Nitrogen Fixation in the Arctic N-Arc

DY167 Cruise Report

GEOTRACES GApr19

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RRS Discovery cruise DY167
9th July 2023 – 13th August 2023

Acknowledgements

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1 Introduction and cruise summary

1.1 Background and motivation

The Arctic Ocean is undergoing dramatic environmental change. It has warmed twice as fast as the rest of the planet, causing the areal extent of sea ice to decline by 9% since the 1970s. Expansion of summertime ice-free waters and removal of light limitation has enhanced primary production by 30% since 1998 and is predicted to increase primary production by 60% in an ice-free Arctic. Primary production ultimately drives production of higher trophic levels, including fished species, and impacts biogeochemical cycles in the oceans. How primary production will respond in a future Arctic Ocean depends on the evolution of other limiting factors such as nutrients. Primary productivity in the contemporary Arctic is already limited by nitrate availability and nitrate demand will increase as future productivity increases. Models predict the ultimate arrival of oligotrophy in the future Arctic Ocean – a condition of chronically low nutrients typically associated with the lower latitude warm subtropical waters. However, there is now sparse but accumulating evidence that nitrogen fixing organisms or ‘diazotrophs’ are present and active in the cold waters (< 5°C) of the Arctic Ocean. Nitrogen fixation fertilises the global ocean with nitrogen, relieves nitrogen limitation and thus supports primary production. The prevailing paradigm is that the thermal constraints of common diazotrophs, such as *Crocosphaera* and *Trichodesmium* (18 to 32 °C) effectively exclude all diazotrophs from the Arctic Ocean and instead restrict nitrogen fixation to the warm oligotrophic low latitude ocean. Indeed, current ocean models that include nitrogen fixation ignore this process in the cold high latitude ocean. Thus, the occurrence of diazotrophs in the Arctic Ocean is unexpected. We hypothesise that nitrogen supply from diazotrophs is a fundamental yet understudied component of contemporary Arctic biogeochemistry, which will become critical as the Arctic Ocean rapidly moves towards a state of oligotrophy in the coming decades.

Data collected from this cruise will be used to challenge the prevailing paradigm that nitrogen fixation is restricted to the warm low latitude ocean and will enable quantification of the importance of nitrogen fixation as an essential nitrogen source to the Arctic Ocean.

1.2 Scientific and ships personnel

Scientific and technical personnel

Jo Hopkins	National Oceanography Centre, UK
Claire Mahaffey	University of Liverpool, UK
Maeve Lohan	University of Southampton, UK
Mar Benavides	Mediterranean Institute of Oceanography, France
Louisa Norman	University of Liverpool, UK
Mille Goddard-Dwyer	University of Liverpool, UK
Xin Meng	University of Liverpool, UK
Thanh-Ngan Hua	University of Liverpool, UK
Lewis Wrightson	University of Liverpool, UK
Catherine Berridge	University of Liverpool, UK
Benjamin Fisher	University of Edinburgh, UK
Stefanie Rynders	National Oceanography Centre, UK
Ben Barton	National Oceanography Centre, UK
Ruth Hawley	University of Southampton, UK
Oliver Flanagan	University of Southampton, UK
Arthur Coët	Mediterranean Institute of Oceanography, France
Ariana Desouza	Duke University, USA
Katryna Niva	Duke University, USA
Paul Henderson	National Oceanography Centre, National Marine Facilities
Martin Weeks	National Oceanography Centre, National Marine Facilities
Simon Jones	National Oceanography Centre, National Marine Facilities
Joshua Pedder	National Oceanography Centre, National Marine Facilities
Emmy McGarry	National Oceanography Centre, National Marine Facilities

N-Arc science and technical team (photo credit: Marshall Mackinnon)

Ship's crew

Antonio Gatti	Master
Robert Ovenden	Chief Officer
Bryn Beaurain	2nd Officer
Jordan Greenhow	3rd Officer
James Bills	Chief Engineer
Sundar Govindan Srinivasan	2nd Engineer
Marc Smith	3rd Engineer
Elliot Draper	3rd Engineer
Charles Fisher	ETO
Valerija Forbes-Simpson	Purser
Andrew Maclean	CPO-Deck
Craig James	CPO-Scientific
Marshall Mackinnon	POD
Craig Gilfillan	POS
Gary Crabb	SG1A
Colin McMaster	SG1A
Steven Crickmore	SG1A
Glyndor Henry	ERPO
Mark Ashfield	Head Chef
Mona Shah	Chef
Ashleigh Lipson	Steward
Anthony Darke	A/Steward

1.3 Sampling approach and station locations

The cruise track (Figure 1.1) and sampling locations (Figure 1.2 and Table 1.2) were chosen to ensure that the water mass end members in the Barents Sea were all adequately sampled and that strong gradients in hydrographical and biogeochemical variables were crossed. Sea water samples for analysis were collected from 5 main sampling devices: (1) A tow-FISH, deployed off the starboard side that continually pumped surface sea water into two different laboratories, (2) a stainless steel CTD (SS-CTD), (3) a titanium trace metal free CTD (Ti-CTD), (4) a Marine Snow Catcher (MSC) and (5) the ships non-toxic sea water intake.

Sampling for many of the N-Arc parameters was conducted from more than one of the sampling platforms and also during the incubation experiments (Table 1.1).

Table 1.1 Summary of the samples taken from the FISH, CTDs, MSC, non-toxic sea water intake and from the incubation experiments. [a] Storfjorden only, [b] one deep cast only, [c] Yo-Yo casts only

	FISH	**Ti-CTD**	**SS-CTD**	**MSC**	**Non-toxic sea water intake**	**Nutrient Limitation Exp.**	**Diazo. Exp.**
Inorganic nutrients	x	x	x			x	
Chlorophyll *a*	x		x		x	x	
Dissolved oxygen		x [b]	x				
Oxygen isotopes	x [a]		x				
Dissolved Organic Carbon	x	x					
Dissolved iron, dissolved trace metals, iron isotopes	x	x					
Particulate iron		x					
Fv/Fm (maximal photochemical quantum yield)	x					x	
Nitrogen Fixation rates from FARACAS	x						
Rates of nitrogen fixation and carbon uptake	x		x				x
NifH gene abundance and diversity	x		x				x
Phytoplankton DNA/RNA for nutrient biomarkers			x			x	
CARD-FISH	x						x
Salinity		x	x		x		
RNA			x [c]				
Phytoplankton community (IFCB)			x		x	x	
pCO_2					x		
Particle-associated N_2 fixation rates and 'non cyanobacterial' diazotroph community composition				x			
Ultraplankton N_2 fixation rates and community composition				x			

Tow-FISH overview

Surface gradients in dissolved iron, chlorophyll, Fv/Fm, inorganic nutrients, dissolved organic carbon (DOC), genes, $^{15}N_2$ and ^{13}C derived nitrogen and carbon fixation rates and signals of nitrogen fixation from FARACAS are essential in understanding natural variability and to place the results from incubation studies in context. High-resolution underway surface samples were collected using a 'towfish' which was deployed off the starboard side of the ship. Surface seawater was pumped into two different laboratories, the trace metal clean laboratory and the constant temperature laboratory connected to the FARACAS using a Teflon diaphragm pump (Almatec A-15) connected by acid-washed braided PVC pump tubing to a towed 'fish' positioned at approximately 2-3 m. On station the 'fish' depth was changed depending upon the CTD to ensure we were away from the deep chlorophyll maximum for filling incubation bottles. Underway samples were collected every 2 or 3 hours (depending on ship speed) along the transect between stations (Figure 1.1).

At Station N08 (26/7/23-27/723) close to the ice edge, samples were collected every 1 hr over a 27 h time period in order to understand the diel cycle in nitrogen fixation gene expression. A high signal was observed on the FARACAS at 18:00 on the 27/7/2023.

At station N13 (10/08/23), milky waters were observed and sustained a high FARACAS signal so sampling for genes took place every hour from midnight until 17:00 when the fish was taken out of the water.

Unfiltered samples were collected for Chlorophyll, DOC, Fv/Fm and Total Dissolvable iron, while samples were filtered through 0.8/0.2 µm polyethersulfone membrane filter capsule (Sartobran, Sartorius) for dissolved iron, dissolved trace metals, iron isotopes and inorganic nutrients (nitrate, nitrite, phosphate and silicate). At certain time points unfiltered samples were collected for Nitrogen Fixation rates and genes and when the FARACAS saw a sustained Nitrogen Fixation signal (see Fish log, Appendix D). In all, 321 towed fish time point samples were taken along the transect (Appendix D).

CTDs and Marine Snow Catcher overview

A total of 208 CTD casts were completed: 22 from the Ti-CTD and 186 from the SS-CTD. The Ti-CTD frame was fitted with 24 x 10L trace metal free Niskin bottles. The stainless steel CTD frame was fitted with 24 x OTE 20L Niskin bottles.

Of the total number of stainless CTDs, 150 were conducted during two 12-hour Yo-Yo CTD experiments at stations N03 and N08 that profiled the top ~100-120 m of the water column only, targeting the structure and evolution of the deep chlorophyll maximum (DCM).

At each core N-Arc station (stations N00-N19), a full depth SS-CTD was completed at midday and sampled for inorganic nutrients, chlorophyll *a*, dissolved oxygen and salinity. Samples for analysing the rates of nitrogen and carbon fixation, NifH gene abundance and diversity were taken from 3 depths; the surface mixed layer, deep chlorophyl maximum (DCM) peak and DCM base. Oxygen isotope samples were taken from 14 casts. The depth of the DCM peak on this midday cast was used to guide the deployment depth (10 m below the DCM) of the Marine Snow Catcher (off the starboard side) early to mid- afternoon. Suspended, slow-sinking and fast-sinking particle fractions were collected from 16 stations using the MSC for the analysis of particle-associated and ultradiazotroph N_2 fixation rates and community composition.

Full depth Ti-CTD casts were conducted at each core station late afternoon (~16:00), following setup, breakdown and/or sampling of the incubation experiments being run. Samples for dissolved iron, dissolved trace metals, iron isotopes, particulate iron, dissolved inorganic nutrients, dissolved organic carbon and salinity were collected on each Ti-CTD cast.

Transit between stations and sampling from the tow-FISH every 2-3 hours (typically) took place between early evening (~17:30-18:00) and midday.

Non-toxic surface sea water intake

A pCO_2 monitoring system and IFCB (Imaging FlowCytoBot) were both connected to the ships underway sea water intake, providing (near continual) observations of the partial pressure of carbon dioxide in the surface waters and images of the phytoplankton communities respectively.

Table 1.2 Station locations and depths. Please refer to the cruise event log (Appendix A) for the exact locations, depths and times of each activity at these stations (Note that the originally planned stations N11 and N14 were not visited during the cruise and are not listed in the table below).

Station	Latitude	Longitude	Depth (m)	Experiments started
N00	68° 48.40' N	10° 26.19' E	3024 m	
N01	71° N	11° E	2619 m	
N02	72° N	15° E	1128 m	
N03*	72° 51.6' N	19° 4.2' E	417 m	Nutrient limitation & Diazotroph 7 and 8 (MSC)
N04	73° 43.8' N	23° 22.2' E	459 m	
N05	74° 36.6' N	27° 54' E	383 m	Diazotroph 5
N06	76° N	30° E	316 m	Diazotroph 4
N07	78° N	30° E	298 m	Nutrient limitation
N07x	78° 32.39' N	30° 2.99' E	250 m	
N07y	78° 3.45' N	26° 40.68' E	297 m	Nutrient limitation
N08*◊	79° 20.67' N	33° 55.35' E	262 m	Nutrient limitation & Diazotroph 3
N09	79° 23' E	27° 46.04' E	350 m	
N10	78° 39.5' N	24° 39' E	141 m	Diazotroph 2
N12	75° 30' N	22° 30' E	55 m	Diazotroph 1
N13	76° 20' N	20° E	255 m	
N15	77° 13.32' N	19° 20.68' E	180 m	Nutrient limitation
N16	78° 30.92' N	19° 16.40' E	131 m	Diazotroph 6
RAS01	74° 45.06' N	27° 2.03' E	347 m	
RAS02	74° 50.55' N	26° 27.13' E	302 m	
RAS03	79° 16.82' N	28° 29.38' E	234 m	
N17	72° 30' N	25° E	246 m	
N18	73° 30' N	30° E	400 m	
N19	74° N	36° E	239 m	

** Locations of 12h Yo-Yo CTDs and high-resolution DCM sampling. ◊ 1 hr FISH sampling*

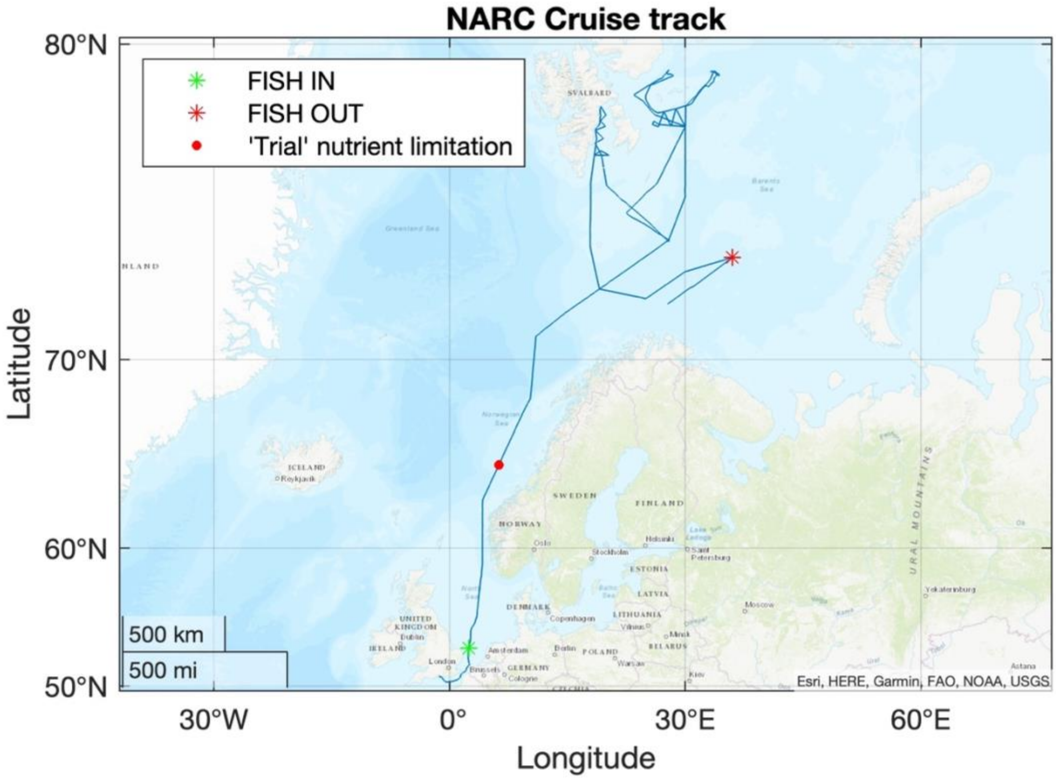

Figure 1.1 N-Arc cruise track from Southampton (UK) to Tromso (Norway). Green star marks the location at which the trace metal FISH was deployed. The red star marks the location of FISH recovery at the end of the cruise. The red dot shows the location at which water was collected for the trial nutrient limitation experiment (ship speed was 10 knots at the time of sampling).

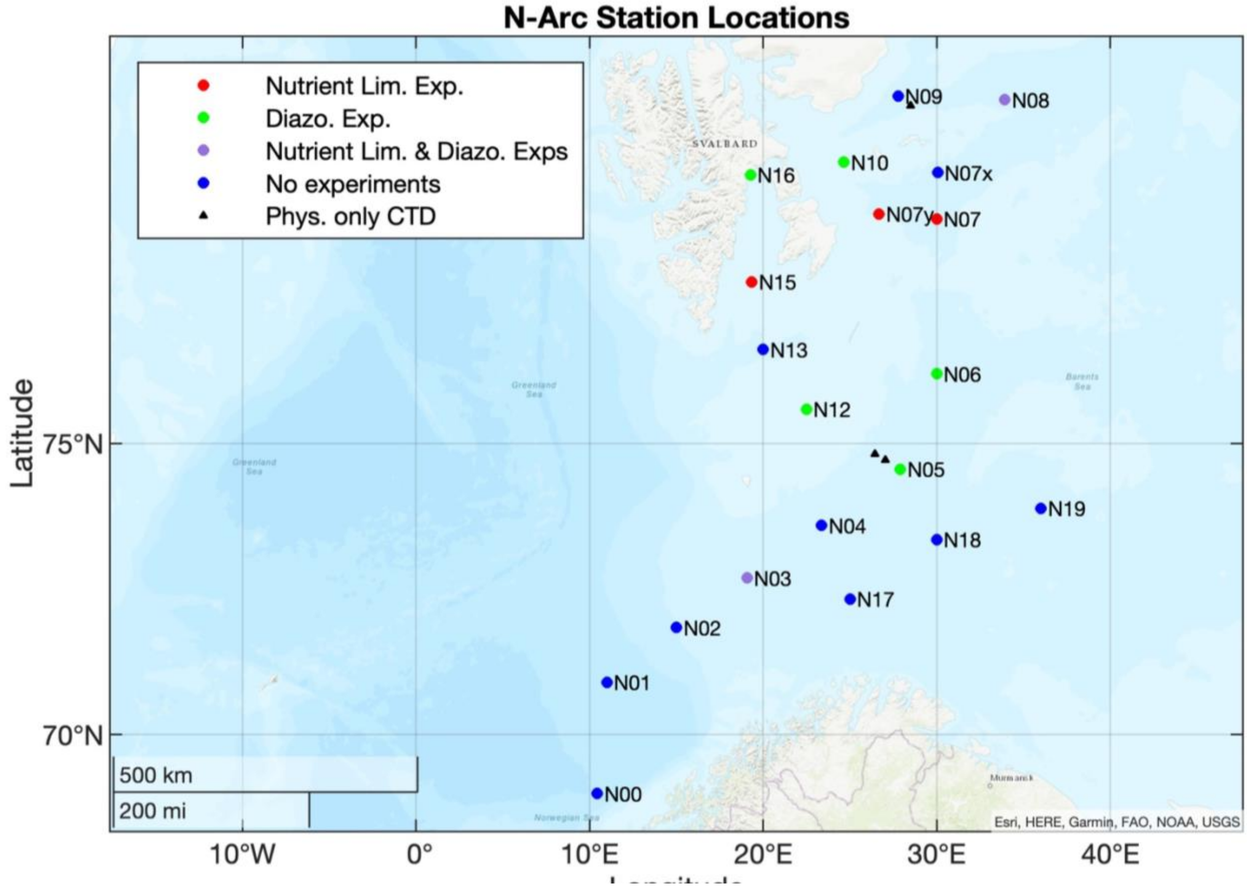

Figure 1.2 DY167 Station locations and experiment setups

1.4 Cruise diary

The following table provides a summary of the events that took place each day. Event number refers to each activity's unique identifier. A full set of times and positions for each event can be found in the Event Log (see Appendix A). All times are in GMT unless otherwise stated. Day number is based on Day 1 being 00:00 1st January.

Date	Activities
07/07/2023 Day 188	08:00 BST start mobilisation
08/07/2023 Day 189	08:00 BST mobilisation continues
09/07/2023 Day 190	09:08:54 Ships VMADCP switched on 09:30 BST Sailed from Southampton 13:00 BST Safety briefing and orientation 16:00 BST Muster Drill 18:30 BST Science Briefing
10/07/2023 Day 191	Approx. 07:45 BST pCO2 switched on Clear skies and sunny 16°C at 08:00 Light breeze 10:30 BST Captains brief **** ALL TIMES NOW GMT ****** Event 001 10:22 FISH DEPLOYMENT
11/07/2023 Day 192	Ship moved onto GMT at 00:00 15°C at 08:00. Raining. Slight swell 16:00 Muster & Fire Drill 17°C at 18:00. Sunny
12/07/2023 Day 193	12:00 Trial nutrient addition experiment started 14:00 Birthday cake for Arthur
13/07/2023 Day 194	Oxygen titration kit not working 17°C at 10:00. 4 knots of wind. Calm 12:30 Science briefing and tool box talks 10:00-11:28 Water from FISH collected for 'trial' nutrient addition experiment

	Started collection: 64° 52.7’ N, 6° 15.6’ E Ended collection: 65° 6.5’ N, 6° 30.4’ E
14/07/2023 Day 195	Shakedown station in Norwegian Sea Event 002 **N00** 12:04 Stainless CTD Event 003 N00 13:24 MSC003 O Event 004 N00 13:53 MSC004 N (misfire) Event 005 N00 14:03 MSC005 N Event 006 N00 16:01 CTD002T 13°C at 16:00. Flat calm
15/07/2023 Day 196	Arrive Station **N01** Approx. 12:00 (Norwegian Sea) Event 007 N01 12:10 CTD003S Event 008 N01 14:31 MSC008N Event 009 N01 15:26 CTD004T 11°C, fog, slight swell at 18:30
16/07/2023 Day 197	Arrive station **N02** Approx. 12:00 (Continental slope) Event 010 N02 12:13 CTD005S Event 011 N02 14:15 CTD006T 11°C, 20 knot winds at 17:30 Remained on Station until 18:00
17/07/2023 Day 198	Storm – no working – N03 skipped
18/07/2023 Day 199	Arrive **N04** Approx. 11:00 (Bear Island Trough) Problem with FISH pump. Replaced with spare. Fixed. Event 012 N04 CTD007S 12:09 Events 013 – 016 Four new MSC misfires Event 017 N04 MSC016N 14:07 15:00 11°C air temp, 21 knots wind, sea state slowly dropping Delay to starting Ti-CTD because of FISH pump repair and nutrient addition exp. Water collection Event 018 N04 CTD008T 18:29
19/07/2023 Day 200	Arrive **N05** Approx. 11:45 (Hopen Trench)

	10:00 5°C air temp, 20 knots Event 019 N05 CTD009S12:05 Event 020 N05 MSC020O 13:22 Attempting to fix firing issue with the new Marine Snow Catcher (Yuki) Event 021 N05 MSC021N 13:42 misfire Event 022 N05 MSC022N 13:58 misfire Event 023 N05 MSC023N 14:14 misfire Event 024 N05 CTD010T 16:09 Transit towards N12 Two CTDs for nutrients only Event 025 RAS1 CTD011S 20:08 Event 026 RAS2 CTD012S 23:02
20/07/2023 Day 201	Nutrient addition experiments started at N04 abandoned 09:00 3°C air temp, 12 knots Arrive **N12** Approx. 11:45 (Spitzbergen Bank) Diazo. N2 Fix experiment started Event 027 N12 CTD013S 12:02 Event 028 N12 MSC 028O 12:47 (strong tidal current) Event 029 N12 MSC 029O 12:56 Event 030 N12 CTD014T 15:01 Transit towards N07 (speed increased to 9-10 knots) Tape at the end of FISH tubing/wire come away (made brittle by cold water?). FISH recovered, re-taped then redeployed Event 031 N12 FISH OUT 20:43 Event 032 N12 FISH IN 20:55 Continue towards N07
21/07/2023 Day 202	Arrive **N07** Approx. 11:45 (south of Kong Karls Land) Event 033 N07 CTD015S 12:05 Event 034 N07 MSC 034O 13:09 (leaked) Event 035 N07 MSC 035O 13:32 14:00 3°C air temp, 5 knots wind Nutrient limitation experiment started Events 036-038 New MSC (Yuki) test deployments

	Event 039 N07 CTD016T 16:13 Bottle firing error in upper half of cast, so upper 100 m profiled again Event 040 N07 CTD017T 17:11 Left Station at 18:00. Continuing to N10
22/07/2023 Day 203	Arrive **N10** Approx. 11:45 (West of Kong Karls Land in the Olgastretet channel) Land/islands in sight 08:00 5°C air temp, 6 knots wind Event 041 N10 CTD081S 11:59 Event 042 N10 MSC042O 12:45 Event 043 N10 CTD019T 16:42 Diazo. N2 Fix experiment started Left station at 17:30. Transit to N09
23/07/2023 Day 204	**N09** (North of Kong Karls Land in the Erik Eriksenstretet channel) Peak in the FARACAS 05:05-05:20 when close to the ice edge. 40 nm away from nominal N09 station. Too much fog to see clearly or progress further north Event 044 N09 CTD020S 10:13 Event 045 N09 CTD021S 12:02 Event 046 N09 MSC046O 13:09 Event 047 N09 CTD022T 15:16 18:30-21:00 spent following low temperature, low salinity ice melt (running along the ice edge). 0°C water. At 19:00 FISH was raised to 3 m water depth (ensuring it was above the SBE38 hull intake temp sensor and in the thin ice melt layer) No clear FARACAS signal detected. Event 048 RAS03 CTD023S 21:11 Left station approx. 22:30. Heading west and will skirt Kong Karl Land to the south. Ice extends too far south to reach N08.
24/07/2023 Day 205	In transit to N08 5 ppb signal on FARACAS approx. 12:10 5°C water temp, 78° 26.72‘ N, 28° 20.77‘ E Low Fv/Fm signal at 78° 34.59‘ N, 30° 37.49‘ E

	Reached ice edge approx. 19:00
25/07/2023 Day 206	**N08** (South of Kvitøya) Event 049 N08 CTD024S 15:08 Event 050 N08 MSC050O 15:55 Event 051 N08 CTD025T 16:44 Nutrient limitation started Event 052 N08 CTD Yo-Yo Trial CTD026S to CTD038S
26/07/2023 Day 207	**N08** Diazo. N2 Fix experiment started ~36-hour time series started from FISH, sampling every hour for nifH genes (FISH141 to FISH185) Event 053 CTD039S 10:03 Event 054 (Yo-Yo) CTD040 – 054S 11:17 Event 055 CTD055S 13:29 Event 056 (Yo-Yo) CTD056 – 067S 14:28 Event 057 CTD068S 16:12 Event 058 (Yo-Yo) CTD069 – 086S 17:07 Event 059 N08 CTD087 19:22 Event 060 (Yo-Yo) CTD088 – 102S 20:21 FARACAS signal was high (5 ppb) early evening (18:00) until early hours of 27^{th}.
27/07/2023 Day 208	10:00 Boat work planned but poor visibility 10:00 -1°C air temp, 5 knots wind, thick fog Event 061 N08 CTD103S 12:09 Event 062 N08 MSC062O15:57 Event 063 Work Boast Launch 15:16 Samples collected at 15:27 at 79° 22' 21'' N 33° 22' 24'' E (position and time taken from an iphone) Valeport Temp-SVP probe towed along side of boat (SN 22356). Stopped recording at 15:26 Salts samples taken: TSG Crate 21 Bottles 228 and 224 Event 064 N08 CTD104S 17:58

	Begin transit to N07x approx. 00:00
28/07/2023 Day 209	**N07x** – south of Kong Karls Land Event 065 N07x CTD105S 12:07 Event 066 NO7x MSC066O 12:53 (leaked) Event 067 NO7x MSC067O 13:14 Event 068 CTD106T 14:08 Planned nutrient addition experiment not started. Surface water bloom, high activity on IFCB and high Fv/Fm. 15:30 start of a survey between NO7 and NO7x to identify a low Fv/Fm, low dFe and low Chl area
29/07/2023 Day 210	07:30 Review of overnight survey. New station location (**N07y**) chosen to setup the final Arctic nutrient limitation experiment 78° 3.45'N, 26° 40.68'E Event 069 **N07y** CTD107T 15:33 Transit to N06 – via N07
30/07/2023 Day 211	**N06** (Head of Hopen Trench) 08:30 8°C air temp, 7 knots wind Event 070 N06 CTD108S 12:05 Event 071 N06 MSC071O 13:00 Event 072 N06 CTD109T 16:15 Transit to N05
31/07/2023 Day 212	**N05** (Hopen Trench) Event 073 N05 CTD110S 12:09 Event 074 N05 MSC074O 13:06 Event 075 N05 CTD111T 16:18
01/08/2023 Day 213	**N13** (Head of Storfjordrenna channel) Event 076 N13 CTD112S 12:07 Event 077 N13 MSC077O (leaked) 12:56 Event 078 N13 MSC 078O 13:11 Event 079 N13 CTD113T 15:28 d18O sampling from FISH started at 17:00 (for Storfjorden) Started 2-3 hourly d18O sampling from the underway for BIOPOLE
02/08/2023 Day 214	**N15** (Storfjorden)

	08:30 6°C air temp, 20 knots wind Event 080 N15 CTD114S 12:04 Event 081 N15 MSC081O 12:40 Event 082 N15 CTD115T 16:12
03/08/2023 Day 215	**N16** (Top of Storfjorden at the Negribreen Glacier front) High FARACAS Signals! Started 2-hourly sampling from FISH for nifH gene at 14:31 At glacier front Lunch on back deck Event 083 N16 CTD116S 12:05 Event 084 N16 MSC084O 12:49 Event 085 N16 CTD117T 16:31 Raining late the afternoon/evening
04/08/2023 Day 216	**N16** Very patchy transmission Event 086 N16 Small boat launch - 3 x ice samples retrieved – patchy fog and drizzle Event 087 N16 CTD118S 12:29 FISH raised to Approx. 1.5 m depth below surface based on seeing a very shallow SML (slightly colder & fresher) Ice cracking Event 088 N16 CTD119S 14:01 (1.5 m SML) Event 089 N16 CTD120S 16:00 Event 090 FISH raised for taping repair 16:29 Event 091 FISH back in water 16:50 Stopped nifH 2-hourly sampling at 16:00 Left station 17:00 for slow coastal transect along the fjord, following the 50 m contour. Turbid water at the surface for much of the day
05/08/2023 Day 217	In transit to N03
06/08/2023 Day 218	**N03** (south of Bear Island in Bear Island Trough) 09:00 8°C air temp, 28 knots wind, heavy swell

	Event 092 N03 CTD121S 12:00 Event 093 NO3 MSC093O 12:49 Event 094 NO3 MSC094O 13:04 Event 095 NO3 CTD122T 15:53 Nutrient addition experiment started
07/08/2023 Day 219	**N03** 08:30 10°C air temp, 20 knots wind, slight swell Event 096 N03 CTD123S 06:02 Event 097 N03 YoYo6 CTD124S – CTD161S 07:06 Event 098 N03 MSC098O 12:13 Event 099 N03 CTD162S 12:15 Event 100 N03 YoYo7 CTD163S-CTD201S 13:13 Event 101 N03 CTD202S 18:15 Experiment to test the natural diel cycle in Ethylene Transit to N17
08/08/2023 Day 220	**N17** 08:30 9°C air temp, 12 knots wind Event 102 N17 CTD203S 12:01 Event 103 N17 MSC103O 12:43 Event 104 N17 CTD204T 15:28 Transit to N18
09/08/2023 Day 221	**N18** 09:00 9°C air temp, 24 knots wind Event 105 N18 CTD205S 12:06 Event 106 N18 CTD206T 13:36 Transit to N19
10/08/2023 Day 222	**N19** Arrive at N19 in the middle of a Haptophyte bloom (started around 22:00) High FARACAS signal. Started regular (1 to 2 hourly) sampling for nifH between 03:00 and 17:00 (FISH308 to FISH321) Event 107 CTD207S 11:59 Event 108 CTD208T 13:33 Event 109 FISH OUT of water 17:08 Begin transit to Tromso
11/08/2023 Day 223	Packing and running remaining samples

	07:25 Non-toxic underway flow stopped 09:36 VM-ADCPs stopped logging End of cruise RCP
12/08/2023 Day 224	Pilot at approx. 13:30 Alongside approx. 16:00
13/08/2023 Day 225	Demobilisation
14/08/2023 Day 226	Demobilisation

2 Hydrography and ocean dynamics

2.1 Stainless and titanium CTD casts

Ben Barton[1] (National Oceanography Centre), Jo Hopkins (National Oceanography Centre)[2]
[1]*Author*, [2]*Data set PI*

The Conductivity Temperature Depth (CTD) casts were conducted using two separate CTD frames; a Stainless Steel frame and a Titanium frame. The Titanium frame was used for trace metal sampling. On most stations a Stainless Steel and a Titanium CTD cast were conducted. In total 186 Stainless Steel and 22 Titanium casts were completed. Sensors and Niskin bottles were supplied by NMF for both CTDs and set up by Paul Henderson (NMF). The Stainless Steel CTD had 24 x 20 L Niskin bottles. The Titanium CTD had 24 x 10 L Niskin bottles. On both CTD frames twin sets of identical conductivity and temperature sensors were mounted. The "secondary" sensors were attached to the vane of the CTD frame making them less prone to artefacts from the Niskin bottles moving water around them. For the Stainless Steel CTD an additional dissolved oxygen sensor was added (to the vane) from CTD005S onwards.

The locations of the main sampling stations are shown in Figure 1.2. These stations are named N00 to N19 (note that stations N11 and N14 as originally planned were not sampled). We also conducted CTD casts at additional stations, named RAS01 to RAS03.

The serial numbers of all instrumentation mounted on both frames can be found in Appendix F (NMF Sensors and Moorings Report)

Table 2.1 CTD cast number, unique event numbers and locations. All information is from the cruise event log (Appendix A).

CTD CAST #	TYPE	EVENT	STATION	LAT	LON	DEPTH (m)	DATE-TIME
CTD001	S	2	N00	68.80658	10.43655	3024	14/07/2023 12:04
CTD002	T	6	N00	68.80667	10.43658	3023	14/07/2023 16:00
CTD003	S	7	N01	70.99988	10.99990	2619	15/07/2023 12:10
CTD004	T	9	N01	70.99990	10.99988	2618	15/07/2023 15:24
CTD005	S	10	N02	72.00055	15.00288	1128	16/07/2023 12:13
CTD006	T	11	N02	71.99997	14.99952	1127	16/07/2023 14:15
CTD007	S	12	N04	73.72458	23.36800	459	18/07/2023 12:09
CTD008	T	18	N04	73.72458	23.36798	459	18/07/2023 18:30
CTD009	S	19	N05	74.60580	27.89973	383	19/07/2023 12:05
CTD010	T	24	N05	74.60580	27.89975	383	19/07/2023 16:09
CTD011	S	25	RAS01	74.75100	27.03383	347	19/07/2023 20:08
CTD012	S	26	RAS02	74.84250	26.45217	302	19/07/2023 23:02

CTD013	S	27	N12	75.50067	22.49788	55	20/07/2023 12:02
CTD014	T	30	N12	75.50087	22.49993	55	20/07/2023 15:01
CTD015	S	33	N07	77.99997	29.99913	297	21/07/2023 12:05
CTD016	T	39	N07	77.99993	29.99937	297	21/07/2023 16:12
CTD017	T	40	N07	77.99995	29.99945	298	21/07/2023 17:11
CTD018	S	41	N10	78.65857	24.65000	141	22/07/2023 11:59
CTD019	T	43	N10	78.65855	24.65017	141	22/07/2023 16:42
CTD020	S	44	N09	79.38077	27.79767	350	23/07/2023 10:13
CTD021	S	45	N09	79.38333	27.76740	347	23/07/2023 12:02
CTD022	T	47	N09	79.38587	27.73932	336	23/07/2023 15:16
CTD023	S	48	RAS03	79.28038	28.48973	234	23/07/2023 21:11
CTD024	S	49	N08	79.34430	33.92528	262	25/07/2023 15:08
CTD025	T	51	N08	79.35067	33.89067	267	25/07/2023 16:49
CTD026 - CTD038	S	52	N08	79.35153	33.88633	267	25/07/2023 18:30
CTD039	S	53	N08	79.35803	33.80927	265	26/07/2023 10:03
CTD040 - CTD054	S	54	N08	79.35397	33.72305	269	26/07/2023 11:17
CTD055	S	55	N08	79.37042	33.71688	269	26/07/2023 13:29
CTD056 - CTD067	S	56	N08	79.37828	33.69203	271	26/07/2023 14:28
CTD068	S	57	N08	79.39048	33.72540	271	26/07/2023 16:12
CTD069 - CTD086	S	58	N08	79.39260	33.72542	270	26/07/2023 17:07
CTD087	S	59	N08	79.39272	33.72542	271	26/07/2023 19:22
CTD088 - CTD102	S	60	N08	79.39047	33.73867	270	26/07/2023 20:21
CTD103	S	61	N08	79.36917	33.47442	270	27/07/2023 12:09
CTD104	S	64	N08	79.38303	33.32277	271	27/07/2023 17:58
CTD105	S	65	N07x	78.53983	30.04997	250	28/07/2023 12:07
CTD106	T	68	N07x	78.53992	30.04953	250	28/07/2023 14:08
CTD107	T	69	N07y	78.05752	26.67632	212	29/07/2023 15:33
CTD108	S	70	N06	76.00000	29.99948	316	30/07/2023 12:05

CTD109	T	72	N06	76.00003	29.99952	316	30/07/2023 16:15
CTD110	S	73	N05	74.60998	27.89917	380	31/07/2023 12:09
CTD111	T	75	N05	74.61000	27.89917	380	31/07/2023 16:18
CTD112	S	76	N13	76.33333	19.99893	255	01/08/2023 12:07
CTD113	T	79	N13	76.33300	19.99900	250	01/08/2023 15:28
CTD114	S	80	N15	77.22200	19.34460	177	02/08/2023 12:04
CTD115	T	82	N15	77.22200	19.34450	174	02/08/2023 16:13
CTD116	S	83	N16	78.51543	19.27338	131	03/08/2023 12:05
CTD117	T	85	N16	78.50965	19.28215	124	03/08/2023 16:31
CTD118	S	87	N16	78.51648	19.22908	124	04/08/2023 12:29
CTD119	S	88	N16	78.51467	19.22833	120	04/08/2023 14:01
CTD120	S	89	N16	78.51493	19.23007	115	04/08/2023 16:00
CTD121	S	92	N03	72.86012	19.07078	417	06/08/2023 12:00
CTD122	T	95	N03	72.86013	19.07078	418	06/08/2023 15:53
CTD123	S	96	N03	72.86040	19.07310	419	07/08/2023 06:02
CTD124 - CTD161	S	97	N03	72.86013	19.07053	419	07/08/2023 07:06
CTD162	S	99	N03	72.86012	19.07052	419	07/08/2023 12:15
CTD163 - CTD201	S	100	N03	72.86013	19.07055	419	07/08/2023 13:13
CTD202	S	101	N03	72.86017	19.07050	419	07/08/2023 18:15
CTD203	S	102	N17	72.49998	24.99803	246	08/08/2023 12:01
CTD204	T	104	N17	72.49985	24.99922	247	08/08/2023 15:28
CTD205	S	105	N18	73.50000	29.99923	400	09/08/2023 12:06
CTD206	T	106	N18	73.50007	29.99927	400	09/08/2023 13:36
CTD207	S	107	N19	74.00013	35.99943	235	10/08/2023 11:59
CTD208	T	108	N19	74.00013	35.99933	235	10/08/2023 13:33

Data Acquisition
The sensor data was acquired through Seasave Version 7.26.7.121 by Lead Technician Paul Henderson. The following raw data files were generated for each CTD cast:

- DY167_CTD_001S.bl
- DY167_CTD_001S.hdr
- DY167_CTD_001S.hex
- DY167_CTD_001S.XMLCON

The naming convention is cruise number (DY167), followed by CTD cast number (not Event number) and either S or T for Stainless Steel or Titanium respectively. The cast number is incremented per cast regardless of whether it was with the Stainless or Titanium frame.

SBE Data Processing Steps
The data from both CTD frames were pre-processed in the Seabird data processing software (SBEDataProcessing Version 7.26.7 [2018]).

1. Data Conversion (DatCnv)
DatCNv is a conversion routine that reads the raw CTD data files (.hex) containing data in engineering units (e.g. voltage) that is generated by the CTD hardware. The routine applies conversion equation constants and calibrations as found in the instrument configuration file (.xmlcon).

Input files: DatCnv.psa, DY167_CTD_XXX$.XMLCON, DY167_CTD_XXX$.hex

Output files: DY167_CTD_XXX$.cnv, DY167_CTD_XXX$.ros

Where XXX is the CTD cast number and $ is “S” or “T” for Stainless Steel or Titanium respectively e.g. 001S or 208T.

The default oxygen Tau correction was applied at this stage because JR15005 cruise established the oxygen Tau correction was good and only made a 1% difference in deeper CTD casts. An additional dissolved oxygen sensor was added to the Stainless Steel CTD from CTD005S onwards. This was because of issues with the primary dissolved oxygen sensor in the first few casts (from CTD001S to CTD009S inclusive). The Titanium CTD had a similar set of instruments to the Stainless Steel CTD, the differences were a pH sensor on the Titanium CTD and the secondary dissolved oxygen sensor on the Stainless Steel CTD. The depth is temporarily calculated using 75°N but this is re-calculated later in the Derive routine.

The DatCnv routine also outputs the .ros files which contain variables averaged around the bottle firing times. A 5 second scan range was used for these .ros files with a -2.5 seconds offset.

Variables output for the Stainless Steel CTD:

name 0 = scan: Scan Count
name 1 = latitude: Latitude [deg]
name 2 = longitude: Longitude [deg]
name 3 = timeJ: Julian Days
name 4 = timeS: Time, Elapsed [seconds]
name 5 = pumps: Pump Status
name 6 = prDM: Pressure, Digiquartz [db]
name 7 = t090C: Temperature [ITS-90, deg C]

name 8 = t190C: Temperature, 2 [ITS-90, deg C]
name 9 = c0mS/cm: Conductivity [mS/cm]
name 10 = c1mS/cm: Conductivity, 2 [mS/cm]
name 11 = sbeox0PS: Oxygen, SBE 43 [% saturation]
name 12 = sbox0Mm/Kg: Oxygen, SBE 43 [umol/kg]
name 13 = sbeox0Mg/L: Oxygen, SBE 43 [mg/l]
name 14 = sbeox0Mm/L: Oxygen, SBE 43 [umol/l]
name 15 = sbeox0V: Oxygen raw, SBE 43 [V]
name 16 = CStarAt0: Beam Attenuation, WET Labs C-Star [1/m]
name 17 = CStarTr0: Beam Transmission, WET Labs C-Star [%]
name 18 = turbWETbb0: Turbidity, WET Labs ECO BB [m^-1/sr]
name 19 = flC: Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]
name 20 = par: PAR/Irradiance, Biospherical/Licor [umol photons/m^2/sec]
name 21 = par1: PAR/Irradiance, Biospherical/Licor [umol photons/m^2/sec]
name 22 = altM: Altimeter [m]
name 23 = depSM: Depth [salt water, m]
name 24 = flag: 0.000e+00

From CTD005S onwards addition secondary oxygen sensor variables changed from #16 to 29 (for #0 to 15 see above):

name 16 = sbeox1PS: Oxygen, SBE 43, 2 [% saturation]
name 17 = sbox1Mm/Kg: Oxygen, SBE 43, 2 [umol/kg]
name 18 = sbeox1Mg/L: Oxygen, SBE 43, 2 [mg/l]
name 19 = sbeox1Mm/L: Oxygen, SBE 43, 2 [umol/l]
name 20 = sbeox1V: Oxygen raw, SBE 43, 2 [V]
name 21 = CStarAt0: Beam Attenuation, WET Labs C-Star [1/m]
name 22 = CStarTr0: Beam Transmission, WET Labs C-Star [%]
name 23 = turbWETbb0: Turbidity, WET Labs ECO BB [m^-1/sr]
name 24 = flC: Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]
name 25 = par: PAR/Irradiance, Biospherical/Licor [umol photons/m^2/sec]
name 26 = par1: PAR/Irradiance, Biospherical/Licor [umol photons/m^2/sec]
name 27 = altM: Altimeter [m]
name 28 = depSM: Depth [salt water, m]
name 29 = flag: 0.000e+00

Variables output for the Titanium CTD 29 (for #0 to 15 see above):

name 16 = CStarAt0: Beam Attenuation, WET Labs C-Star [1/m]
name 17 = CStarTr0: Beam Transmission, WET Labs C-Star [%]
name 18 = turbWETbb0: Turbidity, WET Labs ECO BB [m^-1/sr]
name 19 = flC: Fluorescence, Chelsea Aqua 3 Chl Con [ug/l]
name 20 = ph: pH
name 21 = par: PAR/Irradiance, Biospherical/Licor [umol photons/m^2/sec]
name 22 = par1: PAR/Irradiance, Biospherical/Licor [umol photons/m^2/sec]
name 23 = altM: Altimeter [m]
name 24 = depSM: Depth [salt water, m]
name 25 = flag: 0.000e+00

2. Wild Edit (WildEdit)
The WildEdit routine removes pressure and depth spikes. WildEdit was not applied to the conductivity and temperature variables because it results in bad data values for oxygen concentration after dynamic corrections (Filter, AlignCTD, Cell Thermal Mass) are applied. A Matlab routine for filtering the data similar to WildEdit is applied later to remove spikes from conductivity, salinity, temperature etc.

Input and output file: DY167_CTD_XXX$.cnv

Standard deviation for pass 1: 2
Standard deviation for pass 2: 20
Scans per black: 100
Keep data within this distance of the mean: 0
Exclude scans marked as bad: yes

3. Filter
The Filter routine smooths high frequency pressure and depth noise using a low pass filter. The low pass filter time is 0.15 as recommended by Seabird.

Input and output file: DY167_CTD_XXX$.cnv

4. Align CTD (AlignCTD)
The AlignCTD routine shifts conductivity and oxygen values to compensate the sensor for time lags. This routine can only be used once suitable alignment values have been determined.

Input and output file: DY167_CTD_XXX$.cnv

(a) Conductivity

A misalignment between conductivity and temperature sensor data can result in salinity spikes. This is most noticeable over sections of the profile where there are strong gradients. The deck unit (SBE 11 plus) that receives the initial CTD data, automatically advances the primary and secondary conductivity sensors. The ideal alignment minimises the salinity spiking. The deck unit automatically applies a 1.75 scan (0.0729 seconds) advancement to the both the primary and secondary conductivities.

The alignment of both sensors was checked using the downcast data (Figure 2.1). Without any alignment both sensors produce negative spikes on the downcast, indicating conductivity lags temperature.

To minimise spiking the following adjustments were made to the alignment using the AlignCTD module. For the Stainless Steel CTD:
Primary sensor: -0.0416 seconds (-1 scan, making the overall advancement 0.75 scans).
Secondary sensor: -0.0416 seconds (-1 scan, making the overall advancement 0.75 scans).

For the Titanium CTD:
Primary sensor: -0.0416 seconds (-1 scan, making the overall advancement 0.75 scans).
Secondary sensor: -0.0208 seconds (-0.5 scan, making the overall advancement 1.25 scans).

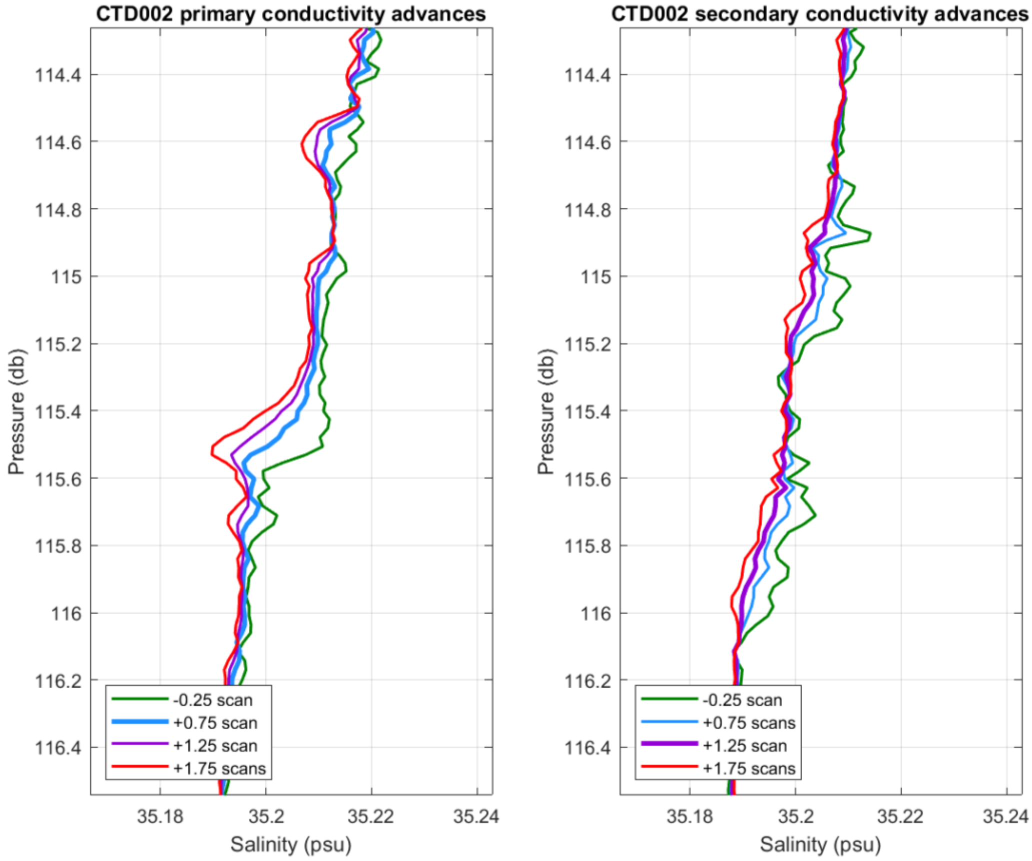

Figure 2.1 Example of conductivity alignment tests using CTD002T. (a) Primary sensor. The red line (+1.75 scans) shows the default advancement. The purple line (+1.25 scans) shows not enough correction. The blue line (+0.75 scans) shows the advancement that minimises the spiking on the primary sensor. The green line (-0.25 scans) shows over-correction and spiking in the opposite direction. (b) Secondary sensor (on the vane). The red line (+1.75 scans) shows the default advancement. The purple line (+1.25 scans) shows the advancement that minimises the spiking on the secondary sensor. The blue line (+0.75 scans) over-correction and spiking in the opposite direction. For completeness, the green line (-0.25 scans) also shows over-correction and larger spiking in the opposite direction.

(b) Oxygen

The dissolved oxygen sensors have a response time of several seconds which varies with each individual sensor and temperature (a longer lag at colder temperatures). To correct for this, several different alignments (0, 2, 4, 6, 8 and 10 seconds) were applied to a range of CTD casts with different temperatures. Oxygen was plotted against temperature for each cast (Figure 2.2). The alignment that produced the smallest difference in dissolved oxygen between the downcast and upcast could then be identified from visual inspection of various temperature-oxygen plots.

The chosen alignment for the Stainless Steel CTD:
Primary Oxygen: 6 seconds
Secondary Oxygen: 4 seconds

The chosen alignment for the Titanium CTD:
Primary Oxygen: 8 seconds

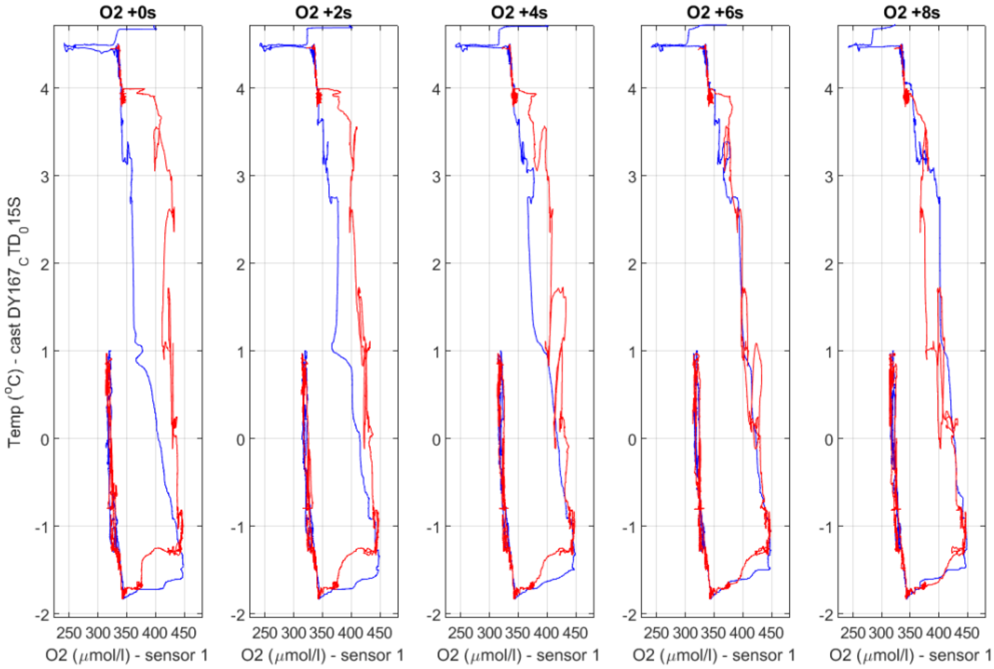

Figure 2.2 Example of temperature vs. oxygen concentration for 0, 2, 4, 6 and 8 second alignment for CTD015S primary oxygen sensor. Blue is the downcast, red is the upcast. A 6 second alignment minimises the difference between the down and upcast.

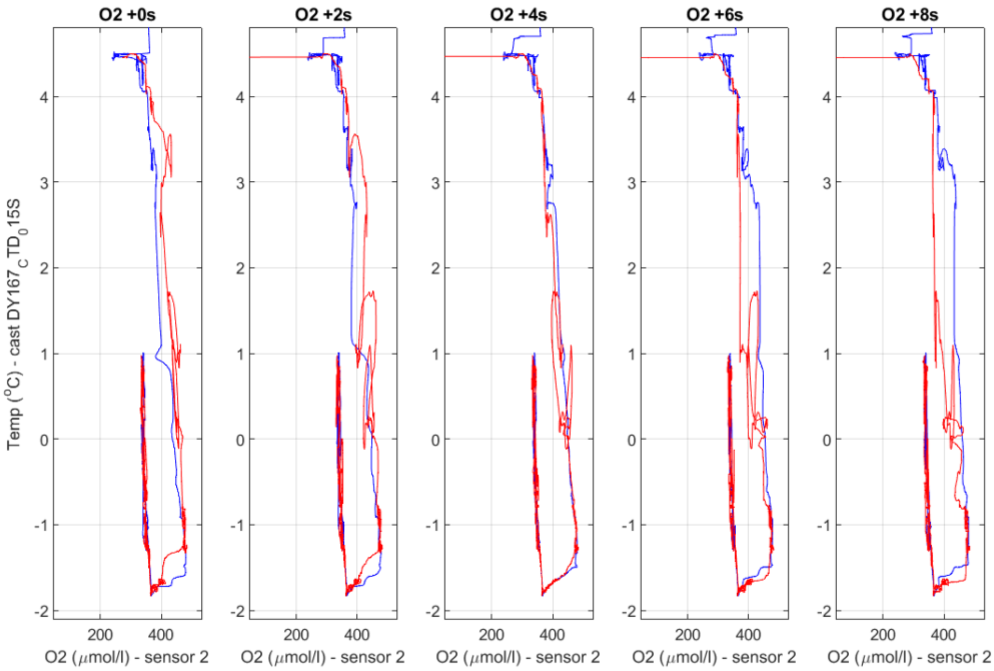

Figure 2.3 Example of temperature vs. oxygen concentration for 0, 2, 4, 6 and 8 second alignment for CTD015S secondary oxygen sensor. Blue is the downcast, red is the upcast. A 4 second alignment minimises the difference between the down and upcast.

5. Cell Thermal Mass (CellTM)
The CellTM routine removes the effect of thermal inertia on the conductivity cells. Alpha = 0.003 (thermal anomaly amplitude) and 1/beta = 7 (thermal anomaly time constant) for both cells.

Input and output file: DY167_CTD_XXX$.cnv

6. Derive
The Derive routine calculates the oxygen, salinity, density and sound speed after the dynamic corrections have been applies (Filter, AlignCTD, CellTM). Depth is now also calculated using the correct latitude (instead of the 75°N that was used in DatCnv).

Input files: DY167_CTD_XXX$.cnv, DY167_CTD_XXX$.XMLCON (must be in processed directory)

Output file (input and output cannot be the same): DY167_CTD_XXX$_derived.cnv

For the Stainless Steel CTD casts with only a primary oxygen sensor (CTD001S and CTD003S), the derived variables output are:

name 23 = depSM: Depth [salt water, m]
name 24 = sal00: Salinity, Practical [PSU]
name 25 = sal11: Salinity, Practical, 2 [PSU]
name 26 = sigma-é00: Density [sigma-theta, kg/m^3]
name 27 = sigma-é11: Density, 2 [sigma-theta, kg/m^3]
name 28 = svCM: Sound Velocity [Chen-Millero, m/s]
name 29 = svCM1: Sound Velocity, 2 [Chen-Millero, m/s]
name 30 = sbeox0PS: Oxygen, SBE 43 [% saturation]
name 31 = sbox0Mm/Kg: Oxygen, SBE 43 [umol/kg]
name 32 = sbeox0Mg/L: Oxygen, SBE 43 [mg/l]
name 33 = sbeox0Mm/L: Oxygen, SBE 43 [umol/l]

For the Stainless Steel CTD casts from CTD005S onwards, the derived variables are:

name 28 = depSM: Depth [salt water, m]
name 29 = sal00: Salinity, Practical [PSU]
name 30 = sal11: Salinity, Practical, 2 [PSU]
name 31 = sigma-é00: Density [sigma-theta, kg/m^3]
name 32 = sigma-é11: Density, 2 [sigma-theta, kg/m^3]
name 33 = svCM: Sound Velocity [Chen-Millero, m/s]
name 34 = svCM1: Sound Velocity, 2 [Chen-Millero, m/s]
name 35 = sbeox0PS: Oxygen, SBE 43 [% saturation]
name 36 = sbox0Mm/Kg: Oxygen, SBE 43 [umol/kg]
name 37 = sbeox0Mg/L: Oxygen, SBE 43 [mg/l]
name 38 = sbeox0Mm/L: Oxygen, SBE 43 [umol/l]
name 39 = sbeox1PS: Oxygen, SBE 43, 2 [% saturation]
name 40 = sbox1Mm/Kg: Oxygen, SBE 43, 2 [umol/kg]
name 41 = sbeox1Mg/L: Oxygen, SBE 43, 2 [mg/l]
name 42 = sbeox1Mm/L: Oxygen, SBE 43, 2 [umol/l]

For the Titanium CTD casts, the derived variables are:

name 24 = depSM: Depth [salt water, m]
name 25 = sal00: Salinity, Practical [PSU]
name 26 = sal11: Salinity, Practical, 2 [PSU]

name 27 = sigma-é00: Density [sigma-theta, kg/m^3]
name 28 = sigma-é11: Density, 2 [sigma-theta, kg/m^3]
name 29 = svCM: Sound Velocity [Chen-Millero, m/s]
name 30 = svCM1: Sound Velocity, 2 [Chen-Millero, m/s]
name 31 = sbeox0PS: Oxygen, SBE 43 [% saturation]
name 32 = sbox0Mm/Kg: Oxygen, SBE 43 [umol/kg]
name 33 = sbeox0Mg/L: Oxygen, SBE 43 [mg/l]
name 34 = sbeox0Mm/L: Oxygen, SBE 43 [umol/l]

7. Bottle Summary (BottleSum)

Input files: DY167_CTD_XXX$.XMLCON (in processed directory), DY167_CTD_XXX$.ros

Output files: DY167_CTD_XXX$.btl

The bottle files (.btl) are created using BottleSum. The files are made using an average of the 5 second window centred around the bottle firing times. All DatCnv variables plus derived salinity and oxygen are included. Note that the final bottle files are produced during the Matlab processing steps.

8. Strip

The Strip routine removes the first depth variable created at the DatCnv Stage.

Input and output files: DY167_CTD_XXX$_derived.cnv

9. Bin Average (1) (BinAvg)

The BinAvg routine was used to make a 2 Hz (0.5 seconds) average file of all variables (needed for Matlab processing).

Input file: DY167_CTD_XXX$_derived.cnv

Output file: DY167_CTD_XXX$_derived_2hz.cnv

10. Bin Average (2) (BinAvg)

The BinAvg routine was used to make a 1 Hz (1 seconds) average file of all variables for LADCP processing.

Input file: DY167_CTD_XXX$_derived.cnv

Output file: DY167_CTD_XXX$_derived_LADCP.cnv

11. ASCII Out (Asciiout)

The Asciiout routine produces a .asc file with latitude, longitude, time (seconds), pressure, temperature, salinity and oxygen for the LADCP processing software.

Matlab Processing Steps

1. Create meta data file
The following information was stripped from the cruise master event log and used as header information for each CTD cast file.

CRUISE	DY167
CAST	CTD cast number
STNNBR	Event number (matches bridge log)
DATE	Date of the start of the CTD cast
TIME	Time of the start of the cast (in GMT)
LAT	Latitude of the start of the CTD cast
LON	Longitude of the start of the CTD cast
DEPTH	EA640 echo sounder depth at the start of the CTD cast

2. Read .cnv files

The 24 Hz and 2 Hz .cnv derived files that were created by the SBEDataProcessing Software were read into a matlab structre and combined with the meta data information.

3. Remove surface soak and out of water readings

The 24 Hz pressure, pump status and oxygen data (slowest of all the sensors) were plotted on screen and the start and end of each cast was identified manually. The start was defined as the shallowest pressure after the initial surface soak (approximately 5 m but dependant on wave conditions), just before the CTD package started it's decent. The end of each cast was selected as the last good oxygen data point when the CTD was near 0 db (approximately 2 m). The pump status was plotted to ensure that the pumps were on during the selected time period. The start and end times were saved in a master file and used to crop the full 24 Hz profile.

4. Filter

A routine that performs a similar job to the WildEdit SBEDataProcessing software was used to automatically de-spike the temperature, conductivity, salinity, density, oxygen and transmission variables. Blocks of data were scanned twice. In the first pass the mean and standard deviation of data in a block are calculated. Any data point within that block the differed from the mean by more than the specified standard deviations were removed. The mean and standard deviation were then recomputed. Any remaining data that differed from the second mean by more than the standard deviation specified for pass 2 were also removed (NAN'd). The block size and number of standard deviations differed for each variable.

Scans per block: 50 to 200
Standard deviations for pass 1: 2 or 3
Standard deviations for pass 2: 2 or 3

5. Create bottle files

The scan number for each bottle firing was extracted from the .bl files and all variables were extracted in 5 second windows centred on the bottle firings. Averages, standard deviations, minima and maxima were all computed and saved.

6. Split up and downcasts

Each profile was split into up and down casts based on the maximum pressure recorded.

7. Manual de-spiking

The downcast twin temperatures, twin salinities and oxygen (twin for Stainless Steel CTD cast), fluorometer, PAR, beam attenuation and transmission were all further quality controlled in a manual graphical user interface. (1) Any spikes not removed by the automatic filter were flagged and removed. (2) Larger spikes/artefacts in the CT (conductivity - temperature) sensors lasting a few seconds, predominantly in regions of strong density gradients were identified. This is a persistent problem in near surface waters with strong property gradients, particularly when a CTD package carrying large volume Niskin bottles is used. This problem was more prevalent in the Stainless Steel CTD cast as the Titanium frame had 10 L as opposed to 20 L bottles. The spikes tend to coincide with a decrease in the decent rate of the CTD package and are therefore likely associated with inefficient flushing of water around the sensors. This is caused by the pitch, roll and heave of the ship, so it is accentuated in rough weather. As the decent rate of the CTD package slows on the downcast, previously sampled water (from above) is pushed passed the sensors. As the decent rate increases again un-sampled water is flushed past the sensors. A similar problem can occur if the veer rate on the CTD winch varies. This change in flushing can produce variability and spiking in the CT sensors. Active heave compensation which elevates some of the larger CT artefacts, was only turned on below 100 m on longer casts > 150 m and in rough weather. (3) The CTD package is stopped at times by the winch operator to turn on the active heave compensation or when approaching the bottom. This produces similar spiking and artefacts described in (2) but with the addition of overlapping CT against the depth dimension as the heave of the ship moved the CTD over the same patch of water. If spiking or a disturbance from the general CT trend of the profile was identified when the CTD was stopped, this period was flagged.

When spikes were identified in the temperature or conductivity, the matching derived salinity and density vales were also removed. The weather was rough around CTD cast 007 to 013. These casts therefore had the most data manually removed. While the most significant anomalies were removed it was impossible to eliminate every instance. Care should be taken not to over interpret these features.

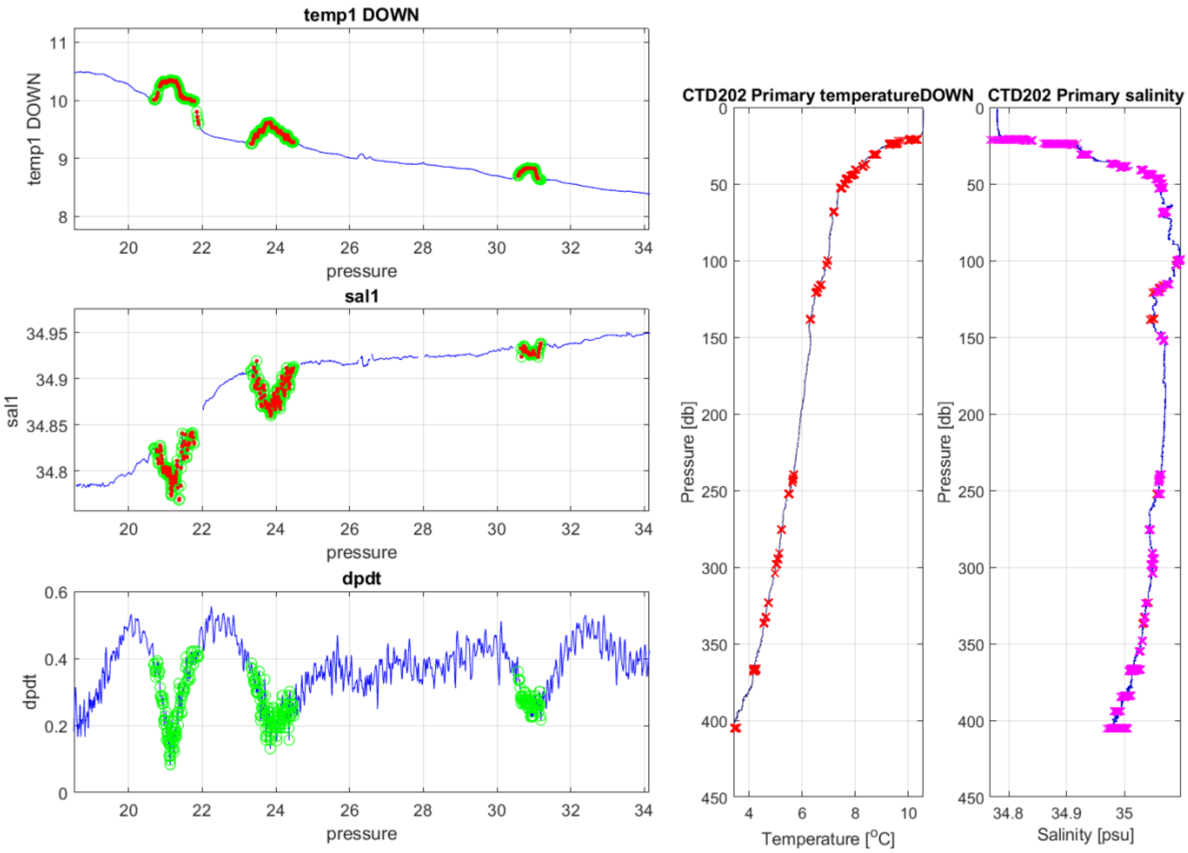

Figure 2.4 Example from CTD202S of broad (1 m) spikes in the temperature and salinity associated with a decrease in the decent rate of the CTD package as it passed through a sharp gradient in temperature (2°C decrease over 5 m) and salinity. As the CTD package slows, colder and fresher water from above is pushed back passed the sensors again. The sections identified in red/green between 20.5 - 22 db and 23 – 24.5 db were identified manually and removed from the profile.

8. 1 db averaging

Variables were averaged into 1 db bins. Missing or cropped out data were linearly interpolated for bins between maximum and minimum pressure. No extrapolation was performed at the surface or bottom.

9. Apply salinity, oxygen, chlorophyll and transmission calibrations

Salinity, oxygen and chlorophyll samples were taken from the CTD Niskin bottles to calibrate the respective sensors. The new transmissometer calibration values were obtained by Paul Henderson during the cruise.

(a) Salinity

A total of 172 salinity samples were taken from Niskin bottles during the cruise. 96 of these were taken from the Stainless Steel CTD and 76 were taken from the Titanium CTD. The salinity samples range between 32.45 and 35.25 PSU.

For each sample the bottle (including cap and plastic insert) was rinsed 3 times with the Niskin sea water and then filled. The bottle neck (inside and outside), plastic insert and cap were all wiped dry and then the insert and bottle cap were fitted. Once a crate of 24 bottles had been filled, the crate was placed in the same temperature controlled room as the Autosal (S/N

71185) for at least 24 hours to acclimate to the laboratory temperature (21 °C). Further details on the Autosal setup and standardisation can be found in the report provided by NMF technician Paul Henderson (Appendix F).

At the start and end of each crate a standard sea water (SSW) sample was analysed to monitor any drift of the Autosal instrument. One reading on 1st August 2023 was 0.0021 PSU, i.e. outside the instrument specification of 0.002 PSU, however the average of the two SSW samples for that crate was below 0.002 PSU. All of the other Autosal SSW samples were within the instrument specification of 0.002 PSU.

