Cruise report

HM2024009021

1. Cruise overview

The cruise was organized within the projects FJO2RD and CLIFFORD. We deployed an oceanographic mooring at Sognesjøen, and did hydrographic work - including methane sampling – in Masfjorden and Lurefjorden.

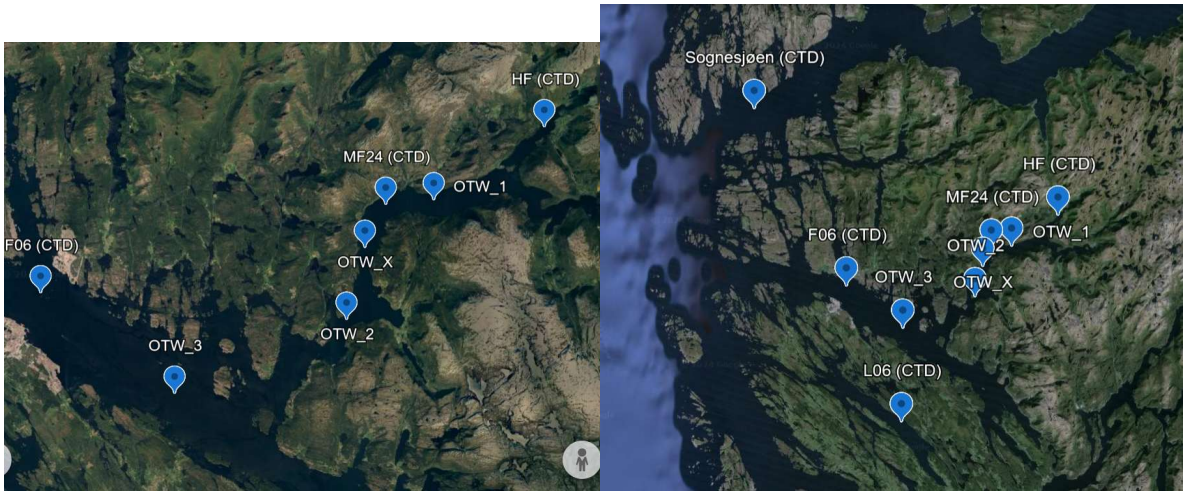

Figure 1: Maps over the study area showing the location of the CTD-stations.

2. CTD

We occupied a total of five CTD-stations during the cruise using the RBR Maestro sn 205914 available onboard. The conductivity, temperature, pressure, and PAR sensor were last calibrated in January, 2023. As we collected radio active tracer samplers we needed a lot of water (>10 L per depth) we had to make more than one cast at these stations. Water from the deepest level was collected first, so that the following cast dis not reach all the way to the bottom.

The water sampler mal-functioned on several stations; there was no reaction when the “action” button on the deck unit was pressed. On a few occasions, everything on the deck unit was “frozen”, i.e. the pressure did not change either, but sometimes it appeared to be just the action function that did not work. At times, the bottle closed only after about ten seconds. We only had these problems on shallow depths.

The stations are listed in Table 2.

No CTD data was collected on the downcast of cast 9.

3. Water sampling

Water samples were obtained from the Rosette available onboard during the upcast. As CTD data can not be viewed live, sample depths were determined based on profiles from HB2024009015 (and from the last cast from Sognesjøen available on hi.no). 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 on previous cruises has shown an offset of about 1 bar, with the Rosette showing a higher value.

Niskin 5 & 6 leaked a little from the bottom at a few stations.

The depths at which the Niskin bottles were closed (as read from the deck unit) are shown in Table 3

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 MnCl2 and 1 mL NaOH/NaI to the sample and put a cap on the flask. The sample was then shaken for about 20 seconds and stored dark and cool (in the fridge). The samples were analyzed 5/4 at GFI by Kristin Misje-Jackson.

b) 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 K. Jackson-Misje.

A total of six samples were collected.

c) Radio-active Tracers

Samples for determination of radio-active tracer concentration were collected for Jixin Qiao at DTU, Denmark (Jixin Qiao <jiqi@dtu.dk>). Water was collected in 10L plastic containers, that were rinsed once before being filled. Water was collected at three stations, from three depths at each station.

d) Greenhouse gases

At five stations, full-depth CTD casts were conducted to collect water samples for dissolved greenhouse gases (methane - CH_4 and nitrous oxide - N_2O) at different water depths (9 to 10 layers). Samples consisted of water samples stored in 22 mL glass vials and fixed using $ZnCL_2$ to stop microbial activity. A total of 60 samples were collected and analyzed using a gas chromatograph (GC) at Gothenburg University (SE).

