the Nansen LEGACY

Ocean Mixing Process Study 2018

Cruise Report

The Nansen Legacy Report Series 1/2020

Ocean Mixing Process Study 2018

Cruise 2018616

R.V. Kristine Bonnevie

Longyearbyen-Longyearbyen

June 27– July 10, 2018

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1. Background

The cruise KB 2018616 aboard the Research Vessel *Kristine Bonnevie* is the first research cruise of the project the Nansen Legacy. The Nansen Legacy is the Norwegian Arctic research community's joint effort to establish a holistic understanding of a changing marine Arctic climate and ecosystem. The project will provide a scientific knowledgebase needed for future sustainable resource management in the transitional Barents Sea and the adjacent Arctic Basin. It is a collaborative project between ten Norwegian research institutions, and will run from 2018-2023. Activities in the project will include international cooperation, and several cruises mainly with the new, ice-going research vessel *Kronprins Haakon*. The first cruise, however, was aboard *Kristine Bonnevie*, addressing ocean mixing process studies in the region west and north of Svalbard.

The cruise contributes to the Task 1-2-1 "Oceanic processes", and deliverable D1-2.1.1. The general aim is to identify and quantify the processes that control the heat budget north of Svalbard, with particular focus on the warm Atlantic boundary current. The field programme of Task 1-2-1 includes the present cruise and the planned cruises coordinated with deployments of moorings, gliders and AUVs, to capture the role of frontal processes, tides, background shear and wind energy in turbulent mixing distribution within the ocean and interactions and feedback with sea ice cover.

The cruise KB 2018616 aims to collect ocean stratification, currents, and microstructure profiles along selected transects across the Spitsbergen shelf and slope, and provides the background for the *Kronprins Haakon* cruise scheduled in late September 2018. This report provides an overview of the methods employed and the data collected during KB 2018616.

2. Survey area

The cruise took place between 27 June and 10 July 2018 with port calls Longyearbyen - Longyearbyen. The main operations were hydrography, current, and ocean microstructure profiling. Additionally, a glider equipped with microstructure sensors (Gnå) was deployed and recovered to collect profiles in the upper 300 m (mission unsuccessful). Other operations include a deployment of an ARGO profiler for the NorArgo programme and collection of water samples at selected stations for the Veterinary Institute. A timeline of events is given in Appendix II. The cruise track is shown in **Figure 1**.

Ocean stratification, current and microstructure measurements were made along four main sections across the path of the warm West Spitsbergen Current; a fifth section was incomplete, interrupted by the ice edge extending to shelf at 24E. Profiles covered the full water column, except the shipboard acoustic Doppler current profiler (SADCP) sampled the upper 300-400 m. Profiles were collected at stations along the sections from shelf to deep water as well as at process stations. Two process stations were repeat stations (RS1 and RS2), each for approximately 24 hours duration. One process sampling was done at 3 stations (T1 to T3) forming corners of a triangle along the 1000-m isobath near 15E where the bathymetric contours are substantially curved. Additional 3 stations were taken near the REOCIRC site. The cruise was completed with a section into Isfjorden (without microstructure measurements). The Isfjorden section crosses the West Spitsbergen Current, the continental shelf along west Spitsbergen and into the inner parts of the Isfjorden system. The section is repeated 2-4 times a year and reflect the strength and heat content of the northward flowing warm AW, the water mass exchange with the adjacent shelf, and the level of intrusion of warm AW into the Arctic fjords in Svalbard. The Isfjorden section has been collected regularly since 1999 and constitutes a climate time series.

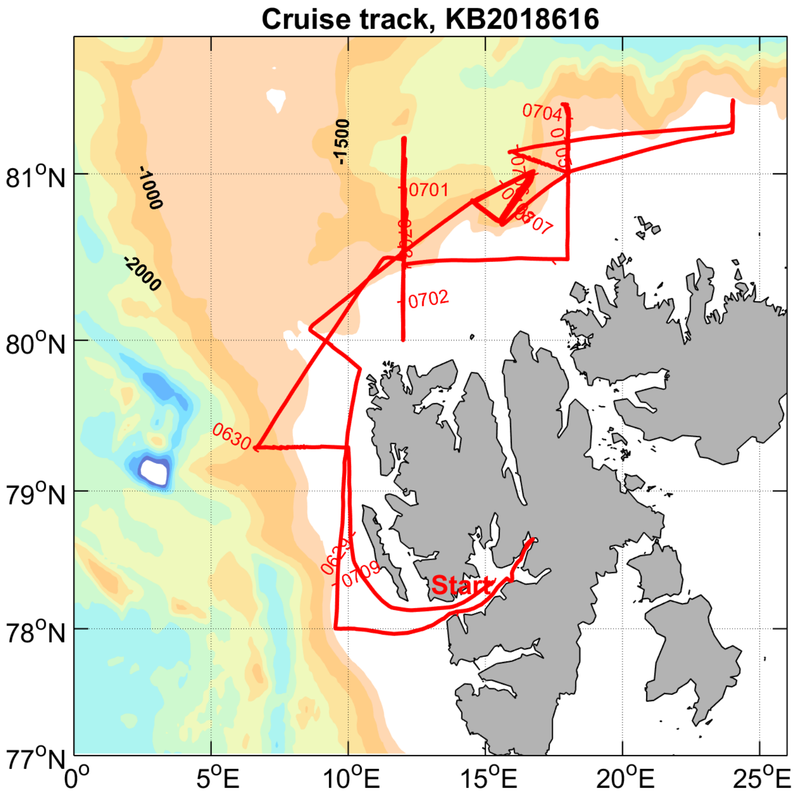


Figure 1. Cruise track of KB 2018616. Date format is MMDD.

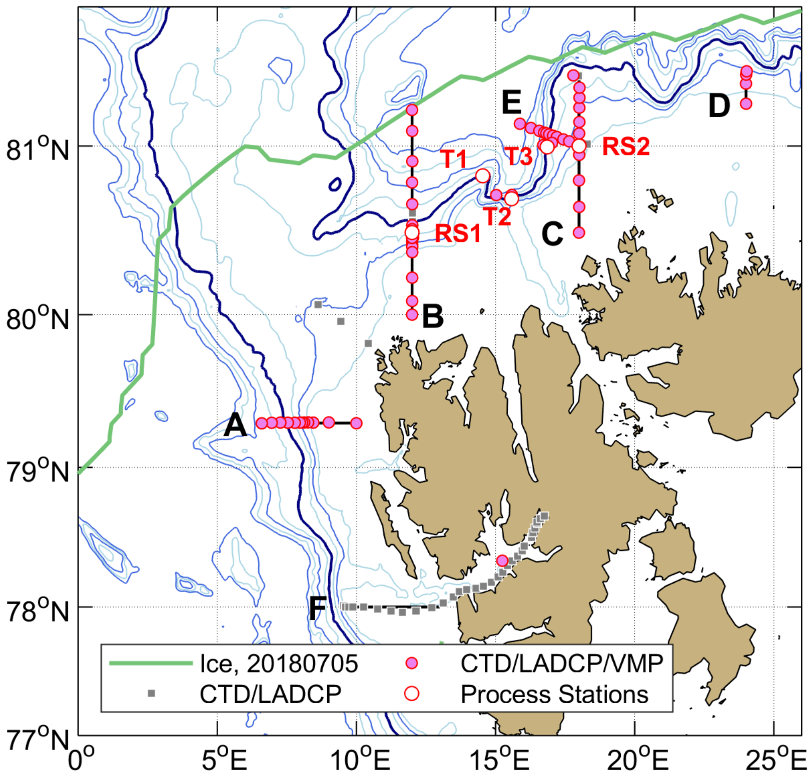


Figure 2. Station map, KB 2018616. Ice edge (15% concentration) is for 5 July 2018. Process stations are taken using CTD/LADCP/VMP. The three stations (CTD/LADCP) between sections A and B are at the REOCIRC site. The innermost shallow stations of the Isfjord section (F) did not have LADCP.

In total 120 CTD (conductivity temperature depth), 106 LADCP (lowered acoustic Doppler current profiler), and 200 microstructure profiles were collected. The glider aborted mission after 6 hours and no data is reported from Gnå nor the microstructure package installed on Gnå. The shipboard ADCP (SADCP) sampled continuously, for 11.5 days, throughout the cruise. In total, 87 and 33 water samples were drawn for salinity and oxygen concentration calibration, respectively. A station map is shown in **Figure 2**.

A complete list of CTD and microstructure stations is tabulated in Appendix II. Instrument and sampling details are given in the following sections.

3. Activity reports

3.1. Environmental conditions

Following strong winds early in the cruise period, the conditions were generally calm. Sections A and B, and the repeat station RS1 were worked during spring tides and the remaining stations in transitions to neap (Section C and RS2), and during neap tides (Section D). Wind picked up early in process "triangle" (T1-T2-T2 stations along the 1000-m isobath), and peaked when we were sampling at the REOCIRC site. No VMP was taken at these stations.

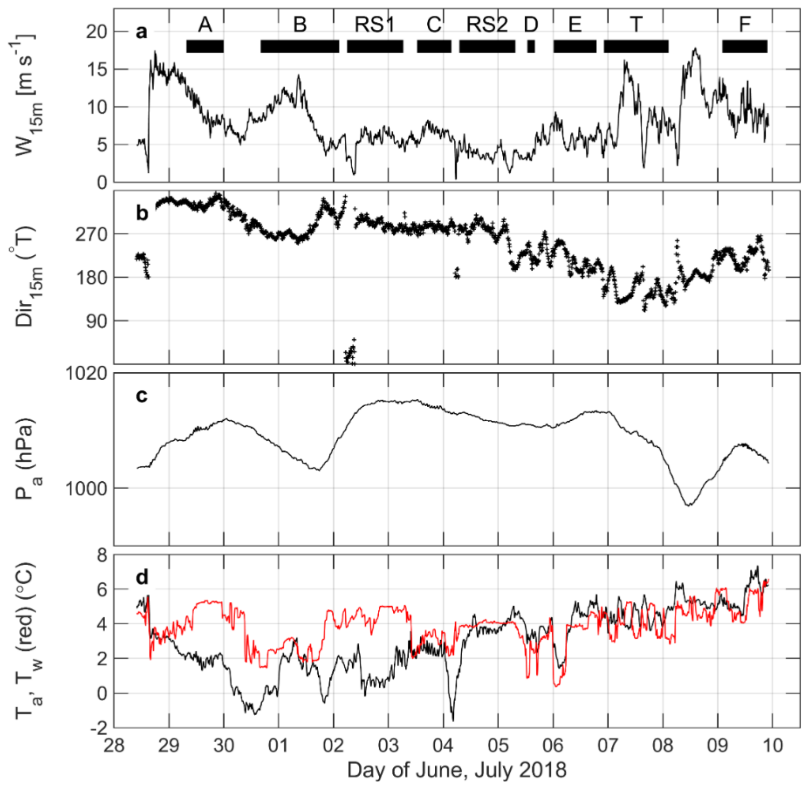


Figure 3. 10-minute averaged data from the ship's log: a) wind speed, b) direction, c) atmospheric pressure measured at 15-m height, and d) near-surface water (red) and 15-m height air temperature. Duration of activities (sections and process stations) are indicated at the top.

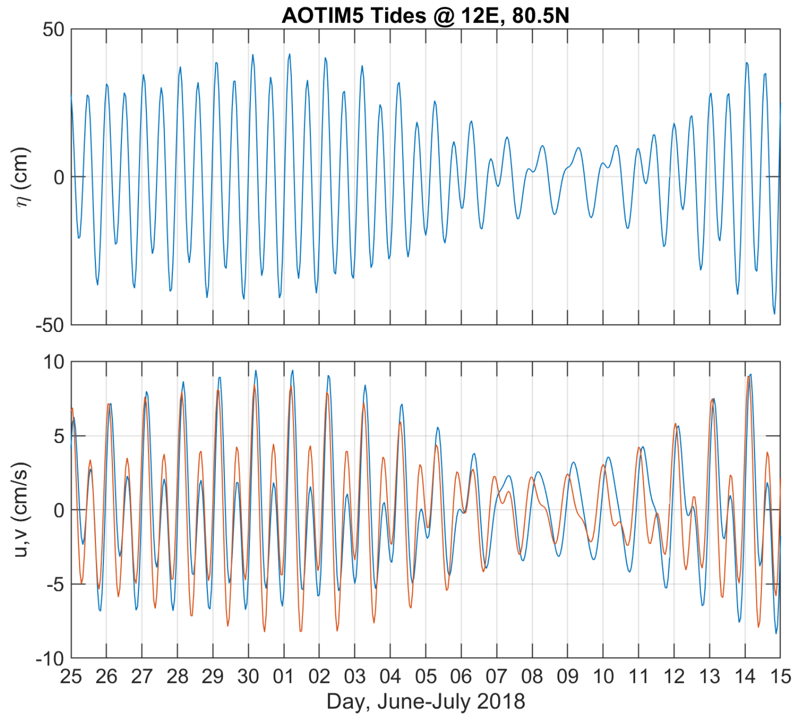


Figure 4. Tidal elevation and currents during a spring-neap cycle covering the cruise period, inferred from the AOTIM5 model at 12E and 80N30.

3.2. 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. The CTD was equipped with a 12 position SBE 32 Caroussel (SN 1109), fitted with one 10-litre sampling bottle for salinity calibration at all stations, and with 4 more bottles in selected stations for water samples for dissolved oxygen calibration. In total 120 CTD-stations were taken, recorded in files sta0762 to sta0881. At 87 stations, water samples for salinity calibration were collected at the deepest sampling level. At 7 stations, 33 samples in total were drawn at selected levels for oxygen concentration analysis. The CTD rosette, together with LADCPs (Section 3.3.1), is shown in **Figure 5**. Their locations are listed in Appendix II. Station positions are shown in **Figure 2.**

Table 1. Sensor details installed on the CTD rosette.

Sensor	SN	Calibration/Service date
Temperature	5884	19.10.2017
Conductivity	4386	14.12.2017
Pressure	134950	17.11.2015
Temperature, 2	4306	19.10.2017
Conductivity, 2	2860	14.11.2017
Altimeter, Benthos PSA-916	67087	01.02.2015
Oxygen, SBE 43	0633	31.10.2017
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, downward	10012	2015
RDI WH300 L-ADCP, upward	10151	Dec. 2016

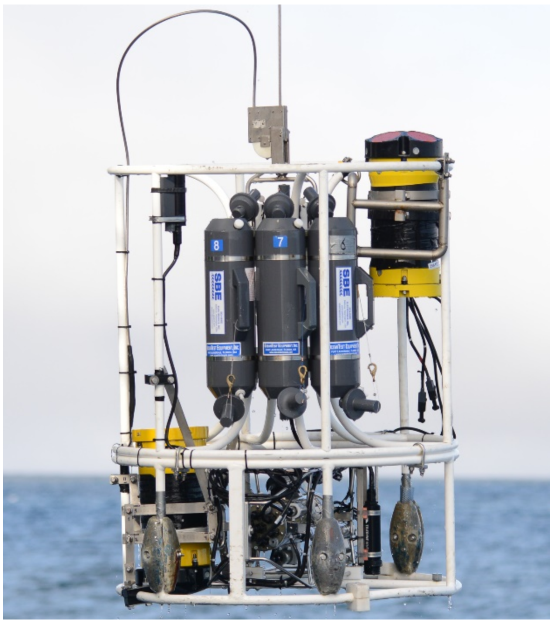


Figure 5. The CTD rosette together with the CTD sensors, three 10-liter Niskin bottles, a down and uplooker ADCP, and a benthos altimeter installed. The transducers of both ADCPs and the altimeter have a non-obstructed path. The position of the lead weights and the ADCPs are adjusted to have a negligible 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 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, $\pm 2\times10^{-3}$ °C, and $\pm 3\times10^{-3}$, respectively.

Conductivity correction from salinity bottle samples – A total of 88 salinity bottle samples are analyzed at IMR with a Guildline Portasal 8410 salinometer. 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. The difference between CTD-derived and bottle data is shown in **Figure 6**. Following the procedure recommended by UNESCO [1988], only data within the 95% confidence interval are used to correct the calibration of the CTD conductivity.

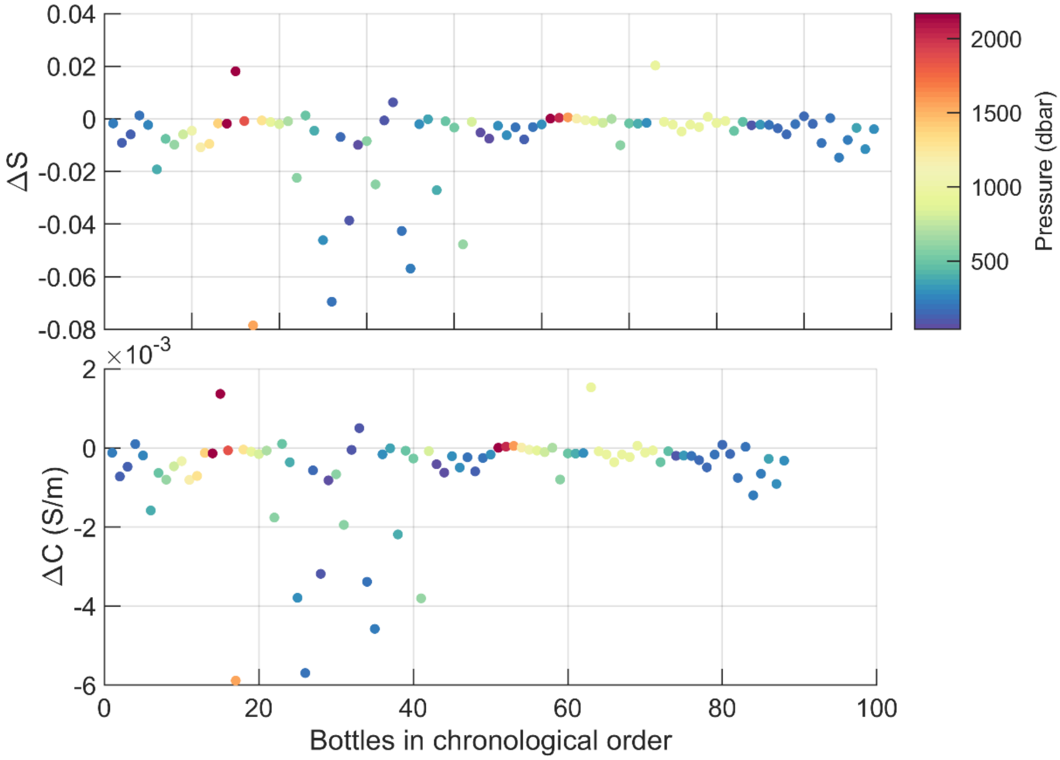


Figure 6. Difference between CTD-derived and bottle data: upper panel, salinity, lower panel, conductivity. Data points are color-coded for the sample pressure.