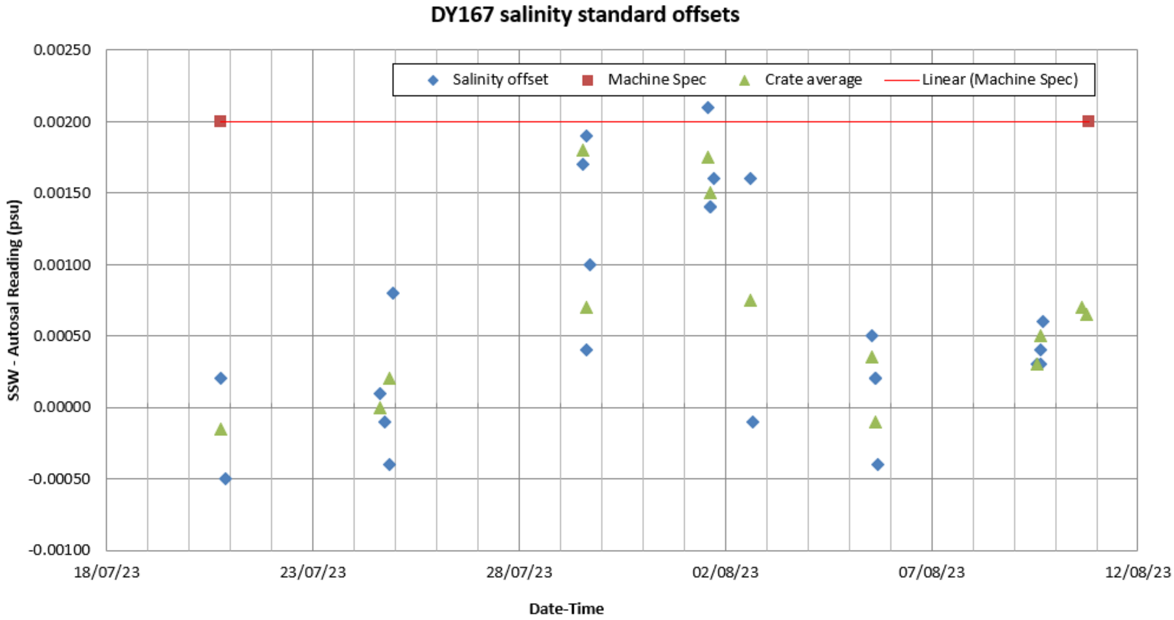

Figure 2.5 Autosal salinity offset from the seawater standard. Green triangles are the average crate offset applied to the salinity readings within the associated crate.

The difference between the Autosal salinity and the primary/secondary CTD salinity were calculated for all 172 salinity samples.

The median and standard deviation of the CTD and Autosal salinity differences were calculated for both sensors. All samples with a difference larger than 0.3 standard deviations from the median were excluded. This was a little generous, but meant low salinity samples were kept. These were predominantly in the top 20 m of the water column where both temperature and salinity gradients were highest. The median offsets were subsequently recalculated.

For Stainless Steel sensor 1, 22 out of 96 points were rejected (22.9%)
For Stainless Steel sensor 2, 13 out of 96 points were rejected (13.5%)

For Titanium sensor 1, 10 out of 78 points were rejected (12.8%)
For Titanium sensor 2, 12 out of 78 points were rejected (15.4%)

There was no temporal trend (Figure 2.6). So, the following constant offsets were applied.

For Stainless Steel sensor 1, -0.0020 PSU (CTD reading too low)
For Stainless Steel sensor 2, -0.0008 PSU (CTD reading too low)

For Titanium sensor 1, -0.0032 PSU (CTD reading too low)

For Titanium sensor 2, -0.0046 PSU (CTD reading too low)

Once the salinity had been corrected the conductivity and potential density were both recalculated.

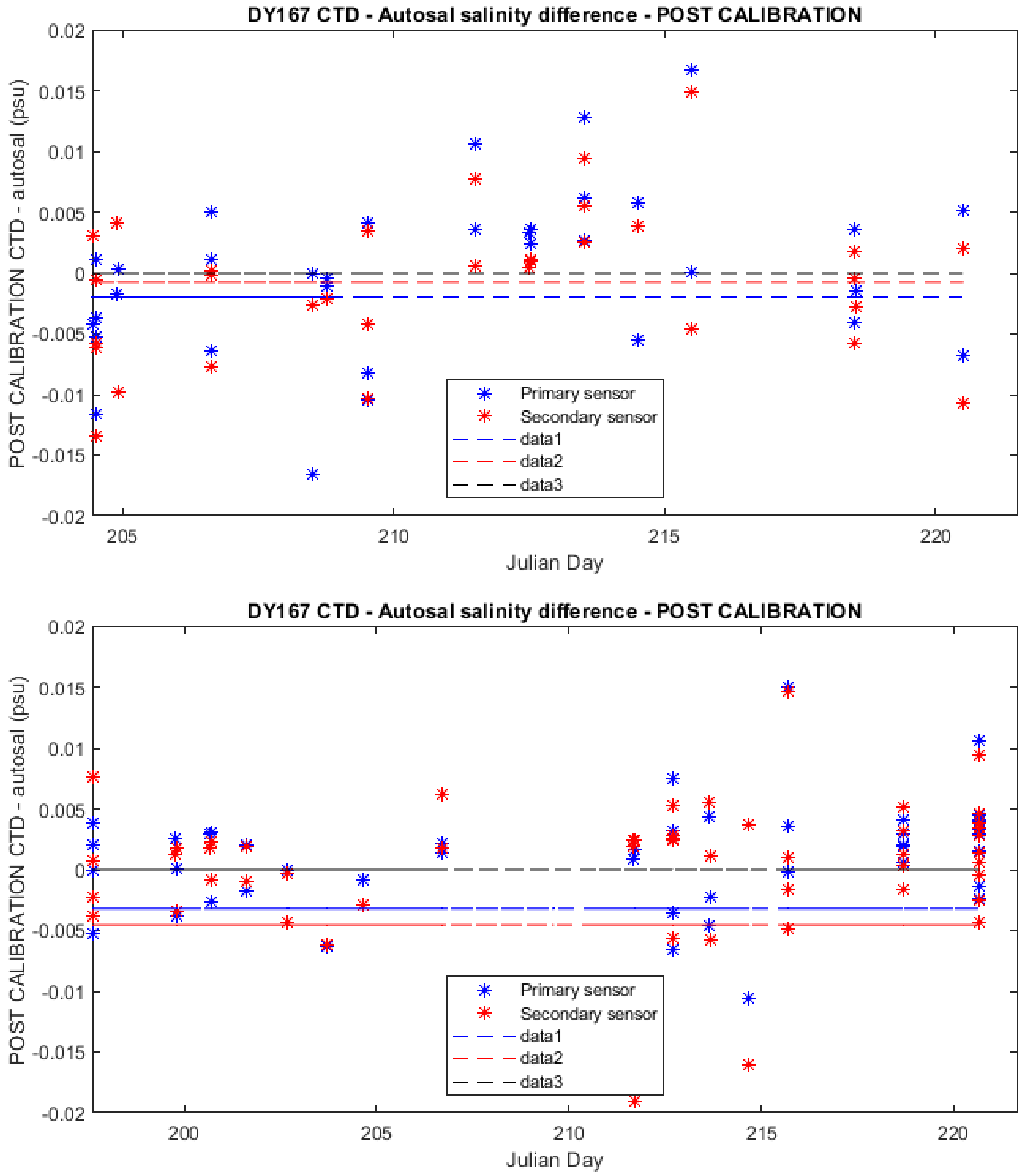

Figure 2.6 Stainless Steel CTD minus Autosal differences for the primary and secondary sensors once the offsets (dashed red and blue horizontal lines) had been applied. Bottom. Same as top but for the Titanium CTD.

(b) Oxygen

The SS-CTD oxygen sensor has been calibrated against Winkler titration samples collected from the Stainless Steel CTD Niskin bottles (see Section 3.2). There were 18 sample measurements available (average values from triplicate samples). No oxygen samples were collected from the Titanium CTD so we were unable to calibrate the oxygen sensor on this frame.

The secondary CTD oxygen sensor gave erroneous measurements of oxygen in the upper 15 m of the water column. 2 samples were rejected from the analysis for the secondary sensor that were in the upper 15 m.

For Stainless Steel sensor 1, 0 out of 18 points were rejected (0%)
For Stainless Steel sensor 2, 2 out of 18 points were rejected (11.8%)

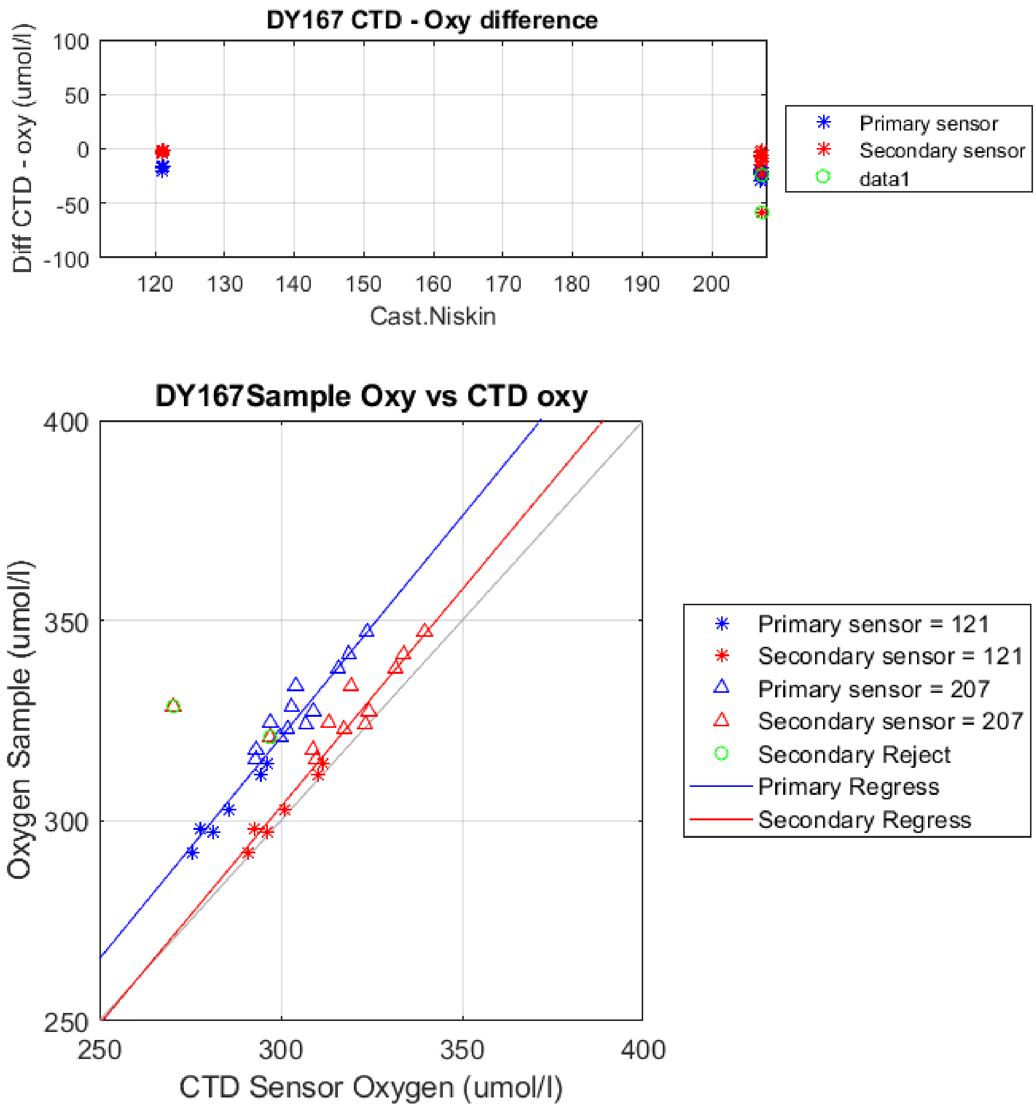

Figure 2.7 CTD sensor oxygen vs Oxygen Winkler Sample value for both SS-CTD sensor 1 and sensor 2. Coloured lines show the respective regressions. Green points have been rejected.

The linear gradient and offset between the SS-CTD sensor and the Winkler samples were calculated. The equations for calibrating the oxygen sensors are:

Stainless Steel sensor 1: oxygen = (1.0664 x sensor) + 0.2909
Stainless Steel sensor 2: oxygen = (1.1022 x sensor) - 26.8829

The deepest oxygen sample was for 400 m. There was no significant trend of oxygen against depth (Figure 2.8). A trend might have been found over a larger depth range but 400 m is too shallow for a correction.

A check of calibrated oxygen against time was carried out. We have decided there is insufficient temporal range (2 sample days) to identify or correct for any drift in the calibration over time.

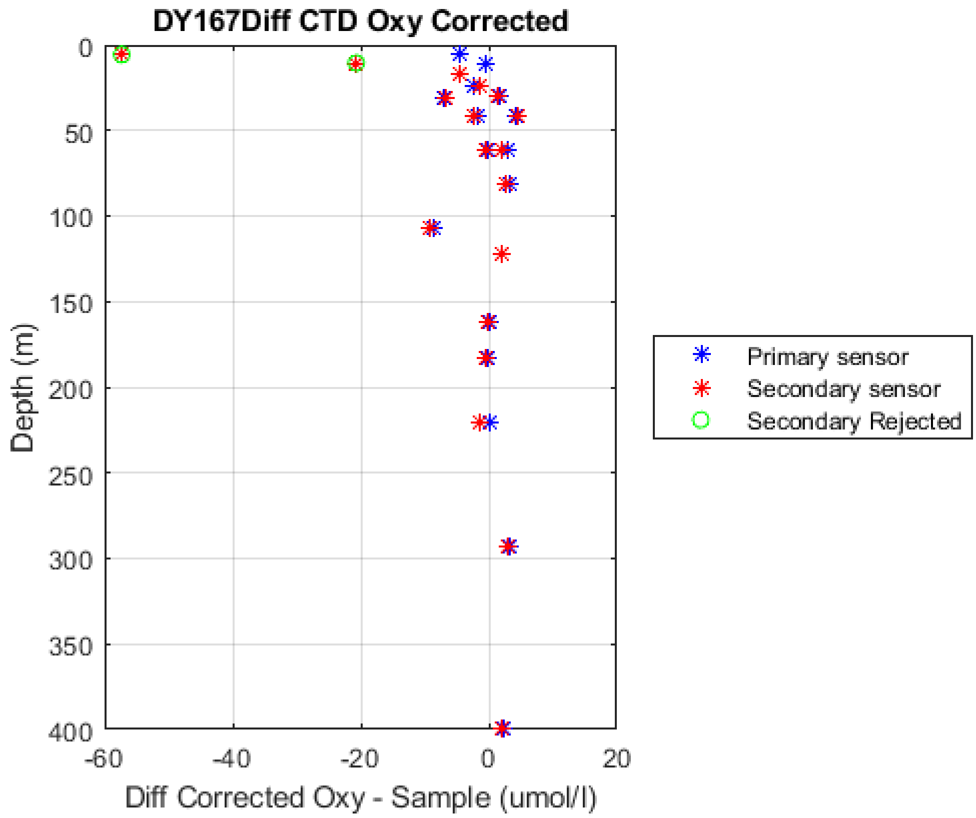

Figure 2.8 Stainless Steel CTD sensor 1 – Winkler sample vs. sample depth AFTER calibration (blue), Stainless Steel CTD sensor 2 – Winkler sample vs. sample depth AFTER calibration (red). Green points have been rejected.

(c) Chlorophyll

The fluorometer sensors on both the Stainless Steel and Titanium CTDs have been calibrated against chlorophyll samples collected from the respective CTD Niskin bottles (see Section 3.4). Both fluorometers on the CTD showed a bimodal response in the fluorescence to the chlorophyll. This response appears dependant on T/S properties and could be different species in cold, salinity stratified water compared to warmer, temperature stratified water.

However, T/S properties are variable with depth, so to avoid a discontinuity in a fluorescence profile we use Latitude 77 °N as the criteria for splitting the dataset (Figure 2.9 and Figure 2.10). For simplicity we use two linear regressions. The linear gradient and offset between the CTD sensor and the chlorophyll samples were calculated for each latitude grouping. Before calculating the calibration, 3 points which had CTD sensor fluorescence > 2.9 ug/l were rejected from the Stainless Steel CTD calibration. 1 point which had CTD sensor fluorescence > 2 ug/l of were rejected from the Titanium CTD calibration. This was because they were spurious and deviated from the other points. Of the extracted chlorophyl *a* measurements available (average values from triplicate samples) those that had a standard deviation greater than 1 ug/l were discarded.

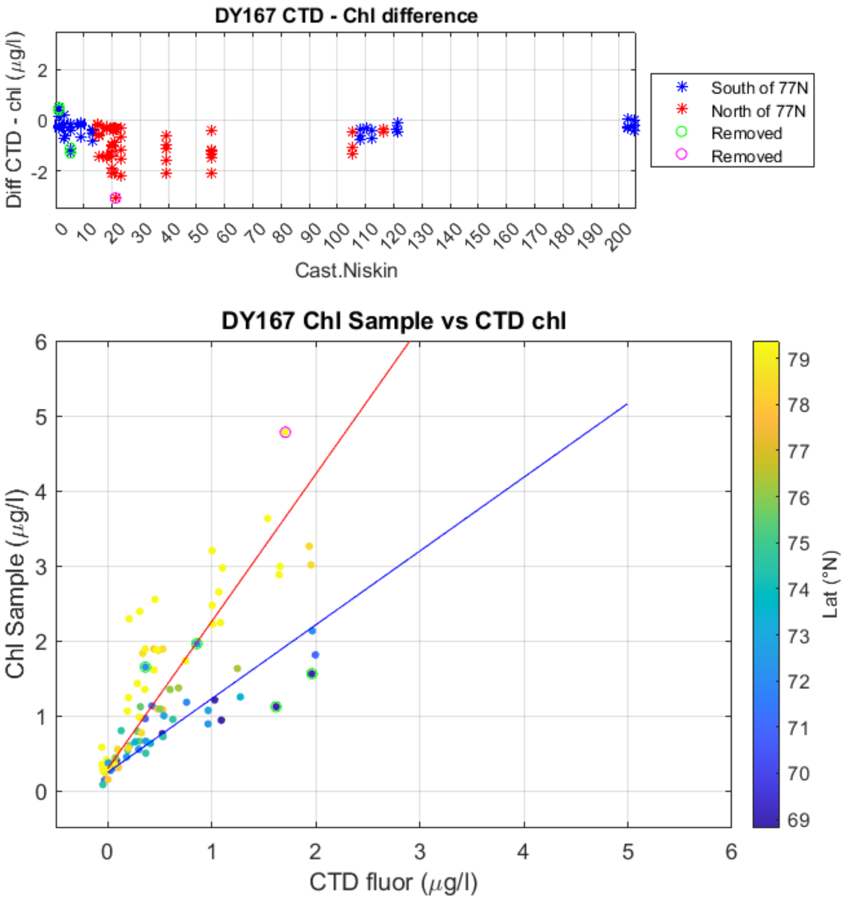

Figure 2.9 (top) The difference in sensor and sample value over the SS- CTD cast number. Green and magenta circles indicate rejected points outside 1 standard deviation. (bottom) Stainless Steel CTD fluorometer sensor vs chlorophyll sample, points coloured by latitude. Two separate regression lines are plotted for casts north (red line) and south (blue line) of 77 °N. Green and magenta circles indicate rejected points outside 1 standard deviation.

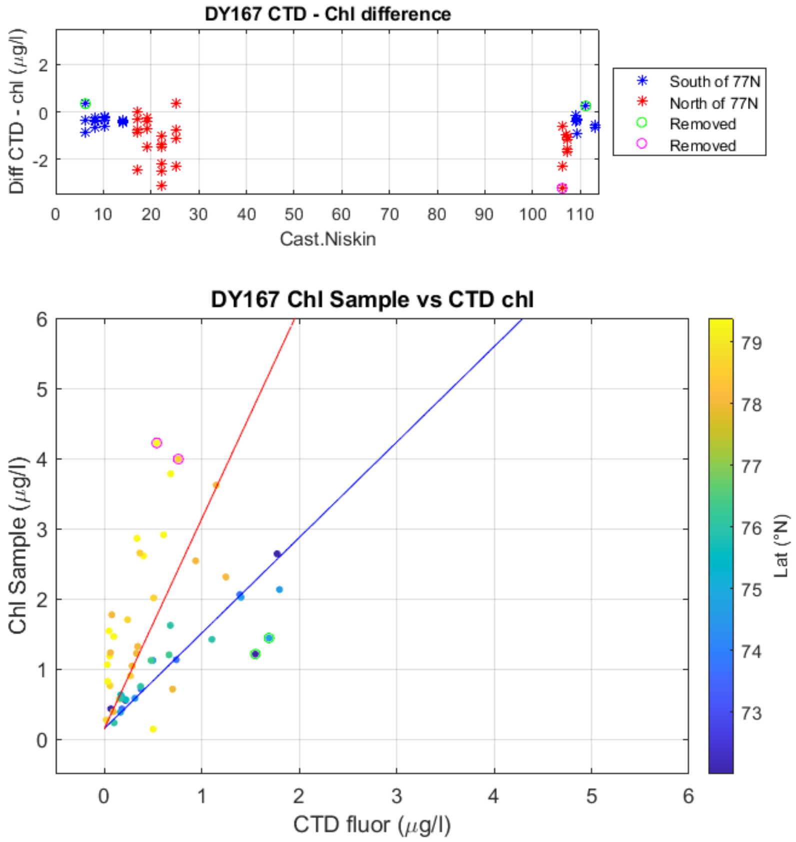

Figure 2.10 Same as Figure 2.9 but for the Titanium CTD.

For Stainless Steel CTD sensor 1 < 77 °N, 4 out of 48 points were rejected (8.3%)
For Stainless Steel CTD sensor 1 >= 77 °N, 1 out of 49 points were rejected (2.0%)
For Titanium CTD sensor 1 < 77 °N, 2 out of 24 points were rejected (8.3%)
For Titanium CTD sensor 1 < 77 °N, 2 out of 30 points were rejected (6.7%)

To ensure that low chlorophyll values, typically at depth, were not artificially high due to the least squares calibration line, an intercept was calculated prior to the least squares fit. For the Stainless Steel CTD, the intercept was calculated from the average value of chlorophyll samples < 0.4 ug/l. For the Titanium CTD, there were too few chlorophyll samples < 0.4 ug/l so a fixed value of 0.15 ug/l was used to produce a close comparison with the Stainless Steel CTD casts below the subsurface chlorophyll maximum. This intercept was then used to force the least squares fit line through on the y-axis and the linear gradient between the CTD sensor and the chlorophyll samples was calculated. The equation for calibrating the fluorometer sensors is:

chl_sensor = chl_gradient * fluorescence_sensor + chl_intercept

Stainless Steel CTD < 77 °N coefficients: chl_gradient = 0.9841, chl_intercept = 0.2433
Stainless Steel CTD >= 77 °N coefficients: chl_gradient = 1.9640, chl_intercept = 0.2936
Titanium CTD < 77 °N coefficients: chl_gradient = 1.3608, chl_intercept = 0.15
Titanium CTD >= 77 °N coefficients: chl_gradient = 2.9912, chl_intercept = 0.15

(d) Transmission

An update to the manufacturer calibration of the transmissometer on the Stainless Steel CTD was received during the cruise. The new calibration values were not inserted into the SeaBird config files mid-cruise. Instead, we made the transmission correction during post-processing and apply it to all CTD casts. The equation used to apply the new calibration coefficients is below:

CTDxmiss_cal = (((CTDxmiss + 0.044) / 21.947) * 21.150) – 0.042

10. Final output and data delivery

The calibrated 1 db files are output as .csv files. In the cases where there are two sensors the "cleanest" sensor is output to file. For temperature, salinity and density, the secondary sensors on the vane are used. For the oxygen sensor on the Stainless Steel CTD, the primary sensor is mostly used due to problems with the secondary sensor. In profiles CTD005S and CTD007S the primary oxygen sensor had problems (which were later resolved) and the secondary had been fitted so the secondary is used for these casts. Variable names that have "_cal" at the end are the calibrated version of the variable.

The Stainless Steel CTD files (e.g. DY167_CTD_001S_final_1db_down_sel.csv) contain the following variables:

CTDscan	Scan count
CTDlatitude	Latitude (decimal °N)
CTDlongitude	Longitude (decimal °E)
CTDjday	Julian Days
CTDtime	Time, elapsed (seconds)
CTDpump	Pump status
CTDpres	Pressure (db)
CTDtemp2	Secondary temperature (on the vane) (°C)
CTDatt	Beam Attenuation (m^{-1})
CTDturb	Turbidity (m^{-1} sr^{-1})
CTDpar	PAR/Irradiance (upwards looking) (umol photons m^{-2} sec^{-1})
CTDpar1	PAR/Irradiance (downwards looking) (umol photons m^{-2} sec^{-1})
CTDaltim	Altimeter (meters above bottom)
CTDdepth	Depth (m)
CTDflag	Flag
CTDcond2_cal	(calibrated) Secondary conductivity (on the vane) (mS cm^{-1})
CTDsal2_cal	(calibrated) Secondary Salinity (on the vane) (psu)
CTDpden2_cal	(calibrated) Potential density (from vane sensors) (kg m^{-3})
CTDsigma_theta2_cal	Potential density anomaly (from vane sensors) (kg m^{-3})
CTDsound_vel2_cal	Sound speed from secondary sensors (on the vane) (m s^{-1})
CTDoxy2_umoll_cal	(calibrated) Primary dissolved oxygen concentration (µmol L^{-1})
CTDoxy2_umolkg_cal	(calibrated) Primary dissolved oxygen concentration (µmol kg^{-1})
CTDxmiss_cal	Beam Transmission (%)
CTDfluor_cal	(calibrated) Chlorophyll-a (mg m^{-3})

The Titanium CTD files (e.g. DY167_CTD_002T_final_1db_down_sel.csv) contain the following variables:

CTDscan	Scan count
CTDlatitude	Latitude (decimal °N)
CTDlongitude	Longitude (decimal °E)
CTDjday	Julian Days
CTDtime	Time, elapsed (seconds)
CTDpump	Pump status
CTDpres	Pressure (db)
CTDtemp2	Secondary temperature (on the vane) (°C)
CTDatt	Beam Attenuation (m^{-1})
CTDxmiss	Beam Transmission (%)
CTDturb	Turbidity (m^{-1} sr^{-1})
CTDph	pH (unitless)
CTDpar	PAR/Irradiance (upwards looking) (umol photons m^{-2} sec)
CTDpar1	PAR/Irradiance (downwards looking) (umol photons m^{-2} sec)
CTDaltim	Altimeter (meters above bottom)
CTDdepth	Depth (m)
CTDoxy2_umoll	Primary dissolved oxygen concentration (µmol L^{-1})
CTDoxy2_umolkg	Primary dissolved oxygen concentration (µmol kg^{-1})
CTDflag	Flag
CTDcond2_cal	(calibrated) Secondary conductivity (on the vane) (mS cm^{-1})
CTDsal2_cal	(calibrated) Secondary Salinity (on the vane) (psu)
CTDpden2_cal	(calibrated) Potential density (from vane sensors) (kg m^{-3})
CTDsigma_theta2_cal	Potential density anomaly (from vane sensors) (kg m^{-3})
CTDsound_vel2	Sounds speed from secondary sensors (on the vane) (m s^{-1})
CTDfluor_cal	(calibrated) Chlorophyll-a (mg m^{-3})

Preliminary results

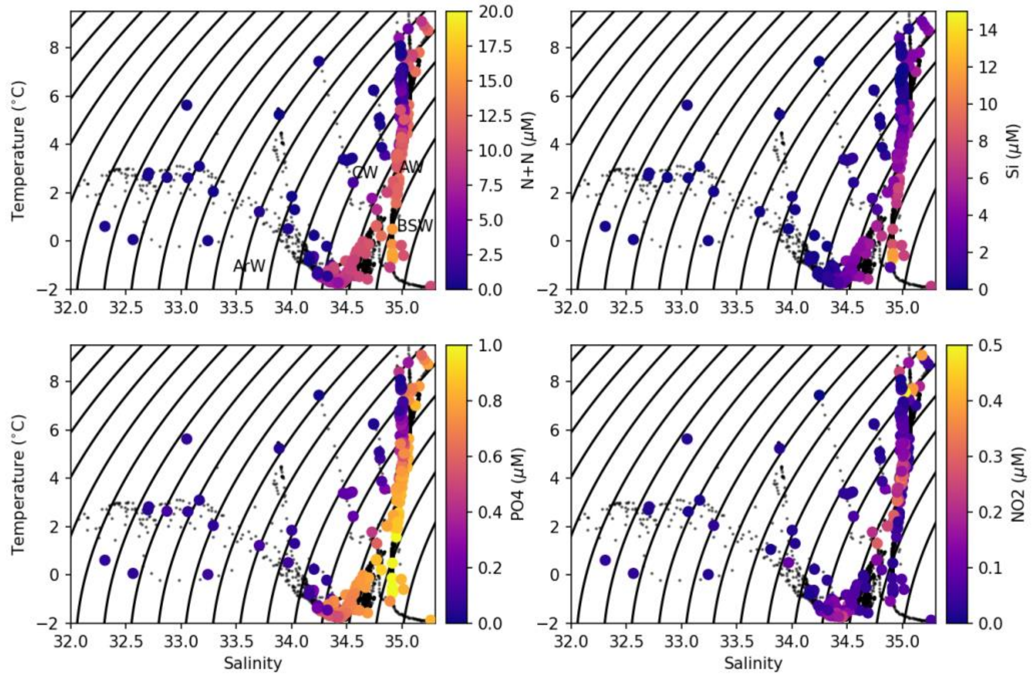

Figure 2.11 TS plot for Stainless Steel CTD casts 001 to 114. Nutrients are shown on the colour scale.

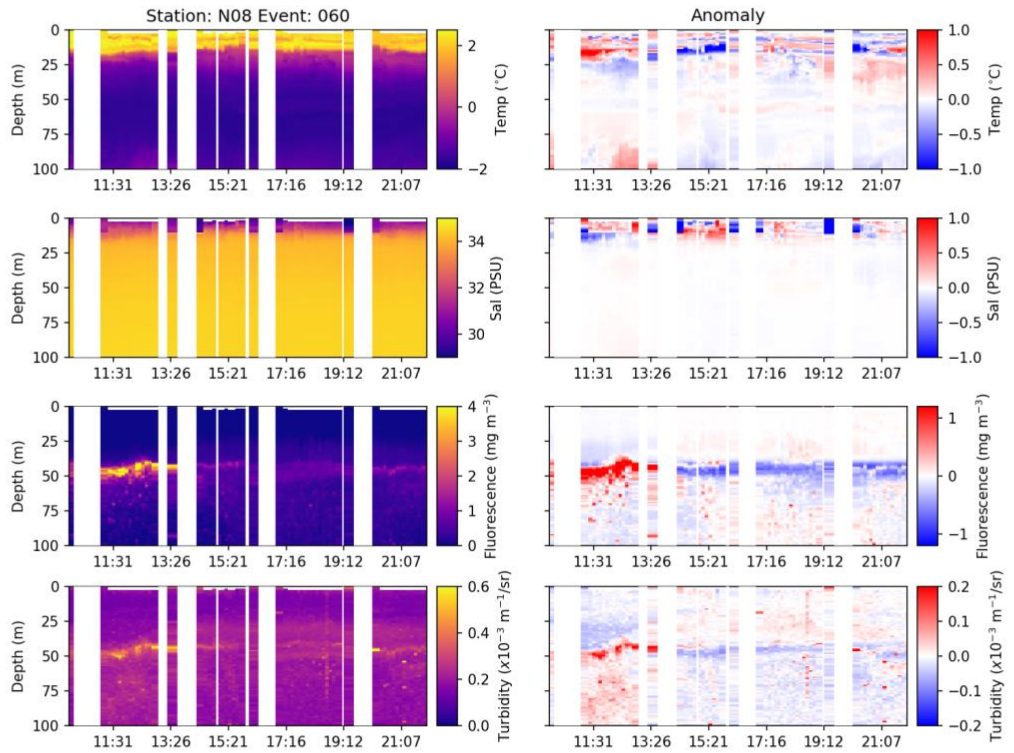

Figure 2.12 Yo-Yo CTD casts from N08 (downcasts only). (Left) Actual values. (Right) Anomaly from mean.

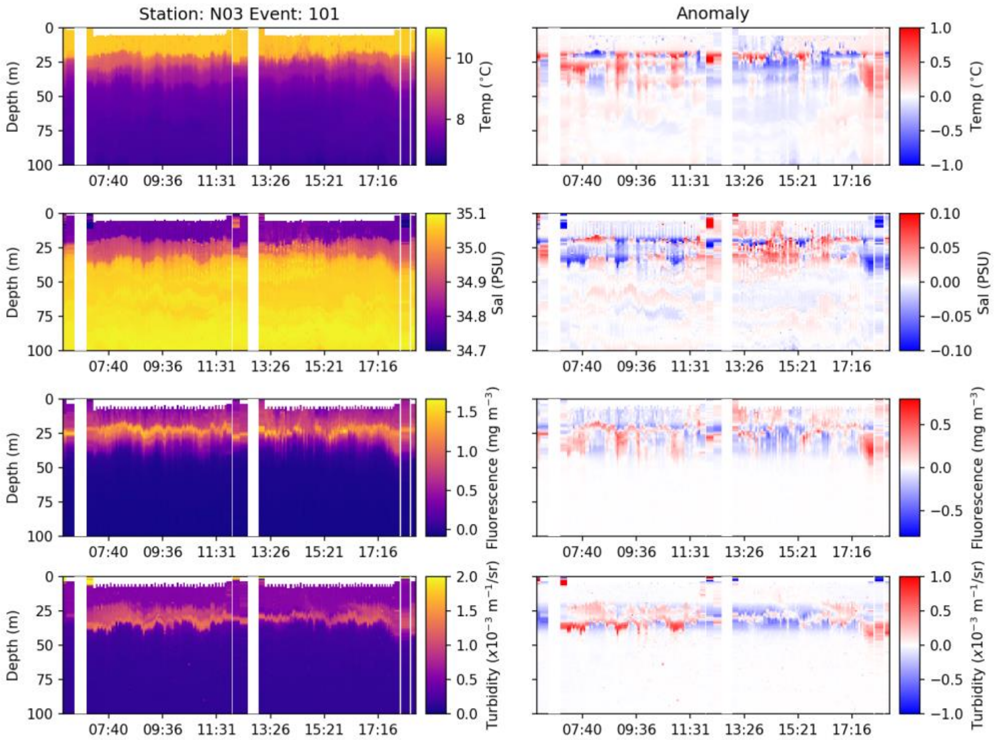

Figure 2.13 Yo-Yo CTD casts from N03 (up and downcasts). (Left) Actual values. (Right) Anomaly from mean.

2.2 Underway navigation, sea surface hydrography and meteorology

Stefanie Rynders[1] (National Oceanography Centre), Jo Hopkins (National Oceanography Centre)[2]
[1]Author, [2]Data set PI

Position
GPS readings of latitude (short name: lat) and longitude (short name: lon) were taken from the POSMV data on TechSAS in NetCDF format. The original data frequency is 1 Hz. Unphysical points were removed assuming a maximum speed of 15 knots, comparing the distance of each point to the previous and next points and calculating the distances between them. Data was then averaged over 1- and 10-min intervals. Latitude is in degrees north [-90, 90], Longitude is in degrees east [-180,180].

Bathymetry
Depth readings (short name: depth) were taken from the EA600 echosounder output in NetCDF format on TechSAS. The original output frequency is 1 Hz, unphysical values with negative depth were removed and the data was averaged over 1- and 10-min intervals. There were several time periods when the echo sounder was not functioning properly, mainly due to double reflection (Table 2.2). These were removed from the record. There were a few days when correlations with the GEBCO and/ or IBCAO datasets were unusually low, esp. 18 July and 27 July, but no data has been removed on this account. The unit of depth is m.

Table 2.2 Echosounder outtakes

start	end
13 July 2023 07:04:00	13 July 2023 07:37:00
14 July 2023 08:34:00	14 July 2023 08:59:00
14 July 2023 10:57:00	14 July 2023 11:12:00
15 July 2023 20:43:00	16 July 2023 08:31:00
20 July 2023 00:00:00	20 July 2023 08:35:00
1 August 2023 04:40:00	1 August 2023 08:10:00

Sea surface measurements
The underway sea water intake was switched off during 3 maintenance periods during the cruise. A leak occurred on the 17 of July which also necessitated switching off the system. The periods listed in Table 2.3 were removed from all the surface physics measurements.

Table 2.3 Underway system outtakes

start	finish
17 July 2023 05:00:00	17 July 2023 13:20:00
19 July 2023 13:10:00	19 July 2023 13:25:00
28 July 2023 14:12:00	28 July 2023 14:30:00
6 August 2023 12:10:00	6 August 2023 12:30:00

SST
There are two sea surface temperature measurements available on the TSG system on TechSAS in NetCDF format. Both measurements are of water taken at a depth of 5.5 m, one direct at the sea water inlet (short name: SST) and one inside the ship at the sensor board (short name: temp_h). The original data has a frequency of 1 Hz. The signal was despiked using a median filter with a 3-point window. Data was then averaged over 1- and 10-min intervals. The unit is degrees Celsius.

Drop keel temperature

Drop keel temperature is abbreviated as DKT. The sensor is located on the keel of the ship at approximately 7m depth. Data is taken from the surfmet NetCDF files on TechSAS. The native data frequency is 1 Hz. A period of sensor malfunction was removed (Table 2.4), and the data averaged over 1- and 10-min intervals. The unit is degrees Celsius.

Table 2.4 Drop keel temperature outtakes

start	finish
17 July 2023 11:00:00	17 July 2023 13:10 00

Sea surface salinity (SSS)

Sea surface salinity data was taken from the TSG output on TechSAS in NetCDF format. The sensor data has a frequency of 1 Hz. The signal was despiked using a median filter of bandwidth 3. The data was then averaged in 1-minute intervals and then again despiked using a median filter of bandwidth 3. Salinity samples were taken from the underway system to calibrate the sensor 3 to 4 times a day. The salinity samples were processed with the AUTOSAL and calibrated with standard seawater. Comparison between the sensor and sample measurements showed that the underway sensor exhibited a drift towards reading too low (Figure 2.14). The drift changed when the sensors were cleaned. To correct the sensor the measurements were therefore split into sections according to the cleaning times. For each time section the difference between sensor and sample measurements was fitted to a linear polynomial using the iterative weighted least squares method in MATLAB, the so-called robust linear fit. Figure 2.14 shows the final weights of the data points, with outliers given low weights. The fitted line was then subtracted from the sensor reading to obtain the final corrected measurement. The timeseries is shown in Figure 2.16. There are still some residual differences between the sensor and sample readings. Figure 2.16 and Figure 2.17 show that these differences typically occur in locations with relatively fresh water, or locations with rapidly changing values close to the sea ice edge or in the fjord with glacier outflow. The precision of recording the exact time that a salinity sample was taken is potentially a limiting factor here. Figure 2.18 shows that the sensor drift was eliminated after calibration. The calibration was calculated before the second median filtering of the signal but applied afterwards. The timeseries was finally averaged into 10 min intervals.

Calibration:
range1 = timerange(datetime(2023,07,9,14,0,0),datetime(2023,7,19,13,20,0));
range2 = timerange(datetime(2023,7,19,13,20,0),datetime(2023,7,28,14,20,0));
range3 = timerange(datetime(2023,7,28,14,20,0),datetime(2023,8,6,12,20,0));
range4 = timerange(datetime(2023,8,6,12,20,0), datetime(2023,08,12));

SSS_corrected(range1)= SSS(range1) - (juliandate(range1) * -0.001589866782959 + 3.911282221005874e+03);

SSS_corrected(range2)= SSS(range2) - (juliandate(range2) * -0.003582453306100 + 8.813335151028276e+03);

SSS_corrected(range3)= SSS(range3) - (juliandate(range3) * -0.006739731045641 + 1.658075949546627e+04);

SSS_corrected(range4)= SSS(range4) - (juliandate(range4) * 6.880263495774752e-05 + -1.693058287209003e+02).

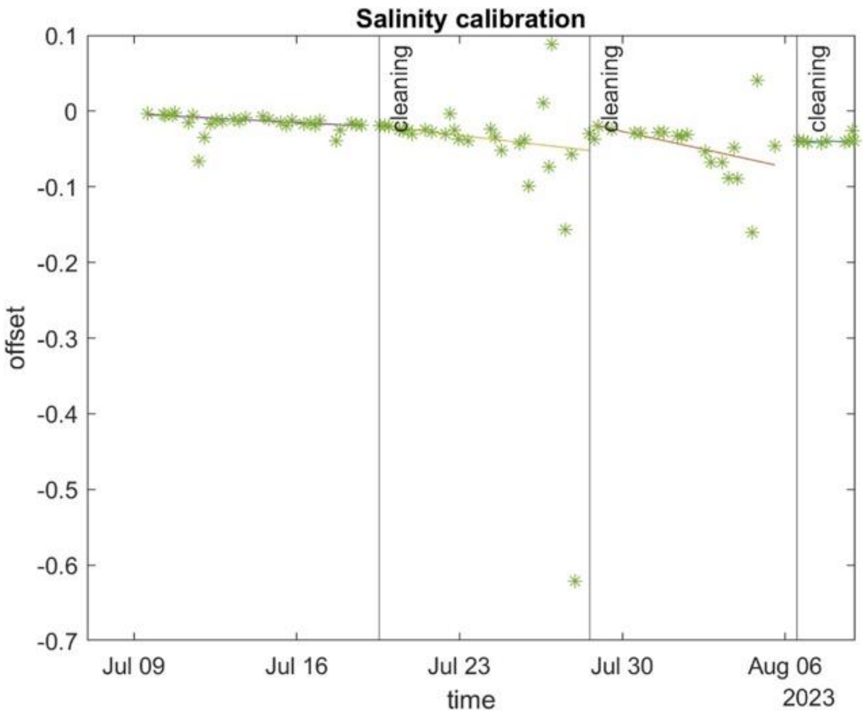

Figure 2.14 Salinity offset between the sensor and salinity sample. Red lines are the regressions fitted and used in the calibration for each of the 4 time periods.

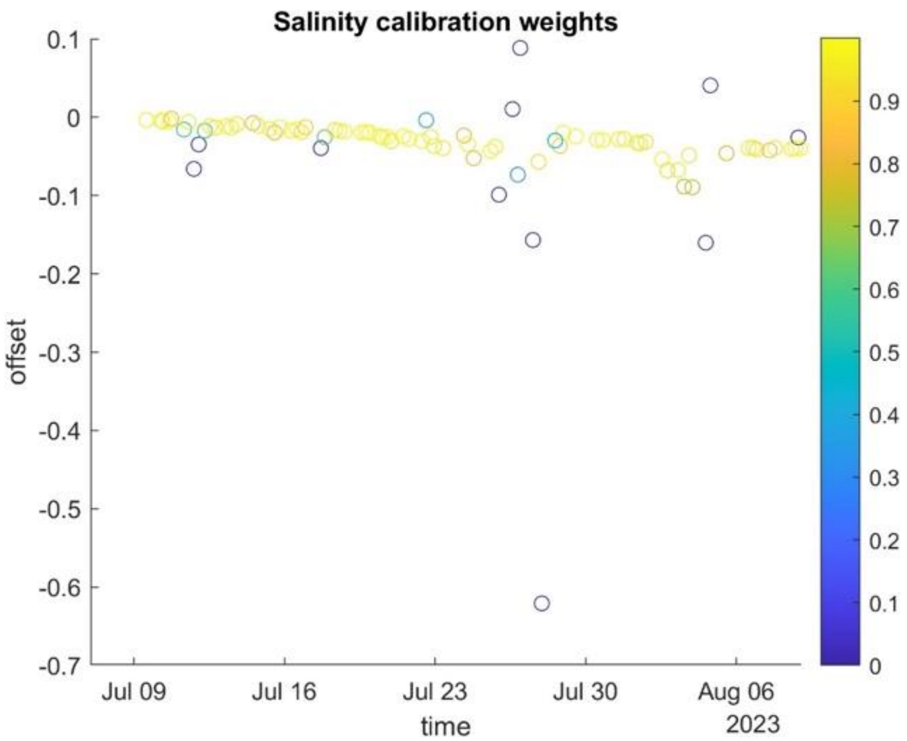

Figure 2.15 Weightings used for the salinity calibration

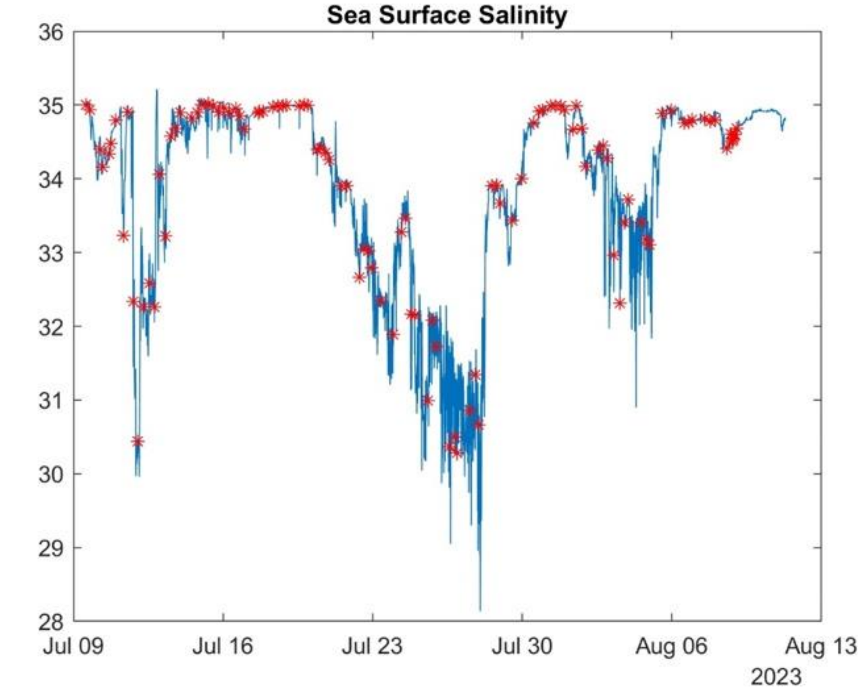

Figure 2.16 Calibrated salinity timeseries (blue) and salinity samples (red)

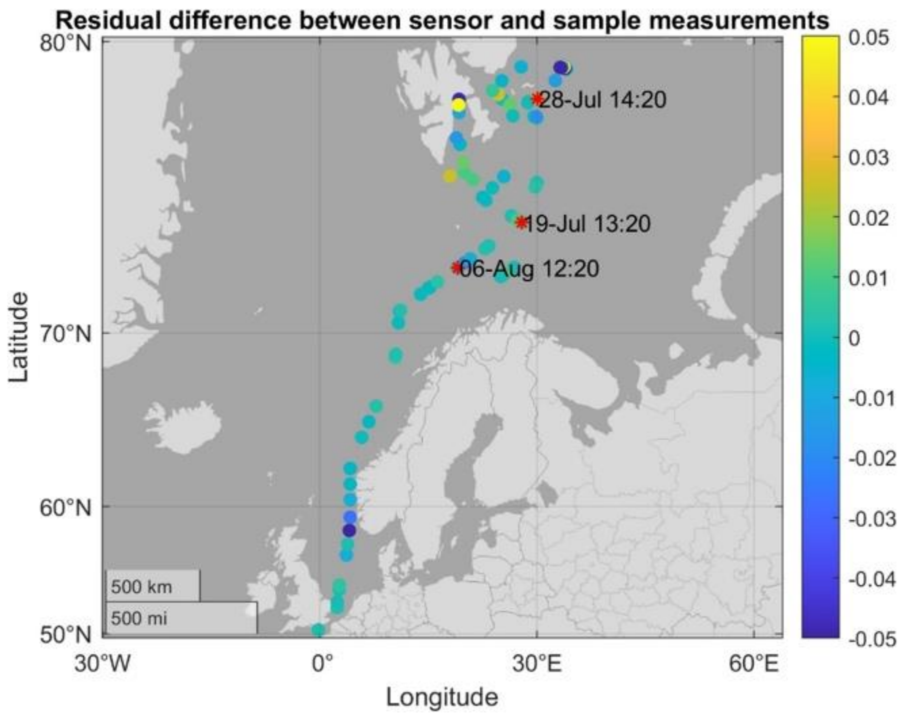

Figure 2.17 Residuals of calibration show fit is worse in areas with very fresh water or where there were sharp gradients in salinity

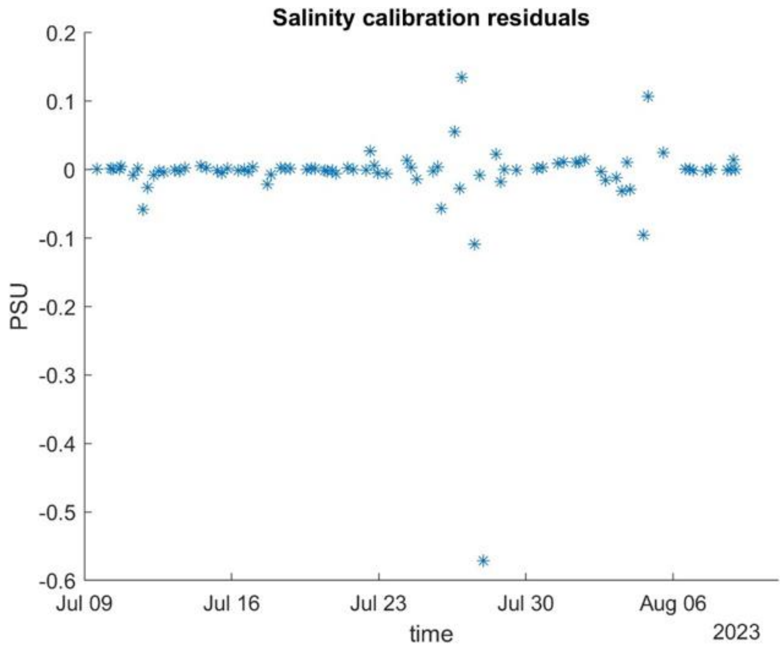

Figure 2.18 Timeline of sensor and sample differences after calibration was applied

The underway measurements have captured a wide range of the TS parameter space, including various water masses, e.g. Atlantic water, surface and coastal water and melt water (see Table 2.5). The observed salinity went down to 28 PSU and temperature to just below 0°C (Figure 2.19).

Table 2.5 Water mass definitions. References [1] Oziel et al., 2016; [2] Våge et al, 2016

Water mass	**Description**	**Pot. Temperature Limits (C)**	**Salinity limits (psu)**
Arctic Water[1]	Cold and fresh water of Arctic origin	< 0	34 – 34.7
Atlantic Water[1]	Warm and saline waters originating in the Atlantic	> 3	> 34.8
Barents Sea Water[1]	Cold and saline bottom layer of the Barents Sea	< 2	> 34.8
Coastal Water / Surface Water[2]	Warm and fresh surface waters, coming from warming of the MW and / or coastal influences	> 3	< 34.5
Melt Water (MW)[1]	Fresh surface layer produced by sea ice melting	0 < T < 3	< 34.4

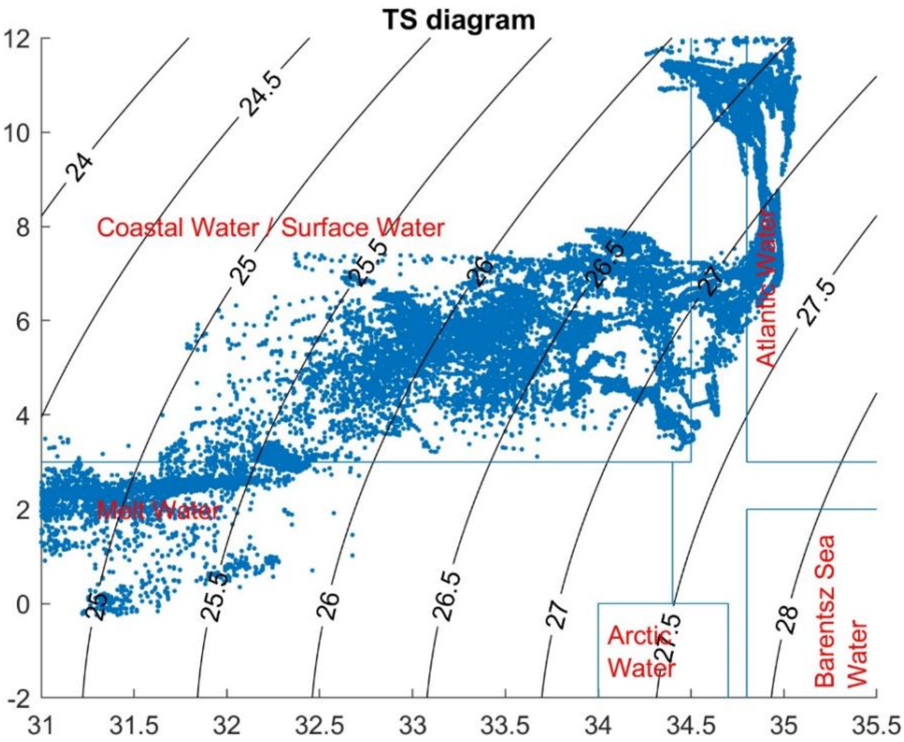

Figure 2.19 Observed surface water masses from the underway system

Transmission

Measurements of the transmission of light through sea water (short name 'trans') were taken from the surfmet system on TechSAS in NetCDF format. Transmission is 1 – the percentage of light reflected. The original unit is V, which has been converted into a percent according to the calibration certificate of the sensor (trans = (x - 0.017)/(4.699-0.017)). Spikes in the signal were removed using a 5-point median filter on the timeseries. The data was averaged over 1- and 10-min intervals.

Chlorophyll a fluorescence

The chlorophyll a fluorescence data was taken from the surfmet system on TechSAS in NetCDF format. The original data has a frequency of 1 Hz. Data was despiked using a 5-point median filter before it was averaged into 1 minute intervals. Fluorescence was then converted into chlorophyll concentration using the formula Chl = 10.24 * (fluo - 0.073). The chlorophyll timeseries was calibrated using of two sets of samples. The first set were collected from the ships underway system intake (from a tap next to the sensor board). The second set were collected from the "Fish" being towed behind the ship (at varying depths, but typically between 2-3 m below the surface). The two sample sets showed no significant differences. A calibration curve was fitted with the correction dependent on the magnitude of the signal (Figure 2.20, Figure 2.21). The algorithm is the robust linear fit in MATLAB, which iteratively calculates a weighted least square linear fit.

The calibration is applied as:

coeff_x1 = 0.5863;
coeff_intercept = -0.2251;

Chl_corrected = Chl - (Chl* coeff_x1 + coeff_intercept).

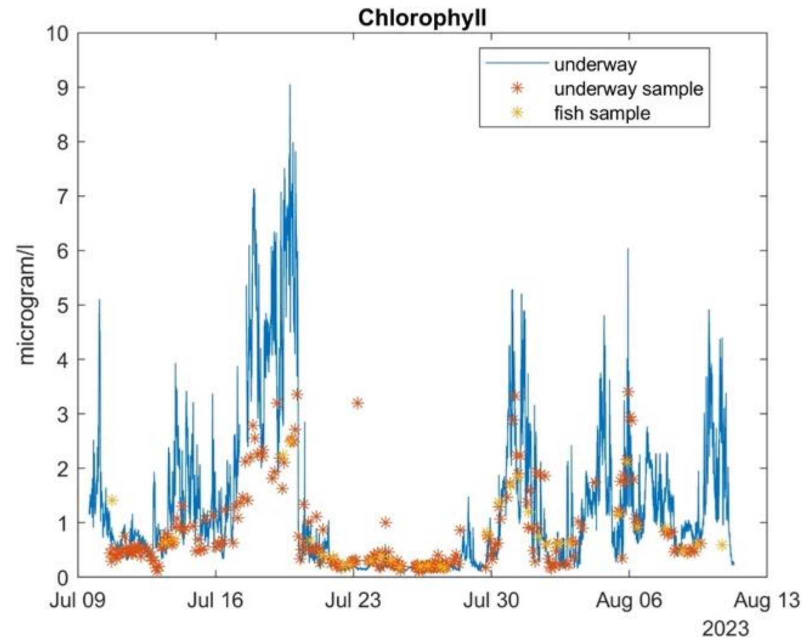

Figure 2.20 Uncalibrated chlorophyll a timeseries (blue) and extracted chlorophyll a samples (red dots: ships intake; yellow dots: FISH)

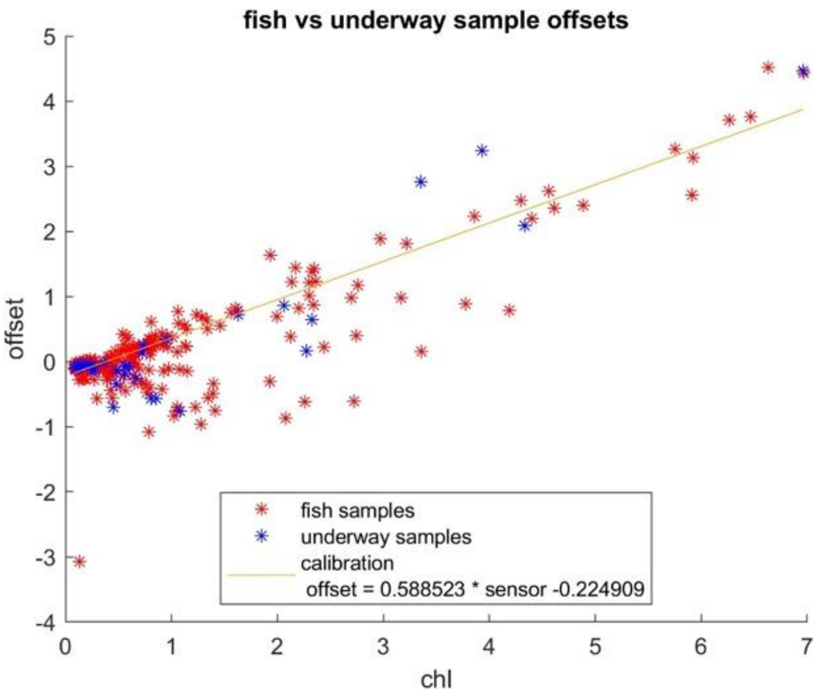

Figure 2.21 Chlorophyll a calibration

There is a group of datapoints that stand out as clustering lower than the calibration line. Figure 2.22 shows that those points have mostly been ignored in the calibration. A change in the stock of acetone was ruled as a potential cause. Figure 2.23 confirms that the outliers have no relation to cleaning periods. There is however some geographical clustering and correlation with low transmission over the shallow banks and in Storfjorden.

The chlorophyl a timeseries was averaged into 10 min intervals.

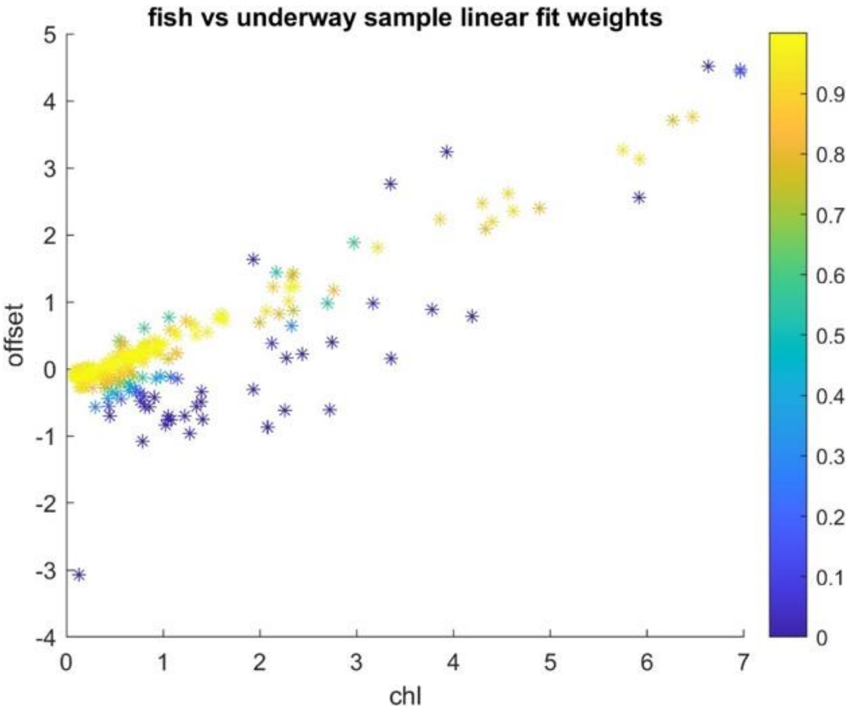

Figure 2.22 Sample weights used for the chlorophyll calibration

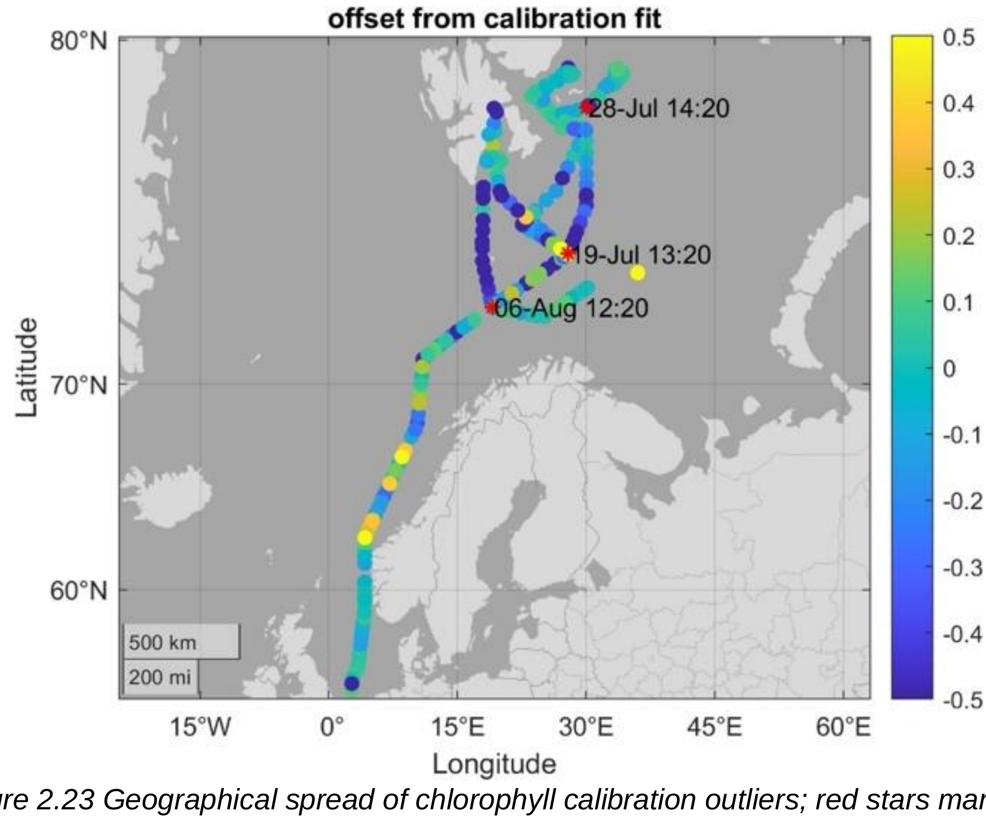

Figure 2.23 Geographical spread of chlorophyll calibration outliers; red stars mark the locations at which the underway sensors were cleaned

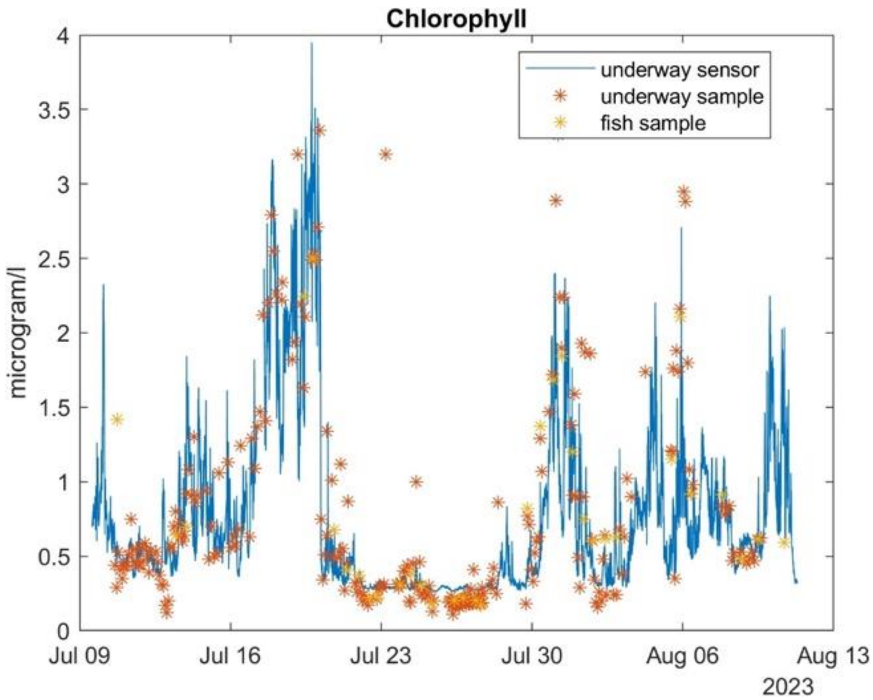

Figure 2.24 Calibrated chlorophyll a timeseries (blue) and extracted chlorophyll a samples (red dots: ships intake; yellow dots: FISH)

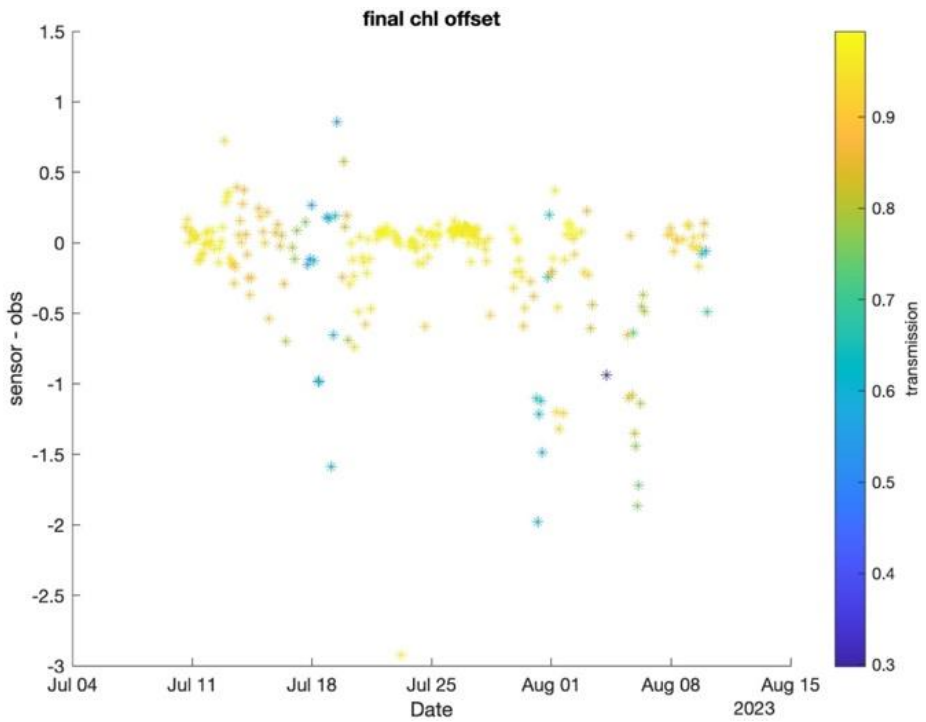

Figure 2.25 Chlorophyll calibration residuals coloured by transmission: large offsets occur in periods with low transmission

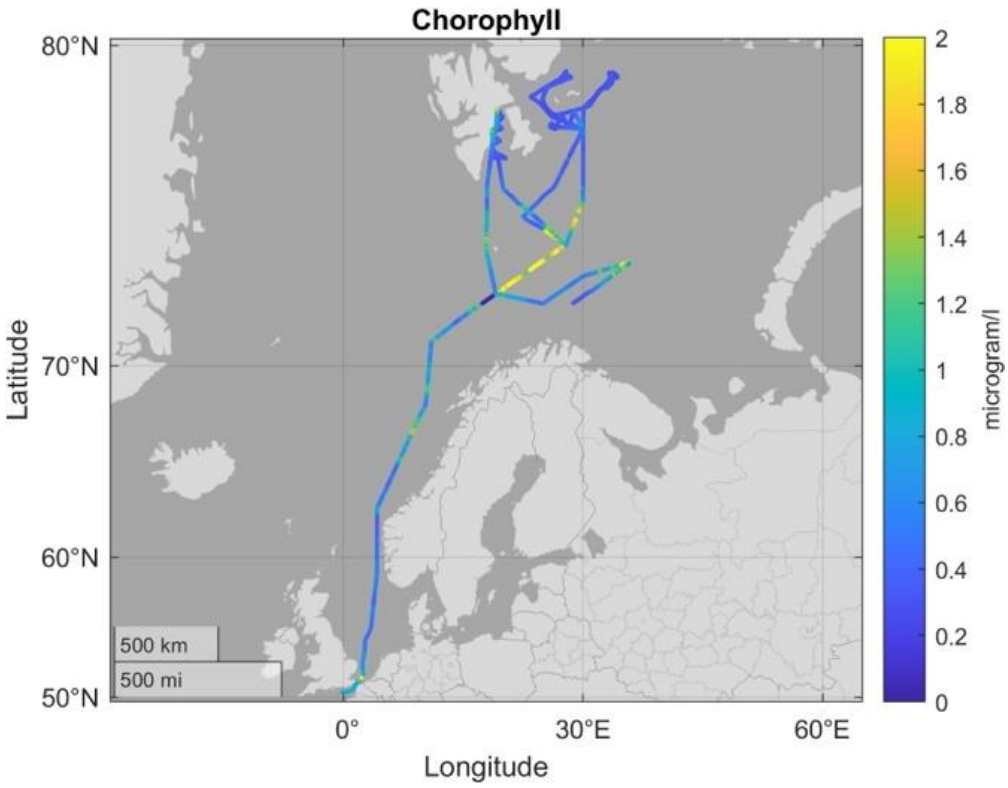

Figure 2.26 Calibrated underway chlorophyll a measurements along the full DY167 cruise track

Meteorology

Humidity

Relative humidity data (short name RH) was taken from the Surfmet output on TechSAS in NetCDF format. The original data has a frequency of 1 HZ. Outliers were removed using the “isoutlier” function in MATLAB, Outliers are defined as elements more than three scaled MAD from the median. The scaled MAD is defined as c*median(abs(A-median(A))), where c=-1/(sqrt(2)*erfcinv(3/2)). Data was then averaged over 1- and 10-min intervals. The unit of relative humidity is percent.

