METEOR-Berichte

Geochemistry and Ecology of the Namibian Upwelling System
NAMUFIL: Namibian Upwelling Filament Study

Cruise No. M103

December 27, 2013 - February 11, 2014
Walvis Bay (Namibia) - Walvis Bay (Namibia)

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1 Summary

Cruise M103 NAMUFIL (Namibian Upwelling Filament Study) onboard RV METEOR was dedicated to the GENUS (Geochemistry and Ecology of the Namibian Upwelling System) project (Phase II) and represented the sixth field campaign within this program since 2008. The scientific work focussed on the Namibia Benguela region between the Orange River (28.6°S) in the south and the Kunene River (17.25°S) in the north during low to moderate upwelling conditions in the austral summer season and aimed to clarify relationships between climate change, biogeochemical cycles of nutrients, and ecosystem structure in one of the largest upwelling ecosystems. The cruise was divided into two legs: Leg 1 was the synoptic part and designed to study the entire Northern Benguela upwelling area with pre-defined transects and comprised empirical studies of processes and rates of ocean circulation, biogeochemical cycling of nutrients between the water column, biota and the sediments, trophic interactions and energy flows. Leg 2 focussed on the ecosystem succession of a filament in order to investigate processes within and across a dynamic water mass. Overall, the cruise was highly successful as we were able to conduct sampling at 86 stations during leg 1 stations and 76 stations during leg 2. In addition to routine shipboard operations such as CTD casts and the deployment of several plankton nets and a multicorer we also recovered and redeployed various short-term and long-term moorings on the 23°S, 20°S and 18°S transects. The filament observations consisted of high resolution transects with towed CTD, multidisciplinary work at stations and a drifter experiment. The M103 filament experiment was the follow-up study of the METEOR expedition M100 in September 2013.

Zusammenfassung

Die Forschungsfahrt METEOR M103 war bereits die sechste Feldstudie im Rahmen des Verbundprojekts GENUS (Geochemistry and Ecology of the Namibian Upwelling System, Phase II). Der Schwerpunkt der Reise lag auf der Erforschung des nördlichen Benguela Auftriebsgebiets zwischen der Orange Fluss-Mündung (28.6°S) im Süden und dem Kunene Fluss (17.25°S) im Norden unter abgeschwächten Auftriebsbedingungen während der Sommermonate auf der Südhalbkugel. Grundlegendes Ziel war die Untersuchung der Zusammenhänge zwischen Klimawandel, biogeochemischen Zyklen von Nährstoffen und das Zusammenspiel des Ökosystems in einem der größten Auftriebsgebiete weltweit. Die Fahrt wurde in zwei Abschnitte unterteilt: Teil 1 konzentrierte sich auf die großflächige und synoptische Aufnahme mit vorher festgelegten Transekten und umfasste demzufolge Untersuchungen bezüglich der vorherrschenden Meeresströmungen, des Nährstoff-Kreislaufs in der Wassersäule und in Oberflächensedimenten sowie in ausgewählten Organismen einschließlich deren trophischer Wechselwirkungen. Teil 2 untersuchte die Sukzession eines Filaments, um insbesondere auch die Wechselwirkungen an den Filamenträndern zu erforschen. Insgesamt war die Fahrt mit 86 durchgeführten Stationen während Leg 1 und 76 Stationen während Leg 2 äußerst erfolgreich. Neben den Routinearbeiten vom Schiff aus konnten auch geplante Verankerungsarbeiten durchgeführt werden. Die Filamentbeobachtungen umfassten hochauflösende Transekte mit einer geschleppten CTD, interdisziplinäre Arbeiten auf Stationen, sowie ein Drifterexperiment. Die M103 Filamentstudie war das Nachfolgeexperiment der Meteorexpedition M100 im September 2013.

2 Participants

Name	Working Group	Affiliation	Leg
Lahajnar, Niko Dr.	Chief Scientist	IfBM	103/1
Mohrholz, Volker Dr.	Chief Scientist	IOW	103/2
Angenendt, Svenja	Carbon Biogeochemistry	ZMT	103/2
Ankele, Markus	Ferry Box	HZG	103/1
Annighöfer, Meike	Biogeochemistry / Sedimentology	IfBM	103/1
Beier, Sebastian	CTD / Oceanography	IOW	103/2
Birkicht, Matthias	Carbon Biogeochemistry	ZMT	103/1
Bohata, Karolina	Zoo-Planktology	IHF	103/1+2
Brust-Möbius, Juliane Dr.	Remote Sensing	IOW	103/2
Buchholz, Fritz Prof. Dr.	Krill	AWI	103/2
Chikwililwa, Chibo Dr.	Phytoplankton	IOW/NatMIRC	103/2
Cordts, Hannah M.	Zoo-Planktology	IHF	103/2
Dähnke, Kirstin Dr.	Nitrogen Biogeochemistry	HZG	103/1
Denda, Anneke	Zoo-Planktology, Copepods	MarZoo	103/2
Flohr, Anita Dr.	Carbon Biogeochemistry	ZMT	103/1+2
Frame, Caitlin	Geochemistry	HZG/UniBas	103/2
Geist, Simon Dr.	Ichthyoplanktology	ZMT	103/1+2
Gerth, Monika Dr.	Remote Sensing	IOW	103/1
Hansen, Anja	Phyto-Planktology	IOW	103/1
Heene, Toralf	CTD / Oceanography	IOW	103/1+2
Höring, Flavia	Zoo-Planktology, Copepods	MarZoo	103/2
Janssen, Silke	Zoo-Planktology	IHF	103/1
Koppelmann, Rolf Dr.	Zoo-Planktology	IHF	103/2
Kunzmann, Andreas Dr.	Ichthyoplanktology	ZMT	103/1
Kretzschmann, Lisett	Biogeochemistry	IfBM	103/1
Martin, Bettina Dr.	Zoo-Planktology	IHF	103/1+2
Mlambo, Lindan	Krill	AWI / NatMIRC	103/1
Möbius, Jürgen Dr.	Biogeochemistry / Sedimentology	IfBM	103/1
Muyongo, Aphary	Observer Namibia	GSN	103/2
Nickel, Gerald	Hydroacoustics/Parasound	IOW	103/2
Ngutjinazo, Thusnelda	Phyto-Planktology	NatMIRC	103/1
Numwa, Oliver	Oceanography	NatMIRC	103/2
Ohde, Thomas Dr.	Remote Sensing	IOW	103/1
Pavloudi, Christina	Microbial Physiology	HCMR / DMB	103/1
Paul, Nina	Ichthyoplanktology	ZMT	103/1
Rejoice N.E., Josephine	Ichthyoplanktology	NatMIRC	103/2
Rixen, Tim Dr.	Carbon Biogeochemistry	ZMT	103/1
Schmidt, Martin Dr.	CTD / Oceanography	IOW	103/1+2
Schukat, Anna Dr.	Zoo-Planktology, Copepods	MarZoo	103/2

Name	Working Group	Affiliation	Leg
Siegel, Herbert Dr.	Remote sensing	IOW	103/2
Simon, Stephanie	Ichthyoplanktology	ZMT	103/1+2
Stöber, Anette	Multimedia	MMKH	103/1
Teichert, Lea	Biogeochemistry	IfBM	103/1
Vorrath, Maria-Elena	Biogeochemistry	IfBM	103/1
Wasmund, Norbert Dr.	Phytoplankton	IOW	103/2
Werner, Thorsten Dr.	Krill	AWI	103/1+2

Leg 103/1: Walvis Bay - Walvis Bay (27.12.2013 - 18.01.2014)
Leg 103/2: Walvis Bay - Walvis Bay (21.01.2014 - 11.02.2014)

Participating Institutions

AWI	Alfred-Wegener-Institut für Polar- und Meeresforschung, Am Handelshafen 12, D-27570 Bremerhaven, Germany
HCMR/ DME	Helenic Centre for Marine Research, Institute of Marine Biology, Biotechnology and Aquacultureinstitute of Marine Biology, Thalassocosmos, 71003 Heraklion, Crete, Greece; Department of Microbial Ecophysiology, Faculty of Biology, University of Bremen, Leobener Straße, 28359 Bremen, Germany
GSN	Geological Survey of Namibia, Namibian Ministry of Mines & Energy, Private Bag 13297, 1 Aviation Road, Windhoek, Namibia
HZG	Helmholtz Zentrum Geesthacht, Institut für Material und Küstenforschung, Max-Planck-Straße 1, D-21502 Geesthacht, Germany
IfBM	Institut für Biogeochemie und Meereschemie, Universität Hamburg, Bundesstraße 55, D-20146 Hamburg, Germany
IHF	Institut für Hydrobiologie und Fischereiwissenschaft, Universität Hamburg, Große Elbstraße 133, D-22767 Hamburg, Germany
IOW	Leibniz-Institut für Ostseeforschung Warnemünde, Seestraße 15, D-18119 Rostock-Warnemünde, Germany
MarZoo	Marine Zoologie, FB-02, Universität Bremen, Leobener Straße, D-28359 Bremen, Germany
MMKH	Multimedia Kontor Hamburg, Saarlandstraße 30, D-22303 Hamburg, Germany
NatMIRC	National Marine Information and Research Centre Strand Street, Swakopmund, Namibia
ZMT	Leibniz-Zentrum für Marine Tropenökologie Bremen, Fahrenheitstraße 6, D-28359 Bremen, Germany

3 Research Program

Upwelling areas in the eastern boundary currents respond sensitively to global, regional, and local changes in atmospheric circulation patterns. The observed changes at lower trophic levels of upwelling ecosystems primarily reflect changes in this external physical forcing. In the past several coastal upwelling systems have experienced dramatic changes (regime shifts) in ecosystem structure and fish catches, which are not fully understood yet. In the northern Benguela upwelling system the supply of oxygen to the shelf environment plays a cruicial role in ecosystem behavior. Oxygen availability is directly coupled to the hydrodynamic conditions, and fluctuating oxygen levels over the shelf have significant consequences for nutrient levels and nutrient ratios, for rates of exchange at the sediment-water interface, for gas exchange between the ocean and the atmosphere, and for biological production and therefore for the entire ecosystem. Using dedicated process studies and long term observations, the GENUS (**G**eochemistry and **E**cology of the **N**amibian **U**pwelling **S**ystem) project aims to clarify the interactions between the particular trophic levels of the ecosystem in order to improve the knowledge about the system and to enhance the predictive capabilities of ecosystem models.

The cruise M-103 "NAMUFIL" forms the main field experiment of the GENUS II project; first leg M-103/1 was the synoptic part, the following leg M-103/2 aims to study the succession of a filament. During the seasonal upwelling minimum the status and development of the northern Benguela ecosystem was investigated by an interdisciplinary working group in close cooperation with African partner institutions. The cruise M103 was dedicated to the northern and southern Benguela upwelling area, which is part of the eastern boundary current system of the South Atlantic subtropical gyre. The targeted working area included the weak upwelling cell offshore Walvis Bay, the Terrace Bay (20°S) and Kunene cell (17°15' S) in the north and the very stable upwelling cell close to Lüderitz (25-27°S) as well as oxygenated water areas at the Namibian - South African border (28°38' S) in the south. We performed a combined oceanographic, remote sensing, biogeochemical, biological, and sediment sampling programme on a total of 8 transects perpendicular to the coast, which were connected with several stations between each transect. In addition, during transit time, we employed a lowered ADCP for measurements of currents and several Ferrybox-systems for en-route determinations of temperature and salinity as well as nutrient concentrations plus pCO_2, methane and online cavity ring down spectrometers in order to determine the isotopic composition of carbon bearing compounds (DIC, DOC, CH_4). In sum, station work comprised sampling in water depths between 30 and 2200 m at 164 stations.

Data collection during the first leg covered the coast of Namibia from the Kunene mouth at 17.5°S to Oranje mouth 28.5°S (Fig. 3.1). The stations are organized in cross shelf transects. The following transects were worked during leg 1 of M103:

1. Several stations between 23°S and 25°S
2. cross shelf transect starting at 25°S
3. zonal transect at 28° 38'S
4. zonal transect with CTD and MSS casts at 23°S
5. zonal transect off Kunene mouth at 17° 15'S
6. zonal transect with CTD and MSS at 20°S

During day light optical properties are investigated at all transects. In addition, a number of CTD/LADCP casts were carried out at stations between 17 °S and 23°S, which were not assigned to a particular transect. An overview of the location of stations and the cruise track is given in Fig. 3.1. A station list is given in the appendix.

The second leg of M103 aimed to a filament study in the northern Benguela (Fig. 3.2). It covered the coastal ocean from 23°S to 17°S. The following transects are worked:

7. An alongshore transect with TADCP and TCTD (ScanFish) oriented at the 200 m line to identify filamental structures
8. Cross shore transect off Terrace Bay
9. Cross shore transect off Möwe Bay
10. Cross shore transect off Rocky Point
11. A cross filamental transect with TADCP and TCTD (ScanFish)

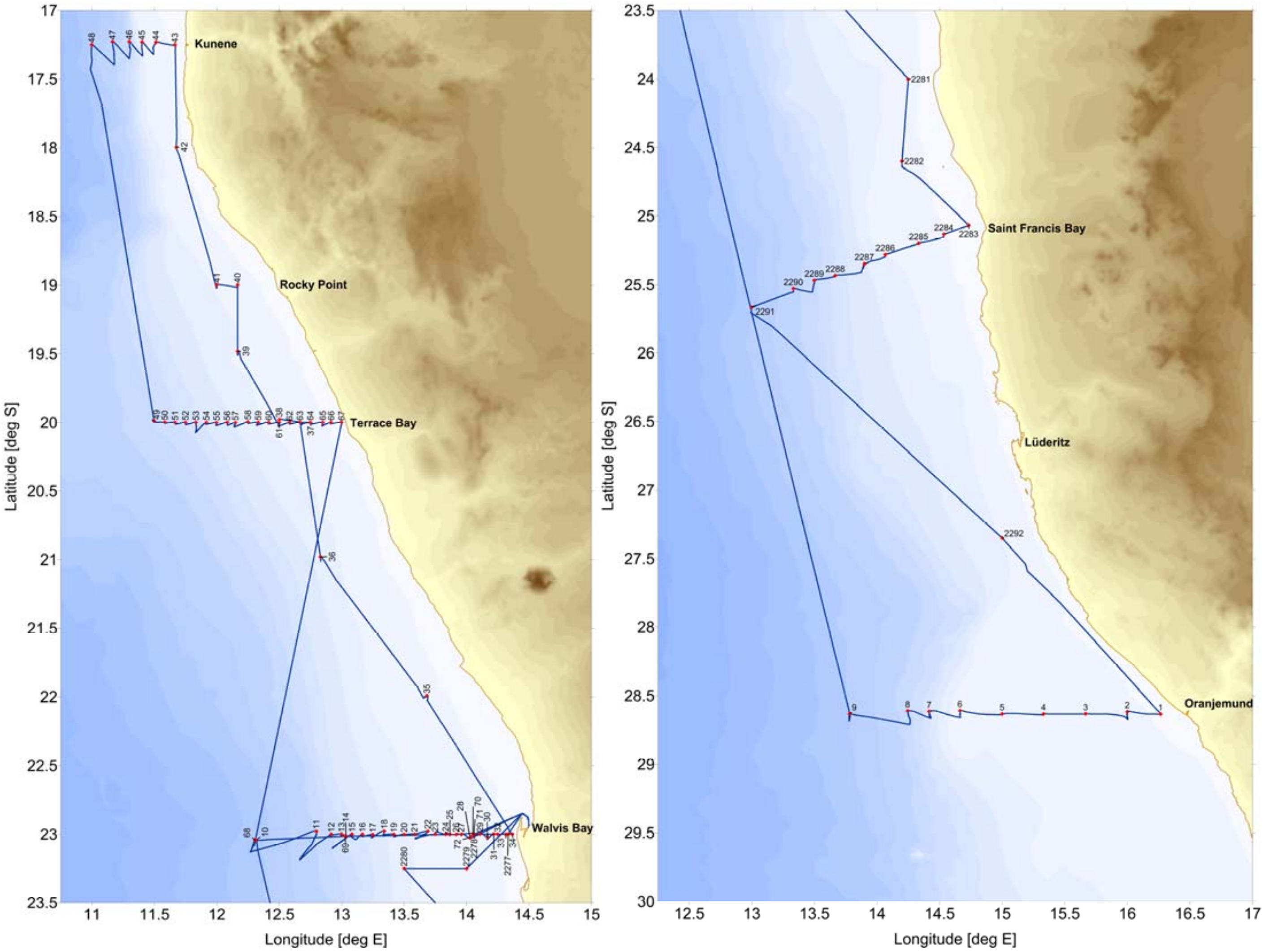

Fig. 3.1 Station map for M103/1 (northern part left, southern part right). The stations are indicated by red dots and METEOR station numbers, the black line depicts the ship track.

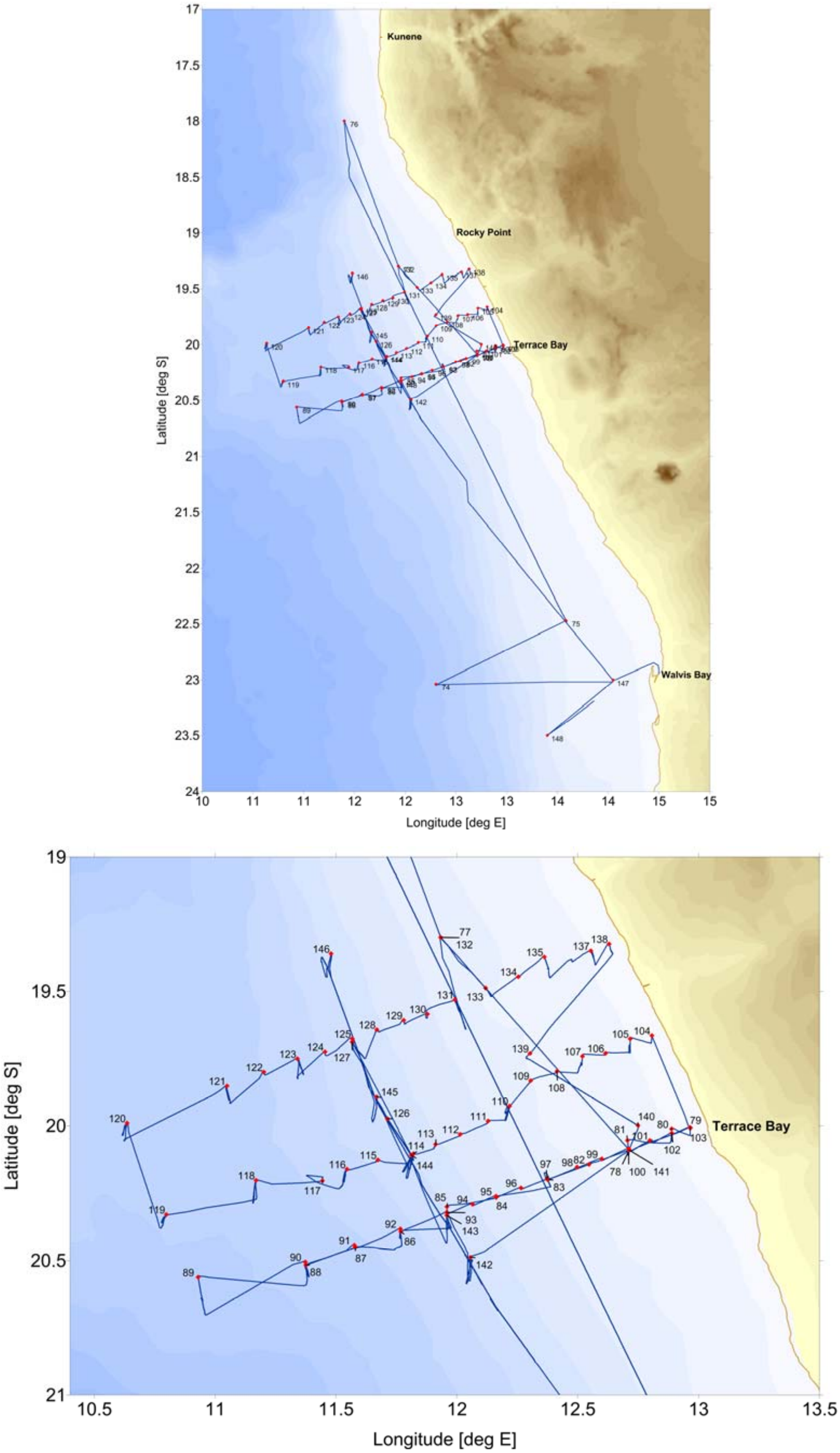

Fig. 3.2 Station map for M103/2 (upper part overview, lower part details during filament sampling). The stations are indicated by red dots and METEOR station numbers, the black line depicts the ship track.

4 Narrative of the Cruise

4.1 Leg 1

On December 26 2013, 29 scientists from Germany, Czech Republic, Greece and Namibia boarded RV METEOR for cruise M103/1. For this cruise two 20' containers with scientific equipment and one lab container owned by ZMT had been sent from Germany to the harbour of embarkation in Walvis Bay, Namibia. In addition, three containers which had been sent in Aug 2013 for M-100/1 were already on board. All containers were emptied on Dec. 23 so that the full equipment load was provided to the arriving scientists in time.

With this successfully planned and performed cruise organisation RV METEOR casted off from the port of Walvis Bay on Dec 27 at 09:00 local time. The first destination was a long-term mooring station on the so-called Walvis Bay transect at 23°'S in approx. 130 m water depth. The ship reached this first station in the early afternoon on the same day where the mooring with oceanographic sensors were deployed. All sensors had been working according to their schedules. After their successful re-deployment a station nearby was sampled using a variety of different gears such as CTD, multicorer and several types of nets (e.g., plankton net, MOCNESS, Multi-net, and Tucker Trawl). Sampling with all these gears and nets subsequently became the standard programme for the entire cruise. After this successful start RV METEOR headed south. Several stations were sampled on the short transit to a transect line (25-26°S) north of Lüderitz which was reached in the evening of Dec 28. The Lüderitz cell is a very stable upwelling region and represents the boundary between the southern and northern Benguela system. The Lüderitz transect was sampled to a depth of 2100 m, intending to catch the coastal mud belt as well as a secondary depot center offshore. Then the ship headed southward to the Namibian border at the Orange River and performed another transect perpendicular to the coastline. The outermost station (2000 m water depth) was completed in the evening of Jan 03 2014.

We then returned back to the 23°S line and started with the outermost station at 2150 m water depth on Jan. 05. There we intended to retrieve the first of three sediment trap moorings that had been deployed in January 2013 with the Namibian vessel FRS MIRABILIS. However, it proved that the mooring replied to the acoustic signals but failed to release. Several attempts with different deck units were unsuccessful. Either the release got stuck with the anchor rope or the flotation modules were broken or lost due to bottom water trawling in that area. After several hours the mooring operation was abandoned in order not to jeopardize the overall mission of this cruise. We continued with our station work on the 23°S-line. On Jan 06 the second sediment trap mooring equipped with various oceanographic sensors provided by the IOW were due for retrieval. Again, we received some random signals; however, these signals came most likely from the near-by fish trawlers. There was no connection possible between deck unit (both IfBM and IOW) and release. In addition, the whole mooring operation was interfered by strong fishing operations very close to the ship. If this fishing prevailed over the complete deployment period then without much doubt the system fell victim to the fishing activities in this area although a daily safety warning has been sent out by NAMPORT throughout the year. Without any substantial success with respect to our sediment trap moorings we continued our station work and headed towards the inner shelf. On Jan 08 at least the shallow sediment trap mooring was retrieved and provided a valuable insight into the vertical particle flux in that area.

After having finished the 23°S line, METEOR headed towards the northern Namibian border for the Kunene transect at 17°15' S. In between the ichthyoplanktologists were able to catch different target species for their experiments between 21 and 17° S. The ship arrived at the innermost transect station on Jan 11 in the afternoon hours. This transect was sampled down to 2100 m water depth until Jan 13 in the evening. Afterwards the vessel moved on to the 20°S transect mainly for microstructure probe sampling in combination with monitoring support for the Namibian partner institutions. Station work at 20°S ceased on Jan 16 early in the morning.
METEOR then headed to the two abandoned mooring stations in order to check for a solid triangulation. The deep mooring at 2150 m was still at its initial position and was marked for a dredging attempt during M-103/2 whereas the central mooring at 440 m did not reply for a single time so that the latter was declared as irrecoverably lost. During the day of Jan 17, the last day at sea, we retrieved one short-term and one long-term oceanographic mooring close to Walvis Bay and re-deployed the sediment trap mooring for the forth time at this position. Mooring operations and thus station work of M-103/1 ceased in the late afternoon and METEOR prepared for entering port on Jan 18. Initially docking was scheduled for 10:00 local time; however, due to harbour reorganisation docking was completed not until 20:00.

4.2 Leg 2

After partial exchange of the scientific crew the second leg of M103 started on 21st January in Walvis Bay. All scientists and the necessary technical and scientific equipment were on board in time. However, for unknown reason the announced Angolan observer did not participate in the cruise. As first task on the second leg two moorings were deployed at the long term mooring position 20n.m. off Walvis Bay. One of the moorings was the long term mooring which is operated by the IOW in close cooperation with NatMIRC since 2003. The second mooring was deployed for the time of the cruise. This mooring gathered hydrographic data on a high temporal resolution to supply information on short term physical processes e.g. turbulent mixing and internal waves. From the mooring station we proceeded to another mooring position nearly 90n.m. offshore. There a sediment trap mooring could be not recovered during the first leg. After deploying a search and recovery wire during the night the mooring was successfully dredged at the first trial. All parts of the mooring were recovered without any damage.

On 22. January we started an along shelf transect with towed devices to gather hydrographic information and to localize active upwelling filaments in the investigation area. Due to high cloud coverage satellite derived SST data were not available in sufficient quality for identification of upwelling filaments. The transect was finished in the late evening on 24th January. The hydrographic patterns revealed no signatures of active upwelling cells in the Northern Benguela. Only a weak signature of an old filament was observed. After a discussion with all scientists we decided to sample this old filament. The second option to shift the entire program to the Lüderitz upwelling cell was rejected, since we were seeking for the seasonal contrast to the investigations carried out in the northern Namibian upwelling cell during the cruise M100/1. However, the sampling strategy was changed to adapt the measurements to the actual situation. On 25 January two stations were worked inside and outside of the filament structure to collect water for a mesocosm experiment, which investigated the response of phytoplankton to mixing between filament and oceanic water. During the station inside the filament a drifting surface mooring (Drifter) was deployed to follow the way of filament water during the next two weeks. This mooring consisted of a surface drifter with a 70m long chain of hydrographic instruments, which measures stratification and current in the upper layer.

From 25. to 28. January we performed the first cross shelf transect from the coast up to 120n.m. offshore. This transect with 16 stations was located south of the filament structure. Eight of the stations were extensively sampled with the full set of gear: CTD, Microstructure Profiler (MSS), optical instruments, and several plankton nets (e.g., MSN, MOCNESS, Ringtrawl). The other stations were worked with CTD and MSS to get a high spatial resolution of hydrographic data along the transect. Additionally, to the in situ measurements some lab experiments were started for physiological investigation on zoo- and ichthyoplankton.

After finishing the first transect another two cross shelf transects were worked in the core and north of the filament from 28th January to 02nd February and from 02nd to 06th February, respectively. The sampling strategy was similar to the first transect.

On 6th February we recovered successfully the drifting mooring. All devices have worked properly. On the same day the ADCP mooring at 20°S was recovered and redeployed after maintenance. In the evening of the 6th February we started with the cross filament transect along the 500m depth isobaths. This transect consisted of 6 stations, with 4 extended stations. The cross filament transect was finished on 8th February. The same transect was now measured with a combined TADCP/ScanFish transect to get high spatial resolution hydrographic data across the fronts between the filament and the ambient oceanic waters. The towed devices were recovered on the afternoon of 9th February. Afterwards we began the transit back to the Walvis Bay area. The remaining two tasks, the recovery of the short term mooring of Walvis Bay and an additional phytoplankton station south of Walvis Bay kept us busy on 10 February. The scientific work of the cruise was completed at 18:00 of the 10th February. On 11 February arrived the port of Walvis Bay, were the cruise was finished after unloading of the scientific equipment and disembarking of scientific crew on 12th February.

5 Preliminary Results

5.1 Hydrographic Conditions and Dynamic of Upwelling Filaments

(M. Schmidt, V. Mohrholz, T. Heene, S. Beier)

The hydrographic investigations performed during M103 contribute to the key physical oceanography and modeling research themes in GENUS II, these are:

- Filaments and mesoscale dynamic and the impact on the availability of nutrients
- Primary production and phytoplankton succession in relation with the physical forcing conditions
- Swell, internal waves and turbulent mixing at the sediment-water-interface
- Plankton organisms and their feedback on the oxygen and carbon cycle with special consideration of calcifying primary producers (coccolithophorides) and macrozooplankton

The focus of the investigations carried out during M103 was on a hydrographic survey at several transects between the Southern and the Northern Benguela, and high resolution observations of an upwelling filament in summer conditions. The field data obtained during the cruise will be used to understand the impact of upwelling filaments on the ecosystem. This work package also delivered the base-line data of hydrographic key parameters in austral summer, which expand the existing series of hydrographic data in the northern Benguela.

Data acquisition was carried out using the following devices and measuring platforms.

At stations and transects:

- CTD SBE 911+ with rosette water sampler
- Lowered ADCP 300kHz Workhorse (LADCP) mounted on the CTD frame
- Oceanographic mooring LTMB (maintenance during the cruise)
- Oceanographic mooring HRMB (40 days deployment during the cruise)
- Microstructure profiler (MSS)
- ScanFish towed CTD
- TADCP towed current meter for current measurements in the upper layer

Continuous measurements:

- Vessel mounted ADCP 38kHz Ocean Surveyor (VMADCP) mounted at moon pool
- Vessel mounted ADCP 75kHz Ocean Surveyor (VMADCP) mounted at ship hull
- Underway measurements of surface water properties
- Ship weather station
- Drifter deployment
- ATLAS PARASOUND P70

Data quality of CTD, Microstructure profiler and ship thermosalinograph were ensured by comparison measurements with electronic reversal thermometers, and water sampling for salinity and oxygen measurements with an autosalinometer and Winkler titration, respectively.

5.1.1 Large Scale Hydrographic Conditions in the Northern Benguela

During the cruise the typical weather conditions dominated by the St. Helena high pressure area were met (Fig. 5.1). The corresponding winds were prevailing southerly trade winds with intermittent perturbations from local low pressure areas. During the first days of the cruise a strong pulse of southerly winds favored upwelling at the west coast of southern Africa. The mean wind speed was between 12 and 14 m/s with gusts of 16 m/s. On 31st of December the wind speed decreased significantly but was increasing again to up to 10 m/s during the following day. Wind kept its southerly direction during the whole cruise with the exception of the 4th and 7th - 9th of January with prevailing north-westerly winds. At the second leg wind speed was generally lower, but the winds kept the general south-easterly direction. Winds were upwelling favoring, but not strong enough for substantial upwelling events. The wind stress derived from ASCAT scatterometer data revealed more details on the spatial wind pattern. During the whole cruise coastal winds were weak. Especially at the coast north of Walvis Bay a band of low wind stress was observed. Wind stress increased off-shore, which corresponds to a significant wind stress curl.

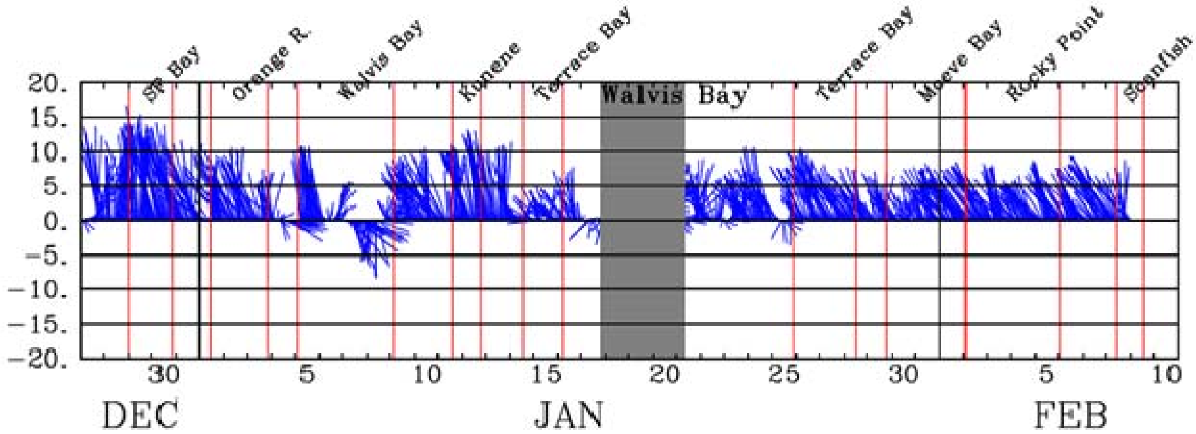

Fig. 5.1 Stick plot of wind vector measured by the ship weather station of FS METEOR. The red lines indicate the period, of station work.

Although daily cloud coverage was generally low, only a few SST-scenes could be gained. On 9th as well as 11th of January there were upwelling favoring winds. Accordingly a band of colder water was driven to the surface along the Namibian coast (Fig. 5.2). Within this time filamental structure emerged broadening the upwelling structure. The upwelling band extended rapidly northward.

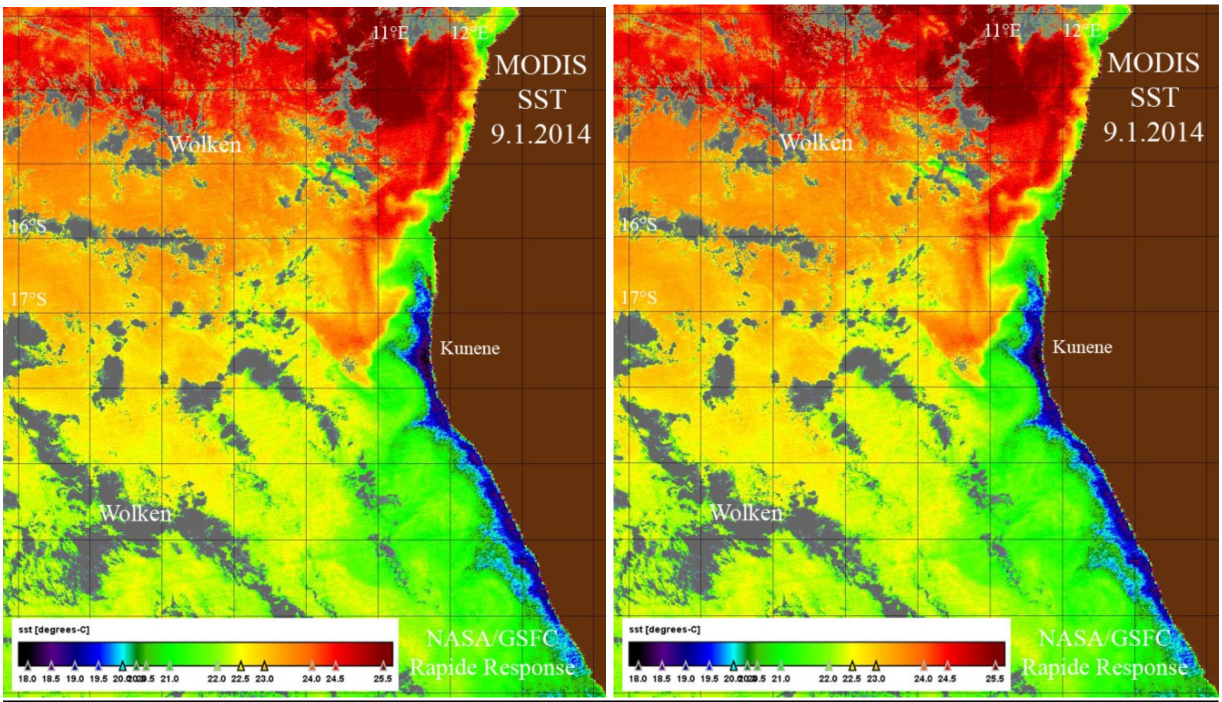

Fig. 5.2 SST distribution off Namibia derived from MODIS AQUA. Note the stretched color scale to highlight the thin band of cold water at the Namibian coast up to 16°S.

For the second leg several SST scenes from composites of microwave and infrared based instruments (MW_IR) are available. There was no indication for well pronounced filament activity. A weak filamental structure was observed near 20°S. The sea surface temperature measured by the ships thermosalinograph varied between 12°C in coastal upwelling cells of the Orange River mouth and 22°C at off shore at the Kunene transect. Generally SST is reduced near the coast in accordance with the generally upwelling favoring winds. Comparing with the air temperature from ships weather station, SST generally exceeds the air temperature except for the first five days of the cruise where the ship was operating either in the Lüderitz upwelling cell or in the coastal (upwelling) area at the Orange River transect.

The hydrographic observations during the first leg were organized in five cross shelf transects between the Orange River mouth and the Kunene river mouth (entire Namibian shelf).

The Orange River transect (28°38’S) includes 9 hydrographic stations from the shelf to a depth of 2000 m off-shore. Surface temperature was below 13°C at the coast and increased towards the open ocean. Salinity was decreasing with depth, but there was a layer of enhanced salinity at about 50 m depth. Considering the strong upwelling favoring southern winds the less saline surface water should be upwelled from a layer between 100 m depth. Oxygen was depleted near the bottom. In contrast, the newly upwelled less saline surface water was oversaturated with oxygen. The high fluorescence suggested new primary production as the oxygen source. This is consistent with the depleted CO_2-concentration in the surface waters found from the underway measurements of TP-4.

The Saint Francis Bay transect (25°30’S) was worked during strong upwelling favoring conditions from 29th to 30th December 2013. The transect consists of 9 CTD stations, most of them at the shelf but 3 covered the deeper ocean down to 2000 m water depth. This included

Antarctic Intermediate Water (AAIW) with its salinity minimum at about 800 m depth and North Atlantic Deep water (NADW) below. The temperature distribution was consistent with the picture of a cross shelf flow with off-shore flow in the surface and on-shore flow below and the tilt of isotherms suggested upwelling. However, the area of low salinity surface waters near the coast was separated from deeper water with similar salinity and temperature.
This water must stem from the south and was advected equator-ward most probably with the wind driven coastal jet. Indeed, on the Orange River transect the central water appears to have direct continuation to the coastal surface waters as it is typical for wind driven upwelling.

The Walvis Bay transect at 23°S includes 12 hydrographic stations and 19 MSS deployments down to 400 m depth or to the bottom respectively. The upper 300m were governed by a mixture of SACW and ESACW with maximum salinity and oxygen concentration near the surface. The salinity minimum at about 800 m depth marked the core of AAIW, below there was more saline NADW. Oxygen was depleted off-shore at about 500 m depth and near the bottom over the shelf. A thin surface layer was stabilised from solar heating. Surface salinity was reduced near the coast, but the surface water was separated from the deeper water with similar salinity by a layer with enhanced salinity in about 60 m depth. Off shore salinity is highest at the surface and is decreasing monotonically with depth (Fig. 5.3). There was an extended oxygen minimum zone on the shelf with concentrations less than 0.5 ml/l. It extended over the complete shelf down to a depth of 300 m. Large patches of oxygen depleted waters were found also off shore. They may be related to west-ward drifting eddies originating from the shelf. The maximum chlorophyll fluorescence was found at the surface at the coastal stations. It turned into a deep chlorophyll maximum near station 32 and 31 and was found at about 50 m depth more off-shore. At stations 31 and 32 there was also fluorescence in the layers below 100 m depth and even near the bottom indicated sinking of phytoplankton from the euphotic layer to the bottom. Whether or not this was the result of zooplankton grazing needs to be investigated.

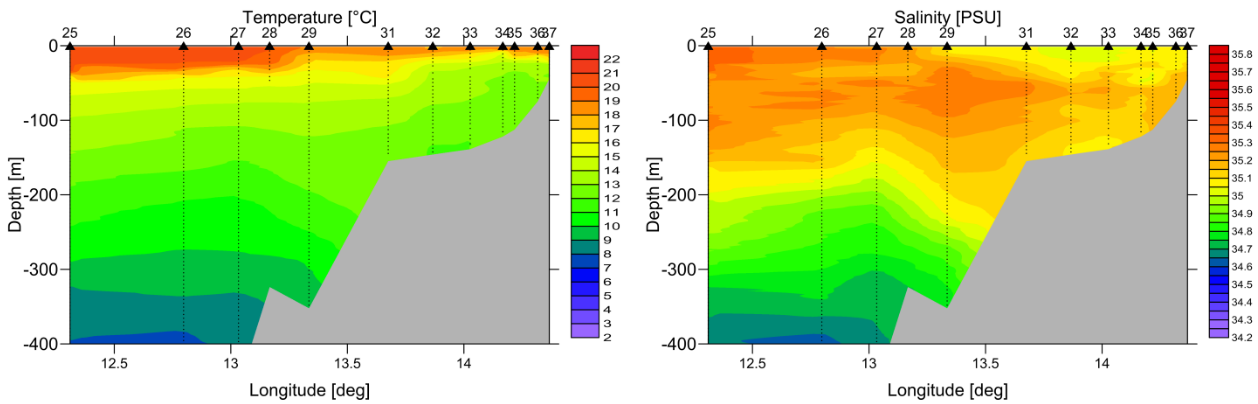

Fig. 5.3 Temperature and salinity distribution along the Walvis Bay transect from the surface down to 400m depth.

The Terrace Bay transect (20°S) was worked mainly by MSS casts. Only a few stations belonging to the NatMIRC monitoring line are worked with a CTD cast and water sampling. The surface layer revealed as highly stratified. Especially, salinity was reduced within a thin warm surface layer; the salinity maximum was met between 50 and 100 m depth. Except some patches in the bottom as well as a thin surface layer turbidity was generally weak. Patches of enhanced dissipation corresponded to the turbidity maxima. There was also some dissipation in the water column related to the salinity maximum.

Since the shelf is very narrow at 17°30'S, along the Kunene transect only 6 stations were worked. The situation was similar to the Terrace Bay transect, but also near the coast surface water is dominated by saline water from the north. The transect missed both the coastal upwelling band and the filamental structures. An overview about the surface conditions in the Northern Benguela in January 2014 (10 m depth) is given in Fig. 5.4.

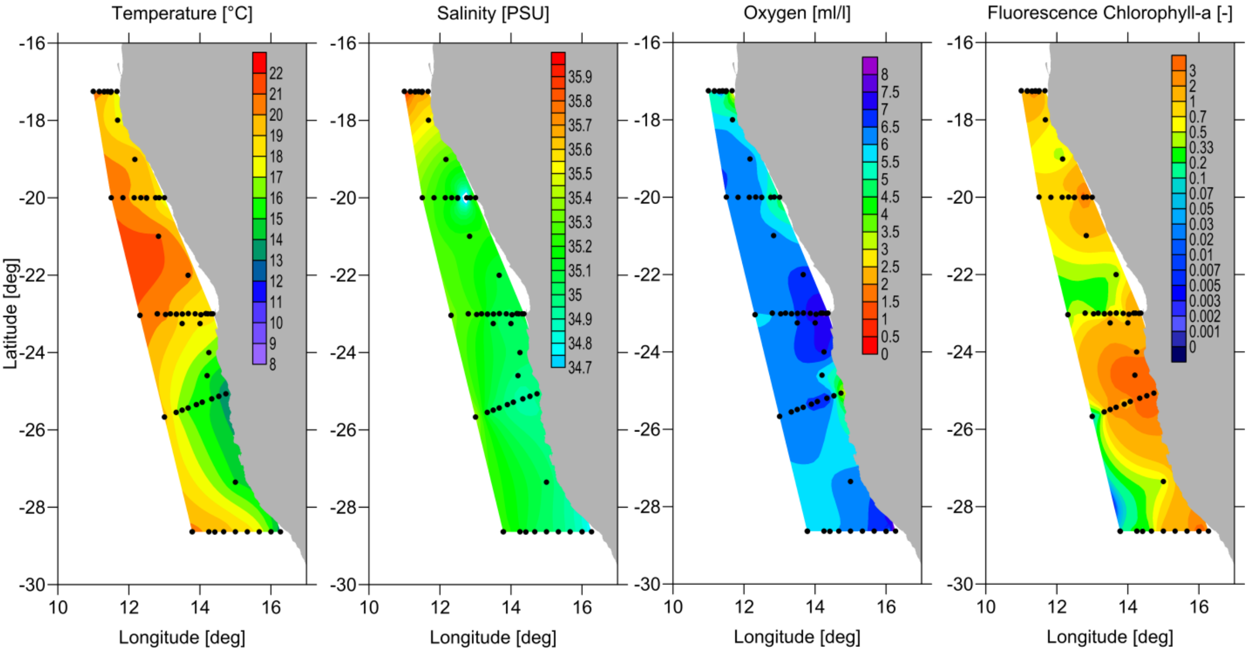

Fig. 5.4 Surface distribution of Temperature, Salinity, Oxygen and Chlorophyll-a fluorescence during the first leg of M103 in January 2014.

5.1.2 Filament Observations

The filament observations were carried out during the second leg of M103. Unfortunately, the wind forcing decreased considerably in this time and only a weak pronounced upwelling filament was observed in the SST data. Thus, a scanfish transect was performed parallel to the coast in order to proof the existence of the filament *in situ*. In the evening January 22nd the ScanFish was deployed at 22°30'S for a northward transect, following the 300 m isobath. There was only slight indication for a developed filament north of 20°30'S (marked with a rectangle in the Fig. 5.5).

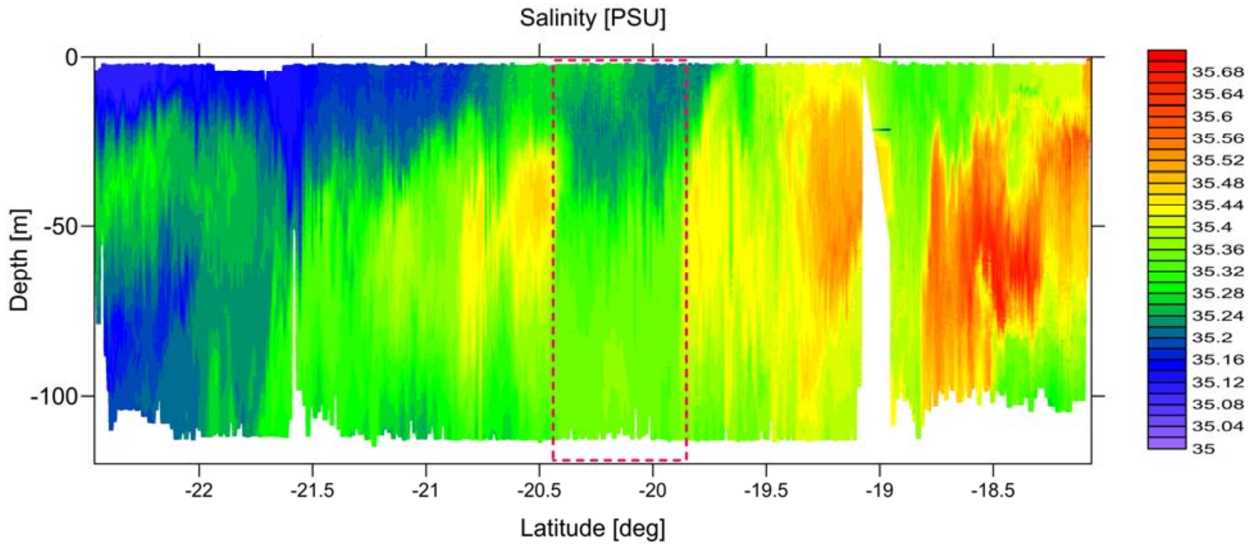

Fig. 5.5 Salinity along the 300m isobaths off the northern Namibian shelf (Scanfish transect 22.01. - 24.01.2014).

