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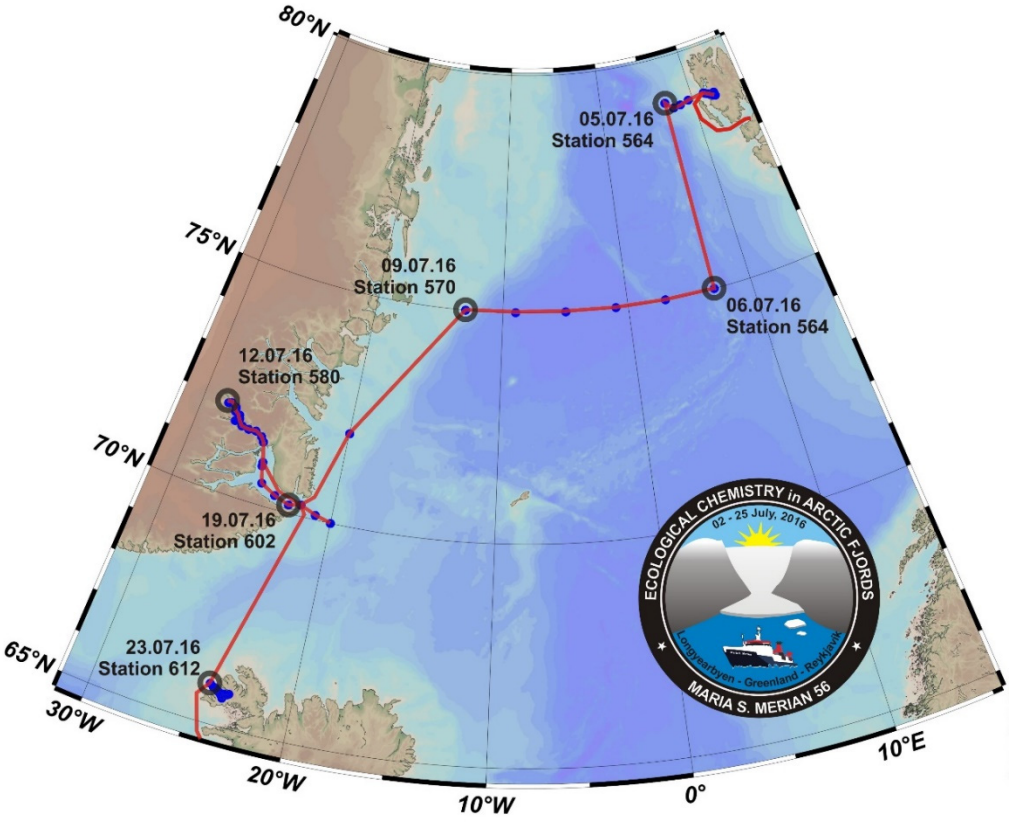
Short Cruise Report
Maria S. Merian MSM56

Longyearbyen - Reykjavík
July 2nd 2016 – July 25th 2016
Chief Scientist: Boris Koch
Captain: Ralf Schmidt



Objectives

Global change causes fundamental environmental changes in the Arctic. Increasing temperatures result in melting of the Arctic ice sheet and glaciers and the increasing freshwater discharge inevitably leads to changes in Arctic fjord systems. Our study thus aimed at two major topics:
(i) changes of the phyto- and bacterioplankton community along salinity gradients in Arctic fjords and (ii) the impact of such changes on biogeochemical fluxes and chemical modification of organic substrates and metabolites. Community composition is an important driver of particulate and dissolved matter partitioning and for the bioavailability of organic matter to grazers and microbes. Hence, carbon flux in the water column depends on primary production and respiration from both microbes and vertically migrating zooplankton flux feeders.

Our study aimed at comparing three Fjord systems (Kongsfjord, Svalbard; Scoresby Sund, Greenland and Arnarfjörður, Iceland), which differed in their extent of available scientific information, their size, geomorphology, glacier volume, extent of freshwater input, and their biogeochemical settings. Diurnal changes were studied during a time series station in the Scoresby Sund. From the results of our study, we expect new insights into how Arctic fjords respond to changes induced by climate warming.