Following the recommendations given by Seabird Electronics, the corrected conductivity values are, 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 81 values inside the 95% confidence interval, m = 1.0001. Prior to correction, the conductivity difference between CTD and bottles, $\Delta C = C_{CTD} - C_{bot}$ averaged -3 (± 5.3) $\times 10^{-4}$ (± 1 standard deviation) over 81 samples. After correction ΔC = 0.1 (± 5.0) $\times 10^{-4}$ S/m. However, the effect on the salinity is not better than the measurement accuracy. After applying the conductivity slope correction, the RMS difference between bottle and CTD salinity before correction is 0.0077, and improves slightly to 0.0067. In conclusion, the salinity measurements are deemed accurate and no further correction is applied.

Samples for oxygen calibration - During the cruise, 33 water samples were taken at several depth levels at 7 CTD stations (CTD-stations 780, 781, 784, 786, 787, 788, 789) on the 30 June and 1 July and analysed for dissolved oxygen. The Winkler titration method with visual detection of the end point was used. The dissolved oxygen concentrations obtained by the Winkler method (Ox sample) were slightly higher than the concentrations measured by the CTD dissolved oxygen sensor (Ox CTD) as can be seen in **Figure 7**. The difference between the two varied from 0.29 ml L^{-1} to 0.46 ml L^{-1}. The mean offset was 0.33 ml L^{-1}. Although there is an apparent dependency to pressure, it was not deemed necessary to conduct a more detailed, multiple-parameter calibration.

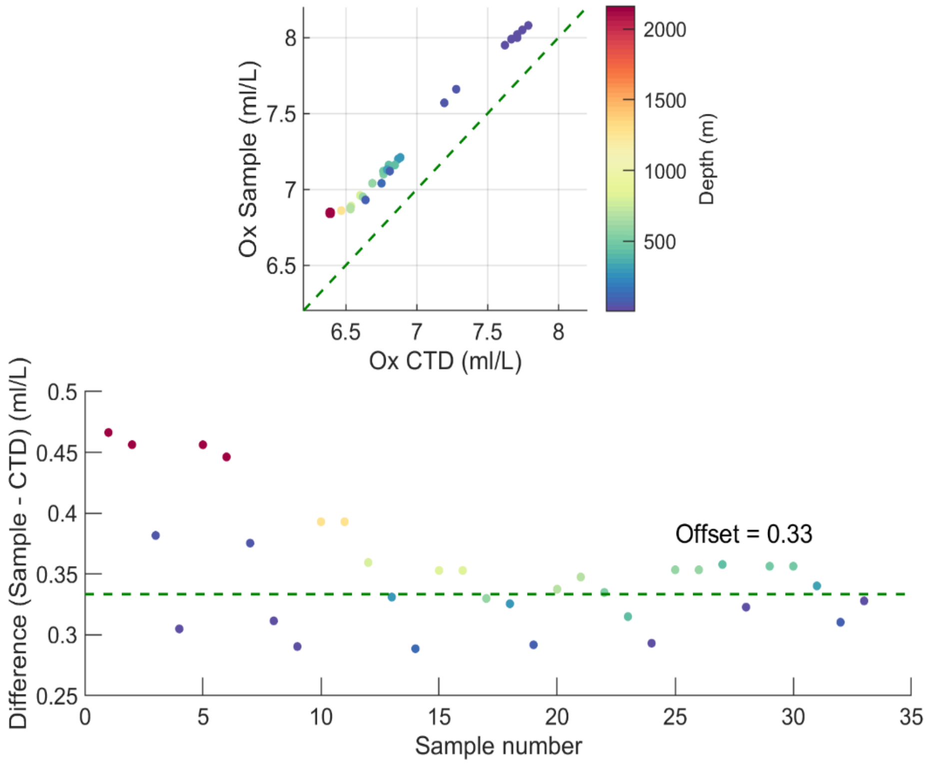


Figure 7. (upper panel) Scatter plot of CTD-measured oxygen values against oxygen samples analyzed on board, color coded with sample depth. (lower panel) difference between the sample reading and the CTD reading. An average offset of 0.33 is obtained excluding samples deeper than 1000 m.

3.3. Current Profiling

3.3.1. Lowered-ADCP (LADCP)

Two LADCP-profilers (RD Instruments) were mounted on the CTD rosette in order to obtain current profiles (**Figure 5**). 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). The compass of each instrument was calibrated on land (in Bergen) in their respective orientation prior to the cruise, and the resulting compass errors were 1-2°. Communication with the instruments, start & stop of data acquisition and data download were done using the 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 II.

The LADCP data are processed using the LDEO software version IX-13 based on *Visbeck* [2002]. For each master/slave profile data, synchronized time series of CTD and navigation is used. The NMEA GPS stream is automatically stored in the CTD .hex files with each scan, and are post-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-minute time averaged profiles from the VM-ADCP are included for additional constraint on the inversion of the LADCP data.

3.3.2. Shipboard ADCP (SADCP)

The shipboard acoustic Doppler velocity profiler (SADCP) is a 150 kHz Teledyne RDI Ocean Surveyor (SN 30236). SADCP continuously collected velocity profiles below the ship, using the UHDAS software, and the default set-up (os150-default.cmd) with Narrowband mode, and 50 bins of 8-m vertical thickness. Bottom tracking was disabled. The SADCP data are processed using the University of Hawaii Software, as 3-min averages. Typical final processed horizontal velocity uncertainty is 2-3 cm s^{-1}.

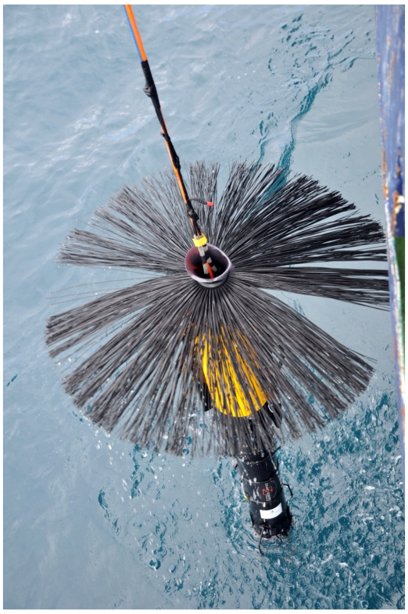
3.4. Microstructure Profiling

Ocean microstructure measurements were made using the vertical microstructure profiler VMP2000, 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 3.5). Operation and deployment methods for the VMP system are described below. VMP data reported here are from preliminary processing conducted during the cruise. Data are post-processed to high-quality for analysis, using the 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 II. 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 8. 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.



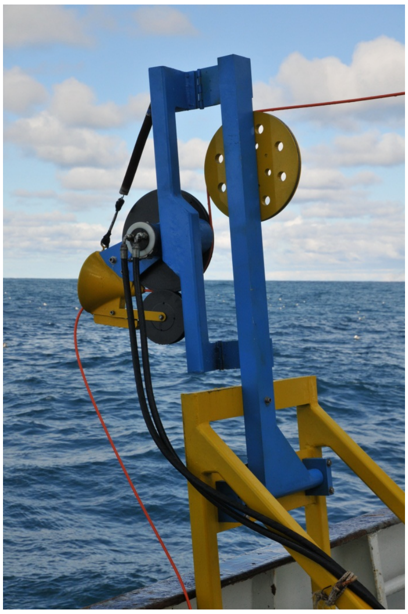


Figure 9. (Left) The VMP profiler during deployment. The brushes provide the drag for the profiler. Drag, together with the buoyancy elements (yellow) set the nominal sink velocity of the profiler. Note the recovery line attached to the cable which allows recovery by a crane without damaging the cable. (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). Approximately 2-m long rope is attached to the upper end of the VMP and strapped (using cable ties and tape) 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, which is helpful to estimate the slack in the water.

Microstructure sensors:

casts	S1	S2	T1	T2	C1
1	M1109	-	T1175	-	-
2-9	M1109	M1293	T1175	T1176	C200
10-14	M1109	M1293	T1175	T1001	C200
15-20	M462	M546	T1175	T1001	C200
21-20?	M1109	M546	-	T1001	C200

SBE sensors: **sbeT**: 4788, **sbeC**: 3340
S1 is oriented to be sensitive in the direction of the P-port, vertical
S2 is sensitive perpendicular to the P-port, horizontal.
Measured pressure offset is 1.5 m (4 m actual depth is sensed as 2.5 dbar).

3.5. Glider

During the cruise, a deep electric Slocum glider from Teledyne Webb Research (Gnå, **Figure 10**) equipped with a unpumped SBE CT, a Wetlab ECO-puck (Fluorescence and Turbidity), Andreraa oxygen Optode and Rockland Scientific Microrider was deployed on 1 July 04:00 UTC and successfully recovered on the same day, at around 12:00 UTC. The MicrosRider 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 512 Hz, 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].

Deployment and recovery of ocean gliders is often challenging. The onboard work boat can often not be used due to waves/wind conditions. To that end, we use specialized tools for deployment and recovery, described in the following. The glider was deployed from the aft deck of the ship using a crane and a custom-made deployment tool kindly provided by French collaborators from IFREMER. Initially designed for the deployment of Spray gliders, the foam of the cradle could be easily adapted to the shape the Slocum glider carrying a microrider. Two straps holding the underside of the glider are connected to a quick release, easily opened by pulling a string from the end of the steering pole (see photographs) for a simple and safe deployment. It is important that the ship is moving at a few knots to quickly move away from the glider once released. The deployment on this cruise was problem free, and we are satisfied with the method and the release cradle.

A first test dive to 30 m was successfully completed within the range of the Freewave radio signal. A second dive to 100 m is then done in order to observe the flight behavior of the glider and further decide on fixed battery position to set to achieve stable dives with ±20-25 degree pitch angle. Fixed battery positions are necessary to prevent perturbations of the glider flight required for the Microrider.

The glider mission was planned to repeat a 40 km North-south section between 80N49' and 80N27' along 12E. The mission aborted on the first dive to 100 m due to a leak. There was no communication with the glider for 6 h, which made Gnå drop her safety weight and finally come up to the surface. After recovery, we discovered that the glider went down to 1000 m in about 6 h (see **Figure 12**). The downcast was going well, with pitch angle around -25. Still, a drift in the pitch angle, leading to a progressive move of the battery to the back is observed, suggesting that the glider front was becoming heavier with time. When reaching 100m, the glider inflated the ballast pump with 260cc of oil, which normally makes it buoyant enough to move up. Instead, it kept falling down yet at a slower rate and a positive pitch angle. Once reaching around 1000m, the glider had a leak detect, but still could not make it to the surface. It reached a depth of about 1060m, before it started to move toward the surface by dropping his weight. Once recovered, the Microrider was found to have severely leaked (water flooded the nose cone), which probably was the cause of excess weight of the glider. After 2 days, the glider was open, and a substantial amount of salt crystals was discovered, both in the front and aft compartment (see **Figure 13**). The glider was also leaking quite severely, but probably only when it reached depth of around 1000m.

When the conditions do not allow the use of a work boat, the recovery of a Slocum glider fitted with a MicroRider from ships is generally challenging because of a lack of grabbing handle. As a result, microstructure sensors have often been broken on previous cruises. We have now constructed a tool to ease recovery. The recovery tool consists of a hexagonal frame with a net, attached by four ropes to a big marionette that is held by a ship crane (see photograph). The framework is made out of hollow steel pipes. To add weight to the hexagonal frame we use a long-linked steel chain, tightened to hold the parts together. Bolts are inserted at the joints to prevent the frame from twisting. The hex-frame is lowered below the glider, and fenders attached to the frame make it follow the wave movement rather than the ship movement. The ropes connecting the frame to the marionette are approximately 4m long, allowing the marionette to stay safely above water, while the net goes below the glider. A rope is attached to the hexagonal frame to help control the frame movement and direction. Approaching the glider slowly from behind, the marionette is lifted when the glider is safely inside the hexagonal frame net.

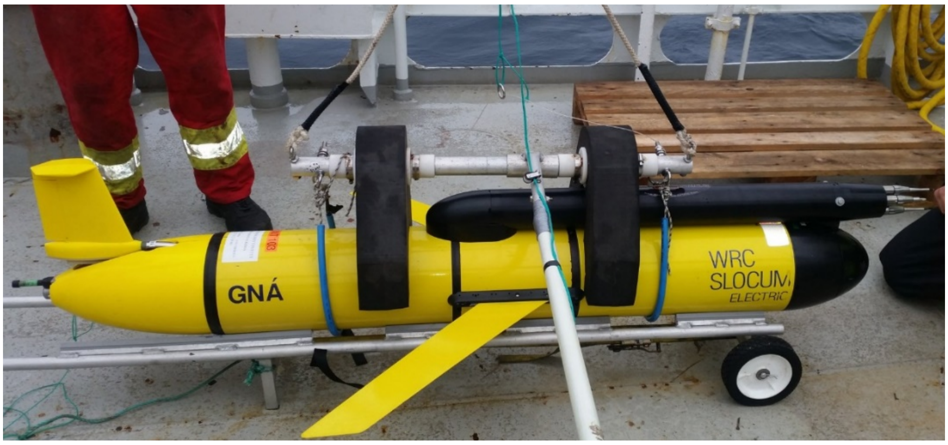
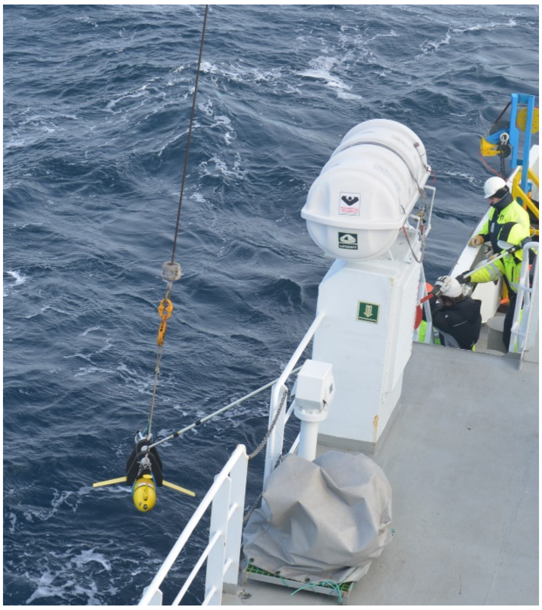


Figure 10. Photo of the glider Gnå mounted with MicroRider, on the transportation trolley, together with the deployment tool.



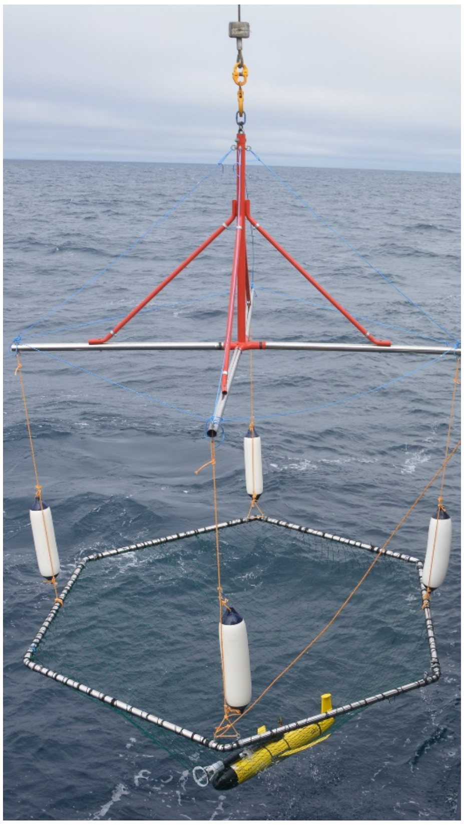


Figure 11. Glider deployment and recovery. (Pictures by Zoe Koenig).

We found the recovery tool to work satisfactorily, and it seems to operate well even during moderately rough sea. For future use, we will further improve the design at a few points: The net should be replaced by one with smaller masks. The net should be attached tighter, and using some form of quick attachment (hooks or clips) would reduce time needed for assembly/disassembly. To ease adjustments of buoyancy height, the fenders should be attached by knots only at the hexagonal frame, and rather use a loop around the marionette ropes to hold them in place.

