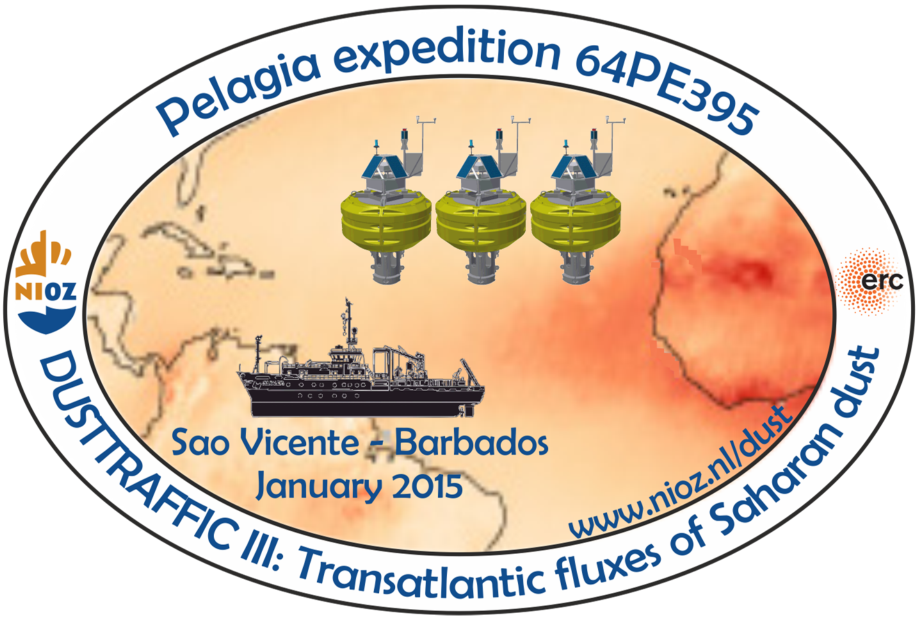
Cruise Report
and preliminary results

DUSTTRAFFIC III: Transatlantic fluxes of Saharan dust

Cruise No. 64PE395

11 January – 6 February 2015
Mindelo, Sao Vicente (Cape-Verdian Islands) – Bridgetown, Barbados



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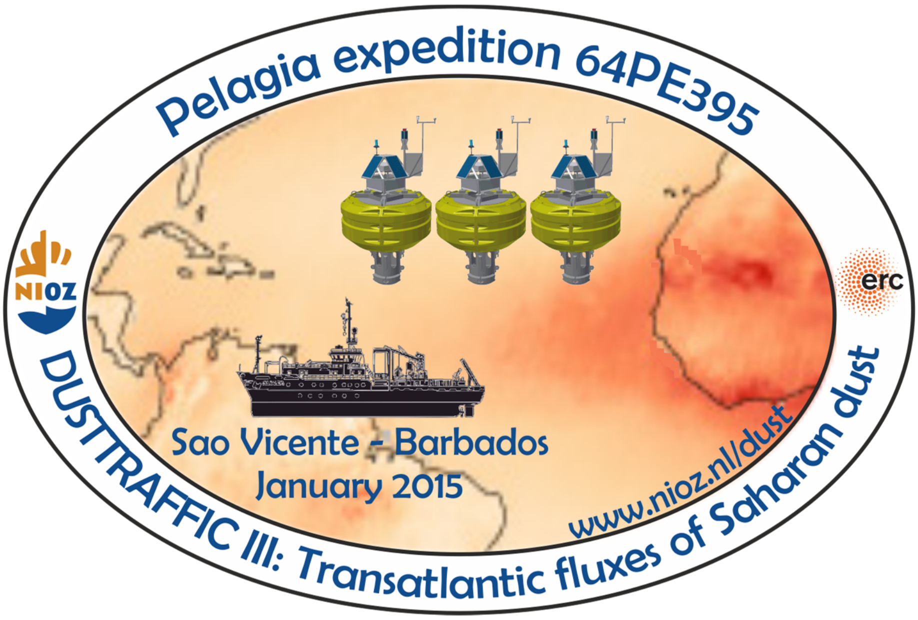

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1. Summary

RV Pelagia cruise 64PE395 was dedicated to service the transatlantic array of instruments that are collecting Saharan dust at the sea surface as well as in the ocean between Africa and the Caribbean. This set of instruments was initially deployed during cruise M89 in October 2012, and serviced during cruise 64PE378 in November 2013. During the latter cruise the instruments were programmed to finish sampling in October 2014. Unfortunately, the ship's management did not prioritize this cruise to ensure a continuous sampling program but instead decided to schedule this cruise in January 2015, thus causing a gap of three months.

The experiment is 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 is monitored along a transatlantic transect between NW Africa and the Caribbean at the 12^{th} parallel using sediment traps and floating dust collectors since 2012. 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 64PE395 was used to service all instruments between the Cape-Verde Islands and the Caribbean and check the status of the mooring lines. In general, it was concluded that these moorings should not be left for longer than one year. Small improvements to the mooring design and the dust collector were made and they are described in this report. Details of all instruments and moorings can be found in the various appendices.

Due to rough weather, the mooring at station M1 could not be recovered. As a result of this, the mooring at station M2 could not be re-deployed. Consequently, the new transect consists of moorings with two traps at 1200m and at 3500m each for the stations M1, M3, M4, and M5. In addition, stations M3 and M4 have a dust-collecting buoy. Sample names start with the year in which most of the sample was collected.

Table 1.1: Key data of the moorings recovered / (re-)deployed during 64PE395

Station	Device	Lat (° '. N)	Lon (° '. W)	Depth (m)	Start date
M1	Mooring 15M1	12°3.7092	23°04.1398	5056	15 Jan 2015
M3	Mooring 15M3	12°23.628	38°38.0698	4615	26 Jan 2015
	Buoy: Michèlle	12°18.9685	38°45.1428	4830	26 Jan 2015
M4	Mooring 15M4	11°59.418	49°14.4941	4941	6 Feb 2015
	Buoy: Laura	11°57.5849	49°04.7209	5103	6 Feb 2015
M5	Mooring 15M5	11°59.8180	56°06.7473	4630	6 Feb 2015

The sampling scheme of the redeployed sediment-trap carrousels in moorings M1 – M5 started at different dates in order to keep the gap in the sampling series as small as possible. Moorings 15M1 and 15M3 have KUM-type sediment traps, which have a higher sampling resolution thanks to 39 sampling cups. Moorings 15M4 and 15M5 have Technicap sediment traps with 24 sampling cups, resulting in a lower-resolution sampling scheme. As a result, sampling intervals vary between 11 and 22 days. See paragraph 5.10.

The buoys' sampling intervals are synchronous with the sediment traps at the same station. All instruments shall be serviced in March 2016 during the fourth and final DUSTTRAFFIC cruise.

On 11 January 2015 we left the port of Mindelo, Sao Vicente, Cape Verde Islands, in a haze of Saharan dust.

2. Participants

Table 2.1: Participants of cruise 64PE395

Name, title	Discipline	Affiliation
Jan-Berend Stuut, Dr	Marine Geology, chief scientist	NIOZ & MARUM
Karel Bakker	Marine Geology, Nutrients	NIOZ
Barry Boersen	Marine Technology	NIOZ
Michèlle van der Does	Marine Geology	NIOZ
Hans van Hateren	Marine Geology	Utrecht University
Laura Korte	Marine Geology	NIOZ
Bob Koster	Marine Geology	NIOZ
Patrick Laan	Marine Geology, Metals	NIOZ
Chris Munday, Dr	Marine Geology/Microbiology	NIOZ
Jan-Dirk de Visser	Marine Technology	NIOZ
Yvo Witte	Marine Technology	NIOZ

NIOZ – Royal Netherlands Institute for Sea Research, Texel, the Netherlands
MARUM – Center for Marine Environmental Sciences, Bremen, Germany

3. Research program

The purpose of cruise 64PE395 was to service the dust-collecting instruments, which were moored between the African continent and the Caribbean, and which were deployed during 64PE378 late 2013. Not only were we interested in the samples that had been collected since deployment in November 2013, we also wanted to check on the under-water parts of the buoys' moorings. In addition to harvesting and re-deploying the moorings, we wanted to test the ballasting effect of mineral-dust particles using so-called drifting sediment traps. Another new piece of equipment that we used for the first time in this area was the Omni sampler, with which samples are taken in order to study the micro-biology of Saharan dust. A third typical aim of this cruise was to sample the ocean for trace metals, using the Ultra-Clean CTD system developed at NIOZ. Given that early winter is the dustiest season in terms of proximal NW African dust, we were hoping to encounter a dust outbreak, which actually happened!

Figure 3.1: Track of RV Pelagia *cruise 64PE395 with sampling stations.*

4 Narrative of the cruise

On Wednesday 9 January the scientific crew arrived at the ship, which was docked in Mindelo, the capital of Sao Vicente, one of the Cape Verde Islands. Rumour has it that our 21-hour delay that we suffered from was caused by a Saharan dust-outbreak that hampered air traffic….
A day later, all the new ship's crew arrived in time and also all other stuff like containers, equipment, and stores were delivered to the ship timely.

On the morning of 11 January we set sail towards the first station: M1 at ~12°N/23°W, a distance of about 300nm. At a fresh wind of force 7-8 Bft we did not get a lot of time to get accustomed to the ship's movements but despite these relatively rough conditions, everybody showed up for lunch. The fog that seemed to make the view hazy turned out to be Saharan dust, which was quite obvious on all the ship's filtration systems. At first sight the hazy skies did not look very orange but on the white filters it was clearly visible that this must be mineral dust. We immediately started sampling the dust with the two Anderson high-volume samplers as well as the Omni sampler on the bird-observation deck. Already after two hours we could harvest our first beautiful samples! In the course of the day the wind decreased a tick and the unpredictable movements due to waves were replaced by a more gentle rolling of the ship on the swell.

Figure 4.1 View from RV Pelagia's upper deck on 10 January (left) and 11 January (right), illustrating how the Saharan dust outbreak influences visibility.

On the next day, Monday 12 January, we continued our south-easterly course and carried out some tests with the ultra-clean CTD system. During the first test run to 400m depth, 8 bottles were filled at three depths: 400, 200, and 100m, respectively. This water was later used for the drifting sediment traps. Next was a deep cast to 5000m, followed by yet another shallow cast to 400m. All equipment seemed to work fine and provided good data. We were still sailing through a whitish haze of Saharan dust; the first aerosol samples on the Anderson high-volume samplers as well as the Omni sampler were very rich in yellow-orange dust.

On Tuesday 13 January we arrived at the position of station M1 where we started with the deployment of the drifting traps. These traps consist of three levels (400, 200, and 100m) of four tubes that are open at the top. The traps are meant to collect material settling through the ocean for a period of 24 hours. The sea was too rough to attempt a recovery of the mooring at M1 and therefore, we continued with a CTD to 5000m. We decided to linger near the station and carry out a multibeam survey, hoping that on the next day the wind would have decreased in strength and the waves would have calmed down.

On Wednesday 14 January in the early morning we recovered the drifting sediment traps, which had worked perfectly; in all tubes there was a considerable amount of particles, most likely caused by the dust that is still obscuring visibility. It still seemed as if we were sailing through a whitish fog that seemed to clear a little bit during the course of the day. It was decided to deploy a second mooring at station M1, about five nautical miles west of the original M1. The deployment was carried out from the aft deck and ran very smoothly despite sometimes large movements of the ship due to passing high waves. As soon as the deployment was finished at about 15.30, we set sail towards the 12th parallel and from there on, sailed west. On the way to the second station at about 38°W, we deployed four more CTDs, which meant about one CTD cast per day. The wind was still about 20 knots and also the sea state had not changed much. The foggy appearance of the Saharan dust cloud was still present all around.

Thursday 15 January still showed the same weather; a light haze of dust through which the sun could only get through during midday. A fresh wind blew at about 10m/s, which resulted in 3-4m high waves. Right after breakfast we deployed the CTD to bottom at about 25°30W, which was back on deck just after lunch. We continued our west-bound transit at 12°N. In the evening we discussed the why and how of this cruise and the related projects TRAFFIC and DUSTTRAFFIC.


Figure 4.2 Hazy view of the Cape-Verde Islands.

Friday 16 January through Sunday 18 January all showed the same pattern with a deep UC-CTD cast just after breakfast, which was rounded up around lunch time. The further west we went along the 12th parallel, the clearer the skies got. Thanks to the sun gaining in strength, the temperature rose from about 20°C to about 27°C. In the course of Sunday 18 January, we experienced some light rain, which meant that now the atmosphere was cleansed of all dust.

On Monday 19 January, we reached station M2 just after breakfast. We started with the deployment of the drifting traps, and then continued with releasing the moored sediment trap that we had deployed here in November 2013. Just as we started with the radio sounding, the wind picked up and also the swell seemed to increase again. Despite that, the trap and all the accompanying instruments from the mooring could be recovered safely from the side. All cups from the sediment trap contained some material so this was a big success! We continued with a CTD to 5000m and a multibeam survey.

In the morning of Tuesday 20 January, it turned out that we had neither working internet, nor phone. This was unfortunate, as we depended on the eMails from the iridium satellite to tell us the position of the drifting traps. These mails are sent to other people at NIOZ as well but as the phone did not work, we could not ring these people to ask for the coordinates. The only thing we could use was the estimated course of the traps since deployment and the radio soundings that indicated how far away the traps were, based on the signal strength. Eagle-eyed Jan Dirk spotted the traps first and by 9.00 we had the traps on deck. They functioned very well again; all tubes contained some material and also the gels had worked properly this time, thanks to replacing the borax salt with sea salt. After recovery of these traps we continued our trip towards station M3, which we were scheduled to reach in the early evening.

On arrival at station M3 it has just gotten dark and this allowed us to clearly see the flasher on the buoy. We deployed the drifting traps at about 19.30, this time also including a flasher. The lights attracted quite a bit of fish and Jan-Dirk and Jose managed to catch a few squid.

On Wednesday 21 January, we started the recovery of buoy Michelle at station M3. It turned out that we were lucky because one of the bolts of the chain from the float had loosened itself completely, so that the mooring was actually only attached to a single chain. The connecting bolt of the other chain was also already half loose. In the upper end of the black nylon line there were some weak places due to wear and also further down the line, where the connection to the rubber lines is, there was considerable damage due to wear. Recovery of the mooring ran smoothly and all was on deck just before lunch. There was considerable fouling on the line and the buoy itself but not as much as was the case on buoy Carmen, offshore Cape Blanc, Mauritania. Around the buoy there were a lot of fish and Jose managed to catch three >1 m Dorades. The sky was now clear blue, the water temperature 26°C and the air 25°C. The wind slackened a bit to 8m/s and also the swell was considerably lower than during the previous days.

Figure 4.3 Three dorades caught by Jose

The nice weather continued on Thursday 22 January; some clouds but mostly sunny and a 4-5 Bft wind. We started the deployment of the (dummy) buoy mooring and the anchor was dropped at 12.30: right in time for lunch. In the afternoon, the dummy buoy/smartie was exchanged for the real buoy Michèlle, which we finished at 15.15. We continued with recovering the drifting traps, of which we received the positions every 3 hours, which made looking for it relatively easy. The traps did not contain a lot of material, although they had been collecting material for almost double the time of the previous two drifting traps. As we had gel for only two more deployments, we chose to have this deployment with four tubes that were only filled with water. The next two deployments at M4 and M5 would have one tube with a gel cup again. For the second time there were problems with the internet, and they somehow looked a tick more serious this time. We ended the day with a continued multibeam survey at Station M3.

The multibeam surveys resulted in a really nice comprehensive overview of the area that seemed to show a deep fault zone with North-South oriented faults as well as East-West oriented ridges and valleys. Friday 23 started out nice again as far as the weather was concerned, and shortly after breakfast we started with a CTD to 4650m. After lunch mooring M3 was deployed. At about 16.00 the deployment was completed and we sailed around the anchor drop point in a circle with a radius of one water depth (4700m) to try and determine the position of the anchor through triangulation. Afterwards, we set sail towards station M4, which was about 620nm away, and where we expected to arrive in the early morning of Tuesday 27 January. During the transit along the 12th parallel, we carried out a daily routine of a deep UC-CTD after breakfast, which usually was back on deck just before lunch.

On Monday 26 January we had passed the actual Mid Atlantic Ridge. The day started with the good news that we were connected to the outside world again. Also, the internet was even a tick faster than before (500kb instead of 300kb).
We arrived at station M4 in the early morning of the 27th where Jose first lifted another big fish out of the water to start the day. After that we deployed the drifting traps and recovered buoy Laura. It turned out that the instrument tower of this buoy was heavily damaged; all the acids that had leaked out of the batteries had severely corroded the aluminium and several parts had broken off. Also, all the electronics were destroyed, although the SD card seemed to contain some data still of the four months it had actually worked. The broken electronics part was very unfortunate because on tower 1, the SD-card holder was broken. We decided to deploy buoy Laura with tower 1 without the SD-card / logging option and live with the twice-daily data that are sent home through iridium. The weather was too rough to recover the mooring at M4. Instead, we did a CTD to 5000m.

On Wednesday 28 January, the weather was still too rough to risk recovery of the mooring at M4. Instead, we decided to redeploy buoy Laura. We did this at more or less exactly the same position as at which she used to be. After dinner, we deployed the drifting traps for a second time.

Figure 4.4 The sea is too rough to allow recovery of the mooring

Thursday 29 January did not really show a different pattern as far as the weather was concerned. The forecast told us that the wind would decrease a bit further but we could not really see this, let alone that it resulted in a calmer sea. We decided to use the extra time that we had budgeted for and continued our multibeam survey. At 17.00 we recovered the second series of drifting traps. Again there seemed to be plenty of material settling through the water column although obviously not way as much as we saw near station M1.

On Friday 30 January the wind had finally decreased to about 10m/s and we decided to recover the mooring at M4. This went really well; for the first time the releaser even reported that it had released, a thing we had not experienced so far during this cruise. The recovery was a great success; all instruments had worked fine and both the traps contained bottles with some material in them. We decided to use this window of good weather to also re-deploy mooring M4. After triangulation, we knew that the mooring is at 11°59.418'N/49°14.749'W at a water depth of 4941m. We set sail towards the next CTD position at about 175nm.

On Saturday 31 January the weather had improved further; with a wind of 6m/s there was a swell of less than a meter. The water and air temperatures were around 27°C. At about 14.00 we arrived at CTD station 14, which is a crossover station with GEOTRACES cruise 64PE321 at 11°22.38'N/52°2.72'W and a water depth of almost 5000m.

The next day, Sunday 1 February, we arrived at our last CTD station at 12°N/54°W at a water depth of about 4800m. During the upcast, a communication error occured, which affected the last 6 bottles that should have profiled the upper 75m. On deck it turned out that the connecting plug had burnt out. After Bob had replaced the plug, the CTD worked fine again.

On Monday 2 February, we arrived at station M5 in the early morning, providing us with the opportunity to do a quick scan of the sea floor with the multibeam. Given that during the day wind was forecasted to pick up in strength again, we started with the deployment of mooring 15M5 at 7.30. At 10.15 the mooring was deployed; a new record! Because the ADCP at station M2 was flooded, we replaced the ADCP in the smartie above the upper trap with a RCM current meter just below the upper trap. This mooring is now positioned 20 miles outside Barbados' EEZ at 11°59.733N/56°6.767W. We continued the station with the deployment of the drifting traps and a CTD. The rest of the day, evening, and night we continued with multibeam mapping. As we had thought and hoped, the seafloor topography is rather boring: a flat, slightly tilted pancake.

During the night, we observed that the messages from the iridium beacon on the drifting trap had an issue; four consecutive messages within 9 hours contained the exact same position. Fortunately, just before lunch on Tuesday 3 February, a new and correct position was reported and we could pick up the drifting traps just after lunch. Again, they had worked perfectly and the tubes were all filled with suspended matter. This was probably the best gel of the four traps that we had attempted. After recovery of the drifting traps, we did a shallow dip with the UC-CTD that was now equipped with the ship's GoPro camera, to film the opening and closing of the bottles. The film is a great success; it clearly shows how the CTD works and shows some curious fish and some under-water footage of the ship. In the evening, we presented a wrap-up of the cruise with preliminary results to all interested crew and scientists.

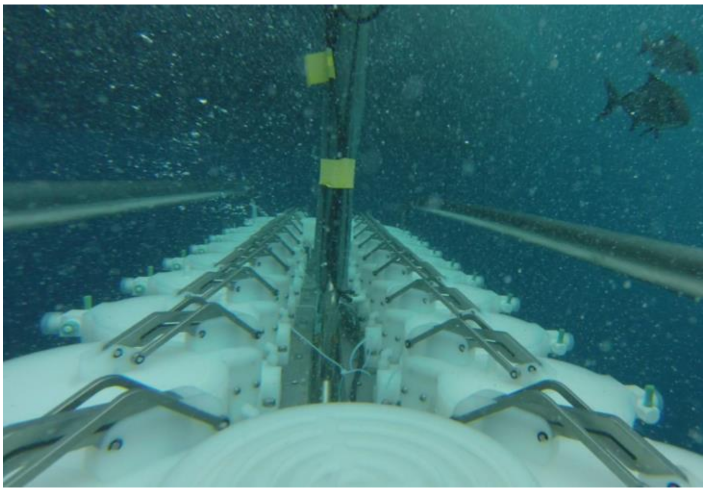


Figure 4.5 GoPro registration of the clean CTD.

On Wednesday 4 February, we continued our last transit to Barbados. The last sediments from the drifting traps were filtered and we started packing and cleaning up. In the evening we had a nice barbecue on the aft deck. Unexpectedly, we were summoned into port, although initially we were told to anchor just outside the harbour of Bridgetown.

In the morning of 5 February, we found ourselves in between three huge cruise ships that unloaded heaps of tourists who were wondering what we are doing unpacking the ship. We spent all day unloading the ship and re-arranging all equipment and containers.

Figure 4.6 RV Pelagia being dwarfed by two cruise ships.

