CRUISE REPORT

Cruise KB 2022605

with R.V. Kristine Bonnevie

23/2 –1/3 2022

Working Areas:

Osterfjord, Sørfjord, Masfjorden, Fensfjorden, Lurefjord

Geophysical Institute, University of Bergen

Compiled from inputs of GEOF232 & GEOF337 students, spring 2022

Version: 1 March 2022

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3 BACKGROUND

The cruise on board 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 study was Masfjorden, Fensfjorden, Lurefjorden, Osterfjorden, and Sørfjorden. The data set collected aimed to address the processes related to tides and mixing processes in Masfjorden, ocean-fjord exchange mechanisms, the observed deoxygenation of the inner basis and the recent deep-water renewal, and freshwater sources and distribution. The students become familiar with typical and state-of-the-art measurement systems, including ship-based measurements (CTD, thermosalinograph and Ship-ADCP) as well as moored instruments, and measurements of oxygen, salt concentrations, CO2, nutrients and isotopes in collected water samples. The students participated in the planning of the cruise and sampling and contributed substantially to the cruise report.

In total, 1 mooring was recovered inside the Lurefjord Sill, and two moorings were re-deployed in the inner Masfjord basin and on the Masfjord Sill. The moorings consisting of current meters, current profilers, and temperature, salinity, oxygen and pressure loggers, which will collect data for one-year duration. During the cruise, data collection was primarily by using the ship's CTD and vessel-mounted current profiling system, GFI's microstructure profiler, drifters, and a mini-CTD operated from the working boat.

4 CRUISE PARTICIPANTS

Table 1: Cruise participants

Last Name	First Name	Role	Time Onboard
Daae	Kjersti	Cruise leader	23.02.2022-01.03.2022
Darelius	Elin	Scientist	23.02.2022 – 26.02.2022
Arstein	Sofie	GEOF337 student	23.02.2022 – 26.02.2022
Frank	Lukas	GEOF337 student	23.02.2022 – 26.02.2022
King	Dana	GEOF337 student	23.02.2022 - 26.02.2022
Ølberg	Judith Thu	GEOF337 student	23.02.2022 - 26.02.2022
Rahm	Tabea	GEOF337 student	23.02.2022 - 26.02.2022
?	?	GEOF337 student	23.02.2022 - 26.02.2022
?	?	GEOF337 student	23.02.2022 - 26.02.2022
?	?	GEOF337 student	23.02.2022 - 26.02.2022
?	?	GEOF337 student	23.02.2022 - 26.02.2022
?	?	GEOF337 student	23.02.2022 - 26.02.2022
Rosendahl	Andrea	GEOF232 student	26.02.2022 - 01.03.2022
Dahl	Viktor	GEOF232 student	26.02.2022 - 01.03.2022
Selstad	Filip	GEOF232 student	26.02.2022 - 01.03.2022
Blackley	Kathleen	GEOF232 student	26.02.2022 - 01.03.2022
Krågebakk	Frida	GEOF232 student	26.02.2022 - 01.03.2022
Rust	Vinjar	GEOF232 student	26.02.2022 - 01.03.2022
Taraldsen	Christoffer	GEOF232 student	26.02.2022 - 01.03.2022
Vik	Gard	GEOF232 student	26.02.2022 - 01.03.2022
Solhaug	Eskil	GEOF232 student	26.02.2022 - 01.03.2022
Bryhni	Helge	Engineer	23.02.2022 – 27.02.2022
Jackson-Misje	Kristin	Chemical engineer	23.02.2022 – 01.03.2022
Dörr	Jakob	Teaching assistant	23.02.2022 – 01.03.2022
Sagen	Torun Sandven	Teaching assistant	26.02.2022 – 01.03.2022
Thurnherr	Iris	Teaching assistant	27.02.2022

5 CRUISE OVERVIEW

A detailed cruise narrative is given in Appendix A.

Figure 1: Cruise track

6 ENVIRONMENTAL CONDITIONS: WEATHER (GEOF232) & TIDES (GEOF337)

23.02: Cloudy with rain, snow and sleet throughout the day, but most during the evening. Quite strong wind gusts in the afternoon. Less wind in the evening as the precipitation came.

24.02: Partly cloudy with periods of sun and precipitation in form of rain, hail, sleet and snow.
Wind from south-west.

25.02: Rainy night and morning. Clearing up a bit before mid-day, staying sunny the rest of the day. Wind staying quite low, but slightly increasing in the afternoon before calming down. Strongest wind gusts in the morning.

26.02: Mostly cloudy throughout the day, but little precipitation. Wind staying calm until mid-day where it increased. Staying at a relatively stable rate the rest of the day. Temperature a bit below 0 just past midnight.

27.02: Sunny day with no precipitation. Beautiful sunrise and sunset. Quite windy most of the day. Calmed down at night.

28.02: Sunny morning with a beautiful sunrise. Beautiful cloud formations at mid-day with clear turbulence in them. Rain coming in the evening. Quite a lot of wind during the day. East to south-east wind direction at the day, turning to more northerly at the evening.

01.03: Changing weather all through the day. Some periods of sun, some rain showers. Wind mostly from the north. Little wind during the morning, increasing during the day.

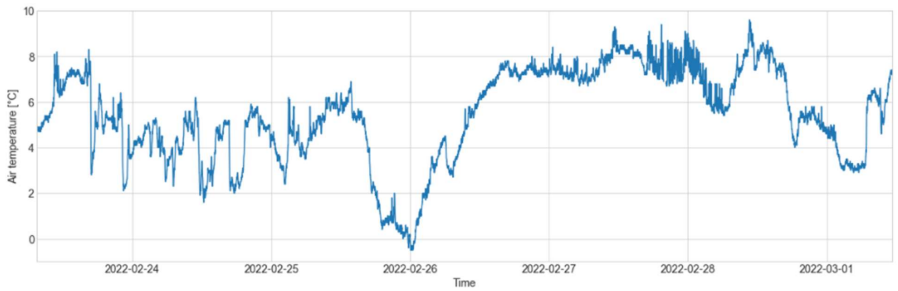

Figure 6.1. Air temperature from the ship during the cruise.

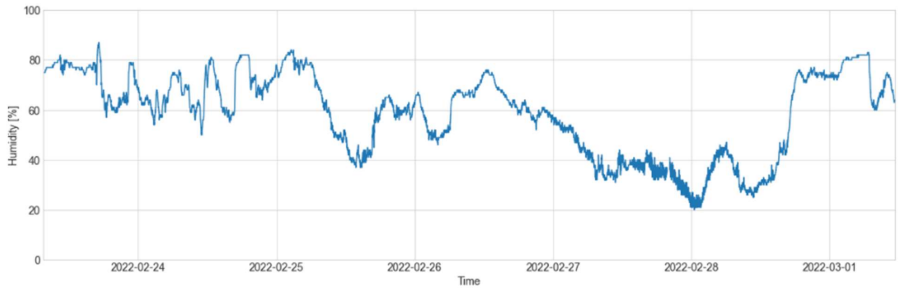

Figure 6.2. Humidity taken from the ship log during the cruise.

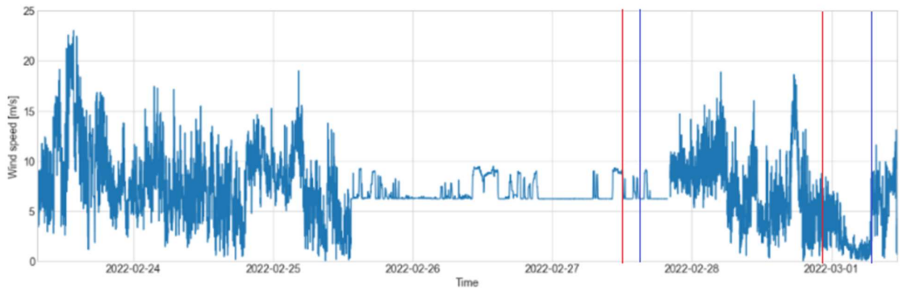

Figure 6.3. Wind speed taken from the ship log during the cruise. Note that there was an error from the 25th to the 27th with the measurement equipment resulting in incomplete and bugged wind measurements. The equipment were reset the 27th to get the correct measurements. Red lines mark drifters put out. Blue lines mark drifters collected.

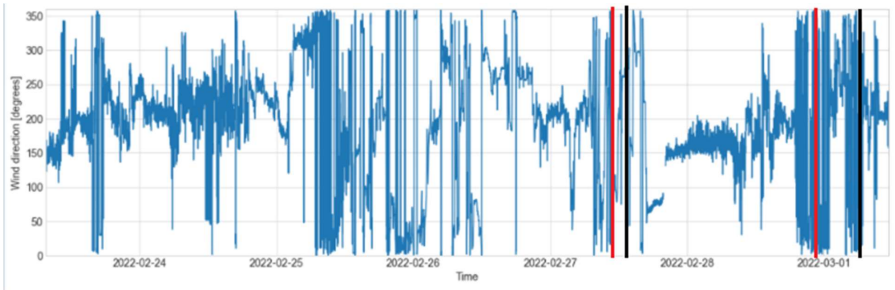

Figure 6.4. Wind direction taken from the ship log during the cruise. Error in the wind measurement equipment between the 25th to 27th had probably some effect on the measurements on wind direction as well. Red lines mark drifters set out. Black lines mark drifters collected.

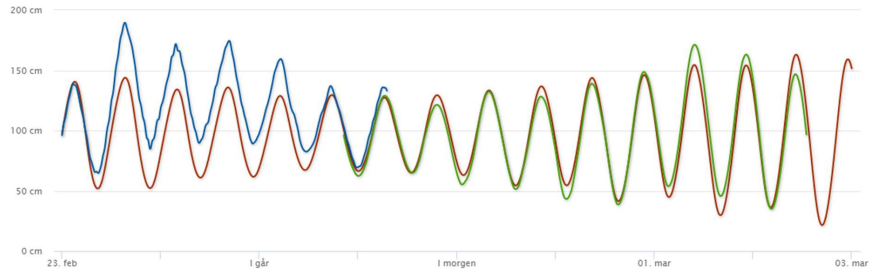

Figure 6.5. Tidal prediction (and actual water level) for Masfjorden during (the first half of) the cruise period.

