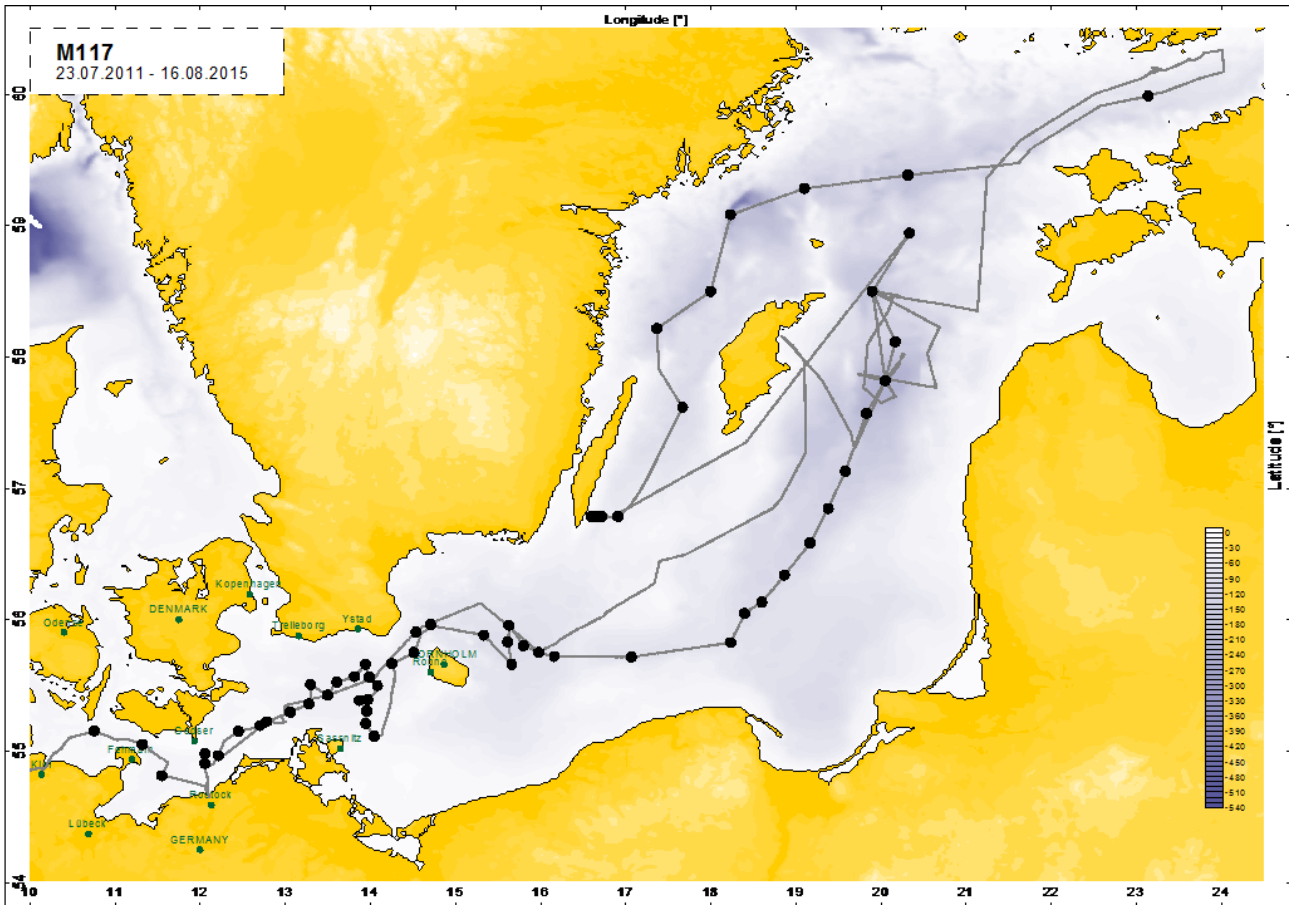
Oliver Wurl
Institute for Chemistry and Biology of the Marine Environment
Carl von Ossietzky University Oldenburg
Emsstrasse 20
26382 Wilhelmshaven