Additionally, at four of the five stations, 250 mL water samples were collected for stable isotope analysis of ^{13}C-CH_4. Samples were collected from the surface, bottom, and two intermediate water layers for a total of 16 serum bottles. These will be analyzed using a Picarro G2210-i Analyzer.

An overview of the samples is given in Table 5

The sampling was carried out by Tobia Politi from Gothenburg University, Sweden.

4. Moorings

a) Mooring deployment

Two moorings were deployed during the cruise – one at Sogensjøen and one the deep basin of Masfjorden, see Table 1. At each location, we took a CTD-cast prior to deployment. The mooring MF_inner had to be dragged quite a distance (>1 km) through the water since we were far from its location when the mooring was sat out behind the boat.

The moorings were deployed with the anchor hanging behind the ship. In Masfjorden, it was only put behind the ship once the entire mooring line was out.

There was some uncertainty regarding what Acoustic releases that were used – but Helge has notes at GFI and will check once we return.

Positions below are from the "toktlogger".

Mooring diagrams are shown in Fig. XX

Table 1: Mooring details

	Lon	Lat	In	Depth	CTD cast
MF_inner	5° 22.0148' E	60°52.198′ N	2024.04.04 07:40	462 m	5
Sognesjøen	4° 51.389' E	61°01.170′ N	2024.04.03 13:20	402 m	0

5. Calibration of sensors

a) Salinity

The salinity of the water samples was determined by K. Jackson (GFI). The mean offset (Bottle-CTD) for the five samples collected at the bottom was -0.006. There were no outliers.

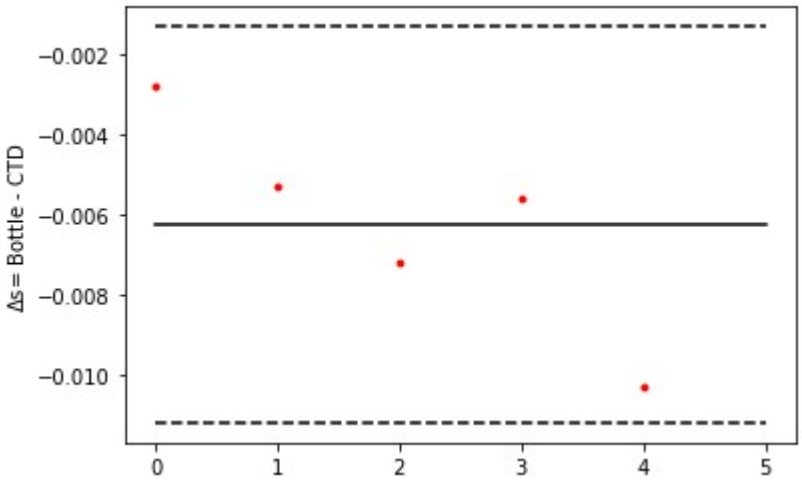

Figure 2: Calibration of the salinity sensor for cruise HB2021009021

b) Dissolved Oxygen

Oxygen concentrations observed by the CTD and those determined through Winkler titration were converted to [umol/kg] and compared.

On one station, two samples were drawn from the same bottle – the difference between them was relatively big (0.2 ml/l), but as they fall on different sides of the regression line, both samples were retained.

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 were removed. This procedure was repeated until either no more samples were removed or the root mean square error of the remaining samples was smaller than 2 umol/kg.

A total of 8 samples were included in the analysis, and 7 samples were included in the final regression (Figure 3). The root mean square error is 3 umol/kg.

