CRUISE REPORT

Cruise KB 2017618
with R.V. Kristine Bonnevie

2 – 15 September 2017

Working Areas:
Norwegian Sea, Lofoten Basin

Geophysical Institute, University of Bergen

Compiled by Ilker Fer with inputs from
Anthony Bosse and Henrik Søiland

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1. Background

The cruise KB 2017618 aboard the Research Vessel *Kristine Bonnevie* is the third and final research cruise of the project "Watermass transformation processes and vortex dynamics in the Lofoten Basin of the Norwegian Sea (ProVoLo)". ProVoLo is led at the Geophysical Institute, University of Bergen (principal investigator: Ilker Fer) and is funded by the Research Council of Norway (project number 250784/F20) for the period 01.01.2016-31.12.2019.

The overall objective of ProVoLo is to describe and quantify the processes and pathways of energy transfer and mixing in the Lofoten Basin and their role in water mass transformation. Three connected geographical regions of the Lofoten Basin (the Norwegian slope, the central basin with its persistent eddy (LBE), and the Mohn Ridge) are studied in periods covering summer and wintertime conditions, and in the entire water column covering from spatial scale of turbulence to mesoscale. The field component includes dedicated process cruises in summer and in winter, coordinated with deployments of moorings, gliders and Lagrangian floats.

The cruise KB 2017618 aims to recover all deployed instruments (moorings, acoustic source moorings and gliders) and to work a transect across LBE to collect ocean hydrography, current, ocean microstructure profiles, as well as total carbon and nutrient water samples. The earlier cruises were the summer process study and instrument deployment cruise (HM 2016611) in June 2016 and the winter process study cruise (KB 2017606) in March 2017.

This report provides an overview of the methods employed and the data collected during KB 2017618. More details can be found in the reports from HM 2016611 and KB 2017606 (available from Ilker.Fer@uib.no and also included with the data sets submitted to the Norwegian Marine Data Centre).

2. Cruise participants

	Name	Institute[1]	Responsibility[2]
Scientists	Ilker Fer (cruise leader) Ilker.fer@uib.no	UIB	VMP, UIB Moorings, MR
	Henrik Søiland	IMR	IMR Moorings & VMADCP
	Anthony Bosse	UIB	Gliders, water sampling (TC, NU)
	Johannes Dugstad	UIB	LADCP, VMP
Technical Personnel	Helge Bryhni	UIB	Moorings and VMP winch
	Algot Peterson	UIB	Moorings and VMP winch
	Tore Mørk (ship's instr. chief)	IMR	CTD and water sampling (S)

[1] UIB: University of Bergen; IMR: Institute of Marine Research, Bergen

[2] The instruments and acronyms are described in the report. TC: total carbon, NU: nutrients, S: salinity

Captain : Tom Ole Drange **Chief Officer** : Rolf Blakstad

3. Cruise Overview

The cruise took place between 2 and 15 September 2017 with port calls Bergen - Bergen. The main operations were the recovery of the oceanographic moorings, the acoustic sound source moorings deployed in June 2016, and a Seaglider deployed in January 2017. Additionally, a glider equipped with microstructure sensors (Gnå) was deployed and recovered to collect profiles in the upper 300 m, while the ship worked a detailed transect and ADCP survey across the LBE. Other operations include a Seaglider deployment for another project, and opportunistic recovery of neutrally buoyant, acoustically-tracked subsurface drifters (RAFOS) which were trapped in the Lofoten Basin. A timeline of events is given in Appendix A. The cruise track is shown in Figure 1.

In total 17 CTD (conductivity temperature depth), 13 LADCP (lowered acoustic Doppler current profiler), 9 microstructure profiles, and 5-days of glider data from Teledyne Webb Research glider Gnå were collected. The microstructure profiles were made both from the ship, and a microstructure package installed on Gnå. The vessel-mounted ADCP (VM-ADCP) sampled continuously throughout the cruise. In addition, 6 oceanographic moorings, 5 moored sound sources, 10 RAFOS floats, and one Seaglider were recovered. In total, 144 and 72 water samples were drawn for nutrient and total carbon analysis, respectively. A station map is shown in Figure 2, with an enlarged view of the mooring site given in Figure 3.

A complete list of CTD and shipboard microstructure stations is tabulated in Appendix B and C, respectively. Instrument and sampling details are given in the following sections.

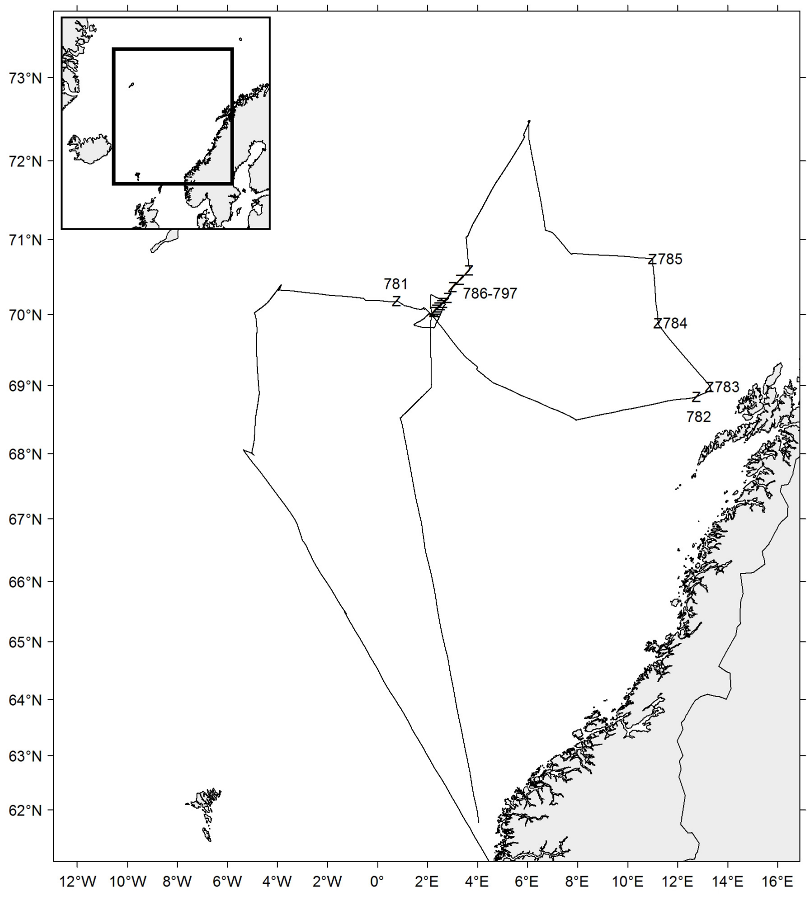


Figure 1. Cruise track of KB 2017618, with CTD stations marked.

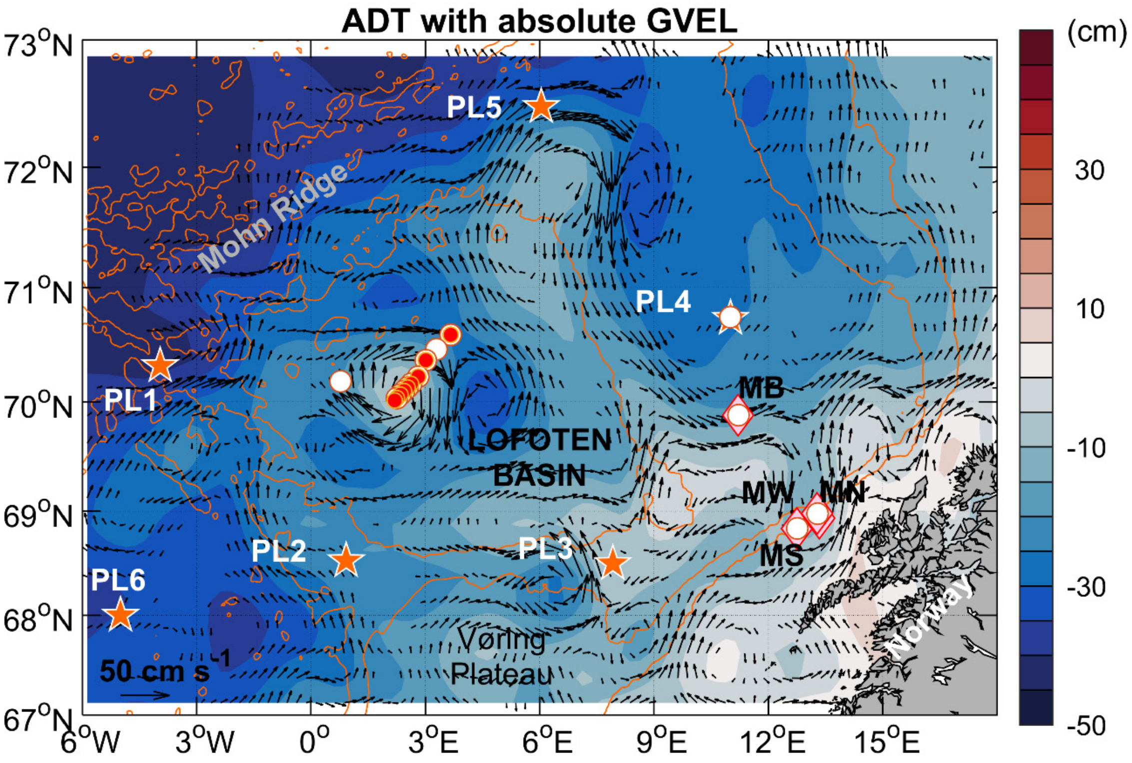


Figure 2. Station map, KB 2017618. Open circles are CTD/LADCP, filled circles are with VMP2000. Pentagrams mark the sound source moorings, PL1 to PL6. Oceanographic moorings are marked by diamonds (see Figure 3 for an enlarged map). Black traces (LBE and MR) mark the process study stations during the cruise. Background fields are the sea level anomaly and surface geostrophic current anomalies.

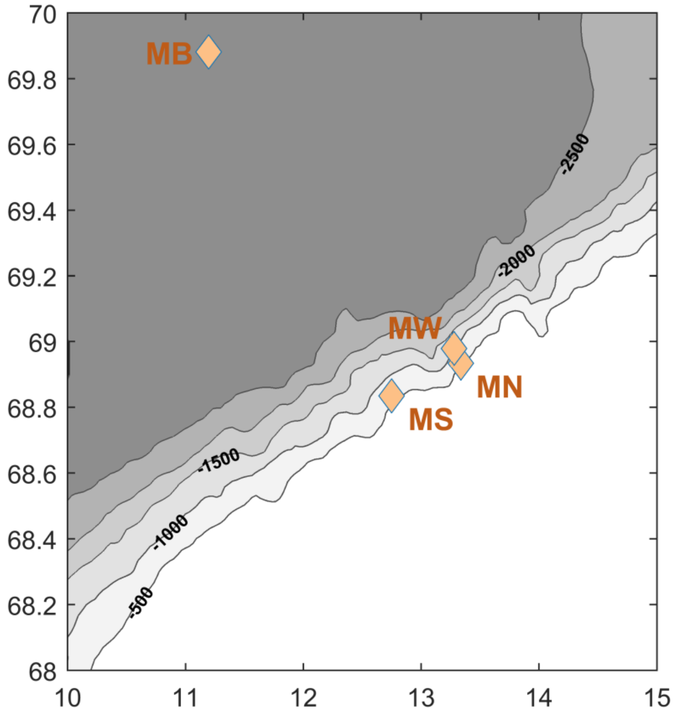


Figure 3. A zoom in to the mooring positions. The labeling stands for Mooring South (MS), Mooring West (MW), Mooring North (MN) and Mooring Basin (MB).

4. Environmental conditions

Measurements from the meteorological station on board the R.V. K. Bonnevie are shown in Figure 4.

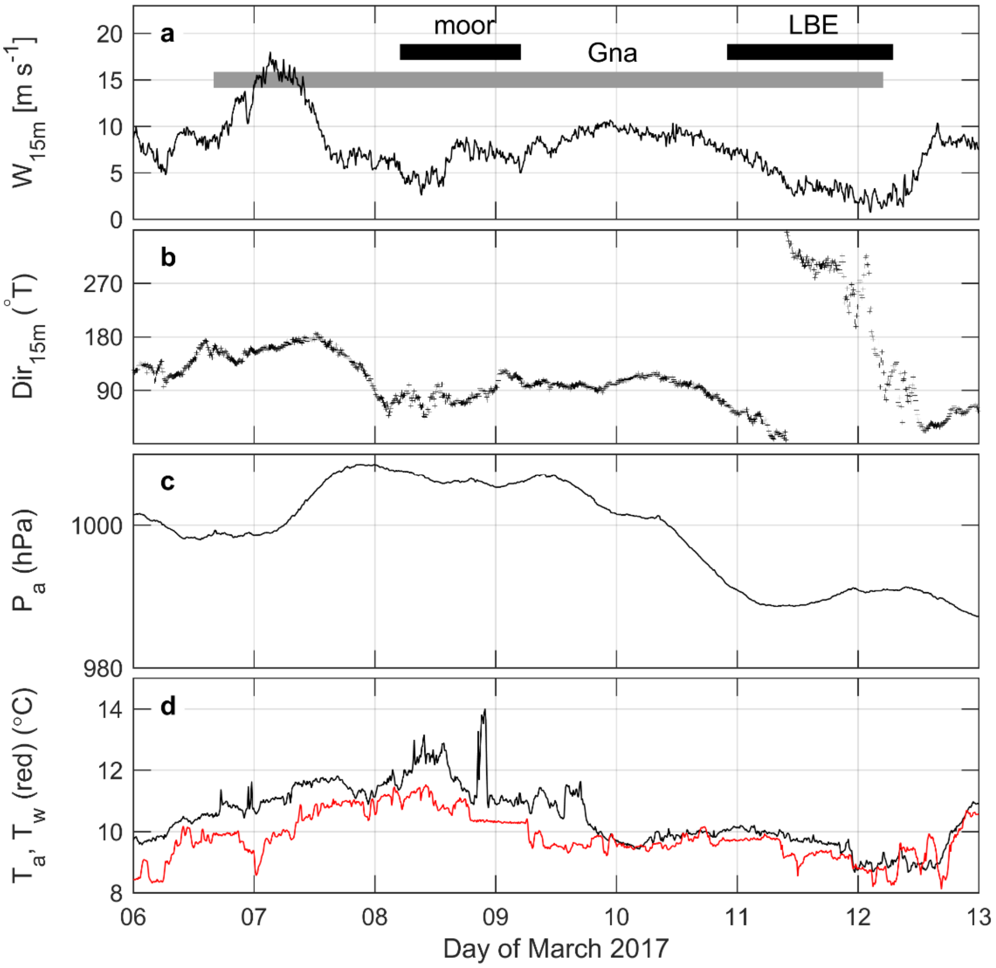


Figure 4. (left) 10-minute averaged data from the ship's log: a) wind speed, b) direction, c) atmospheric pressure measured at 15-m height, and d) near-surface water (red) and 15-m height air temperature. Duration of activities are indicated at the top: mooring work, LBE site and sampling period using the glider Gnå.