Narrative

The 22 participating scientists from Germany, Norway, the Netherlands, Denmark, Sweden, Finland and the United States covered scientific expertise in (micro-) biology, chemistry, and oceanography. Apart from aerosol and rain water collection, which was applied to assess atmospheric deposition, sampling was restricted to the water column. Phyto- and zooplankton were sampled by vertical net hauls using plankton net, multinet and a pump system for the filtration of large water volumes to collect different size classes of phytoplankton, followed by DNA and RNA extraction. Phytoplankton was also characterized and quantified onboard by microscopy and flow cytometry. Primary productivity was assessed in incubations in the isotope container using radiocarbon labels. Clonal cultures were established to identify selected key species and their phylogenetic status. Bacterial abundance, community composition and production was also determined onboard. Chemical sampling and analytical parameters (most of which will be measured back in the home labs) were carried out using the water rosette. The final dataset will cover inorganic nutrients, oxygen concentration, dissolved inorganic carbon, total alkalinity, He/Ne ratios for the estimation of basal melt water, $\delta^{18}O$ for the contribution of meteoric water, particulate and dissolved organic carbon and nitrogen, optical properties (fluorescence), molecular characterization and radiocarbon age of organic matter.

A ferry box system continuously recorded surface water information on turbidity, chlorophyll fluorescence and dissolved oxygen. On each station, salinity and temperature profiles were recorded by the CTD system and by profiler deployments, which recorded the light profile in the water column. Vertical material flux was investigated by the deployment of drifting sediment traps, a camera system and a marine snow catcher.

Maria S. Merian expedition MSM56 started early in the morning on July 2nd, slightly earlier than originally planned due to changes in the harbor schedule. During the transit from Longyearbyen to the first test station at the mouth of Kongsfjord, the lab equipment and instruments were installed and a safety drill was carried out.

Generally, the sampling scheme differentiated between regular stations and “super-stations”. On regular stations the CTD water rosette was deployed and samples for chemical and most biological parameters were taken. Super-stations additionally included large volume filtration and sediment trap deployments on selected stations. In each fjord, glacier runoff and ice samples were collected using the ships zodiac. ADCP transects were carried out to assess water exchange.

Sampling locations in the Kongsfjord were aligned to the long-term monitoring program by the colleagues from the Norwegian Polar Institute (see map). After the first test station (551), the official sampling started at the toe of the Kongsbreen glacier at station 553 (equivalent to Norwegian station Kb7). Between, July 2nd and July 5th, we sampled a transect towards the mouth of the Kongsfjord and further on the Svalbard shelf. In sunny and calm weather conditions, we visited a total of 13 stations, six of which were super-stations.

