PS111 – Weekly Report No. 1 | 19 - 26 January 2018

Temperature Changes

[30. January 2018]

We just escaped from the snowstorm in Germany. Since our plane had to be de-iced and then re-fueled twice, we started our flight to South Africa with a 3-hour delay. Between the Bavarian slush and the Antarctic sea ice, we enjoy a short warm-up period with wonderful 26 °C while having a 'farewell beer' at Cape Town's Waterfront.

Polarstern leaves port early, because increasing Cape Winds might cause the port to close – which actually happened two hours after we left. During the afternoon of 19 January, we start crossing the latitudes, with their furious names and bumpy seas – and within a few days we are back to German winter temperatures.

Fig. 1: Cape Town's Table Mountain says goodbye with a splendid 'icing' on its top. (Photo: H. Grobe)

Fig. 2: AWI's curious administrative director, Karsten Wurr, is impressed by the variety of scientific instruments and sampling devices on board. Here, the Autonomous Underwater Vehicle (AUV) of our British colleagues is prepared for its mission in the (Photo: H. Grobe)

Fig. 3: Humpback whale watching the progress of a CTD cast. (Photo: Mike-Schroeder)

Our life on board starts with an introduction to the ship, the safety regulations, and common procedures like the schedule for meals, the change of linen, etc. A high-pressure ridge calms the Roaring Forties, making it easier for us to unpack our instruments. Countless boxes are pulled to the labs – we have 360 tons of scientific gear and other equipment on board, stored in within the 41 containers that are onboard. Many of those containers stay untouched as they contain the supplies for the Neumayer III station on Ekstrom Ice shelf. Fifty-three scientists start setting-up their labs, supported by the professionals – the 43 crew members.

Already in the Furious Forties, the first instruments go over board: Argo floats, which are autonomous oceanographic instruments, profiling the ocean for temperature and salinity from a depth of 2000 m up to the surface, from where the data are transmitted via satellite to the data storage facility ‘Coriolis’ until their batteries die. A new under-way CTD (conductivity, temperature, depth) is towed behind the ship to measure temperature and salinity of the upper 600 m as we cross the many fronts of the Antarctic Circumpolar Current (ACC). And the geologists prepare the pipes to get the first sediments from the ocean floor.

A big hole in the sea ice cover, larger than 100 m in diameter, is called by the Russian name ‘polynya’. Most polynyas are caused by katabatic winds coming from the ice sheet and blowing the sea ice away from the ice shelf fronts. However, there is an exception: The Maud Rise Polynya, in the middle of the ocean, very unique and, when it appeared in the winters of the mid 1970’s, bigger than 80 000 square kilometres. After an absence of more than 40 years, the polynya showed up again, smaller than before, but still exposing 40 000 square kilometres of open water to the winter atmosphere. Now it is austral summer and the sea ice has retreated to its minimum. However, as we cross the area of last winter’s phenomenon, we stop to check whether the fingerprints of strong winter convection can still be detected in the deep water column.

In the early morning of 27 January, the close visit of a family of Humpback whales, showing their offspring what a research vessel looks like from all sides, changes priorities. Not just does the coffee get cold in our cups, but also all the sonars go quiet to enjoy the encounter.

PS111 sends kind regards from Maud Rise, the ‘Home-Hill’ in front of Atka Bay.

Kind Regards to all at home

Michael Schröder

Chief Scientist

PS111 – Weekly Report No. 2 | 27 January - 2 February 2018

Neumayer and beyond

[09. February 2018]

Now we have arrived – Polarstern makes her way easily through the disintegrating winter sea ice cover, heading for the northeastern edge of Ekström Ice Shelf.

On the way through the ice, we encounter the first Ross seal, which gets a sensor glued to its head as a little present from our seal researchers. The sensor transmits information on what a seal does during the day – diving, foraging, sleeping, diving, foraging, sleeping...what a wonderful life in the Antarctic marginal seas. Since one seal is not enough for any reliable analysis on the behavior of Ross seals, the search must go one. When you step onto the working deck now, you will not see the horizon in the far distance. Instead, on the starboard side you face a 10 m high wall of ice, which can be overlooked only from the upper decks. We have definitely arrived at the Ekström Ice Shelf edge.

