## RE: essd-2020-233: Seabed video and still images from the northern Weddell Sea and the western flanks of the Powell Basin

Dear ESSD editorial team and reviewers,

We would like to thank the ESSD team and the reviewers for taking the time to read our manuscript and put forward some sensible suggestions on how we can present the data in a more immediately useful way and give a better understanding of the strengths and drawbacks of the data. We have incorporated the suggestions into this revised and resubmitted version of the manuscript, and we present how we incorporated the various suggestions here below. A 'tracked changes' version of the manuscript then follows.

Anonymous Referee #1

Received and published: 2 November 2020

This data manuscript outlines the results of a field campaign using a novel acoustic-assisted camera system in a region currently under-sampled by traditional methods due to permanent ice cover. This is a valuable contribution to the scientific community and the data provided could support a variety of analyses that the authors suggest. The data manuscript provides the metadata necessary for use of the image dataset as well as information about the camera system and data collection sites.

The only information lacking (which may be present in other manuscripts referenced) is whether the images undergo any colorcorrection as these appear to be corrected in the panels of figures 3 and 4, and the height above the seafloor at which images are captured to determine the seafloor area captured per image. Though this information may be documented elsewhere, it is important to include to ensure proper use of the data set by other researchers. These missing data are imperative for the accurate calculation of abundances, for example. Reporting of colorcorrection methods is standard for image data sets, and is important for future use for taxonomy, etc. The description of the camera sled itself should be explicitly referenced (i.e. "a full description of the OFOBS system and its components are available in ____.") and if it does not exist, then a description (even brief) should be added here.

Thank you for this observation. As you suggest, much of this information is indeed in the referenced manuscripts, but for ease of reading, we place it directly into this revised version of the manuscript. All figures presented in the paper are actually not colour corrected, and presented as raw images, which holds true also for the uploaded PANGAEA data set. We agree that undocumented colour (and lens) corrections can cause problems for later data users, so we prefer to avoid that by uploading the most basic form of collected image as possible to the archive. This is now made clear in the text and figure heading.

A short description with technical specs of the cameras and strobes is at least provided in the downloaded file - it should be clear this information exists prior to downloading by an interested user. This data manuscript is very short but provides the necessary information for use of the dataset in a succinct manner.

We have made a more complete description of the OFOBS camera equipment in this revised version of the manuscript.

I recommend publishing this data manuscript with the following minor edits:

1)add information regarding color-correction or explicitly reference where this information/methodology can be found

Done, as described above.

2) explicitly reference the full description of the vehicle and its components. If this does not exist then a description should be added here

Improved, as described above.

3)note the height above the seabed at which images were collected and thus the approximate seafloor area covered by each image

The text relating to image coverage has been improved within this version of the manuscript.

4) line 30 - this change in ice cover has not have

Changed as suggested.

5) missing ) on line 78 after (GNSS).

Corrected as suggested.

Referee #2

k.v.landeghem@bangor.ac.uk

Received and published: 6 November 2020

This short, but well-written manuscript describes two seafloor survey campaigns with the Ocean Floor Observation and Bathymetry System (OFOBS) and the significance of surveying the seabed in these areas. This camera sled with forward looking sound-waves is designed to safely operate in partly sea ice covered oceans and in areas where seafloor bathymetry varies quickly. Both these conditions have traditionally hampered seafloor studies of areas where the impact of the climate crisis on West Antarctic Peninsula seafloor habitats are happening at a fast pace, and therefore critical for us to better understand wider ecological effects (see also Barnes et al., 2020 – GCB 26, 2750-2755). I recommend publishing this data manuscript, but I have a few minor recommendations to take into consideration to allow more users to interact with the dataset:

1. The acoustic element of the OFOBS is mentioned several times – both the forward looking acoustics and the integrated side scan sonar (SSS). The former is a truly great asset to safely survey seafloor with variable topography. The latter, the SSS, is not represented in the data images or downloadable datasets. Such high-resolution and high-quality data of backscatter intensity from just a few meters above the seabed is invaluable to assess the relationship between seafloor habitats and acoustic backscatter, and the impact of this data manuscript could be much higher if some acoustic backscatter data was visualised to capture this potential.

