# CRUISE REPORT

# Cruise KB 2020603

# with R.V. Kristine Bonnevie

# 2 – 8 March 2020

**Working Areas:**

**Masfjorden, Fensfjorden, Lurefjorden, Sognesjøen**

Geophysical Institute, University of Bergen

Compiled from inputs of GEOF232 & GEOF337 students, spring 2020

Version: 1 February 2020

## Contents

# 1 Background (Elin & Kjersti)

The cruise onboard the Research Vessel Kristine Bonnevie was undertaken as a part of the GEOF232 & GEOF337 courses offered at the Geophysical Institute (GFI), University of Bergen. The site of the study was Masfjorden, Fensfjorden, and Lurefjorden. The data set collected aimed to address the tides and mixing processes in Masfjorden, the ocean-fjord exchange mechanisms, the observed deoxygenation of the deep inner basin, surface currents, and the upper mixed layer hydrography. The students become familiar with typical and state-of-the-art measurement systems, including ship-based measurements (CTD, thermosalinograph, Ship-ADCP, and Lidar) as well as moored instruments, turbulence measurements (MSS) and measurements of oxygen, salt, Carbon, and nutrients from collected water samples. The students participate in the planning of the cruise and sampling and contribute substantially to the cruise report.

In total, two moorings were recovered and re-deployed consisting of current meters, current profilers, and temperature, salinity, oxygen, and pressure loggers, which will collect data for a one-year duration. During the cruise, data collection was primarily by using the ship's CTD, vessel-mounted current profiling system, GFI's Lidar, GFI's microstructure profiler, drifters, and a homemade construction equipped with hydrography sensors, that was towed after the working boat to measure the surface layer hydrography.

# 2 Cruise participants

This cruise is part of the practical training in the GFI courses GEOF337 (Fjord oceanography) and GEOF232 (Practical meteorology and oceanography). Five students from GEOF337 joined the full cruise (2-8 March), and ten students from GEOF232 were split into two groups, staying on the ship for half the period each (2-5 or 5-8 March). One GEIF232 student (Martine) stayed the full week to do some light measurements for her Ph.D. project. An overview of the cruise participants, their role, and the periods they stayed onboard are given in Table 1.

**Table 1. Cruise participants**

| Last name | First name | Role | Time onboard |
|---|---|---|---|
| Darelius | Elin | Cruise leader | 2-8 March |
| Daae | Kjersti | Assisting cruise leader | 2-8 March |
| Bryhni | Helge | Engineer | 2-8 March |
| Dörr | Jakob | Teaching assistant | 2-8 March |
| Duscha | Christiane | Teaching assistant | 2-8 March |
| Rieke | Ole | Geof 337 | 2-8 March |
| | Victor | Geof 337 | 2-8 March |

| | | | |
|---|---|---|---|
| Pou | Joan | Geof 337 | 2-8 March |
| Sagen | Torunn | Geof 337 | 2-8 March |
| Clay | Jacintha | Geof 337 | 2-8 March |
| Solås | Martine Røysted | Geof 232 (PhD Bio) | 2-8 March |
| Skavang | Jacob Qvam | Geof 232 | 2-5 March |
| Harestad | Jonas | Geof 232 | 2-5 March |
| Larsen | Henrik | Geof 232 | 2-5 March |
| Bardel | Franziska | Geof 232 | 2-5 March |
| Moe | Thorbjørn Østenby | Geof 232 | 5-8 March |
| Horpestad | Kjartan | Geof 232 | 5-8 March |
| Davidson | Perrin Wesley | Geof 232 | 5-8 March |
| Auganæs | Sigrid Marie Vildskog | Geof 232 | 5-8 March |
| Knudsen | Carina | Geof 232 | 5-8 March |

# 3 Cruise Overview

During cruise KB2020603 to Masfjord, we recovered and redeployed two moorings, made 106 CTD-stations and 44 MSS-cast, and measured irradiance at the surface and underwater irradiance using Trios RAMSES hyperspectral radiometers and an underwater light sensor prototype. The moorings, MF_sill and MF_inner, were first deployed in February 2019 (during KB2019602) to monitor the exchange of water across the main sill of Masfjorden (79 m) and the evolution of hydrography and oxygen in the deep inner basin respectively. The moorings were redeployed for one more year of measurements.

Along-fjord CTD-section were taken a) along Masfjorden (Section M), along Fensfjorden (Section F) and along Lurefjorden (section L) and across Masfjorden (Section XM) and  Fensfjorden (Section XFa/XFb). We also made 7 CTD casts in Sognesjøen on request from IMR.

MSS-section was taken along Section M (extending across Fensfjorden), and a 12h time series was occupied in the Duesund sill area in Masfjord. An additional MSS-section was obtained along Lurefjorden (L-section).

We visited Haugsværfjorden, the inner, northern branch of Masfjorden, and measured oxygen, salt, carbon, nutrients, and isotopes from water samples. In 2019, there was no oxygen at the bottom of Haugsværfjorden, and the bottom water did not smell of Hydrogensulfur ($H_2S$). In this cruise, however, we found anoxic conditions higher up in the water column, and a strong smell of $H_2S$.

Water samples for calibration of the oxygen sand salinity sensors of the CTD were taken at 73 stations, and these were analyzed onboard. In addition to the one bottle that IMR takes at the bottom of each station, we took 112 water bottles for calibration of the conductivity sensor. These bottles were analyzed onboard, using a Portasal instrument. We sampled 134 water bottles for calibration of the oxygen sensor. These were analyzed using Winkler titration.

The cruise track is shown in Figure 1.

The thermosalinograph, the shipADCP, the weather station, and the GFa Lidar ran continuously throughout the cruise.

A detailed cruise narrative is given in Appendix A.

**Figure 1: Cruise track**

# 4 Environmental conditions: Weather (GEOF232) & tides (GEOF337)

Short description of weather conditions – figure showing strength/direction of wind and temperature. Mark periods when drifters were out

Our cruise in Masfjorden took place during neap tide. In Figure 4.1, we can see the tidal predictions for Masfjorden and the observed water level. The figure shows that the period between the 2nd and 8th of March is a neap tide period. The blue line shows the observed water levels. The data and figures are from Kartverket.no.

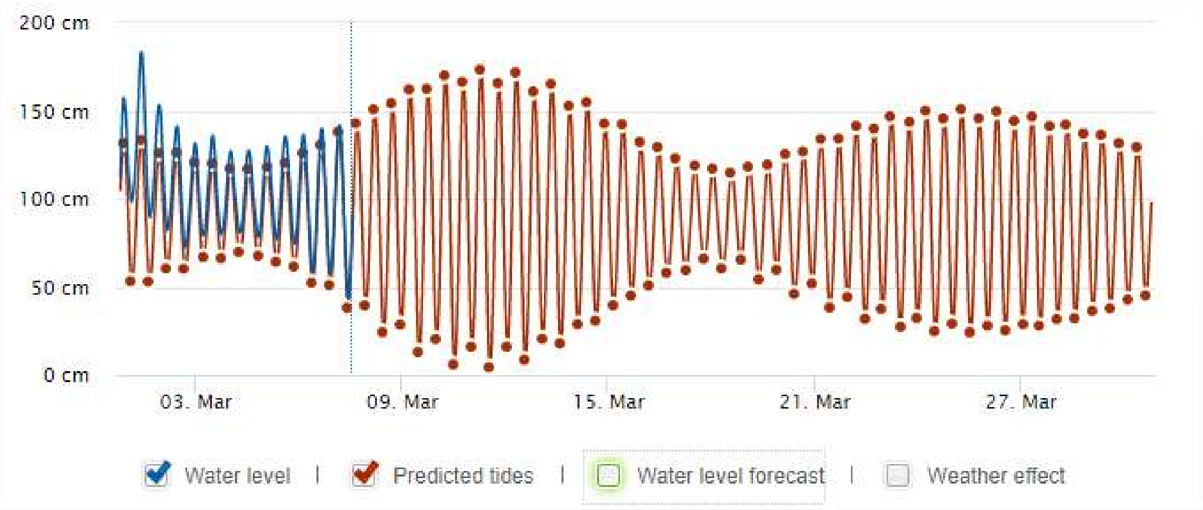



Figure 4.1. Tidal predictions for Masfjorden for the period 1-30 March 2020. The blue line shows the observed water level. Figure and data from Kartverket.no

In Figure 4.2, we see the tidal prediction and observed water levels for Masfjorden for the period 2nd – 7th of March. In the figure, we have marked when we measured the MSS time-series. The green area shows when data are collected in Masfjorden, and the purple area when data were collected in Lurefjorden. The data and figure are from Kartverket.no, but modified by us to indicate when the MSS time-series were taken. See chapter 9 for information about the MSS, and appendix G for the list of the MSS stations.

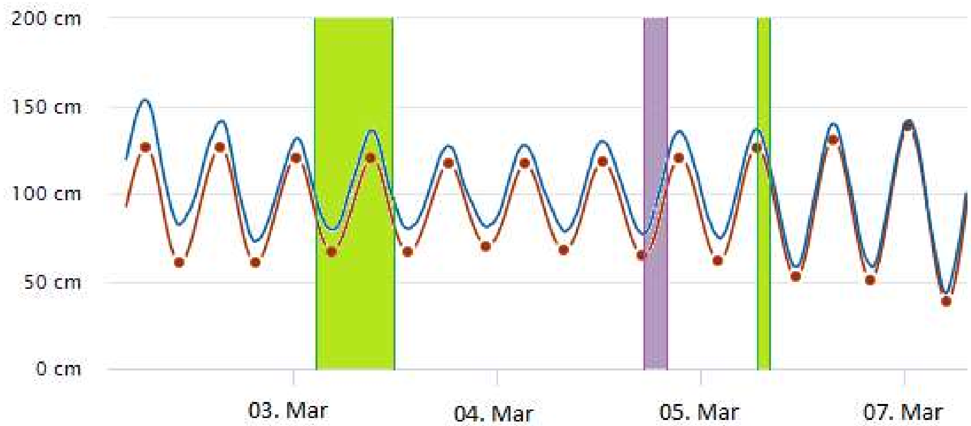


Figure 4.2. Tidal predictions and observed water levels in Masfjorden for the period 2nd to 8th of March. Data and figure from Kartverket.no, modified by us.

# 5 Moorings (GEOF337)

## *5.1 Mooring recovery*

The moorings MF_sill and MF_inner deployed during KB2019602 (February 2019) were recovered during the cruise. The location of the moorings is shown in Figure (??) and the moorings drawings are in Appendix D. The recovery information is specified in Table 2 and the instrumentation in

Table 3 - Table 4.

**MF_inner:**

SBE37 sn 5446 at 45 m depth: The instrument had slid down and was located just above the SBE37 ODO 12338 on recovery. The SBE37 upper mounting was not threaded as it should be (this was fixed before redeployment).

**MF_sill:**
The entire mooring was covered by biology, see Figur 1.

**Figur 1: Instrumentation recovered from MF_sill.**

SBE37 sn 5446 at 45 m depth: The SBE37 upper mounting was not threaded as it should be (this was fixed before redeployment). During the downloading process, it was seen that there was no data logged during the whole deployment period; the instrument had never started logging.

The RDCP600 had short-circuited by 10/03/2019, so no data was logged after that. The instrument was found to be tilted in the frame, but this most likely happened after the instrument had stopped logging since tilt remains low (and constant) throughout the deployment.

**Table 2 Mooring Recovery Details**

| ***MOORING RECOVERY*** | | |
|---|---|---|
| | MF_sill | MF_inner |
| *Position* | 60° 48.231' N, 5° 17.875' E | 60° 52.204'N 5° 22.105'E |
| *Time* | 4/3 08:20 | 2/3 17:25 |
| *Echodepth* | | 470 |
| *CTD station* | | |

The information regarding the structure of the moorings and some comments are found in the tables below.

Table 3 Instrument details mooring MF_inner

| Depth(m) | Height(m) | Instrument | Serial # | SI (min) | Comments |
|---|---|---|---|---|---|
| 200 | 260 | SBE37ODO | 12340 | | |
| 275 | 185 | SBE37CTD | 8974 | 5 | Instrument had slid down, was located just above 12338. |
| 350 | 110 | SBE37ODO | 12338 | | |
| 450 | 10 | SBE37ODO | 12339 | | |
| 455 | 5 | AR | 2424 | | |

Table 4 Instrument details mooring MF_sill during the recovery.

| Depth(m) | Height(m) | Instrument | Serial # | SI (min) | Comments |
|---|---|---|---|---|---|
| 15 | 55 | Seaguard | 1050 | 60 | |
| 25 | 45 | SBE56 | 1946 | 5 | |
| 45 | 25 | SBE37 | 5446 | | Did not log any data from the beginning. It presented communication troubles |
| 65 | 5 | RDCP600 | 229 | 120 | Th wire sqeezed ans short circuited afer a month (10/3/2019). No data logged after that. Tilted in buoy. |
| 66 | 4 | SBE37 | 8975 | | |
| 67 | 3 | AR | 1224 | | |

## 5.2 Mooring deployment

Instruments were serviced onboard and most instrument were set to start on 07/03 14:00 UTC, see Appendix xx for details on instrument set up.

The moorings were redeployed 7/3 2020, starting with MF_inner. By 10:00 the upper buoys of MF_inner were in the water and at 10:15 finally the weight was released

Table 5: Mooring deployment details

| MOORING DEPLOYMENT | | |
|---|---|---|
| | MF_sill | MF_inner |
| *Position* | 60°48.230'N 5°17.916'E | 60° 52.204'N 5° 22.105'E |
| *Time* | 7/3 10:15 | 7/3 09:15 |
| *Echodepth* | 86.5 | 470 |
| *CTD station* | 265 | 267 |
| *Acoustic release* | sn 1222 Arm:0899, Rel:Arm+0855 | SN:1564 Arm:0A0E Rel: Arm+0A55 |

Some changes were done regarding the mooring design and updated mooring drawings are shown in Appendix E.
The mooring MF_inner was triangulated and the results are shown in Figure 5.1.

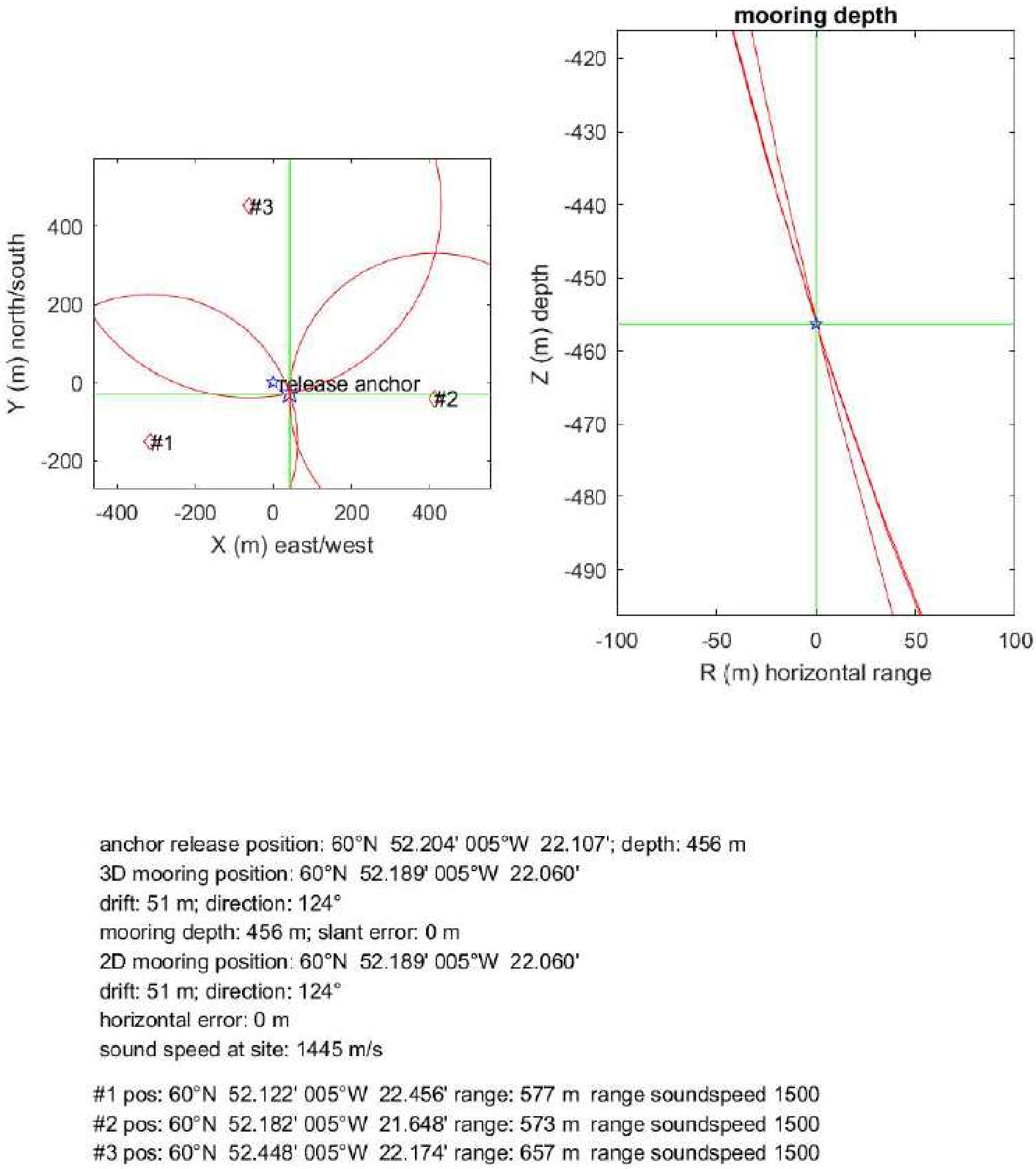



**Figure 5.1: Results from the triangulation of mooring MF_inner.**

## *5.3 Calibration of conductivity sensors (SBE37 & RBR Concerto)*

As part of the mooring re-deployment, three calibration stations were done. See Table 6, Table 7, and Table 8. The instruments were attached to the rosette, and the CTD was held 5 minutes at the bottom (and one more depth for some of the casts).

The mean difference between the conductivity measured by the instrument and that measured by the CTD during the five minutes stop is listed in Table 9. A five minute stop is not enough for the oxygen sensor to settle, and the data cannot be used to calibrate these sensors.

Table 6: Calibration station 1

| Calibration 1. | | CTD station M26 | Cast : 215 |
|---|---|---|---|
| Instrument | SN | Comments | |
| SBE37 | 8795 | Poor data. Possible due to unclean sensor | |
| | 8794 | It was set to local time, not to UTC. | |
| | 12338 | | |
| | 12339 | | |
| | 12340 | | |

**Table 7: Calibration station 2**

| Calibration 2 | | CTD station L6 | Cast : 245 |
|---|---|---|---|
| Instrument | SN | Comments | |
| SBE37 | 8795 | Data OK | |
| RBR concerto | 60648 | | |
| | 5446 | No data collected, instrument did not start. | |

**Table 8: Calibration station 3**

| Calibration 2 | | CTD station L6 | Cast : 257 |
|---|---|---|---|
| Instrument | SN | Comments | |
| SBE37 | 5446 | Data OK | |

**Table 9: Calibration results. "Cond" is the mean conductivity [mS/cm] measured during the 5-minutes stop, dc is the mean difference in conductivity (instrument-ctd) and dc_std the standard deviation of dc.**

| sn | cond | dc | dc_std |
|---|---|---|---|
| '12338' | [36.5348] | [-0.0016] | [ 0.0041] |
| '12338' | [36.4602] | [-0.0018] | [4.0000e-04] |
| '12339' | [36.5348] | [-0.0173] | [ 0.0037] |
| '12339' | [36.4602] | [-0.0178] | [2.0000e-04] |
| '12340' | [36.5348] | [-0.0030] | [ 0.0070] |
| '12340' | [36.4602] | [-0.0022] | [4.0000e-04] |
| '5446' | [36.5731] | [-0.0038] | [ 0.0013] |
| '5446' | [36.4577] | [-0.0102] | [ 0.0016] |
| '8974' | [36.5348] | [-0.0103] | [ 0.0076] |
| '8974' | [36.4602] | [-0.0172] | [ 0.0018] |
| '8975' | [33.8094] | [-0.0173] | [ 0.0031] |
| 'RBR 60648' | [33.8094] | [ 0.0089] | [6.0000e-04] |

# 6 Thermosalinograph (GEOF232)

A thermosalinograph is mounted close to the water intake of the ship. It measures the sea surface temperature and conductivity while the ship is in motion. The data that is collected can be used to calculate salinity, density, sound velocity, and other parameters.

The measuring of the seawater conductivity is done by a conductivity cell in the thermosalinograph. The conductivity can be used to calculate the salinity. The temperature is measured by a thermistor cell. Since the instrument is often placed in the engine room, the measurement could be biased by the heat of the room.

# 7 CTD profiling (GEOF232)

The CTD is an oceanographic instrument used during the cruise to measure salinity, temperature, and pressure. The name reflects this: conductivity from which salinity is determined, temperature, and depth which is determined from pressure. For our experiments, the CTD, which is a cylindrical instrument, was placed at the base of a larger metal framework and lowered through the water column at a continuous speed via a winch attached to the cruise boat. Instantaneously, data from the CTD was relayed to the cruise boat's computers displaying a vertical profile of the water column at that location. The total set of data included: salinity, pressure and depth, temperature, fluorescence implying organic carbon concentration, density, and oxygen. Upon completing the CTD, this data was saved and used for calibration of other sensors used on the cruise. The calibration dates and list of sensors used on this cruise are presented in Table ??.

The CTD framework also housed a rosette of 12 Niskin Bottles. These bottles were triggered remotely from the boat to capture water samples at different depths below sea level, starting at the lowest point and moving upward toward the water's surface. Each bottle was fired 30 seconds after stopping the instrument from moving. Importantly, the bottles captured the samples on the "down-cast" to avoid any perturbations in the collected water due to the moving instruments.

The cruise ran 105 CTDs throughout the 7-day cruise with CTD model SBE9 and rosette water sample SBE32. For each CTD, a different number of Niskin bottles were fired, ranging from 0 to all 12. (Firing all 12 was called a "Full CTD.") Niskin Bottle 1 was also fired at the lowest point of the CTD profile, around 10 meters from the seafloor. The water samples from these bottles were analyzed for a variety of chemical constituents. On the cruise, the constituents measured from these samples were: oxygen, nitrate, sulfate, phosphorous, dissolved inorganic carbon, salinity, and alkalinity. Different procedures were undergone to collect water samples from Niskin Bottles depending on the chemical constituent being measured. Before all samples were collected, a datasheet was created, denoting the samples collected per Niskin Bottle. This sheet included the numbers for each bottle and the sample included in each.

For collecting water samples of oxygen, the procedure reflected the need to have no air bubbles in the sample as this would relay inaccurate measurements. After washing all surfaces in contact with the water sample, the sample bottle was rinsed out 3 times and overfilled to twice the volume of the bottle. Then, 1 mL of manganese sulfate ($MnSO_4$) and 1 mL of alkali-iodide-azide ($NaOH$-$KI$-$NaN_3$) were added to the samples and a stopper carefully placed to ensure no bubbles were in the sample. After shaking the samples for 20 seconds, the bottles were stored before undergoing the rest of the Winkler Method of titration.

Samples for nitrate, sulfate, phosphorous, and dissolved inorganic carbon followed a similar procedure. After cleaning all surfaces in contact with the water sample were cleaned, each bottle was rinsed 3 times in the sample before being overfilled to twice the volume of the bottle. Then, each bottle was stoppered, and the number was marked down for proper accounting of the sample in analysis later.

For all samples of salinity and alkalinity, after all surface contacting the sample were cleaned, the bottle was overfilled to twice its volume and then stoppered. The number was also marked. It is important to note here that a water sample from Niskin Bottle 1, the lowest water sample, was taken for analysis by the Institute for Marine Research. Additionally, a light sensor was mounted on the CTD rosette to according to the procedure produced by a graduate student for her thesis work. This did not impact the function of the CTD-proper.

This cruise made five sections across five fjords, consisting of numerous CTD stations. These sections are: Masfjorden (M), Fensfjorden (F), Lurefjorden (L), Haugsværfjorden (H), and Sognefjorden (S). See Figure 7.1 for the Map showing the distribution of these sections. The Masfjorden section consisted of 35 stations, the Fensfjorden section consisted of 25 stations, the Lurefjorden section consisted of 7 stations, the Haugsværfjorden section consisted of 3 stations, and the Sogneforden section consisted of 5 stations. Additionally, one last section was made across Fensfjorden, denoted FX, and consisted of 6 stations. There were also numerous CTDs not a part of these sections. Table 11 includes the section by name, corresponding number of stations, and the dates occupied.

