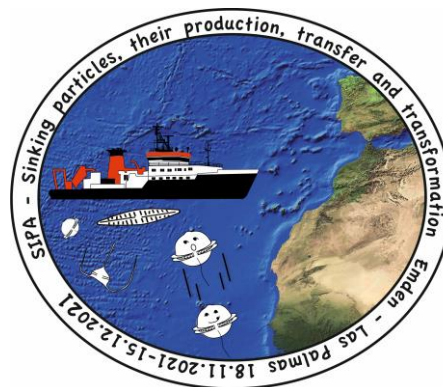


Prof. Dr. Karin Zonneveld
MARUM Center for marine environmental Sciences
Leobener Straße
D-28359 Bremen
Germany

Tel.: +49 421 218 65797
Fax: +49 421 218 9865974
email: kzonneveld@marum.de



RV MARIA S. MERIAN
Short Cruise Report
Cruise MSM104

Emden - Las Palmas
18.11.2021 - 15.12.2021

Chief Scientist: Karin Zonneveld
Captain: Björn Maass

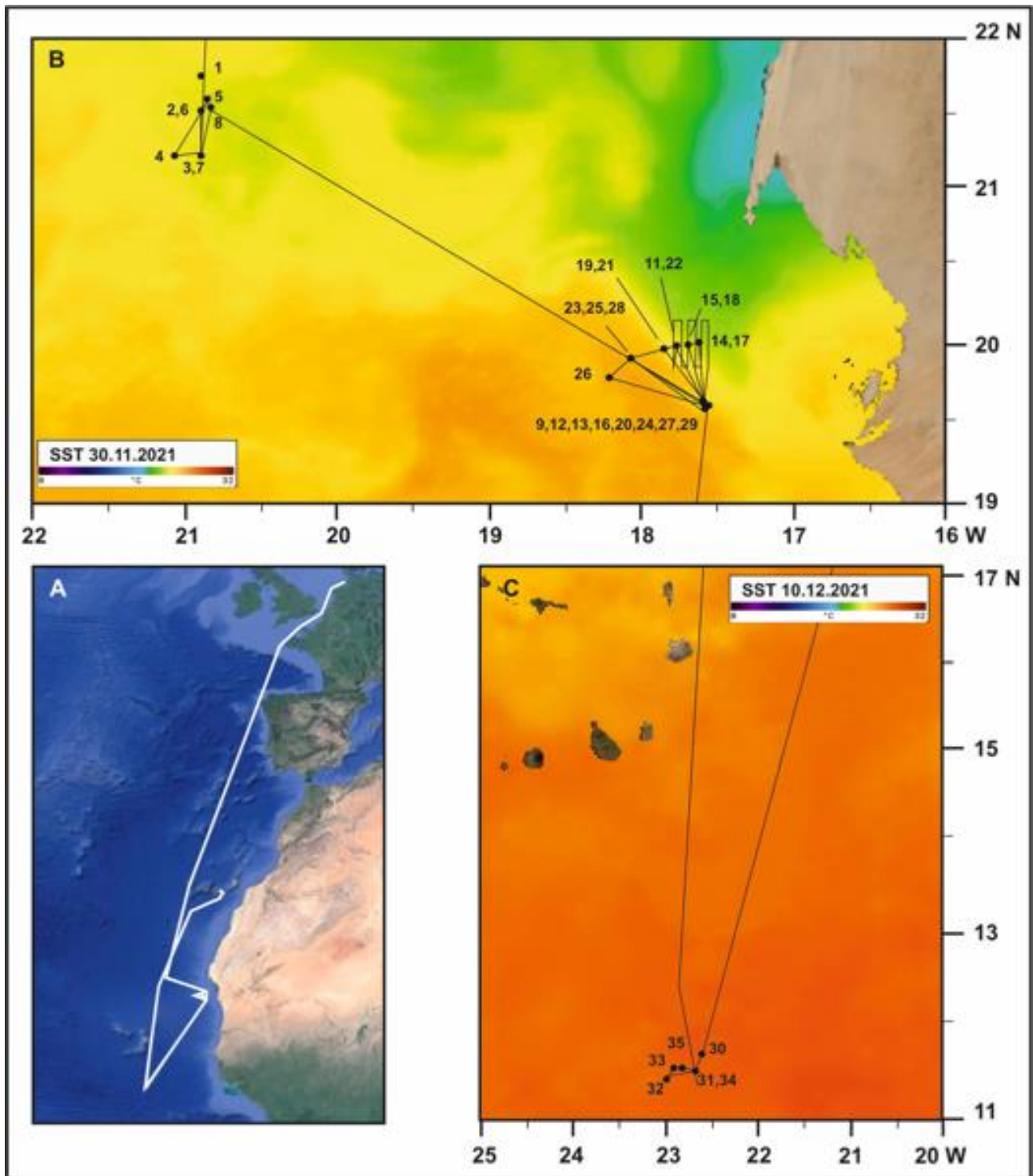


Figure 1. A. Cruise track, B. Detailed map depicting satellite derived sea surface temperature at 30.11.21 depicting cruise track and station positions in the research area off Cape Blanc, C. Detailed map depicting satellite derived sea surface temperature at 10.12.21 depicting cruise track and station positions in the research area south of the Cape Verde Islands. Numbers represent the MSM104 station numbers (Figures established with the courtesy of the NASA and downloaded from the NOAA website “state of the Ocean”)

Objectives

The laterally and temporally highly dynamic Cape Blanc upwelling region is one of the most productive regions in the world and is a key player in the global carbon cycle. Surface primary production drives the biological pump, which is largely controlled by sinking and lateral transport of marine snow, particle aggregates and fecal pellets. However, today we still largely lack a quantitative understanding about processes that drive production, sinking velocities, lateral transport in the water column as well as transformation and export of particulate organic matter, mineral and micro-plastic particles.

During the cruise MSM104, scientists from the MARUM at the University of Bremen and Carl von Ossietzky University of Oldenburg, the Alfred-Wegener-Institute Helmholtz centre for polar and marine research in Bremerhaven and the Royal Netherlands Institute for Sea Research performed joint investigations. They study