The filament was covered with three cross shelf hydrographic transects. One along the core of the filament (Möwe Bay transect), and two transects north (Rocky Point transect) and south (Terrace Bay transect), respectively, of the filament core. The distance between the particular transects was about 30 nautical miles. According SST images, the transect off Terrace Bay was located in the southern warm branch of the filamental structure. Starting from the coast within upwelling water the transect was worked with CTD, optical devices and plankton nets. After finishing the transect, it was repeated toward the coast with MSS profiler. The surface was dominated by warm, but salinity reduced water (Fig. 5.6). A salinity maximum is found at about 100 m depth, slightly elevated off shore and at the coastal station. The coastal water has lower temperature. With the prevailing weak southerly winds this corresponds most probably to a coastal jet and weak upwelling. The oxygen distribution below 100 m depth is dominated by oxygen depleted water with oxygen concentration below 2 ml/l (Fig. 5.7). The oxygen depleted water is uplifted on the shelf, but does not penetrate to the surface. Chlorophyll-fluorescence reached the bottom at the coast. Offshore the chlorophyll maximum was found at about 30 m depth.

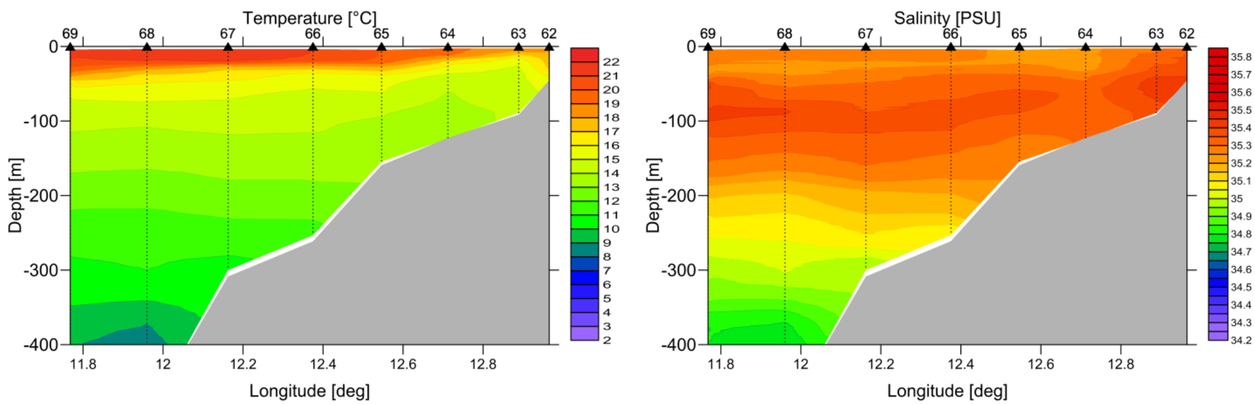

Fig. 5.6 Temperature and salinity distribution along the cross shelf transect in the center of the filamental structure (Möwe Bay transect).

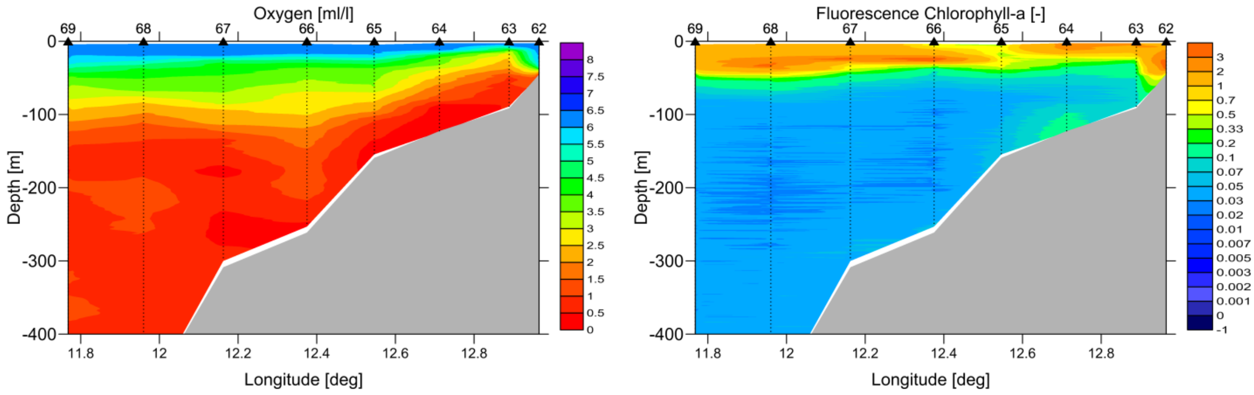

Fig. 5.7 Oxygen and Chlorophyll-a fluorescence distribution along the cross shelf transect in the center of the filamental structure (Möwe Bay transect).

The Möwe Bay transect along the core of the weak filament was worked between the evening of 29th Jan 2014 to the morning of 2nd Feb 2014. No separate MSS transect was conducted. Compared with the Terrace Bay transect SST and SSS are reduced, especially the thermocline is significantly thinner. The chlorophyll fluorescence maximum is displaced upward; the oxygen surface concentration is enhanced, indicating a higher primary productivity, compared to the ambient water.

The Rocky Point transect was worked between the morning of 2nd Feb 2014 to the morning of 6th Feb 2014. The hydrographic conditions compared to the southern transect off Terrace Bay.

Although the observed filament structure was weak, the field data provide valuable information about the usual conditions during weak upwelling in summer, and contrasting the situation observed at the expedition M100 in September 2013. The combination of both data sets will supply an excellent basis for detailed investigation of the system's seasonal behavior.

Drifter deployment

The short term fluctuations in the surface layer inside the filamental structure were investigated using a drifter. It was equipped with an upward looking ADCP at 50m depth, and 12 temperature loggers equally distributed along the 80m long measuring string. The deployment period of the device was from 25^{th} January to 6^{th} of February. The observed mean drift velocity of about 0.09 m/s in northwesterly direction is typical for a weak upwelling situation. This mean drift is overlayed with inertial motions of the surface layer. The current meter data show the action of inertial motion and waves in the upper layer (Fig. 5.8). At about 30m depth the pronounced phase shift of current directions indicates the position of the seasonal thermocline.

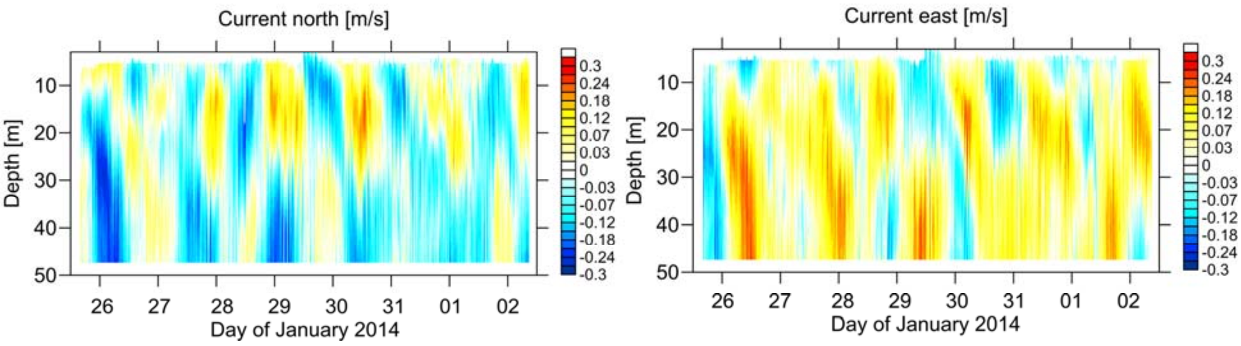

Fig. 5.8 Relative current velocity in the upper 50m along the drifter track on the northern Namibian shelf.

On shorter time scales (hours) nonlinear internal waves (NLIW) dominate the dynamic properties of the near surface layer. During summer the NLIWs are detectable in satellite images of visible light, due to their impact on surface roughness. Fig. 5.9 depicts an example of NLIW distribution in the investigation area.

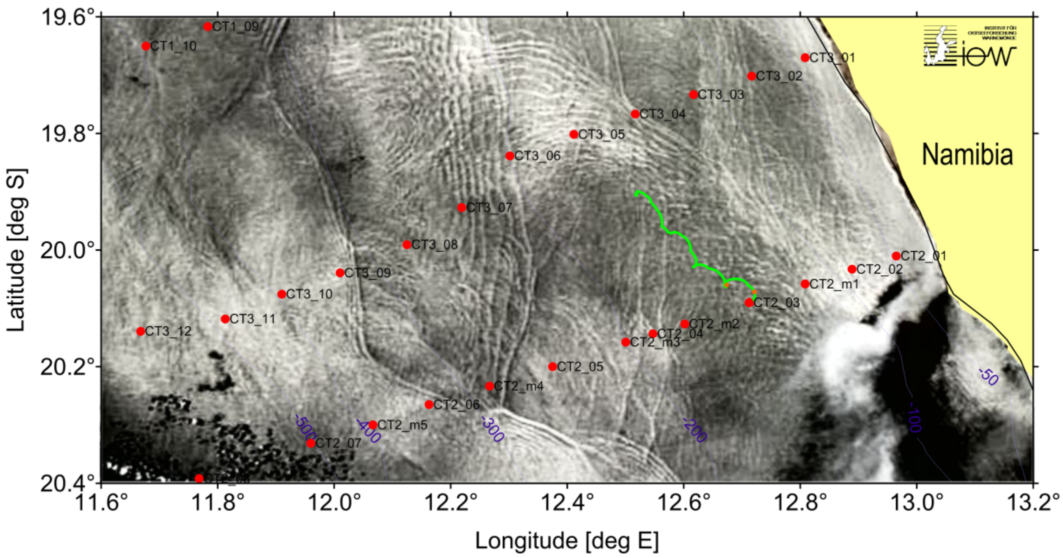

Fig. 5.9 Track of surface drifter (green line) related to the CTD stations of filament transects (red dots). The processed MODIS image (29.01.2014) in the background shows the surface expressions of nonlinear internals waves traveling towards the coast.

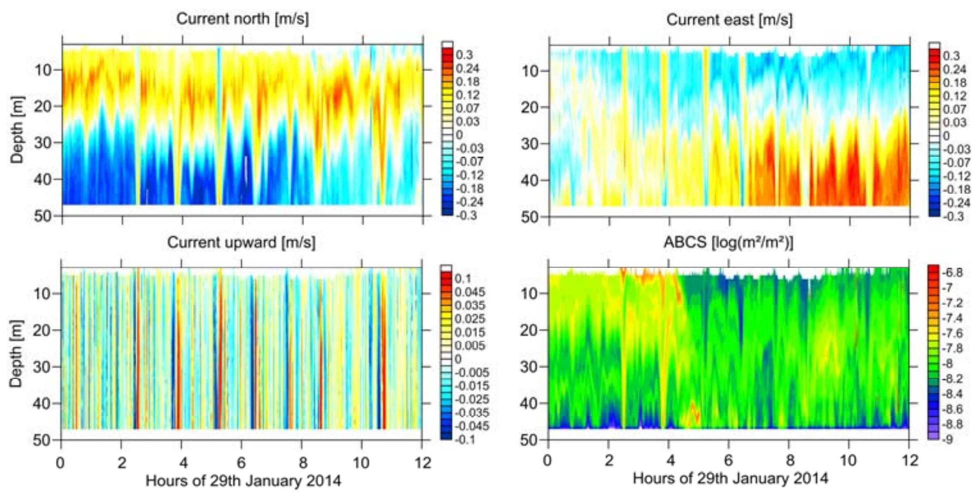

Fig. 5.10 12 hour section of the current meter time series of the drifter (29.01.2014 0:00 – 12:00 UTC). The impact of NLIW is clearly seen in all current components and in the acoustic backscatter cross section as well. The NLIW wave period is about 80 minutes.

The NLIWs are generated at the shelf edge and traveling towards the coast. During their passage at a certain location a depression of the thermocline of approximately 20 to 30m can be observed. The NLIW related disturbances of the current field are shown in a short section of the current meter time series of the drifter (Fig. 5.10). The vertical current velocities caused by the NLIWs can reach 0.1 m/s or more. In combination with vertical shear in the background current the NLIW may cause local unstable stratification and contribute to diapycnal mixing.

5.2 Turbulent Mixing and Matter Transport

(V. Mohrholz, M. Schmidt, T. Heene, S. Beier)

Turbulent mixing in the near bottom layer was investigated during the cruise with MSS measurements along cross shore transects and a mooring (HRMB). On 27.12.2013 12:00 UTC the HRMB mooring was deployed at 23°00.004'S, 14°03.257'E on the central Namibian shelf. The main purpose of this mooring was obtaining hydrographic data from the lower water column with a high temporal and spatial resolution. The data will used for detecting internal waves, swell and other short term processes that may control the vertical mixing and resuspension of SPM. The mooring consisted of a bottom mounted Workhorse ADCP 1200 kHz with 54° beam angle, a downward looking Workhorse ADCP 600 kHz, 2 SEACAT thermosalinometers SBE16, four RBR TR1060 temperature recorder, and an RBR TRD2050 temperature and pressure recorder. The final recovering of the mooring was carried out on 10th February.

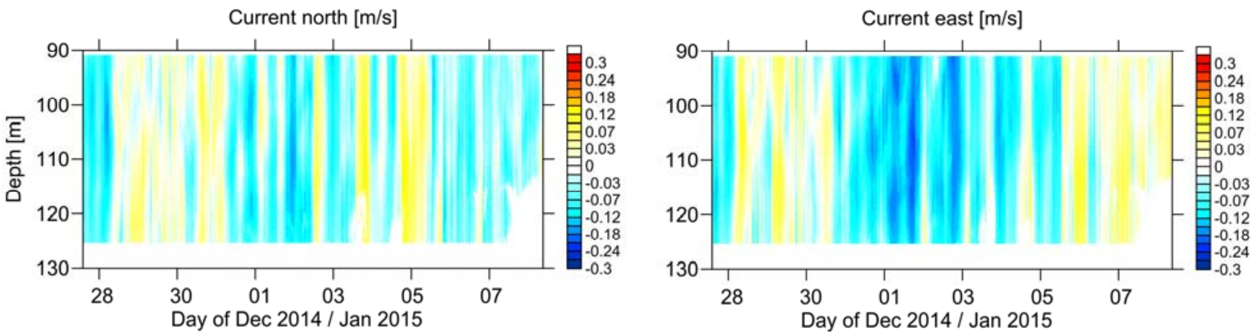

Fig. 5.11 Time series of current velocity in the lower 40m on the central Namibian shelf (HRBM mooring).

Fig. 5.11 shows a short section of the time series of current velocity above the bottom at the position of HRMB mooring. The barotropic signal due to tides and the background velocity dominates the current field. The measurements near the bottom are disturbed by the lack of scattering particles (zooplankton), which avoids the anoxic bottom layer. The acoustic backscattering cross section (ABCS) data from the ADCP shows two types of scattering particles (Fig. 5.12). The zooplankton above the oxycline (magenta line) depict a well pronounced diurnal migration, with maximum concentrations in deepwater during the daylight hours. Near the bottom the increase in ABCS is caused by resuspended matter. Its concentration is qualitatively related to the current velocity above the bottom.

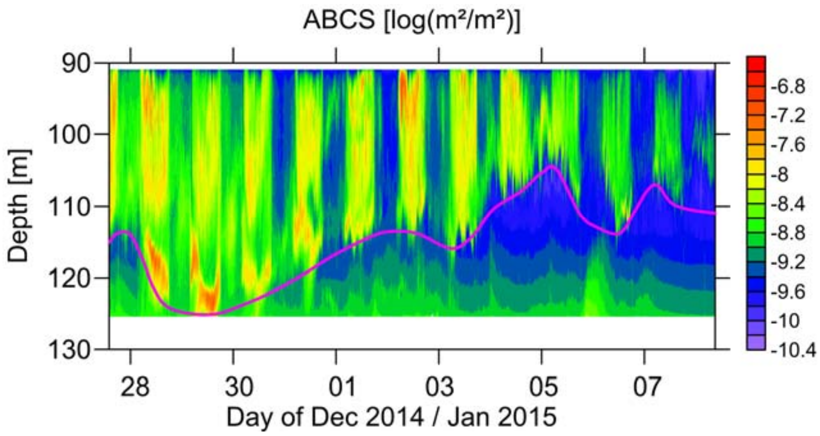

Fig. 5.12 Time series of acoustic backscatter cross section in the lower 40m on the central Namibian shelf (HRBM mooring).

The bottom mounted Workhorse ADCP 1200 kHz was deployed to gather high accuracy current data to estimate the Reynolds stress and the TKE dissipation near the bottom. Unfortunately, during the measuring period the turbulence level was lower than the noise level of the instrument.

MSS measurements

Along the Walvis Bay transect the MSS profiler was used to obtain information about the spatial distribution of TKE dissipation across the shelf. The preliminary results show hot spots and shadow zones of turbulent mixing. Turbidity and dissipation (Fig. 5.13) derived from MSS measurements are enhanced near the bottom, especially in areas with steep slope of the sea floor. Dissipation is also large in several patches in the surface layer. At about 13.2°E near the shelf edge an enhanced TKE dissipation was observed throughout the whole water column. This is caused by the interaction of internal tide with the bottom topography. The breaking internal tide cause high turbulence and resuspension near the bottom, and generates NLIWs described above. The flat inner shelf areas are shadow zones with low TKE dissipation in the water column, and reduced turbulence in the bottom layer.

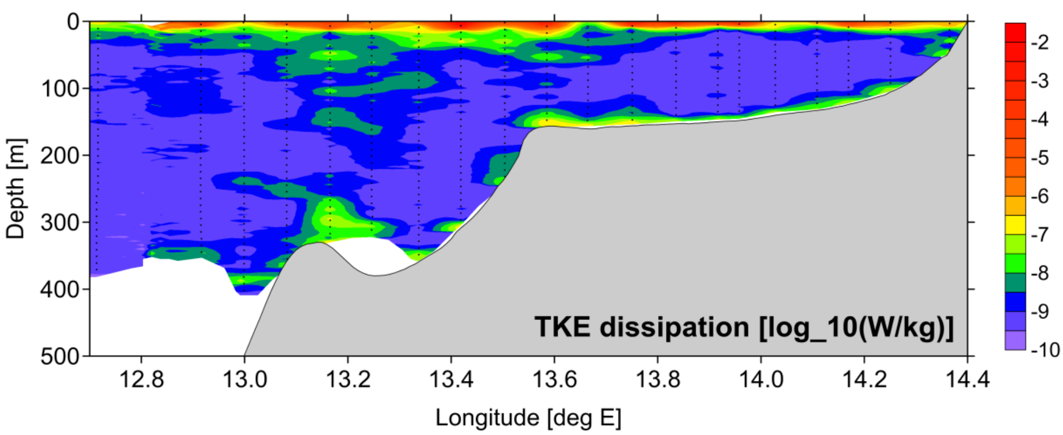

Fig. 5.13 Distribution of TKE dissipation rate along a cross shelf transect on the central Namibian shelf off Walvis Bay (23°S).

5.3 Optical Properties of Sea Water and Remote Sensing

(H. Siegel, T. Ohde, M. Gerth, J. Brust-Möbius)

Main objectives

The main objective of the remote sensing group of the Baltic Sea Research Institute during the METEOR 103 cruise was the investigation of horizontal and vertical distributions of optical properties in relation to optically active water constituents. This contains:

- Identification, optical characterisation and classification of different water bodies in the area of Namibian upwelling system by measurements of inherent and apparent optical water properties,
- overview of horizontal and vertical concentration of optically active water constituents and selected optical properties,
- study of downwelling spectral irradiance, downwelling spectral attenuation coefficient, euphotic depth and PAR in dependence of optical water bodies,
- investigation of the relation between the spectral reflectance and the optically active water constituents and their inherent optical properties,
- spectral investigations of special events: absorbing and scattering algae blooms, river plumes
- investigation of absorbing and scattering algae blooms in relation to hydrographical conditions,
- high resolution studies on the vertical structure of optical properties for the detailed characterisation of filaments,
- supply of satellite data to support the detailed study of filaments.

Sampling

Radiation measurements above the water surface were continuously performed with RAMSES-TriOS system (Oldenburg, Germany) at the bow of the vessel. The incident irradiance Es (λ), the sky radiance Lsky (λ) and the upward radiance L0 (λ) were measured using RAMSES-ACC-VIS and ARC-VIS hyper-spectral radiometer in 256 channels covering the 320 nm to 950 nm range with a spectral resolution of 3.3 nm. The built-in miniature spectrometer consisted of a quartz fibre bundle which ended in the slit of the spectrograph (Heuermann et al., 1999). The detector type was a silicon photodiode array. The integration time was automatically adjusted. The calibration was made by the manufacturer using a calibrated tungsten lamp for the visible part of the light spectrum which was driven by stabilized power supplies (NIST standard). The spectral accuracy of the spectral calibration was 0.3 nm. The detector accuracy was derived by the manufacturer and was better than 6 to 10 % depending on the spectral range. During both field measurements legs the sensors were checked before and after the campaigns by the field calibrator FieldCAL (TriOS, Oldenburg, Germany, http://www.trios.de).

Vertical profiles of downward irradiance Ed (z,λ) and upward radiance Lu (z,λ) were determined with SATLANTIC Profiler (SPMR) during daytime for optical characterisation of water bodies. Profiles up to 100 m were covered by 13 channels between 400 nm and 700 nm. The incident irradiance above water Es (λ) and the upward radiance under water Lu (λ) were measured with SATLANTIC surface reference (SMSR). All measurements were made according to the recommendations of the SeaWiFS validation team (Mueller and Austin, 1995). The devices were far away of the vessel to avoid perturbation of the in-water radiance field by the ship body. The sampling data rate of both instruments was 6 Hz. The free fall velocity of the SPMR instrument was justified by ballast in such a way that at least 8 spectra were samples per meter.

Vertical profiles of downward irradiance Ed (z,λ) and upward radiance Lu (z,λ) were also determined with TriOS system. The radiometers measured both quantities in 256 channels between 320 nm and 950 nm above the water surface and in the standard depths: 0, 1, 5, 10, 20, 30, 40, and 50 m depending on the incident radiation and the transparency of the water column.

The Wetlabs AC-S is an in-situ spectrophotometer to measure the total absorption a and beam attenuation coefficients at 80 wavelengths in the spectral range from 400 to 730 nm in about 4 nm steps with half-widths of 10-18 nm. The device system consisting of the AC-S, data logger and battery pack is installed with a pump and a pressure sensor in a frame and operates autonomously. The water is pumped through a flow-through system by two 25 cm cuvettes. The light source is a Wolfram lamp. The device start-up takes place just prior to exposure through the connection with the battery pack. The device is programmed with a delay time (1-2 min), to reach the water before the warm up phase (3min) starts. During the warm up phase water is pumped through the systems a and c tubes to ensure bubble-free measurements, which then leaves the pump. The AC-S System was lowered by a crane with a velocity of 0.3 - 0.5 m/s to the maximum measuring depth of 300 m depending on the stratification.

Water samples at different depth including the chlorophyll-a maximum were taken to investigate the vertical distribution of concentration of optically active water constituents like chlorophyll-a (Chl-a) and suspended particulate matter (SPM) as well as of the absorption of particulate material (ap) and yellow substance (CDOM). Selected samples were taken for SEM (scanning electron microscopy), EDX and pigment analysis by HPLC.
The transparency and ocean colour were determined using Secchi disc and Forel scale.

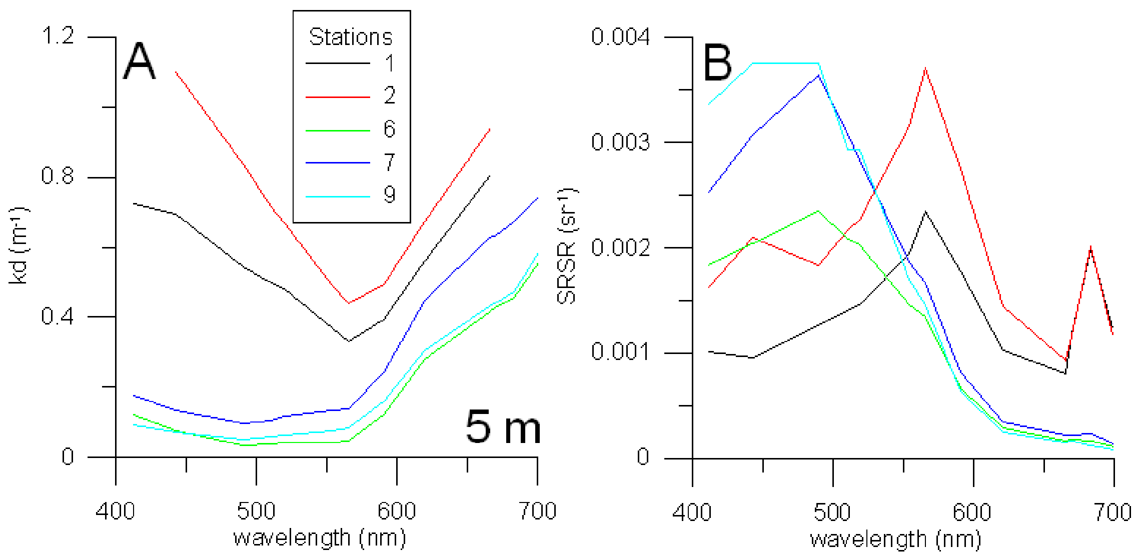

Fig. 5.14 Variation ranges of diffuse vertical attenuations coefficients in 5 m depth (A) and surface remote sensing reflectance (B).

Preliminary results

The SATLANTIC radiation measurements near the water surface were used to calculate the surface remote sensing reflectance, a parameter which describes the water colour, and the diffuse vertical downwelling attenuation coefficient representing the amount of light attenuation in the water column. As an example, the variation ranges of both parameters at the Orange transect area are shown in Fig. 5.14. The light attenuation in the water column was higher at the coastal stations 1 and 2 corresponding to Secchi disc depth of 2.5 m to 4.5 m. Between 11 m and 14 m Secchi disc depths were observed at the outmost stations 6 to 9. The water colour varied between blue-green at stations 6, 7 and 9 to green at stations 1 and 2.

The nearest coastal stations could be influenced by the Orange River outflow. This result was also reflected in the higher attenuation coefficients (kd, Fig. 5.14) and in the photosynthetically active radiation (PAR, Fig. 5.15). The 1% depth of PAR was only 8 m to 9 m at the nearest coastal stations but up to 53 m at the outmost stations. The spectral signatures of raw data of absorption of particulate matter were different among the stations and reflected variation in phytoplankton community (Fig. 5.15). Further investigation will give final assessment of optical active water constituents.

The MODIS images of 2 January 2014 verified the measurements (Fig. 5.16). The nearest coastal stations of the transect were characterized by cooler water masses with higher chlorophyll-a concentrations and higher light attenuation coefficients as the outmost stations. The stations 7 to 9 were influenced by an aged chlorophyll-a filament. It could be seen in Fig. 5.16D that the clearest bluest water was not reached by the outmost station. The optical and the remote sensed data set have to be further processed to achieve the objectives.

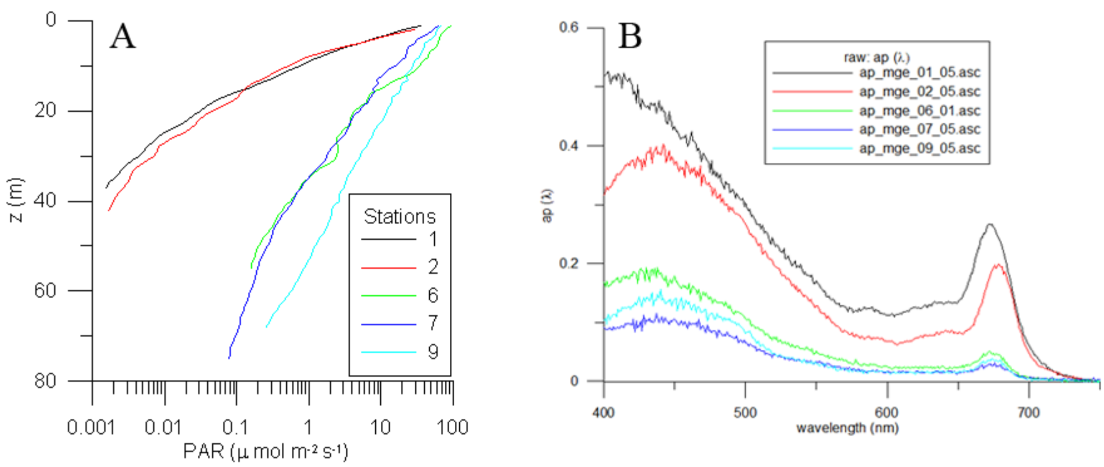

Fig. 5.15 Photosynthetically active radiation (A) and absorption of particulate matter (B, raw data) at the Orange transect.

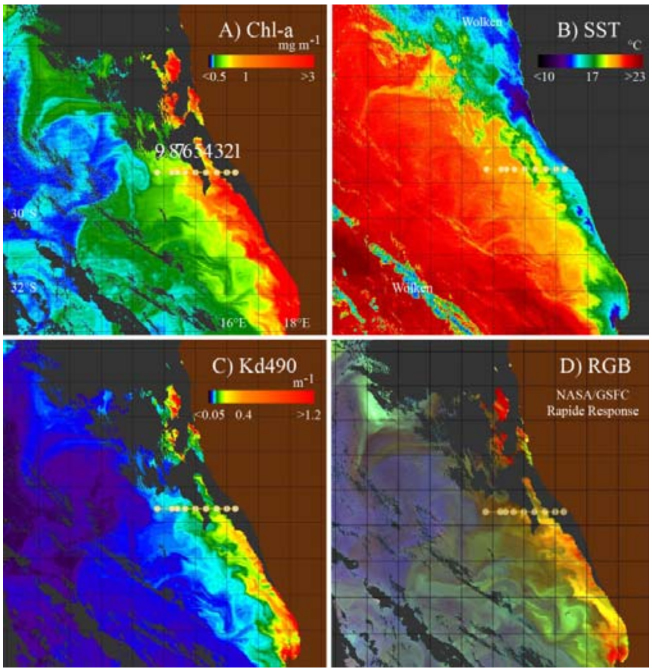

Fig. 5.16 MODIS at 2 January 2014: A) MODIS Chl-a. B) MODIS SST. C) MODIS Kd490. D) MODIS RGB (443 nm/555 nm/667nm).

During leg 2 the radiation measurements at the bow of the vessel showed the strong variations in the incident light due to the daily cycle and cloud coverage and the variation of water colour at the transects which is due to the variation in the composition and concentration of optically active water constituents. This was reflected also in the Forel-Ule colour scale and in the Secchi-disk depth. The Secchi disk depth varied between 3.5 and 15 m.

Along the transect 2 the Secchi disk depth varied between 4.5 m and 13.5 m which points the presence of different water masses. This was also reflected in the vertical percentage distribution of the photosynthetically active radiation (PAR) where the 1 % depth varied between 18 and 38 m. In the upper 30 m the difference follow the distance from the coast with the lowest transparency at the station nearest to the coast and the highest at the offshore station. The offshore stations 118 and 119 show the highest transparency.

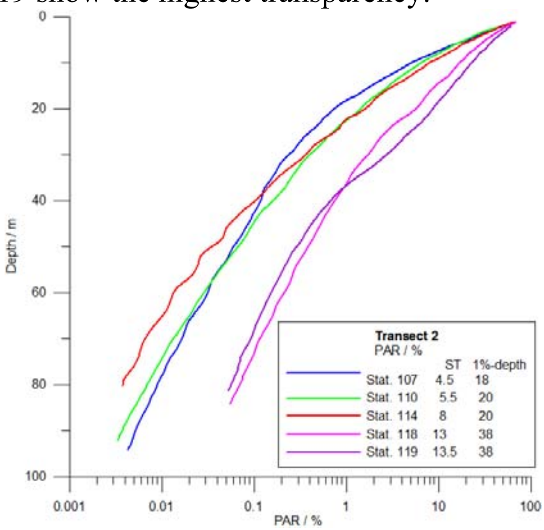

Fig. 5.17 Percentage photosynthetically active radiation (PAR) at the second transect including the Secchi disk depth and the 1% depth of PAR.

The vertical attenuation coefficient calculated from the downward irradiance describing the light attenuation in the water column and the spectral reflectance at the surface representing the water colour in Fig. 5.18A and B show the same behaviour. The water colour (Fig. 5.18B) varied from bluish water at the offshore station 119 with the lowest CDOM absorption (Fig. 5.18), blue-green at stations 118. Further to the coast the reflectance maximum shifts over 520 nm to 560 nm.

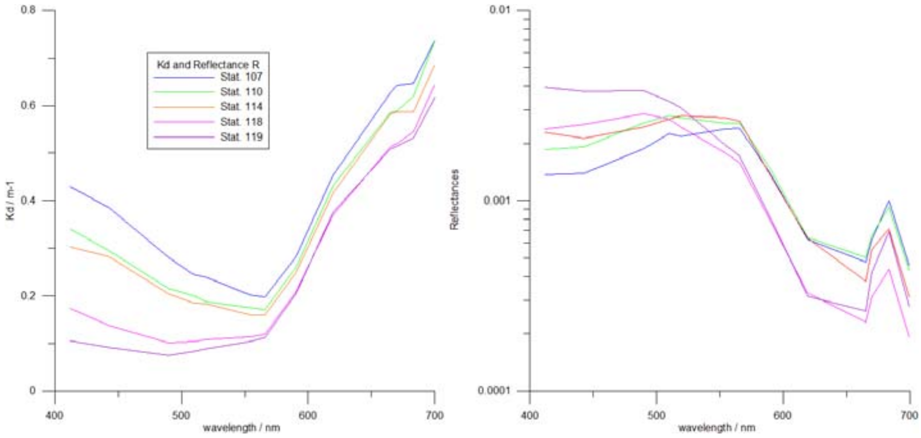

Fig. 5.18 Variation ranges of diffuse vertical attenuations coefficients in 5 m depth (A) and surface remote sensing reflectance (B).

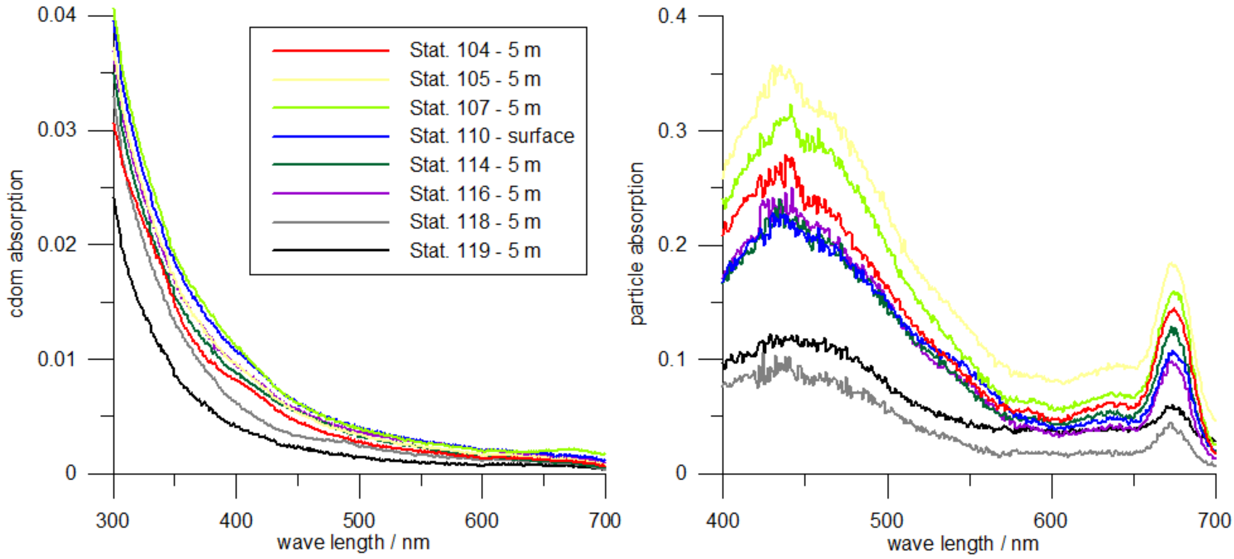

Fig. 5.19 Absorption of CDOM and particulate matter (B, raw data) at the second transect.

The raw data of spectral absorption of CDOM and particulate matter reflect the two different water masses along the second transect (Fig. 5.19).

Vertical distribution of total absorption coefficients at three wavelengths and from the stations 107 and 119 are presented in Fig. 5.19. The data represent different vertical structures at both stations. The maxima of absorption represent the Chlorophyll maxima and the different wavelength show different resolved vertical structures.

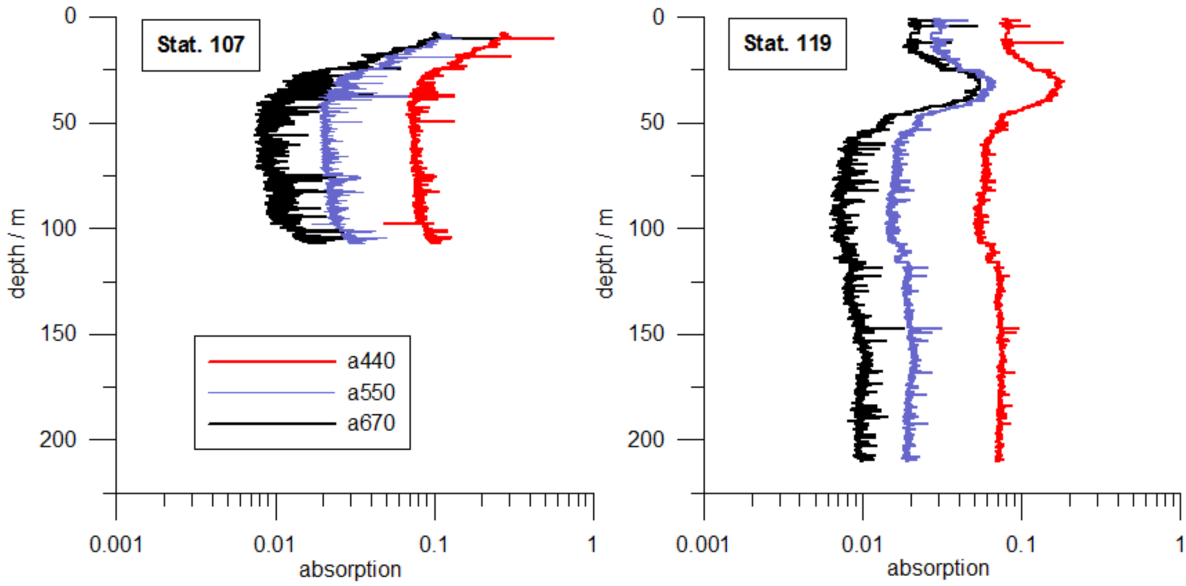

Fig. 5.20 Vertical distribution of total absorption coefficients at three wavelengths and from stations 107 and 119.

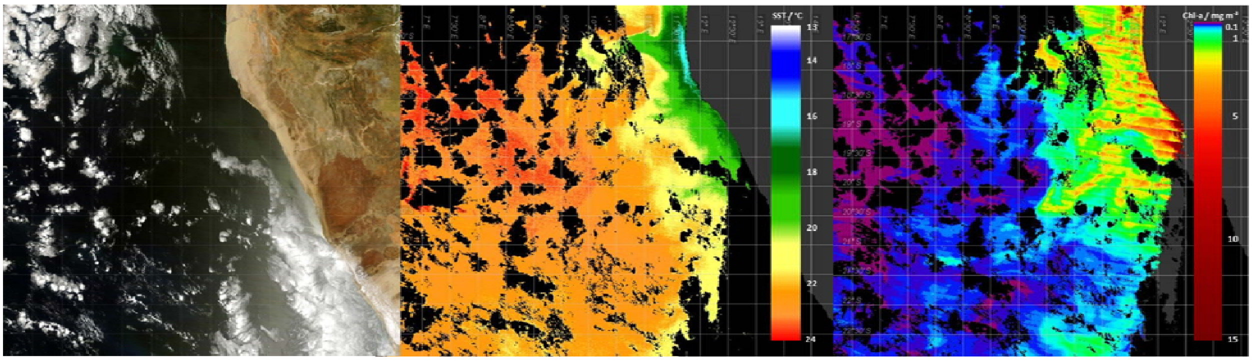

Fig. 5.21 MODIS Terra at 28 January 2014: A) MODIS RGB. B) MODIS SST. C) MODIS Chl-a.

The MODIS images acquired at the 28th of January 2014 are shown in Fig. 5.21. The SST and the Chl-a patterns hint to different water masses present in the study area.

Measurements of particle absorption and CDOM were implemented in the container experiment of the biological working group, which showed increasing differences between the three water bodies.

5.4 Primary Production and Phytoplankton Community

(N. Wasmund, A. Hansen, Ch. Chikwililwa, T. Ngutjinazo)

The intention of the cruise was to establish a practicable method to quantify primary production by means of oxygen measurements using optical sensors. Furthermore the determination of phytoplankton biomass and its species composition is of main interest as phytoplankton is a key player in terms of nutrient uptake and remineralisation (Brown and Hutchings 1987, Pitcher 1991, Boyer et al. 2000, Wasmund et al. 2005, Hansen et al. 2014).

Sampling

Phytoplankton samples from the mixed layer, the chl-*a* maximum depth and from underneath the halocline have been taken along the 29°S-, 25°S-, 23°S-, 20°S- and 17°S lines. 60 stations have been sampled in total. About 200 samples will be analysed microscopically and about 300 filters will serve for chlorophyll measurements. Incubation experiments for oxygen production were done at 18 stations.

5.4.1 Chlorophyll Distribution, Phytoplankton Abundance and Productivity

The mixed surface layer was mostly located in the upper 20 m and generally included the chlorophyll maximum. At the most shallow stations the water column was nearly completely mixed. At the outermost stations, especially in the southern part of the research area (Orange River transect) the chlorophyll maximum was located underneath a warmer surface layer. The greatest depth of the chlorophyll maximum amounted to 70 m. The innermost stations off Oranjemund were characterized by high phytoplankton biomass and productivity (Fig. 5.22). Oxygen concentrations of about 10 mg/l and a saturation of 120% were measured. An abundant phytoplankton species turned out to be the diatom *Chaetoceros decipiens* (Fig. 5.23). The middle of the same transect was characterized by a strong presence of salps in very clear water. The oxygen concentration in the incubated samples decreased due to the respirating salps

At the innermost stations of the Saint Francis Bay transect between 25°S and 26°S, an increasing phytoplankton biomass dominated by the diatoms *Chaetoceros socialis, Leptocylindrus mediterraneus and Pseudo-nitzschia* spp. caused an intensive fluorescence of > 6 according to the CTD.

At the most northern line (Kunene transect) the mixed layer depth increased to 50 m with increasing distance to the coast. The chlorophyll maximum was than located at about 20-40 m.

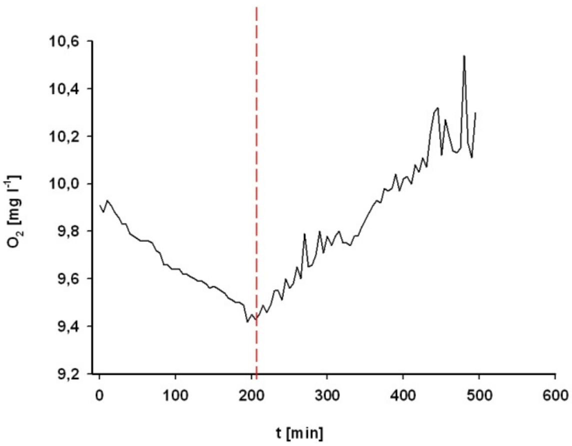

Fig. 5.22 Development of the O2 concentration at station 001 in surface seawater during dark- and light incubation (separated by dotted line)

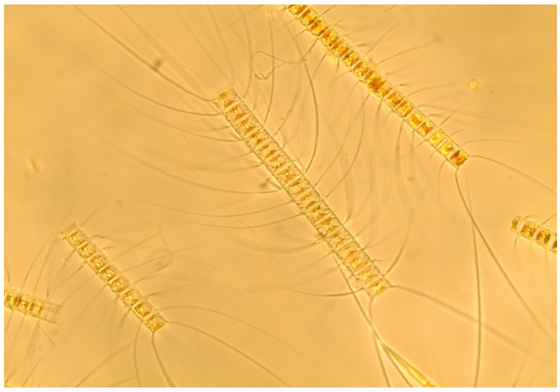

Fig. 5.23 *Chaetoceros decipiens*; abundant species at station 001

During the northward transition to the 20° line (Terrace Bay transect) abundant phytoplankton species like *Rhizosolenia* spp. and *Planktoniella sol* indicated a change in the phytoplankton composition. This might be owed to a coastward transport of the surface water, as *P. sol* is a common offshore species. At the 20°S line, *Coscinodiscus radiatus* and *C. wailesii* were quite abundant beside *N. scintillans* and *Thalassiosira* spp. At the outermost stations net catches were less dense but the share of dinoflagellates increased.

At the 17° line (Kunene transect) *Thalassiosira rotula* and *Thalassiosira anguste-lineata* were predominant in the net samples (Fig. 5.24). The diatoms were later intensively grazed by a dense population of *Noctiluca scintillans* (Fig. 5.25). In contrast to the very low oxygen content in the water column, O_2 concentration increased during all incubations, which was somehow unexpected.

