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

EXPEDITION PROGRAMME PS113

Polarstern

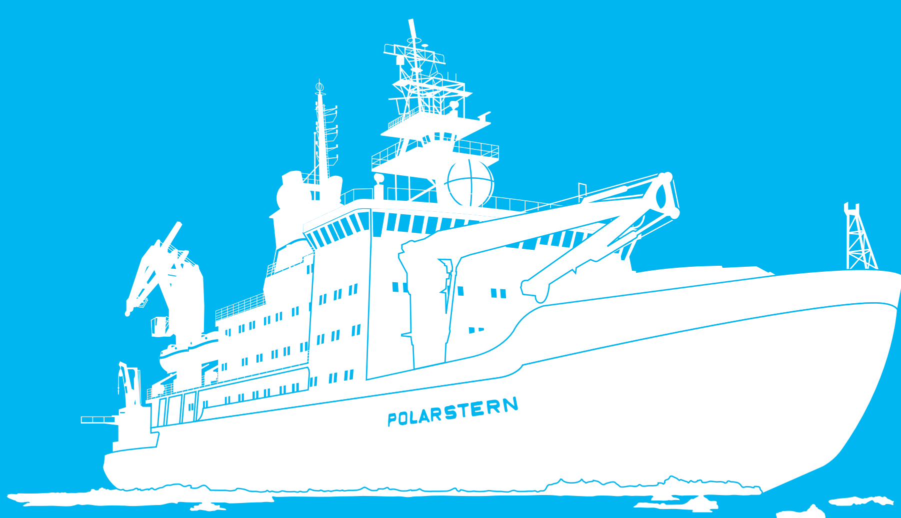
PS113

Punta Arenas - Bremerhaven

07 May 2018 - 11 June 2018

Coordinator: Rainer Knust

Chief Scientist: Volker Strass



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PS113

South-North Atlantic Transit

07 May 2018 - 11 June 2018

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Chief scientist
Volker Strass

Coordinator
Rainer Knust

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1. ÜBERBLICK UND FAHRTVERLAUF

Volker Strass
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Der Fahrtabschnitt PS113 deckt sich mit der Rückreise von *Polarstern* nach Beendigung der der Antarktis-Forschungssaison 2017/18. Er wird am 07. Mai 2018 in Punta Arenas, Chile, beginnen und am 11. Juni 2018 in Bremerhaven enden. Für den 03. Juni ist ein Hafenanlauf in Las Palmas, Kanaren, geplant, um Personal der AWI-Logistik für technische Arbeiten an Bord zusteigen zu lassen.

Der größte Teil (ca. 9/10) der zur Verfügung stehenden Schiffszeit wird allein für das Zurücklegen der Fahrtstrecke Punta Arenas – Bremerhaven bei ökonomischer Marschfahrt von *Polarstern* benötigt. Die Zeit für wissenschaftliche Stationsarbeiten ist folglich sehr knapp. Deswegen wird der Schwerpunkt bei solchen Forschungsarbeiten liegen, die vom fahrenden Schiff aus entlang des Transit-Kurses durchgeführt werden können. Dazu gehört auch das Haupt-Vorhaben während PS113, die Indienststellung des neuen geschleppten Messsystems topAWI (towed ocean profiler of the AWI), wofür *Polarstern* langsamer dampfen muss als mit normaler Marschfahrt.

Die Forschungsvorhaben während PS113 sind im Überblick:

1. topAWI: Test und Indienststellung eines geschleppten Messsystems
2. PHYTOOPTICS: Messung von biooptischen Eigenschaften und Pigment-Zusammensetzungen im lichtdurchfluteten Ozean mit dem Ziel der Validation von Satellitensensoren der Ozeanfarbe und damit verbesserter Fernerkundung von Phytoplanktonkonzentrationen
3. Plankton-Genomik: Ermittelung meridionaler Unterschiede der Plankton-Artendiversität mittels genetischer Methoden
4. WaMoS: Radar-Messungen von Oberflächenwellen und -strömungen
5. OCEANET: Messung von Eigenschaften und Prozessen der Atmosphäre zwischen der von menschlichen Aktivitäten weniger belasteten Südhemisphäre und der stärker belasteten Nordhemisphäre
6. MICROTOPS: Bestimmung von Aerosoleigenschaften und des atmosphärischen Wasserdampfgehaltes mittels Sonnen-Photometern
7. Argo: Aussetzen von profilierenden Treibkörpern zur Messung von Ozean-Temperatur und -Salzgehalt
8. Bathymetrie: Wassertiefen-Kartierung und Meeresboden-Profilierung
9. Benthic Fish: Pflege und physiologische Untersuchungen lebend-gehälterter antarktischer Fische.

SUMMARY AND ITINERARY

Following *Polarstern's* return journey from Antarctica which finished the Antarctic season 2017/2018, the expedition leg PS113 will begin on 07 May 2018 in Punta Arenas, Chile, and end on11 June 2018 in Bremerhaven.

An intermediate port call at Las Palmas, Canary Islands, is planned for 03 June in order to allow the embarkation of personnel of the AWI Logistics Department to conduct technical works on board.

Since most of the time (ca. 9/10) allocated to PS113 will be used for the transit between Punta Arenas and Bremerhaven at an economically reasonable steaming speed of *Polarstern*, the ship time available for scientific station work will be very limited. Therefore, the focus will be laid on research work that can be conducted *en route* along the transit course. This encompasses the main scientific project to be conducted during PS113, the commissioning of a new measuring system, the towed ocean profiler of the AWI (topAWI), for which purpose *Polarstern* has to steam at a lower than normal transit speed.

In summary, the research projects assigned to PS113 are:

1. topAWI: Test and commissioning of a new towed ocean profiler
2. PhytoOptics: Measurements of bio-optical properties and pigment compositions in the sun-lit upper ocean, aimed *i.a.* at the validation of ocean colour satellite sensors hence at improved remotely sensed phytoplankton concentrations
3. Plankton-Genomics: Assessment of meridional differences in plankton species diversity by genetic methods
4. WaMoS: Radar-based measurements of surface waves and currents
5. OCEANET: Measuring atmospheric properties and processes underway from the southern hemisphere, which is less perturbed by human activities, and the more disturbed northern hemisphere
6. MICROTOPS: Determination of the properties of aerosols and of the water vapor content of the atmosphere by use of sun-photometers
7. Argo: Deployments of profiling floats for the measurement of ocean temperature and salinity
8. Bathymetry: Bathymetric Mapping and Sub-Bottom Profiling
9. Benthic Fish: Care and physiological investigations of live Antarctic fish in aquaria.

