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

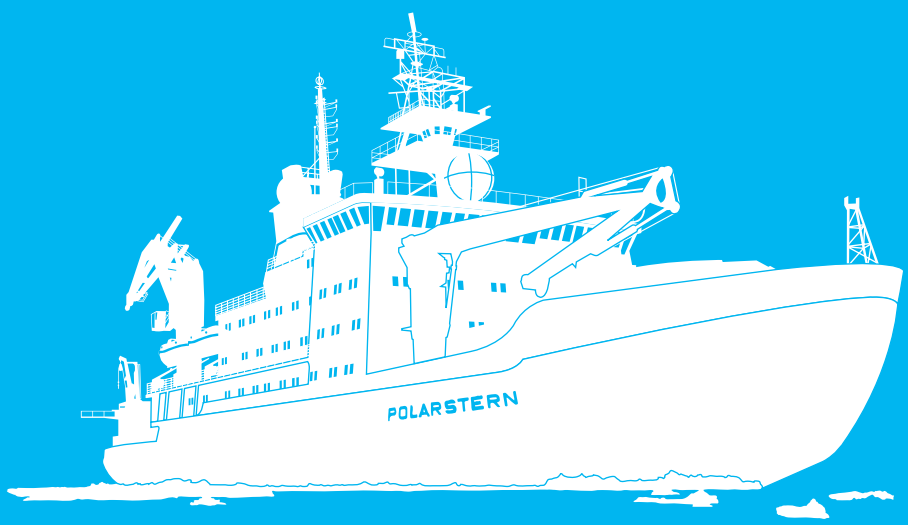
EXPEDITION PROGRAMME PS127

Polarstern

PS127
Bremerhaven – Cape Town
5 December 2021 – 2 January 2022

Coordinator: Ingo Schewe

Chief Scientist: Laura Hehemann



HELMHOLTZ

Bremerhaven, November 2021

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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*.
The papers contained in the Expedition Programme *Polarstern* do not necessarily reflect the opinion of the AWI.

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1. ÜBERBLICK UND FAHRTVERLAUF

Laura Hehemann [1]DE.AWI

Am 05. Dezember 2021 wird *Polarstern* ihre Antarktis-Expedition 2021/2022 mit dem Fahrtabschnitt PS127, dem Atlantik-Transit, beginnen. Entlang der Fahrtroute werden physikalische, biologische und chemische Meerwasserparameter sowie atmosphärische Messparameter kontinuierlich gemessen. Schulungen an hydroakustischen Messsystemen werden durchgeführt. Neu installierte und neu entwickelte Messsysteme werden getestet.

Im Rahmen des Projekts Oceanet (TROPOS) werden Material und Energieflüsse zwischen Ozean und Atmosphäre untersucht. Seit 11 Jahren werden Messungen mit einem speziell angefertigten Messcontainer auf der *Polarstern* auf Expeditionen in der nördlichen und südlichen Hemisphäre durchgeführt. Die Messungen umfassen regelmäßig Strahlungs- und Mikrowellen-Fernerkundung sowie Laser-basierende Profil-Messungen (Lidar) von Aerosolen und Wolken.

Fest in das Schiff integrierte Messsysteme messen auf der Transitfahrt kontinuierlich definierte Meerwasserparameter, wie CO_2-Gehalt, Algenpigmente, Salzgehalt und Temperatur entlang der Fahrtstrecke von *Polarstern*. Diese und weitere Messungen *en route* tragen zu den Untersuchungen während Expeditionen bei und bezogen auf größere Raum- und Zeitskalen zu einem wissenschaftlichen Verständnis wichtiger Prozesse und deren Veränderungen.

Hydroakustischen Messmethoden stellen wichtige Untersuchungsmethoden für die Erforschung des Meeresbodens und des Meeres dar. Sie werden auf der *Polarstern* regelmäßig unter anderem für die Erkundung der Topographie und des Sedimentaufbaus des Meeresbodens eingesetzt. Auf dem Fahrtabschnitt PS127 werden Schulungen für den Einsatz des für Bathymetrie genutzten Fächerlotsystems Hydrosweep, sowie für das parametrische Sedimentecholot Parasound durchgeführt.

Polar- und Meeresforschung benötigt neben einer Kontinuität von Messungen (Langzeitdatensätze) eine stetige Weiterentwicklung von Messmethoden und Messmitteln. Auf der PS127 werden neu installierte und neu entwickelte Messsysteme getestet. Hierzu zählt der Test einer Clean CTD mit Wasserprobennehmer, ein für den Einsatz spezielles Windensystem und Reinraum-Container. Die Clean-CTD dient bei späteren Expeditionen der Probenahme von Meerwasser in der Wassersäule frei von Spurenmetall-Verunreinigungen.

