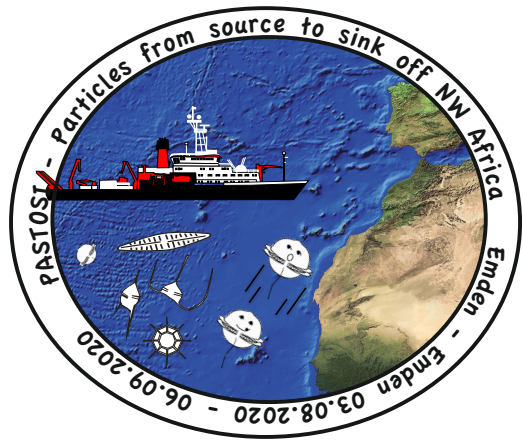


Prof. Dr. Karin Zonneveld
MARUM Center for Marine
Environmental Sciences
Leobener Straße
D-28359 Bremen
Germany

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



Short Cruise Report
R/V METEOR
cruise M165 (GPF 18-1_081)
Emden - Emden
03.08.2020 - 06.09.2020
Chief Scientist: Karin Zonneveld
Captain: Detlef Korte



Figure 1. Cruise track

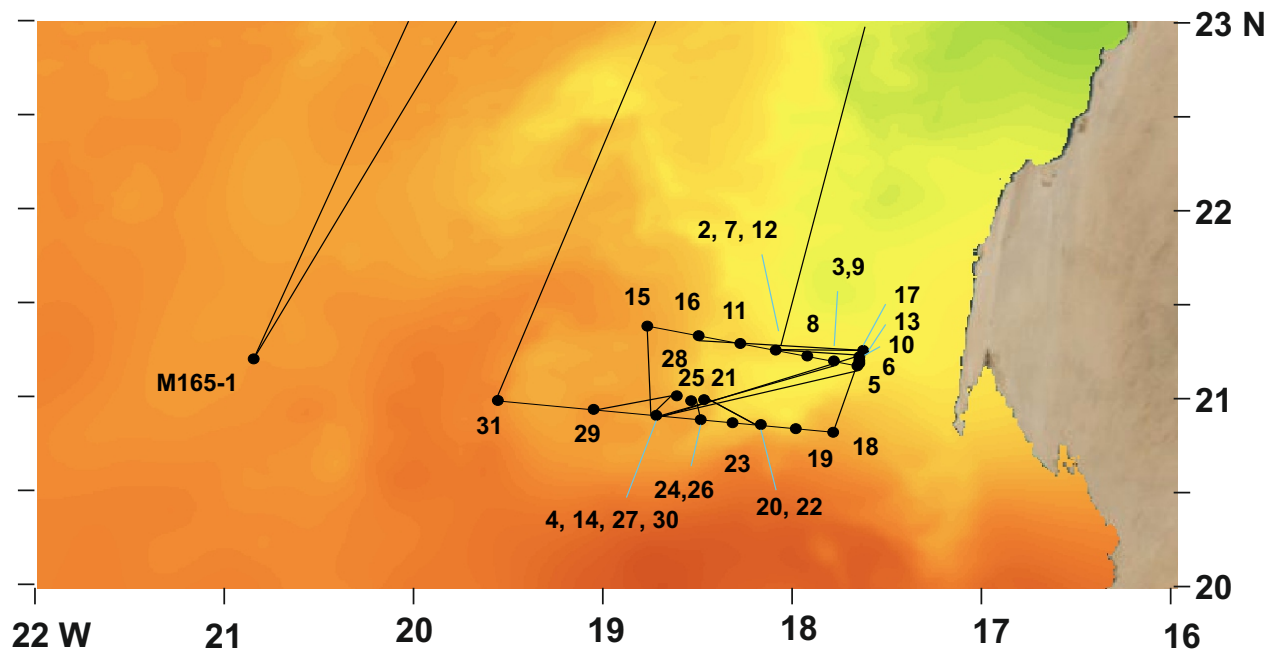


Figure 2. Detailed map depicting satellite derived sea surface temperature at 19.08.20, cruise track and station positions in the research area. Numbers represent the M165 station numbers (Figures established with the courtesy of NASA and downloaded from NOAA website “state of the Ocean”)

