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

737
2019

Berichte
zur Polar- und Meeresforschung
Reports on Polar and Marine Research

# The Expedition PS105 of the Research Vessel POLARSTERN to the Atlantic Ocean in 2017

Edited by

Rainer Knust

with contributions of the participants

HELMHOLTZ

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*Titel: Polarstern am Tag der Veranstaltung"Open Ship" auf dem Gelände der Lloyd Werft in Bremerhaven (Foto: Alfred-Wegener-Institut / Kerstin Rolfes)*

*Title: Polarstern on the day of the event "Open Ship" on the site of the Lloyd Yard in Bremerhaven (photo: Alfred Wegener Institute / Kerstin Rolfes)*

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**Please cite or link this publication using the identifiers**

**http://hdl.handle.net/10013/epic.d7fecdbb-eef6-4c8a-8122-324c5e42b9f4 and https://doi.org/10.2312/BzPM_0737_2019**

**ISSN 1866-3192**

# PS105

**21 March 2017 - 20 April 2017**

**Punta Arenas - Las Palmas - Le Havre - Bremerhaven**

**Chief scientists**

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**Karin Lochte**
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**Coordinator**
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# 1. ZUSAMMENFASSUNG UND FAHRTVERLAUF

Rainer Knust AWI

*Polarstern* verließ den Hafen von Punta Arenas (Chile) wie geplant am 21.04.2017, um die Rückfahrt nach Bremerhaven zu beginnen. Die Transitfahrt wurde genutzt, um Untersuchungen zur Wasserchemie und Meteorologie, die von einem Ausbildungsprogramm des Deutschen Wetterdienstes (DWD) begleitet wurden, durchzuführen. Die Überfahrt wurde ebenfalls genutzt, um umfangreiche Vorarbeiten zum Tausch der Wellengeneratoren durchzuführen.

Auf dem Abschnitt von Las Palmas bis Bremerhaven fand ein intensiver Trainingskurs statt, in dem ca. 15 Studenten aus Deutschland und dem europäischen Ausland hydroakustische Messverfahren zu geologischen Untersuchungen erlernten. In einem kurzen Zwischenstopp in Le Havre (Frankreich) wurden Mitglieder des Wissenschaftsausschusses des deutschen Bundestages und Vertreter des BMBF eingeschifft, welche die zweitägige Überfahrt nach Bremerhaven nutzten, um sich über die Einsatzfähigkeit des Schiffes und über die Möglichkeiten zur Ausbildung von Studierenden an Bord zu informieren. Abbildung 1.1 zeigt den Fahrtverlauf der Expedition PS105.

Der Abschnitt ab Las Palmas wurde außerdem dazu genutzt, umfangreiche Vorbereitungs-arbeiten für die geplante Veranstaltung "OpenShip *Polarstern*" durchzuführen, die in Bremerhaven nach Rückkehr des Forschungsschiffes aus der Antarktis am 22. und 23. April mit einem groß angelegten Besucherprogramm stattfinden sollte.

## SUMMARY AND ITINERARY

As scheduled, *Polarstern* left the harbour of Punta Arenas (Chile) on April 21, 2017 to return to Bremerhaven. During the transit cruise meteorological and water chemistry studies were conducted. Part of the meteorological studies was also a training program of the “Deutsche Wetterdienst”. Additionally, extensive work took place in preparation of the change of the shaft generators.

During the cruise leg from Las Palmas to Bremerhaven, a training course took place, during which 15 students from Germany and other European countries were instructed methods for hydro-acoustic measurements for geological studies. During a short stopover in Le Havre (France), members of the Science Committee of the German Federal Parliament and representatives from BMBF (Ministry of Education and Research) embarked. They took the opportunity of the two-day journey to gain information about the operational capability of the vessel and the possibilities for education of students on board. Figure 1.1 depicts the course of the expedition PS105.

The leg from Las Palmas was also used to carry out extensive preparatory work for the planned event "OpenShip *Polarstern*" that was scheduled to take place in Bremerhaven on 22 and 23 April after the return of the research vessel from Antarctica. For that event a large-scale visitor programme had to be organized.

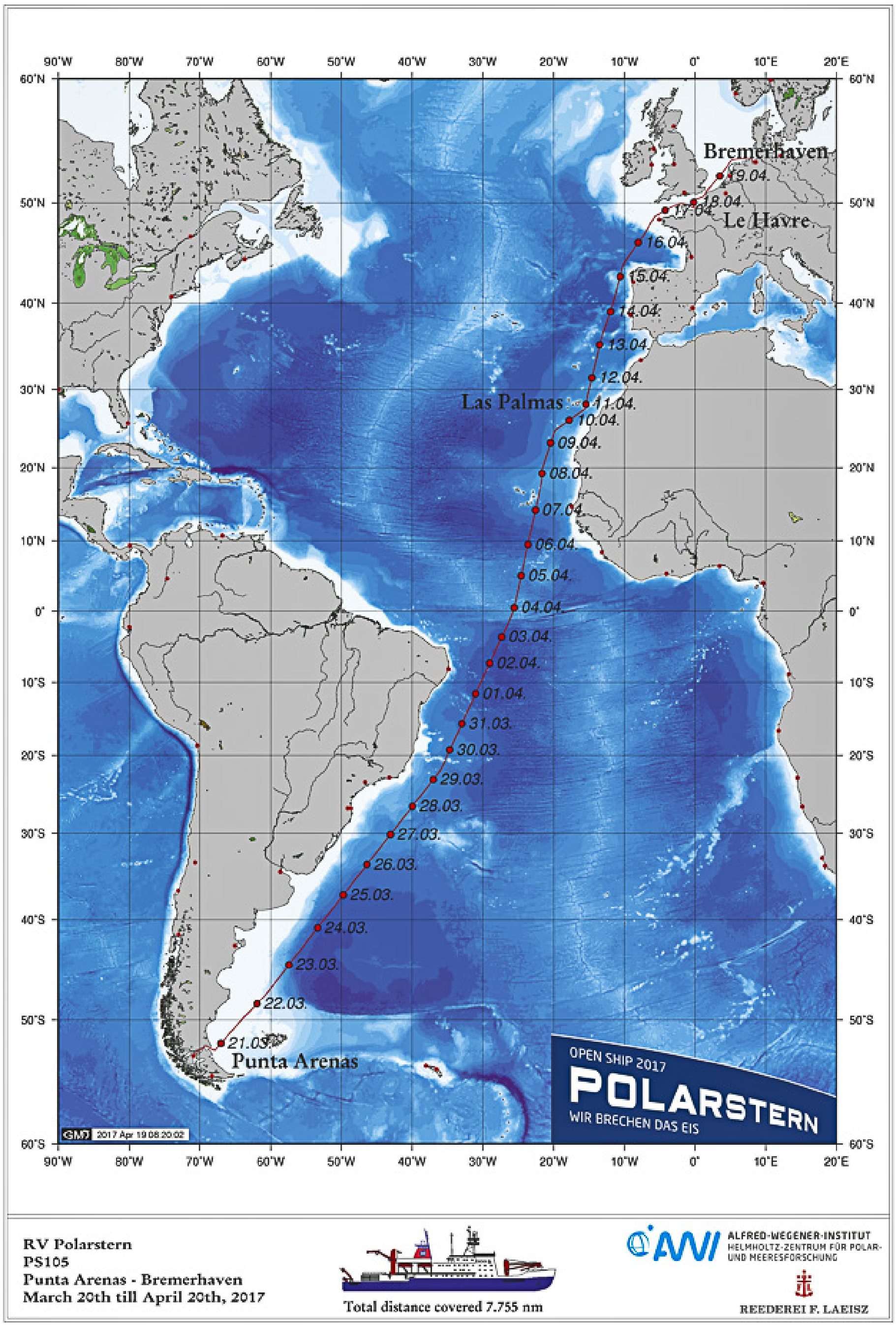


*Fig. 1.1: Fahrtroute von PS105. Siehe https://doi.pangaea.de/10.1594/PANGAEA.881578 für eine Darstellung des master tracks in Verbindung mit der Stationsliste für PS105.*