On Friday 6 February we finally received our Bajan entry stamps in our passports and said goodbye to the ship's crew. Cruise 64PE395 was a really successful expedition, with excellent scientific results and a few "firsts"; a dust outbreak that we sampled in great detail and great sampling with the drifting sediment traps. Next to very nicely dusty, the atmosphere on board the ship was very relaxed, which is a result of a very pleasant and efficient collaboration between Master Kuijt's crew and us "opstappers", for which I thank you all cordially!

6 February, Bridgetown, Barbados
Jan-Berend Stuut

5.1 Multi-beam mapping of the sea floor

[Jan-Berend Stuut, Bob Koster]

The shipboard KONGSBERG multi-beam echo-sounder EM302 was operated at all five stations to add bathymetric information to the already existing maps that were acquired during cruises M89 [2012] and 64PE378 [2013]. This was mostly done autonomously by the ship's officers while at station and waiting for sunrise. The maps presented here are screenshots of the compilations of the two previous cruises and the added data in this cruise. Post-processing of the raw data needs to be carried out still, using the sound-velocity profiles resulting from our own CTD casts at the stations.
We did not spend the same amount of time at each of the stations. For this reason, the spatial extent of each map is variable. Most time was spent at M4, the least amount of mapping was done at M1. The position of M5 is new; just outside Barbados' EEZ (200 mile zone).

The EM302 system is a swath multi-beam system with ping and chirp mode and a seapath GPS and motion sensors, 1° x 2°, 30kHz, with a swath of 4200m at a water depth of 5km. It is heave-pitch-roll compensated. Depth uncertainties are less than 0.5 % of the water depth. The raw-data output of the system was backed up automatically. The raw- and processed data are archived at NIOZ.

In general, multi-beam mapping went flawlessly, except for some occasions where there was a communication error between the multi-beam system and the seapath GPS. This problem seems to occur more often with the RV Pelagia system and is –according to Kongsberg—a result of increased sunspot activity, when radio-magnetic disturbances hamper the GPS position determined by the satellites. The pragmatic solution to this problem is a system reset.

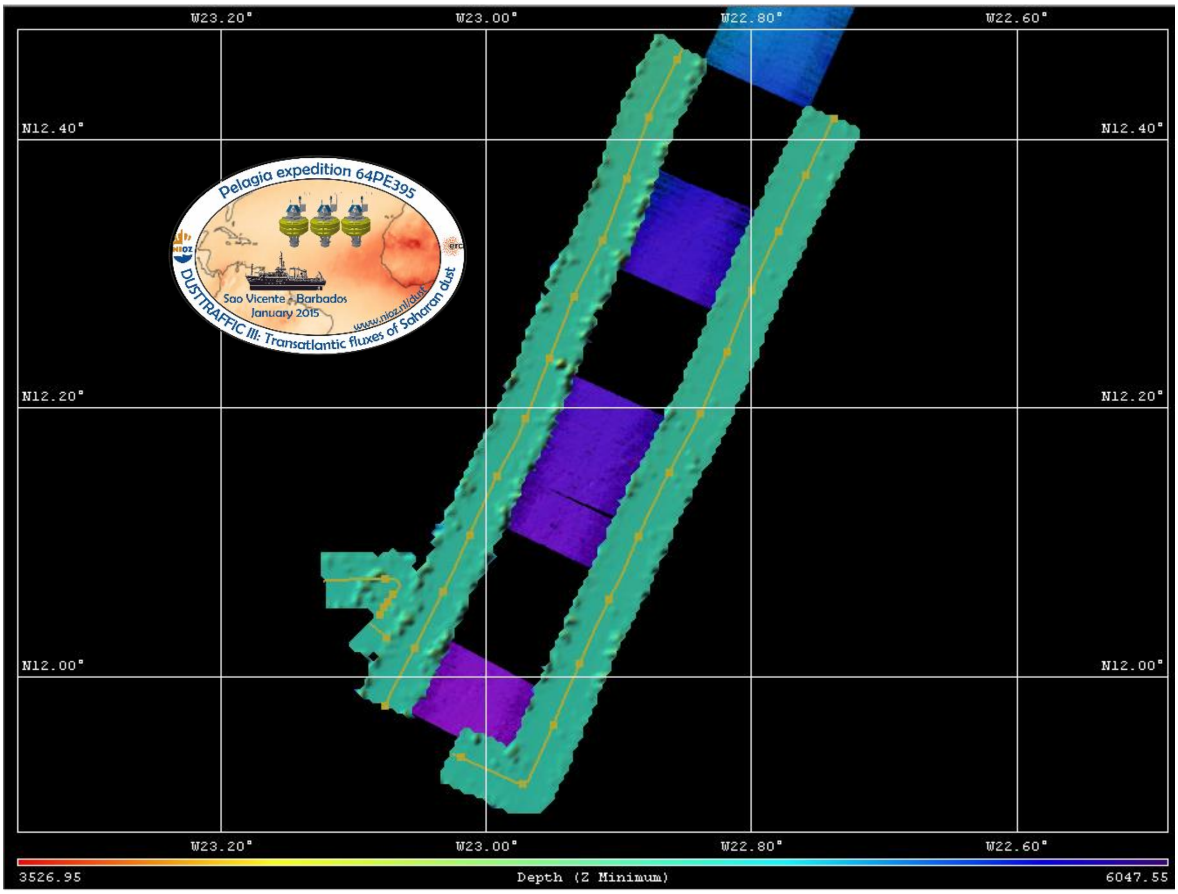


Figure 5.1.1: Bathymetric map of station M1

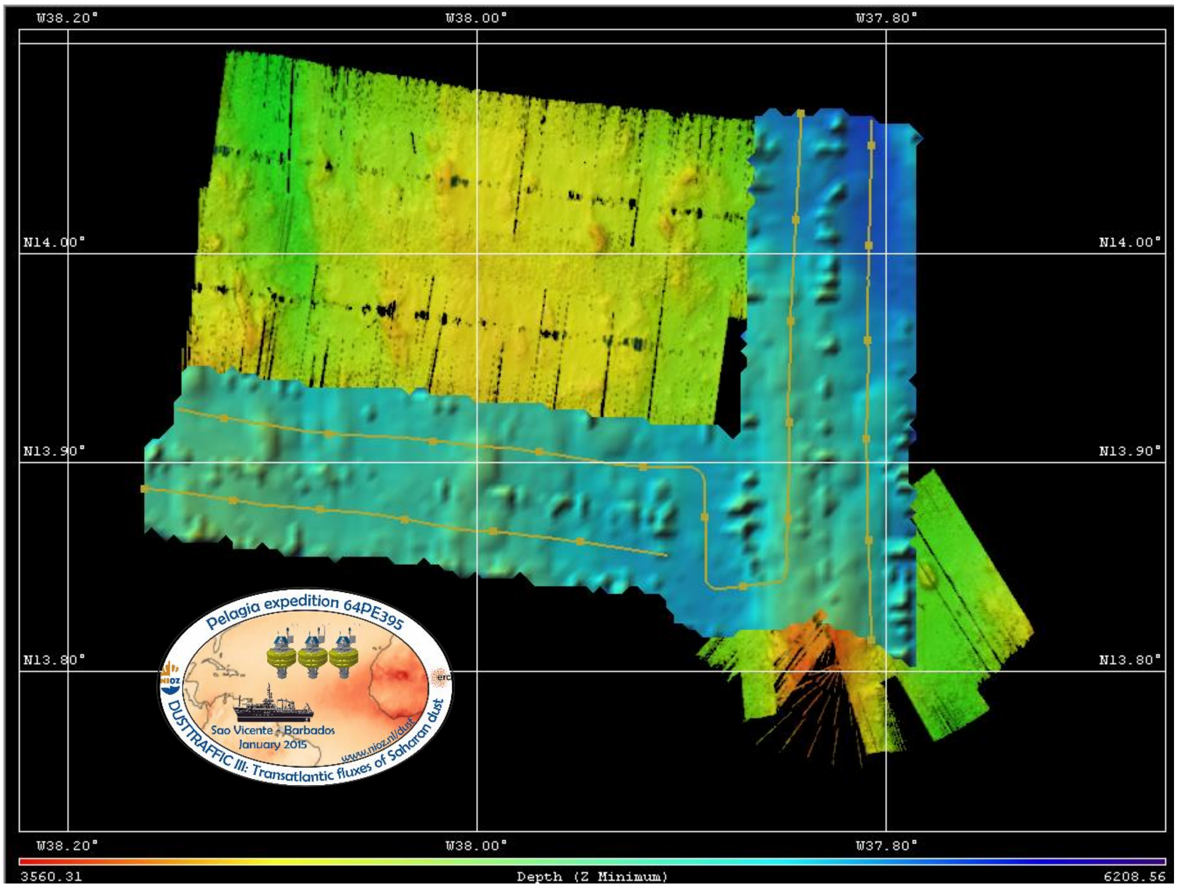


Figure 5.1.2: Bathymetric map of station M2

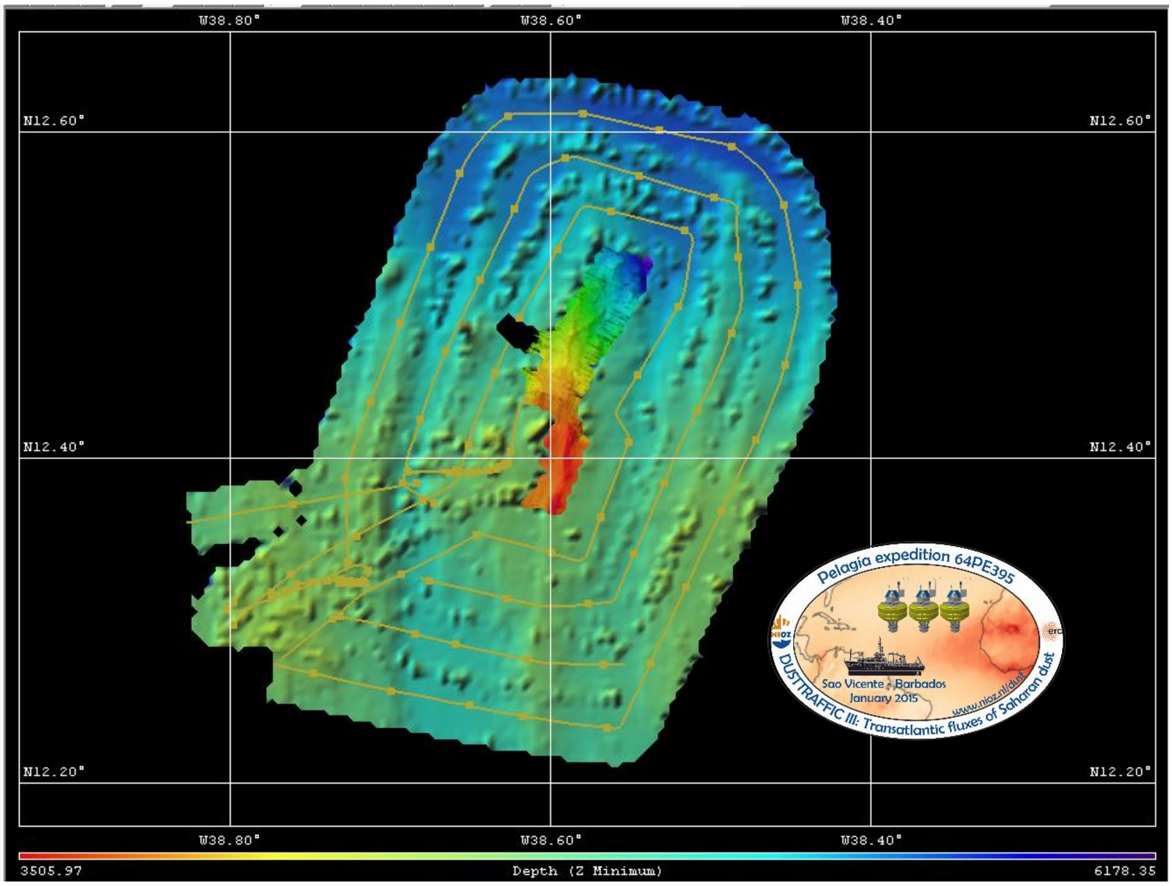


Figure 5.1.3: Bathymetric map of station M3

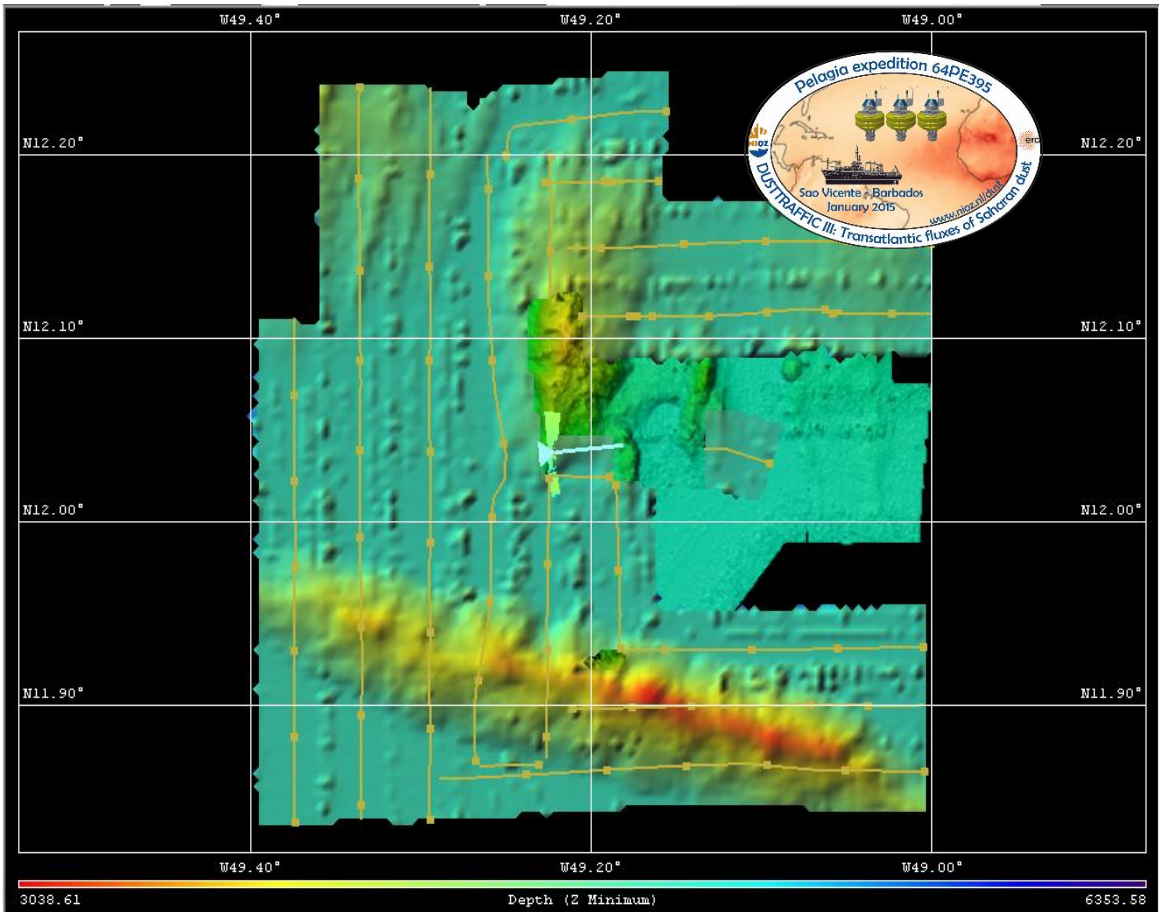


Figure 5.1.4: Bathymetric map of station M4

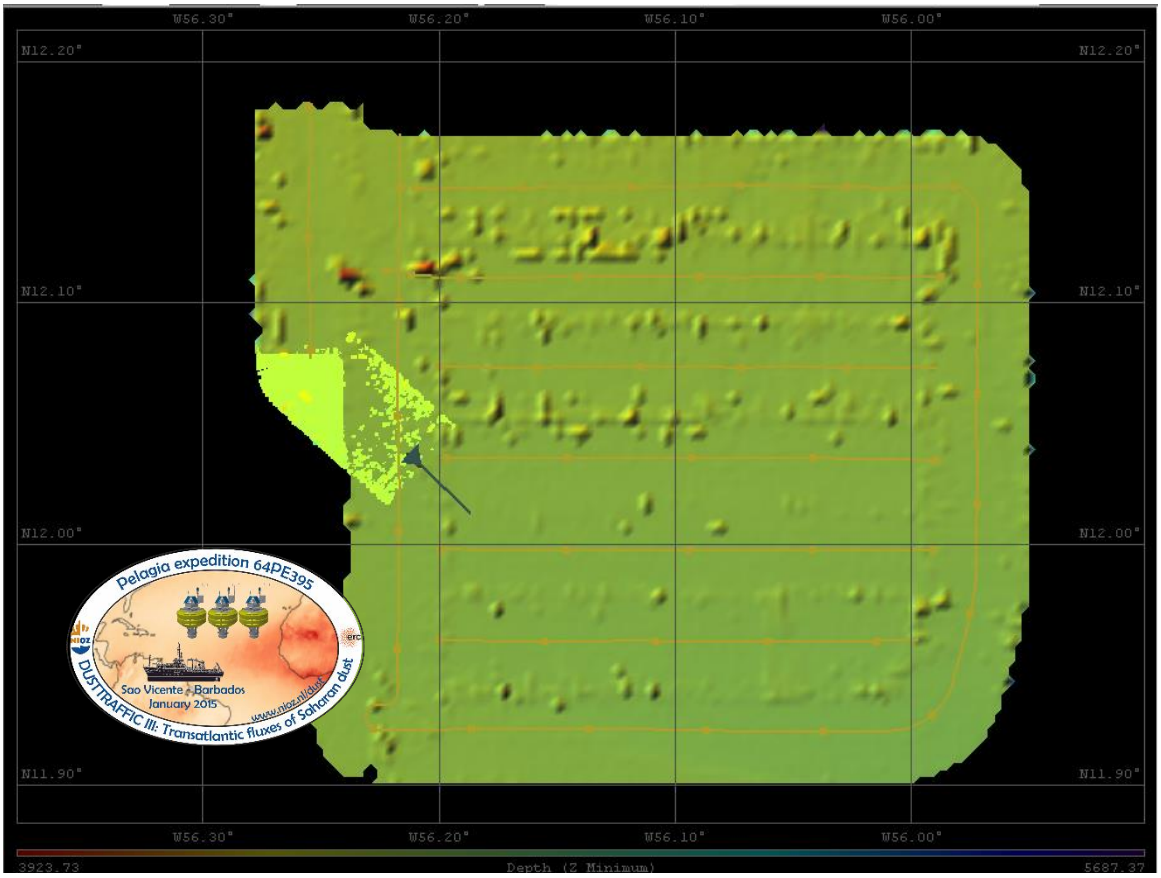


Figure 5.1.5: Bathymetric map of station M5

5.2 Water-sampling and Ultra-Clean CTD

[Laura Korte, Chris Munday]

A Sea-Bird SBE911-Plus Profiler, in conjunction with an Ultra-Clean CTD (UC-CTD) was used during this cruise. The UC CTD was built at the NIOZ with a titanium frame to be able to collect water samples for trace metal analysis. It contains 23 PVDF bottles with a total volume of 27 L and one test bottle made out of PP with a volume of around 10 L, see paragraph 5.9 for detailed information.
The SBE911-Plus Profiler is equipped with a conductivity, temperature (pumped), pressure, oxygen, chlorophyll, transmissivity and irradiance sensor (Table 5.2.1).

Table 5.2.1: Sensor type, serial number and calibration date of CTD parameter

Parameter	Sensor type	S/N	Calibrated on
Conductivity [S/m]	SBE 4	0995	18-Sept-14
Temperature [°C]	SBE 3	2211	18-Sept-14
Pressure [db]	Digiquartz pressure transducer 4000 series	0230	8-Aug-08
Dissolved oxygen [µmol/Kg]	SBE 43	1141	15-Nov-13
Chlorophyll [µg/l]	Chelsea Aqua 3	088-026	8-Jan-14
Transmissivity [%]	Wetlabs C-star transmissometer	1311	27-Mar-12
PAR/Irradiance	Satlantic deepwater PAR sensor	0280	14-May-12
Altimeter	Benthos PSA-916	49562	2009

All sensors registered their specific observations online through both the down- and up-casts.
The CTD system was mounted on the 8-mm Kevlar (iron-free) wire of the CTD winch. It was used in on-line mode, i.e., during the cast all data were directly sent to the computer on board the ship where they were registered and stored. The motor-driven water sampler was connected to the deck command unit via the single-core, armoured cable of the winch, thus, allowing to remotely control each cast. The bottles (N=24, on a 24-position trip mechanism) were tripped during the up-cast at chosen depths using the acquisition software of the CTD (Seasafe remote). At the beginning of each deployment the CTD was lowered to 40 m to get pressure on the spring that is used in the closing mechanism of the bottles. After that the CTD was uplifted to the surface where the actual CTD cast then started with a speed of 1 m/s. During the cast the ship was held on position.
In total, 18 Ultra-Clean CTD casts were conducted during the cruise (see station list/figure 5.2.1 for positions). The purposes of the UC CTD were to get or filter water samples for:

- drifting traps (see section 5.4)
- nutrient analysis (see section 5.8),
- trace metal analysis (see section 5.9),
- sediment trap deployment (see section 5.10)
- DIC analysis,
- Total suspended particles (TSP)

The water samples were filtered for the sediment trap stations M1, M2, M4 and M5. Station M3 was left out due to the vicinity to M2. Filtering was done on pre-weighed polycarbonate filters. 5 L of seawater were filtered of all the UC CTD bottles, resulting in a profile through the water column. To prevent particles

settling in the CTD bottles, N_2 was blown into the bottom part of the bottles immediately before filtration. After filtering the filters were rinsed with a few drops of MilliQ to avoid sea salt crystallisation. The filters will be weighed back at NIOZ.
In addition to the purposes mentioned above, the CTD data will also be used for the sound-velocity profiles of the multi-beam, which will be conducted at the MARUM, Bremen.
During UC CTD cast S23C01 the communication between the CTD and the computer was lost due to a burned connection plug. For that reason the last six bottles could not close, meaning the upper 75 m were not sampled for that specific cast. The problem was solved by replacing the connecting plug after the CTD was back on deck.

