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Meckel, S., Ruhland, G., Van der Jagt, H., Waldmann, C.

Report and preliminary results of R/V Poseidon cruise POS481

Las Palmas (Canary Islands) – Las Palmas (Canary Islands)
15.02.2015 – 03.03.2015

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2015

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1 Participants

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Markussen, Thor	Geography	UniCH/GeoB
Meckel, Sebastian	Technician	MARUM
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Waldmann, Christoph, Dr.	Marine Technology	MARUM

MARUM	Center for Marine Environmental Sciences, University of Bremen, Germany
GeoB	Geosciences Department, University of Bremen, Germany
AWI	Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany
UniCH	University of Copenhagen, Denmark, guest scientist at Geosciences Dept. University of Bremen (GeoB)
IMROP	Institut Mauritanien de Recherches Océanographiques et des Pêches, Nouadhibou, Mauritania

2 Narrative of the Cruise

(Gerhard Fischer)

R/V Poseidon left the port of Las Palmas, Gran Canaria, Spain, on February 18th, 2015 at 13:00 pm heading in SW direction to the study area off Cape Blanc, Mauritania (Fig. 2.1). We had a delay of departure of about 3 days due to late delivery of spare parts for the ships' freshwater system, which was defect.

We planned to perform optical, microbial, biological and geochemical studies of the water column as well as the exchange of two sediment trap moorings off Cape Blanc (CB and CBi, Figs. 2.1 and 2.2). The mesotrophic mooring site CB is located roughly 200 nm offshore Cape Blanc and is operated since 1988. It is one of the longest time series sites for particle fluxes worldwide. The eutrophic site CBi has been first deployed in 2003 and is operated since then. Both mooring arrays were deployed during R/V POS464 cruise in February 2014.

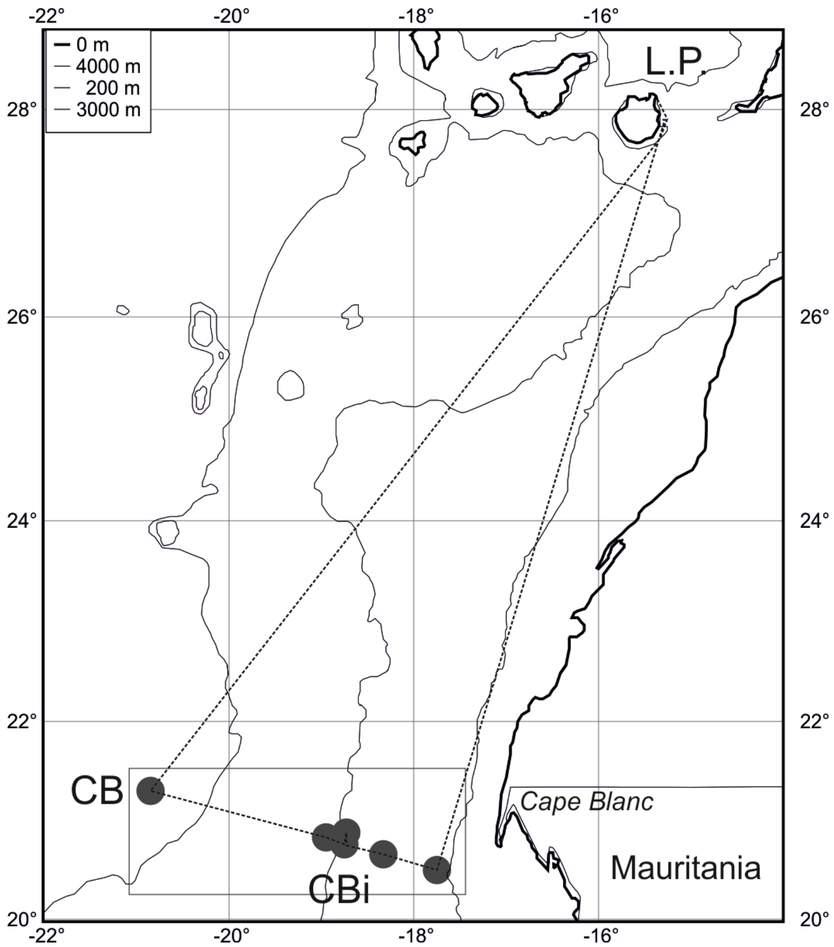


Fig. 2.1 Track and study sites of R/V Poseidon cruise 481 (Las Palmas–Las Palmas, 15.2.-3.3.2015) with the two long-term mooring sites CB (mesotrophic) and CBi (eutrophic). The tracks of the two drifting arrays were only a few miles and cannot be shown on this scale.

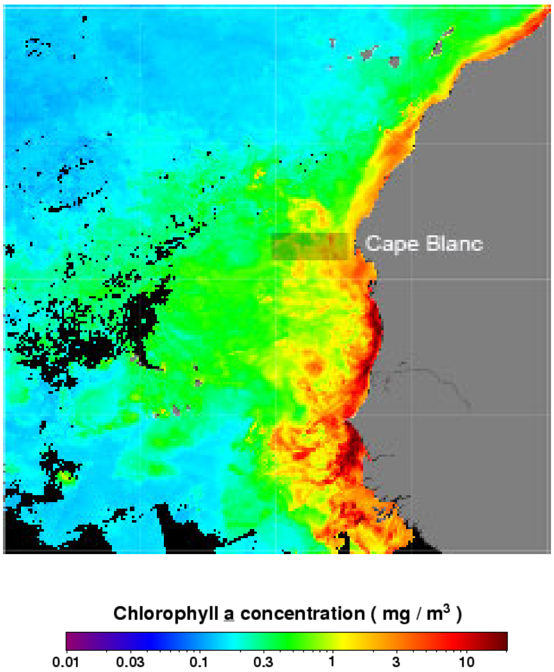


Fig. 2.2 MODIS-Satellite chlorophyll (in mg m^{-3}) in winter (February 2015), showing high chlorophyll off Cape Blanc, NW Africa. (http://oceancolor.gsfc.nasa.gov/cgi/l3). Some eddy systems further offshore can be seen The working box (including the two sediment trap sites CBi and CB; Fig. 2.1.) off Cape Blanc, Mauritania, during Poseidon cruises is indicated.

In addition to the installation of the two sediment trap moorings, we have conducted process studies since about one decade. During this cruise, we intended to deploy 2-3 drifting arrays with cylindrical traps around the eutrophic site CBi. They were planned to be combined with a newly developed camera platform (ThorCam, TC), equipped with an infrared camera system (for zooplankton activity) and a high resolution particle camera to study the nepheloid layers. Additionally, our standard particle camera system (ParCa-CTD) was planned to be launched to measure the distribution and size of marine snow aggregates and other larger particles in a larger sample volume. We further planned to use another particle camera, the DriftCam (DC), which was developed in 2013 to perform time series measurements of particle concentration and size in the surface layer within the drifting arrays (see report of POS 464, Fischer et al., 2014). To study zooplankton abundance and distribution, we intended to use the multinet with 5 nets, if possible for day- and night hauls to consider dial vertical migration of zooplankton. The studies were completed by roller tank incubation experiments and lab studies with marine snow aggregates collected by the new Marine Snow Catcher (MSC). Respiration rates and sinking rates were determined on marine snow particles from different sources. We further sampled Saharan dust with two dust samplers on the uppermost deck when wind direction allowed it. For testing purposes, a new wave glider equipped with an Acoustic Doppler Current Profiler (ADCP) was available. On board the cruise were 7 scientists from the University of Bremen (Marum and GeoB) and the AWI (Bremerhaven) and one scientist from the University of Copenhagen. One observer from Mauritania (IMROP, Nouadhibou) joined the cruise.

In the early Saturday afternoon of February 21st, we reached the first mooring site off Cape Blanc (CB_{meso}) where the sediment trap mooring CB-25 was successfully recovered. The lower trap had worked perfectly, while the upper trap had failed. We then sampled the water column with the rosette-CTD (SBE-3) and later used the new Marine Snow Catcher for the collection of marine snow in 60 m water depths. Thereafter, we performed several tests in 50 and 250 m water depths with the particle camera systems, the Driftcam and the ThorCam. The handnet was launched to 60 m, followed by the ParCa-CTD with oxygen and turbidity sensors. Overnight, we deployed the DriftCam in 100 m water depth to measure larger particles formed during day-night cycles. After recovery of the DriftCam the next morning, February 22nd, the multinet was launched to 1000 m, collecting zooplankton in different depths in the upper 1000 m of the water column. In the afternoon, we deployed the long-term mooring CB-26 at our mesotrophic long-term study site. In addition, another MSC was used to collect marine aggregates in 60 m. We then sailed about 120 nm overnight to the east to reach the eutrophic sediment trap mooring site CBi.

On early Monday morning, we could recover the ca. 2000 m long mooring array with a Multi-Sensor Platform (MSP) and two sediment traps which both had worked perfectly. The MSP was equipped with a video particle camera for studying particle distribution and size over annual cycles. In the afternoon, the first drifting array DF-11 was deployed with the ThorCam (infrared and particle camera) in about 100 m water depth and three cylindrical traps each with 4 cylinders in 150, 200 and 400 m, respectively. One of each cylinder was filled with a special gel to preserve the large and fragile marine snow particles. We launched the Secchi disk, the multinet, the rosette-CTD and the handnet, followed by the ParCa-CTD. Overnight, the DriftCam was deployed again in 100 m to record time series particle distribution and size.

After recovery of the Driftcam on Tuesday morning February 24th, we deployed the rosette-CTD. In the early afternoon, we successfully recovered the drifting array DF-11 that had been drifting in NE direction, which was quite unusual. In the years before, all drifting arrays moved in southerly direction (SE to S to SW). We later deployed the multinet and the ThorCam down to 250 m. We later sailed about 20 nm to the west to the next study site (3300 m water depth), where we performed several tests with the Driftcam to further improve the focus before deploying it overnight. On early Wednesday morning of February 24th, we deployed ParCa-CTD, rosette-CTD, the multinet and the ThorCam.

In the early afternoon of February 25nd, we sailed back to the eutrophic mooring site CBi where we deployed the MSC in 60 m and later launched the DriftCam, again overnight. In the early Thursday morning of February 26th, we successfully deployed the long-term mooring CBi-13 with two sediment traps only. The MSP was not redeployed and will be newly constructed at the MARUM to prepare for a deployment scheduled in 2016 with Poseidon. Afterwards, we made a profile with the ThorCam down to 250 m while it was lowered slowly to get a high depth resolution and study the potential occurrence of particles within pycnocline layers. We further stopped at certain depths during the upcast to make clear pictures of fined-grained particles potentially concentrated within the pycnoclines. The ThorCam was again launched at the next site about 25 nm to the east (about 1300 m line), which we reached in the late afternoon. In the evening, we deployed the drifting array DF-12 with similar configuration as DF-11. The rosette-CTD was deployed, followed by the multinet (nighthaul) and the ParCa-CTD. The DriftCam was deployed overnight in 50 m, now with a downward looking ADCP for the study of subsurface currents. On Friday morning we took a marine snow sample with the MSC in 100 m. All earlier samples of the MSC from 60 m water depths delivered quite unusual whitish marine snow. In contrast, marine snow sampled with the drifting traps or those derived from lab experiments with roller tanks had greenish, yellowish or brownish colours. We measured the sinking rates of the whitish marine snow aggregates, which were quite high. We later launched the multinet down to 600 m.

In the early afternoon of February 27th, we recovered the drifting array DF-12 and sailed about 35 nm to the east to the shelf edge in about 300 m water depths. There, the multinet, rosette-CTD, ThorCam, ParCa-CTD were launched, mostly down to 250 m, and the Marine Snow Catcher was used as well. In the late evening, the handnet was lowered, followed by the night deployment of the Driftcam, again equipped with a downward-looking ADCP. After recovering this system in the early Saturday morning, February 28th, we started to sail back the 480 nm to Las Palmas which we reached on March 3 in the early morning as scheduled.

During the cruise, we have launched 51 instruments: ParCa-CTD (5x), rosette-CTD (6x), multinet (6x), handnet (4x), Marine Snow Catcher (5x), DriftCam (8x) and ThorCam (8x). Additionally, we tested our newly developed camera systems. We recovered and redeployed two long-term mooring arrays with sediment traps and set out/recovered two drifting arrays with camera systems and three traps each. We could not deploy and test the new wave glider due to persistently rough weather conditions; we had mostly winds of 5-7 Bft and 3-6 m cross swell. Our now more than 20-year old ParCa system did not work well and is planned to be reconstructed at the MARUM. Alltogether, we had a successful cruise and we would like to thank Capt. Günther and his crew for supporting us and to make this possible.

