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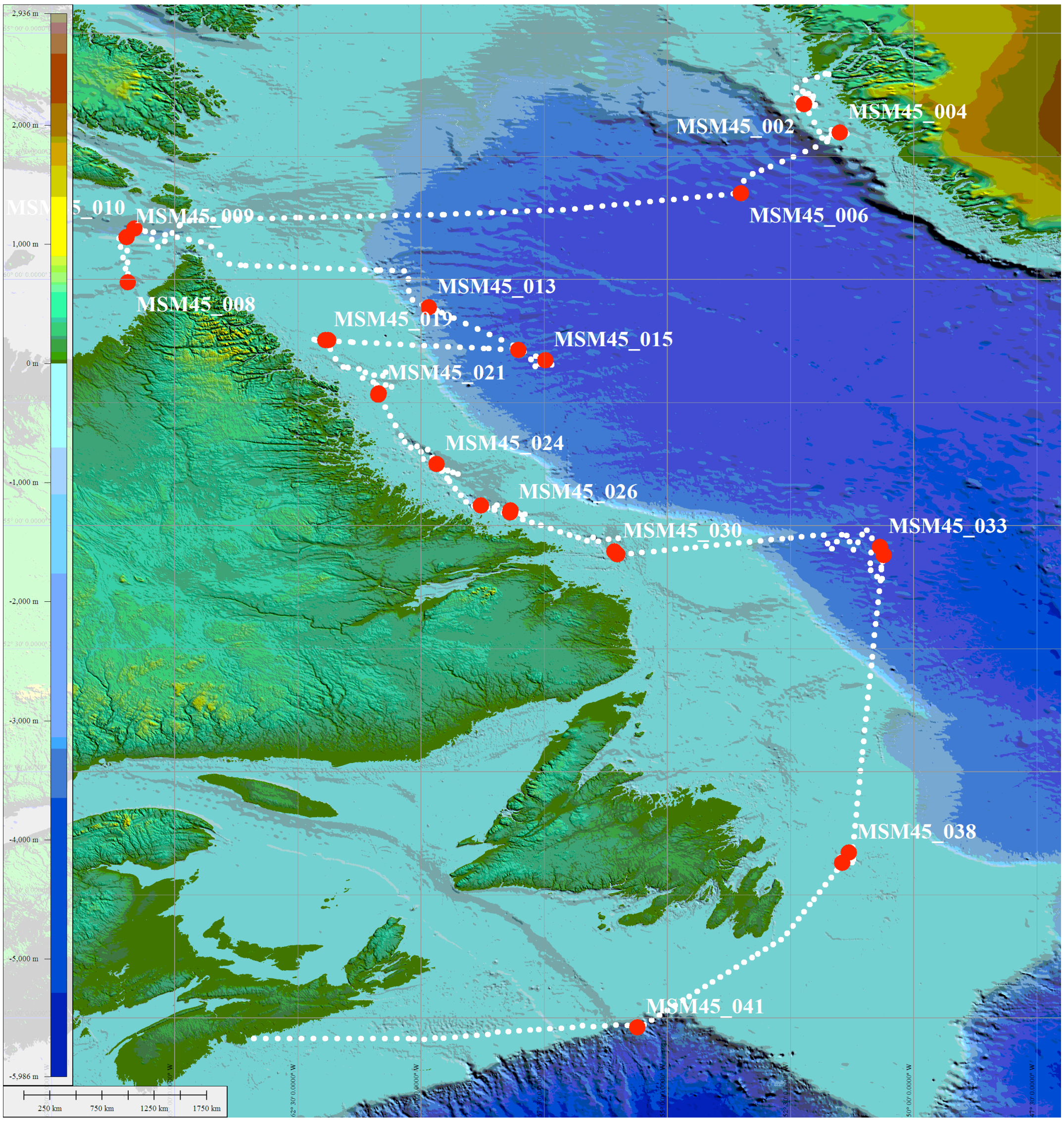
Short Cruise Report
Maria S. Merian cruise MSM45

Nuuk (Greenland) – Halifax (Canada)
01.08.2015 – 22.08.2015
Chief Scientist: Prof. Dr. Ralph Schneider
Captain: Björn Maaß



