RRS James Cook

Research Expedition 231

1st May – 19th May 2022

UK

Time-series studies at the Porcupine Abyssal Plain Sustained Observatory

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Reference

Southampton, UK: National Oceanography Centre, Southampton, 201 pp. (National Oceanography Centre Cruise Report, No. 77)

Abstract

RRS James Cook cruise 231 departed Southampton 1st May 2022, operated in the Whittard Canyon (2-3 May) and the Porcupine Abyssal Plain Sustained Observatory area (4-16th May), returning to Southampton 19th May 2022. The goal of the cruise was to continue time-series observations of the surface ocean, water column, and seafloor at the site, as first studied by NOC (then the Institute of Oceanographic Sciences) in 1985. Also, to service a mooring at Whittard Canyon. These activities are supported by CLASS and EU project iFADO. Additional goals were to deploy a BGC Argo float and investigate particle flux (ANTICS team onboard, with some AtlantECO support). The ongoing Covid-19 pandemic resulted in reduced staff onboard but all operations were completed before the weather changed on 16th May. The main aims were to recover data and infrastructure and deploy replacement moorings at PAP and in the Whittard Canyon, to continue time series sampling at PAP-SO.

The Met Office Mobilis buoy was successfully recovered and a similar one was redeployed with a sensor frame at 30m. The sediment traps were successfully turned around at both PAP and the Whittard canyon, this time deploying an Anderson trap. A series of water column observation and sampling operations were successfully carried out with a CTD instrument package. The CTD deployments included pre-and post-deployment calibrations of PAP1 and PAP3 sensors. Surface to 600m observations were made with a new camera frame plus Marine Snow Catchers (the old and new 'Yuki' style were used). Other water column observations included underway CO2 SubCtech system and day/night zooplankton nets. The benthic time series was continued with a series of seafloor sediment core sampling, amphipod traps and trawling. A Met Office Biogeochemistry Argo float was deployed but had to be recovered when it developed a fault.

This cruise was a contribution to the Climate Linked Atlantic Section Science (CLASS) project supported by the UK Natural Environment Research Council (grant number NE/R015953/1) and iFADO (EAPA_165/2016).

Keywords

Porcupine Abyssal Plain, Whittard Canyon, Ocean Observation, ICOS, EMSO, iFADO, Met Office, Biogeochemistry, time series, Marine snow catcher

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A pdf of this report is available for download at: https://nora.nerc.ac.uk/

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Contents

1. Personnel

NAME	ROLE	NAME	ROLE
SUE HARTMAN	PSO	JIM GWINNELL	Master
BRIAN BETT	Scientist	PHIL GAULD	C/O
ALICE CARTER-CHAMPION	Student	DECLAN MORROW	2/O
EMMA CURTIS	Student	EWAN McMILLAN	3/O
CHRIS FELTHAM	Scientist	CHRIS UTTLEY	C/E
CHRIS FLETCHER	Scientist	MIKE MURRAY	2/E
ANITA FLOHR	Scientist	EDIN SILAJDZIC	3/E
SARI GIERING	Scientist	GARY SLATER	3/E
EDWARD MAWJI	Scientist	CONRAD LAVERSUCH	ETO
OLMO MIGUEZ-SALAS	Scientist	PAUL LUCAS	PCO
RAPHAE RAPHAELA	Student	MARTIN HARRISON	CPOS
ELOISE SAVINEAU	Student	NATHAN GREGORY	CPOD
MARIKA TAKEUCHI	Scientist	IAIN FORBES	POS
DAISY TONG	Scientist	DAVID MACKENZIE	POD
JACK WILLIAMS	Student	BRIAN BURTON	SG1A
TOM ROBERTS	ST	JAMES ENGLISH	SG1A
JOSH PEDDER	SST	OLEG AVDEJEV	SG1A
DAVID CHILDS	Technician	SEAN ANGUS	ERPO
JADE GARNER	Technician	MIKE REDSHAW	Chef
HAWARD KING	Technician	JANE BRADBURY	Stwd
TIM POWELL	Technician		
RICHIE PHIPPS	Technician		
NICK RUNDLE	Technician		
JOSUE VIERA RIVERO	Technician		

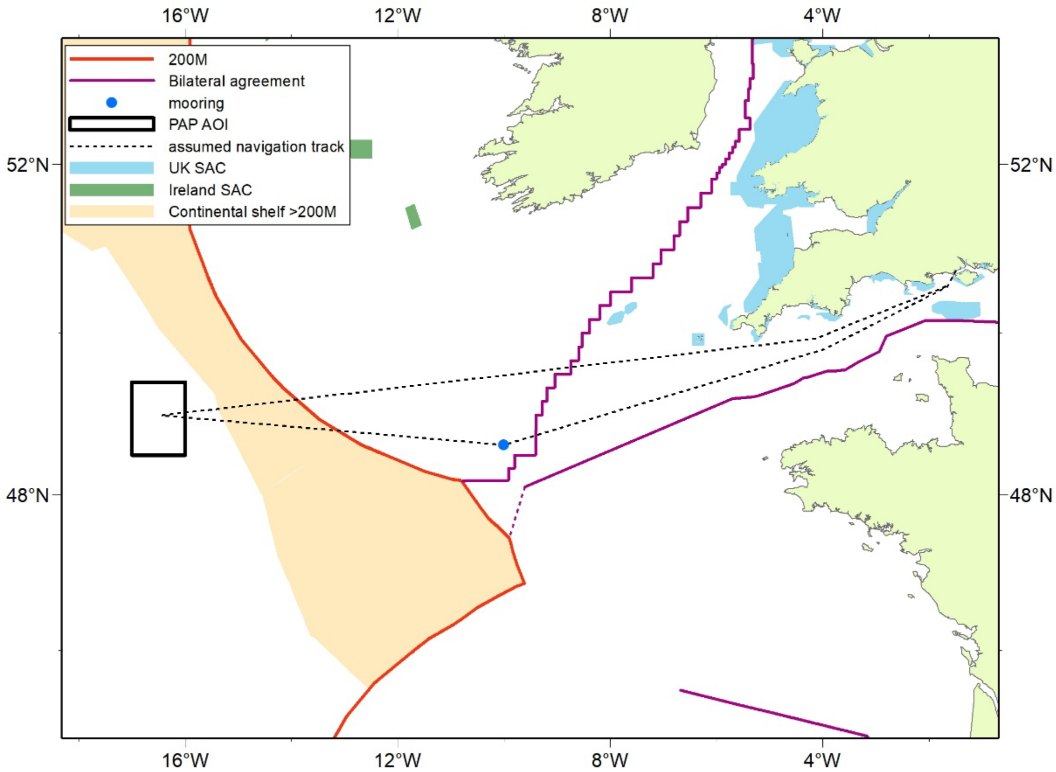
2. Itinerary

Onboard from 24/4/2022. Sail NOC, Southampton, UK 1st May 2022

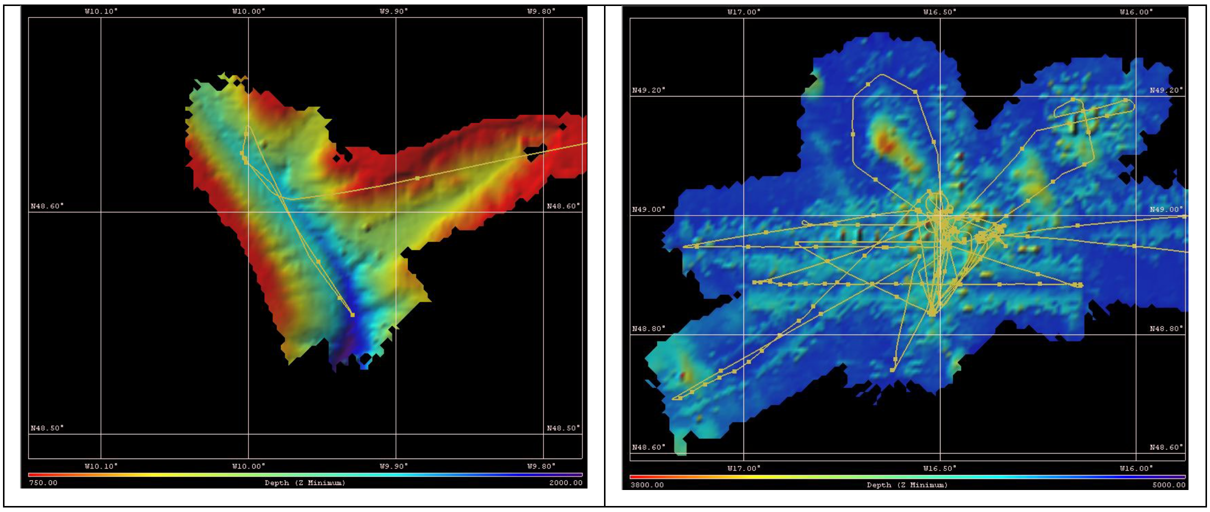
Operations at Whittard Canyon, 2-3 May 2022

Operations at the Porcupine Abyssal Plain Sustained Observatory, 4-16th May 2022

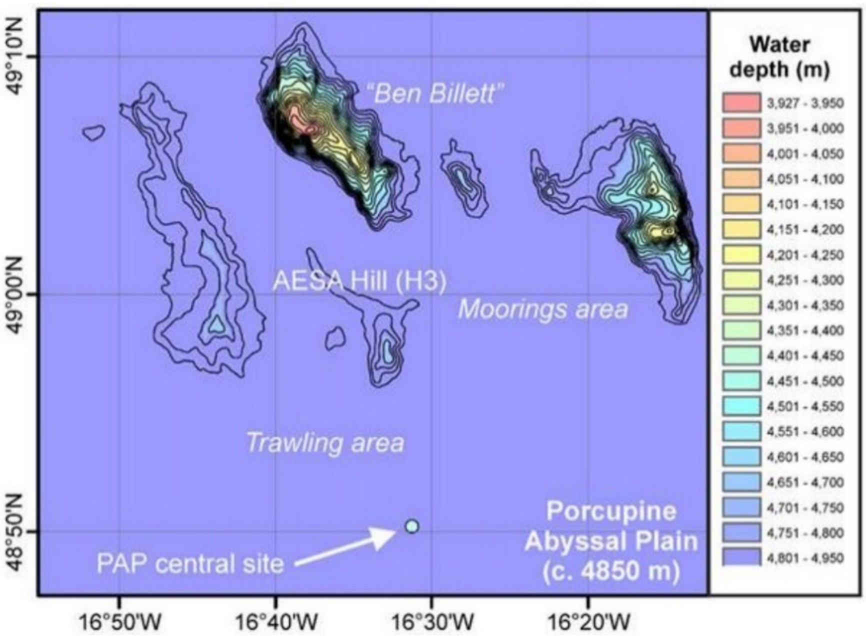
Dock, Southampton, UK 19 May 2022



Cruise track and EEZ



Map of JC231 cruise track (around Whittard Canyon and PAP)



General chart of the Porcupine Abyssal Plain Sustained Observatory operations area for RRS James Cook 231, indicating selected locations referred to in this cruise report.

3. Objectives

The oceanic water column and the underlying seabed change on different temporal and spatial scales. The PAP observatory, in international waters, aims to observe these changes from surface of the ocean, through the water column to the seabed by providing high temporal resolution (hours-annual) data of an increasing number of variables which are relevant from the perspective of the biology, physics, and chemistry over a relatively small spatial scale (30km). The site has been under examination since 1985 and during that time, substantial changes have been observed in the benthic and pelagic environment. The intention is to sustain and enhance these observations in order that a deeper understanding is obtained into the processes which operate; in particular, the responses to the changes which are currently taking place in the global environment.

The primary aim of the *RRS James Cook* (231) to the PAP-SO was to service moorings and carry out sampling at the Porcupine Abyssal Plain Sustained Observatory (PAP-SO), and to service a mooring at Whittard Canyon. This cruise, including both the operations at the Porcupine Abyssal Plain Sustained Observatory and within the Whittard Canyon forms part of the UK Natural Environment Council's "Climate Linked Atlantic Sector Science" CLASS project (https://projects.noc.ac.uk/class-project/sustained-ocean-observations) that is managed by the National Oceanography Centre (NOC). At the PAP-SO open-ocean time-series site in the Northeast Atlantic (49.0 °N 16.5 °W, 4850 m water depth) studies are made on ocean-atmosphere interactions and pelagic-benthic coupling using a range of mooring systems and direct sampling approaches. In parallel to maintaining and extending existing measurements, the work was enhanced by parallel research using novel technology (gliders and floats). Investigations were carried out using a multi-instrument observational approach combined with direct sampling. In addition, the cruise achieved substantial sampling of the seabed at PAP-SO and associated abyssal hills, directly by coring and trawling. Additional aims were to enhance collaboration with the Met Office.

The specific objectives of JC231 were:

Whittard Canyon (Irish EEZ):

1. Recovery of Whittard Canyon mooring (sediment trap, ADCP and CTD sensors)
2. CTD for testing release for new mooring
3. Deployment of replacement sediment trap mooring at Whittard Canyon

PAP-SO (International waters):

4. Recovery of sediment trap mooring at PAP-SO
5. Recovery of Met Office/NOC mooring with surface buoy
6. Deployment of sediment trap and sensors at PAP-SO
7. Deployment of Met Office buoy with surface ocean biogeochemistry sensors at PAP-SO
8. Deployment (and recovery) of Met Office BGC Argo float
9. Photography of the upper water column using a new red camera frame
10. Marine snow catcher deployments
11. Megacore, gravity core, and box core sampling of the seabed
12. Trawls
13. WP2 zooplankton nets
14. Other associated CTDs at PAP-SO
15. Underway sampling of the surface seawater
16. Amphipod trap deployment and recovery

4. Narrative

Prior the cruise we have all undergone home Covid-19 tests to allow us to join the cruise. All initial planning by Jen Durden, then Andy Gates – Sue Hartman PSO from start of May. Note that clocks change to GMT on 1/5/22. Overall calm conditions were forecast for PAP area for JC231, with a little weather around the 8th and a force 11 right at the end (after the last station at PAP, a Metcal). Quite a few pilot whales were seen, even from cabins around the 7th and when the trawl was coming in towards the end of JC231. Many dolphins and gannets too. The *RRS James Cook* entered the EEZ of Ireland at 1316UTC 2nd May in position 48° 41.3’N 009° 24.7'W. The vessel recovered and re-deployed a sub-surface scientific mooring conducted water sampling over the next 24hrs before exiting the EEZ. A new Anderson trap was deployed at WC and triangulation took until 10am (then 24 hours on to the PAP-SO). The *RRS James Cook* departed the Irish EEZ at 2114 UTC in position 48° 47.3’N 012° 56.5'W. On the 4th May initial work at the PAP-SO was a deep CTD at the PAP3 site to test releases, prior to deployment of the mooring – then overnight watches started with a night of coring. Collect PAP1 top half on the 5th, aiming to deploy on the 7th with a new station number this time (the anchor has a DY116 number). After the initial net it was decided to move these aft as there is more control on ascent/decent/depth from the Romica. The Antics teams were keen to get started with the RCF and MSC. Box and gravity cores overnight. Friday 6th May saw PAP1 preparations and welding. Deep cast for some microcats and Po sampling. MSCs then night coring and nets. On Saturday 7th we aimed to deploy PAP1 a day early to avoid poor weather over weekend. It went well, although the trakka which was attached last minute never sent us the required data. A disadvantage of having the nets aft was the slight rain and wind meant that the nets were difficult to deploy as the position was not as sheltered and the nets are quite light. This is when we noticed how long the filtering was taking – likely the jellies present throughout the cruise and as the ANTIC teams were down on people the RCF work was postponed. A night of coring and the Amphipod trap was set up. Sunday 8th Amphipod trap 1 deployed before breakfast. Planned a CTD but there are still issues with the wire. More metcals in sight of PAP1 and hope for a CTD after lunch. Westward transits were planned once we have SSH sent (alongside the chl satellite data). Will have a day free of MSC. To hill site for box and gravity core tonight. Monday 9th: recover Amphipod trap. CTD shallow was cancelled due to the greasy CTD wire, and a few reterminations were needed and 350m wire lost. MSC/net day – too rough for small net (200 only and day only) and the MSC had some issues with leaks. Back to MgC site. Tuesday 10th: Amphipod trap 2 deployed but released early by mistake and had to redeploy. Then a PAP3 recovery was difficult in swells and rough conditions. Bottom trap had no samples (others stopped @ cup 19).

Wed 11th: Amphipod trap didn't come up (and the outreach heads were on there). Aiming for W/M now (with interactive CTD T/S plots). Early gravity core, midnight net and RCF. Thurs 12th: Busy downloading data from PAP1. Fri 13th: Trawl on deck and plan to redeploy an Amphipod trap (it again came back too early). Back to trawl site tonight. Weather getting worse by end, so will turn back towards NOC early pm on 16th. Sat 14th: V sunny day. 10 pilot whales seen around as the trawl net came up at breakfast. After a successful trawl head to PAP1 – and en route had some messages re: the Navis position, which was 10 miles back to southeast. A good team effort of recovery. A busy day as it was followed with MSC, CTD, RCF etc. The Romica couldn't be used because of ship side hydraulics. So, net and RCF deployed in original position. SBP profile at night around "Ben Billett". Sun 15th: Deep CTD, ATRAP triangulate and SBP to the north. Weather deteriorating. Mon 16th Last captain meeting and final station at the site was a metcal. Skip the last CTD due to the weather. Tue 17th Large low pressure over us. Went backwards overnight due to high seas and winds (8m heave). Lots of tidy up to do. Wed 18th better night sleep for everyone. PCA meet with captain 10:30. Sign off and cruise photo before coming into NOC on the 19th for a morning demob.

JC231 cruise photographs

Links to outreach and news stories from the JC231 cruise Managed by Chris Feltham

Date	Name of Author	Link
01.05.2022	Sue Hartman	https://papobservatory.wordpress.com/2022/05/01/jc231-sets-sail/
03.05.2022	Alice Carter-Champion	https://papobservatory.wordpress.com/2022/05/03/first-stop-sediment-trap-retrieval/
05.05.2022	Sue Hartman	https://papobservatory.wordpress.com/2022/05/05/pap-so-arrival/
07.05.2022	Eloïse Savineau	https://papobservatory.wordpress.com/2022/05/07/monitoring-zooplankton-at-the-pap-so/
09.05.2022	Anita Flohr	https://papobservatory.wordpress.com/2022/05/09/next-generation-researchers-on-jc231/
11.05.2022	Emma Curtis	https://papobservatory.wordpress.com/2022/05/11/investigating-scavengers-of-the-deep/
13.05.2022	Jade Garner	https://papobservatory.wordpress.com/2022/05/13/varied-equipment-in-use-at-the-pap-so/
15.05.2022	Olmo Miguez-Salas	https://papobservatory.wordpress.com/2022/05/15/core-blimey/
17.05.2022	Sue Hartman	https://papobservatory.wordpress.com/2022/05/17/floating-laboratory/
17.05.2022	Sue Hartman	https://papobservatory.wordpress.com/2022/05/17/communicating-with-schools-ashore/
18.05.2022	Sari Giering	https://papobservatory.wordpress.com/2022/05/18/the-twilight-zone/

Document on Google drive (sent to the Lanes End school) after receiving lots of letters and questions prompted by our shore side chat with this and other schools on 27th/4/22.

https://docs.google.com/document/d/1CrXMa60-yrt6arznjuvhGcSdOO5kmxE1/edit?usp=sharing&ouid=113515349860467469885&rtpof=true&sd=true

Overview of cruise plans:

	Whittard	PAP3	PAP1 rec	PAP 1 prep	PAP1 dep			PAP3 rec		TRAWL				PAP	TRANSIT		
	Tue 3	Wed 4	Thu 5	Fri 6	Sat 7	Sun 8	Mon 9	Tue 10	Wed 11	Thu 12	Fri 13	Sat 14	Sun 15	Mon 16	Tue 17	Wed 18	Thu 19
0 - 4 am			nets RCF		nets RCF		nets RCF			nets	TRAWL	TRAWL	nets RCF				
4 - 8 am			CTD (shallow)														
8 - 12 am		CTD (deep)	PAP1 (rec)	MSC	PAP1 (dep)	Amphipod (dep)	Amphipod (rec)	Amphipod (dep) PAP3 (rec)	Amphipod (rec) CTD (deep)	MSC RCF nets MSC	CTD (deep)	CTD (100 m)@PAP 1	ARGO ? (rec)	CTD (deep)			Multibe m Cal
12 - 4 pm		PAP3 (dep)	MSC nets RCF MSC	CTD (deep)	nets MSC	CTD (deep) ARGO (dep)	MSC nets RCF MSC	MSC CTD (1000 m)	North Plain leave by 6 pm	setup trawl	Amphipod (dep)	MSC CTD (1000 m)	CTD (deep)	Leave for home			
4 - 8 pm		MSC/RCF LEAVE BY 7 pm	LEAVE BY 7 pm	MSC LEAVE BY 7 pm	Met Cal LEAVE BY 7 pm	transit west LEAVE BY 7 pm	transit west LEAVE BY 7 pm	MSC LEAVE BY 7 pm	GC @ 7pm	LEAVE BY 4 pm	Amphipod (rec)	MSC RCF	Met Cal				
8 - 12 pm		CORING	CORING	CORING	CORING	CORING	CORING	CORING	CORING	TRAWL	TRAWL						

5. NMF technical report Sensors and Moorings

Tom Roberts, Nick Rundle

JC231 Expedition is a top end turn around on PAP1 Full turnaround of PAP 3 and Whittard canyon. The Priority mission of JC231 is the PAP1 mooring which is a collaborative effort involving three NOC groups, OBE, OTEG and NMF and two external organisations, the Met Office and Campbell Ocean Data. The Surface boy for PAP 1 was prepared on the quay side at NOC with the help of logistics and Met Office staff. The sensor frame was built on board the ship while transiting to the work site. With all mooring activities during the day OEG technicians were able to coor and trawl through the night. JC231 also was used to trial the new design snow catcher. All science targets have been met and many bonus achievements and activities have been added to the list.

Following DY130

The PAP 1 mooring deployed on DY130 was complete with full sensor cage suspended at 30m with near real time data. It also trialled an acoustic modem as a backup for the NRT data.

As with the DY130 cruise in 2021 the weather conditions at PAP in May for JC231 are constantly changing with high probability of downtime as a result. Unfavourable conditions in 2021 resulted in the deployment of the Whittard Canyon mooring on the way out to the PAP site. It was decided to do the same again for JC231

Mooring Deck Equipment

The consensus of the team was to prioritise the deployment of PAP 1 for the optimum weather window as the procedure for this operation is still under development and the experience of handling the larger MOBLIS buoy is still limited to the two deployments. The DY116 deployment was a complete deployment in which the buoy was deployed first and the anchor last. The DY130 PAP1 operation was a top end turnaround in which just the top 30m of the mooring is replaced.

