Cruise report

HM2024009007

1. Cruise overview

The cruise was organized as part of the course “Fjord oceanography” at the Geophysical Institute, UiB and we visited mainly Lurefjorden and Masfjorden to do mooring and hydrographic work (see Fig. 1).

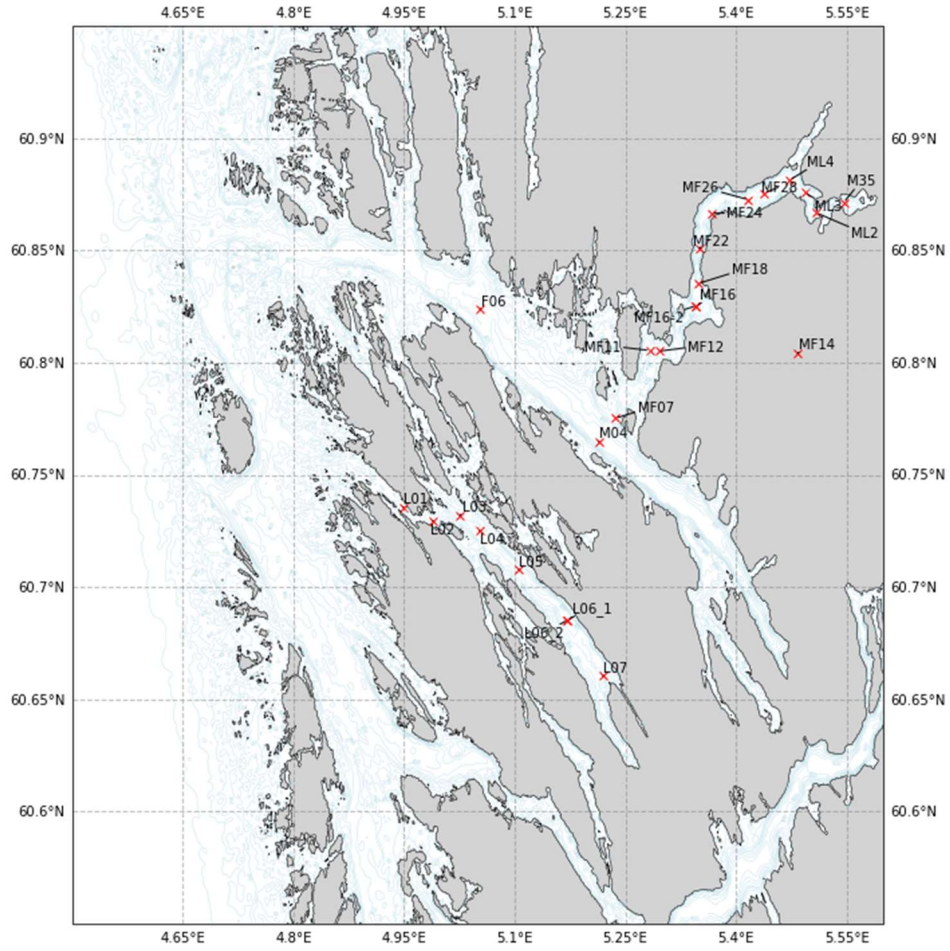

Figure 1: Map over the study area showing the position of CTD-stations as labelled red crosses.

2. Cruise participants

	Leg 1 (6-8/2)	Leg 2 (8-9/2
Elin Darelius, Scientist	x	
Torunn Sagen, PhD-student	x	x
Helge Bryhni, Technician		x

Daniel Lid	x	
Marte Vrålstad	x	
Reidar Lier		x
Marre Groeneboer		x

3. CTD

We occupied a total of 31 CTD-casts during the cruise using the RBR Maestro sn 205914 available onboard. The conductivity, temperature, pressure, and PAR sensor were last calibrated in January, 2023.

The sensor protection was not removed during cast 4-6, and O2, PAR, and Chlorophyll data were hence discarded.