Tel.: +49 (0)4421 778 5811
Fax: +49 (0)4421-944-140
email: oliver.wurl@uni-oldenburg.de

Short Cruise Report
Meteor M117

Hamburg - Rostock
23 July – 17 August 2015
Chief Scientist: Oliver Wurl
Captain: Michael Schneider



Objectives

The overall objective of cruise M117 was to investigate biochemical processes in upwelling zones. Upwelled water is characterized by remineralized nutrients, CO_2-saturation, cold temperature and enhanced primary productivity. Although upwelling systems are typical features of coastlines of the world oceans and also the Baltic Sea, some processes in those zones remain poorly understood. During M117, different working groups [WP] investigated biochemical processes in upwelling systems and their horizontal (seaward) gradients. Biochemical processes included the interaction of upwelled cold water and nutrients with the development of cyanobacteria blooms [WP1], which will support better forecast and management of those harmful blooms. Another objective was to understand the impact of upwelling systems on air-sea CO_2 fluxes with the transport of CO_2-rich deep water to the surface, and the antagonistic effect of increased primary productivity. Particularly, we investigated the formation of the sea-surface microlayer within upwelling zones and their impact on air-sea CO_2 exchange [WP2] and aerosol composition [WP3]. The WP4 investigated the formation of organic mercury compounds in anoxic deep water, including consequences of their upward transport on the air-sea exchange. The WP5 investigated the role of amino acids in energy turnover within zooplankton communities, in particular for lipid-poor conditions as encountered during cyanobacteria blooms. Finally, WP6 completed the HELCOM and IOW long-term monitoring, which also provided supplementary data to the other WPs.

Narrative

R/V METEOR departed from the shipyard Norderwerft in Hamburg on 23 July 2015 at 9:00 and transited through the North Sea-Baltic Sea Canal. During the first transect of the cruise M117, the HELCOM and IOW monitoring stations within the Baltic Proper were sampled by the WP6 on chemical (oxygen, nutrients) and biological properties (phytoplankton, zooplankton). R/V Meteor arrived at the first station on 24 July at 00:00. For a transfer of personnel, R/V Meteor went into the port of Rostock on 24 July at 18:00, and continued the journey one hour later. Despite technical problems with the main CTD and bad weather, the stations planned for the first week could be sampled within the time frame. The monitoring data from western Baltic Sea to the northerly Gotland Basin confirm the salt water introduction detected in March 2015. This intrusion of saline water from the North Sea was forced by storm events in December 2014 (Fig. 1). With the introduction of saline water from the North Sea, a significant increase in oxygen in the Gotland Basin was also be observed. Oxygen in the deep water of the Baltic Sea has been very low since 2005, and measurements during M117 show that the water column in the Gotland Basin is no longer anoxic. Further north, at the Farö Deep, hydrogen sulfide is still present below the halocline, e.g. the intrusion of the saline water masses has not yet reached this area. At station ME 117/603 (29-31 July), the Gotland Deep, we tested a newly developed field instruments to measure biochemical properties of the sea surface and air-sea CO_2 exchange rates, namely a remote controlled catamaran and a drifting buoy (Fig. 2). After solving the technical problems arising from the first deployment, both instruments were ready for further deployments at the upcoming stations in upwelling systems. Potential areas with upwelling systems had been monitored for the previous days via satellite images on sea surface temperature. The images were provided by Herbert Siegel (IOW) and Andreas Raeke, the meteorologist on board. In the evening of 31 July, we departed to a potential upwelling area offshore the southern tip of Oland. In the early morning of the 1 August, we observed a drop in the sea surface temperature from 16 °C to 8°C during a 12 nm transect towards the coastline of Oland. We were within a distinct upwelling system with a rarely seen temperature difference of 8 °C. Over the next four days, we completed our research program at four stations located at different temperature regimes, e.g. approximately 8.7°C, 11.7°C, 14.0°C and 15.9°C. We started each station with several CTDs and water sampling for oxygen, nutrients (WP6), cyanobacteria (WP1) and mercury species (WP4). WP6 and WP4 analyzed samples onboard. WP1 conducted incubation experiments to investigate structural and functional reactions of cyanobacteria

