CRUISE REPORT

Cruise HM 2016611
with R.V. Håkon Mosby

26 May – 15 June 2016

Working Areas:
Norwegian Sea, Lofoten Basin and Mohn Ridge

Geophysical Institute, University of Bergen

Compiled by Ilker Fer with inputs from Henrik Søiland, Bruno Ferron, Pascal Bouruet-Aubertot and Anthony Bosse

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1. Background

The cruise HM 2016611 aboard the Research Vessel *Håkon Mosby* is the first 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 (PI: 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 watermass transformation. Three connected geographical regions of the Lofoten Basin (the Norwegian slope, the central basin with its persistent eddy (LBE), and the Mohn Ridge) will be 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. HM 2016611 is the summer cruise when we deployed moorings, gliders, RAFOS floats, drifters and conducted shipboard measurements of finescale temperature, salinity and current profiles, as well as ocean microstructure sampling.

This report provides an overview of the methods employed and the data collected.

2. Cruise participants

	Name	Institute[1]	Responsibility[2]
Scientists	Ilker Fer (cruise leader) Ilker.fer@uib.no	UIB	VMP2000 & MR
	Henrik Søiland	UIB	RAFOS & Glider
	Bruno Ferron	IFREMER	VMP5500, VMP6000
	Pascale Bouruet-Aubertot	LOCEAN	VMP5500, VMP6000
	Anthony Bosse	UIB	Slocum Glider, VMP2000
	Stefanie Semper	UIB	CTD & LADCP
	Hauk M Løvseth	UIB	CTD & LADCP
Technical personnel	Steinar Myking	UIB	Moorings and VMP winch
	Helge Bryhni	UIB	Moorings and VMP winch
	Geir Landa	HI	CTD
	Olivier Menage	IFREMER	VMP5500, VMP6000

[1] UIB: University of Bergen; HI: Institute of Marine Research, Bergen; IFREMER, University of Brest, France; LOCEAN, Sorbonne Universities, France.

[2] The instrument and acronyms are described in the report.

Captain : Tom Ole Drange **Chief Officer** : Rune Kleppe

3. Cruise Overview

The cruise was conducted between 25 May and 15 June 2016 with port calls Bergen - Bergen. Surveys and process studies were made at three sites: the long-lived anticyclonic LBE in the central basin (radial transect, and repeat occupation of the eddy center), the Mohn Ridge (MR section across the ridge) at the northern edge of the basin, and near a seamount of the Mohn Ridge located at a front close to station 7/8 of the MR section. A cruise narrative is given in Appendix A. The cruise track is shown in Figure 1. Other operations include mooring, subsurface and surface drifters, and ocean glider deployments.

In total 46 CTD (conductivity temperature depth), 39 LADCP (lowered acoustic Doppler current profiler), and 61 microstructure profiles were collected. Of the microstructure profiles 29 were made using a telemetered microstructure profiler VMP2000 system, and 13 (VMP5500) and 19 (VMP6000) using internal recording, free-fall VMP5500 and VMP6000 systems. In addition, 6 oceanographic moorings, 5 moored sound sources, 25 neutrally buoyant, acoustically-tracked subsurface drifters (RAFOS), 11 GPS-tracked surface drifters, a deep Slocum glider equipped with turbulence probes, and one Seaglider were deployed. A station map is shown in Figure 2, with an enlarged view of the mooring site given in Figure 3. More detailed station maps in the Mohn Ridge region are shown in Figure 22 and Figure 28

A complete list of CTD and VMP stations is tabulated in Appendix B and C, respectively. The vessel-mounted ADCP (VM-ADCP) sampled continuously throughout the cruise. Instrument and sampling details are given in the following sections. Early in the cruise, 4 Svinøy Section moorings were recovered and 2 redeployed for K.A. Orvik (UIB), which are not detailed in this report.

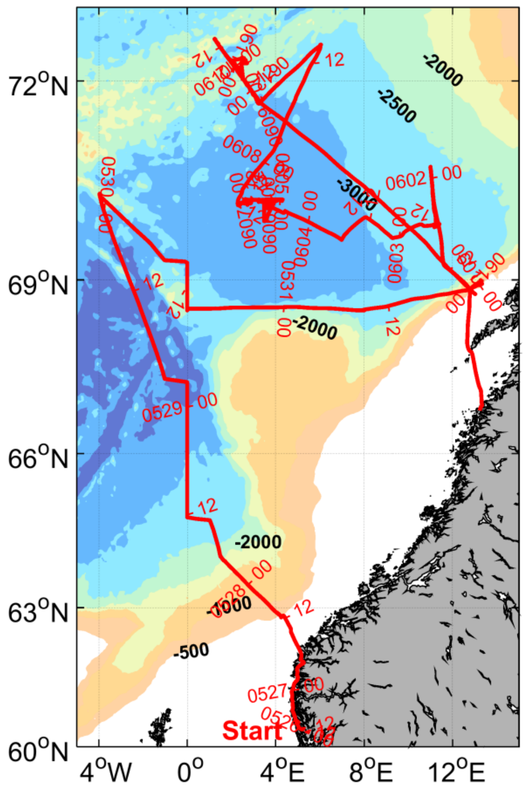


Figure 1. Cruise track of HM 2016611. Start is from Bergen. Ship track after Vestfjorden (67N, 13E) follows the coastline and not shown. Tick marks are ever 12 h. Date format is mmdd.

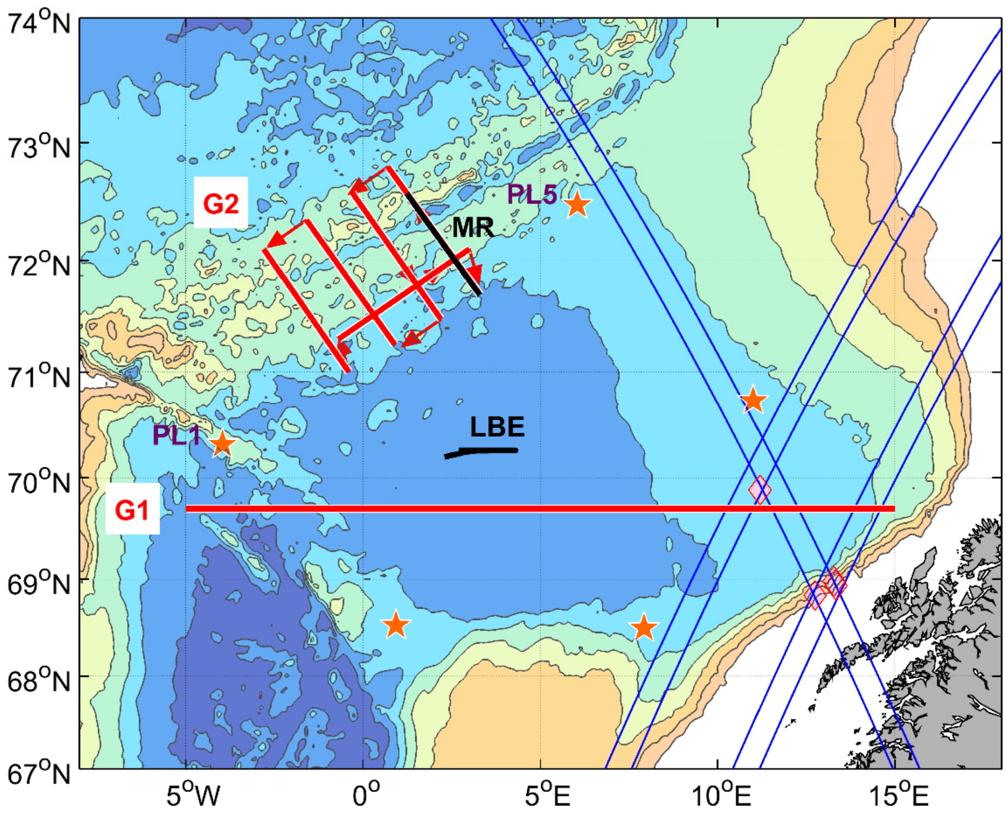


Figure 2. Station map, HM 2016611. G1 and G2 are the idealized mission tracks for Seagliders. Pentagrams mark the sound source moorings, PL1 to PL5 (counterclockwise). Oceanographic moorings are marked by diamonds (see Figure 3 for an enlarged map). Black traces (LBE and MR) mark the process study stations during the cruise. Relevant satellite (Altika) tracks are shown for reference (blue).

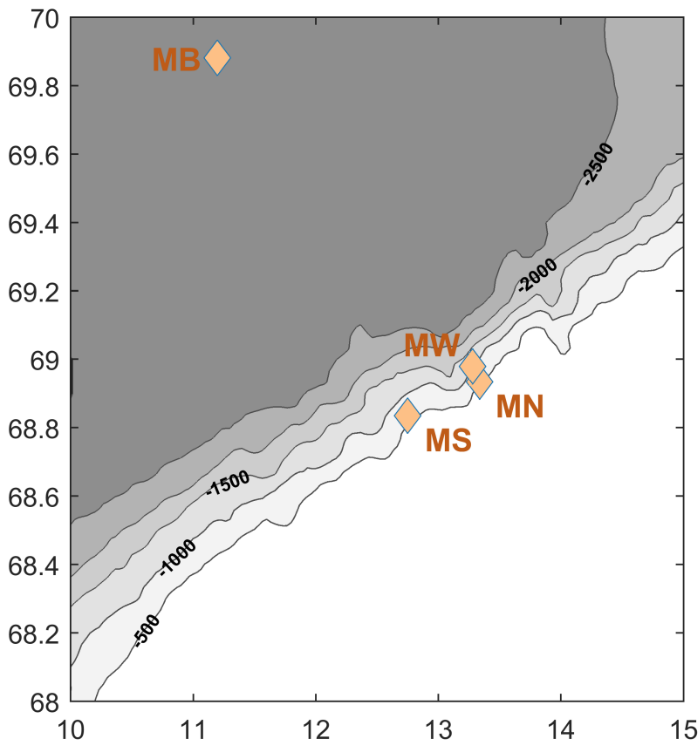
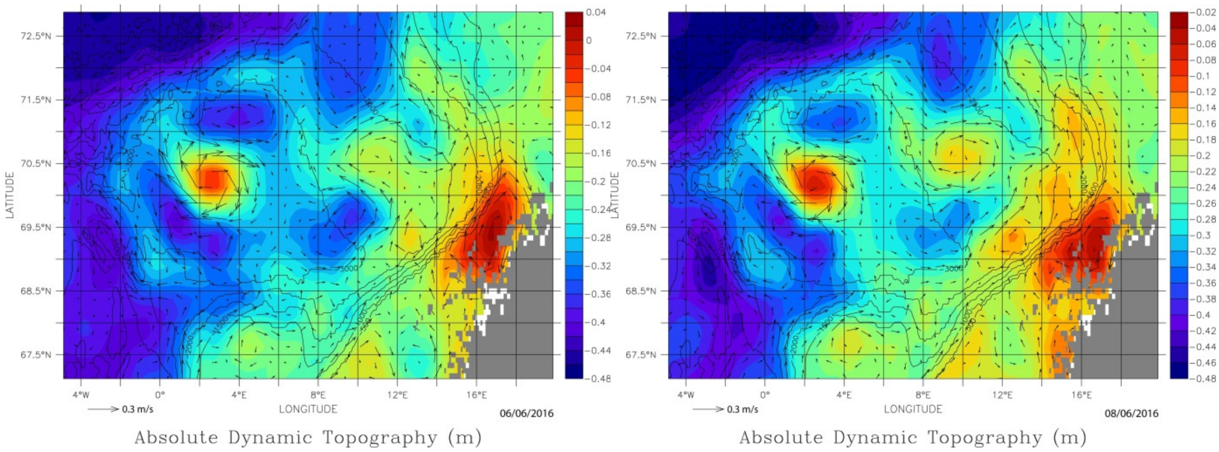


Figure 3. A zoom in to the mooring positions. The labeling stands for Mooring South (MS), Mooring West (MW), Mooring North (MN) and Mooring Basin (MB). Drifters are repeatedly deployed nearby MS position, at Gimsøy standard station 10.

4. Environmental conditions

Throughout the cruise, Roshin Raj and Johnny Johannessen (Nansen Center, Bergen), kindly supplied maps of absolute dynamic topography and geostrophic currents derived from satellite altimetry as well as SST fields produced by Ssalto/Duacs and distributed by Aviso. The maps were produced daily, using all data gathered in one week windows. These images have been instrumental in planning the cruise and interpreting the surface currents observed by the VMADCP underway. An example in Figure 4, separated by 2 days, shows the position and extent of the LBE (approx. 3E, 70N), as well as pinching off of an anticyclone between 10-12°E.

Atmospheric forcing as measured by the ship's mast (15 m height) is shown in Figure 5.



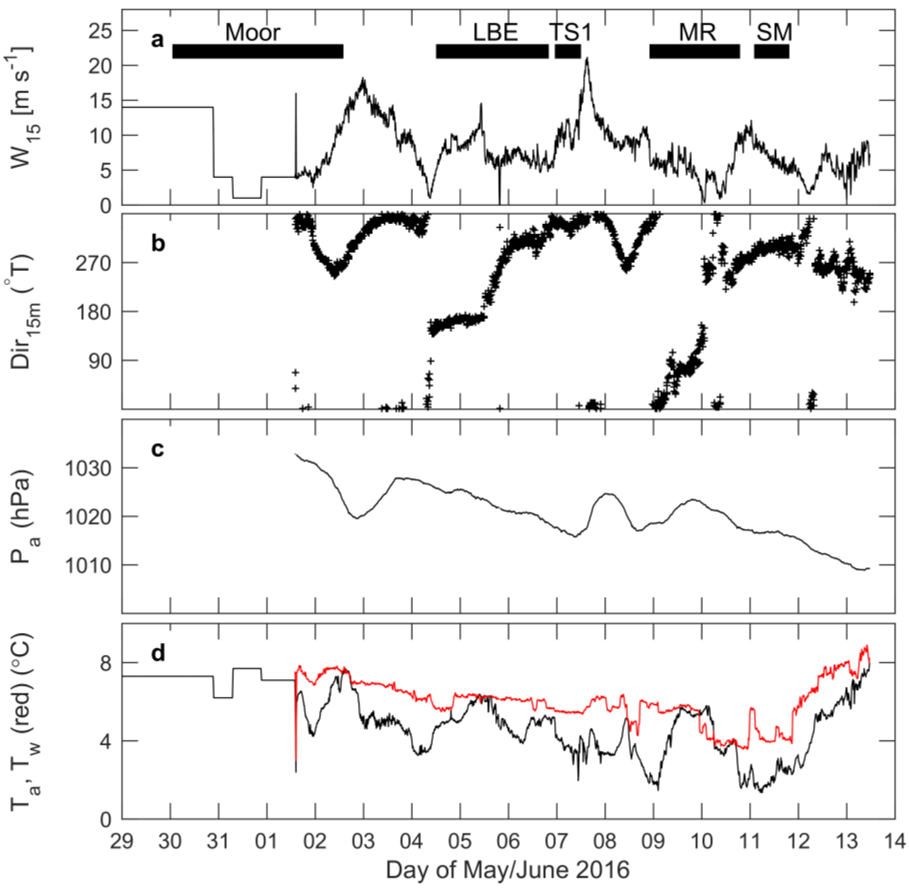


Figure 4. (above) Fields of absolute dynamic topography and surface geostrophic currents on 6 June and 8 June 2016.

Figure 5. (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, repeat station (TS1) at eddy core, Mohn Ridge section (MR), and seamount work (SM).

5. Moorings

5.1. Oceanographic moorings

6 bottom-anchored oceanographic moorings were deployed for ProVoLo. The positions are detailed in Table 1 and shown in Figure 3. The details of the instrumentation are given in mooring diagrams in Appendix F. All moorings are planned to be retrieved in August-September 2017.

All moorings were deployed anchor last, from the stern. No complications occurred. Mooring names follow South (MS), North (MN), West (MW), and Basin (MB). Because of the risk due to fishing activity in the region, we split each MS and MN mooring to accommodate a near-bottom spherical buoy equipped with an uplooker ADCP, instead of including this in the main mooring line. 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.

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

Mooring	Latitude	Longitude	Depth (m)	Deployed (UTC)
MS	68 N 50.128	012E 45.082	680	31.05.2016 21:06
MSs	68 N 50.038	012E 44.777	681	31.05.2016 21:50
MN	68 N 56.06	013E 20.24	645	01.06.2016 00:02
MNs	68 N 56.109	013E 19.866	650	01.06.2016 00:48
MW	68 N 58.759	013E 16.845	1500	01.06.2016 05:37
MB	69 N 52.89	011E 11.89	2925	02.06.2016 13:44

5.2. Sound source moorings

In order to allow acoustic-tracking of the RAFOS floats, sound source moorings were deployed. Five sources were deployed in a horse shoe pattern along the edge of the Lofoten Basin (see map in Figure 2). The details are given in Table 2. The sound source moorings are all in deep water and the moorings are tall. The moorings are very simple to deploy and all deployments were done in less than an hour with the help of the highly competent crew on R/V Håkon Mosby.

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. Five sources provide redundancy.