7 MOORINGS (GEOF337)

7.1 MOORING DEPLOYMENT

During the GEOF337 student cruise, two moorings were deployed in the inner (main) basin and on the sill of Masfjorden. The moorings replace predecessors located in the same positions during previous years and their data will complement long-term time series in the monitoring of the Masfjorden system. At each location, a CTD cast was done directly before the deployment to be used for calibration and sensor drift corrections after recovery.

Table 1. Information about the deployment cites of the Masfjord moorings

	Masfjorden sill	**Masfjorden inner**
Latitude	60° 48.231' N	60° 52.204' N
Longitude	5° 17.875' E	5° 22.098' E
Depth	78 m	460 m
CTD station	M12	M24
Time	25.02.2022, 15:45 UTC	25.02.2022, 14:30 UTC

The new mooring in the main basin consists of four SBE37 and one SeaGuard. The mooring on the sill includes two SBE37, one SeaGuard and one RDCP. All instruments were set up and checked upon installation, equipped with new batteries and prepared for deployment onboard RV Kristin Bonnevie. For further details on the instrumentation and the setup see the appendix C and E.

Figure showing mooring locations.

7.2 TRIANGULATION

In addition to the GPS coordinates logged during the deployment, the position of the mooring placed on the sill of Masfjorden was for training purposes confirmed by triangulation. In this procedure, the distance between the ship and the mooring is determined using the acoustic communicator of the mooring release. Measuring the distance from three different locations, the position of the mooring can be triangulated. The three measurements are summarized in Table ? and the results are shown in Figure ?.

Table 2. Locations and distances from the mooring used for the triangulation.

	Position 1	Position 2	Position 3
Distance from mooring [m]	363.2	148.2	372.0
Latitude	60° 48.149' N	60° 48.266' N	60° 48.262' N
Longitude	5° 17.507' E	5° 17.978' E	5° 17.473' E

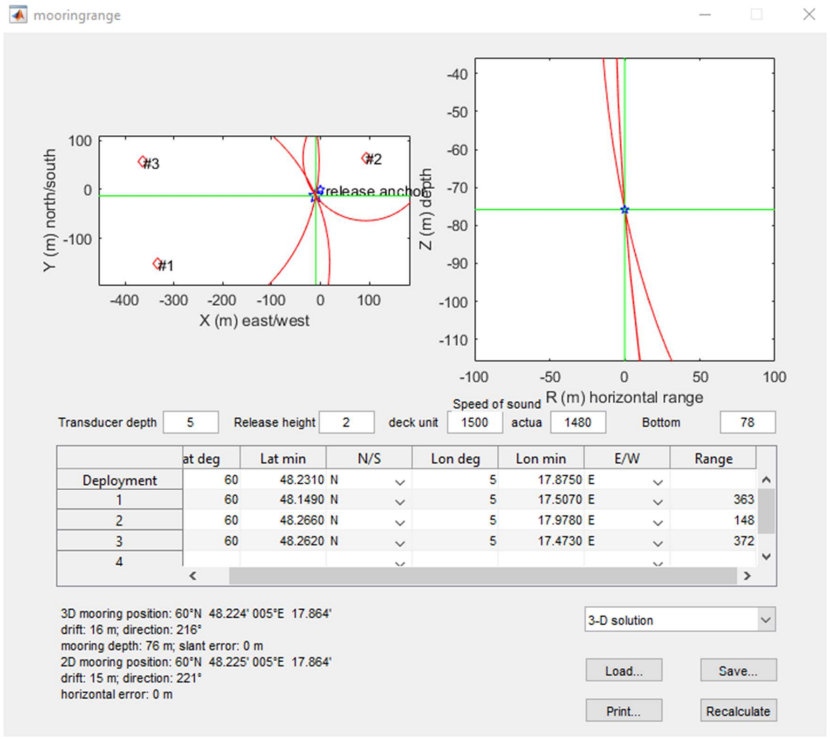

Figure 7.1 Triangulation of the Masfjord Sill mooring

7.3 MOORING RECOVERY

A mooring deployed in the vicinity of the sill of Lurefjorden (60°43.847' N, 4° 58.625' E, 50 m depth) on 2/2 2022 was recovered 24/2 13:50 UTC. See Appendix D for mooring drawing. The data from the ADCP was later processed by Kristin Svingen at Nortek. See appendix F for details.

Only one of the two mini-moorings deployed 2/2 2022 on either side of the Lurefjorden sill (Table X) could be recovered. The second one was nowhere to be found. We hypothesize that someone has picked it up to look at it, and that it then has been deployed to deep for the buoy to reach the surface.

Commented [KD1]: Specify which one

Table 3. MINI-MOORING DEPLOYMENT

	Longitude	Latitude	Date & time Deployment / recovery	Sensor, sn	Sampling interval
Mini – mooring 1	4 56.891E	60 44.300N	2/2 15:20 24/2 08:30	SBE39 sn 3252	10 s
Mini – mooring 2	4 59.107E	60 43.944N	2/2 15:25 MISSING	RBR Duo 051098	1 s

8 THERMOSALINOGRAPH (GEOF232) (ANDREA)

The thermosalinograph is placed on the starboard side on the ship and measures continuously temperature and conductivity 3m below sea level. From the conductivity measurements one can estimate salinity values. The salinity is given in g/kg and ranges from 18-34g/kg and the temperature is given in °C and ranges from 5-10 °C.

The instrument takes measurements every 3 seconds. Even though it is supposed to measure continuously during the whole cruise, the measurements are instead taken irregularly, and not every day. This results in problems with using the thermosalinograph data for further research, as there is not a regular interval of datapoints and great gaps with no data during the whole period.

Table 4. Overview of thermosalinograph measurments periods

Dates	23.02.2022	24.02.2022	25.02.2022	26.02.2022	27.02.2022	28.02.2022	01.03.2022
Data taken	10.25 – 16.00	05.00 – 12.46	*No data*	13.47 – 19.00	07.09 – 11.55	07.10 – 7.55	07.42 – 08.41

9 CTD PROFILING (GEOF337+GEOF232)

9.1 SHIP CTD

CTD casts were taken in all fjords visited during the cruise. The measured profiles of temperature, conductivity (salinity), dissolved oxygen content and pressure are used to characterize the hydrography of the investigated areas. Put in context of measurements from previous years, annual changes can be identified. In addition to the continuous profiles of the variables listed above, water samples were taken at selected depth levels at most stations and “manually” analyzed for their dissolved oxygen content using Winkler titration. The results are used for calibrating the CTD oxygen probem.

The first station during the cruise was located outside Bergen (“Bystasjonen”, 23.02.2022, 10:30 UTC) and served as a training station for the cruise participants to get familiar with the system used on RV Kristin Bonnevie. From 23.02.2022 to 26.02.2022, CTD sections were taken in Lurefjorden, Fensfjorden and Masfjorden, for details see Table ? and Figure ?.

From 26.02.2022 to 01.03.2022, CTD sections were taken in Sørfjorden, Osterfjorden, Romarheimsfjorden,Eidsfjorden and Veafjorden.

Table: sensors & calibration date

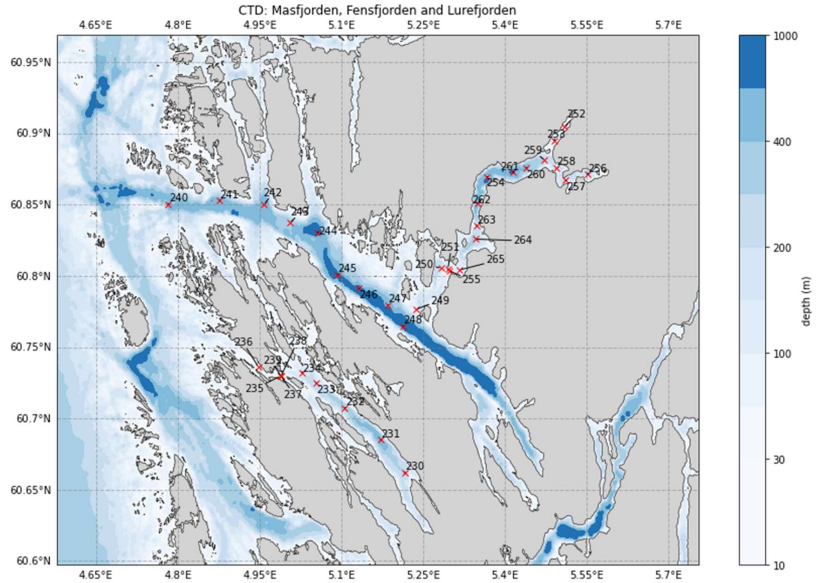

Figure 9.1. CTD overview of all stations in Masfjorden, Fensfjorden, and Lurefjorden with depth contours at latitude and longitude

