Cruise Report

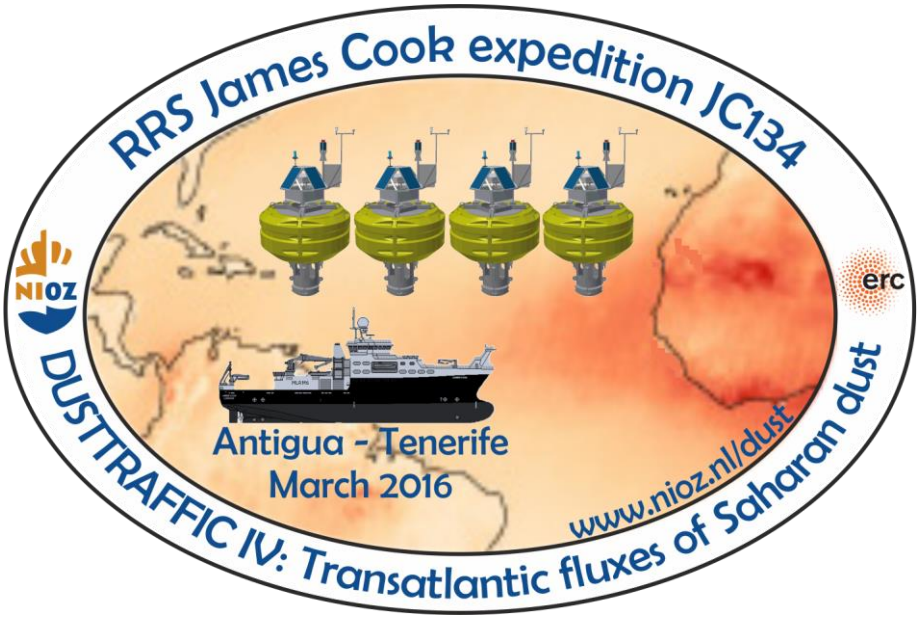
and preliminary results

DUSTTRAFFIC IV: Transatlantic fluxes of Saharan dust

Cruise No. JC134

19 March – 16 April 2016

S^{t} Johns, Antigua – S^{ta} Cruz, Tenerife (Spain)



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1. Summary

RRS James Cook cruise JC134 was dedicated to recover the transatlantic array of instruments that have been collecting Saharan dust at the sea surface as well as in the ocean between Africa and the Caribbean since 2012. The set of instruments was initially deployed during cruise M89 (*FS Meteor*) in October 2012, and serviced during cruises 64PE378 in November 2013, and 64PE395 (both *RV Pelagia*) in January-February 2015. The experiment was carried out in a set of research projects focussing on Saharan dust:

1) TRAFFIC (NWO funded),
2) DUSTTRAFFIC (ERC funded),
3) Mineral aerosols in the Earth system (DFG funded)

The overall aim of these projects is to study the marine-environmental effects of Saharan dust deposition. Modern Saharan dust was monitored along a transatlantic transect between NW Africa and the Caribbean at the 12th parallel using sediment traps and floating dust collectors for three years. In addition, a dust-collecting buoy was deployed off Cape Blanc, Mauritania, where German colleagues from Bremen University have been collecting sediments since the late 1980's and ongoing.

Cruise JC134 was the last one of the (DUST)TRAFFIC projects, but additional funding was received from the German Science Foundation (DFG) to visit the study area with the *FS Meteor* in late summer 2017. Thanks to this ship time, we can carry on with the two moorings M1 and M3 that were positioned east of the mid-Atlantic Ridge. Also the three dust-collecting buoys were re-deployed; buoy Laura was moved from 12°N/49°W to 12°N/23°W.

Royal Research Ship James Cook in the harbour of St John's, Antigua

The mechanical improvements on the buoys that were implemented in 2015 paid off; all filters on the three buoys were intact and contained very nice dust samples. Also the experiment with the KUM traps at stations M1 and M3 worked out well and resulted in high-resolution (11-day) sampling. At station M3, unfortunately two carrousels got stuck due to a mechanical failure. Details of all instruments and moorings can be found in the various appendices.

Due to rough weather, the mooring at Station M4 could not be recovered. Already during the cruise, we received the offer from colleagues from the Max-Planck Institute for Marine Microbiology in Bremen that they are willing to recover this mooring for us in April this year o/b *FS Meteor*. Station M1 was shifted a tick (25nm) to the southeast to international waters. Sample names start with the year in which the majority of the samples were collected.

Table 1.1: Key data of the moorings recovered during JC134

Station	Device	Lat (° '. N)	Lon (° '. W)	Depth (m)
M5	Mooring 15M5	11°59.8180	56°06.747	4630
M4	Buoy Laura	11°57.5849	49°04.721	5103
M3	Mooring 15M3	12°23.628	38°38.069	4615
	Buoy Michelle	12°18.9685	38°45.143	4830
M1	Mooring 14M1	11°59.813	23°00.481	5000
	Mooring 15M1	12°18.968	38°45.142	4830
CB	Buoy Carmen	21°16.099	20°55.562	4200

The sampling scheme of the redeployed sediment-trap carrousels in mooring M3 and buoys Michelle and Laura started synchronously. Station M1 was set up to sample in a four-day interval, in order to study the lunar cycle in foraminiferal reproduction. Buoy Carmen samples synchronously with the Bremen sediment-trap mooring CB27.

Table 1.2: Key data of the moorings re-deployed during JC134

Station	Device	Lat (° '. N)	Lon (° '. W)	Depth (m)	Start date
M3	Mooring 16M3	12°23.887	38°38.228	4665	6 Apr 2016
	Buoy Michelle	12°21.189	38°52.064	4830	6 Apr 2015
M1	Mooring 16M1	11°30.539	22°41.102	5065	18 Apr 2015
	Buoy Laura	11°24.939	22°56.486	5118	6 Apr 2015
CB	Buoy Carmen	21°14.844	20°57.072	4200	26 Apr 2015

We are well aware that this is going to be a tropical cruise!

2. Participants

Table 2.1: Participants of cruise JC134

Name, title	Discipline	Affiliation
Jan-Berend Stuut, Dr	Marine Geology, chief scientist	NIOZ & MARUM
Bert Boekschoten, Prof. em.	Marine Geology, Paleoceanography	VUA
Barry Boersen	Marine Technology	NIOZ
Geert-Jan Brummer, Prof.	Paleoceanography, plankton	NIOZ & VUA
Corina Brussaard, Prof.	Marine Biology, incubations	NIOZ & UvA
Jaap de Boer, MSc.	Paleoceanography, pteropods	NIOZ
Tessa de Bruin	Marine Biology, incubations	UvA
Dirk Jong	Marine Geology, dust	UU
Oliver Knebel	Paleoceanography, plankton	VUA
Kirsten Kooijman	Marine Biology, incubations	NIOZ
Laura Korte, MSc.	Marine Geology, fertilisation	NIOZ
Bob Koster	Marine Geology	NIOZ
Patrick Laan	Marine Geology	NIOZ
Monica Martens	Marine Geology, dust	VUA
Chris Munday, Dr.	Microbiology dust	NIOZ
Anna Noordeloos	Marine Biology, incubations	NIOZ
Franzi Pausch	Marine Biology, fertilisation	AWI
Anne Roepert, MSc.	Paleoceanography, plankton	UU
Toni Rosell-Melé, Dr.	Organic Geochemistry, dust	UAB
Laura Schreuder, MSc.	Organic Geochemistry, dust	NIOZ
Lydia Sevenster, MSc.	High-school teacher	SGH
Michèlle van der Does, MSc.	Marine Geology, sediment traps	NIOZ
Gemma Venhuizen, MSc.	Journalist, PR	Freelance
Catarina Vicente Guerreiro, Dr.	Paleoceanography, plankton	GeoB
Yvo Witte	Marine Technology	NIOZ

NIOZ – Royal Netherlands Institute for Sea Research, Texel, the Netherlands
MARUM – Center for Marine Environmental Sciences, Bremen, Germany
VUA – Vrije Universiteit Amsterdam, the Netherlands
UvA – University of Amsterdam, the Netherlands
AWI – Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany
UU – Utrecht University, the Netherlands
SGH – Stedelijk Gymnasium Haarlem, the Netherlands
GeoB – Faculty of Geology at the University of Bremen, Germany
UAB – Autonomous University of Barcelona, Spain

3. Research program

The main purpose of cruise JC134 was to service the dust-collecting instruments, which were moored between the African continent and the Caribbean, and which were deployed during 64PE395 in January – February 2015 along the 12th northern parallel, as well as at the station off Cape Blanc, Mauritania.

Not only were we interested in the samples that had been collected during the past year, we also wanted to check on- and service the under-water parts of the buoys' moorings.
The instruments that were moored west of the mid-Atlantic ridge were to be recovered and the ones located on the eastern side of the ridge were to be re-deployed again. This meant that buoy Laura was to be re-located from station M4 to station M1.

In addition to harvesting and re-deploying the moorings, we wanted to test the ballasting effect of mineral-dust particles using so-called floating sediment traps.

A third typical aim of this cruise was to carry out incubations with "wet" and "dry" dust to test the hypothesis that dust that has been exposed to atmospheric moisture contains metals that are easier accessible for marine life.

Underway sampling of the upper ocean for all kinds of marine life, including viruses, phytoplankton and zooplankton was a fourth aim of the cruise, in addition to underway sampling of PAHs and (micro-)plastics. Moreover, underway sampling of the atmosphere for mineral dust as well as soot particles was an important target.

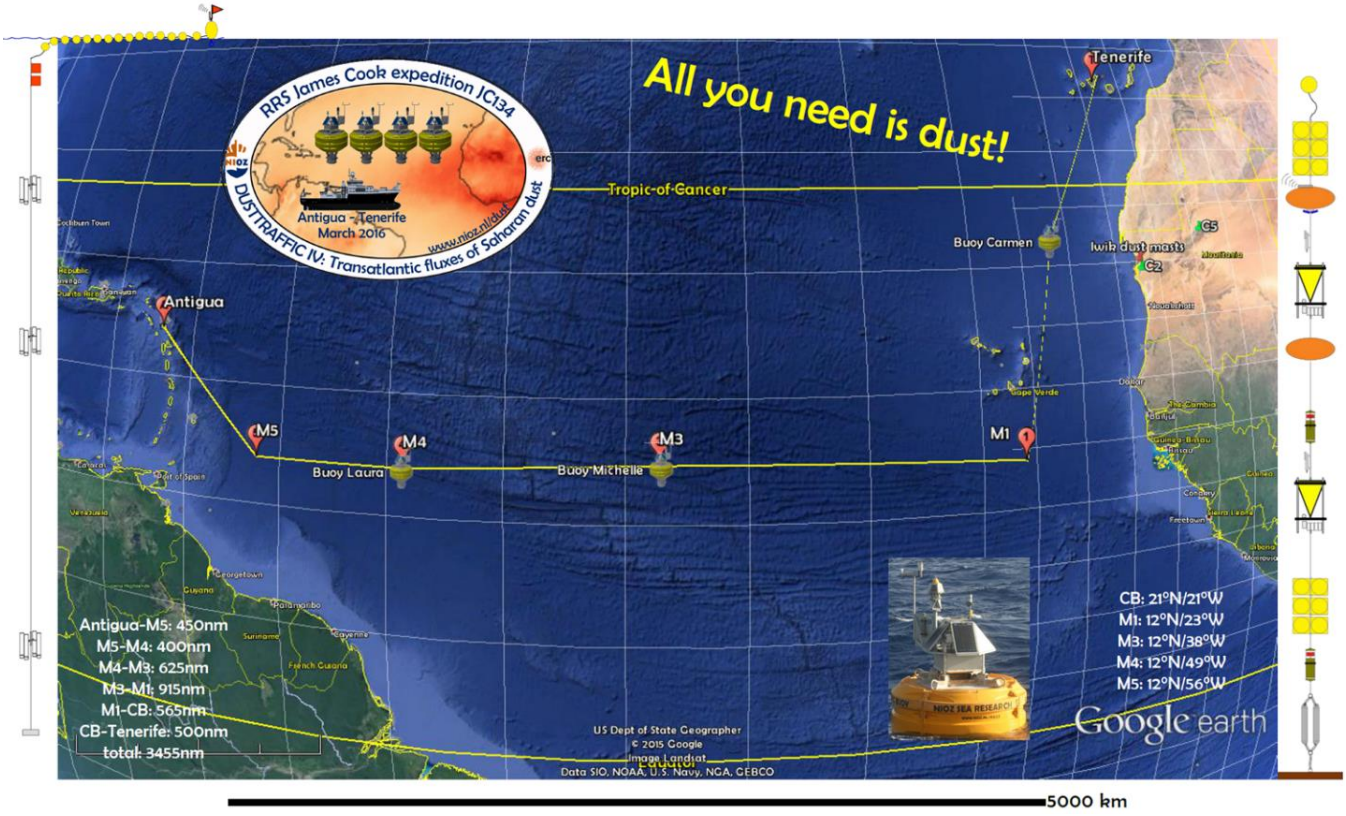


Figure 3.1: Track of RRS James Cook *cruise JC134 with sampling stations.*

4. Narrative of the cruise

On Friday 18 March we are brought to the harbour of St John's, Antigua, where we are getting our passports stamped right in the middle of the hundreds of tourists that are coming down one of the cruise ships. At lunch everybody has made it to the ship and we receive a warm welcome on board by the captain as well as a safety training by the purser. We enjoy our last night on the shore and sleep in our cabins for the first night.

On 19 March 2016 we leave the port of St John's, Antigua

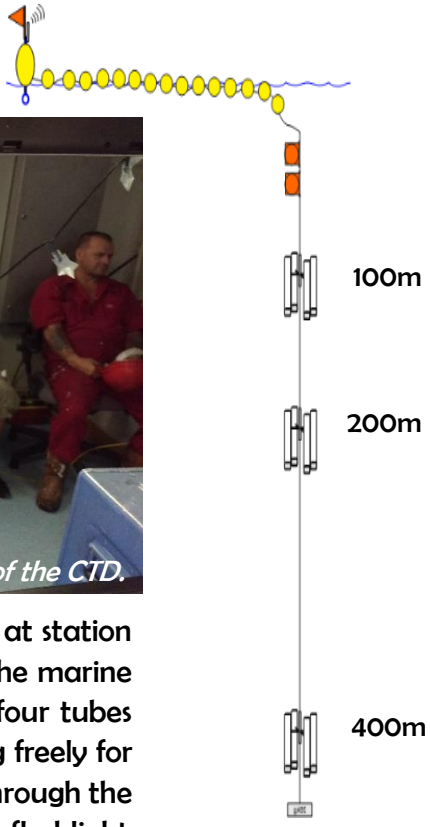
After a luxurious and typical English breakfast (we could and will get used to this!) we leave the harbour on Saturday 19 March to set sail in south-easterly direction, towards station M5. In the evening, the last of the tropical islands (Barbados) drifts by on portside and we enter the Guyana Current, which causes the ship to roll a tick, although everybody is happy how stable the ship is. During the day we do a safety drill, which ends with climbing into one of the lifeboats. In the evening we introduce ourselves to each other and conclude that the large science team (N=25) is very heterogeneous.

We all listen intently to purser Anthony

Also the next day we spend organising ourselves in the labs. We notice first hand that everything needs to be latched securely as we are steaming right into the waves and easterly winds. Thanks to a very stable high-pressure cell at the Azores, we will probably keep this wind (15-25knots) for the coming week. The seawater is a pleasant 27^{0}C and the sun is only occasionally obscured by clouds. The first sample is taken by Toni, who studies PAHs in surface waters. Soon the first dust samples and plankton-pump samples are also collected.
Early in the morning of Monday 21 March we arrive at our first station: M5, where we start with a CTD to 300m. We can clearly see a freshwater lens overlying the saltier Atlantic waters.

This freshwater most likely originates from the Orinoco or Amazon Rivers. Samples are taken by Anna, Corina, Kirsten and Tessa for the viruses, and by Anne and Catarina for coccolithophores and nutrients. In addition, Toni takes samples for PAHs, and Billy for quality control on the salinity sensor. This procedure is repeated at each regular CTD station.

At the first station, everybody is eager to learn the ins & outs of the CTD.

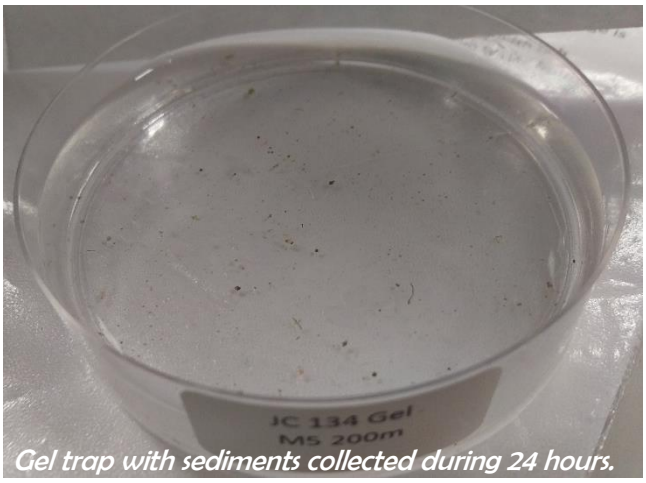


The second piece of equipment that goes into the water at station M5 is the set of drifting traps; this instrument, made by the marine technics department at NIOZ, consists of three levels of four tubes that are open towards the top. They are typically drifting freely for a period of 24 hours and collect material that is settling through the water column. The buoy of these traps is equipped with a flashlight and a GPS/iridium beacon, so that we can find her back. *Figure 4.1: Sketch of drifting traps.*

By noon, the drifting traps have been deployed and we can start with the recovery of mooring 15M5. Contact is made with the releasers of the mooring through the underwater acoustic transducer mounted to the ship. Upon arrival at the mooring site there is immediate bi-directional communication with the releasers and they let us know that they functioned successfully. Within 15 minutes, the upper smartie of the mooring is in sight and the team on deck starts with the recovery, which runs very smoothly. There is one incident where a short piece of cable breaks, leading to the drop of a smartie on deck. Fortunately, there are no injuries and because the smartie was secured, the rest of the mooring can be recovered still.
Just after dinner, we complete the day with a deep CTD (4000m) and a vertical plankton net, with a mesh size of 150µm to 200m.
At $7.^{00}$ in the morning of Tuesday 22 March we start with what is going to be our early-morning routine sequence of four deployments: CTD to 300m, two times a vertical plankton net to 200m, and an hour of fishing with the plastics net at a speed of 1knot (relative to the water).
We conclude station M5 with the recovery of the drifting traps. The positioning of the drifting traps is somewhat problematic as the mails that we get do not always contain a new GPS position. Also, it seems that despite the eastern trades, the drifting traps have moved towards

the east: upwind…. Just before arrival at the guesstimated position, we receive an update on the traps' position and just before lunch, eagle-eyed Chris spots the orange floats.
Despite the absence of significant amounts of dust in the atmosphere, there are considerable amounts of particles and zooplankton to be seen in the drifting traps' tubes.

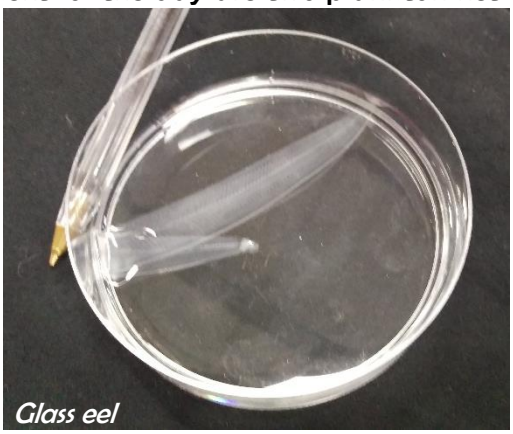

Drifting traps are being recovered.



Gel trap with sediments collected during 24 hours.

After all the gear is on deck and the shifting on the aft deck is completed, we set sail towards the next big station: M4, about 400nm east of station M5 where we arrive in the early evening of Thursday 24 March. During the transit we stop every morning for a daily CTD dip to 300m, two deployments of vertical plankton nets to 200m, and fishing for plastics.
After dinner we deploy the drifting traps about four miles northwest of the buoy's anchor position. Due to some adjustments on the beacon buoy, the antenna is now oriented nicely vertical, hopefully leading to regular updates on the drifting traps' position. Again, despite the easterly winds, the buoy seems to have moved upwind and sits in the northeast corner of the free space that she is allowed to move about in.

We start "Good Friday" (25 March) with a shallow (250m) CTD, followed by another CTD to tap water for the big incubation experiments with dust. For this first attempt at fertilizing the ocean, we take water from the mixed layer, at 20m depth. Next is the recovery of buoy Laura, which we do by attaching a line to the buoy from the aft deck. The 2-3m swell leads to a gentle kiss of the boat so that the top of the air inlet breaks off. Other than this minimal damage, the recovery of the buoy goes really smooth and the gooseneck-barnacle covered buoy is on deck within the hour. All the buoy's filters are intact and quite a few have some orange colouration: dust! In the late afternoon, we sample water with the CTD to 4000m. Unfortunately, we do still not get regular updates from the beacon but the flashlights are more easily spotted and by extrapolating the traps' path further north, we soon have found them and they're on deck by 21.30. The last deployments of the day are two plankton nets and a plastic net. The catch of the day is a glass eel in the plankton net.


Glass eel

We complete station M4 on Saturday 26 March with our daily CTD dip to 300m and a shallow one for the large incubations with dust to 100m. Unfortunately, the wind has freshened to 25-30

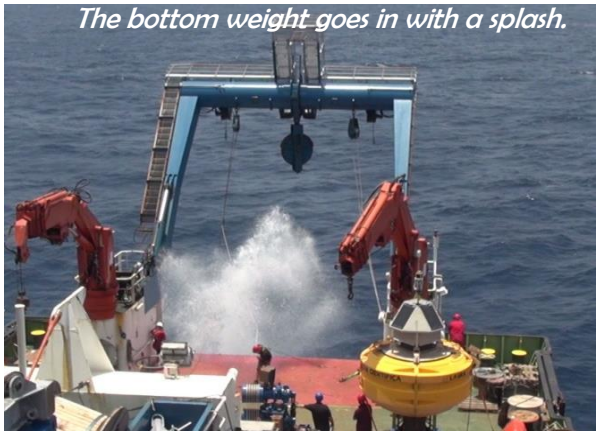
knots and the swell has increased to 3-4m, which is simply too much to recover the moored sediment traps. We take the difficult decision to leave the mooring be and move on toward station M3, which is about 600nm further east.


Laura has spotted "her" buoy

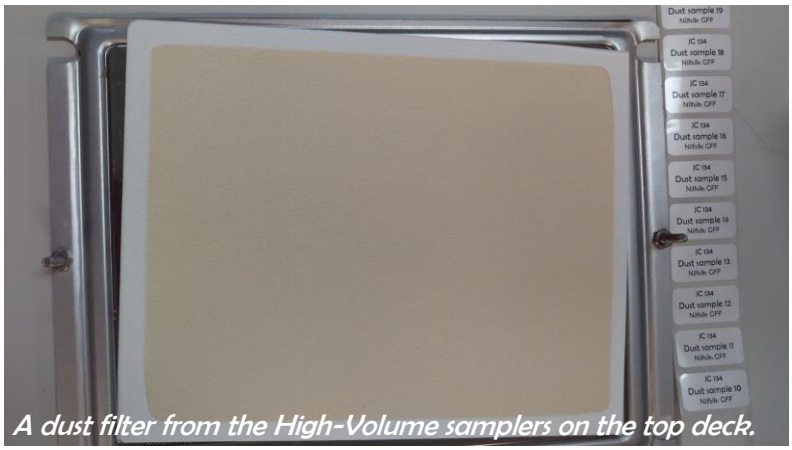

Dust on the buoy's filters

In the early morning of Tuesday 29 March we arrive at station M3 which will be a loooong station, given the recovery of both moored sediment traps and buoy Michelle as well as the re-deployments of both moorings. First thing, like always, is the CTD-300. We decide to re-baptize buoy Laura to Michelle and deploy her first, in order to create some more space on deck. The deployment of buoy Michelle runs really smoothly and takes about 7 hours. The early GoPro watch reports a haze on the horizon, which turns out to be dust! The filters from the High-Volume samplers confirm this; they're nicely coloured in orange tones. For this reason, we decide to adapt the depths at which we normally sample (100, 200, 400m) to 35, 75, and 175m, respectively. These depths allow insight into the settling speed of the dust and accompanying marine snow as a consequence of this dust event. 75m corresponds to the DCM, as seen in the CTD cast at 7.^{00}. To collect water for the new sediment traps as well as for processing the recovered traps at home, we deploy the CTD to 4000m. The day is then concluded with two short dips of the plankton net and one hour of fishing with the plastics net.

Before the daily CTD cast at 7.^{00} in the morning of Wednesday 30 March, we pick up the drifting traps after they've been out there for almost 14 hours. Thanks to the dust event there is still enough material in them. We collect water for the incubation experiments that Laura and her team are carrying out. The waters that will be incubated are from 85m (DCM) and from 20m (mixed layer). Following this, we recover mooring 15M3, which is equipped with two KUM traps with 40 bottles. In the upper trap only the lower carrousel has rotated, the upper carrousel got stuck in between the 4th and 5th bottle. The lower trap malfunctioned as well; the lower carrousel got stuck between the 3rd and 4th bottle. The recovery runs very smoothly; within 5 hours all material is on deck. We continue directly with the deployment of mooring 16M3 at 15.^{00}, which is finished with a big splash of the anchor just before dinner. To be sure where exactly the anchor has landed on the seafloor, we carry out a triangulation. The day is concluded with two plankton-net deployments.


The bottom weight goes in with a splash.

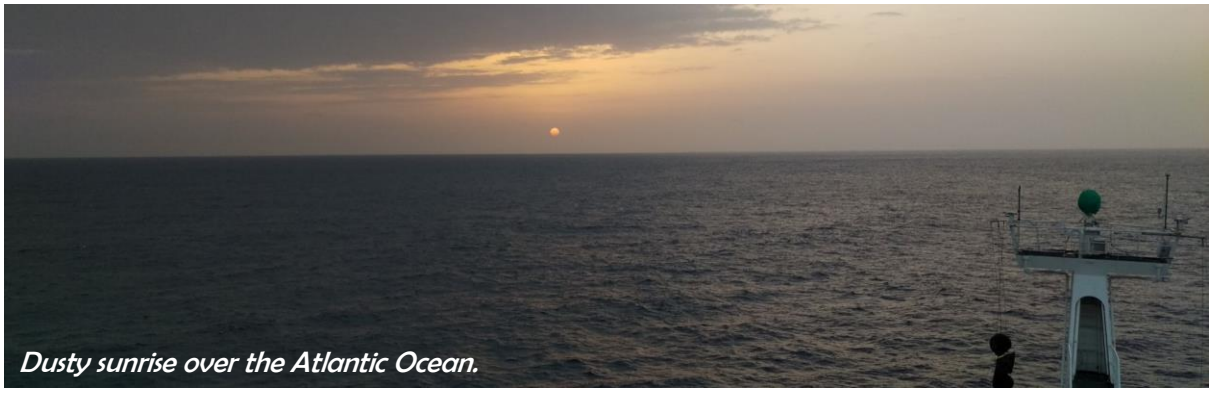
Before recovering buoy Michelle, we start Thursday 31 March with our daily CTD-dip to 300m. The recovery of the buoy has a rather difficult start, thanks to the 2-3m swell but Captain John Leask manages to "park" the ship nicely next to the buoy so that bosun John and Yvo and Barry can hook up the buoy and hoist her on deck. Just after lunch, the releasers are recovered and this station is completed. It turns out that also the filters from this buoy are all intact and they contain considerable more dust than those on buoy Laura. This obviously has to do with the more proximal location of buoy Michelle. We sail on towards station M1.



A dust filter from the High-Volume samplers on the top deck.

On Friday 1 April we limit the deployments of instruments to our daily CTD dip at 7.^{00}, followed by a plankton-net deployment. This will be the routine for the next few days. In the labs, Anna and Kirsten happily continue with their daily microbiological analyses. Laura and her team in the wet lab continue the large incubation experiments, where so-called dry- and wet-dust is added to the 6-liter bottles of sea water. It is decided to carry out one additional experiment, to get a better grip on the pH and also to have a closer look at the influence of varying amounts of dust additions.

On Sunday 3 April we are approaching the Cape Verde EEZ, in which we don't have permission to work yet. Therefore, we sample water to prepare the sediment traps that are going to be deployed at station M1 with a deep CTD to 4000m in the afternoon.
As the permission to work in the EEZ has not been received yet, we do our morning dip of CTD and plankton on Monday 4 April in international waters, just west of the Cape Verde 200 miles zone. Afterwards, we continue our course towards station M1, which takes us into the Cape Verde EEZ.


Dusty sunrise over the Atlantic Ocean.

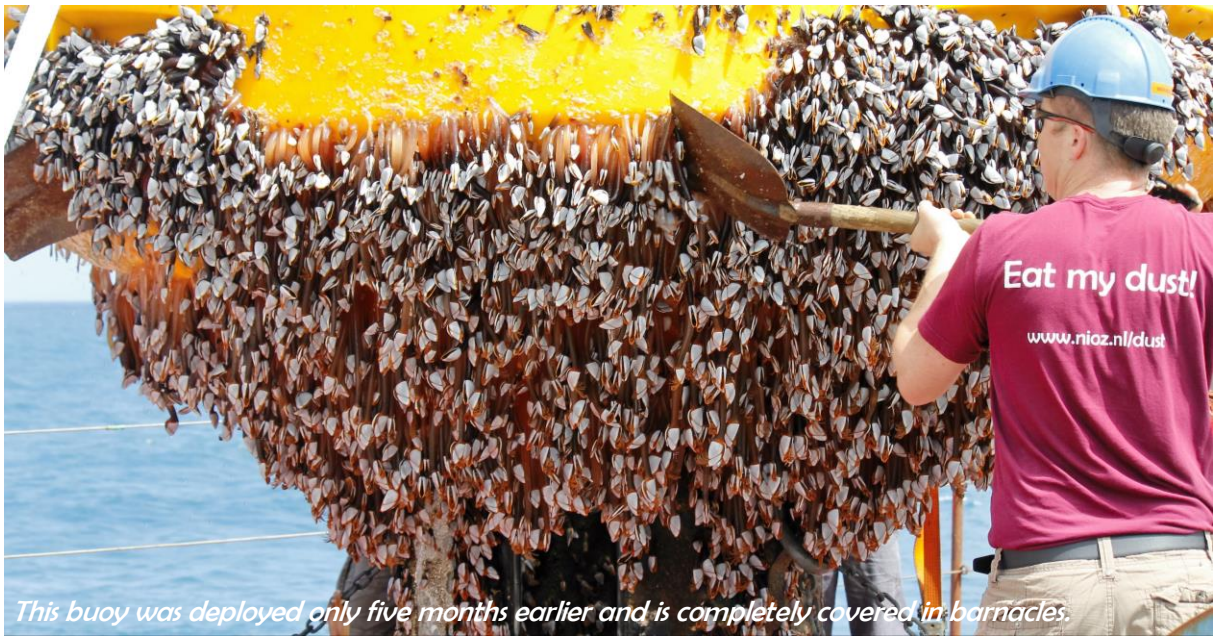
On Tuesday 5 April we have traversed the Cape Verde 200 miles zone and are now outside, just southeast of the original mooring position M1. We decide to deploy buoy Laura here, after the deployment of a shallow CTD, and taking into account the position of a nearby NOAA buoy as well as a number of telephone cables that the captain found on the bathymetric map. After contacting colleagues of the National Fisheries Institute in Mindelo, Sao Vicente, we learn that there have been elections in Cape Verde and the whole government is being renewed. This probably means that there is not a lot of attention for such minor things as scientists wanting to recover their instruments. We decide to wait and do some more fishing for plankton and plastics as well as bathymetric surveying. We continue this routine until Thursday 7 April, when we get clearance from the office in Southampton to recover the moorings. In the morning we first deploy the drifting traps, just outside the Cape Verde EEZ. After lunch we start recovering the old mooring 14M1, of which we know that the cable strength may be below 1 Ton. Very carefully the men on deck manage to get the whole mooring on deck, including the sediment trap that also contains material!! At 16.^{00} we start the recovery of the second mooring, which was deployed in 2015 and which is an exciting one as well because it contains two KUM traps that have sampled in high resolution but with half the collecting surface; will it have resulted in enough material? Also this mooring is recovered successfully and what's more; the KUM traps have worked fine and almost of all the cups contain material! In the upper trap something may have clogged the funnel; one cup is full-to-the-brim. After a very successful day we steam back towards the position that we selected for deployment of the new mooring, just outside Cape Verde's EEZ.

All hands on the bridge to look out for the floats!

Friday 8 April starts with our daily routine of the 7.^{00} CTD, followed by the pick-up of the drifting traps. The new mooring 16M1 will be used to study the lunar cycle in foraminifers that has been hypothesised but never demonstrated. To this end, the sampling interval needs to be fairly high: four days. Initially, we planned to have four KUM traps in series but the experiences gained during our present cruise dictate that this is simply not feasible and would result in too high strain on the cable. We adapt and deploy three traps instead, which still enables us to sample in high resolution. On programming the traps it appears that the software does not allow programming the traps so far in advance. A phone call with the traps' manufacturer in Kiel (on Friday afternoon) suffices to get a new version of the software and we can carry on. Shortly after 17.^{00} the mooring's anchor is dropped and we finalise this

station with a plastics-net tow and a triangulation to determine the final position of the mooring's anchor. In the early evening we enter territorial waters of Cape Verde again for our passage north towards buoy Carmen at ~21N/21W, where we'll arrive in the early morning of Monday 11 April. On this transit we do not deploy any instruments as there is still uncertainty about the dipclear.

On Monday 11 April at 10.^{00} we see buoy Carmen and by 11.^{00} she's standing safely on deck, covered in a thick blanket of gooseneck barnacles! Weather conditions are very smooth with a 2-m swell and very little wind. The releasers do not confirm release but at 12.^{30} we see the smartie surface. At around 15.^{00} the whole mooring is on deck. Next deployment is the drifting traps, followed by a CTD to 300m, two plankton nets and a tow of the plastics net.



This buoy was deployed only five months earlier and is completely covered in barnacles.

On Tuesday 12 April we sample our last routine CTD to 300m but which looks like a completely different profile than the day before. Probably yesterday we were still inside an upwelling filament. Today we're clearly outside..... We continue at 7.^{30} with the deployment of buoy Carmen, which goes really smoothly; at 11.^{30} the anchor goes in with a big splash. After lunch we pick up the dummy buoy and by 13.^{30} buoy Carmen is in the water for another year of dust sampling. At 14.^{45} the drifting traps have been found and recovered and we set sail towards Tenerife, where we'll arrive on Friday 15 April. Our last deployment is a tow with the plastics net, just before entering the EEZ of Western Sahara. Only the biologists are still working on their short incubations and the on-deck incubations with dust are being continued for two more days. In addition, dust collection is continued as well as sampling of surface water with the plankton pump.

This last cruise of a series of five was an expedition we will not soon forget, thanks to the excellent communication and collaboration with Master John Leask and his entire crew. Every member of the ship's crew did their utmost best to make our chaotic lives easy and make us feel at home. We achieved all our goals and more, and experienced a working environment which was both very professional and good fun. For this, I thank everybody cordially!

16 April, S^{ta} Cruz, Tenerife, Spain

Jan-Berend Stuut

5. Preliminary results

5.1 Underway sampling

5.1.1 Aerosol sampling [Laura Schreuder, Monica Martens, Toni Rosell-Melé]

Studying mineral dust sampled with filters on board *RRS James Cook* allows gathering important information with respect to the modern composition of mineral dust as well as its origin, transport and depositional mechanisms. Understanding modern mineral dust composition, mobilization and involvement in feedback mechanisms is not only required in order to provide data for climate models but also to aid interpreting dust deposits in marine paleo-environmental sediment core records with respect to past climate reconstructions. Microbiological analysis also allows investigation into the bacterial-community composition of the transported dust and scan for any species of human or agricultural interest. Also, the dust samples are analyzed from biomarkers and soot particles from fires in equatorial West Africa that are transported over the North Atlantic.

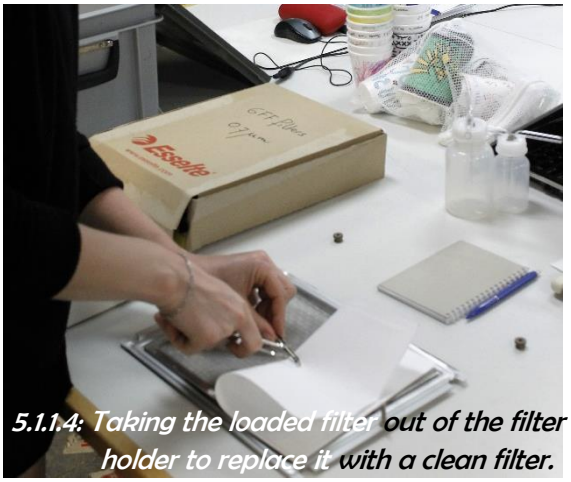
5.1.1.1: Three High-Volume dust collectors on the bridge.

Aerosol sampling was performed with two Anderson high-volume dust collectors mounted on the deck above the bridge of the ship (Photo 5.1.1.1 and 5.1.1.2). Each collector contains a motor which sucks air through an air filter, covered with a rain cover. A logger on each collector monitors the volume of air collected, and increases the suction when the filter gets loaded with material to maintain constant air flow. Each of these two samplers contains a filter made from different material; glass fiber (GF/F) and cellulose acetate (CA), allowing for multiple analyses. The glass fiber filters were muffled at the NIOZ and separately stored in muffled aluminum foil, and will be used to analyze biomarkers and soot particles. The cellulose acetate filters will be used to analyze chemical composition and grain-size distributions. GF/F filters were stored at -20°C, while CA filters were stored at room temperature.

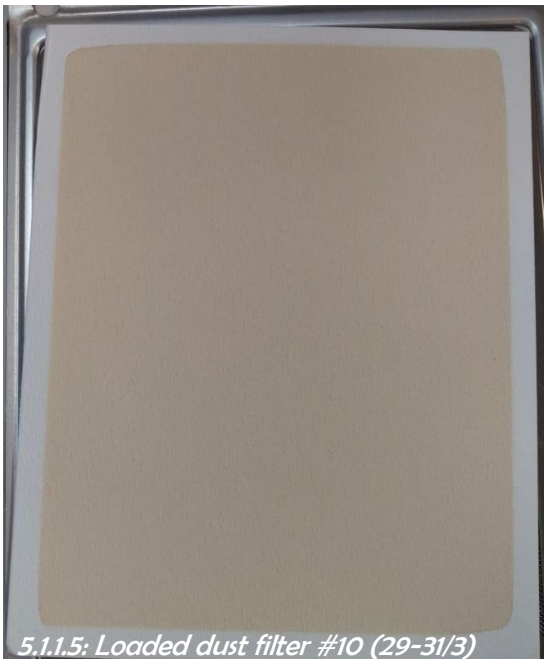
All filters were sampling for approximately 24 hours, after which they were taken out of the dust collector together with the filter holder (Photo 5.1.1.3) and taken down to the lab to exchange it for a clean filter (Photo 5.1.1.4).

5.1.1.2: The inside of one of the dust collectors, where the dust filter can be seen.

5.1.1.3: Taking the filter holder out of the dust collector.



5.1.1.4: Taking the loaded filter out of the filter holder to replace it with a clean filter.



5.1.1.5: Loaded dust filter #10 (29-31/3)

From 29-31 March we encountered a dust event, resulting in clearly visible orange-colored dust on the filters (Photo 5.1.1.5). We found the same coloration of the filters on the 9th and 10th of April. The rest of the filters were not so clearly filled with dust (Photo 5.1.1.6).

5.1.1.6: Less-loaded dust filter #23 (11-12/4)

Table 5.1.1.1 Aerosol samples collected with the High-Volume samplers

Nr	Date	Lat	Lon	Date	Lat	Lon	Time (min)
1	19/3	16°48'	61°33	20/3	14°15.7	58°29	1398.2
2	20/3	14°15.7	58°29	21/3	11°59.8	56°07.1	1417.4
3	21/3	11°59.8	56°07.1	22/3	11°56.9	56°02.2	1380.4
4	22/3	11°56.9	56°02.2	24/3	11°58.1	50°34.3	1613
5	24/3	11°58.1	50°34.3	25/3	11°58.1	49°04.4	1427.8
6	25/3	11°58.1	49°04.4	26/3	11°58.3	48°50.8	1300
7	26/3	11°58.3	48°50.8	27/3	12°04.8	45°38.2	1396.4
8	27/3	12°04.8	45°38.2	28/3	12°12.8	42°07.4	709.4
9	28/3	12°12.8	42°07.4	29/3	12°20.7	38°52.9	1409
10	29/3	12°20.7	38°52.9	30/3	12°23.6	38°38.0	1167.5
11	30/3	12°23.6	38°38.0	31/3	12°19.27	38°43.7	1329.3
12	31/3	12°19.27	38°43.7	1/4	12°16.73	36°20.34	1324.6
13	1/4	12°16.73	36°20.34	2/4	12°14.05	33°09.0	1396.5
14	2/4	12°14.05	33°09.0	3/4	12°10.616	29°38.550	1471.7
15	3/4	12°10.616	29°38.550	4/4	12°08.41	26°51.20	1277.1
16	4/4	12°08.41	26°51.20	5/4	11°22.01	22°58.43	1111.9
17	5/4	11°22.01	22°58.43	6/4	11°35.43	22°36.04	1275.5
18	6/4	11°35.43	22°36.04	7/4	11°59.71	23°0.72	1161.2
19	7/4	11°59.71	23°0.72	8/4	11°30.51	22°43.28	1118.8
20	8/4	11°30.51	22°43.28	9/4	14°1.16	22°16.52	1341.1
21	9/4	14°1.16	22°16.52	10/4	17°40.04	22°16.52	1355.6
22	10/4	17°40.04	22°16.52	11/4	21°16.25	20°55.90	1400.5
23	11/4	21°16.25	20°55.90	12/4	21°14.84	20°57.07	1325.0
24	12/4	21°14.84	21°14.84	13/4	23°40.75	20°1.60	1371.4
25	13/4	23°40.75	20°1.60	14/4	26°15.74	18°0.72	246.6
26	14/4	26°15.74	18°0.72	15/4	28°12.54	16°19.54	
27	14/4	26°15.74	18°0.72	15/4	28°12.54	16°19.54	1160.3

Air sampling was also carried out with a high volume cascade impactor (multi-stage particulate size fractionator; Tisch TE-235), placed on a Tisch TE-1123 high volume sampler, with a flow of ca. 40 scfm.
The impactor has five stages, each with a slotted substrate (glass fiber filter, pre-weighted), with the following cut off (in microns):

Stage 1: 7.2 to infinite

Stage 2: 3.0 to 7.2

Stage 3: 1.5 to 3.0

Stage 4: 0.95 to 1.5

Stage 5: 0.49 to 0.95

On the base plate, there is a glass fiber filter (8" x 10", pre-weighted) which collects particles <0.49 μm. Samples were collected as follows:

Table 5.1.1.2 Aerosol samples collected with the cascade impactor

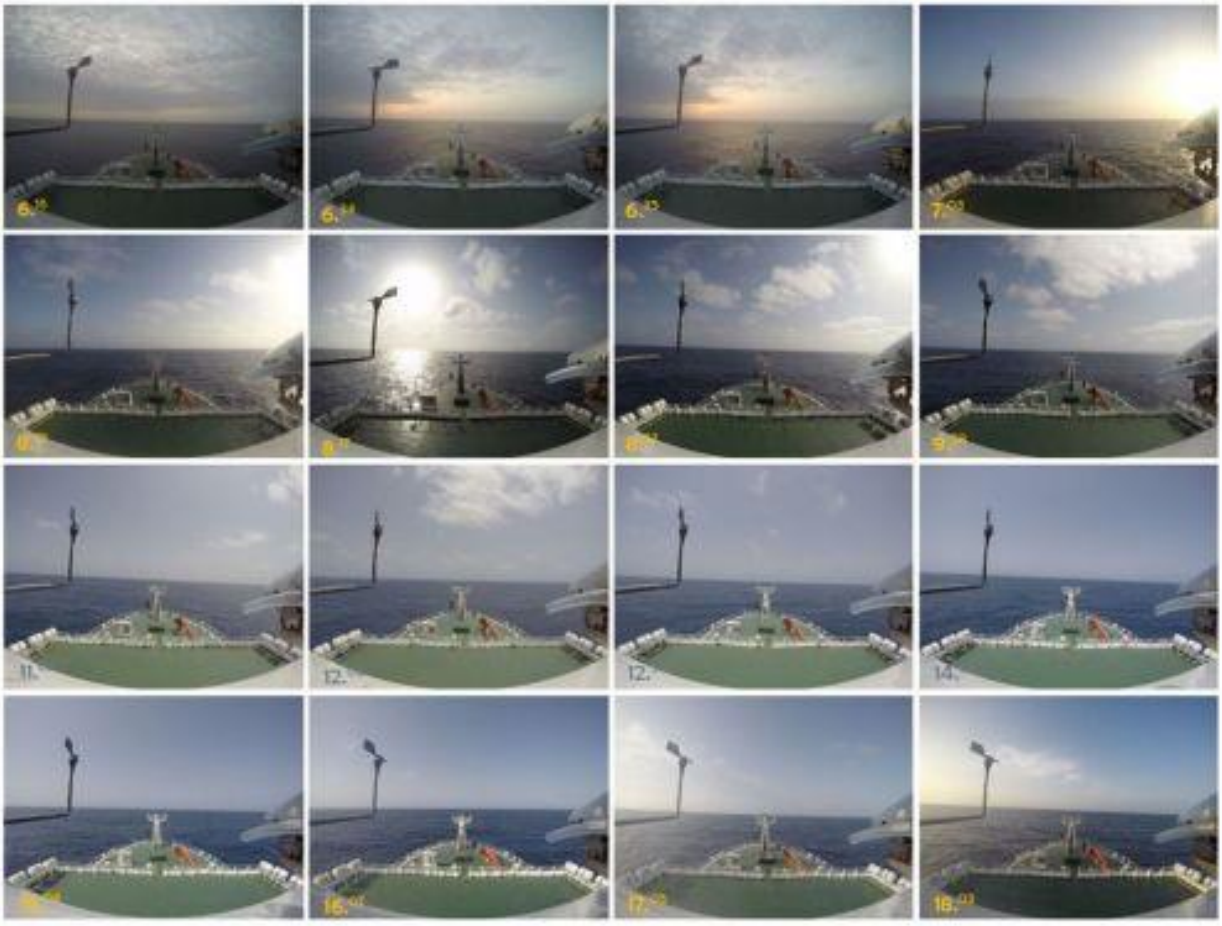
	Start			Stop			Total
Nr	Lat (° ' N)	Lon (° 'W)	Date	Lat (° ' N)	Lon (° ' W)	Date	Hrs.
1	16 37,76	61 08,00	19/3	12 04,90	48 11,98	21/3	41,4
2	11 57,95	56 06,61	21/3	11 58,99	53 25,69	23/3	29,3
3	11 57,95	49 28,92	24/36	11 58,42	48 43,77	26/3	40,0
4	11 58,75	48 36,96	26/3	12 12,82	42 05,38	28/3	34,4
5	12 13,03	41 56,90	28/3	12 21,19	38 52,13	29/3	24,9
6	12 20,73	38 52,79	29/3	12 22,86	38 39,58	30/3	23,6
7	12 23,46	38 38,44	30/3	12 16,81	36 20,34	1/4	35,7
8	12 16,35	35 57,46	1/4	12 11,07	29 51,32	3/4	43,7
9	12 09,45	28 21,68	3/4	11 22,60	22 57,95	5/4	30,1
10	11 23,04	22 57,79	5/4	11 33,75	22 26,23	6/4	23,8
11	11 45,69	22 53,38	7/4	13 22,76	22 23,26	9/4	41,0
12	13 32,20	22 21,62	9/4	21 09,42	20 58,46	11/4	46,8
13	21 16,23	20 55,91	11/4	21 24,86	21 00,04	12/4	25,4
14	21 30,51	20 57,88	12/4				

The filters will be weighed in the lab on land, at ICTA-UAB, and analysed for their lipid and total carbon content.