5. Moorings

5.1. Oceanographic moorings

Six bottom-anchored oceanographic moorings were recovered. The positions are detailed in Table 1 and shown in Figure 3. The details of the instrumentation are given in mooring diagrams in Appendix E (see also the first cruise report, HM6112016). All moorings were deployed in June 2016, during HM6112016. Mooring names follow South (MS), North (MN), West (MW), and Basin (MB). Because of the risk due to fishing activity in the region, ADCPs in the MS and MN moorings were deployed separately in a near-bottom spherical buoy, very close (100-200 m) to MS and MN. These "short" moorings (approximately 25 m tall) are dubbed MSs and MNs, and were deployed within a couple of 100 m to MS and MN.

MN: This mooring was adrift in August 2016. The drifting part of the mooring was recovered on 24.08.2016, from Kystverket Strilborg. The earlier recovered upper part of the mooring included Novatech ARGOS A04-007; a hardball float, 4x17" glass spheres; SBE37 SN 13351; SBE56, SNs 4325 & 4326. The remaining part was successfully retrieved on 8 September 2017.

MS: Upon release, only the bottom part of MS surfaced, including the release, the Seaguard SN 1898 and 4x17" glass spheres. It was clear that the mooring line was cut by a trawler. The following instruments were lost: SBE56 SNs 4334, 4324 and 4330; SBE37 SNs 7335 and 13350, ARGOS Xeos 738, and 4x17" glass spheres.

MB: The acoustic release (AR2500 SN948) did not respond to ranging, however it released successfully. Upper SBE37 SN 6097 and SBE56 SN 4252 (70-80m) were at the same depth (pressure record from SBE37 must be inspected to conclude which instrument slid). Above the Longranger buoy, SBE37 SN 5452 (750m) and SBE56 SN 4322 (600m) were at the same depth. Again the pressure record from the SBE37 must be inspected.

Table 1. Mooring deployment details. Deployment time is anchor drop.

Mooring	Latitude	Longitude	Depth (m)	Deployed (UTC)	Recovered (UTC)
MS	68 N 50.128	012E 45.082	680	31.05.2016 21:06	08.09.2017 06:20 (bottom part only)
MSs	68 N 50.038	012E 44.777	681	31.05.2016 21:50	08.09.2017 07:20
MN	68 N 56.06	013E 20.24	645	01.06.2016 00:02	24.08.2016 (upper part) 08.09.2017 09:00 (rest)
MNs	68 N 56.109	013E 19.866	650	01.06.2016 00:48	08.09.2017 10:00
MW	68 N 58.759	013E 16.845	1500	01.06.2016 05:37	08.09.2017 12:10
MB	69 N 52.89	011E 11.89	2925	02.06.2016 13:44	09.09.2017 04:10

5.2. Sound source moorings

In order to allow acoustic tracking of the RAFOS floats, sound source moorings were deployed in 2016. Five sources were deployed in a horse shoe pattern along the edge of the Lofoten Basin (see map in Figure 2) in June 2016. Later, in September 2016, a sixth source was deployed further south (PL6). Acoustic transmissions were set to occur four times a day, shortly after midnight UTC and at 6 hours intervals. The source locations were chosen to have good geometrics for RAFOS floats in the Lofoten Basin Eddy and along the Mohn Ridge. To determine a unique position three acoustic signals are necessary, but if the geometry is good two signals is enough. Six sources provide redundancy.

All source moorings except PL3 were successfully recovered. The details are given in Table 2. All sound sources were active throughout the deployment duration.

Table 2. Positions (anchor drop), depths of the sound source moorings (ProVoLo 2016-2017), and deployment / recovery dates. All sources 4 pongs per 24 hrs, 6 hr intervals

Site	latitude	longitude	Pong-UTC	Deployed [yymmdd]	depth(m)	Recovered [yymmdd]
PL1	N70° 19.225’	W003° 57.519	00:30:00	160529	800/2606	170906
PL2	N68° 31.755’	E000° 55.607	00:40:00	160530	800/2820	170913
PL3	N68° 30.139’	E007° 55.394	00:50:00	160531	800/2830	-
PL4	N70° 44.077’	E011° 00.244	01:00:00	160601	800/2685	170909
PL5	N72° 28.885	E006° 02.520	01:10:00	160608	800/2645	170910
PL6	N67°59.610’	E004°59.897’	01:20:00	160904	800/3515	170904

The following RAFOS floats were recovered during the cruise.

RAFOS#	Date	Time [UTC]	Latitude	Longitude
RF1277	2017-09-05	21:01:16	N 70 01.164	W 004 55.794
RF1285	2017-09-06	23:32:26	N 70 05.268	E 001 51.018
RF1273	2017-09-07	10:02:55	N 69 02.016	E 004 39.33
RF1284	2017-09-09	19:31:17	N 70 48.342	E 007 45.75
RF1266	2017-09-09	23:02:12	N 71 07.194	E 006 42.702
RF1269	2017-09-10	19:31:03	N 71 02.136	E 003 32.796
RF1203	2017-09-12	09:00:58	N 70 16.170	E 002 08.682
RF1261	2017-09-12	10:30:48	N 70 08.052	E 002 43.122
RF1265	2017-09-12	12:30:48	N 69 48.834	E 002 14.502
RF1448	2017-09-12	14:01:44	N 69 51.060	E 001 27.882

6. Hydrography and water sampling

The hydrographic work was carried out using a CTD-water sampling package from SeaBird Inc., acquiring data during both down and upcast. The package consisted of a SBE 911plus CTD (underwater unit SBE9plus SN 1258, deck unit SBE11 SN 1075) with sensors listed below. The Benthos altimeter (200 kHz) allowed profiling close to the bottom (when needed). The CTD was equipped with a 12 position SBE 32 Caroussel (SN 1109), fitted with 9 5-litre sampling bottle. 3 bottles were compromised to allow room for the upward pointing lowered acoustic Doppler current profiler (LADCP). In total 17 CTD-stations were taken, recorded in files sta0781 to sta0797. At all stations, water samples for salinity calibration were collected at the deepest sampling level. At 16 stations samples were drawn at 9 levels for nutrient analysis. At 12 stations samples were taken for total carbon analysis, at selected levels (see below for the details of water sampling). The CTD stations are listed in Appendix B. Station positions are shown in Figure 2. A complete list of water sampling is given in Appendix D.

Table 3. Sensor details installed on the CTD rosette.

Sensor	SN	Calibration/Service date
Temperature	4340	26.04.2017
Conductivity	4387	16.05.2017
Pressure	134950	17.11.2015
Temperature, 2	2369	26.04.2017
Conductivity, 2	1827	27.04.2017
Altimeter, Benthos PSA-916	67087	01.02.2015
Oxygen, SBE 43	0365	29.04.2017
Fluorometer, Wet Labs ECO-AFL	4131	02.10.2015
PAR, Biospherical QCP-2300-HP	70656	13.01.2017
SPAR, Biospherical QCP-2200	20539	13.01.2017
RDI WH300 L-ADCP, downlooker	10012	2015
RDI WH300 L-ADCP, uplooker	10151	2015

Data processing - SBEDataProcessing-Win32, standard Seabird Electronics software for Windows (version 7.23.2), is used for post-processing of the CTD data. Only data from downcasts are used to avoid turbulence caused by rosette package on the upcast. Raw data (pressure, temperature and conductivity from dual sensors) are converted to physical units using calibration files modified for air pressure and conductivity slope factor (DATCNV). Outliers, differing more than 2 and 20 standard deviations for the first and second pass, respectively, from the mean of 100 scan windows are flagged and excluded from analysis (WILDEDIT). The thermal mass effects in the conductivity cell are corrected for (CELLTM, with parameters alpha = 0.03 and 1/beta = 7.0). Pressure is low-pass filtered with a time constant of 0.15 s. Both conductivity signals were low-pass filtered using a time constant of 0.03 s. Scans when the CTD package moved less than the set minimum fall rate of 0.25 m s^{-1} are flagged to remove pressure reversals due to ship heave (LOOPEDIT). Data are then averaged into 1 dbar bins (BINAVG). In the final (converted and bin-averaged) data files, temperature is saved using the ITS-68 scale, and salinity on the practical salinity scale (PSS-78). Pressure, temperature, and salinity data are accurate to ±0.5 dbar, $\pm2\times10^{-3}$ °C, and $\pm3\times10^{-3}$, respectively.

There was an offset in the practical salinity measured by the primary and secondary CT sensors Figure 5. We use salinity from the primary sensor pair, and correct for the bottle samples as described below.

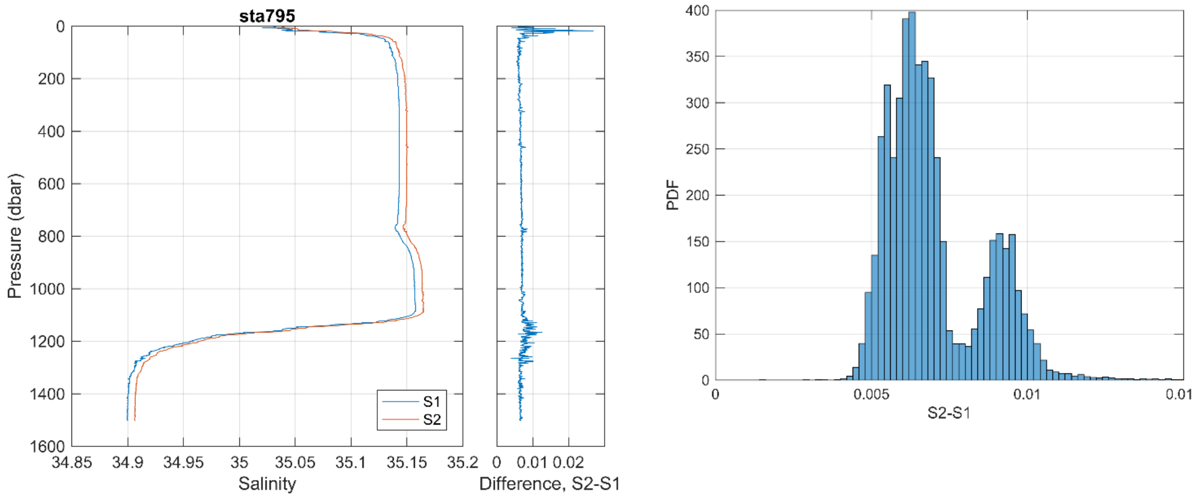


Figure 5. (left) Salinity profiles from two sensors on the CTD, for an example cast (sta 795). This is typical of the cruise. (right) Histogram of the salinity difference between the sensors using data form all profiles.

Conductivity correction from salinity bottle samples – A total of 17 salinity bottle samples are analyzed at IMR with a Guildline Portasal 8410 salinometer. 3 readings appear erroneous and are excluded from the analysis. Salinity and conductivity values from each bottle are merged with the corresponding CTD data. Bottle conductivity is calculated from bottle salinity and CTD temperature and pressure. Following the procedure recommended by UNESCO [1988], only data within the 95% confidence interval are used to correct the calibration of the CTD conductivity.

Following the recommendations given by Seabird Electronics, the conductivity values are corrected by the formula, $C_{new} = m\, C_{old}$, where m is the slope calculated by

$$m = \frac{\sum_{i=1}^{n} a_i \times b_i}{\sum_{i=1}^{n} a_i \times a_i}.$$

Here a_i and b_i are the CTD conductivity and the bottle conductivity, respectively and n is the total number of bottles. Resulting slope correction is **m = 1.00026**. Prior to correction, the conductivity difference between CTD and bottles, $\Delta C = C_{CTD} - C_{bot}$ averaged -7.8 (± 2.6) $\times 10^{-4}$ (± 1 standard deviation). After correction $\Delta C = 0.0$ (± 2.6) $\times 10^{-4}$ S/m. The RMS difference between bottle and CTD salinity before correction is 0.0105, and improves to 0.0027 after the correction.

Samples for nutrient and carbon analysis - Water samples at different depths were drawn from the 9 Niskin bottles mounted on the rosette. A summary of sampling is given below. A complete list is given in Appendix D. The eddy survey stations are listed at the nominal distance (r in km) to the eddy center. Core (r=0), rim (r=20) and outer (r=80km) stations were repeated (for nutrient samples only) with higher resolution in the upper 300 m. The additional 4 stations are at the Seaglider deployment site and the mooring sites, MB, MN and MW.

In total, 144 samples will be analyzed on land at Institute of Marine Research for nutrients titration (Nitrate, Nitrite, Phosphate and Silicate), as well as 72 samples of total carbon and alkalinity to be analyzed at the Carbon Laboratory of the Geophysical Institute.

For carbon sampling, seawater was tapped into 250 mL bottles, poisoned by adding 0.02 mL of HgCl2. The stopper was sealed using grease. Nutrients samples were carried out in 20 mL polyethylene scintillations vials in which 0.2 mL of chloroform was added for conservation. Until the end of the mission, samples were conserved in a dark closed box put in a refrigerator.

Depth \ Station	9, r=0	9b, r=0	8, r=5	7, r=10	6, r=15	5, r=20	5b, r=20	4, r=30	3, r=45	2, r=60	1, r=80	1b, r=80
10	XO	O	XO	XO	XO	XO	O	XO	XO	XO	XO	O
30		O	O	O	O		O	O	O	O		O
50	XO	O	XO	XO	XO	XO	O	XO	XO	XO	XO	O
75		O	O	O	O		O	O	O	O		O
100	XO	O	XO	XO	XO	XO	O	XO	XO	XO	XO	O
150		O					O					O
200	XO	O	O	XO	XO	XO	O	XO	O	O	XO	O
250		O					O					O
300		O					O					O
500	XO		O	XO	XO	XO		XO	O	O	XO	
1000	XO		O	XO	XO	XO		XO	O	O	XO	
1500	XO		O	O	O	XO		O	O	O	XO	
2300	XO					XO					XO	
bottom	XO					XO					XO	

O = Nutrients only
XO = Carbon and Nutrients

Depth \ Station	SG deploy	MB	MW	MN
10	O	XO	XO	XO
30	O		O	O
50	O	XO	XO	XO
75	O		O	O
100	O	XO	XO	XO
150	O		O	
200	O		O	
300		XO	XO	XO
500	O	O		O
1000	O	XO		XO
1500		O		
2300		XO		
bottom		XO	XO	XO

7. Current Profiling

7.1. Lowered-ADCP (LADCP)

Two LADCP-profilers (RD Instruments) were mounted on the CTD rosette in order to obtain current profiles. The ADCPs are 6000 m-rated 300 kHz Sentinel Workhorses with internal batteries. Each ADCP has the L-ADCP option installed and has the firmware v16.3. The ADCPs were configured to sample in master/slave mode to ensure synchronization. The master ADCP pointed downward (SN 10012) and the slave ADCP pointed upward (SN 10151). Communication with the instruments, start & stop of data acquisition and data download were done using BBTalk software. PC time (UTC) was transferred to each instrument before each cast. The vertical bin size (and pulse length) was set to 8 m for each ADCP. Single ping data were recorded in narrow bandwidth (to increase range), in beam coordinates, with blank distance set to zero. The data from the first bin are discarded during post processing. In order to mitigate a possible influence of previous pinging, especially close to steep slopes, staggered pinging with alternating sampling intervals of 0.8 s and 1.2 s were used. The altimeter worked reliably and no sign of degradation of LADCP data quality was observed. The command files for the master and slave LADCPs (see Appendix F) are identical in all PROVOLO cruises.