There were a few problems that we encountered during this cruise relating to the CTD profiling. All of these related to the firing of Niskin Bottles. Bottle 2 was faulty during the first leg of the cruise at Station M31 in Masfjorden on 02/03. This bottle was attended to and fixed by cruise technicians. Additionally, a CTD at M26 was aborted and checked for clean tubes before resuming on 03/03. Bottles 4 and 7 were faulty during the second leg of the cruise, 05/03 to 08/03, and were never fixed. Bottle 7 did not fire during a CTD at Station M26 on 04/03. Bottle 4 did not fire at Station S2 on 05/03 and 07/03 and at Station H3 on 06/03.

To account for these bottle issues, an additional bottle was fired as a redundancy in case a faulty bottle would not fire. Unfortunately, if a bottle was faulty and no redundancy was in place, then this will be noted in the subsequent water sample analysis.

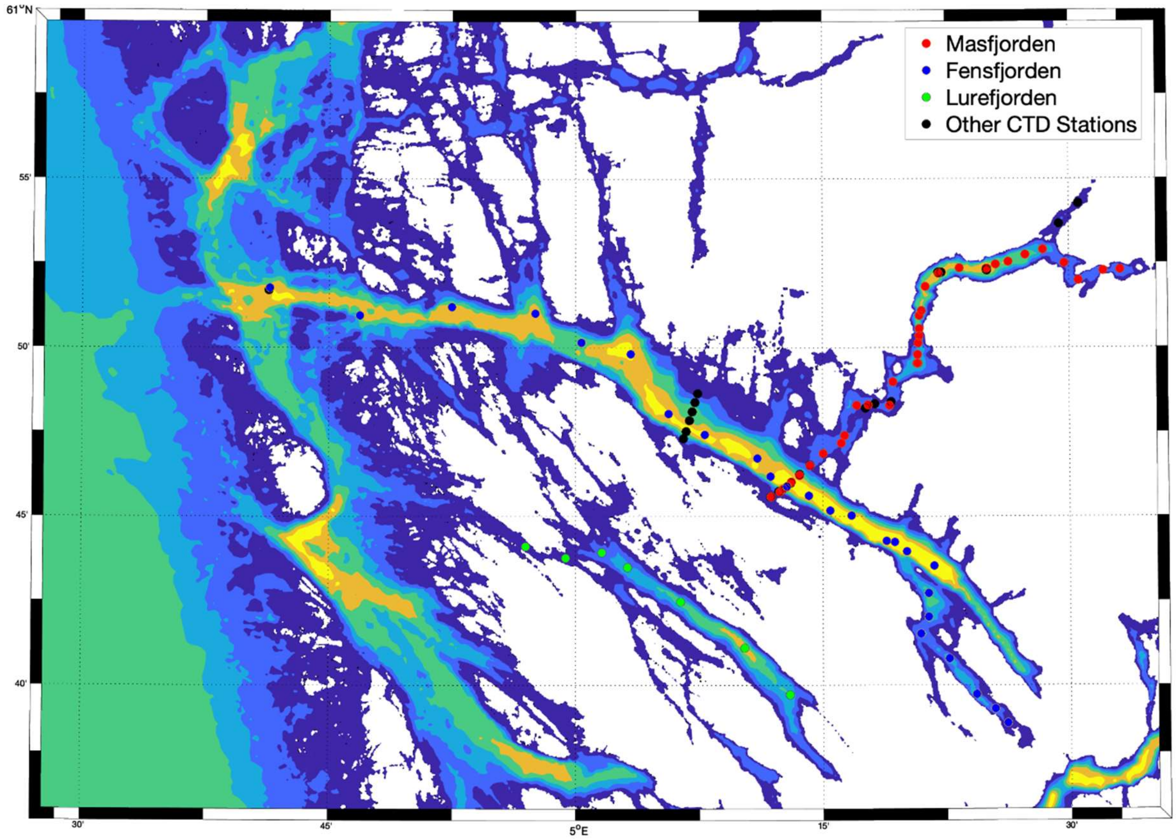



**Figure 7.1. CTD Sites in Masfjord, Fensfjorden, and Lurefjord. Each cast was taken between 02/03 to 08/03.**

**Table 10. Oceanographic Sensor List and Calibration Date.**

| Sensor | Serial Number | Last Calibrated |
|---|---|---|
| Primary Temperature Sensor | 03-5884 | 19. October 2017 |
| Secondary Temperature Sensor | 03-4306 | 19. October 2017 |
| Primary Conductivity Sensor | 04-4386 | 14. December 2017 |
| Secondary Conductivity Sensor | 04-2860 | 14. November 2017 |
| Pressure Sensor | 134950 | 147 November 2015 |

| | | |
|---|---|---|
| Submersible Pump | 05-8402 | N/A |
| Oxygen Sensor | 43-0633 | 31. October 2017 |
| Fluormeter, Wet Labs ECO-AFL/FL | FLRTD-4131 | 02. October 2015 |
| PAR sensor, Biospherical QCP2300-HP | 70656 | 13. January 2017 |
| SPAR sensor, Biospherical QCR-2200 | 20539 | 13. January 2017 |

**Table 11. sections, when they were occupied**

| Section | Date Occupied | Number of Stations |
|---|---|---|
| Masfjorden (M) | 02/03 to 04/03 | 35 |
| Fensfjorden (F) | 04/03 to 05/03 | 25 |
| Sognesfjorden (S) | 05/03 | 5 |
| Lurefjorden (L) | 05/03 | 5 |
| Haugsværfjorden (H) | 06/03 | 3 |
| Fensfjorden II (FX) | 07/03 to 08/03 | 6 |

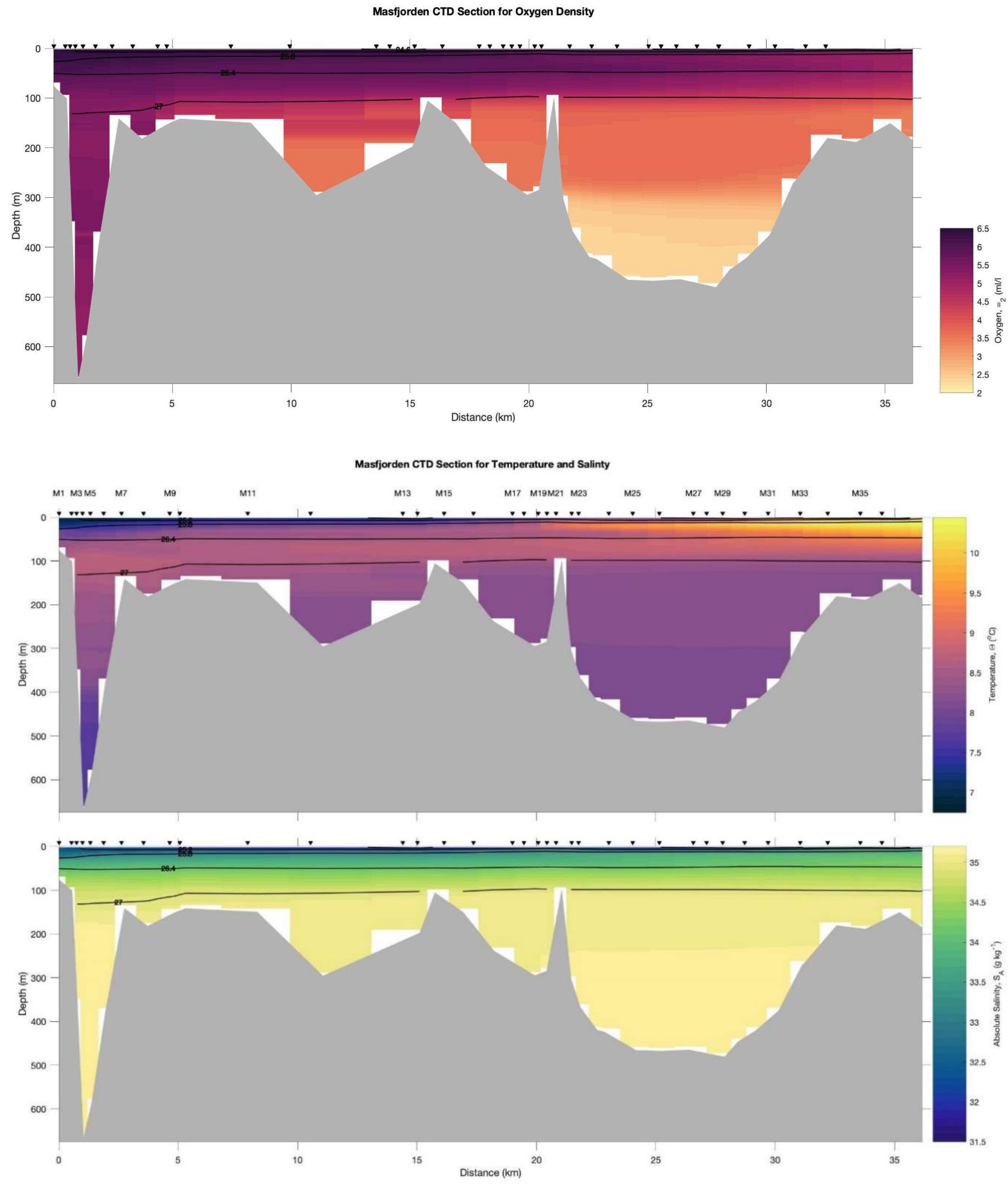



Figure 7.2 Masfjorden Oxygen, Temperature, and Salinity from CTD Casts. .

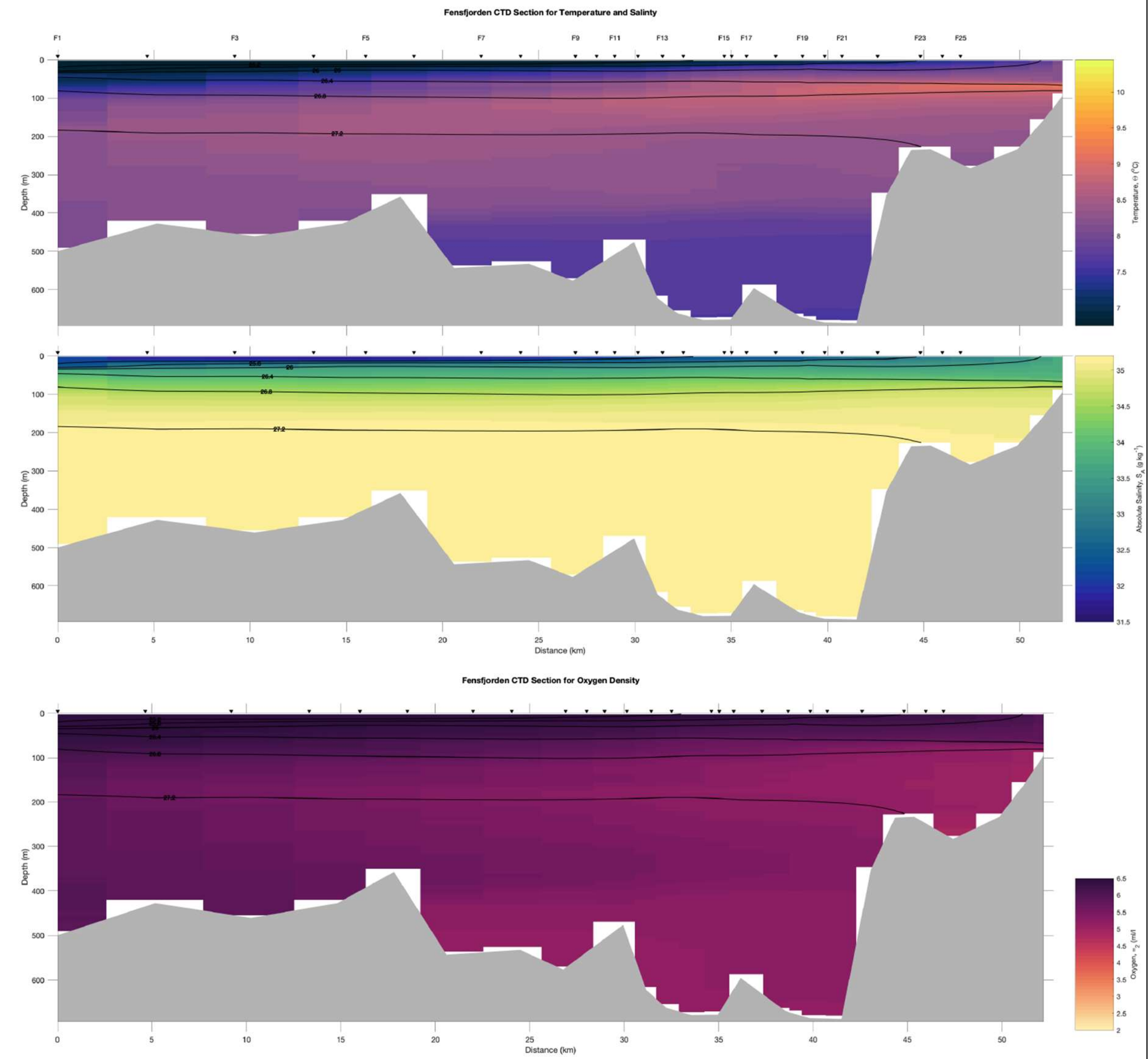



**Figure 7.3. Fensfjorden Temperature, Salinity, and Oxygen from CTD Casts.**

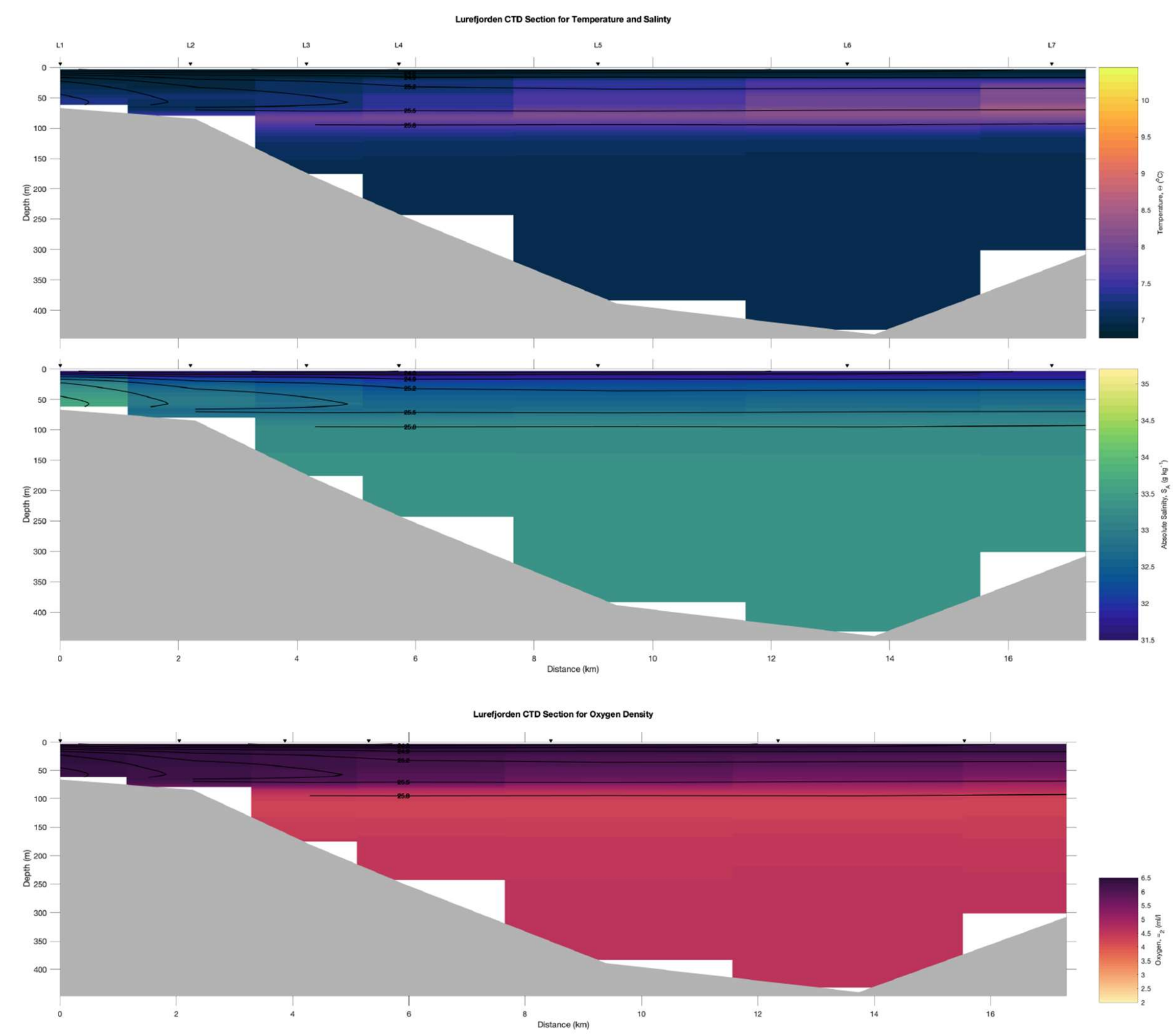



**Figure 7.4. Lurefjorden Temperature, Salinity, and Oxygen, from CTD Casts.**

## 7.1 *Water sampling*

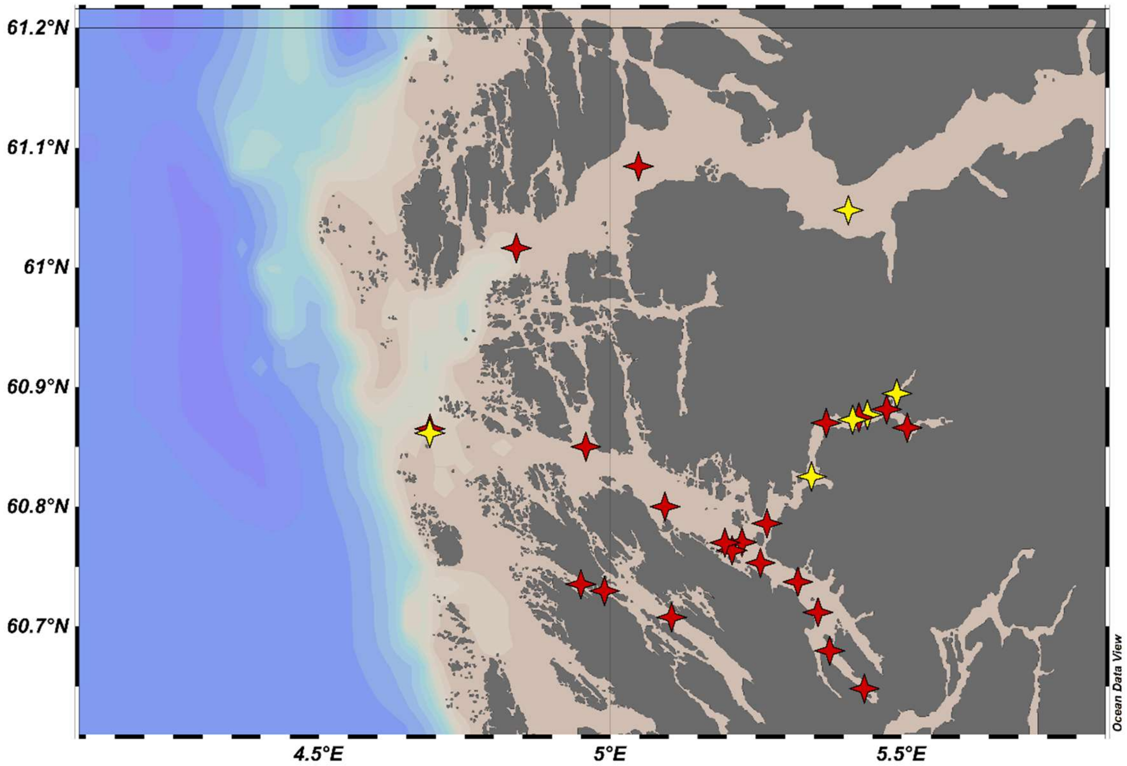



**Figure 7.5.** Map of CTD-stations in Sognesjøen, Fensfjord, Masfjord, and Lurefjord where water samples were collected for Winkler-titration. Yellow stars mark full stations (8-12 sample depths per station) and red stars mark normal stations (3-4 sample depths per station).

### 7.1.1 Dissolved oxygen

To calibrate the CTD oxygen sensor we collected a total of 134 water samples from 28 different CTD stations. (Appendix F.1). The water samples were collected at different depths and were analyzed onboard by manualWinkler-titration.

Several measures were taken in order to minimalize oxygen loss/introduction from/to the water samples: A tube was attached to the niskin bottle and air bubbles were removed by pressing lightly on the tube while water was flowing through it. The sample flask, flask stopper and tube were rinsed with the sample water ca. three times. Furthermore, we inserted the tube into the flask, and let the water overflow the flask volume ca. two times. While the flask was overflowing, we measured the water temperature (to the nearest 0.1 °C). After the second overflow, we removed the tube while water was still flowing, and added 1 ml of $MnCl_2$ (3M) and then 1 ml of NaOH + NaI (4M) to the water sample. The stopper was then carefully put into the flask before the solutions were mixed by shaking the bottle thoroughly for ca. 20 seconds. Throughout the whole procedure, the flask was inspected for trapped air bubbles. If bubbles were discovered and could not be removed, the sample was discarded. If samples could not be titrated shortly after sampling, distilled water was added on top of the stopper to prevent oxygen leakage.

All oxygen samples were titrated onboard. The preparation of standards and blanks used during the titration were described in a hand-out-manual given onboard.

Before titration, 1 ml of $H_2SO_4$ (5M) was added to the sample. During titration a magnet stirrer was used to mix reagents. $NaS_2O_3$ (0.01M) was titrated in doses of 0.05ml until the solution was nearly colorless (a hint of yellow). Three drops of starch solution (glycerol-based) was added to the solution to make it blue, and the titration of $NaS_2O_3$ (0.01M) continued in doses of 0.002 ml until the solution was colorless.

To further calculate the concentration of dissolved oxygen in each water sample, we followed the calculations described in the hand-out-manual.

A total of four datapoints were removed before any analysis of Winkler titration results and CTD measurements due to either over titration or missing titration-volume data. To correct the CTD measurements we used linear regression between CTD measurements and Winkler titrations. Outliers were removed using 2 x standard deviation (SD) of the difference between Winkler-titrations and CTD as the outlier limit. If the point's residual value (value of the difference between the regression line and the plotted point) was outside this limit, it was considered an outlier. After removal of outliers, the SD was calculated again for the new dataset and the whole procedure was repeated until no more datapoints were considered outliers.

A total of 11 outliers were removed by this method, resulting in the regression line: y = 0.035 + 1.04x (Figure 7.6).

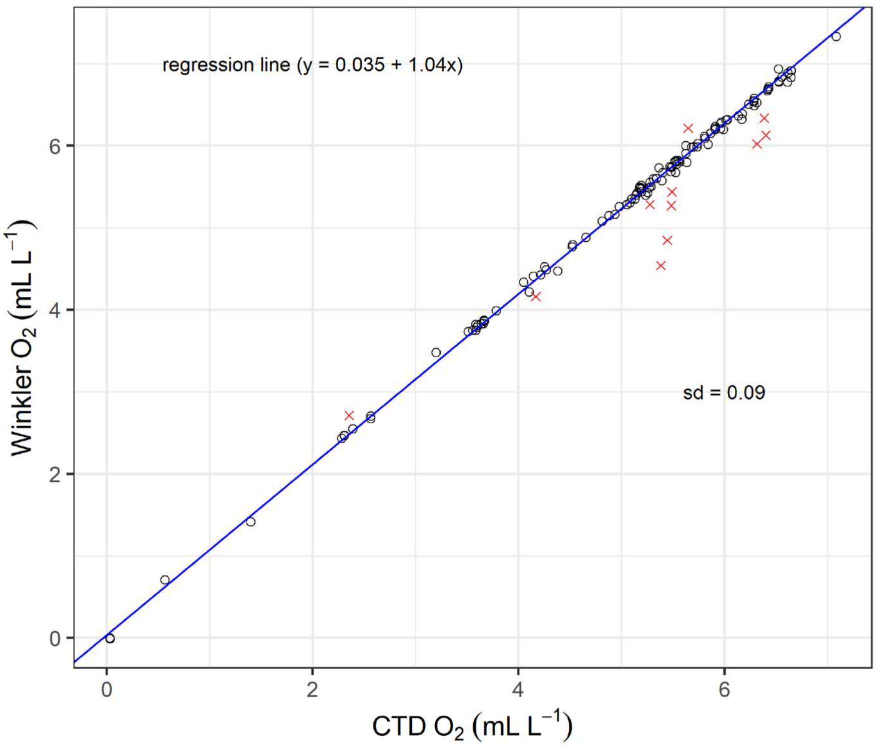



**Figure 7.6. Linear regression between CTD oxygen values and Winkler-titration oxygen values. O marks general datapoints, Xmarks datapoints considered outliers and the blue line is the regression line of the model without outliers. sd refers to the standard deviation without outliers.**

### 7.1.2 salt calibration

To calibrate the CTD conductivity sensor we collected a total of 114 water samples from 68 different CTD stations to measure salinity. Before water collection, the sample flask and stopper were rinsed three times with the sample water. The flask was filled, stoppered and the samples were furthermore stored in room temperature. We used the Portasal 8410A Salinometer to calculate salinity of our water samples. The water bath temperature was set to 24 °C, and the samples were at room temperature (bath temperature ± 5 °C).