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

Site	latitude	longitude	Pong-UTC	Deployed [yymmdd]	depth(m)
PL1	N70° 19.225’	W003° 57.519	00:30:00	160529	800/2606
PL2	N68° 31.755’	E000° 55.607	00:40:00	160530	800/2820
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
PL5	N72° 28.885	E006° 02.520	01:10:00	160608	800/2645

6. Hydrography

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 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, fitted with a single 5 litre sampling bottle. The CTD rosette, together with the acoustic Doppler current profilers (Section 7.1), is shown in Figure 6. At all stations, water samples for salinity calibration were collected at the deepest sampling level. Because of a hydraulic problem of the CTD winch, the profiling depth was typically limited to 2000 m. Occasional full-depth profiles were made. In total 46 CTD-stations were taken, recorded in files sta0468 to sta0513. Their locations are listed in Appendix B. Station positions are shown in Figure 2 (see also Figure 22).

Table 3. Sensor details installed on the CTD rosette.

Sensor	SN	Calibration/Service date
Temperature	5458	29-Oct-15
Conductivity	4221	06-Oct-15
Pressure	0365	070406
Temperature, 2	4306	29-Oct-15
Conductivity, 2	2860	06-Oct-15
Altimeter, Benthos	1186	Aug 2005
Oxygen, SBE 43	3095	28-Mar-15
Fluorometer, Chelsea Aqua 3	11-8393-001	17-11-2011
Transmissometer, Chelsea/Seatech/Wetlab CStar	CST-996DR	21-sept-2006
PAR/Irradiance, Biospherical/Licor	70140	27-aug-2007
RDI WH300 L-ADCP, downlooker	10012	2015
RDI WH300 L-ADCP, uplooker	10151	2015

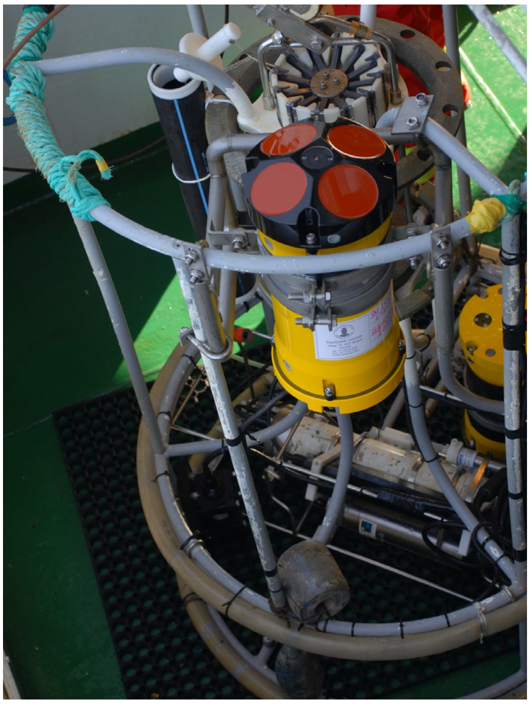


Figure 6. The CTD rosette together with the CTD sensors, one 5-liter Niskin bottle, a down and uplooker ADCP, and a benthos altimeter installed. The transducers of both ADCPs and the altimeter have a non-obstructed path. The position of the lead weights and the ADCPs are adjusted to have a negligible tilt of the entire system.

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 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, $\pm 2\times10^{-3}$ °C, and $\pm 3\times10^{-3}$, respectively.

Conductivity correction from salinity bottle samples – A total of 45 salinity bottle samples are analyzed at IMR with a Guildline Portasal 8410 salinometer. 1 reading appears erroneous and is 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. Histogram of $\Delta C = C_{CTD} - C_{Bot}$, difference of conductivity measured by CTD and inferred from bottle salinity, is approximately normally distributed 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. Using the 41 values inside the 95% confidence interval, the value for the slope is calculated to be **m = 0.99995**. Prior to correction, the conductivity difference between CTD and bottles, $\Delta C = C_{CTD} - C_{bot}$ averaged 1.4 (± 2.0) $\times10^{-4}$ (± 1 standard deviation) over 41 samples. After correction ΔC = 0.0 (± 2.0) $\times10^{-4}$ S/m. However, the effect on the salinity result is not better than the measurement accuracy. After applying conductivity slope correction to the 44 samples, the RMS difference between bottle and CTD salinity before correction is 0.0035, and improves slightly to 0.0033. In conclusion, the salinity measurements are deemed accurate and no further correction is applied.

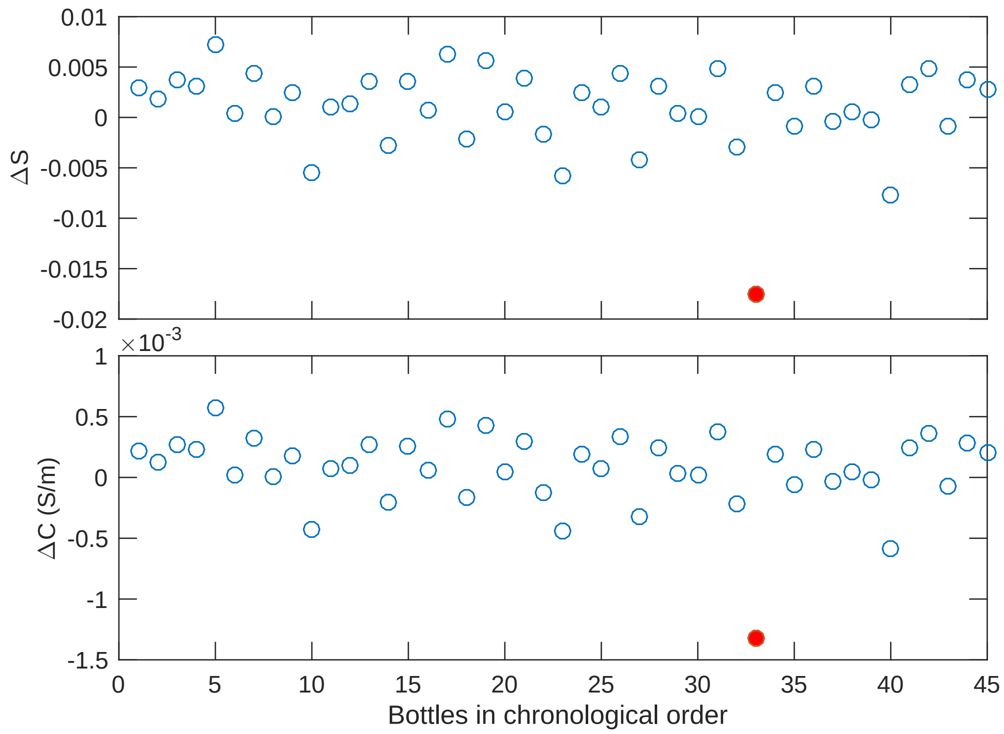


Figure 7. Difference between CTD-derived and bottle data: upper panel, salinity, lower panel, conductivity. One outlier marked in red is excluded from the analysis.

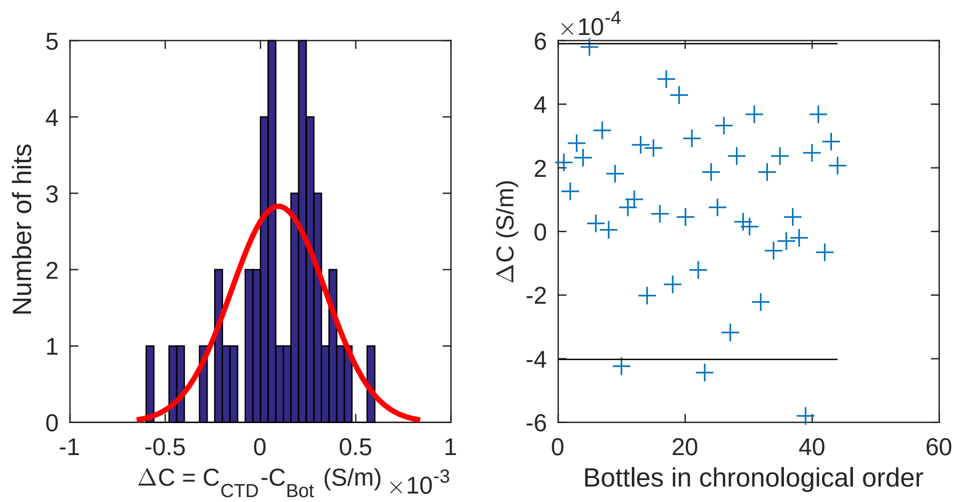


Figure 8. (Left) Histogram of CTD-derived and bottle conductivity differences. Red curve is the normal-distribution fit for the sample mean and standard deviation. (Right) ΔC in chronological order with 95% confidence intervals on the mean indicated (black envelopes).

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 (Figure 6). 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 are given in Appendix G.

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. 2-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) is a 75 kHz Teledyne RDI Ocean Surveyor ADCP on board the RV *Håkon Mosby*. VMADCP continuously collected velocity profiles below the ship, sampling approximately every 1.5 s. Deployment file DeepWaterLongRange_16m _NB_TR_ON_2016611a was used (see Appendix G). Blank distance was set to 16 m, bin size to 16 m and the number of bins to 50. Bottom tracking was disabled. Selected duration of averaging for STA and LTA files were 120 s and 300 s, respectively. Over the continental shelf, en route to Svinøy section and also after the transit back from the Lofoten Basin, we used a setup with broad band (8 m bins) and bottom tracking. During sampling, data acquisition was restarted several times with unit increment on file number. The VMADCP data are processed using the University of Hawaii Software, as 2-min averages. Typical final processed horizontal velocity uncertainty is 2-3 cm s^{-1}.

8. Microstructure Profiling

Ocean microstructure measurements were made using the vertical microstructure profilers VMP5500, VMP6000 and VMP2000, each manufactured by Rockland Scientific International (http://www.rocklandscientific.com). In addition, a Teledyne Slocum Webb glider was equipped with turbulence sensors (microRider package, by Rockland Scientific International), however only few dives are available from this instrument (not reported) because of a leak abort (Section 9.1). Operation and deployment methods for each VMP system are described below in the corresponding subsection. VMP data reported here are from preliminary processing conducted during the cruise.

Data from all VMPs are further consistently post-processed to high-quality for analysis, using the same set of routines based on RSI's ODAS MATLAB software v 4.01.

8.1. VMP5500 & VMP6000

VMP5500 & 6000 watch: Pascale Bouruet-Aubertot, Olivier Ménage, Bruno Ferron

A total of 32 deep VMP profiles were collected during the cruise (Figure 9). The two VMPs were used alternatively to increase the sampling frequency and to get enough time to load the internal main battery. A complete list of casts is provided in Appendix C.

We did not experience systematic random deviations between shear channels on any of the two VMPs; soldering work done at the lab on hockey puck was successful.

The two VMPs were assembled after the moorings were deployed. The first VMP with a CTD-LADCP was done in the secondary maximum of EKE according to Aviso maps.

Deployments were done on the starboard side of the ship with the crane. Recovery was done with the mooring winch and the boom on the starboard side. The mean sound velocity was changed for 1480 m/s after some discussion. It still slightly overestimates the real speed by around 2 m/s. The microconductivity was not installed on the deep VMPs. We used the ship VHF goniometer (Taiyo) to locate the VMPs at the surface; it worked perfectly.

We used preferentially the NOVATECH MMI 7500 ARGOS beacon (small size design). It needs to stand sufficiently high on the lifting bail to be received by satellites when at sea. On VMP5500, we finally used the Argos beacon to add weight and reach a mean downcast velocity of 0.55 m/s, equal to that of the VMP6000.

Sensors:

VMP 5500 was equipped with CTD SBE3F 5400 and SBE4C 3826. Surface pressure set to zero. PC104 time was updated between Lofoten eddy study and Mohn Ridge section: "date -s hh:mm" + "mount -o remount,rw /dev/root /" + "hwclock -w".

We started with sensors (shear probe sensitivities in brackets):

S1 = M753 (0.0679), S2 = M754 (0.0590), T1 = T397, T2 = T417.

Since the ratio epsilon(S2)/epsilon(S1) was a function of pressure below 2000 m and that S2 had relatively poor quality below 2000 m (seen in histograms), M754 was replaced by M756 (0.0593)

VMP 6000 was equipped with CTD SBE3F 5000 and SBE4C 3444. PC104 time was updated at the beginning of the cruise (date -s was sufficient) and surface pressure set to zero. The SBE3F was refitted by Seabird in Germany and coefficients were updated for sbt prior to deployments.

We started with: S1 = M693(0.0824), S2 = M738 (0.0647), T1 = T242, T2 = T399. T1 was replaced after station 3.

None of the thermistors used in deep VMPs were calibrated, hence require internal calibration using SBE temperature records.

Problems during the cruise:

VMP6000 release test failed on deck. It was due to a failure in the release battery. Voltage initially was 5.4V (despite we had controlled it in the lab) and there was no activation of the solenoid. After one night of loading. Voltage of the release was 5.9 V, the solenoid was a bit activated but with no power. Olivier replaced the release battery with a spare that we had (bought in 2015). Release then worked normally.

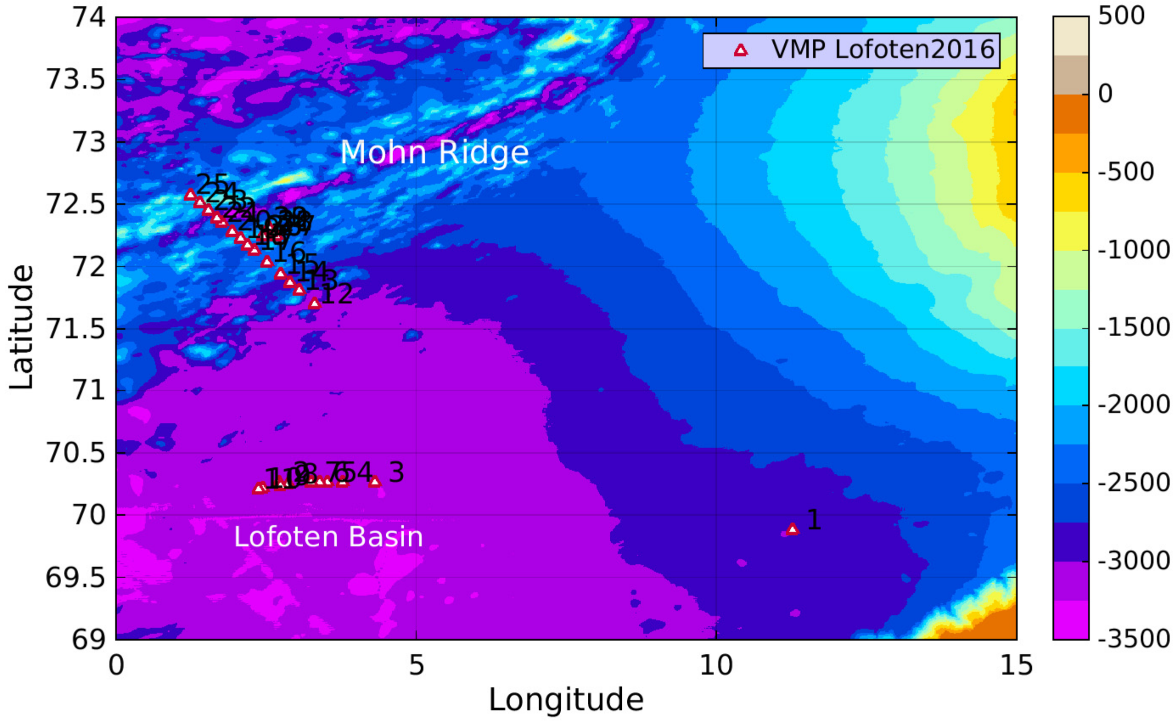


Figure 9. Distribution of the 32 VMP5500-6000 stations during the ProVoLo 2016 cruise

VMP6000 during first profile, the main battery dropped from 12 V to 9V suddenly => we then re-opened the VMP and changed the main battery.

Procedure followed before deployment:

Check that the profile of sound speed is up to date (and regularly updated if needed, e.g. when ship moves from one oceanic basin to a neighbouring one). No update on this cruise after initial change from 1487.1 to 1480 m/s.

Check that the bottom detection range is correctly set-up for the sounder/multi-beam.

Follow the depth evolution (from sounder/multibeam) in the last kilometer before the arrival at the station (not necessary for the eddy site).

Convert depth to pressure (pressure_at_seafloor) and adjust max_pressure (and max_time) in the instrument configuration file:

max_pressure = seafloor_pressure – safety_depth_range – instrumental_release.

The safety_depth_range (e.g. about 70 m or more) corresponds with the accepted uncertainty on depth (including downcast instrument drift, sound speed, presure sensor error, ...).

The instrumental_release is related to the time constant (38 seconds) needed for the electronics to effectively activate the mechanical release: instrumental_release [dbar] = 38 s * downcast velocity [dbar/s].

max_time = max_pressure / downcast_velocity + additional_time. Additional_time was set to 600 s and corresponds with some extra time needed for operations on deck for deployment, positioning of the ship, variation of downcast velocity with depth.