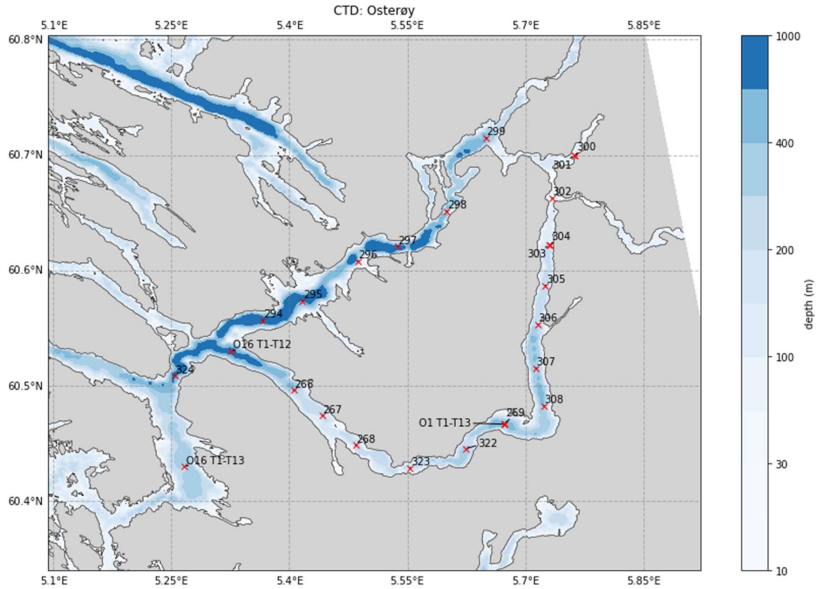

Figure 9.2. CTD overview of all stations in the osterø area with depth contours at latitude and longitude

Table 5. Overview of CTD sections

Section	Date Occupied	Number of Stations
Lurefjorden	23.02.2022 20:30 UTC – 24.02.2022 06:00 UTC	7; LF01 – LF07
Fensfjorden	24.02.2022 21:30 UTC – 25.02.2022 03:30 UTC	8; F2 – F9; F1 skipped due to high waves
Masfjorden	25.02.2022 04:00 UTC – 26.02.2022 08:00 UTC	17 , M04 – M35
Haugsværfjorden	25.02.2022 12:00 UTC – 25.02.2022 13:00 UTC	2; H3, H7
Sørfjorden	26.02.2022 18:40 UTC – 01.03.2022 07:16 UTC	12; O21,O20,O19,O16 (12 takes),O1(13 takes), O10,O11 (2 takes),O12, O13,O14,O15,O16 (13 takes)
Osterfjorden	28.02.2022 06:40 UTC – 28.02.2022 16:30 UTC	7; O2- O6, O8, O9(2 takes)

Include figures of CTD-sections showing SA, CT, and OX

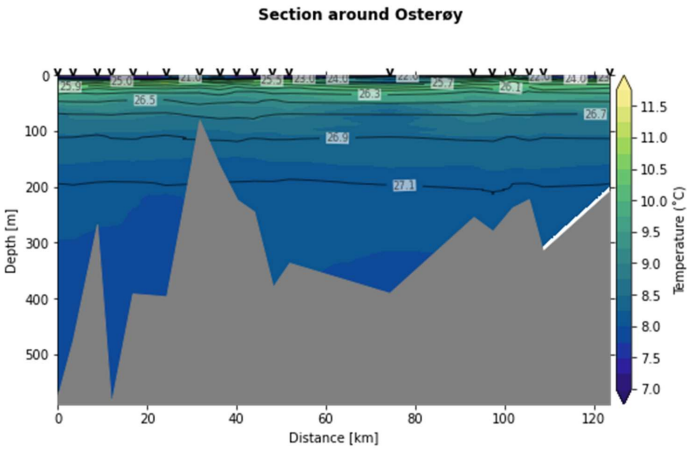

Figure 9.3. CTD section around Osterøy for conservative temperature

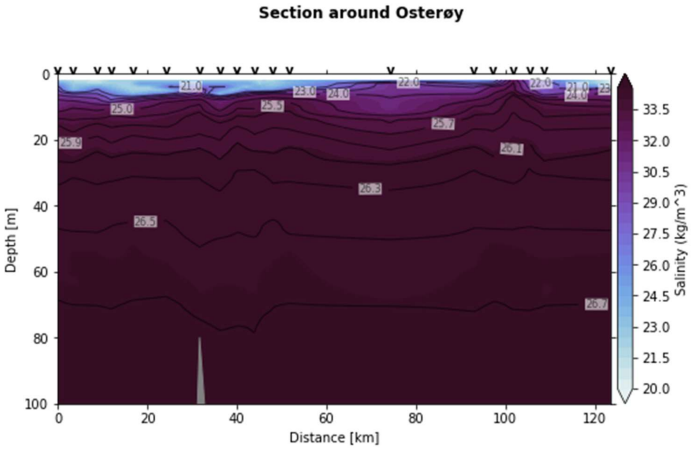

Figure 9.4. CTD section around Osterøy for absolute salinity (only upper 100m)

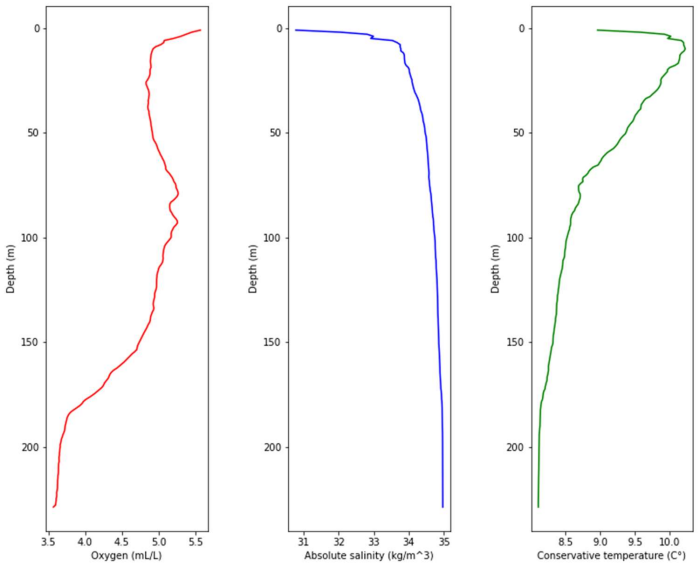

Figure 9.5. CTD-profile of oxygen, absolute salinity and conservative temperature w/ depth at station 294 in Osterfjorden

9.2 MINI CTD

The mini CTD measured conductivity, temperature and pressure in the upper ~10 meters. It was used at four locations across Masfjorden, at one location in Osterfjorden and at one location in Eidsfjord, see Table #?. It measures with a higher resolution (0.2 meters?) than the CTD and needs to be lowered slowly by hand. The measurements were taken from a smaller boat to prevent disturbances.

Comment on the problems with the mini-CTD. No data from the first CTD-section (Jakob can help describe the problem)

Information about the mini CTD – brand, resolution, seettings

Table 6. Overview of mini CTD sections

Section	Date Occupied	Number of stations
Osterfjorden	27.02.2022 12:42 UTC – 27.02.2022 13.15 UTC	1
Eidsfjord	28.01.2022 13:46 UTC – 28.02.2022 14:15 UTC	1

During the cruise of 6 days, 95 CTD measurements were taken in 10 different fjords and 6(?) mini CTD measurements were taken in 3 different fjords.

9.3 7.1 SALT CALIBRATION (GEOF337)

The conductivity measurements from the CTD were calibrated using water samples of salinity from a total of 104 bottles taken from 55 stations (table 8). The salinity was measured after the cruise by Kristin Jackson-

Misje and students from GEOF232 using a Portasal 8410A salinometer. For the calibration, the conductivity was calculated from the salinity samples with the Gibbs SeaWater toolbox, using the pressure and temperature from the CTD at the sample depth. The conductivity was then compared to the conductivity measured by the CTD when the samples were taken. 11 outliers were removed iteratively by repeatedly removing samples where the conductivity difference between samples and CTD were outside the 2 standard deviation range (3 iterations). Finally, a linear regression revealed that the CTD's conductivity sensor only had constant offset to the sample conductivity (slope close to 1; Figure 9.6). We removed calibration values above 100 m depth because the offset was too variable there (Figure 9.7) and applied a mean offset of 0.018 S/m which was added to the CTD's conductivity measurements.

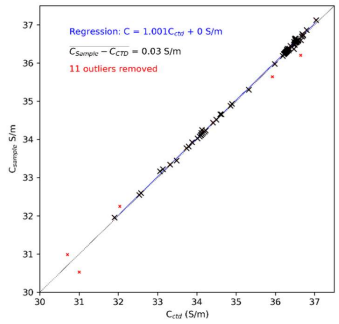

Figure 9.6. Linear regression of conductivity from samples and conductivity from CTD using all samples (black crosses) except outliers (red crosses). Regression slope (assuming no offset) and mean offset are given in the top left.

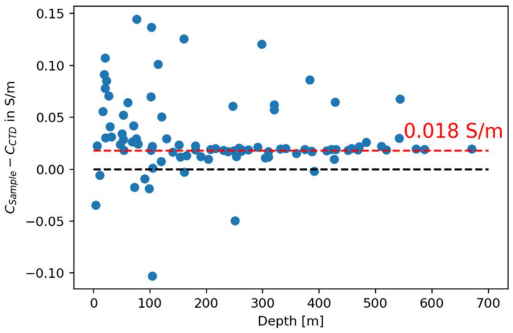

Figure 9.7. Difference between sampled conductivity and CTD conductivity as a function of the sample depth. The final correction offset of 0.018 S/m is shown in red.

10 CURRENT PROFILING USING VESSEL-MOUNTED ADCP (VMADCP) GEOF232

The vessel-mounted Acoustic Doppler Current Profiler was running throughout the cruise using standard settings: narrowband mode, with 50 bins of length 8.0 m and blanking distance 4.0 m. Narrowband mode causes a long range for the measurements, but with lower resolution. Sampling rate was set to 1.10 seconds.

Processing of data is done automatically by the ADCP-system on board. It uses CODAS (Common Ocean Data Access System) to calculate ocean velocities from ADCP measured velocities, positions, and heading.

The ADCP recorder throughout the whole cruise. The time period of interest is the thirteen hours between 28.02, at 19:19 UTC and 01.03, at 07:16 UTC. At this time period we were stationed outside of Bruvik.