Objectives

The scientific activities of cruise M165 focus on particulate and dissolved organic carbon and processes that steer their turnover. Carbon dioxide is an important greenhouse gas affecting our climate and the ocean plays an important role in the global carbon cycle, notably as storage of organic carbon in ocean floor sediments. Apart from storage of organic carbon the ocean floor is likely to store anthropogenic pollutants such as microplastic. However, many aspects are still unclear on influencing processes and mechanisms that shape the organic-matter and (bio-)mineral vertical particulate flux, the vertical and lateral displacement of particles and their transformation as well as the influence these aspects have on selected environmental proxy signals. Furthermore, it is not known to what extent microplastics are being preserved or degraded in ocean floor sediments.

During cruise M165 we aimed to obtain insight into the formation, sinking, lateral advection, alteration and storage of organic matter, bio-mineral and microplastic particles in the active upwelling area off Cape Blanc. We intended to study both the species composition as well as the molecular composition of the particles. Furthermore, we aimed to obtain insight into the relationship between dissolved and particulate organic matter (DOM/POM) as well as their age. Results shall be compared to long-term flux records in sediment-trap series. Sediment traps were serviced. Although not initially planned for this cruise, the investigation of sinking behavior, lateral and vertical transportation, sedimentation and preservation and molecular composition of microplastics can be carried out on exactly the same samples and the same use of analytics, measurements and data needed for our organic matter and bio-mineral particles studies. Since gathering data and samples for this societal important subject would not affect our sampling strategy and would not require extension of ship time, we decided to extend our aims and study simultaneously microplastic behavior in the ocean as well.

In detail the following aims have been addressed:

- a. Determination of carbon flux attenuation in the epi- and mesopelagic to get a better understanding of the major underlying processes.
- b. Obtaining insight into the influence of zooplankton flux feeding on carbon flux and remineralisation.
- c. Quantify the rate of production as well as determination of the vertical and lateral transport of different POM particles of known origin (e.g. coccolithophorids, dinoflagellate cysts, pollen/spores, planktic foraminifera) in relationship to upwelling dynamics and the presence and location of nepheloid layers.
- d. 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.
- e. 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.
7. Obtaining insight into the lateral and vertical transportation of microplastics in the water column as well as their degradation and preservation in marine sediments.

Narrative

In the morning of August 3rd the R/V METEOR left the port of Emden to start a 10 days transit to the research area off Cape Blanc (NW Africa). We arrived there in the late morning of August 12th where station work was started by recovering the mooring CB that contained two sediment traps that had collected particles at 3635 and 1228 m water depth. These traps are part of the long-term monitoring program of the MARUM that had its origin in 1988. With exception of one of the two releasers the traps did not suffer from extreme damage despite the 5 months longer than expected stay in the water column as a result of the COVID-19 Pandemic. The traps had functioned perfectly and had collected material from November 2018 until March 2020. After the safe recovering of the mooring, station work continued by characterizing the water column by CTD profiling and sampling particles from the bottom nepheloid layer by in-situ pumps. Taking advantage of the good weather, in the early afternoon of August 13th, the now serviced and cleaned mooring was released for another two years of sampling. The station work was continued by collecting surface sediments by multi coring. Station work had to be interrupted as a result of an accident of one of the scientific crew members. Although not life threatening, the injury required medical treatment that was unavailable on board. Therefore, we interrupted our scientific program and headed north to Las Palmas de Gran Canaria where we arrived in the early morning of the 16th of August. From there transport was organized to bring our colleague home on the most safe and direct way available. Our colleague arrived safely in Germany in the night of August 16th and underwent surgery already on August 18th. The injuries are treated well and it is extremely likely that the absolved treatment leads to complete recovery.

