

EXPEDITION PROGRAMME
PS135/1 and PS135/2

Polarstern

PS135/1 and PS135/2

Punta Arenas - Mindelo - Bremerhaven

08 March 2023 - 11 April 2023

Coordinator:

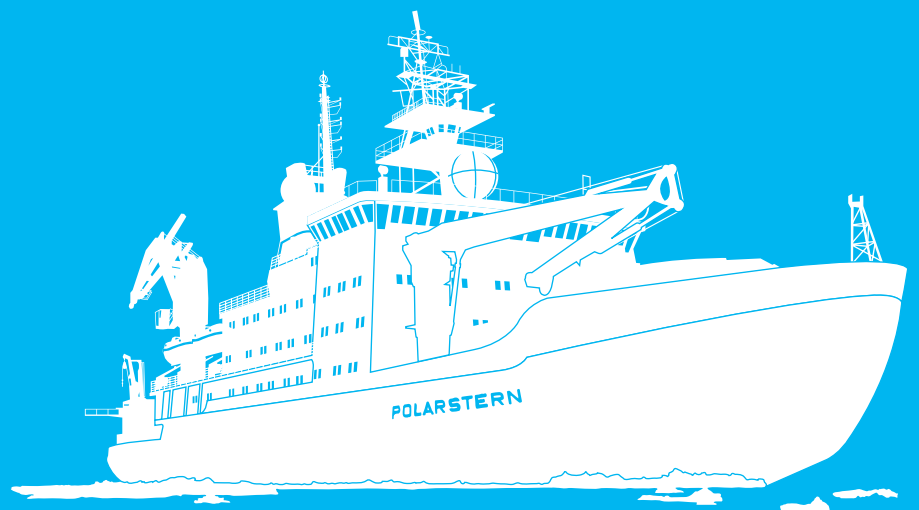
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The Expedition Programme *Polarstern* is issued by Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI) in Bremerhaven, Germany.

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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**PS135/1
PS135/2**

08 March 2023 – 11 April 2023

Punta Arenas – Mindelo – Bremerhaven



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1. ÜBERBLICK UND FAHRTVERLAUF

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Der Fahrtabschnitt PS135 ist der letzte Abschnitt der antarktischen Forschungssaison 2022/23 und dient der Überführung des Schiffes in seinen Heimathafen Bremerhaven. Die Expedition PS135 startet in Punta Arenas am 08.03.2023 und endet am 11.04.2023 in Bremerhaven (Abb. 1). Am 28.03.2023 wird ein Zwischenstopp in Mindelo stattfinden, der die Fahrt in die Abschnitte PS135/1 und PS135/2 gliedert. Auf dem ersten Abschnitt liegt der Fokus auf *en route* Messungen, welche ebenfalls auf dem zweiten Abschnitt fortgeführt werden. Ab Mindelo liegt der Schwerpunkt auf einer akademischen Ausbildungsfahrt („Floating University“) für westafrikanische M.Sc. Studierende, bei welcher zusätzlich auch tägliche Stationsarbeiten durchgeführt werden. Die Ausbildung auf diesem Abschnitt findet im Rahmen des vom Bundesministerium für Bildung und Forschung (BMBF) finanzierten WASCAL Programms statt (West African Science Service Centre on Climate Change and Adapted Land-Use).

Auf der gesamten Reise (Abschnitte 1 und 2) werden folgende *en route* Messungen und Tätigkeiten durchgeführt:

- Mit den schiffsinternen hydroakustischen Systemen wird auf der gesamten Strecke ein Streifen Meeresbodentopographie bathymetrisch vermessen. Die Gesamtfahrtzeit von vier Wochen enthält einige Stunden Stationszeit für die Kalibration der Echolotsysteme mittels Wasserschallsonde und CTD Messungen.
- Es werden Wasser- und Luftproben zur Bestimmung von persistenten organischen Schadstoffen (POPs) sowie von und neuartigen, noch nicht regulierten organischen Kontaminanten genommen.
- Weiterhin werden atmosphärische Messungen von Aerosolen, Wasserdampf und Wolken mittels eines Sonnenphotometers und einer Wolkenkamera durchgeführt.
- Biogeochemische Messungen im Oberflächenozean mittels im Durchfluss betriebener Sensorik (u.a. CO₂ Partialdruck, gelöster Sauerstoff etc.).