11 MICROSTRUCTURE PROFILING (GEOF337)

Microstructure Sonde (MSS) profilers are instruments providing measurements of high resolution for temperature, salinity, pressure, and velocity shear in the water column. The detailed measurements allow calculation of properties such as turbulence dissipation rates.

For best possible data quality, the MSS should be deployed in freefall vertically. This leads to a risk of hitting the instrument hitting the seafloor if too much cable is released. Although the sensors are situated within a steel ring, a collision with the bottom is likely to cause them damage as they are extremely fragile. Good communication between the crew lowering the MSS and the students monitoring and recording data is therefore necessary. This was solved using a buzzer as means of communication. To ensure the instrument is lowered vertically, weights are installed at the bottom and buoyancy at the top.

Section	Date Occupied	Number of Stations
Lurefjorden	23.02.2022 16:00 UTC – 23.02.2022 18:30 UTC	2; LF02 – LF07
Masfjorden	25.02.2022 07:00 UTC – 26.02.2022 18:30 UTC	10 , M11, M12, M14, M_bonus, M_shallow, M18, M22, M24, M28, M31

Figure 11.1. Overview of MSS sections

Table: list of sensors

Figure: Map showing Time series location and locations of sections/stations

Full list of MSS-stations in the appendix

12 OXYGEN SAMPLING (GEOF232) (ESKIL)

On the CTD instrument, there were attached multiple water sampling bottles that were able to take water samples at various depths. We were able to take a total of 206 water samples at different depths at a total of 20 stations (O stations). With all our water samples we had to undergo the Winkler Titration to analyze our results. Before the titration we had to make sure that the samples were not to be contaminated.

We started by attaching our sampling tube to the Niskin bottle. Then we removed air bubbles by gently pressing the tube while the water was running. We then rinsed the sample bottle, the bottle cap and bottle tube three times. Afterwards we proceeded to measure the temperature. While measuring temperature we made sure that we let the bottle overflow three times. The tube had to be at the bottom of the bottle. While the water was still flowing, we removed the bottle. 1 mL of $MnCl_2$ were added followed by 1 mL of NaOH & NaI. In some of the samples with there were attained a brown precipitate. This indicated an oxygen-rich sample. The bottle was then gently stoppered after checking for air bubbles. In the case of air bubbles, the bottle would be declared contaminated, and

then it was discarded. Throughout the entire sampling process, we had to make sure that no air bubbles had occurred.

On the lab onboard we then proceeded to the Winkler titration. The precipitate in the samples were dissolved by adding 1mL of H_2SO_4. A magnet stirrer was used to mix the solution. 0,1 mL (Dose A) of NaS_2O_3 were added as doses until the solution was colorless. 3-4 drops of starch were then added as an indicator. The solution then became purple. Again, we added doses of NaS_2O_3, but this time the doses were 0,01 mL (Dose B). This was repeated till the solution again became colorless. The entire process was done onboard.

Table 7. Table from water samples at station 229. Here at bottom depth, 229. We have 14 water samples showing that the Oxygen level is at about 4,3-4,4 (mL/L). This is around the minimum for marine life to survive. It is nowhere near favorable conditions.

Samples							
Station	Niskin	Depth	Flask	Draw Temp	Salinity	O2(mL/L)	O2(µmol/kg)
229	1	321	49	10,7	34,8564	4,343	188,9
229	2	321	36	10,7	34,8564	4,425	192,5
229	3	321	40	11	34,8564	4,339	188,7
229	4	321	41	11	34,8564	4,33	188,4
229	5	321	60	10,7	34,8567	4,322	188
229	6	321	45	10,6	34,8566	4,402	191,5
229	8	321	50	10,2	34,8565	4,324	188,1
229	9	321	38	10,7	34,8566	4,38	190,5
229	10	321	76	10,3	34,8567	4,322	188
229	11	321	53	10,8	34,8567	4,354	189,4
229	11	321	74	11,3	34,8567	4,379	190,5
229	12	321	43	10,5	34,8566	4,356	189,5
229	12	321	46	10,9	34,8566	4,329	188,3

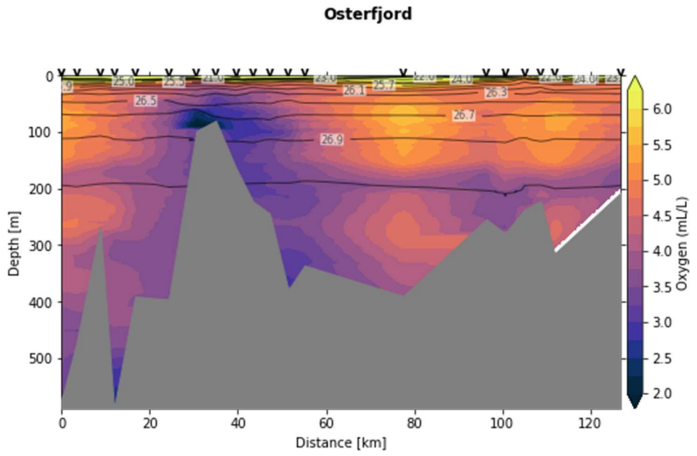

Figure 12.1. Shows oxygen levels at depths from station 294 (Hamre), clockwise around Osterøy, and then to station 309 (Hamre).

13 OTHER BIOGEOCHEMICAL SAMPLING (GEOF232) (GARD)

There was also taken samplings of salinity, nutrients and carbon dioxide at various depths, through the CTD instrument. For salinity measuring, own bottles were used. These were washed three times, before filling them up and sending them to lab.

For nutrients, own bottles were rinsed two times before they were filled to the neck. 0.2 mL chloroform was added to prevent organisms to affect the nutrient level in the bottle. After the chloroform was added, the bottles were stored in a fridge until they were analyzed.

The sampling procedure for carbon dioxide was as followed. As for the oxygen and temperature, a tube was used to transport the water from the CTD instrument to the bottles. The tube was squeezed while water was flowing through to remove oxygen bubbles inside the tube. The bottles were rinsed two times before they were filled. Once the bottles were filled, a droplet of $HgCl_2$ was added to kill the biological activity in the sample. Then, greased caps were put on the bottles, and the bottles were turn upside down three times, before sending them to lab. It was only taken carbon dioxide and nutrient measures at station 278.

SALINITY

Table 8. TABLE THAT SHOWS THE SALINITY AT DIFFERENT PLACES AND DEPTH THROUGHOUT THE CRUISE.

CTD File	Date			UTC	Depth	Latitude		Longitude			
	year	mon	day	hh:mm	m	deg	min	deg	min	Bottle label	Salinity
229	2022	2	23	09:26	333	60	25,793	5	15,96	7125	34.916
229	2022	2	23	09:26	333	60	25,793	5	15,96	7124	34.921
230	2022	2	23	20:27	292	60	39,894	5	14,037	7123	33,345
231	2022	2	23	21:30	422	60	41,113	5	10,358	7122	33,226
231	2022	2	23	21:30		60	41,113	5	10,358	7121	33,225
231	2022	2	23	21:30		60	41,113	5	10,358	7120	33,225
231	2022	2	23	21:30		60	41,113	5	10,358	7119	33,218
231	2022	2	23	21:30		60	41,113	5	10,358	7118	33,206
231	2022	2	23	21:30		60	41,113	5	10,358	7117	33,183
231	2022	2	23	21:30		60	41,113	5	10,358	7134	33,004
231	2022	2	23	21:30		60	41,113	5	10,358	7133	32,77
231	2022	2	23	21:30		60	41,113	5	10,358	7132	32,619
231	2022	2	23	21:30		60	41,113	5	10,358	7131	32,424
231	2022	2	23	21:30		60	41,113	5	10,358	7130	31,931
231	2022	2	23	21:30		60	41,113	5	10,358	7129	31,266
232	2022	2	23	23:06	368	60	42,457	5	6,378	7128	33,228
233	2022	2	24	00:08	240	60	43,516	5	3,186	7127	33,277
234	2022	2	24	01:13	180	60	43,943	5	1,617	7126	33,221
235	2022	2	24	05:26:58	90	60	43,79	4	59,344	7135	32,417
236	2022	2	24	06:06	64	60	44,1743	4	56,8759	7136	32,045
240	2022	2	24	21:37	390	60	51,039	4	46,934	7148	35,121
241	2022	2	24	22:30	466	60	51,18	4	52,562	7152	35,072
241	2022	2	24	22:30		60	51,18	4	52,562	7137	34,875