3 Preliminary Results

3.1 Marine Microbiology

3.1.1 Marine snow particles from experiments and the Marine Snow Catcher (MSC)

(Helga van der Jagt and Morten Iversen)

Background

The sedimentation of marine snow aggregates (>0.5 mm) plays an important role in the ocean's carbon cycle. Marine snow aggregates are composed of phytoplankton cells, detritus, faecal pellets and inorganic mineral grains, and by settling the aggregates remove organic matter from the surface ocean layer. Since the organic matter is formed by the fixation of atmospheric carbon dioxide (CO_2) that is absorbed in the surface ocean, the removal of organic aggregates via settling allows for more CO_2 uptake from the atmosphere by the surface ocean. The settling of aggregates is influenced by ballasting minerals, which can increase the sinking velocity of individual aggregates (Iversen and Ploug 2010; Iversen and Robert, 2015.). The influence of ballast minerals on aggregate formation and settling have been studied in several laboratory studies, but no studies have focused on the influences from natural ballast minerals (such as Saharan dust) on individual natural aggregates.

The study area off the coast of Cape Blanc (Mauritania) is located in a highly dynamic coastal upwelling system with high primary production. The area receives high inputs of dust minerals via Saharan storms. To understand how this dust input influences the export of material, we incubated Saharan dust together with either a natural plankton community to form aggregates or together with *in-situ* collected aggregates and compared that to treatments without additions of Saharan dust.

Methods and sampling

Water samples for the incubation experiments were collected on stations GeoB19401-2 and GeoB19403-2 (see chapter 3.4.2), and were used to fill 10 roller tanks. To half of the tanks a dust suspension was added, while the other half received a blanco mixture of GF/F seawater and milliQ. The dust was collected in Mauritania by J.B. Stuut, and was stored in a milliQ suspension. In the first experiment, the final dust concentration was almost 3 times higher than in the second experiment, to be able to compare different concentrations. The roller tanks were incubated for 36 hours (3 RPM), after which all formed aggregates were carefully collected and their sizes and sinking velocities were measured in a flow chamber. Each aggregate was stored individually for later analyses.

Next to these experiments, we deployed the OSIL Marine Snow Catcher (MSC, Fig. 3.1) on five locations during the cruise (Table 3.1). The collected aggregates were incubated in roller tanks with GF/F filtered seawater. Half of the roller tank incubations had a dust suspension added while the other half received the blanco treatment. After 36 h of incubation, the aggregates were collected and their size and sinking velocity were measured before they were stored individually (Fig. 3.8).

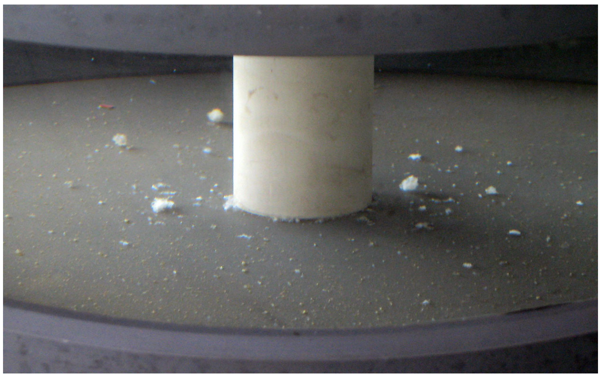


Fig. 3.1 The Marine Snow Catcher (MSC) from OSIL on board of R/V Poseidon (left). The water volume sampled by the collector is 100 l. Marine snow particles settle downwards into a collector (right) where they can be sampled. GeoB19401-12 (mooring site CB).

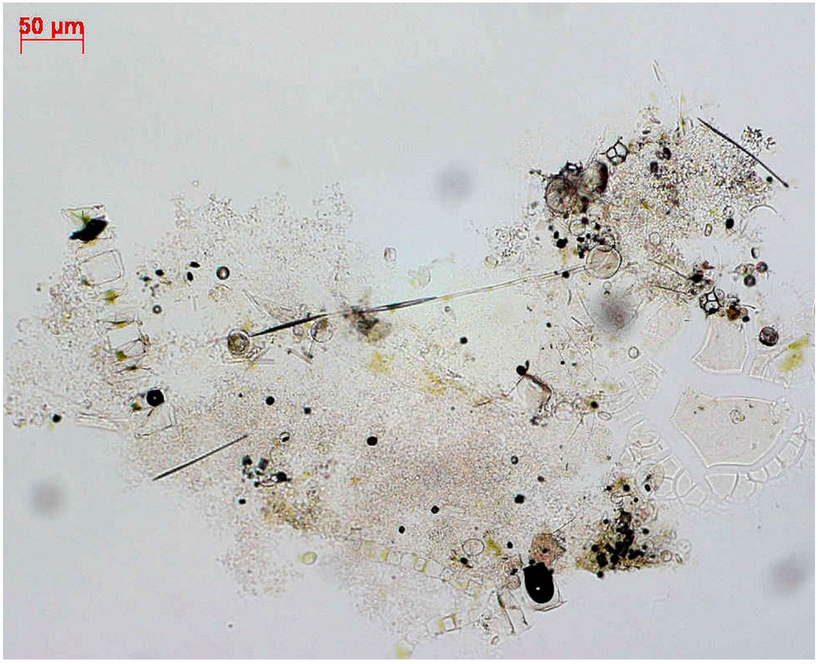


Fig. 3.2 Microscopic photograph of a sample taken from the Marine Snow Catcher (MSC) from site GeoB19406-5 showing a ca. 0.5 mm large marine snow aggregate. It consists of various diatom species and their resting spores, indicative for the coastal site off Cape Blanc. Green pigments can be seen as well.

Table 3.1 List of the Marine Snow Catcher (MSC) deployments. The aggregates were used in an incubation experiment or measured to determine size, sinking velocity and composition.

Station No.	Latitude	Longitude	Water depth	Sample depth
GeoB	N	W	m	m
19401-3	21°19.09’	20°50.14’	4192	60
19401-12	21°16.78’	20°52.24’	4166	60
19404-1	20°46.69’	18°44.39’	2639	60
19405-8	20°39.48’	18°17.50’	1285	100
19406-5	20°29.97’	17°44.98’	306	60

Preliminary results

The incubations of water containing a natural plankton community formed aggregates within the first ten hours. The effect of the dust treatment was clearly visible and we observed that the ballasted aggregates were bigger and settling faster compared to the non-ballasted aggregates. We also observed that this effect of ballasting was proportional to the amount of added dust, resulting in less clear differences between aggregates ballasted with low amounts of dust and non-ballasted aggregates.

Aggregates collected with the MSC showed similar sinking rates to aggregates formed in the control treatment. Surprisingly, many of the aggregates collected with the MSC seemed to have a white colour (Fig. 3.1) in comparison to those formed in roller tanks from *in-situ* collected plankton. However, we cannot offer any explanation to this colour difference until we have performed further analyses in the home laboratory. On board, we made several slides with marine snow aggregates from the MSC for further microscopic analysis (Fig. 3.2). Preliminary studies at home showed marine snow from the near-coastal sites showed some greenish pigments as well as diatoms, restins spores and silicoflagellates. Slides from marine snow particles further offshore seem to contain more coccolithophorids and pigments were rare.

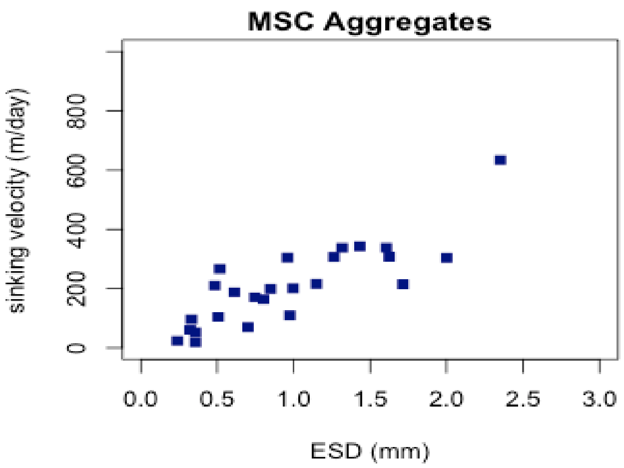


Fig. 3.3 Equivalent spherical diameter (ESD) and sinking velocity of marine aggregates caught with the Marine Snow Catcher (MSC, Fig. 3.1).

3.2 Marine Zoology

3.2.1 Mesozooplankton collected with the multinet and the hand net

(Marco Klann, Morten Iversen and Gerhard Fischer)

We used a multiple net from HYROBIOS, Kiel, fitted with five nets of 200 µm mesh size to sample meso-zooplankton in various depth ranges from the water column in the Cape Blanc area and used standard collection depths of 1000-600, 600-300, 300-150, 150-80 and 80-0 m (Table 3.2). We planned to perform day-and-night hauls to account for dial vertical migration of the various species, however, all together only five hauls could be done. This was due to late departure in Las Palmas and partly rough weather conditions off Cape Blanc. Together with plenty of hauls during other Poseidon cruises (POS 425, 445, 464), we plan to investigate the importance of zooplankton (e.g. copepods, euphausiids, appendicularia) for particle degradation in the upper water column, mainly in the epi- and mesopelagic. Day-and-night profiles were done to determine which species exert vertical diel migration. The collected samples were fixed with formaldehyde and stored cold (4°C).

Table 3.2 Samples taken with the multiple plankton net (multinet, MN) equipped with nets of 200 µm mesh size. Planned standard sampling depths with the five nets were: 1) 1000-600, 2) 600-300, 3) 300-150, 4) 150-80 and 5) 80-0 m. Due to problems with the battery housing of the net control unit at site GeoB19402-04 (see station list), we decided to lower the net only down to 600 m water depth and changed the depth ranges for collection accordingly.

Station No. GeoB-No.	Date 2015	Time MN at depth UTC	Latitude N	Longitude W	Water depths m	Remarks
19401-10	23.02	09:49	21°19.16’	20°49.02’	4172	Standard
19402-04	23.02	17:13	20°48.10’	18°45.03’	2724	Standard, malfunction, only net 1 and 2
19402-11	24.02	14:04	20°51.72’	18°41.94’	2623	600-400, 400-300, rest standard depths
19405-05	26.02	21:19	20°40.10’	18°18.43’	1335	600-400, 400-300, rest standard depths
19405-09	27.02.	10:04	20°39.18’	18°17.57’	1273	600-400, 400-300, rest standard depths

In addition to the multinet hauls, we made four vertical hauls with a small handnet (Fa. Hydrobios, Kiel). They were made from 50 and 60 m water depth up to the surface with a plankton hand net of 75 µm mesh size (see Table 3.3). The hand nets were made after sunset in order to have as much zooplankton in the surface waters as possible. The zooplankton collected with the hand nets were incubated in roller tanks together with marine snow aggregates and video recordings were made with illumination from infrared light. The goal of these recordings was to capture the feeding behaviour of different zooplankton species on marine snow. Several hours of video recordings were made during the cruise, and analysis of the recordings will be performed on the shore.

Table 3.3 Samples taken with the handnet (HN) equipped with a mesh size of 75µm.

Station No. GeoB-No.	Date 2015	Time HN at depth UTC	Latitude N	Longitude W	Water depths m	Remarks
19401-07	23.02	22:23	21°18.99’	20°50.02’	4181	50m
19402-06	23.02	19:54	20°48.19’	18°45.01’	2735	60m
19405-91	26.02	20:50	20°40.22’	18°18.60’	1350	60m
19406-06	28.02	22:09	20°29.97’	17°44.97’	306	50m

3.3 Optical studies

3.3.1 *In situ* particle properties acquired with ParCa-Pro

(Nico Nowald)

System description

The particle camera ParCa-Pro is a profiling system to acquire the *in-situ* size distribution and abundance of particulate matter in the ocean down to about 4000 m water depth. ParCa-Pro consists of a Kodak ProBack, 16 Megapixel digitalisation device mounted behind the optics of an analogue Photosea, 60 mm middle format camera. A strobe, mounted perpendicular to the optical axis of the camera, provides a collimated light beam of 12 cm width illuminating a sample volume of 12 litres of seawater. Pictures are usually taken in 10 m depth intervals while being lowered at a winch speed of 0.5 m/sec. The camera system is powered by a 24V/38 Ah rechargeable lead battery. All devices are mounted in a galvanised frame and total weight of the system is about 250 kg. Real-time communication via a serial link with the ship is done by a microcontroller and adapted software. After recovery of the system, the images were downloaded from the cameras flash disk and processed using the image analysis software IMAGEJ for particle abundance and size. Unfortunately, the camera did not work properly and it was not possible to fix the problem during the cruise. Thus, no useable particle profiles were acquired. However, the camera was deployed on five stations to collect oceanographical data with the CTD, which is part of the camera system (Table 3.4).