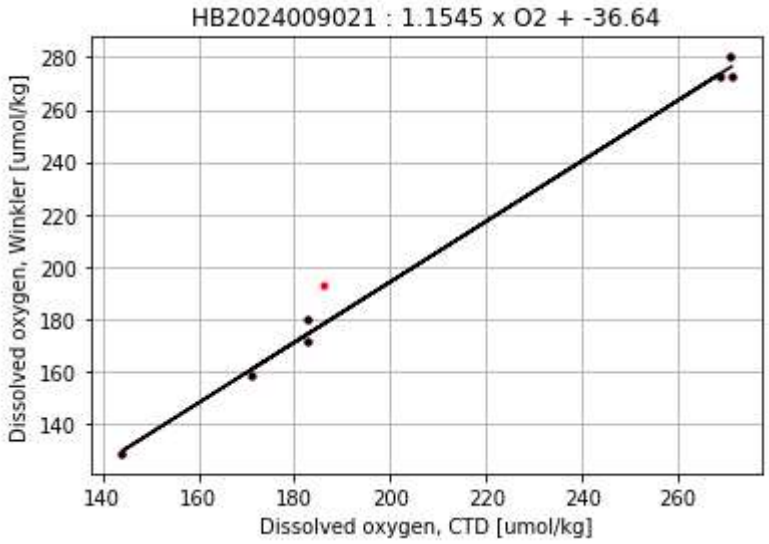

Figure 3: Dissolved oxygen concentration observed with the CTD versus that determined through Winkler titration. The black line shows the regression line used to correct the CTD data, and the black (red) dots are the samples included (not included) in the final regression analysis.

6. **Cruise diary** (Times in UTC)

20240403

07:30 Left Bergen (Delayed due to CTD-cable re-termination)

08:00 Bunkering

12:10 Arrive at Sognesjøen. Mattia took a surface water sample. CTD – station (after trouble with display on the deck unit)

13:20 Mooring deployed. Given position 61 01.155N, 4 51.396E

15:10 Arrived at F06 and made three casts to collect water for RAT. On the third cast the water sampler lost contact and we had to take it up on deck to turn it off and on again. It then worked.

Delicious Italian pasta for dinner – thanks Tobia!

20240404

05:40 Left quay

06:10 CTD at mooring position. Bottle 1 had probably leaked – not enough water for salinity sample.

06:52 First instrument attached on MF_inner.

07:14 Last instrument attached. Still far from mooring position, so mooring had to be dragged for quite some distance through the water.

07:40 Mooring released.

08:10 Haugsværfjorden. The water smelled bad. Trouble with the water sampler at cast 3, so we had to abort and make a fourth cast.

We ran late and had to skip M26. On the way out, Tobia took surface samples at M26, M16 and M12.

11:40 Started CTD in Lurefjorden (LF06).

