PS113 - Weekly report No. 1 | 7 – 13 May 2018

Leaving Punta Arenas

[14. May 2018]

On our arrival on 5th and 6th May the weather in Punta Arenas in Chile showed an unexpectedly pleasant side with scattered clouds, temperature just under 10°C and hardly any wind – unexpected, because here in the Southern Hemisphere it is now autumn and the climate at the southern extremity of Chile is harsh anyway. On 7th May the cruise participants were brought on board the Polarstern at anchor offshore by a harbour launch.

By 10 o'clock, all were safely aboard. For those setting foot aboard Polarstern for the first time this was an exciting and moving moment, while, for those who had often sailed before, it was combined with a happy reunion with old acquaintances amongst the crew and scientists. The 25 scientists on board represent six nations from three continents.

By the time we scientists came on board the crew had already extracted our equipment from the freight containers and put it where we could easily find it. All the larger pieces of equipment such as winches, measurement systems for deployment at sea and laboratory containers were to be found at the places previously agreed with the AWI logistics department before the cruise. We were therefore able to start straight away with assembling our measurement systems and setting up our laboratories.

The departure planned for the evening of the 7th May was unfortunately delayed because of the difficult arrangements in the harbour of Punta Arenas. Firstly, Polarstern had to steam to the bunkering pier to take fuel on board. After that, she was able to dock at the harbour pier, which was not free on 6th and 7th, in order to take back on board the freight from the previous cruise and from Neumayer Station, which had been temporarily put ashore to allow ours to be made available. At 6 o'clock in the evening on the 8th we finally set sail, with a day's delay. In view of the fact that the time available for scientific work during the Atlantic transit with slow steaming speeds or with the vessel stationary was already only reckoned to be three days, this represented a serious loss. Strong tail winds and a strong tidal current flowing towards the Atlantic in the Straights of Magellan helped us to recover a couple of hours of this lost time.

On the 10th, after we had left the Exclusive Economic Zones of both Argentina and the United Kingdom around the Falkland Islands, we were immediately able to commence our programme of measurements. The details of these will form the theme of future Weekly Reports

The first, and hopefully only, storm with Force 10 winds is already safely behind us thanks to Polarstern's stability and her experienced nautical leadership. In the meantime, we have left the temperate zone of the Southern Hemisphere and are steaming through the southern subtropical region.

All cruise participants are well and send with me hearty greetings to those at home.

Volker Strass.

PS113 - Weekly Report No. 2 | 14th-20th May (Whit Sunday) 2018

Whitsun Excursion with a Towed System

[23. May 2018]

Since crossing the Tropic of Capricorn at 23° 26’ 05” South on Thursday this week travelling north we find ourselves, according to the astronomical definition, in the Tropics. The weather is what you would expect; water and air temperature lie between 26 and 27°C. Since we have also arrived in the zone of the SE Trade Winds there is a stiff and steady breeze and by day the sun shines from a sky with few clouds into deep blue ocean water.




Regarding our scientific programme, since leaving the Economic Zones of Argentina and the UK around the Falkland Islands, a regular daily routine has been established. Apart from the measurements, which are made continuously or at regular intervals around the clock, we stop every day around midday to make casts with a package of optical sensors (of which more next week) - and with the CTD-Sonde with its rosette sampler for water bottles, with which, apart from measurements of temperature, salinity, oxygen concentration, phytoplankton fluorescence and optical transmissivity, water samples for various investigations can be taken. Midday was chosen for the sake of the optical measurements because then, when the sun is at its highest, the light penetrates deepest into the ocean.

Fig. 1: Making the mechanical, electrical and fibre optic connection between the towing cable and Triaxus. (Photo: Volker Strass, AWI)

The measurements with the optical sensors and the CTD are principally required for comparison with the instruments and sensors on the towed measurement system Triaxus/topAWI (towed ocean profiler of the AWI) which was procured last year and during this cruise is now being deployed for the first time. Additionally Triaxus/topAWI is equipped with pH and nitrate sensors, high-frequency acoustic Doppler current profilers (ADCPs) for measuring turbulent current shears and also a multi-frequency echo-sounder for detecting zooplankton. There are more sensors for the positioning and safety of the towed body. These include an acoustic transponder, which allows the position relative to the ship to be determined, upward and downward-looking altimeters which can measure the distance to the sea surface and the sea bed, and also a small radio transmitter, which can be located from the ship.