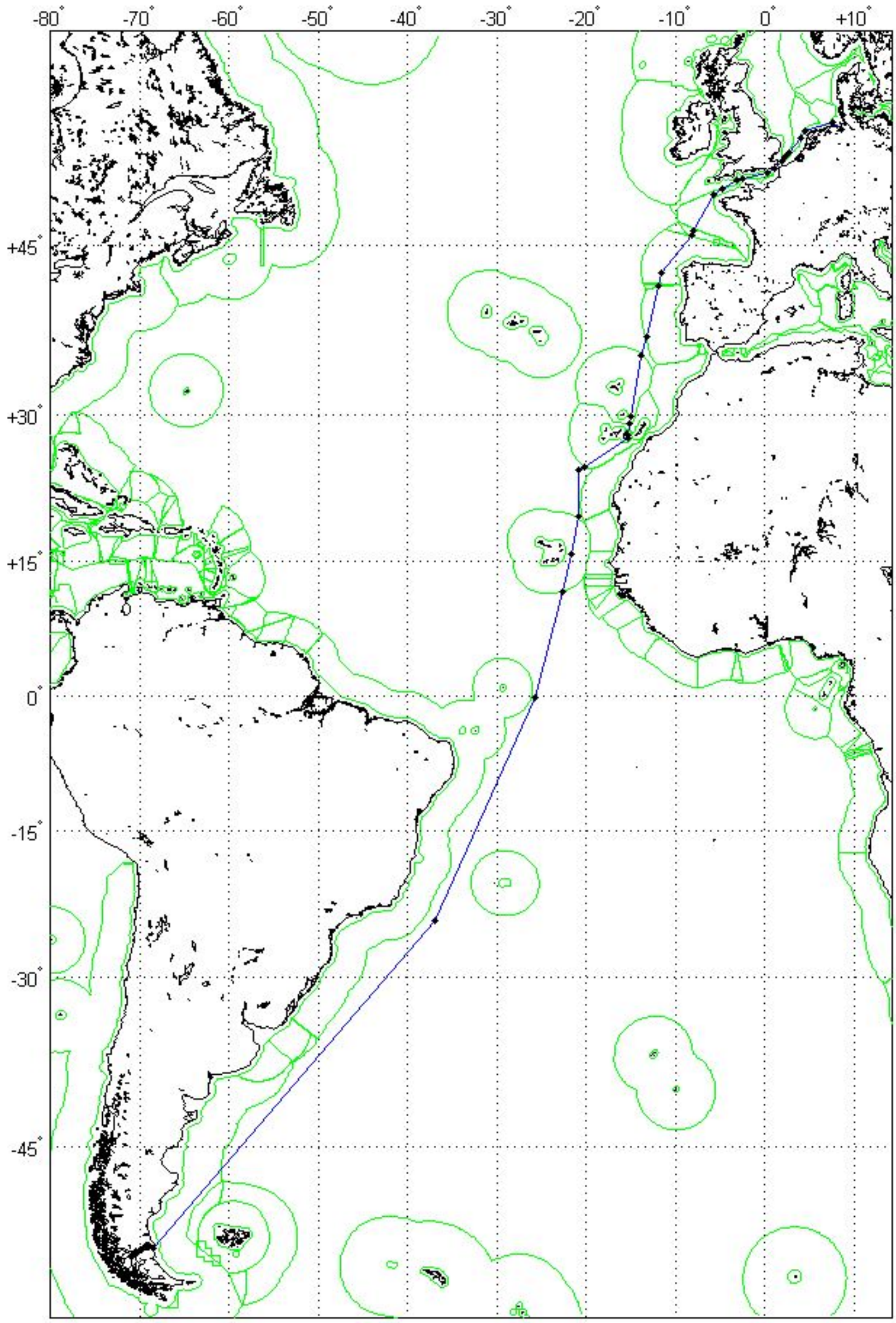

Abb. 1.1: Geplante Route (blaue Linie) PS113. Die grünen Linien zeigen die Gebiete der Hoheitsgewässer und der ausschließlichen Wirtschaftszone

Fig. 1.1: Planned cruise track (blue line) of PS113. The green lines indicate boundaries of territorial waters and exclusive economic zones of coastal states.

2. SYSTEM-TESTING AND COMMISSIONING OF THE MULTIDISCIPLINARY TOWED OCEAN PROFILER OF THE AWI (TOPAWI)

V. Strass (AWI), A. Bracher (AWI), H. Flores (AWI; not on board), S. El Naggar (SELNA), W.-J. von Appen (AWI), H. Haake (AWI), J. Hagemann (AWI), S. Spahić (AWI), Giulia Castellani (AWI), J. Gerken (AWI), A. Neubauer (UFSC), S. Lenius (AWI), H. Leach (UoL)

Objectives

The oceans play a key role within the Earth system, *inter alia* by the sequestration and global-scale redistribution of CO_2, heat, and nutrients. They harbor diverse marine ecosystems, which yield living resources and effect biogeochemical fluxes that influence global climate. The ecosystems change with the physical and chemical environment, in ways which are however not completely identified. To better understand the functioning of marine systems with their high degree of complexity resulting from the interaction of physical, chemical and biological processes, measurements are needed that comprise the different disciplines and that are taken simultaneously over a very wide range of temporal and spatial scales and trophic levels.

Simultaneously measuring the relevant physical, chemical and biological variables with high temporal and spatial coverage and resolution in a quasi-synoptic manner represents a challenge that can be best met by towed undulating vehicles that have sufficient payload capacity. To this end, AWI recently purchased a vehicle-winch system type Triaxus E from MacArtney, Denmark, modified and instrumented to AWI's scientific needs and termed topAWI, the towed ocean profiler of the AWI. It is designed to achieve a vertical undulation range of 450 m below surface, once the optimal combination of towing speed and tow cable length have been assessed, and provided the scientific payload is not too hydrodynamically obstructive. The large vertical undulation is achieved by an automatic winch control embedded in the vehicle steering software, which directs the winch to pay out and retrieve cable on demand. The vehicle is also able to sheer out to the side of the ship track, in order to obtain vertical profiles close to the surface outside the propeller wash. At present, the basic scientific payload comprises a CTD sonde for determination of temperature, salinity, depth (and density), oxygen sensor, fluorometer for chlorophyll concentration, light transmissiometer, PAR sensor for photosynthetically available radiation, hyperspectral radiometer, pair of up- and downward looking acoustic Doppler current profilers (ADCPs), and a broad-band acoustic zooplankton sounder.

A complex, new and unique system such as topAWI needs intensive testing at sea after completion and initial instrument integration. Its operability on board of *Polarstern* will have to be assessed for different payload configurations and tow parameter settings. It also requires sufficient excellent personnel being trained on its deployment and collection of scientific data.