We agree with this comment on the usefulness of the acoustic data collected by the OFOBS during PS118. We intended to publish processed seafloor maps generated from this data in the future, but we have decided to take this comment on board and upload the data to PANGAEA to further support the image dataset. This data will be available in April 2021 and this has been made clear in the revised manuscript. We maintain the focus of this revised manuscript on the image data, but point the interested reader in the right direction to acquire the acoustic data.

2. In relation to point 1 above, geo-positioning is a key component of potential time-lapse analyses from repeated surveys. Do the authors have a handle on the confidence intervals of the USBL positioning? This is a minor point out of interest, really, but I suspect the positioning is very good and once again show-cases the potential for the data to be used to study both spatial and temporal changes.

The accuracy of this is now presented more clearly in the revised text (0.2% of slant angle resolution a rough estimate of accuracy).

3. The video images are left unprocessed for people to download, that is good practice. For the purpose of the short manuscript, I would recommend that at least some example images are published in a processed form. That would allow the laser pointers to become visible (providing a scale, which they really need to have), and it would showcase the full potential of detail achievable with the OFOBS.

As mentioned in response to the previous reviewer, the seafloor covered by each image is now better described in the text. Although the lazers are difficult to spot in the small images within figs 3 and 4 they are actually quite distinct in the majority of images within the dataset when downloaded and viewed.

4. The authors don't emphasise enough in my opinion that the OFOBS allows seabed surveys in partly sea ice covered areas. In fact, "ice conditions were harsh" – L42, and the abstract could mention that accomplishment specifically I feel.

This aspect of the OFOBS was described in one of the cited papers, but we have highlighted this usefulness in the revised version of the manuscript.

Thank you for taking the time to make these suggestions for our manuscript!

On behalf of all authors, yours sincerely,

Autun Purser

## TRACK CHANGES VERSION OVERLEAF:

# Seabed video and still images from the northern Weddell Sea and the western flanks of the Powell Basin

Autun Purser[1], Simon Dreutter[1], Huw Griffiths[2], Laura Hehemann[1], Kerstin Jerosch[1], Axel Nordhausen[3], Dieter Piepenburg[1,4], Claudio Richter[1], Henning Schröder[1], Boris Dorschel[1]

[1] Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research Bremerhaven, Am Handelshafen 12, 26570 Bremerhaven, Germany

[2]British Antarctic Survey, High Cross, Madingley Rd, Cambridge, CB3 OET, UK

[3]Max Planck Institute for Marine Microbiology, Celsiusstrasse 1, 28359, Bremen, Germany

[4]Helmholtz Institute for Functional Marine Biodiversity at the University of Oldenburg (HIFMB), Carl-von-Ossietzky-Str. 9–11, 26129 Oldenburg, Germany

*Correspondence to*: Autun Purser (autun.purser@awi.de)

**Abstract.** Research vessels equipped with fibreoptic and copper cored coaxial cables support the live onboard inspection of high-bandwidth marine data in real-time. This allows towed still image and video sleds to be equipped with latest generation higher resolution digital camera systems and additional sensors. During RV *Polarstern* expedition PS118 in February-April 2019, the recently developed Ocean Floor Observation and Bathymetry System (OFOBS) of the Alfred Wegener Institute was used to collect still and video image data from the seafloor at a total of 11 predominantly ice covered locations in the northern Weddell Sea and Powell Basin. Still images of 26 megapixel resolution and HD quality video data were recorded throughout each deployment. In addition to downward facing video and still image cameras, OFOBS also mounted sidescan and forward-facing acoustic systems, which facilitated safe deployment in areas of high topographic complexity, such as above the steep flanks of the Powell Basin and the rapidly shallowing, iceberg scoured Nachtigaller Shoal. To localise collected data, the OFOBS system was equipped with a POSIDONIA transponder for Ultra Short Baseline triangulation of OFOBS positions. All images are available from: https://doi.org/10.1594/PANGAEA.911904 (Purser et al., 2020).