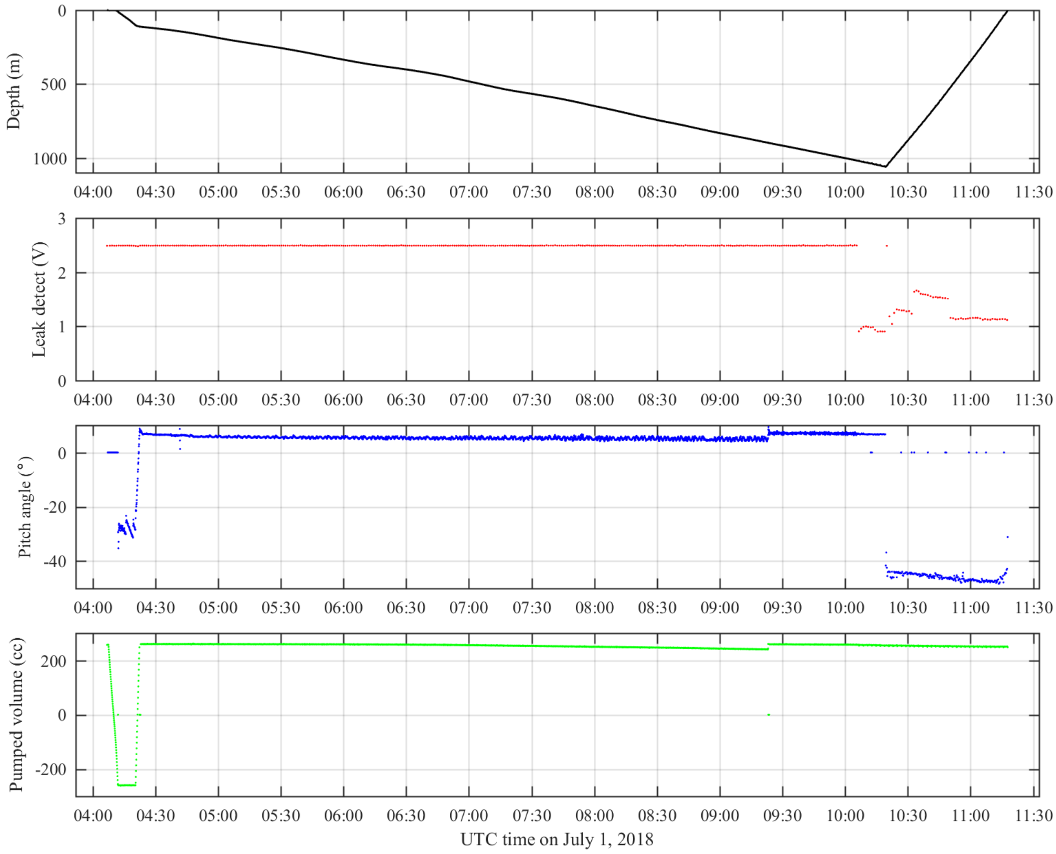


Figure 12. Time series of depth, leak detect, pitch angle and pumped volume during the 6 hours of sinking to 1000 m, before the emergency weight is released.

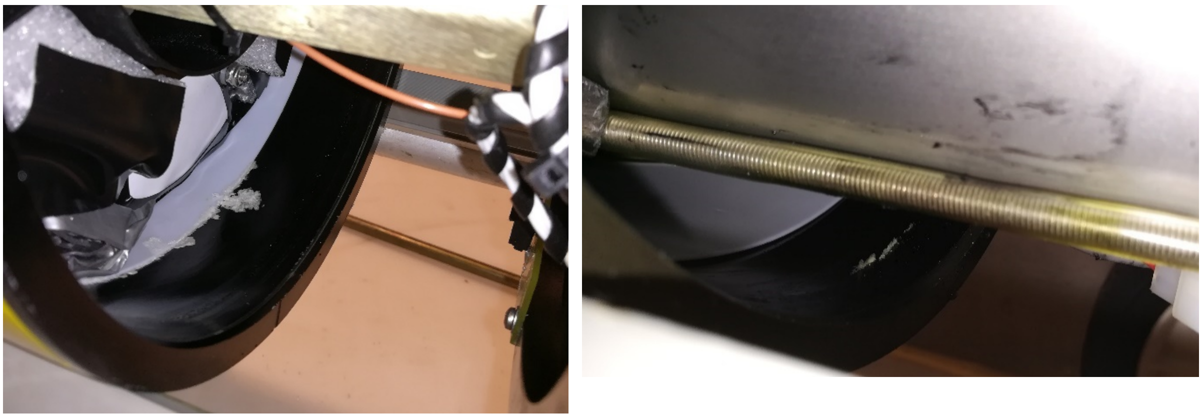


Figure 13. Pictures showing presence of salt in the (left) rear and (right) front section (Pic by Anthony Bosse).

In total 9 files were recovered from the MR. Of these, 7 were while Gnå was at surface (not shown), and DAT_008 and DAT_009 were during the successful 30-m dive, and the unsuccessful 100-m dive, respectively. The summary plots from each are shown in the following, together with a zoom in of the 100-m dive, which according to the pressure record reached deeper than 1000 m depth over the course of 6 hours. The data set is not useful for further analysis.

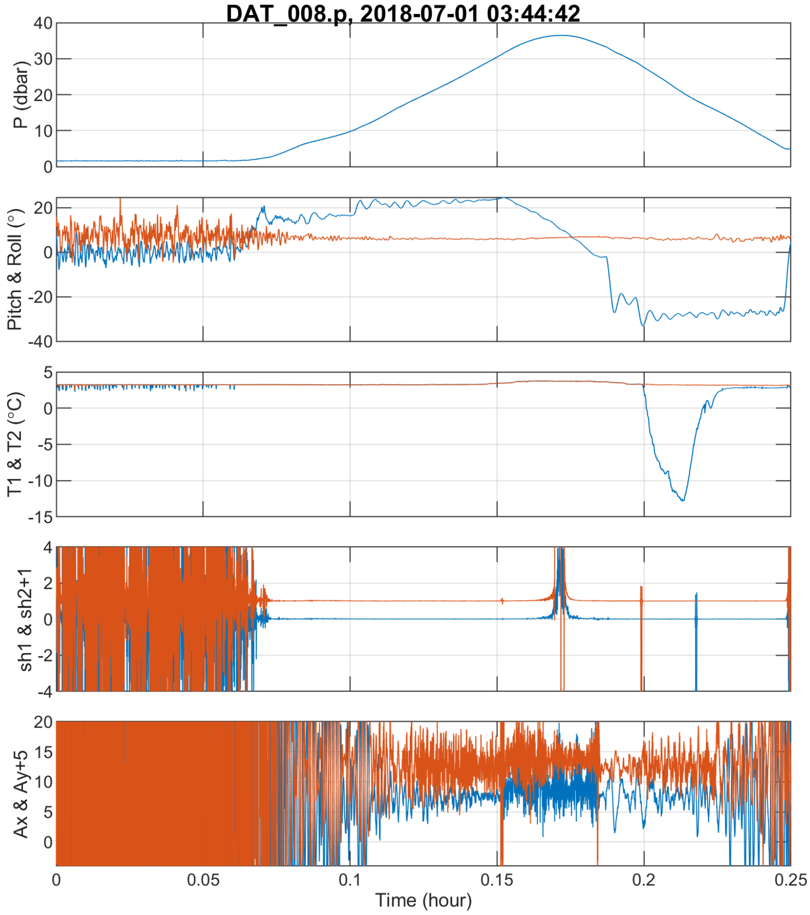


Figure 14. Records from the selected channels of the microrider: pressure, pitch & roll, thermistors 1&2, shear probes 1&2, and x and y axis accelerometers. File, DAT_008, 30 m dive.

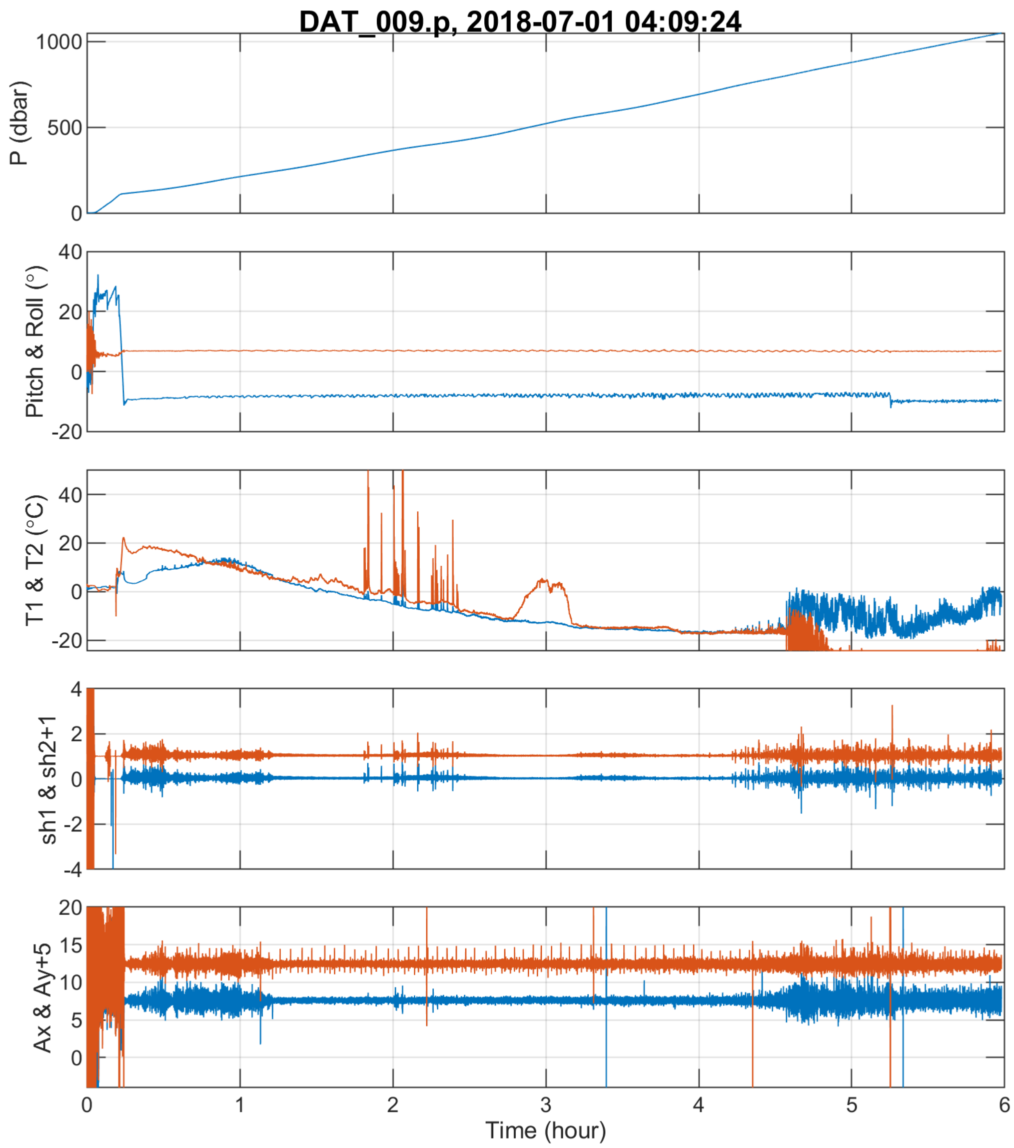


Figure 15. Same as **Figure 14**, but for the unsuccessful 100 m dive, File, DAT_009.

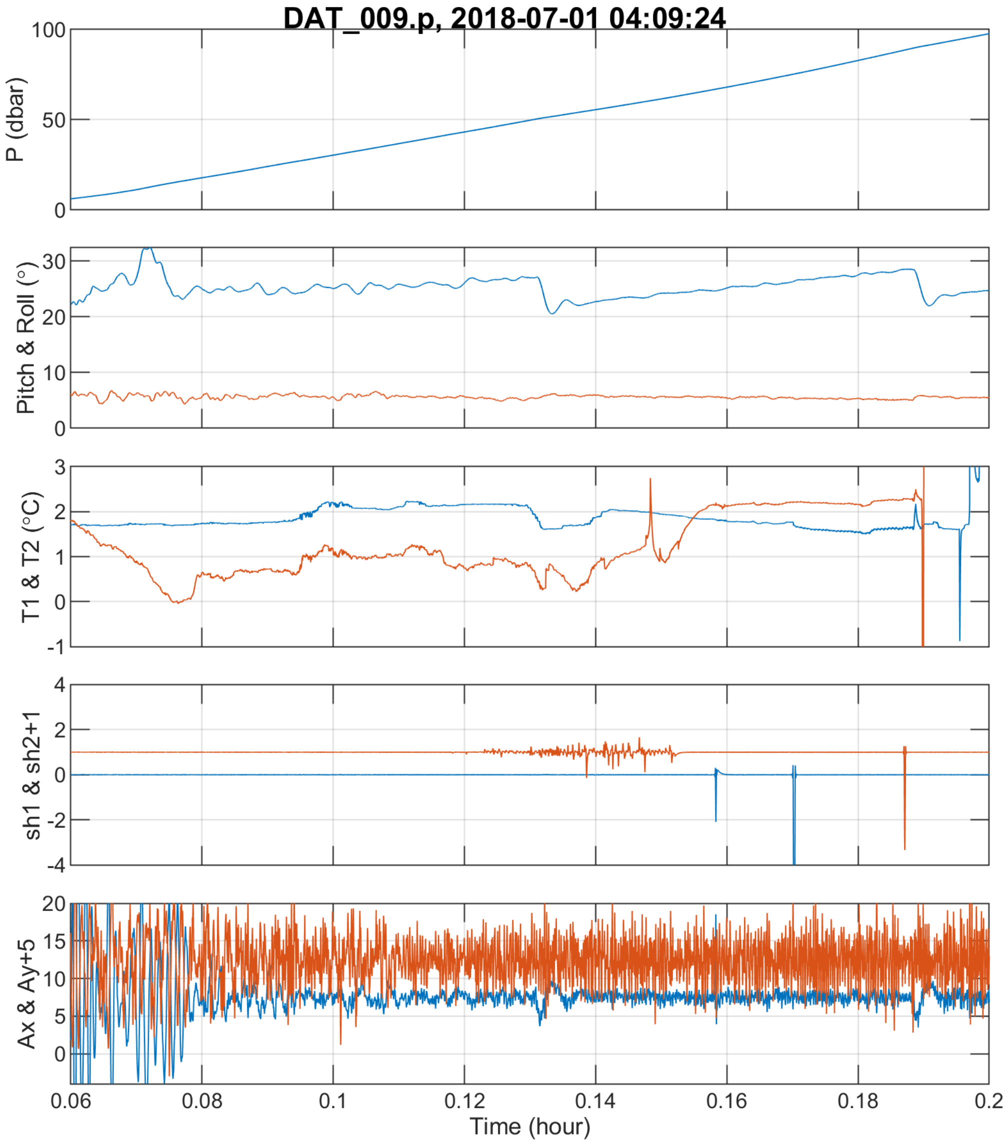


Figure 16. Same as **Figure 15**, but for zoom in to the first 0.2 hours (100 m dive).

3.6. Presentation of Data

Below we present selected plots from the CTD, LADCP, SADCP and VMP2000 profiles at sections and repeat stations. CTD salinity is not corrected against bottle samples, but oxygen is. Current profiles are *in situ* (not detided nor corrected for magnetic declination). LADCP profiles are processed without SADCP data. VMP2000 data are not screened carefully for outliers and glitches, other than the automated despiking carried out during the processing.