*Fig. 1.1: Course plot of PS105. See https://doi.pangaea.de/10.1594/PANGAEA.881578 to display the master track in conjunction with the list of stations for PS105.*

## 2. WEATHER CONDITIONS

Juliane Hempelt, Tobias Schaaf DWD

PS105 departed from Punta Arenas/Chile at the evening of 20 March 2017. The cruise along Strait of Magellan was located at the northern flank of the westerly flow, that typically developed best across the Drake Passage. After a frontal passage on 22 March 2017, nearby the Falkland Islands, a mainly high pressure driven weather pattern dominated the cruise along the eastern coastline of South-America. However, the subtropical high was rather unstable in strength and position. It vanished and was rebuilt several times while *Polarstern* sailed northeastwards. In the end the high established with a center, rather unseasonably far south. However, as the high pressure pattern established in the beginning fog was experienced as of late 22 March 2017 to 24 March 2017 and associated with a connection to the cold Falkland / Malvinas Current.

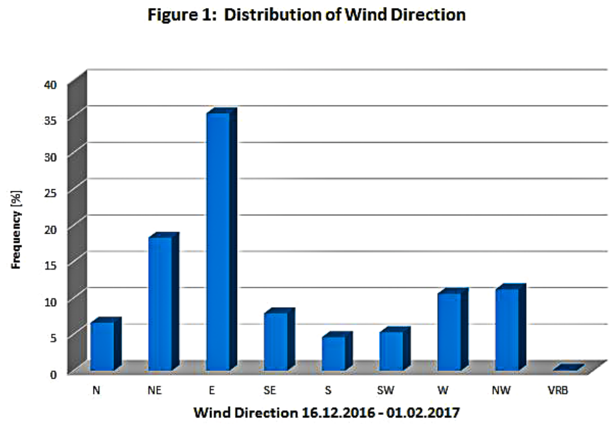


*Fig. 2.1: Wind directions*

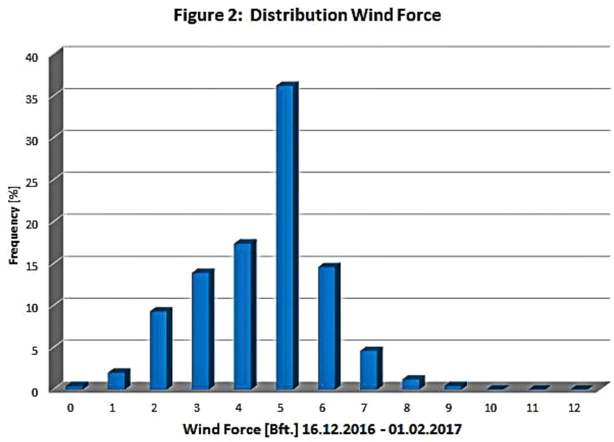


*Fig. 2.2: Wind force*

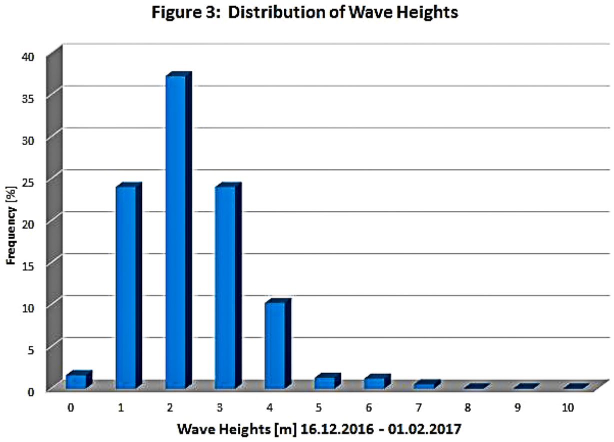


*Fig. 2.3: Wave heights*

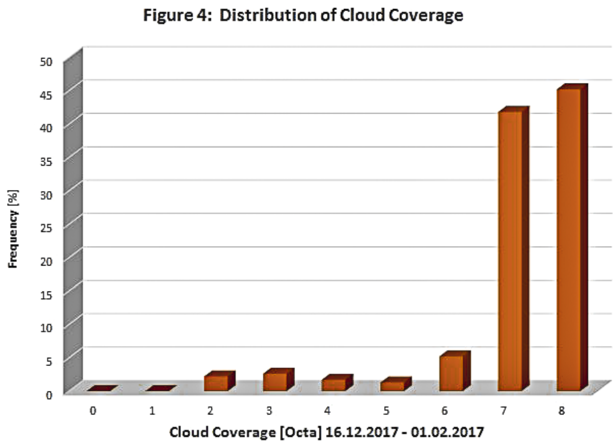


*Fig. 2.4: Cloud coverage*

Afterwards *Polarstern* sailed along the northeastern fringe of the high for a couple of days. A trough extended from southeast of Cabo Frio (Brazil) to the northern interior of Brazil and moved slowly northeastwards. Showers and thunderstorms were associated with the trough. On 31 March 2017 *Polarstern* passed the trough east of Bahia (Brazil). Southeast trade winds established gradually thereafter and advected a rather dry-warm and mainly stable air mass to *Polarstern*. The Intertropical Convergence Zone (ITCZ) stretched from N04 West-Africa to S03 Amazon estuary while *Polarstern* passed the equator. As isolated showers or thunderstorms are common in this region it was no surprise that also *Polarstern* was hit by a few showers and thunderstorms without any hazardous impact. Afterwards the ship sailed into rather weakly developed northeasterly trades and weather stabilized quickly again. Apart from dust deposition of the Sahara and slightly reduced visibility, respectively, no significant meteorological events took place until arrival in Las Palmas (Gran Canaria) on 11 April 2017. This was mainly due to a low that stalled around the Azores and replaced the rather typical dynamical high pressure system of the subtropics centered nearby the Azores. To east of the aforementioned low constant deep warm air advection built up an upper level ridge amplifying northwards across the East Atlantic and favouring high pressure from the Canary Islands all the way to the Bay of

Biscay. Hence, calm conditions continued for another couple of days and Le Havre (France) was reached within calm conditions on the 18 April 2017 to pick up some guests. As the high moved northwards onto the UK flow at the English Channel became more cyclonically and a low travelled from the North Sea region into northern France on late of 18 April 2017. Weather remained rather insignificant but winds increased to strong Northeast winds along the eastern portions of the English Channel temporarily. Furthermore, a wintery polar air mass was driven onto the North Sea. As the high extended from the UK to the German Bight on 19 April 2017 calm weather reestablished. Furthermore, the highest sea level air pressure of PS105 was recorded on 19 April 2017 with slightly above 1037 mbar. Bremerhaven was reached on time with calm conditions prevailing on 20 April 2017.