Favorite swell and winds brought us back in the research area and station work could be continued on the 17th of August in the early afternoon. In the following week, station work concentrated on the characterization of the water column as well as the collection of water, particulate organic matter (incl. microplastic 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. From August 17th to 22nd the position and extension of the oxygen minimum zone as well as the bottom water nepheloid layers were determined at 7 stations at an offshore - onshore transect at about 21°10.5' N. At this "northerly" transect the water column contained no nepheloid layers at intermediate water depths. At August 18th, and August 21st the transect work was shortly interrupted by the recovery and successive deployment of the second MARUM monitoring program mooring CBI. This mooring contained two sediment traps that had collected water at 2164 m and 1264 m water depth. The traps of this mooring had functioned without any problems providing a maximum of collected samples. They had received some damage as a result of the 5 months longer than planned stay in the water-column. However, this damage could be repaired on board. Between the 17th and 22nd of November each of the previously characterized northerly transect stations was revisited to collect water and particles from the water column at different oxygen concentrations and from the bottom nepheloid layers using CTD/Rosette and in-situ pumps. Next to the transect station work, in the morning of August 18th a drifting trap was released at the rim of a newly formed active upwelling cell. The position of this upwelling cell was determined on the basis of satellite imaging of surface water temperatures and Chlorophyll-a. This drifting trap was released for a period of about 23 hours. Hereafter, it was replaced by a second drifting trap that again was released for a period of about 23 hours. This deployment and recovery of drifting traps was executed every day between

August 18th and 22nd. Every day the water column was characterized at the recovery/redeployment site with CTD and under water particle camera profiling. At selected locations, marine aggregates were sampled with a marine snow catcher. During the last deployment day in the active upwelling, the drifting trap was caught by a local eddy that transported it to shallow waters and we were forced to end the survey after four days of particle collection.

From August 23rd to 26th we continued our Station work on a transect located about 30 nm south of the first transect. Water column characterization with CTD profiling revealed that the water column now contained clearly detectable nepheloid layers that were not observed on the northern transect. This indicates that in contrast to what is commonly assumed, the presence of nepheloid layers in the NW African upwelling area is patchy and has locally restricted extensions. Station work concentrated on the characterization of the water column as well as the collection of water, particulate organic matter (incl. micoplastic particles) and dissolved organic matter from the photic zone, from intermediate and bottom nepheloid layers with CTD/Rosette and in-situ pump systems as well as collecting of surface sediments with a multicorer. On Wednesday 26th of August the very intense station work was completed and the long transit back to the port of Emden was started in the early afternoon. After a safe trip the port was reached in the afternoon of September 6th.