The closer the water sample is to the water bath temperature the better, but with a low flow rate the temperature will have time to adjust in the machine. A high difference will result in **higher uncertainty, which is an error source. It is also important to make sure there are no**

air bubbles in the conductivity cells, as this is another error source. Other error sources include not properly rinsing bottles when taking samples, touching or improper wiping of the tube that goes into the sample, improper- or not enough flushing before reading (3-4 times), and other human errors. We only accepted readings with standard deviations below 0,0002, but they were mostly between 0-0,00004. Later, we cross-checked the values with the CTD data to calibrate. The salinity data did not require a calibration. All calibrations can be found in Table (2.1).

In appendix, list of all CTD stations

### 7.1.3 Nutrients

We collected at total of 29 water samples at five different CTD-stations for nutrient analysis (Figure 7.7). We used 20 ml polyethylene scintill bottles to collect the water samples. The bottle and the stopper were rinsed three times before water collection. We added 0.20 ml chloroformto the water sample and stored them in the fridge until after the cruise.
The samples were sent to the Institute of Marine Research (IMR) and analyzed for concentration of nitrite, nitrate, phosphate and silicate by gas segmented continuous flow analysis (Gundersen and Lunde, 2015).

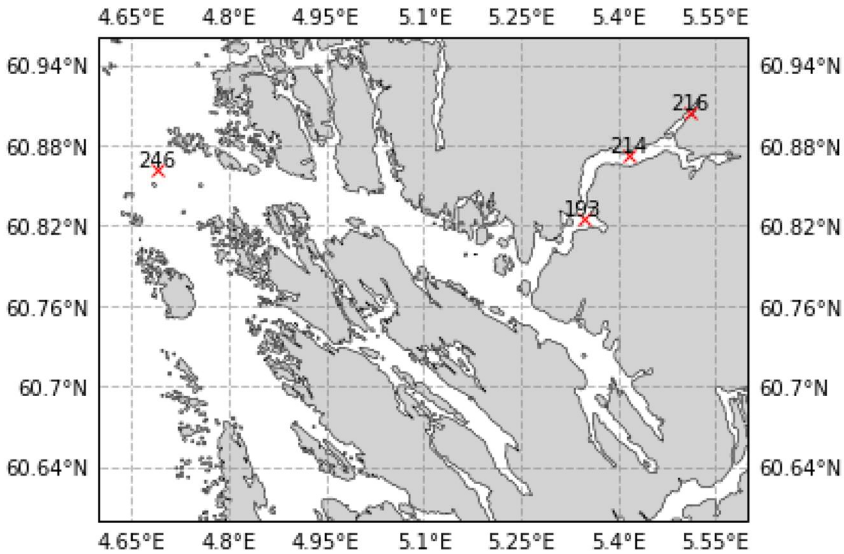



**Figure 7.7. Overview of the locations where water samples for nutrient analysis were collected. An additional station for nutrient samples (st. 167) was located at the same location as st. 246. NB! In our datafiles, st. 215 rather than st 216 was listed as a station for nutrient samples. We believe, however, that there has been a mix-up of st. 215 and st. 216, and have chosen to include the latter in this map.**

### 7.1.4 Dissolved inorganic carbon (DIC)

Dissolved inorganic carbon (DIC) is the amount of carbonate in the seawater:
DIC = [$H_2CO_3$] +$CO_2$(aq) + [$HCO_3^-$ ] + [$CO_3^{2-}$ ]

The distribution of the different carbon species are determined by the pH (see Figure 7.8).

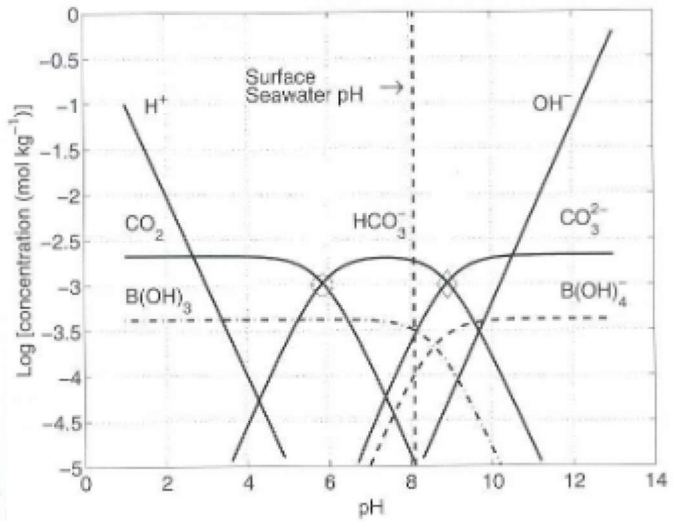



**Figure 7.8. Bjerrumplot. Showing how carbon species changes with pH (Turley et al., 2004)**

We collected at total of 51 water samples at seven different CTD-stations for dissolved inorganic carbon analysis (Figure 7.9). The tapping of water for the carbon samples was done in 250 mL bottles. First, we filled out an enclosed sample log. Then a plastic tube was attached to the drain valve of the Niskin bottle in order to tap the water. The air vent and the drain valve was opened, and the tube was squeezed so that all air bubbles disappeared. Further, the bottle was rinsed 2-3 times with seawater. After this the tube was lowered into the bottom of the bottle and filled completely. The water was then let to overflow for as long as it took to fill. The bottles were then checked for air bubbles and the tube was taken out of the bottle. After all this we added (approximately 0.02 mL) og $HgCl_2$ to the seawater in the bottle. Then two pea-sized globs of grease were put on the stopper, and the stopper put in the bottle. The stopper was turned slightly to distibute the grease. The bottle was then turned upside down a couple of times to mix. The bottles were stored in a dark and cool environment and returned to the lab after the cruise for further handling.

At the lab a peristaltic pump transferred seawater from the bottles into pipettes (see setup in Figure 7.10). The pipette measures aboute 20 mL before it is emptied into the stripper. Further, phosphoric acid is added to the stripper which then reacts with the DIC and forms $CO_2$. The $CO_2$ gas is then transferred into the coulometer cell, which turns the solution acidic. The color changes from blue to clear at this point. A base is formed by a current flow, which then removes the acid and the solution returns to its blu color. An indicator will show when the color is restored and then the amount of $CO_2$ can then be calculated. The current needed is equivalent to the amount of $CO_2$ (Mintrop, 2012; Hartman and Roberts, 2011).

Three dummy samples (left seawater from the previous samples) were analysed before the samples. These dummies were calibrated by a know standard (CRM).

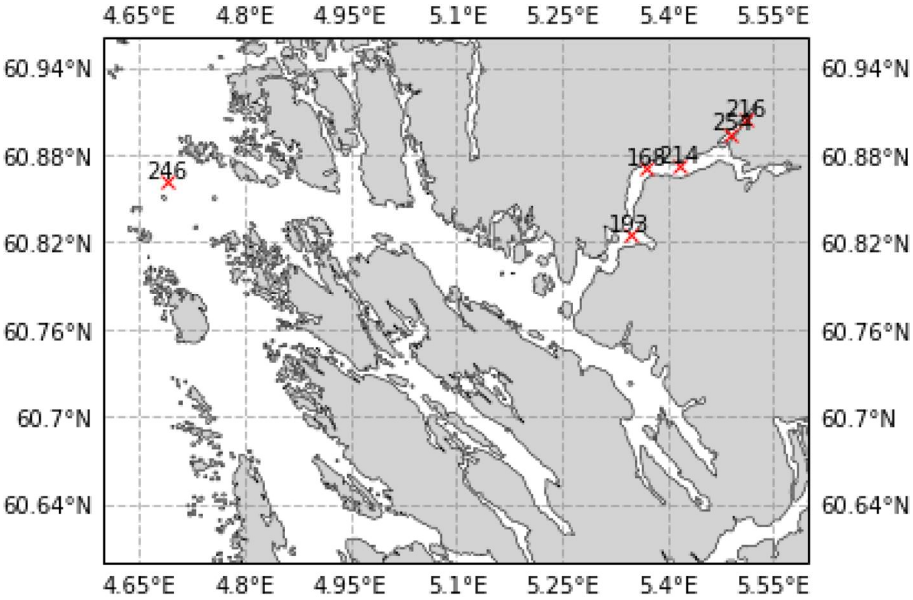



**Figure 7.9. Overview of the locations where water samples for dissolved inorganic carbon (DIC) were collected. An additional station for DIC samples (st. 167) was located at the same location as st. 246. NB! In our datafiles, st. 215 rather than st 216 was listed as a station for DIC samples. We believe, however, that there has been a mix-up of st. 215 and st. 216, and have chosen to include the latter in this map.**

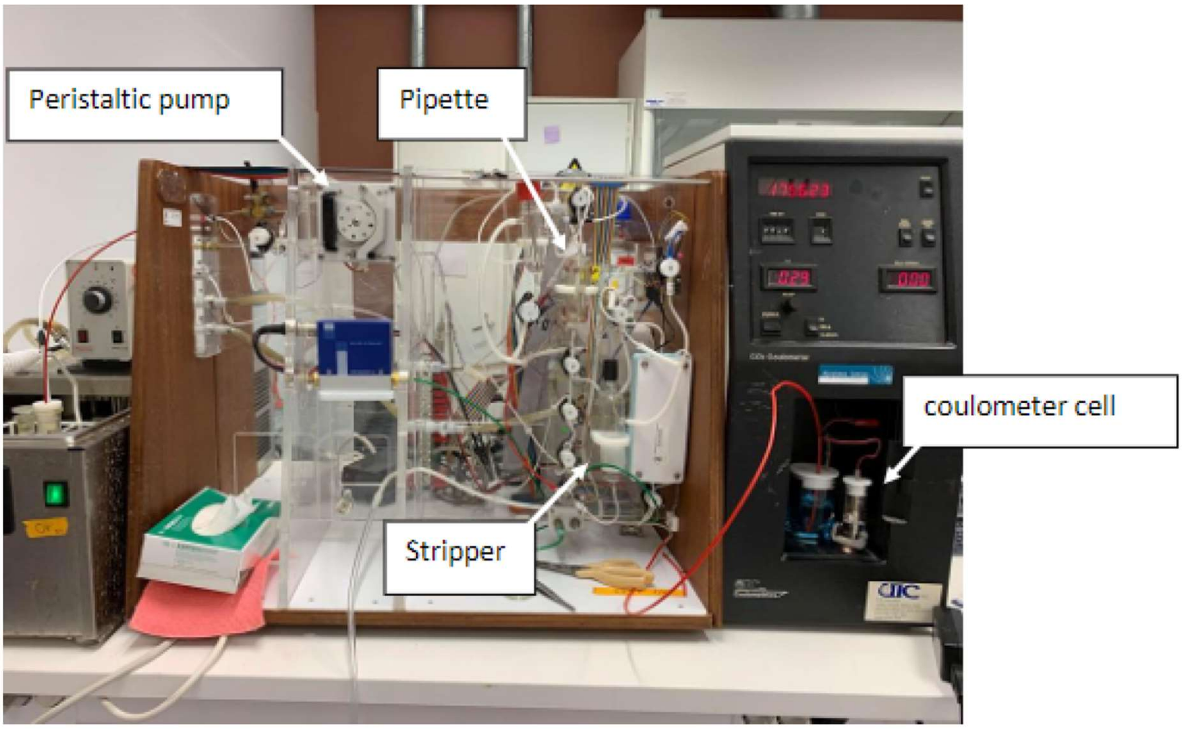



**Figure 7.10. VINDTA 3D at GFI**

## 7.1.5 Stable isotope analysis

From a stable isotope analysis important details of the fjord hydrology can be deciphered.
An analysis of the isotope composition can help to reveal the source of the water and atmospheric pathways (FARLAB, date). The isotope composition can help answer where rain comes fromor howthe water becomes a cloud. This is important knowledge for understanding

precipitation extremes and the effects of climate change (Sodemann, 2018).

Elements, such as oxygen and hydrogen, can naturally be found in different configurations, called isotopes. Each of these configurations have their own molecular weight. This is due to the fact that they have different amounts of neutrons (Piana, 2020).

The most common isotope of water is $H_2 16O$. It has 2 hydrogen atoms with 1 proton and 1 neutron each, and one oxygen atom with 8 protons and 8 neutrons. This isotope is called a heavy stable isotope.$H_2 18O$ is another isotope, but with a slightly heavier mass. In nature, there is about 99,77 % $H_2 16O$, 0,20 % of $H_2 18O$ and 0,03 % of HDO (heavy water).

Isotopes of different mass will react differently fromeach other (Sodemann, 2020). The heaviest isotopes (like HDO) can be expected to be found in relatively more abundance in solid water than in gas state. This is because in vapor state the chemical bonds are weaker. It is also because the heaviest isotopes will be precipitated first while in clouds. Heavier isotopes will also have a harder time rising in the air than lighter isotopes. Heavier isotopes
have lower diffusion velocities and lower water vapor pressure. Due to this heavier isotopes will fractionate during phase transitions. The isotopic composition of the atmospheric water depends on their complex phase transition history.

The ratio between $H_2 16O$ and $H_2 18O$ can be compared with an isotopic ratio standard made by IAEA in Vienna. In this standard the ratio of an isotope to $H_2 16O$ is denoted with *±*. The isotope mass ratio analysis was done by an Isotope RatioMass Spectometer at FARLAB.
The $\pm_1 8$ is calculated as:

$$\delta^{18}O = (\frac{R^{18}_{sample}}{R^{18}_{standard}} - 1) * 1000‰$$

where $R^{18}$ is $\frac{H_2 180}{H_2 16O}$.

Diffusion speed is also important. Heavier isotopes evaporate later than lighter isotopes.
In evaporation and strong winds there will be less heavier isotopes in the water vapor than without. The d-excess can tell us where diffusion speed has been important for the isotope content distribution. d-excess can be found with:
*d - excess* =*δD*-8 x $\delta^{18}$O[‰]

We took 22 water samples for stable isotope analysis. 14 of these were taken on land on the meteorological fieldtrip. The rest were taken at the surface at different outlets in the Masfjord. The samples from the meteorological fieldtrip were mostly taken from rivers around theMasfjord. The samples were collected into 8 mL vials. Afterwards there were filtered and put into 1,5 mL vials for analysis at FARLAB.

At FARLAB the samples were filtered, if needed, with 25mm Nylon filters with a 0.2 um PTFE membrane (part #514-0066, VWR, USA), and transferred to 1.5 ml glass vials with rubber/ PTFE septa (part #548-0907, VWR, USA) (Morkved, 2020). An autosampler (A0325, Picarro Inc) transferred ca. 2ul per injection into a high-precision vapourizer (A0211, Picarro Inc, USA) heated to 110°C. After blending with dry N2 (< 5 ppm H2O) the gas mixture was directed into the measurement cavity of a Cavity-Ring Down Spectrometer (L2140-i, Picarro Inc) for about 7min with a typical water concentration of 20 000 ppm. Memory effects were reduced by two times measuring a vapour mixture at a mixing ratio of 50 000 ppm, obtained from 2 injections of 2 ul for 5 min at the beginning of each new sample vial (Morkved, 2020). Thereafter, another 8

injections of 2 ul per sample were measured individually as described above, and averages of the last -1 injections were used for further processing.
Three standards were measured at the beginning and end of each batch (Morkved, 2020).
Batches consisted typically of 20 samples, with drift standard FIN (*±D*: -81.08±0.40 permil, *±*$_{18}$*O*: -11.68±0.06h, *±*$_{17}$*O*: 0.00±0.00h), measured typically every 5 samples. For calibration according to IAEA recommendations, the laboratory standards GLW (*±D*: -307.91±0.81 h, *±*$_{18}$*O*: -40.09±0.04h, *±*$_{17}$*O*: 0.00±0.00h), BERM (*±D*: 6.57±0.30 permil, *±*$_{18}$*O*: 0.56±0.05 h, *±*$_{17}$*O*: 0.00±0.00h), were used, and averaged over the beginning and end of each batch for calibration.
An empirical memory correction to represent fast and slow memory compartments in the system has been applied (Morkved, 2020). The correction is based on a fit of the 3-parameter function f(i) = c0 * (b exp(-alpha*i)+(1-b) exp(-beta*i)), where c0 is the initial memory amplitude (calculated), b is the weight between the fast and slow component, and alpha and beta are the decay constants of the fast and slow component, respectively, to a sufficiently long sequence of injections (typically 12 injections from all standard measurements).

# 8 Mini CTD and Helgeboat

The 6th and 7th ofMarch we used a mini-CTD at five different stations partitioned at the different sections in Masfjorden. The mini-CTD measured salinity, pressure and temperature at the same cross sections that we towed a construction called Helgeboat.

The Helgeboat is a “homemade” construction consisting of the different instruments hanging in a rope under the boat at different depths. We towed the construction after the small boat we were sitting in across the fjord. We did one cross section each day at two different locations. The homemade construction we called "The Helgeboat" named after the constructor. We used this to obtain higher spatial resolution of the data since we only had 5 mini-CTD stations.

The structure of the instruments under the boat was different for the two days. The first day we had an instrument that measures temperature, pressure and conductivity at the surface and temperature loggers further down. The second day the upper three instrument was the same as day 1, but we changed the fourth instrument to an instrument that measures temperature, pressure and conductivity. Since we had pressure at the lowermost instrument, we could calculate the actual depth to the different instruments. These depths are more accurate than the rope length (see Figure 8.2).

**Figure 8.1. picture of the Helgeboat at the surface when we dragged it across the fjord**

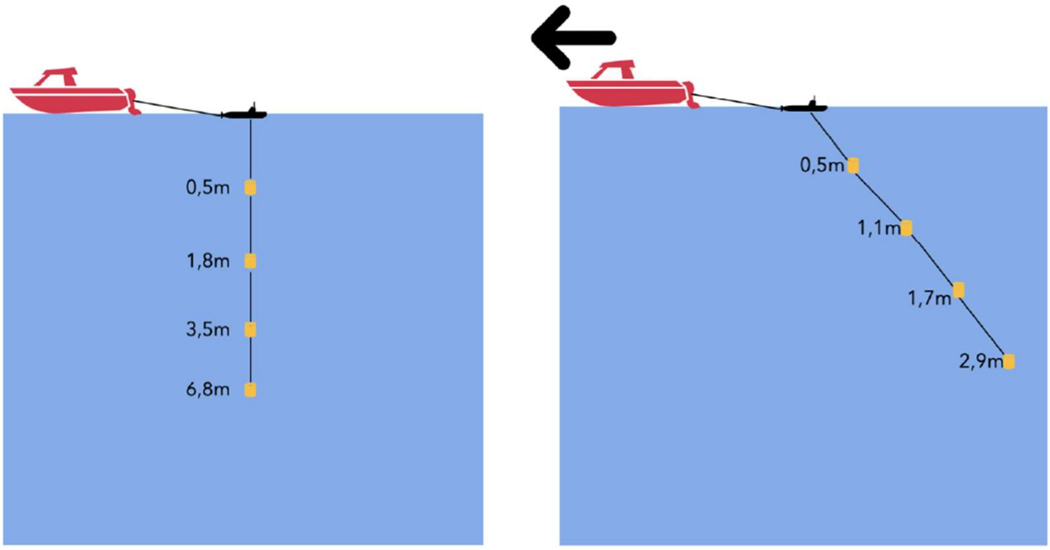



Figure 8.2. A figure that shows the structure of the Helgeboat and how the depths changes when it moves forward

The mini-CTD measured salinity, pressure and temperature. To obtain higher spatial resolution we towed the Helgeboat across the same section as we used the mini-CTD shown in Figure 2.

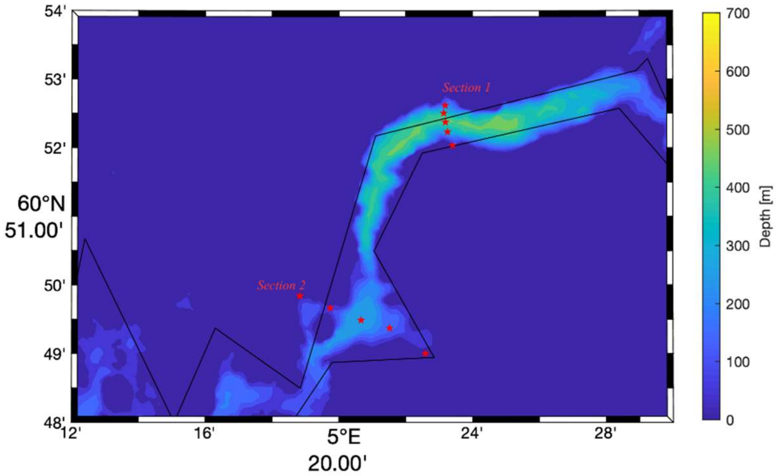



Figure 2: Map of the two cross sections where we took the mini CTDs and dragged Helge's boat

Table 12. First cross-Masfjord section, Friday 6. March

| Number | When | Lat | Lat(matlab) | Lon | Lon(matlab) |
|---|---|---|---|---|---|
| 1 | 13:50 | 60°52,738´ N | 60,879° | 005°23,186´E | 5,386° |
| 2 | 14:02 | 60°52,507´ N | 60,875° | 005°23,141´E | 5,386° |
| 3 | 14:12 | 60°52,376´ N | 60,873° | 005°23,191´E | 5,387° |
| 4 | 14:20 | 60°52,233´ N | 60,871° | 005°23,253´E | 5,388° |
| 5 | 14:28 | 60°52,036´ N | 60,867° | 005°23,402´E | 5,390° |

Table 13. Second cross-Masfjord section, Saturday 7. March

| Number | When | Lat | Lat(matlab) | Lon | Lon(matlab) |
|---|---|---|---|---|---|
| 1 | 14:42 | 60°49,005´ N | 60,8167° | 005°22,589´ E | 5,376° |
| 2 | 14:53 | 60°49,377´ N | 60,823° | 005°21,518´ E | 5,359° |
| 3 | 14:58 | 60°49,492´ N | 60,825° | 005°20,664´ E | 5,344° |
| 4 | 15:06 | 60°49,667´ N | 60,828° | 005°19,743´ E | 5,329° |
| 5 | 15:15 | 60°49,844´ N | 60,831° | 005°18,833´ E | 5,314° |

Table 14. Helge’s boat instrumentation for section 1

| What | Distance from surface | Measures |
|---|---|---|
| SBE37 - 9945 | 0 | |
| SBE 56 (temperature logger) - 4312 | 180 cm | T |
| SBE 56 (temperature logger) - 4311 | 350 cm | T |
| RBR | 680 cm | T,p |

Table 15. Helge's boat instrumentation for section 2

| What | Distance from surface | Measures |
|---|---|---|
| SBE37 - 9945 | 0 | |
| SBE 56 (temperature logger) - 4312 | 180 cm | T |
| SBE 56 (temperature logger) - 4311 | 350 cm | T |
| SBE37 - 5225 | 680 cm | |

# 9 Current Profiling using Vessel-mounted ADCP (VMADCP)

A vessel-mounted Acoustic Doppler Current Profiler (VMADCP) was used for current measurements in the water column. The VMADCP transmits acoustic signals that are backscattered by particles in the water. The instrument calculates the current speed at various depths by calculating the Doppler shift between the transmitted signal and the reflected signal.

The VMADCP measured the current profile throughout the whole cruise. It was set in narrowband mode, that is with 50 bins of length 8.0 meters. By using the narrowband mode, the instrument receives a broad range of signals, but with lower resolution. The blanking distance was set to 4.0 meters. The sampling rate was set to 1.10 seconds.

The ADCP-system onboard automatically processed the signals from the VMADCP. The Common Ocean Data Access System (CODAS) was used to calculate current velocities. The output from CODAS was speed, position, and heading of the currents throughout the water column.

## 9. Microstructure Profiling (GEOF337)

Microstructure Profilers (MSS profilers) provide high-resolution temperature, salinity, and pressure data, as well as velocity shear for a one-dimensional water column. The data is collected by multiple sensors at the lower-end of the instrument. It is intended to be deployed directly vertically from a stationary vessel, and the data is only considered reliable when the instrument is experiencing freefall. If the instrument were to collide with the ocean bottom, the sensors at the tip of the profiler could be damaged. Constraining the freefall period of the profiler is, therefore, imperative to obtain a reliable profile of the water column, without compromising the future functionality of the instrument.

To achieve this, the student scientists and crew depended on communication between those monitoring the depth of the MSS profiler and those controlling the freefall. Student scientists were responsible for running the computer program, using it to monitor the depth, and saving the MSS data. The GFI technician Helge, accompanied by at least one crew member, was responsible for ensuring freefall in the instrument, by feeding the submerged profile rope (in this case, cord) via a machine on the ship. Helge was also able to stop feeding more rope, which would allow the MSS to continue freefalling, or to begin pulling the profiler up, which would disrupt freefall, but prevent a dangerous collision.