Radiation

There were two total radiation (TIR) and two photosynthetically active radiation (PAR) sensors on board. One on each of the port and starboard sides. Measurements were at times influenced by birds sitting on the platform blocking light. Therefore, the maximum was taken from the two (port and starboard) sensors as true measurement. The data has a native frequency of 1 Hz. The timeseries were despiked using a median filter of bandwidth 5. Data was converted from the native units of 10^-5 V to W/m2 according to the individual sensors’ calibration certificate. Data was then averaged over 1- minute intervals.

Unphysical negative values were removed as well as periods where PAR was higher than TIR. Data was then smoothed using a 5-point centred moving mean and averaged over 10-minute intervals.

Surface air temperature

Surface air temperature (short name SAT) was taken from the surfmet data on TechSAS in NetCDF format. The native data has a frequency of 1 Hz. Outliers were removed using the “isoutlier” function in MATLAB, Outliers are defined as elements more than three scaled median absolute deviations from the median. Data was averaged over 1- intervals and filtered using a 10-point moving average to remove the steps in the signal. The data was then averaged over 10-minute intervals. The unit of surface air temperature is degrees Celsius.

Surface air pressure
Surface air pressure (short name SAP, unit hPa) data was taken from the surfmet output on TechSAS in NetCDF format. The original frequency is 1Hz. Unphysical values of less than 700 hPa were removed and data was averaged into 1- and 10-minute intervals.

Wind data
Apparent wind speed and apparent direction were taken from the surfmet data on TechSAS in NetCDF format. The original frequency is 1 hz. A period with unrealistically high wind speed readings was removed from both speed and direction data Table 2.6. The apparent winds were converted into true winds using the WOCE MATLAB script for which ship ground speed was first converted into m/s using 1 knot = 0.514 m/s. The data was then averaged over 1- and 10-minute intervals. For the averaging, wind direction units were converted from degrees to radians, unwrapped using the MATLAB function to eliminate jumps, and averaged before converting back into degrees and remapped to the [0 360[interval. The origin convention is: 0 degrees is northerly, 90 degrees is easterly. The short variable names are 'true_speed' and 'true_direct'.

Table 2.6 Wind speed and direction outtakes

start	finish
26 July 2023 17:22:00	26 July 2023 17:26:00

Auxiliary data

Flow rate
The flow rate of the underway water intake system was taken from the Surfmet output on TechSAS in NetCDF format. The original frequency of the data is 1 Hz. The maintenance and leak periods were cut out (see Table 2.3). The data was averaged into 1 min intervals. The flow rate was despiked using a 10-point median filter and then averaged into 10-min intervals. After maintenance periods the flow rate increases slowly, which can take up to a few hours, but there has been no removal of data based on low flow rate. The unit of flow rate is l/min, the short name is 'flow'.

Ship heading
Ship heading is needed to calculate true winds. Ship heading was taken from the POSMV data on TechSAS in NetCDF format, consistent with the GPS data. The original frequency of the data is 1 Hz. The data was then averaged over 1- and 10-minute intervals. For the averaging units were converted from degrees to radians, unwrapped using the MATLAB function to eliminate jumps, and averaged before converting back into degrees and remapped to the [0 360[interval. The origin convention is: 0 degrees is northward, 90 degrees is eastward. The variable is named 'heading'.

Ship course
Ship course (short name gndcourse) is needed to calculate true winds. Ship course was taken from the POSMV data on TechSAS in NetCDF format, same as the GPS data. The original frequency of the data is 1 Hz. The data was then averaged over 1- and 10-minute intervals. For the averaging units were converted from degrees into radians, unwrapped using the MATLAB function to eliminate jumps, and averaged before converting back into degrees and remapped to the [0 360[interval. The origin convention is: 0 degrees is northward, 90 degrees is eastward.

Ship speed
Ship speed (short name gndspeed, unit knots) is needed to calculate true winds. Ship speed was taken from the POSMV data on TechSAS in NetCDF format, the same source as the GPS data. The original frequency of the data is 1 Hz. The data was then averaged over 1- and 10-minute intervals. Ship speed is recorded in knots.

2.3 Lowered ADCP

Jo Hopkins[1,2] (National Oceanography Centre) and Paul Henderson[1] (National Oceanography Centre, NMF)
[1]*Author,* [2]*Data set PI*

Background motivation and objectives
Full interpretation of the DY167 measurements of nitrogen fixation rates, nifH gene abundance and diversity, inorganic nutrients, trace metals and phytoplankton community structure requires understanding of the hydrodynamics of the area. The hydrography, dense water formation, frontal systems and bathymetry of the Barents Sea, coupled with strong tidal currents, particularly over the shallow banks, results in complex submeso-scale circulation patterns, frontal jets and regions of intense vertical mixing (e.g. Oziel et al., 2016; Fer and Drinkwater, 2014; Våge et al., 2014). To help place the N-Arc sampling locations into a wider dynamical context, velocity profiles were collected at each station, giving instantaneous horizontal water velocities for each of the stainless steel CTD casts.

Instrument setup
Lowered Acoustic Doppler Current Profiler (LADCP) data were obtained from every stainless steel CTD cast. Two self-logging LADCPs were installed on the stainless-steel CTD frame. The down-looking unit (S/N: 13329) was a 300kHzTeledyne RDI Workhorse sited at the centre of the frame with its transducers just above the bottom tube of the CTD frame. The up-looking unit (S/N: 1855) was located within an outrigger frame with its transducers just below the top tube of the CTD frame. The downward looking instrument behaved as a master to the upwards looking instrument (the slave).

The down-looking 300 kHz instrument was configured to output information via its serial port. The serial port was connected to the 9plus 9600 baud uplink cable prior to deployment and displayed during the CTD casts using TRDI Tool. The instruments were powered with NMF Workhorse Battery Pack serial number WH010T.

It was noted that the up-looker (S/N: 1855) often had poor correlation on Beam 1.

The ADCPs were set with 1.3s ensembles in 2.8s bursts and averaged into 25 x 8 m bins.

Raw data was saved using the file naming convention DY167_CTD_XXXM.000 and DY167_CTD_XXXS.000 where XXX refers to the CTD cast number and 'S' or 'M' to the slave or master ADCP.

The command files for the Master and Slave can be found in Appendix F.

Data processing
Each cast was processed using the LDEO version IX.14 software, a package that implements the velocity inversion method for LADCP processing, originally developed by Martin Visbeck. Setup details can be found in '*A. M. Thurnherr, How to Process LADCP Data With LDEO Software (Version IX.14), Jun 29th 2021*'. Raw data from each LADCP file was combined with 1 second averaged temperature, salinity and pressure from the corresponding CTD cast to provide accurate information on the vertical velocity of the frame through the water, and with 1 second navigation data (longitude and latitude) to calculate the frames exact position and to constrain its motion using a drag model. The exact geographical location of the station is also used to calculate the magnetic declination. Further QC and constraint with processed VMADCP data will be conducted in the lab post-cruise.

2.4 Vessel-Mounted Acoustic Doppler Current Profiler

Jo Hopkins[1,2] (National Oceanography Centre)
[1]*Author,* [2]*Data set PI*

Background motivation and objectives

Full interpretation of the DY167 measurements of nitrogen fixation rates, nifH gene abundance and diversity, inorganic nutrients, trace metals and phytoplankton community structure requires understanding of the hydrodynamics of the area. The hydrography, dense water formation, frontal systems and bathymetry of the Barents Sea, coupled with strong tidal currents, particularly over the shallow banks, results in complex submeso-scale circulation patterns, frontal jets and regions of intense vertical mixing (e.g. Oziel et al., 2016; Fer and Drinkwater, 2014; Våge et al., 2014). To help place the N-Arc sampling locations into a wider dynamical context, data on the structure and strength of the ocean currents was collected throughout the cruise from two vessel mounted ADCPs.

Instrument setup and processing

Ocean Surveyor 150 kHz

Narrow band water tracking
50 x 8 m bins
4 m blacking distance
1.1 seconds between pings

Ocean Surveyor 75 kHz
Narrow band water tracking
60 x 16 m bins
8 m blacking distance
1.8 seconds between pings

The transducer heads are mounted 6 m below the water line.

Data collection was started at 09:08:54 on 9th July 2023. Data collected stopped at 09:33:47 on 11th August 2023.

Data was acquired from the ADCPs and ancillary sensors (e.g. GPS, gyrocompass) using the University of Hawaii Data Acquisition System (UHDAS) acquisition system. CODAS (Common Ocean Data Access System) software was run onboard to build a data set of 5-minute averaged ocean velocities, corrected for compass errors. Further quality control to clean up glitches or gaps in the heading data will happen post-cruise.

References

Våge, S., Basedow, S. L., Tande, K. S., Zhou, M. (2014). Physical structure of the Barents Sea Polar Front near Storbanken in August 2007. Journal of Marine Systems, 130, 256-262.

Oziel, L., Sirven, J., Gascard, J. C. (2016). The Barents Sea frontal zones and water masses variability (1980-2011). Ocean Science, 12, 169-184.

Fer, I., Drinkwater, K. (2014). Mixing in the Barents Sea Polar Front near Hopen in spring. Journal of Marine Systems, 130, 206-218.

Preliminary results

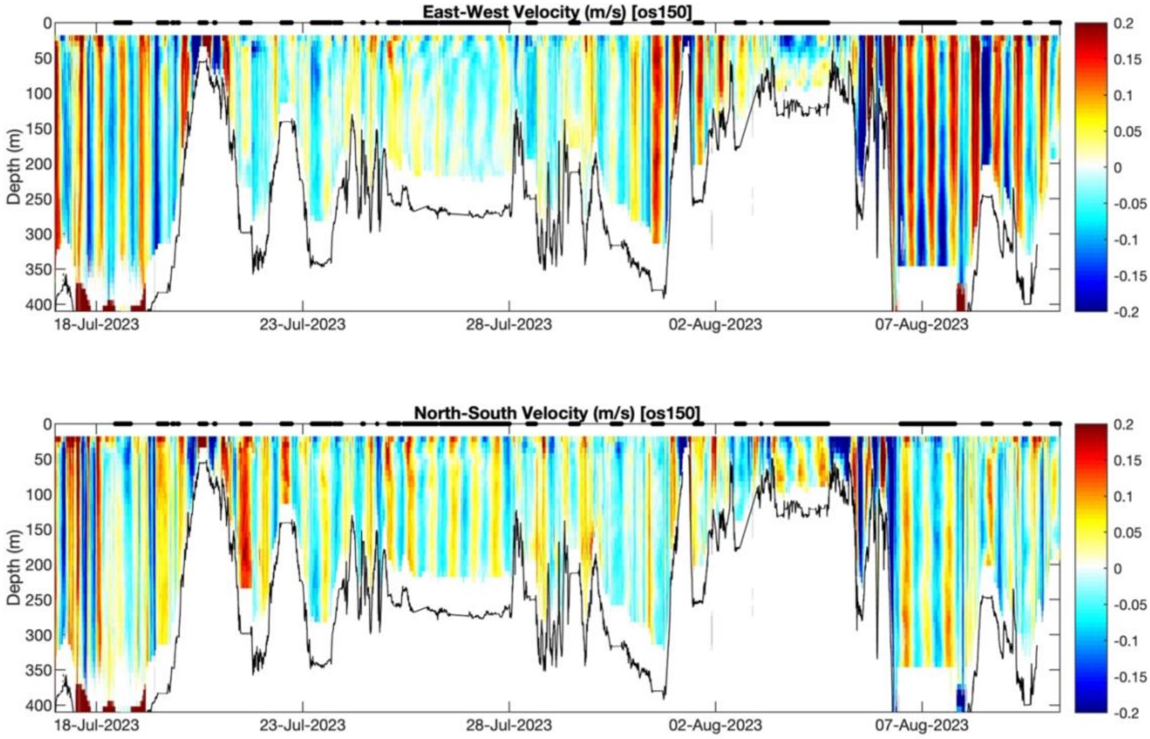

Figure 2.27 East-West (top) and North-South (bottom) velocities (m/s) from the OS150 between 17th July 2023 and 10th August 2023.

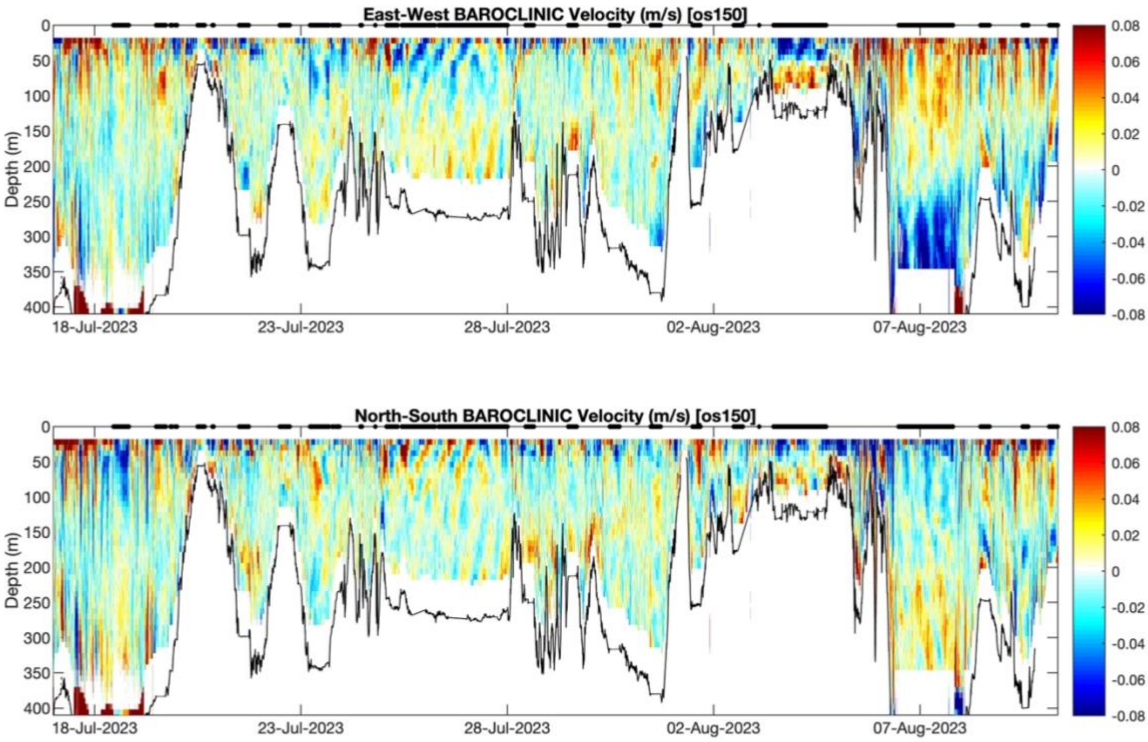

Figure 2.28 East-West (top) and North-South (bottom) baroclinic velocities (m/s) from the OS150 between 17th July 2023 and 10th August 2023

3 Biogeochemistry

3.1 Inorganic nutrients

Louisa Norman[1,] Claire Mahaffey[2] (University of Liverpool)
[1] Author, [2] Data set PI

Background motivation and objectives

The Barents Sea is a typical shelf sea, with vertical stratification depleting nutrients in surface waters in the summer due to phytoplankton growth. However, the distribution and stoichiometry of nutrients is of interest to N-Arc due to the competing supply from the Atlantic versus Arctic enriched waters, and the potential for nutrients to be limiting phytoplankton growth in this region. To investigate the spatial and vertical distribution of inorganic nutrients, we analysed filtered seawater samples from the towed FISH and CTD casts and performed colorimetric analysis to determine the concentration of nitrate plus nitrite, phosphate, silicate and nitrite.

Methods

Nutrient concentrations were determined using a Bran and Luebbe QuAAtro 5-Channel Nutrient Auto-analyser. Specifically, nitrate plus nitrite, phosphate, silicate and nitrite were determined using colorimetry. Nitrate plus nitrite was determined via reduction of nitrate to nitrite at pH 8 using a copperized cadmium reduction coil and subsequent reaction of nitrite with sulphanilamide and NEDD to produce a reddish-purple azo dye (Brewer and Riley, 1965). Nitrite is measured in the same manner but without the need for the copperized cadmium column (Grasshoff, 1976). Phosphate was determined by reacting phosphate with molybdate ion and antimony ion followed by reduction with ascorbic acid to produce a phospho-molybdenum complex (Kirkwood, 1989). Silicate was determined by reducing a silico-molybdate complex in acid solution to a molybdenum blue by ascorbic acid. Oxalic acid is added to minimize interference from phosphate (Kirkwood, 1989).

Stock standards (10mM) were at the start of the cruise using high purity salts of potassium nitrate, sodium nitrite, potassium dihydrogen phosphate and sodium metasilicate nonahydrate. All standards were prepared in artificial seawater (35 g sodium chloride + 0.5 g sodium bicarbonate in 1L of Milli-Q water).

Seawater samples were analysed in triplicate using an autosampler. Baseline and drift corrections were applied during analysis. Baseline, calibration slope, CRM values and precision was recorded for every analysis run. Certified reference materials (CRMs, KANSO Lot CI-2029) were analysed at the start, middle and end of every run. Precision and accuracy were typically better than 1% for all nutrients (Table 3.1, Figure 3.1). The limits of detection of nitrate plus nitrite, silicate, phosphate, ammonium and nitrite were 0.1, 0.1, 0.05, 0.05 and 0.05 μM, respectively.

Table 3.1 Summary of typical daily CRM concentrations (μM) compared to the expected KANSO CRM of Lot. CI-2029.

Nutrient	CRM expected value (μM)	Daily cruise mean ± stdev
Nitrate+nitrite	14.534	14.589 ± 0.076
Silicate	8.450	8.502 ± 0.04
Phosphate	0.971	0.975 ± 0.006

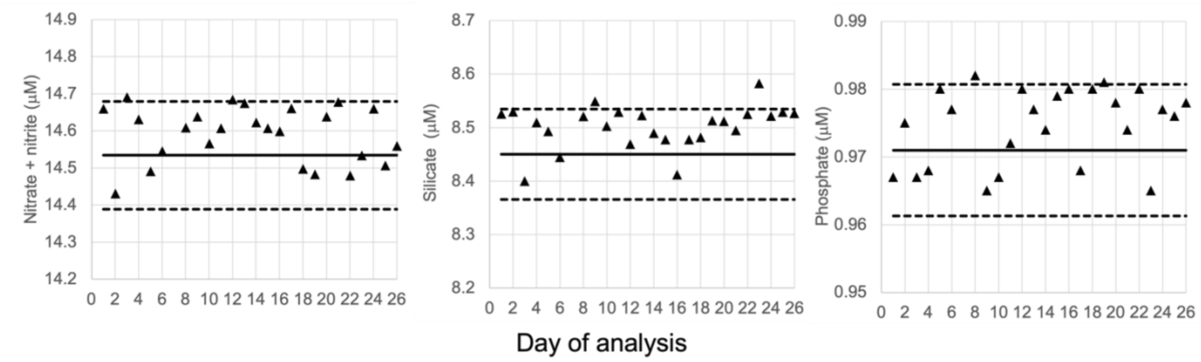

Figure 3.1 Typical daily measured nutrient concentrations of Certified Reference Material (CRM: Kanso CRM Lot. CI-2029) for nitrate plus nitrite, phosphate and silicate. Solid line represents expected value. Dashed lines represent plus or minus 1% from the expected value. Triangles represent the measured value.

Samples collected

Sample collection: Samples for nutrient analysis were collected during three activities: (a) trace metal clean FISH during transit and during time-series on station, (b) stainless steel and titanium CTD casts and (c) nutrient addition experiments. Samples from activities (a) and (b) were filtered through an AcroPak 500 capsule filter with Supor membrane 0.1 μm (ref:12997). Samples from (c) were analysed unfiltered. In all cases, samples were collected into acid-washed, MQ rinsed HDPE bottles after triple rinsing and filled to 80% capacity. Samples were either analysed on the same day, stored in the fridge and analysed the next day, or frozen until analysis later in the cruise. A summary of samples collected from each activity is reported in Table 3.2. Over the entire cruise, 1732 samples were analysed in triplicate and 214 CRMs were analysed in triplicate, resulting in a total of 1946 samples analysed with 5828 injections. See sample logs in Appendices B, C and D for details.

Table 3.2 Summary of the number of samples analysed for each nutrient during DY167 from 4 sampling activities.

Nutrient	FISH	Stainless CTD	Titanium CTD	Experiments
Nitrate+nitrite	242	328	273	889
Silicate	242	328	273	889
Phosphate	242	328	273	889

Brewer, P.G and Riley, J.P. (1965). The automatic determination of nitrate in seawater. Deep Sea Research, 12, 765-772.

Grasshoff, K., (1976). Methods of seawater analysis. Verlag Chemie, Weinheim and New York.

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3.2 Dissolved Oxygen

Xin Meng, Claire Mahaffey[1,2] (University of Liverpool)
[1] Author, [2] Data set PI

Background motivation and objectives

To calibrate the oxygen sensor on the CTD frames, dissolved oxygen concentrations were determined using the standard Winkler technique. Oxygen concentrations were to be determined using the Metrohm Titrando potentiometric titration system. However, a fault was found on the electronics board at the start of the cruise and could not be repaired. We switched to manual methods, using the stir plate function on the Metrohm only.

Methods

Reagents: Reagents were prepared as follows:
Manganese chloride reagent (3 M): Dissolve 600 g of manganese chloride tetrahydrate ($MnCl_2.4H_2O$) in 800 ml distilled water and make up to 1 liter in a volumetric flask.

Alkaline iodide reagent
Dissolve 320 g sodium hydroxide (NaOH) in 500 ml distilled water (HEAT EVOLVED, ADD NaOH slowly) and, separately, dissolve 600 g sodium iodide in 500 ml distilled water. Mix the two solutions 1:1, by volume.

Sulfuric acid reagent (10 N)
Mix 280 ml of concentrated sulfuric acid into distilled water using a 1 liter volumetric flask
NOTE: ADD ACID TO WATER, **NOT** WATER TO ACID

Sodium thiosulfate reagent (0.2 N)
Dissolve 49.64 g of reagent grade sodium thiosulfate ($Na_2S_2O_3$. $5H_2O$ and make up to one liter with distilled water. Determine exact normality as described below.

Potassium iodate reagent (0.025 N)
Dissolve 0.8918 g of dry (100°C, 2 hours) KIO_3 into 800 ml distilled water and bring up to 1 liter in a volumetric flask.

Iodate standard for standardisation: From OSIL, 0.01N, 1.667 millimolar, code 57012

Sample collection: Samples were collected from the stainless steel CTD only from between 8 and 12 depths per CTD cast (See Appendix B). Note that samples for oxygen analysis were not collected on all casts (e.g. Yo-Yo activities). Three calibrated glass stoppered bottles were rinsed and overfilled for up to 45 seconds with running seawater. Seawater was transferred from the Niskin bottle to the glass bottle via a Tygon tube. Once overfilled, the bottle remained un-stoppered and was fixed with 1 mL of manganese chloride and 1 mL of alkaline iodide using automated dispersers. The bottle was stoppered, shaken for 30 seconds, and placed back into the plastic storage box. Bottle numbers were recorded in the CTD log sheet and temperature of the first sample collected was also recorded in °C.

Standardisation of thiosulphate: Due to the faulty Metrohm Titrando, we performed manual titration of oxygen samples using an 1 mL Eppendorf pipette. Initially, 0.2 N thiosulphate was used to titrate samples but this was deemed too concentrated, resulting in poor accuracy. A range of thiosulphate concentrations were tested, from 0.005N to 0.2N. A concentration of 0.01N was deemed to be satisfactory, resulting in improved precision and accuracy.

To standardise the thiosulphate daily, 100 mL of seawater was placed in a clean plastic beaker and placed on the stir plate with a magnetic stirrer. 1 mL of sulphuric acid was added, followed by 1 mL of alkaline iodide and 1 mL of manganese chloride, ensuring the solution had time to mix between reagent addition. If the solution turned brown, it was discarded and restarted in a clean beaker. If clear, then 5 mL of the OSIL iodate standard was added to turn the solution iodine brown. The solution was titrated to clear by adding 100μL increments of 0.01N sodium thiosulphate. The thiosulphate concentration ranged from 0.0172 M to 0.0179 M. This was measured and recorded daily and used to calculate the concentration of oxygen daily.

Sample analysis: Oxygen analysis was performed on the same day and at least 4 hours after collection. Each bottle, one at a time, was un-stoppered and 1 mL of 10N sulphuric acid was added to the sample using an automated 1 mL pipette. The bottle was stoppered and shaken to dissolve the precipitate. The entire contents of the bottle were poured into a clean and dry plastic beaker and were placed on the stir plate on a piece of white paper. Sodium thiolsulphate was added in 200 μL increments until an initial colour change was observed, the reduced to 100 μL increments. The solution was titrated to clear, then one or two extra aliquots of sodium thiosulphate were added to ensure the colour change was complete. The volume was recorded in a logbook. Typical volumes of sodium thiosulphate added to samples were between 8.5 and 11.2 mL. Beakers were rinsed with Milli-Q and dried completely between samples. The bottle number was recorded as each bottle is individually calibrated for volume.

Precision, accuracy and calibration: The precision of analysis was typically better than 1%. Accuracy was problematic and, on some casts, there was a 20 to 30 μM offset between the bottle oxygen and sensor oxygen. Only two casts were identified to have data of sufficient quality to be used for calibration, specifically CTD121S and CTD207S. See Section 2.1 for the resulting relationship between the bottle oxygen and CTD sensor data.

3.3 Dissolved organic matter (DOC and eHS)

Millie Goddard-Dwyer[1] (University of Liverpool), Louisa Norman (University of Liverpool), Hannah Whitby[2] (University of Liverpool), and Claire Mahaffey[1,2] (University of Liverpool)
[1] *Author,* [2]*Data set PI*

Background motivation and objectives

Dissolved organic matter (DOM) represents the largest reservoir of reduced carbon in the ocean (Hansell et al., 2009). Therefore, resolving DOM spatial variation, and its sources and sinks is crucial to understand marine carbon cycling. Sources of DOM include terrestrial, atmospheric, sedimentary, and in-situ primary production while sinks of DOM include photooxidation and microbial degradation (Dittmar et al., 2021). In the context of the aims of N-ARC cruise, nitrogen fixers may act as a potential source of DOM through exudation, or may use DOM to fuel heterotrophic activity, especially the non-cyanobacterial diazotrophs or NCDs (von Friesen and Riemann, 2020). Therefore, the availability and cycling of DOM may be an important constraint on diazotroph activity in the Arctic Ocean and may also place a control on the distribution and availability of DOM in the Arctic Ocean.

DOM influences the cycling of dissolved trace metals (TM) via complexation, which influences the solubility, bioavailability, and toxicity of TM (Rue and Bruland, 1995). One group of TM binding DOM which are thought to be important in the cycling of TM are electroactive humic substances (eHS) (Muller, 2018, Whitby et al., 2020). Previous studies have observed abundant eHS in the Arctic Ocean (Slagter et al., 2017, Laglera et al., 2019), which suggests that eHS may play an important role in the supply of TM to microorganisms in the region. In the context of the aims of the N-Arc cruise, the availability of TM may influence the distribution of nitrogen fixation as TM are used as enzyme cofactors in the nitrogenase enzyme (Twining and Baines, 2013).

During the N-ARC cruise, samples for DOC were collected from (a) the FISH and (b) the titanium CTD (Table 3.3). Samples for DOC and eHS were also collected from 3 treatments in the nutrient limitation experiments (control, NP and NPFe) (Table 3.3).

Table 3.3 Summary of number of samples collected for dissolved organic carbon (DOC) and electroactive humic substances (eHS) during DY167 N-ARC cruise

Activity	Number of DOC samples	Number of eHS samples
Titanium CTD	136	136
FISH	274	22
NutLim Experiments	17	17
Ice-edge	1	1
Glacier	1	4
TOTAL	429	180

Methods
Seawater was collected from the FISH or titanium-CTD rosette. Ice samples for eHS samples were melted at 4 °C in the dark in acid clean HDPE containers, subsequently filtered through a GF/F filter (Whatman) using an acid cleaned glass filtration system into acid cleaned LDPE/HDPE bottles.

Seawater for DOC samples were collected in an amber HDPE bottle (Nalgene), filtered through a pre-combusted 47mm GF/F filter (Whatman) using an acid cleaned glass filtration system into ashed glass vials and acidified to pH 2 using reagent grade HCl. Samples were stored at 4 °C until analysis on shore. The samples will be analysed using a Shimadzu TOC analyser at the University of Liverpool.

Seawater for eHS samples collected using the FISH or TM-clean rosette were filtered through a 0.2 µM filter into TM clean LDPE/HDPE bottles. Seawater for eHS samples subsampled from nutrient limitation experiments (*see* relevant section in cruise report) were collected dark HDPE bottles (Nalgene), filtered through a GF/F filter (Whatman) using an acid cleaned glass filtration system into acid cleaned LDPE/HDPE bottles. All eHS samples were stored at -20 °C until analysis on shore and will be analysed using cathodic stripping voltammetry at the University of Liverpool.

Samples collected

See Appendix H for a list of samples collected for DOC and eHS.

References:

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A CONTROVERSY STIMULATES NEW INSIGHTS. *Oceanography,* **22** (4), 202-211.

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3.4 Chlorophyll *a*

Catherine Berridge[1], Xin Meng[1] and Claire Mahaffey[1,2] (University of Liverpool).
[1] *Author,* [2]*Data set PI*

Background motivation and objectives

We collected samples to measure chlorophyll *a* concentrations to estimate autotrophic biomass and calibrate the fluorescence sensors on the underway seawater system (UW), stainless CTD and titanium CTD.

Seawater collection

Seawater samples were collected in 1L amber HDPE bottles. Bottles were rinsed 3 times and filled to the top. Either 1 L or 500 mL was then filtered. Samples were collected from the towed FISH (see Appendix D), from 2 to 6 depths from the stainless steel CTD (see Appendix B) and from 2 to 6 depths from the titanium CTD (see Appendix C). Samples were also collected from the nutrient limitation experiments for all 24 treatments for up to 7 days (see section 7.1). A summary of samples collected for each activity is reported in Table 3.4.

Table 3.4 Summary of chlorophyll a samples collected

Activity	Number of samples
FISH	253
Underway (UW)	35
Stainless CTD	120
Titanium CTD	61
NutLim Experiments	835
TOTAL	1304

Samples filtration

All samples were processed immediately after collection. Either 500 mL or 1000 mL of seawater was filtered through a 47 mm GFF microfibre filter on a 3-port filtration rig under vacuum (Welch vacuum pump). After filtration, the filters were rolled and extracted into a glass test tube, containing 5mL of 90% acetone. The filter was fully submerged into the acetone and the plastic screw cap was attached. The time of submersion in acetone was noted. The test tube was then wrapped completely, including the lid, in aluminum foil and labelled before being stored for 24 hours in a -20°C freezer.

Sample analysis

The fluorescence was measured to determine the chlorophyll concentrations after 24 hours of incubation in the freezer. A Turner Design Field fluorometer was used to give values in raw fluorescence units (RFU). The time at which the sample was analysed was also noted. The fluorometer was calibrated at the start and the end of the cruise using a pure chlorophyll *a* standard. Instrument drift was monitored daily using a solid standard. The instrument was left on throughout the duration of the cruise and no instrument drift occurred.

3.5 Oxygen Isotopes (d18O)

Jo Hopkins[1] (National Oceanography Centre), Claire Mahaffey[1] (University of Liverpool), Mike Meredith[2] (British Antarctic Survey)
[1] Author, [2]Data set PI

Background motivation and objectives

Collected on behalf of the BIOPOLE Project, a NERC programme examining biogeochemical processes and ecosystem function in the polar ecosystems. The samples will be analysed to determine the meteoric water content.

Methods

50 ml glass bottles were rinsed by overfilling them with > 3 times their volume. The bottles were filled to the rim and care was taken to flush out air bubbles. A rubber seal was placed over each bottle and crimped closed with a aluminium cap. The bottles were stored at room temperature.

Samples collected

102 samples for d18O were collected from the stainless steel CTD (Appendix I). Typically 6-8 depths were sampled between the surface and bottom.

38 samples were collected from the ships underway intake whilst surveys were being carried out within Storfjorden.

samples were taken from ice blocks and water collected from the small boat (on 04/08/2023) near the foot of the Negribreen Glacier.

4 Trace metals

Seawater samples were collected at all stations, using a titanium CTD rosette fitted with 24 x 10 L trace metal clean Teflon-coated OTE (Ocean Test Equipment) bottles with external springs, deployed on a Kevlar coated conducting wire. Upon recovery, the OTE bottles were transferred into a class 1000 clean air shipboard laboratory and pressurised (1.7 bar) with compressed air filtered in line through a 0.2 µm PTFE filter capsule (Millex-FG 50, Millipore). All samples for dissolved iron, dissolved trace metals and iron isotopes were collected into trace metal clean low density polyethylene (LDPE, Nalgene) bottles. Unfiltered samples were collected for total dissolvable iron which is defined as iron, which is solubilized after at least 6 months of acidification to 0.024 M HCL. Samples for dissolved iron dissolved trace metals and iron isotopes were filtered using 0.2 µm acetate membrane filter cartridge filters (Sartobran-300, Sartorius). All of these samples were acidified with ultra-pure HCL (UPA, Romil) to 0.024 M. Dissolved iron samples were analysed onboard (see section 0). Total dissolvable iron, dissolved trace metals and iron isotope samples will be run back at the National Oceanography Centre in a trace metal clean van.

Particulate samples were collected from a sub-set of bottles onto acid clean 25 mm Supor® polyethersulfone (PES) membrane disc filters (Pall, 0.45 µm) housed in acid cleaned Millipore Swinnex filter houses and connected to the OTE bottles using luer lock fittings and acid cleaned Bev-a-line tubing (Cole Parmer). Following filtration, the filter houses were removed and placed in a laminar flow bench. Using an all-polypropylene syringe attached to the top of the filter holder, residual seawater was forced through the filter using air from within the laminar flow bench. This ensures there is no spillage and loss of particulate material from face of filter when filter holder is opened, and will remove as much seawater as possible in order to reduce the residual seasalt matrix for analytical simplicity after the sample is digested. The filter holders were gently opened and the PES filter was placed in clean petri slides and frozen at -20°C until analysis.

From every cast and each OTE bottle macronutrient samples were collected by filtering through 0.2 µm acetate membrane filter cartridge filters (Sartobran-300, Sartorius). Samples for Dissolved Organic Carbon (DOC) were collected unfiltered (see section 3.3). Between three and six salinity samples were collected from each cast for calibration purposes. Dissolved oxygen samples were collected in triplicate from 12 depths from the deep cast for calibration.

Appendix C details all samples collected from the trace metal titanium CTD

4.1 Dissolved Fe distribution

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Introduction

Iron (Fe) is an essential micronutrient for biological processes during primary production such as nitrogen fixation (Morel et al. 1991; Morel 2003). Despite its key roles, Fe is present only at nanomolar concentrations in the ocean as a results of its low solubility under oxic conditions (Boyd & Ellwood 2010). Hence, Fe (co-)limitation of primary production has been observed for example in various ocean settings (Boyd et al. 2007).

In the Barents Sea the main sources of dissolved iron (dFe) in the surface ocean have been shown to be from seasonal ice-melt (Aguilar-Islas et al., 2008; Bhatia et al., 2013) and riverine input, which is transported to the Barents Sea by the transpolar drift (Klunder et al., 2012a). The deep water composition of dFe in the Barents Sea is controlled by the balance between scavenging processes and the dissolution of resuspended particles originating from shelf sediments (Klunder et al., 2012b). Over the past two decades, there has been an 88% increase in primary production in the Barents Sea (Lewis et al., 2020), which has been attributed to large reductions in sea ice and increased light availability (Arrigo and van Dijken 2015). However, like other regions of the ocean (e.g., the Southern Ocean), it has been hypothesised that iron has the potential to limit primary production in the Barents Sea (Rijkenberg et al. 2018); yet, due to a lack of existing studies, this has not been quantified.

To investigate the potential Fe limitation of Nitrogen Fixation and primary production, dissolved Fe (dFe) (defined as passing through a 0.2µm filter) was measured along the surface gradient as well as in full depth profiles and was used to place nutrient limitation experiments and Diazotroph experiments in context.

Methods

Sampling – Dissolved Fe (dFe) samples were collected from Ti-CTD casts at all stations. During transit between stations N00 and N19, dFe samples were collected from the underway FISH. All sampling took place in a clean laboratory and samples were collected in acid-cleaned (one week soaked in 3 M HCl, one week in 0.5 M HCl, stored in 0.024 M HCl) LDPE bottles by attaching a 0.2 µm Sartobran filter to pressurized OTE bottles. All sampling bottles were rinsed three times with seawater prior to filling. The samples were acidified to pH 1.7 with ultrapure HCl (Romil, UpA) and left to equilibrate for at least twelve hours before analysis.

Analysis – Flow injection analysis with chemiluminescence detection (FIA-CL) was used to determine nanomolar concentrations of dFe (Obata et al. 1993; Obata et al. 1997). At least 15 min prior to analysis samples were spiked with 60 µl 0.01 M H_2O_2 to allow any present Fe(II) to be oxidized to Fe(III). The sample was then buffered to pH 3.5 and preconcentrated on a Toyopearl resin. Upon elution by HCl, the Fe entered a reaction stream with luminol, NH_4OH and H_2O_2 to induce the chemiluminescent oxidation of luminol detected by a photomultiplier tube. Each sample was measured in triplicate with a column loading time of 60 s, resulting in a total of approximately 10 min per run.

Results -Dissolved Fe concentrations were analysed on board for the 16 casts and the underway gradient. Preliminary results indicate a strong influence of ice edge inputs on surface ocean concentrations of dFe, which ranged between 0.54 nM and 1.96 nM, at the ice edge. This resulted in high concentrations in the surface waters, with a surface concentration of 0.61 nM at Station N10. The concentration of dFe then decreases with depth as Fe is scavenged onto particles. Lowest concentrations were observed at the deep chlorophyll maxima (DCM) due to biological uptake. At several stations, iron concentrations increased with depth to > 2 nM, indicative of benthic inputs. Figure 4.1 displays an example of this typical profile, taken from Station N04, with the lowest dFe concentration at the DCM, and increased concentrations with depth.

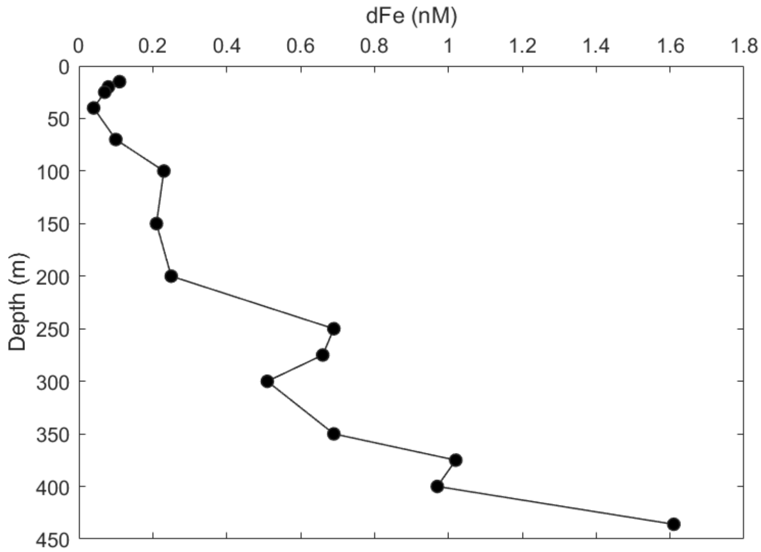

Figure 4.1. Example depth profile of dissolved iron at station N10 (shelf station with a bottom depth of 460 m) taken from a titanium CTD cast and analysed by FIA-CL.

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5 Activity, abundance and diversity of nitrogen fixing organisms

5.1 Near-real time rates of nitrogen fixation using the FARACAS

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Background motivation and objectives
With polar regions changing more rapidly than other regions, it is important to examine which factors drive productivity and ultimately carbon cycling in these regions. It is only recently that measureable rates of biological nitrogen fixation (BNF) have been recorded in polar regions (Blais et al. 2012; Fernández-Méndez et al. 2016; Shiozaki et al. 2017; Sipler et al. 2017; Shiozaki et al. 2018). It is unclear if BNF is important to the local nitrogen fluxes in the Arctic, and how it might evolve with climate change. To address this question, we deployed, over a large swath of the Arctic Ocean, an instrument which allows for high-resolution estimates of BNF. We ran the Flow-Through Incubation Acetylene Reduction Assays by Cavity Ring-Down Laser Absorption Spectroscopy (FARACAS) (Cassar et al. 2018) to measure BNF.

Methods
Along the cruise track (Figure 1.1), we operated the FARACAS to collect continuous measurements of BNF. Unfiltered seawater was pumped continuously through using the Towfish. Seawater was then mixed with acetylene gas trace water, which was prepared by dissolving C2H4 gas (created by mixing water with high purity CaC2) into filtered seawater. The two solutions were combined at a ratio of 1:6, achieving a 10% final acetylene saturation. The mixed seawater solution was then pumped into a 9-L incubation chamber, maintained at in-situ temperature using a water jacket with seawater flowing continuously through the jacket.

Light intensity mimicked outdoor conditions by changing the intensity of a PAR light bank that shone on the incubator. The incubator was continuously stirred using a stir bar. From the incubator, water was continuously being pumped into a glass bubbler, where ambient air was combined with the water at a rate of 39.3 mL/min to strip the gas of any ethylene produced in the incubator. This ethylene that was extracted was measured by a Picarro CRDS (Cavity Ring Down Laser Spectroscopy) analyzer (model G2106, Santa Clara, CA).

Every few hours, depending on activity, a control experiment was performed where water would bypass the incubator and background ethylene values would be measured for comparison. Ethylene production rates were then converted to BNF rates using a conversion ratio of 4:1.

Samples collected
Samples were continuously collected and data was recorded every few milliseconds throughout the whole course of the cruise. Seawater was pumped into the system, and then returned through the drain, so no samples were collected and preserved and shipped back to Duke University.

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5.2 Whole community bottle-derived rates of nitrogen fixation and carbon uptake ($^{15}N_2$ and ^{13}C)

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[1] Author, [2] Data set PI

Background motivation and objectives

Rates of nitrogen fixation are most commonly determined by the incorporation of ^{15}N labelled dinitrogen gas (N_2) in to particulate nitrogen (PN) following the incubation of a seawater sample under local environmental conditions. $^{15}N_2$ fixation rates were used to routinely determine rates of nitrogen fixation on underway FISH and CTD samples, as well as measuring rates of $^{15}N_2$ uptake by diazotrophs during nutrient manipulation experiments. Alongside the $^{15}N_2$ method, nitrogen fixation was continuously determined from the FISH by FARACAS (see section 5.1), during periods of detected activity, additional $^{15}N_2$ experiments were conducted to cross-check against FARACAS rates. As nitrogen fixation relieves nitrate limitation on phytoplankton communities, we expect high rates of nitrogen fixation to result in increased CO_2 drawdown. To determine the rates of primary productivity, we added a ^{13}C tracer alongside the ^{15}N experiments. In total, 177 sets of $^{15}N_2$/^{13}C experiments were conducted during DY167 (Table 5.2). We followed recommendations outlined in White et al (2020), including collecting samples for the initial $\delta^{15}N$, incubating un-spiked seawater for 24 hours to determine the change in the natural abundance of $\delta^{15}N$ and measuring the atom% enrichment of seawater after the addition of $^{15}N_2$ gas. We deployed the 'bubble method' but without removing the bubble in order to reduce the potential for nutrient contamination.

Methods

A single 20L sample of unfiltered water was collected from the towed FISH while underway on a regular schedule of 0500, 1200 (on days without a CTD) and 2300 each day (see Appendix D). On days with a CTD, station water was collected from 1-3 depths, typically the surface (~10m), deep chlorophyll maximum (~35-50m) and below the DCM (~60-70m) (see Appendix B). 2 niskin bottles per depth from the stainless steel CTD were assigned, with 3 x natural abundance samples (Table 5.1) collected in 2L polycarbonate bottles from the low number niskin and triplicate 2L samples to be spiked with ^{15}N collected from the higher numbered niskin. All $^{15}N_2$ spiked bottles were labelled with red tape to avoid cross contamination when reusing bottles and filled with tubes that were similarly marked.

Table 5.1 Bottle setup for $^{15}N_2$/^{13}C experiments

Bottle number	Content
1	^{15}N+^{13}C
2	^{15}N+^{13}C
3	^{15}N+^{13}C
4	T_0
5	T_1
6	^{13}C Dark

Bottles 1-3 were always filled with no headspace to avoid dilution of the ^{15}N signal when spiking. Immediately after collection, bottles 1-3 were spiked with 4 ml of ^{15}N enriched dinitrogen gas (Cambridge Isotope Laboratories, Lot#:1-26354), added with a gas tight syringe through a septum cap on each 2L bottle. These were then shaken on a shaker table at sea surface temperature in a temperature-controlled incubator van. Meanwhile, bottle 4 was filtered on to a pre-combusted 25 mm GF/F, providing the initial particulate carbon and nitrogen content at the start of the incubation. After 15 minutes of shaking, bottles 1-3 were removed from the shaker table, bottles 1,2,3 and 6 were spiked with 0.1 ml 0.5M $NaHCO_3$-^{13}C, then these bottles plus bottle 5 were placed in light banks for 24 hours. The incubated light intensity corresponded to the relative light intensity based on sample depth, with surface samples being incubated at 135 μmol photon m^{-2} s^{-1}, DCM samples at 65 μmol photon m^{-2} s^{-1} and below DCM samples being incubated in dark bags, along with the ^{13}C dark control (bottle 6). The light cycle of the container matched the outside conditions, initially following an 18:6 routine through the North Sea, before spending the majority of the cruise following a 24 hour Arctic light cycle. Temperature was changed regularly to match the changing sea surface temperature.

After 24 hours of incubation, bottles 1,2,3,5 and 6 were removed from the container and bottles 1-3 were subsampled for membrane inlet mass spectrometry (MIMS) by removing 12 ml of sample and transferring to an extetainer vial. The incubation was then terminated by filtering the remaining bottles on to 25 mm pre-combusted GF/F.

Rates of $^{15}N_2$ fixation performed on the diazotroph nutrient manipulation experiments were conducted according to the same protocol as described for FISH and CTD samples, except bottles were allowed to incubate for 24-48 hours prior to spiking with $^{15}N_2$, ^{13}C uptake was not performed on these experiments.

Details of samples collected for rates of $^{15}N_2$, and ^{13}C uptake are summarised in Appendix J.

Table 5.2 Summary of number of samples collected for $^{15}N_2$, and ^{13}C uptake during various activities on DY167.

Activity	**$^{15}N_2$, and ^{13}C uptake**	**$^{15}N_2$ only**
FISH	68	
SS-CTD	61	
Diazo		46
Ice	2	
Total	131	46

After the cruise, each 25mm GFF filter will be pelletized in tin cups and measured by EA-IRMS obtaining particulate nitrogen concentrations and particulate matter ^{15}N atom% values. Together with the dissolved ^{15}N atom% values obtained from MIMS analyses onboard, bulk N_2 fixation rates will be calculated according to White et al. 2020 and expressed as nmol N l^{-1} d^{-1}.

Analysis of enrichment of dissolved N2 with 15N2 using MIMS

The ^{15}N enrichment of each spiked sample was measured at the end of the incubation using a Hiden Analytical Membrate Inlet Mass Spectrometer or MIMS. Each morning a new file was started using the naming convention *dy167 15n2 sem only_ddmmyy_sw#*. Seawater from the underway system was run for at least 10 minutes at the start of a new file and between samples. Samples were loaded by placing the membrane probe in the exetainer vial and noting the sample start time, this results in a peak in the mass 28 and mass 30 curve. After approximately 10 minutes, the mass 28 peak stabilises back towards the baseline and the sample is removed, replacing the membrane in seawater until the mass 30 reading reaches 1.2 e^{-10} or below. MIMS data was analysed by exporting each days file as a .csv and uploading this to a custom python script, designed for peak integration. This code requires the sample names, along with the start and end time of each sample. The end time of a sample is derived from when the approximate atom % of the mass 30 value falls below 1%. The seawater start time is usually 10 minutes before the first sample is run, this is used to calibrate the data so should ideally be a period when all masses are stable (i.e. after running seawater for >10 minutes). Processing code is available in the appendix. Subsequently, true atom % enrichment was calculated by performing a calibration against the seawater standard of each run and the theoretical nitrogen content (μmol kg^{-1}) from the temperature and salinity of each sample.

After the cruise, rates of $^{15}N_2$ fixation and ^{13}C uptake will be derived from EA-IRMS analysis of the particulate nitrogen and carbon content collected on the filters, alongside the MIMS data (representing the nitrogen source of the $^{15}N_2$ incubations).

MIMS Processing Code can be found in Appendix P

White, A. E. *et al.* A critical review of the 15N2 tracer method to measure diazotrophic production in pelagic ecosystems. *Limnol. Oceanogr. Methods* 18, 129–147 (2020).

5.3 Whole community abundance and diversity of nifH gene

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[1] *Author,* [2] *Data set PI*

Background motivation and objectives

Methods

Before sampling, sampling bottles were cleaned with 2% HCL solution and rinsed thoroughly with milliQ. Before handling samples, the workstation and equipment were cleaned with a 10% ethanol solution. When handling samples, nitrile gloves were worn, and surfaces were wiped down with a 10% ethanol solution. Samples were collected with approximately 2.2 L of seawater and pumped with peristatic pumps with *masterflex* tubing set to a speed between 2 and 3. The Sterivex filters and sample bags were then labelled. Approximately 0.2 L was pumped through the tubing without a Sterivex filter, followed by the attachment of the filter at 2L mark. Once the sample was completely filtered, a 10 ml syringe was used to blow the air out of the filter. The filter ends were sealed with Cha-seal on both ends and the filter was flash frozen in liquid nitrogen. The samples were then placed in labelled bags and placed in a -80 ^{o}C freezer.

To avoid contamination between samples, the sampling bottles were rinsed with milli-Q after sampling followed by ~50 ml of a 2% acid solution being poured into the bottle and shaken before soaking overnight. Further, milli-Q was pumped through the *masterflex* tubing before a 10% bleach solution was pumped through the *masterflex* tubing, followed by a thorough rinse with milli-Q. Both solutions could be reused by rinsing bottles and tubes with milli-Q before using acid and bleach.

Samples collected.

344 samples were collected for the analysis of the abundance, diversity, and activity of nifH gene (DNA and RNA) from the FISH, SS-CTD and Diazotroph Experiments (Table 5.3). Details of sample collection can be found in Appendix K. Two litres of seawater was filtered for each sample, unless otherwise stated.

Table 5.3 Summary of the number of samples collected during different activities during DY167

Activity	Number of individual samples
FISH	182
SS-CTD	58
Nutrient Limitation*	68
Diazo	104
Ice	4
Total	412

5.4 CARD-FISH

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Methods

Samples from towed fish surface seawater incubations for $^{15}N_2$-dervied nitrogen fixation rates and selected diazotroph experiments were fixed with paraformaldehyde (1.85% v/v final concentration) and stored at 4ºC in the dark for 1-4 h. Samples were then filtered through 0.6 µm polycarbonate filters with 0.8 µm acetate backing filters, air dried and stored in cryovials at -80ºC.

Samples collected

The list of samples collected is provided in Appendix L.

5.5 Particle-associated N_2 fixation rates

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Background

Nitrogen is a key element to produce proteins and nucleic acids, crucial for sustaining life. The most important source of nitrogen in the ocean is dinitrogen (N_2) fixation carried out by microorganisms called “diazotrophs”. Diazotrophs fall into two operational groups: cyanobacterial and ‘non-cyanobacterial’ diazotrophs (NCDs). While cyanobacteria rely on photosynthesis to obtain carbon and energy, NCDs lack a photosynthetic apparatus and are thought to associate to organic matter particles to obtain such resources. The sustained warming of the Arctic Ocean has led to increased primary productivity levels and reactive nitrogen limitation, thought to create a niche for diazotrophs. Past sequencing efforts suggest that NCDs are dominant in the Arctic Ocean, potentially being the major contributors to nitrogen inputs in this region. Due to the lack of methods able to measure NCD-specific N_2 fixation rates, the contribution of these microorganisms to nitrogen cycling and productivity remains unquantified. At present, no visual evidence NCDs’ association with particles or even their ability to fix N_2 exists. Our objective for the N-ARC cruise is to identify, visualize and measure particle-associated N_2 fixation rates in NCDs.

Methods

Suspended, slow-sinking and fast-sinking particle fractions (Susp, SS and FS, respectively) were collected from 16 stations using a marine snow catcher (MSC) deployed to 10 m below the DCM (Appendix M). After deployment, the MSC was allowed to sediment on deck for 2 h before sampling each MSC fraction (Riley et al 2012).

Triplicate 4300 ml, 500 ml and 40 ml samples were collected from the Susp, SS and FS fractions, respectively. Each fraction set of triplicates was incubated in with 10% v/v $^{15}N_2$-enriched filtered seawater for 48h in a temperature-controlled room. After the incubation period, subsamples from each MSC fraction (500 ml, 50 ml, and 10 ml for the Susp, SS and FS fractions, respectively) were filtered through 3 µm (particle-associated) and 0.2 µm (free-living) polycarbonate filters, fixed with 1.6% PFA and stored at -80ºC for single-cell mass spectrometry analyses (nanoSIMS). The rest of the incubated sample volume was filtered through precombusted GFF filters for bulk N_2 fixation rate measurements (EA-IRMS). Aliquots of the Susp fraction were collected in 12 ml Exetainer tubes for MIMS measurements (done onboard, see section 5.2). The natural abundance of particulate matter was only measured from the Susp fraction in triplicate 4000 ml samples filtered onto pre-combusted GFF filters and stored at -20ºC.

After the cruise, GFF filters will be pelletized in tin cups and measured by EA-IRMS obtaining particulate nitrogen concentrations and particulate matter ^{15}N atom% values. Together with the dissolved ^{15}N atom% values obtained from MIMS analyses onboard (see section 5.2), bulk N_2 fixation rates will be calculated according to White et al. 2020 and expressed as nmol N l^{-1} d^{-1}.

Size-fractionated samples collected on polycarbonate filters will be used for single-cell mass spectrometry analyses. Using a combination of immunolabeling against the nitrogenase enzyme, phycoerythrin autofluorescence and DAPI staining, we will be able to visualize and quantify particle-associated and free-living NCDs in 3 µm and 0.2 µm filters, respectively (Geisler et al 2019). Single-cells identified as NCDs will be mapped and marked using laser marking and subsequently scanned on a nanoscale secondary ion mass spectrometer (nanoSIMS) to obtain single-cell ^{15}N atom% enrichment values. Single-cell N_2 fixation rates (fmol N cell^{-1} d^{-1}) will be calculated from at least 20 regions of interest (ROIs) per sample as detailed in Benavides et al.2022. Further taxon-specific N_2 fixation rates will be obtained by mapping CARD-FISH targeted cells on the nanoSIMS (see section 5.4 and Appendix L).

Samples collected

The MSC was deployed 19 times at 16 stations (Figure 5.1 and Appendix M), obtaining 156 and 198 samples for bulk and single-cell particle-associated N_2 fixation rate measurements, respectively.

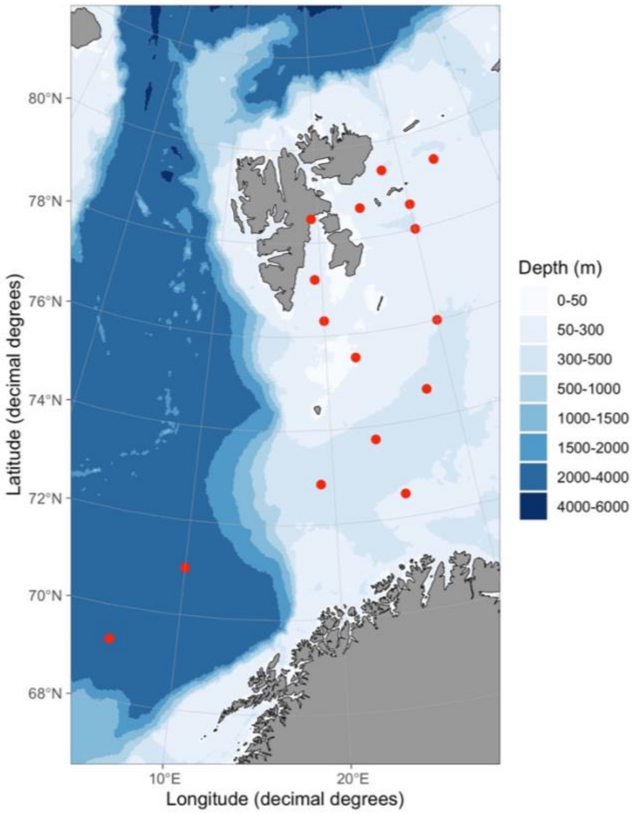

Figure 5.1 Stations where MSCs were deployed

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5.6 Particle-associated diazotroph community composition (MSC)

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Methods

Samples from each MSC fraction (see section 5.5) were obtained in triplicate as 4000 ml, 500 ml and 100 ml for the Susp, SS and FS fractions, respectively. Each sample was filtered through 3 µm polycarbonate and 0.2 µm polysulfone filters, the filters transferred to bead beater tubes and stored at -80ºC.

After the cruise, DNA will be extracted from filters using a Qiagen Mini Plant Kit with additional freeze-fracture steps as detailed in Moisander et al. (2008). DNA extracts will be quantified by PicoGreen assays and *nifH* genes amplified and sequenced using the Illumina MiSeq platform with 2 × 300 bp paired-end reads (Benavides et al 2018). Demultiplexed paired-end sequences will be dereplicated, denoised, assembled and chimeras discarded using the DADA2 pipeline (Callahan et al 2016). Sequences will be annotated using the DADA2 adapted *nifH* gene database (https://github.com/moyn413/nifHdada2). Sequences will be deposited in the Sequence Read Archive of NCBI.

The top 3 *nifH* sequences retrieved will be used to design specific horseradish peroxidase CARD-FISH probes. Single-cells hybridized will be mapped, laser marked and scanned by nanoSIMS as explained in section 5.5 (Harding et al 2022).

Samples collected

The MSC was deployed 19 times at 16 stations (Appendix M and Figure 5.1), obtaining 290 samples for DNA analyses.

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Harding, K. J. *et al.* Cell-specific measurements show nitrogen fixation by particle-attached putative non-cyanobacterial diazotrophs in the North Pacific Subtropical Gyre. *Nat. Commun.* 13, 1–10 (2022).

5.7 Ultraplankton N_2 fixation rates

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Background

Recent metagenomic studies in the Arctic Ocean have reported *nifH* genes in the <0.2 µm fraction, suggesting an existence of “ultradiazotrophs” Pierella Karlusich et al (2021). However, these organisms have not been imaged, isolated, nor their N_2 fixation potential measured. During the N-ARC cruise, we sampled surface seawater at selected stations to assess the ultradiazotroph community composition and its specific N_2 fixation activity.

Methods

Duplicate 20 l surface seawater samples were collected on acid-clean PET carboys and pre-filtered with a 0.2 µm Sartorius cartridge using a peristaltic pump. The <0.2 µm filtrate was concentrated to 500 ml using a VivaFlow cassette with a 100 kDa membrane cut-off (Fadeev et al 2023). From the 500 ml concentrate, triplicate 50 ml samples were transferred to septum cap glass vials, spiked with 10% v/v $^{15}N_2$-enriched filtered seawater, and incubated for 48h at simulated in situ temperature and light conditions in a climatised van. After incubation, the samples were filtered onto 0.1 µm polycaonate filters, fixed with 1.6% PFA and stored at -80ºC for posterior nanoSIMS analyses as detailed in section 5.5.

Samples collected

Table 5.4 Surface samples collected for VivaFlow concentration of ultraplankton and $^{15}N_2$ incubations.

Date (dd/mm/yyyy)	Time GMT	Station	Latitude (°N)	Longitude (°E)	ti concentration	tf concentration	ti incubation	tf incubation
15/07/2023	13:32	N01	70.98	10.98	15/07/2023 13:32	16/07/2023 02:10	16/07/2023 10:50	18/07/2023 10:40
21/07/2023	11:04	N07	75.51	22.50	21/07/2023 11:04	21/07/2023 19:55	22/07/2023 21:20	24/07/2023 21:40
27/07/2023	10:23	N08	79.20	33.54	27/07/2023 10:23	28/07/2023 14:35	28/07/2023 16:20	30/07/2023 16:20
03/08/2023	19:53	N16	78.52	19.22	03/08/2023 19:53	04/08/2023 18:27	05/08/2023 10:04	07/08/2023 10:37
07/08/2023	19:23	N03	72.85	19.07	07/08/2023 19:23	08/08/2023 18:33	08/08/2023 14:32	10/08/2023 14:19

References

Pierella Karlusich, J. J. *et al.* Global distribution patterns of marine nitrogen-fixers by imaging and molecular methods. *Nat. Commun.* 12, 1–18 (2021)

5.8 Ultraplankton diazotroph community composition

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*dataset PI

Methods

From the 500 ml concentrate obtained (see section 5.7) triplicate 10 ml samples were collected in Falcon tubes and stored at -80ºC for extracellular vesicle enumeration (Fadeev et al 2023). Another set of triplicate 100 ml samples were collected on Falcon tubes and stored at -80ºC for downstream DNA analyses. After the cruise, DNA samples will be extracted using a VivaSpin kit (Fadeev et al 2023). *NifH* gene sequences will be obtained and processed as detailed in section 5.6.

Samples collected

Table 5.5 Surface seawater collected for ultraplankton fraction extracellular vesicles (EVs) and DNA sampling.

Date (dd/mm/yyyy)	Time GMT	Latitude (°N)	Longitude (°E)	initial vol (ml)	concentrated vol (ml)	nanoSIMS replicates	EV replicates	DNA replicates
15/07/2023	13:32	70.98	10.98	20000	500	3	3	6
21/07/2023	11:04	75.51	22.50	20000	500	3	3	6
27/07/2023	10:23	79.20	33.54	20000	500	3	3	6
03/08/2023	19:53	78.52	19.22	20000	500	3	3	6
07/08/2023	19:23	72.85	19.07	20000	500	3	3	6

References

Fadeev, E. *et al.* Characterization of membrane vesicles in Alteromonas macleodii indicates potential roles in their copiotrophic lifestyle. *microLife* 4, (2023).

6 Phytoplankton community structure and activity

6.1 Phytoplankton Community Structure

Christopher Follet[1,2] and Louisa Norman[1] (University of Liverpool),
[1] *Author,* [2]*Data set PI*

Background motivation and objectives

Methods
Images of the phytoplankton communities were obtained using a McLane Laboratories Imaging FlowCytoBot (IFCB). The IFCB captures high resolution images of suspended particles using flow cytometry and video technology. Images are produced by the triggering of laser-induced fluorescence and light scattering from suspended particles in the size range of 10 to 100 µm. A continual sample rate of approximately 15 mL, or 3 samples, per hour can be obtained. Images can be seen in real time and later processed using image classification software.

During DY167, the IFCB was setup to continually capture images on particles containing chlorophyll (phytoplankton) from the ship underway system and sampled both on station and during transit between stations.

Samples collected
Between 22nd July and 10th August 2023, the IFCB obtained images from ~183 samples per day, except for 2nd and 10th August where communication between the IFCB and operating platform were lost and a re-start was required. On these days 80 and 120 samples were imaged, respectively. Post-processing of the several thousand images obtained will be undertaken during the next year.

Issues encountered.
The IFCB was initially set up on 8th July prior to leaving Southampton. The instrument was placed in its housing and secured in a sink next to the underway system in the wet lab on the RRS Discovery. The system was primed using Milli-Q ultrapure water and then switched to filtered seawater to further prime the sheath flow filters, prior to the introduction of underway seawater. It was intended that the instrument would start recording data once the ship had passed the Thames plume. However, a fluid leak from the bleach clean reagent bag meant that the instrument had to be stopped and removed from the housing before any sampling had begun. Once the leak had been fixed, the instrument was once again primed with seawater to remove air from the system that had been introduced by the leak. Unfortunately, an unrelated issue with a non-functioning rotary valve motor once again halted operations. The rotary valve ensures that sheath flow fluid and sample are directed to the correct location. For example, that samples enters the intake, excess fluid and air are expelled through the exhaust, sample is directed to the flow cell, or cleaning agents are introduced. After email advice from McLane, the camera focus motor was swapped for the rotary valve motor. This provided a fully functioning rotary valve, but camera focus had to be done manually. Manual focus proved to be a little challenging as the majority of particles captured were close to the lower end of the size range. The IFCB was not returned to the housing, but was run on the bench in the general-purpose lab, screened off from the sink with a plastic sheet curtain to ensure the instrument remained dry should a leak from the underway occur. This setup allowed access to the instrument for focusing and for any further maintenance that may be required.

6.2 Fast Repetition Rate Fluorescence (FRRF)

Claire Mahaffey[1,2] (University of Liverpool),
[1] *Author*, [2]*Data set PI*

Background motivation and objectives

We performed a series of nutrient addition experiments to determine which nutrient limited phytoplankton growth in the Barents Sea (see section 7.1). To quantify how phytoplankton were responding to the addition of different nutrients, we measured the maximal photochemical quantum yield (F_v:F_m). We also used the chlorophyll from the FRR to get a first estimate of phytoplankton growth because we had to wait 24 hours for the extracted chlorophyll measurement. As we sailed through gradients in nutrients, we also took the opportunity to measure F_v:F_m from samples collected from the FISH.

Methods

F_v/F_m was measured using a Chelsea Technology Group FRRF II Sensor (S/N 15 0093 002). The measurement conditions remained the same throughout the cruise. An example of the setup conditions is reported in Figure 6.1. Four Protocols were setup to measure the fluorescence properties under different wavelengths, although F_v/F_m was recorded for protocol A only (See Table 6.1). Note that the FRRF belonged to Prof Mark Moore (University of Southampton) and was initially setup by Mark Moore at the start of the cruise. The PMT was optimised for a typical coastal high biomass water sample (from the docks).

Figure 6.1 Summary of measurement conditions, including PMT eht, and an example of the fluorescence scans (FISH 0265).

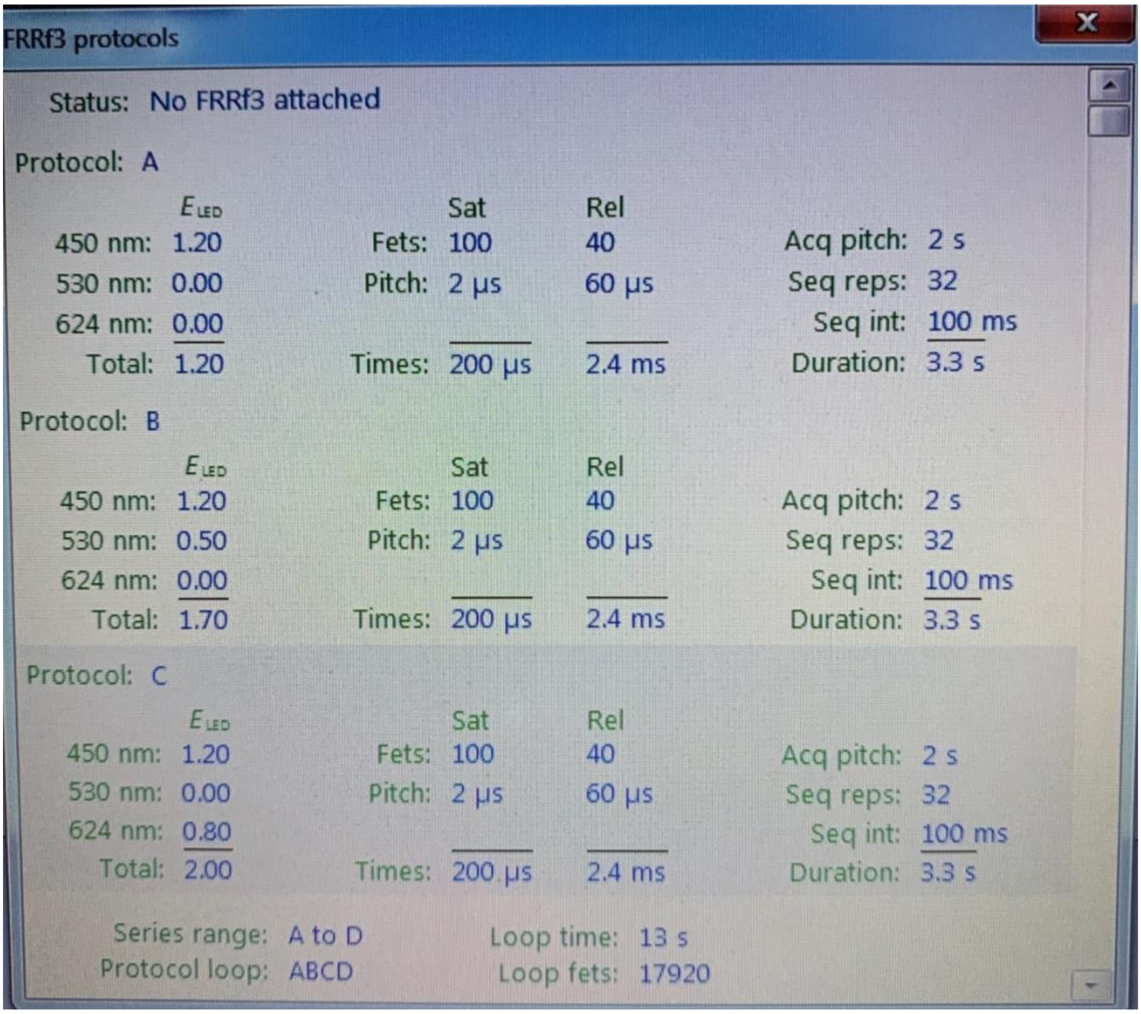

Figure 6.2 Example of protocols used to measure the fluorescence properties of phytoplankton at different wavelengths where 450 nm is blue, 530 nm is green and 624 nm is orange.