Objectives

The Labrador Sea is an important region of the North Atlantic Ocean to study climate change. The formation of deepwater in this region is supposed to stabilize the Holocene warm climate mode and additionally may act as trap for anthropogenic CO_2 trough sequestration in the deepwater. Disturbances in the Labrador Sea deepwater formation e.g. by melt-water discharges from the continental ice sheets that surround the Labrador Sea, can have major impacts on the Atlantic Meridional overturning circulation (AMOC) and thereby can even effect the climate on a global scale. This has been shown in reconstructions of melt-water discharges from the Laurentian ice sheet into the Labrador Sea for the last deglaciation and the early to Mid Holocene. However, little is known of the late Holocene climate variability in the Labrador Sea. This knowledge is important to assess the potential impact of the anthropogenic caused climate changes that may include the decay of the Ice sheet of Greenland.

The purpose of cruise MSM45 was to better understand the natural climate variability in the Labrador Sea and unravel interactions between melt-water events and Labrador Sea deep-water formation. These are closely linked to North Atlantic surface and deep circulation and to fluctuations in sea ice extent, and also can determine the flux of terrigenous and biogenic material into the Labrador Basin. Special focus of our cruise was to gain late Holocene sediment records in order to extend historical time series from observations of climate change in the Labrador Sea by several millennia. Comparison of with results from ongoing hydrographic monitoring projects in the same region allows to better differentiate natural climate variability from anthropogenic induced climate change. Moreover, regional studies on water chemistry and plankton studies were conducted to develop and calibrate regional paleoceanographic proxies. Our plankton studies focussed on pteropods. These winged snails have fragile aragonitic shells, and are thought to be sensitive indicators of the marine carbon cycle, and thus could faithfully record the increasing acidification of the polar oceans. For this purpose also culturing experiments on pteropods were conducted onboard.

Our sampling program included in the water column sampling with plankton net and CTD with water bottles to gain water and plankton samples and coring operations with Multicorer and piston corer to get deglacial to Holocene sediment sequences. Sediment acoustic surveys along the shelf and upper slope of Canada and Greenland were used to identify and recover sedimentary sequences of sufficient thickness to allow for high-resolution climate reconstructions of the Holocene interglacial. There are only few regions along the shelves and continental slopes off W Greenland and NE Canada where the much thicker sediments from the glacial period and the time of deglacial melting of the massive glacial ice sheets are overlain by a significant Holocene sediment cover. The biggest challenge of the MSM45 expedition was thus to identify and sample the few spots with undisturbed sediments of the present interglacial. Only from such sediments, and their records of past surface ocean temperatures, productivity, and ice extent, will it be possible to reconstruct in detail the ocean and climate conditions of the Labrador Sea during the last 10.000 years.

Narrative

On August 1, the day of the arrival of the scientific crew for the MSM45 expedition at Nuuk, Greenland, all sampling gears, laboratories and hydroacoustic systems aboard the vessel were set up for an immediate start of research activities upon departure the next day, August 2. During the first three days, two glacial troughs on the upper slope off W Greenland were charted and sampled at water depths of around 500 m. These small depressions in this area southwest of Nuuk were filled with Holocene sediment sequences in excess of 10 m. The dark green, hemipelagic muds contain high concentrations of hydrogen sulfide, a clear indication of degradation of high amounts of organic matter, probably delivered during the early summer season when high surface ocean productivity and export flux takes place. This plankton blooming was also obvious in the recovery of the plankton nets, which swarmed of life and contained a sufficient amount of pteropods for the start of incubation experiments. In addition, we sampled the entire water column with CTD and the water bottle rosette, in which the relatively warm surface waters of the W-Greenland Current and a pronounced chlorophyll maximum at 25 m depth could be identified very well.

Finally on day three, a station in the deep Labrador Sea followed the shallow sites. There, we cored glacial sandy sediments in 2900 m water depth, covered by only 30 cm of Holocene mud. Again, we also sampled the entire water column with CTD, water bottle rosette and plankton nets. From these samples, we will be able to characterize the biological diversity as well as the nutrient concentrations and isotopic and trace elemental composition of the water column in the deep eastern Labrador Basin.