Due to PAP 1 being a top end turnaround the large PAP winch was not required, the design of the other moorings were such that all mooring operations could be comfortably accomplished with 5Tonne deck winches, the gantry and ships cranes. Other stern operation, the otsb trawl, which used 3 deck winches. The modified Romica winch was used to deploy red camera frame, nets and the snow catchers.

Whittard Canyon

The conditions at Whittard on arrival were as workable as the forecast had suggested 2m swell, predictions for the PAP site for the next week did not look good enough to start any work, it was therefore decided that a complete turnaround of the Whittard mooring would be the best use of time.

Whittard Canyon Mooring Recovery Procedure DY130

The Whitard Canyon mooring was released on the 2nd of May 2022. It was ranged through the acoustic deck unit, connected to the ship's transducer. It was giving a good range so with the Bridge's permission it was released. It took 45 mins for the top of the mooring to reach the surface

The ship was carefully manoeuvred to bring the top of the mooring and the pellet float to midships on the starboard side, where the pellet float was grappled, disconnected, and then connected to the recovery line. The line was then slowly walked aft while the winch took the slack and the ship started to move off slowly at 0.5Knotts.

The deck stopper was used to hold the outboard line while the two ADCP floats were retrieved on deck and also the sediment trap.

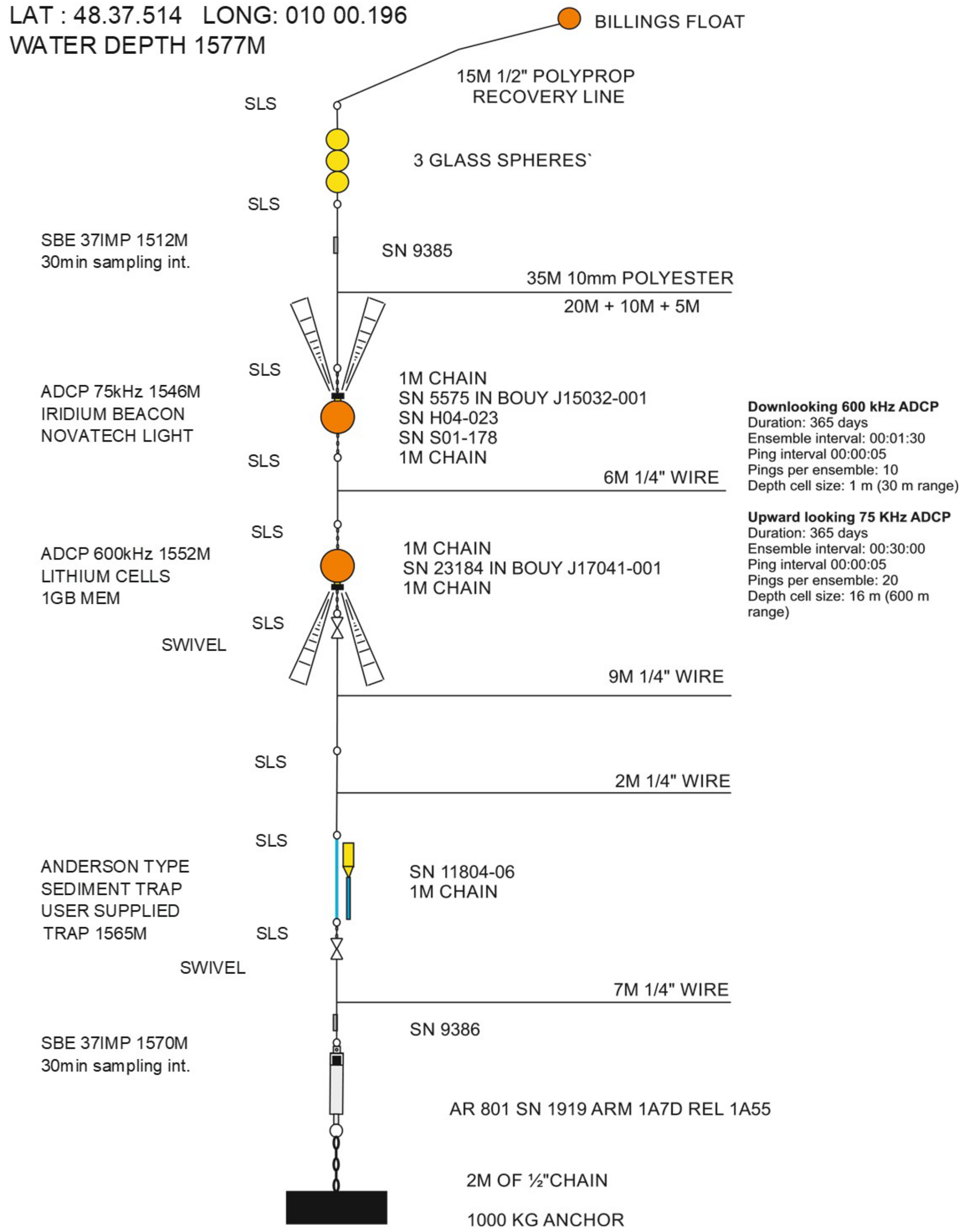
AS with the 2021 deployment the sediment trap funnel was blocked with an unknown deposit on retrieval. Although it was significantly less than was present in the 2021 mooring, the quantity was still significant enough to prevent some of the bottles of the trap from indexing.

The two SeaBird sensors and the ADCPs were rinsed and taken into the deck lab to be downloaded. The sediment trap was left on deck for interrogation and assessed for marine growth along with the two ADCP floatation spheres.

WHITTARD CANYON MOORING

DEPLOYED JC231 2022

03/05/2022

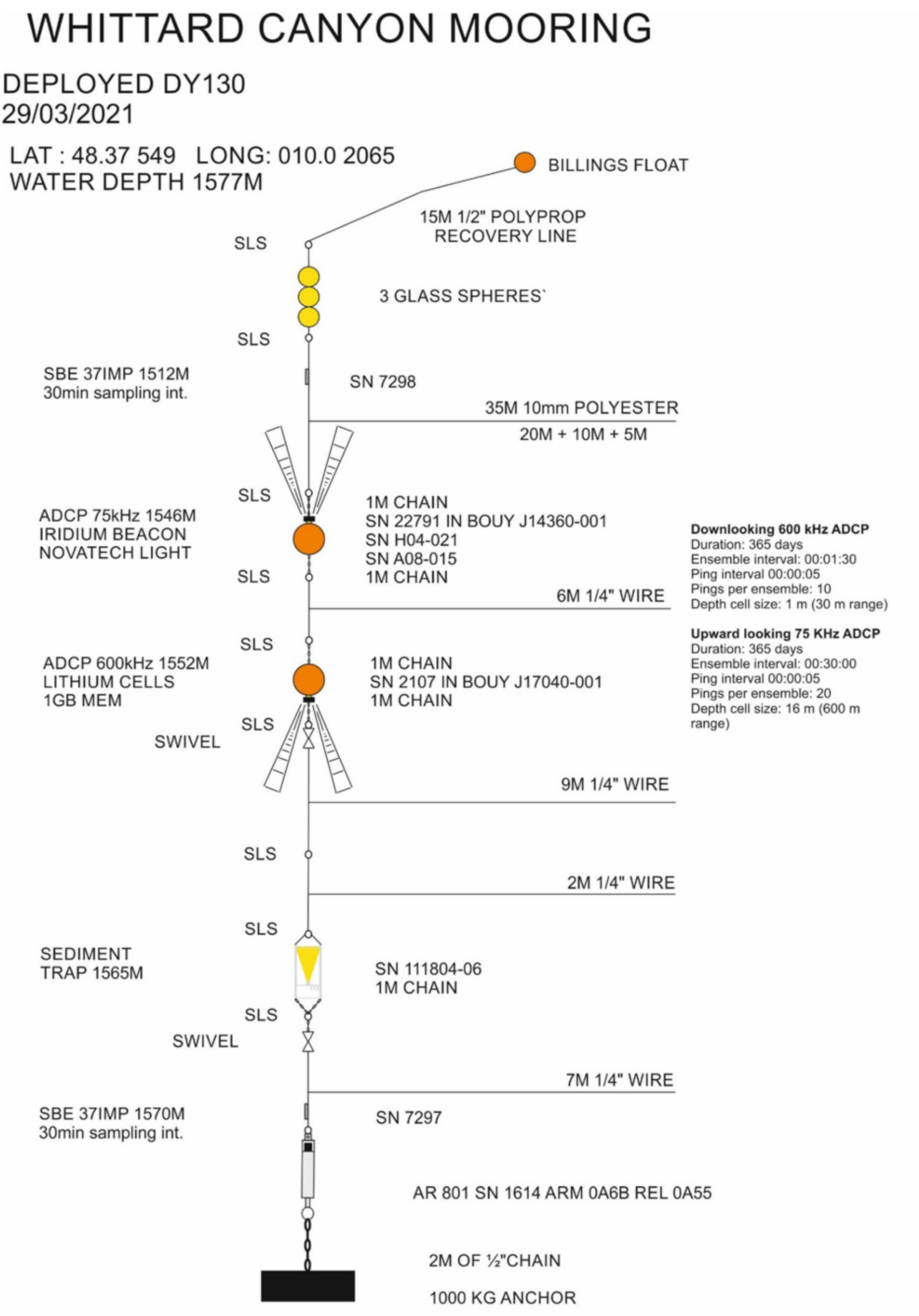


Whittard Canyon Deployment Procedure JC231

The ropes and wire were wound onto the centre 5T deck winch in sections with shackles and links connecting each length, then wrapped in plastic to protect the rope of the mooring. The anchor chain was placed to the edge of the red zone with the opening jaw of the release attached to the anchor. The top package of glass and recovery float were placed on the red deck connected and stopped off to the deck stopper with the connecting rope passing through a block on the port pedestal crane. Once on station and with the bridge's permission. The rope, wire and glass were deployed directly over the aft deck using a deck stop to hold the mooring while the floats, instruments, ADCP's and sediment traps were shackled inline. The recovery float and first glass package were deployed manually to start. Each sediment trap and ADCP float was released off the starboard crane using a Seacatch. The anchor was lifted into position at the start of the mooring and is connected in at the end of the mooring to the acoustic release, it is deployed using the Stbd 5T deck winch with the winch wire run through the gantry hanging block and a Seacahtch to release when on station.

The mooring was successfully streamed aft whilst the ship maintained a heading at 0.5knotts on a heading to give a 200mrun into the drop site with a 50m fall back. The mooring was released from the starboard crane by Seacatch. The mooring was followed down acoustically.

Whittard is quite a short mooring, the distance between the ADCP spheres especially requires careful positioning of the deck stoppers and crane use. Viable modifications to the mooring were discussed between the scientists and technicians prior to sailing, but it was agreed that the gains to the deployment process did not justify the science sacrifice. It could be possible to look again at the options with changes to the hardware, like having a large single syntactic that can accommodate both ADCPs.



SENSORS & MOORINGS

Whittard Canyon Mooring recovery

Brian Bett

The first action of JC231, the Whittard Canyon mooring (DY130-018 @1572m), was successfully recovered 2nd May. As last year the funnel filled about 1/3 depth with sediment. However, carousel had rotated to bottle 15 before stopping (note 16 started and ended out of alignment, as was 17 – cups 18 to 21 stopped due to recovery). Bottle 1 had black sediment layers at recovery. Body of funnel, and other instruments, sparsely colonised with barnacles, goose barnacles, and anemones.

DY130-018 Bottles 1 to 21 (carousel stopped on bottle 15)

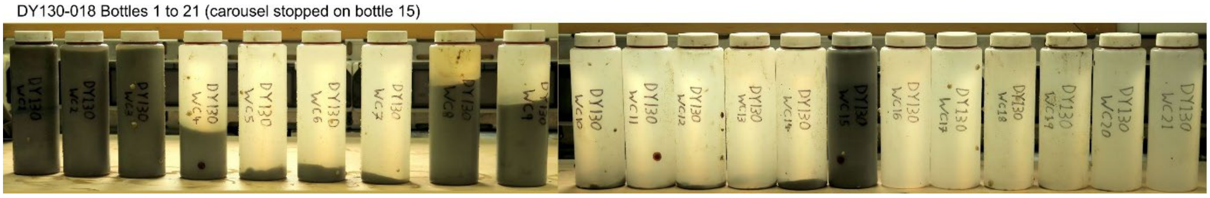


Photo of Whittard canyon trap on recovery and line up of the bottle samples over the year

PAP3 Mooring

Technical report continued

The PAP 3 sediment trap mooring is normally deployed before recovery of the previous deployment This is to ensure overlap and continuity of data.

PAP 3 DEPLOYMENT

The ropes and wire were wound onto the centre 5T deck winch in sections with shackles and links connecting each length, then wrapped in plastic to protect the rope of the mooring. The anchor chain was placed to the edge of the red zone with the opening jaw of the release attached to the anchor. The top package of glass, billings float and recovery float were placed on the red deck connected together and stopped off to the deck stopper with the connecting rope passing through a block on the port pedestal crane. Once on station and with the bridge's permission. The rope, wire and glass were deployed directly over the aft deck using a deck stop to hold the mooring while the floats, instruments and sediment traps were shackled inline. The recovery float and billings float are deployed manually to start. Each sediment trap was released off the starboard crane using a Seacatch. The anchor was lifted into position at the start of the mooring and is connected in at the end of the mooring to the acoustic release, it is deployed using the Stbd 5T deck winch with the winch wire run through the gantry hanging block and a Seacahtch to release when on station.

The mooring is streamed at approximately 0.5Knotts and the run up was 3000Metres with a 200m fall back allowance.

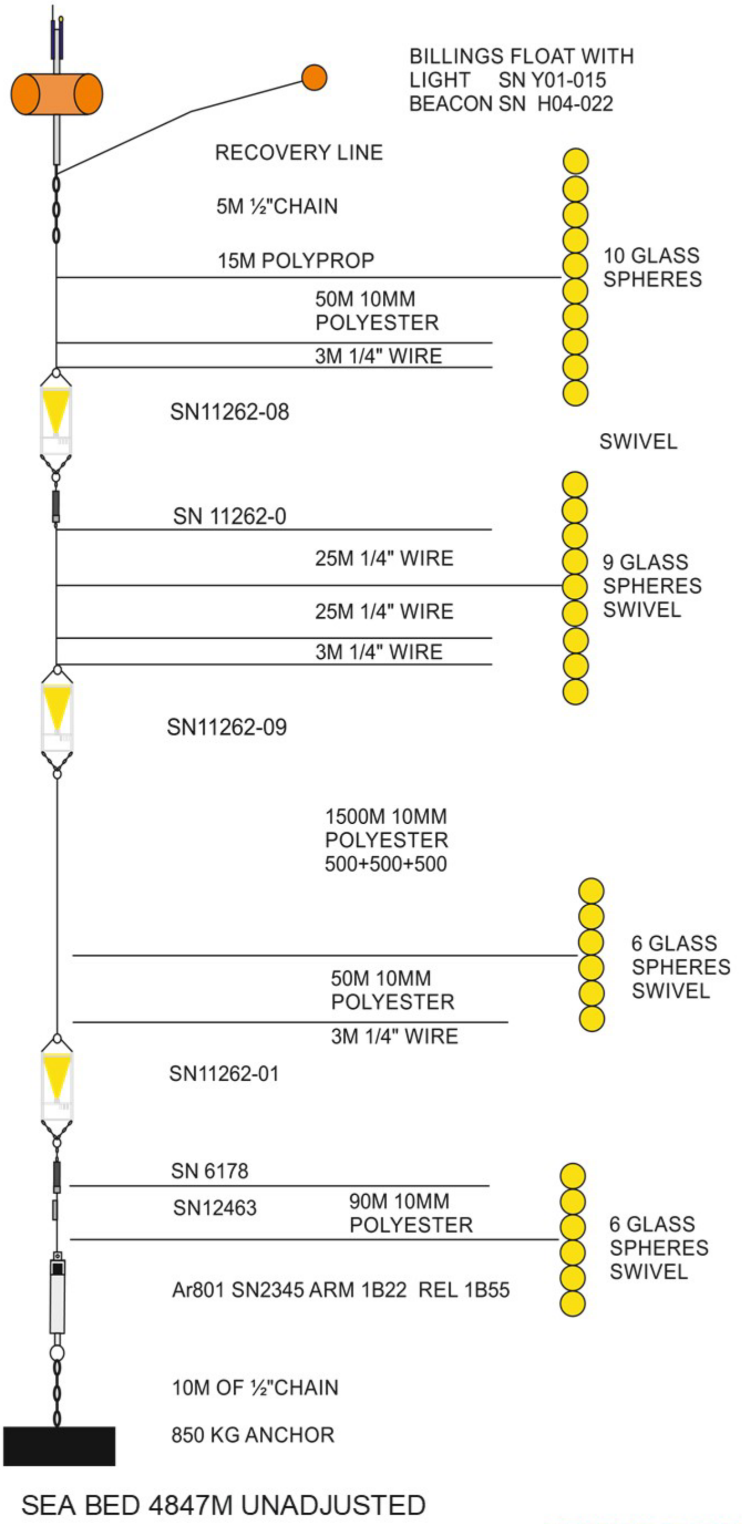
The mooring deployment commenced on the 4th May and took 2.5 hours.

PAP 3

DEPLOYED 2022

JC231

04.05.2022
48 56.927 N
016 19.888 W



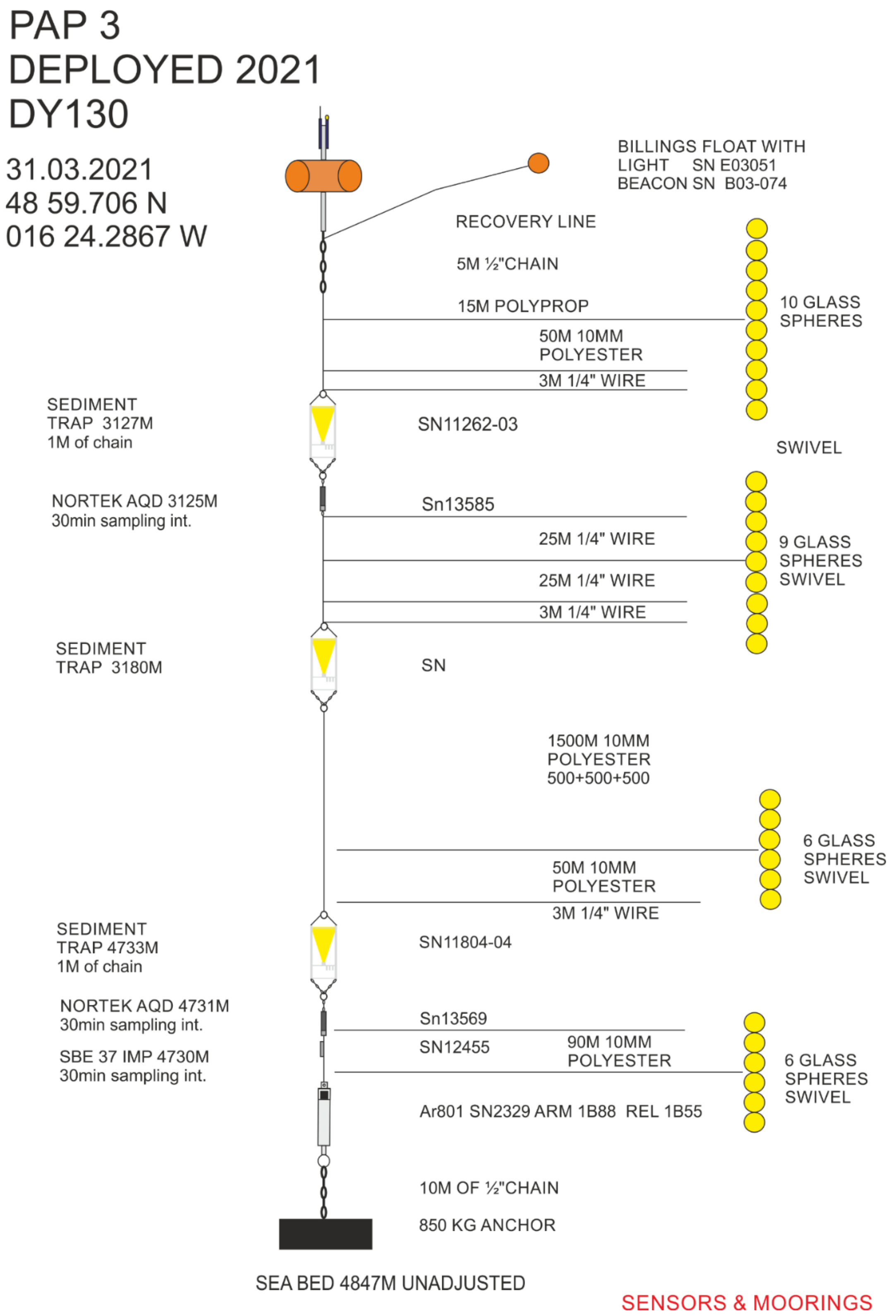
SENSORS & MOORINGS

PAP 3 DY130 Recovery Procedure

The PAP3 mooring was released on the 10th May 2022. It was ranged through the acoustic deck unit, connected to the ship's transducer. It was giving a good range so with the Bridge's permission it was released. It took 30 mins for the top of the mooring to reach the surface. Once on the surface we realised it had come up either side of the ship, so we repositioned to be able to safely approach the mooring, meaning we had to recover on the port side of the deck. The ship slowly manoeuvred up to the mooring and the top package of floats were grappled and then connected to the recovery line hook on a long poll then the ship started to move off so the mooring could stream Aft.

The retrieval was a direct pull with the recovery line connected to it. Once the mooring was connected to the deck stopper the recovery line was removed, then mooring was re connected to the 5T deck winch and passed through the moorings hanging block on the port pedestal crane. The mooring was stopped off for every instrument and float package then re connected to keep pulling in the mooring rope.

Other than a small amount of tangling at the top end the mooring came in quite easily. Unfortunately, the top of the billings mast and float were missing on recovery allowing the recovery line to tangle with the top glass package.



PAP 3 Mooring Diagram DY130

PAP3 recovery

Corinne (Ashore), Sue and Chris

The aim was to recover PAP3 after the 9th to capture the last sample (we recovered on the 10th). Traps A and B samples were recovered but there were no samples in trap C (likely set up incorrectly in error). The logs for the samples are as follows.

SAM has photos.