The LADCP data are processed using the LDEO software version IX-12 based on *Visbeck* [2002]. For each master/slave profile data, synchronized time series of CTD and navigation is used. For the purpose, NMEA GPS stream is added to each scan of the ship CTD and the data files are processed as 1-s bin averages, similar to the ADCP ping rate. LADCP-relevant processing of the CTD data included the following steps in the SBE-Data Processing software: DatCnv, WildEdit, CellTm, Filter, Binavg (1 s) and Derive. 3-min averaged VMADCP profiles are included for additional constraint on the inversion of the LADCP data.

7.2. Vessel-mounted ADCP (VMADCP)

The Vessel Mounted Acoustic Doppler Velocity Profiler (VMADCP) on board the RV *Kristine Bonnevie* is a 150 kHz RDI ADCP. The VMADCP continuously collected velocity profiles below the ship using the UHDAS software. The UHDAS software automates the editing to a large degree. 8 m depth bins were used during the cruise. Final processed files are 3-min averaged with typical final processed horizontal velocity uncertainty is 2-3 cm s^{-1}.

8. Microstructure Profiling

Ocean microstructure measurements were made using a vertical microstructure profiler VMP2000 (http://www.rocklandscientific.com) and a Teledyne Slocum Webb glider was equipped with turbulence sensors (microRider package, by Rockland Scientific International). VMP data reported here are from preliminary processing conducted during the cruise. Data from all VMPs are further post-processed to high-quality for analysis, using the same set of routines based on RSI's ODAS MATLAB software v 4.01.

The VMP2000 is 2000-m depth rated, loosely tethered vertical microstructure profiler (http://www.rocklandscientific.com), for the measurement of dissipation-scale turbulence to depths down to 2000 m. During the cruise VMP SN009 was deployed. A complete list of casts is provided in Appendix C. It is equipped with high-accuracy conductivity temperature depth (CTD) sensors (P Keller, T, SBE-3F, C, SBE-4C with pump SBE-5T), microstructure velocity probes (shear probes), one high-resolution temperature sensor (FP07-38-1 thermistor), one high-resolution micro-conductivity sensor (SBE7-38-1 micro-C), and three accelerometers. VMP samples signal-plus-signal-derivative on thermistor, micro-conductivity and pressure transducer, and derivative for shear signals, which is crucial for turbulence measurements, especially for the temperature microstructure. Data are transmitted in real time to a ship-board data acquisition system. VMP has an overall length of 2 m with 40/3.5 kg weight in air/water and with a nominal fall rate of 0.6 m/s.

Deployments were made using a Sytech Research Ltd. CMK-2 Hydraulic winch with Linepuller (an active line payout system) and 2500 m deployment cable. We used the ship's hydraulics for the VMP winch, bypassing the hydraulic/electric motor. The winch and line puller system was designed to feed cable over the side of the ship, allowing the profiler to free-fall through the water column.

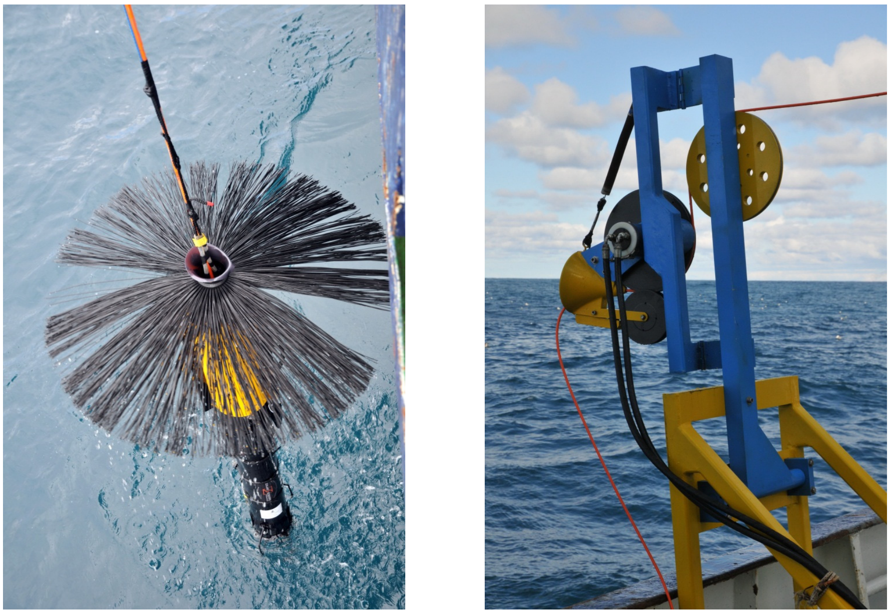


Figure 6. (Left) The VMP profiler during deployment. Drag from brushes, together with the buoyancy elements (yellow) set the nominal sink velocity of the profiler. Note the line attached to the cable which allows recovery by a crane without damaging the cable. (Right) The hydraulic line-puller.

Sampling was made from the starboard side, while drifting. We placed a block between the winch and the linepuller. The block is suspended from the main crane. The block is slightly (10-30 cm) above the linepuller level, ensuring that the cable does not jump off the linepuller. The block is strapped to the deck. Additionally the block is tied (by rope) to the winch, to avoid excessive wagging. The setup worked very well. The VMP is deployed and recovered using the secondary (smaller) crane, behind the main crane (holding the block). Rope is attached to the upper end of the VMP and strapped (using cable ties and tape) approx. 2 m along the bottom part of the VMP cable. The rope ends with an eye, which is used to lift the VMP. The instrument is guided directly to its stand, secured close to the railing. The operation worked well. The pictures of the VMP2000 setup are from an earlier cruise on board R.V. Håkon Mosby (2015 617). In the present cruise, the setup is identical and, additionally we equipped the block with a digital cable-length meter.

Microstructure sensors:

casts	S1	S2	T1	T2	C1
1-10	M1109	M1293	T1175	T1176	C200

SBE sensors, sbeT: 4788, sbeC: 2108

S1 is oriented to be sensitive in the direction of the P-port. S2 is sensitive perpendicular to the P-port.

9. Slocum glider– Gnå

During the cruise, a deep electric Slocum glider from Teledyne Webb Research (Gnå, Figure 7) equipped with an unpumped Seabird CTD, a Wetlab ECO-puck (Fluorescence and Turbidity), Andreraa oxygen Optode and a Rockland Scientific Microrider was deployed on 6 September 17:00 UTC and successfully recovered on September 12 at around 4:00 UTC. The Microrider is a self-contained turbulence instrument package, fitted with two velocity shear probes (SPM-38), two fast response thermistors (FP07), one micro conductivity probe (SBE7-38-1) and high resolution pressure, acceleration and tilt sensors. Sampling rate for the turbulence sensors is 512Hz, while the slow-response sensors sample at 64Hz. The Microrider is powered by the glider's battery, but stores data separately on a flash card. For details, see *Fer et al.* [2014].

The glider was deployed at the outer rim of the Lofoten basin vortex, about 60 km from its center with the aim to reach the center in about 4 to 5 days. The eddy center was estimated from data of a Seaglider (Sg562) swirling around it at the same time. The glider was deployed from the aft deck of the ship using a crane and a deployment tool kindly provided by French collaborators from IFREMER. Initially designed for the deployment of Spray gliders, it was adapted to the shape the Slocum glider carrying a Microrider and led to an easy and safe deployment.

A first test dive to 30m was successfully done within the range of the Freewave radio signal. A second dive to 100m was done in order to observe the flight behavior of the glider and further decide on battery positions to set in order to achieve stable dives at ±20-25 degree pitch angle and avoid perturbation of the glider flight required for the Microrider.

The main mission parameter was then updated with 300m dives and the glider went finally off the Freewave range. Despite a successful Iridium call during test on deck, the glider had then serious communications problem at sea. We only got in touch with it twice through Iridium at the beginning of the mission. No change of waypoint, or mission parameters could thus be done during the mission. No files could be transmitted from the glider neither. Regular updates at 1h to 3h interval of the position were provided the Argos positioning system. Based on those positions, the glider could be easily recovered using a small work boat, and avoiding any damage on the Microrider sensors. The Iridium issue needs to be investigated before deploying Gnå for a new mission.

The initial waypoint ended up being about 18 km north of the eddy by the end of the mission because of the southward eddy drift. The glider was however able to approach the eddy center to a final distance of about 8 km (see Figure 8). The glider completed 106 dives over 99 km of distance while recording temperature, salinity, chlorophyll-a fluorescence, turbidity, oxygen (see Figure 9), as well as turbulence dissipation rate (not shown, needs further non-trivial post processing).

Once onboard, the two CF memory cards were removed from the glider and raw data were processed using Geomar Slocum glider processing toolbox (version 7 March 2017). This latter includes main correction of the thermal lag effect following *Garau et al.* [2011], as well as a flight model following the approach of *Merckelbach et al.* [2010], but including more advanced features such as vertical acceleration during a non-steady flight.

Despite all the communication problems and subsequent lack control of the glider, the mission was successful.

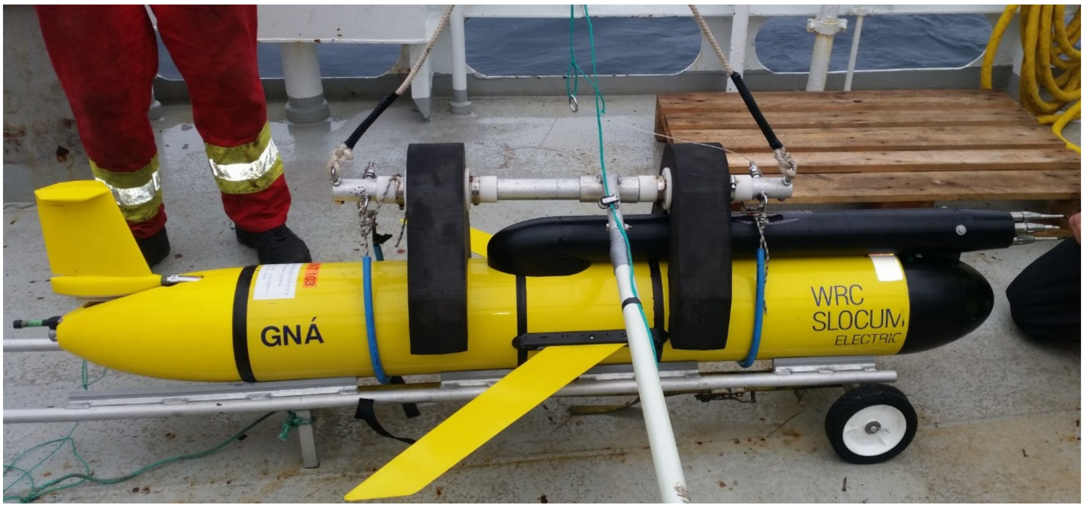


Figure 7. The glider Gnå mounted with MicroRider, on the transportation trolley, together with the deployment tool.

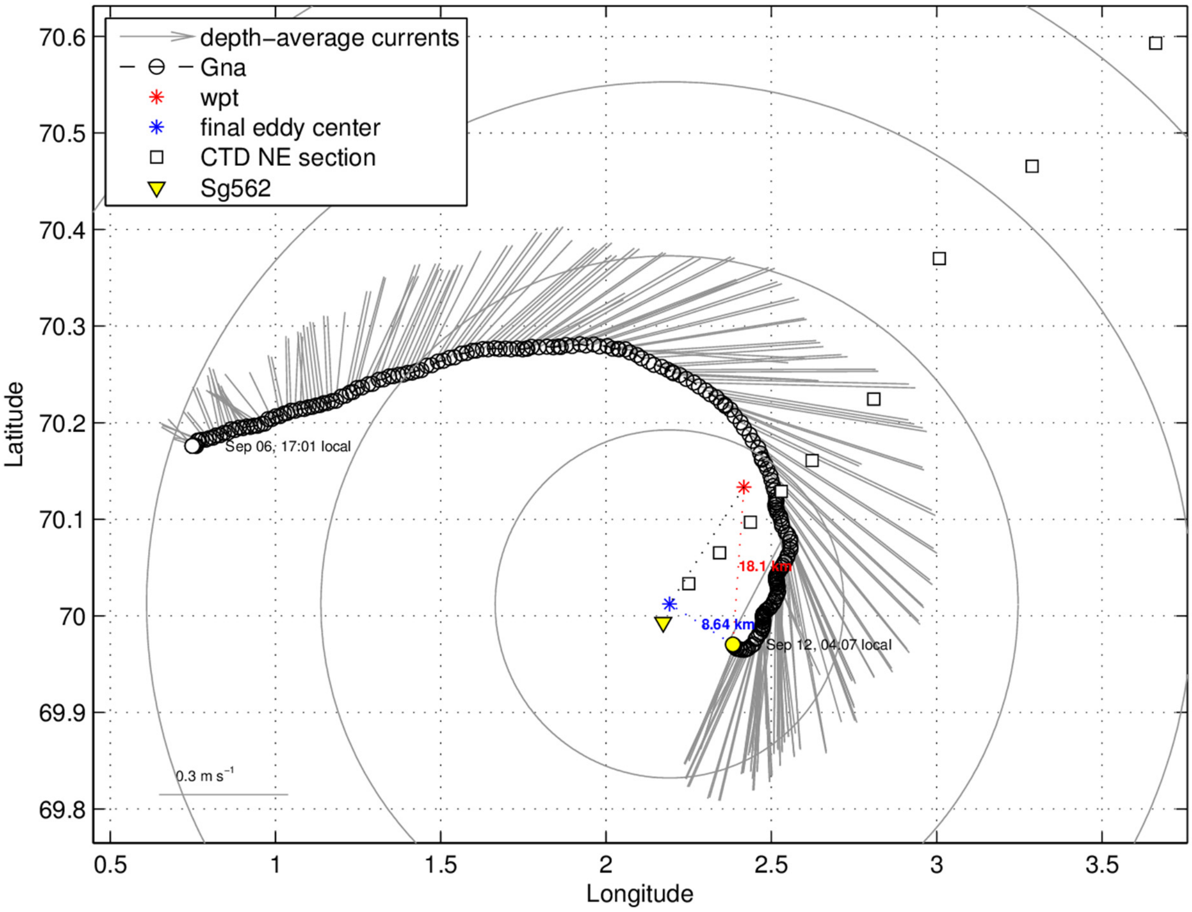


Figure 8. Map of the glider trajectory with depth-average currents estimated after each dive. Position of the waypoint in red and actual eddy center by the end of the mission in blue are plotted. The position of the CTD casts carried out during the cruise is indicated by the white squares. The yellow triangle shows where the Seaglider Sg562 was recovered on September 12 around noon.