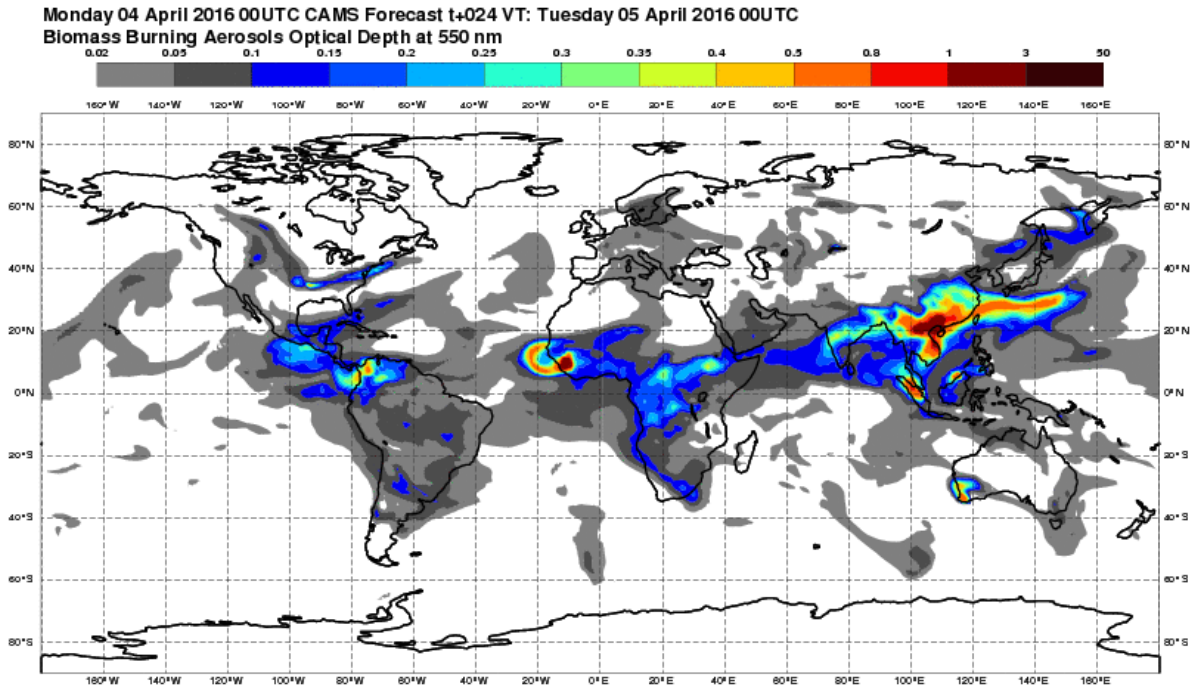
These three samplers were connected to a wind vane programmed to have the units switch on when wind is coming from a predetermined arc (range from -90° to +100°) in front of the ship, and off at other times. This is to prevent contamination from the ship's chimney. We also took samples without the use of the wind vane, to see if we have different organic compounds on our dust filters when the wind can come from all directions (so possibly also from the direction of the ship's exhaust). And to sample this exhaust, and thus analyze the contamination from this source, we placed the dust collectors on the back of the ship.

In addition, an OMNI 3000 wet concentrating air sampler was used to collect samples for microbiological characterization. This sampler collects samples by sucking air (at 300 liters per minute) into a glass cylinder containing clean water. Mineral and biological particles are removed from the air by the liquid, creating a concentrated sample of approximately 10mL at the end of each sample period. This liquid was transferred to a polypropylene tube and stored at -80°C. Due to the nature of the software in the unit, the OMNI could not be connected to the wind vane, so wind direction was monitored to ensure it was coming from the front side of the ship. The total time and air volume sampled is logged on board the system.

The atmospheric situation during the sampling of the dust filters has been recorded hourly (during day-time) using a 'GoPro HERO4' (action)camera, which allows to observe changes in the atmosphere during the dust sampling, like visibility and wind direction (Photo 5.1.1.7).



5.1.1.7 Compilation of GoPro pictures of 29 March.



During the cruise we benefited from dust and biomass-burning forecasts.

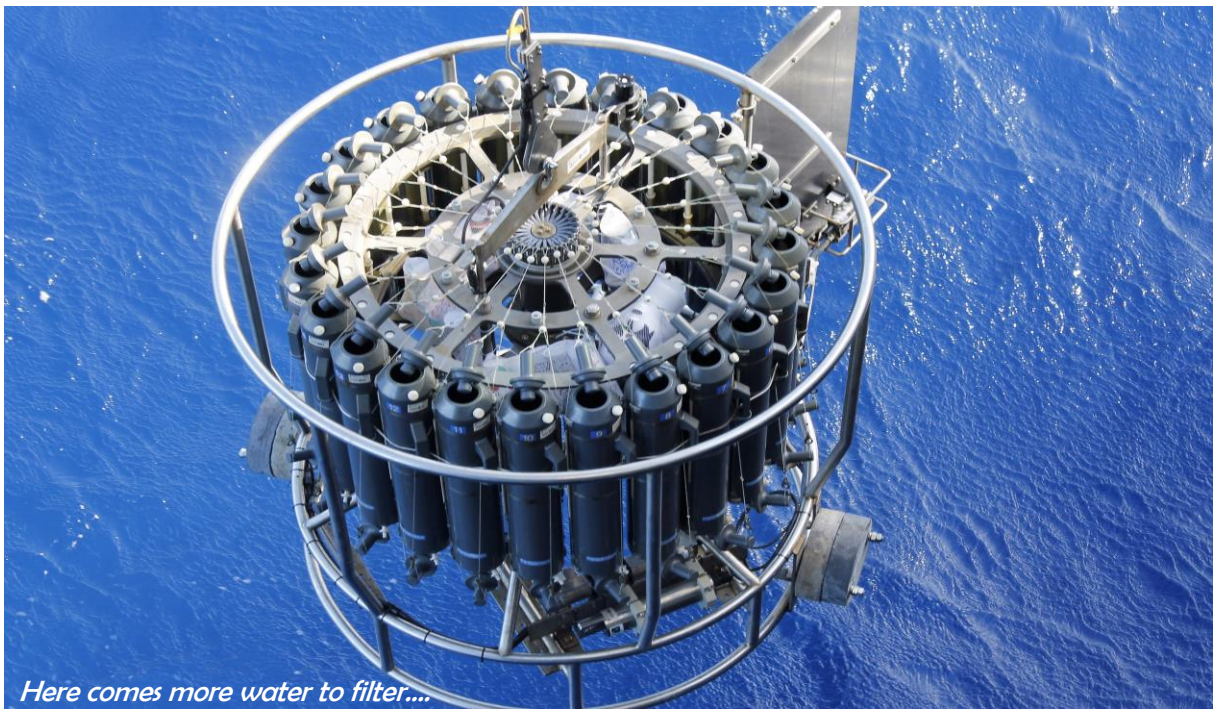
5.1.2 $\delta^{15}N$ in pigments

[Toni Rosell-Melé]

Pigment-specific $\delta^{15}N$ isotopes can tell us something about Nitrogen fixation in the water column. To study this, underway samples were taken from the non-toxic water inlet on the ship. Per sample, three filters (GF/F, 45mm, 0.7µm) were used. The aim was to sample continuously for periods of about 12 hours at an average flow of 50L/min.
These samples shall be analysed in the lab at UAB.

Table 5.1.2.1: Samples collected for $\delta^{15}N$ analysis

	Start						Stop					
ID	Lat (° ' N)		Lon (° ' W)		Date	Time	Lat (° ' N)		Lon (° ' W)		Date	Time
P1	14	44,81	59	0,01	20/3	8:05	13	26,58	57	37,27	20/3	20:34
P2	11	59,63	56	5,83	22/3	8:12	11	59,66	55	23,36	22/3	18:13
P3	11	59,58	55	21,70	22/3	18:30	11	59,01	53	43,04	23/3	8:00
P4	11	59,25	53	39,78	23/3	11:04	11	58,65	52	5,60	23/3	21:05
P5	11	58,66	52	5,33	23/3	21:28	11	58,14	50	42,43	24/3	8:45
P6	11	58,01	50	23,81	24/3	12:23	11	59,16	49	13,06	24/3	20:25
P7	11	58,82	48	34,75	26/3	14:20	12	3,75	46	10,16	27/3	7:10
P8	12	4,03	46	5,25	27/3	9:20	12	7,78	44	11,87	27/3	21:21
P9	12	7,87	44	8,97	27/3	21:34	12	11,11	42	40,57	28/3	8:30
P10	12	11,21	42	40,58	28/3	8:43	12	15,62	40	37,59	28/3	20:30
P11	12	15,73	40	45,36	28/3	20:38	12	20,07	38	54,11	29/3	10:37
P12	12	20,16	38	53,99	29/3	10:50	12	21,71	38	48,43	30/3	8:24
P13	12	19,16	38	43,95	31/3	8:38	12	17,82	37	36,12	31/3	21:17
P14	12	17,79	37	33,90	31/3	21:31	12	16,70	36	14,05	1/4	9:34
P15	12	16,51	36	11,36	1/4	9:52	12	15,34	34	39,40	1/4	20:12
P16	12	15,20	34	37,57	1/4	20:25	12	13,49	32	48,91	2/4	10:28
P17	12	13,49	32	46,77	2/4	10:42	12	11,03	29	51,30	3/4	8:04
P18	12	11,16	29	48,26	3/4	9:08	12	9,38	28	17,84	3/4	21:57
P19	12	9,35	28	16,15	3/4	22:05	11	59,21	25	57,76	4/4	14:04
P20	11	58,83	25	55,50	4/4	14:15	11	24,31	23	4,30	5/4	7:50
P21	11	22,79	23	0,33	5/4	8:30	11	25,49	22	47,57	5/4	20:33
P22	11	49,39	22	55,26	7/4	9:46	12	1,58	23	2,51	7/4	21:25
P23	13	34,05	22	21,27	9/4	9:18	15	36,20	21	59,60	9/4	22:08
P24	15	37,86	21	59,29	9/4	22:17	17	13,33	21	42,17	10/4	9:26
P25	17	15,20	21	41,80	10/4	9:36	19	11,90	21	20,76	10/4	21:24
P26	19	13,30	21	20,50	10/4	21:33	21	16,22	20	55,94	11/4	9:54
P27	21	16,17	20	56,26	11/4	10:09	21	12,78	20	58,03	11/4	21:43
P28	21	31,80	20	57,41	12/4	17:03	23	24,66	20	11,10	13/4	8:52
P29	23	24,82	20	11,03	13/4	9:00						



Here comes more water to filter....

5.1.3 Plankton pump [Oliver Knebel, Geert-Jan Brummer]

(Continuous surface water plankton sampling and physical parameters)

The „Plankton Pump" is a highly efficient way of collecting surface water microplankton in the >0.1 mm range along an entire cruise transect. It uses the ship's deck-wash or fire extinguishing system to continuously filter large volumes of surface water (during this cruise 15-30 m^3 per interval of 6 hours), without costing shiptime, while sea surface parameters such as temperature, salinity and fluorescence are semi-continuously measured by the ship's system. It has successfully been used for three decades to sample skeletal microplankton, particularly the calcitic planktonic foraminifera. Continuous surface water plankton pumping (horizontal) is particularly attractive in combination with sampling the water column (vertical) with a plankton net at stations.

Methods

Surface water was continuously pumped up from an inlet at 5.5 m depth in the stern of the James Cook, and eventually passed through a hose via a flowmeter into a plankton net of 100 µm mesh size that was suspended in a large open vessel (Photo 5.1.3.1). Every 6 hours, at 6:00, 12:00, 18:00 and 24:00 hours (ship-time), the flowmeter (to the nearest 0.01m^3) and time (to the minute) were read and the hose was taken out of the net. The net was drained, then washed down from the outside using the hose to concentrate the sample into the cod-end, after which the cod-end beaker was replaced. In the meantime, a water sample was taken in a 250ml PE bottle for nutrient analysis. The pump was running at a flow of 3 – 4 m^3 per hour, thus filtering about 20 m^3 per sample.

5.1.3.1: Plankton-pump set up.

The full cod-end beaker was taken to the wet-lab where its content was transferred onto a 90 µm sieve using pre-filtered seawater and drained. The plankton sample was shortly rinsed with milli-Q to remove the sea salts, and flushed into a small zip-lock plastic bag labelled with the cruise name (JC134) and consecutively numbered PP1 to PP99. Samples were stored at -80°C.

The nutrient sample was taken up in a syringe and pressed through a 0.2µm acrodisc filter to fill up two ponyvials (ca. 5 ml each), of which one was stored at 4°C (for dissolved Si-analysis)

and the other at -20°C (for phosphate and nitrate analysis), for post-cruise analysis at the NIOZ nutrient lab.

In the lab at NIOZ, all plankton samples will be freeze-dried in their original sample bags, dry-weighed for biomass (total dry weight including the sample bag and post-weighing the empty sample bag), and dry-ashed to retrieve the skeletal matter (in an oxygen plasma using the low-temperature asher).

Sampling irregularities

- On the 27th of March between 10:32 and 11:15 the sampling (PP27) was interrupted, because the plankton pump was moved from the aft deck to the side deck.
- The water volume filtered by the plankton net at the end of sample PP34 and the start of sample PP35 was noted incorrectly, which resulted in a slightly too high amount of water filtered during sample PP34 and slightly too low amount of water filtered during sample PP35.
- No meteorological data is available for sample PP30, because the ship system didn't record any data during the time of sampling.
- For sample PP57 no end time was noted.
- Plankton pump sample PP63 and the nutrient samples 63 were forgotten in the wet lab. For that reason they were stored in the freezer 6 hours after sampling

For further details, see Table 5.1.3.1 and the plankton pump manual (Annex VI).

Data processing

Oceanographic parameters including temperature, salinity and fluorescence were derived from the ship's continuously recording system from the inlet at 5.5 meter water depth (Fig. 5.1.3.2, 3, 4 and 5). From the ship's Intranet all meteorological data and the ship's position could be determined for the exact time of sampling. Measurements were taken every second, from which we calculated one minute averages. The continuously recorded temperature, salinity and fluorescence were cross-plotted against the vertical CTD data at 10 meter water depth (Figure 5.1.3.6, 7 and 8). Data will be post-calibrated at NIOZ: Only use this data at face value!

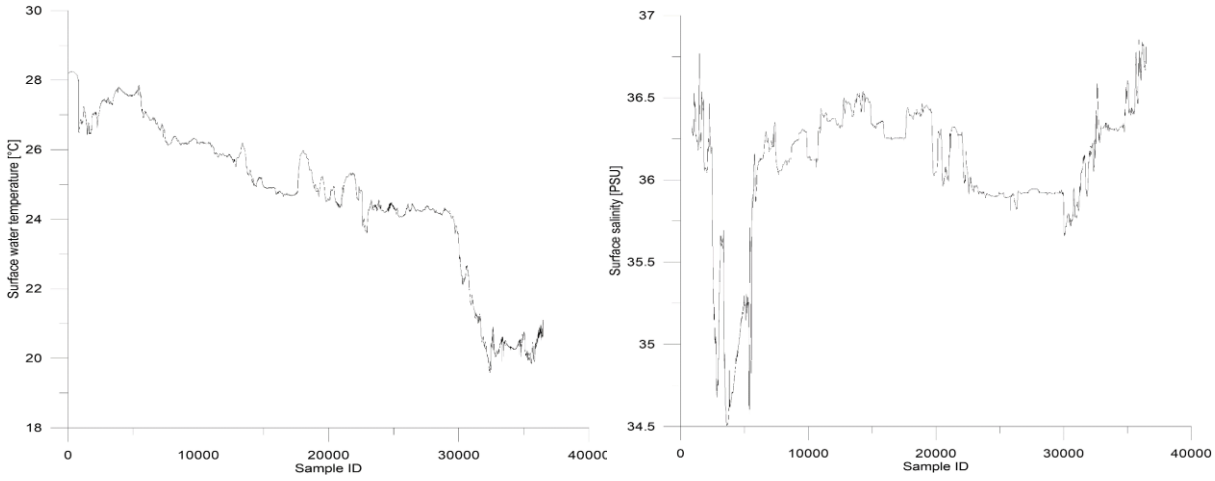


Fig. 5.1.3.1: One-minute averaged water temperature (L) and salinity (R) for the entire cruise.

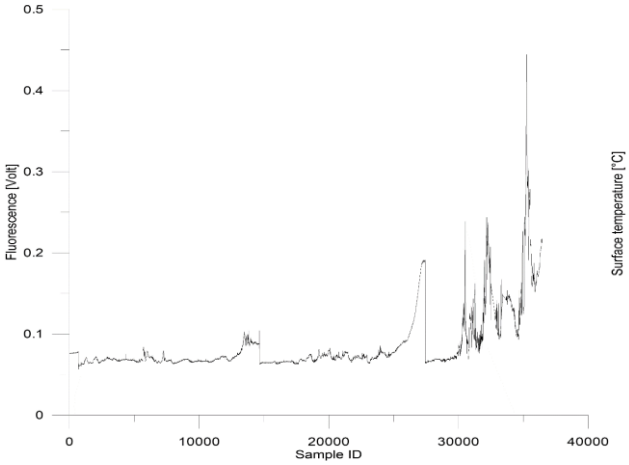


Fig. 5.1.3.4: One-minute averaged Fluorescence for the entire cruise.

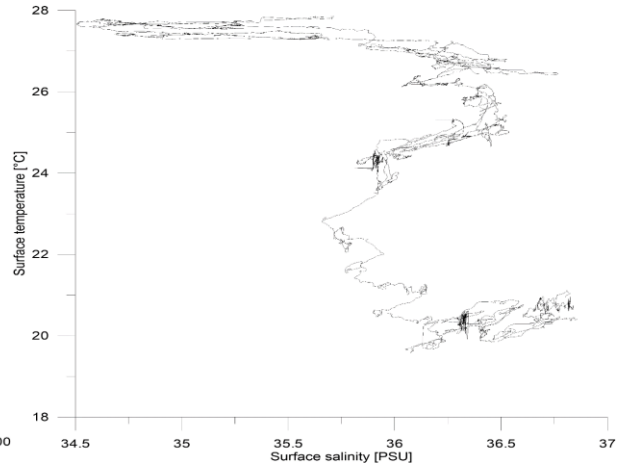


Fig. 5.1.3.5: cross-plot of Temperature against Salinity from the ship's recording system.

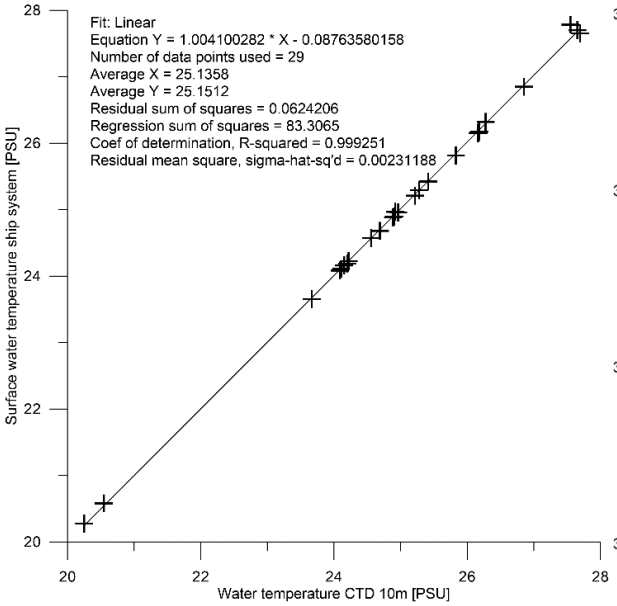


Fig. 5.1.3.6: Cross-plot of surface-water Temperature measured by the ship's recording system (at 5.5 m depth) plotted against Temperature measured by the CTD at 10 m depth.

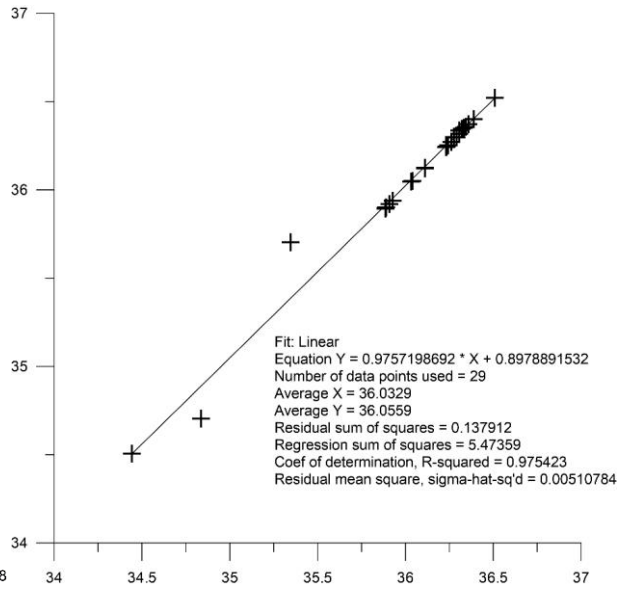
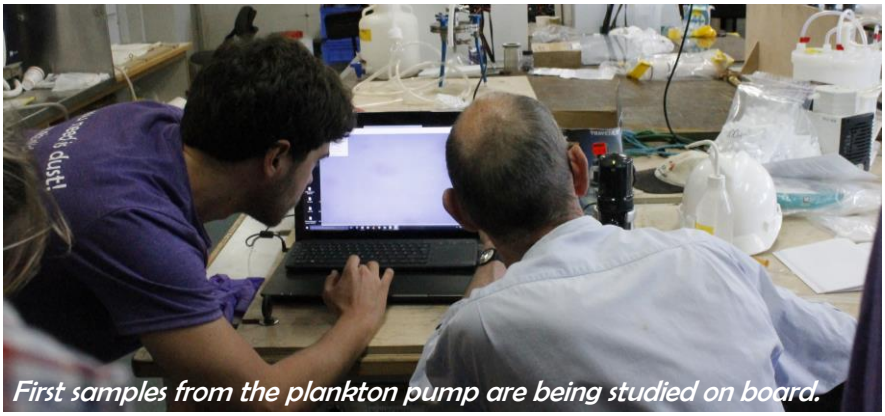


Fig. 5.1.3.7: Cross-plot of surface-water Salinity measured by the ship's recording system (at 5.5 m depth) plotted against Salinity measured by the CTD at 10 m depth.



First samples from the plankton pump are being studied on board.

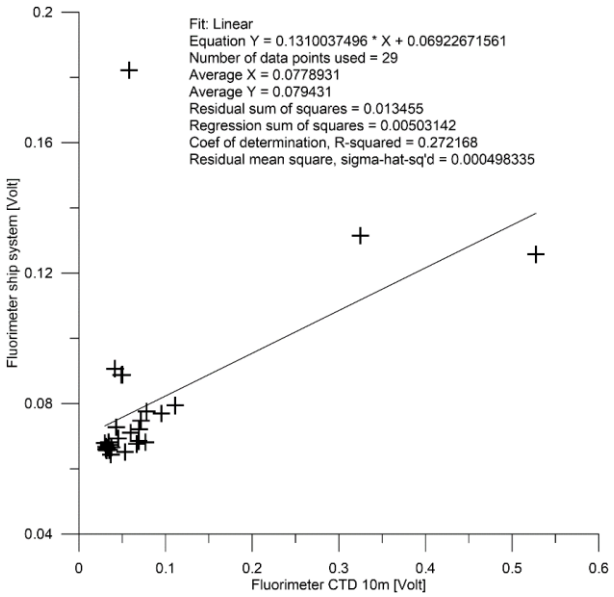
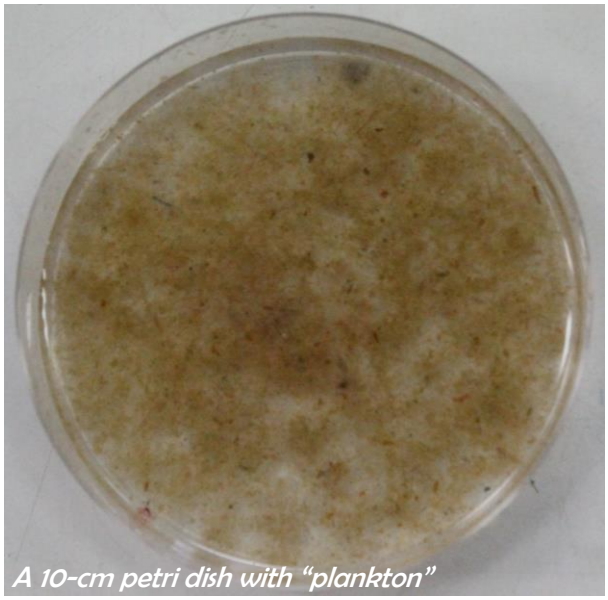
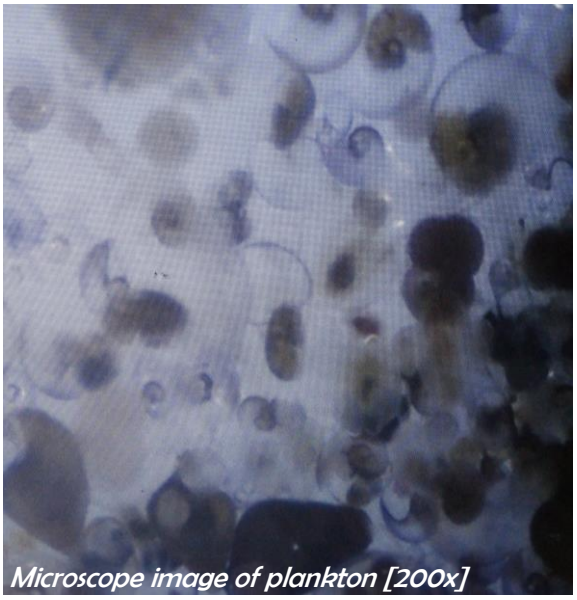


Fig. 5.1.3.8: Cross-plot of surface-water Fluorescence measured by the ship's recording system (at 5.5 m depth) plotted against Fluorescence measured by the CTD at 10 m depth.



A 10-cm petri dish with "plankton"



Microscope image of plankton [200x]

Table 5.1.3.1: Plankton pump samples and physical parameters averaged across the entire transect.

ID	Start/ End	UTC +/-	Date UTC	Time UTC	Pump time hr	Volume filtered m³	Lat (°N)	Lon (°W)	SST °C	Salinity PSU	Fluorim. volt
PP1	Start	UTC+4	20/3	22:40	5.43	17.23	13.097086	57.261603	27.41	34.90	0.070
PP1	End	UTC+4	21/3	4:08							
PP2	Start	UTC+4	21/3	4:09	5.93	18.90	12.458828	56.591891	27.37	35.56	0.069
PP2	End	UTC+4	21/3	10:05							
PP3	Start	UTC+4	21/3	10:08	6.07	19.77	11.974929	56.12101	27.59	34.63	0.068
PP3	End	UTC+4	21/3	16:12							
PP4	Start	UTC+4	21/3	16:16	6.67	24.18	11.992228	56.101136	27.74	34.67	0.068
PP4	End	UTC+4	21/3	22:20							
PP5	Start	UTC+4	21/3	22:24	5.55	22.36	11.993461	56.0985	27.64	34.86	0.068
PP5	End	UTC+4	22/3	3:57							
PP6	Start	UTC+4	22/3	3:59	6.08	24.54	11.993478	56.098497	27.56	35.07	0.068
PP6	End	UTC+4	22/3	10:04							
PP7	Start	UTC+4	22/3	10:07	6.02	24.17	11.946083	56.04078	27.57	35.21	0.067
PP7	End	UTC+4	22/3	16:08							
PP8	Start	UTC+4	22/3	16:11	6.02	24.11	11.994929	55.408382	27.68	35.16	0.067
PP8	End	UTC+4	22/3	22:12							
PP9	Start	UTC+4	22/3	22:15	6.22	23.52	11.988391	54.560593	27.13	35.95	0.072
PP9	End	UTC+3	23/3	4:02							
PP10	Start	UTC+3	23/2	4:04	5.07	20.53	11.98527	53.825318	27.00	36.07	0.074
PP10	End	UTC+3	23/2	9:08							
PP11	Start	UTC+3	23/3	9:10	6.8	27.29	11.982073	53.382055	26.87	36.15	0.070
PP11	End	UTC+3	23/3	15:58							
PP12	Start	UTC+3	23/6	16:00	5.12	20.65	11.979469	52.604239	26.77	36.25	0.066
PP12	End	UTC+3	23/3	21:07							
PP13	Start	UTC+3	23/3	21:11	5.68	22.75	11.972791	51.733823	26.63	36.21	0.069
PP13	End	UTC+3	24/3	2:52							
PP14	Start	UTC+3	24/3	2:55	6.12	24.89	11.968451	50.826659	26.35	36.18	0.068
PP14	End	UTC+3	24/3	9:02							
PP15	Start	UTC+3	24/3	9:06	5.92	23.44	11.967276	50.448588	26.18	36.06	0.066
PP15	End	UTC+3	24/3	15:01							
PP16	Start	UTC+3	24/3	15:03	6.35	25.57	11.966187	49.510827	26.35	36.10	0.064
PP16	End	UTC+3	24/3	21:24							
PP17	Start	UTC+3	24/3	21:27	5.67	22.81	11.993658	49.07972	26.20	36.13	0.067
PP17	End	UTC+3	25/3	3:07							
PP18	Start	UTC+3	25/3	3:09	6.1	24.14	11.993644	49.079712	26.18	36.23	0.068
PP18	End	UTC+3	25/3	9:03							
PP19	Start	UTC+3	25/3	9:03	5.98	23.76	11.968146	49.07463	26.20	36.26	0.067
PP19	End	UTC+3	25/3	15:02							
PP20	Start	UTC+3	25/3	15:04	5.98	23.61	11.974517	49.062255	26.30	36.30	0.066
PP20	End	UTC+3	25/3	21:03							
PP21	Start	UTC+3	25/3	21:06	5.83	23.15	12.011663	49.212575	26.21	36.18	0.067
PP21	End	UTC+3	26/3	2:56							
PP22	Start	UTC+3	26/3	2:57	9.42	33.70	11.9899	49.250297	26.20	36.12	0.067
PP22	End	UTC+3	26/2	11:22							
PP23	Start	UTC+3	26/2	11:24	3.75	14.71	11.971653	48.895798	26.19	36.20	0.066
PP23	End	UTC+3	26/2	15:07							
PP24	Start	UTC+3	26/2	15:10	6.05	23.63	12.001387	48.045965	26.09	36.38	0.067
PP24	End	UTC+3	26/2	21:13							
PP25	Start	UTC+3	26/2	21:16	5.7	22.49	12.027052	47.206699	25.86	36.38	12827.920
PP25	End	UTC+3	27/3	2:58							
PP26	Start	UTC+3	27/3	3:01	6.05	23.91	12.057294	46.283354	25.86	36.36	0.072
PP26	End	UTC+3	27/3	9:04							
PP27	Start	UTC+3	27/3	9:06	5.42	21.53	12.080463	45.639863	25.82	36.37	0.071
PP27	End	UTC+3	27/3	13:32							
PP27	Start	UTC+3	27/3	14:15							
PP27	End	UTC+3	27/3	15:14							
PP28	Start	UTC+3	27/3	15:16	6.05	23.54	12.111684	44.693773	25.79	36.33	0.069
PP28	End	UTC+3	27/3	21:13							
PP29	Start	UTC+3	27/3	21:16	5.75	23.15	12.135948	44.02519	25.63	36.43	0.072
PP29	End	UTC+3	28/3	3:01							
PP30	Start	UTC+3	28/3	3:03	6.08	24.03					
PP30	End	UTC+3	28/3	9:08							
PP31	Start	UTC+3	28/3	9:11	5.92	23.19	12.212073	42.157636	25.79	36.47	0.076
PP31	End	UTC+3	28/3	15:01							
PP32	Start	UTC+3	28/3	15:03	6.03	24.14	12.247115	41.172638	26.05	36.43	0.088
PP32	End	UTC+3	28/3	21:05							
PP33	Start	UTC+3	28/3	21:08	5.92	22.96	12.280308	40.237571	25.52	36.48	0.091
PP33	End	UTC+3	29/3	2:53							
PP34	Start	UTC+3	29/3	2:56	6.23	31.89	12.31381	39.240831	25.20	36.48	0.089
PP34	End	UTC+3	29/3	9:10							
PP35	Start	UTC+3	29/3	9:12	5.78	14.22	12.342699	38.886677	25.03	36.51	0.088
PP35	End	UTC+3	29/3	14:59							
PP36	Start	UTC+3	29/3	15:01	6.18	24.58	12.386397	38.743889	25.13		0.064
PP36	End	UTC+3	29/3	21:12							

ID	Start/ End	UTC +/-	Date UTC	Time UTC	Pump time hr	Volume filtered m³	Lat (°N)	Lon (°W)	SST °C	Salinity PSU	Fluorim. volt
PP37	Start	UTC+3	29/3	21:15	5.7	23.40	12.383035	38.757567	24.91	36.33	0.065
PP37	End	UTC+3	30/3	3:01							
PP38	Start	UTC+3	30/3	3:03	5.95	23.71	12.364055	38.80064	24.90	36.34	0.065
PP38	End	UTC+3	30/3	9:00							
PP39	Start	UTC+3	30/3	9:03	5.9	23.78	12.393815	38.634506	24.84	36.32	0.065
PP39	End	UTC+3	30/3	14:57							
PP40	Start	UTC+3	30/3	14:59	6.5	25.52	12.391115	38.640686	24.77	36.25	0.065
PP40	End	UTC+3	30/3	21:14							
PP41	Start	UTC+3	30/3	21:17	5.7	23.38	12.329787	38.712118	24.71	36.25	0.066
PP41	End	UTC+3	31/3	3:59							
PP42A	Start	UTC+3	31/3	4:01	5.25	79.08	12.327096	38.720127	24.70	36.25	0.066
PP42A	End	UTC+3	31/3	9:16							
PP42B	Start	UTC+3	31/3	9:20	5.72	23.49	12.326385	38.716115	24.70	36.25	0.065
PP42B	End	UTC+3	31/3	15:03							
PP43	Start	UTC+3	31/3	15:05	6.25	24.80	12.312575	38.055938	25.26	36.35	0.066
PP43	End	UTC+3	31/3	21:20							
PP44	Start	UTC+3	31/3	21:23	5.25	23.27	12.292219	37.174391	25.91	36.39	0.067
PP44	End	UTC+3	01/4	3:08							
PP45	Start	UTC+3	01/4	3:11	6.23	21.56	12.278369	36.39328	25.72	36.40	0.071
PP45	End	UTC+2	01/4	8:25							
PP46	Start	UTC+2	01/4	8:27	5.62	22.64	12.272127	35.856893	25.27	36.40	0.070
PP46	End	UTC+2	01/4	14:04							
PP47	Start	UTC+2	01/4	14:07	5.9	23.84	12.252426	34.981576	24.87	36.44	0.069
PP47	End	UTC+2	01/4	20:01							
PP48	Start	UTC+2	01/4	20:04	5.8	23.93	12.245345	34.117019	25.04	36.44	0.073
PP48	End	UTC+2	02/4	1:52							
PP49	Start	UTC+2	02/4	1:55	6.28	25.44	12.230331	33.168885	24.71	36.17	0.074
PP49	End	UTC+2	02/4	8:12							
PP50	Start	UTC+2	02/4	8:15	5.75	23.17	12.221608	32.576828	24.70	36.16	0.075
PP50	End	UTC+2	02/4	14:00							
PP51	Start	UTC+2	02/4	14:04	6.02	24.30	12.203679	31.626468	24.68	36.11	0.070
PP51	End	UTC+2	02/4	20:05							
PP52	Start	UTC+2	02/4	20:08	5.87	23.96	12.191437	30.742196	24.42	36.04	0.071
PP52	End	UTC+2	03/4	2:00							
PP53	Start	UTC+2	03/4	2:03	5.03	20.53	12.184485	29.964133	24.97	36.27	0.075
PP53	End	UTC+1	03/4	7:05							
PP54	Start	UTC+1	03/4	7:08	5.9	23.99	12.172101	29.32452	25.25	36.31	0.073
PP54	End	UTC+1	03/4	7:45							
PP54	Start	UTC+1	03/4	7:49							
PP54	End	UTC+1	03/4	13:06							
PP55	Start	UTC+1	03/4	13:09	5.78	23.59	12.165922	28.93622	25.28	36.27	0.069
PP55	End	UTC+1	03/4	18:56							
PP56	Start	UTC+1	03/4	18:59	5.92	24.03	12.151753	27.98012	24.77	36.09	0.072
PP56	End	UTC+1	04/4	0:54							
PP57	Start	UTC+1	04/4	0:55		24.86					
PP57	End	UTC+1	04/4								
PP58	Start	UTC+1	04/4	7:06	5.97	23.98	12.045388	26.300806	23.88	35.95	0.069
PP58	End	UTC+1	04/4	13:04							
PP59	Start	UTC+1	04/4	13:07	6	24.21	11.867902	25.280227	24.38	35.94	0.068
PP59	End	UTC+1	04/4	19:07							
PP60	Start	UTC+1	04/4	19:10	5.75	23.72	11.689985	24.275618	24.37	35.92	0.071
PP60	End	UTC+1	05/4	0:55							
PP61	Start	UTC+1	05/4	0:57	6.15	24.91	11.452941	23.200208	24.34	35.91	0.078
PP61	End	UTC+1	05/4	7:06							
PP62	Start	UTC+1	05/4	7:08	5.87	23.27	11.41248	22.943485	24.23	35.90	0.074
PP62	End	UTC+1	05/4	13:00							
PP63	Start	UTC+1	05/4	13:03	6.8	24.82	11.538853	22.931407	24.38	35.90	0.075
PP63	End	UTC+1	05/4	19:08							
PP64	Start	UTC+1	05/4	19:11	5.73	23.56	11.417729	22.668617	24.29	35.92	0.078
PP64	End	UTC+1	06/4	0:55							
PP65	Start	UTC+1	06/4	0:57	6.3	24.75	11.589815	22.601866	24.11	35.90	0.085
PP65	End	UTC+1	06/4	6:59							
PP66	Start	UTC+1	06/4	7:01	5.95	24.20	11.551682	22.519477	24.13	35.90	0.090
PP66	End	UTC+1	06/4	12:58							
PP67	Start	UTC+1	06/4	13:01	6.12	25.13	11.464212	22.35239	24.31	35.87	0.098
PP67	End	UTC+1	06/4	19:08							
PP68	Start	UTC+1	06/4	19:11	5.73	23.56	11.488796	22.808798	24.35	35.92	0.116
PP68	End	UTC+1	07/4	0:55							
PP69	Start	UTC+1	07/4	0:56	6.23	25.61	11.587942	22.80827	24.25	35.92	0.153
PP69	End	UTC+1	07/4	7:10							
PP70	Start	UTC+1	07/4	7:12	5.97	24.25	11.995125	23.012046	24.26	35.93	0.187
PP70	End	UTC+1	07/4	13:10							
PP71	Start	UTC+1	07/4	13:13	5.77	24.01	12.059307	23.072213	24.34	35.94	0.066
PP71	End	UTC+1	07/4	19:01							
PP72	Start	UTC+1	07/4	19:03	5.85	23.90	11.671293	22.86645	24.28	35.94	0.067
PP72	End	UTC+1	08/4	0:54							

ID	Start/ End	UTC +/-	Date UTC	Time UTC	Pump time hr	Volume filtered m³	Lat (°N)	Lon (°W)	SST °C	Salinity PSU	Fluorim. volt
PP73	Start	UTC+1	08/4	0:55	6.3	24.92	11.592306	22.818298	24.19	35.92	0.069
PP73	End	UTC+1	08/4	6:57							
PP74	Start	UTC+1	08/4	7:00	6.2	24.69	11.508605	22.721468	24.16	35.92	0.068
PP74	End	UTC+1	08/4	13:01							
PP75	Start	UTC+1	08/4	13:13	5.92	24.69	11.538082	22.710595	24.25	35.92	0.068
PP75	End	UTC+1	08/4	19:08							
PP76	Start	UTC+1	08/4	19:11	5.8	23.66	12.103459	22.623132	24.12	35.92	0.069
PP76	End	UTC+1	09/4	0:59							
PP77	Start	UTC+1	09/4	1:01	6.33	24.61	13.05549	22.443084	23.80	35.92	0.071
PP77	End	UTC+1	09/4	7:03							
PP78	Start	UTC+1	09/4	7:05	5.92	23.98	13.995471	22.279923	22.90	35.77	0.081
PP78	End	UTC+1	09/4	13:00							
PP79	Start	UTC+1	09/4	13:03	5.95	24.22	14.931887	22.11386	22.35	35.76	0.124
PP79	End	UTC+1	09/4	19:00							
PP80	Start	UTC+1	09/4	19:03	4.95	20.28	15.742738	21.966601	22.14	35.82	0.094
PP80	End	UTC	10/4	0:00							
PP81	Start	UTC	10/4	0:02	6.33	24.47	16.689313	21.797609	21.49	35.83	0.117
PP81	End	UTC	10/4	6:04							
PP82	Start	UTC	10/4	6:08	5.88	23.82	17.652394	21.624657	21.17	36.06	0.092
PP82	End	UTC	10/4	12:01							
PP83	Start	UTC	10/4	12:03	6.25	25.42	18.688623	21.440709	20.60	36.01	0.107
PP83	End	UTC	10/4	18:18							
PP84	Start	UTC	10/4	18:22	5.57	22.41	19.628697	21.266817	20.09	36.17	0.189
PP84	End	UTC	10/4	23:56							
PP85	Start	UTC	10/4	23:58	6.33	24.46	20.65632	21.055772	20.25	36.31	0.000
PP85	End	UTC	11/4	6:00							
PP86	Start	UTC	11/4	6:03	6.17	25.07	21.271046	20.931871	20.14	36.29	0.077
PP86	End	UTC	11/4	12:13							
PP87	Start	UTC	11/4	12:16	5.93	24.35	21.293478	20.976582	20.43	36.33	0.000
PP87	End	UTC	11/4	18:12							
PP88	Start	UTC	11/4	18:15	5.67	22.80	21.212857	20.967092	20.42	36.31	0.057
PP88	End	UTC	11/4	23:55							
PP89	Start	UTC	11/4	23:58	6.73	26.98	21.212362	20.967071	20.31	36.31	0.140
PP89	End	UTC	12/4	6:42							
PP90	Start	UTC	12/4	6:49	5.25	21.39	21.247415	20.951195	20.29	36.31	0.115
PP90	End	UTC	12/4	12:04							
PP91	Start	UTC	12/4	12:14	6.07	24.37	21.682747	20.909216	20.44	36.36	0.120
PP91	End	UTC	12/4	18:18							
PP92	Start	UTC	12/4	18:22	5.67	23.18	22.369054	20.644706	20.44	36.50	0.194
PP92	End	UTC	13/4	0:02							
PP93	Start	UTC	13/4	0:06	5.97	24.43	23.09373	20.375599	20.04	36.42	0.279
PP93	End	UTC	13/4	6:04							
PP94	Start	UTC	13/4	6:10	5.92	24.12	23.653956	20.042026	20.18	36.63	0.169
PP94	End	UTC	13/4	12:05							
PP95	Start	UTC	13/4	12:08	5.97	23.89	24.339271	19.646987	20.66	36.74	0.175
PP95	End	UTC	13/4	18:06							

5.2 Water sampling and CTD

5.2.1 CTD [Anne Roepert, Geert-Jan Brummer]

Station map of cruise JC134

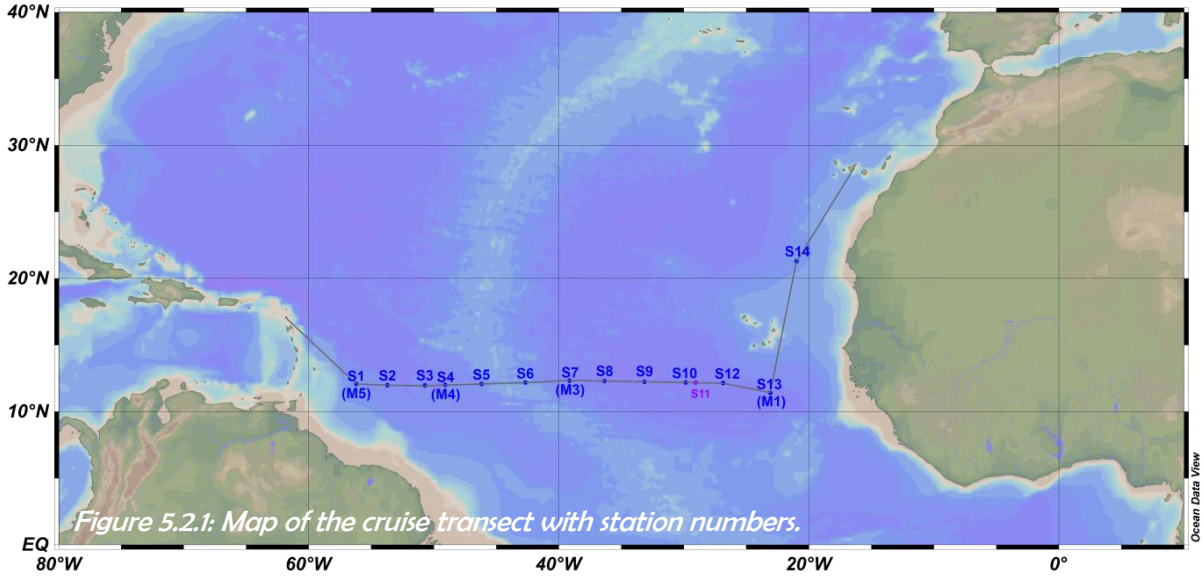


Figure 5.2.1: Map of the cruise transect with station numbers.

During cruise JC134 a total of 30 casts were carried out at 14 stations (Fig. 5.2.1) with a Seabird CTD equipped with a rosette of 24 10-litre Niskin bottles for water sampling.

Four deep casts were taken down to 4000 meters, while the 26 others extended to 300 meters or occasionally shallower.
For visualization of preliminary results, data from the upcast were averaged to 1 m depth bins and used for contour plots (Figs. 5.2.2-6) and depth profiles (Figs. 5.2.7-36) of temperature, salinity, oxygen, fluorescence, and photosynthetic active radiation (PAR).
In addition, T-S diagrams for each CTD cast are given (Figs. 5.2.37-46). During the first two deployments (Station 1 cast 1 and Station 1 cast 4) the light sensor did not work, resulting in zero values for PAR is throughout the casts.

From bottom to top, the four deep casts show the familiar sequence of Antarctic Bottom Water, North Atlantic Deep Water and Antarctic Intermediate Water to a depth of around 1000 m, at the base of the permanent thermocline, which is most pronounced in the western basin. Ocean properties diverge towards the surface where data coverage is much better upward from 300 m.

