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Short Cruise Report

- RV Maria S. Merian, cruise MSM-53 -

Kiel/Germany – St. John's/Canada

31 Mar – 09 May 2016

Chief Scientist: Dr. Dagmar Kieke

Captain: Björn Maaß

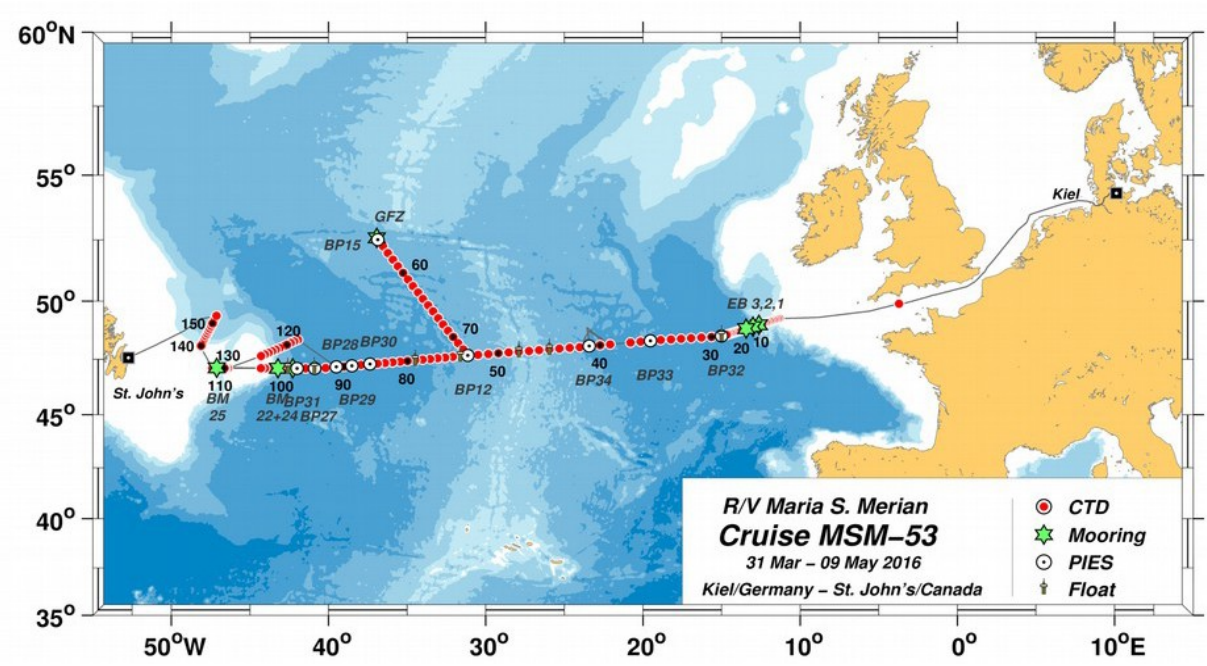

Figure 1*. Track of RV* MARIA S. MERIAN*, cruise MSM-53, and locations of hydrographic profiles. Bathymetric contours are shown every 1000 m.*

1. Objectives

Physical oceanographic measurements conducted during cruise *MSM-53* contributed to the scientific project *RACE-II* (“Regional Atlantic ChangE**”**), sub-project 1.2, funded by the *German Ministry for Education and Research* (BMBF).

Scientific work during cruise *MSM-53* emphasized on a detailed mapping of water mass properties along 47°/48°N and along the western flank of the Mid-Atlantic Ridge (MAR) that was combined with comprehensive measurements of the current system. In addition to ship-based observations, exchange of existing and deployment of new deep-sea moorings at the western and eastern boundaries of the North Atlantic was conducted. These serve to determine the export and import rates of subpolar or subtropical water masses in these regions. Various locations within the deep basins have been equipped (partly since 2006) with inverted echo-sounders carrying pressure sensors (PIES) that allow capturing variations of the different branches of the North Atlantic Current (NAC). Together with the deep-sea moorings these form the oceanic long-term observatory NOAC (“North Atlantic Changes”) deployed along 47°/48°N. In combination with satellite altimetry the data serve to investigate the main components of the Atlantic Meridional Overturning Circulation (AMOC) at this latitude. The primary objectives of cruise *MSM-53* were:

1) to capture variations in the transport of the subpolar gyre as it enters the eastern North Atlantic;
2) to analyze the deep water export in the Deep Western Boundary Current (DWBC) across 47°N in the Newfoundland Basin as well as the export of Labrador Sea Water (LSW) through Flemish Pass;
3) to investigate the strength and variability of the NAC crossing 47°/48°N in the Newfoundland Basin and in the West European Basin;
4) to identify and quantify southward recirculation cells at this latitude;
5) to capture the strength and the variability of the eastern boundary current off Goban Spur at the European shelf edge;
6) to investigate temporal, regional, and large-scale variability regarding water mass properties, with particular focus on the components of North Atlantic Deep Water (NADW).