# 3. ISOTAM: STABLE N – ISOTOPES OF AMMONIUM AND AMMONIA IN AND OVER THE ATLANTIC OCEAN

Gode Gravenhost[1] (not on board)
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**Grant-No. AWI_PS105_01**

## Objectives

Apart from Nitrogen oxides (NOx), ammonia (NH3) is the main component of reactive nitrogen in the atmosphere (Fowler et al., 2013). It is also the most abundant alkaline gas, which is the source of ammonium (NH4+) in atmospheric particles, droplets and ice cores (Lenhard & Gravenhorst, 1980; Bobrutzki et al., 2010). Due to chemical reactions, NH3 and NH4+ are able to build up salts with sulphur dioxide ($SO_2$) and with sulfate ($SO_4$), nitrate (NO3) and chlorine (Cl), respectively. Ammonia- and Ammoniumsalts serve as fine particulate matter (PM2,5), which harms human health (Pope et al., 2002, Aneja et al., 2008) and leads to radiative forcing, since these salts serve as condensation nuclei, that affect atmospheric scattering and increase cloud lifetime (Ellis et al., 2010; Behera et al., 2013). The major sources of atmospheric NH3, in descending order, are livestock wastes, natural sources, fertilizers and biomass mass burning (Clarisse et al., 2009; Behera et al., 2013). This mainly anthropogenic induced NH3 input in ecosystems can cause eutrophication, soil acidification, forest decline and a decreasing biodiversity (Fangmeier et al., 1994; Ferm, 1998; Erisman et al., 2008; Van Grinsven et al., 2013).

In the marine atmosphere, NH3 could have its source in the ocean surface water (Bell, 2006; Paulot et al., 2015). It can flow between the atmosphere and the ocean in both directions (e.g. Schaefer et al., 1999; Paulot et al., 2015). The ocean was divided to be a sink in high and, therefore, cold latitudes and a source in low and, therefore, warm latitudes (Johnson et al., 2008). However the free NH4+- N pool in the global ocean is only a small fraction (less than one per mill) compared to the NO3- N pool (Gruber, 2008).

Maritime airborne ammonium is mainly found in the nucleation and accumulation mode (e.g. Gravenhorst, 1978; Gravenhost et al., 1979; Schaefer et al., 1993). It is produced within the ocean via N2 fixation, ammonification of organic material, denitrification of nitrite and excretion by organisms and leaves the water via assimilation uptake, nitrification within the ocean, reaction of NH4+ with NO2- (anammox) and by emission of NH3 into the atmosphere (Gruber, 2008; Koike et al., 1986).

Considering ammonia and ammonium sources, this basic research will contribute to the few existing field data and will complement the more abundant model data.

*∂ 15N ratios of ammonia and ammonium in the atmosphere*

Stable isotopes can indicate sources and transfer routes of atmospheric trace substances. Ratios of 15N- $NH_4^+$ and 15N- $NH_3$ isotope values in atmospheric samples are very rare. The particulate ammonium in the atmosphere has a high ∂ 15N value similar to the ∂ 15N value of the $NH_3$-source material. The rain ∂ 15N-$NH_4^+$ value seems to fall between ∂ 15N values for gaseous airborne $NH_3$ and for particulate airborne $NH_4^+$. All $NH_3$ and $NH_4^+$ and their isotopes in updrafts at cloud base will be incorporated into cloud droplets and subsequent into rain drops (Gravenhorst, 1983).

*∂ 15N values of ammonia and ammonium in sea water*

The N-cycle in the ocean is connected to the atmosphere (e.g. Duce, 1986; Schaefer et al., 1993; Voss et al., 2013). N cycling has been characterized with ∂ 15N values in different transformation processes (e.g. Sigman et al., 2009). We want to measure actual concentrations of sea water $NH_4^+$ and $NH_3$ x $H_2O$ and their 15N -isotope ratios (Watson et al., 2005) in comparison with atmospheric particulate $NH_4^+$ and gaseous $NH_3$. Cruise PS103 traverses open water and sea ice covered regions. Oceanic flux of $NH_3$ from the ocean into the atmosphere or vice versa should therefore be strongly reduced. This should be reflected in atmospheric concentrations of $NH_3$, $NH_4^+$ and their isotope ratios.

Our aim is, therefore, to determine on the Northern and the Southern Atlantic from northern mid- latitudes to Antarctica the background pattern of the ratios of stable isotopes 15N / 14N of $NH_4^+$ and of $NH_3$ in the air and in the surface water to characterize possible sources of atmospheric $NH_4^+$ and their regional distribution. Our questions are:

- What 15N / 14N-isotope ratios are found in ammonium of size separated airborne particles and in gaseous ammonia over the Atlantic?
- What differences in $NH_4$ - and $NH_3$ - concentrations and in N - isotope ratios do exist between air over the North Atlantic, the South Atlantic and air over the ice- covered Atlantic?
- Can we differentiate $NH_3$ -source and - sink regions on the Atlantic?
- What finger prints do ammonia and ammonium, dissolved in the surface water of the Atlantic, leave in the atmosphere?

**Work at sea**

The main task at sea is to collect data of particulate $NH_4^+$ and gaseous $NH_3$ in the lower troposphere as well as physically dissolved $NH_3$ x $H_2O$ and $NH_4^+$ in the surface sea water. These measurements were already taken on the cruises PS102 from Bremerhaven to Cape Town and on PS103 from Cape Town to Punta Arenas passing the Filchner shelf ice. Together with PS105 cruise from Punta Arenas to Bremerhaven we acquired a lot of data, which gives us much information about the distribution of $NH_4^+$ and $NH_3$ in the lower troposphere over the Atlantic Ocean.

*Fig. 3.1: Filter pack system*

*NH4+ - and NH3 sampling in the atmosphere*

For NH4+- and NH3 concentrations as well as δ 15N-NH3 and δ 15N- NH4+ isotope measurements the NH4+ and NH3-gas molecules had been collected on 4 filter pack systems (90 mm diameter). The filter pack system consists of one Teflon-membrane filter in front to accumulate particles and three acidified membrane filters behind to absorb gas phase ammonia. These filter pack systems (filter pack, gas meter, gas pump, wind direction controller) are located in front of our container on the monkey deck, starboard side (Fig. 3.1). Depending on NH4+ mass found on each NH4+- particle filter and on each NH3 ammonia filter, the solution of filters will be used for NH4-N - and NH3-N isotope analyses on land according to Watson et al. (2005) and Holmes et al. (1998).