Fig. 1: The Manta-trawl is ready for sampling micro-plastic from the ocean surface. (Photo: Alfred-Wegener-Institut)

Fig. 2: End of visit to Neumayer III Station, the sledge ride back to the ship is ready to leave. (Photo: Alfred-Wegener-Institut)

Fig. 3: Not only on board Polarstern's chief-mate and boson go to the limit. (Photo: Alfred-Wegener-Institut)

The next two days are dominated by unloading 130 tons of material, stored in 15 containers, 150 cubic metres of Arctic Diesel, 64 cubic metres of Kerosene, one Pisten Bully (snow mobile), and a lot of small boxes. During the spare time, crewmembers and scientists are allowed to visit the German permanent station in Antarctica, Neumayer III, which is reached with a 20-km (one hour) long sledge ride on a bumpy, back-breaking ice track. However, the weather is perfect for travelling – air temperature -5°C, wind 2 bft, and the sky partly cloudy – requiring a high-summer sun block of factor 50. What is missing to round up the Antarctic experience? Sure, penguins! As ambassador, one Emperor is watching five ice floes away, and small groups of Adelies add to the biosphere on the sea ice. However, they do not seem to be impressed nor disturbed by our high-tech research vessel. Maybe, 35 years of the same procedure every year might have made the inhabitants of Atka Bay bored.

Neumayer III: As a masterpiece of German engineering, this station can escape the accumulation of snow by going up (https://www.awi.de/expedition/stationen/neumayer-station-iii/bau-der-neumayer-station-iii.html). While the 'old' over-winterers guide us through all four floors of the station, telling us enthusiastic stories of the past year, the 'new' over-winterers have to stow away the food for the next 12 months. Since we don't want to disturb them, we leave for the "Garden Eden", a near-by greenhouse container run by the German Space Agency (DLR). The vegetables are already growing inside, but not yet enough for a decent soup for all. Neumayer III is a very spacious station, but accommodating 53 people right now, is at the edge of its capacity. However, in the next few weeks most of them will leave by plane, allowing the 10 over-winterers to relax, settle-in, feel at home, and prepare for the long polar night. Finally, a note from the old (under-snow) station Neumayer II: The load of 25 years of snow accumulation has caused the station tubes to collapse, making further visits impossible.

The support stop at Neumayer III ends with the traditional soccer game 'Polarstern vs. Neumayer' and a few cups of mulled wine afterwards. The ship's horn says good-bye and we leave, heading in the direction where the ice floes get thicker. In the following weeks, Polarstern will show her full capability of surveying and sampling all components of the polar Earth system from the atmosphere to the deep ocean floor. The tools we brought with us include a wide range of instruments, which allow for a large variety of observational methods. In the coming weeks we will report about the details – the excitement increases with the morale - or vice versa?

On behalf of PS111, the chief scientist and the editorial board send regards from a sunny coastal polynya in front of an impressive ice shelf edge – all are doing very well!

Supplement to Weekly Report #1: On our way to Neumayer Station III we surveyed a previously uncharted area of sea floor the size of Lower Saxony.

Michael Schröder, Chief Scientist PS111

PS111 – Weekly Report No. 3 | 3 - 9 February 2018

Moorings

[13. February 2018]

This week's work on PS111 was focused on moorings. Instruments, which have stayed in the water for up to 4 years, were retrieved and re-deployed.