the input/formation, sinking, lateral advection and alteration in the water column and surface sediments of organic matter, (bio)mineral and micro plastic particles and their environmental proxies in relationship to different environmental conditions. Hereby the processes in active upwelling cells, offshore drifted upwelling filaments and the open ocean off the highly dynamic Cape Blanc region have been compared to open ocean conditions off southeast Cape Verde. The focus of the cruise is the study of the input of mineral dust as well as the production, transport and alteration of marine-derived particles and their proxy signals in relationship to active upwelling. Results shall be compared to long-term flux records in sediment-trap series and dust collection.

- a. Determination of carbon flux attenuation in the epi- and mesopelagic to get a better understanding of the major underlying processes.
- b. Quantify the rate of production as well as determination of the vertical and lateral transport of different POM particles of known origin (e.g. dinoflagellate cysts, pollen/spores) in relationship to upwelling dynamics and the presence and location of nepheloid layers.
- c. Determination of the alteration of organic matter based proxy signals in relationship to transportation and transformation of their proxy carriers in the water column, notably within nepheloid layers.
- d. Determination of the relationship between DOM and POM, their age as well as of DOM/POM based proxy signals in relationship to upwelling intensity, redox conditions and the presence of nepheloid layers.
- e. Obtaining insight into the lateral and vertical transportation of microplastics in the water column as well as their degradation and preservation in marine sediments.
- f. Determine the input of aerobe Sahara dust into the oceanic region and its relationship to plankton production.