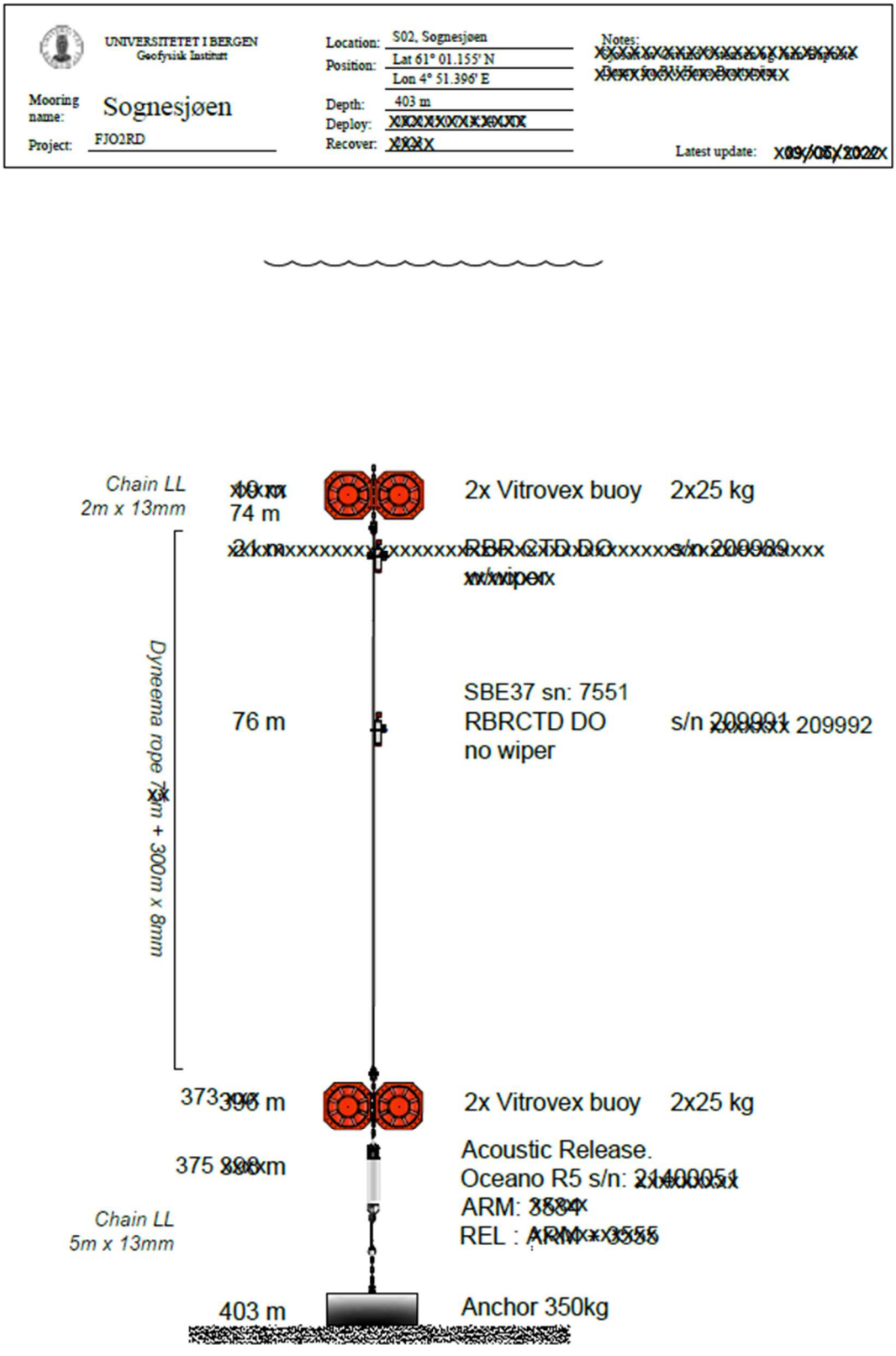

Figure 4: Mooring Sognesjøen (deployed)