3.6.1. CTD

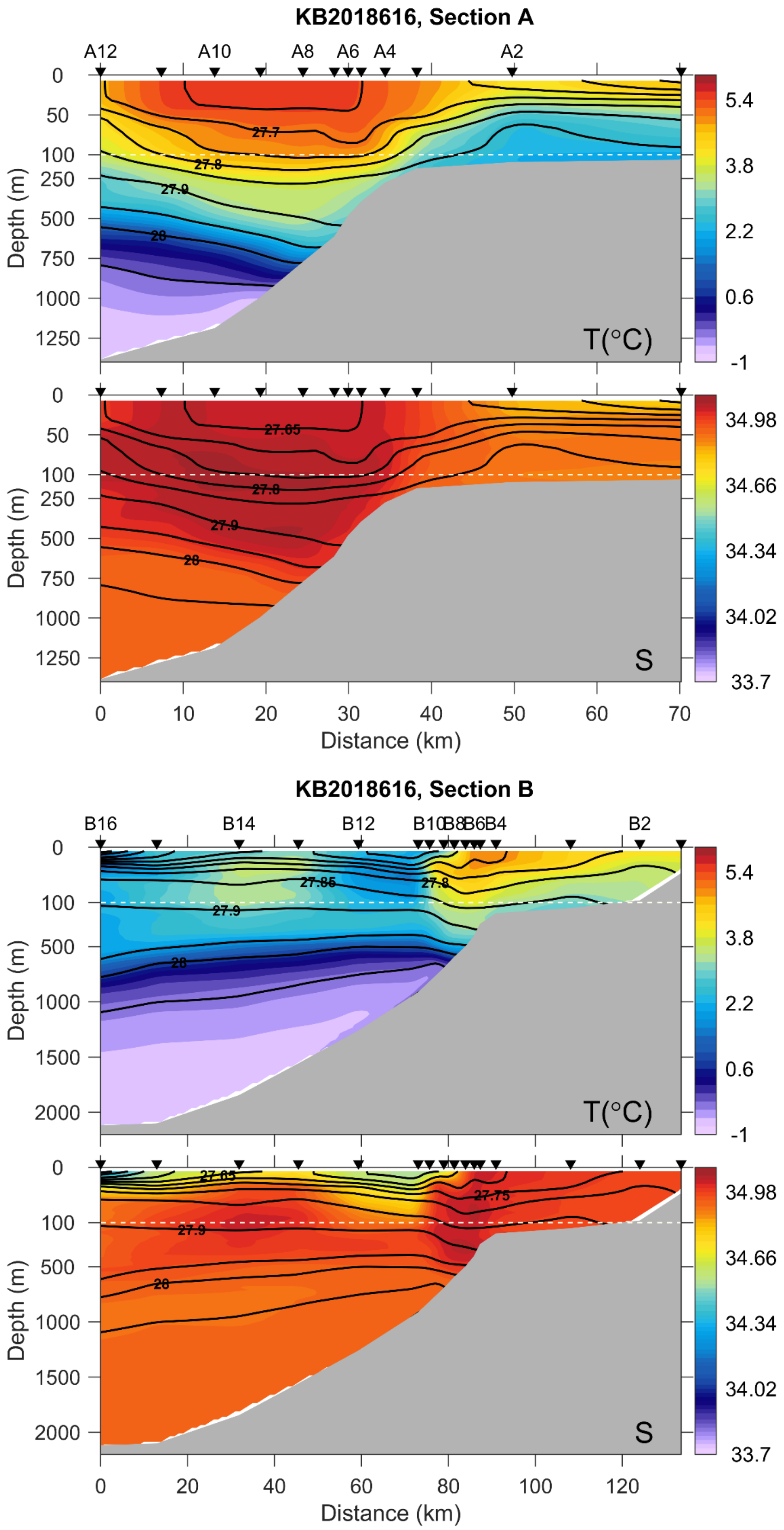


Figure 17. Contours of temperature (*T*) and salinity (*S*) for Sections A, B, C and E. Potential density anomaly (σ_θ) surfaces are also shown (black). Distance is relative to the outer (deepest) station of each section. Note the change of scale at 100 m depth.

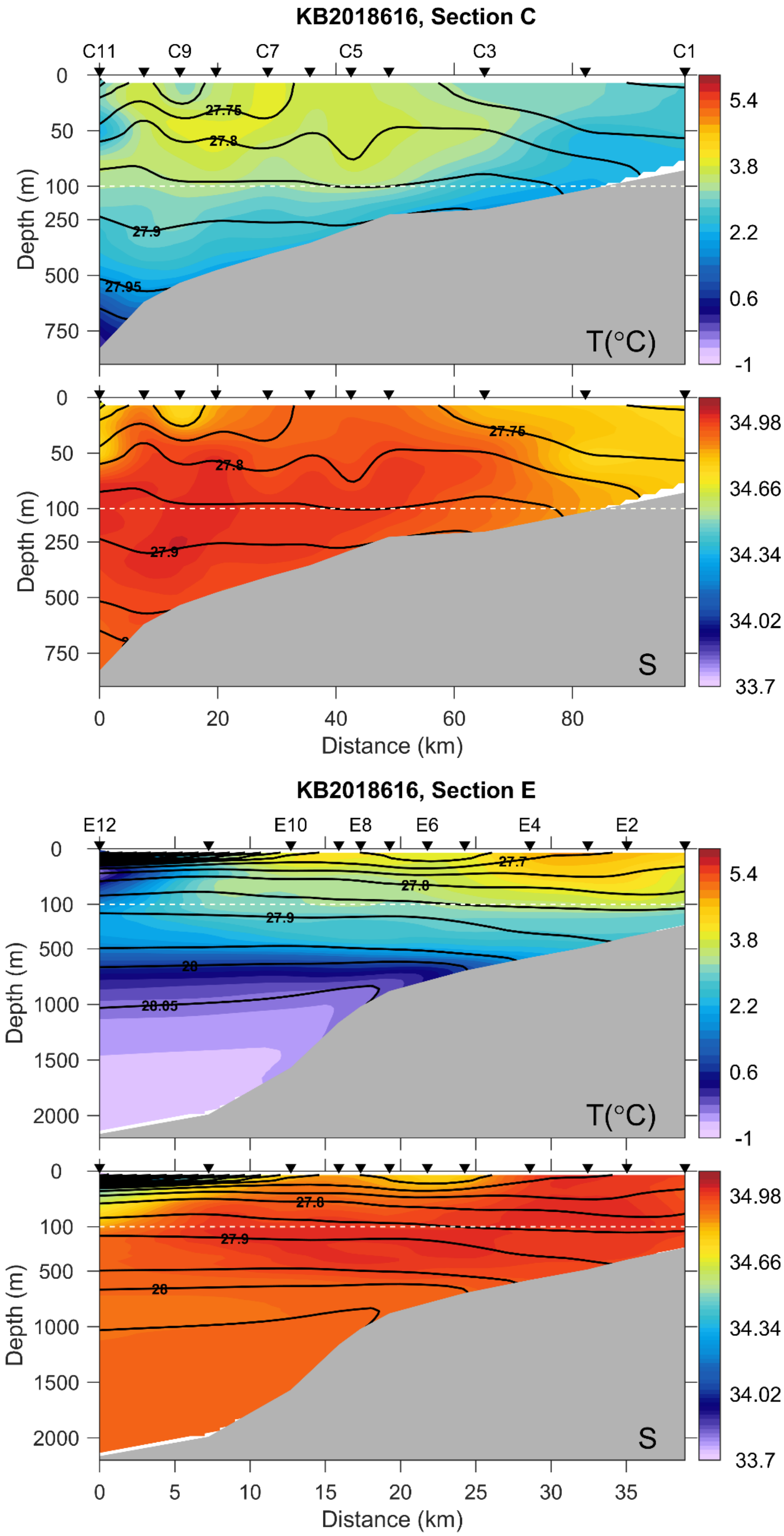


Figure 17, continued.

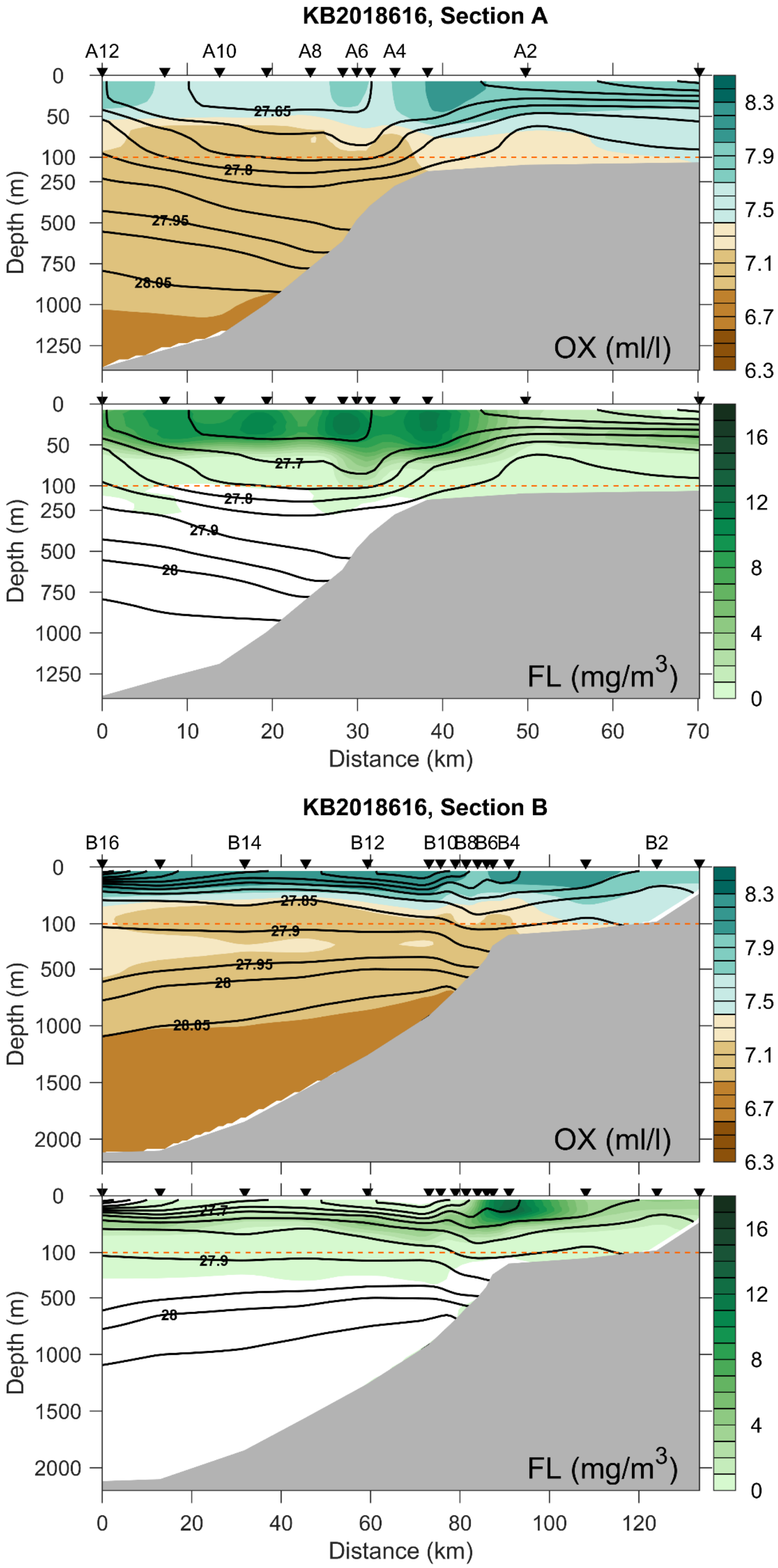


Figure 18. Contours of dissolved oxygen (OX) and fluorescence (flC) for Sections A, B, C, and E. Potential density anomaly (σ_θ) surfaces are also shown (black). Distance is relative to the outer (deepest) station of each section. Note the change of scale at 100 m depth.

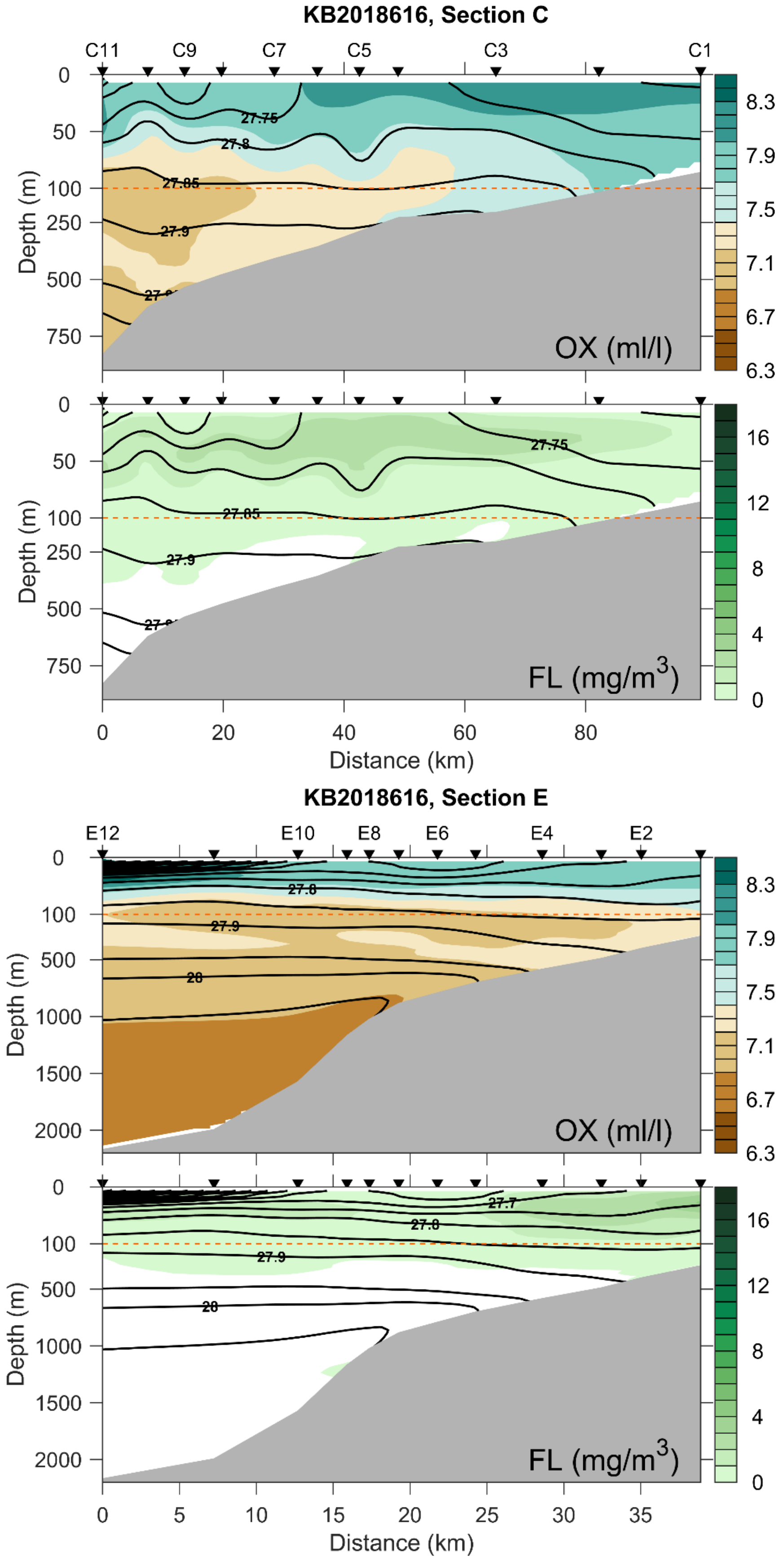


Figure 18, continued.

3.6.2. LADCP

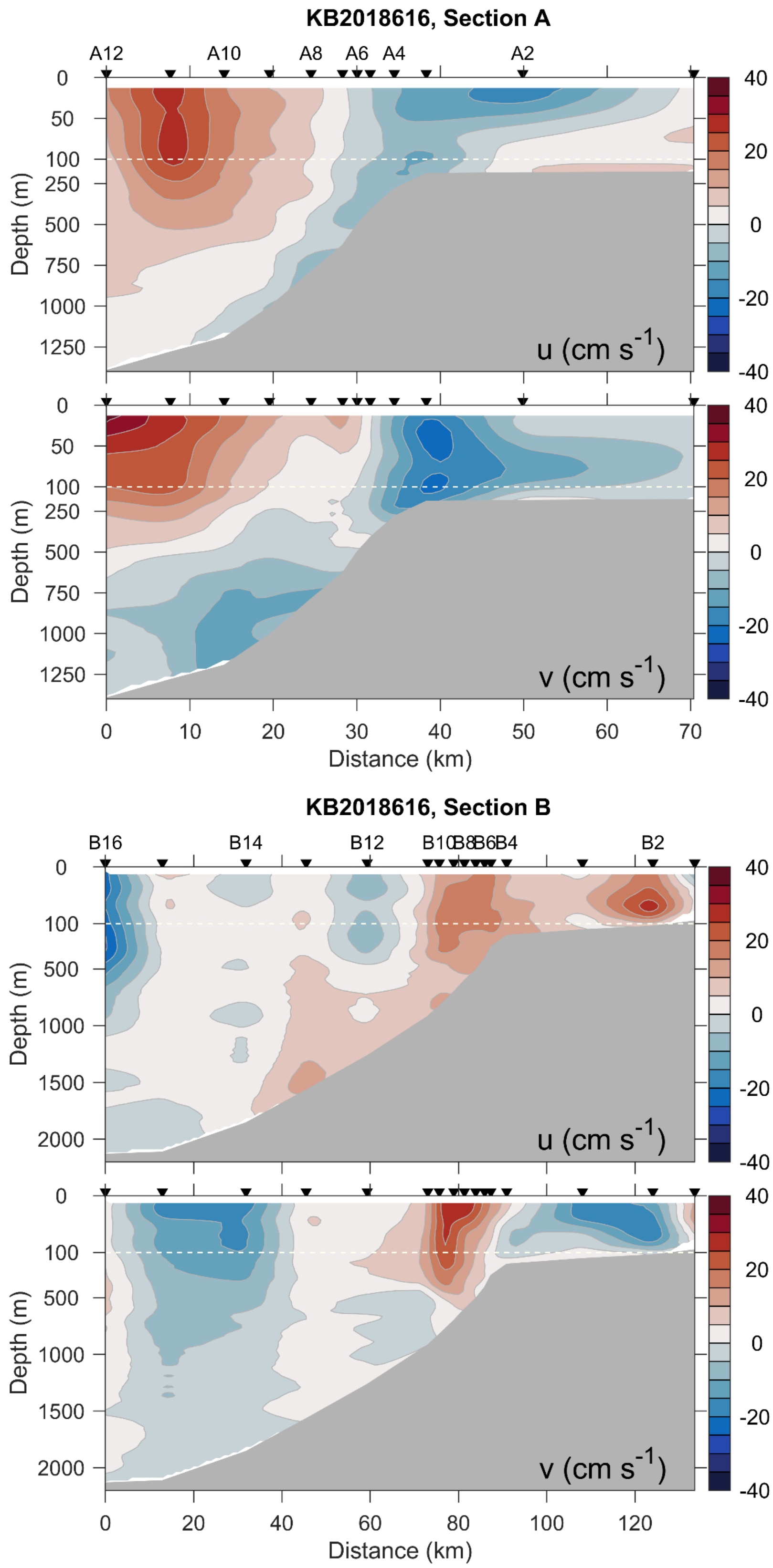


Figure 19. East (u) and North (v) velocity distribution for Sections A, B, C, and E. Distance is relative to the outer (deepest) station of each section. Note the change of scale at 100 m depth.