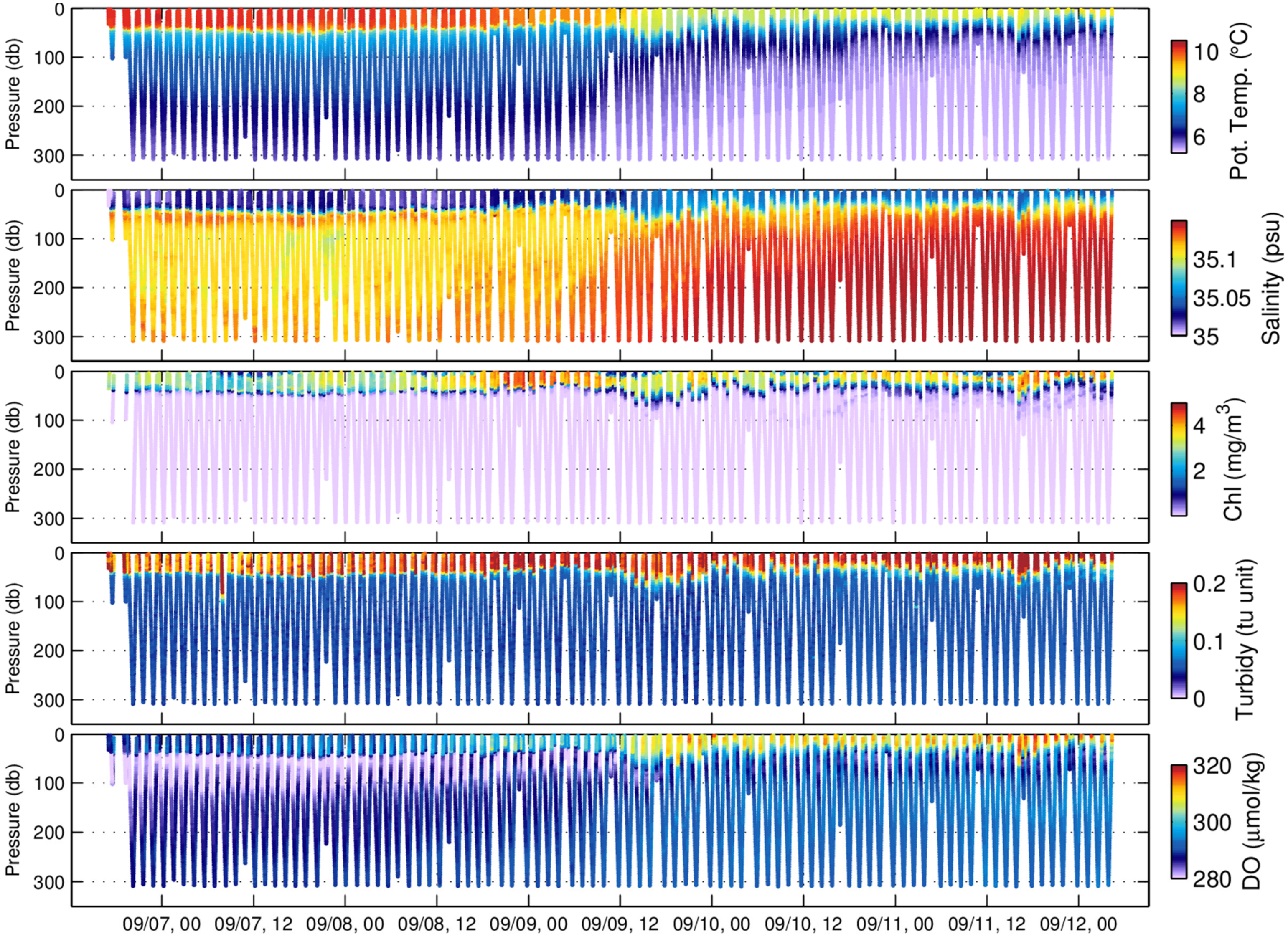


Figure 9. Time-pressure trajectory of the glider with recordings from the different sensors.

10. Presentation of Data

10.1. CTD

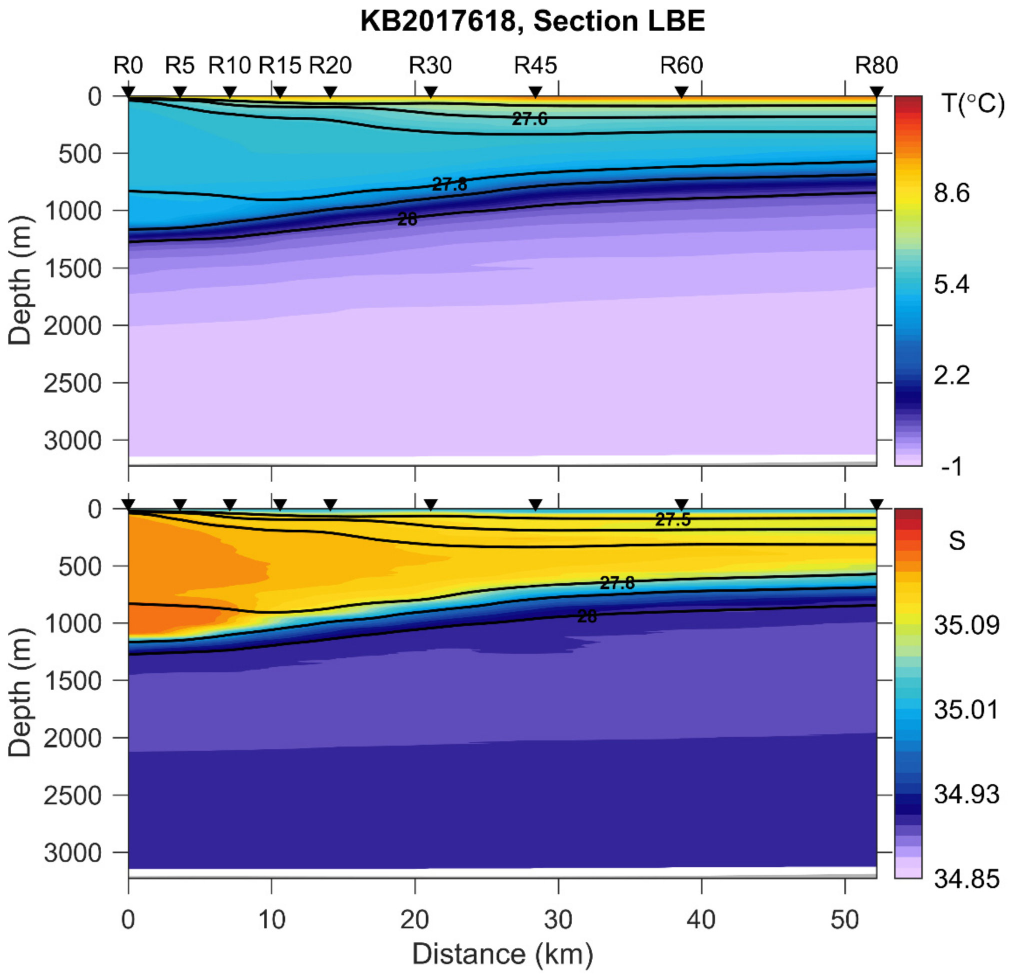


Figure 10. Contours of potential temperature (θ) and salinity (S) for the LBE transect. Isolines of potential density anomaly (σ_θ) are also shown (black) on each panel. Distance is relative to first station (i.e., not the eddy center which propagates in time). The center location is not accurately calculated for this presentation.

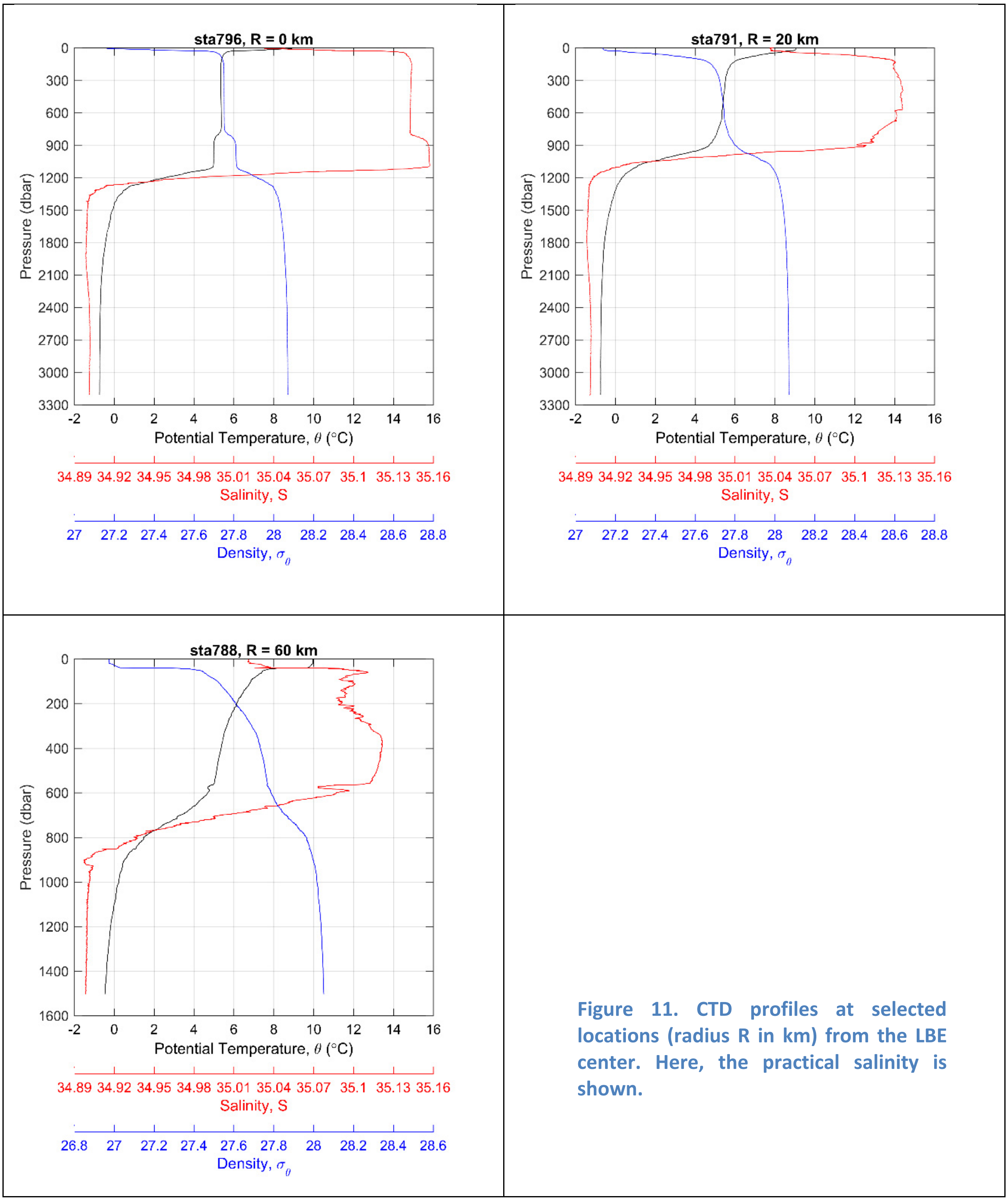


Figure 11. CTD profiles at selected locations (radius R in km) from the LBE center. Here, the practical salinity is shown.

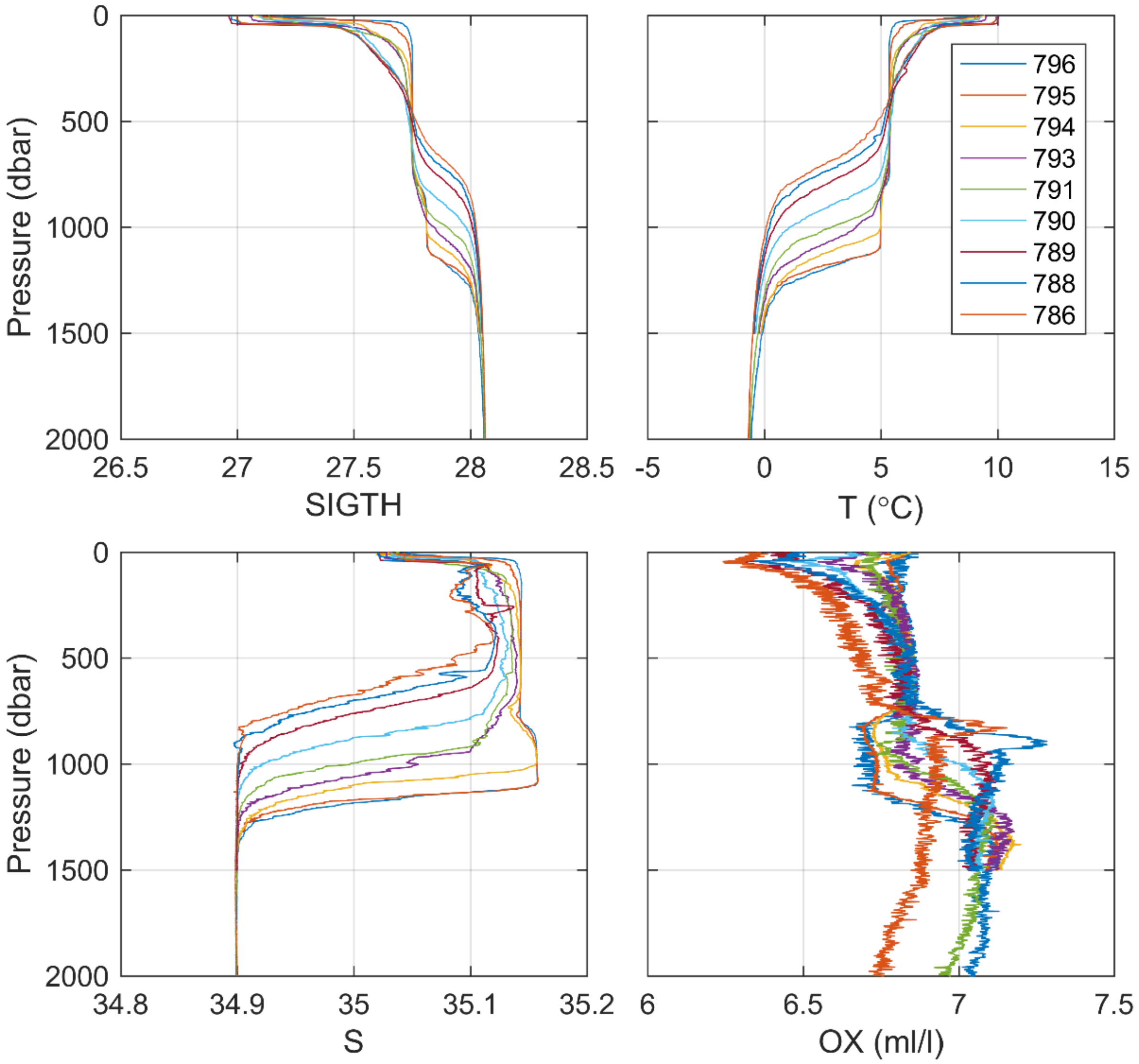


Figure 12. Profiles of potential density anomaly, temperature, practical salinity and oxygen concentration at the indicated stations across the LBE.