On most stations, the CTD was lowered to 10 depth and then brought back to the surface before the cast was started. This was done to make sure that the CTD started correctly.

The stations are listed in Table 2.

4. Water sampling

Water samples were obtained from the Rosette available onboard during the upcast. As CTD data can not be viewed live, sample depths had to be chosen beforehand. Sample depths are listed in Table 3, were the depths are the depths given by the pressure sensor of the Rosette. A comparison between the pressure records from the CTD and the pressure from the Rosette shows that there is an offset of about 1 dbar between the two, with the Rosette showing the higher value.

The Rosette holds 6 bottles of 3.5L each, and when that was not enough, we first collected water from the largest depths and then did a second cast to obtain water from shallower depths.

a) Winkler titration

Samples for measuring dissolved oxygen were collected using a tube, ensuring each sample was as bubble-free and exposed to air as little as possible. Draw temp was measured before we added 1 mL $MnCl_2$ and 1 mL NaOH/NaI to the sample and put a cap on the flask. The sample was then shaken for about 20 sec, and stored dark and cool until Winkler titration started.

We used an automatic Winkler titration instrument, using UV light to determine the endpoint of the titration for each sample. We removed the cap, added 1 mL H_2SO_4 and a stirring bar to the sample, and placed the sample in the Winkler titration system, and started titrations.

b) Dissolved Inorganic Carbon / Alkalinity, and nutrients

Samples for carbon analysis (dissolved inorganic carbon and alkalinity) were collected using a tube, adding a drop (ca 0.02 mL) of mercury to the sampled bottles. Samples were kept cool and dark, and brought back to GFI for analysis.

Samples for nutrients were collected by rinsing the flasks three times, then adding a drop of chloroform to the sample. Samples were stored in the fridge, and sent to IMR for analysis.

c) Salinity

The samples were collected following standard procedures, i.e., the bottles were rinsed three times and then brought back to GFI, where they were analyzed in the lab by the students, supervised by K. Jackson-Misje.

5. Mooring recovery

Three moorings deployed during cruise KB2023006004 in February 2023 were recovered during the cruise, see Table 1 and Figure 1-3. A fourth mooring, MF_inner, responded when called but did not release, and had to be left in the water.

Table 1: Mooring details

	Lon	Lat	In	Out	CTD-cast
LF_sill	4°58.593' E	60°43.899' N	2023.02.17	2024.02.08 08:00	5,30
MF_sill	5° 18.346' E	60° 47.680' N	2023.02.15	2024.02.06 12:10	20,22
MF_outer	5° 20.584' E	60°49.451' N	2023.03.21	2024.02.08 15:00	24,25

a) LF_sill

The mooring was covered in mussels and “biology” on recovery. The ADCP did not communicate on board, nor at GFI with a new battery connected. We suspect that the instrument has leaked.

b) MF_outer

The SBE37 (sn: 8974) at 162 m depth had not logged data. Logging was not started. (The instrument started when prompted to do so)

6. Calibration of CTD sensors

a) Salinity

The salinity of the water samples was determined by K. Jackson together with the students of the course using a portasal. Values from bottles obtained during the upcast, i.e. higher up than the bottom are consistently too high – likely because the Rosette pulls water up with it and we have not waited long enough for the water column to settle before closing the bottle. These data have hence been discarded. In addition, data collected above 200 m show a large spread (Figure 2) and they were not included in the analysis.

The mean offset (Bottle-CTD) for the 12 samples collected at the bottom and at a depth greater than 200 m was 0.002. There were no outliers.