Table 3.4 List of ParCa-Pro stations, with CTD-chlorophyll-fluorescence-oxygen-turbidity sensors.

Station GeoB#	Date 2015	Lat (N)	Lon (W)	Depth (m)	Profiling depth (m)	Interval (m)	Deploy time	Recovery
19401	21.02.	21°18.99	20°50.03	4173	1000	10	22:30	23:30
19402	23.02.	20°48.20	18°44.91	2724	2200	10	20:10	22:15
19403	25.02.	20°51.82	18°57.57	3120	1000	10	09:30	10:25
19405	26.02.	20°40.22	18°18.64	1348	1000	-	21:55	22:30
19406	27.02.	20°30.07	17°44.97	305	296	-	21:20	22:00

3.3.2 Time-series particle studies with the DriftCam

(Nico Nowald, Sebastian Meckel and Christoph Waldmann)

The DriftCam (Fig. 3.4; formerly used in the drifting trap arrays, report POS 464) was deployed during this cruise to observe changes in the particle abundances and sizes over time at a given depth and at a very high temporal resolution. Further, migrating zooplankton should be tracked and its possible effects on the particle population. The camera was attached to the ship´s coaxial wire and lowered to a specific depth, where it was left over night, acquiring images in 2 minute intervals. The system was deployed at 6 sites along an east-west transect (Table 3.5). Overnight deployment depths were 50, 75 and 100 m. Deployment times were usually between 20:00 in the evening to 09:00 in the next morning. An ADCP was attached to the System at sites GeoB19405-7 and GeoB19406-7 to study ocean currents (Fig. 3.4). A detailed station list is shown in Table 3.5.

Table 3.5 Station list of the DriftCam deployments for time-series measurements. At two sites, a downward looking ADCP was installed (see Fig. 3.4).

Station GeoB	Position N and W	Deployment Date 2015/Time	Recovery Date 2015/Time	Durartion h	Depth m	Exposure interval min	Remark
19401-9	21°19,08' 20°50,10'	21.02. 23:58	22.2. 09:00	9	100	2	
19402-8	20°48,53' 18°44,99'	23.02. 22:47	24.02. 09:00	10	100	2	
19403-1	20°49,96' 18°59,97'	24.02. 18:30	24.02 /20:00		100-200	-	four calibration tests
19403-2	20°49,82' 18°59,75'	24.02. 20:20	25.02. 09:10	11	100	2	
19404-3	20°51,75' 18°57,71'	25.02. 19:45	26.02. 09:00	13	100	2	camera stop at 01:50
19405-7	20°39,84' 18°17,87'	26.02 /23:05	27.02. 09:00	10	50	2	with ADCP
19406-7	20°29,94' 17°45,00'	27.02. 22:50	28.02. 09:00	10	75	2	with ADCP, camera stop at 03:50

System discription

The DriftCam consists of a Canon EOS 600D DSLR (18 Megapixel resolution) with an EF 50.2 macro-lens connected to a Canon Speedlight 430 EX II flash (Fig. 3.4). Camera and flash were installed each in a POM pressure housing with a depth rating of 500 m. The camera could be programmed by using a Delamax LCD Timer, which allows time lapse exposures at given intervals. The pressure housings for the camera and the flash were mounted inside an aluminium frame and total weight is ~50 kg. The flash was mounted perpendicular to the optical axis of the camera at a distance of 30 cm. Sharp particles were acquired in a sample volume of ca. 100 ml and smallest particle diameter which could be measured was 20 µm.

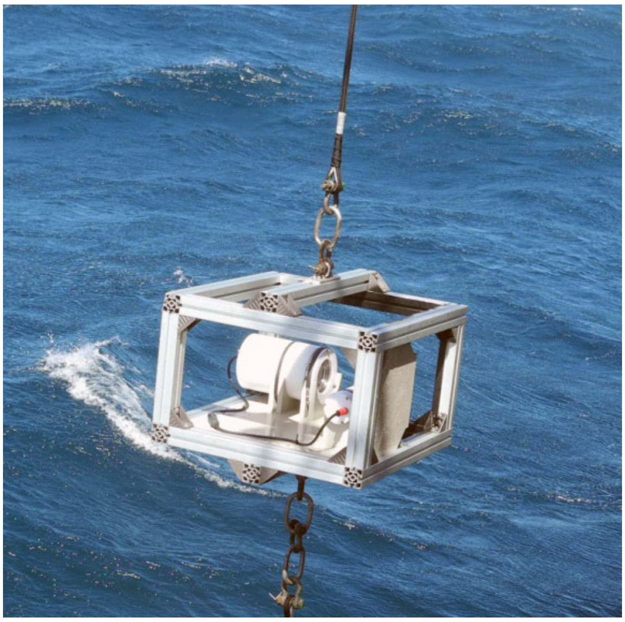
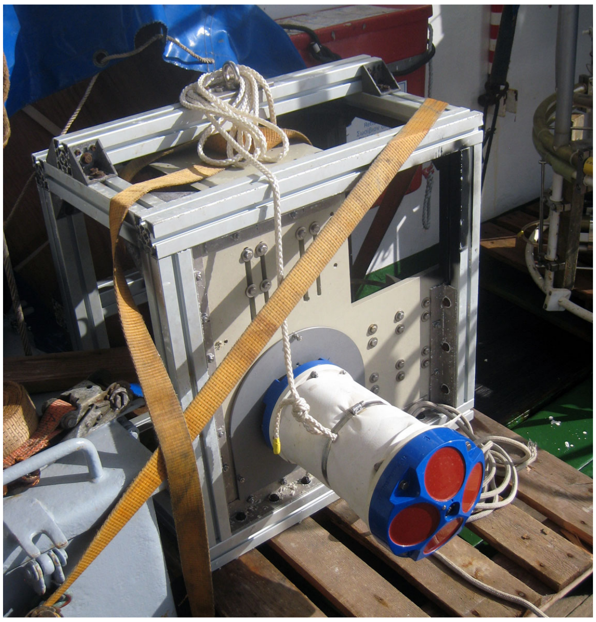



Fig. 3.4 The DriftCam during recovery on R/V Poseidon 481 (left). On the right side, a downward looking ADCP is shown installed during two profiles (Table 3.5).

Preliminary Results

During the cruise, the abundance and the sizes of individual particles were extracted from the pictures by using the image analysis software IMAGEJ. In Figure 3.5., time-series of average particle abundance and the average Equivalent Spherical Diameter (ESD) are shown. The particle abundance is the number of all particles divided by the sample volume, giving the concentration of particles in one litre of seawater. The average ESD is calculated by averaging the diameters of all particles acquired by IMAGEJ.

The particle abundances ranged from 500 n l^{-1} at site GeoB19402-8 to 3300 n l^{-1} at station GeoB19406-7. The four stations located further offshore (GeoB19401-2, GeoB19402-8, GeoB19403-2, GeoB19404-3) were characterised by rather constant abundances at 100 m water depth, ranging between 498 n l^{-1} and 837 n l^{-1}. The abundance pattern showed no clear trends, apart from increases during shorter periods of time. For instance, at site GeoB19401-2, the particle abundance exceeded 2000 n l^{-1} between 1:50 am and 02:40 am on the 22nd of February. Stations GeoB19402-8 and GeoB19404-3 were located at the same geographical position. However, the overnight series at these stations were acquired at a time distance of 2 days. The particle abundance increased from an average particle abundance of 498 n l^{-1} at station GeoB19402-8 to 837 n l^{-1} at site GeoB19404-3. Probably, primary production of particles had increased within the two days, resulting in higher abundances at station GeoB19404-3. The overnight time-series taken at station GeoB19405-7 and GeoB19406-7 were located closer to the coast. Here, particle abundancies were far higher compared to the stations further offshore. GeoB19405-7 showed abundances of 1917 n l^{-1} on average and GeoB19406-7 had values around

3300 n l^{-1}. There might be two reasons for these changes. Firstly, particle abundances were usually higher close to the coast as a direct result of the increased primary production. Secondly, the time series with higher values were acquired at shallower deployment depths, 50 m at station GeoB19405-7 and 75 m at station GeoB19406-7. In general, particle concentrations are lower at subsurface water depths, compared to the uppermost ocean surface.

The particle abundance pattern at station GeoB19405-7, was characterised by a drop in concentration. The decrease from ~ 2000 n l^{-1} to ~800 n l^{-1}, started around 06:00 am on the 27th of February and continued until the device was recovered. By contrast, station GeoB19406-7 shows a continuous increase in the abundance, starting with the deployment at 11:00 pm until 03:50 am, where the camera stopped taking pictures for unknown reasons. These patterns might reflect migrating zooplankton but this requires further investigations.

Compared to the particle abundance, the particle sizes showed little variations at all stations. The average ESD ranged between 151 µm at site GeoB19406-7 and 181 µm at station GeoB19404-3. However, at site GeoB1905-7, the drop in the particle abundance coincided with a decrease in ESD. A remarkable observation was made at station GeoB19406-7. While the particle abundance increased continuously, the average ESD remained constant and appears to be unaffected by the steadily rising particle concentrations. Further examinations on the DriftCam images and the ADCP data will be carried out in the home lab.

ADCP profiles have been taken within two consecutive days to explore the backscattered acoustic signal in regard to zooplankton occurrence in the upper water column (Table 3.5). The 600 KHz ADCP is particular well suited to respond to particles in the size range of ~ 1 mm. The range of the signal is limited to about 50 m and we averaged over a depth range of 4 m. In the first deployment (GeoB19405-7) the ADCP was in a depth of 50 m while on the following day (GeoB19406-7) was at 75 m. In the Fig x. the results of these measurements are shown after a first inspection. During the second deployment, an echo maximum was seen in about 90 m depth during the night time at around 3 AM UTC and a similar maximum - although not that well pronounced - at around 8 AM UTC. The first deployment showed similar echo intensity maxima at similar times. Further examinations of the DriftCam images and the ADCP data will be carried out at the marum.