Scientific tools comprised profiling of the entire water column using a Conductivity-Temperature-Depth-Oxygen (CTDO) unit and two lowered Acoustic Doppler Current Profilers (LADCP) attached to the carousel water sampler. Analysis of anthropogenic tracers consisted of measuring oceanic concentrations of chlorofluorocarbon (components CFC-12 and CFC-11) and sulphur hexafluoride (SF_6), with high concentrations marking young or newly formed NADW in the deep ocean. Vessel-mounted ADCP measurements delivered velocity data of the upper water column while transiting across the working area. Seven Argo floats of type *NKE ARVOR* were deployed and programmed to drift at a parking depth of 1000 dbar and to cycle between 2000 dbar and the sea surface every ten days. Work related to deploying and recovering deep-sea moorings concentrated on the boundary currents at the eastern and western continental margins as well as on the western exit of Charlie Gibbs Fracture Zone in the north. Telemetry, recovery, and (re-)deployment of inverted echo-sounders equipped with pressure sensors (PIES) focused on devices installed in the deep basins along the 47°/48°N section as well as at the northern end of the PIES-line following the western flank of the Mid-Atlantic Ridge.

2. Narrative of cruise MSM-53

RV MARIA S. MERIAN left the pier at Ostsee-Kai, Kiel, Germany, on March 31st, 2016, at 06:24 UTC. Having passed the Kiel Canal and the pilot station Elbe 1, the scientific mission of cruise MSM-53 started at 20:42 UTC the same day, when continuous logging of underway data was switched on. Course was set to southwest towards the southern North Sea, the English Channel, and finally the Irish shelf break at Goban Spur.

While on the way towards the Irish shelf break, a test station was carried out on Apr 02nd, with the purpose to check the performance of the CTDO unit and the two LADCP devices attached to the carousel water sampler and to test the water sample analysis devices.

Scientific station work began on Apr 03rd, 2016, 18:00 UTC, when the first hydrographic section crossing the boundary current off Goban Spur at the Irish shelf break was carried out (stations #138/001 to #166/029). Work at all stations included profiling of the entire water column with the CTDO and LADCP units attached to the carousel water sampler as well as water sampling and subsequent analysis in the laboratories. Water sampling comprised salinity and oxygen samples required for sensor calibration as well as water samples to analyze the oceanic contents of anthropogenic tracers.

While heading towards southwest, three deep-sea moorings (*EB-1* to *EB-3*) were deployed

along the crest of Goban Spur on Apr 04th and Apr 05th. On Apr 07th, the first inverted echo-sounder equipped with a pressure sensor (PIES), *BP-32/1*, was installed at the sea bottom and the first *Argo* float was deployed, both at station #166, which marked the end of the eastern boundary current section.

Having finished this section, RV MARIA S. MERIAN headed on a western course towards the location of PIES *BP-12/5* (47°39.91'N, 31°08.88'W), marking the end of the section across the deep eastern basin, and hydrographic station work was continued. While proceeding towards west, two more PIES were installed (*BP-33/1* and *BP-34/1*) as well as three *Argo* floats deployed. A pronounced atmospheric pressure low bringing northerly winds of 10 Beaufort (Bf) forced us to abandon any hydrographic station work between noon of Apr 09th and early morning of Apr 12th.

Having finished data acquisition of PIES *BP-12/5* (#190) via acoustic telemetry on Apr 14th, RV MARIA S. MERIAN was on transit on a northwestern course, covering a distance of 360 nm and reaching the location of PIES *BP-15/3* (52°30.48'N, 36°51.63'W, #191) in the morning hours of Apr 16th. Data recorded by the PIES was successfully acquired via telemetry. In the course of the same day, recovery of deep-sea mooring *GFZ* located at 52°35'N, 36°56'W was begun at very favorable conditions regarding weather, range of visibility, and state of sea roughness. The recovery, however, finally failed. Both acoustic releases responded and were successfully released, but the mooring did not ascend to the sea surface. Neither a radio signal from the top buoy, nor any Iridium-based information could be received. Furthermore, both acoustic releases responded unclear information about their actual location (vertical or horizontal), which initiated an effort to dredge for the mooring. Dredging activities lasted on for 8 hours, but did not provide any remnants of the *GFZ* mooring. Therefore, it is considered to be lost due to unknown reasons.

On Apr 16th/17th, PIES *BP-15/3* was successfully recovered from the sea bottom and replaced by a new device (#191, PIES *BP-15/4*). The hydrographic section was then resumed again in southeastern direction towards 47°N, where station work was continued while heading towards Flemish Cap.

Available weather forecasts strongly supported mooring activities in the western boundary current region off Flemish Cap to be carried out on Apr 23rd. The hydrographic station work was therefore interrupted on Apr 21st (station #218), and RV MARIA S. MERIAN headed towards the mooring sites *BM-22* and *BM-24*. While on the way, five PIES sites were visited. PIES *BP-27/1* and *BP-30/1* were recovered, *BP-30/2* was immediately re-installed, and data of PIES *BP-31/1* was retrieved via acoustic telemetry (Apr 21st/22nd). Data of

PIES *BP-28/1* and *BP-29/1* could not be retrieved due to unfavorable acoustic conditions caused by high swell and wind.

Having experienced high winds of 9-10 Bf on Apr 22nd, weather conditions were fair enough the next day to successfully recover the two deep-sea moorings *BM-22/6* and BM-24/3 (April 23rd). Afterwards, the vessel headed back towards east to resume hydrographic station work. While on the way, another attempt to read out the two PIES *BP-28/1* and *BP-29/1* failed due to degrading weather conditions and increased acoustic noise in the water column. Hydrographic station work was resumed on Apr 25th, when high swell repeatedly caused kinks in the conducting wire leading to an untimely abortion of two hydrographic casts. While continuing hydrographic station work when on the way towards Flemish Cap again, a third attempt to acoustically retrieve data of PIES *BP-28/1* and *BP-29/1* was successful. Both instruments were recovered (Apr 26th/27th), and a device was re-installed again at PIES site *BP-29/2* (station #232).

