



Seabed images from Southern Ocean shelf regions off the northern Antarctic Peninsula and in the southeastern Weddell Sea

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Abstract. Recent advances in underwater imaging technology allow for gathering invaluable scientific information on sea-floor ecosystems, such as direct in-situ views of seabed habitats and quantitative data on composition, diversity, abundance and distribution of epibenthic fauna. The imaging approach has been extensively used within the research project Dynamics of Antarctic Marine Shelf Ecossystems (DynAMo) of the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research Bremerhaven (AWI), which aimed to comparatively assess the pace and quality of the dynamics of Southern Ocean benthos. Within this framework, epibenthic spatial distribution patterns have been comparatively investigated in two regions of the Atlantic sector of the Southern Ocean, the shelf areas off the northern tip of the Antarctic Peninsula, representing a region with above-average warming of surface waters and sea-ice reduction, and the shelves of the eastern Weddell Sea, as an example of a stable high-Antarctic marine environment that is not (yet) affected by climate change. The Ocean Floor Observation System (OFOS) of the AWI was used to collect seabed imagery during two cruises of the German research vessel *Polarstern*, ANT-XXIX/3 (PS81) to the Antarctic Peninsula in January-March 2013 and ANT-XXXI/2 (PS96) to the Weddell Sea from December 2015 to February 2016. Here, we report on the image and data collections gathered during these cruises. During PS81, OFOS was successfully deployed at a total of 31 stations at water depths between 29 and 784 m. At most stations, series of 500 to 530 pictures (> 15,000 in total, each depicting a seabed area of approx. 3.45 m² (= 2.3 m x 1.5 m)) were taken along transects of approx. 3.7 km length. During PS96, OFOS was used at a total of 13 stations at water depths between 200 and 754 m, yielding series of 110 to 293 photos (2,670 in total) along transects of 0.9 to 2.6 km length. All seabed images taken during the two cruises, including metadata, are available from the data publisher PANGAEA via the two persistent identifiers doi:10.1594/PANGAEA.872719 (for PS81) and doi:10.1594/PANGAEA.862097 (for PS96).



1 Introduction

The research project *Dynamics of Antarctic Marine Shelf Ecosystems* (DynAMo) of the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research Bremerhaven (AWI), aimed to comparatively assess the pace and quality of the dynamics of Southern Ocean benthos and endotherms. It is a contribution to the international Scientific Research Program

- 5 *Antarctic Thresholds – Ecosystem Resilience and Adaptation* (AnT-ERA) of the *Scientific Committee on Antarctic Research* (SCAR). Applying a comparative field study approach, the geographical focus of DynAMo was on an area with above-average warming of surface waters and sea-ice reduction around the tip of the Antarctic Peninsula (Gutt, 2013; Gutt et al., 2016) and a stable high-Antarctic marine environment that is not (yet) affected by climate change in the southeastern Weddell Sea (Schröder, 2016).
- 10 Special emphasis has been on the study of spatial distribution patterns of shelf megabenthic epifauna. According to an often used pragmatic definition proposed by Gage and Tyler (1991), this seabed community fraction comprises all organisms that are large enough to be visible in seabed images and/or to be caught by towed sampling gear (i.e., organisms of body sizes larger than approximately 1 cm). They are of ecological significance for Southern Ocean shelf ecosystems (Gutt, 2006), as they affect the small-scale topography of seafloor habitats and, hence, the structure of the entire benthic community (Gili et
- 15 al., 2006). In addition, they contribute to biogeochemical cycling, e.g. recycling of nutrients and sequestration of carbon and silicate. Moreover, some megabenthic species are sensitive to environmental change, due to their slow growth, specific reproduction mode, high degree of environmental adaptation, and narrow physiological tolerances, and can thus serve as early indicators of ecosystem shifts in response to environmental change (Barnes et al., 2009).

Based on several investigations performed during previous cruises of the German research vessel *Polarstern* to the Antarctic Peninsula and the Weddell Sea, we have carried out comparative follow-up field studies in austral summers of 2013 and

20 2015/16, the main objectives of which were:

- Complement surveys of mega-epibenthic assemblages of the shelf off the northern Antarctic Peninsula (cruise PS81 2013) and of the southeastern Weddell Sea (cruise PS96 2015/16), providing further data comparable with those gained in earlier studies in these regions (Biebow et al., 2014)
- 25 • Identify spatial distribution patterns of epibenthic megafauna across multiple spatial scales (10-m, 100-m, 10-km, 100-km)
- Contribute to the standardization of the classification of Antarctic megabenthic communities (Gutt, 2007; Gutt, 2013)

Seabed images are used for different purposes: (1) to assess the large epibenthos as a whole, (2) to carry out quantitative community and diversity analyses, (3) to include environmentally relevant (e.g., CTD data if CTD sensors are integrated in

30 OFOS) and visible seabed parameters (e.g., amount of gravel, debris, ripple marks) at exactly the same spots from which the biological information originates, (4) to allow analyses with high spatial resolution (patterns within and between adjacent photographs, e.g. to survey the impact of iceberg scouring), (5) to acquire information of biological interactions such as epibiotic life mode.