Work at sea

In order to optimize the flight performance and thus to determine the best set of control parameters, it will be necessary for the topAWI to be towed during transit at different ship speeds with varying cable lengths, horizontal offset angles, and vertical dive ranges and rates. Tests will have to be conducted also in order to determine the influence of varying payload configurations on flight behaviour. New instruments will be integrated to the system in addition to the existing scientific payload. Reconfigurations of instruments and sensors require repeated launching and recovery of the vehicle.

These stoppages of towing will be used for vertical casts of the CTD/Rosette Water Sampler and an optical instruments package at hydrographic stations. These casts are needed for cross-validation of measurements made with instruments on the towed vehicle. Further cross-validation will be conducted with data sampled *en route*, such as by the thermosalinograph and from the seawater supply system; this encompasses also the vessel-mounted ADCP of *Polarstern*.

Preliminary (expected) results

Resulting from the work planned for PS113 we expect a much better knowledge of the vehicle performance under different boundary conditions, and consequently an optimized set of recommended vehicle control parameters for different payload configurations and towing speeds. This will support an informed and thus more accurate planning of topAWI deployments during future cruises. PS113 will also yield, among the group of cruise participants foreseen to work with topAWI and hence to benefit from in-depth and hands-on learning during the cruise, personnel that is well trained in the deployment of the vehicle and the collection of scientific data with this towed system.

Provided the system functions as foreseen and does not suffer from serious technical problems, a valuable data set will be collected during transit through major oceanographic regimes of the Atlantic; from the southern hemisphere mid-latitude westerlies and subtropics, across the equatorial current system, and further through the northern hemisphere subtropics to finally the northern mid-latitude westerlies. This data set, on its own and in combination with other projects hosted by PS113, will provide new insights into the interaction between meso- to large-scale currents and mixing in the ocean surface layer and further into the controls these physical processes exert on phytoplankton primary production, the phytoplankton-related underwater light field, and the phytoplankton-dependent zooplankton, in the different oceanographic regimes and biogeographic provinces crossed.

Data management

The ship's station list and metadata of the collected scientific data will be transmitted shortly after the cruise in the Cruise Summary Report (CSR) to the Deutsches Ozeanographisches Datenzentrum (DOD). All data will be deposited step by step after processing in PANGAEA, a database accessible to the public. We expect all data to become publically available within two years after completion of the cruise.

3. PHYTOOPTICS

A. Bracher (AWI), S. Wiegmann (AWI), H. Xi (AWI)

Objectives

The Phytooptics group will perform measurements on bio-optical properties and pigment composition, taken continuously and during topAWI operations in near-surface waters, as well as at discrete hydrographic CTD stations and with underwater light instruments casts down to 120 m depth. With that, as much as possible collocated data to OLCI ocean color satellite sensor measurements (launched in February 2016 on Sentinel-3A and to be launched in December 2017 Sentinel-3B) shall be acquired for validation. (The Phytooptics group is part of the Sentinel-3 Validation Team). In addition these *in-situ* data will be important for the validation of the group's own satellite products on phytoplankton composition derived from the hyperspectral atmospheric satellite sensor TROPOMI (to be launched in October 2017 on-board Sentinel-5 Precursor). Measurements at discrete water samples and analytical methods developed by the Phytooptics Group will be performed for calibration purpose. The continuous surface and profile bio-optical data will yield a continuous data set on the composition of pigments, phytoplankton groups and particle size distributions.

Water samples will be taken every 3h near the surface and at CTD stations from 6 depths (down to max. 100 m), from which pigment and phytoplankton group composition, CDOM (coloured dissolved organic matter), particle and phytoplankton absorption will be measured to determine the composition and amount of phytoplankton, other particles and CDOM.

Work at sea

Active and passive bio-optical measurements for the survey of the underwater light field, specific light attenuation, particle and phytoplankton composition as well as distribution shall be performed continuously on the surface water but also in the profile during topAWI operation and daily noon-time CTD stations:

1. Continuous and discrete measurements of inherent optical properties (IOPs) with a hyperspectral spectrophotometer: For the continuous underway surface sampling an *in-situ* spectrophotometer (AC-S; Wetlabs) will be operated in flow-through mode to obtain total and particulate matter attenuation and absorption of surface water. The instrument shall be mounted to a seawater supply taking near-surface ocean water. A flow-control with a time-programmed filter is mounted to the AC-S to allow alternating measurements of the total and the CDOM inherent optical properties of the sea water. Flow-control and debubbler-system ensure water flow through the instrument with no air bubbles. The AC-S needs to be operated on the seawater supply at the Nasslabor-1, with seawater pumped from the moon-pool by the membrane pump - in order to deliver living phytoplankton cells continuously throughout the cruise.
2. A second AC-S instrument is mounted on a steel frame together with a depth sensor and a set of hyperspectral radiometers (Ramses sensors from TRIOS) and operated during CTD stations around noon time daily. The frame is lowered down to maximal 120 m with a continuous speed of 0.1 m/s or during daylight with additionally stops at 2, 4, 6, 8, 10, 12.5, 15, 20, 25 and 30 m to allow a better collection of radiometric data (see later). The Apparent Optical Properties of water (AOPs) (mostly light attenuation through the water column) will be estimated based on downwelling and upwelling irradiance measurements in the surface water profile (down to the 0.1 % light depth) from the radiometers calibrated for the incident sunlight with measurements of a radiometer on deck. The AC-S will measure the inherent optical properties (IOPs: total attenuation, scattering and absorption) in the water profile.
3. Discrete measurements of IOPs (absorption) at water samples are performed a) for samples from the underway surface sampling (as for the AC-S flow-through system connected to the ship's sea water supply system) at an interval of 3 hours, and b) for samples from the CTD stations at 6 depths within the top 100 m. Water samples for CDOM absorption analysis are filtered through 0.2 µm filters and analyzed onboard with a 2.5-m path length liquid waveguide capillary cell system (LWCC, WPI). Particulate and phytoplankton absorption coefficients are determined with the quantitative filter techniques using samples filtered onto glass-fiber filters QFT-ICAM and measuring them in a portable QFT integrating cavity setup (Röttgers et al. 2016).
4. Samples for determination of phytoplankton pigment concentrations and composition are taken at a 3-hourly interval from the underway-sampling system, and from 6 depths (max. 100 m) at CTD-stations. These water samples are filtered on board immediately after sampling and the filters are thermally shocked in liquid nitrogen. Samples are stored at -80°C until the ship is back in Bremerhaven in June 2018 and then will be analyzed within

the next three months by High Performance Liquid Chromatography Technique (HPLC) at the AWI following Taylor et al. (2011).