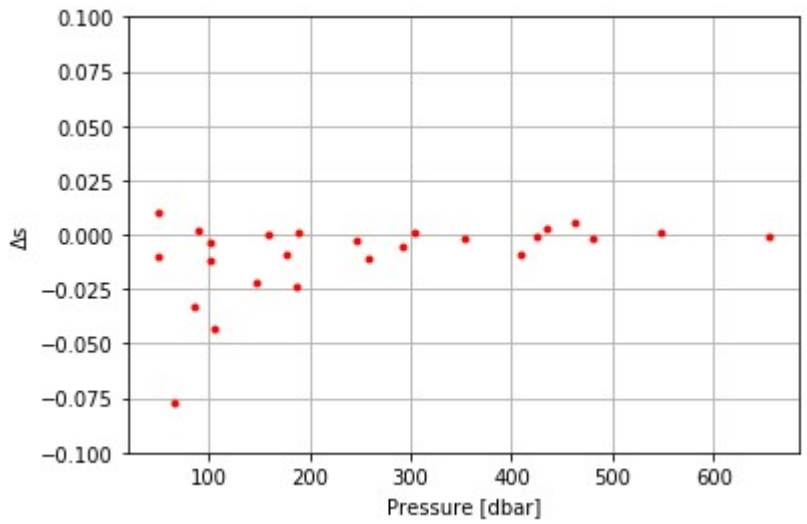

Figure 2: Difference between the salinity observed with the CTD and the salinity from the water samples.

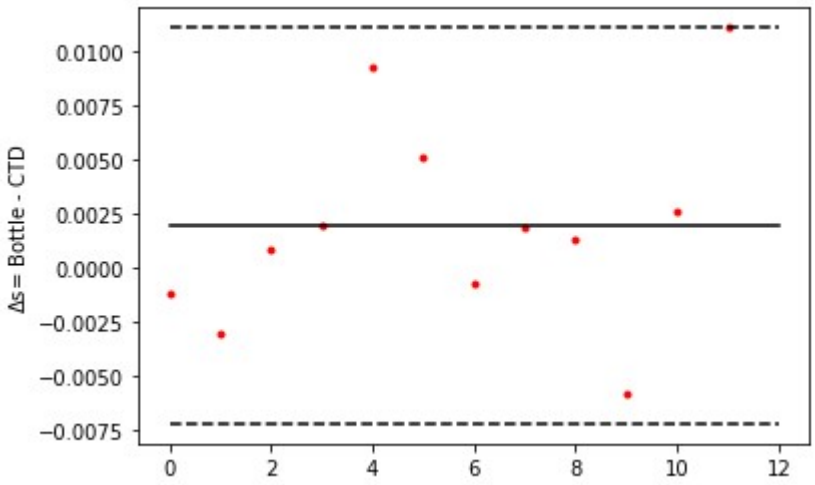

Figure 3: Salinity difference between the salinity value from bottles and the CTD for samples collected at the bottom and deeper than 200 m. The black line shows the mean value, and the dashed lines show the mean value +/—2 times the standard deviation. There were no outliers.

b) Dissolved Oxygen

Oxygen concentrations observed by the CTD and those determined through Winkler titration was converted to [umol/kg] and compared – one obvious outlier (The difference between CTD and Winkler was more than 2.5 standard errors off the mean difference) was flagged and removed from further analysis.

When the difference between doubles (samples taken from the same depth and station, but not necessarily the same Niskin) was lower than 3 umol/kg, the mean value was retained. If the value was higher than 3 umol/kg both samples were removed.

Samples collected shallower from depths than 100 m were removed.

We fitted a line to the data using linear regression, and samples with an error larger than 2.5 times the root mean square error was removed. This procedure was repeated until either no

more samples were removed or the root means square error of the remaining samples was smaller than 2 umol/kg.