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2 Material and methods

2.1 Ocean Floor Observation System

The Ocean Floor Observation System (OFOS) of the AWI was used for seabed imaging surveys along drift profiles (transects) to investigate the epibenthic megafauna and its seafloor habitats. The setup and mode of deployment of OFOS

40 was similar to that described by Bergmann and Klages (2012). OFOS is a surface-powered gear (Fig. 1), equipped with two downward-looking cameras installed side-by-side: a high-resolution, wide-angle still camera (CANON® EOS 5D Mark III;



lens: Canon EF 24 f/1.4L II, f stop: 13, exposure time: 1/125 sec; in-air view angles: 74° (horizontal), 53° (vertical), 84° (diagonal); image size: 5760 x 3840 px = 21 MPix; front of pressure resistant camera housing consisting of plexiglas dome port) and [only in 2015/16] a high-definition colour video camera (SONY® FCB-H11). During cruise PS81, OFOS did not feature the video camera yet.

- 5 The system was vertically lowered over either the starboard side (PS81) or the stern of the ship (PS96) with a broadband fibre-optic cable, until it hovered approximately 1.5 m above the seabed. It was then towed after the slowly sailing ship at a speed of approximately 0.5 kn (0.25 m s⁻¹). The ship's POSIDONIA (PS81) or Global Acoustic Positioning System (GAPS) (PS96), combining Ultra Short Base Line (USBL), Inertial Navigation System (INS) and satellite-based Global Positioning System (GPS) technologies, was used to gain highly precise underwater position data of the OFOS.
- 10 During the profile, OFOS was kept hanging at the preferred height above the seafloor by means of the live video feed and occasional minor cable-length adjustments with the winch to compensate small-scale bathymetric variations in seabed morphology. Information on water depth and height above the seafloor were continuously recorded by means of OFOS-mounted sensors (POSIDONIA transponder in 2013, GAPS transponder in 2015/16, Tritech altimeter during both PS81 and PS96).
- 15 Three lasers, which are placed beside the still camera, emit parallel beams and project red light points, arranged as an equilateral triangle with a side length of 50 cm, in each photo, thus providing a scale that can be used to calculate the seabed area depicted in each image and/or measure the size of organisms or seabed features visible in the image. In addition, the seabed area depicted was estimated using altimeter-derived height above seafloor and optical characteristics of the OFOS still camera.
- 20 In automatic mode, a seabed photo, depicting an area of approximately 3.45 m² (= 2.3 m x 1.5 m; with variations depending on the actual height above ground), was taken every 30 seconds to obtain series of "TIMER" stills distributed at regular distances along the profiles that vary in length depending on duration of the cast. At a ship speed of about 0.5 kn, the average distance between seabed images was approximately 5 m. Additional "HOTKEY" photos were taken from interesting objects (organisms, seabed features, such as putative iceberg scours) when they appeared in the live video feed, which was recorded,
- 25 in addition to the stills, for documentation and later analysis.

2.2 Field sampling

- Within the context of the overall ecological DynAMo working programme, OFOS was used to collect seabed imagery during two cruises of RV *Polarstern*: the ANT-XXIX/3 (PS81) cruise to the Antarctic Peninsula in January-March 2013 (for
- 30 cruise report see Gutt, 2013) and the ANT-XXXI/2 (PS96) cruise to the Weddell Sea from December 2015 to February 2016 (for cruise report see Schröder, 2016).

2.2.1 *Polarstern* cruise ANT-XXIX/3 (PS81)

- During cruise PS81, OFOS was successfully deployed at a total of 31 stations at water depths between 29 and 784 m (Table 1), delivering a total of more than 15,000 seabed photos (Gutt, 2013). At most stations, series of 500 to 530 pictures were
- 35 taken along transects of approx. 3,700 m (2 nautical miles) length during net wire times (with OFOS at the bottom) of four hours per transect. At some stations, OFOS had to be deployed for shorter periods of time due to high wave heights and strong winds.

The stations were placed in three regions off the Antarctic Peninsula between 61°S and 64°S: the northwestern Weddell Sea off Joinville Island, the southern Bransfield Strait and the southern Drake Passage west of South Shetland Islands (Fig. 2).