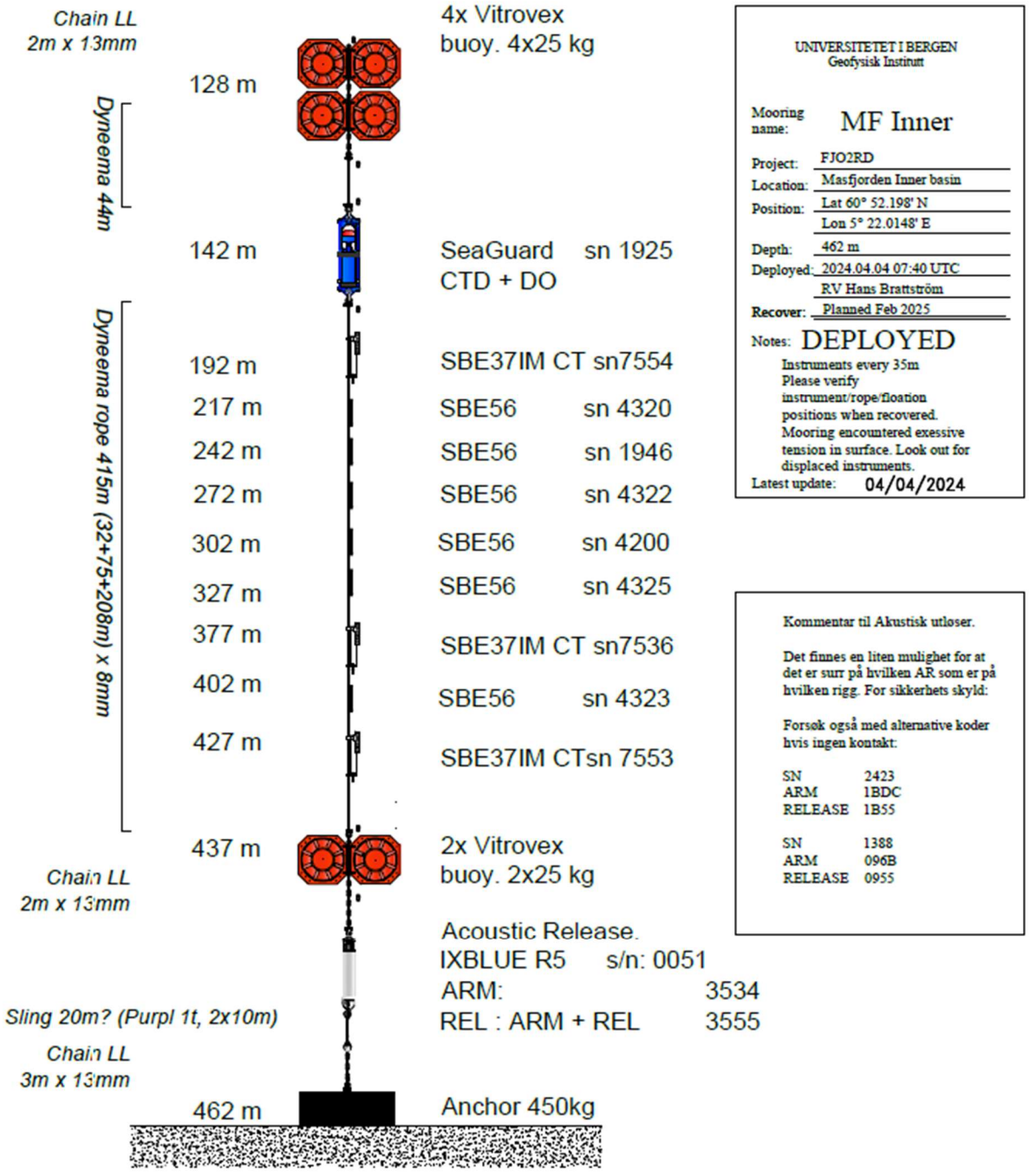

Figure 5: MF_inner (deployed)

Table 2: Details about CTD-stations occupied during HB2024009015.

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	RA-tracers	Met	
0	Sognes		2024	4	3	12:10	403	61	01.170	4	51.396	x	x		x	
1	F06		2024	4	3	14:36	546	60	49.827	5	3.283	x	x	x	x	
2	F06		2024	4	3	15:11	546	60	49.827	5	3.283			x	x	
3	F06		2024	4	3	15:28	546	60	49.827	5	3.283					Water sampler did not work
4	F06		2024	4	3	15:35	546	60	49.827	5	3.283			x	x	
5	M24		2024	4	4	06:06	464	60	52.191	5	22.037	x	x		x	
6	HF		2024	4	4	08:08	122	60	54.284	5	30.638			x	x	
7	HF		2024	4	4	08:22	122	60	54.284	5	30.638	x		x	x	
8	HF - 3		2024	4	4	08:43	122	60	54.284	5	30.638			x	x	
9	HF - 4		2024	4	4	08:55	122	60	54.284	5	30.638			x	x	
10	LF06		2024	4	4	11:40	430	60	41.091	5	10.360	x	x	x	x	
11	LF06		2024	4	4	12:10	430	60	41.091	5	10.360			x	x	
12	LF06		2024	4	4	12:24	430	60	41.091	5	10.360			x	x	

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	SS	389	203	127	51	31	12
1	F06 - 1	547	404	253	253	253	253
2	F06 - 2	102	102	102	102	81	51
3	F06 - 3						
4	F06 - 4		10	10	10	10	10
5	M24	461	304	203	142	82	51
6	HF - 1	122	122	122	122	122	122
7	HF-2	82	62	51	31	31	31
8	HF3	32	22				
9	HF - 4			11	11	11	11
10	LF06	425	425	425	425	425	253
11	LF06	101	61	61	61	61	31
12	LF06			11	11	11	11

Table 4: Information about radio active tracer sampling

Cast	Station	Depth	R-A-T
1	F06	253	1
2	F06	102	2
4	F06	10	3
6	HF	122	4;5
7	HF	31	6
8	HF	32	7
9	HF	11	8
10	LF06	425	9;10
11	LF06	61	11; 12
12	LF06	11	13; 14