The fourth day, August 6, we traversed the entire Labrador Sea along the latitude of 61° N to the entrance of Hudson Strait. Following multi-beam mapping and sediment echosounding, we sampled the water column and the sea floor sediments at three sites in the eastern basin of the inner Hudson Strait, at water depths between 300 and 900 m at August 7. Most of the up to 12 m long sedimentary sequences contained predominantly grey glacial clayey mud, intercalated with more sandy sections that also contained gravel-sized rock fragments transported by icebergs. The thickness of Holocene sediment cover in the Hudson Strait of about 2 m is much less than on the Greenland slope.

After further mapping and sediment echosounding along the shelf and upper slope off Labrador close to Saglek Bank we performed a geological station at about 1300 m at August 8 and further for surveyed deep-sea stations at 2000- 3000 m water depth. Here, at August 9, we recovered sediments that record the last glacial period including the high frequency climate variations of Heinrich events.

In the beginning of the second week of MSM 45, we returned to shallower waters on the shelf. Thanks to detailed and painstaking PARASOUND and EM122 multi-beam bathymetry surveys, we could identify very promising sampling stations with thick Holocene sediment piles in shallow shelf basins as planned before. From Monday, August 10, to Friday, August 14, we sampled our way through five of the larger of these 250 to 700 m deep shelf basins, at the Karsfelni Trough, Makkovik Trough, Okak Trough, Hopedale Saddle, and Cartwright Saddle, and performed two to three geological station in each of the basins accompanied by water column sampling at one or two of the geological stations. The most exciting results are the more than 150 m of sediment cores recovered from the shallow shelf basins off Labrador, that contain up to 12 m sediments of the Holocene per station. Based on preliminary stratigraphic identification, these cores will, for the first time, allow continuous reconstruction of climate variability of the Labrador Current during the 12,000 years of the current interglacial, including the preceding brief cold spell of the Younger Dryas. Colour scan images and core descriptions of our sediment cores, by comparison with published records, reveal repeated melt events of the glacial ice shield not only during the Younger Dryas but also during the subsequent Holocene warm period. In addition, ice-rafted detritus - glacial dropstones embedded in the soft Holocene mud – provides evidence that the Labrador Current carries icebergs into the western N Atlantic all the time. However, even decimeter large drop stones could not prevent recovery of 10 to 15 m long gravity cores, which do not show any indication for sediment slumps or hiatuses. The latter is also owed to the detailed survey work at each station prior to core recovery.

Also profiling and sampling the water column by CTD and water bottle rosette over the shelf basins identified and captured the various surface and subsurface water masses of the western Labrador Sea. We could thus identify the Inner Labrador Current on the shelf, 4 to 5 degrees colder than the offshore branch of the Labrador Current. This water mass is either result of extensive iceberg melting or outflow of very cold but less saline waters from Hudson Bay. Deployments of the multi net were also very successful, though biological activity was not as high as on the Greenland shelf, as is also indicated in the lack of pronounced chlorophyll maximum off Labrador.

Friday and Saturday, August 15 and 16, we left the shelf to survey and sample the deeper continental slope south of Hamilton Spur, at water depths around 3,300 m. Here we collected two sediment cores of more than 15 m in length, containing sediments of the last glacial cycle probably reaching back into the late Marine Isotope Stage 5, which may allow climate reconstructions of the Labrador Current covering the last 80,000 to 90,000 years. If corroborated, these records could be directly compared to the climate records of the Greenland ice cores. In addition, two plankton tows were carried out in this region, while a CTD cast and water bottle sampling was performed for characterization of the deep-water masses in the outer western Labrador Basin.

During the third week we returned to shallower water depths again, crossed the wide shelf of Grand Banks southward, and sampled Holocene sediments at two shallow stations in the Dowing Basin on Tuesday, August 18. These sediments were characterized by higher content of silt and biogenic carbonates than those in the shelf basins off Labrador and are most likely deposited as current shaped contourites. Finally, on Wednesday, August 19, we retrieved one gravity core and box core on the upper Laurentian Fan system for geotechnical studies on slope stability and failure. This was to serve a request by colleagues from the Bedford Institute of Oceanography, involved in the planning of the cruise and participating in MSM45. After a last short survey of the geotechnical core site, all operations were stopped when reaching the eastern margin of the French EEZ extending southward from the island of St. Pierre. All survey and sampling work proceeded without incidents, so that we were able to meet our ambitious goals for the cruise. This was made possible by the technical support and great flexibility of the ship's crew during the search for optimal core sites, supported by the shipboard hydroacoustic equipment, and during the deployment of continuously changing gears on station.