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241	2022	2	24	22:30		60	51,18	4	52,562	7138	34,169
241	2022	2	24	22:30		60	51,18	4	52,562	7139	33,97
241	2022	2	24	22:30		60	51,18	4	52,562	7140	33,1
242	2022	2	24	22:59	435	60	51,016	4	57,501	7141	35,119
242	2022	2	24	22:59		60	51,016	4	57,501	7142	34,67
242	2022	2	24	22:59		60	51,016	4	57,501	7143	33,067
243	2022	2	24	23:51	353	60	50,234	5	0,336	7144	35,049
243	2022	2	24	23:51		60	50,234	5	0,336	7145	34,19
243	2022	2	24	23:51		60	50,234	5	0,336	7146	33,413
244	2022	2	25	00:43	557	60	49,839	5	3,328	7147	35,151
244	2022	2	25	00:43		60	49,839	5	3,328	7149	34,813
244	2022	2	25	00:43		60	49,839	5	3,328	7150	34,112
245	2022	2	25	01:38	523	60	48,06	5	5,58	7151	35,098
279	2022	2	27	08:04	421	60	28,026	5	40,424	7192	30,978
279	2022	2	27	08:04		60	28,026	5	40,424	7191	32,331
279	2022	2	27	08:04		60	28,026	5	40,424	7190	34,015
279	2022	2	27	08:04	421	60	28,026	5	40,424	7189	34,328
281	2022	2	27	16:32	390*	60	31,805	5	19,567	7193	34,883
294	2022	2	28	06:19	569	60	33,386	5	21,997	7194	34,884
295	2022	2	28	07:19	484	60	34,418	5	25,044	7198	28,937
295	2022	2	28	07:19		60	34,418	5	25,044	7197	33,912
295	2022	2	28	07:19		60	34,418	5	25,044	7195	34,886
295	2022	2	28	07:19		60	34,418	5	25,044	7207	19,622
296	2022	2	28	08:37	265	60	36,471	5	29,209	7206	34,864
296	2022	2	28	08:37		60	36,471	5	29,209	7204	33,945
296	2022	2	28	08:37		60	36,471	5	29,209	7203	32,816
296	2022	2	28	08:37		60	36,471	5	29,209	7202	28,715
297	2022	2	28	09:28	580	60	37,254	5	32,262	7205	34,882
298	2022	2	28	11:28	390	60	39,082	5	36,01	7201	34,88
299	2022	2	28	11:51	401	60	42,907	5	39,023	7200	13,933
299	2022	2	28	11:51		60	42,907	5	39,023	7216	11,284
299	2022	2	28	11:51		60	42,907	5	39,023	7218	34,846
303	2022	2	28	15:27	171	60	37,31	5	43,79	7215	34,706
305	2022	2	28	16:25	225	60	35,212	5	43,5	7214	34,831
306	2022	2	28	17:07	247	60	33,193	5	43,947	7213	34,834
307	2022	2	28	17:46	380	60	30,915	5	42,803	7212	34,838
308	2022	2	28	18:28	335	60	28,948	5	43,41	7211	34,843
322	2022	3	1	07:51	243	60	26,713	5	37,44	7210	34,839
323	2022	3	1	08:27	280	60	25,713	5	33,214	7209	34,84
324	2022	3	1	10:04	512	60	30,523	5	15,265	7217	34,886

NUTRIENTS

Table 9. Table that shows the nutrient level at station 279 at different depths.

CTD file	Time	Latitude	Longitude	Depth 1 [m]	Prøve ID	NO2 µmol/l	NO3 µmol/l	PO4 µmol/l	Si µmol/l
279	27/02/22 08:04	60 28,026	5 40,424	413	278 12	0,04	6,5	0,37	4,4
279	27/02/22 08:04	60 28,026	5 40,424	310	278 11	0,03	0,0	0,02	3,5
279	27/02/22 08:04	60 28,026	5 40,424	258	278 10	0,34	0,0	0,07	5,6
279	27/02/22 08:04	60 28,026	5 40,424	258	278 9	0,05	11,2	0,93	7,2
279	27/02/22 08:04	60 28,026	5 40,424	181	278 8	0,40	9,8	0,89	7,8
279	27/02/22 08:04	60 28,026	5 40,424	130	278 7	0,02	0,0	0,00	8,9
279	27/02/22 08:04	60 28,026	5 40,424	104	278 6	0,03	12,6	1,16	9,6
279	27/02/22 08:04	60 28,026	5 40,424	79	278 5	1,31	8,6	1,14	13,9
279	27/02/22 08:04	60 28,026	5 40,424	53	278 4	0,23	14,5	1,57	15,2
279	27/02/22 08:04	60 28,026	5 40,424	27	278 3	0,47	13,7	1,59	15,2
279	27/02/22 08:04	60 28,026	5 40,424	8	278 2	0,02	14,8	1,74	16,8
279	27/02/22 08:04	60 28,026	5 40,424	4	278 1	0,03	15,3	2,03	21,2

CARBON DIOXIDE

Table 10. Table that shows carbon and alkalinty level at different depths at station 279.

Bottle number	Time	Latitude	Longitude	Niskin	Depth [m]	DIC (µmol/kg)	Alkalinity (µmol/kg)
7458	27/02/22 08:04	60 28.026	5 40.424	1	413	2279.77	2328.51
7459	27/02/22 08:04	60 28.026	5 40.424	2	310	2253.31	2322.17
7460	27/02/22 08:04	60 28.026	5 40.424	3	258	2245.83	2320.52
7460	27/02/22 08:04	60 28.026	5 40.424	3	258	2243.83	2318.80
7462	27/02/22 08:04	60 28.026	5 40.424	5	181	2238.17	2316.42
7463	27/02/22 08:04	60 28.026	5 40.424	6	130	2197.38	2308.23
7464	27/02/22 08:04	60 28.026	5 40.424	7	104	2198.20	2304.92
7465	27/02/22 08:04	60 28.026	5 40.424	8	79	2184.68	2302.12
7466	27/02/22 08:04	60 28.026	5 40.424	9	53	2184.84	2295.69
7467	27/02/22 08:04	60 28.026	5 40.424	10	27	2170.06	2283.42
7468	27/02/22 08:04	60 28.026	5 40.424	11	8	2062.71	2183.73
7469	27/02/22 08:04	60 28.026	5 40.424	12	4	1984.34	2099.42

14 CARBON ISOTOPES (GEOF337)

The water samples for the isotope measurements were taken from the CTD Rosette at bottom depth, 5 meters and one depth in between at selected stations in all fjords (table with stations). The samples were treated with mercury chloride to preserve them for further analysis and stored in the fridge.

Table 11. Overview of the carbon isotope samples

Station	Niskin	Depth	Lat	Lon
231 (LF2)	1	426	60 41.10 N	5 10.35E
	8	53		
	12	5		
233 (LF4)	1	247	60 43.51N	5 03.19E
	3	51		
	7	6		
246 (F8)	1	541	60 47.47N	5 07.90E
	2	251		
	3	6		
249 (M7)	1	120	60 46.59N	5 14.20E
	2	63		
	3	6		
252 (H3)	1	114	60 54.27N	5 30.55E
	5	32		
	8	6		
254 (M24)	1	468	60 52.18N	5 22.06E
	2	182		
	3	6		
256 (M35)	1	180	60 52.28N	5 33.08E
	2	81		
	3	6		
260 (M28)	1	422	60 52.55N	5 26.36E
	3	6		
261 (Mdeep)	2	52	60 52.36N	5 24.94E
264 (M16)	1	291	60 49.55N	5 20.75E
	2	74		
	3	7		

15 WATER ISOTOPES (GEOF232) (KATE)

We collected surface water samples using a small boat to go to areas where we assumed freshwater input. Using a syringe we collected water samples and transferred them into tiny bottles to examine on land later. We chose to go to Fotlandsvågen and Lonevågen to sample fresh water inputs. Taking one sample at the end of the river, one sample at the entrance of the river, and one in-between. This we did for both rivers including one extra sample in-between the two rivers. Overall we took 7 samples in these areas. We also took mini-CTDs at every sample spot, but this data was unsuccessful because of instrumental error. Due to instrumental error we will not be using the data collected on the small boat trip 27.feb as it is not reliable.

As we were not able to collect the mini-CTD data we took the small boat out again. This time we collected samples and mini-CTD in Romheimsvågen. Taking 3 samples and 3 mini-CTDs in the same areas.

Further we took samples from the CTD water samples collected into Niskin bottles from stations O3, O4 and O8. At each station 3 isotope samples were retrieved at depths of from 4-22 m as we are more interested in the surface layer.

Tabel of the isotopes taken from Lonevågen and Fotlandsvågen

Name	Position	Date-Time		dD			d18O		
				f_H	f_A		f_H	f_A	
L_1	60˚31.716 5˚29.045	27.02 - 13:55		43%	57%		42%	58%	
L_2	60˚32.417 5˚28.067	27.02 - 14:04		70%	30%		70%	30%	
L-3	60˚33.834 5˚26.260	27.02 - 14:20		70%	30%		71%	29%	
L-F	60˚35.560 5˚27.191	27.02 - 14:36		57%	43%		58%	42%	
F_1	60˚35.485 5˚31.152	27.02 - 14:59		16%	84%		17%	83%	
F_2	60˚35.676 5˚30.753	27.02 - 15:08		26%	74%		26%	74%	
F_3	60˚36.136 5˚29.931	27.02 - 15:15		46%	54%		47%	53%	

16 DRIFTERS (GEOF232) (FRIDA)

Drifters are used to collect information about ocean circulations and other parameters like temperature and salinity. The locations of the drifters are tracked by a GPS, and can be monitored by your phone. Before a drifter is placed in the ocean, a weight must be added if you want to collect information below 1 m. The drifters movements are affected by the wind, the inner ocean circulation or the tides. As they float it is easy to see how the drifters moves with the flow.

We have two different depths of the drifters to compare the effect by the wind, the inner ocean circulation or the tides at 1- and 10-meters depth. All three drifters were placed out twice, and the set out point can be seen on the figures below.

Figure 16.1. Maps showing the deployment cites for drifters

Table 12. Time in the datafiles are given in normal Norwegian winter time (UTC+1). Table with position, time, drifter depth for deployment and recovery. Drifter 1 and 4 at surface. Drifter 2 at 10m depth

Drifter #	Deploy date/ time	Deploy Lat	Deploy Lon	Recovery date/ time	Recovery Lat	Recovery Lon	Comment
1	27.02.22/ 12.20	60*33.261	5*24.294	27.02.22/ 15:32	60.575312	5.404555	1 m depth
2	27.02.22/ 12.20	60*33.261	5*24.294	27.02.22/ 15:40	60.563138	5.394203	10 m depth
4	27.02.22/ 12.20	60*33.261	5*24.294	27.02.22/ 15:32	60.575312	5.404555	1 m depth
1	28.02.22 /22:04	60*27.903	5*40.416	01.03.22/ 07:01 UTC	60.453695	5.636971	1m depth
2	28.02.22 /22:04	60*27.903	5*40.416	01.03.22/ 07:04 UTC	60.452229	5.630105	10 m depth
4	28.02.22 /22:04	60*27.903	5*40.416	01.03.22/ 06:57 UTC	60.458216	5.645081	1 m depth

Appendix A: Cruise Narrative (everybody)

KB2022605: Cruise narrative (UTC)

Day 1 Wednesday 23.02.2022

08:00 Everyone arrived. Familiarization.