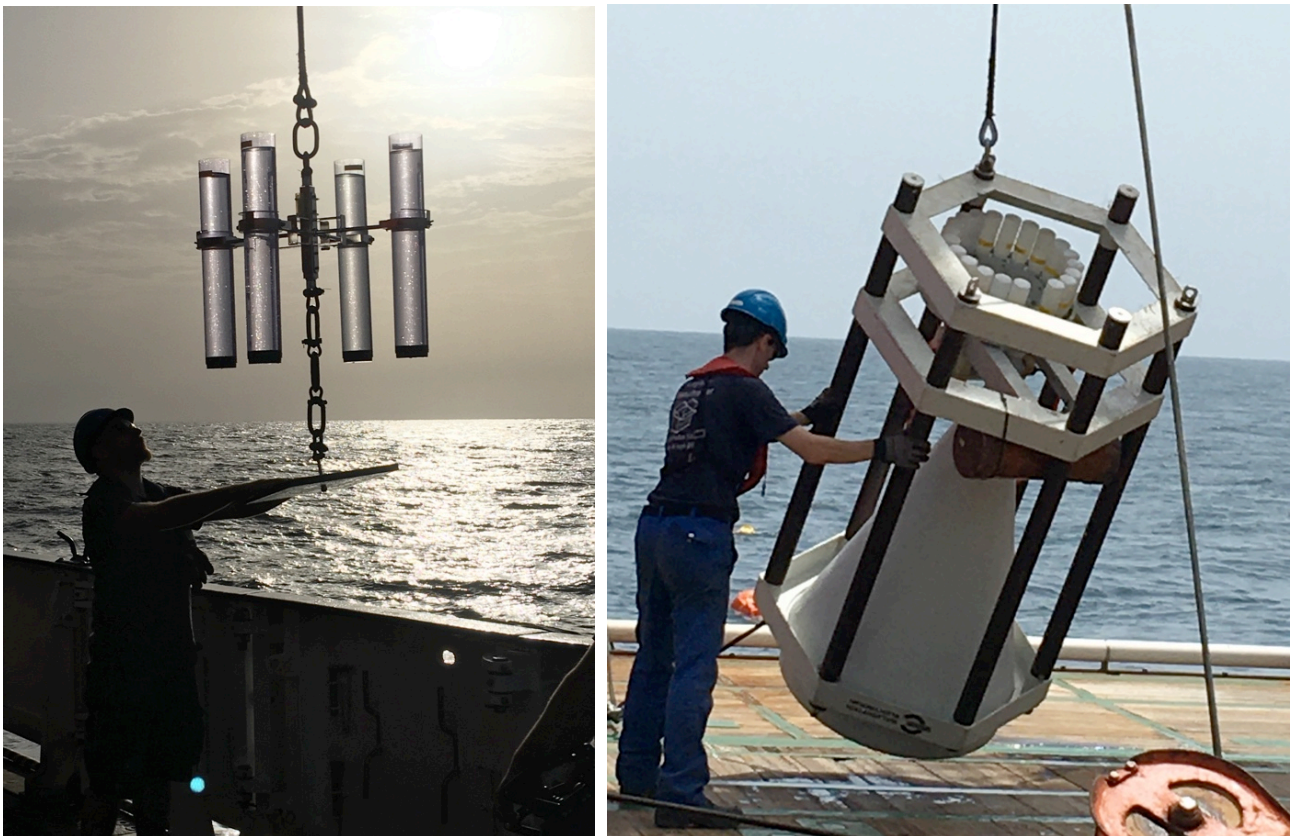


Figure 3: Left: deployment of a drifting trap. Right: deployment of the Mooring CBI.

Acknowledgements

The scientific crew of cruise M165 thanks Captain Korte 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 want to thank Dr. Gunter Rütter for the fast and excellent treatment of our wounded colleague. We greatly appreciate the support, excellent cooperation and flexibility of the Gutachterpanel Forschungsschiffe (German Research Foundation), the German Research Fleet Coordination Centre (University of Hamburg) and the shipping Company Briese Research that provided us this unique possibility to execute the research cruise M165 in times of COVID-19.

List of scientific participants

1. Karin Zonneveld	Chief Scientist*	Univ. Bremen
2. Ousmane Coulibaly	Mooring/Logistic	MARUM
3. Clara Flintrop	Drifting Trap	AWI
4. Hendrik Grotheer	In-situ Pumps	MARUM/AWI
5. Marco Klann	Mooring/Logistic	MARUM
6. Melina Knoke	DOC	Univ. Oldenburg
7. Brit Kokisch	Nanoplankton	Univ. Bremen
8. Nasrollah Moradi	Marine Particles	Univ. Bremen
9. Kristina Kotzem	Palynology	Univ. Bremen
10. Götz Ruhland	Mooring/Logistic	MARUM
11. Nicola Steinke	Polysaccharides	MARUM
12. Steffen Swoboda	Mar. Snow Catcher, Part. Camera	MARUM
13. Sara Schlagenhauff	In-situ Pumps	AWI
14. Elinor Tessin	CTD, Biomolecules	MARUM
15. Gerard Versteegh	Multi corer, Org. Geochemistry	AWI