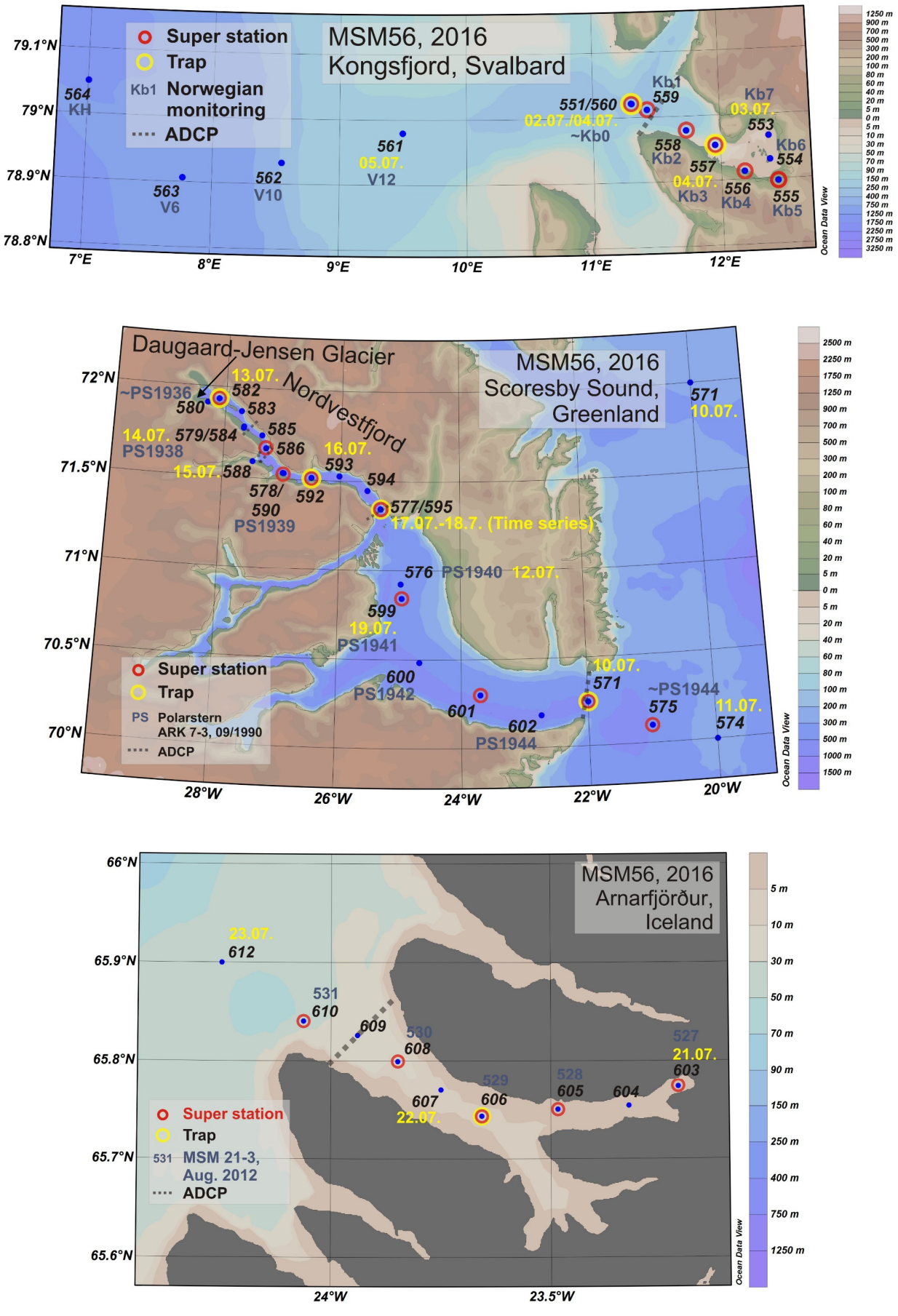
In the evening of July 5th, we headed for the first station of a latitudinal transect on 75°N from Svalbard to Greenland. Six stations were sampled that complemented a Polarstern cruise (ARK 30-2, PS100), which took place almost simultaneously (July/August) and covered a transect on 79°N. After a stormy passage through the Greenland Sea and one coastal station on the Greenland shelf,

we reached our main study area, the Scoresby Sund (Greenlandic: Kangertittivaq), on the evening of July 10th. The ice conditions had improved substantially in the last few days so that we were able to instantaneously start our sampling in the mouth of the fjord. During the night, an ADCP transect was carried out to assess water exchange. In the morning of July 11th, we sampled two stations outside of the Scoresby Sund and thereafter started the 350 km transit to the inner part of the Scoresby Sund (Nordvestfjord), where the Daugaard Jensen glacier terminates. On the way, we sampled four CTD stations (each of which was resampled on the return trip to the mouth of the fjord). In ice conditions with only little remaining sea ice and many icebergs, we were able to reach the glacier after 30 hours in the evening of July 12th.

The Daugaard Jensen Glacier drains approximately 4% of the Greenland Ice Sheet. Therefore, the density of icebergs was high so that the first station was still a few miles away from the glacier terminus. Several sampling locations were aligned with positions that were previously sampled by an expedition with research vessel Polarstern in September 1990 (cruise ARK VII-3). The first comparison with previous data showed identical salinity profiles but temperatures 0.5°C warmer in the deep fjord than 26 years ago. The sampling transect from the inner part of the fjord back to the mouth of Scoresby Sund covered 26 stations, eight of which were super-stations. During the transect on July 16th, we originally planned to start the time series station for the assessment of diurnal changes in the water column. However, we found only very little chlorophyll in the water and therefore postponed the time series. On July 17th, the algal production was still low and we decided to shorten the duration of the time series to 24h and two tidal cycles at the outlet of the Nordvestfjord (station 595) followed by an echo-sounder and ADCP survey to get a better picture of the bottom topography and water exchange. The echo-sounder transects showed that some areas at the entrance of the Nordvestfjord were much shallower than shown in the navigation maps. After our last station in Scoresby Sund (602), our transit to Iceland started half a day earlier than originally planned, to drop-off one member of the science team who had to leave the ship for family reasons. In the morning of July 20th, the station work in the Arnarfjörður started. The size of Arnarfjörður is comparable to the Kongsfjord and represented an important ice-free reference. The stations were aligned with locations previously sampled during Maria S. Merian cruise MSM21 (August 2012). At partly cloudy weather conditions, we sampled nine stations, five of which were super-stations.