5. The acquisition of optical data (hyperspectral irradiance from an ACC-RAMSES sensor, hyperspectral transmission and absorption from a third AC-S instrument, and Chlorophyll and CDOM fluorescence and backscatter at 550 nm from a Wetlabs triplet sensor, PAR data) during the topAWI deployments is supported by helping in the control of the output data. The measurements of the AC-S taken continuously at the surface (see 1) and in the water column (see 2) during stations will be inter-compared to the AC-S run on the topAWI system as quality control. In addition the discrete measurements on water samples (3 and 4) will be used to calibrate the above mentioned topAWI sensor data.

Data management

During our cruises we will sample a large variety of interconnected parameters. The filters sampled for pigment determination will be shipped back (stored at -80°C) and analysed. We plan that the full data set will be available about two years after the cruise by the latest. Data will be made available to the public via PANGAEA after publishing (depending on how many comparisons will be made, and for long-term studies 2 to 5 years after the cruise).

References

Röttgers R, Doxaran D, Dupouy C (2016) Quantitative filter technique measurements of spectral light absorption by aquatic particles using a portable integrating cavity absorption meter (QFT-ICAM). Opt. Express 24, A1-A20.

Taylor BB, Torrecilla E, Bernhardt A, Taylor MH, Peeken I, Röttgers R, Piera J, Bracher A (2011) Bio-optical provinces in the eastern Atlantic Ocean and their biogeographical relevance. Biogeosciences, 8, 3609–3629.

4. PLANKTON-GENOMICS: PRO- AND EUKARYOTIC DIVERSITY ALONG A LATITUDINAL GRADIENT IN THE ATLANTIC OCEAN

C. Hoerstmann (AWI), S. Spahić (AWI), A. Waite (AWI; not on board)

Objectives

Global climate change is impacting a wide variety of marine ecosystems globally and adequate quantification of the base of the marine food web is rapidly becoming urgent (Barnosky et al., 2012). Marine microbes, along with hetero-, mixo- and phototrophic eukaryotes, form the foundation of the marine food web (Sunagawa et al. 2015, Hutchins and Fu 2017). Ocean salinity and temperature have been shown to co-vary with species distributions, suggesting that oceanographic changes can shift geographic boundaries and alter phenology and community structures from planktonic eukaryotes to higher trophic levels (Richardson and Schoeman 2004, Brown et al. 2009). Alterations in the biogeography patterns of prokaryotic and eukaryotic microorganisms in the upper ocean could impact the efficiency of C-fixation and cycling, and ultimately the export of organic carbon to the deep ocean, as microorganisms are key biogeochemical regulators (Hutchins and Fu 2017). The mechanisms supporting biodiversity gradients (see Mittelbach et al. 2007)) are primarily understood for larger size taxa, and the controls for marine unicellular pro- and eukaryotic diversity trends remain more elusive due to the paucity of the spatial resolution (Rusch et al. 2007, Amend et al. 2013).

Work at sea

During PS113 we aim to generate a high-resolution dataset describing pro- and eukaryotic diversity and environmental parameters every half a degree in the Atlantic Ocean. We will take water samples for population genome analysis (DNA) and RNA expression analysis from the flow through water system every 0.5°. Furthermore, we will collect samples, also from the flow through water system for dissolved inorganic nutrients, phytoplankton pigment composition, particulate organic nitrogen (PON) and particulate organic carbon (POC). Primary productivity measurements will be executed in triplicate using ^{13}C onboard using an incubation vessel located port aft.

Expected results

We will use this dataset to test the following hypotheses concerning the ecological mechanisms controlling pro- and eukaryotic richness in the Atlantic Ocean: H_1) Richness increases with increasing productivity (more resources support higher numbers of species), and H_2) Richness increases with increasing temperature (higher temperatures increase the rates of biochemical and metabolic pathways). In addition, we hypothesize (H_3) that stable fronts and hydrographic features can act as control mechanisms on microbial assemblages (structuring of unique microbial oceanic provinces via ecological boundary).

Testing these hypotheses would provide us a better understanding how pro- and eukaryotic richness relate to ecosystem processes such as primary productivity, as well as insights into the potential geographical community-range shifts in light of the rapidly changing global climate (Burrows et al. 2014).

Data policy

All data will be submitted to the Pangaea database.

References

Amend AS, Oliver TA, Amaral-Zettler LA, Boetius A, Fuhrman JA, Horner-Devine MC, et al. (2013) Macroecological patterns of marine bacteria on a global scale. Journal of Biogeography, 40, 800-811.

Brown M, Philip G, Bunge JA, Smith MC, Bissett A, Lauro FM, et al. (2009) Microbial community structure in the North Pacific ocean. ISME J, 3, 1374-1386.

Burrows MT, Schoeman DS, Richardson AJ, Molinos JG, Hoffmann A, Buckley LB, et al. (2014) Geographical limits to species-range shifts are suggested by climate velocity. Nature, 507, 492-495.

Hutchins DA, Fu F (2017) Microorganisms and ocean global change. Nature microbiology, 2, 17058.

Mittelbach GG, Schemske DW, Cornell HV, Allen AP, Brown JM, Bush MB, et al. (2007) Evolution and the latitudinal diversity gradient: speciation, extinction and biogeography. Ecology letters, 10, 315-331.

Richardson AJ, Schoeman DS (2004) Climate impact on plankton ecosystems in the Northeast Atlantic. Science, 305, 1609-1612.

Rusch DB, Halpern AL, Sutton G, Heidelberg KB, Williamson S, Yooseph S, et al (2007) The Sorcerer II global ocean sampling expedition: northwest Atlantic through eastern tropical Pacific. PLoS Biol, 5, e77.

Sunagawa S, Coelho LP, Chaffron S, Kultima JR, Labadie K, Salazar G, et al. (2015) Structure and function of the global ocean microbiome. Science, 348, 1261359.

5. WAMOS: RADAR-BASED MEASUREMENTS OF SURFACE WAVES AND CURRENTS

K. Hessner (OWS), S. El Naggar (SELNA), W.-J. von Appen (AWI), V. Strass (AWI)

Objectives

The information about ocean surface waves and currents is of high importance for various kinds of applications, ranging from marine safety of offshore activities such as shipping and offshore mining and fish farming and to civil engineering challenges in the design of off-shore platforms, harbors or coastal protection constructions. Besides the need from the industry the accurate and comprehensive knowledge of surface waves and currents is also of importance for the scientific community. The sea state plays a key role in air sea interaction processes which control the energy and gas transport between ocean and atmosphere. Further, ocean currents are responsible for energy and mass transport ranging from local to global scale.