Ab Mindelo beginnen dann tägliche Stationsarbeiten mit dem bordeigenen CTD Kranzwasserschöpfer sowie einem Multischließnetz. Es werden außerdem die beiden Zeitserienstationen CVOO nördlich von Cabo Verde („Cabo Verde Ocean Observatory“) sowie ESTOC nördlich von Gran Canaria („European Station of Time-Series in the Ocean of the Canary Islands“) beprobt, um Langzeit-Datenerhebungen fortzuführen. Darüber hinaus finden mehrere Auslegungen von Argo Tiefendriftern im Rahmen des internationalen Argo Programms statt.

Die Expedition trägt zu den Zielen des Forschungsprogramms „Erde im Wandel – Unsere Zukunft sichern“ bei. Es ist Teil der programmorientierten Förderung (PoF IV) der Helmholtz-Gemeinschaft. Die Tätigkeiten der Expedition stehen im engen Zusammenhang mit den Themen 2 (Ozeane und Kyrosphäre im Klimawandel), 4 (Die Küstengebiete im globalen Wandel) sowie 6 (Marines und polares Leben).

SUMMARY AND ITINERARY

Expedition PS135 is the last leg of the 2022/23 Antarctic research season and will bring back the ship to its home port of Bremerhaven. Expedition PS135 starts in Punta Arenas on 08.03.2023 and ends in Bremerhaven on 11.04.2023 (Fig. 1.1). On 28.03.2023 there will be a stopover in Mindelo, which will divide the voyage into legs PS135/1 and PS135/2. On the first leg, the focus is on *en route* measurements, which will also be continued on the second leg. From Mindelo, the focus is on an academic training cruise (“Floating University”) for West African M.Sc. students, during which daily station work will be carried out. The training on this leg takes place within the framework of the WASCAL Programme (West African Science Service Centre on Climate Change and Adapted Land-Use) funded by the German Federal Ministry of Education and Research (BMBF).

Throughout the voyage (leg 1 and 2), the following *en route* measurements and activities will be carried out:

- With the ship-mounted hydroacoustic systems, a swath of seabed topography will be bathymetrically surveyed along the ship’s track. A few hours of station time will be spent on calibrating the echosounding systems by sound velocity profiler and CTD casts.
- Water and air samples will be collected to determine persistent organic pollutants (POPs) and not yet regulated emerging organic contaminants (EOCs).
- Further, atmospheric measurements of aerosols, water-vapour and clouds will be conducted with a sun-photometer and a cloud camera.
- Biogeochemical measurements in the surface ocean using flow-through sensors (e.g. CO₂ partial pressure, dissolved oxygen, etc.).

From Mindelo, daily station work will begin with the on-board CTD rosette water sampler and a multinet. The two time series stations CVOO north of Cabo Verde (“Cabo Verde Ocean Observatory”) and ESTOC north of Gran Canaria (“European Station of Time-Series in the Ocean of the Canary Islands”) will also be sampled to continue long-term data collection. In addition, several deployments of Argo Floats will take place as part of the international Argo Programme.

The expedition contributes to the goals of the Research Programme “Changing Earth – Sustaining our Future”. It is part of the programme-oriented Funding (PoF IV) of the Helmholtz Association. The activities of the expedition are closely related to the topics 2 (Ocean and Cyrosphere in Climate Change), 4 (Coastal Zones at a Time of Global Change) and 6 (Marine and Polar Life).