The in-situ sampling was complemented with several on board experiments covering the photo and microbial degradation of organic matter in endmember samples such as Atlantic and Polar water, meltwater, and melted ice. Also micro-zooplankton grazing and zooplankton feeding on fecal pellets were studied in additional experiments.

In total we sampled 57 CTD stations, and six glacial runoffs and ice samples. We deployed 14 sediment traps, recorded 38 profiles with the particle camera, and performed 21 large volume filtrations.



Main study areas of MSM56. Kongsfjord, Svalbard (upper panel), Kangertittivaq (=Scoresby Sund), Greenland (middle panel), and Arnarfjörður, Iceland (lower panel).

Acknowledgements

The success of the expedition MSM56 was especially possible due to the commitment and competence of Captain Ralf Schmidt and his crew. We are indebted to the entire crew for the outstanding assistance and the friendly and cooperative atmosphere on board Maria S. Merian.

We are also grateful for the excellent logistic support by Briese Research, the Leitstelle Deutsche Forschungsschiffe, the logistics department of the Alfred-Wegener-Institut Helmholtz Zentrum für Polar- und Meeresforschung and LPL Projects + Logistics GmbH. We would also like to thank University of Bremen (namely Uwe Schüssler and Prof. Tilmann Harder) for providing the clean-lab container.

We are grateful for the support and research permits by the Norwegian Petroleum Directorate, the Directorate of Fisheries of Norway, the Royal Danish Ministry of Foreign Affairs, the Ministry of Nature, Environment and Energy of Greenland, and the Ministry of Foreign Affairs of Iceland. We also acknowledge the German embassies in Denmark, Norway and Iceland for their kind support.

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List of participants

Name	Task	Institute
1. Koch, Boris	Chief scientist	AWI / UAB
2. Amann, Rudi	Prokaryotes; FISH	MPI
3. Bach, Lennart	Eukaryotes; Flow cytometry	GEOMAR
4. Burau, Claudia	Water chemistry; extraction	AWI
5. Edvardsen, Bente	Microalgal ecology; microscopy	UiO
6. Fernandez-Mendez, Mar	Eukaryotes; incubations	NPI
7. Friedrichs, Anna	Oceanography: CTD, optical profiling	ICBM
8. Geuer, Jana	Water chemistry; trace elements	AWI
9. John, Uwe	Diversity; DNA/RNA extraction	AWI
10. Konrad, Christian	Grazing; sediment traps	MARUM
11. Kühne, Nancy	Eukaryotes; extraction	AWI
12. Lechtenfeld, Oliver	Water chemistry; radiocarbon	UFZ
13. McCallister, Leigh	Bacterial production; incubation	VCU
14. Nystedt, Elina	Eukaryotes; sampling	NPI
15. Schmitt-Kopplin, Philippe	Aerosol chemistry; sampling, extraction	HMGU
16. Schwalfenberg, Kai	Oceanography: CTD, optical profiling	ICBM
17. Seifert, Miriam	Water chemistry; pCO_2, oxygen	AWI
18. van de Waal, Dedmer	Eukaryotes; incubation experiments	NIOO
19. van der Jagt, Helga	Particle export; sediment traps	MARUM
20. Wohlrab, Sylke	Eukaryote diversity; extraction	AWI
21. Wulf, Jörg	Prokaryotes; FISH	MPI
22. Wünsch, Urban	Optical OM properties; fluorescence	DTU

Participants of MSM56 (left to right). *Back row*: Lennart Bach, Oliver Lechtenfeld, Urban Wünsch, Philippe Schmitt-Kopplin, Kai Schwalfenberg, Claudia Burau, Christian Konrad, Sylke Wohlrab, Helga van der Jagt, Bente Edvardsen, Jörg Wulf, Rudi Amann, Uwe John. *Front row*: Boris Koch, Mar Fernandez-Mendez, Anna Friedrichs, Elina Nysted, Jana Geuer, Nancy Kühne, Dedmer van der Waal, Miriam Seifert, Leigh McCallister.