The hydrographic section across the boundary current region east of Flemish Cap was finished on Apr 29th (station #250), and the last two Argo floats were deployed. The next day, the two deep-sea moorings *BM-24/4* and *BM-22/7* were installed in the western boundary current region at water depths of 4000 m and 3000 m. In the following, the vessel headed towards west and transited across Flemish Cap to continue scientific work in the Flemish Pass. Mooring *BM-25/3* was recovered on May 1st and replaced the same day by mooring *BM-25/4*. Snow fall during the night was accompanied by increasing wind forces reaching 11-12 Bf. This forced us to abandon hydrographic station work in Flemish Pass after having finished half of the section. Having been forced to weather for about 10 hours, course was set towards east again with the aim to re-equip the two remaining PIES sites *BP-27* and *BP-28*. On May 3rd, the instrument to be addressed as *BP-27/2* was equipped with an additional currentmeter to measure bottom-near absolute currents. Hence, the device was installed as the first and only C-PIES (station #262). PIES *BP-28/2* was installed the same day.

Station work in the Newfoundland Basin at 47°/48°N was thus finished, and the vessel turned towards northwest to conduct a hydrographic section across the boundary current system located to the northeast of Flemish Cap. Having finished this section on top of Flemish Cap on May 05th, in the following the hydrographic section across Flemish Pass 47°N was completely repeated. Afterwards, RV MARIA S. MERIAN transited towards the shelf break in the southern Orphan Basin. Having arrived there on May 07th, the final set of hydrographic stations was carried out along a section directed from the shelf break

towards Orphan Knoll (stations #286-300). On May 08th, scientific station work was finished at 02:36 UTC (station #300, 49°22.7'N, 47°07.7'W). Continuous logging of underway data was stopped on May 09th, 09:30 UTC, which marked the end of the scientific mission *MSM-53* of RV MARIA S. MERIAN. The vessel arrived at the pilot station of St. John's at 10:30 UTC and was finally alongside at pier 17 at 11:06 UTC.

In total, 154 hydrographic stations were carried out during cruise *MSM-53*. Station work in the deep eastern and western basins of the North Atlantic proper was frequently affected by high sea states and swell from different directions. These conditions caused losses of several work days and high acoustic noise levels. Several PIES sites had to be visited more often than previously planned to finish the intended station works. Visibility was highly reduced due to frequent to quasi-permanent occurrence of dense fog when working on the western and northwestern side of Flemish Cap at the end of the cruise.

Acknowledgements

We would like to thank the master of the vessel, Björn Maaß, and his entire crew for the assistance and great support granted to us during cruise *MSM-53*. Again, we have benefited a lot from the great team spirit, the enthusiasm, and the close cooperation between the scientific team and the ship's team. Over the course of six weeks, the crew made our stay aboard RV Maria S. Merian very comfortable and despite some technical and meteorological drawbacks this cruise a great success.

Further thanks goes to Barbara Kozak at our home laboratory, the *Senatskommission für Ozeanographie,* the *German Science Foundation* (DFG), the *Federal Ministry for Education and Research* (BMBF), and the *Control Station German Research Vessels* (*Leitstelle Deutsche Forschungsschiffe*) that provided the necessary ship time, funding, and support to pursue all scientific work.

Table 1. Participants of cruise *MSM-53*

	Name	Institute	Field of Activity
1.	Kieke, Dagmar, Dr.	IUPHB/MARUM	chief scientist
2.	Böke, Wolfgang	IUPHB	technics
3.	Büttner, Sharina	UBremen	oxygen analysis
4.	Bulsiewicz, Klaus	IUPHB	tracer sampling, analysis, data evaluation
5.	Danek, Christopher	AWI	CTDO/LADCP watch and data evaluation
6.	Hempel, Tim	IUPHB/MARUM	CTDO/LADCP watch
7.	Khordakova, Dina	IUPHB/MARUM	CTDO/LADCP watch
8.	Mirau, Bastian	IUPHB/MARUM	moorings
9.	Rochner, Andrea	IUPHB/MARUM	CTDO/LADCP watch
10.	Roessler, Achim, Dr.	IUPHB/MARUM	ADCP and PIES data processing
11.	Rohlfs, Nina	IUPHB/MARUM	tracer sampling and analysis
12.	Schneehorst, Anja	BSH	moorings, Argo floats
13.	Steinfeldt, Reiner, Dr.	IUPHB/MARUM	CTD/O data processing, calibration, analysis
14.	Sültenfuß, Pia	IUPHB/MARUM	tracer sampling and analysis
15.	Uhde, Hans-Hermann	BSH	moorings, Argo floats
16.	Wett, Simon	IUPHB/MARUM	CTDO/LADCP watch
17.	Wiegand, Kevin	IUPHB/MARUM	CTDO/LADCP watch
18.	Wischnewski, Fanny	IUPHB/MARUM	CTDO/LADCP watch

AWI	Alfred-Wegener Institute, Bremerhaven, Germany
BSH	Federal Maritime and Hydrographic Agency, Hamburg, Germany
IUPHB	University of Bremen, Institute of Environmental Physics, Dep. Oceanography Bremen, Germany
MARUM	University of Bremen, Center for Marine Environmental Sciences, Bremen, Germany
UBremen	University of Bremen, Faculty 2, Biology/Chemistry, Bremen, Germany