Sailing from west to east, probably the most distinctive feature in the upper 300 m is the low salinity surface layer (< 35) at station 1 (M5), which may be caused by entrainment of fresh water advected by the Amazone/Orinoco. A clear deep chlorophyll maximum is present throughout the transect, deepening from ca. 70 m at station 1 (M5) to ca. 110 m at station 3, along with the deepening of the seasonal pycnocline. Further towards the east, all properties show geostrophic shoaling to a depth of ca. 50 m at station 10, while both salinity and temperature decrease. Consequently, also the clear subsurface salinity maximum levels off eastward. Sailing north from station 13 (M1), the last CTD profile taken at station 14 shows clear signs of nearby upwelling, possibly through advection of filaments, including high and shallow fluorescence.

CTD data section plots along the transect at 12°N (Station 1 to Station 13).

All sections were generated with Ocean Data View 4.6.5 by weighted average gridding

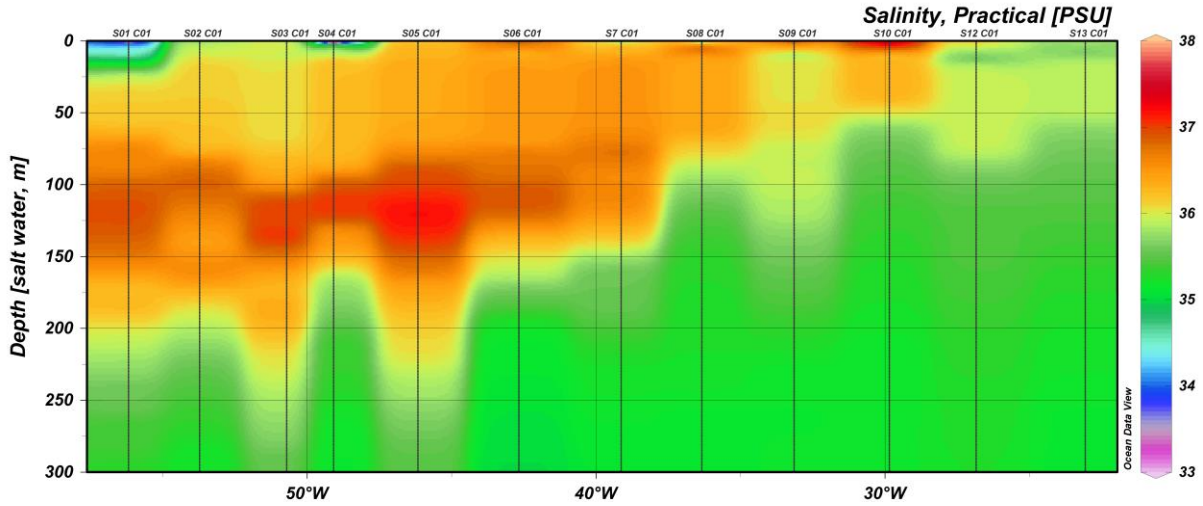


Figure 5.2.2: Salinity section plot.

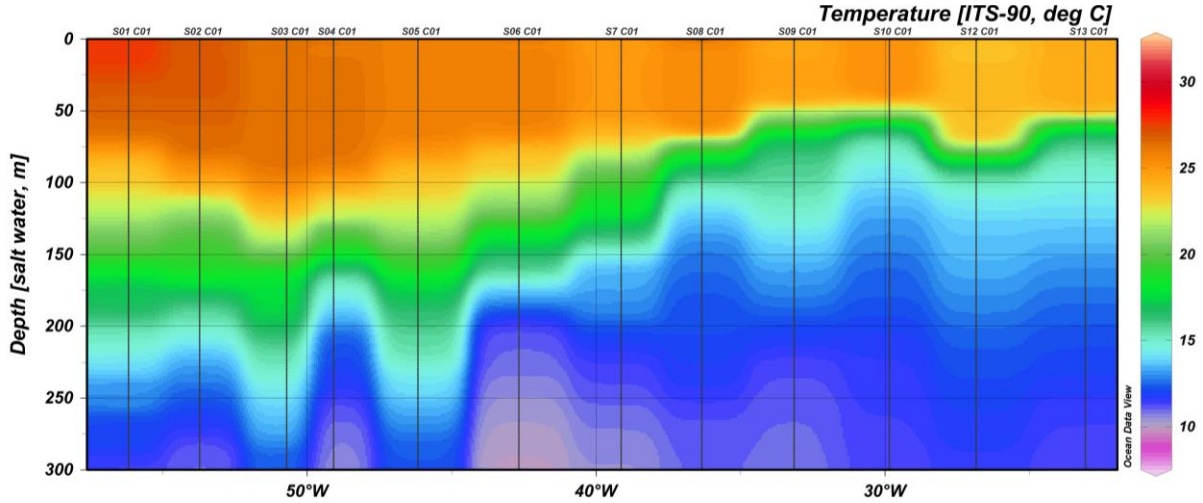


Figure 5.2.3: Temperature section plot.

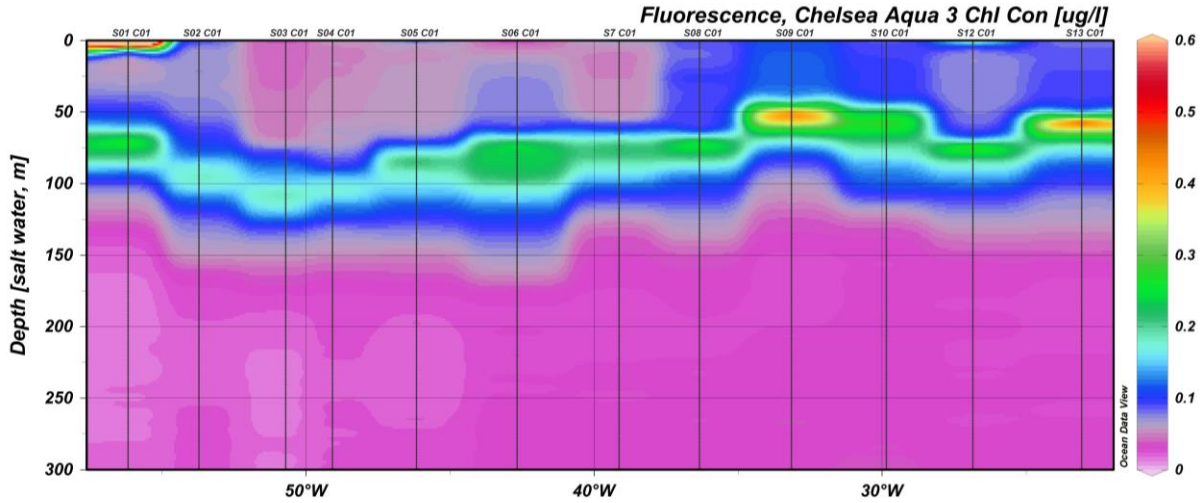


Figure 5.2.4 Fluorescence section plot.

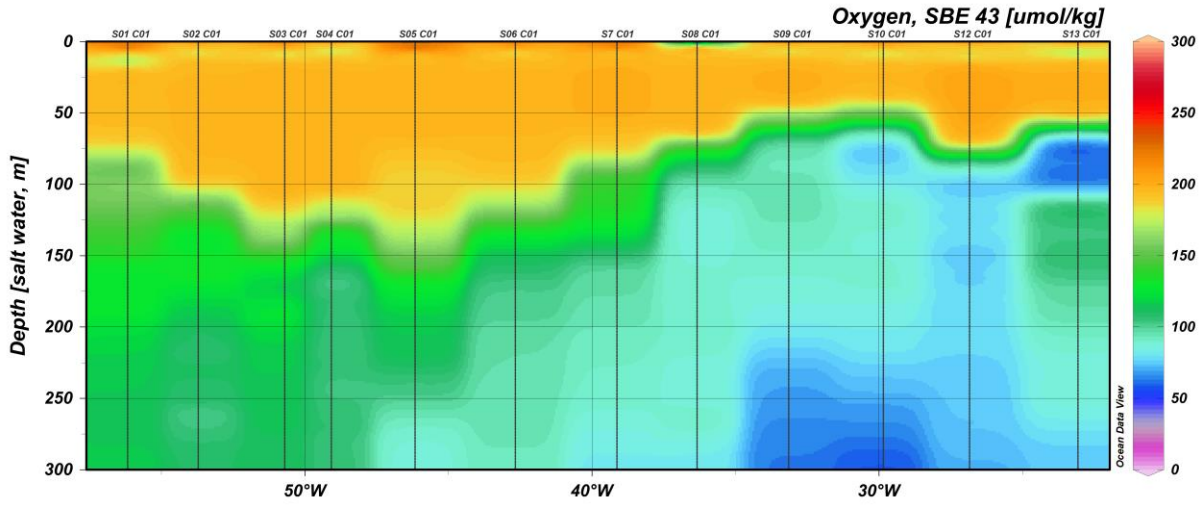


Figure 5.2.5: Oxygen section plot.

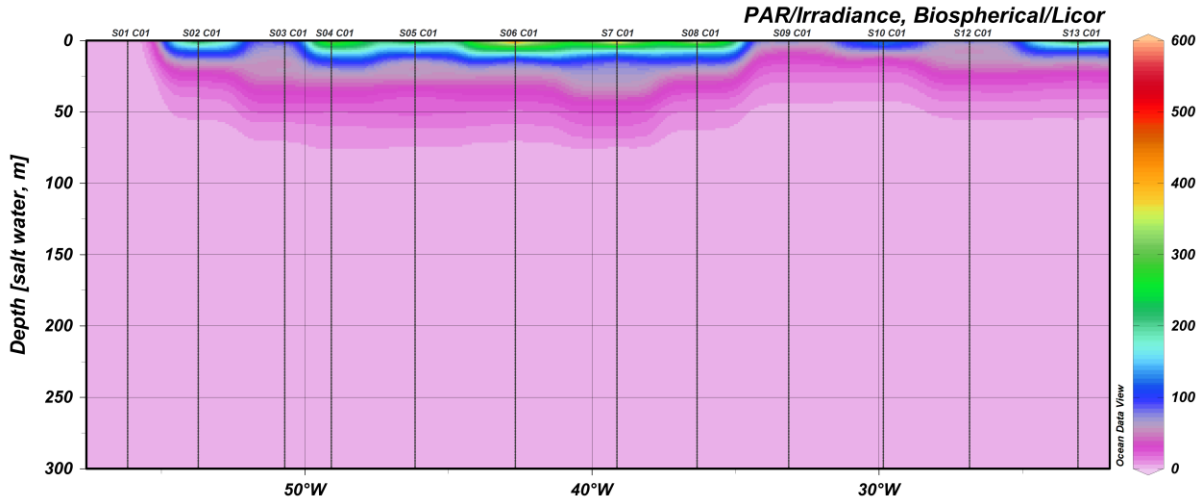


Figure 5.2.6: Photosynthetic Active Radiation (PAR) section plot. Note that the low values at station 1-1 is an artefact caused by malfunctioning of the sensor.

CTD depth profiles

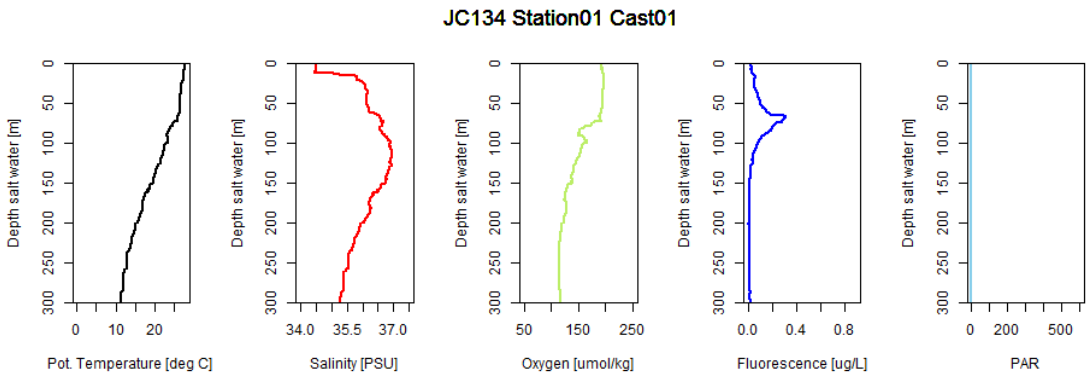


Figure 5.2.7: CTD profile of Station01 Cast01

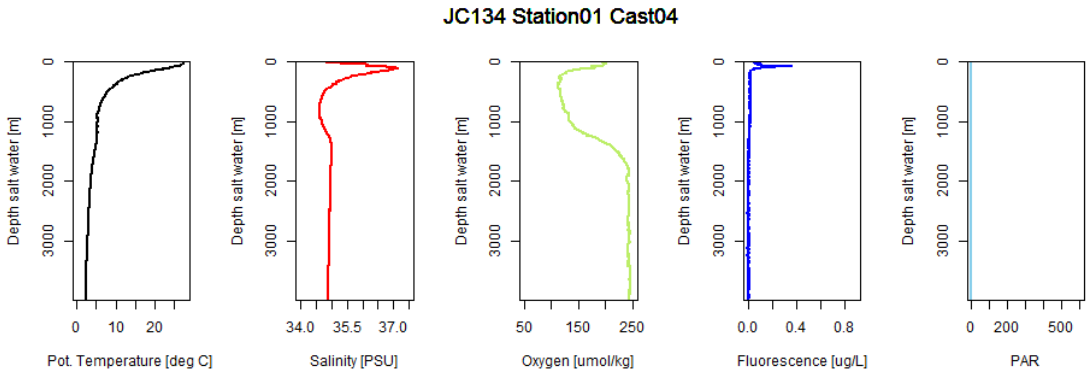


Figure 5.2.8: CTD profile of Station01 Cast04

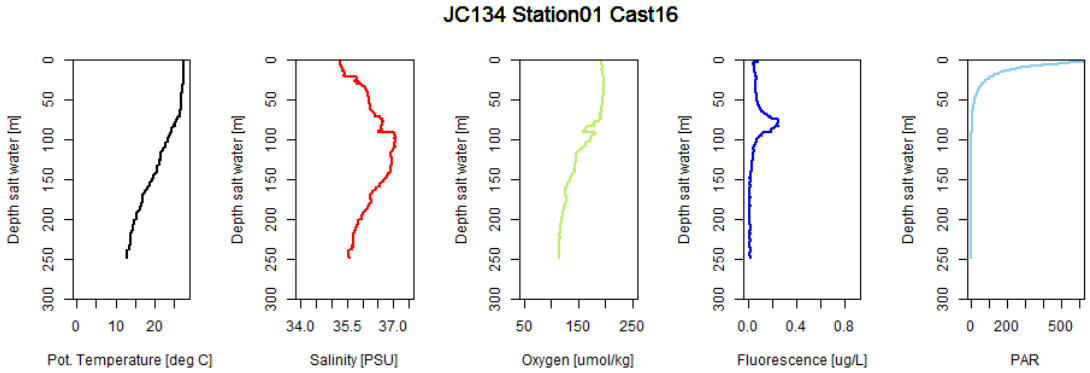


Figure 5.2.9: CTD profile of Station01 Cast16

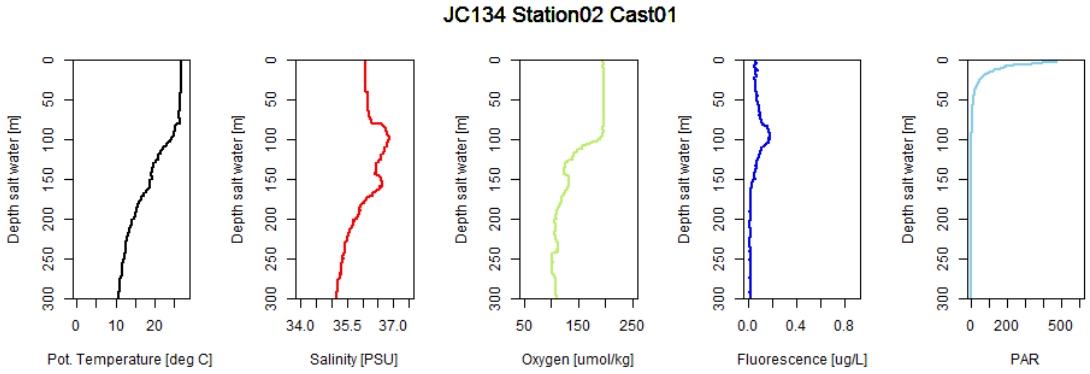


Figure 5.2.10: CTD profile of Station02 Cast01

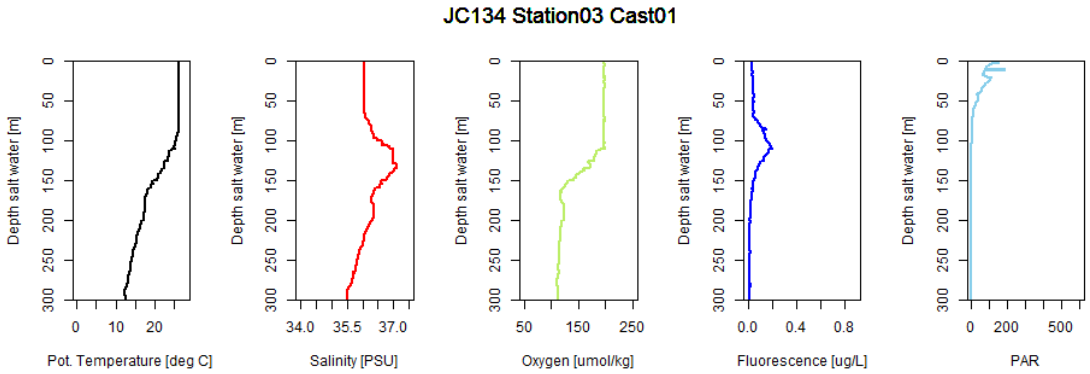


Figure 5.2.11: CTD profile of Station03 Cast01

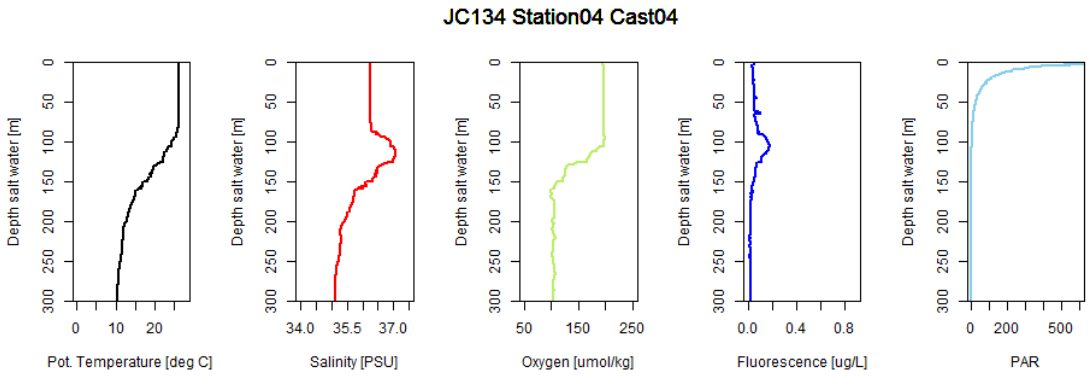


Figure 5.2.12: CTD profile of Station04 Cast04

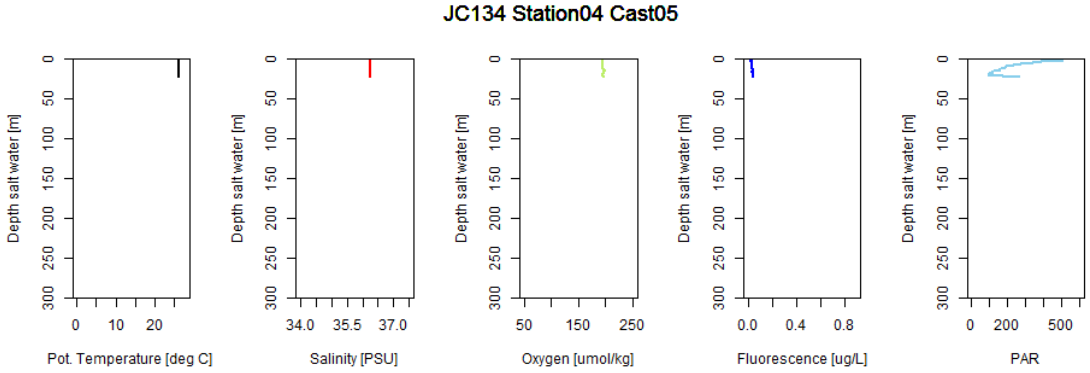


Figure 5.2.13: CTD profile of Station04 Cast05

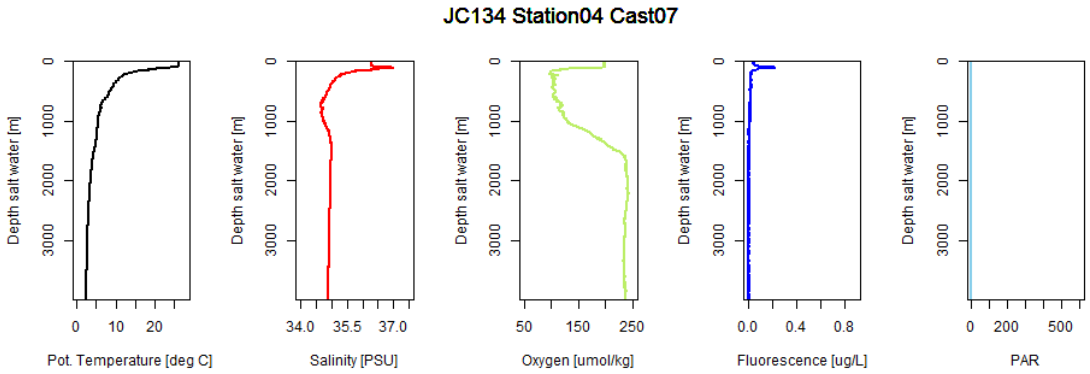


Figure 5.2.14: CTD profile of Station04 Cast07

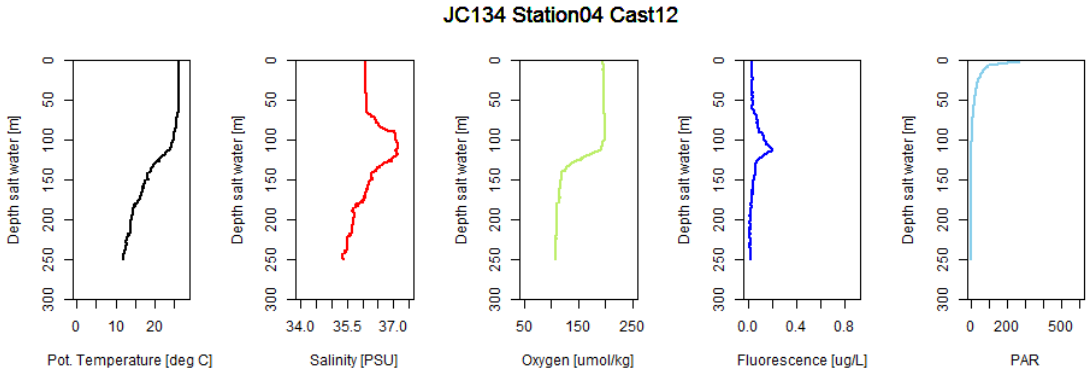


Figure 5.2.15: CTD profile of Station04 Cast12

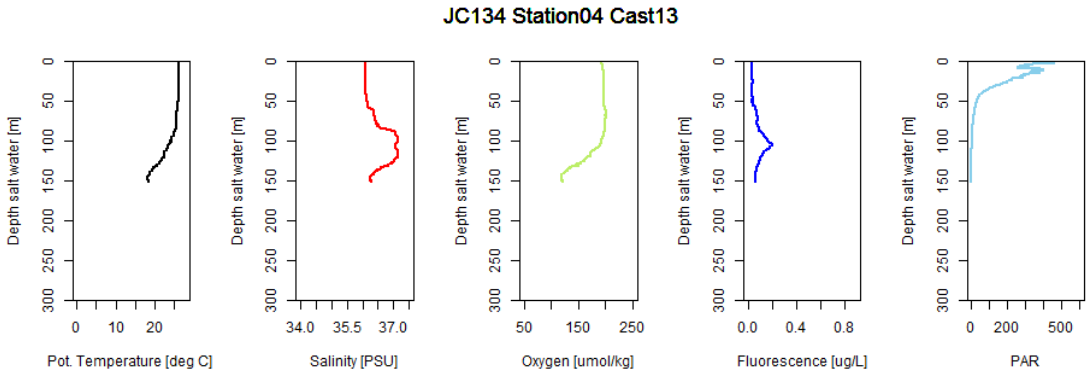


Figure 5.2.16: CTD profile of Station04 Cast13

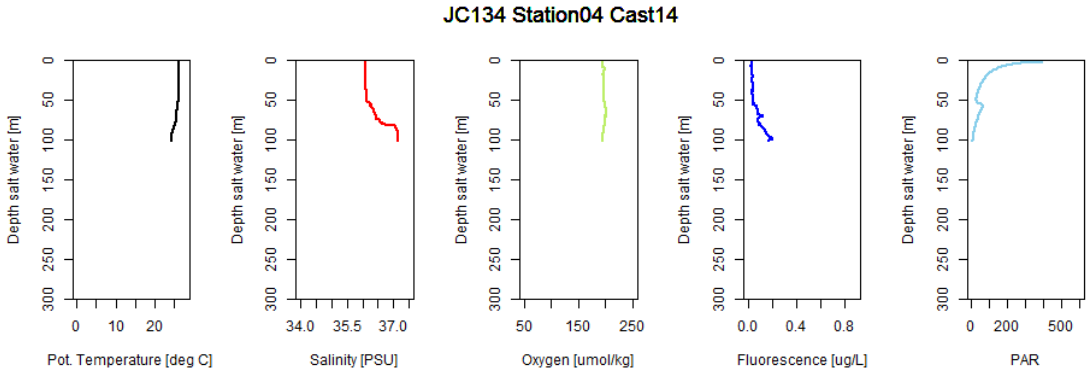


Figure 5.2.17: CTD profile of Station04 Cast14

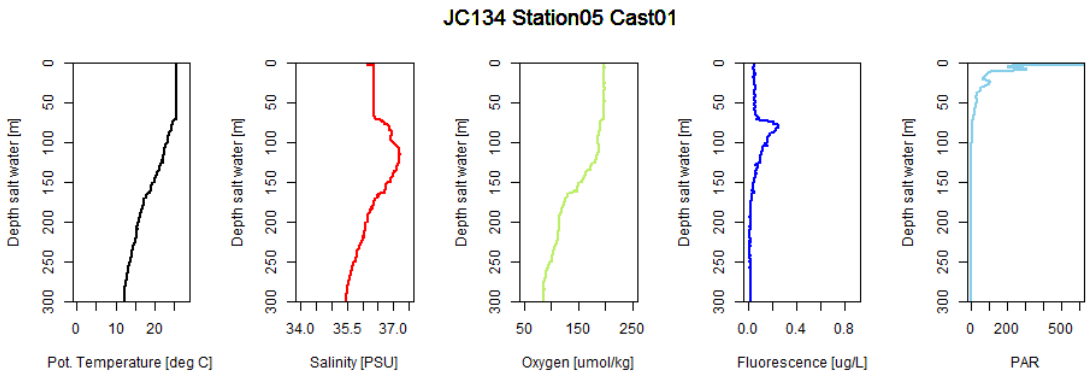


Figure 5.2.15: CTD profile of Station05 Cast01

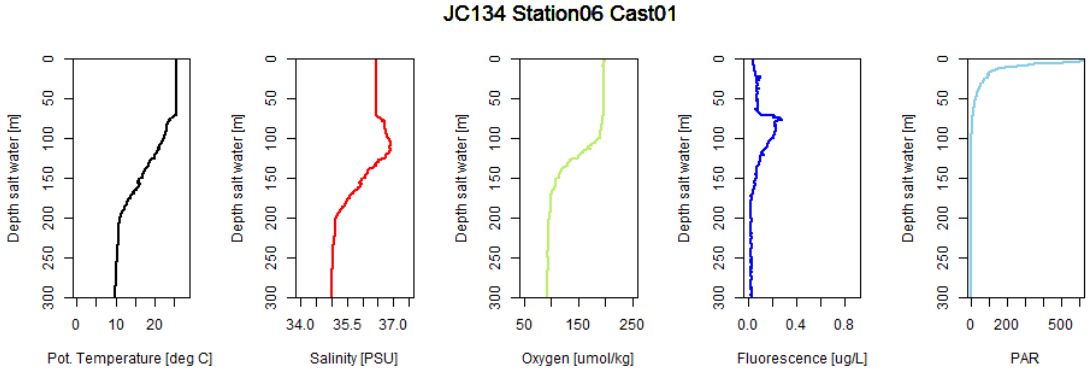


Figure 5.2.19: CTD profile of Station06 Cast01

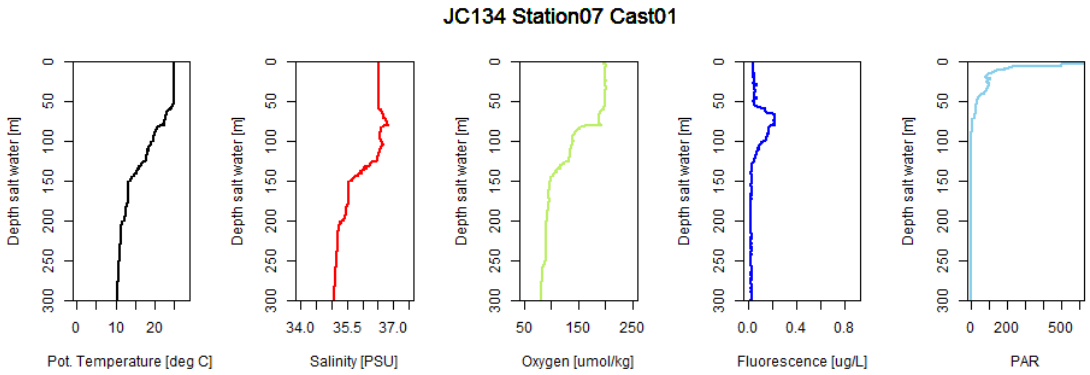


Figure 5.2.20: CTD profile of Station07 Cast01

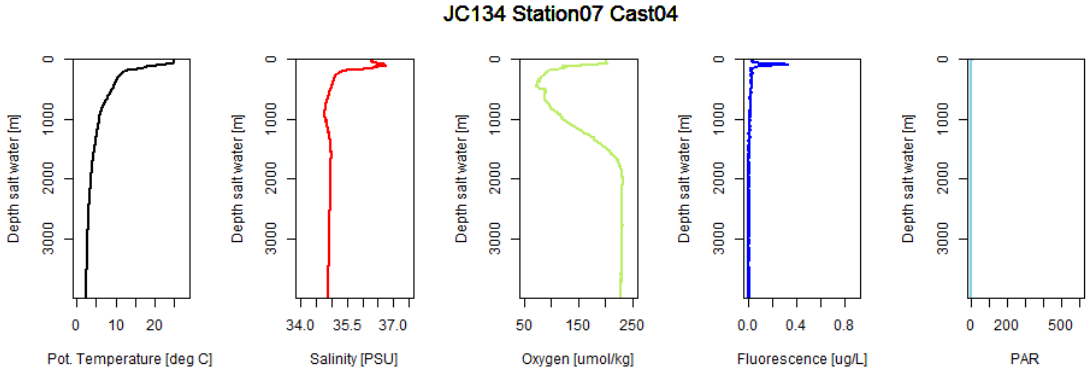


Figure 5.2.21: CTD profile of Station07 Cast04

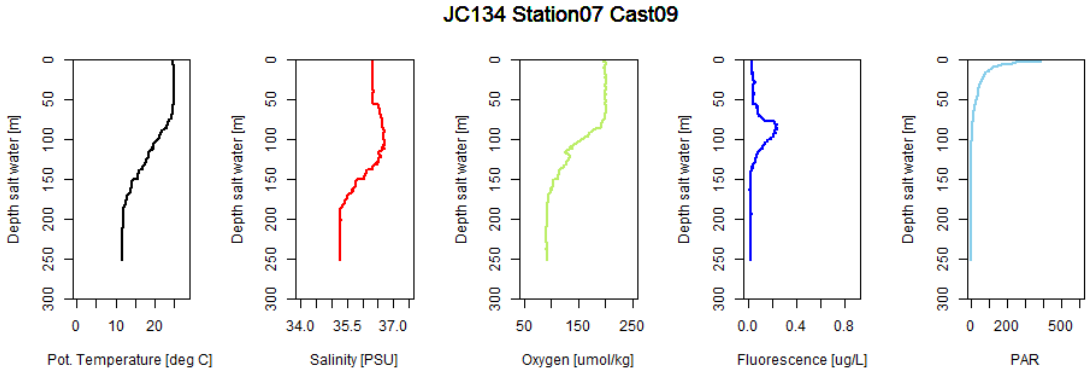


Figure 5.2.22: CTD profile of Station07 Cast09

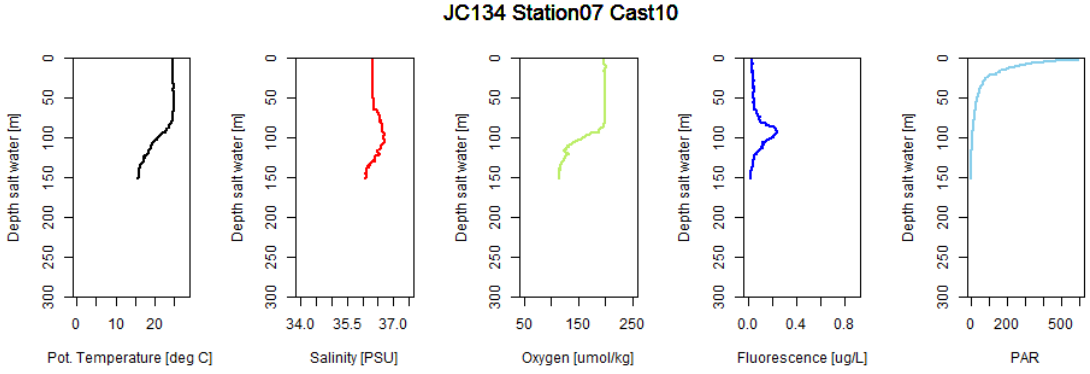


Figure 5.2.19: CTD profile of Station07 Cast10

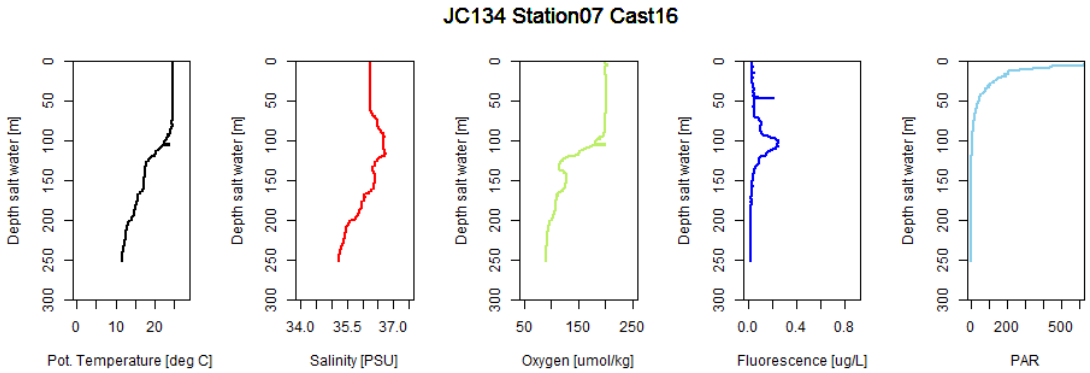


Figure 5.2.24: CTD profile of Station07 Cast16

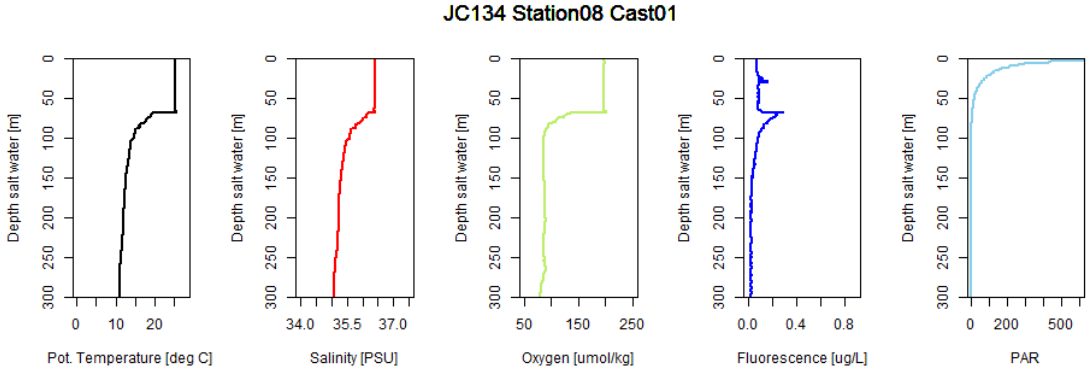


Figure 5.2.25: CTD profile of Station08 Cast01

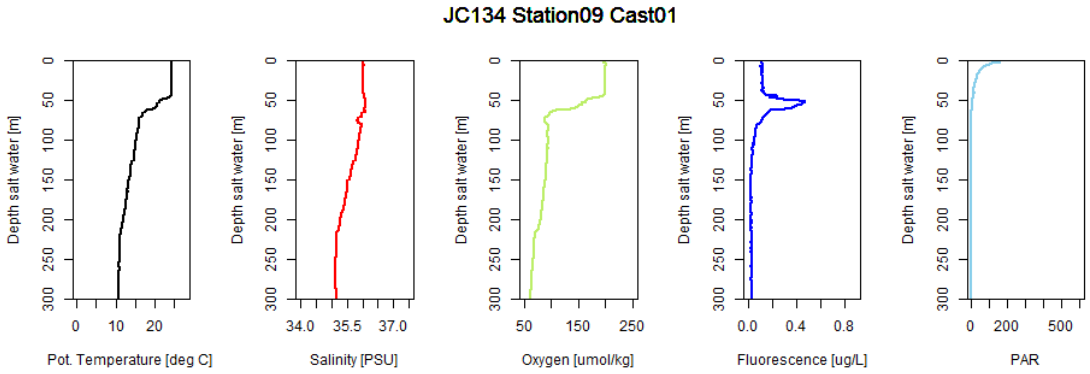


Figure 5.2.26: CTD profile of Station09 Cast01

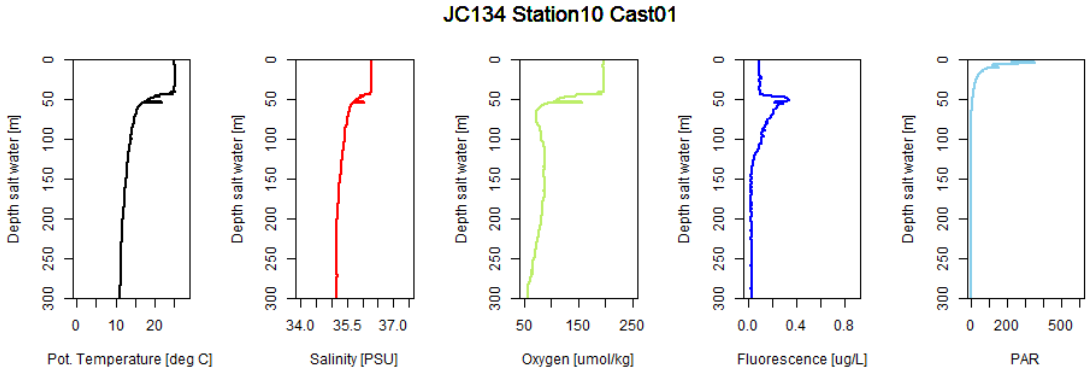


Figure 5.2.27: CTD profile of Station10 Cast01

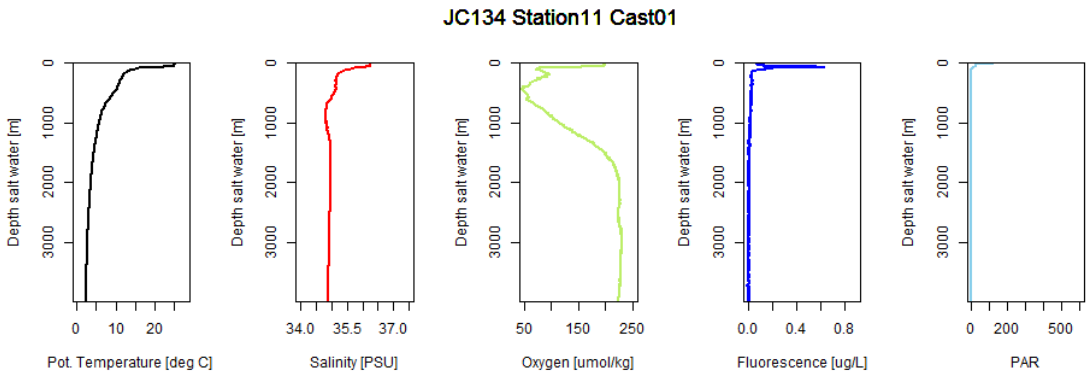


Figure 5.2.28: CTD profile of Station11 Cast01

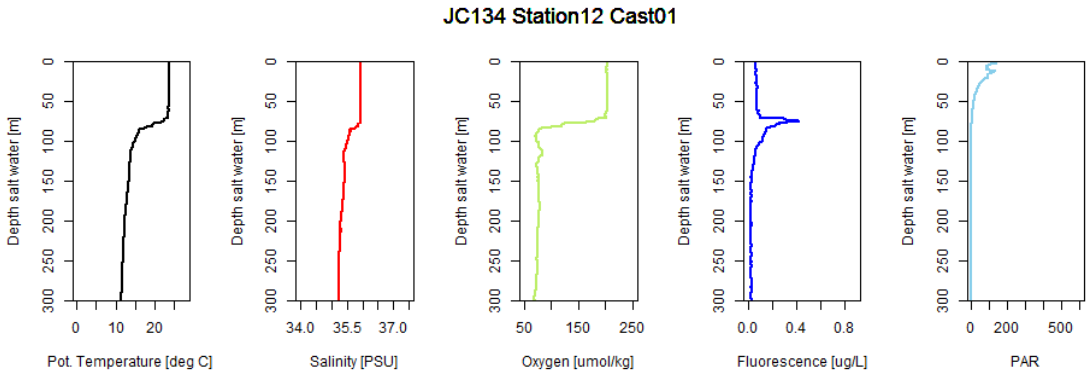


Figure 5.2.29: CTD profile of Station12 Cast01

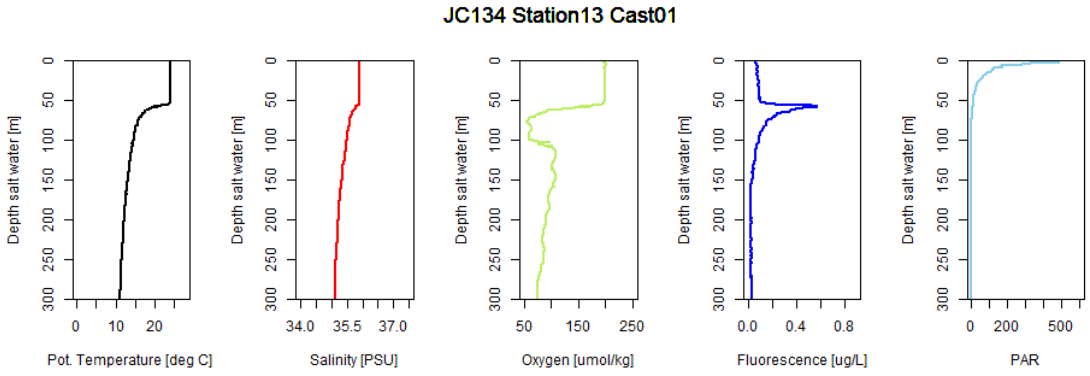


Figure 5.2.30: CTD profile of Station13 Cast01

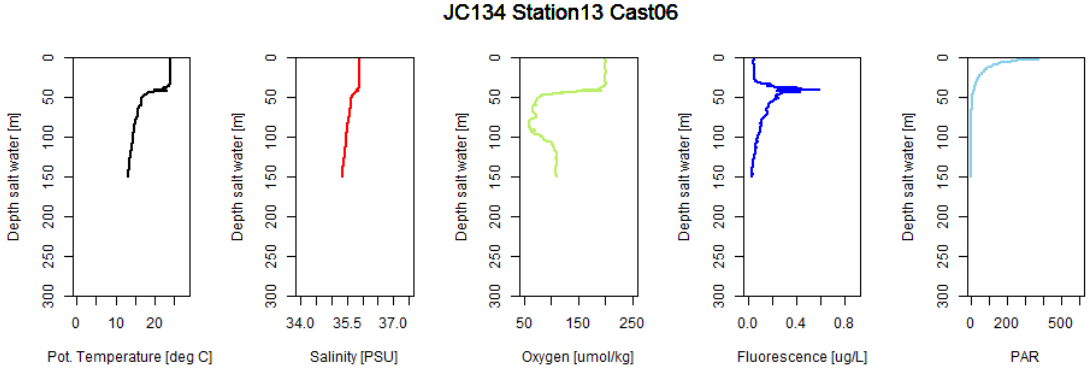


Figure 5.2.31: CTD profile of Station13 Cast06

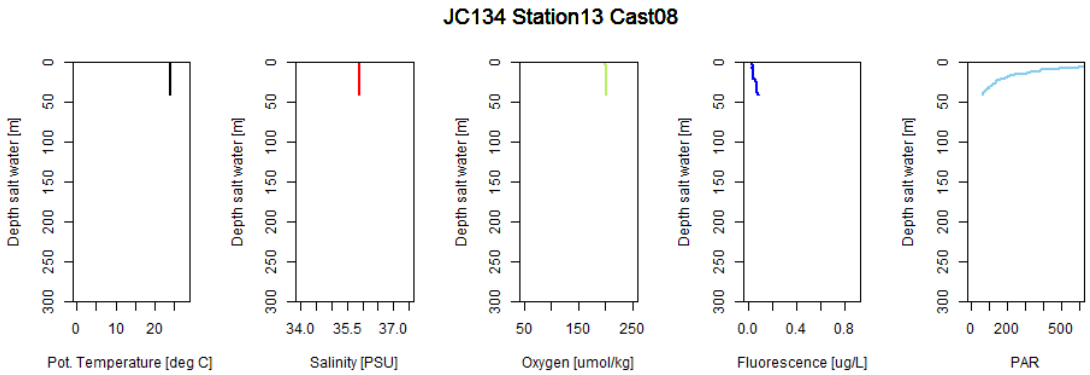


Figure 5.2.32: CTD profile of Station13 Cast08

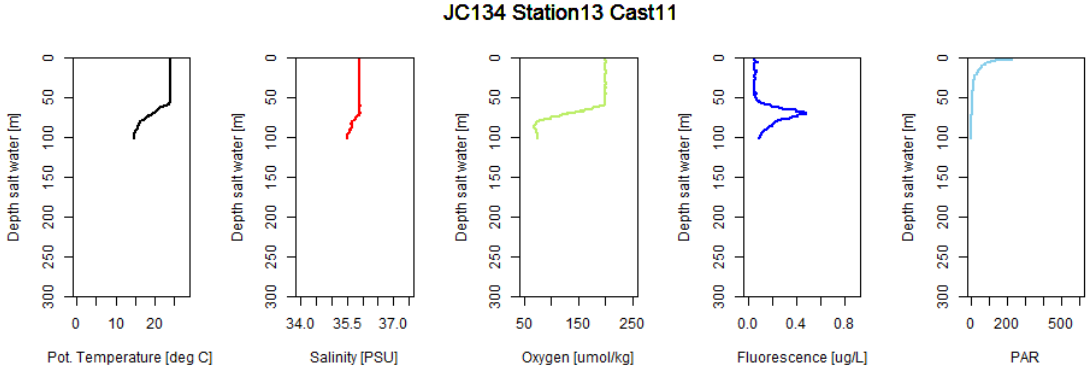


Figure 5.2.33: CTD profile of Station13 Cast11

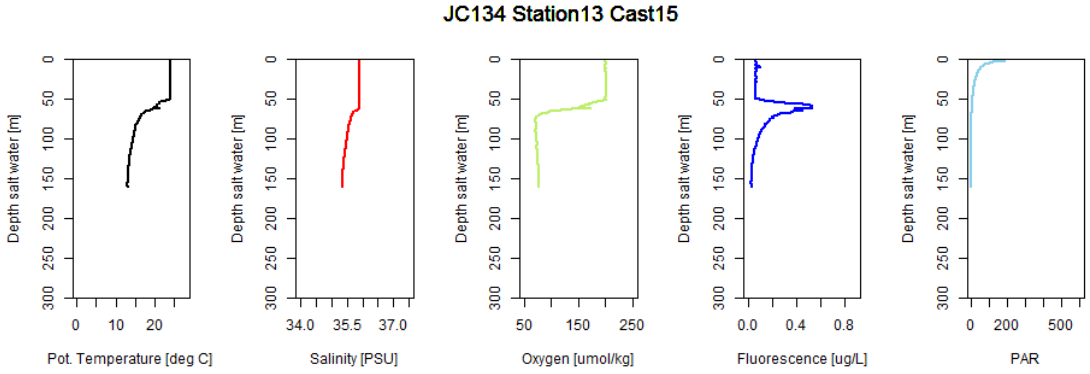


Figure 5.2.34: CTD profile of Station13 Cast15

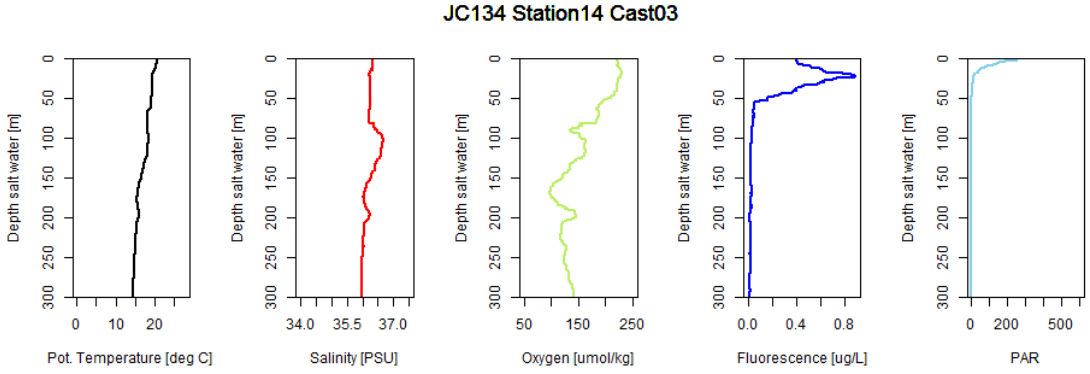


Figure 5.2.35: CTD profile of Station14 Cast03

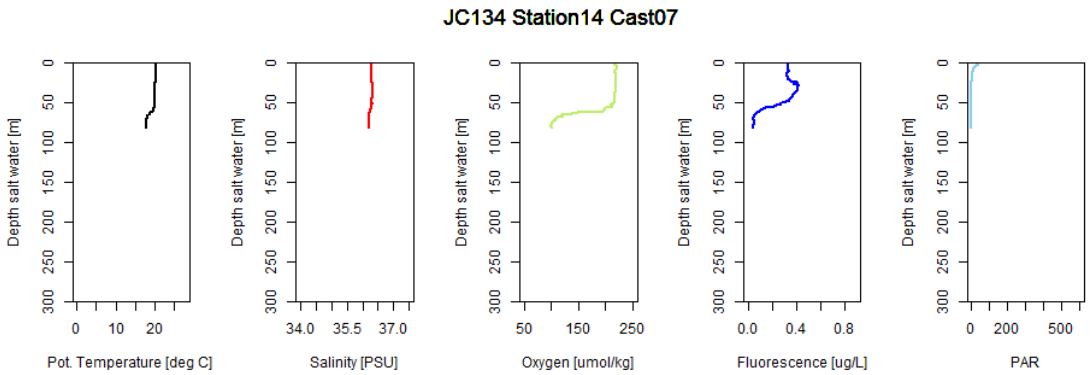


Figure 5.2.36: CTD profile of Station14 Cast07

TS diagrams

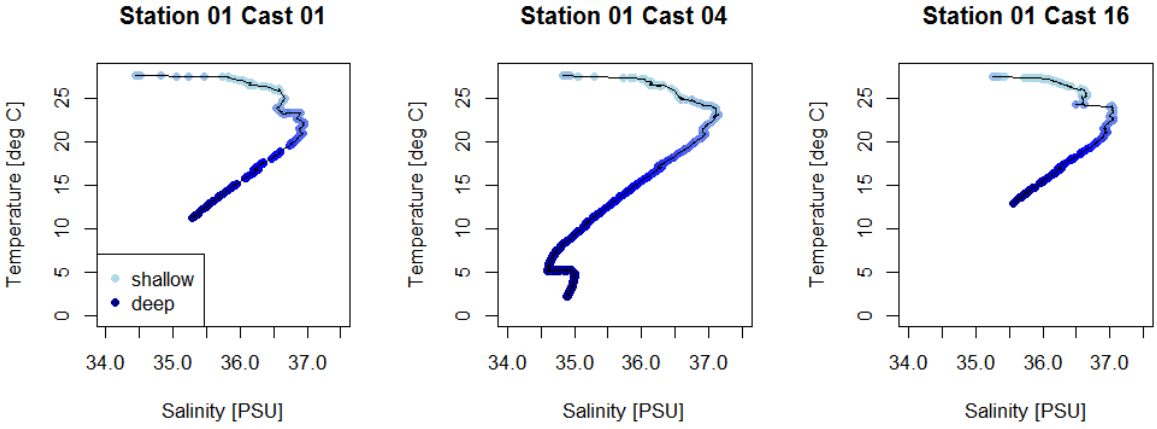


Figure 5.2.37: TS diagrams of Station 01 Casts 01, 04, and 16.