Narrative

In the morning of November 18, RV MARIA S. MERIAN left the port of Emden to start a 9-day transit to the research area off Cape Blanc (NW Africa). There we arrived in the early evening of November 26, at a position located at the outermost rim of filaments of upwelled waters that have their origin at the shelf break of the shelf off Cape Blanc. On this location, the MARUM/university of Bremen conducts a long-term monitoring program that started in 1988.

The sampling program started as soon as international waters were reached south of the Canary Islands by sampling airborne dust input. This collection of dust was continued throughout the complete cruise with exception of a short interruption on November 29/30 during a transit through the EEZ off Western Sahara.

We started our water column/sediment sampling program at the CB station off Cape Blanc by deploying a CTD and releasing a drifting trap array to collect particles at 400m, 200m and 100m depth. During the night, the water column was characterized by CTD and first deep water samples for aggregate forming experiments were sampled.

The short nice weather window at November 27 was used to recover the MARUM Sediment trap mooring "CB31". The sediment traps connected to this mooring had collected particles since August 2020. They had functioned without problems and a, for the location, exceptionally large amount of material was collected for the years 2020 and 2021. The afternoon was used to recover, service and redeploy the dust buoy "Carmen" from the Royal Netherlands Institute of Sea Research (NIOZ). This device had collected samples without problems during as well throughout the last year.

During the late evening, an additional CTD cast experienced transmitting problems. Fortunately, the ship's crew was able to find the problem and in the early morning hours of November 27 the water column characterization could successfully be completed.

The next day and nights were used to collect and re-deploy the free drifting trap array and to collect water and suspended matter from the water column and ocean floor.

On November 29, the MARUM Sediment trap was released for another year of sampling. After recovery of the drifting trap array a transit to the coast of Mauretania was started.

Unfortunately, no research activities could be executed in the EEZ off Western Sahara since the Moroccan side had not issued a research permit until the end of the cruise. As a consequence, the second MARUM sediment trap mooring could not be recovered and the initially planned research activities in Western Sahara waters were moved to the region of a newly developing upwelling cell off Mauretania.

Favorable swell and winds brought us in this research area off the Banc d'Arquin (Mauretania) already the next day and station work could be continued at November 30 before lunchtime. We started station work in this area by executing a CTD cast and releasing the drifting trap array for a 6-day collecting survey at the rim of a newly formed upwelling cell.

Despite that this region of is known to be characterized by the presence of large underwater canyon systems, no detailed maps of the ocean floor existed for this area. We therefore used the rest of the day and night to map the ocean floor with the ship's multibeam echo sounder. Based on the now detailed geographical ocean floor map we were able to localize station positions along an upwelling - open ocean transect at sites where maximal sediment deposition could be expected.

In the following week from November 30 to December 6, station work concentrated on the characterization of the water column as well as the collection of water, particulate organic matter (incl. micro plastic particles) and dissolved organic matter from the photic zone, from intermediate and bottom nepheloid layers with the CTD/rosette, in-situ pump systems as well as collecting of surface sediments with the multicorer on 6 locations along the transect. Locations were selected on a ridge between two onshore-offshore directed underwater canyons and a maximal recovery of sediments was achieved.

Due to the professionalism of the MARUM Deck-team and the excellent cooperation with the ship's crew, the nautical team, machinists, electricians and technical staff, maximal sample and data collection was realized in a minimum amount of time.

Next to the transect station work, every morning the drifting trap was recovered, serviced and released again at the same location where it was recovered. Local currents and the constant strong blowing northeasterly winds resulted that the drifting trap array staid nearly on the same position. Due to the constant strong winds, upwelling intensity increased in the region resulting in more eutrophic conditions at the drifting trap location and along the more coastal part of the transect.

On Monday, December 6, the very intense station work was completed and a transit south to our last research area was started. At this location, south of the Cape Verde Islands, we again released our drifting trap after water column characterization with CTD.

This southern region is the location of a Moored sediment trap system and the dust buoy "Laura" of the royal Netherlands institute of Sea Research. These devices had functioned optimal as well, providing a maximal sample recovery. As a result, both sediment trap mooring and dust buoy could be serviced and additionally being release in a minimum amount of time.