Table 5: Details regarding the greenhouse gas sampling

Station Name	Station	Label Vials	Date	Time	Coordinates (°N/°E)		Wind speed (m/s)	Depth (m)	Temp	Sal.	Gas (CH_4 + N_2O)	DIC	13C-CH4
SS	1	1.1 Surf.	03.04.2024	12:00	61°01.155'	4°51.396'	8.7	1			x		x
SS	1	1.2 Surf.	03.04.2024	12:00	61°01.155'	4°51.396'	8.7	1			x		
SS	1	1.3 Surf.	03.04.2024	12:00	61°01.155'	4°51.396'	8.7	1			x		
SS	1	1.4	03.04.2024	12:00	61°01.155'	4°51.396'	8.7	10			x		
SS	1	1.5	03.04.2024	12:00	61°01.155'	4°51.396'	8.7	30			x		x
SS	1	1.6	03.04.2024	12:00	61°01.155'	4°51.396'	8.7	50			x		
SS	1	1.7	03.04.2024	12:00	61°01.155'	4°51.396'	8.7	125			x		x
SS	1	1.8	03.04.2024	12:00	61°01.155'	4°51.396'	8.7	200			x		
SS	1	1.9	03.04.2024	12:00	61°01.155'	4°51.396'	8.7	389			x		x
F06	2	2.1 Surf.	03.04.2024	15:10	60°49.808'	5°03.313'	9	1			x	x	x
F06	2	2.2 Surf.	03.04.2024	15:10	60°49.808'	5°03.313'	9	1			x	x	
F06	2	2.3 Surf.	03.04.2024	15:10	60°49.808'	5°03.313'	9	1			x	x	
F06	2	2.4	03.04.2024	15:10	60°49.808'	5°03.313'	9	10			x		
F06	2	2.5	03.04.2024	15:10	60°49.808'	5°03.313'	9	50			x		x
F06	2	2.6	03.04.2024	15:10	60°49.808'	5°03.313'	9	80			x		
F06	2	2.7	03.04.2024	15:10	60°49.808'	5°03.313'	9	100			x		
F06	2	2.8	03.04.2024	15:10	60°49.808'	5°03.313'	9	250			x		x
F06	2	2.9	03.04.2024	15:10	60°49.808'	5°03.313'	9	400			x		
F06	2	2.10	03.04.2024	15:10	60°49.808'	5°03.313'	9	480-500?			x		x
MF24	3	3.1 Surf.	04.04.2024	06:10	60°52.198'	5° 22.0148'	7	1			x	x	x
MF24	3	3.2 Surf.	04.04.2024	06:10	60°52.198'	5° 22.0148'	7	1			x	x	
MF24	3	3.3 Surf.	04.04.2024	06:10	60°52.198'	5° 22.0148'	7	1			x	x	
MF24	3	3.4	04.04.2024	06:10	60°52.198'	5° 22.0148'	7	50			x		
MF24	3	3.5	04.04.2024	06:10	60°52.198'	5° 22.0148'	7	80			x		x
MF24	3	3.6	04.04.2024	06:10	60°52.198'	5° 22.0148'	7	140			x		
MF24	3	3.7	04.04.2024	06:10	60°52.198'	5° 22.0148'	7	200			x		x
MF24	3	3.8	04.04.2024	06:10	60°52.198'	5° 22.0148'	7	426			x		x

OTW_X	int.	S. X_1	04.04.2024	09:07	60°51.036'	5°20.885'	8.1	1	4.7	0.9	x	x	
OTW_X	int.	S. X_2	04.04.2024	09:07	60 51 036	5 20 885	8.1	1	4.7	0.9	x	x	
OTW_X	int.	S. X_3	04.04.2024	09:07	60 51 036	5 20 885	8.1	1	4.7	0.9	x	x	
HF	4	4.1 Surf.	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	1			x	x	x
HF	4	4.2 Surf.	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	1			x	x	
HF	4	4.3 Surf.	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	1			x	x	
HF	4	4.4	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	10			x		x
HF	4	4.5	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	20			x		
HF	4	4.6	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	30			x		
HF	4	4.7	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	50			x		
HF	4	4.8	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	60			x		x
HF	4	4.9	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	80			x		
HF	4	4.10	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	120			x		x
HF	4	4.11	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	120			x		
HF	4	4.12	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	120			x		
OTW_1	int	S.3_1	04.04.2024	11.23	60°52.318'	5°24.629'	8.5	1	4.8	1.0	x	x	
OTW_1	int	S.3_2	04.04.2024	11.23	60°52.318'	5°24.629'	8.5	1	4.8	1.0	x	x	
OTW_1	int	S.3_3	04.04.2024	11.23	60°52.318'	5°24.629'	8.5	1	4.8	1.0	x	x	
OTW_2	int	S.2_1	04.04.2024	11:39	60°49.092'	5°19.886'	1.7	1	4.4	1.1	x		
OTW_2	int	S.2_2	04.04.2024	11:39	60°49.092'	5°19.886'	1.7	1	4.4	1.1	x		
OTW_2	int	S.2_3	04.04.2024	11:39	60°49.092'	5°19.886'	1.7	1	4.4	1.1	x		
OTW_3	int	S.4_1	04.04.2024	12:07	60°47.097'	5°10.575'	4.4	1	4.8	10	x	x	
OTW_3	int	S.4_2	04.04.2024	12:07	60°47.097'	5°10.575'	4.4	1	4.8	10	x	x	
OTW_3	int	S.4_3	04.04.2024	12:07	60°47.097'	5°10.575'	4.4	1	4.8	10	x	x	
L_06	5	5.1 Surf.	04.04.2024	14:00	60°41.107'	5°10.363'	6.7	1			x		
L_06	5	5.2 Surf.	04.04.2024	14:00	60°41.107'	5°10.363'	6.7	1			x		
L_06	5	5.3 Surf.	04.04.2024	14:00	60°41.107'	5°10.363'	6.7	1			x		
L_06	5	5.4	04.04.2024	14:00	60°41.107'	5°10.363'	6.7	10			x		
L_06	5	5.5	04.04.2024	14:00	60°41.107'	5°10.363'	6.7	30			x		

