

MARIA S. MERIAN -Berichte

Water mass transport and transformation in the western SPNA

Cruise No. MSM74

May 25 – June 26, 2018
St. John's (Canada) – Reykjavik (Iceland)
Western SPNA transport



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1 Cruise Summary

1.1 Summary in English

The scientific program of the MARIA S. MERIAN MSM74 expedition was dedicated to studies on the intensity of water mass transformation and the southward transport of water masses in the boundary current systems off Labrador and at the southern tip of Greenland. During the expedition we recovered 17/deployed 8 deep sea moorings. Measurements of the vertical structure of temperature, salinity, density, oxygen, optical properties and the flow along selected sections have been surveyed during the MSM74 expedition. Close to the surface, permanent registrations are carried out with the thermosalinograph (temperature, salinity) and meteorological data are continuously collected. Flow measurements up to 1000m depth are performed with the ships installed ADCPs. The expedition is a contribution to national (RACE) and international projects (OSNAP, AtlantOS).

1.2 Zusammenfassung

Das wissenschaftliche Programm der MARIA S. MERIAN MSM74-Expedition widmete sich Untersuchungen zur Wassermassenumwandlung und zum südlichen Transport im Tiefen Westlichen Randstrom vor der Küste Labradors sowie im Süden Grönland. Während der MSM74-Expedition wurden 17 (8) Tiefsee Verankerungen geborgen (installiert). Zudem wurde entlang ausgewählter Sektionen die Temperatur-, Salzgehalt-, Dichte-, Sauerstoffverteilung und die optische Eigenschaften und der Strömung vermessen. In Oberflächennähe wurden Dauerregistrierungen mit dem Thermosalinographen (Temperatur, Salzgehalt) durchgeführt und meteorologische Daten wurden erfasst. Strömungsmessungen bis in 1000m Tiefe wurden dem Akustischen Doppler Strömungsmesser durchgeführt. Die Expedition war ein Beitrag zum deutschen RACE Projekt, aber auch zu internationalen Projekten und Programmen (OSNAP, AtlantOS).

2 Participants

2.1 Principal Investigators

Name	Institution
Johannes Karstensen, Dr.	GEOMAR
Penny Holliday, Dr.	NOC
Anya Waite, Prof. Dr.	AWI/Dalhousie
Douglas Wallace, Prof. Dr.	Dalhousie
Julie LaRoche, Prof. Dr.	Dalhousie

2.2 Scientific Party

Name	Discipline	Institution
Karstensen, Johannes, Dr.	Fahrtleiter/Chiefscientist	GEOMAR
Atamanchuk, Dariia, Dr.	Oxy sensors & titration; Dal. team lead	Dalhousie
Barboni, Alexandre	ADCP respons. & CTD watch	ENS
Begler, Christian	Mooring lead, telemetry	GEOMAR
Bendinger Arne	lADCP respons.; CTD watch	CAU Kiel
Fonseca, Debany, Dr.	Biology, incubation	Dalhousie
Fried, Nora	Salinometer respons., CTD watch	CAU Kiel
Holliday, Penny, Dr.	Mooring data, CTD watch	NOCS
Hundsörfer, Marie	Argo float; Real-time data; CTD watch	CAU Kiel
Kerrigan, Liz	Nutrient analysis	Dalhousie
Leimann, Ilmar	UVP; CTD watch	CAU Kiel
Martens, Wiebke	Mooring Instruments, CTD tech.	GEOMAR
Normandeau, Claire	DIC-13, TA and nutrients	Dalhousie
Oltmanns, Marilena, Dr.	Mooring data respons.; CTD watch	GEOMAR
v. Oppeln-Bronikowski, Nicolai	DVS & OSNAP Blog; CTD watch	Memorial
Ribbe, Joachim, Dr.	Salino helper; CTD watch	USQ
Roberts, Thomas	Mooring, Logistics	NOCS
Schmidtke, Sunke, Dr.	CTD respons.; CTD watch	GEOMAR
Suits, Thea	Mooring data; CTD watch	CAU Kiel
Willis, Ciara	helper chemistry/biology	Dalhousie
Witt, Rene	Mooring, Logistics	GEOMAR

2.3 Participating Institutions

GEOMAR	Helmholtz Zentrum für Ozeanforschung Kiel, Kiel, Germany
CAU Kiel	Christian-Albrechts-Universität Kiel, Germany
NOC	National Oceanographic Centre, Southampton, UK
Dalhousie	Dalhousie University, South St, Halifax, Canada
USQ	University of Southern Queensland, Toowoomba, Queensland, Australia
Memorial	Memorial University, St. Johns, Newfoundland, Canada
ENS	Ecole Normale Supérieure, Paris, France

2.4 Crew

Name	Rank
SCHMIDT, Ralf	Master
MAASS, Bjoern	Chief Mate
JANSSEN, Soeren	1st Officer
SCHILLING, Sandra	2nd Officer
OGRODNIK, Thomas Peter	Chief
WOLTEMADE, David	2nd Engineer
FOKKEN, Johannes	3rd Engineer
STAAK, Ludwig	Ship's Doctor
BEYER, Thomas	Electrician
HERRMANN, Jens	Electronics
REIZE, Emmerich	System Operator
WIECHERT, Olaf	Fitter
BOSELTMANN, Norbert	Bosun
PLINK, Sebastian	SM
PETERS, Karsten	SM
ZEIGERT, Michael	SM
PESCHEL, Jens	SM
WOLFF, Andreas	AB
PESCHKES, Peter	SM
NEBE, Tom	SM
SAUER, Jürgen	Motorman
MATTER, Sebastian	1st Cook
PREUSS, Georg	2nd Cook
KLUGE, Sylvia	Stewardess

3 Research Program

3.1 Description of the Work Area

The North Atlantic Ocean circulation is regarded as a major driver of large-scale climate variability on interannual and longer time scales. In particular, it has been shown that the relatively mild climate in northern Europe is closely linked to the northeastward transport of warm, subtropical water in the North Atlantic Current, which connects the warm, subtropical gyre Gulf Stream with the cold, subpolar gyre. The North Atlantic Current is thought to be, in turn, influenced by the water mass transformation of surface water in the northern North Atlantic – north of the Greenland-Scotland Ridges and in the Labrador and Irminger Seas. By cooling, the surface water becomes denser and sinks into the deep ocean where it spreads southward, preferentially within the “Deep Western Boundary Currents” (DWBC) on the western side of the North Atlantic. Besides waters being transformed in the subpolar gyre, the DWBC also transport water southward that originate from the Greenland-Scotland Ridges overflow regions. Changes in the magnitude and

hydrographic characteristics of the DWBC represent therefore the integrated effect of variations in the different processes in the water mass transformation and in the overflow regions. In order to identify the individual sources of the variability of the DWBC, it is critical to survey the DWBC regularly, with high temporal and spatial resolution and over long periods of time.

3.2 Aims of the Cruise

The aim of the MARIA S. MERIAN MSM74 expedition was to collect observational data to study different aspects of water mass transformation and southward transport of water masses in the DWBC of the western subpolar North Atlantic. The vertical distribution of temperature, salinity, density, oxygen, optical properties and flow velocity was measured along selected sections, the near surface salinity and temperature was continuously monitored with the thermosalinograph, meteorological data was recorded and the flow velocity down to a depth of 1000 m was acquired with ship ADCPs throughout the cruise (Fig. 3.1). Long term moorings that belong to the OSNAP program were recovered and in part redeployed. The expedition contributed to national projects (RACE) and international projects and programs (OSNAP, AtlantOS).

3.3 Agenda of the Cruise

The work program had two parts: (1) operations related to moored sensors and (2) ship based observations (Fig. 3.1). Central components of the international “Overturning in the Subpolar North Atlantic Programm” (OSNAP) are mooring arrays. Relevant for MSM74 were the "WHOI Array & NOCS Array" that have been installed on either side of southern tip of Greenland since 2014. Moreover the "53°N Array" (in operation since 1997) at the southern exit of the Labrador Sea contributes to OSNAP, augmented by moorings from the Bedford Institute /DFO Canada at the shelf edge (“C-Array”).

In the main subpolar gyre convection regions two mooring sites have been in operation since the beginning of the 2000s in the Irminger Sea (CIS, Germany, and LOCO, Netherlands) and since 1997 in the Labrador Sea the K1 mooring (also contributing to the "Ocean Frontier" node). During the MSM74, the 53°N Array and two German moorings in the WHOI array were re-deployed. The NOCS array was recovered. The K1 mooring was recovered and deployed, CIS and LOCO were only recovered. Another contribution to the OSNAP was recovery of two RAFOS sound source moorings.

Vertical profiles of properties were collected with the CTD rosette (CTD, oxygen, optical properties, currents IADCP) – “CTD+”. The CTD data (salinity, oxygen) was validated on board the ship against discrete analysis of oxygen and salinity from water samples. This procedure ensures high quality data and is a quality assessment of the data during the cruise. Underway data was collected with the Thermosalinograph (Temperature, Salinity) and with meteorological sensors. Vessel mounted ADCP systems (38kHz, 75kHz) were used to survey quasi-continuously the currents in upper 500 to 1000m.

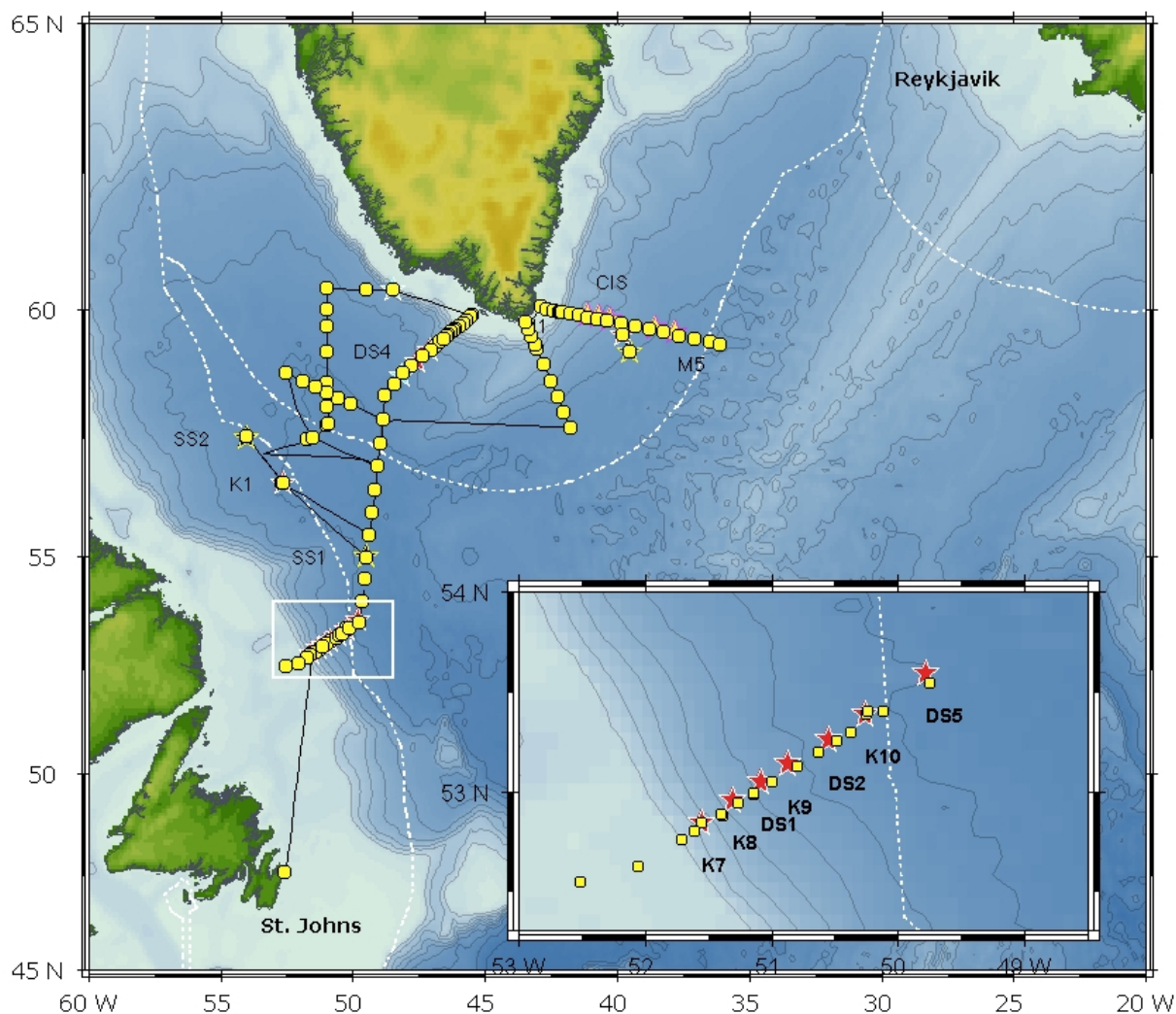


Fig. 3.1 RV Maria S. Merian MSM74 cruise track from St. Johns to Reykjavik. Yellow dots indicate CTD/IADCP casts, red stars indicate mooring operations, Underway data tracks (black line) are shown. Selected mooring names are shown (see section 5.2 for decoding).

4 Narrative of the Cruise

(J. Karstensen)

The Maria S. Merian arrived on the 22nd May 2018 in St. Johns, Canada, ending the MSM73 expedition (Chiefscientist: D. Kieke, University Bremen). In the afternoon of the same day, MSM74 container movement started, in total 8 containers were operated: 6 went on board incl. a lab container from Dalhousie University and a workshop container from NOC; 2 containers were loaded to the ship from the pier. Over the following days the equipment was installed, labs prepared and science crew briefings done.

On 25th May, the Merian left at 08:30 for the bunker pier, and the MSM74 cruise started at 15:00, when Maria S Merian left the bunker pier. Shortly after the safety drill (15:30) we reached the 1st station (Station 27 – Canadian Time Series) and a first CTD cast was conducted. Afterwards, the

transit to the “53°N Array” operation area begun. Underway data acquisition started when crossing the 3nm zone. We arrived in the afternoon of the 26th May at the 53°N Array area and recovered the first mooring (K7). The weather was grey and snowy/rainy but calm seas. During the night, CTD casts with biogeochemical sampling of the Dalhousie group were done. On the 27th May 2018 we recovered four moorings (DSOW1, K9, DSOW2, K10) starting at 06:00 and finishing at 21:00. CTD casts followed including a first “double cast” with 150 m only for biology and full depth for CTD/biogeochemical sampling. The full depth cast was also used for calibration of Microcats (MC) and Aquadopps current meters and mooring acoustic releasers. The weather was in general sunny and calm with sporadic snowfall. A first biological sampling and incubation experiment (executed in the 6°C scientific cold storage room) was performed by the Dalhousie University group. On the 28th May we recovered DSOW5, the outermost mooring of the 53°N Array. Some irregularities (outages) of the CTD occurred which could be tracked back to the new (unproven) IADCP voltage supply (via the CTD wire). We thus moved back to the battery pack system from GEOMAR. Later (up to cast 13) this system was malfunctioning because of a battery leakage and we used the University Hamburg battery container (RDI original container). For the upcoming re-deployments a number of instruments required reading out the data and preparation of the devices. Ciara Willis (Dalhousie) did some taxonomy work on Plankton images recorded with the UVP (Anya Waite/Andreas Rogge, AWI; Bremerhaven, Germany). On the 29th May the last 53°N Array mooring was recovered (K8) and K10 and DSOW5 were deployed again. We approached the shelf (CTD Station 21) on the 30th May 2018 and encountered some growlers but they did not limit navigation of the ship. Heading back, we deployed a number of CTDs until we reached the northeastern most part of the 53N Array where the first Argo float was released (with a CTD cast nearby). Later, the moorings K9 and DSOW2 were also deployed.

We left the 53N Array operations area and recovered the WHOI (USA; Amy Bower) Sound Source 01 (SS01) on the 1st June on our way to the northwest. Working up the devices recovered the days before we realized that the motor of the McLane moored profiler was flooded and the device did not record data. On the 2nd June we recovered the K1 mooring in the morning. The mooring showed many wire turns in its upper part, most likely related to the break-off of the surface telemetry system in December 2017. The wire suggested that the break was due to a not well manufactured connector (a piece purchased from the manufacturer of the MI.SAT I buoy, Develogics, Hamburg, Germany). The recovery of the WHOI sound source 02, located northwest of K1, was delayed because no communicating with the releaser could be established. Only after changing from the former “best estimated position (Thalassa MSM40 cruise) towards “anchor drop” location the floating surface elements were spotted. As a consequence, recovery started late (7:30pm) and went on until 09:30pm. On the 3rd June K1 was deployed and calibration casts were performed. The original plan to deploy the remaining two Argo floats in the K1 area was postponed because of issues with the pH sensor calibration sheets.

The following days were dedicated to the CTD program along the “OSNAP west” section. The weather and waves were getting bad (wave height >9m) which caused intense roll of the ship (maximum roll angle of 26°). Therefore, CTD work was stopped and we changed the ship's course from 310° to 270° to better align with the wave and wind. During the 5th June we mostly steamed westward on a reasonable course until late night. The scientific meetings during these days were filled with discussions on the first results/observations of the cruise. In the morning of June 6th, we started navigating towards the lander mooring deployment position and realized that we

crossed a very intense mesoscale eddy. The eddy field was composed by a cyclone surrounded by up to four anticyclonic eddies aligned in a rather symmetric structure. The ADCP & CTD survey of eddies continued until we were close to the Greenlandic coast. Only few icebergs were spotted. On the 7th June we prepared the lander mooring deployment which took place on the 8th June, starting with a calibration (sound profile) CTD at the approximate target position of the lander. It revealed that the sea floor was very structured and the depth was very variable. Because we did not have a lander launching device on board we used the “Ranger 2” device (which is a kind of POSIDONIA system) for SBLN of the CTD. By knowing the exact CTD position and depth it helped to position the lander mooring on to the sea floor. What followed was a very detailed bathymetric survey which again nicely revealed a very steep and complex topography with many ridges and valleys. We identified a “valley” and finally deployed the lander at a water depth of about 930 m. A CTD was done close to the deployment location which showed a surprisingly different T/S profile compared to the CTD station only about 1 km away.