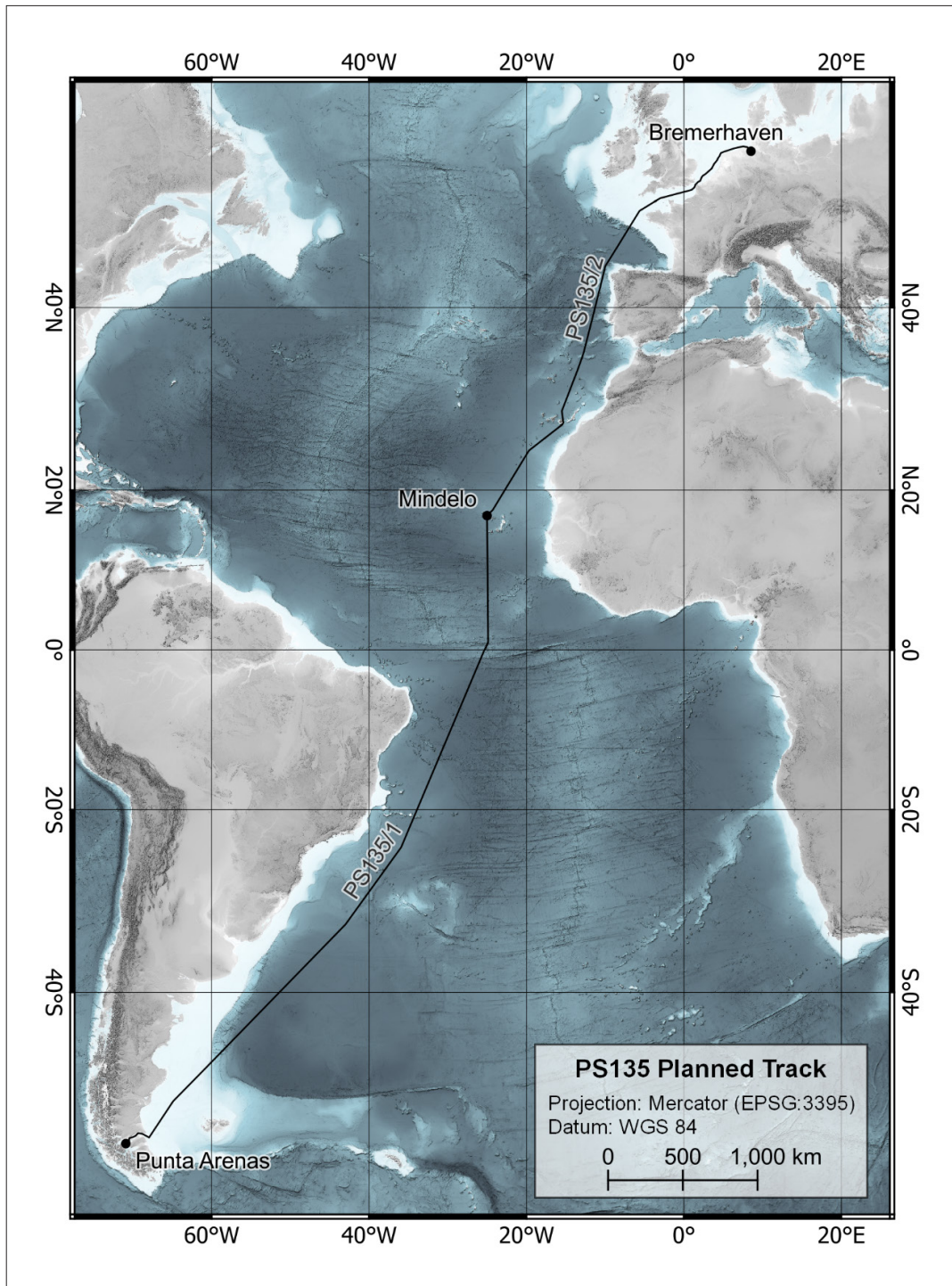


Abb. 1.1: Geplante Route der Fahrtabschnitte PS135/1 und PS135/2: Schwarze Punkte markieren die Hafenanläufe während dieser Reise.

Fig. 1.1: Planned route of expeditions PS135/1 and PS135/2: Black markers indicate port calls during the cruise.

2. BATHYMETRIC UNDERWAY MEASUREMENTS

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Not on board: Boris Dorschel¹

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Grant-No. AWI_PS135_01

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 of the top 10s 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 floor 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 meso-scale geomorphological features (e.g. sediment waves, glaciogenic features and small seamounts). Ship-borne multibeam data provide bathymetry information in a resolution sufficient to resolve those features and for site selection for the other scientific working groups on board.

The collection of underway data during PS135/1 and PS135/2 will contribute to the bathymetry data archive at the AWI and therefore contribute 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 Teledyne Reson Hydrosweep DS3. The main task of the bathymetry group is to run hydroacoustic systems during 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.

Sound velocity profiles will be collected with a CTD (Conductivity Temperature Depth), an Underway CTD, or an SVP (Sound Velocity Probe) whenever possible.

Preliminary (expected) results

Expected results will consist of high-resolution seabed maps along the cruise track.

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

This expedition was supported by the Helmholtz Research Programme “Changing Earth – Sustaining our Future” Topic 2, Subtopic 3 Sea Level Change.

In all publications based on this expedition, the **Grant No. AWI_PS135_01** will be quoted and the following publication 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. **ATMOSPHERIC AND OCEANIC TRANSPORT OF EMERGING ORGANIC CONTAMINANTS IN THE ATLANTIC OCEAN**

