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

EXPEDITION PROGRAMME PS105

Polarstern

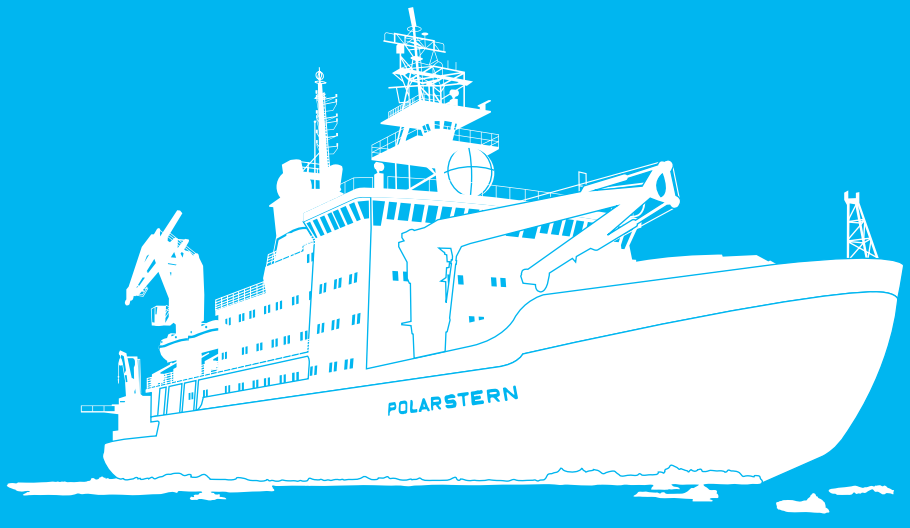
PS105

Punta Arenas - Las Palmas - Le Havre - Bremerhaven

21 March 2017 - 20 April 2017

Coordinator: Rainer Knust

Chief Scientists: Rainer Knust
Karin Lochte



Bremerhaven, März 2017

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Chief Scientists

Rainer Knust
(Las Palmas - Le Havre)

Karin Lochte
(Le Havre - Bremerhaven)

Coordinator

Rainer Knust

Contents

1. ÜBERBLICK UND FAHRTVERLAUF

Rainer Knust
Alfred-Wegener-Institut

Die Rückfahrt nach Bremerhaven beginnt am 21.03.2017 in Punta Arenas, Chile, mit Zwischenstopps in Las Palmas, Spanien, am 11.04.2017 und Le Havre, Frankreich, am 18.04.2017. Am 20.04.2017 wird *Polarstern* in Bremerhaven einlaufen.

Von Punta Arenas bis Bremerhaven werden luftchemische und physikalische Untersuchungen stattfinden, die durch die Universitäten Göttingen und Frankfurt en Route durchgeführt werden. Ebenfalls en Route werden Aerosole in der Atmosphäre in den unterschiedlichen Klimaregionen gemessen. Diese Untersuchungen werden durch das Max-Planck-Institut für Meteorologie, Hamburg, durchgeführt. Weiter wird der Deutsche Wetterdienst (DWD) an Bord ein Trainingsprogramm durchführen. Zur Vorbereitung der Erneuerung der beiden Wellengeneratoren, die im Herbst 2017 stattfinden soll, werden von Punta Arenas bis Le Havre erste vorbereitende Arbeiten durch eine Fremdfirma durchgeführt.

Ab Las Palmas bis Bremerhaven wird ein Training-Programm zu hydroakustischen Messungen stattfinden, an dem insgesamt 16 Studentinnen und Studenten aus Deutschland, Italien, Irland und der Volksrepublik China teilnehmen werden.

Ab Le Havre bis Bremerhaven werden 9 Gäste des Wissenschaftsausschuss des Deutschen Bundestages, sowie Vertreter des BMBF an Bord sein, um sich über die wissenschaftlichen Arbeiten auf und mit dem Schiff und der studentischen Ausbildung vor Ort zu informieren.

SUMMERY AND ITINERARY

The return voyage to Bremerhaven will start on March 21, 2017 in Punta Arenas, Chile, with stopovers in Las Palmas, Spain, on April 11, 2017 and Le Havre, France, on April 18, 2017. *Polarstern* will return to Bremerhaven on April 20, 2017.

During the cruise from Punta Arenas to Bremerhaven the universities of Göttingen and Frankfurt will conduct en route measurements in the fields of air chemistry and physics. Furthermore the Max Planck Institute for Meteorology in Hamburg will carry out measurements of particulate material in the atmosphere en route. Additionally the German Weather Service (Deutscher Wetterdienst/ DWD) will run a training programme on board. In preparation for the renewal of the two shaft generators, which will take place in autumn 2017, initial work will be conducted by an external company on the trip from Punta Arenas to Le Havre.