communities on different phosphate concentrations (Fig. 3). Afterward, the catamaran was deployed for 4-6 hours to characterize the sea surface on various chemical and biological properties (WP2). Properties included pH, oxygen, chromophoric dissolved organic matter (CDOM), UV absorption, fluorescence spectra, chlorophyll-a and photosynthetic efficiency. A total of 24 discrete water samples were collected during each deployment of the catamaran. Simultaneous deployment of the drifting buoy (Fig. 2), measuring CO_2 gas exchange rates, allowed investigating the effects of the sea surface on gas exchange processes. Manual sampling of the sea surface was conducted for samples prone to be contaminated by the catamaran, namely microbiological samples for DNA/RNA fingerprints (WP2) and organic matter characterization on a molecular level (WP3). The team from TROPOS also ran aerosol sampling devices (Fig. 4) for continuous sampling with a 24h interval. A direct comparison of organic matter composition from seawater and aerosols should verify that the sea surface is an important source of marine aerosols. After recovery of the catamaran and buoy, WP5 conducted net sampling for zooplankton. Zooplankton communities were fed with different mixed communities of cyanobacteria to investigate effects on the zooplankton's amino acid pool and, therefore, energy turnovers. At last, the WP4 sampled contamination-free water for the analysis of mercury species with a pumpCTD developed at IOW (Fig. 5). On 5 August, we steamed to the Gulf of Finland as satellite images indicated another upwelling system along the southern coast of Finland, although weaker than the one offshore Oland. For the following two days, we defined two stations to conduct the same sampling program as we did offshore Oland. However, we were not able to find colder layers of surface water. Satellite images confirmed that the earlier observed upwelling system had weakened. We decided on 9 August to cancel work in the Gulf of Finland and to use the remaining time to re-visit the Gotland Basin with intense cyanobacteria blooms (Fig. 6). From 10 to 12 August we conducted our usual sampling program at station ME 117/623 and ME 117/629. Cyanobacteria blooms were present on the sea surface, and the catamaran and drifting buoy was used to investigate their effects on the gas exchange (Fig. 7). Also, further stations of the monitoring program were sampled in the Gotland Basin to obtain additional data on the saline water intrusion. On 13 August, we canceled planned deployments of catamaran and buoy due to wind forces of up to 7. On 14 August at 00:00, the ScanFish was deployed (Fig. 8). The Scanfish is a towed CTD profiling the water column. The high-resolution data provided detailed information on the saline water intrusion. The R/V Meteor returned to the port of Rostock in the evening of the 16 August.