## 1 Introduction

Recent studies indicate that climate change processes in the maritime Antarctic are accelerating, leading to the increasing retreat of the ice sheets of the eastern coast of the Antarctic Peninsula and the near disintegration of the ice shelves Larsen A in 1995 and Larsen B in 2002 (Rott et al., 1996; Scambos et al., 2013; Shepherd et al., 2003), as well as the break-off of giant icebergs from Larsen C (Han et al., 2019; Shepherd et al., 2003; Skvarca, 1993). This change in ice coverage ~~have~~ has resulted in spatially extensive habitat change both above and below water, with many processes from light penetration, ocean stratification, surface productivity and food transportation pathways affected (Barnes and Tarling, 2017; Chaabani et al., 2019; Fillinger et al., 2013; Griffiths et al., 2017; Gutt et al., 2019). By assessing the seafloor habitats and associated benthic

fauna communities in these areas recently free of permanent ice cover with the Ocean Floor Observation and Bathymetry System (OFOBS) of the Alfred Wegener Institute (AWI), Helmholtz Centre for Polar and Marine Research Bremerhaven (Germany) (**Figure 1**), the ecological effects of climate-driven ice shelf loss can be studied. OFOBS is a towed platform capable of deployment in moderate ice-cover conditions and capable of concurrently collecting acoustic, video and still image data from the seafloor (Purser et al., 2018).

During RV *Polarstern* expedition PS118 (February 9$^{th}$ – April 10$^{th}$ 2019) (Dorschel, 2019b) OFOBS was deployed 11 times, conducting concurrent high-resolution still image, video and acoustic surveys across diverse and contrasting regions of the Antarctic seafloor (**Figure 2**). Ice conditions during the cruise were harsh, though a north-south transect from the Weddell Sea continental shelf to the northwest continental shelf edge of the Powell Basin was completed, with stations on the Weddell Sea plateau, Nachtigaller Shoal (Dorschel et al., 2014) and the flanks and rim of the Powell Basin investigated (**Table 1)**. The forward facing acoustic camera allows the towed OFOBS operator to be aware of steep structures or rising seafloor ahead of the device, and allow ample time to winch the system to a safer height. This allowed use even in heavy ice, with minimal ability for ship manoeuvre, and close to the steep flanks of the Powell Basin, allowing collection of this novel dataset.

The PS118 OFOBS data was collected with the same cameras, illumination regime and deployment protocols as mounted on the previous AWI towed camera sled system, (Ocean Floor Observation System (OFOS)), used to survey the Antarctic seafloor during previous recent RV *Polarstern* expeditions (Piepenburg et al., 2017), such as PS81, also to the western Weddell Sea area in 2013 (Gutt, 2013; Gutt et al., 2016) and PS96, to the southeastern Weddell Sea in 2015/16 (Schröder et al., 2016). By continuing to mount the same camera systems, observations made during PS118 can be most readily compared with those made during the previous expeditions, uncomplicated by methodological problems relating to variabilities in camera performance, flight height or illumination (Schoening et al., 2020).

The OFOBS data collected during PS118 and presented here is of use for a range of scientific studies, such as:

1) Assessment of epibenthic megafauna communities observed at several sites along a South-North transect from the Weddell Sea Antarctic Peninsula continental shelf to the Powell Basin.
2) For spatial comparison of these observed shelf and basin megafauna communities with those observed with the very similar OFOS towed device sled during recent cruises.
3) A temporal picture of seafloor communities occupying these seafloor regions in 2019, for comparison with future studies following continued ice loss.
4) An extensive set of seafloor images from several locations on the Powell Basin flank, a region of southern seafloor sparsely surveyed to date.

## 2 Materials and methods

### 2.1 Ocean Floor Observation and Bathymetry System (OFOBS)

The OFOBS is a state-of-the-art towed camera and acoustic survey sled recently developed by the Deep Sea Ecology and Technology group of AWI for benthic polar research in ice-covered environments (Purser et al., 2018). The device was deployed during PS118 as described in Purser et al. (2018), taking images under comparable illumination conditions, flight heights and with the same camera systems as were mounted on the OFOS sled during the PS86 and PS96 cruises in 2013 and 2015/16, respectively (Piepenburg et al., 2017). OFOBS positioning during deployments was carried out with the iXBlue POSIDONIA Ultra-Short Base Line (USBL) system used by RV *Polarstern*, localising the relative position of the OFOBS to the vessel (itself deriving its position from a satellite based Global Navigation Satellite System (GNSS)). Every few seconds (depending on deployment depth) the OFOBS received a new position fix, which was used to position stamp each collected image against a UTC timestamp. During PS118, a stable position fix was attained with an accuracy of approximately 0.2% of the slant range from the ship to the subsea unit. Environmental and operational factors, such as ice coverage and vessel speed could result in a slanted tether cable, though for the deployment depths made during PS118 a positional accuracy of within ~20 m was likely maintained throughout. Images were taken at 26 megapixels resolution with the camera system (iSiTEC, CANON EOS 5D Mark III) with an automated timer (for the majority of images, these were taken with a frequency of ~1 image every 20 seconds), with additional Additional images taken at the discretion of the operator. These two image categories are distinguished in the data set as 'HOTKEY' and 'TIMER' images – designations automatically incorporated into the timestamped filenames. 'HOTKEY' images were commonly taken on the first observation of a particular fauna species or to record a feature of interest, such as a whale fall or interesting geological structure. No processing stages were applied to the collected data, with the native camera .jpeg data provided in the dataset at full acquired resolution.