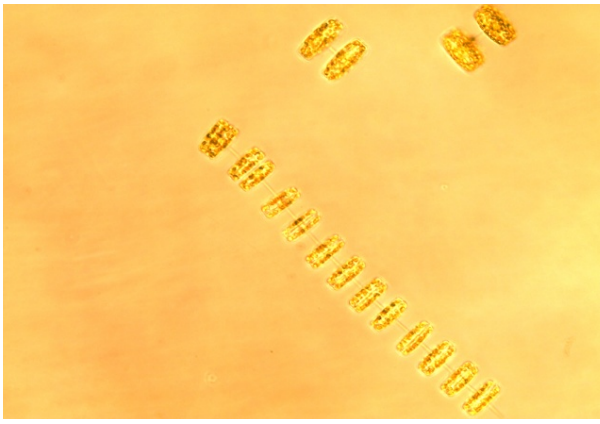

Fig. 5.24 Station 040, *Thalassiosira rotula*

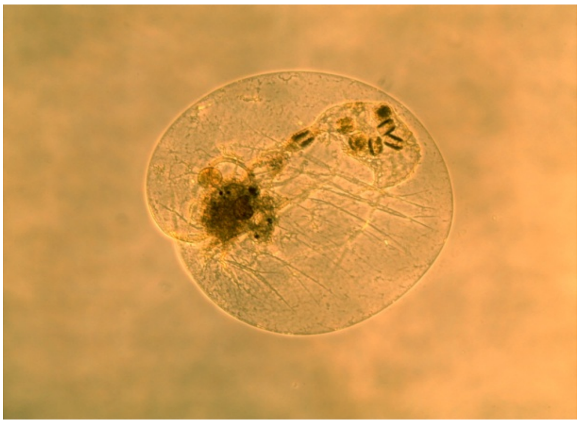

Fig. 5.25 Station 043, *Noctiluca scintillans* feeding on *Thalassiosira*

5.4.2 Distribution of Phytoplankton Species, Biomass and Primary Production with Special Respect to a Filament

An uneven growth of the phytoplankton inside and outside the filament is expected, leading to specific spatial patterns of phytoplankton distribution. Reasons for these patterns will be elaborated in connection with oceanographic parameters (section 5.2) and data on nutrient concentrations (section 5.6). The phytoplankton basic data are also of interest for other working groups of GENUS (e.g. for food chain investigations by zooplanktologists or for validation of the biological parts of the models).

The following phytoplankton parameters are investigated:

- phytoplankton composition and biomass, by qualitative and quantitative microscopic analyses,
- chlorophyll a analyses,
- primary production, based on 13C incorporation, to be measured by mass spectrometry,
- nitrogen fixation, based on 15N incorporation, to be measured by mass spectrometry,
- primary production and total community respiration, measured by oxygen changes, analysed by optodes,
- primary production and total community respiration, measured by oxygen changes, analysed by Winkler titration,

- Phytoplankton identifications may be supported by specific methods (e.g. electron microscopy) based on net samples (“Handnetz” 25 µm), which were taken from 0-20 m depth.

Data are not available yet as the analyses will be carried through in the institute.

5.4.3 Influence of Mixing Processes at the Fronts Between Filament and Surrounding Water on Phytoplankton Composition and Productivity

As such mixing is hardly to be followed in the field, we simulated the mixing by mesocosm (“tank”) experiments, as explained below. We found indications for increased productivity in frontal regions already on cruise M100 and had to improve the data basis for verifying that finding. Also the maturation of the filament water can be followed in these tanks. It is hypothesized that a specific phytoplankton succession from diatoms via dinoflagellates to coccolithophores may occur in aging filaments.

Experimental setup: Tanks 1-3 were filled in the oceanic water north of the filament (station 077), tanks 7-9 inside the filament (station 078), and tanks 4-6 contained a 1:1 mixture of these waters. After filling on 25.1.2014, the tanks were sampled on 27.1., 29.1., 31.1., 2.2., 4.2. and 6.2.2014.

A selected result of the measurement of primary production by means of the optodes is presented in Fig. 5.26, showing the decrease of oxygen concentrations during the incubation in the dark (= community respiration, for 260 minutes in this case), and the increase of oxygen concentration during subsequent incubation in artificial light (= net community production) on the 27.1.2014. This was the day with the most impressive differences between the different sets of tanks. It appears that the oxygen consumption during the dark incubation phase is similar in all tanks, but the oxygen production during the light incubation phase is strongly increased.

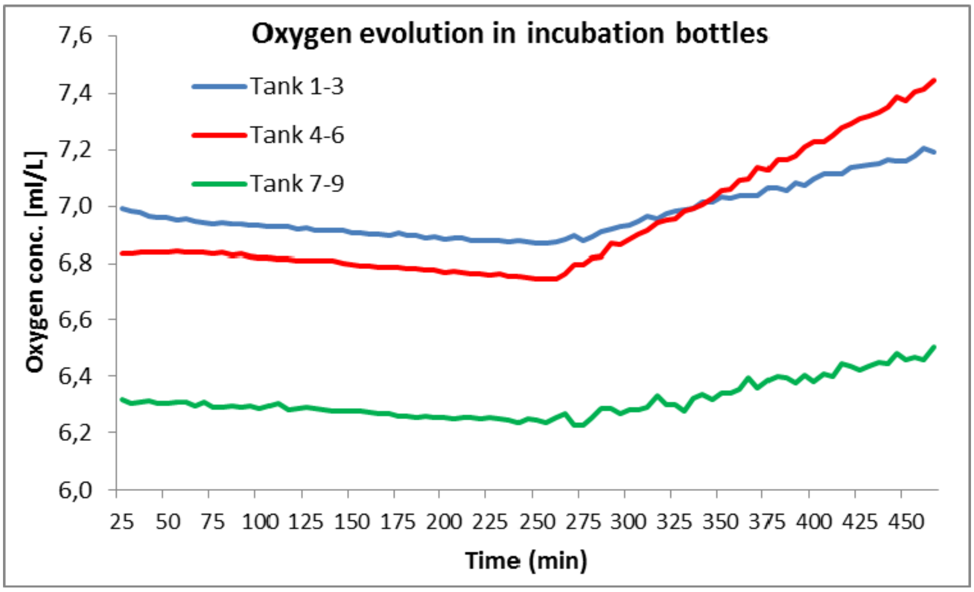

Fig. 5.26 Oxygen consumption (in dark, until t = 260 min.) and oxygen production (in light, after t = 260 min.) in bottles filled with waters of tanks 1-9 (mean values of the replicate tanks, n=3) on 27.1.2014.

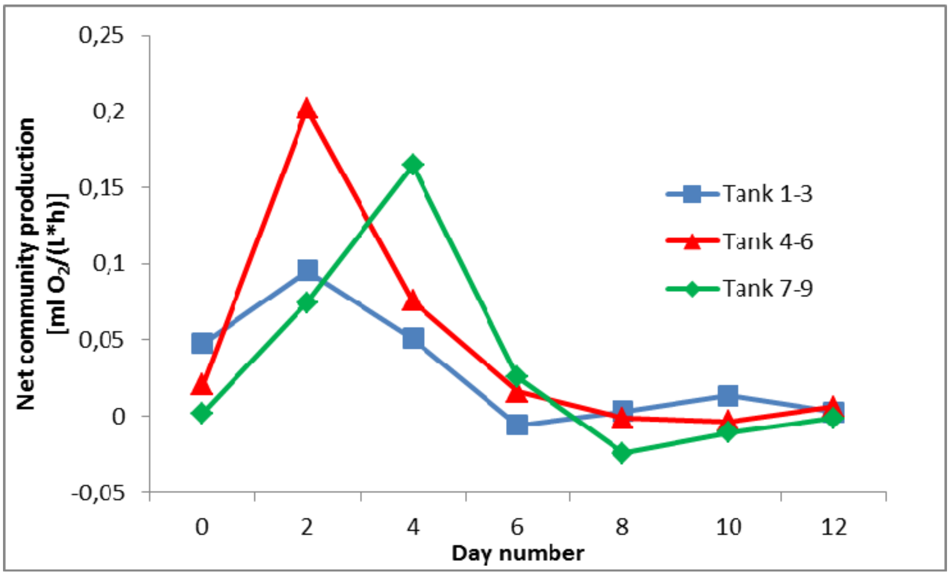

Fig. 5.27 Development of net community production in the tanks. The three replicate tanks are averaged to one curve.

From the oxygen production occurring in the light, the net community production can be calculated for each set of tanks on every investigation day. The results are compiled in Fig. 5.27. When the experiment started by mixing the different water bodies (day 0), the production in the mixed water (tanks 4-6) was just between the original waters. However, net community production in this mixed water increased strongly within two days, indicating that frontal regions are hot spots of primary production. Of course the high phytoplankton growth can only be maintained until the nutrients are exhausted and the bloom decreases rather quickly, whereas the growth in the filament water (tank 7-9) was lower but long-lasting due to the higher nutrient resources (nutrient data are not available yet). In any case, the net community production declined to a minimum already by day 6-8 and the water became clear. The phytoplankton biomass decreased because of feeding by the developing small zooplankton (ciliates and copepods); zooplankton data will be analyzed later. Obviously the system is kept in a kind of equilibrium between primary production and community respiration, i.e. moderate phytoplankton production based on regenerated nutrients and net community production approaching zero.

These results suggest that a high patchiness can be expected in the field: Higher phytoplankton biomass and production in upwelling (filament) water, but very quick response at the margins of such upwelling cells. These hot spots of primary production cannot be maintained for long unless fed by more or less continuous new nutrient delivery, as it may be realized by long-lasting upwelling events.

5.5 Geochemical Fluxes in the Water Column and at the Sediment Water Interface

5.5.1 Online Measurements of Surface Water Composition (Ferrybox and SYSTEA)

(N. Lahajnar, M. Ankele)

The Ferrybox including an auto-analyzer SYSTEA MICROMAC 1000 was attached to a continuous flow (ca. 5 litres per minute) of surface seawater and measured every minute (every 30 minutes for nutrients) the following variables: conductivity, temperature, salinity, oxygen (content and saturation), fluorescence, turbidity, pH, phycoerythrin, CDOM, NO_2, NO_x, PO_4 and SiO_2. Precision of nutrient measurements was checked against fresh calibration standards on a daily basis. In addition, samples were re-calibrated on board with an autoanalyzer (section 5.6). Our results show clear trends where, for example, upwelling in terms of changing water temperature and to a lesser extent the pH as well as enhanced nutrient concentrations (Fig. 5.28) occurred in the region of the Lüderitz upwelling cell around 26°S. Similar but more locally this trend was also observed in the Kunene region (17.5°S). Compared to the GENUS cruise MARIA S. MERIAN 17/3 in Feb. 2011, the Lüderitz upwelling cell was significantly larger during M-103/1 whereas maximum nutrient values along the coastline (19-26°S) were much higher in Feb. 2011. Local maxima in the northern part point to a presumably relatively weak influence of SACW water masses from the Angola Dome region.

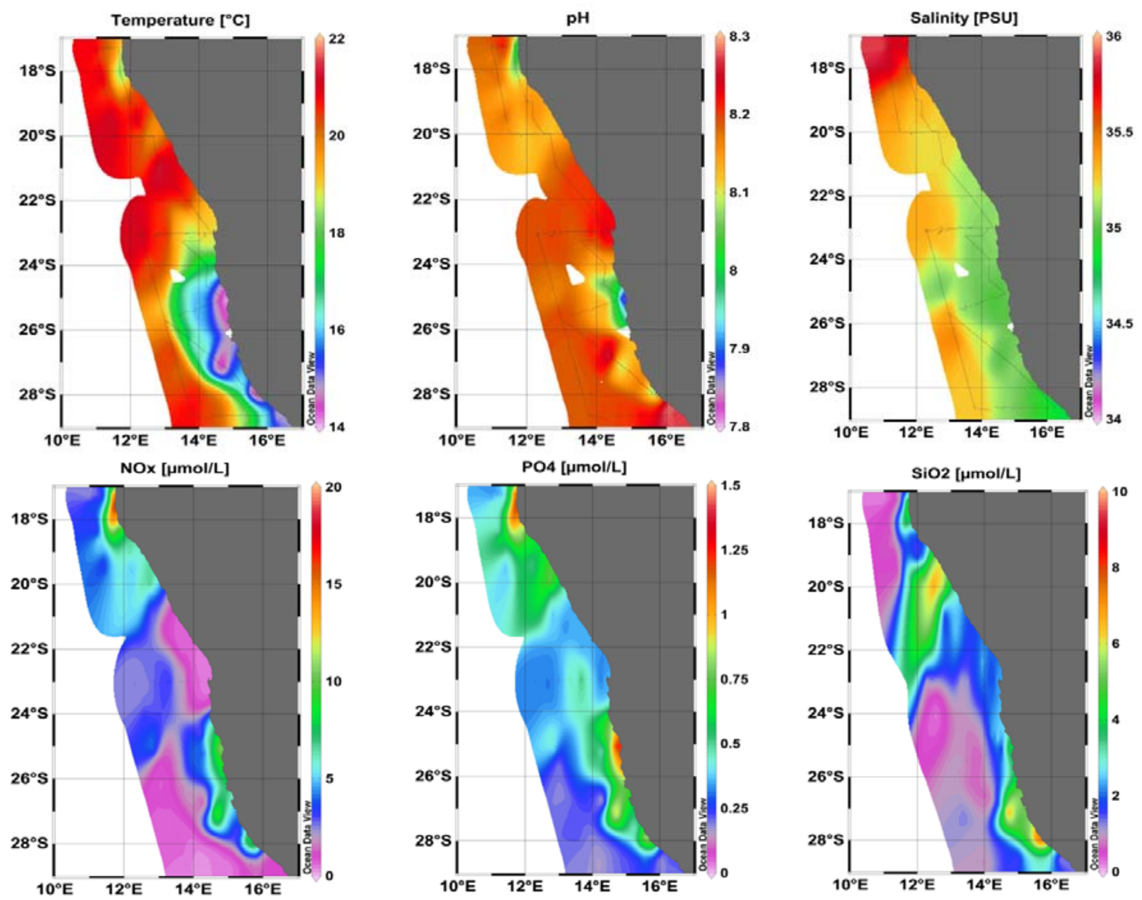

Fig. 5.28 Physical and chemical properties of the Benguela upwelling area in Dec. 2013/ Jan. 2014 derived from continuous measurements (>25,000 data points) of a Ferrybox and SYSTEA autoanalyzer installed on RV METEOR.

5.5.2 Ultrafiltration of Seawater for DOM and Amino Acid Determination

(L. Kretzschmann, N. Lahajnar)

Suspended particulate matter appears to exchange amino acids and nitrogen isotopes at subthermocline and oligotrophic stations, respectively, with the dissolved organic matter (DOM) pool (Gaye et al., 2013). Thus, it is important for the GENUS project to decipher the isotopic and reactive composition of dissolved organic compounds in order to understand the carbon and nitrogen cycle in the Namibian upwelling system. Therefore, we applied a newly designed ultrafiltration technique to accumulate DOM in designated water samples.

Tab. 5.1 Overview of ultrafiltration sampling.

Station	Date – UTC - GPS	Water Depth [m]	Remarks
2291	30.12.2013	200	SACW
	02:49:53	700	AAIW
	25°39.973’S 12°59.942’E	2000	NADW
010	05.01.2014	200	SACW
	06:08:28	800	AAIW
	23°02.287’S 12°18.611’E	1900	NADW
014	06.01.2014	40	Chlorophyll maximum
	18:01:43	300	SACW
	23°00.982’S 13°01.965’E	450	AAIW
028	07.01.2014	60	Chlorophyll maximum
	12:22:17		
	23°01.498’S 14 01.600’E		
048	12.01.2014	40	Chlorophyll maximum
	05:33:46	300	SACW
	17°14.954’S 10°59.909’E	800	AAIW
		2000	NADW

At each station, 30 L water samples of designated depths (Tab. 5.1) were collected during CTD-casts and filled in pre-cleaned containers. First, a subsample was taken for total organic carbon (TOC) measurement. The water was pre-filtered through GF/F glass-fibre-filters (pre-combusted at 450°C for 4h). From the filtrate another subsample was taken for dissolved organic carbon (DOC) determination. The remaining water was concentrated by an ultrafiltration technique. At the beginning, the ultrafiltration unit was adjusted to a cross flow ratio (CFR) ranging from 15 to 20. Based on the Pall tangential flow filtration system, two molecular weight cut-off membranes of 50 kDa and 1 kDa were used to get at least 3 different high-molecular-weight fractions: 50 kDa-0.7 µm, 1-50 kDa and <1 kDa.

For the 50 kDa-0.7 µm-fraction, the filtrate from the GF/F filtration was concentrated up to a volumetric enrichment factor of 20. Retentate (50 kDa-0.7 µm fraction) and permeate (<50 kDa-fraction) subsamples were taken for DOC measurements, acidulated with HCl and kept dark at 4°C. In the next step the permeate was taken and run through the 1 kDa-ultrafiltration up to a volumetric enrichment factor of 20. The resulting permeate-fraction divides between the <1kDa and the retentate fraction of 1-50 kDa. Again, subsamples were taken from both retentate and permeate. In addition, 250 mL water was taken from the 50 kDa-0.7 µm and 1-50 kDa fractions for amino acid determination and stored in the dark at 4°C. Chemical analysis will be performed after the cruise at the IfBM laboratories in Hamburg.

5.5.3 Suspended Matter Sampling

(J. Möbius, M.E. Vorrath, L. Teichert, N. Lahajnar)

Suspended matter of the water column has been sampled by filtration of volumes between 2 and 31.5 litres of sea water on pre-combusted and tarred glass fibre filters (WHATMAN GF/F; ~0.7µm; 47 mm diameter). Filtration was finished when filters were well covered (Tab. 5.2). Filters were further rinsed two times with deionised water in order to remove sea salt and subsequently dried in the oven at 40°C for 48 hours. After determination of total suspended matter loads (Fig. 5.29), the analytical program in the home lab will include biogeochemical analyses such as contents of total carbon and nitrogen, organic carbon, amino acid composition and stable isotope ratios of nitrogen.

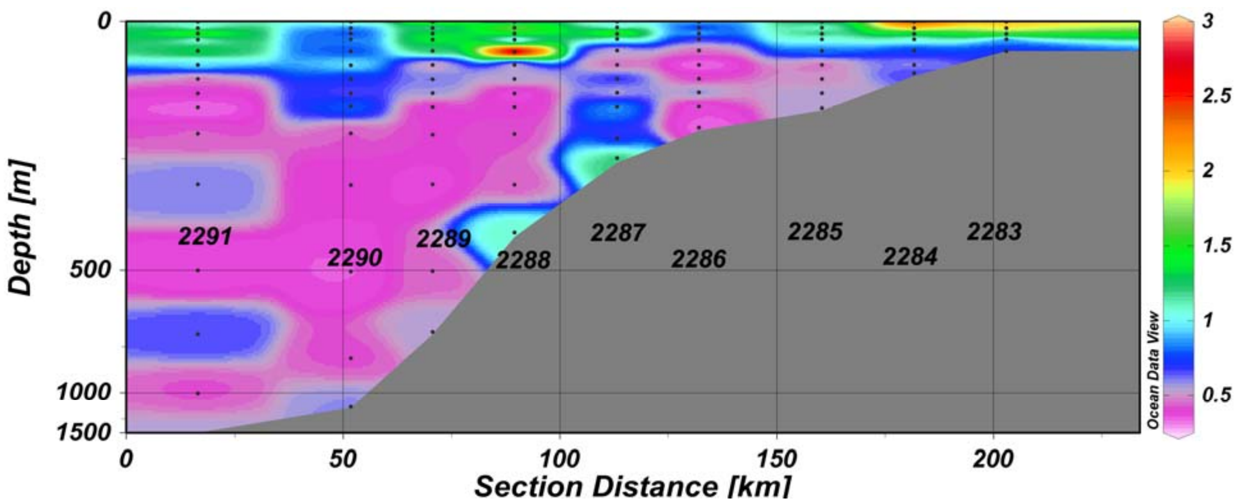

Fig. 5.29 Total suspended matter concentrations along the SW transect (stations 2283 to 2291) in mg/l. Overall loads are comparably low. Elevated concentrations in the surface waters at stations 2284 and 2285 probably reflect slightly enhanced productivity resulting from upwelling. Higher values at the bottom of stations 2287 and 2288 give evidence for sediment resuspension at the shelf break.

General sampling strategy for each station comprised surface water (recovered with a bucket) and – depending on water depth – further standard depths sampled by a free flow rosette sampler at 10 m, 20 m, 30 m, 50 m, 75 m, 100 m, 125 m, 150 m, 200 m, 300 m, 500 m, 800 m and 1000 m as well as 10 meters above the sea floor (Tab. 5.2).

In addition, at most stations a bottom water sampler (KUM K/MT 420) has been deployed with the purpose to sample and examine fluxes across the benthic boundary layer in a higher resolution. The bottom water sampler was equipped with five NISKIN bottles that sample volumes of each 7 l at 26 cm, 50 cm, 72 cm, 110 cm and 144 cm above the sea floor. In order to enable an exchange of bottle water the time lag for closing bottles was generally set to 3 minutes after entering the sea floor. According to extremely high suspended matter loads at the sediment water interface, filtration volumes were only 0.2 to 6.4 litres.

Bottom water sampling was not successful at stations 2280, 2284, and 34. We attribute this to a bumpy sea floor that handicapped the trigger mechanism.

Tab. 5.2 Stations and water depths sampled for suspended matter. BWS = successful bottom water sampling.

Station	Lat. [°N]	Lon. [°E]	W. Depth [m]	Bottle depth [m] derived from pressure sensor	BWS
2279	-23.24966	14.00008	151.3	0, 12, 22, 31, 52, 77, 101, 127, 145	
2280	-23.24938	13.49994	234.1	0, 11, 22, 31, 51, 77, 101, 153, 227	
2281	-24.00018	14.24952	127.0	0, 12, 21, 32, 51, 76, 101, 114	
2282	-24.60020	14.19908	150.9	0, 12, 21, 31, 52, 77, 102, 127, 144	
2283	-25.06614	14.73316	52.2	0, 12, 22, 31, 52	x
2284	-25.13268	14.53410	96.0	0, 11, 22, 32, 51, 76, 91	
2285	-25.19934	14.33310	158.6	0, 11, 22, 31, 51, 76, 101, 126, 154	x
2286	-25.28276	14.06640	196.3	0, 11, 21, 31, 51, 77, 101, 126, 151, 190	
2287	-25.34964	13.89985	1038.2	0, 11, 22, 31, 51, 77, 101, 126, 152, 211, 249	x
2288	-25.43316	13.66662	416.3	0, 11, 21, 32, 53, 76, 102, 152, 202, 302, 406,	x
2289	-25.48894	13.50076	700.0	0, 11, 21, 32, 51, 76, 102, 127, 152, 204, 302, 503, 692	x
2290	-25.54990	13.33317	1125.6	0, 12, 21, 31, 52, 77, 101, 127, 150, 201, 303, 503, 802, 1117	x
2291	-25.66622	12.99906	2217.1	0, 11, 21, 32, 52, 76, 101, 128, 153, 201, 301, 500, 701, 1005, 2013, 2243	x
1	-28.63386	16.26584	45.8	0, 11, 21, 31, 43	x
2	-28.63614	15.99884	120.8	0, 11, 21, 31, 51, 76, 101, 117	x
3	-28.63286	15.66704	164.2	0, 11, 21, 51, 102, 128, 159	x
4	-28.63308	15.33180	191.9	0, 12, 23, 31, 51, 76, 102, 128, 152, 184	x
5	-28.63324	14.99930	176.7	0, 11, 22, 31, 52, 72, 102, 127, 170,	x
6	-28.63292	14.66656	164.7	0, 11, 22, 32, 51, 71, 101, 126, 160	x
7	-28.64002	14.41730	373.9	0, 11, 22, 31, 51, 77, 101, 127, 152, 201, 301, 369	x
8	-28.63318	14.24990	735.5	0, 12, 20, 32, 51, 76, 102, 127, 152, 201, 301, 510, 720	x
9	-28.63354	13.78314	2025.0	0, 12, 22, 31, 52, 76, 100, 127, 152, 203, 302, 502, 802, 1102, 2042	x
10	-23.03806	12.30986	2089.9	0, 11, 21, 31, 51, 44, 102, 127, 154, 203, 304, 502, 802, 1004, 2105	x
11	-23.00006	12.79954	903.1	0, 11, 22, 31, 51, 77, 102, 127, 152, 202, 303, 502, 817, 902	
14	-23.01636	13.03272	458.4	0, 12, 22, 41, 53, 77, 102, 129, 153, 202, 301, 450	x
18	-23.01216	13.33684	362.0	0, 11, 21, 31, 52, 76, 102, 127, 151, 202, 302, 352	x
20	-23.00298	13.50258	243.4	0, 11, 21, 31, 52, 76, 101, 126, 151, 201, 235	x
22	-22.99580	13.67270	155.0	0, 12, 21, 31, 51, 76, 101, 126, 147	x
28	-23.02498	14.02668	137.9	0, 11, 22, 31, 52, 76, 101, 126, 131	x
30	-22.99532	14.16728	133.1	0, 11, 21, 31, 51, 77, 101, 114	x
34	-23.00012	14.36634	39.5	0, 10, 20, 31, 40	x
35	-22.00196	13.66846	120.7	0, 16, 117	
36	-20.99572	12.83106	306.1	0, 27, 295	
43	-17.24972	11.66503	77.6	0, 11, 22, 31, 52, 73	x
44	-17.27096	11.48871	148.3	0, 11, 21, 32, 51, 77, 101, 126, 145	x
45	-17.25782	11.39904	251.8	0, 11, 22, 31, 51, 76, 101, 128, 152, 240	x
46	-17.26360	11.30095	478.6	0, 11, 21, 31, 52, 76, 102, 126, 151, 202, 302, 467	x
47	-17.25812	11.16750	1020.7	0, 11, 21, 31, 51, 77, 102, 127, 152, 201, 302, 501, 803, 1015	x
48	-17.25012	10.99898	2110.2	0, 11, 21, 31, 51, 76, 101, 126, 151, 203, 300, 503, 802, 1003, 2118	x
53	-19.99950	11.83254	419.5	0, 11, 31, 51, 102, 202, 409	
59	-19.99916	12.33280	219.8	0, 11, 23, 31, 52, 101, 152, 212	
65	-19.99901	12.84977	102.9	0, 12, 21, 31, 51, 76, 91,	
67	-19.99994	12.99902	87.9	0, 12, 21, 31	

5.5.4 Denitrification and Stable Nitrogen Isotopes
(K. Dähnke)

In the Benguela upwelling system, large amounts of bioavailable nitrogen are removed in anoxic sediments and in the anoxic water column overlying the shelf. Two candidate processes are responsible for this conversion of fixed nitrogen to N_2: denitrification and anammox. Denitrification is heterotrophic, releasing CO_2 from organic matter, while anammox is autotrophic, so this represents an important link between N-loss processes and carbon cycling. Intriguingly, denitrification was long assumed to be solely responsible for N_2 generation, until, relatively recently, the importance of anammox in natural systems has been shown. Ever since then, more and more studies suggest that anammox is the main N_2 loss pathway within OMZs (Dalsgaard et al., 2012; Jensen et al., 2011; Kuypers et al., 2005), while relatively few studies find relevant denitrification rates (Gaye et al., 2013; Ward et al., 2009). However, there is evidence that spatial heterogeneity between anammox and denitrification is high (De Brabandere et al., 2013), and little is known of its seasonal variability.

The proportion of denitrification vs. anammox in the Benguela upwelling thus is under debate, and we aimed to re-assess the role of these two processes in a combination of natural abundance stable isotope measurements and rate determinations the isotope pairing technique.
The isotope pairing technique (IPT) can distinguish between anammox and denitrification, but has the draw-back that it relies on laboratory incubations, which may not represent true rates. On the other hand, the analysis of stable isotope signatures of nitrate, nitrite, and, where possible, ammonium in the water column can also be used to infer the importance of either process, because both processes strongly favour the light nitrogen isotopes over the heavy ones, and these trends in isotope values with concentration can be used to unravel these different nitrogen turnover processes (e.g. Gaye et al., 2013; Voss et al., 2001).

Sampling
Samples for stable isotope analysis were taken in depth profiles along three transects perpendicular to the coastline, at 17°S, 23°S and ~25°S, in total, 27 stations were sampled. Samples were filtered (0.45 µM PVDF) and stored frozen at -18°C for later analysis of $\delta^{15}N_{NO3}$, $\delta^{18}O_{NO3}$ and, where possible, $\delta^{15}N_{NO2}$. Nutrient concentrations were determined on board within TP4 with an automated continuous flow system.

The IPT was applied at selected stations (Stns #2284, #0028, #0030, and #0047), where water column [O_2] fell below 20 µM. Briefly, water samples were amended with $^{15}N\text{-}NO_3^-$ or $^{15}N\text{-}NH_4^+$ and incubated near in situ temperature for 24 hrs. Samples were processed in a glove bag, and great care was taken during all steps of sampling and incubation to minimize oxygen contamination. Incubation samples will be analyzed for the production of N_2 gas ($^{28}N_2$, $^{29}N_2$ and $^{30}N_2$) at the University of Southern Denmark, Odense.

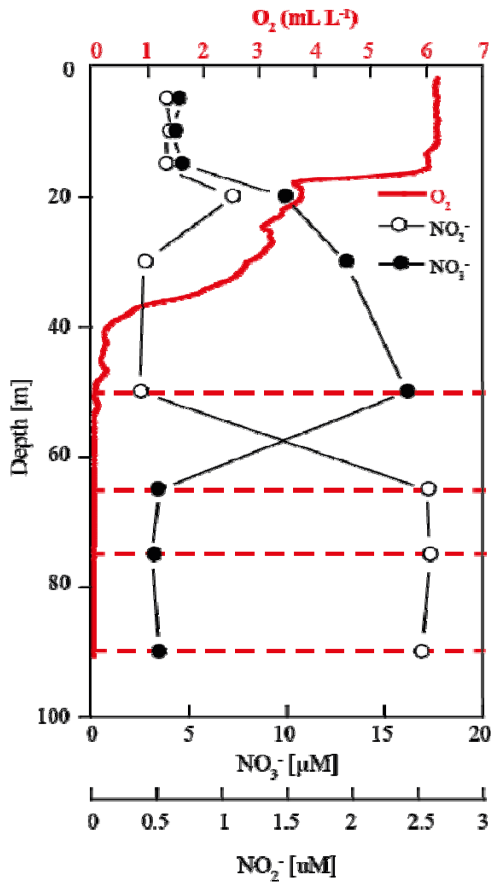

Fig. 5.30 Depth profile of [O2] and [NO3-] at Stn #2284. Dashed lines mark sampling for IPT.

Preliminary results

All isotope samples will be analyzed in shore-based laboratories after the cruise. Initial measurements of nutrient depletion in the isotope pairing incubations showed no visible change in nitrate or nitrite concentration, but this is within our expectations, because N_2 production rates in the water column usually are too low to be detected by mere concentration measurements over such short time scales. Nevertheless, the strong decrease of nitrate concentration in the anoxic water body at the selected station 2284 (nutrient data: courtesy of T. Rixen, A. Flohr, M. Birkicht, section 5.6) indicates that either denitrification or anammox are active at the sampling sites (Fig. 5.30). All further conclusions await natural abundance isotope determinations of dissolved inorganic nitrogen and label distribution in isotope pairing incubations.

5.5.5 Vertical Profiles of O_2, CO_2, H_2S, N_2 and CH_4 and Pore Water Nutrient Fluxes (M. Annighöfer)

Data generated during the first phase of the GENUS project and previous studies all suggest that processes of uptake and release of nutrients at the sediment-water interface are of prime importance in biogeochemical cycles of the Benguela Upwelling System (BUS). These processes at the sediment-water interface are analysed during the R/V METEOR cruise 103/1.

Material and Methods

Sediment cores have been taken from shelf- and continental slope sediments (33m – 2000m depth) of the BUS. Measurement and detection of bottom water and sediment oxygen concentrations via optode techniques (Glud et al., 1999; Klimant et al., 1997; Klimant et al., 1995; Kühl and Revsbech, 2001) have been performed on board immediately after core retrieval. The results of the oxygen concentration will help to prove or eventually disprove the influence of oxygen concentrations on the magnitude of sediment-water fluxes. The N_2 production in the sediment (from denitrification and anammox) was analysed with a membrane inlet mass spectrometer (MIMS) by direct measurement of the N_2/Ar ratio (Harnett and Seitzinger, 2003; Kana et al., 1994; Neumann, 2012). Additionally, the dissolved gases CH_4, CO_2, and H_2S have been measured via MIMS. The experimental and analytical settings have been assembled according to descriptions by Neumann (2012) in order to obtain comparable data at significantly enhanced spatial and seasonal resolution.

Overlying waters and pore waters of the sediment cores were collected in 1cm steps down to 10cm depth with rhizone samplers. Pore water and overlying bottom water were measured directly after extraction by ZMT Bremen. Additionally, pore water will be analyzed onshore (home laboratory HZG) for NO_2^-, NO_3^-, NH_4^+, Si, PO_4^-as well as concentration of dissolved metal and trace metals. The duplicate sample of pore water for nutrient analysis by ZMT and HZG will be used to compare the results of immediate analysis on board vs. home laboratory analysis. The samples for nutrient analysis (HZG) were frozen immediately after sampling and will be analyzed directly after the cruise. Nutrient concentrations in pore water and overlying water column (NO_2^-, NO_3^-, NH_4^+, Si, PO_4^-) will be analyzed with an Auto Analyzer (SEAL Analytical AA3) according to Grasshoff et al. (1999). Nutrient fluxes will be calculated from concentration profiles as a function of the sediment depth and permeability (Berg et al., 1998). The locations of the sampled station as well as the determined parameters are listed in Tab. 5.4 and 5.5.

Oxygen measurements across the water-sediment interface

Directly after retrieval of the sediment cores from seafloor, the oxygen concentration across the water-sediment interface was determined. The oxygen concentration was measured directly above the sediment surface in 1mm steps down to zero concentrations of oxygen. The oxygen penetration depth in the sediment in all cores never exceeded 1.5 cm. Oxygen was measured with microoptodes (PRESENS) and calibrated with a 2-point calibration (0% and 100% O_2 saturation). The optode was moved through the water-sediment interface and down into the sediment core with an automated micromanipulator (PYRO SCIENCE). Unfortunately the oxygen measurement along the first transect (Saint Francis Bay) is biased due to erroneous calibration. The oxygen concentration right above the sediment ranged from 32µmol/l, directly in front of the Kunene River, to 199µmol/l at the continental slope of the 17°S transect.

Measurements of dissolved gases across the water–sediment interface

After the oxygen concentration was determined, the same core was used to measure dissolved gases across the water-sediment interface. N_2, Ar, H_2S, CO_2 and CH_4 have been measured with a membrane inlet mass spectrometer (INPROCESS INSRUMENTS). A needle type inlet moved through the water-sediment interface down 10 to 15cm into the sediment core. The needle was directed automatically by a micro manipulator (PYRO SCIENCE). The MIMS was calibrated with a 4-point calibration with different salinity standards of 0, 12, 24 and 36 PSU. Via these standards a calibration curve was established to convert the signal ratio for N_2 (m/z 28) and Ar (m/z 40) to the molar ratio of nitrogen and argon in the sediment cores (Harnett and Seitzinger, 2003; Neumann, 2012). Further interpretation of the dissolved gas profiles will follow soon.

5.5.6 Sediment Trap Recoveries and Deployment

(N. Lahajnar, J. Möbius, L. Kretzschmann)

One major goal of the GENUS project (Phase II) was to deploy sediment trap moorings across the shelf in order to quantify and to qualitatively describe the descending particle flux from the photic zone to the sediment surface. Due to the complex structure of the water masses and varying upwelling intensities, the true vertical particle flux is most-likely also affected by a lateral flux component - particularly in the area of the upper slope - and thus influences sedimentation processes. Changing particle flux rates and components can lead to a biogeochemical shift of the coupled carbon, nitrogen and oxygen conditions in the Benguela region. For instance, the Benguela system can act as a sink or source for atmospheric CO_2 or, for example, the sediments release or uptake nitrate under different conditions.

The purpose of the sediment trap deployments is to investigate the variation of particulate matter settling from the sea surface to the bottom in space and time. Particle flux studies represent a key link between surface ocean processes (e.g., primary productivity) and particle sedimentation and accumulation at the seafloor and thus are an invaluable tool for understanding sedimentation records. Detailed analyses of bulk composition and specific organic compounds will provide information on the sources, early diagenetic alteration (in combination with sediment studies from GENUS Phase I) and transport processes of the particulate organic matter in the water column. Additional investigations on the biological components, i.e. phytoplankton and zooplankton species being trapped over the annual sampling period, will help to understand the ecological processes in the study area.

Tab. 5.3 Sediment trap deployment along the 23°S transect.

Mooring ID	Position	Water Depth [m]	Trap Depth [m]	Sampling Cycle [days]	Trap Type	Remarks
WBST East-03	23°01.35'S 14°01.67'E	ca. 130	57	30	HYDROBIOS MST-12	Recovered on M-103/1
WBST Central-01	23°00.93'S 13°01.83'E	ca. 440	210	30	HYDROBIOS MST-12	Lost
WBST West-01	23°02.55'S 12°18.50'E	ca. 2050	1518	30 / 15	KUM KM/T 234	Dredged on M-103/2

During Leg 1 of Cruise RV MIRABILIS January 2013 three sediment trap moorings were deployed on the Walvis Bay transect (23°S). The sediment traps were programmed to sample the particle flux from January 2013 until January 2014. Mooring overviews are given in Tab. 5.3. Moorings WBST-Central and WBST-West were equipped with additional sensors such as

AANDERAA current meters RCM-9 or SEABIRD salinity and temperature sensors SBE-37 SI. Information on the physical conditions of the trap environments is important to interpret the particle flux over the sampling period as, for example, current speed and current direction could significantly influence the settling particles in the water column.

WBST East-03 was recovered without any problems (although the first cup was missing due to seal bites!) and re-deployed at the same position until October 2014. The oceanographic boundary conditions were measured with a separate mooring close to this station (see section 5.2) WBST Central was lost most-likely due to intense fishing activities (see cruise narrative section 4.1). Contact between WBST West-01 and the BENTHOS (and KUM) deck units were established; however, the system did not moved up. During M-103/2 a dredging attempt was successfully performed so that the complete system could have been retrieved without any losses. Most probably the lower steel wire had been clamped by the anchor weight. Particle fluxes (estimates) on the inner shelf did not vary as much as at the continental margin (Fig. 5.31).

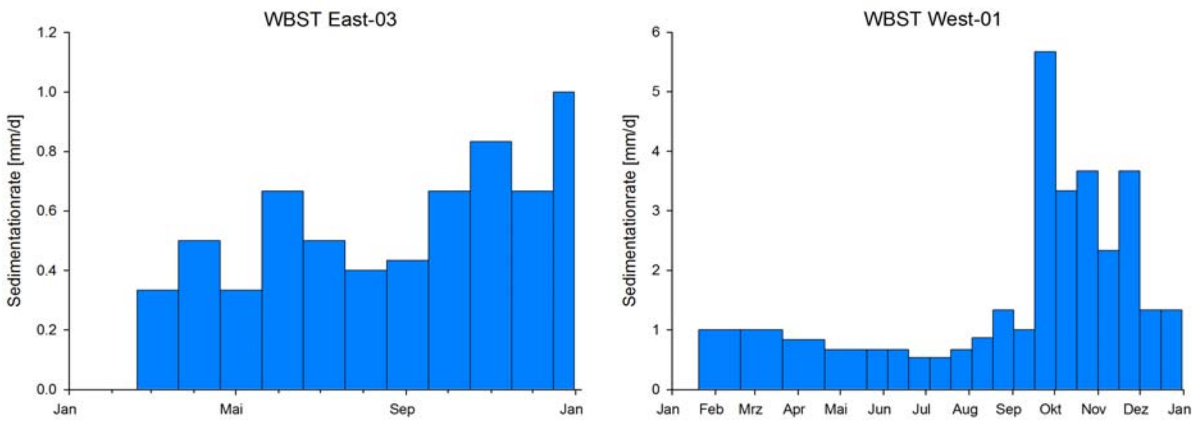

Fig. 5.31 Particle fluxes (estimates) derived from cup load measurements.

5.5.7 Sediment Sampling

(J. Möbius, M. Ankele, M.-E. Vorrath, L. Teichert, N. Lahajnar)

Sediment sampling has been performed with an OCTOPUS multicorer that was equipped with eight polyacryl tubes (60 cm length; 10 cm diameter). In order to prevent caving of the multicorer in the very soft sediments of the mud belt, three wooden planks were fixed at its base. Sediments sampled cover the spectrum from terrestrial dominated siliciclastic sands in front of Orange River mouth via diatom mud in the high productive mud belt to pelagic foraminifera oozes at the most distal and deepest stations. Interestingly, deep-sea sediments at stations 46 to 48 are very similar to shelf sediments as they are mostly composed of diatoms and faecal pellets. We attribute this to intense sediment redistribution from the shelf down the relatively steep continental slope in this area.

Core recovery was typically about 20 cm. Due to very soft sediments at stations 28 and 30 no sediment surface could be sampled although all lead weights were removed. Sampling was not successful at stations 2286 and 2292 which may have been due to very hard seafloor. Generally, tubes were sampled by four different working groups (Tab. 5.4).

Tab. 5.4 List of multicorer sampling. Leads = lead weights on top of multicorer. PW = pore water; UB = Uni Bremen; FL = fluffy layer; d = dark.

Station	Water Depth (m)	Core length (cm)	Lead Weight	Sediment Type	IfBM (0-10cm)	IfBM PW	ZMT PW	UB (0-2cm)	FL
2279	146	58	6	green ooze	x				
2280	227	16	6	sandy	x				
2281	114	47	6	green ooze	x			x	
2282	144	50	6		x			x	
2283	55	30	6	d green ooze	x				
2284	90		6	3 failures					
2285	152	32	6	d green ooze, shells	x	x	x	x	
2286	189		6	2 failures, ground too hard?					
2287	251	10	6	d green ooze	x	x	x	x	x
2288	404	28	10	d green ooze	x				x
2289	687	37	10	d green ooze	x	x	x	x	x
2290	1102	34	10	green ooze, sandy	x				x
2291	2230	18	12	light brown sandy mud, ophiouridea	x	x	x	x	
2292	200		12	2 failures, ground too hard?					
1	43	20	12	d/l green sand	x	x		x	x
2	115	16	12	d green, sandy	x	x	x	x	
3	160	20	16	sandy (mS)	x	x			
4	188	14	16	light green grey, mS-fS	x				
5	170	21	16	green-grey, mS-fS	x			x	x
6	160	5	16	light sand, well sorted	0-1 cm				
7	366	23	16	green brown mS	x	x	x		x
8	731	26	16	green grey, mS	x			x	x
9	2027	27	16	light grey foraminifera ooze	x	x		x	
10	2100	20	16	light grey foraminifera ooze	x	x	x	x	
14	450	28	16	brown grey fS	x	x	x	x	
18	350	28	16	brown grey fS	x				
20	234	28	16	d green sand, shell fragments, worms	x			x	
22	149	19	16	d green mud, depth incr. shells; fish, worm tubes	x	x			
28	130	60	0	d green mud, H_2S smell					
30	125	60	0	d green mud, H_2S smell					
34	40	35	0	d green mud, H_2S smell; well layered	x	x			
36	293	22	10	d green mud, forams, shell fragments	x			x	
39	233	16	10	d green mud, forams, shell fragments	x	?		?	x
41	210	12	14	d green, fine sand	x	?		?	
43	142	47	14	d green mud, many snails, slime eel	x	x	x	x	
44	152	25	14	d green sandy mud, many snails	x	x	x		
45	245	17	16	d grey, basaltic sand; forams and radiolaria	x			x	
46	463	17	16	d green, black/brown smears	x	x	x	x	
47	1013	18	16	d green mud	x			x	
48	2112	27	16	green mud, sandy	x	x		x	
53	409	21	16	green mud, sandy	x	x	x	x	x
59	212	23	16	d green mud, increasing shells	x	x	x	x	x
65	98	50	16	d green mud; H_2S smell	x	x			x
67	28	28	12	d green mud; H_2S smell	x				x

At every station the uppermost 10 cm were sampled in 1 cm slices and stored deep frozen at -20 °C for analyses of C and N contents, stable N isotopes and amino acid composition at the IfBM. At selected stations pore water profiles from each two cores were sampled by ZMT and IfBM working groups in order to determine nutrient contents, denitrification rates and further parameters. The 0 to 2 cm interval was sampled and stored deep frozen by Bremen University with purpose of further investigation of microbial life.

5.6 Carbon and Nutrient Cycling

(T. Rixen, A. Flohr, M. Birkicht)

Introduction

One of the main GENUS objectives is to clarify the relationships between upwelling and greenhouse gases emissions from the Benguela upwelling system (BUS). The subproject TP4-Biogeochmistry aims to study the functioning of the biological pump. The biological pump strongly influences CO_2 fluxes across the air-water interface and the distribution of dissolved oxygen in the water column. Furthermore it plays an important role for the long-term sequestration of atmospheric CO_2 by linking the three major carbon reservoirs, atmosphere, ocean and lithosphere (e.g. McElroy, 1983). During cruise M103 newly developed instruments were applied that continuously measure gas concentrations but also the carbon isotopic ratios of CO_2 ($\delta^{13}C_{CO2}$) and CH_4 ($\delta^{13}C_{CH4}$) in the ocean and the atmosphere. These isotopic data will help to better understand the carbon dynamic in ocean and the atmosphere. Additionally, water samples were taken along cross-shore transects for later analysis on the vertical characteristics of the inorganic carbonate system and the distribution of dissolved inorganic nutrients. Recently published GENUS results showed that in addition to nitrate reduction via anammox and denitrification also nutrient fluxes across the sediment water interface could control the nutrient ratios on the Namibian shelf where upwelling is strongest (Flohr et al., 2014; Nagel et al., 2013). To quantify the nutrient fluxes across the sediment water interface and to investigate the role of sediments texture and the bottom-water oxygen concentration on the microbial community structure sediment cores were studied jointly by working groups from ZMT, HZG and the University Bremen/ Hellenic Centre for Marine Research, Crete.

Aims

Our aims during this cruise M103/1 were:

1. to determine pH, CO_2, CH_4 and the carbon stable isotope composition of CO_2 and CH_4 concentrations in surface water along the cruise track,
2. to measure dissolved nutrients (PO_4, NO_3, NO_2, Si), total Alkalinity (TA) and dissolved inorganic carbon (DIC) concentrations in water samples collected along vertical profiles,
3. to take samples for the determination of dissolved organic carbon (DOC) and stable carbon isotope ratios of DIC ($\delta^{13}C$ – DIC),
4. to jointly (working groups from ZMT, HZG and the University of Bremen/ HCMR, Crete) study nutrient fluxes across the sediment water interface and the role of sediments texture and the bottom-water oxygen concentration on the microbial community on sediment cores (see section 5.5).

Material and Methods

The atmospheric measurements were carried out jointly with the Max Planck Institute of Biogeochemistry in Jena, Germany (MPI BGC), for which we maintained a PICARRO G1301 (CFADO-96) determining continuously the concentrations of CO_2 and CH_4 in the atmosphere. Our ocean/atmosphere underway systems consisted of a SUNDANS (#001), a PICARRO G2201-i (1510CFIDS2047_v1.0) and a FERRY BOX. The underway measurements are complemented by data measured by a THERMOSALINOGRAPH (TSG) and the DWD office on board R/V METEOR.