In the early afternoon of Friday, December 10, the drifting trap was recovered and after a last characterization of the water column, the long transit north to Las Palmas was started. The transit to Las Palmas was executed in the EEZ of the Cape Verde and through international Waters to allow maximum duration of the underway atmospheric dust sampling. Dust sampling was terminated on Monday, December 13, at 20:20 shortly before the Spanish EEZ was reached. MSM 104 came to an end in the morning of December 15 when we arrived in the port of Las Palmas.

Acknowledgements

The scientific crew of cruise MSM104 thank Captain Björn Maas and his crew for their great flexibility, their excellent technical assistance, health service and by creating a very pleasant working atmosphere that substantially contributed to the success of this cruise. We especially acknowledge the small gestures and decorations related to Advent and "Sinterklaas" by the galley team and stewardess that contributed greatly to the positive happy atmosphere on board. The support of the engine crew as well as the professional and pleasant cooperation between deck crew, bridge and the MARUM and NIOZ deck team was excellent.

We furthermore greatly appreciate the support and cooperation of the employees of the Review Panel German Research Vessels (GPF), the German Research Foundation (DFG) the German Research Fleet Coordination Centre (LDF), the shipping company Briese Research, that provided us the possibility to execute this research cruise MSM104 in Corona Pandemic times.

Cruise Participants

1. Karin Zonneveld	Chief Scientist*	Univ. Bremen
2. Aman Akeerath Mundanatt	Polysaccharids	MARUM
3. Alek bolte	Polysaccharids	MARUM
4. Daan Elderink	Dust collection	NIOZ/UVA
5. Jan-Dirk de Visser	Dust Buoy/Mooring	NIOZ
6. Joshua Gottwald	Palynology/Microplastic	Univ. Bremen
7. Hendrik Grotheer	In-situ Pumps/POC/DOC age	MARUM/AWI
8. Marco Klann	Mooring/Logistic	MARUM
9. Melina Knoke	DOC/POC relationship	Univ. Oldenburg
10. Bob koster	Dust collection/electrician	NIOZ
11. Kristina Kotzem	In-situ Pumps/Palynology	Univ. Bremen
12. Leon Pfeil	Palynology/Microplastic	Univ. Bremen
13. Surya Eldo Virma Roza	Palynology/Microplastic	Univ. Bremen
14. Götz Ruhland	Mooring/Logistic	MARUM
15. Michael Seidel	DOC/POC relationship	Univ. Oldenburg
16. Jan-Berend Stuu	Dust collection	NIOZ/UVA
17. Gerard Versteegh	Multi corer, Org. Geochemistry	AWI
18. Eduardo Queiroz Alves	POC/DOC age	MARUM/AWI

* palynology/microplastic

Institutes

Univ. Bremen: University of Bremen. Faculty of Earth Sciences

AWI: Alfred-Wegener-Institute, Heimholz-Zentrum für Polar- und Meeresforschung

MARUM: Research Faculty University of Bremen, Center for Marine Environmental Sciences

NIOZ: royal Netherlands Institute of Sea Research

Univ. Oldenburg: Carl von Ossietzky University of Oldenburg, Institute of marine biology and chemistry