Sea state and current measurements are traditionally acquired by *in-situ* sensors (e.g. buoys, pressure gauges, ADCPs, etc.). Such measurements are generally based on time series analyses acquired at a particular location over coherent times of 20-30 minutes. Central challenge in using *in-situ* sensors are the proper deployment, data accessibility and maintenance. Regarding the resulting data it needs awareness on how point measurements reflect the actual sea state especially in highly variable seas.

With the growing need of precise knowledge on waves/sea state, not only the number of wave measurements is continuously increasing, but also the number of different measurement devices. These devises range from *in-situ* sensors like buoys to remote devices like ground or satellite based radars. All these instruments use different sampling strategies and analysis algorithms to derive sea state properties, hence they allow different views on the sea on one hand but raise on the other hand new discussions on what is an accurate measure and how to deal with different and maybe inconsistent.

One way to remotely observe sea surface waves is by using nautical X-Band radars. These radars are generally used for ship traffic control. Such radars are designed to identify solid targets like ships at ranges of up to around 50 nautical miles and allow to scan the sea surface with high temporal and spatial resolution. They are able to monitor the sea state in time and space. Under various conditions, signatures of the sea surface are visible in the near range (< 3 nm) of nautical radar images. These signatures are known as sea clutter. As they are undesirable for navigation purposes they generally are suppressed by filter algorithms. The sea clutter is created by the backscatter of the transmitted electromagnetic waves from the short sea surface ripples (in the range of cm). The longer waves like wind sea and swell become visible in the radar images as they modulate the sea clutter signals and (Keller & Wright 1975, Alpers, Ross & Rufenach 1981, Plant 1990, Wenzel 1990, Lee et al. 1995). Via wave current interaction, also the current in the wave-influenced upper ocean can be monitored. As the presence of short ripples is directly related to the local wind, a minimum wind speed of about 3 m/s is required to generate sea clutter. For sea clutter modulation by longer waves a minimum wave height of 0.5 m is required. As nautical X-Band radars are designed to work under harsh conditions, they are best suited for high wind and wave conditions.

During several scientific campaigns and industrial applications WaMoS II® proved to be a powerful tool to monitor ocean waves from fixed platforms as well as from moving vessels, especially under extreme weather conditions. However, due to the different sampling strategy of radars in contrast to *in-situ* sensors, deviations of wave and current observations were reported, which question the reliability of such remote sensing technologies (Hessner, Reichert & Nieto-Borge 2014, Hessner et al. 2017)

Depending on the used radar and antenna and the sampling conditions, remote sensing technologies cover a different range of wave measurements than *in-situ* sensors. Like *in-situ* measurements may be affected by its mounting or subject of fouling or interferences with nearby structures, radar observations are somehow limited by environmental conditions, such as wind and precipitation.

Measurements on moving platforms include additional uncertainties, as they depend also on the accuracies of external information such as ship heading, velocity and position. This holds for onboard remote sensing technologies as well as on-board *in-situ* sensors like ship mounted ADCPs for current observations. *In-situ* sensors like ADCPs are susceptible to disturbances like air bubbles, noise or turbulences generated by the vessel.

When validating current measurements carried out by radar and ADCP it needs to be taken into account that both systems monitor the current at a different water level. As vertical homogeny of currents cannot be assumed at any time, observed deviation between the sensors might be misinterpreted. Therefore, current validations in the past were carried out only under quasi barotropic (no significant vertical current shear) conditions (Hessner et al. 2017). This restriction makes the data validation on one hand challenging but offers on the other the potential to study the link between the surface and the subsurface currents.

Work at sea

During PS113 the accuracy and reliability of the WaMoS II surface current measurements shall be evaluated under real time conditions, and the associated quality control thereupon be improved. Therefore, the following action items are planned:

1. Analysis during real operation of the system to find out the environmental limitations
2. Evaluate limiting factors such as ship speed, course changes, wind and sea state conditions, etc.
3. Optimize the system setting with respect to different environmental conditions
4. Find out the practical requirements and needs for the user, with respect to data display and data handling
5. Evaluate the usability of the graphical display
6. Comparison of WaMoS surface current data with currents measured by both the ship-mounted ADCP and the up-/down-looking ADCP pair installed on the topAWI TRIAXUS vehicle
7. Evaluate the consistency of the WaMoS and ADCP measurements with respect to synergy effects.

Preliminary (expected) results

From the work carried out during PS113 we expect:

- A better assessment of the actual performance range of WaMoS in relation to particular ship parameters (speed, course changes, etc.) and environmental conditions (wind, sea state, precipitation)
- An enhanced reliability of the WaMoS quality control
- An evaluation of the usability of the Sea View display indicating simultaneous status of the Sigma WaMoS measurement with respect to results and reliability of the measurement
- An improved understanding of near-surface current shears.

Data management

During the sea trial, WaMoS radar as well as derived sea state and surface current data will be stored on external hard drives. For particular cases sigma s6 raw data (SIG stream files) will be stored. The data should be back-uped on additional hard drives. All data will be deposited step by step after processing in PANGAEA, a database accessible to the public. We expect all data to become publically available within two years after completion of the cruise.

References

Alpers WR, Ross DB, Rufenach CL (1981). On the detectability of ocean surface waves by real and synthetic aperture radar. *J. Geophys. Res. , 86*(C7), 6481-6498.

Bitner-Gregersen EM, Hagen Ø (1990). Uncertainties in Data for the Offshore Environment. *Structural Safety*, Vol. 7, No. 1, 11-34.

Hessner K (2007). *WaMoS II - WAVE ANALYSIS METHOD, LIMITATIONS, AND DEFINITIONS.* OceanWaveS GmbH.

Hessner KG, El Naggar S, Strass V, Krägefsky S, Witte H (2017). Evaluation of X-band MR surface and ADCP subsurface currents obtained onboard the German research vessel Polarstern during ANT-XXXI expedition 2015/16. *Oceans 2017.* Anchorage, USA.

Hessner, KG, Reichert K, Nieto Borge JC (2014). Accuracies and error statistics for measured - Area covering X- band radar wave measurements vs point measurements. *OCEANS'14 MTS/IEEE.* St. Johns.

Keller WC, Wrigh, JW (1975). Microwave scattering and the straining of wind-generated waves. *Radio science, 10*(2), 139-147.

Lee P, Barte J, Beach K, Hindman C (1995). X-Band microwave backscattering from ocean waves. *J. Geophys. Res., 100*(C2), 2591-2611.

Plant W (1990). Bragg Scattering of Electromagnetic Waves from the Air/Sea Interface. In G. G. Plant, *Surface Waves and Fluxes: Current Thory and Remote Sensing* (pp. 41-108). Kluwer Academic Publishers.

Wenzel LB (1990). Electromagnetic scattering from the sea at low grazing angles. In G. L. Geernaert, *Surface Waves and Fluxes: Current Theory and Remote Sensing.* (pp. 41-108). Kluwer Academic Publishers.