The mole fraction of CO_2 (xCO_2) of surface water and atmosphere was continuously measured by the SUNDANS system (MARIANDA, Kiel). The system was calibrated every 7 hours by measuring pure nitrogen and two different standard gases with mixing ratios of CO_2 in air covering the range of the expected pCO_2 values (CO_2 = 380.9 ppm, bottle no.: DO45090; CO_2 = 799.4 ppm, bottle no.: DO45116). The validation gases were provided by DEUSTE STEININGER and prior to its use at sea they were recalibrated against NOAA standard gases (Ref. No. CB08923, 359.83 ppm and CA06265, 1021.94 ppm) at the ZMT. The collected data will be evaluated and used to convert xCO_2 to the fugacity of CO_2 (fCO_2) which is required to calculate the CO_2 flux across the sea water interface.

In addition, a cavity ring down spectrometer (PICARRO G2201-i) was coupled to an equilibrator allowing the underway determination of the mole fraction and isotopic composition of CH_4 and CO_2 both in the water phase and in the atmosphere. The PICARRO was run in two modes alternating between the equilibrator mode (280 minutes) and atmospheric mode (60 minutes). In between these two modes the system was flushed for 20 minutes. These two flushing-periods were excluded from the data evaluation. A target gas (DEUSTE STEININGER) with known CO_2 (199.8 ppm) and CH_4 (1805 ppb) concentrations was measured once a day for later recalibration (bottle no.: DO45090, provided by the working group of H. Bange, GEOMAR, Kiel). The PICARRO G2201-i was further coupled to an AUTOMATE FX unit for measuring DIC in discrete water samples. For calibration of the DIC analysis certified reference material (CRM, batch #111, provided by A. Dickson (Scripps Institution of Oceanography, La Jolla, CA, USA)) was used.

A FERRY BOX system (4H JENA) was installed to record the S, T, O_2 and pH in surface water along the cruise track. The FERRY BOX is equipped with a "SBE45 Micro TSG" as well as with an "AANDERAA Oxygen Optode 3835 (S/N 1732 – SR10/RS-232)" and a pH sensor (MEINSBERGER ELECTRODE – EGA 140 /PT1000). To recalibrate the pH electrode the measured TA and the SUNDANS xCO_2 (converted to fCO_2) will be used to calculate the pH (sea water scale) by using the subroutine CO_2sys. Please refer also to the Tab. 5.5 summarizing the measured parameters.

The measurements of TA were performed on board with a VINDTA 3S system (MARIANDA, Kiel) following Dickson et al. (2007). The VINDTA 3S was calibrated using certified reference material (CRM, batch #111, provided by A. Dickson (Scripps Institution of Oceanography, La Jolla, CA, USA)). The standard measurements agreed to ±2.1 µmol kg^{-1} to the reference value. Additionally, fixed surface water was used as sub-standard. The water samples were fixed with saturated $HgCl_2$ (150 µL per 250 ml of sample) immediately after sampling.

Discrete Water Sampling

Vertical profiles were obtained by CTD casts along cross shelf transects (Tab. 7.1). The filament was sampled down to 400 m water depth. Water samples were taken for later analysis on DIC, DOC and stable isotopic ratio of $\delta^{13}C_{DIC}$ while TA and nutrient samples were measured on board. The measurements of TA were performed with a VINDTA 3S system (MARIANDA, Kiel) following Dickson *et al.* (2007). The VINDTA 3S was calibrated using certified reference material (CRM, batch #111, provided by A. Dickson (Scripps Institution of Oceanography, La Jolla, CA, USA)).

For nutrient (NO_x, NH_4, SiO_2, o-PO_4) measurements the water samples were filtered (0.45 µm syringe filter) and analyzed by a segmented continuous flow analyzer (SKALAR SAN++) applying photometric and fluorometric methods according to standard procedures (Armstrong et al., 1967; Grasshoff et al., 1999; Kerouel and Aminot, 1997; Murphy and Riley 1962).

Pore Water Chemistry

Sediment cores were taken along 5 transects and were obtained by a multicorer, which was operated by the University of Hamburg (Tab. 5.4). Samples for the determination of nutrients, DIC and DOC were taken from the supernatant water overlying the sediment as well as from the pore water. For details on the sampling and methods used please refer to the above section. The pH was measured in the supernatant water overlying the cores and in the pore water using a SENTIX 81 pH electrode (WTW) and prototype optical pH sensors provided by PRESENS (Regensburg, Germany).

Tab. 5.5 Summary of measured parameters and the applied methods.

No	**Parameter**	**Methods**					
		G1301	**G2201-i**	**SUNDANS**	**FerryBox**	**DSHIP**	**Titration**
	Atmosphere						
1	xCO_2	X	X				
2	$\delta^{13}C_{CO2}$		X				
3	xCH_4	X	X				
4	$\delta^{13}C_{CH4}$		X				
5	Pressure			X		X	
6	Wind direction					X	
7	Wind speed					X	
	Water						
8	xCO_2		X	X			
9	$\delta^{13}C_{CO2}$		X				
10	xCH_4		X				
11	$\delta^{13}C_{CH4}$		X				
12	SST				X	X	
13	Salinity				X	X	X
14	Oxygen				X		
15	EQ-Temp.			X			
16	pH				X		
17	TA						X

Preliminary Results

Our preliminary result show, e.g. high CO_2 concentrations along the coasts of Namibia south of Lüderitz. An upwelling induced plankton bloom reduces the CO_2 concentrations, which even falls below those in the atmosphere and turns the region into a CO_2 sink (Fig. 5.32). Our simultaneous measurements of CH_4 show on the other hand that exactly at the site were the plankton reduces the CO_2 it increases the methane concentrations. If the biological carbon pump acts as CO_2 sink and CH_4 source, it rises the questions how the upwelling-driven carbon pump influences greenhouse effect, and therewith our climate. In order to better understand the system and answer such questions our results will be discussed in detail our GENUS colleagues after our return to Germany.

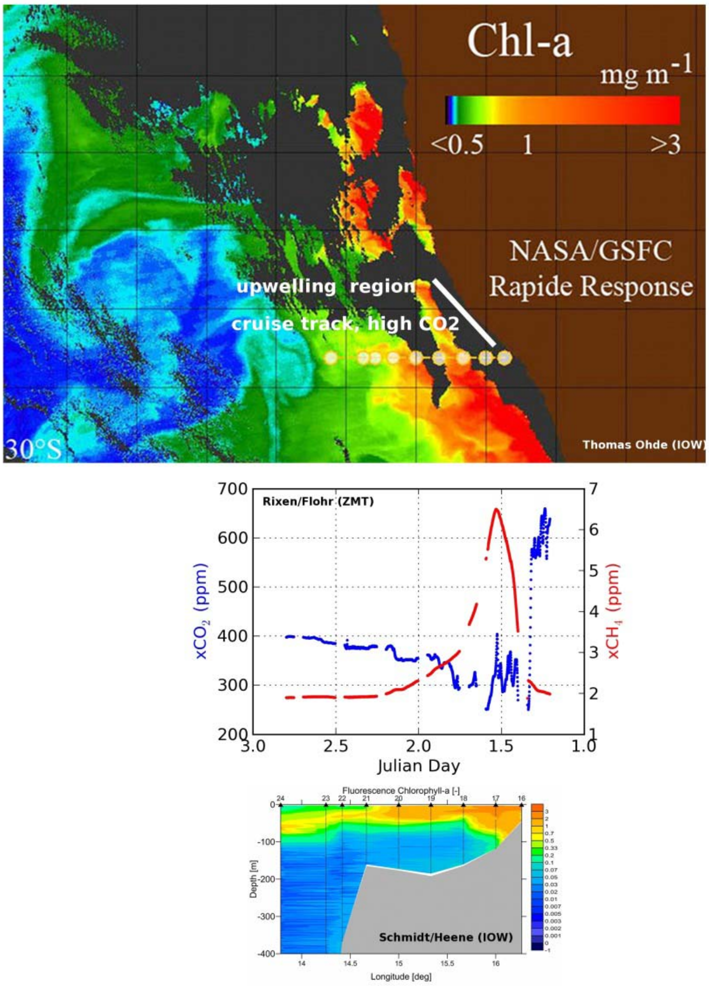

Fig. 5.32 Satellite data showing the spatial chlorophyll a distribution as well as the cruise track (bold white line) where the CO_2 concentrations were up to 600 ppm. At the first station on the transect (indicated by the white circles Chl a data showing an intensive plankton bloom reducing the CO_2 and increasing the CH_4 concentrations.

The nutrient concentrations in the water column, the bottom water and the pore water are shown for stations #10 and #34 representing the offshore most and coastal most stations of the Walvis Bay transect (Fig. 5.33).

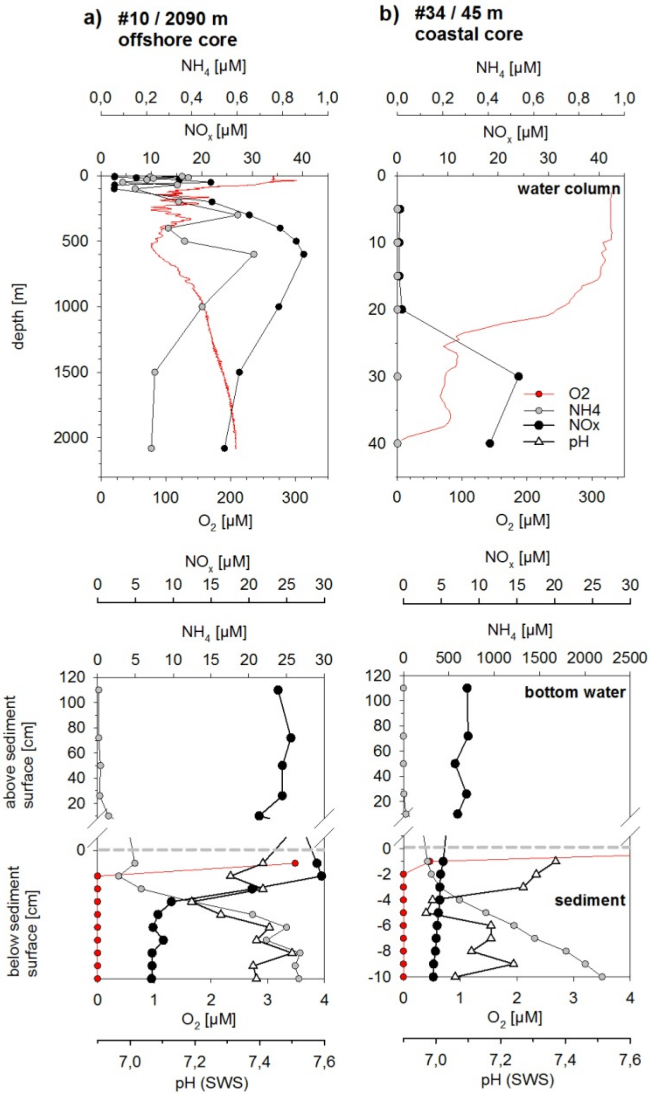

Fig. 5.33 (a) an offshore core and (b) a coastal core taken along the Walvis Bay (23° S) transect. Preliminary results of O2 (red line), NO_x (black circles), NH4 (grey circles) and pH (open triangles, only in sediment pore water) as measured in the water column (upper panel) and bottom and pore water (lower panel), respectively. The O2 concentrations are the courtesy of TP2 and not validated yet.

At the offshore station highest nutrient concentrations were observed in the oxygen minimum zone at ~600 m water depth indicating oxic remineralization. In contrast, N-reduction under anoxic conditions is suggested by the decreasing NO_x concentrations at #34 in the bottom water and pore water also indicated by the very low O_2 concentrations. The most pronounced differences were observed for NH_4 that did not exceed 1 µmol kg^{-1} throughout the water column but shows a 10 fold increase in the coastal core compared to the offshore core off Walvis Bay (23° S) (Fig. 5.33). A strong increase of PO_4 and SiO_2 in pore waters was observed as well (not shown) but is less pronounced.

The pH in pore waters ranged from 6.97 – 7.73 with low values related to coastal organic-rich sediment cores.

Filament investigations

The underway measurements showed a low spatial variability along the transects that were sampled perpendicular to the coast. The typical influence of upwelling expressed in elevated xCO_2 (~550 ppm) and xCH_4 (~5 ppm, data not shown) concentrations close to the coast with decreasing values towards offshore direction was measured (Fig. 5.34). However, a pronounced variability would be expectable when crossing a filament structure with pronounced fronts suggesting that we sampled a weak filament structure with stronger expression in subsurface which cannot be detected by the underway systems.

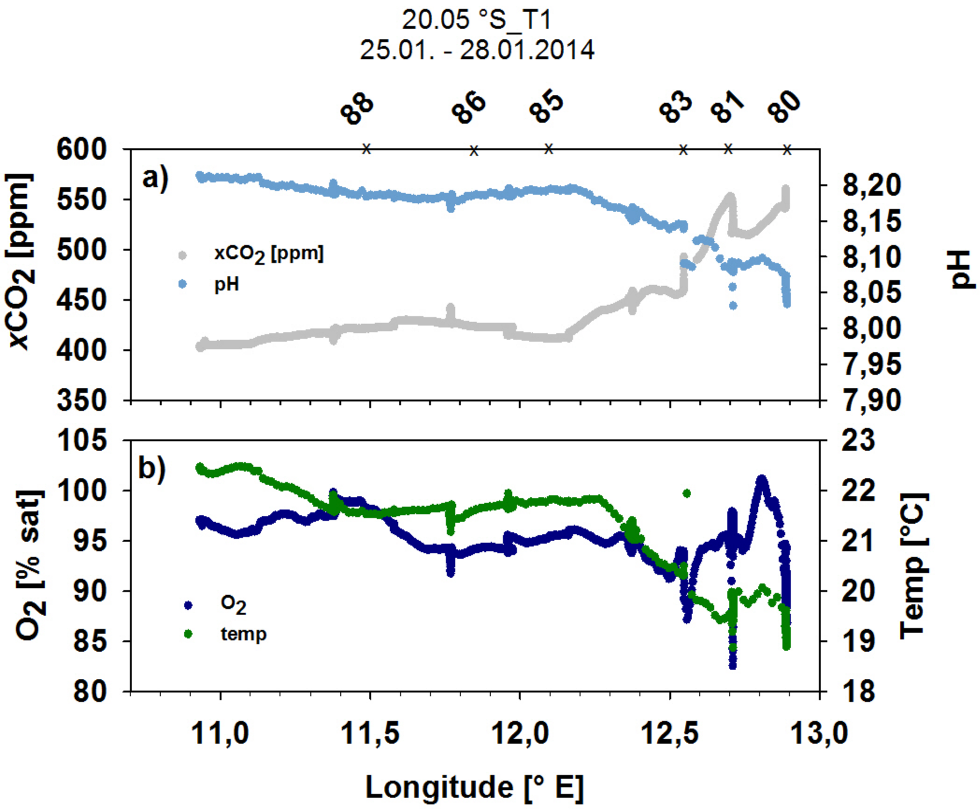

Fig. 5.34 Preliminary results of a) xCO2 (ppm) and pH, b) O2 (% sat) and temperature (°C) in surface water along the first sampled transect perpendicular to the coast off ~20.05 °S (25. – 28.01.2014). Station numbers are indicated.

At the end of the filament study the transects that were sampled perpendicular to the coast were crossed by a ScanFish cross section. Preliminary results of this ScanFish cross section are shown in Fig. 5.35.

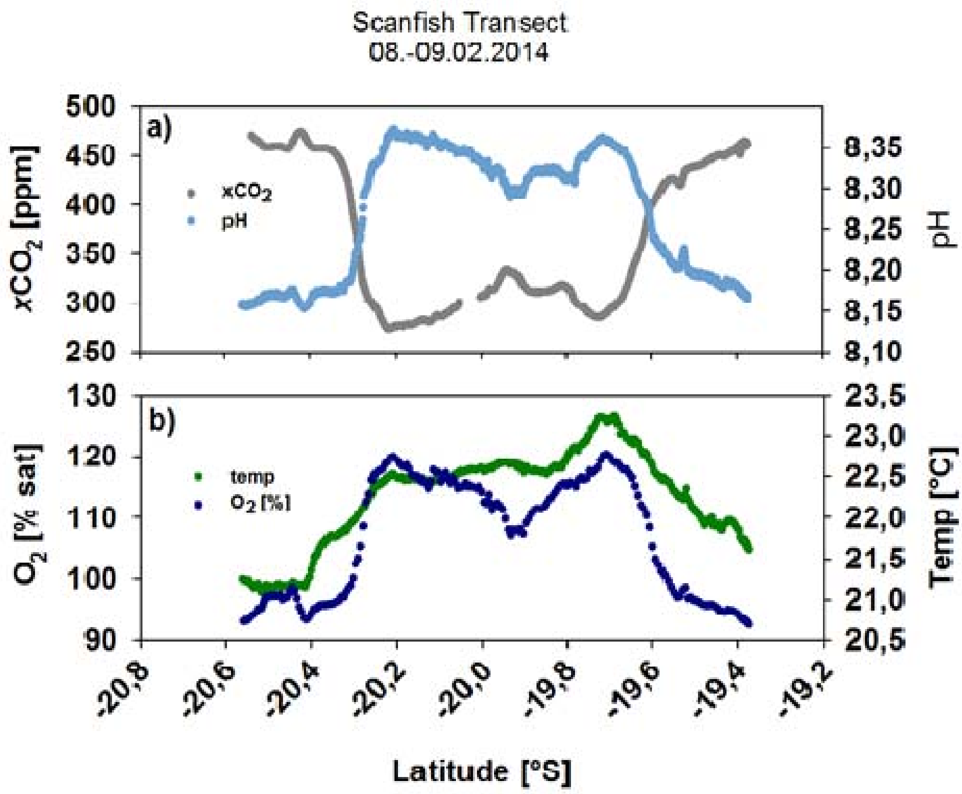

Fig. 5.35 Preliminary results of underway measurements a) xCO2 (ppm) and pH, b) O2 (% sat) and temperature (°C) during a during the SCANFISH cross section (08.–09.02.2014) (also refer to section 5.2).

Instead of pronounced fronts a rather gradual decrease of surface water temperature was observed without clear filament structure. However, during this section strong gradients in xCO_2 were observed with lowest xCO_2 values of ~260 ppm which are strongly below atmospheric values indicating a net flux of CO_2 into the water. The coinciding O_2 increase suggests that this drop in xCO_2 was caused by intense primary production. However, these are preliminary results and still subject to validation.

The samples taken for determination of dissolved nutrients, DOC, δ^{13} CDIC and DIC will be measured subsequently to the expedition.

5.7 Micro- and Mesozooplankton

5.7.1 Microzooplankton

(B. Martin, K. Bohata, R. Koppelmann, Silke Janssen, H. M. Cordts)

Microzooplankton are small predators (up to 200 µm) consisting of Protozoa and Metazoa. Microzooplankton organisms are important members of the pelagic food web since they provide a link between primary producers and higher trophic levels. In the past, only few studies on microzooplankton distribution and composition and their position in the food web related to different water masses were conducted in upwelling areas.

To estimate the distribution of different microzooplankton groups, samples were collected by vertical hauls in max. five depth intervals (max. haul depth: 100 m) using a multiple-closing-net (HYDROBIOS) with a mesh size of 55 µm on every transect during the first leg and on every station during the filament study (leg 2). All material was preserved in a 4% formaldehyde-seawater solution buffered with sodium-tetraborate. During the filament study, no differences between the fixed samples taken on the three parallel transects (outer southern and northern transect and inner middle transect) could be detected; however, exact analyses of the samples will be undertaken in home laboratory (Fig. 5.36). Additionally, water samples were collected using the CTD-rosette sampler. Depending on sampling depth, between 200 ml and 450 ml of seawater were fixed with acidic Lugol's solution (75 samples; Tab. 5.6). All samples were kept dark at 5°C until further analyses.

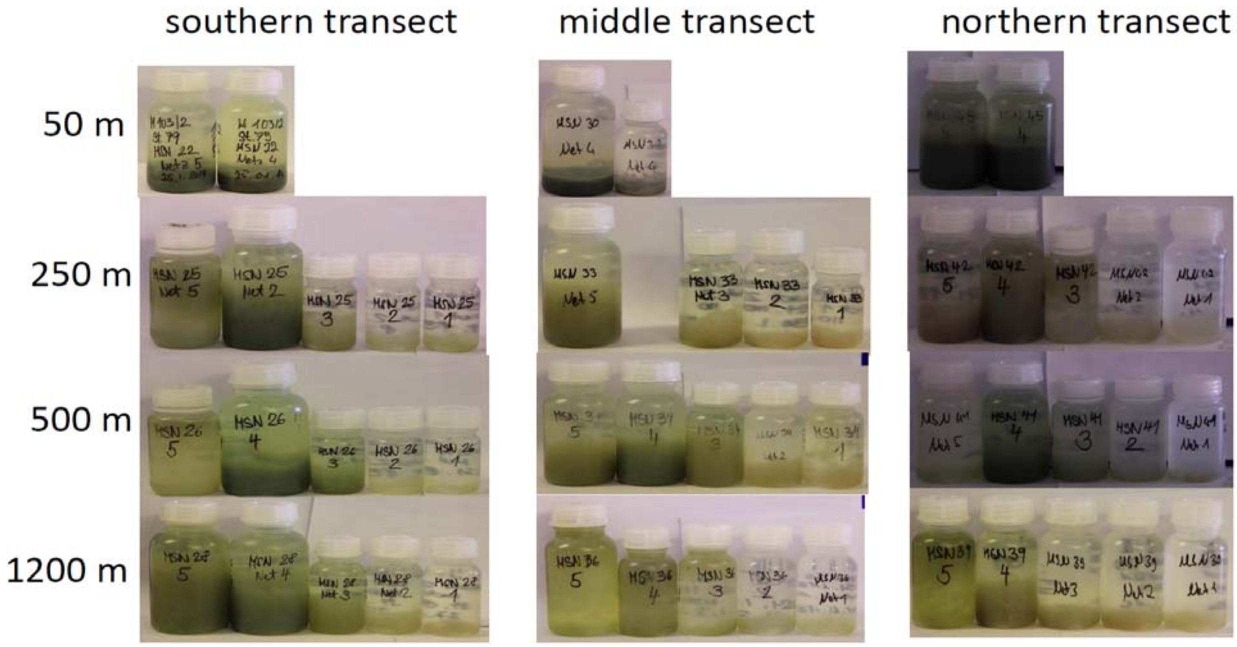

Fig. 5.36 Samples of microzooplankton taken on the three transects in the upper 100 m depth during the filament study.

To estimate the importance of microzooplankton as grazers of phytoplankton, the dilution technique introduced by Landry and Hassett (1982) has been used. This method assumes that phytoplankton growth rates in incubated samples are not affected by the dilution level, but the mortality declines proportional to the dilution level, due to the decreased concurrence between the primary producers and grazers. We conducted 16 dilution experiments, two on each transect during the first leg and 7 during the filament study (Tab. 5.6). For each experiment, water was collected from the surface using the CTD-rosette sampler and gently siphoned into the 30 L canister through a 200 µm mesh to remove larger mesozooplankton. Water for the dilution series was filtered through WHATMAN GF/C glass fiber filter (0.2 µm). Series of dilutions (100, 80, 60 and 40 %) were made up by gently combining the siphoned water and the 0.2 µm filtered seawater. The bottles were incubated in a temperature-controlled room (17 ± 4°C) under (12:12) dark:light cycle. The incubator was equipped with rotating wheels to keep particles from settling. Triplicate subsamples were taken from all dilution levels at the beginning and at the end of the experiments for the measurement of initial chlorophyll concentrations. The subsamples were filtered onto 25 mm WHATMAN GF/C glass fiber filters and stored dark at -20°C until further analyses.

Tab. 5.6 Overview of sampling stations for microzooplankton; MSN = hauls with Multi-closing-net, EXP = experiments, WS = water samples

St. No.	Transect	Lat.	Long.	Depth [m]	MSN	EXP	WS
79	southern t.	20°01'S	12°58'E	40	√		√
80	southern t.	20°02'S	12°53'E	80	√		√
81	southern t.	20°05S	12°43'E	123	√	√	√
83	southern t.	20°12'S	12°23'E	252	√	√	√
85	southern t.	20°20'S	11°58'E	501	√		√
86	southern t.	20°24'S	11°46'E	840	√		
88	southern t.	20°31'S	11°23'E	1179	√		
89	southern t.	20°39'S	10°57'E	1748	√		
104	middle t.	19°40'S	12°49'E	42	√		√
105	middle t.	19°42'S	12°43'E	90	√		
107	middle t.	19°46'S	12°31'E	130	√	√	√
110	middle t.	19°56'S	12°13'E	244	√	√	√
114	middle t.	20°07'S	11°49'E	496	√		√
116	middle t.	20°10'S	11°32'E	857	√	√	√
118	middle t.	20°13'S	11°10'E	1222	√		
119	middle t.	20°20'S	10°48'E	1469	√		
120	northern t.	20°00'S	10°38'E	1399	√		
121	northern t.	19°52'S	11°03'E	1202	√		
123	northern t.	19°46'S	11°21'E	860	√		
125	northern t.	19°41'S	11°34'E	504	√		√
131	northern t.	19°33'S	12°00'E	301	√	√	√
135	northern t.	19°25'S	12°23'E	130	√	√	√
137	northern t.	19°22'S	12°34'E	82	√		
138	northern t.	19°20'S	12°38'E	47	√		√
142	cross section	20°30'S	12°04'E	495	√		
144	cross section	20°07'S	11°48'E	498	√		

5.7.2 Mesozooplankton

(B. Martin, K. Bohata, R. Koppelmann, Silke Janssen, H. M. Cordts)

Zooplankton organisms are important for the transfer of organic material from primary producers into higher trophic levels and greater depths. They play an important role for the re-mineralization of organic matter (Robinson et al. 2010). The main goals of the GENUS subproject 5 during the METEOR cruise 103 were to examine the horizontal and vertical distributions of different groups of micro-, meso- and macrozooplankton on the Namibian shelf and offshore (leg 1) as well as related to an upwelling filament (leg 2), their trophic role, and their contribution to the oceanic carbon cycle in the high productive Benguela upwelling region. The variability of these processes and the involvement of different zooplankton groups will be assessed in the GENUS project. To study the link between the biological production in the upper water column and the benthos, bottom-near zooplankton was sampled during both legs of the cruise.

During leg one a synoptic sampling of the mesozooplankton in the northern Benguela was performed with the 1 m² Double-MOCNESS (Multiple Opening and Closing Net and Environmental Sensing System, 330 µm mesh seize, Wiebe et al. 1985) to analyse the role of different zooplankton groups for biogeochemical and ecological processes in the region. Additionally, several hauls were undertaken with a Multiple-closing-net (HYDDROBIOS; mesh aperture 300 µm, five nets; Tab. 5.7).This is part of time-series sampling already performed in March/April 2008 (RV MARIA S. MERIAN), December 2009 (FRS AFRICANA), September/October 2010 (RRS DISCOVERY), January/February 2011 (RV MARIA S. MERIAN), and September 2013 (RV METEOR).

Tab. 5.7 Sampling data of vertical Multinet hauls (300 µm) for mesozooplankton analyses.

Haul	Station#	Date	Start Time UTC	Water Depth [m]	Region	Sample intervals [m depth]
23	79	25.01.14	19:19	48	Filament outside south	40-25-0
24	80	25.01.14	22:46	93	Filament outside south	85-50-25-0
26	81	26.01.14	05:00	123	Filament outside south	100-50-25-0
27	83	26.01.14	13:08	253	Filament outside south	200-100-50-25-0
28	85	26.01.14	23:43	501	Filament outside south	400-200-100-50-25-0
29	86	27.01.14	07:28	843	Filament outside south	400-200-100-50-25-0
30	88	27.01.14	18:04	1179	Filament outside south	400-200-100-50-25-0
31	89	28.01.14	07:37	1751	Filament outside south	400-200-100-50-25-0
32	104	29.01.14	18:00	42	Filament inside	50-25-0
33	105	29.01.14	22:36	90	Filament inside	80-50-25-0
35	107	30.01.14	07:39	129	Filament inside	100-50-25-0
36	110	30.01.14	18:00	245	Filament inside	230-200-100-50-25-0
37	114	31.01.14	07:40	499	Filament inside	400-200-100-50-25-0
39	116	31.01.14	20:30	865	Filament inside	400-200-100-50-25-0
40	118	01.02.14	08:46	1229	Filament inside	400-200-100-50-25-0
41	119	01.02.14	19:30	1465	Filament inside	400-200-100-50-25-0
42	120	02.02.14	05:30	1399	Filament outside north	400-200-100-50-25-0
43	121	02.02.14	17:56	1205	Filament outside north	400-200-100-50-25-0
44	123	03.02.14	06:02	842	Filament outside north	400-200-100-50-25-0
45	127	04.02.14	05:30	504	Filament outside north	400-200-100-50-25-0
46	131	04.02.14	19:41	303	Filament outside north	280-200-100-50-25-0
47	135	05.02.14	14:10	132	Filament outside north	100-50-25-0
48	137	05.02.14	19:43	81	Filament outside north	75-50-25-0
50	138	06.02.14	01:10	48	Filament outside north	40-25-0
51	142	64.02.14	20:20	496	Filament cross transect	400-200-100-50-25-0
53	144	07.02.14	11:58	500	Filament cross transect	400-200-100-50-25-0
54	145	07.02.14	20:00	520	Filament cross transect	400-200-100-50-25-0
55	146	04.02.14	08:34	550	Filament cross transect	400-200-100-50-25-0

The 1 m² Double-MOCNESS is equipped with 18 nets with a mesh size of 330 µm. The sampling intervals on this cruise were 25 m in the top 50 m, 50 m down to 100 m, and 100-200 m at greater depths. Upon recovery of the MOCNESS, the nets were rinsed with seawater and subsamples of the right nets were frozen at -80°C for subsequent stable isotope analyses.

The left nets were preserved in a 4% formaldehyde-seawater solution buffered with sodium-tetraborate for future taxonomical and biomass analyses.

Tab. 5.8 Sampling data of the Double-MOCNESS haul.

Haul No.	Station No.	Date	Start Time UTC	End Time UTC	Water Depth [m]	Position Start	Position End	Sample intervals [m depth]
10	126	03.02.14	19:55	00:50	510-499	19°58.50'S 11°42.82'E	20° 6.69'S 11°48.71'E	0-100-30-15-30-15-30-15-30-100-30-15-30-15-30-15-30-15-30-100-0

Like in former years, mesozooplankton were sampled at two main transects, off Walvis Bay and off the Kunene River mouth, to obtain a synoptic picture of the composition and distribution of the main taxonomic groups of the mesozooplankton. At these transects the gear was deployed above the shelf, shelf-break, slope and at an oceanic reference station (Tab. 5.8) One haul was performed above the shelf at the 20° monitoring line of the NatMIRC Institute (Swakopmund, Namibia; Tab. 5.8). At the Walvis Bay and 20° shelf stations a camera and light system was deployed on the frame of the gear to control the opening of nets. Additionally to the time series on former cruises, the southern part of the northern Benguela was studied more intensively during this expedition. Zooplankton was sampled with the multiple-closing-net (HYDROBIOS; mesh aperture 300 µm) at the Lüderitz and the Oranje River transects.

During the filament study in leg two, several locations inside the filament, as well as north and south of it, were sampled with the multiple-closing-net (Tab. 5.7). Additionally, the MOCNESS was deployed horizontally, sampling from outside to inside of the filament. During five hours the nets were opened in intervals of 20 minutes, alternately in 15 and 30 m depth. At the beginning, in the middle and at the end of the haul a net was lowered down to 100 m depth to sample temperature and salinity data (Tab. 5.8). However, no distinct changes in temperature and salinity could be detected during the haul.

Quantification and qualification of major zooplankton groups will be undertaken in the home-laboratory, as well as stable isotope analyses of N and C for further insights in the food web structure. Migrating taxa will be determined and quantified and certain zooplankton groups will be studied more intensively concerning their abundance, composition, distribution, predation pressure and level in the food web. A first inspection of the samples showed distinct patchiness of gelatinous zooplankton as well as faunal stratification above slopes and at oceanic stations (Fig. 5.37).

Near-bottom zooplankton feed on sunken organic material and are therefore an important link between the ecosystem of the upper water column and the benthos (see Christiansen et al. 1999). Moreover, they may help to investigate the off-slope transport of organic matter from the shelf into the deep-sea.

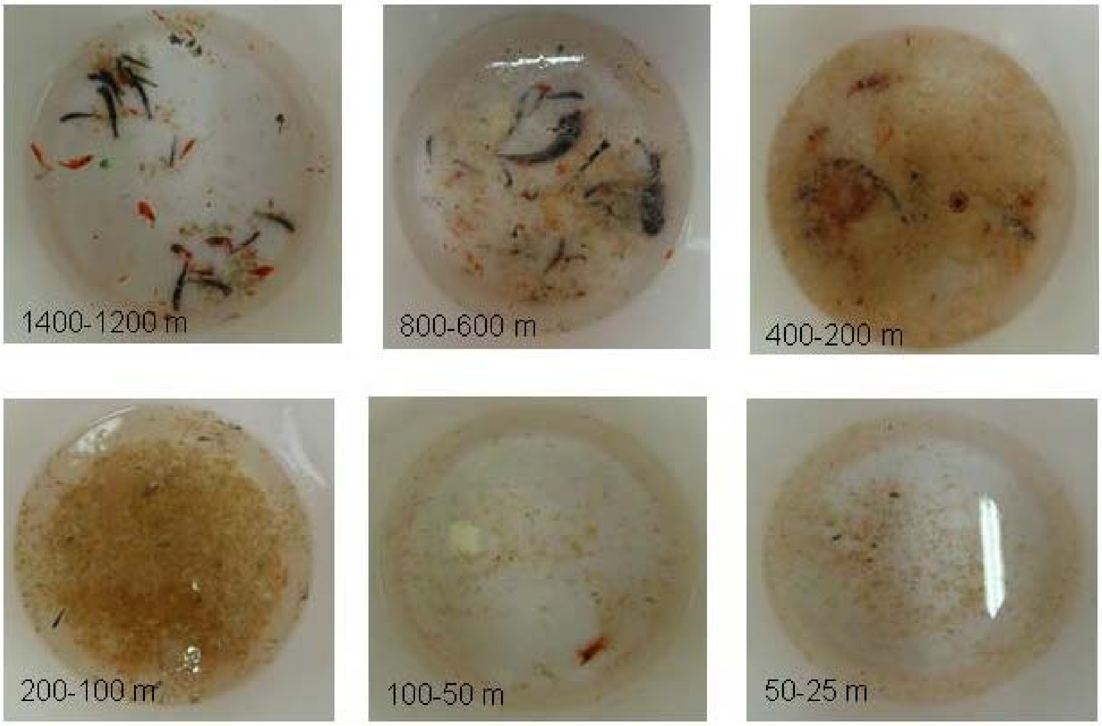

Fig. 5.37 Mesozooplankton composition from different depth strata in a haul performed at the oceanic station off Kunene River (max. water depth 1600 m).

To study the epibenthic zooplankton fauna, we equipped the multiple-closing-net with an echo-sounder (altimeter) to measure the distance to the bottom. The nets were towed at 1.5-2 knots with a distance of approximately 6 m above the bottom. For synoptic sampling, eight hauls at depths between 100 and 900 m were taken on the Oranje River, Walvis Bay and Kunene transects during leg one (Tab. 5.9). Inside and outside of the filament the net was deployed four times during leg two (Tab. 5.9).

The samples were preserved immediately in a 4% formaldehyde-seawater solution buffered with sodium-tetraborate for future taxonomical and biomass analyses.

Tab. 5.9 Sampling data of towed bottom-near Multinet hauls (300 µm) for mesozooplankton analyses. Ab=above bottom.

Haul	Station#	Date	Start Time UTC	Water Depth [m]	Region	Sample intervals [m depth]
25	80	25.01.14	23:30	94	Filament outside south	0-5 m ab,5 m ab, 5 m ab, 5 m ab, 5 m ab -0
34	105	29.1.14	23:28	94	Filament outside south	0-5 m ab,5 m ab, 5 m ab, 5 m ab, 5 m ab -0
38	114	31.01.14	08:55	504-560	Filament inside	0-5 m ab,5 m ab, 5 m ab, 4-9 m ab, 9 m ab -0
49	137	05.02.14	20:13	81	Filament outside north	0-5 m ab,5 m ab, 5 m ab, 5 m ab, 5 m ab -0
52	143	07.02.14	04:05	508-565	Filament cross transect	0-7 m ab,-75 m ab, 5 m ab, 5-10 m ab, 5 m ab -0

5.7.3 Microbial Community Structre
(C. Pavloudi)

Introduction

Microorganisms drive biogeochemical processes that are critical for maintaining the planet in a habitable state and they achieve primary production and global cycling of nutrients through the action of individuals with specific functional traits, often performing diverse roles within a significantly larger community (Falkowski et al., 2008; Glöckner et al., 2012). Hence, the study of the ecology of marine microbial communities, and their interactions, is essential for an understanding of the ecosystem functions.

The main goal of this study is to understand the role of the microbial biodiversity in hypoxic/anoxic sediments by studying its associations with various environmental functions. Specifically, the main scientific question that will be addressed concerns the effect of the microbial community assemblages, and specifically chemolithoautotrophic prokaryotes, on the biogeochemical cycles of the Benguela Coastal Upwelling System. In particular, this study aims at understanding the coupling between of the oxidation reactions with the reduction reactions for nitrogen and sulphur by investigating the contribution of different types of sulphur/sulphide oxidizers (aerobic, nitrate reducing, photosynthetic) on the removal of hydrogen sulphide and their possible competition towards the various energy sources. Also, this study aims at understanding how sulphate reducers compete with each other for the available sulphate, when the latter is insufficient for complete oxidation of organic compounds, given that they can use a wide range of other electron acceptors.

Material and Methods

Samples were taken from sediment cores at stations from all the sampled transect (Tab. 5.10) and stored at -80 ^{o}C until return to the laboratory on shore. Combination of both metagenomic and metatranscriptomic approaches will be used to characterize microbial structure and gene expression in the sediments of the different sampling stations. Comparing the metagenomic with the metatranscriptomic dataset may also reveal the relative activity levels of different populations in these microbial communities (e.g. Shi et al., 2011).

Furthermore, stable isotope probing was employed in samples from certain stations (Tab. 5.10) in an attempt to link the function and identity of the microorganisms of the sediment samples (Friedrich, 2006). Two microcosm experiments were conducted (Tab. 5.11) with one involving the addition of nitrate as substrate and the other one sulphate. In both experiments the provided electron donor was acetate. Samples were collected from the microcosms and frozen at -80 ^{o}C until nucleic acid extraction. Analysis of the SIP-derived metagenomic RNA will allow the description of the microbial community that was directly involved in the metabolism of the substrates used and it will reveal its functional potential (Neufeld et al., 2007).

Tab. 5.10 **Overview of the stations sampled. SIP: Stable-isotope probing.**

Station	Date	Position Latitude	Position Longitude	Depth [m]	No. of samples	SIP experiment
2281	28/12/2013	24° 0,02' S	14° 14,90' E	122,3	3	-
2282	28/12/2013	24° 36,02' S	14° 11,98' E	144,6	3	-
2285	29/12/2013	25° 11,95' S	14° 19,94' E	153,1	2	-
2287	29/12/2013	25° 21,03' S	13° 53,79' E	250,1	2	+ (2 replicates)
2289	30/12/2013	25° 29,32' S	13° 30,01' E	700,2	3	-
2290	30/12/2013	25° 32,99' S	13° 19,95' E	1125,3	3	-
2291	31/12/2013	25° 39,99' S	13° 0,00' E	2225,9	1	-
1	1/1/2014	28° 38,00' S	16° 16,01' E	40,6	1	-
2	1/1/2014	28° 38,15' S	15° 59,75' E	113,7	1	+ (1 replicate)
4	2/1/2014	28° 37,96' S	15° 19,97' E	187,4	1	-
5	2/1/2014	28° 38,00' S	14° 59,95' E	170,7	3	-
7	2/1/2014	28° 38,41' S	14° 25,26' E	358,2	1	-
8	3/1/2014	28° 37,99' S	14° 14,95' E	728	3	-
9	3/1/2014	28° 38,02' S	13° 47,02' E	2032,8	3	-
10	5/1/2014	23° 2,28' S	12° 18,59' E	2099,4	3	-
14	6/1/2014	23° 0,98' S	13° 1,96' E	454,6	2	-
18	7/1/2014	23° 0,74' S	13° 20,24' E	350,8	2	+ (2 replicates)
20	7/1/2014	23° 0,18' S	13° 30,16' E	233,7	3	-
34	9/1/2014	23° 0,01' S	14° 21,98' E	39,3	2	+ (2 replicates)
36	9/1/2014	21° 0,72' S	12° 49,96' E	302,3	2	-
39	10/1/2014	19° 29,63' S	12° 9,99' E	233,2	3	+ (2 replicates)
43	11/1/2014	17° 15,04' S	11° 39,84' E	80,9	2	-
45	12/1/2014	17° 15,47' S	11° 23,94' E	243,9	3	-
46	12/1/2014	17° 15,82' S	11° 18,06' E	453,8	2	
47	12/1/2014	17° 15,49' S	11° 10,04' E	1015,4	3	-
48	13/1/2014	17° 15,01' S	10° 59,94' E	2115,2	2	-
53	14/1/2014	19° 59,97' S	11° 49,92' E	408,4	2	-
59	15/1/2014	19° 59,95' S	12° 19,97' E	212,5	2	-

Tab. 5.11 Summary of the stable isotope experiments conducted on board.

	Electron acceptor (substrate)	Electron donor	Sampling	Substrate addition
Nitrate microcosms	Nitrate	^{13}C - acetate	Day 3 and Day 7	Day 0, 2, 4, 6
		^{12}C - acetate		
		No addition (control)		
Sulfate microcosms	Sulfate	^{13}C – acetate		Day 0
		^{12}C – acetate		
		No addition (control)		
Control microcosms	No addition (control)	^{13}C - acetate		-------
		^{12}C – acetate		
		No addition (control)		

5.8 Distribution, Condition and Trophic Relation of Calanoid Copepods in Upwelling Filaments and Population Genetics of Calanoides carinatus

(A. Schukat, F. Höring, A. Denda)

Copepods are major components of mesozooplankton communities in coastal upwelling areas with key species representing major trophic links between primary production and higher trophic levels (Loick et al., 2005; Verheye et al., 2005). Furthermore, copepods play a crucial role in the cycling of organic matter in the ocean, e.g. via moulted exoskeletons, fecal pellets, and respiration processes (Al-Mutairi and Landry, 2001; Dam et al., 1995; Steinberg et al., 2008). In the Benguela Current, upwelling filaments typically form on the fronts of the upwelling cells where the upwelling is well developed (Lutjeharms et al., 1991). These filamentous bands are usually between 100 and 500 km wide (Lutjeharms et al., 1991). Biological processes in general and the role of zooplankton species in particular within upwelling filaments are poorly understood. Therefore, one focus of subproject 6 on this cruise was to investigate the distribution, condition (RNA/DNA ratios) and trophic relation ($\delta^{13}C$, $\delta^{15}N$) of dominant copepod species in different structures of an upwelling filament. These data will be compared to filament data from the METEOR cruise M100-1 in September 2013, on which an upwelling filament at a similar position at times of higher upwelling intensities was investigated.

Additionally the population structure of the copepod *Calanoides carinatus* in the Benguela upwelling system was analysed. This species inhabits upwelling systems worldwide and is an important component of the herbivorous zooplankton in these productive ecosystems. It is able to overcome unfavorable conditions in non-upwelling seasons by diapausing stages that reside in deeper layers outside the shelf and are assumed to reseed the active population at the surface under active upwelling. The genetics of this important species are widely unexplored and the extent of gene flow via diapausing stages transported by undercurrents across the shelf edge is unknown.

Sampling

Mesozooplankton were collected by stratified vertical hauls with a MULTINET MIDI (HYDROBIOS, Kiel, Germany; mouth opening: 0.25 m2: mesh size: 200 µm).

In case of the filament study the maximum sampling depth was 400 m. Sampling depth intervals were adjusted to the other subprojects of GENUS (400-200 m, 200-100 m, 100-60 m, 60-20 m and 20-0 m) for a better comparison of data. The filament was sampled on three cross shore transects north, south and in the middle of the filament (20.0°S, 19.6°S, 19.3°S) with eight stations each. An additional transect was sampled parallel to the coast at the 500 m line with four stations.

Animals for DNA/RNA and stable isotopes analysis were sorted out immediately after the hauls under a dissecting microscope. These samples were used to determine the condition of species and the food web structure within the filament. More than 200 samples (> 600 individuals) of the copepods *Nannocalanus minor, Aetideopsis carinata, Centropages brachiatus* and *Calanoides carinatus* were collected and deep-frozen at -80°C for further analysis at the home lab.

The remains of the hauls were preserved in a 4% formaldehyde-seawater solution for later analyses of mesozooplankton abundance, biomass, vertical distribution and species composition.

To investigate the genetic connectivity of the active surface population of *C. carinatus* and the diapausing stages in the Benguela upwelling system, females of *C. carinatus* were collected at coastal stations (80 and 135) from surface waters and diapausing animals from depth of 800-400 m at offshore stations (88 and 121) and deep-frozen at -80°C. The hauls from that *C. carinatus* samples were taken for the genetic analysis were preserved in ethanol (98%).

Distribution of copepods

The copepod distribution was similar at all three transects but precise analyses of the hauls and the identification of species composition will be undertaken in home laboratory. In general, females of *Calanoides carinatus* and *Centropages brachiatus* dominated at the coastal stations (80, 81, 105, 107), while females and copepodite stage C5 of *Nannocalanus minor* occurred further offshore (83, 96, 110, 116). *Aetideopsis carinata* was the prevailing copepod species over the shelf edge (85, 114). Biomasses of mesozooplankton seemed also rather similar between transects (Fig. 5.38). In contrast to the cruise in September 2013 (M100-1), eucalanid copepods such as *Eucalnus hyalinus* and *Rhincalanus nasutus* were scarce, as well as *Metridia lucens*.

