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Oceanography
Centre

RESEARCH EXPEDITION REPORT

RRS James Cook Expedition JC268

15-30 August 2024

ReBELS-1

Principal Scientist: Filipa Carvalho

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Abstract <p>The project ReBELS (Resolving Biological carbon Export in the Labrador Sea) is funded by the UK Natural Environmental Research Council (NERC) and aims to understand and quantify the transport of oceanic organic carbon into the deep sea and its effect on ocean carbon storage. To do so, we proposed to set up a year-long ocean observatory in the Labrador Sea using state-of-the-art autonomous observing technologies (gliders and biogeochemical ARGO floats) paired with traditional measurements of carbon flux (moored sediment trap) to understand the different contribution of particle injection pumps to the overall carbon export in the Labrador Sea. This cruise will collect all assets.</p> <p>JC268, is the first of three cruises which set up this year-long observatory in the Labrador Sea. The cruise comprised several goals:</p> <ul style="list-style-type: none">- Deploy a mooring, containing 3 sediment traps, physical and bio-optical sensors, acoustic doppler current profilers and current meters and 2 FluxCams (custom-made camera system aiming at characterising the sinking speed of particles).- Deploy 2 BGC-Argo floats, one of them contributing to the BGC-Argo Network and a second one, the ReBELS float, fitted with specialty sensors to characterise particles (UVP6), the upper ocean phytoplankton community (hyperspectral radiometer) and estimate carbon flux (optical sediment trap, transmissometer).- Conduct physical and biogeochemical measurements to validate/calibrate the deployed assets and create a baseline and understanding of the physical and biogeochemical drivers of carbon export.- Conduct opportunistic measurements at the GOSNAP mooring lines around Greenland to validate sensor measurements, in particular oxygen sensors recently fitted on the array. <p>The cruise consisted of 4 main stations: 1. CTD line off Nuuk; 2. mooring; 3. Floats deployment; 4. GOSNAP mooring array.</p>	
KEYWORDS Biological carbon pump, ocean carbon sink, turbulence, particles, Labrador Sea	
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List of personnel

Scientific Personnel

Filipa Carvalho (Chief Scientist)	National Oceanography Centre
Ashley Hall	Royal College of Art
Elisa Lovecchio	National Oceanography Centre
Kitty Kam	Dalhousie University (USA)
Hans Hilder	National Oceanography Centre
Heather Jaques	University of Southampton
Louis Clement	National Oceanography Centre
Will Major	National Oceanography Centre

Technical Personnel

Andrew Leadbeater (Chief Technician)	Ocean Engineering, National Oceanography Centre
Billy Platt	Sensors & Moorings, National Oceanography Centre
Nicholas Rundle	Sensors & Moorings, National Oceanography Centre
Daniel Philips	Scientific Ships Systems, National Oceanography Centre

Ship's Personnel

James Gwinnell	Master
Philip Gauld	C/O
Declan Morrow	2/O
Rachel Astell	3/O
Christopher Uttley	C/E
Michael Murray	2/E
Edin Silajdzic	3/E
Gary Slater	3/E
David Hawksworth	ETO
Paul Lucas	PCO
Grant Fraser	CPOS
John Allen	CPOD
Iain Forbes	POS
Paul Marshall	POD
Brian Burton	SG1A
Niel Channing	SG1A
Robert Leech	SG1A
Sean Angus	ERPO
Christopher Keighley	Head Chef
Marius Constantin	Chef
Jane Bradbury	Stwd

Itinerary

The cruise was composed of 5 sequential stations as shown in Figure 1:

- Science Station 1: 3 sites across the shelf off Nuuk
- Test site
- Science Station 2: Mooring site
- Science station 3: Float deployment site
- Science station 4: 4 sites on the GOHSNAP western Irminger Sea

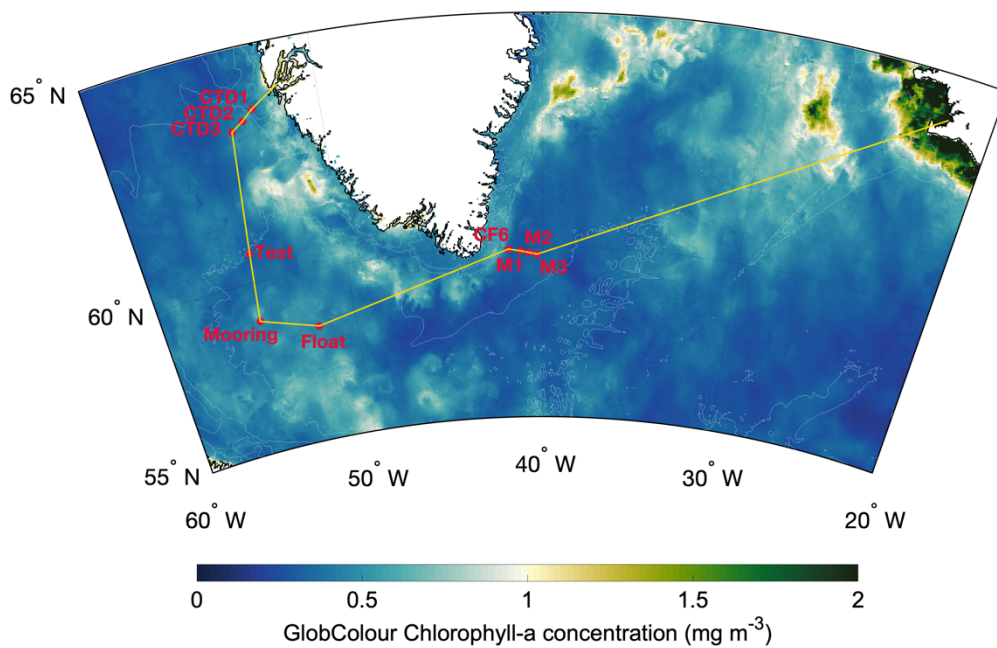


Figure 1: Map of the cruise main stations overlaid on a composite Copernicus-GlobColour in units of chlorophyll concentration (mg m^{-3}) for 16-29 August 2024

Narrative

Saturday, 17th August

The RRS James Cook departed from Nuuk, Greenland, beginning transit towards the first science station. The first CTD was deployed in the afternoon, just four hours after departure, followed by two more CTD casts across the continental shelf. Once all three were completed, we started our transit towards the mooring site. The weather was cloudy with a light drizzle in the morning, clearing in the afternoon. Winds remained from the northwest at 10-12 knots, with slight sea and low swell.

Sunday, 18th August

On our way to the mooring site, we made a stop after lunch to test the equipment. We tested all Marine Snow Catchers, followed by the turbulence profiler. Once completed, we continued our transit towards the mooring site (59°N, 55°W), scheduled to arrive the following morning. The weather remained overcast, with rain showers in the afternoon and light drizzle in the evening. Winds were steady at 10-11 knots from the northwest.

Monday, 19th August

We arrived at the mooring site in the morning. The first deployment was the turbulence profiler to 500m and 200m; we aimed for 10 profiles per deployment, which required several hours. A Red Camera Frame was then deployed to 600m, followed by a full-depth (~3300m) CTD cast, during which we calibrated all the instruments to be deployed in the mooring. An MMO (marine mammal observation) survey was conducted for one hour without any sightings before an overnight multibeam survey around the mooring site to characterize the bathymetry where we were going to deploy the ReBELS mooring. The day was partly cloudy with occasional clearing, and winds shifted slightly to the northeast at 9-12 knots.

Tuesday, 20th August

Since the mooring instruments weren't completely ready for deployment, and to give scientists and technicians more time to complete preparations, an underway survey was conducted in the morning to collect photos and timelapses of the water, along with underway acoustics and discrete sampling throughout the day. A second survey was conducted in the evening to allow more time to finalize mooring preparations, ensuring the vessel returned to station by the next morning. Cloud cover persisted throughout the day, though skies cleared slightly in the evening. Winds held steady from the northwest at 12-15 knots.

Wednesday, 21st August

Mooring deployment started first thing in the morning. FluxCAMs were deployed first, followed by an ADCP, microcats, and current meters. Another ADCP was then deployed, along with three sediment traps, and finally, the mooring weight. The mooring deployment was followed by a triangulation survey. The Red Camera Frame was deployed to 600m in the afternoon, followed by Marine Snow Catchers at 50m and 140m. A turbulence profiler deployment was conducted in the evening before another overnight survey. The weather

remained calm, with occasional cloud cover and slight sea conditions. Winds from the northwest remained at 12-14 knots.

Thursday, 22nd August

A second triangulation survey was conducted in the morning to confirm the location of the mooring releases. This was followed by a 1000m CTD deployment with SUNA and Octopus sensors. Additional deployments included the Red Camera Frame (600m), Marine Snow Catchers (50m, 140m), and a turbulence profiler operation in the afternoon. The weather remained overcast, with patchy fog throughout the day. Winds held steady from the northwest at 10-12 knots.

Friday, 23rd August

We aimed to remain at the mooring site for a third day to collect sufficient concurrent calibration data with the mooring instruments. A 3000m CTD cast was performed in the morning, followed by the Red Camera Frame at 600m and Marine Snow Catchers at 50m and 140m. Turbulence profiling was done in the afternoon, followed by an evening underway survey. Cloud cover persisted, with occasional drizzle. Winds remained from the northwest at 12-14 knots. We then started our transit to the float deployment site.

Saturday, 24th August

The vessel approached the float site (58.5°N, 52°W) and commenced operations in the morning with a turbulence profiler deployment (400m). Two floats were deployed sequentially, 10 minutes apart, with the ship moving at 2 knots. This was followed by a 2000m CTD cast around midday to provide a calibration profile to match the float's descent. The Red Camera Frame was deployed to 600m in the afternoon, followed by the Marine Snow Catchers at 50m and 140m. The vessel then began transiting to GOHSNAP W, LS7 (59° 18.0'N, 46° 52.4'W), with arrival expected the following evening. The weather featured rain showers in the morning, clearing slightly by midday, with continued slight sea and low swell.

Sunday, 25th August

Sunday ended up being a catch-up day for data processing. While the weather was nice and calm overnight, it picked up in the morning with rippled seas and some drizzle. In the afternoon, large icebergs became visible as fog started to set in. Foggy conditions worsened, with thick fog and scattered bergy bits in the water. A decision was made to skip the GOHSNAP eastern Labrador Sea site Mooring Array (on the western side of Greenland) and go straight to the GOHSNAP Western Irminger Sea Mooring Array (on the eastern side of Greenland, station named 'GOHSNAP E'), to ensure we could spend the necessary two days sampling concurrently at four different moorings in that array.

Monday, 26th August

The vessel arrived at GOHSNAP E (CF6) and began operations in the morning with a full-depth (~1800m) CTD cast, followed by a 400m turbulence profiler deployment. The ship then transited to M1 (59° 54.204'N, 41° 06.594'W), where the Red Camera Frame (600m) and Marine Snow Catchers (50m, 140m) were deployed. The second turbulence profiler deployment of the day was completed in the evening, followed by a full-depth CTD cast. The vessel prepared for transit to M2 (59° 51.534'N, 40° 41.626'W). Conditions remained partly

cloudy with occasional drizzle, and winds from the northwest at 10-12 knots.

Tuesday, 27th August

The vessel continued operations at GOHSNAP E, arriving at M2 in the morning, where a full-depth CTD cast was conducted, followed by a turbulence profiler deployment. The ship then transited to M3 (59° 48.912'N, 40° 16.746'W), where another turbulence profiler was deployed in the afternoon. A final full-depth (~2557m) CTD cast was conducted, followed by the cruise's last Red Camera Frame deployment. With over-the-side science operations completed, the vessel started its transit towards Reykjavik, Iceland. Conditions remained stable with cloud cover and occasional clearing, and winds from the northwest at 10-12 knots.



Figure 2: Scientists and technicians on JC268. From top to bottom and left to right: Billy Platt (NMF), Daniel Phillips (NMF), Hans Hilder (NOC), Ashley Hall (RCA), Louis Clement (NOC), Elisa Lovecchio (NOC), Filipa Carvalho (NOC), Nick Rundle(NMF), Andy Leadbeater(NMF), Kitty Kam (Dalhousie), Heather Jaques (NOC/UoS), Will Major (NOC).

Event log

Science Station 1:

#	Event	Date	Time	Lat	Lon	Station
1	CTD001	17/08/2024	13:05	63.789	-53.002	CTD1
2	CTD002	17/08/2024	16:03	63.590	-53.530	CTD2
3	CTD003	17/08/2024	19:38	63.429	-54.093	CTD3

Test Site:

#	Event	Date	Time	Lat	Lon	Station
4	MSC01	18/08/2024	13:19	60.735	-54.665	Test
5	MSC02	18/08/2024	13:33	60.735	-54.665	Test
6	MSC03	18/08/2024	13:49	60.735	-54.665	Test
7	MSC04	18/08/2024	14:23	60.735	-54.665	Test
8	MSC05	18/08/2024	14:46	60.735	-54.665	Test
9	ISW01	18/08/2024	15:17	60.736	-54.666	Test

Mooring Site:

#	Event	Date	Time	Lat	Lon	Station
10	ISW02	19/08/2024	08:19	59.000	-55.001	Mooring
11	RCF01	19/08/2024	13:42	59.000	-55.001	Mooring
12	CTD004	19/08/2024	15:05	59.000	-55.001	Mooring
13	Multibeam Survey01	19/08/2024	19:25	59.000	-55.000	Mooring
16	Camera Survey01	20/08/2024	16:26	58.995	-54.979	Mooring
17	Mooring01	21/08/2024	08:38	58.988	-54.996	Mooring
18	Mooring Triangulation01	21/08/2024	14:25	59.010	-55.003	Mooring
19	RCF02	21/08/2024	16:26	59.000	-54.978	Mooring
20	MSC06	21/08/2024	18:15	59.000	-54.975	Mooring
21	MSC07	21/08/2024	18:29	58.999	-54.976	Mooring
22	ISW03	21/08/2024	18:58	59.005	-54.978	Mooring
23	MooringTriangulation02	22/08/2024	08:10	58.981	-55.041	Mooring
24	CTD005	22/08/2024	08:59	58.999	-55.006	Mooring
25	RCF03	22/08/2024	10:35	59.001	-55.014	Mooring
26	MSC08	22/08/2024	12:40	59.001	-55.017	Mooring
27	MSC09	22/08/2024	13:01	59.001	-55.020	Mooring
28	ISW04	22/08/2024	14:33	59.004	-55.002	Mooring
29	CameraSurvey02	22/08/2024	18:24	59.025	-55.002	Transit
30	CTD006	23/08/2024	08:42	59.006	-55.009	Mooring
31	RCF04	23/08/2024	12:35	59.006	-55.041	Mooring
32	MSC10	23/08/2024	14:08	59.006	-55.050	Mooring
33	MSC11	23/08/2024	14:20	59.005	-55.051	Mooring
34	ISW05	23/08/2024	15:19	59.005	-55.052	Mooring
35	CameraSurvey03	23/08/2024	19:16	59.016	-55.174	Transit

Float Site:

#	Event	Date	Time	Lat	Lon	Station
36	ISW06	24/08/2024	08:55	58.502	-51.999	Float
37	Float1	24/08/2024	12:47	58.500	-52.000	Float
38	Float2	24/08/2024	12:56	58.500	-52.003	Float
39	CTD007	24/08/2024	13:21	58.500	-52.006	Float
40	MSC12	24/08/2024	14:47	58.500	-52.006	Float
41	MSC13	24/08/2024	14:59	58.500	-52.006	Float
42	RCF05	24/08/2024	15:47	58.500	-52.006	Float

GOHSNAP E Site:

#	Event	Date	Time	Lat	Lon	Station
43	CTD008	2024-08-26	08:03	59.956	-41.743	CF6
44	ISW07	2024-08-26	10:23	59.956	-41.743	CF6
45	RCF06	2024-08-26	14:21	59.903	-41.110	M1
46	MSC14	2024-08-26	15:53	59.903	-41.110	M1
47	MSC15	2024-08-26	16:16	59.903	-41.110	M1
48	ISW08	2024-08-26	16:45	59.904	-41.110	M1
49	CTD009	2024-08-26	18:25	59.903	-41.110	M1
50	CTD010	2024-08-27	08:32	59.859	-40.694	M2
51	ISW09	2024-08-27	11:13	59.859	-40.694	M2
52	ISW10	2024-08-27	14:29	59.815	-40.279	M3
53	CTD011	2024-08-27	16:23	59.816	-40.293	M3
54	RCF07	2024-08-27	18:55	59.816	-40.293	M3

Ship Scientific Systems Technical Report

Overview

Ship Scientific Systems (SSS) is responsible for operating and managing the Ship's scientific information technology infrastructure, data acquisition, compilation and delivery, and the suite of ship-fitted instruments and sensors in support of the Marine Facilities Programme (MFP)

The work site was the Labrador Sea.

The main objectives for SSS in the service of the science party on this cruise were:

1. Acquire underway data and metadata, including sea-surface, meteorological, position and attitude, depth and multibeam swath.
2. Provide services for recording metadata and events and monitoring data streams.
3. Provide basic IT support.

All times in this report are in UTC.

Summary

A summary of the progress made against objectives is shown below.

[X] Objectives, [X] completed, [X] partially completed, [X] not completed.

Target	Outcomes	Objective met?
Acquire underway data and metadata, including sea-surface, meteorological, position and attitude, depth and multibeam swath.	Data collected as RVDAS NMEA, Database ASCII, Techsas NetCDF and ASCII.	Yes
Provide services for recording metadata and events and monitoring data streams.	Eventlogger and Metadata system provided and used.	Yes
Provide basic IT support		Yes

Scientific computer systems

Underway data acquisition

Data from the suite of ship-fitted scientific instrumentation was aggregated onto a network drive on the ship's file server. This was available throughout the voyage in read-only mode to permit scientists to work with the data as it was acquired. A Public network folder was also available for scientists to share files.

A copy of these two drives are written to the end-of-cruise disks that are provided to the Principal Scientist and the designated data centre.

The designated data centre for this cruise is: British Oceanographic Data Centre.

List of logged ship-fitted scientific systems:

`/Cruise_Reports/[Keywords]_Ship_fitted_information_sheet.docx`

The data acquisition systems used on this cruise are detailed in the table below. The data and data description documents are filed per system in the *Data* and *Documentation* directories respectively within Ship Systems folder on the cruise data disk.

Table 1: Data acquisition systems used on this cruise.

Data acquisition system	Usage	Data products	Directory system name
Ifremer TechSAS	Continuous	NetCDF ASCII pseudo-NMEA	/TechSAS/
NMF RVDAS	Continuous/	ASCII Raw NMEA	/RVDAS/
Kongsberg SIS (EM122)	Discrete	Kongsberg .all	/Acoustics/EM-122/
Kongsberg EA640	Continuous	None, redirected to Techsas/RVDAS RAM	/Acoustics/EA-640/
Kongsberg EK80	Continuous		/Acoustics/EK-80/
UHDAS (ADCPs)	Continuous.	ASCII raw, RBIN, GBIN, CODAS files	/Acoustics/ADCP/

Data description documents per system:

`/Ship_Systems/Documentation/[systemName]/`

Data directories per system:

`/Cruise_Reports/Documentation/[systemName]/`

Significant acquisition events and gaps

On this cruise, the NMF Event Logger was used with CSV records of events saved to the cruise data directory.

Path and pattern to event log CSV files:

`/Cruise_Reports/Event_Logs/[logName]/*.csv`

Summary of main events

Date	Time start*	Time end*	Event
2024-08-15	13:31:50		JC268 data acquisition started.
2024-08-15	17:43:17		James Cook moved to Nuuk, Greenland anchorage.
2024-08-17	09:30:00		James Cook departed Nuuk, Greenland.
2024-08-28	23:52:26		JC268 data acquisition ended.
2024-08-30	09:50:00		James Cook arrived in Reykjavík, Iceland.

Summary of data gaps

Date	Time start	Time end	Event

Internet provision

Satellite communications were provided with OneWeb, Starlink, VSat and Iridium Certus.

The ship operated with bandwidth controls to prioritise business use.

Outreach and streaming

None.

Instrumentation

Coordinate reference

Path to ship survey files:

Origin (RRS James Cook)

The common coordinate reference was defined by the Blom Maritime survey (2006) as:

1. The reference plane is parallel with the main deck abeam (transversely) and with the baseline (keel) fore- and aft-ways (longitudinally).
2. Datum ($X = 0, Y = 0, Z = 0$) is centre topside of the Applanix motion reference unit (MRU) chassis.

Multibeam

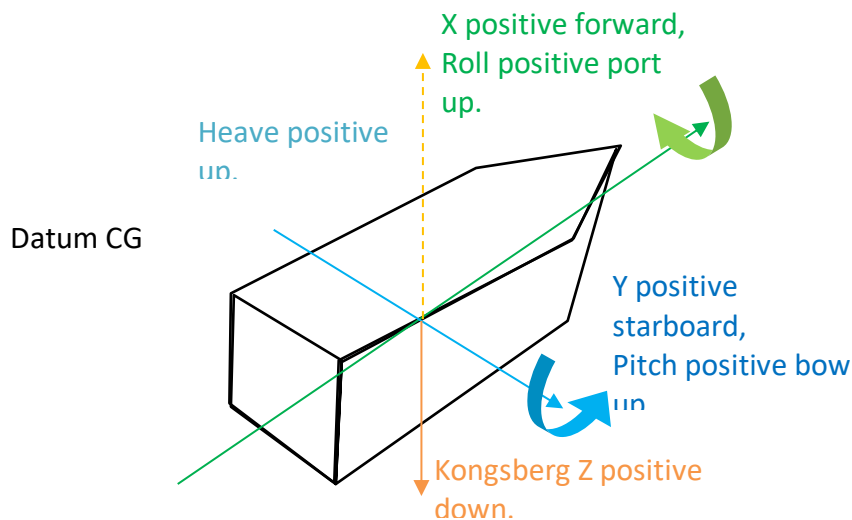


Figure 3: Conventions used for position and attitude. On the Discovery, the Datum is the CRP at the CG. On the Cook the Datum is on the centre, topside of the Applanix MRU.

The Kongsberg axes reference conventions are (see Figure 3) as follows:

1. X positive forward,
2. Y positive starboard,
3. Z positive downward.

The rotational sense for the multibeam systems and Seapath is set to follow the convention of Applanix PosMV (the primary scientific position and attitude system), as per Figure 3.

Primary scientific position and attitude system

The translations and rotations provided by this system (Applanix PosMV) have the following convention:

1. Roll positive port up,
2. Pitch positive bow up,
3. Heading true positive to starboard,

4. Heave positive up.

Position, attitude and time

System	Navigation (Position, attitude, time)		
Data product(s)	NMEA (mvpos,mvatt,spatt,sppos,cnpos): /Ship_Systems/Data/TechSAS/NMEA/ NetCDF (GPS): /Ship_Systems/Data/TechSAS/NetCDF/ Raw NMEA (POSMV,SEAPATH,CNAV): /Ship_Systems/Data/RVDAS/rawdata		
Data description	/Ship_Systems/Documentation/TechSAS/Data_Description		
Other documentation	/Ship_Systems/Documentation/GPS_and_Attitude		
Component	Purpose	Outputs	Headline Specifications
Applanix PosMV	Primary GPS and attitude.	Serial NMEA to acquisition systems and multibeam	Positional accuracy within 0.15 m.
Kongsberg Seapath 330	Secondary GPS and attitude.	Serial and UDP NMEA to acquisition systems and multibeam	Positional accuracy within 1 m.
Oceaneering CNav 3050	Correction service for primary and secondary GPS and dynamic positioning.	RTCM to primary and secondary GPS	Positional accuracy within 0.15 m.
Meinberg NTP Clock	Provide network time	NTP protocol over the local network.	

Significant position, attitude or time events or losses

Date	Time start*	Time end*	Event

Ocean and atmosphere monitoring systems

SURFMET

System	SURFMET (Surface water and atmospheric monitoring)	
Data product(s)	<p>NMEA (surfm,sbe38,sbe45,winds): /Ship_Systems/Data/TechSAS/NMEA/</p> <p>NetCDF (SURFMETV3, SBE38,TSG,WINDSONIC): /Ship_Systems/Data/TechSAS/NetCDF/</p> <p>Raw NMEA (SURFMET,SBE38,SBE49, WINDSONIC): /Ship_Systems/Data/RVDAS/rawdata</p>	
Data description	/Ship_Systems/Documentation/Surfmet/Data_Description	
Other documentation	/Ship_Systems/Documentation/Surfmet	
Calibration info	See Ship Fitted Sensor sheet for calibration info for each sensor.	
Component	Purpose	Outputs
Inlet temperature probe (SBE38)	Measure temperature of water at hull inlet.	Serial to Interface Box.
Drop keel temperature probe (SBE38)	Measure temperature of water in drop keel space.	Serial to Interface Box.
Thermosalinograph (SBE45)	Measure temp. and conductivity at sampling board. Salinity is calculated.	Serial to Interface Box.
Interface Box (SBE90402)	Signals management.	Serial to Moxa.
Debubbler	Reduces bubbles through instruments.	None.
Transmissometer (CST)	Measure of transmittance.	Analogue to NUDAM.
Fluorometer (WS3S)	Measure of fluorescence.	Analogue to NUDAM.
Air temperature and humidity probe (HMP45A,	Temperature and humidity at met. platform.	Analogue to NUDAM.

HMP155)		
Ambient light sensors (PAR, SKE510; TIR, CMP6)	Ambient light at met. platform.	Analogue to NUDAM.
Barometer (PTB110, PTB210)	Atmospheric pressure at met. platform.	Analogue to NUDAM.
Anemometer (Windsonic)	Wind speed and direction at met. platform.	Serial to Moxa.
NUDAM	A/D converter.	Serial NMEA to Moxa.
Moxa	Serial to UDP converter.	UDP NMEA to Surfmet VM.
Surfmet Virtual Machine	Data management.	UDP NMEA to TechSAS, RVDAS.

Component	Calibrated product steps
SBE38: Temperature (°C)	No calibration to apply because the residuals are below uncertainty.
SBE45: Temperature (°C)	No calibration to apply because the residuals are below uncertainty.
SBE45: Conductivity (S m ⁻¹)	No calibration to apply because the residuals are below uncertainty.
CST: Transmission (%)	Product = $(Data - V_{dark}) / (V_{ref} - V_{dark})$. Here product has units % and data, V_{dark} and V_{ref} have units V.
WS3S: Fluorescence (µg L ⁻¹)	Product = Coefficient × (Data – Offset). Here product has units µg L ⁻¹ , coefficient has units µg L ⁻¹ V ⁻¹ , and data and offset have units V.
HMP45A / HMP155: Temperature (°C)	No calibration to apply because the residuals are below uncertainty.
HMP45A / HMP155: Relative humidity (%)	No calibration to apply because the residuals are below uncertainty.
PTB110 / PTB210: Pressure (hPa)	No calibration to apply because the residuals are below uncertainty.

SKE510: PAR ($W m^{-2}$)	<p>TechSAS</p> $\text{Product} = \text{Data} \times \left(\frac{10^6}{\text{Coefficient}} \right).$ <p>Here product has units $W m^{-2}$, data has units $10^{-5} V$, the 10^6 scalar has units $\mu V V^{-1}$, and coefficient has units $\mu V m^2 W^{-1}$.</p> <p>RVDAS</p> $\text{Product} = \text{Data} \times \left(\frac{10}{\text{Coefficient}} \right).$ <p>Here product has units $W m^{-2}$, data has units $W m^{-2}$, the 10 scalar has units $\mu V m^2 W^{-1}$, and coefficient has units $\mu V m^2 W^{-1}$.</p>
CMP6: TIR ($W m^{-2}$)	<p>TechSAS</p> $\text{Product} = \text{Data} \times \left(\frac{10^6}{\text{Coefficient}} \right).$ <p>Here product has units $W m^{-2}$, data has units $10^{-5} V$, the 10^6 scalar has units $\mu V V^{-1}$, and coefficient has units $\mu V m^2 W^{-1}$.</p> <p>RVDAS</p> $\text{Product} = \text{Data} \times \left(\frac{10}{\text{Coefficient}} \right).$ <p>Here product has units $W m^{-2}$, data has units $W m^{-2}$, the 10 scalar has units $\mu V m^2 W^{-1}$, and coefficient has units $\mu V m^2 W^{-1}$.</p>
Windsonic: Wind speed ($m s^{-1}$)	No calibration to apply.
Windsonic: Wind direction ($m s^{-1}$)	No calibration to apply.

Note that while the residuals (difference of reference and measured) are below uncertainty and the output is considered calibrated for the SBE38, SBE45, HMP45A, HMP155, PTB110 and PTB210 instruments, a regression could still be made between the reference and measured data (see the calibration certificate) if desired. Follow the steps below:

1. Calculate $y = Bx + A$ from calibration data, where x is reference data.
2. Product = (Data – A)/B.

The NMF Surfmet system was run throughout the cruise, excepting times for cleaning, entering and leaving port, and whilst alongside. Please see the separate information sheet for details of the sensors used and whether their recorded data have calibrations applied or not. The system was cleaned prior to the cruise.

Water samples were taken three times daily from the underway sampling board to be analysed by the Autosol. The comparison between the SBE45 TSG and the Autosol can be

found here:

Path to TSG vs Autosal:

X:\Ship_Systems\Data\SURFMET\TSG\TSG_autosal_comp.
CSV

Percentage difference between 23 SBE45 TSG and Autosal measurements of salinity.

Statistic	Percentage difference
Mean	0.01
Min	-0.17
Max	0.06

Data gaps

Channel	Acquisition System	Date Time Start	Date Time End	Affected files	Comment
SURFMET	TechSAS		2024-08-21 19:08	TechSAS NMEA and NetCDF.	TechSAS acquisition failed. Use RVDAS dataset.
SURFMET	RVDAS		2024-08-21 19:10	Raw NMEA.	RVDAS acquisition failed from incorrect configuration. See comment below.
SURFMET	TechSAS/RVDAS	2024-08-22 14:10	2024-08-22 15:08	All.	Instrument cleaning.
SURFMET	TechSAS	2024-08-22	2024-08-24 10:27:52	TechSAS NMEA and	TechSAS acquisition

		12:39:18		NetCDF.	failed. Use RVDAS dataset.
SURFMET	TechSAS/RVDAS	2024-08-26 10:42	2024-08-26 11:31	All.	Instrument cleaning.

An update was recently made to the RVDAS acquisition of SURFMET data and the \$SFUWY dataset was incorrectly configured. Up until 2024-08-21 19:08:00, the values for fluorescence were recorded as flow rate, transmission were recorded as fluorescence and flow rate were recorded as transmission. Prior to recording, the values of flow rate (fluorescence) were multiplied by 0.43. For complete clarity, the raw NUDAM data are provided in the file `\Ship_Systems\Data\SURFMET\NuDAM\4001.txt`. The first voltage is fluorescence, the second voltage is transmission and the third voltage is flow rate ($>+0.1926+3.0797+3.8980+0.0067+0.0064+0.0066-0.0108-0.0110$). A processed dataset is also provided, in geophysical units using the calibration coefficients, in the file `\Ship_Systems\Data\SURFMET\NuDAM\uwy_data.txt`. After 2024-08-21 19:08:00, the standard acquisition files can be used.

Wave radar

System	WAMOS Wave Radar	
Data product(s)	NMEA (wamos, rexwr): <code>/Ship_Systems/Data/TechSAS/NMEA/</code> NetCDF (NC): <code>/Ship_Systems/Data/TechSAS/NetCDF/</code> Raw NMEA (WAMOS, REX2): <code>/Ship_Systems/Data/RVDAS/rawdata</code>	
Data description	<code>/Ship_Systems/Documentation/TechSAS/Data_Description</code>	
Other documentation	<code>/Ship_Systems/Documentation/Wamos</code>	
Component	Purpose	Outputs
Rutter OceanWaves WAMOS	Measure wave height, direction, period and spectra.	Summary statistics in NMEA to TechSAS and RVDAS. Spectra files.
RsAqua Rex2 Wave Height Sensor	Measure wave height at bow to provide calibration reference dataset.	Wave height NMEA, UDP to TechSAS, RVDAS.
Furuno Radar	Measures radar reflection on sea surface.	Radar data to WAMOS.

The wave radar magnetron requires annual replacement. Following replacement, WAMOS needs to collect wave data within 5 km of another wave height sensor over the full range of sea-states in order to derive wave height calibration coefficients for the new magnetron. This reference dataset can be derived by examining the ship's track for wave buoys and downloading their data, or by using the onboard RsAqua Wave Height sensor fitted on the ship's bow.

Data between 2024-08-19T02:00Z and 2024-08-24T09:00Z was saved on the external disks given to BODC and the cruise PI.

Summary of data gaps

Date	Time start	Time end	Event

Hydroacoustic Systems

System	Acoustics	
Data product(s)	Raw (EA-640, EM-122): /Ship_Systems/Data/Acoustics NMEA (eadep, emdep): /Ship_Systems/Data/TechSAS/NMEA NetCDF (EA600, DEPTH): /Ship_Systems/Data/TechSAS/NetCDF Raw NMEA (EA640, EM122cb): /Ship_Systems/Data/RVDAS/rawdata	
Data description	/Ship_Systems/Documentation/TechSAS/Data_Description	
Other documentation	/Ship_Systems/Documentation/Acoustics	
Component	Purpose	Operation and Outputs
10/12 kHz Single beam (Kongsberg EA-640)	Primary depth sounder	Continuous, free running NMEA over serial, raw files
12 kHz Multibeam (Kongsberg EM-122)	Full-ocean-depth multibeam swath.	Discrete Binary swath, centre-beam NMEA, *.all files, optional water column data
Drop keel sound velocity sensor	Provide sound velocity at transducer depth	Continuous Value over serial to Kongsberg SIS.

75 kHz ADCP (Teledyne OS75)	Along-track ocean current profiler	Continuous, free running (via UHDAS)
150 kHz ADCP (Teledyne OS150)	Along-track ocean current profiler	Continuous, free running (via UHDAS)

Marine Mammal Protection

NMF policy is to follow JNCC guidelines for marine mammal observations before operating any equipment which causes significant acoustic disturbance in the water column. Such equipment includes the deep-water multibeam and sub-bottom profiler. For these systems, an MMO procedure is followed, which, in summary, involves a 60-minute bridge observation with a ramped start 45 minutes into the observation.

Path to Marine Mammal Observations logs:

`/Ship_Systems/Documentation/Acoustics/MMOs`

A member of the scientific party was responsible for carrying out and recording MMO activities.

Table 2: Marine mammal observation events reported to SSS.

Date	System	Obs. Start Time	Sys. Start Time Full Power	Notes (inc. any observations or actions)
2024-08-19	EM122	18:20	19:43	None

Sound velocity profiles

Sound velocity profiles were measured directly with a Midas SVP, derived from CTD or calculated from the WOA13 model using Ifremer DORIS.

Path of sound velocity profile data on the cruise datastore:

`/Ship_Systems/Data/Acoustics/Sound_Velocity`

Details of when sound velocity profiles were taken and applied are shown in the table below:

Table 3: Sound velocity profiles.