During the trip from Las Palmas to Bremerhaven a training programme in hydro acoustic measurements will take place. 16 students from Germany, Italy, Ireland and the People's Republic of China will participate.

From Le Havre to Bremerhaven we will welcome 9 guests from the scientific committee of the German Federal Parliament as well as representatives from the Federal Ministry of Education and Research (BMBF). Our guests will be informed about the scientific work carried out on the ship and also with the vessel. Furthermore the education of students on board is another subject to be presented during the journey.

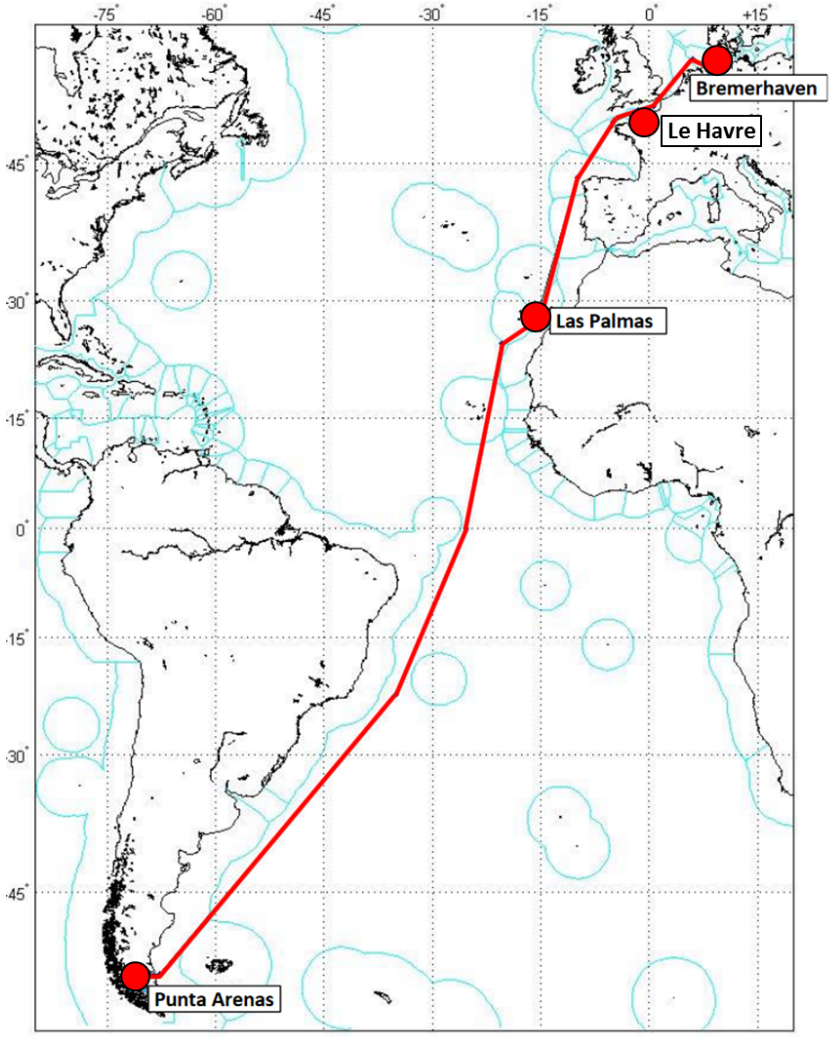

Abb.1.1: Fahrtroute Polarstern während der Expedition PS105 von Punta Arenas über las Palmas und Le Havre nach Bremerhaven

Fig. 1.1: Planned track of Polarstern during PS105 from Punta Arenas via Las Palmas and Le Havre to Bremerhaven

2. ISOTAM: STABLE N- ISOTOPES OF AMMONIA AND AMMONIUM IN AND OVER THE ATLANTIC

J. Goedecke (UniFra), D. Machill (UniFra), P. Tubbesing (UniGö), P. Konopscak (UniGö), G.Gravenhorst (UniGö, not on board)

Objectives

We want to improve the understanding of the atmospheric ammonia / ammonium cycle.

Atmospheric ammonia is important, since it is nearly the only atmospheric alkaline reacting gas and is participating in nucleation processes for newly formed atmospheric particles and in reacting with already existing particles and droplets. Particulate ammonium is formed from gaseous ammonia and is not emitted into the atmosphere. Ammonium is a counter ion of sulfate. It is besides nitrate a main component of nitrogen deposition and of acid deposition to the ground. Atmospheric ammonia and ammonium are parts of the global nitrogen cycle.