It was the responsibility of the student scientists to communicate to Helge when the deployed profile was 1) suitably deep for those feeding slack to the instrument to stop doing so and 2) in jeopardy of colliding with the ocean bottom. Both communications were done via a mechanical buzzer signal. Variability in the currents, basin depth, and human response time have resulted in variation in the total depth surveyed by the MSS profiler while at the same station.

One of the objectives during this cruise was to detect the effect of tides over the sill and how this might influence the vertical mixing. To do that, we established three stations along the Sill in Masfjorden, where we did 9 casts on each station during the tidal cycle. The locations and information regarding the position and time, **Error! Reference source not found.**

**Table 16: MSS stations corresponding to the time series over the Masfjorden Sill. Blue=1st station, Red=2nd Station, Black=3d station. The casts were repeated 9 times along the tidal cycle.**

| ST | YEAR | MONTH | DAY | HOUR | Min | Depth | LON deg | LON min | LAT deg | LAT min |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 2020 | 3 | 3 | 7 | 24 | 111 | 60 | 48,360 | 5 | 19,262 |
| 3 | 2020 | 3 | 3 | 7 | 45 | 70 | 60 | 48,292 | 5 | 18,098 |
| 4 | 2020 | 3 | 3 | 7 | 58 | 205 | 60 | 48,205 | 5 | 16,681 |
| 5 | 2020 | 3 | 3 | 8 | 30 | 159 | 60 | 48,340 | 5 | 19,215 |
| 6 | 2020 | 3 | 3 | 8 | 54 | 100 | 60 | 48,290 | 5 | 17,908 |
| 7 | 2020 | 3 | 3 | 9 | 7 | 205 | 60 | 48,210 | 5 | 16,674 |
| 8 | 2020 | 3 | 3 | 10 | 2 | 120 | 60 | 48,396 | 5 | 19,070 |
| 9 | 2020 | 3 | 3 | 10 | 17 | 75 | 60 | 48,276 | 5 | 18,013 |
| 10 | 2020 | 3 | 3 | 10 | 31 | 205 | 60 | 48,229 | 5 | 16,608 |
| 11 | 2020 | 3 | 3 | 11 | 36 | 120 | 60 | 48,422 | 5 | 19,172 |
| 12 | 2020 | 3 | 3 | 11 | 57 | 103 | 60 | 48,311 | 5 | 17,815 |
| 13 | 2020 | 3 | 3 | 12 | 10 | 205 | 60 | 48,221 | 5 | 16,755 |
| 14 | 2020 | 3 | 3 | 13 | 1 | 126 | 60 | 48,458 | 5 | 19,014 |
| 15 | 2020 | 3 | 3 | 13 | 43 | 93 | 60 | 48,258 | 5 | 17,891 |
| 16 | 2020 | 3 | 3 | 13 | 56 | 205 | 60 | 48,245 | 5 | 16,557 |
| 17 | 2020 | 3 | 3 | 14 | 32 | 149 | 60 | 48,319 | 5 | 18,96 |
| 18 | 2020 | 3 | 3 | 14 | 59 | 78 | 60 | 48,281 | 5 | 17,999 |
| 19 | 2020 | 3 | 3 | 15 | 13 | 205 | 60 | 48,22 | 5 | 16,775 |
| 20 | 2020 | 3 | 3 | 16 | 17 | 93 | 60 | 48,312 | 5 | 19,226 |
| 21 | 2020 | 3 | 3 | 16 | 33 | 95 | 60 | 48,289 | 5 | 17,828 |
| 22 | 2020 | 3 | 3 | 17 | 3 | 205 | 60 | 48,253 | 5 | 16,745 |
| 23 | 2020 | 3 | 3 | 17 | 44 | 134 | 60 | 48,388 | 5 | 19,096 |
| 24 | 2020 | 3 | 3 | 18 | 1 | 82 | 60 | 48,282 | 5 | 17,979 |
| 25 | 2020 | 3 | 3 | 18 | 14 | 206 | 60 | 48,21 | 5 | 16,673 |
| 26 | 2020 | 3 | 3 | 18 | 42 | 131 | 60 | 48,41 | 5 | 19,21 |
| 27 | 2020 | 3 | 3 | 18 | 59 | 74 | 60 | 49,55 | 5 | 20,82 |
| 28 | 2020 | 3 | 3 | 19 | 11 | 206 | 60 | 48,23 | 5 | 16,58 |

During the following days we did two sections of MSS casts along Masfjorden and Lurefjorden. The latter showed non expected results in terms of mixing profiles that can be used as basis for further cruises. The list of the stations can be found in Table 17.

**Table 17 Lurefjorden transec. Station location and time information.**

| ST | YEAR | MONTH | DAY | HOUR | Min | Depth | LON deg | LON min | LAT deg | LAT min |
|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 29 | 2020 | 3 | 5 | 13 | 22 | 309 | 60 | 39,74 | 5 | 13,02 |
| 30 | 2020 | 3 | 5 | 13 | 55 | 442 | 60 | 41,12 | 5 | 10,19 |
| 31 | 2020 | 3 | 5 | 14 | 33 | 365 | 60 | 42,51 | 5 | 6,52 |
| 32 | 2020 | 3 | 5 | 15 | 1 | 259 | 60 | 43,47 | 5 | 3,14 |
| 33 | 2020 | 3 | 5 | 15 | 23 | 178 | 60 | 43,85 | 5 | 1,79 |
| 34 | 2020 | 3 | 5 | 15 | 50 | 87,8 | 60 | 43,78 | 4 | 59,39 |
| 35 | 2020 | 3 | 5 | 16 | 9 | 76,6 | 60 | 44,07 | 4 | 57,07 |

The section measurements regarding the vertical mixing can be seen in,**Error! Reference source not found.**:

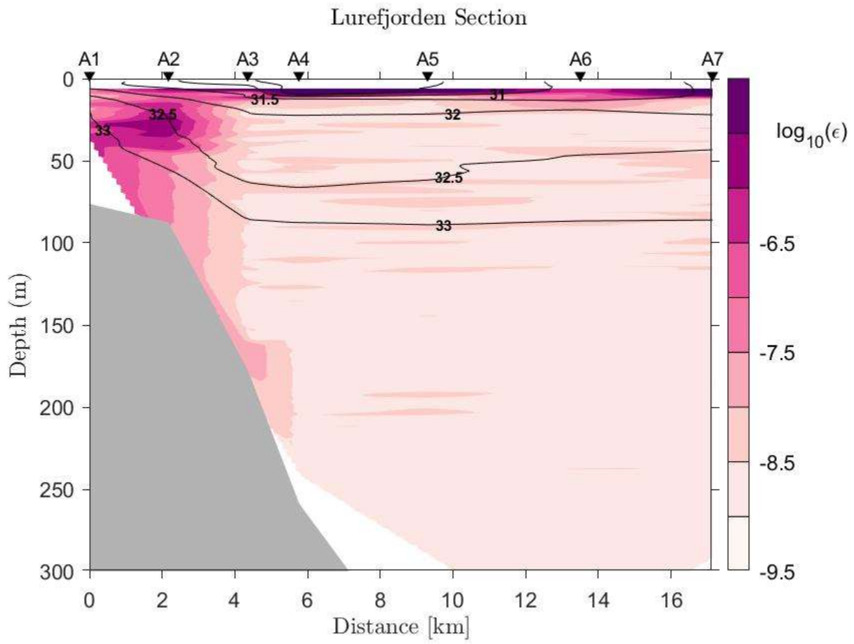



Figure 9.1: Lurefjorden MSS section.

The Masfjorden section stations are listed in Table 18.

Table 18 Masfjorden section information. Section positions and time.

| ST | YEAR | MONTH | DAY | HOUR | Min | Depth | LON deg | LON min | LAT deg | LAT min |
|---|---|---|---|---|---|---|---|---|---|---|
| 36 | 2020 | 3 | 6 | 7 | 12 | 148 | 60 | 47,381 | 5 | 16,30 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 37 | 2020 | 3 | 6 | 7 | 37 | 150 | 60 | 48,31 | 5 | 19,13 |
| 38 | 2020 | 3 | 6 | 7 | 59 | 298 | 60 | 49,54 | 5 | 20,84 |
| 39 | 2020 | 3 | 6 | 8 | 27 | 426 | 60 | 50,98 | 5 | 20,93 |
| 40 | 2020 | 3 | 6 | 8 | 59 | 470 | 60 | 52,20 | 5 | 22,09 |
| 41 | 2020 | 3 | 6 | 9 | 31 | 482 | 60 | 51,35 | 5 | 24,89 |
| 42 | 2020 | 3 | 6 | 10 | 7 | 280 | 60 | 52,89 | 5 | 28,40 |
| 43 | 2020 | 3 | 6 | 10 | 32 | 187 | 60 | 52,51 | 5 | 29,57 |
| 44 | 2020 | 3 | 6 | 17 | 16 | 188 | 60 | 52,32 | 5 | 33,14 |
| 45 | 2020 | 3 | 6 | 17 | 38 | 191 | 60 | 52,00 | 5 | 30,54 |

The section of the vertical mixing coefficient are presented in Figure 9.2 Masfjorden MSS section measurements..

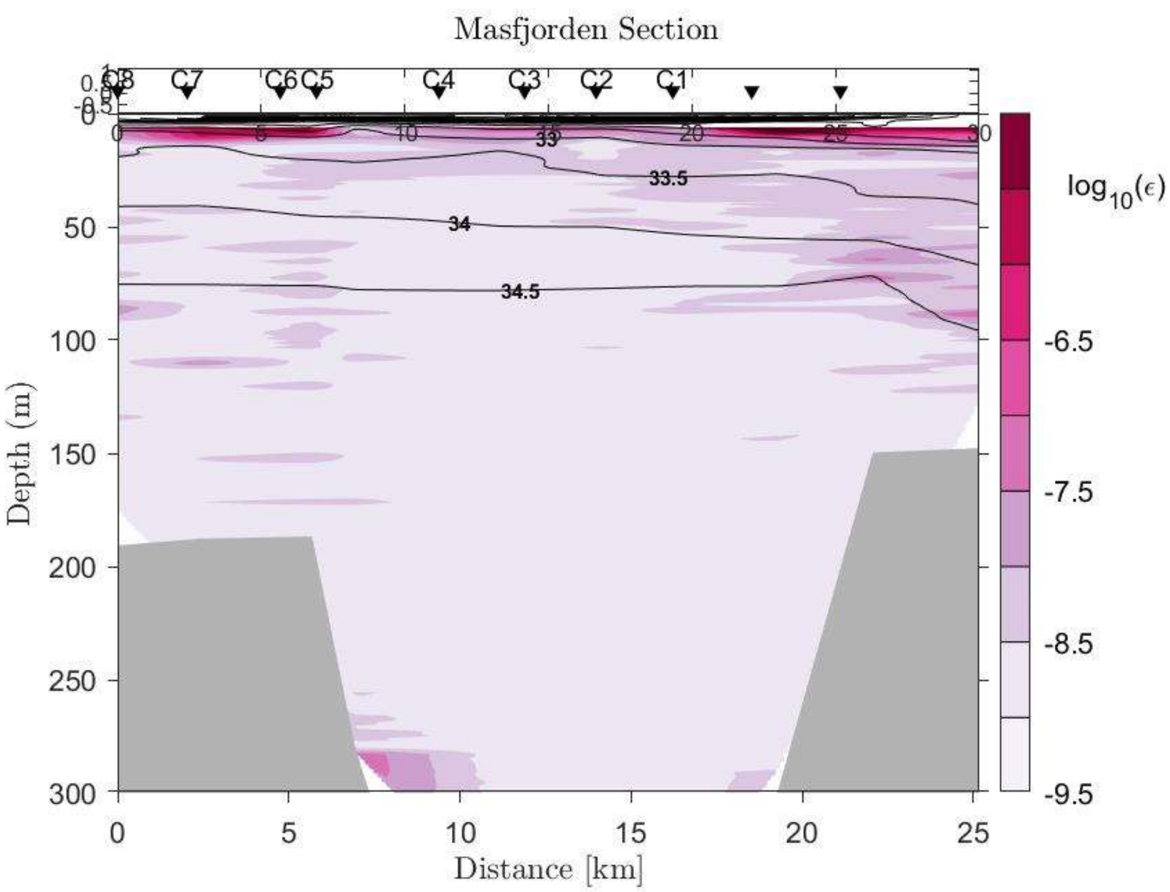


Figure 9.2 Masfjorden MSS section measurements.

The location of the stations where MSS casts were done can be seen in Figure 9.3 MSS station positions in Masfjorden (red) and Lurefjorden (magenta). and the time series in Figure 9.4.

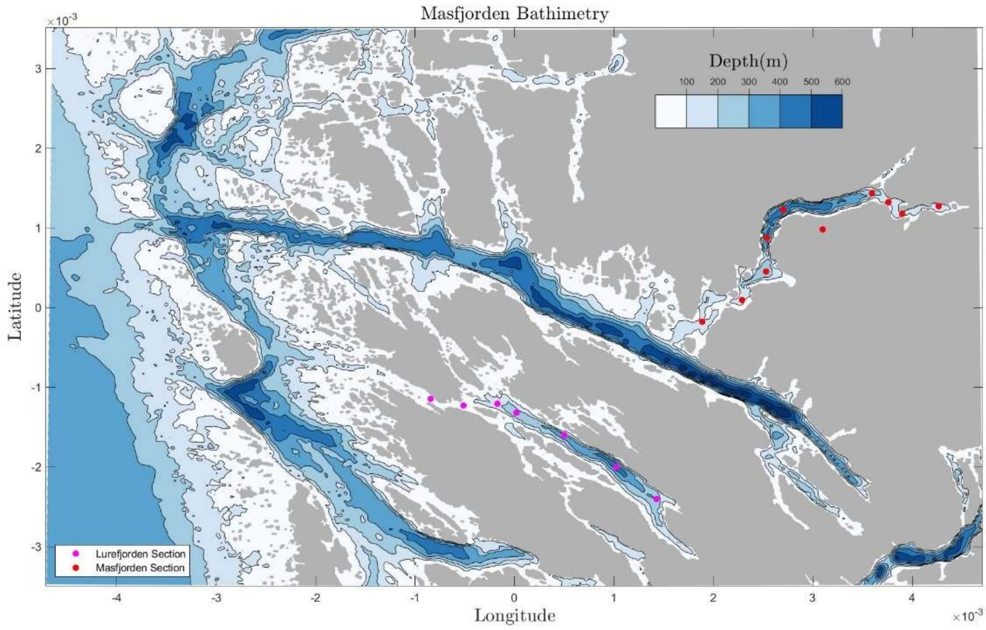



Figure 9.3 MSS station positions in Masfjorden (red) and Lurefjorden (magenta).

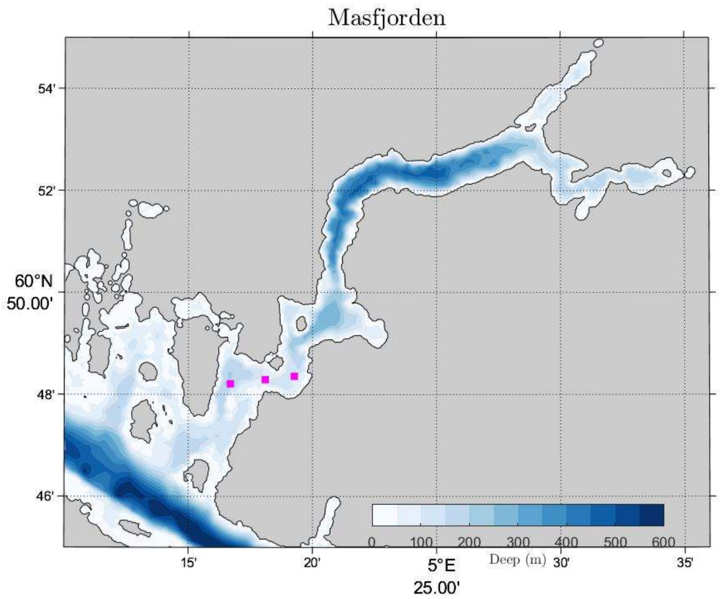



Figure 9.4 Masfjorden MSS time series. Station locations.

## 12. Isotopes (GEOF232)

Short description of the sampling procedure

Table: position, time & sample number

## 13. LIDAR (GEOF232)

## 14. Irradiance and light absorbance

**Surface irradiance**

Surface irradiance was measured using a hyperspectral TriOS Ramses radiometer with a measurement frequency of one measurement every 5th minute. The surface sensor was set up on the roof of the ship's wheelhouse, away from direct light from the ship (Figure 8a). It was adjusted to a better position on March 3rd (Figure 8b) and usable data is consequently limited to those collected after March 3rd 14:00 UTC.

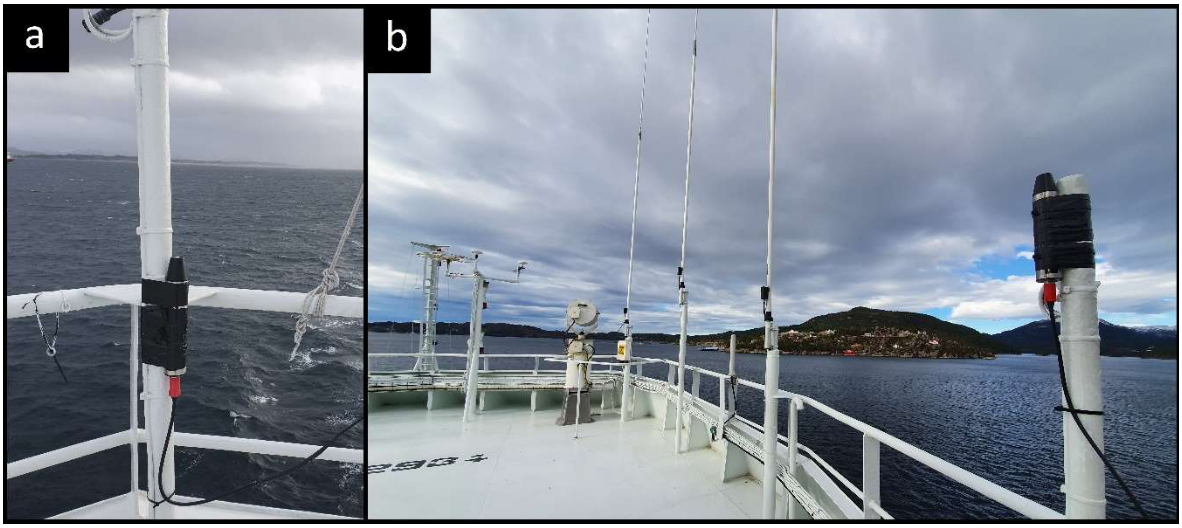



**Figure 9.5.** Photographs of the Ramses TriOS radiometer set-up. a) initial placement of sensor which was not ideal for surface irradiance measurements b) final sensor placement.

**Underwater irradiance**

All underwater irradiance measurements were completed at stations in the deepest basins of the fjords: Masfjorden (60°52.366 N, 05°24.991), Haugsværfjorden (60°54.268 N, 05°30.598 E) and Lurefjorden (60°41.100 N, 05°10.258). During underwater measurements the ship was positioned with the starboard side (from which equipment was lowered) in the direction of the sun.

*TriOS radiometer measurements*

Underwater, downwelling irradiance was measured using a TriOS Ramses hyperspectral radiometer. The sensor was mounted on a metal frame and lowered into the water at a constant speed (exact speed unknown) to depths between 70 and 100 m (Table 16). When the sensor was back at the surface, we repeated the procedure to get an additional set of measurements.

**Table 19.** Overview of irradiance measurements with the TriOS Ramses radiometer. Start time is the time we began lowering the sensor into the water, and stop time is the time the sensor was back on deck (after being lowered to max. depth twice). Max. depth is the maximum depth to which the sensor was lowered.

| Fjord | Date | Start time - stop time (UTC) | Max. depth (m) |
|---|---|---|---|
| Masfjord | 04.03 | 14:36 – 15:00 | ca. 100 |
| | 06.03 | 13:31 – 13:49 | ca. 80 |
| Haugsværfjord | 04.03 | 13:41 – 14:04 | ca. 90 |
| Lurefjord | 05.03 | 12:05 – 12:19 | ca. 70 |

During measurements of underwater irradiance with the TriOS radiometer, the surface sensor was set to measure in intervals of one measurement per second. The underwater sensor was set to the same setting but could only measure once per 2nd second.

*Prototype light sensor (LOw Light integrating sensor, LOL)*

To get an indication of underwater, downwelling irradiance at greater depths, a sensitive broad-spectrum prototype light sensor (LOL) was used (developed by Thor Klevjer). Keep in mind that this prototype is still under testing and results must be interpreted thereafter. The sensor and its external battery were attached to the CTD-frame (Figure 9a-c).

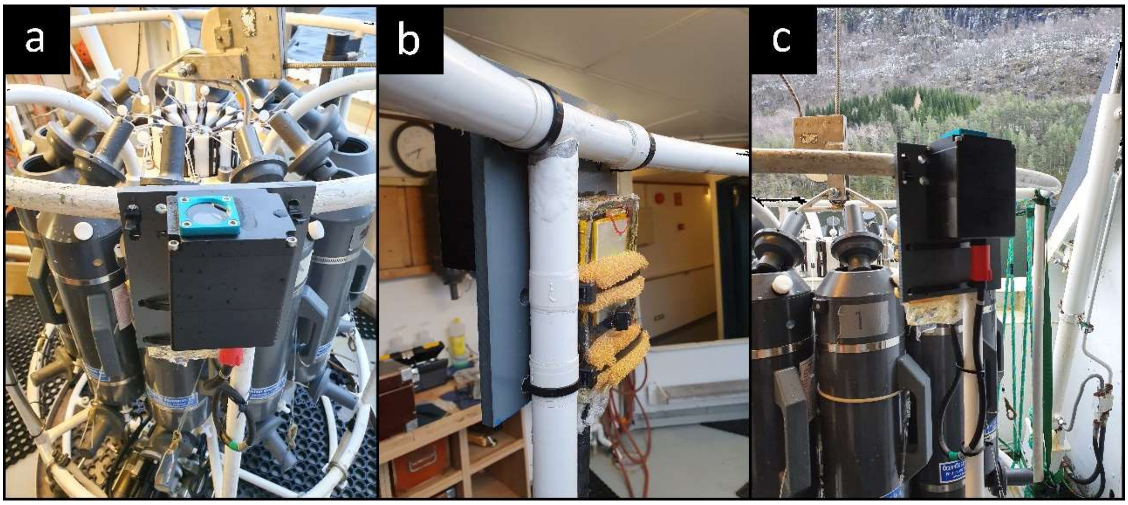



**Figure 9.6.** Photographs of light sensor prototype set-up. a) sensor overview; b) battery attachment to the CTD-frame; c) sensor attachment to the CTD-frame.

The LOL was then lowered into the water with the CTD at a constant speed of 1 m/s and had a measurement frequency of one measurement every $5^{th}$ second. The surface irradiance TriOS sensor was supposed to make simultaneous measurements every second but was unfortunately set to measure every $5^{th}$ minute at three out of seven stations (Table 17).

**Table 20.** Overview of irradiance measurements with the LOL. Start time is the time when the CTD went into the water and stop time is the time when CTD was back on deck. Depth is the bottom depth at the station and surface sensor time interval is the measurement.

| Fjord | Date | Start time – stop time (UTC) | CTD station | Depth (m) | Surface sensor time interval |
|---|---|---|---|---|---|
| Masfjord | 04.03 | 15:15 – 15:41 | 218 | 484 | 5 min |
| | 06.03 | 13:11 – 13:26 | 256 | 478 | 1 sec |
| | 07.03 | 11:33 – 12:06 | 266 | 480 | 1 sec |
| Haugsværfjord | 04.03 | 11:55 – 12:12 | 216 | 123 | 5 min |
| | 04.03 | 12:50 – 13:03 | 217 | 123 | 5 min |
| | 06.03 | 12:11 – 12:30 | 255 | 123 | 1 sec |
| Lurefjord | 05.03 | 12:26 – 13:06* | 245 | 442 | 1 sec |

*the CTD was lowered twice at one station and remained max. depth for five minutes. Stop time was estimated based on this knowledge, station depth and winch speed (1 m/s).

**Light absorbance**

To get an indication of light absorbance at different depths and oxygen conditions, water samples were collected in the rosette-mounted niskin water collectors and measured for absorbance in a spectrophotometer (UV/VIS Spectrometer Lambda 2, Perkin Elmer) (Table 18).

