GEOMAR REPORT

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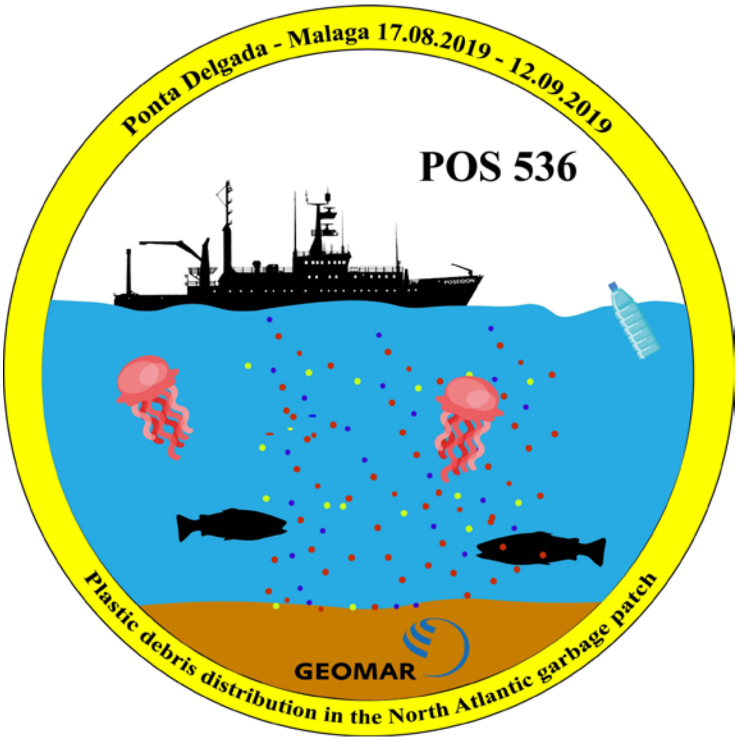
Helmholtz-Zentrum für Ozeanforschung Kiel

RV POSEIDON Fahrtbericht / Cruise Report POS536/Leg 1

DIPLANOAGAP: Distribution of Plastics in the North Atlantic Garbage Patch

Ponta Delgada (Portugal) – Malaga (Spain)
17.08. – 12.09.2019



Berichte aus dem GEOMAR
Helmholtz-Zentrum für Ozeanforschung Kiel

Nr. 56 (N. Ser.)

October 2020

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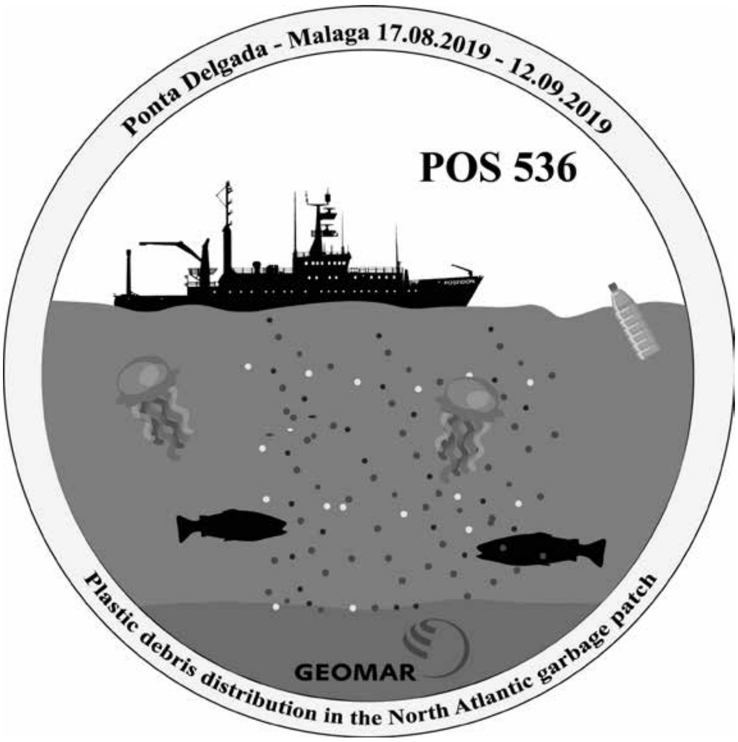

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1. Summary

1.1 Summary in English

The expedition POS 536 is part of a multi-disciplinary research initiative of GEOMAR investigating the origin, transport and fate of plastic debris from estuaries to the oceanic garbage patches. The main focus will be on the vertical transfer of plastic debris from the surface and near-surface waters to the deep sea and on the processes that mediate this transport. The obtained data will help to develop quantitative models that provide information about the level of plastic pollution in the different compartments of the open ocean (surface, water column, seafloor).

Furthermore, the effects of plastic debris on marine organisms in the open ocean will be assessed. The cruise will provide data about the:

(1) abundance of plastic debris with a minimum size of 100 µm as well as the composition of polymer types in the water column at different depths from the sea surface to the seafloor including the sediment,

(2) abundance and composition of plastic debris in organic aggregates ("marine snow"),

(3) in pelagic and benthic organisms (invertebrates and fish) and in fecal pellets,

(4) abundance and the identity of biofoulers (bacteria, protozoans and metazoans) on the surface of plastic debris from different water depths,

(5) identification of chemical compounds ("additives") in the plastic debris and in water samples.

1.1 Zusammenfassung

Eine multidisziplinäre Forschungsinitiative des GEOMAR soll in den kommenden Jahren die Herkunft, den Transport und den Verbleib von Plastikmüll von den Mündungen großer Flüsse bis zu den subtropischen Konvergenzzonen („Müllstrudel“) untersuchen. Im Besonderen soll der vertikale Transport des Plastiks quantifiziert und die involvierten Prozesse identifiziert werden.

Mit diesem Wissen sollen Modelle erstellt werden, die die Belastung des offenen Ozeans (Oberfläche, Wassersäule, Meeresboden) mit Plastikmüll abschätzen. Zudem sollen Erkenntnisse über die Auswirkungen der Plastikverschmutzung auf Organismen und Ökosysteme des offenen Ozeans gewonnen werden. Während der Expedition POS 535 wurden hierfür Proben gesammelt, die nach der Aufreinigung und Analyse mit Hilfe spektroskopischer Methoden bzw. der Gaschromatographie/Massenspektroskopie am GEOMAR Informationen liefern werden, die folgendes ermöglichen:

Quantifizierung und Charakterisierung von Plastikpartikeln (>100 µm) in verschiedenen Wassertiefen von der Meeresoberfläche bis zum Meeresboden. Hierfür wurden mit Hilfe eines Neuston-Netzes, eines WP2-Planktonnetzes, eines Bongo-Netzes sowie eines Kastengreifers Proben genommen. Zusätzlich wurden in-situ Pumpen eingesetzt, die in verschiedenen Wassertiefen definierte Volumina filtrierten.

Erfassung und Charakterisierung von Plastikpartikeln (>100 µm) in Aggregaten [„Marine Snow“] sowie in marinen Organismen und deren Fäzes. Hierfür wurden während der Fahrt an zwei Positionen driftende Sedimentfallen ausgebracht, die für jeweils 4 Tage in 8 verschiedenen Wassertiefen Aggregate sammelten

Identifizierung und Quantifizierung von Bakterien, Protozoen und Metazoen auf der Oberfläche von Plastikpartikeln.

Identifizierung von chemischen Zusatzstoffen („Additive“) im gefundenen Plastikmüll und in Wasserproben. Hierfür und für Punkt 3 wurden händisch Plastikfragmente > 1000 µm aus den Netzproben aussortiert.

2. Participant List

2.1 Scientific Party

Name	Discipline	Institution
Dr. Mark Lenz	Principle Investigator, Marine Ecology	GEOMAR
Dr. Luisa Galgani	Biogeochemistry	University of Siena
Dr. Erik Borchert	Marine Ecology	GEOMAR
Thea Hamm	Marine Ecology	GEOMAR
Jon Roa	Biogeochemistry Technician	GEOMAR
André Mutzberg	Biogeochemistry Technician	GEOMAR
Ulrike Christiane Panknin	Marine Ecology Technician	GEOMAR
Kristin Hamann	Biogeochemistry, Co-Chief Scientist	GEOMAR
Jenny Friedrich	Student helper	CAU Kiel
Sarah-Marie Kröger	Student helper	CAU Kiel
Lindsay Grace Walls	Student helper	CAU Kiel

2.2 Participating institutions

GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel
University of Siena

Scientific Party

3. Research Program

3.1 Aims of the Cruise

The POS536 research cruise serves as a starting point of a number of connected research cruises to build an understanding of the transport pathways of plastic and microplastic debris in the North Atlantic from the input through rivers and air across coastal seas into the accumulation spots in the North Atlantic gyre and the vertical export to its final sink at the seabed.

Assessing the abundance, composition and size distribution of micro- and mesoplastic particles (0.3 - 200 mm) at the sea surface in the working area using a neuston catamaran trawl

Assessing the abundance, composition, size distribution and transport rates of micro- and mesoplastic particles (0.1 – 5 mm) in the water column using drifting sediment traps

Assessing the abundance and size distribution of microplastic particles (0.1 – 5 mm) in the water column using *in situ* pumps

Assessing the abundance, composition and size distribution of microplastic particles (0.2 – 5 mm) near the surface using subsurface underway samples

Assessing the abundance, composition and size distribution of micro- and mesoplastic particles (0.1 – 200 mm) as well as of phyto- and zooplankton organisms including jellyfish in the water column using a multi-net trawl

Measuring concentrations of selected additive compounds that commonly leach from plastic materials

Capturing fish of species feeding in the upper layer (5-10 m) and mid-layer (50-200 m) of the water column using an Isaacs-Kidd midwater trawl

Assessing the abundance, composition and size distribution of micro- and mesoplastic particles (0.1 – 200 mm) in seafloor sediments as well as in epi- and infauna organisms

Describing the abundance and composition of bacterial biofilms and of eukaryotic biofoulers on micro- and mesoplastic particles from the sea surface, the water column and the seafloor

Assessing the role of eddies in the horizontal, long-distance transport of buoyant micro- and mesoplastics (0.1 – 200 mm)

3.2 Description of the Work Area

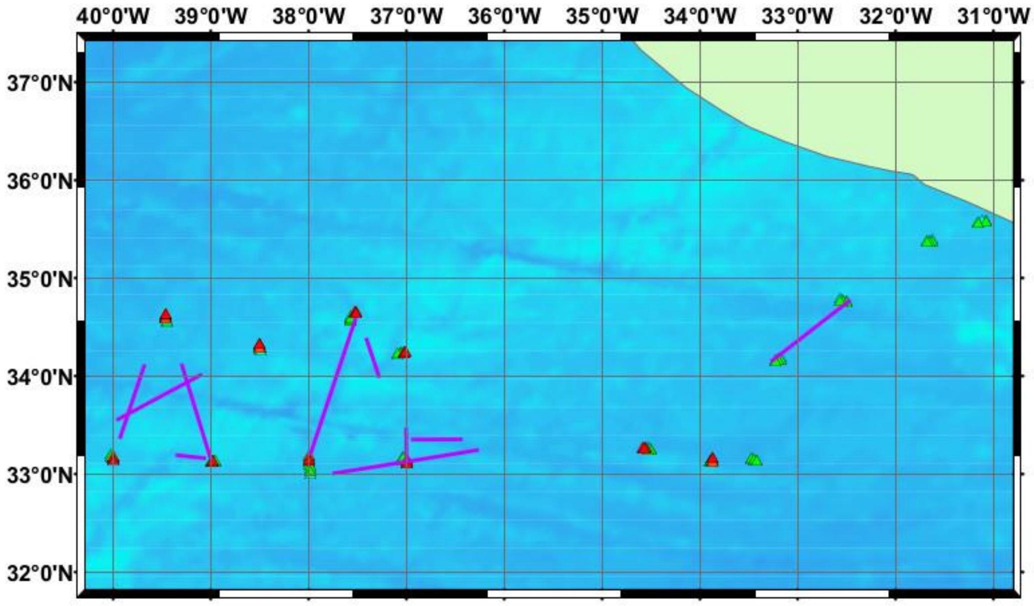

Figure 3.2 Map of POS536, location of the working area and stations (symbols: green=neuston trawls, red=bongo net trawls), litter monitoring transects (purple lines) and Portuguese EEZ (light green area).

4. Narrative of the Cruise

4.1 Leg 1

The scientific crew with 11 researchers, technicians and student helpers embarked RV POSEIDON in Ponta Delgada/Azores on August 16th 2019. The vessel left the harbour on the following day and headed south-west towards the working area at the north-eastern edge of the inner accumulation zone of the North Atlantic garbage patch.

This garbage patch, which spans from the Azores to Bermuda, is supposed to contain 20 % of the global amount of floating plastic. At 11 stations along the north-eastern edge of the patch, we collected samples that will allow to assess the abundance of microplastics, i.e. synthetic particles in a size range between 20 and 5 000 µm, at the ocean surface, in various water depths between 0 m and 1500 m and at the ocean floor (3000 m).

Samples encompassed sea water, marine organisms and sediment and we used various sampling techniques: surface (manta) trawls, subsurface bongo net trawls, vertical plankton hauls, in-situ water pumps, pelagic sediment traps, multicoring, box coring, the underway seawater system and the OceanPack™Race. To characterize the oceanographic conditions at the stations where samples were taken, the CTD of RV POSEIDON was used.

During the first week of the cruise (17th – 24th August 2019), we set-up the laboratories and prepared the different sampling devices for their first deployment. As soon as we had left the EEZ of Portugal, we started sampling with the Ocean Pack and also began with the visual litter monitoring (see below).

Furthermore, samples were taken at three stations, of which two were located in the working area, while the third one was inside an ocean eddy that we passed by on our way from the Azores to the working area.

The entire sampling gear despite the multicorer (MUC) worked well, while the latter was too light-weighted to penetrate into the very dense and hard deep-sea sediment that we encountered at the stations. This was the case at all stations in the working area, so that no sediment cores were collected with the MUC.

During a first visual inspection of the sampled material, we already detected significant quantities of plastic particles in the manta trawl samples. Furthermore, we were able to deploy the drifting sediment traps on the 22nd of August 2019. Their position was constantly tracked via a satellite signal and we took them back on board on August 27th 2019.

The visual litter monitoring allowed to count and to categorize large-sized drifting litter objects during our transits from one station to the next. For this, a protocol, which was developed by colleagues from the Alfred-Wegener-Institute for Polar and Ocean Research, was adopted. It included the observation of the sea surface in a 10 m range on both sides of the vessel, what was done by two observers who were standing on the foredeck of the vessel.

During the second week (25th – 31st August 2019), we finished sampling at the six stations in our rectangular working area between 33° 09.00 N/40° 00.00’W and 33° 15.00’N/ 37° 00.00’W. Furthermore, we deployed the drifting sediment traps for the second time on August 29th 2019. Since we were two days ahead of our schedule, we added an extra sampling station at the position 34° 14.74’N/37° 00.76’W, which we reached in the morning of September 2nd 2019.

After the sampling at this station was accomplished, we went to retrieve the sediment traps, which we took on board again in the morning of September 3rd 2019.

Due to the fact that we still had 9 days available for the transit to Malaga, we decided to sample at a further extra station at 33° 09.898' N / 033° 52.552' W. This was accomplished in the evening of September 4th 2019 and we then left the working area to start our transit to Malaga, Spain, which we reached in the evening of September 11th 2019. During the entire cruise, the weather conditions were excellent with low winds, short and moderate events of rain fall that were intercepted by long sunny periods. The water and air temperatures ranged between 25°C and 30°C. This was problematic for the crew member who operated the winch, since the temperature in the glass cabin reached extreme values.

However, weather conditions changed during the transit back to Malaga, when wind speed increased and we had large waves hitting the port side of the vessel.They damaged the catamaran trawl, which was stowed on deck.

5. Preliminary results and methods

5.1 Visual litter surveys

(Mark Lenz and Shipboard Scientific Party)

Research objectives and summary

The majority of microplastic particles in the open ocean is supposed to have derived from the fragmentation of larger plastic debris (Andrady 2011).

Hence, it is plausible to assume that the abundance of microplastics is positively correlated with the abundance of macroplastic items. For this reason and to assess the general abundance of plastic litter in the working area and during transits from and to port, we conducted a visual litter monitoring. The data will later be correlated with the abundances of microplastics that we found in the water, sediment and biota samples, which collected in the respective sea area. Furthermore, the data will be provided for the Litterbase data repository that the Alfred-Wegener Institute for Marine and Polar Research (AWI) is maintaining.

Method

The method for this was adopted from a protocol, which was provided by the AWI.
Monitorings were subdivided into one hour shifts and were only conducted during transits, when the ship was moving with at least 4 knots.

For this, two members of the scientific crew stood on the foredeck of RV POSEIDON and counted all litter items down to a minimum size of approximately 5 cm that passed by the ship at a maximum distance of 10 m. One person observed the sea on the starboard side, while the other person surveyed the portside of the ship. Litter items were documented with regard to their shape, size and colour as well was with regard to the material they consisted of. Each sighting was documented with its coordinates that were read from a handheld GPS device.

Preliminary results

During 10 transits between stations within and also outside the working area, we observed the sea surface on both sides of the vessel (Figure 5.1-1a).

This is equivalent to a total survey time of 50 hours.

The monitorings revealed that the majority of litter items at the north-eastern edge of the North-Atlantic garbage patch were small fragments with a size smaller than 10 cm (Figure 5.1-2).

Only about 1 % of all observed items were larger than 90 cm, while ~3 % were larger than 50 cm (Figure 5.1-1b).

Figure 5.1-4 shows the size distribution of the litter items smaller than 50 cm.

Furthermore, 99 % of all the items that were counted and described during the cruise were classified as plastic.

The mean number of litter items that were observed during one of the 10 transects, during which the visual litter monitoring was conducted (Figure 5.1-3), ranged between 2 on transect 5 and 35 on transect 8 (Figure 5.1-5).

Figure 5.1-1a The litter monitoring was conducted by two researchers who stood on the foredock of RV Poseidon and surveyed an area of 10 m on the starboard and the port side of the vessel. Photo: Jon Roa.

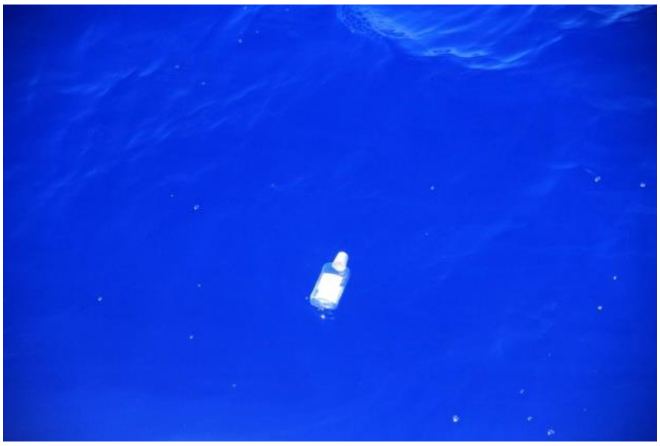

Figure 5.1-1 b Larger litter items like this plastic bottle were observed approximately once an hour, since the majority of debris items were small-sized fragments. Photo: Thea Hamm.

Figure 5.1-2 The majority of litter items that were observed during the monitorings were small-sized plastic fragments like the piece shown here, which was approximately 5 cm in length. Photo: Mark Lenz.