- 40 These regions are well suited for a comparative ecological study with a biogeographic/ecological background, since they are characterized by different environmental conditions in terms of sea-ice coverage, current regime, and food supply to the



benthos. Within these regions, regional habitat blocks were selected, which comprised bathymetric intermediate-scale shelf-slope gradients (Gutt et al., 2016; Dorschel et al., 2016). In the Bransfield Strait, such bottom-topography structures were most obvious, and three distinct habitat blocks were sampled. Within the blocks, single stations were associated to the following defined, primarily depth-related habitats: bank, upper slope, slope, and deep/canyon. In the Drake Passage, where the bottom topography was similar, albeit less pronounced as in the Bransfield Strait, also three habitat blocks were sampled. In the northern Weddell Sea, stations were selected to cover a range of habitats that are as comparable as possible to those sampled in the Bransfield Strait. Four stations were situated at the northeastern side of the Nachtigaller Shoal on the western Weddell Sea shelf (Dorschel et al., 2014).

Figure 3 is an example of a seabed photo taken along the OFOS transect at station PS81/110, showing rich megabenthic epifauna (e.g., abundant ascidians and a swarm of demersal nototheniid fish) on the shelf off Joinville Island in the eastern Bransfield Strait at 212 m water depth on January 26, 2013.

2.2.2 *Polarstern* cruise ANT-XXXI/2 (PS96)

During cruise PS96, OFOS was deployed at a total of 13 stations at water depths between 200 and 754 m (Table 2). During the casts of 0:54 to 2:14 hours on-ground duration, series of 110 to 293 photos (2,670 in total) were obtained along OFOS transects of 0.9 to 2.6 km length. In addition, more than a total of 14:50 hours of video footage (available from first author on request) were recorded.

OFOS stations were distributed over several regions in the southeastern and southern Weddell Sea (Fig. 4): (1) Off Austasen, one transect (PS96/001) was positioned in close vicinity to the BENDEX sites investigated in 2003, 2011 and 2014 (Biebow et al., 2014). Unfortunately, the actual main BENDEX location, artificially disturbed in 2003, could not be revisited, since in December 2015 it was located under fast ice and, hence, not accessible. (2) Four stations (PS96/026, 027, 037 and 048) were located in the main study area of the PS96 cruise, the broad shelf of the southern Weddell Sea west of Filchner Trough. (3) Five stations (PS96/007, 008, 010, 057 and 061) were situated on the shelf east of Filchner Trough. Some of these stations were revisits of sites that had been investigated during *Polarstern* cruise PS82 in 2014 (Knust and Schröder, 2014), using seabed imaging gears other than OFOS: a) Station PS96/008 was close to the position of St. PS82/277 (74°54.3'S, 29°40.1'W), where in 2014 evidence of demersal eggs and nest-parental care behaviour (guarded fishnests) had been recorded; b) Station PS96/057 was a revisit of a ROV track made in 2014 (from 79°19.1'S, 29°02.0'W to 79°19.3'S, 29°00.9'W; available on request from Claudio Richter, AWI), where close to the coast of Coats Land, at water depths of about 240 m, a rich sponge-dominated seabed fauna had been recorded. (4) One station (PS96/072) was located in Filchner Trough itself, at about 750 m depth. (5) Two additional stations (PS96/090 and 106) were situated on the southeastern Weddell Sea shelf, close to the mouths of inlets in the edge of the Riiser-Larsen Ice Shelf.

As an example of prominent epibenthic megafauna recorded in seabed photos taken during PS96, see Figure 5 showing a compilation of organisms photographed along the OFOS transect at station PS96/090 on the shelf off the Riiser-Larsen Ice Shelf (Rampen) at water depths from 265 to 310 m on January 29, 2016.

3 Data availability and use

All images taken during the two cruises, including metadata, are available from the data publisher PANGAEA (Piepenburg et al., 2013, for PS81; Piepenburg, 2016, for PS96). Images are listed with georeference and time for each transect in single child datasets. All transects of each cruise are grouped in a parent dataset (PS81: <https://doi.pangaea.de/10.1594/PANGAEA.872719>; PS96: <https://doi.pangaea.de/10.1594/PANGAEA.862097>). This granularity ensures detailed metadata information for each image and each transect. A station map in Google Earth format



(kmz) is provided with hot links to the images, see ‘Further details’ in the dataset description in PANGAEA. For convenient download of one or multiple image datasets from PANGAEA, special software tools (including instructions how to install and use them) are available (Sieger, 2012; Buschmann, 2016). Ancillary environmental data for PS81 can be found in Dorschel et al. (2016).