10.2. VMP

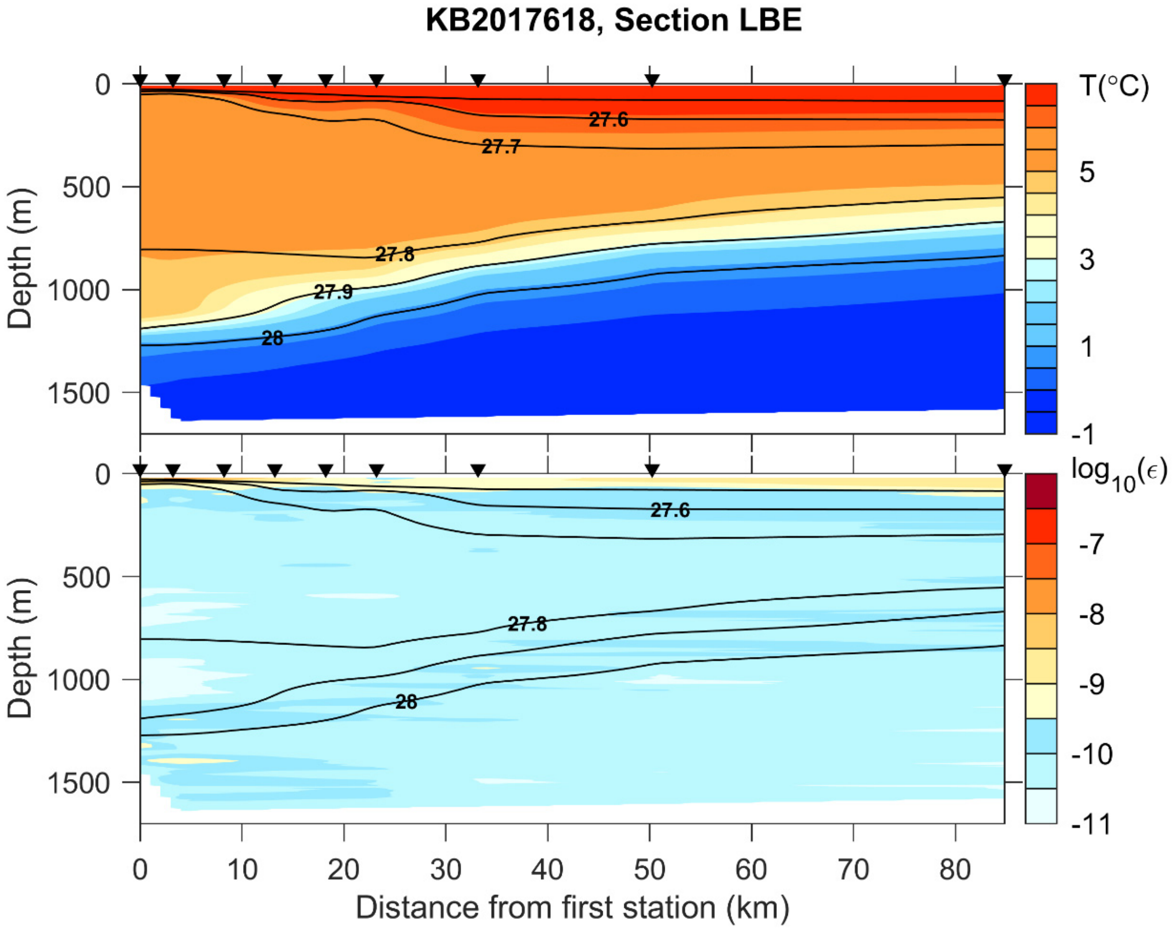


Figure 13. Contours of potential temperature and dissipation rate of TKE for the LBE transect. Isolines of potential density anomaly are also shown (black) on each panel. Distance is relative to first station (i.e., not the eddy center which propagates in time). The center location is not accurately calculated for this presentation. VMP profiles are 10-m vertically smoothed.

10.3. LADCP and VMADCP

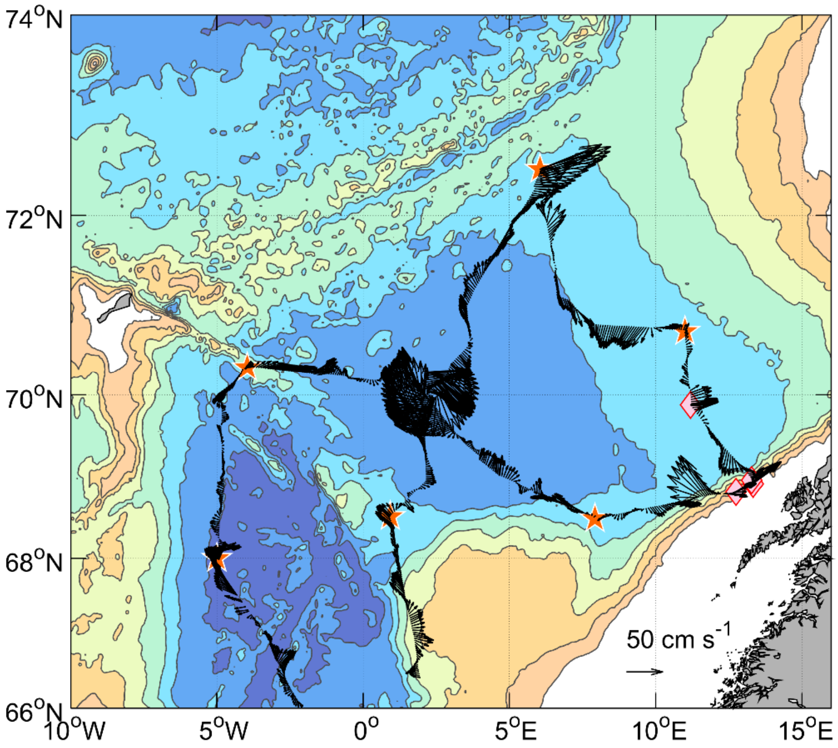


Figure 14. Depth-averaged current vectors (200-250 m) measured by the VMADCP during the cruise. Scale vector in bottom right. Oceanographic mooring and sound source positions are shown for reference.

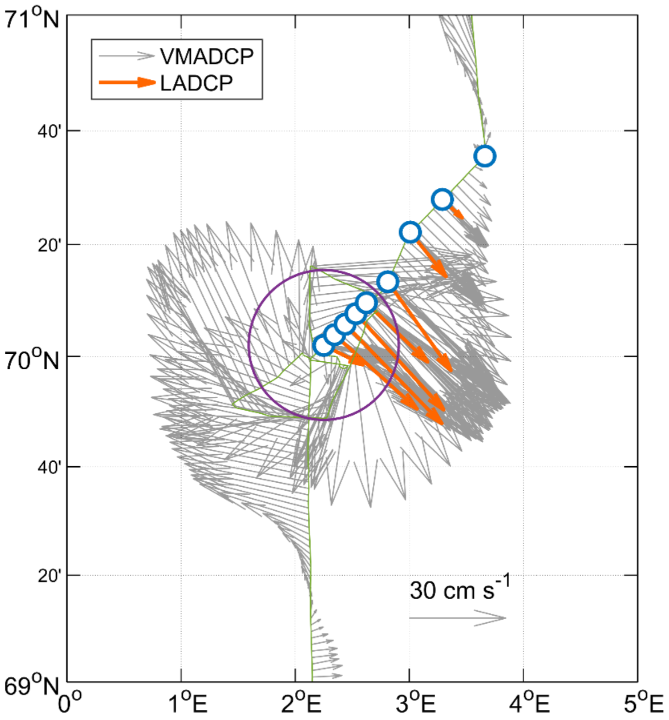


Figure 15. Depth-averaged current vectors (50-300 m) during the LBE survey, from the VMADCP (gray), and LADCP (orange). CTD/LADCP stations are marked. A large circle with 25 km radius is drawn for reference at the station close to the eddy center.

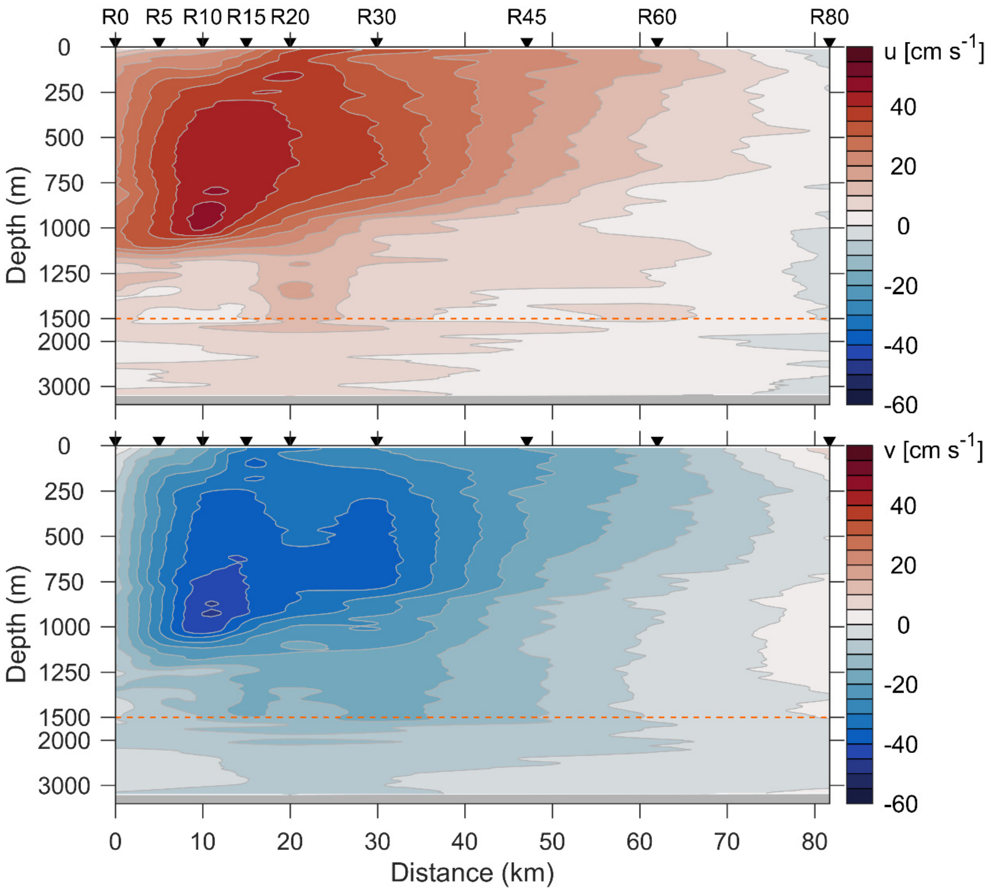


Figure 16. Distribution of the east (u) and north (v) component of the velocity measured by the LADCP during the LBE survey. Note the change of scale at 1500 m depth.

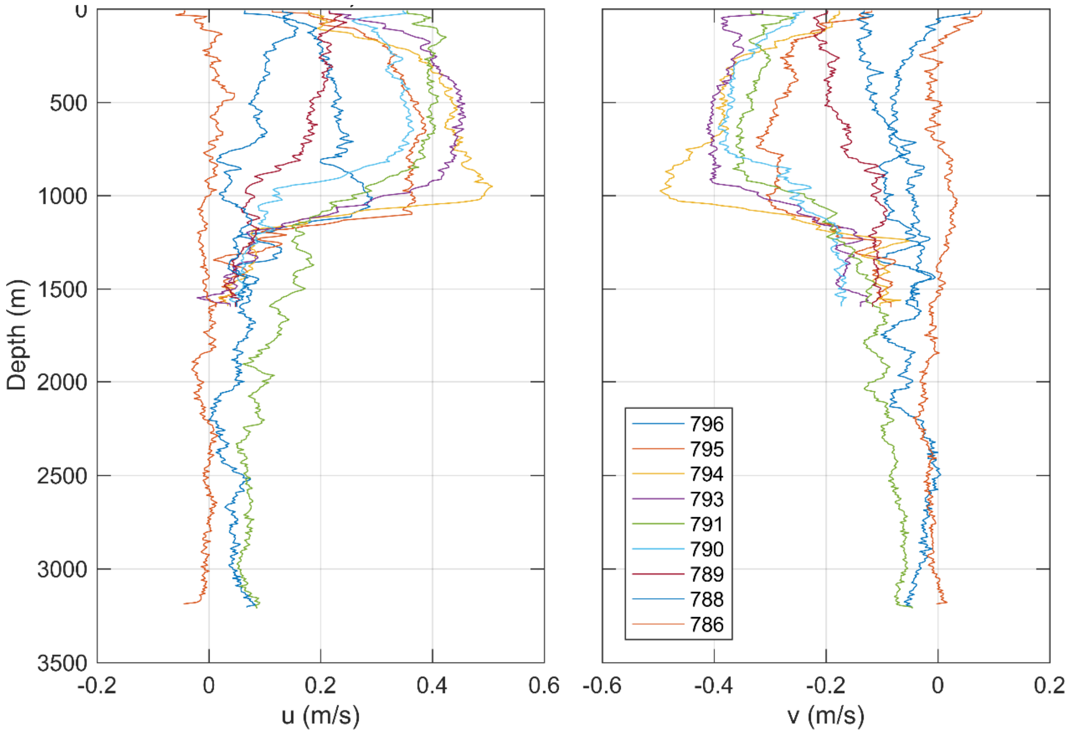


Figure 17. Vertical profiles of the east (u) and north (v) component of the velocity measured by the LADCP at selected stations during the LBE survey.

11. Appendix A: Cruise Narrative

2 Sep 2017, Saturday

RV Kristine Bonnevie (KB hereafter) departed from Bergen at 10:00 local time (LT = UTC+2h).

Fueling at Skålevik until 12:00

Start steaming to PL6 acoustic source mooring site

Started VMADCP using the UHDAS software, using 8 m bins.

3 Sep 2017, Sunday

Algot & Helge installed the LADCPs

Ilker set up the LADCP PC and the cabling.

Around 23:00 the engine stopped. The machine chief found a temporary solution, but recommended repair by experts, and we decided to steam back to Ålesund to fix it. Later in the night, he detected the reason for the failure and was confident that the engine would get us through the cruise. We proceed back to PL6.

4 Sep 2017, Monday

Transit to sound source PL6

PL6 released 0630 UTC, on deck 0830 (2500 m rope).

Steaming to PL1

At 2130 UTC one RAFOS float is recovered en route to PL1.

5 Sep 2017, Tuesday

Transit to PL1

6 Sep 2017, Wednesday

Arrived at PL1; released at 0440 UTC

Prepared Seaglider SG564 (PI K. Våge). Self test OK. Confirmed by pilot Idar Hessevik, at 13:30 UTC.

Steaming to launch site approx. 60 km west (70N, 0E45) of the LBE core. Note that the glider will be left unattended during the night (left to drift), and will be taken over by pilot Ailin Brakstad, visitng at WHOI, to conduct initial dives.

We performed two simulations with Gnå. All good. Vacuum a bit high (10 mm/Hg) but OK.

The dockserver #40 worked successfully (#46 was OK except the data visualizer did not work).

MR on Gnå flashed LED as expected.

SG564 deployed successfully at 1600 UTC, approx. 70N, 0E45

Gnå deployed, following SG564, at 1630 UTC.

First dive to 30 m with servo (OK)

Second dive to 100 m with servo. Obtain the batt position for the ideal pitch angle of about 26deg.

Gnå battpos fixed -0.30 → -26deg, dive; -0.68 → +20deg, climb

CTD taken after Gnå deployment, sta781, 1000 m only.

Gnå has issues with Iridium connection. We receive very few calls. She does send some positions through ARGOS. (From later, we know that the mission proceeds without aborts.)