*Fig. 3.2: High-volume-impactor (top), gas meters pumps for the filter pack systems*

Two identical high - volume samplers (ca. 70 $m^3$ / h) collected size-fractionated airborne particles with a 5 stage impactor (Fig. 3.2). The 5 stages of the impactor (ca, < 10 µm to > 0.1 µm radius) were covered by a Teflon foil and backed up with a Teflon membrane filter (filter Ø = 22 cm, particle r < 0.1 µm radius). The impactors are installed in the measurement container at the monkey deck. About 5,000 $m^3$ sample sizes are necessary to collect enough NH4+- N, and SO4- S for isotope analyses for the different particle size ranges.

*On board analyses of dissolved NHy (the sum of NH4+ + NH3 x H2O)*

An indirect method to measure the concentration of NHy was tested. In sea water dissolved Ammonia was concentrated into a 35 ml sample, to set the concentration above the detection limit. To do so a sample of sea water was put into a closed circle of air. Air free of ammonia was led into the sea water. The air absorbs part of the ammonia and is then filtered through several Sartorius Minisart Syringe Filters (regenerated cellulose, 0.45 µm), sprinkled with citric acid and glycerin. After several runs all gaseous Ammonia should have been purged from the sea water. In addition the sea water was enriched with sodium hydroxide to set the pH-value to a higher level. This leads to a higher concentration of gaseous NH3 compared to NH4+. The filters were irrigated with 35 ml water each and the samples were stored in PE-bottles.

The parameters for this method were changed throughout this cruise to determine the possibilities of indirect measurements of NHy. Measurements were operated with different sizes of sea water samples, different times to purge the ammonia, pH-values, temperatures, different amounts and sizes of air bubbles and different amounts of citric acid and glycerin on the filters. Collected samples will be analyzed at University of Göttingen.

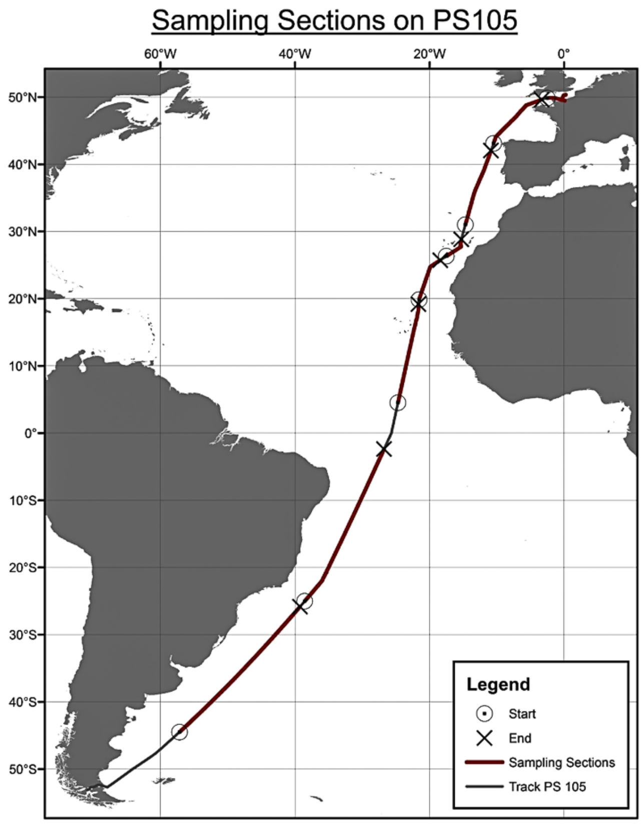


*Fig. 3.3: Expedition track and position of sampling data*

**Preliminary (expected) results**

*NH3 - and NH4+ sampling in the atmosphere*

In general, our team sampled particulate ammonium and gaseous ammonia in a series of 8 measurements on PS105. The *Polarstern* cruise track from Punta Arenas over Las Palmas and Le Havre to Bremerhaven with the different measurement points is shown in the Map (see Fig. 3.3).

*Storing samples*

The filter samples are stored in PE-bottles above the freezing point at 4°C to avoid microbiological contamination.

*Analyses*

All samples, including the NH4+- and the NH3- concentration measurements as well as the Nitrogen and Sulphur isotope ratios will be analyzed at the Georg-August-University of Göttingen. Backtracking air trajectories will allow us to approximate regions of air mass sources, analyzing filter samples for the determination of aerosol bulk composition. Furthermore we will quantify the contribution of trace metals and nutrients into the ocean by aerosol deposition. Because of the back trajectories of the air masses we can follow the sources of airborne trace substances. The trajectories, which have been taken from the DWD analyses, have large influence on the history of components and their appearance at the sampling site.

**Data management**

Samples of airborne particles and gases will be analyzed chemically in laboratories of the University Göttingen. The generated data will be evaluated in several bachelor and master theses. Concentrations and stable N-isotopes of these constituents will be discussed in a Polar Research report. Tabulated results will be submitted to the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (www.pangaea.de). Moreover the outcome of these data will be proposed to scientific journals for marine and atmospheric sciences.

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# 4. MICROTOPS AEROSOL AND WATER VAPOR SURVEY

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**Grant-No. AWI_PS105_01**

## Objectives

Reference for satellite remote sensing and global modelling are sparse over ocean regions. Thus, NASA's AERONET group distributes calibrated handheld (MICROTOPS) sun-photometers to sample aerosol properties and water vapor content, as long as the solar disk is not obscured by clouds. In contrast to interpretations of solar reflection by satellite data these atmospheric solar transmission measurements of direct sun-light are highly accurate, since the sun offers a well-defined radiative background and since no assumptions to the composition are required. The solar attenuations (by relating the measurements to corresponding values at the top of the atmosphere, which are known form latitude and time) are simultaneously determined at five different solar spectral intervals. Four intervals are spectral bands without trace-gas absorption and offer data on aerosol amount and via their spectral dependence also general data on aerosol size so that contributions from pollution and wildfire can be distinguished from contributions from sea-salt or mineral dust. One interval measures in a solar spectral band with water vapor absorption so that in conjunction with data of a trace-gas free solar spectral band the atmospheric water vapor content can be determined. The data are transferred at the end of each day into NASA's Marine Aerosol Network (MAN, Smirnov et al., 2009) data- base and serve mainly as references to satellite remote sensing and global modeling.

## Work at sea

MICROTOPS measurements require unobstructed views of the sun's solar disk. Thus, regular (every 15 min) sampling is requested during daytime, when the direct view of the sun in not obstructed (e.g. mainly by clouds but also by other obstructions such as masts or ship exhaust). Hereby 8-second long individual samples are always asked to be immediately repeated 5 to 10 times (conditions permitting) to better filter poor data from cloud-contamination and mis-orientation, since the MICROTOPS instrument (with the support of a pointing device) needs to be manually directed (and held there for short time-periods) towards the sun-disk.

## Preliminary results

The measured data are immediately available to the science community and can be downloaded at http://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html. Also summary plots are provided at that website. As examples, daily averages by Atlantic location are downloaded for the aerosol amount (AOD at 500 nm wavelength) in Fig. 4.2 and for atmospheric water vapor content in Fig. 4.3.