13585 = T, 13569 = B current meters

Deployment No:LXXXVIII

Cruise deployed: DY130
Date: 31/3/21
Trap A= 3000m S/N: ML11262-03
Trap B= 3000m S/N: ML11804-04
Trap C= 100mab S/N: ML11262-03

Site: PAP
Station #: DY130-024
Sounding: 4682m

Position:
Cruise recovered: JC231
Date: 10/5/22
Current Meters: 13585 + 13569
Acoustic release: 2329
Microcat: 12455

Sample code	Open Date at 1200h	Open Date US style	Julian Day Open	Open day 2006	Julian Day Mid-day	Interval days	Comments	pH
Trap A 3000M								
LXXXVIII-A-1	04/04/21	04/04/21	87	88	94	14	1 (cm)	
LXXXVIII-A-2	18/04/21	04/18/21	101	102	108	14	1.5	
LXXXVIII-A-3	02/05/21	05/02/21	115	116	125.5	21	2.4	
LXXXVIII-A-4	23/05/21	05/23/21	136	137	146.5	21	2.7	
LXXXVIII-A-5	13/06/21	06/13/21	157	158	167.5	21	4.5 v. fluffy	
LXXXVIII-A-6	04/07/21	07/04/21	178	179	188.5	21	4.0 "	
LXXXVIII-A-7	25/07/21	07/25/21	199	200	209.5	21	10.2	
LXXXVIII-A-8	15/08/21	08/15/21	220	221	230.5	21	14.0 v. fluffy (full)	
LXXXVIII-A-9	05/09/21	09/05/21	241	242	251.5	21	4.8 "	
LXXXVIII-A-10	26/09/21	09/26/21	262	263	272.5	21	1.0	
LXXXVIII-A-11	17/10/21	10/17/21	283	284	293.5	21	0.6	
LXXXVIII-A-12	07/11/21	11/07/21	304	305	318	28	0.6	
LXXXVIII-A-13	05/12/21	12/05/21	332	333	346	28	0.4	
LXXXVIII-A-14	02/01/22	01/02/22	360	361	9	28	0.2	
LXXXVIII-A-15	30/01/22	01/30/22	23	24	37	28	0.1	
LXXXVIII-A-16	27/02/22	02/27/22	51	52	65	28	0.1	
LXXXVIII-A-17	27/03/22	03/27/22	79	80	89.5	21	0.2	
LXXXVIII-A-18	17/04/22	04/17/22	100	101	110.5	21	2.5	
LXXXVIII-A-19	08/05/22	05/08/22	121	122	131.5	21	0.1	
LXXXVIII-A-20	29/05/22	05/29/22	142	143	152.5	21	MT	
LXXXVIII-A-21	19/06/22	06/19/22	163	164	173.5	21	MT	
FVIinal move to ope	10/07/22	07/10/22	184					

Really add @ summer Z's

Site: PAP

ployment No:LXXXVIII
Cruise deployed: DY130

Sample code	Open Date at 1200h	Open Date US style	Julian Day Open	Open day 2006	Julian Day Mid-day	Interval days	Comments (cm)	pH
Trap B 3000M								
LXXXVIII-B-1	04/04/21	04/04/21	87	88	94	14	1.5	
LXXXVIII-B-2	18/04/21	04/18/21	101	102	108	14	1.8	
LXXXVIII-B-3	02/05/21	05/02/21	115	116	125.5	21	3.0	
LXXXVIII-B-4	23/05/21	05/23/21	136	137	146.5	21	3.0	
LXXXVIII-B-5	13/06/21	06/13/21	157	158	167.5	21	5.5 fluffy	
LXXXVIII-B-6	04/07/21	07/04/21	178	179	188.5	21	4.8	
LXXXVIII-B-7	25/07/21	07/25/21	199	200	209.5	21	5.1 fluffy	
LXXXVIII-B-8	15/08/21	08/15/21	220	221	230.5	21	0.1 crud	
LXXXVIII-B-9	05/09/21	09/05/21	241	242	251.5	21	0.1 crud	
LXXXVIII-B-10	26/09/21	09/26/21	262	263	272.5	21	0.1 crud	
LXXXVIII-B-11	17/10/21	10/17/21	283	284	293.5	21	0.1	
LXXXVIII-B-12	07/11/21	11/07/21	304	305	318	28	0.1	
LXXXVIII-B-13	05/12/21	12/05/21	332	333	346	28	0.1	
LXXXVIII-B-14	02/01/22	01/02/22	360	361	9	28	0.1	
LXXXVIII-B-15	30/01/22	01/30/22	23	24	37	28	0.1	
LXXXVIII-B-16	27/02/22	02/27/22	51	52	65	28	0.0	
LXXXVIII-B-17	27/03/22	03/27/22	79	80	89.5	21	0.1 (1 Aggregate)	
LXXXVIII-B-18	17/04/22	04/17/22	100	101	110.5	21	<0.1 "	
→ LXXXVIII-B-19	→ 08/05/22	05/08/22	121	122	131.5	21	2.5 pteropod?	
LXXXVIII-B-20	29/05/22	05/29/22	142	143	152.5	21		
LXXXVIII-B-21	19/06/22	06/19/22	163	164	173.5	21		
FVIinal move to ope	10/07/22	07/10/22						

Site: PAP

DY130 PAP 1 Recovery Procedure

Technical report continues

The PAP1 mooring deployed on DY130 was the first complete platform using the MOBLS surface buoy and sensor frame. The PAP1 mooring was approached from the stern to bring the MOBLIS buoy right up against the ship in order to hook one of the four lifting loops on the buoy which are positioned on top of the buoyancy approximately 0.5 above sea level.

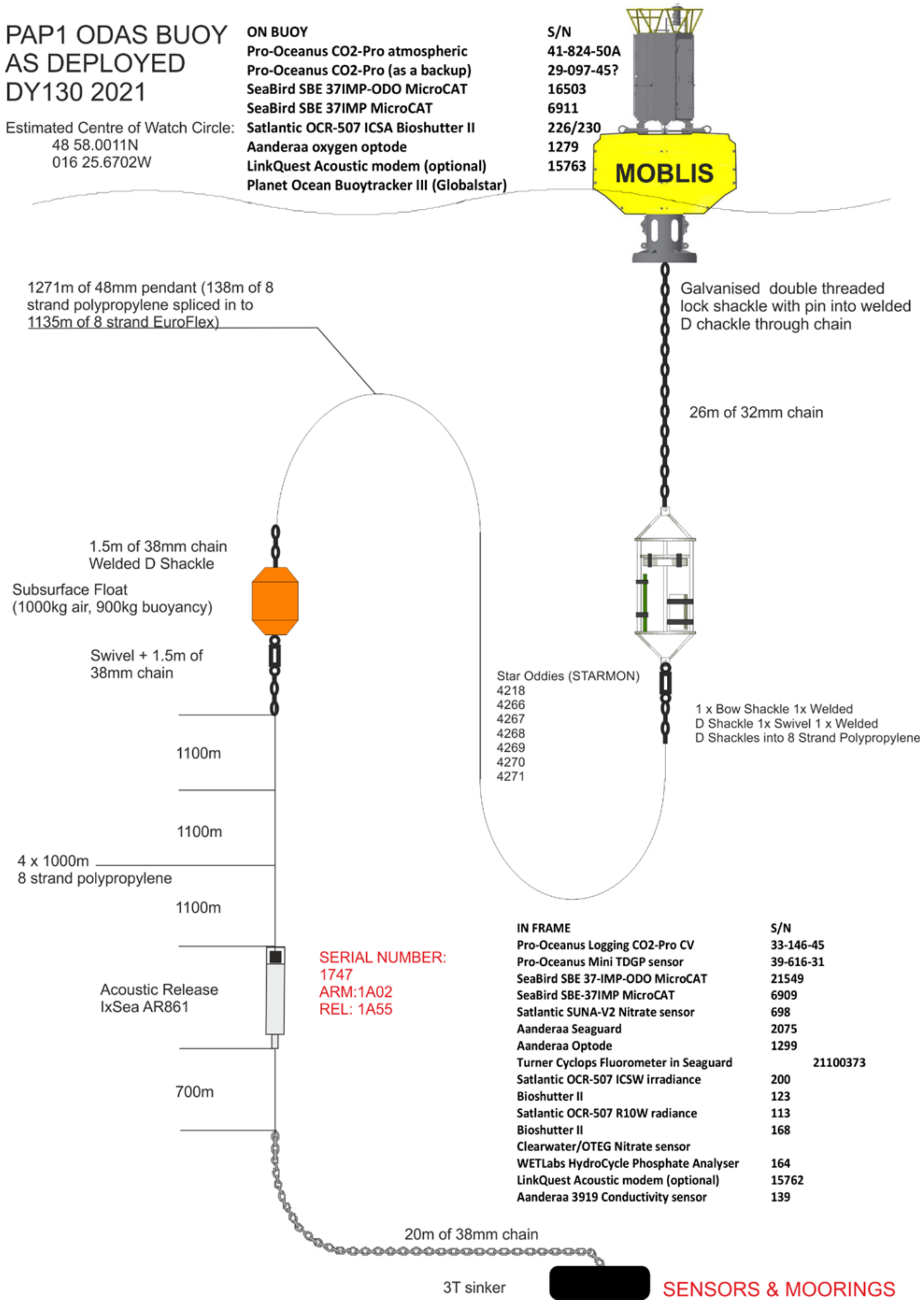
The plasma recovery line was passed through the main block on the gantry and shackled to a snap hook on an aluminium pole. This was the longest recovery pole available and only just able to reach the buoy recovery loops. The movement of the ship created a swell between the buoy and the ship making it awkward to hook the buoy. The buoy was hocked from the Stbd aft corner. When hooked the gantry was positioned outboard before any load was transferred.

As the load came onto the plasma recovery line the buoy turned with the load on the chain to the seabed streaming aft. The aft gantry was then fully extended to clear the back of the ship. The buoy was lifted from the water and the gantry brought in slowly.

The buoy was then landed on deck, the 2 x 5tonne deck winches were connected to the loops at the side quadrants so that the buoy could be pulled forward whilst being lifted on the top loop by main warp. The buoy was landed clear of the red zone and firmly secured with ratchet straps.

The 30m of chain below the buoy was pulled in by the starboard 5T winch and a deck stopper until the sensor frame was at deck Hight. The Stbd pedestal crane was then used to lift the sensor frane on to the deck. The thimble of the main braided rope was stopped off on deck through the thimble eye on the red zone Stbd side. The shackle bolt was removed from the bottom of the sensor frame The top sensor frame shackle was welded so had to be cut off using a disc cutter separating the buoy from the mooring and sensor frame. The sensor frame was then lifted out the way with the Stbd crane.

Using the Stbe pedestal crane, the guard buoy was moved into position next to where the thimble was stoppered. The guard buoy was then shackled to the thimble. The top of the guard buoy was connected to a Seacatch on the crane. The buoy was then lifted and disconnected from the then slack deck stopper and taken outboard, lowered to the water and released.


PAP1 ODAS BUOY
AS DEPLOYED
DY130 2021
Estimated Centre of Watch Circle:
48 58.0011N
016 25.6702W
ON BUOY
S/N
Pro-Oceanus CO2-Pro atmospheric
41-824-50A
Pro-Oceanus CO2-Pro (as a backup)
29-097-45?
SeaBird SBE 37IMP-ODO MicroCAT
16503
SeaBird SBE 37IMP MicroCAT
6911
Satlantic OCR-507 ICSA Bioshutter II
226/230
Aanderaa oxygen optode
1279
LinkQuest Acoustic modem (optional)
15763
Planet Ocean Buoytracker III (Globalstar)
MOBLIS
1271m of 48mm pendant (138m of 8 strand polypropylene spliced in to 1135m of 8 strand EuroFlex)
Galvanised double threaded lock shackle with pin into welded D chackle through chain
26m of 32mm chain
1.5m of 38mm chain
Welded D Shackle
Subsurface Float
(1000kg air, 900kg buoyancy)
Swivel + 1.5m of
38mm chain
Star Oddies (STARMON)
4218
4266
4267
4268
4269
4270
4271
1 x Bow Shackle 1x Welded D Shackle 1x Swivel 1 x Welded D Shackles into 8 Strand Polypropylene
1100m
1100m
4 x 1000m
8 strand polypropylene
1100m
Acoustic Release
IxSea AR861
SERIAL NUMBER:
1747
ARM:1A02
REL: 1A55
IN FRAME
S/N
Pro-Oceanus Logging CO2-Pro CV
33-146-45
Pro-Oceanus Mini TDGP sensor
39-616-31
SeaBird SBE 37-IMP-ODO MicroCAT
21549
SeaBird SBE-37IMP MicroCAT
6909
Satlantic SUNA-V2 Nitrate sensor
698
Aanderaa Seaguard
2075
Aanderaa Optode
1299
Turner Cyclops Fluorometer in Seaguard
21100373
Satlantic OCR-507 ICSW irradiance
200
Bioshutter II
123
Satlantic OCR-507 R10W radiance
113
Bioshutter II
168
Clearwater/OTEG Nitrate sensor
WETLabs HydroCycle Phosphate Analyser
164
LinkQuest Acoustic modem (optional)
15762
Aanderaa 3919 Conductivity sensor
139
700m
20m of 38mm chain
3T sinker
SENSORS & MOORINGS

DY130 PAP 1 Deployment Procedure

The replacement buoy was positioned in the red zone, with the keel pointing aft and fully strapped down. The 30m chain shackled to the cross bar of the keel was flaked out on the deck and shackled to the sensor frame A 3m length of 250mm diameter hose sheathing the last section of chain. The telemetry cable was clamped to the chain at 2m intervals. With the top end replacement set up, the guard buoy could be retrieved.

Bringing the buoy along the starboard side the pellet float was grappled and the buoy walked round to the stern and lifted onboard using the Stbd crane with hanging block and the Stbd 5T deck winch and landed on a pallet. With just enough space for the guard buoy to sit between the sensor frame and sensor frame and the MOBLIS buoy, the mooring rope thimble was stopped off on the deck while being reconnected to the bottom end of the new frame. The guard buoy was moved out of the way with the Stbd pedestal crane.

The sensor frame was lifted with the Stbd pedestal crane while A deck stopper held the chain in the red zone and the frame was lowered until the load was on the deck stopper and the strop released. The flaked chain was then paid out in sections using the Stbd 5T deck winch and deck stopper until the load was transferred to the cross bar of the buoy keel.

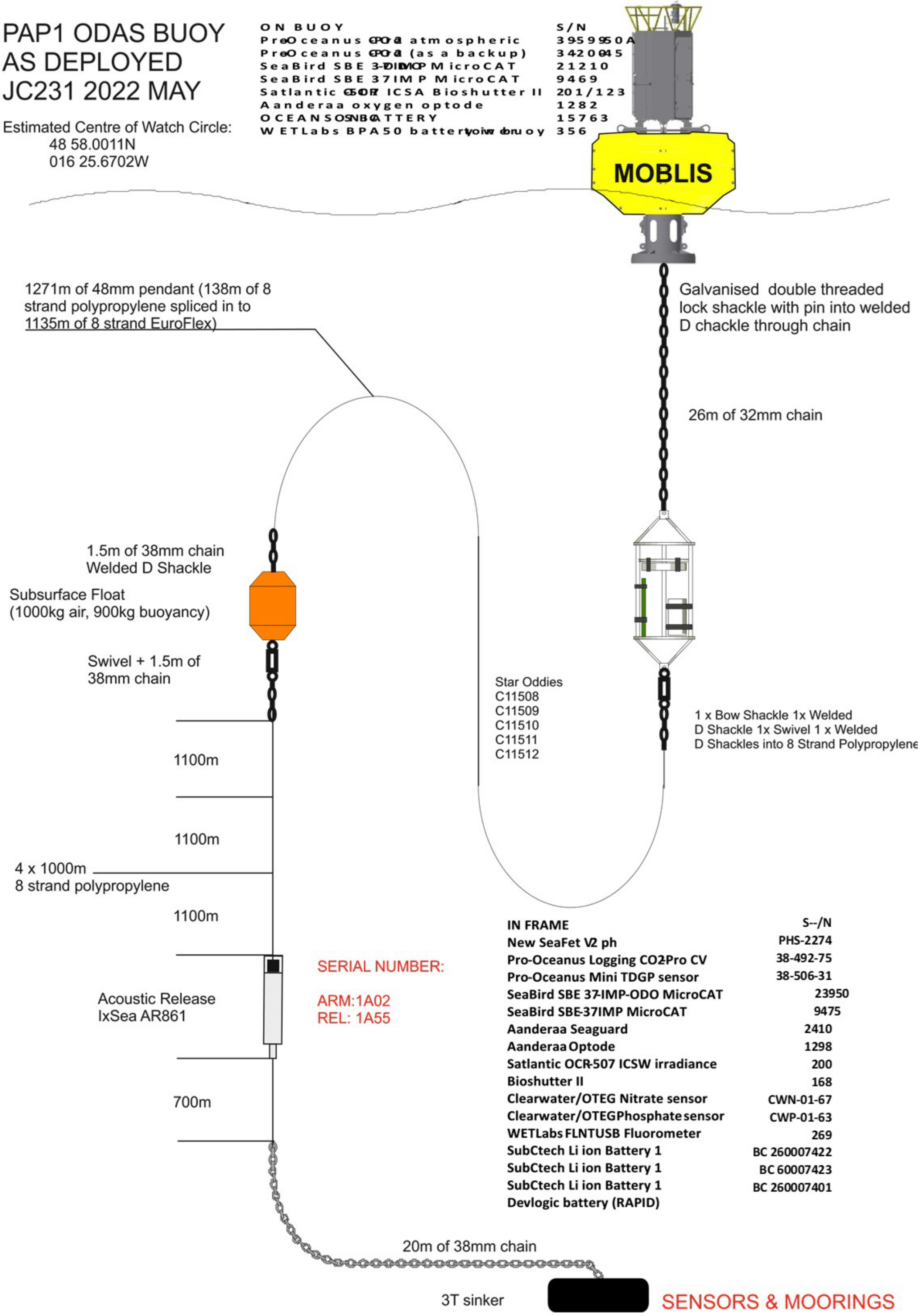
The plasma line through the main sheave on the gantry was connected to the lifting loop on the top quadrant of the buoy using a strop going back onto the large SeaCatch. Both 5Tonne winches were attached to the lifting loop in the bottom quadrant of the buoy. Tag lines were also looped round the halo to keep the top from swinging when lifted. The rachets on the MOBLIS buoy were then removed.

With the tension on the lifting eye the buoy was lifted on the main warp and the gantry slowly moved outboard the 5T deck winched were paid out to steady the buoy then removed when the buoy was clear of the aft deck the gantry was moved out to full extension and the buoy lowered to the water level where it was release from the SeaCatch.

PAP1 ODAS BUOY AS DEPLOYED JC231 2022 MAY

Estimated Centre of Watch Circle:
48 58.0011N
016 25.6702W

ON BUOY	S/N
Pro-Oceanus CO2-Pro atmospheric	3959950A
Pro-Oceanus CO2-Pro (as a backup)	3420045
SeaBird SBE 37-IMP-ODO MicroCAT	21210
SeaBird SBE 37IMP MicroCAT	9469
Satlantic OCR-507 ICSA Bioshutter II	201/123
Aanderaa oxygen optode	1282
OCEANSONICS BATTERY	15763
WETLabs BPA50 battery on buoy	356

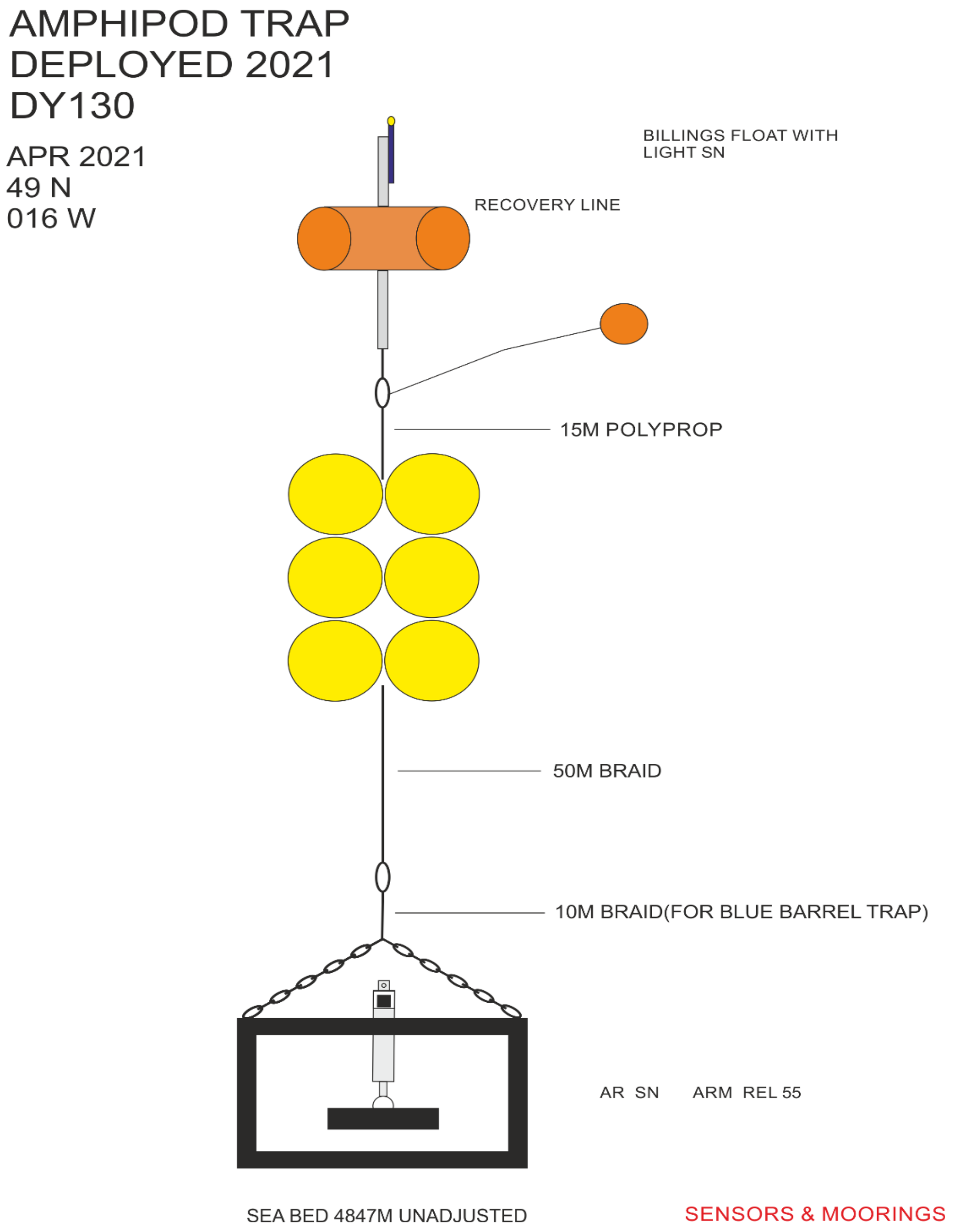


IN FRAME	S--/N
New SeaFet V2 ph	PHS-2274
Pro-Oceanus Logging CO2-Pro CV	38-492-75
Pro-Oceanus Mini TDGP sensor	38-506-31
SeaBird SBE 37-IMP-ODO MicroCAT	23950
SeaBird SBE-37IMP MicroCAT	9475
Aanderaa Seaguard	2410
Aanderaa Optode	1298
Satlantic OCR-507 ICSW irradiance	200
Bioshutter II	168
Clearwater/OTEG Nitrate sensor	CWN-01-67
Clearwater/OTEG Phosphate sensor	CWP-01-63
WETLabs FLNTUSB Fluorometer	269
SubCtech Li ion Battery 1	BC 260007422
SubCtech Li ion Battery 1	BC 60007423
SubCtech Li ion Battery 1	BC 260007401
Devlogic battery (RAPID)	

SENSORS & MOORINGS

Amphipod Trap

There were two amphipod deployments of approximately 24hrs each. These moorings are handballed of the back deck and released by SeaCatch from the starboard crane.