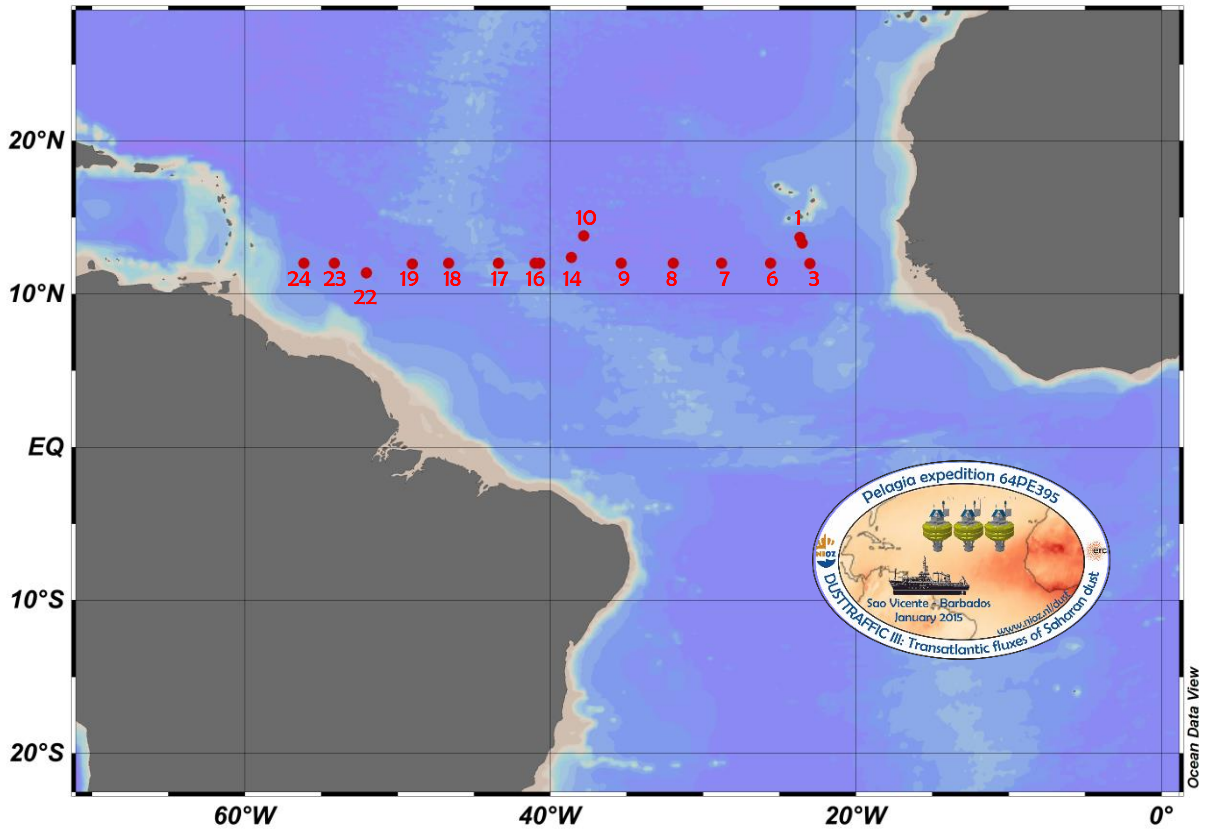


Figure 5.2.1: UC CTD stations
(Note that numbering is not sequential; from 1-24 nrs 4,5,11,12,13,20, and 21 were not sampled)

For a first impression of the distribution of the different parameters we used the software package Ocean Data View to interpolate between the stations. The images below show chosen parameters. The Temperature/Salinity/Depth plot shows in comparison with the salinity plot below (Figure 5.2.2) that there is a different water mass at around 1000 m in the western Atlantic Basin, which is the Antarctic Intermediate Water. Below this water mass there is the North Atlantic Deep Water.

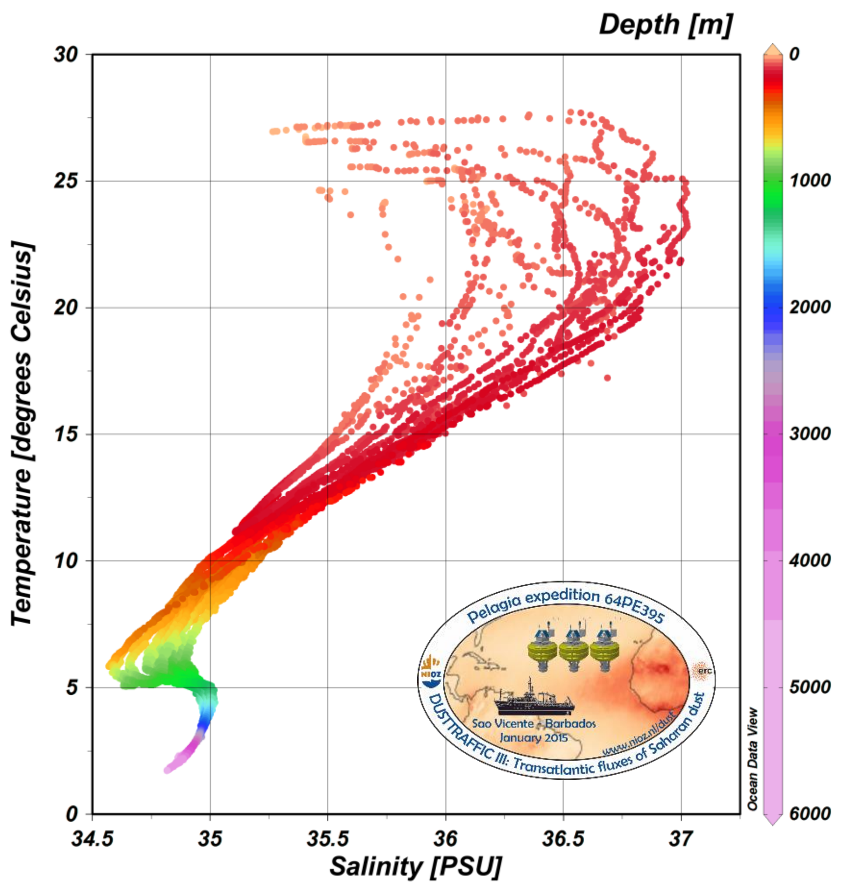


Figure 5.2.2: Temperature/Salinity/Depth plot of all CTD stations for a first indication of different water masses

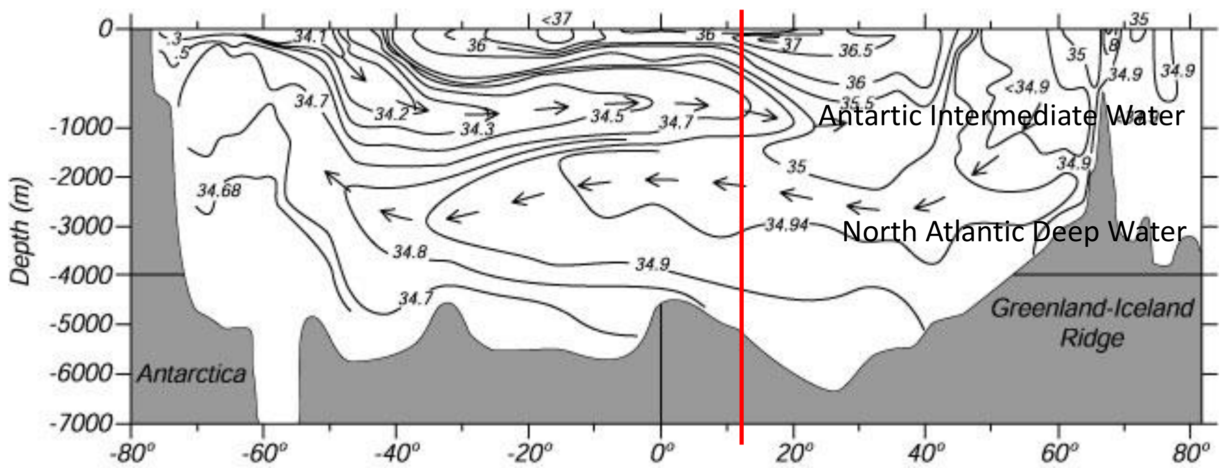


Figure 5.2.3: Salinity in the western Atlantic Basin. Red bar indicates the latitude of the studied transatlantic transect at 12° N.
[Image from: http://oceanworld.tamu.edu/resources/ocng_textbook/chapter13/chapter13_03.htm ,
after Lynn and Reid (1968)]

The oxygen minimum zone is located at approximately 400 m water depth (Figure 5.2.4). This is more prominent in the eastern Atlantic Ocean. Note that the minimum in the western part is an artefact due to sensor problems.

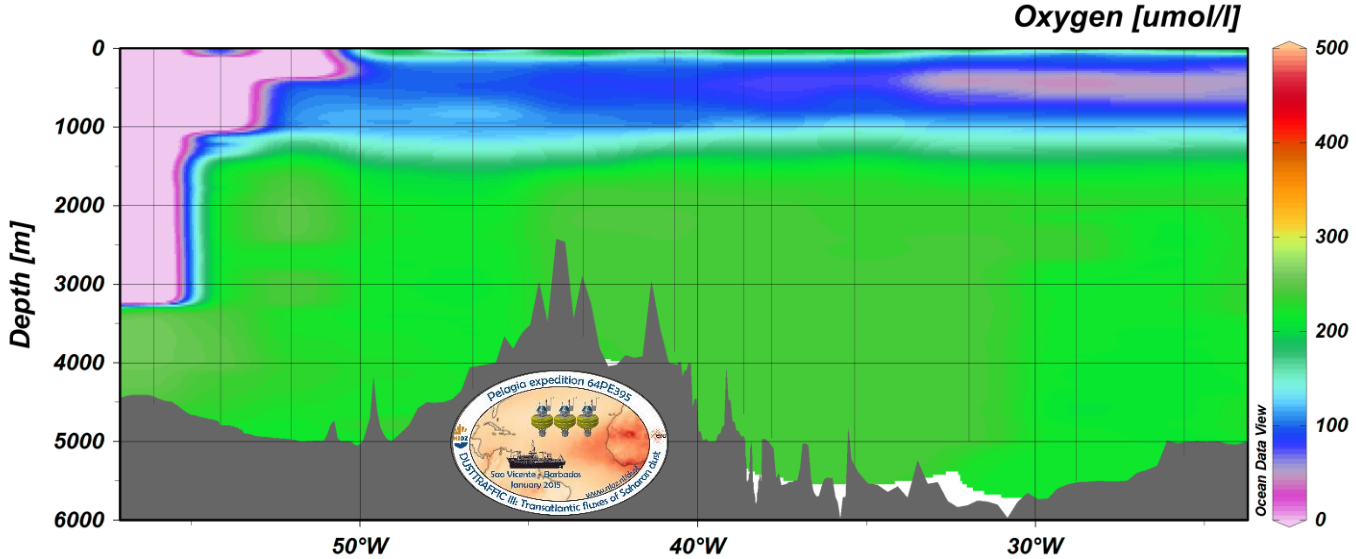


Figure 5.2.4: Oxygen interpolation along the 12th northern parallel

The salinity shows higher values at the surface due to evaporation and lower values for the Antarctic Intermediate water mass at around 1000 m water depth.

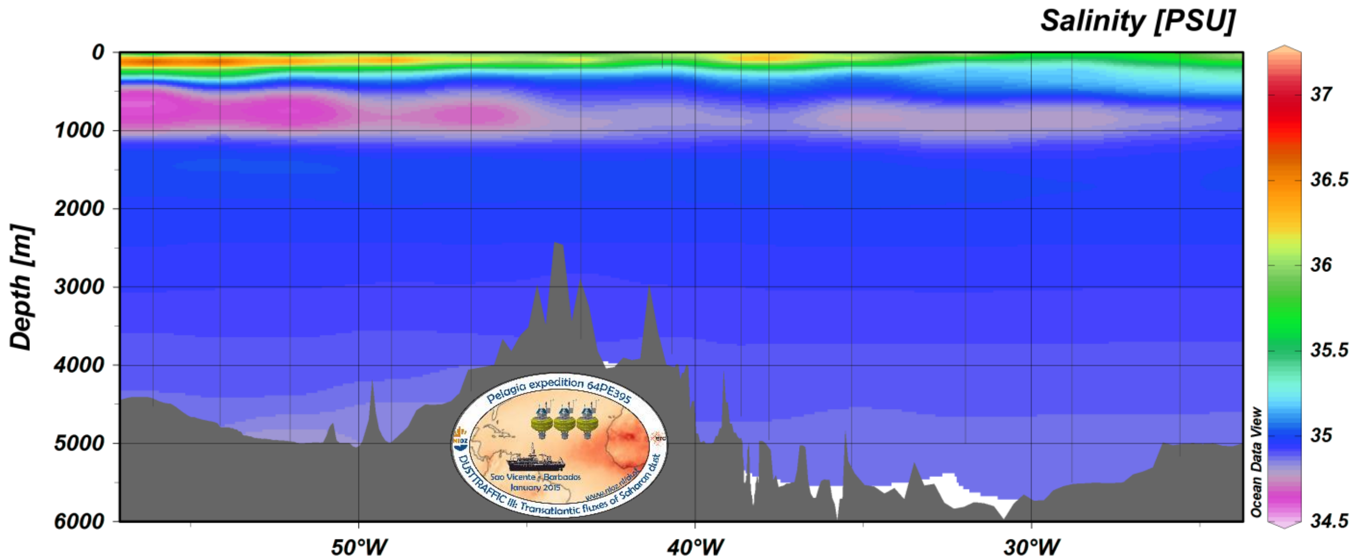


Figure 5.2.5: Salinity interpolation along the 12th northern parallel

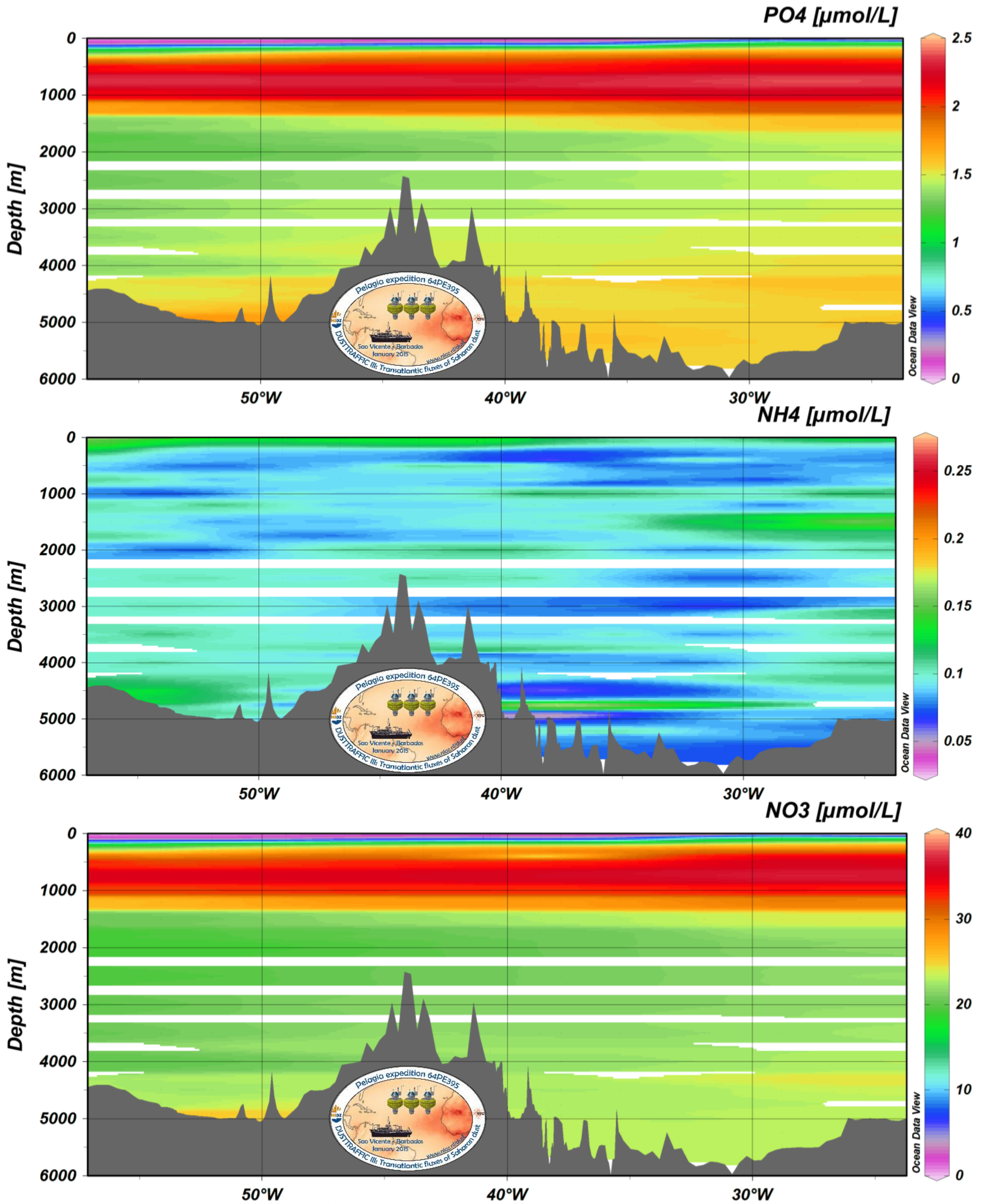


Fig 5.2.6: Nutrients profiles along the 12^{th} North parallel. T2B: Phosphate [PO_4], Ammonia [NH_4], and Nitrate [NO_3]

References

Lynn, R. J., and Reid, J. L., 1968, Characteristics and circulation of deep and abyssal waters: Deep Sea Research and Oceanographic Abstracts, v. 15, no. 5, p. 577-598.

Schlitzer, R. Ocean Data View, http://odv.awi.de, 2014

5.3 Water profiling with the L-ADCP

[Laura Korte]

A Teledyne RDI LADCP workhorse 75 KHz was mounted as a Master feature to the side of the UC CTD rosette frame at almost all CTD stations (Fig. 5.2.1, except S16C01 and S01C01) to measure ocean currents and
-speed across the entire water column along the transect.

The LADCP was programmed according to the GO-SHIP Manual and retrieved data was processed using the LDEO software (http://www.ldeo.columbia.edu/~ant/LADCP) back at the NIOZ.

Unfortunately, it turned out that the LADCP was not working properly and reliable data failed to be obtained. A number of problems might have been involved:

- At least one of the four beams of the LADCP seems to have been malfunctioning. The beam is weak and collects faulty data. Therefore it is difficult to correct for the other beams since only the Master feature was used without the Slave. Figure 5.3.1 shows an example of cast 3 and cast 10 visualizing the weakness of the beams.

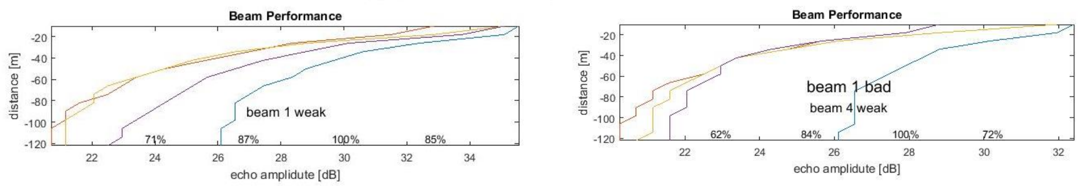


Fig. 5.3.1: Extract from the matlab output for the beam performance. Left: Cast 3, Right: Cast 10.

- Another occurring problem was a time delay of a few minutes between the CTD and LADCP data although the times of the LADCP and CTD instruments were set to UTC and synchronized. Due to this mismatch the data does not fit together and the interpretation is extremely difficult.

- For a lot of data points the software creates an error report for an oversized tilt of more than 22° due to an angled CTD rosette frame. Until a tilt of 22° the software is able to correct for it; if the tilt is larger, the LADCP doesn't collect reliable data anymore and the software reports an error automatically.

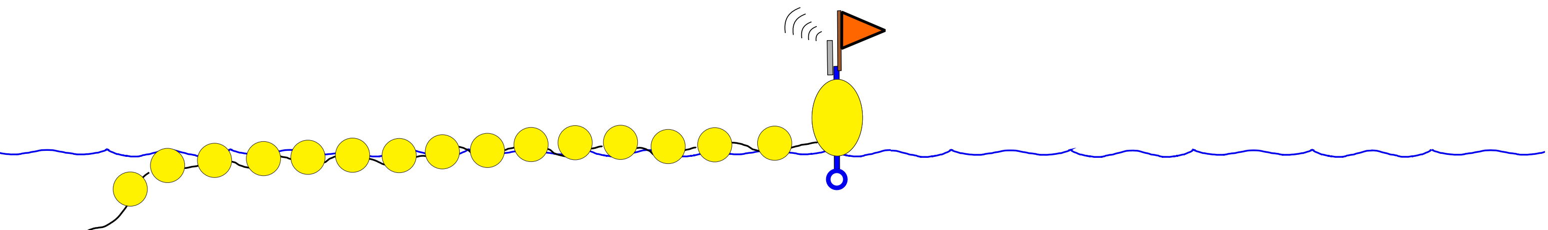
Due to the issues mentioned above it was decided to not use the data and to replace the LADCP instrument during future cruises for the common approach, which consists of:

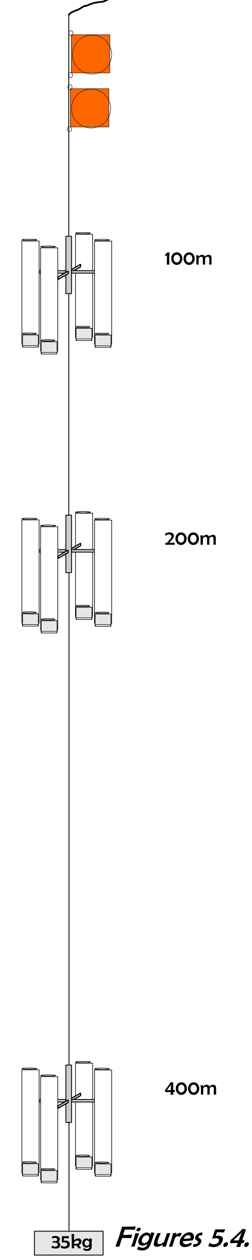
- A double LADCP with Master and Slave features (one ADCP is looking up, the other one is looking down) for best results.
- Control of UTC time on all instruments, also in between the casts, to ensure synchronized times.
- In case of an angled CTD a counter weight to compensate for the tilt is recommended.