Table 2. Deep-Sea moorings recovered and deployed during cruise *MSM-53*

MSM-Station	Mooring ID	Latitude	Longitude	Depth [m]	Recovery Date/Time	Deployment Date/Time	CTD Profile
148-2	EB-1/1	49°00.02'N	12°37.08'W	1530	---	04 Apr 2016 08:35 – 10:03	11
150-1	EB-2/1	48°55.02'N	13°00.00'W	3065	---	04 Apr 2016 13:57 – 17:14	13
155-2	EB-3/1	48°49.98'N	13°25.98'W	4453	---	05 Apr 2016 11:34 – 15:35	18
192-1	GFZ/4	52°35.00'N	36°56.00'W	3272	16 Apr 2016 10:34 – 23:06 mooring lost	---	55
222-1	BM-22/6	47°06.20'N	43°13.30'W	3000	23 Apr 2016 08:22 – 11:50	---	1ß0
252-1	BM-22/7	47°06.19'N	43°13.37'W	3048	---	30 Apr 2016 08:52-12:09	100
223-1	BM-24/3	47°06.20'N	42°16.50'W	4000	23 Apr 2016 15:23 – 18:42	--	96
253-1	BM-24/4	47°06.20'N	42°16.50'W	4000	--	30 Apr 2016 15:42-17:31	96
254-1	BM-25/3	47°07.11'N	47°06.38'W	1003	01 May 2016 14:24-15:05	---	109
255-3	BM-25/4	47°07.11'N	47°06.38'W	1003	---	01 May 2016 20:58-21:14	110

All times are given as UTC. The top buoy of all deployed moorings was equipped with radio beacons, flags, and flashers. All deployed moorings (except BM-25/4) carried an additional *Iridium* beacon.

Table 3. Argo floats deployed during cruise *MSM-53*

MSM-Station	Float s/n	WMO ID	Argos ID	Latitude	Longitude	Deployment Date/Time	CTD Profile
241-1	15DARL12	6902643	157472	47°06.00'N	42°35.46'W	29 Apr 2016 04:00	97
236-2	15DARL13	6902644	157473	47°07.35'N	40°53.89'W	28 Apr 2016 12:34	93
216-2	15DARL14	6902645	157474	47°27.26'N	34°29.36'W	21 Apr 2016 07:49	79
210-2	15DARL15	6902646	157475	47°38.11'N	31°37.15'W	20 Apr 2016 06:28	73
185-2	15DARL16	6902647	157476	47°49.92'N	27°53.77'W	13 Apr 2016 20:51	48
182-2	15DARL17	6902648	157477	47°55.91'N	25°57.29'W	13 Apr 2016 08:34	45
166-3	15DARL18	6902649	157478	48°31.15'N	15°00.18'W	07 Apr 2016 06:29	29

All times are given as UTC. All deployed floats are of type *NKE ARVOR* and carry conductivity, temperature, and pressure sensors. The parking depth is 1000 dbar, the cycling period is 10 days.

Table 4. Activities related to inverted echo-sounders equipped with pressure sensors (PIES)

MSM Station	PIES ID	s/n	Latitude	Longitude	Depth [m]	Deploy-ment	Telemetry Date/Time	Recovery Date/Time	CTD #
190-2	BP12/5	271	47°39.91'N	31°08.88'W	4090	---	14 Apr 2016 18:23-20:45	---	53
191-1 191-3	BP15/3	235	52°30.48'N	36°51.63'W	3386	---	16 Apr 2016 05:29-08:01	17 Apr 2016 02:00-03:40	54
191-4	BP15/4	201	52°30.53'N	36°51.93'W	3387	17 Apr 2016 03:59-05:33	---	---	54
220-1	BP27/1	272	47°05.84'N	40°52.53'W	4486	---	---	22 Apr 2016 21:15-23:48	93
262-1	BP27/2	302	47°05.75'N	40°53.82'W	4503	3 May 2016 16:53-18:19	---	---	---
234-1 234-2	BP28/1	240	47°09.68'N	39°30.06'W	4578	---	27 Apr 2016 15:15-21:03	28 Apr 2016 00:44-02:09	91
263-1	BP28/2	240	47°09.72'N	39°29.12'W	4591	3 May 2016 23:35-01:17	---	---	---
232-1	BP29/1	302	47°12.52'N	38°31.09'W	4607	---	26/27 Apr 2016 19:14-01:19	27 Apr 2016 01:20-02:58	89
232-2	BP29/2	272	47°12.55'N	38°30.95'W	4612	27 Apr 2016 03:15-04:42	---	---	89
219-1	BP30/1	303	47°17.52'N	37°21.47'W	4546	---	21/22 Apr 2016 23:05-00:30	22 Apr 2016 00:38-03:15	87
219-2	BP30/2	235	47°18.06'N	37°21.70'W	4539	22 Apr 2016 03:36-05:26	---	---	87
221-1	BP31/1	075	47°05.84'N	41°59.94'W	4236	---	23 Apr 2016 03:52-06:44	---	95
166-2	BP32/1	270	48°31.12'N	15°00.02'W	4796	7 Apr 2016 04:48-06:45	---	---	29
173-2	BP33/1	268	48°18.56'N	19°31.32'W	4574	8 Apr 2016 18:26-20:33	---	---	36
176-1	BP34/1	269	48°06.74'N	23°25.17'W	4502	10 Apr 2016 22:15-23:45	---	---	41

All times are given as UTC. All instruments are equipped with flags, radio senders, and flashers. PIES BP-27/2 was deployed as a C-PIES, i.e., it carried an additional currentmeter of type *Nortek Aquadopp* (s/n 13024) and buoyancy.