Datetime	Method	Location (Lat/Lon)	Filename	Datetime SVP applied to SIS / Ranger2
2024-08-19 19:27	DORIS WOA13	59.000/- 55.000	JC268-240819- CTD.asvp	2024-08-19 19:27

Equipment-specific comments

ADCPs

Path of ADCP data on the cruise datastore:

`/Ship_Systems/Data/Acoustics/ADCP`

Attribute	Value
Acquisition software	UHDAS
Frequencies used	75 kHz, 150 kHz
Running mode	Free-running (untriggered)

EM-122 Configuration and Surveys

Path of Multibeam data on the cruise datastore:

`/Ship_Systems/Data/Acoustics/EM-122`

Path of EM122 CARIS Vessel Configuration File:

`/Ship_Systems/Data/Acoustics/EM-122/VesselConfig`

Attribute	Value
-----------	-------

Number of surveys	1			
Date of patch test	Not undertaken.			
Offsets and rotations	Item	X (m, + Forward)	Y (m, + Starboard)	Z (m, + Down)
	Tx transducer	19.205	1.830	6.934
	Rx transducer	14.094	0.950	6.932
	Item	Roll (deg)	Pitch (deg)	Yaw (deg)
	Tx transducer	-0.35	-0.1	0.19
	Rx transducer	-0.06	0.1	0.15
Post-processing undertaken	None.			

Other systems

Cable Logging and Monitoring

Winch activity is monitored and logged using the CLAM system.

CTD Technical Report (NMF)

Personnel on the field: Billy Platt and Nick Rundle (NMF)

S/S CTD on CTD wire 2

CTD casts were undertaken using the NMF 24-way stainless steel CTD frame with 24, 20 litre OTE water samplers attached. Primary temperature, conductivity and oxygen sensors were mounted on the 9P unit. The secondary temperature, conductivity and oxygen sensors were mounted on the vane.

CTD wire 1 was insulation and resistance tested, and had the following readings. Insulation >1000MOhms, resistance 71.9MOhms. The CTD was terminated using the potting method.

A user-supplied SUNA sensor was mounted horizontally on the bottom of the vane for all casts shallower than 2000m. The battery pack was mounted on a vertical outside leg of the CTD frame. The instrument was secured with cable-ties and the battery pack with jubilee bands.

A user-supplied 'Optics-Octopus' was mounted on the vane for one cast (CTD_004) but removed afterwards as there was uncertainty around if it was working and if it had been too deep (~3300m). The science party later established that it was working with a different battery pack and it is believed that the battery connector had been lost during CTD_004, which had caused the Optics-Octopus to stop recording.

After CTD_005 the science party noticed that bottle 17 appeared to be leaking at the bottom. This was reported to the CTD technician just as CTD_006 was launched. After CTD_006 bottle 17 was inspected and found to be leaking from the back where the clamp is mounted. It was replaced with a spare bottle.

CTD_007 bottle 10 failed to fire correctly. It closed during recovery due to the movement of the winch/wire.

Oxygen

The oxygen sensor on the vane, Sn2575, was initially showing brief periods during the early casts of noisy data. The profile of the data closely matched the profile of the other oxygen sensor. The cable connections were cleaned, dried and blown out with air but this did not improve the observed noise. The sensor was replaced with Sn2055, but this showed large differences in value and profile in the upper 20m and had an offset of ~50umol/kg throughout the cast. Sensor Sn2575 was cleaned in Triton and Bleach as per the SBE application note for cleaning oxygen sensors. It was re-installed for one cast but showed the same noise in the data as previously. It was replaced by another oxygen sensor, which worked as expected and matched the profile of the other installed oxygen sensor.

LADCP's

Two 300KHz ADCP's were mounted on the CTD frame. The down-looking, main, located at the bottom centre of the frame and the up-facing slave on an out-rigger sub-frame on the side of the CTD frame opposite the vane. They were configured with agreement from the

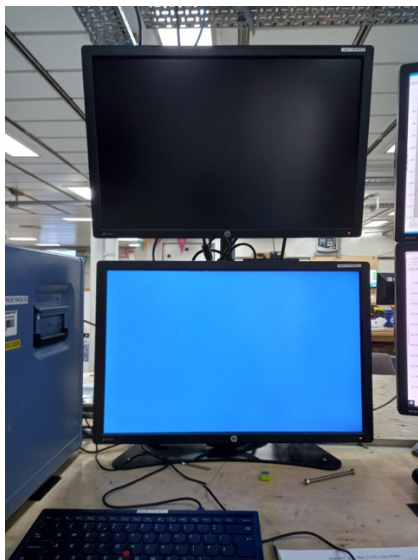
science team and deployed on every CTD cast.

On CTD007 the master LADCP script file was not fully sent and as such the Master did not record any data. The Slave recorded two files had it auto-deployed when the pre-set time-out elapsed after not receiving the sync-ping from the Master.

On CTD009 an operator error during setup meant that neither LADCP deployed correctly and thus no files were created for this cast.

It was observed during the final few deployments that the Master would sometimes 'hang-up' after the pre deployment tests. Power had to be removed by disconnecting the comms cable at the instrument and re-attached in order to establish communication again. It is unclear why this occurred.

At the end of the final CTD, moments after the data were backed up the CTD computer suddenly crashed, as per the photo below. After forcing a hard restart, it appears to be working ok.



AUTOSAL

A Guildline 8400B, s/n 71126, was installed in the Electronics Workshop as the main instrument for salinity analysis. The Autosal temperature set point was 21°C. The salinometer was standardised prior to any samples being processed. All salinity samples from the CTD and the TSG were taken by the science party and were then run through the salinometer by the on board NMF technicians using the standard NMF analysis process.

The glass cell was slightly sticky on electrode 2 causing an air bubble to regularly be held there. It was noticed that often, after flushing three times and running the first two 'reading' measurements that the third value would be quite different. Upon re-reading a fourth measurement the value would be nearer that of the first two measurements. Increasing amounts of diligence was applied to ensuring there were no air bubbles in the electrodes of the cell but this event was still observed. On average, it was happening every 3-4 samples.

A new method for comparing CTD .btl and autosal .xls salinity data was tested. A Python

script was written to automate the matching of bottle numbers from the CTD log sheets to the autosal output files. To achieve this, “CTD cast” and “CTD bottle number” columns were appended to the end of the autosal output data. Rows with bottle numbers formatted as CTD_*_999 did not have cast reference data.

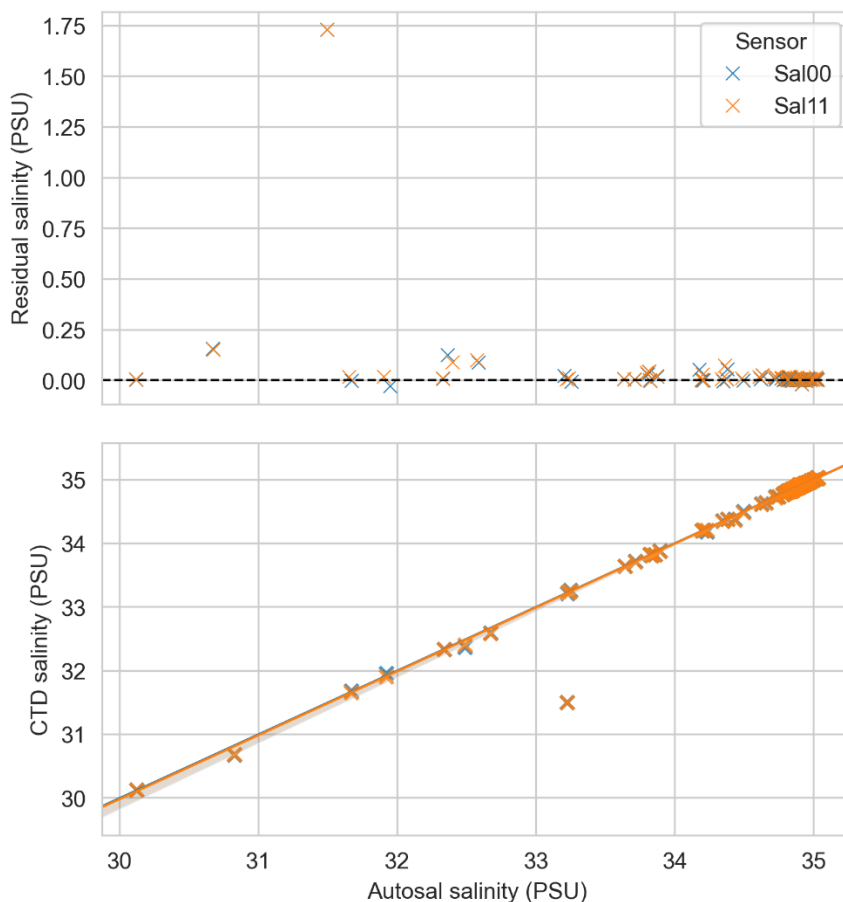
Autosal data was appended to the CTD .btl data and saved as *processed_ctd_autosal.csv*. For each conductivity sensor, Sal00 and Sal11, a residual salinity and percentage difference was calculated;

Residual salinity = autosal salinity – CTD salinity

Percentage difference = 100 x (autosal salinity – CTD salinity) / autosal salinity

Statistic	Sal00		Sal11	
	Residual (PSU)	Percent diff.	Residual (PSU)	Percent diff.
Mean	0.0229	0.07	0.0250	0.08
Min	-0.0296	-0.09	-0.0194	-0.06
Max	1.7287	5.20	1.7281	5.20

A figure of residual salinity vs autosal salinity and CTD salinity vs autosal salinity was provided as *processed_ctd_autosal.png*.



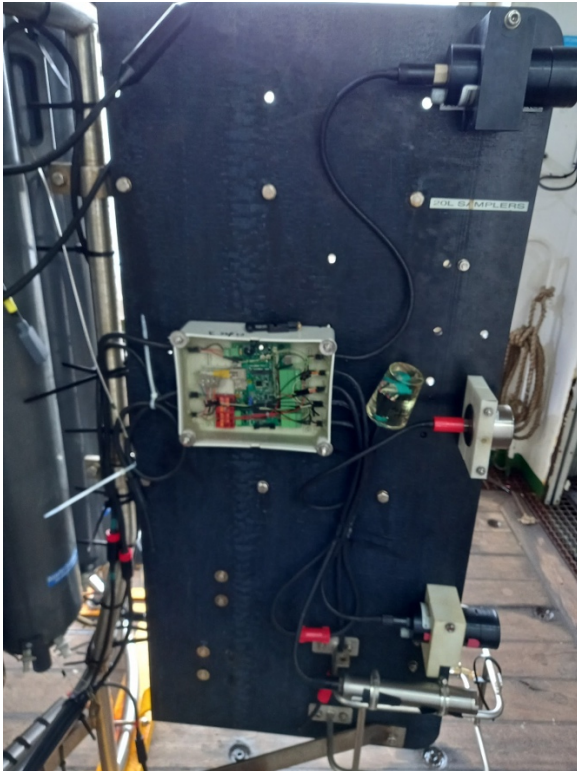
CTD Sensor information sheet

Setup of Stainless Steel 24-way CTD frame JC268

Instrument / Sensor	Manufacturer/ Model	Serial Number	Channel	Casts Used
Stainless steel 24-way CTD frame	NOCS	SBE CTD10	n/a	All casts
Primary CTD deck unit	SBE 11plus	11P-24680-0589	n/a	All casts
CTD Underwater Unit	SBE 9plus	09P-87077-1257	n/a	All casts
24-way Carousel	SBE 32	32-31240-0423	n/a	All casts
Primary Temperature Sensor	SBE 3P	03P-4782	F0	All casts
Primary Conductivity Sensor	SBE 4C	04C-2450	F1	All casts
Digiquartz Pressure sensor	Paroscientific	134949	F2	All casts
Secondary Temperature Sensor	SBE 3P	03P-4872	F3	All casts
Secondary Conductivity Sensor	SBE 4C	04C-2858	F4	All casts
Primary Pump	SBE 5T	05T-3607	n/a	All casts
Secondary Pump	SBE 5T	05T-3609	n/a	All casts
Primary Dissolved Oxygen Sensor	SBE 43	43-1940	V0	All casts
Secondary Dissolved Oxygen Sensor	SBE 43	43-2575	V1	Casts 1-7, 10
Secondary Dissolved Oxygen Sensor	SBE 43	43-2055	V1	Casts 8-9
Secondary Dissolved Oxygen Sensor	SBE 43	43-2819	V1	Cast 11
Altimeter	Valeport VA500	81632	V2	All casts
Light Scattering Sensor	WET Labs ECO BBrtD	BBRTD-5690	V3	All casts
Transmissometer	WET Labs C-Star DR	CST-1602DR	V4	All casts
Fluorometer	CTG AquaTracka Mk3	88-2615-126	V5	All casts
PAR Down-looking UWIRR	Satlantic Cosine PAR-LOG	PARLOGICSW-2365	V6	All casts
PAR Up-looking DWIRR	Satlantic Cosine PAR-LOG	PARLOGICSW-2364	V7	All casts
LADCP Down-looking (Master)	TRDI WHM 300KHz	4275	n/a	All casts
LADCP Up-looking (Slave)	TRDI WHM 300KHz	12369	n/a	All casts
LADCP battery pack	NOCS	WH007	n/a	
20L Water Samplers	Ocean Test Equipment	1 through 24	n/a	
Titanium EM CTD Swivel	MDS ST6003-2E2-Ti	1267-1	n/a	

User supplied equipment mounted on CTD frame

Optics Octopus



SUNA



SUNA battery pack



Master down-looking LADCP script file

CR1
RN JC268M
WM15
TC2
LP1
TB 00:00:02.80
TE 00:00:01.30
TP 00:00.00
LN25
LS0800
LF0
LW1
LV400
SM1
SA011
SB0
SW5500
SIO
EZ0011101
EX00100

CF11101
CK
CS

Slave up-looking LADCP script file

CR1
RN JC268S
WM15
LP1
TP 00:00.00
TE 00:00:00.00
LN25
LS0800
LF0
WB1
LW1
LV400
SM2
SA011
SB0
EZ0011101
EX00100
CF11101
CK
CS

CTD configuration file cast 001-007

PSA file: C:\Users\sandm\Documents\Cruises\JC268\Seasave Setup
Files\JC268_1257_SS_nmea.psa

Date: 08/25/2024

Instrument configuration file: C:\Users\sandm\Documents\Cruises\JC268\CTD
Data\Raw\JC268_CTD_002.xmlcon

Configuration report for SBE 911plus/917plus CTD

Frequency channels suppressed : 0
Voltage words suppressed : 0
Computer interface : RS-232C
Deck unit : SBE11plus Firmware Version >= 5.0
Scans to average : 1
NMEA position data added : Yes
NMEA depth data added : No
NMEA time added : Yes
NMEA device connected to : PC

Surface PAR voltage added : No
Scan time added : Yes

1) Frequency 0, Temperature

Serial number : 03P-4782
Calibrated on : 15 June 2023
G : 4.34980255e-003
H : 6.36221097e-004
I : 2.06812211e-005
J : 1.71285614e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 04C-2450
Calibrated on : 24 August 2023
G : -1.02521792e+001
H : 1.63486154e+000
I : -2.55901524e-003
J : 3.02717930e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 134949
Calibrated on : 10 March 2022
C1 : -3.695717e+004
C2 : -2.691791e-001
C3 : 1.143300e-002
D1 : 3.349300e-002
D2 : 0.000000e+000
T1 : 3.049225e+001
T2 : -3.372510e-004
T3 : 3.990980e-006
T4 : 3.875890e-009
T5 : 0.000000e+000
Slope : 1.00008000
Offset : -1.82150
AD590M : 1.280330e-002
AD590B : -9.092840e+000

4) Frequency 3, Temperature, 2

Serial number : 03P-4872
Calibrated on : 08 March 2023

G : 4.34416650e-003
H : 6.38935080e-004
I : 2.13025530e-005
J : 1.81731040e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 04C-2858
Calibrated on : 23 Novemberr 2022
G : -1.02374119e+001
H : 1.44087492e+000
I : -3.83686105e-004
J : 1.07640793e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

6) A/D voltage 0, Oxygen, SBE 43

Serial number : 43-1940
Calibrated on : 21 September 2023
Equation : Sea-Bird
Soc : 5.34400e-001
Offset : -4.94300e-001
A : -2.62170e-003
B : 1.23730e-004
C : -1.11680e-006
E : 3.60000e-002
Tau20 : 1.66000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

7) A/D voltage 1, Oxygen, SBE 43, 2

Serial number : 2575
Calibrated on : 23 September 2022
Equation : Sea-Bird
Soc : 4.31200e-001
Offset : -4.73900e-001
A : -4.57280e-003
B : 2.08010e-004
C : -2.82230e-006
E : 3.60000e-002

Tau20 : 1.20000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

8) A/D voltage 2, Altimeter

Serial number : 81632
Calibrated on : 09 June 2022
Scale factor : 15.000
Offset : -0.013

9) A/D voltage 3, OBS, WET Labs, ECO-BB

Serial number : 5690
Calibrated on :
ScaleFactor : 1.000000
Dark output : 0.000000

10) A/D voltage 4, Transmissometer, WET Labs C-Star

Serial number : 1602DR
Calibrated on : 17 August 2024
M : 21.7660
B : -0.0805
Path length : 0.250

11) A/D voltage 5, Fluorometer, Chelsea Aqua 3

Serial number : 88-2615-126
Calibrated on : 10 July 2023
VB : 0.166500
V1 : 2.148400
Vacetone : 0.257850
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

12) A/D voltage 6, PAR/Irradiance, Biospherical/Licor

Serial number : 2365
Calibrated on : 16 April 2024
M : 0.80517400
B : 1.01436000
Calibration constant : 735889322.20000005
Conversion units : $\mu\text{mol photons/m}^2/\text{sec}$
Multiplier : 1.00000000
Offset : 0.00000000

13) A/D voltage 7, PAR/Irradiance, Biospherical/Licor, 2

Serial number : 2364
Calibrated on : 16 April 2024
M : 0.81672400
B : 1.01436000
Calibration constant : 735889322.20000005
Conversion units : umol photons/m²/sec
Multiplier : 1.00000000
Offset : 0.00000000

Scan length : 45

Pump Control

This setting is only applicable to a custom build of the SBE 9plus.
Enable pump on / pump off commands: NO

Data Acquisition:

Archive data: YES
Delay archiving: NO
Data archive: C:\Users\sandm\Documents\Cruises\JC268\CTD
Data\Raw\JC268_CTD_007.hex
Timeout (seconds) at startup: 60
Timeout (seconds) between scans: 20

Instrument port configuration:

Port = COM5
Baud rate = 19200
Parity = N
Data bits = 8
Stop bits = 1

Water Sampler Data:

Water Sampler Type: SBE Carousel
Number of bottles: 36
Port: COM6
Enable remote firing: NO
Firing sequence: User input
Tone for bottle fire confirmation uses PC sound card.

Header information:

Header Choice = Prompt for Header Information
prompt 0 = Ship: RRS James Cook
prompt 1 = Cruise: JC268
prompt 2 = Cast:
prompt 3 = Station:

TCP/IP - port numbers:

Data acquisition:

Data port: 49163
Status port: 49165
Command port: 49164
Remote bottle firing:
Command port: 49167
Status port: 49168
Remote data publishing:
Converted data port: 49161
Raw data port: 49160

Miscellaneous data for calculations

Depth, Average Sound Velocity, and TEOS-10
Latitude when NMEA is not available: 52.00000000
Longitude when NMEA is not available: 0.00000000

Average Sound Velocity

Minimum pressure [db]: 20.00000000
Minimum salinity [psu]: 20.00000000
Pressure window size [db]: 20.00000000
Time window size [s]: 60.00000000

Descent and Acceleration

Window size [s]: 2.00000000

Plume Anomaly

Theta-B: 0.00000000
Salinity-B 0.00000000
Theta-Z / Salinity-Z 0.00000000
Reference pressure [db] 0.00000000

Oxygen

Window size [s]: 2.00000000
Apply hysteresis correction: 0
Apply Tau correction: 1

Potential Temperature Anomaly

A0: 0.00000000
A1: 0.00000000
A1 Multiplier: Salinity

Serial Data Output:

Output data to serial port: NO

Mark Variables:

No variables are selected.

Shared File Output:

Output data to shared file: NO

TCP/IP Output:

Raw data:
Output raw data to socket: NO

XML wrapper and settings: NO
Seconds between raw data updates: 0.00000000
Converted data:
Output converted data to socket: NO
XML format: NO

SBE 11plus Deck Unit Alarms

Enable minimum pressure alarm: NO
Enable maximum pressure alarm: NO
Enable altimeter alarm: NO

SBE 14 Remote Display

Enable SBE 14 Remote Display: NO

PC Alarms

Enable minimum pressure alarm: NO
Enable maximum pressure alarm: NO
Enable altimeter alarm: NO
Enable bottom contact alarm: NO
Alarm uses PC sound card.

Options:

Prompt to save program setup changes: YES
Automatically save program setup changes on exit: NO
Confirm instrument configuration change: YES
Confirm display setup changes: YES
Confirm output file overwrite: YES
Check scan length: YES
Compare serial numbers: YES
Maximized plot may cover Seasave: NO

CTD configuration file cast 007-

PSA file: C:\Users\sandm\Documents\Cruises\JC268\Seasave Setup
Files\JC268_1257_SS_nmea_O2_2055.psa

Date: 08/25/2024

Instrument configuration file: C:\Users\sandm\Documents\Cruises\JC268\CTD
Data\Raw\JC268_CTD_002.xmlcon

Configuration report for SBE 911plus/917plus CTD

Frequency channels suppressed : 0
Voltage words suppressed : 0
Computer interface : RS-232C
Deck unit : SBE11plus Firmware Version >= 5.0
Scans to average : 1
NMEA position data added : Yes
NMEA depth data added : No

NMEA time added : Yes
NMEA device connected to : PC
Surface PAR voltage added : No
Scan time added : Yes

1) Frequency 0, Temperature

Serial number : 03P-4782
Calibrated on : 15 June 2023
G : 4.34980255e-003
H : 6.36221097e-004
I : 2.06812211e-005
J : 1.71285614e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 04C-2450
Calibrated on : 24 August 2023
G : -1.02521792e+001
H : 1.63486154e+000
I : -2.55901524e-003
J : 3.02717930e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 134949
Calibrated on : 10 March 2022
C1 : -3.695717e+004
C2 : -2.691791e-001
C3 : 1.143300e-002
D1 : 3.349300e-002
D2 : 0.000000e+000
T1 : 3.049225e+001
T2 : -3.372510e-004
T3 : 3.990980e-006
T4 : 3.875890e-009
T5 : 0.000000e+000
Slope : 1.00008000
Offset : -1.82150
AD590M : 1.280330e-002
AD590B : -9.092840e+000

4) Frequency 3, Temperature, 2

Serial number : 03P-4872
Calibrated on : 08 March 2023
G : 4.34416650e-003
H : 6.38935080e-004
I : 2.13025530e-005
J : 1.81731040e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 04C-2858
Calibrated on : 23 Novemberr 2022
G : -1.02374119e+001
H : 1.44087492e+000
I : -3.83686105e-004
J : 1.07640793e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

6) A/D voltage 0, Oxygen, SBE 43

Serial number : 43-1940
Calibrated on : 21 September 2023
Equation : Sea-Bird
Soc : 5.34400e-001
Offset : -4.94300e-001
A : -2.62170e-003
B : 1.23730e-004
C : -1.11680e-006
E : 3.60000e-002
Tau20 : 1.66000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

7) A/D voltage 1, Oxygen, SBE 43, 2

Serial number : 2055
Calibrated on : 21 September 2023
Equation : Sea-Bird
Soc : 4.04200e-001
Offset : -6.90600e-001
A : -4.09850e-003
B : 1.45220e-004

C : -2.27490e-006
E : 3.60000e-002
Tau20 : 1.60000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

8) A/D voltage 2, Altimeter

Serial number : 81632
Calibrated on : 09 June 2022
Scale factor : 15.000
Offset : -0.013

9) A/D voltage 3, OBS, WET Labs, ECO-BB

Serial number : 5690
Calibrated on :
ScaleFactor : 1.000000
Dark output : 0.000000

10) A/D voltage 4, Transmissometer, WET Labs C-Star

Serial number : 1602DR
Calibrated on : 17 August 2024
M : 21.7660
B : -0.0805
Path length : 0.250

11) A/D voltage 5, Fluorometer, Chelsea Aqua 3

Serial number : 88-2615-126
Calibrated on : 10 July 2023
VB : 0.166500
V1 : 2.148400
Vacetone : 0.257850
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

12) A/D voltage 6, PAR/Irradiance, Biospherical/Licor

Serial number : 2365
Calibrated on : 16 April 2024
M : 0.80517400
B : 1.01436000
Calibration constant : 735889322.20000005
Conversion units : $\mu\text{mol photons/m}^2/\text{sec}$
Multiplier : 1.00000000
Offset : 0.00000000

13) A/D voltage 7, PAR/Irradiance, Biospherical/Licor, 2

Serial number : 2364
Calibrated on : 16 April 2024
M : 0.81672400
B : 1.01436000
Calibration constant : 735889322.20000005
Conversion units : umol photons/m²/sec
Multiplier : 1.00000000
Offset : 0.00000000

Scan length : 45

Pump Control

This setting is only applicable to a custom build of the SBE 9plus.
Enable pump on / pump off commands: NO

Data Acquisition:

Archive data: YES
Delay archiving: NO
Data archive: C:\Users\sandm\Documents\Cruises\JC268\CTD

Data\Raw\JC268_CTD_007.hex

Timeout (seconds) at startup: 60
Timeout (seconds) between scans: 20

Instrument port configuration:

Port = COM5
Baud rate = 19200
Parity = N
Data bits = 8
Stop bits = 1

Water Sampler Data:

Water Sampler Type: SBE Carousel
Number of bottles: 36
Port: COM6
Enable remote firing: NO
Firing sequence: User input
Tone for bottle fire confirmation uses PC sound card.

Header information:

Header Choice = Prompt for Header Information
prompt 0 = Ship: RRS James Cook
prompt 1 = Cruise: JC268
prompt 2 = Cast:
prompt 3 = Station:

TCP/IP - port numbers:

Data acquisition:

Data port: 49163
Status port: 49165
Command port: 49164

Remote bottle firing:

Command port: 49167
Status port: 49168

Remote data publishing:

Converted data port: 49161
Raw data port: 49160

Miscellaneous data for calculations

Depth, Average Sound Velocity, and TEOS-10

Latitude when NMEA is not available: 52.00000000
Longitude when NMEA is not available: 0.00000000

Average Sound Velocity

Minimum pressure [db]: 20.00000000
Minimum salinity [psu]: 20.00000000
Pressure window size [db]: 20.00000000
Time window size [s]: 60.00000000

Descent and Acceleration

Window size [s]: 2.00000000

Plume Anomaly

Theta-B: 0.00000000
Salinity-B: 0.00000000
Theta-Z / Salinity-Z: 0.00000000
Reference pressure [db]: 0.00000000

Oxygen

Window size [s]: 2.00000000
Apply hysteresis correction: 0
Apply Tau correction: 1

Potential Temperature Anomaly

A0: 0.00000000
A1: 0.00000000
A1 Multiplier: Salinity

Serial Data Output:

Output data to serial port: NO

Mark Variables:

No variables are selected.

Shared File Output:

Output data to shared file: NO

TCP/IP Output:

Raw data:

Output raw data to socket: NO
XML wrapper and settings: NO
Seconds between raw data updates: 0.00000000

Converted data:

Output converted data to socket: NO
XML format: NO

SBE 11plus Deck Unit Alarms

Enable minimum pressure alarm: NO
Enable maximum pressure alarm: NO
Enable altimeter alarm: NO

SBE 14 Remote Display

Enable SBE 14 Remote Display: NO

PC Alarms

Enable minimum pressure alarm: NO
Enable maximum pressure alarm: NO
Enable altimeter alarm: NO
Enable bottom contact alarm: NO
Alarm uses PC sound card.

Options:

Prompt to save program setup changes: YES
Automatically save program setup changes on exit: NO
Confirm instrument configuration change: YES
Confirm display setup changes: YES

CTD configuration file cast 011

PSA file: C:\Users\sandm\Documents\Cruises\JC268\Seasave Setup
Files\JC268_1257_SS_nmea_O2_2075.psa
Date: 08/29/2024

Instrument configuration file: C:\Users\sandm\Documents\Cruises\JC268\Seasave Setup
Files\JC268_1257_SS_nmea_O2 2575.xml\con

Configuration report for SBE 911plus/917plus CTD

Frequency channels suppressed : 0
Voltage words suppressed : 0
Computer interface : RS-232C
Deck unit : SBE11plus Firmware Version >= 5.0
Scans to average : 1
NMEA position data added : Yes
NMEA depth data added : No
NMEA time added : Yes
NMEA device connected to : PC

Surface PAR voltage added : No
Scan time added : Yes

1) Frequency 0, Temperature

Serial number : 03P-4782
Calibrated on : 15 June 2023
G : 4.34980255e-003
H : 6.36221097e-004
I : 2.06812211e-005
J : 1.71285614e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 04C-2450
Calibrated on : 24 August 2023
G : -1.02521792e+001
H : 1.63486154e+000
I : -2.55901524e-003
J : 3.02717930e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 134949
Calibrated on : 10 March 2022
C1 : -3.695717e+004
C2 : -2.691791e-001
C3 : 1.143300e-002
D1 : 3.349300e-002
D2 : 0.000000e+000
T1 : 3.049225e+001
T2 : -3.372510e-004
T3 : 3.990980e-006
T4 : 3.875890e-009
T5 : 0.000000e+000
Slope : 1.00008000
Offset : -1.82150
AD590M : 1.280330e-002
AD590B : -9.092840e+000

4) Frequency 3, Temperature, 2

Serial number : 03P-4872
Calibrated on : 08 March 2023

G : 4.34416650e-003
H : 6.38935080e-004
I : 2.13025530e-005
J : 1.81731040e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 04C-2858
Calibrated on : 23 Novemberr 2022
G : -1.02374119e+001
H : 1.44087492e+000
I : -3.83686105e-004
J : 1.07640793e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

6) A/D voltage 0, Oxygen, SBE 43

Serial number : 43-1940
Calibrated on : 21 September 2023
Equation : Sea-Bird
Soc : 5.34400e-001
Offset : -4.94300e-001
A : -2.62170e-003
B : 1.23730e-004
C : -1.11680e-006
E : 3.60000e-002
Tau20 : 1.66000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

7) A/D voltage 1, Oxygen, SBE 43, 2

Serial number : 2575
Calibrated on : 23 September 2022
Equation : Sea-Bird
Soc : 4.31200e-001
Offset : -4.73900e-001
A : -4.57280e-003
B : 2.08010e-004
C : -2.82230e-006
E : 3.60000e-002

Tau20 : 1.20000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

8) A/D voltage 2, Altimeter

Serial number : 81632
Calibrated on : 09 June 2022
Scale factor : 15.000
Offset : -0.013

9) A/D voltage 3, OBS, WET Labs, ECO-BB

Serial number : 5690
Calibrated on :
ScaleFactor : 1.000000
Dark output : 0.000000

10) A/D voltage 4, Transmissometer, WET Labs C-Star

Serial number : 1602DR
Calibrated on : 17 August 2024
M : 21.7660
B : -0.0805
Path length : 0.250

11) A/D voltage 5, Fluorometer, Chelsea Aqua 3

Serial number : 88-2615-126
Calibrated on : 10 July 2023
VB : 0.166500
V1 : 2.148400
Vacetone : 0.257850
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

12) A/D voltage 6, PAR/Irradiance, Biospherical/Licor

Serial number : 2365
Calibrated on : 16 April 2024
M : 0.80517400
B : 1.01436000
Calibration constant : 735889322.20000005
Conversion units : $\mu\text{mol photons/m}^2/\text{sec}$
Multiplier : 1.00000000
Offset : 0.00000000

13) A/D voltage 7, PAR/Irradiance, Biospherical/Licor, 2

Serial number : 2364
Calibrated on : 16 April 2024
M : 0.81672400
B : 1.01436000
Calibration constant : 735889322.20000005
Conversion units : umol photons/m²/sec
Multiplier : 1.00000000
Offset : 0.00000000

Scan length : 45

Pump Control

This setting is only applicable to a custom build of the SBE 9plus.
Enable pump on / pump off commands: NO

Data Acquisition:

Archive data: YES
Delay archiving: NO
Data archive: C:\Users\sandm\Documents\Cruises\JC268\CTD
Data\Raw\JC268_CTD_010.hex
Timeout (seconds) at startup: 60
Timeout (seconds) between scans: 20

Instrument port configuration:

Port = COM5
Baud rate = 19200
Parity = N
Data bits = 8
Stop bits = 1

Water Sampler Data:

Water Sampler Type: SBE Carousel
Number of bottles: 36
Port: COM6
Enable remote firing: NO
Firing sequence: User input
Tone for bottle fire confirmation uses PC sound card.

Header information:

Header Choice = Prompt for Header Information
prompt 0 = Ship: RRS James Cook
prompt 1 = Cruise: JC268
prompt 2 = Cast:
prompt 3 = Station:

TCP/IP - port numbers:

Data acquisition:

Data port: 49163
Status port: 49165
Command port: 49164
Remote bottle firing:
Command port: 49167
Status port: 49168
Remote data publishing:
Converted data port: 49161
Raw data port: 49160

Miscellaneous data for calculations

Depth, Average Sound Velocity, and TEOS-10
Latitude when NMEA is not available: 52.00000000
Longitude when NMEA is not available: 0.00000000

Average Sound Velocity

Minimum pressure [db]: 20.00000000
Minimum salinity [psu]: 20.00000000
Pressure window size [db]: 20.00000000
Time window size [s]: 60.00000000

Descent and Acceleration

Window size [s]: 2.00000000

Plume Anomaly

Theta-B: 0.00000000
Salinity-B 0.00000000
Theta-Z / Salinity-Z 0.00000000
Reference pressure [db] 0.00000000

Oxygen

Window size [s]: 2.00000000
Apply hysteresis correction: 0
Apply Tau correction: 1

Potential Temperature Anomaly

A0: 0.00000000
A1: 0.00000000
A1 Multiplier: Salinity

Serial Data Output:

Output data to serial port: NO

Mark Variables:

No variables are selected.

Shared File Output:

Output data to shared file: NO

TCP/IP Output:

Raw data:
Output raw data to socket: NO

XML wrapper and settings: NO
Seconds between raw data updates: 0.00000000
Converted data:
Output converted data to socket: NO
XML format: NO

SBE 11plus Deck Unit Alarms

Enable minimum pressure alarm: NO
Enable maximum pressure alarm: NO
Enable altimeter alarm: NO

SBE 14 Remote Display

Enable SBE 14 Remote Display: NO

PC Alarms

Enable minimum pressure alarm: NO
Enable maximum pressure alarm: NO
Enable altimeter alarm: NO
Enable bottom contact alarm: NO
Alarm uses PC sound card.

Options:

Prompt to save program setup changes: YES
Automatically save program setup changes on exit: NO
Confirm instrument configuration change: YES
Confirm display setup changes: YES
Confirm output file overwrite: YES
Check scan length: YES
Compare serial numbers: YES
Maximized plot may cover Seasave: NO

Confirm output file overwrite: YES
Check scan length: YES
Compare serial numbers: YES
Maximized plot may cover Seasave: NO

CTD Scientific Report

Personnel: Louis Clement

Scientific Computing Systems

One primary computer was used to process the CTD data (a Dell Precision 7680 laptop 'ulili') along with the backup secondary Dell T3420 'ewaewa'. The secondary workstation and its monitor were powered to a UPS. The computers were synchronized on a 2TB external hard drive through a crontab job that backed up both data and programs.

Once connected to ethernet, a fixed IP was set up for both computers. All the drives were mapped in `/etc/fstab` and mounted with `'sudo mount -a'`. The following drives were mounted: the external hard drive, the cruise data drive (`current_cruise`) that contains the `ctd/ladcp/mss90/Autosal` data (in `Sensors_and_Moorings`) and the navigation/underway data and documentations (in `Ship_Systems`), the public drive (`science_public`), and the `uhdas` and `rvdas` drives. The `mexec_exec` script on `onship_datalinks` was executed to create the symbolic links to the cruise data drive (in `/data/pstar/mounts/links`).