7 Sep 2017, Thursday

En route to PL3 we recovered 2 RAFOS floats

Recovered PL3 at 1830 UTC (on deck)

8 Sep 2017, Friday

Gnå called again for a short time (at approx. 00 UTC)

Arrived at MS position. We start with CTD sta782 (0545 UTC) before recovery

MS released 0620 UTC

Unfortunately only release, SG 1898 and 4 glass spheres surfaced. No other instruments. The mooring line was cut, possibly by a trawler.

MSs released 0720 UTC. All OK.

The remnants of MN are recovered with no loss of instrument. Released 0900 UTC. Note the upper part of the mooring was adrift in Aug 16 and were recovered. (Possibly cut by a trawler)

MNs released 1000 UTC. All OK.

CTD before MW recovery, sta783

MW released 1210 UTC.

Arrived at MB position 1900 UTC. The releaser did not respond. Decided to wait until early morning (light) and release. Release was successful.

9 Sep 2017, Saturday

MB released (0410 UTC) and recovered successfully. All instruments are recovered. Upper SBE37 6097 and SBE56 4252 (70-80m) were at the same depth (possibly SBE56 slided). Above the LR buoy, SBE37 5452 (750m) and SBE56 4322 (600m) were at the same depth (close to the buoy).

Steaming to PL4

Installed all mooring SBE instruments (37, 39, 56), except 350m-rated SBE37 13357 on CTD rosette for a calibration cast. On upcast stopped at 3 levels and waited for approx. 15 min. SBE37 sampling is 5 min and SBE56 sampling is 10 s. CTD cast is sta0785.

Stop	Depth (m)	UTC	T (T90C)	S (psu)
1	850	1231	0	34.9
2	225	1257	5.44	35.12
3	15	1316	9.58	35.03

10 Sep 2017, Sunday

PL5 recovered at 0830 UTC.

Transit to outer station at 80 km from eddy core (inferred from a Seaglider).

En route ,we assembled VMP2000 and the winch. Winch slip-ring to data cable connector is damaged. Replaced with a spare.

We start the eddy section. Labelling RXX where XX is the km distance from eddy core (inferred from Seaglider at site). This center was found to be 2 km off from the center later detected by VMADPC.

R80: CTD/LADCP full depth, sta786, 2230 UTC followed by VMP2000 to 1500 m (vmp_001)

11 Sep 2017, Monday

Took R80, R60, R45, R30, R20, R15, R10, R5

At R80, during the recovery of vmp_001, the winch broke. Upon inspection we found the part driving the winch was loose. Fixed it, but missed a vmp cast at R80

12 Sep 2017, Tuesday

VMP winch broke again during the upcast of vmp_004 (R20). The damage is serious and must be fixed by the manufacturer. We temporarily fixed it to serve the rest of the programme.

Took R0.

Recovered Gnå using work boat, 0430 UTC

Took a deep VMP2000 at R0 (VMADCP derived center) down to 1500 m (vmp_010)

After VMPstation, we recovered 4 RAFOS floats which were trapped in the eddy.

The Seaglider SG562 was recovered t 1615 UTC, 70N 0.54’, 002E 3.449’.

After the recovery we work a VMADCP section, from the eddy center to 60 nm south. Course 180T, speed 8 knots. Start about 1630 UTC.

13 Sep 2017, Wednesday

VMADCP survey completed about 01 UTC.

Transit to PL2

PL2 recovered at 05 UTC

Transit to Bergen.

12. Appendix B: List of CTD stations

Table 4. List of CTD stations. Echo depth is from the ship's echo sounder corrected for transducer depth and depth averaged (adjusted for full depth) speed of sound. Last two columns indicate the cast number in file names for corresponding master/slave LADCP and VMP2000 profiles (e.g., staXXX_LADCPM.000, VMP_0XX.p, etc.)

CTD	Station	Date	Time (UTC)	LAT	LON	EDepth (m)	LADCP	VMP-2000
781	W60	2017-09-06	18:18	70N10.96	000E46.77	3234	-	-
782	MS	2017-09-08	05:46	68N50.26	012E45.48	670	782	-
783	MW	2017-09-08	10:53	68N58.59	013E17.48	1432	783	-
784	MB	2017-09-08	20:28	69N52.81	011E12.83	2912	784	-
786	R80	2017-09-10	22:30	70N35.57	003E39.75	3194	786	1
787	R80	2017-09-11	02:10	70N35.57	003E39.72	3201	-	-
788	R60	2017-09-11	03:43	70N27.96	003E17.36	3212	788	-
789	R45	2017-09-11	05:47	70N22.17	003E00.56	3217	789	2
790	R30	2017-09-11	09:11	70N13.44	002E48.59	3216	790	3
791	R20	2017-09-11	12:15	70N09.63	002E37.39	3215	791	4
792	R20	2017-09-11	15:58	70N09.64	002E37.47	3216	-	-
793	R15	2017-09-11	16:44	70N07.70	002E31.87	3214	793	5
794	R10	2017-09-11	18:46	70N05.80	002E26.26	3212	794	6
795	R5	2017-09-11	20:53	70N03.91	002E20.65	3213	795	7
796	R0	2017-09-11	23:01	70N02.00	002E15.01	3215	796	9
797	R0	2017-09-12	02:22	70N02.00	002E15.02	3215	-	-

13. Appendix C: List of VMP stations

Table 5. List of the VMP2000 deployments. Echo depth (ED) is from the ship's echo sounder. Start and end pressures mark the reading on the VMP data acquisition software when started and stopped logging. CTD file is the corresponding ship CTD cast taken before the VMP deployment.

Cast	Sta.	Date, Time (UTC)		LAT	LON	ED (m)	Start (m)	End (m)	CTD File	Comments
1	R80	2017-09-11	00:40	70N35.57	03E39.75	3194	2.0	1560	786	During recovery, the winch axel driver losened. Fixed it (and lost station R60)
2	R45	2017-09-11	07:00	70N22.17	03E00.56	3217	2.0	1499	789	-
3	R30	2017-09-11	10:23	70N13.44	02E48.59	3216	2.0	1617	790	-
4	R20	2017-09-11	14:29	70N09.63	02E37.39	3215	2.0	1602	791	winch broken again- temporarily fixed
5	R15	2017-09-11	17:58	70N07.70	02E31.87	3214	2.0	460	793	-
6	R10	2017-09-11	19:58	70N05.80	02E26.26	3212	2.0	373	794	-
7	R5	2017-09-11	22:03	70N03.91	02E20.65	3213	2.0	482	795	
8	R0	2017-09-12	01:02	70N02.00	02E15.01	3215	2.0	3	-	do not process (no data)
9	R0	2017-09-12	01:03	70N02.00	02E15.01	3215	2.0	1668	796	-
10	R0	2017-09-12	06:06	70N00.74	02E11.51	3214	2.0	1488	-	

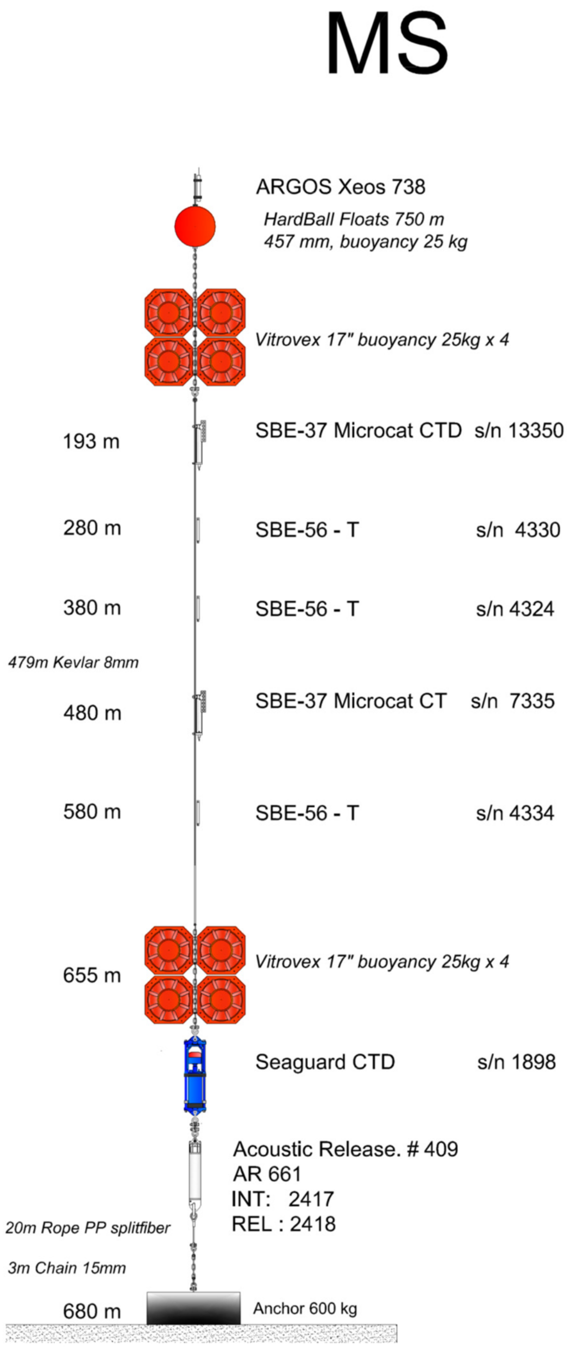
14. Appendix D: List of water sampling

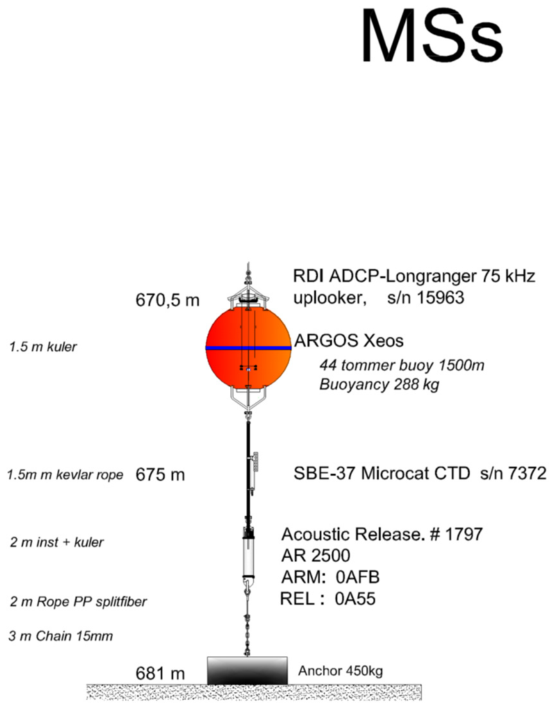
Cast	St Name	Date-UTC	Time (UTC)	LAT	LON	ED (m)	Sample Depth	Salinity Case/Bot.	Ct/At Bottle	Nutrient Bottle
781	W60	2017-09-06	18:38	70N10.96	000E46.77	3234	1000	112/2733	-	KB781-1
781	W60	2017-09-06	18:47	70N10.96	000E46.77	3234	499	-/-	-	KB781-2
781	W60	2017-09-06	18:51	70N10.96	000E46.77	3234	202	-/-	-	KB781-6
781	W60	2017-09-06	18:52	70N10.96	000E46.77	3234	148	-/-	-	KB781-7
781	W60	2017-09-06	18:53	70N10.96	000E46.77	3234	100	-/-	-	KB781-8
781	W60	2017-09-06	18:54	70N10.96	000E46.77	3234	74	-/-	-	KB781-9
781	W60	2017-09-06	18:54	70N10.96	000E46.77	3234	50	-/-	-	KB781-10
781	W60	2017-09-06	18:55	70N10.96	000E46.77	3234	29	-/-	-	KB781-11
781	W60	2017-09-06	18:55	70N10.96	000E46.77	3234	10	-/-	-	KB781-12
782	MS	2017-09-08	05:57	68N50.26	012E45.48	670	558	112/2734	A1	KB782-1
782	MS	2017-09-08	06:02	68N50.26	012E45.48	670	302	-/-	A2	KB782-2
782	MS	2017-09-08	06:04	68N50.26	012E45.48	670	199	-/-	-	KB782-6
782	MS	2017-09-08	06:05	68N50.26	012E45.48	670	150	-/-	-	KB782-7
782	MS	2017-09-08	06:06	68N50.26	012E45.48	670	99	-/-	A3	KB782-8
782	MS	2017-09-08	06:06	68N50.26	012E45.48	670	74	-/-	-	KB782-9
782	MS	2017-09-08	06:07	68N50.26	012E45.48	670	51	-/-	A4	KB782-10
782	MS	2017-09-08	06:09	68N50.26	012E45.48	670	30	-/-	-	KB782-11
782	MS	2017-09-08	06:09	68N50.26	012E45.48	670	11	-/-	A5	KB782-12
783	MW	2017-09-08	11:20	68N58.59	013E17.48	1432	1402	112/2735	A6	KB783-1
783	MW	2017-09-08	11:26	68N58.59	013E17.48	1432	1001	-/-	A7	KB783-2
783	MW	2017-09-08	11:35	68N58.59	013E17.48	1432	500	-/-	-	KB783-6
783	MW	2017-09-08	11:38	68N58.59	013E17.48	1432	299	-/-	A8	KB783-7
783	MW	2017-09-08	11:42	68N58.59	013E17.48	1432	101	-/-	A9	KB783-8
783	MW	2017-09-08	11:43	68N58.59	013E17.48	1432	75	-/-	-	KB783-9
783	MW	2017-09-08	11:44	68N58.59	013E17.48	1432	51	-/-	A10	KB783-10
783	MW	2017-09-08	11:44	68N58.59	013E17.48	1432	31	-/-	-	KB783-11
783	MW	2017-09-08	11:45	68N58.59	013E17.48	1432	11	-/-	A11	KB783-12
784	MB	2017-09-08	21:20	69N52.81	011E12.83	2912	2894	112/2736	A12	KB784-1
784	MB	2017-09-08	21:31	69N52.81	011E12.83	2912	2301	-/-	B1	KB784-2
784	MB	2017-09-08	21:45	69N52.81	011E12.83	2912	1501	-/-	-	KB784-6
784	MB	2017-09-08	21:54	69N52.81	011E12.83	2912	999	-/-	B2	KB784-7
784	MB	2017-09-08	22:02	69N52.81	011E12.83	2912	501	-/-	-	KB784-8
784	MB	2017-09-08	22:05	69N52.81	011E12.83	2912	301	-/-	B3	KB784-9
784	MB	2017-09-08	22:09	69N52.81	011E12.83	2912	102	-/-	B4	KB784-10
784	MB	2017-09-08	22:10	69N52.81	011E12.83	2912	51	-/-	B5	KB784-11
784	MB	2017-09-08	22:11	69N52.81	011E12.83	2912	11	-/-	B6	KB784-12
786	R80	2017-09-10	23:29	70N35.57	003E39.75	3194	3183	112/2737	B7	KB786-1
786	R80	2017-09-10	23:45	70N35.57	003E39.75	3194	2300	-/-	B8	KB786-2
786	R80	2017-09-10	23:59	70N35.57	003E39.75	3194	1500	-/-	B9	KB786-6
786	R80	2017-09-11	00:09	70N35.57	003E39.75	3194	1000	-/-	B10	KB786-7
786	R80	2017-09-11	00:17	70N35.57	003E39.75	3194	500	-/-	B11	KB786-8
786	R80	2017-09-11	00:23	70N35.57	003E39.75	3194	201	-/-	B12	KB786-9
786	R80	2017-09-11	00:25	70N35.57	003E39.75	3194	100	-/-	C1	KB786-10
786	R80	2017-09-11	00:26	70N35.57	003E39.75	3194	51	-/-	C2	KB786-11
786	R80	2017-09-11	00:27	70N35.57	003E39.75	3194	11	-/-	C3	KB786-12
787	R80	2017-09-11	02:16	70N35.57	003E39.72	3201	300	-/-	-	KB787-1
787	R80	2017-09-11	02:18	70N35.57	003E39.72	3201	250	-/-	-	KB787-2
787	R80	2017-09-11	02:19	70N35.57	003E39.72	3201	201	-/-	-	KB787-6
787	R80	2017-09-11	02:20	70N35.57	003E39.72	3201	150	-/-	-	KB787-7