A total of 27 samples were included in the analysis, and 24 samples were included in the final regression (Figure 4). The offset depends strongly on the oxygen concentration (

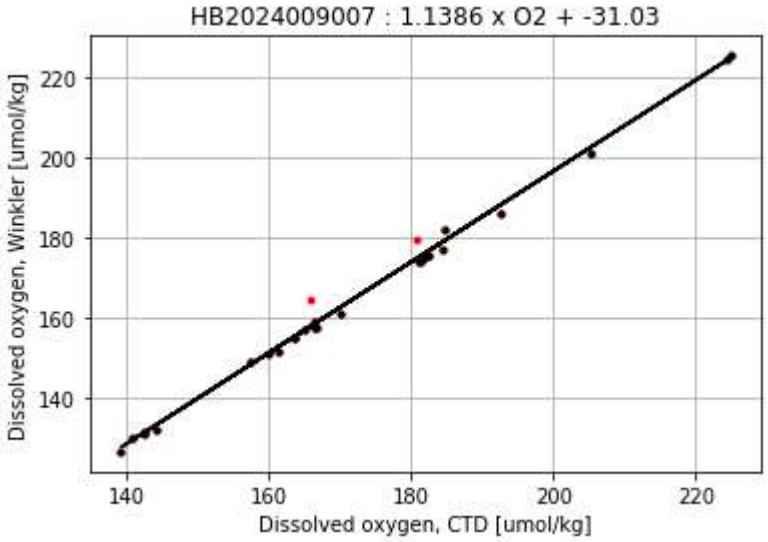

Figure 4: Dissolved oxygen concentration observed with the CTD versus that determined through Winkler titration. The black line shows the regression line used to correct the CTD data, and the black (red) dots are the samples included (not included) in the final regression analysis.

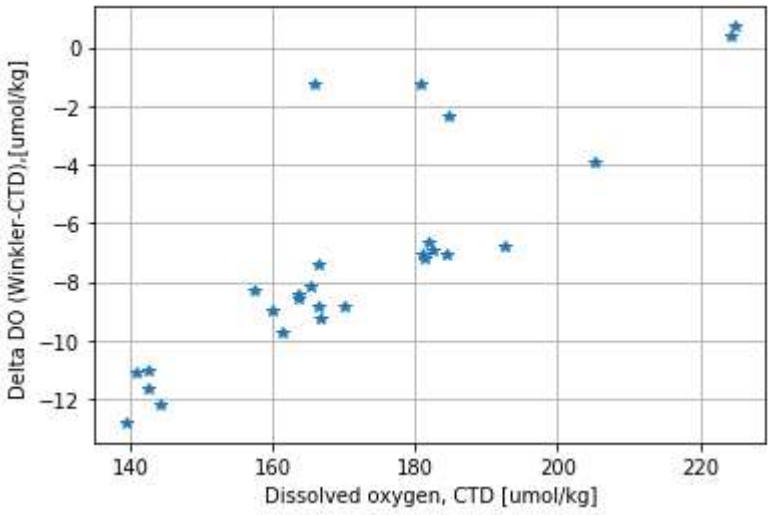

Figure 5: Offset between CTD and Winkler as a function of the dissolved oxygen concentration observed by CTD.

c) Rosette pressure sensor vs Pressure sensor of the RBR CTD

A comparison of the depth registered from the Rosette and that of the pressure records from the RBR when the instrument has hold at a constant depth suggest an offset of about 1 dbar, with values on the rosette being higher.