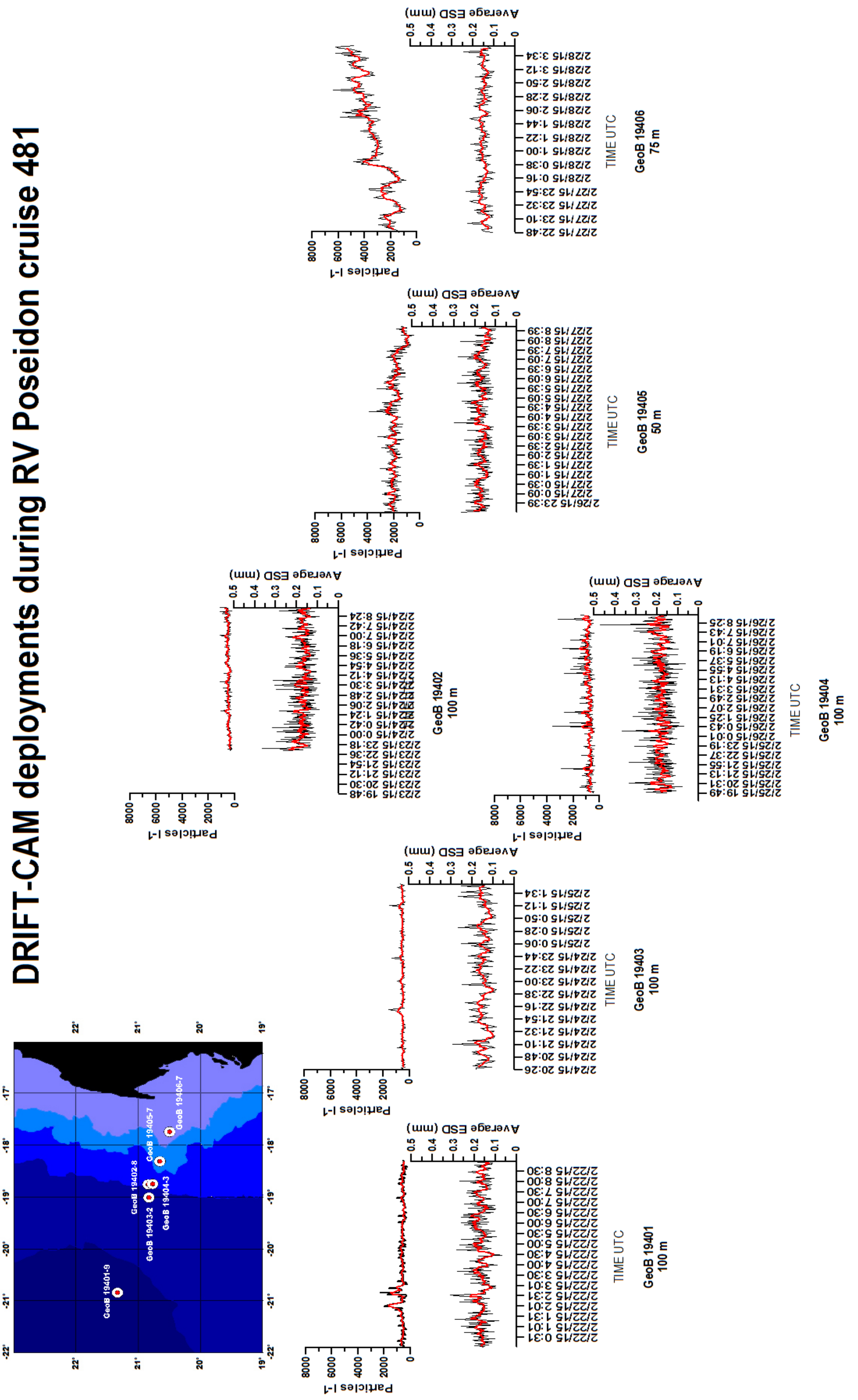
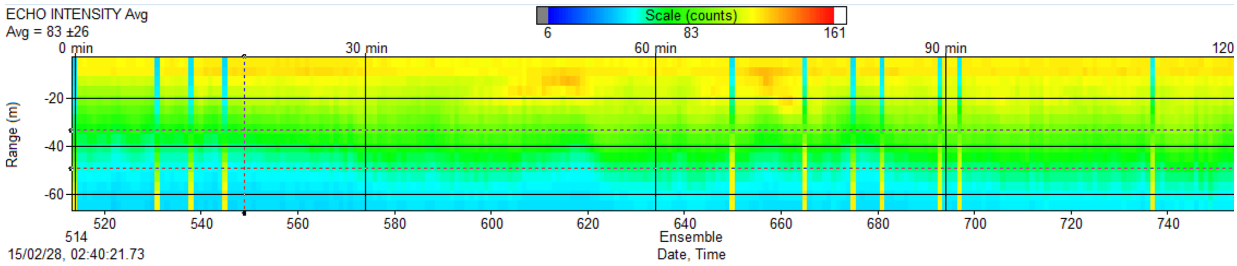


Fig. 3.5 DriftCam positions and time-series data obtained with the DriftCam. Average particle abundance and the average Equivalent Spherical Diameter (ESD) are shown, both plotted against time.



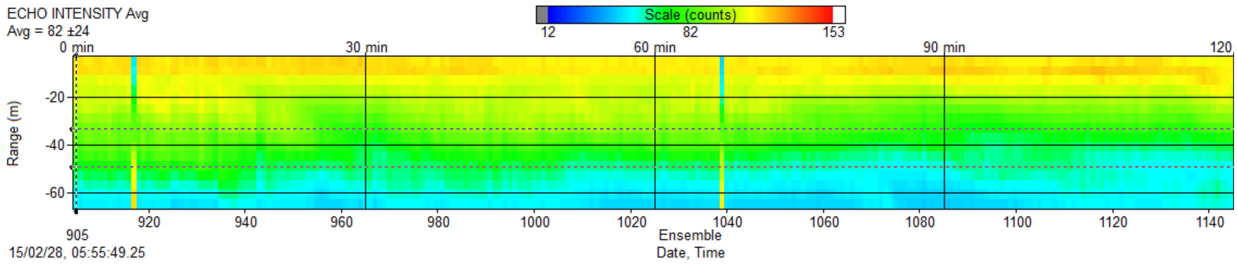


Fig. 3.6 Two cut-outs from the 10 hours time-series of echo intensity from the second deployment of the ADCP (GeoB19406-7) are shown. The ADCP was in 75 water depths (Table x).

3.3.3 Particle studies with the ThorCam

(Thor Markussen, Christian Konrad (not on board) and Morten Iversen)

The camera setup

The ThorCam is equipped with two camera systems for particle measurements, the IRcam and the Pcam (Fig. 3.7).

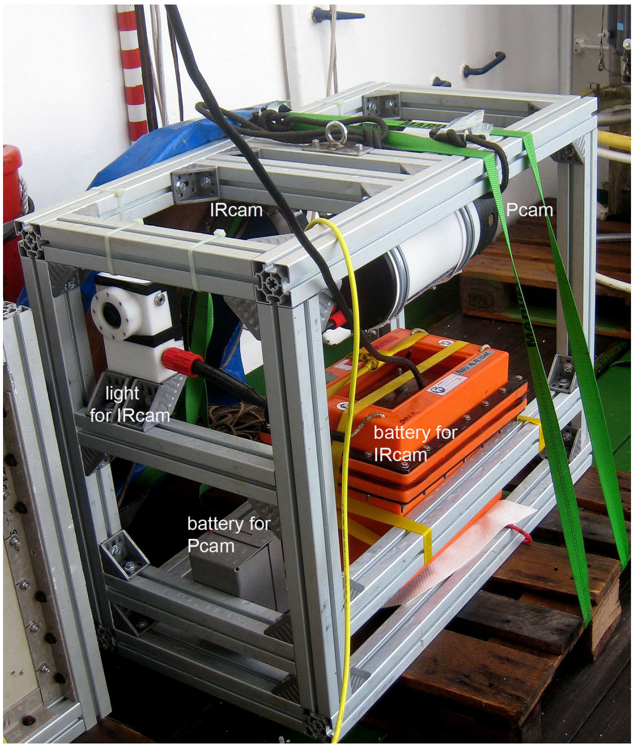


Fig. 3.7 The ThorCam, a combined system with a high resolution particle camera (Pcam) and an infrared camera (IRcam).

The Pcam

The Pcam was designed to measure relatively fine-grained particles (approximate size spectrum from 10-1000 microns) and therefore, the hope was to use this system to show the abundance and characteristics of the smaller particles, e.g. in the nepeloid layers (Karakas et al., 2006) in the research area. The Pcam was initially developed by Christian Winter's group at MARUM, however, the version 2.1, which we used on cruise POS 481, was an updated version that was previously tested and used in estuarine waters in Greenland fjords. The system consisted of a normal consumer DSLR camera, the Canon D70, with a 60 mm Canon EF-S macro lens inside a pressure house with a pressure sensor rated to 300 meters. The camera could be moved back and forth electronically inside the house using a small motor to get the optimal focus of particles in the water column. Particles were illuminated from the side by a collimated, green laser diode, and the illuminated sheet had a thickness of 1 mm with a sensor size of 20x15 mm. Thus, the measuring volume of one picture was only 0.3 ml. Pictures were analyzed with Matlab. The Thorcam setup was used for several vertical profiles in the upper 300 m of the water column as well as for two free-drifting sediment trap deployments at which the ThorCam system was positioned at 100 m water depth (Table 3.6).

The IRcam

The IRcam consisted of an infrared camera (from Bassler) that was connected to a Raspberry Pi. The Raspberry Pi was both used as the operating system for the infrared camera and to acquire the images from the camera and send them to a SSD hard drive where they were stored. The illumination was done with infrared LEDs that were placed in an array in front of the IRcam. The choice of the infrared illumination was done to avoid disturbing the zooplankton that potentially would feed on the settling particles. The IRcam continuously recorded 2 images per second, both when it was deployed as a profiling camera system in the upper 300 m of the water column and when it was deployed in a drifting system (drifting traps DF-11 and DF-12) during approximately 24 hours (Table 3.6).

Due to the small measuring volume, very few particles were seen in individual pictures of both the Pcam and the IRcam, but good trends were visible when the pictures from the Pcam were binned. For the preliminary analyses done during the cruise, the Pcam pictures from the different profiles were binned in groups of 5 and pictures from drifting trap deployments were binned in groups of 10.

Table 3.6 List of stations where the ThorCam was deployed. GeoB station name, date, deployment time, latitude, longitude, total water depth, profiling depth, and drifting trap stations are provided.

Number	GeoB#	Date 2015	Deploy. time at depth UTC	LAT N	LOG W	Water depth m	Profiling depth/ wire length m	Drifting trap#
1	19401-05	21.2.	21.13	21°19.03’	20°50.09’	4173	50	
2	19401-06	21.2	21:54	21°19.01’	20°50.07’	4174	250	
3	19402-02	23.2	15:35	20°47.80’	18°43.49’	2683	100	**DF-11**
4	19402-12	24.2	15:00	20°51.66’	18°41.91’	2622	250	
5	19403-05	25.2	13:35	20°52.44’	18°56.45’	3096	250	
6	19403-07	25.2	19:24	20°46.72’	18°44.33’	2739	50	
7	19404-05	26.2	11:12	20°53.11’	18°44.16’	2779	20	
8	19404-05	26.2	11:33	20°53.24’	18°44.17’	2756	250	
9	19405-01	26.2	16:26	20°40.03’	18°19.99’	1355	250	
10	19405-02	26.2	19:00	20°39.97’	18°19.54’	1345	100	**DF-12**
11	19406-03	27.2	20:36	20°30.03’	17°45.00’	306	295	

Fig. 3.8. shows some examples of particles captured in the water column off Cape Blanc. The green coloration was due to the use of a green laser to illuminate the particles and does not mean that the particles were green. The particles were composed of many different shapes and types of particles.

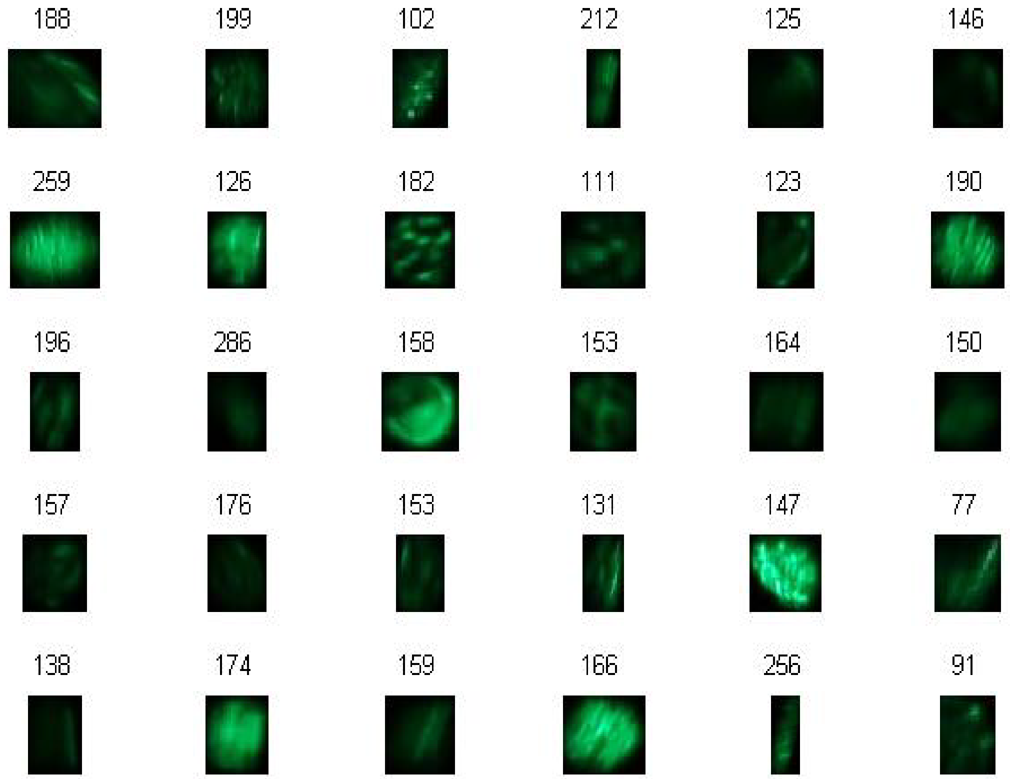


Fig. 3.8 Examples of particles taken over one minute of the GeoB19406-1 profile. The numbers above each picture of a particle shows the Equivalent Spherical Diameter (ESD) in microns.

Preliminary Results

The shapes and sizes of the particles recorded during one profile had large variations, some were very platy, some elongated, some hollow and some appeared to be aggregates of smaller particles. Note, though, that these particles were identified with initial and non-optimized setup parameters and that the MatLab script might have to be updated to get more correct particle characterizations. However, the size distribution (Fig. 3.9) showed a log-normal distribution as is expected from theory. Generally, the particle sizes (calculated as equivalent spherical diameter, ESD) decreased slightly with increasing water depth (Fig. 3.10, left panel). We did not observe any clear changes in particle size between the different sites, however, the particle abundance clearly decreased with increasing distance from the coast (Fig. 3.10, right panel).