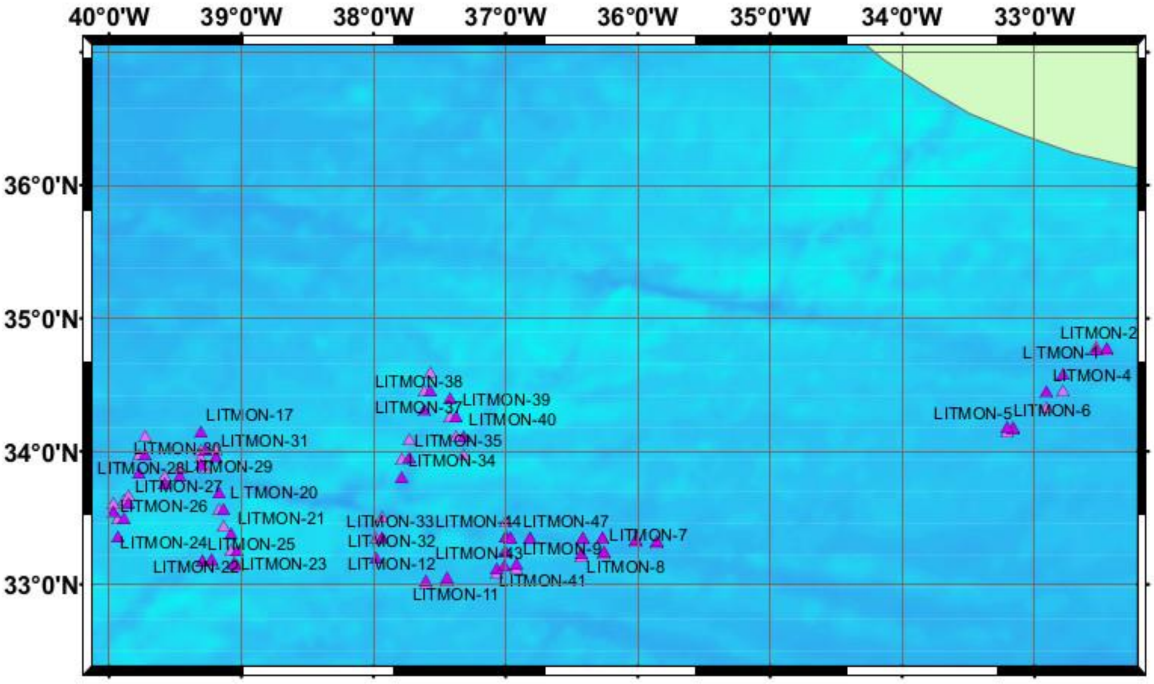

Figure 5.1-3 Visual litter monitorings conducted during POS536.

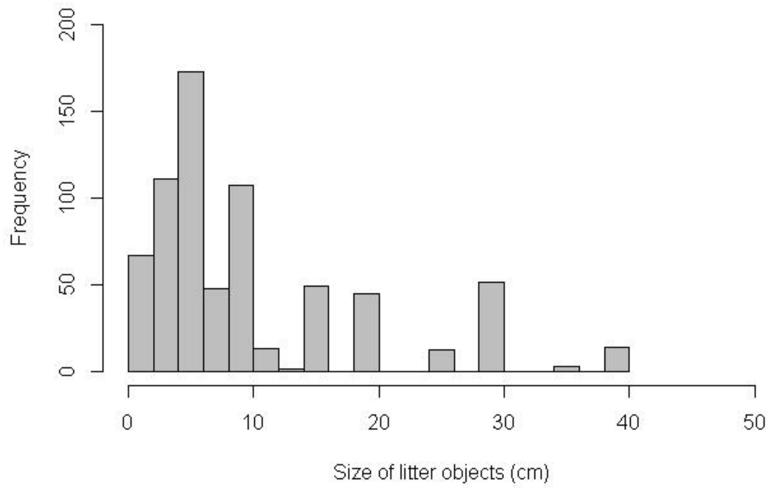

Figure 5.1-4 Size distribution of all litter items < 50 cm that were observed during the visual litter monitorings on the POS536 cruise.

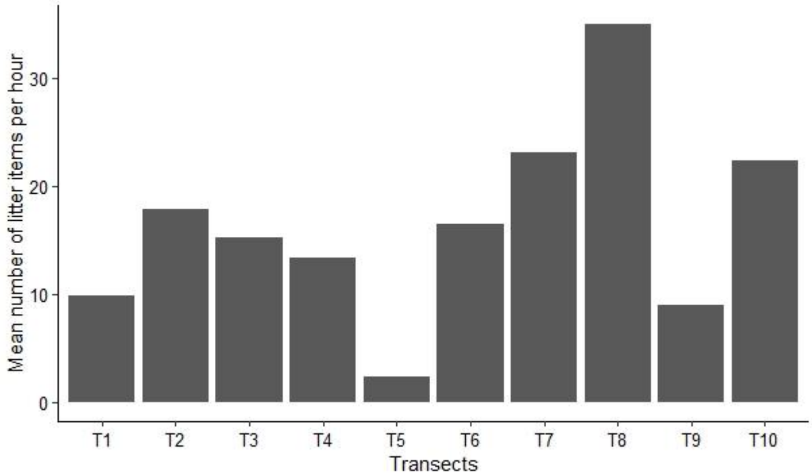

Figure 5.1-5 Mean number of litter items that were observed per hour on the different transects during which visual litter monitorings were conducted on the POS536 cruise (see Figure 5.1-3).

Table 5.1 Visual litter surveys during POS536.

D-Ship	**Date**	**Time (UTC)**	**Area**	**Latitude (start)**	**Longitude (start)**	**Latitude (end)**	**Longitude (end)**
POS536_0_Underway-1	19.08.2019	08:00	A-B	34°46.756'N	32°27.550'W	34°46.011'N	32° 31.689'W
POS536_0_Underway-2	19.08.2019	09:00	A-B	34°45.907'N	32°32.061'W	34°47.778'N	032°34.965'W
POS536_0_Underway-2	19.08.2019	12:00	A-B	34°34.880'N	32°47.328'W	34°27.530'N	32° 54.034'W
POS536_0_Underway-2	19.08.2019	13:00	A-B	34°27.197'N	32°54.342'W	34°19.852'N	33° 01.039'W
POS536_0_Underway-2	19.08.2019	15:30	A-B	34°10.122'N	33°09.997'W	34°11.152'N	33° 12.553'W

D-Ship	Date	Time (UTC)	Area	Latitude (start)	Longitude (start)	Latitude (end)	Longitude (end)
POS536_0_Underway-2	19.08.2019	16:30	A-B	34°11.185'N	33°12.594'W	34°08.890'N	33° 16.517'W
POS536_0_Underway-2	21.08.2019	08:00	B-C	33°14.873'N	36°15.452'W	33°14.363'N	36° 25.606'W
POS536_0_Underway-2	21.08.2019	09:00	B-C	33°14.334'N	36°25.789'W	33°12.616'N	36° 35.660' W
POS536_0_Underway-2	21.08.2019	12:00	B-C	33°09.179'N	36°54.823'W	33°07.224'N	37° 04.077'W
POS536_0_Underway-2	21.08.2019	13:00	B-C	33°07.207'N	37°04.150'W	33°05.475'N	37° 13.077'W
POS536_0_Underway-2	21.08.2019	15:30	B-C	33°03.390'N	37°26.891'W	33°01.888'N	37° 36.010' W
POS536_0_Underway-2	21.08.2019	16:30	B-C	33°01.875'N	037°36.073'W	33°00.355'N	37° 45.414'W
POS536_0_Underway-2	23.08.2019	15:30	C-D	33°21.697'N	39° 55.798' W	33°29.728'N	39° 53.137'W
POS536_0_Underway-2	23.08.2019	16:30	C-D	33°29.789'N	39° 53.117'W	33°38.011'N	39° 50.383'W
POS536_0_Underway-2	23.08.2019	19:00	C-D	33°50.309'N	39° 46.291'W	33°58.760'N	39° 43.485'W
POS536_0_Underway-2	23.08.2019	20:00	C-D	33°58.822'N	39°43.464'W	34°07.267'N	39° 40.630'W
POS536_0_Underway-2	25.08.2019	12:00	D	34°08.943'N	39° 18.538'W	34°01.025'N	39°16.070'W
POS536_0_Underway-2	25.08.2019	13:00	D	34°00.958'N	39°16.050'W	33°52.973'N	39° 13.573'W
POS536_0_Underway-2	25.08.2019	15:30	D	33°41.690'N	39° 10.079'W	33°34.254'N	39° 07.775'W
POS536_0_Underway-2	25.08.2019	16:30	D	33°34.188'N	39° 07.756' W	33°26.583'N	39° 05.409'W
POS536_0_Underway-2	25.08.2019	18:00	D-E	33°22.865'N	39° 04.269'W	33°15.461'N	39° 01.987'W
POS536_0_Underway-2	25.08.2019	19:00	D-E	33°15.405'N	39° 01.968'W	33°08.956'N	38° 59.988'W
POS536_0_Underway-2	26.08.2019	15:30	E-F	3309.649'N	39° 03.292'W	33°10.295'N	39° 07.352'W
POS536_0_Underway-2	26.08.2019	18:00	E-F	33°11.033'N	39° 13.381' W	33°10.597'N	39° 17.845'W
POS536_0_Underway-2	26.08.2019	19:00	E-F	33°10.593'N	39° 17.845'W	33°11.609'N	39° 21.560'W
POS536_0_Underway-2	27.08.2019	12:00	E-F	33°33.097'N	39° 57.759' W	33°36.625'N	39° 51.179'W
POS536_0_Underway-2	27.08.2019	13:00	E-F	33°36.655'N	39° 51.123' W	33°40.156'N	39° 44.617'W
POS536_0_Underway-2	27.08.2019	15:30	E-F	33°45.482'N	39° 34.751'W	33°48.963'N	39° 28.161'W
POS536_0_Underway-2	27.08.2019	16:30	E-F	33°49.005'N	39° 28.085'W	33°52.529'N	39° 21.509'W
POS536_0_Underway-2	27.08.2019	18:00	E-F	33°54.313'N	39° 18.156'W	33°57.698'N	39° 11.815'W
POS536_0_Underway-2	27.08.2019	19:00	E-F	33°57.727'N	39° 11.761'W	34°01.146'N	39° 05.386'W
POS536_0_Underway-2	30.08.2019	08:00	G-H	33°12.420'N	37° 58.856'W	33°21.374'N	37° 55.905'W
POS536_0_Underway-2	30.08.2019	09:00	G-H	33°21.448'N	037°55.880'W	33°30.440'N	37° 52.905'W
POS536_0_Underway-2	30.08.2019	12:00	G-H	33°48.565'N	37° 46.877'W	33°57.078'N	37° 44.039'W
POS536_0_Underway-2	30.08.2019	13:00	G-H	33°57.155'N	037°44.013'W	34°05.617'N	037°41.184'W
POS536_0_Underway-2	30.08.2019	15:30	G-H	34°18.948'N	37° 36.730'W	34°27.345'N	037°33.920'W
POS536_0_Underway-2	30.08.2019	16:30	G-H	34°27.368'N	37°33.911'W	34°35.719'N	37°31.111'W
POS536_0_Underway-2	31.08.2019	18:00	H-I	34°24.194'N	37° 25.025'W	34°15.770'N	37° 22.207'W
POS536_0_Underway-2	31.08.2019	19:00	H-I	34°15.707'N	37° 22.187'W	34°07.284'N	37° 19.370'W
POS536_0_Underway-2	31.08.2019	20:00	H-I	34°07.196'N	37°19.341'W	33°58.850'N	37° 16.551'W
POS536_0_Underway-2	01.09.2019	18:00	I-J	33°08.913'N	37° 00.265'W	33°14.966'N	37° 00.070'W
POS536_0_Underway-2	01.09.2019	19:00	I-J	33°15.029'N	37°00.070'W	33°21.646'N	37°00.150'W
POS536_0_Underway-2	01.09.2019	20:00	I-J	33°21.691'N	37°00.151'W	33°28.511'N	37°00.222'W
POS536_0_Underway-2	03.09.2019	12:00	J-K	33°21.033'N	36° 57.621'W	33°21.093'N	36° 48.641'W
POS536_0_Underway-2	03.09.2019	13:00	J-K	33°21.093'N	36°48.576' W	33°21.173'N	36° 39.318'W
POS536_0_Underway-2	03.09.2019	15:30	J-K	33°21.281'N	36° 25.226'W	33°21.357'N	36° 16.026'W
POS536_0_Underway-2	03.09.2019	16:30	J-K	33°21.357'N	36° 15.966'W	33°20.937'N	36° 05.870'W
POS536_0_Underway-2	03.09.2019	18:00	J-K	33°20.557'N	36° 01.258'W	33°19.734'N	35° 51.202'W
POS536_0_Underway-2	03.09.2019	19:00	J-K	33°19.726'N	35°51.103'W	33°18.902'N	35° 40.989'W

5.2 Neuston net trawls

(Grace Lindsay Walls, Erik Borchert, Jenny Friedrich, Nicolas Ory (PI))

Research objectives and summary

Microplastics (> 300 µm) floating at the sea surface within the working area and inside oceanic eddies were sampled with a neuston catamaran trawl.

The collected material was screened for plastic debris by microscopic inspection on board of RV Poseidon and plastic particles were picked and stored for later polymer identification in laboratories at GEOMAR using Raman micro-spectroscopy. This will provide information about the abundance and composition of microplastics at the sea surface, which will complement the data gained by sampling the water column and the seafloor. Neuston trawls will also be screened for macroplastic fragments, on which very likely microbial biofilms have established during the time they spent at sea.

These microbial communities will be analysed with regard to their composition and potential bioactivity.

It was shown that some bacteria and fungi are able to produce enzymes/biocatalysts that are able to degrade synthetic polymers. Nonetheless to date only a handful of enzymes that can degrade PET and PU are known and for most other man-made polymers no enzymes have been found. Exploiting environmental sources, such as bacterial enzymes, will be a crucial step in reducing plastic pollution.

Description of the gear

A neuston catamaran outfitted with a microplastic trawl net (mesh size 300 µm, mouth opening 70 cm x 40 cm, Figure 5.2-2a.) was used to collect microplastics at the sea surface. The net opening was equipped with a flowmeter to measure the volume of water that was filtered by the net during one trawl. Furthermore, we attached a GoPro camera to observe the average height to which the net opening was filled with water during the trawls. The catamaran was towed portside of the ship, with the current wind direction and outside of the ships wake at 4 knots for 20 minutes. If sampling was conducted inside a very dense patch of floating *Sargassum* sp. (Figure 5.2-1), trawl time was reduced to 10 minutes to minimize the amount debris collected outside of the codend and to reduce the risk of getting the flowmeter entangled in the algal material.

Figure 5.2-1 A dense patch of floating *Sargassum* sp. Photo: Mark Lenz.

After each tow, the body of the net was thoroughly cleaned from the outside using a seawater supplied deck hose to push all particles and debris into the codend, while avoiding contaminating the sample with potential particles from inside the hose. The content of the codend was collected and *Sargassum* thalli were thoroughly rinsed with MilliQ and checked for monofilaments or microplastic particles before being discarded (Fig 5.2-2b). The remainder was sieved through a 100 µm mesh sieve and stored in a 200 ml Kautex bottle preserved in 70 % ethanol for further analysis.

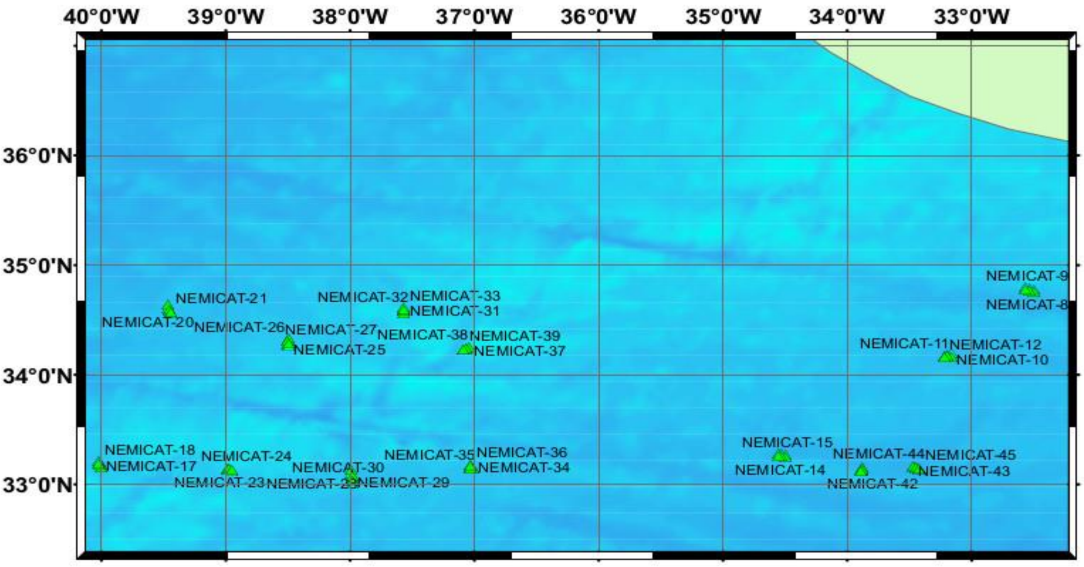

Figure 5.2-2 Neuston trawls conducted during POS536.

Samples sorted at sea were visually inspected under a binocular. Microplastics found were removed and stored in Eppendorf vials in 70 % ethanol, while information about the shape, size, and color of each fragment was recorded (Figure 5.2-3).

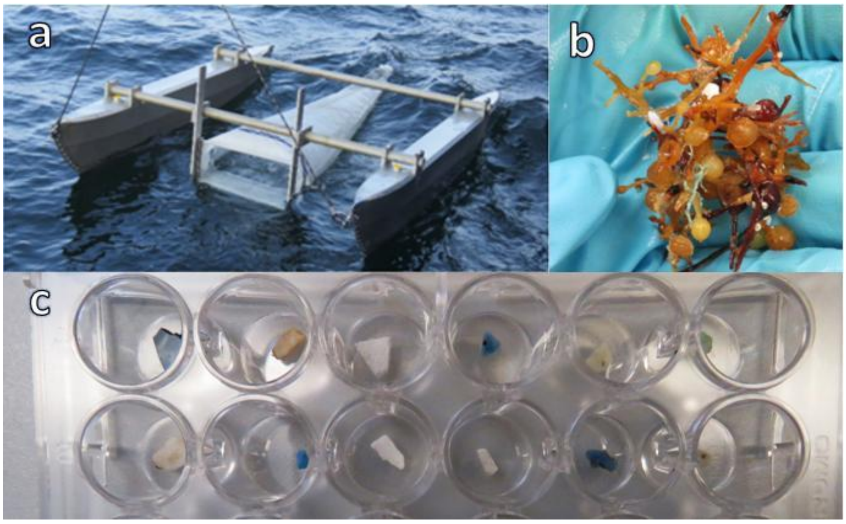

Figure 5.2-3 a) Neuston catamaran trawl outfitted with a microplastic trawl net (300 µm). b) Thallus fragment of *Sargassum* sp. containing multiple microplastic particles (white) and mono-filaments (green). c) Microplastics sepa-rated out of one haul awaiting documentation and storage.

Sample preparation and analysis at GEOMAR

The picked plastic fragments will be analysed with regard to their polymer types in laboratories at GEOMAR using ATR Raman micro-spectroscopy.

5.2.1. Analysis of microbial communities on macroplastics

Samples retrieved with the neuston catamaran microplastic trawl were also screened for macroplastic fragments. All plastic fragments ≥ 0.5 mm were removed from the trawl sample and conserved in a saturated ammonium sulphate solution (Figure 5.2-4).