Table 5. List of CTDO/lowered ADCP/Water Sampling Stations, MSM-53

Station	Profile	Date	Time [UTC]	Latitude	Longitude	Water Depth [m]	Max Press [dbar]	SF_6/ CFC	CFC offline	Bottle Oxygen	LADCP	Comments
MSM-138	0	2016/04/02	15:13	49°53.66'N	3°43.17'W	75	62	-	-	x	x	test station
MSM-138	1	2016/04/03	18:00	49°15.72'N	11°19.33'W	280	269	-	-	x	x	
MSM-139	2	2016/04/03	18:56	49°14.15'N	11°26.77'W	465	453	-	-	x	x	
MSM-140	3	2016/04/03	20:00	49°12.59'N	11°34.22'W	625	617	-	x	x	x	
MSM-141	4	2016/04/03	21:18	49°11.05'N	11°41.74'W	789	777	-	-	x	x	
MSM-142	5	2016/04/03	22:37	49°9.45'N	11°49.17'W	794	787	-	x	x	x	
MSM-143	6	2016/04/03	23:52	49°7.86'N	11°56.57'W	852	846	-	-	x	x	
MSM-144	7	2016/04/04	01:13	49°6.30'N	12°4.05'W	917	909	-	x	x	x	
MSM-145	8	2016/04/04	02:33	49°4.74'N	12°11.52'W	1011	1002	-	-	x	x	
MSM-147	9	2016/04/04	03:56	49°3.17'N	12°18.98'W	1124	1114	-	x	x	x	
MSM-147	10	2016/04/04	05:19	49°1.60'N	12°26.44'W	1265	1263	-	-	x	x	
MSM-148	11	2016/04/04	06:56	48°59.99'N	12°37.00'W	1525	1528	x	-	x	x	
MSM-149	12	2016/04/04	10:43	48°58.45'N	12°41.40'W	1766	1762	x	-	x	x	calibration of MicroCATs and NKE loggers
MSM-150	13	2016/04/04	17:48	48°55.55'N	12°57.07'W	2610	2599	x	-	x	x	
MSM-151	14	2016/04/04	20:08	48°56.87'N	12°48.83'W	2092	2074	x	-	x	x	
MSM-152	15	2016/04/04	22:34	48°53.75'N	13°3.78'W	3631	3613	x	-	-	x	no upcast data from 200 m above bottom to surface, LADCP data not processable due to missing CTD data
MSM-153	16	2016/04/05	02:23	48°52.18'N	13°11.22'W	3710	3691	x	-	x	x	
MSM-154	17	2016/04/05	05:12	48°50.61'N	13°18.66'W	3795	3774	x	-	x	x	
MSM-155	18	2016/04/05	08:09	48°49.98'N	13°25.96'W	4456	4442	-	-	x	x	
MSM-156	19	2016/04/05	16:15	48°47.47'N	13°33.59'W	4485	4466	x	-	x	x	
MSM-157	20	2016/04/05	19:27	48°45.89'N	13°41.05'W	4510	2710	-	-	-	x	profile aborted at 2750 dbar due to cable problems
MSM-158	21	2016/04/05	22:03	48°44.93'N	13°48.51'W	4534	4515	x	-	x	x	
MSM-159	22	2016/04/06	01:22	48°43.34'N	13°55.96'W	4514	4495	-	-	x	x	
MSM-160	23	2016/04/06	04:34	48°41.78'N	14°3.43'W	4530	4512	x	-	x	x	
MSM-161	24	2016/04/06	07:55	48°40.21'N	14°10.89'W	4545	4529	x	-	x	x	