- 5 An example for a scientific study based on the analyses of the seabed images, the collection of which are reported here, is an investigation of the composition and distribution patterns of the epibenthic ascidian fauna on the shelves off the Antarctic Peninsula (Segelken-Voigt et al., 2016b). The supplementary information used in this study, including environmental data, is also available at PANGAEA (Segelken-Voigt et al., 2016a). A second example is the investigation of the influence of geo-morphological and sedimentological settings on the distribution of epibenthic assemblages on the Nachtigaller Shoal, a flat-topped submarine hill at the over-deepened shelf of the western Weddell Sea that has been discovered during the PS81 cruise in 2013 (Dorschel et al., 2014).

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CAPTIONS

Table 1: List of stations at which the Ocean Floor Observation System (OFOS) was deployed during *Polarstern* cruise ANT-XXIX/3 (PS81) to the waters off the northern Antarctic Peninsula in January-March 2013.

5 **Table 2:** List of stations at which the Ocean Floor Observation System (OFOS) was deployed during *Polarstern* cruise ANT-XXXI/2 (PS96) to the Weddell Sea in December 2015-February 2016.

10 **Figure 1:** Ocean Floor Observation System (OFOS) of the Alfred Wegener Institute (AWI), Helmholtz Centre for Polar and Marine Research Bremerhaven, deployed from RV *Polarstern* during cruise PS81 to the waters off the northern Antarctic Peninsula in January-March 2013 (photo: A. Segelken-Voigt).

Figure 2: Map of the geographic positions of stations, at which seabed photographs were taken by means of OFOS along photographic transects in three regions (Weddell Sea, Bransfield Strait, Drake Passage) off the northern Antarctic Peninsula during *Polarstern* cruise ANT-XXIX/3 (PS81) in January-March 2013.

15 **Figure 3:** Example of a seabed photo taken during *Polarstern* cruise PS81 ANT-XXIX/3 (PS81) January-March 2013, showing abundant ascidians and a swarm of demersal nototheniid fish recorded along the OFOS transect at station PS81/116 on the shelf off Joinville Island in the eastern Bransfield Strait at 212 m water depth on January 26, 2013

Figure 4: Maps showing the geographic positions of OFOS stations in the Weddell Sea during *Polarstern* cruise ANT-XXXI/2 (PS96) in December 2015-February 2016 (after Schröder 2016). Bathymetric data acquired from IBCSO (Arndt et al. 2013).

20 **Figure 5:** Example of photographic material gathered during *Polarstern* cruise PS96 ANT-XXXI/2 (PS96) to the Weddell Sea December 2015-February 2016, showing a compilation of epibenthic megafauna recorded along the OFOS transect at station PS96/090 on the shelf off the Riiser-Larsen Ice Shelf (Rampen) at water depths from 265 to 310 m on January 29, 2016 (collage created by H. Grobe, using Photoshop to collate clips from 25 seabed images).