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Not on board: Hanna Joerss¹

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Grant-No. AWI_PS135_02

Outline

Legacy and emerging organic contaminants can enter the coast, marine and ocean environment by a number of processes (Xie et al., 2022a). Once introduced they are subject to biogeochemical cycling, sinks, and bioaccumulation process in the ocean. Apart from the discharge of the rivers and runoff, atmosphere is considered to be the primary and most rapid pathway for pollutant transport to the coast and marine environment as a result of their hydrophobic and semi-volatile nature, respectively (Xie et al., 2020). Several leading groups of Environmental Analytical Chemistry are joining *Polarstern* during PS135/1 and PS135/2 to determine emerging and legacy organic contaminants in moderate latitudes of the Northern and Southern hemisphere in proposal to further investigate their up to date levels and air-sea interactions in remote oceans. The research programme is focused on the determination of selected POPs in air and water, which is subdivided into several major groups. Considering ocean currents and fronts, the origin of air masses as well as changing air-sea gradients of pollutants, field study-based analysis of long oceanic transects from source regions to remote areas are considered a promising approach to improve the understanding of the underlying transport mechanisms (Xie et al., 2022b).

Objectives

The investigation of emerging and legacy organic contaminants (pesticides, PFAS, BFR, OPFR, PAE, UV filters, alkyl phenols and PPCPs) in this project aims to improve the knowledge for a better understanding of the occurrence, distribution and transport pathways of chemical contaminants. The main objectives are

- to provide data sets on the occurrence and distribution of selected emerging organic contaminants in atmospheric and seawater samples along latitudinal transects in the Atlantic Ocean,
- to evaluate atmospheric transport mechanisms of microplastics and related organic chemical additives,
- to compare data on legacy persistent organic pollutants to earlier data regarding temporal trends and the efficacy of international regulations,
- to investigate atmospheric and oceanic transport pathways along the sampling transects with respect to the possible source regions Europe, Africa and South America,
- to improve the understanding of the underlying transport mechanisms based on ocean currents and fronts,

- to estimate air-sea gas exchange fluxes and atmospheric deposition of the investigated emerging organic contaminants.

Work at sea

Air sampling

Four high-volume air samplers will be mounted on the upper deck of the research vessel. While airborne particles will be collected on glass fibre filters, the gaseous compounds will be trapped on PUF/XAD-2 glass cartridges. Field blanks will be prepared by espousing the PUF/XAD-2 column and glass fibre filters shortly to the sampling site. The samples will be stored at -20°C until sample extraction in a land-based laboratory (Xie et al. 2011).

Water sampling

1 L surface seawater will be collected in polypropylene bottles for analysis of PFAS and PPCP. They will be taken from the ship's seawater intake system (stainless steel pipe) in 11 m depth at regular intervals along the cruise track. Simultaneously, another 1 L surface seawater will be collected in glass bottle and filtered on board, and then stored in cooling room at 5°C. Besides, 1L seawater samples will be also collected from CTD in order to determine the vertical profile of chemical contaminants in the water column.

High-volume water sampling

High volume seawater about 100-500 L are collected in the wet lab via a seawater intake system. Samples are collected with a glass fibre filter for the particles and an XAD-2 resin column for the dissolved chemicals. Samples are stored at 0°C in the cooling room.

Preliminary (expected) results

To investigate the occurrence and the environmental fate of legacy and emerging organic contaminants, high-volume air and water samples will be simultaneously taken along the cruise route of PS135. Concentrations of emerging organic contaminants in ocean waters and the atmosphere from southern Hemisphere will be investigated across several provinces of the Atlantic Ocean. Both, the particulate and the gas or water phase will be analyzed to identify the partitioning behaviour in the oceans and the atmosphere. Based on the data, the transport behaviour and long-range transport potential of emerging organic contaminants on the southern and northern Hemisphere will be studied, and the air-water exchange process will be estimated. Unknown substances and transform products of chemical contaminants will be identified with nontarget analysis and suspecting programme.

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 expedition at the latest. By default, the CC-BY license will be applied.

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

This expedition was supported by the Helmholtz Research Programme "Changing Earth – Sustaining our Future" Topic 4, Subtopic 4.1.

In all publications based on this expedition, the **Grant No. AWI_PS135_02** will be quoted and the following publication 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>.

References

- Xie Z, Wang P, Wang X, Castro-Jiménez J, Kallenborn R, Liao C, Mi W, Lohmann R, Vila-Costa M, Dachs J (2022a) Organophosphate ester pollution in the oceans. Nature Reviews Earth & Environment 3: 309-322. <https://doi.org/10.1038/s43017-022-00277-w>
- Xie Z, Zhang P, Wu ZL, Zhang S, Wei LJ, Mi LJ, Kuester A, Gandrass J, Ebinghaus R, Yang RQ, Wang Z, Mi W (2022b) Legacy and emerging organic contaminants in the polar regions. Science of the Total Environment 835: <https://doi.org/10.1016/j.scitotenv.2022.155376>
- Xie Z, Wang Z, Magand O, Thollot A, Ebinghaus R, Mi W, Dommergue A (2020) Occurrence of legacy and emerging organic contaminants in snow at Dome C in the Antarctic. Science of the Total Environment 2020, 741: 140200. <https://www.sciencedirect.com/science/article/pii/S0048969720337219>
- Xie Z, Moller A, Ahrens L, Sturm R, Ebinghaus R (2011) Brominated Flame Retardants in Seawater and Atmosphere of the Atlantic and the Southern Ocean. Environmental Science & Technology 45 (5): 1820-1826. <https://pubs.acs.org/doi/10.1021/es103803t>