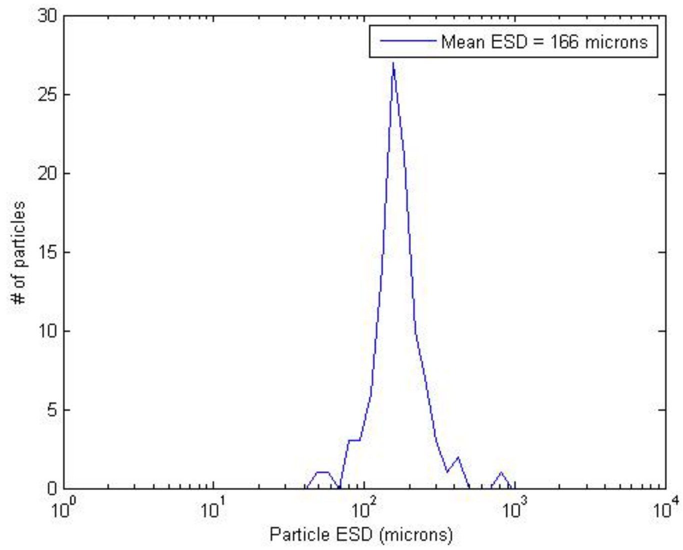


Fig. 3.9 Size distribution of 100 particles. Some of those particles are shown in Fig. 3.10. Mean ESD was 166 µm.

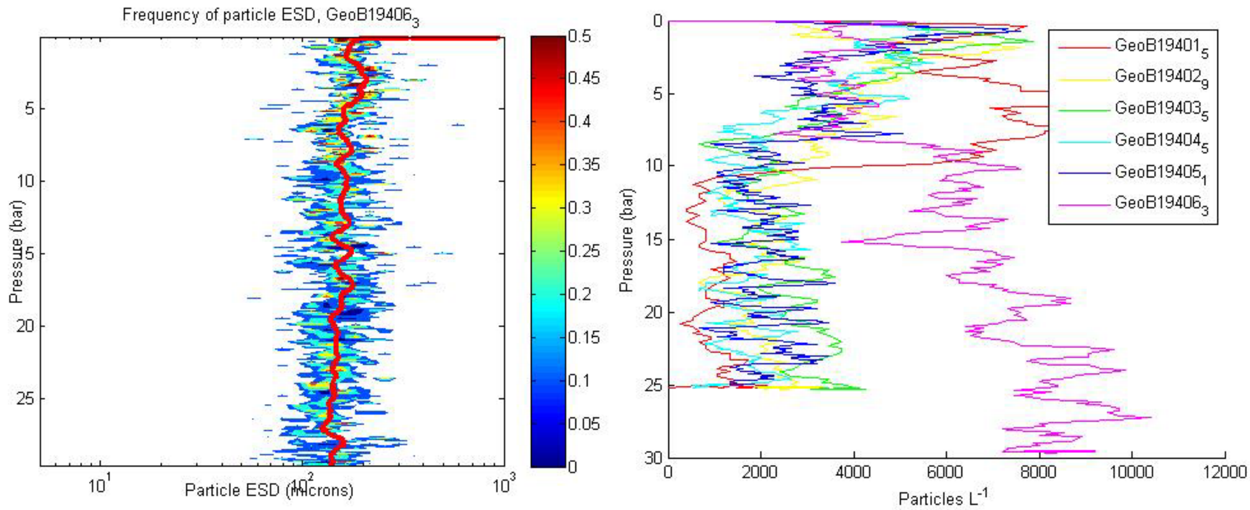


Fig 3.10 Left: Example of change in frequencies of particle ESDs and mean ESD (red line) in a profile from station GeoB19406-3. Right: The amount of particles per liter in all six profiles. Note the large amount of particles at the innermost station GeoB19406-3.

ThorCam deployed on the drifting trap array

The Pcam recorded a change in particle abundance at 100 m depth during the drifting trap DF-12 deployment. From deployment start at around 19:00 and until around 22:00 there was a particle abundance of ~4500 particles per liter of sea water, thereafter the abundance dropped to between 2500 and 3000 particles per liter until 09:00 where the abundance again rose to ~4500 particles per L (Fig. 3.11). It is not possible to say yet what caused this change in particle abundance, but once we have compiled and analysed all the data and samples collected during the cruise, we hope to be able to answer this question.

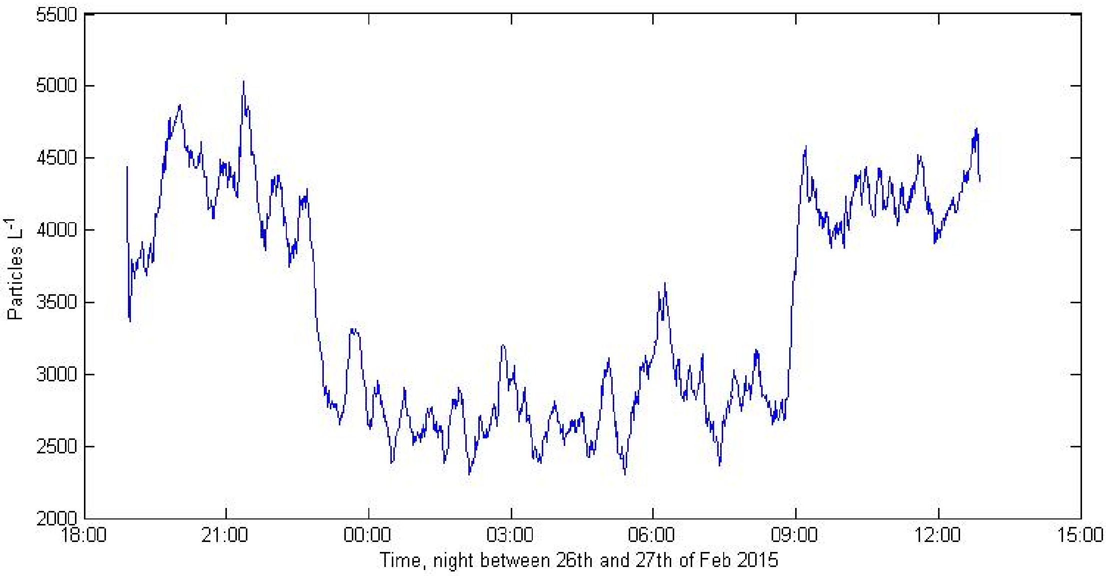


Fig. 3.11 Time series of fine particle concentrations taken with the ThorCam at 100m water depth during DF-12 (Table 3.6 and station list). Note the rather low concentrations during the late night and early morning.

3.3.4 Video records with the Multi-Sensor Platform (MSP)

(Nico Nowald and Götz Ruhland)

The Multi-Sensor Platform (MSP, Fig. 3.12) is part of the eutrophic sediment trap mooring CBi since 2008 and is generally installed in a water depth of around 1100 m. The hexagonal frame is made of glass fibre reinforced plastic and has a height of 2.3 m and a diameter of 1 m. The MSP is equipped with a Sony HDTV video camera that was developed to acquire *in-situ* particle abundances and particle sizes over a period of about one year. The camera system consists of the camera itself and a strobe electronic that triggers the external strobe head. The entire system is powered by a 12V/38 Ah DSPL rechargeable battery. The camera was programmed to record a 20 second video sequence every 3 days between the 30th of May 2014 to the 8th of February 2015. The video sequences were recorded on a MiniDV tape and digitalized as one MPEG file on a PCs harddisk upon recovery. The video camera was removed from the mooring after its recovery and was not redeployed during this cruise as it will be replaced by an improved video system. Data from a time series of particle characteristics derived from a two-years deployment of the MSP camera system were published in Nowald et al. (2015). A detailed description of the whole system of the MSP is provided there as well.

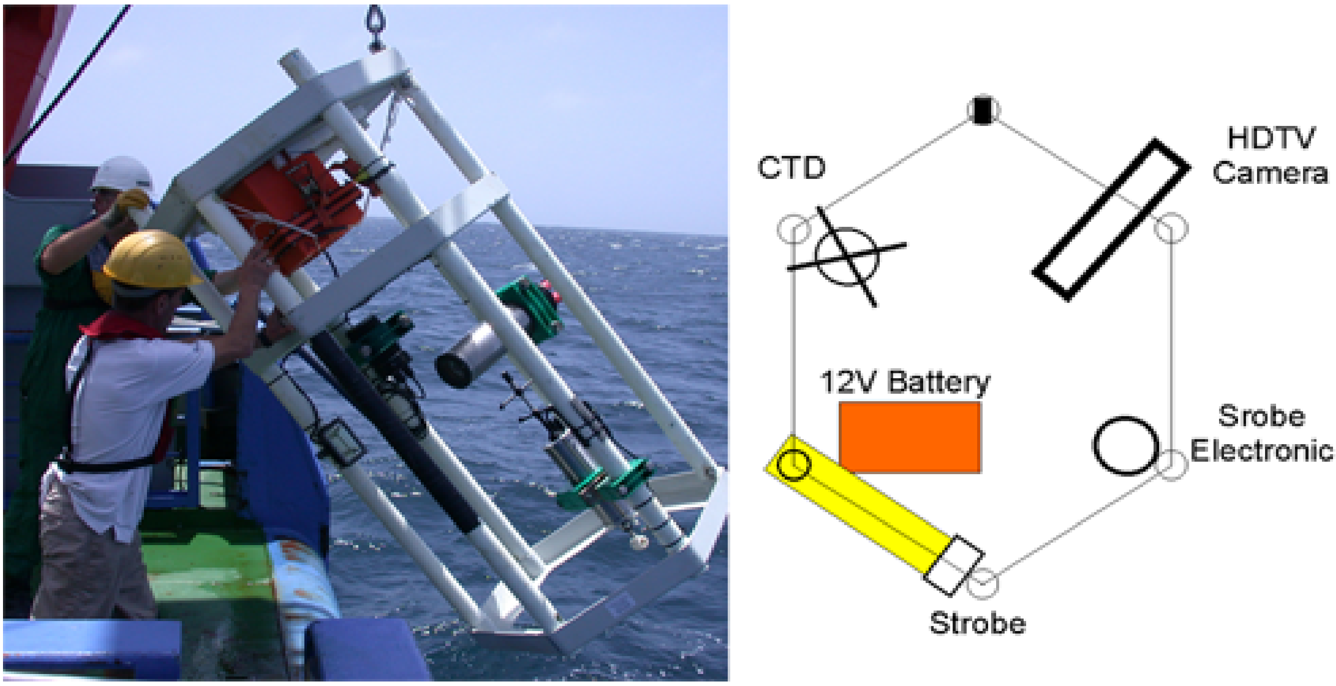


Fig. 3.12 Deployment of the Multi-Sensor Platform (MSP) during a R/V Poseidon cruise (left) in an upside-down position. Top view of the devices installed within the MSP is shown on the right panel.

3.4 Oceanography

3.4.1 CTD-O_2-chlorophyll-fluorescence-turbidity probe (SBE-19)

(Nico Nowald and Gerhard Fischer)

CTD/O_2/chlorophyll-fluorescence-turbidity profiles were taken with a self-contained SBE-19 profiler equipped with a conductivity-temperature-depth probe plus oxygen sensor, a CHELSEA-fluorometer and a WETLAPS turbidity sensor. This CTD was attached to the frame of the ParCa-Pro system. Turbidity profiles acquired along a West-East transect with a SBE19-CTD mounted on the particle camera ParCa (chapter 3.3.1 and Table 3.4) are shown in Fig. 3.13. Unfortunately, no turbidity data are available for station GeoB19401 due to wrong settings of the external voltages in the CTDs configuration. At sites GeoB19403, GeoB19402 and GeoB19405 located further offshore, the nepheloid turbidity unit (NTU) ranged between 0.5 NTU and 0.3 NTU. A rather fast decrease in the turbidity between 50 m and 100 m can be observed at CTD stations GeoB19403 and GeoB19402. Beyond that depth, the turbidity remains rather constant at almost constant values and no intermediate particle layer was seen. However, a small peak at around 2000 m water depth is visible at station GeoB19402. Such patterns were repeatedly observed at the CBi mooring position during previous cruises and appear to be related to the lateral input of material from the shelf areas. Station GeoB19406, located closer to the coast, is characterized by rather constant values around 0.4 NTU which increased slightly with increasing depth.