## Data management

MICROTOPS measurements will be transmitted (if possible) at the end of each day to per e-mail to alexander.smirnov-1@nasa.gov at NASA-GSFC in the US. After quality screening by Dr. Smirnov the measurements are immediately publically available on the web (http://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html).

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*Fig. 4.1: calibrated Microtops and GPS provided by NASA's Marine Aerosol Network (MAN)*

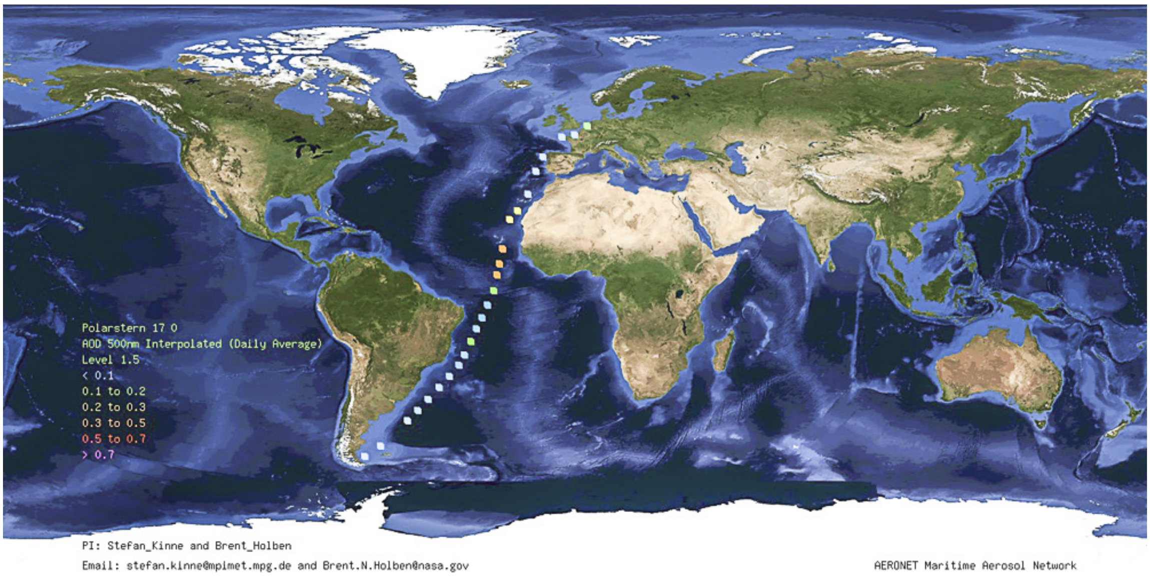


*Fig. 4.2: Daily average for the atmospheric aerosol load. Total aerosol optical depth (AOD at 500 nm) are presented at the corresponding location over the Altantic. Larger AOD (orange) were observed off western Africa and smaller AOD (blue) were observed at higher latitudes. Iinterestingly with enhanced AOD contributions off Africa are caused by both larger (dust) and smaller (wildfire) aerosol sizes.*

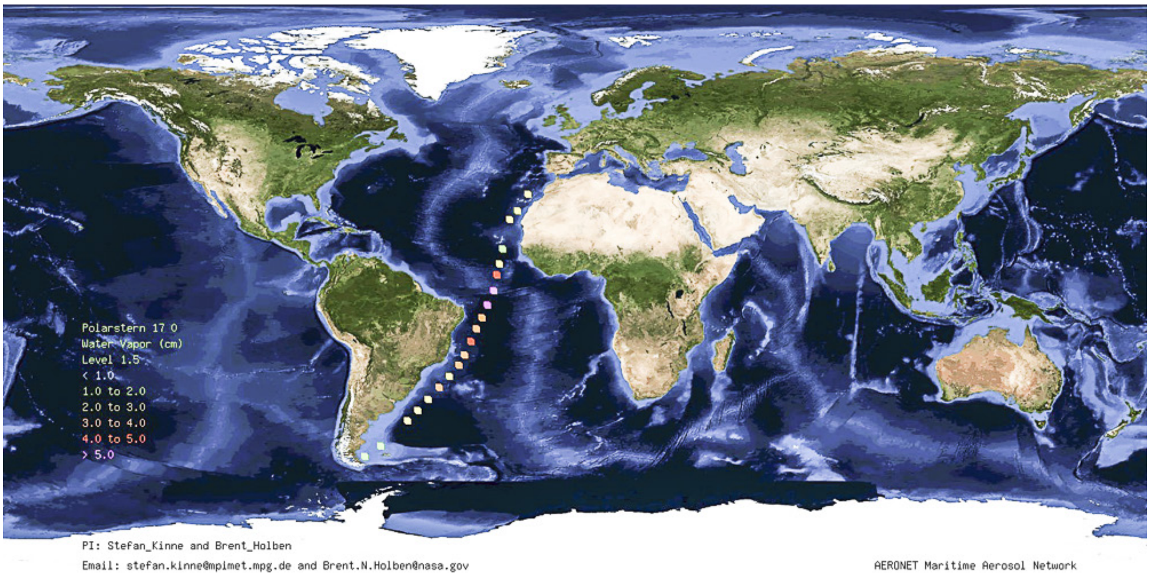


*Fig. 4.3: Daily averages for total water vapor (in cm/atm) over the Atlantic. As expected atmospheric water vapor is higher at lower latitudes, where temperatures are warmer. The highest water vapor contents are near the equator. Still there is significant (day to day) variability (at any latitude region).*

# 5. ECHOSOUNDING TRAINING CRUISE (POLMAR-TRAIN 2017)

Frank Niessen, Gerhard Kuhn, Svenja Papenmeier, Simon Dreutter and Claudia Hanfland (not on board) — AWI

## Objectives

POLMAR-TRAIN 2017 is a student-training course that was jointly run by the AWI-based Helmholtz Graduate School for Polar and Marine Research (POLMAR) and the University of Bremen. The purpose was to provide master students and doctoral candidates from the field of geosciences with a hands-on training in operating the hull-mounted echosounding systems of RV *Polarstern* (multibeam echosounder Atlas HYDROSWEEP DS3 and sediment echosounder PARASOUND P70). Parallel to the practical training, the aim was to promote peer-learning by combining master students (beginners and advanced stage) and doctoral candidates / scientists in this course. In addition, and first in 2017, we provided knowledge and literature about the near-surface marine geology along the north western and south western continental margin of African and Europe, respectively. Thus, the objectives of the work at sea are now threefold: (i) learn to operate the systems during shifts, (ii) store, process and interpret the sub-bottom and bathymetric data, and, (iii) put the hydro-acoustic results into a broader regional perspective, in order to understand the geology along the cruise track.

POLMAR-TRAIN is part of the programme “Master of Sciences Marine Geosciences” at the University of Bremen as well as of the scientific programme of POLMAR. Both programmes involve ship-based field-work for students and doctoral candidates. The training was carried out by five lecturers affiliated with both the University of Bremen and AWI.