Cast	St Name	Date-UTC	Time (UTC)	LAT	LON	ED (m)	Sample Depth	Salinity Case/Bot.	Ct/At Bottle	Nutrient Bottle
787	R80	2017-09-11	02:22	70N35.57	003E39.72	3201	100	-/-	-	KB787-8
787	R80	2017-09-11	02:22	70N35.57	003E39.72	3201	76	-/-	-	KB787-9
787	R80	2017-09-11	02:23	70N35.57	003E39.72	3201	50	-/-	-	KB787-10
787	R80	2017-09-11	02:24	70N35.57	003E39.72	3201	31	-/-	-	KB787-11
787	R80	2017-09-11	02:25	70N35.57	003E39.72	3201	11	-/-	-	KB787-12
788	R60	2017-09-11	04:10	70N27.96	003E17.36	3212	1502	112/2738	-	KB788-1
788	R60	2017-09-11	04:20	70N27.96	003E17.36	3212	999	-/-	-	KB788-2
788	R60	2017-09-11	04:29	70N27.96	003E17.36	3212	499	-/-	-	KB788-6
788	R60	2017-09-11	04:35	70N27.96	003E17.36	3212	199	-/-	-	KB788-7
788	R60	2017-09-11	04:38	70N27.96	003E17.36	3212	101	-/-	C4	KB788-8
788	R60	2017-09-11	04:39	70N27.96	003E17.36	3212	75	-/-	-	KB788-9
788	R60	2017-09-11	04:39	70N27.96	003E17.36	3212	50	-/-	C5	KB788-10
788	R60	2017-09-11	04:40	70N27.96	003E17.36	3212	30	-/-	-	KB788-11
788	R60	2017-09-11	04:41	70N27.96	003E17.36	3212	10	-/-	C6	KB788-12
789	R45	2017-09-11	06:15	70N22.17	003E00.56	3217	1499	112/2739	-	KB789-1
789	R45	2017-09-11	06:25	70N22.17	003E00.56	3217	1001	-/-	-	KB789-2
789	R45	2017-09-11	06:35	70N22.17	003E00.56	3217	501	-/-	-	KB789-6
789	R45	2017-09-11	06:41	70N22.17	003E00.56	3217	201	-/-	-	KB789-7
789	R45	2017-09-11	06:44	70N22.17	003E00.56	3217	101	-/-	C7	KB789-8
789	R45	2017-09-11	06:45	70N22.17	003E00.56	3217	76	-/-	-	KB789-9
789	R45	2017-09-11	06:46	70N22.17	003E00.56	3217	51	-/-	C8	KB789-10
789	R45	2017-09-11	06:47	70N22.17	003E00.56	3217	32	-/-	-	KB789-11
789	R45	2017-09-11	06:48	70N22.17	003E00.56	3217	10	-/-	C9	KB789-12
790	R30	2017-09-11	09:40	70N13.44	002E48.59	3216	1501	112/2740	-	KB790-1
790	R30	2017-09-11	09:49	70N13.45	002E48.59	3216	999	-/-	C10	KB790-2
790	R30	2017-09-11	09:59	70N13.46	002E48.59	3216	501	-/-	C11	KB790-6
790	R30	2017-09-11	10:05	70N13.47	002E48.59	3216	202	-/-	C12	KB790-7
790	R30	2017-09-11	10:08	70N13.48	002E48.59	3216	102	-/-	D1	KB790-8
790	R30	2017-09-11	10:09	70N13.49	002E48.59	3216	76	-/-	-	KB790-9
790	R30	2017-09-11	10:10	70N13.50	002E48.59	3216	50	-/-	D2	KB790-10
790	R30	2017-09-11	10:10	70N13.51	002E48.59	3216	29	-/-	-	KB790-11
790	R30	2017-09-11	10:11	70N13.52	002E48.59	3216	11	-/-	D3	KB790-12
791	R20	2017-09-11	13:15	70N09.63	002E37.39	3215	3206	112/2741	D4	KB791-1
791	R20	2017-09-11	13:32	70N09.63	002E37.39	3215	2298	-/-	D5	KB791-2
791	R20	2017-09-11	13:48	70N09.63	002E37.39	3215	1500	-/-	D6	KB791-6
791	R20	2017-09-11	13:57	70N09.63	002E37.39	3215	999	-/-	D7	KB791-7
791	R20	2017-09-11	14:05	70N09.63	002E37.39	3215	502	-/-	D8	KB791-8
791	R20	2017-09-11	14:11	70N09.63	002E37.39	3215	203	-/-	D9	KB791-9
791	R20	2017-09-11	14:14	70N09.63	002E37.39	3215	99	-/-	D10	KB791-10
791	R20	2017-09-11	14:15	70N09.63	002E37.39	3215	52	-/-	D11	KB791-11
791	R20	2017-09-11	14:17	70N09.63	002E37.39	3215	10	-/-	D12	KB791-12
792	R20	2017-09-11	16:04	70N09.64	002E37.47	3216	300	-/-	-	kb792-1
792	R20	2017-09-11	16:05	70N09.64	002E37.47	3216	251	-/-	-	kb792-2
792	R20	2017-09-11	16:07	70N09.64	002E37.47	3216	201	-/-	-	kb792-6
792	R20	2017-09-11	16:08	70N09.64	002E37.47	3216	153	-/-	-	kb792-7
792	R20	2017-09-11	16:10	70N09.64	002E37.47	3216	102	-/-	-	kb792-8
792	R20	2017-09-11	16:11	70N09.64	002E37.47	3216	74	-/-	-	kb792-9
792	R20	2017-09-11	16:12	70N09.64	002E37.47	3216	51	-/-	-	kb792-10
792	R20	2017-09-11	16:13	70N09.64	002E37.47	3216	31	-/-	-	kb792-11
792	R20	2017-09-11	16:14	70N09.64	002E37.47	3216	9	-/-	-	kb792-12
793	R15	2017-09-11	17:14	70N07.70	002E31.87	3214	1499	112/2742	-	kb793-1

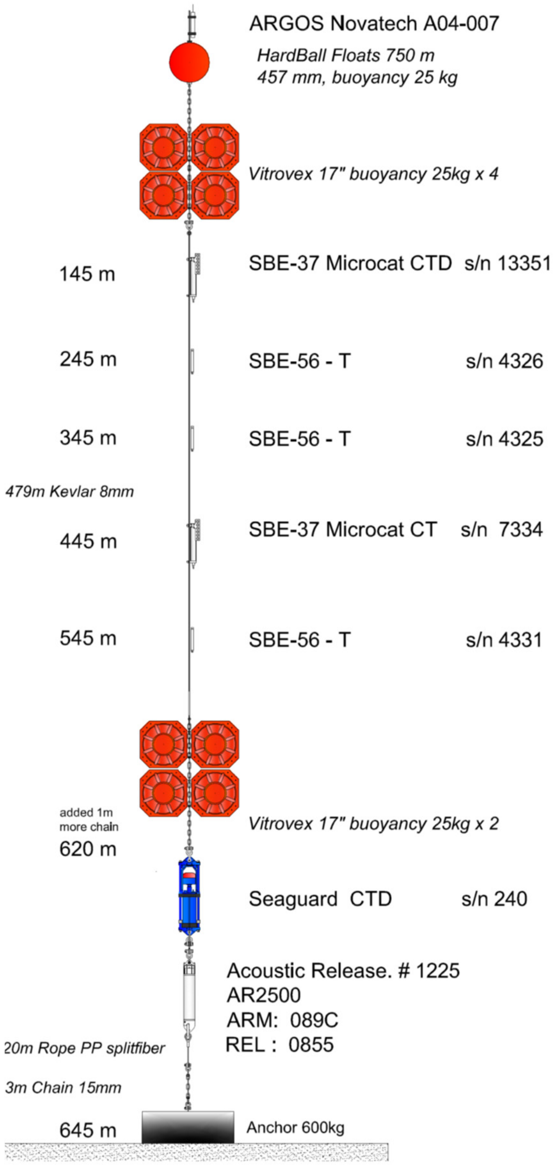
Cast	St Name	Date-UTC	Time (UTC)	LAT	LON	ED (m)	Sample Depth	Salinity Case/Bot.	Ct/At Bottle	Nutrient Bottle
793	R15	2017-09-11	17:23	70N07.71	003E31.88	3214	996	-/-	E1	kb793-2
793	R15	2017-09-11	17:33	70N07.72	004E31.89	3214	503	-/-	E2	kb793-6
793	R15	2017-09-11	17:40	70N07.73	005E31.90	3214	205	-/-	E3	kb793-7
793	R15	2017-09-11	17:42	70N07.74	006E31.91	3214	101	-/-	E4	kb793-8
793	R15	2017-09-11	17:43	70N07.75	007E31.92	3214	76	-/-	-	kb793-9
793	R15	2017-09-11	17:44	70N07.76	008E31.93	3214	51	-/-	E5	kb793-10
793	R15	2017-09-11	17:45	70N07.77	009E31.94	3214	31	-/-	-	kb793-11
793	R15	2017-09-11	17:46	70N07.78	010E31.95	3214	10	-/-	E6	kb793-12
794	R10	2017-09-11	19:16	70N05.80	002E26.26	3212	1500	112/2743	-	kb794-1
794	R10	2017-09-11	19:25	70N05.80	002E26.26	3212	998	-/-	E7	kb794-2
794	R10	2017-09-11	19:35	70N05.80	002E26.26	3212	502	-/-	E8	kb794-6
794	R10	2017-09-11	19:43	70N05.80	002E26.26	3212	204	-/-	E9	kb794-7
794	R10	2017-09-11	19:45	70N05.80	002E26.26	3212	103	-/-	E10	kb794-8
794	R10	2017-09-11	19:46	70N05.80	002E26.26	3212	76	-/-	-	kb794-9
794	R10	2017-09-11	19:47	70N05.80	002E26.26	3212	49	-/-	E11	kb794-10
794	R10	2017-09-11	19:48	70N05.80	002E26.26	3212	29	-/-	-	kb794-11
794	R10	2017-09-11	19:49	70N05.80	002E26.26	3212	10	-/-	E12	kb794-12
795	R5	2017-09-11	21:22	70N03.91	002E20.65	3213	1500	112/2744	-	KB795-1
795	R5	2017-09-11	21:32	70N03.91	002E20.65	3213	999	-/-	-	KB795-2
795	R5	2017-09-11	21:41	70N03.91	002E20.65	3213	500	-/-	-	KB795-6
795	R5	2017-09-11	21:48	70N03.91	002E20.65	3213	201	-/-	-	KB795-7
795	R5	2017-09-11	21:50	70N03.91	002E20.65	3213	101	-/-	F1	KB795-8
795	R5	2017-09-11	21:51	70N03.91	002E20.65	3213	76	-/-	-	KB795-9
795	R5	2017-09-11	21:52	70N03.91	002E20.65	3213	49	-/-	F2	KB795-10
795	R5	2017-09-11	21:53	70N03.91	002E20.65	3213	30	-/-	-	KB795-11
795	R5	2017-09-11	21:54	70N03.91	002E20.65	3213	10	-/-	F3	KB795-12
796	R0	2017-09-12	00:00	70N02.00	002E15.01	3215	3203	112/2745	F4	KB796-1
796	R0	2017-09-12	00:16	70N02.00	002E15.01	3215	2299	-/-	F5	KB796-2
796	R0	2017-09-12	00:28	70N02.00	002E15.01	3215	1499	-/-	F6	KB796-6
796	R0	2017-09-12	00:37	70N02.00	002E15.01	3215	999	-/-	F7	KB796-7
796	R0	2017-09-12	00:46	70N02.00	002E15.01	3215	499	-/-	F8	KB796-8
796	R0	2017-09-12	00:51	70N02.00	002E15.01	3215	200	-/-	F9	KB796-9
796	R0	2017-09-12	00:53	70N02.00	002E15.01	3215	100	-/-	F10	KB796-10
796	R0	2017-09-12	00:54	70N02.00	002E15.01	3215	49	-/-	F11	KB796-11
796	R0	2017-09-12	00:56	70N02.00	002E15.01	3215	10	-/-	F12	KB796-12
797	R0	2017-09-12	02:29	70N02.00	002E15.02	3215	301	-/-	-	KB797-1
797	R0	2017-09-12	02:30	70N02.00	002E15.02	3215	250	-/-	-	KB797-2
797	R0	2017-09-12	02:31	70N02.00	002E15.02	3215	200	-/-	-	KB797-6
797	R0	2017-09-12	02:33	70N02.00	002E15.02	3215	149	-/-	-	KB797-7
797	R0	2017-09-12	02:34	70N02.00	002E15.02	3215	100	-/-	-	KB797-8
797	R0	2017-09-12	02:35	70N02.00	002E15.02	3215	75	-/-	-	KB797-9
797	R0	2017-09-12	02:36	70N02.00	002E15.02	3215	50	-/-	-	KB797-10
797	R0	2017-09-12	02:37	70N02.00	002E15.02	3215	29	-/-	-	KB797-11
797	R0	2017-09-12	02:37	70N02.00	002E15.02	3215	11	-/-	-	KB797-12