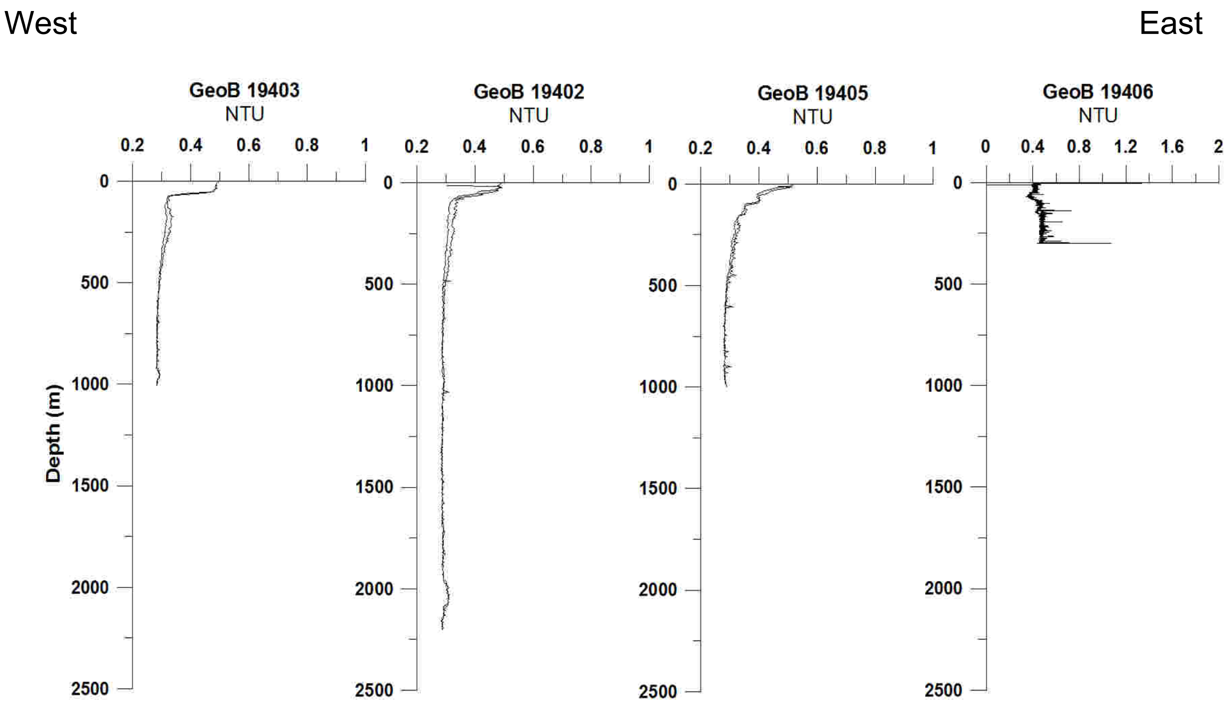


Fig. 3.13 Depth profile of turbidity (NTU = natural turbidity units) acquired along a West-East transect with the SBE 19-CTD.

3.4.2 Rosette with CTD-O_2-chlorophyll-fluorescence-probe (SBE-5) and the Secchi disk

(Morten Iversen, Helga van der Jagt and Thor Markussen)

Background

We recorded six vertical profiles with the shipboard Seabird CTD-SBE-5 (see Table 3.7). The Seabird-CTD was equipped with additional oxygen and fluorescence sensors and mounted on a rosette with 12 Niskin bottles, which each collected 8 litres of water. Water samples were collected on all CTD-Rosette casts, except station GeoB19402-5, and used for incubations in roller tanks to form settling aggregates (see chapter 3.1.1) and for water filtrations to determine the organic (particulate organic carbon and particulate organic nitrogen) and inorganic (lithogenic material) material of the particles through the water column off Cape Blanc. An example of the filters is given in Fig. 3.16. The vertical CTD profiles were obtained along a transect in an offshore direction off Cape Blanc (Fig. 3.14).

Table 3.7 List of CTD-Rosette profiles and sample depths of water taken with Niskin bottles. Water samples were taken for studies of marine snow aggregation and organic and inorganic components of the particular material through the water column.

Station GeoB#	LAT N	LONG W	Water depth m	Water depths of samples m
19401-2	21°18.9'	20°50.34'	4172	6 x 20, 2 x 100, 2 x 500, 2 x 630
19402-5	20°48.1'	18°44.91'	2724	No water samples taken
19402-9	20°52.42	18°41.74'	2627	6 x 30, 2 x 300, 500, 2 x 600
19403-4	20°51.87	18°57.08'	3146	12 x 20
19405-3	20°40.2'	19°19.01'	1352	15, 25, 30, 2 x 50, 70, 80, 90, 100, 150, 200
19406-2	20°30.0'	17°44.95'	305	5 x 20, 45, 69, 102, 126, 152, 221, 300

Preliminary Results

The different water layers were characterized by their temperature and salinity showing vertical density gradients with a pycnocline between 0-300 m depth (Fig. 3.15, left panel). The relatively colder surface water close to the coast off the Mauritanian (~15 °C) indicated the strong upwelling of nutrient rich deep water, which fuelled the primary productivity in the surface water during the cruise. The intense subsurface respiration of the sinking organic matter resulted in the formation of relatively low oxygen concentration between 200 and 600 m water depth close to the continental slope (Fig. 3.15, right panel). We additionally measured the Secchi depth to 9 m at station GeoB19402-3.

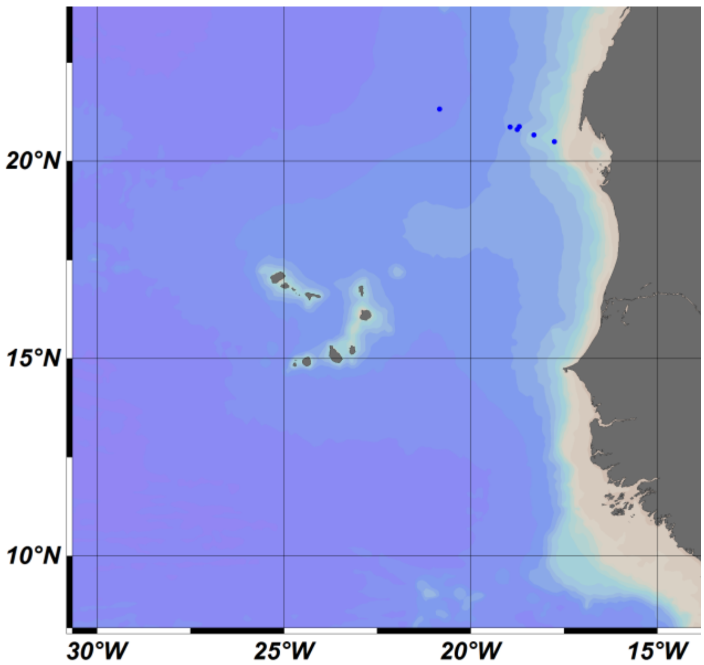


Fig. 3.14 CTD-profiles were obtained along a W-E transect off Cape Blanc, Mauritania. Blue circles indicate the sampling stations.

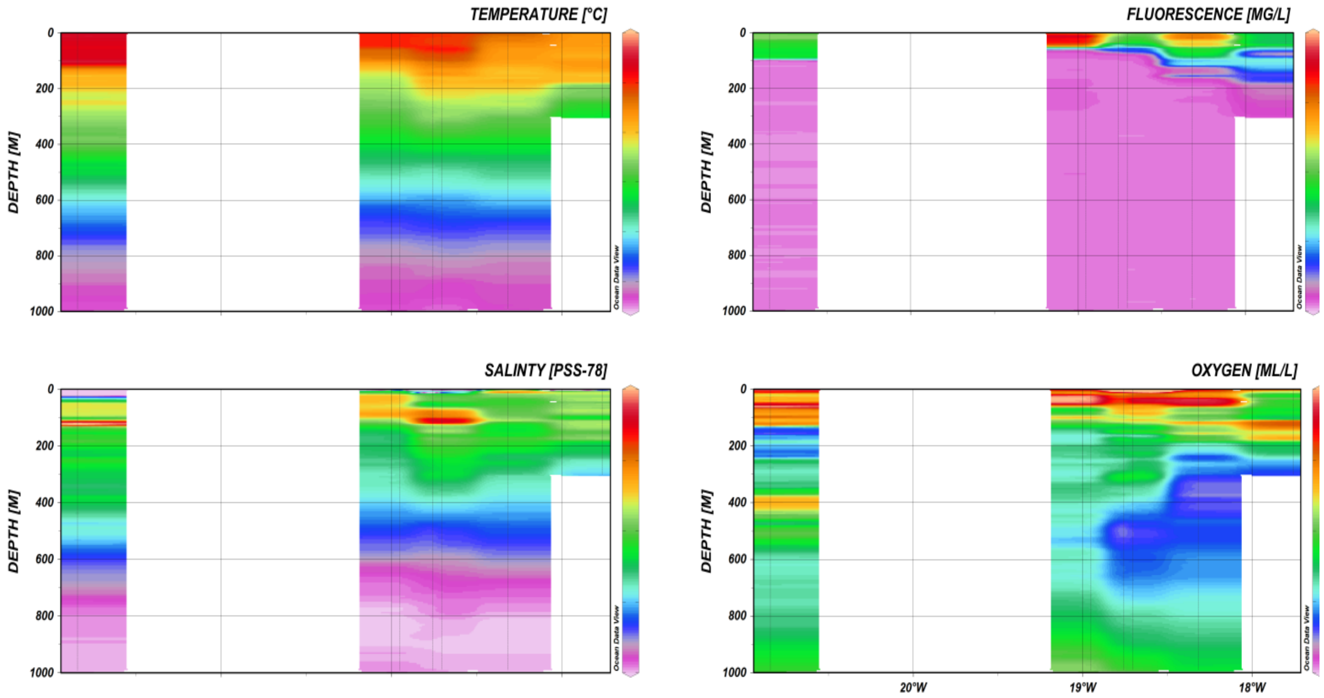


Fig. 3.15 Vertical profiles of temperature, salinity, fluorescence, and oxygen concentrations were measured along an off-shore transect off Cape Blanc (see Fig. 3.14).

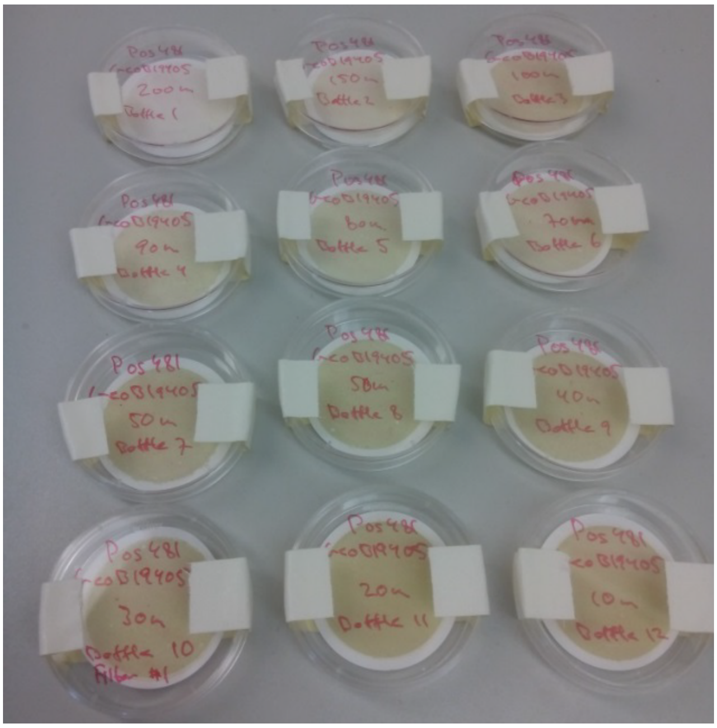


Fig. 3.16 Example of 12 filtered water samples taken from the CTD-Rosette at the station GeoB19405. The depth of sampling is written on each individual filter cap. The colour of the material on the filters clearly indicates high dust concentrations in the water column.

3.5 Marine Geology

3.5.1 Upper ocean particle flux measured with free-drifting particle traps

(*Helga van der Jagt, Nicolas Nowald, and Morten Iversen*)

Background

The export fluxes in the upper 400 m of the water column were collected by free-drifting sediment traps (Figs. 3.17 and 3.18). Two deployments were carried out during the cruise (DF-11 and DF-12, Table 3.8). Each deployment had four cylindrical traps at 150, 200, and 400 m. At each depth three of the four trap cylinders collected bulk fluxes while the fourth cylindrical trap was equipped with a viscous gel that preserved the sinking organic particles in their original shape. The bulk fluxes were preserved after recovery of the traps and will be used to determine mass fluxes of carbon, nitrogen, biogenic opal, calcium carbonate, and lithogenic material. The different particle types collected in the gel were photographed using a digital camera and will be used to create particle size distribution of the flux and to identify transformation processes between the different trap depths.