6. OCEANET-ATMOSPHERE: AUTONOMOUS MEASUREMENT PLATFORMS FOR ENERGY AND MATERIAL EXCHANGE BETWEEN OCEAN AND ATMOSPHERE

A. Macke (not on board), R. Engelmann (not on board), H. Deneke (not on board), M. Radenz, C. Jimenez, Z. Yin (all TROPOS)

Objectives

The OCEANET-ATMOSPHERE project delivers valuable atmospheric measurement datasets over the oceans – in regions of the world that are not easily accessible. For the last 8 years, a container-based platform is operated regularly on board *Polarstern* to obtain measurements and to contrast atmospheric processes between the anthropogenic polluted northern hemisphere and the more undisturbed southern hemisphere.

a) Radiation & microwave remote sensing

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

A multichannel microwave radiometer will be applied to continuously retrieve the integrated water vapor and the cloud liquid water path over the ocean. Time series of these values will resolve small-scale atmospheric structures as well as the effects of the mean state of the atmosphere and its variability on the co-located measurements of the downwelling shortwave and longwave radiation. These data will be compared to and combined with METEOSAT SEVIRI products for a characterization of atmospheric state and radiative fluxes. Atmospheric aerosol optical thickness will be measured by means of hand held sun photometer and a multi-spectral solar radiometer, which also enables the determination of spectrally resolved aerosol and cloud radiative effects. Most instruments are integrated in the container-based atmosphere observatory.

b) Lidar measurements of aerosol and cloud profiles

Since more than 15 years, TROPOS has developed and operated advanced lidar systems in order to study optical and microphysical aerosol properties in the troposphere. The system PollyXT, a semi-autonomous multiwavelength polarization Raman lidar will be operated inside a container, together with the radiation and microwave sensing equipment. The lidar is able to measure independently profiles of particle backscatter at three wavelengths and extinction at two wavelengths, which allows identifying particle type, size, and concentration. Additionally particle depolarisation is measured in order to discriminate between spherical and non-spherical particles, e.g. biomass-burning smoke vs. mineral dust or water clouds vs. ice clouds. The lidar is equipped with a measurement channel for atmospheric water vapour, too. The data are used to characterize long-range transport of aerosol and identify pollution. The determined height-resolved aerosol extinction completes the radiation measurements. In this way, the radiative influence of single lofted aerosol or cloud layers can be calculated with radiation-transport models.

For the PS113 cruise, the lidar will be equipped with a dual-wavelength near-range channel in order to observe the aerosol in the shallow marine boundary layer as well at 355 and 532 nm.

Work at sea

Upon departure from Punta Arenas, the container-based atmosphere observatory OCEANET will be installed at the monkey deck of *Polarstern*. Most measurements will be performed underway and continuously. The following individual instruments are combined:

1. Multichannel microwave radiometer HATRPO. The instrument requires a calibration with liquid nitrogen at the port
2. Whole sky imager for cloud structure measurements
3. Multiwavelength polarization Raman lidar PollyXT
4. Handheld sun photometer (Microtops) for aerosol and cloud optical thickness
5. Standard meteorological and radiation data logging
6. Multispectral shadow-band radiometer

Expected results

- 2d structure of the clear sky atmosphere and corresponding net radiation budget.
- Horizontal structure of the cloud water path and its effect on the downwelling shortwave and longwave radiation
- Vertical structure of temperature and humidity as well as its variability for validation of satellite products
- Vertical profiles of tropospheric aerosols and their effect on radiation

Data policy

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

Additionally, higher-level data are uploaded at the Pangaea database under the keyword OCEANET-ATMOSPHERE.

7. MICROTOPS: MEASUREMENTS OF ATMOSPHERIC COLUMN INTEGRATED AEROSOL PROPERTIES AND WATER VAPOR

S. Kinne (MPI-M; not on board), J. Vial (MPI-M)

Objectives

Reference data 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 to 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 to NASA's growing Marine Aerosol Network (MAN) database and serve as references for satellite remote sensing and (aerosol) global modeling.

Work at sea

MICROTOPS measurements require unobstructed views of the sun's solar disk. Thus, regular (every 15 min) sampling in a handheld operation 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.

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 evaluation exercises (e.g. AeroCom) of global models and in improvements to climatologies (e.g. Max-Planck's aerosol climatology)

Data management

MICROTOPS measurements will be transmitted each evening to the publicly accessible MAN database (http://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html).

Extras

For the aerosol data analysis, there is a useful property which describes from the AOD spectral dependence the aerosol particle size: The Angstrom parameter, defined by the negative slope in ln(AOD)/ln(wavelength), thus requires AOD samples at two different (solar) wavelength. A smaller Angstrom (0.0 to 0.5) indicates the dominant impact of larger (super-micrometer) aerosol particles, whereas a larger value (1.2 to 2.0) indicates the dominant impact of smaller (sub-micrometer) aerosol particles.

The Angstrom parameter also allows to estimate an AOD value at other than the sampled wavelengths (which is particularly important for data comparisons since the reference wavelength for AOD in modeling and also often in satellite remote sensing is at 550nm, a wavelength generally not sampled by a sun-photometer).

Below two FORTRAN coding lines define the determinations of the Angstrom parameter (based on AOD samples at 440 and 870 nm wavelengths) and of the AOD at 550 nm by applying that Angstrom parameter to the sampled AOD at 440 nm.

```
Angstrom = - alog (AOD_440nm / AOD_870nm) / alog (440. / 870.)
AOD_550nm = exp [-Angstrom * alog(550./440.) +alog(AOD_440nm)]
```

In addition, we hope to also have our cloud camera system ready. If that is the case, there will be the following additional activity:

Monitoring clouds cover, structure and cloud base altitude

Objectives

Clouds are the strongest modulator to the atmospheric energy budget, yet clouds are highly variable in time and space. To capture this variability (e.g. as a function of latitude or in terms of daily cycles) two simple upward looking cameras are employed to capture cloud images (jpeg) every 10 seconds. One of the cameras records visible images while the other camera records thermal images. Aside from clouds cover and structure the (thermal) infrared image (if the temperature profile is known) reveals also estimates for the cloud base altitude – even at night.

Work at sea

The camera system, preferably with an undisturbed upward hemispheric view, records pictures automatically. Once set up properly, the recording only needs to be checked regularly.

Expected results

The more interesting results depend on the available time for data-analysis. Ideally, each recorded image should be described by a few parameters: (1) cloud cover, (2) inhomogeneity parameter and (3) cloud base altitude (estimate via the recorded IR temperature). These data could then be examined as a function of day or latitude or they could be placed in the context of simultaneous sampled data by the sun photometer (e.g. aerosol. water vapor) or the ship's standard data instrumentation (e.g. wind, humidity, SST) in order to capture relationships. Hereby, the ship's (solar and infrared) broadband radiation data even allow closure studies via radiative transfer simulations. To what degree such a data-analysis is already possible during the cruise depends on available time and tools.