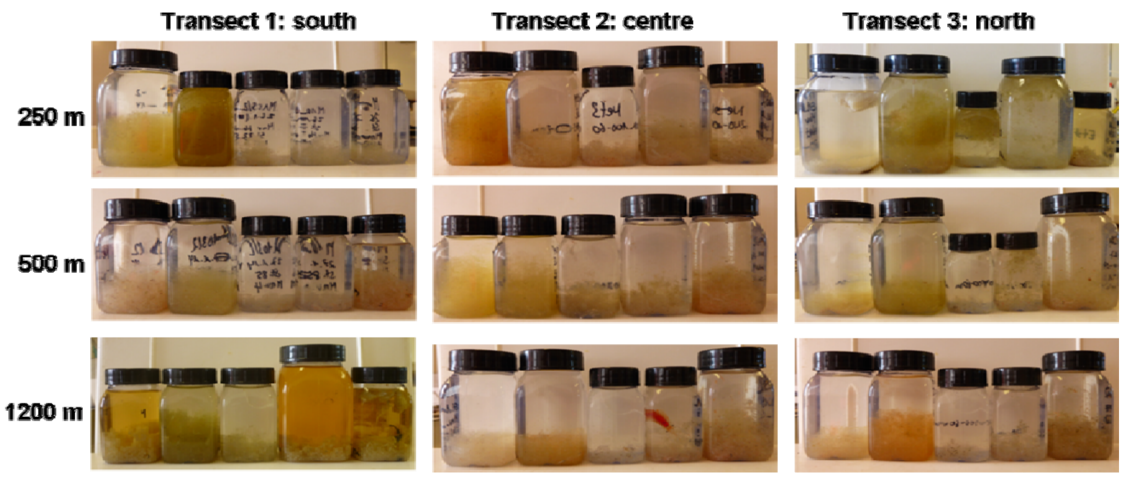

Fig. 5.38 Illustration of sampling vials within the filament (centre) and at the fronts/outside the filament for the 250 m, 500 m and 1200 m depth line.

Population structure of Calanoides carinatus

C. carinatus is highly adapted to life in coastal upwelling systems. Its life strategies are characterised by lipid (wax ester) storage, ontogenetic vertical migration and diapause, to ensure its population retention within the highly seasonal coastal upwelling system. Reproduction takes place on the shelf within the upwelling region. A part of the population is transported towards the open ocean by Ekman drift and pre-adult copepodite stages C5 descend to depths below 400 m. At depth they overcome periods of food shortage in a dormant stage. They return to surface waters and moult to adults at the onset of a new upwelling event. Coinciding to that, females of *C. carinatus* dominated the biomass at the coast and diapausing C5s were found in high densities at offshore stations below 400 m depth. More than 200 females from surface waters at the coast and 250 diapausing copepodite stages C5 of *C. carinatus* at offshore stations were collected. Further analysis of the population structure will be done after the cruise to answer the following questions: Do genetic barriers in the ocean circulation exist which lead to the formation of metapopulations? How large is the impact of diapause stages transported by undercurrents on the gene flow between populations?

5.9 Distributional Behaviour of Ichthyoplankton

(S. Geist, S. Simon, A.Kunzmann, N. Paul, J. Edward)

Abundance and condition of early life stages (ELS) determine recruitment success and by this the size of fish stocks. Complementing preceding GENUS cruises during 2008-2013, the ichthyoplankton work during cruise M103-1 focused on the collection of fish larvae during the low upwelling season in the northern Benguela to describe horizontal and vertical distribution patterns of fish larvae continuing the GENUS time series. The major aim of the GENUS SP4-Bio team was to collect samples for nutritional condition-, growth-, biochemical-, and molecular-analyses to address the following research questions: (1) variation of nutritional condition of larvae of horse mackerel (*Trachurus capensis*), sardine (*Sardinops sagax*), anchovy *(Engraulis encrasicolus*) and hake (*Merluccius* sp.), species of economic interest, in relation to water temperature, oxygen concentration and density and composition of potential prey organisms (in collaboration with K. Bohata). (2) Interspecific comparison of metabolic enzyme activities related to hypoxia tolerance. (3) Interspecific comparison of digestive enzymatic activities and (4) improvement of species identification of taxonomically closely related larvae (e.g. *Trachurus capensis* vs. *T. trecae* at the Angola-Benguela-Frontal Zone).

As follow up for investigations on feeding ecology of horse mackerel larvae (*T. capensis*) during GENUS phase I, another aim was to collect live larvae for feeding and starvation experiments for the determination parameters related to their energy budget, which are the practical part of the MSc thesis of S. Simon.

During leg 1 an additional aim was to conduct hypoxia stress experiments with larval and early juvenile stages of *T. capensis* to define critical threshold levels with hypoxic conditions building up on the study of metabolic activity of *T. capensis* larvae during GENUS phase I.

During leg 2, small scale processes along an upwelling filament during the low upwelling season were in focus, complementing our study during high upwelling season (M100-1). These hydrographic structures may transport fish larvae from high food concentrations at the coast to offshore waters. However, the frontal zones at the edge of the filament are hypothetically zones of high plankton concentrations. For this we collected samples to assess ichthyoplankton abundance and species composition, to compare nutritional condition of fish larvae in relation to the different water masses within, at the fronts and outside the filament sampling from the coast to offshore waters, and to construct stable isotope food-webs for these different water masses together with our partners from the other working groups.

Finally, the successful cooperation with and further training of J. Edward, junior ichthyoplankton scientist at NatMIRC, which started during M100 was continued with focus on operating ichthyoplankton nets, identification of larvae from key species and conservation of larvae to be used as a reference collection for identification purposes at NatMIRC.

Sampling

Three different nets were used to catch fish eggs and larvae: an obliquely towed Multinet (MNobl), a Ring Trawl (RT) and a Tucker Trawl (TT). The Multinet (HYDROBIOS, type Midi: 0.25 m^2 mouth area) was equipped with five nets of 500 µm-mesh size, temperature and oxygen probes, and an inner and outer flow meter to monitor the net’s trajectory (for volume filtered calculations) as well as net clogging (Fig. 5.39). The upper two nets were equipped with small net inlays (mouth diameter of 12 cm and 55 µm mesh size) to simultaneously catch potential food organisms of the fish larvae. The Ring Trawl has a diameter of 1.6 m (2 m^2 mouth area) and a mesh size of 1000 µm. At each station, usually a deep cast to 60-80 m water depth lasting around 20 min was followed by two short “Drift casts” to 40 m and 20 m with the ship standing still. The first cast was used to catch specimen available for biochemical and growth analyses, whereas the two “Drift-casts” targeted live larvae for on-board feeding and respiration experiments. The TT has an effective mouth area of 1 m^2 and a mesh size of 1000 µm. Its opening/closing mechanism allows the collection of larvae in a targeted depth stratum of the water column. It was used instead of the RT at stations with high jellyfish densities in surface water layers. All nets were handled over the side, towed horizontally at 1.5 knots except the RT “Drift casts”. Winch speed when fearing was 0.5 or 0.3 m/s, heaving velocity 0.1 or 0.2 m/s.

During leg 1, ichthyoplankton collections were made at stations on the shelf and slope up to water depths of 1041 m. The MNobl was towed obliquely at 24 stations sampling the upper 200 m of the water column, which were divided into five different depth strata after inspection of temperature and oxygen concentration depth profiles (Tab. 5.12). The RT was deployed at 13 stations and the TT at two stations only.

During leg 2, three transects from the coast to off shore (max. bottom depth ~1800 m) with 8 stations per transect and for a fourth transect parallel to the coast at 500 m bottom depth with 4 stations were sampled (Tab. 5.12). At each station a MNobl was deployed first to get a quantitative overview of the present fish larvae population. The upper 200 m of the water column were divided into five different depth strata (0-20, 20-60, 60-100, 100-150, 150-200 m), chosen after an initial inspection of temperature and oxygen concentration depth profiles and in agreement with the other biological working groups. Multinet hauls were followed by 1-3 Ringtrawl casts to increase the number of specimen available for subsequent laboratory analyses and to catch live hose mackerel larvae. RT was deployed at 29 stations. At each station, usually a deep cast to 60-80 m water depth lasting around 20 min (1.5 knots ship speed) was followed by one or two short casts to 40 m and 20 m at reduced ship speed (0.5 or 1.0 knots). At the first two sampling stations a Tucker Trawl was used instead of the RT, because of high jellyfish densities in surface water layers. However, since catch success of the larger RT was significantly higher, it was deployed at all other stations independent of jellyfish concentrations.

All samples were screened for their content of fish larvae. Live larvae were transferred to a temperature controlled cultivation fridge, simulating in-situ temperature. Dead fish larvae were sorted out, identified, measured for standard length and immediately frozen to -80°C for subsequent determination of growth rates, nutritional condition and trophic analysis at ZMT, Germany. All remaining MNobl samples were preserved in buffered formalin (4% in seawater) for quantitative community studies, which are part of a more than ten years long time series. Additional larvae were also collected from plankton nets of WP7 and WP10.

Preliminary results

In total more than 5000 fish larvae were sorted out, identified and frozen for subsequent analysis (Fig. 5.40). In terms of fish larvae abundance a clear geographical division was encountered. From the Walvis Bay region (23°S) southwards, with the two transects at the permanent Lüderitz upwelling cell (~25°S) and the Oranje River mouth (28°S) larval abundance was very low with a few goby and mesopelagic fish larvae caught. This result confirms earlier reports on the distribution of ELS of our target species. The Lüderitz upwelling cell was known for low fish abundance from previous cruises, for the Oranje River Transect this is the first detailed record with regard to ELS of the a.m. species. In contrast, stations from 21°S to 17°S yielded very high numbers of fish larvae and also higher species richness. *Trachurus capensis* and *Engraulis encrasicolus* larvae were most abundant; amongst other encountered species were sardine (*Sardinops sagax*), hake (*Merluccius* sp.) and pelagic goby (*Sufflogobius bibarbatus*). At the Kunene transect (17°S) the northern Benguela fauna mixed with that of tropical Angolan waters as indicated by e.g. the presence of round sardinella larvae (*Sardinella aurita*). Larvae of rat tails (Macrouridae), tuna (Scombridae, to be confirmed) and oarfish (*Regalecus glesne*) were caught at 19.5°S and 20°S and deep-frozen for the first time during all GENUS cruises. During leg 2, *E. encrasicolus* larvae were found over the whole size range (5-30 mm) both near the coast and off shore. In contrast larger *T. capensis* were mainly found near the coast whereas small larvae (<6 mm) were also abundant further off shore. Sardine (*Sardinops sagax*) and hake (*Merluccius* sp.) larvae were only caught in higher numbers in the colder, near shore upwelling waters. Larvae of Myctophidae, Scombridae and Sparidae occurred in higher numbers stations of 500 m bottom depth or more. Goby larvae (*Sufflogobius bibarbatus*) were hardly found. Jellyfish density was remarkably low in almost all stations north of 23°S, which allowed us to use the RT.

Only in the innermost stations of the 20°S-transect massive jellyfish densities were apparent during both legs. Nevertheless, during leg 2 live *T. capensis* juveniles were caught in RT-hauls with a parallel high number of jellyfish in the catch. The number and quality of -80° frozen samples for subsequent growth and biochemical (condition, enzyme, molecular) analyses was exceptionally high during this cruise with very broad size spectra for *T. capensis*, *E. encrasicolus* and *S. sagax*, ranging from early larvae caught a few days after hatch to late larvae and early juveniles.

The successful catch of live fish larvae and early juveniles of particularly *T. capensis* over a wide size spectrum depends on a high number of sampling stations in their main spawning area, since distribution is patchy and size range at single stations tends to be narrow. Thus, the final cruise track during leg 1 with focus on stations from 23°S southwards during the first two weeks turned out to be unfavourable for experimental work in comparison to the original plan with more sampling transects north of 23°S. As conclusion of the encountered ichthyoplankton distribution during this cruise, it is desirable to start sampling from north to south to increase the available time for experiments in case of successful live catches. Due to low numbers of larger *Trachurus* larvae and missing catches of *Trachurus* juveniles, and because priority was on feeding experiments for MSc thesis work, only very few larvae were available for respiration experiments during leg 1.

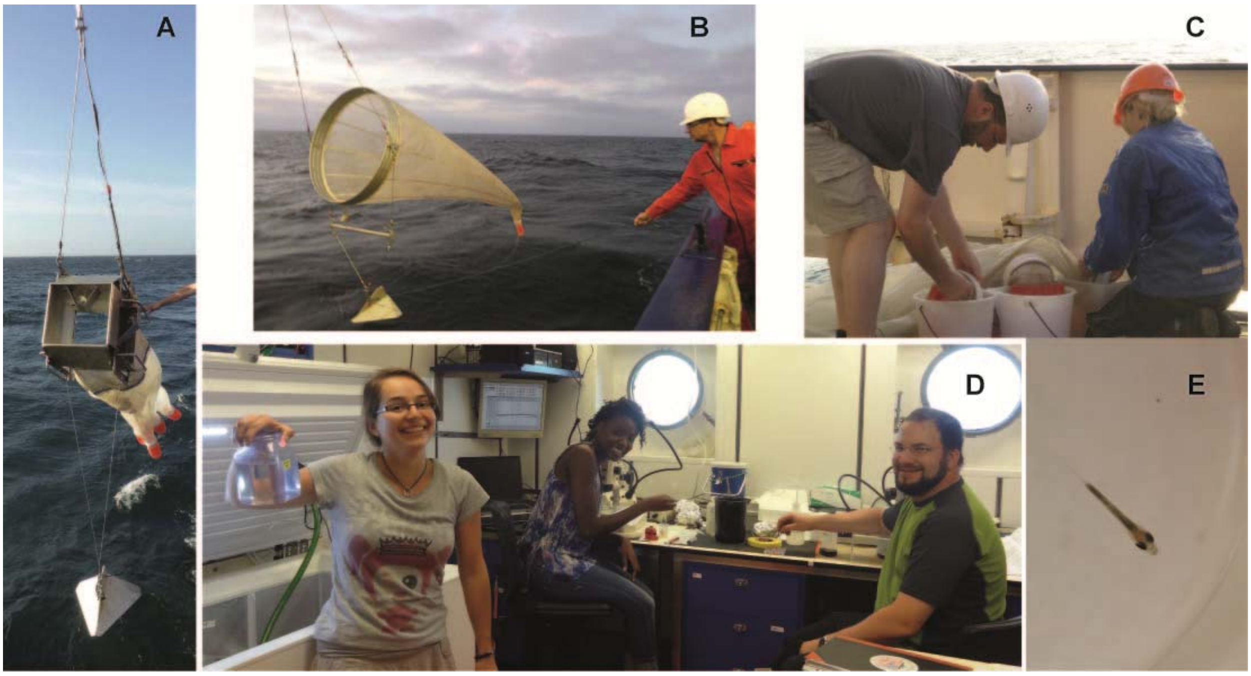

Fig. 5.39 Work at deck and in dry lab, catching and sorting fish larvae. A Multinet, B Ringtrawl, C opening net bags of the multinet, D sorting of fish larvae and maintenance of live larvae, E live fish larva.

The total amount of live caught *Trachurus* larvae that survived the first 12 h after catch was 184 individuals for both legs. With 92 small *Trachurus* larvae (3-5 mm) a starvation experiment was conducted. The larvae were frozen in liquid nitrogen at time intervals of 6 hours, starting at 12 h of starvation (after catch) up to 66 hours. 31 larger *Trachurus* sp. larvae (7-25 mm) were used for feeding experiments. Larvae were divided into four groups fed with different food quantities of newly hatched Artemia nauplii once a day: a.) 1 nauplia ml^{-1} b.) 5 nauplii ml^{-1} c.) 10 nauplii ml^{-1} d.) 15 nauplii ml^{-1}. Fish larvae were kept separately in beakers and water quality was guaranteed by constant cleaning and replacing 50 % of the water by pre-filtered seawater every second day. The larvae are kept in a temperature-controlled refrigerator, which is set to the ambient temperature at sampling depth (18°C ± 1°C). The effect of starvation and food quantity on growth and nutritional condition will be examined in ZMT laboratories (e.g. otolith analysis, RNA:DNA ratio). The remaining live *T. capensis* larvae (17-70 mm) were transported to NatMIRC (Swakopmund) for a repeat of the feeding experiments at higher temperatures, to investigate the effect of a warming in the northern Benguela System.

Finally, J. Edward was able to enlarge her reference collection of fish larvae significantly, which will help her with correct identification of fish larvae in her future work at NatMIRC, Swakopmund.

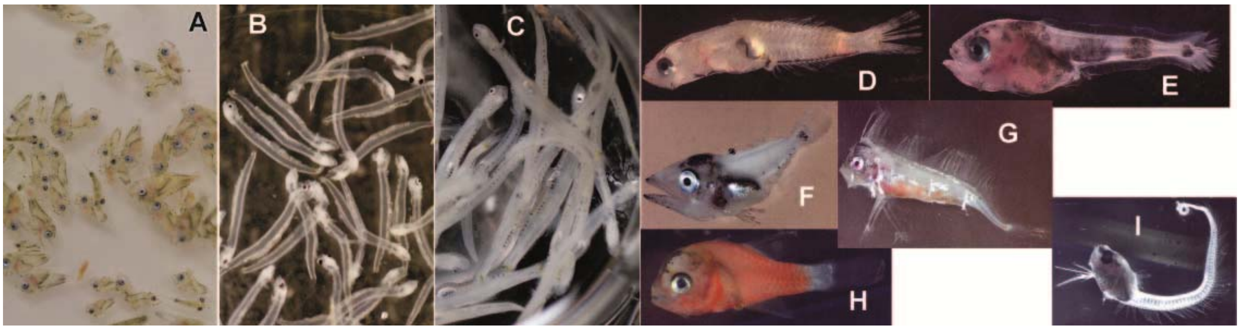

Fig. 5.40 Different species of fish larvae. A horse mackerel, B sardine, C anchovy, D goby, E hake, F scombrid, tuna (?), G oarfish, H unknown tropical species, I rattail.

Tab. 5.12 Ichthyoplankton net casts during M103-1 (Stat.2281-061) and M103-2 (stat. 079-146). Abbreviations: SST = sea surface temperature, MNobl = Multinet oblique, RT = Ring Trawl, TT = Tucker Trawl.

Ship station	Date	Latitude (°S)	Time at depth (UTC)	Water depth (m)	SST (°C)	MNobl Haul No.	RT Haul No.	TT Haul No.
2281	28.12.13	24°00’	09:35	115	16.7		1	
2282	28.12.13	24°38’	16:25	146				1
2284	29.12.13	25°08’	02:58	90	13.8	1		
2286	29.12.13	25°16’	12:23	192	15.5	2		
2287	29.12.13	25°21’	18:36	250	15.2	3		
2289	30.12.13	25°28’	02:14	800	16.2	4		
2290	30.12.13	25°31’	10:23	996	16.7	5		
002	1.1.14	28°36’	14:08	113.5	15.6	6		
006	2.1.14	28°36’	07:23	157	19.6	7		
007	2.1.14	28°36’	14:22	365	20.0	8		
008	2.1.14	28°36’	23:02	732	19.7	9		
011	5.1.14	23°00’	23:21	895	20.0	10		
014	6.1.14	23°00’	22:16	455	20.2	11		
018	7.1.14	23°00’	09:18	350	18.7	12		
022	7.1.14	23°00’	22:09	144	18.6	13		
030	8.1.14	23°00’	17:12	128	18.5	14		
035	9.1.14	22°00’	10:28/12:54	118	20.1	15		2
036	9.1.14	21°00’	20:26	295	21.1	16	2	
038	10.1.14	20°00’	07:40	150	19.0	17	3	
039	10.1.14	19°30’	13:41	231	21.2	18	4	
040	10.1.14	19°00’	18:36	123	19.5	19	5	
041	10.1.14	19°00’	21:34	204	20.0	20	6	
044	11.1.14	17°14’	15:57	133	19.7	21	7	
045	11.1.14	17°14’	22:40	217	19.9	22	8	
046	12.1.14	17°14’	05:12	502	20.1	23	9	
047	12.1.14	17°14’	16:35	1041		24	10	
053	14.1.14	20°00’	19:50	408			11	
057	15.1.14	20°00’	05:16	195			12	
061	15.1.14	20°00’	15:22	151	19.5		13	
079	25.1.14	20°00’	19 :55	47.5	18.2	25		3
080	26.1.14	20°02’	00 :31	93	18.7	26		4
081	26.1.14	20°05’	05 :39	123	19.2	27	14	
083	26.1.14	20°12’	15 : 41	250	20.9	28	15	
085	27.1.14	20°20’	01:42	500	21.2	29	16	
086	27.1.14	20°23’	08:49	843	20.9	30	17	
088	27.1.14	20°31’	19:56	1200	21.2	31	18	

Ship station	Date	Latitude (°S)	Time at depth (UTC)	Water depth (m)	SST (°C)	MNobl Haul No.	RT Haul No.	TT Haul No.
089	28.1.14	20°39'	09:02	1750	22.1	32	19	
104	29.1.14	19°40'	18:35	45	17.4	33	20	
105	30.1.14	19°46'	00:38	90	19	34	21	
107	30.1.14	19°00'	08:21	130	19.8	35	22	
110	30.1.14	19°57'	09:18	350	18.7	36	23	
114	31.1.14	20°07'	13:53	500	21.6	37	24	
116	31.1.14	20°10'	22:15	860	18.5	38	25	
118	1.2.14	20°14'	13:18	1260	22.1	39	26	
119	1.2.14	20°21'	21:38	1470	22.9	40	27	
120	2.2.14	20°00'	07:41	1400	22.5	41	28	
121	2.2.14	19°51'	19:48	1200	21.8	42	29	
123	2.2.14	19°47'	08:48	840	22.0	43	30	
125	3.2.14	19°41'	16:35	500	21.0	44	31	
131	3.2.14	19°32'	20:46	350	20.8	45	32	
133	5.2.14	19°30'	05:45	250			33	
135	5.2.14	19°25'	14:49	132	19.5	46	34	
137	5.2.14	19°21'	21:06	80	18.6	47	35	
138	6.2.14	19°20'	01:42	50	17.2	48	36	
142	7.2.14	20°32'	00:51	500	21.1	49	37	
144	7.2.14	20°07'	13:21	500	22.5	50	38	
145	7.2.14	19°54'	21:19	520	22.4	51	39	
146	8.2.14	19°24'	09:51	550	21.0	52	40	

5.10 Krill Distribution, Transport and Behaviour

(Th. Werner, L. Mlambo, F. Buchholz, A. Muyongo)

The GENUS subproject 7 investigated the abundance, distribution, and physiological performance of Euphausiids in the northern Benguela upwelling system. Euphausiacea are an important group of the mesozooplankton community in this ecosystem since they contribute largely to the zooplankton biomass and may contribute substantially to the vertical flux of organic carbon to deeper water layers. Krill are an important trophic link between primary producers and higher trophic levels. Furthermore, changes in krill abundance and distribution patterns may affect fish stock dynamics since they are a considerable food source for e.g. juvenile and adult hake and horse mackerel.

Euphausiids were targeted using a 1m^2-MOCNESS (Multi Opening and Closing Net with Environmental Sensing System), optimized for catch of fast swimming macro-zooplankton which usually avoids smaller nets. The MOCNESS is equipped with 9 single nets of large mesh-size (2000 µm), which can be opened and closed sequentially. Soft cod ends were used to increase the catchability of the net and to decrease damage to the specimen at the same time. The device carries CTD probes for simultaneous collection of environmental parameters. Fifteen oblique MOCNESS hauls were performed in depth-discrete steps down to a maximum of 500 m depth (Tab. 5.13) at an average ship speed of two knots. Fishing depths intervals were pre-determined regarding diel vertical migration behavior of euphausiids (Werner and Buchholz 2013) before specific hauls were conducted. At stations over the shelf the whole water column was sampled.

After catch the amount of krill in each net was estimated, recorded in a net protocol and up to 30 animals in good conditions were transferred to aquaria with ambient cooled sea water (10°C) for further analysis. Species were identified and their size and sex were noted. Stomach fullness and hepatopancreas color were assessed to estimate the trophic conditions of the animals at time of catch. Sexual maturity staging was done according to Makarov & Denys's (1980) `Stages of Sexual Maturity of *Euphausia superba*`, modified for the species under study. At least 10 live animals per station were briefly blotted on Kim-Wipes, and frozen at -80°C for further biochemical and stable isotope (SI) analysis. Samples to determine a SI baseline for calculation of the trophic level of the different species were generously provided by WP9 (taken from the 55 µm Multinet inlay nets). Additionally, stomachs were analyzed for different food sources under a stereomicroscope in cooperation with Anja Hansen (section 5.4) and Karolina Bohata (section 5.7) for some animals.

5.10.1 Krill Distribution
(Th. Werner, L. Mlambo)

Within the sampling area (17-28°S) eight krill species were found, namely Euphausia gibboides (to be confirmed), Euphausia hanseni, Euphausia lucens, Euphausia recurva, Nematoscelis megalops, Nyctiphanes capensis, Stylocheiron abbreviatum and Thysanoessa gregaria. E. lucens, the dominant euphausiid species of the southern Benguela, was unexpectedly found in high abundances at the Walvis Bay transect at 23°S. Furthermore, this species seemed to reproduce in this area (Fig. 5.41), suggesting (in contrast to previous findings) that the permanent upwelling cell at Lüderitz is not a physical barrier for euphausiids. Uncommon species, such as Stylocheiron abbreviatum and Thysanoessa gregaria were found at Station 10 along the Walvis Bay transect, indicating the influence of oceanic water masses.

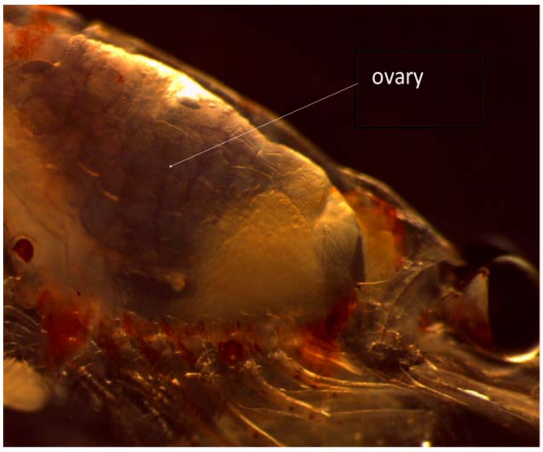

Fig. 5.41 *Euphausia lucens*, female, cephalothorax. The ovary displays a violet tint in large oocytes indicating impending spawning (picture taken by T. Werner).

To estimate the energy demand of the different species, respiration measurements of all euphausiid species caught, except *S. abbreviatum*, were conducted using a closed-respirometry system with oxygen sensor spots and a 10-channel oxygen transmitter (PRESENS, Germany) at two different temperatures (10°C and 15°C). In total 88 respiration measurements were performed. Furthermore, hypoxia incubation experiments were used to asses adaptations of *E. hanseni* to low oxygen levels/environmental conditions in the oxygen minimum zone. For these, water was taken from CTD casts (WP-1/2) at different oxygen levels (1, 2, 3, 5 mg O_2 l^{-1}).

Per oxygen level eight animals were placed individually in filled plastic bottles for 3 hours and were immediately deep-frozen in liquid nitrogen for further biochemical analyses.

Tab. 5.13 Sampling intervals of MOCNESS hauls.

MOCNESS Haul#	Station	Latitude (°S)	Longitude (°E)	Depth interval (m)
1	2287	25°21,01	13°53,91	220-0, 200-150, 150-100, 100-50, 50-0
2	2289	25°29,80	13°29,72	500-450, 450-400, 400-350, 350-300, 300-200, 200-100, 100-50, 50-10
3	2291	25°40,20	12°59,91	500-400, 400-350, 350-300, 300-250, 250-200, 200-150, 150-50, 50-0
4	7	28°38,02	14°25,07	340-300, 300-250, 250-200, 200-150, 150-100, 100-50, 50-0
5	8	28°40,35	14°15,82	500-400, 400-350, 350-300,300-250,250-200, 200-150, 150-50, 50-0
6	9	28°38,02	13°47,02	500-400, 400-300, 300-250, 250-200, 200-150, 150-100, 100-50, 50-0
7	10	23°02,54	12°18,68	500-450, 450-400, 400-350, 350-300, 300-250, 250-200, 200-100, 100-0
8	11	23°04,63	12°45,45	500-450, 450-400, 400-350, 350-300, 300-250, 250-200, 200-100, 100-0
9	14	23°00,98	13°01,96	400-350, 350-300, 300-250, 250-200, 200-150, 150-100, 100-50, 50-0
10	22	23°01,20	13°37,58	135-110, 110-90, 90-70, 70-50, 50-30, 30-10, 10-0
11	45	17°17,64	11°24,11	230-200, 200-150, 150-100, 100-80, 80-60, 60-40, 40-20, 20-0
12	46	17°17,13	11°18,49	400-350, 350-300, 300-250, 250-200, 200-150, 150-100, 100-50, 50-0
13	47	17°17,79	11°10,55	500-400, 400-300, 300-250, 250-200, 200-150, 150-100, 100-50, 50-0
14	48	17°15,13	10°59, 91	500-450, 450-400, 400-350, 350-300, 300-250, 250-200, 200-100, 100-0
15	53	20°01,55	11°50,08	250-200, 200-160, 160-120, 120-80, 80-60, 60-40, 40-20, 20-0

5.10.2 Krill as Indicators of Environmental Variation and as Pivotal Components of the Plankton of the Northern Benguela Current System

(Th. Werner, A. Muyongo, F. Buchholz)

The GENUS project with determinations of primary and secondary production is an excellent background to elucidate the hydro-climatic situation in the food web of the research area (Huenerlage and Buchholz, 2013). The particularly short food chain of krill secures it an indicator function in the integrative modelling approach. Physiological studies of euphausiid key species are part of the project’s analysis of key rates of physical, biogeochemical and biological ecosystem components and to energy flows and feedback of trophic structures on biogeochemical cycles. The specific objective of the cruise was to focus on krill as part of the plankton within smaller scale processes along and across an upwelling filament and associated boundary zones. The current summer study within NAMUFIL complemented the previous winter study during M100/1 in September 2013, NamBo. The upwelling maximum was compared to the current upwelling minimum.

An upwelling filament at approx. 20°S was chosen for intensive study. Twenty five MOCNESS hauls were performed in depth-discrete steps. Euphausiids from the MOCNESS hauls were analysed to investigate small scale differences in physiological performance and biomass of krill along and across the filament. Sampling was done at night at fixed depth intervals in accordance with the sub-projects SP4-Bio, SP-5 and SP 6 (400-300m, 300-200m, 200-150 m, 150-100 m, 100-60 m, 60-20 m and 20-0 m). These depth intervals ensured a high-resolution at boundary zones pre-determined by the hydrographic investigations done by SP-2. Comparative day to night hauls were performed to assess the diel vertical migration behavior of krill and to compare with previous findings (Werner and Buchholz 2013). These served also for paralleling PARASOUND traces (SP 2).

The dense station grid oriented at inside and outside of the filament, was ideal to study the occurrence of krill from the coast into the open ocean. A clear zonation was found from coastal *Nyctiphanes capensis*, to the krill associated with the shelf break, the most numerous *Euphausia hanseni*, an omnivore, which mixes towards the ocean with the raptorial Nematoscelis megalops. Both species are specialized to use the oxygen minimum zone as a retreat niche during day time. At sunset, *E. hanseni*, ascended to the surface to graze on phytoplankton. In fact, the digestive tract was very green, indicating a good feeding state, particularly in association with the filament. Within the filament, krill adjusts its vertical migration amplitude to the maximal depth of the filament, at about 100m, apparently to stay with the high production zone for optimal feeding. Outside the filament, the amplitude was between 250 and 300m. In contrast, N. megalops showed weak migration and stayed within the OMZ. Over depths of more than 1200m, the small *Euphausia recurva* was found in high numbers indicating oligo-trophic, oceanic conditions. The observation of *E. hanseni* orienting diurnally at the filament parallels those of the previous filament study when the filament structure was much stronger developed during winter. Accordingly, the Krill belongs to the actively swimming micro-nekton taxa aimed at maximizing feeding rather than to the plankton – which passively drifts with the currents.

Physiological measurements flanked the ecological observations. Respiration measurements were conducted with *E. hanseni*, the dominant euphausiid species of the Namibian upwelling system, to assess physiological adaptations caused by different trophic conditions in relation to the different water masses and filament structure. A 10-channel closed-respirometry system with oxygen sensor spots (PRESENS, Germany) was used to determine the oxygen demand at 10°C, the mean ambient water temperature. In total 30 measurements were done.

For the estimation of the trophic levels by stable isotope analyses, at least 10 animals of each species caught were frozen in liquid nitrogen. Furthermore, stomach content analyses were conducted to construct a filament food web in cooperation with subprojects 4-Bio, 5 and 6. The resulting food web will be compared with the one from the previous filament study allowing us to identify and understand possible differences between the high-upwelling and the off-peak season in terms of food web structure and trophic flow of the northern Benguela upwelling system. The frozen samples will be used for biochemical analyses at AWI, Bremerhaven, Germany. Biochemical analyses will include RNA/DNA ratios to estimate the trophic condition of the animals in the field. Assumed differences in trophic conditions between water masses inside (center), at the border (fronts) and outside the filament may lead to differences in the productivity of zooplankton/krill in terms of growth and reproductivity. Accordingly, at each station sampled, freshly caught animals were analysed for their sexual developmental stages according to Makarov & Denys's (1980), modified for the species under study and for their moult activity. Further parameters like the sex ratio, size and colour of the hepatopancreas were analysed. Physiological performance determined may indicate if and how upwelling filaments contribute to the high productivity of the northern Benguela upwelling system.

6 Ship's Meteorological Station

6.1 Leg 1

(J. Hempelt, H. Sonnabend)

Accompanied by a light breeze from southwest and cloudy sky RV METEOR left the harbor of Walvis Bay on December 27th 2013 at 09 o'clock. As the first stations were located only a few miles offshore, it was no problem to return to the bay in order to pick up some delayed pieces of luggage of altogether 7 participants of this expedition. After having finished this unexpected side trip, the cruise was ready to take its course as scheduled.

The meteorological conditions of the first days at sea were affected by the elongated seasonal trough over the southern parts of Africa with small sized secondary lows along the coast of Namibia and a ridge of high pressure, extending from the Subtropical High over the Southeast Atlantic towards the off shore regions, producing a sharp air pressure gradient between these systems. This constellation caused strong southerly winds in the evening of 27th as well as during 28.12. The wind sea rose from 1.5 meters at first to 2.5 meters. This bottleneck situation with small sized troughs along the coast and the high pressure ridge in the nearby west continued affecting the research area through the following days. Between 28th of December and the morning of 31.12., the wind persisted constantly at a high level of force 6–7 Beaufort with gusts around Bft. 8 from southerly directions, associated with a rise of sea state up to 3.5 meters. In spite of the strong wind the sun could have been enjoyed shining from a partly clear sky. The wind started to decrease gradually not before noon of 31.12., but accelerated south to southeast 5 - 6 Bft. once again in the evening. The sea state flattened leisurely down to 2 meters.

Also the New Year brought only little change at first. The research area remained being located along the eastern flank of the Subtropical High over the Southeast Atlantic and dominating low pressure over the southern Africa. The New Year's Day started cloudy but with a good view to the not too far away mainland. In the course of forenoon RV METEOR encountered some fog patches having been formed above the upwelling water along the coast. Shortly after noon the sun could have been seen again through scattered to broken low cloud layers, clearing away until evening to enable a clear sky until evening. During the course of the day the sea calmed down to around 1.5 meters. The southeast wind abated to force 3 – 4 Bft. for a short time, before oscillating between south and southeast with force 4 – 5 Bft during the same day as well as through the whole following day. Maintaining speed the wind shifted a little south to southwest until 03.01.

In the evening of 04.01., a trough belonging to a low south of South Africa encountered the research area from the west. During the full-time transit from 28°South to 23°South the wind shifted between south and southeast with force 4 Bft. at first, continued shifting southwest to west, reaching north temporarily, before stabilizing between west to northwest with force 3– 4.

The wave heights remained around 1.5 meters. Until 05.01., the trough started to develop to a separate low, tracking from its position west of South Africa northward along the coast, before filling until 08.01 just south of the research area of RV METEOR.
In the forenoon of 05.01., the front belonging to a low south of South Africa crossed the working area, producing the first rain shower RV METEOR got through the previous cruise so far. During passage of the front, the wind shifted from a gentle northwesterly breeze at first back to south very soon, accelerating to force 5 and temporarily 6 Bft. Until evening the sea rose to wave heights of around 3 meters, mainly consisting of swell from southsouthwesterly directions. During the night to 06.01., the southerly wind started to decrease more and more into a short period of nearly calm conditions around forenoon, before regenerating to force 3–4 from south to southwest later on. The swell remained around 3 meters, reaching a maximum of temporarily 3.5 meters in the evening.

In the first part of the night of 07.01., the wind decreased once again to nearly calm conditions before shifting north to northwest with force 3–4 Bft. during forenoon. After these "wavering days" as a result of the uncomfortable rolling of the ship and due to these not very recreative nights, another clear and sunny day invited some cruise-participants for tanning on the upper decks during their leisure time. Meanwhile the swell flattened down to only 2 meters. The 08.01. started with light northerly to northwesterly winds, reaching temporarily force 5 Bft. during forenoon, backing south to a gentle breeze again until evening. During night to 09.01., fog patches encountered the cruise line of RV METEOR along the immediate coastal areas. Leaving behind the area of upwelling water next morning, the coastal fog patches retreated gradually. The southerly wind increased a little from force 2–3 at first to Bft. 4 later on.
RV METEOR continued being located along the eastern flank of a high pressure zone centered over the Southeast Atlantic and a flat trough over Namibia. Predominantly southerly to southeasterly winds around 4–5 Bft., shortly rising up to force 6 with an associated sea state of around 1.5 meters enabled comfortable working conditions during 10.01. and 11.01. Around noon the wind decreased to force 3 Bft. Starting and ending with broken to overcast low level clouds, both days weather conditions started to improve soon, and apart of some fractured convective clouds with some high clouds above they became fine and sunny, enjoying all those being hungry for sunshine.

The high pressure ridge extending towards the coast of Namibia started to weaken a little bit, enabling a flat trough to spread along the shores of Namibia and Angola producing an increase of the air pressure gradient from 12.01. On the same day we had to feel the consequences of this development, when the south to southeasterly wind accelerated from 5 –6 Bft. at first to force 7 until evening. Correspondently the sea state increased from 1.5 meters up to 2.5 meters. On 13.01., the strong southerly wind calmed down from force 7 Bft. at first to force 3 fading to nearly calm winds from variable directions on 14.01. Subsequently the wave heights flattened down to relative comfortable 1.5 meters within these 2 days. Regrettably this low pressure trough was connected with much cloudiness causing skies to be broken to completely overcast during both days.

Also the 15.01. remained calm with an agreeable sea state of around 1.5 meters. These conditions didn't change until 16.01., when a small depression north of Walvis Bay brought a slight increase of the wind to force 4 Bft. In the beginning of the second part of the night RV METEOR got another rain shower and even lightning could have been observed in not too far distance. However, this short event ended soon during the night to 17.01., when a ridge of the Subtropical High covered the research area causing the wind to become calm and variable. Also the cloudiness broke up to be replaced by increasingly fine weather, enabling to enjoy the sun also during the last day of this cruise with wave heights of 1–1.5 meters. RV METEOR reached the harbor of Walvis Bay in the evening of 18th.

6.2 Leg 2

(A. Raeke)

On the 21th of January at 09:30 RV METEOR left the harbour of Walvis Bay and went on research journey M103/2. The purpose of this trip was to find and study the dynamics of filaments and their role in the physical , biochemical and biological ecosystem. The research area was off the northern coast of Namibia .

At the beginning of the journey the FS METEOR was located between a high over the southeastern Atlantic and a low pressure trough over South Africa. Hence, the shipping area was within a south to southeasterly airflow. The weather was cloudy to mostly cloudy with low stratus. Within the cool coastal Benguela current off the African coast the air temperature only managed to reach 17 °C.

At first westerly winds about 2 to 3 Bft were experienced. While cruising to the north winds increased to 4 to 5 Bft and shifted to the south to southeast. The significant wave height showed 2m with a swell from 1.5 to 2m from the south. While heading to latitude 20° south the water and air temperature increased to 20 to 21°C.

On the 24th the south Atlantic high extended towards South Africa causing the pressure gradient to increase. During the afternoon the wind increased to 6 Bft. Later the wind dropped to 4 to 5 Bft. On the 25th in coastal areas only light winds were experienced. On the 27th the low pressure influence widened towards South Africa. The wind increased to 6 Bft causing the sea to rise to 2 to 2.5 m. Later the wind abated to 3 Bft with the sea dropping to 1.5m.

In the morning hours of the 28th RV METEOR experienced a brief shower, however on most of the journey a stable trade inversion in about 900 m mostly ensured mostly fine and dry days. Until noon low stratus or mostly cloudy conditions prevailed, clearing to a mostly fine afternoon with sun and clouds in the mix. Later on the day clouds increased again.

On the 29th around noon the cold offshore current around 17 °C caused local fog banks. The predominantly weather pattern with southeasterly trade winds of about 4 Bft and a sea of 1.5 to 2m did not change until the end of the journey. On the 06th and 7th low pressure systems moving well to the south enhanced the swell to about 2.5 m. In the morning of the 11th RV METEOR reached the port of Walvis Bay.

7 Station List

Abbreviations:

AC-S	AC-S, In-Situ Spectrophotometer
BWS	Bottom Water Sampler
CATM	Katamaran
CTD/RO	CTD/Rosette
HN	Hand Net
MOC	MOCNESS
MOC-D	Double MOCNESS
MOR	Mooring
MSN	Multinet
MSS	Microstructure Probe
MUC	Multicorer
RTR	Ring-Trawl
SCF	Scanfish
SD	Secchi-Disk
SLS	SATLANTIC
TD	Drifter
TRBM	Trawl Resistant Bottom Mooring
TRIOS	Trios
T-TRAW	Tucker Trawl
VGRAB	VanVeen Grab

Tab. 7.1 List of stations and devices.