**Table 21.** Overview of the water samples for absorbance readings. "Sample" refers to the water samples and "measurement" refers to the absorbance reading in the spectrophotometer. All sample depths are rounded to the nearest 5, apart from the deepest sample (marked in bold) ca. 10 m above bottom. Samples from sample depths that are through-lined were lost during measurements.

| Fjord | Sample date | CTD station | Sample depths (m) | Analysis date | ca. hours between sampling and measurement |
|---|---|---|---|---|---|
| Masfjord | 02.03 | 179 | 5, 10, ~~20~~, 50, 100, 150, 200, 300, 400, 450[2], **478** | 03.03 | 19 |
| | 04.03 | 218 | ~~5~~, ~~10~~, 20, ~~40~~, 60, 100*, 150, 200, ~~300~~, 400, ~~450~~, **484** | 06.03 | 50 |
| | 07.03 | 266 | 5, ~~15~~, 20, 40, 70, 160, 200, ~~250~~, 350*, 390, **472[2]** | 07.03 | 9 |
| Haugsværfjord | 04.03 | 217 | 5[2], 10[2], 20[2], 40[2], 80[2], **113[2]** | 05.03 | 32 |
| | 06.03 | 255 | 5, 10, 20, 30, 60, 70, 80*, ~~90~~, ~~100~~, **112** | 07.03 | 32 |

*niskin bottle did not fire [2]two samples were collected at this depth

Water samples were collected in plastic bottles, which were rinsed three times in the sample water before sampling. The samples were stored in darkness and acclimatized to room temperature before light absorbance was measured at 400, 420, 440, 450, 460, 480, 500 and 550 nm in the spectrophotometer (blank control sample: Milli-Q water).

The initial plan was to have a total of 4 absorbance readings of each water sample: two successive readings of each cuvette (10 cm quartz cuvette), and two cuvettes from each water sample. However, due to multiple challenges while measuring, several water samples (n = 9) had to be discarded (Table XX3). Water samples from CTD-station 218 should not be used in any further analysis due to the long time between sampling and absorbance reading.

## 15. Drifters

Four drifters were deployed on 3rd of March in the outer part of Masfjorden. The drifters are handmade by an institute technician from a buoy and a selection of supplies from a hardware store. There are GPS trackers attached to the drifters that record the position every 5 minutes, and the position and speed can be monitored via a webpage. The drifters were put out to investigate the surface currents in Masfjorden with strong winds.

Drifters 2 and 3 were put out at roughly the same location, but Drifter 2 beached and was recovered the next morning. Drifter 1 was redeployed once because it came to close to land, Drifter 4 had to be redeployed twice for the same reason and then went out to Fensfjorden, it was also recovered at the next morning.

In leg 2 all the drifters were deployed at the same position, but drifters 3 and 4 was lowered 10 meters below surface. The drifters were deployed in calm weather conditions and appeared to follow an estuarine circulation before being affected by the wind and then beaching. The drifters was recovered the next day and were out in roughly 23 hours.

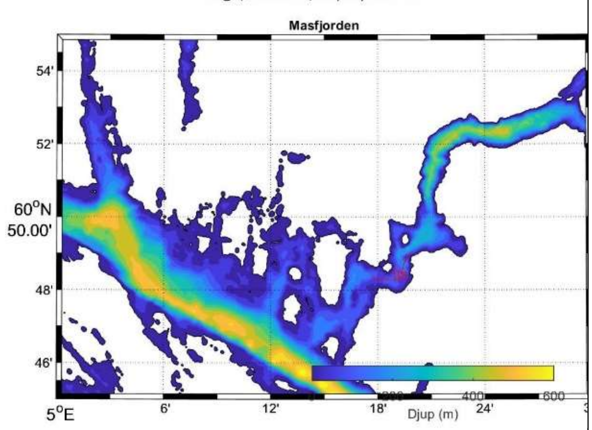
**Table 22. Time and Position of the deployment and recovery of Drifters, leg 1 Table 23. Time and Position of the deployment and recovery of drifters, leg 2.**

| | Deployment | | | | Recovery | | | |
|---|---|---|---|---|---|---|---|---|
| Drifter | Date | Time (UTC) | Latitude | Longitude | Date | Time (UTC) | Latitude | Longitude |
| 1 | 06.03.2020 | 13:21 | 60°52,404' N | 5°23,450' E | 07.03.2020 | 12:20 | 60°52,068' N | 5°23,796' E |
| 2 | 06.03.2020 | 13:21 | 60°52,404' N | 5°23,450' E | 07.03.2020 | 12:15 | 60°52,038' N | 5°23,556' E |
| 3 | 06.03.2020 | 13:21 | 60°52,404' N | 5°23,404' E | 07.03.2020 | 12:05 | 60°52,074' N | 5°20,88' E |
| 4 | 06.03.2020 | 13:21 | 60°52,404' N | 5°23,400' E | 07.03.2020 | 12:01 | 60°52,272' N | 5°21,318' E |

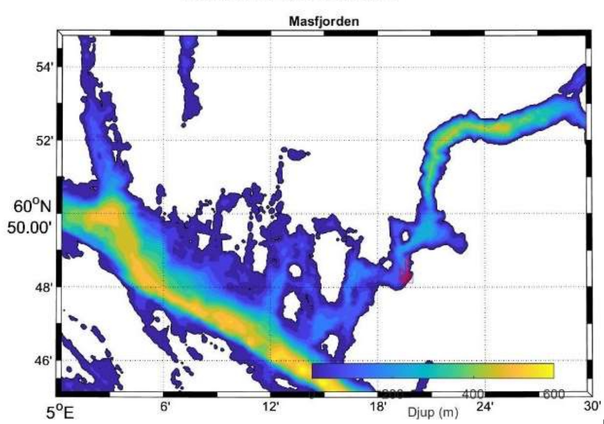
**Table 24. Time and Position of the deployment and recovery of drifters, leg 2.**

| | Deployment | | | | Recovery | | | |
|---|---|---|---|---|---|---|---|---|
| Drifter | Date | Time (UTC) | Latitude | Longitude | Date | Time (UTC) | Latitude | Longitude |
| 1 | 03.03.2020 | 12:04 | 60°48.988' N | 5°19.847' E | 03.03.2020 | 14:35 | 60°46.950' N | 5°19.388' E |
| | 03.03.2020 | 14:38 | 60°48.815' N | 5°19.663' E | 03.03.2020 | 17:18 | 60°48.815' N | 5°19.663' E |
| 2 | 03.03.2020 | 12:12 | 60°47.999' N | 5°17.727' E | 04.03.2020 | 07:18 | 60°49.260' N | 5°8.640' E |
| 3 | 03.03.2020 | 12:14 | 60°47.934' N | 5°17.618' E | 03.03.2020 | 17:50 | 60°47.900' N | 5°16.002' E |
| 4 | 03.03.2020 | 12:19 | 60°46.868' N | 5°15.241' E | 03.03.2020 | 14:20 | 60°47.109' N | 5°13.740' E |
| | 03.03.2020 | 14:25 | 60°46.950' N | 5°16.300' E | 03.03.2020 | 15:48 | 60°46.783' N | 5°15.216' E |
| | 03.03.2020 | 15:53 | 60°46.769' N | 5°14.993' E | 04.03.2020 | 07:18 | 60°47.837' N | 5°15.801' E |

Leg1, drifter 1, deployment 1




Leg 1, drifter 1, deployment 2



## Appendix A: Cruise narrative

The following log is timestamped in UTC. A shortened text summary is provided at the end

**Shift schedules:**

**GEOF 232 had a change of students on the 5/3; the shifts are denoted as leg 1 and leg 2, respectively.**

| Time | Shift |
|---|---|
| 05:00-11:00 | GEOF 337 Students |
| 11:00-17:00 | GEOF 232 students |
| 17:00-23:00 | GEOF 337 Students |
| 23:00-05:00 | GEOF 232 Students |

**Monday 02.03**

> 08:00 (UTC) Students boarded the ship
> 09:00 (UTC) Safety and ship information meeting and tour
> 10:10 (UTC) Briefing in the CTD-room
> 11:00 (UTC) Start of the first ordinary shift
> 13:13 (UTC) First CTD station (Full CTD):
> 16:25 (UTC) Recovery of mooring in the inner part of Masfjorden:

**17:00 Shift change**

> 17:00 (UTC) CTD station 168
> 18:05 (UTC) MSS test (successful)
> 19:40 (UTC) CTD station 169 (M35)
> 20:02 (UTC) CTD station 170 (M34)
> 20:24 CTD station 171 (M33)
> 20:58 CTD station 172 (M32)
> 21:23 CTD station 173 (M31)
> 21:40 CTD station 174 (M30)
> 22:12 CTD station 175 (M29)
> 22:38 CTD station 176 (M28)

**23:00 Shift Change (Tuesday 03.03 local time)**

> 23:05 (UTC) CTD station 177 (M27)
> 23:57 (UTC) CTD station 178 (M26) aborted
> 00:14 (UTC) CTD station 179 (M26)
> 01:14 (UTC) CTD station 180 (M25)
> 01:50 (UTC) CTD station 181 (M24)
> 02:26 (UTC) CTD Station 182 (M23)
> 03:01 (UTC) CTD station 183 (M22)
> 03:29 (UTC) CTD station 184 (M21)
> 03:58 (UTC) CTD station 185 (M20)

> 04:30 (UTC) CTD station 186 (M19)

**05:00 Shift change**

> 05:09 (UTC) CTD station 187 (M18)
> 5:23 (UTC) CTD station 188 (M17)
> 05:43 (UTC) CTD station 189 (M16)
> 6:15 (UTC) CTD station 190 (M15)
> ??:?? CTD station 191, station does not exist, misunderstanding with bridge crew
> 07:25 (UTC) Start of the MSS time series. First section
> Started analyzing oxygen samples
> 08:30 (UTC) MSS time series, second section
> Transferred the data from the mooring instruments (SBEs) to the computer.
> 10:00 (UTC) MSS time series, third section

**11:00 Shift change**

>12:00 (UTC) Boarding small boat for drifter deployment
>12:40 (UTC) returned from drifter deployment
>14.20 (UTC) Recover drifter 4 at (60°47.109’, 05°13.740’)
> 14:25 (UTC) Redeployed drifter 4 at (60°46.950’, 5°16.300’)
> 14:35 (UTC) Recover drifter 1 at (60°40.039’, 5°19.388’)
> 14:38 (UTC) Redeployed drifter 1 at (60°48.815’, 5°19.663’)
> 15:46 (UTC) CTD test deployment with light sensor, at m14
> 15:48 (UTC) Recover drifter 4 at (60°46.783’, 5°15.216’)
> 15:53 (UTC) Redeployed drifter 4 at (60°46.769’, 5°14.993’)
> 17:00 UTC Leaving with lightboat to pick up drifters.
Two drifters successfully recovered, third presumed beached

**17:00 Shift change**

**>**5:18-5:50 Drifter recovery (nr.1 and nr.3)
> 19:45 (UTC) Minor issue with charger/computer shut down caused loss of a few journal entries relating to the last two hours. The CTD log was not compromised in the shutdown.
> 19:56 (UTC) CTD deployed at M16 (60°48.536’, 5°20.777’). 12 bottles of oxygen. Error in bottle labeling
> 20:05 (UTC) Seaguards prepared to start logging 08.03.2020 08:00:00 UTC.
> 21:19 There were multiple excel files (i.e. ‘log’ and ‘log copy’), there were stations in copy but not in the original, so we updated the ‘log’ and saved a backup, with the date and Norwegian time. Because of the misunderstanding noted in three shifts before, there is no saved data for station 191. We are assuming there was a glitch or else the computer was compensating for another procedure, such as one done by Martine or Lise.
> 21:00 Victor and Ole started processing Oxygen samples from M16
> 21:18(UTC) CTD station 195 (M10)
> 21:34 (UTC) CTD station 196 (M09)
> 21:58 (UTC) CTD station 197 (M08)
> 22:14 (UTC) CTD station 198 (M07)
> 22:31 (UTC) CTD station 199 (M06)

**23:00 Shift change (Wednesday 04.03 local time)**

> 22:57 (UTC) CTD station 200 (M05)
> 23:37 (UTC) CTD station 201 (M04)

> 00:08 (UTC) CTD station 202 (M03)
> 00:42 (UTC) CTD station 203 (M02)
> 00:57 (UTC) CTD station 204 (M01)
> 01:20 (UTC) CTD cleaned and filled with chlorine
> 02:10 (UTC) CTD rinsed
> 02:16 (UTC) CTD station 205 (F25)
> 02:40 (UTC) CTD station 206 (F24)
> 03:03 (UTC) CTD station 207 (F23)
> 03:28 (UTC) CTD station 208 (F22)
> 03:58 (UTC) CTD station 209 (F21)
> 04:18 (UTC) CTD station 210 (F20)
> 04:43 (UTC) CTD station 211 (F19)

**05:00 Shift change**

> Plan of shift: an early morning of CTDs with bottom level salinity, with sampling two salinity samples every 2$^{nd}$ CTD and 3 oxygen samples every 3$^{rd}$ CTD. Retrieving the mooring is intended, but that might be delayed in hopes of retrieving the two remaining drifters.
> 5:17 (UTC) CTD station 212 (F18)
> Salinity Bottle note: the ship has lent us another box of salinity bottles (box 42) they are numbered starting with 116. The box is in the Halvtørr room (the room between the oxygen titration lab and the CTD itself—the room with all the shoes). This means that there are now 31 more available salinity samples

> 5:55 (UTC) CTD station 213 (F17)
> Plans (6:21 UTC): no more CTDs for a while; first we will retrieve the drifters and then the mooring. Then we will do a full CTD station and then we will calibrate the microCATS.

> Only the MS30… computer is able to read the microCATS data therefore the CTD log and Cruise diary is now MOVED to BollE…
> Written 8:11 (UTC): a team of three students retrieved the two remaining drifters and took GoPro and Cellphone videos in the process.
> 8:20 UTC: Masfjorden Sill Mooring recovered. Weird organisms on it.
> 8:45 UTC A white bucket of saltwater containing a few of these organisms were collected by a few students for Martine; the rest were returned to the ocean (in hopes of letting the organisms live)
> 8:20 – 9:20 Jacinta, Kjersti, and the crew took some photos during this time
> 9:20 Bucketed organisms at this point are believed to include Common Starfish (Asterias Rubens), Crawfish/Crayfish (Norwegian: “kreps”), sea urchins,
> 9:09 (UTC) CTD station 214 (M26)
> 10:32 (UTC) CTD station (M28)

**11:00 Shift change**

> 11:55 (UTC) CTD station216 (H3A)
>12:50 (UTC) CTD station217 (H3B)
> 13:41 (UTC) H3 2x light measurements (Station 32). Down to approx. 80 m.
> 14:36 (UTC) m26 2x light measurements (Station 33). Down to approx. 100 m.
> 15:15 (UTC) CTD station 218 (M26), with sensitive light sensor
> 16:32 (UTC) CTD station 219 (M13)

> 16:48 (UTC) CTD station 220 (M12)
**17:00 Shift change**
> 17:02 (UTC) CTD station 221 (M11)
> 17:46 (UTC) CTD station 222 (F16)
> 18:21 (UTC) CTD station 223 (F15)
> 19:02 (UTC) CTD station 224 (F14)
> 19:41 (UTC) CTD station 225 (F13)
> 20:10 (UTC) Note: Microcat #8… has been set to start recorded data for Saturday March 7th starting at 12:00 UTC. This is summarized in the SBE…8… file on the computer that handles the MSS procedure.
> 20:21 (UTC) CTD station 226 (F12)
> 20:54 (UTC) CTD station 227 (F11-M4)
> 21:28 (UTC) CTD station 228 (F10)
> 22:04 (UTC) CTD station 229 (F9)
> 22:41(UTC) CTD station 230 (F8)
**23:00 Shift change (Thursday 05.03 local time)**
> 23:20 (UTC) CTD station 231 (F07)
> 00:07 (UTC) CTD station 232 (F06)
> 00:46 (UTC) CTD station 233 (F05)
> 01:20 (UTC) CTD station 234 (F04)
> 02:05 (UTC) CTD station 235m (F03)
> 02:46 (UTC) CTD station 236 (F02)
> Niskin 2 should work again but to be sure fire both niskin 2 and 3 at same depth
**05:00 Shift change**
> 5:14 (UTC) CTD station 237 (L7), bottle 2 is leaking
> 05:53 (UTC) CTD station 238 (L6)
> 07:01 (UTC) CTD station 239 (L5)
> 07:40 (UTC) CTD station 240 (L4)
> 08:03 (UTC) CTD station 241 (L3)
> 9:50 (UTC) Technical stop. The GEOF 232 Students from the first leg will leave. The second leg students will get on board.
> 10:22 (UTC) CTD station 242 (L2)
> 10:36 (UTC) station 243 (L2)
> 10:58 (UTC) CTD station 244 (L1)
**11:00 Shift change**
> 12:00 Martine Light measurements with winch (L6). Down to approx. 70 m.
> 12:22 CTD station 245 at L6 Calibration of SBE37 5446, 8795 & Concerto, Light measurements. Five minutes at bottom + two casts in one.
**17:00 Shift change**
> 17:22 Full CTD station 246 at L1
> 18:45 Bottle 4 was broken, but it was repaired
> 19:05 (UTC) CTD station 247 (Sognesjøen)
> 20:07 (UTC) CTD station 248 (S_T_5)
> 20:27(UTC) CTD station 249(S_T_4)
> 20:45 (UTC) CTD station 250(S_T_3)

>21:08 (UTC) CTD station 251 (S_T_2)
> 21:25 (UTC) CTD station 252 (S_T_1)
> 22:48 (UTC) CTD station 253 (S_dyp_2M)
**23:00 Shift change (Friday 06.03 local time)**
> Notes on salinity measurements:

    5 Salinity bottles cannot be related to stations and depths:

        Bottle 07023
        Bottle 07027
        Bottle 07031 – probably from station 167, 497m depth
        Bottle 07032
        Bottle 07035 – probably from station 167, 194m depth

    Some of them can probably be related to stations, where salinity measurements were not marked by bottle number. This occurred at:

        Station 246, 500.9 m depth
        Station 250, 11 m depth

**05:00 Shift change**
*> No log entries*
**11:00 Shift change**
> 12:11 (UTC) CTD station H3 (Water Samples and light sensor attached for Martine)
> 13:11 (UTC) CTD station 256 (m26/xs2 Martine, Light Measurements for Martine)
> 13:30 (UTC) TriOS Light measurements with winch (Martine).
> 13:57 (UTC) CTD station 257 (m26/xs2 Martine, calibrating SBE37 5446)
>First team went on the working boat. Occurred between Fossheim and Stigavika; Deployed Drifters, Helge Boat towing, Mini-CTD section
> 15:00 (UTC) Back on boat
> 15:15 (UTC) Second team went on the working boat. Occurred in Masfjorden, took isotope samples, Dropped Lise of in Matre
> 16:15 (UTC) Back on boat
**17:00 Shift change**
> 18:41 (UTC) MSS session run and finished, Moorings were cleaned and readied for deployment tomorrow.
> 21:21 (UTC) First CTD at M7 of slow section (1 hour standing for ADCP and LIDAR to sample data), station 258
> 22:35 (UTC) CTD station 259 (M6, 1 hour)
**23:00 Shift change (Saturday 07.03 local time)**
> 23:40 Flushing at the portasal did not work
> 23:45 (UTC) CTD station 260 (M5, 1 hour)
> 00:04 (UTC) CTD station 261 (M5, 1 hour)
> 01:06 (UTC) CTD station 262 (M4, 1 hour)
> 02:17: (UTC) CTD station 263 (M2, 1 hour)
> 03:25: (UTC) CTD station 264 (M1, 1 hour)
> 04:25 (UTC) Head to M7 at <0.5 knots to get ADCP and LIDAR data, 08:00 Intended time of arrival
**05:00 Shift change**
> 7:10 (UTC) Continue with preparing the moorings for redeployment.
> 9:15 (UTC) Mooring lowered into the deep part of the fjord basin

> 10:20 (UTC) Sill mooring lowered

>10:36 (UTC) CTD station 265 (Control CTD for the Sill Mooring)

**11:00 Shift change**

> 11:33 (UTC) CTD at M26

> 13:19 (UTC) CTD station 267 (salt for IMR). Calibration of deep mooring.

> 14:10 (UTC) Team 2 left on working boat; took isotope samples and mini-CTD cross-sections

> 15:30 (UTC) Ran Helge Boat across same section of Masfjorden between Andvika and Mollandsvågen described above.

> 16:15 (UTC) Back on boat

**17:00 Shift change**

> 17:36 (UTC) CTD station 268

17:42 Echo radar depth changed suddenly from 400m to ~¨200m depth, CTD hit the bottom, came up upside down, but seems to be fine.

> 17:45 CTD on deck

> 18:45 (UTC) CTD station 269 (???)

> 19:54 (UTC) CTD station 270

> 21:06 (UTC) CTD station 271

> 22:16 (UTC) CTD station 272

**23:00 Shift change (Sunday 08.03 local time)**

**>** 23:33 (UTC) CTD station 273

>00:39 (UTC) Head to station nr 268 and 273, low speed for ADCP and LIDAR

> 01:20 (UTC) Head back to Bergen

## Appendix B: List of CTD stations

Table 25. List of CTD stations listed by the time of measurement.

