Albertus	DE.HeliService	Engineer	Helicopter Service
Suter	Patrick	DE.DWD	Scientist	Meteorology
Tebben	Jan	DE.AWI	Scientist	Chemistry
Tippenhauer	Sandra	DE.AWI	Scientist	Oceanography
Van de Putte	Anton	BE.IRSNB	Scientist	Biology
van Dorssen	Michiel	NL.DORSSEN	Technician	Biology
Vortkamp	Martina	DE.AWI	Technician	Biology
Wilkinson	Jeremy	UK.BAS	Scientist	Oceanography

A.3 SCHIFFSBESATZUNG / SHIP'S CREW

No.	Nachname	Vorname	Position
1	Wunderlich	Thomas Wolf	Master
2	Kentges	Felix	Chiefmate
3	Langhinrichs	Jacob	Chiefmate Cargo
4	Grafe	Jens	Chief
5	Fallei	Holger	2nd Mate
6	TBN		2nd Mate
7	Müller	Andreas	ELO
8	Goessmann-Lange	Petra	Ships Doc
9	Brose	Thomas Christian Gerhard	2nd. Eng
10	TBN		2nd. Eng
11	Haack	Michael Detlev	2nd. Eng
12	Redmer	Jens Dirk	ELO
13	Frank	Gerhard	ELO
14	Hüttebräucker	Olaf	ELO
15	Nasis	Ilias	ELO
16	Kliemann	Olaf	ELO
17	Sedlak	Andreas Enrico	Bosun
18	Neisner	Winfried	Carpen.
19	Heinstein	Patricia	MP Rat.
20	TBN		MP Rat.
21	Hoche	Jan	MP Rat.
22	TBN		MP Rat.
23	Mohr	Tassilo Peter	MP Rat.
24	Denzer	Florian	MP Rat.
25	Wende	Uwe	AB
26	Baecker	Andreas	AB
27	Burzan	Gerd-Ekkehard	AB
28	Preußner	Jörg	Storek.
29	Schwarz	Uwe	MP Rat.
30	TBN		MP Rat.
31	Rhau	Lars-Peter	MP Rat.
32	Klinger	Dana	MP Rat.

33	Waterstradt	Felix	MP Rat.
34	TBN		Cook
35	Silinski	Frank	Cooksm.
36	TBN		Cooksm.
37	Pieper	Daniel	Chief Stew.
38	Braun	Maja Alexandra	Nurse
39	Silinski	Carmen Viola	2nd Stew.
40	Krause	Tomasz	2nd Stew.
41	Dibenau	Torsten	2nd Stew.
42	Arendt	René	2nd Stew.
43	Chen	Dansheng	2nd Stew.
44	Sun	Yongsheng	Laundym.