* CTD + palynology/microplastic

Institute

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

AWI: Alfred-Wegener-Institute, Helmholtz-Center for Polar- and Marine Research

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

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

Stationlist

Station Ship No.	Station GeoB No.	Date	Device	Time [UTC] seafloor / maximum wire length	Latitude [N]	Longitude [W]	Water depth [m]	Samples / Core recovery
M165_1-1	GeoB 24101-1	12.08.20	Mooring	11:43	21°13.482'	20°52.610'	4175	CB recovery
M165_1-2	GeoB 24101-2	12.08.20	CTD	15:20	21°13.589'	20°51.418'	4170	
M165_1-3	GeoB 24101-3	12.08.20	CTD	19:44	21°13.591'	20°51.421'	4171	
M165_1-4	GeoB 24101-4	12.08.20	CTD	20:21	21°13.591'	20°51.421'	4169	
M165_1-5	GeoB 24101-5	12.08.20	ISP	22:45	21°13.590'	20°51.421'	4170	
M165_1-6	GeoB 24101-6	13.08.20	CTD	04:15	21°13.591'	20°51.420'	4170	
M165_1-7	GeoB 24101-7	13.08.20	CTD	07:05	21°13.591'	20°51.420'	4171	
M165_1-8	GeoB 24101-8	13.08.20	CTD	09:44	21°13.591'	20°51.421'	4171	
M165_1-9	GeoB 24101-9	13.08.20	Mooring	15:54	21°13.109'	20°52.887'	4186	CB deployment
M165_1-10	GeoB24101-10	13.08.20	MUC	17:41	21°13.590'	20°51.421'	4169	
M165_2-1	GeoB 24102-1	17.08.20	CTD	23:00	21°12.406'	18°07.467'	1812	
M165_3-1	GeoB 24103-1	18.08.20	CTD	01:36	21°10.132'	17°46.292'	822	
M165_3-2	GeoB 24103-2	18.08.20	PARCA	03:28	21°10.132'	17°46.292'	822	
M165_3-3	GeoB 24103-3	18.08.20	DF	08:28	21°10.136'	17°46.296'	822	DF-1 deployed
M165_4-1	GeoB 24104-1	18.08.20	Mooring	15:13	20°49.508'	18°45.377'	2717	CBi recovery
M165_5-1	GeoB 24105-1	18.08.20	CTD	22:39	21°08.314'	17°40.256'	449	
M165_5-2	GeoB 24105-2	18.08.20	ISP	23:27	21°08.314'	17°40.256'	449	
M165_5-3	GeoB 24105-3	19.08.20	ISP	06:35	21°08.314'	17°40.257'	449	
M165_6-1	GeoB 24106-1	19.08.20	DF	08:53	21°10.505'	17°46.479'	822	DF1-recovered
M165_6-2	GeoB 24106-2	19.08.20	CTD	09:16	21°10.505'	17°46.479'	822	
M165_6-3	GeoB 24106-3	19.08.20	DF	10:53	21°10.505'	17°46.479'	822	DF-2 deployed
M165_6-4	GeoB 24106-4	19.08.20	PARCA	11:58	21°10.256'	17°46.602'	838	
M165_6-5	GeoB 24106-5	19.08.20	MSC	12:43	21°10.256'	17°46.605'	822	
M165_7-1	GeoB 24107-1	19.08.20	CTD	15:30	21°12.436'	18°07.448'	1795	
M165_8-1	GeoB 24108-1	19.08.20	CTD	18:16	21°11.039'	17°55.104'	1301	
M165_8-2	GeoB 24108-2	19.08.20	ISP	19:31	21°11.040'	17°55.105'	1303	
M165_9-1	GeoB 24109-1	19.08.20	CTD	23:57	21°10.159'	17°46.315'	823	
M165_9-2	GeoB 24109-2	20.08.20	CTD	01:03	21°10.159'	17°46.316'	823	
M165_9-3	GeoB 24109-3	20.08.20	ISP	01:57	21°10.161'	17°46.316'	823	