| St. name | CTD file name | Date year | Date month | Date day | UTC hh:mm | Depth m | Latitude / N deg | Latitude / N min | Longitude / E deg | Longitude / E min | W. samples # |
|---|---|---|---|---|---|---|---|---|---|---|---|
| F1 | 167 | 2020 | 3 | 2 | 13:13 | 497 | 60 | 51.787 | 4 | 41.447 | 12 |
| D_mooring_1 | 168 | 2020 | 3 | 2 | 17:00 | 468 | 60 | 52.202 | 5 | 22.238 | 12 |
| M35 | 169 | 2020 | 3 | 2 | 19:40 | 188 | 60 | 52.305 | 5 | 33.090 | 2 |
| M34 | 170 | 2020 | 3 | 2 | 20:02 | 154 | 60 | 52.280 | 5 | 32.072 | 2 |
| M33 | 171 | 2020 | 3 | 2 | 20:24 | 191 | 60 | 51.993 | 5 | 30.589 | 3 |
| M32 | 172 | 2020 | 3 | 2 | 20:58 | 185 | 60 | 52.496 | 5 | 29.734 | 2 |
| M31 | 173 | 2020 | 3 | 2 | 21:23 | 271 | 60 | 52.903 | 5 | 28.415 | 2 |
| M30 | 174 | 2020 | 3 | 2 | 21:44 | 271 | 60 | 52.901 | 5 | 28.417 | 3 |
| M29 | 175 | 2020 | 3 | 2 | 22:12 | 368 | 60 | 52.741 | 5 | 27.340 | 2 |
| M28 | 176 | 2020 | 3 | 2 | 22:38 | 422 | 60 | 52.546 | 5 | 26.332 | 2 |
| M27 | 177 | 2020 | 3 | 3 | 23:05 | 451 | 60 | 52.466 | 5 | 25.552 | 3 |
| M26 | 178 | 2020 | 3 | 3 | 23:57 | 486 | 60 | 52.366 | 5 | 24.991 | |
| M26 | 179 | 2020 | 3 | 3 | 00:14 | 486 | 60 | 52.366 | 5 | 24.991 | 12 |
| M25 | 180 | 2020 | 3 | 3 | 01:14 | 469 | 60 | 52.358 | 5 | 23.338 | 2 |
| M24 | 181 | 2020 | 3 | 3 | 01:50 | 467 | 60 | 52.358 | 5 | 23.336 | 2 |
| M23 | 182 | 2020 | 3 | 3 | 02:26 | 468 | 60 | 51.790 | 5 | 21.258 | 2 |
| M22 | 183 | 2020 | 3 | 3 | 03:01 | 414 | 60 | 51.093 | 5 | 21.016 | 2 |
| M21 | 184 | 2020 | 3 | 3 | 03:29 | 411 | 60 | 50.941 | 5 | 20.905 | 2 |
| M20 | 185 | 2020 | 3 | 3 | 03:58 | 363 | 60 | 50.557 | 5 | 20.878 | 2 |
| M19 | 186 | 2020 | 3 | 3 | 04:30 | 302 | 60 | 50.353 | 5 | 20.874 | |
| M18 | 187 | 2020 | 3 | 3 | 05:09 | 105 | 60 | 50.140 | 5 | 20.826 | |
| M17 | 188 | 2020 | 3 | 3 | 05:23 | 287 | 60 | 49.807 | 5 | 20.787 | 1 |
| M16 | 189 | 2020 | 3 | 3 | 05:43 | 297 | 60 | 49.535 | 5 | 20.807 | 1 |
| M15 | 190 | 2020 | 3 | 3 | 6:15 | 239 | 60 | 48.989 | 5 | 19.288 | 1 |
| | | | | | | | | | | | |
| --- | 191 | 2020 | 3 | 3 | --- | 239 | 60 | 48.989 | 5 | 19.288 | --- |
| M_light_1 | 192 | 2020 | 3 | 3 | 15:46 | 140 | 60 | 48.408 | 5 | 19.215 | 1 |
| M16 | 193 | 2020 | 3 | 3 | 19:56 | 290 | 60 | 48.536 | 5 | 20.777 | 12 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| M14 | 194 | 2020 | 3 | 3 | 20:53 | 202 | 60 | 48.295 | 5 | 19.060 | 2 |
| M10 | 195 | 2020 | 3 | 3 | 21:18 | 134.9 | 60 | 47.395 | 5 | 16.316 | 1 |
| M09 | 196 | 2020 | 3 | 3 | 21:34 | 144.4 | 60 | 47.173 | 5 | 16.128 | 3 |
| M08 | 197 | 2020 | 3 | 3 | 21:58 | 176.4 | 60 | 46.869 | 5 | 15.024 | 1 |
| M07 | 198 | 2020 | 3 | 3 | 22:14 | 134.9 | 60 | 46.514 | 5 | 14.230 | 2 |
| M06 | 199 | 2020 | 3 | 3 | 22:31 | 371.7 | 60 | 46.224 | 5 | 13.579 | 3 |
| M05 | 200 | 2020 | 3 | 3 | 22:57 | 563 | 60 | 46.020 | 5 | 13.087 | 2 |
| M04 | 201 | 2020 | 3 | 3 | 23:37 | 668 | 60 | 45.895 | 5 | 12.817 | 1 |
| M03 | 202 | 2020 | 4 | 3 | 00:08 | 351 | 60 | 45.810 | 5 | 12.587 | 3 |
| M02 | 203 | 2020 | 4 | 3 | 00:42 | 94 | 60 | 45.731 | 5 | 12.397 | 1 |
| M01 | 204 | 2020 | 4 | 3 | 00:57 | 69 | 60 | 45.587 | 5 | 11.879 | 2 |
| F25 | 205 | 2020 | 4 | 3 | 02:16 | 88 | 60 | 38.880 | 5 | 26.160 | 3 |
| F24 | 206 | 2020 | 4 | 3 | 02:40 | 156 | 60 | 39.316 | 5 | 25.405 | 2 |
| F23 | 207 | 2020 | 4 | 3 | 03:03 | 228 | 60 | 39.738 | 5 | 24.282 | 1 |
| F22 | 208 | 2020 | 4 | 3 | 03:28 | 279 | 60 | 40.790 | 5 | 22.640 | 3 |
| F21 | 209 | 2020 | 4 | 3 | 03:58 | 228 | 60 | 41.537 | 5 | 20.940 | 1 |
| F20 | 210 | 2020 | 4 | 3 | 04:18 | 230 | 60 | 42.038 | 5 | 21.401 | 2 |
| F19 | 211 | 2020 | 4 | 3 | 04:43 | 350 | 60 | 42.728 | 5 | 21.425 | 3 |
| F18 | 212 | 2020 | 4 | 3 | 5:16 | 680 | 60 | 43.554 | 5 | 21.740 | 2 |
| F17 | 213 | 2020 | 4 | 3 | 5:56 | 680 | 60 | 43.972 | 5 | 20.091 | 1 |
| M26 | 214 | 2020 | 4 | 3 | 9:09 | 478 | 60 | 52.335 | 5 | 25.015 | 12 |
| M28 | 215 | 2020 | 4 | 3 | 10:40 | 420 | 60 | 52.564 | 5 | 26.377 | |
| H3A | 216 | 2020 | 4 | 3 | 11:55 | 123 | 60 | 54.266 | 5 | 30.599 | 10 |
| H3B | 217 | 2020 | 4 | 3 | 12:50 | 123 | 60 | 54.268 | 5 | 30.598 | 12 |
| M26 | 218 | 2020 | 4 | 3 | 15:15 | 484 | 60 | 52.307 | 5 | 24.979 | 12 |
| M13 | 219 | 2020 | 4 | 3 | 16:32 | 64 | 60 | 48.341 | 5 | 18.186 | 2 |
| M12 | 220 | 2020 | 4 | 3 | 16:48 | 98 | 60 | 48.317 | 5 | 17.766 | 1 |
| M11 | 221 | 2020 | 4 | 3 | 17:02 | 199 | 60 | 48.293 | 5 | 17.069 | 2 |
| F16 | 222 | 2020 | 4 | 3 | 17:44 | 674 | 60 | 44.243 | 5 | 19.358 | 3 |
| F15 | 223 | 2020 | 4 | 3 | 18:21 | 669 | 60 | 44.290 | 5 | 18.864 | 2 |
| F14 | 224 | 2020 | 4 | 3 | 19:02 | 593 | 60 | 45.035 | 5 | 16.743 | 1 |
| F13 | 225 | 2020 | 4 | 3 | 19:41 | 676 | 60 | 45.186 | 5 | 15.459 | 3 |
| F12 | 226 | 2020 | 4 | 3 | 20:21 | 678 | 60 | 45.620 | 5 | 14.171 | 1 |
| F11 | 227 | 2020 | 4 | 3 | 20:54 | 662 | 60 | 45.901 | 5 | 12.809 | 2 |
| F10 | 228 | 2020 | 4 | 3 | 21:28 | 622 | 60 | 46.194 | 5 | 11.823 | 3 |
| F9 | 229 | 2020 | 4 | 3 | 22:04 | 474 | 60 | 46.736 | 5 | 11.034 | 2 |
| F8 | 230 | 2020 | 4 | 3 | 22:41 | 575 | 60 | 47.470 | 5 | 07.887 | 1 |
| F7 | 231 | 2020 | 4 | 3 | 23:20 | 530 | 60 | 48.044 | 5 | 5.642 | 3 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| F6 | 232 | 2020 | 5 | 3 | 00:07 | 541 | 60 | 49.820 | 5 | 3.358 | 1 |
| F5 | 233 | 2020 | 5 | 3 | 00:46 | 354 | 60 | 50.150 | 5 | 0.341 | 2 |
| F4 | 234 | 2020 | 5 | 3 | 01:20 | 424 | 60 | 51.26 | 4 | 57.554 | 3 |
| F3 | 235 | 2020 | 5 | 3 | 02:05 | 458 | 60 | 51.203 | 4 | 52.480 | 2 |
| F2 | 236 | 2020 | 5 | 3 | 02:46 | 423 | 60 | 50.966 | 4 | 46.899 | 1 |
| L7 | 237 | 2020 | 5 | 3 | 05:15 | 309 | 60 | 39.733 | 5 | 13.009 | 4 |
| L6 | 238 | 2020 | 5 | 3 | 05:53 | 442 | 60 | 41.100 | 5 | 10.258 | 1 |
| L5 | 239 | 2020 | 5 | 3 | 07:01 | 384 | 60 | 42.476 | 5 | 06.361 | 4 |
| L4 | 240 | 2020 | 5 | 3 | 07:40 | 253 | 60 | 43.502 | 5 | 03.154 | 1 |
| L3 | 241 | 2020 | 5 | 3 | 08:03 | 184 | 60 | 43.927 | 5 | 01.599 | 2 |
| L2 | 242 | 2020 | 5 | 3 | 10:22 | 89 | 60 | 43.783 | 4 | 59.372 | 6 |
| L2 | 243 | 2020 | 5 | 3 | 10:36 | 89 | 60 | 43.783 | 4 | 59.374 | 3 |
| L1 | 244 | 2020 | 5 | 3 | 10:58 | 70 | 60 | 44.120 | 4 | 56.960 | 4 |
| M_light_2 | 245 | 2020 | 5 | 3 | 12:26 | 442 | 60 | 41.096 | 5 | 510.26 | |
| F1 | 246 | 2020 | 5 | 3 | 17:22 | 501 | 60 | 51.696 | 4 | 41.317 | 12 |
| --- | 247 | 2020 | 5 | 3 | 19:05 | 302 | 61 | 00.989 | 4 | 50.388 | 3 |
| S_T_5 | 248 | 2020 | 5 | 3 | 20:07 | 184 | 61 | 04.430 | 5 | 04.064 | 2 |
| S_T_4 | 249 | 2020 | 5 | 3 | 20:17 | 160 | 61 | 04.796 | 5 | 03.439 | 1 |
| S_T_3 | 250 | 2020 | 5 | 3 | 20:45 | 174 | 61 | 05.107 | 5 | 02.894 | 3 |
| S_T_2 | 251 | 2020 | 5 | 3 | 21:08 | 149 | 61 | 05.443 | 5 | 02.223 | 1 |
| S_T_1 | 252 | 2020 | 5 | 3 | 21:25 | 244 | 61 | 05.903 | 5 | 01.441 | 2 |
| S_dyp_2M | 253 | 2020 | 5 | 3 | 22:48 | 1236 | 61 | 02.904 | 5 | 24.551 | 12 |
| H7 | 254 | 2020 | 6 | 3 | 10:59 | 109 | 60 | 53.668 | 5 | 29.424 | |
| H3 | 255 | 2020 | 6 | 3 | 12:11 | 123 | 60 | 54.287 | 5 | 30.606 | 10 |
| m26/xs2 | 256 | 2020 | 6 | 3 | 13:11 | 478 | 60 | 52.286 | 5 | 25.015 | |
| M7 | 258 | 2020 | 6 | 3 | 21:21 | 143 | 60 | 46.518 | 5 | 14.214 | 1 |
| M6 | 259 | 2020 | 6 | 3 | 22:35 | 331 | 60 | 46.249 | 5 | 13.587 | 1 |
| M5* | 260 | 2020 | 6 | 3 | 23:45 | 607 | 60 | 45.992 | 5 | 13.058 | 0 |
| M5* | 261 | 2020 | 7 | 3 | 00:04 | 607 | 60 | 45.992 | 5 | 13.058 | 1 |
| M4 | 262 | 2020 | 7 | 3 | 01:06 | 666 | 60 | 45.881 | 5 | 12.790 | 3 |
| M2 | 263 | 2020 | 7 | 3 | 02:17 | 100 | 60 | 45.753 | 5 | 12.352 | 3 |
| M1 | 264 | 2020 | 7 | 3 | 03:31 | 62 | 60 | 45.589 | 5 | 11.835 | 3 |
| --- | 265 | 2020 | 7 | 3 | 10:36 | 52 | 60 | 48.209 | 5 | 17.609 | 1 |
| M26 | 266 | 2020 | 7 | 3 | 11:33 | 480 | 60 | 52.284 | 5 | 25.013 | 12 |
| D_mooring_2 | 267 | 2020 | 7 | 3 | 13:19 | 453 | 60 | 52.234 | 5 | 22.052 | 1 |
| FX1 | 268 | 2020 | 7 | 3 | 17:36 | 210 | 60 | 47.308 | 5 | 06.533 | 1 |
| FX2 | 269 | 2020 | 7 | 3 | 18:45 | 406 | 60 | 47.529 | 5 | 06.703 | 1 |
| FX3 | 270 | 2020 | 7 | 3 | 19:55 | 375 | 60 | 47.850 | 5 | 06.920 | 1 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FX4 | 271 | 2020 | 7 | 3 | 21:06 | 342 | 60 | 48.106 | 5 | 07.088 | 1 |
| FX5 | 272 | 2020 | 7 | 3 | 22:17 | 240 | 60 | 48.381 | 5 | 07.267 | 1 |
| FX6 | 273 | 2020 | 8 | 3 | 23:33 | 64 | 60 | 48.145 | 5 | 07.690 | 2 |

**Table 26. Comments for the CTD-stations**

| St.name | CTD file name | Comments |
|---|---|---|
| F1 | 167 | First CTD |
| D_mooring_1 | 168 | |
| M35 | 169 | |
| M34 | 170 | |
| M33 | 171 | Samples for oxygen and bottle 2 failed (see diary) |
| M32 | 172 | |
| M31 | 173 | Bottle #2 failed |
| M30 | 174 | Samples for oxygen |
| M29 | 175 | |
| M28 | 176 | |
| M27 | 177 | Samples for oxygen, Used the last oxygen bottles |
| M26 | 178 | Aborted, cleaning tubes not removed during launch, check computer logs for data |
| M26 | 179 | Error in logging sheet, niskin 4 should be at 399m, corrected |
| M25 | 180 | |
| M24 | 181 | |
| M23 | 182 | |
| M22 | 183 | |
| M21 | 184 | |
| M20 | 185 | Using the last two bottles (salt, 1. container) |
| M19 | 186 | No more sample bottles, taking the IMR sample and CTD profile |
| M18 | 187 | |
| M17 | 188 | |
| M16 | 189 | |
| M15 | 190 | |
| | 191 | No stored data |
| M_light_1 | 192 | IMR sample only, light measurement test (Martine) |
| | | NB; there were two m14 stations on the map, m14 and M14, m14 was the actual location |
| M16 | 193 | |
| M14 | 194 | |
| M10 | 195 | |

| | | |
|---|---|---|
| M09 | 196 | |
| M08 | 197 | |
| M07 | 198 | |
| M06 | 199 | |
| M05 | 200 | |
| M04 | 201 | |
| M03 | 202 | |
| M02 | 203 | |
| M01 | 204 | |
| F25 | 205 | |
| F24 | 206 | |
| F23 | 207 | |
| F22 | 208 | |
| F21 | 209 | |
| F20 | 210 | |
| F19 | 211 | |
| F18 | 212 | |
| F17 | 213 | |
| M26 | 214 | |
| M28 | 215 | |
| H3A | 216 | |
| H3B | 217 | |
| M26 | 218 | Bottle 7 didn't fire |
| M13 | 219 | |
| M12 | 220 | |
| M11 | 221 | |
| F16 | 222 | |
| F15 | 223 | |
| F14 | 224 | |
| F13 | 225 | |
| F12 | 226 | |
| F11 | 227 | |
| F10 | 228 | |
| F9 | 229 | |
| F8 | 230 | |
| F7 | 231 | |
| F6 | 232 | |
| F5 | 233 | |
| F4 | 234 | |
| F3 | 235 | |
| F2 | 236 | |
| L7 | 237 | |
| L6 | 238 | |
| L5 | 239 | |
| L4 | 240 | |
| L3 | 241 | |
| L2 | 242 | 30 m Test run before with the GoPro attached to the CTD |
| L2 | 243 | |
| L1 | 244 | |

| | | |
|---|---|---|
| M_light_2 | 245 | Calibration of RBR Concerto, SBE37 8795, 5446 + Light measurements. Yoyo cast. |
| F1 | 246 | Full CTD station |
| | 247 | |
| S_T_5 | 248 | |
| S_T_4 | 249 | |
| S_T_3 | 250 | |
| S_T_2 | 251 | |
| S_T_1 | 252 | |
| S_depth_2M | 253 | Bottle 4 was empty |
| H7 | 254 | |
| H3 | 255 | Bottle 4 did not fire |
| m26/xs2 | 256 | |
| M7 | 258 | |
| M6 | 259 | |
| M5* | 260 | Aborted due to echo sounder issues |
| M5* | 261 | Niskin bottle 1 empty |
| M4 | 262 | Fire 3 to ensure water, salt bottle 07017 |
| M2 | 263 | Fire 3 to ensure water, salt bottle 07006 // |
| | | CTD went up 50m and back to bottom due to radio misunderstanding before firing bottles. |
| M1 | 264 | Fire 3 to ensure water, salt bottle 07001 |
| | 265 | Sill Mooring Control CTD, one botle at bottom, salinity sample got lost! |
| M26 | 266 | Niskin 4 did not fire |
| D_mooring_2 | 267 | |
| FX1 | 268 | Echo radar depth suddenly changed from 400 to 200 m |
| | | CTD hits bottom, but appears to be fine |
| FX2 | 269 | Everything sems ok |
| FX3 | 270 | |
| FX4 | 271 | |
| FX5 | 272 | IMR only salinity |
| FX6 | 273 | |

## Appendix C: Mooring instrumentation setup

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Seaguard | 1925 | Vel, P, C, T | 60 | 08.03.2020 08:00 | Memory & Battery & Sensors checked | | Victor & Elin |
| | 1929 | Vel,P,C,T,O | 60 | 08.03.2020 08:00 | Memory & Battery & Sensors checked | | Joan & Elin |
| SBE37 | 12338 | CTO | 1800 | 07.03.2020 12:00 | Memory cleared, New batteries | | Joan & Elin |
| | 8974 | CT | 300 | 07.03.2020 12:00 | Memory cleared, New batteries | | Jacinta & Elin |
| | 5446 | CT | 300 | Start Now | Memory cleared, New batteries | | Elin |
| RDCP | | | 120 | 07.03.2020 12:00 | | | Elin, Torunn & Jakob D. |
| SBE56 | 1946 | T | 5 | 07.03.2020 14:00 | Memory cleared &battery changed | | Joan & Elin |
| RBR Concerto | 60648 | CTD | 5 | 07.03.2020 12:00 | Memory cleared &battery changed | | Elin |

**Additional settings**

RBR Concerto: Sampling average, Speed 00:00:02, Duration 00:00:01.

RDCP: cell size 4 m, # of pings 100, ping mode: burst, power level: low, data stored to mmc card

**Deployment logs**

SBE37-SM V 2.6b **SERIAL NO. 5446** 06 Mar 2020 20:01:00
not logging: waiting to start at 07 Mar 2020 14:00:00
sample interval = 300 seconds
samplenumber = 0, free = 190650
do not transmit real-time data
output salinity with each sample
do not output sound velocity with each sample
store time with each sample
number of samples to average = 1
serial sync mode disabled
wait time after serial sync sampling = 30 seconds
internal pump not installed
temperature = 17.48 deg C

SBE37SM-RS232 v3.1 **SERIAL NO. 8974** 04 Mar 2020 19:58:38
vMain = 7.02, vLith = 3.18
samplenumber = 0, free = 838860
not logging, waiting to start at 07 Mar 2020 12:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars

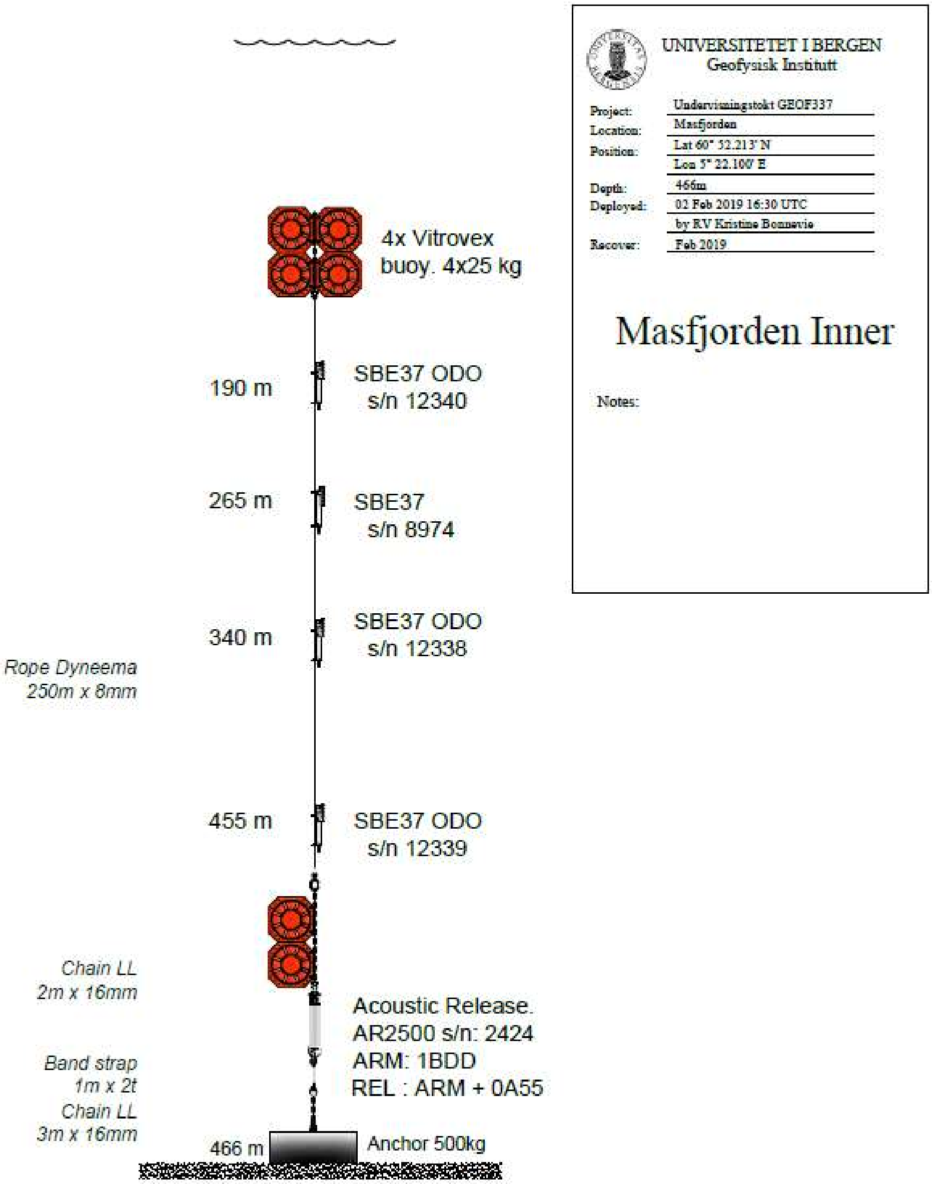
SBE37SM-RS232 v3.1 **SERIAL NO. 8975** 05 Mar 2020 14:59:28
vMain = 6.98, vLith = 3.15
samplenumber = 0, free = 838860
not logging, waiting to start at 07 Mar 2020 12:00:00
sample interval = 300 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = no
reference pressure = 0.0 decibars
<Executed/>

SBE37SMP-ODO-RS232 v2.3.1 **SERIAL NO. 12338** 04 Mar 2020 19:26:03
vMain = 13.37, vLith = 3.05
samplenumber = 0, free = 524288
not logging, start at 07 Mar 2020 12:00:00
sample interval = 1800 seconds
data format = converted engineering
output temperature, Celsius
output conductivity, S/m
output oxygen, ml/L
transmit real time data = no
sync mode = no
reference pressure = 0.0 decibars
minimum conductivity frequency = 2886.4
adaptive pump control enabled

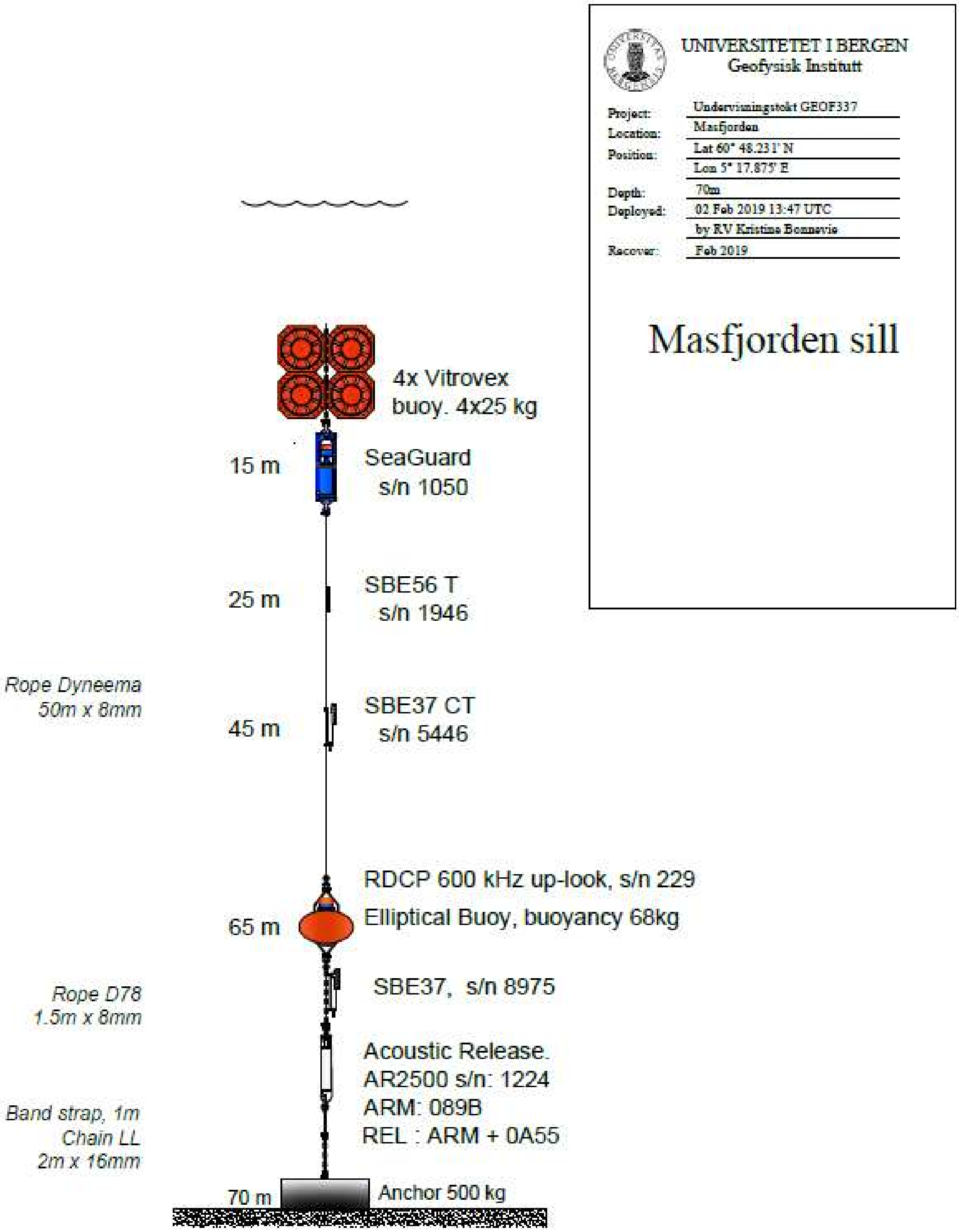
Current Configuration:
**Serial number: 05601946**
Firmware version: SBE56 V0.96
Sample period (sec): 300,0
Date/time: 04-Mar-2020 18:48:12
Start sampling at: 07-Mar-2020 14:00:00
Current temperature: 16,9528
Events recorded: 0
Battery changed: 01-Jan-2000 00:00:00
Number of samples in memory: 0
Memory Remaining: 154,28 years [100%]
Calculated battery life remaining: 0,00 seconds [0%]
Calibration:
 Date: 2012-07-22
 Coefficients:
  A0 = -1.225091E-03
  A1 = 3.424143E-04
  A2 = -6.376194E-06
  A3 = 1.977309E-07