5.4 Drifting traps: sampling fresh marine snow

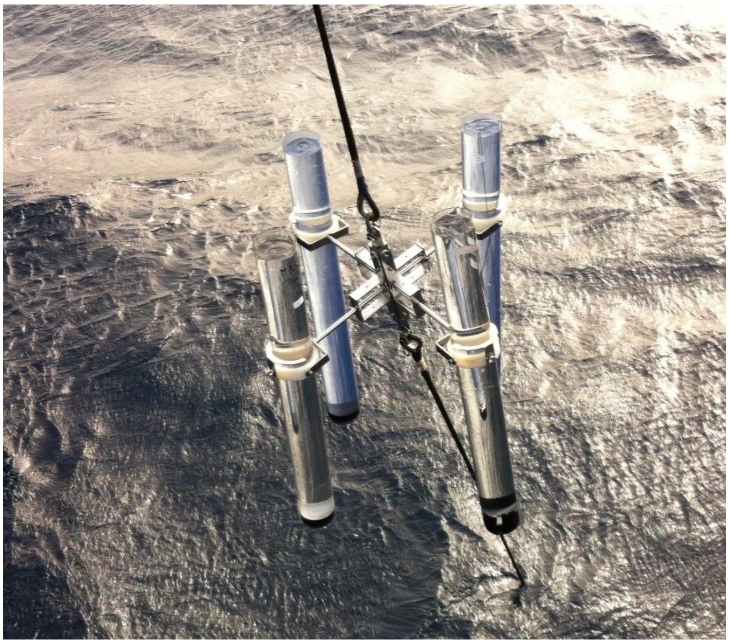
[Hans van Hateren]

Drifting traps were deployed for ± 24 hours at stations M1, M2, M4a, M4b, M5 and for 44 hours at station M3. The main goal was to sample fresh marine snow. We were lucky enough to sample during a dust event (M1 and to a lesser extent M2).





The drifting traps sample at three depths: 100, 200 and 400 m (Figure 5.4.1). Each level consists of four Perspex tubes attached to a metal frame, numbered 1 to 4 (Figure 5.4.2). The tubes are 1 m long and have an inner diameter of 10,5 cm. Each tube holds 8 L filtered sea water. One out of four tubes in each layer is used as a gel trap. This trap holds a shorter Perspex tube, 5 cm deep, which is filled with medical tissue gel (water, polyvinyl alcohol and carbowax). It should be noted, however, that this tube was not always used as gel trap; at station M3 and M4b it was used as a regular drifting trap. The tubes are kept upright by a ballast weight in the bottom of the tube. They are held afloat by a series of floats and the line is kept vertical by a 35 kg anchor. A flashing light, radio beacon and iridium beacon on the buoy aid in retrieving the traps. The iridium beacon sends an e-mail with GPS coordinates every 3 hours.



Figures 5.4.1 (sketch, left) and 5.4.2 (photo, right) depicting the drifting sediment trap

Before deployment, the traps were filled with filtered seawater. Seawater from corresponding depths was taken from the CTD and directly filtered through a 0,20 µm folded cellulose-acetate filter. Subsequently it was densified using 1,225 g/L Borax. After station M3 we ran out of Borax, so we switched to using approximately 1,1 g/L of regular kitchen salt to densify the water. At station M1, the gel traps were also densified using Borax. However, this gel came back with a whitish and impenetrable top layer and thus we decided to use regular kitchen salt which greatly improved results. Once on deck, the tubes were left to settle for approximately 5 hours. Since we were mainly interested in the denser fraction with higher settling velocity, tubes 2-4 of each depth were decanted to approximately 2 L after settling. Subsequently they were filtered over different kinds of filters, depending on the specific analyses (Table 5.4.1), using a vacuum pump.

Table 5.4.1: Distribution of the different tubes over filters of various kinds at 100m, 200m, and 400m

Purpose / Station	M1	M2	M3	M4A	M4B	M5
Marine snow (gel)	1	1		1		1
Pigments (nylon filter)			1		1	
C/N ratio and pigments (GFF)	2	2	2	2	2	2
Microbes (PC)	3	3	3	3	3	3
Particle size and bulk chemistry (PC)	4	4	4	4	4	4

5.4.1 Marine snow

The gel trap (tube 1) was decanted to approximately 3 L. Subsequently, the short Perspex tube containing the gel with trapped marine snow was removed from the tube. The gels were stored at -20°C. At NIOZ, they will be sliced to study the shape and penetration depth of different marine-snow particles.

The remaining water was filtered using nylon filters (0,20 µm) to be analysed for pigments at NIOZ. The samples were placed in petri dishes, wrapped in tin-foil and then frozen at -80°C. These duplicate pigment filters will serve to test whether nylon filters keep pigments fresher than glass-fibre filters.

There were a few exceptions to this general procedure: as mentioned earlier, tube 1 was used as a regular trap at station M3 and M4b. Furthermore, the filtering of tube 1 (100, 200 and 400m) from station M4a was exceptionally slow, so we were forced to stop halfway and throw away the samples. Apart from the first gel, all drifting-trap samples look very promising (Figures 5.4.3 and 5.4.4) and will hopefully increase our knowledge of the ballasting function of dust.

Figure 5.4.3: Gel-filled cup with marine snow

Figure 5.4.4: GFF filter with sediments

5.4.2 C/N ratios and pigments

The sediments in tube 2 were filtered over a glass-fibre filter (GFF, ~0.4µm), which is better suited for C/N analysis. Of the stations M1, M2, M4A, and M5, this GFF filter will also be used for pigment analyses. In order to preserver the pigments, seawater was used instead of Milli-Q water. After filtration, the filters were wrapped in pre-combusted aluminium foil and stored at -20°C.

5.4.3 Microbes

Tube 3 was filtered over a polycarbonate filter with a mesh size of 0,20 μm. The filters were placed in sterile petri dishes and frozen at -80°C to be analysed for microbes.

5.4.4 Particle size and bulk chemical composition

Tube 4 was filtered over a polycarbonate filter, placed in petri dishes and subsequently stored at 4°C to be used for particle-size analysis of the terrigenous fraction (dust) and bulk chemical composition.

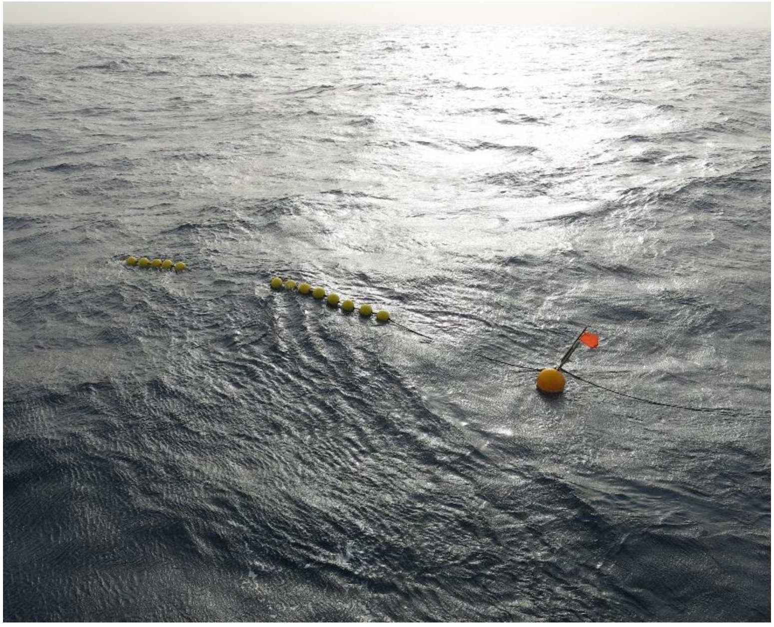


Figure 5.4.5: The drifting traps in a calm sea.

5.5 Mineral Dust sampling
[Chris Munday]

Studying mineral dust sampled with filters on board *RV Pelagia* 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 palaeo-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.
Aerosol sampling was performed with two Anderson high-volume dust collectors mounted above the bridge of the ship (Figure 5.5.1). Each collector contains a motor which sucks air through an air filter mounted on top, underneath a rain cover. In addition, an OMNI 3000 wet concentrating air sampler was used to collect samples for microbiological characterization.

Figure 5.5.1: The air samplers on top of the bridge. Anderson high-volume samplers are blue. The smaller grey piece of equipment is the OMNI sampler. The blue inlet hose to the OMNI has its opening to the front on the right.

The Anderson samplers were connected to a wind vane programmed to have the units switch on when wind is coming from a predetermined arc in front of the ship, and off at other times. This is to prevent contamination from the ship's chimney. Originally, the 'on' range was approximately 45° to each side of 0° (straight ahead). After observation of the prevailing wind, it was decided that the arc could be widened, to approximately 100° to each side to allow collection of aerosols for a longer time. A logger on board each collector monitors the volume of air collected, and increases the suction when the filter gets loaded with material to maintain a constant air flow. Each of the two samplers contained a filter made from a different material – Glass Fiber (GF/F) and Cellulose Acetate (CA), allowing for multiple analyses. The glass fiber filters were pre-combusted at NIOZ and stored in pre-combusted aluminium foil, and will be used to analyse lipid content of the aerosols. The cellulose acetate filters will be used to analyse chemical composition and grain-size distributions. GF/F filters were stored at -80°C, while CA filters were stored at room temperature.

The OMNI 3000 sampler collects samples by sucking air (at 300 litres 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 or side of the ship. The total time and air volume sampled is logged on board the system.

The day before our departure from Mindelo a slight haze could be seen in the air, and by the time we departed the following day, it was clear that we were in a dust storm. All samplers were activated shortly after departure, and the concentration of dust in the air meant that the sampling resolution could be very high. Between the 11th and 16th of January, 17 samples were collected from the Anderson samplers and 14 from the OMNI. Examples of the dust load can be seen in Figure 5.5.2. The dust storm ultimately subsided around the 19th of January and the intensity of sampling was greatly reduced. The westerly track of the ship also meant that the prevailing wind was from behind the ship, further limiting sampling time.

Figure 5.5.2: Examples of the dust load seen from just 3 hours of sampling during the dust storm. These particular samples (GF/F filter on the left on and OMNI cartridge with blank for comparison on the right) were collected on the afternoon of the 11th of January.

The Anderson samplers experienced almost problem-free sampling for the duration of the voyage, while some problems were experienced with the OMNI. During preparation for the cruise, a problem within the wiring inside the hinge of the unit was identified and thought to be fixed. After one day of usage, the problem returned and another fix was made. After several days of problem free sampling, small issues began to surface, thought to be a result of the very dusty conditions. A cleaning of the unit was attempted, but to be most effective, a full disassembly of the unit is required, which will be much easier at NIOZ.

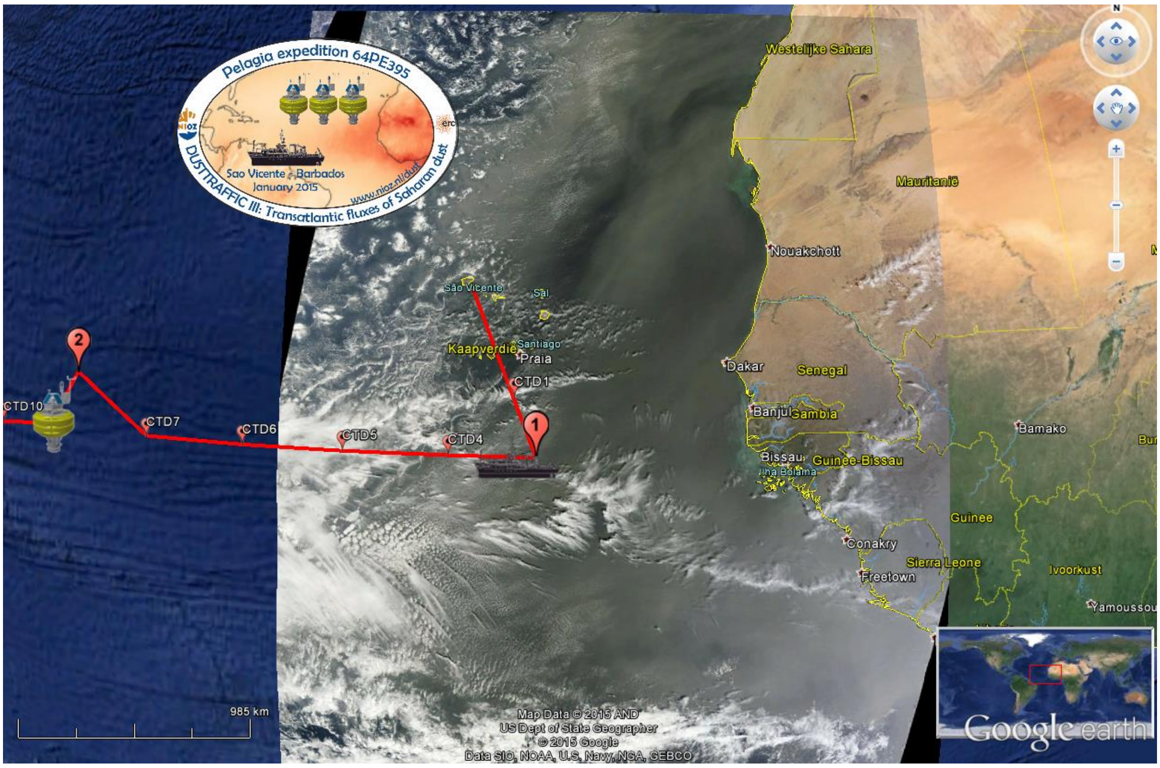


Figure 5.5.3: Google-Earth file showing the eastern part of the transatlantic transect with the ship's position on 14 January 2015. Overlay is a satellite image of the same day, showing dust from NW Africa.

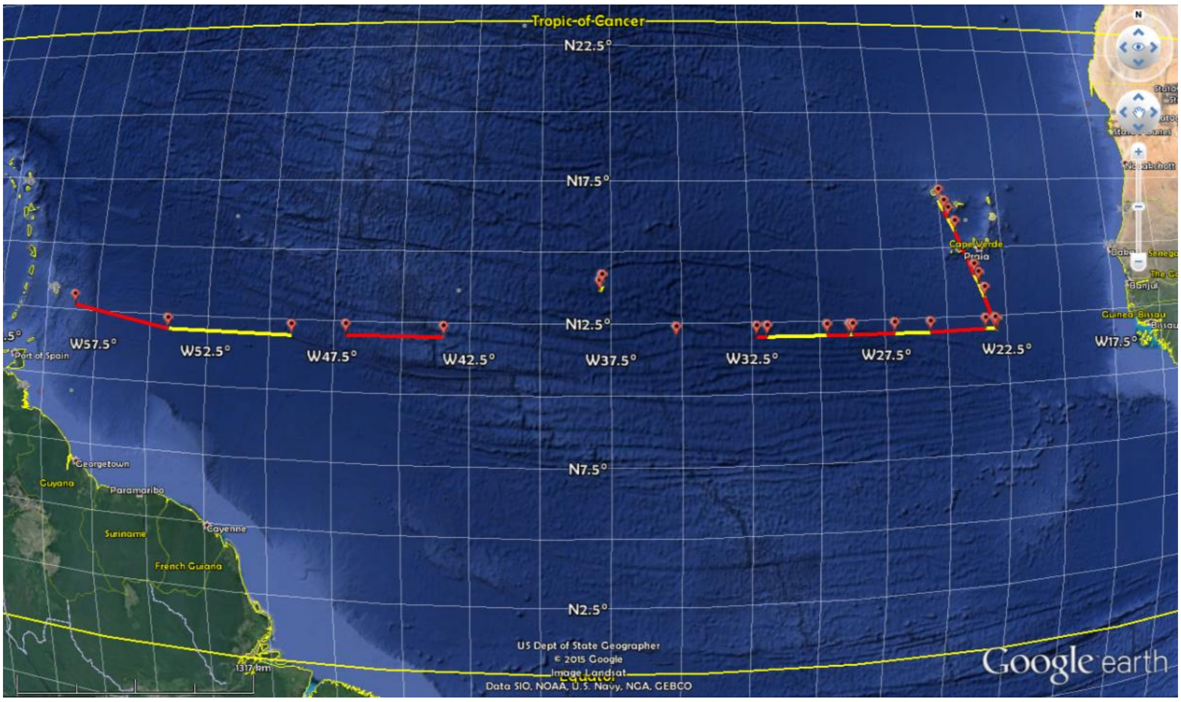


Figure 5.5.4: Google-Earth file showing the positions and transects of all dust samples collected during 64PE395.

5.6 Mooring recoveries

[Michèlle van der Does]

5.6.1 Overview moorings 2013-2014

One of the major goals of this cruise was the recovery, servicing and redeployment of long-term moorings at a transect across the equatorial North Atlantic Ocean, at 12°N. These sub-surface moorings are deployed for a total period of 3 years. The sampling started in October 2012, and the moorings are serviced every year. Along the transect, originally a total of five moorings were deployed, each equipped with ADCP's, current meters and T-S sensors and sediment traps. However, in 2013, at M5 no mooring was deployed. 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 5.6.1 for more details on the sensors.

Table 5.6.1: Instrument details of equipment deployed during 64PE378, 2013. SN = Serial Number, BC = Barcode

Station	Depth	Instrument	SN	BC	Start
14M1	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
		Data logger	B7	7252	11/18/2013
		Sensor FLNTU	2774	74575	
14M2	790	ADCP	3175	1953	
	1190	Sedimenttrap Technicap PPS-5/2 Funnel	45	43465	
		Motor Unit	29	7238	
		Carrousel		43281	12/1/2013
		Data logger	C3	9546	11/23/2013
		Sensor SeaPoint	11908	41508	
		SBE 37 MicroCat CTD	2667	10856	
14M3	962	ADCP	3616	2905	
	1362	Sedimenttrap Technicap PPS-5/2 Funnel	53	9942	
		Motor Unit	9-263	34982	
		Carrousel		43168	12/1/2013
		Data logger	BB	1205	11/26/2013
		Sensor SeaPoint	11104	22545	
		SBE 37 MicroCat CTD	4352	12775	
14M4	700	ADCP	6778	5302	
	1100	Sedimenttrap Technicap PPS-5/2 Funnel	46	8488	
		Motor Unit	9-265	35354	
		Carrousel		1250	12/9/2013
		Data logger	B1	12171	11/30/2013
		Sensor FLNTU	2855	74551	
		SBE 37 MicroCat CTD	4345	12805	
	3316	Sedimenttrap Technicap PPS-5/2 Funnel	53	9942	
		Motor Unit	2-212	9614	
		Carrousel		43199	12/9/2013
		Data logger	C4	9522	11/30/2013
		Sensor SeaPoint	11421	25027	
		SBE 37 MicroCat CTD	2657	3803	
	3336	Aanderaa RCM-11	202	4107	
	4612	Aanderaa RCM-11	35	1786	

Table 5.6.2. Sediment trap sampling intervals of 2014.