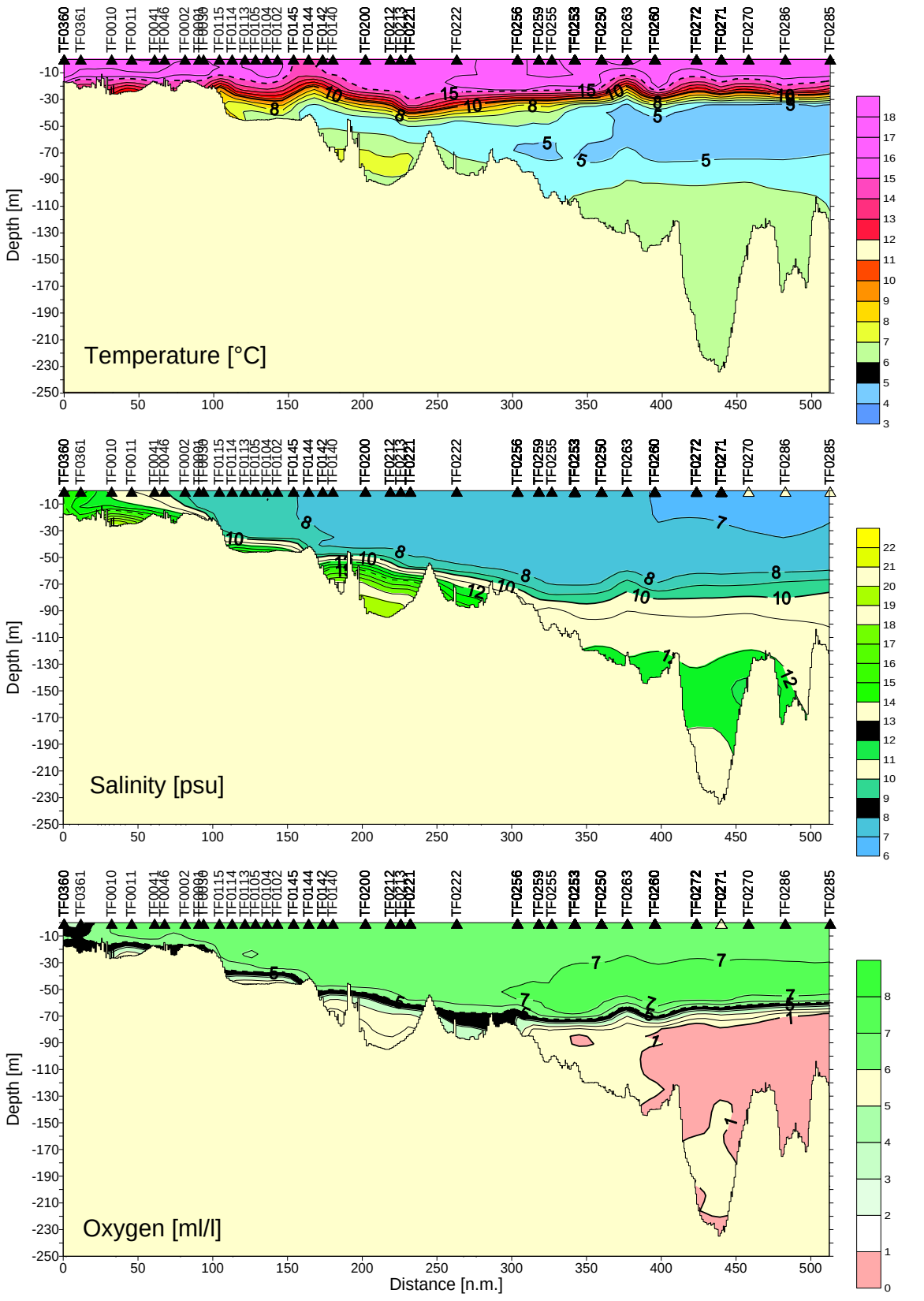


Figure 1: Temperature, salinity, and oxygen distribution along a transect from the Kieler Bright to the northerly Gotland Basin.

Figure 2: Simultaneous deployment of the catamaran and drifting buoy.