We then transited to the northern part of the OSNAP West section, close to Greenland, and worked our way south with CTD stations on the shelf and through the DWBC, following the OSNAP line. On our way south we redeployed two short DWBC extension moorings DSOW4/3 on the West-Greenland side (contributions to the WHOI array, Bob Pickard, USA). A second and better targeted eddy survey was started along a more zonal track and mainly with ADCP (38kHz and 75kHz) and only a few CTDs stations at selected positions. In the center of the cyclonic (the inner) eddy two Argo floats were deployed on the 12th June early morning and after that we completed two more CTD casts, one with full carbon/nutrient observations. After heading further northwest, the edge of the cyclonic eddy was reached and a 4h Yo-Yo CTD, covering the lower LSW range (1100 to 1900m), was performed to follow the evolution of a warm/saline intrusion driven by a subsurface filament. We moved east towards the beginning (most southerly position) of the Kap Farvel section, starting on the 14th June. While approaching the coast the wind increased substantially up to 9 Bft. Still, we had clear view on the coast during the last CTD station only about 3 nm away from land. After finishing the Kap Farvel section we moved north northeast and started the OSNAP East section in the evening of the 14th June. We continued with CTD stations the full night, including station 100, and began recovery of the M1 to M3 moorings from NOC Southampton, UK on the 16th June at 6am. The NOC mooring operations were part of the BARTER agreement added to the cruise. All three moorings were fully recovered by 13:30. In the afternoon the RV Neil Armstrong appeared on our radar and the two ships passed each other in a distance of about 2 nm and we exchanged information via HF radio.

In the morning of the 17th June we recovered the CIS mooring. The upper (the “slack”) part of the mooring, designed from “Meteor rope”, was missing and unfortunately also the upper two MicroCat instruments. The weather was calm and the recovery went well. Similarly, the LOCO mooring was recovered after CIS on the 17th June. LOCO belongs to the NIOZ, Netherlands, and was also recovered as part of the BARTER charter that was added to the MSM74 cruise. We continued with CTD station until 18th June when we recovered the last two moorings of the NOC OSNAP array.

The CTD program continued until on the 19th June at about 3am when a shortage in the electric system of the ship occurred. The shortage damaged parts of one engine and the pump-jet and made navigation at station difficult. Attempts to replace the broken part kept going until 20th June 8 am, when it was decided to leave the area for Reykjavik – thus losing a bit more than 4 days of ship

time. Over the next days all groups on the ship prepared for the early arrival by packing equipment, documenting the cruise, and preparing for demobilization. Last salinity samples were analyzed with the salinometer and a first release of the CTD data set created. The ships ADCPs/TSG/Underway data were switched off 22.6.2018. We arrived in Reykjavik, Iceland, on Friday June 22nd, 2018 at 16:00. Further container packing was done. Transportation to the different destinations (RV Neil Armstrong; GEOMAR; Dalhousie University) was prepared and containers were unloaded from the ship on the 26th June 2018.

5 Preliminary Results

5.1 CTD observations

(S. Schmidtke, M. Oltmanns, A. Bendinger)

5.1.1. CTD systems and calibration

During MSM074 the GEOMAR CTD-Rosette systems #4 was used (see table 5.1), herein after CTD, equipped with a SBE911plus and a Seabird Rosette System and 22 bottles mounted (IADCP system required space of two niskin bottle). For some casts more niskin bottles were removed to provide space for MicroCat calibration racks. A total of 115 CTD-profiles and 1793 bottle samples were collected. Data acquisition was done using Seabird Seasave software version 7.23.2; preprocessing was done with SBE Data Processing 7.23.2. Note the UVP system details can be found in section 5.6 .

Tab. 5.1 Summary of CTD system configuration used during MSM074.

	CTD system SBE#4
Pressure sensor	# 61184
T primary	# 4831
T secondary	# 4875
C primary	# 3300
C secondary	# 3981
O2 primary	SBE 43 # 1306
O2 secondary	SBE 43 # 1302
Turbidity Meter	# FLNTURTD-2294
Fluorometer CDOM	# 2687
WET_LabsCStar	# CST-1617DR
UVP, IADCP	See respective sections

CTD#1 (test station) was done at the DFO time series station “Station 27”, off St. John in shallow water where all parameters, despite some minor spikes, were within the expected range and the system was stable. At Cast #9 started to show erratic behavior on the downcast, and shortly afterwards a complete loss of signal. The cast was aborted; the files recorded on the downcast could not be processed by the Seabird software. A check of the wire required a new termination of the ships winch equipment. The successive CTD #10 showed better behavior, with still some erratic data. CTD #11 indicated similar problems as cast #9 with loss of connection to the CTD.

After detailed analysis of the sensors the fault was assumed to be the connector to the CDOM sensor as well as a new termination of the ships winch equipment. CTD #12 showed no improvement and had to be aborted as well. Another corrosion issue in the CTD connectors was found to be the culprit. The CTD system proofed to be stable from cast #13 onwards. At CTD #38 did not close any bottles, the fault was likely a faulty termination of the wire, the wire required a new termination of the ships winch equipment and showed no issues thereafter. Only the downcast of cast #115 was sampled, due to a ship wide power failure, the cast was stopped and the CTD recovered after power was partly restored. Subsequently no bottles were taken on this cast. Data from casts #9, #11 and #12 are flagged as bad, and could not be calibrated, since all sensors showed suspicious behavior and good data could not be separated from spikes and interferences. The oxygen sensors provided reliable high quality data throughout the cruise, despite increased noise at greater depth ($>2000\text{dbar}$), a detailed analysis showed that the quality of the median filtered data were still excellent. No further problems were recorded with the sensors or sampling systems of the CTD system. The CTD system worked without problems for 110 out of 115 profiles. From the five profiles with errors (#9, #11, #12, #38, #115), two could be restored and regarded as good data (#38, #115).

Real-time data submission

Processed preliminary CTD data, 5-dbar binned, was sent in near real time to the Coriolis Data Centre in Brest, France, (via email: codata@ifremer.fr) for integration in the databases to be used for operational oceanography applications and the WMO supported GTS/TESAC system.

5.1.2 Conductivity sensor calibration

370 salinity were taken and analyzed (see Section 5.8) and 246 used for the CTD calibration. Salinity samples were taken by the CTD watch in recycled 'Flensburger' beer bottles, which proved to be ideal for storing salt samples over a prolonged time, as used by the GEOMAR. For the final calibration the largest 33% deviations between CTD and bottle samples were removed prior to calibration (taking care that the pressure horizons were still adequately resolved).

The projection from the bottle closure depth of the up- to the downcast was done by searching for similar potential temperatures within 50dbar pressure internal around similar pressure horizons between up- and downcast. Loop edit velocity was 0.1m/s.

From the preliminary calibrations on board we expect the final CTD salinity to show a RMS misfit after calibration of <0.0016 (primary and secondary sensor).

5.1.3 Oxygen CTD sensor calibration

The CTD oxygen downcast for CTD systems was calibrated by using the best two thirds of the joint data pairs between downcast CTD sensor value and titrated oxygen on samples taken during the upcast (see Section 5.3). For the calibration, a linear correction polynomial depending on pressure, temperature and the actual oxygen value as well as the cubed pressure correction was fitted. Despite the very accurate titration and stable oxygen data no temporal drift was detected. From the preliminary calibrations on board we expect the final CTD oxygen to show a RMS misfit after calibration of $<1\mu\text{mol/l}$ (primary and secondary sensor).

5.1.3 CTD Sections

An overview of the OSNAP West and (partly) East sections for temperature, salinity and oxygen is shown in Figure 5.1.

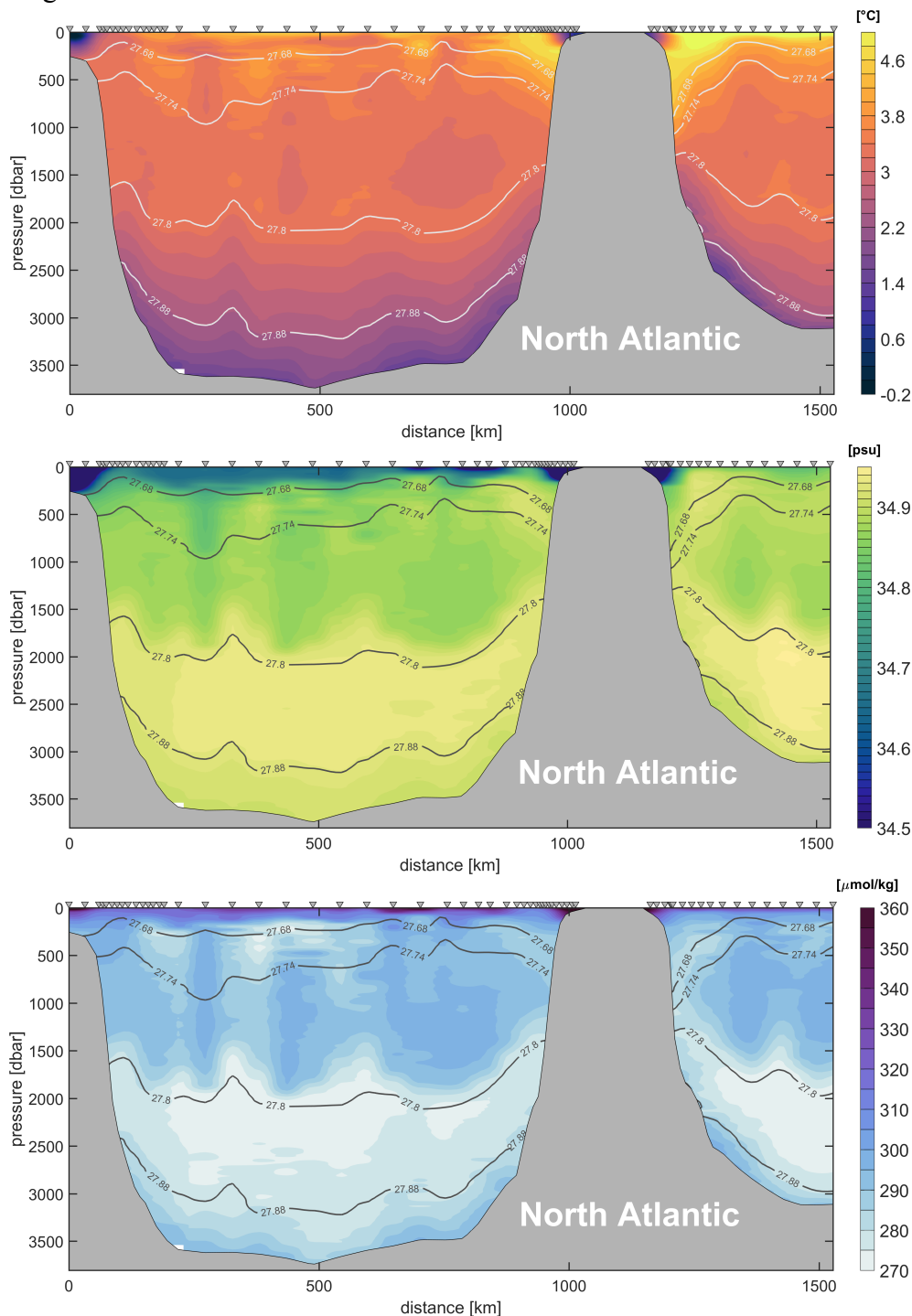


Fig. 5.1: CTD transect along the OSNAP line: potential temperature (upper, left), salinity (upper, right), dissolved oxygen (lower, left), fluorescence (no bottom).

5.2 Mooring Operations

5.2.1 GEOMAR Moorings

(M. Oltmanns, T. Suits)

As part of the international Overturning in the Subpolar North Atlantic Program (OSNAP), one goal of the cruise was to recover 7 moorings from the 53N Array (DSOW1-5 and K7-10) and redeploy them with one additional mooring (DSOW6). The purpose of these 8 moorings is to measure variations in the deep western boundary currents at the entrance and exit of the Labrador Sea and to record transport and property changes of the dense overflow waters. In addition, we recovered and deployed the mooring K1 in the central Labrador Sea, which observes the local convection activity, and we recovered 2 moorings in the central Irminger Sea (CIS from GEOMAR and LOCO from the Royal Netherlands Institute for Sea Research), 5 moorings from the National Oceanography Center at the eastern side of south Greenland (M1-5) and two sound sources from the Woods Hole Oceanographic Institution in the Labrador Sea.

Table 5.2: List of GEOMAR moorings recovered during cruise MSM74. R= Recovery; D= Deployment

R	D	Mooring		Date and Time	Latitude	Longitude	Depth
x		CIS 14	KPO 1167	17.06.2018 07:41-10:21	59°31.826'N	039°46.982'W	2904
x		DSOW 1	KPO 1159	27.05.2018 08:26-10:05	53°02.796'N	051°04.804'W	2599
	x	DSOW 1	KPO 1187	30.05.2018 19:14-20:32	53°02.852'N	051°04.774'W	2617
x		DSOW 2	KPO 1161	27.05.2018 16:45-18:38	53°15.399'N	050°33.267'W	3162
	x	DSOW 2	KPO 1189	31.05.2018 15:59-16:56	53°15.402'N	050°33.247'W	3156
x		DSOW 3	KPO 1164	09.06.2018 14:43-16:44	59°00.43'N	47°33.87'W	3100
	x	DSOW 3	KPO 1192	09.06.2018 17:04-17:48	59°00.43'N	047°33.87'W	3104
x		DSOW 4	KPO 1165	09.06.2018 10:51-12:11	59°12.930'N	047°4.910'W	2942
	x	DSOW 4	KPO 1193	09.06.2018 12:45-13:48	59°12.93'N	047°4.99'W	2935
x		DSOW 5	KPO 1163	28.05.2018 09:19-10:48	53°35.522'N	049°46.905'W	3605
	x	DSOW 5	KPO 1191	28.05.2018 14:31-15:32	53°35.556'N	049°46.968'W	3606
	x	DSOW 6	KPO 1206	10.06.2018 16:25-17:06	58°44.00'N	048°10.01'W	3348
x		K 1	KPO 1166	02.06.2018 11:12-14:29	56°33.702'N	052°39.421'W	3490
	x	K 1	KPO 1194	03.06.2018 17:48-18:55	56°34.168'N	052°39.622'W	3492
x		K 7	KPO 1157	26.05.2018 9:24-10:56	52°51.418'N	051°18.606'W	2201
	x	K7	KPO 1185	30.05.2018 12:43-14:43	52°50.419'N	51°32.907'W	1403
x		K 8	KPO 1112	29.05.2018 16:11-18:23	52°57.339'N	051°18.606'W	2201
	x	K 8	KPO 1186	30.05.2018 15:48-18:12	52°57.344'N	51°18.612'W	2204
x		K 9	KPO 1160	27.05.2018 11:16-13:41	53°08.221'N	050°52.253'W	2901
	x	K 9	KPO 1188	31.05.2018 11:43-14:37	53°8.218'N	50°52.256'W	2901
x		K 10	KPO 1162	27.05.2018 19:03-22:17	53°23.245'N	050°15.285'W	3212
	x	K10	KPO 1190	28.05.2018 17:22-20:58	53°23.240'N	050°15.28'W	3366
	x	Lander		08.06.2019 09:34:58	60° 22.276' N	048° 27.099' W	947

The moorings CIS and LOCO were only recovered and not re-deployed, because their task to measure convection variability in the Irminger Sea has been taken over by 4 nearby moorings from

the Ocean Observatories Initiative. Thus, in total we recovered 14 moorings and deployed 9. Details about the moorings from GEOMAR can be found in Table 5.2 and in the Appendix.

Instrument performance

The 9 recovered moorings from GEOMAR (CIS, K1, K7-10, DSOW1-5) were equipped with a total of 82 microcats, 21 aquadopps, 13 RCMs, 6 Argonauts, 3 ADCPs, 1 MMP and 1 Develologic Seaguard. They also included a fluorescence and turbidity sensor and additional instruments from Dalhousie University, such as acoustic devices VR2W and VMT, a StarOddi to record tilt and several oxygen sensors not assessed here.

Of the 82 microcats, 2 were lost (MC 940 and MC 10707 in the upper part of CIS), 1 was programmed incorrectly (MC 936), 1 stopped recording after 30 days because of an early battery discharge (MC 9510 with an added oxygen sensor) and 1 stopped recording for a period of over 7 months before it started working again (MC 1599). All other instruments returned a full record, although some had many spikes in the salinity records (e.g. MC 942, MC 946, MC 952, MC 957, MC 1316, MC 1320, MC 1322 and MC 1323) and some had drifts in pressure or conductivity. MC 3504 did not record negative temperatures and MC 10690 and MC 10708 had problems returning the correct dates. However, the error could be resolved such that less than 2 days of data were lost.

Of the current meters, all aquadopps were recovered with full records and the RCMs only had short interruptions, one being ~7 weeks (RCM 5569) and two being 3-4 weeks long (RCM 9930 and RCM 10558). Among the 6 Argonauts, 4 had beam errors (ARG 145, ARG 184, ARG 188 and ARG 329), but the other two returned full records. The 3 ADCPs were also recovered with full records but one of them had a time offset of 8 hours (ADCP 2280).

The MMP did not work (MMP 12255) and the Develologic Seaguard (12008) recorded only for one year.

Lander Deployment

A POZ Lander from GEOMAR was deployed on the 08.06.2019. The lander was placed in rough topography at the west coast of Greenland and as such an extensive survey of the topography was done before deployment (see Fig. 5.2). The lander was lowered until close to the ground (based on the Echo sounder depth sounding) and free fall released a couple of meters over ground.