4. ATMOSPHERIC REFERENCE DATA

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Grant-No. AWI_PS135_03

Objectives

Scientific goals are the collection of atmospheric reference data for satellite remote sensing and global modeling and to complement satellite views of clouds with images from below. During the voyage, atmospheric properties of aerosol and water vapor will be collected with a sun-photometer and cloud properties will be examined with visible and thermal camera images. In addition, associations among these data are examined as well in the context to meteorological state data recorded on the ship.

Work at sea

Aerosol and water vapor atmospheric column averages are collected by a sun-photometer during the day, when the sun is not obscured by clouds, in a labor-intensive handheld operation. Data will be transmitted each evening to NASA, where data are quality controlled and placed on http://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html for general viewing within days. On the vessel, data are summarized into hourly averages and placed into an Excel cruise summary worksheet. Examined cloud properties of cloud cover, cloud structure and cloud base altitude distributions are derived from thermal sky images (in a complex processing effort each evening). Hourly averages of these cloud properties and hourly averages of selected meteorological data (offered by the ship's standard instrumentation via the Dship server) are fed into the same Excel cruise summary worksheet. This worksheet then allows to examine time-series, daily cycles and data associations, also in support of process understanding in atmospheric modeling.

Preliminary (expected) results

Hourly averaged data of meteorological data will be offered in an excel spreadsheet, which illustrates time-series, daily cycles and associations. The aerosol data are expected to serve as ocean references in satellite remote sensing (e.g. AeroSAT) and modeling (e.g. AeroCom) and contribute to the MAC aerosol climatology. The cloud data are compared to global data from satellite remote sensing hereby adding information on cloud base altitudes.

Data management

All data will be immediately available (via the web and/or contacts). During the voyage efforts will be made to assure a high data quality and to develop derived data products and data associations. For any data download or request, it is suggested to contact instrument PIs to understand data quality and data limitations to avoid potential data mis-interpretations. More specifically:

During the voyage efforts will be made to assure a high data quality and to develop derived data products and data associations. For any data download or request, it is suggested to contact instrument PIs to understand data quality and data limitations to avoid potential data mis-interpretations. More specifically:

- MICROTOPS data for aerosol reference data will be accessible via the NASA website at http://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html
- CLOUD visible and black-body sky images (recorded every 10 sec, ca 200 Gb) will be stored at a MPI-M facility – at least initially (final location needs to be discussed).

In all publications based on this expedition, the **Grant No. AWI_PS135_03** will be quoted and the following publication 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. WASCAL FLOATING UNIVERSITY

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Grant-No. AWI_PS135_04

Outline

Leg PS135/2 hosts the second edition of the WASCAL Floating University Programme (GPF 211_041; WASCAL-II) which combines a research expedition with an academic curricular education cruise. This floating university cruise is part of the curriculum of the international Master Programme “Climate Change and Marine Sciences”, which is currently implemented at the Atlantic Technical University of Cabo Verde (UTA) in the framework of the BMBF-funded WASCAL Programme (“West African Science Service Centre on Climate Change and Adapted Land Use”). During the cruise, several modules of the curriculum will be taught theoretically as well as practically. In addition, scientists on board will be able to communicate their research to West African students and data will be collected for individual master thesis projects. Therefore, ongoing scientific research efforts off West Africa will be integrated into the work programme (e.g. ecological and biogeochemical time-series observations). The students will benefit, not only through the teaching component delivered by the lecturing PIs, but even more through their immersion into real individual research projects as compared to the more “staged” experience of classical field work practicals.

Through the combination of teaching and research (“training-through-research”), the WASCAL Floating University during PS135/2 benefits academic education as well as for current research projects in the region.

The WASCAL Programme in Cabo Verde including this expedition is endorsed by IOC-UNESCO as a Decade Project hosted by the Decade ECOP Programme within the framework of the UN Decade of Ocean Research for Sustainable Development.