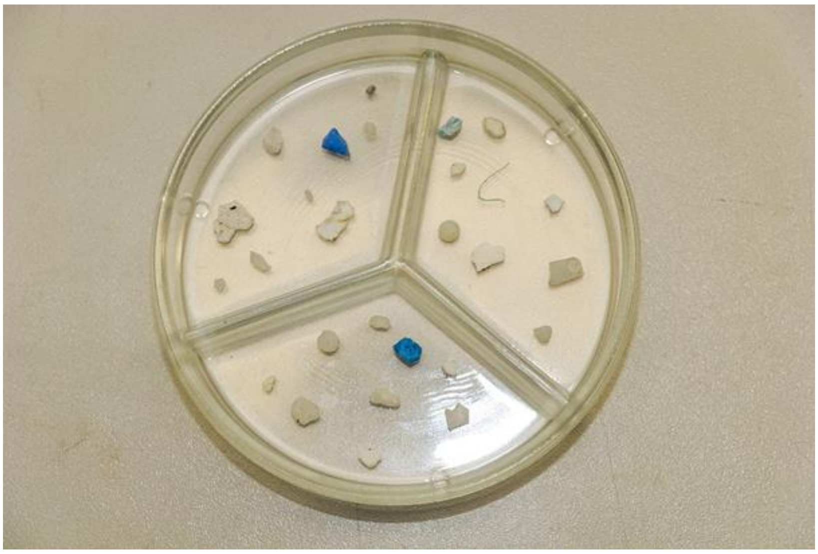

Figure 5.2-4 Plastic fragments and pre-production pellets that were picked from one neuston trawl. Photo: Mark Lenz.

This solution precipitates all proteins and therefore prevents DNA and RNA degradation for an elongated time, even at room temperature. The fragments will be subsequently used for microbiological/bioinformatic analysis via the use of state-of-the-art sequencing techniques to identify the bacterial communities inhabiting the surfaces of plastic items floating in the open ocean. Biofilms will be characterized by 16S rRNA sequencing, specifically targeting the V3/V4 region of the 16S rRNA gene. This sequencing will give a information about the structure of the communities that established on floating particles in the North Atlantic garbage patch.

At GEOMAR, all fragments will further be investigated with Attenuated Total Reflectance Fourier Transform Infrared Spectroscopy (ATR-FTIR) to identify the synthetic polymers of which the fragments were made of. For the analyses of structural changes of the particles' surfaces, which possibly are related to biodegradation processes, nearfield FTIR microscopy (NEASPEC) will be applied. Ultimately, the retrieved metagenomic DNA will also be used for metagenomic sequencing to get an in depth understanding of the enzymatic capabilities of the inhabiting bacterial communities.

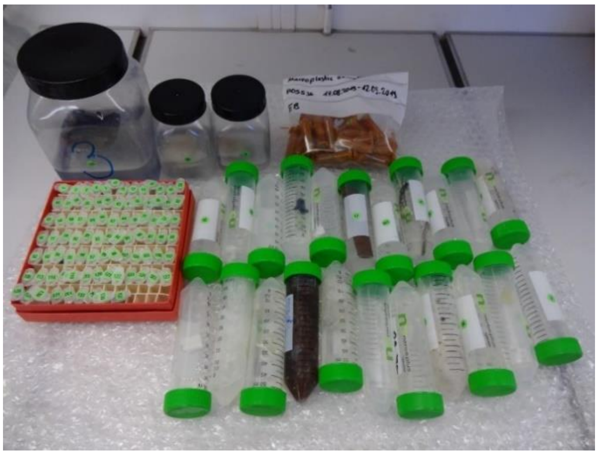

Figure 5.2-5 137 macroplastic fragments were retrieved from 45 neuston catamaran trawls and preserved for later analysis in an ammomium sulphate solution during the POS536 cruise. Photo: Erik Borchert.

Table 5.2 Stations at which neuston trawls were performed during POS536.

D-Ship	Date	Time (UTC)	Area	Latitude (start)	Longitude (start)
POS536_1-1	18.08.2019	18:17	A	35°34.98'N	31°04,93'W
POS536_2-1	18.08.2019	18:56	A	35° 35,021' N	31°07,41'W
POS536_3-1	18.08.2019	19:33	A	35°34.26'N	31°09,18'W
POS536_4-1	18.08.2019	22:58	A	35°22.50'N	31°37,54'W
POS536_5-1	18.08.2019	23:47	A	35°22.26'N	31°39,52'W
POS536_6-1	18.08.2019	00:30	A	35°22.31'N	31°40,83'W
POS536_7-1	19.08.2019	08:27	A	34°45.20'N	32°30,15'W
POS536_8-1	19.08.2019	09:07	A	34°46.04'N	32°32,12'W
POS536_9-1	19.08.2019	09:45	A	34°46.61'N	32°34,25'W
POS536_10-1	19.08.2019	15:31	A	34°10.10'N	33°09,99'W
POS536_11-1	19.08.2019	16:09	A	34°10.16'N	33°11,56'W
POS536_12-1	19.08.2019	16:48	A	34°09.43'N	33°13.34'W
POS536_13-1	20.08.2019	02:29	B	33°15.19'N	034°29.97'W
POS536_14-1	20.08.2019	03:09	B	33°15.31'N	034°31.90'W
POS536_15-1	20.08.2019	03:51	B	33°15.70'N	034°33.47'W
POS536_30-1	23.08.2019	00:02	C	33° 09.37'N	39° 59.89'W
POS536_31-1	23.08.2019	00:40	C	33° 10.55'N	40° 00.77'W
POS536_32-1	23.08.2019	01:19	C	33° 11.43'N	40° 01.55'W
POS536_45-1	24.08.2019	15:35	D	34° 38.36'N	39° 27.74'W
POS536_46-1	24.08.2019	16:09	D	34° 36.10'N	39° 27.34'W
POS536_47-1	24.08.2019	16:36	D	34° 34.36'N	39° 26.84'W
POS536_61-1	26.08.2019	02:44	E	33° 08.676' N	038° 59.411' W
POS536_62-1	26.08.2019	03:24	E	33° 08.515' N	038° 58.179' W
POS536_63-1	26.08.2019	04:04	E	33° 08.209' N	038° 57.089' W
POS536_74-1	28.08.2019	13:00	F	34° 20.106' N	038° 29.931' W
POS536_75-1	28.08.2019	13:38	F	34° 18.739' N	038° 30.039' W
POS536_76-1	28.08.2019	14:19	F	34° 17.456' N	038° 29.632' W
POS536_87-1	29.08.2019	14:40	G	33° 07.944' N	037° 59.550' W
POS536_88-1	29.08.2019	15:20	G	33° 04.964' N	037° 59.046' W
POS536_89-1	29.08.2019	15:58	G	33° 02.236' N	037° 58.635' W
POS536_106-1	31.08.2019	13:00	H	34° 33.939' N	037° 33.988' W
POS536_107-1	31.08.2019	13:39	H	34° 35.127' N	037° 34.108' W
POS536_108-1	31.08.2019	14:18	H	34° 36.097' N	037° 34.247' W
POS536_113-1	01.09.2019	05:42	I	33° 08.943' N	037° 00.766' W
POS536_114-1	01.09.2019	06:11	I	33° 08.686' N	037° 02.161' W
POS536_115-1	01.09.2019	06:36	I	33° 10.288' N	037° 01.954' W

D-Ship	Date	Time (UTC)	Area	Latitude (start)	Longitude (start)
POS536_130-1	02.09.2019	13:33	J	34° 15.032' N	037° 02.846' W
POS536_131-1	02.09.2019	14:13	J	34° 14.586' N	037° 04.179' W
POS536_132-1	02.09.2019	14:53	J	34° 14.116' N	037° 05.377' W
POS536_141-1	04.09.2019	14:46	K	33° 09.342' N	033° 52.645' W
POS536_142-1	04.09.2019	15:08	K	33° 08.417' N	033° 53.058' W
POS536_143-1	04.09.2019	15:34	K	33° 07.543' N	033° 53.676' W
POS536_145-1	04.09.2019	22:11	K	33° 09.908' N	033° 28.410' W
POS536_146-1	04.09.2019	22:35	K	33° 09.286' N	033° 26.872' W
POS536_147-1	04.09.2019	23:01	K	33° 08.620' N	033° 25.227' W

5.3 Vertical sampling of the water column with the WP2 plankton net

(Sarah-Marie Kröger, Jenny Friedrich, Thea Hamm, Ulrike Panknin, Mark Lenz (PI),

Jamileh Javid (PI))

Research objectives and summary

Most of the available data on the abundance and composition of plastic debris in the open ocean stem from samplings that used sea surface trawls (e.g. Manta trawl), while very few studies quantified plastic debris by sampling in different water depths. Plastic-biota interactions in the open ocean comprise the ingestion of particles by pelagic or benthic organisms, their colonization by biofoulers (bacteria to metazoans) and their entrapment in mucus that was released by gelatinous plankton organisms. All of these processes presumably play a role in the vertical transport of plastic debris from the ocean surface to the deep-sea and further into deep-sea sediments, but very few empirical data exist that document their action.

The use of the WP2 net allowed to collect microplastic particles as well as planktonic organisms that ingested or trapped microplastics on their sticky surfaces across different parts of the water column.

Description of the gear

The WP (Working Party) 2 is a vertically or horizontally operated oceanographic plankton net with a long funnel shaped net bag that allows to assess the vertical and diagonal distribution of phyto - or zooplankton in the water column.

On this cruise, the model “WP2-closing net” by HYDRO-BIOS Kiel was used for vertical hauls only (Figure 5.3-1). The net closing mechanism was not installed and therefore the hauls collected material over the entire water column that was sampled.

The net bag is made of nylon and has a length of 2.6 m and a mesh size of 100 µm. The diameter of the net mouth is 57 cm. The stainless-steel ring has a diameter of 60 cm and the WP2 net was fastened to the ring with a zipping system. For easy retrieval, the sampled material is collected in a removable collector with a mesh-window (mesh size 100 µm) that allows the water to flow out.

Figure 5.3-1 The WP2 plankton net (Image: HYDRO-BIOS Kiel).

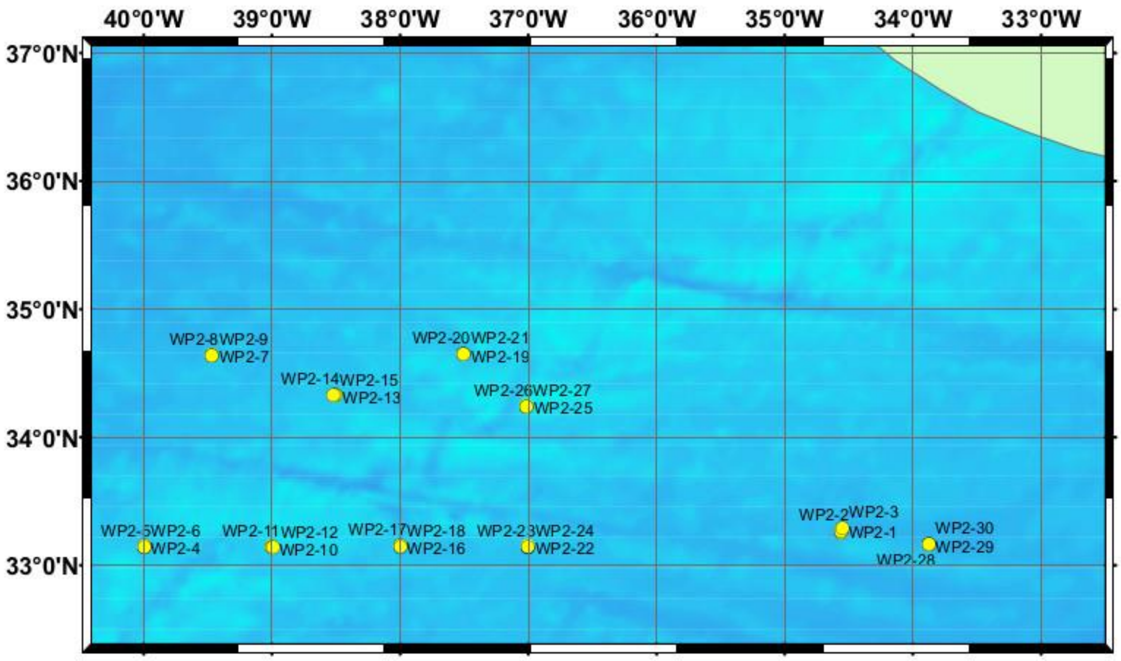

Figure 5.3-2 WP2 plankton net hauls done during POS536.

The collector was attached to a stainless-steel net bucket frame and both were attached to the WP2 steel ring with three ropes to prevent the detachment of the collector from the net bag while retrieving the net.

The net mouth was equipped with a mechanical flowmeter (HYDRO-BIOS Kiel) with backrun-stop, to determine the water flow during the sampling process. Furthermore, a 12 kg metal weight was attached to the steel frame with ropes to ensure a correct orientation of the net during deployments. For a later monitoring of the actual deployment depth, two depth loggers (Star Oddi) were attached to the steel ring.

At a total of 10 stations (B – K), the WP2 was deployed for three times, while each time it was lowered to one of three depth levels, i.e. 500 m, 1000 m and 1500 m, at a speed of 0.5 m/s. Right after reaching the sampling depth, the net was heaved again with a speed of 1 m/s. Before and after each deployment, the flowmeter was read and protocolled.

When the net was on deck again, it was rinsed with seawater that was previously filtered through a 20 µm filter cartridge (Knaub Trading GmbH & Co. KG, Bad Salzuflen). For this, a filter cartridge cascade was connected to one of the vessel's sea water supply systems. The content of the collector, which was attached to the end of the net bag, was rinsed into an aluminium pot by the use of PFA-squeeze bottles that were filled with pre-filtered seawater (20 µm). Between the deployments, the net was rinsed with pre-filtered seawater (20 µm) supplied by a hose.

Sampling of gelatinous plankton organisms

Gelatinous plankton organisms were collected from all WP2 hauls (stations B-K) and from all Bongo trawls (station B- K). In total, 812 specimens were picked, sorted and measured. They were stored in 247 containers (plastic bags and Eppendorf vials) and preserved in an -20°C freezer. A picture database of every sampled organism was also created.

On most stations the processing of the samples directly followed the net hauls. Larger Jellies were picked directly from the tin bucket with stainless-steel tweezers. The remaining content of the collectors was sieved through a 175 µm sieve and gelatinous organisms were picked from the mesh. Blanks of all potential plastic contamination sources were also sampled.

Table 5.3 Stations at which WP2 net samples were collected during POS536.

D-Ship	Date	Time (UTC)	Area	Latitude	Longitude	Depth (m)
POS536_19-1	20.08.2019	08:30	B	33°15.70'N	034°33.49'W	500
POS536_20-1	20.08.2019	09:10	B	33°16.47'N	034°33.40'W	1000
POS536_21-1	20.08.2019	10:03	B	33°17.46'N	034°33.02'W	1500
POS536_36-1	23.08.2019	06:17	C	33° 09.13'N	39° 59.88'W	550
POS536_37-1	23.08.2019	06:54	C	33° 08.81'N	39° 59.91'W	1150
POS536_38-1	23.08.2019	07:56	C	33° 08.96'N	39° 59.87'W	1800
POS536_51-1	25.08.2019	04:16	D	34° 38.674' N	039° 27.896' W	500
POS536_52-1	25.08.2019	04:49	D	34° 38.605' N	039° 27.964' W	1000
POS536_53-1	25.08.2019	05:48	D	34° 38.535' N	039° 28.062' W	1500
POS536_55-1	25.08.2019	19:57	E	33° 08.988' N	039° 00.004' W	500
POS536_56-1	25.08.2019	20:27	E	33° 08.693' N	038° 59.813' W	1000
POS536_57-1	25.08.2019	21:22	E	33° 08.367' N	038° 59.443' W	1500
POS536_77-1	28.08.2019	15:28	F	34° 20.026' N	038° 30.081' W	500
POS536_78-1	28.08.2019	15:53	F	34° 19.910' N	038° 30.498' W	1000
POS536_79-1	28.08.2019	16:44	F	34° 19.644' N	038° 31.402' W	1500
POS536_90-1	30.08.2019	00:08	G	33° 09.050' N	037° 59.881' W	500
POS536_91-1	30.08.2019	00:34	G	33° 09.035' N	037° 59.868' W	1000

D-Ship	Date	Time (UTC)	Area	Latitude	Longitude	Depth (m)
POS536_92-1	30.08.2019	01:20	G	33° 08.979' N	037° 59.857' W	1500
POS536_97-1	30.08.2019	18:18	H	34° 38.939' N	037° 30.134' W	600
POS536_98-1	30.08.2019	18:53	H	34° 38.886' N	037° 30.223' W	1100
POS536_99-1	30.08.2019	19:51	H	34° 39.055' N	037° 30.262' W	1600
POS536_110-1	01.09.2019	03:06	I	33° 09.000' N	036° 59.962' W	500
POS536_111-1	01.09.2019	03:30	I	33° 08.933' N	036° 59.938' W	1000
POS536_112-1	01.09.2019	04:20	I	33° 08.921' N	037° 00.001' W	1500
POS536_122-1	02.09.2019	04:04	J	34° 14.743' N	037° 00.802' W	500
POS536_123-1	02.09.2019	04:31	J	34° 14.699' N	037° 00.918' W	1000
POS536_124-1	02.09.2019	05:23	J	34° 14.565' N	037° 01.095' W	1500
POS536_138-1	04.09.2019	11:55	K	33° 10.069' N	033° 52.525' W	500
POS536_139-1	04.09.2019	12:21	K	33° 10.024' N	033° 52.538' W	1000
POS536_140-1	04.09.2019	13:15	K	33° 09.912' N	033° 52.510' W	1500

Sample preparation and analysis at GEOMAR and at Odense University (SDU)

Frozen samples will be freeze dried under contamination-free conditions at the SDU eco-toxicology laboratory. To purify samples, we will apply internal protocols that were used successfully in previous studies.

Samples will be concentrated on cellulose acetate filters to be inspected for microplastic and nanoplastic particles and shapes as well as polymer types will be identified with Raman micro-spectroscopy. Data will be standardized by comparing the level of microplastic contamination with blank samples as well as collected environmental samples such as water samples.

5.4 Horizontal water column sampling with the bongo net

(Thea Hamm, Ulrike Panknin, Mark Lenz (PI))

Research objectives and summary

Most of the available data on the abundance and composition of plastic debris in the open ocean stem from samplings that used sea surface trawls (e.g. manta trawl), while very few studies quantified plastic debris by sampling in different water depths. Therefore, we know very little about the distribution of, in particular, microplastics across the water column in oceanic waters as well as about the abundance of microplastics in the digestive tracts, the gills and the surface of planktonic organisms. Plastic-biota interactions in the pelagic environment potentially comprise the ingestion of particles, their colonization by biofoulers (bacteria to metazoans), their entrapment in mucus released by gelatinous plankton organisms or their retention in gills. All of these processes could impair the physiological performance as well as the fitness of the affected animals. Furthermore, they presumably play a role in the vertical transport of plastic debris from the ocean surface to the deep-sea and further into deep-sea sediments. The use of the bongo net allowed us to collect microplastic particles as well as planktonic organisms, which may have microplastics in their digestive tract, on their gills or on their body surface, in different layers of the water column.

Description of the gear

A bongo net (HYDRO-BIOS Kiel) with a 22 kg V-fin depressor and with a 300 µm mesh size on both nets was used to sample different water depths (Figure 5.4-1a+b). The bongo net was equipped with two depth loggers (Star Oddi), which recorded the water depth during towing, as well as with a mechanical flowmeter with back-run stop (HYDRO-BIOS Kiel) to measure the water volume that passed through the net bags during deployment. The net bags were rinsed with filtered seawater (20 µm) before the first deployment and were again rinsed after each further deployment to wash the retained material into the collectors that were at the end of the net bags. At each station the bongo net was deployed three times to sample in 10 m, 100 m and 300 m depth for 30 minutes at 2 knots ship speed (Table 5.4-1). We lowered the bongo net with 0.7 m/s and hoisted it with 0.5 m/s rope speed. After each deployment the ship returned to its initial position.