Station METEOR	Date	Time	Position [°Lat]	Position [°Lon]	Depth [m]	Wind [m/s]	Course [°]	Speed [kn]	Gear
M103/1_2277-1	27.12.2013	09:26	22° 59.98' S	14° 20.02' E	60.9	SW 4	164	0	CTD/RO
M103/1_2277-2	27.12.2013	09:48	22° 59.98' S	14° 20.02' E	59.8	WSW 4	143.8	0	SD
M103/1_2278-1	27.12.2013	12:20	23° 0.02' S	14° 3.66' E	129.4	SSW 8	340.3	0	MOR
M103/1_2279-1	27.12.2013	18:55	23° 14.98' S	14° 0.01' E	145.3	S 14	261.7	0.1	CTD/RO
M103/1_2279-2	27.12.2013	19:00	23° 14.98' S	14° 0.01' E	145.5	S 13	186.7	0	HN
M103/1_2279-3	27.12.2013	20:13	23° 14.98' S	14° 0.01' E	145.8	SSE 14	322.5	0	MUC
M103/1_2280-1	27.12.2013	23:24	23° 14.96' S	13° 30.00' E	228.6	SSE 10	291.6	0.1	CTD/RO
M103/1_2280-2	27.12.2013	23:24	23° 14.96' S	13° 30.00' E	228.6	SSE 10	291.6	0.1	HN
M103/1_2280-3	27.12.2013	23:50	23° 14.96' S	13° 30.00' E	228.1	SSE 8	133.8	0	BWS
M103/1_2280-4	28.12.2013	00:30	23° 15.00' S	13° 30.00' E	227.1	SSE 12	273.6	0.1	MUC
M103/1_2281-1	28.12.2013	07:28	24° 0.01' S	14° 14.97' E	120.4	SSE 4	285.2	0.1	CTD/RO
M103/1_2281-2	28.12.2013	07:29	24° 0.01' S	14° 14.97' E	118.9	SSE 4	271.4	0.1	HN
M103/1_2281-3	28.12.2013	07:34	24° 0.01' S	14° 14.97' E	116.8	SSE 4	91.2	0.1	SD
M103/1_2281-4	28.12.2013	07:48	24° 0.01' S	14° 14.97' E	118.8	SSE 4	83.3	0	SLS
M103/1_2281-5	28.12.2013	08:19	24° 0.02' S	14° 14.86' E	121.2	SSE 4	107.5	0.1	TRIOS
M103/1_2281-6	28.12.2013	09:03	24° 0.02' S	14° 14.90' E	57.9	S 6	99	0	MUC
M103/1_2281-7	28.12.2013	09:40	24° 0.26' S	14° 14.87' E	119.6	S 7	177.5	2.9	RTR
M103/1_2282-1	28.12.2013	13:40	24° 36.03' S	14° 11.94' E	145.3	S 10	114.9	0.3	CTD/RO
M103/1_2282-2	28.12.2013	13:42	24° 36.02' S	14° 11.94' E	144.6	S 10	298	0.5	HN
M103/1_2282-3	28.12.2013	13:43	24° 36.01' S	14° 11.94' E	145.2	S 10	114.2	0.1	SD
M103/1_2282-4	28.12.2013	14:05	24° 36.02' S	14° 11.98' E	146.0	S 11	289.5	0	SLS
M103/1_2282-5	28.12.2013	14:39	24° 36.02' S	14° 11.98' E	144.2	S 12	231.2	0	TRIOS
M103/1_2282-6	28.12.2013	14:54	24° 36.02' S	14° 11.98' E	144.9	S 12	115.2	0.1	CTD/RO
M103/1_2282-7	28.12.2013	15:28	24° 36.02' S	14° 11.98' E	144.6	S 12	146.3	0.1	MUC
M103/1_2282-8	28.12.2013	15:49	24° 36.36' S	14° 11.94' E	147.1	S 13	174.2	1.8	T-TRAW
M103/1_2283-1	28.12.2013	21:08	25° 3.97' S	14° 43.99' E	253.8	S 15	213.6	0.1	CTD/RO
M103/1_2283-2	28.12.2013	21:10	25° 3.97' S	14° 43.99' E	0.0	S 15	0	0	HN
M103/1_2283-3	28.12.2013	21:37	25° 3.97' S	14° 43.99' E	52.2	S 14	110.2	0	BWS
M103/1_2283-4	28.12.2013	22:09	25° 3.99' S	14° 43.99' E	51.2	S 14	246.6	0.1	MUC
M103/1_2284-2	28.12.2013	23:48	25° 7.98' S	14° 32.05' E	91.5	S 13	81.7	0.1	HN
M103/1_2284-3	29.12.2013	00:14	25° 7.99' S	14° 32.00' E	92.3	S 12	316.4	0.1	MSN
M103/1_2284-4	29.12.2013	00:22	25° 7.99' S	14° 32.00' E	92.0	S 13	196.8	0.2	CTD/RO

Station METEOR	Date	Time	Position [°Lat]	Position [°Lon]	Depth [m]	Wind [m/s]	Course [°]	Speed [kn]	Gear
M103/1_2284-5	29.12.2013	00:54	25° 7.99' S	14° 32.00' E	91.8	S 13	100.4	0	BWS
M103/1_2284-6	29.12.2013	01:14	25° 7.99' S	14° 32.00' E	91.0	S 13	117.4	0.1	BWS
M103/1_2284-7	29.12.2013	01:50	25° 7.99' S	14° 32.00' E	92.1	S 13	0	0.1	BWS
M103/1_2284-8	29.12.2013	01:56	25° 7.99' S	14° 32.00' E	94.3	S 13	145.8	0.1	MUC
M103/1_2284-9	29.12.2013	02:16	25° 7.96' S	14° 32.01' E	91.1	S 13	0	0.2	MUC
M103/1_2284-10	29.12.2013	02:31	25° 7.97' S	14° 32.01' E	90.8	S 12	151	0	MUC
M103/1_2284-11	29.12.2013	02:49	25° 8.06' S	14° 32.00' E	93.1	S 11	175.9	2.3	MSN
M103/1_2285-1	29.12.2013	04:34	25° 11.96' S	14° 19.99' E	152.6	SSE 13	200.1	1.7	CTD/RO
M103/1_2285-2	29.12.2013	04:41	25° 11.96' S	14° 19.99' E	153.1	SSE 14	75.4	0.6	HN
M103/1_2285-3	29.12.2013	05:02	25° 11.96' S	14° 19.99' E	153.1	SSE 12	63.8	0.2	BWS
M103/1_2285-4	29.12.2013	05:25	25° 11.96' S	14° 19.99' E	153.1	SSE 11	92.5	1.9	CTD/RO
M103/1_2285-5	29.12.2013	06:01	25° 11.95' S	14° 19.94' E	153.1	S 10	236.3	0.7	MUC
M103/1_2286-1	29.12.2013	08:10	25° 16.96' S	14° 3.99' E	191.1	S 13	57	0.8	CTD/RO
M103/1_2286-2	29.12.2013	08:17	25° 16.96' S	14° 3.98' E	190.6	S 13	238.2	0.4	SD
M103/1_2286-3	29.12.2013	08:55	25° 16.97' S	14° 3.99' E	190.3	S 14	123.2	1.1	MSN
M103/1_2286-3	29.12.2013	09:08	25° 16.97' S	14° 3.99' E	191.8	S 13	83.4	2	MSN
M103/1_2286-4	29.12.2013	09:26	25° 16.97' S	14° 3.98' E	191.8	S 13	312.5	0.4	CTD/RO
M103/1_2286-5	29.12.2013	09:57	25° 16.96' S	14° 3.99' E	190.2	S 12	259.2	1.2	HN
M103/1_2286-6	29.12.2013	10:06	25° 16.96' S	14° 3.98' E	190.8	S 12	65.9	0.4	SLS
M103/1_2286-7	29.12.2013	10:28	25° 16.97' S	14° 3.94' E	190.9	S 12	351.8	0.9	TRIOS
M103/1_2286-8	29.12.2013	10:59	25° 16.97' S	14° 3.95' E	190.8	S 12	239.6	0.6	MSN
M103/1_2286-9	29.12.2013	11:42	25° 16.97' S	14° 3.95' E	190.5	S 13	273.7	1.5	MUC
M103/1_2286-10	29.12.2013	11:44	25° 16.97' S	14° 3.96' E	191.0	S 13	96.4	1	MUC
M103/1_2286-11	29.12.2013	12:23	25° 17.28' S	14° 3.95' E	190.6	S 13	179.2	1.8	MSN
M103/1_2287-1	29.12.2013	14:00	25° 20.93' S	13° 53.97' E	248.8	S 12	325.6	1.2	CTD/RO
M103/1_2287-2	29.12.2013	14:13	25° 20.99' S	13° 54.00' E	249.4	S 12	232.7	1.6	HN
M103/1_2287-3	29.12.2013	14:18	25° 20.99' S	13° 54.00' E	248.8	S 11	157.8	0.2	SD
M103/1_2287-4	29.12.2013	14:41	25° 20.99' S	13° 54.00' E	250.4	S 12	104.5	1.2	MSN
M103/1_2287-5	29.12.2013	15:11	25° 20.99' S	13° 54.00' E	249.4	S 12	161.4	0.3	CTD/RO
M103/1_2287-5	29.12.2013	15:21	25° 20.99' S	13° 54.00' E	248.5	S 12	356.9	0.8	CTD/RO
M103/1_2287-6	29.12.2013	15:26	25° 20.99' S	13° 53.99' E	248.9	S 12	348.1	0.5	SLS
M103/1_2287-7	29.12.2013	15:56	25° 21.01' S	13° 53.83' E	249.8	S 12	262.7	1.2	TRIOS
M103/1_2287-8	29.12.2013	16:10	25° 21.01' S	13° 53.83' E	249.9	S 11	47.1	0.8	MSN
M103/1_2287-9	29.12.2013	16:36	25° 21.01' S	13° 53.83' E	250.2	S 12	77.3	0.8	BWS
M103/1_2287-10	29.12.2013	17:06	25° 21.03' S	13° 53.79' E	250.1	S 13	109.4	0.3	MUC
M103/1_2287-11	29.12.2013	17:40	25° 21.01' S	13° 53.64' E	251.3	S 12	356.3	0.6	MUC
M103/1_2287-12	29.12.2013	18:24	25° 21.07' S	13° 53.61' E	250.8	S 13	195.2	2.5	MSN
M103/1_2287-13	29.12.2013	19:40	25° 20.96' S	13° 53.92' E	250.0	S 13	139.5	2.8	MOC
M103/1_2288-1	29.12.2013	22:33	25° 25.97' S	13° 40.04' E	411.5	S 15	75.6	1.2	CTD/RO
M103/1_2288-2	29.12.2013	22:58	25° 25.99' S	13° 40.01' E	411.9	SSE 15	154.4	0.6	MSN
M103/1_2288-2	29.12.2013	23:04	25° 25.99' S	13° 40.01' E	412.4	SSE 14	273.8	3.3	MSN
M103/1_2288-3	29.12.2013	23:16	25° 25.99' S	13° 40.00' E	412.2	SSE 13	58	1.2	CTD/RO
M103/1_2288-4	29.12.2013	23:26	25° 25.99' S	13° 40.00' E	412.9	SSE 14	75.1	1.3	HN
M103/1_2288-5	29.12.2013	23:48	25° 25.99' S	13° 40.00' E	415.0	SSE 15	126	1.5	BWS
M103/1_2288-6	30.12.2013	00:27	25° 26.00' S	13° 40.00' E	411.4	SSE 16	60.3	1.1	MUC
M103/1_2289-1	30.12.2013	02:14	25° 28.41' S	13° 29.98' E	1694.2	SSE 14	203.4	2.9	MSN
M103/1_2289-2	30.12.2013	03:03	25° 29.34' S	13° 30.05' E	712.7	SSE 14	61.9	2	CTD/RO
M103/1_2289-3	30.12.2013	03:28	25° 29.33' S	13° 30.04' E	700.0	SSE 13	85.7	2.5	MSN
M103/1_2289-4	30.12.2013	04:01	25° 29.34' S	13° 30.04' E	696.7	SSE 13	119.6	1.5	CTD/RO
M103/1_2289-5	30.12.2013	04:46	25° 29.34' S	13° 30.05' E	697.0	SSE 14	166.8	0.7	BWS
M103/1_2289-6	30.12.2013	05:39	25° 29.32' S	13° 30.01' E	700.2	SSE 14	279.2	2	MUC
M103/1_2289-7	30.12.2013	06:17	25° 29.27' S	13° 29.85' E	703.2	SSE 13	112	1.9	SD
M103/1_2289-8	30.12.2013	06:19	25° 29.27' S	13° 29.85' E	716.5	SSE 12	335.7	1.5	SLS
M103/1_2289-9	30.12.2013	07:18	25° 29.76' S	13° 29.73' E	1729.8	SSE 12	169.5	2.2	MOC
M103/1_2290-1	30.12.2013	10:14	25° 31.73' S	13° 19.94' E	883.7	SSE 10	219.7	1.9	MSN
M103/1_2290-2	30.12.2013	11:05	25° 32.98' S	13° 20.00' E	1002.2	SSE 10	152.3	1.4	SD
M103/1_2290-3	30.12.2013	11:12	25° 32.99' S	13° 20.00' E	858.5	SSE 11	245.2	1.9	CTD/RO
M103/1_2290-4	30.12.2013	11:12	25° 32.99' S	13° 20.00' E	858.5	SSE 11	245.2	1.9	HN
M103/1_2290-5	30.12.2013	12:16	25° 32.99' S	13° 19.91' E	1121.8	SSE 12	287	2.3	SLS
M103/1_2290-6	30.12.2013	12:32	25° 32.99' S	13° 19.95' E	1131.5	SSE 11	98.5	0.3	CTD/RO
M103/1_2290-7	30.12.2013	13:05	25° 32.99' S	13° 19.99' E	1125.9	SSE 11	137.1	2.6	TRIOS

Station METEOR	Date	Time	Position [°Lat]	Position [°Lon]	Depth [m]	Wind [m/s]	Course [°]	Speed [kn]	Gear
M103/1_2290-8	30.12.2013	13:53	25° 32.99' S	13° 19.99' E	1129.3	SSE 11	63.4	1.3	BWS
M103/1_2290-9	30.12.2013	14:52	25° 33.00' S	13° 19.99' E	1124.4	SSE 12	75.3	0.5	MSN
M103/1_2290-10	30.12.2013	15:20	25° 32.99' S	13° 19.99' E	1119.9	S 12	286.6	3.5	MUC
M103/1_2290-11	30.12.2013	16:45	25° 32.99' S	13° 19.93' E	1128.0	S 12	155.2	0.3	MSN
M103/1_2290-12	30.12.2013	17:35	25° 32.99' S	13° 19.93' E	1129.6	S 13	311.5	1.7	MSN
M103/1_2291-1	30.12.2013	20:51	25° 39.97' S	12° 59.94' E	2560.2	SSE 13	107.6	2.1	CTD/RO
M103/1_2291-2	30.12.2013	22:23	25° 39.97' S	12° 59.94' E	2223.3	SSE 13	48.6	0.7	CTD/RO
M103/1_2291-3	30.12.2013	23:10	25° 39.97' S	12° 59.94' E	2236.9	SSE 12	352.1	1.4	CTD/RO
M103/1_2291-4	30.12.2013	23:46	25° 39.97' S	12° 59.94' E	2232.4	SSE 16	125.7	0.7	CTD/RO
M103/1_2291-5	31.12.2013	00:02	25° 39.97' S	12° 59.94' E	2234.7	SSE 14	339.5	0.8	BWS
M103/1_2291-6	31.12.2013	00:10	25° 39.98' S	12° 59.96' E	2231.1	SSE 15	248.7	1.5	HN
M103/1_2291-7	31.12.2013	02:28	25° 39.99' S	13° 0.00' E	2225.9	SSE 14	20.3	1.4	MUC
M103/1_2291-8	31.12.2013	04:20	25° 39.98' S	12° 59.96' E	2232.5	SSE 13	224.9	1.9	MUC
M103/1_2291-9	31.12.2013	05:34	25° 40.14' S	12° 59.92' E	2422.3	SSE 12	203.1	1.6	MOC
M103/1_2292-1	31.12.2013	23:22	27° 20.97' S	15° 0.00' E	191.4	SSE 10	92.9	0.1	CTD/RO
M103/1_2292-2	31.12.2013	23:27	27° 20.97' S	15° 0.00' E	190.4	SSE 10	258.2	0.1	HN
M103/1_2292-3	01.01.2014	00:05	27° 20.99' S	15° 0.01' E	190.3	SSE 10	45.4	0	MUC
M103/1_001-1	01.01.2014	10:22	28° 38.05' S	16° 15.94' E	40.7	S 5	63.9	0	CTD/RO
M103/1_001-2	01.01.2014	10:25	28° 38.04' S	16° 15.95' E	39.8	S 5	0	0.1	HN
M103/1_001-3	01.01.2014	10:26	28° 38.03' S	16° 15.95' E	40.6	S 5	62.4	0.2	SD
M103/1_001-4	01.01.2014	10:46	28° 38.00' S	16° 15.99' E	40.1	S 6	0	0	SLS
M103/1_001-5	01.01.2014	11:07	28° 38.00' S	16° 16.02' E	39.7	S 7	287.3	0.1	TRIOS
M103/1_001-6	01.01.2014	11:40	28° 38.00' S	16° 16.01' E	40.2	S 8	173.1	0.1	BWS
M103/1_001-7	01.01.2014	12:05	28° 38.00' S	16° 16.01' E	40.6	S 8	131.2	0	MUC
M103/1_001-8	01.01.2014	12:23	28° 38.00' S	16° 16.01' E	39.9	S 9	0	0.2	MUC
M103/1_002-1	01.01.2014	14:08	28° 37.28' S	16° 0.00' E	114.1	S 8	203.4	2.3	MSN
M103/1_002-2	01.01.2014	14:38	28° 38.17' S	15° 59.97' E	116.9	S 7	82.3	0.5	CTD/RO
M103/1_002-3	01.01.2014	14:46	28° 38.17' S	15° 59.98' E	116.6	S 7	26.8	0.2	SD
M103/1_002-4	01.01.2014	15:00	28° 38.17' S	15° 59.97' E	116.6	S 7	102.2	0.5	MSN
M103/1_002-5	01.01.2014	15:01	28° 38.17' S	15° 59.97' E	116.1	S 6	0	0.2	HN
M103/1_002-6	01.01.2014	15:27	28° 38.17' S	15° 59.98' E	116.2	S 6	254.3	1.1	CTD/RO
M103/1_002-6	01.01.2014	15:33	28° 38.17' S	15° 59.98' E	116.6	S 6	301.1	0.3	CTD/RO
M103/1_002-7	01.01.2014	15:36	28° 38.17' S	15° 59.97' E	117.1	S 6	60.3	0.5	SLS
M103/1_002-8	01.01.2014	16:09	28° 38.17' S	15° 59.93' E	115.0	S 6	107.4	1.6	TRIOS
M103/1_002-9	01.01.2014	16:22	28° 38.17' S	15° 59.93' E	115.2	S 6	344	0.3	CTD/RO
M103/1_002-10	01.01.2014	17:11	28° 38.13' S	15° 59.87' E	114.5	S 7	221.5	0.7	BWS
M103/1_002-11	01.01.2014	17:45	28° 38.15' S	15° 59.76' E	114.9	S 6	286.1	0.4	MSN
M103/1_002-12	01.01.2014	18:05	28° 38.15' S	15° 59.75' E	113.7	S 6	150.9	0.7	MUC
M103/1_002-13	01.01.2014	18:22	28° 38.14' S	15° 59.71' E	114.3	S 6	80	2.6	MUC
M103/1_002-14	01.01.2014	18:53	28° 38.70' S	15° 59.83' E	114.8	S 7	167.5	1.4	MSN
M103/1_002-15	01.01.2014	19:07	28° 39.03' S	15° 59.95' E	114.2	S 7	181.2	2.5	MSN
M103/1_002-16	01.01.2014	19:45	28° 39.90' S	16° 0.17' E	115.9	S 7	159.8	2.1	MSN
M103/1_003-1	01.01.2014	22:09	28° 37.98' S	15° 40.02' E	160.0	SSE 10	96.9	0	CTD/RO
M103/1_003-2	01.01.2014	22:12	28° 37.98' S	15° 40.02' E	160.9	SSE 11	100.9	0	HN
M103/1_003-3	01.01.2014	22:20	28° 37.98' S	15° 40.02' E	160.2	SSE 11	288.4	0.2	BWS
M103/1_003-4	01.01.2014	23:00	28° 38.00' S	15° 40.02' E	161.7	SE 10	111.7	0	MUC
M103/1_004-1	02.01.2014	01:10	28° 37.98' S	15° 19.92' E	187.9	SE 9	222.9	0	CTD/RO
M103/1_004-2	02.01.2014	01:34	28° 37.97' S	15° 19.99' E	187.9	SE 10	99	0	BWS
M103/1_004-3	02.01.2014	01:59	28° 37.96' S	15° 19.97' E	187.4	SE 9	138.2	0.1	MUC
M103/1_005-1	02.01.2014	04:08	28° 37.99' S	14° 59.96' E	171.4	SSE 9	280.2	1.2	CTD/RO
M103/1_005-2	02.01.2014	04:29	28° 37.99' S	14° 59.96' E	171.5	SE 11	283.9	0.9	BWS
M103/1_005-3	02.01.2014	04:59	28° 38.00' S	14° 59.96' E	171.2	SE 10	79.9	0.3	BWS
M103/1_005-4	02.01.2014	05:01	28° 38.00' S	14° 59.96' E	171.8	SE 10	247.8	2.6	HN
M103/1_005-5	02.01.2014	05:20	28° 38.00' S	14° 59.95' E	170.7	SE 10	249.3	2.8	MUC
M103/1_006-1	02.01.2014	07:23	28° 36.79' S	14° 39.81' E	158.4	SSE 11	211.3	1.9	MSN
M103/1_006-2	02.01.2014	07:58	28° 37.97' S	14° 39.99' E	158.9	SSE 10	106.3	0.1	CTD/RO
M103/1_006-3	02.01.2014	08:06	28° 37.97' S	14° 39.99' E	158.6	SE 11	259.5	0	HN
M103/1_006-4	02.01.2014	08:58	28° 38.00' S	14° 39.68' E	157.3	SSE 10	322.2	1.8	SLS
M103/1_006-5	02.01.2014	08:59	28° 38.00' S	14° 39.66' E	156.8	SSE 11	232.7	1.6	SD
M103/1_006-6	02.01.2014	09:40	28° 38.01' S	14° 39.62' E	156.7	SSE 12	251.5	0.6	TRIOS
M103/1_006-7	02.01.2014	09:58	28° 38.01' S	14° 39.61' E	157.3	SSE 11	47.8	0.3	MSN

Station METEOR	Date	Time	Position [°Lat]	Position [°Lon]	Depth [m]	Wind [m/s]	Course [°]	Speed [kn]	Gear
M103/1_006-8	02.01.2014	10:19	28° 38.01' S	14° 39.63' E	157.7	SSE 10	130	0.2	BWS
M103/1_006-9	02.01.2014	10:44	28° 38.01' S	14° 39.62' E	156.8	SSE 9	259.1	2.7	MSN
M103/1_006-10	02.01.2014	11:07	28° 38.03' S	14° 39.63' E	158.5	SSE 9	107	0.4	MUC
M103/1_006-11	02.01.2014	11:29	28° 38.05' S	14° 39.63' E	158.6	SSE 9	91.4	0.4	MUC
M103/1_006-13	02.01.2014	12:12	28° 38.47' S	14° 39.69' E	159.8	SSE 9	119.6	1.8	MSN
M103/1_007-1	02.01.2014	14:22	28° 37.29' S	14° 25.01' E	370.9	S 10	168.1	2.4	MSN
M103/1_007-2	02.01.2014	15:02	28° 38.36' S	14° 24.99' E	367.4	S 11	250.1	1.5	CTD/RO
M103/1_007-3	02.01.2014	15:07	28° 38.36' S	14° 25.00' E	368.4	S 10	93.6	1.8	SD
M103/1_007-4	02.01.2014	15:09	28° 38.36' S	14° 25.00' E	367.9	S 11	269.4	0.3	HN
M103/1_007-5	02.01.2014	15:47	28° 38.38' S	14° 25.03' E	366.2	S 10	252.8	0.7	SLS
M103/1_007-6	02.01.2014	16:06	28° 38.40' S	14° 25.04' E	367.9	S 10	92.5	1.8	TRIOS
M103/1_007-7	02.01.2014	16:25	28° 38.40' S	14° 25.04' E	366.0	S 11	283.8	2.3	CTD/RO
M103/1_007-8	02.01.2014	16:42	28° 38.40' S	14° 25.06' E	364.8	S 11	110.9	0.5	MSN
M103/1_007-9	02.01.2014	17:08	28° 38.40' S	14° 25.15' E	362.1	S 10	271.6	1.6	BWS
M103/1_007-10	02.01.2014	17:42	28° 38.41' S	14° 25.17' E	360.5	S 10	99.1	3.2	MSN
M103/1_007-11	02.01.2014	18:17	28° 38.41' S	14° 25.26' E	358.2	SSE 10	95.7	1.5	MUC
M103/1_007-12	02.01.2014	19:22	28° 39.49' S	14° 25.51' E	347.1	SSE 10	130.2	1.9	MSN
M103/1_007-13	02.01.2014	20:52	28° 38.50' S	14° 25.08' E	362.9	SE 7	246.9	2	MOC
M103/1_008-1	02.01.2014	23:01	28° 36.80' S	14° 14.74' E	731.3	SSE 7	192.8	0.3	MSN
M103/1_008-2	03.01.2014	00:01	28° 37.99' S	14° 15.00' E	726.0	SSE 9	263.2	1.3	CTD/RO
M103/1_008-3	03.01.2014	00:31	28° 37.99' S	14° 15.00' E	726.6	SSE 9	338.7	0.6	MSN
M103/1_008-4	03.01.2014	00:51	28° 37.99' S	14° 15.00' E	725.4	SSE 8	70.9	0.6	CTD/RO
M103/1_008-5	03.01.2014	01:21	28° 37.99' S	14° 15.00' E	726.6	SSE 10	126.4	0.9	BWS
M103/1_008-6	03.01.2014	02:12	28° 37.99' S	14° 15.00' E	726.4	SSE 9	93	0.6	MSN
M103/1_008-7	03.01.2014	02:53	28° 37.99' S	14° 15.00' E	725.6	SSE 10	85.2	1.1	MSN
M103/1_008-8	03.01.2014	03:29	28° 37.99' S	14° 14.95' E	728.0	SSE 10	0	0.2	MUC
M103/1_008-9	03.01.2014	04:13	28° 38.02' S	14° 14.87' E	731.3	SSE 10	242.9	1.4	MUC
M103/1_008-10	03.01.2014	05:22	28° 39.07' S	14° 15.22' E	3002.5	SSE 9	106.4	2.7	MSN
M103/1_008-11	03.01.2014	06:45	28° 40.89' S	14° 15.88' E	701.2	SSE 9	161.1	1.3	MOC
M103/1_009-1	03.01.2014	10:10	28° 37.98' S	13° 46.87' E	2028.4	SSE 7	325.4	0.2	CTD/RO
M103/1_009-2	03.01.2014	10:17	28° 37.98' S	13° 46.87' E	2037.5	SSE 8	15.8	-0.1	SD
M103/1_009-3	03.01.2014	11:50	28° 38.01' S	13° 46.99' E	2033.7	SSE 8	170.1	0.1	SLS
M103/1_009-4	03.01.2014	11:54	28° 38.01' S	13° 46.99' E	2033.7	SSE 8	36.8	0	HN
M103/1_009-5	03.01.2014	12:20	28° 38.01' S	13° 46.99' E	2035.1	SSE 7	162.2	0	TRIOS
M103/1_009-6	03.01.2014	13:14	28° 38.01' S	13° 46.99' E	2035.7	S 8	329.6	0.1	CTD/RO
M103/1_009-7	03.01.2014	14:27	28° 38.01' S	13° 46.99' E	2033.7	S 7	2.9	0.9	CTD/RO
M103/1_009-8	03.01.2014	15:21	28° 38.02' S	13° 47.02' E	2032.8	S 7	182.1	0.7	MUC
M103/1_009-9	03.01.2014	16:20	28° 38.13' S	13° 47.17' E	2026.5	SSE 6	325.6	0.6	CTD/RO
M103/1_009-10	03.01.2014	17:10	28° 38.13' S	13° 47.18' E	2026.5	SSE 6	279.1	0.5	BWS
M103/1_009-11	03.01.2014	18:43	28° 39.24' S	13° 47.10' E	2038.9	SSE 5	208.2	1.8	MOC
M103/1_010-1	05.01.2014	03:50	23° 2.38' S	12° 18.78' E	0.0	SW 4	18.9	0.1	MOR
M103/1_010-2	05.01.2014	06:04	23° 2.29' S	12° 18.61' E	2098.8	S 9	119.5	0	CTD/RO
M103/1_010-3	05.01.2014	06:28	23° 2.29' S	12° 18.61' E	2102.5	SSE 10	168.9	0	HN
M103/1_010-4	05.01.2014	06:38	23° 2.29' S	12° 18.61' E	2098.1	S 9	264.7	0.1	HN
M103/1_010-5	05.01.2014	07:06	23° 2.29' S	12° 18.61' E	2099.7	S 9	273.7	0	SD
M103/1_010-6	05.01.2014	07:58	23° 2.29' S	12° 18.60' E	2099.1	S 9	121.5	0	SLS
M103/1_010-7	05.01.2014	08:17	23° 2.29' S	12° 18.59' E	2100.8	SSE 8	277.1	0	TRIOS
M103/1_010-8	05.01.2014	09:14	23° 2.29' S	12° 18.59' E	2099.3	S 9	94.5	0	CTD/RO
M103/1_010-9	05.01.2014	10:09	23° 2.28' S	12° 18.59' E	2099.0	S 8	105.6	0.1	CTD/RO
M103/1_010-10	05.01.2014	11:00	23° 2.28' S	12° 18.59' E	2097.6	S 8	249.9	0	BWS
M103/1_010-11	05.01.2014	12:03	23° 2.28' S	12° 18.59' E	2098.4	S 8	188.5	0.1	CTD/RO
M103/1_010-12	05.01.2014	13:06	23° 2.28' S	12° 18.59' E	2099.4	S 10	92.5	0	MUC
M103/1_010-13	05.01.2014	13:49	23° 2.32' S	12° 18.63' E	2906.6	S 11	143.1	0.1	HN
M103/1_010-14	05.01.2014	14:48	23° 3.52' S	12° 18.43' E	3769.2	S 11	179	2.1	MOC
M103/1_010-15	05.01.2014	17:59	23° 4.54' S	12° 17.51' E	3748.7	S 10	144.1	2.8	MOC-D
M103/1_011-1	05.01.2014	23:21	22° 58.96' S	12° 47.89' E	905.6	SSE 8	114.2	4.4	MSN
M103/1_011-2	06.01.2014	00:20	22° 59.97' S	12° 47.89' E	1588.2	SSE 7	306.4	2.6	CTD/RO
M103/1_011-3	06.01.2014	00:51	22° 59.99' S	12° 47.96' E	2111.5	SSE 7	96.7	0.5	MSN
M103/1_011-4	06.01.2014	01:14	23° 0.00' S	12° 47.97' E	2909.8	SSE 8	136.1	1	CTD/RO
M103/1_011-5	06.01.2014	01:40	23° 0.01' S	12° 47.98' E	2307.3	S 8	256.5	0.9	CTD/RO
M103/1_011-6	06.01.2014	01:43	23° 0.01' S	12° 47.99' E	2595.6	SSE 8	101.7	0.4	HN

Station METEOR	Date	Time	Position [°Lat]	Position [°Lon]	Depth [m]	Wind [m/s]	Course [°]	Speed [kn]	Gear
M103/1_011-7	06.01.2014	02:22	23° 0.01' S	12° 47.99' E	906.6	SSE 7	149.3	1.4	MSN
M103/1_011-8	06.01.2014	03:06	23° 0.01' S	12° 47.99' E	896.6	SE 7	309.8	2.1	MSN
M103/1_011-9	06.01.2014	04:43	23° 2.21' S	12° 46.76' E	2800.7	SSE 8	212	2.6	MSN
M103/1_011-10	06.01.2014	06:39	23° 5.46' S	12° 44.57' E	2907.9	SSE 4	237.6	2.8	MOC
M103/1_011-11	06.01.2014	08:43	23° 7.58' S	12° 42.67' E	1186.8	SSE 2	145.4	1.4	MSS
M103/1_011-12	06.01.2014	08:57	23° 7.81' S	12° 42.49' E	1195.8	SSE 2	211.8	3.2	MOC-D
M103/1_013-1	06.01.2014	14:30	22° 59.93' S	12° 59.96' E	502.2	SW 6	231.6	0.8	MSS
M103/1_014-1	06.01.2014	17:30	23° 0.92' S	13° 1.92' E	0.0	SSW 5	135.7	0.5	MOR
M103/1_014-2	06.01.2014	17:55	23° 0.98' S	13° 1.96' E	0.0	SSW 6	75.1	0.1	CTD/RO
M103/1_014-3	06.01.2014	18:11	23° 0.98' S	13° 1.96' E	455.5	S 6	273.7	1.1	HN
M103/1_014-4	06.01.2014	18:48	23° 0.98' S	13° 1.97' E	458.2	SSW 5	111.7	5.7	MSN
M103/1_014-5	06.01.2014	19:13	23° 0.98' S	13° 1.96' E	454.7	S 5	201.3	0.6	CTD/RO
M103/1_014-6	06.01.2014	19:43	23° 0.98' S	13° 1.96' E	458.0	SSW 6	111.4	3.7	BWS
M103/1_014-7	06.01.2014	20:17	23° 0.98' S	13° 1.96' E	454.4	S 5	292.8	3.5	BWS
M103/1_014-8	06.01.2014	20:49	23° 0.98' S	13° 1.96' E	455.5	S 5	355.8	0.2	CTD/RO
M103/1_014-9	06.01.2014	21:39	23° 0.98' S	13° 1.96' E	454.6	SSW 3	295.1	4.7	MUC
M103/1_014-10	06.01.2014	22:19	23° 1.32' S	13° 1.87' E	462.6	SW 2	292.2	3.4	MSN
M103/1_014-11	06.01.2014	23:34	23° 2.67' S	13° 0.67' E	517.4	WSW 1	282.2	3.2	MOC
M103/1_014-12	07.01.2014	01:35	23° 4.86' S	12° 57.35' E	642.2	WSW 2	208.4	2.7	MOC-D
M103/1_015-1	07.01.2014	04:22	23° 0.62' S	13° 4.63' E	373.1	NW 4	264.5	1	MSS
M103/1_016-2	07.01.2014	05:28	22° 59.99' S	13° 10.01' E	322.7	NW 4	83.7	0.8	HN
M103/1_016-4	07.01.2014	06:30	23° 0.49' S	13° 9.81' E	325.8	NW 5	240.3	1	MSS
M103/1_017-1	07.01.2014	08:09	23° 1.12' S	13° 14.40' E	368.7	NNW 6	246	2.2	MSS
M103/1_018-1	07.01.2014	09:05	22° 58.63' S	13° 20.48' E	347.1	NNW 8	198.4	3.4	MSN
M103/1_018-2	07.01.2014	09:55	23° 0.39' S	13° 20.13' E	352.8	NNW 8	322.7	0.6	CTD/RO
M103/1_018-3	07.01.2014	10:00	23° 0.39' S	13° 20.13' E	352.4	NNW 8	275.2	0.8	SD
M103/1_018-4	07.01.2014	10:11	23° 0.39' S	13° 20.13' E	351.1	NNW 8	235	0.4	HN
M103/1_018-5	07.01.2014	10:38	23° 0.69' S	13° 20.19' E	351.6	NNW 9	186.4	1.4	SLS
M103/1_018-6	07.01.2014	10:44	23° 0.73' S	13° 20.21' E	351.1	NW 8	290.2	1.2	TRIOS
M103/1_018-7	07.01.2014	11:20	23° 0.73' S	13° 20.21' E	350.2	NW 7	79.8	0.5	CTD/RO
M103/1_018-8	07.01.2014	11:59	23° 0.73' S	13° 20.21' E	350.4	WNW 8	83.2	0.2	BWS
M103/1_018-9	07.01.2014	12:14	23° 0.73' S	13° 20.21' E	350.8	WNW 8	284.1	0.3	HN
M103/1_018-10	07.01.2014	12:18	23° 0.73' S	13° 20.21' E	351.7	WNW 8	65.6	1.4	CTD/RO
M103/1_018-11	07.01.2014	13:10	23° 0.74' S	13° 20.25' E	352.4	W 8	10.2	0.8	MUC
M103/1_018-12	07.01.2014	13:12	23° 0.74' S	13° 20.25' E	351.6	W 8	162.4	0.6	MSS
M103/1_019-1	07.01.2014	15:39	23° 0.64' S	13° 25.06' E	304.1	WNW 7	137.2	0.9	MSS
M103/1_020-1	07.01.2014	16:18	23° 0.06' S	13° 30.05' E	235.9	WNW 7	357.4	1	SLS
M103/1_020-2	07.01.2014	16:30	23° 0.22' S	13° 30.18' E	232.6	NW 6	135.2	0.6	TRIOS
M103/1_020-3	07.01.2014	16:38	23° 0.20' S	13° 30.18' E	233.7	NW 6	315.3	1.6	HN
M103/1_020-4	07.01.2014	16:53	23° 0.17' S	13° 30.15' E	232.9	NW 6	73.5	0.3	CTD/RO
M103/1_020-5	07.01.2014	16:55	23° 0.17' S	13° 30.15' E	234.8	NW 6	86.4	1	SD
M103/1_020-6	07.01.2014	17:29	23° 0.18' S	13° 30.16' E	234.0	NW 6	335	0.3	BWS
M103/1_020-7	07.01.2014	18:00	23° 0.18' S	13° 30.16' E	232.7	WNW 5	133	2.3	CTD/RO
M103/1_020-8	07.01.2014	18:17	23° 0.18' S	13° 30.16' E	234.2	WNW 5	9	1.1	BWS
M103/1_020-9	07.01.2014	18:47	23° 0.18' S	13° 30.16' E	233.7	WNW 3	134	0.8	MUC
M103/1_020-10	07.01.2014	19:51	23° 0.15' S	13° 30.23' E	231.9	NW 3	0	0.2	MSS
M103/1_021-1	07.01.2014	20:33	22° 59.96' S	13° 35.04' E	146.7	NW 4	331.4	0.4	MSS
M103/1_022-1	07.01.2014	22:09	22° 58.80' S	13° 41.34' E	147.0	WNW 4	201.3	1.2	MSN
M103/1_022-3	07.01.2014	22:58	22° 59.65' S	13° 40.52' E	149.7	N 2	302.4	0.8	HN
M103/1_022-2	07.01.2014	23:02	22° 59.66' S	13° 40.50' E	148.9	N 2	305.6	0.2	CTD/RO
M103/1_022-4	07.01.2014	23:20	22° 59.69' S	13° 40.44' E	148.8	N 3	193.7	0.3	MSN
M103/1_022-5	07.01.2014	23:35	22° 59.74' S	13° 40.37' E	148.7	NNE 4	183.2	0.2	CTD/RO
M103/1_022-6	07.01.2014	23:52	22° 59.81' S	13° 40.28' E	148.1	N 4	274.8	0.3	BWS
M103/1_022-7	08.01.2014	00:17	22° 59.84' S	13° 40.22' E	149.5	NNE 4	22.6	0.4	BWS
M103/1_022-8	08.01.2014	00:43	22° 59.83' S	13° 40.23' E	149.1	NNE 4	243	0.6	MSN
M103/1_022-9	08.01.2014	01:03	22° 59.83' S	13° 40.24' E	148.1	NNE 5	125.2	0.6	MUC
M103/1_022-10	08.01.2014	02:10	23° 0.05' S	13° 39.30' E	148.4	N 4	298	0.9	MSS
M103/1_022-11	08.01.2014	02:29	23° 0.35' S	13° 38.76' E	147.7	N 4	240.4	1.9	MSN
M103/1_022-12	08.01.2014	03:20	23° 1.34' S	13° 37.26' E	147.5	N 5	262.2	2.3	MOC
M103/1_024-1	08.01.2014	06:33	22° 59.94' S	13° 50.01' E	150.2	N 6	351.8	0.9	MSS
M103/1_025-2	08.01.2014	07:47	23° 0.03' S	13° 51.98' E	142.7	N 8	155.3	0.3	SD

Station METEOR	Date	Time	Position [°Lat]	Position [°Lon]	Depth [m]	Wind [m/s]	Course [°]	Speed [kn]	Gear
M103/1_025-3	08.01.2014	07:53	23° 0.03' S	13° 51.98' E	145.0	N 9	0	0.1	HN
M103/1_025-4	08.01.2014	07:56	23° 0.03' S	13° 51.98' E	144.7	N 8	33.8	0.3	HN
M103/1_028-1	08.01.2014	10:52	23° 1.60' S	14° 1.72' E	135.1	WNW 6	333.6	0.2	SLS
M103/1_028-2	08.01.2014	11:11	23° 1.60' S	14° 1.79' E	135.7	WNW 6	112.1	0.4	TRIOS
M103/1_028-3	08.01.2014	11:31	23° 1.62' S	14° 1.84' E	0.0	WNW 5	89.3	0.1	MOR
M103/1_028-4	08.01.2014	12:29	23° 1.50' S	14° 1.60' E	131.9	WNW 5	187.2	0	CTD/RO
M103/1_028-5	08.01.2014	12:58	23° 1.50' S	14° 1.60' E	134.3	W 4	40.7	0	CTD/RO
M103/1_028-6	08.01.2014	12:59	23° 1.50' S	14° 1.60' E	136.0	W 4	0	0	HN
M103/1_028-7	08.01.2014	13:03	23° 1.50' S	14° 1.60' E	136.9	W 4	0	0.1	SD
M103/1_028-8	08.01.2014	13:05	23° 1.50' S	14° 1.60' E	134.5	W 4	308.4	0	HN
M103/1_028-9	08.01.2014	13:25	23° 1.50' S	14° 1.60' E	132.2	W 5	268.6	0	BWS
M103/1_028-10	08.01.2014	13:56	23° 1.50' S	14° 1.60' E	134.2	W 5	132	0	MUC
M103/1_028-11	08.01.2014	14:19	23° 1.46' S	14° 1.64' E	135.3	W 4	50.3	0.3	MUC
M103/1_028-12	08.01.2014	15:15	23° 0.91' S	14° 1.67' E	137.0	W 6	355.9	0.7	MSS
M103/1_029-1	08.01.2014	15:52	22° 59.90' S	14° 6.53' E	125.0	WSW 6	19.5	1.4	MSS
M103/1_030-1	08.01.2014	17:11	23° 0.89' S	14° 10.01' E	118.1	WSW 5	1.8	2.7	MSN
M103/1_030-2	08.01.2014	18:00	22° 59.73' S	14° 10.00' E	127.8	SW 5	69.6	0.8	CTD/RO
M103/1_030-3	08.01.2014	18:18	22° 59.72' S	14° 10.04' E	119.9	SSW 4	231.5	0.3	MSN
M103/1_030-4	08.01.2014	18:34	22° 59.73' S	14° 10.04' E	127.6	SSW 5	70.4	0.5	CTD/RO
M103/1_030-5	08.01.2014	18:35	22° 59.72' S	14° 10.04' E	127.0	SSW 5	0	0	HN
M103/1_030-6	08.01.2014	19:16	22° 59.72' S	14° 10.04' E	127.4	SSW 4	0	0.2	RTR
M103/1_030-7	08.01.2014	19:23	22° 59.72' S	14° 10.04' E	120.1	SSW 4	312.4	0.5	BWS
M103/1_030-8	08.01.2014	20:00	22° 59.73' S	14° 10.05' E	124.4	S 3	0	0	MUC
M103/1_030-9	08.01.2014	20:31	22° 59.74' S	14° 10.07' E	126.3	S 3	155.9	1	MUC
M103/1_030-10	08.01.2014	20:56	23° 0.18' S	14° 10.09' E	126.7	SSE 3	170.6	1.6	MSN
M103/1_030-11	08.01.2014	22:05	23° 1.34' S	14° 10.10' E	126.4	SSE 3	178.1	0.8	MSS
M103/1_030-12	08.01.2014	22:29	23° 1.85' S	14° 9.93' E	118.2	SE 3	196.9	2.3	MOC-D
M103/1_031-1	08.01.2014	23:30	22° 59.92' S	14° 13.03' E	106.6	SE 3	166.2	0.6	CTD/RO
M103/1_031-2	09.01.2014	00:16	23° 0.12' S	14° 12.98' E	108.1	SSE 2	163.7	0.3	MSS
M103/1_034-1	09.01.2014	02:38	23° 0.01' S	14° 21.98' E	39.5	SW 3	52.4	0.3	CTD/RO
M103/1_034-2	09.01.2014	02:49	23° 0.01' S	14° 21.98' E	38.8	SSW 4	208.2	0.3	BWS
M103/1_034-3	09.01.2014	03:13	23° 0.01' S	14° 21.98' E	39.3	SSW 4	321.5	0.4	MUC
M103/1_034-4	09.01.2014	03:15	23° 0.01' S	14° 21.98' E	39.1	SSW 4	265	0.2	HN
M103/1_034-5	09.01.2014	03:39	23° 0.20' S	14° 21.85' E	39.7	SSW 4	217.9	0.5	MSS
M103/1_035-1	09.01.2014	10:20	21° 59.46' S	13° 40.94' E	117.0	S 4	233.7	1.9	MSN
M103/1_035-2	09.01.2014	10:56	22° 0.12' S	13° 40.11' E	117.8	S 5	272.7	0	CTD/RO
M103/1_035-3	09.01.2014	11:03	22° 0.12' S	13° 40.11' E	114.8	SSW 4	110.1	0	SD
M103/1_035-4	09.01.2014	11:04	22° 0.12' S	13° 40.11' E	114.8	SSW 4	0	0	HN
M103/1_035-5	09.01.2014	11:16	22° 0.12' S	13° 40.11' E	114.7	SSW 6	0	0	SLS
M103/1_035-6	09.01.2014	11:50	22° 0.13' S	13° 39.96' E	114.0	SSW 6	271.1	0	BWS
M103/1_035-7	09.01.2014	12:36	22° 0.13' S	13° 39.96' E	113.3	SSW 6	23.5	0	TRIOS
M103/1_035-8	09.01.2014	12:48	22° 0.13' S	13° 39.95' E	115.8	SSW 7	235.8	0.6	T-TRAW
M103/1_036-1	09.01.2014	20:26	20° 59.06' S	12° 49.79' E	296.4	SSE 10	167.1	1.5	MSN
M103/1_036-1	09.01.2014	20:26	20° 59.06' S	12° 49.79' E	296.4	SSE 10	167.1	1.5	MSN
M103/1_036-2	09.01.2014	21:00	20° 59.74' S	12° 49.86' E	299.6	SSE 9	136.4	0	CTD/RO
M103/1_036-3	09.01.2014	21:01	20° 59.74' S	12° 49.87' E	300.3	SSE 9	61.8	0	HN
M103/1_036-4	09.01.2014	21:28	20° 59.81' S	12° 49.87' E	298.7	SSE 8	155.3	1.2	RTR
M103/1_036-5	09.01.2014	22:10	21° 0.65' S	12° 49.95' E	301.2	SSE 9	175.9	1.2	RTR
M103/1_036-6	09.01.2014	22:38	21° 0.72' S	12° 49.96' E	302.3	SSE 9	316.8	0	MUC
M103/1_037-1	10.01.2014	05:03	20° 0.05' S	12° 45.12' E	116.6	SE 7	300.9	0	TRBM
M103/1_037-2	10.01.2014	05:32	20° 0.03' S	12° 45.19' E	117.7	SE 7	89.1	0	CTD/RO
M103/1_037-3	10.01.2014	05:46	20° 0.04' S	12° 45.19' E	117.7	SE 7	263.7	0.1	MSN
M103/1_037-4	10.01.2014	05:58	20° 0.04' S	12° 45.19' E	117.4	SE 6	98.9	0	SD
M103/1_037-5	10.01.2014	05:59	20° 0.04' S	12° 45.19' E	119.5	SE 6	286.8	0	HN
M103/1_038-1	10.01.2014	07:39	19° 58.95' S	12° 30.02' E	148.2	SSE 9	182.7	2.2	MSN
M103/1_038-2	10.01.2014	08:16	19° 59.59' S	12° 29.83' E	150.2	SE 9	283	0.1	SLS
M103/1_038-3	10.01.2014	08:24	19° 59.59' S	12° 29.81' E	149.8	SE 9	272	0	TRIOS
M103/1_038-4	10.01.2014	08:51	19° 59.63' S	12° 29.80' E	150.4	SSE 10	231.3	1.2	RTR
M103/1_038-5	10.01.2014	09:16	20° 0.26' S	12° 29.75' E	151.9	SE 9	167.6	1.6	RTR
M103/1_038-6	10.01.2014	09:53	20° 0.64' S	12° 29.72' E	152.3	SSE 10	260.3	0	CTD/RO
M103/1_038-7	10.01.2014	09:57	20° 0.64' S	12° 29.72' E	153.0	SSE 9	280.4	0	SD