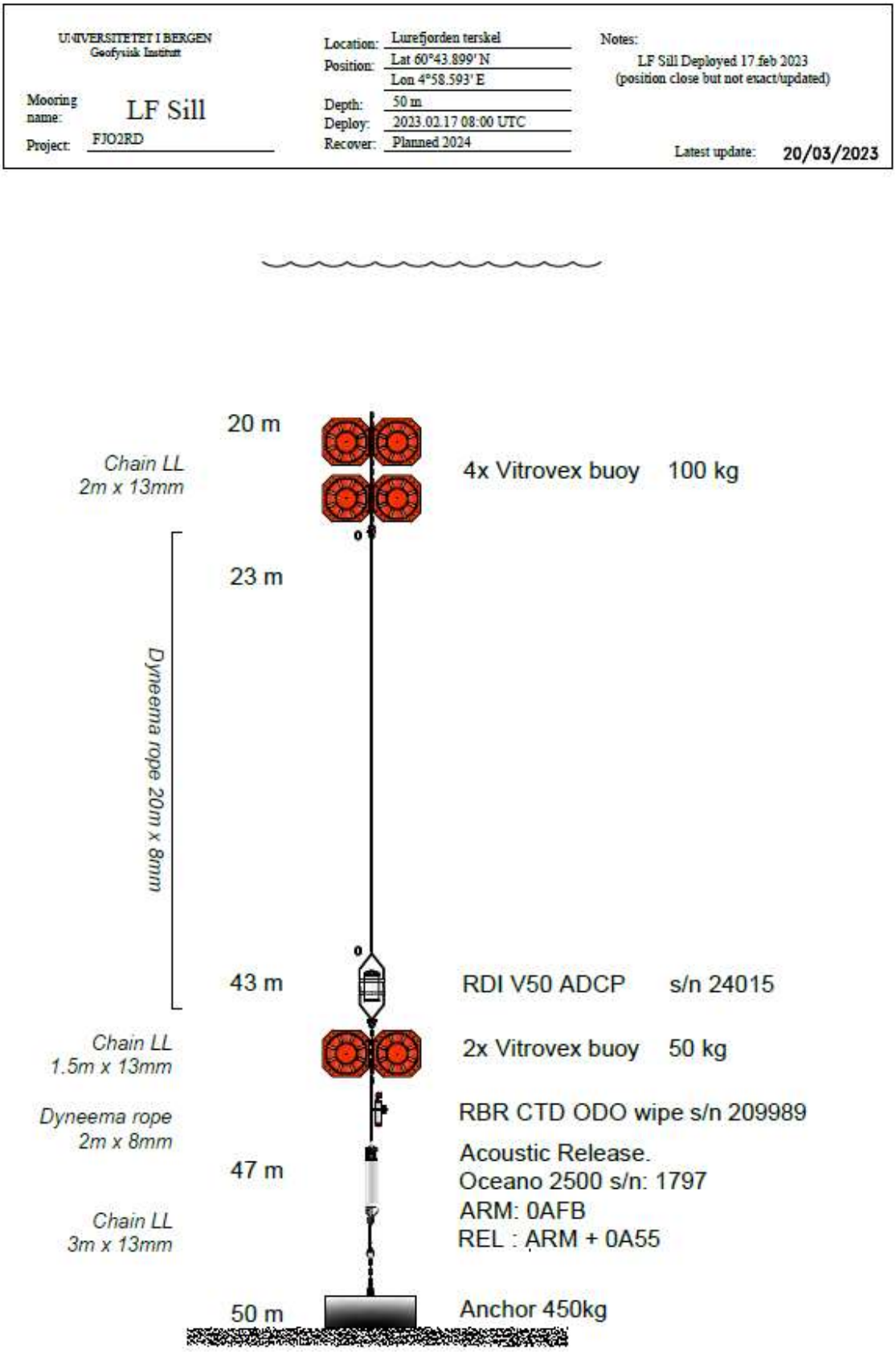

Figure 6: LF_sill

Figure 7: MF_sill

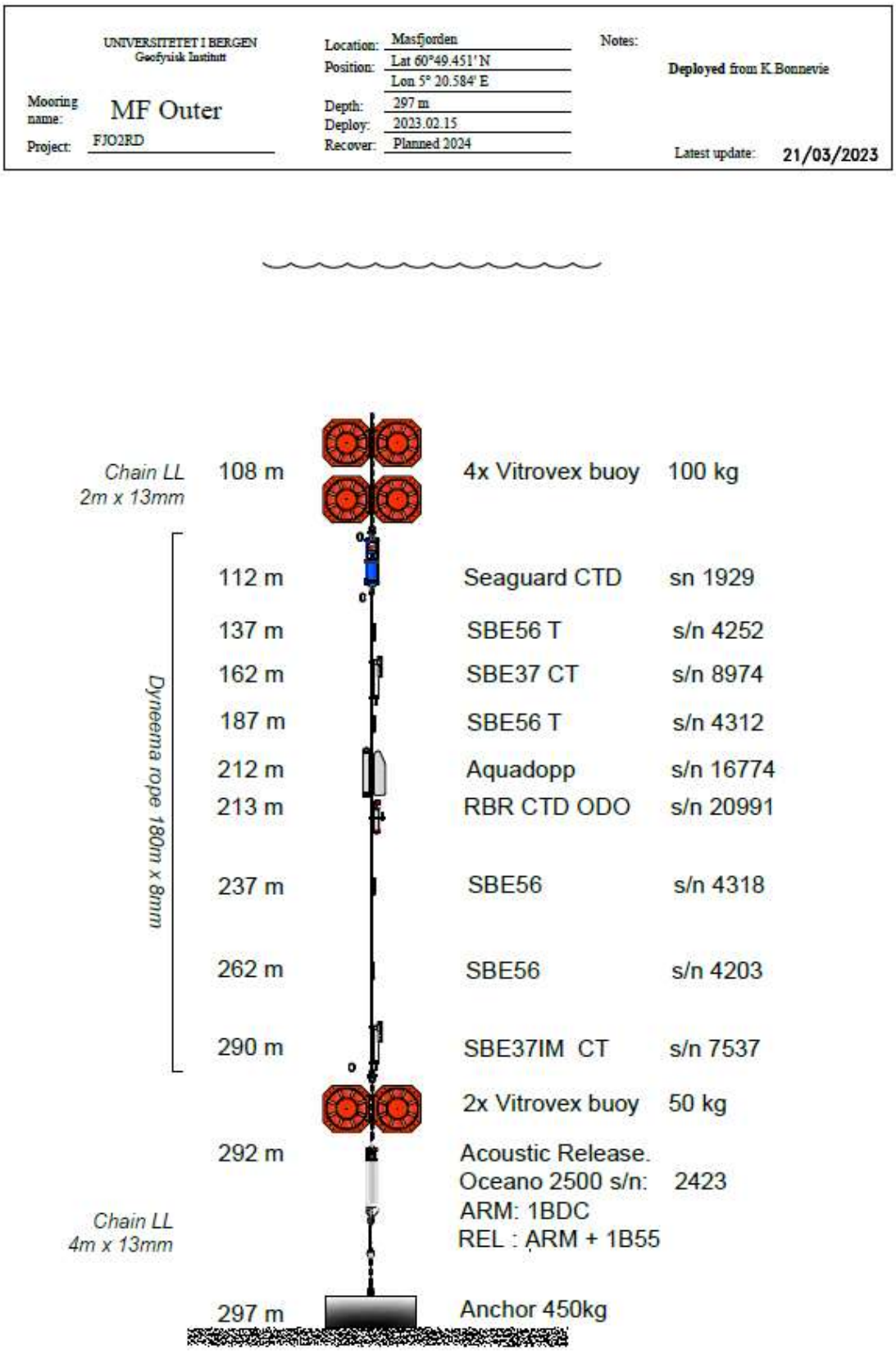

Figure 8: Mooring drawing of MF_outer

Table 2: Details about CTD-stations occupied during HB2024009007

CAST	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/nutrients	filtering	Isotopes	Trace m.	
0	L01		2024	2	6	11:08	65	60	44.139	4	56.928	x						
1	L07	DL	2024	2	6	13:33	310	60	39.627	5	13.183	x	x					
2	L06_1		2024	2	6	14:10	439	60	41.117	5	10.302	x	x	x				
3	L06_2		2024	2	6	15:18	437	60	41.117	5	10.302	x		x				
4	L05	DL	2024	2	6	16:47	363	60	42.469	5	06.326	x	x					
5	L02	XXX	2024	2	7	07:20	77	60	43.773	4	59.330							Protection caps on CTD
6	L03	XXX	2024	2	7	07:37	179	60	43.926	5	01.564		x					Protection caps on CTD
7	L04	XXX	2024	2	7	07:55	254	60	43.500	5	3.148		x					Protection caps on CTD
8	M04		2024	2	7	09:36	662	60	45.888	5	12.826	x	x	x				
9	M35		2024	2	7	11:25	190	60	52.286	5	32.770	x	x					
10	ML2		2024	2	7	11:54	192	60	52.007	5	30.560	x	x					
11	ML3		2024	2	7	12:15	163	60	52.546	5	29.632	x	x					