Estimate what will the VMP drift be during its downcast using ship-ADCP and adjust the safety depth range accordingly (larger range for a longer estimated drift).

Just before deploying the VMP at sea, last depth check.

8.2. VMP2000

VMP2000 watch: Stefanie Meyer and Helge Bryhni / Anthony Bosse, Ilker Fer and Steinar Myking

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 that makes it possible to perform rapid repeated profiles) and 2500 m deployment cable. With proper adapters, we used the ship's hydraulics for the VMP winch, bypassing the hydraulic/electric motor. The pressure on the ship's hydraulics is adjustable, and we obtained ca. 50 bar, slightly above the recommended working pressure for the winch. During recovery, however, pressure was 80-100 bar; this did not lead to any problems. 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 10. The set-up, on deck, of the VMP microstructure profiling system. The hydraulic winch (above); the cable is fed through a block supported by the crane in the middle. The block is fastened by straps to the deck to avoid swings due to wind and ship's roll. The tether then is fed into the line-puller (right) fastened to the ships' railing. In addition to the winch operator, a second person observes the cable in water during the deployment, and assists with deployment and recovery.

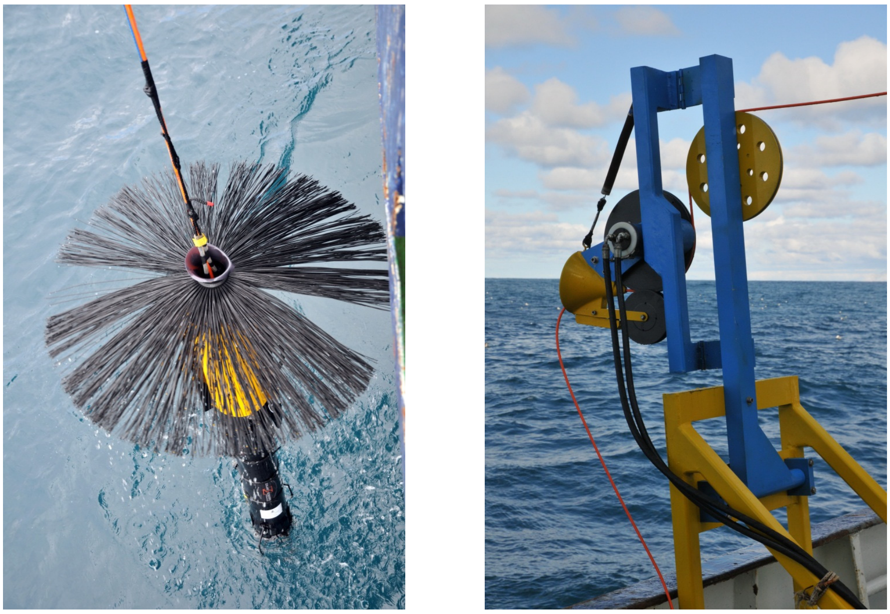


Figure 11. (Left) The VMP profiler during deployment. The brushes provide the drag for the profiler. Drag, together with the buoyancy elements (yellow) set the nominal sink velocity of the profiler. Note the recovery line attached to the cable which allows recovery by a crane without damaging the cable. (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
1-2	M1109	M1112	T1175	T1176	C200
3-8	M462	M546	T1175	T1176	C200
9-11	M1109	M1112	T1175	T1176	C200
12-	M1109	M1293	T1001	T1176	C206

Problems encountered:

In the first cast, VMP did not respond on SBE channels. We opened the VMP and found that the SBE connector was disconnected. After connecting, the SBE is OK. (This is remarkable because the VMP2000 was just back from service and inspection.)

The fast channels, particularly shear probes, were very noisy. After several tests and trial and errors, and correspondence with RSI, it was decided the there was a grounding issue with 50Hz signal and harmonics dwarfing the data. We re-opened the VMP (after the completion of the LBE transect, cast 9), and confirmed that the profiler was not properly grounded. Grounding was established by soldering an earth strap as described in Figure 12. All microstructure data are of high quality after this fix (cast 10 and on). RSI provided a detailed report after inspection, post cruise. This is available upon request, and confirms the problem related to lack of grounding.

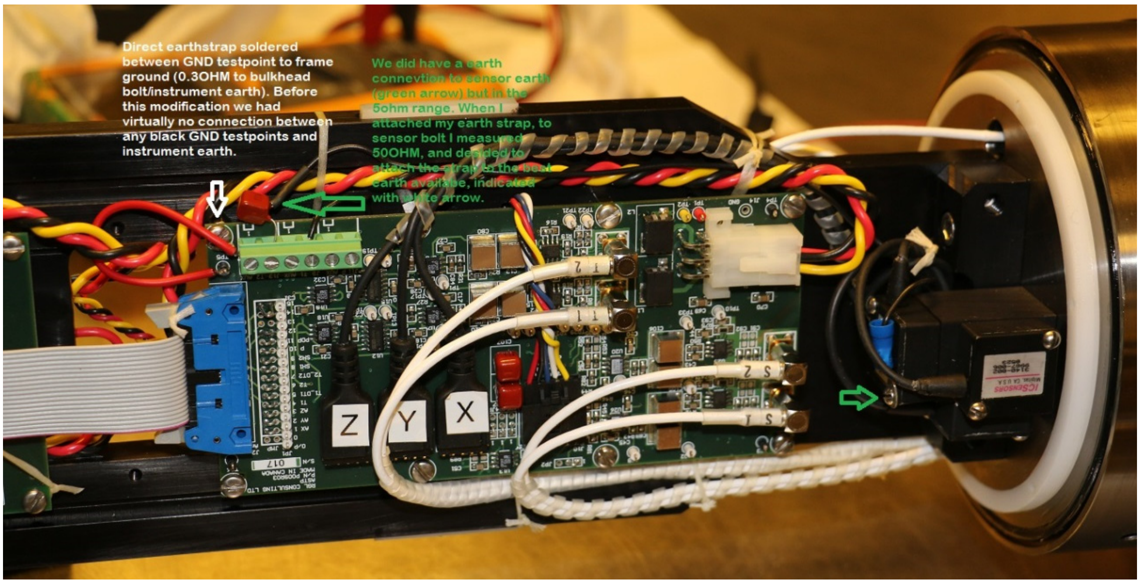


Figure 12. Grounding of the VMP2000. (Photo: Helge Bryhni)

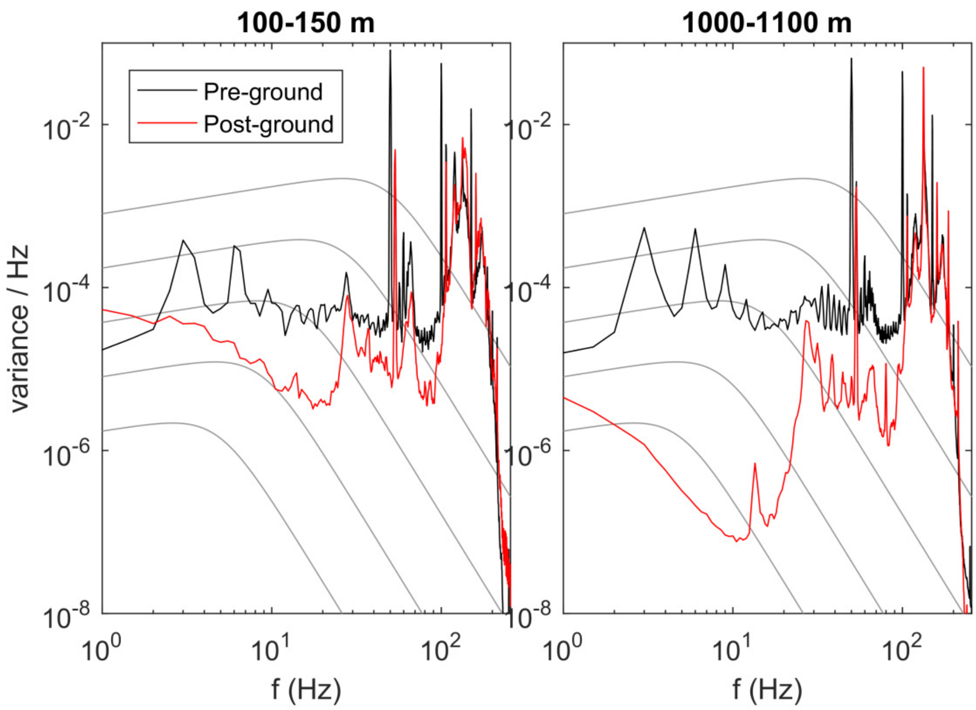


Figure 13. Shear spectra (probe 1) over two selected segments of 100-150 m and 1000-1100 m depth range using the data from cast 9 (before grounding) and cast 11 (after grounding). Spectra from other channels show a similar contamination but shear probes are the most affected.

9. Gliders

9.1. Slocum – Gnå

During the cruise a deep electric Slocum glider (Gnå) from Teledyne Webb Research was deployed. Gnå is rated to 1000 m, and is equipped with a SeaBird Electronics CTD, Aanderaa oxygen optode, and WetLabs fluorescence and turbidity meter, as well as a Rockland Scientific MicroRider (Figure 14), which is a self-contained turbulence instrument package. The MicrosRider is 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 must be deployed and recovered using a light boat, where it is easy to carefully slip the glider into and out of the water. Because of the turbulence sensors, the front of the glider must be handled with utmost care. Unfortunately, because of a damaged O-ring (see below), the glider leaked and the data set is limited to few yo's.

Figure 14. Photo of the glider Gnå mounted with MicroRider, strapped on the transportation trolley.

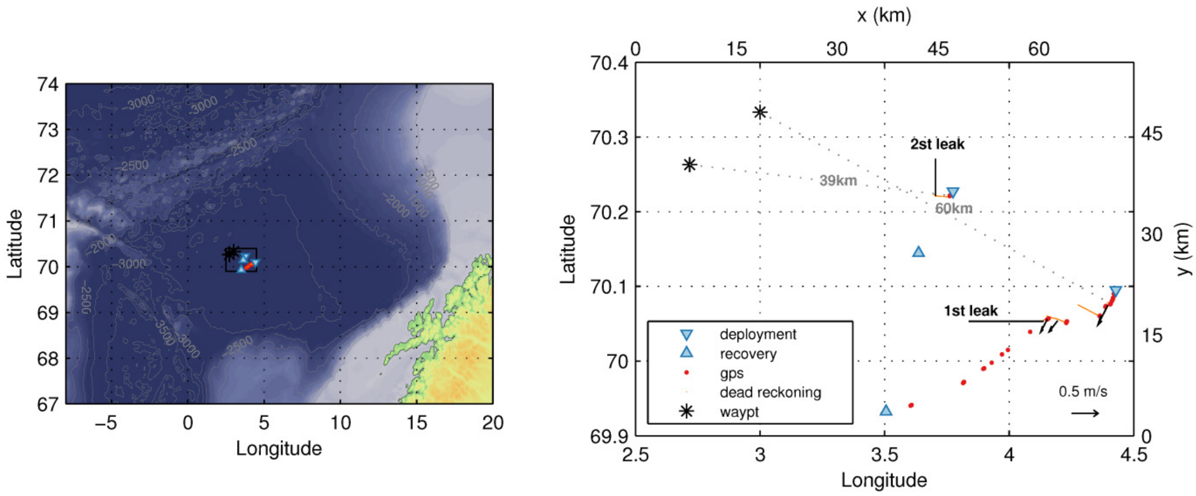


Figure 15. (left) Map showing the general location of deployment of Gnå. (right) enlarged view showing details of deployment and recovery, depth-averaged currents when available, way points, and the position when abort due to leak occurred.

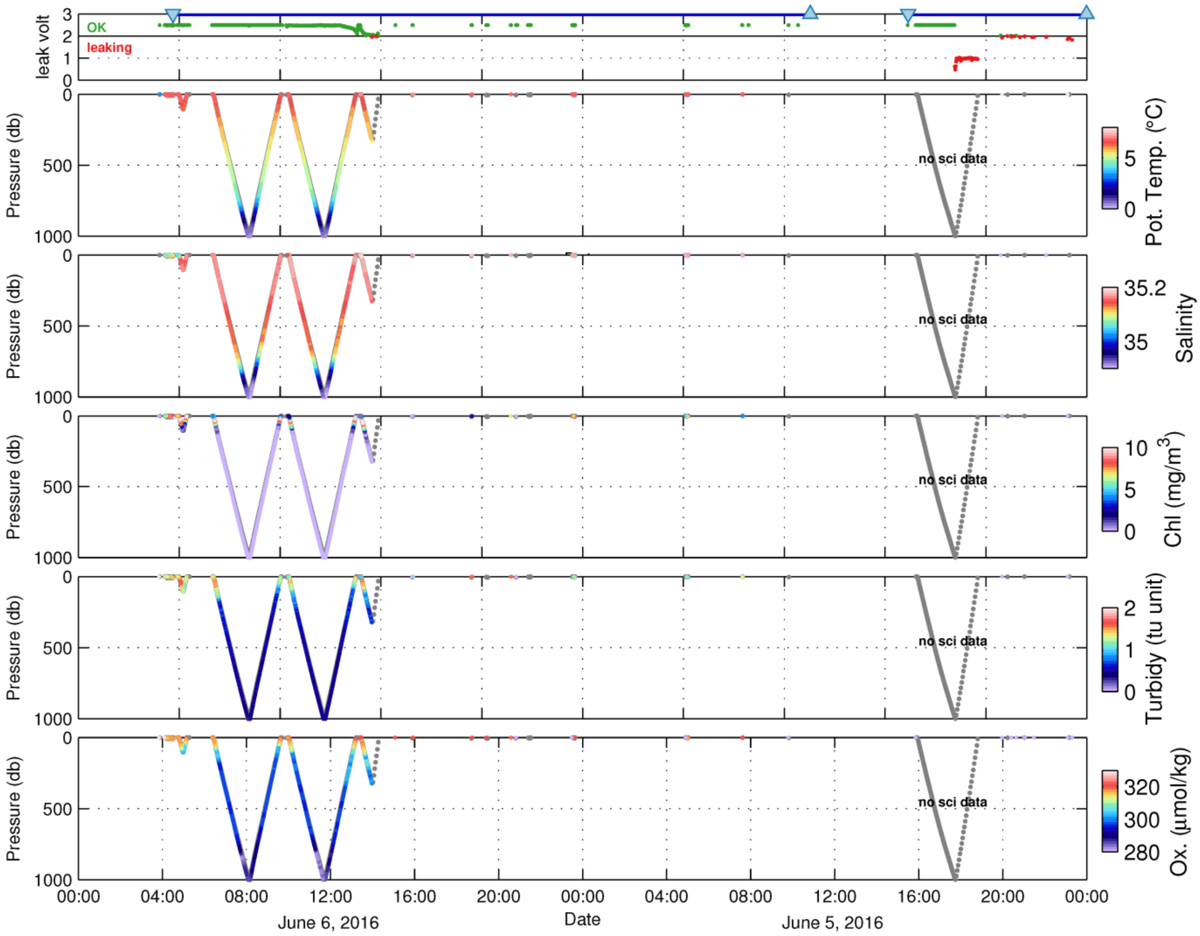


Figure 16. The upper panel shows the evolution of leak voltage throughout the deployments, with values indicative of a leakage marked in red. Lower panels: time-depth profiles color coded for science sensors. During the second deployment, no science data is available.

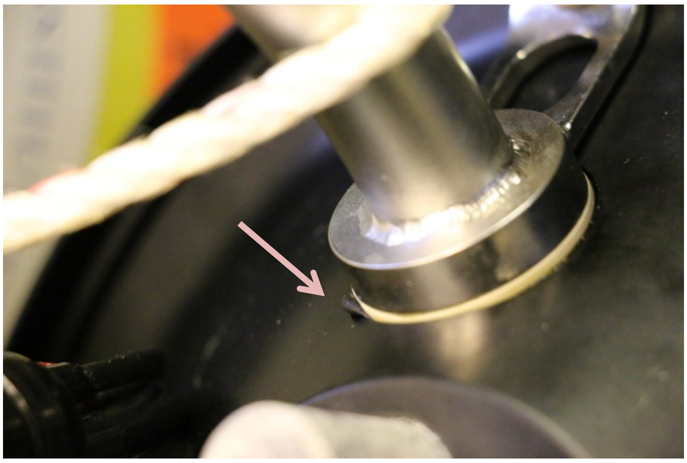


Figure 17. A zoom in to the aft section of Gnå where the tail fin is mounted on the pressure case. Note the damaged O-ring (arrow) that cause the leak. (Photo by H. Bryhni)

9.2. Seaglider

Seaglider SG560 was deployed on 9 June 2016, 0830 UTC, 71N52.40’; 002E50.46’. SG560 is targeted to perform the mission G2 in Figure 2. Prior to deployment all pre-launch tests were conducted and completed successfully. The challenge has been to establish Iridium connection. We corresponded with the pilot Karsten Kvalsund (Runde Centre) who gave a go for the launch after going through the self-test results. Deployment was done from the starboard side using a simple rope and a “quick release”. It was confirmed that the glider floated in water as expected upon being flooded. The trimming, compass calibration and variable style dives (for flight model parameter optimization) were further conducted from land by the pilots. For SG560, dives 34-41 are dedicated to flight model parameter optimization.