Table 1

PS81/ #	Area	Start Transect				End Transect				Duration (h)
		Date/Time	Latitude (S)	Longitude (W)	Depth (m)	Date/Time	Latitude (S)	Longitude (W)	Depth (m)	
116	Joinville Island North Bank	2013-01-26 11:40	62°33.88846'	56°23.54047'	201	2013-01-26 15:36	62°33.77724'	56°27.23258'	249	3:58
118	Joinville Island North Depression	2013-01-27 08:25	62°27.21296'	56°15.88939'	419	2013-01-27 12:25	62°25.54464'	56°17.21200'	448	4:10
159	Joinville Island East Depression	2013-02-08 04:38	63°04.87023'	54°32.71884'	518	2013-02-08 08:31	63°05.28929'	54°28.95352'	474	3:52
160	Joinville Island East Bank	2013-02-08 16:36	63°10.18160'	54°07.01506'	215	2013-02-08 20:14	63°10.97898'	54°05.84667'	248	3:38
161	Erebus & Terror Gulf Bank	2013-02-09 22:24	64°00.46051'	56°43.85487'	218	2013-02-10 02:15	64°00.17069'	56°40.03329'	251	4:31
163	Erebus & Terror Gulf Deep Shelf	2013-02-10 19:58	63°53.09911'	56°26.33014'	467	2013-02-10 23:34	63°51.17350'	56°25.43633'	514	3:36
164	Dundee Island Bank	2013-02-11 11:59	63°37.17158'	56°13.55894'	197	2013-02-11 15:58	63°36.89483'	56°09.11971'	100	3:47
185	Nachtigaller Shoal	2013-02-19 06:26	63°53.22734'	55°37.61190'	35	2013-02-19 10:25	63°51.20534'	55°36.32512'	397	4:01
186	Nachtigaller Shoal	2013-02-19 16:35	63°54.13320'	55°34.53080'	31	2013-02-19 20:36	63°51.90430'	55°33.77545'	362	4:04
188	Nachtigaller Shoal	2013-02-20 06:30	63°52.24563'	55°34.01042'	316	2013-02-20 10:30	63°50.41847'	55°33.67264'	413	4:00
189	Nachtigaller Shoal	2013-02-20 17:26	63°53.57372'	55°35.51688'	29	2013-02-20 18:27	63°53.15766'	55°34.70198'	186	1:00
192	Bransfield Strait East Canyon	2013-02-22 19:00	62°44.03795'	57°30.97398'	460	2013-02-22T22:59	62°43.36775'	57°26.93258'	416	4:01
194	Bransfield Strait East Bank	2013-02-23 18:26	62°44.83983'	56°56.55342'	183	2013-02-23 22:25	62°43.81675'	56°53.39118'	195	3:59
196	Bransfield Strait East Slope	2013-02-24 09:20	62°48.20766'	57°06.08067'	490	2013-02-24 13:19	62°48.05814'	57°01.70616'	311	4:00
197	Bransfield Strait East Upper Slope	2013-02-25 08:24	62°45.39565'	57°28.15632'	232	2013-02-25 12:20	62°44.19235'	57°25.24211'	297	3:56
198	Bransfield Strait Central Bank	2013-02-26 07:39	63°02.31317'	58°07.10720'	165	2013-02-26 11:43	63°01.69328'	58°02.96777'	190	4:01
199	Bransfield Strait Central Upper Slope	2013-02-26 16:01	62°57.50145'	58°14.02833'	410	2013-02-26 19:40	62°56.66211'	58°11.83289'	250	3:00
200	Bransfield Strait Central Bank	2013-02-27 09:34	63°00.05927'	58°07.36271'	219	2013-02-27 11:11	63°00.02188'	58°05.57044'	232	1:49
204	Bransfield Strait West Canyon	2013-02-28 06:27	62°56.13385'	57°59.63105'	781	2013-02-28 10:15	62°55.99081'	57°55.56216'	737	4:49
215	Bransfield Strait Central Slope	2013-03-01 20:42	62°53.57811'	58°14.76205'	546	2013-03-02 00:43	62°53.48399'	58°10.53389'	452	4:01
218	Bransfield Strait West Canyon	2013-03-02 16:40	62°56.99251'	58°26.61432'	695	2013-03-02 20:38	62°56.54480'	58°22.23068'	784	4:04
222a	Bransfield Strait West Bank	2013-03-03 14:46	63°02.98617'	58°37.98601'	169	2013-03-03 16:46	63°03.04611'	58°36.00606'	169	2:00
222b	Bransfield Strait West Upper Slope	2013-03-03 17:29	63°00.47046'	58°37.58964'	269	2013-03-03 21:19	63°00.47866'	58°33.15579'	294	3:50
225	Bransfield Strait West Slope	2013-03-04 14:27	62°55.73349'	58°41.60434'	580	2013-03-04 16:02	62°56.24464'	58°39.92816'	538	1:36
231	Deception Island	2013-03-05 22:32	62°52.61208'	60°29.39819'	118	2013-03-06 00:22	62°52.69115'	60°27.33816'	356	3:52
234	Drake Passage West Slope	2013-03-07 11:46	62°17.28139'	61°13.94834'	244	2013-03-07 14:30	62°17.57826'	61°09.66123'	239	3:44
237	Drake Passage West Upper Slope	2013-03-08 07:27	62°15.71101'	61°12.44901'	466	2013-03-08 11:19	62°16.79212'	61°09.09319'	284	3:42
244	Drake Passage Central Slope	2013-03-10 08:23	62°06.59610'	60°36.35834'	403	2013-03-10 12:17	62°07.92081'	60°39.68043'	438	3:54
246	Drake Passage East Upper Slope	2013-03-11 07:21	62°00.66477'	60°03.65346'	269	2013-03-11 11:21	61°58.65092'	60°03.97988'	306	4:00
249	Drake Passage East Slope	2013-03-12 06:19	61°57.03291'	60°07.80429'	408	2013-03-12 10:20	61°55.67425'	60°04.69596'	441	4:42
251	Drake Passage Central Upper Slope	2013-03-12 19:07	62°07.74196'	60°37.80090'	271	2013-03-12 23:03	62°06.36773'	60°34.65803'	302	4:00