The Mexec scripts and functions were used to process the `ctd` and `ladcp` data.

This processing tool contains Matlab scripts, `ocp_hydro_matlab` (located in `/data/pstar/programs/gitvcd/ocp_hydro_matlab/mexec_processing_scripts/`), and the shell scripts `mexec_exec` (in `/data/pstar/programs/gitvcd/mexec_exec`). The processing was run with Matlab2024a (`/usr/local/MATLAB/R2024a/bin/matlab`) using the Gibbs-SeaWater (GSW) Toolbox.

The cruise options (folder paths and measurements) are set up in the `ocp_hydro_matlab` script `m_setup.m`, which is run at the start, and the cruise characteristics (calibration coefficients, sensors, ...) are set up in `mexec_processing_scripts/cruise_options/opt_jc268.m`.

CTD processing

A total of 11 CTD profiles were taken during the cruise. Three CTDs (CTD1/2/3) were taken on the first day offshore Nuuk to sample across the boundary current of the Labrador Sea. Three CTDs (CTD4/5/6) were taken at the mooring site over 4 days followed by 1 CTD (CTD7) at the location of the float deployment. Finally, 4 CTDs (CTD8/9/10/11) were taken at the OSNAP eastern mooring array (CF6, M1, M2, and M3) to help calibrate the oxygen sensor of GOHSNAP. Half of the bottles were fired at most stations to take water samples.

The CTD processing is done through the scripts (`ctd_all_part1.m` and `ctd_all_part2.m`), which partly output the `_raw` and `_24hz` files, and the 2db-averaged (`_2db` and `_2up`) and the bottle values (`sam_jc268_all.nc`), respectively. For each station, the raw files are analysed to detect spikes and bad ranges with `mctd_rawshow.m`. The edits are implemented in `_raw_cleaned` files with `mctd_rawedit` and saved in `ctd/editlogs/mplxied*`. Spikes in conductivity and oxygen are detected for each individual profiles and removed from the raw data by running `mctd_rawedit(stn)` and `mctd_rawedit(stn,'oxy')`, respectively.

Conductivity calibration

Nine Seawater standards were analysed with an Autosal salinometer in a constant-temperature lab. The bath temperature was at 21°C and the seawater batch P167 was used (with $K_{15}=0.99988$). The csv files that contain the Autosal readings (numbered 999XXX) are read in script *msal_01* and displayed in Figure 4. The averaged offsets (standard-recorded values) are added in the *sal_cal* variable of *opt_jc268.m* (under *opt1=botpsal* and *opt2=sal_calc*) to apply the offsets to all samples run on the salinometer between each pair of standards. This corrects the salinometer drift.

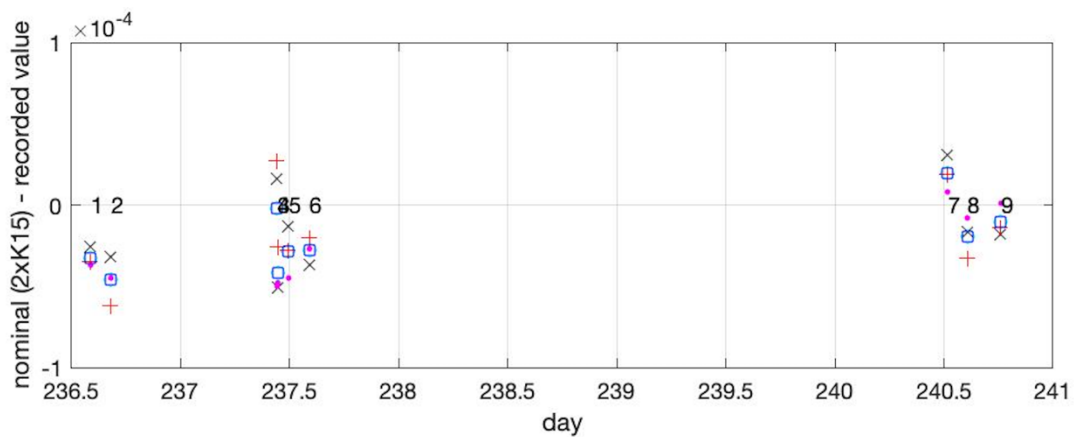


Figure 4: Offset readings (b,r,m) and average (b) between seawater standards and the salinometer.

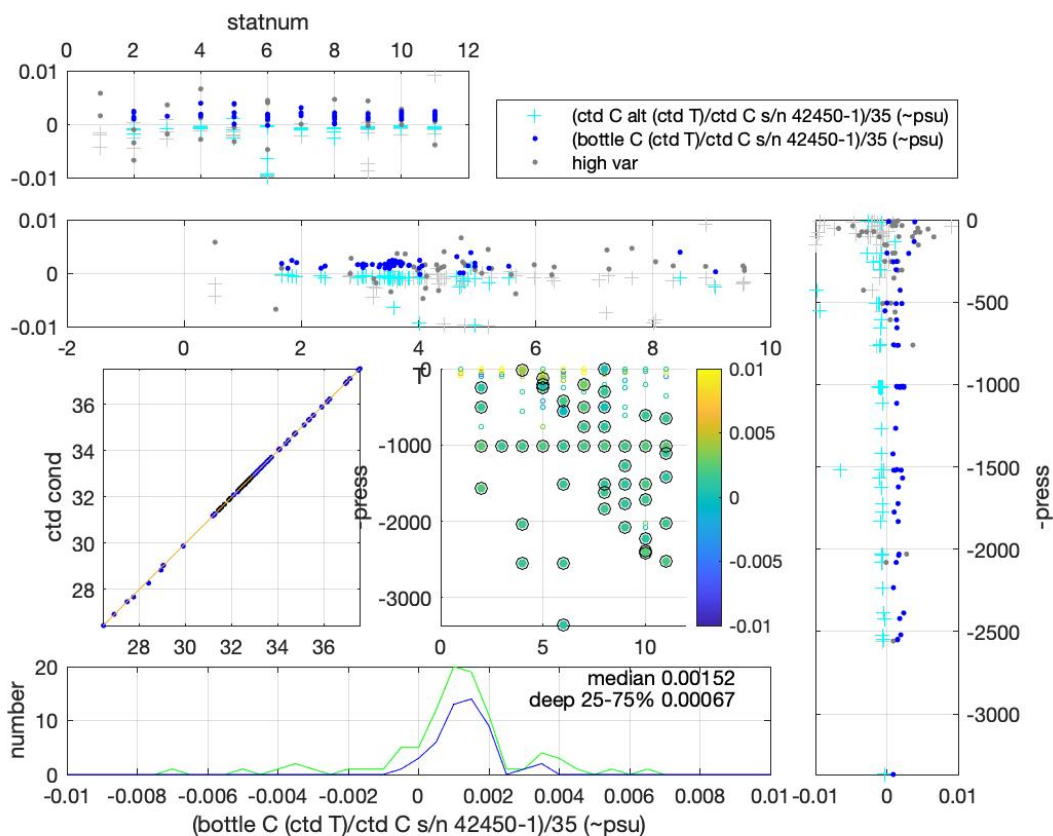


Figure 5: Comparison of the bottled vs CTD salinity from sensor 1 before applying the conductivity calibration (dark blue points). Sensors 1 and 2 are compared together (cyan). The high variability points (grey) correspond to large background gradient or points with noise at the bottle stops.

The salinity anomalies (CTD vs bottles) are identified with the script `checkbottles_01([], 'botpsal')` that allows to detect and isolate the outliers. These outliers are then manually flagged (flag=4 for bad bottle) in `opt_jc268` (under `opt1=botpsal` and `opt2=sal_flags`) and removed from the conductivity calibration. The temporal drift, the pressure and temperature dependences of the conductivity sensors are checked for both sensors using the script `mctd_evaluate_sensors('cond')`. The uncorrected comparisons (Figure 5) shows an offset between the bottle and CTD conductivity that can be corrected in `opt_jc268` (under `opt1=ctd_proc` and `opt2=ctd_calcs`) by adding `dcal.cond = d0.cond.*(1+offset/35)`, with `offset=1.5e-3` for sn42450 and `offset=2e-3` for sn42858. The corrections are then applied through `testcal.cond = 1; mctd_evaluate_sensors('cond', testcal);` which produces Figure 6.

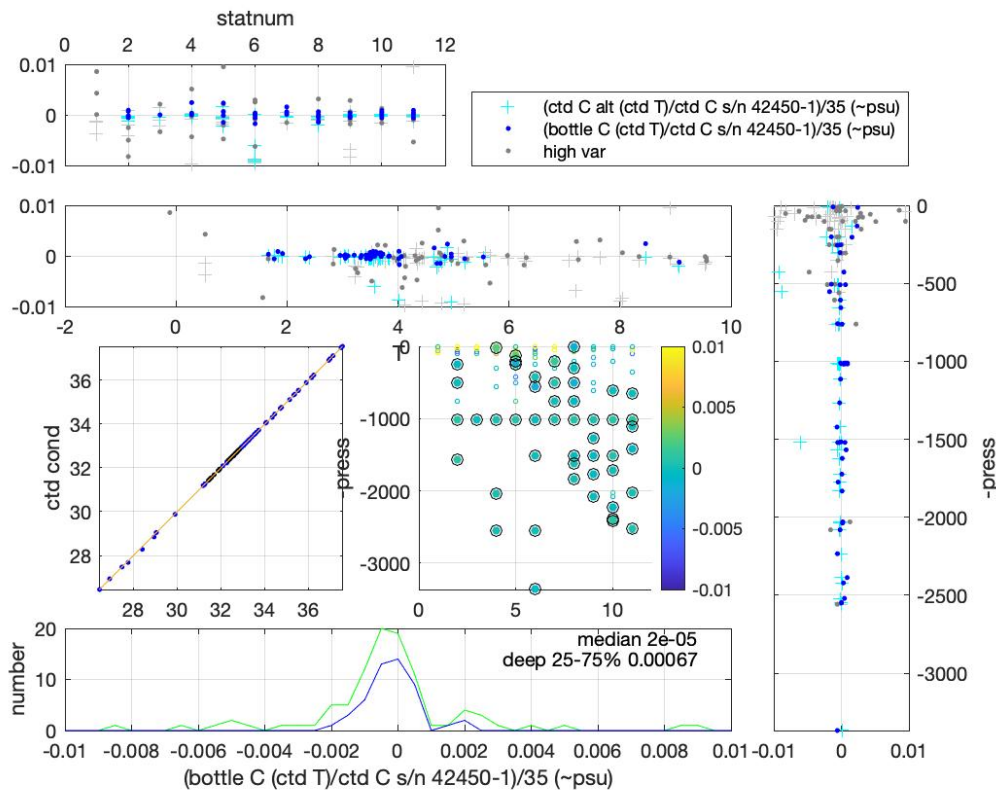


Figure 6: Comparison of the bottled vs CTD salinity from sensor 1 after applying the conductivity calibration (dark blue points). Sensors 1 and 2 are compared together (cyan). The high variability points (grey) correspond to large background gradient or points with noise at the bottle stops.

Oxygen calibration

The secondary oxygen sensor (S/N43-2575) was rather noisy for the first few casts (CTD1-7, and 10). It was swapped for CTD08 and 09 (S/N43-2055) and swapped for CTD11 (S/N43-2819). To calibrate the oxygen sensors with the bottle oxygen data, the duplicate readings of the bottle oxygen are first displayed by running `moxy_01` (after adding `set check_oxy = 1;` under case 'check_sams' `opt_jc268`). Six disagreeing replicates are identified and flagged accordingly as bad (=4) in `opt_jc268` (under case `botoxy/oxyflags`).

Then by running `mctd_evaluate_sensors('oxygen')`, we can identify the necessary corrections for the oxygen sensors. In `opt_jc268` (under `opt1=ctd_proc` and `opt2=ctd_calcs`), we correct for an oxygen offset, which is independent of time and pressure, by adding $dcal.oxygen = d0.oxygen \cdot (1+0.025)$ for S/N43-1940 (oxygen1). This correction can be seen from the pre to post calibrated data from Figure 7 to Figure 8. For S/N2575 and S/N2819 (oxygen2), a depth-dependent correction is implemented of $dcal.oxygen = d0.oxygen \cdot interp1([0 \ 2600],[1.035 \ 1.07],d0.press)$ and $dcal.oxygen = d0.oxygen \cdot interp1([0 \ 2600],[1.015 \ 1.032],d0.press)$, respectively. The corrections are tested and first applied through `testcal.oxygen = 1; mctd_evaluate_sensors('oxygen', testcal)`.

Finally, the salinity and oxygen correction (in `opt_jc268.m`) are applied to all casts by running `ctd_all_postedit`, which updates the final files that are sent to BODC (`ctd_jc268_nnn_2db.nc` (the downcast profile) and `sam_jc268_all.nc`).

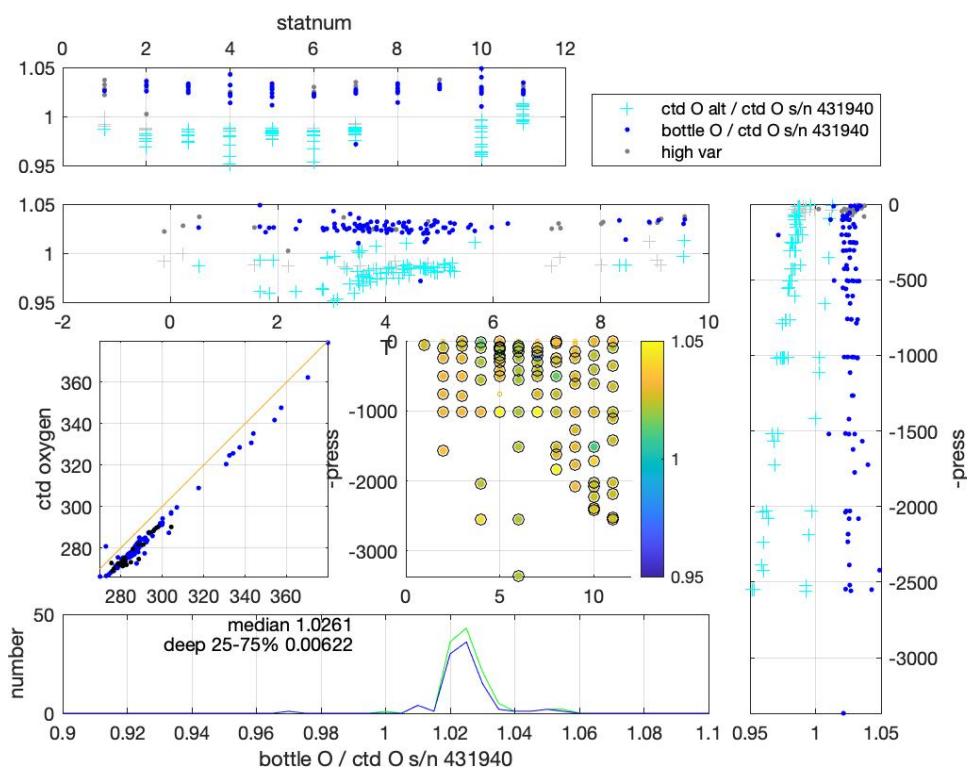


Figure 7: Comparison of the bottled vs CTD oxygen from sensor 1 before applying the oxygen calibration (dark blue points). Sensors 1 and 2 are compared together (cyan). The high variability points (grey) correspond to large background gradient or points with noise at the bottle stops.

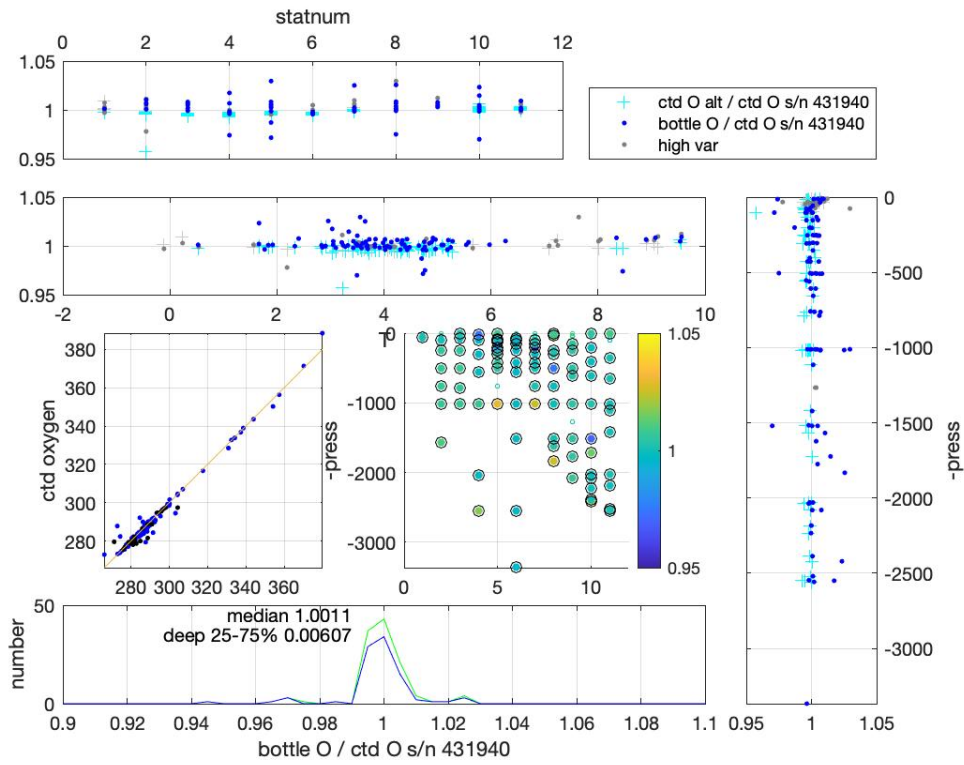


Figure 8: Comparison of the bottled vs CTD oxygen from sensor 1 after applying the oxygen calibration (dark blue points). Sensors 1 and 2 are compared together (cyan). The high variability points (grey) correspond to large background gradient or points with noise at the bottle stops.

CTD Filtering Report

Personnel: Heather Jaques, Will Major, Filipa Carvalho, Elisa Lovecchio, Hans Hilder (National Oceanographic Centre).

Overview:

Seawater was collected by CTD from a range of depths during the JC268 ReBELS cruise. Water collected by Niskin bottles was sampled for HPLC, PIC, POC, BSi and Chlorophyll-a using the following methods. All details of the samples taken are shown in Table 4.

Method:

Samples were filtered in the wet lab on the RRS James Cook using the filtering rig shown in Figure 9. All ship windows behind the rig were closed to avoid sunlight exposure, and foil caps were used on the funnels between sampling. MilliQ water was used to wash the funnels and bottles between filtering.



Figure 9: Filtering rig in the wet lab of the RRS James Cook that was used to filter for HPLC (not the samples from events 49, 50 and 53), POC, PIC and BSi.

Phytoplankton Pigments from High Performance Liquid Chromatography (HPLC)

2325 ml (see the cruise logs for any deviations from this amount) of seawater was filtered onto GF/F filters (0.7 μm pore size, 25 mm diameter; Whatman). MilliQ water was used to rinse for any remaining particles in the funnel. After filtration, the filters were folded in half and put into 2.0 ml cryotubes, flash frozen in liquid nitrogen, and then placed into the -80°C freezer for storage and analysis at NOC.

Particulate Inorganic Carbon (PIC):

500 ml of seawater was measured and filtered through polycarbonate filters (pore size 0.4

µm, 25 mm diameter; Isopore). pH adjusted MilliQ water (made with 1 Liter of MilliQ water mixed with 2ml of 25% ammonia solution) was used to rinse for any remaining particles in the funnel. Filters were placed into 15 ml centrifuge tubes and oven dried at 50°C overnight (without the tube lid). The lids were then placed back onto the tubes which were then stored in a dark box to be analysed at NOC.

Particulate Organic Carbon (POC):

1000 ml of seawater was measured and filtered onto pre-ashed (400°C for 8 hours in a muffle furnace) GF/F filters (0.7 µm pore size, 25 mm diameter; Whatman). MilliQ water was used to rinse for any remaining particles in the funnel. Filters were folded in half and placed into labelled foil pouches which were put into the -80°C freezer for storage and analysis at NOC.

Biogenic Silica (BSi):

500ml of seawater was measured and filtered through polycarbonate filters (pore size 0.4 µm, 25 mm diameter; Isopore). MilliQ water was used to rinse the funnel for any remaining particles. Filters were placed into 50 ml centrifuge tubes and were oven dried at 50°C overnight (without the tube lid). The lids were then placed back onto the tubes, and they were then stored in a dark box to be analysed at NOC.

Table 4: CTD Filtering sampling details. Bolded depths represent where HPLC and Chlorophyll-a were filtered

Date	Site	Event #	Event Name	Niskin Bottle	Depth (m)	HPLC	CHL-a	POC	PIC	BSi
17/08	Science Station 1	1	CTD 01	2, 4, 6, 8, 10	85, 60, 40, 35, 10	x	x			
17/08	Science Station 1	2	CTD 02	2, 4, 6, 10, 12, 16, 18, 20	1540, 1000, 750, 250, 100, 50, 30, 10		x	x	x	x
17/08	Science Station 1	3	CTD 03	1, 3, 7, 11, 13, 15	1000, 775, 250, 70, 35, 10		x	x	x*	x*
19/08	Mooring Site	12	CTD 04	7, 11, 13, 15, 17, 19, 21, 23	2500, 1000, 550, 300, 100, 70, 35, 10	x	x	x	x	x
22/08	Mooring Site	24	CTD 05	1, 3, 7, 9, 13, 15, 17, 19, 21, 23	1000, 750, 420, 300, 200, 130, 100, 80, 45, 10	x (not for N3, N7, N13)	x (not for N3, N7, N13)	x	x	x
23/08	Mooring Site	30	CTD 06	3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23	2500, 1500, 1000, 550, 420, 250, 150, 100, 75, 35, 10	x (not for N3, N5, N9, N13)	x (not for N3, N5, N9, N13)	x	x	x
24/08	Float Site	39	CTD 07	1, 5, 7, 9, 13, 15, 17**, 19, 21, 23	1000, 500, 420, 300, 150, 100, 80, 50, 25, 10	x** (not for N5, N7, N13, N15)	x (not for N1, N5, N9, N15)	x**	x**	x**

26/08	GOHSNA P East	43	CTD 08	1, 3, 5, 7, 13, 17, 19, 21, 24	1800, 1600, 1500, 1000 , 300, 200, 75 , 35, 10	x (not for N1, N3, N5, N13)	x (not for N1, N3, N5, N13)	x	x	
26/08	GOHSNA P East	49	CTD 09	1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23	2050, 1750, 1500, 1250, 1000 , 600, 500, 250, 150 , 50, 35, 10	x (not for N1, N3, N5, N7, N11, N13, N15)	x (not for N1, N3, N5, N7, N11, N13, N15)	x	x	x
27/08	GOHSNA P East	50	CTD 10	1, 3, 5, 7, 9, 11, 13, 15, 17, 18, 19, 21, 23,	2383, 2380, 2200, 2050, 2000, 1700, 1500, 1000 , 600, 400, 200 , 35, 10	X (only for N15, N19, N21, N23)	x (only for N15, N19, N21, N23)	x (not for N13)	x (not for N13)	
27/08	GOHSNA P East	53	CTD 11	1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23***	2517, 2480, 2150, 2000, 1400, 1100, 1000 , 650, 350, 95, 40, 10	x (only for N13, N18, N19, N21)	x (only for N13, N18, N19, N21)	x	x	

Notes:

*Except for Niskin bottle number 10 (the sample was taking too long to filter so this was stopped and not completed).

** Note that at this site before deployment, Niskin bottle 17 on the CTD had to be replaced due to it leaking. It was replaced with a bottle numbered as '12'. The samples then taken from this Niskin bottle were labelled as N12, but they should have remained labelled as N17 (depth 80 m).

***Note that the labels for the last three samples (N19-N23) are incorrect. The physical samples are labelled as N18, N19 and N21 respectively, but should be how they were written here as N19, N21, N23.

Chlorophyll-a Filtration and Analysis Report

Personnel: Elisa Lovecchio, Filipa Carvalho, Kitty Kam, Louis Clement, Will Major

Chlorophyll filtration and concentration measurements were made on board of JC268 in the chemistry lab using the filtration system shown in Figure 10. Water was sampled from the CTD's Niskin bottles, from the Marine Snow Catcher (MSC) and from the underway system (UW). A list of all the chlorophyll sampling dates and depths from CTD is provided in Table 4 (see *CTD Filtering* section). A full list of the Marine Snow Catcher events, each of which generated chlorophyll data, is provided in the dedicated **Error! Reference source not found.** section. A full list of the chlorophyll sampling dates and times from the UW system is provided in the section

Underway measurements.

When sampling sea water for chlorophyll, carboys were rinsed with the same sea water to minimise contamination with previous samples. Samples were filtered as soon as possible after the water was collected. Samples that were not immediately filtered because the filtering station was at full capacity, were either stored in the lab in low light conditions (if filtered within an hour) or stored in a fridge (if filtered 1-2h after collection).

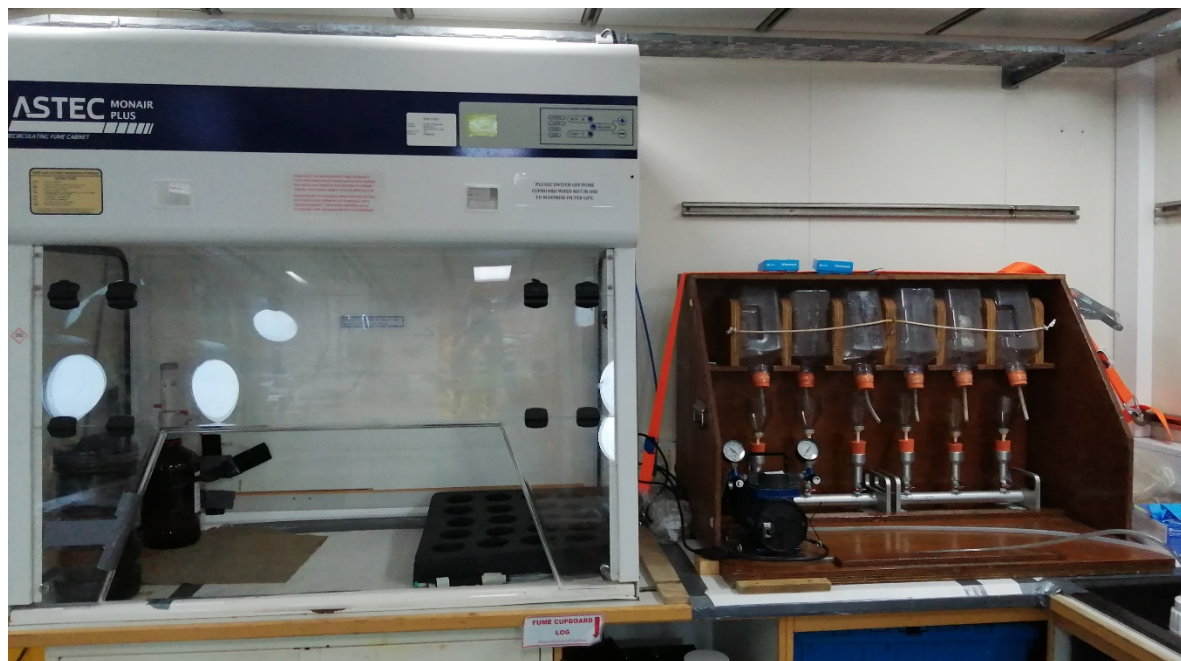


Figure 10: Chlorophyll filtration station on board of JC268 with fume cupboard containing acetone dispenser on the left, and filtration system on the right

Sea water was filtered through Whatman GF/F glass microfiber filters 25 mm diameter that were carefully placed in the allocated slots of the filtration system just before processing a sample (Figure 11). Before filtering a sample, the sea water collected in the carboy was mixed again by gently agitating the carboy, so that larger particles were in suspension. Filtering bottles and measuring cylinder were washed using MilliQ or some of the sampled water from the carboy, to minimise potential contamination. Then, 250 ml (or 100 ml for the snowcatcher's tray) of sampled water were measured and poured into a bottle of the filtration system. The bottle was flipped over the filtration system's cup screwed onto the filter, the pump was turned on and the tap was opened for filtering.

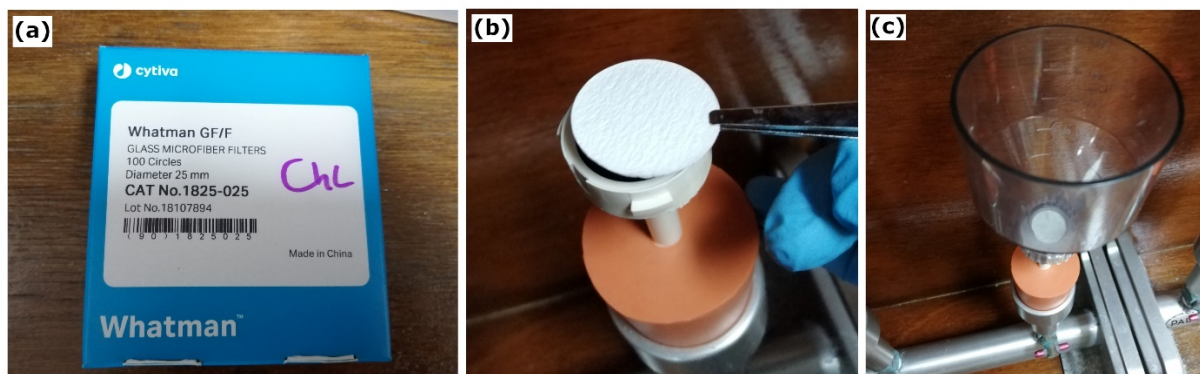


Figure 11: (a) Whatman GF/F filters in the left picture; (b) Placement of the filter; (c) Cup ready for the filtering of the sample.

While the filtration was taking place, 6 ml of 90% HPLC-grade acetone were collected into a numbered 20 ml glass vial. Once the sea water sample had fully passed through the filter, some MilliQ water was poured on the edges of the cup with a squirty bottle (Figure 12), clearing any chlorophyll residue and allowing it to settle onto the filter. Once the MilliQ water had fully passed through, the tap was closed, and the pump was switched off. The cup was unscrewed from the filter and the filter was carefully collected using tweezers by grabbing it at the edge and was placed into the vial with the acetone sample-side-up, making sure that it was fully submerged. The vial was then stored in the dark into a fridge at 4°C for 18-24 h to extract the chlorophyll-a from the cells on the filter.

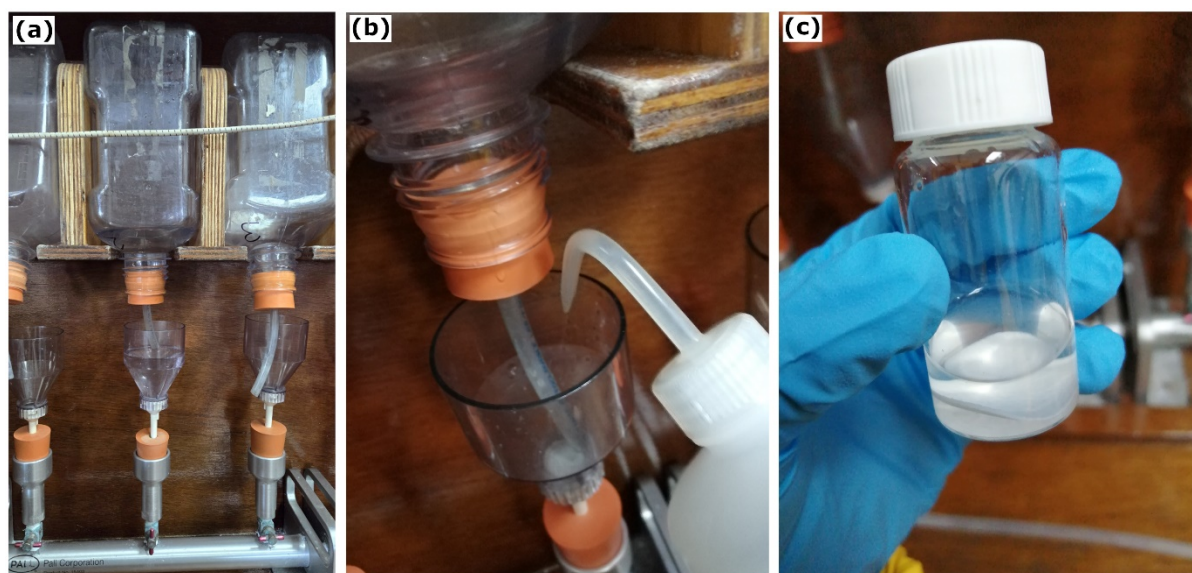


Figure 12: (a) A sea water sample being filtered in bottle nr.2; (b) Cleaning of the filtering cup with MilliQ to allow all the chlorophyll that may be left on the cup's walls to set onto the filter; (c) Filter with chlorophyll under acetone in the glass vial.

Before processing, vials containing the filters were removed from the fridge and stored in a dark drawer for about 30 minutes to allow them to warm to room temperature. The Turner Trilogy fluorometer was started selecting a non-acidification unit (Chlorophyll-NA). Before each set of measurements, one measurement of the solid chlorophyll-a standard and one

reading of a blank sample were taken. Blanks were run with both pure acetone (in line with the protocol followed in previous cruises) and, starting from 22/August, with acetone containing an unused filter (as per fluorometer manual). Comments on the differences and significance of these measurements are provided at the end of this chapter.

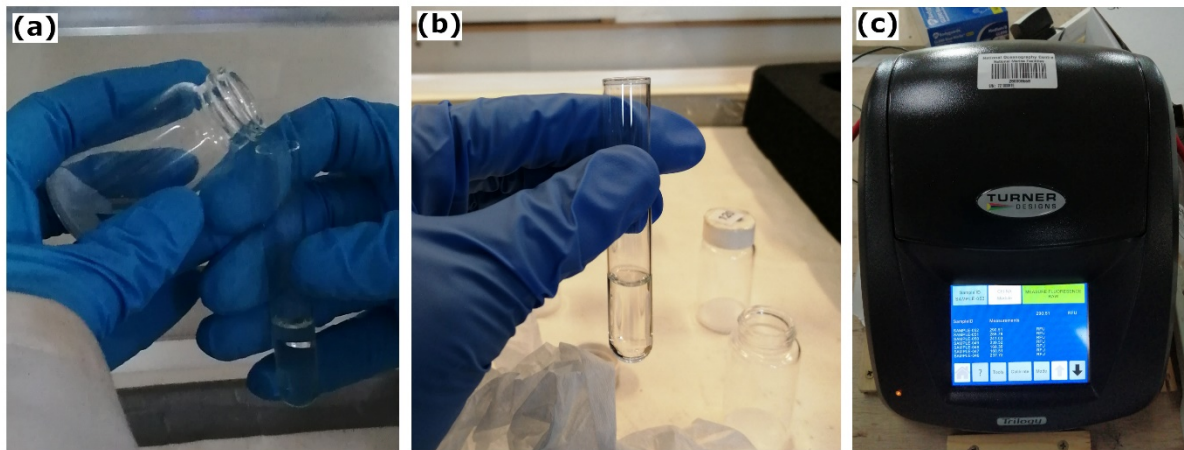


Figure 13: (a) Sample being poured from the extraction vial into the fluorometer's glass test tube; (b) About 2 ml of sample in the fluorometer's test tube; (c) Turner fluorometer running a non-acidification (NA) chlorophyll unit.