## Work at sea

### *Educational Aspects*

Nine master students from the Universities of Bremen, Hafen-City Hamburg, Kiel, and Florence (Italy) and eight doctoral candidates/ scientists from AWI (Bremerhaven, List and Potsdam), University of Bremen (MARUM) and University of Köln participated in the training (see list of participants below). Study topics of the students include geology, geophysics and sea-ice physics.

The course started with a theoretical introduction into the physics of echosounding and how to operate sounding systems, followed by a general introduction into the geology along the continental margins from the Canary Islands to the English Channel. Afterwards, students started going on watches (generally 4 hours each) in pairs of two to three for both systems.

In groups of two (or three in one case), participants took over responsibilities for, in total, seven regional areas of specific geological/geophysical characteristics along the cruise track to Le Havre. These include:

1. - The Canary Island volcanic district
2. - The Agadir submarine canyon complex
3. - The area of the boundary between the African and Eurasian plates
4. - The area west of the major submarine canyons off northern Portugal
5. - The Galicia Bank
6. - The Biscay Abyssal Plain and the Amorican continental margin
7. - The western Amorican Shelf and entrance to the English Channel

fig. They learned to interpret submarine geomorphological structures from bathymetric images, sediment echographs combined with information from the literature including seismic-profile and sediment-core results. With regard to multibeam-bathymetric data, participants were introduced to data acquisition, data processing, and visualization with different kind of profiling and GIS mapping software. For processing of Parasound data, the use of different software packages were applied including data conversion to SEG-Y.

*Technical Aspects*

On the way from Las Palmas to Bremerhaven PARASOUND recording was started on April 11, 2017 at 18:18 UTC north of Las Palmas (28° 32.6' N, 15° 18.4' W). Data acquisition was interrupted for entering the port of Le Havre on April 18 from 04:34 until 09:07 UTC and ended on April 18 at 21:50 UTC near the Strait of Dover (51° 00.1' N, 1° 35.1' E). Mode of transmission was mostly Quasi-Equal-Distant (QED) with the exception of Single-Pulse mode in two time windows at the beginning (11.4.17, 22:00 - 12.4.17, 12:46 UTC) and at the end in shallow water (16.4.17 after 20:15 UTC).

HYDROSWEEP recording was started on April 11, 2017 at 17:44 UTC. Data acquisition was interrupted for entering the port of Le Havre on April 18 from 04:34 until 09:06 UTC and ended on April 18 at 21:16 UTC in the western North Sea.

During the entire operation of PARASOUND one system crash has occurred after a period with partly wrong depth detection (PARASOUND PHF) and irregular auto-calculation of the QED transmission mode. This crash led to data lost on April 16 between 17:34 and 21:54 UTC. An analysis of this problem will be reported to shipping company Laeisz, although the cause of the problem was not detected yet. The operational settings of PARASOUND transmissions are summarized in Table 5.1.

Using Software ATLAS PARASTORE PHF and SLF profiles were visualized online. PHF and SLF data were stores in ASD and PS3 (without phase and carrier) formats. In addition, auxiliary data (navigation and PARASOUND settings) were stored in one-minute intervals. Printing of SLF data was performed using a PDF-creator of the operator PC via PNG output formats stored on disc.

**Tab. 5.1:** Settings of ATLAS HYDROMAP CONTROL for operating PARASOUND during cruise PS105

| **Used Settings** | **Selected Options** | **Selected Ranges** |
|---|---|---|
| Mode of Operation | P-SBP/SBES | PHF, SLF |
| Frequency | PHF | 19 kHz (18.975 kHz) |
| | SLF | 4 kHz (3.987 kHz) |
| Pulselength | No. of Periods | 2 |
| | Length | 0.5 ms |
| Transmission Source Level | Transmission Power | 100% |
| | Transmission Voltage | 159 V |
| Beam Steering | none | |
| Mode of Transmisson | Single Pulse | Auto according to water depth |
| | Quasi-Equidistant | Interval 400-1,200 ms |
| Pulse Type | Continuous Wave | |
| Pulse Shape | Rectangular | |
| Receiver Band Width | Output Sample Rate (OSR) | 6.1 kHz |
| | Band Width (% of OSR) | 66 % |
| Reception Shading | none | |
| System Depth Source | Fix Min/Max Depth Limit | ATLAS PARASOUND PHF |
| | | ATLAS HYDROSWEEP PHF (for very short periods only) |
| Water Velocity | C-Mean | Manual 1500 m/s |
| | C-Keel | System C-keel |
| Data Recording | PHF | Full Profile, Sediment |
| | SLF | Full Profile, Sediment |

**Preliminary results**

*Educational Results*

The concept of combining undergraduates and postgraduates in this training proved to be a successful approach. Next to guidance and discussion with the team of lecturers, peer-learning was an important factor for the success of this training concept.

The combination of theoretical background, practical work on the hydroacoustic systems (including troubleshooting), discussion of published data and student presentations was the right combination for a thorough and comprehensive training in echosounding techniques.

Course preparation prior to the cruise was done by the graduate school POLMAR. Participants, lecturers and ship logistics department had one contact point to turn to which greatly improved maintaining the planning phase, coordination on board and the subsequent evaluation phase.

All participants gave a 15 min presentation on their Bachelor, Master or PhD projects, which, in parts, included their previous experiences with hydro-acoustic data. In addition at the end of the cruise, the groups responsible for the seven regions along the cruise track (Canary Islands to English Channel listed above) gave a 15-to-20-minute presentation each, in which they present PARASOUND and Hydrosweep results obtained during PS105 (and/or during PS97/PS88 along parallel course tracks) in the context of the regional geology published elsewhere (provided to the students on board). In this way a very good overview was compiled about the characteristics of the geology of the continental margins. This includes understanding how the results documented by *Polarstern* hydroacoustic data support or extend the state-of-the-art knowledge. This combination turned out to be very effective for both motivating the students to acquire hydroacoustic data and developing interpretation skills. Also at the beginning of the cruise, it was very useful to have hydroacoustic data available from the cruise area, which was obtained during previous training cruises (PS88-1 and PS97). In this way the different groups were able to work simultaneously without waiting for their area to be surveyed. It was straight forward to fit in interesting results, which were recorded during PS105.

*Technical Problems*

During the PARASOUND online operation, two major problems had occurred:

(1) For the first days of the cruise (11.4.17 until 13.4.17 about 15:00 UTC) during online-operation, PS3 data was stored using the option “with phase and carrier” together with data in SEG-Y format (ATLAS PARASTORE, SLF-Window). Other than during previous *Polarstern* cruises, these data formats turned out neither to be readable by ATLAS PARASTORE, SeNT (University of Bremen) and Kingdom-Suite Software, nor to be convertible to readable SEG-Y format. For the time window mentioned above, readable PS3 data were reproduced by replaying ASD data (ATLAS PARASTORE, SLF-Window) using the option “without phase and carrier”.