Station	Profile	Date	Time [UTC]	Latitude	Longitude	Water Depth [m]	Max Press [dbar]	SF_6/ CFC	CFC offline	Bottle Oxygen	LADCP	Comments
MSM-162	25	2016/04/06	11:39	48°38.64'N	14°18.38'W	4570	4555	x	-	x	x	
MSM-163	26	2016/04/06	15:05	48°37.05'N	14°25.85'W	4621	4605	-	-	x	x	
MSM-164	27	2016/04/06	18:19	48°35.49'N	14°33.25'W	4700	4686	x	-	x	x	
MSM-165	28	2016/04/06	21:59	48°33.92'N	14°40.74'W	4755	4739	-	-	x	x	
MSM-166	29	2016/04/07	02:06	48°31.11'N	14°59.98'W	4811	4794	x	-	x	x	
MSM-167	30	2016/04/07	09:22	48°28.27'N	15°38.63'W	4848	4830	x	-	x	x	
MSM-168	31	2016/04/07	14:39	48°26.69'N	16°17.30'W	4652	4654	-	x	x	x	
MSM-169	32	2016/04/07	19:55	48°25.13'N	16°55.93'W	4675	4668	x	-	x	x	
MSM-170	33	2016/04/08	01:29	48°23.56'N	17°34.56'W	4210	557	-	-	-	x	profile aborted at 560 dbar due to cable problems
MSM-171	34	2016/04/08	04:54	48°21.96'N	18°13.24'W	4455	4428	x	-	x	x	
MSM-172	35	2016/04/08	10:15	48°20.38'N	18°51.90'W	4238	4217	x	-	x	x	
MSM-173	36	2016/04/08	15:50	48°18.90'N	19°30.91'W	4579	4559	x	-	x	x	
MSM-174	37	2016/04/08	23:49	48°16.16'N	20°9.36'W	4434	4412	-	x	x	x	
MSM-175	38	2016/04/09	06:05	48°13.78'N	20°47.77'W	4365	3792	-	x	x	x	bad CTD data below 3860 dbar, profile aborted, LADCP data not processable due to missing CTD data
MSM-177	39	2016/04/12	02:15	48°9.05'N	22°4.89'W	4463	4442	x	-	x	x	
MSM-178	40	2016/04/12	06:26	48°6.70'N	22°43.23'W	4245	4218	x	x	x	x	bad CTD data during upcast above 2180 dbar, no bottles could be closed above 3000 dbar, LADCP data not processable due to missing CTD data
MSM-176	41	2016/04/12	11:48	48°6.72'N	23°25.27'W	4503	4480	x	-	x	x	
MSM-179	42	2016/04/12	16:49	48°1.89'N	24°0.77'W	3955	3933	-	x	x	x	
MSM-180	43	2016/04/12	21:33	47°59.89'N	24°39.65'W	3996	3987	-	x	x	x	
MSM-181	44	2016/04/13	02:22	47°57.87'N	25°18.47'W	3671	3667	-	x	x	x	
MSM-182	45	2016/04/13	06:54	47°55.87'N	25°57.26'W	2820	2827	-	x	x	x	
MSM-183	46	2016/04/13	11:07	47°53.87'N	26°36.16'W	3318	3305	-	x	x	x	
MSM-184	47	2016/04/13	15:29	47°51.87'N	27°14.98'W	2208	2187	-	x	x	x	
MSM-185	48	2016/04/13	19:12	47°49.84'N	27°53.78'W	2400	2383	-	x	x	x	
MSM-186	49	2016/04/13	23:19	47°47.82'N	28°32.64'W	3247	3234	-	x	x	x	

Station	Profile	Date	Time [UTC]	Latitude	Longitude	Water Depth [m]	Max Press [dbar]	SF_6/ CFC	CFC offline	Bottle Oxygen	LADCP	Comments
MSM-187	50	2016/04/14	03:45	47°45.82'N	29°11.50'W	3442	3432	-	x	x	x	
MSM-188	51	2016/04/14	08:13	47°43.83'N	29°50.30'W	3026	3034	-	x	x	x	
MSM-189	52	2016/04/14	12:31	47°41.80'N	30°29.15'W	3381	3361	x	-	x	x	
MSM-190	53	2016/04/14	17:07	47°39.89'N	31°8.89'W	4090	4074	x	-	x	x	
MSM-191	54	2016/04/16	08:03	52°30.35'N	36°51.56'W	3400	3373	-	-	x	x	
MSM-192	55	2016/04/16	23:17	52°34.73'N	36°57.31'W	3318	3307	-	x	x	x	
MSM-193	56	2016/04/17	07:21	52°14.60'N	36°32.40'W	3595	3575	-	x	x	x	
MSM-194	57	2016/04/17	11:07	51°58.45'N	36°13.20'W	3893	3881	-	x	x	x	
MSM-195	58	2016/04/17	15:15	51°42.28'N	35°54.08'W	3430	3419	-	x	x	x	
MSM-196	59	2016/04/17	18:56	51°26.13'N	35°34.97'W	3815	3804	-	x	x	x	
MSM-197	60	2016/04/17	22:56	51°9.98'N	35°15.80'W	3645	3662	-	x	x	x	
MSM-198	61	2016/04/18	02:56	50°53.80'N	34°56.68'W	3548	3535	-	x	x	x	
MSM-199	62	2016/04/18	06:45	50°37.61'N	34°37.52'W	4190	4176	-	x	x	x	
MSM-200	63	2016/04/18	11:01	50°21.48'N	34°18.32'W	3927	3914	-	x	x	x	
MSM-201	64	2016/04/18	15:15	50°5.32'N	33°59.25'W	4235	4227	x	-	x	x	
MSM-202	65	2016/04/18	19:49	49°49.14'N	33°40.10'W	3850	3847	x	-	x	x	
MSM-203	66	2016/04/18	23:56	49°32.97'N	33°20.91'W	3945	3930	x	-	x	x	
MSM-204	67	2016/04/19	03:54	49°16.79'N	33°1.76'W	3819	3808	x	-	x	x	
MSM-205	68	2016/04/19	07:48	49°0.62'N	32°42.63'W	4000	3993	-	x	x	x	
MSM-206	69	2016/04/19	11:52	48°44.47'N	32°23.48'W	3841	3827	x	-	x	x	
MSM-207	70	2016/04/19	15:52	48°28.30'N	32°4.37'W	4221	4206	x	-	x	x	
MSM-208	71	2016/04/19	20:18	48°12.14'N	31°45.24'W	3830	3817	x	-	x	x	
MSM-209	72	2016/04/20	00:19	47°55.95'N	31°26.10'W	3832	3850	-	x	x	x	
MSM-210	73	2016/04/20	04:15	47°38.01'N	31°37.32'W	3767	3754	x	-	x	x	only downcast LADCP data, batteries empty during upcast
MSM-211	74	2016/04/20	08:05	47°36.22'N	32°6.01'W	4070	4066	x	-	x	x	
MSM-212	75	2016/04/20	12:09	47°34.45'N	32°34.72'W	3961	3945	-	x	x	x	
MSM-213	76	2016/04/20	16:11	47°32.64'N	33°3.41'W	3980	3969	x	x	x	x	
MSM-214	77	2016/04/20	20:22	47°30.85'N	33°32.15'W	4100	4089	x	-	x	x	
MSM-215	78	2016/04/21	00:36	47°29.06'N	34°0.82'W	4731	4715	x	-	x	x	
MSM-216	79	2016/04/21	05:16	47°27.26'N	34°29.51'W	4414	4397	-	x	x	x	
MSM-217	80	2016/04/21	09:41	47°25.47'N	34°58.22'W	4160	4148	x	-	x	x	
MSM-218	81	2016/04/21	14:15	47°23.67'N	35°26.95'W	4318	2907	-	-	-	x	bad CTD data below 2950 dbar,