Mooring M1				Mooring M2				Mooring M3				Mooring M4			
				16				16				16			
start	end	bottle	days	start	end	bottle	days	start	end	bottle	days	start	end	bottle	days
23/nov/2013	1/dec/2013	1	8												
1/dec/2013	9/dec/2013	2	8	1/dec/2013	9/dec/2013	1	8	1/dec/2013	9/dec/2013	1	8				
9/dec/2013	17/dec/2013	3	8	9/dec/2013	17/dec/2013	2	8	9/dec/2013	17/dec/2013	2	8	9/dec/2013	17/dec/2013	1	8
17/dec/2013	25/dec/2013	4	8	17/dec/2013	25/dec/2013	3	8	17/dec/2013	25/dec/2013	3	8	17/dec/2013	25/dec/2013	2	8
25/dec/2013	10/jan/2014	5	16	25/dec/2013	10/jan/2014	4	16	25/dec/2013	10/jan/2014	4	16	25/dec/2013	2/jan/2014	3	8
											16	2/jan/2014	10/jan/2014	4	8
10/jan/2014	26/jan/2014	6	16	10/jan/2014	26/jan/2014	5	16	10/jan/2014	26/jan/2014	5	16	10/jan/2014	26/jan/2014	5	16
26/jan/2014	11/feb/2014	7	16	26/jan/2014	11/feb/2014	6	16	26/jan/2014	11/feb/2014	6	16	26/jan/2014	11/feb/2014	6	16
11/feb/2014	27/feb/2014	8	16	11/feb/2014	27/feb/2014	7	16	11/feb/2014	27/feb/2014	7	16	11/feb/2014	27/feb/2014	7	16
27/feb/2014	15/mrt/2014	9	16	27/feb/2014	15/mrt/2014	8	16	27/feb/2014	15/mrt/2014	8	16	27/feb/2014	15/mrt/2014	8	16
15/mrt/2014	31/mrt/2014	10	16	15/mrt/2014	31/mrt/2014	9	16	15/mrt/2014	31/mrt/2014	9	16	15/mrt/2014	31/mrt/2014	9	16
31/mrt/2014	16/apr/2014	11	16	31/mrt/2014	16/apr/2014	10	16	31/mrt/2014	16/apr/2014	10	16	31/mrt/2014	16/apr/2014	10	16
16/apr/2014	2/mei/2014	12	16	16/apr/2014	2/mei/2014	11	16	16/apr/2014	2/mei/2014	11	16	16/apr/2014	2/mei/2014	11	16
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18/mei/2014	3/jun/2014	14	16	18/mei/2014	3/jun/2014	13	16	18/mei/2014	3/jun/2014	13	16	18/mei/2014	3/jun/2014	13	16
3/jun/2014	19/jun/2014	15	16	3/jun/2014	19/jun/2014	14	16	3/jun/2014	19/jun/2014	14	16	3/jun/2014	19/jun/2014	14	16
19/jun/2014	5/jul/2014	16	16	19/jun/2014	5/jul/2014	15	16	19/jun/2014	5/jul/2014	15	16	19/jun/2014	5/jul/2014	15	16
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6/aug/2014	22/aug/2014	19	16	6/aug/2014	22/aug/2014	18	16	6/aug/2014	22/aug/2014	18	16	6/aug/2014	22/aug/2014	18	16
22/aug/2014	7/sep/2014	20	16	22/aug/2014	7/sep/2014	19	16	22/aug/2014	7/sep/2014	19	8	22/aug/2014	7/sep/2014	19	16
7/sep/2014	23/sep/2014	21	16	7/sep/2014	23/sep/2014	20	16	7/sep/2014	15/sep/2014	20	8	7/sep/2014	15/sep/2014	20	8
								15/sep/2014	23/sep/2014	21	8	15/sep/2014	23/sep/2014	21	8
23/sep/2014	9/okt/2014	22	16	23/sep/2014	1/okt/2014	21	8	23/sep/2014	1/okt/2014	22	8	23/sep/2014	1/okt/2014	22	8
				1/okt/2014	9/okt/2014	22	8	1/okt/2014	9/okt/2014	23	8	1/okt/2014	9/okt/2014	23	8
9/okt/2014	17/okt/2014	23	8	9/okt/2014	17/okt/2014	23	8	9/okt/2014	17/okt/2014	24		9/okt/2014	17/okt/2014	24	8
17/okt/2014	25/okt/2014	24	8	17/okt/2014	25/okt/2014	24	8								

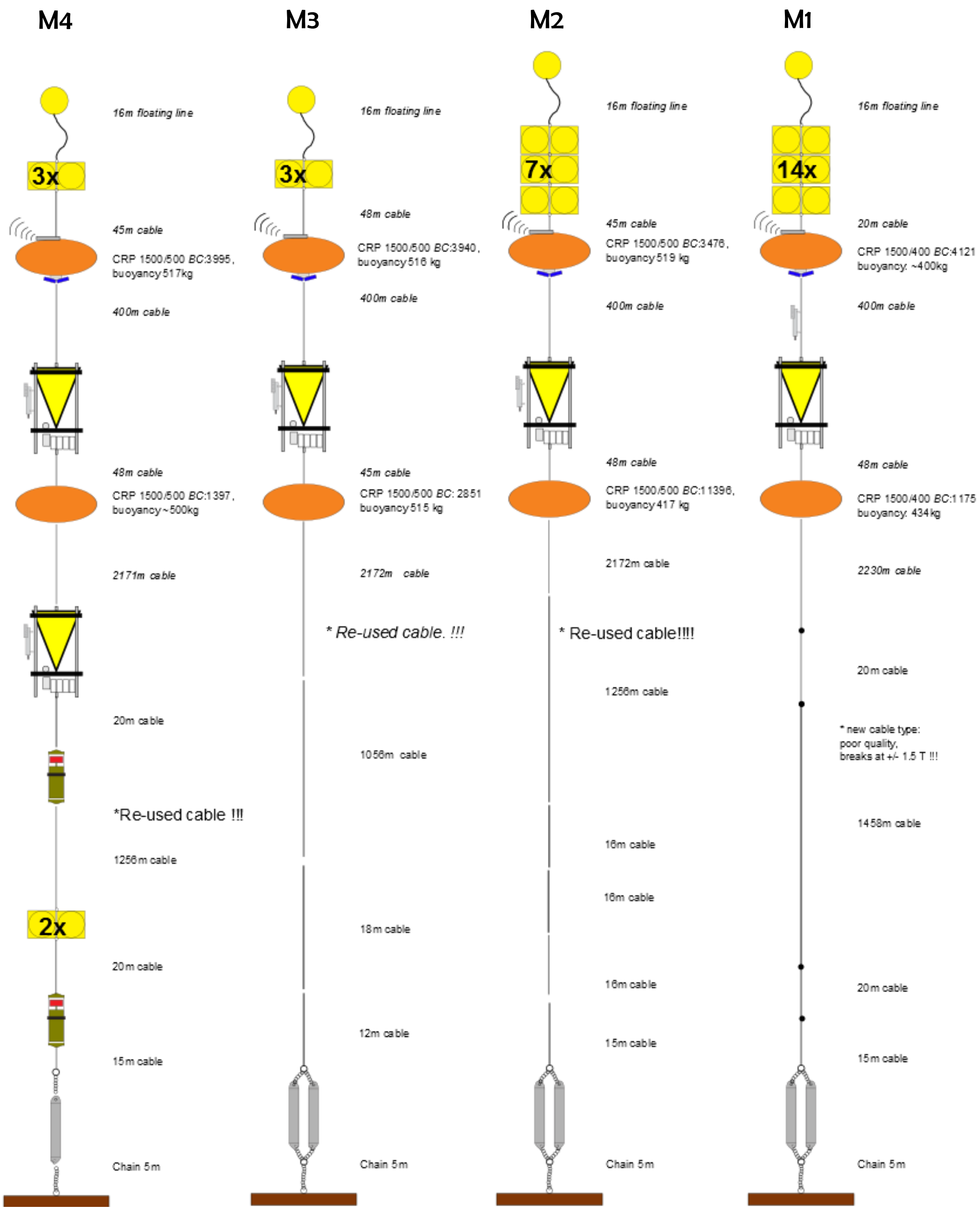

Figure 5.6.1. Sketches of the four sediment-trap moorings deployed during 64PE378 in November 2013.

The moorings of M1-M5 were originally equipped with two Technicap PPS-5/2 sediment traps, one at 1200 meters below sea level and the other at 3500 meters below sea level. They have a collecting area of 1.0m^2 and are provided with a 1 cm^2 honeycomb baffle. The Technicap PPS-5/2 sediment traps consist of a funnel, carrousel and motor-unit. Their pre-programmed sampling intervals differed between 8 and 16 days for the 24 collecting cups on both traps, the first trap starting on 23 November 2013 and the last trap ending on 25 October 2014. More details on the sampling intervals is provided in Table 5.6.2.

The five moorings were originally deployed during RV Meteor Expedition M89 in October 2012, with a total of 10 sediment traps. During RV Pelagia Expedition 64PE378 these traps were serviced, and due to damage to the traps, cables and other problems during the recovery and redeployment of the moorings, only five sediment traps could be redeployed; one at stations M1, M2 and M3, and two at station M4 (see Figure 5.6.1 for details).

5.6.2 Sample recovery

Upon arrival on deck, the entire carrousel with sample bottles was dismounted from each trap, and transferred to the cold room for dark storage at 4°C. 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 1.29 g/L) and pH-buffer (Borax; $Na_2B_4O_7{\cdot}10H_2O$; end concentration 1.29 g/L) had been added create a density slightly in excess of the ambient seawater.

As part of the shipboard processing protocol, the sample carrousel 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. 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 shipboard analysis of nitrate and nitrite, phosphate and ammonium, and 5 mL for DIC. The remaining 30 mL was transferred to a 40mL ZPE bottle for subsequent analysis of 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 a first order estimate of the mass flux, the height of the residue in the collecting bottles was measured to the next millimeter and converted into residue volumes using a calibration curve (Fig 5.6.2).

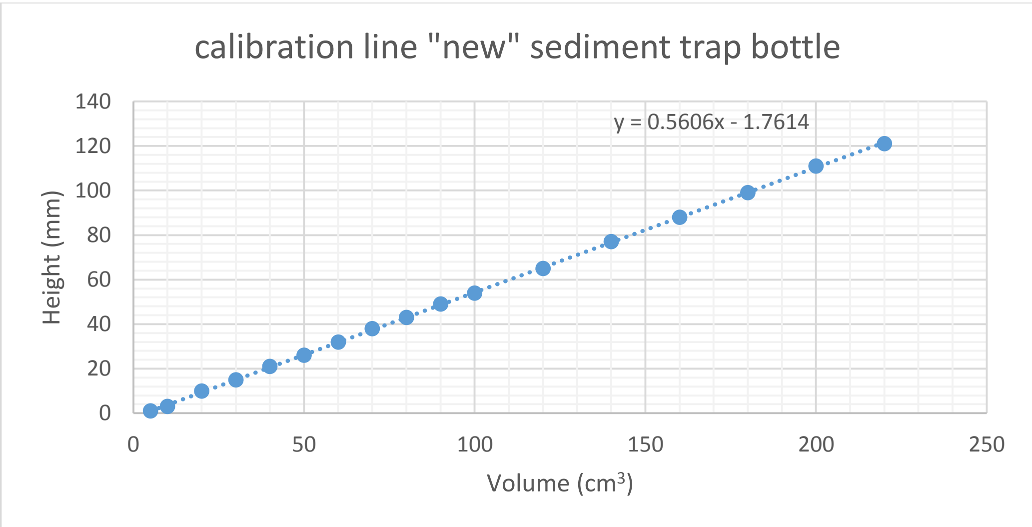

Figure 5.6.2: Calibration line between sample height and sediment volume.

5.6.3 Preliminary results

In general the instruments that were recovered worked well, with the exception of the ADCP at M2, which appeared to be flooded and the data could not be recovered. There are chances that the memory card may be revived. The ADCP was in such a bad state that it also could not be re-deployed.

Collecting efficiencies of sediment traps are strongly affected by the (changing) tilt of the sediment trap during their deployment and the (changing) current velocities at depth. In order to determine these parameters, each sediment trap was equipped with a sensor package that recorded tilt in two perpendicular directions and pressure. Current velocities were measured using a downward-looking ADCP mounted in the flotation body 400m above the upper sediment trap for all moorings and a current meter 16m above the lower sediment trap of M4, and one current meter just above the ocean floor on mooring M4 (See fig 5.6.1 for detailed sketches of the deployed moorings with their instruments). In general, tilt measurements and temperature-pressure data indicate that the moorings remained effectively vertical during the deployment period.

All releasers on the trap moorings responded immediately upon the acoustic wake-up calls. The traps were all recovered in good shape and had functioned well. All the O-rings of the trap carrousels were still present, except at station M4, and in good shape, and no repairs were necessary.

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. Therefore, from station 14M2 on, it was decided not to use these cables but to re-use the old cables.
Knowing that the new cables at station M1 were weak (maximum load of 1.3 Ton), we would risk losing the mooring in rough weather. Due to the strong wind and rough sea state it was decided to not recover the mooring of M1 during this cruise, but to postpone the recovery to the cruise next year, planned in March 2016 with RV Discovery.

Mooring 14M2

Mooring 14M2 was successfully recovered, including the sediment trap that was deployed at a depth of 1200m below the sea surface. The sediment trap had performed flawlessly and all the 24 sample cups were filled with sediments (see Figure 5.6.3).
Values for pH ranged between 7.4 (14M2-U4) and 8.3 (14M2-U6, 23, U24). Two samples were smelly and/or discolored (14M2-U11 and U12). Although the pH of some samples was quite low, it was decided not to re-poison the samples. The estimated residue volumes of the samples wasn't very high in general, but increased fluxes appear for samples7-9. The nutrient analyses show increased values around sample 10-12 for NH_4, PO_4 and NO_2 (See Figure 5.6.4).

Figure 5.6.3: Pictures of all 24 sample bottles of the sediment trap 14M2-Upper.

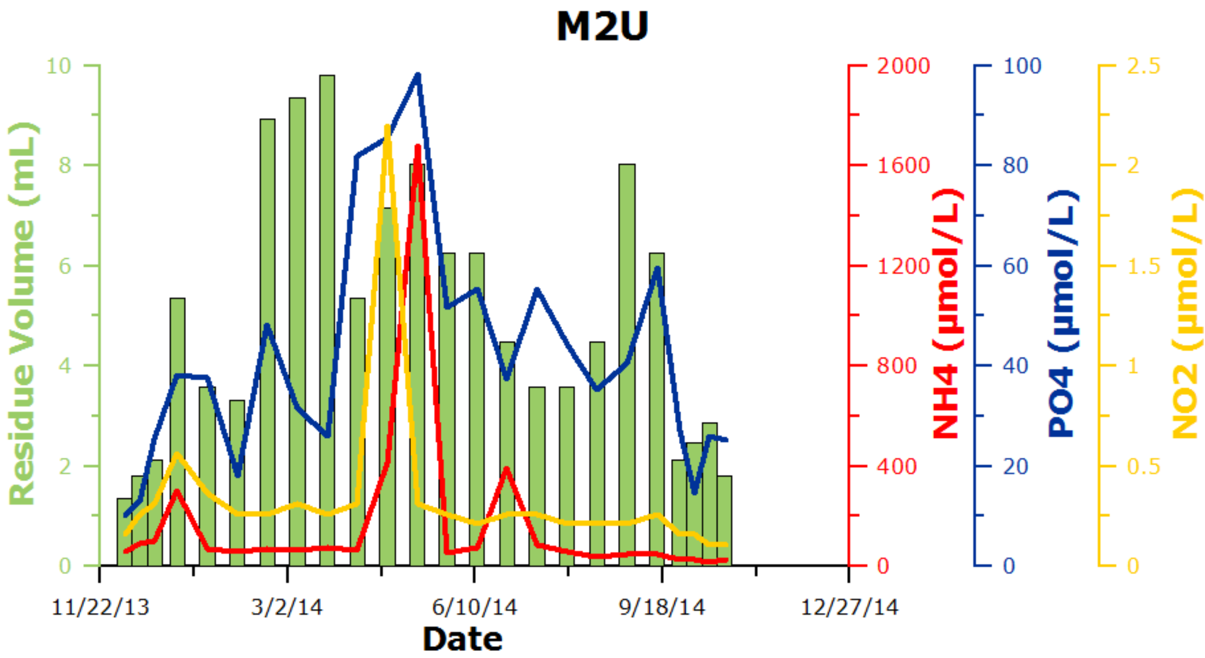

Figure 5.6.4. 14M2 Upper sediment trap estimated mass fluxes and nutrients

Mooring 14M3

Mooring 14M3 was successfully recovered, including the sediment trap that was deployed at a depth of 1200m below the sea surface. The sediment trap had performed flawlessly and all the 24 sample cups were filled with sediments (see Figure 5.6.5).

Values for pH ranged between 7.3 (14M3-U14) and 8.5 (14M3-U1). Two samples were smelly and/or discolored (14M3-U7 and U14) and two samples contained large wiry 'structures', which may be plant material. Although the pH of some samples was quite low, it was decided not to re-poison the samples. The estimated residue volumes of the samples were in general higher than the samples of 14M2-U, with one outlier with an impressive estimated residue volume of 76 mL (sample 14M3-U7). The nutrient analyses show increased values around sample 2, 7 and 14 (see Figure 5.6.6).

Figure 5.6.5: Pictures of all 24 sample bottles of the sediment trap 14M3-Upper.

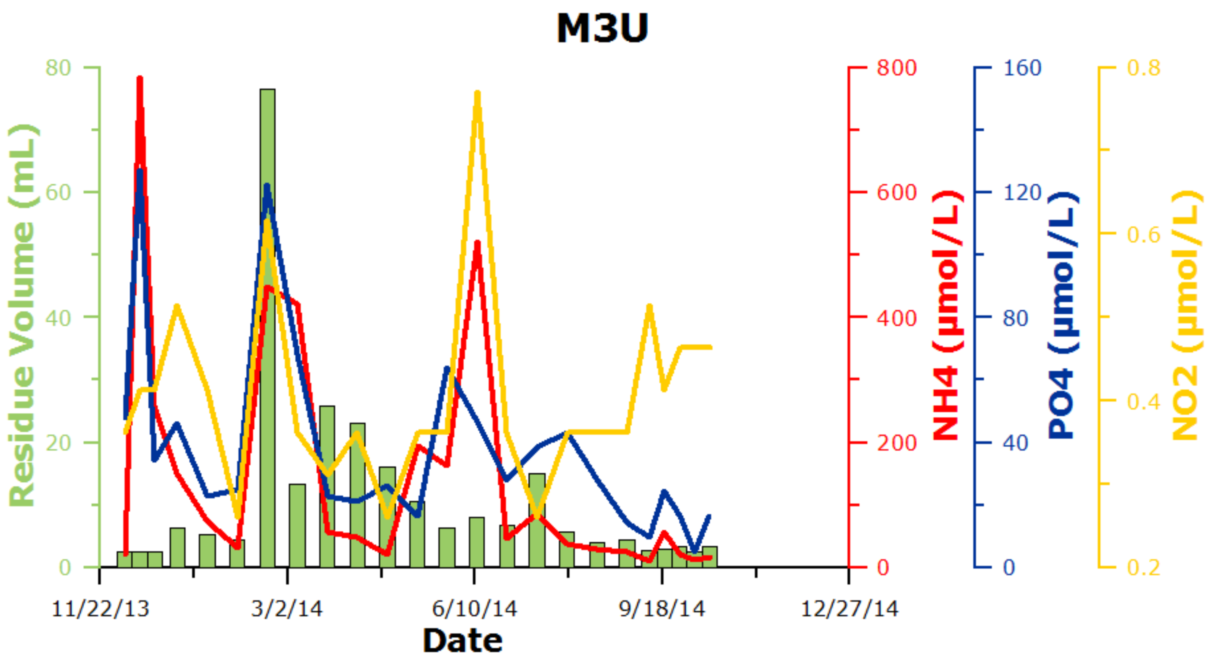

Figure 5.6.6: 14M3 Upper sediment trap estimated mass fluxes and nutrients.

Mooring 14M4

Upon arrival on station M4, the sea appeared to be too rough for a mooring recovery and therefore it was decided to postpone the recovery several days. When the waves and swell reduced, the mooring could successfully be recovered, including both sediment traps, at 1200 and 3500 m water depth. The traps had both worked perfectly and all the sample cups were filled with sediments (see Figure 5.6.7 and 5.6.9). However, the FLNTU-sensor (at the upper sediment trap) appeared to have faulty wiring and therefore the data-logger had not recorded any of the data.

For the upper sediment trap (1200m), values for pH ranged between 7.2 (14M4-U7) and 8.3 (14M4-U3 and U21). One sample was slightly yellowish (14M4-U5). Although the pH of some samples was quite low, it was decided not to re-poison the samples.

The estimated residue volumes of the samples was much higher for samples 14M4-U12, U13 and U14 compared to the other samples. Also the nutrients show peaks for these samples (see Figure 5.6.8).

Figure 5.6.7: Pictures of all 24 sample bottles of the sediment trap 14M4-Upper.

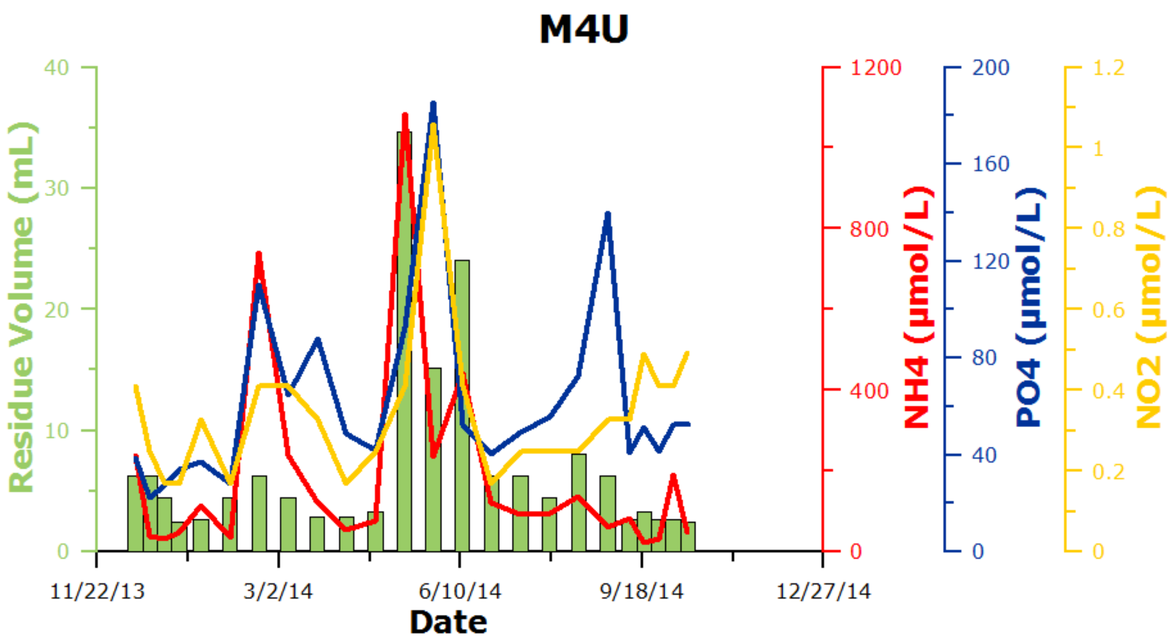

Figure 5.6.8: 14M4 Upper sediment trap estimated mass fluxes and nutrients.

For the lower sediment trap (3500m), 14-M4-Lower, values for pH ranged between 7.6 (14M4-L9) and 8.1 (14M4-L21), but in general it did not show much variation between the different samples. The estimated residue volumes peak at sample 12 and 13, similar as for the Upper sediment trap of M4. The PO_4 concentrations are much lower for this Lower trap than for the Upper trap of M4 (see Figure 5.6.10).