12	ML4		2024	2	7	12:36	270	60	52.884	5	28.367	x	x					
13	MF28	DL	2024	2	7	12:57	422	60	52.540	5	26.323	x	x					
14	MF26		2024	2	7	13:36	482	60	52.363	5	25.000							Cast aborted as bottles were not zeroed.
15	MF26		2024	2	7	13:45	482	60	52.363	5	25.000	x	x	x				
16	MF26		2024	2	7	14:33	483	60	52.366	5	24.932	x	x	x				Only down to 200 m
17	MF22		2024	2	7	15:07	427	60	51.060	5	20.997	x	x					
18	MF18		2024	2	7	15:38	198	60	50.121	5	20.950	x	x					
19	MF14		2024	2	7	15:55	151	60	48.262	5	29.030	x	x					
20	MF12		2024	2	7	16:30	105	60	48.309	5	17.737	x						
21	MF11		2024	2	7	16:40	200	60	48.330	5	17.003	x	x					
22	MF12		2024	2	8	08:30	108	60	48.311	5	17.731	x						Logged data as 07-02-24, assume it is from 08-02-2
23	MF24		2024	2	8	13:06	468	60	51.997	5	22.011	x	x					Mooring CTD station
24	MF16		2024	2	8	15:42	298	60	49.525	5	20.753	x	x	x				Full station & MF Outer mooring.
25	MF16-2	DL	2024	2	8	16:30	298	60	49.525	5	20.753	x	x	x				
26	MF07		2024	2	9	08:05	143	60	46.519	5	14.225	x						
27	F06		2024	2	9	8:55	549	60	49.44	5	03.2	x						