Figure 3: Incubation experiments on phosphate availability for cyanobacteria

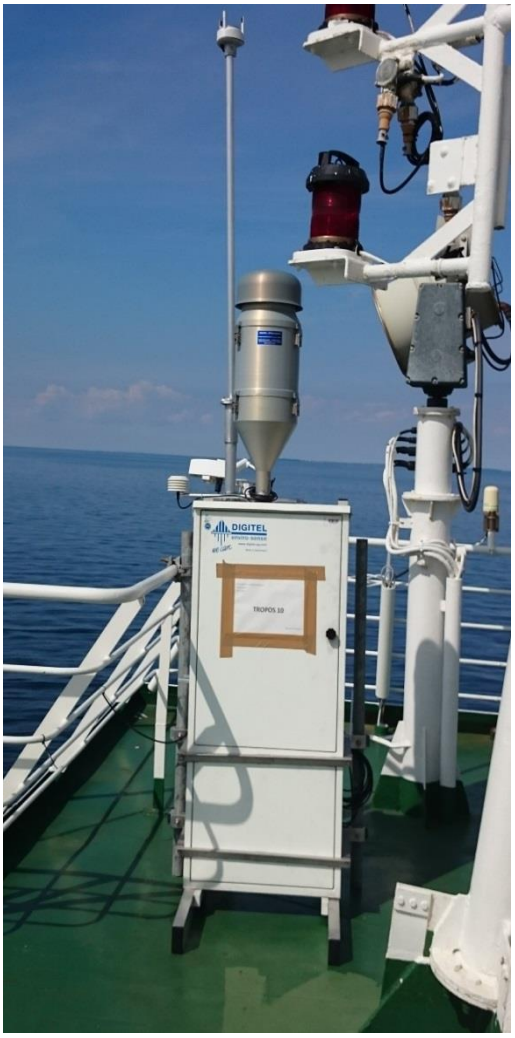


Figure 4: Aerosol sampling on the upper deck of the R/V Meteor

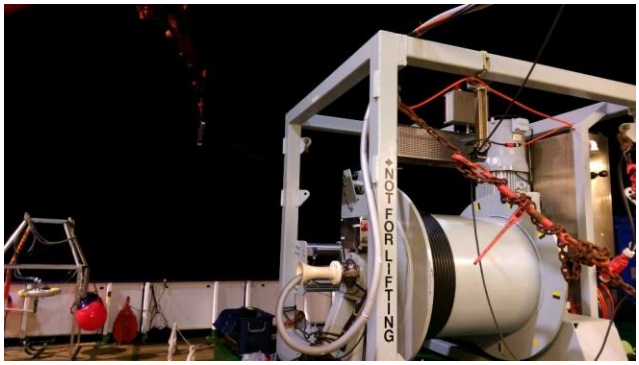


Figure 5: PumpCTD in operation to collect contamination-free samples for mercury analysis.

Figure 6: Intensive cyanobacteria blooms on the sea surface in the Gotland Basin (Photo: Andreas Radke)

Figure 7: Catamaran and buoy in surface films (Oberflächenfilm) of cyanobacteria.

Figure 8: Operation and recovery of the ScanFish, an undulant and towed CTD.

Acknowledgements

Participants thank the German Research Foundation and Senatskommission für Oceanographie for funding the expedition M117. The investigations in WP1 were funded by the "Forschungsstiftung Ostsee" provided by the OCEANEUM Stralsund GmbH. Investigators of WP2 thank the European Research Council for funding the project PassMe (GA336408) on the air-sea CO_2 exchange.

Teilnehmerliste

1.	Wurl, Oliver	*Chief Scientist, gas exchange (WP2)*	ICBM
2.	Nausch, Günther	Senior scientist, Monitoring (WP6)	IOW
3.	Ribas Ribas, Mariana	microlayer, gas exchange (WP2)	ICBM
4.	Nur Ili Hamizah	microlayer, gas exchange (WP2)	ICBM
5.	Rahlff, Janina	microlayer, gas exchange (WP2)	ICBM
6.	Van Pinxteren, Manuela	microlayer, aerosol chemistry (WP3)	TROPOS
7.	Eglite, Elvita	zooplankton (WP5)	IOW
8.	Laudan, Christin	cyanobacteria (W1)	IOW
9.	Nausch, Monika	cyanobacteria (W1)	IOW
10.	Braun, Philipp	cyanobacteria (W1)	IOW
11.	Kreuzer, Lars	Monitoring (WP6)	IOW
12.	Mars, Robert	CTD (WP6)	IOW
13.	Schoene, Susanne	Monitoring (WP6)	IOW
14.	Wlost, Klaus-Peter	CTD (WP6)	IOW
15.	Kolbe, Martin	CTD (WP6)	IOW
16.	Schuffhauer, Ingo	CTD (WP6)	IOW
17.	Donath, Jan	CTD (WP6)	IOW
18.	Loick-Wilde, Natalie	zooplankton (WP5)	IOW
19.	Streicher, Michael Daniel	zooplankton (WP5)	IOW
20.	Weber, Sarah	zooplankton (WP5)	IOW
21.	Karle, Mattis	Methane, underway measurement	IOW
22.	Poetzsch, Michael	Monitoring (WP6)	IOW
23.	Trinkler, Sven	Monitoring (WP6)	IOW
24.	Kuss, Joachim	Mercury cycle (WP4)	IOW
25.	Cordes, Florian	Mercury cycle (WP4)	IOW
26.	Steffen Ilona	Monitoring (WP6)	IOW
27.	Feldmann, Frederik	microlayer, gas exchange (WP2)	ICBM
28.	Ladehoff, Maike	microlayer, gas exchange (WP2)	ICBM