Figure 5.4-1 a) Bongo net with V-fin depressor and flowmeter (Image: HYDRo-BIOS Kiel) and b) during deployment at sea. Photo: Ulrike Panknin.

Table 5.4-1 The bongo net was used for collecting samples in three water depths. The water volume indicated was the volume sampled averaged across all stations.

Depth (m)	Rope length (m)	Average volume (l)	Towing time (min)
10	30	1 050 472	30
100	250	1 613 346	30
300	750	2 189 464	30

Samples were transferred from the collectors to aluminium pots and then sieved in the laboratory through a 250 µm stainless steel sieve. During sieving gelatinous plankton organisms were picked, transferred to glass petri dishes and then frozen for later analysis. Furthermore, each sample was visually inspected for microplastic particles and for particularly fragile or conspicuous organisms (Figure 5.4-2 & Figure 5.4-3). Both were then transferred to petri dishes and photographed under a stereomicroscope. After having returned the photographed objects, the samples were transferred into 500 ml glass containers with a lid and preserved with a formaldehyde solution (4 %).

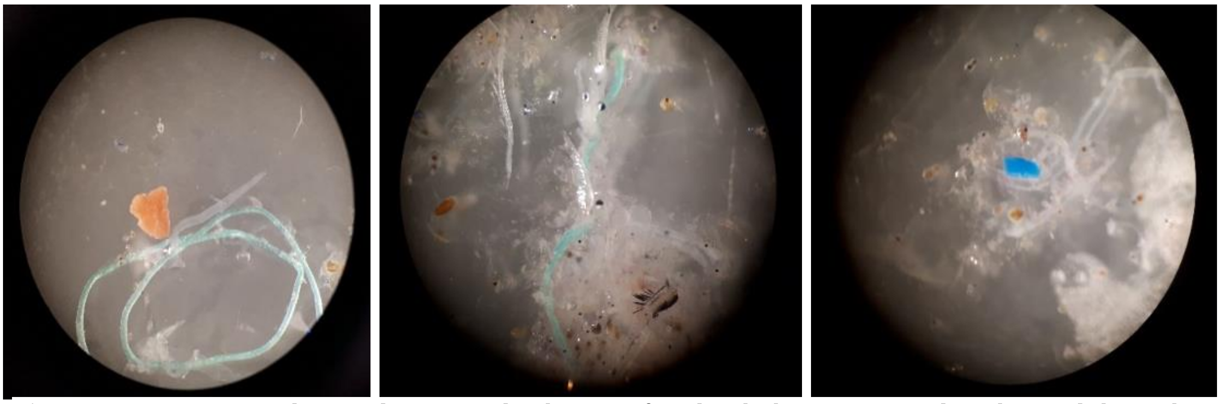

Figure 5.4-2 Potential microplastic particles that were found in the bongo net samples. Photo: Ulrike Panknin**.**

Figure 5.4-3 Plankton organisms that were collected with the bongo net. a) Leptochephalus larva. Photo: Thea Hamm, b) Acantephyra sp. Photo: Ulrike Panknin, and c) Hyperia sp. Photo: Ulrike Panknin.

To avoid the contamination of the samples with plastic particles originating from the used materials, aluminium pots, steel tweezers, glass petri dishes, a metal net and 500 ml glass jars with glass lids were used to handle and store the samples. Only pre-filtered seawater was used to rinse or wash the samples out of the net bags or to transfer them into the storage containers (Figure 5.4-4). Apart from the nylon net bags, the net collector that was made from PV and the PTFE squeeze bottles, the sample material was never in contact with plastic.

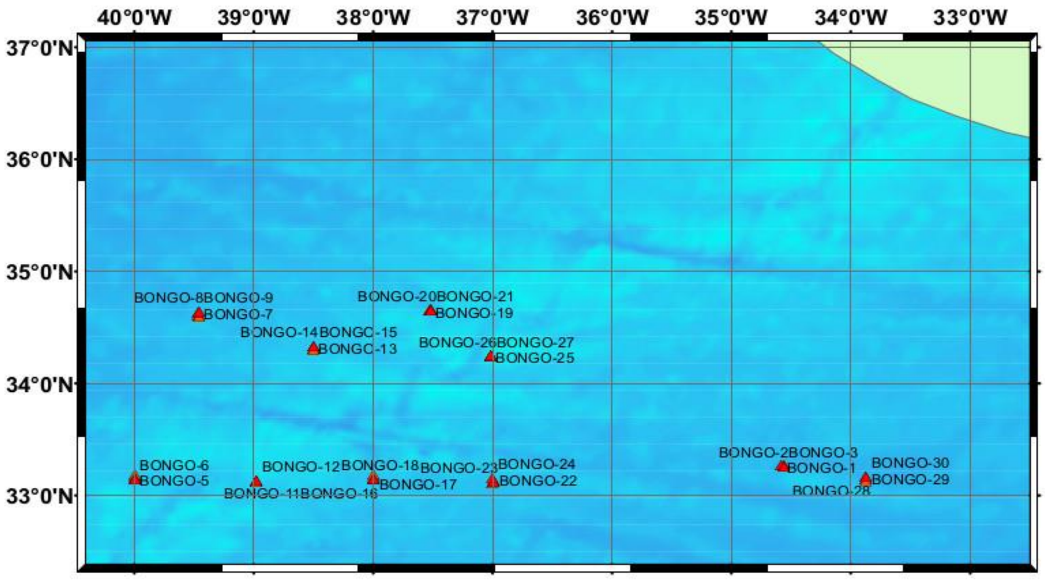

Figure 5.4-4 Bongo net trawls during POS536.

Figure 5.4-5 Rinsing the cod end of the bongo net with pre-filtered seawater. Plankton organisms and particles were first washed into an aluminium pot for visual inspection and then transferred to the glass storage containers Photo: Mark Lenz.

Sample processing and analysis at GEOMAR

The samples were transported to GEOMAR and will be prepared and analysed during 2020.

For this, each sample will be rinsed again to remove the formalin and will then be visually inspected to a) pick microplastic particles and b) sort the collected plankton organisms into taxonomic groups (order or family level).

After this, the biomass and the number of individuals in each groups will be assessed and then the organic material will be digested using enzymes of Fenton's reagent to release microplastic particles, which were potentially contained in the digestive tract or the gills of the collected organisms. After filtering the residual of the digestion process, the filter will be inspected for potentil microplastic particles under a microscope. All potential microplastic particles will finally be analysed using a Raman spectroscope or an FT/IR spectroscope to identify the polymer type.

Table 5.4-2 Stations at which bongo net samples were collected during POS536.

D-Ship	Date	Time (UTC)	Area	Latitude (start)	Latitude (end)	Longitude (start)	Longitude (end)	Depth (m)
POS536_16-1	20.08.2019	04:34	B	33°16.46'N	33°16.05'N	034°34.72'W	34°36.15'W	10
POS536_17-1	20.08.2019	05:25	B	33°15.86'N	33°16.64'N	034°33.31'W	34°35.99'W	100
POS536_18-1	20.08.2019	06:36	B	33°15.74'N	33°16.35'N	034°33.86'W	34°38.28'W	300
POS536_33-1	23.08.2019	02:29	C	33°09.05'N	33°10.71'N	39° 59.88'W	39°59.75'W	17
POS536_34-1	23.08.2019	03:24	C	33°09.16'N	33°10.41'N	39° 59.96'W	39°59.95'W	174
POS536_35-1	23.08.2019	04:29	C	33°08.97'N	33°11.34'N	39° 59.91'W	39°59.80'W	336
POS536_48-1	25.08.2019	23:56	D	34°37.687'N	34°36.50'N	039°27.872'W	039°27.47W	10
POS536_49-1	25.08.2019	01:04	D	34°38.561'N	34°36.791'N	39° 27.808' W	39° 27.481'W	100
POS536_50-1	25.08.2019	02:23	D	34° 38.506' N	34° 35.846' N	039° 27.788' W	039° 27.439' W	300
POS536_58-1	25.08.2019	22:49	E	33° 07.908' N	33° 07.588' N	038° 58.880' W	038° 57.349' W	10
POS536_59-1	26.08.2019	23:47	E	33° 08.174' N	33° 07.655' N	038° 58.738' W	038° 57.134' W	100
POS536_60-1	26.08.2019	00:59	E	33° 08.326' N	33° 07.529' N	038° 58.758' W	038° 56.426' W	300
POS536_80-1	28.08.2019	18:20	F	34° 20.145' N	34° 18.996' N	038° 30.235' W	038° 30.291' W	10
POS536_81-1	28.08.2019	19:20	F	34° 19.983' N	34° 18.399' N	038° 30.097' W	038° 30.013' W	100
POS536_82-1	28.08.2019	20:31	F	34° 20.002' N	34° 17.876' N	038° 30.055' W	038° 30.010' W	300
POS536_93-1	30.08.2019	02:34	G	33° 08.826' N	33° 09.586' N	037° 59.724' W	037° 59.392' W	10
POS536_94-1	30.08.2019	03:32	G	33° 09.277' N	33° 10.990' N	037° 59.872' W	038° 00.072' W	100
POS536_95-1	30.08.2019	04:48	G	33° 09.086' N	33° 11.720' N	037° 59.989' W	037° 59.370' W	300
POS536_100-1	30.08.2019	21:22	H	34° 39.407' N	34° 39.567' N	037° 31.874' W	037° 33.887' W	10
POS536_101-1	30.08.2019	22:30	H	34° 39.374' N	34° 39.750' N	037° 31.084' W	037° 33.355' W	100
POS536_102-1	30.08.2019	23:50	H	34° 39.286' N	34° 39.875' N	037° 31.009' W	037° 34.061' W	300
POS536_118-1	01.09.2019	13:06	I	33° 08.428' N	33° 07.320' N	036° 59.402' W	036° 59.793' W	10
POS536_119-1	01.09.2019	14:10	I	33° 08.999' N	33° 07.572' N	037° 00.064' W	037° 00.988' W	100
POS536_120-1	01.09.2019	15:26	I	33° 09.037' N	33° 06.896' N	037° 00.030' W	037° 01.401' W	300
POS536_127-1	02.09.2019	09:40	J	34° 14.595' N	34° 14.670' N	037° 01.106' W	037° 02.301' W	10
POS536_128-1	02.09.2019	10:36	J	34° 14.891' N	34° 15.370' N	037° 00.967' W	037° 02.940' W	100
POS536_129-1	02.09.2019	11:49	J	34° 14.961' N	34° 15.092' N	037° 00.654' W	037° 03.726' W	300
POS536_135-1	04.09.2019	08:02	K	33° 09.898' N	33° 08.659' N	033° 52.552' W	033° 52.757' W	10
POS536_136-1	04.09.2019	08:59	K	33° 09.958' N	33° 08.494' N	033° 52.583' W	033° 53.080' W	100
POS536_137-1	04.09.2019	10:09	K	33° 09.951' N	33° 07.650' N	033° 52.391' W	033° 52.531' W	300

5.5 Sediment sampling with multiple coring and box coring

(Kristin Hamann, Sarah-Marie Kröger, Jenny Friedrich, Matthias Haeckel (PI))

Research objectives and summary

To assess the vertical distribution of micro-plastic from the water surface to the deep-sea, sediment samples were supposed to be collected at every station.

However, for our research area, no detailed bathymetric maps or data on sediment conditions are published. Due to the silty to sandy sediments that we encountered within the working area no multicorer (MUC) deployment was successful, but sediment samples were collected with the box corer (BC) at 5 (C, D, E, F, H) out of 11 stations.

At station "I" the wire on the box corer broke and this prevented any further deployment of the gear.

Description of the gear: Multicorer (MUC)

The MUC is designed to recover undisturbed surface sediment sections along with the overlying bottom water. The MUC of GEOMAR is equipped with twelve 60 cm long plastic tubes (Figure 5.5-1). The MUC was used six times, but none of these deployments was successful (Table 5.5-1).

The MUC was lowered with a speed of 1 m/s till about 50 m above the seafloor, where it was stopped for approximately 1 minute and then lowered with a speed of 0.5 m/s until contact with the seafloor was monitored through the rope tension. The corer was left on the seafloor for about 1 minute, then pulled out with 0.1 m/s to 0.3 m/s and finally heaved with a speed of 1 m/s.

After some unsuccessful tries the MUC was only equipped with four liners to achieve a better weight to surface ratio. Still, no sediment was retrieved with the MUC. At station E we decided not to try further MUC deployments, but used two BCs instead. At station J another MUC deployment was tried after the wire of the BC broke. At station K a deployment was not possible as the water depth was below 3500 m and the ship's winch was only equipped for 3100 m.

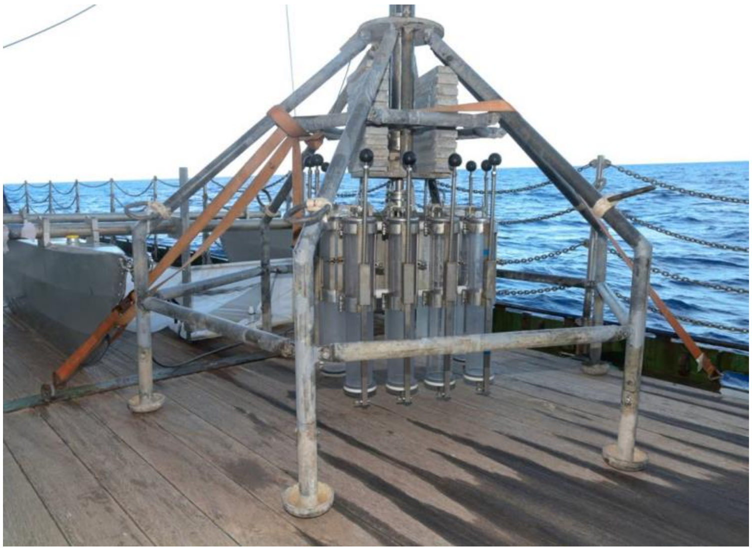

Figure 5.5-1 The multicorer on deck of RV Poseidon. Photo: Mark Lenz.

Table 5.5-1 Positions at which the multicorer (MUC) was deployed during POS536. Coordinates indicate the ship's GPS position.

D-Ship	Date	Time (UTC)	Number of liners	Area	Latitude	Longitude	Water depth (m)
POS536_29-1	22.08.2019	15:50	1 (probably disturbed)	C	33° 09.62'N	40°00.705'W	2956
POS536_40-1	23.08.2019	12:40	0	C	33° 08.849'N	40° 00.006'W	2928
POS536_43-1	24.08.2019	12:46	0	D	34° 38.527'N	39° 27.732'W	3027
POS536_44-1	24.08.2019	14:24	0	D	34° 38.496'N	39° 27.758'W	3029
POS536_68-1	26.08.2019	13:23	0	E	33° 08.833' N	038° 59.378' W	2154
POS536_125-1	02.09.2019	08:26	0	J	34° 14.701' N	037° 00.961' W	1473
POS536_126-1	02.09.2019	09:10	0	J	34° 14.611' N	037° 01.100' W	1417

Description of the gear: Box Corer (BC)

The BC was used to collect the silty to sandy and quite stiff sediment in the working area (Figure 5.5-3). The corer consists of a 50 cm x 50 cm x 60 cm stainless steel box that sinks into the sediment. A friction release frees the spade arm when the weight of the corer is relieved from the wire. When the wire is reeled in to return the device to the ship, the initial action is to lever the spade down into the substrate until it closes off the bottom of the core. Subsequent take-up on the wire pulls the apparatus out of the bottom. At the top of the core box a cylindrical valve allows free passage to water entering at the mouth. The valve is opened during the descent and closed by a friction release mechanism triggered by the spade closure.

The BC was operated over winch 3 and lowered at a speed of 1 m/s until it reaches a position at 100 m above the seafloor (Figure 5.5-2). After a stop of about one minute, the BC was lowered at a speed of 0.5 m/s to 0.8 m/s to the seafloor. Landing was visually assessed by a significant drop in rope tension. The winch was stopped 20 seconds after landing and the BC was pulled out after another 20 seconds. Pull out tension for successful box-coring is about 50 kN.

In total, the BC was deployed 12 times, while 7 deployments were successful (Table 5.5-2). In area A and B, the BC was not deployed due to the fact the water depths exceeded the available cable length. After the 12th deployment, the wire was eroded and further deployments were considered too risky. For this reason, there were no BC deployments in area J and K.

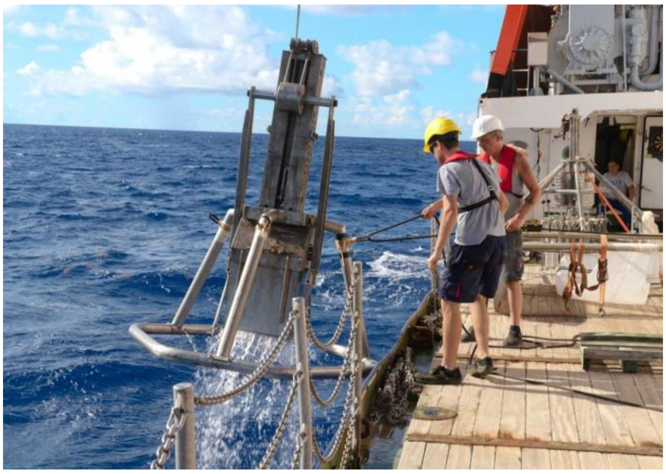

Figure 5.5-2 Recovery of the box corer after deployment to 3000 m water depth. Photo: Mark Lenz.

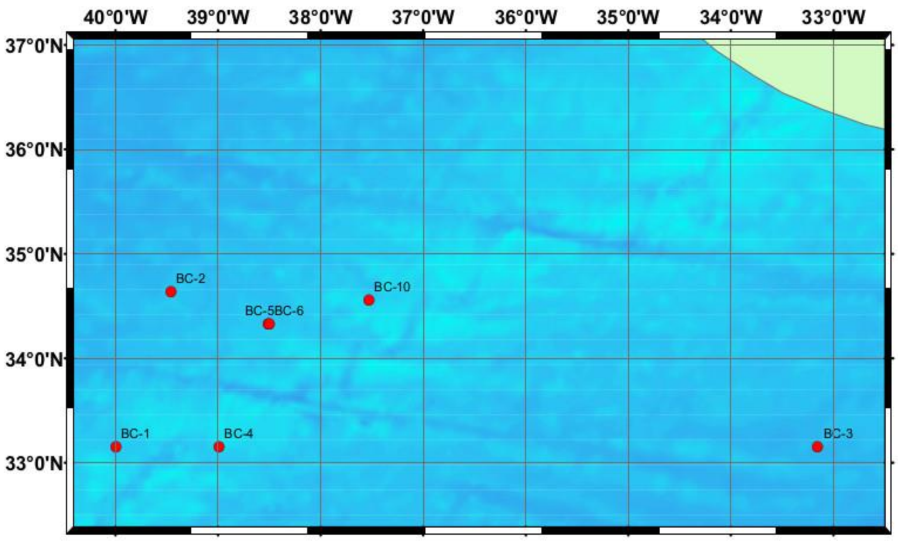

Figure 5.5-3 Stations at which boy corers were taken during POS 536.

Sampling

When the box corer was back on deck, the box was taken out of the gear for sampling. First, the geochemists put one to five MUC-liners into the sediment, leaving the rest of the sediment for the biologists (Figure 5.5-4).