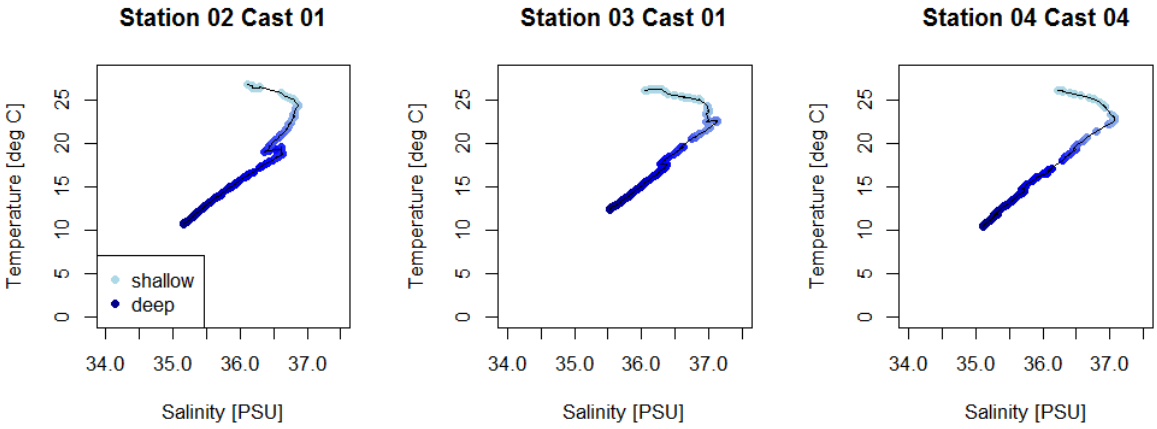


Figure 5.2.38: TS diagrams of Station 02 cast 01, Station03 cast 01, and Station04 cast04.

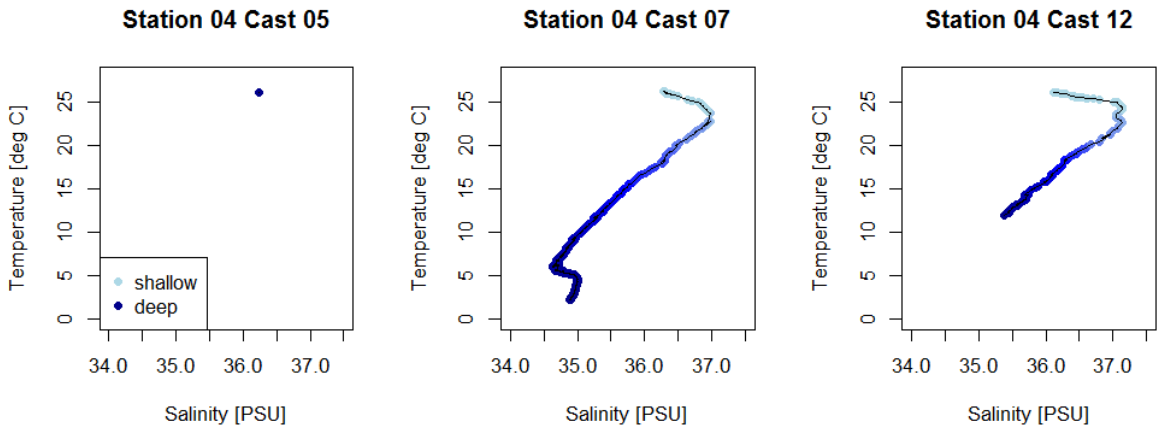


Figure 5.2.39: TS diagrams of Station 04 cast 05, Station04 cast 07, and Station04 cast12.

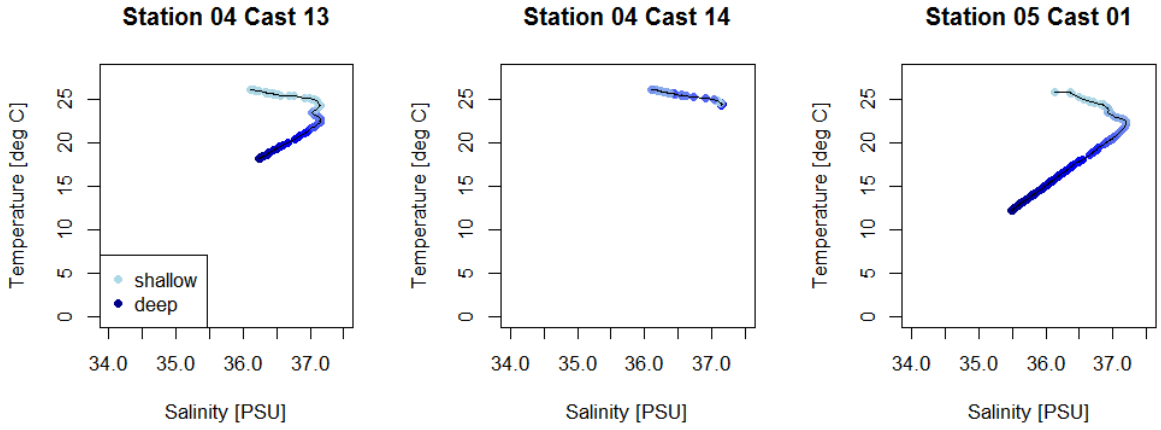


Figure 5.2.40: TS diagrams of Station 04 casts 13 and 14, and Station05 cast01.

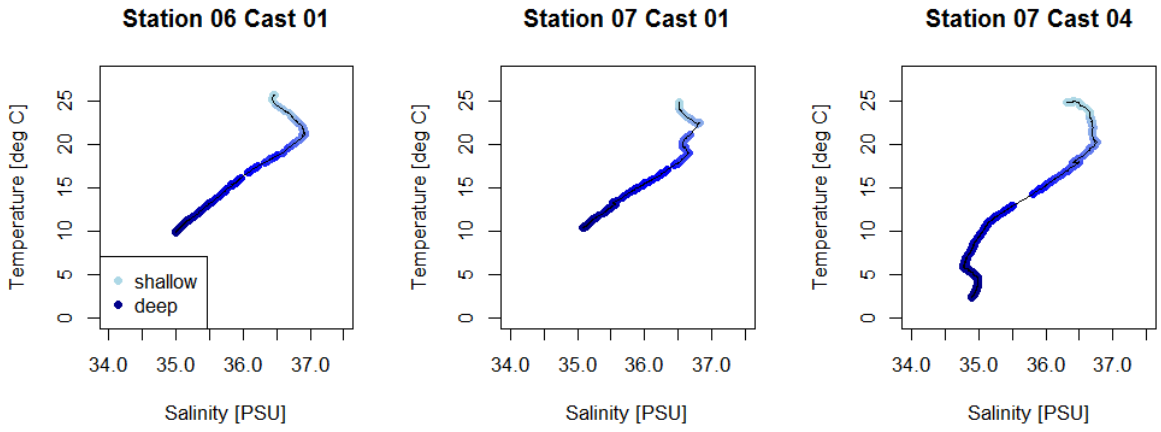


Figure 5.2.41: TS diagrams of Station 06 cast 01, and Station07 casts 01 and 04.

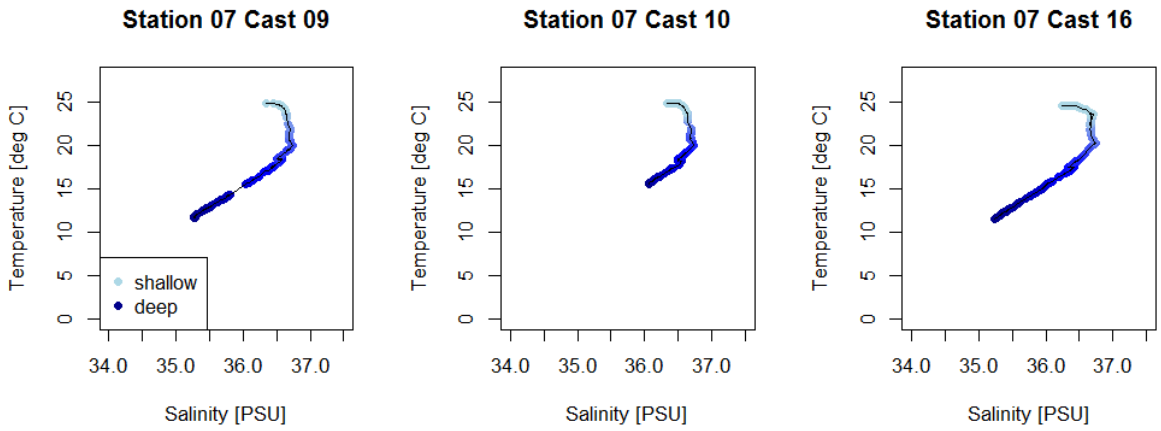


Figure 5.2.42: TS diagrams of Station 07 casts 09, 10, and 16.

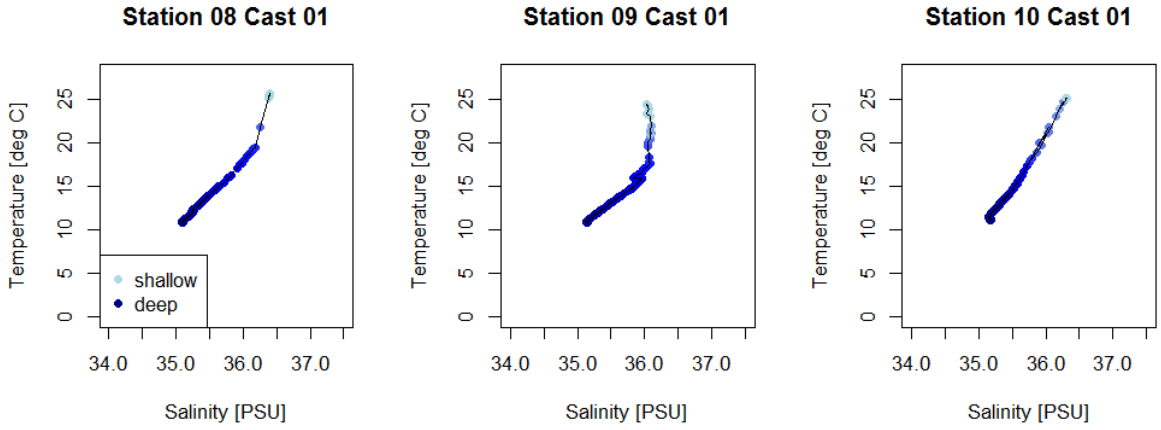


Figure 5.2.43: TS diagrams of Station 08 cast 01, Station 09 cast 01, and Station 10 cast01.

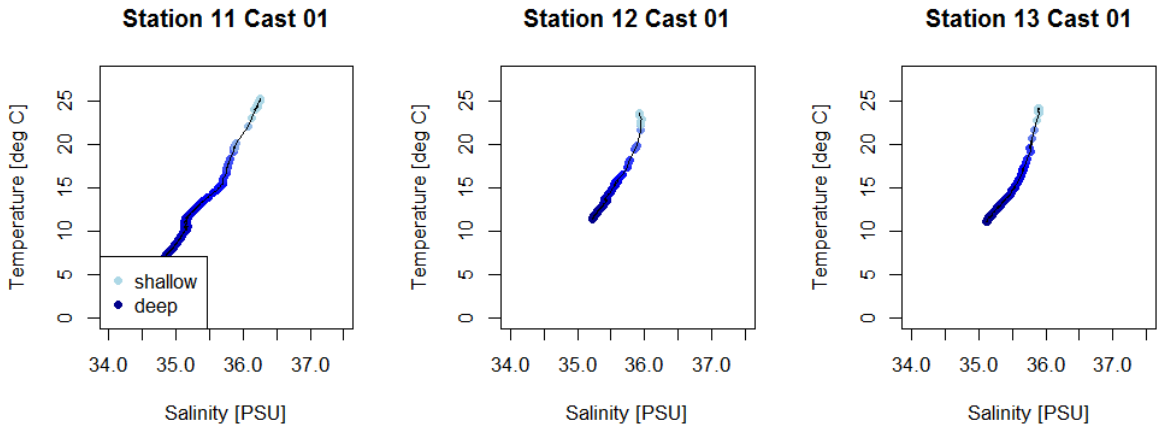


Figure 5.2.44: TS diagrams of Station 11 cast 01, Station 12 cast 01, and Station 13 cast01.

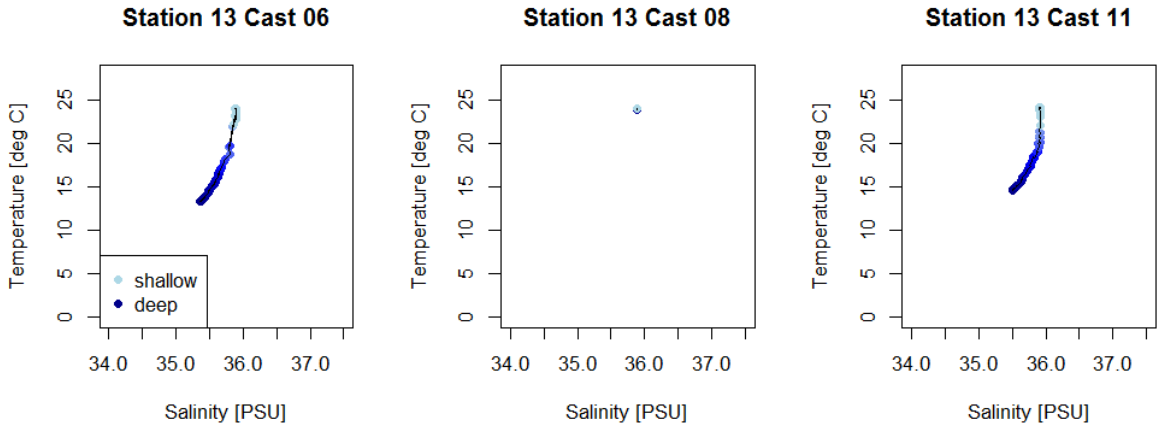


Figure 5.2.45: TS diagrams of Station 13 casts 06, 08, and 11.

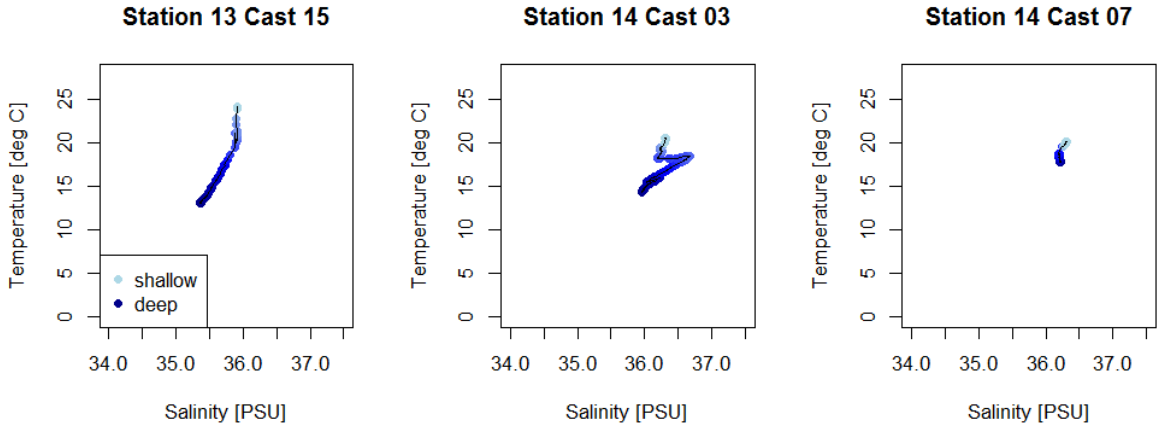
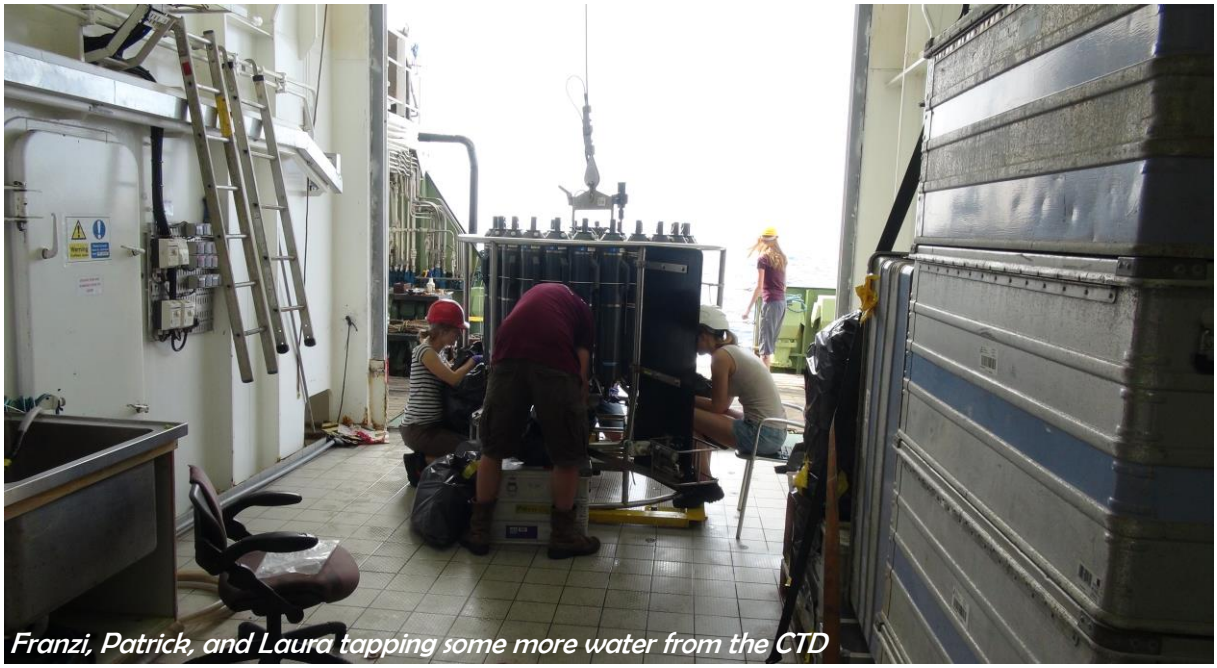


Figure 5.2.46: TS diagrams of Station 13 cast 15, and Station 14 casts 03 and 07.



Franzi, Patrick, and Laura tapping some more water from the CTD

5.2.2 Coccolithophore communities [Catarina Guerreiro]

Coccolithophores, which are autotrophic marine algae (Prymnesiophyceae), form a major component of the oceanic microplankton and are one of the main open-ocean primary producers. Because they also include r-selected taxa capable of responding to short-term environmental changes related to nutrient input [e.g. Guerreiro et al., 2013], this phytoplankton group provides interesting perspectives as indicators of transient primary productivity in the Equatorial Atlantic Ocean. In addition, because their cells' surfaces are covered by minute external calcite scales - the coccoliths -, coccolithophores represent the single most important component of deep-sea sediments, providing floral and biomarker signals for interpreting global change in the geological record. Their ecological record, thus, can be used as a tool to investigate environmental variability both in the present and in the past [e.g. McIntyre and Bé, 1967; Winter and Siesser, 1994].

In the context of the DUSTTRAFFIC project, we are interested in using the coccolith export production and species composition as potential indicators of ocean fertilization by aeolian dust originated from the Sahara Desert. In order to do that, it is fundamental to have a good understanding of the modern coccolithophore communities thriving in the Equatorial Atlantic Ocean, as well as their coupling with the hydrographic and meteorological conditions prevailing in this area. Of especial importance for our project is the region covered by our transatlantic array of sediment trap moorings, lying directly underneath the largest dust plume originating from the African continent (approx. 12° N).

To this aim, we have collected seawater samples at discrete water depths within the oceanic photic layer and performed CTD profiling from the photic layer along a transatlantic transect between the Caribbean Sea (Antigua) and the region offshore Cape Blanc (Mauritania). At 13 stations, 131 water samples were taken from NISKIN-bottles of the CTD-rosette, at 10 m, 20 m, 40 m, 60 m, 80 m, 100 m, 125 m, 150 m, 200 m and 250 m water depths (Table 5.2.2.1), although the water depth corresponding to the Deep Chlorophyll Maximum (DCM) varied from station to station.

Collection time usually took place early in the morning. For most of the cases, 5 L of water was filtered through cellulose nitrate filters (25 mm diameter, 0,45 μm pore size) by means of a water jet pump immediately on board. In the majority of the open-ocean stations, the filtration of the samples took around 2,5 to 3 hours. Samples regarding the (DCM) usually took more time, reflecting the presence of higher concentrations of Chl-a in this water level (ranging between 0,18 and 0,35 μg/l).

Samples collected at station 14 (offshore Cape Blanc), took around 3,5 to 4 hours to be fully filtered, reflecting the higher phytoplankton production in this area (up to 0,86 μg/l). As expected, the Chl-a maximum was much shallower in this location (approx. 22 m), reflecting higher productivity near the surface, most likely under the influence of the coastal upwelling offshore Cape Blanc.


Catarina taking samples from the CTD


....plenty of water to be filtered....

After filtering, the filters were washed with tap water, dried at room temperature and stored in petri dishes. The filtered material will be used for studies on the distribution and composition of the coccolithophore communities using Scanning Electron Microscope (SEM). Species composition and abundance will be determined by identification and counting on measured filter transects. The coccolithophore analysis will be undertaken within a multi-parameter approach, taking into account the hydrographic and meteorological conditions (i.e. temperature, salinity, fluorometry, nutrient concentrations, PAR, wind, AOD) during the cruise, and further compared with the coccolith assemblages and fluxes recently obtained from the sediment traps. We are especially interested in the W-E ecological gradients that we found in the trap records, in terms of the distribution of the upper- and the lower photic layer species.

We are also interested in looking for eventual changes in cells' density and/or species composition between the 28th March and the 1st April, a period during which an aeolian dust event originating from Africa took place. Insights gained from this study will ultimately contribute to calibrate the ecological preferences of coccolithophores and their potential as environmental proxies for the Tropical Atlantic Ocean.


This machine really sucks! (D. Jong)


Filters and residues, could that orange colour....??

References:

Guerreiro, C., Oliveira, A., De Stigter, H., Cachão, M., Sá, C., Borges, C., Cros, L., Quaresma, L., Santos, A.I., Fortuño, J.M., Rodrigues, A. (2013). Late winter coccolithophore bloom off central Portugal in response to river discharge and upwelling. Continental Shelf Research 59, 65 - 83.

McIntyre, A., Bé, A., 1967. Modern coccolithophoridae of the atlantic ocean—I. Placoliths and cyrtolyths. Deep-Sea Research 14, 561–597.

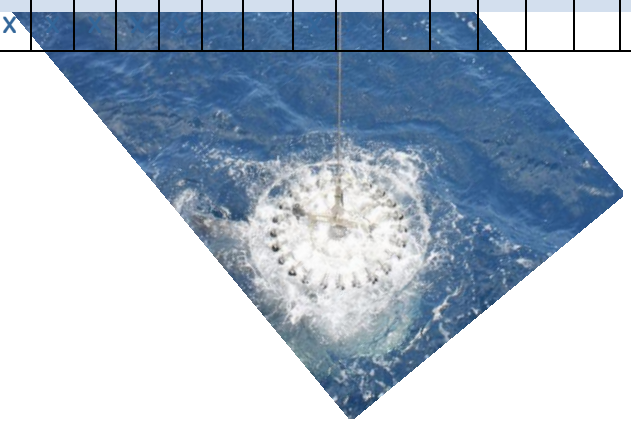
Winter, A., Siesser, W.G., 1994. Coccolithophores. Cambridge University Press, New York, 242 PP. ISBN 0-521-38050-2

Table 5.2.2.1: Seawater sampling for coccolithophore analysis (CTD-Rosette samples).

Station (Cast)	Date	Time	Lat (N)	Lon (W)	Depth (m)	Sample depth (m)	Volume (L)
1-1 (M5)	21/03	07:00	12° 04,42'	56° 10,93'	4491	10, 20, 40, 60, (72), 80, 100, 125, 150, 200, 250	5 x 11
2-1	23/03	07:00	11° 59,01'	53° 43,05'	4789	10, 20, 40, 60, 80, 96, 125, 150, 200, 250	5 x 10
3-1	24/03	07:00	11° 58,03'	50° 42,37'	5000	10, 20, 40, 60, 80, 110, 150, 200, 250	5 x 9
4-4 (M4)	25/03	07:00	11° 59,61'	49° 04,78'	3102	10, 20, 40, 60, 80, 105, 125, 150, 200, 250	5 x 10
5-1	27/03	07:00	12° 03,75'	46° 10,16'	4158	10, 20, 40, 60, 82, 100, 125, 150, 200, 250	5 x 10
6-1	28/03	07:00	12° 11,03'	42° 40,56'	3596	10, 20, 40, 60, 70, 100, 125, 150, 200, 250	5 x 10
7-1 (M3)	29/03	07:00	12° 19,06'	39° 8,12'	4696	10, 20, 40, 60, 71, 100, 125, 150, 200, 250	5 x 10
8-1	01/04	07:00	12° 16,74'	36° 20,35'	5111	10, 20, 40, 60, 67, 100, 125, 150, 200, 250	5 x 10
9-1	02/04	07:00	12° 13,98'	33° 8,94'	5735	10, 20, 40, 60, 80, 100, 125, 150, 200, 250	5 x 10
10-1	03/04	07:00	12° 11,03'	29° 51,29'	5726	10, 20, 40, 55, 80, 100, 125, 150, 200, 250	5 x 10
12-1	04/04	07:00	12° 8,32'	26° 51,19'	5257	10, 20, 40, 60, 75, 100, 125, 150, 200, 250	5 x 10
13-1 (M1)	05/04	07:00	11° 24,31'	23° 4,30'	5099	10, 20, 40, 58, 80, 100, 125, 150, 200, 250	5 x 10
14-4 (CB)	11/04	16:20	21° 17,15'	20° 58,41'	4217	5, 10, 22, 40, 60, 80, 100, 125, 150, 200, 250	5 x 11

Table 5.2.2.2: Overview of the CTD seawater samples collected for the coccolithophores' study

Station		CTD bottle																						
Nr	Cast	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	1	X	X	X	X	X	X										X		X	X	X			X	
2	1	X	X	X	X	X										X	X		X				X	X	
3	1	X	X	X										X	X	X			X	X			X		
4	4	X	X	X	X		X									X		X		X		X		X	
5	1	X	X	X	X	X	X											X		X		X		X	
6	1	X	X	X	X	X	X											X		X		X		X	
7	1	X	X	X	X	X	X												X		X	X		X	
8	1		X	X	X	X	X	X											X		X		X	X	
9	1	X	X	X	X	X	X	X														X		X	
10	1	X	X	X	X	X	X	X												X		X		X	
12	1	X	X	X	X	X	X													X	X	X		X	
13	1	X	X	X	X	X	X	X												X		X		X	
14	3	X	X	X	X														X						X



5.2.3. Sampling diatoms and coccoliths for post-cruise nanoSIMS analyses [Anne Roepert]

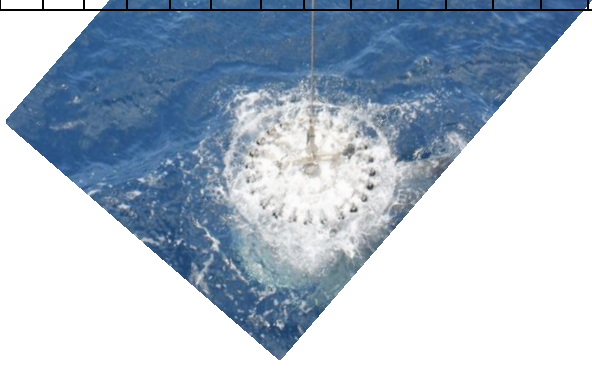
The PhD projects of Anne Roepert and Shaun Akse (Geochemistry, Utrecht University, PI: Jack Middelburg) aim at developing new and refining existing paleoceanographic proxies. For the two projects, diatoms (for Shaun Akse) and coccoliths (for Anne Roepert) were targeted to be sampled by filtration of seawater collected from the CTD. At each station, three depths were sampled: one shallow sample from 20 m, one sample from the deep chlorophyll maximum (DCM) and one sample from a depth in between the two. This scheme was carried out for all stations but station 14 cast 03, where the chlorophyll maximum was shallower than at the other stations at 20 m depth and one sample was collected from underneath the chlorophyll maximum.

At each station, for each sampled depth, three different volumes ranging between approximately 500 ml to 5000 ml were filtered through 25 mm 5 µm polycarbonate filter to target diatoms. The filtrate was collected and three volumes ranging between 50 ml and 1000 ml were filtered through 25 mm 0.4 µm polycarbonate filters mounted onto a 25 mm GFF support filter to target coccoliths. For each depth, the remaining collected water (between 3 – 7 litres) was filtered over one 47 mm 0.4 µm polycarbonate filter mounted onto a 47 mm GFF support filter as a backup. All filters were rinsed three times with 10 ml 0.05 M NH_4HCO_3 (pH 7.8) in order to remove salts.

An overview over the sampled CTD bottle positions of all sampled CTD casts for post-cruise nanoSIMS analyses is provided in table 5.2.3.1.

Table 5.2.3.1: Overview of the CTD seawater samples collected for nanoSIMS studies

Station		CTD bottle																						
Nr	Cast	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	1															X		X				X			
2	1														X			X				X			
3	1													X				X				X			
4	4					X													X		X				
5	1							X											X				X		
6	1							X											X				X		
7	1							X										X					X		
8	1								X											X		X			
9	1								X														X		
10	1								X										X		X				
12	1																	X	X				X		
13	1								X												X		X		
14	3																				X				



5.2.4. Nutrient depth profiles of shallow CTD casts [Anne Roepert]

In order to obtain nutrient profiles (dissolved nitrogen, phosphorous and silica) for the shallow CTD casts (300 m depth), samples were taken from shallow CTD casts by Catarina Guerreiro and Anne Roepert and stored for post-cruise analysis at NIOZ. An overview of the sampled CTD casts and bottle positions is given in table 5.2.4.1. Three depths were taken at station 1 corresponding to the CTD bottles of the samples for nanoSIMS analysis (§5.2.2), while as of station 2, nutrient samples were collected from all depths sampled by Catarina and Anne.

Samples for NO_x, NH_4 and PO_4 were filtered through 0.2 µm acrodisc filters into 5 ml pony vials, after rinsing the syringe, filter and tubes once with sample water. Pony vials were filled so that there was enough space left for expansion caused by freezing. Samples were stored at -20 °C. Samples for dissolved silicate were filtered through 0.2 µm acrodisc filters into 5 ml pony vials, after rinsing the syringe, filter and tubes once with sample water. Samples were stored at +4 °C.

Table 5.2.4.1: Overview of nutrient samples collected from shallow CTD casts by Catarina and Anna

Station		CTD bottle																					
Nr	Cast	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	1															X		X				X			
2	1	X	X	X	X	X									X	X	X	X	X			X		X	
3	1	X	X	X										X		X	X	X		X		X		X	
4	4	X	X	X	X	X										X		X	X	X	X			X	
5	1	X	X	X	X	X		X										X	X	X			X	X	
6	1	X	X	X	X	X		X											X	X			X	X	
7	1	X	X	X	X	X		X												X	X		X	X	
8	1		X	X	X	X	X		X											X	X	X		X	
9	1	X	X	X	X	X	X		X			X											X	X	
10	1	X	X	X	X	X	X		X										X		X			X	
12	1	X	X	X	X	X												X	X		X		X	X	
13	1	X	X	X	X	X	X		X												X		X	X	
14	3	X	X	X	X	X	X	X	X			X							X						X

Welcome to the water lab

5.2.5 Microbial Ecology

[Corina Brussaard, Anna Noordeloos, Kirsten Kooijman, Tessa de Bruin]

Microbes (viruses, heterotrophic prokaryotes, phytoplankton and zooplankton) make up more than 95% of the ocean's biomass and are essential for the cycling of biogeochemical elements. Furthermore, phytoplankton that are responsible for about 50% of the Earth's oxygen production, form the base of most of the pelagic food chains in the seas. Phytoplankton production is regulated by physicochemical variables such as light, temperature and nutrients. Phytoplankton in the subtropical Atlantic Ocean are limited in their growth by macro- (N, P, Si) and often also micronutrients (Fe). Input of Sahara dust has the potential to stimulate phytoplankton growth. At the same time, primary production has been shown to be controlled by predation and viral lysis. To fully understand the effect of dust on the composition and functioning of the pelagic microbial community, we sampled along the cruise transect for microbial abundances, growth and losses.

Phytoplankton, bacterial and viral abundance sampling

From every CTD (except station 11), samples were taken for phytoplankton, bacteria, and viruses. Samples for abundance were typically taken at 6 separate depths from each CTD. Furthermore, samples for microbial analysis from on-deck incubations with and without dust additions (project Laura Korte) were taken daily. Phytoplankton samples were fixed using formaldehyde/hexamine (18%/10% v/w; 100µl per 3.5ml sample). Bacterial and viral abundance were fixed in glutaraldehyde (0.5% final concentration). All fixed samples were flash frozen after fixation for 15-30 min at 4°C, and stored at -80°C. Samples will be analysed in the home laboratory upon completion of the cruise.

Additionally, we analysed phytoplankton abundances (<20µm cell diameter) from the CTD samples directly onboard using a bench top flow cytometer (BD FACSCalibur). The instrument is equipped with a 15mW Argon laser (488 nm excitation), which has an emission in the green, orange, and red. In addition, forward and side (90°) light scatter are collected. The phytoplankton abundances from the deck incubation experiments were analysed fresh for 10 min using a second bench top flow cytometer (BD Accuri) with a 20 mW solid state blue laser (488 nm excitation). Finally, phytoplankton abundances from bioassays performed were also counted fresh using the BD Accuri flow cytometer (5 min per sample).

Anna performs the initial flow-cytometer analyses.

The fresh phytoplankton populations were discriminated using red chlorophyll auto fluorescence and scatter. Species/group composition was characterized based on the cellular bio-optical properties, including forward- and side scatter and chlorophyll fluorescence, of the algal cells. The natural community was gravity size-fractionated, using 12, 10, 8, 5, 3, 2, 1, 0.8, and 0.6 µm pore-size PC-filters, to provide the size distribution of the phytoplankton; different clusters of phytoplankton <20 um were observed. Figure 1 displays 2 examples of the deep chlorophyll maximum (DCM, 60 and 70m, respectively) phytoplankton community and 1 example showing phytoplankton populations of the mixed layer (ML).

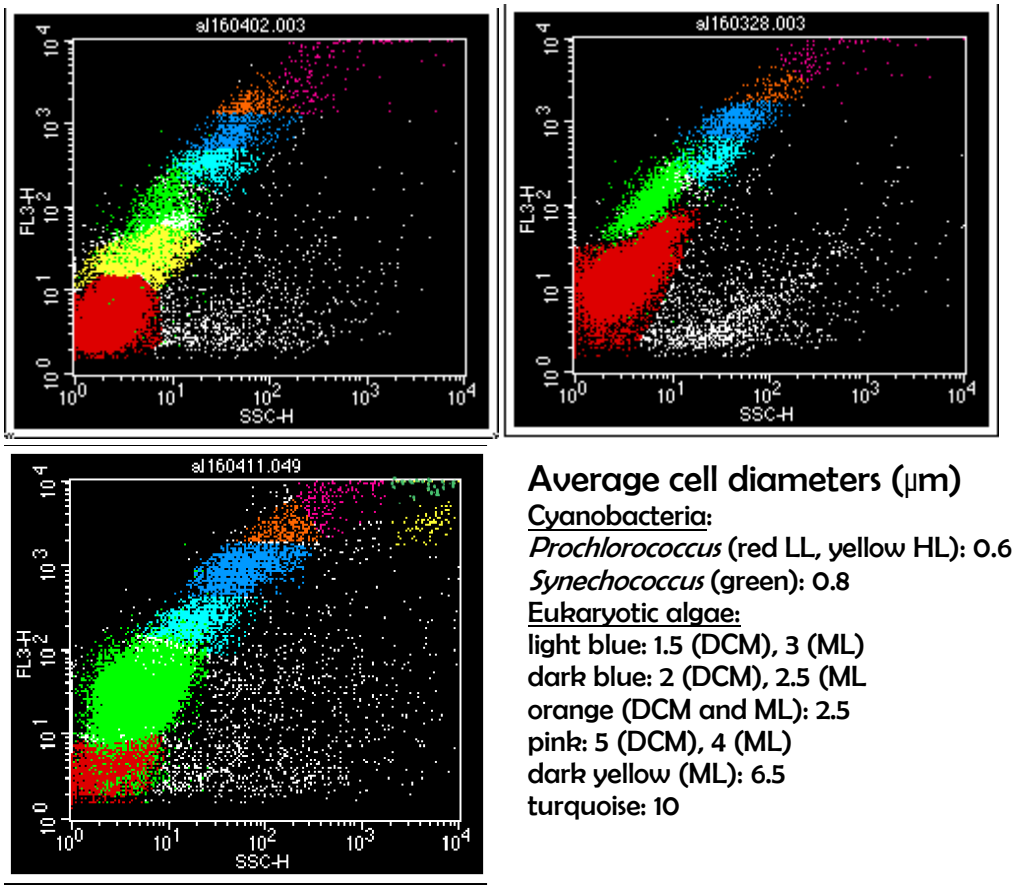


Figure 5.2.5.1. Flow cytometric distribution of the phytoplankton found during this cruise; (A and B, i.e. top left and right) from DCM, with clear distinction in Prochlorococcus ecotypes (B); and (C, i.e. lower plot) from ML.

The most abundant phytoplankton was smaller than 1 µm cell diameter, largely made up by the cyanobacteria *Prochlorococcus* and *Synechococcus* (Figure 5.2.5.1). Mid transect the two ecotypes of *Prochlorococcus*, i.e. high-light (HL) and low-light (LL) ecotypes, could be clearly discriminated (Figure 5.2.5.1B). Larger-sized phytoplankton populations showed up in the mixed layer (ML) of the eastern stations (Figure 5.2.5.1C). The eastern most station showed a distinct population with higher side scatter signature (dark yellow cluster Figure 5.2.5.1C), likely coccolithophores.

Abundance plots of the DCM phytoplankton community (Figure 5.2.5.2) display a west-east trend of declining *Prochlorococcus* and increasing *Synechococcus*, related to the shallowing of the chlorophyll maximum. This trend is also visible for the total Prochlorococcus abundances (Figure 5.2.5.3).

Abundances of the various most common phytoplankton populations are for both DCM and ML presented in Figures 5.2.5.4 and 5.2.5.5.

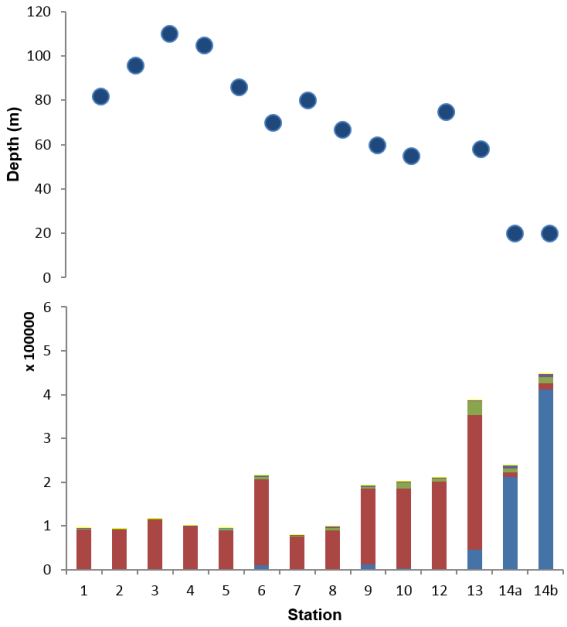


Figure 5.2.5.2: Depth of DCM and total phytoplankton (pp) abundance with relative distribution of the different pp populations found during this cruise in the DCM.

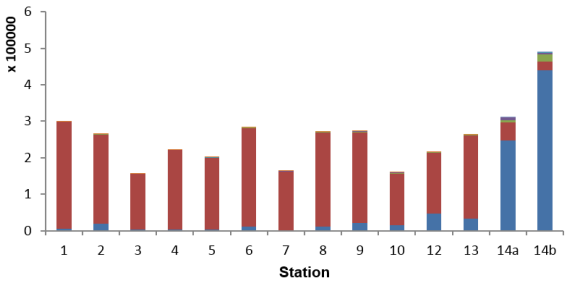


Figure 5.2.5.3: Total pp abundance with relative distribution of the different pp populations found in the ML.

See Figure 5.2.5.1 for colour indication of the phytoplankton groups.