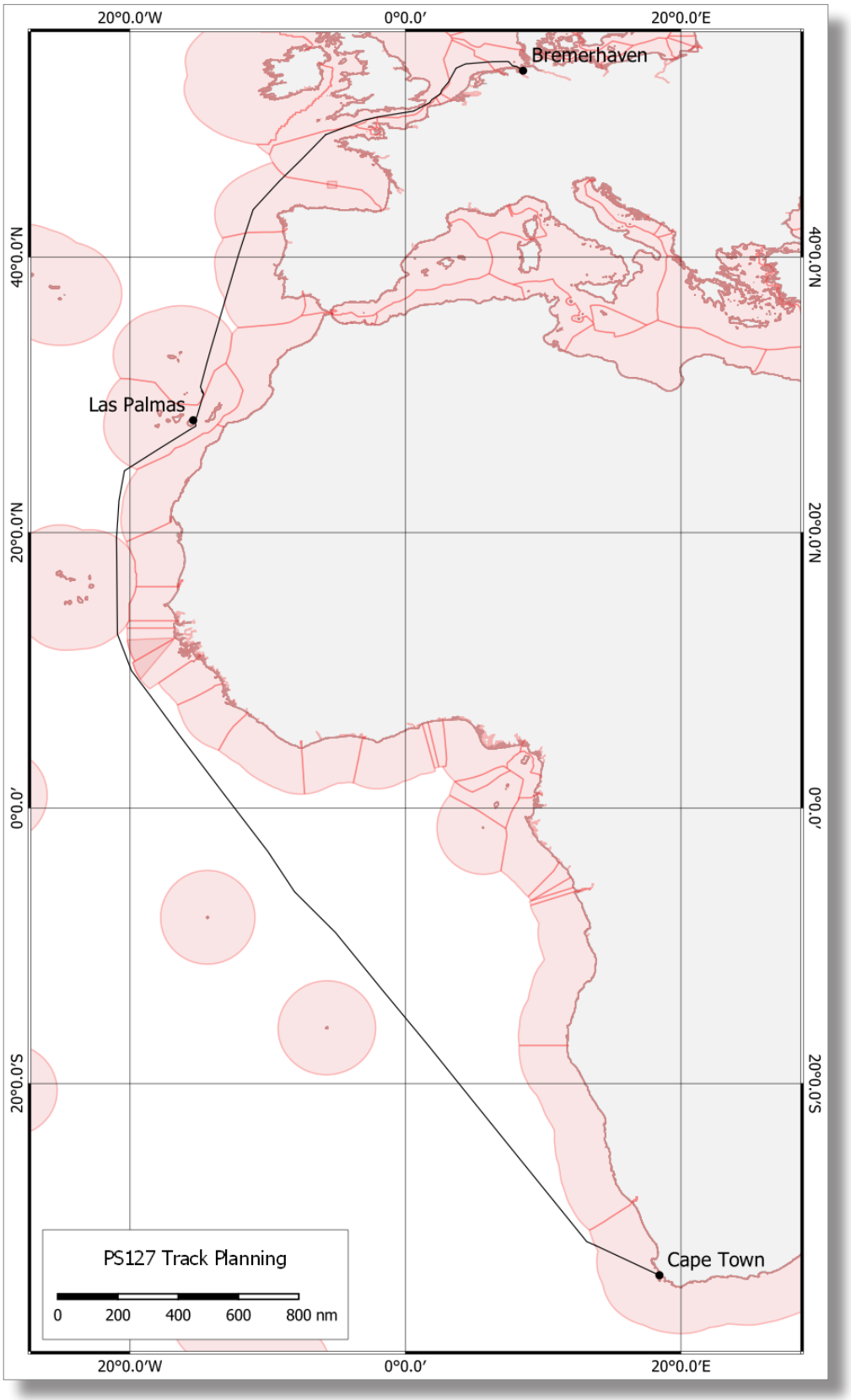

Abb. 1: Geplante Route des Fahrtabschnitts PS127 der Polarstern Antarktis-Expedition 2021/22
Fig. 1: Planned route of cruise leg PS127 of the Polarstern Antarctic Expedition 2021/22

SUMMARY AND ITINERARY

On 05 December 2021, *Polarstern* will start its Antarctic expedition 2021/2022 with cruise leg PS127, the Atlantic transit. Physical, biological and chemical seawater parameters as well as atmospheric measurement parameters will be measured continuously. Training on hydroacoustic measurement systems will be conducted. Latest developed and newly installed measurement systems will be tested.