(2) Along the Biscay Abyssal Plain with excellent sounding conditions and perfect sea-floor detection, several gaps of data were observed at the sea floor and in the upper 200 m of the sediments over a lateral time range of about one to five minutes (at about 4,900 m water depth) (Fig. 5.1). During this time, ATLAS PARASOUND PHF was used as System Depth Source for Quasi-Equidistant transmission (Table 5.1). These gaps appear to be similar to those observed during the entire cruise of PS97 (last year), when ATLAS HYDROSWEEP PHF was used as System Depth Source for Quasi-Equidistant transmission. Last year, PARASOUND received wrong depth values from HYDROSWEEP in the moments, in which PARASOUND starts to recalculate the pulse rate of transmission. This results in data digitalization of received echoes in the wrong depth interval leading to the data gaps at the sea floor until one of the next reconfigurations is using correct depth. Apparently, last-year wrong HYDROSWEEP depth detections were caused by interference with PARASOUND PHF pulses along the centre beam. For PARASOUND data acquisition during PS105, we were hoping to overcome this problem by using ATLAS PARASOUND PHF as System Depth Source (Table 5.1) as long as sounding conditions allow. Although significantly fewer gaps occurred during PS105 compared to PS97, the problem was not eliminated completely.

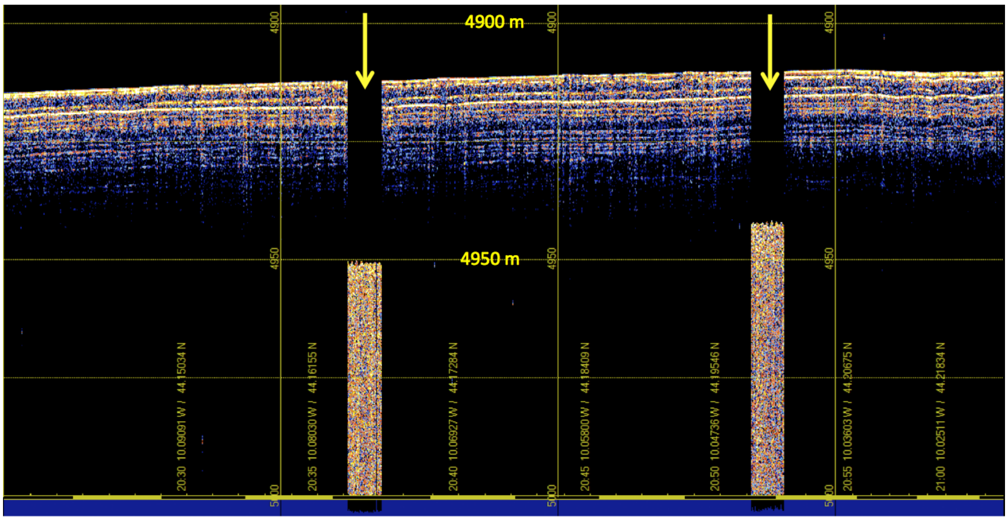


*Fig. 5.1: Offline (replay) operation SLF echogram window (200 m vertical scale) with data gaps at the sea floor (indicated by yellow arrows). Data time window from 2017, April 17, 20:23-21:03 UTC.*

**Data management**

Hydroacoustic data (multibeam and sediment echosounder) collected during the expedition have been copied to the *Polarstern* data base. From there the data will be transferred to the data mass storage at AWI Bremerhaven. Finally the data will be stored and linked to the World Data Center PANGAEA Data Publisher for Earth & Environmental Science (www.pangaea.de) at the AWI. Furthermore, the data will be provided to international mapping projects and included in regional data compilations such as the General Bathymetric Chart of the Ocean (GEBCO).

## APPENDIX

A.1 Teilnehmende Institute / Participating Institutions

A.2 Fahrtteilnehmer / Cruise Participants

A.3 Schiffsbesatzung / Ship's Crew

A.4 Stationsliste / Station List

## A.1 TEILNEHMENDE INSTITUTE / PARTICIPATING INSTITUTIONS

| | Address |
|---|---|
| AWI | Alfred-Wegener-Institut<br>Helmholtz-Zentrum für Polar- und Meeresforschung<br>Postfach 120161<br>27515 Bremerhaven<br>Germany |
| DWD | Deutscher Wetterdienst<br>Geschäftsbereich Wettervorhersage<br>Seeschifffahrtsberatung<br>Bernhard Nocht Str. 76<br>20359 Hamburg<br>Germany |
| FH-Bund | Fachhochschule der Bundeswehr<br>Fliegerhorst Fürstenfeldbruck<br>Straße der Luftwaffe 233A<br>82256 Fürstenfeldbruck<br>Germany |
| GEOMAR | Helmholtz-Zentrum<br>Für Ozeanforschung Kiel<br>Wischhofstraße 3<br>24148 Kiel<br>Germany |
| HCU | HafenCity Universität Hamburg<br>Überseeallee 16<br>20457 Hamburg<br>Germany |
| HMG | HMG Industriedienstleistungen GmbH<br>Betsbruchdamm 23<br>28816 Stuhr<br>Germany |
| Kircher | Kirchner Consulting GmbH<br>Hinterm Felde 38<br>27721 Ritterhude<br>Germany |
| MARUM | MARUM<br>Leobener Stra0e 2<br>28359 Bremen<br>Germany |

| | Address |
|---|---|
| MPImet | Max-Planck-Institut<br>Mittelweg 187<br>20148 Hamurg<br>Germany |
| RFL | Reederei F. Laeisz<br>Bartelstraße 1<br>27570 Bremerhaven<br>Germany |
| Timeko | Timeko Fachpersonal<br>Mühlenstraße 30<br>28779 Bremen<br>Germany |
| UniFI | Universitá degli Studi di Firenze<br>Pizza S.Marco, 4<br>50121 Firenze<br>Italy |
| UniFra | Goethe Universität Frankfurt<br>60323 Frankfurt am Main<br>Germany |
| UniGö | Universität Göttingen<br>Georg-Autust-Universität Göttingen<br>Wilhelmsplatz 1<br>37073 Göttingen<br>Germany |
| UniHB | Universität Bremen<br>Bibliothekstraße 1<br>28359 Bremen<br>Germany |
| UniHH | Universität Hamburg<br>Mittelweg 177<br>20148 Hamburg<br>Germany |
| UniKiel | Christian-Albrechts-Universität<br>Christian-Albrechts-Platz 4<br>24118 Kiel<br>Germany |
| UniKöln | Universität zu Köln<br>Albertus-Magnus-Platz<br>50923 Köln<br>Germany |

## A.2 FAHRTTEILNEHMER / CRUISE PARTICIPANTS

**Punta Arenas - Bremerhaven**

| Name | First Name | Institut/ Institute | Beruf / Profession | Fachrichtung / Discipline |
|---|---|---|---|---|
| Drese | Mark | MPImet | Technician | Meteorology |
| Goedecke | Julia | UniFra | Student | Chemistry |
| Hempelt | Juliane | DWD | Technician | Meteorology |
| Konopczak | Philipp | UniGö | Student | Chemistry |
| Laerum | Philipp | UniHH | Student | Chemistry |
| Machill | Daniel | UniFra | Student | Chemistry |
| Schaaf | Tobias | DWD | Scientist | Meteorology |
| Sievers | Oliver | DWD | Scientist | Meteorology |
| Tubbesing | Raphael | UniGö | Student | Chemistry |