Table 3.8 Overview of deployment and recovery dates for the two drifting sediment trap deployments DF-11 and DF-12.

Trap name/ GeoB#	Deployment/ Recovery	Lat N	Long W	Time UTC	Equipment
DF-11:					
19402-2	23.02.15	20°47.80’	18°43.49’	15:35	Traps at 150, 200 and 400m
19402-10	24.02.15	20°51.73’	18°42.27’	13:01	ThorCam at 100 m
DF-12:					
19405-2	26.02.15	20°39.97’	18°19.54’	19:00	Traps at 150, 200 and 400m
19405-10	27.02.15	20°34.76’	18°22.48’	13:01	ThorCam at 100 m

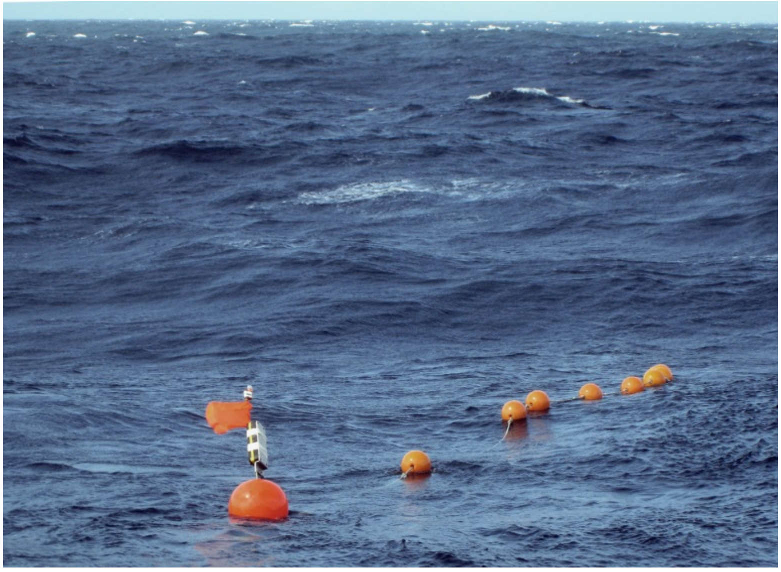


Fig. 3.17 Deployment of the drifting array DF-11. The top buoy with the Iridium satellite unit and the orange small plastic fishery buoys can be seen which are used to damp wave action. Below are three cylindrical traps (Fig. 3.18) and the particle camera system (ThorCam, see Fig. 3.7.).

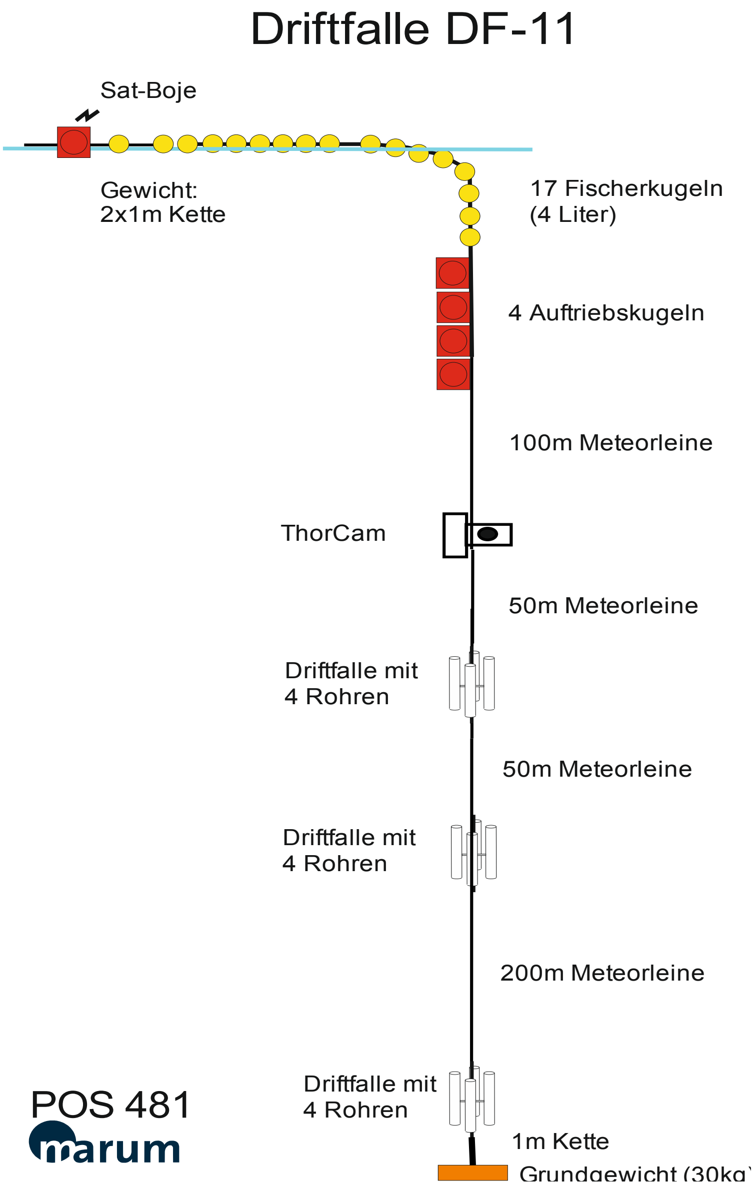


Fig. 3.18 Example of a drifting array deployment during POS 481. The array consisted of the ThorCam in 100 m and three traps in 150, 200 and 400 m water depth. Top satellite buoy with plastic fishery buoys (Fig. 3.17) is shown.

Preliminary Results

Vertical export of organic matter is typically dominated by marine snow aggregates and zooplankton fecal pellets (Figs. 3.1 and 3.19). These particles are degraded by microbes and feed upon by zooplankton while they sink through the water column. However, it is still unclear how these degradation processes influence the efficiency of the biological pump at different seasons and different regions. Grazing on marine snow by zooplankton can have several implications for the vertical flux; e.g. marine snow aggregates can be completely removed by ingestion of whole aggregates. Aggregate size can decrease due to fragmentation and partly ingestion, and the sinking particles can be repacked from marine snow to fecal pellets. Both repackaging and changes in aggregate sizes will change the sinking velocity of the aggregates, either to slower velocities, in case of fragmentation and partly ingestion, or potentially, higher velocities when repackaged into dense fecal pellets. Hereby, the retention time of sinking particles in the upper water column may be strongly influenced by the presence of zooplankton. By investigating the composition of vertical fluxes at different depths in the upper water column, we hope to observe and understand the processes responsible for the transformation and degradation of sinking particles.

A first glimpse into the material collected in the gel traps showed that fecal pellets especially from copepods were common in the exported material but that marine snow aggregates seemed to make up a large part of the exported material as well (Fig. 3.19).

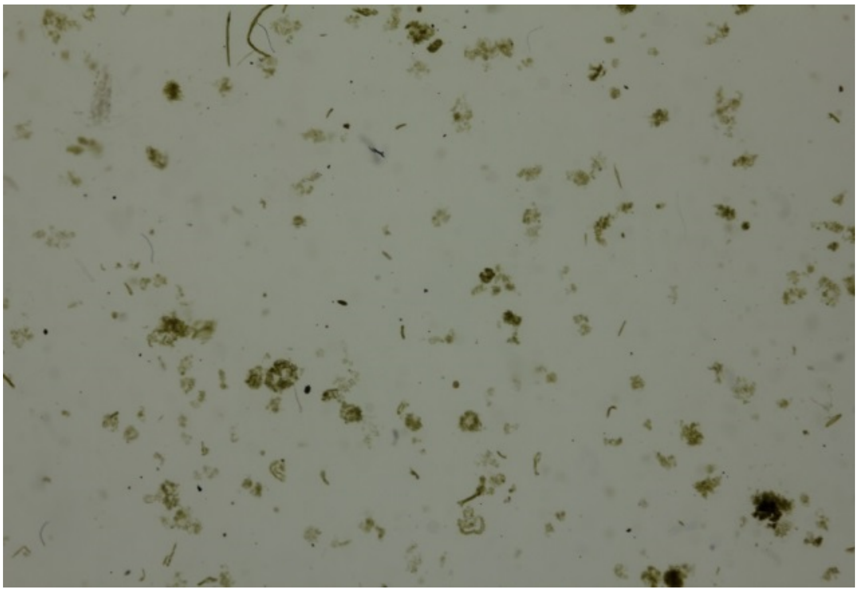


Fig. 3.19 Image taken from the gel-filled cylindrical trap deployed at 150 m during DF-11. The collected material consists both of degraded fecal pellets and marine snow aggregates.

3.5.2 Seasonal particle fluxes measured with moored sediment traps

(Götz Ruhland, Marco Klann Nico Nowald, Sebastian Meckel and Gerhard Fischer)

Background

Meanwhile, we have a long-term mass flux record from the mesotrophic study site CB starting in 1988 and from the eutrophic site CBi from 2003 onwards. Both sites are situated with in the 'giant Cape Blanc filament (Van Camp et al., 1991) and were designed to monitor the long term (intradecadal to decadal) flux variability as well as potential trends in fluxes due to some climatic forcing or anthropogenic issues (e.g. 'Bakun coastal upwelling intensification hypothesis', Bakun, 1990; Cropper et al., 2014). It was planned to recover the mooring CB-25 as first work of the cruise and deploy it again as CB-26 the following day. The mooring position is located about 210 nm off Cape Blanc, Mauritania. Therefore it is located in the outer part of the Cape Blanc filament in about 4150 m water depth. The mooring array is used to monitor the long-term change of particle fluxes in the Mauritanian offshore upwelling zone (Fig. 2.2). Another mooring named CBi-12 was deployed during Poseidon POS-464 cruise around 120 nm further to the east and was also planned to be exchanged too (CBi-12/13) (Figs. 2.1 and 2.2). The data of deployments and recoveries of the moorings are listed in Table 3.9 alongside with the sampling data of the traps.

Preliminary Results

After the transit from Las Palmas, the mooring CB-25 was successfully recovered in the afternoon of February 21st, 2015. It is planned to recover the moorings approximately in February-March 2015. The upper particle trap had not worked due to an unknown malfunction. The lower trap had worked perfectly as scheduled and delivered 19 samples. The sampling carousel was located on the last sample bottle #20 due to earlier recovery. Due to the upside down recovery of the lower trap, the last sample could not be taken. The mooring was redeployed as CB-26 with a similar configuration in the afternoon of the next day (February 22nd, 2015).

In the morning of February 23rd, 2015 the 1500 m long mooring array CBi-12 has been released in the coastal part of the Cape Blanc filament. This mooring was equipped with two particle traps each equipped with a sampling carousel of twenty bottles. Additionally, the so-called Multi-Sensor Platform (MSP) was moored equipped with a video camera to record a time-series of number and size of sinking particles (Nowald et al., 2015). Two sets of sediment trap samples of CBi-12 could be received, each with 20 samples due to the programming schedule of the traps. The video camera had recorded a two month set of video sequences. In the early morning of February 26th, the mooring array CBi-13 could be redeployed with a comparable set of devices, except of the MSP which had been removed for maintenance reasons. It is planned to recover and redeploy these moorings with R/V POSEIDON in winter-spring 2016.

Table 3.93 Data for recoveries and redeployments of the sediment trap mooring arrays.