Throughout all of these deployments the OFOS and OFOBS systems were equipped with three red sizing lazers (FLEXPOINT) (Purser et al., 2018; Purser and Sablotny, 2020), arrayed in an equilateral triangle with 50 cm spacing around the still camera housing. This lazer array ensures that each image recorded has three red dots near the centre of the image, each spaced by 50 cm. These dots can be used in subsequent analysis to determine accurately the area covered by a particular image. Throughout PS118 the OFOBS was deployed approximately 1.5 – 2m above the seafloor, giving a coverage within each collected image of 4 – 6 $m^2$.The OFOBS system has three parallel lasers mounted in an isometric triangular arrangement with 50 cm spacing. These lasers assure that all collected images include three red laser points, which allow

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~~both the scaling of the seafloor image as a whole, as well as the facility to size all fauna and features observed on the seafloor.~~ Illumination of the seafloor was provided by four downward facing SeaLight sphere 3150 LED lights positioned in the corners of the main OFOBS frame, with two additional strobe lights (iSiTEC UW-Blitz 250, TTL driven) firing concurrently with image collection.

Throughout all deployments, HD video data was recorded by the OFOBS for the duration of each ~~dive.~~dive with an HD video recorder (iSiTEC, Sony FCB-H11) (Purser et al., 2018).

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### 2.2 Field sampling

#### 2.2.1 Weddell Sea sampling

OFOBS surveys were carried out in a roughly south-north transect from the Weddell Sea continental shelf of the Antarctic Peninsula to the northern Powell Basin. In total, 7 OFOBS deployments were made between 65 and 62°S (**Table 1**, **Figure 2**). With the exception of an OFOBS deployment across the Nachtigaller Shoal (Dorschel et al., 2014) (station PS118/11-2), the seafloor in these regions was observed to be predominantly made up of soft material with occasional drop stones present (**Figure 3**).

#### 2.2.2 Powell Basin sampling

Four successful OFOBS deployments were made on the flanks and rim of the Powell Basin (**Table1, figure 2**). Three of these deployments, PS118/39-1, PS118/69-1 and PS118/81-1, benefitted from the equipping of the OFOBS sled with a forward looking sonar (Purser et al., 2018). This sensor allowed OFOBS to be used over very steep terrain with minimum risk, by giving advance warning of any hard structures ~30 m ahead of the sled. The majority of towed sleds, such as OFOS, are less capable in high-relief regions, where snagging on tall structures such as cliffs or vent structures can occur. With OFOBS, the ~30 m warning of approach is sufficient to allow the operators to commence winching of the system in good time to minimise the risk of impact of the sled with the seafloor whilst still collecting usable image data. These data sets each cover many 100s of meters of the Powell Basin flank walls, visually surveying these traditionally difficult to investigate regions of seafloor (**Figure 4**).

### 3 Data availability

All seafloor images collected with the OFOBS system are available from the data publisher PANGAEA. No preprocessing or processing stages were applied prior to upload, with no colour correction or light vignetteing algorithms applied. These images are provided with georeferenced positions for each image, as derived from the POSIDONIA system

(https://doi.org/10.1594/PANGAEA.911904; (Purser et al., 2020)). The full cruise track is also available via PANGAEA (https://doi.org/10.1594/PANGAEA.901319; (Dorschel, 2019a)) with information on additional environmental and scientific data collected during the cruise given in the PS118 cruise report (Dorschel, 2019b). Video data collected via the OFOBS system is available from the authors on request. In addition to the image data presented in this paper, the multibeam data concurrently collected by the OFOBS device has also been uploaded to PANGAEA and will be available from April 2021 for open access download, or on request from the authors.