6. PAP Instrumentation Report

Dave Childs

A range of different instruments are used across the Whittard Canyon, PAP 1 and PAP 3 moorings including Sea-Bird SBE 37 Microcat CTD's, Nortek Aquadopp Current Meters, Teledyne ADCP's and McLANE Sediment Traps. In addition to these instruments, a user supplied Anderson Sediment Trap was also used.

All instrumentation was serviced and tested back at NOC prior to being loaded for JC231 and had new battery packs installed where required.

Prior to deployment all Sea-Bird SBE 37's were placed on the CTD frame using custom built brackets in order to perform calibration checks against the CTD system on board.

All Ixsea releases were serviced, and bench tested at NOC prior to the cruise, but in order to verify their operation at depth all of the releases were attached to the CTD frame and then tested using the TT801 Deck Unit and the ship fitted transducer on the drop keel.

Whittard Canyon Mooring

For the Whittard Canyon deployment the following instrumentation was used:

Instrument	Serial Number
Sea-Bird SBE 37	9385
Sea-Bird SBE 37	9386
Teledyne 600 kHz ADCP	23184
Teledyne 75 kHz ADCP	5575
Novatech Light	S01-178
Novatech Iridium	H04-023
Ixsea Release	1919
Anderson Sediment Trap	N/A

Both ADCP's were programmed in the lab prior to being fitted into the deepwater syntactic buoyancy and an audio check was performed to make sure the instruments were logging before being deployed.

The following configuration settings were applied to the ADCP's, assuming a 400-day deployment. This was to allow for a full year's deployment plus some additional time to cover any possible delays in the turnaround next year.

SN: 5575 (75 kHz)	SN: 23184 (600 kHz)
CR1	CR1
CQ255	CF11101
CF11101	EA0
EA0	EB0
EB0	ED15500
ED14550	ES35
ES35	EX11111
EX11111	EZ1111101
EZ1111101	WA50
WA50	WB0
WB1	WD111100000
WD111100000	WF88
WF704	WN30
WN91	WP10
WP10	WS100
WS1600	WV175
WV175	TE00:01:30.00
TE00:30:00.00	TP00:05.00
TP00:05.00	TF22/05/01 15:00:00
CK	CK
CS	CS
;	;
;Instrument = Workhorse Long Ranger	;Instrument = Workhorse Sentinel
;Frequency = 76800	;Frequency = 614400
;Water Profile = YES	;Water Profile = YES
;Bottom Track = NO	;Bottom Track = NO
;High Res. Modes = NO	;High Res. Modes = NO
;High Rate Pinging = NO	;High Rate Pinging = NO
;Shallow Bottom Mode= NO	;Shallow Bottom Mode= NO
;Wave Gauge = NO	;Wave Gauge = NO
;Lowered ADCP = YES	;Lowered ADCP = YES
;Ice Track = NO	;Ice Track = NO
;Surface Track = NO	;Surface Track = NO

;Beam angle = 20 ;Temperature = 5.00 ;Deployment hours = 9600.00 ;Battery packs = 4 ;Automatic TP = NO ;Memory size [MB] = 512 ;Saved Screen = 2 ; ;Consequences generated by PlanADCP version 2.06: ;First cell range = 24.45 m ;Last cell range = 1464.45 m ;Max range = 703.08 m ;Standard deviation = 2.39 cm/s ;Ensemble size = 1974 bytes ;Storage required = 36.15 MB (37900800 bytes) ;Power usage = 1750.40 Wh ;Battery usage = 3.9 ; ; WARNINGS AND CAUTIONS: ; Advanced settings have been changed.	;Beam angle = 20 ;Temperature = 3.00 ;Deployment hours = 9600.00 ;Battery packs = 4 ;Automatic TP = NO ;Memory size [MB] = 1000 ;Saved Screen = 2 ; ;Consequences generated by PlanADCP version 2.06: ;First cell range = 2.10 m ;Last cell range = 31.10 m ;Max range = 43.14 m ;Standard deviation = 2.21 cm/s ;Ensemble size = 754 bytes ;Storage required = 276.12 MB (289536000 bytes) ;Power usage = 837.42 Wh ;Battery usage = 1.9 ; ; WARNINGS AND CAUTIONS: ; Advanced settings have been changed.

For the Sea-Bird SBE 37 Microcats, the following settings were used. Each instrument was programmed using Sea-Bird SeaTerm Version 2 software.

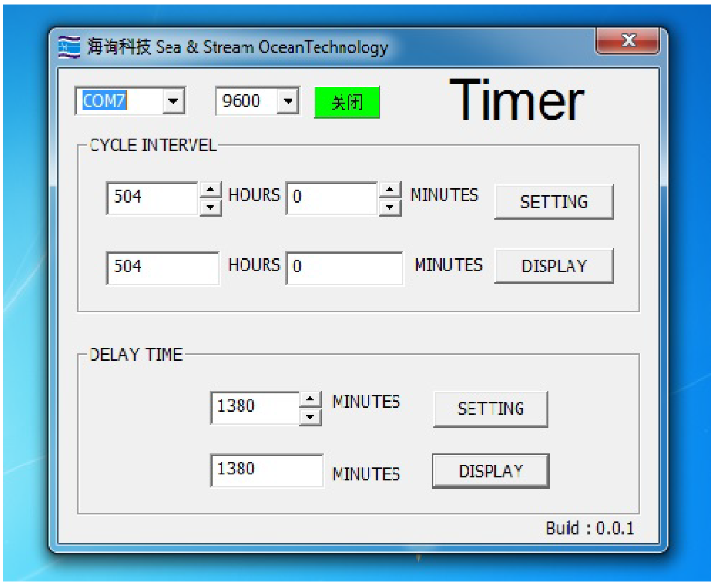
SN: 9385	**SN: 9386**
S>DS SBE37SM-RS232 v4.1 SERIAL NO. 9385 03 May 2022 07:53:27 vMain = 13.41, vLith = 2.93 samplenumber = 0, free = 559240 not logging, waiting to start at 03 May 2022 12:00:00 sample interval = 1800 seconds data format = converted engineering alternate transmit real-time = no sync mode = no	S>DS SBE37SM-RS232 v4.1 SERIAL NO. 9386 03 May 2022 07:55:48 vMain = 13.48, vLith = 3.06 samplenumber = 0, free = 559240 not logging, waiting to start at 03 May 2022 12:00:00 sample interval = 1800 seconds data format = converted engineering alternate transmit real-time = no sync mode = no

pump installed = yes, minimum conductivity frequency = 3344.1 S>	pump installed = yes, minimum conductivity frequency = 3330.6 S>

For the sediment trap on the Whittard Canyon mooring the decision was made to use an Anderson Sediment Trap, this was assembled on board the cruise rather than being set up back at NOC. Individual drop disks were loaded into the electronics and motor assembly, and the electronics timer set-up before finally being installed into the funnel housing.

A delayed start date and time of 12:00 noon on the 03/05/2022 was chosen, with subsequent disk drops programmed every 21 days at 12:00 noon.

Details of the cycle interval and delay time are shown below.



For the Whittard Canyon mooring recovered instruments, each instrument was cleaned and washed in fresh water, dried and then stopped before the data was downloaded.

- Sea-Bird SBE 37 SN: 7297 was not logging data due to depleted battery pack. It was noted this instrument had a sample interval of 10s rather than the expected interval of 1800s.
- Sea-Bird SBE 37 SN: 7298 was still logging data upon recovery.
- Sediment Trap SN: 11804-06 completed events 1 to 15 without issue, event 16 ended out of alignment, event 17 wasn't aligned at all and then all remaining events not completed due to recovery – battery voltage normal.
- Both ADCP's logged data and were downloaded via the serial comms cable.

PAP 1 Instruments

Four Sea-Bird SBE 37 IMP's were used on the PAP 1 Mooring deployment, with each instrument having a unique inductive ID number.

- Serial number 9469 was given #33 as it's ID number
- Serial number 9475 was given #46 as it's ID number
- Serial number 21210 was given #12 as it's ID number
- Serial number 23950 was given #50 as it's ID number

Two SBE 37's were installed on the PAP 1 Frame, the other two installed on the PAP 1 Buoy.

The following settings were used to program the SBE 37's

SN: 9469	**SN: 9475**
#33ds	#46sds
SBE37-IM v4.1 SERIAL NO. 9469 06 May 2022 08:53:20	SBE37-IM v4.1 SERIAL NO. 9475 06 May 2022 08:31:06
vMain = 13.21, vLith = 2.85	vMain = 13.22, vLith = 2.98
samplenumber = 0, free = 559240	samplenumber = 0, free = 559240
not logging, waiting to start at 06 May 2022 10:00:00	not logging, waiting to start at 06 May 2022 10:00:00
sample interval = 900 seconds	sample interval = 900 seconds
data format = converted engineering	data format = converted engineering
compatible mode enabled	compatible mode disabled
do not transmit sample number	do not transmit sample number
do not transmit sample HEX time	do not transmit sample HEX time
pump installed = yes, minimum conductivity frequency = 3323.4	pump installed = yes, minimum conductivity frequency = 3161.1
PC baud rate = 9600	PC baud rate = 9600
<Executed/>	<Executed/>
S>	S>

SN: 21210	SN: 23950
#12ds SBE37IMP-ODO v6.1.1 SERIAL NO. 21210 06 May 2022 08:47:39 vMain = 13.79, vLith = 2.98 samplenumber = 0, free = 399457 not logging, start at 06 May 2022 10:00:00 sample interval = 1800 seconds data format = converted engineering output temperature, Celsius output conductivity, S/m output pressure, Decibar output oxygen, ml/L minimum conductivity frequency = 3124.5 adaptive pump control disabled, pump on time 7.0 * 5.5 = 38.5 sec RS232 baud rate = 9600 <Executed/> S>	#50ds SBE37IMP-ODO v6.1.1 SERIAL NO. 23950 06 May 2022 08:37:46 vMain = 13.85, vLith = 3.16 samplenumber = 0, free = 399457 not logging, start at 06 May 2022 10:00:00 sample interval = 1800 seconds data format = converted engineering output temperature, Celsius output conductivity, S/m output pressure, Decibar output oxygen, ml/L minimum conductivity frequency = 3241.0 adaptive pump control disabled, pump on time 7.0 * 5.5 = 38.5 sec RS232 baud rate = 9600 <Executed/> S>

For the PAP 1 recovered instruments, each instrument was cleaned and washed in fresh water, dried, and then stopped before the data was downloaded.

- SN: 6909 #36 was still logging data, 38129 samples. It was noted this instrument had a one-hour time difference to GMT
- SN: 21549 #33 was still logging data, 19047 samples. It was noted this instrument had an 8-hour time difference to GMT
- SN: 16503 #03 was still logging data, 16503 samples. It was noted this instrument had an +48 second time difference to GMT
- SN: 6911 #46 was still logging data, 38152 samples. It was noted this instrument had an -9 second time difference to GMT

A visual inspection of the recovered instruments showed that on the instruments mounted in the PAP 1 Frame, some of the sensor guard securing screws had worked lose, although they remained in place.

All data was saved locally to the moorings laptops and then uploaded to the network drive and made available for the scientific party.

PAP 3 Instruments

For the PAP 3 recovered instruments, each instrument was cleaned and washed in fresh water, dried and then stopped before the data was downloaded.

- SN: 12455 (SBE 37) was still logging data, 19442 samples. It was noted this instrument had a one-hour time difference to GMT
- SN: 13585 (Nortek CM) was still logging data. It was noted this instrument had a one-hour time difference to GMT
- SN: 13569 (Nortek CM) was still logging data. It was noted this instrument had a one-hour time difference to GMT

All three sediment traps were secured on deck once the mooring recovery had been completed. All sample bottles were removed by the science party and safely stowed in fridges in the lab. Once all of the samples had been removed the instruments log files were downloaded.

- ML11262-03 recovered early, still logging – battery voltage normal
- ML11804-03 recovered early, still logging – battery voltage normal
- ML11804-03 logging not started; no setup file found – battery voltage normal

All data was saved locally to the moorings laptops and then uploaded to the network drive and made available for the scientific party.

For the PAP 3 mooring deployment the following instruments were used:

Instrument	Serial Number
Sea-Bird SBE 37	12463
Nortek CM	6178
Nortek CM	8351
Sediment Trap	11262-08
Sediment Trap	11262-09
Sediment Trap	11262-10
Novatech Light	Y01-015
Novatech Iridium	H04-022
Ixsea Release	2245

All three sediment traps were serviced and had new batteries fitted prior to the cruise at NOC. Once serviced sample bottles were fitted and filled. A fresh set on batteries were then installed allowing each trap to be programmed with its deployment schedule.

Two Nortek current meters were used on the mooring, each being set up with the following settings:

SN: 6178	SN: 8351
Deployment : 6178 Current time : 03/05/2022 13:23:51 Start at : 03/05/2022 18:00:00 Comment: PAP3 JC231 2022 -- ---- Measurement interval (s) : 1800 Average interval (s) : 30 Blanking distance (m) : 0.50 Measurement load (%) : 9 Power level : HIGH Diagnostics interval(min) : 720:00 Diagnostics samples : 20 Compass upd. rate (s) : 10 Coordinate System : ENU Speed of sound (m/s) : MEASURED Salinity (ppt) : 35 Analog input 1 : NONE Analog input 2 : NONE Analog input power out : DISABLED Raw magnetometer out : OFF File wrapping : OFF TellTale : OFF AcousticModem : OFF Serial output : OFF Baud rate : 9600 -- ---- Assumed duration (days) : 400.0 Battery utilization (%) : 50.0 Battery level (V) : 13.3 Recorder size (MB) : 9 Recorder free space (MB) : 8.973	Deployment : 8351 Current time : 03/05/2022 13:16:32 Start at : 03/05/2022 18:00:00 Comment: PAP3 JC231 2022 -- ---- Measurement interval (s) : 1800 Average interval (s) : 30 Blanking distance (m) : 0.50 Measurement load (%) : 9 Power level : HIGH Diagnostics interval(min) : 720:00 Diagnostics samples : 20 Compass upd. rate (s) : 10 Coordinate System : ENU Speed of sound (m/s) : MEASURED Salinity (ppt) : 35 Analog input 1 : NONE Analog input 2 : NONE Analog input power out : DISABLED Raw magnetometer out : OFF File wrapping : OFF TellTale : OFF AcousticModem : OFF Serial output : OFF Baud rate : 9600 -- ---- Assumed duration (days) : 400.0 Battery utilization (%) : 50.0 Battery level (V) : 13.3 Recorder size (MB) : 9 Recorder free space (MB) : 8.973

Memory required (MB) : 1.4 Vertical vel. prec (cm/s) : 1.4 Horizon. vel. prec (cm/s) : 0.9 -- ---- Instrument ID : AQD 6178 Head ID : A6L 3859 Firmware version : 3.37 -- ---- Aquadopp Deep Water Version 1.40.16 Copyright (C) Nortek AS	Memory required (MB) : 1.4 Vertical vel. prec (cm/s) : 1.4 Horizon. vel. prec (cm/s) : 0.9 -- ---- Instrument ID : AQD 8351 Head ID : A6L 5308 Firmware version : 3.37 -- ---- Aquadopp Deep Water Version 1.40.16 Copyright (C) Nortek AS

Software Used

- Sea-Bird SeaTerm 1.59
- Sea-Bird SBE Data Processing 7.26.6.28
- TRDI BBTalk

7. Scientific Computer Systems

Joshua Pedder: joshua.pedder@noc.ac.uk, *Josue Daniel Viera Rivero:* josue.viera.rivero@noc.ac.uk

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)

All times in this report are in UTC.

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. A Public network folder was also available for scientists to share files.

A copy of these two drives is written to the end-of-cruise disks that are provided to the principal scientists and BODC.

List of logged ship-fitted scientific systems:

/Cruise_Reports/JC231_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	Kongsberg .raw & .XYZ, redirected to Techsas/RVDAS RAM	/Acoustics/EA-640/
Kongsberg EM122	Continuous	Kongsberg .all	/Acoustics/EM122/Raw/
Kongsberg EM710	Discrete	Kongsberg .all	/Acoustics/EM1710/Raw/

Data acquisition system	Usage	Data products	Directory system name
Kongsberg SBP27	Discrete	Kongsberg .raw, .seg	/Acoustics/SBP27/
Sound Velocity	Discrete	.asvp	/Acoustics/Sound_Velocity/
UHDAS (ADCPs)	Continuous	ASCII raw, RBIN, GBIN, CODAS files	/Acoustics/ADCP/
Sonardyne Ranger2	Discrete	CSV, redirected to Techsas/RVDAS RAM	/Acoustics/USBL/

Data description documents per system:

/Ship_Systems/Documentation/[System]/Data_Description

Data directories per system:

/Ship_Systems/Data/[System]/

Significant acquisition events and gaps

On this cruise, the NMF Event Logger was used for bridge and ship systems tech logs with CSV records of events saved to the cruise data directory.

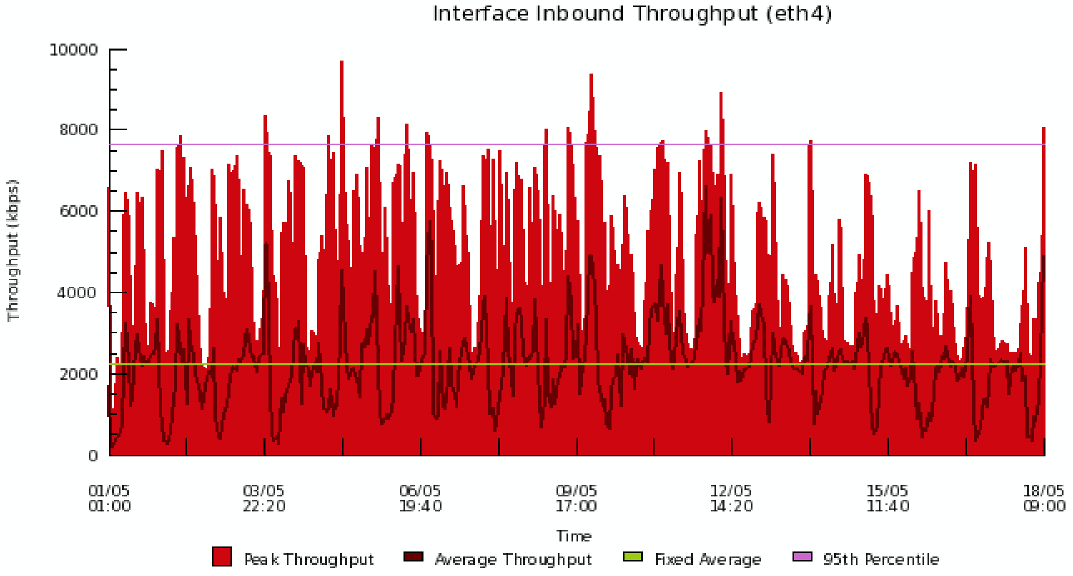
Path and pattern to event log CSV files:

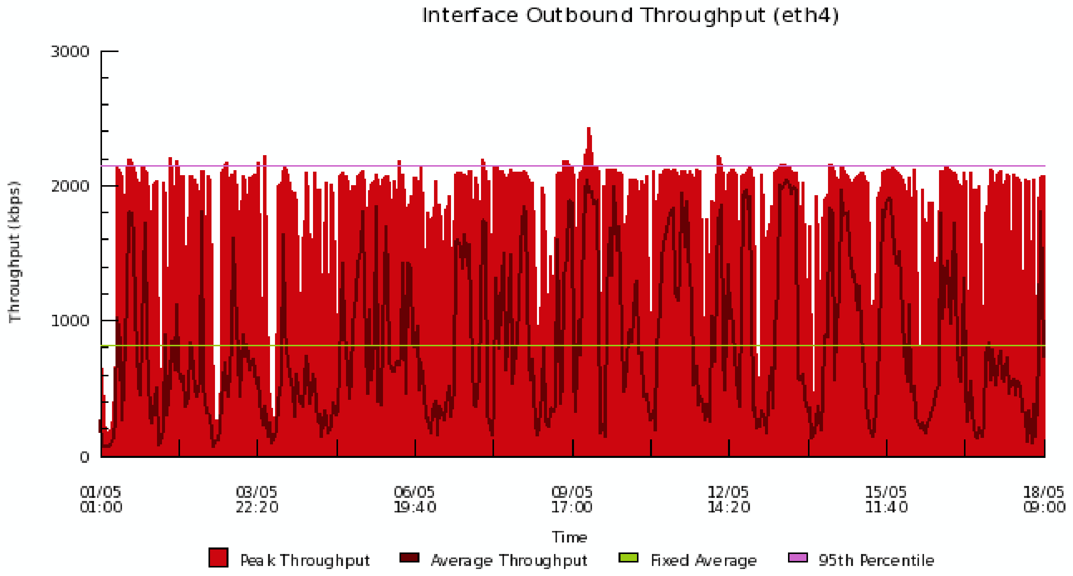
/Cruise_Reports/Event_Logs/*.csv

Internet provision

Satellite communications were provided with both the VSat and Fleet Broadband systems.

Internet usage:





WAN Interface Throughput Summary (eth4)			
Data Direction	**Total Data (MB)**	**Throughput Avg (Mbps)**	**Throughput Max (Mbps)**
Inbound	407938.456	2.23	9.69
Outbound	149110.259	0.81	2.43

Instrumentation

Coordinate reference

Path to ship survey files:

/Ship_Systems/Documentation/Vessel_Survey

Origin (*RRS James Cook*)

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

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

Multibeam

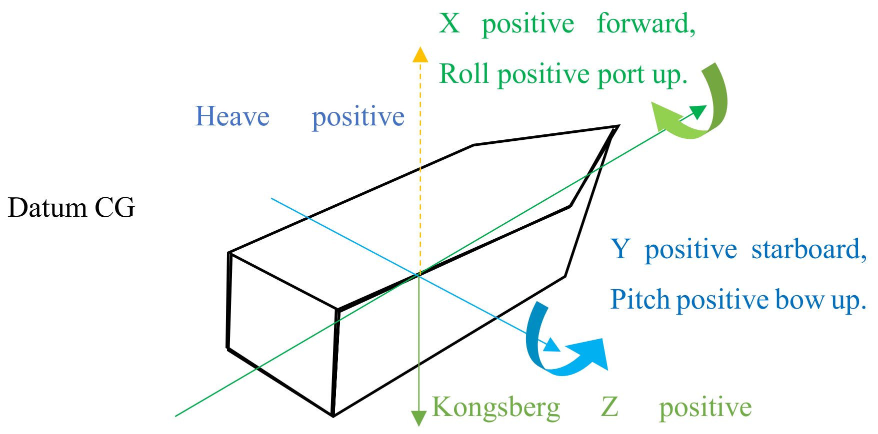


Figure 1 Conventions used for position and attitude. On the Discovery, the Datum is the CRP at the CG. On the Cook the Datum is on the centre, topside of the Applanix MRU.