Within the Oceanet project (TROPOS) material and energy fluxes between ocean and atmosphere are investigated. Since 11 years, measurements are performed with a custom-built measurement container on *Polarstern* during expeditions in the northern and southern hemisphere. The measurements regularly include radiation and microwave remote sensing as well as laser-based measurements (lidar) of aerosols and clouds profiles.

Measurement systems permanently integrated into the ship continuously measure defined seawater parameters such as CO_2 content, algal pigments, salinity and temperature along *Polarstern's* transit route. These and other *en-route* measurements contribute to investigations during expeditions and to a scientific understanding of important processes and their changes on larger space and time scales.

Hydroacoustic measurement methods are important investigation methods for seafloor and ocean research. They are regularly used on *Polarstern* to investigate the topography and sediment structure of the seafloor, among other things. On cruise leg PS127, training is provided for the use of the Hydrosweep multibeam sounding system used for bathymetry, as well as for the parametric sediment echosounder Parasound.

Polar and marine research requires a continuity of measurements (long-term data sets) as well as a continuous development of measurement methods and equipment. Latest developed and newly installed measurement systems are tested on PS127. This includes the test of a Clean CTD with water sampler, a winch system specially designed for the application and cleanroom container. The Clean-CTD will be used to sample seawater in the water column free of trace metal contaminants during subsequent expeditions.

2. BATHYMETRIC MAPPING AND GEOPHYSICAL UNDERWAY MEASUREMENTS

Simon Dreutter[1], Sacha Viquerat[1], [1]DE.AWI
Laura Hehemann[1];
Boris Dorschel[1] (not on board)

Grant-No. AWI_PS127_00

Objectives

Accurate knowledge of the seafloor topography, hence high-resolution bathymetry data, is key basic information necessary to understand many marine processes. It is of particular importance for the interpretation of scientific data in a spatial context. Bathymetry, hence geomorphology, is furthermore a basic parameter for the understanding of the general geological setting of an area and geological processes such as erosion, sediment transport and deposition. Even information on tectonic processes can be inferred from bathymetry. Supplementing the bathymetric data, high-resolution sub-bottom profiler data from the top tens of meters below the seabed provide information on the sediments at the seafloor and on the lateral extension of sediment successions.

While world bathymetric maps give the impression of a detailed knowledge of worldwide seafloor topography, most of the world's ocean floors remains unmapped by hydroacoustic systems. In these areas, bathymetry is modelled from satellite altimetry with a corresponding low resolution. Satellite-altimetry derived bathymetry therefore lack the resolution necessary to resolve small- to mesoscale geomorphological features (e.g. sediment waves, glaciogenic features and small seamounts). Ship-based multibeam data provide bathymetric information at a resolution sufficient to resolve these features. The collection of underwater data during PS127 will contribute to the bathymetry data archive at the AWI and therefore to bathymetric world datasets like GEBCO (General Bathymetric Chart of the Ocean).

Work at sea

Bathymetric data will be recorded with the hull-mounted multibeam echosounder Atlas Hydrosweep DS3, and sub-bottom data will be recorded with the hull-mounted sediment echosounder Atlas Parasound P70. The main task of the bathymetry group is to run hydroacoustic systems during the transit. The raw bathymetric data will be corrected for sound velocity changes in the water column, and will be further processed and cleaned for erroneous soundings and artefacts. Simultaneously recorded sub-bottom data provide information on the sedimentary architecture of the surveyed area.

Sound velocity profiles will be collected with an Underway CTD (Conductivity Temperature Depth) probe whenever possible.

Additionally, magnetic and gravimetric data will be collected with the ship mounted Magnetometer and Gravimeter.

Preliminary (expected) results

Expected results will consist of high-resolution seabed maps and sub-bottom information along the cruise track, as well as other geophysical underway data (magnetics and gravimetry).

Data management

Geophysical and oceanographic 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. Furthermore, bathymetric data will be provided to the Nippon Foundation – GEBCO Seabed 2030 Project.

In all publications, based on this cruise, the **Grant No. AWI_PS127_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.