After the liners were pushed into the stiff sediment, the sediment water was soaked out and filtered before the front cover of the box was opened. Only in 2 out of the 7 successful deployments the BC held surface water.

Then the biologists removed two sediment layers: 0-3 cm and 3-6 cm and divided these in two grain size fractions by sieving.

The sediment was first washed through a 1000 µm and then through a 500 µm stainless steel sieve. Particles that remained on the sieves were stored in glass containers and preserved in a 4% formaldehyde/seawater solution. A first inspection under a dissecting microscope revealed that the sediment > 500 µm contained mostly foraminifera shells, while the fraction >1000 µm revealed mostly shells of scaphopods, pteropods and a few small stones. No living organisms were found in the upper 6 cm of the sediment during sieving.

The liners were taken out and individually sliced into segments of 0 – 3 cm, 3 – 6 cm and 6 - 9 cm, whereas the rest was discarded. The surface water, if any was available, was stored with the 0 – 3 cm sample of the respective liner.

In total, we collected 40 samples.

At the beginning only one liner was taken by the geochemists as it was planned to take more samples of the MUC-deployments. After later BC-deployments up to five liners were taken from one BC.

For geochemical analysis, the liner was sliced in steps of 1 cm until a depth of 10 cm was reached and then in steps of 2 cm from there to the lower end of the liner. The sediment was stored in whirlpacks and cooled.

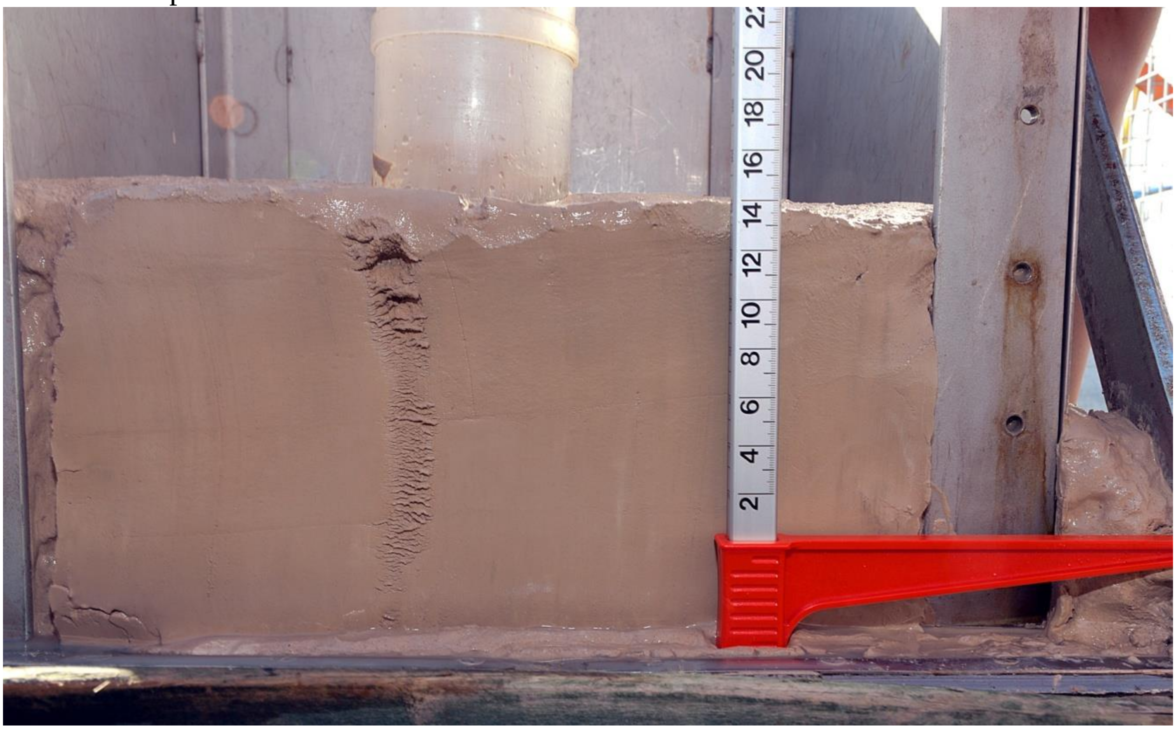

Figure 5.5-4 The sediment, which was collected by the box corer in the working area, was silty to sandy and very stiff. Photo: Mark Lenz.

Figure 5.5-5 Taking liners from the box corer. Photo: Mark Lenz.

Sample processing and analysis at GEOMAR

The collected sediment samples will now be dried to avoid strong microbial degradation during storage. Samples will be processed sequentially for microplastic extraction by density separation and filtering as well as subsequent microscopic particle quantification and Raman spectroscopic polymer identification. This will likely take until the end of 2020.

Additional sediment subsamples are currently being processed for porosity measurements (by weight difference before and after freeze-drying), determination of solid phase POC, PON, TS and $CaCO_3$ contents as well as porewater cation and anion analyses.

Table 5.5-2 Positions at which sediment samples were taken with the box corer (BC) during POS536. Coordinates indicate the ship's GPS position.

D-Ship	Date	Time (UTC)	Sampled depth (cm)	Sample number	Area	Latitude	Longitude	Depth (m)
28-1	22.08.2019	12:58	0-3 3-6 6-9	1 2 3	C	33° 09.478'N	40° 00.251'W	2931
42-1	24.08.2019	09:04	0-3 3-6 6-9	4 5 6	D	34° 38.59'N	39° 27.875'W	3037
66-1	26.08.2019	09:16	0-3 3-6 6-9 0-3 3-6 6-9 0-3 3-6 6-9 14	7 8 9 10 11 12 13 14 15 *12 whirlpacks*	E	33° 09.081' N	38° 59.641' N	2271

D-Ship	Date	Time (UTC)	Sampled depth (cm)	Sample number	Area	Latitude	Longitude	Depth (m)
67-1	26.08.2019	10:31	0-3 3-6 6-9	16 17 18	E	33° 09.081' N	38° 59.507' W	2171
72-1	28.08.2019	08:46	0-3 3-6 6-9	19 20 21	F	34° 19.957' N	38° 30.378' W	3043
73-1	28.08.2019	10:47	0-3 3-6 6-9 0-3 3-6 6-9 0-3 3-6 6-9 0-3 3-6 6-9 14	22 23 24 25 26 27 28 29 30 31 32 33 *12 whirlpacks*	F	34° 19.568' N	38° 30.614' W	3051
84-1	29.08.2019	08:45		empty	G	33° 09.331' N	37° 59.851' W	3064
85-1	29.08.2019	10:13		empty	G	33° 09.102' N	38° 00.033' W	3070
104-1	31.08.2019	08:32		empty	H	34° 39.029' N	37° 30.302' W	3066
105-1	31.08.2019	10:48	water sample 0-3 3-6 6-9 0-3 3-6 6-9 16	34 35 36 37 38 39 40 *13 whirlpacks*	H	34° 33.329' N	37° 32.261' W	2593
116-1	01.09.2019	08:48		empty	I	33° 09.003' N	36° 59.976' W	2980
117-1	01.09.2019	10:20		empty	I	33° 09.046' N	36° 59.994' W	2973

5.6 Thorium isotope tracer measurements and particle filtration with the Kiel-In-Situ-Pump system (KISP)

(Aaron J. Beck, André Mutzberg, Eric Achterberg (PI))

This is a novel application of the naturally-occurring ^{234}Th tracer to quantify the vertical flux of microplastic particles under the North Atlantic garbage patch.

Less than approximately 10 % of the plastic entering the ocean can currently be accounted for, likely due to fragmentation into small microplastics that are exported from the surface to the deep ocean. The radionuclide ^{234}Th has a half-life of 24.1 days, and is constantly produced by the decay of its parent ^{238}U. While U is highly soluble and mixes conservatively in oxygenated waters, ^{234}Th scavenges strongly to particle surfaces. Export of particulate ^{234}Th from the euphotic zone to the deep ocean produces a ^{234}Th deficit in the upper water column equal to the export flux. With information on the microplastic to ^{234}Th ratio (MP/^{234}Th) in sinking particles, the vertical fluxes of MPs can be quantified. These export fluxes will be used to improve the marine plastic mass balance, and determine if a deep ocean sink can account for the missing plastic mass.

During POS536, unfiltered seawater samples along a depth profile in the upper 500 m of the water column were collected with Niskin bottles mounted on a traditional CTD at 7 stations (Table 5.6-1; Fig. 5.6-1). Total ^{234}Th activities, which include both dissolved and particulate phases, were determined on 4 l samples, and up to 16 l each were collected for particulate ^{234}Th. Stations were chosen within the accumulation zone of the North Atlantic garbage patch (Cozar et al., 2014), where the highest MP abundances were expected. High vertical resolution sampling was performed within the upper 200 m, where most of the biological activity occurs. Additional samples were collected as deep as 500 m. Filtered (0.45 µm PES) seawater (10 ml) for ^{238}U concentrations was sampled from the same Niskin bottles as for ^{234Th} (Figure 5.6-2). Additional samples for dissolved plastic leachates were collected downstream of the particulate ^{234}Th filters by preconcentration on SPE-columns.

At 6 CTD stations, suspended and sinking particulates (>10 µm on stainless steel mesh) were collected using the Kiel In Situ Pump system (KISP) (Figure 5.6-3, Table 5.6-2) that was deployed with the CTD cable. These KISP stations comprise a transect across the mid-ocean ridge (Fig. 5.6-4) and within the core of the North Atlantic garbage patch.

Figure 5.6-1 Samples of unfiltered seawater were collected along a depth profile in the upper 500 m of the water column by Niskin bottles that were mounted on the CTD. Photo: Mark Lenz.

Figure 5.6-2 Water samples from the Niskin bottles were pre-filtered for the later follloed determination of ^{238}U concentrations. Photo: Mark Lenz.

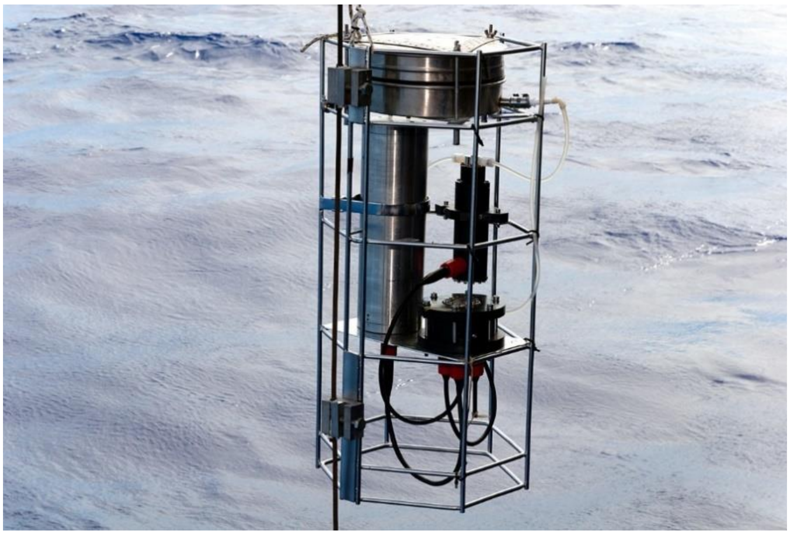

Figure 5.6-3 At six stations, particulates were collected from various water depth using the Kiel-In-Situ-Pump system. Photo: Mark Lenz.

Further samples for particulate ^{234}Th and microplastics (>10 µm) were collected from the underway seawater system along four transects using a stand-alone filtration unit (10 µm stainless steel mesh) that was connected to the POSEIDON aquarium pump seawater tap (Table 5.6-3).

The chemical separation of thorium from seawater on board followed Van Der Loeff et al. (2006). Thorium was co-precipitated with MnO_2 and filtered onto 25 mm silver filters (3 µm pore size). These precipitates were dried in an oven at 50˚C for several hours before analysis. Filters of both total and particulate ^{234}Th were mounted onto the Risø sample holders, and initial activities of ^{234}Th were counted on the Risø low-level beta GM multicounter.

Silver filters were used to collect particulate material to avoid contamination from plastic filter membranes, and to allow detection and identification of MP particles, as well as particulate organic carbon (POC). This method will provide the MP/Th ratio for quantifying MP export fluxes to the deep ocean.

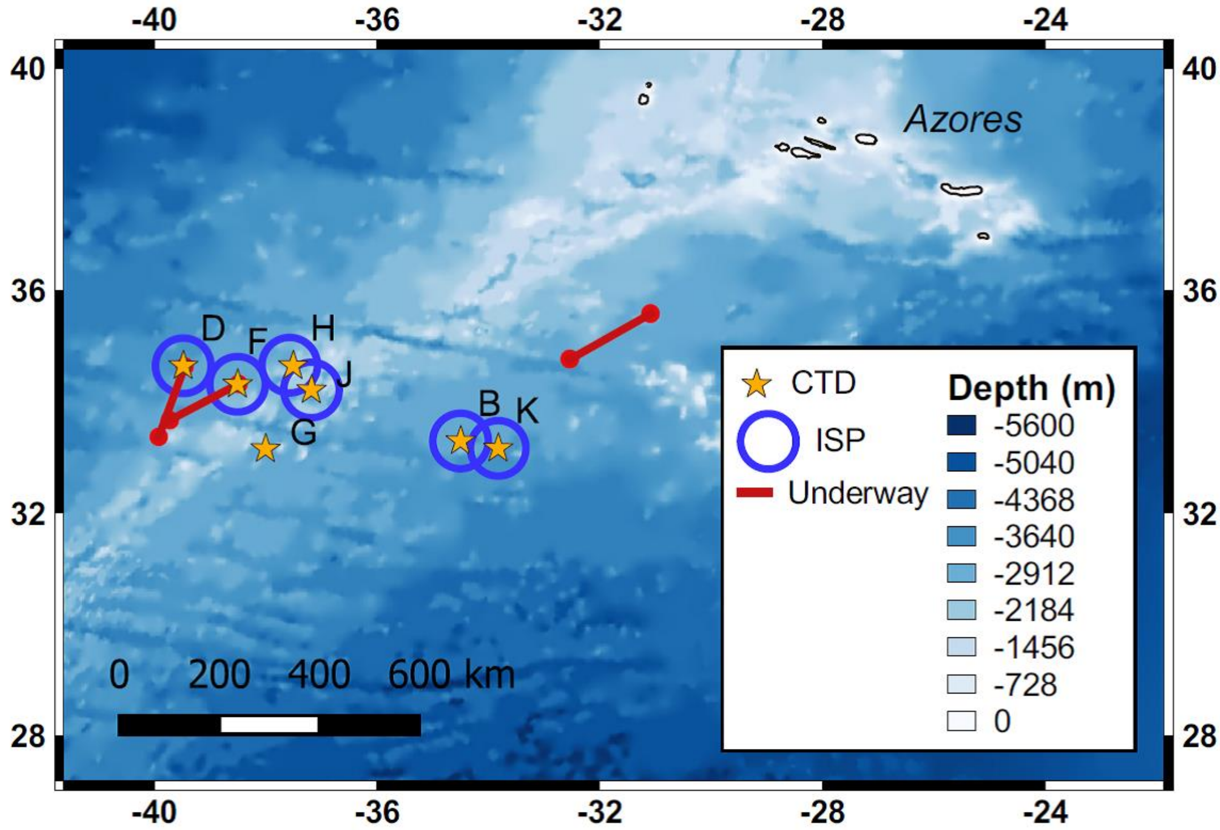

Figure 5.6-4 Stations at which either water samples were taken with the CTD or at which the In-Situ-Pump (ISP) system was deployed.

Table 5.6-1 List of stations at which seawater was collected with the CTD for total ^{234}Th, Uranium, particulate ^{234}Th, microplastics and plastic leachates during POS536.

D-Ship	Date	Time (UTC)	Area	Latitude	Longitude	Depths (m)
POS536_26-1	20.08.2019	16:39	B	33°17.564´N	034°29.724´W	300,150,100,75,25
POS536_41-1	24.08.2019	01:59	D	34°38.676´N	039°28.616´W	300,150,100,75,50,25
POS536_71-1	28.08.2019	02:10	F	34°18.769´N	038°30.130´W	300,150,100,75,50,25
POS536_96-1	30.08.2019	07:05	G	33°09.066´N	037°59.975´W	500,300,100,10
POS536_103-1	31.08.2019	02:06	H	34°39.369´N	037°33.936´W	CTD failed
POS536_109-1	31.08.2019	15:53	H	34°38.755´N	037°30.174´W	300,150,75,25
POS536_133-1	02.09.2019	16:57	J	34°12.681´N	037°10.490´W	300,150,75,25
POS536_144-1	04.09.2019	16:25	K	33°09.643´N	033°49.178´W	300,150,75,50

Table 5.6-2 List of stations at which the in situ-pumps were used for sampling particulate ^{234}Th and microplastics during POS536.

D-Ship	Date	Time (UTC)	Area	Latitude	Longitude	Depths (m)
POS536_26-1	20.08.2019	16:39	B	33°17.564´N	034°29.724´W	300,150,75,50
POS536_41-1	24.08.2019	01:59	D	34°38.676´N	039°28.616´W	300,150,75,50
POS536_71-1	28.08.2019	02:10	F	34°18.769´N	038°30.130´W	300,150,75,50
POS536_103-1	31.08.2019	02:06	H	34°39.369´N	037°33.936´W	CTD failed
POS536_133-1	02.09.2019	16:57	J	34°12.681´N	037°10.490´W	300,150,75,50
POS536_144-1	04.09.2019	16:25	K	33°09.643´N	033°49.178´W	150,75,50

Table 5.6-3 List of underway water samples for particulate ^{234}Th and microplastics.

Station number/sample ID	Latitude start	Longitude start	Latitude stop	Longitude stop
POS536_29-1-UWS-1	35°35,74´N	031°05,82´W	34°46,62´N	032°32,48´W
POS536_62-1-UWS-2	33°22,66´N	039°55,48´W	34°38,65´N	039°27,84´W
POS536_84-1-UWS-3	35°35,74´N	031°05,82´W	34°46,62´N	032°32,48´W
POS536_111-1-UWS-4	33°40,64´N	039°43,69´W	34°19,99´N	038°29,98´W

Sample processing and analysis at GEOMAR

Filters of both total and particulate ^{234}Th will be re-counted on the Risø low-level beta GM multicounter 5 months after sample collection, at which time ^{234}Th will have decayed to undetectable levels. The original beta activities will be corrected for any residual activity (i.e., from other nuclides with longer half-life). After the final counting, total ^{234}Th samples will be dismounted and dissolved in a mixture of H_2O_2 and HNO_3, and analyzed by ICP-MS to determine chemistry yield (Pike et al., 2005). Particulate ^{234}Th samples will be dismounted for MP analysis by FTIR or Raman spectroscopy, followed by POC analysis in order to determine the MP/^{234}Th and POC/^{234}Th ratios.

Seawater samples for uranium concentrations will be measured on the Element ICP-MS (Owens et al., 2011). We expect all chemical processing and analysis be completed within half a year from the end of POS536.

5.7 Drifting Sediment Traps

(L. Galgani, J. Roa, C. Schlundt, A. Engel (PI))

Research objectives and summary

Most of the particulate matter that is suspended in the water column is very fine, while larger particles rapidly sink to the benthic environment.

To characterize the ambient particle field in a given water body and to quantify the rates at which particles sink, *in-situ* particle collectors or *sediment traps* have been developed to distinguish between the permanently suspended and the sinking particulate matter.