The Kongsberg axes reference conventions are (see Figure 1) as follows:

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

The rotational sense for the multibeam systems and Seapath is set to follow the convention of Applanix PosMV (the primary scientific position and attitude system), as per Figure 1.

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,
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/ Pseudo-NMEA: /Ship_Systems/Data/TechSAS/NMEA/ Raw NMEA: /Ship_Systems/Data/RVDAS/NMEA/		
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.	DGPS 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

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/ Pseudo-NMEA: /Ship_Systems/Data/TechSAS/NMEA/ Raw NMEA: /Ship_Systems/Data/RVDAS/NMEA/	
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
Thermosalinograph (SBE45)	Measure temp, sal and conductivity at sampling board	Serial to Interface Box
Interface Box (SBE 90402)	Signals management	Serial to Moxa
Debubbler	Reduces bubbles through instruments.	
Transmissometer (CST)	Measure of transmittance	Analogue to NUDAM
Fluorometer (WS3S)	Measure of fluorescence	Analogue to NUDAM
Air temperature and humidity probe (HMPxxx)	Temperature and humidity at met platform	Analogue to NUDAM

Ambient light sensors (PAR, TIR)	Ambient light at met platform	Analogue to NUDAM
Barometer (PTBxxx)	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

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	Start	End	Event	Trans Vair (V)	Trans Vdark (V)
2022-05-01	12:00	12:30	Initial Cleaning	4.9040	0.006300
2022-05-01	12:40		Underway system started		
2022-05-18	14:19		Underway system shutdown and cleaned	4.8932	0.006400

Hydroacoustic systems

System	Acoustics		
Statement of Capability	/Ship_Systems/Documentation/Acoustics		
Data product(s)	Raw: /Ship_Systems/Data/Acoustics NetCDF (EA640,EM122): /Ship_Systems/Data/TechSAS NMEA (EA640,EM122): /Ship_Systems/Data/RVDAS		
Data description	/Ship_Systems/Documentation/Acoustics		
Other documentation	/Ship_Systems/Documentation/Acoustics		
Component	Purpose	Outputs	Operation
10/12 kHz Single beam (Kongsberg EA-640)	Primary depth echosounder	NMEA over serial, raw files	Continuous
Kongsberg EM122	Deep Water Multibeam echosounder	Kongsberg .all	Continuous
Kongsberg EM710	Shallow Water Multibeam echosounder	Kongsberg .all	Discrete
Kongsberg SBP27	Sub Bottom Profiler	Kongsberg .raw, .seg	Discrete
Sound velocity profilers (Valeport Midas)	Direct measurement of sound velocity in water column.	ASCII pressure vs sound velocity files. Manually loaded into EM's & Sonardyne Ranger2.	Discrete
75 kHz ADCP (Teledyne OS75)	Along-track ocean current profiler	(via UHDAS)	Discrete Free running
150 kHz ADCP (Teledyne OS150)	Along-track ocean current profiler	(via UHDAS)	Discrete Free running

USBL (Sonardyne Ranger2)	Underwater positioning system to track deployed packages or vehicles.	NMEA over serial	Discrete

Kongsberg EA640 – Single Beam Echosounder

The Kongsberg EA640 was run throughout the cruise, this is run with a constant sound velocity profile of 1500 m/s. Kongsberg raw data format and XYZ format dat is recorded.

Path of EA640 data on the cruise datastore: /Ship_Systems/Data/Acoustics/EA-640

Kongsberg EM122 – Multibeam Echosounder

Attribute	Value			
Offsets and rotations	Item	X (m, + Forward)	Y (m, + Starboard)	Z (m, + Down)
	Tx transducer	19.205	1.0830	6.934
	Rx transducer	14.094	0.950	6.932
	Att 1 (Applanix)	0	0	0
	Att 2 (Seapath)	-0.350	0.056	-0.373
	Waterline (distance from Att 1 to W/L)			1.2
	Item	Roll (deg)	Pitch (deg)	Heading (deg)
	Tx transducer	-0.35	-0.1	0.19
	Rx transducer	-0.06	0.1	0.15
	Att 1 (Applanix)	0.15	0.12	-0.2
	Att 2 (Seapath)	0.06	0.16	0.03

The Kongsberg EM122 was run continuously in international waters. Kongsberg's all format was recorded.

Path of EM122 .all data on the cruise datastore: /Ship_Systems/Data/Acoustics/EM-122/Raw

Kongsberg EM710 – Multibeam Echosounder

Attribute	Value			
Offsets and rotations	Item	X (m, + Forward)	Y (m, + Starboard)	Z (m, + Down)
	Tx transducer	5.415	-0.015	6.965
	Rx transducer	4.988	0.013	6.965
	Att 1 (Applanix)	0	0	0
	Att 2 (Seapath)	-0.350	0.056	-0.373
	Waterline (distance from Att 1 to W/L)			1.2
	Item	Roll (deg)	Pitch (deg)	Heading (deg)
	Tx transducer	-0.418	0.228	0.000
	Rx transducer	0.130	0.00	0.00
	Att 1 (Applanix)	-0.45	0.68	-0.38
	Att 2 (Seapath)	-0.46	0.39	-1.01

The Kongsberg EM710 was run in UK waters on departure. Kongsberg's .all format was recorded.

Path of EM710 .all data on the cruise datastore: /Ship_Systems/Data/Acoustics/EM-710/Raw

Kongsberg SBP27

The Kongsberg SBP27 was run discretly at the worksite. Kongsberg's .raw format and segy format was recorded.

Path of SBP27 all data on the cruise datastore: /Ship_Systems/Data/Acoustics/SBP27

Sound velocity profiles

Sound velocity profiles were calculated form the WOA13 model using Ifremer DORIS while on transit or derived from CTD at the worksite. These were input into the EM122, EM710 and Ranger 2 for USBL activities.

Date Time	Location	Source	File Name
2022-04-27 13:50:00	N50.230 W1.780	WOA13	WOA13_27042022_SVP1.asvp
2022-05-02 08:51:00	N49.016 W8.040	WOA13	WOA13_02052022_SVP2.asvp
2022-05-02 20:22:00	N48.553 W9.929	WOA13	WOA13_02052022_SVP3.asvp
2022-05-03 12:31:48	N48.649 W10.633	CTD	CTD_03052022_SVP4.asvp
2022-05-05 16:55:36	N48.962 W16.397	CTD	CTD_05052022_SVP5.asvp
2022-05-06 16:49:27	N48.996 W16.504	CTD	CTD_06052022_SVP6.asvp
2022-05-11 16:22:26	N48.947 W17.130	CTD	CTD_11052022_SVP7.asvp
2022-05-16 11:27:58	N49.008 W15.725	CTD	CTD_16052022_SVP8.asvp

Path of sound velocity profile data on the cruise datastore: /Ship_Systems/Data/Acoustics/Sound_Velocity/SVP_[X]/

ADCPs

Attribute	Value
Acquisition software	UHDAS or VMDAS
Frequencies used	75 kHz, 150 kHz or both
Running mode	Free-running (untriggered)
Configuration details	150 kHz 50x8m Bins with 4m Blanking 75 kHz 50x16n Bins with 8m Blanking

Path of ADCP data on the cruise datastore: /Ship_Systems/Data/Acoustics/ADCP

Sonardyne Ranger2 USBL

Ship Systems WMT Mega Core and on the wire for Grav Core. Data is logged to Techsas and CSV files were exported from Ranger2.

Path of USBL data on the cruise datastore: /Ship_Systems/Data/Acoustics/USBL

Other systems

Drop Keels

Starboard drop keel was lowered by 2.5m on multiple occasions. All movements are log in the acoustic event log found in:

Path and pattern to event log CSV files:/Cruise_Reports/Event_Logs/techlogs/Acoustic_events.csv

Cable Logging and Monitoring

Winch activity is monitored and logged using the CLAM system.

Gravity Meters

The gravity meters were temporarily run for engineering purposes only no tie-in's were performed.

8. CTD systems

Tim Powell, Dave Childs, Jade Garner - Sensors & Moorings Group, NMF, NOC, Southampton

11 CTD casts were undertaken with an NMF 24-way Stainless Steel CTD frame with 24 off 20l OTE water samplers. All instrument serial numbers were checked and all channels of the 9plus underwater unit checked before the first deployment.

The primary T, C & DO sensors with associated pump were mounted within the frame attached to the 9plus underwater unit. The secondary T, C & DO sensors with associated pump were mounted on the vane.

The PAR sensors that were used were Biospherical Quantum QCP-2350-HP cosine units that have a depth rating of 10,000 m and were fitted throughout the cruise.

The CTD was operated out of the Water Sampling Annex and returned to the annex after each cast. It was deployed on the 11.43mm conducting CTD wire (CTD1 storage drum) using the hydroboom. The wire was terminated using the Scotchkote and amalgamating tape method and attached to the CTD frame via an NMF MDS EM swivel. Initial electrical tests gave an insulation resistance of >1000MOhms and a continuity value of 77.4Ohms.

After each cast the sensors were flushed with Milli-Q and drained before installation of caps on the TC-duct inlet and pump exhaust of both sensor ducts. The whole CTD package was rinsed with fresh water to prevent salt crystals forming on the sensors, associated tubing and particularly the SBE 32 carousel latch assembly.

CTD Wire Condition

A new CTD wire had recently been fitted to CTD1 storage drum. It had been streamed on the previous cruise and was found fitted with a hard eye, three bulldog grips and a plastic container filled with potting compound on the end. The wire was heavily greased as was the spare wire CTD2.

The highly greased cable made it difficult to obtain a waterproof termination, led to grease dripping from the hydroboom onto the CTD and left a visible oil slick on the sea surface. The reduced friction also enabled the wire to pull through the hauler wheels when hauling accelerating their wear.

CTD Performance, Technical Issues & Instrument Changes

During cast 002 the primary oxygen data appeared noisy, upon recovery of the CTD jellyfish remains were found attached to the carousel. The primary sensors were thoroughly flushed with milliQ, the tubing removed, and the oxygen sensor membrane inspected. The oxygen Y cable was also removed, connectors were cleaned and re-greased before reinstalling.

Testing of the electrical termination following cast 004 revealed a very low insulation resistance value of 0.04MOhms indicating that the termination was close to failure. The termination was removed, and water was found within the wire. 30m of wire was cut off and the remaining wire appeared to be dry. A new termination was made taking additional steps to degrease the wire as much as was practical.

During cast 005, primary oxygen was found to still be noisy at depths below 3000m. At approximately 35m from the surface on the upcast, the deck unit briefly alarmed and powered off. The 240v AC input fuse had blown. Seasave indicated a loss of communication, the cast was halted and the CTD was returned to the water sampling annex. The CTD wire once again had water inside it. An additional 300m of wire was removed until no water could be found exiting. Another termination was made which initially had an insulation resistance of >1000MOhms however overnight this fell to 56MOhms suggesting there may still be water within the wire. The resistance was measured following each subsequent cast and was stable for the remainder of the cruise.

Between casts 006 and 007 the primary oxygen sensor 43-0363 was swapped for 43-2575, the oxygen data during cast 007 was much improved.

Cast 010 primary oxygen was over saturated, the primary pump 05T-7514 was swapped for a replacement 05T-7517.

Stainless Steel CTD Configuration

Instrument Package

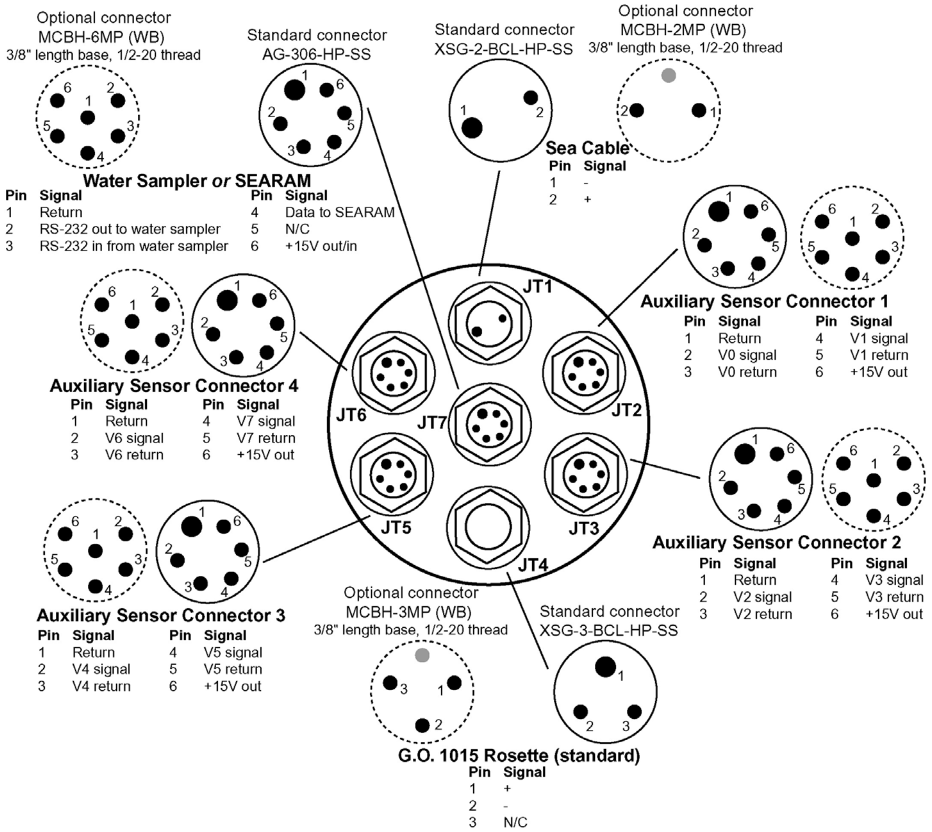
The following sensors were installed on the CTD frame:

Instrument / Sensor	Manufacturer/ Model	Serial Number	Channel	Casts Used
Primary CTD deck unit	SBE 11plus	11P-19817-0495	n/a	All casts
CTD Underwater Unit	SBE 9plus	09P-39607-0803	n/a	All casts
Stainless steel 24-way CTD frame	NOCS	SBE CTD8	n/a	All casts

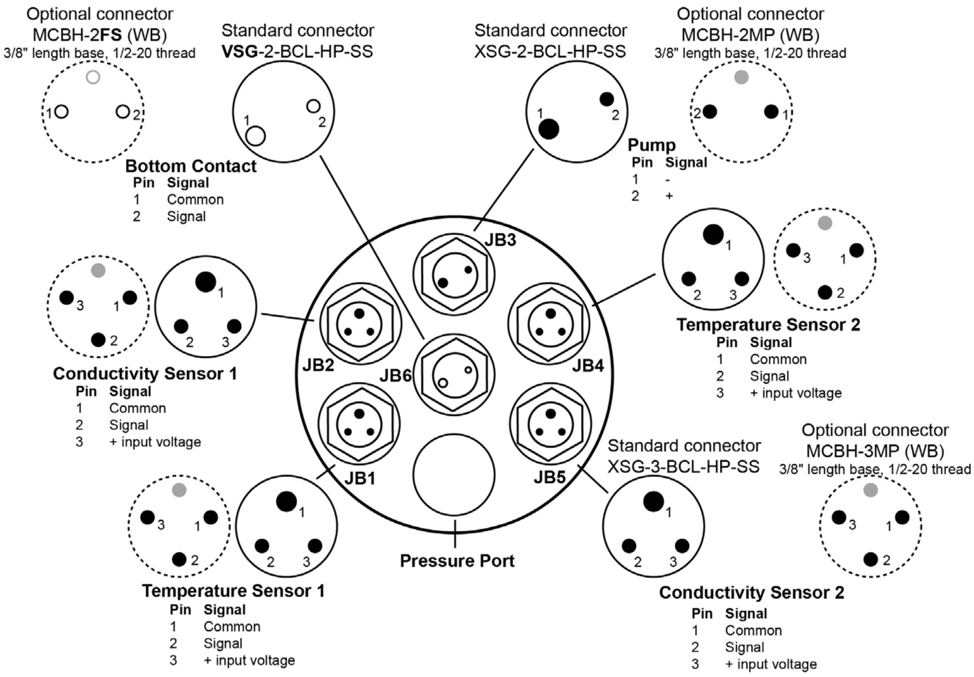
Primary Temperature Sensor	SBE 3P	03P-5700	F0	All casts
Primary Conductivity Sensor	SBE 4C	04C-2164	F1	All casts
Digiquartz Pressure sensor	Paroscientific	93896	F2	All casts
Secondary Temperature Sensor	SBE 3P	03P-5838	F3	All casts
Secondary Conductivity Sensor	SBE 4C	04C-3258	F4	All casts
Primary Pump	SBE 5T	05T-7514	n/a	Casts 1-10
Primary Pump	SBE 5T	05T-7517		Cast 11
Secondary Pump	SBE 5T	05T-7516	n/a	All casts
24-way Carousel	SBE 32	32-19817-0243	n/a	All casts
Primary Dissolved Oxygen Sensor	SBE 43	43-0363	V0	Casts 1-6
Primary Dissolved Oxygen Sensor	SBE 43	43-2575	V0	Casts 7-11
Secondary Dissolved Oxygen Sensor	SBE 43	43-1882	V1	All casts
Fluorometer	CTG Aquatracka MKIII	088195	V2	All casts
Altimeter	Tritech PA-200	6196.118171	V3	All casts
PAR Upward-looking DWIRR	Biospherical QCP Cosine PAR	70510	V4	All casts
PAR Downward-looking UWIRR	Biospherical QCP Cosine PAR	70520	V5	All casts
Transmissometer	Wet Labs C-Star	CST-1602DR	V6	All casts

Light Scattering Sensor	WETLabs BBRTD	BBRTD-759R	V7	All casts
20L Water Samplers	Ocean Test Equipment	Set A	n/a	All casts SBE 11p-0495
Titanium EM CTD Swivel	Machinery Development Services/V2_2	1253/2	n/a	All casts

SBE 9plus CTD Top End Cap Configuration



SBE 9plus CTD Bottom End Cap Configuration



Seasave Configuration & Instrument Calibrations

The Seasave Instrument Configuration file used for all cast 1-6 was JC231_0803_SS.xmlcon

Date: 05/06/2022

Instrument configuration file: C:\Users\sandm\Documents\Cruises\JC231\Seasave Setup Files\JC231_0803_SS_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 : No
NMEA device connected to : PC
Surface PAR voltage added : No
Scan time added : Yes

1) Frequency 0, Temperature

Serial number : 5700

Calibrated on : 13-May-20

G : 4.34186349e-003

H : 6.29063188e-004

I : 1.90923104e-005

J : 1.24105815e-006

F0 : 1000.000

Slope : 1.00000000

Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 2164

Calibrated on : 13-Aug-20

G : -1.02235021e+001

H : 1.40934617e+000

I : -2.55368159e-003

J : 2.48419414e-004

CTcor : 3.2500e-006

CPcor : -9.57000000e-008

Slope : 1.00000000

Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 93896

Calibrated on : 12-Nov-20

C1 : -8.331332e+004

C2 : -3.281962e-001

C3 : 2.216060e-002

D1 : 2.906000e-002

D2 : 0.000000e+000

T1 : 3.005232e+001

T2 : -3.843669e-004

T3 : 4.436390e-006

T4 : 0.000000e+000

T5 : 0.000000e+000

Slope : 1.00005000

Offset : -2.68480

AD590M : 1.289250e-002

AD590B : -8.106440e+000

4) Frequency 3, Temperature, 2

Serial number : 5838

Calibrated on : 15-Apr-20

G : 4.34189039e-003

H : 6.69115825e-004

I : 2.66887413e-005

J : 2.12598330e-006

F0 : 1000.000

Slope : 1.00000000

Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 3258

Calibrated on : 26-Nov-2019

G : -1.06703633e+001

H : 1.36457748e+000

I : -9.48489629e-004

J : 1.47928362e-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 : 0363

Calibrated on : 29-Jul-20
Equation : Sea-Bird
Soc : 4.64400e-001
Offset : -4.96600e-001
A : -4.93950e-003
B : 2.37130e-004
C : -3.50080e-006
E : 3.60000e-002
Tau20 : 1.51000e+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 : 1882
Calibrated on : 28-Apr-21
Equation : Sea-Bird
Soc : 4.56800e-001
Offset : -4.93300e-001
A : -4.84780e-003
B : 2.10850e-004
C : -2.84750e-006
E : 3.60000e-002
Tau20 : 1.15000e+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, Fluorometer, Chelsea Aqua 3

Serial number : 088195
Calibrated on : 06-Aug-20

VB : 0.242859

V1 : 1.957390

Vacetone : 0.277470

Scale factor : 1.000000

Slope : 1.000000

Offset : 0.000000

9) A/D voltage 3, Altimeter

Serial number : 6196.118171

Calibrated on : 14-Nov-06

Scale factor : 15.000

Offset : 0.000

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

Serial number : 70510

Calibrated on : 13-Aug-21

M : 1.00000000

B : 0.00000000

Calibration constant : 16700000000.00000000

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

Calibrated on : 13-Aug-21

M : 1.00000000

B : 0.00000000

Calibration constant : 15400000000.00000000

Conversion units : umol photons/m^2/sec

Multiplier : 1.00000000

Offset : -0.06666738

12) A/D voltage 6, Transmissometer, WET Labs C-Star

Serial number : 1602DR
Calibrated on : 18-Jul-19
M : 21.4720
B : -0.1310
Path length : 0.250

13) A/D voltage 7, OBS, WET Labs, ECO-BB

Serial number : BBRTD-759R
Calibrated on : 12-Oct-19
ScaleFactor : 0.003806
Dark output : 0.040600

Scan length : 41

The Seasave Instrument Configuration file used for all cast 7 onwards was JC231_0803_SS_2.xmlcon

Date: 05/12/2022

Instrument configuration file: C:\Users\sandm\Documents\Cruises\JC231\Seasave Setup Files\JC231_0803_SS_nmea_2.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 : No
NMEA device connected to : PC
Surface PAR voltage added : No