Samples collected

Samples were collected from the towed FISH and nutrient addition experiments only (Table 6.1). All samples were collected in 125 mL polycarbonate bottles. Bottles were triple rinsed in Milli-Q water between samples but were not acid rinsed. Samples were left in dark bags for 15 minutes prior to measurement. Samples from the nutrient limitation experiment were analysed within 30 minutes of collection. Samples from the towed FISH were sometimes stored in dark bags at sea surface temperature for up to 7 hours before analysis due to hours of rest restrictions. F_m, F_v:F_m and chlorophyll were recorded in a laboratory notebook.

Table 6.1 Summary of FRRF measurements made during DY167

Activity	**Number of measurements**
Nutrient limitation experiment	810
Towed FISH	321
Total	1131

Between 2 and 3 measurements were made per sample. For the nutrient limitation experiments, the mean was estimated for each replicate, and a subsequent mean estimated per treatment, taking into consideration the instrument variability and between carboy variability. The MQ jacket was changed daily and MQ blanks were analysed at the start and end of each run. Filtered sample blanks were not analysed due to time constraints.

There were no issues with data quality during DY167 cruise and F_v:F_m increased as expected with the addition of nutrients, and between regions of sampling. However, near the ice edge, when autotrophic biomass was low, temperature and salinity were low, it was not possible to get a reading of F_v:F_m on protocol A (see Figure 6.2) and instead were measurable with protocols B and C. This may be due to the low biomass and/or high light adapted plankton in these surface waters and will be further investigated.

6.3 High-resolution DCM community transcription diel cycle

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*dataset PI

Background

DCMs are localized layers of high-chlorophyll concentration where phytoplankton cells meet optimal nutrient concentration levels and sufficient light to perform photosynthesis. Within DCMs, phytoplankton communities can structure vertically according to fine-scale gradients of nutrients, light and concomitant bacterioplankton communities. Along a diel cycle, the DCM vertical structure is also subject to change according to sunlight incidence and water column stability variability (Latasa et al 2017). To assess the functional response of phyto- and bacterioplankton species according to physical-chemical fine-scale gradients in the DCM layer along a diel cycle, we sampled RNA at high vertical resolution over four repeated casts at stations N08 and N03.

Methods

To examine diel cycle phytoplankton community structure and transcription variability within a DCM layer, we sampled the DCM layers of station N08 (four casts at 3-4 m resolution) and N03 (three casts at 3 m resolution) over a 12h cycle.

From each targeted depth, 2 l were collected in acid-clean polycarbonate bottles and filtered through 3 µm polycarbonate and 0.2 µm polysulfone filters, transferred to bead beater tubes containing 500 µl RNAlater, flash-frozen in liquid nitrogen and stored at -80ºC. After the cruise, RNA will be extracted using the Qiagen RNeasy Mini Kit with β-mercaptoethanol added to the kit's lysis buffer to enhance intracellular RNase denaturation (Mosiander et al 2008). Prior to extraction, filters will be ground and submitted to five to ten flash freezing steps with liquid nitrogen to maximise the extraction yield. An extra DNase treatment will be done using the Ambion TURBO DNA-freeTM Kit, followed by a Zymo-5 column clean up kit. RNA concentrations will be quantified using the Invitrogen RiboGreen RNA Quantification Kit. RNA extracts will be sequenced using an Illumina NovaSeq 6000 platform and reads QCd as detailed in Gifford et al (2016). RNA reads will be annotated Kofam database.

Samples collected

See Appendix N for details of sample collection.

References

Latasa, M., Cabello, A. M., Morán, X. A. G., Massana, R. & Scharek, R. Distribution of phytoplankton groups within the deep chlorophyll maximum. *Limnol. Oceanogr.* 62, 665–685 (2017).
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Gifford, S. M., Becker, J. W., Sosa, O. A., Repeta, D. J. & DeLong, E. F. Quantitative transcriptomics reveals the growth- and nutrient- dependent response of a streamlined marine methylotroph to methanol and naturally occurring dissolved organic matter. *MBio* 7, 1–15 (2016).

7 Incubation experiments

7.1 Nutrient Limitation Experiments

Maeve Lohan[1] (University of Southampton) Claire Mahaffey[2] (University of Liverpool),
[1] *Author* ,[1, 2] *Data set PI*

Motivation:
In the Barents Sea both macro and micronutrients such as iron can be very low and have been hypothesized to limit phytoplankton growth, particularly nitrate and iron (Rijkenberg et al. 2018). Interestingly primary production has increased in this region due to increased light availability and reductions in sea ice. To date, however no nutrient limitation studies have been carried out in this region, this has been inferred from concentration data. To investigate the macro and micronutrient control on primary productivity we performed 6 nutrient addition experiments at different locations to capture ice edge end member (Station N08), Atlantic water end member (Station NO3), Arctic influenced (N07 & NO7y) and glacial fjord (N15).

Experimental design and sampling:
Nutrient limitation experiments were carried out at 6 Stations (Underway, N07, N08, N07y, N15 & N03). With the exception of the first experiment, all experiments were conducted on station. Experiment 1 was sampled underway at 10 knots.

All polycarbonate bottles (2 L) and carboys (20 L) were acid cleaned at the University of Liverpool or Southampton under trace metal clean conditions. They were first rinsed 4 times with Milli-Q and then filled with 3 M HCl for one week, rinsed 4 times with Milli-Q and filled with 0.5 M HCL for one week. The bottles and carboys were then rinsed with Milli-Q 5 times and transported with a small volume of Milli-Q at the bottom. Between each experiment the bottles were rinsed with Milli-Q and a small volume of 2 M HCL added to the bottle or carboy, shaken and left for at least 24 hrs. They were then rinsed with Milli-Q 3 times on the day of filling for nutrient limitation experiment.

For Nutrient limitation experiments 20 L polycarbonate carboys were rinsed 3 times from the FISH prior to filling. All handling took place in the trace metal clean laboratory on the RSS Discovery. Rinsing started at noon. Seawater was pumped into the trace metal clean laboratory using a Teflon diaphragm pump (Almatec A-15) connected to the acid-washed braided PVC tubing. Unfiltered seawater was then used to rinse and fill the polycarbonate carboys to a final volume of 15 L. The carboy filling protocol was that each carboy was filled to 1/3rd (5L), when all 24 were 1/3rd full the second 3rd was added and then the final 3rd. Filling time took ~ 2 hours. Carboys were filled at random and no replicates were filled directly after one from the same set. Time zero samples for chlorophyll, inorganic nutrients, genes, Fv/Fm, phytoplankton and dissolved Fe were also collected at the start, middle and end of the filling time.

The carboys were then spiked with Nitrate (100 mM), phosphate (10 mM) and dissolved Fe chloride (20 μM) in a factorial design (see Figure 7.1) to give final concentrations of Nitrate (10 μM), phosphate (0.8 μM) and dissolved Fe chloride (2 nM). After spiking the polycarbonate carboys had parafilm placed around the lids. A spigot was placed on the carboy and was then covered with a plastic bag and tapped before being placed in the incubator. Bottles were then incubated for varying days (Table 7.1) in the incubator van, located in the hanger, which were fitted with LED light panels on a 24 hour on cycle as there was no night time at this time of year (Part no: LED-PANEL-300-1200-DW and LED-PANEL-200-6-DW, Daylight White, supplier Power Pax UK Limited). The photon flux from the light banks ranged from 180 to 220 μmol photos m^{-2} sec^{-1}.

Each day the carboys were sub sampled for inorganic nutrients, chlorophyll, Fv/Fm, phytoplankton (one from every treatment). The inorganic nutrients, chlorophyll and Fv/Fm were analysed each day. The data from this enabled us to decide when to break down the experiment (see Table 7.1). At each sub-sampling time point the spigots and carboys were rinsed with copious amounts of Milli-Q and rebagged and lids covered with parafilm before going back into the incubator. The time taken to get the 24 carboys from incubator, sub sampled and back in the incubator was one hour. At T_{final} inorganic nutrients, chlorophyll, Fv/Fm were taken from each carboy, in addition, phytoplankton and gene samples were taken from one of each treatment.

Table 7.1 Location and timings for nutrient limitation experiments

Station	Date	T0 beginning	T0 middle	T0 end	T final	Number of days
Underway	02/07/2023	09:00	10:20	11:25	06/07/2023 12:00	4
N07	21/07/2023	12:07	13:30	14:10	25/07/2023 10:30	4
N08	25/07/2023	12:20	14:10	15:02	01/08/2023 14:30	7
N07 y	29/07/2023	11:50	13:15	14:19	04/08.2023 10:30	6
N15	02/08/2023	12:10	13:52	14:55	08/08/2023 10:30	7
N03	06/08/2023	12:28	13:35	14:48	12/08/2023 10:00	6

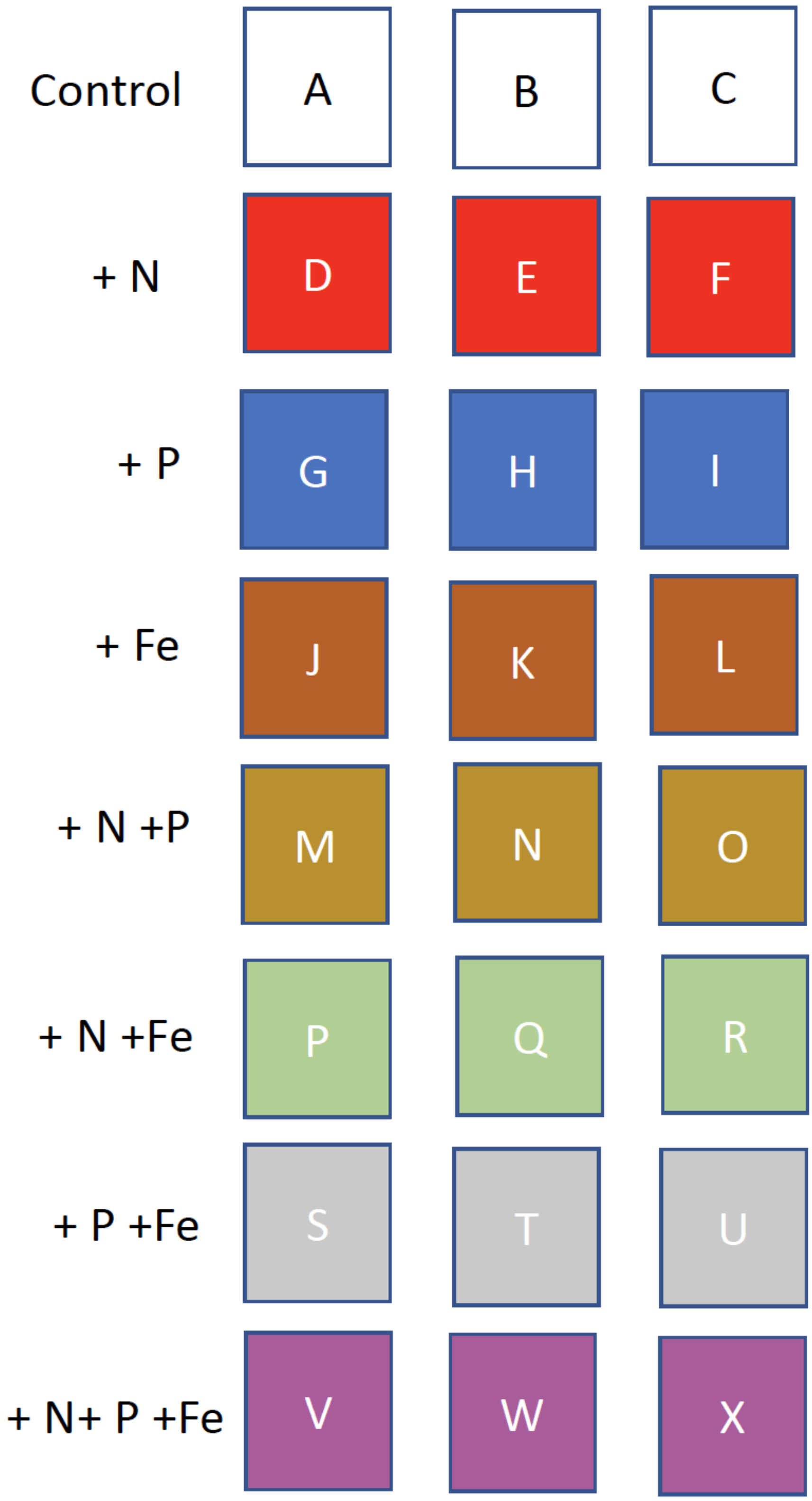

Figure 7.1 Factorial additions for all nutrient limitation experiments with additions of 10 µM NO_3^-, 0.8 µM PO_4^{3-} and 2nM Fe.

7.2 Diazotroph experiments

Claire Mahaffey[1,2] (University of Liverpool), Maeve Lohan[1] (University of Southampton)
[1] Author, [2] Data set PI

Background motivation and objectives

In the subtropical ocean, diazotroph activity is typically limited by the availability of iron and phosphorus. The environmental controls on diazotrophy in the Arctic Ocean are currently poorly constrained. To investigate the nutrient control on diazotroph activity in the Barents Sea, we performed 8 nutrient addition experiments at 7 locations, spanning the range of environments sampled from Atlantic-dominated to Arctic-dominated waters. Molecular data from this region suggests that the dominant diazotroph is the non-cyanobacterial diazotrophs or NCDs. Previous experiments suggested that organic carbon and phosphorus may limit the activity of NCDs (Turk-Kubo et al., 2022) and we used this knowledge to motivate the design of our experiments.

Methods

All sampling and experimental setup was performed by Maeve Lohan using trace metal clean sampling techniques in a trace metal clean laboratory on the RRS Discovery. We used acid cleaned and MQ-water rinsed 20L polycarbonate carboys and 2L polycarbonate bottles for the experiments. Using the towed FISH, the 20L carboys were rinsed three times and filled to 20 L. Stocks of nutrients were added to each carboy to adjust the organic carbon (final concentration= 4.83 μM), organic phosphorus (final concentration = 0.55 μM), iron (final concentration= 2 nM), organic nitrogen (final concentration=1 μM) and phosphate concentration (final concentration= 0.8 μM) (Figure 7.2).

Triplicate 2L bottles were filled from each treatment for $^{15}N_2$ fixation rates and DNA/RNA. The duration of the experiments changed depending on (a) if the FARACAS detected significant activity (> 3 ppb) or (b) water temperature, with experiments lasting 72 hours in colder waters).

$^{15}N_2$ fixation rates were performed as described in section 5.2, except there was no initial PN sample for $\delta^{15}N$ or incubated sample for $\delta^{15}N$, because the treatments are compared to the controls. Sampling for collection of DNA/RNA for nifH were performed as described in section 5.3. For Diazo 8, particle fractions (suspended, slow sinking, fast sinking) from the MSC were incubated with DOCP+Iron and Iron alone alongside a control with no amendment. The MSC was deployed at the DCM (instead of in the surface waters), a depth horizon corresponding to a decrease in dissolved iron.

Reference

Turk-Kubo et al (2022). Non-cyanobacterial diazotrophs: global diversity, distribution, ecophysiology, and activity in marine waters. FEMS Microbiology Reviews, 1-25.

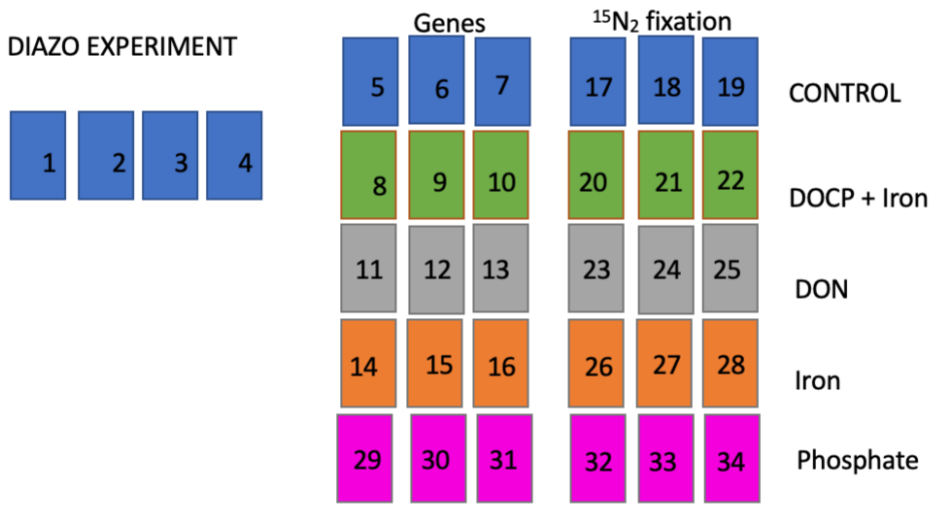

Figure 7.2 Summary of diazotroph experiments including labelling scheme during DY167.

Table 7.2 Locations, timings and treatments for diazotroph experiments

Experiment and location	Start date	End date	Treatment	Notes
DIAZO 1 Station N12	20/07/2023	23/07/2023	Control DOCP+Iron DON Iron	
DIAZO 2 Station N10	22/07/2023	25/07/2023	Control DOCP+Iron DON Iron	Samples collected for CARD-FISH
DIAZO 3 Station NO8	26/07/2023	29/07/2023	Control DOCP+Iron DON Iron	
DIAZO 4 Station NO6	30/07/2023	02/08/2023	Control DOCP+Iron DON Iron Phosphate	Samples collected for CARD-FISH
DIAZO 5 Station NO5	31/07/2023	02/08/2023	Control DOCP+Iron DON Iron Phosphate	Suspected haptophyte bloom. 48h incubation. Samples collected for CARD-FISH
DIAZO 6 Station N16	03/08/2023	05/08/2023	Control DOCP+Iron DON Iron Phosphate	High FARACAS activity. 48h incubation. Samples collected for CARD-FISH
DIAZO 7 Station NO3	07/08/2023	09/08/2023	Control DOCP+Iron DON Iron Phosphate	
DIAZO 8 MSC* Station NO3	07/08/2023	09/08/2023	Control DOCP+Iron Iron	Particle fractions incubated, insufficient material for gene samples.

7.3 Particle colonization experiments

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*dataset PI

Background

Organic matter particles are considered potential habitats for NCDs, supported by indirect evidence such as the presence of NCD *nifH* gene sequences on large size fractions (Benavides et al 2016, Delmont et al 2021, Cornejo-Castillo et al 2020). However, there is currently limited visual evidence of NCD colonization and N_2 fixation activity on and within these particles. In order to observe and quantify NCD particle colonization dynamics, we adapted the In Situ Chemotaxis Assay (ISCA) from Lambert et al. 2017 to investigate particle colonization from natural ocean communities. This adaptation allowed us to conduct time course colonization experiments of different organic carbon sources using surface seawater.

Methods

In order to study and quantify particle colonization, we developed an adapted a version of the ISCA device using PMMA and 3D printing resin. This modified device allows us to incubate artificial particles and make it reusable for future experiments. The ISCA consists of bars, each containing 5 wells designed to accommodate single one-millimetre diameter agarose or alginate bead. As controls, we also included one-millimetre diameter glass beads and two empty wells to collect free-living bacteria. To allow particle colonization, the ISCA well bars are equipped with a lid featuring an 800 µm diameter opening above each well, enabling bacteria to access different carbon sources. These bars are then placed in aquaria, where they are incubated with 4 l surface seawater pre-filtered by 10 µm. For our study, we set up two aquaria: one for microscopy analyses and another for DNA analyses to investigate the colonization architecture and community composition of the particle-associated communities, respectively. The arrangement of the beads can be found in Table 7.3. For microscopy analysis, the samples were fixed in a 1.6% v/v paraformaldehyde solution for one hour, followed by storage in a 50% EtOH filtered seawater solution at -80°C. The samples for DNA extraction and sequencing were directly stored in a 50% EtOH filtered seawater solution and kept at -80°C.

Table 7.3 Arrangement of the different beads in the ISCA wells, and their incubation time.

Time	Carbon source				
2h	Control glass bead 1	Control glass bead 2	Agarose bead 1	Agarose bead 2	Agarose bead 3
	Alginate bead 1	Alginate bead 2	Alginate bead 3	Control free living	Control free living
36 h	Control glass bead 1	Control glass bead 2	Agarose bead 1	Agarose bead 2	Agarose bead 3
	Alginate bead 1	Alginate bead 2	Alginate bead 3	Control free living	Control free living
72 h	Control glass bead 1	Control glass bead 2	Agarose bead 1	Agarose bead 2	Agarose bead 3
	Alginate bead 1	Alginate bead 2	Alginate bead 3	Control free living	Control free living

Samples collected

Table 7.4 Stations where surface seawater was sampled for ISCA particle colonization experiments.

Experiment start Date (dd/mm/yyyy)	Experiment end Date (dd/mm/yyyy)	Station	Latitude (°N)	Longitude (°E)	Microscopy samples	DNA samples
15/07/2023	19/07/2023	N01	70.59	10.59	30	30
20/07/2023	23/07/2023	N12	75.30	22.29	30	30
26/07/2023	29/07/2023	N08	79.20	33.58	30	30
03/08/2023	06/08/2023	N16	78.50	19.26	30	30

References

Lambert, B. S. *et al.* A microfluidics-based in situ chemotaxis assay to study the behaviour of aquatic microbial communities. *Nat Microbiol* 2, 1344–1349 (2017).

Benavides, M., Moisander, P. H., Daley, M. C., Bode, A. & Arístegui, J. Longitudinal variability of diazotroph abundances in the subtropical North Atlantic Ocean. *J. Plankton Res.* 38, (2016).

Delmont, T. O. *et al.* Heterotrophic bacterial diazotrophs are more abundant than their cyanobacterial counterparts in metagenomes covering most of the sunlit ocean. *ISME J.* (2021) doi:10.1038/s41396-021-01135-1.

Cornejo-Castillo, F. M. & Zehr, J. P. Intriguing size distribution of the uncultured and globally widespread marine non-cyanobacterial diazotroph Gamma-A. *ISME J.* (2020) doi:10.1038/s41396-020-00765-1.

8 Underway pCO_2

Anita Flohr[1,2] (National Oceanography Centre) Joshua Peddar[1] (NMF-SSS), Louisa Norman[1] (University of Liverpool)
[1] Author , [2]Data set PI

Methods
The underway seawater flow was connected to the SubCtech on 10th July and PCO2 recording was started. The underway was turned off, briefly, on 13th July to troubleshoot a temperature issue on the SubCtech.

DIC samples were taken daily from 11th July to 10th August 2023, except 17th July when the underway was turned for several hours. Two seawater samples of 250 mL were collected in glass bottles with stopper from the SubCtech outflow. The bottles were rinsed twice with seawater and then the outflow tube was placed in the bottle and the water allowed to flow for 3 x the volume of the bottle. The tube was carefully removed and the stopper placed in the bottle. 2.5 mL of seawater was removed from the bottle and 50 µL of mercuric II chloride was introduced. The stopper was dried, Apiezon grease applied and the stopper placed back in the bottle. The stopper was secured to the bottle using an elastic band and plastic clip.
Samples will be analysed post-cruise at the National Oceanography Centre.

Samples collected
Duplicate samples for DIC were collected daily for 30 days during the cruise.

9 Appendices

9.1 Appendix A – Cruise Event Log

				START (deployed)							At Bottom							Recovered (on-deck)								
EVENT	STATION	ID	TYPE	DATE-TIME	LAT_DEG	LAT_MIN	NS	LON_DEG	LON_MIN	EW	DATE-TIME	LAT_DEG	LAT_MIN	NS	LON_DEG	LON_MIN	EW	DATE-TIME	LAT_DEG	LAT_MIN	NS	LON_DEG	LON_MIN	EW	WDEPTH	Comment
1	TGF	FISHIN	FISH	10/07/2023 10:22	53	0.194	N	2	27.847	E															38	
2	N00	CTD001	S	14/07/2023 12:04	68	48.395	N	10	26.193	E	14/07/2023 12:26	68	48.396	N	10	26.193	E	14/07/2023 13:02	68	48.42	N	10	26.22	E	3024.23	Primary Sensor blockage at 500 m
3	N00	MSC003	O	14/07/2023 13:24	68	48.42	N	10	26.22	E	14/07/2023 13:27	68	48.42	N	10	26.22	E	14/07/2023 13:29	68	48.42	N	10	26.22	E	3023.59	30 m
4	N00	MSC004	N	14/07/2023 13:53	68	48.42	N	10	26.22	E	14/07/2023 13:55	68	48.42	N	10	26.22	E	14/07/2023 13:56	68	48.42	N	10	26.22	E	3023.23	30 m Misfire
5	N00	MSC005	N	14/07/2023 14:03	68	48.42	N	10	26.22	E	14/07/2023 14:12	68	48.42	N	10	26.22	E	14/07/2023 14:14	68	48.42	N	10	26.22	E	3023.19	30 m
6	N00	CTD002	T	14/07/2023 16:00	68	48.4	N	10	26.195	E	14/07/2023 16:31	68	48.4	N	10	26.2	E	14/07/2023 17:04	68	48.4	N	10	26.195	E	3023	Btl 11 not present
7	N01	CTD003	S	15/07/2023 12:10	70	59.993	N	10	59.994	E	15/07/2023 13:02	70	59.897	N	10	59.896	E	15/07/2023 14:07	70	59.9	N	10	59.9	E	2619	Primary Sensor blockage at 600 m
8	N01	MSC008	N	15/07/2023 14:31	70	59.94	N	10	59.94	E	15/07/2023 14:33	70	59.94	N	10	59.94	E	15/07/2023 14:36	70	59.94	N	10	59.94	E	2618.84	30 m
9	N01	CTD004	T	15/07/2023 15:24	70	59.994	N	10	59.993	E	15/07/2023 16:20	70	59.83	N	10	59.84	E	15/07/2023 17:44	70	59.686	N	10	59.69	E	2618	
10	N02	CTD005	S	16/07/2023 12:13	72	0.033	N	15	0.173	E	16/07/2023 12:42	72	0.018	N	15	0.072	E	16/07/2023 13:26	72	0.008	N	15	0.01	E	1128	2nd Oxygen sensor added and primary sensor blockage at 630 m
11	N02	CTD006	T	16/07/2023 14:15	71	59.998	N	14	59.971	E	16/07/2023 14:42	71	59.998	N	14	59.976	E	16/07/2023 15:20	71	59.998	N	14	59.976	E	1127	
12	N04	CTD007	S	18/07/2023 12:09	73	43.475	N	23	22.08	E	18/07/2023 12:26	73	43.476	N	23	22.079	E	18/07/2023 12:59	73	43.48	N	23	22.08	E	459	Primary sensor blockage at 380 m. Strong waves (winch adjust below 100m)
13	N04	MSC013	N	18/07/2023 13:16	73	43.5	N	23	22.08	E	18/07/2023 13:18	73	43.5	N	23	22.08	E	18/07/2023 13:20	73	43.5	N	23	22.08	E	460	30 m Misfire
14	N04	MSC014	N	18/07/2023 13:27	73	43.5	N	23	22.08	E	18/07/2023 13:29	73	43.5	N	23	22.08	E	18/07/2023 13:31	73	43.5	N	23	22.08	E	460	30 m Misfire
15	N04	MSC015	N	18/07/2023 13:42	73	43.5	N	23	22.08	E	18/07/2023 13:44	73	43.5	N	23	22.08	E	18/07/2023 13:47	73	43.5	N	23	22.08	E	460	30 m Misfire
16	N04	MSC016	N	18/07/2023 13:48	73	43.5	N	23	22.08	E	18/07/2023 13:50	73	43.5	N	23	22.08	E	18/07/2023 13:51	73	43.5	N	23	22.08	E	460	30 m Misfire
17	N04	MSC017	O	18/07/2023 14:07	73	43.5	N	23	22.08	E	18/07/2023 14:09	73	43.5	N	23	22.08	E	18/07/2023 14:11	73	43.5	N	23	22.08	E	460	30 m
18	N04	CTD008	T	18/07/2023 18:30	73	43.475	N	23	22.079	E	18/07/2023 18:48	73	43.475	N	23	22.076	E	18/07/2023 19:22	73	43.47	N	23	22.08	E	459	Strong waves (no winch adjust)
19	N05	CTD009	S	19/07/2023 12:05	74	36.348	N	27	53.984	E	19/07/2023 12:21	74	36.349	N	27	53.984	E	19/07/2023 12:53	74	36.349	N	27	53.982	E	383	Pump on primary changed. Oxygen sensor on primary cable not connected
20	N05	MSC020	O	19/07/2023 13:22	74	36.36	N	27	54	E	19/07/2023 13:24	74	36.36	N	27	54	E	19/07/2023 13:26	74	36.36	N	27	54	E	383	30 m
21	N05	MSC021	N	19/07/2023 13:42	74	36.36	N	27	54	E	19/07/2023 13:44	74	36.36	N	27	54	E	19/07/2023 13:46	74	36.36	N	27	54	E	383	30 m Test Misfire
22	N05	MSC022	N	19/07/2023 13:58	74	36.36	N	27	54	E	19/07/2023 14:00	74	36.36	N	27	54	E	19/07/2023 14:01	74	36.36	N	27	54	E	383	30 m Test Misfire
23	N05	MSC023	N	19/07/2023 14:14	74	36.36	N	27	54	E	19/07/2023 14:16	74	36.36	N	27	54	E	19/07/2023 14:18	74	36.36	N	27	54	E	383	30 m Test Misfire
24	N05	CTD010	T	19/07/2023 16:09	74	36.348	N	27	53.985	E	19/07/2023 16:25	74	36.348	N	27	53.984	E	19/07/2023 16:49	74	36.35	N	27	53.99	E	383	
25	RAS01	CTD011	S	19/07/2023 20:08	74	45.06	N	27	2.03	E	19/07/2023 20:28	74	45.06	N	27	2.03	E	19/07/2023 21:00	74	45.06	N	27	2.032	E	347	Oxygen secondary sensor is bad in upper 30 m
26	RAS02	CTD012	S	19/07/2023 23:02	74	50.55	N	26	27.13	E	19/07/2023 23:15	74	50.55	N	26	27.13	E	19/07/2023 23:38	74	50.55	N	26	27.13	E	302	Oxygen secondary sensor is bad in upper 30 m
27	N12	CTD013	S	20/07/2023 12:02	75	30.04	N	22	29.873	E	20/07/2023 12:12	75	30.034	N	22	29.888	E	20/07/2023 12:30	75	30.034	N	22	29.891	E	55	Oxygen secondary sensor is bad in upper 30 m
28	N12	MSC028	O	20/07/2023 12:47	75	30.06	N	22	29.88	E								20/07/2023 12:54	75	30.06	N	22	29.88	E	57	Current too strong towards ship
29	N12	MSC029	O	20/07/2023 12:56	75	30.06	N	22	29.88	E	20/07/2023 12:59	75	30.06	N	22	29.88	E	20/07/2023 13:02	75	30.06	N	22	29.88	E	56	37 m
30	N12	CTD014	T	20/07/2023 15:01	75	30.052	N	22	29.996	E	20/07/2023 15:07	75	30.053	N	22	29.996	E	20/07/2023 15:15	75	30.053	N	22	29.996	E	55	
31	N12	FISHOUT	FISH	20/07/2023 20:43	74	53.682	N	26	12.72	E																The tape on the tubing was coming off. Tubing was still connected.
32	N12	FISHIN	FISH	20/07/2023 20:55	74	53.682	N	26	12.72	E																
33	N07	CTD015	S	21/07/2023 12:05	77	59.998	N	29	59.948	E	21/07/2023 12:24	77	59.998	N	29	59.96	E	21/07/2023 12:56	77	59.998	N	29	59.958	E	297	
34	N07	MSC034	O	21/07/2023 13:09	78	0	N	29	59.94	E	21/07/2023 13:13	78	0	N	29	59.94	E	21/07/2023 13:16	78	0	N	29	59.94	E	297.7	55 m Bottle leaked
35	N07	MSC035	O	21/07/2023 13:32	78	0	N	29	59.94	E	21/07/2023 13:35	78	0	N	29	59.94	E	21/07/2023 13:38	78	0	N	29	59.94	E	297.7	55 m
36	N07	MSC036	N	21/07/2023 13:54	78	0	N	29	59.94	E	21/07/2023 13:57	78	0	N	29	59.94	E	21/07/2023 13:59	78	0	N	29	59.94	E	297.7	55 m Test
37	N07	MSC037	N	21/07/2023 14:09	78	0	N	29	59.94	E	21/07/2023 14:11	78	0	N	29	59.94	E	21/07/2023 14:14	78	0	N	29	59.94	E	297.7	55 m Test
38	N07	MSC038	N	21/07/2023 14:20	78	0	N	29	59.94	E	21/07/2023 14:22	78	0	N	29	59.94	E	21/07/2023 14:25	78	0	N	29	59.94	E	297.7	55 m Test
39	N07	CTD016	T	21/07/2023 16:12	77	59.996	N	29	59.962	E	21/07/2023 16:29	77	59.998	N	29	59.963	E	21/07/2023 16:52	78	0	N	29	59.94	E	297	Top 90 m repeated on cast CTD017T
40	N07	CTD017	T	21/07/2023 17:11	77	59.997	N	29	59.967	E	21/07/2023 17:17	77	59.998	N	29	59.962	E	21/07/2023 17:26	77	59.998	N	29	59.963	E	298	
41	N10	CTD018	S	22/07/2023 11:59	78	39.514	N	24	39	E	22/07/2023 12:08	78	39.514	N	24	38.999	E	22/07/2023 12:34	78	39.512	N	24	38.999	E	141	
42	N10	MSC042	O	22/07/2023 12:45	78	39.54	N	24	39	E	22/07/2023 12:48	78	39.54	N	24	39	E	22/07/2023 12:50	78	39.54	N	24	39	E	141	52 m
43	N10	CTD019	T	22/07/2023 16:42	78	39.513	N	24	39.01	E	22/07/2023 16:51	78	39.513	N	24	39.01	E	22/07/2023 17:00	78	39.514	N	24	39.008	E	141	
44	N09	CTD020	S	23/07/2023 10:13	79	22.846	N	27	47.86	E	23/07/2023 10:26	79	22.867	N	27	47.602	E	23/07/2023 10:50	79	22.891	N	27	47.31	E	350	
45	N09	CTD021	S	23/07/2023 12:02	79	23	N	27	46.044	E	23/07/2023 12:17	79	23.008	N	27	45.882	E	23/07/2023 12:52	79	23.02	N	27	45.628	E	347	
46	N09	MSC046	O	23/07/2023 13:09	79	23.04	N	27	45.54	E	23/07/2023 13:11	79	23.04	N	27	45.54	E	23/07/2023 13:14	79	23.04	N	27	45.48	E	341	66 m
47	N09	CTD022	T	23/07/2023 15:16	79	23.152	N	27	44.359	E	23/07/2023 15:29	79	23.161	N	27	44.261	E	23/07/2023 15:52	79	23.173	N	27	44.149	E	336	
48	RAS03	CTD023	S	23/07/2023 21:11	79	16.823	N	28	29.384	E	23/07/2023 21:30	79	16.823	N	28	29.383	E	23/07/2023 22:12	79	16.812	N	28	29.3	E	234	Ice
49	N08	CTD024	S	25/07/2023 15:08	79	20.658	N	33	55.517	E	25/07/2023 15:20	79	20.669	N	33	55.345	E	25/07/2023 15:50	79	20.669	N	33	54.55	E	262	Ice
50	N08	MSC050	O	25/07/2023 15:55	79	20.82	N	33	54.48	E	25/07/2023 15:57	79	20.82	N	33	54.48	E	25/07/2023 15:59	79	20.82	N	33	54.48	E	267	56m Ice
51	N08	CTD025	T	25/07/2023 16:49	79	21.04	N	33	53.44	E	25/07/2023 16:58	79	21.05	N	33	53.36	E	25/07/2023 17:26	79	21.096	N	33	53.153	E	267	Ice
52	N08	CTD026 - C	S	25/07/2023 18:30	79	21.092	N	33	53.18	E								25/07/2023 21:09	79	20.76	N	33	54.48	E	267	YOYO1 Drift with ice
53	N08	CTD039	S	26/07/2023 10:03	79	21.482	N	33	48.556	E	26/07/2023 10:15	79	21.42	N	33	48	E	26/07/2023 10:32	79	21.38	N	33	48.214	E	265	Ice
54	N08	CTD040 - C	S	26/07/2023 11:17	79	21.238	N	33	43.383	E								26/07/2023 12:56	79	21.42	N	33	37.86	E	269	YOYO2 Drift with ice
55	N08	CTD055	S	26/07/2023 13:29	79	22.225	N	33	43.013	E	26/07/2023 13:38	79	22.277	N	33	42.819	E	26/07/2023 13:57	79	22.416	N	33	41.888	E	269	Ice
56	N08	CTD056 - C	S	26/07/2023 14:28	79	22.697	N	33	41.522	E								26/07/2023 15:53	79	23.34	N	33	43.32	E	271	YOYO3 Ice (ship towed a bit to avoid sea ice)
57	N08	CTD068	S	26/07/2023 16:12	79	23.429	N	33	43.524	E	26/07/2023 16:23	79	23.448	N	33	43.529	E	26/07/2023 16:39	79	23.524	N	33	43.531	E	271	Ice
58	N08	CTD069 - C	S	26/07/2023 17:07	79	23.556	N	33	43.525	E								26/07/2023 19:06	79	23.64	N	33	43.56	E	270	YOYO4 Drift with ice
59	N08	CTD087	S	26/07/2023 19:22	79	23.563	N	33	43.525	E	26/07/2023 19:34	79	23.537	N	33	43.525	E	26/07/2023 19:52	79	23.46	N	33	43.5	E	271	Ice
60	N08	CTD088 - C	S	26/07/2023 20:21	79	23.428	N	33	44.32	E								26/07/2023 22:05	79	22.8	N	33	44.04	E	270	YOYO5 Drift with sea ice
61	N08	CTD103	S	27/07/2023 12:09	79	22.15	N	33	28.465	E	27/07/2023 12:21	79	22.18	N	33	28.463	E	27/07/2023 12:35	79	22.228	N	33	28.46	E	270	Ice
62	N08	MSC062	O	27/07/2023 13:57	79	22.26	N	33	23.16	E	27/07/2023 13:59	79	22.26	N	33	23.04	E	27/07/2023 14:01	79	22.26	N	33	22.98	E	270	54m Ice
63	N08	SMB1	BOAT	27/07/2023 15:16	79	22.44	N	33	22.26	E								27/07/2023 15:53	79	22.62	N	33	20.82	E	270	Near sea ice sampling
64	N08	CTD104	S	27/07/2023 17:58	79	22.982	N	33	19.366	E	27/07/2023 18:12	79	22.944	N	33	19.26	E	27/07/2023 18:28	79	22.924	N	33	19.074	E	271	Ice
65	N07x	CTD105	S	28/07/2023 12:07	78	32.39	N	30	2.998	E	28/07/2023 12:17	78	32.394	N	30	2.975	E	28/07/2023 12:46	78	32.395	N	30	2.97	E	250	
66	N07x	MSC066	O	28/07/2023 12:53	78	32.4	N	30	2.94	E	28/07/2023 12:55	78	32.4	N	30	2.94	E	28/07/2023 12:58	78	32.4	N	30	2.94	E	250	53 m Leaked
67	N07x	MSC067	O	28/07/2023 13:14	78	32.4	N	30	3	E	28/07/2023 13:16	78	32.4	N	30	3	E	28/07/2023 13:17	78	32.4	N	30	3	E	250	53 m
68	N07x	CTD106	T	28/07/2023 14:08	78	32.395	N	30	2.972	E	28/07/2023 14:22	78	32.395	N	30	2.971	E	28/07/2023 14:46	78	32.395	N	30	2.97	E	250	
69	N07y	CTD107	T	29/07/2023 15:33	78	3.451	N	26	40.579	E	29/07/2023 15:43	78	3.452	N	26	40.58	E	29/07/2023 16:03	78	3.582	N	26	40.582	E	212	
70	N06	CTD108	S	30/07/2023 12:05	76	0	N	29	59.969	E	30/07/2023 12:17	76	0	N	29	59.969	E	30/07/2023 12:47	76	0	N	29	59.97	E	316	
71	N06	MSC071	O	30/07/2023 13:00	76	0	N	30	0	E	30/07/2023 13:02	76	0	N	30	0	E	30/07/2023 13:04	76	0	N	29	59.94	E	316	36 m
72	N06	CTD109	T	30/07/2023 16:15	76	0.002	N	29	59.971	E	30/07/2023 16:29	76	0.002	N	29	59.971	E	30/07/2023 16:59	76	0.002	N	29	59.773	E	316	
73	N05	CTD110	S	31/07/2023 12:09	74	36.599	N	27	53.95	E	31/07/2023 12:22	74	36.599	N	27	53.951	E	31/07/2023 12:56	74	36.598	N	27	53.949	E	380	
74	N05	MSC074	O	31/07/2023 13:06	74	36.6	N	27	53.94	E	31/07/2023 13:08	74	36.6	N	27	53.94	E	31/07/2023 13:09	74	36.6	N	27	53.94	E	380	22 m
75	N05	CTD111	T	31/07/2023 16:18	74	36.6	N	27	53.95	E	31/07/2023 16:32	74	36.6	N	27	53.95	E	31/07/2023 16:56	74	36.6	N	27	53.95	E	380	
76	N13	CTD112	S	01/08/2023 12:07	76	20	N	19	59.936	E	01/08/2023 12:21	76	20	N	19	59.938	E	01/08/2023 12:52	76	20	N	19	59.937	E	255	
77	N13	MSC077	O	01/08/2023 12:56	76	20	N	19	59.94	E	01/08/2023 12:58	76	20	N	19	59.94	E	01/08/2023 13:00	76	20	N	19	59.94	E	253	35 m Leaked
78	N13	MSC078	O	01/08/2023 13:11	76	20	N	19	59.94	E	01/08/2023 13:13	76	20	N	19	59.94	E	01/08/2023 13:15	76	20	N	19	59.94	E	253	35 m
79	N13	CTD113	T	01/08/2023 15:28	76	19.98	N	19	59.94	E	01/08/2023 15:41	76	20	N	19	59.94	E	01/08/2023 16:00	76	20	N	19	59.938	E	250	
80	N15	CTD114	S	02/08/2023 12:04	77	13.32	N	19	20.676	E	02/08/2023 12:14	77	13.319	N	19	20.676	E	02/08/2023 12:37	77	13.32	N	19	20.677	E	177	
81	N15	MSC081	O	02/08/2023 12:40	77	13.32	N	19	20.7	E	02/08/2023 12:42	77	13.32	N	19	20.7	E	02/08/2023 12:44	77	13.32	N	19	20.7	E	175	30 m
82	N15	CTD115	T	02/08/2023 16:13	77	13.32	N	19	20.67	E	02/08/2023 16:23	77	13.32	N	19	20.67	E	02/08/2023 16:41	77	13.32	N	19	20.673	E	174	

83	N16	CTD116	S	03/08/2023 12:05	78	30.926	N	19	16.403	E	03/08/2023 12:13	78	30.926	N	19	16.402	E	03/08/2023 12:43	78	30.928	N	19	16.343	E	131	Near Glacier, 10 km away 42 m high, tidal
84	N16	MSC084	O	03/08/2023 12:47	78	30.9	N	19	16.32	E	03/08/2023 12:49	78	30.9	N	19	16.32	E	03/08/2023 12:51	78	30.9	N	19	16.32	E	131	Near Glacier, 10 km away 42 m high, tidal
85	N16	CTD117	T	03/08/2023 16:31	78	30.579	N	19	16.929	E	03/08/2023 16:42	78	30.581	N	19	16.936	E	03/08/2023 16:55	78	30.58	N	19	16.934	E	124	Near Glacier, 10 km away 42 m high, tidal
86	N16	SMB2	BOAT	04/08/2023 18:17	78	31.32	N	19	13.62	E								04/08/2023 10:30	78	31.38	N	19	13.62	E	126	Small boat left to collect iceberg and water samples near the glacier
87	N16	CTD118	S	04/08/2023 12:29	78	30.989	N	19	13.745	E	04/08/2023 12:35	78	13.782	N	19	13.782	E	04/08/2023 12:43	78	30.958	N	19	13.772	E	124	Near Glacier, 10 km away 42 m high, tidal
88	N16	CTD119	S	04/08/2023 14:01	78	30.88	N	19	13.7	E	04/08/2023 14:07	78	30.88	N	19	13.69	E	04/08/2023 14:15	78	30.879	N	19	13.691	E	120	Near Glacier, 10 km away 42 m high, tidal
89	N16	CTD120	S	04/08/2023 16:00	78	30.896	N	19	13.804	E	04/08/2023 16:09	78	30.896	N	19	13.804	E	04/08/2023 16:16	78	30.897	N	19	13.805	E	115	
90	N16	FISHOUT	FISH	04/08/2023 16:29	78	30.9	N	19	13.8	E															116	
91	N16	FISHIN	FISH	04/08/2023 16:50	78	30.72	N	19	12.48	E																
92	N03	CTD121	S	06/08/2023 12:00	72	51.607	N	19	4.247	E	06/08/2023 12:14	72	51.608	N	19	4.246	E	06/08/2023 12:45	72	51.607	N	19	4.247	E	417	
93	N03	MSC093	O	06/08/2023 13:04	72	51.6	N	19	4.26	E	06/08/2023 13:06	72	51.6	N	19	4.26	E	06/08/2023 13:07	72	51.6	N	19	4.26	E	417	
94	N03	MSC094	O24	06/08/2023 13:04	72	51.6	N	19	4.26	E	06/08/2023 13:06	72	51.6	N	19	4.26	E	06/08/2023 13:07	72	51.6	N	19	4.26	E	417	
95	N03	CTD122	T	06/08/2023 15:53	72	51.608	N	19	4.247	E	06/08/2023 16:07	72	51.607	N	19	4.448	E	06/08/2023 16:32	72	51.608	N	19	4.244	E	418	
96	N03	CTD123	S	07/08/2023 06:02	72	51.624	N	19	4.386	E	07/08/2023 06:17	72	51.608	N	19	4.231	E	07/08/2023 06:33	72	51.608	N	19	4.232	E	419	
97	N03	CTD124 - CT	S	07/08/2023 07:06	72	51.608	N	19	4.232	E								07/08/2023 11:58	72	51.6	N	19	4.26	E	419	YOYO6
98	N03	MSC098	O	07/08/2023 12:13	72	51.6	N	19	4.26	E	07/08/2023 12:15	72	51.6	N	19	4.26	E	07/08/2023 12:16	72	51.6	N	19	4.26	E	418	
99	N03	CTD162	S	07/08/2023 12:15	72	51.607	N	19	4.231	E	07/08/2023 12:27	72	51.608	N	19	4.232	E	07/08/2023 12:44	72	51.608	N	19	4.232	E	419	
100	N03	CTD163 - CT	S	07/08/2023 13:13	72	51.608	N	19	4.233	E								07/08/2023 17:59	72	51.6	N	19	4.26	E	419	YOYO7
101	N03	CTD202	S	07/08/2023 18:15	72	51.61	N	19	4.23	E	07/08/2023 18:37	72	51.61	N	19	4.23	E	07/08/2023 18:54	72	51.6	N	19	4.26	E	419	
102	N17	CTD203	S	08/08/2023 12:01	72	29.999	N	24	59.882	E	08/08/2023 12:12	72	29.99	N	24	59.94	E	08/08/2023 12:39	72	29.992	N	24	59.955	E	246	
103	N17	MSC103	O	08/08/2023 12:43	72	30	N	24	59.94	E	08/08/2023 12:45	72	30	N	24	59.94	E	08/08/2023 12:47	72	30	N	24	59.94	E	246	
104	N17	CTD204	T	08/08/2023 15:28	72	29.991	N	24	59.953	E	08/08/2023 15:39	72	29.994	N	24	59.953	E	08/08/2023 16:01	72	29.995	N	24	59.952	E	247	
105	N18	CTD205	S	09/08/2023 12:06	73	30	N	29	59.954	E	09/08/2023 12:37	73	30.002	N	29	59.957	E	09/08/2023 13:08	73	30.005	N	29	59.957	E	400	Winch got stuck at 104 m for 20 minutes on downcast
106	N18	CTD206	T	09/08/2023 13:36	73	30.004	N	29	59.956	E	09/08/2023 13:51	73	30.005	N	29	59.957	E	09/08/2023 14:15	73	30.005	N	29	59.957	E	400	
107	N19	CTD207	S	10/08/2023 11:59	74	0.008	N	35	59.966	E	10/08/2023 12:10	74	0.008	N	35	59.964	E	10/08/2023 12:39	74	0.008	N	35	59.966	E	235	
108	N19	CTD208	T	10/08/2023 13:33	74	0.008	N	35	59.96	E	10/08/2023 13:42	74	0.01	N	35	59.96	E	10/08/2023 14:03	74	0.009	N	35	59.964	E	235	
109	N19	FISHOUT	FISH	10/08/2023 17:08	74	0	N	35	59.88	E															236	

9.2 Appendix B – Stainless CTD Sample Logs

Cruise DY167 Stainless Steel CTD log sheet

Station	N00	CTD No	0015	Date	14/07/23	CTD frame type: SS
Latitude	68°48,396 N	Event No	002	Time I/W (GMT)	12:04	
Longitude	10°26,22°E	Depth	3024	Time bottom (GMT)	12:26	
Filename		Cast Depth	501	Time O/W (GMT)	13:02	
Weather	DRIZZLE, OVERCAST, FLAT, LOVELY					

· on deck 13:08

Fire Seq	Rosette Pos"	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2 Xin	Nuts Louis	Chl a Katryn	N2 Fix	Genes TJ	IFCB			Sal						Other
1	1	1	490		1	X.	X.							- 11/284						116, 78, 31
2	2	2	490		2															
3	3	3	450		3		X.													
4	4	4	400		4		X.													
5	5	5	275		5		X.							- 11/285						
6	6	6	150		6		X.													
7	7	7	90		7	X	X.							- 11/286						218, 202, 21
8	8	8	60		8					X										
9	9	9	60		9				X											
10	10	10	60		10				X											
11	11	11	60		11	X.	X.	X.												257, 119
12	12	12	40		12															
13	13	13	40		13	X.	X.	X.												37, 145, 164
14	14	14	25		14															
15	15	15	25		15		X.	X.												
16	16	16	20		16					X										
17	17	17	20		17				X											
18	18	18	20		18				X											106, 56, 168
19	19	19	20		19	X	X.	X.												
20	20	20	15		20		X.	X.												
21	21	21	5		21					X										
22	22	22	5		22				X											
23	23	23	5		23				X											
24	24	24	5		24	X	X.	X.						- 11/287						207, 86, 61

Comments

12 6

Cruise DY167 Stainless Steel CTD log sheet

Station	NO1	CTD No	CTD003S	Date	15/07/23	CTD frame type:	
Latitude	70° 59.993 N	Event No	007	Time I/W (GMT)	12:10		
Longitude	10° 59.994E	Depth	2619	Time bottom (GMT)	13:02	SS	
Filename	CTD003S	Cast Depth	2565 m	Time O/W (GMT)	14:17		
Weather							

TEM-2 Poor Quality
Oxygen crate
500m

CRATE 11

Fire Seq	Rosette Pos	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O2 - xin	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O Jn		Sal		O2	O2 winklers	O2	SALT	Other
1	1	1	2565		25	x	x					x		-		34,	23,	27	288	
2	2	2	2565		26									-	11/289				11/289	
3	3	3	2200		27		x													
4	4	4	1800		28	x	x					x		-		26,	95,	133	11/290	
5	5	5	1400		29		x													
6	6	6	1000		30		x							-					291	
7	7	7	700		31		x													
8	8	8	500		32	x	x					x		-		53,	5,	68	293	
9	9	9	70		33			x												
10	10	10	50		34					x										DCM base
11	11	11	50		35				x											
12	12	12	50		36				x											
13	13	13	50		37	x	x	x								4,	39,	52		
14	14	14	42		38	x	x	x								137,	124,	136		
15	15	15	30		39			x												
16	16	16	20		40					x										DCM Peak
17	17	17	20		41				x											
18	18	18	20		42				x											
19	19	19	20		43	x	x	x				x				175,	275,	209		
20	20	20	10		44		x	x												
21	21	21	5		45					x										SML
22	22	22	5		46				x											
23	23	23	5		47				x					-						
24	24	24	5		48	x	x	x				x		-		174,	220	88	292	

Comments

Cruise DY167 Stainless Steel CTD log sheet

Primary O2 + CT sensor bad.
Vane O2 + CT ok

White stuff in h2o @ time of deployment

Station	NO2	CTD No	CTD0055	Date	16/7/23.	CTD frame type:
Latitude	72°0,018 N	Event No	10	Time I/W (GMT)	12:13	
Longitude	15°0,072 E	Depth	1130	Time bottom (GMT)	12:42	SS
Filename	CTD0055	Cast Depth	1098	Time O/W (GMT)	13:26	
Weather						

Fire Seq	Rosette Pos*	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal		O_2	O_2	O_2	crate 11	Other
1	1	1	1098		49	x.	x.							x		41	86	207	[illegible] 295	
2	2	2	1098		50															
3	3	3	800		51	x.	x.							x		168	56	106	294	
4	4	4	700		52		x.												294	
5	5	5	600		53									x		114	202	218	296	
6	6	6	400		54	x.	x.							x					297	
7	7	7	200		55															
8	8	8	100		56		x.							x					298	
9	9	9	50		57		x.													
10	10	10	40		58		x.	x.												
11	11	11	30		59		x.	x.												DCM Base.
12	12	12	23		60					x.										
13	13	13	23		61															
14	14	14	23		62											257	37	145		
15	15	15	23		63	x.	x.	x.												
16	16	16	15		64					x.										DCM Peak
17	17	17	15		65				x.											
18	18	18	15		66				x.							116	31	21		
19	19	19	15		67	x.	x.	x.												
20	20	20	10		68		x.	x.												
21	21	21	10		69															SML
22	22	22	5		70					x.				x					299	crate 11
23	23	23	5		71											164	170	48	~~307~~	
24	24	24	5		72	x.	x.	x.												

Comments

17 + 18 $^{15}N_2$ fix only at one depth!!

12x nuts

Bottle Labels
Have NO3
(not NO4)

Cruise DY167 Stainless Steel CTD log sheet

6 x O2 —
6 x Chl
12 x NUTS —

Station	NO4	CTD No	CTD0075	Date	18/07/23	CTD frame type:
Latitude	73° 43.475 N	Event No	12	Time I/W (GMT)	12:09	
Longitude	23° 22.080 E	Depth	459m	Time bottom (GMT)	12:26	SS
Filename	CTD0075	Cast Depth	439 m	Time O/W (GMT)	12:59	
Weather						

Primary O2 sensor issue

Fire Seq	Rosette Pos°	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal						Other
1	1	1	439		73	x.	x.					x.		x	11/300					23, 27, 34
2	2	2	439		74															
3	3	3	400		75															
4	4	4	300		76		x.													
5	5	5	200		77	x.	x.					x.		x	11/301					95, 133, 26
6	6	6	150	78	76		x.													
7	7	7	100	79	77		x.	x.						x	11/302					
8	8	8	65	80	78	x.	x.					x.		x	11/303					68, 5, 53
9	9	9	55	81	79		x.	x.												
10	10	10	45	82	80		x.	x.												
11	11	11	35	83	81															
12	12	12	35	84	82		x.	x												
13	13	13	25	85	83					x.										
14	14	14	25	86	84				y											
15	15	15	25	87	85				x											DCM Base
16	16	16	25	88	86	x.	x.	x.				x.								[illegible], 39, 41, 178
17	17	17	20	89	87					x.										
18	18	18	20	90	88				x.											DCM
19	19	19	20	91	89				x.											
20	20	20	20	92	90	x.	x.	x.				.x		x	11/304					194, 136, 137
21	21	21	15	93	91					x.										
22	22	22	15	94	92				x											SML
23	23	23	15	95	93				x											
24	24	24	15	96	94	x.	x.	x.				x		x	←	11/305				209, 175, 215

Comments

Cruise DY167 Stainless Steel CTD log sheet

Chl

Station	N05	CTD No	CTD0095	Date	19/07/23	CTD frame type:
Latitude	74°36,348 N	Event No	19	Time I/W (GMT)	12:05	
Longitude	27°53,984 N	Depth	383	Time bottom (GMT)	12:21	SS
Filename	CTD0095	Cast Depth	363	Time O/W (GMT)	12:53	
Weather						

Fire Seq	Rosette Pos*	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal		O_2	O_2	O_2	temp	Other
1	1	1	362		97	• x	• x							x		41	86	207	3,9	306 / C11
2	2	2	340		98	• x	• x							x		106	56	168	3,7	307 / C11
3	3	3	250		99		• x													
4	4	4	200		100									x						195 / C07
5	5	5	150		101		• x	• x												
6	6	6	100		102															
7	7	7	80		103	• x	• x							x		114	218	202	5,3	194 Crate 7
8	8	8	50		104		• x													
9	9	9	40		105		• x	• x						x						193 / C07
10	10	10	35		106		• x													
11	11	11	30		107		• x	e x												
12	12	12	25		108					• x										
13	13	13	25		109				• x											
14	14	14	25		110				• x											
15	15	15	25		111	• x	• x	• x								145	257	37	6,8	
16	16	16	20		112					• x										
17	17	17	20		113				~~x~~											
18	18	18	20		114				~~x~~											
19	19	19	20		115	• x	• x	• x								116	31	21	7,6	
20	20	20	15		116			• x												
21	21	21	10		117					• x										
22	22	22	10		118				• x											
23	23	23	10		119				• x											
24	24	24	10		120	• x	• x	• x						x		~~160~~ 170	48	164	7,5	192 / C7

Comments

Cruise DY167 Stainless Steel CTD log sheet

Station	RAS1	CTD No	CTD011S	Date	19/07/23	CTD frame type:
Latitude	74° 45.06 N	Event No	25	Time I/W (GMT)	20:08	
Longitude	27:2.03 E	Depth	347	Time bottom (GMT)	20:28	SS
Filename	CTD011S	Cast Depth		Time O/W (GMT)	21:30	
Weather						

Fire Seq	Rosette Pos*	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal		CRATE	B			Other
1	1	1	325		121		x							x		7	191			
2	2	2	325																	
3	3	3	280		122		x													
4	4	4	280																	
5	5	5	240		123		x													
6	6	6	240																	
7	7	7	200		124		x													
8	8	8	200																	
9	9	9	160		125		x													
10	10	10	160																	
11	11	11	120		126		x							x		7	190			
12	12	12	120																	
13	13	13	90		127		x													
14	14	14	90																	
15	15	15	70		128		x													
16	16	16	70																	
17	17	17	45		129		x													
18	18	18	45																	
19	19	19	30		130		x													
20	20	20	30																	
21	21	21	20		131		x							x		7	189			
22	22	22	20																	
23	23	23	10		132		x													
24	24	24	10														~~159~~			

Comments

Cruise DY167 Stainless Steel CTD log sheet

Station	FAS2	CTD No	CTD0125	Date	19/07/23	CTD frame type: SS
Latitude	74°50.550N	Event No	026	Time I/W (GMT)	23:02	
Longitude	26°27.130E	Depth	302	Time bottom (GMT)	23:15	
Filename	CTD0125	Cast Depth	288	Time O/W (GMT)	23:38	
Weather	Overcast, 5°C air temp.					