Sediment traps collect small sediment particulates or larger accumulations called *marine snow*, which consist of organic matter, dead organisms, tiny shells, atmospheric dust and minerals. These sampling approaches are necessary to study important biogeochemical ocean processes and to assess seasonal variations in fluxes. They allow, inter alia, to describe the relationship between the rate of primary production and the downward flux of particulate organic matter and help to understand how fast nutrients and elements like carbon, nitrogen, phosphorus, calcium, and silicon move from the ocean surface to the deep sea. In the context of researching the fate of microplastics in open ocean environments, they allow to quantify the vertical transport of the anthropogenic particles and this will help us to understand how fast microplastics pass through the water column on their way to the deep sea benthos.

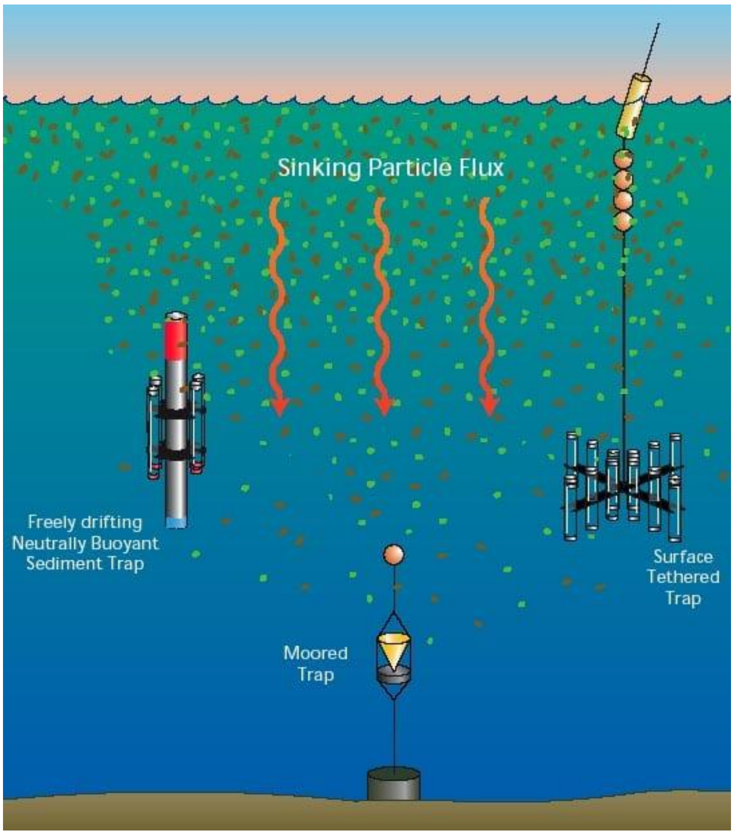

Figure 5.7-1 Different types of sediment traps (from WHOI).

Description of the gear

During POS536 cruise, we deployed a surface tethered drifting trap (Figure 5.7-1.) to collect sinking particulate matter and to capture plastic particles on their descent to the seafloor. The material collected was pre-screened (500 µm) to remove zooplankton and visible plastic particles for later separate identification.

The system consisted of eight arrays mounted on a PVC cross frame to collect sinking material at 50 m, 100 m, 150 m, 200 m, 300 m, 400 m, 500 m and 600 m. Each array contained twelve Particle Interceptor Traps (PITs) of which two served as blank controls for plastic contamination while handling the devices (Figure 5.7-2a). The PITs were 7 cm in diameter and 53 cm in height with an aspect ratio of 7.5 and a collection area of 0.0038 m^2. The procedures for PIT preparation and sample recovery followed Engel et al. (2017). Each PIT was filled with ~1.5 l of filtered seawater (0.2 µm) that was collected from a depth of 300 m up to 24hrs before deployment. 500 ml brine solution, which was prepared by adding 50 g NaCl per l of 0.2 µm filtered seawater were added through a tube to the bottom of each PIT. The difference in salinity allowed sinking particles to enter the traps, while the density gradient prevented that the particles escaped from the traps again.

Ten traps in each array were equipped with a top Acrylic glass baffle to restrain the entry of swimmers. Two blanks per array were closed with the red plastic lid and therefore did not collect any material but served as extra units that allowed to assess the potential contamination of the samples with plastics while handling and preparing the PITs.

During the cruise sediment traps were deployed twice (Table 5.7) and remained drifting in the water for 5 days, what was the longest possible time spam for the deployment, chosen to allow the collection of a maximum of sinking material.

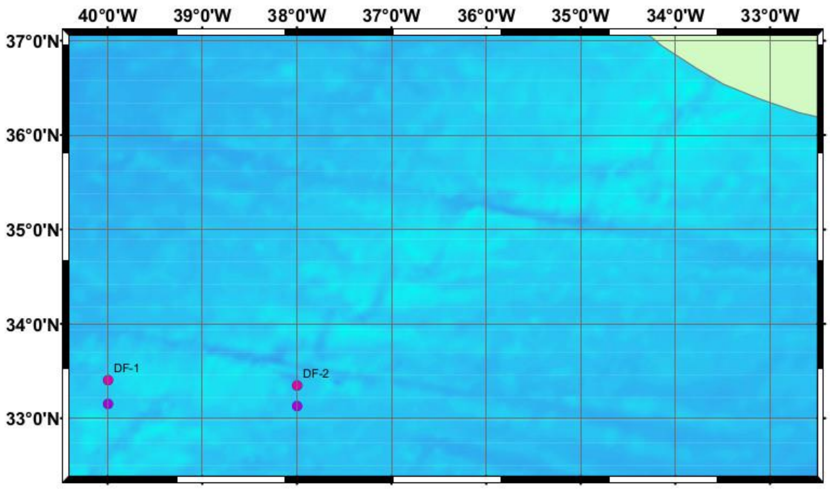

Figure 5.7-2 Positions at which sediment traps were deployed and retrieved during POS536.

Table 5.7 Positions at which sediment traps were deployed and retrieved during POS536.

Dship	**Date of deployment/recovery**	**Time in water (UTC)**	**Latitude (in water) Longitude (in water)**	**Time on deck (UTC)**	**Latitude (on deck) Longitude (on deck)**
POS536_27-1	22.08.2019	9:50	33° 09.086’ N 39° 59.687’ W		
POS536_70-1	27.08.2019			9:25	33° 24.455’ N 40° 13.788’ W
POS536_86-1	29.08.2019	14:16	33° 08.129’ N 37° 59.550’ W		
POS536_134-1	03.09.2019			9:26	33° 20.801’ N 37° 20.931’ W

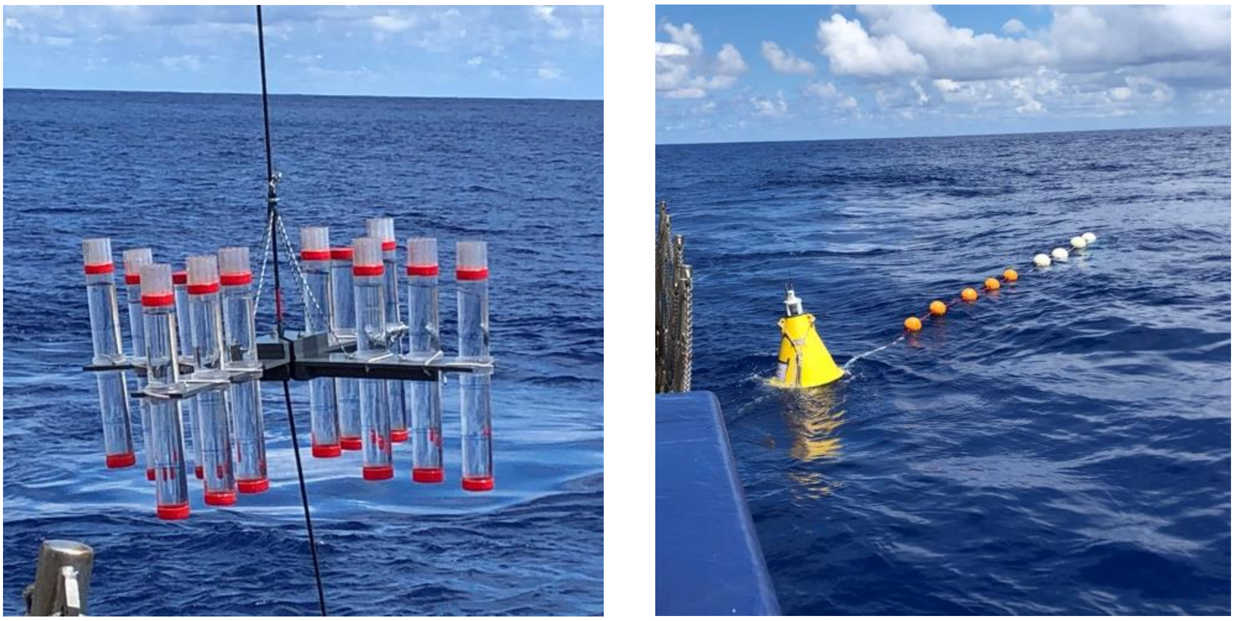

Figure 5.7-3 a) The x-shaped arrays in which each arm was holding three of 12 traps, i.e. 10 samples and two blanks. b) The floats and the buoy, which held the sediment traps in the water column, after deployment (Photo: Luisa Galgani).

The sediment trap system was previously tested during several expeditions in different oceanic areas (e.g. Engel et al. 2017). Each array is hooked onto a main rope, which has marks for the different water depths at which the traps are supposed to be deployed. Its lower end is attached to a weight of 70 kg, while its upper is connected to five smaller (orange) and seven bigger floats (white) as well as a yellow buoy (Figure 5.7-2b). The yellow buoy carries two GPS beacons: an Argos and an Iridium system and a flashlight to allow for tracking and recovery of the traps after they drifted freely in the ocean.

Sample processing and analyses

Blanks and contamination controls

Almost all of the equipment that was associated with the deployment of the sediment traps was made of plastic. Therefore, each array (for every depth and every deployment) contained two traps that served as blank controls.

These traps, similar to those that were destined for sampling, were filled with filtered brine and filtered seawater, but they were kept sealed during deployment, so that neither particles nor seawater could enter the trap.

These served to assess any potential source of contamination that was caused by the set-up or the handling of the system.

The blanks were successively pooled and filtered through pre-combusted GF/F glass fiber filters for later RPy-GCMS. As an additional measure to prevent contamination, in particular with synthetic fibers, we worked in 100 % cotton clothes while preparing the set-up and handling the samples.

After recovery, most of the filtered seawater in the traps was removed from them, while the brine, which contained the sampled material, from the ten traps and two blanks per depth was pooled to become one sample (Figure 5.7-3). On board of RV POSEIDON, all particulate matter contained in one sample was filtered to pre-weighted polycarbonate 0.4 µm membranes.

Figure 5.7-4 The seawater from the sediment traps was removed, while the brine fractions from 10 traps and the 2 blanks, which came from the same water depth, were pooled in one sample. Photo: Mark Lenz.

Material from PITs was collected on different filters on board and stored frozen or dry for later analysis at GEOMAR or partner laboratories. Particulate material collected on pre-combusted GF/F filters (0.7 µm) will be analyzed for plastic hydrocarbons, particulate organic carbon (POC), total particulate carbon (TPC) and Chlorophyll a (Chl a). **Plastic hydrocarbons** will be determined after removal of all organic particles by acid hydrolysis, using Ramped Pyrolysis coupled with Gas Chromatography and Mass Spectrometry (RPy-GC-MS) in collaboration with Z. Liu, University of Texas, US. **(POC)** will be analyzed by high temperature combustion and elemental CN analysis after exposure to fuming hydrochloric acid overnight to remove carbonates. **TPC** will be determined by high-temperature combustion. The PIC (Particulate Inorganic Carbon) will be calculated by subtracting the POC from TPC (TPC = PIC + POC).

Chl a will be quantified by fluorometry after acetone extraction.

For determination of marine gels (Transparent Exopolymer Particles, TEP, and Coomassie Stainable Particles, CSP) different aliquots of trap material were filtered onto 0.4 µm polycarbonate membranes (Nuclepore). The number and size of marine gel particles in the descending flux to the seafloor will be analyzed by brightfield microscopy and quantified by image analysis.

To examine microbial colonization of particles, samples for CLSM – Confocal Laser Scanning Electron Microscope were filtered onto black 0.2 µm polycarbonate membranes. Filters will be stained with fluorescent probes and analyzed by CLSM to individuate biological material attached to plastic particles (< 500 µm).

In addition individual particles > 500 µm that appeared to contain plastic were isolated from 300m, 200m and 150m respectively. The ones collected in traps at 200m and 150 m depths have a spherical shape. From the second deployment, only an irregular fragment was found in the traps deployed at 300m. These particles have been fixed in formaldehyde and subsequently washed and preserved in Eppendorf tubes in a mix of 50:50 Ethanol:Milli-Q water for later analysis of the biofilm community composition by CLSM.

Total mass of sinking particles collected in the PITs will be determined from aliquots of trap material filtered onto pre-weighed 0.4 µm polycarbonate filters using a microbalance.

5.8 CTD and water sampler rosette

(André Mutzberg, Thea Hamm)

A CTD with a water sampler rosette was used to collect oceanographic data at the stations B – K (Figure 5.8-1, Table 5.8). The system was operated with winch 2 from the port side of RV Poseidon and water depths to which the device was deployed were controlled by pressure and altimeter readings.

The CTD was equipped with 6 pressure sensors: 2 temperature sensors, 2 oxygen sensors and 2 conductivity sensors. Furthermore, pH (SBE27) and altimeter sensors were attached. The SBE underwater unit and Niskin bottle carousel motor were powered via the winch's coaxial-cable by using the modem/power unit from SST (Linke et al., 2015).

CTD data recording and triggering of the Niskin bottles were controlled with the SEASAVE software (version 7.21) on an external laptop. CTD data were recorded with 24 Hz. GPS position data were logged parallel to the CTD.

Figure 5.8-1 The CTD with the water sampler rosette. Photo: Mark Lenz

Hydro-casts and hydrographic data from towed CTDs were processed by using the SBE software SBE7.22.1. Usually data files of 1 minute bins and 1 meter bins were created from raw data files and exported to ASCII.

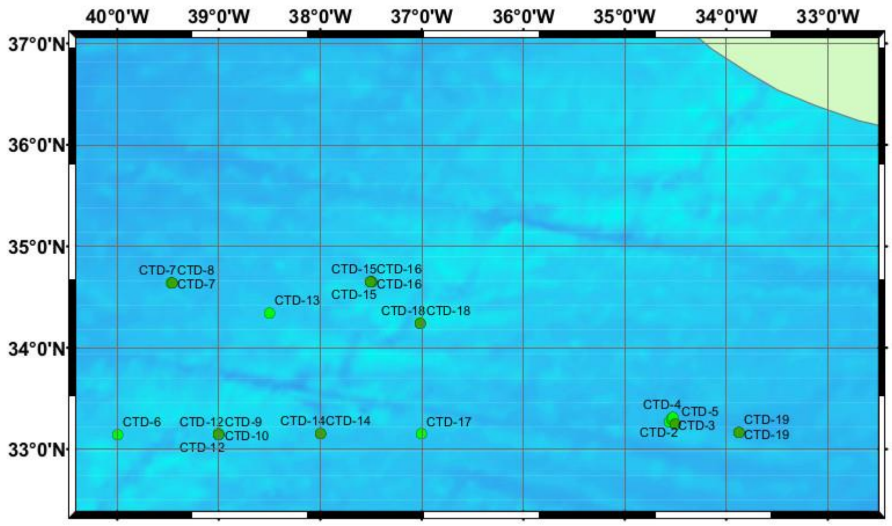

Figure 5.8-2 Stations at which CTD profiles were taken during POS536.

Table 5.8 Stations at which the CTD system was deployed during POS536.

D-Ship	Date	Time/max.depth (UTC)	Area	Latitude/max. depth	Longitude/max depth
POS536_22-1	20.08.2019	12:58	B	33°16.63'N	034°32.97'W
POS536_23-1	20.08.2019	14:05	B	33°17.74'N	34°32.22'W
POS536_24-1	20.08.2019	14:45	B	33°18.39'N	34°31.86'W
POS536_25-1	20.08.2019	15:16	B	33° 18.80'N	34° 31.49'W
POS536_26-1	20.08.2019	16:39	B	33°15.256'N	34°29.895'W
POS536_39-1	23.08.2019	10:25	C	33° 08.87'N	39° 59.97'W
POS536_41-1	24.08.2019	01:59	D	34°38.630'N	39°27.826'W
POS536_54-1	25.08.2019	07:43	D	34° 38.59' N	39° 27.97'W
POS536_64-1	26.08.2019	05:39	E	33° 08.90' N	38° 59.813'W
POS536_65-1	26.08.2019	06:37	E	33° 09.128' N	38° 59.905'W
POS536_69-1	26.08.2019	14:22	E	33°08.981'N	39°00.020'W
POS536_71-1	28.08.2019	02:10	F	34° 19.947' N	38° 30.012'W
POS536_83-1	28.08.2019	22:29	F	34° 19.933' N	38° 30.331'W
POS536_96-1	30.08.2019	07:05	G	33° 09.122' N	37° 59.967'W
POS536_103-1	31.08.2019	02:06	H	34°39.097'N	37°30.029'W
POS536_109-1	31.08.2019	15:53	H	34° 38.912' N	37° 30.121'W
POS536_121-1	01.09.2019	17:33	I	33° 08.991' N	37° 00.182'W
POS536_133-1	02.09.2019	16:57	J	34° 14.572' N	37° 01.210'W
POS536_144-1	04.09.2019	16:25	K	33° 09.916' N	33° 52.464'W

5.9 pCO2 and microplastic sampling in the mixed layer

(Sarah-Marie Kröger, Kristin Hamann, Toste Tanhua (PI))

Description of the gear

We used an OceanPack™Race instrument manufactured by SubCtech GmbH (Kiel, Germany) for recording pCO2 in the surface mixed layer during the cruise. The instrument was installed in the main laboratory of POSEIDON and was connected to the ship’s seawater inlet while the vessel was in Bremerhaven prior to the cruise. During the cruise, the system was started as soon as the the vessel had left the Portuguese EEZ. The instrument operated continuously for 19 days, with a short interruption on August 30th as there was a technical problem with the pump that supplied the seawater. On September 6th a faulty gas pump of the LiCor detector stopped the measurements. The pump could not be repaired on board and, hence, the operation was suspended at this point.

The pCO2 data were calibrated twice a day with zero air (i.e. air with no CO_2 in it) from a soda lime scrubber, and twice daily from a span gas calibrated by the ICOS laboratory. The instrumentation also measured temperature and salinity. The data will be processed and submitted to the SOCAT data base (www.socat.info).

The microplastics sampling equipment of the OceanPack™Race consisted of sets of three custom-built stainless-steel filters with an opening diameter of 44 mm and mesh-size of 28, 100 and 500 µm. The seawater that was pumped to the pCO2 system of the OceanPack was diverted to the microplastics filtration system before reaching the pCO2 system. The filters were exchanged daily and in total 18 filter sets were collected during POS536. The filters were stored in aluminum bags for later analysis. The pCO2 system was connected to the microplastics filtration system and logged the flow of water through the filters so that the total amount of water that passed a filter can be calculated. The samples are in a laboratory in Kiel and will be processed as soon as machine time for the spectroscopic analysis is available.

Table 5.9 Stations at which filters from the OceanPack™Race were collected during POS536.