The instruments are attached to a rope with a heavy weight (500 kilograms) at the bottom and floats at the top to keep the rope straight in the water column. The length of the rope is determined by water depth minus 200 m to keep it clear of deep-drafting passing icebergs. The instruments include current meters, sound sources to guide free drifting floats (see Weekly Report #1), acoustic releases, and CTDs – Conductivity (to calculate salinity), Temperature, Depth (= Pressure). We recovered 4 moorings, which all arrived on board in perfect shape and 'delivered' well-recorded ocean parameters. All together 7 moorings, 4 from AWI and 3 from the University of Bergen, Norway, have now been deployed at 76°S at the northeastern slope of the Filchner Trough to monitor for another 2 or 3 years the outflow of very cold (< -2°C) and the inflow of relatively warm (< -1.3°C) water masses. Recovery and deployment is quite complicated and requires a fair number of people on deck. However, the deck crew is very experienced - who knows how many times they have done it - therefore, our last mooring in 500-m water depth was deployed in just 14 minutes.

Fig. 1: The floats of one of our moorings coming back on deck. (Photo: Alfred-Wegener-Institut)

At each mooring position a CTD is lowered to measure the above-mentioned ocean parameters and to collect water by closing 24 Niskin bottles at different depths. The samples will be analyzed onboard or at home by the different groups including micro-biology, chemistry, geochemistry, and tracer oceanography.

For navigation and location of specific areas of interest we use satellite images. The sea ice concentration has a huge impact on the ship's mobility and the use of our instruments. Because of favorable sea ice concentrations indicating less sea ice to the west of the grounded iceberg A23-A and a coastal polynya in front of the Ronne Ice Shelf, we decided to head south; a polynya is an ice-free area in the sea ice cover caused by winds and/or relatively high ocean temperatures. The 3 days we needed from the Filchner Sill to the Ronne Ice Shelf were used for working on samples, scientific talks, and, as always when the ship is moving, surveying previously uncharted areas of the sea floor using the side-scan sonar and the sediment echo sounder.

On Friday noon Polarstern arrived at the edge of Ronne Ice Shelf.

Best wishes from all members of PS111.

Dr Michael Schröder

Chief Scientist

PS111 – Weekly Report No. 4 | 10 - 16 February 2018

From the Ronne Ice Shelf Polynya

[19. February 2018]

During this week we completed a transect along the Ronne Ice Shelf front, extending from 50°W to 60°W. Every instrument on board has been used.

The biologists, geologists, and oceanographers acquired numerous samples from a total of 23 stations. The CTD and onboard pump provided sea water, the bongo and multi-net delivered biological samples, and the multi-corer and gravity corer transferred sediments from the sea floor to the ship's deck. Some samples were distributed among the different disciplines, to be analyzed in separate labs and lab-containers, while others were sealed in plastic bags or bottles for safe transport back home.

Fig. 1: Manta at 400-m depth at ROV station PS111_36-02. The red dots serve as a reference scale 10 centimetres apart. (Photo: Nils Owsianowski/Claudio Richter/AWI)

Fig. 2: Geological outcrop in the mountains of the Antarctic Peninsula. (Photo: Marcus Gutjahr/GEOMAR)

Fig. 3: A halo above the Ronne Ice Shelf polynya. (Photo: Yannick Kern/AWI)

It is amazing that the harsh environmental conditions near an ice shelf edge at around 75°S can still sustain life. Here, air temperatures around -18°C, winds of 8 bft, and a wind-chill of -35°C are quite normal for an austral summer season. A gap in the ice shelf front forms an inlet that serves as a sunny beach for some seals, the water column contains lots of plankton, and ice floes are very brownish at the base due to algae growth. The weather conditions are favorable for a geologically/biologically motivated helicopter flight - we have two helicopters on board. However, during the flight, weather conditions change such that the biologist cannot tag any seals and the geologists are left without any rock samples from the nearby mountains of the Antarctic Peninsula. The success of everyone's work strongly depends on sea ice and weather conditions.