For each chlorophyll sample, the acetone was first mixed in the extraction vial by giving it a couple of swirls. Then a small amount (<1ml) of the acetone from the sample vial was poured in the glass test tube to rinse it and was disposed of, to minimise the risk of contamination with previous samples. At this point, about 2ml of acetone from the sample vial were poured into the test tube for the first measurement. The test tube was wiped externally with a clean wipe to remove any condensation and placed into the fluorometer, the “measure” tab was pressed, and the measurement recorded. The chlorophyll measurement was repeated by disposing of the acetone in the test tube and by pouring a second 2 ml of liquid from the sample vial into the test tube, wiping it and placing it into the fluorometer. Two measurements per each sample were collected starting from 19/08, while only one measurement was collected before that date. After each measurement, a visual check was performed to make sure that no small drop of acetone was trapped into the test tube; if so, the tube was gently tapped onto a clean wipe to get rid of the drop. At the end of each batch of measurements, the test tube was rinsed with clean acetone and MilliQ and then left to air-dry. After sampling, vials were abundantly washed with MilliQ and let air dry before using them again.

Considerations and caveats:

We record here a few issues and caveats regarding the chlorophyll sampling, filtering and analysis that we hope will be helpful for future cruises and for future reference when using the data.

1 – Fluorometer's solid standard: The fluorometer is very sensitive to the precise placement of the solid standard. Rotating the position of the fluorometer's upper “tongue” would result in significantly different readings: tongue away from user: ~193-197; tongue towards user: ~156; tongue on the right side: ~204; tongue on the left side: ~98. Further, the

fluorometer is also sensitive to the solid standard's precise placement in the fluorometer's measuring slot, as the probe can be slightly tilted, which influences the readings. This sensitivity was not observed with actual chlorophyll samples measurements, which were repeatable, giving us indication that the issue might be caused by the standard itself and not the fluorometer. During our analysis, the solid standard was placed into the fluorometer with the upper "tongue" positioned away from the user (as indicated by Alex Poulton in phone communication).

2 – Filtration: Some of the cups of the filtration system weren't working as effectively as the others and was pumping slower. The system might need to be checked for clogging.

3 – Blank measurements: In analogy with what was done in previous cruises, blank measurements were initially taken from a vial containing only acetone. However, the fluorometer's manual indicates that the blank should be measured from a vial containing acetone and a clean filter of the type used to filter the samples. We measured blanks both without and with the filter in the vial (always containing 6 ml of acetone) and compared them to measurements of blanks from acetone taken directly from the big bottle's dispenser. Fluorescence measurements of acetone taken from the bottle's dispenser provide good indication of contamination in the fluorometer's test tube, and should be performed every time contamination is suspected, and possibly when passing from shallow-to deep-ocean samples. When these measurements are above 0.15-0.20, contamination is likely and a wash of the fluorometer test tube with 1ml of pure acetone is sufficient to lower the reading. Measurements of blanks from vials containing acetone only should correspond to those of acetone taken directly from the test bottle; values likely indicate contamination of the vial and are a good test to make sure that a batch of vials has been properly washed. Measurements of blanks from vials containing acetone and a clean filter instead measured consistently higher than those without the filter (generally twice as high), indicating that the filter alone adds noise to the measurements. In accordance with the fluorometer's manual, we used these readings (when available) as blanks. Since different filters (of the same type) gave slightly different readings, in the future it might be useful to repeat a few measurements of the "blank with filter" to assess the impact of the type of filter used in the analysis.

4 – Condensation: We had issues with condensation in vials washed in previous cruises. Some of the vials (vials 78-86 and 89-95 corresponding to CTD006, MSC010 and MSC011) used to store the samples had to be dried with clean-wipes before use, as no other clean vials were available at the time. Some of the vials of this pre-washed batch that were already filled with a sample developed condensation while in the fridge (vials 65-73, corresponding to CTD005, MSC008 and MSC009). Issues were noted in the data log. Although the condensation was small, we noted down on the log the number of the samples for which this happened. For the same reason, we had to clean vials (vials 01-50, cleaned on 23/08) that had been already used in the present cruise. The vials were left to dry upside down on blue roll for a day, but humidity was still present in most of them. In order to avoid to clean-wipe more vials, we left washed vials 01-50 to air dry upwards in a rack in the fume-hood (switched off) for a night, and then placed them upside down on blue roll again for half a day before using them. This batch of vials was fully used during the cruise between 26-27/August. On following washes, all vials were dried upside-down.

Dissolved Oxygen

Personnel: Kitty Kam (Dalhousie University), Louis Clement and Hans Hilder (National Oceanographic Centre)

Motivation

Dissolved oxygen (DO) samples were collected from stainless steel CTD casts during JC268 to calibrate and correct for drift, temperature, and pressure influences on the CTD DO sensors. Once calibrated, the CTD oxygen will also be used to calibrate the oxygen sensors deployed on moorings.

CTD sampling - Overview

Samples were taken from every cast, and 10-24 Niskin bottles were fired per cast, with duplicate bottles on every depth. One Niskin bottle on each depth was sampled, except for one which was observed obviously leaking upon CTD recovery. Duplicate sample was taken from a randomly selected Niskin bottle per cast. DO samples were subsequently analysed by automatic Winkler titration using a modified Winkler titration system and amperometric endpoint detection.

Table 5: The number of depths sampled for dissolved oxygen for each CTD cast and the number of duplicates also sampled.

Station ID	Cast	Event	Date	Lat (deg N)	Lon (deg E)	# of depths	# of duplicates
CTD1	CTD001	1	2024-08-17	63.7892	-53.0018	5	2
CTD2	CTD002	2	2024-08-17	63.5904	-53.5300	10	3
CTD3	CTD003	3	2024-08-17	63.4294	-54.0933	8	2
Mooring	CTD004	12	2024-08-19	59.0000	-55.0005	8	2
Mooring	CTD005	24	2024-08-22	58.9988	-55.0065	12	2
Mooring	CTD006	30	2024-08-23	59.0062	-55.0086	12	2
Float	CTD007	39	2024-08-24	58.4997	-52.0065	12	3
CF6	CTD008	43	2024-08-26	59.9559	-41.7429	12	2
M1	CTD009	49	2024-08-26	59.9033	-41.1098	14	2
M2	CTD010	50	2024-08-27	59.8588	-40.6935	13	2
M3	CTD011	53	2024-08-27	59.8162	-40.2932	13	3

Sample Collection

Discrete water samples were collected according to Langdon (2010) and Dickson (1994) guidelines, with seawater being collected directly into pre-calibrated Pyrex iodine titration flasks (approximately 125mL capacity) with flared necks and ground glass stoppers.

Key steps:

- Prior to sampling, bubbles that had formed in the chemical lines were removed by emptying and refilling the reagent dispenser 2-3 times. This minimises the risk of bubble injection in the samples.
- All flasks and stoppers were checked to ensure there were no cracks or chips and they were paired correctly, as each stopper is unique to each flask. Flasks and glass

stoppers were rinsed three times with deionised water to remove any residual reagent from a previous sample analysis.

- Silicon Tygon tubing was attached to the Niskin spigot, and the spigot was then pushed in. After, the Niskin tap was opened to allow the flow of water and the detection of leaks.
- Prior to drawing the DO sample, the tubing was massaged several times to minimise air entrapment inside, particularly where in contact with the spigot.
- Flasks were filled slowly, from the bottom, to minimise turbulence and the formation of bubbles. Once full, flasks were overflowed by three flask volumes of water (approximately 15 seconds at full flow).
- Flasks were held at the neck to minimise heat transfer to the seawater during sampling.
- Whilst each flask was overflowing, the fixing temperature was measured using a digital thermometer (Hanna HI93501 with calibrated FC762PW thermistor probe). Temperatures were measured to 0.1°C. The temperature is required to correct the flask volume due to glass expansion/ contraction, to convert the oxygen concentration measured from $\mu\text{mol L}^{-1}$ to $\mu\text{mol Kg}^{-1}$ and is a useful indicator of whether the Niskin bottle was closed at the correct depth.
- 1mL of manganese chloride was added to the flask, followed immediately by 1mL of alkaline iodide solution. Each dispenser tip was lowered beneath the surface of the sample to remove the potential of chemical loss through splashing and the entrainment of bubbles.
- Stoppers were carefully inserted at an angle to prevent air entrapment during flask closure.
- Flasks were shaken vigorously for approximately 30 seconds to facilitate mixing and the formation of manganese hydroxide precipitate. Flasks were shaken again after 30 minutes.
- Deionised water was added to the necks of each flask to prevent gas exchange. This was maintained until sample analysis. All flasks were kept in a covered crate in a laboratory that was maintained at approximately 24°C until analysis. All flasks were analysed within 24 hours of sampling.

Winkler titration

Blank analysis

Reagents can contain impurities that may interfere with the reduction-oxidation reactions involved in the dissolved oxygen analysis. Therefore, reagent blanks are required to quantify the reagents' contribution to the changes in oxygen concentration (Langdon, 2022). Blank measurements were determined as the difference between thiosulphate volumes (V_1 and V_2) required to titrate 2 1mL aliquots of iodate standard solution.

Procedure:

1. Fill a flask with DI water, but not to the very top, and add a stir bar.
2. Add 1ml of reagent 3 and mix.

3. Add 1ml of reagent 2 and mix.
4. Add 1ml of reagent 1 and mix.
5. Check to see if there is any yellow colour in the sample, if so discard, clean the flask, and start again.
6. Add 1ml of potassium iodate, sample should now turn yellow.
7. Titrate with sodium thiosulphate.
8. Record the volume required (as V1).
9. Repeat steps 6 to 8 twice for the same sample (V2 and V3).

Table 6: The volume of sodium thiosulphate required to titrate 1 mL of potassium iodate standard for the reagent blanks

Date	Cast	Volume of Sodium Thiosulphate			1st - Avg(2nd&3rd)	Average	Std Dev
		1st	2nd	3rd			
2024-08-17	1,2	0.0925	0.0900	0.0900	0.0025	0.0013	0.0016
		0.0915	0.0895		0.0020		
		0.0895	0.0900	0.0900	-0.0005		
2024-08-18	3	0.0900	0.0900	0.0900	0.0000	0.0000	0.0000
		0.0900	0.0900	0.0900	0.0000		
2024-08-20	4	0.0900	0.0905	0.0900	-0.0003	-0.0003	0.0000
		0.0900	0.0905	0.0900	-0.0003		
2024-08-22	5	0.0915	0.0890	0.0900	0.0020	0.0010	0.0014
		0.0900	0.0900		0.0000		
2024-08-23	6	0.0860	0.0900	0.0900	-0.0040	-0.0018	0.0032
		0.0900	0.0895		0.0005		
2024-08-25	7	0.0895	0.0900	0.0895	-0.0003	-0.0003	0.0000
		0.0895	0.0900	0.0895	-0.0003		
2024-08-26	8	0.0905	0.0895	0.0900	0.0008	-0.0010	0.0025
		0.0885	0.0925	0.0900	-0.0028		
2024-08-27	9	0.0900	0.0900	0.0900	0.0000	0.0007	0.0006
		0.0910	0.0890	0.0905	0.0013		
		0.0905	0.0895	0.0900	0.0008		
2024-08-29	10,11	0.0900	0.0890	0.0895	0.0008	0.0002	0.0010
		0.0905	0.0900	0.0895	0.0008		
		0.0890	0.0905	0.0895	-0.0010		

Standard Analysis

Standardisation of the thiosulphate solution was conducted before any samples were analysed. Thiosulphate solution was made by adding 17.5g of thio crystals to 500mL of deionized water and leaving to age for 24 hours. The thiosulphate molarity was then checked against a certified iodate standard of known molarity (1.667 mM, OSIL Scientific). A

125mL flask was $\frac{3}{4}$ filled with deionised water and a magnetic stir bar was added. 1mL sulphuric acid, 1mL alkaline iodide solution, 1mL manganous chloride were added to the flask in that order, mixing for approximately 30 seconds in between. 10mL of potassium iodate standard was then added to the flask and titrated with thiosulphate.

Five repeat standard measurements were performed per standardization set. For every standardisation set, the values used were always within 0.15% of the median. The final standard value was an average of the five measurements taken for each standardisation set.

Table 7: The volume sodium thiosulphate required to titrate 5 mL of the potassium iodate standard for the standardisation procedure

Date	Cast	Volume of Sodium Thiosulphate						Average	Std Dev
2024-08-17	1	0.4565	0.4575	0.4575	0.4560			0.4569	0.0008
2024-08-17	2	0.4555	0.4570	0.4575	0.4585	0.4575		0.4572	0.0011
2024-08-18	3	0.4580	0.4580	0.4570	0.4570			0.4575	0.0006
2024-08-20	4	0.4570	0.4570	0.4575	0.4585	0.4580		0.4576	0.0007
2024-08-22	5	0.4565	0.4565	0.4555	0.4560	0.4555		0.4560	0.0005
2024-08-23	6	0.4560	0.4560	0.4560	0.4565	0.4560		0.4561	0.0002
2024-08-25	7	0.4565	0.4560	0.4560	0.4565	0.4565		0.4563	0.0003
2024-08-26	8	0.4560	0.4560	0.4565	0.4565	0.4570		0.4564	0.0004
2024-08-27	9	0.4540	0.4570	0.4555	0.4560	0.4555		0.4556	0.0011
2024-08-29	10	0.4565	0.4565	0.4580	0.4565	0.4575	0.4565	0.4570	0.0007
2024-08-29	11	0.4560	0.4570	0.4560	0.4565	0.4560		0.4564	0.0005

Oxygen Sensor calibration on the CTD

See [Oxygen calibration](#) sub-section on [CTD Scientific Report](#) section.

Inorganic Carbon Chemistry

Personnel in the field: Kitty Kam, Dalhousie University, Canada

Background

Biological growth by phytoplankton takes up dissolved carbon dioxide and nutrients in the euphotic zone to produce oxygen and organic carbon. Through particulate sinking, mixing or vertical migration, these organic carbons are being exported below the mixed layer, hence release inorganic carbon and nutrients back into the water through organic decomposition and remineralization, summarizing the inorganic carbon and nutrient cycles in the biological carbon pump. We aim to capture the distribution of three parameters of inorganic carbonate system, including pH, total alkalinity (TA), dissolved inorganic carbon (DIC), on the surface ocean and throughout the water column in the Labrador Sea. The primary goal of our sampling plan is to tie the inorganic carbonate system to biological components of BCP with the help of in situ data from SeaCycler, a moored profiler that was launched in the same region in 2016. Particularly, we will use DIC-C13 data from this cruise to improve seasonal resolution of the Labrador Sea, and to calculate a carbon-based budget for the net community production.

Method

Seawater samples of pH, total alkalinity (TA) and dissolved inorganic carbon with $\delta^{13}\text{C}$ isotope signal (DIC-C13) are collected at 5-12 depths from CTD casts except on West Greenland Shelf (see Table 8). Table 9 details samples collected from CTD bottles of each cast.

Seawater samples are collected from Niskin bottles with a tygon tube into a 250ml glass bottle. The bottles and screw caps are rinsed thoroughly before filling up the bottle and overflowing for 1-2 volume. Bottles are then capped and brought to the fume hood in the chemistry lab to add 0.05ml of 100% saturated mercury chloride solution into each sample for poisoning and minimizing any organic production in the samples. All inorganic samples are stored in room temperature to be analysed back in Canada.

Sampling Summary

Table 8: JC268 CTD station samples for pH, DIC-C13 and TA.

Station	Cast	Event	Date	Lat (deg N)	Lon (deg E)	Bottom Depth (m)	pH	DIC	TA
W Greenland 1	CTD001	1	2024-08-17	63.7892	-53.0018	92			
W Greenland 2	CTD002	2	2024-08-17	63.5904	-53.5300	1540			
W Greenland 3	CTD003	3	2024-08-17	63.4294	-54.0933	1000			
Mooring	CTD004	12	2024-08-19	59.0000	-55.0005	3250	X	X	X
Mooring	CTD005	24	2024-08-22	58.9988	-55.0065	1000	X	X	X
Mooring	CTD006	30	2024-08-23	59.0062	-55.0086	3250	X	X	X
Argo Float	CTD007	39	2024-08-24	58.4997	-52.0065	1000	X	X	X
E Greenland	CTD008	43	2024-08-26	59.9559	-41.7429	1800	X	X	X
M1	CTD009	49	2024-08-26	59.9033	-41.1098	2043	X	X	X
M2	CTD010	50	2024-08-27	59.8588	-40.6935	2400	X	X	X
M3	CTD011	53	2024-08-27	59.8162	-40.2932	2513	X	X	X

Table 9: DIC, TA and pH samples from CTD bottles

Station	Cast	Date	Niskin	Depth (m)	Bedford #	DIC	TA	pH
Mooring	CTD004	2024-08-19	5	3200	D-002621			
Mooring	CTD004	2024-08-19	7	2500	D-002622	X	X	X
Mooring	CTD004	2024-08-19	9	2000	D-002623	X	X	X
Mooring	CTD004	2024-08-19	10	1500	D-002624	X	X	X
Mooring	CTD004	2024-08-19	11	1000	D-002625	X	X	X
Mooring	CTD004	2024-08-19	13	550	D-002626	X	X	X
Mooring	CTD004	2024-08-19	15	300	D-002627	X	X	X
Mooring	CTD004	2024-08-19	17	100	D-002628	X	X	X
Mooring	CTD004	2024-08-19	19	70	D-002629	X	X	X
Mooring	CTD004	2024-08-19	21	35	D-002630	X	X	X
Mooring	CTD004	2024-08-19	23	10	D-002631	X	X	X
Mooring	CTD005	2024-08-22	1	1000	D-002632	X	X	X
Mooring	CTD005	2024-08-22	3	750	D-002633	X	X	X
Mooring	CTD005	2024-08-22	6	500	D-002634	X	X	X
Mooring	CTD005	2024-08-22	7	420	D-002635	X	X	X
Mooring	CTD005	2024-08-22	9	300	D-002636	X	X	X
Mooring	CTD005	2024-08-22	11	250	D-002637	X	X	X
Mooring	CTD005	2024-08-22	13	200	D-002638	X	X	X
Mooring	CTD005	2024-08-22	15	130	D-002639	X	X	X
Mooring	CTD005	2024-08-22	17	100	D-002640	X	X	X
Mooring	CTD005	2024-08-22	19	80	D-002641	X	X	X
Mooring	CTD005	2024-08-22	21	45	D-002642	X	X	X
Mooring	CTD005	2024-08-22	23	10	D-002643	X	X	X
Mooring	CTD006	2024-08-23	1	3300	D-002644	X	X	X
Mooring	CTD006	2024-08-23	3	2500	D-002645	X	X	X
Mooring	CTD006	2024-08-23	5	1500	D-002646	X	X	X
Mooring	CTD006	2024-08-23	7	1000	D-002647	X	X	X
Mooring	CTD006	2024-08-23	9	550	D-002648	X	X	X
Mooring	CTD006	2024-08-23	11	420	D-002649	X	X	X
Mooring	CTD006	2024-08-23	13	250	D-002650	X	X	X
Mooring	CTD006	2024-08-23	15	150	D-002651	X	X	X
Mooring	CTD006	2024-08-23	18	100	D-002652	X	X	X
Mooring	CTD006	2024-08-23	19	75	D-002653	X	X	X
Mooring	CTD006	2024-08-23	21	35	D-002654	X	X	X
Mooring	CTD006	2024-08-23	23	10	D-002655	X	X	X
Argo Float	CTD007	2024-08-24	1	100	D-002656	X	X	X
Argo Float	CTD007	2024-08-24	3	750	D-002657	X	X	X
Argo Float	CTD007	2024-08-24	5	500	D-002658	X	X	X
Argo Float	CTD007	2024-08-24	7	420	D-002659	X	X	X

Argo Float	CTD007	2024-08-24	9	300	D-002660	X	X	X
Argo Float	CTD007	2024-08-24	11	200	D-002661	X	X	X
Argo Float	CTD007	2024-08-24	13	150	D-002662	X	X	X
Argo Float	CTD007	2024-08-24	15	100	D-002663	X	X	X
Argo Float	CTD007	2024-08-24	12	80	D-002664	X	X	X
Argo Float	CTD007	2024-08-24	19	50	D-002665	X	X	X
Argo Float	CTD007	2024-08-24	21	25	D-002666	X	X	X
Argo Float	CTD007	2024-08-24	23	10	D-002667	X	X	X
E Greenland	CTD008	2024-08-26	1	1800	D-002668	X	X	
E Greenland	CTD008	2024-08-26	3	1600	D-002669	X	X	X
E Greenland	CTD008	2024-08-26	5	1500	D-002670	X	X	X
E Greenland	CTD008	2024-08-26	7	1000	D-002671	X	X	X
E Greenland	CTD008	2024-08-26	13	300	D-002672	X	X	X
E Greenland	CTD008	2024-08-26	17	200	D-002673	X	X	X
E Greenland	CTD008	2024-08-26	23	10	D-002674	X	X	X
M1	CTD009	2024-08-26	1	2050	D-002675	X	X	X
M1	CTD009	2024-08-26	3	1750	D-002676	X	X	X
M1	CTD009	2024-08-26	5	1500	D-002677	X	X	X
M1	CTD009	2024-08-26	8	1250	D-002678	X	X	X
M1	CTD009	2024-08-26	9	1000	D-002679	X	X	X
M1	CTD009	2024-08-26	11	600	D-002680	X	X	X
M1	CTD009	2024-08-26	13	500	D-002681	X	X	X
M1	CTD009	2024-08-26	15	250	D-002682	X	X	X
M1	CTD009	2024-08-26	12	150	D-002683	X	X	X
M1	CTD009	2024-08-26	19	50	D-002684	X	X	X
M1	CTD009	2024-08-26	21	35	D-002685	X	X	X
M1	CTD009	2024-08-26	23	10	D-002686	X	X	X
M2	CTD010	2024-08-27	1	2383	D-002687	X	X	X
M2	CTD010	2024-08-27	3	2350	D-002688	X	X	X
M2	CTD010	2024-08-27	5	2200	D-002689	X	X	X
M2	CTD010	2024-08-27	7	2050	D-002690	X	X	X
M2	CTD010	2024-08-27	9	2000	D-002691	X	X	X
M2	CTD010	2024-08-27	12	1700	D-002692	X	X	X
M2	CTD010	2024-08-27	13	1500	D-002693	X	X	X
M2	CTD010	2024-08-27	15	1000	D-002694	X	X	X
M2	CTD010	2024-08-27	17	600	D-002695	X	X	X
M2	CTD010	2024-08-27	18	400	D-002696	X	X	X
M2	CTD010	2024-08-27	19	200	D-002697	X	X	X
M2	CTD010	2024-08-27	21	35	D-002698	X	X	X
M2	CTD010	2024-08-27	23	10	D-002699	X	X	X
M3	CTD011	2024-08-27	1	2517	D-002700	X	X	X
M3	CTD011	2024-08-27	2	2480	D-002701	X	X	X

M3	CTD011	2024-08-27	6	2150	D-002702	X	X	X
M3	CTD011	2024-08-27	7	2000	D-002703	X	X	X
M3	CTD011	2024-08-27	9	1400	D-002704	X	X	X
M3	CTD011	2024-08-27	11	1100	D-002705	X	X	X
M3	CTD011	2024-08-27	13	1000	D-002706	X	X	X
M3	CTD011	2024-08-27	15	650	D-002707	X	X	X
M3	CTD011	2024-08-27	12	350	D-002708	X	X	X
M3	CTD011	2024-08-27	19	95	D-002709	X	X	X
M3	CTD011	2024-08-27	21	40	D-002710	X	X	X
M3	CTD011	2024-08-27	23	10	D-002711	X	X	X

Dissolved Organic Carbon (DOC)

Personnel in the field: Will Major (National Oceanography Centre)

Background

The Atlantic Meridional Overturning Circulation (AMOC) is a significant sink of DOC into the deep ocean. Knowledge is limited on the processes controlling the export of DOC into the deep ocean via the AMOC, and uncertainties remain about how climate change will affect these processes. DOC samples were collected on JC268 as a part of the DOGMA project (Dissolved Organic matter subduction and transport along the east Greenland Margin).

Method

Samples for DOC, Coloured Dissolved Organic Matter (CDOM), Dissolved Organic Nitrogen (DON) Isotopes and Dissolved Organic Matter (DOM) composition were collected from CTD casts CTD008, CTD009, CTD010 and CTD011 at sites CF6, M1, M2 and M3, respectively (see sample list). All samples will be analysed in the laboratory after the RRS James Cook returns to Southampton on 24/10/2024. A polycarbonate in-line filter holder containing a 47mm GF/F with two attached pieces of silicon tubing was used to filter Niskin bottle water from the rosette into sample containers. The filter was attached to the Niskin bottle via the tubing, beginning with the deepest bottle and working upwards around the rosette. For each Niskin bottle, the filter holder was primed prior to sample collection by unscrewing the white cap until all air bubbles had escaped. Each sample bottle was rinsed twice with a small amount of sample water. Filters were replaced for each CTD and the filter holder and tubing were rinsed with milliQ water and left to dry in between CTD casts.

The following sample volumes were taken and stored:

- DOC: 10mL was sampled into 10 mL glass bottles and acidified to pH2 with 40 μ L concentrated HCl. Samples were stored in the fridge post-collection at 4°C.
- CDOM: 50mL amber glass bottles were filled to the shoulder of the bottle. Samples were frozen at -20°C.
- DON Isotopes: 125mL HDPE bottles were filled to the shoulder with sample water before being frozen at -20°C.
- DOM Composition: 1L samples were taken in glass bottles and acidified to pH2 using 1.05mL of concentrated HCl. Ideally, bottles would be refrigerated at 4°C. However, due to a lack of fridge space on the ship, 4 samples were replicated and refrigerated, while the rest were stored in boxes in the hold of the ship until the ship returns to Southampton on 24/10/2024.

Sample list

Table 10: List of samples taken during JC268 for DOM Composition, DOC, DON Isotopes and CDOM across four CTD casts and sites. Duplicated samples are indicated by XX. Highlighted Niskin bottles are those that were replaced due to misfires. Samples will be labelled as one number lower than stated here, e.g. 12 will be labelled as 11 on the samples.

DateTime	Event	CTD	Location	Site	Lat	Lon	Niskin	Depth (m)	DOM Com	DOC	DON Isoto	CDOM
26/08/2024 09:59	43	CTD008	GOHSNAP	CF6	59.95599	-41.743	1	1800	X	X	X	X
							3	1600	XX	X	X	X
							5	1500	X	X	X	X
							7	1000	X	X	X	X
							13	300	X	X	X	X
							17	200	X	X	X	X
							24	10	XX	X	X	X
							26/08/2024 20:18	49	CTD009		M1	59.90338
							3	1750	X	X	X	X
							5	1500	X	X	X	X
							7	1250	X	X	X	X
							9	1000	X	X	X	X
							11	600	X	X	X	X
							17	150	X	X	X	X
							23	10	XX	XX	X	X
27/08/2024 10:43	50	CTD010		M2	59.85887	-40.6935	3	2350	X	XX	XX	XX
							5	2200	X	X	X	X
							7	2050	X	X	X	X
							9	2000	X	X	X	X
							12	1700	X	X	X	X
							13	1500	X	X	X	X
							15	1000	X	X	X	X
							17	600	X	X	X	X
							18	400	X	X	X	X
							23	10	X	X	X	X
27/08/2024 18:36	53	CTD011		M3	59.81618	-40.2932	1	2517	X	XX	XX	XX
							3	2480	X	X	X	X
							6	2150	X	X	X	X
							7	2000	X	X	X	X
							11	1100	X	X	X	X
							13	1000	X	X	X	X
							15	650	X	X	X	X
							17	350	X	X	X	X
							23	10	X	X	X	X

NMF Mooring Technical Report

Personnel in the field: Nick Rundle, Andy Leadbeater, Billy Platt (NMF)

A Single mooring was deployed on the cruise, using the standard process paying out the top end first and releasing the anchor over a specified drop point. The deck was set up with a standard configuration for this process (Figure 14).

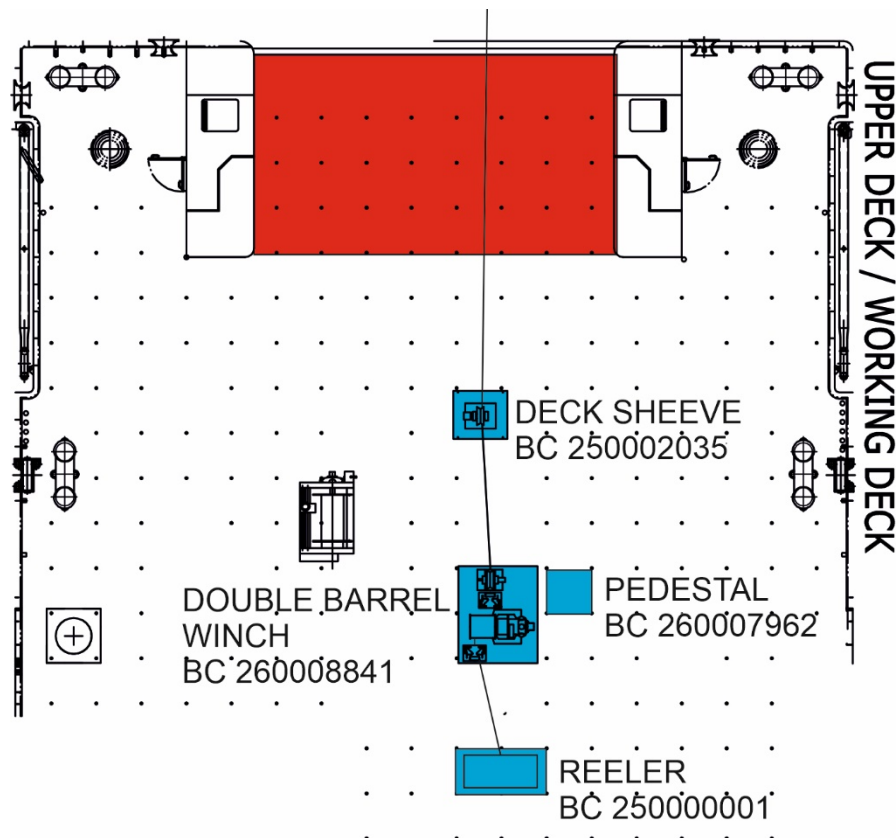


Figure 14: Mooring deployment deck plan

The main mooring line was wound onto the reeler during mobilisation in Greenland. The mooring line was deployed using the double barrel and the deck(counter) sheave and a sheave on the port pedestal crane. The starboard crane was used for the sea catch to release the sediment traps and the anchor chain.

Mooring design

Detail schematics for the mooring design can be found on Figure 15.