Fire Seq	Rosette Pos*	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal						Other
1	1	1	284		133		. x							x	188	Crate 7				
2	2	2	250																	
3	3	3	250		134		. x													
4	4	4	250																	
5	5	5	210		135		. x													
6	6	6	210																	
7	7	7	160		136		. x													
8	8	8	160																	
9	9	9	120		137		. x							X	196	Crate 7				
10	10	10	120																	
11	11	11	90		138		. x													
12	12	12	90																	
13	13	13	70		139		. x													
14	14	14	70																	
15	15	15	60		140		. x													
16	16	16	60																	
17	17	17	50		141		. x													
18	18	18	50																	
19	19	19	40		142		. x													
20	20	20	40																	
21	21	21	25		143		. x													
22	22	22	25																	
23	23	23	10		144		. x							x	197	Crate 7				
24	24	24	10																	

Comments

Cruise DY167 Stainless Steel CTD log sheet

Station	N 12	CTD No	CTD 13S	Date	~~19~~ 20/07/23	CTD frame type:
Latitude	75°30,034 N	Event No	27	Time I/W (GMT)	12:02	SS
Longitude	27°29,888 E	Depth	55	Time bottom (GMT)	12:12	
Filename		Cast Depth	57	Time O/W (GMT)	12:30	
Weather	FLAT, CLEAR					

1
3
5
7
9 4@

Fire Seq	Rosette Pos"	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal	Temp	O_2	O_1	O_2	SALT	O_2	Other SALT	
1	1	1	50 –		145	X.	X.	X.				X.		X.	3,8	207	86	41		126	198 C7	10
2	2	2	50																			
3	3	3	50		146																	20
4	4	4	40																			
5	5	5	40 –		147	X.	X.	X.							3,7	56	106	168		~~3,7~~		30
6	6	6	40																			
7	7	7	30 –		148	X.	X.	X.				X.		X.	4,1	218	114	202	199	C7		
8	8	8	30																			40
9	9	9	30		149																	
10	10	10	30 –																			
11	11	11	20 –		150				x	X.												50
12	12	12	20																			
13	13	13	20 –		151				X.													
14	14	14	20																			
15	15	15	20		152				X.													
16	16	16	20																			
17	17	17	20		153	X.	X.	X.							3,8	37	257	145				
18	18	18	10																			
19	19	19	10		154	X.	X.	X.				X.		X.	3,9	116	21	31	200	C7		
20	20	20	10																			
21	21	21	10		155																	
22	22	22	10																			
23	23	23	10		156																	
24	24	24	10																			

Comments

Cruise DY167 Stainless Steel CTD log sheet

Station	N07	CTD No	CTD0155	Date	21/07/23	CTD frame type:	
Latitude	77°59,998	Event No	33	Time I/W (GMT)	12:05		
Longitude	29°59,960	Depth	298	Time bottom (GMT)	12:25	SS	
Filename		Cast Depth	277	Time O/W (GMT)	12:56		
Weather	FOG, CALM,						

Fire Seq	Rosette Pos"	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal		O_1	O_1	O_1	Temp	Other
1	1	1	277		157		X.					X.		X.		~~[illegible]~~	~~[illegible]~~	~~[illegible]~~		C7/B201
2	2	2	277		158															
3	3	3	260		159															
4	4	4	248		160	X.	X.					X.		X		41	86	207	0,8	C7/B202
5	5	5	210		161		X.					X.		X						
6	6	6	170		162		X.													
7	7	7	130		163									X						
8	8	8	90		164	X.	X.	X.				X.		X		168	106	56	-0,1	C7/203
9	9	9	70		165		X.													
10	10	10	55		166					X.										
11	11	11	55		167				X.											DCM Base.
12	12	12	55		168				X.											
13	13	13	55		169	X.	X.	X.				X.		X.		202	114	218	0,0	C7/B 211
14	14	14	45		170					X.										
15	15	15	45		171				X.											DCM Peak
16	16	16	45		172				X.											
17	17	17	45		173	X.	X.	X.								37	145	257	0,0	
18	18	18	35		174	X.	X.	X.								31	116	21	0,1	
19	19	19	30		175		X.	X.												
20	20	20	20		176					X.										
21	21	21	20		177				X											SML
22	22	22	20		178				X											
23	23	23	20		179	X.	X.	X.				X.		X.		~~[illegible]~~	170	488	2,3	C7/210
24	24	24	10		180		X.									139				

Comments

Cruise DY167 Stainless Steel CTD log sheet

Station	N10	CTD No	CTD0185	Date	22/07/23	CTD frame type: SS	
Latitude	78°39,514 N	Event No	41	Time I/W (GMT)	11:54		
Longitude	24°38,999 E	Depth	141	Time bottom (GMT)	12:08		
Filename		Cast Depth	125	Time O/W (GMT)	12:34		
Weather	FLAT, CLEAR						

Fire Seq	Rosette Pos"	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal		O_2	O_2	O_2	Temp	Other
1	1	1	125		181	X	X	X						X		41	86	207	0,3	B209/C7
2	2	2	125		182															
3	3	3	110		183	X	X					X		X		168	106	56	0,4	B208/C7
4	4	4	90		184	~~X~~														
5	5	5	80		185	X ~~X~~	X					X		X		114	208	202	0,7	B207/C7
6	6	6	70	X	186															
7	7	7	60	X	187															
8	8	8	60		188	~~X~~														DCM Base ?
9	9	9	60		189															
10	10	10	60		190		X	X												
11	11	11	50		191		X	X												
12	12	12	45		192					X										
13	13	13	45		193				X											DCM
14	14	14	45		194				X											
15	15	15	45		195	X	X	X				X		X		257	145	37	0,5	B206/C7
16	16	16	30		196		X													
17	17	17	25		197	X	X					X		X		21	116	31	1,2	B205/C7
18	18	18	20		198		X													
19	19	19	15		199					X										
20	20	20	15		200	X	X	X	~~X~~			X				139	48	170	1,2	SML
21	21	21	15		201				X											
22	22	22	15		202	~~X~~	~~X~~	~~X~~	X			~~X~~								
23	23	23	10		203		X													
24	24	24	5		204		X	X				X		X						B204/C7

Comments

Cruise DY167 Stainless Steel CTD log sheet

Station	N09	CTD No	CTD205	Date	23/07/23	CTD frame type:
Latitude	79°22.867N	Event No	44	Time I/W (GMT)	10:13	SS
Longitude	27°47.602E	Depth	343	Time bottom (GMT)	10:26	
Filename	CTD205	Cast Depth	321	Time O/W (GMT)	10:50	
Weather						

Fire Seq	Rosette Pos[n]	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	Fullr ~~TPCB~~	D18O		Sal	Crate 6					Other
1	1	1	90		205		X	X			X			X	164					
2	2	2	90		206															
3	3	3	90		207															
4	4	4	70		208		X	X			X									
5	5	5	70		209															
6	6	6	70		210															
7	7	7	57		211		X	X			X									
8	8	8	57		212															DCM Peak.
9	9	9	57		213															
10	10	10	50		214		X	X			X									
11	11	11	50		215															
12	12	12	50		216															
13	13	13	40		217		X	X			X									
14	14	14	40		218															
15	15	15	40		219															
16	16	16	30		220		X	X			X									
17	17	17	30		221															
18	18	18	30		222															
19	19	19	20		223		X	X			X									
20	20	20	20		224															
21	21	21	20		225															SML
22	22	22	10		226		X	X			X			X	165					
23	23	23	10		227															
24	24	24	10		228															

Comments

Cruise DY167 Stainless Steel CTD log sheet

Station	N09	CTD No	CTD021S	Date	23/7/23	CTD frame type:
Latitude	79°23,008 N	Event No	45	Time I/W (GMT)	12:02	
Longitude	27°45,882E	Depth	346	Time bottom (GMT)	12:17	SS
Filename	CTD0215.	Cast Depth	321	Time O/W (GMT)	12:52	
Weather	FOG, FLAT					

Fire Seq	Rosette Pos"	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal		O_2	O_2	O_2	Temp	Other
1	1	1	320		229	. X	. X					X		. X		126	86	207	0,1	B166/C6
2	2	2	200		230	. X	. X	. X				X		. X		168	56	106	1,2	B167/C6
3	3	3	140		231		. X					X		. X						B168/C6
4	4	4	100		232		. X													
5	5	5	90		233		. X	. X												
6	6	6	80		234															
7	7	7	70		235					. X										
8	8	8	70		236															
9	9	9	70		237															
10	10	10	70		238	. X	. X	. X				X		. X		202	218	114	0,5	B169/C6
11	11	11	60		239		. X													
12	12	12	56		240					. X										
13	13	13	56		241				. X											
14	14	14	56		242				. X							B170/C6				DCM.
15	15	15	56		243	. X	. X	. X				X		X		[illegible]	[illegible]	[illegible]	0,0	21,116,82
16	16	16	40		244	. X	. X					X		X		145	257	37	0,4	B171/C6
17	17	17	30		245															
18	18	18	30		246		. X													
19	19	19	20		247															
20	20	20	20		248		. X	. X				X		X						B172/C6
21	21	21	10		249					. X										
22	22	22	10		250				. X											
23	23	23	10		251				. X											
24	24	24	10		252	. X	. X	. X				X		X		139	48	170	3,3	B173/C6

Comments

Cruise DY167 Stainless Steel CTD log sheet

Station	RAS 03	CTD No	CTD023S	Date	23/07/23	CTD frame type: SS
Latitude	77°16.823 N	Event No	48	Time I/W (GMT)	21:11	
Longitude	28°29.383E	Depth	234	Time bottom (GMT)	21:30	
Filename	CTD023S	Cast Depth	216	Time O/W (GMT)	22:12	
Weather						

Crate 6

Fire Seq	Rosette Pos"	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal	Fv/Fm					Other
1	1	1	216		253		X							Y	174					
2	2	2	216		254															
3	3	3	160		255		X													
4	4	4	160		256															
5	5	5	120		257		X													
6	6	6	120		258															
7	7	7	80		259		X													
8	8	8	80		260															
9	9	9	60		261		Y	X				X		X	175					
10	10	10	60		262															
11	11	11	52		263		X	X				X			X					
12	12	12	52		264															
13	13	13	43		265		X	X				X			X					
14	14	14	43		266							X								
15	15	15	35		267		Y	X												
16	16	16	35		268															
17	17	17	25		269		X	X				X								
18	18	18	25		270															
19	19	19	15		271		X					X								
20	20	20	15		272															
21	21	21	10		273		Y	X				Y								
22	22	22	10		274															
23	23	23	5		275		Y					X		Y	X	176				
24	24	24	5		276															

Comments

Bottles 6, 12, 15 did not fire

Cruise DY167 Stainless Steel CTD log sheet

Station	N08	CTD No	024S	Date	25/07	CTD frame type:
Latitude	79° 20,669 N	Event No	49	Time I/W (GMT)	15:08	
Longitude	33° 55,355 E	Depth	262 m	Time bottom (GMT)	15:20	SS
Filename	CTD024S	Cast Depth	242 m	Time O/W (GMT)	15:50	
Weather	LIGHT FOG, MIRROR LIKE, NEXT TO SEA ICE					

Fire Seq	Rosette Pos"	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal		O_2	O_2	O_2	Temp	Other
1	1	1	242		277	.X	.X							.X		207	86	126	-0,2	B177/C6
2	2	2	242		278															
3	3	3	200		279		.X	X												
4	4	4	150		280		.X	.X												
5	5	5	100		281	.X	.X	X				.X		X		168	56	106	0,2	B178/C6
6	~~6~~	~~6~~	~~80~~		~~282~~		~~X~~													
7	7	7	60		283					.X										
8	8	8	60		283				.X											
9	9	9	60		285				.X											
10	10	10	60		286	.X	.X	.X				.X		X		218	202	48	-0,6	179/C6
11	11	11	55		287		.X	.X												
12	~~12~~	~~12~~	~~46~~		~~288~~					~~X~~										
13	13	13	46		289			.X	.X	.X										
14	14	14	46		290		.X		.X											
15	~~16~~	~~15~~	~~46~~		~~291~~	~~X~~	~~X~~	~~X~~		~~X~~		~~X~~		~~X~~						
16	16	16	40		292		.X	.X				.X		X						
17	17	17	30		293															
18	18	18	30		[illegible]	.X	.X	.X				.X		X		27	116	82	-0,2	B180/C6
19	19	19	20		295		.X					X								
20	20	20	10		296		.X					X								
21	21	21	5		297					.X										
22	22	22	5		298				.X											
23	23	23	5		299				.X											
24	24	24	5		300	.X	.X	.Y				X		X		37	257	145	2,5	B181/C6

Comments

DY167 CTD Yo-Yo Log Sheet

Date 25 JUL 2023	Julian day: 23206

Station No N08	Event No 052

Latitude 79 21.092	Longitude 33 53.18

Cast No	Start Time	Start Depth	Bottom Time	Bottom Depth	Altimeter	End Time	End Depth	Bottles Fired	Initials	Comments
26S	18:30	2	18:53	243	13.3	19:05	2.7	/	EM	
27S	19:07	2	19:13	150	/	19:16	2	/	SP	
28S	19:20	2	19:24	150	/	19:28	2	/	JP	
29S	19:29	3	19:33	152	/	19:36	2.7	/	EM	
30S	19:38	3	19:42	183	/	19:46	2.8	/	EM	
31S	19:48	3	19:52	183	76.2	19:56	3.2	/	EM	
32S	19:57	3	20:01	183	76.4	20:06	3.1	/	EM	
33S	20:07	3	20:13	183	76.2	20:19	2.6	/	EM	
34S	20:20	2	20:27	180	76.5	20:33	2.6	/	SP	
35S	20:35	2	20:41	183	74.6	20:46	2.7	/	SP	
36S	20:47	2.6	20:50	82	/	20:53	2.8	/	SP	
37S	20:54	2.8	20:57	80	/	20:59	2	/	SP	
38S	21:00	2	21:04	120	/	21:09	0	/	SP	

Cruise DY167 Stainless Steel CTD log sheet YOYO Casts

Station	N08	CTD No	0395	Date	26/07/23	CTD frame type:
Latitude	79° 21.482 N	Event No	53	Time I/W (GMT)	10:03	
Longitude	33° 48.556 E	Depth	265m	Time bottom (GMT)		SS
Filename	CTD0395	Cast Depth	243	Time O/W (GMT)	10:32	
Weather	FOG, CALM, FLAT, NEAR SEA ICE					

Jo Mar Kath Ben B Ben F

Fire Seq	Rosette Pos	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	Nuts	DNA	Chl a	Plankton IFCB	N_2 fix										Other
1	1	1	180		301	X														
2	2	2	120		302	X														
3	3	3	100		303	X														
4	4	4	82		304		X		X											
5	5	5	82		305	X														
~~6~~	~~6~~	~~6~~	~~72~~		~~306~~	~~X~~														DID NOT FIRE
7	7	7	67		307	X	X	X	X											
8	8	8	63		308	X	X		X											
~~9~~	~~9~~	~~9~~	~~59~~		~~309~~		~~X~~		~~X~~											DID NOT FIRE
10	10	10	56		310	X	X	X	X											
11	11	11	52		311		X		X											
12	12	12	48		312	X		X												
13	13	13	48		313					X										
14	14	14	48		314		X		X											
15	15	15	44		315		X		X											
16	16	16	40		316	X	X	X	X											
17	17	17	37		317		X		X											
18	18	18	33		318															
19	19	19	30		319		X		X											
20	20	20	30		320	X		X												
21	21	21	25		321															
22	22	22	10		322		X		X											
23	23	23	10		323	X		X												
24	24	24	10		324					X										

Comments

N_2 fix / ^{13}C fix – SML
– peak of OCM.
Please leave IFCB in fridge for fixing

DY167 CTD Yo-Yo Log Sheet

Date 26/07/23
Station No N08
Latitude 74°21.238

Julian day: 207
Event No 054
Longitude 33°43.383

Cast No	Start Time	Start Depth	Bottom Time	Bottom Depth	Altimeter	End Time	End Depth	Bottles Fired	Initials	Comments
040S	11:17	2	11:21	120	—	11:24	2	—	PH	
041S	11:25	2	11:28	120	—	11:30	2	—	PH	
042S	11:32	2	11:35	120	—	11:37	2	—	PH	
043S	11:38	2	11:41	120	—	11:43	2	—	PH	
044S	11:45	2	11:48	120	—	11:50	2	—	PH	
045S	11:51	2	11:54	120	—	11:57	2	—	SP	
046S	11:57	2	12:01	120	—	12:03	2	—	SP	
047S	12:04	2	12:07	120	—	12:10	2	—	SP	
048S	12:11	2	12:14	120	—	12:17	2	—	SP	
049S	12:17	2	12:21	120	—	12:24	2	—	EM	
050S	12:24	2	12:28	120	—	12:30	2	—	EM	
051S	12:31	2	12:34	120	—	12:36	2	—	EM	
052S	12:37	2	12:40	120	—	12:42	2	—	EM	
053S	12:43	2	12:47	120	—	12:50	2	—	EM	
054S	12:50	2	12:54	120	—	12:56	2	—	EM	

Cruise DY167 Stainless Steel CTD log sheet YOYO Casts

Station	N08	CTD No	CTD555	Date	26/07/23	CTD frame type: SS
Latitude	79°22.277N	Event No	55	Time I/W (GMT)	13:29	
Longitude	33°42.819E	Depth	272	Time bottom (GMT)	13:38	
Filename	CTD0555	Cast Depth	251	Time O/W (GMT)	13:57	
Weather	FOG, CALM, NEAR SEA ICE					

Fire Seq	Rosette Pos'	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	DO ~~Nuts~~	DNA	Chl a	Plankton BEN	N2FIX										Other
1	1	1	180		325	x														
2	2	2	120		326	x														
3	3	3	100		327	x														
4	4	4	74		328	x	x		x											
5	5	5	74		329															
6	6	6	64		330															
7	7	7	64		331	x	x		x											
8	8	8	61		332		x	x	x											
9	9	9	57		333	x	x		x											
10	10	10	54		334	x	x		x											
11	11	11	51		335	x	x	x	x											
12	12	12	47		336		x		x											
13	13	13	44		337	x		x												
14	14	14	44		338					x										
15	15	15	44		339					x										
16	16	16	44		340		x		x											
17	17	17	41		341	x	x	x	x											
18	18	18	37		342		x		x											
19	19	19	34		343		x		x											
20	20	20	22		344	x		x												
21	21	21	10		345		x		x											
22	22	22	10		346	x		x												
23	23	23	10		347					x										
24	24	24	10		348					x										

Comments

120

DY167 CTD Yo-Yo Log Sheet

Date: 26/07/23 | Julian day: 267

Station No: N08 | Event No: 056

Latitude: 79°22.697N | Longitude: 33°41.522E

Cast No	Start Time	Start Depth	Bottom Time	Bottom Depth	Altimeter	End Time	End Depth	Bottles Fired	Initials	Comments
056S	14:28	2	14:31	120	—	14:34	2	—	PH	
057S	14:35	2	14:38	120	—	14:41	2	—	PH	
058S	14:42	2	14:45	120	—	14:48	2	—	PH	
059S	14:49	2	14:52	120	—	14:55	2	—	PH	
060S	14:56	2	14:59	120	—	15:02	2	—	PH	
061S	15:03	2	15:06	120	—	15:09	2	–	EM	
062S	15:09	2	15:13	120	—	15:16	2	–	EM	
063S	15:17	2	15:20	120	—	15:23	2	–	EM	
064S	15:24	2	15:27	120	—	15:30	2	–	EM	
065S	15:30	2	15:34	120	—	15:36	2	–	SP	
066S	15:37	2	15:41	120	—	15:44	2	–	SP	
067S	15:45	2	15:49	120	–	15:52	RTD	–	SP	

Cruise DY167 Stainless Steel CTD log sheet YOYO Casts

No Chl
Collected

Station	NO8	CTD No	068S.	Date	26/07/23	CTD frame type: SS.
Latitude	79°23,448N	Event No	57	Time I/W (GMT)	16:12	
Longitude	33°43,529E	Depth	271	Time bottom (GMT)	16:23	
Filename		Cast Depth	249	Time O/W (GMT)	16:39	
Weather	CLEAR, FLAT, NEAR ICE					

Fire Seq	Rosette Pos*	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	Nuts	DNA	~~Chl~~	Plankton IFCB	N2Fix										Other
1	1	1	160		349	X														
2	2	2	120		350	X														
3	3	3	100		351	X														
4	4	4	85		352	X	X		X											
5	5	5	85		353															
6	6	6	70		354															
7	7	7	70		355	X	X		X											
8	8	8	67		356		X		X											
9	9	9	63		357	X	X		X											
10	10	10	60		358	X	X		X											
11	11	11	57		359	X	X		X											
12	12	12	53		360		X		X											
13	13	13	50		361	X														
14	14	14	50		362					X										
15	15	15	50		363					X										
16	16	16	50		364		X		X											
17	17	17	47		365	X	X		X											
18	18	18	43		366		X		X											
19	19	19	40		367		X		X											
20	20	20	23		368	X														
21	21	21	5		369		X		X											
22	22	22	5		370	X														
23	23	23	5		371					X										
24	24	24	5		372					X										

Comments

DY167 CTD Yo-Yo Log Sheet

Date 26/07/23 Julian day: 207

Station No N08 Event No 058

Latitude 79°23556N Longitude 33°43535E

Cast No	Start Time	Start Depth	Bottom Time	Bottom Depth	Altimeter	End Time	End Depth	Bottles Fired	Initials	Comments
069S	17:07	120	17:11	120	—	17:15	2	—	PH	
070S	17:16	2	17:18	120	—	17:21	2	—	PH	
071S	17:22	2	17:25	120	—	17:27	2	—	PH	
072S	17:29	2	17:31	120	—	17:34	2	—	PH	
073S	17:35	2	17:38	120	—	17:40	2	—	PH	
074S	17:41	2	17:44	120	—	17:46	2	—	PH/EM	
075S	17:47	2	17:50	120	—	17:52	2	—	EM	
076S	17:53	2	17:56	120	—	17:58	2	—	EM	
077S	17:59	2	18:02	120	—	18:04	2	—	EM	
078S	18:04	2	18:08	120	—	18:11	2	—	EM	
079S	18:11	2	18:14	120	—	18:17	2	—	EM	
080S	18:17	2	18:20	120	—	18:23	2	—	JP	—
081S	18:24	2	18:27	120	—	18:29	2	—	JP	—
082S	18:30	2	18:33	120	—	18:36	2	-	JP	—
083S	18:37	2	18:40	120	—	18:43	2	—	JP	—
084S	18:44	2	18:47	120	-	18:50	2	—	JP	—
085S	18:51	2	18:54	120	-	18:58	2	—	JP	—
086S	18:58	2	19:01	120	-	19:05	2	—	JP	—

Cruise DY167 Stainless Steel CTD log sheet YOYO Casts

Station	N08	CTD No	875	Date	26/07/23	CTD frame type: SS
Latitude	79°23.537 N	Event No	59	Time I/W (GMT)	17:22	
Longitude	33°43.525 E	Depth	271	Time bottom (GMT)	17:34	
Filename	CTD875	Cast Depth	249	Time O/W (GMT)		
Weather	FLAT, NEAR ICE					

Fire Seq	Rosette Posn	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	Nuts	DNA	Chl a	Plankton IFCB	N2 Fix										Other
1	1	1	160		373	X														
2	2	2	120		374	X														
3	3	3	100		375	X														
4	4	4	85		376	X	X		X											
5	5	5	85		377															
6	6	6	62		378															
7	7	7	62		379	X	X		X											
8	8	8	59		380		X	X	X											
9	9	9	56		381	X	X		X											
10	10	10	53		382	X	X		X											
11	11	11	51		383	X	X	X	X											
12	12	12	48		384		X		X											
13	13	13	45		385	X		X												
14	14	14	45		386					X										
15	15	15	45		387					X										
16	16	16	45		388		X		X											
17	17	17	42		389	X	X	X	X											
18	18	18	39		390		X		X											
19	19	19	37		391		X		X											
20	20	20	21		392	X		X												
21	21	21	5		393		X		X											
22	22	22	5		394	X		X												
23	23	23	5		395					X										
24	24	24	5		396					X										

Comments

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DY167 CTD Yo-Yo Log Sheet

Date: 26/07/23 | Julian day: 207

Station No: N08 | Event No: 60

Latitude: 79° 23.4281 | Longitude: 33° 44.3206

Cast No	Start Time	Start Depth	Bottom Time	Bottom Depth	Altimeter	End Time	End Depth	Bottles Fired	Initials	Comments
088S	20:21	2	20:24	120	—	20:27	2	—	PH	
089S	20:28	2	20:30	120	—	20:33	2	—	PH	
090S	20:34	2	20:36	120	—	20:39	2	—	PH	
091S	20:39	2	20:42	120	—	20:45	2	—	PH	
092S	20:45	2	20:48	120	—	20:50	2	—	PH	
093S	20:51	2	20:54	140	—	20:57	2	—	PH	
094S	20:58	2	21:00	140	—	21:04	2	—	PH	
095S	21:04	2	21:08	140	—	21:11	2	—	SP	
096S	21:12	2	21:15	140	—	21:19	2	—	SP	
097S	21:19	2	21:23	140	—	21:26	2	—	SP	
098S	21:27	2	21:30	140	—	21:34	2	—	SP	
099S	21:34	2	21:38	140	—	21:41	2	—	SP	
100S	21:42	2	21:45	140	—	21:49	2	—	EM	
101S	21:49	2	21:54	140	—	21:56	2	—	EM	
102S	21:56	2	22:00	140	—	22:04	2	—	Em	

Cruise DY167 Stainless Steel CTD log sheet

Station	N08	CTD No	103S	Date	27/07	CTD frame type: SS
Latitude	79° 22.150 'N	Event No	61	Time I/W (GMT)	12:09	
Longitude	33° 28.465'E	Depth	271	Time bottom (GMT)	12:21	
Filename	CTD103S	Cast Depth	249	Time O/W (GMT)		
Weather	LIGHT FOG, FLAT, NEAR ICE					

Fire Seq	Rosette Pos"	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal	crate 6			*		Other
1	1	1	249											X	182					
2	2	2	249																	
3	3	3	180											X	183					
4	4	4	180																	
5	5	5	60											X	184					
6	6	6	60																	
7	7	7	10											X	185					
8	8	8	10																	
9	9	9																		
10	10	10																		
11	11	11																		
12	12	12																		
13	13	13																		
14	14	14																		
15	15	15																		
16	16	16																		
17	17	17																		
18	18	18																		
19	19	19																		
20	20	20																		
21	21	21																		
22	22	22																		
23	23	23																		
24	24	24																		

Comments

Cruise DY167 Stainless Steel CTD log sheet

Station	NO8	CTD No	104S	Date	27/07/23	CTD frame type: SS .	
Latitude	19° 22.982' N	Event No	64	Time I/W (GMT)	17:58		
Longitude	33° 19.366' E	Depth	270m	Time bottom (GMT)			
Filename	CTD104S	Cast Depth		Time O/W (GMT)			
Weather							

Fire Seq	Rosette Pos"	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal	Crate 6					Other
1	1	1	247											X	186					
2	2	2	247																	
3	3	3	10																	
4	4	4	10											X	187					
5	5	5																		
6	6	6																		
7	7	7																		
8	8	8																		
9	9	9																		
10	10	10																		
11	11	11																		
12	12	12																		
13	13	13																		
14	14	14																		
15	15	15																		
16	16	16																		
17	17	17																		
18	18	18																		
19	19	19																		
20	20	20																		
21	21	21																		
22	22	22																		
23	23	23																		
24	24	24																		

Comments

Cruise DY167 Stainless Steel CTD log sheet

Station	N07x	CTD No	~~C???~~ 105S	Date	28/07/23
Latitude	78°32.394N	Event No	65	Time I/W (GMT)	12:07
Longitude	30°2.975E	Depth	249	Time bottom (GMT)	12:17
Filename		Cast Depth	231	Time O/W (GMT)	12:46
Weather	8 3 GREY, LIGHT RAIN, ~~????~~ SMOOTH				

CTD frame type: SS

Fire Seq	Rosette Pos	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal		O_2	O_2	O_2	Temp	SALT Other
1	1	1	227		397	.X	.X					.X		.X		207	86	126	0,7	B764/C31
2	2	2	227		398															
3	3	3	200		399		.X													
4	4	4	200		400		.X													
5	5	5	130		401	.X	.X					.X				168	56	106	0,5	
6	6	6	100		402		.X													
7	7	7	80		403		.X													
8	8	8	60		404															
9	9	9	60		405	.X	.X					.X		.X		54 ~~208~~	202	48	0,3	B765/C31
10	10	10	50		406					.Y										
11	11	11	50		407															DCM BASE
12	12	12	50		408															DID NOT FIRE
13	13	13	50		409	.X	X.	.X				.X				82	116	21	0,0	
14	14	14	43		410					.Y										
15	15	15	43		411				.X											DCM Peak
16	16	16	43		412				.Y											
17	17	17	43		413	.X	.X	X.				.X				105	37	257	-0,1	
18	18	18	35		414	.X	.X	X.				.X				170	~~31~~ 24	139	0,2	
19	19	19	20		415															
20	20	20	20		416	.X	.X					.X				114	20	209	0,7	
21	21	21	10		417					.X										
22	22	22	10		418				.Y											SML
23	23	23	10		419				.Y											
24	24	24	10		420	.X	.Y					.X		.X		74	113	135	1,3	B766/C31

Comments

[3.5°C]

Cruise DY167 Stainless Steel CTD log sheet

Station	N06	CTD No	CTD 108S	Date	30/07/23
Latitude	76° 00.00 N	Event No	70	Time I/W (GMT)	12:05
Longitude	29° 59.969 E	Depth	316	Time bottom (GMT)	12:17
Filename	CTD108S	Cast Depth	295	Time O/W (GMT)	12:42
Weather	FOG, SLIGHT			CTD frame type:	SS

Fire Seq	Rosette Posn	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal		O_2	O_3	O_2	Tang	Other
1	1	1	295		421	.X	.X					.X				207	86	126	3,3	
2	2	2	295		422															
3	3	3	240		423	.X	.X					.X		.X		56	106	168	3,0	B767/C31
4	4	4	150		424		.X													
5	5	5	120		425		.X													
6	6	6	90		426	.X	.X					.X		.X		48	202	54	3,9	B768/C31
7	7	7	60		427															
8	8	8	60		428		.X													
9	9	9	40		429															
10	10	10	40		430	.X	.X					.X				82	116	21	4,7	
11	11	11	35		431					.X										
12	12	12	35		432															DCM BASE
13	13	13	35		433															
14	14	14	35		434	.X	.X	.X				.X				257	37	145	4,5	
15	15	15	30		435		.X													
16	16	16	26		436					.X										
17	17	17	26		437				.X											DCM Peak
18	18	18	26		438				.X											
19	19	19	26		439	.X	.X	X.				.X				31	24	170	5,6	
20	20	20	15		440	.X	.X					.X				113	74	135	6,5	
21	21	21	10		441					.X										
22	22	22	10		442															SML
23	23	23	10		443															
24	24	24	10		444	.X	.X	.X				.X		.X		83	139	208	6,6	B769/C31

Comments

Cruise DY167 Stainless Steel CTD log sheet

Station	N05	CTD No	1105	Date	31/07/23	CTD frame type: SS
Latitude		Event No	73	Time I/W (GMT)		
Longitude		Depth		Time bottom (GMT)		
Filename	CTD1105	Cast Depth		Time O/W (GMT)		
Weather	~~BS~~ SUNNY, FLAT, GREENISH WATER, 8°C air temp					

Fire Seq	Rosette Pos*	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal		O_2	O_2	O_2	Temp	Other
1	1	1	361		445	.X	.X					.X		X		207	126	86	4,7	B770/C31
2	2	2	361		446	.X	.X									56	168	106	4,1	
3	3	3	335		447		.X													
4	4	4	248		448	.X	.X									54	48	202	3,9	
5	5	5	120		449	.X	.X					.X		X		82	21	116	5,1	B771/C31
6	6	~~6~~	~~70~~		~~450~~		~~X~~													
7	7	~~7~~	~~50~~		~~451~~		~~X~~													
8	8	8	35		452															
9	9	9	35		453		.X													
10	10	10	30		454	.X	.X					.X				37	145	257	7,0	
11	11	11	25		455				.X	.X										
12	12	~~12~~	~~25~~		~~456~~															DCM Base
13	13	13	25		457				.X											
14	14	14	25		458	.X	.X	.X				.X				170	24	31	7,3	
15	15	~~15~~	~~20~~		~~459~~															
16	16	16	20		460		.X					.X								
17	17	17	12		461					X.										
18	18	18	12		462				.X											DCM Peak
19	19	19	12		463				.X											
20	20	20	12		464	.X	.X	.X				.X				139	218	83	8,2	
21	21	21	5		465					.X										
22	22	22	5		466				.X											SML
23	23	23	5		467				.X											
24	24	24	5		468	.X	.X	X				.X		X		20	209	114	8,5	B772/C31

Comments

Cruise DY167 Stainless Steel CTD log sheet

6°C
chill rm.

Station	N13	CTD No	1125	Date	01/08/23	CTD frame type: SS
Latitude	76° 20.00' N	Event No	76	Time I/W (GMT)	12:07	
Longitude	19° 59.936' E	Depth	255 m	Time bottom (GMT)	12:21	
Filename	ctd1125	Cast Depth	232 m	Time O/W (GMT)	12:52	
Weather						

Fire Seq	Rosette Pos"	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal		O_2	O_2	O_2	Temp	Other
1	1	1	233		469															
2	2	2	235		470	.X	.X							X		86	107	126	3,3	B773/C31
3	3	3	225		471		.X													
4	4	4	180		472		.Y													
5	5	5	160		473		.Y													
6	6	6	130		474	.X	.X					.X				106	168	56	7,3	
~~7~~	~~7~~	~~7~~	~~120~~		~~475~~	~~X~~	~~X~~					~~X~~								
8	8	8	100		476	.X	.Y					.X				202	48	54	7,7	
9	9	9	70		477		.X					X								
10	10	10	40		478															
11	11	11	40		479	.X	.X					.X		X		116	20	82	8,3	B774/C31
12	12	12	30		480					.X										
13	13	13	30		481				~~X~~											DCM Baso.
14	14	14	30		482				~~X~~											
15	15	15	30		483	.X	.X					.X				257	37	145	8,4	
16	16	16	25		484					.X										
17	17	17	25		485				.X											DCM (thick)
18	18	18	25		486				.X											
19	19	19	25		487	.X	.X	.X				.X				31	29	170	9,3	
20	20	20	15		488	.X	.X					.X				135	74	113	7,2	
21	21	21	10		489					.X										
22	22	22	10		[illegible]				.X											SML
23	23	23	10		491				.X											
24	24	24	10		492	.X	.X	X				X		X		40	41	34	8,9	B775/C31

Comments

Cruise DY167 Stainless Steel CTD log sheet

6 MUTS.

Station	N15	CTD No	1149	Date	02/08/23	CTD frame type:
Latitude	77° 13,319 N	Event No	80	Time I/W (GMT)	12:04	
Longitude	19° 20,676 E	Depth	177 m	Time bottom (GMT)	12:14	SS
Filename	CTD 1145	Cast Depth	159 m	Time O/W (GMT)	12:37	
Weather	SLIGHT, MEDIUM CLOUD, MODERATE WIND, IN FJORD					

Fire Seq	Rosette Pos"	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal		O_2	O_2	O_2	Temp	Other
1	1	1	157		493									X						B776/C31
2	2	2	157		494	.X	.X					.X				86	207	126	0,4	
3	3	3	150		495															
4	4	4	110		496															
5	5	5	110		497															
6	6	6	80		498															
7	7	7	80		499	.X	.X					.X		X		56	106	168	0,3	B777/C31
8	8	8	50		500															
9	9	9	50		501							X								
10	10	10	40		502															
11	11	11	40		503	.X	.X					X				48	54	202	2,8	
12	12	12	28		504					.X										
13	13	13	28		505															DCM Base
14	14	14	28		506															
15	15	15	28		507	.X	.X					X				116	20	82	3,0	
16	16	16	20		508					.X										
17	17	17	20		509				.X											PCM (V. Small)
18	18	18	20		510				.X											
19	19	19	20		511	X	.X					X				257	37	145	2,8	
20	20	20	10		512							X								
21	21	21	5		513					.X										
22	22	22	5		514															SML
23	23	23	5		515															
24	24	24	5		516	.X	.X					X		X		37	24	170	7,3	B778/C31

Comments

Cruise DY167 Stainless Steel CTD log sheet

Station	N16	CTD No	1165	Date	03/08/23	
Latitude		Event No	83	Time I/W (GMT)		CTD frame type:
Longitude		Depth	131 m	Time bottom (GMT)		SS
Filename	CTD1165	Cast Depth		Time O/W (GMT)		
Weather	MODERATE CLOUD, ICEBERG BITS AROUND, SMOOTH					

10°C

Fire Seq	Rosette Pos"	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal		O_2	O_2	O_2	T	Other
1	1	1	119		517	.X	.X					.X		X		207	86	126	0,3	B779/C31
2	2	2	119		518															
3	3	3	110		519	.X	.X									56	106	168	0,3	
4	4	4	90		520	.X	.X					.X				54	48	202	0,4	
5	5	5	80		521		.X													
6	6	6	70		522															
7	7	7	70		523	.X	.X					.X				116	20	82	1,2	
8	8	8	60		524		.X							X						B780/C31
~~9~~	~~9~~	~~9~~	~~50~~		~~525~~		~~.X~~							~~X~~						
10	10	10	40		526															
11	11	11	40		527	.X	.X					.X				257	37	145	4,1	
12	12	12	30		528		.X					.X								
13	13	13	23		529					.X										
14	14	14	23		530				.X											
15	15	15	23		531				.X											
16	16	16	23		532	.X	.X					.X				170	24	31	3,6	
17	17	17	19		533					.X										
18	18	18	19		534				.X											
19	19	19	19		535				.X											
20	20	20	19		536	.X	.X	X				.X				34	40	41	5,8	
21	21	21	10		537					X.										
22	22	22	10		538				.X											
23	23	23	10		539				.X											
24	24	24	10		540	.X	.X	.X				.X		X		139	23	27	5,7	B781/C31

Comments

Cruise DY167 Stainless Steel CTD log sheet

NO BOTTLES FIRED.

Station	N16	CTD No	1185	Date	04/08/23	CTD frame type: SS
Latitude	78° 30.989 N	Event No	87	Time I/W (GMT)	12:29	
Longitude	19° 13.745 E	Depth	125m	Time bottom (GMT)	12:35	
Filename	CTD1185	Cast Depth	109 m	Time O/W (GMT)	12:40	
Weather						

7.5 m - 2m SML
Use upcast to look.

Fire Seq	Rosette Pos"	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal						Other
1	1	1																		
2	2	2																		
3	3	3																		
4	4	4																		
5	5	5																		
6	6	6																		
7	7	7																		
8	8	8																		
9	9	9																		
10	10	10																		
11	11	11																		
12	12	12																		
13	13	13																		
14	14	14																		
15	15	15																		
16	16	16																		
17	17	17																		
18	18	18																		
19	19	19																		
20	20	20																		
21	21	21																		
22	22	22																		
23	23	23																		
24	24	24																		

Comments

Cruise DY167 Stainless Steel CTD log sheet

NO BOTTLES FOR SAMPLING

Station	N16	CTD No	1195	Date	04/08/23	CTD frame type:
Latitude	78° 30.88 N	Event No	88	Time I/W (GMT)	14:01	
Longitude	19° 13.70 E	Depth	121 m	Time bottom (GMT)	14:07	SS
Filename	CTD1195	Cast Depth	108 m	Time O/W (GMT)	16:15.	
Weather						

1.5 M SML

Use upcast to look.

Fire Seq	Rosette Pos"	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal						Other
1	1	1																		
2	2	2																		
3	3	3																		
4	4	4																		
5	5	5																		
6	6	6																		
7	7	7																		
8	8	8																		
9	9	9																		
10	10	10																		
11	11	11																		
12	12	12																		
13	13	13																		
14	14	14																		
15	15	15																		
16	16	16																		
17	17	17																		
18	18	18																		
19	19	19																		
20	20	20																		
21	21	21																		
22	22	22																		
23	23	23																		
24	24	24																		

Comments

Cruise DY167 Stainless Steel CTD log sheet

Station	N03	CTD No	121S	Date	06/08/23	CTD frame type: SS
Latitude	72° 51.607 N	Event No	92	Time I/W (GMT)	12:00	
Longitude	19° 4.247 E	Depth	417m	Time bottom (GMT)	12:14	
Filename	CTD121S	Cast Depth	398	Time O/W (GMT)	12:45	
Weather						

Fire Seq	Rosette Pos"	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal		O_2	O_2	O_2	T	Other
1	1	1	400		541	.X						.X		X		86	207	126	5,5	B782/C31
2	2	2	400		542		.X													
3	3	3	360		543		.X													
4	4	4	330		544		.X													
5	5	5	290		545	.X	.X					.X		X		168	106	56	6,4	B783/C31
6	6	6	200		546		.X													
7	7	7	120		547	.X	.X					.X		X		54	~~46~~ 113	202	7,5	B784/C31
8	8	8	60		548															
9	9	9	60		549	.X	.X					.X				82	209	~~116~~ 74	8,1	1351
10	10	10	40		550															
11	11	11	40		551	.X	.X					.X				145	37	~~257~~ 39	8,3	
12	12	12	29		552					.X										DCM Base
13	13	13	29		553				.X											
14	14	14	29		554				.X											
15	15	15	29		555	.X	.X	.X				.X				31	~~170~~ 83	24	8,8	Bubbles in 31
16	16	16	25		556		.X													
17	17	17	22		557					.X										DCM Peak
18	18	18	22		558				.X											
19	19	19	22		559				.X											
20	20	20	22		560	.X	.X	.X				.X				114	20	139	–	
21	21	21	10		561					.X										SML
22	22	22	10		562				.X											
23	23	23	10		563				.X											
24	24	24	10		564		.X	.X				.X		X		~~34~~	~~50~~	~~41~~		B785/C31

Comments

Cruise DY167 Stainless Steel CTD log sheet YOYO Casts

LADCP Picked bottom up @ 220m.

Station	N03	CTD No	1235	Date	07/08/23	CTD frame type:
Latitude	72° 51.624 N	Event No	96	Time I/W (GMT)	06:02	
Longitude	19° 6.386 E	Depth	417	Time bottom (GMT)	06:17	SS
Filename	CTD1235	Cast Depth	400	Time O/W (GMT)	06:33	
Weather						

Fire Seq	Rosette Pos^n	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	Nuts	DNA	~~Chl~~	Plankton IFCB	N_2 Fix										Other
1	1	1	80		565	X.														
2	2	2	55		566	X.	X.		X-											
3	3	3	45		567	X.														
4	4	4	40		568		X.		X.											
5	5	5	40		569	X.														
6	6	6	40		570					X.										
7	7	7	40		571					X.										
8	8	8	37		572		X.		X.											
9	9	9	35		573	X.	X.		X.											
10	10	10	32		574		X.		X.											
11	11	11	29		575	X.	X.		X.											
12	12	12	27		576		X.		X.											
13	13	13	24		577		X.		X.											
14	14	14	24		578	X.														
15	15	15	24		579					X.										
16	16	16	24		580					X										
17	17	17	21		581		X.		X.											
18	18	18	19		582		X.		X.											
19	19	19	16		583		X.		X.											
20	20	20	16		584															
21	21	21	5		585		X.		X.											
22	22	22	5		586	X.														
23	23	23	5		587					X.										
24	24	24	5		588					X.										

Comments

#1

DY167 CTD Yo-Yo Log Sheet

120
270

Date 07/08/23 Julian day: 219

Station No N03 Event No 097

Latitude 72°51.608N Longitude 19°4.232E

Cast No	Start Time	Start Depth	Bottom Time	Bottom Depth	Altimeter	End Time	End Depth	Bottles Fired	Initials	Comments
124 S	07:06	5	07:10	120	—	07:13	5	—	PH	
125 S	07:15	5	07:18	120	—	07:21	5	—	PH	
126 S	07:22	5	07:25	120	—	07:28	5	—	PH	
127 S	07:29	5	07:33	120	—	07:36	5	—	EM	
128 S	07:37	5	07:41	120	—	07:44	5	—	EM	
129 S	07:44	5	07:49	120	—	07:52	5	—	EM	
130 S	07:52	5	07:56	120	—	07:59	5	—	EM	
131 S	08:00	5	08:04	120	—	08:06	5	—	SP	
132 S	08:07	5	08:11	120	—	08:13	5	—	SP	
133 S	08:14	5	08:18	120	—	08:21	5	—	SP	
134 S	08:21	5	08:25	120	—	08:29	5	—	SP	
135 S	08:30	5	08:33	120	—	08:36	5	—	PH	
136 S	08:37	5	08:40	120	—	08:47	5	—	PH	5min stop @ 120m
137 S	08:48	5	08:51	120	—	08:54	5	—	PH	
138 S	08:55	5	08:58	120	—	09:01	5	—	PH	
139 S	09:02	5	09:07	270	—	09:12	5	—	EM	
140 S	09:13	5	09:16	120	—	09:19	5	—	EM	
141 S	09:19	5	09:23	120	—	09:25	5	—	EM	
142 S	09:26	5	09:29	120	—	09:32	5	—	EM	
143 S	09:33	5	09:36	120	—	09:41	5	—	SP	

#2

DY167 CTD Yo-Yo Log Sheet

Date 07/08/23 | Julian day: 219

Station No NO3 | Event No 097

Latitude 72° 51.608N | Longitude 19° 4.232E

Cast No	Start Time	Start Depth	Bottom Time	Bottom Depth	Altimeter	End Time	End Depth	Bottles Fired	Initials	Comments
144S	09:40	5	09:44	120	–	09:47	5	–	SP	
145S	09:48	5	09:52	120	–	09:55	5	–	SP	
146S	09:55	5	10:03	270	–	10:05	5	–	PH	
147S	10:09	5	10:11	120	–	10:14	5	–	PH	
148S	10:15	5	10:18	120	–	10:21	5	–	PH	
149S	10:22	5	10:25	120	–	10:28	5	–	PH	
150S	10:28	5	10:31	120	–	10:34	5	–	PH	
151S	10:35	5	10:38	120	–	10:41	5	–	EM	
152S	10:42	5	10:45	120	–	10:48	5	–	EM	
153S	10:49	5	10:52	120	–	10:55	5	–	EM	
154S	10:56	5	10:59	120	–	11:02	5	–	EM/SP	
155S	11:02	5	11:09	270	–	11:15	5	–	SP	
156S	11:15	5	11:19	120	–	11:22	5	–	SP	
157S	11:22	5	11:26	120	–	11:29	5	–	SP	
158S	11:30	5	11:33	120	–	11:36	5	–	PH	
159S	11:37	5	11:40	120	–	11:42	5	–	PH	
160S	11:43	5	11:46	120	–	11:49	5	–	PH	
161S	11:50	5	11:53	120	–		Surface	–	PH	

Cruise DY167 Stainless Steel CTD log sheet YOYO Casts

Station	N03	CTD No	1625	Date	07/08/23	CTD frame type:
Latitude	72° 51.607 N	Event No	899	Time I/W (GMT)	12:15	
Longitude	19° 4.231 E	Depth	419 m	Time bottom (GMT)	12:27	SS
Filename	CTD1625	Cast Depth	400 m	Time O/W (GMT)		
Weather						

Fire Seq	Rose tie Posn	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	Nuts	DNA	~~Cells~~	Plankton IFCB	N2FIX.											Other
1	1	1	80		589	X.															
2	2	2	50		590	X.	X.		X												
3	3	3	49		591	X.															
4	4	4	44		592		X.		X.												
5	5	5	44		593	X,															
6	6	6	44		594					X.											
7	7	7	44		595					X.											
8	8	8	41		596		X		X												
9	9	9	38		597	X	X		X												
10	10	10	35		598		X		X												
11	11	11	33		599	X	X		X												
12	12	12	30		600		X		X												
13	13	13	27		601		X		X												
14	14	14	27		602	X															
15	15	15	27		603					X											
16	16	16	27		604					X											
17	17	17	24		605		X		X												
18	18	18	21		606		X		X												
19	19	19	19		607		X		X												
20	20	20	19		608																
21	21	21	5		609		X		X												
22	22	22	5		610	X															
23	23	23	5		611					X											
24	24	24	5		612					X											

Comments

1+38+1

DY167 CTD Yo-Yo Log Sheet

120/
270

Date 07/08/23 Julian day: 219

Station No N03 Event No 100

Latitude 72°51.608N Longitude 19°4.233E

Cast No	Start Time	Start Depth	Bottom Time	Bottom Depth	Altimeter	End Time	End Depth	Bottles Fired	Initials	Comments
163 S	13:13	5	13:17	120	—	13:20	5	—	EM	
164 S	13:21	5	13:25	120	—	13:28	5	—	EM	
165 S	13:28	5	13:32	120	—	13:35	5	-	EM/SP	
166 S	13:36	5	13:40	120	—	13:43	5	—	SP	
167 S	13:44	5	13:48	120	—	13:51	5	-	SP	
168 S	13:51	5	13:55	120	-	13:58	5	—	SP	
169 S	13:58	5	14:04	270	—	14:10	5	—	PH	
170S	14:10	5	14:14	120	—	14:17	5	—	PH	
171 S	14:18	5	14:21	120	—	14:23	5	—	PH	
172 S	14:24	5	14:27	120	—	14:30	5	—	EM/PH	
173S	14:31	5	14:34	120	—	14:37	5	—	CM	
174 S	14:38	5	14:41	120	—	14:44	5	—	EM	
175S	14:45	5	14:48	120	—	14:50	5	—	EM	
176S	14:51	5	14:55	120	—	14:57	5	—	EM	
177S	14:58	5	15:05	270	—	15:11	5	-	SP	
178S	15:12	5	15:15	120	—	15:18	5	—	SP	
179S	15:19	5	15:22	120	-	15:25	5	-	SP	
180S	15:26	5	15:30	120	-	15:33	5	—	PH	
181S	15:34	5	15:36	120	—	15:39	5	—	PH	
182S	15:40	5	15:43	120	—	15:46	5	—	PH	

DY167 CTD Yo-Yo Log Sheet

Date 07/08/23 Julian day: 219

Station No N03 Event No 100

Latitude 72°51.608 N Longitude 19°4.231 E

Cast No	Start Time	Start Depth	Bottom Time	Bottom Depth	Altimeter	End Time	End Depth	Bottles Fired	Initials	Comments
183S	15:47	5	15:49	120	—	15:52	5	—	PH	
184S	15:54	5	15:56	120	—	15:58	5	—	PH	
185S	16:00	5	16:04	270	—	16:09	5	—	PH/EM	
186 S	16:10	5	16:13	120	—	16:15	5	—	EM	
187 S	16:16	5	16:19	120	—	16:21	5	—	EM	
188 S	16:22	5	16:25	120	—	16:27	5	—	EM	
189 S	16:28	5	16:31	120	—	16:33	5	—	EM/JP	
190 S	16:34	5	16:37	120	—	16:39	5	—	JP	
191 S	16:40	5	16:43	120	—	16:46	5	—	JP	
192S	16:47	5	16:50	120	—	16:53	5	—	JP	
193S	16:54	5	16:57	120	—	17:01	5	—	JP	
194S	17:01	5	17:07	270	—	17:12	5	—	PH	
195S	17:13	5	17:16	120	—	17:18	5	—	PH	
196S	17:19	5	17:21	120	—	17:24	5	—	PH	
197S	17:25	5	17:27	120	—	17:30	5	—	PH	
198S	17:31	5	17:33	120	—	17:35	5	—	PH	
199S	17:36	5	17:38	120	—	17:41	5	—	EM/PH	
200S	17:42	5	17:45	120	—	17:48	5	—	EM	
201S	17:49	5	17:52	120	—	17:57	5	—	EM	

Cruise DY167 Stainless Steel CTD log sheet YOYO Casts

Station	N03	CTD No	2025	Date	07/08/23	CTD frame type:
Latitude	72° 51.610 N	Event No	101	Time I/W (GMT)	18:15	
Longitude	19° 4.230 E	Depth	419 m	Time bottom (GMT)	18:37	SS
Filename	CTD2025	Cast Depth	400 m	Time O/W (GMT)		
Weather						

Fire Seq	Rosette Pos"	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	Nuts	DNA	Chl a	Plankton IFCB	N2 fix										Other
1	1	1	80		613	X														fired doser to 68m
2	2	2	56		614	X	X		X											
3	3	3	46		615	X														
4	4	4	41		616		X		X											
5	5	5	41		617	X														
6	6	6	41		618					X										
7	7	7	41		619					X										
8	8	8	38		620		X		X											
9	9	9	35		621	X	X		X											
10	10	10	32		622		X		X											
11	11	11	29		623	X	X		X											
12	12	12	26		624		X		X											
13	13	13	23		625		X		X											
14	14	14	23		626	X														
15	15	15	23		627					X										
16	16	16	23		628					X										
17	17	17	20		629		X		X											
18	18	18	17		630		X		X											
19	19	19	14		631		X		X											
20	20	20	14		632															
21	21	21	5		633		X		X											
22	22	22	5		634	X														
23	23	23	5		635					X										
24	24	24	5		636					X										

Comments

Cruise DY167 Stainless Steel CTD log sheet

LAST SS-CTD
Salts samples.

Station	N17	CTD No	2035	Date	08/08/2023	CTD frame type:
Latitude	72° 29.999N	Event No	102.	Time I/W (GMT)	12:01	
Longitude	24° 59.882E	Depth	246m	Time bottom (GMT)	12:12	SS
Filename	CTD2035	Cast Depth	230m	Time O/W (GMT)	12:39	
Weather	OVERCAST, SLIGHT					

Fire Seq	Rosette Posn	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal		O_2	O_2	O_2	Temp	Other
1	1	1	227	637	613	.X	.X									207	126	86	6,8	
2	2	2	227	638	614															
3	3	3	210	639	615	.X	.X									56	106	168	6,2	
4	4	4	180	640	616		.Y							.X						B786/C31
5	5	5	150	641	617	.X	.Y									54	[illegible]	202	6,5	113
6	6	6	125	642	618		.Y													
7	7	7	90	663	619															
8	8	8	90	644	620	.X	.X									82	135	209	6,8	
9	9	9	60	645	621															
10	10	10	60	646	622	.X	.X									145	39	37	7,2	
11	11	11	50	647	623	.Y	.X									31	83	24	7,3	
12	12	12	40	648	624					.X										Base
13	13	13	40	649	625				~~X~~											
14	14	14	40	650	626				~~Y~~											
15	15	15	40	651	627	.X	.Y	.Y								257	116	170	7,7	
16	16	16	31	652	628					.Y										Peak
17	17	17	31	653	629				.X											
18	18	18	31	654	630				.Y											
19	19	19	31	655	631	.Y	.X	.X								74	34	132	8,6	
20	20	20	20	656	632	.X	.X									20	27	136	10,0	
21	21	21	[illegible]	657	633					.X										SML
22	22	22	[illegible]	658	634				.X											
23	23	23	10	659	635				.Y											
24	24	24	10	660	636	.X	.X	.X						X		40	114	41	113	B787/C31

Comments

Cruise DY167 Stainless Steel CTD log sheet

Station	N18	CTD No	205S	Date	09/08/23	CTD frame type: SS
Latitude	73° 30' N	Event No	105	Time I/W (GMT)	12:06	
Longitude	29° 59.95 E	Depth	400m	Time bottom (GMT)	12:37	
Filename	CTD 205S	Cast Depth	380m	Time O/W (GMT)	13:08	
Weather						

Stopped @ 104m for approx 20 min – winch problem

Fire Seq	Rosette Pos*	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal	BOTTLE O2 TEMP					Other
1	1	1	380		661															
2	2	2	380		662	X	X								2,3,4			5.9°C		
3	3	3	300		663	X	X								21,23,24			6.1°C		
4	4	4	200		664		X													
5	5	5	100		665	X	X								40,41,20			7.3°C		
6	6	6	60		666															
7	7	7	60		667	X	X								114,116,136			8.2°C		
8	8	8	40		668	X	X								37,31,39			7.5°C		
9	9	9	35		669		X													
10	10	10	30		670	X	X								88,83,257			8.2°C		
11	11	11	26		671					X										
12	12	12	26		672				X											DCM
13	13	13	26		673				X											
14	14	14	26		674	X	X	X							96,27,34			8.0°C		
15	15	15	18		675					X										
16	16	16	18		676				X											
17	17	17	18		677				X											Peak
18	18	18	18		678	X	X	X							145,	164,	170	9.3°C		
19	19	19	10		679															
20	20	20	10		680	X	X								174,	175,	178	10.4°C		
21	21	21	5		681					X										
22	22	22	5		682				X											SML
23	23	23	5		683				X											
24	24	24	5		684	X	X	X							220	139	131	10.6°	C	

Comments

B 02 1 2 3 4

Cruise DY167 Stainless Steel CTD log sheet

Station	N19	CTD No	2075	Date	10/08/23	CTD frame type: SS
Latitude	74° 0.008 'N	Event No	107	Time I/W (GMT)	11:59	
Longitude	35° 59.966 'E	Depth	235m	Time bottom (GMT)	12:10	
Filename	CTD2075	Cast Depth	218 m	Time O/W (GMT)	12:39	
Weather	FLAT, SUNNY, GREEN WATER					

Fire Seq	Rosette Pos*	Bot. No.	Depth = Pressure	Time (GMT)	Label ID	O_2	Nuts	Chl a	N2 Fix	Genes	IFCB	D18O		Sal	O2 Bottles /		TEMP			Other
1	1	1	218		685															Barents Sea Water
2	2	2	218		686	X	X								2, 3,	4	2.7 °C			Leaked
~~3~~	~~3~~	~~3~~	~~200~~		~~687~~	~~X~~									~~21, 23,~~	~~24~~				~~Leaked~~ Temp too high
4	4	4	180		688	X	X								41, 40	, 20	3.8	°C		
5	5	5	160		689	X	X								14, 116,	136	3.9	°C		
6	6	6	105		690	X	X								37,	39, 31		°C	4.9 °C	
7	7	7	80		691	X	X								257,	88, 83			5.2 °C	
8	8	8	60		692	X	X								170,	164,	145		5.8 °C	
9	9	9	40		693	X	X								34,	27, 26			6.5 °C	
10	10	10	30		694															
11	11	11	30		695	X	X								139,	220,	131		7.8 °C	
12	12	12	23		696					X										Baso.
13	13	13	23		697				X											
14	14	14	23		698				X											
15	15	15	23		699	X	X	X							178,	175, 174			8.9 °C	
16	16	16	17		700					X										Peak
17	17	17	17		701				X											
18	18	18	17		702				X											
19	19	19	17		703	X	X	X							54,	74,	106		9.3 °C	
20	20	20	10		704	X	X								135,	202,	126		10.7 °C	
21	21	21	5		705					X										SML
22	22	22	5		706				X											
23	23	23	5		707				X											
24	24	24	5		708	X	X	X							86,	82	168		11.3 °C	

Comments

9.3 Appendix C – Titanium CTD Sample Logs

Station	N00	CTD No	001 T	Date	14/7/23	CTD frame type: Ti
Latitude	68° 48.400 N	Event No	006	Time I/W (GMT)	16:00	
Longitude	10° 20.194 E	Depth	3023	Time bottom (GMT)	16:32	
Filename		Cast Depth	1000	Time O/W (GMT)		
Weather	Calm, sunny					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O_2	Nuts	TDTM	dFe	sFe	dTM	Partic. Trace metals	DOC	CDOM	Chla	$D^{18}O$	Fe iso			sal	Other
1	1	1T																			
2	2	2T																			
3	3	3T																			
4	4	4T																			
5	5	5T																			
6	6	6T																			
7	7	7T																			
8	8	8T																			
9	9	9T																			
10	10	10T																			
11	11	11T																			
12	12	12T																			
13	13	13T																			
14	14	14T																			
15	15	15T																			
16	16	16T																			
17	17	17T																			
18	18	18T																			
19	19	19T																			
20	20	20T																			
21	21	21T																			
22	22	22T																			
23	23	23T																			
	24	24T																			

Comments

Soak Cast | DCM 15 m
Bottle 11 broken during cocking | New bottle in position 11 for next cast
Bottle 2 did not close at the bottom | New bottle and bottle 2 need to be soaked for next cast

Station	N01	CTD No	004 T	Date	15/7/23	CTD frame type: Ti
Latitude	70 ° 59.993 N	Event No	009	Time I/W (GMT)	15:26	
Longitude	10 ° 59.992 E	Depth	2564	Time bottom (GMT)	16:30	
Filename		Cast Depth		Time O/W (GMT)		
Weather	Calm, slight swell, foggy					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O_2	Chla	DOC	TDTM	dFe	sFe	dTM	Partic. Trace metals	eHS	Nuts	Fe iso				sal	Other
1	1	1T	2564		001 T			X	x	X		X		X	X						
2	2	25T	Soak		~~002 T~~																
3	3	3T	2544		003 T			X	x	X		X		X	X						
4	4	4T	2510		004 T			X		X		X		X	X						
5	5	5T	2200		005 T			X		X		X		X	X						
6	6	6T	2000		006 T				X	X		X			X						
7	7	7T	1800		007 T			X		X		X		X	X						
8	8	8T	1400		008 T			X	X	X		X		X	X						
9	9	9T	1000		009 T					X		X			X						
10	10	10T	900		010 T			X	X	X		X		X	X						
11	11	26T	Soak		~~011 T~~																
12	12	12T	750		012 T			X	X	X		X		X	X						
13	13	13T	650		013 T			X		X		X		X	X						
14	14	14T	500		014 T				X	X		X			X						
15	15	15T	400		015 T			X		X		X		X	X						
16	16	16T	300		016 T				X	X		X			X						
17	17	17T	200		017 T			X		X		X		X	X						
18	18	18T	150		018 T			X	X	X		X		X	X						
19	19	19T	100		019 T					X		X			X						
20	20	20T	75		020 T		x	X	X	X		X		X	X						
21	21	21T	40		021 T		X			X		X			X						
22	22	22T	30		022 T		X	X	X	X		X		X	X						
23	23	23T	25		023 T		X	X		X		X		X	X						
24	24	24T	15		024 T		X	x	X	X		x		X	X						

Comments

DCM = ~28m
Bottle 2 replaced with Bottle 25= soak
Bottle 11 replaced with bottle 26=soak
Particles not taken – ?issue with filters and pressure in bottle
sFe not taken – apparatus not ready
Sal not taken

Station	N02	CTD No	006 T	Date	16/07/23	CTD frame type: Ti
Latitude	72° 0.0016 N	Event No	011	Time I/W (GMT)	14:15	
Longitude	15° 0.007 E	Depth	1128	Time bottom (GMT)		
Filename		Cast Depth		Time O/W (GMT)		
Weather	Sunny, calm					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O_2	Chla	DOC	TDTM	dFe	sFe	dTM	Partic. Trace metals	eHS	Nuts	Fe iso				sal	Other
1	1	1T	1096		025 T								X		X						
2	2	25T	1000		026 T			X	X	X		X		X	X					X	Sal ID: 645, Crate 26
3	3	3T	2000		027 T					X		X			X						
4	4	4T	800		028 T								X		X						
5	5	5T	800		029 T			X	X	X		X		X	X						
6	6	6T	650		030 T								X		X						
7	7	7T	650		031 T			X		X		X		X	X					X	Sal ID: 647, Crate 26
8	8	8T	500		032 T			X	X	X		X		X	X						
9	9	9T	400		033 T					X		X			X						
10	10	10T	300		034 T				X	X		X			X					X	Sal ID: 644, Crate 26
11	11	26T	200		035 T								X		X						
12	12	12T	200		036 T					X		X			X						
13	13	13T	150		037 T			X	X	X		X		X	X						
14	14	14T	100		038 T			X		X		X		X	X						
15	15	15T	50		039 T								X		X						
16	16	16T	50		040 T		X	X	X	X		X		X	X						
17	17	17T	40		041 T			X		X		X		X	X						
18	18	18T	30		042 T		X			X		X			X					X	Sal ID: 646, Crate 26
19	19	19T	25		043 T								X		X						
20	20	20T	25		044 T		X	X	X	X		X		X	X						
21	21	21T	20		045 T								X		X						
22	22	22T	20		046 T		X	X		X		X		X	X						
23	23	23T	15		047 T								X		X						
24	24	24T	15		048 T		X	X	X	X		X		X	X						

Comments

DCM = 20 m
Bottle 7 leaking from bottom

Station	N03	CTD No	121 T	Date	6/8/23	CTD frame type: Ti
Latitude	72° 51.60798 N	Event No	095	Time I/W (GMT)	15:52	
Longitude	19° 4.25148 E	Depth	418.2	Time bottom (GMT)		
Filename		Cast Depth		Time O/W (GMT)		
Weather	Sunny + wavy					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O_2	Chla	DOC	TDTM	dFe	sFe	dTM	Partic. Trace metals	eHS	Nuts	Fe iso				sal	Other
1	1	1T										X	X								
2	2	25T	395		259 T			X	X	X		X		X	X	X				X	Sal ID 193 Crate 7
3	3	3T	380		260 T					X		X	X		X						
4	4	4T	350		261 T				X	X		X			X					X	Sal ID 194 Crate 7
5	5	5T	320		262 T					X		X			X	X					
6	6	6T	300		263 T			X	X	X		X		X	X					X	Sal ID 195 Crate 7
7	7	27T	280		264 T					X		X			X	X					
8	8	8T	220		265 T					X		X			X						
9	9	9T																			
10	10	10T	180		266 T			X	X	X		X	X	X	X						
11	11	26T																			
12	12	12T																			
13	13	13T																			
14	14	14T																			
15	15	15T																			
16	16	16T	150		267 T					X		X			X					X	Sal ID 196 Crate 7
17	17	17T	100		268 T				X	X		X			X	X					
18	18	18T	70		269 T			X		X		X	X	X	X						
19	19	19T	40		270 T				X	X		X			X					X	Sal ID 197 Crate 7
20	20	20T	30		271 T					X		X	X		X						
21	21	21T	22		272 T			X	X	X		X	X	X	X	X				X	Sal ID 198 Crate 7
22	22	22T	20		273T					X		X			X						
23	23	23T	15		274 T			X	X	X		X		X	X	X					
24	24	24T																			

Comments

Bottle 9 still had water in from previous cast – used bottle 10 instead, bottle 9 to be soaked on another cast
DCM = 22 m
MLD = 18 m

Station	N04	CTD No	008 T	Date	18/7/23	CTD frame type: Ti
Latitude	73° 43.47 N	Event No	018	Time I/W (GMT)	18:29	
Longitude	23° 22.0012 E	Depth	459.3	Time bottom (GMT)		
Filename		Cast Depth		Time O/W (GMT)		
Weather	Grey & wavy					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O_2	Chla	DOC	TDTM	dFe	sFe	dTM	Partic. Trace metals	eHS	Nuts	Fe iso				sal	Other
1	1	1T	436		049 T			X	X	X		X		X	X						
2	2	25T	436		050 T								X								
3	3	3T	400		051 T								X								
4	4	4T	400		052 T			X		X		X		X	X					X	**Sal ID: 650, Crate 26**
5	5	5T	375		053 T								X								
6	6	6T	375		054 T			X	X	X		X		X	X						
7	7	27T	-		055 T																
8	8	8T	350		056 T					X		X			X						
9	9	9T	300		057 T					X		X			X						
10	10	10T	275		058 T				X	X		X			X						
11	11	26T	250		059 T			X		X		X		X	X						
12	12	12T	200		060 T					X		X			X						
13	13	13T	150		061 T					X		X			X					X	**Sal ID: 648, Crate 26**
14	14	14T	100		062 T			X	X	X		X		X	X						
15	15	15T	70		063 T								X								
16	16	16T	70		064 T					X		X			X						
17	17	17T	40		065 T								X								
18	18	18T	40		066 T		X	X	X	X		X		X	X						
19	19	19T	25		067 T								X								
20	20	20T	25		068 T		X	X	X	X		X		X	X						
21	21	21T	20		069 T								X								
22	22	22T	20		070 T		X			X		X			X					X	**Sal ID: 649, Crate 26**
23	23	23T	15		071 T								X								
24	24	24T	15		072 T		X	x	x	X		X		X	X						
Comments					Bottle 7 replaced (as leaking) with bottle 27																

Station	N05	CTD No	111 T	Date	31/7/23	CTD frame type: Ti
Latitude	74° 36.5974 N	Event No	075	Time I/W (GMT)	16:18	
Longitude	27° 53.9526 E	Depth	379.8	Time bottom (GMT)		
Filename		Cast Depth		Time O/W (GMT)		
Weather	Foggy					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O_2	Chla	DOC	TDTM	dFe	sFe	dTM	Partic. Trace metals	eHS	Nuts	Fe iso				sal	Other
1	1	1T																			
2	2	25T	360		213 T			X	X	X		X	X	X	X	X				X	Sal Id 294 Crate 11
3	3	3T	320		214 T					X		X			X						
4	4	4T	260		215 T			X		X		X		X	X						
5	5	5T	200		216 T				X	X		X	X		X						
6	6	6T	180		217 T					X		X			X	X					
7	7	27T	140		218 T			X		X		X		X	X					X	Sal Id 295 Crate 11
8	8	8T																			
9	9	9T																			
10	10	10T																			
11	11	26T																			
12	12	12T																			
13	13	13T																			
14	14	14T																			
15	15	15T																			
16	16	16T																			
17	17	17T																			
18	18	18T	100		219 T					X		X	X		X	X					
19	19	19T	60		220 T			X	X	X		X		X	X					X	Sal Id 296 Crate 11
20	20	20T	30		221 T					X		X			X						
21	21	21T	20		222 T					X		X			X	X				X	Sal Id 297 Crate 11
22	22	22T	17		223 T				X	X		X	X		X						
23	23	23T	15		224 T		X	X	X	X		X	X	X	X	X				X	Sal Id 298 Crate 11
24	24	24T																			
Comments					DCM = ~10 m																

Station	N05	CTD No	010 T	Date	19/7/23	CTD frame type: Ti
Latitude	74° 36.34 N	Event No	024	Time I/W (GMT)	16:08	
Longitude	27° 53.984 E	Depth	385.5	Time bottom (GMT)		
Filename		Cast Depth		Time O/W (GMT)		
Weather	Cloudy, calm					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O_2	Chla	DOC	TDTM	dFe	sFe	dTM	Partic. Trace metals	eHS	Nuts	Fe iso				sal	Other
1	1	1T	363		073 T			X	X	X		X		X	X						
2	2	25T	363		074 T								X								
3	3	3T	340		075 T				X	X		X			X					X	**Sal ID: 651, Crate 26**
4	4	4T	340		076 T								X								
5	5	5T	300		077 T																
6	6	6T	250		078 T								X								
7	7	27T	250		079 T				X	X		X			X						
8	8	8T	200		080 T					X		X			X						
9	9	9T	150		081 T								X								
10	10	10T	150		082 T			X	X	X		X		X	X						
11	11	26T	100		083 T					X		X			X					X	**Sal ID: 659, Crate 26**
12	12	12T	80		084 T			X		X		X		X	X						
13	13	13T	60		085 T				X	X		X			X						
14	14	14T	50		086 T					X		X			X						
15	15	15T	50		087 T								X								
16	16	16T	40		088 T		X	X		X		X		X	X						
17	17	17T	30		089 T								X								
18	18	18T	30		090 T		X		X	X		X			X						
19	19	19T	25		091 T								X								
20	20	20T	25		092 T		X		X	X		X			X						
21	21	21T	20		093 T								X								
22	22	22T	20		094 T		X		X	X		X			X					X	**Sal ID: 658, Crate 26**
23	23	23T	15		095 T								X								
24	24	24T	15		096 T		X	X	X	X		X		X	X						
Comments					Bottle 5 – Top lid not closed fully → misfire																

Station	N06	CTD No	109 T	Date	30/7/23	CTD frame type: Ti
Latitude	76°0.0027 N	Event No	072	Time I/W (GMT)	16:15	
Longitude	29° 59.9716 E	Depth	316.1	Time bottom (GMT)		
Filename		Cast Depth		Time O/W (GMT)		
Weather	Foggy + rain					

Fire Seq	Rosette Posn	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O_2	Chla	DOC	TDTM	dFe	sFe	dTM	Partic. Trace metals	eHS	Nuts	Fe iso				sal	Other
1	1	1T																			
2	2	25T	301		197 T			X	x	X		x		X	x	X					
3	3	3T	295		198 T				X	X		X			X	X					
4	4	4T	290		199 T			X	X	X		X		X	X					X	Sal Id: 291 Crate 11
5	5	5T	295		200 T					X		X			X						
6	6	6T	260		201 T			X		X		X		X	X	x				X	Sal Id: 292 Crate 11
7	7	27T	230		202 T				X	X		X			X						
8	8	8T	200		203 T			X		X		X		X	X					x	Sal Id: 293 Crate 11
9	9	9T	170		204 T					x		X			X						
10	10	10T																			
11	11	26T																			
12	12	12T																			
13	13	13T																			
14	14	14T																			
15	15	15T																			
16	16	16T	150		205 T					X		X			X						
17	17	17T	100		206 T			X	X	X		X		X	X						
18	18	18T	60		207 T				X	X		X			X						
19	19	19T	45		208 T		X	X	X	X		X		X	X		X				
20	20	20T	35		209 T		X			X		X			X					X	Sal ID:289 Crate 11
21	21	21T	30		210 T		X		X	X		X			X						
22	22	22T	25		211 T		X	X		X		X		X	X		X				
23	23	23T	15		212 T		X	X	X	X		X		X	X					X	Sal Id: 290 Crate 11
24	24	24T																			

Comments

Station	N07	CTD No	CTD 016 T	Date	21/7/23	CTD frame type: Ti
Latitude	77 ° 59.99 N	Event No	039	Time I/W (GMT)	16:13	
Longitude	29° 59.96 E	Depth	297.8	Time bottom (GMT)		
Filename		Cast Depth		Time O/W (GMT)		
Weather	Foggy, calm					

Fire Seq	*Rosette Posn*	*Bot. No.*	*Depth (Pressure)*	*Time (GMT)*	*Label ID*	*O_2*	*Chla*	*DOC*	*TDTM*	*dFe*	*sFe*	*dTM*	*Partic. Trace metals*	*eHS*	*Nuts*	*Fe iso*				*sal*	*Other*
1	1	1T	275		**107 T**								**X**								
2	2	25T	275		**108 T**			X	**X**	**X**		**X**		X	**X**					**X**	**Sal ID: 654, Crate 26**
3	3	3T	262		**109 T**				**X**	**X**		**X**			**X**						
4	4	4T	225		**110 T**								X								
5	5	5T	225		**111 T**			X	**X**	**X**		**X**		X	**X**						
6	6	6T	200		**112 T**					X		**X**			**X**						
7	7	27T	160		**113 T**				**X**	X		**X**			**X**						
8	8	8T	100		**114 T**			X		X		**X**		X	**X**					**X**	**Sal ID: 655, Crate 26**
9	9	9T																			
10	10	10T																			
11	11	26T																			
12	12	12T																			
13	13	13T																			
14	14	14T																			
15	15	15T																			
16	16	16T																			
17	17	17T																			
18	18	18T																			
19	19	19T																			
20	20	20T																			
21	21	21T																			
22	22	22T																			
23	23	23T																			
24	24	24T																			

Comments

Bottles 16-23 not fired correctly (wrong sequence). Surface sampling discontinued, captured on second cast (Event 040).
Bottle 1 failed to close. PTM's collected from Bottle 25 after TDTM's collected

Station	N07	CTD No	CTD 17T	Date	21/2/23	CTD frame type: Ti
Latitude	77 ° 59.99 N	Event No	040	Time I/W (GMT)		
Longitude	29° 59.96 E	Depth	298	Time bottom (GMT)		
Filename		Cast Depth		Time O/W (GMT)		
Weather	Foggy, calm					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (Pressure)*	*Time (GMT)*	*Label ID*	*O_2*	*Chla*	*DOC*	*TDTM*	*dFe*	*sFe*	*dTM*	*Partic. Trace metals*	*eHS*	*Nuts*	*Fe iso*				*sal*	*Other*
1	1	1T																			
2	2	25T																			
3	3	3T																			
4	4	4T																			
5	5	5T																			
6	6	6T																			
7	7	27T																			
8	8	8T																			
9	9	9T																			
10	10	10T																			
11	11	26T																			
12	12	12T																			
13	13	13T																			
14	14	14T																			
15	15	15T																			
16	16	16T	80		115 T								X								
17	17	17T	80		116 T		**X**		**X**	X		**X**			**X**						
18	18	18T	46		117 T		**X**	**X**	**X**	**X**		**X**		X	**X**						
19	19	19T	46		118 T								X								
20	20	20T	35		119 T		**X**	**X**	**X**	**X**		**X**		X	**X**					**X**	**Sal ID: 653, Crate 26**
21	21	21T	20		120 T		**X**			**X**		**X**			**X**						
22	22	22T	15		121 T		**X**	**X**	**X**	**X**		**X**		X	**X**						
23	23	23T	15		122 T								X								
24	24	24T																			

Comments		Second cast at Station N07 to 90 m only

Station	N07-X	CTD No	106 T	Date	28/7/23	CTD frame type: Ti
Latitude	78° 33.39448 N	Event No	068	Time I/W (GMT)		
Longitude	30° 2.9700 E	Depth	249.8	Time bottom (GMT)		
Filename		Cast Depth		Time O/W (GMT)		
Weather	Sunny					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O_2	Chla	DOC	TDTM	dFe	sFe	dTM	Partic. Trace metals	eHS	Nuts	Fe iso				sal	Other
1	1	1T																			
2	2	25T	230		169 T								X							X	Sal ID: 998, Crate 40
3	3	3T	230		170 T			X	X	X		X		X	X	X					
4	4	4T	220		171 T					X		X			X	X					
5	5	5T	210		172 T			X	X	X		X	X	X	X					X	Sal ID: 1000, Crate 40
6	6	6T	190		173 T					X		X			X						
7	7	27T	160		174 T				X	X		X			X	X					
8	8	8T	140		175 T					X		X	X		X						
9	9	9T	110		176 T			X	X	X		X		X	X					X	Sal ID: 1001, Crate 40
10	10	10T																			
11	11	26T																			
12	12	12T																			
13	13	13T																			
14	14	14T																			
15	15	15T																			
16	16	16T	100		177 T					X		X			X						
17	17	17T	80		178 T			X	X	X		X		X	X					X	Sal ID: 1002, Crate 40
18	18	18T	50		179 T		X			X		X	X		X						
19	19	19T	40		180 T								X								
20	20	20T	40		181 T		X	X	X	X		X		X	X	X					
21	21	21T	35		182 T		X	X	X	X		X	X	X	X					X	Sal ID: 997, Crate 40
22	22	22T	25		183 T		X			X		X			X						
23	23	23T	15		184 T		X	X	X	X		X		X	X	X				X	Sal ID: 1003, Crate 40
24	24	24T																			

Comments

Station	N07-Y	CTD No	107 T	Date	29/7/23	CTD frame type: Ti
Latitude	78° 03.45119 N	Event No	069	Time I/W (GMT)	15:38	
Longitude	26° 40.500 E	Depth	212.2	Time bottom (GMT)		
Filename		Cast Depth	192	Time O/W (GMT)		
Weather	Cloudy + calm					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (Pressure)*	*Time (GMT)*	*Label ID*	*O_2*	*Chla*	*DOC*	*TDTM*	*dFe*	*sFe*	*dTM*	*Partic. Trace metals*	*eHS*	*Nuts*	*Fe iso*				*sal*	*Other*
1	1	1T																			
2	2	25T	192		185 T								X								
3	3	3T	192		186 T				**X**	**X**		**X**			**X**					**X**	**Sal ID: 284 Crate 11**
4	4	4T	160		187 T					**X**		**X**			**X**					**X**	**Sal ID: 286 Crate 11**
5	5	5T	142		188 T					**X**		**X**	X		**X**						
6	6	6T	110		189 T				**X**	X		**X**			**X**					**X**	**Sal ID: 285 Crate 11**
7	7	27T	80		190 T					X		**X**			**X**						
8	8	8T																			
9	9	9T																			
10	10	10T																			
11	11	26T																			
12	12	12T																			
13	13	13T																			
14	14	14T																			
15	15	15T																			
16	16	16T																			
17	17	17T																			
18	18	18T	50		191 T		**X**			**X**		**X**			**X**						
19	19	19T	43		192 T								X								
20	20	20T	43		193 T		**X**		**X**	**X**		**X**			**X**					**X**	**Sal ID: 287 Crate 11**
21	21	21T	35		194 T		**X**			**X**		**X**			**X**						
22	22	22T	25		195 T		**X**			**X**		**X**	X		**X**					**X**	**Sal ID: 288 Crate 11**
23	23	23T	15		196 T		**X**		**X**	**X**		**X**			**X**						
24	24	24T																			

Comments

DCM = 43 m

Station	N08	CTD No	025 T	Date	25/7/23	CTD frame type: Ti
Latitude	79° 21.025 N	Event No	051	Time I/W (GMT)	16:48	
Longitude	33° 53.804 E	Depth		Time bottom (GMT)		
Filename		Cast Depth		Time O/W (GMT)		
Weather	Sunny + calm, at ice edge					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O_2	Chla	DOC	TDTM	dFe	sFe	dTM	Partic. Trace metals	eHS	Nuts	Fe iso				sal	Other
1	1	1T																			
2	2	25T	245		153 T			x	x	x		x		x	x	X					
3	3	3T	245		154 T								x							X	**Sal ID: 656 Crate 26**
4	4	4T	210		155 T				X	x		x			X	x				X	**Sal ID: 662 Crate 26**
5	5	5T	190		156 T					X		x			X						
6	6	6T	180		157 T					X		X			X						
7	7	27T	160		158 T			X	X	X		X		x	X						
8	8	8T	140		159 T					X		X	x		X	x					
9	9	9T	100		160 T				X	X		x			X					x	**Sal ID: 663 Crate 26**
10	10	10T																			
11	11	26T																			
12	12	12T																			
13	13	13T																			
14	14	14T																			
15	15	15T																			
16	16	16T	80		161 T					X		X			X						
17	17	17T	60		162 T		X	X	X	X		X		X	X	X				x	**Sal ID: 986 Crate 40**
18	18	18T	46		163 T			X	X	X		X	X	X	X	X					
19	19	19T	46		164 T		X	X	X	X		X		X	X	X					
20	20	20T	42		165 T		X			X		X			X						
21	21	21T	35		166 T		X	X	X	X		X	X	X	X						
22	22	22T	20		167 T		X			X		X			X						
23	23	23T	15		168 T		X	x	x	X		x	x	x	X	x				X	**Sal ID: 987 Crate 40**
24	24	24T																			

Comments	DCM = 45 m Bottle 19 did not close at bottom – samples collected from bottle 18 instead NOTE: Error in labelling – bottle and sample ID's correct but labels say N09, should be N08. Samples <u>have not</u> been relabelled.