M165_10-1	GeoB 24110-1	20.08.20	DF	07:33	21°10.971'	17°46.495'	803	DF-2 recovered
M165_10-2	GeoB 24110-2	20.08.20	CTD	08:31	21°10.979'	17°46.543'	803	
M165_10-3	GeoB 24110-3	20.08.20	DF	09:50	21°10.980'	17°46.546'	803	DF-3 deployed
M165_10-4	GeoB 24110-4	20.08.20	PARCA	11:25	21°11.084'	17°47.633'	874	
M165_11-1	GeoB 24111-1	20.08.20	CTD	15:38	21°14.177'	18°19.498'	2255	
M165_11-1	GeoB 24111-2	20.08.20	CTD	17:10	21°14.176'	18°19.498'	2255	
M165_12-1	GeoB 24112-1	20.08.20	CTD	19:49	21°12.407'	18°07.462'	1796	
M165_12-2	GeoB 24112-2	20.08.20	CTD	21:23	21°12.403'	18°07.458'	1797	
M165_13-1	GeoB 24113-1	21.08.20	PARCA	04:18	21°13.206'	17°44.941'	665	
M165_13-2	GeoB 24113-2	21.08.20	CTD	08:31	21°13.206'	17°44.941'	665	
M165_13-3	GeoB 24113-3	21.08.20	DF	06:48	21°13.674'	17°43.689'	593	DF-3 recovery
M165_13-4	GeoB 24113-4	21.08.20	DF	08:31	21°13.990'	17°43.440'	596	DF-4 deployme
M165_14-1	GeoB 24114-1	21.08.20	Mooring	16:12	20°50.158'	18°44.079'	2684	CBi deployed
M165_14-2	GeoB 24114-2	21.08.20	CTD	17:50	20°50.814'	18°43.501'	2681	
M165_14-3	GeoB 24114-3	21.08.20	MUC	19:51	20°50.814'	18°43.501'	2681	
M165_15-1	GeoB 24115-1	22.08.20	CTD	00:34	21°18.073'	18°47.407'	3029	
M165_16-1	GeoB 24116-1	22.08.20	CTD	04:08	21°15.770"	18°32.254'	2686	
M165_17-1	GeoB 24117-1	22.08.20	DF	09:59	21°18.420'	17°38.179'	436	DF-4 recovery
M165_17-2	GeoB 24117-2	22.08.20	CTD	08:31	21°18.429'	17°38.192'	436	
M165_17-3	GeoB 24117-3	22.08.20	PARCA	11:49	21°18.428'	17°38.192'	437	
M165_17-4	GeoB 24117-4	22.08.20	MSC	12:15	21°18.426'	17°38.191'	437	
M165_17-5	GeoB 24117-5	22.08.20	MSC	12:30	21°18.429'	17°38.186'	438	
M165_18-1	GeoB 24118-1	22.08.20	CTD	16:11	20°46.411'	17°47.443'	774	
M165_18-2	GeoB 24118-2	22.08.20	MUC	17:15	20°46.412'	17°47.441'	774	
M165_19-1	GeoB 24119-1	22.08.20	CTD	19:17	20°47.208'	17°57.135'	1153	
M165_19-2	GeoB 24119-2	22.08.20	ISP	20:24	20°47.209'	17°57.136'	1153	
M165_19-3	GeoB 24119-3	23.08.20	ISP	00:20	20°47.216'	17°57.159'	1156	
M165_20-1	GeoB 24120-1	23.08.20	CTD	04:59	20°48.103'	18°08.243'	1631	
M165_21-1	GeoB 24121-1	23.08.20	CTD	07:36	21°00.369'	18°22.212'	2426	
M165_21-2	GeoB 24121-2	23.08.20	PARCA	08:59	21°00.392'	18°22.197'	2426	
M165_21-3	GeoB 24121-3	23.08.20	MSC	09:46	21°00.390'	18°22.197'	2426	
M165_21-4	GeoB 24121-4	23.08.20	MSC	10:02	21°00.391	18°22.196'	2426	
M165_21-5	GeoB 24121-5	23.08.20	DF	11:00	21°00.392'	18°22.203'	2429	DF-5 deployme