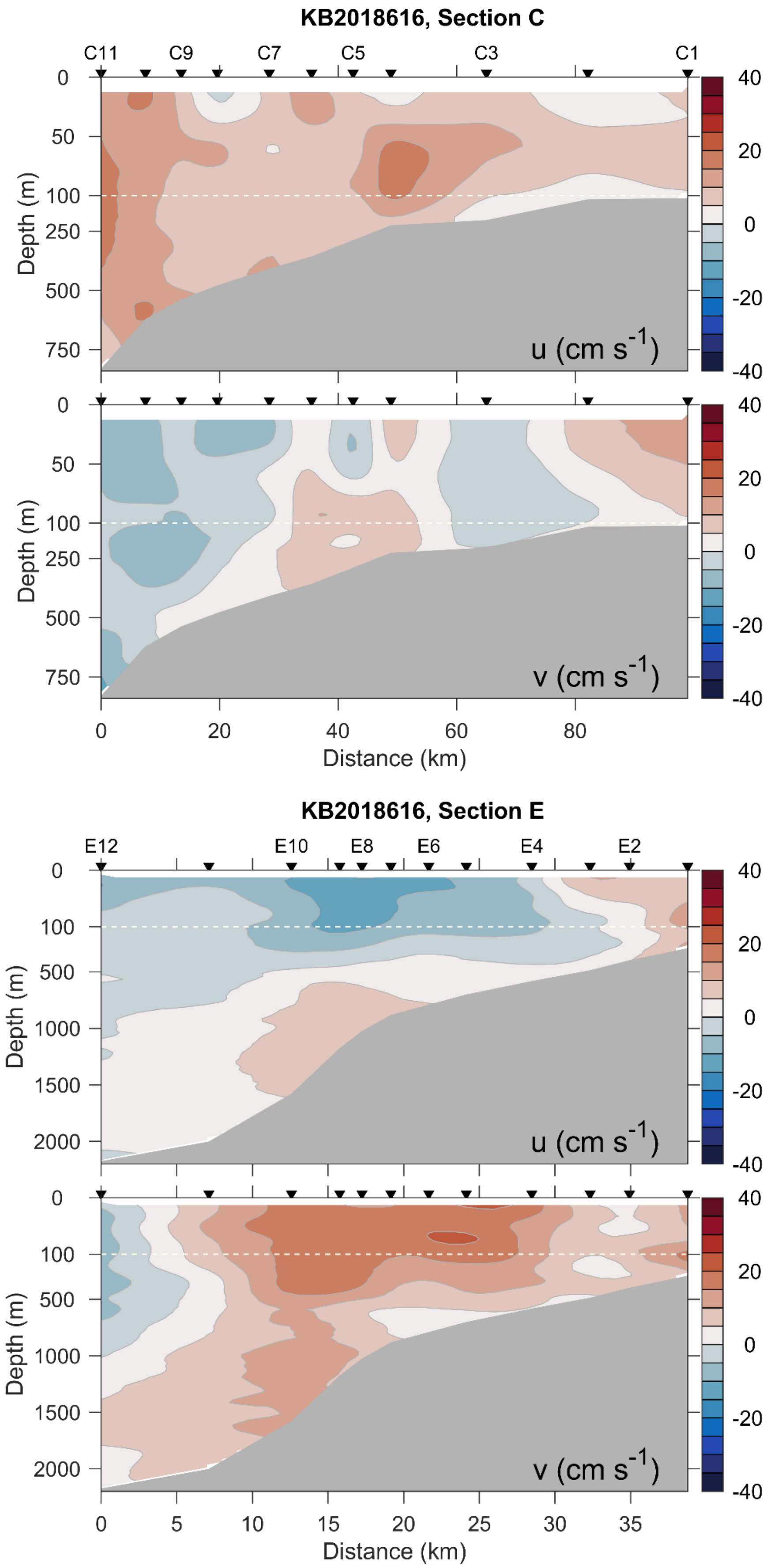


Figure 19, continued.

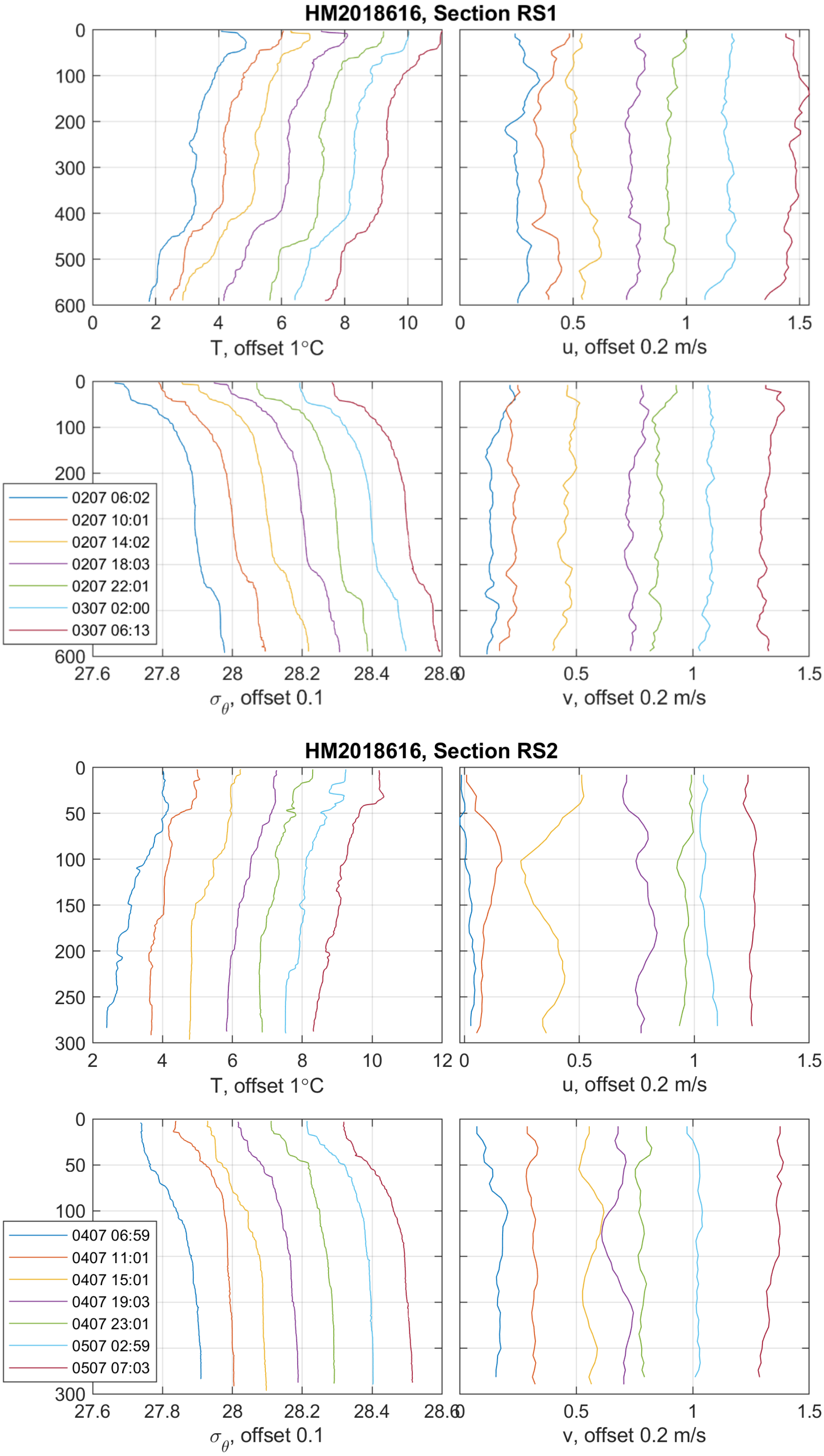


Figure 20. Profiles of T, σ_θ , u and v collected at repeat stations, RS1 and RS2. Subsequent profiles after the first are offset by the indicated amount. Legend is UTC in ddmm HH:MM.

3.6.3. SADCP

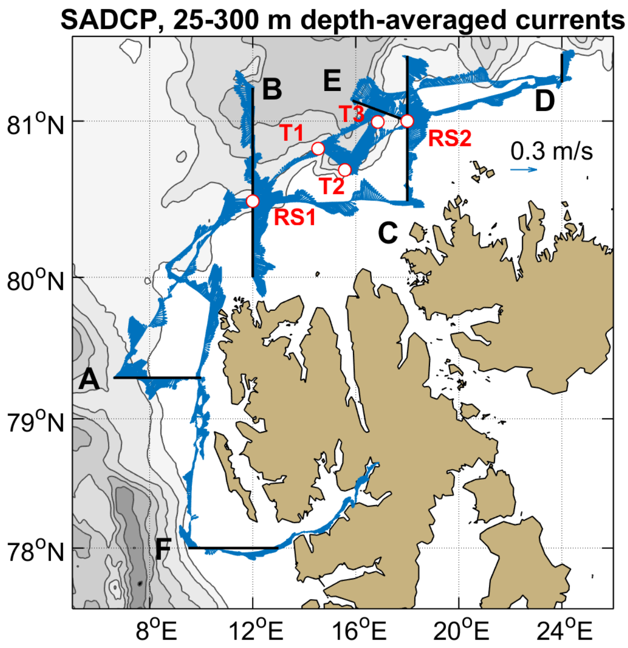


Figure 21. Vector plot of 25-300 m depth-averaged currents from the SADCP. Sections and process stations are indicated.

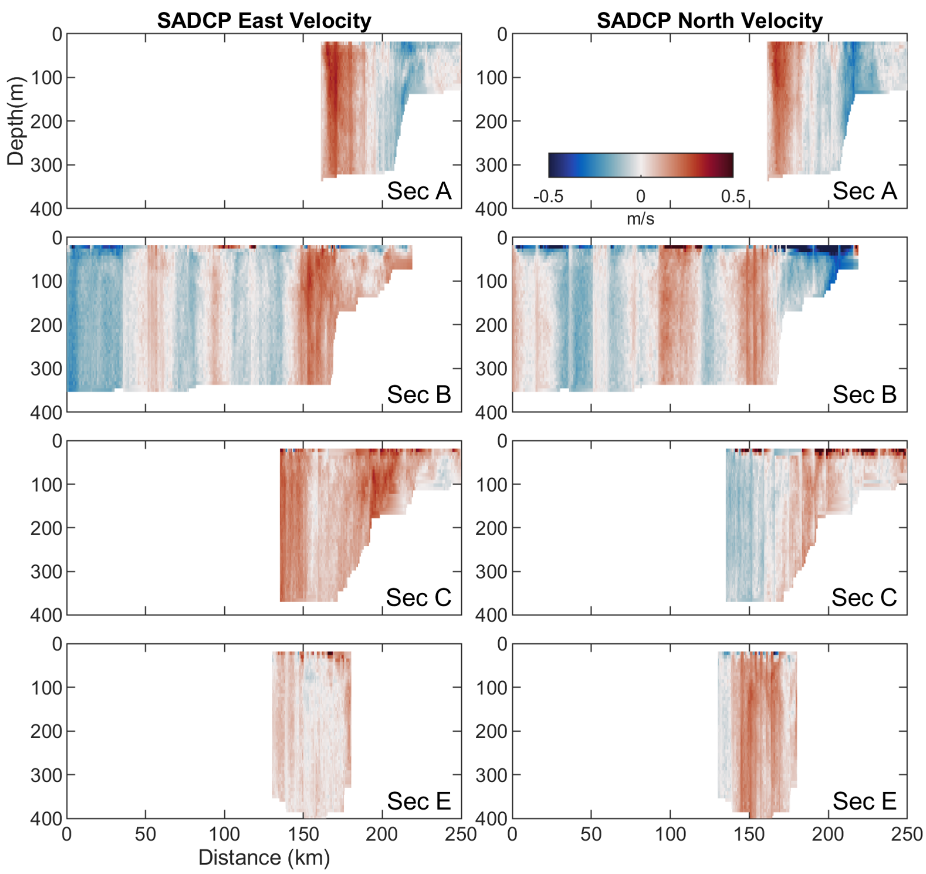


Figure 22. East and north components of the velocity measured by the SADCP in Sections A, B, C and E. The horizontal distance is arbitrarily referenced from deep waters toward the continental shelf on the right. Axis and color scales are identical in all panels.

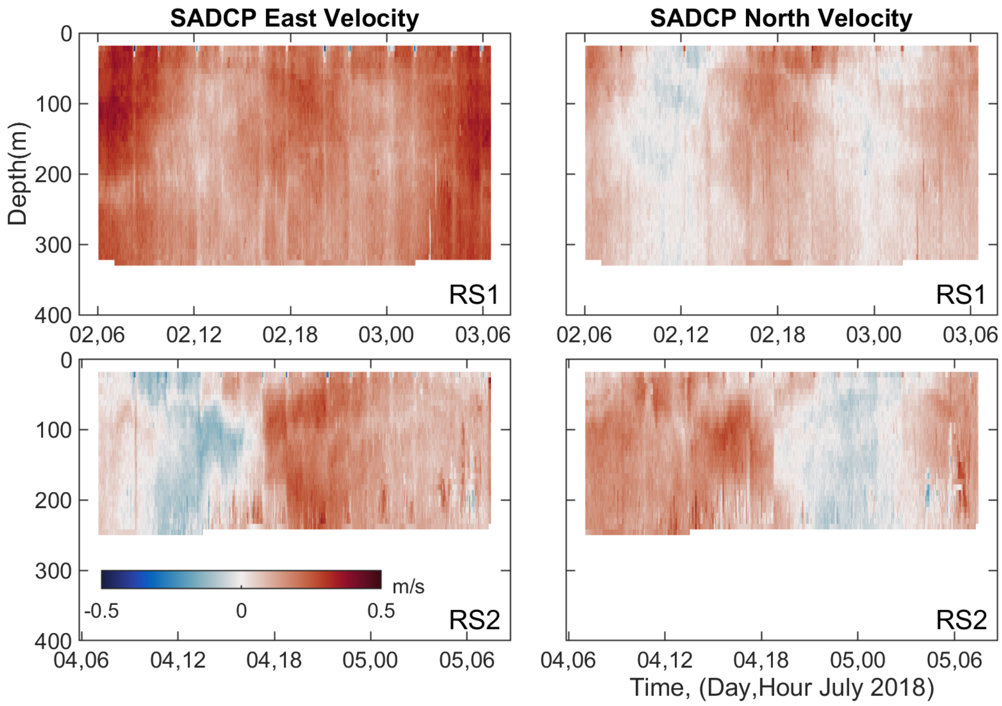


Figure 23. East and north components of the velocity measured by the SADCP in Repeat Stations, RS1 and RS2 for approximately 24-hour duration. Time is given as DD, HH of July 2018.

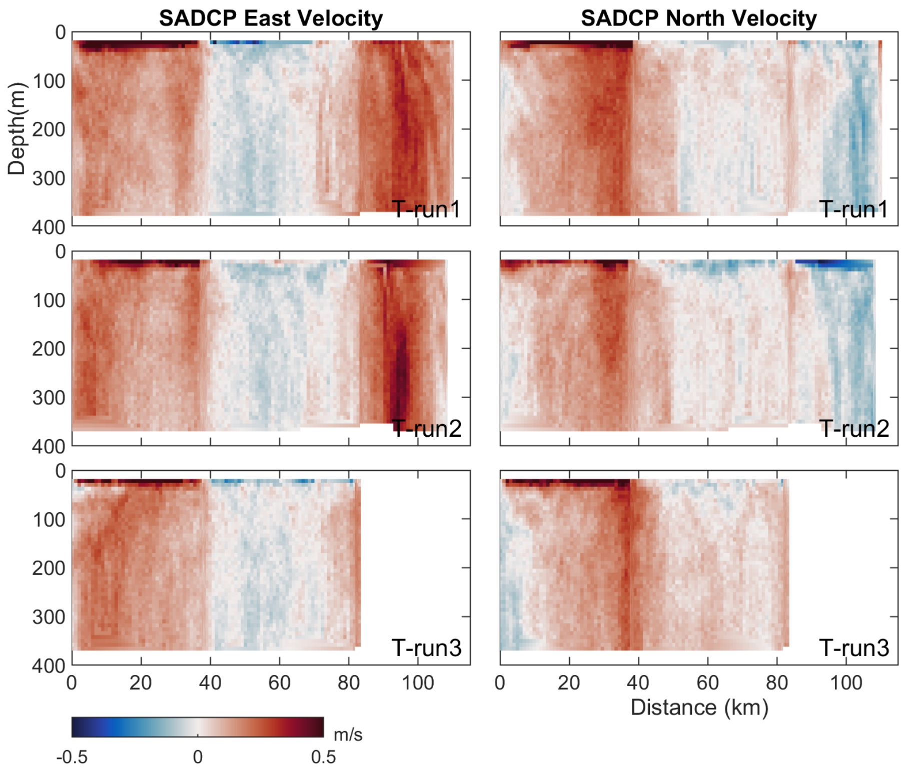


Figure 24. East and north components of the velocity measured by the SADCP in the process stations set T1-T2-T3 for runs 1 to 3. The horizontal distance is referenced to T2. Axis and color scales are identical in all panels.