Stationsliste

Station	Date	Time UTC	PositionLat	PositionLon	Depth [m]
ME 117/557	23.07.2015	23:12	54° 36,00' N	010° 26,95' E	14.5
ME 117/558	24.07.2015	02:31	54° 39,30' N	010° 45,24' E	19.7
ME 117/559	24.07.2015	05:22	54° 33,08' N	011° 19,25' E	26.2
ME 117/560	24.07.2015	08:53	54° 24,73' N	011° 37,17' E	25.3
ME 117/561	24.07.2015	10:31	54° 18,83' N	011° 33,06' E	32.1
ME 117/562	24.07.2015	14:37	54° 13,87' N	012° 04,62' E	11.6
ME 117/563	24.07.2015	19:39	54° 24,34' N	012° 03,50' E	15
ME 117/564	24.07.2015	21:14	54° 28,76' N	012° 03,47' E	10.4
ME 117/565	24.07.2015	23:10	54° 28,01' N	012° 13,02' E	22.6
ME 117/566	25.07.2015	01:16	54° 39,03' N	012° 26,93' E	14
ME 117/567	25.07.2015	02:42	54° 41,69' N	012° 42,29' E	17.6
ME 117/568	25.07.2015	03:31	54° 43,39' N	012° 46,89' E	19.9
ME 117/569	25.07.2015	06:12	54° 47,75' N	013° 03,58' E	26.5
ME 117/570	25.07.2015	07:43	54° 51,58' N	013° 16,73' E	58.4
ME 117/571	25.07.2015	09:13	55° 00,35' N	013° 17,95' E	45.3
ME 117/572	25.07.2015	10:44	54° 55,55' N	013° 29,91' E	56.7
ME 117/573	25.07.2015	14:29	55° 01,51' N	013° 36,42' E	51.5
ME 117/574	25.07.2015	15:38	55° 04,10' N	013° 48,81' E	50.6
ME 117/575	25.07.2015	17:05	55° 09,73' N	013° 56,49' E	50.9
ME 117/576	25.07.2015	18:31	55° 03,80' N	013° 59,28' E	57.2
ME 117/577	25.07.2015	19:33	54° 59,94' N	014° 04,96' E	53.3
ME 117/578	26.07.2015	00:12	54° 53,47' N	013° 58,10' E	45.7
ME 117/579	26.07.2015	01:10	54° 53,22' N	013° 52,25' E	47.8
ME 117/580	26.07.2015	02:11	54° 48,23' N	013° 57,55' E	45.4
ME 117/581	26.07.2015	03:21	54° 42,62' N	013° 56,84' E	26.7
ME 117/582	26.07.2015	04:31	54° 36,72' N	014° 02,69' E	19.7
ME 117/583	26.07.2015	14:32	55° 09,94' N	014° 15,27' E	44.6
ME 117/584	26.07.2015	16:06	55° 15,04' N	014° 30,56' E	44.6
ME 117/585	26.07.2015	18:15	55° 24,35' N	014° 32,25' E	58.6
ME 117/586	26.07.2015	19:31	55° 27,83' N	014° 42,67' E	68.5
ME 117/587	26.07.2015	22:08	55° 22,99' N	015° 20,02' E	21.9
ME 117/588	27.07.2015	00:10	55° 09,60' N	015° 39,61' E	104.2
ME 117/589	27.07.2015	01:48	55° 19,84' N	015° 36,90' E	106.3
ME 117/590	27.07.2015	03:09	55° 27,41' N	015° 37,79' E	95.1
ME 117/591	27.07.2015	04:51	55° 18,12' N	015° 47,86' E	105.1
ME 117/592	27.07.2015	06:11	55° 15,03' N	015° 58,78' E	97.4
ME 117/593	27.07.2015	21:07	55° 13,31' N	016° 09,65' E	83.7
ME 117/594	28.07.2015	00:28	55° 12,98' N	017° 03,97' E	89.4
ME 117/595	28.07.2015	05:18	55° 19,61' N	018° 14,13' E	74.1
ME 117/596	28.07.2015	07:29	55° 32,82' N	018° 23,89' E	87.5
ME 117/597	28.07.2015	12:56	55° 38,03' N	018° 36,09' E	92.7
ME 117/598	28.07.2015	15:02	55° 50,43' N	018° 52,04' E	99.8
ME 117/599	28.07.2015	23:25	56° 05,05' N	019° 10,07' E	123.9
ME 117/600	29.07.2015	01:33	56° 20,83' N	019° 22,74' E	138.6