Station	N09	CTD No	022 T	Date	23/7/23	CTD frame type: Ti
Latitude	79° 23.14776 N	Event No	047	Time I/W (GMT)	15:16	
Longitude	27° 44.3872 E	Depth	335	Time bottom (GMT)		
Filename		Cast Depth		Time O/W (GMT)		
Weather	Calm, foggy					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O_2	Chla	DOC	TDTM	dFe	sFe	dTM	Partic. Trace metals	eHS	Nuts	Fe iso				sal	Other
1	1	1T	310		135 T								X								
2	2	25T	310		136 T			X	X	X		X		X	X	X					
3	3	3T	300		137 T				X	X		X			X	X				X	**Sal ID: 666, Crate 26**
4	4	4T	300		138 T								X								
5	5	5T	280		139 T			X		X		X		X	X						
6	6	6T	240		140 T					X		X			X						
7	7	27T	200		141 T			X		X		X	X	X	X						
8	8	8T	150		142 T				X	X		X			X						
9	9	9T	110		143 T					X		X			X						
10	10	10T																			
11	11	26T																			
12	12	12T																			
13	13	13T																			
14	14	14T																			
15	15	15T	100		144 T			X	X	X		X		X	X						
16	16	16T	80		145 T					X		X			X						
17	17	17T	70		146 T		X			X		X			X						
18	18	18T	58		147 T		X	X	X	X		X		X	X	X					
19	19	19T	58		148 T								X								
20	20	20T	40		149 T		X	X		X		X		X	X				X		**Sal ID: 665, Crate 26**
21	21	21T	30		150 T		X		X	X		X			X	X					
22	22	22T	25		151 T		X	X		X		X	X	X	X						
23	23	23T	15		152 T		X	X	X	X		X		X	X	X			X		**Sal ID: 664, Crate 26**
24	24	24T																			

Comments

DCM = 58 m
MLD = 10 m

NOTE: Error in labelling – samples from N08 labelled with station ID N09 by mistake. Sample and bottle ID's for N08 and N09 match log. Samples have not been relabelled.

Station	N10	CTD No	019 T	Date	22/07/23	CTD frame type: Ti
Latitude	78° 39.513 N	Event No	043	Time I/W (GMT)	16:42	
Longitude	24° 39.009 E	Depth	140.9	Time bottom (GMT)		
Filename		Cast Depth		Time O/W (GMT)		
Weather	Sunny, calm					

Fire Seq	*Rosette Pos^n^*	*Bot. No.*	*Depth (Pressure)*	*Time (GMT)*	*Label ID*	*O_2*	*Chla*	*DOC*	*TDTM*	*dFe*	*sFe*	*dTM*	*Partic. Trace metals*	*eHS*	*Nuts*	*Fe iso*				*sal*	*Other*
1	1	1T	124		123 T			X	X	X		X		X	X						
2	2	25T	124		124 T								X								
3	3	3T	110		125 T			X	X	X		X		X	X					X	Sal ID: 652, Crate 26
4	4	4T	90		126 T				X	X		X			X						
5	5	5T	70		127 T		X	X	X	X		X	X	X	X						
6	6	6T	62		128 T					X		X			X						
7	7	27T																			
8	8	8T																			
9	9	9T																			
10	10	10T																			
11	11	26T																			
12	12	12T																			
13	13	13T																			
14	14	14T																			
15	15	15T																			
16	16	16T																			
17	17	17T																			
18	18	18T	47		129 T								X								
19	19	19T	47		130 T		X	X	X	X		X		X	X						
20	20	20T	35		131 T		X	X		X		X		X	X						
21	21	21T	25		132 T								X								
22	22	22T	25		133 T		X			X		X			X						
23	23	23T	15		134 T		X	X	X	X		X		X	X					X	Sal ID: 667, Crate 26
24	24	24T																			
Comments																					

Station	N012	CTD No	014 T	Date	20/7/23	CTD frame type: Ti
Latitude	75° 30.052 N	Event No	030	Time I/W (GMT)	15:01	
Longitude	22° 29.996 E	Depth	55.6 m	Time bottom (GMT)		
Filename		Cast Depth		Time O/W (GMT)		
Weather	Calm, partial cloud					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O_2	Chla	DOC	TDTM	dFe	sFe	dTM	Partic. Trace metals	eHS	Nuts	Fe iso				sal	Other
1	1	1T	45		097 T								X								
2	2	25T	45		098 T			X	x	X		X		X	x					x	Sal ID: 661, Crate 26
3	3	3T	40		099 T								X								
4	4	4T	40		100 T				X	X		X			X						
5	5	5T	35		101 T								X								
6	6	6T																			
7	7	27T																			
8	8	8T																			
9	9	9T																			
10	10	10T																			
11	11	26T																			
12	12	12T																			
13	13	13T																			
14	14	14T																			
15	15	15T																			
16	16	16T																			
17	17	17T																			
18	18	18T																			
19	19	19T	30		102 T		X		X	X		X			X					x	Sal ID: 660, Crate 26
20	20	20T	20		103 T		X		X	X		X			X						
21	21	21T	20		104 T								X								
22	22	22T	15		105 T		x	x	x	x		x		x	X						
23	23	23T	15		106 T								X								
24	24	24T																			

Comments

PTM's accidently collected from bottle 4 instead – sample re-labelled with ID 100 T (ROS 4)
DFE, DTM and Nuts that should have been collected from bottle 4, instead collected from bottle 3 – samples re-labelled with ID 099 T (ROS 3)

TDTM had already been sampled from bottle 4 so label is unchanged and correct

Station	N13	CTD No	113 T	Date	01/08/23	CTD frame type: Ti
Latitude	76° 20.000 N	Event No	079	Time I/W (GMT)	15:27	
Longitude	19° 59.9382 E	Depth	254	Time bottom (GMT)		
Filename		Cast Depth	235	Time O/W (GMT)		
Weather	Sunny + calm					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (Pressure)*	*Time (GMT)*	*Label ID*	*O_2*	*Chla*	*DOC*	*TDTM*	*dFe*	*sFe*	*dTM*	*Partic. Trace metals*	*eHS*	*Nuts*	*Fe iso*				*sal*	*Other*
1	1	1T																			
2	2	25T	235		225 T			X	x	X		x	X	X	x	X					
3	3	3T	230		226 T					X		x			x					X	**Sal Id 299 Crate 11**
4	4	4T	220		227 T				x	X		x	X		x	X					
5	5	5T	210		228 T			X		X		x		X	x						
6	6	6T	190		229 T			X		X		x		X	x					X	**Sal Id 303 Crate 11**
7	7	27T	150		230 T			X	x	X		x	X	X	x	X				X	**Sal Id 304 Crate 11**
8	8	8T																			
9	9	9T																			
10	10	10T																			
11	11	26T																			
12	12	12T																			
13	13	13T																			
14	14	14T																			
15	15	15T																			
16	16	16T																			
17	17	17T																			
18	18	18T	100		231 T			X	x	X		x	X	X	x	X				X	**Sal Id 305 Crate 11**
19	19	19T	40		232 T					X		x			x						
20	20	20T	30		233 T					X		x			x					X	**Sal Id 306 Crate 11**
21	21	21T	25		234 T				x	X		x	X		x	X					
22	22	22T	20		235 T		X	X		X		x		X	x					X	**Sal Id 307 Crate 11**
23	23	23T	15		236 T		X	X	x	X		x	X	X	x	X					
24	24	24T																			

Comments		DCM = 14.5 m

Station	N15	CTD No	115 T	Date	02/08/23	CTD frame type: Ti
Latitude	77° 13.320 N	Event No	082	Time I/W (GMT)	16:12	
Longitude	19° 20.678084 E	Depth	174.6	Time bottom (GMT)		
Filename		Cast Depth		Time O/W (GMT)		
Weather	Sunny + windy					

Fire Seq	*Rosette Pos^n*	*Bot. No.*	*Depth (Pressure)*	*Time (GMT)*	*Label ID*	*O_2*	*Chla*	*DOC*	*TDTM*	*dFe*	*sFe*	*dTM*	*Partic. Trace metals*	*eHS*	*Nuts*	*Fe iso*				*sal*	*Other*
1	1	1T																			
2	2	25T	164		237 T			X	X	X		X	X	X	X	X				X	Sal Id 300 Crate 11
3	3	3T	160		238 T				X	X		X	X		X	X					
4	4	4T	150		239 T			X		X		X		X	X						
5	5	5T	140		240 T				X	X		X	X		X	X				X	Sal Id 301 Crate 11
6	6	6T	100		241 T			X		X		X		X	X						
7	7	27T																			
8	8	8T																			
9	9	9T																			
10	10	10T																			
11	11	26T																			
12	12	12T																			
13	13	13T																			
14	14	14T																			
15	15	15T																			
16	16	16T																			
17	17	17T																			
18	18	18T																			
19	19	19T	60		242 T			X		X		X		X	X						
20	20	20T	40		243 T			X	X	X		X		X	X	X					
21	21	21T	30		244 T					X		X			X					X	Sal Id 302 Crate 11
22	22	22T	20		245 T			X	X	X		X	X	X	X						
23	23	23T	15		246 T					X		X			X	X					
24	24	24T																			

Comments

DCM = none
MLD = non

Station	N16	CTD No	117 T	Date	03/08/23	CTD frame type: Ti
Latitude	78° 30.50014 N	Event No	085	Time I/W (GMT)	16:29	
Longitude	19° 16.934	Depth	121.4	Time bottom (GMT)		
Filename		Cast Depth		Time O/W (GMT)		
Weather	Windy + light rain					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O_2	Chla	DOC	TDTM	dFe	sFe	dTM	Partic. Trace metals	eHS	Nuts	Fe iso				sal	Other
1	1	1T																			
2	2	25T	110		247 T			X	x	X		x	X	X	x	X				X	Sal Id 188 Crate 7
3	3	3T	105		248 T					X		x	X		x					X	Sal Id 189 Crate 7
4	4	4T	100		249 T			X	x	X		x		X	x	X					
5	5	5T	85		250 T					X		x			x						
6	6	6T	70		251 T			X	x	X		x	X	X	x	X				X	Sal Id 190 Crate 7
7	7	27T	60		252 T					X		x			x						
8	8	8T																			
9	9	9T																			
10	10	10T																			
11	11	26T																			
12	12	12T																			
13	13	13T																			
14	14	14T																			
15	15	15T																			
16	16	16T																			
17	17	17T																			
18	18	18T	45		253 T			X	x	X		x	X	X	x	X					
19	19	19T	40		254 T					X		x	X		x					X	Sal Id 191 Crate 7
20	20	20T	30		255 T			X		X		x	X	X	x						
21	21	21T	25		256 T			X	x	X		x	X	X	x	X				X	Sal Id 192 Crate 7
22	22	22T	20		257 T					X		x			x						
23	23	23T	15		258 T				x	X		x	X		x	X					
24	24	24T																			

Comments

Station	N17	CTD No	204 T	Date	08/08/23	CTD frame type: Ti
Latitude	72°29.99178 N	Event No	104	Time I/W (GMT)	15:24	
Longitude	24° 59.93652 E	Depth	248.8	Time bottom (GMT)		
Filename		Cast Depth	229	Time O/W (GMT)		
Weather	Cloudy + windy					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O_2	Chla	DOC	TDTM	dFe	sFe	dTM	Partic. Trace metals	eHS	Nuts	Fe iso				sal	Other
1	1	1T																			
2	2	25T	229		275 T			X	x	X		x	X	X	x	X				x	Sal ID 199 Crate 7
3	3	3T	220		276 T					X		X			X	X				X	Sal ID 200 Crate 7
4	4	4T	200		277 T			X	X	X		X	x	X	X					X	Sal ID 201 Crate 7
5	5	5T	160		278 T					X		X			X					X	Sal ID 202 Crate 7
6	6	6T	140		279 T			X		X		X		X	X	X				X	Sal ID 203 Crate 7
7	7	27T	110		280 T				X	X		X			X	X				X	Sal ID 204 Crate 7
8	8	8T	83		281 T			x	X	x		X		x	X					X	Sal ID 205 Crate 7
9	9	9T																			
10	10	10T	70		282 T					x		x	x		x					x	Sal ID 206 Crate 7
11	11	26T																			
12	12	12T																			
13	13	13T																			
14	14	14T																			
15	15	15T																			
16	16	16T	40		283 T			X	x	X		X		x	X					X	Sal ID 207 Crate 7
17	17	17T	33		284 T					X		X			X					X	Sal ID 208 Crate 7
18	18	18T	27		285 T																
19	19	19T	27		286 T																
20	20	20T	27		287 T																
21	21	21T	27		288 T			X	X	X		X	X	X	X	X					
22	22	22T	22		289 T					X		X			X					X	Sal ID 210 Crate 7
23	23	23T	15		290 T			x	X	x		X	x	X	x	X				X	Sal ID 211 Crate 7
24	24	24T																			

Comments

Bottle 9 still not used – waiting to soak
Bottles 18, 19 & 20 – not sampled, water collected to make calibration seawater (CSW) for FIA, remnants of bottle 21 after sampling also collected for CSW
MLD = 16 m
DCM = 27 m

Station	N18	CTD No	206 T	Date	09/08/23	CTD frame type: Ti
Latitude	73° 30.00468 N	Event No	106	Time I/W (GMT)	13:37	
Longitude	29° 59.957858 W	Depth	399.7	Time bottom (GMT)		
Filename		Cast Depth		Time O/W (GMT)		
Weather	Sunny + windy					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O_2	Chla	DOC	TDTM	dFe	sFe	dTM	Partic. Trace metals	eHS	Nuts	Fe iso				sal	Other
1	1	1T																			
2	2	25T	380		291 T			X	X	X		X	X	X	X	X					
3	3	3T	370		292 T					X		X	X		X						
4	4	4T	320		293 T				X	X		X			X						
5	5	5T	280		294 T			X		X		X	X	X	X						
6	6	6T	240		295 T				X	X		X			X	X					
7	7	27T	180		296 T			X		X		X		X	X						
8	8	8T																			
9	9	9T																			
10	10	10T																			
11	11	26T																			
12	12	12T																			
13	13	13T																			
14	14	14T																			
15	15	15T																			
16	16	16T																			
17	17	17T																			
18	18	18T	100		297 T					X		X	X		X						
19	19	19T	60		298 T					X		X		X	X						
20	20	20T	40		299 T				X	X		X			X						
21	21	21T	35		300 T			X		X		X	X	X	X	X					
22	22	22T	20		301 T			X	X	X		X	X	X	X	X					
23	23	23T	15		302 T			X	X	X		X		X	X						
24	24	24T																			
Comments		DCM = 20 m																			

Station	N19	CTD No	208 T	Date	10/8/23	CTD frame type: Ti
Latitude	74° 8.0010 N	Event No	108	Time I/W (GMT)	13:33	
Longitude	35° 59.9496 E	Depth	235.8	Time bottom (GMT)	13:44	
Filename		Cast Depth		Time O/W (GMT)		
Weather	Sunny + calm					

Fire Seq	Rosette Pos^n	Bot. No.	Depth (Pressure)	Time (GMT)	Label ID	O_2	Chla	DOC	TDTM	dFe	sFe	dTM	Partic. Trace metals	eHS	Nuts	Fe iso				sal	Other
1	1	1T																			
2	2	25T	217		303 T			X	x	X		x		X	x	X					
3	3	3T	200		304 T			X		X		x		X	x						
4	4	4T	190		305 T				x	X		x			x						
5	5	5T	140		306 T					X		x			x						
6	6	6T	100		307 T			X		X		x		X	x	X					
7	7	27T	80		308T					X		x			x						
8	8	8T																			
9	9	9T																			
10	10	10T																			
11	11	26T																			
12	12	12T																			
13	13	13T																			
14	14	14T																			
15	15	15T																			
16	16	16T																			
17	17	17T																			
18	18	18T	60		309 T			X		X		x		X	x						
19	19	19T	40		310 T					X		x			x						
20	20	20T	30		311 T					X		x			x	X					
21	21	21T	23		312 T			X		X		x		X	x						
22	22	22T	18		313 T			X	x	X		x		X	x	X					
23	23	23T	15		314 T			X	x	X		x		X	x	X					
24	24	24T																			
Comments					Bottle 5 did not close MLD = 8 m DCM = 18 m																

9.4 Appendix D – FISH Sample Log

All fish samples are filtered through 0.2 μm unless stated. TDTM, Chla, N_2 Fix, Genes, Fv/Fm, DOC are always unfiltered (uf). CDOM not always

Date	Time range (GMT)	FISH No.	TDTM	Chl a	N_2 Fix	Genes	Fv/Fm	DOC	DFe	DTM	NUTS	CDOM		Comments
10/7/23	15:02-15:09	0001	x	x			x	x	x	x	x			New Filter-Start transect N.Sea
10/7/23	17:04-17:30	0002	x	x	x	x	x	x	x	x	x			Chl-a repeated with underway pump.
10/7/23	19:00-19:10	0003	x	x				x	x	x	x			
10/7/23	21:05-21:15	0004	x	x				x	x	x	x			
10/7/23	23:02-23:12	0005	x	x				x	x	x	x			
11/7/23	00:57-01:06	0006	x	x				x	x	x	x			
11/7/23	03:00-03:08	0007	x	x			x	x	x	x	x			
11/7/23	05:02-05:28	0008	x	x	x	x	x	x	x	x	x			
11/7/23	07:00-07:08	0009	x	x			x	x	x	x	x			
11/7/23	09:01-09:13	0010	x	x			x	x	x	x	X			
11/7/23	10:59-11:07	0011	x	x			x	x	x	x	X			
11/7/23	12:15	0012			x	x			x		X			
11/7/23	12:59-13:08	0013	x	x			x	x	x	x	X			
11/7/23	14:59-15:08	0014	x	x			x	x	x	x	X			
11/7/23	17:00-17:17	0015	x	x	x	x	x	x	x	x	X			Seawater colour change. New filter cartridge used
11/7/23	19:00-19:07	0016	x	x				x	x	x	x			
11/7/23	21:00-21:09	0017	x	x				x	x	x	x			Forgot nuts – was done @21:12
11/7/23	22:56-23:04	0018	x	x				x	x	x	x			
12/7/23	01:00-01:07	0019	x	x				x	x	x	x			
12/7/23	03:00-03:08	0020	x	x			x	x	x	x	x			
12/7/23	05:00-05:15	0021	x	x	x	x	x	x	x	x	X			
12/7/23	07:00-07:09	0022	x	x			x	x	x	x	X			
12/7/23	09:00-09:05	0023						X						Just DOC – T0 incubation begins
12/7/23	10:55-11:04	0024			x	x			X					
12/7/23	12:57-13:05	0025	x	x			x	x	x	x	x			Nutrients now filtered using same filter pack as TM's. 2nd chlorophyll taken @ 13:20

Date	Time range (GMT)	FISH No.	TDTM	Chl a	N_2 Fix	Genes	Fv/Fm	DOC	DFe	DTM	NUTS	CDOM		Comments
12/7/23	14:59-15:08	0026	x	x			x	x	x	x	X			
12/7/23	16:58-17:15	0027	x	x	x	x	x	x	x	x	x			
12/7/23	18:59-19:06	0028	x	x				x	x	x	x			
12/7/23	21:02-21:15	0029	x	x				x	x	x	X			Labelled TM+Fe with 028 stickers so relabelled them with 029
12/7/23	22:55-23:04	0030	x	x				x	x	x	X			Dropped cartridge filter on floor (in bag) after Fish 030
13/7/23	00:54-01:04	0031	x	x				x	x	x	X			
13/7/23	02:58-03:07	0032	x	x			x	x	x	x	X			Forgot to let air out of cartridge until just before sampling
13/7/23	05:00-05:12	0033	x	x	x	x	x	x	x	x	X			
13/7/23	06:58	0034		x			x	x	x	x	X			New filter – DOC collected but not processed
13/7/23	08:59-09:05	0035	x	x			x	x	x	x	X			
13/7/23	10:58-11:03	0036		x			x	x	x	x	X			
13/7/23	12:58-13:05	0037	x	x			x	x	x	x	X			FSW for Fv/Fm collected as well
13/7/23	14:58-15:03	0038		x				x	x	x	x			
13/7/23	16:58-17:13	0039	x	x				x	x	x	X			
13/7/23	19:01-19:06	0040		x				x	x	x	x			
13/7/23	21:01-21:09	0041	x	x				x	x	x	X			
13/7/23	22:56-23:05	0042		x				x	x	x	x			
14/7/23	00:57-01:06	0043	x	x				x	x	x	X			
14/7/23	03:06-03:13	0044		x			x	x	x	x	x			
14/7/23	05:00-05:18	0045	x	x	x	x	x	x	x	x	X			
14/7/23	06:58-07:05	0046		x			x	x	x	x	x			
14/7/23	09:00	0047	x	x			x	x	x	x	x			
14/7/23	11:04-11:12	0048		x					x	x	x			
14/7/23	21:00 – 21:09	0049	x	x				x	x	x	X			
15/7/23	00:01-00:07	0050		x				x	x	x	X			

Date	Time range (GMT)	FISH No.	TDTM	Chl a	N_2 Fix	Genes	Fv/Fm	DOC	DFe	DTM	NUTS	CDOM		Comments
15/7/23	03:14-03:34	0051	x	x	x	x	x	x	x	x	x			
15/7/23	06:00-06:08	0052		x			x	x	x	x	x			
15/7/23	08:59-09:15	0053	x	x	x	x	x	x	x	x	X			
15/7/23	11:24-11:31	0054		x			x	x	x	x	X			Taken after subsampling from incubation experiments
15/7/23	20:49-21:00	0055	x	x				x	x	x	x			
16/7/23	00:05-00:11	0056		x				x	x	x	X			
16/7/23	02:56-03:12	0057	x	x	x	x	x	x	x	x	X			
16/7/23	06:00-06:05	0058		x			x	x	x	x	X			
16/7/23	09:00-09:05	0059	x	x			x	x	x	x	X			
16/7/23	11:32-11:39	0060		x			x	x	x	x	x			
16/7/23	20:58-21:06	0061	x	x				x	x	x	X			Flow rate thru filter slow
16/7/23	23:56-23:58	0062		x				x	x	x	X			
17/7/23	02:56-03:12	0063	x	x	x	x		x	x	x	X			
17/7/23	06:05-06:15	0064		x			x	x	x	x	X			
17/7/23	09:00-0910	0065	x	x			x	x	x	x	X			
17/7/23	12:00-12:05	0066		x	x	x	x	x	x	x	X			New Filter
17/7/23	15:00-15:08	0067	x	x			x	x	x	x	X			
17/7/23	17:57-18:03	0068		x				x	x	x	X			
17/7/23	21:05-21:14	0069	X	X				X	X	X	X			
17/7/23	23:55-00:01	0070		X				X	X	X	X			
18/7/23	02:51-03:08	0071	X	X	X	X	X	X	X	X	X			
18/7/23		0072		X			X	X	X	X	X			
18/7/23	08:58-09:05	0073	X	X			X	X	X	X	X			
18/7/23	10:42-10:47	0074		X			X	X	X	X	X			
18/7/23	20:58-21:08	0075	X	X				X	X	X	X			

Date	Time range (GMT)	FISH No.	TDTM	Chl a	N_2 Fix	Genes	Fv/Fm	DOC	DFe	DTM	NUTS	CDOM		Comments
19/7/23	00:01-00:07	0076		X				X	X	X	X			
19/7/23	02:58-03:13	0077	X	X	X	X	X	X	X	X	X			
19/7/23	06:00-06:09	0078		X			X	X	X	X	X			
19/7/23	09:00-09:12	0079	X	X			X	X	X	X	X			DOC not processed
19/7/23	11:23-11:30	0080		x			x	x	x	x	X			
19/7/23	18:58-19:05	0081	x	x			x	x	x	x	X			
19/7/23	20:45-20:51	0082		x			x	x	x	x	X			
19/7/23	22:40-22:57	0083	x	x	x	x	x	x	x	x	X			
20/7/23	01:00-01:05	0084		x			x	x	x	x	X			
20/7/23	03:00-03:06	0085	x	x			x	x	x	x	X			
20/7/23	05:00-05:18	0086		x	x	x	x	x	x	x	X			
20/7/23	07:00-07:05	0087		x			x	x	x	x	X			
20/7/23	09:01-09:08	0088	x	x			x	x	x	x	X			
20/7/23	11:00-11:05	0089		x			x	x	x	x	X			
20/7/23	11:30-11:35	0090	x	x			x	x	x	x	X			Station N12
20/7/23	17:00-17:05	0091		x			x	x	x	x	X			New Filter
20/7/23	19:00-19:07	0092	x	x			x	x	x	x	x			
20/7/23	22:51-23:09	0093	x	x	x	x	x	x	x	x	X			
21/7/23	01:00-01:05	0094		x			x	X	x	x	X			
21/7/23	03:02-03:09	0095	x	x			x	x	x	x	X			
21/7/23	04:58-05:10	0096		x	x	x	x	x	x	x	x			
21/7/23	07:08-07:15	0097	x	x			x	x	x	x	X			
21/7/23	08:59-09:05	0098		x			x	x	x	x	X			
21/7/23	10:59-11:05	0099	x	x			x	x	x	x	X			
21/7/23	19:00-1906	0100		x			x	x	x	x	X			

Date	Time range (GMT)	FISH No.	TDTM	Chl a	N_2 Fix	Genes	Fv/Fm	DOC	DFe	DTM	NUTS	CDOM		Comments
21/7/23	20:25-21:05	0101	X	x			X	x	X	x	X			
21/7/23	23:01-23:17	0102		X	X	X	X	X	X	X	X			
22/7/23	01:01-01:06	0103		X			X	X	X	X	X			
22/7/23	03:00-03:05	0104		X			X	X	X	X	X			Doing TDTM every 4h now because of slow speed
22/7/23	05:00-05:05	0105	X	X	x	X	X	X	X	X	X			
22/7/23	07:12-07:15	0106		X			X	X	X	X	X			
22/7/23	09:08-09:10	0107		X			X	X	X	X	X			
22/7/23	10:58-11:05	0108		X			X	X	X	X	X			
22/7/23	19:00-19:05	0109	x	X			X	X	X	X	X			
22/7/23	21:00-21:05	0110		X			X	X	X	X	X			
22/7/23	22:59-23:15	0111		X	X	X	X	X	X	X	X			
23/7/23	01:03-01:10	0112		X			X	X	X	X	X			
23/7/23	03:04-03:12	0113	X	X			X	X	X	X	X			
23/7/23	04:58-05:20	0114		X	X	X	X	X	X	X	X			
23/7/23	05:30-05:35	0115				X								FARACAS signal – extra nifH
23/7/23	17:03-17:10	0116		X		X		X	X	X	X			
23/7/23	19:15-19:25	0117	X	X		X	X	X	X	X	X			Fish raised a couple of metres
23/7/23	20:53-21:00	0118		X		X	X	X	X	X	X			
23/7/23	22:59-23:14	0119		X	x	X	X	X	X	X	X			
24/7/23	01:00-01:07	0120		X		X	X	X	X	X	X			
24/7/23	03:01-03:10	0121	x	X		X	X	X	X	X	X			
24/7/23	05:00-05:13	0122		X	x	X	X	X	X	X	X			
24/7/23	07:00-07:07	0123		X		X	X	X	X	X	X			
24/7/23	09:15-09:21	0124		X		X	X	X	X	X	X			
24/7/23	11:35-11:30	0125	x	X		X	X	X	X	X	X			

Date	Time range (GMT)	FISH No.	TDTM	Chl a	N_2 Fix	Genes	Fv/Fm	DOC	DFe	DTM	NUTS	EHS		Comments
24/7/23	12:15-12:25	0126			X	x								FARACAS signal
24/7/23	12:59-13:12	0127		X	x	X	x	x	x	x	X			
		0128												Error in labelling – 128 skipped
24/7/23	14:58-15:03	0129		x			x	x	x	x	X			
24/7/23	16:58-17:03	0130	X	x			x	x	x	x	X			
24/7/23	18:58-19:03	0131		x			x	x	x	x	X			
24/7/23	21:03-21:09	0132		x			x	x	x	x	X			
24/7/23	23:00-23:17	0133		x	x	x	x	x	x	x	X			
25/7/23	01:00-01:06	0134	X	x			x	x	x	x	X			
25/7/23	03:08-03:14	0135		x			x	x	x	x	X			Stationary
25/7/23	05:00-05:10	0136		x	x	x	X							Still not moved
25/7/23	07:50-07:40	0137	x	x			x	x	x	x	X			Started ice survey
25/7/23		0138		x			x	x	x	x	X			
25/7/23	10:55-11:02	0139		x			x	x	x	x	X			
25/7/23	17:12-17:14	0140										X		CTD Ti CTD
26/7/23	03:00-03:05	0141		x		x	x	x	x	x	X	x		
26/7/23	04:00-04:05	0142		x		x	x	x			x			
26/7/23	05:00-05:05	0143		x	x	x	x	x			x			
26/7/23	06:00-06:05	0144		x		x	x	x			x			
26/7/23	07:00-07:05	0145		x		x	x	x			x			
26/7/23	08:00-08:06	0146		x		x	x	x			x			
26/7/23	09:01-09:08	0147		x		x	x	x			x			
26/7/23	09:58-10:05	0148		x		x	x	x			x			
26/7/23	10:58-11:05	0149		x		x	x	x	x	x	x			
26/7/23	12:00-12;04	0150		x		x	x	x			x			

Date	Time range (GMT)	FISH No.	TDTM	Chl a	N_2 Fix	Genes	Fv/Fm	DOC	DFe	DTM	NUTS	eHS	Sal	Comments
26/7/23	13:00-13:05	0151		x		x	x	x			x		207	
26/7/23	13:55-14:05	152		x		x	x	x			x		200	
26/7/23	15:00-15:05	153		x		x	x	x			x		210	
26/7/23	16:02-16:07	154		x		x	x	x	x	x	x	x	208	+eHs
26/7/23	16:57-17:02	155		x		x	x	x			x		209	
26/7/23	17:58-18:03	156		x		x	x	x			x		211	
26/7/23	19:01-19:06	157		x		x	x	x			x		212	
26/7/23	20:00-20:10	158		x		x	x	x	x	x	x	x	215	+eHS
26/7/23	21:00-21:06	159		x		x	x	x			x		223	Small hair on filter nozzle, rinsed with MQ
26/7/23	21:58-22:04	160		x		x	x	x			x		213	
26/7/23	23:00-23:16	161		x		x	x	x			x		222	
27/7/23	00:01-00:12	162		x		x	x	x	x	x	x	x	221	New filter +eHS
27/7/23	01:00-01:06	163		x		x	x	x			x		214	Used old filter
27/7/23	02:00-02:06	164		x		x	x	x			x		219	Used old filter
27/7/23	03:02-03:12	165		x		x	x	x	x	x	x	x	218	Back to new filter used on fish 162
27/7/23	04:00-04:08	166		x		x	x	x			x		217	Collected 4L for genes
27/7/23	05:00-05:20	167		x		x	x	x			x		216	4 L for genes
27/7/23	06:00-06:16	168		x		x	x	x	x	x	x	x	981	
27/7/23	07:00-07:10	169		x		x	x	x			x		220	
27/7/23	08:00	170		x		x	x	x			x		995	
27/7/23	08:55-09-10	171		x		x	x	x	x	x	x	x	980	+ Fe-Iso +eHS
27/7/23	09:58-10:03	172		x		X 4L	x	x			x		994	
27/7/23	10:8-11:03	173		x		X 4L	x	x			x		993	
27/7/23	12:01-12:15	174		x		X 4L	x	x			x		992	
27/7/23	12:57-13:05	175		x		X 4L	x	x	x	x	x	x	991	
27/7/23	13:58-14:04	176		x		X 4L	x	x			x		990	

Date	Time range (GMT)	FISH No.	TDTM	Chl a	N_2 Fix	Genes	Fv/Fm	DOC	DFe	DTM	NUTS	eHS	Sal	Comments
27/7/23	15:00-15:05	177		X		x	X	X			X		989	
27/7/23	16:00-16:05	178		X		X	X	X	x	x	X	x	988	
27/7/23	17:04-17:12	179		X		X	X	X			X		996	
27/7/23	17:51-18:06	180		X	x	X	X	x			X		999	FARACAS signal
27/7/23	18:58-19:01	181				X								nifH only
27/7/23	19:58-20:01	182				X								
27/7/23	20:58-21:01	183				X								
27/7/23	22:00-22:05	184				X								
27/7/23	23:01-23:04	185				X								
28/7/23	00:12-00:21	186	x	X			X	x	X	x	X	x		
28/7/23	02:07-02:15	187		X			X	X	X	X	X	X		
28/7/23	04:08-04:15	188		X			X	X	X	X	X	X		
28/7/23	05:04-05:25	189		X	x	x	X	X	X	X	X	X		DTM in 2x 60 ml bottles
28/7/23	08:00	190	x	X			X	X	X	X	X	X		
28/7/23	09:58-10:03	191		X			X	X	x	X	X	X		
28/7/23	17:01-17:03	192					X		x					
28/7/23	18:58-19:02	193					X		X					
28/7/23	20:01-21:03	194					X		X					
28/7/23	22:58-23:01	195					X		X					
29/7/23	01:02-01:05	196					X		X					
29/7/23	02:58-03:01	197					X		X					
29/7/23	04:56-05:03	198					X		X					
29/7/23	06:55-06:59	199					X		X					
29/7/23	11:55-12:05	200			x	X								
29/7/23	17:00-17:06	201		x		x	x	x	x	x	X			
29/7/23	18:58-19:08	202	x	x		x	x	x	x	x	x			

Date	Time range (GMT)	FISH No.	TDTM	Chl a	N_2 Fix	Genes	Fv/Fm	DOC	DFe	DTM	NUTS	eHS		Comments
29/7/23	21:01-21:11	203		x		x	x	x	x	x	X			
29/7/23	23:00-23:16	204		x	x	x	x	x	x	x	X			
30/7/23	01:01-01:09	205		x		x	x	x	x	x	X			
30/7/23	02:37-02:54	206	X	x	x	x	x	x	x	x	X			Signal on FARACAS
30/7/23	05:00	207		x	x	x	x	x	x	x	X			
30/7/23	07:01-07:08	208		x		x	x	x	x	x	X			
30/7/23	09:00-09:06	209		x		x	x	x	x	x	X			
30/7/23	11:00-11:06	210	X	x		x	x	x	x	x	X			
30/7/23	19:03-19:12	211	X	x		x	x	x	x	x	X			New filter
30/7/23	19:24-19:32	212			X									FARACAS signal!
30/7/23	21:00-21:06	213				x	x	x	x	x	X			
30/7/23	23:02-23:19	214		x	x	x	x	x	x	x	X			
30/7/23	01:04-01:11	215	X			x	x	x	x	X	X			Oops TDTM too soon!
31/7/23	02:38-02:57	216		x	x	x	x	x	x	x	X			FARACAS signal!
31/7/23	05:01-05:20	217		x	x	x	x	x	x	x	X			
31/7/23	07:05-07:10	218		x		x	x	x	x	x	X			
31/7/23	08:59-09:06	219	X	x		x	x	x	x	x	X			
31/7/23	10:58-11:06	220		X		x	x	x	x	x	X			
31/7/23	14:08	221				X								
31/7/23	16:05	222				X								
31/7/23	16:53-16:56	223						X						Surface for Station
31/7/23	18:59-19:08	224	x	X		x	x	x	x	x	x			
31/7/23	21:04-21:20	225		x	x	x	x	x	x	x	X			
31/7/23	23:04-23:21	226		x	x	x	x	x	x	x	X			
01/08/23	01:00-01:08	227		X		x	x	x	x	x	X			
01/08/23	03:01-03:08	228	x	X		x	x	x	x	x	X			

Date	Time range (GMT)	FISH No.	TDTM	Chl a	N_2 Fix	Genes	Fv/Fm	DOC	DFe	DTM	NUTS	eHS	$\delta^{18}O$	Comments
01/08/23	05:03	229		x	x	x	x	x	x	x	X			
01/08/23	07:03	230		x		x	x	x	x	x	X			
01/08/23	08:58-09:06	231		x		x	x	x	x	x	X			
01/08/23	11:01-11:09	232	x	x		x	x	x	x	x	X			
01/08/23	16:58-17:04	233		X		x	x	x	x	x	X			
01/08/23	19:00-19:08	234		x		x	x	x	x	x	x		x	$\delta^{18}O$ added for northern transect. Taken from underway. New filter
01/08/23	21:04-21:12	235		x		x	x	x	x	x	x		x	
01/08/23	22:59-23:17	236	x	x	x	x	x	x	x	x	x		X	
02/08/23	01:00-01:07	237		x		x	x	x	x	x	x		X	
02/08/23	03:00-03:08	238		x		x	x	x	x	x	x		X	
02/08/23	05:00-05:20	239		x	x	x	x	x	x	x	x		X	
02/08/23	07:00	240	x	x		x	x	x	x	x	X		X	
02/08/23	08:57-09:03	241		x		x	x	x	x	x	X		X	
02/08/23	10:59-11:06	242		x		x	x	x	x	x	X		X	
02/08/23	19:00-19:06	243	x	x		x	x	x	x	x	x		X	
02/08/23	22:01-22:19	244		x	x	x	x	x	x	x	x		X	
03/08/23	01:58-02:05	245		x		x	x	x	x	x	X			
03/08/23	04:05-04:16	246		x		x	x	x	x	x	X			
03/08/23	07:00	247	x	x	x	x	x	x	x	x	X			
03/08/23	09:58-10:04	248		x		x	x	x	x	x	X			
03/08/23	14:27-14:35	249	x			x	x	x	x	x	X	x		
03/08/23	16:00	250				X								
03/08/23	18:01-18:19	251			x	x	x	x	x	x	x	x		
03/08/23	19:58-20:02	252				X 4L								
03/08/23	22:07-22:16	253	x			x	x	x	x	x	x	x	X	
04/08/23	00:01-00:14	254			x	x							x	

Date	Time range (GMT)	FISH No.	TDTM	Chl a	N_2 Fix	Genes	Fv/Fm	DOC	DFe	DTM	NUTS	eHS	$\delta^{18}O$	Comments
04/08/23	01:00-01:02	255										X		
04/08/23	02:02-02:10	256				x	x	x	x	x	x	x	x	Cap off $\delta^{18}O$ bottle
04/08/23	04:00-04:06	257				X								
04/08/23	06:00	258	x		x	x	x	x	x	x	x	x	X	
04/08/23	08:00	259				x							X	
04/08/23	09:58-10:04	260				x	x	x	x	x	x	x	X	
04/08/23	12:00-12:18	261			x	x	x	x	x	x	x	x	x	$\delta^{18}O$ taken @12:37
04/08/23	14:00-14:06	262	x			x	x	x	x	x	x		X	
04/08/23	15:58-16:03	263				x	x	x			X		x	
04/08/23	17:28-17:31	264												Leaching sample exp.
04/08/23	18:55-19:12	265			x	x	x	x	x	x	x		X	
04/08/23	21:03-21:10	266	x				x	x	x	x	X			Accidently took TDTM early – sorry!
04/08/23	23:00-23:19	267			x	x	x	x	x	x	X			Filter particle ric
05/08/23	01:02-01:07	268					x	x	x	x	X			
05/08/23	03:02-03:08	269				x	x	x	x	x	X			FARACAS at 4 ppb
05/08/23	05:00-05:18	270	x		x	x	x	x	x	x	X			
05/08/23	07:00-07:05	271					x	x	x	x	X			No more $\delta^{18}O$
05/08/23	09:00-09:05	272					x	x	x	x	X			New filter
05/08/23	11:00-11:04	273	x	x			x	x	x	x	X			
05/08/23	12:30-12:40	274			x	X								
05/08/23	12:58-13:05	275		x			x	x	x	x	X			
05/08/23	15:00-15:05	276		x			x	x	x	x	X			
05/08/23	16:58-17:15	277		x	x	x	x	x	x	x	X			FARACAS signal!
05/08/23	18:52-19:04	278	x	x			x	x	x	x	X			
05/08/23	20:58-21:04	279		x			x	x	x	x	X			Fin @ 21:04
05/08/23	22:14-22:30	280		x	x	x	x	x	x	x	x			FARACAS signal! Did 23:00 fish early

Date	Time range (GMT)	FISH No.	TDTM	Chl a	N_2 Fix	Genes	Fv/Fm	DOC	DFe	DTM	NUTS	eHS		Comments
06/08/23	00:59-01:05	281		x			x	x	x	x	X			
06/08/23	02:58-03:05	282	x	x			x	x	x	x	X			
06/08/23	05:02-05:20	283		x	x	x	x	x	x	x	X			
06/08/23	07:00-07:10	284		x			x	x	x	x	X			
06/08/23	08:58-09:03	285		x			x	x	x	x	X			
06/08/23	10:58-11:04	286	x	x			x	x	x	x	x			
07/08/23	02:30-02:39	287				x								Sustained FARACAS
07/08/23	19:17-19:25	288	x	x			x	x	x	x	X			Leaving Stn N03
07/08/23	22:58-23:15	289		x	x	x	x	x	x	x	X			
08/08/23	00:59-01:04	290		x			x	x	x	x	X			
08/08/23	04:00-04:10	291		x			x	x	x	x	X			
08/08/23	07:08-07:17	292	x	x	x	x	x	x	x	x	X			
08/08/23	09:01-09:06	293		x			x	x	x	x	X			
08/08/23	17:00-17:07	294	x	x			x	x	x	x	X			
08/08/23	19:57-20:02	295		x			x	x	x	x	X			
08/08/23	22:58-23:16	296		x	x	x	x	x	x	x	X			
09/08/23	01:58-02:04	297		x			x	x	x	x	X			
09/08/23	05:03	298	x	x	x	x	x	x	x	x	X			
09/08/23	0:00	299		x			x	x	x	x	x			
09/08/23	11:00	300		x			x	x	x	x	x			Arriving on Stn N18
09/08/23	15:03-15:12	301	x	x			x	x	x	x	x			Leaving Stn N18
09/08/23	16:59-17:04	302		x			x	x	x	x	x			
09/08/23	19:01-19;06	303		x			x	x	x	x	x			
09/08/23	20:58-21:15	304		x	x	x	x	x	x	x	x			
09/08/23	22:56-23:03	305		x			x	x	x	x	x			
10/08/23	00:01-00:12	306		x	x	x		x	x	x	x			High FARACAS

Date	Time range (GMT)	FISH No.	TDTM	Chl a	N_2 Fix	Genes	Fv/Fm	DOC	DFe	DTM	NUTS	eHS		Comments
10/08/23	01:00-01:05	307		x			x	x	x	x	x			
10/08/23	02:58-03:06	308		x		x	x	x	x	x	x			Sustained FARACAS-milky waters
10/08/23	04:40	309				x								
10/08/23	06:00	310				x								
10/08/23	07:12	311				x								
10/08/23	08:00	312				x								
10/08/23	09:00	313				x								
10/08/23	10:00	314				x								
10/08/23	11:00	315				x								
10/08/23	12;00	316				x								
10/08/23	12:58	317				x								
10/08/23	14:08	318				x								
10/08/23	15:02	319				x								
10/08/23	16:00	320				x								
10/08/23	16:58	321				x								
	END of Sampling													

9.5 Appendix E - Small Boat Missions

Ben Barton[1] (National Oceanography Centre)
[1] *Author*

Small Boast Mission Ice1 Event 63

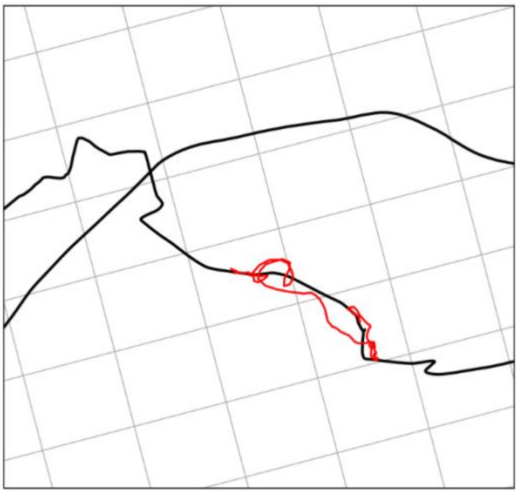

Figure 9.1 Map of small boat Ice1 GPS log (red) and Discovery track (black).

Small Boast Mission Ice2 Event 86
While next to the Negribreen glacier, the small boat was launched to collect iceberg ice and water samples. This allowed small scale manoeuvres around the large icebergs drifting away from the ice shelf of the glacier. Figure 9.2 shows the small boat route relative to the Discovery.

The water sample was collected near the main sampled iceberg (Figure 9.3). The water sample was taken from water that the small boat had not previously passed through and bottles were filled while the boat slowly moved forwards to fill with uncontaminated water.

The ice samples were collected to be representative of different characteristics and depths within the glacier. Ice2(A) was collected from the end of the main iceberg which had a high density of sedimentation lines. Some chunks were taken from the water where a chunk of ice had fallen off the main iceberg. Ice2(B) was a collected as a single large floating chunk of ice that was heavily discoloured by dark sediment (Figure 9.4). The ice itself of Ice2(B) was the most transparent of the three ice samples suggesting it had more air compacted out of it. Ice2(B) may not have originated form the main iceberg but its close proximity suggests it is from the same glacier and would have broken off at a similar time. Ice2(C) was collected from the end of the main iceberg with very few sedimentation lines and a large patch of snow suggesting it sat near the top of the glacier. The ice collected for Ice2(C) was sitting on the main iceberg. The ice had the least sedimentation and was the most opaque (more air and less compacted) out of the three samples suggesting it was from near the top surface of the glacier.

The water sample was called Ice2 (Water Sample1) were analysed for d^{18}O, salinity, nutrients (total nitrogen, silicate, phosphate and nitrate), chlorophyll-a, DOC, nitrogen fixation rates, nif-H gene, humics, eHS and DNA filtration. See the relevant sections for further description of the methods used.

The ice samples were labelled Ice2 (A), (B) and (C), see Figure 9.2. They were sampled for d^{18}O, nutrients (total nitrogen, silicate, phosphate and nitrate), eHS and DNA filtration. See the relevant sections for further description of the methods used.

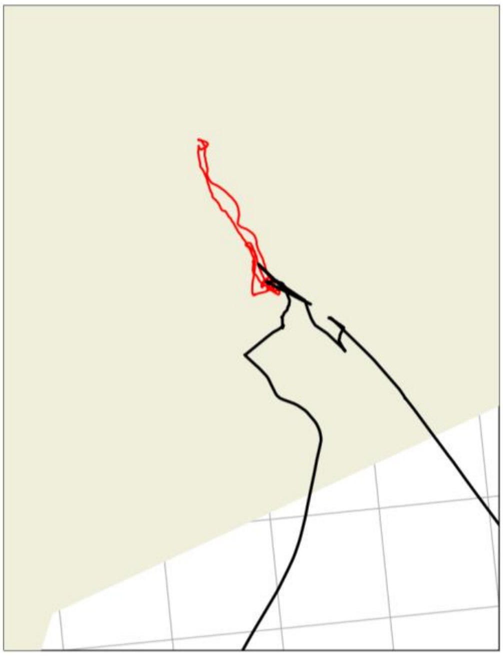

Figure 9.2 Map of small boat Ice2 GPS log (red) and Discovery track (black).

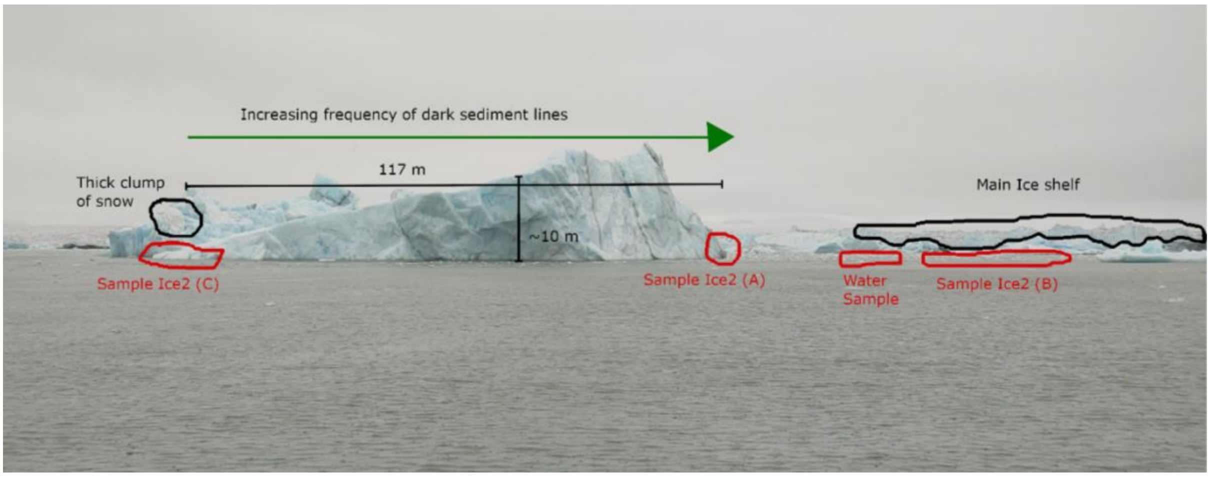

Figure 9.3 Schematic of the iceberg sampled for ice chunks and the spatial separation of the water sample. The length (117 m) was estimated from the latitude and longitude of the samples collected. The vertical height is an estimation.

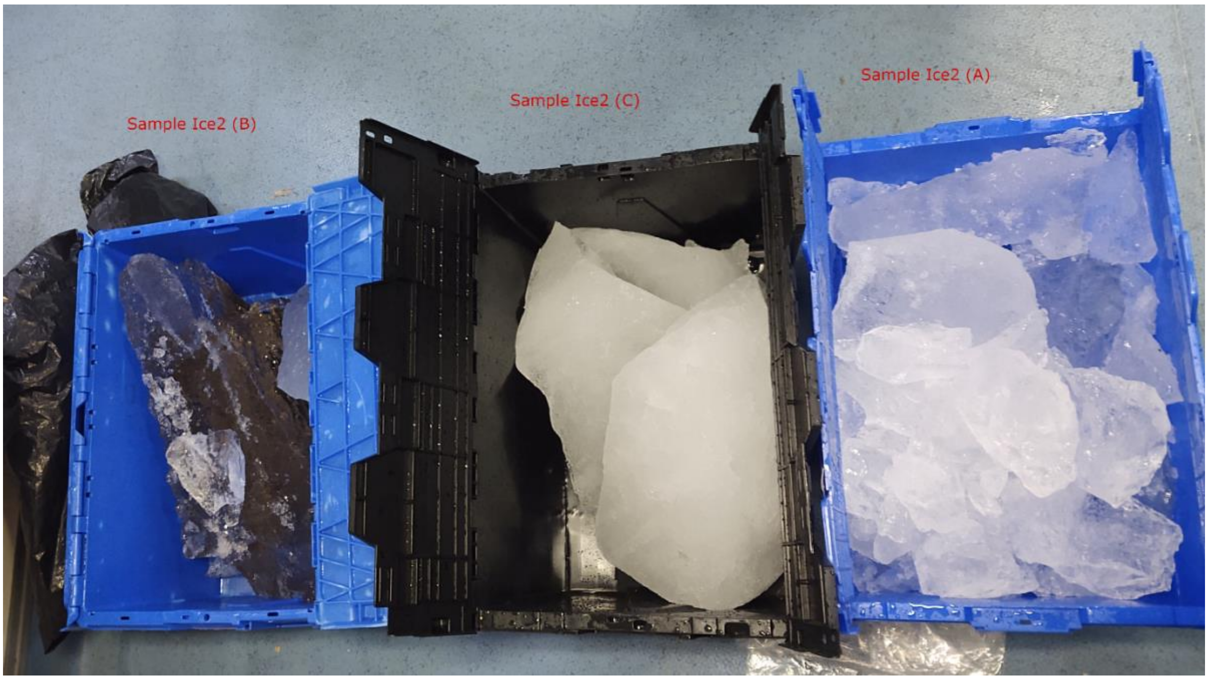

Figure 9.4 Iceberg samples collected on the small boat. The 3 samples show 3 discrete ice sources Ice2(B), Ice2(C) and Ice2(A) from left to right.

9.6 Appendix F - NMF sensors and moorings technical report

Paul Henderson, Sensors and Moorings, National Marine

CTD Cast Summary

Total number of casts: 208
Stainless steel frame with water samplers: 36
Titanium frame casts with water samplers: 22
Stainless steel frame Yo-Yo CTD casts: 150

Deepest casts:
Stainless steel frame – 2565m (Cast 003S)
Titanium frame – 2564m (Cast 004T)

Stainless-Steel CTD

CTD Wire
CTD Wire 2 was used for all casts. The wire was mechanically and electrically terminated on DY166 and load tested to two tonnes. Resistance and insulation of the cable were checked periodically. The torque setting on the fasteners of the mechanical termination was checked throughout and no slippage was noted. The termination was left on at the end of the DY167 to be used on DY169.

CTD Wire 2 before cast 001S readings:
Resistance 74.8 Ohms Insulation >1000 MOhms @500 VDC

CTD Wire 2 readings after cast 207S:
Resistance 74.3 Ohms Insulation >1000 MOhms @500 VDC

CTD sensor set-up
CTD frame was set-up post DY166 with primary conductivity, temperature and dissolved oxygen sensors on the 9plus and secondary conductivity and temperature sensors on the vane. Other sensors on the frame were altimeter, fluorometer, transmissometer, backscatter and 2 x PAR. Full sensor information can be found on the Sensor Information Sheet – Appendix 1. During casts 001S-007S the data from the primary sensors (conductivity, temperature and dissolved oxygen) would become spikey after ~400m. This was due to either a faulty pump or pump cable with no further problems after the pump and cable had been swapped. A secondary dissolved oxygen sensor was added to the vane from cast 005S onwards. The values from secondary oxygen sensor would drop in the top 0 – 30m on both the downcast and the upcast. The cause of this problem was not determined on the cruise.

Water Samplers
OTE 20L Water Samplers were use on the SS frame and performed well throughout the cruise with a small number of bottles not releasing from the carousel (details of water samplers that did not fire can be found in the CTD log – Appendix 2). The carousel was removed from the frame part way through the cruise to through wash and exercise the release mechanisms. A number of the water samplers' taps had their O-rings replaced over the cruise.

Trace Metal Free (Titanium) CTD

CTD Cable and Winch

The 21mm Lebus MFCTD Contingency Winch was set up and maintained by OEG. The cable was terminated and load tested to two tonnes on DY166. A Yalegrip was used as a backup to the mechanical termination.
21mm Lebus MFCTD Cable before cast 002T readings:
Resistance 143.2 Ohms   Insulation ~420 MOhms @500 VDC
21mm Lebus MFCTD Cable after cast 208T:
Resistance 140.0 Ohms   Insulation ~550 MOhms @ 500VDC
Data from the Lebus MFCTD Contingency Winch was displayed using the BlackBox KVM system allowing the CTD operator to see wire out, speed and tension in the main lab.

CTD sensor set-up

CTD frame was set-up post DY166 with primary conductivity, temperature and dissolved oxygen sensors on the 9plus and secondary conductivity and temperature sensors on the vane. Other sensors on the frame were altimeter, fluorometer, transmissometer, backscatter, pH and 2 x PAR (for casts <500m). Full sensor information can be found on the Sensor Information Sheet – Appendix 1. There were no problems with any of the sensors during the cruise. An AMT pH-combined sensor S/N 349 was trialled throughout the cruise with the sensor providing sensible pH values. This sensor was not calibrated on DY167.

Water Samplers

10L Trace Metal Free Water Samplers 01 – 24 were used on the titanium frame. Water Samplers 2,7 and 11 were swapped out with bottles 25, 26 and 27 over the course of the cruise due to breakages or leakages. Water Samplers were stored, sampled and cleaned in the clean laboratory. For deployment water samplers were affixed to the CTD by the CTD technician and then cocked by the science party.

SeaBird Data Processing

All CTD data processing was carried out by the science party.

CTD2MET processing was carried out for each cast stainless-steel CTD and sent to the Met Office.

Configuration reports for the SeaSave setup can be found in Appendix 3

LADCP

Two self-logging LADCPs were installed on the stainless-steel CTD frame. The down-looking unit (S/N: 13329) was 300kHzTeledyne RDI Workhorse sited at the centre of the frame with its transducers just above the bottom tube of the CTD frame. The up-looking unit (S/N: 1855) was located within an outrigger frame with its transducers just below the top tube of the CTD frame. The down-looking 300 kHz instrument was configured to output information via its serial port. The serial port was connected to the 9plus 9600 baud uplink cable prior to deployment and displayed during the CTD casts using TRDI Toolz. The script files for the LADCPs can be found in appendix 4. It was noted that the up-looker (S/N: 1855) often had poor correlation on Beam 1.
The instruments were powered with NMF Workhorse Battery Pack serial number WH010T.

Autosal

A Guildline Autosal 8400B salinometer, S/N: 71185, was used for salinity measurements. The salinometer was sited in the Salinometer lab. Bath temperature was set at 21°C, the ambient temperature being approximately 18.5-19.0°C. The salinometer was standardised before the first set of samples, and checked with an additional standard analysed prior to setting the RS. Once standardised the Autosal was not adjusted for the duration of sampling. A standard was analysed after each crate of samples to monitor & record drift. Standards were recorded in the spreadsheet as '0' and had a standard salinity value of 34.994, K15=0.99986 from batch P165. Standard deviation was set to 0.0005. A program written in Labview called "Autosal" was used to record data for salinity values. All salinity analysis was carried out by the science party.

Appendix 1 – Sensor Information Sheets

<u>SENSOR INFORMATION SHEET – Stainless-Steel CTD with LADCPs</u>

SHIP: RRS DISCOVERY	CRUISE: DY167

FORWARDING INSTRUCTIONS / ADDITIONAL INFORMATION:

Stainles- Steel 24-way CTD frame setup for DY167

20l OTE Water Samplers used on SS CTD frame:
1-9 (s/n’s: 49, 50, 27, 57, 29, 58, 31, 32 & 33)
10-18 (s/n’s: 51, 52, 36, 37, 38, 39, 40, 41 & 53)
19-24 (s/n’s: 56, 44, 54, 46, 55 & 28)

Swivel 1267-2 swapped to 1246-1 to test following service/repair of 1246-1.