The lander was equipped with: ADCP (300kHz, WH upward looking, Serial#6468), an RBR XR-620 CT+Paro (serial#15174); an aanderaa optode (serial# 691), Flasher (Novatech ST-400A); RF Beacon (Novatech RF-700A1, serial W07-044), and a KUM Quat K/MT 562 releaser.

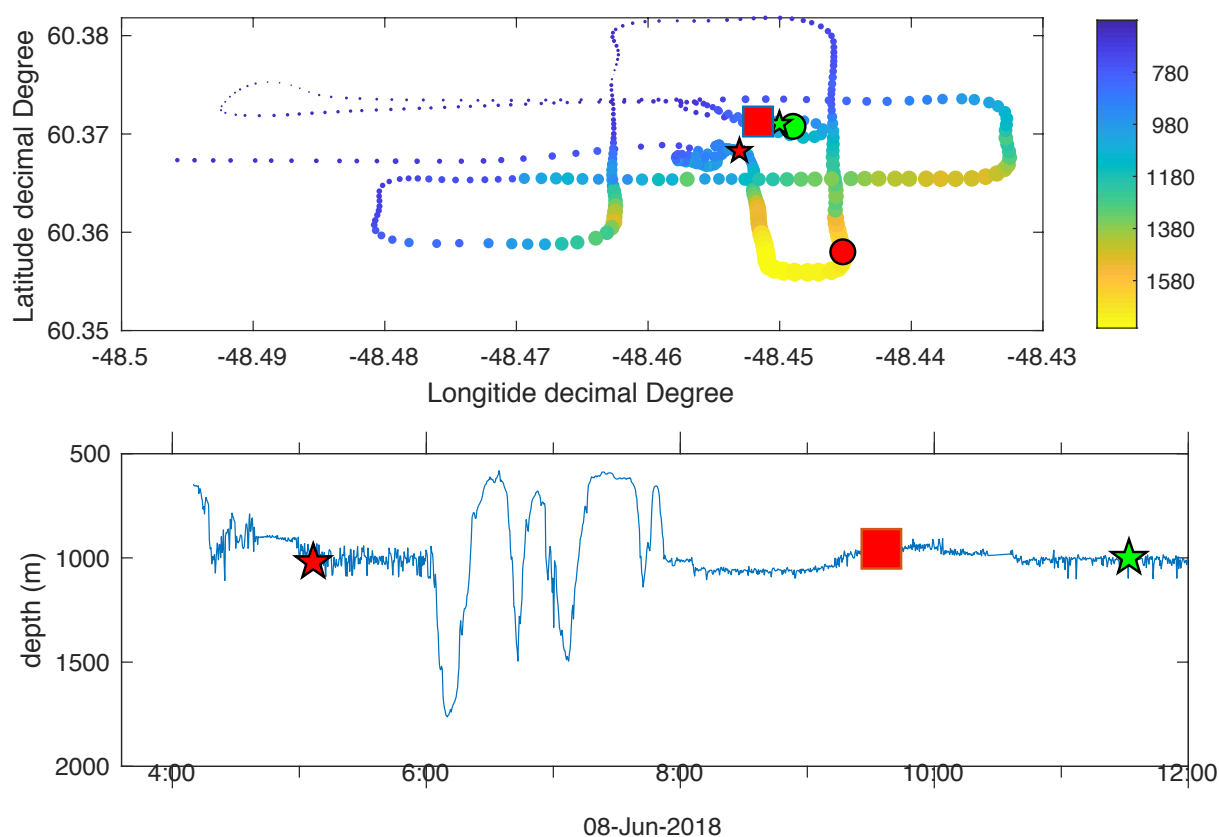


Fig. 5.2: Lander deployment off western Greenland. Map (upper) shows cruise track, (circles; colorcode with depth). CTD before (red star) and after (green star) deployment; start of survey (red circle) and end of survey (green circle) are indicated. Lander Position is red square. (Lower) time series plot of bottom depth soundings during the topography survey and further lander related activities (coding as in upper).

As a contribution to AtlantOS WP5.3, and in collaboration with Dalhousie University and Ocean Tracking Network, Canada, RBR/Aanderaa oxygen sensors and passive acoustic sensors (150m) were mounted on selected moorings at the 53N array in 2016 (See Table 5.3). The oxygen sensors were paired with MCs placed in the core-depth of Labrador Sea Water, in Northeast Atlantic Deep Water, and in the core of the NADW (at K9). All instrumentation was successfully recovered during the turn-around mission.

Table 5.3: List of oxygen sensors recovered from the 53N Array during MSM74

Model	Parameter(s)	Serial number	Location	Nominal depth	Deployed	Recovered	Calibration cast MSM74, recovery	Remarks
Aanderaa/ RBR Concerto	DO/T	052626	K10	610m	20.05.2016	27.05.2018	CTD9	
Aanderaa/ RBR Concerto	DO/T	052627	K9	2888m	17.05.2016	27.05.2018	CTD10/CTD18	no data from CTD10, some bug
Aanderaa/ RBR Concerto	DO/T	052628	K9	610m	17.05.2016	27.05.2018	CTD10	
Aanderaa/ RBR	DO/T	052629	K7	1109m	18.05.2016	26.05.2018	CTD9/CTD10	

Concerto								
Aanderaa/ RBR Concerto	DO/T	052630	K8	1801m	18.05.2016	29.05.2018	CTD18	
Aanderaa/ RBR Concerto	DO/T	052631	K8	608m	18.05.2016	29.05.2018	CTD18	
Aanderaa/ RBR Concerto	DO/T	052633	K9	1875m	17.05.2016	27.05.2018	CTD10	
Aanderaa/ RBR Concerto	DO/T	052634	K7	608m	18.05.2016	26.05.2018	CTD9	
Aanderaa/ RBR Concerto	DO/T	052635	K10	1898m	20.05.2016	27.05.2018	CTD9/CTD10	

The sensors stopped recording on May17, 2018 as scheduled by the logger firmware, even though the batteries weren't completely depleted. It turned out that endurance calculator was underestimating the battery lifetime, which is 2000d at 15min interval. This bug was fixed in the recent software version of Ruskin Software V. The loggers were reprogrammed to measure at 15min interval with a new set of Lithium batteries. The sensors were deployed again at the locations indicated in Table 5.4.

Table 5.4: List of oxygen sensors deployed at 53N Array during MSM74

Model	Parameter	Serial number	Location	Nominal depth	Deployed	Calibration cast MSM74, deployment
Aanderaa/ RBR Concerto	DO/T	052626	K10	608m	28.05.2018	CTD9
Aanderaa/ RBR Concerto	DO/T	052627	K8	1802m	29.05.2018	CTD10/CTD18
Aanderaa/ RBR Concerto	DO/T	052628	K9	613m	28.05.2018	CTD10
Aanderaa/ RBR Concerto	DO/T	052629	K9	2876m	28.05.2018	CTD9/CTD10
Aanderaa/ RBR Concerto	DO/T	052630	K7	1102m	29.05.2018	CTD18
Aanderaa/ RBR Concerto	DO/T	052631	K8	611m	29.05.2018	CTD18
Aanderaa/ RBR Concerto	DO/T	052633	K9	1854m	28.05.2018	CTD10
Aanderaa/ RBR Concerto	DO/T	052634	K10	1902m	28.05.2018	CTD9
Aanderaa/ RBR Concerto	DO/T	052635	K7	611m	29.05.2018	CTD9/CTD10

5.2.2 NOC Moorings operations and data

(P. Holliday)

The UK OSNAP Irminger Sea Deep Western Boundary Current array, consisting of five NOC moorings, was recovered during the cruise. These are summarised in Table 5.5 and shown in Figure 5.3. All of these moorings were deployed from the *RRS Discovery* in July-August 2016 on DY054. Communications with the acoustic releases were made via the hull-mounted transducer, which worked well for all of the moorings. Moorings M2 and M3 rose to the surface with the buoyancy packages well separated but for the other moorings several packages were close to one another on the surface resulting in a number of tangles. The M1-M5 moorings included a total of 10 Nortek Aquadopp current meters, 5 WH300 kHz ADCPs and 29 SBE37 microcats. All instruments were recovered intact and full data records were obtained from each. One ADCP had suffered corrosion on the transducer head. A summary of the recovered instruments is given in Table 5.6.

Table 5.5. List of NOC moorings operations (only recovery) during cruise MSM74.

R	D	Moorings	Date and Time	Latitude	Longitude	Depth
x		NOCM1	16.06.2018 06:24-08:08	59° 54.18'N	41° 06.71'W	2904
x		NOCM2	16.06.2018 09:30-10:50	59° 51.58'N	40° 41.43'W	2599
x		NOCM3	16.06.2018 12:08-13:09	59° 48.87'N	40° 16.63'W	2617
x		NOCM4	18.06.2018 13:42-15:12	59° 38.76'N	38° 33.99'W	3162
x		NOCM5	18.06.2018 09:52-11:32	59° 34.73'N	37° 47.97'W	3156

On-board mooring instrument processing

On board processing and checking of the data followed the procedures used in previous UK OSNAP and RAPID mooring cruises (see cruise reports for DY054 and DY078/79 at bodc.ac.uk for more details). After download from instruments, data were copied from the data server (public_wiss) to a mac laptop with a sub-directory for each instrument type. ADCP data were exported to matlab files using WinADCP. Time offsets at the time of data download were recorded in files "clock.txt" (ADCPs) and on data download logsheets (Aquadopps, microcats).

Meta-data for each deployment are recorded in a file named <deployment>info.dat. The deployment name include the name of the mooring, the number of the deployment and the year of deployment; e.g. nocm1_03_2016. The meta-data includes the location of the mooring, and the start and end time of the deployment. These times are adjusted after inspection of the data so that the launch and recovery periods are excluded.

The first stage of processing for microcat and current meter instruments is to convert the data into the RODB format and merge metadata from the <deployment>info.dat file. Time-series plots are produced which can be used to identify the launch and recovery periods and may highlight any significant issues with the data. In the second stage of processing the launch and recovery periods are removed from the data.

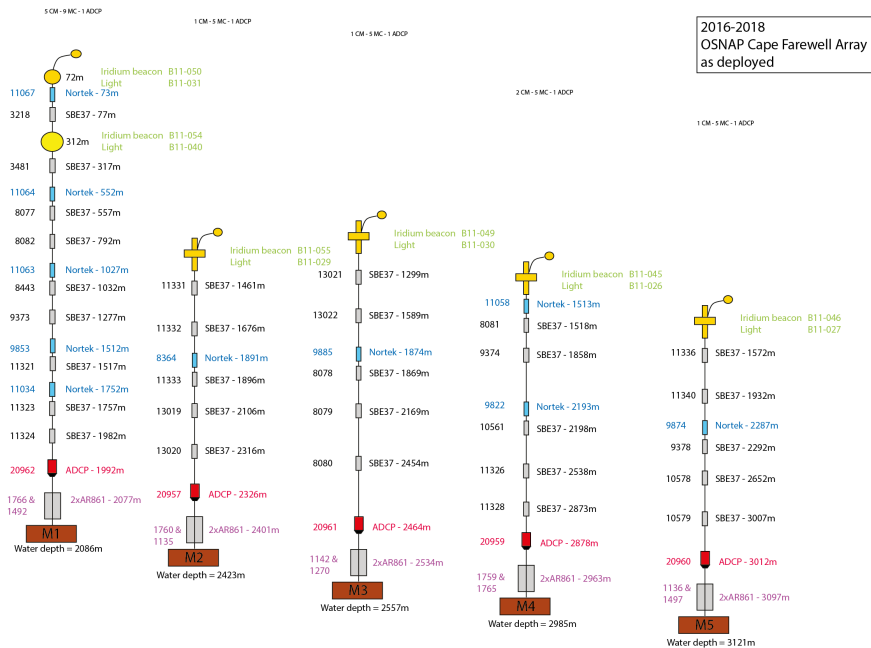


Figure 5.3: The NOC UK OSNAP Deep Western Boundary Array as deployed in 2016 and recovered on MSM74

Microcat calibration

Some of the recovered instruments were calibrated on a “cal-dip” CTD cast. One calibration cast for NOC instruments was conducted during MSM74: **CTD cast 110**. During calibration casts the Microcats were set to record at 10 second intervals and the data were compared to the primary sensor pair on the CTD frame (calibrated 1 sec file). Comparisons are made at the time of bottle stops which are about 5 minutes each (5 stops in total). Data from the deepest bottle stop are summarised in Table 5.6. In assessing data quality we use nominal acceptable tolerances for the offsets of: ± 0.02 mS/cm at deepest stop, ± 5 dbar at deployment depth, ± 0.005 deg C at stable stops. Any instruments that have data outside of these limits are shown in red in Table 5.7.

Cruise MSM74 was cut short early because of problems in the engine room. This meant that not all instruments had a caldip, and this must be done prior to re-deployment on the RV Armstrong cruise (AR30) that follows this cruise in July 2018.

Microcats tested on CTD cast 110:

NOCM1: 3218, 3481, 8077, 8082, 8443, 11321, 11323, 11324

NOCM2: 11331, 11332, 11333, 13019, 13020

NOCM3: 13021, 13022, 8078, 8079, 8080

Microcats not tested on a caldip cast on MSM74:

NOCM1: 9373

NOCM4: 8081, 9374, 10561, 11326, 11328

NOCM5: 11336, 11340, 9378, 10578, 10579

Microcat Data Issues

A preliminary inspection of the data indicated a very small number of issues that should be examined further when processing the data and when allocating the instruments on the new 2018 UK OSNAP Iceland Basin moorings to be deployment from the RV Armstrong in July 2018. Instrument S/N **13020** appears to have a large drift during last few months. During the caldip this instrument had larger variability of conductivity than other instruments. Instrument S/N **13022** had a sudden and unrealistic drop in conductivity in August 2017, from which it did not recover during deployment, and which was still present during the caldip. Instrument S/N **8082** had a pressure offset of 12.3m at 2984 dbar, although it was deployed at 780m and the pressure offset at 500 dbar was 1.6 dbar. This instrument should ideally be deployed at a shallow depth in the future. Instruments S/N **11332** and **11333** had temperature offsets that were an order of magnitude larger than the other instruments, though they are still within our correctable tolerance range. For both instruments the offset did not change noticeably with depth, though was at a minimum (0.0016/0.0019 °C respectively) at 1200 dbar. Data from most microcats were downloaded with conductivity in mS/cm, with the exception of S/N 3218, 3481 and file 8079_cal_dip_data. All conductivity data were converted to S/m in the *.raw and *.use data files.

Current Meter and ADCP Data Issues

There were no immediately apparent issues with the Aquadopp data. The current meter data showed a similar feature to earlier deployment, namely that the data quality degrades with depth significantly during months of ~April to July, probably as a result of low backscatter. The 8m bins tested on the 2016-2018 M4 and M5 deployments did not improve data quality. Data from the corroded ADCP looked fine for the whole deployment.

Table 5.6: Summary of the cal-dip data. The mean difference and standard deviation of the difference between each Microcat and the primary CTD sensors are shown. Data are for the deepest bottle stop only. CTD Cast 110 - Differences evaluated at 2984 db, std =0.5 dbar

Serial Number	No. Smpls	Conductivity (mS/cm) Mean S.D.	Temperature (°C) Mean S.D.	Pressure (dbar) Mean S.D.
3218	20	-0.0012 0.00008	-0.0007 0.00037	3.2 0.18
3481	20	-0.0007 0.00007	0.0007 0.00044	-5.0 0.31
8077	20	0.0004 0.00005	-0.0002 0.00053	3.6 0.27
8082	20	0.0002 0.00005	-0.0018 0.00050	12.3 0.16
8443	20	-0.0007 0.00004	-0.0006 0.00053	6.1 0.22
11321	20	-0.0001 0.00007	0.0004 0.00061	5.0 0.18
11323	20	-0.0001 0.00006	0.0008 0.00060	4.9 0.20
11324	20	-0.0005 0.00004	0.0004 0.00041	3.4 0.10
11331	20	-0.0008 0.00004	-0.0001 0.00049	4.1 0.14
11332	20	-0.0006 0.00005	0.0021 0.00049	4.6 0.10
11333	20	-0.0005 0.00006	0.0024 0.00061	3.9 0.08
13019	20	-0.0012 0.00006	0.0003 0.00051	3.6 0.17
13020	20	0.0811 0.00055	-0.0001 0.00042	2.6 0.13
13021	20	-0.0008 0.00005	0.0001 0.00050	3.1 0.16
13022	20	-1.3928 0.00008	0.0000 0.00040	3.3 0.16
8078	20	-0.0000 0.00004	0.0005 0.00049	4.5 0.17
8079	20	0.0002 0.00006	-0.0001 0.00055	5.0 0.07
8080	20	-0.0009 0.00006	0.0002 0.00051	4.9 0.09

Table 5.7. Instrument record length. Instrument codes are: 337 = microcat CTD (P,T,C), 370 = Nortek Aquadopp current meter, 324 = ADCP 300 kHz.