Prior to the cruise, another Seaglider (SG561) was deployed from a ship of opportunity (Håkon Mosby, Gimsøy section cruise, responsible Vidar Lien, IMR) to perform the target mission G1 (Figure 2). SG561 was deployed on 4 May 2016 16:16 UTC at position 70N 18.496'; 008E 31.333'.

Both gliders are O-give, 15V, and equipped with unpumped SBE CT and an Aanderaa optode. The CTD samples every 10-s for the entire dive & climb. O2 sampling is depth variable:

	CT	O2	
Depth	Time (s)	Time (s)	sample gcint
150	10	12	40
500	10	19	120
1000	10	19	120

Data from the first several days of dives are used to estimate flight model regression parameters, using the University of Washington Matlab functions (v2.09) *regress_vbd_dives.m* and *regress_vbd.m*. Although the gliders are O-give, the setup parameters and regression should be made for 1.8 m glider. The following results are obtained, and sg_calib_constants.m revised accordingly. Note that very small hd_c values cause problems and it is recommended not to change those from the default values.

SG561

```
% USING 1.8 m STANDARD
% Recommended $C_VBD,2282
% 12-May-2016 14:35:03 RMS=0.6715 cm/s Provolo Dives: 5 9 11:21 24:29 31 32 34 37
volmax = 53023.7;
hd_a = 3.79152e-03;
hd_b = 1.07105e-02;
% % hd_c = 2.53055e-12; % DO NOT USE
```

SG560

```
% Recommended $C_VBD,2576
% 16-Jun-2016 15:16:06 RMS=0.8023 cm/s Provolo Dives: 5 16 19 24:29 31:33 35 37 39 41
volmax = 53509.6;
hd_a = 3.53084e-03;
hd_b = 1.14559e-02;
%%% hd_c = 1.12121e-13; % DO NOT USE
```

10. Subsurface floats and surface drifters

10.1. RAFOS

Neutrally buoyant RAFOS floats drift freely through the ocean and thus trace out the movement of waters around them. They are tracked using precisely timed low-frequency (~260Hz) acoustic transmissions from a broad-based array of sound sources. From the arrival time of these signals at a float and knowledge of the average speed of sound one can determine the float's position to an accuracy of a few km, depending upon a number of factors including clock error, uncertainties in speed of sound, and horizontal angle between the signal arrivals used for the float's geolocation. Floats can operate as either 'isobaric' or 'isopycnal' devices. In this study the floats will operate in the (quasi-) isobaric mode because shallow isopycnals outcrop and at depth the stratification is very low. The floats were pre ballasted for 200 m depth, based on properties in the Lofoten Basin Eddy. At sea the weights were adjusted by adding stainless steel string externally. The target depths of the floats deployed were 200, 500 and 800 meters. The ballasting of floats is quite accurate (~ 0.3 grams in 10 kg), but the actual equilibrium depths reflected the local water properties at the times of deployment. CTDs were taken in conjunction with all float deployments. A total of 18 RAFOS floats were deployed in the Lofoten Basin Eddy, at the center, at the radius of max swirl speed (15 km) and at a radius of 30 km. At each location 3 pairs were deployed with the target depths 200, 500 and 800 m. At the Mohn Ridge 7 RAFOS floats were deployed along the section. They were targeted at 800 m to provide the information of the flow below the baroclinic front.

A complete list of RAFOS deployments is given in Appendix D.

Five sources were deployed (Section 5.2, Figure 2). Acoustic transmissions are made 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. Five sources provide redundancy.

10.2. Drifters

During the cruise, 11 Lagrangian current-following surface drifters were deployed. A complete list of drifter deployments is given in Appendix E. 7 of these were MetOcean CODE-I (Coastal Ocean Dynamics Experiment) drifters, and the remaining 4 were Surface Velocity Program (SVP) drifters. Both types are GPS-tracked surface drifters, transmitting data via IRIDIUM Satellite telemetry. Typically the deployment is made from near the Gimsøy station G10 at water depth 675 m, in pairs. This location will be used for further seed of drifters later during the project. Several drifters (all SVPs and 1 CODE-I) were deployed in the Mohn Ridge frontal region.

The MetOcean CODE-I drifter has drogue vanes between 30 and 100 cm depth. The default data transmission interval (after 48 hours) is 30 minute sampling with two transmissions on the hour. The SVP drifter is equipped with a sea surface temperature sensor and a holey sock drogue centered at 15 meters. It is sized to provide a drag ratio (drogue frontal area to that of all other submerged frontal areas) in excess of 40:1.

2 of CODE-I drifters did not start transmitting data. The last two CODE-I drifters were started on deck and deployed in fully open state. They transmitted fine.

11. Sampling Summary

In the following, an overview is given for the Lofoten Basin Eddy site, Mohn Ridge site and the seamount site. Presentation includes preliminary figures from the CTD/LADCP and VMP systems.

11.1. Lofoten Basin Eddy (LBE)

Sampling included one transect into the eddy core (LBE) and a repeat occupation of the eddy center station (TS1). The eddy center was detected *in situ*, at several times, using the VMADCP. CTD properties together with oxygen concentration and fluorescence (not calibrated), inferred from the SBE911+ system are shown in Figure 18 and Figure 19. The 13-h repeat station (TS1) started at eddy core. Sampling scheme was VMP5500 immediately followed by CTD, transit back to station location and deploy VMP2000. The operation took approximately 3 h. After each full set, we relocated the eddy core with VMADCP, to define the position of the next 3-h sampling.

A full-depth section of dissipation rate from the VMP5500-6000 survey is shown in Figure 20. Turbulence levels were found to be elevated in the pycnocline at the eddy center (Figure 20, Figure 21). Rather weak turbulence is found elsewhere apart from a few localized spots. Note that dissipation data shown in this report are from preliminary processing conducted during the cruise.

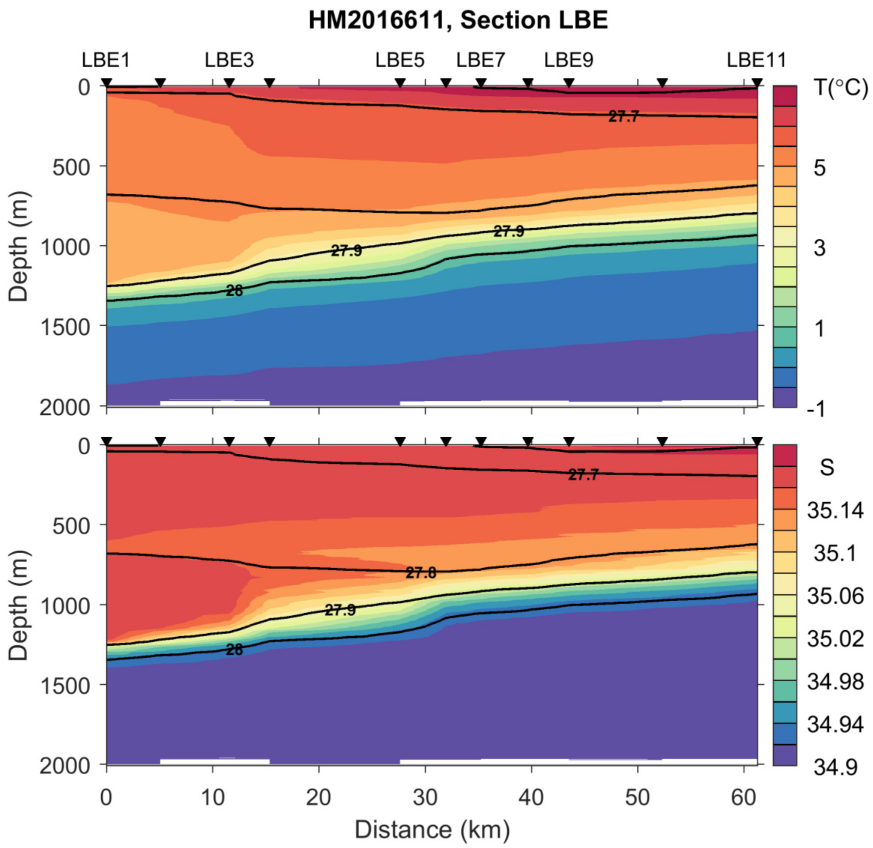


Figure 18. Contours of potential temperature (*θ*) and practical salinity (*S*) for the LBE transect. Isolines of potential density anomaly (σ_θ) are also shown (black) on each panel. Distance is relative to the eddy center, which propagates in time. The center location is not accurately calculated for this presentation.

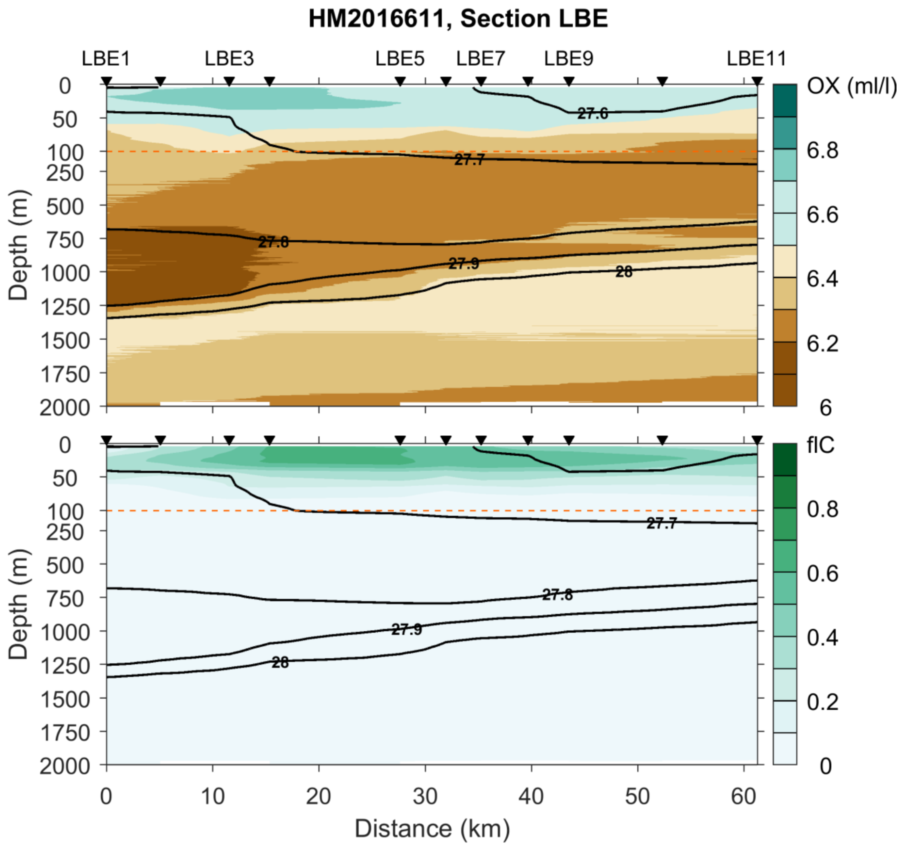


Figure 19. Contours of dissolved oxygen (OX) and fluorescence (flC) for the LBE transect. Isolines of potential density anomaly (σ_θ) are also shown (black) on each panel. Distance is relative to the eddy center, which propagates in time. Note the change of vertical scale at 100 m.

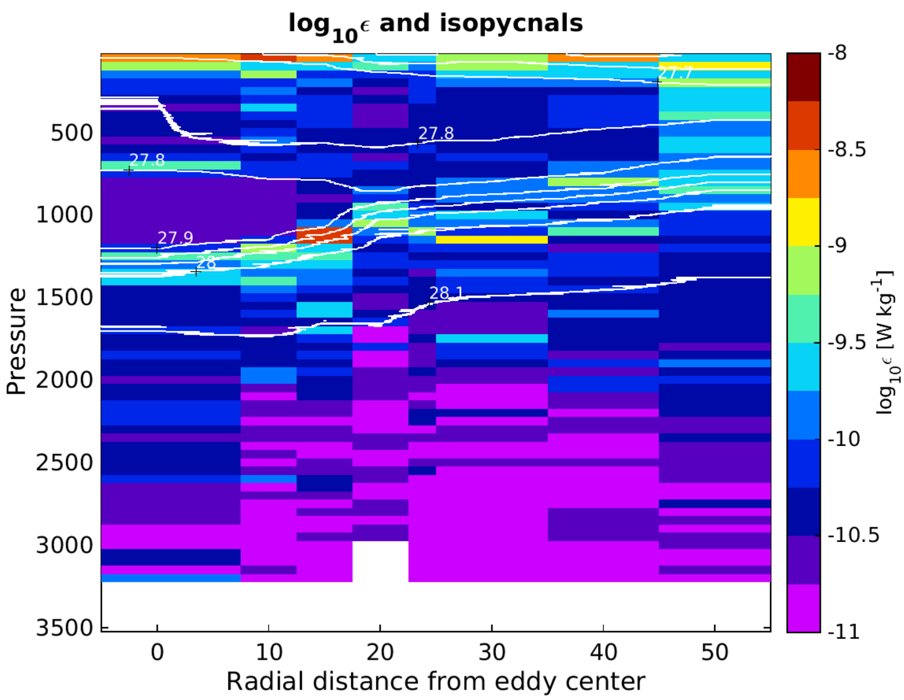


Figure 20. 50-m bin-averaged turbulent kinetic energy dissipation rate (logarithmic scale) across the eddy, measured by VMP5500 and VMP6000 pair. Averaged and pre-processed from shear 1 and 2 channels (bad segments and spikes were removed, further processing may be needed). The largest dissipation rates occur in the main deep thermocline/pycnocline.

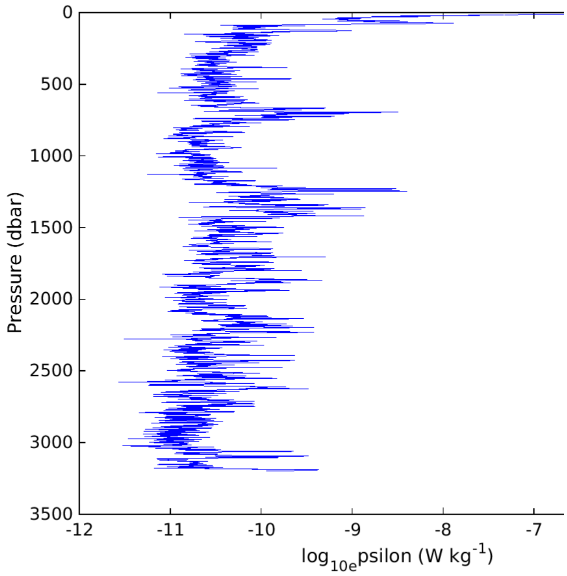


Figure 21. Dissipation rate profile at the eddy center. Two maxima were found at the location of the pycnolines: the shallowest at 700 m is in between the two homogeneous layers of the eddy, the deepest around 1300 m marks the upper boundary of the cold deep/bottom waters.

11.2. Mohn Ridge Section

The Mohn Ridge section (stations MR1 to MR14) sampling scheme was VMP5500 first, immediately followed by the CTD-LADCP. Once the CTD was on deck, we relocated to the station position and deployed VMP2000. Due to time constraints, we skipped VMP2000 on selected stations.

At the MR section, the echo sounder was run with the bottom detection range set to 4000-m, to ensure good quality bathymetry along the section. This can compromise the VMADCP quality on STA. Upon completing the section (after MR14), we switched the echo sounder setting to 1000-m range for bottom detection and run a continuous, high-quality VMADCP section to MR5. After this, the VMADCP section was interrupted for the seamount process study (Section 11.3). Upon completing the seamount work, we transit to MR9 to start a continuous VMADCP transect to the southern end of the section, covering the frontal region, and also providing a repeat sampling until MR5.

Turbulence is bottom enhanced at the Mohn Ridge at some of the stations possibly forced by the barotropic tide (Figure 26).

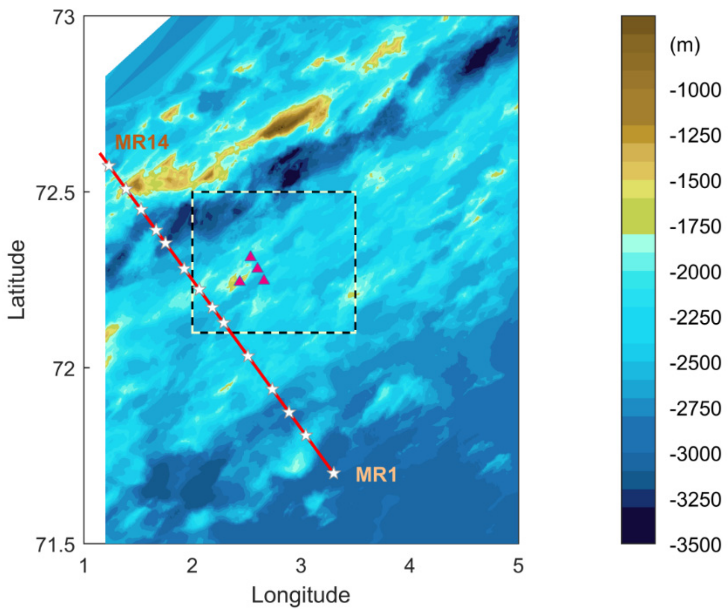


Figure 22. Multi-beam high resolution topography over the Mohn Ridge (data kindly provided by Rolf Birger Petersen, UIB). Red line with stations MR1 to MR14 mark the Mohn Ridge section. The dashed region is expanded in Figure 28. Triangles mark the seamount stations (Section 11.3).