M165_22-1	GeoB 24122-1	23.08.20	CTD	13:34	20°48.095'	18°08.242'	1633	
M165_22-2	GeoB 24122-2	23.08.20	ISP	15:02	20°48.094'	18°08.240'	1634	
M165_22-3	GeoB 24122-3	23.08.20	ISP	18:51	20°48.095'	18°08.241'	1634	
M165_22-4	GeoB 24122-4	23.08.20	MUC	22:23	20°48.095'	18°08.240'	1634	
M165_23-1	GeoB 24123-1	24.08.20	CTD	00:52	20°48.505'	18°17.398'	1980	
M165_24-1	GeoB 24124-1	24.08.20	CTD	03:40	20°49.579'	18°29.102'	2551	
M165_25-1	GeoB 24125-1	24.08.20	MSC	06:25	20°58.348'	18°29.680'	2551	
M165_25-2	GeoB 24125-2	24.08.20	MSC	06:43	20°58.446'	18°29.821'	2551	
M165_25-3	GeoB 24125-3	24.08.20	DF	07:41	20°59.277'	18°29.707'	2571	DF-5 recovery
M165_25-4	GeoB 24125-4	24.08.20	CTD	08:42	20°59.421'	18°29.838'	2877	
M165_25-5	GeoB 24125-5	24.08.20	DF	09:48	20°59.552'	18°29.957'	2571	DF-6 deployme
M165_256	GeoB 24125-6	24.08.20	PARCA	11:45	21°00.247'	18°29.371'	2581	
M165_26-1	GeoB 24126-1	24.08.20	ISP	14:02	20°49.442'	18°28.725'	2089	
M165_26-2	GeoB 24126-2	24.08.20	ISP	18:08	20°49.444'	18°28.726'	2089	
M165_27-1	GeoB 24127-1	25.08.20	CTD	00:04	20°50.787'	18°43.520'	2683	
M165_27-2	GeoB 24127-2	25.08.20	CTD	01:30	20°50.793'	18°43.531'	2683	
M165_27-3	GeoB 24127-3	25.08.20	ISP	02:54	20°50.793'	18°43.534'	2682	
M165_27-4	GeoB 24127-4	25.08.20	ISP	07:11	20°50.794'	18°43.536'	2681	
M165_28-1	GeoB 24128-1	25.08.20	DF	11:49	20°58.460'	18°38.383'	2687	DF-6 recovery
M165_28-2	GeoB 24128-2	25.08.20	CTD	12:54	20°58.460'	18°38.487'	2696	
M165_28-3	GeoB 24128-3	25.08.20	PARCA	14:18	20°58.483'	18°38.561'	2700	
M165_29-1	GeoB 24129-1	25.08.20	CTD	18:05	20°53.279'	19°00.411'	3162	
M165_29-2	GeoB 24129-2	25.08.20	ISP	20:18	20°53.342'	19°00.411'	3162	
M165_30-1	GeoB 24130-1	26.08.20	CTD	05:50	20°50.883'	18°43.667'	2682	
M165_31-1	GeoB 2431-1	26.08.20	CTD	10:43	20°57.568'	19°31.122'	3561	

CTD = CTD/Rosette

DF = Drifting Trap

ISP = In-Situ Pump

MUC = Multicore

PARCA = Particle Camera

MSC = Marine Snow Catcher