Fig. 2: Ready for deployment. (Photo: Volker Strass, AWI)

The programme of work associated with the commissioning of Triaxus/topAWI requires many and various activities. These began in the harbour in Punta Arenas with the correct positioning of the towing winch on Polarstern's afterdeck. So that the towing wire was oriented at the correct angles from the winch and to the stern A-frame a constraining block was mounted between the afterdeck and the helicopter deck above. In addition, Triaxus was first put in the water there to allow the internal buoyancy elements to be adjusted for balance. This was so that in the unlikely, and hopefully never occurring, event of a cable break Triaxus would be positively buoyant and rise to the surface.

Fig. 3: Triaxus being launched. (Photo: Volker Strass, AWI)

Deployments during the cruise are used to determine, amongst other things, which depth range can be profiled for a given length of towing cable and towing speed. The greatest depth is currently limited to 350 m due to the maximum pressure rating of some of the components. In addition the depth range is also influenced by the climb and dive speeds chosen. An important feature of the system is that Triaxus can be made to shear out sideways to enable sampling of water undisturbed by the ship's wake right up to the surface. How far and under which conditions need to be determined using Triaxus' acoustic transponder and an array of hydrophones mounted under Polarstern's hull.

Fig. 4: Launched smoothly! Now the towing and measurement can begin. (Photo: Volker Strass, AWI)

Another important element of this initial deployment is to make colleagues from a variety of disciplines familiar with the system and its deployment at sea, as well as optimising the practices and procedures for its use. To this end a number of technical problems with which we were faced were instructive, if troublesome. This included an underwater connector which had ceased to be watertight. Given around sixty connections, some hidden in the fuselages and wings, finding this proved time consuming but revealed a number of undocumented details of the internal structure.

Fig. 5: Triaxus control centre in the winch control room on Polarstern. (Photo: Volker Strass, AWI)

This new towed system will make it possible for many physical, chemical and biological parameters to be measured simultaneously and quickly with high spatial and temporal resolution and with good spatial coverage. In this way those processes can be identified which influence phytoplankton photosynthesis and primary productivity as well as CO2 uptake. Primary productivity also forms the basis of the marine food chain and ecosystem and thus determines even fishery catches. An improved understanding of the physical processes is a precondition for knowing how developments within the physical environment due to climate change will influence biological, biogeochemical and economic outcomes.

Despite the hard work, including over the Ascension and Whitsun holiday weekends, all cruise participants are in good spirits.

Many greetings from on Board Polarstern,

Volker Strass

PS113 - Weekly Report No. 3 | 21st - 27th May 2018

Cruising through the Blue

[28. May 2018]

After entering the Tropics in the Southeast Trade Wind region and sailing under cloudless skies, the second half of the week was largely cloudy with frequent rainfall. We had arrived in the Inter-Tropical Convergence Zone, in which the air masses transported by the Southeast Trade Winds and their northern hemispheric counterpart, the Northeast Trade Winds, rise up and produce thick clouds reaching high into the atmosphere.

At this season in the northern summer the Inter-Tropical Convergence Zone has moved a few degrees of latitude north of the equator. We crossed the equator itself on the morning of the 25th May. Last night we reached the NE Trade Wind region and are pleased to enjoy radiant sunshine again. So much to the atmospheric climate regions we experienced so far.

Fig. 1: Optical sensor package before deployment. (Photo: Katrin Hessner)

The ocean we have been passing through is really a desert. The visible sign of oceanic deserts is deep blue seawater, which we have been sailing through since 40° south - for the best part of the last 3000 nautical miles. The water has this deep blue colour when it is very pure. And it is so pure here in the open tropical and subtropical ocean, because of the lack of nutrient input from land, or from the upwelling of deep water that there is hardly any growth of phytoplankton, those microscopic algae which float in the water. In the centre of the oceanic subtropical gyre between 20° and 10° south we could see from the fluorometers mounted both on the CTD and the Triaxus towed ocean profiler of the AWI that only at a depth of 140 m, in which there were nutrients but hardly any sunlight for photosynthesis, a little chlorophyll was present. If there is little primary productivity by phytoplankton then the whole basis of the marine food web is missing. It is therefore hardly surprising that for days on end we have seen no sea birds, nor whales for even longer.