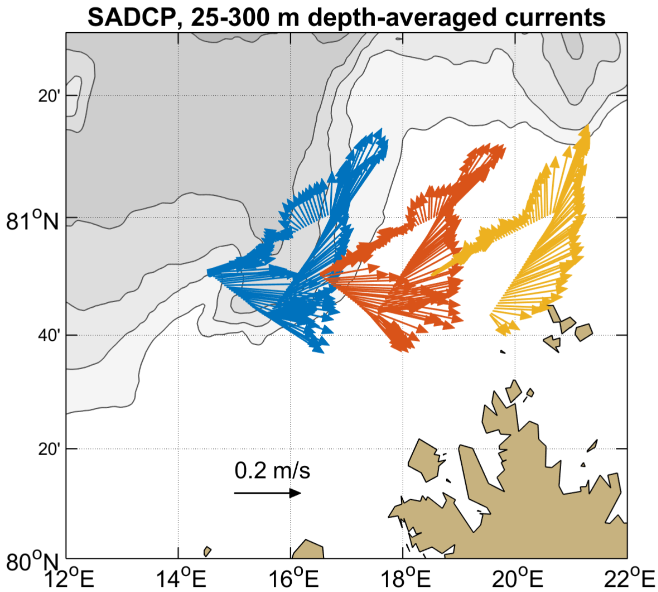


Figure 25. Vector plots of 25-300 m averaged currents at the process station set T1-T2-T3. The first run (blue) is shown along the correct track. The second and third runs are offset for clarity.

3.6.4. Microstructure

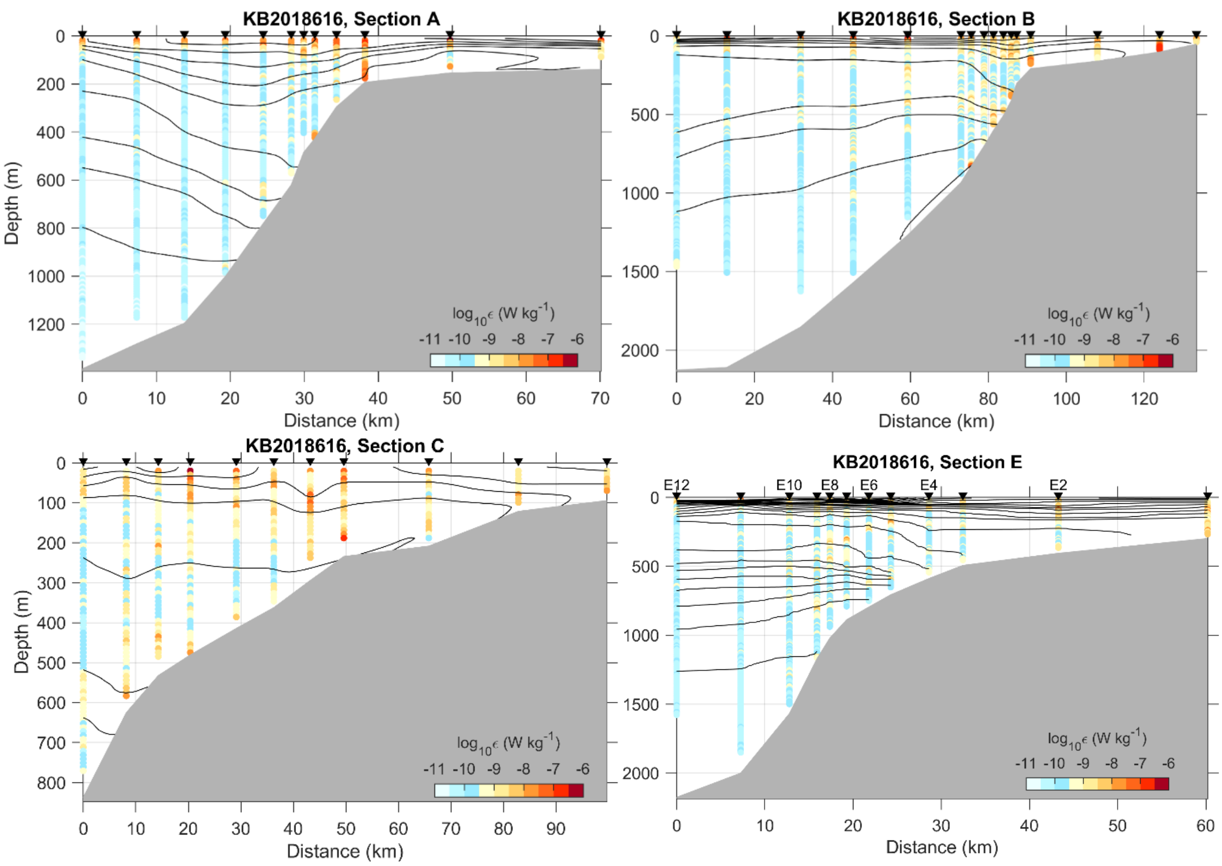


Figure 26. Distribution of dissipation rate (ε, color) and σ_θ (black, CI=0.05 kg m-3), measured by the sensors on the VMP, for Sections A, B, C, and E. σ_θ is gridded and smoothed, ε is vertically averaged over 5 m. Distance is relative to the outer (deepest) station of each section.

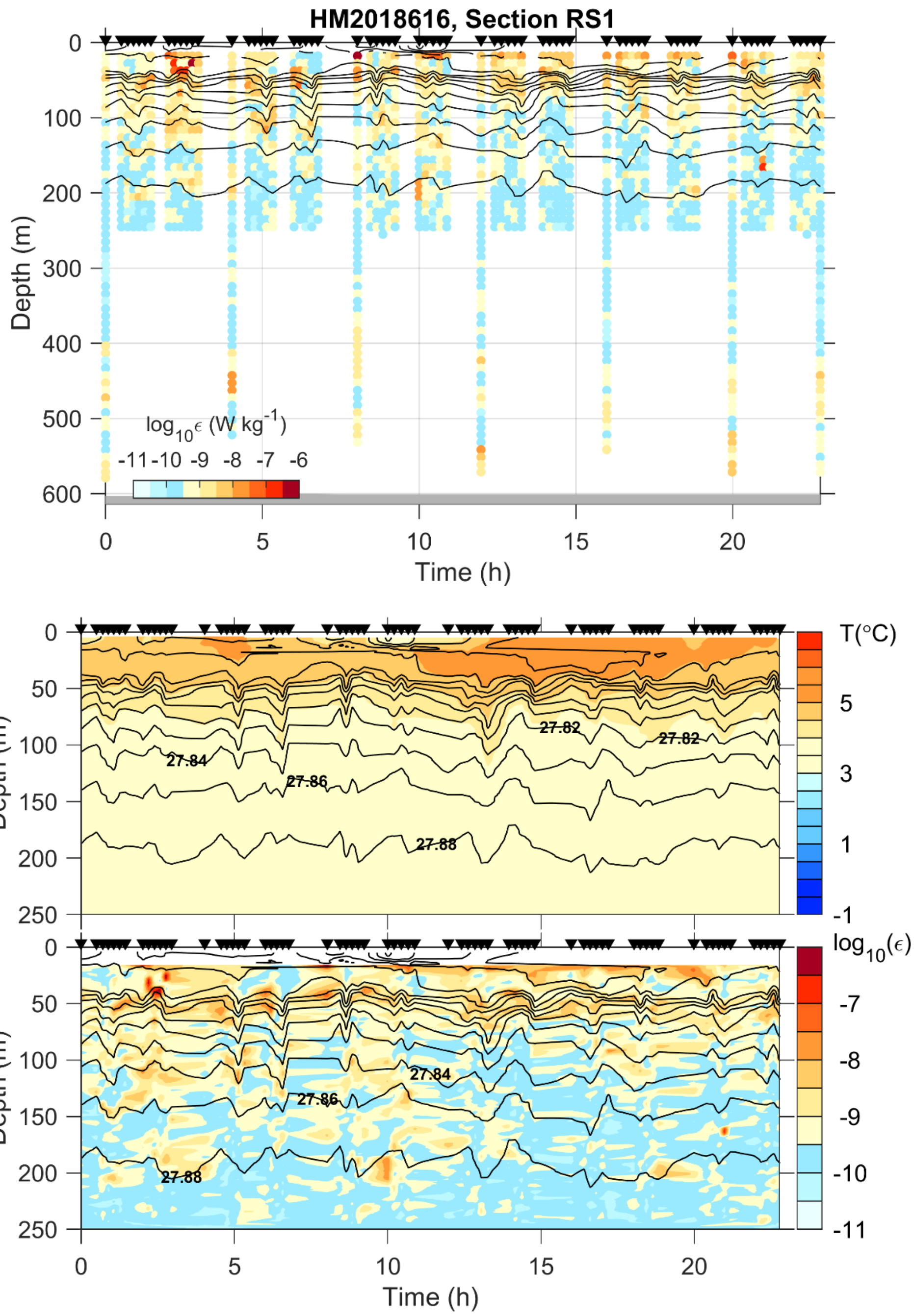


Figure 27. Repeat Station 1. Top: dissipation rate (ε, color) and σ_θ (black, CI=0.02 kg m-3), measured by the sensors on the VMP. Dissipation is 5 m vertically averaged. Isopycnals are not gridded or smoothed.

Lower two panels: An alternative presentation with zoom in to the upper 250 m. Middle panel is temperature and the lower panel is the dissipation rate. All parameters are linearly interpolated between station times and no gridding or smoothing applied. σ_θ drawn at 0.02 intervals.

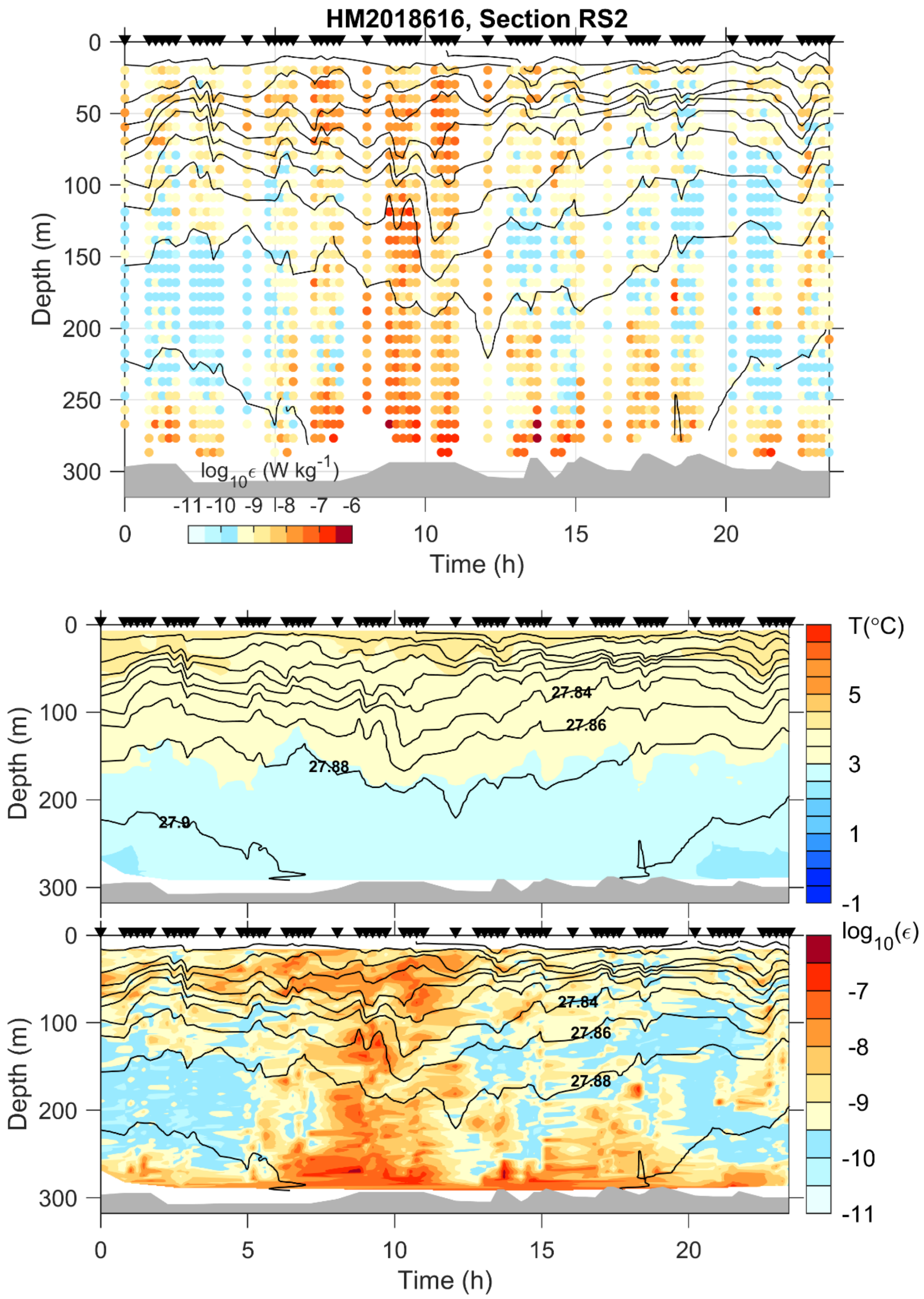


Figure 28. Same as **Figure 27** but for Repeat Station 2.

4. 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*. https://doi.org/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.

Visbeck, M. (2002), Deep velocity profiling using lowered acoustic Doppler current profilers: Bottom track and inverse solutions, *J. Atmos. Ocean. Technol.*, *19*, 794-807. https://doi.org/10.1175/1520-0426(2002)019<0794:DVPULA>2.0.CO;2

Appendix I: List of participants

Left to right: Eva Falck, Ilker Fer, Frank Nilsen, Anthony Bosse, Zoé Koenig, Algot Peterson

	Name	Institute[1]	Responsibility[2]
Scientists	Ilker Fer (cruise leader) Ilker.fer@uib.no	UIB	VMP, LADCP, MR
	Frank Nilsen (co-cruise leader)	UNIS	CTD, water sampling
	Eva Falck	UNIS	LADCP, water sampling
	Anthony Bosse	UIB	Gliders, VMP
	Zoe Koenig	UIB	LADCP, VMP
Technical Personnel	Algot Peterson	UIB	VMP, LADCP
	Terje Haugland (instr. chief)	IMR	CTD, water sampling

[1] UIB: University of Bergen; UNIS: University Centre in Svalbard
[2]The instruments and acronyms are described in the report.

Captain: Kjell Ove Sandøy **Chief Officer:** Kurt Reitan

Appendix II: Cruise Program

Cruise Timeline

27 June 2018, Wednesday

Participants arrived onboard RV Kristine Bonnevie (KB hereafter) in the afternoon and night of 26 June. KB was positioned in Isfjorden off the Bykaien, and transport on/off ship was established using the work boat.

Departure from Longyearbyen was scheduled at midday, but because of poor weather conditions departure was postponed to by 24 hours to 28 June midday.

While waiting, we installed and set up instruments and gear:

- VMP winch system with hydraulics
- An own-design glider recovery device
- Data acquisition PCs for VMP and LADCP, and the cabling
- Installation of 2 ADCPs on CTD rosette
- Installation of microRider on glider

28 June 2018, Thursday

We assembled the VMP profiler, configured and finalized setup files for various instruments.

KB departed from Longyearbyen at 12:00 local time (LT = UTC+2h).

We conducted a test station in the middle part of Isfjorden using CTD/LADCP (sta0762), followed by VMP (vmp_001, with one shear probe and one thermistor).

Ship ADCP (SADCP) started using the UHDAS software with the default setup at 1135 UTC.

Tested the behavior of the glider recovery construction at sea.

Transit to Section A.

29 June 2018, Friday

Arrived at Section A and started working station from shelf (A1) toward Fram Strait.

The sampling is CTD/LADCP followed by the VMP. All probes are installed on VMP.

Station A1: 0745 UTC, CTD/LADCP: sta763, VMP vmp_002

Before vmp_010, T2 probe changed to T1001.

Completed Section A, Station A12. CTD cast at 2334 UTC (sta774); vmp_013 at 30 June 0020 UTC.

30 June 2018, Saturday

Transit toward middle Section B to detect the location of the thermohaline front.

Front is detected after a series of 300 m deep CTD casts (sta775- 779). The LADCP was not started in these profiles.

1230 UTC: Heading to the northernmost station of Section B.

Started Section B at Station B16:

CTD sta780, 1611 UTC / VMP vmp_014, 1727 UTC

Just after B16, an ARGO buoy deployed for NorArgos:

18:43 UTC, 81N12.048, 012E04.302, 2120 m

SN: AI 26 00-18EU 002

IMEI: 30023 406 59661020

@BT: 2017 12 0034

ISA: 04415458

Before continuing section from B15, replaced shear probes on VMP2000 with sh1: M462 (vertical), sh2: M546 (horizontal)

Worked station B15 - B14.

1 July 2018, Sunday

After B13 CTD station, deployed Gnå.

Gnå deployment details: 80N47’, 012E 02’, 1550 m, 0340 UTC

Deployment done while steaming 1-2 knots, using the deployment device. It went smoothly.

First 30 m test dive with servo successful. After sending for 100 m mission, we lost contact with freewave.

Gnå surfaced after 6 hours, after releasing its security weight. Recovery was made at approximately 1400 UTC, using the large recovery device, which worked very well.

One shear probe (M833) was loose out of its socket, and severely damaged. The front cone flooded. Upon inspection, we found out that sh1 sensor holder was not equipped with O-ring and white plastic ring, despite coming back from service.