The ROV (Remotely Operated Vehicle) completed three missions at the edges of the Ronne Ice Shelf and iceberg A23-A to observe life in the water column and at the sea floor. Countless ice platelets grow from the ice wall or form within the rising water, which is at sub-freezing temperatures. The shelf water gets colder and fresher as it melts meteoric ice at great depth. As it rises along the sloping ice shelf base, cooled to temperatures as low as -2.5°C, the pressure release and the consequent increase in the freezing point cause the water to become super-cooled. Ice crystals then form and either settle onto the ice shelf base or float out from beneath the ice shelf and thicken the sea ice in front.

Heavy sea ice conditions and strong winds allow us to stay in the coastal polynya for only five days. On 14 February Polarstern arrived at the eastern edge of Ronne Ice Shelf where we turned north heading for iceberg A23-A. Thirty years ago, three big chunks calved from the Filchner Ice Shelf. All touched ground on the shallow Berkner Bank, but two left and now only A23-A remains. From its position, the iceberg still controls the sea ice conditions in front of Filchner Ice Shelf, allowing only a narrow ice-free channel along its edge which, due to northwesterly winds, unfortunately closed as we arrived, making a shortcut into the Filchner Trough impossible. However, a reconnaissance flight with the helicopter revealed a possible passage to the east on the northern side of the iceberg. This route allows us to extend existing CTD sections to the west, onto the western slope of the Filchner Trough. That was impossible during previous Polarstern cruises to this area due to the solid sea ice cover.

Best wishes from all members of PS111

Dr Michael Schröder

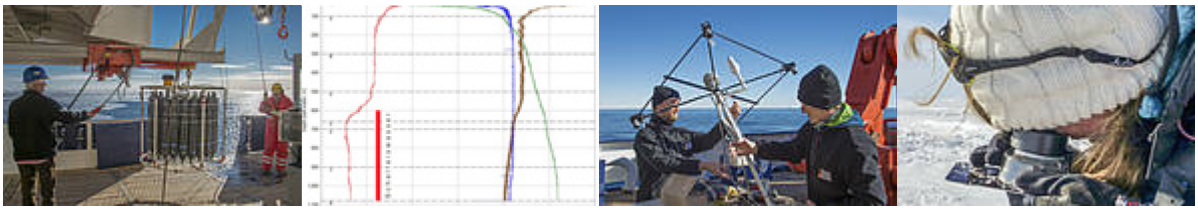
Chief Scientist

PS111 – Weekly report 5 | 17 - 23 February 2018

Ice and water in the Filchner Depression

[26. February 2018]

Favourable ice conditions and stable weather with southwesterly winds enabled Polarstern to go far south into the Filchner Depression and to cross directly in front of the Filchner Ice Shelf close to 44° W this week.



On February 20th, the oceanographic program was adapted at short notice owing to the prevailing weather and ice conditions: the polynya in front of Berkner Island reopened so that a CTD section could be completed at this position.

Fig. 1: The CTD brings 288 litres of water samples from various depths in the ocean onto the deck. Their physical, chemical and biological properties are studied by the different research groups on board. The ADCP (Acoustic Doppler Current Profiler) measu (Photo: Alfred-Wegener-Institut)

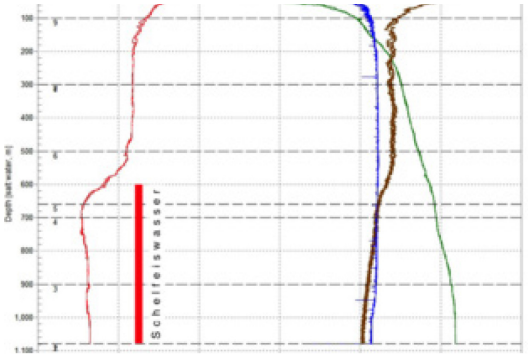


Fig. 2: Profile of the water column showing temperature (red), salinity (green), oxygen (brown) and turbidity (blue). The bar indicates the Ice Shelf Water with temperatures down to -2.29°C. When such cold water is brought up to the surface, ice crystals (Graphic: CTD-Team/PS111)

Three further sections across and along the Filchner Depression complete the oceanographic data set that comprises measurements of a number of parameters: salinity, calculated from conductivity, temperature and pressure. The conductivity probe is calibrated daily, allowing salinity to be determined with an accuracy of two thousandths; temperature is measured with an accuracy of one thousandth of a degree. To ensure the highest possible precision, temperature and salinity are measured in duplicate, as a high degree of accuracy is required to identify the different water masses in the ocean. Additional sensors determine the concentration of dissolved oxygen, the turbidity of the water via light transmission and the fluorescence of chlorophyll.