3. AUTONOMOUS MEASUREMENT PLATFORMS FOR ENERGY AND MATERIAL EXCHANGE BETWEEN OCEAN AND ATMOSPHERE (OCEANET): ATMOSPHERE

Kevin Ohneiser, Rico Hengst, Majid Hajipour;
not on board: A. Andreas Macke, Ronny Engelmann

DE.TROPOS

Grant-No. AWI_PS127_00

Objectives

The OCEANET-ATMOSPHERE project delivers valuable atmospheric measurement datasets over oceans – in regions of the world that are not easily accessible. For the last 11 years, a container-based platform is operated regularly on *Polarstern* to obtain measurements and to contrast atmospheric processes between the anthropogenically polluted northern hemisphere and the less disturbed southern hemisphere.

Recently, the ESA satellite Aeolus with a wind lidar on board was launched. If possible, we will obtain some of the first ground-comparison profiles during PS127 in order to calibrate and validate the data within the EVAA project (Experimental Validation and Assimilation of Aeolus observations).

a) Radiation & microwave remote sensing

The net radiation budget at the surface is the driving force for most physical processes in the climate system. It is mainly determined by the complex spatial distribution of humidity, temperature and condensates in the atmosphere. The project aims at observing both the radiation budget and the state of the cloudy atmosphere as accurate as possible to provide realistic atmosphere-radiation relationships for use in climate models and remote sensing. While similar experiments have been performed from land stations, only few data from measurements over ocean areas exist.

A multichannel microwave radiometer will be applied to continuously retrieve the integrated water vapor and the cloud liquid water path over the ocean. Time series of these values will resolve small-scale atmospheric structures as well as the effects of the mean state of the atmosphere and its variability on the co-located measurements of the downwelling shortwave and longwave radiation. These data will be compared to and combined with METEOSAT SEVIRI products for a characterization of atmospheric state and radiative fluxes. Atmospheric aerosol optical thickness will be measured by means of hand-held sun photometer and by a new Cimel photometer, which has been modified for marine conditions. As an alternative to the sun photometer, additional radiation measurements are conducted with a multi-spectral shadowband radiometer (GUVis-3511), providing measurements of global, direct and diffuse spectral irradiance and aerosol optical thickness. Most instruments are integrated in the container-based atmosphere observatory.

b) Lidar measurements of aerosol and cloud profiles

Since more than 20 years, TROPOS develops and operates advanced lidar systems in order to study optical and microphysical aerosol properties in the troposphere. The system PollyXT, a semi-autonomous multiwavelength polarization Raman lidar, will be operated inside a container together with the radiation and microwave sensing equipment. The lidar is capable of independently measuring particle backscatter profiles at three wavelengths and extinction at two wavelengths, allowing the type, size and concentration of particles to be determined. Additionally, particle depolarisation is measured in order to discriminate between spherical and non-spherical particles, e.g. biomass-burning smoke vs. mineral dust or water clouds vs. ice clouds. The lidar is equipped with a measurement channel for atmospheric water vapour, too. The data are used to characterize long-range transport of aerosol and identify pollution. The determined height-resolved aerosol extinction completes the radiation measurements. In this way, the radiative influence of single lofted aerosol or cloud layers can be calculated with radiation transport models.

For PS127 the lidar will be operated with a second large field-of-view depolarization channel. From this data, we will be able to determine cloud microphysical properties (effective radius and cloud-droplet number concentration) in the base of liquid water clouds.

Work at sea

Upon departure from Bremerhaven, the container-based atmosphere observatory OCEANET will be installed at the deck of *Polarstern*. Most measurements will be performed underway and continuously. During the time on board the scientists of OCEANET will mainly take care of the measurements, calibrations, maintenance of the instruments and early data evaluation. If possible, the ship cruise track shall be slightly adjusted in consultation between the crew and the scientists of OCEANET to match 2–4 Aeolus satellite overpasses in order to get comparison profiles from the surface and from space for the calibration and validation of the Aeolus products. The following individual instruments are combined:

1. Multichannel microwave radiometer HATRPO. The instrument requires a calibration with liquid nitrogen at the port
2. Total-sky imager for cloud-structure measurements
3. Multiwavelength polarization Raman lidar PollyXT
4. Handheld sun photometer (Microtops) for aerosol and cloud optical thickness
5. Automatic Cimel sun photometer
6. Fully-automated spectral shadow band radiometer (GUVis-3511)
7. Standard meteorological and radiation data logging Preliminary (expected) results

Preliminary (expected) results

- Second structure of the clear sky atmosphere and corresponding net radiation budget
- Horizontal structure of the cloud water path and its effect on the downwelling shortwave and longwave radiation

- Vertical structure of temperature and humidity as well as its variability for validation of satellite products
- Vertical profiles of tropospheric aerosols and their effect on radiation

Data management

All OCEANET raw data from this cruise are stored at the oceanet-archive server of TROPOS. Access can be requested via email to ronny@tropos.de.