Table 2

PS96/ #	Area	Start Transect				End Transect				Transect Data		
		Date/Time	Latitude (S)	Longitude (W)	Depth (m)	Date/Time	Latitude (S)	Longitude (W)	Depth (m)	Duration (h)	Length (km)	# of photos
001-4	Austasen	23.12.15 20:44	70°53.19'	11°06.52'	315	23.12.15 22:20	70°53.76'	11°08.79'	293	01:36	1.74	203
007-1	Filchner East	29.12.15 16:08	74°39'42"	26°56.49'	412	29.12.15 17:55	74°40.06'	26°59.91'	414	01:47	2.58	223
008-2	Filchner East	30.12.15 18:33	74°55.23'	29°25.35'	400	30.12.15 20:25	74°54.45'	29°24.58'	405	01:52	1.49	248
010-3	Filchner East	01.01.16 11:52	74°56.65'	26°02.50'	292	01.01.16 13:52	74°57.44'	26°05.13'	294	02:00	1.94	260
026-3	Filchner West	08.01.16 01:58	75°16.98'	37°55.96'	405	08.01.16 03:58	75°15.99'	37°55.17'	404	02:00	1.87	268
027-2	Rönne Depot	14.01.16 13:41	76°43.14'	52°11.30'	298	14.01.16 14:35	76°43.12'	52°09.30'	300	00:54	0.85	110
037-3	Filchner West	16.01.16 14:05	75°43.29'	42°27.65'	390	16.01.16 15:05	75°42.85'	42°26.66'	390	01:00	0.93	131
048-2	Filchner West	18.01.16 20:25	74°46.20'	35°18.63'	487	18.01.16 22:25	74°45.45'	35°21.00'	483	02:00	1.81	266
057-3	Filchner East	21.01.16 01:29	76°19.11'	29°01.97'	241	21.01.16 02:35	76°19.32'	29°00.13'	239	01:06	0.90	131
061-1	Filchner East	21.01.16 18:12	76°05.98'	30°18.04'	469	21.01.16 19:42	76°05.44'	30°20.27'	480	01:30	1.41	213
072-4	Filchner Trough	23.01.16 17:07	75°51.61'	32°22.93'	754	23.01.16 18:30	75°51.43'	32°20.30'	752	01:23	1.24	192
090-4	Rampen	29.01.16 01:29	72°26.08'	17°02.10'	271	29.01.16 03:43	72°26.66'	17°05.00'	305	02:14	1.95	293
106-2	Christmas Tree Inlet	31.01.16 08:28	72°36.54'	17°52.52'	200	31.01.16 09:28	72°36.51'	17°54.15'	210	01:00	0.90	132