JC268 ReBELS-1 DEPLOYED 21.08.24

48 59.706 N
016 24.2867 W

74M

LIGHT SN - X03-077
IRIDIUM SN - H03-062
SYNTACTIC SN - J08604-001

100M

FLUX CAMERA PLATFORM B
TRANSMISSOMETER SN - 1671047
RBR CONCERTO SN - 231310
RBR FERMATA SN - 231149
DEVELOLOGIC BATTERY SN - 19080

103M

NORTEK AQD SN - 16250

105M

SBE 37 IMP SN - 9373

274M

SYNTACTIC SN - J08604-002

299M

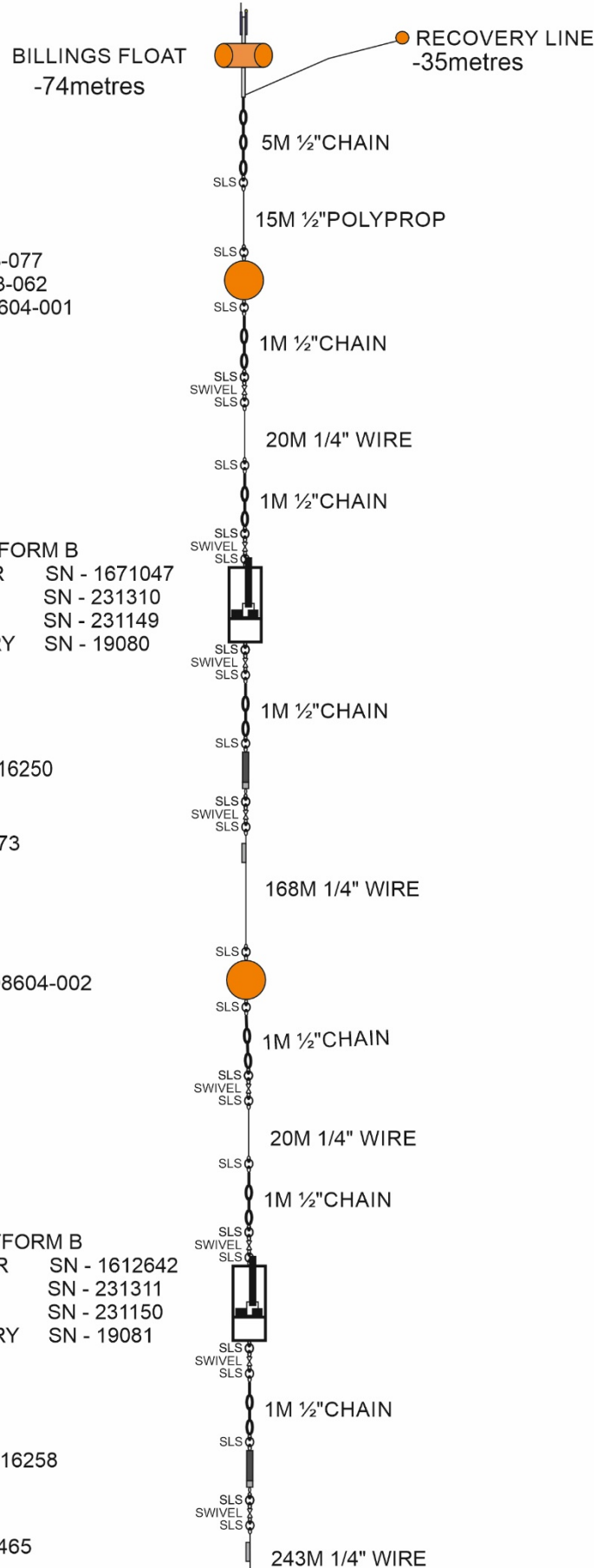
FLUX CAMERA PLATFORM B
TRANSMISSOMETER SN - 1612642
RBR CONCERTO SN - 231311
RBR FERMATA SN - 231150
DEVELOLOGIC BATTERY SN - 19081

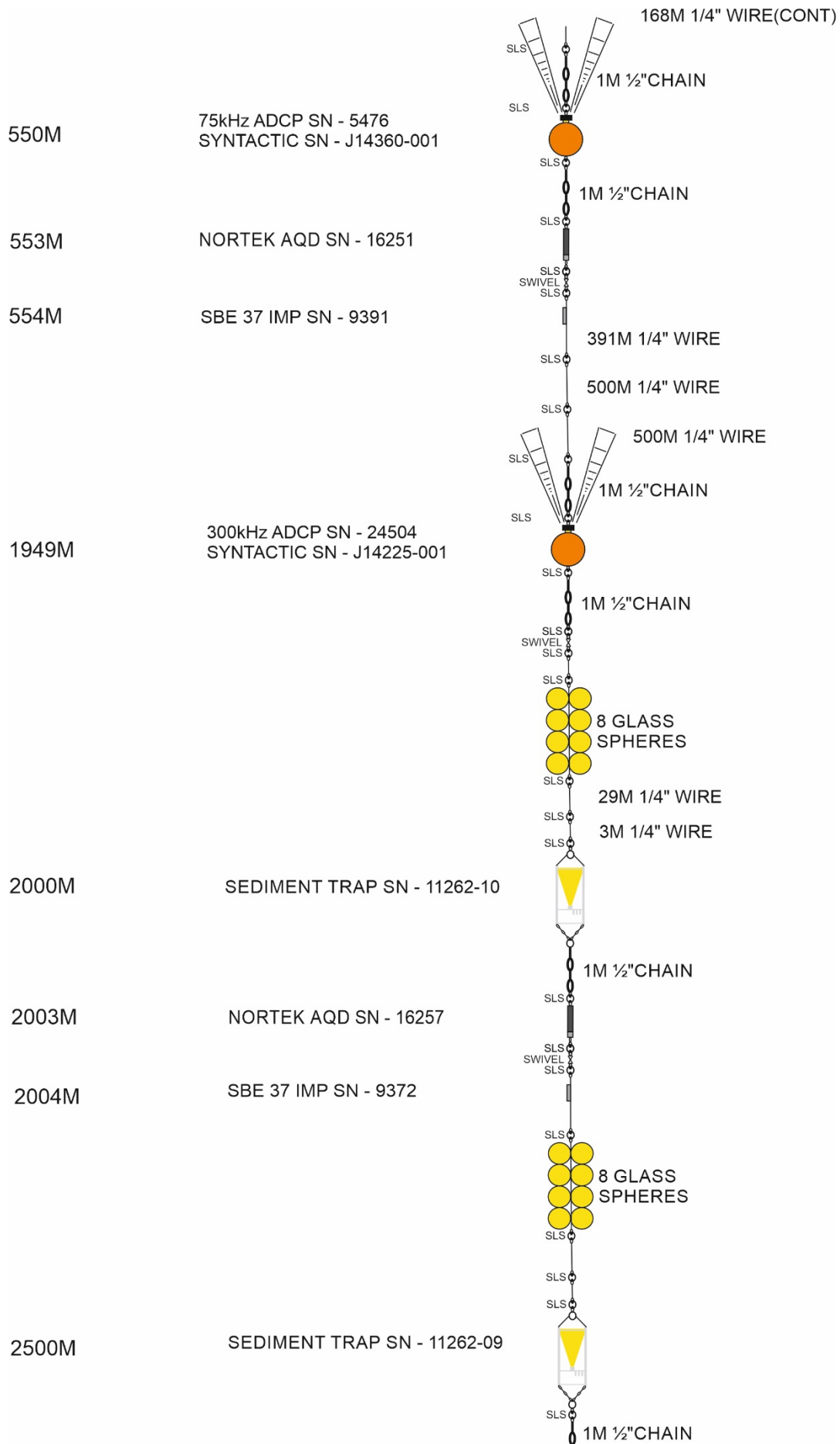
302M

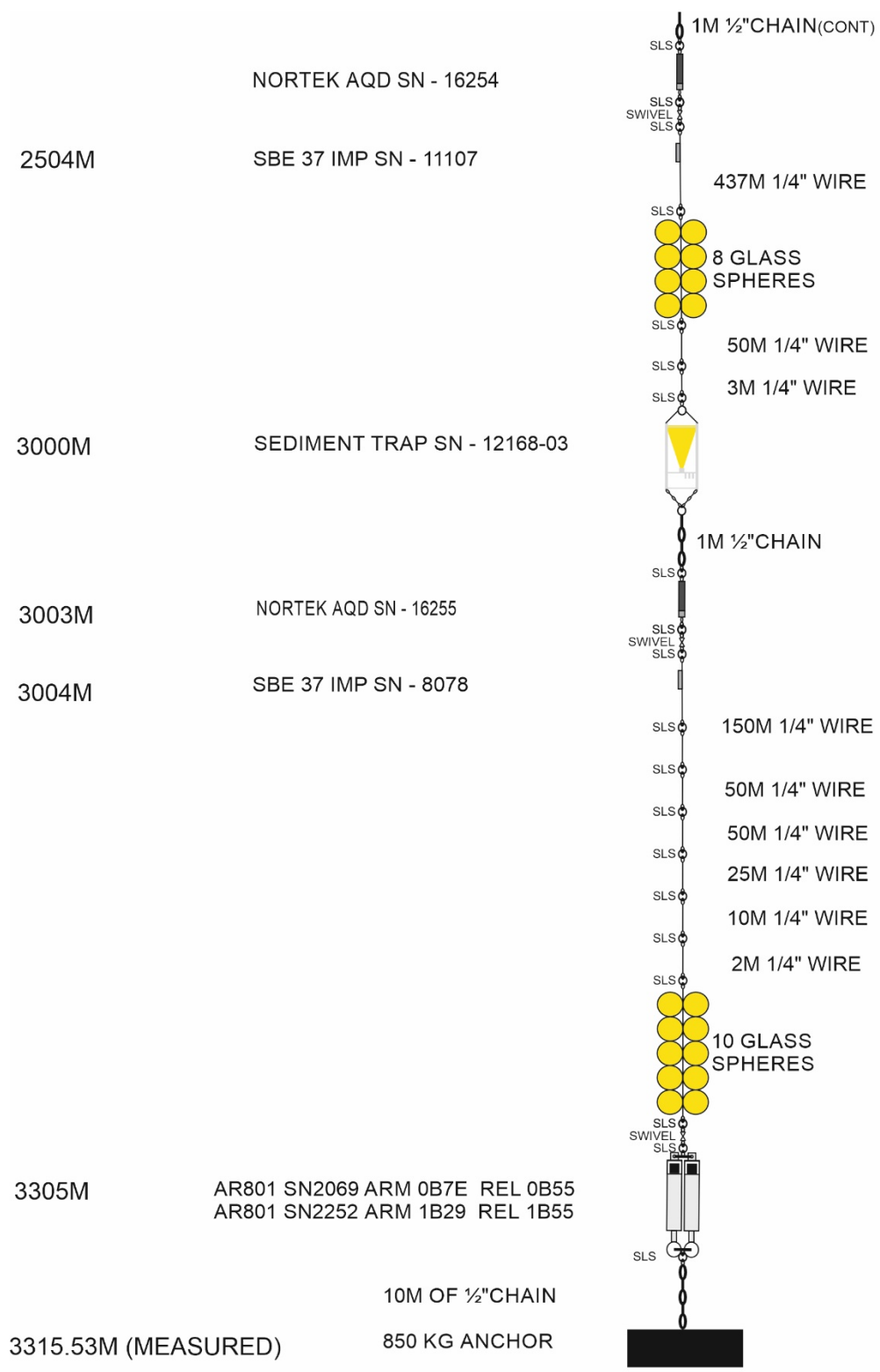
NORTEK AQD SN - 16258

304M

SBE 37 IMP SN - 11465







SEA BED 3316M UNADJUSTED

SENSORS & MOORINGS

Figure 15: As deployed mooring diagram

Mooring deployment on 21st August 2024, sea state average around 3 to 4 with 20knots wind (force 5-6). Current was around 1.6knotts at the surface shifting in direction. Assessment at the time was workable but not ideal.

Deployment commenced at 08:38 and the anchor was released at 14:53. The process went relatively smoothly with a couple of difficult moments releasing the sediment traps when Seacatch release ropes became tangled.

Triangulation

Post deployment the ship was positioned for triangulation as per the current NMF Sensors and Moorings procedure. The ranges taken from the triangulation points were entered into the current spreadsheet calculator and the old calculator neither of which were able to reconcile the inputs for a viable point on the seabed (Figure 16).

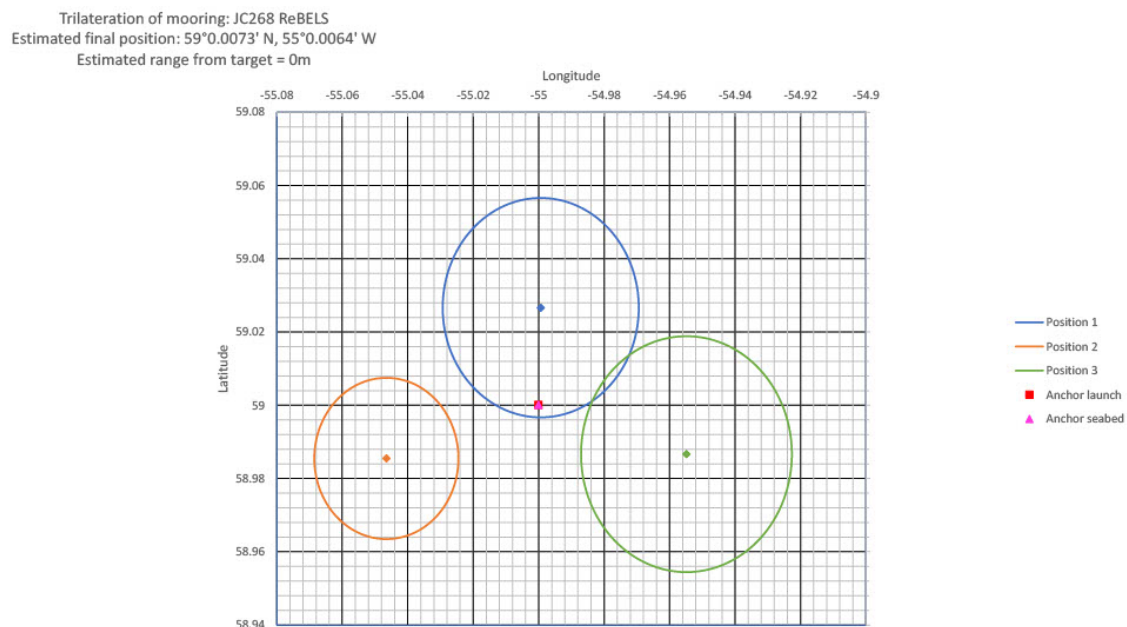


Figure 16: Current S&M trilateration xl file

The triangulation data was sent back to base where a more sophisticated MATLAB program was used (ref D. Rayner) to produce a coherent output (Figure 17).

Triangulation Survey for: REBELS
Releases depth: 3315 m. rate of ascent: 0.0 (m/hour)
Red = anchor seabed position. 58.9977N -55.0131W.
Latitude 58 59.86 N, Longitude 55 0.78 W

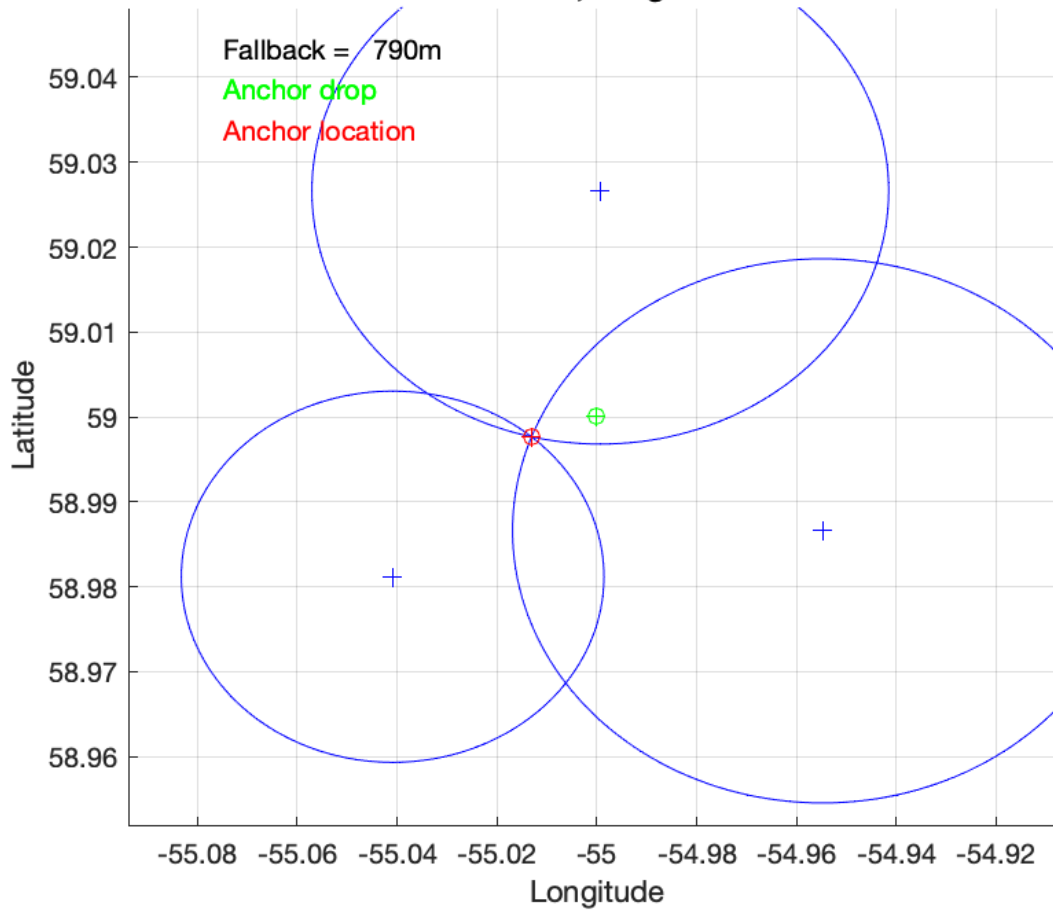


Figure 17: More sophisticated triangulation computation (courtesy of D. Rayner)

Deployment complete recorded on MFP IMS Barcode 30000226.

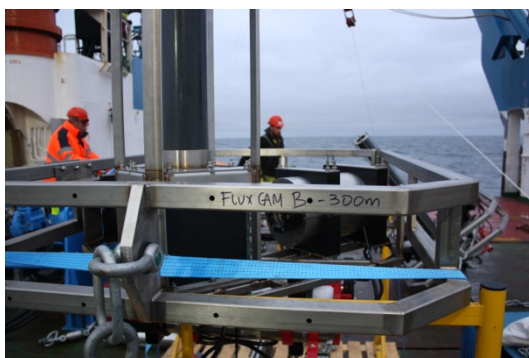




Figure 18: Deployment of the ReBELS mooring on 21-Aug-2024

Table 11: recoverable assets on ReBELS-1

Group	Type	Name	Serial Number	Barcode
NOC NMF S&M	Acoustic release	AR861	2069	260001653
NOC NMF S&M	Acoustic release	AR861 NMEP	2252	260004330
NOC NMF S&M	Buoyancy	Deepwater Buoyancy 3500m Rated, 44inch WHLR575	J14225-001	250009268
NOC NMF S&M	Buoyancy	Deepwater Buoyancy 3500m Rated, 44inch WHLR575	J14360-001	250009398
NOC S&T OBG	Battery Pack	DEVELOGIC BATTERY HOUSING DW.TH.9S19P	19080	260009067
NOC S&T OBG	Battery Pack	DEVELOGIC BATTERY HOUSING DW.TH.9S19P	19081	260009068
NOC NMF S&M	Buoyancy	Flotec 40" Syntactic Buoyancy Sphere 1500m OSNAP	J08604-001	250008495
NOC NMF S&M	Buoyancy	Flotec 40" Syntactic Buoyancy Sphere 1500m OSNAP	J08604-002	250008496
NOC NMF S&M	Beacon	MetOcean Novatech IR-7300 IRIDIUM Satellite Beacon	H03-062	260006224
NOC NMF S&M	Current meter	Nortek AquaDopp DW Current Meter (6000m) NMEP	AQD16250	260006837
NOC NMF S&M	Current meter	Nortek AquaDopp DW Current Meter (6000m) NMEP	AQD16251	260006838
NOC NMF S&M	Current meter	Nortek AquaDopp DW Current Meter (6000m) NMEP	AQD16254	260006839
NOC NMF S&M	Current meter	Nortek AquaDopp DW Current Meter (6000m) NMEP	AQD16255	260006840
NOC NMF S&M	Current meter	Nortek AquaDopp DW Current Meter (6000m) NMEP	AQD16257	260006841
NOC NMF S&M	Current meter	Nortek AquaDopp DW Current Meter (6000m) NMEP	AQD16258	260006842
NOC NMF S&M	Sediment trap	Parflux 78H-21 Sediment Trap	12168-03	250004783
NOC NMF S&M	Sediment trap	Parflux 78H-21tc Sediment Trap	11262-09 [05]	250000435
NOC NMF S&M	Sediment trap	Parflux 78H-21tc Sediment Trap	11262-10 [05]	250000436
NOC S&T OBG	CTD	RBR Concerto CTD ODO TRII fast8 -6000m	231310	260008575
NOC S&T OBG	CTD	RBR Concerto CTD ODO TRII fast8 -6000m	231311	260008576
NOC S&T OBG	Power source	RBR Fermata	231149	260008577
NOC S&T OBG	Power source	RBR Fermata	231150	260008578
NOC NMF S&M	ADCP	RDI ADCP 75KHz Long Ranger NMEP	5476	250002700
NOC NMF S&M	CTD	SBE 37 SMP CTD DIMES	60389-8078	250006715
NOC NMF S&M	CTD	SBE 37 SMP CTD NMEP	9372	250007301
NOC NMF S&M	CTD	SBE 37 SMP CTD NMEP	9373	250007302
NOC NMF S&M	CTD	SBE 37 SMP CTD NMEP	9391	250007320
NOC NMF S&M	CTD	SBE 37 SMP CTD NMEP	11107	250008565
NOC NMF S&M	CTD	SBE 37 SMP CTD NMEP	11465	250008727
NOC NMF S&M	ADCP	TRDI ADCP 300KHz Workhorse Sentinel + kit NMEP	24504	260006132
NOC NMF S&M	Transmissometer	CTG AlphaTracka-II 650nm 25cm Beam T Ti 6,000m	161047	250001270
NOC NMF S&M	Transmissometer	CTG AlphaTracka-II 650nm 25cm Beam T Ti 6,000m	161-2642-002	250001272

Instrumentation Settings

Acoustic Doppler Current Profilers (ADCP)

ADCPs were all programmed as per requirements given by scientists prior to sailing.

Table 12: Details of the 2 ADCPs on the ReBELS mooring

Upward-looking 300 kHz ADCP (~1949 m)	Upward-looking 75 KHz ADCP (~550 m)
Duration: 365 days	Duration: 365 days
Ensemble interval: 00:01:30	Ensemble interval: 00:30:00
Ping interval 00:00:05	Ping interval 00:00:05
Pings per ensemble: 10	Pings per ensemble: 20
Depth cell size: 1 m (30 m range)	Depth cell size: 16 m (600 m range)

PAR FLUX Sediment Traps

The 3 traps were bottled and configured at NOC prior to mobilisation. The voltages of all three traps were showing in excess of 20V. The systems were checked alongside in Nuuk and showed slight drop in voltage in one trap down to 18.1V. The batteries were replaced and the system reprogrammed. When checked again the voltages were still shown to be lower than the expected 20V. One set of batteries were individually checked and then also checked at the output from to the main board and showed to have the correct voltage of 21V. The issue was raised with Mclean and will be investigated further. As all systems exceeded the minimum 18V requirement they were deemed fit for deployment. Further information can be found in *Sediment Traps* Section.

NORTEK

6 NORTEKS were all set up with measurement interval, 1800 seconds (30min) and optimised to use 92% of the battery.

SeaBird SMP 37

6 Seabirds were also set up to run on 30min interval. Cal cast was 10 second interval.

Transmissometers

Set up in Flux Cam software as part of OTE system (user supplied).

Flux Cam and RBR

Flux Cam and RBR also set up as part of the user supplied equipment on the Flux Cam frame.

Releases

Three releases were tested on the CTD cast at the mooring site. SN 2069 Gave good range responses and released. SN 2252 did not respond to ranging, but did release. SN 1917 did not respond to ranging and did not release. SN1917 was not used for deployment and returned to base for investigation.

FluxCAM on the ReBELS Mooring

Personnel on the field: Filipa Carvalho and Nick Rundle (National Oceanography Centre)

Personnel at NOC: Sari Giering, David Miall, Nathan Briggs (National Oceanography Centre)

System description

FluxCam is an *in situ* camera system to measure *in situ* sinking velocities of marine snow. FluxCam was built at NOC for long-term deployments on moorings (Figure 19). The NOC design is based on the American system (US-FC) from the University of Southern Mississippi, used by Arne Diercks and successfully deployed in the Gulf of Mexico (Diercks et al. 2018). The camera is oriented to take pictures of a clear acrylic settling chamber. Sinking particles enter the settling chamber through a stilling chimney (settling tower), which is attached to the top of the settling chamber. To ensure the settling chamber stays upright, the camera frame is located between two swivels on the mooring wire that is aligned using a rubber vane. Inside the frame is a balanced pivot table, designed by NOC and manufactured/fabricated by BD Marine. The main frame was built by DG Pipe fitters. The pressure housings were done by F and M engineering. The assembly, as well as all cables, looms and electronics were done at NOC. An ST-Micro ISM330DHCX Inertial Measurement Unit (IMU) is included in the electronics to record orientation.

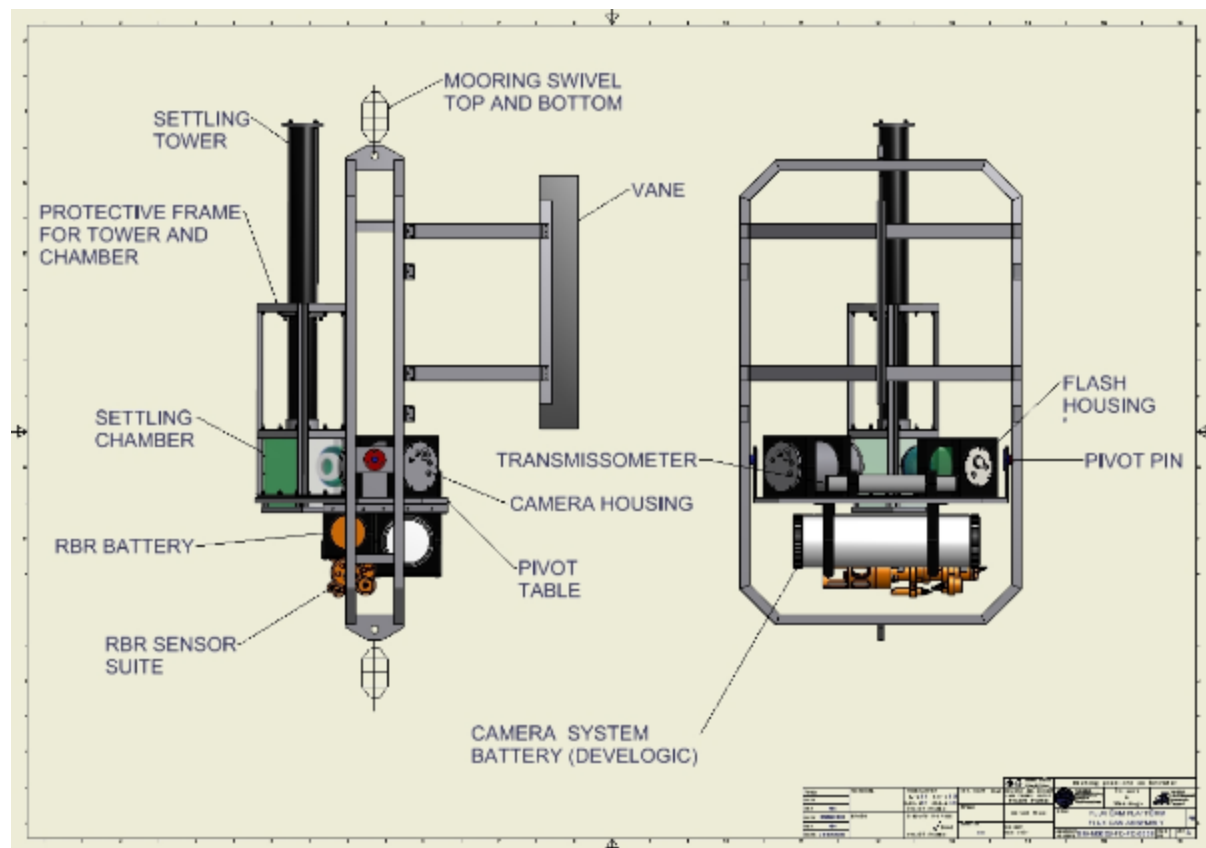


Figure 19: Drawing of FluxCAM frame, including the settling chamber and tower, vane, pivot table, camera and flash housings, RBR logger, transmissometer and housings for extra batteries.

Camera/system setup

The hardware components of the US-FC are similar to NOC’s P-Cam, so we originally planned to use the P-Cam hardware with some modifications like a settling chamber. It uses a digital single-lens reflex (DSLR) camera (Canon EOS 6D DSLR) with a Canon EF-50mm lens with aperture f/2.5. The flash is a Canon Speedlite 600EX-RT, powered by the system (Figure 19). A series of 10 images was planned to be taken at 2 second intervals every 2 hours to capture a range of sinking speeds (10-500 m/d). The photographic settings are pre-programmed into the camera and system capture settings (image rate, transmissometer capture, IMU capture) are set, prior to deployment, using NOC OTE’s standard lab-on-chip state-machines, programmed over USB using a PC-based GUI. The control and acquisition electronics were initially challenging, requiring rapid re-design at NOC to make the system functional and meet power requirements; this was achieved by using NOC OTE’s lab-on-chip “processing board” with FluxCam-specific modifications. It was then noticed during testing that the flash did not operate for every image - a problem which was solved by moving the flash step-down converter from the camera-housing into flash-housing, reducing the current required through long cables when the flash charged. A transmissometer ([CTG Alpha Tracka MKII](#)), mounted sideways, was also connected to provide beam attenuation.

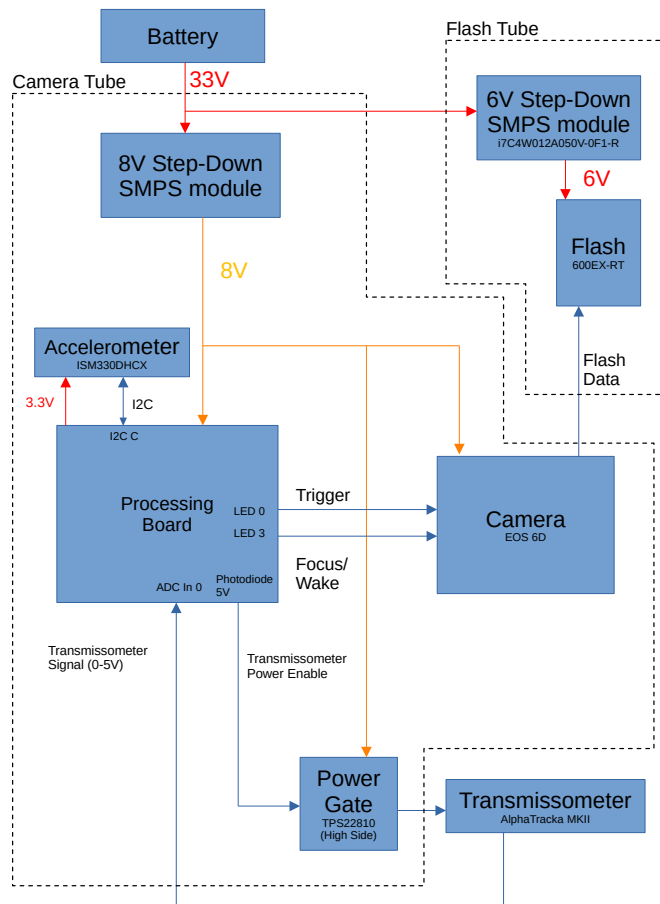
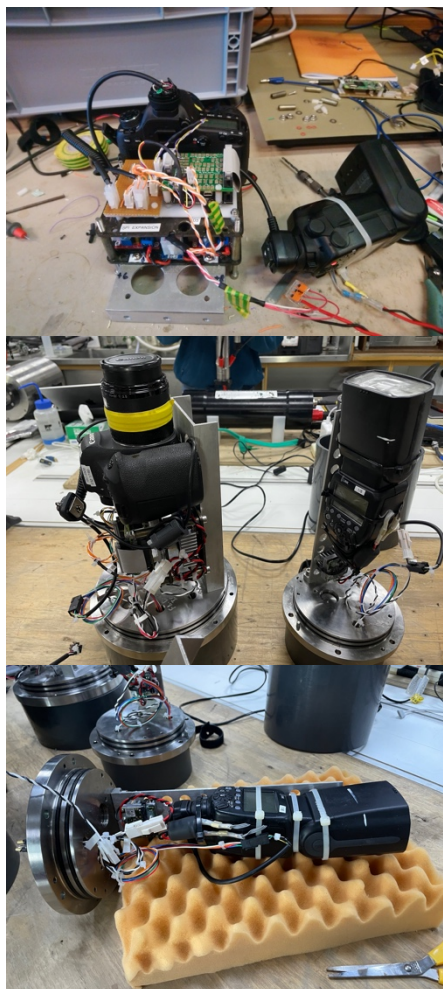


Figure 20: (left) Processing board attached to DSLR fitted to the end-cap of the Camera Tube pressure housing, camera and flash setups. (right) Wiring diagram



Figure 21: different views of the fluxCAM setup, including the RBR logger and batteries; top view of the camera and flash housings and transmissometer; and detail of the pivot table without the camera and flash housings, and front and side views of fully assembled system

Deployment on the mooring

The FluxCAM systems were deployed at 100 and 300 m. The mooring was standard buoy first method, streamed out behind the ship with the anchor released over target site allowing for fall back. The FluxCam platform is designed to keep the settling tower vertical at all times.

To calculate speed, particles will be tracked through the images and the sinking velocity calculated.

RBR logger

Below the FluxCAM, an RBR Concerto (CTD and logger) with Bio-optics and oxygen sensors. The 2 RBR loggers were set to moored operations with an extra carousel of alkaline batteries, which the Ruskin software forecasted 2 years of endurance at the current sampling rate. Each logger was set to burst mode at 480 samples at a speed of 4Hz, with an interval of 20 minutes.

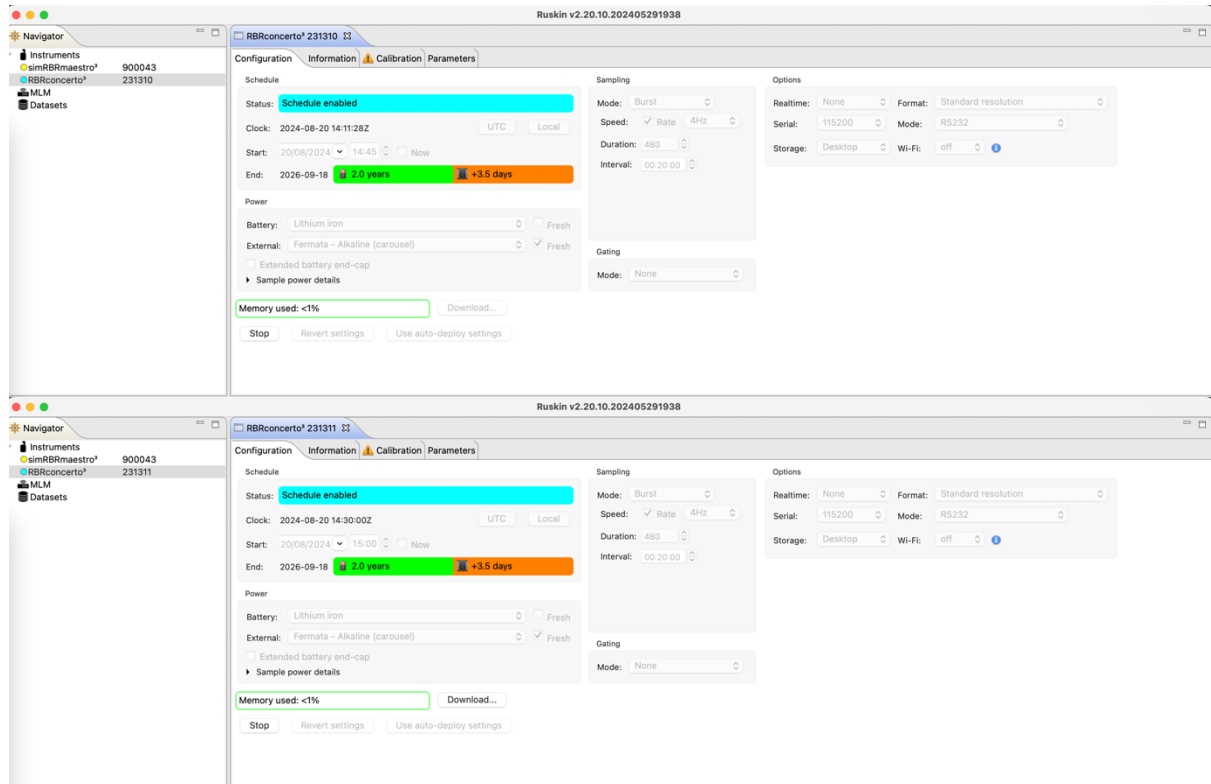


Figure 22: Screenshots of the setup window (for moored operations) for the 2 RBR loggers deployed on the mooring.

RBR loggers were strapped to the CTD rosette on 19/08/2024 for CTD4 (Ev12), to calibrate the sensors. The following files contain data from RBR loggers during the dip test:

- 231310_20240819_Ev12_CTD4.xlsx
- 231311_20240819_Ev12_CTD4.xlsx

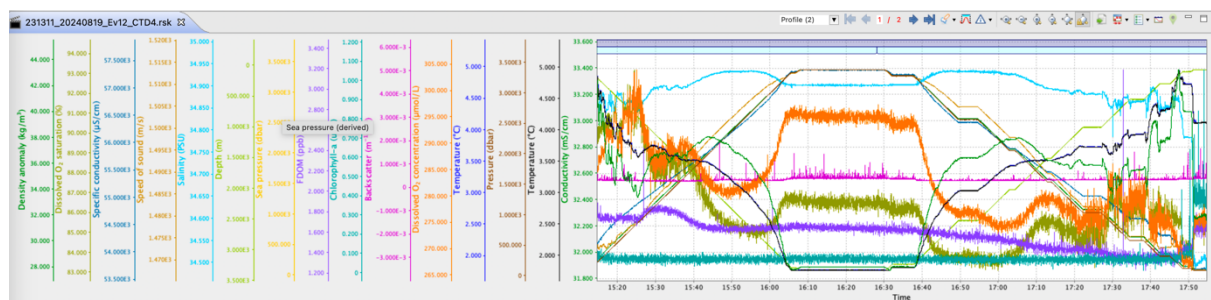


Figure 23: Output from Ruskin software for the dip test data (Event 12, CTD4)

Sediment Traps on ReBELS mooring

Personnel in the field: Elisa Lovecchio, Hans Hilder, Heather Jacques (NOC)

Personnel at NOC: Christopher Feltham, Sari Giering (NOC)

Three sediment traps (traps A, B and C) manufactured by McLane inc. were prepared and programmed at NOC before boarding the RRS James Cook (Figure 24). Each trap includes 21 x 250 ml bottles. The bottles were etched so that each bottle's name indicates: project name (ReBELS), field campaign within the project (campaign nr.1), trap name (A, B or C) and a cardinal number that identifies the bottle (1,2,...,21).



Figure 24: One of the three sediment traps prepared for ReBELS loaded on RRS James Cook.

We prepared 20L of sediment trap preservative following the sediment trap protocol (provided by Corinne Pebody via email). We mixed 100 g of NaCl (salt) to 19L of deep water that was collected several weeks before the procedure. One bottle with 9.5 dL of formaldehyde was available for use at NOC, out of the whole amount needed (1L) to make the sediment trap preservative. Additional formaldehyde available at NOC had some precipitate in it and delays in the delivery service impeded us from obtaining new formaldehyde in time. Hence, 0.5 dL of additional formaldehyde of the available batch was filtered to get rid of any particles and was added to the 9.5 dL. The whole 1 L of formaldehyde was buffered with 5g sodium tetra borate. The following day, the buffered formaldehyde and the sea water solution were mixed together obtaining 20 L of

preservative.