Additionally, higher-level data are uploaded, archived, published and disseminated according to international standards by the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (https://www.pangaea.de) under the keyword OCEANET-ATMOSPHERE 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_P127_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.

4. TEST CLEAN-CTD

Christian Völkner[1], Florian Koch[1],
Ingrid Stimac[1]
Wolfgang Küstner[2], Kley France employee[1,3],
Kley France employee[2,3]

[1]DE.AWI
[2]DE.SERWARTEC
[3]FR.KLEYFRANCE

Grant-No. AWI_PS127_00

Objectives

The main objective of our programme is to perform a sea acceptance test for the newly purchased winch container. Therefore, the cable routing of the new synthetic conductor CTD cable needs to be set up and checked. Two employees from the manufacture of the winch container (Kley France) will perform the test. In addition to the sea acceptance of the winch container, we will test the new cleanroom container and the workflow around it. This includes the transport of 24 x 12 L GoFlo Bottles from the Clean CTD to the cleanroom container and the implemented wash station from the container as well as the workflow for trace metal clean sampling. The first use of the container will be supported by a SerWarTec employee to optimize airflow settings and to assess possible malfunctions.

The test of the newly acquired equipment is essential since it will play a key role on future expeditions. A malfunction of either the winch container or the cleanroom container during such an expedition would prevent the further use of the clean-CTD.

Work at sea

- Implementing the cable routing for the winch container
- Sea acceptance test of the winch container
- 2–3 deep CTD casts (4,000 m)
- Workflow test for trace metal clean sampling
- Cleanroom container test

Expected results

The Clean CTD, CTD cable and winch container work fine and can be used during future cruises.

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_P127_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.

5. ECHOSOUNDER TRAINING COURSE

Catalina Gebhardt[1] [1]DE.AWI

Grant-No. AWI_PS127_00

Objectives

The echosounder training course is an AWI internal training course for senior and young scientists that intend to participate in one of the upcoming *Polarstern* expeditions to Antarctica. The course will provide hands-on training in operating the hull-mounted echosounder system of *Polarstern* (sediment echosounder Parasound P70). The system will be operated between Bremerhaven and Las Palmas/Canary Islands.

Work at sea

After embarkation, scientists will get a brief introduction to the Parasound system. Subsequently, the system will be run continuously and acquire underway data. The scientists will run the system during day hours and get familiar to data handling, preparation for archiving, basic editing, and conversion to standard SGY and UKOOA format. Practical training will also include testing different settings for data acquisition, for example single pulse versus quasi-equidistant mode, and different frequency settings. In addition, the training will also focus on troubleshooting, fully restarting the system, and marine mammal mitigation procedures. After finishing this short course, all participants will be able to run the system independently on future expeditions.

Data management

Hydro-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.

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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
DE.AWI	Alfred Wegener Institut Helmholtz Zentrum für Polar- und Meeresforschung Postfach 120161 27515 Bremerhaven Germany
DE.DWD	Deutscher Wetterdienst Seewetteramt Bernhard Nocht Str. 76 20359 Hamburg Germany
DE.LAEISZ	Reederei F. Laeisz GmbH Bartelstraße 1 27570 Bremerhaven Germany
DE.SERWARTEC	SerWarTec GmbH Stueckweg 14 35325 Muecke Germany
DE.SHIPDESIGN	SDC Ship Design & Consult GmbH Bramfelder Strasse 164 22305 Hamburg Germany
DE.TROPOS	Leibniz Institut für Troposphärenforschung Permoserstraße 15 4318 Leipzig Germany
FR.KLEYFRANCE	4 rue Jacques Daguerre 92500 Rueil-Malmaison France