Figure 5.6.9: Pictures of all 24 sample bottles of the sediment trap 14M4-Lower.

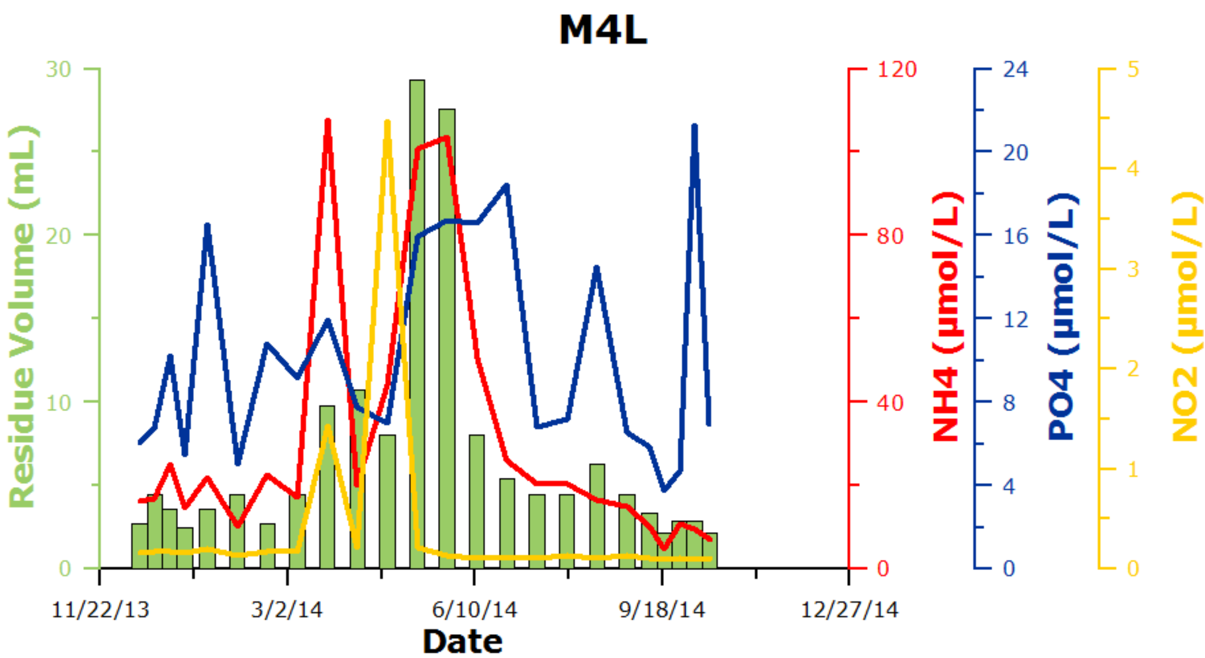

Figure 5.6.10: 14M4 Lower sediment trap estimated mass fluxes and nutrients.

5.7 Buoy recoveries

[Laura Korte]

Two buoys were recovered; "Michèlle" at station M3 and "Laura" at station M4. For recovery of the buoys up, the technicians had to connect the buoy's tower to the A-frame of the ship. For this they used the MOB boat, with which they sailed to the buoy, pulled a rope through the tower hooks and threw the rope back on deck so that the other technicians could connect it to the A-frame and recover the buoy. This went without problems for both of them. The buoys were placed on deck safely for further processing. After recovery of the buoys, the remaining parts of the mooring (smarties and releasers) were recovered easily. However, closer inspection of the towers had some unpleasant surprises.

5.7.1 Buoy Michèlle

The power/electronics box of buoy Michèlle (tower 1) was flooded with water, which damaged and corroded the electronics massively. How the water came into the box is still unknown. All the electronics were cleaned as effectively as possible and partly exchanged. Except for the SD-card, which records additional data (i.e. meteo data and flow rate), everything could be reinstalled. The SD-card reader appeared to be broken beyond repair. 18 filters were taken out of the carrousel. Sadly most of the filters contained just a little amount of dust and most of the filters were broken. Nevertheless, the filters were put in petri dishes carefully, labelled, and stored at -20°C.

The MWAC sampler worked well; the bottle was dry and had some orange dust in it.

5.7.2 Buoy Laura

The tower (tower 3) of buoy Laura came back in very bad conditions. Leaking fluids from the batteries had corroded the aluminium of the tower and all the electronics were damaged. The system could be fixed insofar that at least the filters could have been recovered. The final maintenance will have to be done back at NIOZ.

Eight filters of this buoy were used for air sampling. The first three (1-3) and the last one (8) were still intact but contained little or no dust. All other filters were broken heavily (see picture below). It was not possible to recover all broken pieces, some small parts were gone, and a considerable amount of filter fragments were stuck in the air pump.

Figure 5.7.1: Example of a broken filter

Figure 5.7.2: MWAC sampler containing dust

The MWAC sampler (Figure 5.7.2) on buoy Laura worked well just like on buoy Michèlle. Next to a whole year's worth of dust, the bottle also contained some water, indicating sea water/spray or rain.

Table 5.7.1 Weights of filters before deployment of buoy Michèlle

Michèlle A (Nov 2013-April 2014)		
Buoy cup	Pre-weighed filter	Weight
1	1	16.215
2	2	16.165
3	3	14.96
4	4	14.455
5	5	14.695
6	6	15.075
7	7	14.58
8	8	14.61
9	9	15.245
10	10	13.99

Michèlle A (Sep 2014 – Jan 2015)		
Buoy cup	Pre-weighed filter	Weight
1	1	14.38
2	2	16.6
3	3	15.97
4	4	16.6
5	5	16.11
6	6	16.12
7	7	15.17
8	8	16.66
9	9	16.21
10	10	15.32
11	11	18.48
12	12	17.02
13	13	17.06
14	14	15.98
15	15	16.3
16	16	15.89
17	17	16.39
18	18	17.03

Table 5.7.2 Weights of filters before deployment of buoy Laura

Laura A (Nov 2013-March 2014)		
Buoy cup	Pre-weighed filter	Weight
1	1	16.215
2	2	16.165
3	3	14.96
4	4	14.455
5	5	14.695
6	6	15.075
7	7	14.58
8	8	14.61
9	9	15.245
10	10	13.99

5.8 Nutrients
[Karel Bakker]

5.8.1 Equipment and Methods
Nutrients were analysed in an air-conditioned lab container with a QuAAtro (Seal analytical), gas segmented continuous flow analyser. The sample rate was set at 60 samples per hour, measuring about 500 samples during the cruise. Samples originate from CTD (N=400), and from sediment-trap bottles (supernatant, N=100). CTD samples were taken from the UC CTD directly into the Clean Room, and were filtered over 0.2 µm prior to analysis. Measurements were done simultaneously on four channels: phosphate, ammonium, nitrate and nitrite together, and nitrite separately. All measurements were calibrated with standards diluted in low nutrient seawater (LNSW), and LNSW was used as wash-water between the samples. For the sediment trap samples all samples were diluted with LNSW. Some 100 samples from sediment traps will be taken home for silicate analysis and DIC analysis.

For calibrating the oxygen sensor mounted on the clean CTD system, some 60 oxygen samples in glass stoppered bottles were treated according to the Winkler procedure (Winkler, 1888) and kept under water in a tank and taken home for further analysis. As a reference standard a 100% saturated oxygen sample was created by first oversaturating a deep 3500m sample of 10 L, which was then slowly left to equilibrate with the atmosphere under monitored conditions like air pressure, temperature and salinity in three days before bottling following the Winkler method (Winkler, 1888).

The colorimetric methods were used to measure for:

Phosphate
Ortho-phosphate is measured by formation of a blue reduced Molybdophosphate-complex at pH 0.9-1.1. Potassium Antimonyltartrate is used as the catalyst and ascorbic acid as a reducing agent. The absorbency is measured at 880nm. The method applied here was first described by Murphy and Riley (1962).

Ammonium
Formation of the indo-phenolblue-complex was established, using phenol and sodium hypochlorite at pH 10.5, Citrate is used as a buffer and complexant for calcium and magnesium at this pH. The colour is measured at 630nm. The method applied here was first described by Koroleff (1969) and optimised by Helder and De Vries (1979).

Nitrite
Diazotation of nitrite was established with sulfanyl-amide and N-(1-naphtyl)-ethylene di-ammonium di-chloride to form a pink dye measured at 550nm.

Nitrate and Nitrite
Nitrate is first reduced in a copperised cadmium-coil using imidazole as buffer and is then measured as nitrite at 550 nm. The method applied here was first described by Grasshof et al., (1983).

5.8.2 Sample handling
The samples were collected in syringes equipped with a three-way valve for air free sampling after three times rinsing, directly from the CTD-rosette bottles. The samples were immediately filtered over 0.8/0.2 µm Acrodisc filters and analysed typically within four hours. A subsample is stored cool in the fridge (4°C) for silicate and DIC (DIC in glass vials containing 15 µl saturated $HgCl_2$). Analyses were carried out using high-density polyethylene "pony-vials" with a volume of 6 ml as sample cups. For duplicate analysis purposes

in-between runs, the deepest sample at every CTD-station was capped in a pony-vial to be measured for a second time in the next run. To avoid NH_3 influx from the lab container during the runs, all vials including the calibration standards used were sealed with "parafilm" under tension, so that the sharpened sampler-needle easily penetrated, leaving a small hole in the film.

5.8.3 Calibration and Standards

Nutrient primary stock standards were prepared in the lab at NIOZ by weighing in e.g. for NO_3, KNO_3 in demineralised water. All standards are kept in a so called 100% humidity box at lab temperature to prevent any concentration by evaporation.
The calibration standards were prepared daily by diluting the primary stock standards, using three electronic pipettes, into four volumetric 100ml PP flasks (pre-calibrated in the lab) filled with low nutrient sea water LNSW at 22°C. The background values of the LNSW were measured on board and added to the calibration values to get absolute nutrient values.

Cocktail standard

This standard acts as a lab reference and its use is described under "quality control". It is made in the lab containing a mixture of phosphate, silicate and nitrate in demineralised water containing 40mg Hg_2Cl_2 per litre as a preservative. Every time it was used it was diluted 100 times with the same pipette, and the same volumetric flask in LNSW.

Quality Control

Our standards have already be proven by inter calibration exercises like ICES and Quasimeme, and last years the RMNS exercise organised from Aoyama at MRI/Japan, to be within the best obtainable limits to the consensus-mean of the better laboratories. To gain some accuracy the Cocktail standard is monitored now since 2008, showing in-between runs reproducibility better than 0.7 %.

Cocktail reference	Value*	StanDev	C.V. %
PO_4	2.252µM	0.016µM	0.69
NO_3	34.47µM	0.21µM	0.61

* based on 16 triplicates

The advantage of a cocktail standard is like using a reference standard with two nutrients mixed in one bulk, giving each run a good overview of the machine's output. It also gives you a tool to normalise data from run to run for oceanographic purpose from station to station to produce transect plots.

We monitored a real reference sample from deep water (bottle 4 from CTD station 10) filtrated over 0.2 µm what was stable over two weeks with next results:

Deep-water station 10	Value*	StanDev	C.V. %
PO_4	1.477µM	0.011µM	0.75
NO_3	22.00µM	0.09µM	0.42

* based on 9 triplicates

Note: For the final data some minor correction might be necessary based on normalising on the average cocktail standard value for PO_4 and NO_3.

5.8.4 Statistics:

Mean Detection Limit: calculated as 2.82 x S.D. of ten 2% (from the full range) spiked samples (EPA norm).

	MDL µM/L	StanDev µM/L	Analysis range
PO_4	0.011µM	0.0043µM	3µM
NH_4	0.024µM	0.0084µM	3µM
$NO_3 + NO_2$	0.010µM	0.0036µM	50µM
NO_2	0.003µM	0.0009µM	0.5µM

Precision in a single run: 10 samples at two levels given with coefficient of variation.
Level I is on 3rd standard from calibration line.
Level II is deep water (3500m) taken from CTD station 10.

	Level I	StanDev	C.V.%	Level II	StanDev	C.V.%
PO_4	1.998µM	0.004	0.23	1.466µM	0.0021	0.14
NH_4	2.093µM	0.004	0.17	0.053µM	0.014	26.1
$NO_3 + NO_2$	35.59µM	0.069	0.19	21.99µM	0.038	0.17
NO_2	0.353µM	0.0007	0.19	0.005µM	0.0009	17.2

Accuracy:
To gain accuracy this cruise, reference material for nutrients were measured parallel to the deep CTD sections containing stable values for PO_4, NO_3 and NO_2 all at 22°C.
Reference Material for Nutrients in Seawater (RMNS) were produced by General Technos KANSO in Osaka, Japan, 2 bottles of lot BY and BT were used and one bottle BU.

CTD station 22 was a cross-over station from GEOTRACES II, running those RMNS samples will make it possible to normalise the data and make the two cruises 100% comparable.

Measured values in RMNS lot BY two bottles :

		StanDev			
PO_4	0.04	0.042µM	0.016	n=3	n=10
NH_4	0.92	1.15µM	0.006	n=10	n=3
$NO_3 + NO_2$	0.04	0.07µM	0.003	n=3	n=10
NO_2	0.024	0.025µM	0	n=10	n=3

Measured values in RMNS lot BU one bottle two triplicates:

		StanDev	
PO_4	0.35µM	0.002	n=6
NH_4	1.45µM	0.013	n=6
$NO_3 + NO_2$	4.14µM	0.007	n=6
NO_2	0.08µM	0.0005	n=6

Measured values in RMNS lot BT two bottles:

			StanDev		
PO_4	1.314	1.323µM	0.003	n=6	n=3
NH_4	1.41	1.56µM	0.01	n=6	n=3
$NO_3 + NO_2$	19.02	19.02µM	0.021	n=6	n=3
NO_2	0.487	0.495µM	0.002	n=6	n=3

- NH_4 is not produced as a stabile reference product.

Problems during the cruise:

For the first half of the cruise there were some stability problems in the baseline of the instrument producing a kind of "sling" prior to actually sucking a sample through the system and so causing a relative high detection limit. By using a wider sampler-probe and making tube connections wider, the flow improved a lot resulting in a lower detection limit.

Furthermore, the analyser reacted on the movement of the ship, rolling and pitching causes gravity forces on the vertical waste-line after the flow cell. Introducing a horizontal loop in the waste line improved a lot, and for NH_4 in combination with a resample line over the pump after the waste made it a completely closed system independent of gravity chances.

Some remarkable preliminary results:

For CTD station 15 and 16 (close to 15) an extreme high value for NO_2 below the euphotic zone, where NH_4 is partly oxidised via NO_2 as an intermediate short living specie to NO_3, was observed. NO_2 values of 0.64 µM (station 16) and 0.50 µM (station 15) were measured, showing large biological activity just below the deep chlorophyll maximum zone where phytoplankton is still able to photosynthesise on the available light and nutrients. These observations are corroborated by the iron profile analysed by Patrick Laan (paragraph 5.9) showing a sharp sub minimum at the depth of 100 meter at station 15. Further west the NO_2 values decreased again to values of 0.11 µM down to 0.03 µM and increasing again towards the end of the transect at 12° North: at CTD station number 24, NO_2 values of up to 0.31 µM were measured.

NH_4 show patchy profiles that can be real but should be studied in more detail, preferably in combination with the other parameters. All samples analysed were above detection limit but NH_4 is known to be easily contaminated with NH_3 from the air despite all the precautions we took, such as a closed sampling system (syringes plus three way-valves), 0.2 µm filtration and working with cups that are sealed with parafilm for the auto-analyser to prevent air being trapped.

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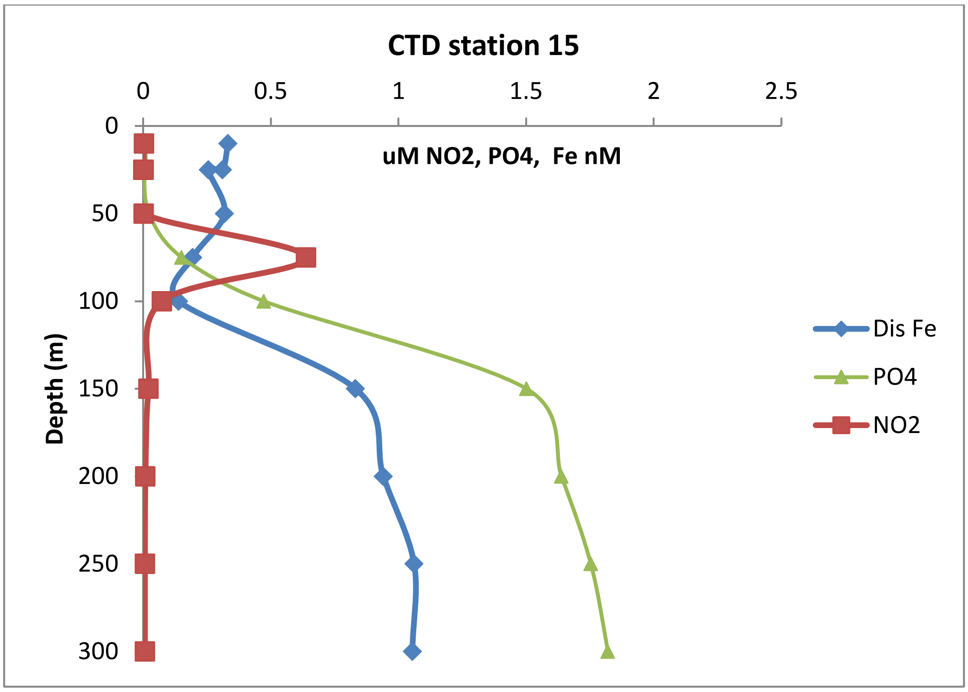

Figure 5.8.1: Depth profile of dissolved Fe, PO_4, NO_2 at CTD station 15

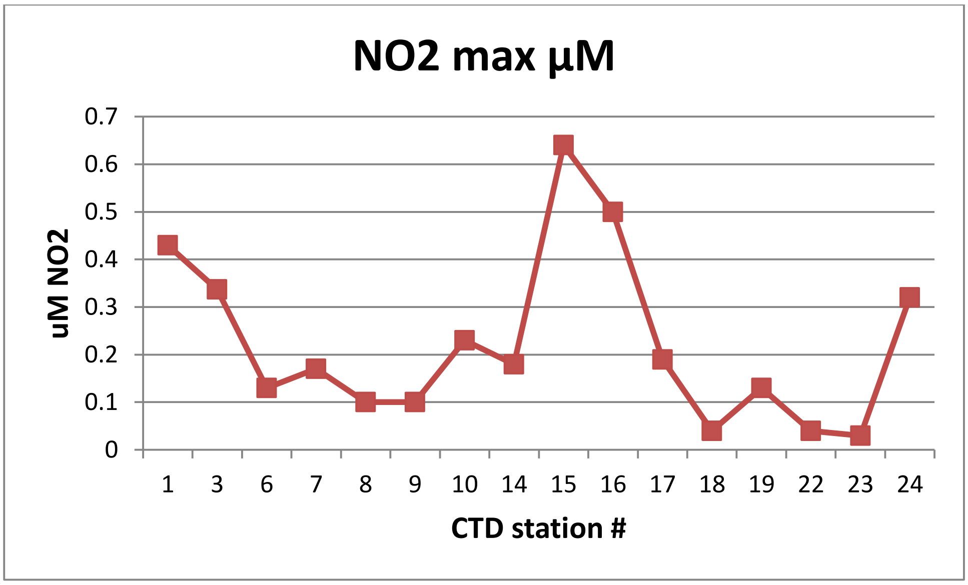

Figure 5.8.2: Transatlantic profile of NO_2 , showing an exceptionally high value at CTD station 15

5.9 Trace metals

[carried out by Patrick Laan, edited by Micha Rijkenberg]

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 for other trace metals during cruise 64PE395.

5.9.1. Work at sea

During the expedition we sampled 16 full-depth stations and conducted 2 shallow deployments using the NIOZ ultraclean (UC) CTD with 24 PRISTINE® ultraclean water samplers of 24L each (Figure 5.2.1). The 24 "PRISTINE" samplers, with a volume of 24.4L each, are made of high-purity PVDF plastic and are opened and closed using a butterfly-valve closing mechanism. The samplers are mounted on an all-titanium frame and deployed using a poly-aramide hydrowire (Super Aram) with internal power/signal conductors. After recovery, the ultraclean CTD was immediately placed in a clean-room container (within the ISO Class 6 clean room requirements; *de Baar et al. 2008)*. In the clean room, CTD bottles were pressurized (~1 bar) using filtered N_2 and samples for dissolved metals were filtered over a 0.2μm Sartobran 300 cartridge (Sartorius). For each UC CTD bottle the 0.2 μm Sartobran 300 cartridge was firstly rinsed with approximately 700 ml water to replace the previous sample from the cartridge.
Samples for dissolved iron (DFe), were acidified within 3 hrs after sampling using ultrapure HCl (pH 1.8, 2ml/L 12M Baseline grade Seastar HCl) 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, 60 μL 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 120s 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 0.4 M HCl (Suprapure, Merck 30%) during 120s. 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. This 1000 ml is again passed over a column overnight and after the addition of 20μl of TETA solution it is ready to be used. 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.

In addition, filtered and unfiltered samples from selected stations were acidified and stored to determine both dissolved and total dissolvable metal concentrations of Fe, Zn, Mn, Cd, Al, Ni, possibly together with additional metals Co, Cu, Ag) in the NIOZ laboratory by inductively coupled plasma mass spectrometry (ICP-MS) in combination with a Seafast pre-concentration system.