UVA: Universiteit van Amsterdam

Station list

Station GeoB No.	Station Ship No.	Date	Device	Time [UTC] seafloor / maximum wire length	Latitude [N]	Longitude [W]	Water depth [m]	
GeoB 24601-1	MSM 104_1-1	26.11.21	CTD	20:46	21°43,342	20°51,342	4266	
GeoB 24601-2	MSM 104_1-2	26.11.21	DF	21:23	21°43,342	20°51,342	4263	DF1 deployed
GeoB 24602-1	MSM104_2-1	26.11.21	CTD	23:27	21°32,687	20°51,718	4228	
GeoB 24603-1	MSM104_3-1	27.11.21	Mooring	07:51	21°13,525	20°52,447	4167	Sed. Trap CB31 recovered
GeoB 24604-1	MSM104_4-1	27.11.21	Mooring	12:05	21°13,574	21°02,118	4230	Dust Buoy Carmen
GeoB 24605-1	MSM104_1-2	28.11.21	DF	08:13	21°36,600	20°49,513	4230	DF1 recovered
GeoB 24605-2	MSM104_5-1	28.11.21	CTD	08:53	21°37,596	20°49,527	4234	
GeoB 24605-3	MSM104_5-2	28.11.21	DF	09:09	21°37.597	20°49,528	4229	DF2 deployed
GeoB 24606-1	MSM104_6-1	28.11.21	MUC	12:15	21°32,695	20°51,716	4234	Empty
GeoB 24606-2	MSM104_6-2	28.11.21	MUC	15:06	21°32.696	20°51.715	4236	Empty
GeoB 24607-1	MSM104_7-1	28.11.21	CTD	18:40	21°13,970	20°52.147	4175	
GeoB 24607-2	MSM104_7-2	28.11.21	ISP	21:30	21°13,972	20°52,146	4176	
GeoB 24607-3	MSM104_7-3	29.11.21	ISP	04:30	21°13,972	20°52,145	4177	
GeoB 24607-4	MSM104_7-4	29.11.21	Mooring	08:27	21°11.965	20°56.469	4193	CB32 deployed
GeoB 24608-1	MSM104_5-2	29.11.21	DF	13:31	21°34,752	20°50,600	4227	DF2 recovered
GeoB 24608-2	MSM104_8-1	29.11.21	CTD	14:16	21°34,761	20°50,639	4229	
GeoB 24609-1	MSM104_9-1	30.11.21	CTD	11:02	19°38,410	17°38,834	1958	
GeoB 24609-2	MSM104_9-2	30.11.21	DF	11:33	19°38,410	17°38,834	1953	DF3 deployed
GeoB 24610-1	MSM104_10-1	30.11.21 01.12.21	Multibeam	14:34 00:57	19°54,482 19°55,035	17°38,913 17°46,732	926 1315	start end
GeoB 24611-1	MSM104_11-1	01.12.21	CTD	01:54	19°59,176	17°50,761	1444	
GeoB 24611-2	MSM104_11-2	01.12.21	ISP	03:12	19°59,176	17°50,762	1445	
GeoB 24612-1	MSM104_9-2	01.12.21	DF	09:41	19°38,425	17°37,836	1996	DF3 recovered
GeoB 24612-2	MSM104_12-1	01.12.21	CTD	10:14	19°38,425	17°37,837	1998	
GeoB 24612-3	MSM104_13-1	01.12.21	DF	10:45	19°38,426	17°37,837	1998	DF4 deployed
GeoB 24613-1	MSM104_14-1	01.12.21	CTD	13:37	20°01.,24 4	17°38,927	503	
GeoB 24613-2	MSM104_14-2	01.12.21	ISP	14:11	20°01,245	17°38,927	505	
GeoB 24613-3	MSM104_14-3	01.12.21	CTD	17:47	20°01,245	17°38,928	504	
GeoB 24613-4	MSM104_14-4	01.12.21	ISP	18:35	20°01,245	17°38,927	505	
GeoB 24615-1	MSM104_15-1	01.12.21	CTD	22:33	20°00.427	17°41.061	756	
GeoB 24615-2	MSM104_15-2	01.12.21	ISP	23:23	20°00.426	17°41.062	756	
GeoB 24615-3	MSM104_15-3	02.12.21	ISP	03:52	20°00.427	17°41.062	756	
GeoB 24616-1	MSM104_13-1	02.12.21	DF	09:54	19°37.508	17°36.386	1955	DF4 recovery
GeoB 24616-2	MSM104_16-1	02.12.21	CTD	10:25	19°37.513	17°36.391	1925	
GeoB 24616-1	MSM104_16-2	02.12.21	DF	11:00	19°37.513	17°36.391	1925	DF5 deployment