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VCU

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List of stations

Station	Date*	Time* [UTC]	Latitude*	Longitude*	Depth [m]*	Gear
551	02.07.16	09:02	79° 1.20' N	11° 18.16' E	335	CTD, TRAP, MN, CAM, PLA, PUMP, SC, PRO, SD
552	02.07.16	17:26	78° 59.13' N	11° 17.06' E	278	ADCP
553	03.07.16	04:03	78° 57.96' N	12° 22.73' E	66	CTD, CAM, PLA, PRO, SD, ZOD
554	03.07.16	09:51	78° 55.80' N	12° 22.93' E	58	CTD, CAM, PLA, PRO, SD
555	03.07.16	11:58	78° 53.80' N	12° 26.42' E	80	CTD, MN, CAM, PLA, PUMP, SD
556	03.07.16	16:42	78° 54.76' N	12° 10.82' E	96	CTD, MN, CAM, PLA, PUMP, PRO, SD
557	03.07.16	04:49	78° 57.25' N	11° 57.15' E	342	CTD, TRAP, MN, CAM, PLA, PUMP, PRO, SD
558	04.07.16	10:35	78° 58.69' N	11° 43.81' E	302	CTD, CAM, PLA, PUMP, PRO, SD
559	04.07.16	13:22	79° 00.68' N	11° 25.65' E	346	CTD, CAM, PLA, PUMP, PRO, SD
560	04.07.16	16:36	79° 01.25' N	11° 18.15' E	336	CTD, MN, CAM, PLA, PUMP, SC, PRO, SD
561	05.07.16	03:54	78° 58.77' N	09° 29.82' E	225	CTD, CAM, PLA, PRO, SD
562	05.07.16	07:55	78° 55.96' N	08° 32.71' E	300	CTD, CAM, PLA, PRO, SD
563	05.07.16	10:24	78° 54.39' N	07° 45.98' E	1137	CTD, PLA, PRO, SD
564	05.07.16	13:45	79° 03.01' N	07° 00.18' E	1327	CTD, CAM, PRO, SD
565	06.07.16	13:57	74° 59.99' N	06° 59.93' E	1869	CTD, CAM, PLA, SD
566	07.07.16	06:01	74° 59.99' N	02° 59.92' E	2499	CTD, PLA
567	07.07.16	14:02	75° 00.03' N	00° 59.99' W	3527	CTD, CAM, SC, SD
568	08.07.16	05:59	75° 00.01' N	05° 00.08' W	3558	CTD, PLA, PRO, SD
569	08.07.16	14:20	74° 59.99' N	08° 59.98' W	3286	CTD, MN, CAM, SC, PRO, SD
570	09.07.16	06:21	74° 59.96' N	12° 59.97' W	325	CTD, MN, CAM, PLA, SC, PRO, SD
571	10.07.16	05:50	71° 59.98' N	20° 00.02' W	247	CTD, PLA, PRO, SD
572	10.07.16	16:20	70° 14.93' N	21° 59.96' W	562	CTD, TRAP, MN, CAM, SC, PRO, SD
573	10.07.16	22:02	70° 24.02' N	21° 57.36' W	145	ADCP
574	11.07.16	07:16	70° 00.00' N	20° 00.08' W	280	CTD, PLA, PRO, SD
575	11.07.16	11:08	70° 05.96' N	20° 59.98' W	437	CTD, PLA, PRO, SD
576	12.07.16	00:03	70° 55.38' N	24° 58.69' W	360	CTD, SD
577	12.07.16	03:08	71° 20.80' N	25° 19.20' W	1262	CTD, SD
578	12.07.16	07:12	71° 32.06' N	26° 58.92' W	1225	CTD, SD
579	12.07.16	11:01	71° 46.59' N	27° 40.33' W	1482	CTD, SD
580	12.07.16	17:59	71° 54.49' N	28° 18.96' W	1083	CTD, CAM, PLA, PUMP, PRO, SD
581	13.07.16	06:22	71° 54.69' N	28° 19.54' W	1084	ZOD
582	13.07.16	10:31	71° 55.94' N	28° 07.23' W	534	CTD, TRAP, MN, CAM, PLA, PUMP, SC, PRO, SD, ZOD
583	13.07.16	19:45	71° 52.11' N	27° 43.44' W	1353	CTD, SD
584	14.07.16	03:57	71° 47.04' N	27° 40.24' W	1482	CTD, CAM, PLA, PUMP, PRO, SD
585	14.07.16	09:00	71° 44.36' N	27° 21.25' W	464	CTD, SD
586	14.07.16	10:35	71° 40.10' N	27° 16.58' W	1413	CTD, MN, CAM, PLA, PUMP, PRO, SD