Atmospheric ammonia is mainly emitted during livestock agricultural activities, during mineral N- fertilizer production and application, by fossil fuel combustion – especially by urea reaction with NOx in catalysts to reduce NOx emission by vehicles, by biomass burning such as forest fires and by some ocean areas with high NH_4 concentrations and at high temperatures.

By measuring the atmospheric concentration of NH_3 and NH_4 from about 50° north to about 70° south we get a latitudinal distribution across the Atlantic with different air masses deriving from different continental ecotypes and with different human activities. The ocean influence will be apparent in air masses from ice-covered polar regions and in high productive surface areas. We will try to determine the NH_4 - concentration in the surface ocean and to calculate with this information the NH_3 equilibrium surface concentration over the ocean in comparison with measured atmospheric actual NH_3 values.

The ratio of stable N isotopes in NH_3 depends on the emission process for NH3 and on the involved compounds. It seems that the NH_3 emitted by combustion processes has N-isotope ratios close to the ones of atmospheric N_2. The NH_3 emitted from animal wastes is much lighter. The NH_3 emitted from the ocean is not known yet. So we want to determine the N isotope ratio in marine NH_3. The atmospheric NH_3 is not stable in the atmosphere but undergoes reactions, in which its N-isotope ratios should change. The formed, more condensed NH_4-phase should get heavier than the lighter gas phase NH_3. The latitudinal distribution of NH_3 isotopes should be similar as to the H - isotopes in water vapour molecules: the further down from the sources NH_3 travels the lighter should the gaseous NH_3 molecules get. In the ice shield of Antarctica, the water isotopes are rather light, because the heavier molecules got into liquid water and rained out before reaching Antarctica. The condensed NH_4 should stay always heavier than the gaseous ammonia, but should also get lighter on its traveling south. Different lifetimes in the atmosphere for NH_3 and NH_4+ should obscure these relationships.

Our aim is to determine across the North and South Atlantic atmospheric gaseous NH_3 and particulate NH_4 concentrations. The particulate NH_4 will be collected in separate particle size classes, so that concentrations and isotope ratios can be interpreted in comparison with gaseous NH_3 in view of sources, transport and reaction pathways.

Our questions are:

- What isotope ratios are found in gaseous ammonia and in size separated particulate ammonium over the North and South Atlantic?
- Are there differences in isotope ratios in air masses coming from the ice covered area of the South Atlantic, from pure marine regions and from different continental landscapes?
- Are we able to differentiate NH_3 source-regions of NH_3 and NH_4+ over the Atlantic?
- What fingerprints do ammonia and ammonium in the surface water of the ocean leave in the atmosphere over the Atlantic?

Work at sea and expected results

Concentrations of gaseous ammonia will be determined by collecting NH_3 on filters doped with citrus acid and glycerine. The particulate NH_4, which could interfere with the analysis of absorbed NH_3, will be separated in front of the ammonia absorbing filter by a membrane filter. These filter pack systems will be installed at the observing deck and regulated by a wind vane. The wind vane will allow the air pumps to run only when the relative wind direction on board will come from 90° to the ship's axis to the port or to starboard. The air sampling devices will collect at a flow rate of about 1 to several m^3/h.

Systems to collect only particulate matter, but size separated, will also be installed at the observing deck. Slot impactors with different cut off sizes will collect only particles. These samples will be analysed for NH_4-concentations and ratios of stable isotopes of N and S. We expect several time periods with relative wind directions indicating influences of the ship on the air sampled on the observing deck. Therefore we will install filter systems on the stern of the ship. About 5,000 m³ should be sampled to be able to analyse the N-isotope ratios of the different particle size fractions.

A closed sea water system will be installed in the lab, in which the ferry box system is operated. A closed sea water tank will be purged with air within a closed air circle. Air leaving the water will be sucked through a filter system doped with citric acid. The acid filter will absorb all NH_3. The NH_3 free air will be led again into the water and purge the remaining NH_4 and NH_3 x H_2O out of the water. The NH_3 absorbing filters will be analysed for NH_4 concentrations and NH_4 isotope ratios. The time span of purging the sea water will be tested to determine the appropriate time intervals for reducing the left ammonia compounds in the sea water.