Mooring	Position	Water Depth (m)	Interval	Instr.	Depth (m)	Intervals (no x days)
Mooring recoveries:						
Cape Blanc mesotrophic:						
CB-25	21°17.8' N	4160	07.02.14-	SMT 243 NE	1214	failed
	20°50.6' W		04.03.15	SMT 234 NE	3622	19 x 19.5d
						recovery 22.1. (#20)
Cape Blanc eutrophic:						
CBi-12	20°46.4' N	2750	14.02.14-	MSP platform	1249	
	18°44.5' W		04.03.15	SMT 234 NE	1356	1 x 12.5d, 19 x 19.5d, recovery 23.1.15 (#20)
				SMT 234 NE	1913	1 x 12.5d, 19 x 19.5d, recovery 23.1.15 8#20)
Mooring deployments:						
Cape Blanc mesotrophic						
CB-26	21°17.3'N	4176	23.02.15-	SMT234NE	1232	20x18d
	20° 51.6'W		18.02.16	SMT234NE	3638	20x18d
Cape Blanc eurtrophic						
CBi-13	20° 53.2'N	2740	27.02.15-	SMT234NE	1346	1x 14d, 19x 18d
	18° 43.9'W		18.02.16	SMT234NE	1903	1x 14d, 19x 18d

Instruments/Devices used:
SMT234 NE = particle trap, KUM, Kiel
SMT243 NE = particle trap (Titanium), KUM, Kiel
MSP platform = platform with video camera and CTD-ADCP

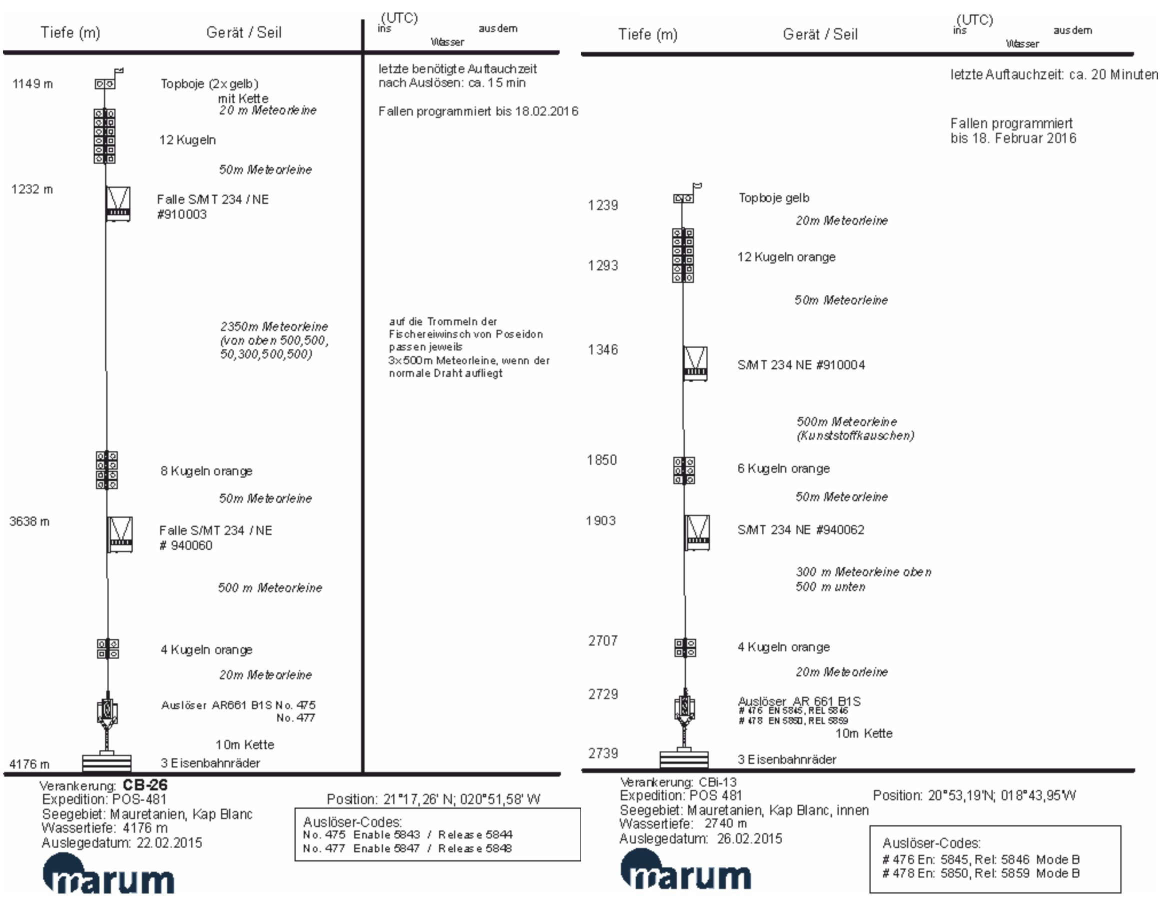


Fig. 3.20 Drawings of the mooring array CB-26 (mesotrophic) and CBi-13 (eutrophic) deployed during the cruise. Recoveries are planned for winter-spring 2016 with R/V POSEIDON.

4 Station List

GeoB#	Ships Stat. No POS481/	Date 2015	Device	Time at seafloor/ max. wire length [UTC]	Latitude N	Longitude W	Water depth [m]	Recovery/Samples/Remarks
19401-1	11/1	22.2.	CB-25	13:50	21°17.78'	20°50.56'	4160	Release and recovery of sediment trap mooring: upper trap failed, lower trap ok, 19 samples, early recovery
19401-2	12/1		ROS - CTD	18:35	21°18.99'	20°50.34'	4172	Down to 1000m: samples 630 (2x), 500 (2x), 100 (2x), 20m (6x)
19401-3	13/1		MSC	19:39	21°19.09'	20°50.14'	4192	Down to 60m
19401-4	14/1		Driftcam	20:36	21°19.07'	20°50.12'	4175	Test down to 100m
19401-5	15/1		ThorCam	21:13	21°19.03'	20°50.09'	4173	Test, down to 50m with cable
19401-6	16/1		ThorCam	21:54	21°19.01'	20°50.07'	4174	Test, down to 250m, 0,5 $msec^{-1}$
19401-7	17/1		HN	22:23	21°18.99'	20°50.02'	4181	Down to 50m, 63µm mesh size
19401-8	18/1		ParCa - CTD	23:13	21°18.97'	20°49.92'	4177	Down to 1000m
19401-9	19/1	22./23.2.	DriftCam	00:00	21°19.04'	20°49.66'	4230	Down to 100m overnight
19401-10	20/1		MN	09:49	21°19.16'	20°49.02'	4172	Down to 1000m: samples in 1000-600, 600-300,300-150,150-80.80-0m
19401-11	21/1		CB-26	15:17	21°17.26'	20°51.58'	4176	Deployment of mooring with two sediment traps
19401-12	22/1		MSC	16:09	21°16.78'	20°52.24'	4166	Down to 60m
19402-01	23/1		CBi-12	09:38	20°46.43'	18°44.53'	2750	Release and recovery of sediment trap mooring: both traps ok, stop at #20, early recovery
19402-02	24/1		DF-11	15:35	20°47.80'	18°43.49'	2683	Start of drifting array: TC in 100, traps in 150, 200, 400m
19402-03	25/1		Secchi disc	16:24	20°47.99'	18°45.07'	2732	Down to 9 meters
19402-04	26/1		MN	17:13	20°48.10'	18°45.03'	2724	Down to 1000m: only net #1+2 due to malfunction
19402-05	27/1		ROS - CTD	18:56	20°48.19'	18°44.91'	2724	Down to 1000m, no water samples taken
19402-06	28/1		HN	19:54	20°48.19'	18°45.01'	2735	Down to 60m
19402-07	29/1		ParCa - CTD	21:35	20°48.32'	18°44.99'	2718	Down to 2200m
19402-08	30/1	23./24.2.	DriftCam	22:51	20°48.55'	18°45.00'	2764	Down to 100m overnight
19402-09	31/1		ROS - CTD	09:35	20°52.42'	18°41.74'	2627	Down to 1000m: samples in 600 (2x),500,300 (2x),30m(6x)
19402-10	32/1		DF-11	13:01	20°51.73'	18°42.27'	2650	Start Recovery of drifting array
19402-11	33/1		MN	14:04	20°51.72'	18°41.94'	2623	Down to 600m: 600-400, 400-300, 300-150, 150-80, 80-0m
19402-12	34/1		ThorCam	15:00	20°51.66'	18°41.91'	2622	Down to 250m: Stops every 50m during upcast
19403-1	35/1		DriftCam	18:32	20°49.93'	18°59.95'	3197	4 Tests DC to 200, 200, 200 and 100m
19403-2	35/2	24./25.2	DriftCam	20:26	20°49.82'	18°59.75'	3180	Down to 100m overnight
19403-3	36/1		ParCa - CTD	10:07	20°51.84'	18°57.30'	3117	ParCa not working
19403-4	37/1		ROS - CTD	11:09	20°51.87'	18°57.08'	3146	Down to 1000m: all bottles closed at 20m
19403-5	38/1		ThorCam	13:35	20°52.44'	18°56.45'	3096	Down to 250m: stops at 250, 200, 150, 100, 80, 70, 60, 50, 40, 30, 20, 10m at upcast
19404-1	39/1		MSC	18:54	20°46.69'	18°44.39'	2679	Down to 60m
19404-2	40/1		ThorCam	19:24	20°46.72'	18°44.33'	2739	Test in 50m
19404-3	41/1	25./26.2	DriftCam	19:48	20°46.80'	18°44.25'	2735	Down to 100m overnight
19404-4	42/1		CBi-13	10:37	20°53.19'	18°43.95'	2740	Deployment with 2 traps, MSP not redeployed
19404-5	43/1		ThorCam		20°47.99'	18°45.07'		Stops in 250, 200, 150, 100, 80, 70, 60, 50, 40, 30, 20, 10m at upcast
19405-1	44/1		ThorCam	16:26	20°40.03'	18°19.99'	1355	3 Tests: Down to 20, 250 and 250m
19405-2	45/1		DF-12	19:00	20°39.97'	18°19.54'	1345	Start of drifting array: TC in 100, traps in 150, 200, 400m
19405-3	46/1		ROS - CTD	19:56	20°40.24'	18°19.01'	1352	Down to 1000m: samples in 200, 150, 100, 90, 80, 70, 50 (2x), 30, 25, 15m
19405-4	47/1		HN	20:50	20°40.22'	18°18.60'	1350	Down to 60m
19405-5	48/1		MN	21:19	20°40.10'	18°18.43'	1335	Down to 600m: 600-400, 400-300, 300-150, 150-80, 80-0m
19405-6	49/1		ParCa - CTD	22:14	20°39.93'	18°18.13'	1321	Down to 1000m, ParCa not working
19405-7	50/1	26./27.2	DriftCam	23:07	20°39.83'	18°17.86'	1311	Down to 50m with downward looking ADCP, overnight
19405-8	51/1		MSC	09:22	20°39.48'	18°17.50'	1285	Down to 100m
19405-9	52/1		MN	10:04	20°39.18'	18°17.57'	1273	Down to 600m: 600-400, 400-300, 300-150, 150-80, 80-0m
19405-10	53/1		DF-12	13:01	20°34.76'	18°22.48'	1275	Start recovery of drifting array
19406-1	54/1		MN	18:49	20°30.09'	17°44.99'	306	Down to 250m: 250-200, 200-150, 150-100, 100-50, 50-0m
19406-2	55/1		ROS - CTD	19:34	20°30.06'	17°44.95'	305	Down to 300m: samples in 300, 221, 152, 126, 102, 69, 45, 20m (5x)
19406-3	56/1		ThorCam	20:36	20°30.03'	17°45.00'	307	Down to 295m, stop at 250, 200, 175, 150, 125, 100, 80, 60, 50, 40, 30, 20, 10m at upcast
19406-4	57/1		ParCa - CTD	21:29	20°29.98'	17°45.01'	307	Down to 296m, ParCa not working
19406-5	58/1		MSC	21:54	20°29.97'	17°44.98'	306	Down to 60m
19406-6	59/1	27./28.2.	HN	22:09	20°29.97'	17°44.97'	306	Down to 50m
19406-7	60/1		DriftCam	22:47	20°29.93'	17°45.00'	304	Down to 75m with downward looking ADCP, overnight

Instruments/Devices used:

CB-25/26, CBi-12/13:	meso- and eutrophic sediment trap moorings off Cape Blanc (Mauritania), final positions of moorings are given,
CBi-12	equipped with the Multi-Sensor-Platform (MSP), with CTD-ADCP
DF-11, 12:	Drifting trap arrays, each with 3 traps in the epi- and mesopelagic (150, 200, 400m) and the ThorCam in 100 m water depth,
ROS - CTD:	Multi-water sampler (rosette) with 12 x 10l bottles and CTD-SBE-3 with ox-chlorophyll-fluorescence sensors (Geomar, Poseidon)
ParCa - CTD:	Particle Camera System with CTD-SBE 19 (No. 2069), with ox-chlorophyll-fluorescence-turbidity sensors
MN:	multinet (5 depth ranges) with 200µm mesh size
HN	handnet (75µm)
Driftcam (DC)	camera system, mainly for overnight measurements of particle characteristics
ThorCam (TC)	camera system with a high resolution particle camera and an infrared camera system for zooplankton
MSC	Marine Snow Catcher with 100 l volume

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