15. Appendix E: Mooring drawings

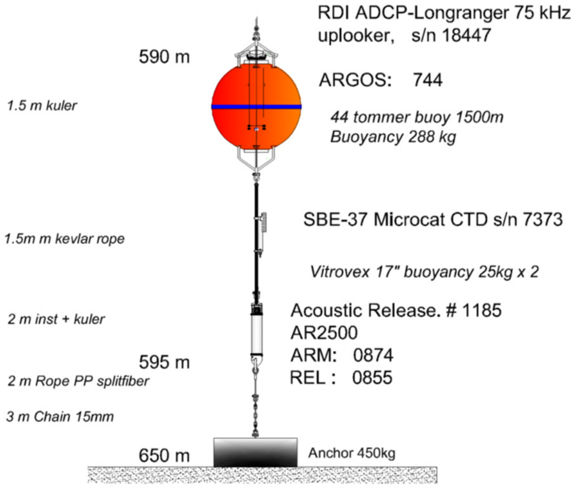

MS


MSs

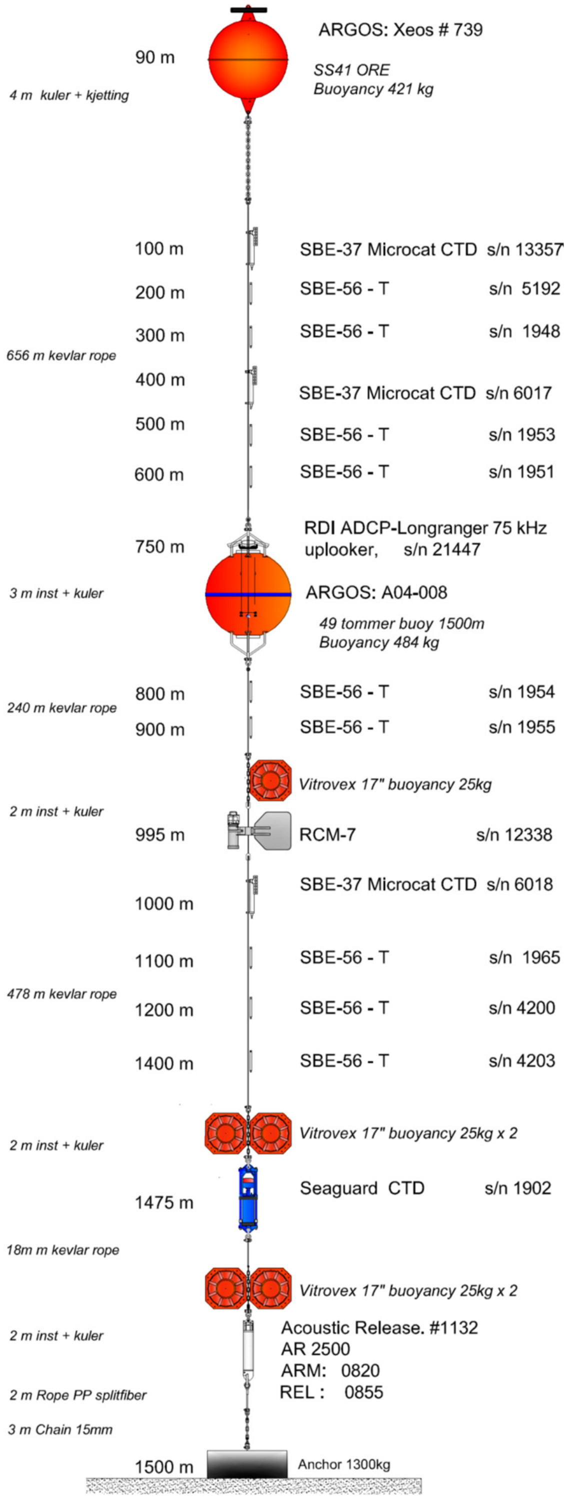
MN


ARGOS Novatech A04-007
HardBall Floats 750 m
457 mm, buoyancy 25 kg
Vitrovex 17" buoyancy 25kg x 4
145 m
SBE-37 Microcat CTD s/n 13351
245 m
SBE-56 - T s/n 4326
345 m
SBE-56 - T s/n 4325
479m Kevlar 8mm
445 m
SBE-37 Microcat CT s/n 7334
545 m
SBE-56 - T s/n 4331
added 1m more chain
620 m
Vitrovex 17" buoyancy 25kg x 2
Seaguard CTD s/n 240
Acoustic Release. # 1225
AR2500
ARM: 089C
REL : 0855
20m Rope PP splitfiber
3m Chain 15mm
645 m
Anchor 600kg

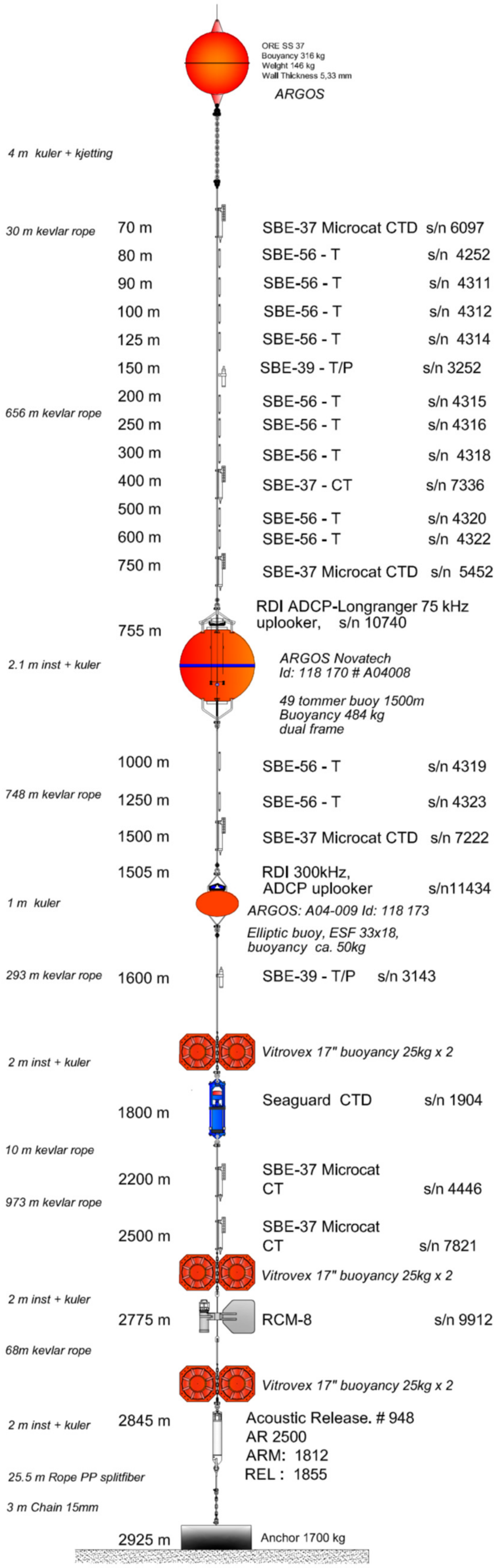
MNs


RDI ADCP-Longranger 75 kHz
uplooker, s/n 18447
590 m
ARGOS: 744
1.5 m kuler
44 tommer buoy 1500m
Buoyancy 288 kg
SBE-37 Microcat CTD s/n 7373
1.5m m kevlar rope
Vitrovex 17" buoyancy 25kg x 2
2 m inst + kuler
Acoustic Release. # 1185
AR2500
ARM: 0874
REL : 0855
595 m
2 m Rope PP splitfiber
3 m Chain 15mm
650 m
Anchor 450kg

MW


90 m
ARGOS: Xeos # 739
SS41 ORE
Buoyancy 421 kg
4 m kuler + kjetting
100 m
SBE-37 Microcat CTD s/n 13357
200 m
SBE-56 - T s/n 5192
300 m
SBE-56 - T s/n 1948
656 m kevlar rope
400 m
SBE-37 Microcat CTD s/n 6017
500 m
SBE-56 - T s/n 1953
600 m
SBE-56 - T s/n 1951
750 m
RDI ADCP-Longranger 75 kHz
uplooker, s/n 21447
3 m inst + kuler
ARGOS: A04-008
49 tommer buoy 1500m
Buoyancy 484 kg
800 m
SBE-56 - T s/n 1954
240 m kevlar rope
900 m
SBE-56 - T s/n 1955
Vitrovex 17" buoyancy 25kg
2 m inst + kuler
995 m
RCM-7 s/n 12338
SBE-37 Microcat CTD s/n 6018
1000 m
1100 m
SBE-56 - T s/n 1965
478 m kevlar rope
1200 m
SBE-56 - T s/n 4200
1400 m
SBE-56 - T s/n 4203
Vitrovex 17" buoyancy 25kg x 2
2 m inst + kuler
1475 m
Seaguard CTD s/n 1902
18m m kevlar rope
Vitrovex 17" buoyancy 25kg x 2
2 m inst + kuler
Acoustic Release. #1132
AR 2500
ARM: 0820
REL : 0855
2 m Rope PP splitfiber
3 m Chain 15mm
1500 m
Anchor 1300kg

MB


ORE SS 37
Bouyancy 316 kg
Weight 146 kg
Wall Thickness 5,33 mm
ARGOS
4 m kuler + kjetting
30 m kevlar rope
70 m
SBE-37 Microcat CTD s/n 6097
80 m
SBE-56 - T s/n 4252
90 m
SBE-56 - T s/n 4311
100 m
SBE-56 - T s/n 4312
125 m
SBE-56 - T s/n 4314
150 m
SBE-39 - T/P s/n 3252
656 m kevlar rope
200 m
SBE-56 - T s/n 4315
250 m
SBE-56 - T s/n 4316
300 m
SBE-56 - T s/n 4318
400 m
SBE-37 - CT s/n 7336
500 m
SBE-56 - T s/n 4320
600 m
SBE-56 - T s/n 4322
750 m
SBE-37 Microcat CTD s/n 5452
RDI ADCP-Longranger 75 kHz
uplooker, s/n 10740
755 m
2.1 m inst + kuler
ARGOS Novatech
Id: 118 170 # A04008
49 tommer buoy 1500m
Buoyancy 484 kg
dual frame
1000 m
SBE-56 - T s/n 4319
748 m kevlar rope
1250 m
SBE-56 - T s/n 4323
1500 m
SBE-37 Microcat CTD s/n 7222
1505 m
RDI 300kHz,
ADCP uplooker s/n11434
1 m kuler
ARGOS: A04-009 Id: 118 173
Elliptic buoy, ESF 33x18,
buoyancy ca. 50kg
293 m kevlar rope
1600 m
SBE-39 - T/P s/n 3143
Vitrovex 17" buoyancy 25kg x 2
2 m inst + kuler
Seaguard CTD s/n 1904
1800 m
10 m kevlar rope
2200 m
SBE-37 Microcat
CT s/n 4446
973 m kevlar rope
2500 m
SBE-37 Microcat
CT s/n 7821
Vitrovex 17" buoyancy 25kg x 2
2 m inst + kuler
2775 m
RCM-8 s/n 9912
68m kevlar rope
Vitrovex 17" buoyancy 25kg x 2
2 m inst + kuler
2845 m
Acoustic Release. # 948
AR 2500
ARM: 1812
REL : 1855
25.5 m Rope PP splitfiber
3 m Chain 15mm
2925 m
Anchor 1700 kg

16. Appendix F: LADCP Deployment Files

Table 6. Master LADCP deployment file

```
; Append command to the log file
$LC:\HM2016611\ladcp\Mladcp_log.txt
$P
*********************************************
$P** LADCP Master. Looking down (firmware v16.3) ***
$P ***Master and Slave will ping at the same time **
$P *** staggered single-ping ensembles every 0.8/1.2 s *
$P ********************************************
; Send ADCP a BREAK
$B
; Wait for command prompt (sent after each command)
$W62
; Display real time clock setting
tt?
$W62
; Set to factory defaults
CR1
$W62
; use WM15 for firmware 16.3
; activates LADCP mode (BT from WT pings)
WM15
; Flow control (Record data internally):
; - automatic ensemble cycling (next ens when ready)
; - automatic ping cycling (ping when ready)
; - binary data output
; - disable serial output
; - enable data recorder
CF11101
$W62
; coordinate transformation:
; - radial beam coordinates (2 bits)
; - use pitch/roll (not used for beam coords?)
; - no 3-beam solutions
; - no bin mapping
EX00100
$W62
; Sensor source:
; - manual speed of sound (EC)
; - manual depth of transducer (ED = 0 [dm])
; - measured heading (EH)
; - measured pitch (EP)
; - measured roll (ER)
; - manual salinity (ES = 35 [psu])
; - measured temperature (ET)
EZ0011101
$W62
; - configure staggered ping-cycle
; ensembles per burst
TC2
$W62
; pings per ensemble
WP1
$W62
; time per burst
TB 00:00:01.20
$W62
; time per ensemble
TE 00:00:00.80
$W62
; time between pings
TP 00:00.00
$W62
; - configure no. of bins, length, blank
; number of bins
WN015
$W62
; bin length [cm]
WS0800
$W62
; blank after transmit [cm]
WF0000
$W62
; ambiguity velocity [cm]
WV250
$W62
; amplitude and correlation thresholds for bottom detection
LZ30,220
$W62
; Set ADCP to narrow bandwidth and extend range by 10%
LW1
$W62
; Name data file
RN MLADCP
$W62
; SET AS MASTER ADCP
SM1
$W62
; TRANSMITS SYNCHRONIZING PULSE BEFORE EACH ENSEMBLE
SA011
$W62
; WAIT .55 s after sending sync pulse
SW05500
$W62
; SYNCHRONIZING PULSE SENT ON EVERY PING
SI0
$W62
; keep params as user defaults (across power failures)
CK
$W62
; echo configuration
T?
$W62
W?
$W62
; start Pinging
CS
; Delay 3 seconds
$D3
$p **************************************
$P Please disconnect the ADCP from the computer.
$p **************************************
; Close the log file
$L
```

Table 7. Slave LADCP deployment file

```
; Append command to the log file
$LC:\HM2016611\ladcp\Sladcp_log.txt
$P ********************************************
$P ***** LADCP SLAVE. Looking UP (firmware v16.30) **
$P *** Master and Slave will ping at the same time ******
$P ** staggered single-ping ensembles every 0.8/1.2 s ****
$P *******************************************
; Send ADCP a BREAK
$B
% Wait for the command prompt; BBTalk needs this before each command
$W62
; Display real time clock setting
tt?
$W62
; Set to factory defaults
CR1
$W62
; use WM15 for firmware 16.3
; activates LADCP mode (BT from WT pings)
WM15
$W62
; Flow control (Record data internally):
; - automatic ensemble cycling (next ens when ready)
; - automatic ping cycling (ping when ready)
; - binary data output
; - disable serial output
; - enable data recorder
CF11101
$W62
; coordinate transformation:
; - radial beam coordinates (2 bits)
; - use pitch/roll (not used for beam coords?)
; - no 3-beam solutions
; - no bin mapping
EX00100
$W62
; Sensor source:
; - manual speed of sound (EC)
; - manual depth of transducer (ED = 0 [dm])
; - measured heading (EH)
; - measured pitch (EP)
; - measured roll (ER)
; - manual salinity (ES = 35 [psu])
; - measured temperature (ET)
EZ0011101
$W62
; - configure staggered ping-cycle
; ensembles per burst
TC2
$W62
; pings per ensemble
WP1
$W62
; time per burst
TB 00:00:01.20
$W62
; time per ensemble
TE 00:00:00.80
$W62
; time between pings
TP 00:00.00
$W62
; - configure no. of bins, length, blank
; number of bins
WN015
$W62
; bin length [cm]
WS0800
$W62
; blank after transmit [cm]
WF0000
$W62
; ambiguity velocity [cm]
WV250
$W62
; amplitude and correlation thresholds for bottom detection
LZ30,220
$W62
; Set ADCP to narrow bandwidth and extend range by 10%
LW1
$W62
; Name data file
RN SLADCP
$W62
; SET AS SLAVE ADCP
SM2
$W62
; TRANSMITS SYNCHRONIZING PULSE BEFORE EACH ENSEMBLE
SA011
$W62
; don't sleep
SS0
$W62
; WAIT UP TO 300 SECONDS FOR SYNCHRONIZING PULSE
ST0300
$W62
; keep params as user defaults (across power failures)
CK
$W62
; echo configuration
T?
$W62
W?
$W62
; start Pinging
CS
; Delay 3 seconds
$D3
$p *******************************************
$P Please disconnect the ADCP from the computer.
$P *****************************************
; Close the log file
$L
```

17. References

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