**Competing interests.**

The authors declare that they have no conflict of interest.

**Author contributions.**

AP applied for the secondary user time for the PS118 cruise, conceived of the investigation and ran the data collection campaign. BD was chief scientist for the PS118 expedition. SD, LH, HS, HG and AN helped run the OFOBS platform. AP, HG, KJ, DP, CR and BD determined sampling strategies for the OFOBS and aided in data collection. AP prepared the manuscript with contributions from all co-authors.

**Acknowledgements.**

The captain and crew of RV *Polarstern* expedition PS118 are thanked for their support and interest in the OFOBS deployments conducted during the cruise. U Hoge is thanked for his assistance in installing the OFOBS system prior to cruise commencement.

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**FIGURES**

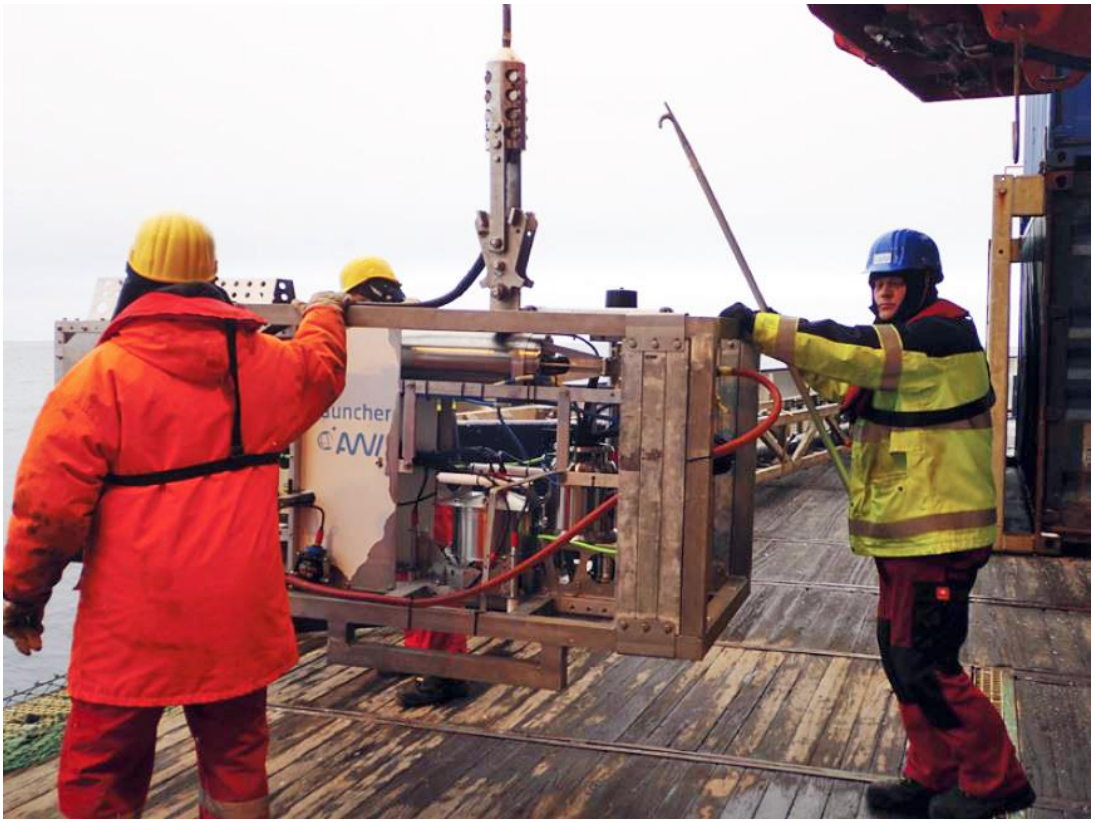
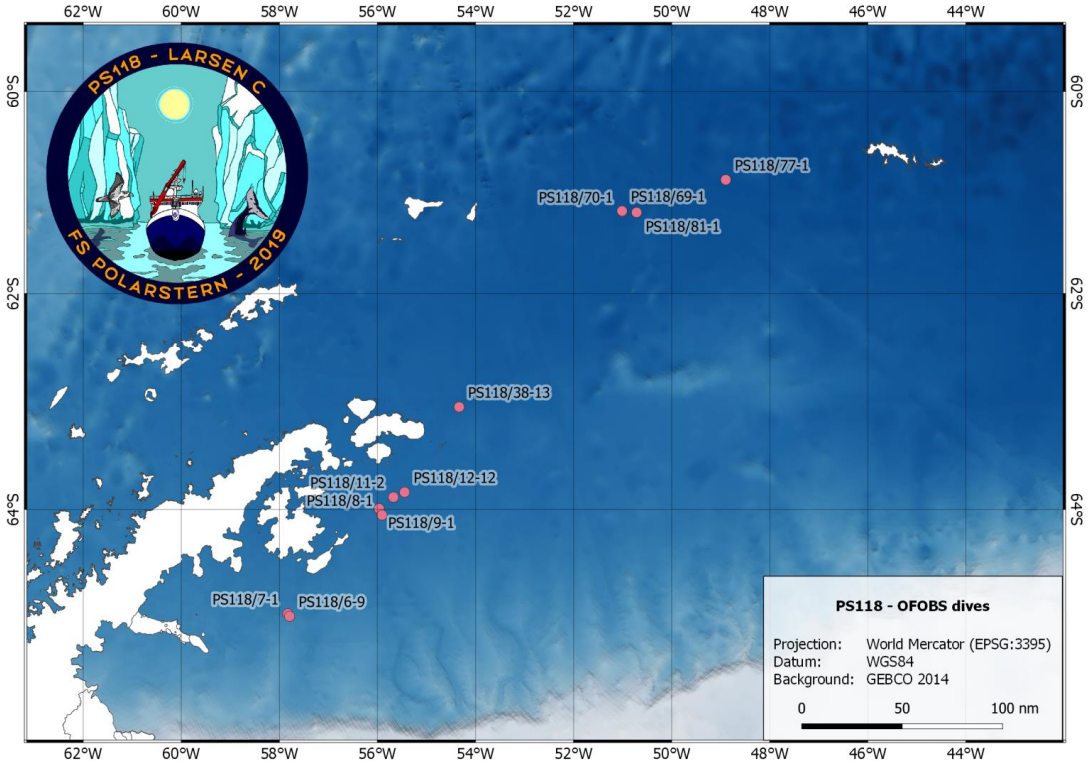