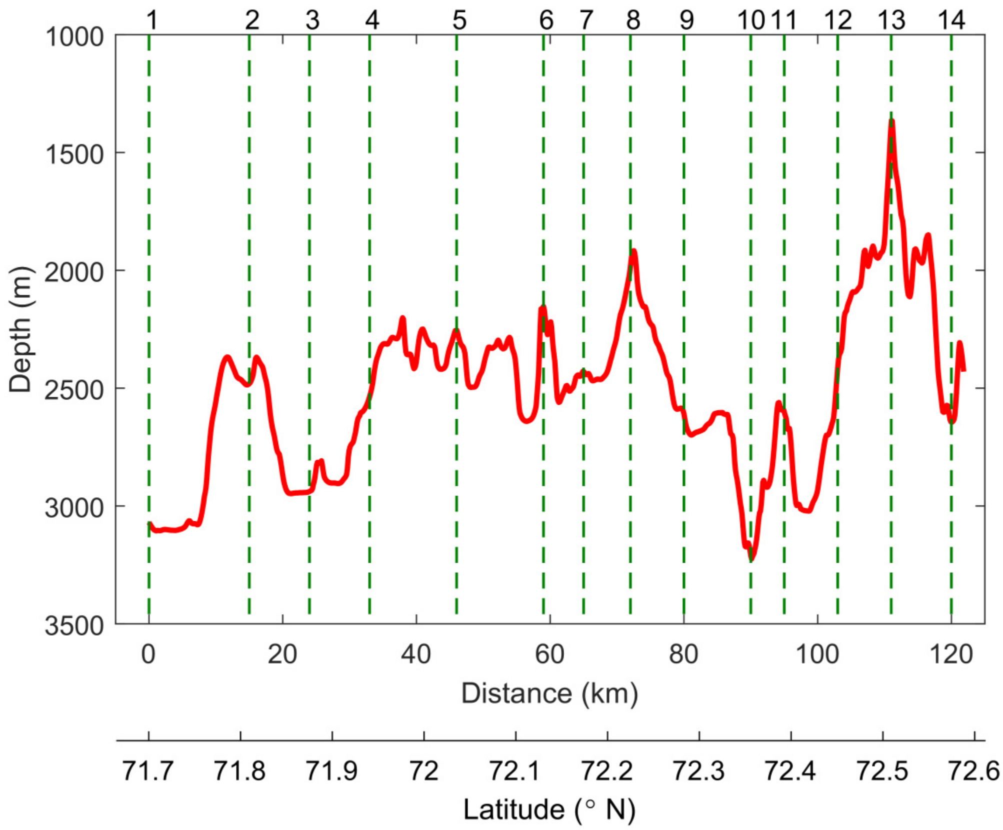


Figure 23. The transect from the high-resolution bathymetry along the MR section. Station positions are marked MR1 to MR14. The main front is located at stations 7 & 8.

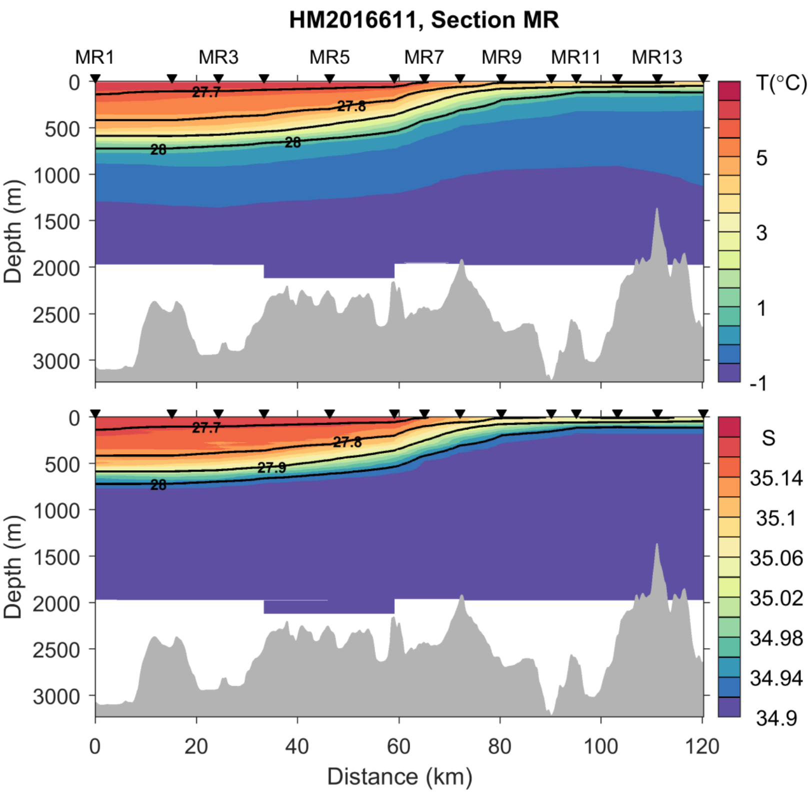


Figure 24. Contours of potential temperature (θ) and practical salinity (S) for the MR section. Isolines of potential density anomaly (σ_θ) are also shown (black) on each panel. Bottom

topography is from the high-resolution multi beam data, interpolated along the section at 100 m horizontally.

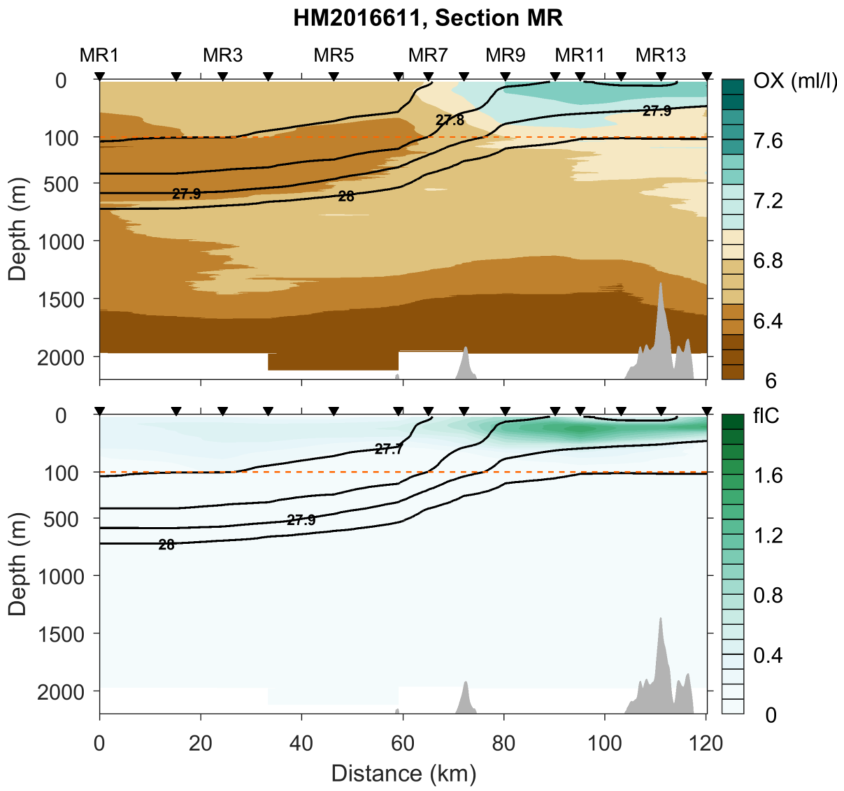


Figure 25. Contours of dissolved oxygen (OX) and fluorescence (flC) for the MR section. Isolines of potential density anomaly (σ_θ) are also shown (black) on each panel. Note the change of vertical scale at 100 m.

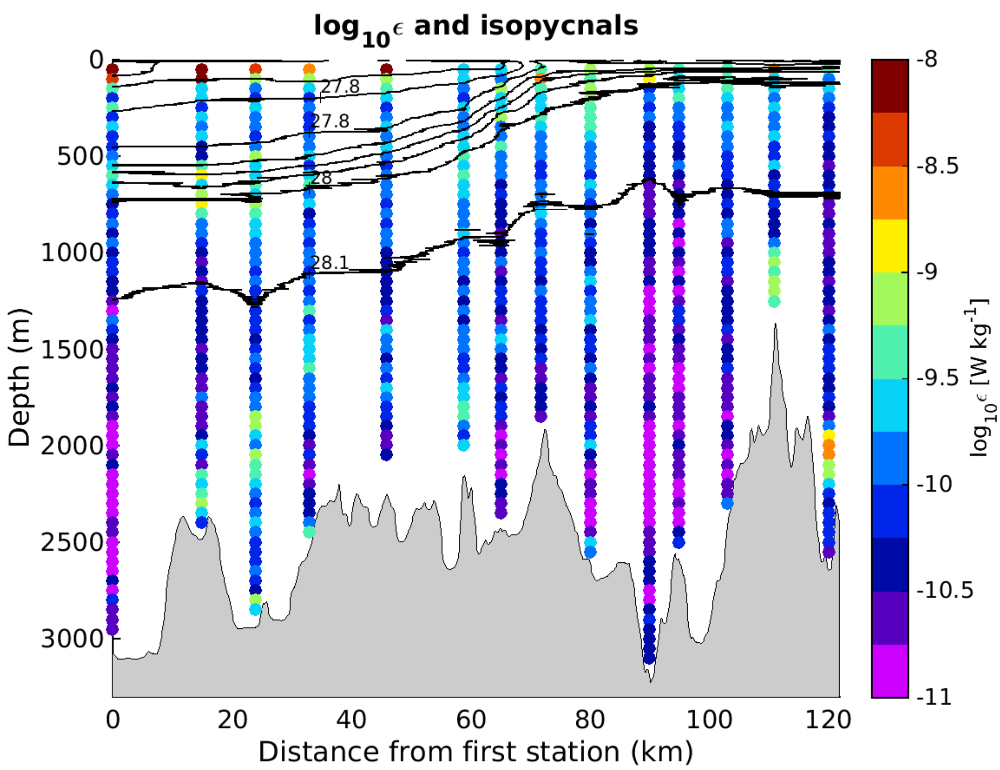


Figure 26. Dissipation rate profiles and contours of density along the MR section obtained using a series of VMP5500 and VMP6000 casts. Dissipation rate is from combined shear 1 and 2 channels. Bad segments and spikes were removed before passing through a 50-m bin-average.

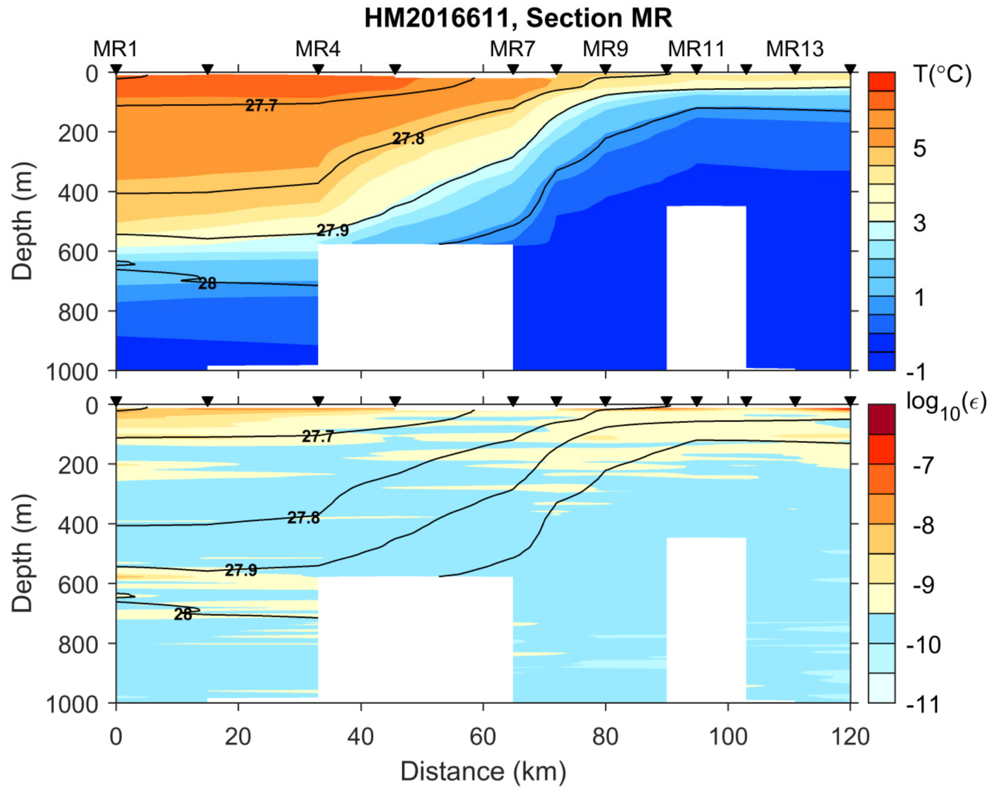


Figure 27. Temperature and dissipation rate contours measured bt the VMP2000 in the upper 1000 m along the MR section. Isopycnals are drawn at 0.1 intervals.

11.3. Seamount

The seamount is located at near the Mohn Ridge front, near the position of the velocity maximum. 4 stations are chosen: SM1 is located at the seamount summit and the other 3 stations are downstream with respect to the strong front current. The distance between SM1 and SM3 (along the seamount axis) is approximately 7 km. The distance between SM2 and SM4 is 8.5 km. A station is sampled in the following order: VMP5500 or VMP6000, immediately followed by CTD/LADCP. Once the CTD is recovered, the ship moved back to position and VMP2000 is deployed. The water depth is relatively shallow at SM1, and the VMP5500 surfaces when the CTD casts completed. Being short of time, we therefore did not deploy VMP2000 at SM1. In other stations, VMP2000 is deployed to 500-700 m depth to cover the front.

The sequence of seamount stations is summarized in Table 4. The station positions are shown in Figure 28.

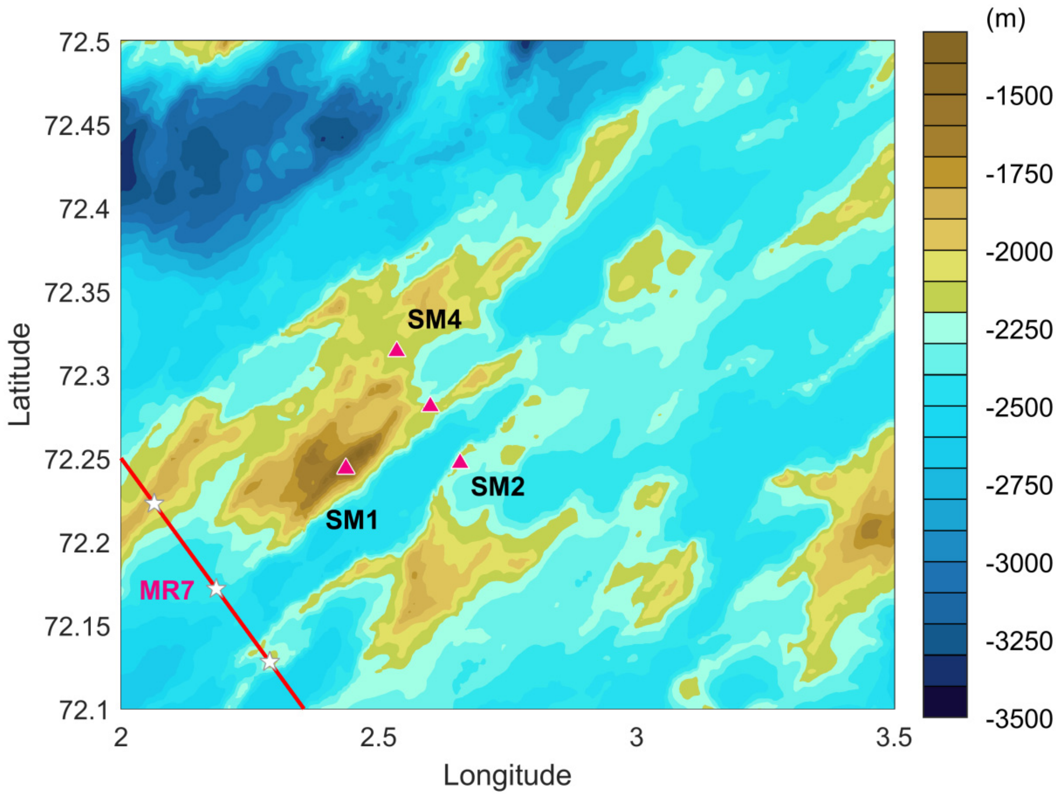


Figure 28. Enlarged view of the bathymetry and station overview at the seamount site.