Station	Profile	Date	Time [UTC]	Latitude	Longitude	Water Depth [m]	Max Press [dbar]	SF_6/ CFC	CFC offline	Bottle Oxygen	LADCP	Comments
												profile aborted, LADCP data not processable due to missing CTD data
MSM-226	82	2016/04/25	12:58	47°23.69'N	35°26.88'W	4314	1436	-	-	-	x	bad CTD data below 1450 dbar, profile aborted, LADCP data not processable due to missing CTD data
MSM-227	83	2016/04/25	16:07	47°21.86'N	35°55.58'W	4333	2730	-	-	-	x	bad CTD data below 2770 dbar, profile aborted, LADCP data not processable due to missing CTD data
MSM-227	84	2016/04/25	19:42	47°21.89'N	35°55.60'W	4332	4319	x	-	x	x	
MSM-228	85	2016/04/26	00:13	47°20.08'N	36°24.32'W	4240	3908	-	-	-	x	bad CTD data below 3980 dbar, profile aborted, LADCP data not processable due to missing CTD data
MSM-229	86	2016/04/26	04:31	47°18.30'N	36°53.02'W	4358	4345	x	-	x	x	
MSM-230	87	2016/04/26	08:54	47°17.55'N	37°21.49'W	4550	4533	x	-	x	x	
MSM-231	88	2016/04/26	13:54	47°15.06'N	37°56.61'W	4605	4583	x	-	x	x	
MSM-232	89	2016/04/27	04:46	47°12.48'N	38°31.10'W	4630	4607	x	-	x	x	test of Iridium transmitter
MSM-233	90	2016/04/27	10:22	47°10.24'N	39°1.24'W	4604	4583	x	-	x	x	
MSM-234	91	2016/04/27	21:08	47°9.65'N	39°30.06'W	4590	4579	x	-	x	x	MicroCAT calibration and test of Iridium transmitter
MSM-235	92	2016/04/28	04:58	47°6.57'N	40°11.32'W	4559	4559	x	-	x	x	
MSM-236	93	2016/04/28	09:58	47°5.86'N	40°52.56'W	4490	4479	x	-	x	x	
MSM-237	94	2016/04/28	14:24	47°5.86'N	41°26.90'W	4358	4323	x	-	x	x	
MSM-238	95	2016/04/28	18:37	47°5.86'N	41°59.96'W	4235	4208	x	-	x	x	
MSM-239	96	2016/04/28	22:11	47°6.23'N	42°16.55'W	3999	3981	x	-	x	x	
MSM-240	97	2016/04/29	01:49	47°6.02'N	42°35.46'W	3670	3651	-	x	x	x	
MSM-242	98	2016/04/29	05:32	47°6.04'N	42°53.62'W	3464	3444	x	-	x	x	
MSM-243	99	2016/04/29	08:39	47°6.05'N	43°7.12'W	3490	3516	-	-	x	x	
MSM-244	100	2016/04/29	11:22	47°6.20'N	43°13.27'W	3042	3022	x	-	x	x	
MSM-245	101	2016/04/29	13:43	47°6.02'N	43°17.83'W	2559	2573	x	-	x	x	
MSM-246	102	2016/04/29	15:43	47°5.90'N	43°20.16'W	1776	1784	x	-	x	x	