Mooring	Instr. Code	Serial Number	Nominal Depth (m)	Median Press (dbar)	Start	End	Number of records	Comments
NOCM1	370	11067	51	44	2016/07/31	2018/06/16	33021	bio growth
	337	03218	57	58	2016/07/31	2018/06/16	16428	bio growth
	337	03481	295	297	2016/07/31	2018/06/16	16428	
	370	11064	530	533	2016/07/31	2018/06/16	33023	
	337	08077	536	541	2016/07/31	2018/06/16	16428	
	337	08082	771	783	2016/07/31	2018/06/16	16428	
	370	11063	1011	1022	2016/07/31	2018/06/16	33023	
	337	08443	1017	1032	2016/07/31	2018/06/16	16428	
	337	09373	1251	1267	2016/07/31	2018/06/16	16428	
	370	09853	1491	1516	2016/07/31	2018/06/16	33023	
	337	11321	1497	1519	2016/07/31	2018/06/16	16428	
	370	11034	1731	1760	2016/07/31	2018/06/16	33024	
	337	11323	1736	1764	2016/07/31	2018/06/16	16428	
	337	11324	1962	1991	2016/07/31	2018/06/16	16428	
	324	20962	1970	1993m	2016/07/31	2018/06/16	16446	28 x 4m bins,
NOCM2	337	11331	1500	1492	2016/07/31	2018/06/16	16435	
	337	11332	1715	1712	2016/07/31	2018/06/16	16435	
	370	08364	1926	1930	2016/07/31	2018/06/16	33026	
	337	11333	1931	1929	2016/07/31	2018/06/16	16435	
	337	13019	2145	2145	2016/07/31	2018/06/16	16435	
	337	13020	2354	2358	2016/07/31	2018/06/16	16435	
	324	20957	2362	2362m	2016/07/31	2018/06/16	16381	28 x 4m bins
NOCM3	337	13021	1500	1317	2016/08/16	2018/06/16	16059	
	337	13022	1790	1612	2016/08/16	2018/06/16	16059	
	370	09885	2075	1911	2016/08/16	2018/06/16	33026	bio growth
	337	08078	2081	1905	2016/08/16	2018/06/16	16059	
	337	08079	2369	2198	2016/08/16	2018/06/16	16059	
	337	08080	2654	2485	2016/08/16	2018/06/16	16059	
	324	20961	2662	2484m	2016/08/05	2018/06/16	16381	28 x 4m bins, Corrosion
NOCM4	370	11058	1493	1531	2016/08/05	2018/06/18	33033	
	337	08081	1499	1539	2016/08/05	2018/06/18	16367	
	337	09374	1839	1886	2016/08/05	2018/06/18	16367	
	370	09822	2174	2227	2016/08/05	2018/06/18	33033	
	337	10561	2180	2235	2016/08/05	2018/06/18	16367	
	337	11326	2518	2581	2016/08/05	2018/06/18	16367	
	337	11328	2853	2922	2016/08/05	2018/06/18	16367	
	324	20959	2861	2916m	2016/08/05	2018/06/18	13663	14 x 8m bins
NOCM5	337	11336	1498	1593	2016/08/05	2018/06/18	16363	
	337	11340	1859	1959	2016/08/05	2018/06/18	16363	
	337	09378	2200	2330	2016/08/05	2018/06/18	16363	
	370	09874	2214	2341	2016/08/05	2018/06/18	33023	
	337	10578	2578	2698	2016/08/05	2018/06/18	16363	
	337	10579	2933	3059	2016/08/05	2018/06/18	16363	
	324	20960	2940	3051m	2016/08/05	2018/06/18	13609	14 x 8m bins

5.3 Oxygen and Nutrient Sampling

(D. Atamanchuk, L. Kerrigan, C. Normandeau)

Oxygen

In order to calibrate the oxygen sensors of the CTD rosette, water samples have been collected and titrated onboard. The CERC.OCEAN group at Dalhousie, Halifax, Canada provided an automated

titration system for the analysis of water samples.

Samples were collected immediately after the CTD rosette was put on deck. A piece of Tygon tube was used to transfer the samples from Niskin bottles into vials. The sample vials were flushed with water 2-3 times their volume. Special care was taken to avoid bubbles in both the tube and the vials. Two reagents, MnCl_2 and NaOH/NaI , were added to the water sample. The vials were vigorously shaken for at least 1 min to ensure the reactions between water sample and reagents were completed. The samples were put in the fridge and analyzed within 2-6 hours after sampling. Blank reagents were run whenever a new batch of reagents was prepared. Average blank value was 0.003ml.

Standardization of titrant (0.04M $\text{Na}_2\text{S}_2\text{O}_3$) was done before each titration session. Several batches of standard (KIO_3) were prepared during the cruise: OSIL 0.01N, Titrisol 0.1N, Dal standard 0.015N. Through comparison with certified standards of OSIL and Titrisol, we have identified that Dal standard reads higher values than expected. This was attributed to the quality of KIO_3 salt used to prepare the standard. Thus, only OSIL and Titrisol were used for calibration of the titrant $\text{Na}_2\text{S}_2\text{O}_3$.

A total of 403 samples were processed, of which 50 were replicates. Precision of the system was 0.62 μM (0.50 μM excluding outliers).

The most common mistake during sampling was mismatching the sampling vials with the stoppers, which have unique numbers (volume error). 9 samples were discarded due to this mistake.

Duplicate samples were taken directly from the Niskin bottles in 15 ml falcon tubes, acid-washed before the start of the cruise. The falcon tubes and caps were rinsed 3x with water from the niskin and then filled to between 12 and 14 ml. No samples were frozen, or filtered, and they were run within 3 days of sampling, with most samples analyzed within 24 hours of sampling. Duplicates were only run if there was an issue with the initial sample (i.e. a high standard deviation, confidence interval >5%, or a concentration that seemed too high or low based on the profile). Any duplicates were also analyzed within 3 days.

Nutrients

Auto Analyzer System:

Analysis was done onboard in a containerized lab, set-up with a Skalar San Plus++ Continuous Flow Autoanalyzer to analyze water samples for phosphate, silicate, nitrite, nitrate+nitrite, and ammonium during this cruise. The system includes a 50-cup autosampler, which can be re-loaded during a run, a chemistry system, and an interface, which connects the autoanalyzer system to the computer. Reagents are added to the samples within the chemistry unit to allow for colorimetric detection by mixing, heating, and/or reducing the samples. The absorbance of the sample is then measured (or fluorometrically for the ammonium channel) as it passes through a flow cell at a given wavelength.

Reagents:

All reagents were made according to the protocol associated with the Dalhousie Skalar AutoAnalyzer. No issues were found with reagents during this cruise. All dry chemicals were pre-weighed in March/April and packed in acid-washed HDPE containers. To make the reagents, we re-used rinsed bottles marked to 1L, added chemicals and filled with Milli-Q.

Standard Methodology:

All five of the stock standards were made at Dalhousie University at the end of April and then packed with the container and sent to St. John's, Newfoundland to join the ship on May 24th. The stock standards were diluted into working standards approximately every week and then these working standards were used to make daily standards. We used our daily standards for 2 runs, or two subsequent days.

Nitrite, phosphate, nitrate+nitrate, and silicate standards were all made using a 35 psu solution, while the ammonium standards were made up in Milli-Q due to salt contamination and the fact that there is no salt effect. Since the baseline of the system is Milli-Q, in order to compensate for the salt effect, a blank of either salt-water or Milli-Q is run for each channel as standard 1 (see table 5.8).

Table 5.8 Overview about the standards used during the cruise

	Set #1		Set #2		Set #3
	TOxN	Silicate	NO ₂	Phosphate	Ammonium
Standard 1	35 psu Blank		35 psu Blank		0 psu Blank
Standard 2	0.5	0.5	0.1	0.1	1
Standard 3	1	1	0.2	0.2	2
Standard 4	2.5	2.5	0.3	0.4	3
Standard 5	5	5	0.6	0.8	4
Standard 6	10	10	1.2	1.6	5
Standard 7	20	20	1.8	2.4	10
Standard 8	30	30	2.4	3.2	
Standard 9	40	40	3.0	4.0	
Standard 10	50	50			

Samples Analyzed

486 samples plus 94 replicates were run between May 26th and June 20th onboard, with no samples brought back to shore. Each run included a standard curve for each channel and a Kanto CRM (CD) run at the beginning and end. An additional CRM (CJ) was run at the start of approximately half of the runs. No curves had to be altered to fit the CJ reference material as well as the CD, so even the runs that did not include CJ should have still fit this higher reference material (CRM values; Table 5.9)

Table 5.9: Kanto CRMs used on MSM74

	Silicate	Phosphate	NO ₂	NO ₃	Ammonium
	[umol/L]	[umol/L]	[umol/L]	[umol/L]	[umol/L]
CD	14.28	0.46	0.02	5.64	-
CJ	39.46	1.22	0.03	16.61	-

A run passes if the CRMs are within +/- 10% of the z-score. The CRMs passed in every run on the ship, however it should be noted that there is no defined CRM value for ammonium, and the value

for nitrite is below the detection limit (0.02 $\mu\text{mol/L}$) for the channel. The variability in the CRM (CD) results during this cruise can be seen in the following plots.

In addition, a drift sample was added after every four samples to perform a drift correction and a drift check (the drift run again as an unknown) was run every four samples, but between the drifts. This was done to ensure that any drift in the results was being correctly compensated within the data. For the majority of the runs, a standard curve was run at the start of each run. This was not the case for the runs on 20180527, 20180529, 20180610, 20180612 where a standard curve from a previous run was used; this was only done for runs analyzed on the same day (i.e. no reagent or Milli-Q change took place) when an issue with the system (i.e. communication error or other issue) resulted in a cancelled run, and the A1, or A2 run would use the calibration curve measured in A0. All of this is noted in the results.

Post processing and selection of data

Samples were run in triplicates (3 x ~4ml cups of sample) and the average, standard deviation, and confidence value was calculated for each sample. If the CV(%) was greater than 5, or the standard deviation was greater than 0.2 an outlier was removed if possible. If there was no clear outlier then the replicate of the sample would be analyzed during the next run (typically the following day). Sample results are either an average of 2 or 3 replicates.

5.4 Microbial Community, Protein, and Organic Micronutrient Sampling

(C. Willis)

Genomic, protein, and vitamin analyses was done in order to gather information on 1) community structure and function of microbial plankton and 2) whether and how organic and organometallic micronutrients influence primary productivity and microbial plankton community structure. Genomic samples will additionally be used to support research on nitrogen fixation carried out by Debany Fonseca P. Batista

DNA and Flow Cytometry Sampling

Microbial communities and their associated processes are the foundation of marine life. Of particular interest to our group is the marine nitrogen cycle, comprising complex microbially-driven reactions whereby atmospheric nitrogen is fixed into a biologically available form and cycled through the ecosystem. Though nitrogen is an essential element for life, the availability of fixed nitrogen can be a limiting factor for primary production and thus diazotrophs – organisms capable of biological nitrogen fixation – can be key to the productivity of an ecosystem. Samples were collected for genomic and fluorescence-based analyses of the microbial communities in the Labrador Sea. Community composition will be assessed via 16S (bacterial) & 18S (eukaryotic) tag sequencing, and the naturally-fluorescent population will be characterized via flow cytometry. The latter method can also be used to quantify the bacterial community via nucleic acid stain SYBR green. Community function will be assessed via metagenomic sequencing, and qPCR assays for selected functional genes. Further samples were taken for manipulation in the

lab, including targeted metagenomics and single cell isolation via fluorescence-associated cell sorting (FACS), and enrichment culturing of putative diazotrophs

Microbial Protein Sampling

Proteins are key to microbial activity: the type and amount of proteins present determines, in large part, the contributions microbes make to the ecosystems they occupy. Proteins can also be used as indices for nutritional status: elevated expression of specific proteins can be diagnostic for different nutritional states, such as nitrogen starvation, iron starvation, or vitamin starvation. Protein sequences also contain taxonomic information and can be used to assess contributions of different organisms to specific functions.

Samples were collected for targeted and untargeted mass spectrometry-based proteomic analyses of microbial communities in order to characterize their functional capacity and nutritional status as well as the role of organic micronutrients in structuring phytoplankton communities in the Labrador Sea.

Vitamin Sampling

To determine the particulate and dissolved concentrations of organic and organometallic micronutrients in the Labrador Sea. Organic and organometallic micronutrients are required by many phytoplankton groups and only produced by a select few microbes, setting up a series of interactive dependencies between microbial groups. The importance of these dependencies are not well known. Measuring the concentrations of these micronutrients in the particulate and dissolved phases is one step towards understanding the role of microbial interactions in driving primary productivity and phytoplankton community structure.

Sampling Methods

Genomic, protein, vitamin, and flow cytometry samples were taken together at 18 select CTD stations with a focus on surface and nutricline regions. Culture and influx samples were taken at a subset of these stations from either surface or chlorophyll max regions. At all stations 4 water depths were sampled except for 1) the K1 mooring (CTD 35), where 12 depths were sampled for genomics, vitamins, and flow cytometry and 4 depths for proteins and 2) 2 shallow stations where only 2 depths were sampled (CTDs 1 and 55). When possible, the standard 4 depths were selected as surface, chlorophyll max, below chlorophyll max and above thermocline, and just below thermocline.

DNA

Duplicate 4L water samples were collected from the CTD rosette. Water samples were sequentially filtered through 3 and 0.2µm polycarbonate filters by peristaltic pump until the water was depleted or the filters clogged. Filters were immediately frozen at -80°C.

Proteins

Targeted protein samples: 8L water samples were collected from the CTD rosette and sequentially filtered through 3 and 0.2µm polycarbonate filters by peristaltic pump until the water was depleted or the filters clogged. Filters were immediately frozen at -80°C.

4 x 8L water samples were also taken from the ship's underway system and filtered as above. These will be used for global, untargeted analyses.

Vitamins

1L water samples were collected from the CTD rosette. Samples were protected from light and gently vacuum filtered through 0.2µm nylon filters. Filters were immediately frozen at -80°C. At the K1 mooring the filtered water samples were frozen in amber HDPE bottles at -20°C.

Flow Cytometry

At each station and depth where genomic samples were collected, duplicate 2mL water samples were fixed with 2% paraformaldehyde (PFA) for 10 minutes at room temperature, then frozen at -80°C for later enumeration of bacteria and characterization of the naturally fluorescent microbial community via the Accuri C6 flow cytometer.

Influx:

At select stations, 45mL of 330µm-filtered water were mixed with 5mL of glyTE buffer and frozen at -80°C for later cell sorting on the BD Influx FACS instrument.

Enrichment Cultures:

At select stations, 650mL water samples were collected. These samples were spiked with phosphate (200nM) and iron (2nM) and secured in the incubation room to approximate natural light/dark cycles and ambient temperature until return to the lab.

5.5 Biological N₂ fixation and diazotrophs

(D. Fonseca)

Biological dinitrogen (N₂) fixation is recognized as the dominant source of new nitrogen to the global ocean (Codispoti, 2007; Gruber, 2008; Gruber & Sarmiento, 1997). Since N is the proximate limiting nutrient of primary production over large areas of the world's ocean (Tyrrell, 1999), N introduced by microbial N₂ fixation not only allows sustaining marine life, but also plays a crucial role in the net sequestration of atmospheric CO₂ into the deep ocean (Mahaffey et al., 2005). Small diazotrophs such as unicellular diazotrophic cyanobacteria (UCYN, classified in groups A, B and C) and non-cyanobacterial diazotrophs, mostly heterotrophic bacteria (e.g., α - and γ -proteobacteria), have lately been observed in a wide range of oceanic environments (Cabello et al., 2015; Krupke et al., 2014; Langlois et al., 2005, 2008). The very few published studies from northern latitudes indicate that shelf-influenced waters of temperate to polar regions harbor diazotrophic communities dominated by these small individuals (i.e. UCYN-A and proteobacteria), with similar or even larger N₂ fixation activity (up to 838 µmol m⁻² d⁻¹) (Blais et al., 2012; Mulholland et al., 2012; Rees et al., 2009; Shiozaki et al., 2015) than for tropical and subtropical regions. Recent assessments of the contribution of shelf systems to basin-wide or global oceanic N₂ fixation highlight their potential importance for the global marine N cycle (D.

Fonseca-Batista, 2017; Tang et al., under review). While there is some molecular marker evidence for the presence of diazotrophs in shelf areas and in high latitude regions (Luo et al., 2012), concurrent N_2 fixation observations are still too scarce and scattered to determine their biogeochemical importance.

The main objective is to investigate the distribution of N_2 fixation activity, the composition of the associated diazotroph community and the potential environmental drivers of such activity in shelf, shelf-influenced and open waters of the Labrador Sea and Irminger Sea, while these are undergoing vernal bloom to post-bloom conditions. The focus was in particular on assessing the possible impact on diazotrophic activity of nutrient-rich shelf waters and phytoplankton derived organic matter (dissolved and/or particulate) resulting from the ongoing to post spring bloom. This was achieved by combining hydrographic measurements (CTD, fluorescence, O_2 , nutrients) to water sampling mainly for the measurements of N_2 fixation activity through stable isotope incubation experiments ($^{15}N_2/H^{13}CO_3^-$ 24 h incubations), and for the detection of diazotrophic communities using biomolecular techniques targeting the N_2 -fixing enzyme (nitrogenase) and its specific genetic tracers (carried out by Ciara Willis).

Sampling for N_2 - HCO_3^- fixation rates measurements

Seawater was sampled using a Rosette sampler system equipped with 22 Niskin bottles (10l). Samples were taken at four depths in the surface waters (5 m, chlorophyll maximum, upper and lower thermocline) in order to collect the natural Particulate Organic Carbon and Particulate Nitrogen (POC and PN) and in parallel carry out the triplicate incubation experiments at each depth (Tabel 5.10).

A new stable isotope incubation method was used on board for N_2 fixation measurement (the “modified bubble-addition method; Klawonn et al., 2015). Triplicate samples (4.5 L Nalgene polycarbonate bottles), were taken at the four depths of interest, spiked added 1.7 mL of a 235 μM solution of 99% $H^{13}CO_3^-$ and injected with 10 mL of 98% $^{15}N_2$ gas to finally be incubated for 24 h in incubators placed in a cold room kept at surface temperature level ($\sim 3^\circ C$) which were equipped with artificial light sources and neutral density blue screens mimicking light attenuation profile (Fig. 5.4).