Station METEOR	Date	Time	Position [°Lat]	Position [°Lon]	Depth [m]	Wind [m/s]	Course [°]	Speed [kn]	Gear
M103/1_039-1	10.01.2014	13:41	19° 29.05' S	12° 9.98' E	231.2	S 9	132.5	1.4	MSN
M103/1_039-2	10.01.2014	14:23	19° 29.63' S	12° 9.99' E	233.2	S 10	0	0	MUC
M103/1_039-3	10.01.2014	14:54	19° 29.63' S	12° 9.99' E	232.9	S 10	0	0	RTR
M103/1_039-4	10.01.2014	15:02	19° 29.71' S	12° 9.97' E	233.1	S 10	211.1	1.2	RTR
M103/1_040-1	10.01.2014	18:36	19° 0.08' S	12° 9.94' E	123.0	SSE 10	141.2	1.5	MSN
M103/1_040-2	10.01.2014	19:02	19° 0.54' S	12° 9.92' E	122.2	SE 9	103.4	0	HN
M103/1_040-3	10.01.2014	19:11	19° 0.54' S	12° 9.92' E	122.0	SE 9	94.8	0	CTD/RO
M103/1_040-4	10.01.2014	19:34	19° 0.74' S	12° 9.92' E	124.3	SE 8	173.4	1.1	RTR
M103/1_040-5	10.01.2014	19:47	19° 0.99' S	12° 9.92' E	125.2	SE 8	109.3	0.8	RTR
M103/1_040-6	10.01.2014	19:59	19° 1.05' S	12° 9.92' E	125.2	SE 7	104.4	0	RTR
M103/1_040-7	10.01.2014	20:08	19° 1.05' S	12° 9.92' E	125.3	SE 7	314.9	0	RTR
M103/1_041-1	10.01.2014	21:34	19° 0.08' S	12° 0.07' E	205.3	SE 9	221.7	1.5	MSN
M103/1_041-2	10.01.2014	22:16	19° 0.74' S	12° 0.06' E	209.0	SE 8	33.8	0.1	MUC
M103/1_041-3	10.01.2014	22:45	19° 0.78' S	12° 0.01' E	210.8	SE 10	212.6	1.2	RTR
M103/1_041-4	10.01.2014	23:17	19° 1.32' S	12° 0.01' E	212.6	SE 8	88.4	0.1	RTR
M103/1_041-5	10.01.2014	23:29	19° 1.24' S	11° 59.88' E	213.8	SE 8	272.2	0.2	RTR
M103/1_042-1	11.01.2014	05:36	17° 59.72' S	11° 40.51' E	0.0	SSE 12	14.1	0.2	TRBM
M103/1_042-2	11.01.2014	06:55	17° 59.83' S	11° 40.66' E	0.0	SSE 9	262.8	0	SLS
M103/1_042-3	11.01.2014	07:01	17° 59.83' S	11° 40.65' E	0.0	SSE 9	257.6	0.1	TRIOS
M103/1_042-4	11.01.2014	08:02	17° 59.84' S	11° 40.77' E	118.3	SSE 8	267.1	0.1	CTD/RO
M103/1_042-5	11.01.2014	08:33	17° 59.84' S	11° 40.77' E	117.5	SSE 8	278.3	0	TRBM
M103/1_043-2	11.01.2014	13:08	17° 14.98' S	11° 39.90' E	70.8	S 7	112.8	0.1	HN
M103/1_043-1	11.01.2014	13:11	17° 14.99' S	11° 39.91' E	70.7	S 7	191.7	0	CTD/RO
M103/1_043-3	11.01.2014	13:12	17° 14.99' S	11° 39.91' E	72.5	S 7	62	0	SD
M103/1_043-4	11.01.2014	13:35	17° 15.02' S	11° 39.82' E	71.1	SSW 8	296	0	SLS
M103/1_043-5	11.01.2014	13:46	17° 15.04' S	11° 39.84' E	71.8	SSW 9	0	0	TRIOS
M103/1_043-6	11.01.2014	14:06	17° 15.04' S	11° 39.85' E	70.8	SSW 8	115.8	0	BWS
M103/1_043-7	11.01.2014	14:32	17° 15.04' S	11° 39.84' E	80.9	S 10	0	0.1	MUC
M103/1_044-1	11.01.2014	15:57	17° 14.09' S	11° 30.60' E	133.8	S 10	228.9	2	MSN
M103/1_044-2	11.01.2014	16:29	17° 14.90' S	11° 30.13' E	141.5	S 10	283	0.8	CTD/RO
M103/1_044-3	11.01.2014	16:33	17° 14.91' S	11° 30.12' E	141.7	S 10	278.6	0.5	HN
M103/1_044-4	11.01.2014	16:38	17° 14.93' S	11° 30.09' E	141.1	S 10	228.7	1	SD
M103/1_044-5	11.01.2014	16:53	17° 15.06' S	11° 29.99' E	143.9	S 10	205.2	1.4	RTR
M103/1_044-6	11.01.2014	17:32	17° 16.26' S	11° 29.32' E	152.8	S 9	234.9	0.2	RTR
M103/1_044-7	11.01.2014	18:12	17° 16.26' S	11° 29.32' E	152.1	S 10	102.1	0.3	MSN
M103/1_044-8	11.01.2014	18:30	17° 16.26' S	11° 29.32' E	152.1	S 10	81.3	0.4	CTD/RO
M103/1_044-9	11.01.2014	18:47	17° 16.26' S	11° 29.32' E	152.7	S 11	299.4	0.2	BWS
M103/1_044-10	11.01.2014	19:15	17° 16.26' S	11° 29.33' E	151.5	S 11	344.9	1.1	MUC
M103/1_044-11	11.01.2014	19:39	17° 16.26' S	11° 29.33' E	152.6	S 11	289.6	0.3	VGRAB
M103/1_044-12	11.01.2014	20:09	17° 16.57' S	11° 29.40' E	151.5	S 12	189.6	2.2	MSN
M103/1_044-13	11.01.2014	21:05	17° 17.88' S	11° 29.56' E	151.2	S 10	162.6	2.4	MOC-D
M103/1_045-1	11.01.2014	22:40	17° 14.00' S	11° 23.99' E	223.1	S 11	179.8	1.8	MSN
M103/1_045-2	11.01.2014	23:23	17° 14.97' S	11° 23.98' E	240.5	S 10	255.3	0.9	CTD/RO
M103/1_045-3	11.01.2014	23:44	17° 15.19' S	11° 23.97' E	242.5	S 10	171	2	RTR
M103/1_045-4	12.01.2014	00:02	17° 15.47' S	11° 23.94' E	245.0	S 10	122.7	0.3	RTR
M103/1_045-5	12.01.2014	00:14	17° 15.47' S	11° 23.94' E	244.9	S 10	107.3	0.7	RTR
M103/1_045-6	12.01.2014	00:31	17° 15.47' S	11° 23.94' E	244.8	S 10	320.5	0.8	MSN
M103/1_045-7	12.01.2014	00:53	17° 15.47' S	11° 23.94' E	243.8	S 10	80.4	0.8	CTD/RO
M103/1_045-8	12.01.2014	01:03	17° 15.47' S	11° 23.94' E	244.3	S 11	300.5	0.6	HN
M103/1_045-9	12.01.2014	01:13	17° 15.47' S	11° 23.94' E	244.8	S 10	0	0.1	BWS
M103/1_045-10	12.01.2014	01:44	17° 15.47' S	11° 23.94' E	243.9	SSE 10	218	0.2	MUC
M103/1_045-11	12.01.2014	02:33	17° 16.69' S	11° 24.00' E	244.9	SSE 10	165.8	2.7	MSN
M103/1_045-12	12.01.2014	03:13	17° 18.09' S	11° 24.19' E	244.9	SSE 10	165.6	2.3	MOC
M103/1_046-1	12.01.2014	05:12	17° 13.95' S	11° 17.93' E	496.1	SSE 10	133	2.2	MSN
M103/1_046-2	12.01.2014	06:13	17° 15.03' S	11° 18.04' E	469.0	SSE 9	239.1	0.8	CTD/RO
M103/1_046-3	12.01.2014	06:36	17° 15.16' S	11° 18.05' E	466.6	SSE 11	183	1.4	RTR
M103/1_046-4	12.01.2014	07:16	17° 15.82' S	11° 18.12' E	450.2	SSE 11	56.3	0.7	RTR
M103/1_046-5	12.01.2014	07:31	17° 15.82' S	11° 18.12' E	450.2	SSE 10	98.1	0.8	MSN
M103/1_046-6	12.01.2014	07:48	17° 15.82' S	11° 18.12' E	451.3	SSE 10	225	1.1	CTD/RO
M103/1_046-7	12.01.2014	07:55	17° 15.82' S	11° 18.12' E	451.5	SSE 10	307.1	0.6	SD
M103/1_046-8	12.01.2014	08:31	17° 15.82' S	11° 18.06' E	452.4	SSE 11	132.4	0.8	SLS

Station METEOR	Date	Time	Position [°Lat]	Position [°Lon]	Depth [m]	Wind [m/s]	Course [°]	Speed [kn]	Gear
M103/1_046-9	12.01.2014	08:39	17° 15.82' S	11° 18.06' E	455.9	SSE 10	315.9	0.3	TRIOS
M103/1_046-10	12.01.2014	08:58	17° 15.82' S	11° 18.06' E	453.7	SSE 11	109	0.6	HN
M103/1_046-11	12.01.2014	09:06	17° 15.82' S	11° 18.06' E	453.3	SSE 10	0	0.1	CTD/RO
M103/1_046-12	12.01.2014	09:40	17° 15.82' S	11° 18.06' E	454.3	SSE 10	126.3	0.6	BWS
M103/1_046-13	12.01.2014	10:16	17° 15.82' S	11° 18.06' E	453.5	S 9	28.2	0.3	MUC
M103/1_046-14	12.01.2014	10:47	17° 15.82' S	11° 18.06' E	453.8	S 9	243.6	0.3	MUC
M103/1_046-15	12.01.2014	11:46	17° 16.57' S	11° 18.33' E	432.6	SSE 9	179.5	1.6	MSN
M103/1_046-16	12.01.2014	12:46	17° 17.42' S	11° 18.47' E	418.1	S 10	189.1	2	MOC
M103/1_046-17	12.01.2014	14:33	17° 19.72' S	11° 18.12' E	421.8	S 10	160.2	2.5	MOC-D
M103/1_047-1	12.01.2014	16:35	17° 14.02' S	11° 9.94' E	1031.3	S 11	162.9	2.2	MSN
M103/1_047-2	12.01.2014	17:11	17° 15.04' S	11° 10.01' E	1015.4	S 11	130.5	0.4	CTD/RO
M103/1_047-3	12.01.2014	17:13	17° 15.03' S	11° 10.01' E	1017.2	S 11	27	0.7	HN
M103/1_047-4	12.01.2014	18:09	17° 15.07' S	11° 10.02' E	1015.5	S 11	188.7	1.4	RTR
M103/1_047-5	12.01.2014	18:40	17° 15.49' S	11° 10.05' E	1013.5	SSE 11	224.7	1	RTR
M103/1_047-6	12.01.2014	18:41	17° 15.49' S	11° 10.05' E	1013.6	S 12	123.9	0.8	RTR
M103/1_047-7	12.01.2014	19:01	17° 15.49' S	11° 10.05' E	1013.4	SSE 12	233.8	0.8	MSN
M103/1_047-8	12.01.2014	19:35	17° 15.49' S	11° 10.05' E	1014.3	SSE 13	317.1	0.7	CTD/RO
M103/1_047-9	12.01.2014	20:16	17° 15.49' S	11° 10.05' E	1014.0	S 13	281.5	0.7	CTD/RO
M103/1_047-10	12.01.2014	20:52	17° 15.49' S	11° 10.05' E	1013.3	S 13	229	0.5	BWS
M103/1_047-11	12.01.2014	21:54	17° 15.49' S	11° 10.04' E	1015.4	S 13	0	0.2	MUC
M103/1_047-12	12.01.2014	23:13	17° 16.63' S	11° 10.28' E	1005.0	SSE 13	154.3	0.8	MSN
M103/1_047-13	13.01.2014	00:44	17° 18.30' S	11° 10.63' E	934.1	SSE 12	127.7	0.9	MOC
M103/1_047-14	13.01.2014	02:53	17° 21.21' S	11° 10.70' E	839.8	SSE 13	176	1.2	MOC-D
M103/1_048-1	13.01.2014	06:14	17° 15.00' S	11° 0.00' E	2083.3	SSE 13	57.9	0.2	CTD/RO
M103/1_048-2	13.01.2014	06:15	17° 15.00' S	11° 0.00' E	2104.6	SSE 12	0	0.1	HN
M103/1_048-3	13.01.2014	06:50	17° 15.00' S	11° 0.00' E	2104.8	SSE 11	55.6	1.1	SD
M103/1_048-4	13.01.2014	07:15	17° 15.00' S	10° 59.97' E	2110.3	SSE 10	0	0.2	SLS
M103/1_048-5	13.01.2014	07:25	17° 15.01' S	10° 59.94' E	2111.2	S 11	89.5	0.6	CTD/RO
M103/1_048-6	13.01.2014	08:45	17° 15.01' S	10° 59.94' E	2114.0	SSE 11	249.4	0.9	TRIOS
M103/1_048-7	13.01.2014	09:10	17° 15.01' S	10° 59.94' E	2117.2	S 10	294.6	0.7	CTD/RO
M103/1_048-8	13.01.2014	10:04	17° 15.01' S	10° 59.94' E	2116.2	S 10	130	1.1	BWS
M103/1_048-9	13.01.2014	11:17	17° 15.01' S	10° 59.94' E	2114.2	S 10	72.6	0.5	CTD/RO
M103/1_048-10	13.01.2014	12:14	17° 15.01' S	10° 59.94' E	2115.2	SSE 10	30.6	1.3	MUC
M103/1_048-11	13.01.2014	13:51	17° 16.02' S	10° 59.81' E	2018.1	S 11	214.7	1.5	MOC
M103/1_048-12	13.01.2014	16:35	17° 21.60' S	11° 0.01' E	1825.9	S 11	186.4	1.7	MOC-D
M103/1_049-1	14.01.2014	12:22	19° 59.78' S	11° 29.91' E	775.7	SSW 3	139.5	0.4	MSS
M103/1_049-2	14.01.2014	12:26	19° 59.80' S	11° 29.92' E	773.4	SSW 3	256.8	0.3	SLS
M103/1_049-3	14.01.2014	12:38	19° 59.85' S	11° 29.97' E	773.9	SW 3	223.7	-0.1	CTD/RO
M103/1_049-4	14.01.2014	12:39	19° 59.85' S	11° 29.97' E	778.2	SSW 3	243.1	-0.1	HN
M103/1_049-5	14.01.2014	12:45	19° 59.85' S	11° 29.97' E	772.9	SW 3	85.7	0	SD
M103/1_050-1	14.01.2014	14:28	19° 59.99' S	11° 34.92' E	680.1	WSW 2	172.6	0.4	MSS
M103/1_051-1	14.01.2014	15:09	19° 59.93' S	11° 39.99' E	581.7	SW 2	106	0.7	MSS
M103/1_052-1	14.01.2014	17:36	20° 0.60' S	11° 44.92' E	492.2	SE 2	118.1	1	MSS
M103/1_053-1	14.01.2014	18:19	19° 59.97' S	11° 49.96' E	407.9	E 3	178	1.2	CTD/RO
M103/1_053-2	14.01.2014	18:23	19° 59.97' S	11° 49.95' E	408.2	ESE 3	48.1	0.5	HN
M103/1_053-3	14.01.2014	18:53	19° 59.97' S	11° 49.95' E	407.8	ESE 2	75.1	0.4	MSN
M103/1_053-4	14.01.2014	19:24	19° 59.97' S	11° 49.92' E	408.4	ESE 3	273.7	0.7	MUC
M103/1_053-5	14.01.2014	19:52	20° 0.17' S	11° 49.92' E	410.5	ESE 3	184.4	1.1	RTR
M103/1_053-6	14.01.2014	20:20	20° 1.01' S	11° 50.00' E	412.6	E 3	0	0.2	RTR
M103/1_053-7	14.01.2014	20:36	20° 1.26' S	11° 50.03' E	415.3	SE 3	89	1.7	RTR
M103/1_053-8	14.01.2014	20:40	20° 1.26' S	11° 50.03' E	414.9	SE 3	144.4	0.3	HN
M103/1_053-9	14.01.2014	21:28	20° 2.16' S	11° 50.17' E	443.8	SE 5	160.7	2.3	MOC
M103/1_053-9	14.01.2014	21:28	20° 2.16' S	11° 50.17' E	443.8	SE 5	160.7	2.3	MOC
M103/1_053-10	14.01.2014	22:56	20° 4.29' S	11° 49.78' E	444.1	ESE 5	169.6	1.3	MSS
M103/1_054-1	14.01.2014	23:48	19° 59.97' S	11° 54.96' E	369.8	E 4	159.8	0.4	MSS
M103/1_055-1	15.01.2014	01:24	20° 0.03' S	11° 59.93' E	338.0	E 1	174.5	0.9	MSS
M103/1_056-1	15.01.2014	03:00	19° 59.99' S	12° 4.99' E	306.2	S 2	183.7	1.3	MSS
M103/1_057-1	15.01.2014	04:27	20° 0.02' S	12° 8.94' E	929.7	S 3	187.8	0.8	CTD/RO
M103/1_057-2	15.01.2014	04:56	20° 0.02' S	12° 8.94' E	281.4	SSE 4	279.7	1	HN
M103/1_057-3	15.01.2014	04:58	20° 0.02' S	12° 8.94' E	281.9	SSE 4	260.3	1.2	MSN
M103/1_057-4	15.01.2014	05:22	20° 0.42' S	12° 8.89' E	282.7	S 4	185.9	3.2	RTR

Station METEOR	Date	Time	Position [°Lat]	Position [°Lon]	Depth [m]	Wind [m/s]	Course [°]	Speed [kn]	Gear
M103/1_057-5	15.01.2014	06:01	20° 0.92' S	12° 8.70' E	284.9	SSE 6	99.8	1	SD
M103/1_057-6	15.01.2014	06:02	20° 0.92' S	12° 8.69' E	286.6	SSE 5	221.3	0.3	SLS
M103/1_057-7	15.01.2014	07:15	20° 1.72' S	12° 8.37' E	288.0	SE 6	165.3	1.2	MSS
M103/1_058-1	15.01.2014	08:12	19° 59.65' S	12° 14.95' E	244.8	ESE 6	220.7	0.6	MSS
M103/1_059-1	15.01.2014	09:49	19° 59.95' S	12° 19.97' E	212.5	SE 1	73.5	1.2	CTD/RO
M103/1_059-2	15.01.2014	09:50	19° 59.95' S	12° 19.97' E	212.9	SE 1	271.8	1.6	SD
M103/1_059-3	15.01.2014	09:56	19° 59.95' S	12° 19.97' E	213.3	S 2	91.3	0.8	HN
M103/1_059-4	15.01.2014	09:58	19° 59.95' S	12° 19.97' E	213.2	SSE 2	145.2	0.4	HN
M103/1_059-5	15.01.2014	10:24	19° 59.95' S	12° 19.97' E	212.5	SE 2	155	0.4	MUC
M103/1_059-6	15.01.2014	11:58	20° 1.10' S	12° 19.13' E	225.5	SSW 4	233.9	1.5	MSS
M103/1_060-1	15.01.2014	13:10	19° 59.96' S	12° 24.98' E	196.6	SSW 5	155.1	0.4	MSS
M103/1_061-1	15.01.2014	14:38	20° 0.00' S	12° 29.99' E	149.5	S 5	165	0.5	SLS
M103/1_061-2	15.01.2014	14:53	19° 59.99' S	12° 29.99' E	149.7	SSE 5	230	0.5	CTD/RO
M103/1_061-3	15.01.2014	14:55	19° 59.99' S	12° 29.99' E	150.4	SSE 5	271.7	1.7	SD
M103/1_061-4	15.01.2014	15:03	19° 59.99' S	12° 29.99' E	150.6	SSE 6	65.6	0.3	HN
M103/1_061-5	15.01.2014	15:27	20° 0.32' S	12° 29.97' E	151.4	SSE 6	179.3	1.8	RTR
M103/1_061-6	15.01.2014	16:04	20° 0.90' S	12° 29.94' E	152.1	SE 6	243	1.3	MSS
M103/1_062-1	15.01.2014	17:33	20° 0.01' S	12° 34.96' E	134.2	SE 3	253.8	0.7	MSS
M103/1_063-1	15.01.2014	18:55	19° 59.97' S	12° 39.96' E	126.0	ESE 4	156.6	0.5	MSS
M103/1_064-1	15.01.2014	20:13	19° 59.94' S	12° 44.98' E	117.5	ESE 4	254.2	0.8	MSS
M103/1_065-1	15.01.2014	21:36	19° 59.94' S	12° 50.99' E	97.1	SSE 3	337.1	0.3	CTD/RO
M103/1_065-2	15.01.2014	21:49	19° 59.94' S	12° 50.99' E	96.0	SE 4	208.1	0.3	HN
M103/1_065-3	15.01.2014	21:54	19° 59.94' S	12° 50.98' E	96.3	SE 4	153.8	0.6	MUC
M103/1_065-4	15.01.2014	22:45	20° 0.60' S	12° 50.70' E	95.9	SE 4	243.9	0.7	MSS
M103/1_065-5	15.01.2014	23:04	20° 0.71' S	12° 50.69' E	102.1	SE 4	180.1	1.9	MOC-D
M103/1_066-1	16.01.2014	00:02	19° 59.97' S	12° 54.94' E	161.5	SE 4	212.6	1.5	MSS
M103/1_067-1	16.01.2014	01:14	19° 59.99' S	12° 59.94' E	87.9	ESE 3	146.2	0.3	CTD/RO
M103/1_067-2	16.01.2014	01:18	20° 0.00' S	12° 59.94' E	28.7	SE 2	108.3	0.6	HN
M103/1_067-3	16.01.2014	01:32	20° 0.00' S	12° 59.94' E	28.3	SSW 3	232.8	0.9	MUC
M103/1_067-4	16.01.2014	01:59	20° 0.22' S	13° 0.04' E	28.1	S 7	91.1	0.7	MSS
M103/1_068-1	16.01.2014	20:56	23° 2.54' S	12° 18.47' E	0.0	SE 5	183.3	0.6	MOR
M103/1_069-1	17.01.2014	02:05	23° 0.95' S	13° 1.78' E	0.0	SSW 1	352	0.1	MOR
M103/1_070-1	17.01.2014	09:27	23° 0.33' S	14° 3.19' E	124.7	NE 4	182	0.8	MOR
M103/1_071-1	17.01.2014	11:20	23° 0.30' S	14° 3.91' E	125.2	NW 2	132.1	0	MOR
M103/1_072-1	17.01.2014	13:12	23° 1.50' S	14° 2.27' E	128.5	WSW 5	119.9	0.1	MOR
M103/2_073-1	21.01.2014	11:21	23° 0.33' S	14° 2.89' E	129	W 4	0	0.1	MOR
M103/2_073-1	21.01.2014	11:53	23° 0.43' S	14° 3.04' E	132	W 4	197	0	MOR
M103/2_073-2	21.01.2014	12:08	23° 0.92' S	14° 2.62' E	131	W 3	14	0.1	CTD/RO
M103/2_073-3	21.01.2014	12:27	23° 0.92' S	14° 2.62' E	131	WSW 4	292	0	HN
M103/2_073-3	21.01.2014	12:31	23° 0.92' S	14° 2.62' E	133	WSW 4	347	0	HN
M103/2_073-4	21.01.2014	12:53	23° 0.92' S	14° 2.62' E	132	WSW 4	64	0.1	MOR
M103/2_073-4	21.01.2014	13:21	23° 0.96' S	14° 2.67' E	132	SW 4	113	0	MOR
M103/2_074-1	21.01.2014	23:18	23° 2.24' S	12° 18.19' E	2114	S 6	231	0	MOR
M103/2_074-1	22.01.2014	12:06	23° 2.66' S	12° 17.89' E	2122	SE 6	307	0.1	MOR
M103/2_074-2	22.01.2014	15:15	22° 49.45' S	12° 47.80' E	785	SSW 5	64	10.8	PS
M103/2_074-2	22.01.2014	19:32	22° 28.73' S	13° 33.75' E	138	SW 0	60	11.4	PS
M103/2_075-1	22.01.2014	19:47	22° 28.28' S	13° 35.02' E	135	SSW 2	327	0	CTD/RO
M103/2_075-2	22.01.2014	20:23	22° 28.84' S	13° 35.36' E	135	S 2	6	2.1	CATM
M103/2_075-3	22.01.2014	20:40	22° 27.97' S	13° 34.80' E	135	SSE 1	316	4.6	PS
M103/2_075-4	22.01.2014	20:41	22° 27.90' S	13° 34.77' E	135	SSE 1	337	4.8	SCF
M103/2_075-4	22.01.2014	20:46	22° 27.53' S	13° 34.57' E	135	SSW 1	331	5.2	SCF
M103/2_075-3	23.01.2014	16:16	20° 40.71' S	12° 36.65' E	56	S 7	330	6.2	PS
M103/2_075-3	23.01.2014	19:05	20° 25.43' S	12° 28.43' E	281	S 7	340	6.3	PS
M103/2_075-4	24.01.2014	10:00	19° 5.03' S	11° 45.36' E	315	SSE 10	334	6.2	SCF
M103/2_075-4	24.01.2014	10:15	19° 4.21' S	11° 44.95' E	315	SSE 10	333	2.7	SCF
M103/2_075-6	24.01.2014	12:04	18° 57.48' S	11° 41.32' E	301	SSE 11	326	3.6	SCF
M103/2_075-6	24.01.2014	12:08	18° 57.32' S	11° 41.15' E	299	SSE 12	314	3.9	SCF
M103/2_075-6	24.01.2014	21:25	18° 4.84' S	11° 24.48' E	562	SE 8	350	5.6	SCF
M103/2_075-3	24.01.2014	21:25	18° 4.84' S	11° 24.48' E	562	SE 8	350	5.6	PS
M103/2_075-5	24.01.2014	21:29	18° 4.51' S	11° 24.45' E	568	SE 8	352	4.4	CATM

Station METEOR	Date	Time	Position [°Lat]	Position [°Lon]	Depth [m]	Wind [m/s]	Course [°]	Speed [kn]	Gear
M103/2_075-6	24.01.2014	21:35	18° 4.13' S	11° 24.42' E	564	SSE 7	360	3.2	SCF
M103/2_076-1	24.01.2014	22:21	17° 59.97' S	11° 23.97' E	1002	SSE 7	57	0.3	CTD/RO
M103/2_076-2	24.01.2014	23:00	18° 0.58' S	11° 24.24' E	377	SSE 7	158	9.3	PS
M103/2_076-2	25.01.2014	07:15	19° 17.86' S	11° 55.94' E	289	SE 4	160	3.2	PS
M103/2_077-1	25.01.2014	07:21	19° 17.98' S	11° 55.96' E	291	SSE 4	215	0.2	CTD/RO
M103/2_077-2	25.01.2014	07:41	19° 17.98' S	11° 55.96' E	294	SE 3	215	0.1	HN
M103/2_077-3	25.01.2014	07:46	19° 17.97' S	11° 55.97' E	291	SE 4	34	0	SD
M103/2_077-3	25.01.2014	07:47	19° 17.97' S	11° 55.96' E	291	SE 3	128	0.1	SD
M103/2_077-4	25.01.2014	08:13	19° 17.99' S	11° 55.99' E	290	SE 2	66	0	CTD/RO
M103/2_077-5	25.01.2014	08:36	19° 18.00' S	11° 56.00' E	289	ESE 3	73	0.1	CTD/RO
M103/2_077-6	25.01.2014	08:54	19° 18.00' S	11° 56.00' E	289	ESE 2	281	0	CTD/RO
M103/2_077-7	25.01.2014	09:25	19° 20.43' S	11° 58.27' E	286	E 2	144	10.4	PS
M103/2_077-7	25.01.2014	15:10	20° 5.42' S	12° 42.72' E	123	SSW 2	0	0.1	PS
M103/2_078-1	25.01.2014	15:11	20° 5.42' S	12° 42.73' E	122	SSW 2	96	0.4	TD
M103/2_078-2	25.01.2014	15:35	20° 5.15' S	12° 42.69' E	123	S 2	229	0	CTD/RO
M103/2_078-3	25.01.2014	15:48	20° 5.15' S	12° 42.69' E	124	S 2	113	0	SD
M103/2_078-4	25.01.2014	16:00	20° 5.15' S	12° 42.69' E	124	S 2	333	0	HN
M103/2_078-5	25.01.2014	16:13	20° 5.15' S	12° 42.69' E	124	S 1	265	0.1	CTD/RO
M103/2_078-6	25.01.2014	16:36	20° 5.15' S	12° 42.69' E	125	ESE 1	271	0.2	CTD/RO
M103/2_078-7	25.01.2014	16:57	20° 5.15' S	12° 42.69' E	125	ESE 1	0	0.1	CTD/RO
M103/2_078-8	25.01.2014	17:10	20° 5.44' S	12° 42.70' E	123	ESE 2	158	7.2	PS
M103/2_078-8	25.01.2014	18:41	20° 0.51' S	12° 57.92' E	47	ENE 1	178	2	PS
M103/2_079-1	25.01.2014	18:45	20° 0.56' S	12° 57.92' E	47	SE 0	92	0	MSN
M103/2_079-2	25.01.2014	19:00	20° 0.56' S	12° 57.92' E	48	SSW 1	58	0.1	CTD/RO
M103/2_079-3	25.01.2014	19:18	20° 0.56' S	12° 57.92' E	49	S 2	0	0	MSN
M103/2_079-4	25.01.2014	19:19	20° 0.56' S	12° 57.92' E	45	S 2	108	0.1	PS
M103/2_079-5	25.01.2014	19:51	20° 0.74' S	12° 57.92' E	47	SSE 2	195	1.8	MSN
M103/2_079-6	25.01.2014	20:17	20° 1.20' S	12° 57.91' E	50	SSE 2	173	1.5	T-TRAW
M103/2_080-1	25.01.2014	21:22	20° 0.71' S	12° 53.33' E	91	SSE 3	156	2.2	MOC
M103/2_080-2	25.01.2014	22:07	20° 1.97' S	12° 53.35' E	93	SSE 4	135	0	MSN
M103/2_080-3	25.01.2014	22:26	20° 1.97' S	12° 53.35' E	93	SSE 4	156	0	CTD/RO
M103/2_080-4	25.01.2014	22:32	20° 1.97' S	12° 53.35' E	93	SSE 4	90	0	HN
M103/2_080-5	25.01.2014	22:46	20° 1.97' S	12° 53.35' E	91	SSE 3	274	0	MSN
M103/2_080-6	25.01.2014	23:06	20° 1.97' S	12° 53.35' E	93	S 4	268	0	MSN
M103/2_080-7	25.01.2014	23:30	20° 2.20' S	12° 53.32' E	93	SSE 4	180	2.1	MSN
M103/2_080-8	26.01.2014	00:26	20° 1.94' S	12° 53.28' E	92	SE 4	175	2	MSN
M103/2_080-9	26.01.2014	01:00	20° 2.45' S	12° 53.23' E	94	SE 4	177	1.9	T-TRAW
M103/2_081-1	26.01.2014	02:41	20° 3.28' S	12° 42.33' E	121	SSE 4	199	1.1	MOC
M103/2_081-2	26.01.2014	03:33	20° 5.40' S	12° 42.72' E	123	SE 5	336	0	MSN
M103/2_081-3	26.01.2014	03:51	20° 5.39' S	12° 42.73' E	122	SSE 5	270	0	CTD/RO
M103/2_081-4	26.01.2014	03:55	20° 5.39' S	12° 42.73' E	123	SE 6	155	0.1	HN
M103/2_081-5	26.01.2014	04:14	20° 5.39' S	12° 42.73' E	122	SE 5	308	0.1	AC-S
M103/2_081-6	26.01.2014	04:37	20° 5.39' S	12° 42.73' E	122	SSE 6	0	0	CTD/RO
M103/2_081-7	26.01.2014	04:59	20° 5.39' S	12° 42.73' E	121	SSE 6	126	0	MSN
M103/2_081-8	26.01.2014	05:16	20° 5.39' S	12° 42.73' E	123	SSE 8	279	0	MSN
M103/2_081-9	26.01.2014	05:34	20° 5.40' S	12° 42.73' E	123	SSE 8	165	0.9	MSN
M103/2_081-10	26.01.2014	06:19	20° 6.25' S	12° 42.67' E	123	SSE 9	190	1.6	RTR
M103/2_081-11	26.01.2014	06:34	20° 6.63' S	12° 42.64' E	124	SSE 8	99	0.1	RTR
M103/2_081-12	26.01.2014	06:38	20° 6.63' S	12° 42.65' E	125	SSE 8	114	0.1	SD
M103/2_081-13	26.01.2014	06:56	20° 6.29' S	12° 42.48' E	124	SSE 9	354	6.6	TRIOS
M103/2_081-14	26.01.2014	07:36	20° 5.39' S	12° 42.72' E	143	SSE 9	205	0	SD
M103/2_081-15	26.01.2014	07:41	20° 5.39' S	12° 42.72' E	123	SSE 8	0	0	SLS
M103/2_082-1	26.01.2014	08:59	20° 8.61' S	12° 32.77' E	152	SE 9	284	0.2	CTD/RO
M103/2_083-1	26.01.2014	10:29	20° 11.98' S	12° 22.50' E	253	SSE 10	89	0	MSN
M103/2_083-2	26.01.2014	10:49	20° 11.98' S	12° 22.50' E	253	SSE 9	286	0.1	CTD/RO
M103/2_083-3	26.01.2014	11:08	20° 11.98' S	12° 22.50' E	253	SSE 8	60	0	SD
M103/2_083-4	26.01.2014	11:21	20° 11.98' S	12° 22.50' E	253	SSE 8	85	0	AC-S
M103/2_083-5	26.01.2014	11:48	20° 11.98' S	12° 22.50' E	254	SSE 8	206	0	CTD/RO
M103/2_083-6	26.01.2014	11:50	20° 11.98' S	12° 22.50' E	253	SSE 8	184	0.1	HN
M103/2_083-7	26.01.2014	12:22	20° 11.98' S	12° 22.50' E	252	SSE 8	46	0	TRIOS

Station METEOR	Date	Time	Position [°Lat]	Position [°Lon]	Depth [m]	Wind [m/s]	Course [°]	Speed [kn]	Gear
M103/2_083-8	26.01.2014	12:46	20° 11.98' S	12° 22.49' E	252	S 8	271	0	SLS
M103/2_083-9	26.01.2014	13:08	20° 12.02' S	12° 22.40' E	253	S 9	67	0.1	MSN
M103/2_083-10	26.01.2014	13:35	20° 12.02' S	12° 22.40' E	252	S 9	58	0	MSN
M103/2_083-11	26.01.2014	14:22	20° 10.50' S	12° 22.15' E	250	S 9	108	1.2	MOC
M103/2_083-12	26.01.2014	15:32	20° 12.01' S	12° 22.51' E	251	S 10	160	0.9	MSN
M103/2_083-13	26.01.2014	16:16	20° 12.85' S	12° 22.94' E	254	S 10	263	0.2	RTR
M103/2_083-14	26.01.2014	16:43	20° 13.47' S	12° 23.26' E	255	S 10	323	0.1	RTR
M103/2_084-1	26.01.2014	18:25	20° 15.91' S	12° 9.75' E	303	SSE 9	258	0.1	CTD/RO
M103/2_085-1	26.01.2014	20:01	20° 17.99' S	11° 57.54' E	468	SSE 9	197	2.5	MOC
M103/2_085-2	26.01.2014	20:53	20° 20.28' S	11° 57.70' E	506	SSE 10	189	2.6	HN
M103/2_085-3	26.01.2014	22:27	20° 19.89' S	11° 57.60' E	502	SSE 8	39	0.1	MSN
M103/2_085-4	26.01.2014	22:30	20° 19.88' S	11° 57.60' E	501	SSE 9	29	0.1	HN
M103/2_085-5	26.01.2014	22:45	20° 19.89' S	11° 57.60' E	501	SSE 8	241	0.1	CTD/RO
M103/2_085-6	26.01.2014	23:22	20° 19.88' S	11° 57.60' E	500	SE 9	309	0.1	AC-S
M103/2_085-7	26.01.2014	23:43	20° 19.89' S	11° 57.60' E	501	SSE 9	86	0.1	MSN
M103/2_085-8	27.01.2014	00:18	20° 19.89' S	11° 57.60' E	501	SE 10	189	0.1	AC-S
M103/2_085-9	27.01.2014	00:48	20° 19.88' S	11° 57.60' E	502	SE 9	128	0.2	MSN
M103/2_085-10	27.01.2014	01:29	20° 19.95' S	11° 57.61' E	501	SE 8	189	1.7	MSN
M103/2_085-11	27.01.2014	02:23	20° 21.54' S	11° 58.03' E	518	SE 9	198	2.1	RTR
M103/2_085-12	27.01.2014	02:58	20° 22.63' S	11° 58.56' E	522	SE 8	276	0.2	RTR
M103/2_086-1	27.01.2014	04:27	20° 23.53' S	11° 46.08' E	842	SSE 8	0	0.4	MSN
M103/2_086-2	27.01.2014	04:44	20° 23.54' S	11° 46.08' E	841	SSE 9	222	0.1	CTD/RO
M103/2_086-3	27.01.2014	05:28	20° 23.54' S	11° 46.08' E	842	SSE 12	129	0	AC-S
M103/2_086-4	27.01.2014	06:04	20° 23.54' S	11° 46.08' E	842	SSE 9	114	0.1	CTD/RO
M103/2_086-5	27.01.2014	06:37	20° 23.52' S	11° 46.08' E	1109	SSE 12	264	0.1	TRIOS
M103/2_086-6	27.01.2014	06:49	20° 23.53' S	11° 46.08' E	848	SSE 12	335	0.1	SD
M103/2_086-7	27.01.2014	06:53	20° 23.53' S	11° 46.08' E	1438	SSE 12	121	0	HN
M103/2_086-8	27.01.2014	07:12	20° 23.54' S	11° 46.08' E	842	SSE 11	204	0	SLS
M103/2_086-9	27.01.2014	07:28	20° 23.54' S	11° 46.04' E	843	SSE 11	103	0.1	MSN
M103/2_086-10	27.01.2014	08:02	20° 23.54' S	11° 46.04' E	843	SE 12	297	0	MSN
M103/2_086-11	27.01.2014	08:38	20° 23.58' S	11° 46.04' E	1928	SE 12	167	1.5	MSN
M103/2_086-12	27.01.2014	09:25	20° 24.62' S	11° 46.05' E	859	SSE 11	204	1.6	RTR
M103/2_086-13	27.01.2014	09:44	20° 25.05' S	11° 46.05' E	865	SSE 10	124	0	RTR
M103/2_086-14	27.01.2014	10:30	20° 23.66' S	11° 46.09' E	847	SSE 10	191	2.1	MOC
M103/2_087-1	27.01.2014	13:23	20° 27.07' S	11° 34.75' E	1081	SE 10	230	0.1	CTD/RO
M103/2_088-1	27.01.2014	15:35	20° 31.01' S	11° 22.55' E	1179	SSE 8	121	0.1	MSN
M103/2_088-2	27.01.2014	15:54	20° 31.01' S	11° 22.55' E	1181	SE 7	264	0.1	CTD/RO
M103/2_088-3	27.01.2014	16:00	20° 31.01' S	11° 22.55' E	1180	SE 7	212	0.1	HN
M103/2_088-4	27.01.2014	16:01	20° 31.01' S	11° 22.55' E	1180	SE 7	233	0	SD
M103/2_088-5	27.01.2014	16:11	20° 31.01' S	11° 22.55' E	1183	SE 7	240	0.1	TRIOS
M103/2_088-6	27.01.2014	16:31	20° 31.01' S	11° 22.56' E	1181	SSE 6	164	0.3	SLS
M103/2_088-7	27.01.2014	16:47	20° 30.95' S	11° 22.59' E	1182	SSE 8	211	0	AC-S
M103/2_088-8	27.01.2014	17:10	20° 30.95' S	11° 22.59' E	1180	SSE 6	99	0.1	CTD/RO
M103/2_088-9	27.01.2014	18:05	20° 30.95' S	11° 22.59' E	1179	SSE 8	21	0.1	MSN
M103/2_088-10	27.01.2014	18:42	20° 30.95' S	11° 22.59' E	1178	SSE 8	83	0.1	MSN
M103/2_088-11	27.01.2014	19:42	20° 31.03' S	11° 22.59' E	1183	SSE 8	202	2.4	MSN
M103/2_088-12	27.01.2014	20:35	20° 32.56' S	11° 23.07' E	1193	SSE 10	184	2.1	RTR
M103/2_088-13	27.01.2014	21:44	20° 31.09' S	11° 22.53' E	1183	SE 10	178	2.6	MOC
M103/2_089-1	28.01.2014	01:55	20° 33.72' S	10° 55.81' E	1677	SE 9	174	2.6	MOC
M103/2_089-2	28.01.2014	03:42	20° 39.09' S	10° 56.88' E	1750	SE 7	222	0.3	MSN
M103/2_089-3	28.01.2014	03:57	20° 38.99' S	10° 56.84' E	1749	SE 6	315	1.2	CTD/RO
M103/2_089-4	28.01.2014	05:14	20° 38.48' S	10° 56.58' E	1739	ESE 8	99	0.8	AC-S
M103/2_089-5	28.01.2014	05:47	20° 39.09' S	10° 56.91' E	1747	SE 8	250	0.1	CTD/RO
M103/2_089-5	28.01.2014	06:11	20° 39.09' S	10° 56.91' E	1748	SE 8	0	0	CTD/RO
M103/2_089-6	28.01.2014	06:28	20° 39.08' S	10° 56.91' E	1751	SSE 8	197	0	TRIOS
M103/2_089-7	28.01.2014	06:54	20° 39.09' S	10° 56.91' E	1747	SE 6	27	0	SLS
M103/2_089-8	28.01.2014	06:56	20° 39.09' S	10° 56.91' E	1749	SE 6	314	0	HN
M103/2_089-9	28.01.2014	07:12	20° 39.10' S	10° 56.84' E	1752	SE 6	227	0.1	CTD/RO
M103/2_089-10	28.01.2014	07:18	20° 39.10' S	10° 56.84' E	1752	SE 6	0	0	SD
M103/2_089-11	28.01.2014	07:37	20° 39.10' S	10° 56.84' E	1752	SE 6	82	0	MSN

Station METEOR	Date	Time	Position [°Lat]	Position [°Lon]	Depth [m]	Wind [m/s]	Course [°]	Speed [kn]	Gear
M103/2_089-12	28.01.2014	08:11	20° 39.10' S	10° 56.84' E	1752	SE 5	11	0.1	MSN
M103/2_089-13	28.01.2014	08:50	20° 39.15' S	10° 56.85' E	1751	SE 6	163	2.2	MSN
M103/2_089-14	28.01.2014	09:40	20° 40.56' S	10° 57.13' E	1774	SSE 6	187	1.2	RTR
M103/2_089-15	28.01.2014	10:14	20° 41.35' S	10° 57.38' E	1781	SSE 6	199	0.5	MSS
M103/2_090-1	28.01.2014	13:56	20° 30.32' S	11° 22.43' E	1176	SE 5	214	0.6	MSS
M103/2_091-1	28.01.2014	16:11	20° 26.59' S	11° 34.58' E	1077	S 6	104	0.5	MSS
M103/2_092-1	28.01.2014	18:26	20° 22.90' S	11° 46.00' E	834	S 8	132	0.5	MSS
M103/2_093-1	28.01.2014	20:36	20° 19.23' S	11° 57.47' E	493	SSE 7	203	0.4	MSS
M103/2_094-1	28.01.2014	22:28	20° 17.42' S	12° 3.87' E	341	SE 9	191	0.3	MSS
M103/2_095-1	29.01.2014	00:19	20° 15.67' S	12° 9.70' E	302	SE 9	141	0.2	MSS
M103/2_096-1	29.01.2014	02:03	20° 13.80' S	12° 15.93' E	279	SE 9	128	0.1	MSS
M103/2_097-1	29.01.2014	03:53	20° 11.81' S	12° 22.37' E	252	SSE 5	80	0.1	MSS
M103/2_098-1	29.01.2014	05:49	20° 9.22' S	12° 29.85' E	2340	SE 3	219	0.5	MSS
M103/2_099-1	29.01.2014	07:32	20° 7.38' S	12° 36.01' E	1498	S 4	209	0.1	MSS
M103/2_100-1	29.01.2014	09:08	20° 5.12' S	12° 42.65' E	124	ESE 3	120	0.2	MSS
M103/2_100-2	29.01.2014	10:00	20° 5.38' S	12° 42.73' E	123	SE 4	115	0.4	HN
M103/2_101-1	29.01.2014	11:05	20° 3.32' S	12° 47.86' E	113	S 4	71	11.1	MSS
M103/2_102-1	29.01.2014	12:32	20° 1.67' S	12° 53.30' E	95	S 4	134	0.2	MSS
M103/2_103-1	29.01.2014	13:44	20° 0.38' S	12° 57.91' E	1642	SSW 7	129	0.3	MSS
M103/2_104-1	29.01.2014	16:13	19° 39.88' S	12° 48.38' E	43	SSE 7	89	0.1	TRIOS
M103/2_104-2	29.01.2014	16:16	19° 39.88' S	12° 48.38' E	43	SSE 7	82	0	HN
M103/2_104-3	29.01.2014	16:29	19° 39.87' S	12° 48.39' E	42	SSE 7	217	0.1	SLS
M103/2_104-4	29.01.2014	16:40	19° 39.85' S	12° 48.41' E	43	SSE 7	0	0.1	HN
M103/2_104-5	29.01.2014	16:43	19° 39.86' S	12° 48.41' E	42	SSE 7	89	0.2	MSS
M103/2_104-6	29.01.2014	17:10	19° 40.05' S	12° 48.44' E	43	SSE 7	171	0.5	MSN
M103/2_104-7	29.01.2014	17:13	19° 40.07' S	12° 48.44' E	43	SSE 7	253	0.3	SD
M103/2_104-8	29.01.2014	17:22	19° 40.08' S	12° 48.45' E	43	SSE 7	261	0	CTD/RO
M103/2_104-9	29.01.2014	17:46	19° 40.08' S	12° 48.44' E	43	SSE 8	88	0	AC-S
M103/2_104-10	29.01.2014	18:02	19° 40.08' S	12° 48.44' E	42	SSE 8	0	0	MSN
M103/2_104-11	29.01.2014	18:13	19° 40.08' S	12° 48.44' E	43	SSE 8	93	0	MSN
M103/2_104-12	29.01.2014	18:29	19° 40.16' S	12° 48.43' E	43	SSE 8	203	1.9	MSN
M103/2_104-13	29.01.2014	18:56	19° 40.79' S	12° 48.31' E	48	SSE 7	192	1.9	RTR
M103/2_104-13	29.01.2014	18:57	19° 40.82' S	12° 48.31' E	48	SSE 7	201	1.9	RTR
M103/2_104-14	29.01.2014	19:21	19° 41.55' S	12° 48.24' E	53	SSE 6	0	0.1	RTR
M103/2_105-1	29.01.2014	20:21	19° 40.60' S	12° 42.98' E	87	SSE 6	174	2.2	MOC
M103/2_105-2	29.01.2014	20:58	19° 41.84' S	12° 42.97' E	89	SSE 7	112	0.3	MSS
M103/2_105-3	29.01.2014	21:40	19° 42.14' S	12° 42.98' E	89	SE 6	0	0	MSN
M103/2_105-4	29.01.2014	21:58	19° 42.14' S	12° 42.98' E	90	SE 5	91	0	CTD/RO
M103/2_105-5	29.01.2014	22:18	19° 42.14' S	12° 42.98' E	90	SE 5	98	0.1	AC-S
M103/2_105-6	29.01.2014	22:41	19° 42.14' S	12° 42.98' E	90	SSE 4	264	0	MSN
M103/2_105-7	29.01.2014	22:54	19° 42.14' S	12° 42.98' E	90	SE 4	105	0.1	MSN
M103/2_105-8	29.01.2014	23:10	19° 42.14' S	12° 42.98' E	90	SE 4	266	0	AC-S
M103/2_105-9	29.01.2014	23:12	19° 42.14' S	12° 42.98' E	90	SE 4	289	0	HN
M103/2_105-10	29.01.2014	23:32	19° 42.26' S	12° 42.96' E	92	SE 4	176	2.7	MSN
M103/2_105-11	30.01.2014	00:34	19° 42.18' S	12° 42.98' E	92	SSE 4	229	1.7	MSN
M103/2_105-12	30.01.2014	01:03	19° 42.70' S	12° 42.98' E	93	SE 4	166	1.2	RTR
M103/2_106-1	30.01.2014	02:21	19° 43.82' S	12° 36.89' E	117	SE 4	63	0.3	MSS
M103/2_107-1	30.01.2014	03:40	19° 44.50' S	12° 31.15' E	129	SE 4	210	2.8	MOC
M103/2_107-2	30.01.2014	04:26	19° 46.06' S	12° 31.07' E	130	SE 4	123	0.3	MSS
M103/2_107-3	30.01.2014	05:22	19° 46.00' S	12° 31.02' E	129	SE 3	71	0.2	MSN
M103/2_107-4	30.01.2014	05:35	19° 46.00' S	12° 31.01' E	129	SE 4	0	0.1	CTD/RO
M103/2_107-5	30.01.2014	05:41	19° 46.00' S	12° 31.01' E	130	SE 3	269	0.1	HN
M103/2_107-6	30.01.2014	05:45	19° 46.00' S	12° 31.01' E	130	SE 4	339	0	SD
M103/2_107-7	30.01.2014	05:54	19° 46.00' S	12° 31.01' E	130	SE 4	104	0	AC-S
M103/2_107-8	30.01.2014	06:18	19° 46.00' S	12° 31.01' E	129	SE 5	234	0	CTD/RO
M103/2_107-9	30.01.2014	06:41	19° 45.99' S	12° 31.02' E	130	SE 4	262	0.1	TRIOS
M103/2_107-10	30.01.2014	07:11	19° 46.01' S	12° 31.01' E	147	SE 5	0	0	SLS
M103/2_107-11	30.01.2014	07:40	19° 45.99' S	12° 31.00' E	128	SE 5	121	0.1	MSN
M103/2_107-12	30.01.2014	07:56	19° 45.99' S	12° 30.99' E	129	ESE 4	287	0.1	MSN
M103/2_107-13	30.01.2014	08:15	19° 46.06' S	12° 30.95' E	130	ESE 5	189	2	MSN