On the way to Halifax, Thursday, August 19, the last day at sea was used for packing the equipment, cleaning the labs, data archiving and report writing and Friday morning, August 21, we arrived at Halifax harbor. There, the local media welcomed us for the "Open Ship" event. The latter took place at Saturday August 22, attended by more than 1000 interested visitors. As the last highlight, an evening reception at Sunday, August 23, with representatives from local companies, governmental bodies, international researchers and their guests, including representatives of the foreign embassies, terminated cruise MSM45.

In total we achieved 24 geological sampling stations and plankton net sampling at 15 stations. CTD casts with water sampling were run at 12 stations. The 17 multi-beam bathymetry and sediment echo-sounder surveys amount to about 2000 nm in total. The detailed meta information about the cruise track, sampling stations and devices will be published in the cruise report until one year after the cruise and archived in the WDC MARE (PANGAEA, www.pangaea.de) data base and on the Kiel Ocean Data archive.

Acknowledgements

On behalf of all scientific crew members I would like to thank all the authorities and the Ship Coordination Office (Leitstelle) at the Institute of Marine Science, Hamburg University, involved in the planning and execution of the cruise, as well as the crew of RV Maria S. Merian and BRIESE Research for their strong engagement and support, which has made cruise MSM45 a very successful scientific venture.

Participant List

1.	Schneider, Ralph	*Chief Scientist*	CAU
2.	Repschläger, Janne	*Paleoceanography*	CAU
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9.	Reißig, Stefan	*Sediment core sampling*	GEOMAR
10.	Tietjens, Annika	*CTD/ rosette, water sampling*	GEOMAR
11.	Evers, Florian	*Technician piston coring*	GEOMAR
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17.	Schulten, Irena	*Hydroacoustic*	NRCAN/BIO
18.	Van Nieuwenhove, Nicolas	*Micropaleontology*	AARHUS U
19.	Gasparotto, Marie-Camille	*Plankton sampling*	UQAM
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21.	Mellon, Stef	*Sediment lab, core logging*	DAL

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Station List

Station List Maria S. Merian cruise MSM45:

MB/PS = Multibeam & PARASOUND, MUC = Multicorer, GKG = Box corer, GC = Gravity corer, PC = Piston corer
CTD/RO = CTD & Water Bottle Rosette, MN = Multinet, HN = Handnet