Station (group protocol	DShip	Area	Date	Time	Latitude	Longitude
POS536_19-1_OP_1	NA	A	19.08.2019	18:18	35°35.02'N (erroneous)	031°04.97'W
POS536_34-1_CTD-5	NA	B	19.08.2019	18:05	33°16,13`N	34°29,54`W
POS536_41-1_OP-2	NA	B-C	21.08.2019	18:15	32°59.21'N	37°52.85`W
POS536_45-1_OP-3	NA	C	22.08.2019	18:15	33° 09.81'N	40°00.86'W
POS536_60-1_OP-4	NA	C-D	23.08.2019	18:14	33° 42.33'N	39° 48.95'W
POS536_69-1_OP-5	NA	D	24.08.2019	18:15	34° 34.36'N	39° 26.84'W
POS536_81-1_OP-6	NA	D-E	25.08.2019	18:15	33° 22.13'N	39° 04.04'W
POS536_102-1_OP-7	NA	E-F	26.08.2019	18:15	33° 08.968'N	39° 00.031'W
POS536_109-1_OP-8	NA	E-F	27.08.2019	18:15	33° 51.46'N	39° 23.51'W
POS536_121-1_OP-9	NA	F	28.08.2019	18:05	34° 19.38'N	38°30.29'W
POS536_133-1_OP-10	NA	G	29.08.2019	18:05	33° 00.479'N	37° 58.040'W
POS536_149-1_OP-11	NA	H	30.08.2019	18:15	34° 38.939'N	37° 30.134'W
POS536_163-1_OP-12	NA	H-I	31.08.2019	18:34	34° 19,19'N	37°23.34'W
POS536_180-1_OP-13	NA	I-J	01.09.2019	18:00	33° 08.92'N	37°00.26'W
POS536_192-1_OP-14	NA	J	02.09.2019	18:00	34° 14.528'N	37° 01.409'W
POS536_202-1_OP-15	NA	J-K	03.09.2019	18:15	33° 20.557' N	036° 01.258' W
POS536_216-1_OP-16	NA	K	04.09.2019	18:15	33° 09.916' N	033° 52.464' W
POS536_220-1_OP-17	NA	Transit	05.09.2019	18:00	33° 46.32'N	30° 19.08'W
POS536_221-1_OP-18	NA	Transit	06.09.2019	10:00	34° 14.34'N	29°42.71'W

6. Ship's Meteorological Station

No data were collected about the ship's meterological station on POS536.

7. Station list POS 536

Table 7.1: Summary of all research activities and stations during POS536. UWS = Underway water sample, NA = not available.

Station	DShip	Area	Date	Time	Gear	Latitude (start)	Longitude (start)	Latitude (end)	Longitude (end)	Status/Comment
1	POS536_1-1	A	18.08.2019	18:17	Neuston Trawl	35° 34.984' N	031° 04.929' W	35° 35.942' N	031° 06.014' W	
2	POS536_2-1	A	18.08.2019	18:56	Neuston Trawl	35° 35.021' N	031° 07.405' W	35° 35.905' N	031° 08.429' W	
3	POS536_3-1	A	18.08.2019	19:33	Neuston Trawl	35° 34.261' N	031° 09.178' W	35° 35.348' N	031° 09.938' W	
4	POS536_4-1	A	18.08.2019	22:58	Neuston Trawl	35° 22.563' N	031° 37.507' W	35° 23.872' N	031° 37.949' W	
5	POS536_5-1	A	18.08.2019	23:47	Neuston Trawl	35° 22.239' N	031° 39.517' W	35° 23.680' N	031° 39.484' W	
6	POS536_6-1	A	19.08.2019	00:30	Neuston Trawl	35° 22.295' N	031° 40.829' W	35° 23.809' N	031° 40.885' W	
7	POS536_0_Underway-1	A	19.08.2019	08:00	Monitoring	34°46.756'N	32°27.550'W	34°46.011'N	32° 31.689'W	
8	POS536_7-1	A	19.08.2019	08:27	Neuston Trawl	34° 45.189' N	032° 30.141' W	34° 46.530' N	032° 30.891' W	
9	POS536_0_Underway-2	A	19.08.2019	09:00	Monitoring	34°45.907'N	32°32.061'W	34°47.778'N	032°34.965'W	
10	POS536_8-1	A	19.08.2019	09:07	Neuston Trawl	34° 46.037' N	032° 32.116' W	34° 47.410' N	032° 32.998' W	
11	POS536_9-1	A	19.08.2019	09:45	Neuston Trawl	34° 46.630' N	032° 34.255' W	34° 47.966' N	032° 35.101' W	
12	POS536_0_Underway-2	A	19.08.2019	12:00	Monitoring	34°34.880'N	32°47.328'W	34°27.530'N	32° 54.034'W	
13	POS536_0_Underway-2	A	19.08.2019	13:00	Monitoring	34°27.197'N	32°54.342'W	34°19.852'N	33° 01.039'W	
14	POS536_10-1	A	19.08.2019	15:31	Neuston Trawl	34° 10.098' N	033° 09.991' W	34° 11.504' N	033° 10.641' W	
15	POS536_0_Underway-2	A	19.08.2019	15:30	Monitoring	34°10.122'N	33°09.997'W	34°11.152'N	33° 12.553'W	
16	POS536_11-1	A	19.08.2019	16:09	Neuston Trawl	34° 10.156' N	033° 11.554' W	34° 11.149' N	033° 12.550' W	
17	POS536_12-1	A	19.08.2019	16:48	Neuston Trawl	34° 09.428' N	033° 13.343' W	34° 10.508' N	033° 14.139' W	
18	POS536_0_Underway-2	A	19.08.2019	16:30	Monitoring	34°11.185'N	33°12.594'W	34°08.890'N	33° 16.517'W	
19	NA	A	19.08.2019	18:18	Ocean Pack	35°35.02'N (possibly erroneous)	031°04.97'W	NA	NA	
20	POS536_13-1	B	20.08.2019	02:30	Neuston Trawl	33° 15.193' N	034° 29.977' W	33° 16.338' N	034° 31.328' W	
21	POS536_14-1	B	20.08.2019	03:09	Neuston Trawl	33° 15.317' N	034° 31.907' W	33° 16.750' N	034° 33.048' W	
22	POS536_15-1	B	20.08.2019	03:51	Neuston Trawl	33° 15.704' N	034° 33.479' W	33° 16.860' N	034° 34.876' W	
23	POS536_16-1	B	20.08.2019	04:34	Bongo Net	33° 16.458' N	034° 34.723' W	33° 16.051' N	034° 36.155' W	
24	POS536_17-1	B	20.08.2019	05:25	Bongo Net	33° 15.858' N	034° 33.317' W	33° 16.647' N	034° 35.991' W	
25	POS536_18-1	B	20.08.2019	06:36	Bongo Net	33° 15.748' N	034° 33.869' W	33° 16.346' N	034° 38.284' W	
26	POS536_19-1	B	20.08.2019	08:31	WP2 Net	33° 15.701' N	034° 33.497' W	33° 16.382' N	034° 33.419' W	
27	POS536_20-1	B	20.08.2019	09:10	WP2 Net	33° 16.478' N	034° 33.408' W	33° 17.390' N	034° 33.053' W	

Station	DShip	Area	Date	Time	Gear	Latitude (start)	Longitude (start)	Latitude (end)	Longitude (end)	Status/Comment
28	POS536_21-1	B	20.08.2019	10:03	WP2 Net	33° 17.456' N	034° 33.027' W	33° 18.812' N	034° 32.251' W	
29	NA	A	19.08.2019	09:15	UWS	35°35.74'N	31°05.82'W	NA	NA	
30	POS536_22-1	B	20.08.2019	12:29	CTD	33° 16.128' N	034° 33.343' W	33° 17.101' N	034° 32.598' W	
31	POS536_23-1	B	20.08.2019	14:00	CTD	33° 17.682' N	034° 32.282' W	33° 17.826' N	034° 32.152' W	
32	POS536_24-1	B	20.08.2019	14:38	CTD	33° 18.287' N	034° 31.947' W	33° 18.464' N	034° 31.793' W	
33	POS536_25-1	B	20.08.2019	15:09	CTD	33° 18.720' N	034° 31.579' W	33° 18.917' N	034° 31.393' W	
34	POS536_26-1	B	20.08.2019	16:24	CTD/INSITU Pumps	33° 15.108' N	034° 29.943' W	33° 17.564' N	034° 29.724' W	At the same time 3 Oceanpack filters were changed, but no station number was assigned to them
35	POS536_0_Underway-2	B-C	21.08.2019	08:00	Monitoring	33°14.873'N	36°15.452'W	33°14.363'N	36° 25.606'W	
36	POS536_0_Underway-2	B-C	21.08.2019	09:00	Monitoring	33°14.334'N	36°25.789'W	33°12.616'N	36° 35.660' W	
37	POS536_0_Underway-2	B-C	21.08.2019	12:00	Monitoring	33°09.179'N	36°54.823'W	33°07.224'N	37° 04.077'W	
38	POS536_0_Underway-2	B-C	21.08.2019	13:00	Monitoring	33°07.207'N	37°04.150'W	33°05.475'N	37° 13.077'W	
39	POS536_0_Underway-2	B-C	21.08.2019	15:30	Monitoring	33°03.390'N	37°26.891'W	33°01.888'N	37° 36.010' W	
40	POS536_0_Underway-2	B-C	21.08.2019	16:30	Monitoring	33°01.875'N	037°36.073'W	33°00.355'N	37° 45.414'W	
41	NA	B-C	21.08.2019	18:15	Ocean Pack	32°59.21'N	37°52.85`W	NA	NA	
42	POS536_27-1	C	22.08.2019	09:50	Sediment Traps	33° 09.086’ N	39° 59.687’ W	33° 24.455’ N	40° 13.788’ W	
43	POS536_28-1	C	22.08.2019	12:58	Box Corer	33° 09.327' N	039° 59.997' W	33° 09.571' N	040° 00.463' W	
44	POS536_29-1	C	22.08.2019	15:00	Multicorer	33° 09.622' N	040° 00.650' W	33° 09.660' N	040° 00.769' W	fail
45	NA	C	22.08.2019	18:15	Ocean Pack	33° 09.81'N	40°00.86'W	NA	NA	
46	POS536_30-1	C	23.08.2019	00:02	Neuston Trawl	33° 09.369' N	039° 59.894' W	33° 10.836' N	040° 00.360' W	
47	POS536_31-1	C	23.08.2019	00:40	Neuston Trawl	33° 10.55'N	40° 00.77'W	33° 12.18'N	40° 01.15'W	
48	POS536_32-1	C	23.08.2019	01:19	Neuston Trawl	33° 11.43'N	40° 01.55'W	33° 13.00'N	40° 02.01'W	
49	POS536_33-1	C	23.08.2019	02:29	Bongo Net	33° 09.05'N	39° 59.88'W	33° 10.71'N	39° 59.75'W	
50	POS536_34-1	C	23.08.2019	03:24	Bongo Net	33° 09.016' N	039° 59.969' W	33° 10.415' N	039° 59.952' W	
51	POS536_35-1	C	23.08.2019	04:29	Bongo Net	33° 08.979' N	039° 59.915' W	33° 11.347' N	039° 59.801' W	
52	POS536_36-1	C	23.08.2019	06:17	WP2 Net	33° 09.113' N	039° 59.887' W	33° 09.250' N	039° 59.840' W	
53	POS536_37-1	C	23.08.2019	06:54	WP2 Net	33° 08.814' N	039° 59.911' W	33° 08.965' N	039° 59.874' W	
54	POS536_38-1	C	23.08.2019	07:56	WP2 Net	33° 08.969' N	039° 59.875' W	33° 08.886' N	039° 59.861' W	
55	POS536_39-1	C	23.08.2019	09:56	CTD	33° 08.877' N	039° 59.908' W	33° 08.820' N	039° 59.965' W	
56	POS536_40-1	C	23.08.2019	11:59	Multicorer	33° 08.867' N	039° 59.984' W	33° 08.841' N	040° 00.073' W	fail
57	POS536_0_Underway-2	C-D	23.08.2019	15:30	Monitoring	33° 21.697' N	039° 55.798' W	33° 29.728' N	039° 53.137' W	
58	POS536_0_Underway-2	C-D	23.08.2019	16:30	Monitoring	33° 29.789' N	039° 53.117' W	33° 38.011' N	039° 50.383' W	
59	NA	C-D	23.08.2019	18:14	Ocean Pack	33° 42.33'N	39° 48.95'W	NA	NA	

Station	DShip	Area	Date	Time	Gear	Latitude (start)	Longitude (start)	Latitude (end)	Longitude (end)	Status/Comment
60	POS536_0_Underway-2	C-D	23.08.2019	19:00	Monitoring	33° 50.309' N	039° 46.291' W	33° 58.760' N	039° 43.485' W	
61	POS536_0_Underway-2	C-D	23.08.2019	20:00	Monitoring	33° 58.822' N	039° 43.464' W	34° 07.267' N	039° 40.630' W	
62	POS536_41-1	D	24.08.2019	01:36	CTD/INSITU Pumps	34° 38.611' N	039° 27.801' W	34° 38.676' N	039° 28.616' W	
63	POS536_42-1	D	24.08.2019	08:14	Box Corer	34° 38.584' N	039° 27.827' W	34° 38.584' N	039° 27.872' W	
64	POS536_43-1	D	24.08.2019	11:55	Multicorer	34° 38.522' N	039° 27.709' W	34° 38.507' N	039° 27.757' W	fail
65	POS536_44-1	D	24.08.2019	13:49	Multicorer	34° 38.498' N	039° 27.739' W	34° 38.459' N	039° 27.747' W	fail
66	POS536_45-1	D	24.08.2019	15:35	Neuston Trawl	34° 38.358' N	039° 27.738' W	34° 36.757' N	039° 27.459' W	
67	POS536_46-1	D	24.08.2019	16:09	Neuston Trawl	34° 36.097' N	039° 27.346' W	34° 35.343' N	039° 27.187' W	
68	POS536_47-1	D	24.08.2019	16:36	Neuston Trawl	34° 34.335' N	039° 26.837' W	34° 34.335' N	039° 26.837' W	
69	NA	D	24.08.2019	18:15	Ocean Pack	34° 34.36'N	39° 26.84'W	NA	NA	
70	POS536_48-1	D	24.08.2019	23:56	Bongo Net	34° 37.687' N	039° 27.872' W	34° 36.507' N	039° 27.471' W	
71	POS536_49-1	D	25.08.2019	01:04	Bongo Net	34° 38.561' N	039° 27.808' W	34° 36.791' N	039° 27.481' W	
72	POS536_50-1	D	25.08.2019	02:22	Bongo Net	34° 38.506' N	039° 27.788' W	34° 35.846' N	039° 27.439' W	
73	POS536_51-1	D	25.08.2019	04:16	WP2 Net	34° 38.674' N	039° 27.896' W	34° 38.607' N	039° 27.933' W	
74	POS536_52-1	D	25.08.2019	04:49	WP2 Net	34° 38.605' N	039° 27.964' W	34° 38.520' N	039° 28.082' W	
75	POS536_53-1	D	25.08.2019	05:48	WP2 Net	34° 38.535' N	039° 28.062' W	34° 38.490' N	039° 28.174' W	
76	POS536_54-1	D	25.08.2019	07:16	CTD	34° 38.503' N	039° 28.113' W	34° 38.589' N	039° 27.915' W	
77	POS536_0_Underway-2	D	25.08.2019	12:00	Monitoring	34°08.943'N	39° 18.538'W	34°01.025'N	39°16.070'W	
78	POS536_0_Underway-2	D	25.08.2019	13:00	Monitoring	34°00.958'N	39°16.050'W	33°52.973'N	39° 13.573'W	
79	POS536_0_Underway-2	D	25.08.2019	15:30	Monitoring	33°41.690'N	39° 10.079'W	33°34.254'N	39° 07.775'W	
80	POS536_0_Underway-2	D	25.08.2019	16:30	Monitoring	33°34.188'N	39° 07.756' W	33°26.583'N	39° 05.409'W	
81	NA	D-E	25.08.2019	18:15	Ocean Pack	33° 22.13'N	39° 04.04'W	NA	NA	
82	POS536_0_Underway-2	D-E	25.08.2019	18:00	Monitoring	33°22.865'N	39° 04.269'W	33°15.461'N	39° 01.987'W	
83	POS536_0_Underway-2	D-E	25.08.2019	19:00	Monitoring	33°15.405'N	39° 01.968'W	33°08.956'N	38° 59.988'W	
84	NA	E	25.08.2019	20:00	UWS	NA	NA	NA	NA	
85	POS536_55-1	E	25.08.2019	19:57	WP2 Net	33° 08.988' N	039° 00.004' W	33° 08.707' N	038° 59.829' W	
86	POS536_56-1	E	25.08.2019	20:27	WP2 Net	33° 08.693' N	038° 59.813' W	33° 08.388' N	038° 59.461' W	
87	POS536_57-1	E	25.08.2019	21:22	WP2 Net	33° 08.367' N	038° 59.443' W	33° 07.975' N	038° 59.018' W	
88	POS536_58-1	E	25.08.2019	22:49	Bongo Net	33° 07.908' N	038° 58.880' W	33° 07.588' N	038° 57.349' W	
89	POS536_59-1	E	26.08.2019	23.48	Bongo Net	33° 08.174' N	038° 58.738' W	33° 07.655' N	038° 57.134' W	
90	POS536_60-1	E	26.08.2019	00:59	Bongo Net	33° 08.326' N	038° 58.758' W	33° 07.529' N	038° 56.426' W	
91	POS536_61-1	E	26.08.2019	02:44	Neuston Trawl	33° 08.676' N	038° 59.411' W	33° 08.092' N	038° 57.761' W	