28	L04		2024	2	9	09:57	250	60	43.516	5	03.104	x						Repeated station
29	L03		2024	2	9	10:20	183	60	43.938	5	1.548	x						Repeated station
30	L02		2024	2	9	10:38	88	60	43.777	4	59.343	x						Repeated station

Table 3: Pressure (dbar) where the Niskin bottles were closed.

Cast	Station Name						
		Bottle 1	Bottle 2	Bottle 3	Bottle 4	Bottle 5	Bottle 6
0	L01	67.5	67.5				
1	L07	306	306	202.4	202.4		
2	L06	435	435	303	303	202	202
3	L06_2	92	92	52	52		
4	L05	355	355	252	252		
5	L02	77					
6	L03	181	181				
7	L04	252	252	131	131	10	
8	M04	655	655	203	203	77	12
9	M35	189	189	12			
10	ML2				190	190	12
11	ML3	161	161	11			
12	ML4				259	259	203
13	MF28	425	425	202			
14	MF26						
15	MF26	482	482	405	405	304	304
16	MF26	204	103	103	52	52	12
17	MF22	410	52	52			
18	MF18	196	51	51			
19	MF14	148	51	51			
20	MF12				102		
21	MF11					197	52
22	MF12	106					
23	MF24	463	463	205	205	54	54
24	MF16	294	294	203	203	102	102
25	MF16-2	52	52	12	12		
26	MF07	143		52			
27	F06	549	203				
28	L04	248					
29	L03	179					
30	L02		87				