A.2 FAHRTTEILNEHMER / CRUISE PARTICIPANTS

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession	Fachrichtung/ Discipline
Boebel	Tobias	DE.AWI	Scientist	Logistics
Crenan	Brieuc	DE.LAEISZ	Engineer	Shipping Company
Dreutter	Simon	DE.AWI	Technician	Geophysics
Endres	Sonja	DE.AWI	Scientist	Logistics
Esper	Oliver	DE.AWI	Scientist	Geology
Freudenberg	Sascha	DE.SHIPDESIGN	Engineer	Logistics
Gebhardt	Catalina	DE.AWI	Scientist	Geophysics
Gosch	Thomas	DE.SHIPDESIGN	Engineer	Engineering Sciences
Hajipour	Majid	DE.TROPOS	PhD student	Physics
Hehemann	Laura	DE.AWI	Technician	Geophysics
Hengst	Rico	DE.TROPOS	Scientist	Geo Sciences
Horvath	Esther	DE.AWI	Photographer	Public Outreach
Koch	Florian	DE.AWI	Scientist	Biology
Krocker	Ralf	DE.AWI	Engineer	Logistics
Kuestner	Wolfgang	DE.SERWARTEC	Scientist	Geology
Kühl	Johannes	DE.AWI	Engineer	Logistics
Lapp	Uta	DE.AWI	Observer	Logistics
Maltby	Johanna	DE.AWI	Scientist	Logistics
Meier	Jan	DE.AWI	Engineer	Logistics
Meier-Ewert	Lavinia	DE.AWI	Observer	Public Outreach
Miller	Heinrich	DE.AWI	Scientist	Glaciology
Ohneiser	Kevin Oliver	DE.TROPOS	PhD student	Meteorology
Otte	Frank	DE.DWD	Scientist	Meteorology
Pautot	Julien	FR.KLEYFRANCE	Technician	Logistics
Pluder	Andreas	DE.LAEISZ	Engineer	Shipping Company
Portere	Loic	FR.KLEYFRANCE	Engineer	Engineering Sciences
Rogenhagen	Johannes	DE.LAEISZ	Inspector	Shipping Company
Schierwater	Andrea	DE.AWI	Other	Logistics
Stimac	Ingrid	DE.AWI	Technician	Chemistry
Stöckle	Sonja	DE.DWD	Other	Meteorology
Viquerat	Sacha	DE.AWI	Scientist	Biology

Name/ Last name	**Vorname/ First name**	**Institut/ Institute**	**Beruf/ Profession**	**Fachrichtung/ Discipline**
Völkner	Christian	DE.AWI	Engineer	Chemistry
Weigelt	Estella	DE.AWI	Scientist	Geophysics
Wilde	Detlef	DE.AWI	Scientist	Logistics
Ziemann	Olaf Hermann August	DE.LAEISZ	Engineer	Shipping Company

A.3 SCHIFFSBESATZUNG / SHIP'S CREW

No.	Last name	First name	Rank
1	Schwarze	Stefan	Master
2	Kentges	Felix	Chiefmate
3	Langhinrichs	Jacob	Chiefmate Cargo
3	Ziemann	Olaf	Chief
4	Strauss	Erik	2nd Mate
5	Fallei	Holger	2nd Mate
6	Hofmann	Jörg Walter	ELO
7	Gößmann-Lange	Petra	Ships doc
8	Brose	Thomas Christian	2nd. Eng.
9	Haack	Michael Detlev	2nd. Eng.
10	Schnürch	Helmut	2nd. Eng.
11	Redmer	Jens Dirk	ELO.
12	Hüttebräuker	Olaf	ELO
13	Frank	Gerhard Ansgar	ELO
14	Krüger	Lars	ELO
15	Nasis	Ilias	ELO
16	Sedlak	Andreas Enrico	Bosun
17	Neisner	Winfried	Carpen.
18	Erlenbach	Colin	MP Rat.
19	Klee	Phillip	MP Rat.
20	Kreutzmann	Lennart	MP Rat.
21	Meier	Jan	MP Rat.
22	Möller	Falko	MP Rat.
23	Bäcker	Andreas	AB
24	Burzan	Gerd-Ekkehard	AB
25	Wende	Uwe	AB
26	Preußner	Jörg	Storek.
27	Gebhardt	Norman	MP Rat.
28	Hilliger	Maik	MP Rat.
29	Rhau	Lars-Peter	MP Rat.
30	Schwarz	Uwe	MP Rat.
31	Teichert	Uwe	MP Rat.
32	TBN		Cook
33	Silinski	Frank	Cooksm.
34	Zahn	Maren	Cooksm.
35	Pieper	Daniel	Chief Stew.

No.	Last name	First name	Rank
36	Braun	Maja Alexandra	Nurse
37	Arendt	René	2nd Stew.
38	Chen	Dansheng	2nd Stew.
39	Krause	Tomasz	2nd Stew.
40	Pieper	Daniel	Chief Stew.
41	Silinski	Carmen	2nd Stew.
42	Sun	Yongsheng	Laundrym.