The optical properties of the waters, the changes of which in terms of intensity and colour with depth, as well as the influence on these of the phytoplankton concentration and species composition, are the focus of the phyto-optics group. Precise knowledge of how the light changes under water and with which intensity and colour it is scattered back into the atmosphere are also necessary to improve the remote sensing of phytoplankton by satellite. The phyto-optics group develops robust algorithms which allow the production of continuous global maps with greater temporal (daily) and spatial (300 m) resolution of the quantity and composition of phytoplankton and its decay products based on satellite measurements.

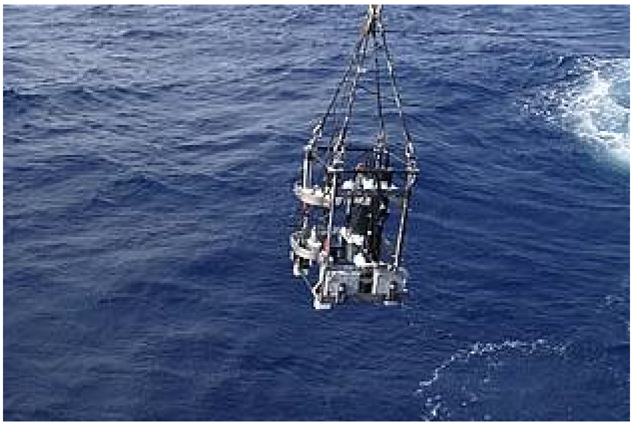

Fig. 2: After an hour in water the optical sensor package on its way back on deck. (Photo: Katrin Hessner)

Every day around noon a package of optical sensors is lowered beside the ship to a maximum depth of 150 m to record profiles of optical parameters. These include a hyperspectral radiometer called RAMSES, for measuring the intensity and colour of the sunlight within the sea coming from above. With a spectrophotometer type ACS absorption and scattering are also measured. To calibrate these optical measurements, water samples, collected at six different depths within the sunlit upper ocean layer using the water bottles on the CTD/Rosette sampler, are analysed for their pigment composition and the optical properties of the various components of the water. The analysis so far indicate that near the Argentinian coast the phytoplankton concentration was high and the most populous form were diatoms growing in the upper 20 m of the water. In contrast in the warm (>28°C) and saline subtropical waters around 15°S there are only a tenth as many algae. These instead, predominantly cyanobacteria, grow best at 140 m.

Fig. 3: Continuous measurement of the scattering and absorption properties with an ACS photometer in the sea water circulation system. (Photo: Hongyan Xi)

A RAMSES and an ACS are also installed in the Triaxus towed vehicle. An advantage of making measurements from this towed system is that they are beyond the influence of the ship and can be made with a significantly higher data rate. A disadvantage could be that the data quality might be lower because Triaxus is towed through the water much more quickly, mostly with 4 m/s horizontally and 1 m/s vertically, than the speed at which the optical package is lowered and raised through the water from the ship. The effect of the fast measurement on the data quality must be determined through comparison of the two techniques.

A further ACS photometer is used to continuously measure the scattering and absorption properties of the surface sea water taken in at keel-depth and distributed to the laboratories via a seawater circulation system. These data are also regularly calibrated with direct measurements of water samples. From these continuous optical measurements much can be learned about the quantity and composition of the phytoplankton. With this dataset many thousands of pixels of satellite data can be validated later on.

On behalf of all the cruise participants I send greetings from on board Polarstern.

Volker Strass.

PS113 - Weekly Report No. 4 | 28th May - 3rd June 2018

The Tropical North Atlantic: Cold in the Water, Dust in the Sky

[04. June 2018]

The whole week long we sailed in the North-east Trade Wind zone under skies with only a few clouds, but with strong head-winds for Polarstern. By crossing the northern tropic, the Tropic of Cancer, at 23° 26’ 05” North during the night of 31st May to 1st June we have left the Tropics and are again in the Subtropics. Although we have been moving through the Tropics and Subtropics, the water and air surrounding us with temperatures of around 20°C have been relatively cool, 10° colder than the daytime temperatures in much of Germany. That sounds like a topsy-turvy world, but it has a simple explanation.

On the west side of the continents, the east side of the oceans, the Trade Winds blowing offshore drive the warm surface water away from the coast. To replace this, colder water from below wells up to the surface. This colder water brings with it new nutrients, such as nitrate, into the sunlit upper ocean where phytoplankton can grow. For this reason, these coastal upwelling regions support some of the most important fisheries on earth.