Figure. 5.4: Incubators setup in dark cold room

At the end of the incubation period, subsamples were taken for the assessment of the isotopic composition of dissolved inorganic substrates (N_2 and inorganic carbon, DIC) and dissolved organic nitrogen (DON). The remaining incubated seawater samples were filtered onto pre-combusted $0.3\ \mu\text{m}$ Advantec glass fiber filters for collecting the suspended cells and particles (post-incubation POC and PN). This will enable us to assess the importance of picoplankton N_2 fixation activity which has often been overseen (Bombar et al., 2018).

The natural isotopic composition of POC and PN was collected by directly filtering 1 to 4 L of seawater from the 4 depths of interest onto pre-combusted $0.3\ \mu\text{m}$ Advantec glass fiber filters. Processing of samples (for concentration and stable isotopic compositions) will be carried out using an Elemental Analyser-Isotope Ratio Mass Spectrometry (EA-IRMS) back at Dalhousie University, Halifax, Canada.

Table 5.10: Station list for the samples used in incubator

CTD No.	Depths	Date	Time	Natural Abundance	Dal ID #
11	5	May 27, 2018	20:30		D-000173
11	20	May 27, 2018	20:30		D-000168
11	70	May 27, 2018	20:30		D-000163
11	120	May 27, 2018	20:30		D-000160
20	10	May 30, 2018	4:30		D-000244
20	40	May 30, 2018	4:30		D-000238
20	70	May 30, 2018	4:30		D-000233
20	90	May 30, 2018	4:30		D-000228
28	10	June 1, 2018	5:05		D-000301
28	25	June 1, 2018	5:05		D-000295
28	50	June 1, 2018	5:05		D-000290
28	200	June 1, 2018	5:05		D-000285
42	10	June 6, 2018	12:00		D-000412
42	40	June 6, 2018	12:00		D-000409
42	80	June 6, 2018	12:00		D-000406
42	125	June 6, 2018	12:00		D-000403
51	5	June 8, 2018	10:00		D-000481
51	30	June 8, 2018	10:00		D-000476
51	60	June 8, 2018	10:00		D-000470
51	150	June 8, 2018	10:00		D-000465
66	5	June 10, 2018	5:55		D-000595
66	40	June 10, 2018	5:55		D-000589
66	60	June 10, 2018	5:55		D-000584
66	80	June 10, 2018	5:55		D-000579
78	5	June 12, 2018	6:20		D-000675
78	30	June 12, 2018	6:20		D-000669
78	50	June 12, 2018	6:20		D-000664
78	70	June 12, 2018	6:20		D-000659
93	5	June 15, 2018	14:35		D-000793
93	25	June 15, 2018	14:35		D-000788
93	50	June 15, 2018	14:35		D-000783
93	70	June 15, 2018	14:35		D-000778
109	5	June 17, 2018	21:00		D-000877
109	20	June 17, 2018	21:00		D-000871
109	60	June 17, 2018	21:00		D-000866
109	100	June 17, 2018	21:00		D-000861

5.6 Underwater Vision Profiler

(I. Leimar)

During MSM74 we performed particles and zooplankton imagery using an underwater vision profiler (UVP5). The UVP5 from Alfred-Wegener-Institute (AWI; group from Anya Waite) was mounted on the CTD. The UVP reports particle profiles.

The UVP5 is an instrument designed to take pictures of a slice of water lighted by 2 rows of flashing LEDs while profiling with CTD. A first image processing was performed on board after profiling. After the first image processing the results estimates the particles size distribution and stores vignettes of the particles found in the images (Figure 5.5 for a selection identified during MSM74).

The pixel size of the camera is approximately 150 μm , so that the particles detected by the UVP are ranging from 150 microns up to few centimeters. Among the 115 CTD casts, 113 UVP profiles have been acquired. We had usually only two types of problems: 1) failed removing Power Dummy (UVP did not start). 2) CTD failed UVP prepositioning (depth 22 m below the surface and wait there about 120 sec) and camera did not start.

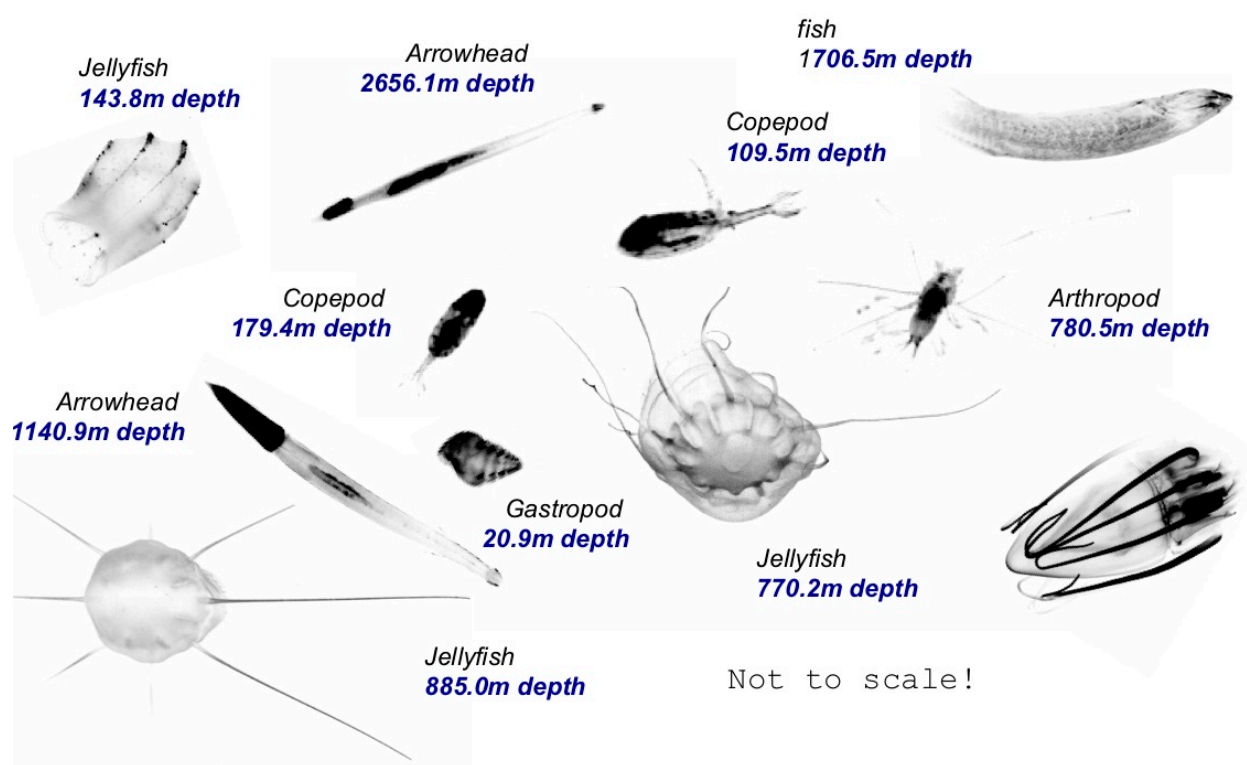


Figure 5.5 Selected images from UVP5 during MSM74 in the western subpolar North Atlantic

UVP Calibration Cast (Sampling by: D. Batista, Dalhousie)

At CTD 33 (at K1 mooring position) POC and PON samples were taken to calibrate the UVP. One “deep” and one “shallow” blank was taken (table 5.11).

Table 5.11 Calibration samples for UVP5

Sample ID	Depth (m)	Volume filtered (mL)	Types
D-000333	1000	8050	Regular samples
D-000347	500	8000	Regular samples
D-000348	200	8000	Regular samples
D-000349	130	4230	Regular samples
D-000350	90	4300	Regular samples
D-000351	70	3555	Regular samples
D-000352	30	2000	Regular samples
D-000353	10	1140	Regular samples
D-000333 deep	1000	7770	Blank
D-000351 shallow	70	2850	Blank

5.7 Argo float deployment

(M. Hundsdörfer, J. Karstensen)

On behalf of the Bundesamt für Seeschifffahrt und Hydrographie (BSH) and in collaboration with the Marine Chemistry group at GEOMAR (Arne Körtzinger, Tobias Steinhoff) we deployed 3 Teledyne Webb Research APEX profiling floats during MSM74 (Table 5.12). Floats were equipped with a pumped CTD, an oxygen optode, and a pH sensor. All floats performed a self-test while connected to a computer via serial adapter. Self-tests of the floats #8504 and #8505 were done on 23rd of May 2018, float #8506 was self-tested on 31st of May. All self-tests were successful and the log output was saved.

On June 1st float #8506 was deployed at the aft of the ship (after CTD cast #26) while the ship was steaming with 0.9kn. The exact position of the deployment was 53° 23.977' N, 050° 07.003' W. On the Argo Global Data Assembly Centre this float will carry the signature WMO 3901669. On 12th June 2019 Float #8505 was deployed at 58°37.511' N, 051°52.491' W at 7:48 UTC and float #8504 at 58°37.511' N, 051°52.491' W right after the other at 07:48 UTC at the aft of the ship. The ship was steaming with 0.9kn and 1.4kn. Float #8504 will have the WMO3901667 and float #8505 will have WMO3901668. First profiles of float #8506 were uploaded.

Table 5.12: Summary of float operations during MSM74

self-test			
Float#	date	time	WMO#
8504	23.05.18	13:06 UTC	3901667
8505	23.05.18	13:48 UTC	3901668
8506	31.05.18	22:29 UTC	3901669

started

Float#	date	time
8504	12.06.18	07:07 UTC
8505	12.06.18	07:15 UTC
8506	31.05.18	23:42 UTC

deployment

Float#	date	time	Latitude	Longitude	CTD#
8506	01.06.18	01:26 UTC	53°23.977' N	050° 07.003' W	26
8504	12.06.18	07:48 UTC	58°37.526' N	051°52.472' W	77
8505	12.06.18	07:49 UTC	58°37.511' N	051°52.491' W	77

5.8 Salinometer

(N. Fried, J. Ribbe)

On board we had two GEOMAR instruments, one newly delivered in February from Optimare and a Guildline Autosol salinometer (#8). The Autosol salinometer measures the electrical conductivity of a salinity sample in relation to a reference conductivity. From that ratio the salinity can be converted. The conductivity measurement range of the Autosol salinometer is between 2 and 42 and the accuracy is according to the manufacturer is better than ± 0.002 .

In the beginning of the cruise we had various problems with both instruments. The Optimare had problems keeping the temperature in both the pre and the main bath at a constant level and furthermore stirrer problems in the pre-bath. Both temperature sensors were broken and had to be recalibrated. We then started measuring but the instrument would drift to fresher salinities after a few samples. Although we cleaned the instrument with Triton and citric acid the drift problem could not be solved. Accordingly, we switched to the old Autosol salinometer where we first had to fix the lights and pump problems. We used the Autosol salinometer since the 03.06.2018.

We took salinity samples at 114 of 115 CTD stations. Furthermore we also sampled the Thermosalinograph approximately 1 to 3 times a day.

All samples were outgassed before measuring them meaning we placed the samples for 30 to 40 minutes into a warm (40°C/104°F) water bath. The samples were shaken after and shortly opened to release the air. Then the closed samples were left in the salinometer room for 24 hours to adjust to the room temperature.

The room temperature was held nearly constant during the whole cruise at 21°C. A first standardization of the instrument was performed on the 3rd of June using IAPSO standard sea water (batch: P159; K15: 0.99988) with a respective salinity of 34.9953 PSU. IAPSO standard and own substandard (taken at CTD#3, #36, #82) were regularly measured during the cruise.

5.9 Acoustic Doppler Current Profiler data

5.9.1 Lowered ADCP

(A. Bendinger)

LADCP measurements during MSM74 were obtained by attaching a downward- and an upward looking ADCP to the CTD rosette. The two ADCPs were run in a Master-Slave configuration with the downward-looking instrument being the Master and the upward-looking device being the Slave. Each device featured a pinging every 1.6 seconds. Overall there were 115 CTD casts.

Starting from cast #1 two Workhorse 300 kHz ADCPs, S/N #11461 (Master) and S/N #11468 (Slave), belonging to GEOMAR were installed. After cast #48 the Slave ADCP was exchanged with a Workhorse 600 kHz ADCP S/N #6468 which was originally planned to be deployed with the lander at 900m depth at the West Greenland shelf. However, it turned out that the 600 kHz ADCP had a too short profiling range in order to measure the velocity field above the sea floor which is why the 300 kHz was exchanged with the 600 kHz ADCP. Nonetheless, after cast # 61 the 600 kHz ADCP was replaced by a Workhorse 300 kHz ADCP S/N #22762 belonging to the University of Hamburg. The ADCP's power supply changed several times during the cruise. From cast #1 to #9 the ADCPs were powered by a rechargeable battery which in turn was connected to the ship's single-core cable via the DC-DC converter. After cast #9 the rechargeable battery power supply was replaced by a conventional battery power supply since a short circuit most likely stopped the power supply for the ADCP's rechargeable battery. As a consequence, the destroyed DC-DC converter was also responsible for the failing communication with the CTD. Leaking batteries at cast #12 then forced the power supply to be replaced by the battery power supply system S/N #3001 belonging to the University of Hamburg.

LADCP data was processed with the GEOMAR LADCP processing software beta-version V11, provided by Gerd Krahmann and including both shear and inversion methods to derive an absolute velocity profile. The software also extracts and considers CTD profiles to correct for sound speed variations within the water column and to locate the LADCP in the vertical axis. In addition, navigational data from the CTD is automatically extracted. Some irregularities and problems that occurred during MSM74 are summarized in table 5.13.

Table 5.13: Summary of LADCP issues encountered during MSM74

CTD cast #	Comments
003	Data from Master was not transferred
009	Abort due to CTD communication failure near the bottom
010	LADCP power supply exchanged from rechargeable battery (DC-DC converter) to conventional battery
012	Leaking batteries, cast stopped at 1100m due to CTD communication failure
013	No LADCP data
014	Short profile due to low batteries
014	New LADCP power supply S/N #3001
049	New Slave installed S/N #6468
062	New Slave installed S/N #22762
093	No LADCP

054-056	No LADCP
066	No LADCP
078	No LADCP
093	No LADCP
115	Abort due to outage at 200m depth

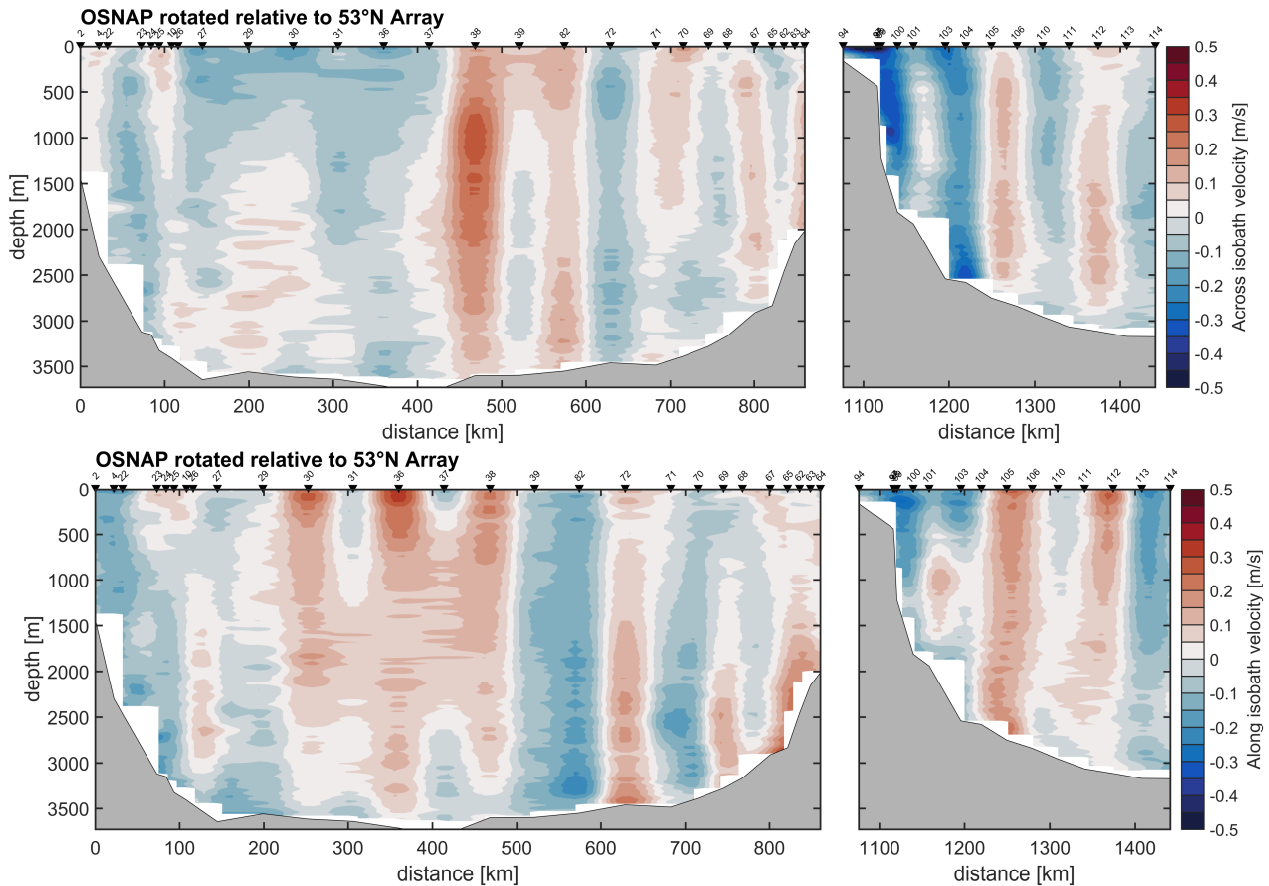


Figure 5.6: LADCP currents section along West and (partly) East OSNAP

5.9.2 Ship mounted ADCP

(A. Barboni)

Two ship mounted ADCP, Ocean Surveyor 38 kHz, installed in the midships shaft, and 75 kHz, installed in the ship's hull mount, were used during MSM74. Because of noise and ship velocity contamination, the depth range were 150 to 1000m for OS38 and 40 to 500m for OS75. Both instruments started measuring at 2018/05/25 19:30, shortly after leaving St. Johns and stopped at 2018/06/21 12:37 (UTC) 250nm distance from Reykjavik (Table 5.14).