**Figure 1:** The Ocean Floor Observation and Bathymetry System (OFOBS) of the Alfred Wegener Institute (AWI), Helmholtz Centre for Polar and Marine Research Bremerhaven, deployed from the RV *Polarstern* during cruise PS118 in the waters east of the Antarctic Peninsula and on the flanks of the Powell Basin (Feb – April 2019)




405 **Figure 2:** Regional map showing the positions of OFOBS deployments made during RV *Polarstern* cruise PS118.

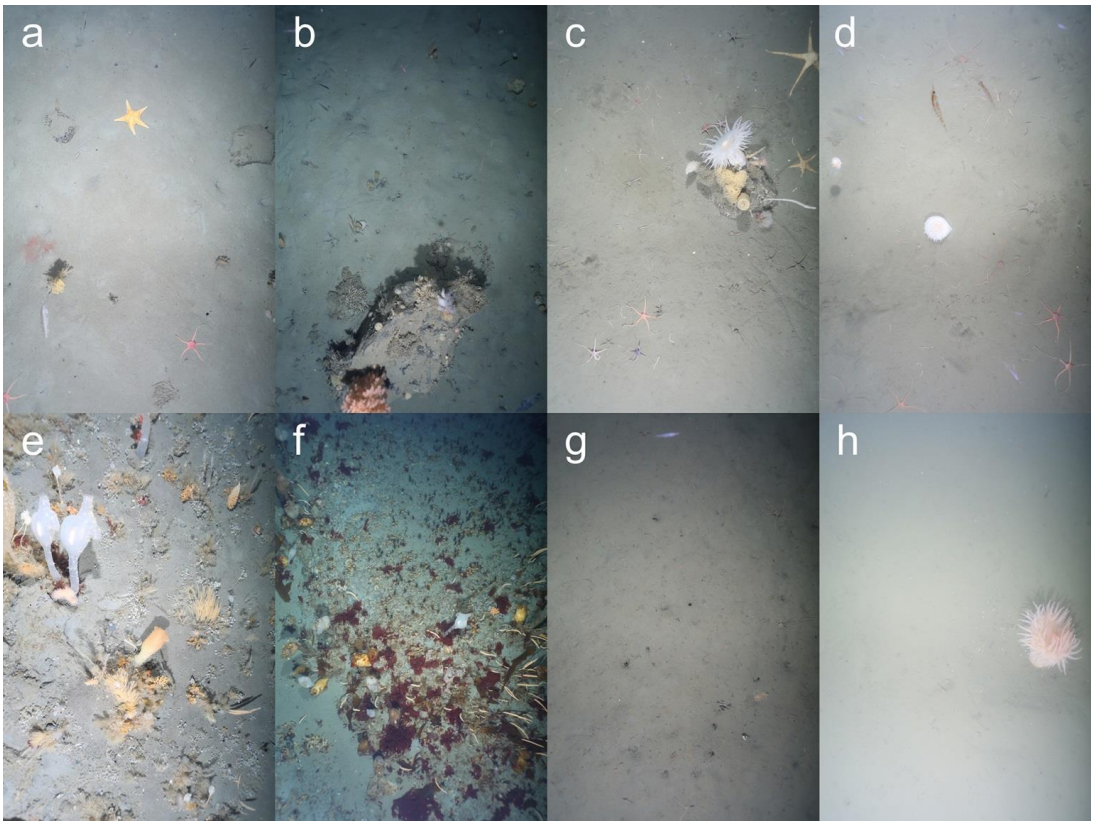



**Figure 3:** Typical seafloor images collected from each of the OFOBS surveys made of the Weddell Sea seafloor during RV *Polarstern* cruise PS118. a) Station PS118_6, hotkey_2019_03_06 at 05_07_31 b) Station PS118_7, hotkey_2019_03_06 at 19_36_28 c) Station PS118_8, hotkey_2019_03_11 at 14_33_24 d) Station PS118_9, timer_2019_03_12 at 06_01_06 e) Station PS118_11, timer_2019_03_13 at 20_14_04 f) Station PS118_11, timer_2019_03_13 at 22_18_47 g) Station PS118_12, timer_2019_03_15 at 01_29_36 h) Station PS118_38, hotkey_2019_03_23 at 06_27_00. All images are presented here and in the dataset with no manipulation or colour correction.