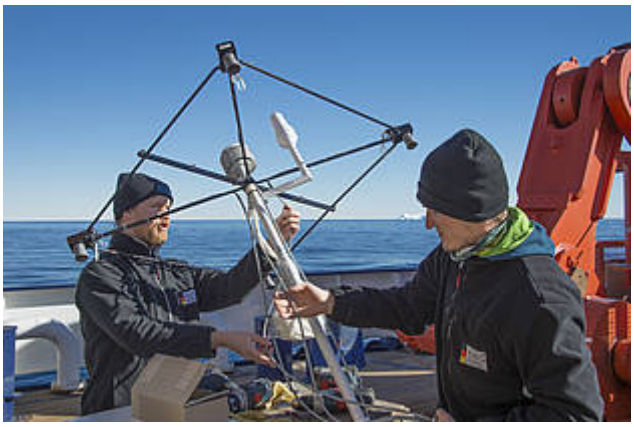


Fig. 3: Marcus Huntemann and Nicolas Stoll from the sea-ice group preparing a snow buoy for deployment. (Photo: Alfred-Wegener-Institut)

Fig. 4: Sea-ice researcher Stefanie Arndt analysing the grain size distribution in the snow cover of an ice floe. (Photo: J. Geilen, Alfred-Wegener-Institut)

The latter is contained in phytoplankton and therefore its concentration is a measure of primary productivity. Two ADCPs (Acoustic Doppler Current Profilers) determine the currents above and below the CTD, making use of the Doppler effect on sound waves reflected from particles in the water.

During a CTD cast, water samples, 12 liters each in volume, are retrieved at various depths selected by the research groups on board. Overall, the CTD brings 288 litres of water samples from up to 24 different depths back onto the ship. On February 19th, a record temperature of -2.290°C was measured with the CTD in the Ice Shelf Water (ISW) flowing out from beneath Filchner Ice Shelf. The complete CTD profile along the Ronne-Filchner ice shelf edge provides a rare dataset that could only be obtained because of the favorable wind and sea ice conditions.

While for many other working groups the growing sea-ice cover along Polarstern’s track can pose a challenge to their work, the sea-ice group is happy about the plethora of sea-ice floes now surrounding the ship in late summer. The work on the sea-ice is as versatile as the ice itself. In addition to snow and ice thickness measurements, the small-scale internal structures of the seven ice floes sampled so far have been analysed. The drilling of ice cores allows vertical profiles of temperature, density and salinity to be measured. Moreover, the snow cover is closely inspected using a magnifying glass: the examination of the grain size distribution in the snow cover provides important information about internal melting and freezing processes. Seasonal changes in snow and ice thickness are detected by autonomous platforms (buoys) deployed on the floes. They will drift with the floes through the Weddell Sea and send the recorded data via satellite directly back to the institute. On this expedition, the buoys are decorated with pictures painted by children from all over Germany. At home, the kids are following the exciting journey of “their" buoy online.

With a contribution from stafanie Arndt / AWI on the sea ice research program.

Best wishes from all members of PS111.

Dr Michael Schröder

Chief Scientist

PS111 -Weekly Report No. 6 | 24 February - 2 March 2018

From the Northern Transect to Halley Bay

[05. March 2018]

A third transect from this week now also covers the Northern part of the Filchner Depression. Net and water samples as well as short sediment cores kept all research groups on Polarstern busy 24 hours a day.