Samples were analysed in triplicate and average DFe concentrations and standard deviation are given. Concentrations of DFe measured during the 64PE395 cruise ranged from 68pM in the sub-surface waters up to 2.27nM in the deep water above the mid-Atlantic Ridge. The standard deviation varied between 0% and 20% (the latter being exceptional), but was on average 3.1% and generally < 5% in samples with DFe concentrations higher than 0.1nM. The average blank was determined at 0.042 ± 0.029 nM and was defined as the calculated intercept of a low iron containing seawater sample loaded for 20 – 10 and 5 seconds and was measured daily. The average limit of detection was determined as 3*standard deviation of the 5 seconds loading blank and measured daily. The average of the daily blank was determined at 0.029 ± 0.027 nM. To better understand the day to day variation 4 to 6 samples from the previous day have been re-analysed the next day. The differences between these measurements were in the order of 5% up to 20%. To correct for this day-to-day variation a so-called lab standard sample was measured daily. After the cruise, these data need to be reanalysed to see if we can better understand the source of this daily variability. 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.).*

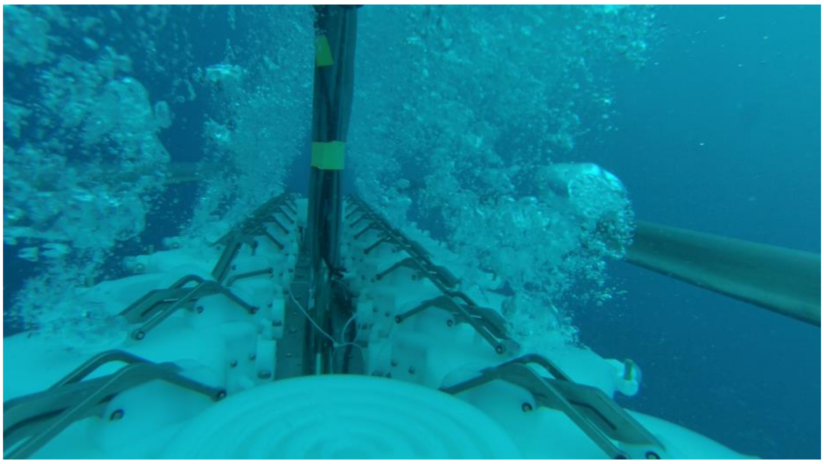

Figure 5.9.1: The UC CTD system during the process of opening the bottles under water.

5.9.2 Preliminary results

Figure 5.9.2 shows a depth profile obtained at station 22 during the 64PE395 cruise. Station 22 is located west of the mid Atlantic ridge (Figure 5.2.1). The higher values of dissolved iron between 100 and 1500 meter correspond with the oxygen-minimum zone. The higher dissolved iron values between 3000 and 4000 meter are most likely related to hydrothermal activity along the mid-Atlantic ridge. Station 22 is also a position that we sampled at during the GEOTRACES cruise 64PE321 and therefore it is used as an intercomparison cross-over station. The data show a very good consistency between the different datasets.

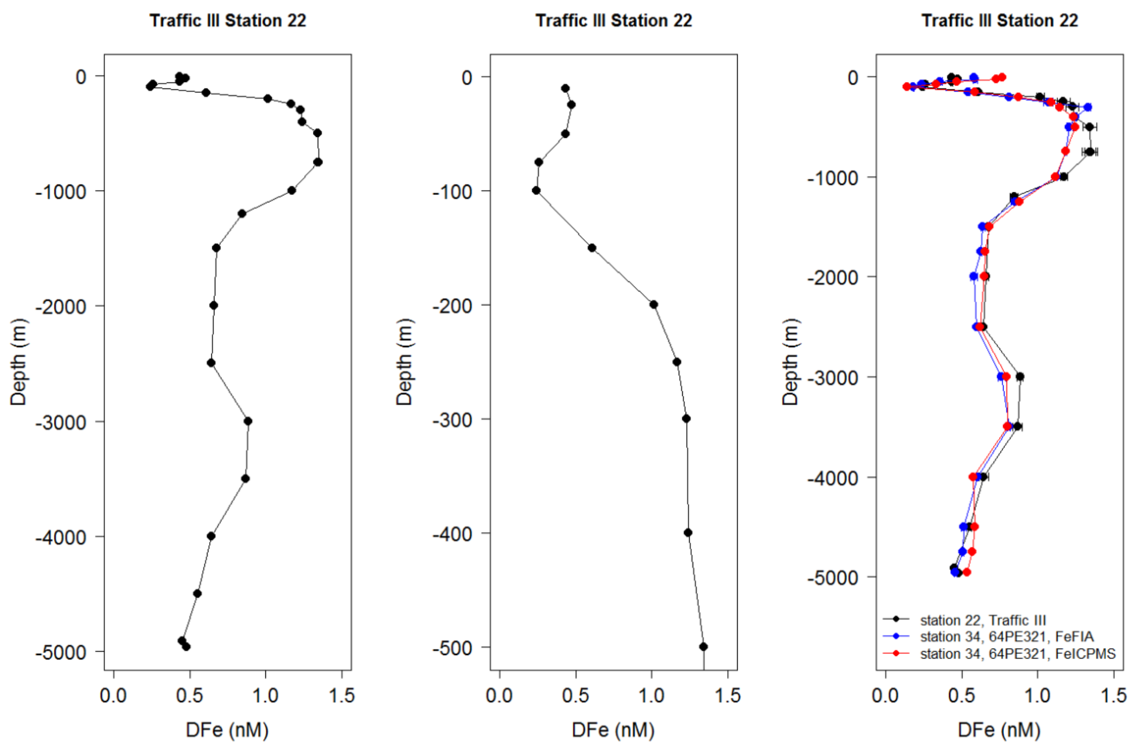

Figure 5.9.2: Depth profiles of dissolved iron over the entire water column and in detail for the first 500 meter for station 22 @11°22.383N - 52°82.729W (see Figure 5.2.1). The third panel shows the intercomparison of DFe at the cross over station between station 22 of 64PE395 and station 34 of the GEOTRACES cruise 64PE321 where DFe was measured by flow injection analysis (blue dots, analyses by Patrick Laan*) as well as by ICPMS (red dots, analyses by* Rob Middag*).*

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5.10 Mooring deployments
[Michèlle van der Does]

5.10.1 Mooring set up
During the first deployment in October 2012, RV Meteor Expedition M89, five moorings with a total of ten sediment traps were deployed along a transect at 12°N in the Atlantic Ocean. During the next cruise in November-December 2013, *RV Pelagia* Expedition 64PE378, this original setup could not be maintained due to a loss of several pieces of equipment and the shortness of time related to the experienced damage. Therefore, only five sediment traps were redeployed at four stations (see Fig 5.6.1).

During the present cruise, *RV Pelagia* Expedition 64PE395, we aimed to reconstruct the original setup with ten sediment traps at five stations. However, due to a rough sea state, the mooring at station M1 could not be recovered (as explained in paragraph 5.6.3), which resulted in a shortage of equipment to deploy a mooring at M2. The positions of the four sediment-trap moorings are presented in Table 5.10.1.

Table 5.10.1 Positions of the moored sediment traps deployed during cruise 64PE395

Station	Latitude	Longitude	Water depth (m)	Traps
15M1	12°03.708'N	23°04.104'W	5056	1200 KUM 3500 KUM
15M3	12°23.581'N	38°38.121'W	4615	1200 KUM 3500 KUM
15M4	11°59.418'N	49°14.749'W	4941	1200 PPS 3500 PPS
15M5	11°59.825'N	56°06.728'W	4630	1200 PPS 3500 PPS

5.10.2 KUM sediment traps
Due to problems with the Technicap PPS-5/2 sediment traps during the previous cruise, 64PE378, it was decided that four sediment traps would be replaced by sediment traps of a different kind, namely KUM K/MT 320 sediment traps. This trap is different from the Technicap sediment traps (described in paragraph 5.5.1) in that they consist of two carrousels containing a total of 39 sample cups. Also the collecting area is half of the Technicap sediment trap, namely 0.5 m^2. The KUM sediment traps were deployed at stations M1 and M3, at 1200 and 3500m water depth. At M4 and M5, Technicap sediment traps were deployed at the same depths (see table 5.10.2).

5.10.3 Mooring deployment
Sample cups were filled with seawater collected at the deployment depth of each trap, in which a biocide (2.23 g/L $HgCl_2$ end concentration for the Technicap traps; 1.97 g/L for the KUM traps) and a pH-buffer (1.29 g/L $Na_2B_4O_7 \cdot 10H_2O$, Borax, end concentration for the Technicap traps; 1.29 g/L for the 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.

Their pre-programmed sampling intervals differed between 11 and 22 days, with the first cup starting on 15 January 2015 and the last cup ending on 30 March 2016. More details on the sampling intervals is provided in Table 5.10.3.

Table 5.10.2. Detailed info on the moorings' sensors deployed during 64PE395.

Station	Depth (m)	Instrument	Serial Number	Barcode	Start date
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+			
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+			
M4	835	ADCP	6778	5302	
	1230	Sediment trap PPS	70	1236	6/2/2015
		Motor unit	29	7238	
		Tilt data logger	C3	9546	
		SBE 37 MicroCat CTD	2667	10856	
	2000	Booij cage nr 21			
	3000	Booij cage nr 24			
	3475	Sediment trap PPS	86	43373	6/2/2015
		Motor unit	9-263	34982	
		Tilt data logger	BB	1205	
		SBE 37 MicroCat CTD	6274	32445	
	3525	Aanderaa RCM11 current meter	240	4114	
	4000	Booij cage nr 3+			
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 5.10.3. Sediment trap sampling intervals of 2015.

Moorings M1 - KUM			
Interval	11		
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		
		30/mrt/2016	22

Moorings M3 - KUM			
Interval	11		
bottle	start	end	days
	Buoy Michelle: 22 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 M4 - PPS			
Interval	22		
bottle	start	end	days
	Buoy Laura: 11 & 22 days		
1	6/feb/2015	17/feb/2015	11
2	17/feb/2015		
		11/mrt/2015	22
3	11/mrt/2015		
		2/apr/2015	22
4	2/apr/2015		
		24/apr/2015	22
5	24/apr/2015		
		16/mei/2015	22
6	16/mei/2015		
		7/jun/2015	22
7	7/jun/2015		
		29/jun/2015	22
8	29/jun/2015		
		21/jul/2015	22
9	21/jul/2015		
		12/aug/2015	22
10	12/aug/2015		
		3/sep/2015	22
11	3/sep/2015		
		25/sep/2015	22
12	25/sep/2015		
		17/okt/2015	22
13	17/okt/2015		
		8/nov/2015	22
14	8/nov/2015		
		30/nov/2015	22
15	30/nov/2015		
		22/dec/2015	22
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

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

5.10.4 'Booij cages'

In addition to the sediment traps, current meters/profilers, CTD's, etc., passive sampler cages ('Booij cages') were attached to the moorings, supplied by dr. Kees Booij. These cages passively sample nonpolar contaminants (e.g., polychlorinated biphenyls, polyaromatic hydrocarbons, hexachlorobenzene, DDE) in the deep ocean (*Booij et al., 2014*). For the samplers, large volumes of water (400-1000L) need to be flushed, which requires long exposure times up to a year. Therefore, the moorings seem a perfect host for these samplers.

The samplers consist of semipermeable membrane devises (SPMDs) that were constructed using low-density polyethylene (LDPE) lay-flat tubing and triolein. The SPMDs are mounted in exposure cages, consisting of seven titanium rods (5 mm diameter), clamped between two poly(axymethylene) plates and a titanium or anodized aluminium mesh screen, with 1.5 x 1.5 cm openings. See figure 5.10.1 for more details on the sampler. The cages were then attached to the mooring line with four bolts at varying depths (see table 5.10.2).

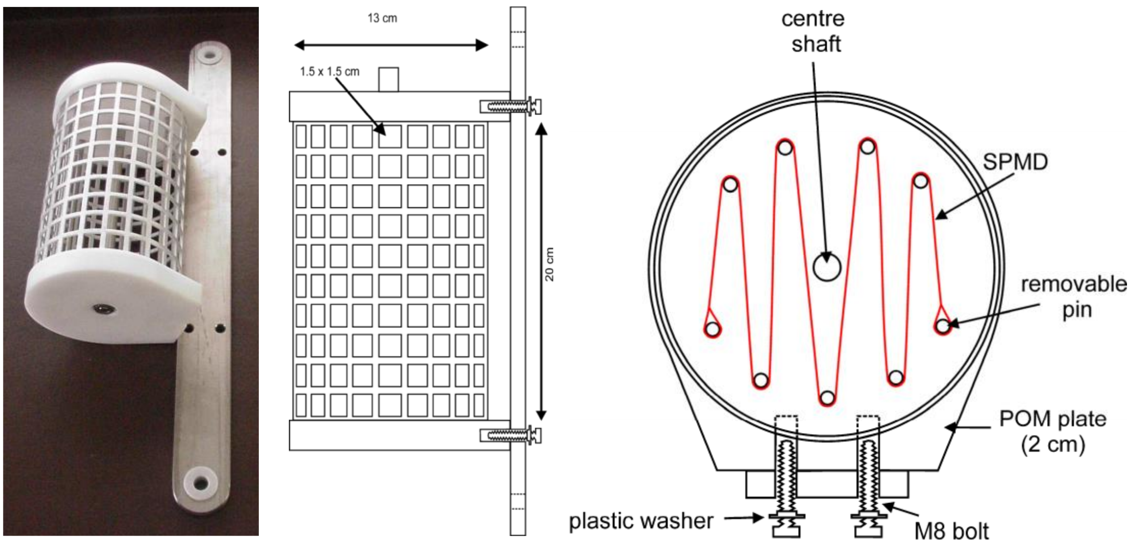


Figure 5.10.1. Photograph and schematic drawings of the 'Booij cages'. From Booij et al., 2014.

Reference

Booij, K., van Bommel, R., van Aken, H.M., van Haren, H., Brummer, G-J.A., Ridderinkhof, H. (2014). Passive sampling of nonpolar contaminants at three deep-ocean sites. Environmental Pollution 195, 101-108.

5.11 Buoy deployments
[Chris Munday]

Before the buoys could be redeployed, several upgrades/maintenance tasks were performed on both, as follows (Buoy Michèlle was deployed with tower 2 and buoy Laura was deployed with tower 1):
- The batteries were firmly secured inside the battery box by securing them to a bracket which was fixed to the aluminium plate supporting the box (new batteries were installed in tower 2, batteries in tower 1 were in good condition and re-used).
- The powder-coated aluminium power supply housing was replaced by a more durable plastic one.
- The springs which hold the sample cups to the carousel were replaced by stiffer ones, which will create a better seal during sampling.
- The sample chimney was replaced by one made from titanium.
- The O-ring on the device that pushes the active filter in place was made more secure.
- An air chamber was added to the air tube between the pump and filter to reduce the cavitation effect of the membrane pump in use. This creates less stress on the sample filter membranes.
- A glass fibre filter (GF/C) was added between the support mesh and the sample filter to create additional protection against broken sample filters.
- Black lettering on the yellow body of the buoy was renewed using permanent marker.
- Temperature/Salinity sensors (Michèlle: Serial # 4687, Barcode 7306, Laura: serial # 4612, Barcode 7206) were added to the inside of the base of the buoy, below the waterline.
- General cleaning and checking of all components was performed, and repair/replacement where necessary (rubber seals inside carousel lids were replaced, flow meter Tower 1 was cleaned of broken sample filters).

Other repairs/upgrades were made to one tower only:
- Water damage inside tower 1 was cleaned and repaired (minor corrosion of wiring, re-mounting pump and flow meter)
- Due to water damage, the memory card containing detailed data from tower 1 could not be accessed, nor could a new card be mounted. As a result, only data sent in twice daily emails will be available for buoy Laura over the year 2015. It is hoped that some data from the old memory card can be retrieved using expertise and equipment at NIOZ.
- The base plate which holds the battery box on tower 2 was replaced due to corrosion.
- A new RVS dummy plug was installed on tower 2.
- A CO_2 sensor (Serial # CO_2-0812-011) was added to the inside of the base of buoy Laura, below the waterline.

The details of the sampling on board the buoys 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 (increased from 2 on the previous deployment), 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 5.11.1 [buoys] and 5.10.3 [traps]).

Table 5.11.1 sampling scheme of the buoys deployed during 64PE395

Buoy Michelle @M3			
Interval	22 / 11		
bottle	start	end	days
1	26-jan-2015	17-feb-2015	22
2	17-feb-2015	11-mrt-2015	22
3	11-mrt-2015	2-apr-2015	22
4	2-apr-2015	24-apr-2015	22
5	24-apr-2015	16-mei-2015	22
6	16-mei-2015	7-jun-2015	22
7	7-jun-2015	29-jun-2015	22
8	29-jun-2015	21-jul-2015	22
9	21-jul-2015	12-aug-2015	22
10	12-aug-2015	3-sep-2015	22
11	3-sep-2015	25-sep-2015	22
12	25-sep-2015	17-okt-2015	22
13	17-okt-2015	8-nov-2015	22
14	8-nov-2015	30-nov-2015	22
15	30-nov-2015	22-dec-2015	22
16	22-dec-2015	2-dec-2073	11
17	2-dec-2073	14-nov-2131	11
18	14-nov-2131	25-okt-2189	11
19	25-okt-2189	7-okt-2247	11
20	7-okt-2247	18-sep-2305	11
21	18-sep-2305	30-aug-2363	11
22	30-aug-2363	10-aug-2421	11
23	10-aug-2421	22-jul-2479	11
24	22-jul-2479	3-jul-2537	11

Buoy Laura @M4			
Interval	22 / 11		
bottle	start	end	days
1	6-feb-2015	17-feb-2015	11
2	17-feb-2015	11-mrt-2015	22
3	11-mrt-2015	2-apr-2015	22
4	2-apr-2015	24-apr-2015	22
5	24-apr-2015	16-mei-2015	22
6	16-mei-2015	7-jun-2015	22
7	7-jun-2015	29-jun-2015	22
8	29-jun-2015	21-jul-2015	22
9	21-jul-2015	12-aug-2015	22
10	12-aug-2015	3-sep-2015	22
11	3-sep-2015	25-sep-2015	22
12	25-sep-2015	17-okt-2015	22
13	17-okt-2015	8-nov-2015	22
14	8-nov-2015	30-nov-2015	22
15	30-nov-2015	22-dec-2015	22
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

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. This may be beneficial as the exact details of the return cruise are as yet not finalized. The sampling period may be extended or shortened to maximize the use of all 24 filters.

Table 5.11.2 Key data of the buoys deployed during 64PE395

Station	Buoy	Laitude (° '.N)	Longitude (° '.W)	Start Date	Sampling Interval
M3	Michèlle	12°19.580'	38°43.026'	26 Jan 2015	22 / 11 days
M4	Laura	11°57.602'	49°04.651'	6 Feb 2015	22 / 11 days

Deployment of the buoys was always 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. A parachute prevents the anchor weight from sinking too fast but still the dummy buoy is dragged under water. 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.

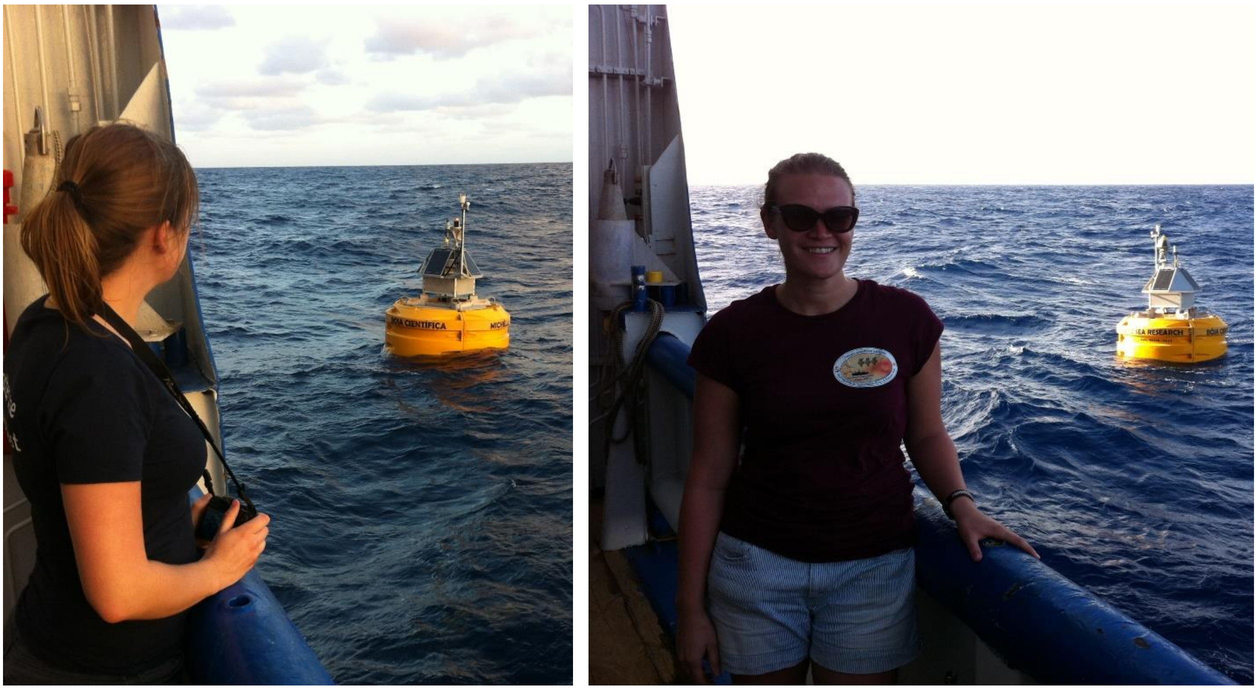


Figure 5.11.1 The re-deployed buoys Michèlle and Laura with the PhD students they were named after

6 *Acknowledgements*

Our sincere thanks go to Master Pieter Kuijt and his crew for the friendly cooperative atmosphere during the entire cruise as well as their competent technical assistance during all operations. You made us all really feel at home!

Back home, many people were involved in the preparation of the 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. 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. 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.
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. At MARUM 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.