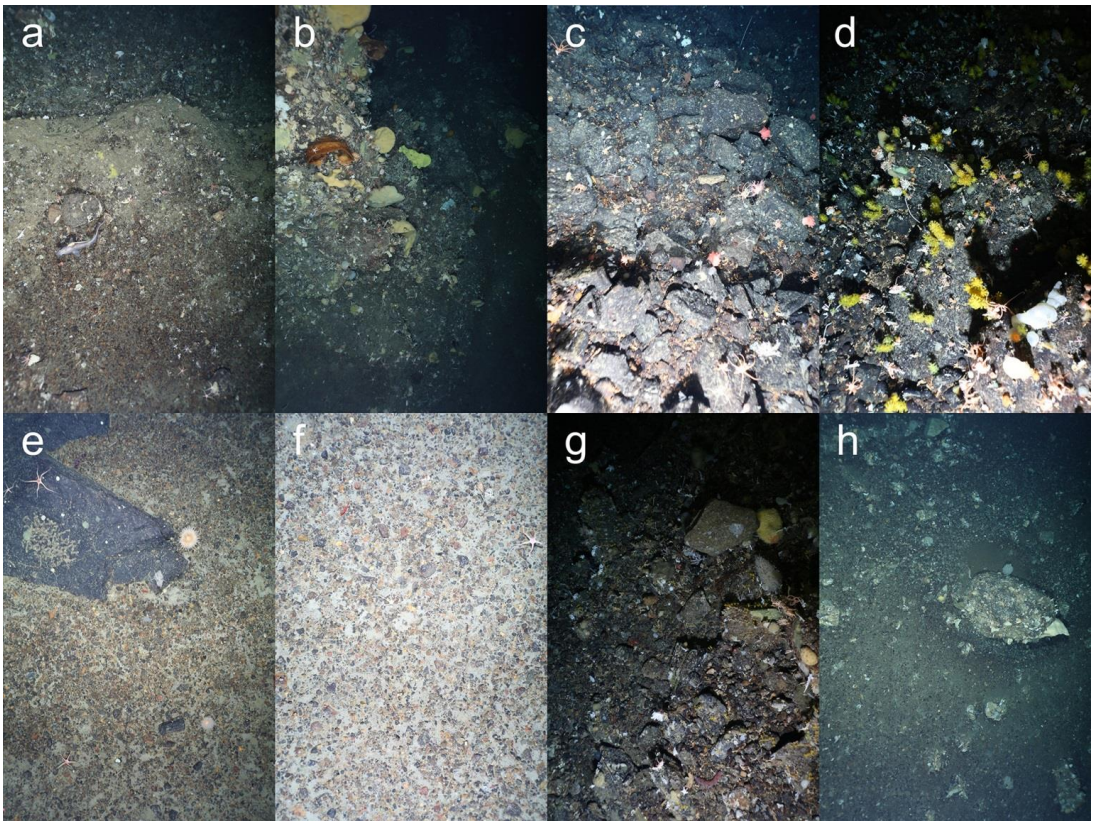



**Figure 4:** Typical seafloor and cliff escarpment images collected during OFOBS surveys of the Powell Basin flanks during RV *Polarstern* cruise PS118 . a) Station PS118_39, hotkey_2019_03_23 at 23_21_46 b) Station PS118_39, timer_2019_03_25 at 18_50_09 c) Station PS118_69, hotkey_2019_03_31 at 12_20_55 d) Station PS118_69, hotkey_2019_03_31 at 14_10_56 e) Station PS118_77, timer_2019_04_01 at 20_39_51 f) Station PS118_77, timer_2019_04_01 at 20_11_32 g) Station PS118_81, timer_2019_04_04 at 00_25_31 h) Station PS118_81, timer_2019_04_04 at 02_27_33. All images are presented here and in the dataset with no manipulation or colour correction.

## TABLES

**Table 1:** Locations of OFOBS deployments during PS118. Start and end position co-ordinates and times are given, in addition to the numbers of 'timer' and 'hotkey' images collected during each deployment.

| Station Number | Region | Date | Start (UTC) | End (UTC) | Latitude Start | Longitude Start | Latitude End | Longitude End | Timer Images | Hotkey Images |
|---|---|---|---|---|---|---|---|---|---|---|
| PS118_6 | Weddell Sea | 06.03.2019 | 05:01 | 09:33 | -64.939363 | -57.791526 | -64.929378 | -57.818072 | 1314 | 90 |
| PS118_7 | Weddell Sea | 06.03.2019 | 19:25 | 20:08 | -64.918268 | -57.824799 | -64.914652 | -57.826477 | 259 | 28 |
| PS118_8 | Weddell Sea | 11.03.2019 | 12:02 | 15:45 | -64.049462 | -55.906690 | -64.007332 | -55.908186 | 891 | 73 |
| PS118_9 | Weddell Sea | 12.03.2019 | 06:00 | 06:51 | -63.991755 | -55.965738 | -63.993996 | -55.968168 | 319 | 4 |
| PS118_11 | Nachtigaller | 13.03.2019 | 20:14 | 22:25 | -63.888204 | -55.675914 | -63.887744 | -55.656926 | 690 | 7 |
| PS118_12 | Weddell Sea | 15.03.2019 | 01:28 | 05:55 | -63.844375 | -55.447947 | -63.844602 | -55.446939 | 1547 | 5 |
| PS118_38 | Weddell Sea | 23.03.2019 | 05:01 | 06:31 | -63-066654 | -54.334116 | -63.073675 | -54.319400 | 379 | 11 |
| PS118_39 | Powell Basin | 23.03.2019 | 18:46 | 09:56 | -61.914657 | -53.323264 | -61.865707 | -53.324424 | 3667 | 140 |
| PS118_69 | Powell Basin | 31.09.2019 | 01:52 | 16:00 | -61.192316 | -50.996506 | -61.192854 | -51.085361 | 2655 | 68 |
| PS118_77 | Powell Basin | 01.04.2019 | 21:08 | 21:48 | -60.888864 | -48.896518 | -60.887241 | -48.905883 | 153 | 5 |
| PS118_81 | Powell Basin | 03.04.2019 | 21:24 | 09:31 | -61.213897 | -50.716745 | -61.186405 | -50.672902 | 373 | 12 |