GeoB 24617-1	MSM104_17-1	02.12.21	MUC	14:14	20°01.251	17°38.923	504	
GeoB 24618-1	MSM104_18-1	02.12.21	MUC	16:27	20°00.434	17°41.076	754	
GeoB 24619-1	MSM104_19-1	02.12.21	CTD	18:12	19°59.792	17°43.334	989	
GeoB 24619-2	MSM104_19-2	02.12.21	CTD	19:31	19°59.788	17°43.332	988	
GeoB 24619-3	MSM104_19-3	02.12.21	ISP	20:17	19°59.788	17°43.332	991	
GeoB 24619-4	MSM104_19-4	03.12.21	ISP	00:46	19°59.789	17°43.332	987	
GeoB 24620-1	MSM104_16-2	03.12.21	DF	08:08	19°36.698	17°35.407	1722	DF5 recovery
GeoiB 24620-2	MSM104_20-1	03.12.21	CTD	08:39	19°36.700	17°35.414	1721	
GeoiB 24620-3	MSM104_20-2	03.12.21	DF	09:08	19°36.700	17°35.414	1721	DF6 deployment
GeoB 24621-1	MSM104_21-1	03.12.21	MUC	12:29	19°59.792	17°43.337	989	
GeoB 24622-1	MSM104_22-1	03.12.21	CTD	14:45	19°59.171	17°50.757	1445	
GeoB 24622-2	MSM104_22-2	03.12.21	ISP	15:53	19°59.168	17°50.755	1444	
GeoB 24622-3	MSM104_22-3	03.12.21	MUC	20:37	19°59.168	17°50.755	1441	
GeoB 24623-1	MSM104_23-1	03.12.21	CTD	23:30	19°52.667	18°07.864	2031	
GeoB 24623-2	MSM104_23-2	04.12.21	ISP	01:04	19°52.668	18°07.55	2029	
GeoB 24624-1	MSM104_20-2	04.12.21	DF	09:05	19°36.153	17°34.608	1709	DF6 recovery
GeoiB 24624-2	MSM104_24-1	04.12.21	CTD	09:26	19°36.153	17°34.608	1709	
GeoiB 24624-3	MSM104_24-2	04.12.21	DF	09:55	19°36.152	17°34.608	1711	DF7 deployment
GeoB 24625-1	MSM104_25-1	04.12.21	MUC	14:29	19°52.668	18°07.856	2029	
GeoB 24626-1	MSM104_26-1	04.12.21	CTD	17:37	19°44.717	18°29.223	2591	
GeoB 24626-2	MSM104_26-2	04.12.21	CTD	19:30	19°44.717	18°29.223	2593	
GeoB 24626-3	MSM104_26-3	05.12.21	MUC	04:07	19°44.717	18°29.223	2591	
GeoB 24627-1	MSM104_24-2	05.12.21	DF	08:06	19°36.073	17°33.936	1713	DF7 recovery
GeoiB 24627-2	MSM104_27-1	05.12.21	CTD	08:55	19°35.073	17°33.936	1714	
GeoiB 24627-3	MSM104_27-2	05.12.21	DF	09:24	19°35.073	17°33.936	1716	DF8 deployment
GeoB 24628-1	MSM104_28-1	05.12.21	CTD	13:12	19°52.674	18°07.855	2024	
GeoB 24628-2	MSM104_28-2	05.12.21	CTD	14:58	19°52.674	18°07.855	2025	
GeoB 24628-3	MSM104_28-3	05.12.21	ISP	16:07	19°52.674	18°07.855	2023	
GeoB 24629-1	MSM104_27-2	06.12.21	DF	08:02	19°34.863	17°33.563	1709	DF8 recovery
GeoiB 24629-2	MSM104_29-1	06.12.21	CTD	08:35	19°34.867	17°33.557	1709	
GeoB 24630-1	MSM104_30-1	08.12.21	CTD	07:59	11°36.983	22°38.014	5053	
GeoB 24630-2	MSM104_30-2	08.12.21	DF	08:29	11°36.984	22°38.014	5056	DF 9 deployment
GeoB 24631-1	MSM104_31-1	08.12.21	Mooring	10:14	11°28.108	22°42.768	5283	M1 recovered
GeoB24632-1	MSM104_32-1	09.12.21	Buoy	08:12	11°21.468	22°59.081	5111	Dust -buoy "Laura"
GeoB24633-1	MSM104_33-1	09.12.21	CTD	11:58	11°29.994	22°54.016	5107	
GeoB24633-2	MSM104_33-2	09.12.21	ISP	15:17	11°29.997	22°54.018	5106	
GeoB24633-3	MSM104_33-3	09.12.21	ISP	21:35	11°29.994	22°54.04	5107	
GeoB24634-1	MSM104_34-1	10.12.21	Mooring	08:13	11°26.366	22°43.741	5081	M1 deployed
GeoB 24635-1	MSM104_30-2	10.12.21	DF	11:55	11°30.979	22°49.259	5003	DF 9 recovery
GeoB 24635-2	MSM104_35-2	10.12.21	CTD	12:25	11°31.013	22°49.311	5007	