Objectives

Primary objective during this expedition is the academic education of Master’s degree students in the course “Climate Change and Marine Sciences” (MRP-CCMS) during an authentic research expedition. Therefore, theoretical lecture modules will be combined with practical training sessions about classical oceanographic field-sampling methods (e.g. gear deployment/recovery, analytical lab techniques, data reduction and visualization, etc.). Scientific data obtained during the cruise will be used instantaneously for teaching and training purposes but also for scientific exploitation.

The following lecture modules of the MRP-CCMS curriculum will be addressed on board:

1. Ocean Observations
2. Hydroacoustics in fisheries and marine ecology and
3. Communication and scientific writing.

Beside teaching modules also research modules will be carried out in order to (i) contribute to current research efforts in the region and to global ocean observing programmes, (ii) teach the students with state-of-the-art oceanographic technologies and real scientific data, and (iii) collect scientific data for individual master thesis projects. Therefore, the following research modules will be an integral part of PS135/2:

Module 1: Surface ocean biogeochemistry Underway measurements of key surface properties (temperature, salinity, CO₂ partial pressure, O₂ partial pressure, chlorophyll, and turbidity) that allow to assess the saturation state for CO₂ and O₂ to deconvolute the observed disequilibrium into its physical and biological drivers and calculate air-sea CO₂ and O₂ fluxes. These observations will be carried out throughout the cruise. Equipment permanently installed on board of *Polarstern* will be used for this purpose.

Module 2: Marine ecology & microbiology The cruise track covers different biomes and offers the opportunity to characterize the associated pelagic ecosystems as well as local communities. To facilitate integration of results, the main aim is to use methods that can be used readily to estimate zooplankton contribution to biomass, bulk metabolic rates and export flux. Specifically, we will determine the total integrated zooplankton biomass at each station, the contribution of larger taxonomic groups and selected sites. Microbiological diversity via genetic analyses will be also investigated across the different regimes.

Module 3: Time-series observations Full-depth CTD hydrocasts including biogeochemical sampling at 2 different time-series sites (Cape Verde Ocean Observatory, CVOO, and European Station of Time-Series in the Ocean of the Canary Islands, ESTOC) will extend the long-term data sets of these sites. Conducted sampling will facilitate the assessment of changes in the Eastern Tropical North Atlantic (e.g., community structure, acidification, deoxygenation).

Work at sea

The following gears and general operational methods will be deployed for carrying out the research modules:

I. Station work:

CTD-rosette system (CTD-rosette): profiling physical properties and water sampling will be performed using the ship's own Seabird 911+ system equipped with 24 x 12 L Niskin bottles. The system will have a sensor configuration with additionally attached oxygen and fluorescence sensors.

Discrete water samples taken from the rosette will be analyzed for nutrients (NO₃⁻, NO₂⁻, PO₄³⁻, SiO(OH)₄⁻) as well as dissolved oxygen and carbon parameters (dissolved inorganic carbon (DIC), total alkalinity (TA)). Chlorophyll a (Chla) concentration will be measured from filtered samples using a Turner fluorometer. Salinity and oxygen analysis will be used to calibrate the CTD sensors. Daily CTD depths profiling along the transit will be performed down to 1,200 m and for the time-series stations we plan to conduct full-depths CTD profiles. Samples will be collected for microbiological diversity and genetic analyses based on filtration and preservation techniques.

Underwater Vision Profiler 6 (UVP): recording images of zooplankton and particles in certain size classes starting at approximately 50 µm with a pressure-safe underwater high-resolution camera. These images allow a qualification and quantification of zooplankton and particles. The UVP will be mounted on the ship's own CTD rosette system (see above).

Multinet: determining the biomass and vertical distribution of mesozooplankton along the latitudinal gradient. The used multinet is a Hydrobios Multinet Midi with a 0.25 m² mouth

opening and five 150 µm mesh nets. The multinet will be deployed down to 1,000 m water depth. The standard depth strata will be 1,000 - 600 - 300 - 200 - 100 - 0 m. Multinet casts will be conducted in pairs (one at daytime, one at nighttime) at CVOO and ESTOC to allow the estimation of diurnal vertical migration.

II. Underway measurements:

Underway multiparameter measurement systems (GO $p\text{CO}_2$ and Ferry Box) and thomosalinograph for underway near-surface water sampling to determine sea surface temperature, sea surface salinity as well as several biogeochemical parameters. Discrete samples for various parameters will be also collected from the underway seawater supply line.

Shipboard observations of current velocity using the **Acoustic Doppler Current Profiler (ADCP)** mounted to the research vessel (150 kHz RDI Ocean Surveyor).