Scan time added : Yes

1) Frequency 0, Temperature

Serial number : 5700
Calibrated on : 13-May-20
G : 4.34186349e-003
H : 6.29063188e-004
I : 1.90923104e-005
J : 1.24105815e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 2164
Calibrated on : 13-Aug-20
G : -1.02235021e+001
H : 1.40934617e+000
I : -2.55368159e-003
J : 2.48419414e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 93896
Calibrated on : 12-Nov-20
C1 : -8.331332e+004
C2 : -3.281962e-001
C3 : 2.216060e-002
D1 : 2.906000e-002
D2 : 0.000000e+000
T1 : 3.005232e+001

T2 : -3.843669e-004

T3 : 4.436390e-006

T4 : 0.000000e+000

T5 : 0.000000e+000

Slope : 1.00005000

Offset : -2.68480

AD590M : 1.289250e-002

AD590B : -8.106440e+000

4) Frequency 3, Temperature, 2

Serial number : 5838

Calibrated on : 15-Apr-20

G : 4.34189039e-003

H : 6.69115825e-004

I : 2.66887413e-005

J : 2.12598330e-006

F0 : 1000.000

Slope : 1.00000000

Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 3258

Calibrated on : 26-Nov-2019

G : -1.06703633e+001

H : 1.36457748e+000

I : -9.48489629e-004

J : 1.47928362e-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 : 2575

Calibrated on : 23-Jul-20
Equation : Sea-Bird
Soc : 4.33200e-001
Offset : -4.63300e-001
A : -4.64700e-003
B : 2.34650e-004
C : -3.22030e-006
E : 3.60000e-002
Tau20 : 9.30000e-001
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 : 1882
Calibrated on : 28-Apr-21
Equation : Sea-Bird
Soc : 4.56800e-001
Offset : -4.93300e-001
A : -4.84780e-003
B : 2.10850e-004
C : -2.84750e-006
E : 3.60000e-002
Tau20 : 1.15000e+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, Fluorometer, Chelsea Aqua 3

Serial number : 088195
Calibrated on : 06-Aug-20

VB : 0.242859
V1 : 1.957390
Vacetone : 0.277470
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

9) A/D voltage 3, Altimeter

Serial number : 6196.118171
Calibrated on : 14-Nov-06
Scale factor : 15.000
Offset : 0.000

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

Serial number : 70510
Calibrated on : 13-Aug-21
M : 1.00000000
B : 0.00000000
Calibration constant : 16700000000.00000000
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
Calibrated on : 13-Aug-21
M : 1.00000000
B : 0.00000000
Calibration constant : 15400000000.00000000
Conversion units : umol photons/m^2/sec
Multiplier : 1.00000000
Offset : -0.06666738

12) A/D voltage 6, Transmissometer, WET Labs C-Star

Serial number : 1602DR

Calibrated on : 18-Jul-19

M : 21.4720

B : -0.1310

Path length : 0.250

13) A/D voltage 7, OBS, WET Labs, ECO-BB

Serial number : BBRTD-759R

Calibrated on : 12-Oct-19

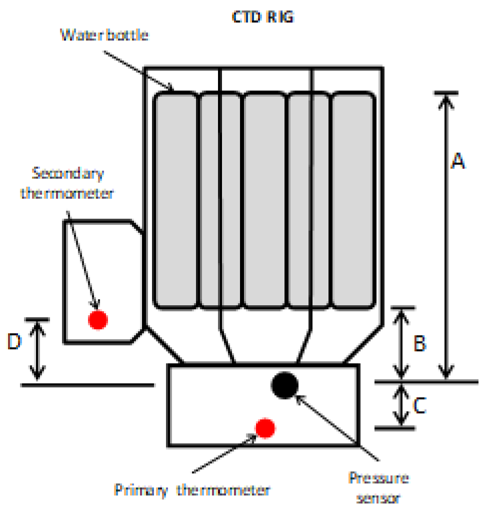
ScaleFactor : 0.003806

Dark output : 0.040600

Scan length : 41

Stainless Steel CTD Frame Geometry

ID	Vertical distance from pressure sensor (m)
A	1.35
B	0.20 s/s system (with 20L samplers)
C**	0.1
D	0.05



Cast Summary

Cast	Station	Julian Day	Max Wire	Altimeter /m	Notes
001	001	122	1850	96	Test cast, release test and microcat cal
002	003	124	4800	20	Microcat cal dip for Pap 3
003	012	125	200	n/a	
004	026	126	4810	10	Microcat cal dip, wire re-terminated
005	047	128	4805	13	Termination failed at 35m during
006	066	130	1000	n/a	Microcat cal dip
007	072	131	4810	9	Primary Oxy swapped prior to cast
008	083	133	4810	13	
009	089	134	1000	n/a	
010	092	134	100	n/a	Microcat cal dip
011	095	135	4810	11	Primary pump swapped before cast

Data Processing

Basic Sea-Bird CTD data pre-processing of the raw data was completed using Sea-Bird Data Processing software primarily following BODC processing guidelines version 1.0 Oct 2010

Scan count, elapsed time (seconds), NMEA latitude and longitude, and all instrument channels in engineering units were selected for data conversion. The primary and secondary oxygen channels were output in µmol/kg, µmol/l and SBE raw V.

The science party requested that no oxygen hysteresis correction be applied, tau correction to be ticked and that a 6s offset be applied to all oxygen variables.

The pre-processing order used was:
Data Conversion
Bottle Summary
AlignCTD (6s on oxygen channels only)
CellTM
Derive
Bin Average
Strip

There was also a requirement to produce 10m binned speed of sound profiles for correcting multi-beam swath data. The Bin Averaged files are named in the form JC231_CTD_xxx_SV_10m.cnv and contain the Chen-Millero (m/s) speed of sound algorithm on the secondary channel.

A separate Data Conversion process was used to produce files for use by the Met Office.

The variables selected were:
Time Elapsed
Depth
Pressure, Digiquartz
Temperature
Temperature 2
Conductivity
Conductivity 2
Salinity
Salinity 2
The converted files are named in the form JC231_CTD_xxx_met.cnv

Salinometer

After each CTD cast salinity samples were taken from the OTE 20l water samplers by the science party. Samples were analysed by Sensors & Mooring technicians using the NMF provided Autosal Salinometer s/n 72227.

The salinometers were operated in the electronics workshop with the AC plant set at 21°C for an ambient temperature of 22°C.

The Autosals was standardised using IAPSO Standard Seawater batch P164 (Use By: 23rd March 2023, K15=0.99985, 2xK15=1.99970, 34.994 PSU).

The NMF Labview Autosal program was checked to ensure correct read/write access and function of the standardisation .ini file. A standard was run as a sample before and after each crate of samples as a control.

A data file from the analysis software was produced for each crate as an Excel spreadsheet and saved in the cruise folder.

All raw double conductivity measurements were also logged manually on paper log-sheets. These log-sheets were also scanned to pdf format and saved to the cruise folder.

Software Used
Sea-Bird Seasave 7.26.7.121 (SBE 9/11plus data acquisition)
Sea-Bird SBE Data Processing 7.26.7 (SBE 9/11plus data processing)

9. PAP 1 Mooring - scientific report

Nick Rundle, Sue Hartman, Corinne Pebody (ashore), Daisy Tong (OTEG), Jon Campbell (COD, ashore)

PAP1 Recovery

The PAP1 buoy and sensor frame were recovered around 10:00 on 5 May 2022. They had been deployed on DY130 on 3 Apr 2021. The anchor had been deployed on DY116 on 21 Nov 2020.

Recovered buoy and sensor frame

The DY130 system used an old Telemetry Unit buoy controller and an old Data Hub frame controller. The Data Hub is mounted inside a large develogic pressure housing, and for the first time the battery container inside the pressure housing was filled with 95 lithium D-cells to provide an 18V backup power supply in the event that the umbilical cable bringing power and communications from the buoy failed. A pair of LinkQuest acoustic modems was also fitted for the first time to provide backup communications between buoy and frame in the event of a cable failure.

The umbilical cable used for this deployment was a Habia cable with black outer sheath protected by a length of hydraulic hose.

The Near Real Time (NRT) satellite communications system worked well throughout the deployment, allowing data to be banked at NOC and control commands to be sent via email. It proved especially useful to be able to power-cycle some of the sensors remotely.

The table below lists the main problems encountered during the deployment:

DY130 - New MOBILIS buoy/frame deployed	**03-Apr-21**	**93.5**	**Telemetry Unit 02, Data Hub 01**
Deployed ~ 1200		**days**	[Anchor deployed on 21 Nov 2020 on DY116]
Atmos CO2 stopped sending data and high current	**14-May-21**	41	
Atmos CO2 OK after power cycle	**16-May-21**	43	
Met Office wind sensor stopped talking	**21-May-21**	48	
TDGP sensor stopped talking	**23-May-21**	50	
TDGP sensor OK after switching to hub supply	**24-May-21**	51	
Problems with corrupt and missing SBE/SBO msgs began	**24-May-21**	51	
Frame CO2 sensor stopped talking	**13-Jun-21**	71	Hub was drawing ~500mA extra. Power cycling did not change anything.
CO2_B sensor stopped talking and 500mA excess current	**21-Jun-21**	79	
CO2_B OK after power cycle	**23-Jun-21**	81	

Sent restart command to data hub	**24-Jun-21**	82	Unsuccessful attempt to get acoustics to work
Atmos CO_2 stopped sending data and high current	**08-Sep-21**	158	
Atmos CO_2 OK after power cycle	**10-Sep-21**	160	
CO2_B sensor stopped talking and 400mA excess current	**16-Oct-21**	196	
CO2_B OK after power cycle	**18-Oct-21**	198	
WETLabs fluorometer sending excess data	**23-Oct-21**	203	
Last message from frame MicroCATs	**24-Oct-21**	204	
30V supply to hub became intermittent	**24-Oct-21**	204	Intermittent 30V supply draws excessive current and causes fluorometer oversampling
30V supply switched OFF	**25-Oct-21**	205	
30V supply switched ON	**26-Oct-21**	206	
30V supply switched OFF	**27-Oct-21**	207	
Last RS232 chars from hub	**02-Nov-21**	213	
Atmos CO_2 stopped sending data and high current	**03-Jan-22**	275	
Atmos CO_2 OK after power cycle	**05-Jan-22**	277	

Atmos CO2 humidity sensor failed - unable to measure CO2	**10-Jan-22**	282	Power cycle had no effect
CO2_B sensor stopped talking and 100mA excess current	**10-Feb-22**	313	
CO2_B OK after power cycle	**12-Feb-22**	315	
Buoy recovered JC231 ~1000	**05-May-22**	397	

The table below lists the sensors deployed and a brief summary of their performance:

PAP1 DY130 deployment 03 April 2021 - 05 May 2022			
Buoy (1m)	**S/N**	**NRT**	**Data status**
Telemetry Unit/Buoy Controller	2	**ST1**	Full dataset
PAP1 mooring - Pro-Oceanus CO2-Pro Atmospheric	41-824-50A	**CO A/B**	Stopped working after 282 days. No comms after recovery
PAP1 mooring - Pro-Oceanus CO2-Pro (backup)	29-097-45	**CO D**	Full dataset
PAP1 mooring - SeaBird SBE-37IMP ODO MicroCAT	16503	**SBO**	Full dataset
PAP1 mooring - SeaBird SBE-37IMP MicroCAT	6911	**SBE**	Full dataset
PAP1 mooring - Satlantic OCR-507 ICSA	226/230	**OC3**	Full dataset
PAP1 mooring - Aanderaa 4330 optode	1279	**OXY**	Full dataset but severe biofouling

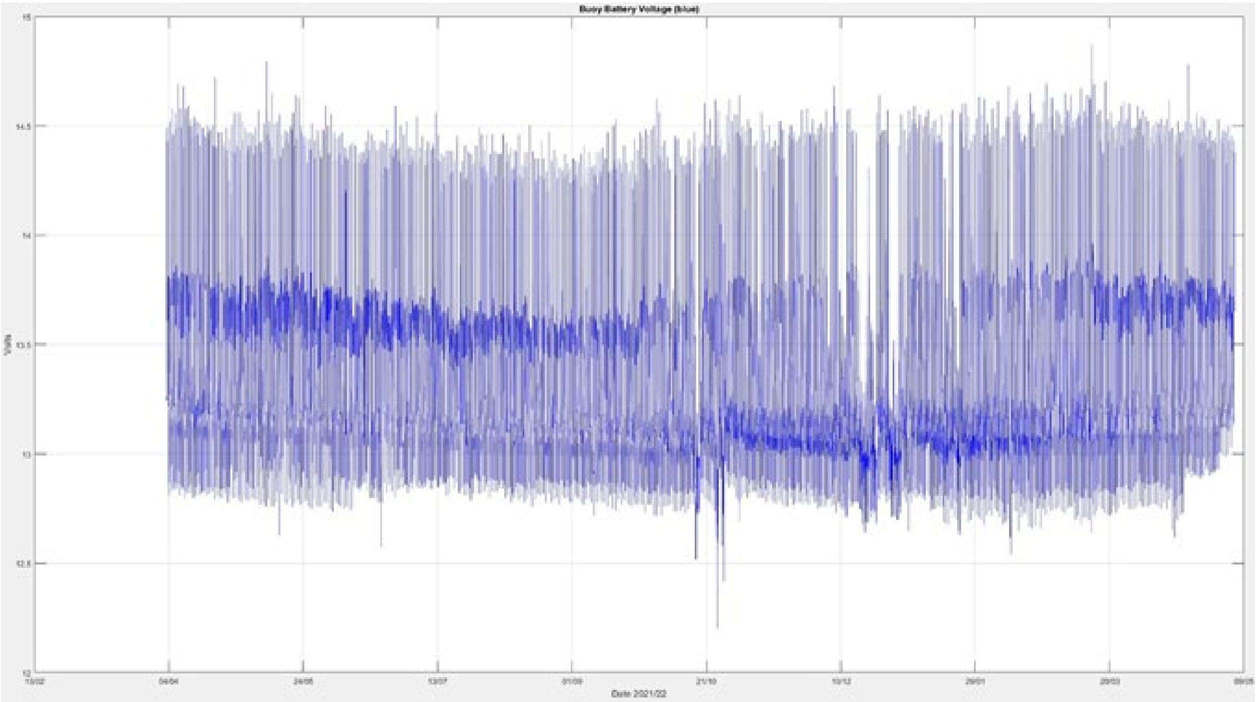
Met Office sensors on buoy		MET	No wave data. Wind sensor failed 21 May 2021.
Sensor Frame (30m)			Umbilical cable failed around 25 Oct 2021 after 205 days
Old Frame Controller/Data Hub	1	HUB	Internal batteries self-destructed, controller and memory card destroyed
PAP1 mooring - WETLabs FLNTUSB Fluorometer	6702	WET	Stopped working properly on 23 Oct 2021 and subsequently found to have flooded
PAP1 mooring - Pro-Oceanus Logging CO2-ProCV	33-146-45	COC	Stopped working after 71 days. Last data 13 Jun 21. Sensor worked after recovery
PAP1 mooring - Pro-Oceanus Mini TDGP	39-616-31	TDG	Stopped recording 27 Dec 21
PAP1 mooring - SBE-37IMP ODO MicroCAT	21549	SBO	Full dataset
PAP1 mooring - SBE-37IMP MicroCAT	6909	SBE	Full dataset
PAP1 mooring - Satlantic SUNA V2 Nitrate sensor	698	SUN	Data up to 18 Apr 2022
PAP1 mooring - Aanderaa Seaguard/Optode	2075/1299	SEA	Full dataset but Cyclops fluorometer lost sometime between Oct - Dec 2021
PAP1 mooring - Satlantic OCR-507 ICSW irradiance	200/231	OC1	NRT data only up to 25 Oct 2021 when cable failed
Clearwater Nitrate sensor	CWN-01-34	none	Data up to 27 Mar 2022, self-logging

As the photo below shows, the underside of the buoy was exceptionally heavily fouled with goose barnacles on any areas that were not painted with antifouling. This included the sensors inside the keel tube.

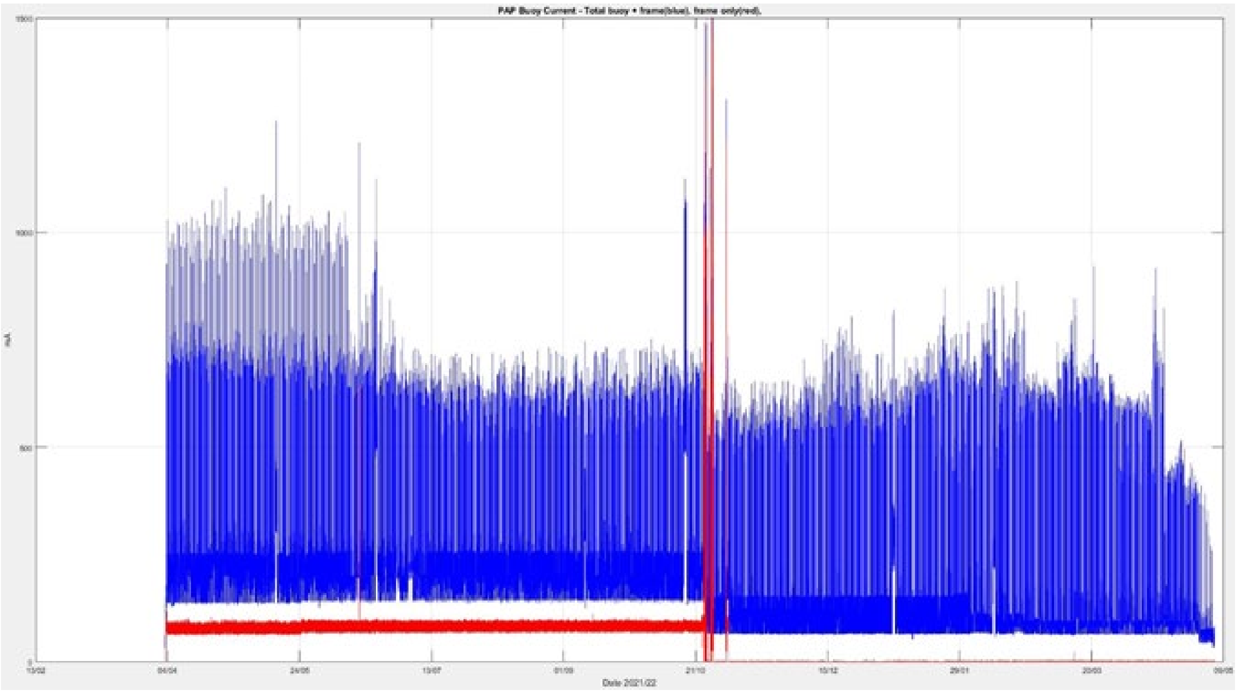
As usual the sensor frame exhibited far less fouling than the buoy and less than has been seen on some of the previous deployments:

Buoy Power

The solar charged batteries in the Met Office Mobilis buoy provide power to the buoy and frame controllers and to many of the sensors. Some of the sensors and the frame controller have dedicated battery supplies as well, in case the main power fails.



The plot above shows the buoy supply voltage as measured at the buoy controller input. It shows that the solar panels were comfortably able to keep the buoy batteries charged throughout the 13-month deployment.



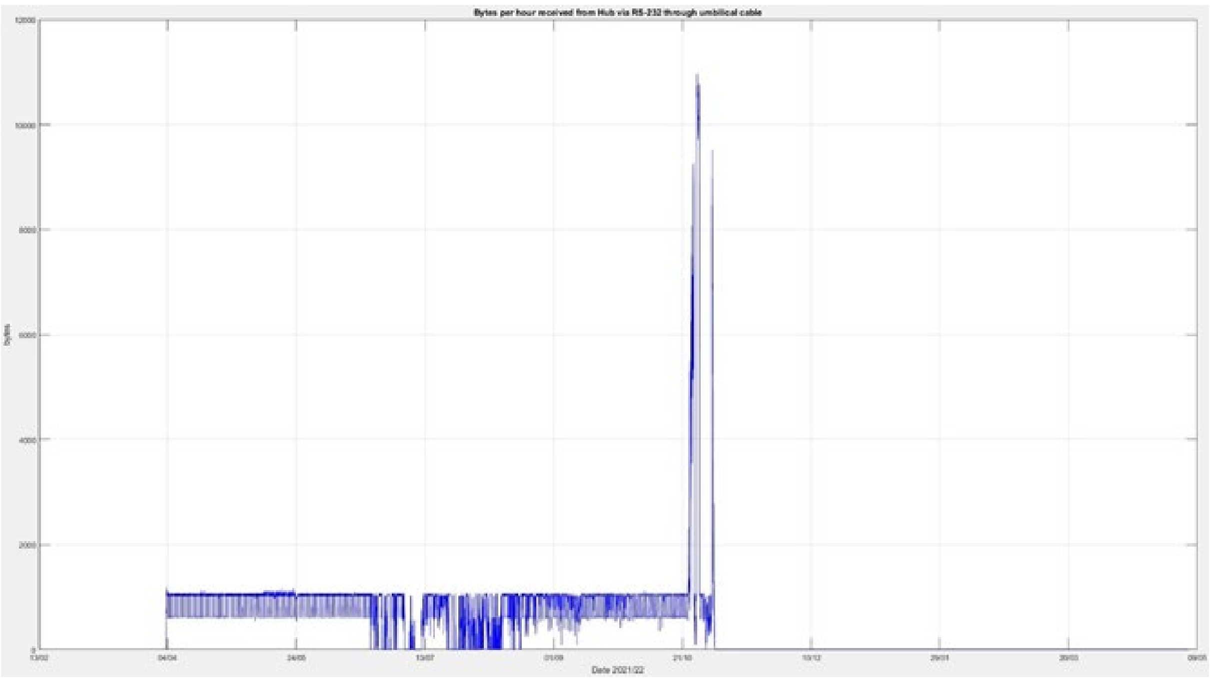
This plot shows the total current flowing into the buoy controller in blue, and the current flowing into the 30V frame power supply in red. It clearly shows where the umbilical cable began to fail resulting in an intermittent short circuit across the frame power supply. This supply was switched off remotely once it became apparent that the cable had failed.

Data communications between buoy and frame

During this deployment there were potentially 3 methods for data to get from the frame to the buoy (and hence back to NOC), namely RS-232, inductive modem and acoustic modem.