Station METEOR	Date	Time	Position [°Lat]	Position [°Lon]	Depth [m]	Wind [m/s]	Course [°]	Speed [kn]	Gear
M103/2_107-14	30.01.2014	08:52	19° 46.89' S	12° 30.45' E	130	SE 5	196	1.9	RTR
M103/2_107-15	30.01.2014	09:36	19° 48.11' S	12° 30.01' E	132	SE 4	291	0.1	RTR
M103/2_108-1	30.01.2014	10:31	19° 47.84' S	12° 24.85' E	152	SSE 4	209	0.2	MSS
M103/2_109-2	30.01.2014	13:09	19° 50.29' S	12° 18.10' E	203	SSE 4	76	0	CTD/RO
M103/2_110-1	30.01.2014	14:20	19° 55.61' S	12° 13.09' E	945	SSW 3	88	0	TRIOS
M103/2_110-2	30.01.2014	14:21	19° 55.61' S	12° 13.09' E	932	S 4	303	0	HN
M103/2_110-3	30.01.2014	14:34	19° 55.60' S	12° 13.09' E	696	SSW 4	289	0	SLS
M103/2_110-4	30.01.2014	14:58	19° 55.75' S	12° 13.06' E	248	SSW 5	117	0.7	MSS
M103/2_110-5	30.01.2014	16:44	19° 55.57' S	12° 13.18' E	246	SSW 2	126	0.1	MSN
M103/2_110-6	30.01.2014	16:47	19° 55.58' S	12° 13.18' E	246	SSW 2	291	0.1	SD
M103/2_110-7	30.01.2014	17:01	19° 55.58' S	12° 13.18' E	247	S 4	0	0	CTD/RO
M103/2_110-8	30.01.2014	17:21	19° 55.58' S	12° 13.18' E	245	S 4	112	0	AC-S
M103/2_110-9	30.01.2014	17:44	19° 55.58' S	12° 13.18' E	246	S 4	4	0	CTD/RO
M103/2_110-10	30.01.2014	18:03	19° 55.58' S	12° 13.18' E	246	S 4	117	0	MSN
M103/2_110-11	30.01.2014	18:25	19° 55.58' S	12° 13.18' E	246	S 4	126	0.1	MSN
M103/2_110-12	30.01.2014	18:53	19° 55.65' S	12° 13.15' E	245	SSE 5	182	2.3	MSN
M103/2_110-13	30.01.2014	19:32	19° 56.92' S	12° 12.56' E	252	SSE 4	204	2.4	MSN
M103/2_110-14	30.01.2014	20:08	19° 57.95' S	12° 12.22' E	256	SE 5	128	0.6	RTR
M103/2_110-14	30.01.2014	20:36	19° 58.50' S	12° 12.24' E	259	SE 6	187	1.6	RTR
M103/2_110-15	30.01.2014	21:14	19° 55.70' S	12° 13.15' E	366	ESE 4	192	2.7	MOC
M103/2_111-1	30.01.2014	22:58	19° 58.96' S	12° 7.74' E	287	E 4	129	0.3	MSS
M103/2_112-1	31.01.2014	00:47	20° 1.91' S	12° 0.81' E	705	SSE 4	286	0.3	MSS
M103/2_112-2	31.01.2014	01:45	20° 2.30' S	12° 0.62' E	336	SE 3	90	0	CTD/RO
M103/2_113-1	31.01.2014	02:44	20° 4.18' S	11° 54.75' E	385	SE 3	203	1.3	MSS
M103/2_114-1	31.01.2014	04:14	20° 6.24' S	11° 49.22' E	482	SE 3	171	0.6	MSS
M103/2_114-2	31.01.2014	05:15	20° 7.01' S	11° 48.80' E	500	S 4	7	0	MSN
M103/2_114-3	31.01.2014	05:27	20° 7.01' S	11° 48.80' E	500	S 4	305	0.1	CTD/RO
M103/2_114-4	31.01.2014	05:57	20° 7.01' S	11° 48.80' E	500	SSE 4	261	0.1	HN
M103/2_114-5	31.01.2014	06:05	20° 7.01' S	11° 48.79' E	500	S 4	293	0	AC-S
M103/2_114-6	31.01.2014	06:34	20° 7.01' S	11° 48.79' E	500	SSE 2	106	0.1	CTD/RO
M103/2_114-7	31.01.2014	06:36	20° 7.01' S	11° 48.79' E	500	SSE 1	111	0.1	SD
M103/2_114-8	31.01.2014	06:56	20° 7.00' S	11° 48.81' E	500	SE 1	302	0	TRIOS
M103/2_114-9	31.01.2014	07:20	20° 7.02' S	11° 48.79' E	500	SE 3	330	0	SLS
M103/2_114-10	31.01.2014	07:44	20° 7.02' S	11° 48.80' E	500	SSE 3	209	0.1	MSN
M103/2_114-11	31.01.2014	08:14	20° 7.06' S	11° 48.89' E	498	SSE 4	136	0	MSN
M103/2_114-12	31.01.2014	08:48	20° 7.11' S	11° 48.99' E	496	SSE 4	351	0.1	MSN
M103/2_114-13	31.01.2014	11:30	20° 6.96' S	11° 48.83' E	499	S 4	186	1.7	MOC
M103/2_114-14	31.01.2014	13:43	20° 6.95' S	11° 48.76' E	501	S 5	195	1.3	MSN
M103/2_114-15	31.01.2014	14:26	20° 7.67' S	11° 48.48' E	518	SSE 7	211	1.3	RTR
M103/2_115-1	31.01.2014	15:46	20° 7.61' S	11° 40.39' E	687	SSE 7	169	0.5	MSS
M103/2_116-1	31.01.2014	17:33	20° 9.67' S	11° 32.74' E	847	S 6	237	0.4	MSS
M103/2_116-2	31.01.2014	18:54	20° 10.29' S	11° 32.39' E	864	SSE 8	294	0	MSN
M103/2_116-3	31.01.2014	18:55	20° 10.29' S	11° 32.39' E	863	SSE 8	9	0.1	HN
M103/2_116-4	31.01.2014	19:10	20° 10.29' S	11° 32.39' E	865	SSE 10	254	0.1	CTD/RO
M103/2_116-5	31.01.2014	19:56	20° 10.29' S	11° 32.39' E	862	SSE 10	66	0.1	AC-S
M103/2_116-6	31.01.2014	20:23	20° 10.29' S	11° 32.39' E	863	SSE 8	311	0	MSN
M103/2_116-7	31.01.2014	20:55	20° 10.29' S	11° 32.39' E	879	SE 8	58	0	CTD/RO
M103/2_116-8	31.01.2014	21:25	20° 10.29' S	11° 32.39' E	862	SE 9	135	0	MSN
M103/2_116-9	31.01.2014	22:08	20° 10.38' S	11° 32.37' E	869	SSE 9	202	1.3	MSN
M103/2_116-10	31.01.2014	22:54	20° 11.27' S	11° 32.26' E	879	SE 7	188	1.6	RTR
M103/2_116-11	01.02.2014	00:05	20° 10.51' S	11° 32.32' E	867	SE 7	186	2.3	MOC
M103/2_117-1	01.02.2014	03:11	20° 12.22' S	11° 26.64' E	969	SSE 4	5	0.1	CTD/RO
M103/2_118-1	01.02.2014	05:22	20° 12.13' S	11° 10.17' E	1221	SSE 8	171	0.5	MSS
M103/2_118-2	01.02.2014	06:22	20° 12.79' S	11° 10.10' E	1973	SSE 6	76	0.1	MSN
M103/2_118-3	01.02.2014	06:39	20° 12.79' S	11° 10.10' E	1257	SE 7	277	0	CTD/RO
M103/2_118-4	01.02.2014	07:14	20° 12.79' S	11° 10.10' E	2116	SE 9	82	0.1	HN
M103/2_118-5	01.02.2014	07:23	20° 12.79' S	11° 10.10' E	1968	SE 7	185	0.1	AC-S
M103/2_118-6	01.02.2014	07:30	20° 12.79' S	11° 10.10' E	2050	SE 8	293	0	SD
M103/2_118-7	01.02.2014	08:01	20° 12.78' S	11° 10.11' E	1223	SE 6	13	0	TRIOS
M103/2_118-8	01.02.2014	08:24	20° 12.79' S	11° 10.10' E	1229	SE 6	285	0.1	SLS

Station METEOR	Date	Time	Position [°Lat]	Position [°Lon]	Depth [m]	Wind [m/s]	Course [°]	Speed [kn]	Gear
M103/2_118-9	01.02.2014	08:49	20° 12.79' S	11° 9.96' E	1230	SE 7	267	0.1	MSN
M103/2_118-10	01.02.2014	09:22	20° 12.79' S	11° 9.96' E	1227	SE 7	256	0	MSN
M103/2_118-11	01.02.2014	10:05	20° 13.19' S	11° 9.93' E	1230	SE 6	199	2.4	MOC
M103/2_118-12	01.02.2014	12:20	20° 12.99' S	11° 10.03' E	1233	SSE 6	207	1.9	RTR
M103/2_118-13	01.02.2014	13:10	20° 14.47' S	11° 10.19' E	1230	SE 5	184	2.3	MSN
M103/2_119-1	01.02.2014	16:00	20° 19.71' S	10° 47.91' E	1464	SSE 7	32	0.1	TRIOS
M103/2_119-2	01.02.2014	16:03	20° 19.71' S	10° 47.91' E	1462	SE 7	183	0	HN
M103/2_119-3	01.02.2014	16:14	20° 19.71' S	10° 47.92' E	1461	SSE 8	251	0	SLS
M103/2_119-4	01.02.2014	16:27	20° 19.87' S	10° 47.89' E	1462	SSE 8	209	0.7	MSS
M103/2_119-5	01.02.2014	17:26	20° 20.29' S	10° 47.56' E	2151	SSE 7	232	2.3	MSN
M103/2_119-6	01.02.2014	17:34	20° 20.32' S	10° 47.56' E	1466	SSE 8	254	0	SD
M103/2_119-7	01.02.2014	17:44	20° 20.33' S	10° 47.57' E	1465	SSE 8	279	0	CTD/RO
M103/2_119-8	01.02.2014	18:45	20° 20.32' S	10° 47.56' E	1467	SE 10	116	0	AC-S
M103/2_119-9	01.02.2014	19:12	20° 20.32' S	10° 47.56' E	1464	SE 9	170	0	CTD/RO
M103/2_119-10	01.02.2014	19:33	20° 20.32' S	10° 47.56' E	1465	SE 9	59	0	MSN
M103/2_119-11	01.02.2014	20:08	20° 20.32' S	10° 47.56' E	1463	SSE 10	14	0	MSN
M103/2_119-12	01.02.2014	20:46	20° 20.36' S	10° 47.55' E	1468	SSE 9	213	1.2	RTR
M103/2_119-13	01.02.2014	21:31	20° 20.86' S	10° 47.24' E	1470	SE 10	226	1.5	MSN
M103/2_119-14	01.02.2014	22:25	20° 20.42' S	10° 47.46' E	1464	SE 8	167	1.8	MOC
M103/2_120-1	02.02.2014	01:57	19° 59.43' S	10° 38.13' E	1401	SE 8	0	0.3	MSS
M103/2_120-2	02.02.2014	03:12	19° 59.99' S	10° 38.00' E	1396	SE 8	260	0.1	MSN
M103/2_120-3	02.02.2014	03:30	19° 59.99' S	10° 38.01' E	1397	SE 8	0	0.1	CTD/RO
M103/2_120-4	02.02.2014	04:36	19° 59.99' S	10° 38.01' E	1400	SE 8	313	0.1	AC-S
M103/2_120-5	02.02.2014	05:11	19° 59.99' S	10° 38.01' E	1400	SE 7	0	0	CTD/RO
M103/2_120-6	02.02.2014	05:25	19° 59.99' S	10° 38.01' E	1398	SE 9	69	0	HN
M103/2_120-7	02.02.2014	05:30	19° 59.99' S	10° 38.01' E	1398	SSE 9	240	0	MSN
M103/2_120-8	02.02.2014	05:55	19° 59.99' S	10° 38.01' E	1398	SE 10	0	0	SD
M103/2_120-9	02.02.2014	06:15	19° 59.82' S	10° 37.86' E	1410	SE 10	56	0.8	TRIOS
M103/2_120-10	02.02.2014	06:38	19° 59.96' S	10° 37.82' E	1399	SE 9	111	0.1	SLS
M103/2_120-11	02.02.2014	06:54	19° 59.92' S	10° 37.59' E	1395	SE 8	0	0	MSN
M103/2_120-12	02.02.2014	07:36	20° 0.00' S	10° 37.56' E	1396	ESE 10	185	1.7	MSN
M103/2_120-13	02.02.2014	08:17	20° 0.96' S	10° 37.37' E	1396	SE 9	195	1.8	RTR
M103/2_120-14	02.02.2014	09:32	20° 0.08' S	10° 37.96' E	1398	SE 8	166	2.2	MOC
M103/2_121-1	02.02.2014	13:43	19° 51.12' S	11° 2.93' E	1672	SE 9	242	0.2	MSS
M103/2_121-2	02.02.2014	14:48	19° 51.59' S	11° 2.91' E	1202	SSE 9	300	0.1	TRIOS
M103/2_121-3	02.02.2014	15:07	19° 51.59' S	11° 2.91' E	1205	SE 9	218	0.1	SD
M103/2_121-4	02.02.2014	15:11	19° 51.59' S	11° 2.91' E	1203	SE 8	81	0.2	SLS
M103/2_121-5	02.02.2014	15:22	19° 51.63' S	11° 2.85' E	1204	SE 8	0	0	MSN
M103/2_121-6	02.02.2014	15:44	19° 51.63' S	11° 2.86' E	1205	SSE 8	66	0.1	CTD/RO
M103/2_121-7	02.02.2014	16:11	19° 51.63' S	11° 2.86' E	1204	SSE 9	69	0	HN
M103/2_121-8	02.02.2014	16:25	19° 51.63' S	11° 2.86' E	1211	SSE 9	43	0.1	AC-S
M103/2_121-9	02.02.2014	17:08	19° 51.63' S	11° 2.86' E	1204	SSE 8	150	0	CTD/RO
M103/2_121-10	02.02.2014	17:56	19° 51.63' S	11° 2.85' E	1204	SSE 9	110	0.1	MSN
M103/2_121-11	02.02.2014	18:37	19° 51.63' S	11° 2.85' E	1205	SSE 8	263	0	MSN
M103/2_121-12	02.02.2014	19:39	19° 51.71' S	11° 2.87' E	1205	SSE 9	171	1.8	MSN
M103/2_121-13	02.02.2014	20:31	19° 53.17' S	11° 3.27' E	1209	SSE 8	169	1.9	RTR
M103/2_121-14	02.02.2014	21:40	19° 51.60' S	11° 2.90' E	1203	SSE 9	163	2.2	MOC
M103/2_122-1	03.02.2014	00:20	19° 48.02' S	11° 12.12' E	1045	SE 9	150	0.4	MSS
M103/2_122-2	03.02.2014	01:33	19° 48.52' S	11° 12.30' E	1056	SE 10	14	0.1	CTD/RO
M103/2_123-1	03.02.2014	03:11	19° 45.07' S	11° 20.45' E	842	SSE 8	84	0.4	MSS
M103/2_123-2	03.02.2014	04:19	19° 45.69' S	11° 20.70' E	843	SSE 7	155	0.6	MSN
M103/2_123-3	03.02.2014	04:35	19° 45.69' S	11° 20.70' E	865	SSE 7	292	0.1	CTD/RO
M103/2_123-4	03.02.2014	05:21	19° 45.69' S	11° 20.70' E	871	SE 8	128	0.1	AC-S
M103/2_123-5	03.02.2014	05:46	19° 45.69' S	11° 20.70' E	841	SSE 8	250	0	CTD/RO
M103/2_123-6	03.02.2014	06:01	19° 45.69' S	11° 20.70' E	841	SSE 7	143	0	HN
M103/2_123-7	03.02.2014	06:04	19° 45.69' S	11° 20.70' E	841	SE 8	97	0.1	MSN
M103/2_123-8	03.02.2014	06:06	19° 45.69' S	11° 20.70' E	842	SE 8	137	0	SD
M103/2_123-9	03.02.2014	06:45	19° 45.67' S	11° 20.71' E	847	SSE 7	218	0.1	TRIOS
M103/2_123-10	03.02.2014	07:06	19° 45.69' S	11° 20.70' E	841	SSE 7	269	0	SLS
M103/2_123-11	03.02.2014	07:24	19° 45.66' S	11° 20.73' E	840	SSE 7	331	0	MSN
M103/2_123-12	03.02.2014	08:01	19° 45.67' S	11° 20.86' E	836	SSE 6	178	1.1	MSN

Station METEOR	Date	Time	Position [°Lat]	Position [°Lon]	Depth [m]	Wind [m/s]	Course [°]	Speed [kn]	Gear
M103/2_123-13	03.02.2014	08:38	19° 47.01' S	11° 21.28' E	1242	S 6	138	2	MSN
M103/2_123-14	03.02.2014	09:10	19° 47.95' S	11° 21.68' E	837	S 6	172	1.2	RTR
M103/2_123-15	03.02.2014	10:06	19° 45.81' S	11° 20.75' E	841	SSE 7	200	2.8	MOC
M103/2_124-1	03.02.2014	12:36	19° 43.48' S	11° 27.31' E	718	S 7	162	0.2	MSS
M103/2_125-1	03.02.2014	14:28	19° 40.58' S	11° 34.03' E	498	SSE 8	358	0.3	MSS
M103/2_125-2	03.02.2014	15:35	19° 41.29' S	11° 33.98' E	504	S 8	93	0.4	MSN
M103/2_125-3	03.02.2014	15:51	19° 41.29' S	11° 33.98' E	504	S 8	279	0	CTD/RO
M103/2_125-4	03.02.2014	16:20	19° 41.29' S	11° 33.98' E	504	SSE 9	356	0.1	HN
M103/2_125-5	03.02.2014	16:25	19° 41.29' S	11° 33.98' E	504	SSE 9	96	0	MSN
M103/2_125-6	03.02.2014	17:09	19° 42.14' S	11° 34.00' E	514	SSE 9	323	0	RTR
M103/2_126-1	03.02.2014	19:58	19° 58.43' S	11° 42.77' E	510	SE 7	180	2.1	MOC-D
M103/2_126-1	04.02.2014	00:46	20° 6.84' S	11° 48.77' E	498	SSE 5	150	1.9	MOC-D
M103/2_127-1	04.02.2014	04:11	19° 41.28' S	11° 33.99' E	1028	SSE 5	233	0.4	CTD/RO
M103/2_127-2	04.02.2014	04:28	19° 41.30' S	11° 33.99' E	504	SE 3	24	0	AC-S
M103/2_127-3	04.02.2014	04:38	19° 41.30' S	11° 33.99' E	505	SE 5	278	0	HN
M103/2_127-4	04.02.2014	05:04	19° 41.30' S	11° 33.99' E	505	ESE 5	304	0	CTD/RO
M103/2_127-5	04.02.2014	05:36	19° 41.30' S	11° 33.99' E	505	ESE 5	93	0	MSN
M103/2_127-6	04.02.2014	06:18	19° 41.29' S	11° 33.95' E	505	SSE 4	0	0	TRIOS
M103/2_127-7	04.02.2014	06:45	19° 41.32' S	11° 33.91' E	747	SE 4	237	0.1	SLS
M103/2_127-8	04.02.2014	07:00	19° 41.39' S	11° 33.82' E	509	SE 4	170	0.3	SD
M103/2_127-9	04.02.2014	07:04	19° 41.40' S	11° 33.81' E	509	SSE 5	45	0	MSN
M103/2_127-10	04.02.2014	07:52	19° 41.49' S	11° 33.88' E	508	SSE 5	156	2.3	MOC
M103/2_128-1	04.02.2014	10:35	19° 38.55' S	11° 40.16' E	705	SSE 5	74	0.3	MSS
M103/2_129-1	04.02.2014	12:20	19° 36.44' S	11° 46.81' E	354	SE 4	10	0.2	MSS
M103/2_129-2	04.02.2014	13:21	19° 36.98' S	11° 46.99' E	355	SSE 4	196	0.1	CTD/RO
M103/2_130-1	04.02.2014	14:29	19° 35.06' S	11° 52.70' E	293	SSE 5	72	0.3	MSS
M103/2_131-1	04.02.2014	16:31	19° 31.87' S	11° 59.53' E	959	SSE 6	112	0.2	TRIOS
M103/2_131-2	04.02.2014	16:37	19° 31.86' S	11° 59.53' E	302	SSE 6	255	0	HN
M103/2_131-3	04.02.2014	16:46	19° 31.87' S	11° 59.53' E	301	SSE 6	241	0.4	SLS
M103/2_131-4	04.02.2014	16:57	19° 31.98' S	11° 59.48' E	307	SSE 6	215	0.5	MSS
M103/2_131-5	04.02.2014	17:53	19° 32.63' S	11° 59.83' E	314	SSE 7	34	0.1	MSN
M103/2_131-6	04.02.2014	17:54	19° 32.63' S	11° 59.83' E	302	SSE 7	287	0	SD
M103/2_131-7	04.02.2014	18:10	19° 32.63' S	11° 59.83' E	302	SSE 6	122	0	CTD/RO
M103/2_131-8	04.02.2014	18:19	19° 32.63' S	11° 59.83' E	303	SSE 6	0	0	HN
M103/2_131-9	04.02.2014	18:40	19° 32.63' S	11° 59.83' E	302	SSE 6	261	0	AC-S
M103/2_131-10	04.02.2014	19:16	19° 32.63' S	11° 59.83' E	301	SSE 6	264	0.2	CTD/RO
M103/2_131-11	04.02.2014	19:40	19° 32.63' S	11° 59.83' E	356	SSE 7	100	0	MSN
M103/2_131-12	04.02.2014	20:08	19° 32.63' S	11° 59.84' E	302	SSE 7	235	0	MSN
M103/2_131-13	04.02.2014	20:37	19° 32.69' S	11° 59.85' E	301	SSE 7	152	1.7	MSN
M103/2_131-14	04.02.2014	21:27	19° 33.94' S	12° 0.33' E	302	SE 6	145	2	RTR
M103/2_131-15	04.02.2014	22:18	19° 34.96' S	12° 0.88' E	300	SE 8	173	3.1	MOC
M103/2_132-1	05.02.2014	01:43	19° 17.98' S	11° 55.99' E	289	SE 8	159	0.3	CTD/RO
M103/2_133-1	05.02.2014	04:02	19° 29.26' S	12° 7.11' E	519	SE 7	167	0.5	MSS
M103/2_133-2	05.02.2014	05:01	19° 29.99' S	12° 7.78' E	250	SE 7	108	1	CTD/RO
M103/2_133-3	05.02.2014	05:12	19° 30.00' S	12° 7.79' E	250	SE 7	0	0	HN
M103/2_133-4	05.02.2014	05:45	19° 30.03' S	12° 7.80' E	250	SE 9	151	1	RTR
M103/2_133-5	05.02.2014	06:50	19° 31.03' S	12° 8.42' E	248	SE 7	288	0	CTD/RO
M103/2_133-6	05.02.2014	06:51	19° 31.03' S	12° 8.42' E	248	SE 7	48	0	HN
M103/2_134-1	05.02.2014	08:01	19° 26.74' S	12° 15.24' E	180	SE 7	82	0.1	MSS
M103/2_135-1	05.02.2014	09:38	19° 22.32' S	12° 21.72' E	130	SSE 8	172	1.9	MOC
M103/2_135-2	05.02.2014	10:19	19° 23.52' S	12° 22.19' E	131	SSE 7	0	0.5	MSS
M103/2_135-3	05.02.2014	10:26	19° 23.57' S	12° 22.21' E	130	SSE 8	132	0.4	HN
M103/2_135-4	05.02.2014	11:17	19° 24.99' S	12° 22.78' E	132	SSE 8	200	0	MSN
M103/2_135-5	05.02.2014	11:46	19° 24.99' S	12° 22.78' E	132	SSE 7	51	0	AC-S
M103/2_135-6	05.02.2014	12:09	19° 24.99' S	12° 22.78' E	133	S 9	256	0	SD
M103/2_135-7	05.02.2014	12:27	19° 24.99' S	12° 22.78' E	132	SSE 9	313	0	TRIOS
M103/2_135-8	05.02.2014	12:52	19° 24.99' S	12° 22.78' E	132	SSE 8	244	0	CTD/RO
M103/2_135-9	05.02.2014	13:21	19° 24.99' S	12° 22.78' E	132	SSE 9	314	0	SLS
M103/2_135-10	05.02.2014	13:48	19° 24.99' S	12° 22.51' E	137	SSE 8	67	0	CTD/RO
M103/2_135-11	05.02.2014	14:11	19° 24.98' S	12° 22.71' E	134	SSE 9	99	0	MSN

Station METEOR	Date	Time	Position [°Lat]	Position [°Lon]	Depth [m]	Wind [m/s]	Course [°]	Speed [kn]	Gear
M103/2_135-12	05.02.2014	14:26	19° 24.98' S	12° 22.77' E	132	SSE 9	263	0	MSN
M103/2_135-13	05.02.2014	14:44	19° 25.00' S	12° 22.77' E	133	SSE 8	180	1.2	MSN
M103/2_135-13	05.02.2014	14:49	19° 25.11' S	12° 22.77' E	133	SSE 9	189	1.4	MSN
M103/2_135-14	05.02.2014	15:14	19° 25.63' S	12° 22.77' E	133	SSE 9	188	1.4	RTR
M103/2_135-15	05.02.2014	16:56	19° 22.92' S	12° 28.50' E	115	SSE 8	151	0.4	MSS
M103/2_137-1	05.02.2014	18:11	19° 20.97' S	12° 33.27' E	81	SSE 8	187	0.3	MSS
M103/2_137-2	05.02.2014	18:55	19° 21.47' S	12° 33.50' E	81	SSE 8	257	0.2	MSN
M103/2_137-3	05.02.2014	18:56	19° 21.47' S	12° 33.50' E	81	SSE 8	89	0	HN
M103/2_137-4	05.02.2014	19:10	19° 21.47' S	12° 33.50' E	82	SSE 8	65	0	CTD/RO
M103/2_137-5	05.02.2014	19:25	19° 21.47' S	12° 33.50' E	80	SSE 8	252	0.1	AC-S
M103/2_137-6	05.02.2014	19:44	19° 21.47' S	12° 33.50' E	80	SSE 8	160	0	MSN
M103/2_137-7	05.02.2014	19:58	19° 21.47' S	12° 33.50' E	82	SSE 8	127	0.1	MSN
M103/2_137-8	05.02.2014	20:13	19° 21.53' S	12° 33.52' E	80	SE 8	136	1.5	MSN
M103/2_137-9	05.02.2014	21:03	19° 21.46' S	12° 33.49' E	80	SE 7	159	1.8	MSN
M103/2_137-10	05.02.2014	21:33	19° 21.96' S	12° 33.69' E	80	SE 7	136	1.4	RTR
M103/2_137-11	05.02.2014	22:22	19° 22.70' S	12° 33.98' E	94	SE 6	134	2.2	MOC
M103/2_138-1	05.02.2014	23:43	19° 19.43' S	12° 37.79' E	50	SSE 7	194	0.6	MSS
M103/2_138-2	06.02.2014	00:15	19° 19.99' S	12° 37.99' E	50	SSE 7	85	0	MSN
M103/2_138-3	06.02.2014	00:31	19° 19.99' S	12° 37.99' E	51	SSE 7	61	0	CTD/RO
M103/2_138-4	06.02.2014	00:33	19° 19.99' S	12° 37.99' E	49	SSE 6	132	0	HN
M103/2_138-5	06.02.2014	00:50	19° 19.99' S	12° 37.99' E	48	SE 6	2	0	AC-S
M103/2_138-6	06.02.2014	01:11	19° 19.99' S	12° 37.99' E	49	SE 6	0	0	MSN
M103/2_138-7	06.02.2014	01:25	19° 19.99' S	12° 37.99' E	49	SE 6	98	0	MSN
M103/2_138-8	06.02.2014	01:39	19° 20.07' S	12° 38.01' E	52	SE 5	171	2	MSN
M103/2_138-9	06.02.2014	02:00	19° 20.62' S	12° 38.10' E	52	SSE 6	221	1	RTR
M103/2_139-1	06.02.2014	05:27	19° 43.86' S	12° 18.15' E	202	SE 7	226	11.3	TD
M103/2_140-1	06.02.2014	10:00	19° 59.92' S	12° 44.95' E	118	S 4	44	0.2	TRBM
M103/2_140-1	06.02.2014	10:41	20° 0.02' S	12° 45.21' E	118	SSE 5	228	0.1	TRBM
M103/2_140-2	06.02.2014	10:48	20° 0.02' S	12° 45.20' E	116	SSE 5	140	0	HN
M103/2_140-3	06.02.2014	11:15	20° 0.02' S	12° 45.20' E	117	SSE 4	101	0.1	CTD/RO
M103/2_140-4	06.02.2014	12:00	20° 0.04' S	12° 45.11' E	120	SSE 5	0	0	TRBM
M103/2_140-4	06.02.2014	12:10	20° 0.04' S	12° 45.12' E	120	SSE 4	72	0	TRBM
M103/2_141-1	06.02.2014	13:11	20° 5.42' S	12° 42.77' E	123	SSE 4	76	0	CTD/RO
M103/2_141-2	06.02.2014	13:13	20° 5.42' S	12° 42.77' E	109	SSE 5	119	0	HN
M103/2_141-3	06.02.2014	13:20	20° 5.42' S	12° 42.77' E	123	SSE 5	85	0	SD
M103/2_142-1	06.02.2014	17:40	20° 29.27' S	12° 3.36' E	491	SSE 8	137	0.9	MSS
M103/2_142-2	06.02.2014	19:03	20° 30.01' S	12° 3.65' E	495	SSE 8	52	0	MSN
M103/2_142-3	06.02.2014	19:05	20° 30.01' S	12° 3.64' E	495	SSE 8	0	0	HN
M103/2_142-4	06.02.2014	19:18	20° 30.01' S	12° 3.63' E	495	SSE 8	262	0	CTD/RO
M103/2_142-5	06.02.2014	19:51	20° 30.01' S	12° 3.64' E	496	SSE 7	52	0	AC-S
M103/2_142-6	06.02.2014	20:23	20° 30.01' S	12° 3.61' E	497	SSE 8	272	0	MSN
M103/2_142-7	06.02.2014	20:52	20° 30.05' S	12° 3.50' E	500	SSE 6	59	0	MSN
M103/2_142-8	06.02.2014	21:33	20° 30.15' S	12° 3.31' E	507	SSE 5	210	2.6	MOC
M103/2_142-9	07.02.2014	00:10	20° 30.20' S	12° 3.65' E	499	SE 6	180	2.7	MSN
M103/2_142-10	07.02.2014	01:20	20° 33.21' S	12° 3.45' E	547	SE 9	205	2.4	RTR
M103/2_143-1	07.02.2014	03:32	20° 19.92' S	11° 57.52' E	504	SE 5	304	0.1	CTD/RO
M103/2_143-2	07.02.2014	04:03	20° 19.91' S	11° 57.51' E	504	ESE 4	306	0	MSN
M103/2_144-1	07.02.2014	08:21	20° 6.53' S	11° 48.66' E	497	ESE 1	159	0.7	MSS
M103/2_144-2	07.02.2014	09:28	20° 7.11' S	11° 48.78' E	503	SE 3	116	0	MSN
M103/2_144-3	07.02.2014	09:46	20° 7.11' S	11° 48.78' E	502	ESE 3	276	0	CTD/RO
M103/2_144-4	07.02.2014	09:54	20° 7.11' S	11° 48.78' E	501	ESE 4	105	0.1	HN
M103/2_144-5	07.02.2014	09:59	20° 7.11' S	11° 48.78' E	502	SE 4	107	0	SD
M103/2_144-6	07.02.2014	10:28	20° 6.99' S	11° 48.80' E	501	ESE 4	282	0	AC-S
M103/2_144-7	07.02.2014	11:15	20° 6.99' S	11° 48.80' E	500	SE 5	106	0.1	TRIOS
M103/2_144-8	07.02.2014	11:34	20° 6.99' S	11° 48.80' E	500	SSE 5	140	0	SLS
M103/2_144-9	07.02.2014	11:58	20° 6.99' S	11° 48.80' E	500	SE 5	258	0	MSN
M103/2_144-10	07.02.2014	12:33	20° 6.99' S	11° 48.82' E	498	SE 6	95	0.1	MSN
M103/2_144-11	07.02.2014	13:14	20° 7.10' S	11° 48.85' E	499	SSE 5	179	1.9	MSN
M103/2_144-12	07.02.2014	13:54	20° 7.95' S	11° 48.88' E	513	SSE 6	163	1.6	RTR
M103/2_144-13	07.02.2014	14:40	20° 7.04' S	11° 48.89' E	498	SSE 6	205	2.2	MOC

Station METEOR	Date	Time	Position [°Lat]	Position [°Lon]	Depth [m]	Wind [m/s]	Course [°]	Speed [kn]	Gear
M103/2_145-1	07.02.2014	17:34	19° 53.58' S	11° 40.11' E	509	SSE 9	144	0.8	MSS
M103/2_145-2	07.02.2014	18:43	19° 54.48' S	11° 40.00' E	521	SSE 10	39	0	MSN
M103/2_145-3	07.02.2014	18:59	19° 54.48' S	11° 40.01' E	520	SSE 10	0	0	CTD/RO
M103/2_145-4	07.02.2014	19:02	19° 54.48' S	11° 40.01' E	521	SE 9	82	0.1	HN
M103/2_145-5	07.02.2014	19:30	19° 54.48' S	11° 40.01' E	520	SE 9	103	0.1	AC-S
M103/2_145-6	07.02.2014	20:01	19° 54.48' S	11° 40.01' E	520	SE 9	0	0.1	MSN
M103/2_145-7	07.02.2014	20:34	19° 54.48' S	11° 40.01' E	520	SE 11	292	0	MSN
M103/2_145-8	07.02.2014	21:12	19° 54.53' S	11° 40.00' E	522	SE 11	203	1.1	MSN
M103/2_145-9	07.02.2014	22:00	19° 55.13' S	11° 40.01' E	527	SE 9	240	0.8	RTR
M103/2_145-10	07.02.2014	22:48	19° 56.09' S	11° 40.05' E	536	SE 10	208	1.9	MOC
M103/2_146-1	08.02.2014	03:51	19° 21.60' S	11° 28.78' E	519	SE 11	193	1.8	MOC
M103/2_146-2	08.02.2014	04:54	19° 23.41' S	11° 28.31' E	537	SSE 10	139	0.5	MSS
M103/2_146-3	08.02.2014	06:20	19° 24.99' S	11° 28.02' E	549	SE 9	310	0.1	MSN
M103/2_146-4	08.02.2014	06:37	19° 24.99' S	11° 28.02' E	549	SE 11	348	0	CTD/RO
M103/2_146-5	08.02.2014	06:38	19° 24.99' S	11° 28.02' E	550	SE 10	134	0	HN
M103/2_146-6	08.02.2014	06:55	19° 24.99' S	11° 28.02' E	549	SE 10	0	0	SD
M103/2_146-7	08.02.2014	07:15	19° 24.99' S	11° 28.02' E	549	SE 10	258	0	AC-S
M103/2_146-8	08.02.2014	07:47	19° 24.91' S	11° 27.99' E	551	SE 10	292	0	TRIOS
M103/2_146-9	08.02.2014	08:14	19° 24.92' S	11° 27.88' E	552	SE 10	69	0	SLS
M103/2_146-10	08.02.2014	08:36	19° 24.92' S	11° 27.67' E	556	SE 10	78	0.1	MSN
M103/2_146-11	08.02.2014	09:10	19° 24.92' S	11° 27.67' E	556	SE 9	0	0	MSN
M103/2_146-12	08.02.2014	09:45	19° 24.96' S	11° 27.67' E	556	SE 8	189	1	MSN
M103/2_146-13	08.02.2014	10:30	19° 26.02' S	11° 27.70' E	560	SE 8	154	0.8	RTR
M103/2_146-14	08.02.2014	11:41	19° 23.52' S	11° 26.47' E	570	SSE 8	332	2	CATM
M103/2_146-14	08.02.2014	19:58	19° 59.42' S	11° 43.18' E	513	SSE 6	155	3	CATM
M103/2_146-15	08.02.2014	12:00	19° 22.42' S	11° 26.58' E	561	SSE 7	133	3.5	SCF
M103/2_146-15	09.02.2014	13:34	20° 52.14' S	12° 19.17' E	525	SSE 6	141	1.9	SCF
M103/2_146-15	09.02.2014	13:20	20° 51.57' S	12° 18.71' E	525	SE 7	141	4.9	SCF
M103/2_147-1	10.02.2014	05:42	23° 0.06' S	14° 2.83' E	133	SE 5	271	0	MOR
M103/2_147-1	10.02.2014	07:43	23° 0.96' S	14° 2.69' E	133	SE 4	308	0	MOR
M103/2_148-1	10.02.2014	12:20	23° 29.99' S	13° 24.01' E	264	S 6	301	0.1	CTD/RO
M103/2_148-2	10.02.2014	12:28	23° 29.99' S	13° 24.01' E	265	S 6	210	0	HN
M103/2_148-3	10.02.2014	12:33	23° 29.99' S	13° 24.01' E	264	SSW 5	108	0.1	SD
M103/2_148-4	10.02.2014	12:54	23° 29.99' S	13° 24.01' E	264	SSW 6	211	0	AC-S
M103/2_148-5	10.02.2014	13:23	23° 29.99' S	13° 24.01' E	264	SSW 8	281	0	TRIOS
M103/2_148-6	10.02.2014	13:43	23° 29.99' S	13° 24.00' E	265	S 8	50	0.4	SLS

8 Data and Sample Storage and Availability

All data and samples collected during cruise M103 refer to the GENUS program. A Cruise Summary Report (CSR) for each leg was compiled and submitted to DOD (Deutsches Ozeanographisches Datenzentrum), BSH, Hamburg, immediately after the cruise. The cruise was performed within waters of Namibian and international jurisdiction. Namibia requests the cruise report three month after finishing the research cruise and scientific publication within the following three years; this will be done as soon as the report and publications are available. A close collaboration exists between scientists of the GENUS project and the NatMIRC Institute in Swakopmund (Namibia); complete data exchange is part of the formal agreement between all subprojects and Namibian partners of GENUS.

In a first stage the GENUS project stores all data of the cruise on an ftp-server at the Leibniz-Institute for Baltic Research in Warnemünde. The server can be accessed through ftp://ftp.io-warnemuende.de. The scientist in charge and to contact for access and further support is Dr. Anja Eggert (anja.eggert@io-warnemuende.de). During the first stage most data are only available to the user groups of the GENUS program and to affiliated project partners and still need to be processed or validated.

However, one central task of the GENUS program is the binding agreement to share the collected data with the scientific community. Therefore, GENUS has already established a legal cooperation with the Pangaea Database (www.pangaea.de) at WDC Mare. This means that all data collected during this cruise as well as for all other GENUS cruises will be transferred and finally stored in the Pangaea Database by July 2015 and then accessible according to the release requirements of the respective working groups.

All biological and biogeochemical samples collected during this cruise were sent under frozen conditions (-80°C or -20°C) to the respective home laboratories in Germany (IOW, IHF, ZMT, MarZoo, AWI). The majority of the samples will be used for measurements and experiments within the GENUS program. The remaining samples are submitted to the German archives according to the agreement with the *Deutsche Zentrum für Marine Biodiversitätsforschung* (DZMB).

All data will be transferred to public databases as soon as possible. Table 8.1 lists the target databases, tentative submission times and responsible scientists.

Hydrography - CTD and ADCP data are held and analyzed at the Leibniz-Institute for Baltic Sea Research Warnemünde under the supervision of Dr. V. Mohrholz. Raw data can be accessed through Dr. V. Mohrholz. Validated data are stored in the IOW oceanographic data base. A copy of the validated will be delivered to Pangaea data base.

Optical Properties and Remote Sensing - Optical and remote sensing data are held at the Leibniz-Institute for Baltic Sea Research Warnemünde under the supervision of Dr. Herbert Siegel. Validated data are in the optical data archive and will be delivered to Pangaea data base.

Phytoplankton - The original data of phytoplankton taxonomic composition and biomass, chlorophyll a concentrations, nitrogen fixation rates and primary production rates are held at the Leibniz Institute for Baltic Sea Research Warnemünde (IOW) under the supervision of Dr. Norbert Wasmund.

Biogeochemistry – samples and data are held at the Universität Hamburg and at the Helmholtz-Center in Geesthacht under the supervision of Dr. Niko Lahajnar, Universität Hamburg.

Carbon and Nutrient Cycling – nutrients and the measured data on CO_2, CH_4 from underway systems are stored at ZMT under the supervision of Tim Rixen, (ZMT/University of Hamburg).

Microbial Community Structure – samples and data are held at the Universität Bremen, Department of Microbial Ecophysiology (responsible: Prof. Dr. Michael W. Friedrich), and are currently being analyzed by Christina Pavloudi (PhD candidate), under the supervision of Prof. Dr. Michael W. Friedrich.

Zooplankton – Micro- and mesozooplankton samples and data are held at the University of Hamburg, Institute for Hydrobiology and Fishery Science (responsible: Dr. Rolf Koppelmann and Dr. Bettina Martin). Microzooplankton samples are currently being analyzed by a Ph.D. student under the supervision of Prof. Dr. Christian Möllmann and Dr. Rolf Koppelmann.

Ichthyoplankton – samples and data are held at the Leibniz Center for Tropical Marine Ecology under the supervision of Dr. Werner Ekau, Leibniz Center for Tropical Marine Ecology.

Krill – samples and data are held at the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (Bremerhaven) under the supervision of Prof. Dr. Friedrich Buchholz and Dr. Thorsten Werner.

Tab. 8.1 Data Storage and Availability

Type	Database	Available	Free access	Contact
Hydrography etc.				
CTD profiles	IOW data base	Jul. 2015	Jul. 2017	volker.mohrholz@io-warnemuende.de
VMADCP data	IOW data base	Jul. 2015	Jul. 2017	volker.mohrholz@io-warnemuende.de
MSS profiles	IOW data base	Jul. 2015	Jul. 2017	volker.mohrholz@io-warnemuende.de
Remote Sensing etc.				
Water constituents	Opt. data archive	Jul. 2015	Jul. 2015	herbert.siegel@io-warnemuende.de
SMSR/SPMR data	Opt. data archive	Jul. 2015	Jul. 2015	herbert.siegel@io-warnemuende.de
Satellite data	Opt. data archive	Jul. 2015	Jul. 2015	herbert.siegel@io-warnemuende.de
Phytoplankton				
Phytoplankton biomass	Pangaea	Mar. 2015	Mar. 2017	norbert.wasmund@io-warnemuende.de
Chlorophyll a	Pangaea	Mar. 2015	Mar. 2017	norbert.wasmund@io-warnemuende.de
Nitrogen fixation	Pangaea	Mar. 2015	Mar. 2017	norbert.wasmund@io-warnemuende.de
Primary production	IOW Data base	Mar. 2015	Mar. 2017	norbert.wasmund@io-warnemuende.de
Biogeochemistry				
Ferrybox	Pangaea	Jul. 2015	Jul. 2017	niko.lahajnar@uni-hamburg.de
Ultrafiltration DOM	Pangaea	Jul. 2015	Jul. 2017	niko.lahajnar@uni-hamburg.de
Suspended Matter	Pangaea	Jul. 2015	Jul. 2017	niko.lahajnar@uni-hamburg.de
Stable Isotopes	Pangaea	Jul. 2015	Jul. 2017	kristin.daehnke@hzg.de
Porewater Chemistry	Pangaea	Jul. 2016	Jul. 2017	meike.rueschkamp@hzg.de
Sediment Traps	Pangaea	Jul. 2015	Jul. 2017	niko.lahajnar@uni-hamburg.de
Surface Sediments	Pangaea	Jul. 2015	Jul. 2017	niko.lahajnar@uni-hamburg.de
Carbon and Nutrients				
Water column nutrients	Pangaea	Jul. 2015	Jul. 2017	tim.rixen@zmt-bremen.de
Underway system (xCO_2, $\delta^{13}CO_2$, xCH_4, $\delta^{13}CH_4$, pH, TA)	Pangaea	Jul. 2015	Jul. 2017	tim.rixen@zmt-bremen.de
Microbial Community Structure				
OTU[1] sequences (total community)	ENA[3]	Jul. 2016	Jul. 2018	cpavloud@hcmr.gr
Gene expression data	ENA	Jul. 2016	Jul. 2018	cpavloud@hcmr.gr
OTU sequences from the SIP[2] experiments (enriched community)	ENA	Jul. 2016	Jul. 2018	cpavloud@hcmr.gr
Zooplankton				
Microzooplankton	Pangaea	Nov 2015	Nov 2017	karolina.bohata@uni-hamburg.de
Mesozooplankton	Pangaea	May 2015	May 2017	bettina.martin@uni-hamburg.de
Stable Isotopes	Pangaea	May 2015	May 2017	bettina.martin@uni-hamburg.de
Ichthyoplankton				
Egg and larval densities	Pangaea	Jul. 2015	Jul. 2017	simon.geist@zmt-bremen.de werner.ekau@zmt-bremen.de
Krill				
Abundance	Pangaea	Jul. 2015	Jul. 2017	thorsten.werner@awi.de
Stable Isotopes	Pangaea	Jul. 2015	Jul. 2017	thorsten.werner@awi.de

[1]OTU: Operational Taxonomic Unit

[2]SIP: Stable Isotope Probing
[3]ENA: European Nucleotide Archive

9 Acknowledgements

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