Scientific echo sounder (EK80): recording underway calibrated backscatter signals to determine and characterize e.g. zooplankton and pelagic fish assemblages and distribution as well as to quantify selected groups.

III. Autonomous mobile platforms:

Along the route, 5 **Argo floats** will be deployed for the Federal Maritime and Hydrographic Agency (BSH) to support the international Argo Programme.

Besides the scientific field work students will also be taught in scientific communication and writing in order to learn how to translate scientific information and knowledge for different target audience groups. These exercises will be combined with general public outreach activities during the cruise, such as blog posts, short video clips, etc.

Preliminary (expected) results

Obtained scientific data during PS135/2 will contribute to long-term biogeochemical, ecological and physical time-series sites off (North-) West Afrika (CVOO and ESTOC). Site occupations with large international research vessels are rare and therefore very important for the extension of these data sets. In particular full-depth samplings at these sites can't be carried out with local research vessels. Collected data contribute to regional assessments of acidification, deoxygenation and potential shift in zooplankton community structure.

Surface ocean $p\text{CO}_2$ measurements along the transit route provide also valuable data for the Eastern Tropical North Atlantic which is a highly undersampled region for carbon dioxide. Carbon measurements on *Polarstern* have a very high accuracy (ICOS class 1 station) and therefore can be also used for validation of other, autonomous platforms such as biogeochemical Argo floats.

The training programme on board for the West African students provides a bi-directional exchange of knowledge during the expedition. The students will have learned to apply observational, multidisciplinary methods to produce scientific knowledge under authentic at-sea conditions. The scientists on board involved will also benefit from the student's experiences and challenges from their home countries in West Africa.

Data management

All data are stored shortly after the cruise in the Ocean Science Information System (OSIS-Kiel) which is hosted at GEOMAR. Data are accessible for all project participants and can be used to share and edit common expedition information and to share ongoing research data as they become available.

All 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 expedition at the latest. By default, the CC-BY license will be applied.

Zooplankton data will be further submitted to the international Ecotaxa database (<https://ecotaxa.obs-vlfr.fr>) and recorded, continuous surface pCO₂ data will be submitted to the ICOS (Integrated Carbon Observing System) Carbon portal and to the Surface Ocean CO₂ Atlas (www.socat.info) by the responsible ICOS PI at AWI.

In all publications based on this expedition, the **Grant No. AWI_PS135_04** will be quoted and the following publication 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>.

APPENDIX

A.1 TEILNEHMENDE INSTITUTE / PARTICIPATING INSTITUTES

A.2 FAHRTTEILNEHMER:INNEN / CRUISE PARTICIPANTS

A.3 SCHIFFSBESATZUNG / SHIP'S CREW

A.1 TEILNEHMENDE INSTITUTE / PARTICIPATING INSTITUTES

Affiliation	Address
CV.UTA	Universidade Técnica do Atlântico Institute of Engineering and Marine Sciences CP.163 - Campus de Ribeira de Julião Mindelo, São Vicente Cabo Verde
DE.AWI	Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung Postfach 120161 27515 Bremerhaven Germany
DE.CAU	Christian-Albrechts-Universität zu Kiel Christian-Albrechts-Platz 4 24118 Kiel Germany
DE.DWD	Deutscher Wetterdienst Seewetteramt Bernhard Nocht Str. 76 20359 Hamburg Germany
DE.GEOMAR	GEOMAR Helmholtz Zentrum für Ozeanforschung Kiel Wischhofstr. 1-3 24148 Kiel Germany
DE.HEREON	Helmholtz-Zentrum Hereon GmbH Max-Planck-Str. 1 21502 Geesthacht Germany
DE.IOW	Leibnitz-Institut für Ostseeforschung Warnemünde Seestraße 15 18119 Rostock-Warnemünde Germany
DE.MPIC	Max-Planck-Institut für Chemie Hahn-Meitner-Weg 1 55128 Mainz Germany
NO.UIO	Universitetet i Oslo Boks 1072 Blindern 0316 Oslo Norway

A.2 FAHRTTEILNEHMER:INNEN / CRUISE PARTICIPANTS

PS135/1: Punta Arenas – Mindelo				
Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession	Fachrichtung/ Discipline
Debler	Freya	DE.HEREON	PhD student	Chemistry
Kinne	Stefan	DE.MPIC	Scientist	Meteorology
Konopatzky	Peter	DE.AWI	Scientist	Geophysics
Raeke	Andreas Wolfgang	DE.DWD	Scientist	Meteorology
Schulze Tenberge	Yvonne	DE.AWI	Scientist	Geophysics
Wenzel	Anna Julia	DE.DWD	Scientist	Meteorology
Xie	Zhiyong	DE.HEREON	Scientist	Chemistry