Checked By: Paul Henderson	DATE: 14 August 2023

Instrument / Sensor	Manufacturer/ Model	Serial Number	Channel	Casts Used
Stainless steel 24-way frame	NOCS	SBE CTD 6	n/a	All stainless casts
EM Swivel	MDS ST6003-2E2-Ti	1267-2 (No. 6)	n/a	Stainless casts 001S – 116S
EM Swivel	MDS ST6003-2E2-Ti	1246-1	n/a	Stainless casts 118S – 207S
Primary CTD deck unit	SBE 11plus	11p-24680-0588	n/a	All casts
CTD Underwater Unit	SBE 9plus	09p-34173-0758	n/a	All stainless casts
24-way Carousel	SBE 32	32-1376	n/a	All stainless casts
Primary Temperature Sensor	SBE 3P	3p-5838	F0	All stainless casts
Primary Conductivity Sensor	SBE 4C	4c-3258	F1	All stainless casts
Digiquartz Pressure sensor	Paroscientific	90074	F2	All stainless casts
Secondary Temperature Sensor	SBE 3P	3p-4116	F3	All stainless casts
Secondary Conductivity Sensor	SBE 4C	4c-2580	F4	All stainless casts
Primary Pump	SBE 5T	5T-7515	n/a	Stainless casts 001S – 007S
Primary Pump	SBE 5T	5T-3088	n/a	Stainless casts from 009S – 207S
Secondary Pump	SBE 5T	5T-3090	n/a	All stainless casts
Primary Dissolved Oxygen Sensor	SBE 43	43-1940	V0	All stainless casts

Secondary Dissolved Oxygen Sensor	SBE 43	43-2055	V1	Stainless casts from 005S – 207S
Altimeter	Valeport VA500	81629	V2	All stainless casts
Light Scattering Sensor	WETLabs BBRTD	1055	V3	All stainless casts
Cosine PAR Up-looking DWIRR	Biospherical QCP2350-HP	70510	V4	All stainless casts
Cosine PAR Down-looking UWIRR	Biospherical QCP2350-HP	70520	V5	All stainless casts
Fluorometer	CTG Aquatracka MKIII	88-2960-163	V6	All stainless casts
Transmissometer	WET Labs C-star	CST-1719TR	V7	All stainless casts
20L Water Samplers	OTE	SMOTE20L01-SMOTE20L24	n/a	All stainless casts
Downward-looking LADCP	TRDI/WHM300kHz	13329	n/a	All stainless casts
Upward-looking LADCP	TRDI/WHM300kHz	1855	n/a	All stainless casts
LADCP Battery Pack	NOCS	WH010T	n/a	All stainless casts

SENSOR INFORMATION SHEET – Metal Free (Titanium) CTD

SHIP: RRS DISCOVERY	CRUISE: DY167

FORWARDING INSTRUCTIONS / ADDITIONAL INFORMATION:

Titanium 24-way CTD frame setup for DY167

Checked By: Paul Henderson	DATE: 14 August 2023

Instrument / Sensor	Manufacturer/ Model	Serial Number	Channel	Casts Used
Titanium 24-way frame	NOCS	SBE CTD TITA1	n/a	All titanium casts
Primary CTD deck unit	SBE 11plus	11p-24680-0588	n/a	All casts
CTD Underwater Unit	SBE 9plus	09p-24680-0637	n/a	All titanium casts
24-way Carousel	SBE 32	32-24680-0346	n/a	All titanium casts
Primary Temperature Sensor	SBE 3P	3p-4712	F0	All titanium casts
Primary Conductivity Sensor	SBE 4C	4c-4065	F1	All titanium casts
Digiquartz Pressure sensor	Paroscientific	79501	F2	All titanium casts
Secondary Temperature Sensor	SBE 3P	3p-4593	F3	All titanium casts
Secondary Conductivity Sensor	SBE 4C	4c-4138	F4	All titanium casts
Primary Pump	SBE 5T	5T-7371	n/a	All titanium casts
Secondary Pump	SBE 5T	5T-3086	n/a	All titanium casts
Primary Dissolved Oxygen Sensor	SBE 43	43-3836	V0	All titanium casts
pH Sensor	AMT deep pH	349	V1	All titanium casts
Altimeter	Valeport VA500	81630	V2	All titanium casts
Light Scattering Sensor	WETLabs BBRTD	758R	V3	All titanium casts
PAR Up-looking DWIRR	CTG PAR	04	V4	All titanium casts <500m
PAR Down-looking UWIRR	CTG PAR	09	V5	All titanium casts <500m
Fluorometer	CTG Aquatracka MKIII	088244	V6	All titanium casts
Transmissometer	WET Labs C-star	CST-1720TR	V7	All titanium casts
TMF 10L Water Samplers	OTE	1-24	n/a	All titanium casts

Appendix 2 – CTD Log

Cast Number	Station	Event	Julian Day	Date	Latitude	Longitude	Water Depth [uncorrected] (m)	CTD Cast Depth (m)	Number of Bottles	Comments
001S	N00	002	195	14/07/2023	68°48.395N	10°26.193E	3024	501	24	Shakedown CTD Cast - Issues with primary temp, cond and DO sensors
002T	N00	006	195	14/07/2023	68°48.400N	10°26.195E	3023	1000	23	Shakedown CTD Cast - Bottle 11 removed from frame
003S	N01	007	196	15/07/2023	70°59.993N	10°59.994E	2619	2565	24	Issues with primary temp, cond and DO sensors
004T	N01	009	196	15/07/2023	70°59.994N	10°59.993E	2618	2564	25	Bottles 2 and 11 swapped with 25 and 26
005S	N02	010	197	16/07/2023	72°0.033N	15°0.173E	1128	1098	24	Issues with primary temp, cond and DO sensors - 2nd DO sensor added to frame
006T	N02	011	197	16/07/2023	72°59.998N	14°59.971E	1128	1097	24	
007S	N04	012	199	18/07/2023	73°43.480N	23°22.080E	459	439	24	Issues with primary temp, cond and DO sensors
008T	N04	018	199	18/07/2023	73°43.475N	23°22.079E	459	436	24	PAR sensors added - Bottle 7 swapped with 27
009S	N05	019	200	19/07/2023	74°36.348N	27°53.984E	383	363	24	Pump changed on primary sensors - Primary DO not pugged in - Bottle 6 did not fire
010T	N05	024	200	19/07/2023	74°36.348N	27°53.985E	383	265	24	
011S	RAS1	025	200	19/07/2023	74°45.060N	25°2.030E	347	327	24	
012S	RAS2	026	200	19/07/2023	74°50.550N	26°27.130E	302	288	24	Bottle 6 did not fire
013S	N12	027	201	20/07/2023	75°30.040N	22.29.873E	55	47	24	
014T	N12	030	201	20/07/2023	75°30.052N	22°29.996E	55	46	10	
015S	N07	033	202	21/07/2023	77°59.998N	29°59.948E	297	277	24	
016T	N07	039	202	21/07/2023	77°59.996N	29°59.962E	300	277	16	Bottles 13-20 fired at wrong depths
017T	N07	040	202	21/07/2023	77°59.997N	29°69.967E	297	91	8	
018S	N10	041	203	22/07/2023	78°39.514N	24°39.000E	141	125	24	Bottles 6 and 7 did not fire
019T	N10	043	203	22/07/2023	78°39.513N	24°39.010E	141	125	12	
020S	N09	044	204	23/07/2023	79°22.846N	27°47.860E	350	321	24	
021S	N09	045	204	23/07/2023	79°23.000N	27°46.044E	347	321	24	Bottle 6 did not fire
022T	N09	047	204	23/07/2023	79°23.152N	27°24.359E	336	312	18	
023S	RAS3	048	204	23/07/2023	79°16.823N	28°29.384E	234	216	24	
024S	N08	049	206	25/07/2023	79°20.658N	33°55.517E	262	242	24	Bottles 6, 12 and 15 did not fire

Cast Number	Station	Event	Julian Day	Date	Latitude	Longitude	Water Depth [uncorrected] (m)	CTD Cast Depth (m)	Number of Bottles	Comments
025T	N08	051	206	25/07/2023	79°21.040N	33°53.440E	268	246	16	
026S	N08	052	206	25/07/2023	79°21.092N	33°53.180E	270	243	0	Yo-Yo 01
027S	N08	052	206	25/07/2023	79°21.092N	33°53.180E	270	150	0	Yo-Yo 01
028S	N08	052	206	25/07/2023	79°21.092N	33°53.180E	270	150	0	Yo-Yo 01
029S	N08	052	206	25/07/2023	79°21.092N	33°53.180E	270	150	0	Yo-Yo 01
030S	N08	052	206	25/07/2023	79°21.092N	33°53.180E	270	180	0	Yo-Yo 01
031S	N08	052	206	25/07/2023	79°21.092N	33°53.180E	270	180	0	Yo-Yo 01
032S	N08	052	206	25/07/2023	79°21.092N	33°53.180E	270	180	0	Yo-Yo 01
033S	N08	052	206	25/07/2023	79°21.092N	33°53.180E	270	180	0	Yo-Yo 01
034S	N08	052	206	25/07/2023	79°21.092N	33°53.180E	270	180	0	Yo-Yo 01
035S	N08	052	206	25/07/2023	79°21.092N	33°53.180E	270	180	0	Yo-Yo 01
036S	N08	052	206	25/07/2023	79°21.092N	33°53.180E	270	80	0	Yo-Yo 01
037S	N08	052	206	25/07/2023	79°21.092N	33°53.180E	270	80	0	Yo-Yo 01
038S	N08	052	206	25/07/2023	79°21.092N	33°53.180E	270	120	0	Yo-Yo 01
039S	N08	053	207	26/07/2023	79°21.482N	33°48.556E	265	243	24	Bottles 6 and 7 did not fire
040s	N08	054	207	26/07/2023	79°21.238N	33°43.383E	268	120	0	Yo-Yo 02
041S	N08	054	207	26/07/2023	79°21.238N	33°43.383E	268	120	0	Yo-Yo 02
042S	N08	054	207	26/07/2023	79°21.238N	33°43.383E	268	120	0	Yo-Yo 02
043S	N08	054	207	26/07/2023	79°21.238N	33°43.383E	268	120	0	Yo-Yo 02
044S	N08	054	207	26/07/2023	79°21.238N	33°43.383E	268	120	0	Yo-Yo 02
045S	N08	054	207	26/07/2023	79°21.238N	33°43.383E	268	120	0	Yo-Yo 02
046S	N08	054	207	26/07/2023	79°21.238N	33°43.383E	268	120	0	Yo-Yo 02
047S	N08	054	207	26/07/2023	79°21.238N	33°43.383E	268	120	0	Yo-Yo 02
048S	N08	054	207	26/07/2023	79°21.238N	33°43.383E	268	120	0	Yo-Yo 02
049S	N08	054	207	26/07/2023	79°21.238N	33°43.383E	268	120	0	Yo-Yo 02
050S	N08	054	207	26/07/2023	79°21.238N	33°43.383E	268	120	0	Yo-Yo 02
051S	N08	054	207	26/07/2023	79°21.238N	33°43.383E	268	120	0	Yo-Yo 02

Cast Number	Station	Event	Julian Day	Date	Latitude	Longitude	Water Depth [uncorrected] (m)	CTD Cast Depth (m)	Number of Bottles	Comments
052S	N08	054	207	26/07/2023	79°21.238N	33°43.383E	268	120	0	Yo-Yo 02
053S	N08	054	207	26/07/2023	79°21.238N	33°43.383E	268	120	0	Yo-Yo 02
054S	N08	054	207	26/07/2023	79°21.238N	33°43.383E	268	120	0	Yo-Yo 02
055S	N08	055	207	26/07/2023	79°22.225N	33°43.013E	269	251	24	
056S	N08	056	207	26/07/2023	79°22.697N	33°41.522E	270	120	0	Yo-Yo 03
057S	N08	056	207	26/07/2023	79°22.697N	33°41.522E	270	120	0	Yo-Yo 03
058S	N08	056	207	26/07/2023	79°22.697N	33°41.522E	270	120	0	Yo-Yo 03
059S	N08	056	207	26/07/2023	79°22.697N	33°41.522E	270	120	0	Yo-Yo 03
060S	N08	056	207	26/07/2023	79°22.697N	33°41.522E	270	120	0	Yo-Yo 03
061S	N08	056	207	26/07/2023	79°22.697N	33°41.522E	270	120	0	Yo-Yo 03
062S	N08	056	207	26/07/2023	79°22.697N	33°41.522E	270	120	0	Yo-Yo 03
063S	N08	056	207	26/07/2023	79°22.697N	33°41.522E	270	120	0	Yo-Yo 03
064S	N08	056	207	26/07/2023	79°22.697N	33°41.522E	270	120	0	Yo-Yo 03
065S	N08	056	207	26/07/2023	79°22.697N	33°41.522E	270	120	0	Yo-Yo 03
066S	N08	056	207	26/07/2023	79°22.697N	33°41.522E	270	120	0	Yo-Yo 03
067S	N08	056	207	26/07/2023	79°22.697N	33°41.522E	270	120	0	Yo-Yo 03
068S	N08	057	207	26/07/2023	79°23.429N	33°43.524E	271	249	24	
069S	N08	058	207	26/07/2023	79°23.556N	33°43.535E	269	120	0	Yo-Yo 04
070S	N08	058	207	26/07/2023	79°23.556N	33°43.535E	269	120	0	Yo-Yo 04
071S	N08	058	207	26/07/2023	79°23.556N	33°43.535E	269	120	0	Yo-Yo 04
072S	N08	058	207	26/07/2023	79°23.556N	33°43.535E	269	120	0	Yo-Yo 04
073S	N08	058	207	26/07/2023	79°23.556N	33°43.535E	269	120	0	Yo-Yo 04
074S	N08	058	207	26/07/2023	79°23.556N	33°43.535E	269	120	0	Yo-Yo 04
075S	N08	058	207	26/07/2023	79°23.556N	33°43.535E	269	120	0	Yo-Yo 04
076S	N08	058	207	26/07/2023	79°23.556N	33°43.535E	269	120	0	Yo-Yo 04
077S	N08	058	207	26/07/2023	79°23.556N	33°43.535E	269	120	0	Yo-Yo 04
078S	N08	058	207	26/07/2023	79°23.556N	33°43.535E	269	120	0	Yo-Yo 04

Cast Number	Station	Event	Julian Day	Date	Latitude	Longitude	Water Depth [uncorrected] (m)	CTD Cast Depth (m)	Number of Bottles	Comments
079S	N08	058	207	26/07/2023	79°23.556N	33°43.535E	269	120	0	Yo-Yo 04
080S	N08	058	207	26/07/2023	79°23.556N	33°43.535E	269	120	0	Yo-Yo 04
081S	N08	058	207	26/07/2023	79°23.556N	33°43.535E	269	120	0	Yo-Yo 04
082S	N08	058	207	26/07/2023	79°23.556N	33°43.535E	269	120	0	Yo-Yo 04
083S	N08	058	207	26/07/2023	79°23.556N	33°43.535E	269	120	0	Yo-Yo 04
084S	N08	058	207	26/07/2023	79°23.556N	33°43.535E	269	120	0	Yo-Yo 04
085S	N08	058	207	26/07/2023	79°23.556N	33°43.535E	269	120	0	Yo-Yo 04
086S	N08	058	207	26/07/2023	79°23.556N	33°43.535E	269	120	0	Yo-Yo 04
087S	N08	059	207	26/07/2023	79°23.563N	33°43.525E	270	249	24	
088S	N08	060	207	26/07/2023	79°23.428N	33°44.320E	269	120	0	Yo-Yo 05
089S	N08	060	207	26/07/2023	79°23.428N	33°44.320E	269	120	0	Yo-Yo 05
090S	N08	060	207	26/07/2023	79°23.428N	33°44.320E	269	120	0	Yo-Yo 05
091S	N08	060	207	26/07/2023	79°23.428N	33°44.320E	269	120	0	Yo-Yo 05
092S	N08	060	207	26/07/2023	79°23.428N	33°44.320E	269	120	0	Yo-Yo 05
093S	N08	060	207	26/07/2023	79°23.428N	33°44.320E	269	140	0	Yo-Yo 05
094S	N08	060	207	26/07/2023	79°23.428N	33°44.320E	269	140	0	Yo-Yo 05
095S	N08	060	207	26/07/2023	79°23.428N	33°44.320E	269	140	0	Yo-Yo 05
096S	N08	060	207	26/07/2023	79°23.428N	33°44.320E	269	140	0	Yo-Yo 05
097S	N08	060	207	26/07/2023	79°23.428N	33°44.320E	269	140	0	Yo-Yo 05
098S	N08	060	207	26/07/2023	79°23.428N	33°44.320E	269	140	0	Yo-Yo 05
099S	N08	060	207	26/07/2023	79°23.428N	33°44.320E	269	140	0	Yo-Yo 05
100S	N08	060	207	26/07/2023	79°23.428N	33°44.320E	269	140	0	Yo-Yo 05
101S	N08	060	207	26/07/2023	79°23.428N	33°44.320E	269	140	0	Yo-Yo 05
102S	N08	060	207	26/07/2023	79°23.428N	33°44.320E	269	140	0	Yo-Yo 05
103S	N08	061	208	27/07/2023	79°22.150N	33°28.465E	271	279	24	Bottles 9-24 not sampled
104S	N08	064	208	27/07/2023	79°22.982N	33°28.366E	270	249	24	Bottles 5-24 not sampled
105S	N07x	065	209	28/07/2023	78°32.390N	30°2.998E	250	231	25	Bottle 12 did not fire - Bottle 15 tap replaced

Cast Number	Station	Event	Julian Day	Date	Latitude	Longitude	Water Depth [uncorrected] (m)	CTD Cast Depth (m)	Number of Bottles	Comments
106T	N07x	068	209	28/07/2023	78°32.395N	30°2.972E	250	231	16	
107T	N07y	069	210	29/07/2023	78°3.451N	26°40.579E	212	194	12	
108S	N06	070	211	30/07/2023	76°0.000N	29°59.969E	316	295	24	
109T	N06	072	211	30/07/2023	76°0.002N	29°59.971E	316	302	16	
110S	N05	073	212	31/07/2023	74°36.599N	27°53.950E	380	361	24	Bottles 6,7,12 and 15 did not fire - Large amount of biofouling
111T	N05	075	212	31/07/2023	74°36.600N	27°53.950E	380	360	12	
112S	N13	076	213	01/08/2023	76°20.000N	19°59.936E	255	235	24	
113T	N13	079	213	01/08/2023	76°20.000N	19°59.940E	250	236	12	
114S	N15	080	214	02/08/2023	77°13.320N	19°20.676E	180	159	24	
115T	N15	082	214	02/08/2023	77°13.320N	19°20.670E	174	164	10	
116S	N16	083	215	03/08/2023	78°30.926N	19°16.403E	131	119	24	Bottle 9 did not fire
117T	N16	085	215	03/08/2023	78°30.579N	19°16.929E	121	110	12	
118S	N16	087	216	04/08/2023	78°30.989N	19°13.745E	125	109	24	No bottles sampled
119S	N16	088	216	04/08/2023	78°30.896N	19°13.804E	121	108	24	No bottles sampled
120S	N16	089	216	04/08/2023	78°30.896N	19°13.804E	115	103	24	No bottles sampled
121S	N03	092	218	06/08/2023	72°51.607N	19°4.247E	417	399	24	
122T	N03	095	218	06/08/2023	72°51.608N	19°4.247E	418	398	16	
123S	N03	096	219	07/07/2023	72°51.624N	19°4.268E	417	400	24	
124S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
125S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
126S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
127S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
128S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
129S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
130S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
131S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
132S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06

Cast Number	Station	Event	Julian Day	Date	Latitude	Longitude	Water Depth [uncorrected] (m)	CTD Cast Depth (m)	Number of Bottles	Comments
133S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
134S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
135S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
136S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06 - 5 min stop at 120m
137S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
138S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	270	0	Yo-Yo 06
139S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
140S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
141S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
142S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
143S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
144S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
145S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
146S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	270	0	Yo-Yo 06
147S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
148S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
149S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
150S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
151S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
152S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
153S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
154S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
155S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	270	0	Yo-Yo 06
156S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
157S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
158S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
159S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06

Cast Number	Station	Event	Julian Day	Date	Latitude	Longitude	Water Depth [uncorrected] (m)	CTD Cast Depth (m)	Number of Bottles	Comments
160S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
161S	N03	097	219	07/08/2023	72°51.608N	19°4.232E	419	120	0	Yo-Yo 06
162S	N03	099	219	07/08/2023	72°51.607N	19°4.231E	419	400	24	
163S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	120	0	Yo-Yo 07
164S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	120	0	Yo-Yo 07
165S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	120	0	Yo-Yo 07
166S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	120	0	Yo-Yo 07
167S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	120	0	Yo-Yo 07
168S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	120	0	Yo-Yo 07
169S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	270	0	Yo-Yo 07
170S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	120	0	Yo-Yo 07
171S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	120	0	Yo-Yo 07
172S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	120	0	Yo-Yo 07
173S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	120	0	Yo-Yo 07
174S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	120	0	Yo-Yo 07
175S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	120	0	Yo-Yo 07
176S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	120	0	Yo-Yo 07
177S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	270	0	Yo-Yo 07
178S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	120	0	Yo-Yo 07
179S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	120	0	Yo-Yo 07
180S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	120	0	Yo-Yo 07
181S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	120	0	Yo-Yo 07
182S	N03	100	219	07/08/2023	72°51.608N	19°4.233E	419	120	0	Yo-Yo 07
183S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	120	0	Yo-Yo 07
184S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	120	0	Yo-Yo 07
185S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	270	0	Yo-Yo 07
186S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	120	0	Yo-Yo 07

Cast Number	Station	Event	Julian Day	Date	Latitude	Longitude	Water Depth [uncorrected] (m)	CTD Cast Depth (m)	Number of Bottles	Comments
187S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	120	0	Yo-Yo 07
188S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	120	0	Yo-Yo 07
189S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	120	0	Yo-Yo 07
190S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	120	0	Yo-Yo 07
191S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	120	0	Yo-Yo 07
192S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	120	0	Yo-Yo 07
193S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	120	0	Yo-Yo 07
194S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	270	0	Yo-Yo 07
195S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	120	0	Yo-Yo 07
196S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	120	0	Yo-Yo 07
197S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	120	0	Yo-Yo 07
198S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	120	0	Yo-Yo 07
199S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	120	0	Yo-Yo 07
200S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	120	0	Yo-Yo 07
201S	N03	100	219	07/08/2023	72°51.608N	19°4.231E	419	120	0	Yo-Yo 07
202S	N03	101	219	07/08/2023	72°51.610N	19°4.230E	419	400	24	
203S	N17	102	220	08/08/2023	72°29.999N	24°59.882E	246	230	24	
204T	N17	104	220	08/08/2023	72°29.991N	24°59.956E	247	321	16	
205S	N18	105	221	09/08/2023	73°30.000N	29°59.954E	400	381	24	20min stop at 100m due to winch issues
206T	N18	106	221	09/08/2023	73°30.004N	29°59.956E	400	381	12	
207S	N19	107	222	10/08/2023	74°0.008N	29°59.966E	235	221	24	
208T	N19	108	222	10/08/2023	73°30.008N	29°59.966E	235	219	12	

Appendix 3 – SeaSave Setup Files

Stainless-Steel CTD Setup

PSA file: C:\Users\sandm\Documents\Cruises\DY167\Data\Seasave Setup Files\DY167_SS_0758_nmea.psa

Date: 08/14/2023

Instrument configuration file: C:\Users\sandm\Documents\Cruises\DY167\Data\Seasave Setup Files\DY167_SS_0758_nmea.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-5838
   Calibrated on : 21-June-2022
   G            : 4.34201005e-003
   H            : 6.69357507e-004
   I            : 2.68285907e-005
   J            : 2.15005389e-006
   F0           : 1000.000
   Slope        : 1.00000000
   Offset       : 0.0000

2) Frequency 1, Conductivity

   Serial number : 04C-3258
   Calibrated on : 23-June-2022
   G            : -1.06618831e+001
   H            : 1.36169803e+000
   I            : -1.76754051e-004
   J            : 8.92351086e-005
   CTcor        : 3.2500e-006
   CPcor        : -9.57000000e-008
   Slope        : 1.00000000
   Offset       : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

   Serial number : 90074
   Calibrated on : 23-September-2022
   C1           : -6.571123e+004
   C2           : 2.050504e-001
   C3           : 1.612220e-002
   D1           : 2.883800e-002
   D2           : 0.000000e+000
   T1           : 2.986693e+001
   T2           : -2.678465e-004
   T3           : 3.986390e-006
   T4           : 7.472100e-010
   T5           : 0.000000e+000
   Slope        : 1.00012000
   Offset       : 0.01710
   AD590M       : 1.283700e-002
   AD590B       : -8.642460e+000

4) Frequency 3, Temperature, 2

   Serial number : 03P-4116
```

Calibrated on : 15-February-2022
G : 4.41813352e-003
H : 6.83200218e-004
I : 2.41440471e-005
J : 2.01915192e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 04C-2580
Calibrated on : 25-January-2022
G : -1.04651671e+001
H : 1.53673829e+000
I : 1.17991776e-003
J : 2.33292989e-006
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 : 03-July-2021
Equation : Sea-Bird
Soc : 5.34300e-001
Offset : -4.97900e-001
A : -3.50440e-003
B : 1.75520e-004
C : -2.46610e-006
E : 3.60000e-002
Tau20 : 1.45000e+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 : 43-2055
Calibrated on : 14 April 2023
Equation : Sea-Bird
Soc : 3.60800e-001
Offset : -6.88700e-001
A : -3.98790e-003
B : 1.75060e-004
C : -2.97420e-006
E : 3.60000e-002
Tau20 : 1.30000e+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 : 81629
Calibrated on : 21-June-2022
Scale factor : 15.000
Offset : 0.000

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

Serial number : 1055
Calibrated on : 19-July-2022
ScaleFactor : 0.003334
Dark output : 0.052900

10) A/D voltage 4, PAR/Irradiance, Biospherical/Licor

Serial number : 70510 (DWIRR)

Calibrated on : 13-August-2021
M : 1.00000000
B : 0.00000000
Calibration constant : 16666666700.00000000
Conversion units : umol photons/m^2/sec
Multiplier : 1.00000000
Offset : -0.06110141

11) A/D voltage 5, PAR/Irradiance, Biospherical/Licor, 2

Serial number : 70520 (UWIRR)
Calibrated on : 13-August-2021
M : 1.00000000
B : 0.00000000
Calibration constant : 15384615400.00000000
Conversion units : umol photons/m^2/sec
Multiplier : 1.00000000
Offset : -0.06666738

12) A/D voltage 6, Fluorometer, Chelsea Aqua 3

Serial number : 88-2960-163
Calibrated on : 20-April-2022
VB : 0.991100
V1 : 1.905480
Vacetone : 0.471530
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

13) A/D voltage 7, Transmissometer, WET Labs C-Star

Serial number : CST-1719TR
Calibrated on : 2-April-2021
M : 21.9474
B : -0.0439
Path length : 0.250

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\DY167\Data\CTD Raw Data\DY167_CTD_207S.hex
Timeout (seconds) at startup: 60
Timeout (seconds) between scans: 10

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: 32
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 / Cruise: RRS DISCOVERY / DY167
prompt 1 = Event:
prompt 2 = Cast:
prompt 3 = Station:
prompt 4 = Julian Day:
prompt 5 = Date:
prompt 6 = Time (UTC):

prompt 7 = Latitude:
prompt 8 = Longitude:
prompt 9 = Depth (uncorrected m)
prompt 10 = Principal Scientist: Joanne Hopkins
prompt 11 = Operator: Paul Henderson

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: 0.000
Longitude when NMEA is not available: 0.000
Average Sound Velocity
Minimum pressure [db]: 20.000
Minimum salinity [psu]: 20.000
Pressure window size [db]: 20.000
Time window size [s]: 60.000
Descent and Acceleration
Window size [s]: 2.000
Plume Anomaly
Theta-B: 0.000
Salinity-B 0.000
Theta-Z / Salinity-Z 0.000
Reference pressure [db] 0.000
Oxygen
Window size [s]: 2.000
Apply hysteresis correction: 1
Apply Tau correction: 1
Potential Temperature Anomaly
A0: 0.000
A1: 0.000
A1 Multiplier: Salinity

Serial Data Output:
Output data to serial port: NO

Mark Variables:
Variables:
Digits Variable Name [units]
------ --------------------
0 Scan Count
4 Depth [salt water, m]
7 Conductivity [S/m]
5 Salinity, Practical [PSU]

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: 0.000
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: NO
Compare serial numbers: NO
Maximized plot may cover Seasave: NO

Metal Free (Titanium) CTD Setup

PSA file: C:\Users\sandm\Documents\Cruises\DY167\Data\Seasave Setup Files\DY167_Ti_0637_nmea.psa

Date: 08/14/2023

Instrument configuration file: C:\Users\sandm\Documents\Cruises\DY167\Data\Seasave Setup Files\DY167_Ti_0637_nmea.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-4712
Calibrated on : 27-September-2022
G : 4.40429823e-003
H : 6.33699202e-004
I : 1.93685991e-005
J : 1.20947056e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 04C-4065
Calibrated on : 17-May-2022
G : -9.85603358e+000
H : 1.48793780e+000
I : -2.57867860e-003
J : 2.82285895e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 79501
Calibrated on : 11-January-2023
C1 : -6.052595e+004
C2 : -1.619787e+000
C3 : 1.743190e-002

D1 : 2.819600e-002
D2 : 0.000000e+000
T1 : 3.011561e+001
T2 : -5.788717e-004
T3 : 3.417040e-006
T4 : 4.126500e-009
T5 : 0.000000e+000
Slope : 0.99991000
Offset : -1.54590
AD590M : 1.293660e-002
AD590B : -9.522570e+000

4) Frequency 3, Temperature, 2

Serial number : 03P-4593
Calibrated on : 27-September-2022
G : 4.35396782e-003
H : 6.44527877e-004
I : 2.17521368e-005
J : 1.75418825e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 04C-4138
Calibrated on : 17-May-2022
G : -9.82757684e+000
H : 1.44836304e+000
I : -7.50881379e-004
J : 1.52913291e-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 : 43-3836
Calibrated on : 09-July-2022
Equation : Sea-Bird
Soc : 4.38300e-001
Offset : -5.09100e-001
A : -4.88900e-003
B : 2.01000e-004
C : -2.69410e-006
E : 3.60000e-002
Tau20 : 1.24000e+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, pH

Serial number : AMT DEEP pH 349
Calibrated on : 02 July 2023
pH slope : 6.0042
pH offset : 2.5426

8) A/D voltage 2, Altimeter

Serial number : 81630
Calibrated on : 21-June-2022
Scale factor : 15.000
Offset : 0.000

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

Serial number : 758
Calibrated on : 21-September-2022
ScaleFactor : 0.003461
Dark output : 0.073000

10) A/D voltage 4, PAR/Irradiance, Biospherical/Licor

Serial number : CTG PAR 04
Calibrated on : 03 September 2020
M : 0.51511971
B : 1.00565570
Calibration constant : 21739130435.00000000
Conversion units : umol photons/m^2/sec
Multiplier : 1.00000000
Offset : 0.00000000

11) A/D voltage 5, PAR/Irradiance, Biospherical/Licor, 2

Serial number : CTG PAR 09
Calibrated on : 03 September 2020
M : 0.52185597
B : 1.00704213
Calibration constant : 21739130435.00000000
Conversion units : umol photons/m^2/sec
Multiplier : 1.00000000
Offset : 0.00000000

12) A/D voltage 6, Fluorometer, Chelsea Aqua 3

Serial number : 088-244
Calibrated on : 29-November-2022
VB : 0.358220
V1 : 2.123120
Vacetone : 0.550570
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

13) A/D voltage 7, Transmissometer, WET Labs C-Star

Serial number : CST-1720TR
Calibrated on : 7-October-2021
M : 21.3083
B : -0.1705
Path length : 0.250

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\DY167\Data\CTD Raw Data\DY167_CTD_208T.hex
Timeout (seconds) at startup: 60
Timeout (seconds) between scans: 10

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: 32
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 / Cruise: RRS DISCOVERY / DY167
prompt 1 = Event:
prompt 2 = Cast:

```
    prompt 3 = Station:
    prompt 4 = Julian Day:
    prompt 5 = Date:
    prompt 6 = Time (UTC):
    prompt 7 = Latitude:
    prompt 8 = Longitude:
    prompt 9 = Depth (uncorrected m)
    prompt 10 = Principal Scientist: Joanne Hopkins
    prompt 11 = Operator: Paul Henderson
--------------------------------------------
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:  0.000
    Longitude when NMEA is not available: 0.000
  Average Sound Velocity
    Minimum pressure [db]:              20.000
    Minimum salinity [psu]:             20.000
    Pressure window size [db]:          20.000
    Time window size [s]:               60.000
  Descent and Acceleration
    Window size [s]:                    2.000
  Plume Anomaly
    Theta-B:                            0.000
    Salinity-B                          0.000
    Theta-Z / Salinity-Z                0.000
    Reference pressure [db]             0.000
  Oxygen
    Window size [s]:                    2.000
    Apply hysteresis correction:        1
    Apply Tau correction:               1
  Potential Temperature Anomaly
    A0:                                 0.000
    A1:                                 0.000
    A1 Multiplier:                      Salinity
--------------------------------------------
Serial Data Output:
  Output data to serial port: NO
--------------------------------------------
Mark Variables:
  Variables:
  Digits   Variable Name [units]
  ------   ---------------------
  0        Scan Count
  4        Depth [salt water, m]
  7        Conductivity [S/m]
  5        Salinity, Practical [PSU]
--------------------------------------------
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:   0.000
  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: NO
  Compare serial numbers: NO
  Maximized plot may cover Seasave: NO

Appendix 4 – LADCP Setup Files

Master (Down-looking) LADCP

```
; DY167 Joanne Hopkins (N-ARC)
; Paul Henderson NMF S&M
; Jul-Aug 2023
;
;======================================================================
;               M A S T E R . C M D
;               doc: Tue Jun 15 11:46:07 2004
;               dlm: Fri Jan  7 23:25:34 2011
;               (c) 2004 A.M. Thurnherr
;               uE-Info: 22 1 NIL 0 0 72 2 2 8 NIL ofnI
;======================================================================
; This is the default master/downlooker command file
; NOTES:
;   - this version requires firmware 16.30 or higher
;   - should contain only commands that change factory defaults
;   - assumes that WM15 (LADCP) mode is installed
;   - collect data in beam coordinates
;   - staggered single-ping ensembles every 1.3s/1.5s
;   - narrow bandwidth
;   - 25x 8m cells

; HISTORY:
;   Jan  7, 2011: - created for Firmware 16.30 or higher from old version
;                 - increased pinging rate

; Jan 2017 : Reset to factory Settings:
CR1
; Jul 2023 : Display system configuration.
PS0
; Jul 2023 : Rename the scripts. Watch for truncating. Only allows for 5 charachters.
RN MAST_
; Jan 2017 : Added following command to update/sync time with the PC time. Ensure that PC is updated with NTP source, otherwise the benefit is lost.
$T

WM15                    ; water mode 15 (LADCP)

TC2                     ; ensembles per burst
LP1                     ; pings per ensemble
TB 00:00:02.80          ; time per burst
TE 00:00:01.30          ; time per ensemble
TP 00:00.00             ; time between pings

LN25                    ; number of depth cells
LS0800                  ; bin size [cm]
LF0                     ; blank after transmit [cm]

LW1                     ; narrow bandwidth LADCP mode
LV400                   ; ambiguity velocity [cm/s]

SM1                     ; master
SA011                   ; send pulse before each ensemble
SB0                     ; disable hardware-break detection on Channel B (ICN118)
SW5500                  ; wait .5500 s after sending sync pulse
SI0                     ; # of ensembles to wait before sending sync pulse

EZ0011101
; Sensor source:
;           - manual speed of sound (EC)
;           - manual depth of transducer (ED = 0 [dm])
;           - measured heading (EH)
;           - measured pitch (EP)
;           - measured roll (ER)
;           - manual salinity (ES = 35 [psu])
;           - measured temperature (ET)

EX00100
; coordinate transformation:
;           - radial beam coordinates (2 bits)
```

```
;		- use pitch/roll (not used for beam coords?)
;		- no 3-beam solutions
;		- no bin mapping

CF11111
; Flow control:
;		- automatic ensemble cycling (next ens when ready)
;		- automatic ping cycling (ping when ready)
;		- binary data output
;		- enable serial output
;		- enable data recorder

; Jul 2023 : Enabled serial output for live serial uplink via CTD SBE9+
CD001000000
;		- disable velocity serial output
;		- disable correlation serial output
;		- enable echo intensity serial output
;		- disable percent good serial output
;		- disable status serial output
;		- reserved
;		- reserved
;		- reserved
;		- reserved

CK				; keep params as user defaults (across power failures)
CS				; start pinging

; Jan 2017: Added following line. Assumed that this supresses the output from device.
$1
```

Slave (Up-looking) LADCP

```
; DY167 Joanne Hopkins (N-ARC)
; Paul Henderson NMF S&M
; Jul-Aug 2023
;
;======================================================================
;		S L A V E . C M D
;		doc: Tue Jun 15 11:46:07 2004
;		dlm: Fri Jan  7 23:25:28 2011
;		(c) 2004 A.M. Thurnherr
;		uE-Info: 22 1 NIL 0 0 72 2 2 8 NIL ofnI
;======================================================================

; This is the default slave/uplooker command file

; NOTES:
;   - this version requires firmware 16.30 or higher
;   - contains only commands that change factory defaults
;   - assumes that WM15 (LADCP) mode is installed
;   - collect data in beam coordinates
;   - single-ping ensembles; timing determined by [MASTER.cmd]
;   - narrow bandwidth
;   - 25x 8m cells

; HISTORY:
;   Jan  7, 2011: - created for Firmware 16.30 or higher from old version
;			- increased pinging rate

; Jan 2017 : Reset to factory Settings:
CR1
; Jul 2023 : Display system configuration.
PS0
; Jul 2023 : Rename the scripts. Watch for truncating. Only allows for 5 charachters.
RN SLAV_
; Jan 2017 : Added following command to update/sync time with the PC time. Ensure that PC is updated with NTP source, otherwise the benefit is lost.
$T

WM15				; water mode 15 (LADCP)

LP1				; pings per ensemble
```

```
TP 00:00.00                     ; time between pings
TE 00:00:00.00                  ; time per ensemble

LN25                            ; number of depth cells
LS0800                          ; bin size [cm]
LF0                             ; blank after transmit [cm]

WB1                             ; narrow bandwidth mode 1 (not sure if required)
LW1                             ; narrow bandwidth LADCP mode
LV400                           ; ambiguity velocity [cm/s]

SM2                             ; slave
SA011                           ; wait for pulse before ensemble
SB0                             ; disable hardware-break detection on Channel B (ICN118)

EZ0011101
; Sensor source:
;           - manual speed of sound (EC)
;           - manual depth of transducer (ED = 0 [dm])
;           - measured heading (EH)
;           - measured pitch (EP)
;           - measured roll (ER)
;           - manual salinity (ES = 35 [psu])
;           - measured temperature (ET)

EX00100
; coordinate transformation:
;           - radial beam coordinates (2 bits)
;           - use pitch/roll (not used for beam coords?)
;           - no 3-beam solutions
;           - no bin mapping

CF11101
; Flow control:
;           - automatic ensemble cycling (next ens when ready)
;           - automatic ping cycling (ping when ready)
;           - binary data output
;           - disable serial output
;           - enable data recorder

CK                              ; keep params as user defaults (across power failures)
CS                              ; start pinging

; Jan 2017: Added following line. Assumed that this supresses the output from device.
$1
```

9.7 Appendix G - Scientific Computing

Joshua Pedder and Emmy McGarry
Ship Scientific Systems, NMF

Cruise 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 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.

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/DY167_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 EA640	Continuous	None, redirected to Techsas/RVDAS RAM	`/Acoustics/EA-640/`
UHDAS (ADCPs)	Continuous	ASCII raw, RBIN, GBIN, CODAS files	`/Acoustics/ADCP/`

> *Data description documents per system:*
> `/Cruise_Reports/DY167_Ship_fitted_information_sheet.docx`
>
> *Data directories per system:*
> `/Cruise_Reports/DY167_Ship_fitted_information_sheet.docx`

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:*
> `/Ship_Systems/Documentation/Eventlog/current_csv_logs`

Summary of data gaps

Date	Time start	Time end	Event
23JUL2023	02:38	07:49	RVDAS stopped recording
25JUL2023	23:57	08:58	Seapath GPS stopped being recorded by Techsas
26JUL2023	23:08	07:50	RVDAS stopped recording

28JUL2023	05:15	08:10	Seapath GPS stopped being recorded by Techsas
29JUL2023	00:58	07:43	Seapath GPS stopped being recorded by Techsas
02AUG2023	21:25	21:58	POSMV restarted

Internet provision

Satellite communications were provided with both the VSAT and Fleet Broadband systems. The ship operated with bandwidth controls to prioritise business use.

Instrumentation

Coordinate reference

> *Path to ship survey files:*
> `/Ship_Systems/Documentation/Vessel_Survey`

Origin (RRS Discovery)

> *All coordinates, unless otherwise specified, use the following convention:*
> Central reference point (0,0,0) at Frame 44, centreline, main deck with sense (X+ fwd, Y+ stbd, Z+ down). This CRP is at (32.4m, 0m, -7.4m) with respect to the ship's absolute stern, centreline, baseline.

The ship's survey (Parker Maritime, 2013) defines two systems of reference point using two different central reference points (CRPs):

1. (0,0,0) at Frame 0 (aft-most frame, 6m forward from stern), centreline (centre of keel), baseline (ship's bottom-most longitudinal).
2. (0,0,0) at ship's centre of gravity (CG), Frame 44 (26.4m forward from Frame 0 at 0.6m framespacing), centreline (centre of keel), main deck (7.4m up from baseline).

The survey coordinate sense is X is positive forward, Y positive starboard, and Z positive down. The coordinate order in the survey is (Y,X,Z), but unless otherwise noted, all coordinates are given elsewhere as (X,Y,Z).

For all scientific purposes, unless otherwise stated, the coordinate system is referenced using the second system, with the CRP at the CG.

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)		
Statement of Capability	/Ship_Systems/Documentation/GPS_and_Attitude		
Data product(s)	NetCDF: /Ship_Systems/Data/TechSAS/NetCDF/ Raw NMEA: /Ship_Systems/Data/RAM/ CSV: /Ship_Systems/Data/RAM/CSV		
Data description	/Ship_Systems/Documentation/TechSAS /Ship_Systems/Documentation/RVDAS		
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 2 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.
Fugro Seastar / MarineStar	Correction service for primary and secondary GPS and dynamic positioning.	Corrections 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
02AUG2023	21:25	21:58	POSMV restarted

Ocean and atmosphere monitoring systems

SURFMET

System	SURFMET (Surface water and atmospheric monitoring)	
Statement of Capability	`/Ship_Systems/Documentation/Surfmet`	
Data product(s)	NetCDF: `/Ship_Systems/Data/TechSAS/NetCDF/` Raw NMEA: `/Ship_Systems/Data/RAM/` CSV: `/Ship_Systems/Data/RAM/CSV`	
Data description	`/Ship_Systems/Documentation/TechSAS` `/Ship_Systems/Documentation/RVDAS`	
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, HMP155)	Temperature and humidity at met. platform.	Analogue to NUDAM.
Ambient light sensors (PAR, SKE510; TIR, CMP6)	Ambient light at met. platform.	Analogue to NUDAM.

Barometer (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 (%)	$\text{Product} = (\text{Data} - V_{\text{dark}})/(V_{\text{ref}} - V_{\text{dark}})$. Here product has units % and data, V_{dark} and V_{ref} have units V.
WS3S: Fluorescence (µg L^{-1})	$\text{Product} = \text{Coefficient} \times (\text{Data} - \text{Offset})$. Here product has units µg L^{-1}, coefficient has units µg L^{-1} V^{-1}, and data and offset have units V.
HMP155: Temperature (°C)	No calibration to apply because the residuals are below uncertainty.
HMP155: Relative humidity (%)	No calibration to apply because the residuals are below uncertainty.
PTB210: Pressure (hPa)	No calibration to apply because the residuals are below uncertainty.
SKE510: PAR (W m^{-2})	$\text{Product} = \text{Data} \times \left(\frac{10^6}{\text{Coefficient}}\right)$. Here product has units W m^2, data has units 10^{-5} V, the 10^6 scalar has units µV V^{-1}, and coefficient has units µV m^2 W^{-1}.
CMP6: TIR (W m^{-2})	$\text{Product} = \text{Data} \times \left(\frac{10^6}{\text{Coefficient}}\right)$. Here product has units W m^2, data has units 10^{-5} V, the 10^6 scalar has units µV V^{-1}, and coefficient has units µV m^2 W^{-1}.
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. $\text{Product} = (\text{Data} - A)/B$.

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.

Surface water sampling board maintenance

Date	Time start*	Time end*	Event	Trans high (V)	Trans low (V)	Fluoro (V)	Salinity (PSU)
17JUL2023	05:15	13:30	Leak	-	-	-	-
19JUL2023	13:12	13:23	Cleaning	4.7	0.004		
28JUL2023	14:14	14:29	Cleaning	4.98	0.005		
06AUG2023	12:10	12:30	Cleaning	4.94	0.005		

The system was cleaned prior to the cruise.

Hydroacoustic Systems

System	Acoustics	
Statement of Capability	/Ship_Systems/Documentation/Acoustics	
Data product(s)	Raw: /Ship_Systems/Data/Acoustics NetCDF (EA640, EM122cb): /Ship_Systems/Data/TechSAS NMEA (EA640, EM122cb): /Ship_Systems/Data/RVDAS CSV: /Ship_Systems/Data/RAM/CSV	
Data description	/Ship_Systems/Documentation/Acoustics	
Other documentation	/Ship_Systems/Documentation/Acoustics	
Component	Purpose	Operation and Outputs
10 kHz Single beam (Kongsberg EA-640)	Primary depth sounder	Continuous, free running NMEA over serial, raw files

Sound velocity profilers (Valeport Midas, Lockheed XBT)	Direct measurement of sound velocity in water column.	Discrete ASCII pressure vs sound velocity files.
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)

Other systems

Cable Logging and Monitoring

Winch activity is monitored and logged using the CLAM system.

PCO2

3rd party flow-through PCO2 Analyser was install onboard. The serial data output was merged with data from the TechSAS acquisition system:

> *Data description documents for merged outputs:*
>
> `/Ship_Systems/Third_Party/pCO2/Documentation`

Data from the pCO2 analyser was output at 1Hz in ‘AllFields’, ‘SelectedFields’ csv files. These data files have also been filtered to use only 1 data point per minute to create the ‘Resampled’ files.

> *Data files can be found in:*
>
> `/Ship_Systems/Third_Party/pCO2/Data`

A log of all data events was made using the ships eventlogger system.

> *Please refer to all log entries with event ‘pco2’ in the Acquisition log:*
>
> `/Ship_Systems/Documentation/Eventlog/current_csv_logs/techlogs/Acquisition.csv`

9.8 Appendix H – DOC and eHS Sample Logs

Table 9.1 DOC and eHS samples collected from the FISH

Date	**Time range**	**FISH no.**	DOC	eHS
10/07/2023	15:02-15:09	1	x	
10/07/2023	17:04-17:30	2	x	
10/07/2023	19:00-19:10	3	x	
10/07/2023	21:05-21:15	4	x	
10/07/2023	23:02-23:12	5	x	
11/07/2023	00:57-01:06	6	x	
11/07/2023	03:00-03:08	7	x	
11/07/2023	05:02-05:28	8	x	
11/07/2023	07:00-07:08	9	x	
11/07/2023	09:01-09:13	10	x	
11/07/2023	10:59-11:07	11	x	
11/07/2023	12:59-13:08	13	x	
11/07/2023	14:59-15:08	14	x	
11/07/2023	17:00-17:17	15	x	
11/07/2023	19:00-19:07	16	x	
11/07/2023	21:00-21:09	17	x	
11/07/2023	22:56-23:04	18	x	
12/07/2023	01:00-01:07	19	x	
12/07/2023	03:00-03:08	20	x	
12/07/2023	05:00-05:15	21	x	
12/07/2023	07:00-07:09	22	x	
12/07/2023	09:00-09:05	23	X	
12/07/2023	12:57-13:05	25	x	
12/07/2023	14:59-15:08	26	x	
12/07/2023	16:58-17:15	27	x	
12/07/2023	18:59-19:06	28	x	

12/07/2023	21:02-21:15	29	x	
12/07/2023	22:55-23:04	30	x	
13/07/2023	00:54-01:04	31	x	
13/07/2023	02:58-03:07	32	x	
13/07/2023	05:00-05:12	33	x	
13/07/2023	06:58	34	x	
13/07/2023	08:59-09:05	35	x	
13/07/2023	10:58-11:03	36	x	
13/07/2023	12:58-13:05	37	x	
13/07/2023	14:58-15:03	38	x	
13/07/2023	16:58-17:13	39	x	
13/07/2023	19:01-19:06	40	x	
13/07/2023	21:01-21:09	41	x	
13/07/2023	22:56-23:05	42	x	
14/07/2023	00:57-01:06	43	x	
14/07/2023	03:06-03:13	44	x	
14/07/2023	05:00-05:18	45	x	
14/07/2023	06:58-07:05	46	x	
14/07/2023	09:00	47	x	
14/07/2023	21:00 – 21:09	49	x	
15/07/2023	00:01-00:07	50	x	
15/07/2023	03:14-03:34	51	x	
15/07/2023	06:00-06:08	52	x	
15/07/2023	08:59-09:15	53	x	
15/07/2023	11:24-11:31	54	x	
15/07/2023	20:49-21:00	55	x	
16/07/2023	00:05-00:11	56	x	
16/07/2023	02:56-03:12	57	x	
16/07/2023	06:00-06:05	58	x	
16/07/2023	09:00-09:05	59	x	
16/07/2023	11:32-11:39	60	x	
16/07/2023	20:58-21:06	61	x	
16/07/2023	23:56-23:58	62	x	
17/07/2023	02:56-03:12	63	x	
17/07/2023	06:05-06:15	64	x	
17/07/2023	09:00-0910	65	x	
17/07/2023	12:00-12:05	66	x	
17/07/2023	15:00-15:08	67	x	
17/07/2023	17:57-18:03	68	x	
17/07/2023	21:05-21:14	69	X	
17/07/2023	23:55-00:01	70	X	
18/07/2023	02:51-03:08	71	X	
18/07/2023		72	X	
18/07/2023	08:58-09:05	73	X	
18/07/2023	10:42-10:47	74	X	
18/07/2023	20:58-21:08	75	X	

19/07/2023	00:01-00:07	76	X	
19/07/2023	02:58-03:13	77	X	
19/07/2023	06:00-06:09	78	X	
19/07/2023	09:00-09:12	79	X	
19/07/2023	11:23-11:30	80	x	
19/07/2023	18:58-19:05	81	x	
19/07/2023	20:45-20:51	82	x	
19/07/2023	22:40-22:57	83	x	
20/07/2023	01:00-01:05	84	x	
20/07/2023	03:00-03:06	85	x	
20/07/2023	05:00-05:18	86	x	
20/07/2023	07:00-07:05	87	x	
20/07/2023	09:01-09:08	88	x	
20/07/2023	11:00-11:05	89	x	
20/07/2023	11:30-11:35	90	x	
20/07/2023	17:00-17:05	91	x	
20/07/2023	19:00-19:07	92	x	
20/07/2023	22:51-23:09	93	x	
21/07/2023	01:00-01:05	94	X	
21/07/2023	03:02-03:09	95	x	
21/07/2023	04:58-05:10	96	x	
21/07/2023	07:08-07:15	97	x	
21/07/2023	08:59-09:05	98	x	
21/07/2023	10:59-11:05	99	x	
21/07/2023	19:00-1906	100	x	
21/07/2023	20:25-21:05	101	x	
21/07/2023	23:01-23:17	102	X	
22/07/2023	01:01-01:06	103	X	
22/07/2023	03:00-03:05	104	X	
22/07/2023	05:00-05:05	105	X	
22/07/2023	07:12-07:15	106	X	
22/07/2023	09:08-09:10	107	X	
22/07/2023	10:58-11:05	108	X	
22/07/2023	19:00-19:05	109	X	
22/07/2023	21:00-21:05	110	X	
22/07/2023	22:59-23:15	111	X	
23/07/2023	01:03-01:10	112	X	
23/07/2023	03:04-03:12	113	X	
23/07/2023	04:58-05:20	114	X	
23/07/2023	17:03-17:10	116	X	
23/07/2023	19:15-19:25	117	X	
23/07/2023	20:53-21:00	118	X	
23/07/2023	22:59-23:14	119	X	
24/07/2023	01:00-01:07	120	X	
24/07/2023	03:01-03:10	121	X	
24/07/2023	05:00-05:13	122	X	

24/07/2023	07:00-07:07	123	X	
24/07/2023	09:15-09:21	124	X	
24/07/2023	11:35-11:30	125	X	
24/07/2023	12:59-13:12	127	x	
24/07/2023	14:58-15:03	129	x	
24/07/2023	16:58-17:03	130	x	
24/07/2023	18:58-19:03	131	x	
24/07/2023	21:03-21:09	132	x	
24/07/2023	23:00-23:17	133	x	
25/07/2023	01:00-01:06	134	x	
25/07/2023	03:08-03:14	135	x	
25/07/2023	07:50-07:40	137	x	
25/07/2023		138	x	
25/07/2023	10:55-11:02	139	x	
26/07/2023	03:00-03:05	141	x	x
26/07/2023	04:00-04:05	142	x	
26/07/2023	05:00-05:05	143	x	
26/07/2023	06:00-06:05	144	x	
26/07/2023	07:00-07:05	145	x	
26/07/2023	08:00-08:06	146	x	
26/07/2023	09:01-09:08	147	x	
26/07/2023	09:58-10:05	148	x	
26/07/2023	10:58-11:05	149	x	
26/07/2023	12:00-12;04	150	x	
26/07/2023	13:00-13:05	151	x	
26/07/2023	13:55-14:05	152	x	
26/07/2023	15:00-15:05	153	x	
26/07/2023	16:02-16:07	154	x	x
26/07/2023	16:57-17:02	155	x	
26/07/2023	17:58-18:03	156	x	
26/07/2023	19:01-19:06	157	x	
26/07/2023	20:00-20:10	158	x	x
26/07/2023	21:00-21:06	159	x	
26/07/2023	21:58-22:04	160	x	
26/07/2023	23:00-23:16	161	x	
27/07/2023	00:01-00:12	162	x	x
27/07/2023	01:00-01:06	163	x	
27/07/2023	02:00-02:06	164	x	
27/07/2023	03:02-03:12	165	x	x
27/07/2023	04:00-04:08	166	x	
27/07/2023	05:00-05:20	167	x	
27/07/2023	06:00-06:16	168	x	x
27/07/2023	07:00-07:10	169	x	
27/07/2023	0.333333	170	x	
27/07/2023	45208.37	171	x	x
27/07/2023	09:58-10:03	172	x	

27/07/2023	10:8-11:03	173	x	
27/07/2023	12:01-12:15	174	x	
27/07/2023	12:57-13:05	175	x	x
27/07/2023	13:58-14:04	176	x	
27/07/2023	15:00-15:05	177	X	
27/07/2023	16:00-16:05	178	X	x
27/07/2023	17:04-17:12	179	X	
27/07/2023	17:51-18:06	180	x	
28/07/2023	00:12-00:21	186	x	x
28/07/2023	02:07-02:15	187	X	X
28/07/2023	04:08-04:15	188	X	X
28/07/2023	05:04-05:25	189	X	X
28/07/2023	0.333333	190	X	X
28/07/2023	09:58-10:03	191	X	X
29/07/2023	17:00-17:06	201	x	
29/07/2023	18:58-19:08	202	x	
29/07/2023	21:01-21:11	203	x	
29/07/2023	23:00-23:16	204	x	
30/07/2023	01:01-01:09	205	x	
30/07/2023	02:37-02:54	206	x	
30/07/2023	0.208333	207	x	
30/07/2023	07:01-07:08	208	x	
30/07/2023	09:00-09:06	209	x	
30/07/2023	11:00-11:06	210	x	
30/07/2023	19:03-19:12	211	x	
30/07/2023	21:00-21:06	213	x	
30/07/2023	23:02-23:19	214	x	
30/07/2023	01:04-01:11	215	x	
31/07/2023	02:38-02:57	216	x	
31/07/2023	05:01-05:20	217	x	
31/07/2023	07:05-07:10	218	x	
31/07/2023	08:59-09:06	219	x	
31/07/2023	10:58-11:06	220	x	
31/07/2023	16:53-16:56	223	X	
31/07/2023	18:59-19:08	224	x	
31/07/2023	21:04-21:20	225	x	
31/07/2023	23:04-23:21	226	x	
01/08/2023	01:00-01:08	227	x	
01/08/2023	03:01-03:08	228	x	
01/08/2023	0.210417	229	x	
01/08/2023	0.29375	230	x	
01/08/2023	08:58-09:06	231	x	
01/08/2023	11:01-11:09	232	x	
01/08/2023	16:58-17:04	233	x	
01/08/2023	19:00-19:08	234	x	
01/08/2023	21:04-21:12	235	x	

01/08/2023	22:59-23:17	236	x	
02/08/2023	01:00-01:07	237	x	
02/08/2023	03:00-03:08	238	x	
02/08/2023	05:00-05:20	239	x	
02/08/2023	0.291667	240	x	
02/08/2023	08:57-09:03	241	x	
02/08/2023	10:59-11:06	242	x	
02/08/2023	19:00-19:06	243	x	
02/08/2023	22:01-22:19	244	x	
03/08/2023	01:58-02:05	245	x	
03/08/2023	04:05-04:16	246	x	
03/08/2023	0.291667	247	x	
03/08/2023	09:58-10:04	248	x	
03/08/2023	14:27-14:35	249	x	x
03/08/2023	18:01-18:19	251	x	x
03/08/2023	22:07-22:16	253	x	x
04/08/2023	02:02-02:10	256	x	x
04/08/2023	0.25	258	x	x
04/08/2023	09:58-10:04	260	x	x
04/08/2023	12:00-12:18	261	x	x
04/08/2023	14:00-14:06	262	x	
04/08/2023	15:58-16:03	263	x	
04/08/2023	18:55-19:12	265	x	
04/08/2023	21:03-21:10	266	x	
04/08/2023	23:00-23:19	267	x	
05/08/2023	01:02-01:07	268	x	
05/08/2023	03:02-03:08	269	x	
05/08/2023	05:00-05:18	270	x	
05/08/2023	07:00-07:05	271	x	
05/08/2023	09:00-09:05	272	x	
05/08/2023	11:00-11:04	273	x	
05/08/2023	12:58-13:05	275	x	
05/08/2023	15:00-15:05	276	x	
05/08/2023	16:58-17:15	277	x	
05/08/2023	18:52-19:04	278	x	
05/08/2023	20:58-21:04	279	x	
05/08/2023	22:14-22:30	280	x	
06/08/2023	00:59-01:05	281	x	
06/08/2023	02:58-03:05	282	x	
06/08/2023	05:02-05:20	283	x	
06/08/2023	07:00-07:10	284	x	
06/08/2023	08:58-09:03	285	x	
06/08/2023	10:58-11:04	286	x	
07/08/2023	19:17-19:25	288	x	
07/08/2023	22:58-23:15	289	x	
08/08/2023	00:59-01:04	290	x	

08/08/2023	04:00-04:10	291	x	
08/08/2023	07:08-07:17	292	x	
08/08/2023	09:01-09:06	293	x	
08/08/2023	17:00-17:07	294	x	
08/08/2023	19:57-20:02	295	x	
08/08/2023	22:58-23:16	296	x	
09/08/2023	01:58-02:04	297	x	
09/08/2023	0.210417	298	x	
09/08/2023	0	299	x	
09/08/2023	0.458333	300	x	
09/08/2023	15:03-15:12	301	x	
09/08/2023	16:59-17:04	302	x	
09/08/2023	19:01-19;06	303	x	
09/08/2023	20:58-21:15	304	x	
09/08/2023	22:56-23:03	305	x	
10/08/2023	00:01-00:12	306	x	
10/08/2023	01:00-01:05	307	x	
10/08/2023	02:58-03:06	308	x	

Table 9.2 DOC and eHS samples collected from the Ti-CTD

Latitude (°N)	Longitude (°E)	Station	CTD	Fire	Rosette	Bottle	Depth (m)
70 ° 59.993	10 ° 59.992	N01	4 T	1	1	1T	2564
70 ° 59.993	10 ° 59.992	N01	4 T	3	3	3T	2544
70 ° 59.993	10 ° 59.992	N01	4 T	4	4	4T	2510
70 ° 59.993	10 ° 59.992	N01	4 T	5	5	5T	2200
70 ° 59.993	10 ° 59.992	N01	4 T	7	7	7T	1800
70 ° 59.993	10 ° 59.992	N01	4 T	8	8	8T	1400
70 ° 59.993	10 ° 59.992	N01	4 T	10	10	10T	900
70 ° 59.993	10 ° 59.992	N01	4 T	12	12	12T	750
70 ° 59.993	10 ° 59.992	N01	4 T	13	13	13T	650
70 ° 59.993	10 ° 59.992	N01	4 T	15	15	15T	400
70 ° 59.993	10 ° 59.992	N01	4 T	17	17	17T	200
70 ° 59.993	10 ° 59.992	N01	4 T	18	18	18T	150
70 ° 59.993	10 ° 59.992	N01	4 T	20	20	20T	75
70 ° 59.993	10 ° 59.992	N01	4 T	22	22	22T	30
70 ° 59.993	10 ° 59.992	N01	4 T	23	23	23T	25
70 ° 59.993	10 ° 59.992	N01	4 T	24	24	24T	15
72° 0.0016	15° 0.007	N02	6 T	2	2	25T	1000
72° 0.0016	15° 0.007	N02	6 T	5	5	5T	800
72° 0.0016	15° 0.007	N02	6 T	7	7	7T	650
72° 0.0016	15° 0.007	N02	6 T	8	8	8T	500
72° 0.0016	15° 0.007	N02	6 T	13	13	13T	150
72° 0.0016	15° 0.007	N02	6 T	14	14	14T	100
72° 0.0016	15° 0.007	N02	6 T	16	16	16T	50

72° 0.0016	15° 0.007	N02	6 T	17	17	17T	40
72° 0.0016	15° 0.007	N02	6 T	20	20	20T	25
72° 0.0016	15° 0.007	N02	6 T	22	22	22T	20
72° 0.0016	15° 0.007	N02	6 T	24	24	24T	15
72° 51.60798	19° 4.25148	N03	121 T	2	2	25T	395
72° 51.60798	19° 4.25148	N03	121 T	6	6	6T	300
72° 51.60798	19° 4.25148	N03	121 T	10	10	10T	180
72° 51.60798	19° 4.25148	N03	121 T	18	18	18T	70
72° 51.60798	19° 4.25148	N03	121 T	21	21	21T	22
72° 51.60798	19° 4.25148	N03	121 T	23	23	23T	15
73° 43.47	23° 22.0012	N04	008 T	1	1	1T	436
73° 43.47	23° 22.0012	N04	8 T	4	4	4T	400
73° 43.47	23° 22.0012	N04	8 T	6	6	6T	375
73° 43.47	23° 22.0012	N04	8 T	11	11	26T	250
73° 43.47	23° 22.0012	N04	8 T	14	14	14T	100
73° 43.47	23° 22.0012	N04	8 T	18	18	18T	40
73° 43.47	23° 22.0012	N04	8 T	20	20	20T	25
73° 43.47	23° 22.0012	N04	8 T	24	24	24T	15
74° 36.34	27° 53.984	N05	010 T	1	1	1T	363
74° 36.34	27° 53.984	N05	10 T	10	10	10T	150
74° 36.34	27° 53.984	N05	10 T	12	12	12T	80
74° 36.34	27° 53.984	N05	10 T	16	16	16T	40
74° 36.34	27° 53.984	N05	10 T	24	24	24T	15
74° 36.5974	27° 53.9526	N05	111 T	2	2	25T	360
74° 36.5974	27° 53.9526	N05	111 T	4	4	4T	260
74° 36.5974	27° 53.9526	N05	111 T	7	7	27T	140
74° 36.5974	27° 53.9526	N05	111 T	19	19	19T	60
74° 36.5974	27° 53.9526	N05	111 T	23	23	23T	15
76°0.0027	29° 59.9716	N06	109 T	2	2	25T	301
76°0.0027	29° 59.9716	N06	109 T	4	4	4T	290
76°0.0027	29° 59.9716	N06	109 T	6	6	6T	260
76°0.0027	29° 59.9716	N06	109 T	8	8	8T	200
76°0.0027	29° 59.9716	N06	109 T	17	17	17T	100
76°0.0027	29° 59.9716	N06	109 T	19	19	19T	45
76°0.0027	29° 59.9716	N06	109 T	22	22	22T	25
76°0.0027	29° 59.9716	N06	109 T	23	23	23T	15
77 ° 59.99	29° 59.96	N07	016 T	2	2	25T	275
77 ° 59.99	29° 59.96	N07	16 T	5	5	5T	225
77 ° 59.99	29° 59.96	N07	16 T	8	8	8T	100
77 ° 59.99	29° 59.96	N07	17T	18	18	18T	46
77 ° 59.99	29° 59.96	N07	17T	20	20	20T	35
77 ° 59.99	29° 59.96	N07	17T	22	22	22T	15

78° 33.39448	30° 2.9700	N07-X	106 T	3	3	3T	230
78° 33.39448	30° 2.9700	N07-X	106 T	5	5	5T	210
78° 33.39448	30° 2.9700	N07-X	106 T	9	9	9T	110
78° 33.39448	30° 2.9700	N07-X	106 T	17	17	17T	80
78° 33.39448	30° 2.9700	N07-X	106 T	20	20	20T	40
78° 33.39448	30° 2.9700	N07-X	106 T	21	21	21T	35
78° 33.39448	30° 2.9700	N07-X	106 T	23	23	23T	15
79° 21.025	33° 53.804	N08	025 T	2	2	25T	245
79° 21.025	33° 53.804	N08	25 T	7	7	27T	160
79° 21.025	33° 53.804	N08	25 T	17	17	17T	60
79° 21.025	33° 53.804	N08	25 T	18	18	18T	46
79° 21.025	33° 53.804	N08	25 T	19	19	19T	46
79° 21.025	33° 53.804	N08	25 T	21	21	21T	35
79° 21.025	33° 53.804	N08	25 T	23	23	23T	15
79° 23.14776	27° 44.3872	N09	022 T	2	2	25T	310
79° 23.14776	27° 44.3872	N09	22 T	5	5	5T	280
79° 23.14776	27° 44.3872	N09	22 T	7	7	27T	200
79° 23.14776	27° 44.3872	N09	22 T	15	15	15T	100
79° 23.14776	27° 44.3872	N09	22 T	18	18	18T	58
79° 23.14776	27° 44.3872	N09	22 T	20	20	20T	40
79° 23.14776	27° 44.3872	N09	22 T	22	22	22T	25
79° 23.14776	27° 44.3872	N09	22 T	23	23	23T	15
78° 39.513	24° 39.009	N10	019 T	1	1	1T	124
78° 39.513	24° 39.009	N10	19 T	3	3	3T	110
78° 39.513	24° 39.009	N10	19 T	5	5	5T	70
78° 39.513	24° 39.009	N10	19 T	19	19	19T	47
78° 39.513	24° 39.009	N10	19 T	20	20	20T	35
78° 39.513	24° 39.009	N10	19 T	23	23	23T	15
75° 30.052	22° 29.996	N12	014 T	2	2	25T	45
75° 30.052	22° 29.996	N12	14 T	22	22	22T	15
76° 20.000	19° 59.9382	N13	113 T	2	2	25T	235
76° 20.000	19° 59.9382	N13	113 T	5	5	5T	210
76° 20.000	19° 59.9382	N13	113 T	6	6	6T	190
76° 20.000	19° 59.9382	N13	113 T	7	7	27T	150
76° 20.000	19° 59.9382	N13	113 T	18	18	18T	100

76° 20.000	19° 59.9382	N13	113 T	22	22	22T	20
76° 20.000	19° 59.9382	N13	113 T	23	23	23T	15
77° 13.320	19° 20.678084	N15	115 T	2	2	25T	164
77° 13.320	19° 20.678084	N15	115 T	4	4	4T	150
77° 13.320	19° 20.678084	N15	115 T	6	6	6T	100
77° 13.320	19° 20.678084	N15	115 T	19	19	19T	60
77° 13.320	19° 20.678084	N15	115 T	20	20	20T	40
77° 13.320	19° 20.678084	N15	115 T	22	22	22T	20
78° 30.50014	19° 16.934	N16	117 T	2	2	25T	110
78° 30.50014	19° 16.934	N16	117 T	4	4	4T	100
78° 30.50014	19° 16.934	N16	117 T	6	6	6T	70
78° 30.50014	19° 16.934	N16	117 T	18	18	18T	45
78° 30.50014	19° 16.934	N16	117 T	20	20	20T	30
78° 30.50014	19° 16.934	N16	117 T	21	21	21T	25
72°29.99178	24° 59.93652	N17	204 T	2	2	25T	229
72°29.99178	24° 59.93652	N17	204 T	4	4	4T	200
72°29.99178	24° 59.93652	N17	204 T	6	6	6T	140
72°29.99178	24° 59.93652	N17	204 T	8	8	8T	83
72°29.99178	24° 59.93652	N17	204 T	16	16	16T	40
72°29.99178	24° 59.93652	N17	204 T	21	21	21T	27
72°29.99178	24° 59.93652	N17	204 T	23	23	23T	15
73° 30.00468	29° 59.957858	N18	206 T	2	2	25T	380
73° 30.00468	29° 59.957858	N18	206 T	5	5	5T	280
73° 30.00468	29° 59.957858	N18	206 T	7	7	27T	180
73° 30.00468	29° 59.957858	N18	206 T	19	19	19T	60
73° 30.00468	29° 59.957858	N18	206 T	21	21	21T	35
73° 30.00468	29° 59.957858	N18	206 T	22	22	22T	20
73° 30.00468	29° 59.957858	N18	206 T	23	23	23T	15
74° 8.0010	35° 59.9496	N19	208 T	2	2	25T	217
74° 8.0010	35° 59.9496	N19	208 T	3	3	3T	200
74° 8.0010	35° 59.9496	N19	208 T	6	6	6T	100
74° 8.0010	35° 59.9496	N19	208 T	18	18	18T	60
74° 8.0010	35° 59.9496	N19	208 T	21	21	21T	23
74° 8.0010	35° 59.9496	N19	208 T	22	22	22T	18
74° 8.0010	35° 59.9496	N19	208 T	23	23	23T	15

Table 9.3 DOC and eHS samples collected from the nutrient limitation experiments

Station	Treatment	Time point
N08	+N+P	Initial
		Final
	Control	Initial
		Final
N15	+N+P	Initial
		Final
	Control	Initial
		Final

Table 9.4 DOC and eHS samples collected from small boat activity

Activity location	Sample	DOC	eHS
Sea Ice	Seawater	X	X
Glacier	Ice sample A		X
	Ice sample B		X
	Ice sample C		X
	Seawater	X	X

9.9 Appendix I – Oxygen Isotopes Sample Logs

Table 9.5 Casts, stations, sampleID and depths of d18O samples taken from the SS-CTD

Cast	Station	Event	Niskin	SampleID	Depth (m)
3S	N01	7	1	25	2565.17
3S	N01	7	4	28	1808.99
3S	N01	7	8	32	501.54
3S	N01	7	19	43	21.66
3S	N01	7	24	48	6.65
7S	N04	12	1	73	439.04
7S	N04	12	5	77	203.00
7S	N04	12	8	80	66.45
7S	N04	12	16	88	25.95
7S	N04	12	20	92	21.24
7S	N04	12	24	96	16.02
15S	N07	33	1	157	277.43
15S	N07	33	4	160	250.60
15S	N07	33	5	161	212.82
15S	N07	33	8	164	91.62
15S	N07	33	13	169	56.29
15S	N07	33	23	179	20.70
18S	N10	41	1	181	125.64
18S	N10	41	3	183	112.40
18S	N10	41	5	185	82.05
18S	N10	41	15	195	46.56
18S	N10	41	17	197	26.42
18S	N10	41	20	200	16.43
18S	N10	41	24	204	6.09
21S	N09	45	1	229	321.93
21S	N09	45	2	230	203.54
21S	N09	45	3	231	142.58
21S	N09	45	10	238	71.68
21S	N09	45	15	243	57.50
21S	N09	45	16	244	41.30
21S	N09	45	20	248	21.11
21S	N09	45	24	252	10.97
23S	RAS03	48	9	261	61.57
23S	RAS03	48	11	263	53.34
23S	RAS03	48	13	265	44.35

23S	RAS03	48	15	267	36.19
23S	RAS03	48	17	269	26.11
23S	RAS03	48	19	271	16.06
23S	RAS03	48	21	273	11.04
23S	RAS03	48	23	275	6.01
24S	N08	49	5	281	102.14
24S	N08	49	10	286	61.55
24S	N08	49	16	292	41.17
24S	N08	49	18	294	31.19
24S	N08	49	19	295	21.31
24S	N08	49	20	296	11.06
24S	N08	49	24	300	5.88
105S	N07x	65	1	397	231.08
105S	N07x	65	5	401	133.28
105S	N07x	65	9	405	62.45
105S	N07x	65	13	409	51.95
105S	N07x	65	17	413	44.98
105S	N07x	65	18	414	37.00
105S	N07x	65	20	416	21.82
105S	N07x	65	24	420	11.57
108S	N06	70	1	421	295.83
108S	N06	70	3	423	243.15
108S	N06	70	6	426	91.66
108S	N06	70	10	430	41.12
108S	N06	70	14	434	35.80
108S	N06	70	19	439	26.90
108S	N06	70	20	440	15.70
108S	N06	70	24	444	10.91
110S	N05	73	1	445	361.07
110S	N05	73	5	449	122.47
110S	N05	73	10	454	31.17
110S	N05	73	14	458	26.19
110S	N05	73	16	460	21.06
110S	N05	73	20	464	13.14
110S	N05	73	24	468	5.82
112S	N13	76	6	474	132.72
112S	N13	76	8	476	102.27
112S	N13	76	9	477	71.89
112S	N13	76	11	479	41.56
112S	N13	76	15	483	31.40
112S	N13	76	19	487	26.26
112S	N13	76	20	488	16.05

112S	N13	76	24	492	11.13
114S	N15	80	2	494	159.70
114S	N15	80	7	499	81.49
114S	N15	80	9	501	51.28
114S	N15	80	11	503	40.82
114S	N15	80	15	507	28.87
114S	N15	80	19	511	20.87
114S	N15	80	20	512	10.85
114S	N15	80	24	516	5.76
116S	N16	83	1	517	119.26
116S	N16	83	4	520	91.94
116S	N16	83	7	523	71.50
116S	N16	83	11	527	41.37
116S	N16	83	12	528	31.31
116S	N16	83	16	532	24.00
116S	N16	83	20	536	19.95
116S	N16	83	24	540	10.96
121S	N03	92	1	541	399.97
121S	N03	92	5	545	292.52
121S	N03	92	7	547	121.82
121S	N03	92	9	549	60.90
121S	N03	92	11	551	40.98
121S	N03	92	15	555	29.83
121S	N03	92	20	560	22.84
121S	N03	92	24	564	10.78

Table 9.6 Location and times of d18O samples taken from the small boat

Sample ID	Date time	Lat	Lon	Comment
Ice 2 (A)	04/08/2023 09:48	78.55	19.17	Next to sedimented bottom of iceberg
Ice 2 (B)	04/08/2023 09:56	78.549	19.177	Sedimented piece floating in iceberg flour
Ice 2 (C)	04/08/3023 10:03	78.549	19.169	On top of the same iceberg near a large snow pile
Ice 2 Water Sample 1 and 2 (replicate)	04/08/2023 09:53	78.55	19.175	Moving away from iceberg, uncontaminated water

9.10 Appendix J - $^{15}N_2$, and ^{13}C uptake Sample Logs

Table 9.7 Summary of the samples taken for nitrogen uptake and carbon fixation rates (from FISH, CTDs and incubation experiments)

FISH	SS-CTD	Diazo experiment	Diazo treatment	RAS
8	1_23S	1	T zero	ICE
12	1_18S	1	Control	ICE2
15	1_10S	1	DOCP+Fe	
21	3_47S	1	DON	
24	3_42S	1	Iron	
27	3_36S	2	T zero	
33	5_66S	2	Control	
39	7_91S	2	DOCP+Fe	
45	9_119S	2	DON	
51	9_110S	2	Iron	
53	13_152S	3	T zero	
57	15_178S	3	Control	
63	15_172S	3	DOCP+Fe	
66	15_168S	3	DON	
71	18_194S	3	Iron	
77	18_202S	4	T zero	
83	21_242S	4	Control	
86	21_251S	4	DOCP+Fe	
93	24_290S	4	DON	
96	24_285S	4	Iron	
102	24_299S	4	Phosphate	
105	39_324S	5	T zero	
111	39_313S	5	Control	
114	55_348S	5	DOCP+Fe	
119	55_339S	5	Phosphate	
122	68_372S	6	T zero	
126	68_363S	6	Control	
127	87_396S	6	DOCP+Fe	
133	87_387S	6	DON	
136	105_419S	6	Iron	
143	105_412S	6	Phosphate	
161	108_438S	7	T zero	
167	110_467S	7	Control	
174	110_463S	7	DOCP+Fe	
180	110_457S	7	DON	
189	112_491S	7	Iron	
200	112_486S	7	Phosphate	
204	114_510S	8	Suspended Control	

206	116_539S	8	Suspended DOCP+Fe	
207	116_535S	8	Suspended Iron	
212	116_531S	8	Slow Sinking Control	
214	121_563S	8	Slow Sinking DOCP+Fe	
216	121_559S	8	Slow Sinking Iron	
217	121_554S	8	Fast Sinking Control	
225	123_588S	8	Fast Sinking DOCP+Fe	
226	123_579S	8	Fast Sinking Iron	
229	123_571S			
236	162_612S			
239	162_603S			
244	162_595S			
247	202_636S			
251	202_627S			
254	202_619S			
258	203_659S			
261	203_654S			
265	205_683S			
267	205_677S			
270	205_673S			
274	205_707S			
277	205_702S			
280	205_698S			
283				
289				
292				
296				
298				
304				
306				

9.11 Appendix K – nifH gene Sample Logs

Summary of samples collected for nifH gene analysis from the towed FISH and DIAZO experiments, and samples for community gene analysis from nutrient addition experiments

Date	Time sampled	Sample ID	Time finished	Bottle	Comments
10/07/2023	17:32	DY 167 FISH 0002	18:17	1	
11/07/2023	05:21	DY 167 FISH 0008	05:44	2	
11/07/2023	12:37	DY 167 FISH 0012	13:01	10	
11/07/2023	17:18	DY 167 FISH 0015	17:39	3	
12/07/2023	05:16	DY 167 FISH 0021	05:37	4	
12/07/2023	11:57	DY 167 FISH 0024	11:27	5	
12/07/2023	17:15	DY 167 FISH 0027	17:31	3	
13/07/2023	05:07	DY 167 FISH 0033	05:22	8	
13/07/2023	17:10	DY 167 FISH 0039	17:26	12	
14/07/2023	04:17	DY 167 FISH 0045	05:32	1	
15/07/2023	03:47	DY 167 FISH 0051	03:55	2	
15/07/2023	09:18	DY 167 FISH 0053	09:33	5	
16/07/2023	03:12	DY 167 FISH 0057	03:32	3	
17/07/2023	03:09	DY 167 FISH 0063	03:33	6	
17/07/2023	12:27	DY 167 FISH 0066	12:47		
18/07/2023	03:20	DY 167 FISH 0071	03:40	1	
19/07/2023	03:11	DY 167 FISH 077	03:30	11	Only filtered 1.7 L
19/07/2023	23:03	DY 167 FISH 083	23:33	5	
20/07/2023	05:10	DY167 FISH 086	05:33	4	
20/07/2023	23:06	DY 167 FISH 093	23:26	1	
21/07/2023	05:02	DY 167 FISH 096	05:22	10	liquid N2 -80
21/07/2023	23:18	DY 167 FISH 0102	23:37	6	
22/07/2023	05:08	DY 167 FISH 105	05:30	10	No liquid Nitrogen available!