Fig. 1: System maintenance in the OCEANET-Container. (Photo: Martin Radenz)

In satellite images of the chlorophyll distribution, which thanks to the AWI-Phytooptics Group are also available here on board, the strong increase in the phytoplankton concentration near to the coast of Africa could clearly be seen. Isolated tongues of enhanced chlorophyll concentration stretched away from the coast to beyond our route over 200 miles out in the open ocean. We used this opportunity to test the instruments and sensors of the Triaxus/topAWI towed system for their suitability for detecting biogeochemical parameters. To this end, we towed Triaxus for 23 hours continuously through one of these tongues – with a very satisfactory result. We had a similar 32-hour long deployment crossing the equator. Then the emphasis was on testing the acoustic Doppler current profilers mounted on Triaxus for their ability to measure current shears. We chose the equator for this test because there, in 50 to 200 m depth, the Equatorial Undercurrent flows with a speed of 1 m/s towards the east, in contrast to the adjacent westward flowing North and South Equatorial Currents.

Fig. 2: The Laser shines out from the OCEANET-Container into the night sky. (Photo: Cristofer Jimenez)

The upwelling region off Northwest Africa touched by our route also receives a trace nutrient from above: iron, which is contained in dust from the Sahara. In many ocean regions far from land there is a lack of iron, so that even with a goodly supply of other nutrients phytoplankton growth is limited. The images from weather satellites presented by the meteorologist on board showed gigantic clouds of dust blown by the Trade Winds out over the Atlantic and right across to America.

The Sahara dust was also measured here on board. During the transit voyag, the team from the Leibniz Institute for Tropospheric Research in Leipzig looks after a variety of remote sensing instruments, which as part of the OCEANET project, are regularly on board during the transit voyages and deliver continuous high-resolution observations. The Atlantic transits permit studies contrasting the anthropologically loaded Northern Hemisphere with the much cleaner Southern Hemisphere. One of the most important instruments is a Lidar (Light Detection and Ranging device), with whose laser beam the vertical aerosol and cloud distribution in the atmosphere can be physically characterised. Amongst other things, the measurements allow the aerosol type as well as the size and concentration to be determined as a function of the height. Other instruments register the solar radiation reaching the earth’s surface and other cloud parameters, such as the column total of water vapour and liquid water.

Fig. 3: MICROTOPS sun photometer in use. (Photo: Katrin Hessner)

On reaching the Trade Wind zone north of the Inter-Tropical Convergence Zone things became more exciting for the atmospheric scientists. After 3 weeks with marine aerosols, the Sahara lay in exactly the direction from which the Trade Wind was blowing and layers of dust aloft were crossing our path on their way westwards. In the Lidar measurements it could be seen how the dust cloud above *Polarstern* increased in thickness and on the following days showed a height between 1.5 and 5 km. The haziness in the sky produced by the dust could be seen with the naked eye. On approaching the Canaries at the end of the week the thickness of the observed dust cloud gradually diminished.

The high values of aerosol optical depth combined with low water vapour content in the atmosphere were also measured by a colleague from the Max-Planck-Institute for Meteorology in Hamburg, using a MICROTOPS solar photometer. This instrument measures the attenuating effect of scattering and absorption by aerosols (such as dust and sea salt) and gases (water vapour) at five different wavelengths and so gives information on aerosol concentration and particle size. To do this the solar disk must be clearly visible and the instrument pointed towards it by hand. So long as the solar disk is not obscured by clouds, these measurements are repeated every 15-30 minutes, a labour intensive procedure. The data obtained are relayed, generally available, to NASA and serve to improve satellite observations and climate models.

Fig. 4: Dual cloud camera attached to the rail around the sighting deck on Polarstern. (Photo: Jessica Vial)

In addition to the MICROTOPS measurements, a dual camera system continuously monitors cloud parameters. The visible spectrum camera is fitted with a fish-eye lens and records the cloud distribution in the sky. The infra-red camera records images which allow cloud characteristics such as height and cloud-base temperature to be derived.

Today we stopped briefly in Las Palmas on Gran Canaria, the staging point of our transit voyage to Bremerhaven. One colleague has unfortunately had to leave us here because of other professional obligations. However, in exchange four colleagues have joined us and are heartily welcomed on board.

With Best Wishes from *Polarstern* to all relatives, friends and colleagues at home,

Astrid Bracher, Martin Radenz, Jessica Vial and Volker Strass.