Figure 1

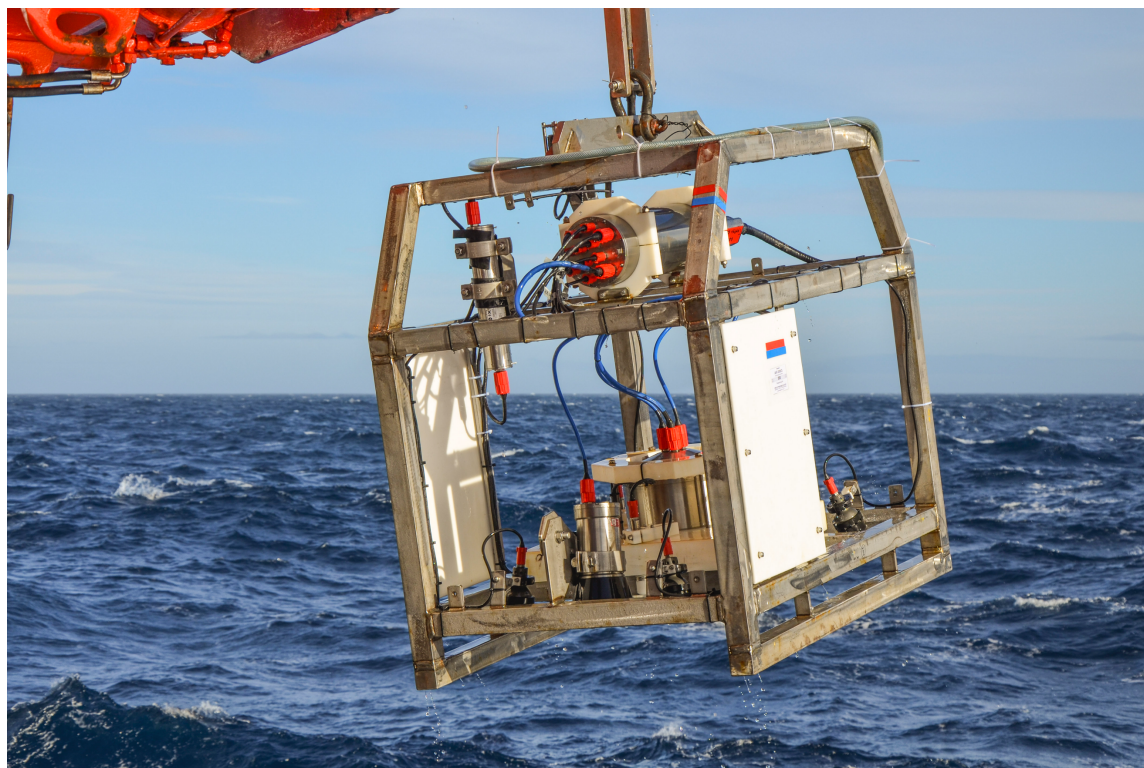




Figure 2

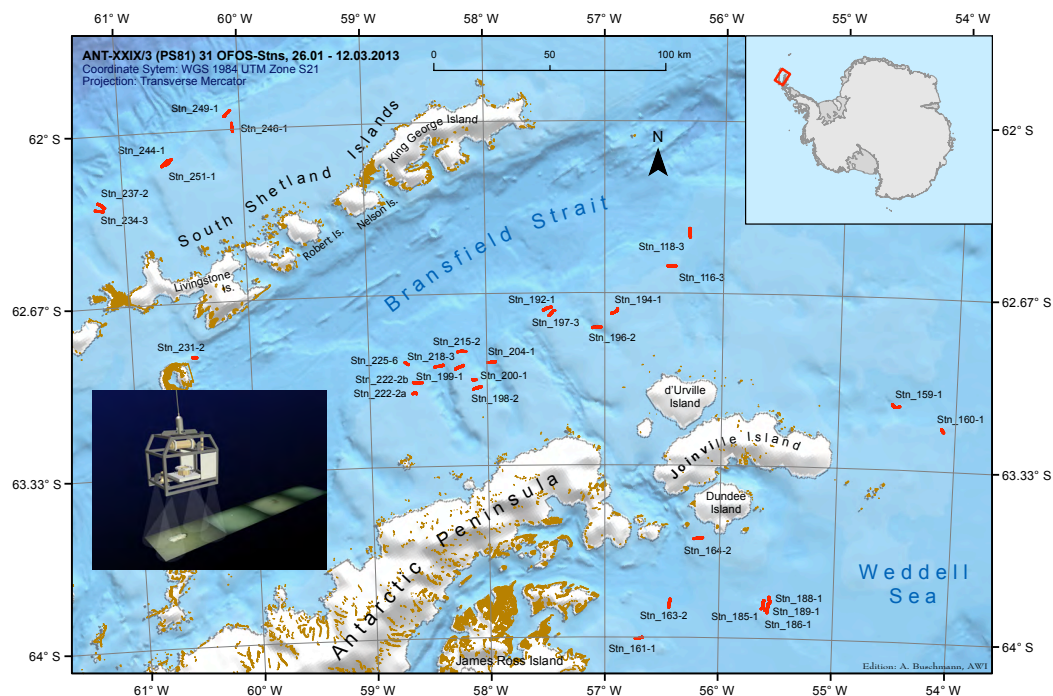