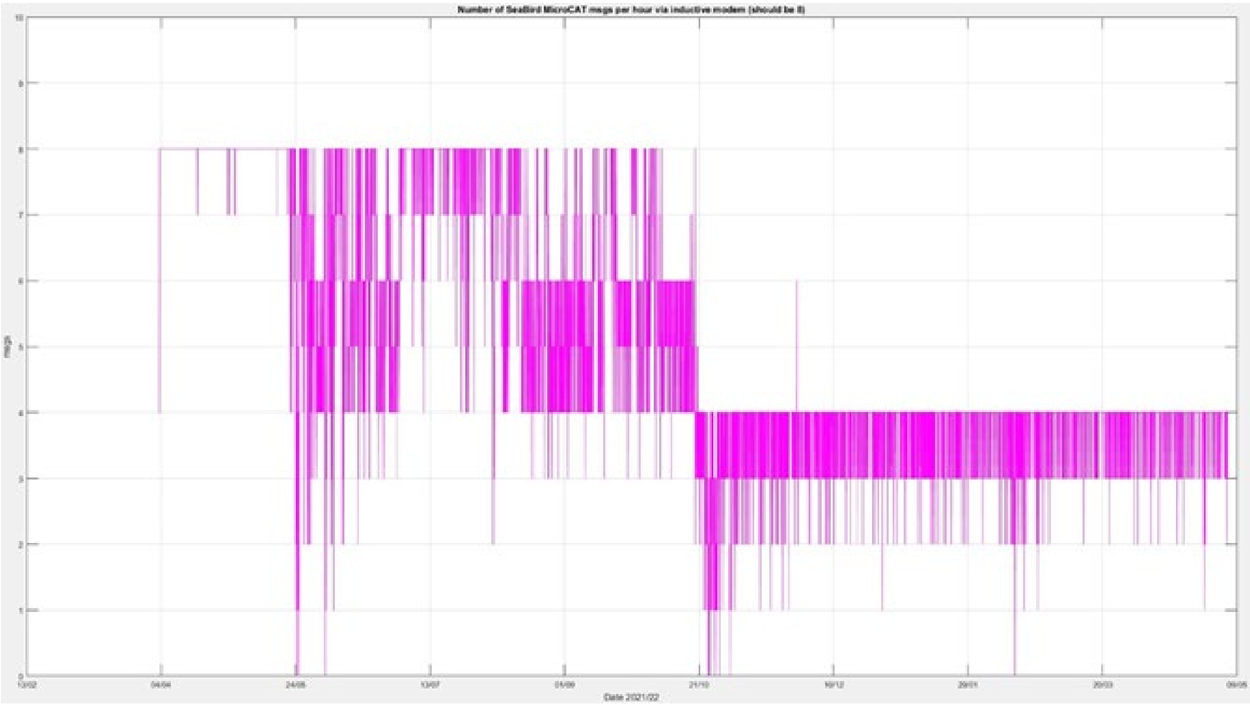
The principal method is via direct, bi-directional RS-232 communication though the umbilical cable. This of course depends on the integrity of the cable and the plot below shows that the RS-232 connection began to struggle towards the end of June before mysteriously recovering in August. It is not clear what caused this problem, but in the Habia cable the RS-232 signals are carried by very thin wires which may have suffered connection issues. The plot also shows a sudden large increase in data traffic shortly before the umbilical cable failed towards the end of October. It appears that the WETLabs fluorometer in the frame suffered water ingress at around this time which caused it to increase its sampling rate from once every 4 hours to roughly once per second! This is a strange coincidence which appears to have repeated on the current JC231 deployment.

The photos below the plots show visible damage to the Habia cable several metres above the sensor frame which may have been caused by one of the cable clamps cutting though the hydraulic hose and into the cable itself.



Plot above shows data bytes per hour received by buoy controller.

The umbilical cable also carries an inductive communications link between an inductive modem in the buoy controller and the 4 SeaBird MicroCAT sensors (2 on the buoy and 2 in the frame). Every 30 minutes this modem interrogates all 4 MicroCATs which should reply with their latest data. Thus 8 data messages should be received every hour. However, the plot below shows this was rarely achieved and the reason is unclear. There was some evidence that one of the buoys MicroCAT’s inductive coupler had not been properly clamped over the inductive cable which had been partially trapped by the coupler. If the coupler is not fully clamped, it is likely to malfunction. There may also have been issues with water ingress into the inductive cabling or issues with the sea earths which are necessary to complete the inductive “circuit”.



Inductive messages received per hour.

Habia umbilical cable damage after recovery.

Location of cable damage close to frame connection.

In order to provide a backup data transfer method if the umbilical cable failed, a pair of LinkQuest UWM1000 acoustic modems were fitted. After deployment both modems were intended to be powered continuously and every few hours the frame modem would transfer a buffer of accumulated data to the buoy. This setup had been tested at NOC prior to the cruise with the modems working in air a centimetre or two apart.

Shortly after deployment a command was sent from NOC telling the buoy modem to “sync” with the frame modem. This command was successful, and the buoy modem reported that a communications channel had been established at a range of 27.5 m. But sadly, no data were received, and all further “sync” commands failed to establish a connection.

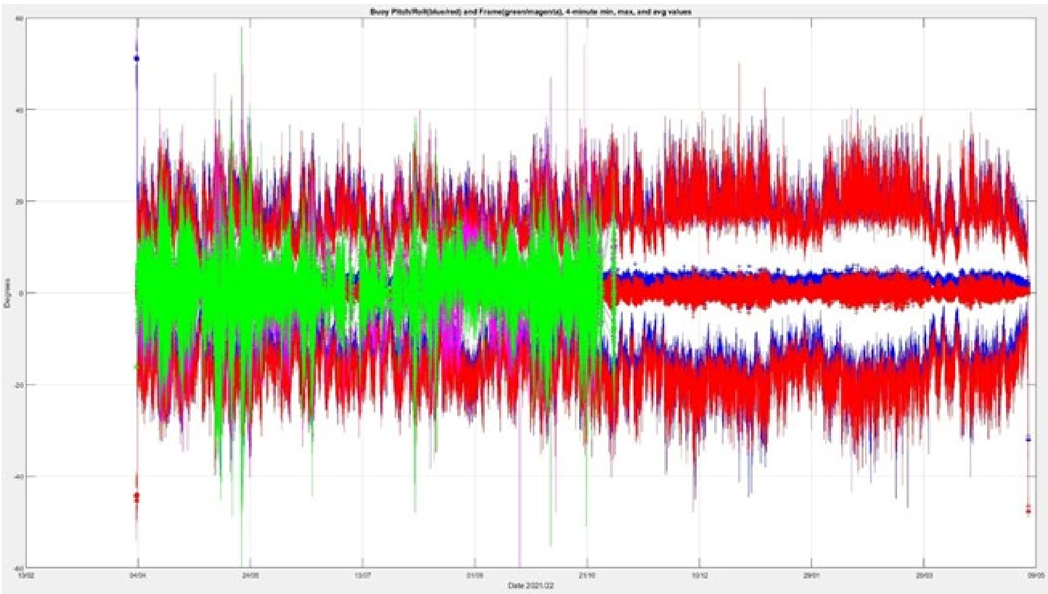
After the cruise the modems were tested in a large tank at NOC and assistance sought from LinkQuest. The modems functioned correctly and LinkQuest was not able to find any problems with the data returned from the sync commands. This suggests that the frame modem lost power shortly after deployment, and closer inspection of the cable harnesses and OceanSonics battery housing revealed that a fuse inside the battery housing had blown. The fuse was a 2A quick blow, and it appears that it blew when the frame modem tried to send its first batch of data.

UK Met Office sensors

The Mobilis buoy belonging to the UK Met Office carries one of their standard suites of meteorological sensors comprising air temperature, pressure and humidity, wind speed and direction, water temperature and wave height. These sensors have their own power supply, controller and satellite telemetry system that is completely separate from the NOC equipment on the buoy. On this deployment the wave height sensor was not functional, and the wind sensor failed after 48 days.

Buoy and frame pitch/roll sensors

In the absence of wave measurements, the pitch and roll sensors mounted in the buoy and frame controller housings give an indication of their motion and any long-term offsets in the attitude of either platform.



Pitch/roll measurements from the buoy and frame.

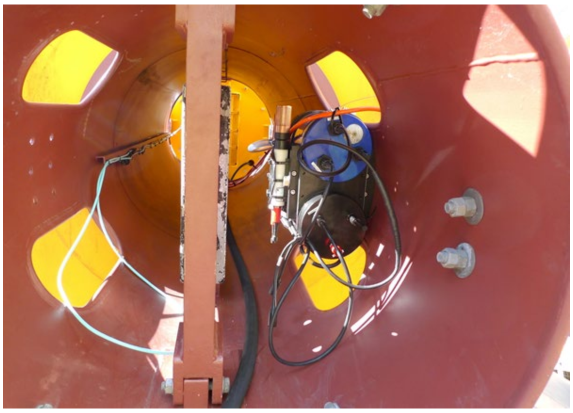
Buoy sensors: Pro-Oceanus CO2-Pro Atmospheric sn 41-824-50A and Pro-Oceanus CO2-Pro (backup) sn 29-097-45

Two Pro-Oceanus CO2 sensors were mounted side by side inside the buoy keel as shown in the photo below. Both measured in-water CO2 and the atmospheric sensor additionally measured atmospheric CO2 via an air intake box mounted on the buoy mast. Both sensors were fitted with SeaBird pumps.

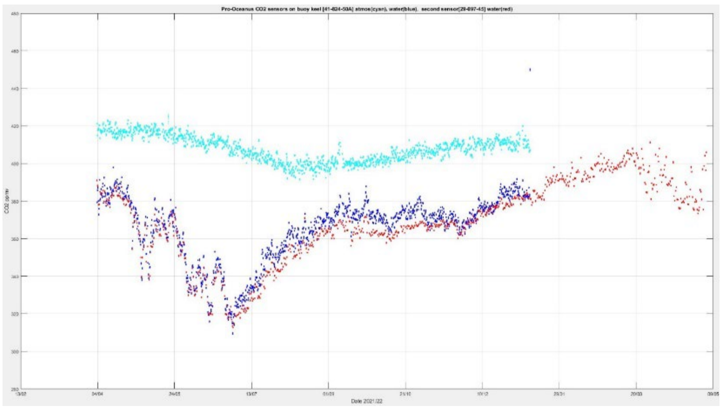
Sensor 41-824-50A failed on 10 Jan 2022 after 282 days. This was subsequently found to have been caused by water ingress through the membrane. It was configured to sample every 6 hours at 00:22, 06:22, 12:22, 18:22 UTC.

Sensor 29-097-45 ran for the entire deployment and was configured to sample every 12 hours at 01:55, 13:55 UTC. Both sensors were configured to perform an Auto Zero Point Calibration (AZPC) every 12 hours.

Both sensors malfunctioned on 3 occasions requiring a remotely initiated power cycle before they would restart. An explanation for this behaviour will be sought from Pro-Oceanus.



CO_2 concentration measured on the buoy

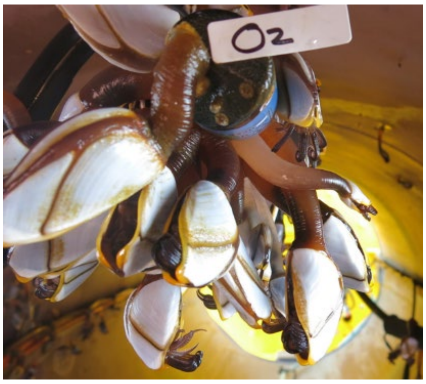


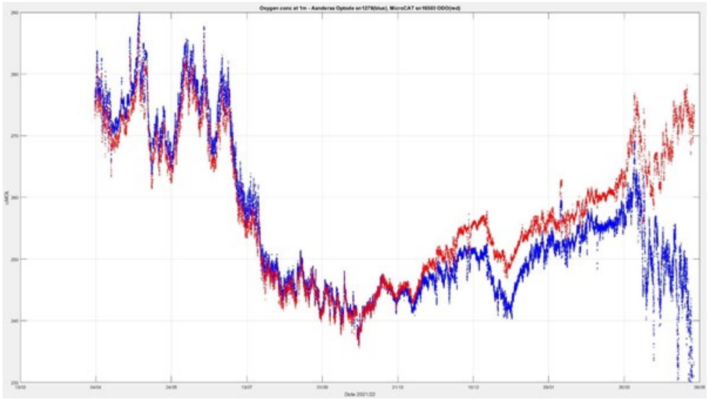
Buoy sensor: Aanderaa 4330 oxygen optode sn 1279

This sensor was mounted inside the buoy keel and functioned for the entire deployment. It was controlled by the buoy controller which switched it on for 95 seconds every 30 minutes at 14 and 44 minutes past the hour. The sensor was configured to sample every 30 seconds, thus producing 3 readings for each sampling interval.

The oxygen concentration values output by the sensor assumes a salinity of zero, so these values need to be corrected using an algorithm provided by Aanderaa. This correction has been applied to the data below using a constant salinity value of 35.5 PSU.

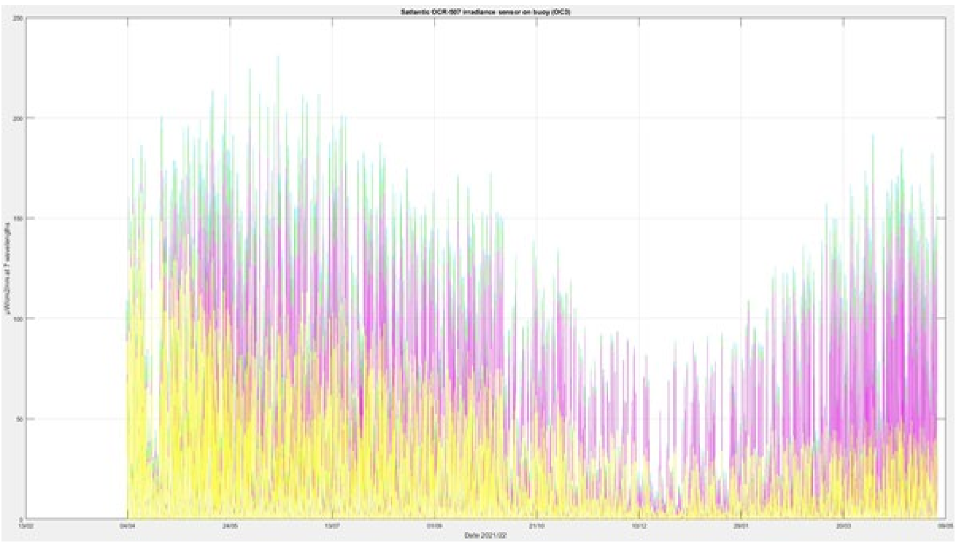
As can be seen from the photo below a large goose barnacle was found to be attached to the sensor membrane after recovery. This probably explains why its oxygen values began diverging from the nearby SeaBird SBE37-ODO MicroCAT sn 16503 (see data plot below).





Buoy sensor: Satlantic OCR-507 ICSA Multispectral Radiometer sn 226

This radiometer (irradiance sensor) is mounted on top of the buoy mast looking up at the sky. It has a Satlantic Bioshutter to protect its optics while it is not measuring. The buoy controller switches power to the sensor every 30 minutes and collects irradiance values every second for around 90 seconds. This sensor functioned normally for the entire deployment and the results are shown in the plot below.



Sensor frame at 30m: Frame controller/Data hub

The data hub was housed in a large develogic MCH composite pressure case with an integral battery holder containing 95 LSH20 lithium D-cells. Although the housing had been deployed on previous occasions, this was the first deployment with batteries which provide backup power at 18V if and when the main 30V supply from the buoy is lost. The hub also employed an old Aanderaa conductivity sensor to sense whether or not it was in the sea. If the hub was not in the sea, the acoustic modem was disabled, and the hub spent most of its time asleep.

Just over 200 days into the deployment the umbilical cable failed and the last few messages from the hub showed that the internal 18V supply was powering the hub.

When the data hub housing was opened at NOC after recovery it was found that the internal battery container and its cells had been destroyed along with the hub electronics and memory card. As there was no obvious sign of water ingress it appears that mechanical damage to the battery container caused by the prolonged violent accelerations experienced by the sensor frame over the winter, caused damage to some of the cells causing them to ignite.

Sensor frame at 30m: Pro-Oceanus CO2-ProCV sn 33-146-45

This sensor was configured to sample every 8 hours at 04:45, 12:45, 20:45, and to perform an AZPC every 12 hours. After 71 days the sensor stopped talking and was continuously drawing around 500 mA. Switching the power supply from the data hub had no effect as the sensor was still taking power from its dedicated battery housing.

After recovery it was found that the tubing between the sensor and its SeaBird pump had been torn off at some point during the deployment. The sensor itself appeared to work normally when back at NOC.

Sensor frame at 30m: Pro-Oceanus Mini TDGP sensor sn 39-616-31

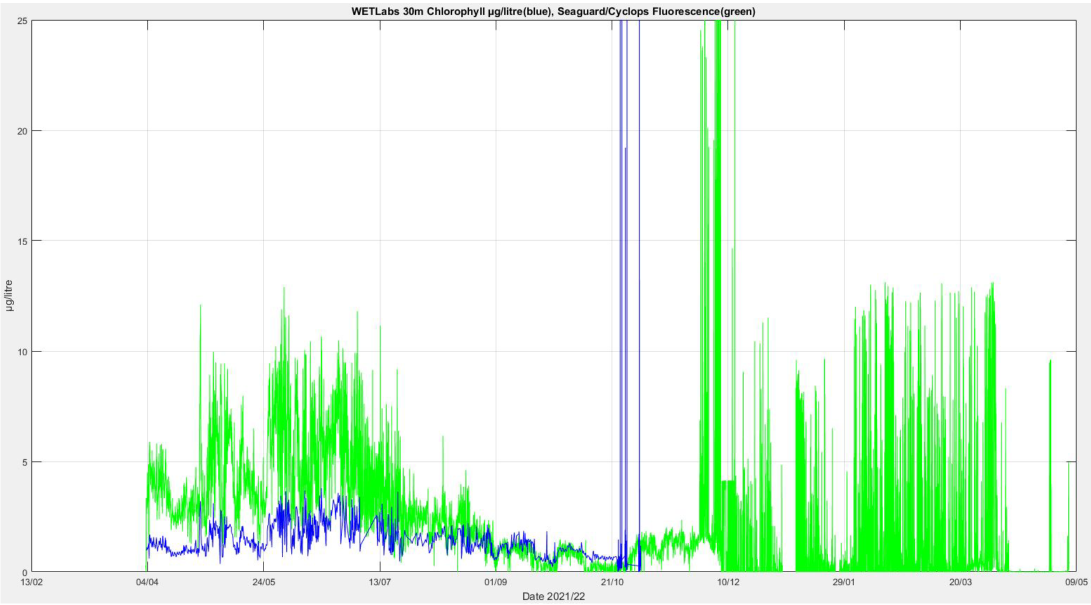
This sensor was configured to sample every 30 minutes at 02 and 32 past the hour. It continued to record internally until 27 Dec 2021. It was still functional when recovered so it seems likely that it ceased recording because of a failure of its BPA50 battery housing, which was found to have a damaged battery pack.

Sensor frame at 30m: Satlantic OCR-507 ICSW irradiance sensor sn 200

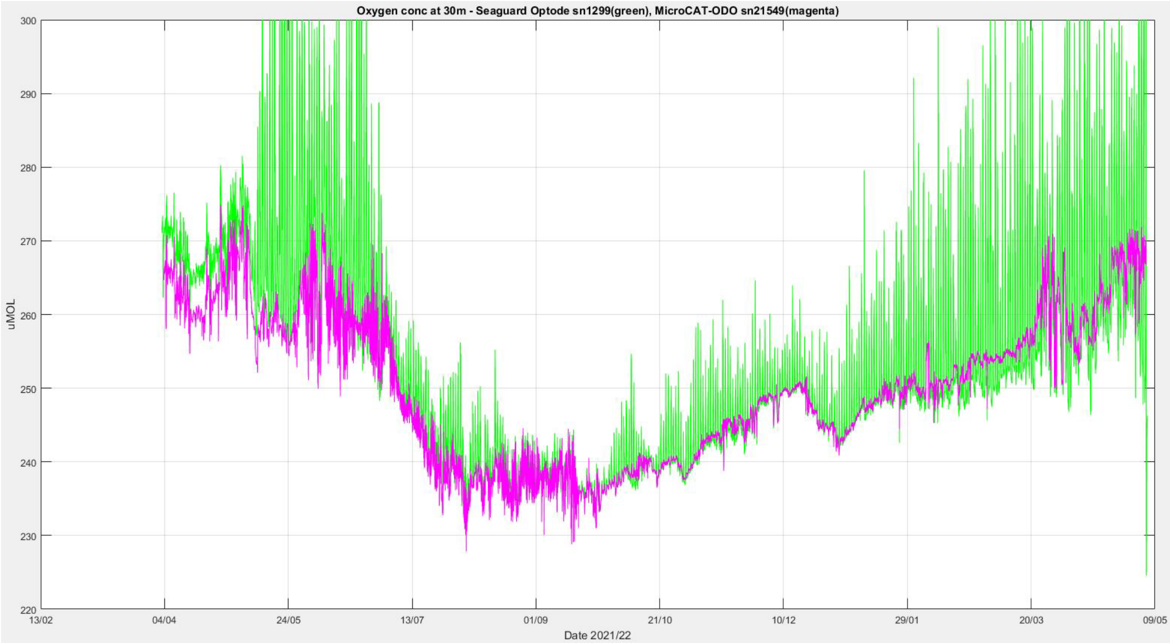
This sensor was mounted at the top of the sensor frame looking upwards. It was powered and logged by the data hub and sampled every 30 minutes at 17 and 47 past the hour, sampling at 1Hz for 2 minutes on each occasion. As the data hub's memory card was destroyed the only data from this sensor is the near real time data which lasted for a little over 200 days until the umbilical cable failed. The sensor may have continued to work beyond this.

Sensor frame at 30m: Aanderaa Seaguard sn 2075 with oxygen optode sn 1299 and Turner Cyclops fluorometer

This sensor was configured to sample every hour at 30 minutes past. It recorded internally for the entire deployment. Upon recovery it was noted that the Turner Cyclops was missing, and the data suggest that this happened towards the end of November 2021. The plot below shows fluorescence values from the Turner together with data from the WETLabs fluorometer.



The Aanderaa 4330 oxygen optode survived the deployment but appears to have become biofouled after a few weeks resulting in excessive oxygen values during the hours of daylight. The plot below shows oxygen data from the optode (corrected for salinity and temperature) plotted with oxygen values from the nearby SeaBird ODO sensor.



The Seaguard was mounted in the top of the sensor frame with the optode looking up at the sea surface. It would seem sensible to try and minimize the amount of sunlight reaching the optode for future deployments.

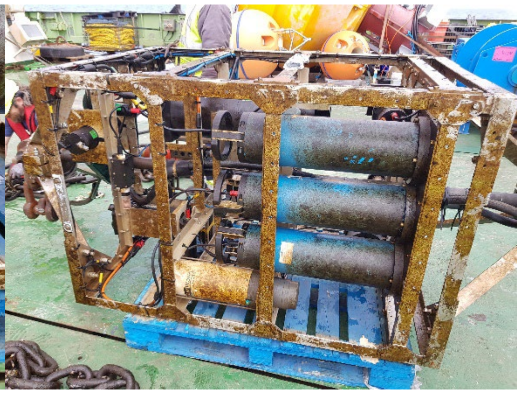
Sensor frame at 30m: WETLabs FLNTUSB Fluorometer sn 6702

This sensor was brand new and was configured to sample every 4 hours on the hour, taking 8 samples in quick succession. Early on 23 Oct 2021 at around the same time that the umbilical cable began to fail, the sensor began sampling continuously. This caused problems for the data hub and satellite telemetry as they were not designed to handle this amount of continuous data. A few days later the umbilical cable failed completely, and the messages stopped.