L_06	**5**	**5.6**	**04.04.2024**	**14:00**	**60°41.107'**	**5°10.363'**	**6.7**	**60**			**x**			
L_06	**5**	**5.7**	**04.04.2024**	**14:00**	**60°41.107'**	**5°10.363'**	**6.7**	**100**			**x**			
L_06	**5**	**5.8**	**04.04.2024**	**14:00**	**60°41.107'**	**5°10.363'**	**6.7**	**250**			**x**			
L_06	**5**	**5.9**	**04.04.2024**	**14:00**	**60°41.107'**	**5°10.363'**	**6.7**	**412**			**x**			

Station Name	**Station**	**Label Vials**	**Date**	**Time**	**Coordinates (°N/°E)**		**Wind speed (m/s)**	**Depth (m)**	**Temp**	**Sal.**	**Gas (CH4 + N2O)**	**DIC**	**13C-CH4**
SS	1	1.1 Surf.	03.04.2024	12:00	61°01.155'	4°51.396'	8.7	1			x		x
SS	1	1.2 Surf.	03.04.2024	12:00	61°01.155'	4°51.396'	8.7	1			x		
SS	1	1.3 Surf.	03.04.2024	12:00	61°01.155'	4°51.396'	8.7	1			x		
SS	1	1.4	03.04.2024	12:00	61°01.155'	4°51.396'	8.7	10			x		
SS	1	1.5	03.04.2024	12:00	61°01.155'	4°51.396'	8.7	30			x		x
SS	1	1.6	03.04.2024	12:00	61°01.155'	4°51.396'	8.7	50			x		
SS	1	1.7	03.04.2024	12:00	61°01.155'	4°51.396'	8.7	125			x		x
SS	1	1.8	03.04.2024	12:00	61°01.155'	4°51.396'	8.7	200			x		
SS	1	1.9	03.04.2024	12:00	61°01.155'	4°51.396'	8.7	389			x		x
F06	2	2.1 Surf.	03.04.2024	15:10	60°49.808'	5°03.313'	9	1			x	x	x
F06	2	2.2 Surf.	03.04.2024	15:10	60°49.808'	5°03.313'	9	1			x	x	
F06	2	2.3 Surf.	03.04.2024	15:10	60°49.808'	5°03.313'	9	1			x	x	
F06	2	2.4	03.04.2024	15:10	60°49.808'	5°03.313'	9	10			x		
F06	2	2.5	03.04.2024	15:10	60°49.808'	5°03.313'	9	50			x		x
F06	2	2.6	03.04.2024	15:10	60°49.808'	5°03.313'	9	80			x		
F06	2	2.7	03.04.2024	15:10	60°49.808'	5°03.313'	9	100			x		
F06	2	2.8	03.04.2024	15:10	60°49.808'	5°03.313'	9	250			x		x
F06	2	2.9	03.04.2024	15:10	60°49.808'	5°03.313'	9	400			x		