Data management

Cloud images will be placed on a data-server at the MPI for Meteorology after the cruise and will be made accessible upon request.

8. ARGO FLOAT DEPLOYMENTS

B. Klein (BSH; not on board), A. Schneehorst (BSH; not on board), V. Strass (AWI)

Background and objectives

The deployment of floats is a contribution of the Federal Republic of Germany in the context of the international Argo program. The German contribution to the Argo programme is organized by the Federal Maritime and Hydrographic Agency (BSH, Bundesamt für Seeschifffahrt und Hydrographie). Argo is a core element of the Global Ocean Observation System (GOOS) and provides temperature and salinity profiles from the upper 2,000 m, in the ocean for climate monitoring. Argo is supported by the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission of UNESCO (IOC). The strategy of Argo aims for an array of 1 float being operative in each 3°x3° latitude-longitude square of the world ocean. Floats have nominal life times of >4 years, and after the battery energy supply has been depleted floats have continuously to be reseeded. Float density in the world ocean is general good, but larger gaps exist in the Southern Ocean and the South Atlantic, and reseeding of these areas is targeted during PS113.

Work at sea

It is planned to deploy four Argo floats along the cruise track in the South Atlantic Ocean, in order to fill gaps in the array along the eastern side of the South Atlantic. The floats are very simple to deploy and nearly need no extra station time. They are set into their preprogrammed mission mode by removing a magnet on the outside of the float. The deployment can either be performed by manually lowering the float to the sea surface or with the help of a crane. The ship speed should be lowered to 2 knots and after the float has been deployed no additional station work is required. However, if possible a CTD cast down to 2,000 m at the deployment site would be helpful in the quality control of the data.

Data policy

All floats deliver their data (profiles of temperature and salinity) in near-real time to the global Argo data centers (http://www.coriolis.eu.org/Data-Products/Data-Delivery) where they are made available within 24 hours. There are no restrictions on the data use and data can be downloaded by the general public in various formats. The float data are subject to a scientific quality control in six-months' intervals to identify potential problems with sensor drift. Quality controlled data are then also made available to the general public.

9. BATHYMETRIC MAPPING AND SUB-BOTTOM PROFILING

B. Dorschel (not on board), S. Dreutter, M. Lütjens, S. Andree (all AWI)

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 environmental setting of an area. 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 hydro-acoustic systems. In these areas, bathymetry is modelled from satellite altimetry with a corresponding low resolution. Satellite-altimetry derived bathymetry therefore lacks 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 bathymetric information in a resolution sufficient to resolve those features.

During Expedition PS113, bathymetric data and sediment echosounder data are recorded as a set of underway data during transit. Research vessels equipped with state of the art bathymetric echosounders cross the world's oceans repeatedly on transits to and from research areas. The systematic collection of bathymetric data during transits successively increases the coverage of high quality and high-resolution depth soundings. Underway data collected during PS113 will contribute to the bathymetry data archive at the AWI and will also be included in bathymetric world datasets like GEBCO (General Bathymetric Chart of the Ocean) and regional mapping initiatives.

Work at sea

Bathymetric data will be recorded with the hull-mounted multibeam echosounder Atlas Hydrosweep DS3, and sub-bottom data will be recorded with the hull-mounted sediment echosounder Atlas Parasound P70. The main task of the bathymetry group is to run bathymetric 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. Simultaneously recorded sub-bottom data provide information on the sedimentary architecture of the surveyed area.

Expected preliminary results

Expected results will consist of high-resolution seabed maps and sub-bottom information along the cruise track.

Data management

Hydro-acoustic data (multibeam and sediment echosounder) collected during the expedition will be stored in the PANGAEA data repository at the AWI. Furthermore, the data will be provided to mapping projects and included in regional data compilations such as GEBCO.

10. BENTHIC FISH: CLIMATE SENSITIVITY IN VARIOUS FISHES FROM THE ANTARCTIC PENINSULA - MOLECULAR ECOLOGY AND CELLULAR MECHANISMS

M. Lucassen (AWI; not on board), A. Tillmann (AWI), F. Veliz-Moraleda (AWI), C. Papetti (UNIPD; not on board), N. Koschnick (AWI; not on board)

Objectives

The ongoing release of the greenhouse gas CO_2 into the atmosphere is considered causing both global warming and ocean acidification. The changes largely differ between regions, and the Antarctic Peninsula is one area of the globe that is currently experiencing rapid warming. Temperature as a main abiotic factor comprises every aspect of the biochemistry and physiology of ectothermal organisms putatively culminating in shifting geographical distribution on a larger scale. Although limits may become manifested at the whole organism first, all levels of organisation from the genetic interior to functional physiological levels, i.e. the integration of molecules into functional units and networks up to the whole animal, must be taken into account for an understanding of climate-driven evolution and response to ongoing change.

To continue our comprehensive physiological and molecular genetic studies of high and low Antarctic fish species and populations, live fish in the most pristine condition possible is indispensible for our physiological work. Especially the Antarctic eelpout (*Pachycara brachycephalum*) became an ideal model for our research resulting in a reasonable number of comparative studies during the past (cf. Windisch et al. 2014). Moreover, endemic Notothenioids were included more recently to expand our evidences to larger scales. During the upcoming campaign we aim to catch fish from several fish orders and bring them alive to the home institute for physiological analyses. We aim to (i) estimate acclimatory capacities/sensitivity towards combined treatments of warming, hypoxia and hypercapnia, (ii) determine the level of cold adaptation, and (iii) compare these laboratory treated samples to *in-situ* samples from the field. The analyses comprise global (RNA-Seq) and targeted (qPCR) gene expression techniques on the background of the population genetic structure, assessment of cellular energy budgets and allocation, as well as metabolic profiling (by means of untargeted nuclear magnetic resonance spectroscopy, NMR). Harmed fish will be used to isolate cells for direct analyses on board and for establishing permanent cell lines for later use at the home institute. Besides, from all specimens tissue samples will be taken and flash-frozen for later molecular physiological and phylogenetic analyses (together with our cooperation partners).

Work at sea

To investigate the sensitivity, resilience and capacity for acclima(tisa)tion of fish species from the coldest regions of our planet, good fish material in the most pristine condition possible is needed. Fishes (including Antarctic eelpout (*Pachycara brachycephalum*), and Notothenioids like *Trematomus spec.*, *Champsocephalus gunnari*) caught during the previous leg PS112 at the Antarctic Peninsula region by means of baited traps and bottom trawls will be kept alive in aquaria systems on board *Polarstern* and be transported to Bremerhaven. The condition of the animals as well the water quality will be controlled on a daily basis to ensure animal welfare at its best.