## Appendix D: Mooring drawings (recovered)

## Appendix E: Mooring drawings (deployed)



UNIVERSITETET I BERGEN
Geofysisk Institutt
Project: Undervisningstokt GEOF337
Location: Masfjorden
Position: Lat 60° 52.213' N
Lon 5° 22.100' E
Depth: 466m
Deployed: 02 Feb 2019 16:30 UTC
by RV Kristine Bonnevie
Recover: Feb 2019
Masfjorden Inner
Notes:
4x Vitrovex buoy. 4x25 kg
190 m
SBE37 ODO s/n 12340
265 m
SBE37 s/n 8974
340 m
SBE37 ODO s/n 12338
Rope Dyneema 250m x 8mm
455 m
SBE37 ODO s/n 12339
Chain LL 2m x 16mm
Acoustic Release.
AR2500 s/n: 2424
ARM: 1BDD
REL : ARM + 0A55
Band strap 1m x 2t
Chain LL 3m x 16mm
466 m
Anchor 500kg




## Appendix E: Mooring drawing (deployed)

# Appendix F: Water samples from CTD

Table 27. List of O2 samples.

| Cast | Station | Depth | Niskin bottle | Oxygen | Bottle O2 (mL/L) | Bottle O2 (µmol/kg) | CTD O2 | Comment |
|---|---|---|---|---|---|---|---|---|
| | | | Bottle | Bottle | | | | |
| **F1** | 167 | 151.0 | 5 | 16 | 6.2380 | 271.2 | 5.9118 | |
| | 167 | 497.0 | 1 | 10 | 6.2709 | 272.6 | 5.8965 | O2 Open niskin |
| | 167 | 151.0 | 5 | 17 | 6.6189 | 269.5 | 5.9118 | |
| | 167 | 52.0 | 8 | 13 | 6.7199 | 292.4 | 6.4271 | |
| | 167 | 52.0 | 8 | 14 | 6.7220 | 292.5 | 6.4271 | |
| | 167 | 5.0 | 12 | 12 | 6.7887 | 295.8 | 6.5254 | |
| **D_mooring_1** | 168 | 464.0 | 1 | 19 | 2.4639 | 107.1 | 2.3083 | |
| | 168 | 464.0 | 2 | 20 | 2.4714 | 107.4 | 2.3071 | |
| | 168 | 340.0 | 5 | 26 | 2.6764 | 116.4 | 2.5639 | |
| | 168 | 340.0 | 6 | 27 | 2.7037 | 117.5 | 2.5645 | |
| | 168 | 190.0 | 9 | 28 | 3.8730 | 168.4 | 3.6610 | |
| | 168 | 190.0 | 10 | 29 | 3.8645 | 168.0 | 3.6665 | |
| **M35** | 169 | 45.0 | 2 | | | | 4.9268 | |
| **M34** | 170 | 144.0 | 1 | | | | 3.4566 | |
| | 170 | 48.0 | 2 | | | | 4.9686 | |
| **M33** | 171 | 183.0 | 1 | 82 | 3.8218 | 166.2 | 3.5850 | |
| | 171 | 76.0 | 2 | 25 | 4.9624 | 215.8 | 4.6354 | 02 overtitration |
| | 171 | 29.0 | 3 | 35 | 5.4229 | 236.0 | 5.1509 | |
| **M32** | 172 | 175.0 | 1 | | | | 3.6228 | |
| **M31** | 173 | 261.8 | 1 | | | | 3.1898 | |
| | 173 | | 3 | | | | 5.1816 | Depth is missing |
| **M30** | 174 | 261.0 | 1 | 21 | 3.4808 | 151.3 | 3.1969 | |
| | 174 | 176.0 | 2 | 23 | 3.8188 | 166.0 | 3.6401 | |
| | 174 | 48.0 | 4 | 30 | 5.5162 | 240.0 | 5.1885 | |
| **M29** | 175 | 372.0 | 1 | 32 | | | 3.3925 | |
| | 175 | 43.0 | 2 | | | | 5.2850 | |
| **M28** | 176 | 418.0 | 1 | | | | 2.3947 | |
| | 176 | 39.5 | 2 | | | | 5.3313 | |
| **M27** | 177 | 442.0 | 1 | 32 | 2.7142 | 118.0 | 2.3549 | |
| | 177 | 262.0 | 3 | 33 | 3.7874 | 164.7 | 3.5933 | |
| | 177 | 16.0 | 4 | 34 | 3.7431 | 162.9 | 5.2564 | O2 wrong volume |
| **M26** | 179 | 478.0 | 1 | | | | 2.2877 | |
| | 179 | 19.0 | 10 | | | | 5.2586 | |
| **M25** | 180 | 462.0 | 1 | | | | 2.3198 | |
| | 180 | 30.0 | 2 | | | | 5.5661 | |
| **M24** | 181 | | 1 | | | | 2.2898 | Depth is missing |
| | 181 | | 2 | | | | 5.2929 | Depth is missing |
| **M23** | 182 | 462.0 | 1 | | | | 2.2731 | |
| | 182 | 27.0 | 3 | | | | 5.6917 | |

| Cast | Station | Depth | Niskin bottle | Oxygen | Bottle O2 (mL/L) | Bottle O2 (µmol/kg) | CTD O2 | Comment |
|---|---|---|---|---|---|---|---|---|
| **M22** | 183 | 418.0 | 1 | | | | 2.3018 | |
| | 183 | 30.0 | 2 | | | | 5.6790 | |
| **M21** | 184 | 416.0 | 1 | | | | 2.3143 | |
| | 184 | 23.0 | 2 | | | | 5.5832 | |
| **M20** | 185 | 303.0 | 1 | | | | 2.3423 | |
| | 185 | 32.0 | 2 | | | | 5.8368 | |
| **M16** | 193 | 300.0 | 1 | 10 | 3.7367 | 162.5 | 3.5109 | |
| | 193 | 250.0 | 2 | 11 | 3.7484 | 163.0 | 3.5549 | |
| | 193 | 200.0 | 3 | 12 | 3.8136 | 165.8 | 3.6048 | |
| | 193 | 150.0 | 4 | 13 | 3.8576 | 167.7 | 3.6664 | |
| | 193 | 125.0 | 5 | 16 | 3.9873 | 173.4 | 3.7825 | |
| | 193 | 100.0 | 6 | 17 | 4.4739 | 194.5 | 4.3814 | |
| | 193 | 75.0 | 7 | 20 | 5.3965 | 234.7 | 5.2324 | |
| | 193 | 50.0 | 8 | 26 | 5.7517 | 250.2 | 5.4899 | |
| | 193 | 30.0 | 9 | 27 | 6.1176 | 266.2 | 5.8086 | |
| | 193 | 20.0 | 10 | 28 | 6.2006 | 269.9 | 5.9889 | |
| | 193 | 10.0 | 11 | 31 | 6.3145 | 274.9 | 6.0158 | |
| | 193 | 5.0 | 12 | 35 | 6.3242 | 275.5 | 6.1660 | |
| **M14** | 194 | 144.0 | 1 | | | | | |
| | 194 | 25.0 | 2 | | | | | |
| **M10** | 195 | 134.9 | 1 | | | | | |
| **M09** | 196 | 144.0 | 1 | 10 | 5.5033 | 239.3 | 5.2842 | |
| | 196 | 85.0 | 2 | 11 | 5.9092 | 257.0 | 5.6236 | |
| | 196 | 10.0 | 3 | 12 | 6.5058 | 283.3 | 6.2347 | |
| **M08** | 197 | 176.4 | 1 | | | | | |
| **M07** | 198 | 134.9 | 1 | | | | | |
| | 198 | 42.3 | 2 | | | | | |
| **M06** | 199 | 372.0 | 1 | 10 | 5.6744 | 246.7 | 5.3997 | |
| | 199 | 84.0 | 2 | 11 | 5.6734 | 246.8 | 5.5256 | |
| | 199 | 22.0 | 3 | 12 | 6.0231 | 262.2 | 6.3131 | |
| **M05** | 200 | 563.0 | 1 | | | | | |
| | 200 | 48.0 | 2 | | | | | |
| **M03** | 202 | 351.0 | 1 | 31 | 5.8226 | 253.1 | 5.5299 | |
| | 202 | 181.0 | 2 | 27 | 5.5967 | 243.3 | 5.3095 | |
| | 202 | 39.0 | 3 | 28 | 6.3927 | 278.2 | 6.1697 | |
| **M01** | 204 | 69.0 | 1 | | | | | |
| | 204 | 21.0 | 2 | | | | | |
| **F25** | 205 | 88.0 | 1 | 10 | 5.2560 | 228.6 | 4.9760 | |
| | 205 | 70.0 | 2 | 11 | 5.4412 | 236.7 | 5.1926 | |
| | 205 | 60.0 | 3 | 12 | 5.8008 | 252.4 | 5.6318 | |
| **F24** | 206 | 156.0 | 1 | | | | | |
| | 206 | 57.0 | 2 | | | | | |
| **F22** | 208 | 279.0 | 1 | 27 | 5.1477 | 223.8 | 4.8768 | |
| | 208 | 213.0 | 2 | 28 | 5.3028 | 230.6 | 5.0823 | |

| Cast | Station | Depth | Niskin bottle | Oxygen | Bottle O2 (mL/L) | Bottle O2 (µmol/kg) | CTD O2 | Comment |
|---|---|---|---|---|---|---|---|---|
| | 208 | 51.0 | 3 | 31 | 6.0163 | 261.8 | 5.8412 | |
| **F20** | 210 | 230.0 | 1 | | | | | |
| | 210 | 86.0 | 2 | | | | | |
| **F19** | 211 | 350.0 | 1 | 27 | 5.4746 | 238.0 | 5.1951 | |
| | 211 | 136.0 | 2 | 28 | 5.4005 | 234.8 | 5.1379 | |
| | 211 | 79.0 | 3 | 31 | 5.6032 | 243.7 | 5.3381 | |
| **F18** | 212 | 688.0 | 1 | | | | | |
| **F17** | 213 | 686.0 | 1 | | | | | |
| **M26** | 214 | 478.8 | 1 | 10 | 2.4349 | 105.9 | 2.2840 | |
| | 214 | 403.0 | 2 | 11 | 2.5513 | 110.9 | 2.3904 | |
| | 214 | 264.0 | 3 | 12 | 3.7526 | 163.2 | 3.5835 | |
| | 214 | 207.0 | 4 | 13 | 3.8280 | 166.4 | 3.6399 | |
| | 214 | 156.0 | 5 | 16 | 3.8352 | 166.7 | 3.6578 | |
| | 214 | 104.0 | 6 | 17 | 4.2199 | 183.5 | 4.1026 | |
| | 214 | 78.0 | 7 | 20 | 4.8824 | 212.3 | 4.6560 | |
| | 214 | 53.0 | 8 | 26 | 5.4317 | 236.2 | 5.2255 | |
| | 214 | 32.6 | 9 | 27 | 5.5733 | 242.5 | 5.3929 | |
| | 214 | 22.0 | 10 | 28 | 5.4389 | 236.7 | 5.4905 | |
| | 214 | 12.0 | 11 | 35 | 5.7345 | 249.6 | 5.4828 | |
| | 214 | 12.0 | 11 | 31 | 5.2725 | 229.5 | 5.4828 | |
| **M28** | 215 | 125.0 | 1 | | -0.0092 | -0.4 | 0.0293 | |
| | 215 | 100.0 | 2 | | -0.0091 | -0.4 | 0.092 | |
| | 215 | 100.0 | 3 | | | | | |
| | 215 | 75.0 | 4 | | -0.0090 | -0.4 | 0.0341 | |
| | 215 | 50.0 | 6 | | 0.7103 | 30.9 | 0.5658 | |
| | 215 | 30.0 | 7 | | 5.0792 | 221.1 | 4.8101 | |
| | 215 | 20.0 | 8 | | 5.1668 | 224.9 | 4.9379 | |
| | 215 | 10.0 | 9 | | 5.2856 | 230.1 | 5.0530 | |
| | 215 | 5.0 | 10 | | 5.2842 | 230.1 | 5.2764 | |
| **M13** | 219 | 64.0 | 1 | | | | | |
| | 219 | 11.0 | 2 | | | | | |
| **M11** | 221 | 192.0 | 1 | | | | | |
| | 221 | 33.0 | 2 | | | | | |
| **F16** | 222 | 676.0 | 1 | 32 | 5.4858 | 238.5 | 5.1805 | |
| | 222 | 361.0 | 2 | 33 | 4.5415 | 197.4 | 5.3824 | |
| | 222 | 83.0 | 3 | 34 | 4.8472 | 210.8 | 5.4424 | |
| **F15** | 223 | 668.9 | 1 | | | | | |
| | 223 | 73.0 | 2 | | | | | |
| **F14** | 224 | 594.0 | 1 | | | | | |
| **F13** | 225 | 678.0 | 1 | 13 | 5.4974 | 239.0 | 7.1704 | |
| | 225 | 332.0 | 2 | 14 | 5.7489 | 249.9 | 5.4710 | |
| | 225 | 76.0 | 3 | 17 | 5.8033 | 252.4 | 5.5308 | |
| **F12** | 226 | 676.0 | 1 | | | | | |
| **F11** | 227 | 662.0 | 1 | | | | | |

| Cast | Station | Depth | Niskin bottle | Oxygen | Bottle O2 (mL/L) | Bottle O2 (µmol/kg) | CTD O2 | Comment |
|---|---|---|---|---|---|---|---|---|
| | 227 | 85.1 | 2 | | | | | |
| **F10** | 228 | 621.9 | 1 | 13 | 5.4901 | 238.7 | 5.1849 | |
| | 228 | 362.2 | 2 | 14 | 5.8117 | 252.7 | 5.5153 | |
| | 228 | 64.6 | 3 | 17 | 6.0914 | 265.0 | 5.8123 | |
| **F09** | 229 | 474.0 | 1 | | | | | |
| | 229 | 77.0 | 2 | | | | | |
| **F08** | 230 | 575.0 | 1 | | | | | |
| **F07** | 231 | 530.0 | 1 | 30 | 5.4761 | 238.0 | 5.1764 | |
| | 231 | 371.0 | 2 | 31 | 5.9853 | 260.2 | 5.7008 | |
| | 231 | 141.0 | 3 | 32 | 5.8023 | 252.1 | 5.5648 | |
| **F5** | 233 | 354.0 | 1 | | | | | |
| | 233 | 61.0 | 2 | | | | | |
| **F4** | 234 | 424.0 | 1 | 29 | 6.1517 | 267.4 | 5.8655 | |
| | 234 | 234.0 | 2 | 33 | 5.8191 | 253.0 | 5.5476 | |
| | 234 | 9.0 | 3 | 34 | 6.8359 | 297.9 | 6.6436 | |
| **F3** | 235 | 458.0 | 1 | | | | | |
| | 235 | 75.0 | 2 | | | | | |
| **L7** | 237 | 303.0 | 1 | 30 | 4.7706 | 207.7 | 4.5210 | |
| | 237 | 115.0 | 3 | 31 | 4.4281 | 192.8 | 4.2131 | |
| | 237 | 54.0 | 4 | 32 | 5.6843 | 247.5 | 5.4793 | |
| **L6** | 238 | 437.0 | 1 | | | | | |
| **L5** | 239 | 384.5 | 1 | 26 | 4.7967 | 208.8 | 4.5246 | |
| | 239 | | 2 | 27 | 4.4886 | 195.4 | 4.2692 | Depth is missing |
| | 239 | 32.0 | 4 | 25 | 6.3688 | 277.4 | 6.1361 | |
| **L4** | 240 | 244.0 | 1 | | | | | |
| **L3** | 241 | 174.0 | 1 | | | | | |
| | 241 | 57.0 | 2 | | | | | |
| **L2** | 243 | 78.0 | 1 | 13 | 6.6972 | 291.6 | 6.4303 | |
| | 243 | 27.0 | 2 | 14 | 6.6884 | 291.3 | 6.4217 | |
| | 243 | 7.0 | 3 | 17 | 6.7760 | 295.4 | 6.5290 | |
| **L1** | 244 | 60.0 | 1 | 34 | 6.5791 | 286.3 | 6.2865 | |
| | 244 | 33.0 | 3 | 30 | 6.6711 | 290.4 | 6.4152 | |
| | 244 | 5.0 | 4 | 31 | 6.8382 | 298.02 | 6.5583 | |
| **F1** | 246 | 500.9 | 1 | 18 | 6.2900 | 273.4 | 5.9682 | |
| | 246 | 401.4 | 2 | 19 | 6.2743 | 272.7 | 5.9587 | |
| | 246 | 300.4 | 3 | 20 | 6.2177 | 270.3 | 5.9042 | |
| | 246 | 196.6 | 4 | 21 | 6.2159 | 270.2 | 5.6476 | |
| | 246 | 150.2 | 5 | 23 | 6.0022 | 261.0 | 5.6228 | |
| | 246 | 100.5 | 6 | 25 | 6.3216 | 274.9 | 6.0275 | |
| | 246 | 49.3 | 8 | 26 | 6.3358 | 275.7 | 6.3864 | |
| | 246 | 29.1 | 9 | 27 | 6.9394 | 309.0 | 6.5234 | |
| | 246 | 20.3 | 10 | 28 | 6.8844 | 299.7 | 6.6137 | |
| | 246 | 10.7 | 11 | 30 | 6.9161 | 301.2 | 6.6447 | |
| | 246 | 5.1 | 12 | 31 | 6.9170 | 301.4 | 6.6481 | |

| Cast | Station | Depth | Niskin bottle | Oxygen | Bottle O2 (mL/L) | Bottle O2 (µmol/kg) | CTD O2 | Comment |
|---|---|---|---|---|---|---|---|---|
| | 247 | 321.0 | 1 | 32 | 6.0257 | 262.0 | 5.7404 | |
| | 247 | 64.3 | 2 | 35 | 6.4934 | 282.5 | 6.2878 | Cast missing |
| | 247 | 28.4 | 3 | 33 | 6.5554 | 285.4 | 6.2815 | |
| **S_T_5** | 248 | 176.0 | 1 | | | | | |
| | 248 | 35.0 | 2 | | | | | |
| **S_T_3** | 250 | 163.0 | 1 | 30 | 5.9788 | 260.0 | 5.6782 | |
| | 250 | 37.0 | 2 | 34 | 6.5365 | 284.6 | 6.2823 | |
| | 250 | 11.0 | 3 | 82 | 7.3325 | 319.7 | 7.0849 | |
| **S_T_2** | 252 | 236.0 | 1 | | | | | |
| | 252 | 13.2 | 2 | | | | | |
| **S_dyp_2M** | 253 | 1252.0 | 1 | 17 | 4.3404 | 188.7 | 4.0486 | |
| | 253 | 999.0 | 2 | 18 | 4.4118 | 191.8 | 4.1427 | |
| | 253 | 804.0 | 3 | 19 | 4.5247 | 196.7 | 4.2508 | |
| | 253 | 403.0 | 5 | 20 | 5.3537 | 232.7 | 5.0996 | |
| | 253 | 300.0 | 6 | 21 | 5.5547 | 241.5 | 5.2270 | |
| | 253 | 199.0 | 7 | 23 | 5.7333 | 249.3 | 5.3647 | |
| | 253 | 152.0 | 8 | 25 | 5.7774 | 251.2 | 5.5378 | |
| | 253 | 102.0 | 9 | 26 | 5.9887 | 260.4 | 5.7321 | |
| | 253 | 53.0 | 10 | 28 | 6.2124 | 270.3 | 5.9591 | |
| | 253 | 33.0 | 11 | 29 | 6.5285 | 284.1 | 6.3128 | |
| | 253 | 13.0 | 12 | 32 | 6.7784 | 295.5 | 6.6120 | |
| **H7** | 254 | 98.3 | 1 | 18 | 0.0018 | 0.1 | 0.0320 | |
| | 254 | 85.0 | 2 | 20 | 0.0018 | 0.1 | 0.0310 | |
| | 254 | 73.5 | 4 | 23 | 0.0018 | 0.1 | 0,0325 | |
| | 254 | 47.7 | 6 | 25 | 1.4148 | 63.2 | 1.3972 | |
| | 254 | 37.0 | 7 | 28 | 4.1607 | 185.9 | 4.1657 | |
| | 254 | 22.0 | 8 | 29 | 5.3512 | 239.0 | 5.1308 | |
| | 254 | 9.5 | 9 | 30 | 5.4855 | 245.1 | 5.2696 | |
| | 254 | 4.5 | 10 | 32 | 6.3110 | 273.0 | 6.4013 | |
| **M07** | 258 | 134.0 | 1 | | | | | |
| **M06** | 259 | 340.0 | 1 | | | | | |
| **M04** | 262 | 666.0 | 1 | | | | | |
| **M02** | 263 | 100.0 | 1 | | | | | |
| **M01** | 264 | 65.0 | 1 | | | | | |
| **M01** | 265 | 525.0 | 1 | | | | | |
| **D_mooring_2** | 267 | 453.0 | 1 | | | | | |
| | H3A | 125.0 | 1 | 14 | | | | |
| | H3A | 100.0 | 2 | 18 | | | | |
| | H3A | 75.0 | 4 | 19 | | | | |
| | H3A | 50.0 | 6 | 21 | | | | |
| | H3A | 30.0 | 7 | 23 | | | | |
| | H3A | 20.0 | 8 | 25 | | | | |
| | H3A | 10.0 | 9 | 29 | | | | |
| | H3A | 5.0 | 10 | 30 | | | | |