Table 4. Summary of deployments at the seamount site.

Station	Start (UTC)		CTD/LADCP	VMP2000	VMP5500	VMP6000
SM1	2016-06-11	02:42	507	-	-	15
SM2	2016-06-11	04:53	508	26	-	16
SM3	2016-06-11	07:36	509	27	12	-
SM4	2016-06-11	10:12	510	28	13	-
SM1	2016-06-11	13:06	511	-	-	17
SM3	2016-06-11	14:37	512	29	-	18
SM4	2016-06-11	17:30	513	30	-	19

At and downstream of the seamount, turbulence is enhanced in a region located above the depth level of the seamount summit, this region deepens downstream of the seamount (Figure 29). Example dissipation profiles from the summit (SM1) and at SM3 show that elevated levels of turbulence extend several 100 m above the topography and has a notable signature at the corresponding depth 7 km downstream.

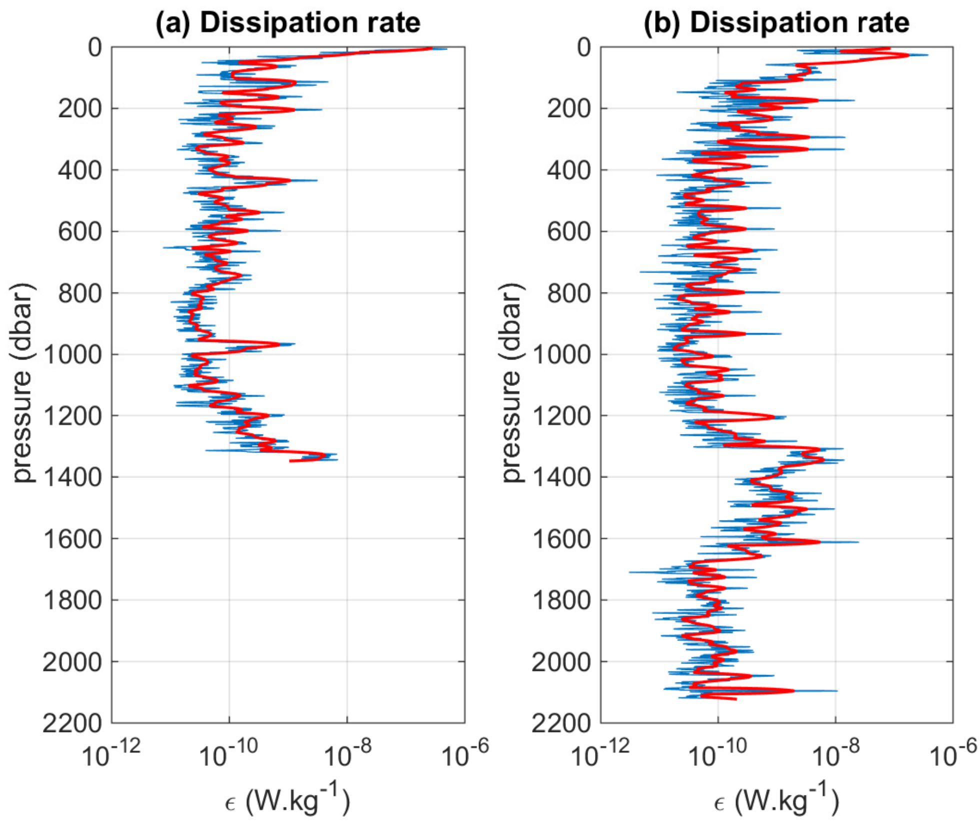


Figure 29. Dissipation profiles measured at (a) SM1 and (b) SM3 at the seamount site. Increased dissipation rates are clearly evidenced above and downstream of the seamount located below an horizontal frontal structure.

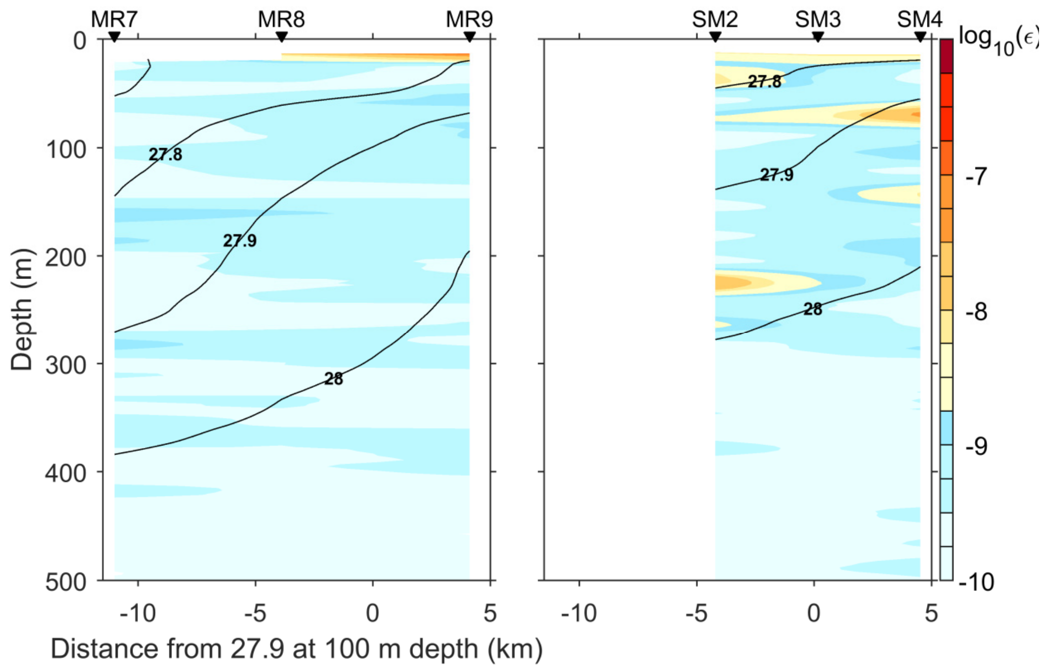


Figure 30. Dissipation rates contrasted at the frontal region before and after the seamount. Horizontal distance is referred to the distance where the 27.0 isopycnal Is at 100 m depth (a coarse estimate of the front).

12. Appendix A: Cruise Narrative

26 May 2016, Thursday

RV Håkon Mosby (HM hereafter) departed from Bergen at 17:30 local time (LT = UTC+2h).

Met-mast logging is not working. Instrument chief is working on a fix.

Fueling at Skålevik, 18.00

Start steaming to Svinøy mooring site

27 May 2016, Friday

Reached Stadt around 0730 LT

Started VMADCP at 06:10 UTC, using command file 2016611_BB_BT_on_600m_8m_bins. Using bottom track setup in this region to ensure good post-processing calibration later. Will switch to 16 m bins no bottom track setup later after the Svinøy mooring work

Note that the VMADCP-PC was updated early this year. The setup.ini files (with comm setups) used in earlier cruises may not be valid. NMEA2 input is enabled at COM3. N2R file does have the strings PADCP and PRDID as needed.

Hauk & Stefanie serviced / armed SBE56s

S1 North mooring recovered (1110 UTC)

S1 North deployed (1420 UTC) 62N50.224'; 004E20.728'; 510 m

S1 South recovered (1520 UTC)

S1 South deployed (1810 UTC) 62N48.788'; 004E14.683'; 510 m

28 May 2016, Saturday

0425 UTC, Recovered the S2000 mooring at Svinøy.

0610 UTC, The acoustic release of the S2200 mooring did not respond. We did not release it.

Hauk & Stefanie serviced / armed SBE37s

Transit to sound source 1

29 May 2016, Sunday

Run simulations on Gnå.

Preparations of sound source mooring 1.

Arrived at sound source mooring 1 (PL1) position 2030 UTC

CTD sta468 to 1000 m depth before deployment

Mooring deployed (2220 UTC) 70N19.225'; 003W57.519'; 2607 m

Preparation of sound source mooring 2

30 May 2016, Monday

CTD sta469 to 1000 m depth before deployment of sound source mooring 2 (PL2)

Mooring deployed (1555 UTC) 68N31.755'; 000E55.607'; 2820 m

31 May 2016, Tuesday

CTD sta470 to 1000 m depth before deployment of sound source mooring 3

Mooring deployed (0838 UTC) 68N30'; 007E55.4'; 2830 m

Transit to MS

Re-organizing on deck to make space for oceanographic mooring preparations.

All Seaguards (SN240, 1902, 1904, 1898) armed to start 31 May 1200 UTC. SN240 has no conductivity sensor, all others have CTD. All are equipped with Doppler current meter and two sets of lithium batteries. Set to sample 200 pings every 10 min.

1 June 2016, Wednesday

Deployed 2 CODE-I drifters at Gimsøy st.10

Started assembling VMP5500 (x2)

Started installing the LADCPs on the CTD rosette. Down-pointing SN 10012, up-pointing SN 10151.

Sound velocity on the echo sounder (constant) is changed from 1487 to 1480 m/s (2130 UTC)

Arrived at Acoustic source 4 position at 2140 UTC, took CTD sta0474.

2 June 2016, Thursday

Deployed sound source 4, 01:00 LT, 70N44.077'; 011E00.244E, 2685 m

Deployed MB mooring.

Before MB we took a VMP5500 and CTD/LADCP. VMP sink speed was slower than normal (Bruno added more weight for the next cast).

Steaming toward W (WHOI mooring position). The wind picked up (30 knots), rough seas and steaming slow (3 knots)

3 June 2016, Friday

We arrived at position W at 1630 UTC. This is a reference station, relatively unaffected by eddies. Because of rough sea conditions we could not deploy VMP5500. Took CTD sta0476.

4 June 2016, Saturday

In the morning, started preparing Gnå for deployment.

From the light boat with security buoy attached we run status.mi and ini1.mi, both completed successfully. We started a version of gna_lbe.mi with 100 m target depth and servo on. Surfaced normally (0515 UTC). All data are downloaded using Freewave and decided on battery positions with ideal pitch:

Dive- pitch = - 26deg, batt_pos = 0.295

Climb- pitch = 26deg, batt_pos = -0.234

After editing yo10 and surfac10 with fixed batt pos, we started a sequence of gna_lbe.mi with 1000 m target depth (0623 UTC)

Gnå aborted during third deep dive to 1000m. Leak detect voltage is low (leak in the aft compartment) at around 350m

Started the Section across the LBE from the core station, LBE1.

The location of radial velocity maximum and the center of eddy core are detected using the VMADCP steering the vessel 90deg to the right of velocity direction at approx 500 m reference depth. Center is recognized with velocity magnitudes of about 10 cm/s or less. Center detected 20160604 1610 UTC, 70N15.793', 002E 42.77'. Velocity maximum is 0.62 m/s, 184deg, 70N15.60', 003E04.56' (approximately 15 km from the core).

Deployment plan is VM5500 immediately followed by a CTD/LADCP, and after CTD, without moving back to the position deploy VMP2000. A 2000-m CTD and 1700 m VMP2000 pair takes approximately one cast duration for VMP5500 (approx 3 hours for 3000 m). CTD is limited to 2000 m because of a damage on wire. VMP2000 is limited to 1700-1800 m because of cable lengths (paid out 2200 m at each cast).

At LBE1, VMP2000 did not respond on SBE channels. Open VMP and found the SBE connector disconnected. After connecting the SBE is OK.

At LBE1 we deployed 6 RAFOS floats (2 at 200 m, 2 at 500 m and 2 at 800 m depth), 16:10 UTC.

At LBE2 we took a full depth CTD (but no VMP profile).

The section is interrupted to transit to outer edge of the eddy to recover Gnå. After recovery, the plan is to work the section from outside (radial distance from the core, r about 60 km) toward r = 10 km.

Took CTD (sta0479) at 2348 UTC at LBE11 (r = 60 km).

5 June 2016, Sunday

Recovered Gnå at 0830 UTC. Because of sea state it is not possible to use the light boat. We constructed a net (2.5 m x 1.5 m) with aluminum tubes at the edges, fixed rigidly. To increase the weight we added chain along the long sides. Approximately 2 m above the net we inserted a cross from aluminum tube at approximately same surface area as the net. We approach the glider from behind, net approx 1 m below surface, and once the glider is above the net we lift and retrieve. Shear probe M1414 and thermistor T1104 are broken.

Opened Gnå (not completely, but ajar at the aft and front sections). Inspected and found no evidence of a leak. Serviced, tested and re-deployed Gnå at 1530 UTC. Used two straps at mid section and crane while pulling by robe from either side on the strap and puhing outward by a long rod at the crane block. Released using Seacat quick release. Note- release is too heavy duty for this operation, especially when the glider is in water (too light). Deployment went OK.

Mission aborted 1700 UTC. Lead detect vol reads 1.9. Included it in the sbdlist and reduced the target depth to 100 m and restarted the mission. Aborted again. We decided to recover.

Opened Gnå. Leak confirmed. Instrument dried and data recovered from the memory card.

On June 5, we worked LBE 10 to LBE 7 (CTD sta0480 to 0483).

At approx. 30 km from the center (tentative), at CTD 483, we deployed 6 RAFOS floats (2 at 200 m, 2 at 500 m and 2 at 800 m depth), 22:09 UTC.

6 June 2016, Monday

VMP2000 shows noisy sh1 & sh2 record. Spectra from all channels show a distinct peak at 50 Hz. After troubleshooting we found that this is a grounding problem with the instrument. Decided to continue the sampling of the last two stations of the LBE section before opening the instrument for repair.

On June 6, we worked LBE 6 to LBE 3 (CTD sta0484 to 0487).

At LBE5 (20 km from the first estimated center of the eddy on 4 June) we started a new VMADCP section to detect the position of velocity maximum and to update the location of the center. The velocity maximum defines the position of LBE4.

Velocity maximum of 0.64 m/s, direction 167deg, at 70N15’, 002E51.8’.

Eddy core center at (20160606 1300 UTC) 70N13.19’, 002E14.00’E with speed 0.068 m/s and direction 143deg (at 500 m).

Velocity maximum is located 15.4 km from the center.

The core has moved approximately 30 km since 4 June, southwestward. The updated positions are used to define LBE4 and LBE3 locations.

At the radial speed maximum at CTD 486, we deployed 6 RAFOS floats (2 at 200 m, 2 at 500 m and 2 at 800 m depth), 18:30 UTC

Upon completing the LBE section we open the VMP2000 to fix the grounding problem.

We start a 13-h repeat station (TS1) at eddy core. Sampling scheme is VMP5500 immediately followed by CTD. Transit back to station location and deploy VMP2000. The operation takes approximately 3 h. After each full set, we relocated the eddy core with VMADCP, to define the position of the next 3-h sampling.

TS1 started at 2315UTC (CTD sta0488, VMP2000 cast 009)

7 June 2016, Tuesday

Continue sampling TS1.

VMP5500 is interrupted due to rough sea state (0730 UTC)

8 June 2016, Wednesday

We deployed sound source mooring PL5 and did a CTD (sta0492) down to 1000 m right after. We also discovered a small cyclone with the ship ADCP at the location of acoustic source number 5. Rough sea until noon. Discovered a bad O-ring at the tail of the glider, this was most likely the reason for the leak. Gnå cannot be repaired on ship, so it will not be deployed again on the cruise.

Started Mohn Ridge section (MR). Sampling scheme is to deploy VMP5500 first, immediately followed by the CTD. Once the CTD is on deck, we move back to station position and deploy VMP2000. Due to time constraints we will skip VMP2000 on selected stations.

Section started 2230 UTC, Sta0493, station MR1.

At MR section we run the echosounder with 4000-m bottom detection to ensure to obtain a good quality bathymetry along the section. This can compromise VMADCP quality on STA.

9 June 2016, Thursday

Prepared SG560 for deployment. Self test was successful. Pilot in charge is Karsten Kvalsund (Runde Centre).

At MR3 station, after CTD cast, we deployed 2x SVP drifters (simultaneously) followed by one RAFOS float.

Seaglider SG560 deployed at 0830 UTC, 71N52.40’; 002E50.46’.

Took CTD stations sta0494 (MR2) to sta0500(MR9)

Deployed RAFOS floats (one each) at stations MR3, 4, 5, 6, and MR7.

10 June 2016, Friday

Calm weather and seas. Continued on section MR across the Mohn ridge. We took stations sta0501 – 0506.

The section completed with VMP2000 at MR14 at 19:22 UTC (start of cast).

We switched the echo sounder setting to 1000-m range for bottom detection and run a VMADCP section to MR5.

Deployed RAFOS floats (one each) at stations MR8 and MR10.

11 June 2016, Saturday

Started sampling around a seamount on Mohn Ridge. We identified 4 stations, SM1 to SM4, with SM1 located at the seamount summit and the other 3 stations downstream wrt the strong (0.5-0.8 ms) frontal current (0-200 m depth) flowing in 90-120deg direction from North. The sampling scheme is to rotate SM1 to SM4 twice. VMP5500, CTD and VMP2000 are deployed. VMP2000 is deployed shallow (500-700 m) or not at all (SM1) because of short station duration due to relatively shallow depth (1400-2200 m).

12 June 2016, Sunday

Completed the seamount sampling on 19:30 UTC.