Station No	Ship log No	Date	Time (UTC)	Position Lat	Position Lon	Depth [m]	Gear	Action
MSM45_001-1	MSM45/400-1	02.08.15	13:30	63° 56,65' N	52° 22,83' W	302	MB/PS	start profile
MSM45_002-1	MSM45/401-1	03.08.15	10:51	63° 33,24' N	52° 13,12' W	506	CTD/RO	surface
MSM45_002-2	MSM45/401-2	03.08.15	11:36	63° 33,24' N	52° 13,11' W	505	MN	surface
MSM45_002-3	MSM45/401-3	03.08.15	12:19	63° 33,24' N	52° 13,12' W	505	BC	surface
MSM45_002-4	MSM45/401-4	03.08.15	12:53	63° 33,24' N	52° 13,12' W	505	MUC	surface
MSM45_002-5	MSM45/401-5	03.08.15	14:20	63° 33,24' N	52° 13,12' W	504	GC	surface
MSM45_002-6	MSM45/401-6	03.08.15	18:53	63° 33,24' N	52° 13,11' W	500	PC	surface
MSM45_003-1	MSM45/402-1	03.08.15	23:52	63° 0,01' N	51° 55,00' W	113	MB/PS	start profile
MSM45_004-1	MSM45/403-1	04.08.15	09:14	62° 58,99' N	51° 29,93' W	549	MUC	surface
MSM45_004-2	MSM45/403-2	04.08.15	10:17	62° 58,99' N	51° 29,94' W	564	PC	surface
MSM45_004-3	MSM45/403-3	04.08.15	11:18	62° 59,00' N	51° 29,96' W	552	MN	surface
MSM45_004-4	MSM45/403-4	04.08.15	11:41	62° 59,00' N	51° 29,96' W	550	GC	surface
MSM45_005-1	MSM45/404-1	04.08.15	16:12	62° 27,33' N	52° 30,99' W	2616	MB/PS	start profile
MSM45_006-1	MSM45/405-1	04.08.15	23:27	61° 45,07' N	53° 30,05' W	2928	MUC	surface
MSM45_006-2	MSM45/405-2	05.08.15	01:24	61° 45,07' N	53° 30,05' W	2928	GC	surface
MSM45_006-3	MSM45/405-3	05.08.15	03:05	61° 45,12' N	53° 30,06' W	2927	CTD/RO	surface
MSM45_006-4	MSM45/405-4	05.08.15	05:17	61° 45,12' N	53° 30,06' W	2930	MN	surface
MSM45_007-1	MSM45/406-1	06.08.15	08:10	61° 13,04' N	64° 10,00' W	408	MB/PS	start profile
MSM45_008-1	MSM45/407-1	07.08.15	05:02	59° 56,60' N	65° 56,59' W	382	MN	surface
MSM45_008-2	MSM45/407-2	07.08.15	05:41	59° 56,60' N	65° 56,59' W	382	CTD/RO	surface
MSM45_008-3	MSM45/407-3	07.08.15	06:33	59° 56,60' N	65° 56,59' W	382	MUC	surface
MSM45_008-4	MSM45/407-4	07.08.15	07:33	59° 56,60' N	65° 56,60' W	378	GC	surface
MSM45_009-1	MSM45/408-1	07.08.15	12:42	60° 51,33' N	65° 58,34' W	789	MN	surface
MSM45_009-2	MSM45/408-2	07.08.15	14:23	60° 55,95' N	65° 58,48' W	888	CTD/RO	surface
MSM45_009-3	MSM45/408-3	07.08.15	15:16	60° 55,93' N	65° 58,39' W	890	MUC	surface
MSM45_009-4	MSM45/408-4	07.08.15	16:05	60° 55,89' N	65° 58,39' W	891	GC	surface