Station	DShip	Area	Date	Time	Gear	Latitude (start)	Longitude (start)	Latitude (end)	Longitude (end)	Status/Comment
92	POS536_62-1	E	26.08.2019	03:24	Neuston Trawl	33° 08.515' N	038° 58.179' W	33° 07.911' N	038° 56.442' W	
93	POS536_63-1	E	26.08.2019	04:04	Neuston Trawl	33° 08.209' N	038° 57.089' W	33° 07.584' N	038° 55.334' W	
94	POS536_64-1	E	26.08.2019	05:12	CTD	33° 09.015' N	038° 59.937' W	33° 08.743' N	038° 59.689' W	
95	POS536_65-1	E	26.08.2019	06:29	CTD	33° 09.128' N	038° 59.905' W	33° 09.215' N	038° 59.970' W	
96	POS536_66-1	E	26.08.2019	08:46	Box Corer	33° 09.130' N	038° 59.670' W	33° 09.067' N	038° 59.584' W	
97	POS536_67-1	E	26.08.2019	10:07	Box Corer	33° 09.083' N	038° 59.551' W	33° 09.103' N	038° 59.345' W	
98	POS536_68-1	E	26.08.2019	12:59	Multicorer	33° 08.845' N	038° 59.384' W	33° 08.772' N	038° 59.365' W	fail
99	POS536_69-1	E	26.08.2019	14:15	CTD	33° 09.006' N	039° 00.022' W	33° 08.968' N	039° 00.031' W	
100	POS536_0_Underway-2	E-F	26.08.2019	15:30	Monitoring	3309.649'N	39° 03.292'W	33°10.295'N	39° 07.352'W	
101	POS536_0_Underway-2	E-F	26.08.2019	18:00	Monitoring	33°11.033'N	39° 13.381' W	33°10.597'N	39° 17.845'W	
102	NA	E-F	26.08.2019	18:15	Ocean Pack	33° 08.968'N	39° 00.031'W	NA	NA	
103	POS536_0_Underway-2	E-F	26.08.2019	19:00	Monitoring	33°10.593'N	39° 17.845'W	33°11.609'N	39° 21.560'W	
104	POS536_70-1	E-F	27.08.2019	8:15	Sediment traps	33° 24.430' N	040° 13.849' W	NA	NA	
105	POS536_0_Underway-2	E-F	27.08.2019	12:00	Monitoring	33°33.097'N	39° 57.759' W	33°36.625'N	39° 51.179'W	
106	POS536_0_Underway-2	E-F	27.08.2019	13:00	Monitoring	33°36.655'N	39° 51.123' W	33°40.156'N	39° 44.617'W	
107	POS536_0_Underway-2	E-F	27.08.2019	15:30	Monitoring	33°45.482'N	39° 34.751'W	33°48.963'N	39° 28.161'W	
108	POS536_0_Underway-2	E-F	27.08.2019	16:30	Monitoring	33°49.005'N	39° 28.085'W	33°52.529'N	39° 21.509'W	
109	POS536_0_Underway-2	E-F	27.08.2019	18:00	Monitoring	33°54.313'N	39° 18.156'W	33°57.698'N	39° 11.815'W	
110	NA	E-F	27.08.2019	18:15	Ocean Pack	33° 51.46'N	39° 23.51'W	NA	NA	
111	POS536_0_Underway-2	E-F	27.08.2019	19:00	Monitoring	33°57.727'N	39° 11.761'W	34°01.146'N	39° 05.386'W	
112	POS536_71-1	F	28.08.2019	01:48	CTD/INSITU Pumps/UWS	34° 19.999' N	038° 29.986' W	34° 18.769' N	038° 30.130' W	
113	POS536_72-1	F	28.08.2019	08:02	Box Corer	34° 20.003' N	038° 30.446' W	34° 19.727' N	038° 30.251' W	
114	POS536_73-1	F	28.08.2019	10:07	Box Corer	34° 19.652' N	038° 30.292' W	34° 19.465' N	038° 30.905' W	
115	POS536_74-1	F	28.08.2019	13:00	Neuston Trawl	34° 20.106' N	038° 29.931' W	34° 18.473' N	038° 29.881' W	
116	POS536_75-1	F	28.08.2019	13:38	Neuston Trawl	34° 18.739' N	038° 30.039' W	34° 16.886' N	038° 29.956' W	
117	POS536_76-1	F	28.08.2019	14:19	Neuston Trawl	34° 17.456' N	038° 29.632' W	34° 15.855' N	038° 29.536' W	
118	POS536_77-1	F	28.08.2019	15:28	WP2 Net	34° 20.026' N	038° 30.081' W	34° 19.934' N	038° 30.449' W	
119	POS536_78-1	F	28.08.2019	15:53	WP2 Net	34° 19.910' N	038° 30.498' W	34° 19.650' N	038° 31.326' W	
120	POS536_79-1	F	28.08.2019	16:44	WP2 Net	34° 19.644' N	038° 31.402' W	34° 19.380' N	038° 32.662' W	
121	NA	F	28.08.2019	18:05	Ocean Pack	34°19.38'N	38°30.29'W	NA	NA	
122	POS536_80-1	F	28.08.2019	18:29	Bongo Net	34° 20.145' N	038° 30.235' W	34° 18.996' N	038° 30.291' W	
123	POS536_81-1	F	28.08.2019	19:19	Bongo Net	34° 19.983' N	038° 30.097' W	34° 18.399' N	038° 30.013' W	

Station	DShip	Area	Date	Time	Gear	Latitude (start)	Longitude (start)	Latitude (end)	Longitude (end)	Status/Comment
124	POS536_82-1	F	28.08.2019	20:31	Bongo Net	34° 20.002' N	038° 30.055' W	34° 17.876' N	038° 30.010' W	
125	POS536_83-1	F	28.08.2019	22:08	CTD	34° 20.037' N	038° 30.093' W	34° 19.831' N	038° 30.539' W	
126	NA		29.08.2019	08:00	UWS	NA	NA	NA	NA	cancelled
127	POS536_84-1	G	29.08.2019	08:09	Box Corer	33° 09.126' N	037° 59.980' W	33° 09.528' N	037° 59.708' W	fail
128	POS536_85-1	G	29.08.2019	12:00	Box Corer	33° 09.149' N	038° 00.092' W	33° 08.974' N	037° 59.874' W	fail
129	POS536_86-1	G	29.08.2019	13:02	Sediment Traps	33° 08.129' N	037° 59.765' W	33° 20.801' N	037° 20.931' W	
130	POS536_87-1	G	29.08.2019	14:40	Neuston Trawl	33° 07.944' N	037° 59.550' W	33° 06.338' N	037° 59.227' W	
131	POS536_88-1	G	29.08.2019	15:20	Neuston Trawl	33° 04.964' N	037° 59.046' W	33° 03.325' N	037° 58.811' W	
132	POS536_89-1	G	29.08.2019	15:58	Neuston Trawl	33° 02.236' N	037° 58.635' W	33° 00.479' N	037° 58.040' W	
133	NA	G	29.08.2019	18:05	Ocean Pack	33° 00.479'N	37° 58.040'W	NA	NA	
134	POS536_90-1	G	30.08.2019	00:09	WP2 Net	33° 09.050' N	037° 59.881' W	33° 09.034' N	037° 59.866' W	
135	POS536_91-1	G	30.08.2019	00:35	WP Net	33° 09.035' N	037° 59.868' W	33° 08.983' N	037° 59.854' W	
136	POS536_92-1	G	30.08.2019	01:19	WP2 Net	33° 08.979' N	037° 59.857' W	33° 08.900' N	037° 59.784' W	
137	POS536_93-1	G	30.08.2019	02:34	Bongo Net	33° 08.826' N	037° 59.724' W	33° 09.586' N	037° 59.392' W	
138	POS536_94-1	G	30.08.2019	03:32	Bongo Net	33° 09.277' N	037° 59.872' W	33° 10.990' N	038° 00.072' W	
139	POS536_95-1	G	30.08.2019	04:48	Bongo Net	33° 09.086' N	037° 59.989' W	33° 11.720' N	037° 59.370' W	
140	POS536_96-1	G	30.08.2019	06:36	CTD	33° 09.073' N	037° 59.935' W	33° 09.066' N	037° 59.975' W	
141	POS536_0_Underway-2	G-H	30.08.2019	08:00	Monitoring	33°12.420'N	37° 58.856'W	33°21.374'N	37° 55.905'W	
142	POS536_0_Underway-2	G-H	30.08.2019	09:00	Monitoring	33°21.448'N	037°55.880'W	33°30.440'N	37° 52.905'W	
143	POS536_0_Underway-2	G-H	30.08.2019	12:00	Monitoring	33°48.565'N	37° 46.877'W	33°57.078'N	37° 44.039'W	
144	POS536_0_Underway-2	G-H	30.08.2019	13:00	Monitoring	33°57.155'N	037°44.013'W	34°05.617'N	037°41.184'W	
145	POS536_0_Underway-2	G-H	30.08.2019	15:30	Monitoring	34°18.948'N	37° 36.730'W	34°27.345'N	037°33.920'W	
146	POS536_0_Underway-2	G-H	30.08.2019	16:30	Monitoring	34°27.368'N	37°33.911'W	34°35.719'N	37°31.111'W	
147	NA	H	30.08.2019	18:00	UWS	NA	NA	NA	NA	cancelled
148	NA	H	30.08.2019	18:15	Ocean Pack	34° 38.939'N	37° 30.134'W	NA	NA	
149	POS536_97-1	H	30.08.2019	18:18	WP2 Net	34° 38.939' N	037° 30.134' W	34° 38.882' N	037° 30.217' W	
150	POS536_98-1	H	30.08.2019	18:53	WP2 Net	34° 38.886' N	037° 30.223' W	34° 39.023' N	037° 30.337' W	
151	POS536_99-1	H	30.08.2019	19:51	WP2 Net	34° 39.055' N	037° 30.262' W	34° 39.323' N	037° 31.525' W	
152	POS536_100-1	H	30.08.2019	21:21	Bongo Net	34° 39.407' N	037° 31.874' W	34° 39.567' N	037° 33.887' W	
153	POS536_101-1	H	30.08.2019	22:30	Bongo Net	34° 39.374' N	037° 31.084' W	34° 39.750' N	037° 33.355' W	
154	POS536_102-1	H	30.08.2019	23:49	Bongo Net	34° 39.286' N	037° 31.009' W	34° 39.875' N	037° 34.061' W	
155	POS536_103-1	H	31.08.2019	01:47	CTD/INSITU Pumps	34° 39.022' N	037° 29.965' W	34° 39.369' N	037° 33.936' W	

Station	DShip	Area	Date	Time	Gear	Latitude (start)	Longitude (start)	Latitude (end)	Longitude (end)	Status/Comment
156	POS536_104-1	H	31.08.2019	08:00	Box Corer	34° 39.051' N	037° 30.062' W	34° 39.035' N	037° 30.520' W	fail
157	POS536_105-1	H	31.08.2019	10:13	Box Corer	34° 33.419' N	037° 31.890' W	34° 33.134' N	037° 32.674' W	
158	POS536_106-1	H	31.08.2019	13:00	Neuston Trawl	34° 33.939' N	037° 33.988' W	34° 35.406' N	037° 34.818' W	
159	POS536_107-1	H	31.08.2019	13:39	Neuston Trawl	34° 35.127' N	037° 34.108' W	34° 36.621' N	037° 34.956' W	
160	POS536_108-1	H	31.08.2019	14:18	Neuston Trawl	34° 36.097' N	037° 34.247' W	34° 37.469' N	037° 35.125' W	
161	POS536_109-1	H	31.08.2019	15:32	CTD	34° 38.967' N	037° 30.019' W	34° 38.755' N	037° 30.174' W	
162	POS536_0_Underway-2	H-I	31.08.2019	18:00	Monitoring	34°24.194'N	37° 25.025'W	34°15.770'N	37° 22.207'W	
163	NA	H-I	31.08.2019	18:34	Ocean Pack	341919'N	37°23.34'W	NA	NA	
164	POS536_0_Underway-2	H-I	31.08.2019	19:00	Monitoring	34°15.707'N	37° 22.187'W	34°07.284'N	37° 19.370'W	
165	POS536_0_Underway-2	H-I	31.08.2019	20:00	Monitoring	34°07.196'N	37°19.341'W	33°58.850'N	37° 16.551'W	
166	NA	I	01.09.2019	02:00	UWS	NA	NA	NA	NA	
167	POS536_110-1	I	01.09.2019	03:06	WP2 Net	33° 09.000' N	036° 59.962' W	33° 08.946' N	036° 59.949' W	
168	POS536_111-1	I	01.09.2019	03:30	WP2 Net	33° 08.933' N	036° 59.938' W	33° 08.919' N	036° 59.993' W	
169	POS536_112-1	I	01.09.2019	04:20	WP2 Net	33° 08.921' N	037° 00.001' W	33° 08.943' N	037° 00.547' W	
170	POS536_113-1	I	01.09.2019	05:42	Neuston Trawl	33° 08.943' N	037° 00.766' W	33° 08.659' N	037° 01.601' W	
171	POS536_114-1	I	01.09.2019	06:11	Neuston Trawl	33° 08.686' N	037° 02.161' W	33° 09.534' N	037° 02.046' W	
172	POS536_115-1	I	01.09.2019	06:36	Neuston Trawl	33° 10.288' N	037° 01.954' W	33° 11.101' N	037° 01.897' W	
173	POS536_116-1	I	01.09.2019	08:03	Box Corer	33° 09.008' N	036° 59.987' W	33° 09.017' N	036° 59.906' W	fail
174	POS536_117-1	I	01.09.2019	09:40	Box Corer	33° 09.007' N	036° 59.896' W	33° 09.090' N	036° 59.920' W	fail
175	POS536_118-1	I	01.09.2019	13:07	Bongo Net	33° 08.428' N	036° 59.402' W	33° 07.320' N	036° 59.793' W	
176	POS536_119-1	I	01.09.2019	14:10	Bongo Net	33° 08.999' N	037° 00.064' W	33° 07.572' N	037° 00.988' W	
177	POS536_120-1	I	01.09.2019	15:26	Bongo Net	33° 09.037' N	037° 00.030' W	33° 06.896' N	037° 01.401' W	
178	POS536_121-1	I	01.09.2019	17:08	CTD	33° 09.026' N	037° 00.036' W	33° 08.917' N	037° 00.263' W	
179	POS536_0_Underway-2	I-J	01.09.2019	18:00	Monitoring	33°08.913'N	37° 00.265'W	33°14.966'N	37° 00.070'W	
180	NA	I-J	01.09.2019	18:00	Ocean Pack	33°08.92'N	37°00.26'W	NA	NA	
181	POS536_0_Underway-2	I-J	01.09.2019	19:00	Monitoring	33°15.029'N	37°00.070'W	33°21.646'N	37°00.150'W	
182	POS536_0_Underway-2	I-J	01.09.2019	20:00	Monitoring	33°21.691'N	37°00.151'W	33°28.511'N	37°00.222'W	
183	NA	I-J	02.09.2019	04:00	UWS	NA	NA	NA	NA	cancelled
184	POS536_122-1	J	02.09.2019	04:04	WP2 Net	34° 14.743' N	037° 00.802' W	34° 14.706' N	037° 00.910' W	
185	POS536_123-1	J	02.09.2019	04:31	WP2 Net	34° 14.699' N	037° 00.918' W	34° 14.573' N	037° 01.069' W	
186	POS536_124-1	J	02.09.2019	05:23	WP2 Net	34° 14.565' N	037° 01.095' W	34° 14.381' N	037° 01.643' W	
187	POS536_125-1	J	02.09.2019	08:00	Multicorer	34° 14.774' N	037° 00.825' W	34° 14.631' N	037° 01.081' W	fail

Station	DShip	Area	Date	Time	Gear	Latitude (start)	Longitude (start)	Latitude (end)	Longitude (end)	Status/Comment
188	POS536_126-1	J	02.09.2019	08:48	Multicorer	34° 14.620' N	037° 01.105' W	34° 14.644' N	037° 01.117' W	fail
189	POS536_127-1	J	02.09.2019	09:40	Bongo Net	34° 14.595' N	037° 01.106' W	34° 14.670' N	037° 02.301' W	
190	POS536_128-1	J	02.09.2019	10:35	Bongo Net	34° 14.891' N	037° 00.967' W	34° 15.370' N	037° 02.940' W	
191	POS536_129-1	J	02.09.2019	11:49	Bongo Net	34° 14.961' N	037° 00.654' W	34° 15.092' N	037° 03.726' W	
192	POS536_130-1	J	02.09.2019	13:33	Neuston Trawl	34° 15.032' N	037° 02.846' W	34° 14.629' N	037° 04.735' W	
193	POS536_131-1	J	02.09.2019	14:13	Neuston Trawl	34° 14.586' N	037° 04.179' W	34° 14.084' N	037° 05.998' W	
194	POS536_132-1	J	02.09.2019	14:53	Neuston Trawl	34° 14.116' N	037° 05.377' W	34° 13.656' N	037° 07.276' W	
195	POS536_133-1	J	02.09.2019	16:25	CTD	34° 14.703' N	037° 00.786' W	34° 12.681' N	037° 10.490' W	
196	NA	J	02.09.2019	18:00	Ocean Pack	34° 14.528'N	37° 01.409'W	NA	NA	
197	POS536_134-1	J-K	03.09.2019	8:22	Sediment Traps	33° 20.801' N	037° 20.931' W	NA	NA	
198	POS536_0_Underway-2	J-K	03.09.2019	12:00	Monitoring	33°21.033'N	36° 57.621'W	33°21.093'N	36° 48.641'W	
200	POS536_0_Underway-2	J-K	03.09.2019	13:00	Monitoring	33°21.093'N	36°48.576' W	33°21.173'N	36° 39.318'W	
201	POS536_0_Underway-2	J-K	03.09.2019	15:30	Monitoring	33°21.281'N	36° 25.226'W	33°21.357'N	36° 16.026'W	
202	POS536_0_Underway-2	J-K	03.09.2019	16:30	Monitoring	33°21.357'N	36° 15.966'W	33°20.937'N	36° 05.870'W	
203	POS536_0_Underway-2	J-K	03.09.2019	18:00	Monitoring	33°20.557'N	36° 01.258'W	33°19.734'N	35° 51.202'W	
204	NA	J-K	03.09.2019	18:15	Ocean Pack	33° 20.557' N	036° 01.258' W	NA	*NA*	
205	POS536_0_Underway-2	J-K	03.09.2019	19:00	Monitoring	33°19.726'N	35°51.103'W	33°18.902'N	35° 40.989'W	
206	POS536_0_Underway-2	J-K	03.09.2019	20:00	Monitoring	NA	NA	NA	NA	fail
208	NA	K	04.09.2019	08:00	UWS	NA	NA	NA	NA	cancelled
209	POS536_135-1	K	04.09.2019	08:02	Bongo Net	33° 09.898' N	033° 52.552' W	33° 08.659' N	033° 52.757' W	
210	POS536_136-1	K	04.09.2019	08:59	Bongo Net	33° 09.958' N	033° 52.583' W	33° 08.494' N	033° 53.080' W	
211	POS536_137-1	K	04.09.2019	10:09	Bongo Net	33° 09.951' N	033° 52.391' W	33° 07.650' N	033° 52.531' W	
212	POS536_138-1	K	04.09.2019	11:55	WP2 Net	33° 10.069' N	033° 52.525' W	33° 10.023' N	033° 52.536' W	
213	POS536_139-1	K	04.09.2019	12:21	WP2 Net	33° 10.024' N	033° 52.538' W	33° 09.931' N	033° 52.508' W	
214	POS536_140-1	K	04.09.2019	13:15	WP2 Net	33° 09.912' N	033° 52.510' W	33° 09.704' N	033° 52.465' W	
215	POS536_141-1	K	04.09.2019	14:46	Neuston Trawl	33° 09.342' N	033° 52.645' W	33° 08.609' N	033° 52.996' W	
216	POS536_142-1	K	04.09.2019	15:08	Neuston Trawl	33° 08.417' N	033° 53.058' W	33° 07.608' N	033° 53.422' W	
217	POS536_143-1	K	04.09.2019	15:34	Neuston Trawl	33° 07.543' N	033° 53.676' W	33° 08.369' N	033° 53.349' W	
218	POS536_144-1	K	04.09.2019	16:09	CTD/INSITU Pumps	33° 10.022' N	033° 52.415' W	33° 09.643' N	033° 49.178' W	
219	NA	K	04.09.2019	18:15	Ocean Pack	33° 09.916' N	033° 52.464' W	NA	NA	
220	POS536_145-1	K	04.09.2019	22:11	Neuston Trawl	33° 09.908' N	033° 28.410' W	33° 09.535' N	033° 27.439' W	
221	POS536_146-1	K	04.09.2019	22:35	Neuston Trawl	33° 09.286' N	033° 26.872' W	33° 08.978' N	033° 26.021' W	

Station	**DShip**	**Area**	**Date**	**Time**	**Gear**	**Latitude (start)**	**Longitude (start)**	**Latitude (end)**	**Longitude (end)**	**Status/Comment**
222	POS536_147-1	K	04.09.2019	23:01	Neuston Trawl	33° 08.620' N	033° 25.227' W	33° 08.435' N	033° 24.374' W	
223	NA	Transit	05.09.2019	18:15	Ocean Pack	33° 46.32'N	30° 19.08'W	NA	NA	
224	NA	Transit	06.09.2019	10:50	Ocean Pack	34° 14.34'N	29°42.71'W	NA	NA	

8. Data and sample storage and availability

Physical samples that were taken during POS536 are stored at GEOMAR repositories and can be accessed on request. Local storage of sediment cores is provided by the GEOMAR lithothek, core and rock repository https://www.geomar.de/en/centre/central-facilities/tlz/core-rock-repository

Video and image raw data will be archived in the IT storage infrastructure at GEOMAR and is available on request. All collected data will be made available via the PANGAEA data repository within three years after the cruise.

All navigation, weather, echosounder, and surface water data recorded during POS536 are available for download at http://dship.geomar.de. Dship data files can only be accessed with a valid password.

9. Acknowledgements

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