22/07/2023	23:17	DY 167 FISH 111	23:26	1	
23/07/2023	05:07	DY 167 FISH 0114 nifH	05:27	6	Faracas signal
23/07/2023	05:38	DY 167 FISH 0115 nifH	06:11	8	Filtered 3L instead of 2L
23/07/2023	05:38	DY 167 FISH 0115 nifH	06:11	12	Filtered 3L instead of 2L
23/07/2023	17:18	DY167 FISH 0116 nifH	17:37	2	
23/07/2023	19:31	DY167 FISH 0117 nifH	19:50	4	
23/07/2023	21:12	DY167 FISH 0118 nifH	21:10	3	
24/07/2023	05:07	DY 167 FISH 122 nifH	05:35	8	filtered for 30 min (3.1 L)
24/07/2023	09:23	DY 167 FISH 124 nifH	09:50	1	
24/07/2023	12:21	DY 167 FISH 126 nifH	12:43	2	Faracas signal
24/07/2023	13:14	DY 167 FISH 127	13:33	11	
24/07/2023	17:10	DY 167 FISH 130	17:35	7	Could not find syringe, tried a small one but did not work
25/07/2023	05:10	DY 167 FISH 136	05:32	10	
26/07/2023	03:00	DY 167 FISH 141	< 30 MIN		MQ
26/07/2023	04:00	DY 167 FISH 142	< 30 MIN		MQ
26/07/2023	05:00	DY 167 FISH 143	< 30 MIN		MQ
26/07/2023	06:00	DY 167 FISH 144	< 30 MIN		MQ
26/07/2023	07:00	DY 167 FISH 145	< 30 MIN		MQ
26/07/2023	08:10	DY 167 FISH 146	08:40		MQ
26/07/2023	09:11	DY 167 FISH 147	09:35		bleach after
26/07/2023	10:10	DY 167 FISH 148	10:43		MQ
26/07/2023	11:00	DY 167 FISH 149	< 30 MIN		MQ
26/07/2023	12:11	DY 167 FISH 150	13:50		bleach after
26/07/2023	13:10	DY 167 FISH 151	14:30	5	MQ
26/07/2023	14:37	DY 167 FISH 152	15:06		MQ
26/07/2023	15:15	DY 167 FISH 153	15:45	2	bleach after
26/07/2023	16:23	DY 167 FISH 154	16:51	3	bleach after
26/07/2023	17:14	DY 167 FISH 155	17:39	12	bleach after
26/07/2023	18:19	DY 167 FISH 156	18:46	7	bleach after

26/07/2023	19:15	DY 167 FISH 157	19:42		bleach after
26/07/2023	20:20	DY 167 FISH 158	20:50		bleach after
26/07/2023	21:15	DY 167 FISH 159	21:39		only filtered 800 ml
26/07/2023	22:15	DY 167 FISH 160	22:37		bleach after
26/07/2023	23:10	DY 167 FISH 161	23:34		bleach after
26/07/2023	00:25	DY 167 FISH 162	00:51		bleach after
27/07/2023	01:10	DY 167 FISH 163	01:40		bleach after
27/07/2023	02:06	DY 167 FISH 164	02:23	11	bleach after
27/07/2023	03:18	DY 167 FISH 165	03:55		bleach after 3L
27/07/2023	04:14	DY 167 FISH 166	04:48		bleach after 3L
27/07/2023	05:14:00	DY 167 FISH 167	05:48		3L
27/07/2023	06:24:00	DY 167 FISH 168	06:51		3L
27/07/2023	07:24:00	DY 167 FISH 169	07:53		3L MQ AFTER
27/07/2023	08:12	DY 167 FISH 170	08:47		3L BLEACH AND MQ
27/07/2023	09:15	DY 167 FISH 171	09:44		3L MQ AFTER
27/07/2023	10:11	DY 167 FISH 172	10:40		3L BLEACH AND MQ
27/07/2023	11:07	DY 167 FISH 173	11:38		3L MQ AFTER
27/07/2023	12:19	DY 167 FISH 174	12:49	8+5	3L
27/07/2023	13:19	DY 167 FISH 175	14:00	3+12	3L
27/07/2023	14:19	DY 167 FISH 176	14:41	4+6	3L
27/07/2023	15:19	DY 167 FISH 177	15:37	1+2	3L
27/07/2023	16:16	DY 167 FISH 178	17:15	9+10	3L
27/07/2023	17:22	DY 167 FISH 179	18:06	5+9	3L
27/07/2023	18:14	DY 167 FISH 180	18:44	2+3	3L
27/07/2023	19:07	DY 167 FISH 181	19:37	6+4	3L
27/07/2023	20:11	DY 167 FISH 182	20:40	11+1	3L
27/07/2023	21:12	DY 167 FISH 183	21:44	10+7	3L
27/07/2023	22:08	DY 167 FISH 184	22:35	2+12	3L
27/07/2023	23:12	DY 167 FISH 185	23:40	9+5	3L

28/07/2023	06:14	DY 167 FISH 189	06:39	7	2L
29/07/2023	12:20	DY 167 FISH 200	12:34	10	2L
29/07/2023	17:20	DY 167 FISH 201	17:35	1	2L
29/07/2023	19:15	DY 167 FISH 202	19:42	7	2L
29/07/2023	21:17	DY 167 FISH 203	21:44	2	2L
30/07/2023	01:19	DY 167 FISH 205	01:34	12	2L
30/07/2023	03:05	DY 167 FISH 206		6	FARACAS SIGNAL ~02:20 HIGH FARACAS AT 206 2L
30/07/2023	05:18	DY 167 FISH 207	05:39	2	2L
30/07/2023	07:19	DY 167 FISH 208	07:37	10	2L
30/07/2023	09:15	DY 167 FISH 209	09:42	4	2L
30/07/2023	11:08	DY 167 FISH 210	11:32	1	2L
30/07/2023	19:14	DY 167 FISH 211	19:31	11	2L
30/07/2023	21:23	DY 167 FISH 213	21:37	8	2L
30/07/2023	23:10	DY 167 FISH 214	23:30	9	2L
31/07/2023	01:22	DY 167 FISH 215	01:36	10	2L
31/07/2023	03:07	DY 167 FISH 216	03:27	6	High Faracas signal - lots of material
31/07/2023	05:14	DY 167 FISH 217	05:38	3	1.8 L
31/07/2023	07:10	DY 167 FISH 218	07:42	2	2L
31/07/2023	09:14	DY 167 FISH 219	09:40	3	2L
31/07/2023	11:14	DY 167 FISH 220	11:34	1	2L
31/07/2023	14:14	DY 167 FISH 221	14:33	11	Faracas signal 2L
31/07/2023	16:10	DY 167 FISH 222	16:32	8	2L
31/07/2023	19:27	DY 167 FISH 224	19:40	6	1.8 L
31/07/2023	21:16	DY 167 FISH 225	21:38	9	2L
31/07/2023	23:20	DY 167 FISH 226	23:45	12	2L
01/08/2023	01:18	DY 167 FISH 227	01:36	3	2L
01/08/2023	03:15	DY 167 FISH 228	03:39	10	2L
01/08/2023	05:18	DY 167 FISH 229	05:40	1	2L
01/08/2023	07:15	DY 167 FISH 230	07:37	12	2L

01/08/2023	09:20	DY 167 FISH 231	09:44	2	2L
01/08/2023	11:26	DY 167 FISH 232	11:45	7	2L
01/08/2023	17:12	DY 167 FISH 233	17:29	6	2L
01/08/2023	19:17	DY 167 FISH 234	19:37	8	2L
01/08/2023	21:18	DY 167 FISH 235	21:37	10	2L
01/08/2023	23:11	DY 167 FISH 236	23:28	4	2L
02/08/2023	01:16	DY 167 FISH 237	01:33	2	2L
02/08/2023	03:10	DY 167 FISH 238	03:37	7	2L
02/08/2023	05:17	DY 167 FISH 239	05:39		2L
02/08/2023	07:09	DY 167 FISH 240	07:31	4	2L
02/08/2023	09:20	DY 167 FISH 241	09:40	3	2L
02/08/2023	11:14	DY 167 FISH 242	11:34	1	2L
02/08/2023	19:12	DY 167 FISH 243	19:32	12	2L
02/08/2023	22:15	DY 167 FISH 244	22:36	4	2L
03/08/2023	01:10	DY 167 FISH 245	01:29	6	Forgot to clay ends before freezing in liquid N2, clayed after frozen
03/08/2023	04:29	DY 167 FISH 246	04:56	10	2L
03/08/2023	07:09	DY 167 FISH 247	07:40	2	1.44 L
03/08/2023	10:29	DY 167 FISH 248	11:10	4	2L
03/08/2023	14:46	DY167 FISH 249	15:12	8	2L
03/08/2023	16:08	DY167 FISH 250	16:32	5	
03/08/2023	18:25	DY167 FISH 251	18:56	12	
03/08/2023	20:09	DY167 FISH 252	20:35	10+9	tried to put 3L through but only got 1.6 L. dark colour on filter
03/08/2023	22:25	DY167 FISH 253	23:00	6+4	2.4L
04/08/2023	00:10	DY167 FISH 254	00:40	1+7	2.2L
04/08/2023	02:25	DY167 FISH 256			
04/08/2023	04:11	DY167 FISH 257	04:44		2L
04/08/2023	06:17	DY167 FISH 258	06:58		1.2L
04/08/2023	08:08	DY167 FISH 259	08:39	3	1.15L
04/08/2023	10:13	DY167 FISH 260	10:58	4	1350ml only

04/08/2023	12:27	DY 167 FISH 261	12:46	3	2L
04/08/2023	14:12	DY 167 FISH 262	14:35	11	2L
04/08/2023	16:06	DY 167 FISH 263	16:25	7	2L
04/08/2023	19:20	DY 167 FISH 265	19:52	5	1.4 L
04/08/2023	23:12	DY 167 FISH 267	23:40	6	1.4 L
05/08/2023	03:14	DY 167 FISH 269	03:45	10	2L
05/08/2023	05:16	DY 167 FISH 270	05:43	10	2L
05/08/2023	12:20	DY 167 FISH 274	12:55	1	2L
05/08/2023	17:11	DY 167 FISH 277	17:25	10	High Faracas signal - lots of material
05/08/2023	22:37	DY 167 FISH 280	22:54	3	High Faracas signal - lots of material
06/08/2023	05:17	DY 167 FISH 283	05:42	3	No liquid Nitrogen available!
07/07/2023	22:10	DY 167 FISH 289	22:26	11	
08/07/2023	07:31	DY 167 FISH 292	07:57	4	
09/08/2023	05:18	DY 167 FISH 298	05:46	6	forgot to flash freeze sample
09/08/2023	21:16	DY 167 FISH 304	21:37	12	
10/08/2023	00:03	DY 167 FISH 306	00:25		
10/08/2023	03:10	DY 167 FISH 308	3:28:00		High biomass
10/08/2023	04:48	DY 167 FISH 307	05:16		1.5 L
10/08/2023	04:50	DY 167 UW 309	05:10		1.5 L
10/08/2023	04:40	DY 167 FISH 309	06:30		2L
10/08/2023	06:00	DY 167 UW 310	06:30		2L
10/08/2023	06:00	DY 167 FISH 310	07:39		2L
10/08/2023	07:22	DY 167 UW 311	07:39		2L
10/08/2023	07:22	DY 167 FISH 311	08:46		2L
10/08/2023	08:12	DY 167 UW 312	08:46		2L
10/08/2023	09:16	DY 167 FISH312	09:49		2L
10/08/2023	09:16	DY 167 UW 313	09:49		2L
10/08/2023	10:10	DY 167 FISH 313	10:38		2L
10/08/2023	10:10	DY 167 UW 314	10:38		2L

10/08/2023	11:07	DY 167 FISH 314	11:21		2L
10/08/2023	11:07	DY 167 UW 315	11:21		2L
10/08/2023	13:04	DY 167 FISH 315	03:28		2L
10/08/2023	13:04	DY 167 UW 316	12:21		2L
10/08/2023	13:27	DY 167 FISH 316	13:45		2L
10/08/2023	13:27	DY 167 UW 317	13:45		2L
10/08/2023	14:17	DY 167 FISH 317	14:33		2L
10/08/2023	14:17	DY 167 UW 318	14:33		2L
10/08/2023	15:12	DY 167 FISH 318	15:28		2L
10/08/2023	15:12	DY 167 UW319	15:28		2L
10/08/2023	16:06	DY 167 FISH 320	16:23		2L
10/08/2023	16:07	DY 167 UW 320	16:23		2L
10/08/2023	17:03	DY 167 UW 321	17:22		2L

Date	Time sampled	Sample ID	Time finished	Bottle	Station	Comments
14/07/2023	14:05	DY 167 CTD 008S	14:26	12	Stn N00	
14/07/2023	14:03	DY 167 CTD 021S	14:26	7	Stn N00	
14/07/2023	14:05	DY 167 CTD 016S	14:26	9	Stn N00	
15/07/2023	14:52	DY 167 CTD 045S	15:09	11	Stn N01	
15/07/2023	14:52	DY 167 CTD 040S	15:09	8	Stn N01	
15/07/2023	14:52	DY 167 CTD 034S	15:09	10	Stn N01	
16/07/2023	14:32	DY 167 CTD 064S	15:57	11	Stn N02	
16/07/2023	14:32	DY 167 CTD 060S	15:57	12	Stn N02	
16/07/2023	14:32	DY 167 CTD 070S	15:57:00	7	Stn N02	
18/07/2023	13:31	DY 167 CTD 085S	13:50	9	Stn N03 (N04)	Different station on the sticker
18/07/2023	13:31	DY 167 CTD 089S	13:50	12	Stn N03 (N04)	
18/07/2023	13:31	DY 167 CTD 093S	13:50	6	Stn N03 (N04)	

19/07/2023	13:29	DY 167 CTD 108S	13:57	8	Stn N05	
19/07/2023	13:29	DY 167 CTD 112S	13:57	12	Stn N05	
19/07/2023	13:29	DY 167 CTD 117S	13:57	7	Stn N05	
20/07/2023	12:54	DY 167 CTD 150S	13:10	12	Stn N12	
21/07/2023	13:33	DY 167 CTD 166S	13:50	9	Stn N07	
21/07/2023	13:33	DY 167 CTD 170S	14:05	11	Stn N07	Filter blocked, had to give up pumping all volume. Approx. 1.8 L
21/07/2023	13:33	DY 167 CTD 176S	13:51	5	Stn N07	
22/07/2023	12:59	DY 167 CTD 192S	13:20	8	Stn N10	
22/07/2023	12:59	DY 167 CTD 199S	13:17	3	Stn N10	
23/07/2023	13:17	DY 167 CTD 235S	13:51	12	Stn N09	
23/07/2023	13:17	DY 167 CTD 240S	14:06	10	Stn N09	
23/07/2023	13:17	DY 167 CTD 249S	13:50	7	Stn N09	
25/07/2023	16:23	DY 167 CTD 283S	16:52	6	Stn N08	
25/07/2023	16:23	DY 167 CTD 289S	17:03	8	Stn N08	
25/07/2023	16:23	DY 167 CTD 297S	16:52	10	Stn N08	
28/07/2023	13:16	DY 167 CTD 406S	13:42	10	Stn N07x	
28/07/2023	13:16	DY 167 CTD 410S	13:39	12	Stn N07 x	
28/07/2023	13:16	DY 167 CTD 417S	13:36	11	Stn N07x	
30/07/2023	13:21	DY 167 CTD 431S	13:44	7	Stn N06	
30/07/2023	13:21	DY 167 CTD 436S	13:44	12	Stn N06	
30/07/2023	13:21	DY 167 CTD 441S	13:44	3	Stn N06	
31/07/2023	13:26	DY 167 CTD 455S	13:46	4	Stn N05	
31/07/2023	13:26	DY 167 CYD 461S	13:53	7	Stn N05	
31/07/2023	13:26	DY 167 CTD 465S	13:47	5	Stn N05	
01/08/2023	13:20	DY 167 CTD 480s	13:40	5	STN N13	
01/08/2023	13:20	DY 167 CTD 484S	13:40	7	STN N13	
01/08/2023	13:20	DY 167 CTD 490S	13:40	2	STN N13	
02/08/2023	13:04	DY 167 CTD 504S	13:23	11	STN N15	
02/08/2023	13:04	DY 167 CTD 508S	13:28	2	STN N15	

02/08/2023	13:04	DY 167 CTD 513S	13:28	9	STN N15	
03/07/2023	13:04	DY 167 CTD 529S	13:28	11	STN N16	
03/07/2023	13:04	DY 167 CTD 537S	13:28	7	STN N16	
03/07/2023	13:04	DY 167 CTD 533S	13:40	9	STN N16	
06/08/2023	13:19	DY 167 CTD 552S	13:41	8	Stn N03	Faulty pumps for CTD 552S, 557S, 561S
06/08/2023	13:21	DY 167 CTD 557S	13:41	12	Stn N03	
06/08/2023	13:19	DY 167 CTD 561S	19:41	3	Stn N03	Forgot to clay ends before N2 :(
08/08/2023	13:04	DY 167 CTD 648S	13:22	3	Stn N17	Stickers for this CTD came out wrong, but was corrected when labelling
08/08/2023	13:04	DY 167 CTD 652S	13:22	11	Stn N17	
08/08/2023	13:04	DY 167 CTD 657S	13:22	5	Stn N17	
09/08/2023	13:31	DY 167 CTD 671S	13:51	5	Stn N18	
09/08/2023	13:31	DY 167 CTD 675S	13:52	3	Stn N18	
09/08/2023	13:31	DY 167 CTD 681S	13:53	11	Stn N18	
10/08/2023	13:05	DY 167 CTD 696S	13:19		Stn N19	
10/08/2023	13:05	DY 167 CTD 700S	13:20		Stn N19	
10/08/2023	13:05	DY 167 CTD 705S	13:25		Stn N19	

Date	Time sampled	Sample ID	Time finished	Bottle	Comments
19/07/2023	15:13	DIAZO1 T0 nifH	15:34	1	
21/07/2023	13:27	DIAZO 2 T0 nifH	13:46	1	
23/07/2023	14:18	DIAZO 1 control bottle 5 set A	14:46	5	
23/07/2023	14:18	DIAZO 1 control bottle 6 set A	14:46	6	
23/07/2023	14:18	DIAZO 1 control bottle 7 set A	14:46	7	
23/07/2023	15:08	DIAZO 1 DOCP+Fe bottle 8 set A	15:30	8	

23/07/2023	15:08	DIAZO 1 DOCP+Fe bottle 9 set A	15:30	9	
23/07/2023	15:08	DIAZO 1 DOCP+Fe bottle 10 set A	15:30	10	
23/07/2023	16:00	DIAZO 1 DON bottle 11 set A	16:25	11	
23/07/2023	16:00	DIAZO 1 DON bottle 12 set A	16:25	12	
23/07/2023	16:00	DIAZO 1 DON bottle 13 set A	16:25	13	
25/07/2023	13:10	DIAZO 2 control bottle 5 set B	13:50	5	
25/07/2023	13:10	DIAZO 2 control bottle 6 set B	13:50	6	
25/07/2023	13:10	DIAZO 2 control bottle 7 set B	13:50	7	
25/07/2023	14:09	DIAZO 2 DOCP + Fe bottle 8 set B	14:41	8	
25/07/2023	14:09	DIAZO 2 DOCP + Fe bottle 9 set B	14:41	9	
25/07/2023	14:09	DIAZO 2 DOCP + Fe bottle 10 set B	14:41	10	
25/07/2023	18:10	DIAZO 2 DON bottle 11 set B	18:41	11	
25/07/2023	18:10	DIAZO 2 DON bottle 12 set B	18:41	12	
25/07/2023	18:10	DIAZO 2 DON bottle 13 set B	18:41	13	
25/07/2023	18:58	DIAZO 2 IRON bottle 14 set B	19:29	14	
25/07/2023	18:58	DIAZO 2 IRON bottle 15 set B	19:29	15	
25/07/2023	18:58	DIAZO 2 IRON bottle 16 set B	19:29	16	
26/07/2023	13:54	DIAZO 3 T0 BOTTLE 1 BLUE TAPE	14:30	1	

29/07/2023	14:11	DIAZO 3 Control bottle 5 Set A	14:47	5	
29/07/2023	14:11	DIAZO 3 Control bottle 6 Set A	14:47	6	
29/07/2023	14:11	DIAZO 3 Control bottle 7 Set A	14:47	7	
29/07/2023	15:20	DIAZO 3 DOCP + Fe Bottle 8 Set A	16:05	8	
29/07/2023	15:20	DIAZO 3 DOCP + Fe Bottle 9 Set A	16:05	9	
29/07/2023	15:20	DIAZO 3 DOCP + Fe Bottle 10 Set A	16:05	10	
29/07/2023	16:25	DIAZO 3 DON bottle 11 Set A	17:04	11	
29/07/2023	16:25	DIAZO 3 DON bottle 12 Set A	17:04	12	
29/07/2023	16:25	DIAZO 3 DON bottle 13 Set A	17:04	13	
29/07/2023	18:11	DIAZO 3 IRON bottle 14 Set A	18:32	14	
29/07/2023	18:11	DIAZO 3 IRON bottle 15 Set A	18:32	15	
29/07/2023	18:11	DIAZO 3 IRON bottle 16 Set A	18:32	16	
30/07/2023	13:50	DIAZO 4 T0 BOTTLE 1 BLUE TAPE	14:25	1	
31/07/2023	14:07	DIAZO 5 T0 BOTTLE 1 BLUE TAPE	14:30	1	
02/08/2023	13:45	DIAZO 4 control bottle 5 set B	14:08	5	
02/08/2023	13:45	DIAZO 4 control bottle 6 set B	14:06	6	
02/08/2023	13:45	DIAZO 4 control bottle 7 set B	14:14	7	
02/08/2023	14:26	DIAZO 4 DOCP + Fe bottle 8 set B	14:50	8	

02/08/2023	14:26	DIAZO 4 DOCP + Fe bottle 9 set B	14:50	9	
02/08/2023	14:26	DIAZO 4 DOCP + Fe bottle 10 set B	14:48	10	
02/08/2023	15:06	DIAZO 4 DON bottle 11 set B	15:30	11	
02/08/2023	15:06	DIAZO 4 DON bottle 12 set B	15:30	12	
02/08/2023	15:06	DIAZO 4 DON bottle 13 set B	15:30	13	
02/08/2023	15:42	DIAZO 4 IRON bottle 14 set B	16:04	14	
02/08/2023	15:42	DIAZO 4 IRON bottle 15 set B	16:03	15	
02/08/2023	15:42	DIAZO 4 IRON bottle 16 set B	16:06	16	
02/08/2023	16:22	DIAZO 4 PHOSPHATE bottle 29 set B	16:45	29	
02/08/2023	16:22	DIAZO 4 PHOSPHATE bottle 30 set B	16:43	30	
02/08/2023	16:22	DIAZO 4 PHOSPHATE bottle 31 set B	16:47	31	
02/08/2023	18:05	DIAZO 5 control bottle 5 set B	18:36	5	
02/08/2023	18:05	DIAZO 5 control bottle 6 set B	18:29	6	
02/08/2023	18:05	DIAZO 5 control bottle 7 set B	18:36	7	
02/08/2023	19:11	DIAZO 5 DOCP + Fe bottle 8 set B	19:38	8	
02/08/2023	19:11	DIAZO 5 DOCP + Fe bottle 9 set B	19:36	9	
02/08/2023	19:11	DIAZO 5 DOCP + Fe bottle 10 set B	19:42	10	
02/08/2023	20:09	DIAZO 5 PHOSPHATE bottle 14 set B	20:43	14	

02/08/2023	20:09	DIAZO 5 PHOSPHATE bottle 15 set B	20:39	15	
02/08/2023	20:09	DIAZO 5 PHOSPHATE bottle 15 set B	20:39	16	
03/08/2023	13:21	DIAZO 6, T0, BOTTLE 1	13:48	1	
05/08/2023	12:09	DIAZO 6 control bottle 5 set B	12:33	5	
05/08/2023	12:09	DIAZO 6 control bottle 6 set B	12:33	6	
05/08/2023	12:09	DIAZO 6 control bottle 7 set B	12:40	7	don't think the pump was put on right. It was slow even after unclamping and reclamping. Only 1.5 L
05/08/2023	12:57	DIAZO 6 DOCP + Fe bottle 8 set B	13:20	8	
05/08/2023	12:57	DIAZO 6 DOCP + Fe bottle 9 set B	13:25	9	
05/08/2023	12:57	DIAZO 6 DOCP + Fe bottle 10 set B	13:25	10	
05/08/2023	13:46	DIAZO 6 DON bottle 11 set B	14:07	11	
05/08/2023	13:46	DIAZO 6 DON bottle 12 set B	14:06	12	
05/08/2023	13:46	DIAZO 6 DON bottle 13 set B	14:09	13	
05/08/2023	14:31	DIAZO 6 IRON bottle 14 set B	14:49	14	
05/08/2023	14:31	DIAZO 6 IRON bottle 15 set B	14:51	15	
05/08/2023	14:31	DIAZO 6 IRON bottle 16 set B	15:27	16	
05/08/2023	15:04	DIAZO 6 PHOSPHATE bottle 29 set B	15:24	29	
05/08/2023	15:04	DIAZO 6 PHOSPHATE bottle 30 set B	15:27	30	
05/08/2023	15:04	DIAZO 6 PHOSPHATE bottle 31 set B	15:56	31	bottle 16 and 31 were swapped during filtering.

07/08/2023	13:10	DIAZO 7, T0, BOTTLE 1	13:33	1	
09/08/2023	14:00	DIAZO 7 control bottle 5 set B	14:22	5	
09/08/2023	14:00	DIAZO 7 control bottle 6 set B	14:23	6	
09/08/2023	14:00	DIAZO 7 control bottle 7 set B	14:24	7	
09/08/2023	14:30	DIAZO 7 DOCP + Fe bottle 8 set B	14:51	8	
09/08/2023	14:30	DIAZO 7 DOCP + Fe bottle 9 set B	14:52	9	
09/08/2023	14:30	DIAZO 7 DOCP + Fe bottle 10 set B	14:53	10	
09/08/2023	15:01	DIAZO 7 DON bottle 11 set B	15:23	11	
09/08/2023	15:01	DIAZO 7 DON bottle 12 set B	15:22	12	
09/08/2023	15:01	DIAZO 7 DON bottle 13 set B	15:24	13	
09/08/2023	15:30	DIAZO 7 IRON bottle 14 set B	15:33	14	
09/08/2023	15:30	DIAZO 7 IRON bottle 15 set B	15:55	15	
09/08/2023	15:30	DIAZO 7 IRON bottle 16 set B	15:54	16	
09/08/2023	16:01	DIAZO 7 PHOSPHATE bottle 29 set B	16:24	29	
09/08/2023	16:01	DIAZO 7 PHOSPHATE bottle 30 set B	16:24	30	
09/08/2023	16:01	DIAZO 7 PHOSPHATE bottle 31 set B	16:25	31	
09/08/2023	16:43	DIAZO 8 control bottle A	17:05	A	
09/08/2023	16:43	DIAZO 8 control bottle B	17:05	B	

09/08/2023	16:43	DIAZO 8 control bottle C	17:05	C	
09/08/2023	16:43	DIAZO 8 DOCP+Fe bottle A	17:05	A	
09/08/2023	16:43	DIAZO 8 DOCP+Fe bottle B	17:05	B	
09/08/2023	16:43	DIAZO 8 DOCP+Fe bottle C	17:05	C	
09/08/2023	16:43	DIAZO 8 IRON bottle A	17:05	A	
09/08/2023	16:43	DIAZO 8 IRON bottle B	17:05	B	
09/08/2023	16:43	DIAZO 8 IRON bottle C	17:05	C	

Date	Time sampled	Sample ID	Time finished	Bottle	Station	Comments
12/07/2023	09:05	DY 167 FISH NL TØ B 0001	09:26	12		
12/07/2023	10:33	DY 167 FISH NL TØ M 0002	10:52	2		no clay
12/07/2023	11:38	DY 167 FISH NL TØ E 0003	11:59	1		ran dry
16/07/2023	16:16	DY 167 NutLim D4 C	16:30		Stn T1	Break down of experiment at T96 NutLim #end =96hours
16/07/2023	16:16	DY 167 NutLim D4 E	16:30		Stn T1	2L filled onto sterivex
16/07/2023	16:16	DY 167 NutLim D4 G	16:30		Stn T1	Liquid N2 + -80*C
16/07/2023	16:16	DY 167 NutLim D4 L	16:30		Stn T1	O = 1.2 L only
16/07/2023	16:30	DY 167 NutLim D4 O	17:00		Stn T1	X = 1.2 L only
16/07/2023	16:30	DY 167 NutLim D4 Q	17:00		Stn T1	
16/07/2023	16:30	DY 167 NutLim D4 T	17:00		Stn T1	Mixed up the last two
16/07/2023	16:30	DY 167 NutLim D4 X	17:00		Stn T1	
18/07/2023	13:45	DY 167 NutLim TØ B Stn N004	14:08	10	Stn N004	First
18/07/2023	14:51	DY 167 Nutlim TØ M Stn N004	14:51	1	Stn N004	Middle
18/07/2023	15:53	DY 167 NutLim TØ E Stn N004	16:16	3	Stn N004	Last

21/07/2023	12:45	DY 167 Nutlim TØ B STN N07	13:08	7	Stn N07	First
21/07/2023	13:38	DY 167 NutLim TØ E Stn N07	14:05	4	Stn N07	Middle
21/07/2023	14:45	DY 167 Nutlim TØ M Stn N07	15:05	2	Stn N07	Last Messed this one up and poured appox 0.2 L out
25/07/2023	10:51	DY 167 NutLim D4 A	11:12	8		
25/07/2023	10:53	DY 167 NutLim D4 K	11:22	11		
25/07/2023	10:53	DY 167 NutLim D4 S	11:24	9		
25/07/2023	11:32	DY 167 NutLim D4 O	11:57	10		1.16 L FILTERED
25/07/2023	11:34	DY 167 NutLim D4 P	12:03	7		1.53 L FILTERED
25/07/2023	11:46	DY 167 NutLim D4 W	12:12	12		1.05 L FILTERED
25/07/2023	12:00	DY 167 NutLim D4 F	12:20	2		1.46 L FILTERED
25/07/2023	12:06	DY 167 NutLim D4 G	12:35			
25/07/2023	12:38	DY 167 NutLim TØ B STN N08	13:03	3	Stn N08	
25/07/2023	14:17	DY 167 NutLim TØ M Stn N08	14:44	5	Stn N08	
28/07/2023	12:20	DY 167 NutLim TØ B Stn N07x	12:42	4	Stn N07x	start
29/07/2023	12:20	DY 167 NutLim TØ B Stn N07 y	12:34	9	Stn N07 y	start
29/07/2023	13:26	DY 167 NutLim TØ M Stn N07 y	13:50	5	Stn N07 y	middle
29/07/2023	14:27	DY 167 NutLim TØ E Stn N07 y	15:05	3	Stn N07 y	end
01/08/2023		DY 167 NutLim D7 L			Stn N08	2L filled onto sterivex
01/08/2023	11:10	DY 167 NutLim D7 X	11:31		Stn N08	2L filled onto sterivex
01/08/2023	11:26	DY 167 NutLim D7 Q	11:45	1	Stn N08	2L filled onto sterivex
01/08/2023	11:26	DY 167 NutLim D7 M	11:47	5	Stn N08	2L filled onto sterivex
01/08/2023	11:26	DY 167 NutLim D7 S	11:46	6	Stn N08	2L filled onto sterivex
01/08/2023	11:59	DY 167 NutLim D7 E	12:17	11	Stn N08	2L filled onto sterivex
01/08/2023	11:59	DY 167 NutLim D7 A	12:18	4	Stn N08	2L filled onto sterivex
01/08/2023	11:59	DY 167 NutLim D7 G	12:18	3	Stn N08	2L filled onto sterivex
02/08/2023	12:29	DY 167 NutLim TØ B Stn N15	12:44	8	Stn N15	2L filled onto sterivex (begin)
04/08/2023	10:39	DY 167 NutLim D6 V (labelled vd6)	11:20	1	Stn N07-Y	2L
04/08/2023	10:44	DY 167 NutLim D6 R (labelled rd6)	11:20	5	Stn N07-Y	2L
04/08/2023	11:10	DY 167 NutLim D6 A	11:36	2	Stn N07-Y	2L

04/08/2023	11:18	DY 167 NutLim D6 G	11:40	12	Stn N07-Y	2L
04/08/2023	11:31	DY 167 NutLim D6 N	11:50	10	Stn N07-Y	2L
04/08/2023	11:31	DY 167 NutLim D6 U	11:48	9	Stn N07-Y	2L
04/08/2023	11:47	DY 167 NutLim D6 F	12:06	6	Stn N07-Y	2L
04/08/2023	11:47	DY 167 NutLim D6 K	12:06	7	Stn N07-Y	2L
06/08/2023	12:43	DY 167 NutLim T0, TØ B	13:07	1	Stn N03	2L
06/08/2023	14:08	DY 167 NutLim T0, TØ M	14:24	10	Stn N03	2L
06/08/2023	15:06	DY 167 NutLim T0, TØ E	15:21	2	Stn N03	2L
08/08/2023	10:55	DY 167 NutLim D6 I	11:11	12	Stn N15	2L
08/08/2023	10:55	DY 167 NutLim D6 J	11:15	8	Stn N15	2L
08/08/2023	11:06	DY 167 NutLim D6 C	11:23	10	Stn N15	2L
08/08/2023	11:18	DY 167 NutLim D6 U	11:35	9	Stn N15	2L
08/08/2023	11:21	DY 167 NutLim D6 E	11:37	2	Stn N15	2L
08/08/2023	11:21	DY 167 NutLim D6 M	11:37	6	Stn N15	2L
08/08/2023	11:45	DY 167 NutLim D6 Q	12:03	7	Stn N15	2L
08/08/2023	11:45	DY 167 NutLim D6 V	12:03	8	Stn N15	2L
12/08/2023	09:28	DY 167 NutLim D6 J	09:46		Stn N03	2L
12/08/2023	09:28	DY 167 NutLim D6 E	09:46		Stn N03	2L
12/08/2023	09:42	DY 167 NutLim D6 Q	10:00		Stn N03	2L
12/08/2023	09:43	DY 167 NutLim D6 U	10:03		Stn N03	2L
12/08/2023	09:55	DY 167 NutLim D6 X	10:16		Stn N03	2L
12/08/2023	10:00	DY 167 NutLim D6 C	10:18		Stn N03	2L
12/08/2023	10:12	DY 167 NutLim D6 I	10:30		Stn N03	2L
12/08/2023	10:19	DY 167 NutLim D6 M	10:45		Stn N03	2L

Date	Time sampled	Sample ID	Time finished	Bottle	Comments
27/07/2023	16:13	DY 167 ICE 1 (4 L)	17:12	7 + 12	3.8 L
27/07/2023	16:13	DY 167 ICE 2 (2 L)	16:38	11	2L

9.12 Appendix L – CARD-FISH Sample Logs

Table 9.8 List of CARD-FISH samples collected.

Date (dd/mm/yyyy)	Station	Latitude decimal (°N)	Longitude decimal (°E)	Experiment	Sample ID	Filter tube #	Date (dd/mm/yyyy)/time (GMT) fixation	Date (dd/mm/yyyy)/time (GMT) filtration
23/07/2023	N12	75.50	22.50	DIAZO1	Control	15820	23/07/2023 14:00	23/07/2023 15:40
23/07/2023	N12	75.50	22.50	DIAZO1	DOCPFe	15821	23/07/2023 14:13	23/07/2023 15:40
23/07/2023	N12	75.50	22.50	DIAZO1	DON	15822	23/07/2023 14:14	23/07/2023 15:40
24/07/2023	FISH 23/07/2023 05:09	79.42	27.88	FISH	FISH114-1	15823	24/07/2023 05:45	24/07/2023 09:00
25/07/2023	FISH 24/07/2023 12:20	78.45	28.41	FISH	FISH126-1	15824	25/07/2023 15:07	25/07/2023 16:07
25/07/2023	N10	78.66	24.65	DIAZO2	Fe	15825	25/07/2023 15:07	25/07/2023 16:07
25/07/2023	N10	78.66	24.65	DIAZO2	Control	15826	25/07/2023 15:07	25/07/2023 16:07
25/07/2023	N10	78.66	24.65	DIAZO2	DOCPFe	15827	25/07/2023 15:07	25/07/2023 16:07
25/07/2023	N10	78.66	24.65	DIAZO2	DON	15828	25/07/2023 15:07	25/07/2023 16:07
27/07/2023	N08	79.35	33.91	DIAZO3	T0	15829	27/07/2023 14:30	27/07/2023 16:45
29/07/2023	N07y	78.06	26.68	DIAZO3	Control	15830	29/07/2023 16:02	29/07/2023 17:24
29/07/2023	N07y	78.06	26.68	DIAZO3	Fe	15831	29/07/2023 16:02	29/07/2023 17:24
29/07/2023	N07y	78.06	26.68	DIAZO3	DON	15832	29/07/2023 16:02	29/07/2023 17:24
29/07/2023	N07y	78.06	26.68	DIAZO3	DOCPFe	15833	29/07/2023 16:02	29/07/2023 17:24
31/07/2023	N05	78.06	26.68	DIAZO4	T0	15834	31/07/2023 14:00	31/07/2023 17:05
31/07/2023	FISH 31/07/2023 02:48	75.27	28.87	FISH	FISH216-1	15835	01/08/2023 03:21	01/08/2023 10:45
31/07/2023	FISH 31/07/2023 05:11	75.08	28.59	FISH	FISH217-2	15836	01/08/2023 05:28	01/08/2023 10:45
31/07/2023	N05	74.61	27.90	DIAZO5	T0	15837	01/08/2023 14:37	01/08/2023 16:15
02/08/2023	N06	76.00	30.00	DIAZO4	Control	15838	02/08/2023 11:33	02/08/2023 13:05
02/08/2023	N06	76.00	30.00	DIAZO4	DOCPFe	15839	02/08/2023 11:33	02/08/2023 13:05
02/08/2023	N06	76.00	30.00	DIAZO4	DON	15840	02/08/2023 14:23	02/08/2023 20:23
02/08/2023	N06	76.00	30.00	DIAZO4	Fe	15841	02/08/2023 14:59	02/08/2023 20:23

02/08/2023	N06	76.00	30.00	DIAZO4	P	15842	02/08/2023 15:13	02/08/2023 20:23
02/08/2023	N05	74.61	27.90	DIAZO5	Control	15843	02/08/2023 16:16	02/08/2023 21:07
02/08/2023	N05	74.61	27.90	DIAZO5	DOCPFe	15844	02/08/2023 17:26	02/08/2023 21:07
02/08/2023	N05	74.61	27.90	DIAZO5	P	15845	02/08/2023 17:26	02/08/2023 21:07
04/08/2023	N16	78.52	19.27	DIAZO6	T0	15846	04/08/2023 13:46	04/08/2023 17:29
05/08/2023	N16	78.52	19.27	DIAZO6	Control	15847	05/08/2023 12:05	05/08/2023 15:02
05/08/2023	N16	78.52	19.27	DIAZO6	DOCPFe	15848	05/08/2023 12:48	05/08/2023 15:02
05/08/2023	N16	78.52	19.27	DIAZO6	DON	15849	05/08/2023 13:17	05/08/2023 15:02
05/08/2023	N16	78.52	19.27	DIAZO6	Fe	15850	05/08/2023 14:41	05/08/2023 18:20
05/08/2023	N16	78.52	19.27	DIAZO6	P	15851	05/08/2023 14:41	05/08/2023 18:28
08/08/2023	N18	73.50	30.00	DIAZO7	T0	15852	08/08/2023 14:03	08/08/2023 20:20
09/08/2023	N18	73.50	30.00	DIAZO7	Control	15853	09/08/2023 13:55	09/08/2023 15:33
09/08/2023	N18	73.50	30.00	DIAZO7	DOCPFe	15854	09/08/2023 14:04	09/08/2023 15:33
09/08/2023	N18	73.50	30.00	DIAZO7	DON	15855	09/08/2023 14:21	09/08/2023 15:33
09/08/2023	N18	73.50	30.00	DIAZO7	Fe	15856	09/08/2023 15:14	09/08/2023 18:48
09/08/2023	N18	73.50	30.00	DIAZO7	P	15857	09/08/2023 15:32	09/08/2023 18:48
11/08/2023	N19	74.00	36.00	CTD207S	Surface	15858	11/08/2023 13:20	11/08/2023 16:07
11/08/2023	N19	74.00	36.00	CTD207S	DCM	15859	11/08/2023 13:20	11/08/2023 16:07
11/08/2023	N19	74.00	36.00	CTD207S	Deep	15860	11/08/2023 14:38	11/08/2023 16:07

9.13 Appendix M – MSC Sample Logs

Table 9.9 MSC deployment metadata.

Event	MSC ID	Station	Precedent CTD cast	Date (dd/mm/yyyy)	t_i sedimentation (GMT)	t_f sedimentation (GMT)	Latitude (°N)	Latitude (′N)	Longitude (°E)	Longitude (′E)	Deployment depth (m)	Temp at deployment depth (°C)
005	MSC005	N00	CTD001S	14/07/2023	14:03	16:10	69.00	17.30	6.00	11.50	30.00	10.50
008	MSC008	N01	CTD003S	15/07/2023	13:36	15:36	70.00	59.98	10.00	59.99	30.00	7.00
017	MSC017	N04	CTD007S	18/07/2023	14:07	16:15	73.00	43.47	23.00	22.08	30.00	6.80
029	MSC029	N12	CTD013S	20/07/2023	13:01	15:01	75.00	30.04	22.00	29.87	37.00	4.00
034	MSC034	N07	CTD015S	21/07/2023	13:40	15:40	77.00	59.95	29.00	59.95	55.00	-1.50
042	MSC042	N10	CTD018S	22/07/2023	12:45	14:45	78.00	39.51	24.00	39.00	52.00	-1.50
046	MSC045	N09	CTD021S	23/07/2023	13:14	15:15	79.00	22.99	27.00	46.00	66.00	-1.00
050	MSC050	N08	CTD024S	25/07/2023	15:59	18:00	79.00	20.44	33.00	58.14	56.00	-1.00
062	MSC062	N08	CTD103S	27/07/2023	14:01	16:00	79.00	22.12	33.00	28.46	54.00	-0.80
067	MSC067	N07x	CTD105S	28/07/2023	13:14	15:13	78.00	32.23	30.00	2.97	53.00	-1.80
071	MSC071	N06	CTD108S	30/07/2023	13:04	15:05	76.00	0.00	29.00	59.97	36.00	3.50
074	MSC074	N05	CTD110S	31/07/2023	13:09	15:09	74.00	36.59	27.00	53.94	22.00	7.00
077	MSC077	N13	CTD112S	01/08/2023	13:15	15:15	76.00	20.00	19.00	59.93	35.00	6.00
081	MSC081	N15	CTD114S	02/08/2023	12:44	14:45	77.00	13.31	19.00	20.67	30.00	1.20
084	MSC084	N16	CTD116S	03/08/2023	12:51	14:52	78.00	30.92	78.52	19.00	28.50	3.50
093	MSC093	N03	CTD121S	06/08/2023	12:54	14:55	72.00	51.60	72.86	19.00	31.00	8.00
094	MSC094	N03	CTD121S	06/08/2023	13:07	13:05 (+1day)	23.97	72.00	72.86	19.00	31.00	8.00
098	MSC098	N03	CTD162S	07/08/2023	12:16	14:16	72.00	51.60	19.00	4.23	28.00	8.00
103	MSC103	N17	CTD203S	08/08/2023	12:47	12:47 (+1day)	72.00	29.99	59.90	25.00	41.00	6.50

9.14 Appendix N – DCM community transcription sample logs

Table 9.10 RNA samples collected from repeated high-resolution DCM casts.

Date (dd/mm/yyyy)	Station	Latitude (°N)	Longitude (°E)	Event	CTD cast	Niskin No	Depth (m)	RNA sample ID	Vol filtered (ml)
26/07/2023	N08	79.36	33.79	053	CTD039S	22	10	2408	2000
26/07/2023	N08	79.36	33.79	053	CTD039S	19	30	2409	2000
26/07/2023	N08	79.36	33.79	053	CTD039S	17	37	2410	1600
26/07/2023	N08	79.36	33.79	053	CTD039S	16	40	2411	1400
26/07/2023	N08	79.36	33.79	053	CTD039S	15	44	2412	1100
26/07/2023	N08	79.36	33.79	053	CTD039S	14	48	2413	2000
26/07/2023	N08	79.36	33.79	053	CTD039S	11	52	2414	2000
26/07/2023	N08	79.36	33.79	053	CTD039S	10	56	2415	2000
26/07/2023	N08	79.36	33.79	053	CTD039S	9	59	NA	NA
26/07/2023	N08	79.36	33.79	053	CTD039S	8	63	2417	2000
26/07/2023	N08	79.36	33.79	053	CTD039S	7	67	2418	2000
26/07/2023	N08	79.36	33.79	053	CTD039S	4	82	2419	2000
26/07/2023	N08	79.37	33.70	055	CTD055S	21	10	2420	1480
26/07/2023	N08	79.37	33.70	055	CTD055S	19	34	2421	2000
26/07/2023	N08	79.37	33.70	055	CTD055S	18	37	2422	1120
26/07/2023	N08	79.37	33.70	055	CTD055S	17	41	2423	1220
26/07/2023	N08	79.37	33.70	055	CTD055S	16	44	2424	1520
26/07/2023	N08	79.37	33.70	055	CTD055S	12	47	2425	1300
26/07/2023	N08	79.37	33.70	055	CTD055S	11	51	2426	2000
26/07/2023	N08	79.37	33.70	055	CTD055S	10	54	2427	2000
26/07/2023	N08	79.37	33.70	055	CTD055S	9	57	2428	2000
26/07/2023	N08	79.37	33.70	055	CTD055S	8	61	2429	1525
26/07/2023	N08	79.37	33.70	055	CTD055S	7	64	2430	2000
26/07/2023	N08	79.37	33.70	055	CTD055S	4	74	2431	2000
26/07/2023	N08	79.39	33.73	057	CTD068S	21	5	2432	1400
26/07/2023	N08	79.39	33.73	057	CTD068S	19	40	2433	1410
26/07/2023	N08	79.39	33.73	057	CTD068S	18	43	2434	1380
26/07/2023	N08	79.39	33.73	057	CTD068S	17	47	2435	1480
26/07/2023	N08	79.39	33.73	057	CTD068S	16	50	2436	2000
26/07/2023	N08	79.39	33.73	057	CTD068S	12	53	2437	2000

26/07/2023	N08	79.39	33.73	057	CTD068S	11	57	2438	2000
26/07/2023	N08	79.39	33.73	057	CTD068S	10	60	2439	2000
26/07/2023	N08	79.39	33.73	057	CTD068S	9	63	2440	2000
26/07/2023	N08	79.39	33.73	057	CTD068S	8	67	2441	2000
26/07/2023	N08	79.39	33.73	057	CTD068S	7	70	2442	2000
26/07/2023	N08	79.39	33.73	057	CTD068S	4	85	2443	2000
26/07/2023	N08	79.39	33.73	059	CTD087S	21	5	2444	1550
26/07/2023	N08	79.39	33.73	059	CTD087S	19	37	2445	1300
26/07/2023	N08	79.39	33.73	059	CTD087S	18	39	2446	2000
26/07/2023	N08	79.39	33.73	059	CTD087S	17	42	2447	1650
26/07/2023	N08	79.39	33.73	059	CTD087S	16	45	2448	2000
26/07/2023	N08	79.39	33.73	059	CTD087S	12	48	2449	2000
26/07/2023	N08	79.39	33.73	059	CTD087S	11	51	2450	2000
26/07/2023	N08	79.39	33.73	059	CTD087S	10	53	2451	2000
26/07/2023	N08	79.39	33.73	059	CTD087S	9	56	2452	2000
26/07/2023	N08	79.39	33.73	059	CTD087S	8	59	2453	2000
26/07/2023	N08	79.39	33.73	059	CTD087S	7	62	2454	1520
26/07/2023	N08	79.39	33.73	059	CTD087S	4	85	2455	2000
07/08/2023	N03	72.86	10.08	096	CTD123S	2	55	2612	2000
07/08/2023	N03	72.86	10.08	096	CTD123S	4	40	2613	2000
07/08/2023	N03	72.86	10.08	096	CTD123S	8	37	2614	2000
07/08/2023	N03	72.86	10.08	096	CTD123S	9	35	2615	2000
07/08/2023	N03	72.86	10.08	096	CTD123S	10	32	2616	2000
07/08/2023	N03	72.86	10.08	096	CTD123S	11	29	2617	2000
07/08/2023	N03	72.86	10.08	096	CTD123S	12	27	2618	2000
07/08/2023	N03	72.86	10.08	096	CTD123S	13	24	2619	2000
07/08/2023	N03	72.86	10.08	096	CTD123S	17	21	2620	2000
07/08/2023	N03	72.86	10.08	096	CTD123S	18	19	2621	2000
07/08/2023	N03	72.86	10.08	096	CTD123S	19	16	2622	2000
07/08/2023	N03	72.86	10.08	096	CTD123S	21	5	2623	2000
07/08/2023	N03	72.86	10.08	099	CTD123S	2	59	2624	2000
07/08/2023	N03	72.86	10.08	099	CTD123S	4	44	2625	2000
07/08/2023	N03	72.86	10.08	099	CTD123S	8	41	2626	2000
07/08/2023	N03	72.86	10.08	099	CTD123S	9	38	2627	2000
07/08/2023	N03	72.86	10.08	099	CTD123S	10	35	2628	2000
07/08/2023	N03	72.86	10.08	099	CTD123S	11	33	2629	2000
07/08/2023	N03	72.86	10.08	099	CTD123S	12	30	2630	2000

07/08/2023	N03	72.86	10.08	099	CTD123S	13	27	2631	2000
07/08/2023	N03	72.86	10.08	099	CTD123S	17	24	2632	2000
07/08/2023	N03	72.86	10.08	099	CTD123S	18	21	2633	2000
07/08/2023	N03	72.86	10.08	099	CTD123S	19	19	2634	2000
07/08/2023	N03	72.86	10.08	099	CTD123S	21	5	2635	2000
07/08/2023	N03	72.86	10.08	101	CTD123S	2	56	2646	2000
07/08/2023	N03	72.86	10.08	101	CTD123S	4	41	2647	2000
07/08/2023	N03	72.86	10.08	101	CTD123S	8	38	2648	2000
07/08/2023	N03	72.86	10.08	101	CTD123S	9	35	2649	2000
07/08/2023	N03	72.86	10.08	101	CTD123S	10	32	2650	2000
07/08/2023	N03	72.86	10.08	101	CTD123S	11	29	2651	2000
07/08/2023	N03	72.86	10.08	101	CTD123S	12	26	2652	2000
07/08/2023	N03	72.86	10.08	101	CTD123S	13	23	2653	2000
07/08/2023	N03	72.86	10.08	101	CTD123S	17	20	2654	2000
07/08/2023	N03	72.86	10.08	101	CTD123S	18	17	2655	2000
07/08/2023	N03	72.86	10.08	101	CTD123S	19	14	2656	2000
07/08/2023	N03	72.86	10.08	101	CTD123S	21	5	2657	2000

9.15 Appendix O – Remote Sensing

Ben Barton (National Oceanography Centre)

Satellite data was downloaded during the cruise when internet download speeds allowed. The key variables obtained were sea surface temperature (SST) derived from infrared satellite sensors, chlorophyll-a derived from optical images and sea ice concentration derived from passive microwave images. SST and chlorophyll-a were downloaded as daily composites from the AQUA MODIS satellite from the following web servers using the provided Python function.

<u>Chlorophyll-a:</u>

oceandata.sci.gsfc.nasa.gov/cgi/getfile/
AQUA_MODIS.YYYYMMDD.L3m.DAY.CHL.chlor_a.4km.NRT.nc

<u>SST:</u>
oceandata.sci.gsfc.nasa.gov/cgi/getfile/
AQUA_MODIS.YYYYMMDD.L3m.DAY.SST.sst.4km.NRT.nc

<u>Sea ice concentration</u> was used as found to mark the sea ice edge as the 10% concentration contour with no further processing. It was downloaded using wget from:

https://n5eil01u.ecs.nsidc.org/PM/NSIDC-
0081.002/2023.07.07/NSIDC0081_SEAICE_PS_N25km_YYYYMMDD_v2.0.nc

Where YYYY is the year, MM is the month and DD is the day.

Processing

1. De-cloud
The satellite SST and chlorophyll-a data were processed to improve their quality and coverage. The SST had a greater data coverage than the chlorophyll-a product, but it suffered from more artefacts associated with cloud and cloud shadows. To improve this, the existing data mask was expanded iteratively over the unflagged data by 3 data points (12 km). This was visually enough to remove the majority of cloud shadow and un-masked cloud.

There were some places with small patches less than 6 data point in diameter that contained good data, but were removed by the expanded shadow mask. These were also un-masked in the more rigorous chlorophyll-a data mask. To re-include these points in the SST, the chlorophyll-a mask was applied to the SST. A merged product of the un-masked data from this method and the result of the expanded de-cloud mask was used to retain the maximum amount of good quality data.

2. Interpolation
The SST and chlorophyll-a data were linearly interpolated to fill gaps. When interpolated over small gaps (< 40 km) the results looked consistent with data available on previous or subsequent days. However, interpolation over larger gaps (> 40 km) risked missing important mesoscale features. The merged-SST-mask and chlorophyll-mask were expanded by 5 data points (20 km) and applied to the linearly interpolated SST and chlorophyll-a data respectively.

3. Composite
Composites were calculated on a daily basis from the previous 3 and 7 days. This gave the best possible picture of the present conditions. When the 3 day composite was available (less

cloud cover) it had more fine scale structures. The 7 day composite is a back up that provided greater coverage of gaps in the satellite data from cloud cover.

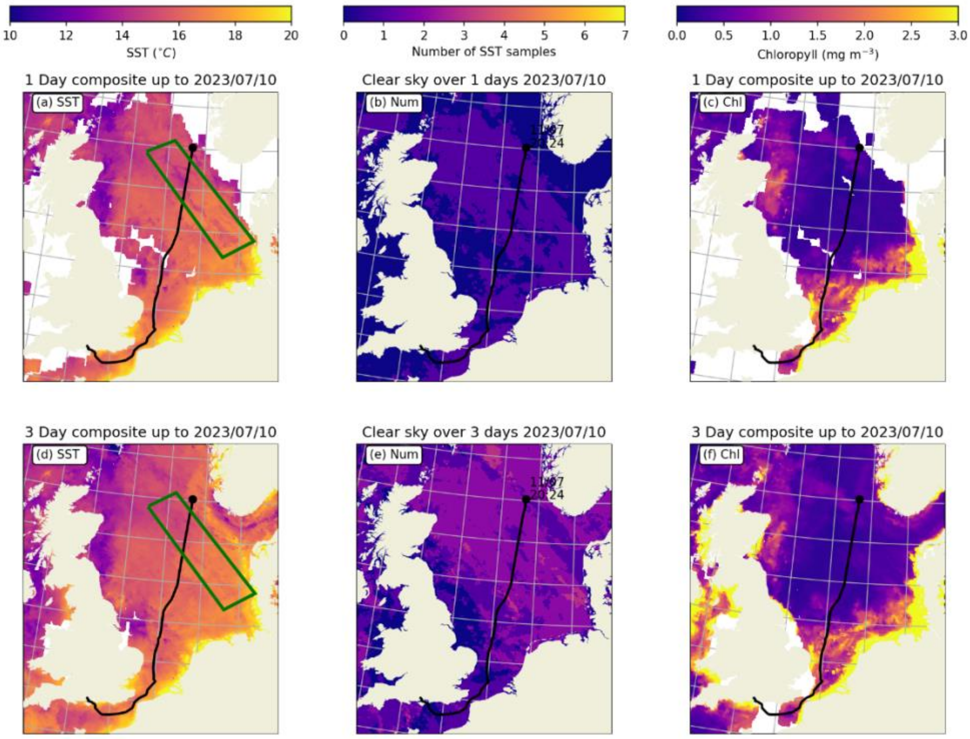

Figure 9.5 Example of cloud shadow artefacts in SST data. (a) 1 day SST composite. (b) 1 day composite amount of cloud cover. (c) 1 day composite of chlorophyll-a. (d)-(f) Same as (a)-(c) but for 3 day composite. The black line is the ship track. The cloud shadow (green box in (a) and (d)) is seen in the 1 day composite but not so strongly in the 3 day composite. (b) shows the cloud gaps match the orientation of the SST artefact in (a).

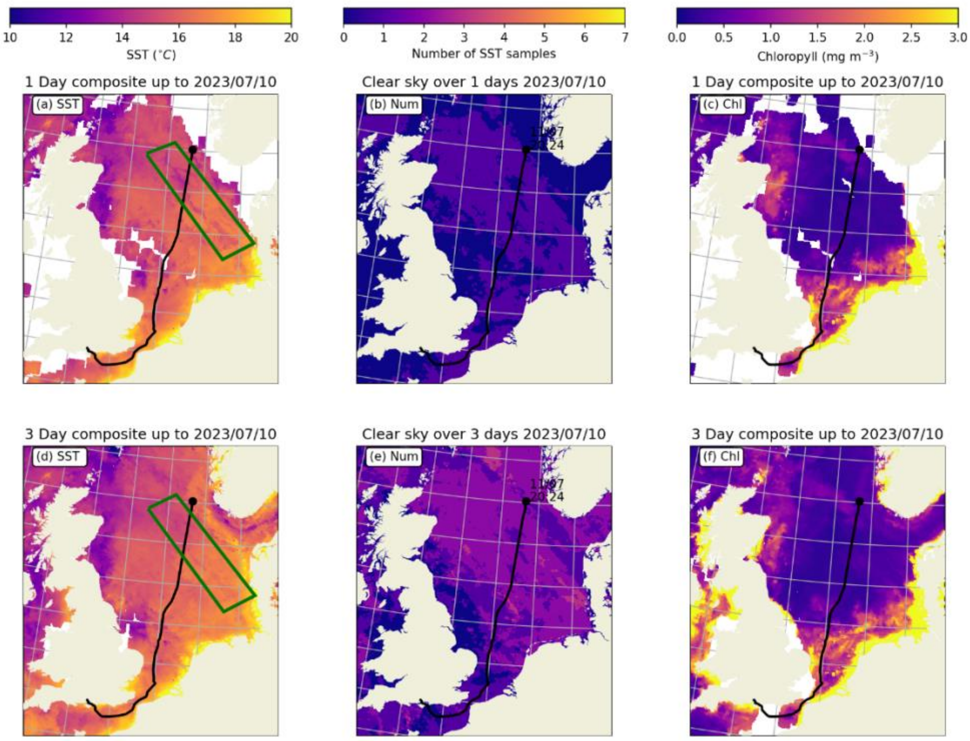

Figure 9.6 Example of cloud shadow artefacts in SST data. (a) 1 day SST composite. (b) 1 day composite amount of cloud cover. (c) 1 day composite of chlorophyll-a. (d)-(f) Same as (a)-(c) but for 3 day composite. The black line is the ship track. The cloud shadow (green box in (a) and (d)) is seen in the 1 day composite but not so strongly in the 3 day composite. (b) shows the cloud gaps match the orientation of the SST artefact in (a).

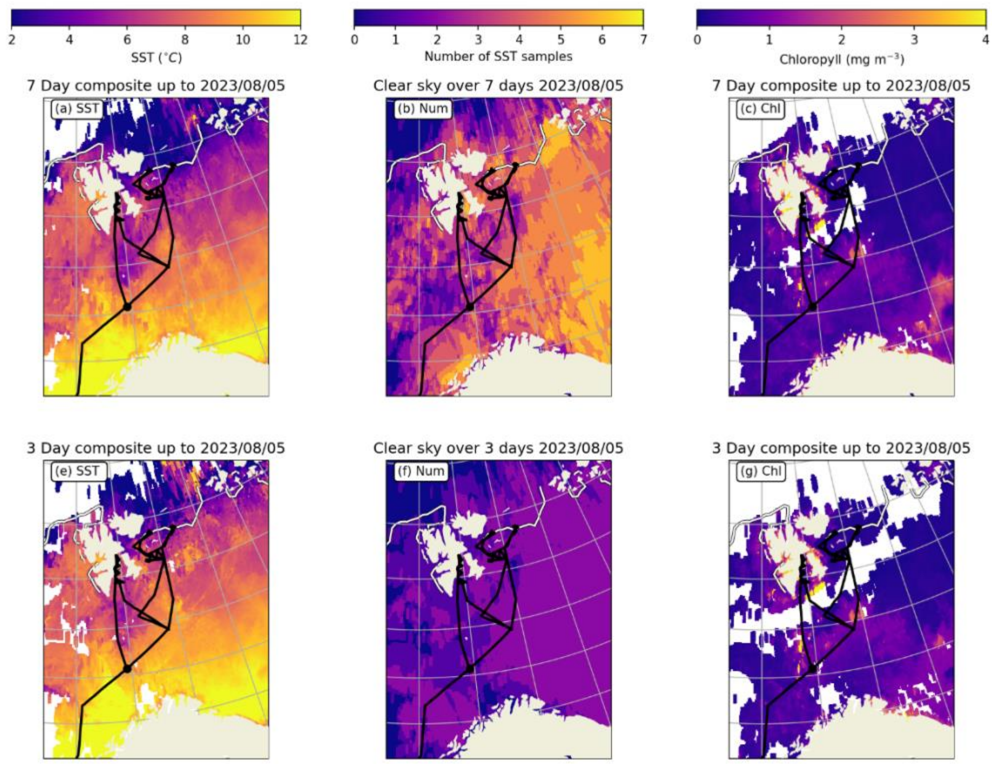

Figure 9.7 Example of satellite data on 05/08/2023. (a)-(f) Are as Figure 9.6.

9.16 Appendix P – MIMS Processing Code

Written in python, run locally on jupyterlab by Ben Fisher

```
import pandas as pd
import numpy as np

Seawater="Seawater_xxxxxx”
Sample_name_1="FISHXXX.1"
Sample_name_2="FISHXXX.2"
Sample_name_3="FISHXXX.3"

SWStart="00:00:00"

Start1="00:00:00"
End1="00:00:00"

Start2="00:00:00"
End2="00:00:00"

Start3="00:00:00"
End3="00:00:00"

Filename="dy167 15n2 sem only_ddmmyy_sw#View2.csv"

df = pd.read_csv(Filename)

df_subset = df[(df['Time'] >= SWStart) & (df['Time'] <= Start1)]

# Convert time to numeric format
time_numeric = pd.to_timedelta(df_subset['Time']).dt.total_seconds().values

# Extract the necessary columns from df_subset
scan1 = df_subset['Scan 1 : mass 28.00'].values
scan2 = df_subset['Scan 2 : mass 29.00'].values
scan3 = df_subset['Scan 3 : mass 30.00'].values

# Calculate the integrals using NumPy's trapz function
integral_scana = np.trapz(scan1, time_numeric)
integral_scanb = np.trapz(scan2, time_numeric)
integral_scanc = np.trapz(scan3, time_numeric)

df_subset = df[(df['Time'] >= Start1) & (df['Time'] <= End1)]

#Repeat for triplicates
time_numeric = pd.to_timedelta(df_subset['Time']).dt.total_seconds().values

scan1 = df_subset['Scan 1 : mass 28.00'].values
scan2 = df_subset['Scan 2 : mass 29.00'].values
scan3 = df_subset['Scan 3 : mass 30.00'].values

integral_scan1 = np.trapz(scan1, time_numeric)
integral_scan2 = np.trapz(scan2, time_numeric)
integral_scan3 = np.trapz(scan3, time_numeric)

df_subset = df[(df['Time'] >= Start2) & (df['Time'] <= End2)]

time_numeric = pd.to_timedelta(df_subset['Time']).dt.total_seconds().values
```

```
scan1 = df_subset['Scan 1 : mass 28.00'].values
scan2 = df_subset['Scan 2 : mass 29.00'].values
scan3 = df_subset['Scan 3 : mass 30.00'].values

integral_scan4 = np.trapz(scan1, time_numeric)
integral_scan5 = np.trapz(scan2, time_numeric)
integral_scan6 = np.trapz(scan3, time_numeric)

df_subset = df[(df['Time'] >= Start3) & (df['Time'] <= End3)]

time_numeric = pd.to_timedelta(df_subset['Time']).dt.total_seconds().values

scan1 = df_subset['Scan 1 : mass 28.00'].values
scan2 = df_subset['Scan 2 : mass 29.00'].values
scan3 = df_subset['Scan 3 : mass 30.00'].values

integral_scan7 = np.trapz(scan1, time_numeric)
integral_scan8 = np.trapz(scan2, time_numeric)
integral_scan9 = np.trapz(scan3, time_numeric)

#Write csv export file
data = [
    [Seawater, "Mass 28", integral_scana],
    [Seawater, "Mass 29", integral_scanb],
    [Seawater, "Mass 30", integral_scanc],
    [Sample_name_1, "Mass 28", integral_scan1],
    [Sample_name_1, "Mass 29", integral_scan2],
    [Sample_name_1, "Mass 30", integral_scan3],
    [Sample_name_1, "Atom percent", (integral_scan3 / (integral_scan1 + integral_scan2 +
integral_scan3)) * 100],
    [Sample_name_2, "Mass 28", integral_scan4],
    [Sample_name_2, "Mass 29", integral_scan5],
    [Sample_name_2, "Mass 30", integral_scan6],
    [Sample_name_2, "Atom percent", (integral_scan6 / (integral_scan4 + integral_scan5 +
integral_scan6)) * 100],
    [Sample_name_3, "Mass 28", integral_scan7],
    [Sample_name_3, "Mass 29", integral_scan8],
    [Sample_name_3, "Mass 30", integral_scan9],
    [Sample_name_3, "Atom percent", (integral_scan9 / (integral_scan7 + integral_scan8 +
integral_scan9)) * 100]
]

df_results = pd.DataFrame(data, columns=["Sample Name", "Measurement", "Value"])
df_results = df_results.pivot_table(index="Sample Name", columns="Measurement",
values="Value").reset_index()
filename = Sample_name_1 + ".csv"
df_results.to_csv(filename, index=False)
```