CTD = CTD/Rosette

DF = Drifting Trap

ISP = In-Situ Pump

MUC = Multicore

Mooring = Sediment trap mooring

Buoy = dust Buoy
Underway dust sampling

Filter nr	Date-time start (UTC)	lat start (N)	lon start (W)	Date-time stop (UTC)	lat stop (N)	lon stop (W)
1	26.11.21 08:00	24°02,90	20°06,47	29.11.21 09:15	21°12,878	20°53,525
2	29.11.21 09:15	21°12,878	20°53,525	29.11.21 16:13	21°26,063	20°37,692
3	30.11.21 08:45	19°51,186	17°59,871	30.11.21 14:40	19°56,30	17°38,99
4	30.11.21 14:40	19°56,30	17°38,99	01.12.21 08:05	19°51,862	17°46,225
5	01.12.21 08:05	19°51,862	17°46,225	01.12.21 14:11	20°01,245	17°38,927
6	01.12.21 14:11	20°01,245	17°38,927	01.12.21 18:30	20°01,245'	17°38,927'
7	01.12.21 18:30	20°01,245'	17°38,927'	02.12.21 08:30	19°51,543	17°40,01
8	02.12.21 08:30	19°51,543	17°40,001	03.12.21 09:00	19°36,699	17°35,413
9	03.12.21 09:00	19°36,699	17°35,413	03.12.21 19:50	19°59,169	17°50,754
10	03.12.21 19:50	19°59,169	17°50,754	04.12.21 19:50	19°44,717	18°29,223
11	04.12.21 19:50	19°44,717	18°29,223	05.12.21 09:15	19°35,073	17°33,936
12	05.12.21 09:15	19°35,073	17°33,936	05.12.21 19:30	19°52,676	18°07,857
13	05.12.21 19:30	19°52,676	18°07,857	06.12.21 09:10	19°34,800	17°33,347
14	08.12.21 08:15	11°36,984	22°38,014	09.12.21 11:00	11°23,349	22°57,776
15	09.12.21 11:00	11°23,349	22°57,776	10.12.21 15:45	11°57,534	22°46,823
16	10.12.21 15:45	11°57,534	22°46,823	11.12.21 11:00	15°22,042	22°24,290
17	11.12.21 11:00	15°22,042	22°24,290	12.12.21 13:15	19°58,247	21°48,802
18	12.12.21 13:15	19°58,247	21°48,802	13.12.21 21:00	25°37,152	21°03,816