The multicorer (MUC) supplies several groups with sampling material. It provides largely undisturbed samples from the ocean - seabed interface, consisting of a few decimeters of sediment including the supernatant soil water. The 12 single cores with a diameter of 6 cm each are analyzed by different research groups and to this end sliced into smaller parts on board.

Fig. 1: After a successful mission with the multicorer, the cores are distributed and analyzed by several research groups. Here Maria-Elena Vorrath hands a core to Claudio Richter to measure the oxygen concentration. (Photo: AWI)

Fig. 2: Pelagic snails (pteropods) belong to the zooplankton. Their shells are made of aragonite and are therefore particularly vulnerable to ocean acidification. This specimen was caught using a bongo net. (Limacina helicina antarctica, Ø = 1.5 mm. (Photo: Stanislav Horb/Uni Kiel)

Fig. 3: Ice researchers Ronja Reese and Ricarda Winkelmann (PIK) from the sea-ice group anchor autonomous platforms, so-called light and salinity harps, on an ice floe in order to measure the physical properties during its growth and decline in the coming (Photo: Yannick Kern, AWI)

Fig. 4: Polarstern navigates through newly-forming and first-year sea-ice floes. (Photo: Yannick Kern/AWI)

The young investigator group PALICE reconstructs the paleo sea-ice cover from the sediment. A 30-40 cm long MUC core, divided into slices, covers time periods of up to several thousands of years. The so-called biomarkers occur in algae that live at the bottom of the sea ice. Once died off, they become part of the sediment and are therefore a good indicator of the sea-ice extent in the past.

Another corer tube is perforated along its longitudinal axis. From a porous rod, a pore water profile can be extracted in 1 cm increments using syringes. The actual chemical analysis of the samples will then take place at AWI after the expedition. The distribution of nutrients and trace elements provides information on how oxygen-rich the sediment is and whether it can release the amount of iron, necessary for plankton blooms.

The isotope geochemists on board investigate the trace metals lead and neodymium in the MUC core profile in order to reconstruct the ice and meltwater input into the Weddell Sea. The signature of these rare elements is characterized by the composition of the ice-covered geological hinterland. The lead samples must be carefully extracted in a protective argon-atmosphere to avoid contamination. The pore water solution centrifuged from the samples will be analyzed in the labs at GEOMAR.

In additional MUC cores, oxygen profiles were taken and microbial conversion rates were determined. To this aim, sediment cores were incubated on board for 2 days and the decrease in oxygen concentrations was determined, which serves as a measure of the respiration of the organisms living in the soil. The results can be related to surface productivity and general environmental conditions such as the sediment and sea-ice properties.

The sea-ice physics group measured the thickness of the so-called fast ice – the multiyear sea-ice attached to the ice shelf – with means of an electromagnetic probe (EM Bird) which was installed underneath the helicopter for a total of five transect flights. For the first time, the ice thickness distribution of the fast ice in front of Berkner Island could be determined this way.

The deployment of the autonomous platforms (buoys) on ice floes was successfully completed this week. The buoys, including the last snow buoy, two ice-mass balance buoys, one spectral radiation station as well as so-called light and salinity harps, will drift with the ice

floes over the coming months and provide real-time data on the snow and ice properties via satellite. The sea-ice group has meanwhile recovered from their last mission - they had worked for 5 hours under strong wind conditions with windchill temperatures down to -50 degrees and heavy snow drift in order to deploy these buoys.

Winter is approaching and with daytime temperatures of -15 to -25 ° C and winds of up to 6-7 Beaufort, even the last areas of open water are freezing over. Drifting snow covers the newly formed sea-ice, so that Polarstern often maneuvers through an ice cover that extends to the horizon. Thanks to the experienced navigators, this is achieved without problems by constantly navigating along the route with the lowest possible ice resistance and thus the lowest fuel consumption.

On Friday, the station work ends at the British Halley station where 16 additional people are coming on board and two pistenbullis, sledges and containers are loaded. En route to the final port of Punta Arenas, the scientific program continues, including seafloor mapping with multibeam echosounder and sediment profiler.