Transit to MR9 to start a VMADCP transect along the MR section, covering the frontal region and to the end of the section.

The VMADCP sampling will continue approximately along the Gimsøy section all the way to Gimsøy St 10 where we will deploy two drifters.

13 June 2016, Monday

Deploy drifters….

Transit to Bergen.

13. Appendix B: List of CTD stations

Table 5. 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 four columns indicates the cast number in file names for corresponding master/slave LADCP, VMP2000, VMP5500 and VMP6000 profiles (e.g., staXXX_LADCPM.000, VMP6000_0XX.p, etc.)

CTD	Station	Date	Time (UTC)	LAT	LON	EDepth (m)	LADCP	VMP-2000	VMP-5500	VMP-6000
468	PL1	2016-05-29	20:42	70N21.05	003W58.75	2667	-	-	-	-
469	PL2	2016-05-30	14:26	68N30.06	000E59.93	2875	-	-	-	-
470	PL3	2016-05-31	07:43	68N30.06	008E00.69	2776	-	-	-	-
471	MS	2016-05-31	21:13	68N50.05	012E44.83	681	-	-	-	-
472	MN	2016-06-01	00:09	68N56.10	013E19.86	653	-	-	-	-
473	MW	2016-06-01	01:55	68N58.72	013E16.89	1495	-	-	-	-
474	PL4	2016-06-01	21:49	70N45.62	011E00.00	2675	-	-	-	-
475	MB	2016-06-02	07:20	69N52.93	011E15.64	2914	475	-	1	-
476	WHOI	2016-06-03	16:50	69N39.16	006E57.35	3167	476	-	-	-
477	LBE1	2016-06-04	12:31	70N15.79	002E42.68	3221	477	1	-	1
478	LBE2	2016-06-04	16:57	70N15.72	002E50.61	3210	478	-	-	-
479	LBE11	2016-06-04	23:48	70N15.84	004E18.37	3208	479	2	-	2
480	LBE10	2016-06-05	03:49	70N15.76	004E02.78	3205	480	-	-	-
481	LBE9	2016-06-05	11:03	70N15.67	003E46.40	3216	481	3	-	3
482	LBE8	2016-06-05	16:24	70N15.77	003E38.56	3216	482	-	-	-
483	LBE7	2016-06-05	18:29	70N15.69	003E30.81	3214	483	4	-	4
484	LBE6	2016-06-06	01:59	70N15.72	003E22.94	3215	484	5	-	5
485	LBE5	2016-06-06	07:46	70N14.92	003E14.07	3209	485	6	2	-
486	LBE4	2016-06-06	14:49	70N14.82	002E52.05	3213	486	8	-	6
487	LBE3	2016-06-06	19:12	70N14.02	002E43.74	3211	487	9	3	-
488	TS1	2016-06-06	23:18	70N12.79	002E25.95	3208	488	10	-	7
489	TS1	2016-06-07	02:58	70N12.30	002E22.17	3210	489	11	4	-
490	TS1	2016-06-07	08:16	70N11.75	002E17.67	3203	490	12	-	-
491	TS1	2016-06-07	10:10	70N12.12	002E17.76	3203	491	13	-	-
492	PL5	2016-06-08	14:36	72N28.68	006E01.00	2652	492	-	-	-
493	MR1	2016-06-08	22:29	71N41.82	003E17.93	3048	493	14	5	-
494	MR2	2016-06-09	02:45	71N48.47	002E45.22	2473	494	15	-	8
495	MR3	2016-06-09	06:47	71N52.40	002E52.89	3935	495	-	6	-
496	MR4	2016-06-09	09:51	71N56.37	002E44.00	2508	496	16	-	9
497	MR5	2016-06-09	13:03	72N02.03	002E30.72	2160	497	17	7	-
498	MR6	2016-06-09	16:10	72N07.65	002E17.48	2107	498	-	-	10
499	MR7	2016-06-09	18:49	72N10.34	002E11.47	2418	499	18	8	-
500	MR8	2016-06-09	23:03	72N13.33	002E04.05	1955	500	19	-	11
501	MR9	2016-06-10	02:54	72N16.91	001E54.45	2604	501	20	9	-
502	MR10	2016-06-10	06:26	72N21.24	001E45.19	3219	502	21	-	12
503	MR11	2016-06-10	09:32	72N23.43	001E40.11	2568	503	22	10	-
504	MR12	2016-06-10	12:14	72N27.00	001E31.76	2365	504	23	-	13
505	MR13	2016-06-10	15:08	72N30.50	001E24.00	1305	505	24	11	-
506	MR14	2016-06-10	17:51	72N34.49	001E14.18	2662	506	25	-	14
507	SM1	2016-06-11	02:42	72N14.77	002E26.54	1428	507	-	-	15
508	SM2	2016-06-11	04:53	72N14.76	002E39.52	2265	508	26	-	16
509	SM3	2016-06-11	07:36	72N16.89	002E36.06	2180	509	27	12	-
510	SM4	2016-06-11	10:12	72N18.84	002E32.15	2124	510	28	13	-
511	SM1	2016-06-11	13:06	72N14.72	002E24.99	1525	511	-	-	17
512	SM3	2016-06-11	14:37	72N16.93	002E36.39	2182	512	29	-	18
513	SM4	2016-06-11	17:30	72N18.83	002E32.17	2124	513	30	-	19

14. Appendix C: List of VMP stations

Table 6. List of the VMP5500 and VMP6000 deployments.

#	Station name	Depth (m)	Latitude Longitude	Safety range (m)	Deployment Date Time (UT)	Comments
Anticyclonic eddy study area						
1	MB	2914	69°52.866' N 11°15.733' E	80	02/06 07:10	VMP 5500. Secondary maximum of EKE. w=0.45 m/s subsurface and 0.3 m/s at 2400 m. Time release. Missed last 400 m. sh1 and sh 2 deviated below 1000 m increasingly with depth. Pb with S2 ? (statistics of QC is a bit worse below 2000 m for sh2).
2	LBE1	3220	70°15.794'N 02°42.759'E	80	04/06 12:25	VMP 6000. HP Eddy Center. Pb with sbt cable. Pb with main battery, low voltage=> Changed
3	LBE11	3208	70°15.830'N 04°18.409'E	80	04/06 23:45	VMP 6000. HP eddy edge (50km from center). SBE OK w/ new cable. T1 broken during deployment with a rope.
4	LBE9	3216	70°15.661'N 03°46.385'E	80	05/06 11:00	VMP 6000. 40 km away from center.
5	LBE7	3214	70°15.722'N 03°30.805'E	70	05/06 18:25	VMP 6000. 30 km away from center.
6	LBE6	3214	70°15.704'N 03°22.994'E	70	06/06 01:59	VMP 6000. 25 km from center. Delayed by 20 mintues at the surface. One weight did not drop!
7	LBE5	3210	70°15.634'N 03°14.733'E	66	06/06 06:19	VMP 5500. 20 km away from center.Added 2*250g of lead. Downcast velocity increased by 0.05 cm/s but still 200 m are missing at depth. Need more extra weight => use Argos beacon
8	LBE4	3213	70°14.858'N 02°51.998'E	69	06/06 14:46	VMP6000. 15 km away from center, velocity maximum.
9	LBE3	3210	70°14.091'N 02°43.850'E	66	06/06 19:08	VMP5500. 10 km away from center. Use of Argos beacon to give more weight and increase downcast velocity. S1 replaced by M756 to test S2/S1=f(pressure). Pb w/ T1.
10	TS1	3208	70°12.800'N 02°25.970'E	64	06/06 23:18	VMP6000. Start of repeated station at eddy center. Cast 1.; sh2 bad values near bottom.
11	TS1	3208	70°12.357'N 02°22.213'E	64	07/06 02:55	VMP5500. Cast 2. Pb w/ T1.
Mohn Ridge study area						
12	MR1	3047	71°41.973'N 03°17.958'E	80	09/06 22:16	VMP5500.
13	MR2	2477	71°48.472'N 03°02.469'E	80	09/06 02:44	VMP6000.
14	MR3	2934	71°52.384'N 02°53.115'E	80	09/06 06:41	VMP5500.
15	MR4	2510	71°56.366'N 02°44.032'E	80	09/06 09:48	VMP6000.
16	MR5	2160	72°02.026'N 02°30.726'E	87	09/06 13:01	VMP5500.

17	MR6	2104	72°07.665'N 02°17.417'E	80	09/06 16:07	VMP6000.
18	MR7	2418	72°10.359'N, 02°11.395'E	70	09/06 18:43	VMP5500
19	MR8	1962	72°13.331'N 02°04.048'E	100	09/08 23:02	VMP6000
20	MR9	2605	72°16.914'N 01°55.630'E	70	10/06 02:54	VMP5500
21	MR10	3220	72°21.255'N 01°45.197'E	90	10/06 06:22	VMP6000
22	MR11	2564	72°23.433'N 01°40.111'E	74	10/06 09:31	VMP5500
23	MR12	2365	72°26.995'N 01°31.756'E	80	10/06 12:13	VMP6000
24	MR13	1310	72°30.496'N 01°23.632'E	70	10/06 15:08	VMP5500
25	MR14	2651	72°34.482'N 01°14.173'E	86	10/06 17:50	VMP6000
Front over Topographic Seamount study area						
26	SM1	1420	72°14.792'N 02°26.526'E	90	11/06 02:44	Seamount summit. Significant drift toward deeper region; VMP6000
27	SM2	2263	72°14.795'N 02°39.575'E	73	11/06 04:49	East of seamount summit; VMP6000 Crash into the mud. No broken sensors. Stayed less than 2 mn at the bottom.
28	SM3	2181	72°16.900'N 02°36.075'E	90	11/06 07:32	NE of seamount summit VMP5500
29	SM4	2126	72°18.837'N 02°32.158'E	86	11/06 10:11	NNE of seamount summit VMP5500
30	SM1 (bis)	1399	72°14.613'N 02°26.469'E	89	11/06 12:58	Seamount summit. VMP 6000.
31	SM3 (bis)	2184	72°16.933'N 02°36.430'E	106	11/06 14:36	NE Seamount summit (bis). VMP6000.
32	SM4 (bis)	2123	72°18.837'N 02°32.207'E	90	11/06 17:27	NNE seamount summit (bis). VMP6000.

Table 7. 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	LBE1	2016-06-04	14:07	70N15.88	02E40.46	3220	3.0	1785	477	no SBE; core (r = 0km); mT1: 1175, mT2:1176; sh1: M1109 (horizontal); sh2 = M1112 (vertical); mC C200; sbet: 4788; sbec: 2108
2	LBE11	2016-06-05	01:08	70N15.89	04E16.97	3212	3.0	1774	479	r=60km
3	LBE9	2016-06-05	12:30	70N14.94	03E46.35	3216	2.0	1730	481	r=40km; sh1 = M462 (h); sh2 = M546 (v)
4	LBE7	2016-06-05	19:55	70N15.25	03E31.27	3215	2.0	1866	483	r=30 km
5	LBE6	2016-06-06	03:21	70N15.72	03E22.94	3215	3.0	1740	484	r=25km
6	LBE5	2016-06-06	08:04	70N15.69	03E14.56	3209	2.0	1898	485	r=20km
7	test1	2016-06-06	14:20	70N14.92	02E52.00	3213	2.0	38	NaN	r=15km, ALL DUMMIES
8	LBE4	2016-06-06	16:20	70N14.81	02E51.75	3213	3.0	1723	486	r=15 km, no mC
9	LBE3	2016-06-06	20:35	70N12.92	02E42.70	3211	2.0	1809	487	r=10 km, mT1=1175, mT2=1176, sh1 = 1109 (h), sh2 = 1112 (v), mC=200
10	TS1	2016-06-07	01:39	70N12.81	02E26.09	3208	4.0	700	488	r=0
11	TS1	2016-06-07	04:38	70N12.30	02E22.30	3210	2.0	1492	489	r=0
12	TS1	2016-06-07	08:30	70N11.90	02E17.60	3203	2.0	1570	490	r=0, mT1=1001, sh2 = 1293, mC = 206
13	TS1	2016-06-07	11:30	70N12.01	02E17.18	3203	2.0	62	491	r=0, rough sea, CAST ABORTED
14	MR1	2016-06-08	23:53	71N41.97	03E17.90	3051	6.0	1731	493	In the rest, moved back to station after CTD
15	MR2	2016-06-09	04:10	71N48.48	03E02.65	2481	2.0	1939	494	
16	MR4	2016-06-09	11:12	71N56.35	02E44.10	2515	2.0	1000	496	early stop to recover VMP5500
17	MR5	2016-06-09	14:27	72N01.61	02E30.22	2161	5.0	586	497	early stop to recover VMP5500
18	MR7	2016-06-09	20:28	72N10.31	02E11.49	2416	15.0	1672	499	strong currents + wind in the opposite direction
19	MR8	2016-06-10	00:30	72N13.40	02E04.05	1936	2.0	1920	500	
20	MR9	2016-06-10	04:15	72N16.90	01E55.68	2600	2.0	1750	501	
21	MR10	2016-06-10	07:50	72N21.28	01E45.21	3237	2.0	1625	502	
22	MR11	2016-06-10	11:00	72N23.47	01E40.20	2566	2.0	455	503	early stop to recover VMP5500
23	MR12	2016-06-10	13:39	72N26.97	01E31.77	2368	6.0	1008	504	
24	MR13	2016-06-10	16:20	72N30.50	01E23.47	1320	2.0	1030	505	deployed after VMP5500 recovery
25	MR14	2016-06-10	19:22	72N34.48	01E14.03	2660	2.0	1087	506	
26	SM2	2016-06-11	06:15	72N14.73	02E39.57	2250	2.0	640	508	early stop to recover VMP5500
27	SM3	2016-06-11	09:10	72N16.90	02E36.50	2163	2.0	510	509	early stop to recover VMP5500
28	SM4	2016-06-11	11:37	72N18.85	02E32.22	2123	2.0	619	510	early stop to recover VMP5500
29	SM3	2016-06-11	16:05	72N16.86	02E36.05	2164	2.0	585	512	early stop to recover VMP5500
30	SM4	2016-06-11	18:52	72N18.66	02E32.07	2163	2.0	619	513	early stop to recover VMP5500

15. Appendix D: List of RAFOS float deployments

Table 8. List of RAFOS float deployments.