We filled the 3 x 21 bottles with preservative solution up to the top. We then screwed the bottles tightly onto the sediment traps, making sure that bottle nr1 is the first to be placed under the funnel by the trap's carousel and that bottle numbers are incremental. Bottles were then topped up with leftover preservative from the top-up hole of the traps and using the sediment trap's software. One additional bottle was filled with the preservative solution and left in the lab for archiving. Leftover preservative was packed and boarded onto the ship for potential topping-up of the traps' bottles before deployment. The three traps were loaded on board of RRS James cook at NOC.

During the field campaign, we carried visual checks of the traps' bottles on board before deployment (15 August). These checks showed no visible air bubbles, hence indicating that the bottles did not need additional topping up (Figure 25). We checked and adjusted the alignment between rotator and open hole. The traps were initially re-battered and programmed at NOC. However, a drop in battery voltage was noted on board of JC268, hence the traps' batteries were changed again on board, which also required to reprogram the instruments on board. After changing the batteries, voltages were checked again using TeraTerm. One trap showed voltage at 19.8V (trap B) while two traps had voltages of about 18.5V. According to the McLane sediment traps manual, the minimum voltage for the traps to be safely deployed is 18V, hence we proceeded with the preparation for the deployment.

For the traps deployment, we set the traps' time to UTC and programmed the traps using the "start date & interval" option. We set the start date to 30/August/2024 (08 30 2024 00 00 00) and the interval to 16 days (16 days, 00 hours, 00 minutes). We made sure that the last bottle of each trap (bottle nr.21) is programmed to be moved away from the funnel by the trap's carousel on the 1st August 2025 (Event 22 of 22 = 08/01/2025 00:00:00). The logs of the three sediment traps from 17 August 2024 on board of JC268 have been copied at the end of the present document.

The three traps were deployed as part of the ReBELS mooring on 21 August 2024.

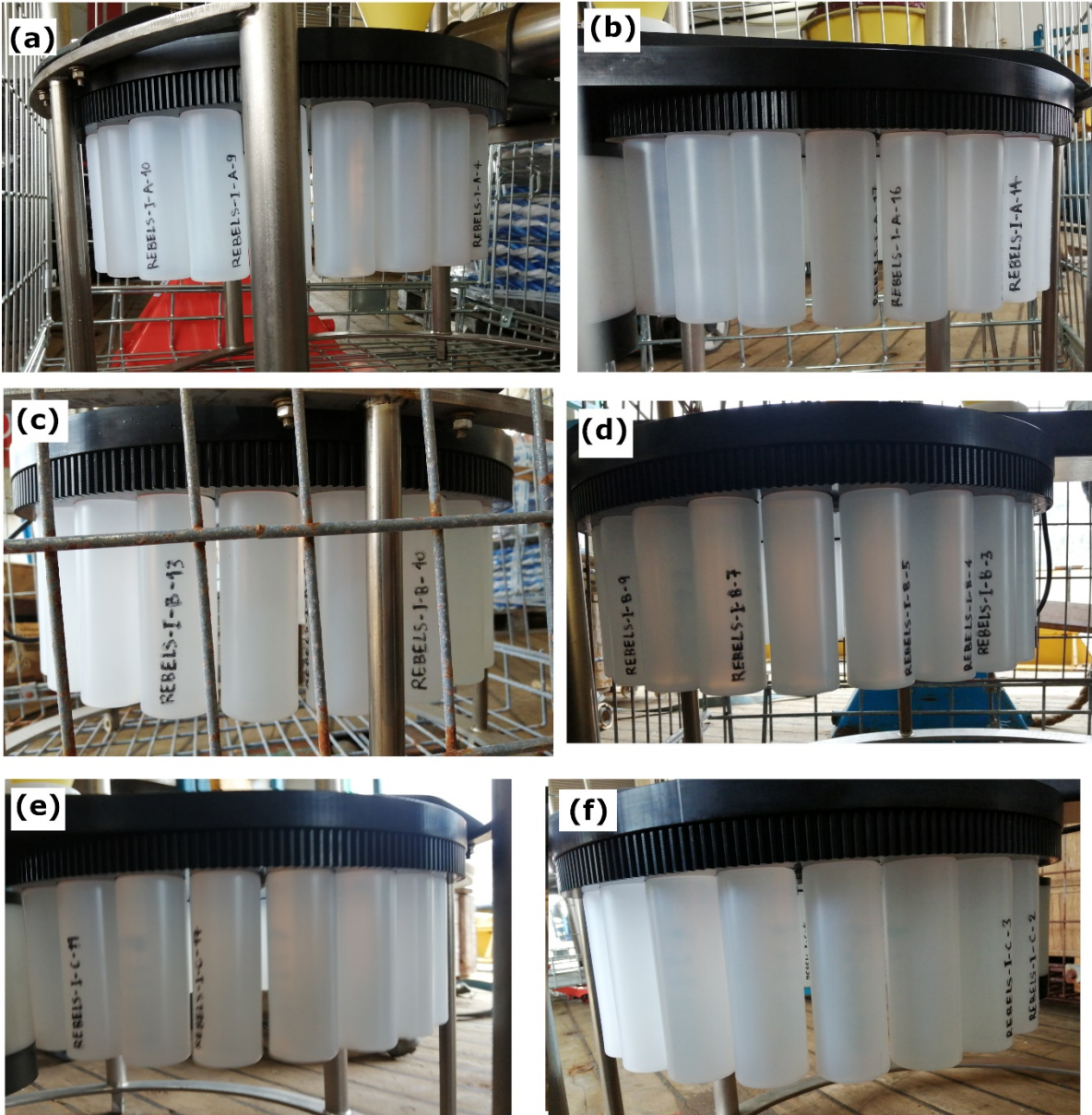


Figure 25: Sediment trap bottles as seen on 15 August on board of RRS James Cook for trap A (first row), trap B (second row) and trap C (third row).



Figure 26: Deployment of one of the three sediment traps on 21/08/2024 as part of the ReBELS mooring.

Programming logs

Sediment trap A

Press any key to pause/continue display, <X> to exit

```

08/17/2024 16:54:01 18.4 Vb 6°C 2°T 335°H aligned
08/17/2024 16:54:03 18.3 Vb 6°C 2°T 329°H aligned
08/17/2024 16:54:04 18.3 Vb 6°C 3°T 325°H aligned
08/17/2024 16:54:05 18.2 Vb 6°C 2°T 329°H aligned
08/17/2024 16:54:06 18.2 Vb 6°C 1°T 342°H aligned
08/17/2024 16:54:08 18.2 Vb 6°C 2°T 348°H aligned

```

McLane Research Laboratories, USA
 ParFlux 21-Cup Sediment Trap
 with Compass and Tilt
 Version: pst-21c4.c S/N: ML11262-09

```

????????????????????????????????????????????????????????
?      Main Menu      ?
????????????????????????????????????????????????????????c

```

Sat Aug 17 16:54:09 2024

- <1> Set Time <5> Create Schedule
- <2> Diagnostics <6> Deploy System
- <3> Fill Containers <7> Offload Data
- <4> Sleep <8> Contacting McLane

Selection ? 5

Existing deployment data file will be
erased. Continue (Yes/No) [N] ? y

Enter new deployment schedule (Yes/No) [N] ? y

Enter the number of events to program (0 to 22) ? 22

```
?????????????????????????????????????????????????????????
?  Schedule Menu  ?
????????????????????????????????????????????????????????c
```

- <1> Enter each event time
- <2> Enter start date & interval
- <3> Enter start date & end date
- <M> Main Menu

Selection ? 2

Enter START date and time [08/17/2024 16:54:43] ? 08 30 2024 00 00 00

Enter interval

- Days (0 to 365) ? 16
- Hours (0 to 23) ? 0
- Minutes (0 to 59) ? 0

Schedule Verification

- Event 1 of 22 = 08/30/2024 00:00:00
- Event 2 of 22 = 09/15/2024 00:00:00
- Event 3 of 22 = 10/01/2024 00:00:00
- Event 4 of 22 = 10/17/2024 00:00:00
- Event 5 of 22 = 11/02/2024 00:00:00
- Event 6 of 22 = 11/18/2024 00:00:00
- Event 7 of 22 = 12/04/2024 00:00:00
- Event 8 of 22 = 12/20/2024 00:00:00
- Event 9 of 22 = 01/05/2025 00:00:00
- Event 10 of 22 = 01/21/2025 00:00:00

Event 11 of 22 = 02/06/2025 00:00:00
Event 12 of 22 = 02/22/2025 00:00:00
Event 13 of 22 = 03/10/2025 00:00:00
Event 14 of 22 = 03/26/2025 00:00:00
Event 15 of 22 = 04/11/2025 00:00:00
Event 16 of 22 = 04/27/2025 00:00:00
Press any key to continue.
Event 17 of 22 = 05/13/2025 00:00:00
Event 18 of 22 = 05/29/2025 00:00:00
Event 19 of 22 = 06/14/2025 00:00:00
Event 20 of 22 = 06/30/2025 00:00:00
Event 21 of 22 = 07/16/2025 00:00:00
Event 22 of 22 = 08/01/2025 00:00:00

Modify an event (Yes/No) [N] ? n

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ParFlux 21-Cup Sediment Trap
with Compass and Tilt
Version: pst-21c4.c S/N: ML11262-09

??
[?] Main Menu [?]
??c
Sat Aug 17 16:55:01 2024

<1> Set Time <5> Create Schedule
<2> Diagnostics <6> Deploy System
<3> Fill Containers <7> Offload Data
<4> Sleep <8> Contacting McLane

Selection ? 6

Is the rotator aligned to the
open hole (Yes/No) [N] ? y

Clock reads 08/17/2024 16:55:16
Change time & date (Yes/No) [N] ? y

Enter date as MM DD YY HH MM SS
Enter year 2001 as 1, 01, 101, or 2001

Enter correct time [08/17/2024 16:55:53] ? 08 17 2024 17 00 00

Clock reads 08/17/2024 17:00:00
Change time & date (Yes/No) [N] ? n

Existing deployment data file will be
erased. Continue (Yes/No) [N] ? y

Enter new deployment schedule (Yes/No) [N] ? n

Schedule Verification

Event 1 of 22 = 08/30/2024 00:00:00
Event 2 of 22 = 09/15/2024 00:00:00
Event 3 of 22 = 10/01/2024 00:00:00
Event 4 of 22 = 10/17/2024 00:00:00
Event 5 of 22 = 11/02/2024 00:00:00
Event 6 of 22 = 11/18/2024 00:00:00
Event 7 of 22 = 12/04/2024 00:00:00
Event 8 of 22 = 12/20/2024 00:00:00
Event 9 of 22 = 01/05/2025 00:00:00
Event 10 of 22 = 01/21/2025 00:00:00
Event 11 of 22 = 02/06/2025 00:00:00
Event 12 of 22 = 02/22/2025 00:00:00
Event 13 of 22 = 03/10/2025 00:00:00
Event 14 of 22 = 03/26/2025 00:00:00
Event 15 of 22 = 04/11/2025 00:00:00
Event 16 of 22 = 04/27/2025 00:00:00
Press any key to continue.
Event 17 of 22 = 05/13/2025 00:00:00
Event 18 of 22 = 05/29/2025 00:00:00
Event 19 of 22 = 06/14/2025 00:00:00
Event 20 of 22 = 06/30/2025 00:00:00
Event 21 of 22 = 07/16/2025 00:00:00
Event 22 of 22 = 08/01/2025 00:00:00

Modify an event (Yes/No) [N] ? n
Current Header reads:

ReBELS I trap A

Do you want a different header (Yes/No) [N] ? n

Enter tilt sample interval [minutes] (49 to 1440) ? 1440

System status:

08/17/2024 17:00:29 18.5 Vb 6°C 3T 326H aligned

Caution: Deployment will overwrite the
EEPROM data backup cache.

Proceed with the deployment (Yes/No) [N] ? y

>>> Remove communication cable and <<<

>>> attach dummy plug. <<<

>>> Sediment trap is ready to deploy. <<<

<08/17/2024 17:00:38> Waiting for Event 01 of 22 @ 08/30/2024 00:00:00

<08/17/2024 17:00:39> Sleeping . . .

Sediment trap B

Enter <CTRL-C> now to wake up?

** Notice : An unexpected error occurred at **
08/17/2024 16:40:03

The system will now attempt to offload any
stored deployment data.

Press any key to continue.

??

Offload/Display Data File

??c

Sat Aug 17 16:42:09 2024

<1> Display data file

<2> Display backup EEPROM

<M> Main Menu

Selection ? M

<CTRL-C> now will re-start the system.

Once the system is restarted, all data
held in main memory is lost.

Clock reads 08/17/2024 16:42:22
Change time & date (Yes/No) [N] ? N

McLane Research Laboratories, USA
ParFlux 21-Cup Sediment Trap
Version: PST-21_3.c S/N: ML12168-03

??

[Main Menu]

??c

Sat Aug 17 16:42:42 2024

- <1> Set Time <5> Create Schedule
- <2> Diagnostics <6> Deploy System
- <3> Fill Containers <7> Offload Data
- <4> Sleep <8> Contacting McLane

Selection ? 2

Press any key to pause/continue display, <X> to exit

08/17/2024 16:43:00 19.8 Vb 6 [C aligned
08/17/2024 16:43:01 19.7 Vb 6 [C aligned
08/17/2024 16:43:02 19.7 Vb 6 [C aligned
08/17/2024 16:43:03 19.7 Vb 6 [C aligned
08/17/2024 16:43:04 19.7 Vb 6 [C aligned
08/17/2024 16:43:05 19.7 Vb 6 [C aligned
08/17/2024 16:43:06 19.7 Vb 6 [C aligned
08/17/2024 16:43:07 19.7 Vb 6 [C aligned

McLane Research Laboratories, USA
ParFlux 21-Cup Sediment Trap
Version: PST-21_3.c S/N: ML12168-03

??

[Main Menu]

??c

Sat Aug 17 16:43:08 2024

- <1> Set Time <5> Create Schedule
- <2> Diagnostics <6> Deploy System
- <3> Fill Containers <7> Offload Data
- <4> Sleep <8> Contacting McLane

Selection ? 5

Enter the number of events to program (0 to 22) ? 22

??

Schedule Menu

??c

- <1> Enter each event time
- <2> Enter start date & interval
- <3> Enter start date & end date
- <M> Main Menu

Selection ? 2

Enter START date and time [08/17/2024 16:46:00] ? 08 30 2024 00 00 00

Enter interval

- Days (0 to 365) ? 16
- Hours (0 to 23) ? 0
- Minutes (0 to 59) ? 0

Schedule Verification

- Event 1 of 22 = 08/30/2024 00:00:00
- Event 2 of 22 = 09/15/2024 00:00:00
- Event 3 of 22 = 10/01/2024 00:00:00
- Event 4 of 22 = 10/17/2024 00:00:00
- Event 5 of 22 = 11/02/2024 00:00:00
- Event 6 of 22 = 11/18/2024 00:00:00
- Event 7 of 22 = 12/04/2024 00:00:00
- Event 8 of 22 = 12/20/2024 00:00:00
- Event 9 of 22 = 01/05/2025 00:00:00
- Event 10 of 22 = 01/21/2025 00:00:00
- Event 11 of 22 = 02/06/2025 00:00:00
- Event 12 of 22 = 02/22/2025 00:00:00
- Event 13 of 22 = 03/10/2025 00:00:00
- Event 14 of 22 = 03/26/2025 00:00:00
- Event 15 of 22 = 04/11/2025 00:00:00
- Event 16 of 22 = 04/27/2025 00:00:00
- Press any key to continue.
- Event 17 of 22 = 05/13/2025 00:00:00
- Event 18 of 22 = 05/29/2025 00:00:00
- Event 19 of 22 = 06/14/2025 00:00:00
- Event 20 of 22 = 06/30/2025 00:00:00
- Event 21 of 22 = 07/16/2025 00:00:00
- Event 22 of 22 = 08/01/2025 00:00:00

Modify an event (Yes/No) [N] ? n

McLane Research Laboratories, USA
ParFlux 21-Cup Sediment Trap
Version: PST-21_3.c S/N: ML12168-03

??

␣ Main Menu ␣

??c

Sat Aug 17 16:46:45 2024

- <1> Set Time <5> Create Schedule
- <2> Diagnostics <6> Deploy System
- <3> Fill Containers <7> Offload Data
- <4> Sleep <8> Contacting McLane

Selection ? 6

Is the rotator aligned to the
open hole (Yes/No) [N] ? y

Clock reads 08/17/2024 16:46:58
Change time & date (Yes/No) [N] ? n

Existing deployment data file will be
erased. Continue (Yes/No) [N] ? y

Enter new deployment schedule (Yes/No) [N] ? n

Schedule Verification

- Event 1 of 22 = 08/30/2024 00:00:00
- Event 2 of 22 = 09/15/2024 00:00:00
- Event 3 of 22 = 10/01/2024 00:00:00
- Event 4 of 22 = 10/17/2024 00:00:00
- Event 5 of 22 = 11/02/2024 00:00:00
- Event 6 of 22 = 11/18/2024 00:00:00
- Event 7 of 22 = 12/04/2024 00:00:00
- Event 8 of 22 = 12/20/2024 00:00:00
- Event 9 of 22 = 01/05/2025 00:00:00
- Event 10 of 22 = 01/21/2025 00:00:00
- Event 11 of 22 = 02/06/2025 00:00:00
- Event 12 of 22 = 02/22/2025 00:00:00
- Event 13 of 22 = 03/10/2025 00:00:00

Event 14 of 22 = 03/26/2025 00:00:00
Event 15 of 22 = 04/11/2025 00:00:00
Event 16 of 22 = 04/27/2025 00:00:00
Press any key to continue.
Event 17 of 22 = 05/13/2025 00:00:00
Event 18 of 22 = 05/29/2025 00:00:00
Event 19 of 22 = 06/14/2025 00:00:00
Event 20 of 22 = 06/30/2025 00:00:00
Event 21 of 22 = 07/16/2025 00:00:00
Event 22 of 22 = 08/01/2025 00:00:00

Modify an event (Yes/No) [N] ? n
Current Header reads:

Do you want a different header (Yes/No) [N] ? y
Enter new header (three lines, 80 characters/line)

> ReBELS I trap B
>
>

Current Header reads:

ReBELS I trap B

Do you want a different header (Yes/No) [N] ? n

System status:

08/17/2024 16:47:51 19.9 Vb 7°C aligned

Caution: Deployment will overwrite the
EEPROM data backup cache.

Proceed with the deployment (Yes/No) [N] ? y

>>> Remove communication cable and <<<
>>> attach dummy plug. <<<
>>> Sediment trap is ready to deploy. <<<

<08/17/2024 16:47:56> Waiting for Event 01 of 22 @ 08/30/2024 00:00:00

08/17/2024 16:47:57 Sleeping . . .

Sediment trap C

Enter <CTRL-C> now to wake up???

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ParFlux 21-Cup Sediment Trap
with Compass and Tilt
Version: pst-21c4.c S/N: ML11262-10

??
? Main Menu ?
??c
Sat Aug 17 17:03:06 2024

- <1> Set Time <5> Create Schedule
- <2> Diagnostics <6> Deploy System
- <3> Fill Containers <7> Offload Data
- <4> Sleep <8> Contacting McLane

Selection ? 2

Press any key to pause/continue display, <X> to exit

08/17/2024 17:03:16 18.5 Vb 6°C 4°T 7°H aligned
08/17/2024 17:03:17 18.5 Vb 6°C 3°T 352°H aligned
08/17/2024 17:03:18 18.5 Vb 6°C 3°T 338°H aligned
08/17/2024 17:03:20 18.5 Vb 6°C 3°T 344°H aligned
08/17/2024 17:03:21 18.5 Vb 6°C 4°T 353°H aligned

McLane Research Laboratories, USA
ParFlux 21-Cup Sediment Trap
with Compass and Tilt
Version: pst-21c4.c S/N: ML11262-10

??
? Main Menu ?
??c
Sat Aug 17 17:03:22 2024

- <1> Set Time <5> Create Schedule
- <2> Diagnostics <6> Deploy System
- <3> Fill Containers <7> Offload Data
- <4> Sleep <8> Contacting McLane

Selection ? 5

Existing deployment data file will be
erased. Continue (Yes/No) [N] ? y

Enter new deployment schedule (Yes/No) [N] ? y

Enter the number of events to program (0 to 22) ? 22

```
?????????????????????????????????????????????????????????c
?  Schedule Menu  ?
?????????????????????????????????????????????????????????c
```

- <1> Enter each event time
- <2> Enter start date & interval
- <3> Enter start date & end date
- <M> Main Menu

Selection ? 2

Enter START date and time [08/17/2024 17:03:44] ? 08 30 2024

Invalid entry. Unrecognized delimiters
or incorrect number of input arguments.
Please check entry and try again.

Enter START date and time [08/17/2024 17:03:44] ? 08 30 2024 00 00 00

Enter interval

Days (0 to 365) ? 16
 Hours (0 to 23) ? 0
 Minutes (0 to 59) ? 0

Schedule Verification

- Event 1 of 22 = 08/30/2024 00:00:00
- Event 2 of 22 = 09/15/2024 00:00:00
- Event 3 of 22 = 10/01/2024 00:00:00
- Event 4 of 22 = 10/17/2024 00:00:00
- Event 5 of 22 = 11/02/2024 00:00:00
- Event 6 of 22 = 11/18/2024 00:00:00
- Event 7 of 22 = 12/04/2024 00:00:00
- Event 8 of 22 = 12/20/2024 00:00:00
- Event 9 of 22 = 01/05/2025 00:00:00
- Event 10 of 22 = 01/21/2025 00:00:00
- Event 11 of 22 = 02/06/2025 00:00:00
- Event 12 of 22 = 02/22/2025 00:00:00
- Event 13 of 22 = 03/10/2025 00:00:00

Event 14 of 22 = 03/26/2025 00:00:00
Event 15 of 22 = 04/11/2025 00:00:00
Event 16 of 22 = 04/27/2025 00:00:00
Press any key to continue.
Event 17 of 22 = 05/13/2025 00:00:00
Event 18 of 22 = 05/29/2025 00:00:00
Event 19 of 22 = 06/14/2025 00:00:00
Event 20 of 22 = 06/30/2025 00:00:00
Event 21 of 22 = 07/16/2025 00:00:00
Event 22 of 22 = 08/01/2025 00:00:00

Modify an event (Yes/No) [N] ? n

McLane Research Laboratories, USA
ParFlux 21-Cup Sediment Trap
with Compass and Tilt
Version: pst-21c4.c S/N: ML11262-10

??

[?] Main Menu [?]

??c

Sat Aug 17 17:04:13 2024

- <1> Set Time <5> Create Schedule
- <2> Diagnostics <6> Deploy System
- <3> Fill Containers <7> Offload Data
- <4> Sleep <8> Contacting McLane

Selection ? 1

Clock reads 08/17/2024 17:04:38
Change time & date (Yes/No) [N] ? y

Enter date as MM DD YY HH MM SS
Enter year 2001 as 1, 01, 101, or 2001

Enter correct time [08/17/2024 17:04:42] ? 08 17 2024 17 08 00

Clock reads 08/17/2024 17:08:00
Change time & date (Yes/No) [N] ? n

McLane Research Laboratories, USA
ParFlux 21-Cup Sediment Trap
with Compass and Tilt
Version: pst-21c4.c S/N: ML11262-10

??

Main Menu

??c

Sat Aug 17 17:08:02 2024

- <1> Set Time <5> Create Schedule
- <2> Diagnostics <6> Deploy System
- <3> Fill Containers <7> Offload Data
- <4> Sleep <8> Contacting McLane

Selection ? 6

Is the rotator aligned to the open hole (Yes/No) [N] ? y

Clock reads 08/17/2024 17:08:10
Change time & date (Yes/No) [N] ? n

Existing deployment data file will be erased. Continue (Yes/No) [N] ? y

Enter new deployment schedule (Yes/No) [N] ? n

Schedule Verification

- Event 1 of 22 = 08/30/2024 00:00:00
- Event 2 of 22 = 09/15/2024 00:00:00
- Event 3 of 22 = 10/01/2024 00:00:00
- Event 4 of 22 = 10/17/2024 00:00:00
- Event 5 of 22 = 11/02/2024 00:00:00
- Event 6 of 22 = 11/18/2024 00:00:00
- Event 7 of 22 = 12/04/2024 00:00:00
- Event 8 of 22 = 12/20/2024 00:00:00
- Event 9 of 22 = 01/05/2025 00:00:00
- Event 10 of 22 = 01/21/2025 00:00:00
- Event 11 of 22 = 02/06/2025 00:00:00
- Event 12 of 22 = 02/22/2025 00:00:00
- Event 13 of 22 = 03/10/2025 00:00:00
- Event 14 of 22 = 03/26/2025 00:00:00
- Event 15 of 22 = 04/11/2025 00:00:00
- Event 16 of 22 = 04/27/2025 00:00:00
- Press any key to continue.
- Event 17 of 22 = 05/13/2025 00:00:00
- Event 18 of 22 = 05/29/2025 00:00:00
- Event 19 of 22 = 06/14/2025 00:00:00
- Event 20 of 22 = 06/30/2025 00:00:00

Event 21 of 22 = 07/16/2025 00:00:00

Event 22 of 22 = 08/01/2025 00:00:00

Modify an event (Yes/No) [N] ? n

Current Header reads:

ReBELS I trap C

Do you want a different header (Yes/No) [N] ? n

Enter tilt sample interval [minutes] (49 to 1440) ? 1440

System status:

08/17/2024 17:08:40 18.8 Vb 6°C 4T 328H aligned

Caution: Deployment will overwrite the
EEPROM data backup cache.

Proceed with the deployment (Yes/No) [N] ? y

>>> Remove communication cable and <<<

>>> attach dummy plug. <<<

>>> Sediment trap is ready to deploy. <<<

<08/17/2024 17:08:45> Waiting for Event 01 of 22 @ 08/30/2024 00:00:00

<08/17/2024 17:08:47> Sleeping . . .

Biogeochemical (BGC-) Argo Floats

Personnel in the field: Filipa Carvalho, Hans Hilder (NOC)

Ground Support: Darren Rayner, Nathan Briggs (NOC)

Mission description and objectives

Two Floats were deployed during JC268. One was a standard 6-parameter BGC-Argo float, a contribution from the UK to the BGC-Argo Network. A second float was also deployed as part of the ReBELS project. This float is a custom float with only a subset of BGC parameters, but is equipped with 3 specialty sensors not commonly found in the BGC-Argo floats: a transmissometer, a UPV6 and a hyperspectral radiometer. This float will be providing the semi-lagrangian framework for when the gliders are deployed in late March and will join the current assets deployed on JC268.

Determining the deployment location

Ideally, the two deployed floats would be retained within the Labrador Sea between the two fieldwork cruises, maximising their contribution to the objectives of ReBELS. Two different approaches were used to decide on the best deployment location to realise this goal. One method was based on analysis of historical float trajectories, the other based on simulated float trajectories using the VirtualFleet python package. The results from both were compared to choose the final float deployment location.

Historical float trajectories – MATLAB Analysis

Historical trajectory analysis was carried out in MATLAB R2024a. The location and time of all ARGO float profiles between January 2024 and January 1997 (<http://www.argodatamgt.org/Access-to-data>) and within 70°W – 30°W and 40°N – 70°N were isolated. The region surrounding the Labrador Sea was gridded in ½° bins centred on .0° and .5° points, hereafter grid cells.

The permissible deployment area was sectioned into grid cells. These became possible deployment cells, e.g. red box (Figure 1). For each deployment cell, any floats that recorded a profile within the deployment cell were identified. Starting with the earliest profile in each deployment cell, the location of each subsequent profile was recorded for 365 days. Each profile, from every float, was summed to a ½° grid. The result being a set of 44 (the number of deployment cells within the permissible deployment zone) ½° grids of summed float profiles. Finally, with these 44 grids, the float retention was assessed by taking the percentage of total profiles for a given deployment cell that were contained within the Labrador Sea region.

The sensitivity of each deployment point was calculated by repeating the above for each deployment cell but shifting this cell ¼° in each cardinal direction (Figure 2). This gives 9 sets of deployment grids for each deployment cell, each with their own retention values. The error for each deployment cell is then calculated as the standard deviation of the retention percentages for these 9 grids, e.g. that shown at the top of

87.7±4.5% of profiles in Labrador Sea
Total Number of Profiles 2340 | Total Number of Floats 54

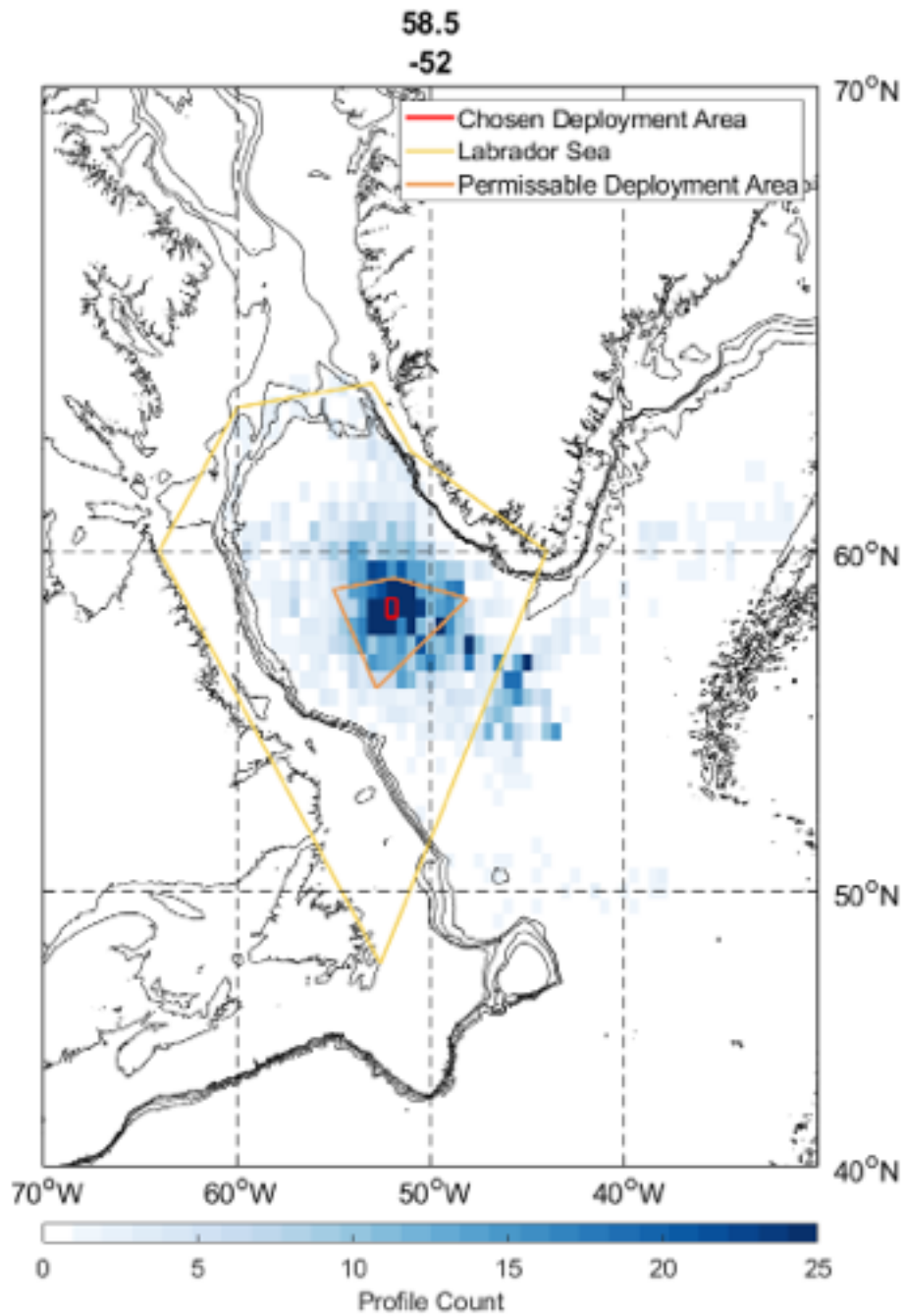


Figure 27. Based on the above analysis, the $\frac{1}{2}^\circ$ region surrounding 58.5°N and 52°W was identified as the best candidate for float deployment.

87.7±4.5% of profiles in Labrador Sea
Total Number of Profiles 2340 | Total Number of Floats 54

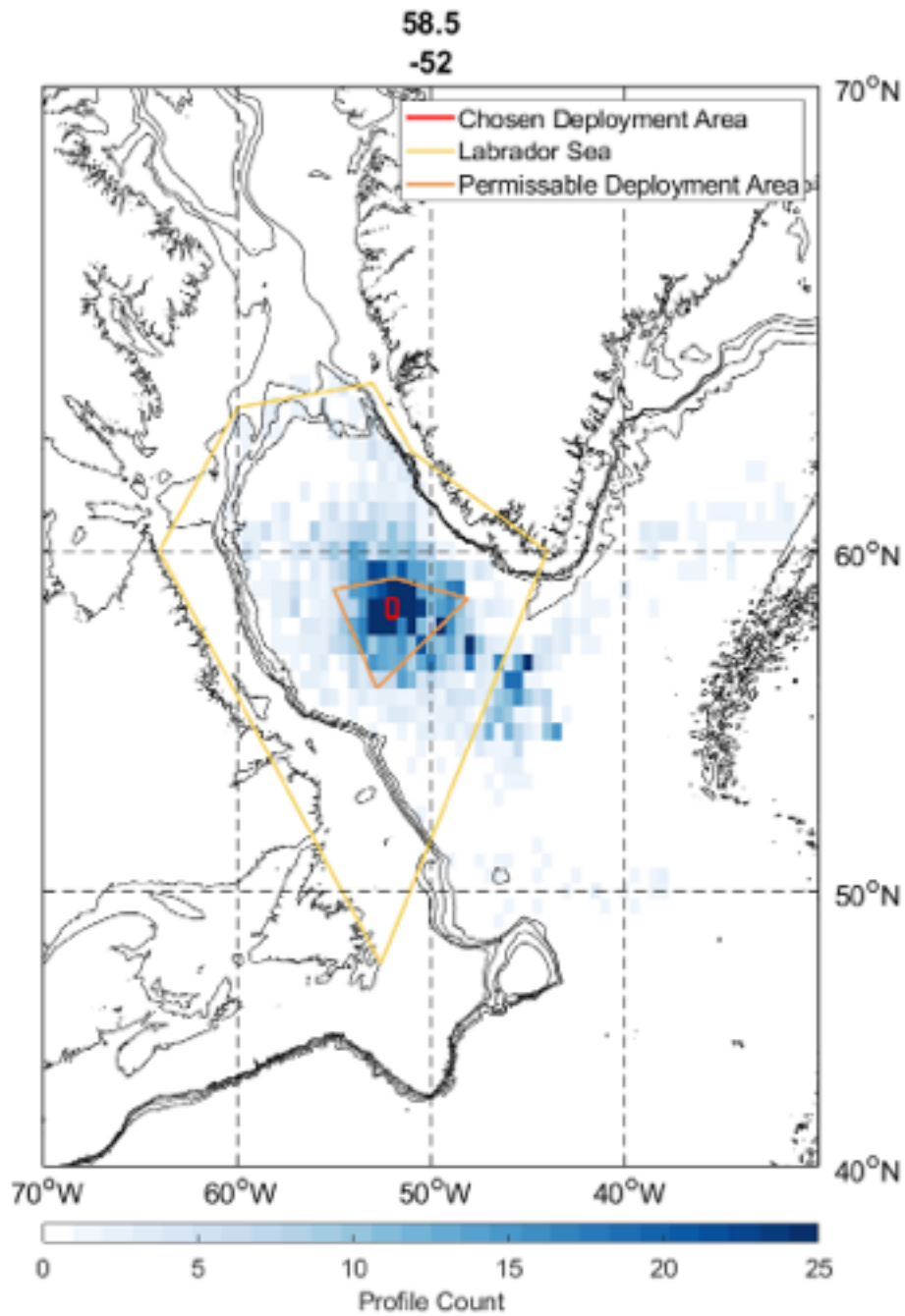


Figure 27: Heat map of profile counts in $\frac{1}{2}^\circ$ grid cells from historical float trajectories, based on the cumulative counting of float profiles since the earliest profile within $\frac{1}{2}^\circ$ of 58.5°N and 52°W (Red box). Yellow and green polygons denote Labrador Sea and permissible float deployment area for JC268 respectively.