VMP2000 cast 020 contact with bottom. Shear probe M462 and thermistor T1175 are damaged.

2 July 2018, Monday

Calm and sunny weather conditions.

Completed Section B at station B1 (sta0795) at 0208 UTC.

Started with a 24-h repeat station (RS1) at B8. The following sampling scheme is repeated (6 times) for 24 hours:

<table>
<tr><th>Time (h)</th><th>Task</th><th>Depth (m)</th></tr>
<tr><td>0</td><td>CTD/LADCP</td><td>600</td></tr>
<tr><td>0.5</td><td>VMP</td><td>600</td></tr>
<tr><td>1</td><td rowspan="2">VMP yo-yo</td><td rowspan="5">250</td></tr>
<tr><td>1.5</td></tr>
<tr><td>2</td><td>pause / re-position</td></tr>
<tr><td>2.5</td><td rowspan="2">VMP yo-yo</td></tr>
<tr><td>3</td></tr>
<tr><td>3.5</td><td>Re-position ship to station</td><td></td></tr>
</table>

EK80 data are logged throughout the station. Salinity samples are taken only at the first and last CTD cast.

3 July 2018, Tuesday

The repeat station RS1 is completed at approximately 0630 UTC by last cast of VMP full-depth vmp_098 followed by CTD/LADCP sta802.

Steaming towards Section C at 18E.

Started working Section C from the shallow end at Station C1: CTD sta803 (1235 UTC), vmp_099 (1240 UTC).

Collected stations C1 to C10.

4 July 2018, Wednesday

Calm weather.

Collected station C11 at 0140 UTC.

Sea ice sighted and section interrupted. A second occupation of C11, but closer to the ice edge is made at 0330 UTC (sta0814).

Water samples taken at C11 for the veterinary institute.

Another stop at C10 and shallow (50m) cast to collect water samples for the veterinary institute.

Started a 24-h repeat station, RS2, at station location C5, water depth of 280-300 m. The sampling plan is as follows:

Time (h)	Task	Depth (m)
0-0.6	CTD/LADCP; VMP	300 (full)
0.5	Pause	full
1	VMP yo-yo	full
1.5		
2	pause / re-position	
2.5	VMP yo-yo	
3		
3.5	Re-position ship to station	

5 July 2018, Thursday

Calm weather.

The repeat station RS2 is completed at approximately 0700 UTC by last cast of VMP yo-yo 176 followed by CTD/LADCP sta882

Steaming toward Section D at 24E.

Only 4 stations could be taken because the sea-ice edge was reached at approximately 300 m isobath. Section D interrupted at 1610 UTC after vmp_181.

Because Section C did not capture the cold Arctic water (section was stopped at approx. 800 m isobath because of ice), we decided to work a section (E) starting from 300 m isobaths of Section C (process station) and across isobaths toward deep water.

6 July 2018, Friday

Great weather, blue skies, sunshine and flat sea.

Section E worked from the deep end toward shelf, starting with CTD sta827 at 0021 UTC, followed by VMP 182.

Completed with CTD sta838 and VMP 194 near C5 (RS2), joining with Section C at the 300 m isobath) at 1900 UTC.

After completing Section E, we decided to work a triangle of 3 stations, to be repeated in 3 runs. The stations are along the 1000-m isobath following the sharp turn of topograghy at 14.5 – 16.5 E. Runs started at 2215 UTC, at station T2, the southernmost corner of the triangle (see station map), with CTD sta839 and VMP vmp_195.

7 July 2018, Saturday

Worked: T2-T3-T1, three times.

Wind picked up.

8 July 2018, Sunday

Process triangle T2-T3-T1 completed by CTD sta847, VMP vmp_203., 0200 UTC., at station T1.

Proceeding toward REOCIRC mooring site.

Because of windy conditions, no VMP was taken. 3 stations with CTD/LADCP were taken at the REOCIRC site (sta848-850), between 1000 and 1430 UTC.

Transit toward the Isfjorden section (Section F) in rough weather.

9 July 2018, Monday

Section F started (CTD/LADCP only) at 0200 UTC, sta851.

Section F completed at 2145 UTC (sta881). LADCP was not run in the last 7 stations.

VMADCP survey completed about 2145 UTC.

Transit to Longyearbyen.

Arrived in Longyearbyen after midnight (kullkaien).

10 July 2018, Tuesday

Unloaded gear and ended the cruise.

List of CTD stations

Table 2. List of CTD stations. Echo depth is from the ship's echo sounder (in situ). Last four columns indicate the cast number in file names for corresponding master/slave LADCP.

Cast	Station Name	Date	Time (UTC)	LAT	LON	E. Depth (m)	LADCP
762	test	2018-06-28	11:38	78N20.45	015E14.56	257	762
763	A1	2018-06-29	07:40	79N17.93	009E59.87	134	763
764	A2	2018-06-29	09:26	79N18.27	009E00.52	149	764
765	A3	2018-06-29	10:34	79N18.18	008E27.03	188	765
766	A4	2018-06-29	11:18	79N18.28	008E15.87	277	766
767	A5	2018-06-29	12:15	79N18.22	008E07.30	407	767
768	A6	2018-06-29	13:23	79N18.19	008E02.94	486	768
769	A7	2018-06-29	14:20	79N18.16	007E58.09	615	769
770	A8	2018-06-29	15:36	79N18.13	007E47.03	776	770
771	A9	2018-06-29	17:10	79N18.15	007E32.11	997	771
772	A10	2018-06-29	19:02	79N18.20	007E16.05	1191	772
773	A11	2018-06-29	21:20	79N18.11	006E57.32	1279	773
774	A12	2018-06-29	23:34	79N17.89	006E35.99	1384	774
775	F1	2018-06-30	10:20	80N29.97	012E00.14	735	-
776	F2	2018-06-30	10:43	80N30.94	012E00.03	798	-
777	F3	2018-06-30	11:11	80N31.96	012E00.02	870	-
778	F4	2018-06-30	11:45	80N33.95	012E00.25	871	-
779	F5	2018-06-30	12:18	80N36.91	012E00.23	1124	-
780	B16	2018-06-30	16:11	81N12.02	011E59.94	2122	780
781	B15	2018-06-30	19:33	81N05.05	012E00.30	2105	781
782	B14	2018-06-30	23:15	80N54.83	012E00.50	1848	782
783	B13	2018-07-01	02:15	80N47.48	012E00.57	1562	783
784	B12	2018-07-01	08:44	80N40.01	012E00.37	1263	784
785	B11	2018-07-01	11:23	80N32.61	012E00.49	916	785
786	B10	2018-07-01	16:17	80N31.20	012E00.36	820	786
787	B9	2018-07-01	17:50	80N29.42	012E00.55	696	787
788	B8	2018-07-01	19:06	80N28.13	012E00.25	597	788
789	B7	2018-07-01	20:14	80N26.74	012E00.28	502	789
790	B6	2018-07-01	21:11	80N25.65	012E00.28	406	790
791	B5	2018-07-01	22:00	80N24.91	012E00.37	297	791
792	B4	2018-07-01	22:45	80N22.97	012E00.36	203	792
793	B3	2018-07-02	00:01	80N13.71	012E00.28	154	793
794	B2	2018-07-02	01:15	80N05.10	012E00.21	97	794
795	B1	2018-07-02	02:08	79N60.00	012E00.04	48	795
796	B8	2018-07-02	06:02	80N28.14	012E00.14	599	796
797	B8	2018-07-02	10:02	80N28.12	012E00.29	596	797
798	B8	2018-07-02	14:01	80N28.12	012E00.17	597	798
799	B8	2018-07-02	18:03	80N28.13	012E00.27	597	799
800	B8	2018-07-02	22:02	80N28.13	012E00.21	597	800
801	B8	2018-07-03	02:00	80N28.12	012E00.21	597	801
802	B8	2018-07-03	06:13	80N28.13	012E00.38	597	802
803	C1	2018-07-03	12:35	80N29.96	017E59.84	82	803

Cast	Station Name	Date	Time (UTC)	LAT	LON	E. Depth (m)	LADCP
804	C2	2018-07-03	13:54	80N39.06	018E00.28	120	804
805	C3	2018-07-03	15:12	80N48.27	017E59.93	208	805
806	C4	2018-07-03	16:36	80N57.00	018E00.36	229	806
807	C5	2018-07-03	17:30	81N00.45	018E00.62	289	807
808	C6	2018-07-03	18:30	81N04.20	018E00.20	357	808
809	C7	2018-07-03	19:38	81N08.05	018E00.68	409	809
810	C8	2018-07-03	20:50	81N12.78	018E00.70	480	810
811	C9	2018-07-03	22:03	81N16.07	018E00.91	536	811
812	C10	2018-07-03	23:35	81N19.36	018E01.00	622	812
813	C11	2018-07-04	01:40	81N23.31	017E55.09	831	813
814	C11	2018-07-04	03:30	81N23.20	017E59.29	814	-
815	C10	2018-07-04	04:52	81N19.35	018E01.13	622	-
816	C5	2018-07-04	06:59	81N00.50	018E00.37	292	816
817	C5	2018-07-04	11:00	81N00.51	018E00.23	295	817
818	C5	2018-07-04	15:02	81N00.50	018E00.21	297	818
819	C5	2018-07-04	19:03	81N00.50	017E59.50	299	819
820	C5	2018-07-04	23:01	81N00.50	018E00.08	295	820
821	C5	2018-07-05	3:00	81N00.51	018E00.20	296	821
822	C5	2018-07-05	07:03	81N00.54	018E17.00	294	822
823	D1	2018-07-05	12:47	81N14.09	024E00.13	198	823
824	D2	2018-07-05	13:56	81N20.66	023E59.96	124	824
825	D3	2018-07-05	14:43	81N23.56	024E00.28	209	825
826	D4	2018-07-05	15:39	81N24.64	024E01.38	281	826
827	E12	2018-07-06	00:21	81N07.42	015E52.49	2169	827
828	E11	2018-07-06	03:07	81N06.06	016E16.23	1994	828
829	E10	2018-07-06	07:08	81N05.13	016E34.21	1573	829
830	E9	2018-07-06	08:19	81N04.50	016E44.64	1167	830
831	E8	2018-07-06	10:04	81N04.28	016E49.47	1022	831
832	E7	2018-07-06	11:35	81N03.91	016E55.68	883	832
833	E6	2018-07-06	12:59	81N03.46	017E03.93	791	833
834	E5	2018-07-06	14:14	81N03.02	017E12.08	701	834
835	E4	2018-07-06	15:31	81N02.22	017E26.18	583	835
836	E3	2018-07-06	16:38	81N01.56	017E38.81	488	836
837	E2	2018-07-06	17:36	81N01.06	017E01.50	400	837
838	E1	2018-07-06	18:28	81N00.42	017E59.88	293	838
839	T2	2018-07-06	22:18	80N43.27	015E34.99	949	839
840	T3	2018-07-07	01:39	81N00.33	016E43.02	958	840
841	T1	2018-07-07	5:19	80N50.16	014E31.86	956	841
842	T2	2018-07-07	8:31	80N43.23	015E35.14	942	842
843	T3	2018-07-07	11:57	81N00.33	016E43.04	958	843
844	T1	2018-07-07	15:42	80N50.18	014E31.96	957	844
845	T2	2018-07-07	18:18	80N43.20	015E01.46	940	845
846	T3	2018-07-07	21:30	81N00.32	016E42.92	960	846
847	T1	2018-07-08	01:15	80N50.16	014E31.86	956	847
848	UNIS-814	2018-07-08	10:05	80N03.85	008E36.87	498	848
849	UNIS-812	2018-07-08	11:57	79N57.47	009E25.88	471	849

Cast	Station Name	Date	Time (UTC)	LAT	LON	E. Depth (m)	LADCP
850	UNIS-804	2018-07-08	14:01	79N49.02	010E25.74	113	850
851	UNIS-52	2018-07-09	2:05	78N00.48	009E31.65	341	851
852	UNIS-51	2018-07-09	2:34	77N59.99	009E37.21	206	852
853	UNIS-50	2018-07-09	2:58	77N59.95	009E43.63	171	853
854	UNIS-49	2018-07-09	3:24	78N00.05	009E52.45	174	854
855	UNIS-48	2018-07-09	04:08	77N59.94	010E16.12	185	855
856	UNIS-47	2018-07-09	04:59	77N59.23	010E46.08	173	856
857	UNIS-46	2018-07-09	05:49	77N58.24	011E14.15	182	857
858	UNIS-45	2018-07-09	06:33	77N57.66	011E38.86	195	858
859	UNIS-44	2018-07-09	07:24	77N58.08	012E08.20	208	859
860	UNIS-43	2018-07-09	08:22	77N59.85	012E42.91	222	860
861	UNIS-42	2018-07-09	09:31	78N01.92	013E07.35	239	861
862	UNIS-41	2018-07-09	10:17	78N04.53	013E28.30	354	862
863	UNIS-40	2018-07-09	11:00	78N06.86	013E42.44	296	863
864	UNIS-39	2018-07-09	11:38	78N07.81	013E57.71	295	864
865	UNIS-38	2018-07-09	12:22	78N08.24	014E17.95	206	865
866	UNIS-37	2018-07-09	12:57	78N09.17	014E33.89	209	866
867	UNIS-36	2018-07-09	13:35	78N10.94	014E51.33	217	867
868	UNIS-35	2018-07-09	14:13	78N13.37	015E05.75	237	868
869	UNIS-34	2018-07-09	15:02	78N15.49	015E15.85	242	869
870	UNIS-33	2018-07-09	15:38	78N18.30	015E25.40	260	870
871	UNIS-32	2018-07-09	16:12	78N20.27	015E35.20	184	871
872	UNIS-31	2018-07-09	16:47	78N22.57	015E46.99	173	872
873	UNIS-30	2018-07-09	18:00	78N24.76	015E57.64	190	873
874	UNIS-23	2018-07-09	18:33	78N26.89	016E01.94	116	874
875	UNIS-17	2018-07-09	19:19	78N30.62	016E17.25	54	-
876	UNIS-12	2018-07-09	19:42	78N32.64	016E20.70	109	-
877	UNIS-10	2018-07-09	20:05	78N34.59	016E24.61	93	-
878	UNIS-6	2018-07-09	20:32	78N36.68	016E31.18	153	-
879	UNIS-5	2018-07-09	20:46	78N37.03	016E28.88	144	-
880	UNIS-3	2018-07-09	21:10	78N38.55	016E36.29	177	-
881	UNIS-2	2018-07-09	21:34	78N39.74	016E44.58	191	-

List of VMP stations

Table 3. 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	Station Name	Date-UTC	Time (UTC)	LAT	LON	Depth (m)	Start (m)	End (m)	CTD File	Comments
1	test	2018-06-28	15:17	78N20.45	15E14.56	257	2	250	762	only sh1 (M1109), t1 (T1175); pressure offset = 1.5 m (4 m actual depth is read as 2.5 dbar)
2	A1	2018-06-29	09:14	79N17.93	09E59.87	134	3	86	763	all probes (sh2:M1293; t2:T1176: mC:C200)
3	A2	2018-06-29	11:29	79N18.27	09E00.52	149	2	132	764	
4	A3	2018-06-29	13:08	79N18.18	08E27.03	188	2	181	765	
5	A4	2018-06-29	15:50	79N18.28	08E15.87	290	2	270	766	
6	A5	2018-06-29	19:05	79N18.22	08E07.30	425	2	431	767	touch the bottom. Mud on the pod but not on the sensor
7	A6	2018-06-29	21:00	79N18.19	08E02.94	480	2	405	768	no T2 signal!
8	A7	2018-06-29	00:15	79N18.19	07E58.08	615	2	581	769	no T2 signal!
9	A8	2018-06-29	04:56	79N18.13	07E47.03	776	2	762	770	no T2 signal!
10	A9	2018-06-29	09:37	79N18.15	07E32.11	997	2	1000	771	changed T2 to T1001
11	A10	2018-06-29	14:51	79N18.20	07E16.05	1191	2	1189	772	
12	A11	2018-06-29	19:17	79N18.11	06E57.32	1277	2	1198	773	
13	A12	2018-06-30	23:01	79N17.89	06E35.99	1381	2	1370	774	
14	B16	2018-06-30	04:22	81N12.02	11E59.94	2122	2	1480	780	
15	B15	2018-06-30	07:05	81N05.05	12E00.30	2105	2	1534	781	changed shear probes: sh1: M462 (vertical), sh2: M546 (horizontal)
16	B14	2018-07-01	06:48	80N54.83	12E00.50	1848	2	1656	782	
17	B13	2018-07-01	08:05	80N47.55	12E00.00	1565	2	1528	783	(CTD taken 4 hours prior)
18	B12	2018-07-01	06:03	80N40.01	12E00.37	1263	2	1173	784	
19	B11	2018-07-01	06:27	80N32.61	12E00.49	927	2	893	785	(CTD taken 4 hours prior)
20	B10	2018-07-01	05:40	80N31.20	12E00.36	820	1	839	786	hit bottom
21	B9	2018-07-01	05:36	80N29.42	12E00.55	696	2	680	787	sh1: M1109; T1:dummy
22	B8	2018-07-01	04:57	80N28.13	12E00.25	597	1	570	788	
23	B7	2018-07-01	04:22	80N26.74	12E00.28	502	1	481	789	
24	B6	2018-07-01	03:46	80N25.65	12E00.28	406	1	390	790	
25	B5	2018-07-01	02:57	80N24.91	12E00.37	297	1	271	791	
26	B4	2018-07-01	01:23	80N22.97	12E00.36	203	1	186	792	