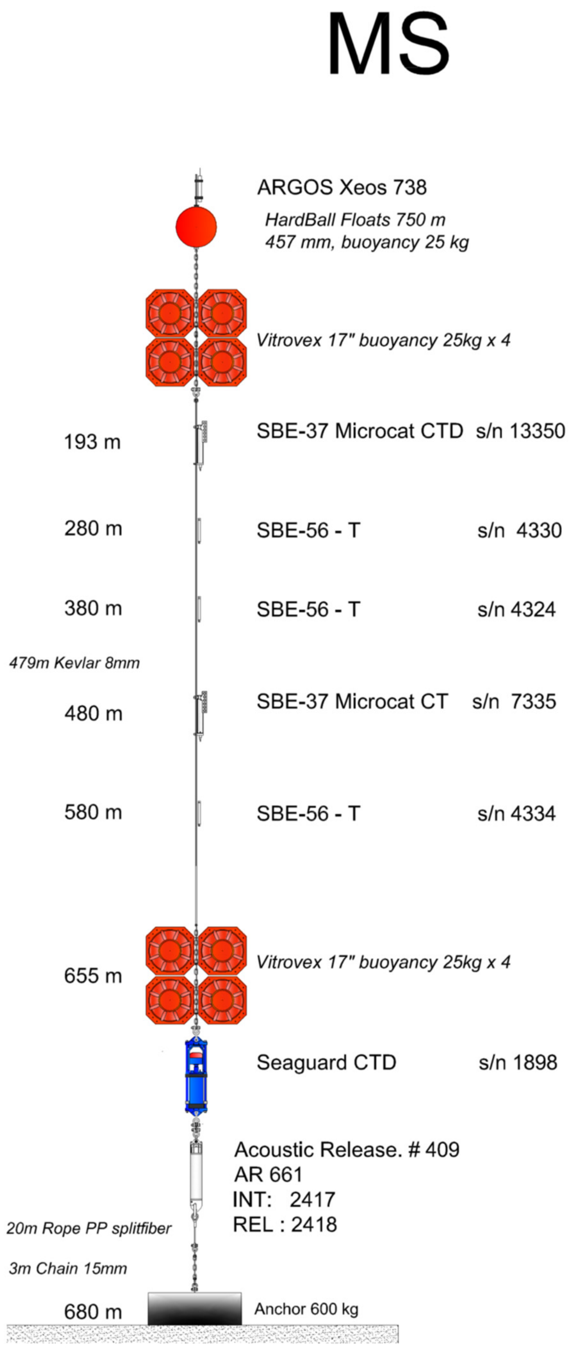
#	Float #	IMEI#	Date (UTC)	Time (UTC)	LAT	LON	Echo Depth (m)	Target Depth	Added wght (g)	CTD #	Comments
1	1448	300234062352330	2016-06-04	16:10	70N15.79	02E42.77	3221	800	25.2	477	Center of LBE - LBE1
2	1449	300234062357320	2016-06-04	16:10	70N15.79	02E42.77	3221	800	25	477	
3	1285	300234060877210	2016-06-04	16:10	70N15.80	02E42.77	3221	500	6.1	477	
4	1286	300234060673960	2016-06-04	16:10	70N15.80	02E42.77	3221	500	6.1	477	
5	1293	300234061823930	2016-06-04	16:10	70N15.80	02E42.77	3221	200	0	477	
6	1302	300234061827930	2016-06-04	16:10	70N15.80	02E42.77	3221	200	0	477	
7	1281	300234060306690	2016-06-05	22:09	70N15.67	03E30.82	3214	800	12.7	483	Nominal 30 km from LBE center, new center distance 36 km - LBE6
8	1287	300234061829910	2016-06-05	22:09	70N15.67	03E30.82	3214	800	13.4	483	
9	1273	300234060878190	2016-06-05	22:09	70N15.67	03E30.82	3214	500	6.1	483	
10	1274	300234060870240	2016-06-05	22:09	70N15.67	03E30.82	3214	500	6	483	
11	1289	300234061829920	2016-06-05	22:09	70N15.67	03E30.82	3214	200	0	483	
12	1291	300234061824920	2016-06-05	22:09	70N15.67	03E30.82	3214	200	0	483	
13	1203	300234010585230	2016-06-06	18:30	70N14.80	02E50.70	3213	800	12.7	486	Speed maximum, nominal 15 km from LBE center - LBE4
14	1211	300234010733190	2016-06-06	18:30	70N14.90	02E50.80	3213	800	12.8	486	
15	1258	300234060870220	2016-06-06	18:30	70N14.10	02E50.90	3213	500	6.4	486	
16	1261	300234060877810	2016-06-06	18:30	70N14.11	02E50.10	3213	500	6.5	486	
17	1303	300234061820940	2016-06-06	18:30	70N14.12	02E50.11	3213	200	0	486	
18	1304	300234061825940	2016-06-06	18:30	70N14.13	02E50.12	3213	200	0	486	
19	1204	300234010466200	2016-06-09	06:45	71N52.37	02E52.93	2935	1000	21.2	495	Mohn Ridge section, MR3
20	1268	300234060773720	2016-06-09	11:11	71N56.35	02E44.10	2516	1000	20.8	496	Mohn Ridge section, MR4
21	1267	300234060870110	2016-06-09	13:05	72N02.05	02E30.67	2160	800	15.7	497	Mohn Ridge section, MR5
22	1447	300234062067080	2016-06-09	17:42	72N07.68	02E17.75	2118	800	28.8	498	Mohn Ridge section, MR6
23	1446	300234063734030	2016-06-09	18:55	72N10.36	02E11.30	2419	800	29.2	499	Mohn Ridge section, MR7
24	1272	300234060877220	2016-06-10	00:28	72N13.40	02E04.02	1941	800	15.9	500	Mohn Ridge section, MR8
25	1271	300234060302620	2016-06-10	06:25	72N21.25	01E45.20	3219	800	15.9	2002	Mohn Ridge section, MR10

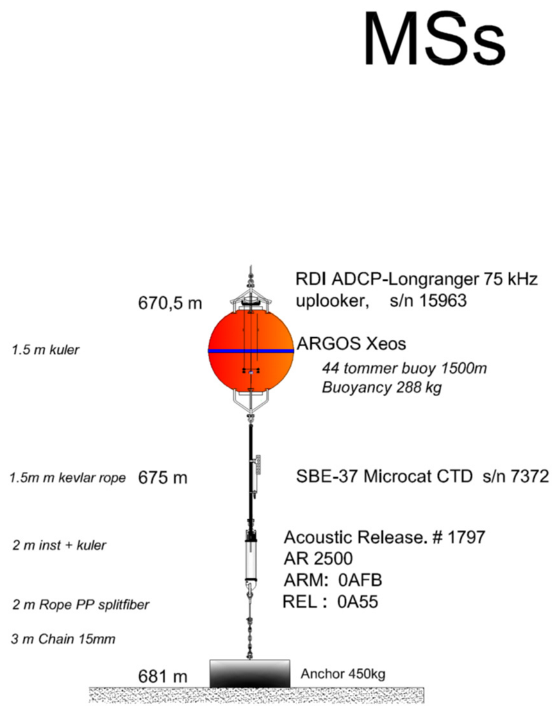
16. Appendix E: List of drifter deployments

Table 9. List of surface drifter deployments.

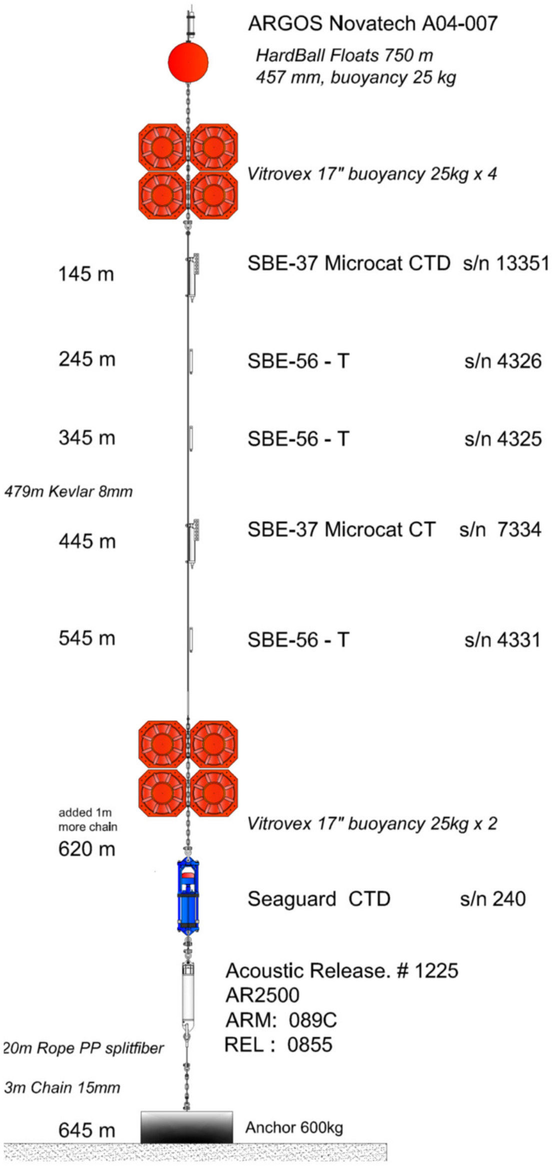
Dep.	Type	ID#	Lat	Lon	Date	UTC	Comments
1	CODE-I	30023406378 5260	68N51	012E48	31.05.2016	20:00	Station G10, water depth 675 m
2	CODE-I	30023406378 7240	68N51	012E48	31.05.2016	20:00	Station G10
3	CODE-I	30023406378 9230	68N51	012E48	01.06.2016	07:13	Station G10
4	CODE-I	30023406378 2960	68N51	012E48	01.06.2016	07:13	Station G10
5	SVP	145931	71N52	002E53	09.06.2016	06:45	Station MR3, water depth 2831 m
6	SVP	145919	71N52	002E53	09.06.2016	06:45	Station MR3
7	SVP	145932	72N08	002E18	09.06.2016	17:40	Station MR6, water depth 2120 m
8	SVP	145939	72N08	002E18	09.06.2016	17:40	Station MR6, water depth 2120 m
9	CODE-I	30023406378 5960	72N21	001E45	10.06.2016	06:25	Station MR10, water depth 3200 m
10	CODE-I	30023406378 1960	68N51	012E48	13.06.2016	00:00	Station G10
11	CODE-I	30023406378 9920	68N51	012E48	13.06.2016	00:00	Station G10

17. Appendix F: Mooring drawings

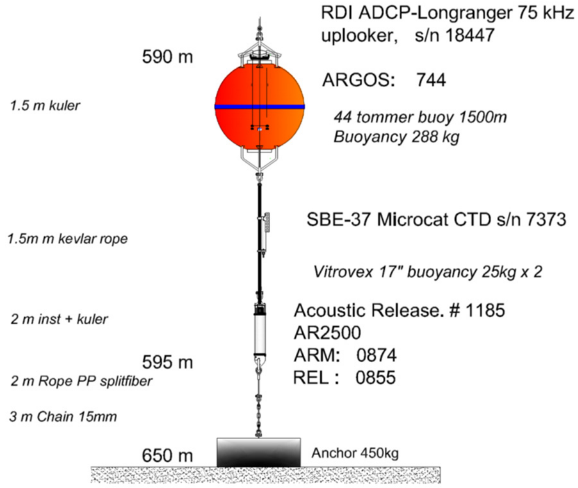




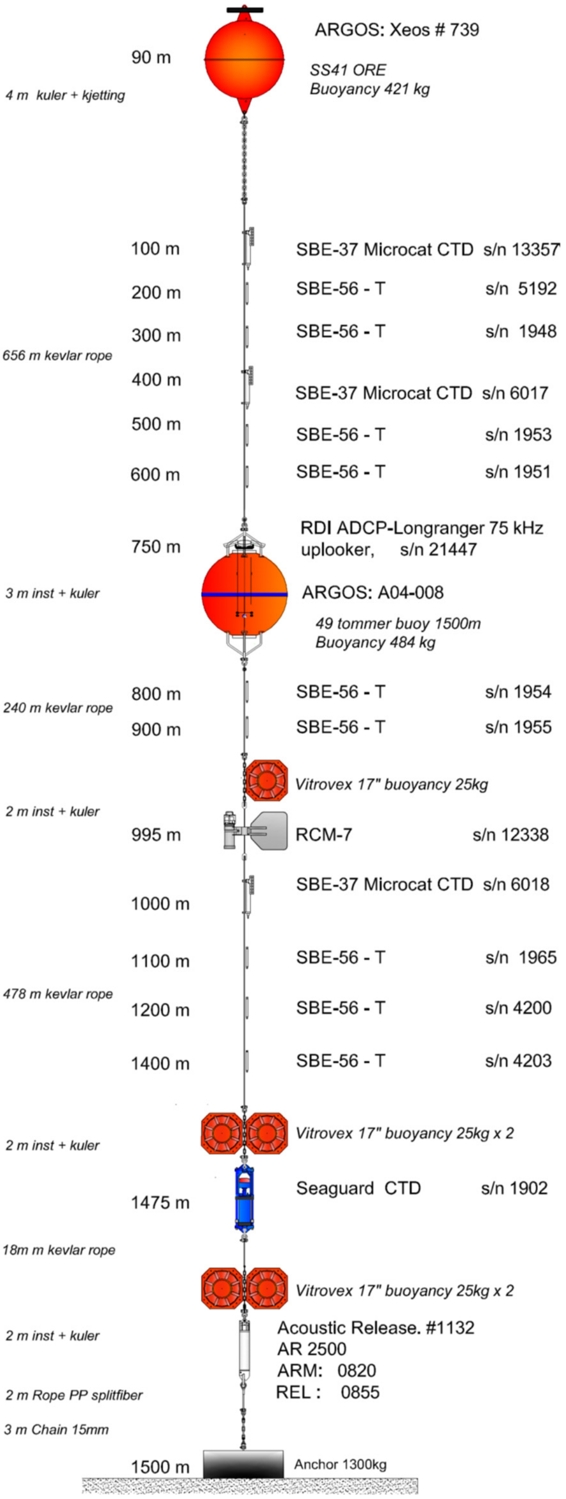
MN


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

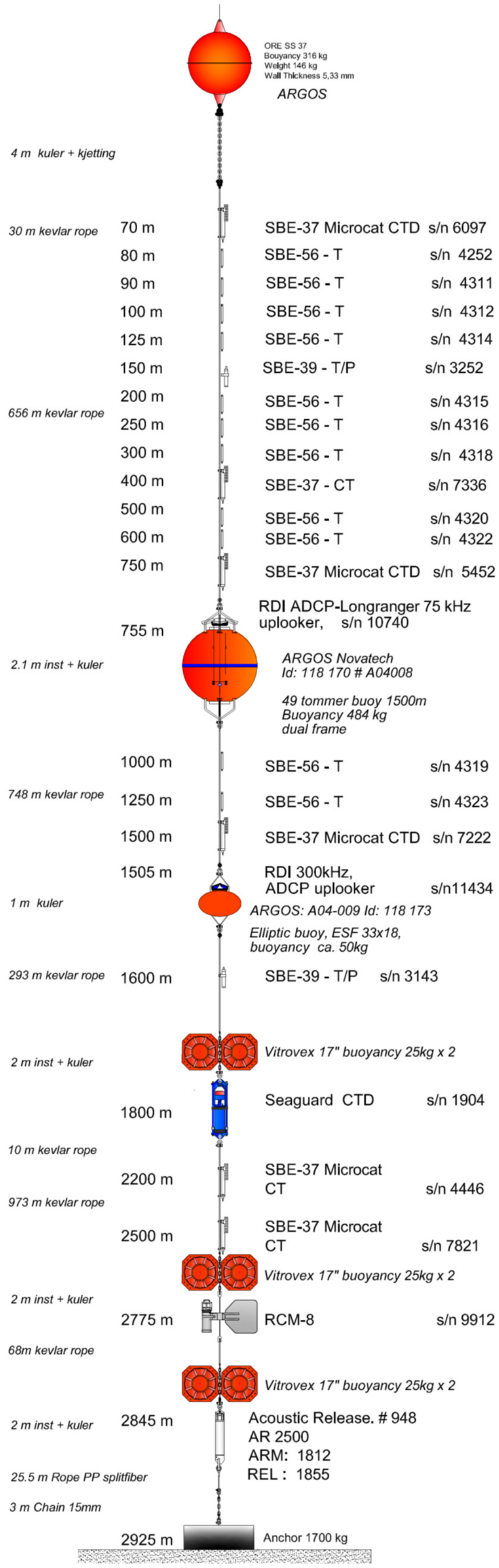

RDI ADCP-Longranger 75 kHz
uplooker, s/n 18447
590 m
ARGOS: 744
1.5 m kuler
44 tommer buoy 1500m
Buoyancy 288 kg
SBE-37 Microcat CTD s/n 7373
1.5m m kevlar rope
Vitrovex 17" buoyancy 25kg x 2
2 m inst + kuler
Acoustic Release. # 1185
AR2500
595 m
ARM: 0874
2 m Rope PP splitfiber
REL : 0855
3 m Chain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

MW



ARGOS: Xeos # 739
90 m
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
ARGOS: A04-008
3 m inst + kuler
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
200 m SBE-56 - T s/n 4315
656 m kevlar rope
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
1800 m Seaguard CTD s/n 1904
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

18. Appendix G: LADCP and VMADCP Deployment Files

Table 10. 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 11. 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
```

Table 12. VMADCP deployment file. (DeepWaterLongRange_16m_NB__TR_ON_2016611a.txt, mainly used during the cruise)

```
;---------------------------------------------------------------------------\
; ADCP Command File for use with VmDas software.
; ADCP type:     75 Khz Ocean Surveyor
; Setup name:    default
; Setup type:    Low resolution, long range profile(narrowband)
;---------------------------------------------------------------------------/

; Restore factory default settings in the ADCP
cr1
cx1,0    ; cx1,0 external input trigger on,  cx0,0 external input trigger off

; set the data collection baud rate to 38400 bps,
; no parity, one stop bit, 8 data bits
; NOTE:  VmDas sends baud rate change command after all other commands in
; this file, so that it is not made permanent by a CK command.
cb411

; Set for narrowband single-ping profile mode (NP), fifty (NN) 16 meter bins (NS),
; 16 meter blanking distance (NF)
WP0
NN055
NP00001
NS1600
NF1600

; Disable single-ping bottom track (BP),
; Set maximum bottom search depth to 1000 meters (BX)
BP000
BX10000

; output velocity, correlation, echo intensity, percent good
ND111100000

; zero seconds between bottom and water pings
TP000000

; Three seconds between ensembles
; Since VmDas uses manual pinging, TE is ignored by the ADCP.
; You must set the time between ensemble in the VmDas Communication options
TE00000100

; Set to calculate speed-of-sound, no depth sensor, external synchro heading
; sensor, no pitch or roll being used, no salinity sensor, use internal transducer
; temperature sensor
EZ10000010

; Output beam data (rotations are done in software)
EX00000

; Set transducer misalignment (hundredths of degrees)
EA04530
; Set transducer depth (decimeters)
ED0042
; Set Salinity (ppt)
ES35

; save this setup to non-volatile memory in the ADCP
CK
```

19. References

Fer, I., A. K. Peterson, and J. E. Ullgren (2014), Microstructure Measurements from an Underwater Glider in the Turbulent Faroe Bank Channel Overflow, *J. Atmos. Ocean. Technol.*, *31*(5), 1128-1150, doi:10.1175/JTECH-D-13-00221.1.

UNESCO (1988), The acquisition, calibration, and analysis of CTD data, Unesco technical papers in marine science, 54, A Report of SCOR Working Group 51.*Rep.*

Visbeck, M. (2002), Deep velocity profiling using lowered acoustic Doppler current profilers: Bottom track and inverse solutions, *J. Atmos. Ocean. Technol.*, *19*, 794-807.