Table 28. List of salinity samples

| Cast | Station | Niskin | Depth | CTD Salinity | Bottle Salinity | Salinity offset | Corr Salinity |
|---|---|---|---|---|---|---|---|
| **F1** | 167 | 5 | 151 | 34.8506 | | | |
| | 167 | 1 | 497 | 35.1065 | | | |
| | 167 | 5 | 151 | 34.8506 | | | |
| | 167 | 8 | 52 | 33.8018 | | | |
| | 167 | 8 | 52 | 33.8018 | | | |
| | 167 | 12 | 5 | 32.0343 | | | |
| **D_mooring_1** | 168 | 1 | 464 | 34.9818 | 34.9711 | -0.0107 | 34.9709 |
| | 168 | 2 | 464 | 34.982 | | | 34.9711 |
| | 168 | 5 | 340 | 34.9764 | | | 34.9655 |
| | 168 | 6 | 340 | 34.9763 | | | 34.9654 |
| | 168 | 9 | 190 | 34.9271 | 34.9160 | -0.0111 | 34.9162 |
| | 168 | 10 | 190 | 34.927 | | | 34.9161 |
| **M35** | 169 | 2 | 45 | 34.1784 | 34.1747 | -0.0037 | 34.1747 |
| **M34** | 170 | 1 | 144 | 34.9125 | 34.8986 | -0.0139 | 34.9086 |
| | 170 | 2 | 48 | 34.2159 | 34.2220 | 0.0061 | 34.2120 |
| **M33** | 171 | 1 | 183 | 34.9205 | 34.9090 | -0.0115 | 34.9485 |
| | 171 | 2 | 76 | 34.52 | | | 34.5480 |
| | 171 | 3 | 29 | 33.99 | 34.0575 | 0.0675 | 34.0180 |
| **M32** | 172 | 1 | 175 | 34.9243 | 34.9133 | -0.0110 | 34.9133 |
| **M31** | 173 | 1 | 261.8 | 34.9563 | 34.9424 | -0.0139 | 34.9554 |
| | 173 | 3 | | 34.2564 | 34.2686 | 0.0122 | 34.2555 |
| **M30** | 174 | 1 | 261 | 34.9555 | 34.9405 | -0.0150 | 34.9604 |
| | 174 | 2 | 176 | 34.9276 | | | 34.9325 |
| | 174 | 4 | 48 | 34.1906 | 34.2154 | 0.0248 | 34.1955 |
| **M29** | 175 | 1 | 372 | 34.9799 | 34.9692 | -0.0107 | 34.9987 |
| | 175 | 2 | 43 | 34.081 | 34.1293 | 0.0483 | 34.0998 |
| **M28** | 176 | 1 | 418 | 34.9803 | 34.9693 | -0.0110 | 34.9732 |
| | 176 | 2 | 39.5 | 34.0764 | 34.0731 | -0.0033 | 34.0693 |
| **M27** | 177 | 1 | 442 | 34.9809 | 34.9686 | -0.0123 | 34.9797 |
| | 177 | 3 | 262 | 34.9446 | | | 34.9434 |
| | 177 | 4 | 16 | 33.7582 | 33.7680 | 0.0098 | 33.7570 |
| **M26** | 179 | 1 | 478 | 34.9815 | 34.9699 | -0.0116 | 34.9955 |
| | 179 | 10 | 19 | 33.763 | 33.8027 | 0.0397 | 33.7770 |
| **M25** | 180 | 1 | 462 | 34.9813 | 34.9694 | -0.0119 | 34.9876 |
| | 180 | 2 | 30 | 33.8278 | 33.8522 | 0.0244 | 33.8341 |
| **M24** | 181 | 1 | | 34.9814 | 34.9682 | -0.0132 | 34.9989 |
| | 181 | 2 | | 33.5707 | 33.6189 | 0.0482 | 33.5882 |
| **M23** | 182 | 1 | 462 | 34.9816 | 34.9704 | -0.0112 | 34.9776 |
| | 182 | 3 | 27 | 33.7516 | 33.7548 | 0.0032 | 33.7476 |
| **M22** | 183 | 1 | 418 | 34.9803 | 34.9686 | -0.0117 | 34.9860 |
| | 183 | 2 | 30 | 33.7137 | 33.7368 | 0.0231 | 33.7194 |
| **M21** | 184 | 1 | 416 | 34.9802 | 34.9695 | -0.0107 | 34.9715 |

| Cast | Station | Niskin | Depth | CTD Salinity | Bottle Salinity | Salinity offset | Corr Salinity |
|---|---|---|---|---|---|---|---|
| | 184 | 2 | 23 | 33.6918 | 33.6852 | -0.0066 | 33.6831 |
| **M20** | 185 | 1 | 303 | 34.9794 | 34.9656 | -0.0138 | 34.9699 |
| | 185 | 2 | 32 | 33.7497 | 33.7445 | -0.0052 | 33.7402 |
| **M16** | 193 | 1 | 300 | 34.935 | 34.9246 | -0.0104 | 34.9821 |
| | 193 | 2 | 250 | 34.9336 | | | 34.9807 |
| | 193 | 3 | 200 | 34.9287 | | | 34.9758 |
| | 193 | 4 | 150 | 34.9198 | | | 34.9669 |
| | 193 | 5 | 125 | 34.9004 | | | 34.9475 |
| | 193 | 6 | 100 | 34.7905 | | | 34.8376 |
| | 193 | 7 | 75 | 34.518 | | | 34.5651 |
| | 193 | 8 | 50 | 34.2037 | | | 34.2508 |
| | 193 | 9 | 30 | 33.6563 | | | 33.7034 |
| | 193 | 10 | 20 | 33.2752 | 33.3798 | 0.1046 | 33.3223 |
| | 193 | 11 | 10 | 33.1204 | | | 33.1675 |
| | 193 | 12 | 5 | 32.2824 | | | 32.3295 |
| **M14** | 194 | 1 | 144 | 34.9151 | 34.9028 | -0.0123 | 35.0400 |
| | 194 | 2 | 25 | 33.259 | 33.5212 | 0.2622 | 33.3839 |
| **M10** | 195 | 1 | 134.9 | 34.8077 | 34.7865 | -0.0212 | 34.7865 |
| **M09** | 196 | 1 | 144 | 34.822 | 34.8001 | -0.0219 | 34.8402 |
| | 196 | 2 | 85 | 34.3965 | | | 34.4147 |
| | 196 | 3 | 10 | 32.7766 | 32.8348 | 0.0582 | 32.7948 |
| **M08** | 197 | 1 | 176.4 | 34.8451 | 34.8338 | -0.0113 | 34.8338 |
| **M07** | 198 | 1 | 134.9 | 34.814 | 34.7920 | -0.0220 | 34.8119 |
| | 198 | 2 | 42.3 | 33.8792 | 33.8970 | 0.0178 | 33.8771 |
| **M06** | 199 | 1 | 372 | 35.0579 | 35.0457 | -0.0122 | 35.0457 |
| | 199 | 2 | 84 | 34.4666 | | | 34.4544 |
| | 199 | 3 | 22 | 33.1884 | | | 33.1762 |
| **M05** | 200 | 1 | 563 | 35.0978 | 35.0885 | -0.0093 | 35.0972 |
| | 200 | 2 | 48 | 33.9334 | 33.9415 | 0.0081 | 33.9328 |
| **M03** | 202 | 1 | 351 | 35.076 | 35.0656 | -0.0104 | 35.1076 |
| | 202 | 2 | 181 | 34.9608 | | | 34.9924 |
| | 202 | 3 | 39 | 33.6256 | 33.6992 | 0.0736 | 33.6572 |
| **M01** | 204 | 1 | 69 | 34.1795 | 34.1593 | -0.0202 | 34.2136 |
| | 204 | 2 | 21 | 32.6134 | 32.7017 | 0.0883 | 32.6475 |
| **F25** | 205 | 1 | 88 | 34.6369 | | | |
| | 205 | 2 | 70 | 34.3358 | | | |
| | 205 | 3 | 60 | 33.914 | | | |
| **F24** | 206 | 1 | 156 | 34.8882 | 34.8654 | -0.0228 | 34.9301 |
| | 206 | 2 | 57 | 33.7125 | 33.8192 | 0.1067 | 33.7544 |
| **F22** | 208 | 1 | 279 | 34.937 | 34.9266 | -0.0104 | 34.9766 |
| | 208 | 2 | 213 | 34.9302 | | | 34.9698 |
| | 208 | 3 | 51 | 33.7703 | 33.8598 | 0.0895 | 33.8099 |
| **F20** | 210 | 1 | 230 | 34.9877 | 34.9733 | -0.0144 | 34.9573 |
| | 210 | 2 | 86 | 34.5778 | 34.5314 | -0.0464 | 34.5474 |
| **F19** | 211 | 1 | 350 | 35.0041 | | | |

| Cast | Station | Niskin | Depth | CTD Salinity | Bottle Salinity | Salinity offset | Corr Salinity |
|---|---|---|---|---|---|---|---|
| | 211 | 2 | 136 | 34.8683 | | | |
| | 211 | 3 | 79 | 34.4376 | | | |
| **F18** | 212 | 1 | 688 | 35.0998 | 35.0905 | -0.0093 | 35.0905 |
| **F17** | 213 | 1 | 686 | 35.0902 | 35.0891 | -0.0011 | 35.0891 |
| **M26** | 214 | 1 | 478.8 | 34.979 | 34.9688 | -0.0102 | 34.9912 |
| | 214 | 2 | 403 | 34.9777 | | | 34.9899 |
| | 214 | 3 | 264 | 34.9416 | | | 34.9538 |
| | 214 | 4 | 207 | 34.9273 | | | 34.9395 |
| | 214 | 5 | 156 | 34.9176 | | | 34.9298 |
| | 214 | 6 | 104 | 34.8266 | | | 34.8388 |
| | 214 | 7 | 78 | 34.5737 | | | 34.5859 |
| | 214 | 8 | 53 | 34.5737 | | | 34.5859 |
| | 214 | 9 | 32.6 | 33.8746 | | | 33.8868 |
| | 214 | 10 | 22 | 33.6863 | 33.7208 | 0.0345 | 33.6985 |
| | 214 | 11 | 12 | 33.4933 | | | 33.5055 |
| | 214 | 11 | 12 | 33.4933 | | | 33.5055 |
| **M28** | 215 | 1 | 125 | 34.7461 | | | 34.7536 |
| | 215 | 2 | 100 | 34.7434 | | | 34.7509 |
| | 215 | 3 | 100 | 34.7435 | 34.7323 | -0.0112 | 34.7510 |
| | 215 | 4 | 75 | 34.7267 | | | 34.7342 |
| | 215 | 6 | 50 | 34.6328 | | | 34.6403 |
| | 215 | 7 | 30 | 33.8444 | | | 33.8519 |
| | 215 | 8 | 20 | 33.7375 | 33.7637 | 0.0262 | 33.7450 |
| | 215 | 9 | 10 | 33.5839 | | | 33.5914 |
| | 215 | 10 | 5 | 33.0985 | | | 33.1060 |
| **M13** | 219 | 1 | 64 | 34.3251 | 34.1360 | -0.1891 | 34.2057 |
| | 219 | 2 | 11 | 32.7308 | 32.6811 | -0.0497 | 32.6114 |
| **M11** | 221 | 1 | 192 | 34.9129 | 34.9002 | -0.0127 | 34.9283 |
| | 221 | 2 | 33 | 33.6521 | 33.6956 | 0.0435 | 33.6675 |
| **F16** | 222 | 1 | 676 | 35.0999 | 35.0869 | -0.0130 | 35.0869 |
| | 222 | 2 | 361 | 35.054 | | | 35.0410 |
| | 222 | 3 | 83 | 34.4253 | | | 34.4123 |
| **F15** | 223 | 1 | 668.9 | 35.0996 | 35.0891 | -0.0105 | 35.0975 |
| | 223 | 2 | 73 | 34.2973 | 34.3037 | 0.0064 | 34.2952 |
| **F14** | 224 | 1 | 594 | 35.0965 | 35.0848 | -0.0117 | 35.0848 |
| **F13** | 225 | 1 | 678 | 35.1 | 35.0878 | -0.0122 | 35.1008 |
| | 225 | 2 | 332 | 35.0655 | | | 35.0663 |
| | 225 | 3 | 76 | 34.3545 | 34.3682 | 0.0137 | 34.3553 |
| **F12** | 226 | 1 | 676 | 35.0996 | 35.0875 | -0.0121 | 35.0875 |
| **F11** | 227 | 1 | 662 | 35.0991 | 35.0870 | -0.0121 | 35.1227 |
| | 227 | 2 | 85.1 | 34.325 | 34.3844 | 0.0594 | 34.3486 |
| **F10** | 228 | 1 | 621.9 | 35.0973 | 35.0859 | -0.0114 | 35.0859 |
| | 228 | 2 | 362.2 | 35.0783 | | | 35.0669 |
| | 228 | 3 | 64.6 | 34.1173 | | | 34.1059 |
| **F09** | 229 | 1 | 474 | 35.0862 | 34.3330 | -0.7532 | 35.1027 |

| Cast | Station | Niskin | Depth | CTD Salinity | Bottle Salinity | Salinity offset | Corr Salinity |
|---|---|---|---|---|---|---|---|
| | 229 | 2 | 77 | 34.287 | 35.0732 | 0.7862 | 34.3035 |
| **F08** | 230 | 1 | 575 | 35.0974 | 35.0863 | -0.0111 | 35.0863 |
| **F07** | 231 | 1 | 530 | 35.0959 | 35.0852 | -0.0107 | 34.5998 |
| | 231 | 2 | 371 | 35.0754 | | | 34.5793 |
| | 231 | 3 | 141 | 35.7974 | 34.8158 | -0.9816 | 35.3013 |
| **F5** | 233 | 1 | 354 | 35.0791 | 35.0682 | -0.0109 | 35.0750 |
| | 233 | 2 | 61 | 33.9391 | 33.9418 | 0.0027 | 33.9350 |
| **F4** | 234 | 1 | 424 | 35.0886 | | | |
| | 234 | 2 | 234 | 35.0376 | | | |
| | 234 | 3 | 9 | 31.6727 | | | |
| **F3** | 235 | 1 | 458 | 35.0865 | 35.0788 | -0.0077 | 35.0735 |
| | 235 | 2 | 75 | 34.156 | 34.1376 | -0.0184 | 34.1430 |
| **L7** | 237 | 1 | 303 | 33.1559 | 33.1478 | -0.0081 | 33.1477 |
| | 237 | 3 | 115 | 33.1341 | 33.1258 | -0.0083 | 33.1259 |
| | 237 | 4 | 54 | 32.6052 | | | 32.5970 |
| **L6** | 238 | 1 | 437 | 33.1569 | 33.1476 | -0.0093 | 33.1476 |
| **L5** | 239 | 1 | 384.5 | 33.1565 | 33.1476 | -0.0089 | 33.1587 |
| | 239 | 2 | 123.6 | 33.1391 | | | 33.1413 |
| | 239 | 4 | 32 | 32.2302 | 32.2435 | 0.0133 | 32.2324 |
| **L4** | 240 | 1 | 244 | 33.1537 | 33.1453 | -0.0084 | 33.1453 |
| **L3** | 241 | 1 | 174 | 33.1492 | 33.1396 | -0.0096 | 33.1436 |
| | 241 | 2 | 57 | 32.4192 | 32.4176 | -0.0016 | 32.4136 |
| **L2** | 243 | 1 | 78 | 32.6179 | 32.6053 | -0.0126 | 32.6160 |
| | 243 | 2 | 27 | 32.2518 | | | 32.2499 |
| | 243 | 3 | 7 | 31.2398 | 31.2486 | 0.0088 | 31.2379 |
| **L1** | 244 | 1 | 60 | 33.523 | 33.5081 | -0.0149 | 33.4439 |
| | 244 | 3 | 33 | 33.2074 | | | 33.1283 |
| | 244 | 4 | 5 | 31.5427 | 31.3995 | -0.1432 | 31.4636 |
| **F1** | 246 | 1 | 500.9 | 35.1289 | | | |
| | 246 | 2 | 401.4 | 35.1121 | | | |
| | 246 | 3 | 300.4 | 35.0614 | | | |
| | 246 | 4 | 196.6 | 34.9663 | | | |
| | 246 | 5 | 150.2 | 34.8727 | | | |
| | 246 | 6 | 100.5 | 34.3744 | | | |
| | 246 | 8 | 49.3 | 33.7122 | | | |
| | 246 | 9 | 29.1 | 32.9974 | | | |
| | 246 | 10 | 20.3 | 32.4714 | | | |
| | 246 | 11 | 10.7 | 31.90 | | | |
| | 246 | 12 | 5.1 | 31.7724 | | | |
| | 247 | 1 | 321 | 35.0001 | 34.9908 | -0.0093 | 34.9908 |
| | 247 | 2 | 64.3 | 33.9325 | | | 33.9232 |
| | 247 | 3 | 28.4 | 32.8418 | | | 32.8325 |
| **S_T_5** | 248 | 1 | 176 | 34.91 | 34.8858 | -0.0242 | 34.9388 |
| | 248 | 2 | 35 | 33.3487 | 33.4305 | 0.0818 | 33.3775 |
| **S_T_3** | 250 | 1 | 163 | 34.8458 | 34.8421 | -0.0037 | 34.8421 |

| Cast | Station | Niskin | Depth | CTD Salinity | Bottle Salinity | Salinity offset | Corr Salinity |
|---|---|---|---|---|---|---|---|
| | 250 | 2 | 37 | 32.971 | | | 32.9673 |
| | 250 | 3 | 11 | 31.0245 | | | 31.0208 |
| **S_T_2** | 252 | 1 | 236 | | 35.0376 | | |
| | 252 | 2 | 13.2 | | 34.5568 | | |
| **S_dyp_2M** | 253 | 1 | 1252 | 35.0508 | | | 35.0502 |
| | 253 | 2 | 999 | 35.0497 | 35.0376 | -0.0121 | 35.0491 |
| | 253 | 3 | 804 | 35.046 | | | 35.0454 |
| | 253 | 5 | 403 | 34.9977 | | | 34.9971 |
| | 253 | 6 | 300 | 34.98 | | | 34.9762 |
| | 253 | 7 | 199 | 34.9101 | | | 34.9095 |
| | 253 | 8 | 152 | 34.8387 | | | 34.8381 |
| | 253 | 9 | 102 | 34.5458 | 34.5568 | 0.0110 | 34.5452 |
| | 253 | 10 | 53 | 33.8415 | | | 33.8409 |
| | 253 | 11 | 33 | 33.4037 | | | 33.4031 |
| | 253 | 12 | 13 | 31.4013 | | | 31.4007 |
| **H7** | 254 | 1 | 98.3 | | 34.7332 | | |
| | 254 | 2 | 85 | | 34.7287 | | |
| | 254 | 4 | 73.5 | | | | |
| | 254 | 6 | 47.7 | | | | |
| | 254 | 7 | 37 | | | | |
| | 254 | 8 | 22 | | | | |
| | 254 | 9 | 9.5 | | | | |
| | 254 | 10 | 4.5 | | | | |
| **M07** | 258 | 1 | 134 | | 34.7783 | | |
| **M06** | 259 | 1 | 340 | | 35.0507 | | |
| **M04** | 262 | 1 | 666 | | 35.0892 | | |
| **M02** | 263 | 1 | 100 | | 34.4389 | | |
| **M01** | 264 | 1 | 65 | | 33.8098 | | |
| **M01** | 265 | 1 | 525 | | | | |
| **D_mooring_2** | 267 | 1 | 453 | | 34.9796 | | |
| | H3A | | | | | | |
| | H3A | | | | | | |
| | H3A | | | | | | |
| | H3A | | | | | | |
| | H3A | | | | | | |
| | H3A | | | | | | |
| | H3A | | | | | | |
| | H3A | | | | | | |

## Appendix G: List of MSS-stations

| Station name | Date/UTC | | | Time/UTC | | E, Depth | Latitude/ N | | Longitude/ E | | CTD station (sta0) | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | year | mon | Dd | hh | min | m | deg | min | deg | min | | |
| 2 | 2020 | 3 | 3 | 7 | 24 | 111 | 60 | 48,360 | 5 | 19,262 | | 1st section |
| 3 | 2020 | 3 | 3 | 7 | 45 | 70 | 60 | 48,292 | 5 | 18,098 | | |
| 4 | 2020 | 3 | 3 | 7 | 58 | 205 | 60 | 48,205 | 5 | 16,681 | | |
| 5 | 2020 | 3 | 3 | 8 | 30 | 159 | 60 | 48,340 | 5 | 19,215 | | **2nd Section** |
| 6 | 2020 | 3 | 3 | 8 | 54 | 100 | 60 | 48,290 | 5 | 17,908 | | |
| 7 | 2020 | 3 | 3 | 9 | 7 | 205 | 60 | 48,210 | 5 | 16,674 | | |
| 8 | 2020 | 3 | 3 | 10 | 2 | 120 | 60 | 48,396 | 5 | 19,070 | | **Third section,** |
| 9 | 2020 | 3 | 3 | 10 | 17 | 75 | 60 | 48,276 | 5 | 18,013 | | |
| 10 | 2020 | 3 | 3 | 10 | 31 | 205 | 60 | 48,229 | 5 | 16,608 | | |
| 11 | 2020 | 3 | 3 | 11 | 36 | 120 | 60 | 48,422 | 5 | 19,172 | | **4th Section** |
| 12 | 2020 | 3 | 3 | 11 | 57 | 103 | 60 | 48,311 | 5 | 17,815 | | |
| 13 | 2020 | 3 | 3 | 12 | 10 | 205 | 60 | 48,221 | 5 | 16,755 | | |
| 14 | 2020 | 3 | 3 | 13 | 1 | 126 | 60 | 48,458 | 5 | 19,014 | | **5th Section** |
| 15 | 2020 | 3 | 3 | 13 | 43 | 93 | 60 | 48,258 | 5 | 17,891 | | |
| 16 | 2020 | 3 | 3 | 13 | 56 | 205 | 60 | 48,245 | 5 | 16,557 | | |
| 17 | 2020 | 3 | 3 | 14 | 32 | 149 | 60 | 48,319 | 5 | 18,96 | | **6th Section** |
| 18 | 2020 | 3 | 3 | 14 | 59 | 78 | 60 | 48,281 | 5 | 17,999 | | |
| 19 | 2020 | 3 | 3 | 15 | 13 | 205 | 60 | 48,22 | 5 | 16,775 | | |
| 20 | 2020 | 3 | 3 | 16 | 17 | 93 | 60 | 48,312 | 5 | 19,226 | | **7th Section** |
| 21 | 2020 | 3 | 3 | 16 | 33 | 95 | 60 | 48,289 | 5 | 17,828 | | |
| 22 | 2020 | 3 | 3 | 17 | 3 | 205 | 60 | 48,253 | 5 | 16,745 | | |
| 23 | 2020 | 3 | 3 | 17 | 44 | 134 | 60 | 48,388 | 5 | 19,096 | | **8th section** |
| 24 | 2020 | 3 | 3 | 18 | 1 | 82 | 60 | 48,282 | 5 | 17,979 | | |
| 25 | 2020 | 3 | 3 | 18 | 14 | 206 | 60 | 48,21 | 5 | 16,673 | | |
| 26 | 2020 | 3 | 3 | 18 | 42 | 131 | 60 | 48,41 | 5 | 19,21 | | **9th section** |
| 27 | 2020 | 3 | 3 | 18 | 59 | 74 | 60 | 49,55 | 5 | 20,82 | | |
| 28 | 2020 | 3 | 3 | 19 | 11 | 206 | 60 | 48,23 | 5 | 16,58 | | |
| 29 | 2020 | 3 | 5 | 13 | 22 | 309 | 60 | 39,74 | 5 | 13,02 | | Lurefjord Section |
| 30 | 2020 | 3 | 5 | 13 | 55 | 442 | 60 | 41,12 | 5 | 10,19 | | |
| 31 | 2020 | 3 | 5 | 14 | 33 | 365 | 60 | 42,51 | 5 | 6,52 | | |
| 32 | 2020 | 3 | 5 | 15 | 1 | 259 | 60 | 43,47 | 5 | 3,14 | | |
| 33 | 2020 | 3 | 5 | 15 | 23 | 178 | 60 | 43,85 | 5 | 1,79 | | |
| 34 | 2020 | 3 | 5 | 15 | 50 | 87,8 | 60 | 43,78 | 4 | 59,39 | | |
| 35 | 2020 | 3 | 5 | 16 | 9 | 76,6 | 60 | 44,07 | 4 | 57,07 | | |
| 36 | 2020 | 3 | 6 | 7 | 12 | 148 | 60 | 47,381 | 5 | 16,30 | M10 | Masfjord Section |
| 37 | 2020 | 3 | 6 | 7 | 37 | 150 | 60 | 48,31 | 5 | 19,13 | M14 | |
| 38 | 2020 | 3 | 6 | 7 | 59 | 298 | 60 | 49,54 | 5 | 20,84 | M16 | |
| 39 | 2020 | 3 | 6 | 8 | 27 | 426 | 60 | 50,98 | 5 | 20,93 | M21 | |
| 40 | 2020 | 3 | 6 | 8 | 59 | 470 | 60 | 52,20 | 5 | 22,09 | M24 | |
| 41 | 2020 | 3 | 6 | 9 | 31 | 482 | 60 | 51,35 | 5 | 24,89 | M26 | |
| 42 | 2020 | 3 | 6 | 10 | 7 | 280 | 60 | 52,89 | 5 | 28,40 | M31 | |
| 43 | 2020 | 3 | 6 | 10 | 32 | 187 | 60 | 52,51 | 5 | 29,57 | M32 | |
| 44 | 2020 | 3 | 6 | 17 | 16 | 188 | 60 | 52,32 | 5 | 33,14 | M35 | |
| 45 | 2020 | 3 | 6 | 17 | 38 | 191 | 60 | 52,00 | 5 | 30,54 | M33 | |

## Appendix H: Notes for next year

Moorings:

- IF RDCP is to be re-deployed, bring a suitable buoy!
- RDCP: be very careful not to squeeze the batterycables so that it doesn't shortcuit again
- Make sure to calibrate conductivity sensors on CTD 😊
- Oxygen sensors needs more than five minutes at depth to settle. After five minutes they where still changing a lot.
- We redesigned the moorings several times onboard – make sure to double check that instrument position in drawings are correct.

What to bring:

- Enough salt bottles
- Whiteboard pens
- Modern CTD-computer for CTD-log

Students:

- Assign shift leaders /make a schedule of shift leaders prior to cruise
- Agree on ONE meeting point for hand over.
- Ask students to put name on chargers, phones, cameras etc.
- Bring water bottle (named), thermos cup (named)
- Ask them to bring their own pharmacy (painkillers, sea sickness pills etc)
- Prior to cruise: use one information channel on mittuib.no (discussion page is messy/not up to date, calendare was not updated)
- Make a plan for who learns what when onboard: CTD, oxygen, salinity etc and make sure that everyone knows what to do at CTD before they are left alone

Location:

- Do MSS – timeseries/turbulence studies in Lurefjorden. NB: check with captain that he is happy to do so! Quite strong currents and narrow sound.
- Mini-moorings on two sides of the sill here is an option.

Preparation:

- Have student groups inform each other about what they will do.
- Is it possible to have students more involved in preparation/packing
- Do we need packing lists so that we know what we have onboard? (or too much work?)