Cast	Station Name	Date-UTC	Time (UTC)	LAT	LON	Depth (m)	Start (m)	End (m)	CTD File	Comments
27	B3	2018-07-02	02:35	80N13.71	12E00.28	155	1	147	793	
28	B2	2018-07-02	02:37	80N05.10	12E00.21	97	1	94	794	
29	B1	2018-07-02	02:47	79N60.00	12E00.04	47	1	42	795	
30	B8	2018-07-02	15:59	80N28.14	12E00.14	599	1	593	796	Start of 24-h repeat station at B8, combination of full casts and 250m yo-yo
31	B8	2018-07-02	16:59	80N28.20	12E01.90	599	1	250		
32	B8	2018-07-02	16:59	80N28.20	12E01.90	599	1	250		
33	B8	2018-07-02	16:59	80N28.20	12E01.90	599	1	250		
34	B8	2018-07-02	16:59	80N28.20	12E01.90	599	1	250		
35	B8	2018-07-02	16:59	80N28.20	12E01.90	599	1	250		
36	B8	2018-07-02	16:59	80N28.20	12E01.90	599	1	250		
37	B8	2018-07-02	17:59	80N28.20	12E01.90	599	1	250		
38	B8	2018-07-02	17:59	80N28.20	12E01.90	599	1	250		
39	B8	2018-07-02	17:59	80N28.20	12E01.90	599	1	250		
40	B8	2018-07-02	18:59	80N28.20	12E01.90	599	1	250		
41	B8	2018-07-02	18:59	80N28.20	12E01.90	599	1	250		
42	B8	2018-07-02	18:59	80N28.20	12E01.90	599	1	250		
43	B8	2018-07-02	19:56	80N28.20	12E00.29	596	1	533	797	
44	B8	2018-07-02	20:56	80N28.20	12E00.29	596	1	250		
45	B8	2018-07-02	20:56	80N28.20	12E00.29	596	1	252		
46	B8	2018-07-02	20:56	80N28.20	12E00.29	596	1	252		
47	B8	2018-07-02	20:56	80N28.20	12E00.29	596	1	252		
48	B8	2018-07-02	20:56	80N28.20	12E00.29	596	1	249		
49	B8	2018-07-02	21:56	80N28.05	12E00.27	596	1	252		
50	B8	2018-07-02	21:56	80N28.05	12E00.27	596	1	247		
51	B8	2018-07-02	21:56	80N28.05	12E00.27	596	1	250		
52	B8	2018-07-02	22:56	80N28.05	12E00.27	596	1	250		
53	B8	2018-07-02	22:56	80N28.05	12E00.27	596	1	244		
54	B8	2018-07-02	23:57	80N28.12	12E00.17	597	1	542	798	
56	B8	2018-07-02	23:57	80N28.12	12E00.17	597	1	250		55 is empty
57	B8	2018-07-02	00:57	80N28.12	12E00.17	597	1	250		
58	B8	2018-07-02	00:57	80N28.12	12E00.17	597	1	260		
59	B8	2018-07-02	00:57	80N28.12	12E00.17	597	1	250		
60	B8	2018-07-02	00:57	80N28.12	12E00.17	597	1	250		
61	B8	2018-07-02	01:57	80N28.12	12E00.17	597	1	250		
62	B8	2018-07-02	01:57	80N28.12	12E00.17	597	1	250		
63	B8	2018-07-02	01:57	80N28.12	12E00.17	597	1	250		
64	B8	2018-07-02	02:57	80N28.12	12E00.17	597	1	250		
65	B8	2018-07-02	02:57	80N28.12	12E00.17	597	1	250		
66	B8	2018-07-02	03:57	80N28.13	12E00.27	597	1	584	799	
67	B8	2018-07-02	03:57	80N28.13	12E00.27	597	1	250		
68	B8	2018-07-02	04:57	80N28.13	12E00.27	597	1	250		
69	B8	2018-07-02	04:57	80N28.13	12E00.27	597	1	250		
70	B8	2018-07-02	04:57	80N28.13	12E00.27	597	1	250		
71	B8	2018-07-02	04:57	80N28.13	12E00.27	597	1	250		
72	B8	2018-07-02	05:57	80N28.13	12E00.27	597	1	250		
73	B8	2018-07-02	05:57	80N28.13	12E00.27	597	1	250		
74	B8	2018-07-02	05:57	80N28.13	12E00.27	597	1	250		
75	B8	2018-07-02	06:57	80N28.13	12E00.27	597	1	250		
76	B8	2018-07-02	06:57	80N28.13	12E00.27	597	1	250		

Cast	Station Name	Date-UTC	Time (UTC)	LAT	LON	Depth (m)	Start (m)	End (m)	CTD File	Comments
77	B8	2018-07-02	07:57	80N28.13	12E00.21	597	1	553	800	
78	B8	2018-07-02	07:57	80N28.13	12E00.21	597	1	250		
79	B8	2018-07-02	08:57	80N28.13	12E00.21	597	1	250		
80	B8	2018-07-02	08:57	80N28.13	12E00.21	597	1	250		
81	B8	2018-07-02	08:57	80N28.13	12E00.21	597	1	245		
82	B8	2018-07-02	08:57	80N28.13	12E00.21	597	1	250		
83	B8	2018-07-03	09:57	80N28.13	12E00.21	597	1	250		
84	B8	2018-07-03	09:57	80N28.13	12E00.21	597	1	250		
85	B8	2018-07-03	09:57	80N28.13	12E00.21	597	1	250		
86	B8	2018-07-03	10:57	80N28.13	12E00.21	597	1	250		
87	B8	2018-07-03	10:57	80N28.13	12E00.21	597	1	250		
88	B8	2018-07-03	11:57	80N28.12	12E00.21	597	1	576	801	
89	B8	2018-07-03	11:57	80N28.12	12E00.21	597	1	250		
90	B8	2018-07-03	12:57	80N28.12	12E00.21	597	1	250		
91	B8	2018-07-03	12:57	80N28.12	12E00.21	597	1	250		
92	B8	2018-07-03	12:57	80N28.12	12E00.21	597	1	250		
93	B8	2018-07-03	12:57	80N28.12	12E00.21	597	1	250		
94	B8	2018-07-03	13:57	80N28.12	12E00.21	597	1	250		
95	B8	2018-07-03	13:57	80N28.12	12E00.21	597	1	250		
96	B8	2018-07-03	13:57	80N28.12	12E00.21	597	1	250		
97	B8	2018-07-03	14:57	80N28.12	12E00.21	597	1	250		
98	B8	2018-07-03	14:57	80N28.12	12E00.21	597	1	582	802	CTD taken approx 0.5 h later, after repositioning the ship
99	C1	2018-07-03	13:29	80N29.96	17E59.83	89	1	75	803	
100	C2	2018-07-03	15:56	80N39.06	18E00.30	116	1	105	804	
101	C3	2018-07-03	18:23	80N48.27	17E59.93	203	1	189	805	
102	C4	2018-07-03	19:49	80N57.00	18E00.36	229	1	190	806	
103	C5	2018-07-03	21:49	81N00.45	18E00.62	289	1	248	807	
104	C6	2018-07-03	23:57	81N04.20	18E00.20	357	1	354	808	
105	C7	2018-07-03	01:49	81N08.05	18E00.68	409	2	395	809	
106	C8	2018-07-03	05:00	81N12.78	18E00.70	480	2	485	810	hit bottom
107	C9	2018-07-03	06:56	81N16.07	18E00.91	536	2	146	811	Test to look at the data after hitting bottom
108	C9	2018-07-03	06:47	81N16.07	18E00.91	527	2	496	811	
109	C10	2018-07-04	10:20	81N19.36	18E01.00	620	1	593	812	
110	C11	2018-07-04	15:52	81N23.31	17E47.77	832	1	790	813	
111	C5	2018-07-04	11:52	81N00.50	18E00.37	292	1	273	816	
112	C5	2018-07-04	12:50	81N00.50	18E00.37	290	1	288		
113	C5	2018-07-04	12:50	81N00.50	18E00.37	290	1	274		
114	C5	2018-07-04	12:50	81N00.50	18E00.37	290	2	287		
115	C5	2018-07-04	12:50	81N00.50	18E00.37	290	2	282		
116	C5	2018-07-04	12:50	81N00.50	18E00.37	290	2	286		
117	C5	2018-07-04	14:03	81N00.47	17E59.29	303	2	285		
118	C5	2018-07-04	14:03	81N00.47	17E59.29	303	2	296		
119	C5	2018-07-04	14:03	81N00.47	17E59.29	303	2	294		
120	C5	2018-07-04	15:03	81N00.47	17E59.29	303	1	290		
121	C5	2018-07-04	15:03	81N00.47	17E59.29	303	1	287		
122	C5	2018-07-04	16:02	81N00.51	18E00.23	302	1	274	817	
123	C5	2018-07-04	16:02	81N00.51	18E00.23	302	1	287		
124	C5	2018-07-04	17:02	81N00.51	18E00.23	302	1	287		
125	C5	2018-07-04	17:02	81N00.51	18E00.23	302	1	286		

Cast	Station Name	Date-UTC	Time (UTC)	LAT	LON	Depth (m)	Start (m)	End (m)	CTD File	Comments
126	C5	2018-07-04	17:02	81N00.51	18E00.23	302	1	290		
127	C5	2018-07-04	17:02	81N00.51	18E00.23	302	1	287		
128	C5	2018-07-04	18:02	81N00.51	18E00.23	302	1	283		
129	C5	2018-07-04	18:02	81N00.51	18E00.23	302	1	283		
130	C5	2018-07-04	18:02	81N00.51	18E00.23	302	1	271		
131	C5	2018-07-04	19:02	81N00.51	18E00.23	302	1	280		
132	C5	2018-07-04	19:02	81N00.51	18E00.23	302	1	276		
133	C5	2018-07-04	19:57	81N00.50	18E00.21	297	1	265	818	
134	C5	2018-07-04	20:49	81N00.40	18E00.40	289	1	275		
135	C5	2018-07-04	20:49	81N00.40	18E00.40	289	1	286		
136	C5	2018-07-04	20:49	81N00.40	18E00.40	289	1	286		
137	C5	2018-07-04	20:49	81N00.40	18E00.40	289	1	281		
138	C5	2018-07-04	20:49	81N00.40	18E00.40	289	1	283		
139	C5	2018-07-04	21:49	81N00.40	18E00.40	289	1	278		
140	C5	2018-07-04	21:49	81N00.40	18E00.40	289	1	289		
141	C5	2018-07-04	21:49	81N00.40	18E00.40	289	2	290		
142	C5	2018-07-04	22:49	81N00.40	18E00.40	289	2	287		
143	C5	2018-07-04	22:49	81N00.40	18E00.40	289	2	287		
144	C5	2018-07-04	23:59	81N00.50	17E59.50	299	2	285	819	
145	C5	2018-07-04	01:00	81N00.47	17E59.37	300	2	292		
146	C5	2018-07-04	01:00	81N00.47	17E59.37	300	2	290		
147	C5	2018-07-04	01:00	81N00.47	17E59.37	300	3	289		
148	C5	2018-07-04	00:46	81N00.47	17E59.37	286	1	282		
149	C5	2018-07-04	00:46	81N00.47	17E59.37	286	1	285		
150	C5	2018-07-04	02:00	81N00.49	17E59.35	300	3	299		
151	C5	2018-07-04	01:56	81N00.50	18E00.10	296	2	283		
152	C5	2018-07-04	01:49	81N00.50	18E00.87	289	2	285		
153	C5	2018-07-04	02:49	81N00.50	18E00.87	289	1	283		
154	C5	2018-07-04	02:45	81N00.50	18E02.20	285	1	280		
155	C5	2018-07-04	03:54	81N00.50	18E00.08	294	1	284	820	
156	C5	2018-07-05	04:55	81N00.46	17E59.85	295	1	283		
157	C5	2018-07-05	04:48	81N00.46	18E00.70	288	1	281		
158	C5	2018-07-05	04:43	81N00.46	18E01.49	283	1	276		
159	C5	2018-07-05	04:43	81N00.46	18E02.27	283	1	277		
160	C5	2018-07-05	04:45	81N00.40	18E03.03	285	1	277		
161	C5	2018-07-05	05:52	81N00.47	18E00.17	292	1	281		
162	C5	2018-07-05	05:50	81N00.42	18E00.90	290	1	286		
163	C5	2018-07-05	05:45	81N00.40	18E01.56	285	1	279		
164	C5	2018-07-05	06:44	81N00.38	18E02.15	284	1	275		
165	C5	2018-07-05	06:43	81N00.34	18E02.76	283	1	275		
166	C5	2018-07-05	07:53	81N00.45	18E00.88	293	1	291	821	
167	C5	2018-07-05	08:54	81N00.47	17E59.76	294	2	287		
168	C5	2018-07-05	08:54	81N00.47	17E59.76	294	2	292		
169	C5	2018-07-05	08:54	81N00.47	17E59.76	294	2	290		
170	C5	2018-07-05	08:54	81N00.47	17E59.76	294	3	293		
171	C5	2018-07-05	08:48	81N00.45	18E00.49	288	3	286		
172	C5	2018-07-05	09:55	81N00.52	18E00.24	295	1	291		
173	C5	2018-07-05	09:55	81N00.52	18E00.24	295	1	292		
174	C5	2018-07-05	10:55	81N00.52	18E00.24	295	2	291		
175	C5	2018-07-05	10:55	81N00.52	18E00.24	295	3	291		
176	C5	2018-07-05	10:55	81N00.52	18E00.24	295	2	292		
178	D1	2018-07-05	15:20	81N14.09	24E00.13	200	2	190	823	177 is empty.
179	D2	2018-07-05	16:10	81N20.65	23E59.94	130	2	127	824	
180	D3	2018-07-05	17:34	81N23.57	24E00.28	214	1	212	825	
181	D4	2018-07-05	19:26	81N24.64	24E01.38	266	1	255	826	

Cast	Station Name	Date-UTC	Time (UTC)	LAT	LON	Depth (m)	Start (m)	End (m)	CTD File	Comments
182	E12	2018-07-06	13:10	81N07.45	15E52.49	2170	1	1600	827	It is 182 and 183. Accidentally stopped (and restarted) recording
184	E11	2018-07-06	13:14	81N06.06	16E16.23	1994	2	1882	828	
185	E10	2018-07-06	07:03	81N05.09	16E34.40	1563	2	1523	829	VMP before CTD
186	E9	2018-07-06	03:27	81N04.50	16E44.64	1167	2	1185	830	
187	E8	2018-07-06	02:56	81N04.28	16E49.47	1016	2	951	831	
188	E7	2018-07-06	02:42	81N03.91	16E55.68	882	2	802	832	
189	E6	2018-07-06	02:10	81N03.46	17E03.93	790	2	760	833	
190	E5	2018-07-06	01:41	81N03.02	17E12.08	701	2	664	834	
191	E4	2018-07-06	00:43	81N02.22	17E26.18	583	2	549	835	
192	E3	2018-07-06	00:08	81N01.56	17E38.81	488	2	458	836	problem with linepuller upper 25m
193	E2	2018-07-06	23:40	81N01.06	17E01.50	400	2	378	837	
194	E1	2018-07-06	22:53	81N00.42	17E59.88	293	2	275	838	
195	T2	2018-07-06	13:50	80N43.27	15E34.99	950	2	834	839	
196	T3	2018-07-07	17:59	81N00.33	16E43.02	959	2	932	840	
197	T1	2018-07-07	21:56	80N50.16	14E31.86	956	2	848	841	30min after CTD
198	T2	2018-07-07	00:42	80N43.23	15E35.14	942	2	872	842	
199	T3	2018-07-07	03:44	81N00.33	16E43.04	944	2	870	843	
200	T1	2018-07-07	07:57	80N50.18	14E31.96	957	2	936	844	
201	T2	2018-07-07	09:40	80N43.20	15E01.46	940	2	930	845	
202	T3	2018-07-07	14:01	81N00.30	16E42.88	961	2	940	846	
203	T1	2018-07-08	16:56	80N50.16	14E31.86	956	2	903	847	

LADCP Deployment Files

Table 4. Master LADCP deployment file

```
; Append command to the log file
$L C:\KB2017618\ladcp\Sladcp_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 5. Slave LADCP deployment file

```
; Append command to the log file
$L C:\KB2017618\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
```

The Nansen Legacy in numbers

6 years

The Nansen Legacy is a six-year project, running from 2018 to 2023.

250 people

There are about 210 researchers working with the Nansen Legacy, of which 50 are early career scientists. In addition, 40 persons are involved as technicians, project coordinators, communication advisers and board members.

1 400 000 km² of sea

The Nansen Legacy investigates the physical and biological environment of the northern Barents Sea and adjacent Arctic Ocean.

10 institutions

The Nansen Legacy unites the complimentary scientific expertise of ten Norwegian institutions dedicated to Arctic research.

>10 fields

The Nansen Legacy includes scientists from the fields of biology, chemistry, climate research, ecosystem modelling, ecotoxicology, geology, ice physics, meteorology, observational technology, and physical oceanography.

50/50 financing

The Nansen Legacy has a total budget of 740 million NOK. Half the budget comes from the consortiums' own funding, while the other half is provided by the Research Council of Norway and the Ministry of Education and Research.

>350 days at sea

The Nansen Legacy will conduct 15 scientific cruises and spend more than 350 days in the northern Barents Sea and adjacent Arctic Ocean between 2018 and 2022. Most of these cruises are conducted on the new Norwegian research icebreaker RV *Kronprins Haakon*.

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