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

Participants of *RV Pelagia* cruise 64PE395
L2R: Michèlle, Leon, Jan-Dirk, Yvo, Laura, Chris, Sergej, Sietske, Rik, Pieter, Patrick, Cor, Bob, Karel, Jose, Hans, Jan-Berend, Barry, Martijn, Len, Bert.
Not on this picture: Martin

On board Research Vessel *Pelagia* in the equatorial North Atlantic, Sunday 18 January 2015

Dear all,

We have been a week at sea now, and next to the blog that we're keeping, it's time for an update on our whereabouts. During the evening prior to our leaving Mindelo, Sao Vicente, Cape Verdian Islands, we saw a kind of haze coming up that initially everyone thought was a fog. However, with a 60% humidity, this seemed unlikely and soon we knew our hopes came true: we were experiencing a Saharan dust outbreak! No dust without wind though, so not everybody was looking forward to going to sea where a force-8 was blowing and the waves were impressive…

These two pictures were taken at exactly the same location: on the top of the bridge of *RV Pelagia*, which was moored in the harbour of Mindelo. The left picture, taken on the 10th, shows local colleagues from the INDP: Pericles da Silva, Tatiana Cabral, Irondina Evora, and Ivanice Monteiro. The right photo, taken on the 11th, depicts Chris Munday and Hans van Hateren, below Chris' elbow you can see a piece of the peer. The mountains across the bay of Mindelo are almost completely obscured by a haze of dust!

At shortly after 10 in the morning of Sunday 11 January we did leave the harbour of Mindelo and set sail on a south-bound course towards the easternmost station of the working area (see below). Cruise 64PE395 is the third one in a set of four that are carried out in the framework of two projects funded by NWO and the ERC to monitor Saharan dust over a period of three years in order to study the marine environmental effects of dust deposition on the Atlantic Ocean.
For the second time we will recover a set of sediment traps and re-deploy them for the third time. For the first time we will visit the dust-collecting buoys that we deployed during the previous cruise in 2013, service and upgrade them, and re-deploy them. During the 2013 cruise we experienced a bit of misfortune and lost a couple of sediment traps and other instruments. For this reason, during that cruise, we could only deploy a total of five sediment traps at four stations. During the present cruise we intend to restore the original array of five moorings consisting of two sediment traps each.

The first station lies about 300nm south of the Cape Verdian Islands, so we had some time to get used to the ship's movements. Soon it became clear that the fog that we were sailing through indeed was dust; although the fog appeared whitish, the ship was slowly getting coated in a yellow-orange colour! All the filters in the engine room were caked with dust in no time and the high-volume air samplers that we have installed on the roof of the bridge soon delivered very nice dust samples.

The Monday was used to carry out some tests with the ultra-clean CTD system. Bob managed to gather all the required sensors and instruments from all around the ship and install them on the CTD frame. This CTD is called ultra-clean because it is made entirely of materials that do not contaminate the samples that are taken with it because it is all titanium and high-quality plastics. For this reason, one can measure tiny amounts of dissolved metals like iron, aluminium, etc. Along the entire transect, we

will take water samples with this ultra-clean CTD and Patrick and Karel will analyse them for dissolved metals and nutrients, respectively.
On Tuesday 13 January we arrive at station M1 at 12°N/23°W, where for the first time we deploy a floating or drifting sediment trap. This piece of equipment consists of three levels of four 10cm diameter Perspex tubes that are open at the top. The tubes are free drifting and as they float around the area, they collect all material that is settling through the water column towards the sea floor. With this sampling method we hope to demonstrate that Saharan dust has an important role in the global Carbon cycle by causing enhanced export of organic matter from the ocean surface to the sea floor.
Unfortunately, the ocean is too rough to allow recovery of the moored sediment trap that was waiting for us here. We do deploy a complete mooring with two sediment traps, current meters and various other kind of sensors. However, some parts of the mooring that was going to be recovered here are needed for moorings along the transect. We select the mooring at station M2 to be the one that we will not re-deploy this year as it is positioned a tick north of the transect at 12°N.
After leaving station M1 we set sail towards the west for an almost 900nm transit and stop each day after breakfast to take water samples and collect current profiles throughout the water column using the ultra-clean CTD.

Planned track of the (Dust)Traffic Transatlantic array of sediment traps and two dust-collecting buoys.

Meanwhile, we very much enjoy the fantastic hospitality onboard the *Pelagia* where Master Pieter Kuijt and his crew treat us very well. We are spoiled with excellent food by cook Leon and his assistant Sergej! Besides, we are very pleased to be in this warm part of the Atlantic Ocean where the trades are blowing happily, the sea has a temperature of 25°C, and the sun mostly adds a few degrees to that.

For more info on our cruise, please have a look at our blog at: www.nioz.nl/pe395-blog.
In addition, you can read a ship's diary on the nioz website at: http://www.nioz.nl/scheepsjournaal

Many greetings to all of you from the Pelagia in the equatorial North Atlantic!
On behalf of the ship's- and scientific crew,
Jan-Berend Stuut

On board RV *Pelagia* in the equatorial North Atlantic [12°N/44°W], Sunday 25 January 2015

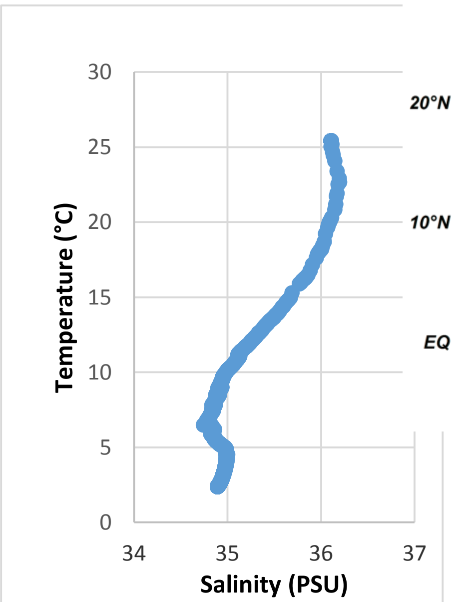
Dear all,

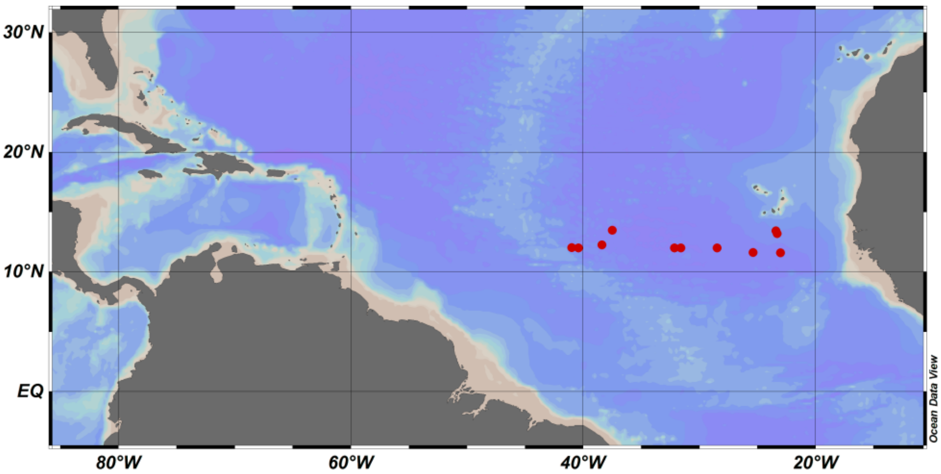
After a tick over two weeks at sea, we are halfway the cruise and indeed also about halfway through the scientific program; we recovered and re-deployed two moorings and a buoy, and there are two moorings and a buoy to go!
Leaving station M1 last week on transit towards the West also meant that we were sailing away from the dust cloud. The horizon moved far away again, skies are once more blue, and our dust filters are empty... The ship's crew is very happy to clean the dust from the outside of the ship as well as from the filters that create a clean and cool working environment inside the ship. We scientists are extremely happy because for the first time we managed to sample such a dust outbreak in great detail; over 60 samples were taken (we use three different samplers to collect the dust) throughout the dust outbreak, offering the opportunity to quantify satellite observations of dust.

An air filter in the engine room, caked with dust

A dust filter from the top of the bridge: very nice yield!

On our way towards the two stations at about 38°W, we stop every day just after breakfast to deploy the ultra-clean CTD. Not only do we sample water from the ocean, and measure all kinds of properties like Oxygen content, Salinity, and Temperature but while the instruments are lowered to the sea floor we also map the vertical structure of the water below the ship. Just like in the atmosphere there are layers piled on top of each other with winds blowing in different directions, in the ocean there are also packages of water stacked on top of each other and flowing in different directions.





Map of the study area with the CTD stations analysed so far. Typical Temperature/Salinity plot measured with the CTD. Different water masses have different T/S properties, and with the ADCP data (not shown) we map the different water masses and their flow directions and speed.

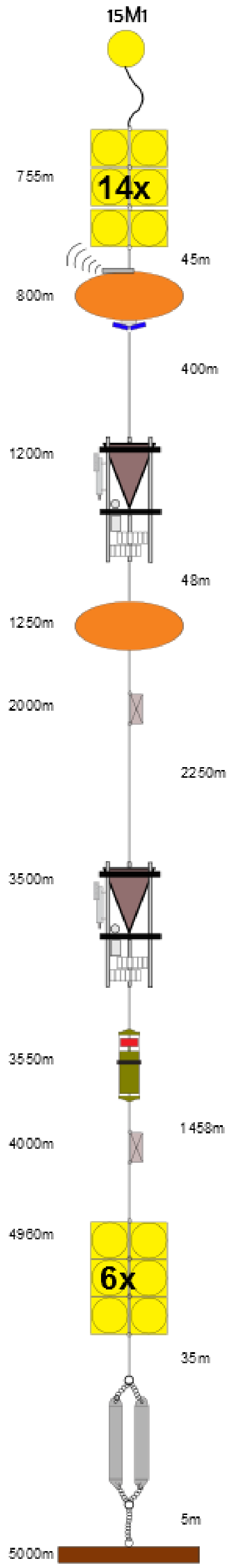
On Monday 19 January, after four days of sailing, we reach Station M2 where we first deploy the floating traps again. Next activity is the recovery of the mooring that was deployed in 2013 and this is done by sending an under-water radio signal to the releasers that hold the mooring's anchor to let go so that the orange floats can lift the mooring to the ocean's surface. To get an idea about the moorings, please see the sketch on the right. The anchor of about 1000kg holds the mooring in place and the orange floats with a combined buoyancy of about 900kg make sure the cable is vertical and they will lift the mooring to the surface once the anchor is released. Yellow balls guarantee additional lift of about 25kg per ball. The grey objects indicate the sediment traps with 40 cups each. They rotate one cup every 11 days so that we can sample material that is settling through the water column continuously for a tick more than one year. We are scheduled to pick up the moorings again in March 2016.
After recovering the floating traps, with a nice catch of particles again, we sail on to station M3, at which we arrive already the next evening. As the recovery of both mooring and buoy has to take place in daylight, we use the night to map the sea floor using the ship's multibeam system.
After three days at station M3 we are totally happy with a 100% score; the recoveries and re-deployments of both mooring and buoy went very successful! Bosun Cor and his team work together smoothly with chief technician Yvo and his team on deck, while Master Pieter and his team keep the ship in position: great team work!

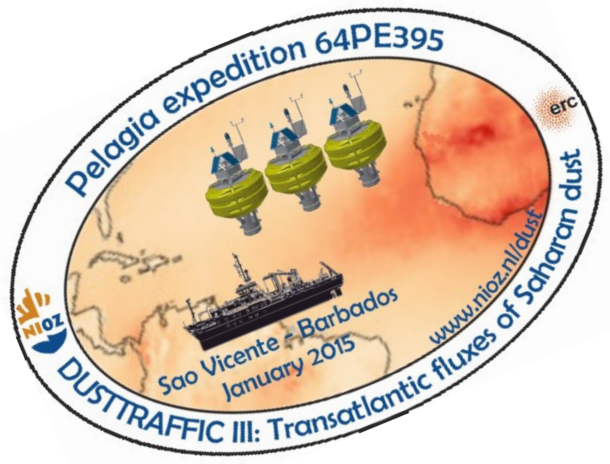
To celebrate this initial success, we have a bbq on the aft deck on Saturday 24 January while we are already on transit to the next station: M4, which lies just over 600nm further westward. We pick up our routine of a daily CTD cast after breakfast and continue analysing the results that Karel and Patrick produce in their respective labs. Also, we already start writing the cruise report. Communication to the world out there is hampered by a shaky internet connection but we have good hopes that it will be restored to the fine connection we had gotten used to already.

The atmosphere on board is still very pleasant, which is also caused by the good food that Leon and Sergej prepare for us and the very nice subtropical weather that we are sailing in!

For more info on our cruise, please have a look at our blog at:
www.nioz.nl/pe395-blog.

Many greetings to all of you from the Pelagia in the equatorial North Atlantic!
On behalf of the ship's- and scientific crew,
Jan-Berend Stuut

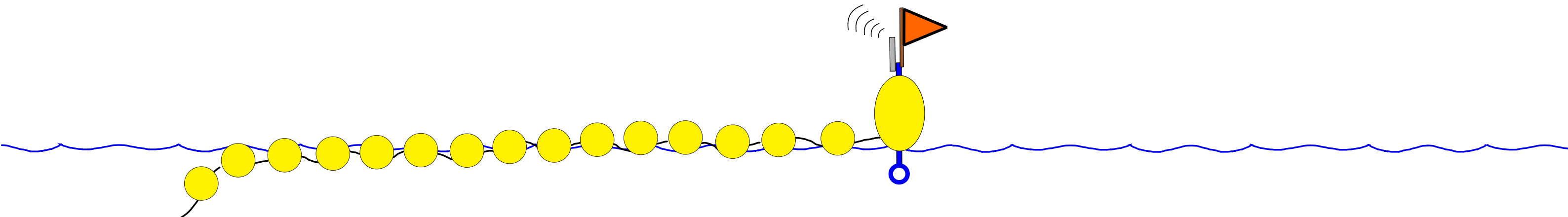


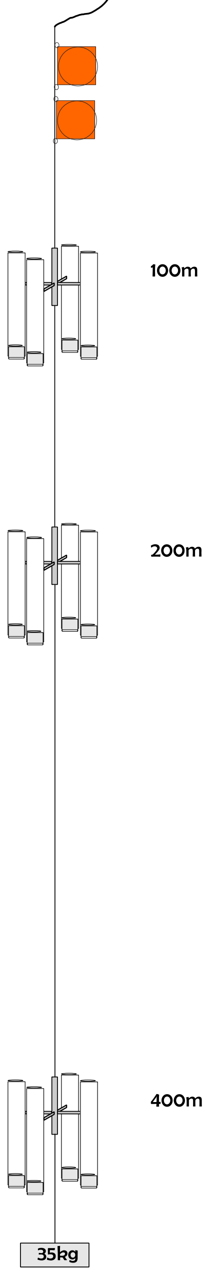


On board RV *Pelagia* in the equatorial North Atlantic [12°N/54°W], Sunday 1 February 2015

Dear all,

Another week has flown past and we're approaching the end of our transatlantic transect already. Since our last report we have spent a lot of time at a single station: M4 at about 12°N/49°W. From the data that were analysed on the samples that we collected after the first year of sampling in November 2013, we concluded that this station may be a very important one in terms of a quantifiable marine-environmental impact of Saharan-dust input. Also, this happens to be a station at which we have a complete set of instruments sampling dust both below and above the sea surface. In other words; we really wanted to have this mooring safe on deck! However, as January is the month where the Trades blow happily, the sea state did not promise an easy recovery of either buoy or mooring.

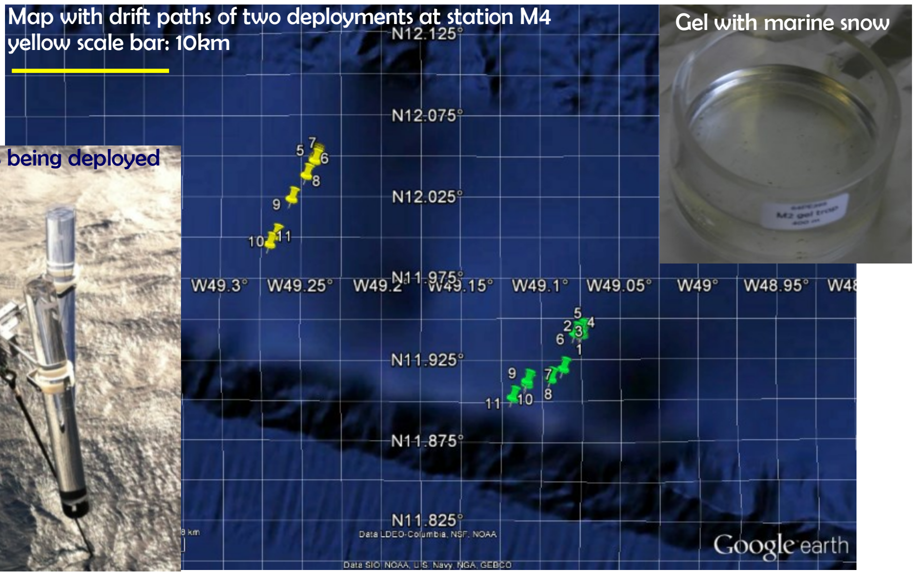




Thanks to the now perfect internet connection we had access to accurate weather reports and it turned out that there would be a window of slightly less wind and a tick calmer sea on Friday 30 January. This offered the luxury to deploy the floating sediment traps twice, which resulted in two very nice collections of sediments collected at 100, 200, and 400m water depths. This piece of equipment was kindly lent to us by Dr Morten Iversen, a colleague from MARUM in Bremen, Germany.

Here you can see the principle of these floating traps; at three levels in the water column, there is a set of four tubes that are suspended in a vertical position and are kept vertical between floats and bottom weight. The tubes are open at the top so that anything settling through the water column can be collected. Prior to deployment, these tubes are filled with filtered seawater that we sampled with the CTD and to which we added salt so that this water actually stays inside the tube. The orange and yellow balls indicate floats that keep the whole thing afloat. On the largest float there is a flag and some beacons so that we can find the traps back after 24 hours of free drifting. An iridium beacon regularly reports the GPS coordinates through eMail and also there are a radio beacon and a flash light.

Dust particles that are deposited on the ocean's surface, are unlikely to settle through the water column as individual particles. Instead, they mostly settle after they've been eaten by plankton or as large fluffy aggregates called marine snow. In regular sediment traps and on the sea floor, this marine snow is never preserved. The floating traps however, do offer the opportunity to study this fluffy stuff: one tube per depth level contains a cup with a gel into which the all settling material sinks so that it is preserved. And this works really well!

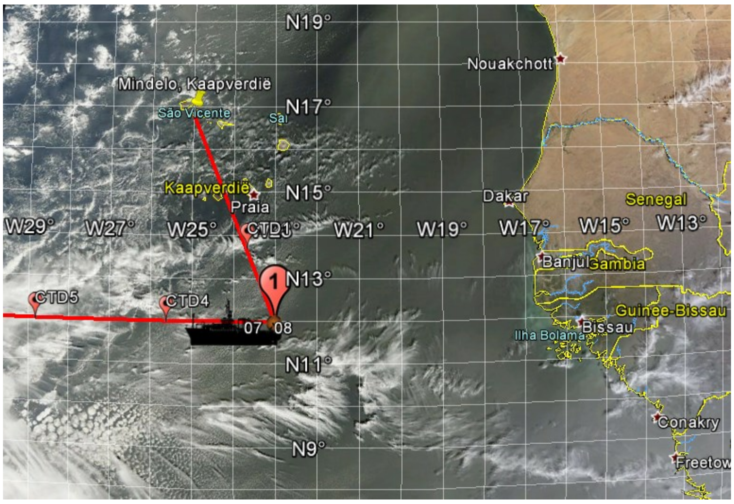


Both recovery and re-deployment of buoy Laura and the mooring-with-sediment-traps at station M4 are successful and all the cups in the two sediment traps contain good samples: a 100% score!

Making use of the rare occasion of having a buoy standing on deck, we make our group picture in which everybody proudly wears the cruise's t-shirt:

The dream team: participants of cruise 64PE395. L2R: Michèlle, Leon, Jan-Dirk, Yvo, Laura, Chris, Sergej, Sietske, Rik, Pieter, Patrick, Cor, Bob, Karel, Jose, Hans, Jan-Berend, Barry, Martijn, Len, and Bert. Not on this picture but valued team-member: Martin

After having changed to a new satellite that covers the western part of the Atlantic Ocean, we have a very good internet connection. This offers the opportunity to download satellite pictures of the dust event that we sailed through. Here you see an example of such an image with our cruise track and actual ship's position projected on it:



Right now, we are on our way to the last station of this expedition: M5 at about 12°N/57°W. After this station, we'll have our last transit to Barbados, where we hope to arrive in the course of Thursday 5 February. The atmosphere on board the ship is still very pleasant and we feel supported by all our friends and family at home who follow our adventures through the blog at: www.nioz.nl/pe395-blog; we're breaking all the records in terms of page visits!

Many greetings to all of you from the Pelagia in the equatorial North Atlantic!
On behalf of the ship's- and scientific crew,
Jan-Berend Stuut

Transatlantic cruise 64PE395

In January 2015 we'll set sail again on board RV Pelagia to service our transatlantic array of instruments and re-deploy them.

On this blog, we'll keep you updated on our adventures at sea. Please drop us a note (jbstuut-at-nioz.nl) if you have any questions!?

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- 31 January: Inside the buoy
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On 8 January 2015 we'll fly to Mindelo, which is the capital of Sao Vicente, which is one of the Cape-Verdian Islands. The ship will arrive one day later and we'll start packing directly; new stores (food and drinks!) will have to be brought on board, and also the equipment and stuff that we need to do our work. All our tools and instruments will be shipped in two 20-ft containers, which we hope to find waiting for us on the 8th!

Below you can see the planned cruise track:

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)ust-team members

an-Berend Stuut
:hris Munday
aura Korte
lichèlle van der Does

\ffiliated members

:armen Friese
:atarina Guerreiro
lalte Jäger





.atest news

'ust book out now!