With contributions from Maria-Elena Vorrath, Claudia Hanfland, Marcus Gutjahr and Claudio Richter on the multicorer and sediment cores.

With best wishes from all members of PS111

Michael Schröder

Chief scientist

PS111 - Weekly Report No. 7 | 3 - 9 March 2018

Across the Weddell Sea

[12. March 2018]

Pteropods spend their life cycle in the water column. The organisms actively “fly” through the water, by using their feet, which transform into two wings. The Pteropods calcium shell is made of Aragonite, which makes them especially vulnerable to ocean acidification. The increasing amount of carbon dioxide in the atmosphere leads to an increased absorption of CO2 in the cold waters of the polar oceans and enhances the acidification there.

Three biologists from GEOMAR and the University of Kiel are investigating the abundance of Pteropods in the Weddell Sea and the impact of ocean acidification on their shells. The organisms were caught along the cruise track with a Bongo net and will subsequently be analyzed under the microscope back at the home laboratory. The CO2 content of the water was determined from water samples. Considering the Pteropods’ sensitivity to ocean acidification, they can serve as an early warning system for further CO2 increases in the Weddell Sea.

Fig. 1: Extracting the catch of the day from the Bongo net. (Photo: H. Grobe, AWI)

Fig. 2: Group photo: Polarstern and James Clark Ross. (Photo: M. Schröder, AWI)

Fig. 3: Shadow of Polarstern on an iceberg in the evening sun. (Photo: Yannick Kern, AWI)

Among the many different activities, PS111 carried out surface trawls to investigate whether microplastics, sadly abundant in much of the world oceans, have already reached the Antarctic waters of the Weddell Sea. A total of seven trawls provided preliminary indications of colored artificial particles, although it remains to be tested whether these are in fact microplastics or perhaps paint particles from Polarstern or other vessels. Additionally, underway water samples were pumped on board to be analyzed back at home alongside sediment cores from the seafloor.

Bathymetric work will continue during the remaining cruise track toward Punta Arenas to survey the topography of the seafloor with a Multibeam echo-sounder. The beam consists of several hundred rays and resolves a swath several times wider than the water depth. The majority of the Weddell Sea is not yet mapped, and therefore every new cruise track provides additional bathymetric information that steadily improves the IBCSO-map (International Bathymetric Chart of the Southern Ocean), which is maintained at AWI. The area that was mapped during this cruise is equivalent to the size of Schleswig-Holstein.

The sediment echo-sounder measures the thickness of the sediments on the seafloor. In contrast to the Multibeam, this echo-sounder has only a single beam, which concentrates its energy to penetrate several meters into the seafloor. The track across the Weddell Sea confirmed that the continental slope region is incised by several submarine canyons. These are the major communication and transport pathways of material from the continent to the deep sea. The echo-sounder mapped thick piles of sediment that has settled at the canyon sides. Both bathymetric systems are monitored and data are quality controlled around the clock by the bathymetry group.

Following the last deep CTD station in the northwestern corner of the Weddell Sea, we leave the region through the Antarctic Sound en route to Bransfield Strait in order to prepare the ship for the crossing of Drake Passage. No more ice means rockin’ and rollin’ so everything on the ship needs to be strapped down again. Coincidentally, the James Clark Ross, flagship of the British Antarctic Survey, is in the area, and Polarstern took the opportunity to meet and greet the British colleagues.

The scientific work of PS111 is now finalized, and overall completes another very successful expedition with Polarstern. Even after 35 years, the ship is as powerful as ever and operates without problems largely down to the professional maintenance and handling of her crew. The cruise participants are looking forward to being home again soon and would like to express their sincere gratitude to Captain Stefan Schwarze and his crew, whose knowledge and seamanship paved the way to a successful science program.

This is the last report before the end of the cruise.

Dr. Michael Schröder

Chief scientist