Corina at the microscope, Kirsten keeps a watchful and merry eye

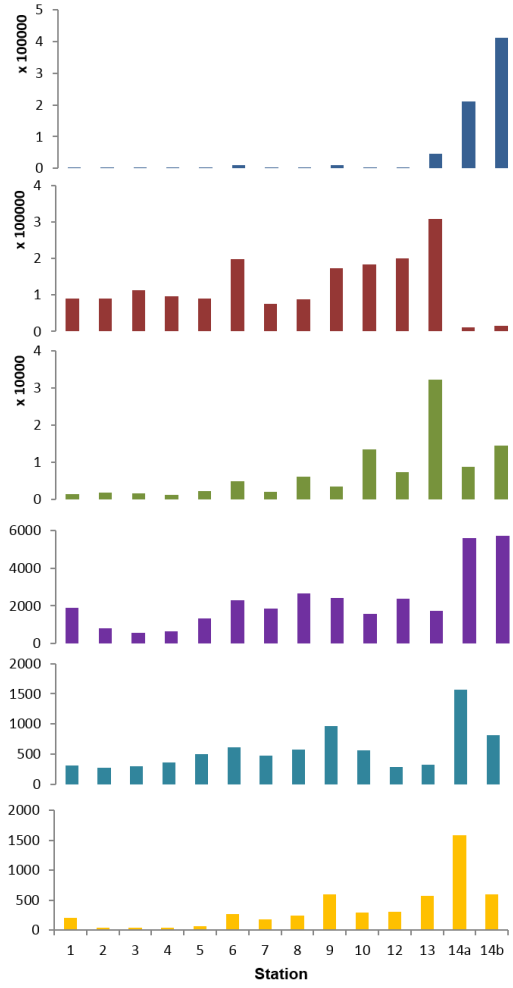


Figure 5.2.5.4: Abundance distribution of the most common pp populations found in the DCM.

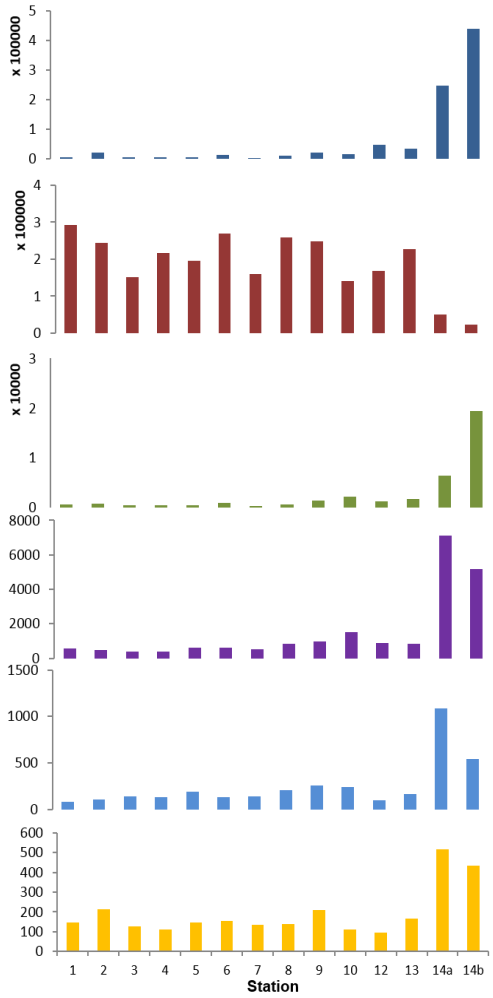


Figure 5.2.5.5: Abundance distrubion of the most common pp populations found in the ML.

See Figure 5.2.5.1 for colour indication of the phytoplankton groups.

Phytoplankton taxonomic composition sampling

For every station, samples were taken for phytoplankton taxonomic composition (HPLC and light microscopy) from the (deep) chlorophyll maximum and occasionally also the mixed layer (in conjunction with viral production assays). Generally 10L of water was filtered onto GF/F and GF75 filters. Filters were then snap frozen and stored at -80°C. Filters will be analysed upon return to the home institute. Pigments on the frozen filters will be separated by HPLC and identified by retention time and diode array spectroscopy. Chlorophyll *a* (and divenyl chlorophyll a) will be used as an indicator for algal biomass because this pigment is present in all algae. Specific marker pigments can be used to estimate the contribution of specific taxonomic groups to the total phytoplankton population. Larger sized phytoplankton (>20µm cell diameter) and zooplankton will be examined from Lugol-fixed samples (300µl per 100ml sample; stored at 4°C) using light microscopy. The last 4 stations showed large centric diatoms (*Planktoniella sol*) in the >20µm concentrate made after examination onboard using an inverted transmitted light microscope (Zeiss Axiovert-25; with HAL 6V, 30W illumination).

....you have to look really closely to see these small creatures....

Inorganic Nutrients (N, P, Si)

For the inorganic nutrients in the seawater, samples were obtained from the CTD rosette sampler. The bottles were rinsed three times with the seawater before being fully filled. In the lab container the nutrient samples were filtered over a 0.2µm Acrodisc filter into 5ml polyethylene vials, (also known as 'ponyvials') rinsing three times, and stored in the dark at 4°C until analysis. The samples will be analysed for inorganic phosphate, nitrite, nitrate and nitrite, ammonium and silicate using a QuAAtro Continuous Flow Analyser upon return to the NIOZ.

The colorimetric methods to be used are as follows:

- Ortho-Phosphate (PO_4) reacts with ammonium molybdate at pH 1.0, and potassium antimonyltartrate is used as an inhibitor. The yellow phosphate-molybdenum complex is reduced by ascorbic acid and measured at 880 nm.
- Ammonium (NH_4) reacts with phenol and sodiumhypochlorite at pH 10.5 to form an indo-phenolblue complex. Citrate is used as a buffer and complexant for calcium and magnesium at this pH. The color is measured at 630 nm.
- Nitrate plus nitrite (NO_3+NO_2) is mixed with an imidazol buffer at pH 7.5 and reduced by a copperized cadmium column to nitrite. The nitrite is diazotated with sulphanylamide and naphtylethylene-diamine to a pink colored complex and measured at 550 nm. Nitrate is calculated by subtracting the nitrite value of the nitrite channel from the 'NO3+NO2' value. * Nitrite (NO_2) is diazotated with sulphanylamide and naphtylethylene-diamine to a pink colored complex and measured at 550 nm.
- Silicate (Si) reacts with ammonium molybdate to a yellow complex, after reduction with ascorbic acid; the obtained blue silica-molybdenum complex is measured at 800 nm. Oxalic acid is added to prevent formation of the blue phosphate-molybdenum. Silicate analyses will be performed in the nutrient laboratory of the NIOZ after the cruise.

Table 5.2.5.1: Overview of samples analysed on board for various microbial analyses

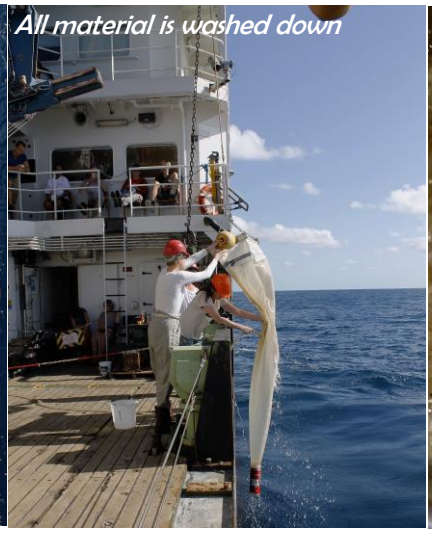
Station		CTD Bottle																							
nr	cast	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	1	N,M	N,M	N,M	N,M	N,M	N,M	N,M									N,M	N,M	N,M	N,M				N,M	N,M
1	6	N,M		N,M		N,M,H	H	L,H	H	H	H	H	H	N,M						N,M			H		
3	1		N,M	N,M			N,M,H	H	L,H	H	H	H	H	H	H			N,M		N,M					N,M	
3	1					H	H	L,H	H	H	H	H	H	N,M				N,M				N,M	H		
4	4		N,M	N,M		N,M		N,M,H	H	L,H	H	H	H	H	H		N,M						N,M		N,M
4	13	N,M	N,M	N,M		N,M					N,M		N,M		N,M					N,M					
5	1		N,M	N,M			N,M		N,M,H	H	L,H	H	H	H	H	H	N,M			N,M	N,M			N,M	N,M
6	1		N,M	N,M			N,M		H	H	L,H	H	H	H	H	H	H	N,M			N,M			N,M	N,M
7	1		N,M		N,M		N,M		N,M,H	H	L,H	H	H	H	H	H	H	H	N,M			N,M			N,M
7	9	N,M,D	D	D	D	N,M	N,M						D	D	D	N,M	N,M,D	D	D	D	N,M				N,M
7	15	N,M	D	D	D	N,M	N,M		L							A	N,M,D	D	D	N,M	N,M		N,M	A	N,M
8	1			N,M	N,M					N,M,H	H	L,H	H	H	H	H	H	H	N,M				N,M		N,M
10	1		N,M		N,M			N,M		L,H	N,M,H	H	H	H	H	H	H	H	N,M			N,M		N,M	N,M
13	1		N,M		N,M		N,M	L,H	H	H	H	H	H	H	H	H	H			N,M		N,M		N,M	N,M
13	1		N,M		N,M			N,M		L,H	H	H	H	H	H	H	H	H	H	N,M		N,M		N,M	N,M
13	6	N,M		N,M														N,M	N,M						N,M
13	11	N,M																							
13	15	N,M	N,M			N,M	H	H	H	H	H	H	H	H	H	H	N,M	N,M		N,M					
14	3		N,M					N,M	N,M			N,M			L,H	H	H	H	N,M,H				H	N,M,H	
14	7	N,M	N,M					N,M																	

N = Nutrients
M = Microbial abundance
L = Lugol
H = HPLC
A = Adsorption
D = Extra dust filtration

5.2.6 Microplastics [Corina Brussaard, Jaap de Boer, Lydia Sevenster]

A neuston net (70x30cm) with 150µm mesh-size was used to collect plastics from the surface ocean. Typically, 1 hour tows were taken at a speed of 1 knot through the water. The net was adjusted with extra weight on a long rope connected to the frame cable. Two small floaters on both sides for more lift and an extra-long line from the net to the cable prevented the net being pulled up out of the water. This worked very well. Catches were concentrated over a 63 µm mesh-size sieve and placed in 50 mL Greiner tubes, and stored at -80°C until analysis in the home laboratory.


The plastics net being towed


All material is washed down


Plastics collected at stat. 15

Table 5.2.6.1: Overview of plastics samples collected during JC134

Station	Cast	Date	Time (local)	Time (UTC)	Lat (N)	Lon (W)
1 (M5)	9	22 March	09:08:00	13:08	11°59.718'	56°56.489'
2	4	23 March	09:42:00	13:42	11°59.0'	53°43.0'
3	4	24 March	09:30:00	12:30	11°58.184'	50°42.447'
4 (M4)	11	25 March	21:55:00	0:55 (26th)	12°04.432	49°07.495
7 (M3)	7	29 March	21:58:00	00:58 (30th)	12°23.179	38°44.63
13 (M1)	5	5 April	15:52:00	16:52	11°25.0	22°56.2
13 (M1)	10	6 April	09:25:00	10:25	11°35.37	22°36.07
13 (M1)	19	8 April	17:20:00	18:20	11°31.88	22°42.83
15	1	13 April	08:56:00	08:56	23°24.73	20°11.07

5.2.7 Polycyclic-Aromatic Hydrocarbons (PAHs) [Toni Rosell-Melé]

Polycyclic-Aromatic Hydrocarbons (PAHs, also poly-aromatic hydrocarbons) are hydrocarbons –organic compounds consisting solely of carbon and hydrogen—that are composed of multiple aromatic rings. PAHs are usually formed by incomplete combustion of organic matter as well as geologically, when organic sediments are chemically transformed into fossil fuels such as coal and oil. As a consequence, the PAHs that we find in the ocean are predominantly the result of human activity: biofuel (wood and fossil fuels but also dung) burning. Wildfires are another notable source of PAHs. The complexity of the PAHs is related to the temperature of the combustion; low-temperature fires (wood- and bush fires) tend to create PAHs of low complexity whereas industrial combustion of organic matter tends to produce highly complex PAHs.

The West-East Transatlantic transect was used to sample for PAHs; of each CTD cast, samples were collected into previously fired 40-ml amber vials with a PTFE lined cap. These samples shall be analysed in the lab at UAB.

Table 5.2.7.1: Samples collected from CTD for PAH analysis

ID	Lat (° ' N)		Lon (° ' W)		Date	Depth (m)
H1CTD	11	59,82	56	6,75	21/3	5
H2CTD	11	59,82	56	6,75	21/3	40
H3CTD	11	59,53	56	6,07	21/3	2000
H4CTD	11	59,53	56	6,07	21/3	3000
H5CTD	11	59,53	56	6,07	21/3	4000
H6CTD	11	59,01	53	43,03	23/3	5
H7CTD	11	59,01	53	43,03	23/3	40
H8CTD	11	58,03	50	42,37	24/3	5
H9CTD	11	58,03	50	42,37	24/3	40
H10CTD	11	59,62	49	4,78	25/3	5
H11CTD	11	59,62	49	4,78	25/3	40
H12CTD	11	58,47	49	3,73	25/3	2000
H13CTD	11	58,47	49	3,73	25/3	3000
H14CTD	11	58,47	49	3,73	25/3	4000
H15CTD	11	59,39	49	15,02	26/3	5
H16CTD	11	59,39	49	15,02	26/3	40
H17CTD	12	3,75	46	10,16	27/3	5
H18CTD	12	3,75	46	10,16	27/3	LOST
H19CTD	12	11,03	42	40,56	28/3	LOST
H20CTD	12	11,03	42	40,56	28/3	40
H21CTD	12	18,98	39	8,22	29/3	5
H22CTD	12	18,98	39	8,22	29/3	40
H23CTD	12	23,19	38	44,63	29/3	2000
H24CTD	12	23,19	38	44,63	29/3	LOST
H25CTD	12	23,19	38	44,63	29/3	3500
H26CTD	12	21,71	38	48,43	30/3	5
H27CTD	12	21,71	38	48,43	30/3	40
H28CTD	12	19,27	38	43,72	31/3	5
H29CTD	12	19,27	38	43,72	31/3	40
H30CTD	12	16,74	36	20,35	01/4	5
H31CTD	12	16,74	36	20,35	01/4	40
H32CTD	12	13,98	33	8,94	02/4	5
H33CTD	12	13,98	33	8,94	02/4	40
H34CTD	12	11,03	29	51,29	03/4	5
H35CTD	12	11,03	29	51,29	03/4	40
H36CTD	12	10,19	29	1,89	03/4	40
H37CTD	12	10,19	29	1,89	03/4	2000
H38CTD	12	10,19	29	1,89	03/4	3000
H39CTD	12	10,19	29	1,89	03/4	4000
H40CTD	12	8,33	26	51,19	04/4	5
H41CTD	12	8,33	26	51,19	04/4	40
H42CTD	11	24,31	23	4,30	05/4	5
H43CTD	11	24,31	23	4,30	05/4	40
H44CTD	21	17,39	20	58,37	11/4	5
H45CTD	21	17,39	20	58,37	11/4	40

5.2.6 Plankton net [Geert-Jan Brummer, Oliver Knebel, Jaap de Boer, Bert Boekschoten]

In addition to the continuous surface water sampling by the plankton pump (§5.1.3), the upper 200 meters of the water column was sampled using a vertical plankton net. During Traffic II (2013) sampling was done using a 'Multi Plankton Sampler' ('Multinet'), which allowed for depth stratified sampling of the complex plankton community in more detail. The Multinet system of the NIOZ was not available for this cruise however. Instead a smaller, single and open net of a different type was used for vertical hauls (Figs. 5.2.6.1-4).

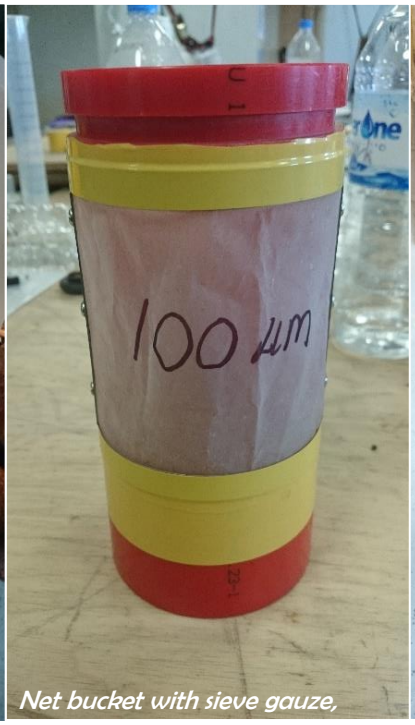
The net ring used is a type WP2, produced by Hydro-Bios, which was fitted with a conical, 270 cm long nylon net with a mesh size of 100 µm (Fig. 5.2.6.1). It consists of a stainless steel ring (⌀ 57 cm) with a three point bridle with shackles and a stainless steel swivel on the upper side (length of the ropes 65 cm, shackles included). The net is attached to the ring cloth with a zipper and ends in a removable cod-end (made of PVC; ⌀ inside 9.3 cm; height 23.7 cm). The cod-end has a side window that is covered with sieve gauze (mesh size 100 µm). The cod-end is placed into a stainless steel frame (⌀ 22 cm, height 44 cm) that protects it for high towing rope speed during descent. In the cod-end frame a plastic ring (made of PVC, height 9 cm) is attached. The cod-end is attached to this ring with three over centre fasteners and secured with a short nylon rope. The cod-end frame is suspended to the stainless steel ring by three double nylon ropes. An improvised weight was attached to the cod-end frame. A mechanical flow meter with back-run stop (Hydro-Bios) was used for measurement of filtered water volume. The flow-meter was located in the center of the ring and mounted with three strings.

4.5.6.1: Vertical plankton net with bridle, steel ring, net bag with suspension lines, and flow meter.

4.5.6.2: Ring with cloth and zipper

Top of bridle with swivel and shackles

4.5.6.3:
Bucket frame with suspension lines and ring for net bucket,



Net bucket with sieve gauze,

Improvised weight.

Sampling was done one or two times per day – either in the morning or in the evening – generally following the CTD. The net was lowered to a depth of 200 m at ca. 20 m/min and hauled at ca. 15m/sec, while the ship stayed in position (Fig. 4.5.6.4). Mostly two casts were taken, the second cast occasionally to a depth of 100 m for more careful sampling. Oceanographic parameters, such as temperature, salinity and fluorescence are derived from CTD-data. From the ship's Intranet all meteorological and position data could be determined for the exact time of sampling. Sampling details are given in table 4.5.6.1.

4.5.6.4: The vertical plankton net is lowered by two members of the crew.

Back on the deck the net was drained, then washed down from the outside using sea water to concentrate the sample into the cod-end. The full cod-end was taken to the wet-lab where its content was transferred onto a 90 µm stainless steel sieve using pre-filtered seawater, and drained. Mostly the first sample was used for qualitative research on board and split and preserved after that, the second sample was immediately preserved for quantitative research after the cruise.

Quantitative samples were split by rotation within a 10 cm diameter petri dish. The heavier particles concentrated in the centre of the petri dish and contained presumably the major fraction of pteropods. These central particles were sampled by Jaap de Boer, while the remainder of the sample was washed with milliQ over a sieve and stored at -20 °C for Shaun Akse (Utrecht University).

Preservation started with rinsing the plankton sample shortly with milli-Q to remove the sea salts, flushed into a small zip-lock plastic bag labeled with the cruise name (JC134), station and cast number, net depth and date. Samples were shock-frozen and stored at -80°C.

4.5.6.5: Draining the sample into the sieve, and after transfer to a petri dish for further study.

4.5.6.6: Geert-Jan an Oliver studying the plankton with the USB-microscope. Dirk keeps an eye too.

For qualitative research (Figs. 4.5.6.5-6), the residue was transferred to a plastic petri dish and examined using a loupe (8x, 15x), a Traveler USB-microscope (10x and 60x; a 200x magnification was not used) and/or a Zeiss Axiovert 25 inverted transmitted light microscope with HAL 6V 30W illumination (objectives used: 10/0,25PH1 and 20/0,45PH2), combined with a Euromex ImageFocus 4.0 Microscope Camera (plus adapter).

4.5.6.7: Two images made with the USB Camera (10x).
Cavolinia uncinata, *a pteropod mollusc,* several mollusks and foraminifers.

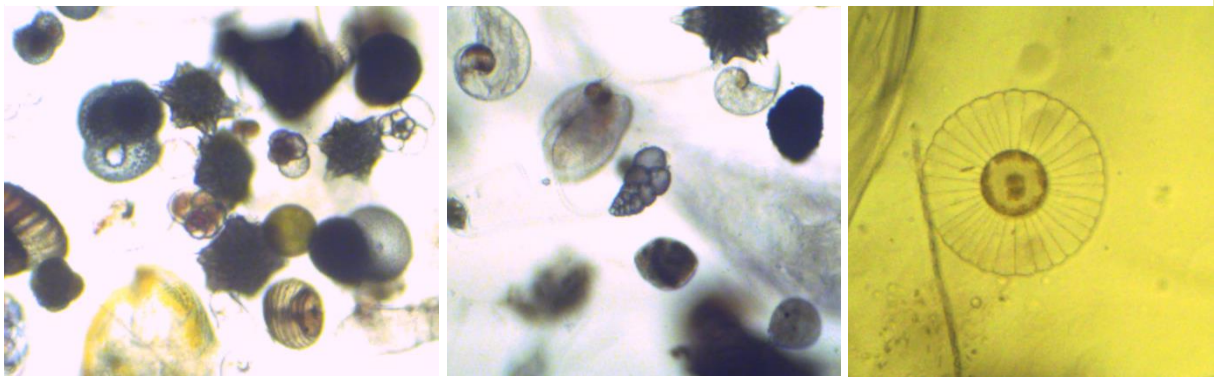


Fig. 4.5.6.8. Three images made with the Zeiss Inverted Microscope and the Euromex camera. At left foraminifera (*G. ruber, G. glutinata, G. menardii* and *D. anfracta*), an unidentified juvenile foram (benthic!), gastropods, and a radiolarian. In the middle heteropods and a (benthic!) foraminifer ("*Streptochilus globigerus*" = *Bolivina variabilis*). At right a large centric diatom: *Planktionella sol.*

At NIOZ all samples will be freeze-dried in their original sample bags, dry-weighed for biomass (total dry weight including the sample bag and post-weighing the empty sample bag), and dry-ashed to retrieve the skeletal matter (in an oxygen plasma using the low-temperature asher).

4.5.6.9: Also larger animals are sometimes surprised by the net.... Diaphus sp. lantern fish

Table 4.5.6.1. Overview sampling vertical plankton net.

Sample_ID	UTC	Date UTC	Water_volume_filtered_net	Sampling_depth_(m)	Latitude_(degree)	Longitude_(degree)	Split
Stat. 1-5	UTC+4	22-3-2016	646	200	11,992258	-56,101154	Geert Jan Brummer
Stat. 1-7	UTC+4	22-3-2016	464	200	11,993466	-56,098514	Geert Jan Brummer
Stat. 1-8	UTC+4	22-3-2016	527	200	11,994519	-56,095379	Anne Roepert and Jaap de Boer
Stat. 2-2	UTC+3	23-3-2016	775	200	11,985825	-53,718671	Anne Roepert and Jaap de Boer
Stat. 2-3	UTC+3	23-3-2016	524	200	11,986897	-53,717151	Geert Jan Brummer
Stat. 3-2	UTC+3	24-3-2016	863	200	11,967209	-50,706132	Anne Roepert and Jaap de Boer
Stat. 3-3	UTC+3	24-3-2016	657	200	11,969807	-50,707478	Geert Jan Brummer
Stat. 4-2	UTC+3	25-3-2016	646	200	12,010858	-49,120897	Anne Roepert and Jaap de Boer
Stat. 4-3	UTC+3	25-3-2016	674	200	12,015557	-49,120574	Geert Jan Brummer
Stat. 4-9	UTC+3	26-3-2016	578	200	12,069803	-49,127102	Anne Roepert
Stat. 4-10	UTC+3	27-3-2016	481	200	12,071558	-49,126267	Geert Jan Brummer
Stat. 5-2	UTC+3	27-3-2016	674	200	12,062509	-46,169298	Geert Jan Brummer
Stat. 6-2	UTC+3	28-3-2016	546	200	12,1866	-42,676201	Geert Jan Brummer
Stat. 7-5	UTC+3	29-3-2016	616	200	12,387647	-38,744127	Anne Roepert and Jaap de Boer
Stat. 7-6	UTC+3	30-3-2016	525	200	12,38944	-38,744553	Geert Jan Brummer
Stat. 7-13	UTC+3	30-3-2016	498	200	12,363289	-38,670038	Anne Roepert and Jaap de Boer
Stat. 7-14	UTC+3	31-3-2016	541	200	12,365373	-38,669997	Geert Jan Brummer
Stat. 8-2	UTC+2	1-4-2016	642	200	12,280197	-36,338943	Geert Jan Brummer
Stat. 9-2	UTC+2	2-4-2016	708	200	12,234156	-33,150277	Geert Jan Brummer
Stat.10-2	UTC+1	3-4-2016	717	200	12,185867	-29,856215	Geert Jan Brummer
Stat. 12-2	UTC+1	4-4-2016	550	200	12,141483	-26,853684	Geert Jan Brummer
Stat.13-3	UTC+1	5-4-2016	467	200	11,416893	-22,936795	Geert Jan Brummer
Stat. 13-4	UTC+1	5-4-2016	199	100	11,416899	-22,93681	Anne Roepert and Jaap de Boer
Stat. 13-7	UTC+1	6-4-2016	403	200	11,591033	-22,600701	Geert Jan Brummer
Stat. 13-8	UTC+1	06.04.206	202	100	11,592925	-22,6003	Jaap de Boer
Stat. 13-17	UTC+1	8-4-2016	230	200	11,584747	-22,81114	Geert Jan Brummer
Stat. 14-4	UTC	11-4-2016	307	200	21,291216	-20,975533	Geert Jan Brummer
Stat. 14-5	UTC	11-4-2016	122	200	21,292344	-20,977202	Geert Jan Brummer

More examples of critters that were caught:


Baby flying fish


Blue button jellyfish


Unidentified beauty


Janthina sp. floating snail (on spoon)

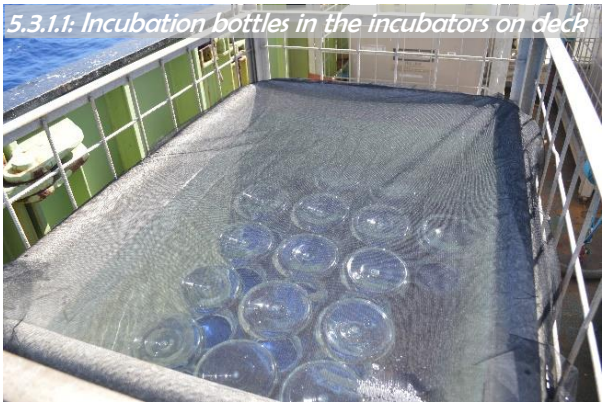
5.3.1 "Long" (multi-day) incubation experiments [Laura Korte]

Phytoplankton needs sunlight and nutrients to conduct photosynthesis and to convert the inorganic greenhouse gas CO_2 into new organic matter (equation 5.3.1.1).

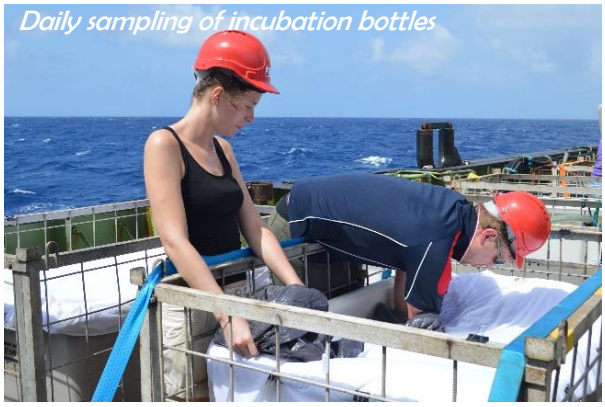
$$106\ CO_2 + 122\ H_2O + 16\ NO_3^- + H_2PO_4^- + 3\ H^+ \leftrightarrow [(CH_2O)_{106}(NH_3)_{16}H_3PO_4]_{organic} + 138\ O_2 \quad \text{(Eq. 5.3.1.1)}$$

While sunlight is prominent throughout the year in the tropical North Atlantic, nutrients are introduced into the meso- to oligotrophic ocean from the bottom via recycling of biomass as well as potentially from the top via atmospheric dust deposition. Saharan dust which is sporadically blown over the Atlantic Ocean might be an important nutrient supplier of nutrients, especially when the dust was exposed to acidic conditions in the atmosphere. Acidic conditions process the dust and dissolve, for example, iron (Fe), which makes it more bioavailable compared to Fe of unprocessed dust. Eventually, the dust is deposited into the ocean by either dry or wet deposition. While dry deposition happens by gravitation, wet deposition occurs together with rain. The rain leaches the dissolved nutrients and introduces them to the sea water.

This described theory was tested with incubation experiments at the stations M4, M3 and M1 (Fig. 5.3.1.1) for the mixed layer (ML) and the depth of the deep chlorophyll maximum (DCM) by adding dry and wet dust to the original sea water from the sampling site. Wet dust deposition was mimicked by leaching two different types of dust in artificial rain water of different pH values. In addition to the incubations at the stations, a small pH test incubation was carried out to get more insights in the Fe solubility.



5.3.1.1: Incubation bottles in the incubators on deck



Daily sampling of incubation bottles

For the incubation experiments the water was taken with the CTD rosette in the distinct water depths. For the ML a water depth of 15 to 20 m was chosen to prevent Fe contamination from the ship, and for the DCM the water was taken right above the chlorophyll maximum to still be able to incubate on deck with the temperature of the surface sea water. After sieving the water into the incubation bottles (6L), the dust treatment was added under the laminar flow hood and the bottles were sealed with parafilm. Each treatment was ran in triplicates. During transport of the incubation bottles from the laboratory to the incubator and the other way around, the bottles were placed into one or two black plastic bags for the ML and DCM, respectively. The bottles were hooked upside-down onto a wooden tray at the bottom of the incubators. On-deck incubators were used

for ambient light conditions suppressed with natural screens and mesh and circulating surface sea water in a temperature range ± 1°C from the sampling site. Each individual incubation at the stations had a duration between four to eight days. Subsamples for flow cytometry measurements and nutrients (NO_3, PO_4 and SiO_4) were taken daily of all the incubation bottles. At the beginning and ending of the incubations, dissolved Fe and dissolved inorganic carbon (DIC) were taken from all the incubation bottles. In addition to that, taxonomy and alkalinity samples were taken from selected samples at the ending day of the incubation. Taxonomy and alkalinity samples were also taken as baseline from the CTD at the beginning of the experiment. Tables 5.3.1.1 – 5.3.1.4 summarize sampling protocols for each station. Dissolved Fe and flow cytometry measurements were done on board (see §5.5).

Two types of Mauritanian dust were used for the dust treatments. The first type is dust from a Sabkha deposit and the second type is one from a dune with displacer. The dust was manipulated to a size distribution comparable to those of the sediment traps. This was done already before the cruise at the NIOZ. For the treatment of dry dust deposition only the Sabkha dust was used with varying amounts (1.5 to 9 mg). For the wet dust deposition treatment both types of dust were used. Before addition to the incubation bottles, the dust (1.5 to 9 mg) was leached in 40 ml artificial rain (acidified MilliQ with H_2SO_4) for 16-24 h with different pH values (2 to 4.5).

First preliminary results of the flow cytometry measurements show a similar behaviour of the phytoplankton cells in all of the incubation bottles with a positive response to at least one of the phytoplankton groups with wet Saharan dust addition.

Table 5.3.1.1: Sampling protocol for both depth (mixed layer and deep chlorophyll maximum) of station M4.
For day 0, the water from the CTD bottles was analysed, X represents sampling from incubation bottles.

Station M4 (ML & DCM)	Day 0	Day 1	Day 2	Day 3	Day 4
Dissolved Fe	CTD	X			X
Nutrients	CTD	X	X	X	X
Flow cytometry	CTD	X	X	X	X
POC/Pigments	CTD				X
DIC	CTD				X
Taxonomy	CTD				X
Alkalinity	CTD				X

Table 5.3.1.2: Sampling protocol for both depth (mixed layer and deep chlorophyll maximum) of station M3.
For day 0, the water from the CTD bottles was analysed, X represents sampling from incubation bottles.

Station M3 (ML & DCM)	Day 0	Day 1	Day 2	Day 3	Day 4
Dissolved Fe	CTD	X			X
Nutrients	CTD	X	X	X	X
Flow cytometry	CTD	X	X	X	X
POC/Pigments	CTD				X
DIC	CTD				X
Taxonomy	CTD				X
Alkalinity	CTD				X

Table 5.3.1.3: Sampling protocol for the mixed layer of station M1 running for 8 days.
For Day 0, the water from the CTD and Incubation bottles was analysed, X represents sampling from incubation bottles.

Station M1 (ML)	Day 0	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
Dissolved Fe	CTD, X								X
Nutrients	CTD, X	X	X	X	X	X	X	X	X
Flow cytometry	CTD, X	X	X	X	X	X	X	X	X
POC/Pigments	CTD								X
DIC	CTD								X
Taxonomy	CTD								X
Alkalinity	CTD								X

Table 5.3.1.4: Sampling protocol of both depth (mixed layer and deep chlorophyll maximum) of station M1 running for 4 days.
For day 0, the water from the CTD and Incubation bottles was analysed, X represents sampling from incubation bottles.

Station M1 (ML & DCM)	Day 0	Day 1	Day 2	Day 3	Day 4
Dissolved Fe	CTD, X				X
Nutrients	CTD, X	X	X	X	X
Flow cytometry	CTD, X	X	X	X	X
POC/Pigments	CTD				X
DIC	CTD				X
Taxonomy	CTD				X
Alkalinity	CTD				X

Kirsten, Anna, Patrick, Oliver, Dirk, Jaap, and Monica intently watch the activities on deck.

5.3.2 "one-day" incubations: viral lysis and grazing rates [Corina Brussaard, Anna Noordeloos, Kirsten Kooijman, Tessa de Bruin]

Using the adapted dilution method, microzooplankton grazing and virally induced mortality can be estimated simultaneously. The principle is that the removal of predators (grazers and viruses) by dilution allows the algal cells to increase in standing stock over the measured 24h period. The difference in algal concentration over the period provides an estimate of algal growth rate. Plotting these apparent growth rates against the dilution factor provides a linear regression, whereby the slope represents the loss rate. Depending on the type of diluent (either grazer-free or grazer & virus-free) the microzooplankton grazing rate and the viral lysis rate can be obtained. From the difference between the two dilutions series the actual virally mediated algal mortality rate can be calculated. Because of the synchronicity of phytoplankton cell division and potential diel effects on viral infection processes, the assay was performed on water samples from the early morning CTD cast. Bottles were incubated randomly on a slow turning wheel in an on-deck incubator at *in situ* temperature (±2°C max) and irradiance (using variable numbers of neutral screens). Specific phytoplankton groups were discriminated (from fresh samples) by differences in side scatter and red/orange fluorescence using flow cytometry and for each group the loss rates can be determined (analysis of data at home institute). Flow rates of the flow cytometer were calibrated daily to maintain quality control.

A different approach of determining the grazing rates of phytoplankton is by using fluorescently labelled algal prey (1 and 16 um diameter size) that is spiked to the natural sample and incubated for 24h. This is also the method used to obtain grazing rates on bacteria by heterotrophic nanoflagellates (HNF) at several of the main stations. Samples have been fixed and will be counted using epifluorescence microscopy upon arrival to NIOZ-TX. Additionally, samples for the abundance of HNF (20ml, 1% glutaraldehyde final concentration; stored at 4°C) and microzooplankton (from Lugol sample described earlier) community structure and abundance were taken and fixed for analysis at home.

Microbial ecology incubations on deck.

Temperature-controlled lab incubations.

Lastly, the viral lysis rates of bacteria (both lytic and lysogenic infection) were determined at the same locations as the grazing of bacteria assay was performed. Using the so called virus production method, the natural viruses present were washed out after which the newly produced viruses released from formerly infected bacteria were counted over time. From the production rate the infection rate of bacteria can be calculated. Additionally, rates of lysogenic infection were determined by addition of Mitomycin C to initiate the lytic phase of any lysogenic viruses that have infected the bacterial population. Assays were performed using water from both the chlorophyll maximum as the mixed layer. Samples were all fixed and flash frozen in liquid nitrogen and brought back to NIOZ-TX for flow cytometric analysis.

Table 5.3.2.1: Overview of samples analysed on board for the one-day bio assays.

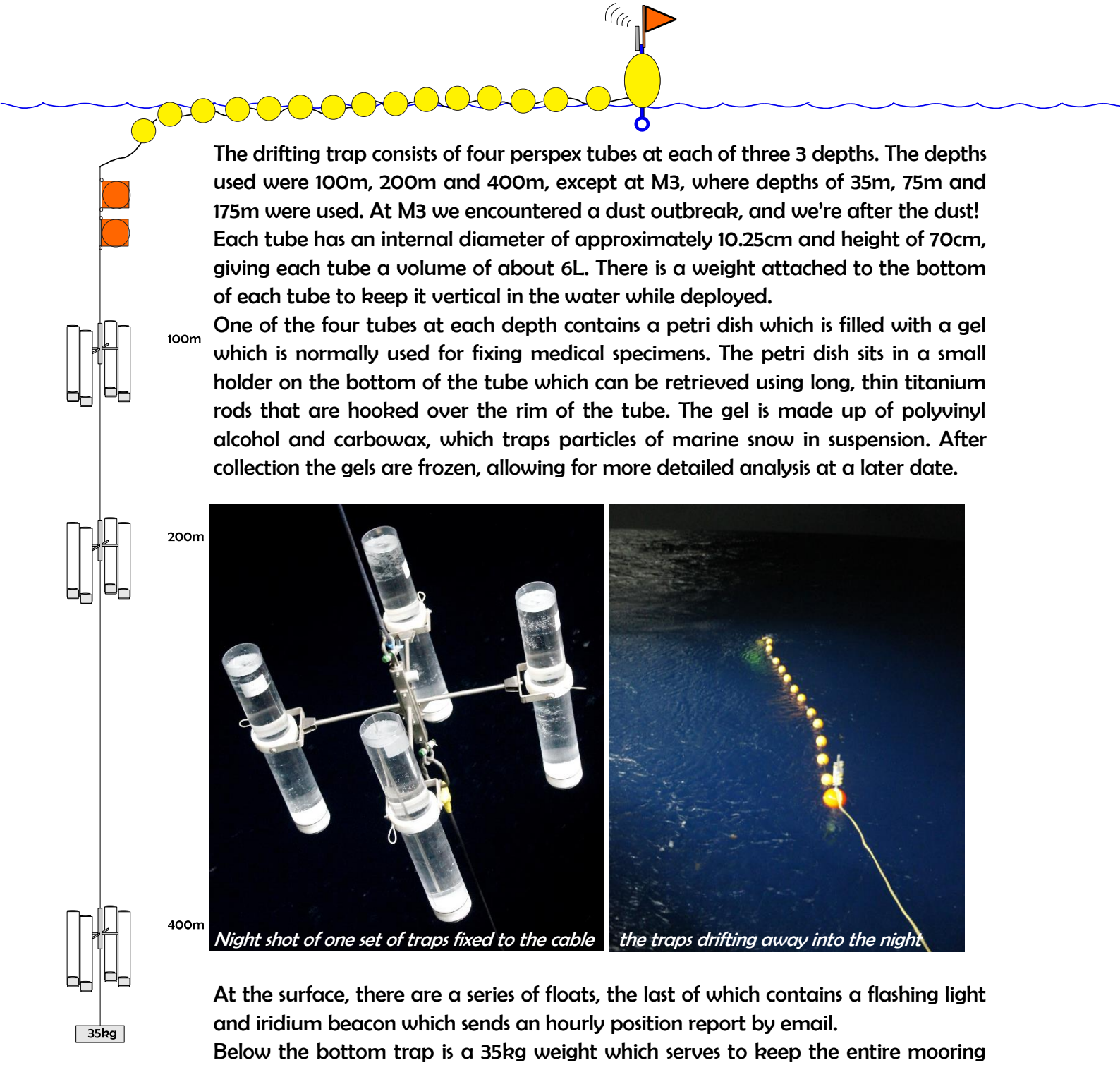
Station nr	cast	CTD Bottle 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	1							B,H	B	B	B	B	B	B	B						B,H		B		
1	6					A	A	A	A	A	A	A	A												
3	1						A	A	A	A	A	A	A	A											
3	1					A	A	A	A	A	A	A	A								A		A		
4	4							A	A	A	A	A	A	A	A										
4	13					B,H	B	B	B	B					B,H		B	B	B						
5	1								A	A	A	A	A	A	A		A								
6	1								A	A	A	A	A	A	A		A								
7	1								A	A	A	A	A	A	A		A	A							
7	9						B,H	B	B	B	B	B	B								B,H	B	B	B	
7	15						A	A	A	A	A	A	A	A	A	A									
8	1									A	A	A	A	A	A	A	A	A							
10	1									A	A	A	A	A	A		A	A							
13	1							A	A	A	A	A	A	A	A		A	A							
13	1									A	A	A	A	A	A		A	A	A						
13	6	B,H	B	B	B	B													B,H	B	B	B	B	B	
13	11	A	A	A	A	A	A	A	A																
13	15								A	A	A	A	A	A	A										
14	3																								
14	7			B,H	B	B			B,H	B	B														

A = Algal mortality
B = Bacterial mortality
H = HNF

Algal mortality dust

5.4 Sediment sampling with drifting traps [Chris Munday]

Drifting traps were deployed for ~24hrs at stations M5, M4, M1 and CB and ~14hrs at M3 with the goal of sampling fresh sediment (marine snow) as it falls through the water column.



The drifting trap consists of four perspex tubes at each of three 3 depths. The depths used were 100m, 200m and 400m, except at M3, where depths of 35m, 75m and 175m were used. At M3 we encountered a dust outbreak, and we're after the dust! Each tube has an internal diameter of approximately 10.25cm and height of 70cm, giving each tube a volume of about 6L. There is a weight attached to the bottom of each tube to keep it vertical in the water while deployed.

One of the four tubes at each depth contains a petri dish which is filled with a gel which is normally used for fixing medical specimens. The petri dish sits in a small holder on the bottom of the tube which can be retrieved using long, thin titanium rods that are hooked over the rim of the tube. The gel is made up of polyvinyl alcohol and carbowax, which traps particles of marine snow in suspension. After collection the gels are frozen, allowing for more detailed analysis at a later date.

Night shot of one set of traps fixed to the cable

the traps drifting away into the night

At the surface, there are a series of floats, the last of which contains a flashing light and iridium beacon which sends an hourly position report by email.

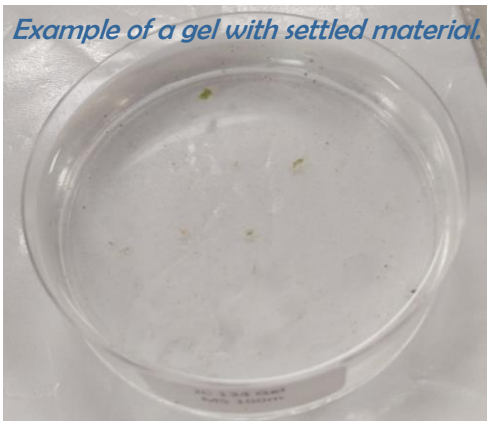
Below the bottom trap is a 35kg weight which serves to keep the entire mooring vertical in the water.

Prior to deployment, the tubes were filled with filtered (0.4µM cellulose acetate membrane) seawater which was densified with table salt. Approximately 300g NaCl was dissolved in 3L filtered seawater, and 250mL of this solution was added to each tube. This increased the salt

concentration by about 4g/L, enough for the water in the tubes to not diffuse into the surrounding water during deployment.

The tube containing the gel was prepared by first freezing the petri dish containing the gel, then lowering it into a partially filled tube. The frozen gel is buoyant, however, if the petri dish is held to the bottom of the tube by a spare titanium rod until the gel thaws, it stays at the bottom and the rod can be removed.

After recovery of the traps, they were allowed to settle for a minimum of 5 hours, which depending on the time of the recovery, sometimes extended overnight. After this settling time, the majority of the water was removed, leaving 1-1.5L containing the settled material of interest to be filtered. As the marine snow and other particles were already embedded in the gel the water from this tube was not filtered at all. Instead, the gel was gently removed from the larger Perspex tube, photographed and frozen at -20°C. An example of the appearance of the gel after sampling can be seen below.



Example of a gel with settled material.

The material from the remaining three tubes was filtered for different purposes. One tube was filtered on a GF/F filter to be analysed for C/N ratios and pigment analysis, while the remaining two tubes were filtered on polycarbonate filters (0.2µM pores). One for particle size of the terrigenous (dust) fraction and bulk chemistry, and one for bacterial analysis. All filters were then stored at -20°C for transport back to NIOZ.

Table 5.4.1: Drifting traps deployed and recovered during JC134.