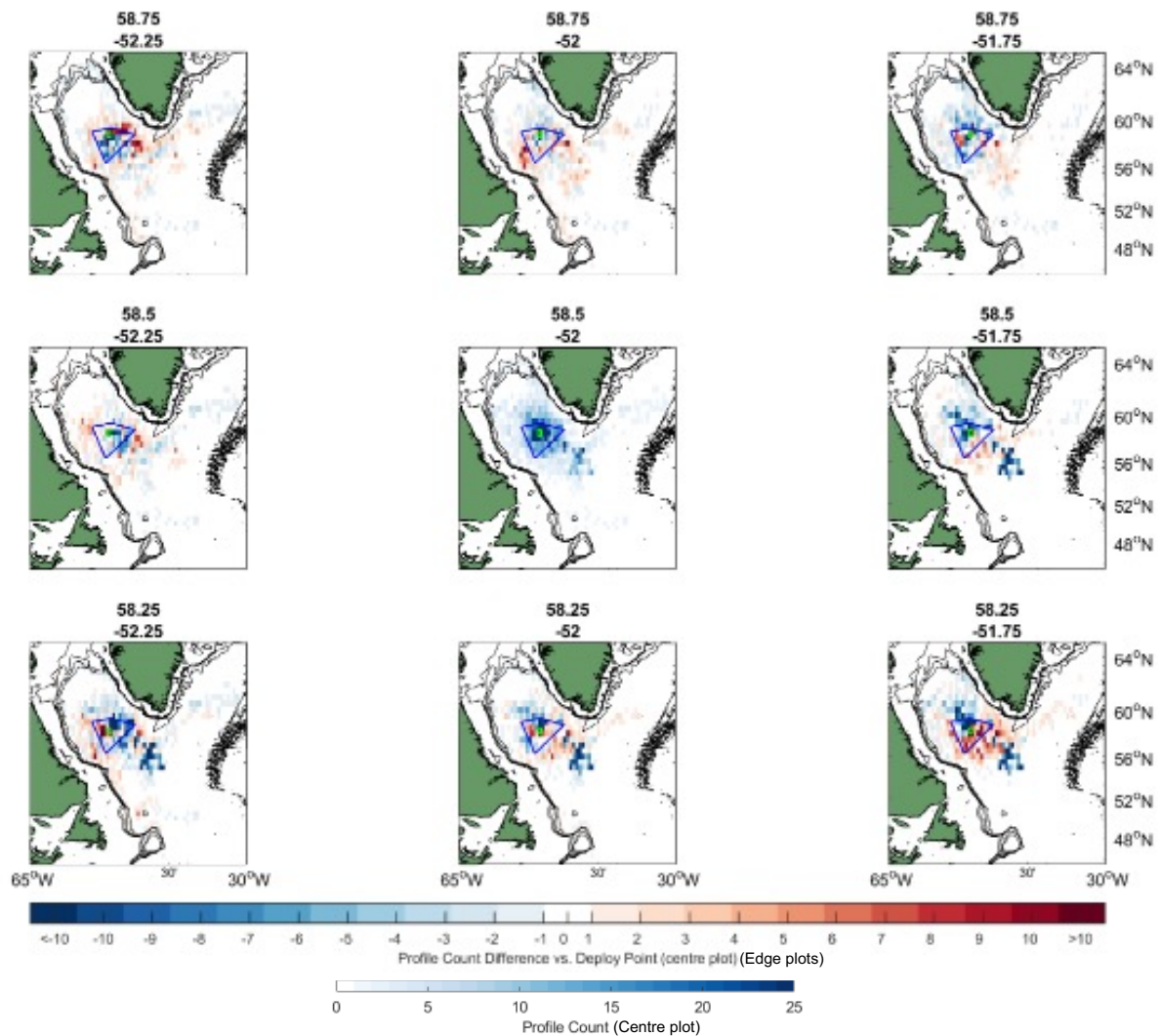


Figure 28: Difference between cumulative float profile counts, starting in the $\frac{1}{2}^\circ$ grid cell centred at 58.5°N and 52°W , and then shifted in each cardinal direction by $\frac{1}{4}^\circ$ (e.g. top left corresponds to a $\frac{1}{4}^\circ$ shift to the northwest). Yellow rectangles indicate deployment cell, blue polygon denotes permissible float deployment area. Top colour bar is for edge plots and shows profile count difference vs. centre plot, bottom colour bar is for centre plot and shows total profile counts for each grid cell

Simulated float trajectories – VirtualFleet Python toolbox

To supplement the historical analysis, the ARGO VirtualFleet Python toolbox¹ was used. This toolbox implements the Parcels² lagrangian ocean analysis toolbox to simulate the deployment of an ARGO float as a particle within a modifiable ocean current field.

For the current field data, we used daily data from the Copernicus Global Ocean Physics Analysis and Forecast³. Two years of data, starting on 10/08/2022 until 10/08/2024, were used. The model was run on each full year of current data, i.e. 2022-2023 and 2023-2024

¹ Maze, G., & Balem, K. (2024). VirtualFleet (v0.4.0). Zenodo. <https://doi.org/10.5281/zenodo.10608991>

² Van Sebille, E., Kehl, C., Lange, M., Delandmeter, P., & The Parcels contributors. (2025). Parcels (v3.1.2). Zenodo. <https://doi.org/10.5281/zenodo.14845686>

³ <https://doi.org/10.48670/moi-00016>

and initialised with 100,000 floats evenly distributed within the permissible deployment region (Figure 29, green box). The virtual floats were configured to profile to a max of 1000 m, have a 36 hour cycle duration, and life expectancy of 365 days. The model simulated at 120 minute time steps, outputting float coordinates every 12 hours, for 365 days. Importantly, two separate runs for each year were carried out, with the float parking depth changed between 500 m and 1000 m. This resulted in 4 simulated outputs.

The output results were gridded to the same ½° grid cells as the MATLAB analysis. The irregular shape of the permissible deployment area results in grid cells on the edge of the area having less total deployments (Table 13). Given the vastly increased number of float profiles for each deployment cell, rather than calculate retention based on the number of profiles, the float endpoint was used. Retention was calculated as the ‘total endpoints in the Labrador Sea’/‘total deployments’ for each deployment cell.

Table 13: Example results from the VirtualFleet float deployment simulation. Shown are results for the most retentive release point (based on mean of all simulations), and the release point chosen based the MATLAB analysis.

Grid cell centre point	Mean retention	Total deployments	Current data, drift depth	Retention (%)	Retained Floats
58.00°N 51.50°W	74.6%	905	2022-2023, 1000m	84.3	763
			2023-2024, 1000m	66.4	601
			2022-2023, 500m	81.8	740
			2023-2024, 500m	65.9	596
58.50°N 52.00°W	64.4%	4404	2022-2023, 1000m	72.8	3204
			2023-2024, 1000m	60.6	2669
			2022-2023, 500m	66.1	2913
			2023-2024, 500m	55	2553

Clear difference in retention was shown across the year-to-year currents and differing drift depths.

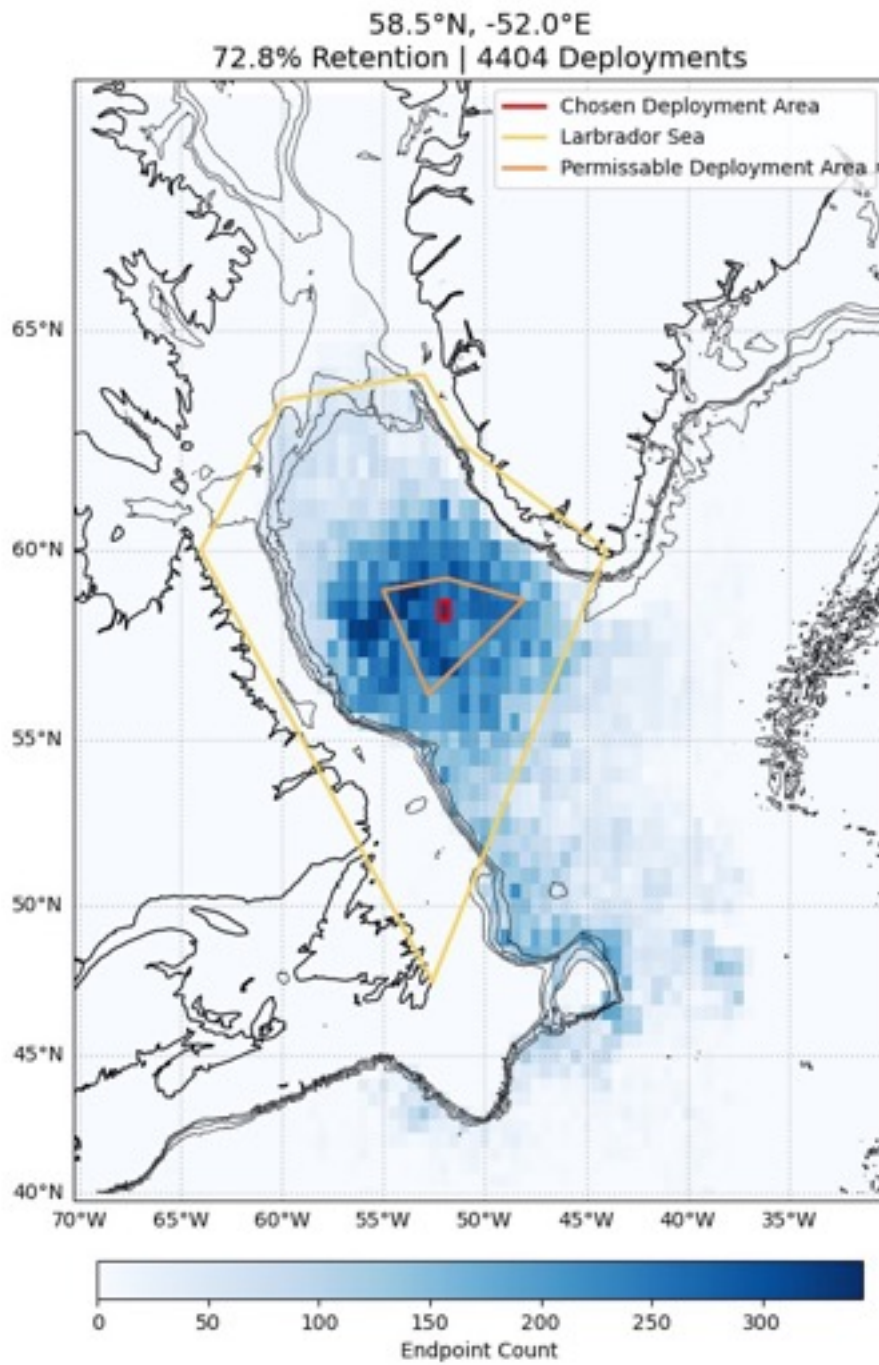


Figure 29: Simulation results of float endpoints binned to $\frac{1}{2}^\circ$ grid cells after release from the $\frac{1}{2}^\circ$ area centred on $58.50^\circ\text{N} - 52.00^\circ\text{E}$ (Red Box). Yellow and green polygons denote Labrador Sea and permissible float deployment area for JC268 respectively. This particular run was based on 2022-2023 current data, with a float drift depth of 1000 m.

Float sensor packages

The following tables summarise the serial numbers, last calibration date, measured variables and additional notes for each sensor on each float.

Table 14: Sensor package details, including serial numbers, last calibration date, measured variables and additional notes for each sensor on each float

	ReBELS float	UK-ASBAN Float
Model	PROVOR CTS5 USEA	PROVOR CTS5 USEA
SN	P53877-24UK001 (nocuse012)	P53851-23UK003 (nocuse003)
CTD (Conductivity, Temperature, Depth)	model S/N:	model S/N:
Bio-optics (chlorophyll fluorescence, optical backscatter, FDOM)	ECO Triplet FLBBCDRT2K S/N: FLBBCDRT2K-8453	ECO Triplet FLBBCDRT2K S/N: FLBBCDRT2K-8613
Dissolved oxygen	Aanderaa 4330 S/N:	Aanderaa 4330 S/N: 4269
Downwelling Irradiance	Hyperspectral irradiance TRIOS RAMSES SAM G2 ACC VIS S/N: 0160005B	Multispectral irradiance (380 nm, 412 nm, 490 nm, PAR) OCR504 ICSW S/N:OCR504ICSW-2362
Beam attenuation/ 'optical sediment trap'	model S/N:	N/A
Particle size/class	Hydroptic UVP6_LP S/N: 000226	N/A
Nitrate oxygen	N/A	SUNA 2000m S/N: NTR-2213
pH	N/A	model S/N:

Deployment details

Two floats were deployed on JC268, a BCG-float that was acquired on the project ('ReBELS float') and a standard UK-ASBAN BGC-Argo float. Floats were deployed August 24th, 2024 (Table 15). A couple hours ahead of the deployment both were taken from their boxes and attached upright onto the Romica winch cage.

Table 15: Glider deployment characteristics.

Float	ReBELS float	UK-ASBAN Float
Date	28/05/2024	28/05/2024
Time	15:43 UTC	17:00 UTC
Lat	59.93475 N	59.94676 N
Lon	23.9597 W	23.9674 W
Event number	040	041

Post-deployment calibration and validation

After deploying the 2 floats, A CTD cast was conducted, followed by a set of Marine snow catchers and a Red Camera Frame profile.

Table 16: Detail of the calibration and validation activities after the floats were deployed

	CTD	MSC	RCF
Date	24/08/2024	24/08/2024	24/08/2024
Time	13:21	14:47, 14:59	15:47
Latitude	58.4997	58.4997	58.4997
Longitude	-52.0065	-52.0065	-52.0065
Event number	39	40-41	42
cast	CTD007	MSC12-13	RCF05
Max depths	1000 m	50, 140 m	600 m

The profiling cycle the float is scheduled to do until the mixed layer deepens to >250m is shown on Figure 30:

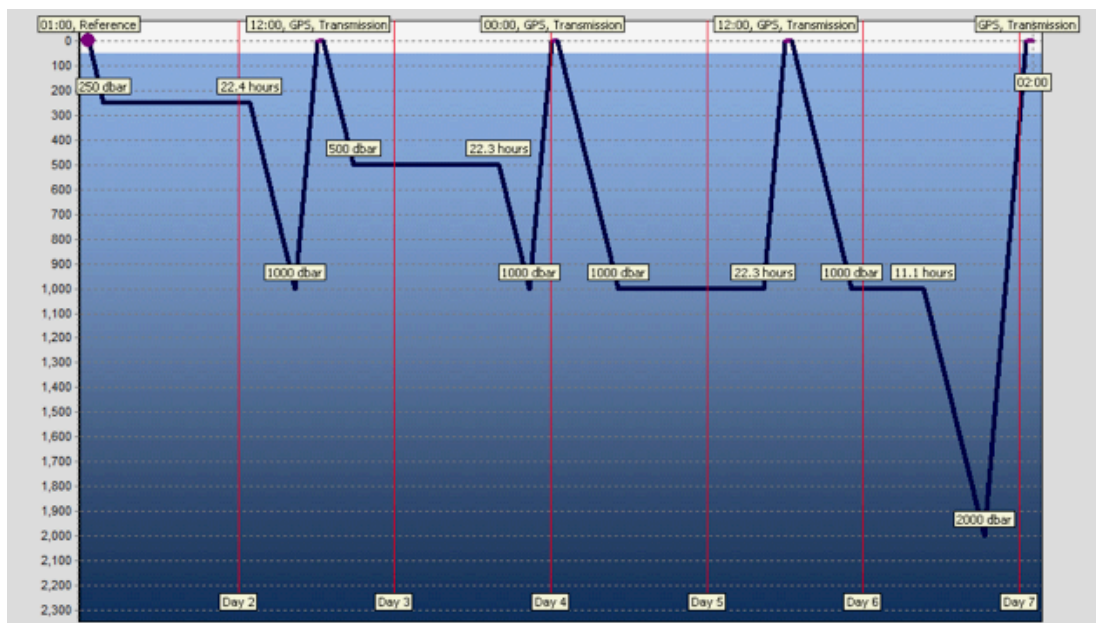


Figure 30: Float cycle composed of 4 different profiles, with increasing parking depths (250, 500 and 1000m)

Preliminary NRT Data (uncalibrated)

Float NRT location and collected data is publicly available via our partners site: <http://oao2022.imev-mer.fr/bioargo/nocuse012b/nocuse012b.html>. At the end of the cruise, the float had conducted a full cycle.

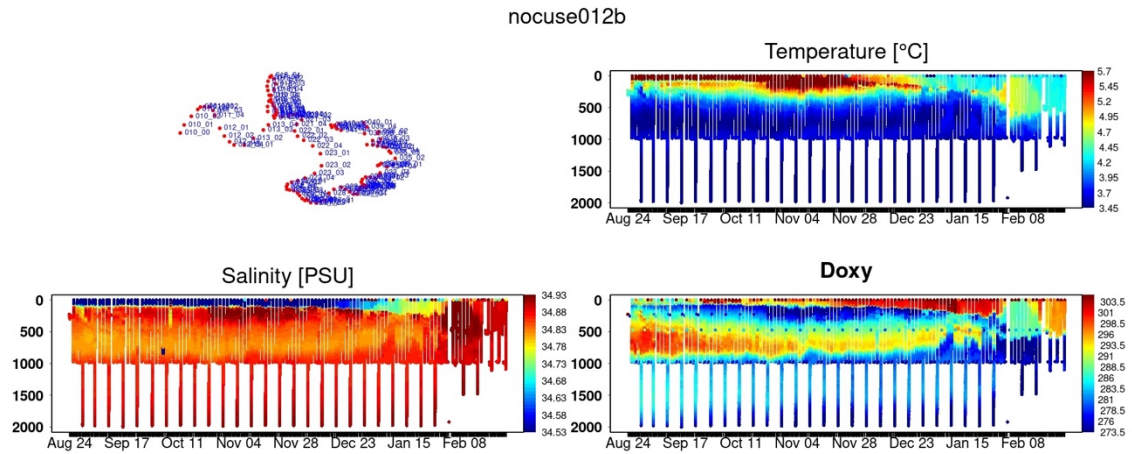


Figure 31: GPS locations of float surfacings (top left). Cross-section of Temperature (top right), Salinity (bottom left) and Dissolved oxygen (bottom right) collected by the float from deployment until February 27th 2025.

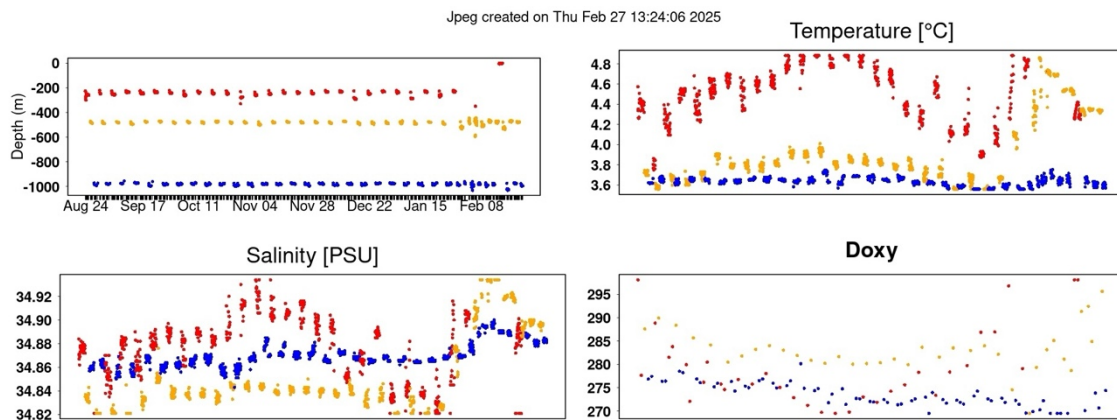


Figure 32: Data collected from the transmissometer during the drifts while the float was parked at depth for a certain period in between profiles.

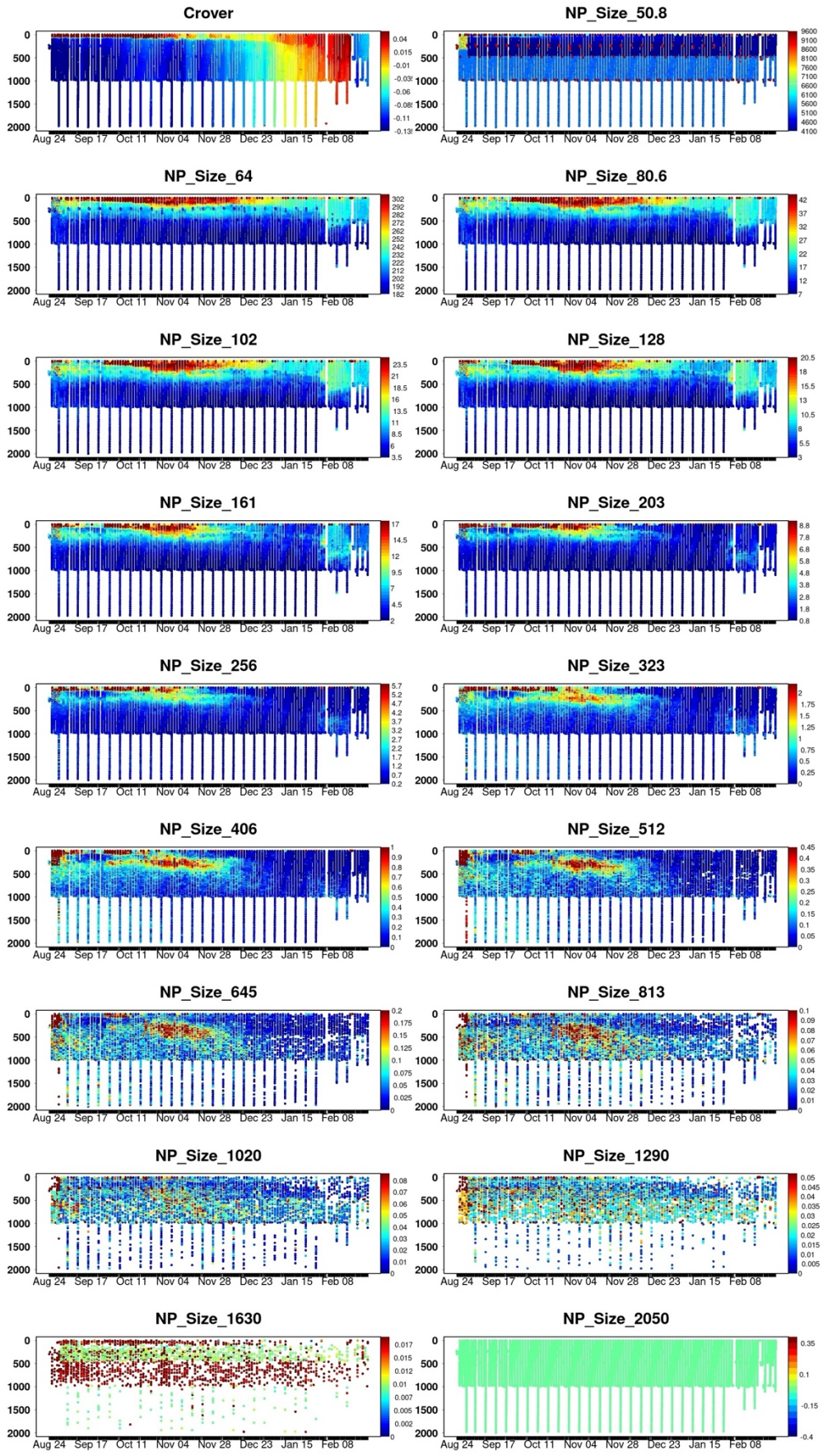


Figure 33: Transmissometer data (top left) and particle size data from the UVP6 for 17 size classes

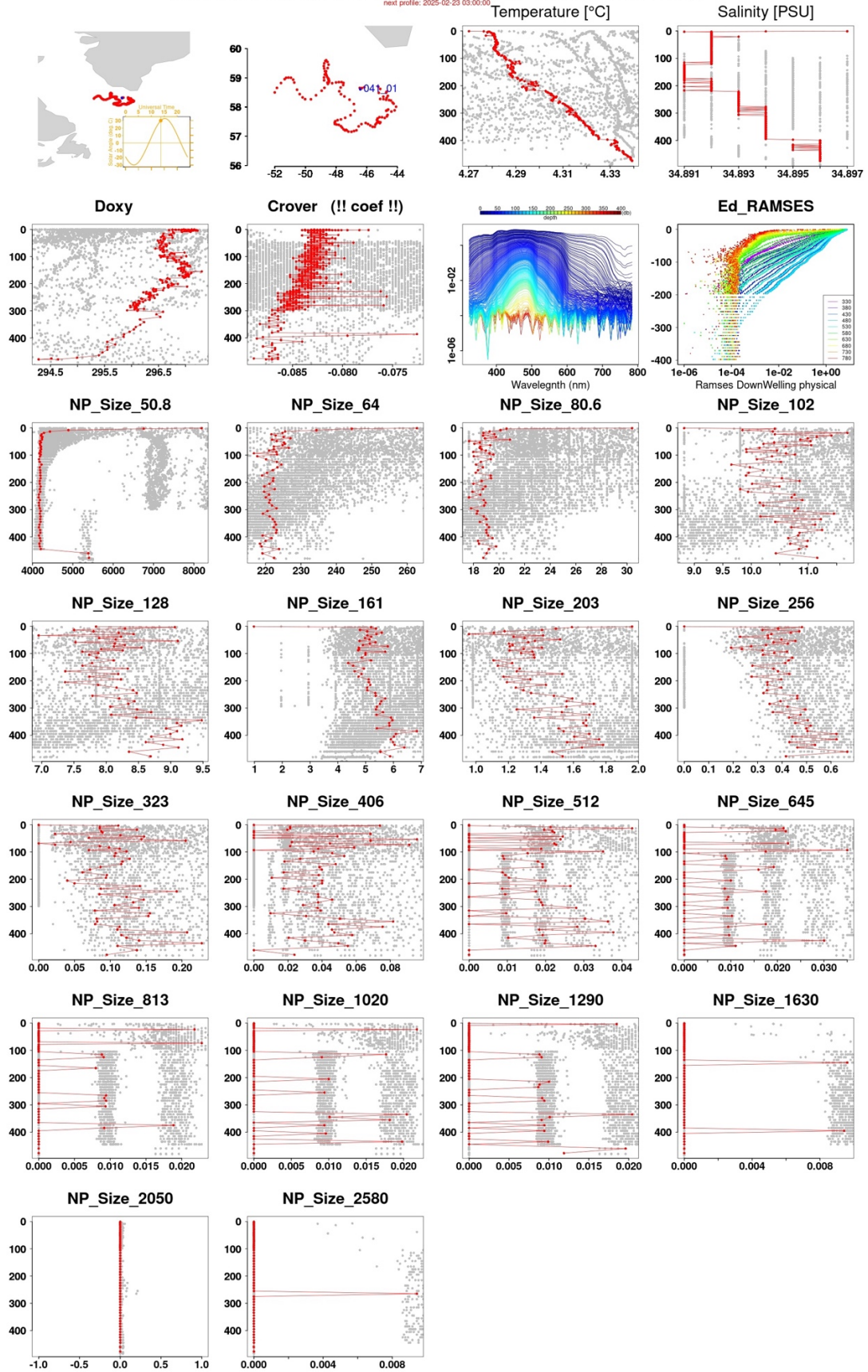


Figure 34: Example of data collected on the 21st February 2025

Particle size distributions from the Red Camera Frame (RCF)

Personnel in the field: Will Major and Hans Hilder, National Oceanography Centre.

Objectives

Particle size, shape and type are key controls on downward carbon transport through the mesopelagic. We aimed to use particle imaging with the Red Camera Frame (RCF) to investigate the impact of particle dynamics and size distributions on carbon export depth. Particle parameters will be used in conjunction with turbulence and POC flux measurements to better understand particle aggregation, fragmentation, and depth of organic carbon remineralisation.

Methods

The RCF housed six devices for the duration of the cruise: Underwater Vision Profiler 5 (UVP5), LISST-Holo2, Continuous Particle Imaging and Classification System (CPICS), ECOTriplet, RBR Concerto and CamHUB. Data from simultaneous deployments of these devices intercalibrated together provide particle information on the entire size spectrum of marine particles. We collected data across 7 deployments of the RCF. The target depth was 600 metres adjudged by winch wire payout, however, currents in the Labrador Sea meant that the ship's wire was often at an angle likely leading to the target depth not being reached. Due to the depth limitations of the RBR Concerto and LISST-Holo2, wire payout did not exceed 600 metres.

Sensors

UVP5

Underwater Video Profiler 5 (UVP5, Hydroptic); Pressure rated to 3000m, continuously records images in the sample volume (field view of 22 x 18 cm). All images are recorded in the internal memory. Fully charged internal battery lasts up to 7 hours in recording mode. The system automatically detects particles in focus, crop the in-focus particles (vignettes) and saves the vignettes. UVP5 took images successfully across 6 profiles. Data were not collected for on profile due to memory on the camera was full. This prompted a change in the settings where the UVP5 now switches off before it comes out of the water at 1 metre depth.

LISST-Holo2

LISST-Holo2 (Sequoia Scientific, Inc.) is a standalone instrument carrying an internal battery that lasts up to 20 hours, however, the internal battery was not working. LISST-Holo2 was powered by its external battery for the duration of the cruise. Holographic images of particles that go through its sample volume (1.86 cm³) were taken at 10 Hz and saved in the internal memory. Each hologram is 1600 x 1200 pixel with 4.5 µm and we can resolve particles larger than 25 µm. Sampling started when LISST-Holo2 was below 5 m (the device has a pressure gauge) and sampling was manually stopped when RCF was recovered on the deck. We used the default setting for image names such as 000-0001 – using timestamps is not possible because the DateTime on LISST-Holo2 resets with each power cycle. Each

deployment captured ~22,000 holograms. We transferred holograms after each deployment to clear the internal memory for next deployment.

CPICS

Continuous Plankton Imaging and Classification (Coastal Ocean Vision) continuously record images in the sample volume (330 mm³ with field view of 15 x 11 mm). It automatically detects particles in focus, crop the in-focus particles (region of interest, ROI) and save the cropped images. Start and end of recording was controlled by the UI (CPICS viewer) that requires communication between CPICS and laptop via ethernet cable before and after deployment.

ECOTRIPLET3

The 1000-m rated standalone Wetlabs Environmental Characterization Optics (ECO) Triplet Fluorometer and Backscattering Sensor measures backscatter at 2 wavelengths (532nm and 700 nm) along with fluorescence. This instrument does not have a pressure sensor. Data transfer and battery Data transfer was carried out via the CamHUB system. Batteries were replaced with new before the cruise and no replacement was required during the cruise.

RBR concerto

RBR concerto measures multiple biological and physical variables (pressure, temperature, conductivity, turbidity and fluorescence). Since CPICS and ECOTRIPLET do not have pressure sensors, measurements of pressure by RBR concerto important. Data is downloaded via the HUB.

Deployments

All devices are powered on prior to connecting to the ship's wire. The power cycle of UVP5 is triggered by pressure and so the RCF is dipped to 20 metres for 90 seconds, before RCF is brought to 3 metres depth before profiling at 0.5 m/s to 600 metres depth (limited by LISST-Holo2 and RBR Concerto). Upcast data were important to compare with float data so 0.5 m/s was used during descent and ascent throughout the cruise. For the last cast, UVP5 settings were altered so that it switches off just before it comes out of the water at 1 metre depth.

Table 17: Information of the profiles collected by the Red Camera Frame

Date Time	Station	Event	RCF #	Latitude	Longitude	Operator	UVP	LISST-Holo2	ECO Triplet	RBR	CPICS	Comments
19/08 13:42	Mooring	11	1	59.0000	-55.0005	Will / Hans	Y	Y	Y	Y	N	New battery for hub - not yet been tested; <2000 LISST-Holo2 images - initially 22,000 but they disappeared while transferring, including disappearing from the device
21/08 16:26	Mooring	19	2	58.9996	-54.9777	Will / Hans	Y	Y	Y	Y	N	
22/08 10:35	Mooring	25	3	59.0009	-55.0135	Hans	Y	Y	Y	Y	N	
23/08 12:35	Mooring	31	4	59.0063	-55.0407	Will / Hans	Y	N	Y	Y	N	Did not turn on LISST-Holo2
24/08 15:47	Float	42	5	58.4997	-52.0065	Will / Hans	?	Y	Y	Y	Y	UVP5 not flashing upon retrieval - insufficient memory - no UVP5 data from this cast
26/08 14:21	M1	45	6	59.9034	-41.1098	Hans	Y	Y	Y	Y	Y	
27/08 18:55	M3	54	7	59.8162	-40.2933	Hans	Y	Y	Y	Y	Y	Post-dip surfacing changed to 5 metres from 3 metres due to a change in the UVP5 settings

Marine Snow Catchers (MSC)

Personnel in the field: Will Major and Hans Hilder, National Oceanography Centre

Overview

Marine snow catchers (MSCs) were deployed during the cruise to collect sinking particle concentration and flux data. MSCs were deployed from the starboard-aft on a Romica winch. The predetermined deployment depth of the MSC was determined by the payout of the winch wire. Predetermined depths during the cruise were always mixed layer depth (MLD) plus 10 metres and MLD plus 100 metres, equating to 50 and 140 metres throughout the cruise. MLD + 10 metres gives information at export depth, while MLD + 100 metres provides a data point for attenuation. Once the MSC was at the predetermined depth, a brass messenger was sent down the ship's wire to trigger the top and bottom openings of the MSC to close. The MSC was then returned to deck and secured. A newer design (Yuki) of the MSC was trialled at Test site on 18/08/2024 but was not used for the remainder of the cruise due to two misfires.

Four fractions of water were sampled from each MSC (not including MSCs deployed at the Test site): Tzero, Suspended (Sus), Slow-Sinking (SS) and Fast-Sinking (FS). Immediately after recovery, the Tzero fraction was taken from the tap in the middle of the column. The MSCs were then left to settle for 2 hours to allow for particles to sink within the column. After two hours, the 4L Sus sample was taken from the middle tap of the column and the SS fraction was sampled (4L) from the lower tap. The MSC was then drained by opening the middle tap fully and partly opening the bottom tap. As the MSC drained (~20 minutes) the bottom tap was gradually opened more but kept at a medium flow. The top of the column was lifted using the crane once the MSC had drained, and the column and base of the MSC were disconnected using a metal hook. Excess water above the tray was siphoned off. The lid was put on the tray and carefully moved to the lab where it was decanted into a carboy using a funnel. Carboys were kept in the dark at 4 °C until filtered.