10:00 Departure

10:30 CTD, Byfjorden, station 4

15:00 Shift change

15:59 MSS station (LF02)

16:25 MSS station (LF03)

17:08 MSS station (LF04), hiccup around 15 m

17:29 MSS station (LF05)

17:51 MSS station (LF06)

18:33 MSS station (LF07) stopped, too many currents. Steaming towards L1.

19:00 Shift change

20:26 Arrive at LF01

20:27 CTD station (LF01)

21:30 CTD station (LF02)

23:06 CTD station (LF03)

00:08 CTD station (LF04)

01:13 CTD station (LF05)

01:51 End of nightshift, leaving LF06 & LF07 for the morning shift

Day 2 Thursday 24.02.2022

05:00 Start of morning shift

05:26 CTD station (LF06)

06:06 CTD station (LF07)

07:00 Started MSS – timeseries at LF06. Communication trouble at the end of the cast. Helge has to re-terminate the cable

08:30 mini-mooring recovery: successful recovery outside the sill, mooring inside the sill missing

08:30 – 10:30 Checked and started the micro cats and seaguards for the mooring tomorrow, meanwhile the oxygen samples from the last shift were titrated

10:07 CTD station (LF06)

11:00 Shift change

11:00 CTD station (LF06)

12:00 CTD station (LF06)

12:24 MSS test (one failed, one successful) (LF06)

12:00 - 13:00 Titration

13:34 MSS (failed at the bottom) (LF06)

14:00 picked up current meter/ADCP/mooring

14:40 – 16:15 ADCP, buoys and mooring preparation for tomorrow

15:00 Shift change

16:00 MSS (LF06)

17:30 MSS (LF06)

18:50 MSS (LF06)

19:00 Shift Change

20:40 CTD (F1) skipped because of too high waves

21:37 CTD station (F2)

22:30 CTD station (F3) Niskin bottle 4 broke (white water tube fell off)

22:59 CTD station (F4)

23:51 CTD station (F5)

Day 3 Friday 25.02.2022

00:43 CTD station (F6)

01:38 CTD station (F7)

02:22 CTD station (F8)

03:00 Shift Change

03:16 CTD station (F9)

04:04 CTD station (M04)

04:50 CTD station (M07)

05:34 CTD Station (M11)

06:06 CTD Station (M12)

07:00 Start MSS section

07:09 MSS (M11)

07:35 MSS (M12) lost contact around 51 m but regained it after a few seconds

07:40 MSS (M12) redo to get full profile at this station

08:00 MSS (M14)

08:15 –10:00 Titration of the oxygen samples from the previous and current shift

08:30 – 10:15 Work on the moorings, connecting instruments and preparing for deployment

08:25 MSS (M_bonus) extra MSS due to error of the bridge

08:55 MSS (MF Shallow)

09:21 MSS (M18)

09:41 MSS (M22)

10:19 MSS (M24 inner)

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11:00 Shift change

12:07 CTD station (H3)

12:38 CTD station (H7)

13:20 CTD station (M24 inner mooring)

14:35 MF inner Mooring deployed

15:00 Shift change

15:30 CTD station (M12/MF Sill)

15:44 MF sill Mooring deployed

16:00 mini CTDs

16:30 sill mooring triangulation

17:40 MSS (M28)

18:13 MSS (M31)

18:52 CTD station (M35)

19:00 Shift Change

19:44 CTD station (M33)

20:24 CTD station (M32)

20:47 CTD station (M31) metal bands came off niskin 3

21:11 CTD station (M28)

21:41 CTD station (M deep)

Day 4 Saturday 26.02.2022

03:00 Shift Change

05:10 CTD station (M22)

5:46 CTD station (M18)

6:14 CTD station (M16), carbon isotope sampling

7:18 CTD station (M14), carbon isotope sampling

15:30 Change from master students to bachelor students

18:40 CTD Station O21

19:23 CTD Station O20

20:20 CTD station O19

21:40 CTD station O16 T1

22:30 CTD station O16 T2

23:30 CTD station O16 T3

Day 5 Sunday 27.02.2022

00:30 CTD station O16 T4

01:30 CTD station O16 T5

02:30 CTD station O16 T6

03:30 CTD station O16 T7

04:31 CTD station O16 T8

05:30 CTD station O16 T9

06:20 CTD station O16 T10

08:04 CTD station O16 T11. O2, Carbon, Salinity, Nutrients sampling (12 stk)

10:02 CTD station O16 T12

12:20 set out three drifters

12:42 miniCTD sampling in Osterfjorden start

15:30 recovery of the three drifters with small boat.

16:30 Helge and Iris left the ship at Steinestø.

17:30 CTD station O1 T1 (ikke UTC)

18:30 CTD station O1 T2

19:30 CTD station O1 T3

20:30 CTD station O1 T4

21:30 CTD station O1 T5

22:30 CTD station O1 T6

23:30 CTD station O1 T7

Day 6 Monday (28.02.2022)

00:30 CTD station O1 T8

01:30 CTD station O1 T9

02:30 CTD station O1 T10

03:30 CTD station O1 T11

04:30 CTD station O1 T12

05:30 CTD station O1 T13 End of 12h station at O1

06:19 CTD station O2. Start of Osterfjorden transect. Oxygen and salinity samples (UTC)

07:16 CTD station O3. Oxygen, salinity and isotope samples.

08:37 CTD station O4. Oxygen, salinity and isotope samples.

09:28 CTD station O5. Oxygen, salinity

11:28 CTD station O6. Oxygen, salinity

11:51 CTD station O8. Oxygen, salinity and isotope samples.

12:00 Small boat left to collect water samples in Bolstadfjorden.

13:46 CTD station O9. Top of the fjord covered with ice, measurement also taken with mini CTD, in Eidsfjord.

14:05 CTD station O9 retake Measurements started at 6m depth, in Eidsfjord.

14:41 CTD station O10. Oxygen, salinity

15.27 CTD station O11. Oxygen, salinity. Error with data. Pump probably not started at correct time

15.57 CTD station O11 retake. Down and up to get the correct data

16.25 CTD station O12. Oxygen, salinity

17:07 CTD station O13. Oxygen, salinity.

17:46 CTD station O14. Oxygen, salinity

18:28 CTD station O15. Oxygen, salinity.

19:19 CTD station O16 (T1) Start of timeseries

20:29 CTD station O16 (T2).

21:29 CTD station O16 (T3)

22:04 Set out three drifters.

22:30 CTD station O16 (T4)

23:31 CTD station O16 (T5)

Day 7 Tuesday (01.03.2022)

00:30 CTD station O16 (T6)

01:30 CTD station O16 (T7)

02:32 CTD station O16 (T8)

03:31 CTD station O16 (T9)

04:31 CTD station O16 (T10)

05:30 CTD station O16 (T11)

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06:20 CTD stations O16(T12)

06:50 recovery of the three drifters with small boat.

07:16 CTD stations O16(T13)

07:51 CTD station O17

08:27 CTD station O18

10:04 CTD station O22

Appendix B: List of CTD stations

Vessel: Kristine Bonnevie

Cruise: KB 2022605

St.name	CTD File	Date			UTC	Depth	Latitude/ N		Longitude/ E		Water samples				Comments
		year	mon	day	hh:mm	m	deg	min	deg	min	Salt	O2	CT/ nutrient	Iso-topes	
Byfjorden sa 4	229	2022	2	23	09:26	333	60	25.793	5	15.967	1	1 to 12			
LF01	230	2022	2	23	20:27	292	60	39.894	5	14.037	1	1 to 7			
LF02	231	2022	2	23	21:30	422	60	41.113	5	10.358	1-12	1 to 12	1,8,12	1,3,8	
LF03	232	2022	2	23	23:06	368	60	42.457	5	06.378	1	1,2			
LF04	233	2022	2	24	00:08	240	60	43.516	5	03.186	1		1,3,7	1,3,7	
LF05	234	2022	2	24	01:13	180	60	43.943	5	01.617	1	1 to 5			
LF06	235	2022	2	24	05:27	90	60	43.790	4	59.344	2				
LF07	236	2022	2	24	06:06	64	60	44.174	4	56.876	1	1,2			
LF06	237	2022	2	24	10:07	91	60	43.781	4	59.362	1				
LF06	238	2022	2	24	11:00	90	60	43.789	4	59.362	1				
LF06	239	2022	2	24	12:00	90	60	43.790	4	59.362	1				
F2	240	2022	2	24	21:37	390	60	51.039	4	46.934	1	1 to 5			
F3	241	2022	2	24	22:30	466	60	51.180	4	52.562	1-5	1 to 5			
F4	242	2022	2	24	22:59	435	60	51.016	4	57.501	1,2,3	1,2,3			
F5	243	2022	2	24	23:51	353	60	50.234	5	00.336	1,2,3	1,2,3			
F6	244	2022	2	25	00:43	557	60	49.839	5	03.328	1,2,3	1,2,3			
F7	245	2022	2	25	01:38	523	60	48.060	5	05.580	1,2	1,2			
F8	246	2022	2	25	02:21	538	60	47.475	5	07.890	1,2,3	1,2,3	1,2,3	1,2,3	
F9	247	2022	2	25	03:16	451	60	46.780	5	11.103	1	1,2,3			
M04	248	2022	2	25	04:04	666	60	45.89	5	12.78	1	1,2,3,5			
M07	249	2022	2	25	04:50	149	60	46.574	5	14.238	1	1,2,3	1,2,3	1,2,3	
M11	250	2022	2	25	05:34	200	60	48.327	5	17.023	1	1,2,3			