Due to an initial continuation of MSM73 numbers, file patterns are OS38MSM74050_000 for the entire cruise on OS38, and OS75MSM74050_000 on OS75 but only from the beginning until 2018/05/27 - i.e. only the Labrador shelf - continuing with pattern msm74os75000_000.

Until 2018/05/27 we used an old configuration files from cruise MSM73. From then (shortly after the start of Labrador shelf section #1) we used the new ini files for MSM74. OS38 was always on narrow band mode (ini_OS38NBMSM74.ini configuration) providing 50 depths bins of 32m, even in older configuration. For the 75 kHz, only the broad band was used (ini_OS75BBMSM74.ini), providing 100 bins of 8m. Nevertheless, in the old configuration before 2018/05/27, both narrow and broad band were used with the 75kHz on the shelf, the first providing 100 depth bins of 8m (files (OS75MSM74)052 and 053), the latter 124 depth bins of 4m (files 050 and 051). Time pinging setting was always as fast as possible on both sADCP. The broad band gives a better accuracy but penetrates less deep, the opposite for the narrow band.

Table 5.14: stops has to be reported, in chronological order :

Day	Hour Stop	Hour restart	Comments
2018/06/08		10:07	Lander deployment
2018/06/17	22:33	22:33	OS38 had to be restarted. Receiving of navigation data perturbed since earlier the same day 01:00
2018/06/19	02:43	11:55	Power outage. Intermediary files msm75os75016_ & OS38MSM74065_ ran from 03:44 until 11:55 but navigation data was received only after 08:11

Navigation data

Beam and navigation data were collected on ADCP Pcs using the VmDas software, integrated and merged in singel .ENX files. The primary source of navigation data was the Kongsberg Seapath 200 GPS, which has an accuracy of 0.7-1.5 m for position, 0.075° for true heading and 0.03° for both pitch and roll. As a backup, positional data from a Trimble SPS461 DGPS was also collected.

Processing

Velocities data were also first monitored onboard using the WinADCP software to look at the short time average data (.STA). A backup of all data was daily made on the ship server, and processing was daily done using Matlab ossi2018 toolbox developped by GEOMAR, Kiel, main correspondent Tim Fischer. Routine used onboard were only **osdatasip.m** and **osrefine.m**, which gave misalignment angles of 0.4354° for OS38 and 0.8178° for OS75. Respective amplitude factors found were 0.997654 and 0.998483.

On 75kHz data appeared some diagonal features around 300-500m deep and vertical ones around 200m deep, which were supposed to be interferences between both instruments. They are almost removed selecting data higher than 70% good. The 3 shallowest bins have also always to be removed as they are contaminated by the ship velocity (upper 40m on OS75, 150m for OS38)

5.10 Underway data

(N. von Oppeln-Bronikowski)

On Maria S. Merian underway sea surface water properties are measured through the “Rein See Wasser System” (RSWS). The RSWS contains two separate measurement units, which alternate on 12 hour cycles, taking water from about 6m below the design water line to measure Temperature, Salinity, Chlorophyll and Turbidity. When one device is switched on, the other device is flushed with water to prevent biofouling, however the RSWS system provides also a merged continuous record from both units, as well as data from the individual sensors. Temperature is measured externally on the ship hull using a Sea Bird Electronics (SBE) Sensor 45. Conductivity, Chlorophyll and Turbidity are sampled internally inside the pumped RSWS container units. Salinity is calculated from internal conductivity cell and internal temperature sensor.

Access to all underway data in up to 1 millisecond resolution is provided through the DAVIS SHIP (DSHIP) intranet server portal (<http://dship1:8080/dship-extraction/>). The RSWS system worked almost continuously starting on the 25.05.2018 at 21:00, except after a power failure between 11.06.2018 6:00 and 12.06.2018 24:00. Consequently, data from this period is not available.

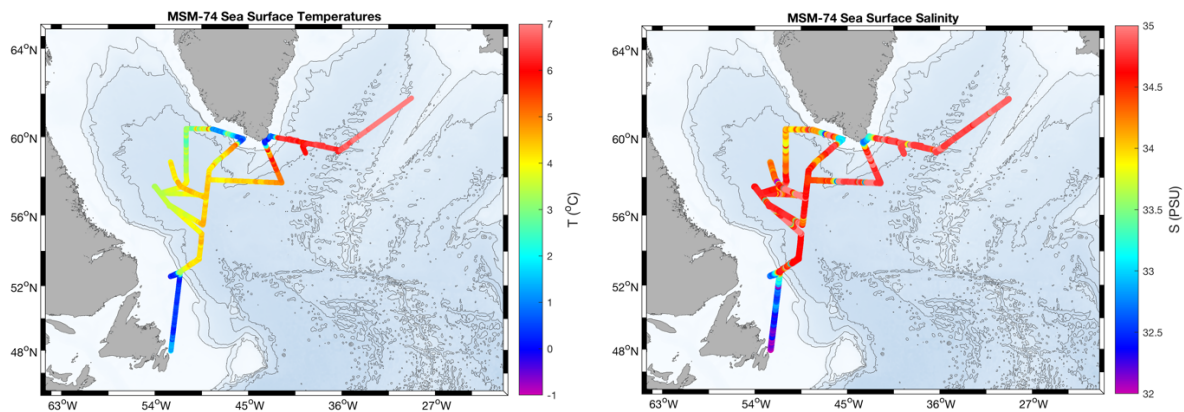


Figure 5.7: Underway Surface Temperature (left) and Salinity (right).

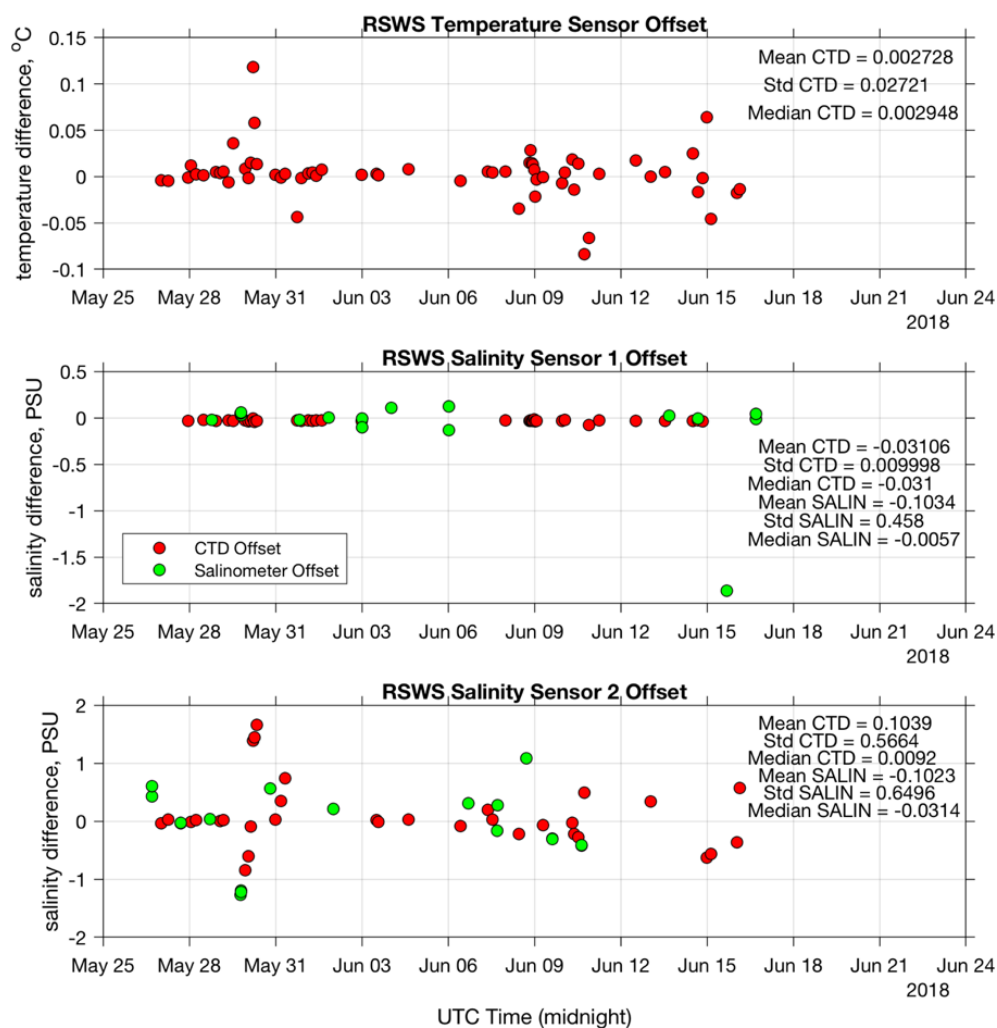
Processing the data revealed large discrepancy between salinities measured in RSWS units 1 and 2. Salinity Sensor 2 showed a lot of spikes. To process and quality control the underway RSWS data, only stable flow rates around 9 and 10 L/min of the RSWS pumping system were used in further analysis. To aid verification of the RSWS performance and calibration, bottle samples were collected and analyzed with the Salinometer. Furthermore, the data was also compared with calibrated CTD data of respective stations. Only CTD data from 6 m below surface was used for comparison with the RSWS data at the respective time interval. A mean offset, standard deviation and median values were estimated for both sensors and the combined temperature sensor record (Table 5.15, 5.16; Figure 5.8). We find that the Salinometer samples gave comparable offsets for both salinity sensors, but the CTD casts gave very different results, even though the same method for calculating the offset was used. Therefore the Salinometer analysis seems more appropriate for bias corrections of the data.

Table 5.15: Summary of Bias Corrections for the RSWs Salinity data determined by comparison with CTD and Salinometer Samples

	RSWS Salinity Sensor 1			RSWS Salinity Sensor 2		
	Mean	Std.	Median	Mean	Std.	Median
CTD CASTS	-0.0311	0.0099	-0.0310	0.1039	0.5664	0.0092
SAMPLES	-0.1034	0.4582	-0.0082	-0.1023	0.6496	-0.0314

Table 5.16: Summary of Bias Corrections for the RSWs Temperature data determined by comparison with CTD Data

	RSWS Temperature Sensor Combined		
	Mean	Std.	Median
CTD CASTS	0.0028	0.027	0.0029

**Figure 5.8:** Underway RSWs temperature and salinity data during the MSM Cruise 74, compared with calibrated CTD cast data and Salinometer samples.

Weather Station Data

On the Maria S. Merian top deck mast and navigation deck mast various sensors record air temperature, humidity, wind speed, precipitation and radiation for the entire cruise (Figure 5.9-5.11). In table 5.3 we summarize the main weather station sensors and their approximate height above the water surface. The heights are estimated based on class survey plans using a ruler and hence the location is not exact, but estimated accurate to ± 1 meter. The weather station data was accessed similarly as for the RSWS data through the DSHIP portal. To aid visualization of the raw weather data, a moving average filter of 60 minutes was applied to the one-minute resolution data set.

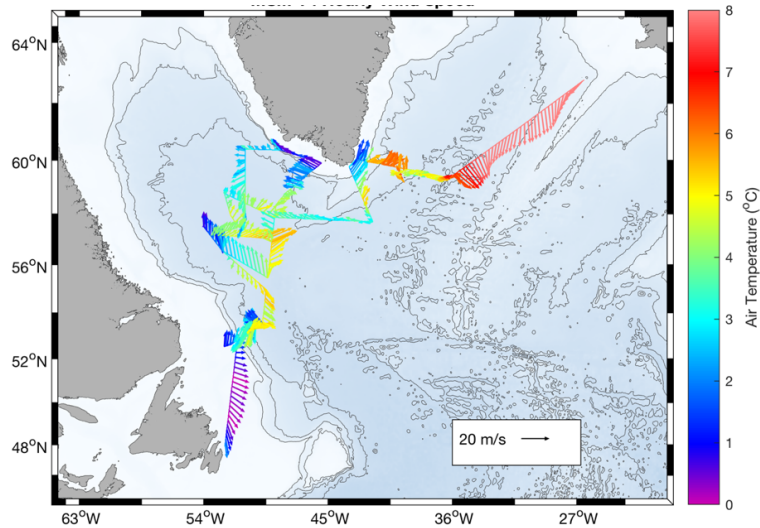


Figure 5.9: Wind vectors (color air temperature) during MSM74

The data reveal air temperatures followed the general ocean surface temperatures (Fig. 5.9), with cooler average air temperatures recorded on the Labrador and Greenland shelves and warmer temperatures in the interior Labrador Sea and Irminger Sea. The mean air temperature for the cruise was 3.84 °C. Wind record show moderate wind conditions with only two days with wind speeds reaching 1 hour sustained speeds of 20 m/s (8 Bft). Average wind speed for the cruise was 10.05 m/s (5 Bft).

Table 5.3: Summary of Weather Station Sensor and Location (Height) from Sea Surface.

Sensor Name	Approx. Height from Sea Surface (m)
Humidity Sensor	16
Wind Speed	29
Air Temperature	29
Solar and IR Radiation	16
Precipitation	16
Barometer	16

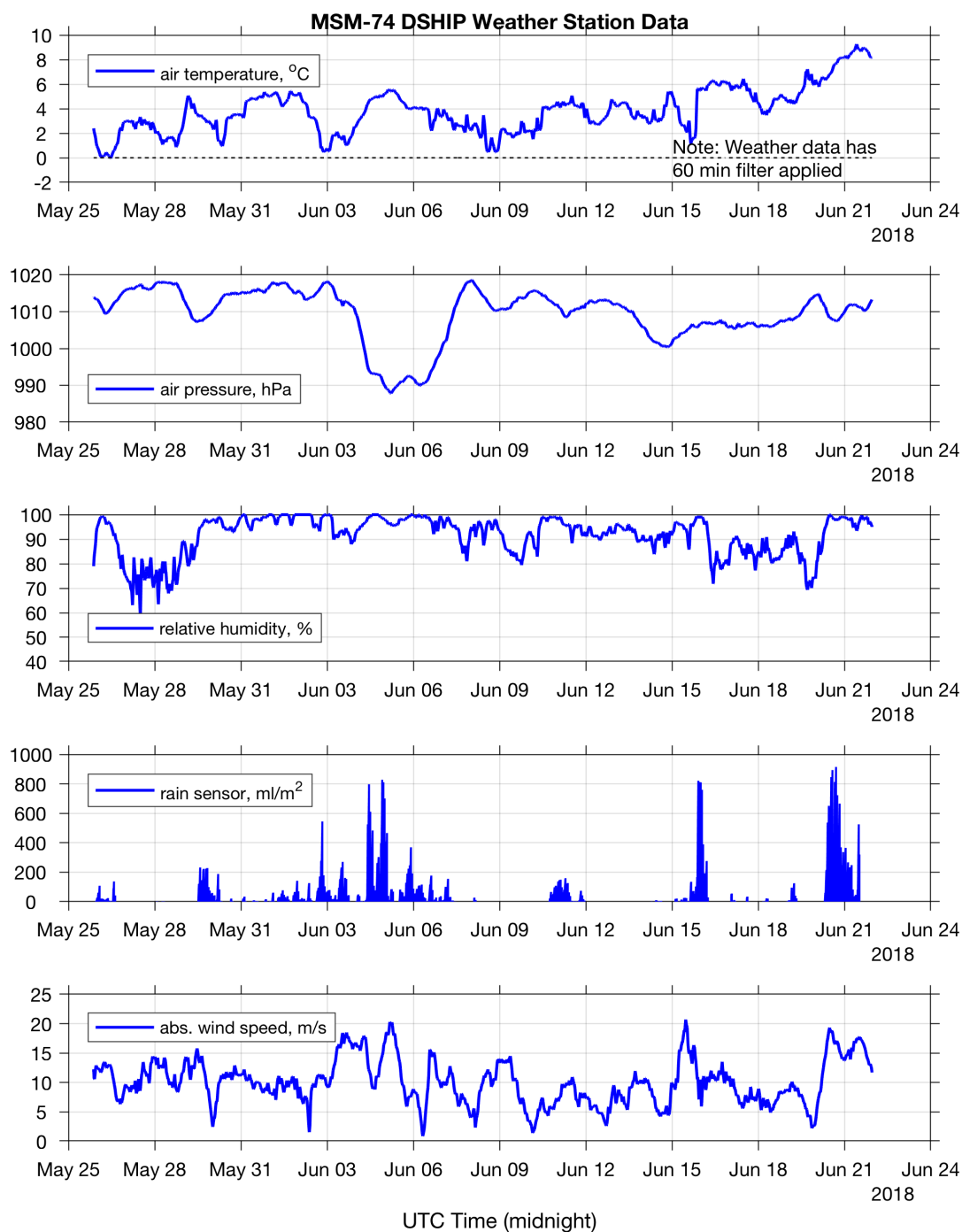


Figure 5.11: Weather Data from Maria S. Merian Cruise MSM 74. Note 1 min resolution data was smoothed with 60 minute moving averaged filter.