From harmed fish different tissues will be taken and cell cultures will be isolated directly on board: Isolated hepatocytes will be prepared and incubated with and without ^{13}C-labelled substrates under different temperatures. The effects of temperature on hepatic cell respiration and cellular energy budget will be investigated during acute warming. The cells will be frozen at -80°C rapidly after different incubation periods and different temperatures, and shipped to the AWI for subsequent molecular and biochemical (metabolic profiling, enzyme activities) analyses. Uptake rates of the specific substrates and incorporation into the glycolytic pathway or TCA-cycle will be determined using NMR spectroscopy at the AWI.

Primary cell cultures from different tissues and species prepared during PS112 will be kept alive along this cruise leg to establish a permanent cell line. The cultures will be observed regularly and media have to be exchanged on a regularly basis until Bremerhaven.

Data management

All data will be made available by publication in scientific journals und subsequent storage in PANGAEA. The molecular data will be submitted to the respective databases (NCBI; EMBL).

References

Windisch HS, Frickenhaus S, John U, Knust R, Pörtner HO, Lucassen M (2014) Stress response or beneficial temperature acclimation: Transcriptomic signatures in Antarctic fish (*Pachycara brachycephalum*). Molecular Ecology 23 (14), 3469-3482.

11. TEILNEHMENDE INSTITUTE / PARTICIPATING INSTITUTIONS

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OWS	OceanWaveS GmbH Hansekontor Vor dem Bardowicker Tore 6b D-21339 Lüneburg Germany
SELNA	SELNA Beratungsbüro Forschungsschifffahrt Dr. Saad El Naggar Karkmeyer-Str. 3 28277 Bremen Germany
TROPOS	Leibniz-Institut für Troposphärenforschung (TROPOS) Permoserstraße 15 D-04318 Leipzig Germany

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UNIPD	University of Padova Department of Biology Via U. Bassi 58/B I-35131 Padova Italy
UoL	Dept. of Earth, Ocean and Ecological Sciences School of Environmental Sciences University of Liverpool 4 Brownlow Street Liverpool, L69 3GP UK

12. FAHRTTEILNEHMER / CRUISE PARTICIPANTS

Name/ Last name	Vorname/ First name	Institut/ Institute	Beruf/ Profession	Fachrichtung/ Discipline
Andree	Sophie	AWI	Student (embarkation Las Palmas)	Bathymetry
Bracher	Astrid	AWI	Scientist	Oceanography
Castellani	Giulia	AWI	Scientist	Geoscience
Dreutter	Simon	AWI	Scientist	Bathymetry
El Naggar	Saad	SELNA	Scientist	Physics
Gerken	Jan	AWI	Student	Physics
Haake	Hauke	AWI	Engineer	Physical oceanography
Hagemann	Jonas	AWI	Engineer	Biosciences
Hessner	Katrin	OWS		Oceanography
Hörstmann	Cora	AWI	PhD student	Biology
Jimenez	Cristofer	TROPOS	PhD student	Physics
Leach	Harry	UoL	Scientist	Oceanography
Lenius	Sven	AWI	Student	Geoscience
Lütjens	Mona	AWI	Student (embarkation Las Palmas)	Bathymetry
Neubauer	Augusto	UFSC	Student	Mech. engineering
N.	N.	DWD	Meteorologist	
N.	N.	DWD	Technician	Meteorology
N.	N.	AWI	Logistics (embark. Las Palmas)	
N.	N.	AWI	Logistics (embark. Las Palmas)	
N.	N.	AWI	Logistics (embark. Las Palmas)	
N.	N.	AWI	Logistics (embark. Las Palmas)	
N.	N.	AWI	Logistics (embark. Las Palmas)	
Radenz	Martin	TROPOS	PhD student	Physics
Spahic	Susanne	AWI	Technician	Biology
Strass	Volker	AWI	Chief Scientist	Oceanography
Tillmann	Anette	AWI	Technician	Biology
Thome	Pauline	AWI	Student	Biology
Veliz Moraleda	Fredy	AWI	Technician	Biology
Vial	Jessica	MPI-M	Scientist	Environmental science
von Appen	Wilken-Jon	AWI	Scientist	Physical Oceanography
Wiegmann	Sonja	AWI	Technician	Biology
Xi	Hongyan	AWI	Scientist	Oceanography
Yin	Zhengping	TROPOS	PhD student	Physics

13. SCHIFFSBESATZUNG / SHIP'S CREW

No.	Name		Rank
01.	Schwarze	Stefan	Master
02.	Lauber	Felix	1. Offc.
03.	Westphal	Henning	Ch. Eng.
04.	Kentges	Felix	1.Offc. Lad.
05.	Fischer	Tibor	2. Offc.
06.	Peine	Lutz	2. Offc.
07.	Pohl	Klaus	Doctor
08.	Christian	Boris	Comm. Offc.
09.	Schnürch	Helmut	2. Eng.
10.	Buch	Erik-Torsten	2. Eng.
11.	Rusch	Torben	2. Eng.
12.	Brehme	Andreas	Elec. Tech.
13.	Frank	Gerhard	Electron.
14.	Markert	Winfried	Electron.
15.	Winter	Andreas	Electron.
16.	Feiertag	Thomas	Electron.
17.	Sedlak	Andreas	Boatsw.
18.	Neisner	Winfried	Carpenter
19.	Clasen	Nils	A.B.
20.	Schröder	Norbert	A.B.
21.	Burzan	Gerd-Ekkehard	A.B.
22.	Hartwig-Labahn	Andreas	A.B
23.	Fölster	Michael	A.B.
24.	Müller	Steffen	A.B.
25.	Brickmann	Peter	A.B.
26.	NN		A.B.
27.			
28.	Beth	Detlef	Storekeep.
29.	Plehn	Markus	Mot-man
30.	Klein	Gert	Mot-man
31.	Krösche	Eckard	Mot-man
32.	Dinse	Horst	Mot-man
33.	Watzel	Bernhard	Mot-man
34.	Meißner	Jörg	Cook
35.	Tupy	Mario	Cooksmate
36.	Martens	Michael	Cooksmate
37.	Wartenberg	Irina	1.Stwdess

No.	Name		Rank
38.	Leue	AndreasGeorg	Stwd/KS
39.	Hischke	Peggy	2.Stwdess
40.	Duka	Maribel	2.Stwdess
41.	Krause	Tomasz	2.Steward
42.	NN		2.Steward
43.	Chen	QuanLun	2.Steward