MSM45_010-1	MSM45/409-1	07.08.15	17:51	61° 2,11' N	65° 48,89' W	686	GC	surface
MSM45_010-2	MSM45/409-2	07.08.15	18:29	61° 2,11' N	65° 48,89' W	685	MUC	surface
MSM45_010-3	MSM45/409-3	07.08.15	19:34	61° 1,90' N	65° 48,99' W	684	BC	surface
MSM45_011-1	MSM45/410-1	08.08.15	02:29	60° 17,72' N	63° 51,98' W	154	MB/PS	start profile
MSM45_012-1	MSM45/411-1	08.08.15	19:15	59° 26,72' N	59° 48,61' W	1314	MB/PS	start profile
MSM45_013-1	MSM45/412-1	08.08.15	19:52	59° 25,77' N	59° 50,12' W	1283	MUC	surface
MSM45_013-2	MSM45/412-2	08.08.15	20:54	59° 25,75' N	59° 50,12' W	1277	GC	surface
MSM45_013-3	MSM45/412-3	08.08.15	22:06	59° 25,84' N	59° 49,94' W	1282	CTD/RO	surface
MSM45_013-4	MSM45/412-4	08.08.15	23:23	59° 25,81' N	59° 49,98' W	1282	MN	surface
MSM45_014-1	MSM45/413-1	09.08.15	06:05	58° 39,79' N	58° 7,90' W	2726	MB/PS	start profile
MSM45_015-1	MSM45/414-1	09.08.15	13:59	58° 21,53' N	57° 28,18' W	2891	MUC	surface
MSM45_015-2	MSM45/414-2	09.08.15	15:11	58° 21,53' N	57° 28,18' W	2891	HN	surface
MSM45_015-3	MSM45/414-3	09.08.15	15:49	58° 21,53' N	57° 28,18' W	2893	GC	surface
MSM45_015-4	MSM45/414-4	09.08.15	17:27	58° 21,59' N	57° 28,13' W	2893	MN	surface
MSM45_016-1	MSM45/415-1	09.08.15	20:23	58° 33,95' N	58° 0,08' W	2677	GC	surface
MSM45_016-2	MSM45/415-2	09.08.15	21:53	58° 34,12' N	58° 0,30' W	2674	CTD/RO	surface
MSM45_017-1	MSM45/416-1	10.08.15	10:05	58° 44,81' N	61° 49,52' W	195	MB/PS	start profile
MSM45_018-1	MSM45/417-1	10.08.15	12:02	58° 45,66' N	61° 52,66' W	202	MN	surface
MSM45_018-2	MSM45/417-2	10.08.15	12:24	58° 45,66' N	61° 52,66' W	202	CTD/RO	surface
MSM45_018-3	MSM45/417-3	10.08.15	12:51	58° 45,66' N	61° 52,66' W	201	MUC	surface
MSM45_018-4	MSM45/417-4	10.08.15	13:10	58° 45,66' N	61° 52,66' W	202	GC	surface
MSM45_018-5	MSM45/417-5	10.08.15	14:47	58° 45,66' N	61° 52,66' W	202	GC	surface
MSM45_019-1	MSM45/418-1	10.08.15	17:53	58° 45,68' N	61° 56,25' W	202	MUC	surface
MSM45_019-2	MSM45/418-2	10.08.15	18:17	58° 45,68' N	61° 56,25' W	202	GC	surface
MSM45_020-1	MSM45/419-1	10.08.15	21:41	58° 14,10' N	61° 39,36' W	272	MB/PS	start profile
MSM45_021-1	MSM45/420-1	11.08.15	10:52	57° 41,05' N	60° 51,13' W	319	MUC	surface