Station	Profile	Date	Time [UTC]	Latitude	Longitude	Water Depth [m]	Max Press [dbar]	SF_6/ CFC	CFC offline	Bottle Oxygen	LADCP	Comments
MSM-247	103	2016/04/29	17:30	47°5.96'N	43°25.28'W	1275	1267	x	-	x	x	
MSM-248	104	2016/04/29	19:25	47°5.99'N	43°38.40'W	765	753	x	-	x	x	
MSM-249	105	2016/04/29	20:49	47°5.99'N	43°47.49'W	580	572	x	-	x	x	
MSM-250	106	2016/04/29	22:36	47°6.06'N	44°2.52'W	354	345	-	-	-	x	
MSM-251	107	2016/04/30	00:21	47°5.98'N	44°18.23'W	244	234	-	-	-	x	
MSM-254	108	2016/05/01	15:15	47°7.09'N	47°6.39'W	1000	986	-	-	-	x	
MSM-255	109	2016/05/01	18:11	47°6.97'N	47°6.90'W	980	969	-	-	-	x	test of acoustic release, s/n 1874
MSM-255	110	2016/05/01	19:55	47°6.86'N	47°6.71'W	990	975	-	-	-	x	test of acoustic release, s/n 1874 + s/n 760
MSM-256	111	2016/05/02	00:29	47°5.94'N	47°22.58'W	241	228	-	-	x	x	
MSM-257	112	2016/05/02	01:25	47°5.92'N	47°15.94'W	472	461	x	-	x	x	
MSM-258	113	2016/05/02	02:28	47°5.97'N	47°9.33'W	879	867	x	-	x	x	
MSM-259	114	2016/05/02	03:31	47°5.94'N	47°5.90'W	1023	1009	x	-	x	x	
MSM-260	115	2016/05/02	04:47	47°6.05'N	47°0.62'W	1124	1113	x	-	x	x	
MSM-261	116	2016/05/02	06:29	47°6.02'N	46°51.27'W	1165	1154	x	-	x	x	
MSM-264	117	2016/05/04	12:48	48°20.98'N	41°56.63'W	4389	4368	x	-	x	x	
MSM-265	118	2016/05/04	17:14	48°16.68'N	42°10.82'W	4298	4268	x	x	x	x	
MSM-266	119	2016/05/04	21:17	48°12.47'N	42°24.83'W	4215	4207	x	-	x	x	
MSM-267	120	2016/05/05	01:07	48°8.21'N	42°38.93'W	4042	4025	-	-	x	x	
MSM-268	121	2016/05/05	04:39	48°3.96'N	42°53.01'W	3741	2052	-	-	-	x	bad CTD data below 2080 dbar, profile aborted, LADCP data not processable due to missing CTD data
MSM-269	122	2016/05/05	07:00	47°59.70'N	43°7.09'W	3300	3288	x	-	x	x	
MSM-270	123	2016/05/05	10:07	47°55.47'N	43°21.17'W	2939	2920	x	-	x	x	
MSM-271	124	2016/05/05	13:01	47°51.22'N	43°35.25'W	1889	1904	x	-	x	x	
MSM-272	125	2016/05/05	15:26	47°46.95'N	43°49.34'W	920	908	x	-	x	x	
MSM-273	126	2016/05/05	17:15	47°42.71'N	44°3.46'W	552	534	x	-	x	x	
MSM-274	127	2016/05/05	18:48	47°38.46'N	44°17.54'W	328	319	-	-	-	x	
MSM-275	128	2016/05/06	03:15	47°6.03'N	46°24.16'W	353	345	-	-	-	x	
MSM-276	129	2016/05/06	04:14	47°6.04'N	46°33.27'W	494	481	x	-	x	x	
MSM-277	130	2016/05/06	05:00	47°6.02'N	46°36.65'W	801	793	x	-	x	x	

Station	Profile	Date	Time [UTC]	Latitude	Longitude	Water Depth [m]	Max Press [dbar]	SF_6/ CFC	CFC offline	Bottle Oxygen	LADCP	Comments
MSM-278	131	2016/05/06	05:57	47°6.03'N	46°40.02'W	1098	1086	x	-	x	x	
MSM-279	132	2016/05/06	07:00	47°6.02'N	46°42.46'W	1135	1124	-	-	x	x	
MSM-280	133	2016/05/06	08:22	47°6.04'N	46°51.23'W	1165	1156	-	-	x	x	
MSM-281	134	2016/05/06	09:48	47°6.07'N	47°0.61'W	1125	1113	-	-	x	x	
MSM-282	135	2016/05/06	11:03	47°5.97'N	47°5.88'W	1022	1009	-	-	x	x	
MSM-283	136	2016/05/06	12:13	47°5.99'N	47°9.34'W	876	866	-	-	x	x	
MSM-284	137	2016/05/06	13:24	47°5.97'N	47°15.90'W	473	461	-	-	x	x	
MSM-285	138	2016/05/06	14:26	47°5.80'N	47°22.87'W	241	228	-	-	-	x	
MSM-286	139	2016/05/06	20:30	48°2.70'N	48°8.43'W	410	399	-	-	-	x	
MSM-287	140	2016/05/06	21:21	48°5.27'N	48°6.39'W	695	680	-	-	-	x	
MSM-288	141	2016/05/06	22:26	48°8.68'N	48°4.06'W	1249	1233	-	-	x	x	
MSM-289	142	2016/05/06	23:45	48°11.16'N	48°2.20'W	1382	1370	-	x	x	x	
MSM-290	143	2016/05/07	01:38	48°17.69'N	47°57.27'W	1750	1744	-	-	x	x	
MSM-291	144	2016/05/07	03:52	48°24.22'N	47°52.30'W	2033	2011	-	x	x	x	
MSM-292	145	2016/05/07	05:56	48°30.73'N	47°47.34'W	2243	2231	-	-	x	x	
MSM-293	146	2016/05/07	08:01	48°37.24'N	47°42.34'W	2320	2311	-	x	x	x	
MSM-294	147	2016/05/07	10:13	48°43.71'N	47°37.40'W	2404	2395	-	-	x	x	
MSM-295	148	2016/05/07	12:39	48°50.17'N	47°32.49'W	2483	2471	-	x	x	x	
MSM-296	149	2016/05/07	15:01	48°56.71'N	47°27.52'W	2567	2553	-	-	x	x	
MSM-297	150	2016/05/07	17:27	49°3.25'N	47°22.53'W	2600	2589	-	x	x	x	
MSM-298	151	2016/05/07	19:53	49°9.69'N	47°17.62'W	2635	2623	-	-	-	x	
MSM-299	152	2016/05/07	22:22	49°16.21'N	47°12.62'W	2698	2687	-	x	-	x	
MSM-300	153	2016/05/08	00:59	49°22.69'N	47°7.70'W	2760	2742	-	x	-	x	