6 Station List RV MARIA S. MERIAN MSM74

Gear coding: CTD: CTD/lowered Acoustic Doppler Current Profiler/UVP and rosette sampler; MOOR: Mooring operation (Moor code: XXXRe – recovery; XXXDe – deployment; with XXX internal code); TSG: Thermosalinograph, EM122: Echosounder, ADCP: Acoustic Doppler Current Profiler

Station No.	Date	Time	Gear e	Latitude	Longitude	Water Depth	Remarks
MSM74_1-1	25/05/18	18:57:09	CTD	47° 32.799' N	052° 35.198' W	182.7	CTD# 1
MSM74_0-4	25/05/18	19:22:21	TSG	47° 27.966' N	051° 23.208' W	127.1	Start
MSM74_0-3	25/05/18	19:22:21	ADCP	47° 35.534' N	052° 34.080' W	180.4	Start
MSM74_0-2	25/05/18	20:15:40	EM122	47° 46.912' N	052° 29.883' W	170.5	Start
MSM74_2-1	26/05/18	21:48:00	MOOR	52° 50.354' N	051° 31.585' W	1445.4	Start
MSM74_3-1	26/05/18	22:47:02	CTD	52° 50.414' N	051° 32.892' W	1388.8	CTD# 2
MSM74_4-1	27/05/18	01:26:23	CTD	52° 52.742' N	051° 22.941' W	2009.8	CTD# 3
MSM74_5-1	27/05/18	03:57:19	CTD	52° 56.528' N	051° 16.005' W	2317.0	CTD# 4
MSM74_6-1	27/05/18	06:59:35	CTD	52° 59.208' N	051° 08.300' W	2418.9	CTD# 5
MSM74_7-1	27/05/18	10:05:22	MOOR	53° 02.185' N	051° 02.902' W	2635.6	DSOW1 Re
MSM74_8-1	27/05/18	13:41:21	MOOR	53° 08.731' N	050° 50.345' W	2882.9	K9 Re
MSM74_9-1	27/05/18	17:37:36	MOOR	53° 16.379' N	050° 34.760' W	3152.7	DSOW2 Re
MSM74_10-1	27/05/18	22:17:12	MOOR	53° 24.282' N	050° 15.401' W	nan	K10 Re
MSM74_11-1	27/05/18	23:03:03	CTD	53° 23.243' N	050° 15.242' W	3363.3	CTD# 6
MSM74_11-2	28/05/18	02:10:17	CTD	53° 23.245' N	050° 15.238' W	3363.6	CTD# 7
MSM74_12-1	28/05/18	06:28:22	CTD	53° 24.016' N	050° 07.030' W	3475.6	CTD# 8
MSM74_13-1	28/05/18	10:48:02	MOOR	53° 35.553' N	049° 47.314' W	3604.6	DSOW5/ Re
MSM74_14-1	28/05/18	12:53:05	CTD	53° 32.489' N	049° 45.176' W	3587.6	CTD# 9
MSM74_15-1	28/05/18	15:28:59	MOOR	53° 35.579' N	049° 47.010' W	3598.7	DSOW5 De
MSM74_16-1	28/05/18	20:37:26	MOOR	53° 23.133' N	050° 16.054' W	3366.8	K10 De
MSM74_17-1	28/05/18	23:03:33	CTD	53° 24.129' N	050° 14.069' W	3398.9	CTD# 10
MSM74_18-1	29/05/18	02:46:06	CTD	53° 17.878' N	050° 22.358' W	3307.7	CTD# 11
MSM74_19-1	29/05/18	05:44:54	CTD	53° 15.008' N	050° 29.271' W	3205.2	CTD# 12
MSM74_20-1	29/05/18	09:44:52	CTD	53° 07.451' N	050° 47.726' W	3011.2	CTD# 13
MSM74_21-1	29/05/18	13:30:48	CTD	53° 02.830' N	051° 00.146' W	2719.2	CTD# 14
MSM74_22-1	29/05/18	18:23:37	MOOR	52° 56.372' N	051° 17.987' W	2247.8	K8 Re
MSM74_23-1	29/05/18	20:24:48	CTD	52° 53.217' N	051° 23.475' W	1974.3	CTD# 15
MSM74_23-2	29/05/18	23:25:30	CTD	52° 53.219' N	051° 23.477' W	1976.2	CTD# 16
MSM74_24-1	30/05/18	01:49:11	CTD	52° 47.845' N	051° 36.730' W	1008.5	CTD# 17
MSM74_25-1	30/05/18	03:25:39	CTD	52° 45.447' N	051° 42.450' W	505.3	CTD# 18
MSM74_26-1	30/05/18	05:29:12	CTD	52° 37.091' N	052° 03.366' W	295.1	CTD# 19
MSM74_26-2	30/05/18	06:32:29	CTD	52° 37.090' N	052° 03.364' W	295.3	CTD# 20
MSM74_27-1	30/05/18	08:37:28	CTD	52° 32.552' N	052° 30.759' W	248.7	CTD# 21
MSM74_28-1	30/05/18	14:34:43	MOOR	52° 50.573' N	051° 32.817' W	1403.4	K7 De

MSM74_29-1	30/05/18	17:59:16	MOOR	52° 57.653' N	051° 18.572' W	2227.2	K8 De
MSM74_30-1	30/05/18	20:24:54	MOOR	53° 02.968' N	051° 04.703' W	2617.0	DSOW1 De
MSM74_31-1	31/05/18	00:42:00	CTD	52° 59.355' N	051° 08.170' W	2420.8	CTD# 22
MSM74_32-1	31/05/18	04:26:45	CTD	53° 11.690' N	050° 37.629' W	3147.1	CTD# 23
MSM74_33-1	31/05/18	08:49:52	CTD	53° 15.010' N	050° 29.382' W	3444.8	CTD# 24
MSM74_34-1	31/05/18	14:20:08	MOOR	53° 08.580' N	050° 52.376' W	2901.5	K9 De
MSM74_35-1	31/05/18	16:52:24	MOOR	53° 15.402' N	050° 33.092' W	3154.5	DSOW2 De
MSM74_36-1	31/05/18	18:58:09	CTD	53° 17.850' N	050° 22.393' W	3302.0	CTD# 25
MSM74_37-1	31/05/18	22:34:20	CTD	53° 23.993' N	050° 07.038' W	3473.1	CTD# 26
MSM74_37-2	01/06/18	01:26:12	FLOAT	53° 23.977' N	050° 07.003' W	3465.6	Fl8506 De
MSM74_38-1	01/06/18	04:13:27	CTD	53° 32.522' N	049° 45.173' W	3827.9	CTD# 27
MSM74_38-2	01/06/18	06:47:13	CTD	53° 32.522' N	049° 45.173' W	3588.5	CTD# 28
MSM74_39-1	01/06/18	10:59:23	CTD	54° 01.373' N	049° 39.318' W	3645.6	CTD# 29
MSM74_40-1	01/06/18	15:42:45	CTD	54° 30.209' N	049° 33.436' W	3854.8	CTD# 30
MSM74_41-1	01/06/18	21:08:12	MOOR	54° 58.862' N	049° 28.966' W	0.0	SS01 Re
MSM74_41-2	01/06/18	22:37:41	CTD	54° 58.863' N	049° 28.969' W	3639.4	CTD# 31
MSM74_42-1	02/06/18	14:29:09	MOOR	56° 34.728' N	052° 41.152' W	3482.0	K1 Re
MSM74_43-1	02/06/18	23:02:25	MOOR	57° 31.130' N	054° 01.835' W	3356.4	SS02 Re
MSM74_44-1	03/06/18	00:57:19	CTD	57° 30.395' N	053° 59.986' W	3364.1	CTD# 32
MSM74_45-1	03/06/18	10:03:00	CTD	56° 33.693' N	052° 39.442' W	3728.3	CTD# 33
MSM74_45-2	03/06/18	12:22:41	CTD	56° 33.691' N	052° 39.442' W	3483.2	CTD# 34
MSM74_45-3	03/06/18	14:56:35	CTD	56° 33.689' N	052° 39.445' W	3493.7	CTD# 35
MSM74_46-1	03/06/18	21:36:10	MOOR	56° 34.168' N	052° 39.622' W	3489.9	K1 De
MSM74_47-1	04/06/18	10:46:00	CTD	55° 27.846' N	049° 21.999' W	3670.8	CTD# 36
MSM74_48-1	04/06/18	15:55:45	CTD	55° 56.683' N	049° 15.779' W	3957.4	CTD# 37
MSM74_49-1	04/06/18	21:41:26	CTD	56° 25.986' N	049° 09.695' W	3940.8	CTD# 38
MSM74_50-1	05/06/18	03:48:58	CTD	56° 54.417' N	049° 03.947' W	3623.7	CTD# 39
MSM74_51-1	06/06/18	05:51:36	CTD	57° 26.998' N	051° 41.955' W	3531.6	CTD# 40
MSM74_52-1	06/06/18	11:32:36	CTD	57° 45.602' N	050° 58.591' W	3578.1	CTD# 41
MSM74_52-2	06/06/18	13:48:28	CTD	57° 46.106' N	050° 56.463' W	3830.2	CTD# 42
MSM74_53-1	06/06/18	17:42:25	CTD	58° 07.408' N	050° 59.828' W	-	CTD# 43
MSM74_54-1	06/06/18	23:13:25	CTD	58° 36.029' N	050° 59.995' W	3528.1	CTD# 44
MSM74_55-1	07/06/18	05:00:47	CTD	59° 11.999' N	051° 00.138' W	3477.3	CTD# 45
MSM74_56-1	07/06/18	09:59:30	CTD	59° 40.315' N	050° 59.976' W	3422.5	CTD# 46
MSM74_57-1	07/06/18	14:10:10	CTD	60° 00.004' N	050° 59.975' W	3306.1	CTD# 47
MSM74_58-1	07/06/18	18:48:43	CTD	60° 24.013' N	051° 00.012' W	3160.0	CTD# 48
MSM74_59-1	08/06/18	00:38:28	CTD	60° 22.867' N	049° 30.044' W	2910.3	CTD# 49
MSM74_60-1	08/06/18	05:06:34	CTD	60° 22.096' N	048° 27.183' W	1020.0	CTD# 50
MSM74_61-1	08/06/18	06:13:36	EM122	60° 21.481' N	048° 26.712' W	1688.3	survey
MSM74_61-1	08/06/18	08:00:24	EM122	60° 22.246' N	048° 26.939' W	1008.9	survey
MSM74_61-2	08/06/18	09:34:58	LANDER	60° 22.276' N	048° 27.099' W	947.4	Lander De
MSM74_61-3	08/06/18	11:31:58	CTD	60° 22.262' N	048° 27.001' W	999.3	CTD# 51
MSM74_62-1	08/06/18	19:53:57	CTD	59° 54.250' N	045° 27.997' W	136.2	CTD# 52

MSM74_63-1	08/06/18	20:52:55	CTD	59° 51.878' N	045° 33.434' W	118.6	CTD# 53
MSM74_64-1	08/06/18	21:55:07	CTD	59° 48.305' N	045° 41.822' W	136.6	CTD# 54
MSM74_65-1	08/06/18	22:49:40	CTD	59° 44.841' N	045° 50.162' W	151.9	CTD# 55
MSM74_66-1	08/06/18	23:54:45	CTD	59° 40.866' N	045° 59.658' W	191.3	CTD# 56
MSM74_67-1	09/06/18	00:58:06	CTD	59° 38.145' N	046° 06.845' W	597.3	CTD# 57
MSM74_68-1	09/06/18	02:01:26	CTD	59° 36.404' N	046° 11.824' W	893.4	CTD# 58
MSM74_69-1	09/06/18	03:26:35	CTD	59° 34.078' N	046° 18.083' W	1326.5	CTD# 59
MSM74_70-1	09/06/18	05:24:52	CTD	59° 32.203' N	046° 23.335' W	1810.9	CTD# 60
MSM74_71-1	09/06/18	07:39:47	CTD	59° 30.093' N	046° 27.407' W	2183.4	CTD# 61
MSM74_72-1	09/06/18	12:11:00	MOOR	59° 12.949' N	047° 05.549' W	3169.8	DSOW4 Re
MSM74_73-1	09/06/18	13:44:14	MOOR	59° 12.943' N	047° 05.079' W	2935.2	DSOW4 De
MSM74_74-1	09/06/18	16:44:34	MOOR	59° 00.259' N	047° 33.968' W	3111.3	DSOW3 Re
MSM74_75-1	09/06/18	17:45:02	MOOR	59° 00.448' N	047° 33.995' W	3104.3	DSOW3 De
MSM74_76-1	09/06/18	21:13:07	CTD	59° 18.448' N	046° 52.012' W	2457.2	CTD# 62
MSM74_77-1	09/06/18	23:43:30	CTD	59° 22.748' N	046° 41.394' W	2136.1	CTD# 63
MSM74_78-1	10/06/18	01:47:01	CTD	59° 26.997' N	046° 32.058' W	2016.6	CTD# 64
MSM74_79-1	10/06/18	05:34:59	CTD	59° 13.535' N	047° 03.517' W	2920.7	CTD# 65
MSM74_79-2	10/06/18	07:38:19	CTD	59° 13.535' N	047° 03.518' W	2925.2	CTD# 66
MSM74_80-1	10/06/18	10:04:33	CTD	59° 06.390' N	047° 20.164' W	2932.9	CTD# 67
MSM74_81-1	10/06/18	13:32:44	CTD	58° 54.908' N	047° 46.307' W	3151.3	CTD# 68
MSM74_82-1	10/06/18	17:02:40	MOOR	58° 43.965' N	048° 09.905' W	3348.9	DSOW6 De
MSM74_83-1	10/06/18	18:41:30	CTD	58° 46.935' N	048° 04.058' W	3304.7	CTD# 69
MSM74_84-1	10/06/18	22:27:16	CTD	58° 34.491' N	048° 25.312' W	3479.8	CTD# 70
MSM74_85-1	11/06/18	02:16:14	CTD	58° 20.866' N	048° 46.253' W	3721.6	CTD# 71
MSM74_86-1	11/06/18	07:01:42	CTD	57° 52.023' N	048° 52.139' W	3483.2	CTD# 72
MSM74_87-1	11/06/18	12:57:27	CTD	58° 11.005' N	050° 05.558' W	3552.7	CTD# 73
MSM74_88-1	11/06/18	16:52:21	CTD	58° 17.858' N	050° 32.578' W	3538.8	CTD# 74
MSM74_89-1	11/06/18	21:11:53	CTD	58° 24.328' N	050° 59.179' W	3526.1	CTD# 75
MSM74_90-1	12/06/18	00:50:56	CTD	58° 30.457' N	051° 25.765' W	3525.3	CTD# 76
MSM74_91-1	12/06/18	04:38:02	CTD	58° 37.492' N	051° 52.524' W	3474.0	CTD# 77
MSM74_91-2	12/06/18	07:07:46	CTD	58° 37.492' N	051° 52.526' W	3482.1	CTD# 78
MSM74_91-3	12/06/18	07:48:08	FLOAT	58° 37.511' N	051° 52.491' W	0.0	Fl8505 De
MSM74_91-4	12/06/18	07:48:59	FLOAT	58° 37.526' N	051° 52.472' W	3484.3	Fl8506 De
MSM74_92-1	12/06/18	10:46:56	CTD	58° 46.843' N	052° 29.999' W	3471.5	CTD#
MSM74_92-2	12/06/18	13:17:27	CTD	58° 46.844' N	052° 30.001' W	3469.9	CTD# 80
MSM74_92-2	12/06/18	16:48:49	CTD	58° 46.843' N	052° 29.998' W	3468.6	CTD# 80
MSM74_93-1	13/06/18	01:53:51	CTD	57° 29.856' N	051° 30.131' W	3507.2	CTD# 81
MSM74_94-1	13/06/18	14:06:51	CTD	57° 22.897' N	048° 58.635' W	3571.1	CTD# 82
MSM74_95-1	14/06/18	13:05:40	CTD	57° 42.056' N	041° 45.470' W	3299.0	CTD# 83
MSM74_96-1	14/06/18	17:21:03	CTD	58° 00.003' N	042° 00.043' W	3172.4	CTD# 84
MSM74_97-1	14/06/18	21:07:43	CTD	58° 18.896' N	042° 15.672' W	2916.3	CTD# 85
MSM74_98-1	15/06/18	00:42:22	CTD	58° 37.752' N	042° 31.263' W	2452.3	CTD# 86
MSM74_99-1	15/06/18	03:59:48	CTD	58° 56.888' N	042° 47.286' W	1911.0	CTD# 87