Station	Date*	Time* [UTC]	Latitude*	Longitude*	Depth [m]*	Gear
587	14.07.16	18:40	71° 38.49' N	27° 15.77' W	683	ADCP
588	15.07.16	06:02	71° 35.62' N	27° 30.07' W	1057	CTD, PRO, SD
589	15.07.16	08:03	71° 37.19' N	27° 40.32' W	255	ZOD
590	15.07.16	10:01	71° 31.99' N	26° 57.72' W	1217	CTD, CAM, PLA, PUMP, PRO, SD
591	15.07.16	16:02	71° 29.43' N	26° 28.96' W	877	ADCP
592	15.07.16	00:15	71° 30.83' N	26° 28.24' W	1091	CTD, TRAP, MN, CAM, PLA, PUMP, SC, PRO, SD
593	16.07.16	06:01	71° 31.58' N	26° 01.26' W	1220	CTD, PLA, PRO, SD
594	16.07.16	14:14	71° 26.89' N	25° 32.85' W	1269	CTD, PRO, SD
595	17.07.16	03:08	71° 19.90' N	25° 15.87' W	373	ADCP, CTD, TRAP, MN, CAM, PLA, PUMP, SC, PRO, SD
596	18.07.16	11:34	71° 20.64' N	25° 18.91' W	1248	EM122
597	18.07.16	13:42	71° 15.12' N	25° 18.22' W	837	ADCP
598	18.07.16	14:37	71° 13.84' N	25° 09.55' W	502	CTD, CAM, PLA, PRO, SD
599	19.07.16	04:00	70° 50.50' N	24° 57.61' W	357	CTD, CAM, PLA, PUMP, PRO, SD
600	19.07.16	09:07	70° 29.04' N	24° 40.16' W	506	CTD
601	19.07.16	11:54	70° 17.94' N	23° 41.84' W	489	CTD, MN, CAM, PLA, PUMP, PRO, SD, ZOD
602	19.07.16	17:03	70° 10.95' N	22° 44.37' W	544	CTD
603	21.07.16	06:46	65° 46.39' N	23° 12.59' W	51	CTD, MN, CAM, PLA, PUMP, PRO, SD, ZOD
604	21.07.16	09:01	65° 45.18' N	23° 20.16' W	96	CTD, CAM, PLA, PRO, SD
605	21.07.16	11:02	65° 44.98' N	23° 29.09' W	101	CTD, CAM, PLA, PUMP, PRO, SD
606	21.07.16	04:57	65° 44.27' N	23° 38.60' W	97	CTD, TRAP, MN, CAM, PLA, PUMP, SC, PRO, SD
607	22.07.16	07:01	65° 46.18' N	23° 44.96' W	93	CTD, CAM, PRO, SD
608	22.07.16	09:56	65° 47.96' N	23° 50.85' W	73	CTD, CAM, PLA, PUMP, PRO, SD
609	22.07.16	12:23	65° 49.56' N	23° 56.42' W	62	CTD, CAM, PRO, SD
610	22.07.16	16:00	65° 50.45' N	24° 03.89' W	43	CTD, CAM, PLA, PUMP, PRO, SD
611	23.07.16	06:12	65° 50.57' N	23° 53.27' W	67	ADCP
612	23.07.16	16:24	65° 53.97' N	24° 15.02' W	45	CTD

**Values for date, time, geographic coordinates and depth represent the first recording at each station.*

Abbreviations

ADCP	Acoustic Doppler current profiler
CTD	CTD, rosette water sampler
TRAP	Drifting sediment trap
EM122	Deep-Sea multibeam echosounder
MN	Multiple net
CAM	Particle camera
PLA	Plankton net
PUMP	Water pump
SC	Snow catcher
PRO	Light profiler
SD	Secchi disc
ZOD	Zodiak