PS113 - Weekly Report No. 5| 4th -10th June 2018

The Final Strai(gh)t

[11. June 2018]

On 5th June after leaving Las Palmas on Gran Canaria we again reduced our speed for 5 hours so that we could tow the Triaxus/topAWI for one final test. Thereupon followed a final comparison station with CTD and the optical measurements package. Thereafter, we were supposed to head to Bremerhaven with all haste and without further ado.

However, on the 6th June at 13:20 Polarstern was informed by the Maritime Rescue Coordination Centre in Lisbon of a Mayday call from an English yacht and reacted immediately with a change of course towards the supposedly stricken vessel – 32 miles to the south, against the direction of our homeward course. From 18:20, Polarstern carried out a systematic search in the allocated area. At 19:15 the search was called off by the Coordination Centre without further explanation. Polarstern resumed her homeward course, the first 32 miles now for the third time. It goes without saying that we should respond to such a call for help at sea.

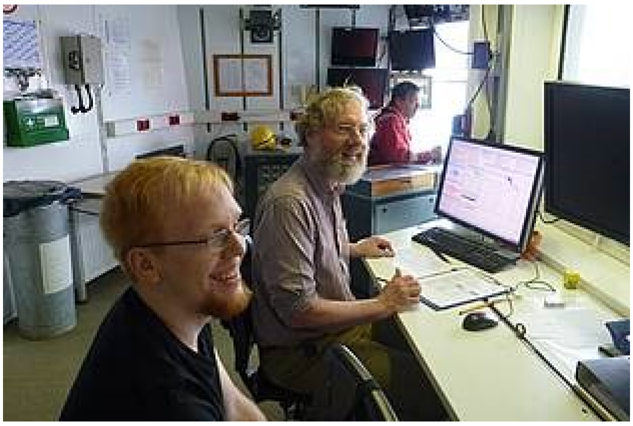

Fig. 1: CTD-Team monitoring the incoming data. (Photo: Volker Strass)

To recoup the lost time and arrive punctually in Bremerhaven Polarstern is now putting in extra effort. So are the scientists on board, busy with packing and stowing of equipment, tidying up and cleaning the laboratories, as well as writing reports. Some groups are nevertheless continuing their underway measurements until shortly before arrival in Bremerhaven.

During virtually all the cruise the computer system "Rutter s6 WaMoS" was used to process radar images of the sea surface to calculate the sea and swell as well as the surface currents. The method needs wind and waves; if there is little wind or heavy precipitation it does not work. The work with this WaMoS system was principally to investigate the influence of environmental conditions on the quality of the measurements. Amongst other things the currents were compared with those measured in the depth range 20 to nearly 300 m with the acoustic Doppler current profiler (ADCP) mounted in the ship's keel. Throughout the greater part of the cruise track both systems showed very similar current speeds and directions. Regarding this comparison it should be noted that WaMoS measures the current in the uppermost 5 m of the water. From this, it can be understood that the Equatorial Undercurrent, which flows with 1 m/s towards the east at depths between 50 and 200 m, was measured by the ADCP but not by WaMoS. In the Spanisch EEZ around the Canaries only WaMoS delivered current measurements, as we had switched off the ADCP to avoid acoustically disturbing the bottle-nosed whales which occur there.

Fig. 2: Radar-Antenna used by WaMoS. (Photo: Katrin Hessner)

Fig. 3: Quality control of the WaMoS-Data. (Photo: Anette Tillmann)

Almost all the cruise up to this morning samples of sea water were taken every three hours from the supply pumped into the ship at 11 m depth. From these samples particles and cells were filtered for genetic investigation. Even if no living matter is visible to the naked eye, there are on average a billion single celled organisms in a litre of seawater. They make up a majority of the oceanic biomass. These marine microbes are not only responsible for the majority of the oceanic primary productivity, but they also influence the chemical composition of our atmosphere, our climate, recycle nutrients and break down pollutants. Because different species of microbes have different effects, it is important to know the species composition and variety of these smallest organisms. Using the genetic fingerprint of marine microbes, their occurrence and species composition can be decoded. How and whether this corresponds to the various ocean regions which we have crossed during our cruise will become apparent from laboratory investigations ashore.

Fig. 4: Filtration of the seawater samples for genetic analysis. (Photo: Volker Strass)

This is my last Weekly Report – for this cruise, and forever, as my retirement is gradually approaching.

With Best Wishes from on board Polarstern to all relatives, friends and colleagues at home; we are looking forward to being reunited with you.

Volker Strass with Harry Leach, Katrin Hessner and Cora Hörstmann