**Punta Arenas - Le Havre**

| Name | First Name | Institut/ Institute | Beruf / Profession | Fachrichtung / Discipline |
|---|---|---|---|---|
| Bear | Hans-Peter | Kircher | Technician | Electrical Engineering |
| Ens | Waleri | Timeko | Technician | Electrical Engineering |
| Hanstein | Andreas | HMG | Technician | Electrical Engineering |
| Henneberg | Hans-Peter | HMG | Technician | Electrical Engineering |
| Kircher | Siegmund Dietmar | Kircher | Technician | Electrical Engineering |
| Sprenger | Werner | Kircher | Technician | Electrical Engineering |

**Las Palmas - Bremerhaven**

| Name | First Name | Institut/ Institute | Beruf / Profession | Fachrichtung Discipline |
|---|---|---|---|---|
| Berghald | Mareike | UniHB | Student | Geology |
| Boche | Martin | RFL | Inspector | Nautics |
| Bochert | Sanne | AWI | Assistant | Logistics |
| Coppolaro | Veronica | UniFI | Student | Geology |
| Diederich | Julia | UniKö | Student | Geology |
| Dreutter | Simon | AWI | Student | Geology |
| Ehrhardt | Sophie | UniHB | Student | Geology |
| Fontes | René Pascal | RFL | Technician | Electronics |
| Grübner | Lars | AWI | Graphic Designer | Public And Media |
| Heil | Volker | DWD | Scientist | Meteorology |
| Knust | Rainer | AWI | Scientist | Biology |
| Kuhn | Gerhard | AWI | Scientist | Geology |

| **Name** | **First Name** | **Institut/ Institute** | **Beruf / Profession** | **Fachrichtung/ Discipline** |
|---|---|---|---|---|
| Lange | Mirko | UniHB | Student | Geology |
| Lenz | Kai-Frederic | CAU | Student | Geology |
| Machner | Nina | AWI | Logistikerin | Logistics |
| Mardani-Nejad | Amin (Mr.) | HCU | Student | Geology |
| Meier | Michaela | UniHB | Student | Geology |
| Michaelis | Rune (Mr.) | UniHB | Student | Geology |
| Mirau | Bastian | UniHB | Student | Geology |
| Niessen | Frank | AWI | Scientist | Geology |
| Nowak | Yves | AWI | Graphic Designer | Public And Media |
| Papenmeier | Svenja | AWI | Scientist | Geology |
| Pichler | Claudia | AWI | Project Manager | Public And Media |
| Stettner | Samuel | AWI | Student | Geology |
| Syring | Nicole | AWI | Student | Geology |
| Syska | Fabian | FH-Bund | Student | Meteorology |
| Tamborrino | Leonardo | MARUM | Student | Geology |
| Tauber | Paul | UniKö | Student | Geology |
| Weise | Alexander | UniHB | Student | Geology |
| Wu | Shuzuang (Mr.) | AWI | Student | Geology |

**Le Havre - Bremerhaven**

| **Name** | **First Name** | **Institut/ Institute** | **Beruf / Profession** | **Fachrichtung/ Discipline** |
|---|---|---|---|---|
| Lochte | Karin | AWI | Scientist | Biology |
| Pfannkuche | Olaf | GEOMAR | Scientist | Geology |
| | | | | |
| As well as 9 guests from the German Federal Parliament and from the Federal Ministry of Education and Research (BMBF) | | | | |

## A.3 SCHIFFSBESATZUNG / SHIP'S CREW

| | Name | Rank |
|---|---|---|
| 1 | Schwarze, Stefan | Master |
| 2 | Grundmann, Uwe | 1.Offc. |
| 3 | Farysch, Bernd | Ch. Eng |
| 4 | Langhinrichs, Moritz | EO Ladung |
| 5 | Hering, Igor | 2.Offc |
| 6 | ohne | 2.Offc |
| 7 | Scholl, Thomas | Doctor |
| 8 | Christian, Boris | Comm.Offc. |
| 9 | Grafe, Jens | 2.Eng. |
| 10 | Krinfeld, Oleksandr | 2.Eng. |
| 11 | Holst, Wolfgang | 3. Eng. |
| 12 | Redmer, Jens | Elec.Tech. |
| 13 | Frank, Gerhard | Electron. |
| 14 | Hüttebräucker, Olaf | Electron. |
| 15 | Nasis, Ilias | Electron. |
| 16 | Himmel,Frank | Electron |
| 17 | Loidl, Reiner | Boatsw. |
| 18 | Reise, Lutz | Carpenter |
| 19 | Hagemann, Manfred | A.B. |
| 20 | Winkler, Michael | A.B. |
| 21 | Scheel, Sebastian | A.B. |
| 22 | Bäcker, Andreas | A.B. |
| 23 | Brück, Sebastian | A.B. |
| 24 | Wende, Uwe | A.B. |
| 25 | Leisner, Karl-Heinz Bert | A.B. |
| 26 | Löscher, Steffen Andreas | A.B. |
| 27 | Preußner, Jörg | Storek. |
| 28 | Teichert, Uwe | Mot-man |
| 29 | Rhau, Lars-Peter | Mot-man |
| 30 | Lamm, Gerd | Mot-man |
| 31 | Schünemann, Mario | Mot-man |
| 32 | Schwarz, Uwe | Mot-man |
| 33 | Redmer, Klaus-Peter | Cook |

| | Name | Rank |
|---|---|---|
| 34 | Silinski, Frank | Cooksmate |
| 35 | Martens, Michael | Cooksmate |
| 36 | Czyborra, Bärbel | 1.Stwdess |
| 37 | Wöckener, Martina | Stwdss/KS |
| 38 | Dibenau, Torsten | 2.Steward |
| 39 | Silinski, Carmen | 2.Stwdess German |
| 40 | Duka, Maribel | 2.Steward |
| 41 | Arendt, Rene | 2.Steward |
| 42 | Sun, Yong Shen | 2.Steward |
| 43 | Chen, Dan Sheng | Laundrym. |

## A.4 STATIONSLISTE / STATION LIST

During PS105 only *en route* data were sampled for education purpose for POLMAR. The data are not considered to be archived in PANGAEA as primary data.

Die **Berichte zur Polar- und Meeresforschung** (ISSN 1866-3192) werden beginnend mit dem Band 569 (2008) als Open-Access-Publikation herausgegeben. Ein Verzeichnis aller Bände einschließlich der Druckausgaben (ISSN 1618-3193, Band 377-568, von 2000 bis 2008) sowie der früheren **Berichte zur Polarforschung** (ISSN 0176-5027, Band 1-376, von 1981 bis 2000) befindet sich im electronic Publication Information Center **(ePIC)** des Alfred-Wegener-Instituts, Helmholtz-Zentrum für Polar- und Meeresforschung (AWI); see https://epic.awi.de. Durch Auswahl "Reports on Polar- and Marine Research" (via "browse"/"type") wird eine Liste der Publikationen, sortiert nach Bandnummer, innerhalb der absteigenden chronologischen Reihenfolge der Jahrgänge mit Verweis auf das jeweilige pdf-Symbol zum Herunterladen angezeigt.

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