At Mooring station on 21/08/2024, silicon grease was applied to the o-ring of both MSCs (Red and Silver). As a result of the grease application, a greasy residue was present on the surface of water in the base hereafter. The residue persisted despite a thorough clean of the o-ring and base with alcohol spray and clean water prior to deployments on 22/08/2024. Silica is contained in the silicon grease applied to the o-rings, and measurements of Biogenic Silica from this cruise must be used with caution, and may not be useable at all.

Sample Preparation

Particulate organic carbon and nitrogen (POC/N)

Samples were filtered onto pre-combusted (24 hrs at 400°C) glass fibre filters (GF/F; pore size 0.7 µm, 25 mm diameter, Whatman) that were stored in individual foil wrappers. Typically, 1L was filtered for the Tzero, top and base samples and 250 mL was filtered from the tray. Replicates (POC 1 and POC 2) were taken for POC/N to ensure no data points were lost. The filters were rinsed with MilliQ water and were not allowed to dry to avoid cell lysis (following Chavez et al., 2021). Filters were returned to their foil wrappers, placed in plastic bags for each MSC deployment and stored at -80 °C. Samples will be freeze dried and analysed onshore. Blanks taken include a single instance of the following: triple volume

filtration (0.2L, 0.45L and 1L); double filter blank, where 1L was filtered through two filters, and the bottom filter used; a filter blank where no water had been filtered and it remained in its foil pouch.

Particulate Inorganic Carbon (PIC)

Samples were filtered onto polycarbonate filters (0.4 µm pore size, 25 mm, Whatman) and briefly rinsed with pH-adjusted MilliQ water (pH 8.5; 180 µL 25% ammonium in 1L MilliQ) to remove any salt. Typically, 500 mL was filtered for the Tzero, Top and Base fractions and 100mL from the Tray. Filters were placed into 15 mL blue capped Falcon tubes and dried overnight at 50 °C for analysis onshore.

Biogenic Silica (BSi)

Samples were filtered onto polycarbonate filters (0.4 µm pore size, 25 mm, Whatman) and briefly rinsed with pH-adjusted MilliQ water (pH 8.5; 180 µL 25% ammonium in 1L MilliQ) to remove any salt. Typically, 500 mL was filtered for the Tzero, top and base fractions and between 100-250mL depending on the size of the snowcatcher tray. Filters were placed into 50 mL blue capped Falcon tubes and dried overnight at 50 °C for analysis onshore. As previously stated, BSi results may be compromised by the use of Silicon grease on the o-ring of the MSCs.

Chlorophyll a

Samples were filtered onto GF/F filters (nominal pore-size 0.7 µm, 25 mm diameter, Whatman), placed into glass vials filled with 6 mL acetone (90%) for pigments to extract for 24 hours. Fluorescence was analysed on board as described in the Filtration and Analysis of Chlorophyll-a section of the cruise report.

Acknowledgements

We would like to thank both Andy the Technician and the faultless crew of the RRS James Cook for their help and support with the MSC deployments. We would also like to thank Mark Moore for his help with last minute cruise preparation.

References

Chavez et al. (2021) Ocean Optics & Biogeochemistry Protocols for Satellite Ocean Colour Sensor Validation: Volume 6: Particulate Organic Matter Sampling and Measurement Protocols: Consensus Towards Future Ocean Color Missions, IOCCG and NASA.

Table 18: List of Marine Snow Catchers during JC268

Date	Time	Station	Event #	MSC #	Lat	Long	MSC type / Name	Depth (m)	Misfire	Notes / Comments/ Weather
18/08	13:20	Test	4	1	60.7355	-54.6652	Yuki	50	Yes	Did not fire - cable slipped from slot
18/08	13:32	Test	5	2	60.7354	-54.6652	Yuki	50	Yes	Base did not fire - empty MSC
18/08	13:47	Test	6	3	60.7355	-54.6652	Yuki	50	No	Leaky from crack in base has got worse - Yuki retired for the duration of the cruise
18/08	14:23	Test	7	4	60.7355	-54.6652	Silver	50	No	Tzero sampled at 14:48
18/08	14:32	Test	8	5	60.7355	-54.6652	Red	50	No	Tray broke during sampling
21/08	18:04	Mooring	20	6	58.9997	-54.9752	Silver	50	No	Silicon grease applied to o-ring. Sample time 20:18; clear residue from grease on surface of base when sampling
21/08	18:25	Mooring	21	7	58.9994	-54.9758	Red	140	No	Silicon grease applied to o-ring. Sample time 20:34; clear residue from grease on surface of base when sampling
22/08	12:32	Mooring	26	8	59.0008	-55.0167	Red	140	No	Strong current creating angle on wire; sample time 14:48; cleaned with alcohol spray and rinsed with clean water prior to use; oily residue persists.
22/08	12:52	Mooring	27	9	59.0007	-55.0196	Silver	50	No	Strong current creating angle on wire; sample time 15:05; cleaned with alcohol spray and rinsed with clean water prior to use; oily residue persists
23/08	14:05	Mooring	32	10	59.0056	-55.0504	Silver	50	No	Sample time 16:11; residue less but persists
23/08	14:17	Mooring	33	11	59.0053	-55.0510	Red	140	No	Sample time 16:24; residue less but persists; sampled 13 minutes early
24/08	14:40	Float	40	12	58.4997	-52.0065	Silver	50	No	Sample time 16:50
24/08	14:55	Float	41	13	58.4997	-52.0065	Red	140	No	Sample time 17:03
24/08	15:49	M1	46	14	59.9034	-41.1098	Red	140	No	Sample time 17:57; partly cloudy.
24/08	16:03	M1	47	15	59.9034	-41.1098	Silver	50	No	Sample time 18:16

Turbulence Profiler

Personnel in the field: Louis Clement, Heather Jaques, Billy Platt, Nick Rundle, Andy Leadbeater (National Oceanography Centre).

Overview

Microstructure profiles were taken from the 19th of August 2024 until 27th August 2024 on the JC268 REBELS cruise to measure small-scale turbulence in the Labrador Sea. Profiling sessions were planned for between 2 and 5 hours, and the aim was to conduct several 500m profiles during this time. Due to variable underwater current speeds that affected the profiles angle of deployment, profiles ranged between 284 m to 515 m. The profiler was deployed from the back deck of the RRS James Cook. Two people were required to oversee the profiler deployment from the outside, and one person had to remain inside to monitor the profilers sinking speed and record information on the log sheet. Updates about the depth and speed from inside the ship were communicated to those outside by radio. The data was recorded and monitored using the SSSA_228 software.

Method

Two people deployed the profiler over the edge of the back deck by gently lowering the device into the ocean. Whilst floating at the surface, those outside communicated with the Bridge to confirm the ship was travelling at approximately 0.3 knots over the water, and it was checked that the profiler was not floating towards the back of the ship. Those outside also communicated via radio to the person stationed in the wet lab, who was at the computer ready to record data from the profiler and complete the log sheet. Once the correct travelling speeds were confirmed, and the data recording was started on the computer, the cable was spooled out from the winch and the turbulence profile began. For each profile, the aim was to spool out the cable at a sufficient rate to enable the profiler to free fall. Tension in the cable had to be avoided, but the cable should not be spooled out too fast otherwise it would tangle. The cable was spooled directly from the drum, rather than from the winch arm during deployment. Radio communication between the lab and back deck was maintained to ensure the profiler was falling at the correct speed (between 0.5 to 0.7 ms⁻¹, which equates to 10 m in 15 seconds).

When at least 6 rings of cable were left on the winch, the cable was stopped, and the profiler was left to continue falling to its final depth. When notified by the scientist inside that the profiler had stopped its descent, the cable was placed onto the winch arm, the winch direction was reversed, and the profiler was then slowly brought back to the surface. Once at the surface, the scientist inside stopped the data recording for this profile. A new profile was then set up to record and the profiler was deployed again. The .MRD files output from the SSSA_228 software were saved using the file naming convention of 'JC268_ISW_##.MRD' with ## representing the profile number (see cruise log). These were later renamed to '___00##.MRD' to be processed in MATLAB, again with ## representing the profile number.



Figure 35: Window on the SSDA_228 software with the selection of drop-down options necessary to process the data.

Data Processing:

To process the data, the files collected on the SSDA_228 system were initially converted from the .MRD files to .TOB (ASCII) files. The following steps were followed to do this:

1. Open the SSDA_228 software on the NMF laptop
2. Go to 'options' and select 'Export Datafile'
3. Select probe MSS050
4. Ensure the sensors are configured with the output shown in Figure 35
5. Select 'close'
6. Select the file to convert and press 'open'
7. Ensure the dataset rate says 'everyone' or '1' and press 'Ok, Show'
8. Choose where to save the file, and rename it if necessary
9. The .MRD and new .TOB files can then be saved onto the science public drive for further processing in MATLAB

Two MATLAB scripts were then used to further process this data. The initial MATLAB script (msswork.m) used to process these files was originally written by Marcus Dengler (GEOMAR) and was later adapted by Adrian Martin during DY111 (NOC). The second script (runs_one_file.m) and subsequent functions in Post_Processing were supplied by Bieito Fernandez-Castro (University of Southampton) and were used to plot the processed data (runs_one_file.m) and conduct necessary calculations.

Before these scripts were used, the following folders were set up in the science drive: MRD, TOB, MAT, DIS, PLOTS, and lines 47 to 51 in msswork.m were updated to have the correct file paths to these folders. The following parameters were also checked and updated in the msswork.m script to accurately reflect the sensor conditions, and only run the necessary tasks.

- ssss2 (line 33)
- ssss1 (line 34)
- cvlati (line 39)
- tasks (line 44)

For this cruise, the sensitivity parameters were left unchanged ($ssss2 = 3.48e-4$, $ssss1 = 5.01e-4$), the approximate latitude was update to 60, and the tasks were updated to 4:6.

Following this, both the msswork.m and runs_one_file.m scripts were run for each individual profile. This created a set of figures (Figure 36) of the temperature/salinity/sinking speed/epsilon values for each profile, which saved within

the PLOTS file path. Processed data files were also saved with the format 'processed__00##.mat' and these contained the outputs of the calculations from the processing scripts, which can be later used for analysis.

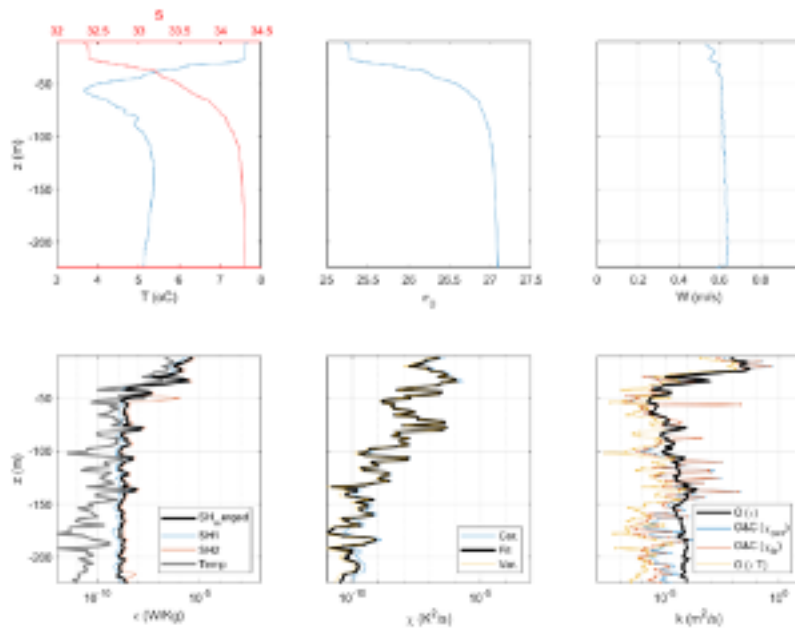


Figure 36: From top left to right, a) temperature and salinity profiles, b) surface-reference potential density profile, c) sinking speed in ms^{-1} of the profiler. From lower left to right, d) turbulent kinetic energy calculated from the shear sensors and from temperature (using the script from Bieito), e) thermal variance and f) vertical diffusivity derived from thermal variance.

Each plot was checked to ensure that there were no issues with the profiler sinking speed or sensors, and spectra plots were also produced in runs_one_file.m by updating the diagnostic on line 17 from 0 to 1. This produced plots of the Kraichnan spectrum amongst other plots to enable investigation into the turbulence data from both shear sensors (Figure 37). Each spectrum analysed 4 m of the water column, overlapping with the previous 2 m (e.g. if a plot covers depths between 10 m to 14 m, the next plot covers depths between 12 m to 16 m). These plots could be used to identify if there were any issues with the sensors. If any issue with the sensors are notified, these would need to be raised with the research technicians to rectify the problem.

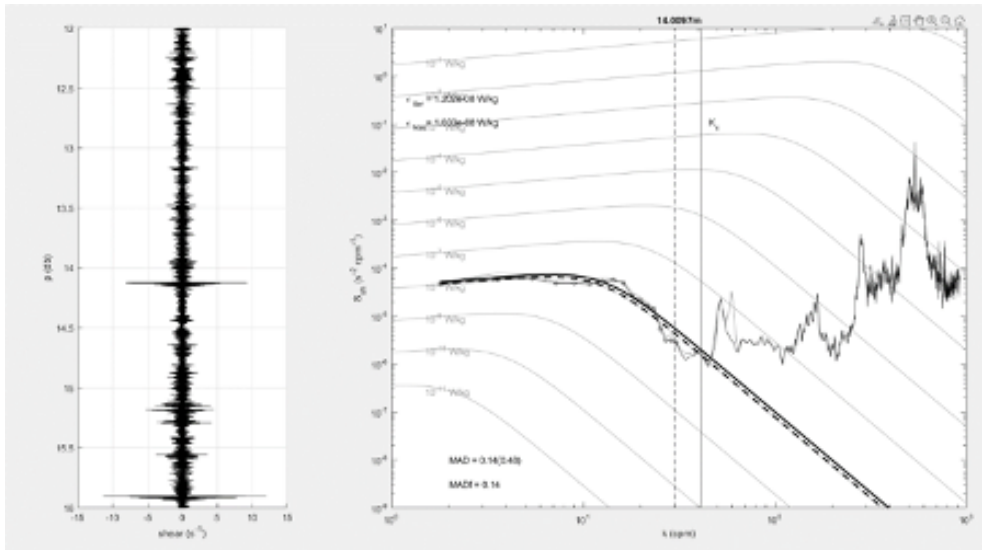


Figure 37: Spectral plot of the turbulence profile showing the spectra (left) and correspondence to projected spectrum (right). Values to the right of the vertical lines in the right profile suggest noise from the machinery rather than variability in the turbulence data

Additional Notes:

At the start of the cruise, it was noted that the profile reached vastly different depths between the test deployment and first science station deployment. This was investigated and was confirmed by Underway data that the direction and strength of the currents beneath the ship had a large impact on the angle of the profiler’s descent. Consequently, any variations in the maximum depths reached by the profiler were a consequence of varying underwater currents and the ships orientation to them.

The following table includes the event log of all ISW deployments during JC268, with the associated profile numbers.

Table 19: Event log of the MSS90 profiler during JC268.

Date	Time	Event Number	Event	Lat	Lon	MSS profile number
19/08/2024	08:20-11:16	10	ISW 01	59.000197	-55.000657	1-9
21/08/2024	18:58-20:50	22	ISW 02	59.004995	-54.978306	10-16
22/08/2024	14:35-17:25	28	ISW 03	59.004425	-55.001907	16-25
23/08/2024	15:19-18:13	34	ISW 04	59.004997	-55.052409	26-34
24/08/2024	08:55-10:20	36	ISW 05	58.502039	-51.999138	35-39
26/08/2024	10:23-11:23	44	ISW 06	59.956065	-41.742951	40-43
26/08/2024	16:42-17:42	48	ISW 07	59.904067	-41.110399	44-47
27/08/2024	11:14-12:23	51	ISW 08	59.85887	-40.693563	48-51
27/08/2024	14:35-15:36	52	ISW 09	59.815269	-40.279413	52-55

Underway measurements

Personnel in the field: Elisa Lovecchio, Louis Clement (National Oceanography Centre), Kitty Kam (Dalhousie University)

Overview

Three measurements of underway were taken per day every 6 hours during the day (at 8am, 2pm and 8pm). Both salinity and chlorophyll were sampled from the 20 to the 27th of August for a total of 24 bottles. The crate of salinity bottles was left 24 hours at constant temperature in the lab with the Autosal room before running the analysis saved in sal_jc268_12.csv.

More data matching these times for met and seawater extracted from the underway data streams can be found in Underway_log.csv file.

Table 20: Log sheet of underway events for in situ samples for salinity and chlorophyll to calibrate the underway SURFMET.

event	time	event	comment	Longitude (°)	Latitude (°)
1	20/08/2024 08:54	Salinity UW	Bottle 716	-55.005756	59.057213
2	20/08/2024 08:59	Chlorophyll UW	chl	-55.029731	59.057516
3	20/08/2024 14:14	Salinity UW	Bottle 717	-54.983614	58.993266
4	20/08/2024 14:15	Chlorophyll UW	chl	-54.983716	58.993281
5	20/08/2024 20:26	Salinity UW	Bottle 718	-55.054076	58.938133
6	20/08/2024 20:29	Chlorophyll UW	chl	-55.068749	58.938111
7	21/08/2024 08:50	Salinity UW	Bottle 719 (NB: forgot plastic lid)	-54.996064	58.988353
8	21/08/2024 08:52	Chlorophyll UW	chl	-54.996117	58.988419
9	21/08/2024 14:31	Salinity UW	Bottle 720	-55.001221	59.017709
10	21/08/2024 14:34	Chlorophyll UW	chl	-55.000257	59.022214
11	21/08/2024 20:55	Salinity UW	Bottle 721	-54.994925	59.016764
12	21/08/2024 20:57	Chlorophyll UW	chl	-54.995095	59.016885
13	22/08/2024 09:06	Salinity UW	Bottle 722	-55.006572	58.998795
14	22/08/2024 09:10	Chlorophyll UW	chl	-55.006495	58.998762
15	22/08/2024 14:40	Salinity UW	Bottle 723	-55.001522	59.005418
16	22/08/2024 14:44	Chlorophyll UW	chl	-55.001307	59.006088
17	22/08/2024 19:34	Salinity UW	Bottle 724	-54.693804	59.013989
18	22/08/2024 19:36	Chlorophyll UW	chl	-54.683308	59.014043
19	23/08/2024 09:00	Salinity UW	Bottle 725	-55.008751	59.006129
20	23/08/2024 09:02	Chlorophyll UW	chl	-55.009174	59.006054
21	23/08/2024 14:46	Salinity UW	Bottle 726	-55.051993	59.004926
22	23/08/2024 14:51	Chlorophyll UW	chl	-55.051966	59.004925
23	23/08/2024 20:02	Salinity UW	Bottle 727	-55.015293	58.971948
24	23/08/2024 20:05	Chlorophyll UW	chl	-54.998401	58.970359
25	24/08/2024 08:03	Chlorophyll UW	chl	-52.215982	58.535117
26	24/08/2024 08:25	Salinity UW	Bottle 728	-52.087899	58.51344
27	24/08/2024 15:18	Salinity UW	Bottle 729	-52.006462	58.499735
28	24/08/2024 15:20	Chlorophyll UW	chl	-52.006461	58.499736
29	24/08/2024 20:09	Salinity UW	Bottle 730	-51.049503	58.649562
30	24/08/2024 20:11	Chlorophyll UW	chl	-51.038039	58.651168
31	25/08/2024 09:29	Salinity UW	Bottle 731	-46.700188	58.728394
32	25/08/2024 09:31	Chlorophyll UW	chl	-46.68745	58.728887
33	25/08/2024 14:38	Salinity UW	Bottle 732	-45.23158	58.792364

34	25/08/2024 14:41	Chlorophyll UW	chl	-45.217576	58.79299
35	25/08/2024 22:08	Salinity UW	Bottle 733	-42.969436	58.967391
36	25/08/2024 22:11	Chlorophyll UW	chl	-42.960639	58.970611
37	26/08/2024 08:27	Salinity UW	Bottle 734	-41.742948	59.955994
38	26/08/2024 08:29	Chlorophyll UW	chl	-41.742947	59.955987
39	26/08/2024 14:33	Salinity UW	Bottle 735	-41.109773	59.90339
40	26/08/2024 14:35	Chlorophyll UW	chl	-41.109771	59.90339
41	26/08/2024 14:55		log started	-41.109765	59.903394
42	26/08/2024 20:07	Salinity UW	Bottle 736	-41.10984	59.903385
43	26/08/2024 20:08	Chlorophyll UW	chl	-41.10983	59.903384
44	27/08/2024 08:57	Salinity UW	Bottle 737	-40.693537	59.858854
45	27/08/2024 09:00	Chlorophyll UW	chl	-40.693536	59.858854
46	27/08/2024 15:21	Salinity UW	Bottle 738	-40.292515	59.816796
47	27/08/2024 15:23	Chlorophyll UW	chl	-40.293018	59.816829
48	27/08/2024 20:13	Salinity UW	Bottle 739	-40.173255	59.814839
49	27/08/2024 20:16	Chlorophyll UW	chl	-40.156143	59.815359

RCA NEMO Cameras

Personnel in the field: Ashley Hall (Royal College of Art)

Research description and significance

Following on from our 6,000nm 2021 project researching ocean objects and linking them back to communities in Poole UK and Nuuk in Greenland, we plan to test a new camera set alongside gathering visual and quantitative data from two significant climate change hotspots in the Labrador sea and the Irminger sea. Post-cruise we intent to design participatory design 'data ingredients' that will inform co-visualisation workshops with key representative communities including ocean scientists and coastal communities in Greenland, Iceland and the UK. Our ultimate aim is to understand how to bridge the tangibility gap between lived experience by coastal communities and key climate change locations in the ocean. Our objectives on the ReBELS cruise are to:

- Deploy and test action cameras with lower data timelapse footprints to capture ocean objects.
- Test camera reliability and operating procedures.
- Test transect timing.
- Gather visual data.
- Gather quantitative ships systems data.
- Use the opportunity to gain a deeper insight into NOC data gathering and future collaborative opportunities.

Determining camera locations on ship

On ship locations

To enable clear views of the sea and minimise sea state interference the cameras were installed on the port and starboard handrail on the wheelhouse top. 240v power was provided by two commando plugs connected by 15m cables to waterproof junction boxes with USBC adaptors inside leading to the camera's with 2m cables. All cables tied in place. Cameras installed with enduro batteries and 1TB max speed Sandisk v30 micro SD cards.

One InstaAce shooting 3 seconds between each frame at 36MP mounted on port and starboard rail. One GoPro Hero 12 mounted on Port handrail shooting 2 second between frames at 27MP (backup and comparative image test).





Figure 38: GoPro and Insta Ace Pro cameras and shrouds installed at Nuuk Harbour Greenland

Diplomatic clearance

Diplomatic limitations meant photographs could only be captured in international (EZ) waters and any additional images outside the specific time window deleted. Coordinated EZ times with the bridge.

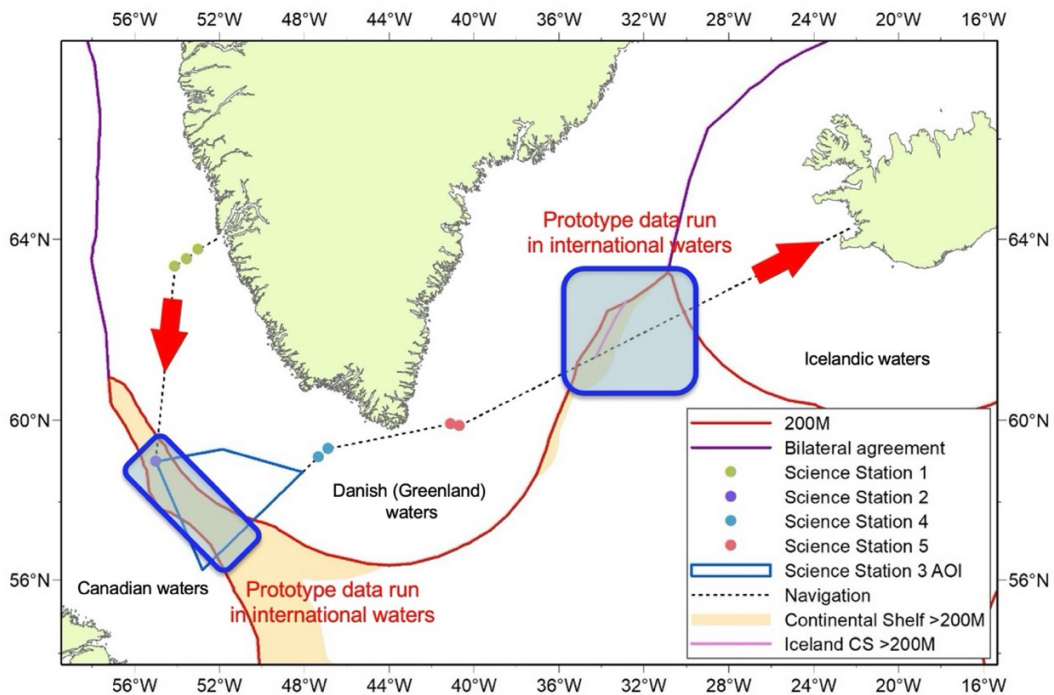


Figure 39: Approximate locations of image data gathering tests

Charlie Sierra Survey patterns

During periods when 'over the side' science data gathering was not taking place four ocean surface surveys were conducted using a Charlie Sierra creeping line search pattern. Surveys 3 and 4 doubled the return legs from 5 to 10 and 20 miles. Overall distance was constrained by the 45 mile width of the EZ in this location.

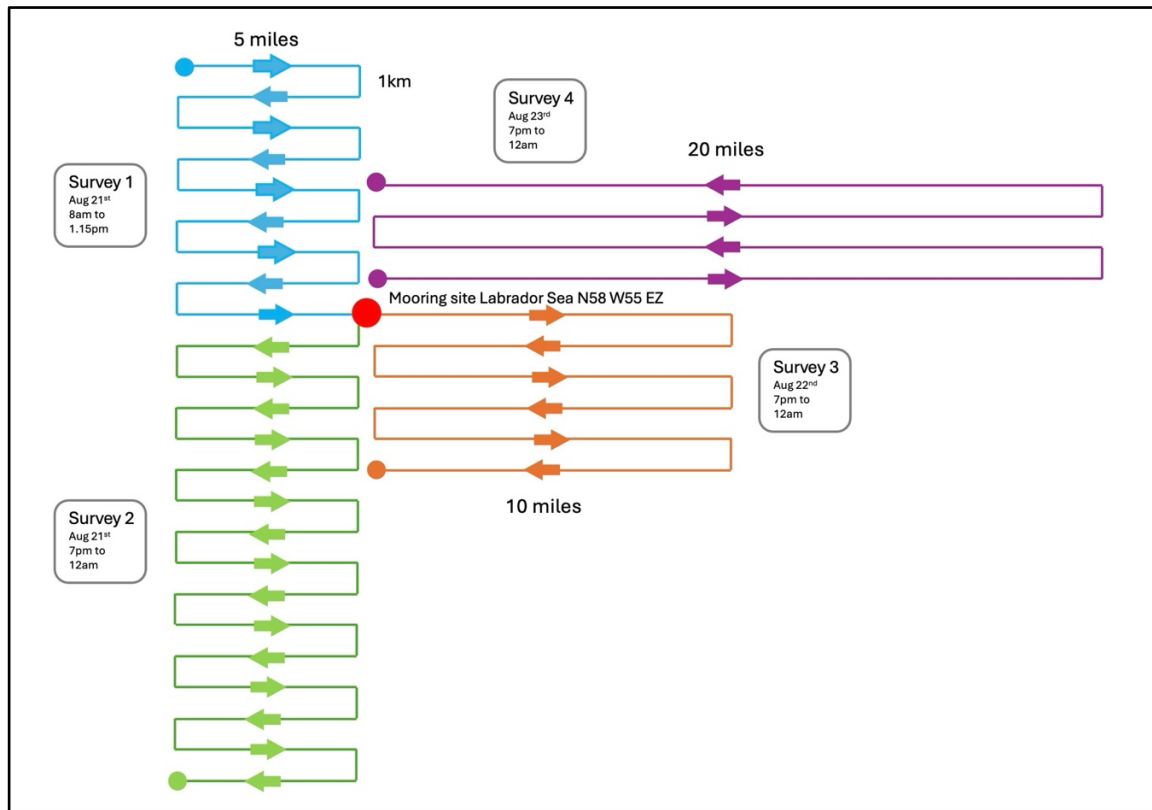


Figure 3. Design of camera Charlie Sierra creeping line search pattern ocean object surveys

Static and moving surveys

During the EZ section of the cruise it was possible to compare static and object observations, in effect objects moving past a static ship versus transit and Charlie Sierra search patterns with the ship moving past objects.

Performance

Transect timing

Tests showed objects appeared multiple times in each image.

GoPro and Insta Ace Pro

The GoPro worked well while the Insta Ace prop was initially unreliable eventually needing extended trouble shooting and an insulating pad placed in the back of the camera to compensate for environmental factors. See Table 21 shooting log for details.

Shroud Design

Provided good general weather protection, sound location to ship and points to secure cables and tethers. Allowed angle adjustment to the sea with approx. 20% sky to allow for ship roll and pitch.

SD swap

Involved dismounting the cameras and breaking weather seal. Successful but could be optimised for future use depending on reliable long term running.

Table 21: Camera shooting log

NEMO ReBELS Shooting Log GoPro & Insta Pro August 19th - 27th 2024														
Date	Location (Approx.)	Star GoPro AM 2spf	Star GoPro PM	GB	Images	Star Insta AM 3spf	Star Insta PM	GB	Images	Port Insta AM 3spf	Port Insta PM	GB	Images	Charlie Sierra Search Pattern
August 19th	Labrador sea N58 W55	8am on UTC	Dark Midnight UTC	82.76	30,469	8am on UTC	Dark Midnight UTC	115.96	14,332	8am on UTC	Dark Midnight UTC	99.66	12,554	
August 20th	Labrador sea N58 W55	8am running	7pm running	118.24	43,150	AM short stop then disruption then running. Swapped SD card (late AM check) then running better	Running at 7pm	137.02	16,728	Disrupted	Switching off on its own end of day. Heat issues reported on error message from 1pm issue back on around 5 athen again 8am next day	79.94	10,811	AM and PM set 8am to 1.15pm then 4pm to midnight
August 21st	Labrador sea N58 W55	Running at 8.10am Running at 10.30am	3pm check GoPro stopped swapped SD card. 7.30 not working as lead sea loose. Reconnected and working again. Battery would have carried on for a while after 4.30 pm. 2 hour drop.	97.92	35,877	Running at 8.10am, running at 10.30am	3pm Port insta not running (restarted). 4.30 port insta stopped, back packed with bubble wrap restarted. 7pm check stopped after less than 100 shots like some saving/buffering issue. Restarted.	69.33	9,395	Off at 8.10am reset, not running at 10.00am swapped SD and reformatted in camera running.	3pm running, 4.30 running, back packed with bubble wrap. 7.30 working.	103.69	12,249	
August 22nd	Labrador sea N58 W55	Running at 8.15am	Running at 1pm, running at 4pm. Running at 8pm	118.32	43,150	8.15am Not running, reset and restarted.	1pm not running swapped SD reformatted and restarted, running at 4pm. Running at 8pm	108.01	10,580	8.15am running	1pm running, running at 4pm. Running at 8pm.	162.69	19,723	Planned Charlie Sierra 7pm to midnight, longer lines to the west & knots.
August 23rd	Labrador sea N58 W55	Running at 8.30, running at 11am	Swapped GoPro SD by 3pm running swapped SD at 2.45pm. Running at 7.15pm	117.1	43,006	Running at 8.30, running at 11am	Running swapped SD 2.45pm. Running at 7.15pm	177.78	19,762	Swapped SD by 10am Running at 8.30, decided not to swap the SD, running at 11am	Running SD swapped 2.45pm. Running at 7.15pm	171.68	19,900	Planned for PM 7-midnight
August 24th	Labrador sea N58 W55	Running at 9.00am	Left EZ 3am	16.75	6,128	Running at 9.00am	Left EZ 3am	12.48	2,346	Running at 9.00am	Left EZ 3am	30.30	3,057	
August 24-27th	Labrador sea to Irminger sea transit & science dipclear data gathering			0	0	(Res...)		0	0			0	0	
August 27th	Irminger sea N59 W40		NO DATA TEST RUN: 1pm installed and running, card reformatted, testing ahead of international waters tomorrow. 4.15pm running, 7.45 pm running.	0	0		NO DATA TEST RUN: 1pm installed and running, card reformatted, testing ahead of international waters tomorrow. 4.15pm running, 7.45 pm running.	0	0			0	0	
August 28th	Irminger sea N60 W35 to	Entered EZ 6.52am. 7.30am running, 11am running.	3.15pm running, 7.45pm running			Entered EZ 6.52am. 7.30am running, 11am running.	3.15pm running, 7.45pm running			Entered EZ 6.52am. 7.30am running, 11am running.	3.15pm running, 7.45pm running			
August 29th		4.50am EZ line crossed, Camera Running 9.30am (no data)	Running 3pm, running 7pm.	0	0	4.50am EZ line crossed, Camera Running (no data)	Running 3pm, running 7pm	0	0	4.50am EZ line crossed, Camera Running (no data)	Running 3pm, running 7pm	0.00	0	
August 30th	Reykjavik Port from 10am													
			Port GoPro Total	551	201,788		Port Insta Total	621	73,133		Star Insta Total	648.16	77,894	
			GB											
			Images	1,820	352,815									

Technical Improvements

- Externalising data and power – externalising power supply worked well with the GoPro weather-proof door but needs additional sealant for full weather protection. Insta pro mic. adaptor provided seal and was possible to waterproof with additional electrical tape when broken for SD swap.
- Rear door – useful to add for additional weatherproofing and to solve InstaAce environment performance issue.
- Second waterproof USBC male to female connector – useful to add a second waterproof USBC connector if camera's need to be removed without breaking weather seal and removing from case.
- Smaller and more rigid junction box – current junction box design difficult to service and waterproofing not 100%. Needed to bag adaptors and mounted on angle to allow any water to drain.
- Dipclear – useful for focussing methodology but worth factoring in with 8 month lead time for a future cruise.
- Remote monitoring – Visiting wheelhouse top can be reduced with some remote monitoring either with WiFi, cables small cameras or other methods. Useful during poor weather.

Data captured

Labrador Sea Davis Strait coordinates N88 W55 and Irminger sea (update).

GB 1,820 (update)

Images 352,815 (update)

Assessed objectives

- Deploy and test action cameras with lower data footprints to capture ocean objects – Met. Camera's successfully deployed
- Test camera reliability and operating procedures – Camera reliability tested back to back two different models and experimented with various setting form transit to search pattern and static image capture (exceeded expectations).
- Test transect timing – Successful, Camera's captures objects at least 3-4 times per image. Possible to consider narrower FOV and remove need for Dewarp setting to be used reducing image fisheye distortion.
- Gather visual data – Successful with over TB and lots images gathered. InstaAce pro image 8MB image quality and size superior to GoPro.
- Gather quantitative ships systems data – Successful with WAMOS, GPS and other ship data systems gathered.
- Use the opportunity to gain a deeper insight into NOC data gathering and future collaborative opportunities – Successful with many insightful conversations with chief scientist and science team.

Acknowledgements

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