Station No	Ship log No	Date	Time (UTC)	Position Lat	Position Lon	Depth [m]	Gear	Action
MSM45_021-2	MSM45/420-2	11.08.15	11:29	57° 41,05' N	60° 51,13' W	319	GC	surface
MSM45_022-1	MSM45/421-1	11.08.15	13:14	57° 39,35' N	60° 51,97' W	336	GC	surface
MSM45_022-2	MSM45/422-1	11.08.15	13:43	57° 39,35' N	60° 51,97' W	335	MUC	surface
MSM45_023-1	MSM45/423-1	11.08.15	19:51	56° 33,57' N	60° 15,11' W	232	MB/PS	start profile
MSM45_024-1	MSM45/424-1	12.08.15	14:26	56° 14,90' N	59° 40,56' W	551	MN	surface
MSM45_024-2	MSM45/424-2	12.08.15	15:14	56° 14,90' N	59° 40,56' W	529	CTD/RO	surface
MSM45_024-3	MSM45/424-3	12.08.15	15:53	56° 14,90' N	59° 40,56' W	529	MUC	surface
MSM45_024-4	MSM45/424-4	12.08.15	16:27	56° 14,90' N	59° 40,56' W	530	GC	surface
MSM45_025-1	MSM45/425-1	12.08.15	22:12	55° 24,01' N	59° 1,06' W	110	MB/PS	start profile
MSM45_026-1	MSM45/426-1	13.08.15	08:26	55° 15,86' N	58° 11,35' W	319	MN	surface
MSM45_026-2	MSM45/426-2	13.08.15	08:59	55° 15,86' N	58° 11,34' W	319	MUC	surface
MSM45_026-3	MSM45/426-3	13.08.15	09:29	55° 15,86' N	58° 11,34' W	320	GC	surface
MSM45_027-1	MSM45/427-1	13.08.15	10:56	55° 18,58' N	58° 10,94' W	340	GC	surface
MSM45_027-2	MSM45/427-2	13.08.15	11:27	55° 18,58' N	58° 10,94' W	342	MUC	surface
MSM45_028-1	MSM45/428-1	13.08.15	14:04	55° 24,25' N	58° 46,81' W	750	GC	surface
MSM45_029-1	MSM45/429-1	13.08.15	22:24	54° 40,33' N	56° 33,82' W	370	MB/PS	start profile
MSM45_030-1	MSM45/430-1	14.08.15	07:40	54° 28,53' N	56° 4,33' W	527	MN	surface
MSM45_030-2	MSM45/430-2	14.08.15	08:23	54° 28,53' N	56° 4,33' W	527	CTD/RO	surface
MSM45_030-3	MSM45/430-3	14.08.15	08:54	54° 28,53' N	56° 4,33' W	527	MUC	surface
MSM45_030-4	MSM45/430-4	14.08.15	09:29	54° 28,53' N	56° 4,33' W	528	GC	surface
MSM45_031-1	MSM45/431-1	14.08.15	11:04	54° 24,74' N	56° 0,53' W	564	GC	surface
MSM45_031-2	MSM45/431-2	14.08.15	11:38	54° 24,74' N	56° 0,53' W	563	MUC	surface
MSM45_032-1	MSM45/432-1	15.08.15	00:29	54° 48,82' N	51° 49,83' W	2541	MB/PS	start profile
MSM45_033-1	MSM45/433-1	15.08.15	17:32	54° 34,11' N	50° 40,57' W	3297	MUC	surface
MSM45_033-2	MSM45/433-2	15.08.15	19:39	54° 34,11' N	50° 40,57' W	3295	GC	surface
MSM45_033-3	MSM45/433-3	15.08.15	21:39	54° 34,01' N	50° 40,82' W	3294	MN	surface
MSM45_033-4	MSM45/433-4	15.08.15	22:23	54° 34,01' N	50° 40,83' W	3297	CTD/RO	surface
MSM45_034-1	MSM45/434-1	16.08.15	00:44	54° 32,69' N	50° 40,85' W	3292	MB/PS	start profile
MSM45_035-1	MSM45/435-1	16.08.15	10:26	54° 23,68' N	50° 36,08' W	3295	MUC	surface
MSM45_035-2	MSM45/435-2	16.08.15	12:36	54° 23,67' N	50° 36,08' W	3298	GC	surface
MSM45_035-3	MSM45/435-3	16.08.15	14:39	54° 23,69' N	50° 36,50' W	3298	MN	surface
MSM45_036-1	MSM45/436-1	17.08.15	21:04	48° 28,04' N	51° 13,97' W	162	CTD/RO	surface
MSM45_037-1	MSM45/437-1	17.08.15	21:41	48° 27,30' N	51° 13,83' W	168	MB/PS	start profile
MSM45_038-1	MSM45/438-1	18.08.15	09:22	48° 21,18' N	51° 18,58' W	292	CTD/RO	surface
MSM45_038-2	MSM45/438-2	18.08.15	09:50	48° 21,18' N	51° 18,58' W	290	MN	surface
MSM45_038-3	MSM45/438-3	18.08.15	10:24	48° 21,18' N	51° 18,58' W	292	MUC	surface
MSM45_038-4	MSM45/438-4	18.08.15	11:06	48° 21,18' N	51° 18,58' W	291	GC	surface
MSM45_038-5	MSM45/438-5	18.08.15	11:38	48° 21,18' N	51° 18,58' W	290	MUC	surface
MSM45_039-1	MSM45/439-1	18.08.15	14:09	48° 8,15' N	51° 27,02' W	263	MUC	surface
MSM45_039-2	MSM45/439-2	18.08.15	14:45	48° 8,65' N	51° 26,29' W	320	MUC	surface
MSM45_039-3	MSM45/439-3	18.08.15	15:12	48° 8,65' N	51° 26,29' W	312	GC	surface
MSM45_040-1	MSM45/440-1	19.08.15	10:52	44° 50,93' N	55° 29,37' W	1472	MB/PS	start profile
MSM45_041-1	MSM45/441-1	19.08.15	14:20	44° 48,59' N	55° 36,06' W	688	BC	surface
MSM45_041-2	MSM45/441-2	19.08.15	15:04	44° 48,57' N	55° 36,06' W	688	GC	surface
MSM45_042-1	MSM45/442-1	19.08.15	16:08	44° 48,58' N	55° 36,09' W	687	MB/PS	start profile