F06	2	2.10	03.04.2024	15:10	60°49.808'	5°03.313'	9	480-500?			x		x
MF24	3	3.1 Surf.	04.04.2024	06:10	60°52.198'	5° 22.0148'	7	1			x	x	x
MF24	3	3.2 Surf.	04.04.2024	06:10	60°52.198'	5° 22.0148'	7	1			x	x	
MF24	3	3.3 Surf.	04.04.2024	06:10	60°52.198'	5° 22.0148'	7	1			x	x	
MF24	3	3.4	04.04.2024	06:10	60°52.198'	5° 22.0148'	7	50			x		
MF24	3	3.5	04.04.2024	06:10	60°52.198'	5° 22.0148'	7	80			x		x
MF24	3	3.6	04.04.2024	06:10	60°52.198'	5° 22.0148'	7	140			x		
MF24	3	3.7	04.04.2024	06:10	60°52.198'	5° 22.0148'	7	200			x		x
MF24	3	3.8	04.04.2024	06:10	60°52.198'	5° 22.0148'	7	426			x		x
OTW_X	int.	S. X_1	04.04.2024	09:07	60°51.036'	5°20.885'	8.1	1	4.7	0.9	x	x	
OTW_X	int.	S. X_2	04.04.2024	09:07	60 51 036	5 20 885	8.1	1	4.7	0.9	x	x	
OTW_X	int.	S. X_3	04.04.2024	09:07	60 51 036	5 20 885	8.1	1	4.7	0.9	x	x	
HF	4	4.1 Surf.	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	1			x	x	x
HF	4	4.2 Surf.	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	1			x	x	
HF	4	4.3 Surf.	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	1			x	x	
HF	4	4.4	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	10			x		x
HF	4	4.5	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	20			x		
HF	4	4.6	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	30			x		
HF	4	4.7	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	50			x		
HF	4	4.8	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	60			x		x

HF	4	4.9	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	80			x		
HF	4	4.10	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	120			x		x
HF	4	4.11	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	120			x		
HF	4	4.12	04.04.2024	10:12	60°54.282'	5°30.648'	5.2	120			x		
OTW_1	int	S.3_1	04.04.2024	11.23	60°52.318'	5°24.629'	8.5	1	4.8	1.0	x	x	
OTW_1	int	S.3_2	04.04.2024	11.23	60°52.318'	5°24.629'	8.5	1	4.8	1.0	x	x	
OTW_1	int	S.3_3	04.04.2024	11.23	60°52.318'	5°24.629'	8.5	1	4.8	1.0	x	x	
OTW_2	int	S.2_1	04.04.2024	11:39	60°49.092'	5°19.886'	1.7	1	4.4	1.1	x		
OTW_2	int	S.2_2	04.04.2024	11:39	60°49.092'	5°19.886'	1.7	1	4.4	1.1	x		
OTW_2	int	S.2_3	04.04.2024	11:39	60°49.092'	5°19.886'	1.7	1	4.4	1.1	x		
OTW_3	int	S.4_1	04.04.2024	12:07	60°47.097'	5°10.575'	4.4	1	4.8	10	x	x	
OTW_3	int	S.4_2	04.04.2024	12:07	60°47.097'	5°10.575'	4.4	1	4.8	10	x	x	
OTW_3	int	S.4_3	04.04.2024	12:07	60°47.097'	5°10.575'	4.4	1	4.8	10	x	x	
L_06	5	5.1 Surf.	04.04.2024	14:00	60°41.107'	5°10.363'	6.7	1			x		
L_06	5	5.2 Surf.	04.04.2024	14:00	60°41.107'	5°10.363'	6.7	1			x		
L_06	5	5.3 Surf.	04.04.2024	14:00	60°41.107'	5°10.363'	6.7	1			x		
L_06	5	5.4	04.04.2024	14:00	60°41.107'	5°10.363'	6.7	10			x		
L_06	5	5.5	04.04.2024	14:00	60°41.107'	5°10.363'	6.7	30			x		
L_06	5	5.6	04.04.2024	14:00	60°41.107'	5°10.363'	6.7	60			x		
L_06	5	5.7	04.04.2024	14:00	60°41.107'	5°10.363'	6.7	100			x		
L_06	5	5.8	04.04.2024	14:00	60°41.107'	5°10.363'	6.7	250			x		
L_06	5	5.9	04.04.2024	14:00	60°41.107'	5°10.363'	6.7	412			x		