MSM74_100-1	15/06/18	07:11:26	CTD	59° 15.601' N	043° 02.760' W	1499.6	CTD# 88
MSM74_101-1	15/06/18	08:50:34	CTD	59° 20.277' N	043° 06.892' W	984.8	CTD# 89
MSM74_102-1	15/06/18	10:43:42	CTD	59° 29.116' N	043° 14.305' W	455.2	CTD# 90
MSM74_103-1	15/06/18	12:12:27	CTD	59° 37.278' N	043° 21.006' W	171.1	CTD# 91
MSM74_104-1	15/06/18	13:37:33	CTD	59° 46.024' N	043° 28.176' W	153.4	CTD# 92
MSM74_105-1	15/06/18	14:18:21	CTD	59° 46.024' N	043° 28.178' W	152.7	CTD# 93
MSM74_106-1	15/06/18	17:18:13	CTD	60° 03.087' N	042° 52.355' W	167.8	CTD# 94
MSM74_107-1	15/06/18	18:22:52	CTD	60° 00.373' N	042° 39.860' W	195.1	CTD# 95
MSM74_108-1	15/06/18	19:45:52	CTD	59° 58.622' N	042° 22.484' W	196.6	CTD# 96
MSM74_109-1	15/06/18	20:53:52	CTD	59° 57.334' N	042° 10.229' W	482.2	CTD# 97
MSM74_110-1	15/06/18	22:00:38	CTD	59° 57.047' N	042° 08.746' W	880.1	CTD# 98
MSM74_111-1	15/06/18	23:18:37	CTD	59° 56.814' N	042° 05.876' W	1428.7	CTD# 99
MSM74_112-1	16/06/18	01:34:07	CTD	59° 54.948' N	041° 45.343' W	1807.5	CTD# 100
MSM74_113-1	16/06/18	04:04:00	CTD	59° 53.192' N	041° 25.569' W	1896.9	CTD# 101
MSM74_114-1	16/06/18	08:07:39	MOOR	59° 54.481' N	041° 06.255' W	2090.3	M1 Re
MSM74_115-1	16/06/18	10:50:29	MOOR	59° 50.811' N	040° 41.130' W	2454.4	M2 Re
MSM74_116-1	16/06/18	13:27:09	MOOR	59° 48.986' N	040° 17.089' W	2546.8	M2 Re
MSM74_117-1	16/06/18	15:44:05	CTD	59° 51.238' N	041° 05.917' W	2092.1	CTD prblm
MSM74_117-2	16/06/18	16:41:03	CTD	59° 51.237' N	041° 05.916' W	2088.1	CTD# 102
MSM74_118-1	16/06/18	19:20:44	CTD	59° 49.324' N	040° 46.376' W	2554.1	CTD# 103
MSM74_119-1	16/06/18	22:17:22	CTD	59° 46.884' N	040° 21.099' W	2568.0	CTD# 104
MSM74_120-1	17/06/18	01:35:13	CTD	59° 43.844' N	039° 49.767' W	2724.5	CTD# 105
MSM74_121-1	17/06/18	04:53:21	CTD	59° 40.794' N	039° 18.262' W	2839.8	CTD# 106
MSM74_122-1	17/06/18	10:21:45	MOOR	59° 32.821' N	039° 47.549' W	2881.3	CIS Re
MSM74_123-1	17/06/18	14:11:33	MOOR	59° 12.613' N	039° 29.778' W	3011.1	LOCO Re
MSM74_123-2	17/06/18	15:23:50	CTD	59° 12.585' N	039° 29.727' W	2988.7	CTD# 107
MSM74_124-1	17/06/18	19:14:01	CTD	59° 31.812' N	039° 46.936' W	2901.6	CTD# 108
MSM74_124-2	17/06/18	20:50:57	CTD	59° 31.813' N	039° 46.935' W	2902.0	CTD# 109
MSM74_125-1	18/06/18	00:40:08	CTD	59° 37.753' N	038° 46.935' W	2947.3	CTD# 110
MSM74_126-1	18/06/18	04:35:47	CTD	59° 34.253' N	038° 13.741' W	3049.5	CTD# 111
MSM74_127-1	18/06/18	08:15:36	CTD	59° 30.512' N	037° 39.058' W	3113.8	CTD# 112
MSM74_128-1	18/06/18	11:44:15	MOOR	59° 35.047' N	037° 48.631' W	3121.5	M5 Re
MSM74_129-1	18/06/18	15:09:22	MOOR	59° 38.775' N	038° 33.485' W	2979.4	M4 Re
MSM74_130-1	18/06/18	20:12:35	CTD	59° 26.756' N	037° 04.377' W	3122.5	CTD# 113
MSM74_131-1	19/06/18	00:17:09	CTD	59° 23.033' N	036° 29.822' W	3097.7	CTD# 114
MSM74_132-1	19/06/18	02:32:59	CTD	59° 20.558' N	036° 06.179' W	3322.5	CTD# 115

7 Data and Sample Storage and Availability

(GEOMAR Data management: datamanagement@geomar.de)

In Kiel a joint Datamanagement-Team is active, which stores the data in a web based multiuser-system. In a first phase the data are only available to the user groups (e.g. OSNAP via OSNAP website). Latest after a three year proprietary time these data will be made public by distributing them to national and international data archives through the GEOMAR data management team, i.e. the data will be submitted to PANGAEA. When the data sets will be archived in the PANGAEA Open Access library digital object identifiers (DOIs) will be assigned. A kml link can be found at <https://portal.geomar.de/metadata/leg/kmlexport/337574>.

Type	Available (internal GEOMAR)	Free Access (PANGAEA)	Contact
CTD O ₂ data	11/2018	08/2021	jkarstensen@geomar.de
vmADCP data	11/2018	08/2021	jkarstensen@geomar.de
Physics Mooring data GEOMAR	03/2019	08/2021	jkarstensen@geomar.de
lADCP data	11/2018	08/2021	jkarstensen@geomar.de
TSG data	11/2018	08/2021	jkarstensen@geomar.de
Underway data	11/2018	08/2021	jkarstensen@geomar.de
Multibeam data	published	https://doi.org/10.1594/PANGAEA.898612 -	jkarstensen@geomar.de awoelfl@geomar.de
UVP data	11/2018	Pangaea	anya.waite@awi.de
oxygen data	11/2018	Canada data server	Douglas.Wallace@dal.ca
NOC mooring data	BODC	BODC	penny.holliday@noc.ac.uk

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10 Appendix**10.1. Configuration of recovered GEOMAR moorings****KPO_ 1157/ K7, Labrador Sea****Deployment**

Date: 18.05.2016 Time: 20:49-22:32 Cruise: MSM 54

Mooring PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Expected position: Latitude: 52°51.418 Longitude: 51°18.606**Water depth:** 1403 m**Recovery**

Date: 26.05.2018 Time: 19:27-21:48 Cruise: MSM 74

PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Instrument			Calibration (CTD cast #, date)		
Depth nom.	Type Sensors	& S/N	Pre- deployment	Post- deployment	Remarks
49 m	Argos	2263			
51 m	MCP	3504		CTD64, 26.05.	Full record; no negative temperatures recorded
51 m	VR2W	106582			From Dalhousie
100 m	MC	2263	CTD09	CTD22, 31.05.	Full record
209	MCP	3061		CTD64	Full record
401 m	LR-ADCP, FL45''	3580			Full record, 8-hr time offset
413 m	MC	2799	CTD09	CTD27, 21.05.	Full record
597 m	RCM-8	10818			Full record
608 m	RBR-O2	52634			From Dalhousie
609 m	MCP	3062		CTD64, 26.05.	Full record
898 m	RCM-8	5002			Full record
909 m	MC	2934	CTD10	CTD74	Full record
1099 m	RCM-8	5569			7-week interruption in speed
1109 m	RBR O2	52629			
1110 m	MCP	6854	CTD10	CTD25, 20.05.	Full record
1354 m	RCM-8	10504			Full record
1374 m	MCP	6855	CTD10	CTD25	Full record, slight drift
1387 m	AR 861 RT 661	1256 107			

KPO_ 1158/ K8, Labrador Sea**Deployment**

Date: 18.05.2016

Time: 16:34-19:05

Cruise: MSM 54

Mooring PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Expected position:

Latitude: 52°57.339

Longitude: 51°18.606

Water depth:

2201 m

Recovery

Date: 29.05.2018

Time: 16:10-18:23

Cruise: MSM 74

PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Instrument			Calibration (CTD cast #, date)		
Depth nom.	Type & Sensors	S/N	Pre-deployment	Post-deployment	Remarks
48 m	Argos	5510			
50 m	MCP	3415	CTD09	CTD32	Full record
51 m	VR2W	106584			
100 m	MC	2254	CTD09	CTD35	Full record
100 m	AquadopDW	P26209-15		CTD43	Full record
209 m	AquadopDW	P26209-35		CTD44	Full record
608 m	RBR O2	52631			
608m	MC	962	CTD09	CTD32	Full record
609 m	AquadopDW	P26209-26		CTD44	Full record
999 m	RCM-8	9311			Full record
1500 m	Argonaut	D304			Full record
1511 m	MCP	6858	CTD10	CTD32	Full record
1701 m	MC	1520	CTD09	CTD32	Full record
1801 m	RBR O2	52630			
1801 m	MC	2809	CTD09	CTD35	Full record
1901 m	AquadopDW	P26209-10		CTD32	Full record
2175 m	MCP	2264	CTD10	CTD35	Full record
2176 m	Argonaut	D294			Full record
2188 m	AR 861 AR 661	1549 52			

KPO_ 1159/ DSOW1, Labrador Sea**Deployment**

Date: 17.05.2016

Time: 11:07-13:15

Cruise: MSM 54

Mooring PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Expected position:

Latitude: 53°02.796

Longitude: 51°04.804

Water depth:

2599 m

Recovery

Date: 27.05.2018

Time: 08:25-10:05

Cruise: MSM 74

PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Instrument			Calibration (CTD cast #, date)		
Depth nom.	Type & Sensors	S/N	Pre- deployment	Post- deployment	Remarks
1610 m	Argos	15172			
1612 m	MCP	2484		CTD32	Full record, offset in pressure
1762 m	MC	957	CTD08	CTD22	Full record, many spikes
1912 m	MC	1320	CTD08	CTD22	Full record, many spikes
2522 m	MC	2279	CTD08	CTD22	Full record
2523 m	AquadopDW	P26209/14		CTD14	Full record
2668 m	RCM-8	10502			Full record
2689 m	MCP	2265	CTD08	CTD74	Full record
2701 m	AR RT 661	32			

KPO_1160/ K9, Labrador Sea**Deployment**

Date: 17.05.2016 Time: 15:27-19:16 Cruise: MSM 54

Mooring PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Expected position: Latitude: 53°08.221 Longitude: 50°52.253**Water depth:** 2901 m**Recovery**

Date: 27.05.2018 Time: 11:16-13:41 Cruise: MSM 74

PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Instrument			Calibration (CTD cast #, date)		
Depth nom.	Type & Sensors	S/N	Pre- deployment	Post- deployment	Remarks
131 m	Argos	22662			
134 m	MCP	3752	CTD08	CTD32	Full record
134 m	VR2W	100925			
244 m	AquadoppDW	26209-25		CTD14	Full record
635 m	RCM-8	8412			Full record
646 m	RBR O2	52628			
647 m	MCP	3753	CTD09	CTD32	Full record
1037 m	RCM-8	10660			Full record
1547 m	MC	952	CTD08	CTD22	Full record, many spikes
1548 m	AquadoppDW	26209-4		CTD16	Full record
1788 m	MC	53	CTD08	CTD14	Full record
1888 m	MC	278	CTD08	CTD14	Full record
1888 m	RBR O2	52633			
1988 m	MCP	6859	CTD08	CTD?	Full record
2038 m	Argonaut	184			Beam error
2438 m	RCM-8	9816			Full record
2449 m	MCP	10693	CTD?		Full record
2738 m	MC	1599	CTD08	CTD14	Partial record (>7 month break)
2732 m	AquadoppDW	26209-8		CTD16	Full record
2855 m	Argonaut	D329			Beam error
2875 m	RBR O2	52633			
2876 m	MCP	10695	CTD08	CTD22	Full record
2887 m	AR 861 RT 661	1548 173			

KPO_1161/ DSOW2, Labrador Sea**Deployment**

Date: 20.05.2016

Time: 17:00-20:12

Cruise: MSM 54

Mooring PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Expected position:

Latitude: 53°15.399

Longitude: 50°33.267

Water depth:

3162 m

Recovery

Date: 27.05.2018

Time: 15:09-17:37

Cruise: MSM 74

PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Instrument			Calibration (CTD cast #, date)		
Depth nom.	Type Sensors	& S/N	Pre- deployment	Post- deployment	Remarks
94 m	Argos	12264			
104 m	MCP	2713	CTD10	CTD32	Full record, errors in C-T
105 m	VR2W	110169			
150 m	McLane MMP	12255			Did not record
2698 m	RCM-8	9930			3-week interruption in speed
2709 m	MCP	10661	CTD10	CTD22	Full record
2950 m	RCM-8	10076			Full record
2961 m	MC	936	CTD17		No data due to incorrect programming
3103 m	RCM-8	10558			4-week interruption in speed
3124 m	MCP	10660	CTD10	CTD22	Full record
3136 m	AR 861	271			
3136 m	AR 661	235			

KPO_1162/ K10, Labrador Sea**Deployment**

Date: 20.05.2016 Time: 10:48-13:59 Cruise: MSM 54

Mooring PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Expected position: Latitude: 53°23.245 Longitude: 50°15.285**Water depth:** 3212 m**Recovery**

Date: 27.05.2018 Time: 19:03-22:17 Cruise: MSM 74

PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Instrument			Calibration (CTD cast #, date)		
Depth nom.	Type Sensors	& S/N	Pre- deployment	Post- deployment	Remarks
156 m	Argos	11307			
158 m	MCP	2712	CTD09	CTD22	Full record, some errors (at the end?)
159 m	VR2W	106588			
269 m	MC	3196	CTD08	CTD14	Full record
269 m	AquadopDW	P26209-32		CTD43	Full record
459 m	MC	1942	CTD08	CTD14	Full record
667 m	RBR O2	52626			
668 m	MC	1317	CTD17	CTD22	Full record, some errors
668 m	AquadopDW	P26209-23		CTD14	Full record
1066 m	MCP	10690	CTD17	CTD47	Full record, corrupt date
1312 m	MCP	10704	CTD25	CTD14	Full record
1566 m	MC	945	CTD09	CTD32	Full record, large drift, maybe errors
1566 m	AquadopDW	P24543-2		CTD14	Full record
1956 m	RBR O2	52635			
1956 m	MCP	10633	CTD25	CTD14	Full record, some errors
2065 m	MC	7417	CTD10	CTD22	Full record
2065 m	AquadopDW	P26209-5		CTD16	Full record
2463 m	MCP	10700	CTD25	CTD14	Full record
2862 m	MCP	10691	CTD25	CTD14	Full record
2863 m	AquadopDW	P26209-22		CTD14	Full record
3152 m	MCP	10634	CTD25	CTD14	Full record
3335 m	MCP	10703	CTD25	CTD14	Full record
3336 m	AquadopDW	P26209-31		CTD14	Full record
3347 m	AR661 AR661	838 189			

KPO_1163/ DSOW5, Labrador Sea**Deployment**

Date: 19.05.2016

Time: 17:07-18:17

Cruise: MSM 54

Mooring PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Expected position:

Latitude: 53°35.522

Longitude: 49°46.905

Water depth:

3605 m

Recovery

Date: 28.05.2018

Time: 09:17-10:48

Cruise: MSM 74

PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Instrument			Calibration (CTD cast #, date)		
Depth nom.	Type & Sensors	S/N	Pre-deployment	Post-deployment	Remarks
3114 m	Argos	15173			
3151 m	Argonaut	D145			Beam error
3161 m	MCP	10637	CTD17	CTD14	Full record
3559 m	RCM-8	11618			Full record
3580 m	MCP	10708	CTD17	CTD47	Full record, corrupt date
3592 m	AR RT 661	37			

KPO_1164/ DSOW3, Labrador Sea**Deployment**

Date: 29.05.2016 Time: 15:57-17:02 Cruise: MSM 54

Mooring PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Expected position: Latitude: 59°00.43 Longitude: 47°33.87**Water depth:** 3100 m**Recovery**

Date: 09.06.2018 Time: 15:40-16:44 Cruise: MSM 74

PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Instrument			Calibration (CTD cast #, date)		
Depth nom.	Type & Sensors	S/N	Pre-deployment	Post-deployment	Remarks
2530 m	XEOS Sable	300034013902340			
2576 m	MCP	10654	CTD38	CTD74	Full record, drift in pressure
2577 m	AquadoppDW	26209-11		CTD62	Full record
3081 m	MCP	10655	CTD38	CTD74	Full record
3082 m	AquadoppDW	26209-29		CTD68	Full record
3093 m	AR RT 661	34			

KPO_1165/ DSOW4, Labrador Sea**Deployment**

Date: 29.05.2016 Time: 11:45-12:48 Cruise: MSM 54

Mooring PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Expected position: Latitude: 59°12.93 Longitude: 47°04.91**Water depth:** 2942 m**Recovery**

Date: 09.06.2018 Time: 10:49-12:11 Cruise: MSM 74

PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Instrument			Calibration (CTD cast #, date)		
Depth nom.	Type & Sensors	S/N	Pre-deployment	Post-deployment	Remarks
2366 m	Argos	12620			
2412 m	MCP	10658	CTD38	CTD74	Full record
2413 m	AquadoppDW	26209-30		CTD62	Full record
2917 m	MCP	10659	CTD38	CTD74	Full record
2918 m	AquadoppDW	26209-37		CTD68	Full record
2929 m	AR RT 661	41			

KPO_1167 / CIS, Irminger Sea**Deployment**

Date: 30.05.2016 Time: 18:14-21:16 Cruise: MSM 54

Mooring PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Expected position: Latitude: 59°31.826 Longitude: 39°46.982**Water depth:** 2904 m**Recovery**

Date: 17.06.2018 Time: 07:41-10:21 Cruise: MSM 74

PI on-board: J. Karstensen, GEOMAR, Kiel, Germany

Instrument			Calibration (CTD cast #, date)		
Depth nom.	Type & Sensors	S/N	Pre- deployment	Post- deployment	Remarks
-140 m	MC-IM	940	CTD38		Lost
-125 m	MCP-IM	10707	CTD26		Lost
60 m	MCP-SM	10699	CTD27	CTD113	Full record
60 m	FLNTU	1616			
60 m	O2-Log	945			
60 m	VR2W	106613			
81 m	MC-SM	2614	CTD27	CTD113	Full record, some errors
114 m	WH-ADCP	2379			Full record
114 m	IMEI	300043013 004340			
192 m	MCP-SM	10636	CTD26	CTD113	Full record
272 m	MCP-IM	10651	CTD38	CTD113	Full record
352 m	MCP-IM	10656	CTD38	CTD113	Full record
432 m	MCP-SM	10692	CTD68	CTD113	Full record
513 m	MCP-IM	10638	CTD38	CTD113	Full record
593 m	MC-SM	1316	CTD38	CTD113	Many spikes
704 m	MCP-SM-ODO	9511	CTD22		Full record
834 m	MCP-IM	10639	CTD38	CTD113	Full record
870 m	MC-IM	1720	CTD82		Full record
965 m	Aquadopp DW	26209-09			Full record
1216 m	MC-SM	1323	CTD26	CTD113	Many spikes
1466 m	MCP-SM	10706	CTD25	CTD113	Full record
2860 m	Argonaut	188			Beam error
2880 m	MCP-SM	10697	CDT68	CTD113	Full record
3466 m	AR861 AR861	095 1649			