Figure 3

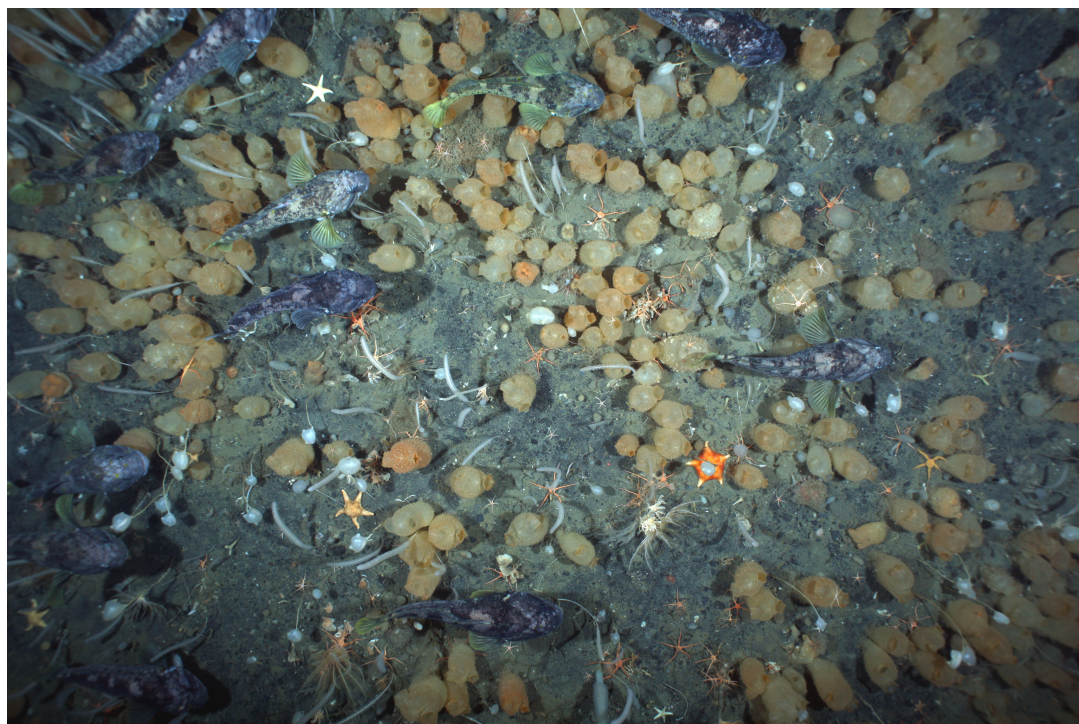




Figure 4

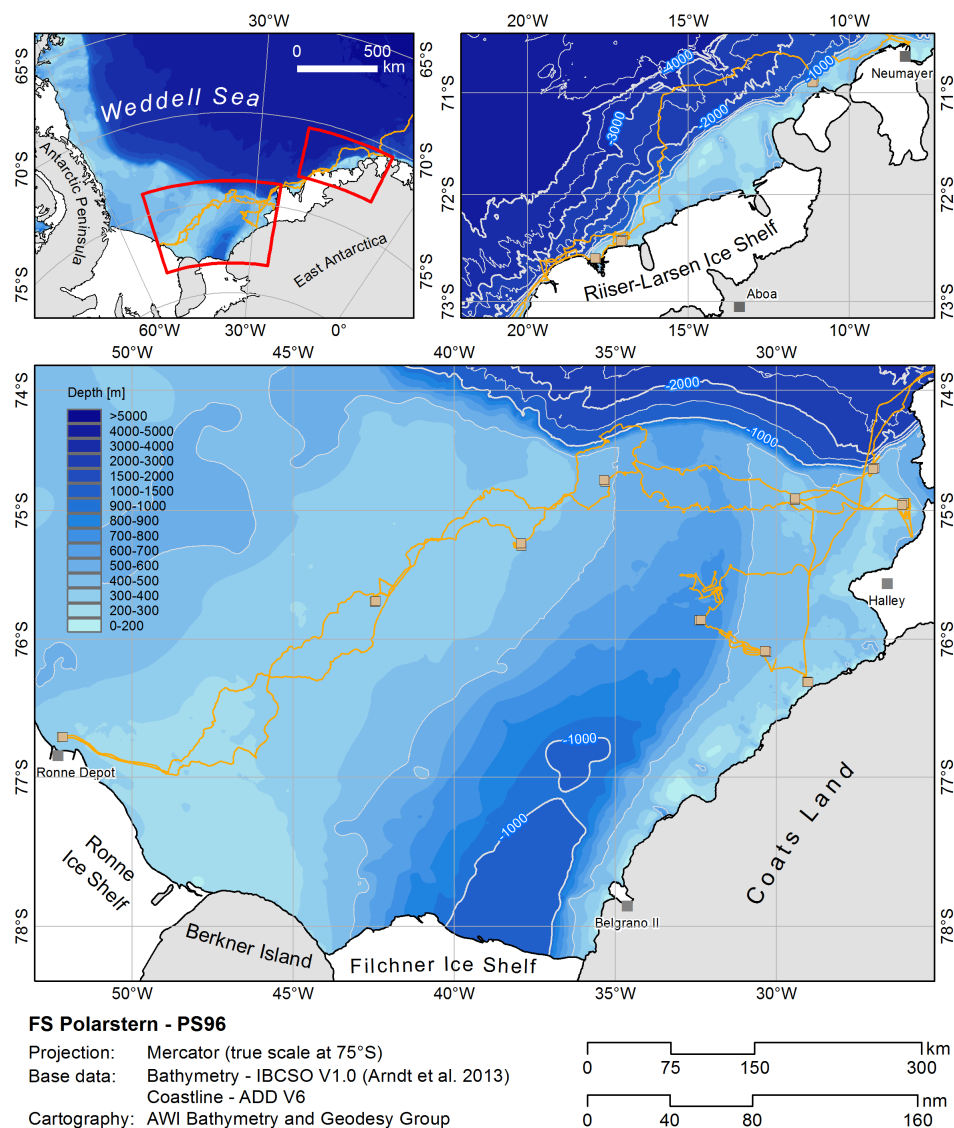




Figure 5