M12	251	2022	2	25	06:06	117	60	48.315	5	17.744	1	1			
H3	252	2022	2	25	12:07	125	60	54.270	5	30.564	1-3	1 to 8		1,5,8	
H7	253	2022	2	25	12:38	98	60	53.703	5	29.463	1	1,2,3	1,5,8		
M24	254	2022	2	25	13:20	460	60	52.189	5	22.060	1	1,2,3	1,2,3	1,2,3	
M12	255	2022	2	25	15:30	78	60	48.227	5	17.872	1				
M35	256	2022	2	25	18:57	189	60	52.288	5	33.088	1	1,2,3	1,2,3	1,2,3	
M33	257	2022	2	25	19:44	184	60	52.022	5	30.717	1	1,2,3			
M32	258	2022	2	25	20:24	175	60	52.540	5	29.682	1	1,2,3			
M31	259	2022	2	25	20:46	275	60	52.875	5	28.388	1	1,2,3			
M28	260	2022	2	25	21:11	435	60	52.550	5	26.347	1	1,2,3	1,3	1,3	
Mdeep (M26)	261	2022	2	25	21:41	485	60	52.365	5	24.936	1	1,2,3	2	2	
M22	262	2022	2	26	05:10	428	60	51.051	5	20.995	1	1,2,3			
M18	263	2022	2	26	05:46	116	60	50.123	5	20.87	1	1,2,3			
M16	264	2022	2	26	06:14	299	60	49.555	5	20.772	1	1,2,3	1,2,3	1,2,3	
M14	265	2022	2	26	07:18	152	60	48.256	5	19.006	1	1,2,3		1,2,3	
O21	266	2022	2	26	18:40	316	60	29.767	5	24.347	1	1,2,3,4			
O20	267	2022	2	26	19:23	227	60	28.457	5	26.516	1	1,2,3			
O19	268	2022	2	26	20:20	240	60	26.903	5	29.067	1	1,2,3			
O16 T1	269	2022	2	26	21:40	425	60	28.010	5	40.416	1				Stillestående på O16 i 12 timer
O16 T2	270	2022	2	26	22:30	420	60	28.011	5	40.423					
O16 T3	271	2022	2	26	23.31	420	60	28.010	5	40.430					
O16 T4	272	2022	2	27	00.31	420	60	28.011	5	40.435					
O16 T5	273	2022	2	27	01:30	420	60	28.012	5	40.437					
O16 T6	274	2022	2	27	02:31	420	60	28.013	5	40.438					
O16 T7	275	2022	2	27	03:30	420	60	28.014	5	40.437					
O16 T8	276	2022	2	27	04:31	420	60	28.020	5	40.430					
O16 T9	277	2022	2	27	05:30	421	60	28.018	5	40.430					
O16 T10	278	2022	2	27	06:20	421	60	28.019	5	40.431					
O16 T10	279	2022	2	27	08:04	421	60	28.026	5	40.424		1,2,..,12			Full/deep station
O16 T12	280	2022	2	27	10:02	420	60	28.028	5	40.418					
O1 T1	281	2022	2	27	16:32	390*	60	31.805	5	19.567	1	1,2..,6			Stillestående på O1 i 12 timer, echolodd mulig hengt seg opp på 390m, ekte dybde 494m, altimeter fant ikke bunn
O1 T2	282	2022	2	27	17:31	390*	60	31.804	5	19.565					echolodd mulig hengt seg opp på 390m, ekte dybde 494m, altimeter fant ikke bunn
O1 T3	283	2022	2	27	18:34	494	60	31.805	5	19.565					
O1 T4	284	2022	2	27	19.49	494	60	31.800	5	19.575					
O1 T5	285	2022	2	27	20:29	494	60	31.801	5	19.574					
O1 T6	286	2022	2	27	21:29	494	60	31.800	5	19.573					
O1 T7	287	2022	2	27	22:48	494	60	31.801	5	19.573					
O1 T8	288	2022	2	28	23:30	494	60	31.801	5	19.574					

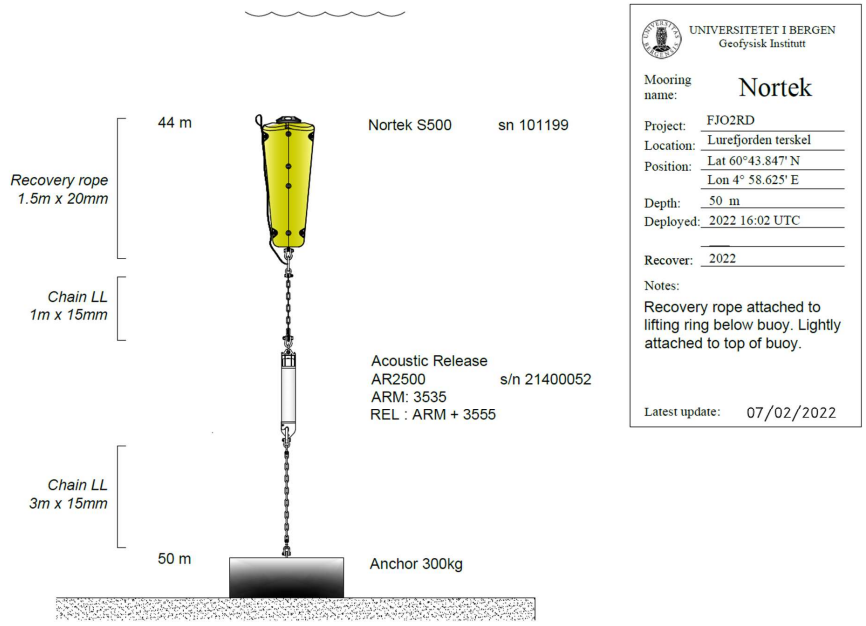
O1 T9	289	2022	2	28	00:31	493	60	31.800	5	19.574					
O1 T10	290	2022	2	28	01:30	493	60	31.801	5	19.574					
O1 T11	291	2022	2	28	02:30	493	60	31.802	5	19.568					
O1 T12	292	2022	2	28	03:29	493	60	31.806	5	19.568					
O1 T13	293	2022	2	28	04:31	494	60	31.810	5	19.567					
O2	294	2022	2	28	06:19	569	60	33.386	5	21.997	1	1,2,3,4			Osterfjord snitt begynner
O3	295	2022	2	28	07:19	484	60	34.418	5	25.044	1,6	1,2,3,4,5		6,7, bøtte	To flasker samme dyp (flaske 2 og 3)
O4	296	2022	2	28	08:37	265	60	36.471	5	29.209	1,5,6,7	1,3,4		5,6,7	To flasker samme dyp (flaske 2 og 3)
O5	297	2022	2	28	09:28	580	60	37.254	5	32.262	1	1, 3, 4, 5, 7, 8			
O6	298	2022	2	28	11:28	390	60	39.082	5	36.010	1	1, 3, 4			
O8	299	2022	2	28	11:51	401	60	42.907	5	39.023	1,5,6	1,3,4		5,6,bøtte	
O9	300	2022	2	28	13.46	100	60	41.973	5	45.721	1,4	1,3,4,5			Is på toppen av fjorden, målinger også tatt med mini CTD.
O9	301	2022	2	28	14:05	99	60	41.973	5	45.722					Målinger startet på 6m dyp
O10	302	2022	2	28	14:41	72	60	39.767	5	44.028	1	1,2,3			
O11 T1	303	2022	2	28	15:27	171	60	37.310	5	43.790	1	1,2,3			Noe feil med data på 303, så tok ny med kun data (304)
O11 T2	304	2022	2	28	15:57	164	60	37.337	5	43.868					
O12	305	2022	2	28	16:25	225	60	35.212	5	43.500	1	1,2,3,4			
O13	306	2022	2	28	17:07	247	60	33.193	5	43.947	1	1,2,3			
O14	307	2022	2	28	17:46	380	60	30.915	5	42.803	1	1, 2, 3			
O15	308	2022	2	28	18:28	335	60	28.948	5	43.410	1	1,2,3,4			
O16 T1	309	2022	2	28	19.19	421	60	27.994	5	40.438					
O16 T2	310	2022	2	28	20:29	422	60	27.990	5	40.424					
O16 T3	311	2022	2	28	21:29	421	60	28.986	5	40.427					
O16 T4	312	2022	2	28	22:30	421	60	27.990	5	40.427					
O16 T5	313	2022	2	28	23:31	421	60	27.987	5	40.430					
O16 T6	314	2022	3	1	0:30	421	60	27.987	5	40.430					
O16 T7	315	2022	3	1	1:30	421	60	27.989	5	40.429					
O16 T8	316	2022	3	1	2:32	421	60	27.989	5	40.427					
O16 T9	317	2022	3	1	03:31	420	60	27.988	5	40.427					
O16 T10	318	2022	3	1	04:31	420	60	27.990	5	40.427					
O16 T11	319	2022	3	1	05:30	421	60	27.990	5	40.425					
O16 T12	320	2022	3	1	06:20	421	60	27.990	5	40.426					
O16 T13	321	2022	3	1	07:16	421	60	27.993	5	40.424					
O17	322	2022	3	1	07:51	243	60	26.713	5	37.440	1	1,2,3			
O18	323	2022	3	1	08:27	280	60	25.713	5	33.214	1	1,2,3			
O22	324	2022	3	1	10:04	512	60	30.523	5	15.265	1	1, 2, 3, 4			

Appendix C: Mooring instrumentation setup

Table 13. Overview of mooring instrumentation setup for the Masfjord moorings

Instrument	sn	Sampling interval / start	Comment
SBE37	7535-36, 7550-52	600 s 25/2 09:00	CT
SBE56	1946	60 s 25/2 09:00	T
SeaGuard	1925, 1929	3600 s 25/2 09:00	CDT, sn 1925 includes DO
RDI 300kHz	13771	1200 s 25/2 09:00	

Appendix D: Mooring drawings (recovered)