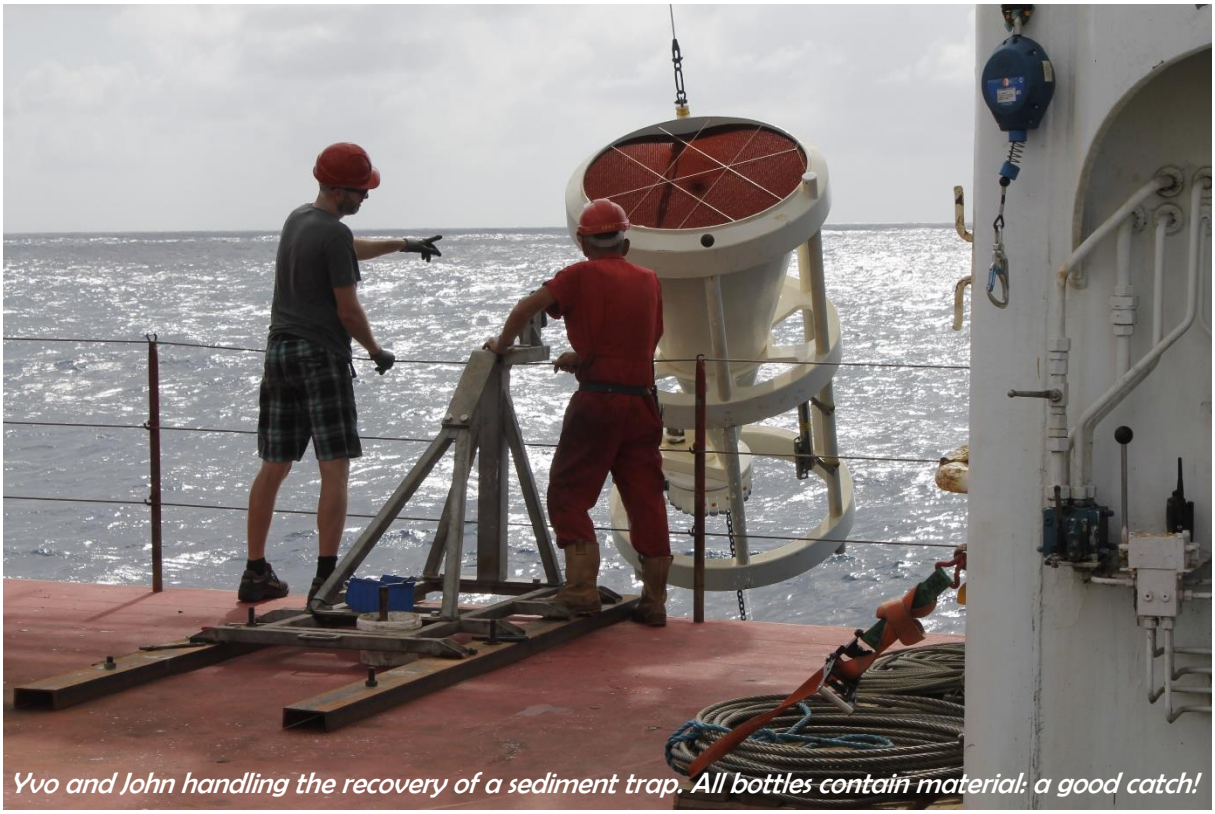
ID	date	Deployment/Recovery (UTC)	Duration (hr)	Lat (N)	Lon (W)	Trap depths (m)
M5	21/3	16:26	23:34	11°57.9'	56°06.8'	100, 200, 400
M5	22/3	16:00		11°56.75'	56°02.38'	
M4	25/3	00:04	23:26	12°00.55'	49°08.53	100, 200, 400
M4	25/3	23:30		12°04.067	49°07.655	
M3	29/3	19:56	14:08	12°22.678	38°45.126	45, 75, 175
M3	30/3	10:04		12°21.71	38°48.43	
M1	7/4	08:54	24:45	11°35.238	22°48.45	100, 200, 400
M1	8/4	09:39		11°34.93	22°48.65	
CB	11/4	15:32	23:05	21°17.11	20°58.39	100, 200, 400
CB	12/4	14:37		21°37.35	21°02.85	

5.5 Mooring recoveries [Michèlle van der Does, Geert-Jan Brummer]

Overview moorings 2014-2015

One of the major goals of this cruise was the recovery, servicing and redeployment of long-term moorings along a transect across the equatorial North Atlantic Ocean, at 12°N. These sub-surface moorings were first deployed in October 2012 and are serviced every year. Along the transect, originally a total of five moorings were deployed, each equipped with ADCPs, current meters and T-S sensors and two large sediment traps (PPS-5/2). However, for 2014-2015 moorings were deployed at only four stations (M1, M3, M4 and M5), containing two sediment traps on each mooring: 2 KUM traps (with 39 sample bottles each) at M1 and M3, and two Technicap PPS-5/2 traps (with 24 bottles each) at M4 and M5. During the previous cruise with RV Pelagia (64PE395) in January-February 2015, the mooring at M1 (14M1 with one PPS-5/2 only) could not be recovered, and was recovered during the present cruise. The measuring intervals of the physical instruments ranged from 5 minutes (T-S sensors), 15 minutes (current meters, OBS) to 30 minutes (ADCP's). See table 5.5.1 for more details on the sensors on the moorings.

Two of the moorings, at stations M1 and M3, were equipped with two KUM K/MT 320 sediment traps, at 1200 and 3500 meters below sea level (mbsl). They consist of two carrousels containing a total of 39 sample cups. The collecting area is 0.5 m^2 and is provided with a 3.75 cm^2 honeycomb baffle. At M4 and M5 the moorings were equipped with Technicap PPS-5/2 sediment traps, also at 1200 and 3500 mbsl, each with a single carrousel containing 24 sample cups. They have a collecting area of 1.0m^2 and are provided with a 1 cm^2 honeycomb baffle. Also the 2014 mooring at M1 held a Technicap PPS-5/2 sediment trap, at 1200 mbsl. For sampling intervals see Table 5.5.2.



Yvo and John handling the recovery of a sediment trap. All bottles contain material: a good catch!

Table 5.5.1: Instrument details of equipment recovered during JC134.

Station	Depth (m)	Instrument	Serial Number	Barcode	Start date
14-M1	800	ADCP	3174	1854	
	1190	SBE 37 MicroCat CTD	2671	925	
	1200	Sedimenttrap Technicap PPS-5/2 Funnel	91.26	8501	
		Motor Unit	3-230	1212	
		Carrousel		43250	11/23/2013
		Tilt data logger	B7	7252	11/18/2013
		Sensor FLNTU	2774	74575	
15-M1	848	ADCP	3553	7528	
	1248	Sediment trap KUM Funnel	2014422	60264	1/15/2015
		KUM electr. Unit	2014422	39765	
		KUM motor 1	2014422A	39741	
		KUM motor 2	2014422B	39727	
		Tilt data logger	BA	27908	
		Sensor wetlabs FLNTU	2737	74582	
		SBE 37 MicroCat CTD	2676	3162	
	2048	Booij cage nr 9			
	3523	Sediment trap KUM Funnel	2014420	60257	1/15/2015
		KUM electr. Unit	2014420	39802	
		KUM motor 1	2014420A	39796	
		KUM motor 2	2014420B	39772	
		Tilt data logger	C6	35330	
		SBE 37 MicroCat CTD	4349	12843	
	3573	Aanderaa RCM11 current meter	404	734	
	4023	Booij cage nr 15+			
15-M3	795	ADCP	3616	2905	
	1190	Sediment trap KUM Funnel	2014421	60240	1/26/2015
		KUM electr. Unit	2014421	39789	
		KUM motor 1	2014421A	39758	
		KUM motor 2	2014421B	39734	
		Tilt data logger	BD	9416	
		SBE 37 MicroCat CTD	4351	12768	
	1990	Booij cage nr 1+			
	3000	Booij cage nr 8			
	3475	Sediment trap KUM Funnel	2009402	60271	1/26/2015
		KUM electr. Unit	2009402	71970	
		KUM motor 1	2009402A	71857	
		KUM motor 2	2009402B	71826	
		SBE 37 MicroCat CTD	4140	5050	
	3524	Aanderaa RCM11 current meter	188	1793	
	3975	Booij cage nr 7+			
15-M5	1216	Sediment trap PPS	46	8488	6/2/2015
		Motor unit	9-265	35354	
		Tilt data logger	B1	12171	
		Sensor wetlabs FLNTU	2855	74551	
		SBE 37 MicroCat CTD	4345	12805	
		Aanderaa RCM11 current meter	204	3889	
	2000	Booij cage nr 2			
	3000	Booij cage nr 4			
	3536	Sediment trap PPS	91-27	9836	6/2/2015
		Motor unit	11-282	72007	
		Tilt data logger	C4	9522	
		SBE37 MicroCat CTD	2657	3803	
	3584	Aanderaa RCM11 current meter	416	765	
	4000	Booij cage nr 22			

Table 5.5.2 Sediment trap sampling intervals of the recovered traps (2013-2014 and 2014-2015).

Mooring 14-M1			
bottle	start	end	days
1	23-nov-2013	1-dec-2013	8
2	1-dec-2013	9-dec-2013	8
3	9-dec-2013	17-dec-2013	8
4	17-dec-2013	25-dec-2013	8
5	25-dec-2013	10-jan-2014	16
6	10-jan-2014	26-jan-2014	16
7	26-jan-2014	11-feb-2014	16
8	11-feb-2014	27-feb-2014	16
9	27-feb-2014	15-mrt-2014	16
10	15-mrt-2014	31-mrt-2014	16
11	31-mrt-2014	16-apr-2014	16
12	16-apr-2014	2-mei-2014	16
13	2-mei-2014	18-mei-2014	16
14	18-mei-2014	3-jun-2014	16
15	3-jun-2014	19-jun-2014	16
16	19-jun-2014	5-jul-2014	16
17	5-jul-2014	21-jul-2014	16
18	21-jul-2014	6-aug-2014	16
19	6-aug-2014	22-aug-2014	16
20	22-aug-2014	7-sep-2014	16
21	7-sep-2014	23-sep-2014	16
22	23-sep-2014	9-okt-2014	16
23	9-okt-2014	17-okt-2014	8
24	17-okt-2014	25-okt-2014	8

Moorings 15-M1 - KUM			
bottle	start	end	days
1	15-jan-2015	26-jan-2015	11
2	26-jan-2015	6-feb-2015	11
3	6-feb-2015	17-feb-2015	11
4	17-feb-2015	28-feb-2015	11
5	28-feb-2015	11-mrt-2015	11
6	11-mrt-2015	22-mrt-2015	11
7	22-mrt-2015	2-apr-2015	11
8	2-apr-2015	13-apr-2015	11
9	13-apr-2015	24-apr-2015	11
10	24-apr-2015	5-mei-2015	11
11	5-mei-2015	16-mei-2015	11
12	16-mei-2015	27-mei-2015	11
13	27-mei-2015	7-jun-2015	11
14	7-jun-2015	18-jun-2015	11
15	18-jun-2015	29-jun-2015	11
16	29-jun-2015	10-jul-2015	11
17	10-jul-2015	21-jul-2015	11
18	21-jul-2015	1-aug-2015	11
19	1-aug-2015	12-aug-2015	11
20	12-aug-2015	23-aug-2015	11
21	23-aug-2015	3-sep-2015	11
22	3-sep-2015	14-sep-2015	11
23	14-sep-2015	25-sep-2015	11
24	25-sep-2015	6-okt-2015	11
25	6-okt-2015	17-okt-2015	11
26	17-okt-2015	28-okt-2015	11
27	28-okt-2015	8-nov-2015	11
28	8-nov-2015	19-nov-2015	11
29	19-nov-2015	30-nov-2015	11
30	30-nov-2015	11-dec-2015	11
31	11-dec-2015	22-dec-2015	11
32	22-dec-2015	2-jan-2016	11
33	2-jan-2016	13-jan-2016	11
34	13-jan-2016	24-jan-2016	11
35	24-jan-2016	4-feb-2016	11
36	4-feb-2016	15-feb-2016	11
37	15-feb-2016	26-feb-2016	11
38	26-feb-2016	8-mrt-2016	11
39	8-mrt-2016		22
		30-mrt-2016	

Moorings 15-M3 - KUM			
bottle	start	end	days
1	26-jan-2015	6-feb-2015	11
2	6-feb-2015	17-feb-2015	11
3	17-feb-2015	28-feb-2015	11
4	28-feb-2015	11-mrt-2015	11
5	11-mrt-2015	22-mrt-2015	11
6	22-mrt-2015	2-apr-2015	11
7	2-apr-2015	13-apr-2015	11
8	13-apr-2015	24-apr-2015	11
9	24-apr-2015	5-mei-2015	11
10	5-mei-2015	16-mei-2015	11
11	16-mei-2015	27-mei-2015	11
12	27-mei-2015	7-jun-2015	11
13	7-jun-2015	18-jun-2015	11
14	18-jun-2015	29-jun-2015	11
15	29-jun-2015	10-jul-2015	11
16	10-jul-2015	21-jul-2015	11
17	21-jul-2015	1-aug-2015	11
18	1-aug-2015	12-aug-2015	11
19	12-aug-2015	23-aug-2015	11
20	23-aug-2015	3-sep-2015	11
21	3-sep-2015	14-sep-2015	11
22	14-sep-2015	25-sep-2015	11
23	25-sep-2015	6-okt-2015	11
24	6-okt-2015	17-okt-2015	11
25	17-okt-2015	28-okt-2015	11
26	28-okt-2015	8-nov-2015	11
27	8-nov-2015	19-nov-2015	11
28	19-nov-2015	30-nov-2015	11
29	30-nov-2015	11-dec-2015	11
30	11-dec-2015	22-dec-2015	11
31	22-dec-2015	2-jan-2016	11
32	2-jan-2016	13-jan-2016	11
33	13-jan-2016	24-jan-2016	11
34	24-jan-2016	4-feb-2016	11
35	4-feb-2016	15-feb-2016	11
36	15-feb-2016	26-feb-2016	11
37	26-feb-2016	8-mrt-2016	11
38	8-mrt-2016	19-mrt-2016	11
39	19-mrt-2016	30-mrt-2016	11

Moorings 15-M5 - PPS			
bottle	start	end	days
1	6-feb-2015	17-feb-2015	11
2	17-feb-2015		22
		11-mrt-2015	
3	11-mrt-2015		22
		2-apr-2015	
4	2-apr-2015		22
		24-apr-2015	
5	24-apr-2015		22
		16-mei-2015	
6	16-mei-2015		22
		7-jun-2015	
7	7-jun-2015		22
		29-jun-2015	
8	29-jun-2015		22
		21-jul-2015	
9	21-jul-2015		22
		12-aug-2015	
10	12-aug-2015		22
		3-sep-2015	
11	3-sep-2015		22
		25-sep-2015	
12	25-sep-2015		22
		17-okt-2015	
13	17-okt-2015		22
		8-nov-2015	
14	8-nov-2015		22
		30-nov-2015	
15	30-nov-2015		22
		22-dec-2015	
16	22-dec-2015	2-jan-2016	11
17	2-jan-2016	13-jan-2016	11
18	13-jan-2016	24-jan-2016	11
19	24-jan-2016	4-feb-2016	11
20	4-feb-2016	15-feb-2016	11
21	15-feb-2016	26-feb-2016	11
22	26-feb-2016	8-mrt-2016	11
23	8-mrt-2016	19-mrt-2016	11
24	19-mrt-2016	30-mrt-2016	11

Sample recovery

Upon arrival on deck, the entire carrousel of the Technicap PPS-5/2 with sample bottles was dismounted from each trap, and transferred to the chemical laboratory. For the KUM sediment traps, the bottles were unscrewed individually on deck and brought to the chemical laboratory. Prior to deployment the sample cups had been filled with seawater collected at the deployment depth of each trap and from the actual deployment site, to which a biocide ($HgCl_2$; end-concentration 2.23 g/L for Technicap traps and 1.97 g/L for the KUM TRAPS) and pH-buffer (Borax; $Na_2B_4O_7{\cdot}10H_2O$; end concentration 1.29 g/L for both traps) had been added, which also created a density slightly in excess of the ambient seawater.

As part of the shipboard processing protocol, the sample carrousel of the Technicap traps was put on top of a stable stand for safe manual rotation of the carrousel and collection of any unwanted leakage of the poisonous supernatant solution. After slight loosening of the imbus bolts, the carrousel was manually rotated to the first sample position to remove the top 40 mL of supernatant solution from the connecting neck with an all-PP syringe. About 15 mL of deionized (Milli-Q) water was used twice to flush the syringe and the attached tube, followed by 5 mL of the supernatant solution to flush a syringe-top 0.2 µm Acrodisc® filter. About 5mL of the supernatant solution was used to fill a PE-pony vial for later analysis of nitrate, phosphate and silica at the NIOZ. The remaining 30 mL was transferred to a 40 mL ZPE bottle for subsequent analysis of the pH. This procedure was repeated until the supernatant solution was removed from the connecting neck above each of the 24 sample bottles of the trap carrousel, so that all sample bottles could safely be removed from the carrousel, capped, and stored at 4°C. For the KUM sediment traps, some of the top water was transferred to a 40 mL ZPE bottle for analysis of pH; nutrient samples will be taken at the NIOZ.

For a first order estimate of the mass flux, the height of the residue in the collecting bottles was measured to the next millimeter (all traps) and converted into residue volumes for the PPS-5/2 traps using the specific calibration curve (Fig 5.5.1). For the KUM traps a specific calibration line will be determined at NIOZ.

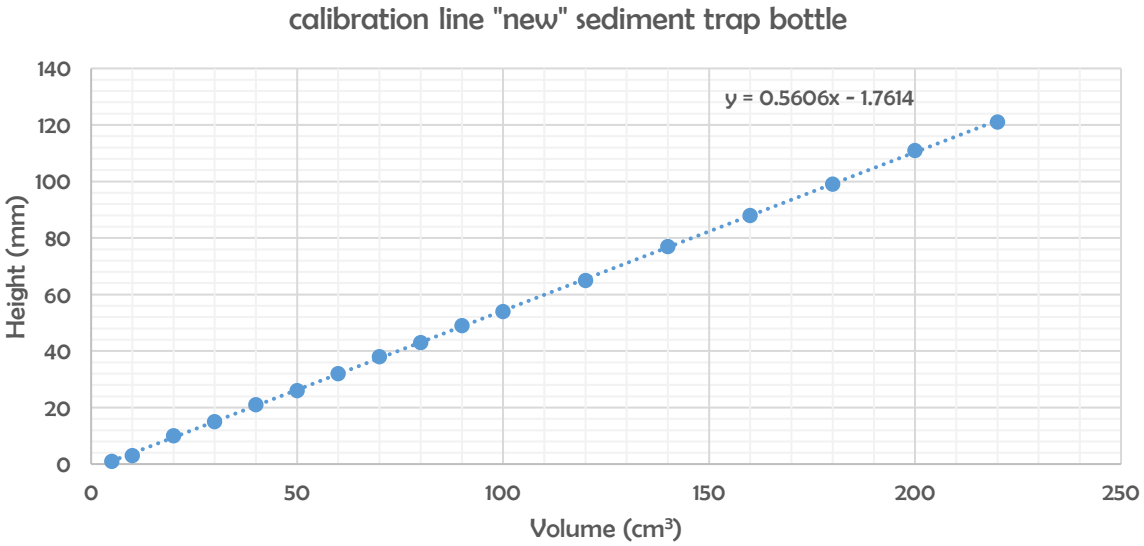


Fig 5.5.1: Calibration between sample height and sediment volume for Technicap trap bottles.

Preliminary results

Collecting efficiencies of the sediment traps depend on the (changing) tilt and current velocities. In order to determine these parameters, each sediment trap was equipped with a tilt meter that records the tilt in two perpendicular directions, as well as pressure. Current velocities and directions were measured using a downward looking ADCP mounted on the top float 400 m above the upper sediment trap for all moorings except at station M5. A current meter was mounted approximately 50 meters below the lower sediment traps for all 2015 moorings, and at M5 also a current meter was mounted approximately 50 meters below the upper sediment trap.

In general, data from the tilt meters and CTDs indicated that the moorings remained effectively vertical during the sampling period (see graphs in the respective paragraphs below). The CTD recovered at M5 (3500 m) appears to have had a broken pressure sensor; the temperature sensor however worker properly. The CTD at 15M1L (3500 m) flooded and data could not be recovered. This also meant that the CTD could not be redeployed. All data from the Aanderaa RCM11 current meters show unrealistically low temperature values (<0 °C), and should be re-calibrated back at NIOZ. It is unsure what this means for current direction and current velocity data. The KUM traps recovered from M3 required some repairs before redeployment since they did not function properly over the past year.

Mooring 15M5

Mooring 15M5 was successfully recovered, including the two Technicap sediment traps at 1200 and 3500 mbsl. One sample bottle from the upper trap (sample 10) was no longer on the carrousel during recovery and considered lost. Besides that, both the sediment traps performed flawlessly and all the 24 (23) sample cups were filled with sediment (Fig. 5.5.2 and 5.5.3). Values for pH ranged between 7.6 (15M5-U6) and 8.6 (15M5-L19, 20 and 21) (Fig. 5.5.4) and some samples appeared to have some larger organisms in them. Residue heights show differences throughout the year, with most peaks in the lower trap lagging behind the upper trap by 1 sample (Fig. 5.5.4). Highest amounts of residue seem to be present during summer and fall, and lowest during winter.

Data from the tilt meters (Fig. 5.5.5) shows the angle of tilt amounted to only a few degrees, and also the temperature is very stable. The pressure sensor shows not too much variation, however the pressure sensor of the CTD at 3500 m appears to be broken and yields unreliable data (Fig. 5.5.6). Pressure and temperature recorded by the tilt meter shows synchronous fluctuations between both upper and lower traps (Fig. 5.5.5), meaning that minimal changes in the mooring's position as influenced by e.g. currents was the same for both traps. Current meter data shows that the current has a dominant SW direction, and velocities range mainly between 5 and 10 m/s (Fig. 5.5.7).

Figure 5.5.2: Photos of all sample bottles of the upper sediment trap at station M5 (15M5U).

Figure 5.5.3: Photos of all sample bottles of the lower sediment trap at station M5 (15M5L).

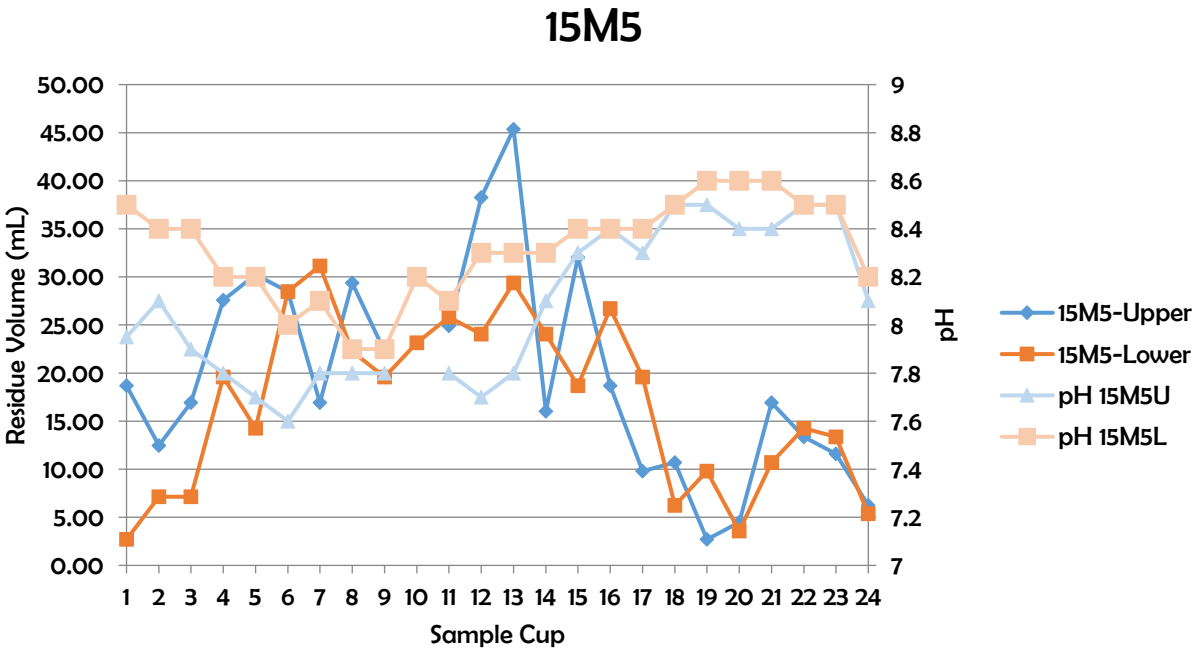


Figure 5.5.4: Residue volume and pH of the upper (1200 m) and lower (3500 m) sediment traps of 15M5. Calculated from residue heights using the calibration curve in Fig. 5.5.1.

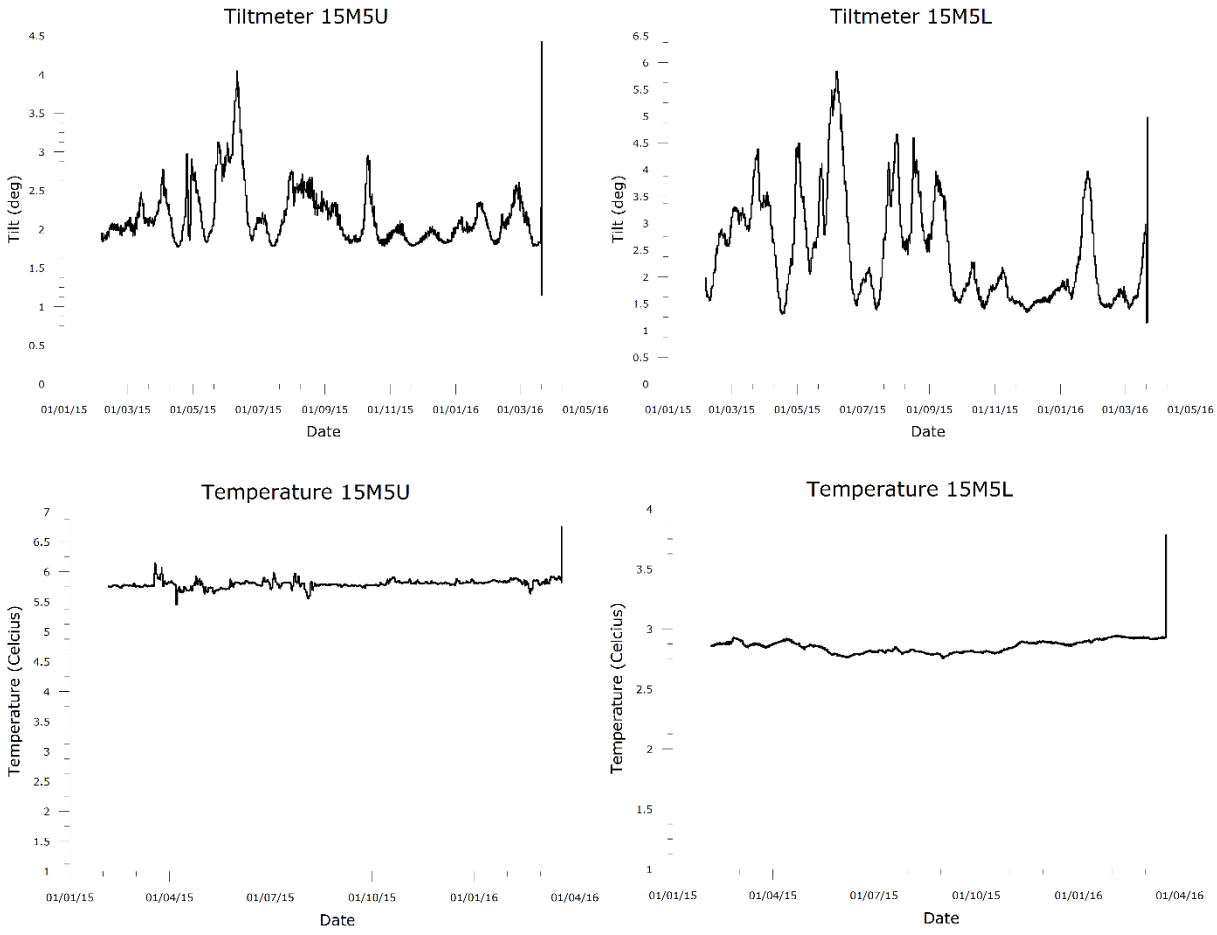


Figure 5.5.5a. Tilt and Temperature logged by the tiltmeters mounted on the sediment traps.

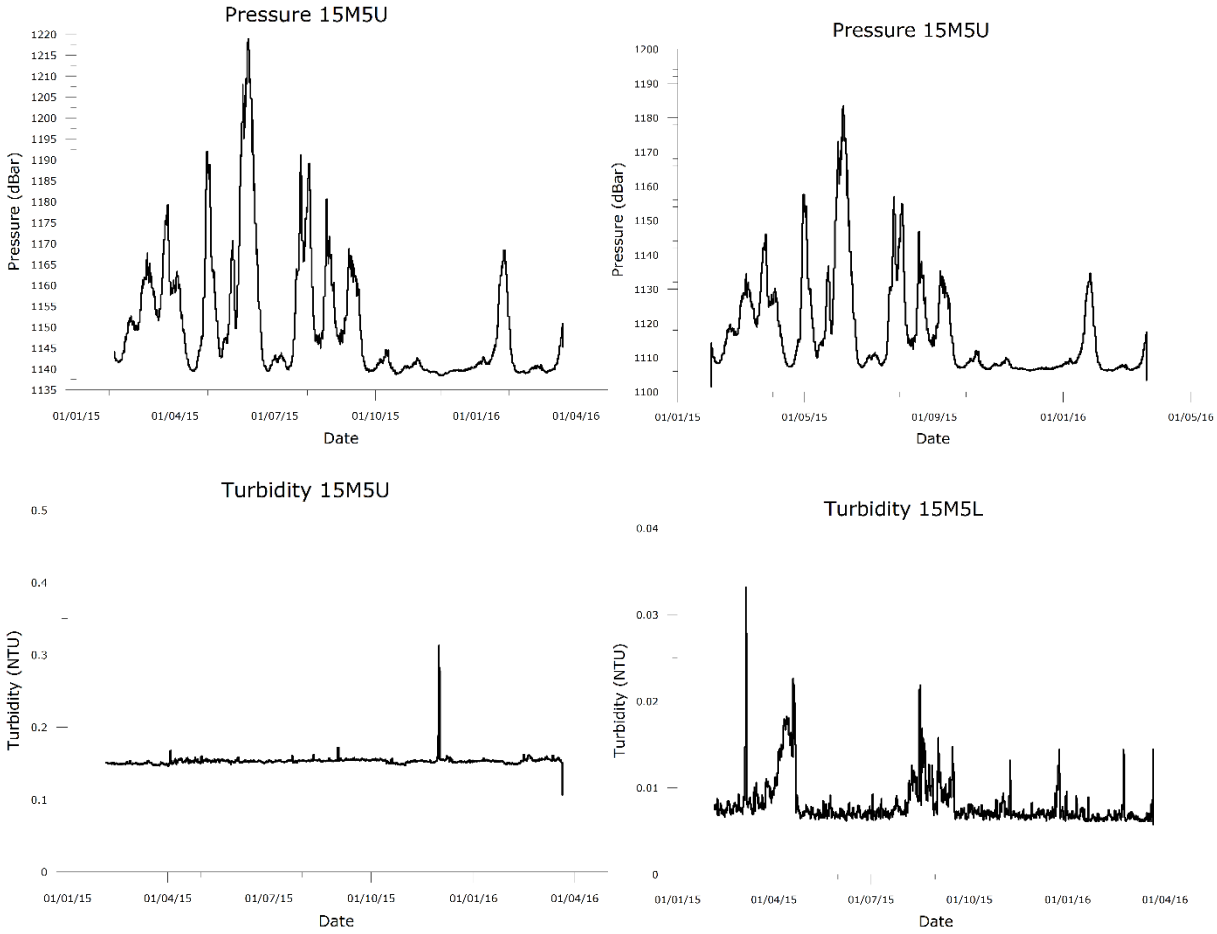


Figure 5.5.5b. Pressure and Turbidity logged by the tiltmeters mounted on the sediment traps.

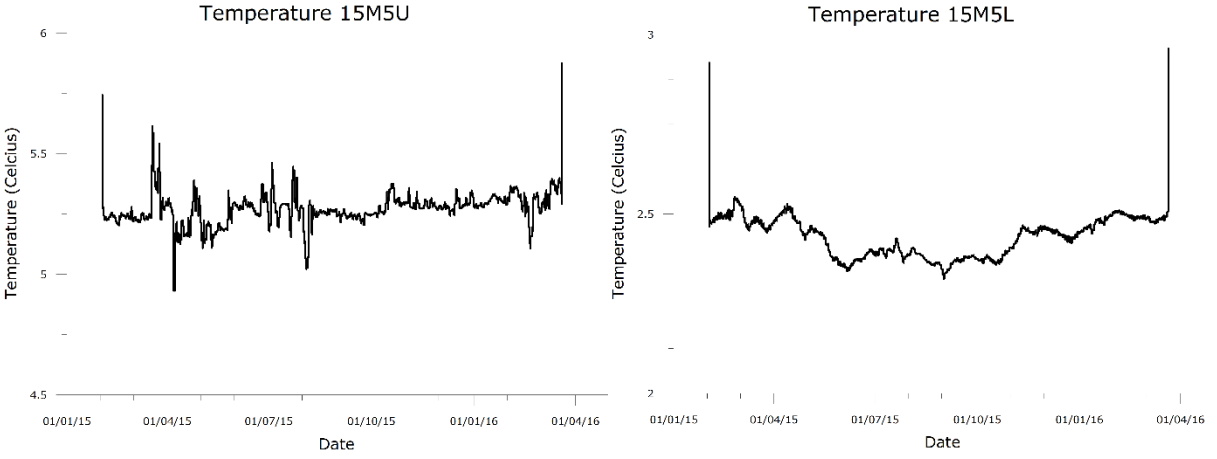


Figure 5.5.6a. Temperature logged by the CTDs mounted on the sediment traps.

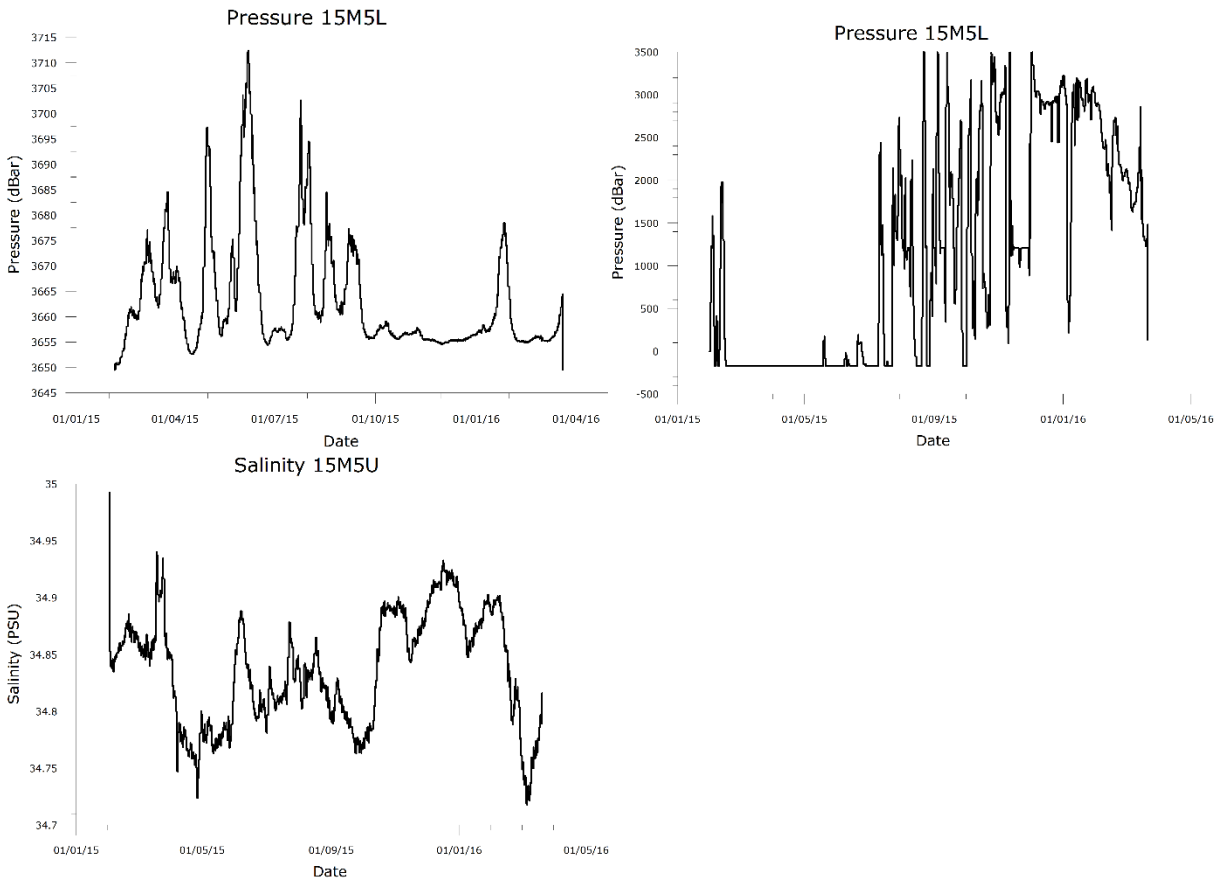


Figure 5.5.6b. Pressure and Salinity logged by the CTDs mounted on the sediment traps.

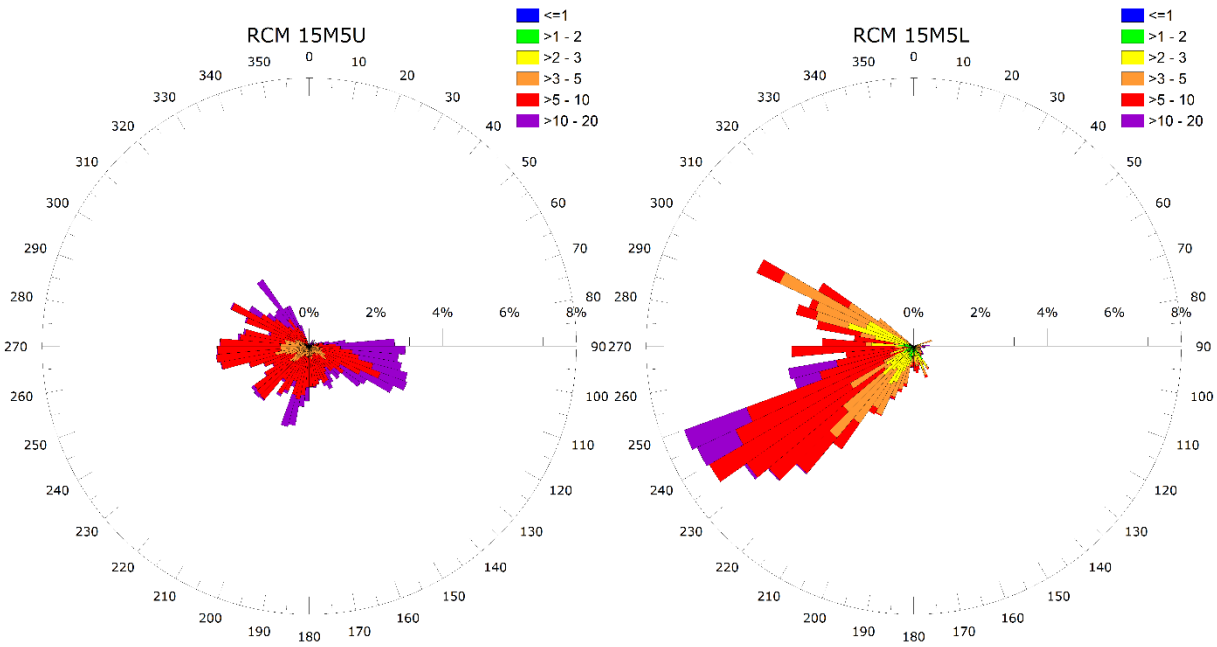


Figure 5.5.7. RCM current meter plots, with current direction and speed (colours, in cm/s).

Mooring 15M4

Due to high swell at station M4, and without forecasted improvement for the next few days, it was decided to not recover the mooring for safety reasons. It will be retrieved by German colleagues of the team of Prof Nicole Dubilier during *FS Meteor* cruise M126 in May 2016.

Mooring 15M3

Mooring 15M3 was successfully recovered, including the two KUM sediment traps at 1200 and 3500 mbsl. For the upper trap, it appeared that the carrousel with sample bottles got stuck between bottles 25 and 26, so the 13 remaining bottles had stayed empty. For the lower trap, the carrousel was stuck between bottle 3 and 4, and therefore the rest of the cups were empty (Fig. 5.5.8 and 5.5.9). pH values ranged between 7.8 and 8.7 for the samples that contained any sediments (Fig. 5.5.10). Residue heights could not be measured in most samples, since there was either not enough material to cover the bottom of the sample bottle, or the sample contained no sediments at all (Fig. 5.5.10).

A tilt meter was only present for the upper trap, and the data shows the angle of tilt amounted less than a degree (Fig. 5.5.11), and also the temperature remained very stable. The pressure sensor shows not too much variation, around 5 dBar. Data from the CTD sensor is similar to the tilt meter data (Fig. 5.5.12). Salinity for the upper traps shows more variation than the lower trap. Current meter data shows that the current has a dominant southern direction, and velocities range mainly between 2 and 5 m/s (Fig. 5.5.13).

Figure 5.5.8: Photos of all bottles (N=13) from the upper trap at M3 (15M3U) that contain sediments.

Figure 5.5.9: Photos of all bottles (N=3) from the lower trap at M3 (15M3L) that contain sediments.

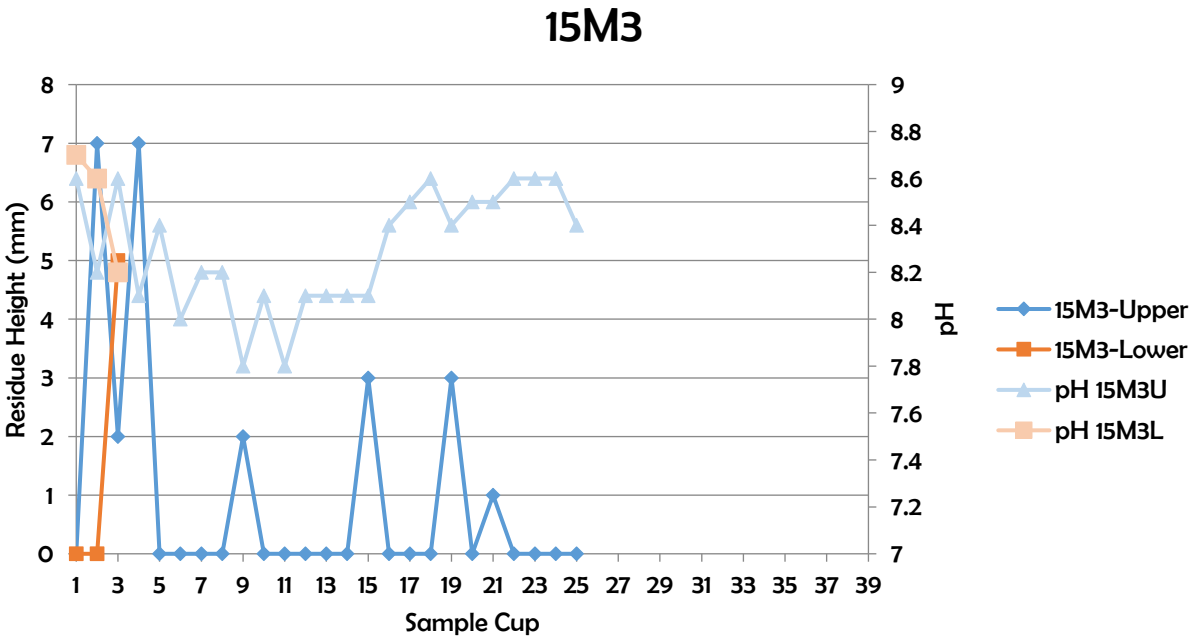


Figure 5.5.10 Residue heights and pH of the upper (1200 m) and lower (3500 m) traps of 15M3.

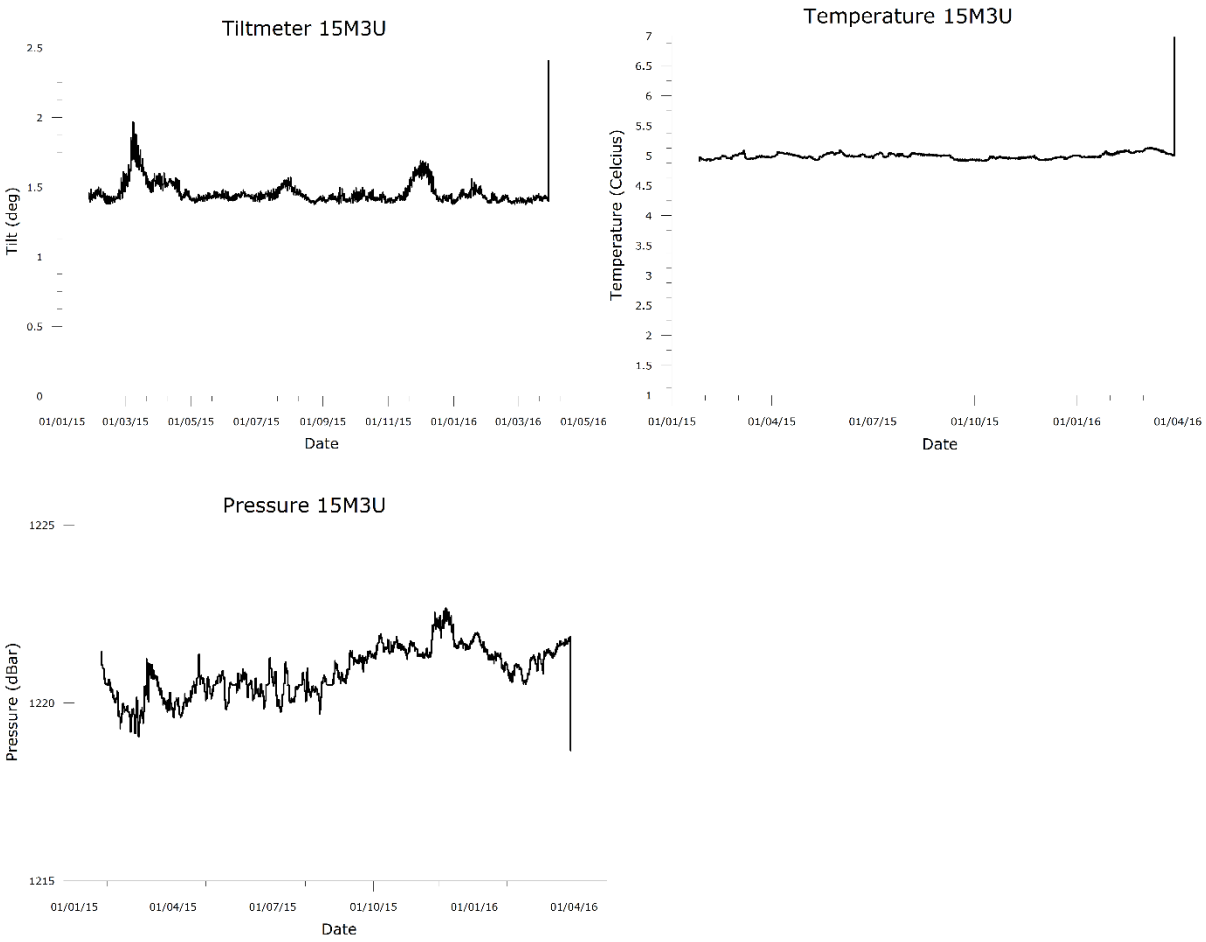


Figure 5.5.11 Tilt, Temperature and Pressure measurements logged by the tiltmeter mounted on the sediment trap.