Station	Date	Time UTC	PositionLat	PositionLon	Depth [m]
ME 117/601	29.07.2015	09:49	56° 37,82' N	019° 34,96' E	144.4
ME 117/602	29.07.2015	13:19	57° 04,34' N	019° 49,92' E	250.7
ME 117/603	29.07.2015	16:04	57° 19,22' N	020° 03,03' E	242.9
ME 117/604	31.07.2015	06:03	57° 36,99' N	020° 10,06' E	148.8
ME 117/605	31.07.2015	10:06	57° 59,97' N	019° 53,79' E	198.8
ME 117/606	31.07.2015	15:01	58° 26,52' N	020° 20,05' E	122.2
ME 117/607	01.08.2015	07:24	56° 17,20' N	016° 35,43' E	15.8
ME 117/608	02.08.2015	04:18	56° 16,98' N	016° 39,05' E	31.5
ME 117/609	03.08.2015	04:04	56° 17,16' N	016° 43,12' E	62.2
ME 117/610	04.08.2015	04:02	56° 17,12' N	016° 54,69' E	46.2
ME 117/611	05.08.2015	05:46	57° 07,01' N	017° 40,01' E	114.5
ME 117/612	05.08.2015	11:09	57° 42,94' N	017° 22,01' E	143.1
ME 117/613	05.08.2015	14:09	57° 59,98' N	018° 00,02' E	168.4
ME 117/614	05.08.2015	17:47	58° 35,03' N	018° 13,95' E	458.3
ME 117/615	06.08.2015	17:20	58° 47,00' N	019° 06,04' E	123.1
ME 117/616	07.08.2015	03:56	58° 53,00' N	020° 19,03' E	172.8
ME 117/617	07.08.2015	14:08	59° 29,15' N	023° 08,35' E	91.6
ME 117/618	08.08.2015	04:43	59° 46,08' N	023° 37,19' E	25.9
ME 117/619	09.08.2015	03:50	59° 41,99' N	023° 11,16' E	57.9
ME 117/620	10.08.2015	10:14	57° 50,97' N	021° 07,84' E	74.1
ME 117/621	10.08.2015	11:51	57° 53,37' N	020° 50,07' E	87.1
ME 117/622	10.08.2015	14:53	57° 57,89' N	020° 13,06' E	124.7
ME 117/623	10.08.2015	16:37	58° 00,00' N	019° 54,00' E	197.6
ME 117/624	11.08.2015	15:13	57° 43,65' N	020° 41,14' E	134.3
ME 117/625	11.08.2015	17:14	57° 31,49' N	020° 32,62' E	160.3
ME 117/626	11.08.2015	19:41	57° 16,00' N	020° 39,05' E	70.3
ME 117/627	11.08.2015	21:25	57° 17,99' N	020° 21,14' E	186.1
ME 117/628	12.08.2015	00:41	57° 22,04' N	019° 44,05' E	156.3
ME 117/629	12.08.2015	03:57	57° 19,21' N	020° 03,03' E	243.6
ME 117/630	13.08.2015	03:51	57° 12,14' N	020° 10,27' E	234
ME 117/631	13.08.2015	05:27	57° 08,97' N	019° 59,93' E	224.5
ME 117/632	13.08.2015	08:03	57° 15,98' N	019° 47,75' E	209
ME 117/633	13.08.2015	21:59	58° 01,33' N	019° 55,43' E	193.1
ME 117/634	15.08.2015	16:37	55° 14,99' N	015° 58,89' E	93.4
ME 117/635	16.08.2015	03:48	54° 55,49' N	013° 29,99' E	42.9
ME 117/636	16.08.2015	08:41	54° 43,45' N	012° 46,87' E	17.9
ME 117/637	16.08.2015	11:49	54° 28,12' N	012° 13,21' E	20.3