PS135/2: Mindelo – Bremerhaven				
Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession	Fachrichtung/ Discipline
Akonde	Bôla-Nié Christelle	CV.UTA	M.Sc. Student	Marine Sciences
Antia	Avan	DE.CAU	Scientist	Biology
Assokpa	Kodjo Olivier	CV.UTA	M.Sc. Student	Marine Sciences
Biteye	Amadou	CV.UTA	M.Sc. Student	Marine Sciences
Bittig	Henry	DE.IOW	Scientist	Chemistry
Christiansen	Svenja	NO.UIO	Scientist	Biology
Datsomor	Wise Goodluck	CV.UTA	M.Sc. Student	Marine Sciences
Debler	Freya	DE.HEREON	Scientist	Chemistry
Dembele	Massitan Beny Dite Kanta	CV.UTA	M.Sc. Student	Marine Sciences
Dos Santos	Sarah Sofia Dias	CV.UTA	M.Sc. Student	Marine Sciences
Fiedler	Björn	DE.GEOMAR	Scientist	Chemistry
Kinne	Stefan	DE.MPIC	Scientist	Meteorology
Konopatzky	Peter	DE.AWI	Scientist	Geophysics
Lacho	Almoustapha Amadou Malan	CV.UTA	M.Sc. Student	Marine Sciences
Lourenço	Mayara Jany Sousa	CV.UTA	M.Sc. Student	Marine Sciences
Ndure	Amie	CV.UTA	M.Sc. Student	Marine Sciences
Needham	David	DE.GEOMAR	Scientist	Biology
Nworgu	Uzoma Chukwuemeka	CV.UTA	M.Sc. Student	Marine Sciences
Pinto	Antonio	CV.UTA	Scientist	Biology
Raeke	Andreas Wolfgang	DE.DWD	Scientist	Meteorology
Schmidtco	Sunke	DE.GEOMAR	Scientist	Physics
Schulze Tenberge	Yvonne	DE.AWI	Scientist	Geophysics
Soares	Osvaldina Julião Fernandes	CV.UTA	M.Sc. Student	Marine Sciences

PS135/2: Mindelo – Bremerhaven				
Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession	Fachrichtung/ Discipline
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Traore	Sienfoungo	CV.UTA	M.Sc. Student	Marine Sciences
Wenzel	Julia	DE.DWD	Scientist	Meteorology
Wimart-Rousseau	Cathy	DE.GEOMAR	Scientist	Chemistry
Xie	Zhiyong	DE.HEREON	Scientist	Chemistry

A.3 SCHIFFSBESATZUNG / SHIP'S CREW

Name	Vorname	Master
Schwarze	Stefan	Master
Kentges	Felix	C/M
Hering	Igor	2/M
Falk	Stefan	2/M
Fallei	Holger	3/M
Grafe	Jens	C/E
Haack	Michael Detlev	2/E
Brose	Thomas Christian Gerhard	2/E
Beyer	Mario	2/E
Mueller	Andreas	E/E Com.
Kliemann	Olaf	E/E Brücke
Zohrabyan	David Rubeni	E/E Brücke
Hüttebräucker		E/E Labor
Redmer	Jens Dirk	E/E SET
Nasis	Ilias	E/E System
Jaeger	Vladimir	E/E Winde
Sedlak	Andreas Enrico	Bosun
Münzenberger	Börge	MPR
TBN	n.n	MPR
Schwarz	Uwe	MPR
Rhau	Lars-Peter	MPR
Meier	Jan	MPR
Klinger	Dana Maria	MPR
TBN	n.n	MPR
Denzer	Florian	MPR
Claasen	Thies	MPR
TBN	n.n	MPR
Haenert	Ove	MPR
Neisner	Winfried Wolfgang	Carp.
Wende	Uwe	AB
Burzan	Gerd-Ekkehard	AB
Baecker	Andreas	AB

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Name	Vorname	Master
Preussner	Joerg	Fitter/E
Matter	Sebastian Udo	Cook
Hammelmann	Louisa	2./Cook
Silinski	Frank	2./Cook
Pieper	Daniel	C/Stew.
Braun	Maja Alexandra	Stew./Nurse
TBN	n.n	2./Stew.
Silinski	Carmen Viola	2./Stew.
Dibenau	Torsten Karl	2./Stew.
Arendt	Rene	2./Stew.
Krause	Tomasz	2./Stew.
Chen	Dansheng	2./Stew.
Goessmann-Lange	Petra	Dr.