Data management

Samples collected at sea will be analysed in the home laboratories. They will be first analysed in bachelor and master theses. The measurements will be reported and evaluated and discussed in Reports on Polar and Marine Research. The results will be incorporated into PANGAEA. A discussion of the measurements will be submitted to scientific journals of atmospheric and marine sciences.

3. MEASUREMENTS OF ATMOSPHERIC COLUMN INTEGRATED AEROSOL PROPERTIES AND WATER VAPOR

M. Drese (MPImet), S. Kinne (MPImet, not on board)

Objectives

Reference for satellite remote sensing and global modeling are sparse over ocean regions. Thus, the NASA's AERONET group distributes calibrated handheld (MICROTOPS) sun-photometers to sample aerosol properties and water vapor content. In contrast in interpretations by satellite data these attenuation measurements of direct sun-light are highly accurate since the sun offers a well-defined radiative background. These solar attenuation measurements are simultaneously sampled at five different solar spectral intervals, to allow not only information on aerosol amount, but also on aerosol particles (e.g. pollution vs sea-salt or mineral dust) and on atmospheric water vapor content. Hereby, the water vapor content is determined by comparing solar attenuations in a trace gas free interval with attenuations affected (by known strength) for water vapor absorption. The MICROTOPS is paired with a GPS to define via the latitude information at the time of the data-sampling the incoming reference solar irradiance for each of the five solar spectral sub-intervals. The data are transferred at the end of each day into NASA's growing Marine Aerosol Network (MAN) database and serve as references to satellite remote sensing, to (aerosol) 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 (expected) results

The data will be immediately available to the entire science community. The new references will help in the development of more accurate aerosol retrievals from satellite data (e.g. SLSTR, MODIS, MISR), in evaluations exercises (e.g. AeroCom) of global models and in improvements to climatology (e.g. Max-Planck's aerosol climatology)

Data management

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

Reference

Smirnov, A., B. N. Holben, I. Slutsker, D. M. Giles, C. R. McClain, T. F. Eck, S. M. Sakerin, A. Macke, P. Croot, G. Zibordi, P. K. Quinn, J. Sciare, S. Kinne, M. Harvey, T. J. Smyth, S. Piketh, T. Zielinski, A. Proshutinsky, J. I. Goes, N. B. Nelson, P. Larouche, V. F. Radionov, P. Goloub, K. Krishna Moorthy, R. Matarrese, E. J. Robertson, and F. Jourdin (2009).

Fig. 3.1: Calibrated Microtops and GPS unit provided by NASA's Marine Aerosol Network

4. METEOROLOGICAL TRAINING IN THE DIFFERENT CLIMATE ZONES OF THE ATLANTIC

V. Heil (DWD), O. Sievers (DWD), F.H. Syska (HS-Bund), P. Schmitt (DWD, not on board)

Objectives

One of our objectives is to describe the actual weather conditions along the cruise track with all measurements from board and to demonstrate the tasks and challenges from the board meteorologist and the weather technician during the expedition PS105 from Punta Arenas to Bremerhaven. The data and collected information will later be used for education purposes within the training programme EUMeTrain.

Furthermore there will be a training programme on board to gain experience in the field of maritime meteorological measuring technologies.

Another objective is to to create an internet blog to present not only the weather conditions in a way that is easily understandable but also to give an impression of work and life on board of a research vessel.

Work at sea

All meteorological data, radio soundings and images which will be used in the blog and for the EUMeTrain will be generated and thus be available on board *Polarstern*. Additionally, satellite images will be compared with the local measurements on board. Furthermore we plan to produce additional images, sound and film recordings for education purposes.

Expected results

During the expedition the *Polarstern* Weather Blog will be published by EUMESAT and DWD on following web page:

https://scienceblog.eumetsat.int/

The meteorological data from the expedition will be integrated in a learning module about the Atlantic transfer cruise. We aim to optimise the automatic data transfer from the webcam to DWD. It will be a new focus in the training related to maritime meteorological measurements with problems and sources of error in extreme climate zones.