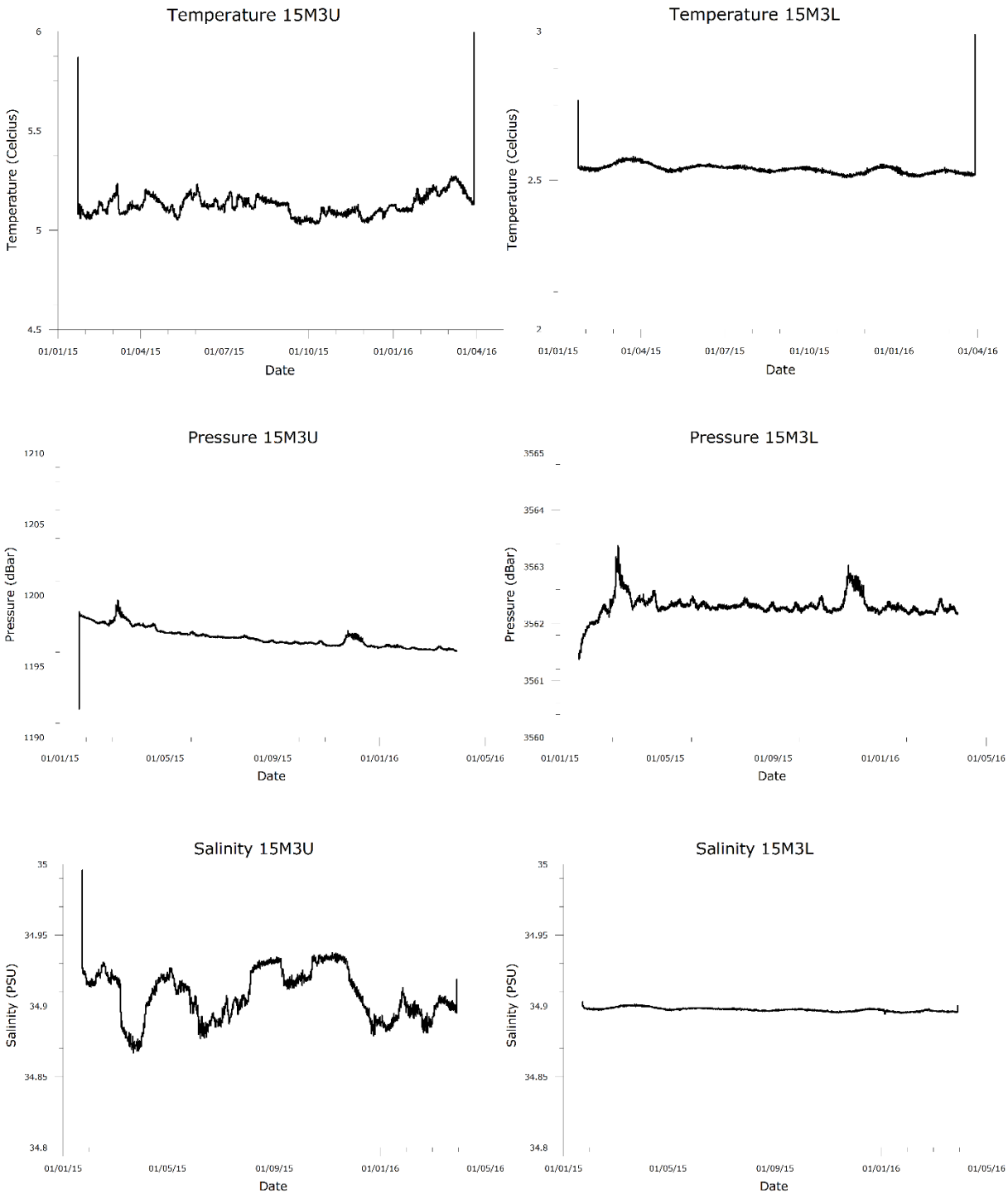


Figure 5.5.12 Temperature, Pressure and Salinity logged by the CTDs mounted on the sediment traps.

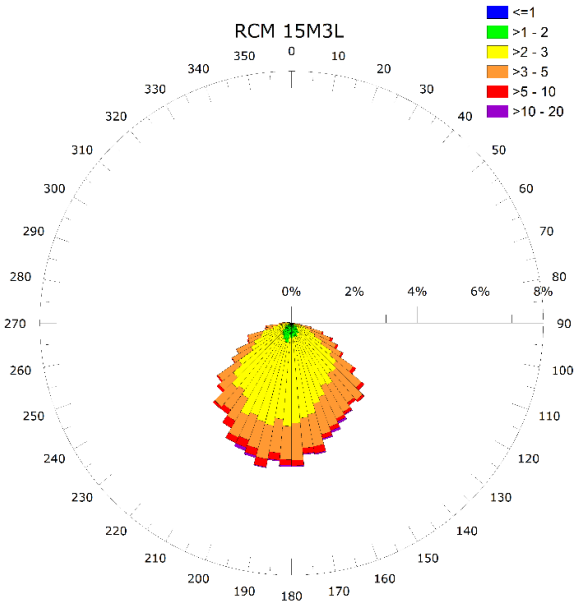


Figure 5.5.13. RCM current meter plot, with current direction and speed (colours, in cm/s).

Mooring 15M1

During the release of mooring 15M1, initially, the release gears did respond to the acoustic wake-up call, however the mooring did not surface. Therefore, it was decided to activate the second releaser, which did result in a successful surfacing of the mooring, after which it could be recovered, at the loss of the special chain connecting the two release gears. On deck, the cause appeared to be overgrowth from the zinc anode that blocked the release arms. Also the lower CTD (SBE 37 MicroCat) at 3500 m had flooded, and no data could be recovered from it.

Both the KUM traps seemed to have worked well, i.e. had both carrousels turned to their zero position. However, in the upper (1200 m) trap, the first few bottles of the first (lower) carrousel contained notable amounts of sediments, while subsequent bottles showed only a few 'single' particles of marine snow (Fig. 5.5.14). The same is true for the second (upper) carrousel of sample bottles. By contrast, the sample bottles of the lower (3500 m) sediment trap all contained some sediment, i.e. appeared to have performed flawlessly (Fig. 5.5.15).

For the upper (1200 m) trap, values for pH ranged between 8.0 and 8.6 for bottles than contained sediments. For the lower (3500 m) trap, values for pH ranged between 7.4 and 8.6 (Fig. 5.5.16). Residue heights show little or no material for most samples of the upper (1200 m) trap (Fig. 5.5.16).

Tilt meter data shows the angle of tilt amounted less than a degree (Fig. 5.5.17), and the small variations seem synchronous for both upper and lower traps. Also the temperature remained very stable. The pressure sensor of the upper trap seems to be gradually increasing over time. The turbidity data shows a constant value, which is probably incorrect. The CTD of the lower trap flooded, so only data for the upper trap is present (5.5.18). It shows that the temperature and salinity are in good accordance with each other. Current meter data shows that the current varies between 90 and 270 degrees in direction, and velocities are low, mainly below 3 cm/s (Fig. 5.5.19).

Figure 5.5.14: Photos of all sample bottles of the sediment trap 15M1-Upper.

Figure 5.5.15: Photos of all sample bottles of the sediment trap 15M1-Lower.

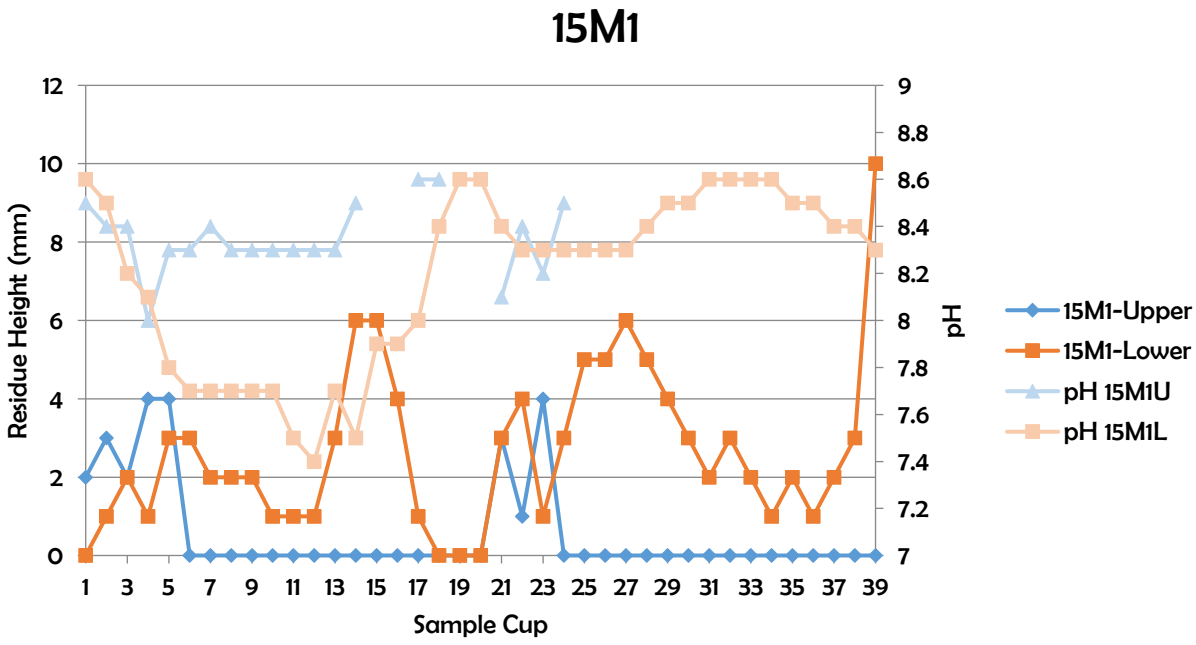


Figure 5.5.16: Residue heights and pH of the upper (1200 m) and lower (3500 m) traps of 15M1.

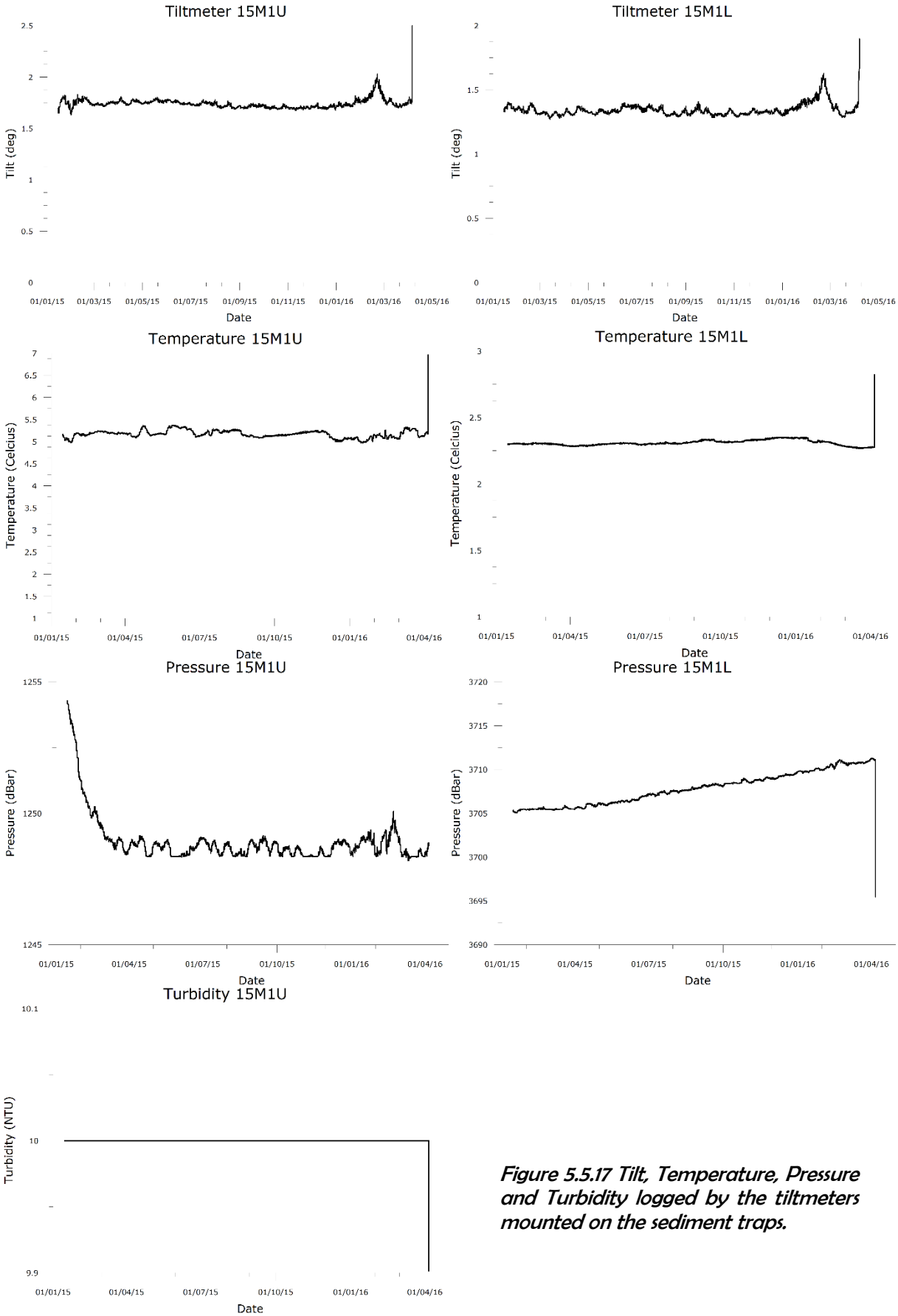


Figure 5.5.17 Tilt, Temperature, Pressure and Turbidity logged by the tiltmeters mounted on the sediment traps.

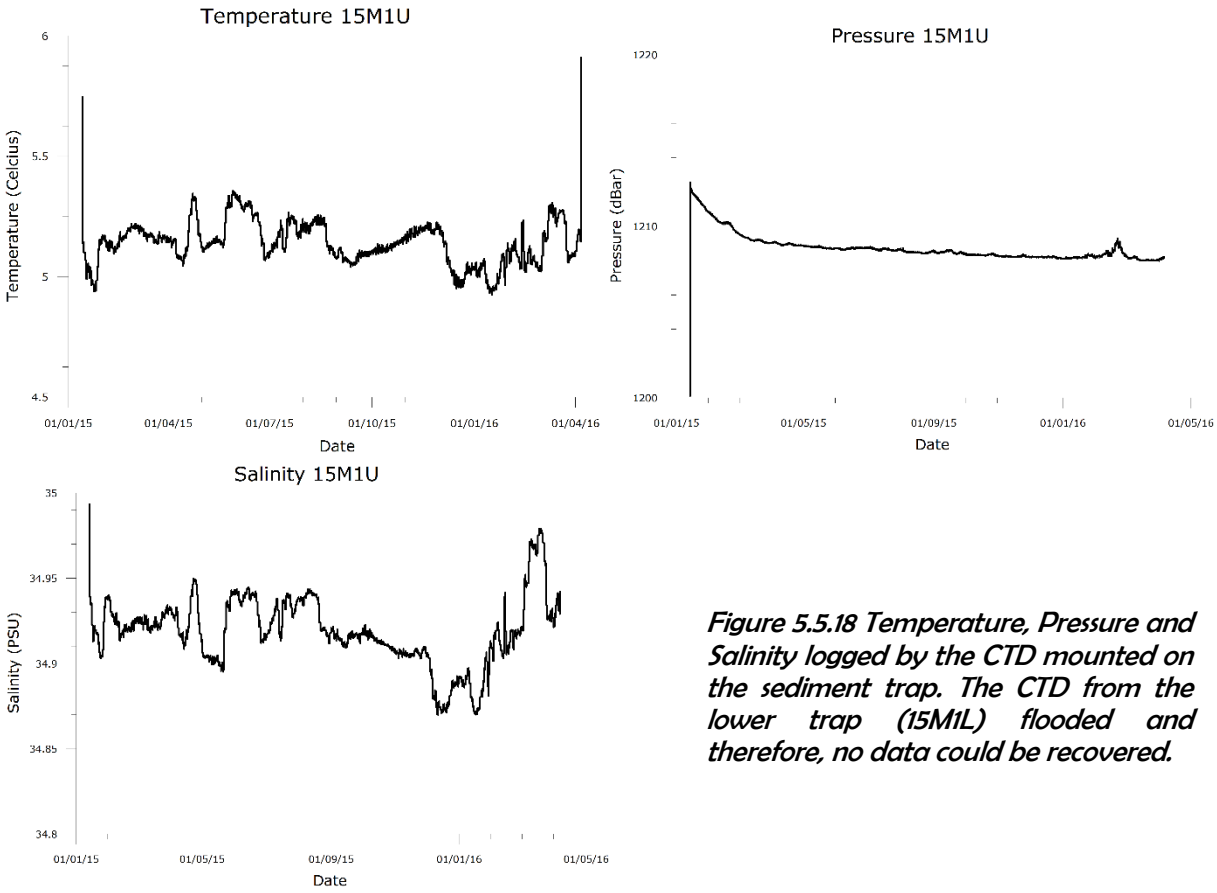


Figure 5.5.18 Temperature, Pressure and Salinity logged by the CTD mounted on the sediment trap. The CTD from the lower trap (15M1L) flooded and therefore, no data could be recovered.

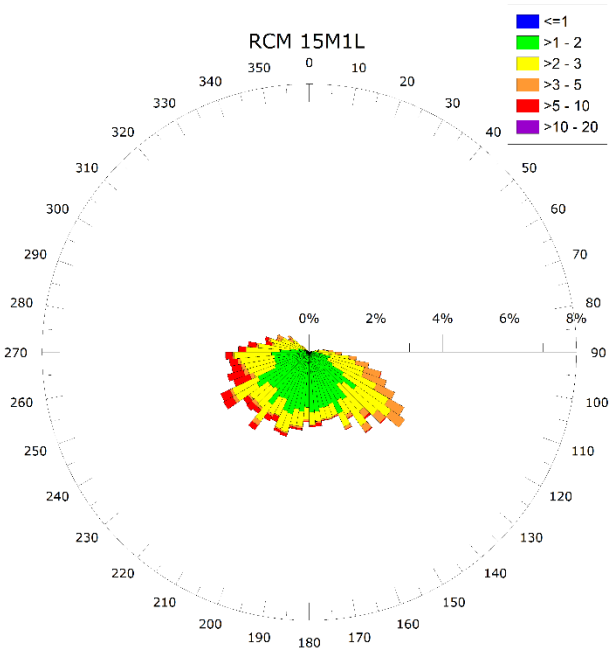


Figure 5.5.19 RCM current meter plot, with current direction and speed (colours, in cm/s).

Mooring 14M1

During RV Pelagia Expedition 64PE378 in November 2013, new cables from a different supplier were planned to be used to replace the original mooring cables at all stations. At station 14M1, these new cables were also used. However, during the re-deployment of the mooring at station M2 these new cables turned out to be not strong enough and the sockets of the cables broke twice. Knowing that the new cables at station M1 were weak (maximum load of 1.3 Ton), it was decided to not recover mooring M1 during 64PE395 under adverse weather conditions. During the present cruise we did recover the mooring successfully.

One of the sample bottles (sample 9) was filled to the top entirely, and also the bottle before that was rather full. Whilst bottle 10 still contained some sediment, samples 11-24 contained little or no sediment (Fig. 5.5.20). This did not result from a rotation failure, because the read-out from the trap motor showed that the motor functioned as it was programmed, as is also evidenced by the fact that the carrousel was recovered with the carrousel in the zero position, i.e. after a complete rotation given that bottles 1-10 were filled. Because both the tilt meter and current meter showed no anomalies (Fig. 5.5.22), we suspect clogging of the funnel occurred. Since bottle 9 was filled to the top, this may have resulted in partial to complete blockage of the funnel, preventing sediment to enter all subsequent sample bottles. After arriving at the zero-position some 32 weeks later, the blockage must have disappeared sometime during the year it took prior to recovery, since there was no sign of it upon retrieval. Values for pH ranged between 7.3 and 8.0 for the filled bottles (U1-U10), and between 8.5 and 8.6 for the empty samples (U11-U24), with U12 having a pH of 8.1 (Fig. 5.5.21). Sample 8 and 9 had a strong sulfuric smell. The residue heights show a peak at samples 8 and 9, and were below detection limit in samples 11-24 (Fig. 5.5.20).

Tilt meter data shows the angle of tilt amounted less than a degree (Fig. 5.5.22) and it seems that it only recorded data from November 2014 until January 2016, although it sampled from November 2013 until October 2014 (Table 5.5.2). Data from the CTD shows also that the trap was in a stable position (Fig. 5.5.23).

Figure 5.5.20: Photos of all sample bottles of the sediment trap 14M1-Upper.

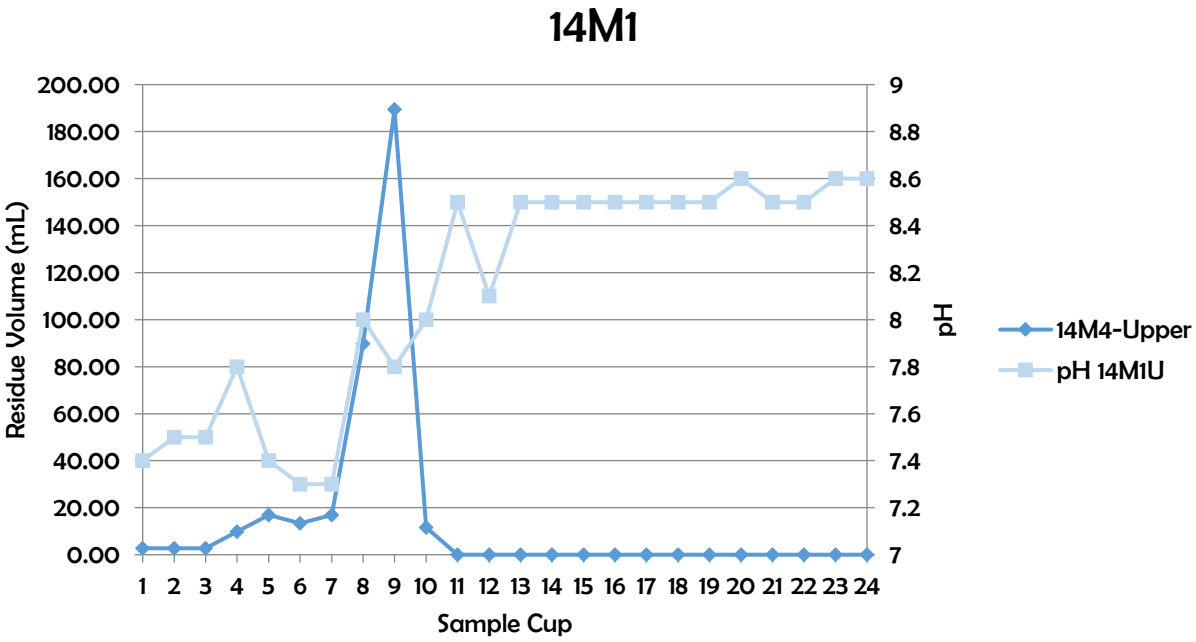


Figure 5.5.21: Residue volume and pH of the upper (1200 m) sediment trap of 14M1. Calculated from residue heights using the calibration curve in Fig. 5.5.1.

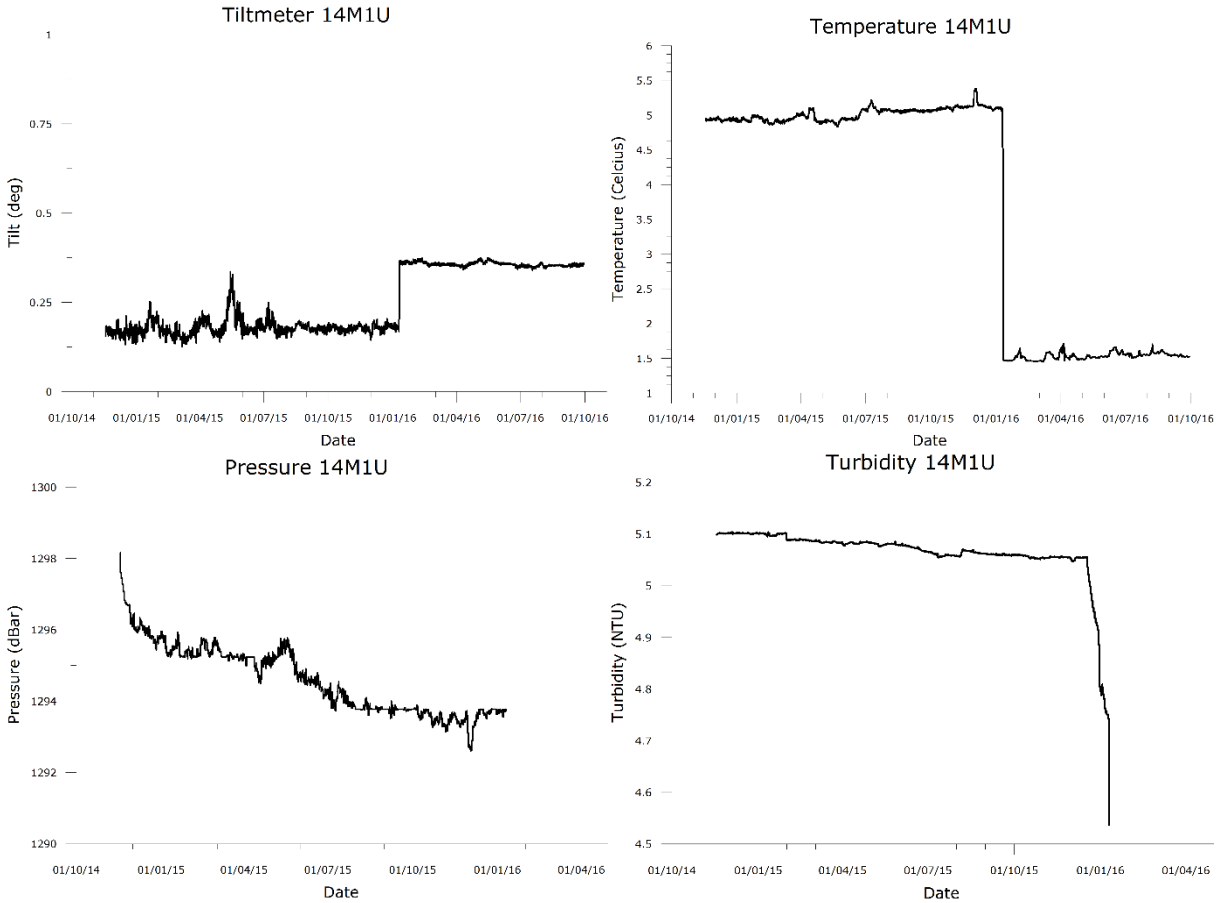


Figure 5.5.22 Tilt, Temperature, Pressure and Turbidity logged by the tiltmeter on the trap.

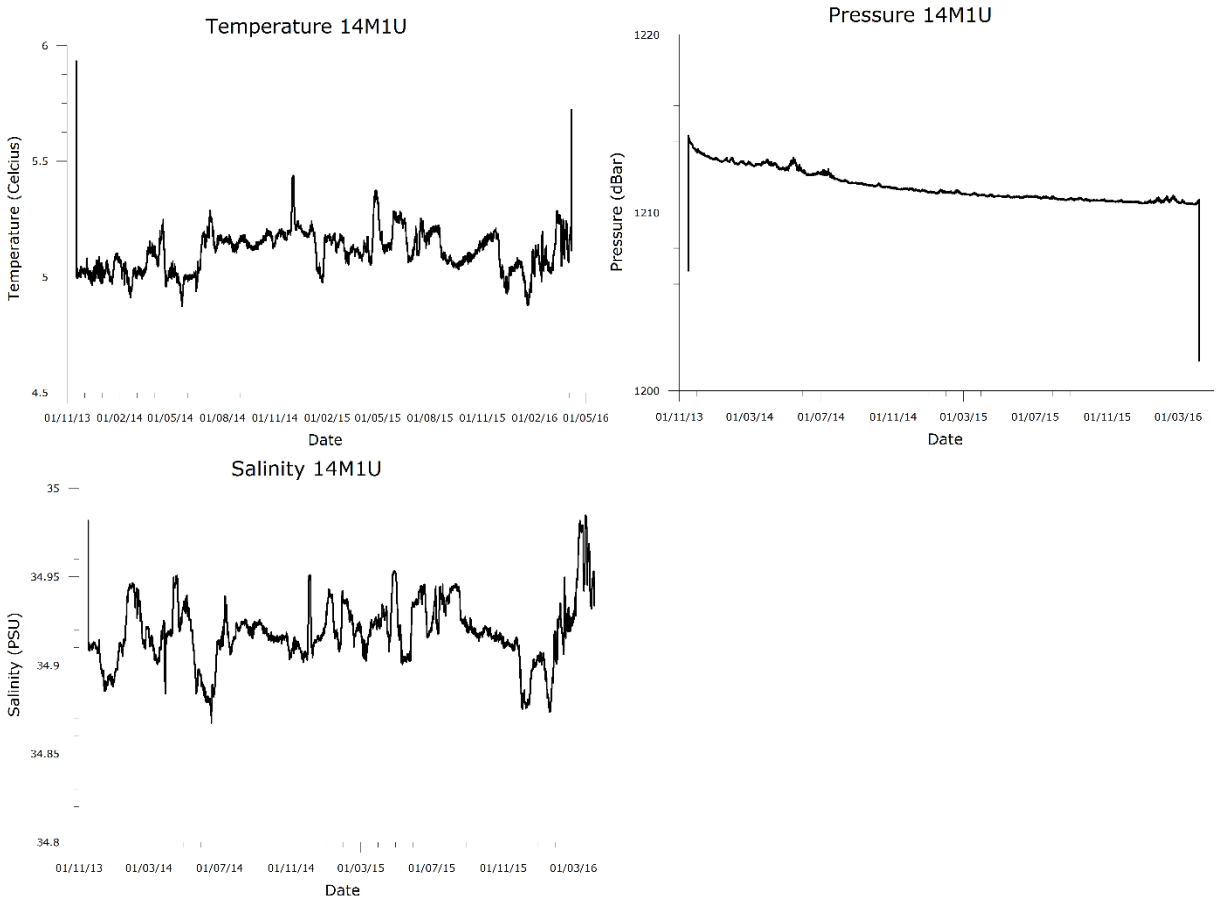


Figure 5.5.23 Temperature, Pressure and Salinity logged by the CTD mounted on the sediment trap.

Geert-Jan and Michèlle harvesting a sediment trap.

5.6 Buoy recoveries [Laura Korte, Chris Munday, Michèlle van der Does]

Three buoys "Laura, Michelle and Carmen" were recovered at the stations M4, M3 and Cape Blanc, respectively. For recovery, the ship approached the buoys backwards, where they were hooked from the aft deck and lifted aboard. After securing the buoys on the metal foot, the remaining parts of the mooring (smarties and releasers) were retrieved. All buoys had the same mooring setup (see Annex I).

Through the iridium connection to the buoy, we get an update on a number of properties in an eMail twice a day. These data, plus additional data points, are also saved on the SD on the buoys at a 20-second interval. In general, the data include:

1) Meteorological data
    a. Wind speed
    b. Wind direction
    c. Temperature
    d. Air pressure
    e. Humidity
    f. Rain
2) Navigation
    a. Position
    b. Heading
    c. Tilt (pitch & roll)
3) Dust collection
    a. Filter status
    b. Battery status
    c. Amount of filtered air per session

Complementary attachments were mounted to some of the buoys. A SBE Seacat CTD was mounted in the base of buoys Laura and Michelle and an additional CO_2 sensor was connected to buoy Laura.

Buoy Laura

During the lifting of buoy Laura to the deck, the upper part of the chimney hit the ship and disconnected. The readout of the CO_2 sensor resulted in recorded data for only one month, from January 29th to February 23rd 2015. The CTD sensor recorded data half-way through the deployment, from January 28th to July 1st 2015. A possible reason for this might be a battery failure.

Throughout the deployment the buoy was pushed to the west due to mostly easterly winds (Fig. 5.6.1). Most of the winds are blowing as fresh breeze (5 Bft). For unknown reasons the recording of the meteorological data (Fig. 5.6.2) was interrupted for about two months in October to December 2015. The amount of filtered air per session, however, stopped being recorded shortly after and this situation continued throughout the entire deployment. However, as can be clearly seen on the filters, sampling of air continued throughout the entire sampling period.

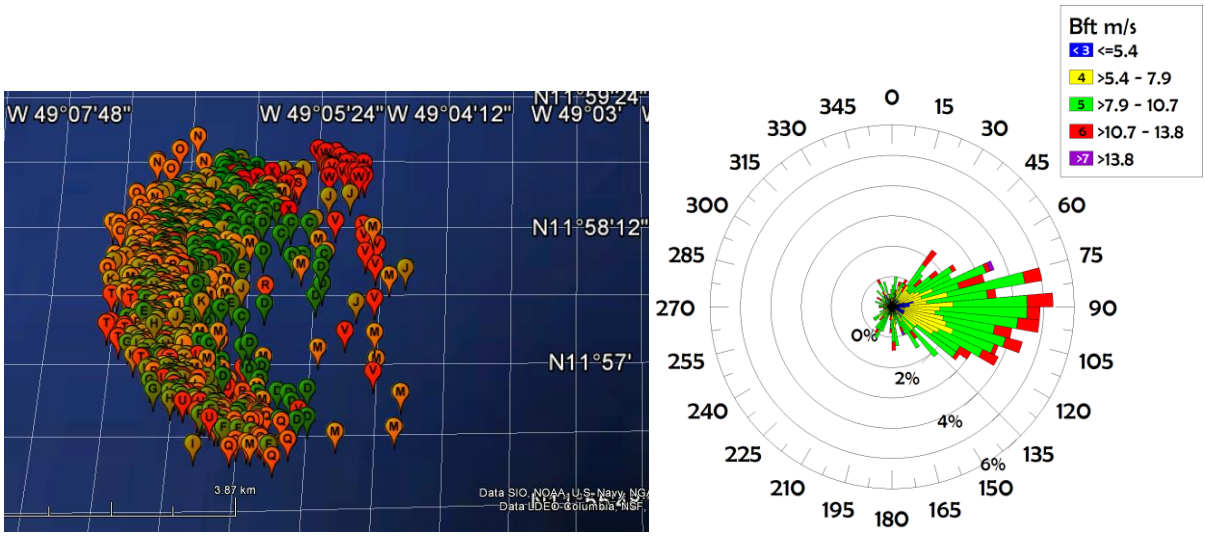


Fig. 5.6.1: Locations and wind rose of buoy Laura. Left: locations between February 2015 and March 2016 (N=827), plotted with Google Earth. Letters (A-X) in the marks and colour coding refer to individual filters 1-24. Right: Wind rose for the same sampling interval.

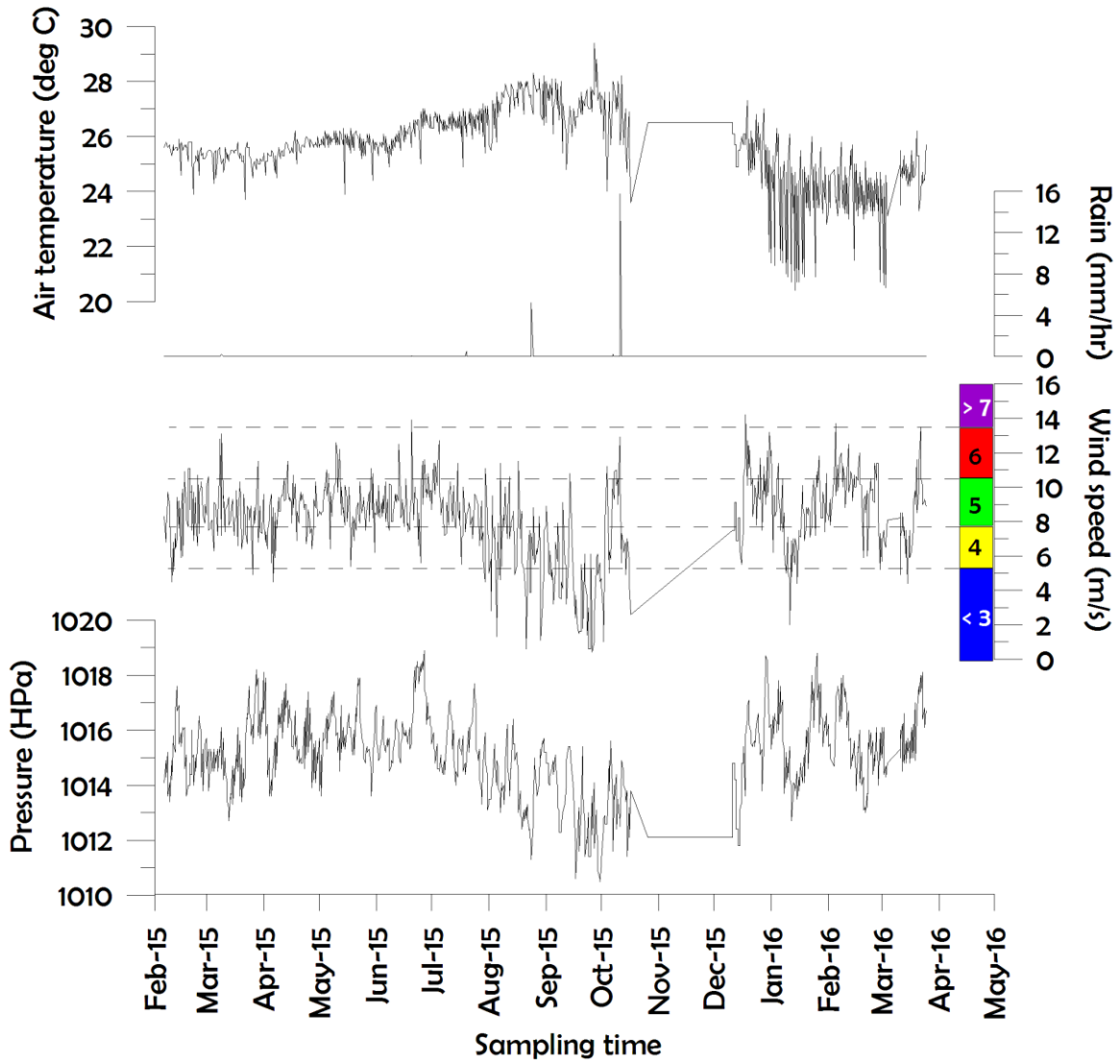


Fig. 5.6.2: Meteorological data logged by buoy Laura between February 2015 and March 2016.

Buoy Michelle

During recovery of buoy Michelle, the meteorological sensor hit the ship, breaking the mount. The sensor was to be replaced anyway, as it was malfunctioning during the last period of sampling (from September 2015 onwards) and did not send any updates in the daily emails. Unfortunately, this data was also not recorded on the SD card. The CTD sensor collected data from January 22nd to April 3rd 2015.

The moderate breeze from the east is also pushing buoy Michelle to the west during most of the deployment period (Fig. 5.6.3).

Fig 5.6.4 displays the meteorological data from January until August 2015.

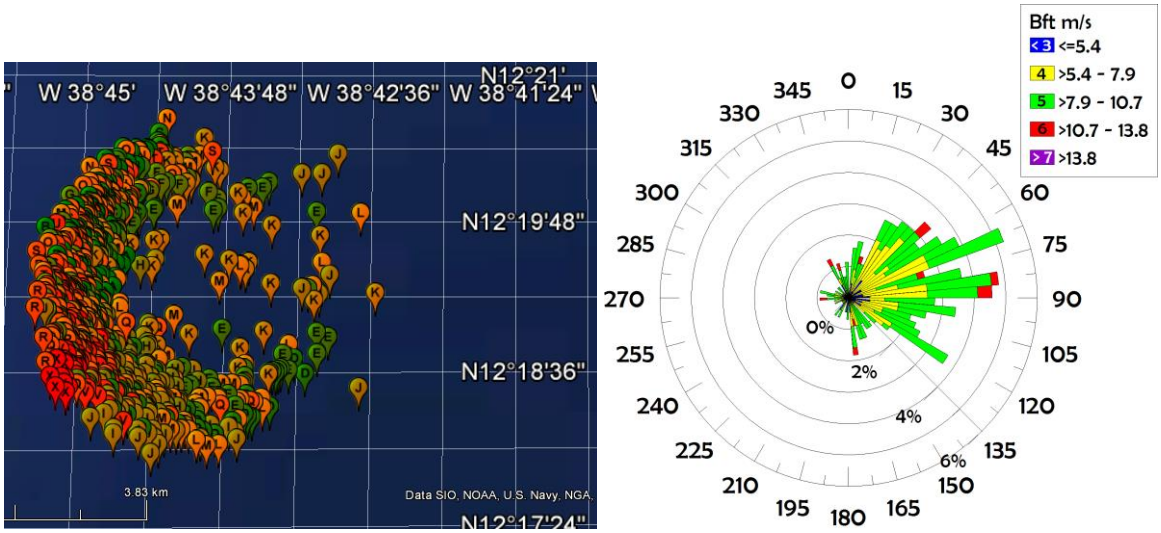
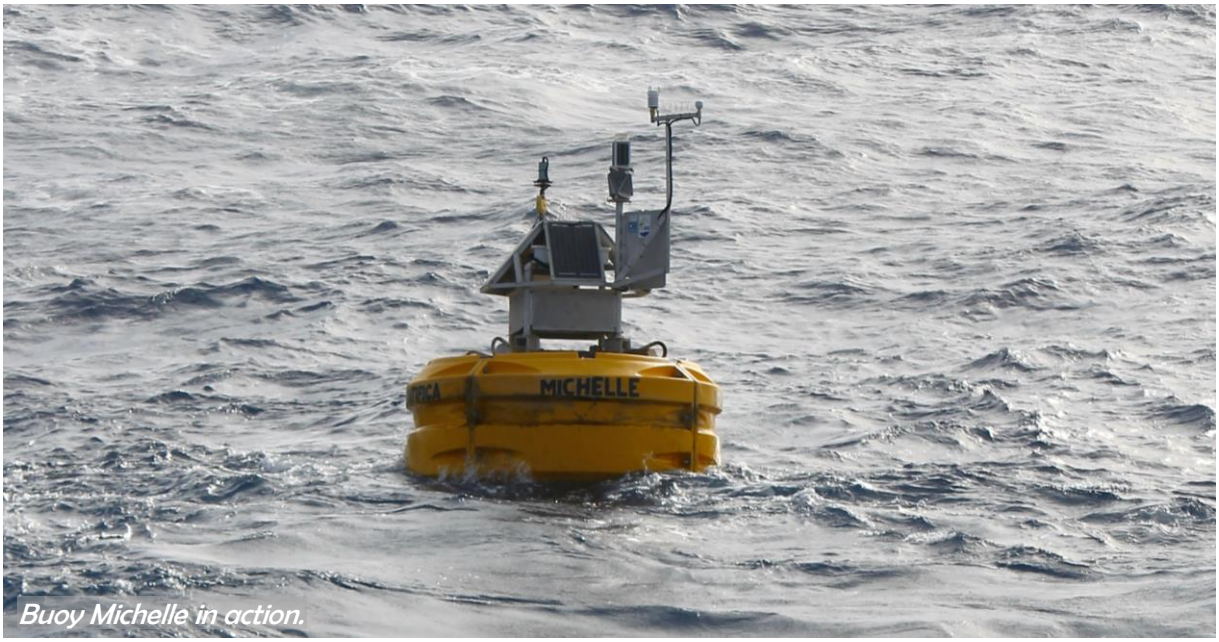


Fig. 5.6.3: Locations and wind rose of buoy Michelle. Left: locations between January and September 2015 (N=437), plotted with Google Earth. Letters in the marks and colour coding refer to individual filters 1-24. Right: Wind rose for the same sampling interval.



Buoy Michelle in action.

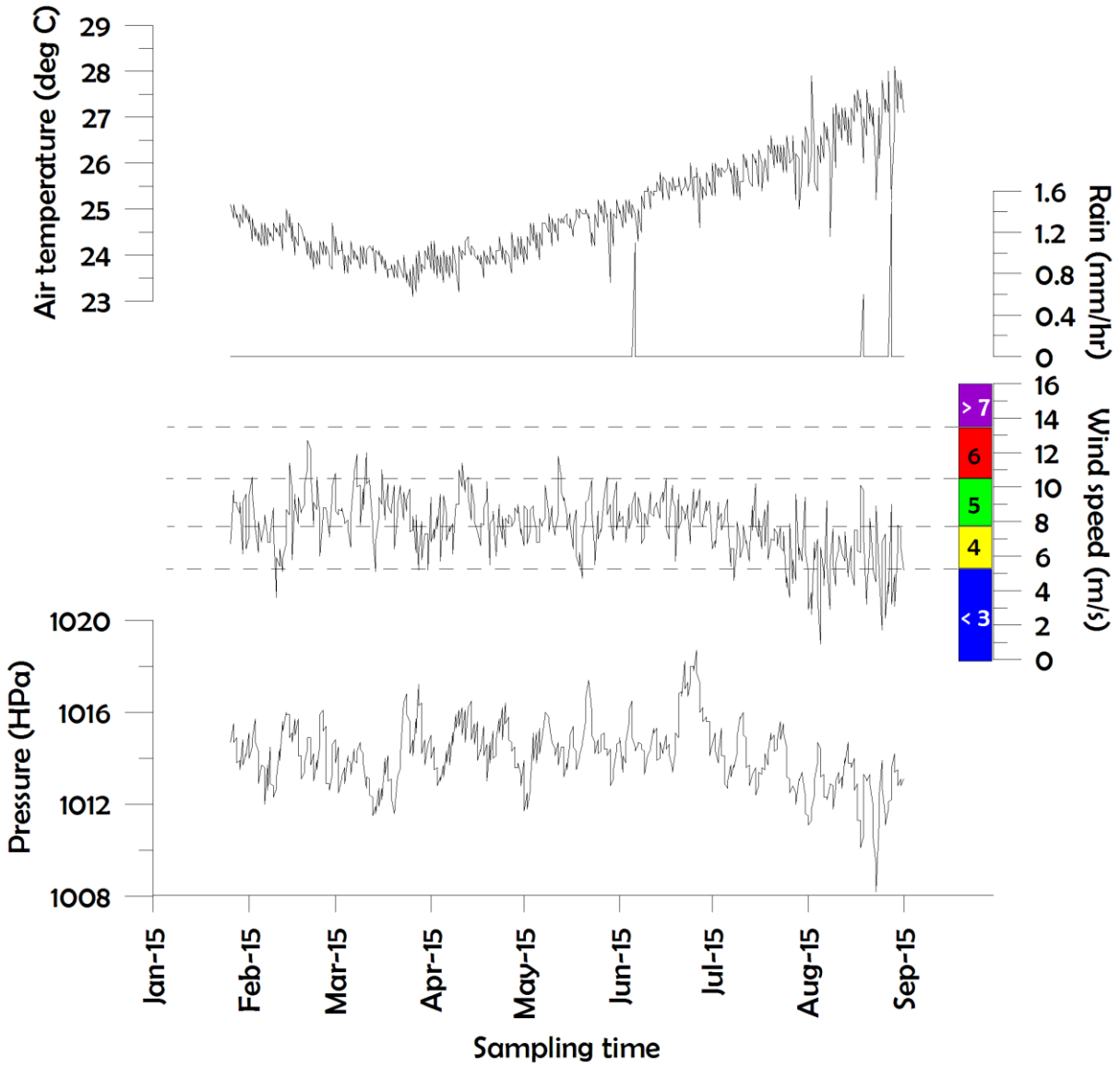


Fig. 5.6.4: Meteorological data collected by buoy Michelle between January and September 2015.

Buoy Carmen

Recovering buoy Carmen went without any complications. This buoy was attached to the A-frame by 2 hooks for a level recovery, compared to Michèlle and Laura, which were lifted aboard using only one hook, resulting in the buoy hanging at a 45° angle for some time.

Within the five months of deployment the dominant wind direction is from the Northeast with a tendency to a strong breeze (Fig. 5.6.5). The meteorological data shows a decrease in temperature and not a single rain event (Fig. 5.6.6).

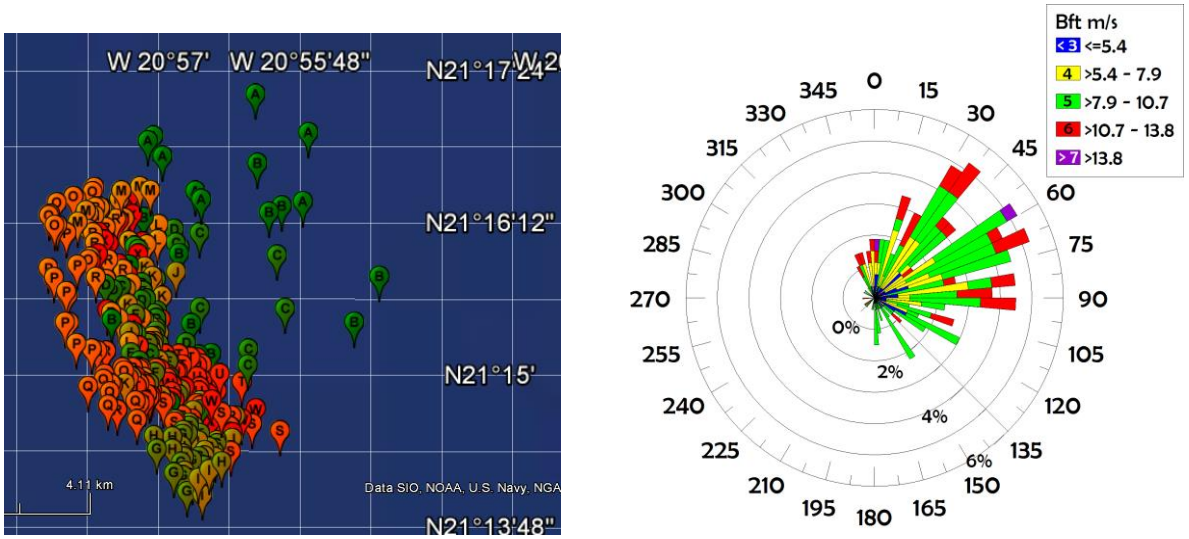


Fig. 5.6.5: Locations and wind rose of buoy Carmen. Left: locations between November 2015 and April 2016 (N=292), plotted with Google Earth. Letters in the marks and colour coding refer to individual filters 1-24. Right: Wind rose for the same sampling interval.