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Geofysisk Institutt

Mooring name: Nortek

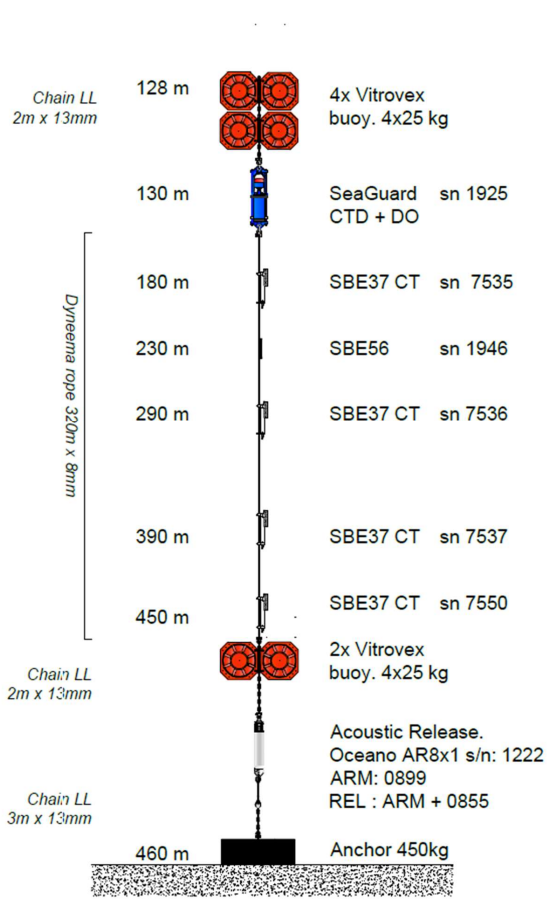
Project: FJO2RD
Location: Lurefjorden terskel
Position: Lat 60°43.847' N
Lon 4° 58.625' E
Depth: 50 m
Deployed: 2022 16:02 UTC
Recover: 2022

Notes:
Recovery rope attached to lifting ring below buoy. Lightly attached to top of buoy.

Latest update: 07/02/2022

Appendix E: Mooring drawing (deployed)

KB 2022605



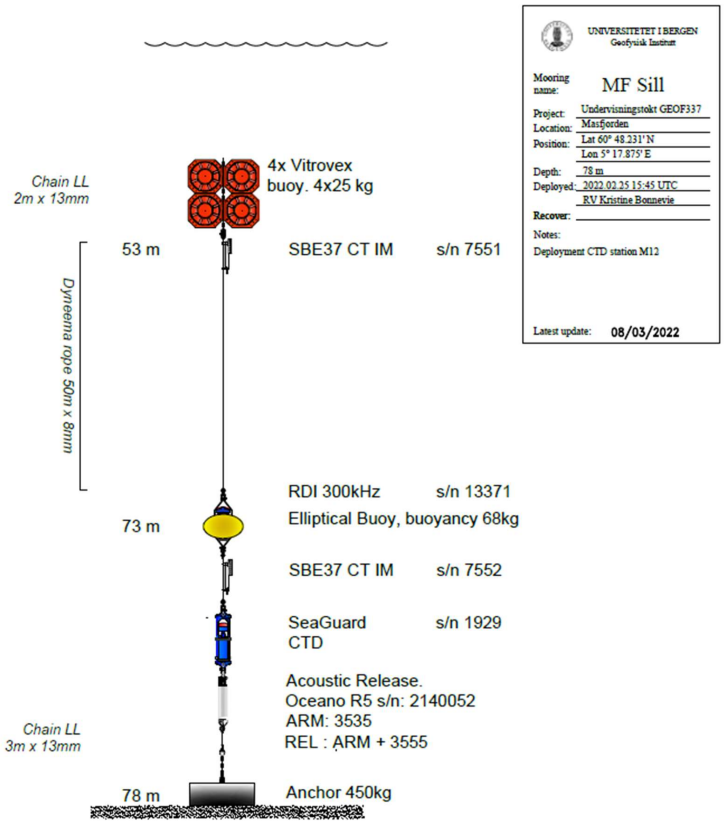
UNIVERSITETET I BERGEN
Geofysisk Institutt

Mooring name: MF Inner

Project: Undervisningstokt GEOF337
Location: Masfjorden
Position: Lat 60° 52.204' N
Lon 5° 22.098' E
Depth: 460 m
Deployed: 2022.02.25 14:30 UTC
R.V Kristine Bonnevie
Recover:

Notes:
Deployment CTD station M24.

Latest update: 08/03/2022



Appendix F: Data processing, Nortek ADCP (Kristin Svingen)

Processing of ADCP data from Lurefjorden

The instrument (Signature 500, see web page for technical specifications) was configured to measure for five minutes every ten minutes (Measurement interval = 600 s and Average interval = 300 s). Within each average interval, the instrument pinged 1200 times (sampling frequency of 4 Hz). The cell size was set to 2 m and the blanking distance was 0.5 m. The set up resulted in a horizontal precision of 0.2 cm/s.

The data was visually inspected in the post processing software Ocean Contour and a simple quality control procedure was carried out. With the resulting, processed data, the following is done:

- Velocities were calculated in ENU coordinates. In addition, the speed and direction were calculated.
- The effect of tilted instrument is accounted for by performing a so-called Bin Mapping. Read more about how tilt affects the measurements in chapter 6.5.1 in the Principles of Operation manual.
- Using the heading data from the deployment, while the instrument has been rotating in the buoy, the compass was recalibrated, applying new hard iron offsets removing the effect of magnetic influence from materials surrounding the instrument during deployment (see Figure 1 for the measured and corrected magnetometer values)
- Interference from the surface (read more about sidelobe interference in chapter 3.4 in the Principles of Operation manual) were removed by removing the upper 10 % of the profile.
- Data points with less than 50 % correlation were removed.
- The data is averaged over one average interval (five minutes) and one cell (2 m)

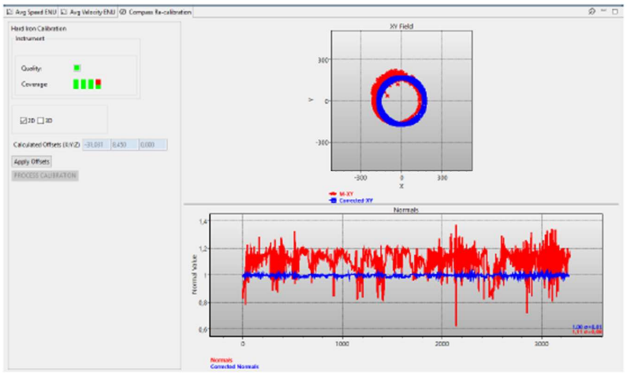


Figure 1: Original and corrected magnetometer data, with the offsets that were applied.

Appendix G: Water samples from CTD

Appendix H: List of MSS-stations

File name cast_x	Station name	Date/UTC			Time/UTC		E. Depth	Latitude/N		Longitude/E		Start	End	CTD station (sta0)
		year	mon	dd	hh	min	m	deg	min	deg	min	m	m	
1	1	2022	2	23	15	34	414	60	41,142	5	10,351	0	380	LF2
2	2	2022	2	23	16	25	364	60	42,564	5	6,281	0	336	LF3
3	3	2022	2	23	17	5	256	60	43,504	5	3,181	0	216	LF4
4	4	2022	2	23	17	31	187	60	43,923	5	1,684	0	115	LF5
5	5	2022	2	23	17	50	87	60	43,783	4	59,404	0	64	LF6
6	6	2022	2	23	18	33	69	60	44,14	4	56,861	0	-	LF7
7	7	2022	2	24	7	8	77	60	43,768	4	59,281	0	46	LF6
8	8	2022	2	24	12	17	90	60	43,79	4	59,363	0	11	LF6
9	9	2022	2	24	12	23	90	60	43,802	4	59,361	0	70	LF6
10	10	2022	2	24	14	37	55	60	43,8	4	59,323	0		LF6
11	11	2022	2	24	15	15	90	60	43,779	4	59,343	0	77	LF6
12	12	2022	2	24	16	20	92	60	43,779	4	59,343	0	77	LF6
13	13	2022	2	24	17	30	92	60	43,779	4	59,343	0	77	LF6
14	14	2022	2	24	18	53	91	60	43,773	4	59,361	0	84	LF6
15	15	2022	2	25	7	9	200	60	48,327	5	17,028	0	160	M11
16	16	2022	2	25	7	35	113	60	48,305	5	17,708	0	67	M12
17	17	2022	2	25	7	40	113	60	48,305	5	17,708	0	73	M12
18	18	2022	2	25	8	0	151	60	48,262	5	19,029	0	108	M14
19	19	2022	2	25	8	25	148	60	48,991	5	19,501	0	131	M_bonus
20	20	2022	2	25	8	55	299	60	49,251	5	20,661	0	271	MF shallow
21	21	2022	2	25	9	21	106	60	50,429	5	20,39	0	76	M18
22	22	2022	2	25	9	41	429	60	51,059	5	20,956	0	414	M22
23	23	2022	2	25	10	19	470	60	52,193	5	22,049	0	441	M24 inner
24	24	2022	2	25	10	59	482	60	52,369	5	24,893	0	445	MF deep
25	25	2022	2	25	17	41	425	60	52,547	5	26,373	0	413	M28
26	26	2022	2	25	18	13	265	60	52,872	5	28,353	0	246	M31

File name cast_x	Comments
1	top 50 m is not working
2	top 50 m is not working
3	hiccup around 15 m
4	
5	
6	hiccup around 1 m, too much current, no measurement
7	Stopped giving cable at 46 m, mearurements cut off after that
8	Unstable data stream - aborted
9	YESSSSSSS!!!!!!!
10	stopped when giving the signal
11	YESSSSSSS!!!!!!!
12	lost contact briefly at 55 m
13	
14	
15	
16	lost some contact at 51m
17	redo of M12 due to lost contact in previous run
18	
19	Extra MSS due to error from bridge
20	
21	
22	
23	
24	
25	
26	Everything went perfectly normal with this very good and reliable MSS instrument.