EUMeTrain: International Project, founded und supported by EUMETSAT, and dedicated to the development of satellite meteorology training resources and training methods. www.eumetrain.org

DWD (Deutscher Wetterdienst), Meteorological Training Centre in Langen.
http://www.dwd.de/EN/aboutus/locations/btz/btz.html

Federal University of Applied Administrative Sciences, Meteorological Service
http://www.fhbund.de/EN

5. ECHO SOUNDING TRAINING COURSE (POLMAR-TRAIN 2)

C. Hanfland (AWI, not on board), G. Kuhn (AWI), F. Niessen (AWI)

Objectives

On the cruise section between Las Palmas / Canary Islands and Bremerhaven, Master students and doctoral candidates will be jointly trained to operate the echo sounding systems of *Polarstern*. Participants will be responsible for the watches, process and edit the data and learn some simple trouble-shooting. They will get familiar with the relevant software and learn to create maps from the acquired data. Discussion of case studies from literature is a further focus of the training. The project POLMAR-TRAIN 2 is a course jointly run by the AWI-based Helmholtz Graduate School for Polar and Marine Research (POLMAR) and University of Bremen. It offers Master and PhD students from geosciences a hands-on

training in operating the hull-mounted echo sounding systems of *Polarstern* (multi-beam echo sounder Atlas Hydrosweep DS3 and sediment echo sounder Parasound P70). Both systems will be operated continuously between Las Palmas and Bremerhaven. The course 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. Lecturers are affiliated with both institutions and jointly offer this training. Students will be trained in data evaluation and interpretation with published and on-route collected examples. This training format has been carried out on yearly base since 2014 and got excellent feedback from the participants. AWI has a clear commitment to use the transit cruises of *Polarstern* for regular ship-based trainings, hence experience from this (and previous) cruises will help to build future proposals, e.g. for future EUROFLEET ship-based training courses in related sciences.

Work at sea

After embarkation, students will start with a half-day introduction to get familiar with the principles of hydro-acoustic data acquisition, to learn how to use the required software and to know how to operate the echo sounding systems. Participants will be trained in all parts of the systems and go on watches in 2-hours shifts at day and 4-hours shifts at night. They will learn about sediment properties, reflector horizons, bottom topography and the principles of sediment acoustics. One key objective is the study of the spatial and temporal morphological variability of the huge sea-floor sand dunes in the English Channel. Practical training on the systems will be complemented through plenary lectures and software training in smaller groups to discuss published case studies. Being able to combine and interpret sediment core and multi-beam-bathymetric data with Parasound profiles is a further learning outcome. Participants will also be introduced to survey planning, data handling, editing, and visualization with different kind of profiling and GIS mapping software. Being able to produce a map from originally raw data will be one of the outcomes which the participants can “take home”. Besides the watch duties, students will give a 15 min presentation on their individual research project (Master or PhD) and the relevance of the course content for their project. Given the composition of participants (both Master and PhD students), participants will greatly benefit from each other. By experience we know that peer-teaching is an added value in every course. Working on a ship will foster this exchange. Master students can further clarify their motivation for their next career step, e.g. whether following a PhD is an option for them.

Data management

Hydro-acoustic data (multi-beam and sediment echo-sounder) collected during the expedition will be stored in a specific file structure to be directly imported in the PANGEA data repository at the AWI. Furthermore, the data will be provided to mapping projects and included in regional data compilations such as IBCSO (International Bathymetric Chart of the Southern Ocean) and GEBCO (General Bathymetric Chart of the Ocean).

6. TEILNEHMENDE INSTITUTE / PARTICIPATING INSTITUTIONS

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

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

7. FAHRTTEILNEHMER / CRUISE PARTICIPANTS

Punta Arenas - Bremerhaven				
Name	**Firstname**	**Institute**	**Profession**	**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	**Firstname**	**Institute**	**Profession**	**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**	**Institute**	**Profession**	**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
Lange	Mirko	UniHB	Student	Geology
Lenz	Kai-Frederic	CAU	Student	Geology
Machner	Nina	AWI	Logistician	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**	**Institute**	**Profession**	**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)				

8. SCHIFFSBESATZUNG / SHIP'S CREW

No.	Name	Rank
01.	Schwarze, Stefan	Master
02.	Grundmann, Uwe	1.Offc.
03.	Farysch, Bernd	Ch. Eng.
04.	Langhinrichs, Moritz	EO Ladung
05.	Hering, Igor	2.Offc.
06.	ohne	2.Offc.
07.	Scholl, Thomas	Doctor
08.	Christian, Boris	Comm.Offc.
09.	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
34.	Silinski, Frank	Cooksmate
35.	Martens, Michael	Cooksmate
36.	Czyborra, Bärbel	1.Stwdess
37.	Wöckener, Martina	Stwdss/KS

No.	Name	Rank
38.	Dibenau, Torsten	2.Steward
39.	Silinski, Carmen	2.Stwdess
40.	Duka, Maribel	2.Steward
41.	Arendt, Rene	2.Steward
42.	Sun, Yong Shen	2.Steward
43.	Chen, Dan Sheng	Laundrym.