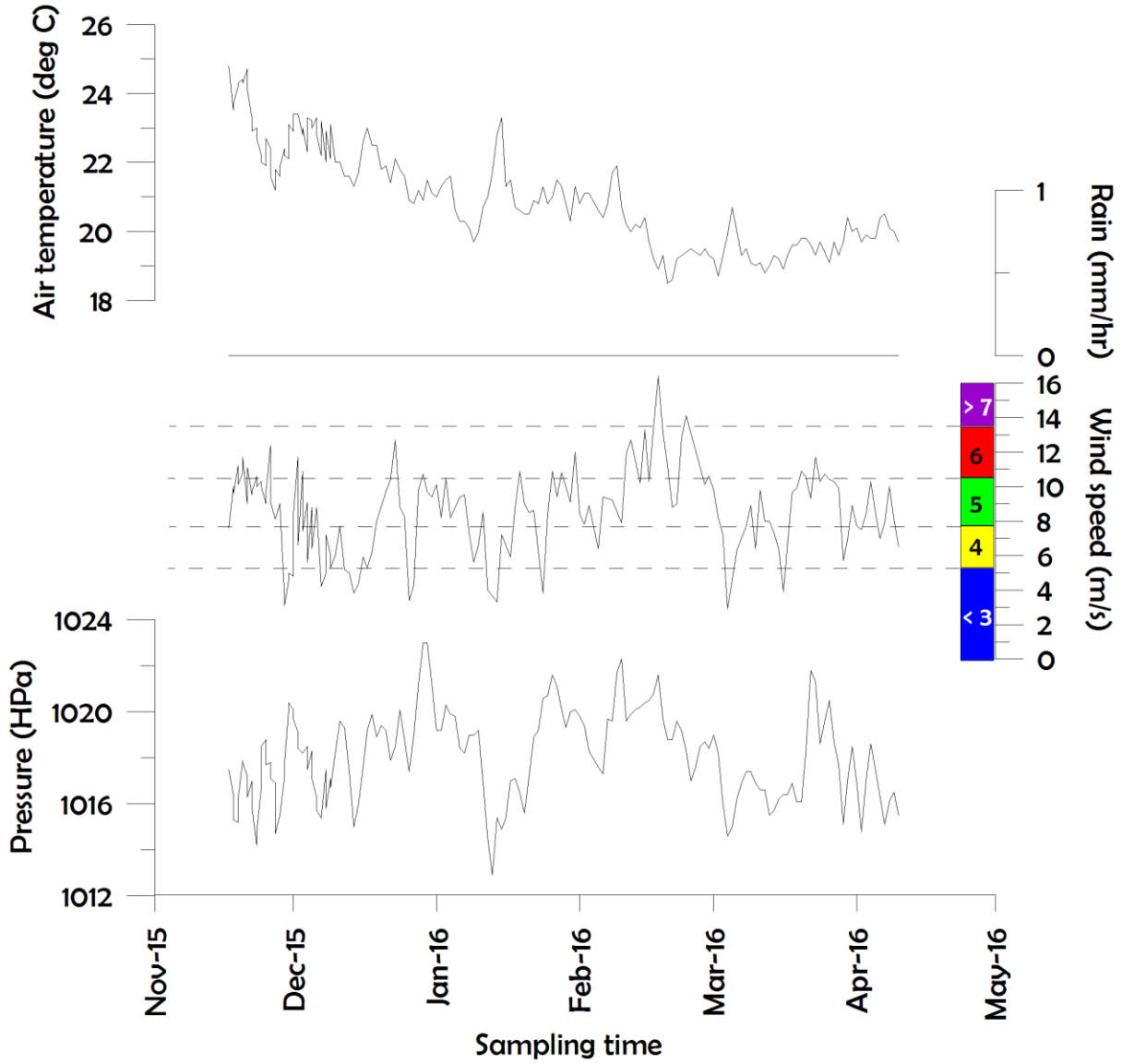


Fig. 5.6.6: Meteorological data collected by buoy Carmen between November 2015 and April 2016.

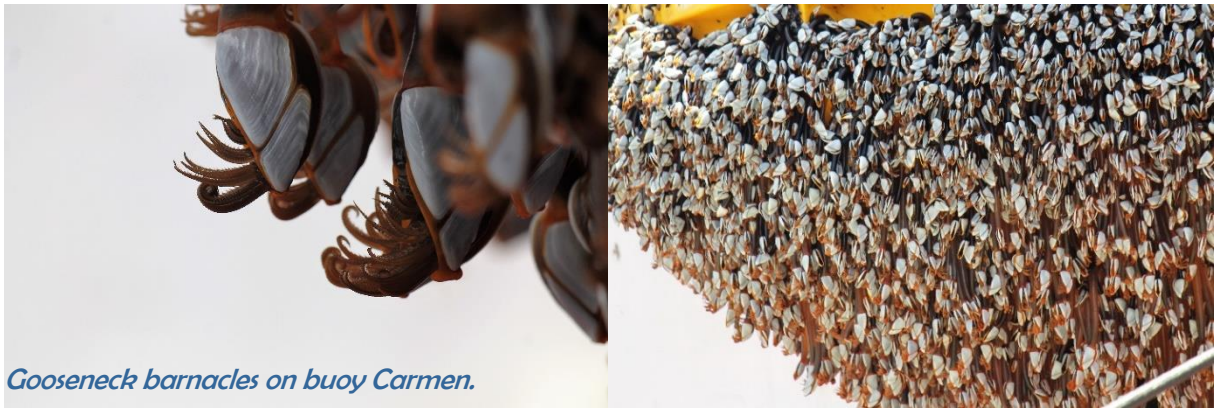
Filters

The filters of all the buoys stayed intact due to the improvement of the support filters. Some filters looked like they have been exposed to water, they turned transparent and greyish. All filters were carefully removed from the buoy carrousels using pincers and placed folded into petri dishes. The additional MWAC samplers collected the dust nicely and were removed and stored as well.

Fig. 5.6.7: all filters collected by buoy Michèlle

Others

All buoys created their own micro-habitat in the ocean, with large amounts of fish and other marine life. The floating parts of the buoys were overgrown with gooseneck barnacles from which buoy Carmen was most affected.



Gooseneck barnacles on buoy Carmen.

Polychaete barnacle-eating worm Amphinome rostrata *and crabs (eating them…)*

5.7 Trace metals [Patrick Laan]

The trace metal iron (Fe) is one of the 6 key elements in the GEOTRACES Science plan. It is an important bio-essential element present in extremely low concentrations and therefore limiting primary productivity in large parts of the world oceans (*Martin and Gordon*, 1988*; De Baar et al.,*1995*; Bruland et al.,*1995*; Boyd et al. 2000*). Dust is a main transport pathway of bio-essential trace elements to the surface of the open ocean. The heavy Saharan dust impact on the Atlantic Ocean is ideal to investigate the effect of dust on the biogeochemical cycles of trace elements and isotopes and iron in particular. This paragraph describes the measurement of DFe and the sampling from the CTD and the incubation experiments during cruise JC134.

Work at sea

During the expedition all CTD stations at 5m, 20m and the Chlorophyl max depths were sampled. Also the biological incubation experiments were monitored during the incubation. The initial water for the incubation was measured and after one day and at the end of the experiment a subsample was measured. A 500ml subsample was directly sampled from the CTD bottle. This bottle was filtered in a flowhood (ISO class 5).

This bottle was pressurized (~1 bar) using filtered compressed air (by the lack of N_2) and samples for dissolved iron over a 0.2µm Sartobran 300 cartridge (Sartorius). For each sample the 0.2 µm Sartobran 300 cartridge was firstly rinsed with approximately 150 ml water to replace the previous sample from the cartridge. After the last sample was filtered the cardridge was washed with 500ml ultra-pure type 1 water (18.2 MΩ, MQ integral system).

The same filtration system was used to filter the samples from the incubation experiment. On either day 1 or day 0 and at the end of the experiment, day 4 or 6 all incubation bottles were sampled for their Fe content.

Filtration setup as used during the cruise.

Samples for dissolved iron (DFe), were acidified within 2 hrs after sampling using Romil ultraclean HCl (pH 1.8, 2ml/L 34-36%) and analysed directly on board.

Dissolved iron concentrations were measured directly on board using an improved automated Flow Injection Analysis (FIA) system, which is based on luminol chemiluminescence (*Klunder et al. 2011*). At least 12h prior to analysis, 1‰ of 10 mM H2O2 (Suprapure, Merck 30%) was added to ensure the oxidation of any Fe(II) in the sample (*Lohan and Bruland, 2006*). The acidified sample was pre-concentrated for 90s on a

Toyopearl AF-Chelate-650M (TosoHaas, Germany) column. Hereafter the column was rinsed for 60s with Milli-Q water to remove interfering salts. The Fe was subsequently eluted from the column with 0.4M HCl (Suprapure, Merck 30%) during 100s. The eluted Fe/HCl mixture subsequently mixes with a 0.96 M ammonium hydroxide (Suprapur, 25% Merck), 0.3M hydrogen peroxide (Suprapure, Merck 30%) and luminol/TETA solution. The luminol solution is prepared by dissolving 120 mg luminol (3-aminophtal-hydrazide, Aldrich) in 2ml of 1/1 diluted ammonia/ ml ultra-pure type 1 water (18.2 MΩ). This mixture is passed over a (IDA containing) column into a 1000ml ultra-pure type-1 water. Finally 500µL TETA was added. An extra cleanup column was placed in the luminol stream of the FIA system. Sample and reaction solution passed a 1.5 m length mixing coil placed in a 35°C water bath.

The chemiluminescence was detected with a Hamamatsu HC135 Photon counter. Concentrations of DFe were calculated in nanomol/liter (nM) from the photon emission peak height. Calibration was done with the method of standard addition. On low Fe containing seawater spikes of iron were added. For the CTD samples additions of up to 1nM was done. This correlation was linear. However for the experiments higher additions were necessary especially for the dust additions. Additions of 30nM were necessary to calibrate these incubations. Up to these concentrations there was not a linear relation anymore and a polynomial fit has been used for calibration of these samples.

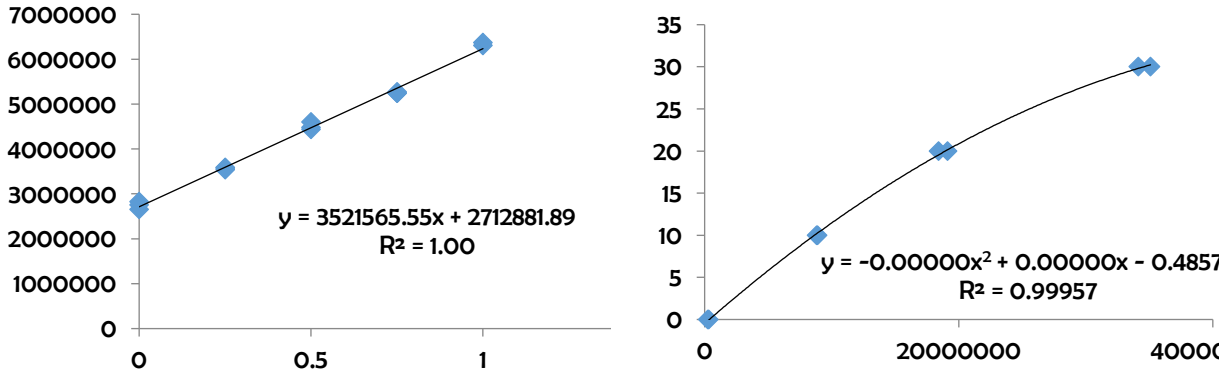


Fig 5.7.1: Linear and non-linear calibration lines used to calculate Fe concentrations in the samples.

Samples were analysed in duplicate for the samples and in triplicate for the standards, the average DFe concentrations and standard deviation are given. Concentrations of DFe measured during the JC134 cruise ranged from 0.19 nM in the deep chlorophyll maximum waters up to 2.10 nM in the surface waters at station 1 which was the closest towards Antigua. The standard deviation varied between 0% and 8% (the latter being exceptional), but was on average 2.2%.

The average blank was determined at 0.008 ± 0.0006 nM and was defined as the calculated intercept of a low iron containing seawater sample loaded for 15 – 10 and 5 seconds and was measured daily. To better understand the day to day variation 2 samples from the previous day have been re-analysed the next day. The recovery between these measurements was in the order of 80% up to 120%. The consistency of the FIA system over the course of the day

was verified using a drift standard. Drift has been observed and seemed to be variable from day to day. All data will be corrected for this daily drift after the cruise and all results so far are not corrected. For the long term consistency, the standards will be measured against seawater with a consensus value like SAFe and GEOTRACES reference seawater *(Johnson et al 2007)*. This was not done on board and will be done at the NIOZ after the cruise. On board 2 different stock solutions were used and checked against each other.

Preliminary results

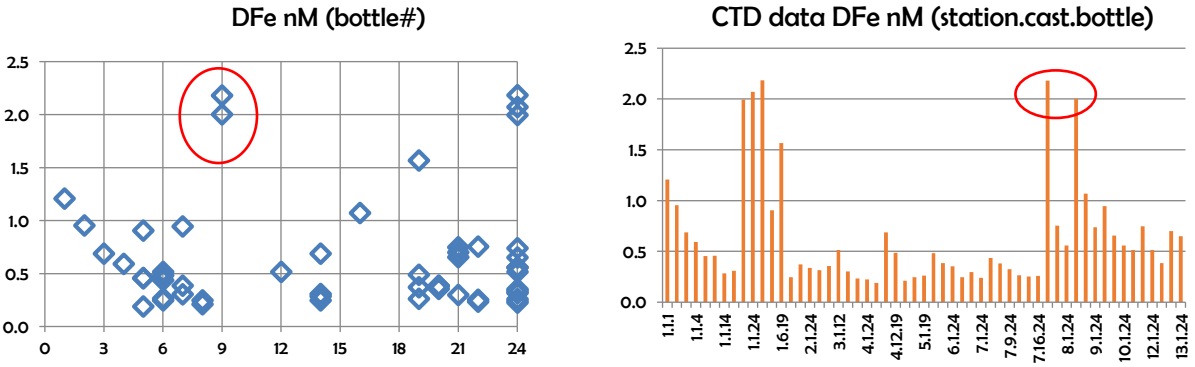


Figure 5.7.2: Dissolved iron plotted against bottle number and against station + bottle number.

Figure 5.7.2 shows the DFe concentration per sample per CTD bottle. All samples are around 2nM or lower. This is in good agreement of what we have measured last year with the Titanium ultraclean CTD. This indicates that the CTD used, even though it is not a trace metal clean system, did not contaminate the samples. Except bottle 9 which shows elevated values that are not believed to be true for the type of water we collected. Figure 5.7.1b shows the higher numbers sampled in bottle 9 do not correspond with the iron concentration at that position.

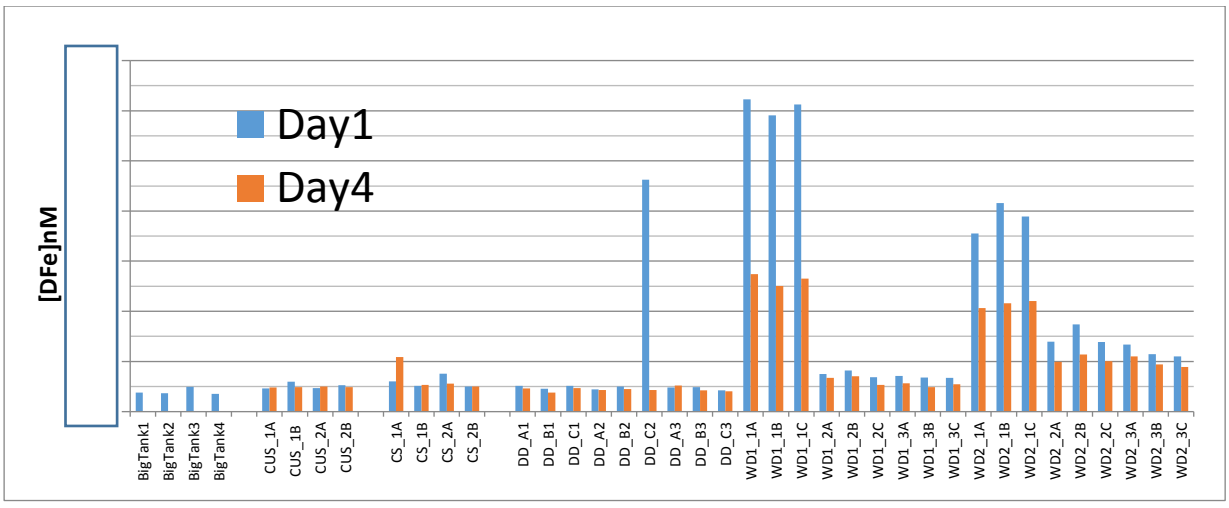


Figure 5.7.3: Dissolved iron content of one of the experiments.

Figure 5.7.3 shows the iron content of one of the experiments after day 1 and day 4. It is shown that no contamination occurred during the entire experiment. Also it indicates that some treatments show a higher dissolved iron concentration throughout the experiment.

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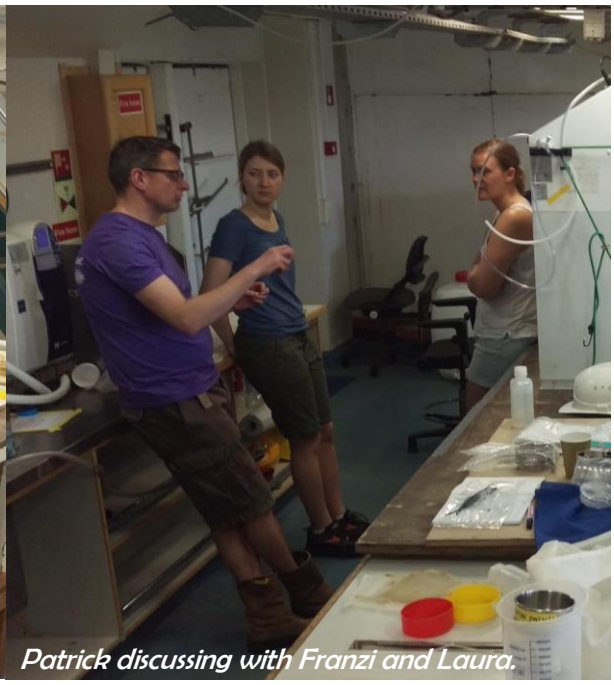
The wet lab is by far the busiest lab on the ship

Patrick preparing for metal analyses



Patrick discussing with Franzi and Laura.

5.8 Mooring deployments [Michèlle van der Does, Geert-Jan Brummer]

Mooring set up

Although this was the last cruise within the DustTraffic [ERC] programme, the mooring programme could be continued at stations M3 and M1 within the recently funded "FORAMFLUX" programme (MARUM-DFG). The mooring at M3 is equipped with two Technicap PPS sediment traps, at 1200 and 3500 m BSL, sampling synchronously, and mooring M1 consists of three KUM sediment traps, at 1050, 1150 and 1250 m, which are scheduled to sample consecutively at extremely high resolution (Table 5.8.1). Table 5.8.2 shows more details on the equipment of the moorings that were deployed. The CTD recovered at M5 (SBE 37 MicroCat, SN: 2657) appeared to have a broken pressure sensor, however this was discovered after redeployment at M3 (3500 m).

Table 5.8.1 Positions of the moored sediment traps deployed during cruise JC134

Station	Latitude	Longitude	Water depth (m)	Traps
16M3	12°23.887'N	38°38.228'W	4665	1200m PPS 3500m PPS
16M1	11°30.539'N	22°41.102'W	5065	1050m KUM 1150m KUM 1250m KUM

Mooring deployment

Sample cups were filled with filtered seawater collected at the deployment depth of each trap, in which a biocide ($HgCl_2$ 2.23 g/L end concentration for Technicap traps; 1.97 g/L for KUM traps) and a pH-buffer (Borax: $Na_2B_4O_7{\cdot}10H_2O$ 1.29 g/L end concentration for Technicap traps; 1.29 g/L for KUM traps) were added, to create a solution with a density slightly in excess of the ambient seawater. A blank sample was taken for later comparison with the actual collecting cups to determine in-situ chemical decomposition fluxes.

The pre-programmed sampling intervals for the Technicap traps at M3 are 12 and 24 days. The KUM sediment traps are programmed for sampling at an extremely high resolution of 4 days for a full year, except for the initial 9 cups of the lowermost trap (12 days) and the initial cup of the uppermost trap (36 days) because of limitations imposed by the programming software. For drawings of the traps, see Annex I.

The sampling intervals of the two moorings are presented in Table 5.8.3

Table 5.8.2. Detailed info on the moorings' sensors deployed during JC134.

Station	Depth (m)	Instrument	Serial Number	Barcode	Start date
M3	842	XEOS Iridium beacon		3944	
		XEOS flash unit		40860	
	1242	Sediment trap PPS	046	8488	06/04/2016
		Motor unit	9-265	35354	
		Tilt data logger	C1	12171	
		FLNTU	2855	74551	
		SBE 37 MicroCat	4345	12805	
	3534	Sediment trap PPS	91-27	9836	06/04/2016
		Motor unit	11-282	72007	
		SBE 37 MicroCat	2657	3803	[P-sensor broken)
	4660	IXSEA Acoustic releasers AR861	167	826	
			156	2981	
	4665	Anchor weight (bottom)			
M1	980	XEOS Iridium beacon		39437	
	1053	Sediment trap KUM	2014420	60257	01/04/2017
		KUM electr. Unit	2014420	39802	
		KUM motor 1	2014420A	39796	
		KUM motor 2	2014420B	39772	
		Tilt data loger	BD	9416	
		SBE 37 MicroCat	4140	5050	
	1149	Sediment trap KUM	2014422	60264	02/12/2016
		KUM electr. Unit	2014422	39765	
		KUM motor 1	2014422A	39741	
		KUM motor 2	2014422B	39727	
		Tilt data logger	C4	9522	
		SBE 37 MicroCat	4351	12768	
	1264	Sediment trap KUM	2014421	60240	18/04/2016
		KUM electr. Unit	2014421	39789	
		KUM motor 1	2014421A	39758	
		KUM motor 2	2014421B	39734	
	5060	IXSEA Acoustic releasers AR861	175	3001	
			156	11211	
	5065	Anchor weight (bottom)			

Table 5.8.3. Sediment trap sampling intervals of 2016.

	Lower				Middle				Upper			
	Mooring M1 - KUM-1250			4	**Mooring M1 - KUM-1150**				**Mooring M1 - KUM-1050**			
Interval	12				12				12			
bottle	start	end	days		start	end	days		start	end	days	
1	18-apr-2016	30-apr-2016	12		2-dec-2016	6-dec-2016	4		1-apr-2017	7-mei-2017	36	
2	30-apr-2016	12-mei-2016	12		6-dec-2016	10-dec-2016	4		7-mei-2017	11-mei-2017	4	
3	12-mei-2016	24-mei-2016	12		10-dec-2016	14-dec-2016	4		11-mei-2017	15-mei-2017	4	
4	24-mei-2016	5-jun-2016	12		14-dec-2016	18-dec-2016	4		15-mei-2017	19-mei-2017	4	
5	5-jun-2016	17-jun-2016	12		18-dec-2016	22-dec-2016	4		19-mei-2017	23-mei-2017	4	
6	17-jun-2016	29-jun-2016	12		22-dec-2016	26-dec-2016	4		23-mei-2017	27-mei-2017	4	
7	29-jun-2016	11-jul-2016	12		26-dec-2016	30-dec-2016	4		27-mei-2017	31-mei-2017	4	
8	11-jul-2016	23-jul-2016	12		30-dec-2016	3-jan-2017	4		31-mei-2017	4-jun-2017	4	
9	23-jul-2016	4-aug-2016	12		3-jan-2017	7-jan-2017	4		4-jun-2017	8-jun-2017	4	
10	4-aug-2016	8-aug-2016	4		7-jan-2017	11-jan-2017	4		8-jun-2017	12-jun-2017	4	
11	8-aug-2016	12-aug-2016	4		11-jan-2017	15-jan-2017	4		12-jun-2017	16-jun-2017	4	
12	12-aug-2016	16-aug-2016	4		15-jan-2017	19-jan-2017	4		16-jun-2017	20-jun-2017	4	
13	16-aug-2016	20-aug-2016	4		19-jan-2017	23-jan-2017	4		20-jun-2017	24-jun-2017	4	
14	20-aug-2016	24-aug-2016	4		23-jan-2017	27-jan-2017	4		24-jun-2017	28-jun-2017	4	
15	24-aug-2016	28-aug-2016	4		27-jan-2017	31-jan-2017	4		28-jun-2017	2-jul-2017	4	
16	28-aug-2016	1-sep-2016	4		31-jan-2017	4-feb-2017	4		2-jul-2017	6-jul-2017	4	
17	1-sep-2016	5-sep-2016	4		4-feb-2017	8-feb-2017	4		6-jul-2017	10-jul-2017	4	
18	5-sep-2016	9-sep-2016	4		8-feb-2017	12-feb-2017	4		10-jul-2017	14-jul-2017	4	
19	9-sep-2016	13-sep-2016	4		12-feb-2017	16-feb-2017	4		14-jul-2017	18-jul-2017	4	
20	13-sep-2016	17-sep-2016	4		16-feb-2017	20-feb-2017	4		18-jul-2017	22-jul-2017	4	
21	17-sep-2016	21-sep-2016	4		20-feb-2017	24-feb-2017	4		22-jul-2017	26-jul-2017	4	
22	21-sep-2016	25-sep-2016	4		24-feb-2017	28-feb-2017	4		26-jul-2017	30-jul-2017	4	
23	25-sep-2016	29-sep-2016	4		28-feb-2017	4-mrt-2017	4		30-jul-2017	3-aug-2017	4	
24	29-sep-2016	3-okt-2016	4		4-mrt-2017	8-mrt-2017	4		3-aug-2017	7-aug-2017	4	
25	3-okt-2016	7-okt-2016	4		8-mrt-2017	12-mrt-2017	4		7-aug-2017	11-aug-2017	4	
26	7-okt-2016	11-okt-2016	4		12-mrt-2017	16-mrt-2017	4		11-aug-2017	15-aug-2017	4	
27	11-okt-2016	15-okt-2016	4		16-mrt-2017	20-mrt-2017	4		15-aug-2017	19-aug-2017	4	
28	15-okt-2016	19-okt-2016	4		20-mrt-2017	24-mrt-2017	4		19-aug-2017	23-aug-2017	4	
29	19-okt-2016	23-okt-2016	4		24-mrt-2017	28-mrt-2017	4		23-aug-2017	27-aug-2017	4	
30	23-okt-2016	27-okt-2016	4		28-mrt-2017	1-apr-2017	4		27-aug-2017	31-aug-2017	4	
31	27-okt-2016	31-okt-2016	4		1-apr-2017	5-apr-2017	4		31-aug-2017	4-sep-2017	4	
32	31-okt-2016	4-nov-2016	4		5-apr-2017	9-apr-2017	4		4-sep-2017	8-sep-2017	4	
33	4-nov-2016	8-nov-2016	4		9-apr-2017	13-apr-2017	4		8-sep-2017	12-sep-2017	4	
34	8-nov-2016	12-nov-2016	4		13-apr-2017	17-apr-2017	4		12-sep-2017	16-sep-2017	4	
35	12-nov-2016	16-nov-2016	4		17-apr-2017	21-apr-2017	4		16-sep-2017	20-sep-2017	4	
36	16-nov-2016	20-nov-2016	4		21-apr-2017	25-apr-2017	4		20-sep-2017	24-sep-2017	4	
37	20-nov-2016	24-nov-2016	4		25-apr-2017	29-apr-2017	4		24-sep-2017	28-sep-2017	4	
38	24-nov-2016	28-nov-2016	4		29-apr-2017	3-mei-2017	4		28-sep-2017	2-okt-2017	4	
39	28-nov-2016	2-dec-2016	4		3-mei-2017	7-mei-2017	4		2-okt-2017	6-okt-2017	4	

	Mooring M3 - PPS			
Interval	24			
bottle	start	end	days	
1	6-apr-2016	30-apr-2016	24	
2	30-apr-2016	24-mei-2016	24	
3	24-mei-2016	17-jun-2016	24	
4	17-jun-2016	11-jul-2016	24	
5	11-jul-2016	4-aug-2016	24	
6	4-aug-2016	28-aug-2016	24	
7	28-aug-2016	21-sep-2016	24	
8	21-sep-2016	15-okt-2016	24	
9	15-okt-2016	8-nov-2016	24	
10	8-nov-2016	2-dec-2016	24	
11	2-dec-2016	14-dec-2016	12	
12	14-dec-2016	26-dec-2016	12	
13	26-dec-2016	7-jan-2017	12	
14	7-jan-2017	19-jan-2017	12	
15	19-jan-2017	31-jan-2017	12	
16	31-jan-2017	12-feb-2017	12	
17	12-feb-2017	24-feb-2017	12	
18	24-feb-2017	8-mrt-2017	12	
19	8-mrt-2017	1-apr-2017	24	
20	1-apr-2017	25-apr-2017	24	
21	25-apr-2017	19-mei-2017	24	
22	19-mei-2017	12-jun-2017	24	
23	12-jun-2017	6-jul-2017	24	
24	6-jul-2017	30-jul-2017	24	

5.9 Buoy deployments [Chris Munday]

After the smooth operation of the dust collecting buoys following the upgrades and repairs during the last cruise, little work was required on the buoys aside from routine service and maintenance.

Activity is summarised below:

- All towers were provided with a firmware update, which now allows the buoys to measure rainfall accumulation, the details of which were added to the twice daily messages sent by the buoy. The software update also added data from the CO_2 sensor (at M3, buoy Michelle, only) to the daily messages.
- For all buoys, the support filter (formerly GF/F) under the polycarbonate sample filter was replaced with a cellulose acetate one due to the risk of glass fibres from the GF/F filter piercing the polycarbonate membrane, compromising the sample.
- New polycarbonate filters were installed and MWAC samplers were fixed to the chimney of the towers.
- A faulty meteorological sensor on tower 2 was replaced by a unit which had been refurbished by the manufacturer (Vaisala).
- The seabird temperature/salinity sensors on buoys Michelle and Laura were serviced and reinstalled.

Buoy Laura, formerly located at M4, was to be moved to M1, however due to space restrictions on deck, it was re-christened Michelle and deployed at M3. Thereafter, the buoy originally named Michelle was picked up from M3 and redeployed at M1 as Laura. The names and locations of the new deployments are shown in table 5.9.1.

Table 5.9.1: Deployment details of the dust-collecting buoys

Deployment Date	Buoy	Lat (°N)	Lon (°W)	Sampling Interval	Start Date
29 March 2016	Michelle	12°20.74	38°52.765	*In sync* with M3 (Table 5.8.3)	6 April 2016
5 April 2016	Laura	11°24.23	22°56.72	*In sync* with M1 (Table 5.8.3)	6 April 2016
12 April 2016	Carmen	21°14.32	20°57.76	*In sync* with trap CB (21.5 days)	24 April 2016

The dust collecting towers were shuffled slightly in order to make most effective use of time. The placements of the towers is shown in table 5.9.2.

Table 5.9.2: Summary of the dust-tower placements

Tower	Before	After
1	M4 (Laura)	NIOZ
2	M3 (Michelle)	M1 (Laura)
3	NIOZ	M3 (Michelle)
4	CB (Carmen)	CB (Carmen)

Deployment of the buoys was carried out, just like the other moorings, "top down". The first piece of equipment to touch the water surface is always a smartie, which acts as a dummy buoy. The last piece of the mooring is always the anchor. After the weight is deployed, the dummy buoy is dragged under water due to the speed of the anchor's sinking. At some point, when the anchor weight is standing on the seafloor, the mooring erects itself and at this point the top smartie can be exchanged with the real buoy.

The details of the sampling on board the buoy are very similar to those used from the previous deployment. They consist of a carousel with 24 filters which rotate one-by-one in front of a chimney through which air is pumped daily at a prescribed interval. At 10.00 AM UTC, the daily routine starts; before the air pump starts sucking air through the filters, a meteorological station determines the weather and sea state. If there is rain (>0.2mm/min) or too strong wind (>20m/s), the air inlet does not open. During a period of eight hours, the weather is monitored and when conditions are favourable for at least one hour within those eight hours, the sampling scheme is initiated after all. For four hours air is sucked through the filter. If during those four hours the weather changes to unfavourable conditions, the schedule is aborted. The schedule of the filters is in sync with the submarine sediment traps (see table 5.8.3).
Twice daily, the buoys report the meteorological conditions (wind speed, wind direction, temperature, humidity) as well as the buoy's conditions (battery status, position, pitch, roll, heading, filter nr, amount of air filtered) through eMail. The contact is bi-directional; the measuring parameters can be altered remotely.

Buoy Michelle, just after recovery,

and just before re-deployment, now as Laura.

6 Acknowledgements

Our sincere thanks go to Master John Leask and his entire crew for the friendly cooperative atmosphere during the cruise as well as their competent technical assistance during all operations. Such a large group of demanding scientists always finds a way to ask for more and you really tried hard (and managed!) to meet all our requests. You made us all feel at home on board the Cook and managed to create an atmosphere that was both very professional as well as good fun.

Back home at NIOZ, many people were involved in the preparations of this cruise and of all the instruments. Our genuine thanks go to Edwin Keijzer and Roel Bakker (NIOZ-MTI) and Matthias Schrama (Schrama Metaaltechniek) for designing and constructing the dust-collecting masts. Johan van Heerwaarden (NIOZ-MTI) is thanked for constructing the new set of drifting traps. Furthermore, we thank Jack Schilling, Harry de Porto, Jan Blom, and Piet Grisnigt (NIOZ-MTM) for helping out with the preparation of the moorings, cables, and swivels and transport of them.

Frank van Maarsseveen, Martin Laan, and Walther Lenting (NIOZ-MTE) are thanked for writing the software for the dust-collecting buoys, creating the solar-panel electronics, and facilitating the electronic support, respectively.

Peter-Roy Alkema, Mildred Jourdan, Erica Koning, and Thomas de Greef are thanked for help with logistics and planning and Marcel van der Linden and Irene Wernand for administrative support.

At MARUM in Bremen also a number of people were involved in preparing this cruise, for which we would like to thank in particular Götz Ruhland, Eberhard Kopiske, and Morten Iversen.

From NOC in Southampton, we received good support from many people, notably Matt Tiahlo, Sally-Anne Heath, and Daniel Comben.

This work was funded by the Dutch National Science Foundation (NWO) through the project TRAFFIC and the European Research Council (ERC) grant 311152 DUSTTRAFFIC.

7 Station list

Station	Cast	Total casts	Device	Date	Time (local)	Time (UTC)	Lat (N)	Lon (W)	Depth (m)	Comments
	1	1	CTD 01	21-mrt-16	9:40	13:40	12°04.424'	56°10.933'	300	
	2	2	Drifting trap	21-mrt-16	12:26	16:26	11°57.9'	56°06.8'		Deployment 100m, 200m, 400m
	3	3	Mooring	21-mrt-16	14:08	18:08	11°59.7'	56°06.8'		Recovery 15M5 1200m & 3500m, caroussel not entirely finished
	4	4	CTD 02	21-mrt-16	17:48	21:48	11°59.53'	56°06.07'	4000	Archive water for sediment traps, pH
1 (M5)	5	5	Plankton Net	21-mrt-16	20:59	23:59	11°59.53'	56°06.07'	200	
(UTC-4)	6	6	CTD 03	22-mrt-16	6:56	10:56	11°59.6'	56°05.9'	250	
	7	7	Plankton Net	22-mrt-16	8:04	12:04	11°59.6'	56°05.9'	100	
	8	8	Plankton Net	22-mrt-16	8:35	12:35	11°59.6'	56°05.9'	200	
	9	9	Plastics Net	22-mrt-16	9:08	13:08	11°59.718'	56°56.489'	Surface	
	10	10	Drifting trap	22-mrt-16	12:00	16:00	11°56.75'	56°02.38'		Recovery 100m, 200m, 400m
	1	11	CTD 04	23-mrt-16	6:58	10:58	11°59.0'	53°43.0'	300	
2	2	12	Plankton Net	23-mrt-16	8:16	12:16	11°59.0'	53°43.0'	200	
(UTC -4)	3	13	Plankton Net	23-mrt-16	8:50	12:50	11°59.0'	53°43.0'	200	
	4	14	Plastics Net	23-mrt-16	9:42	13:42	11°59.0'	53°43.0'	Surface	
	1	15	CTD 05	24-mrt-16	7:02	10:02	11°58.0'	50°42.4'	300	DCM 110m
3	2	16	Plankton Net	24-mrt-16	8:16	11:16	11°58.0'	50°42.4'	200	
(UTC -3)	3	17	Plankton Net	24-mrt-16	8:56	11:56	11°58.184'	50°42.447'	200	
	4	18	Plastics Net	24-mrt-16	9:30	12:30	11°58.184'	50°42.447'	Surface	
	1	19	Drifting Trap	24-mrt-16	21:04	00:04 (25th)	12°00.55'	49°08.53		Deployment 100m, 200m, 400m
	2	20	Plankton Net	24-mrt-16	21:59	00:59 (25th)	12°00.64	49°07.25	200	
	3	21	Plankton Net	24-mrt-16	22:29	01:29 (25th)	12°00.64	49°07.25	200	
	4	22	CTD 06	25-mrt-16	7:00	10:00	11°59.61	49°04.78	300	
	5	23	CTD 07	25-mrt-16	8:45	11:45	11°59.61	49°04.78	20	For incubation experiment
	6	24	Buoy Laura	25-mrt-16	9:50	12:50	11°58.306	49°05.170		Recovery complete at 15:50 (18:50 UTC)
4 (M4)	7	25	CTD 08	25-mrt-16	16:00	19:00	11°58.47	49°03.73	4000	Archive water from 1200m and 3500m for 15M4
(UTC -3)	8	26	Drifting trap	25-mrt-16	20:30	23:30	12°04.067	49°07.655		Recovery 100m, 200m, 400m
	9	27	Plankton Net	25-mrt-16	21:08	0:08 (26th)	12°04.188	49°07.127	200	
	10	28	Plankton Net	25-mrt-16	21:32	0:32 (26th)	12°04.297	49°07.574	200	
	11	29	Plastics Net	25-mrt-16	21:55	0:55 (26th)	12°04.432	49°07.495	surface	Ship at 1 kt.
	12	30	CTD 09	26-mrt-16	6:55	09:55	11°59.4	49°15.0	300	
	13	31	CTD 10	26-mrt-16	8:19	11:19	11°59.4	49°15.0	150	Miscommunication - should have been 100m
	14	32	CTD 11	26-mrt-16	8:52	11:52	11°59.4	49°15.0	100	For Incubation experiment
			Recovery of mooring 15M4 abandoned due to high swell, with no let up in the immediate forecast. The entire mooring was rescued by colleagues from MPI-Bremen on board FS Meteor *in May 2016*							
5	1	33	CTD 12	27-mrt-16	6:55	09:55	12°03.75	46°10.16	300	
(UTC -3)	2	34	Plankton Net	27-mrt-16	8:10	11:10	12°03.75	46°10.16	200	
6	1	35	CTD 13	28-mrt-16	6:56	09:56	12°11.03	42°40.56	300	
(UTC -3)	2	36	Plankton Net	28-mrt-16	8:50	11:50	12°11.02	42°40.55	200	
	1	37	CTD 14	29-mrt-16	7:02	10:02	12°19.06	39°08.12	300	
	2	38	Buoy Michelle	29-mrt-16	9:42	12:42	12°17.80	38°54.40		Anchor dropped 13:30
	x	x	Buoy Michelle	29-mrt-16	15:49	18:49	12°20.743	38°52.765		Buoy deployed
	3	39	Drifting Trap	29-mrt-16	16:56	19:56	12°22.678	38°45.126	35,75,175	Deployment
	4	40	CTD 15	29-mrt-16	17:42	20:42	12°23.179	38°44.63	4000	For archive water for 15M3 and preparation for 16M3
	5	41	Plankton Net	29-mrt-16	20:48	23:48	12°23.179	38°44.63	200	
	6	42	Plankton Net	29-mrt-16	21:23	00:23 (30th)	12°23.179	38°44.63	200	
	7	43	Plastics Net	29-mrt-16	21:58	00:58 (30th)	12°23.179	38°44.63	surface	
7 (M3)	8	44	Drifting Trap	30-mrt-16	7:04	10:04	12°21.71	38°48.43		Recovery
(UTC -3)	9	45	CTD 16	30-mrt-16	7:12	10:12	12°21.71	38°48.43	250	
	10	46	CTD 17	30-mrt-16	8:44	11:44	12°21.71	38°48.43	180	For Incubation experiment
	11	47	Sediment Trap	30-mrt-16	13:58	16:58	12°23.737	38°37.916		Recovery 15M3 (KUM). 1200m and 3500m. Both caroussels failed during deployment
	12	48	Sediment Trap	30-mrt-16	17:17	20:17	12°33.462	38°38.449		Deployment 16M3 (PPS) 1200 and 3500m
	13	49	Plankton Net	30-mrt-16	20:48	23:48	12°21.70	38°40.18	200	
	14	50	Plankton Net	30-mrt-16	21:12	00:12 (31st)	12°21.70	38°40.18	200	
	15	51	CTD 18	31-mrt-16	7:00	10:00	12°19.27	38°43.72	250	
	16	52	Buoy Michelle	31-mrt-16	8:56	11:56	12°19.17	38°43.91		Recovery complete at 13:44 local (16:44 UTC)
8	1	53	CTD 19	1-apr-16	7:02	09:02	12°16.7	36°20.4	300	
(UTC -2)	2	54	Plankton Net	1-apr-16	8:15	10:15	12°16.7	36°20.4	200	
9	1	55	CTD 20	2-apr-16	6:34	08:34	12°13.9	33°08.9	300	
(UTC -2)	2	56	Plankton Net	2-apr-16	7:44	09:44	12°13.9	33°08.9	200	
10	1	57	CTD 21	3-apr-16	7:00	08:00	12°11.0	29°52.3	300	
(UTC -1)	2	58	Plankton Net	3-apr-16	8:16	09:16	12°11.0	29°52.3	200	
11	1	59	CTD 22	3-apr-16	14:07	15:07	12°10.14	29°02.66	4000	For archive water for 14M1, 15M1 and prep for 16M1
12	1	60	CTD 23	4-apr-16	7:02	08:02	12°08.3	26°52.19	300	
(UTC -1)	2	61	Plankton Net	4-apr-16	8:10	09:10	12°08.3	26°52.19	200	
13 (M1)	1	62	CTD 24	5-apr-16	7:02	08:02	11°24.30	23°04.29	300	
(UTC -1)	2	63	Buoy Laura	5-apr-16	8:58	09:58	11°22°33	22°58.07		Weight dropped 12:27
	x	x	Buoy Laura	5-apr-16	14:37	15:37	11°24.23	22°56.72		Buoy deployed
	3	64	Plankton Net	5-apr-16	15:05	16:05	11°25.0	22°56.2	200	
	4	65	Plankton Net	5-apr-16					200	Recorded by Jan-Berend, but not the bridge *(and guess who was right....??? :-)* The PSO!!!
	5	66	Plastics Net	5-apr-16	15:52	16:52	11°25.0	22°56.2		
	x		Multibeam Survey		17:00	18:00				Continued until 02:00 6/4
	6	67	CTD 25	6-apr-16	7:02	08:02	11°35.37	22°36.07	150	
	7	68	Plankton Net	6-apr-16	7:56	08:56	11°35.37	22°36.07	200	
	8	69	Plankton Net	6-apr-16	8:25	09:25	11°35.37	22°36.07	200	
	9	70	CTD 26	6-apr-16	8:59	09:59	11°35.37	22°36.07	40	For Incubation experiment
	10	71	Plastics Net	6-apr-16	9:25	10:25	11°35.37	22°36.07		
	x		Multibeam Survey		10:38	11:38				Waiting for clearance from Cape Verde authorities to retrieve traps
	11	72	CTD 27	7-apr-16	6:57	07:57	11°35.04	22°48.49	100	
	12	73	Drifting trap	7-apr-16	7:54	08:54	11°35.238	22°48.45	100,200,400	Deployment
	13	74	Sediment Trap	7-apr-16	13:25	14:25	11°59.61	23°00.7		Recovery 14M1 (PPS - 1200m). Complete 14:43 local time
	14	75	Sediment Trap	7-apr-16	18:03	19:03	12°03.65	23°04.40		Recovery 15M1 (KUM - 1200m and 3500m). Complete 20:51 local time
	15	76	CTD 28	8-apr-16	7:10	08:10	11°35.539	22°48.65	300	
	16	77	Drifting trap	8-apr-16	8:39	09:39	11°34.93	22°48.65	100,200,400	Recovery
	17	78	Plankton Net	8-apr-16	9:08	10:08	11°34.93	22°48.65	200	
	18	79	Sediment Trap	8-apr-16	10:36	11:36	11°32.12	22°47.76		Deployment 16M1 (KUM - 1050m,1150m,1250m hi-res sampling). Anchor dropped at 17:12
	19	80	Plastics Net	8-apr-16	17:20	18:20	11°31.88	22°42.83		
	1	81	Buoy Carmen	11-apr-16	9:53	9:53	21°16.22	20°05.593		Recovery
	2	82	Drifting trap	11-apr-16	15:32	15:32	21°17.11	20°58.39	100,200,400	Deployment
	3	83	CTD 29	11-apr-16	16:12	16:12	21°17.33	20°58.38	300	
14 (CB)	4	84	Plankton Net	11-apr-16	17:20	17:20	21°17.33	20°58.38	200	
(UTC +0)	5	85	Plankton Net	11-apr-16	18:04	18:04	21°17.49	20°58.57	200	
	6	86	CTD	12-apr-16	7:00	07:00	21°12.77	20°58.08	80	
	7	87	Buoy Carmen	12-apr-16	8:04	08:04	21°12.77	20°58.08		Deployment with dummy buoy
	x	x	Buoy Carmen	12-apr-16	11:32	11:32	21°14.83	20°57.07		Anchor dropped
	x	x	Buoy Carmen	12-apr-16	13:37	13:37	21°14.32	20°57.66		Buoy deployed
	8	88	Drifting trap	12-apr-16	14:37	14:37	21°37.35	21°02.85		Recovery
15 (UTC +0)	1	89	Plastics Net	13-apr-16	8:56	08:56	23°24.73	20°11.07		To Tenerife!