After recovery the senor was returned to SeaBird/WETLabs and was found to have been damaged internally by a small amount of water ingress.

Sensor frame at 30m: Clearwater Nitrate sensor sn CWN-01-34

Clearwater nitrate sensor (S/N CWN-01-34) was recovered and data downloaded via the provided GUI onboard. The sensor has a backup battery pack (the blue Ocean Sonic pack, as seen in photo on the right below). The nitrate has a standard reference at 16µMol, and it is set up to carry out a standard, sample then blank measurement every 12 hours.

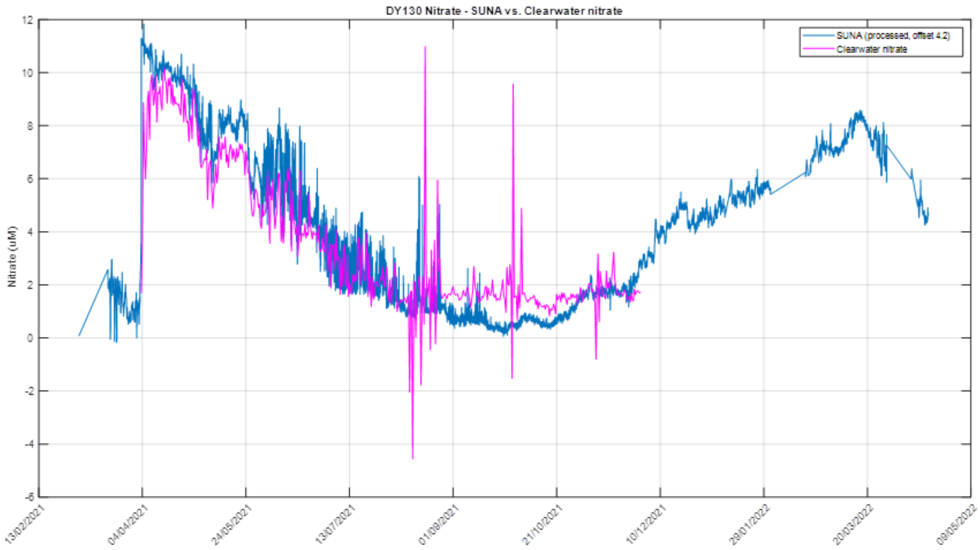



The data set recorded from 3rd April 2021 till 27th March 2022, when the backup battery pack was used up. Data was processed using the Clearwater GUI, and data for the medium channel is plotted below. It was noted that data seems to be irregular after Dec 2021, which might be due to ageing of the standard, thus the plotted data is only up to 10^{th} Dec 2021.

Sensor frame at 30m: Satlantic SUNA-V2 Nitrate sensor sn 698

Down loaded daily files from the SUNA SN698 onboard – initial issues trying to merge all data (likely lack of java code). Note values twice as high as autoanalyzer @30m. At deployment was ~16uM compared with 30m DY130 niskin (nitrate + nitrite = 7.8 +/- 0.5 n=8). Likely need to halve the data values NB: there is a Clearwater nitrate comparison to make for the 1^{st} time on this deployment.

SUNA stopped NRT data in November 2021 – but internal recorded until 18^{th} April 2022, a month before it was retrieved, and the time stamp at GMT looked OK. The data has been corrected (using SBE SN6909) but this gives many negative results. In tests the deionised water offset was -4.2. The negative values may be resolved by applying a correction for this drift in the blank? Note that in the SUNA ‘post cal’ onboard a 1.5uM standard read 2.8uM in the SUNA (the 12.5uM standard read 13.8uM on the SUNA when corrected for deionised water offset). Clearwater and SUNA nitrate comparison below.



Sensor checks future PAP:

The OCR sensors and their bioshutters need to be checked to see that they talk sensibly and can be configured for deployment. Likewise, the TDGP sensor. This should be a quick job with a laptop, power supply and the relevant test leads. For all new or serviced sensors, the calibration certificates/coefficients need to be archived. The CO2 sensors can be checked and configured without getting them wet. When the time comes to test them with the controllers and harnesses, the Seabird pumps need to be connected to provide a proper electrical check, and a plastic storage box is probably a decent size container to use for that. The optode data can be logged on a laptop using TeraTerm or something similar.

PAP1 deployment

The PAP1 buoy and frame were deployed on the morning of 7th May 2022 and attached to the anchor and mooring rope that were deployed on 21 November 2020.

The UK Met Office kindly provided a refurbished Mobilis buoy which had been fitted with a new skirt to the same design as on the buoy that was recovered.

UK Met Office sensors

For this deployment the Met Office fitted two of their standard suites of meteorological sensors comprising air temperature, pressure and humidity, wind speed and direction, water temperature and a single wave height sensor. Two Iridium satellite telemetry systems were also fitted with data from each sensor going to both telemetry systems for maximum redundancy. The Mobilis buoy has two independent solar power systems, one of which powered all the Met Office equipment and the other all the NOC equipment. This was the first time that the Met Office had deployed a buoy with two sensor suites running from a single power supply.

NOC Buoy and Frame controllers

For this deployment the NOC equipment was controlled by an old-style buoy controller (telemetry unit) and a new frame controller provided by OTEG. In a departure from previous deployments, the buoy controller was powered directly from the buoy batteries (via new circuit breakers) rather than taking its power from the buoy's solar charge controller. This arrangement was to prevent a recurrence of the total power failure experienced on the DY116 deployment caused by the solar charge controller switching off the supply.

The buoy controller was connected to the frame controller using a new type of multicore cable purchased from HydroCable. This cable supplies power (at 30V) and RS-232 communications to the frame controller, and an inductive communications link to the SeaBird MicroCAT sensors in the frame. Sadly, this cable proved less robust than previous cable types and failed after only 52 days.

Buoy Sensors

Tables below show a list of the sensors deployed on JC231.

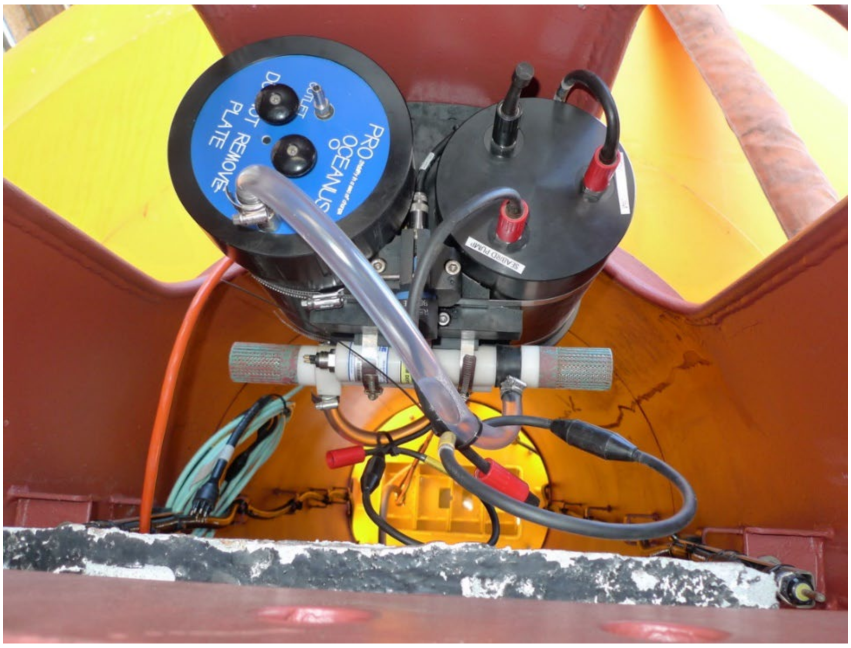
Buoy sensor: Pro-Oceanus CO2-Pro Atmospheric sn 39-599-50A

Buoy sensor: Pro-Oceanus CO2-Pro (backup) sn 34-200-45

Two Pro-Oceanus CO2-Pro sensors were mounted side-by-side inside the buoy keel as on previous deployments (see photo below). Horizontally mounted SeaBird pumps were connected to the sensor heads with Tygon tubing and the atmospheric sensor additionally measured atmospheric CO2 via an air intake box mounted on the buoy mast. Sensor 39-599-50A was configured to sample every 6 hours at 00:25, 06:25, 12:25, 18:25 UTC.

Sensor 34-200-45 was configured to sample every 12 hours at 01:55, 13:55 UTC, but unfortunately refused to function after deployment despite having been successfully tested at NOC.

Both sensors were configured to perform an Auto Zero Point Calibration (AZPC) every 12 hours, and to take 10 samples in quick succession.



Buoy sensor: Aanderaa 4330 oxygen optode sn 1282

This sensor was mounted inside the buoy keel and is controlled by the buoy controller which switches it on for 95 seconds every 30 minutes at 14 and 44 minutes past the hour. The sensor was configured to sample every 30 seconds, thus producing 3 readings for each sampling interval.

The oxygen concentration values output by the sensor assumes a salinity of zero, so these values are corrected using an algorithm provided by Aanderaa when the NRT data arrive at NOC. A constant salinity value of 35.5 PSU is used for this correction.

Buoy sensor: Satlantic OCR-507 ICSA Multispectral Radiometer sn 201

This radiometer (irradiance sensor) is mounted on top of the buoy mast looking up at the sky. It has a Satlantic Bioshutter to protect its optics while it is not measuring. The buoy controller switches power to the sensor every 30 minutes at 17 and 47 past the hour, and collects irradiance values every second for around 90 seconds.

Buoy sensor: WETLabs FLNTUSB Fluorometer sn 7381

This sensor was brand new and was configured to sample every 4 hours on the hour, taking 8 samples in quick succession. When the umbilical cable began to fail 52 days into the deployment, the sensor began sampling continuously. This caused problems for the satellite telemetry system as it is not designed to handle this amount of continuous data. 8 days later the sensor stopped talking.

Buoy sensor: SeaBird SBE 37IMP-ODO MicroCAT sn 21210

Buoy sensor: SeaBird SBE 37IMP MicroCAT sn 9469

Two SeaBird MicroCAT sensors were mounted inside the buoy keel and were configured to run autonomously from their internal batteries.

The ODO sensor was configured to sample every 30 minutes at 0 and 30 minutes past.

The other sensor was configured to sample every 15 minutes at 0, 15, 30 and 45 minutes past.

Both sensors are interrogated every 30 minutes by the buoy controller via the inductive communications system.

PAP1 Sensor Frame deployment

New batteries were acquired from SubCtech. A lot of the build still had to be done onboard, whereas we would aim to test the entire system before deployment.

Day of PAP1 deploy (7/5/22) we heard the buoy microcat not responding. Nick removed it and Dave checked it over – found to be all ok (Issue with search on '33'). No NRT data but it will self-record. Daisy Last minute switch of Trakka SUPP-796 rover s/n 1322 – all tested day before. Corinne ashore and Oks by XEOS – only that it recorded on the system though (by 10th May no position received…). but only 1 bracket available, which had to come off the DY130 buoy. Nick attached. (NB: Corinne saying no mssgs on 10th…). Nick also switched on Nav light and AIS, and Bolted doors on the MO buoy. The copper on the frame OCR did not move so this had to be removed for deployment.

A note on the OCR:

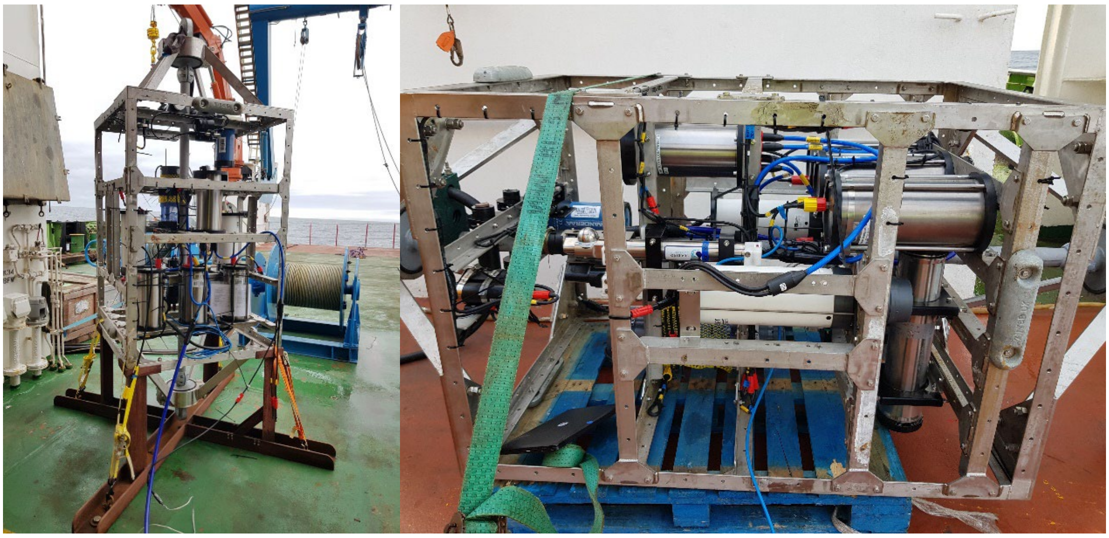
OCR 113/168 removed as it is down looking (radiance)
note 200 only changed (not the shutter 231) - deploy without Cu

PAP1 sensors for 2022 deployment (JC231)

	PAP1 sensor list for JC231 May2022	Serial number	Battery housing	Timing can be altered remotely?	Possible sampling times
	BUOY				
1	Pro-Oceanus CO2-Pro with atmospheric option	38-599-50A	none	NO	Every 6 hours at 00:22, 06:22, 12:22, 18:22
2	Pro-Oceanus CO2-Pro (as a backup)	34-200-45	none	NO	Every 12 hours at 01:55, 13:55
3	SeaBird SBE 37IMP-ODO MicroCAT	21210	internal	NO	Every 30 mins at 00 and 30
4	SeaBird SBE 37IMP MicroCAT	9469	internal	NO	Every 15 minutes at 00, 15, 30, 45
5	Satlantic OCR-507 ICSA with Bioshutter II	201/122 (123?)	none	YES	Every 30 mins at 17 and 47, sampling at 1Hz for 2 mins
6	Aanderaa oxygen optode	1282	none	YES	Every 30 mins at 14 and 44, sampling every 15 sec for 65secs
7	WETLabs FLNTUSB Fluorometer (new)	7381	internal	NO	Every 4 hours at 00 past (0:00, 4:00..)
INST #	FRAME				
1	Pro-Oceanus CO2-Pro CV (Cu and pump required)	38-492-75	External	NO	Every 8 hours at 04:45, 12:45, 20:45
2	WETLabs FLNTUSB Fluorometer	269	internal	NO	Every 4 hours at 00 past
3	Pro-Oceanus Mini TDGP sensor	38-506-31	none	NO	Every 30 mins at 02 and 32
4	New SeaFET V2 pH	PHS-2274	internal	NO	Every 30 mins at 23 and 53
5	Satlantic OCR-507 R10W radiance with Bioshutter II	200	none	YES	Every 30 mins at 17 and 47, sampling at 1Hz for 2 mins
6	Clearwater Nitrate	CWN-01-67	External	NO	Every 12 hours at 00:00 and 12:00
7	Clearwater Phosphate	CWP-01-63	None	NO	Every 12 hours at 00:00 and 12:00
9	Aanderaa 4330 oxygen optode	1298	none	YES	Every 30 mins at 14 and 44, sampling every 15 sec for 65secs
10	OTE pH	38	External	NO	Every 6 hours at 0:00, 6:00, 12:00, 18:00
11	Aanderaa SeaGuard (with Turner fluorometer + optode?)	2410	internal	NO	Every hour at 30 past
	SeaBird SBE 37IMP-ODO MicroCAT	23950	internal	NO	Every 30 mins at 00 and 30
	SeaBird SBE 37IMP MicroCAT	9475	internal	NO	Every 15 minutes at 00, 15, 30, 45
	CHAIN				
	Star oddis	C11508	internal	n/a	5m
	Star oddis	C11509	internal	n/a	10m
	Star oddis	C11510	internal	n/a	15m
	Star oddis	C11511	internal	n/a	20m
	Star oddis	C11512	internal	n/a	25m

Need to modify check list to do many tasks ahead of time. Note that on JC231 all optode caps were removed the day before deployment, Cu cover was added onto the SeaFET pH, OTE ran without bag (as frame was moved) – pumps were started on the day of deployment. Zebratech was switched on last minute (9am 7th – this could be done ahead of time). We could not tell if the Buoy OCR cover moved. Buoy was deployed with all sensors switched off, using a later remote switch on. At 8pm 6th tarter plug was put on the buoy Florometer (which was done at midday for the frame wetlabs sensor). Frame CO2 pump was started at 8am 7/5/22.

Buoy and Sensor frame at 30m



PAP1 deployed sensor frame

Frame/Hub controller

Frame controller mounted on the frame and inside the transportation box with cables

There was a newly designed controller that are used with the frame this deployment, the new controller was required due to obsolete parts in the old design and is also designed the added functionality of individual control of the power and communication for each sensor port.

The frame controller can be connected to a PC and configured using the custom graphical user interface (GUI). In the GUI, the user can set up the 14 instrument ports on the controller individually and select the type of sensor through a drop-down list. Options for power control include a user 'enabled' power to the ports being used by the sensors and add a schedule if desired. There are additional options for whether the ‘instantaneous’ data will be sent back via iridium (‘telemetry’), and data can be averaged to reduce iridium traffic. Figure 4 shows the configuration for the PAP 2022 (JC231) deployment.

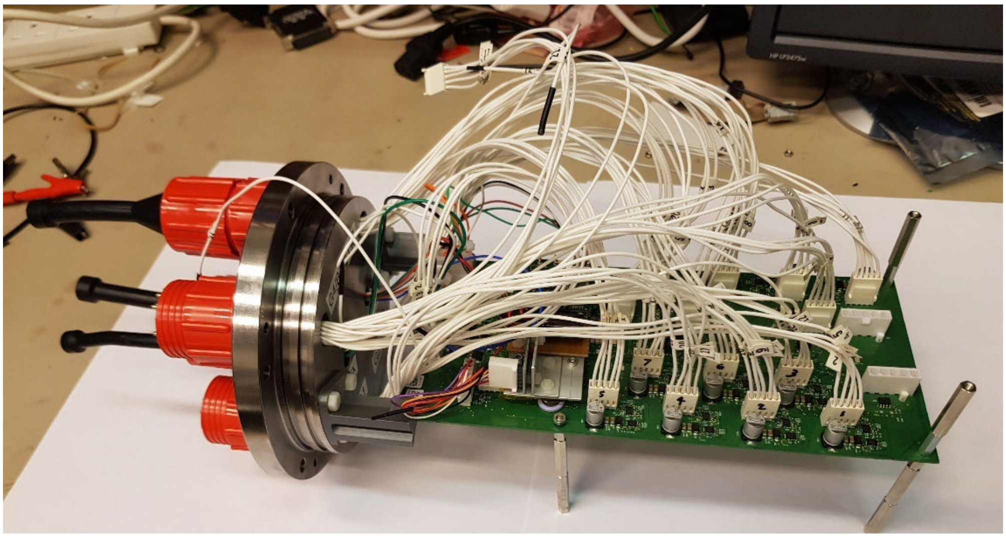
Config Parser

File

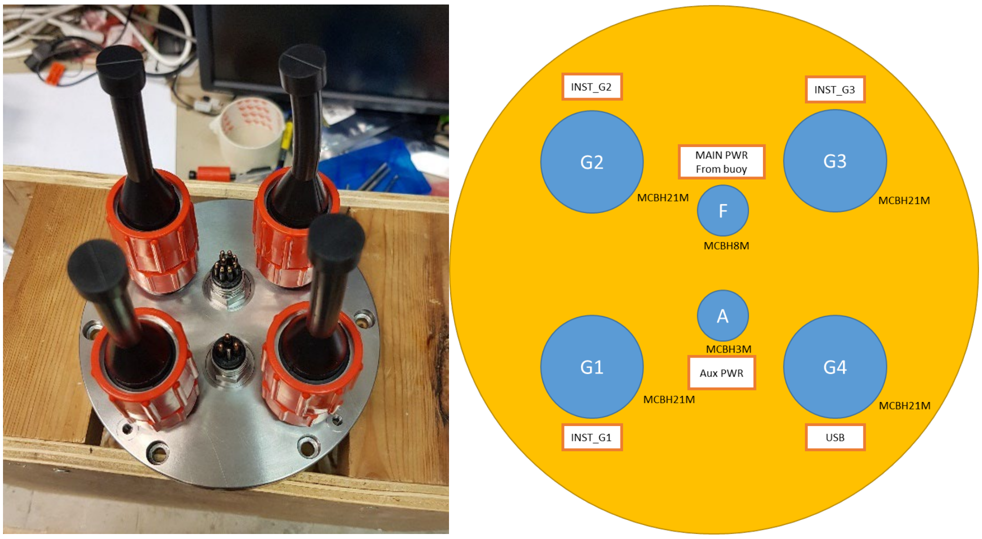
Config item	Index	Args
Hub type		Frame (legacy)
Instrument Comms	Instr 1	Enabled, instr=CO2 Pro CV, telemetry=Enabled, averaging=Enabled
Instrument Comms	Instr 2	Enabled, instr=ECO FLNTU, telemetry=Enabled, averaging=Enabled
Instrument Comms	Instr 3	Enabled, instr=Mini TDGP, telemetry=Enabled, averaging=Enabled
Instrument Comms	Instr 4	Enabled, instr=SeaFET v2, telemetry=Enabled
Instrument Comms	Instr 5	Enabled, instr=OCR 507, telemetry=Enabled, averaging=Enabled, data avg period=
Instrument Comms	Instr 6	Enabled, instr=ClearWater LOC, telemetry=Enabled
Instrument Comms	Instr 7	Enabled, instr=ClearWater LOC, telemetry=Enabled
Instrument Comms	Instr 8	Disabled
Instrument Comms	Instr 9	Enabled, instr=Aanderaa Optode, telemetry=Enabled, averaging=Enabled, data av
Instrument Comms	Instr 10	Enabled, instr=ClearWater LOC, telemetry=Enabled
Instrument Comms	Instr 11	Enabled, instr=Aanderaa SeaGuard, telemetry=Enabled
Instrument Comms	Instr 12	Disabled
Instrument Comms	Instr 13	Disabled
Instrument Comms	Instr 14	Disabled
Instrument Power	Instr 1	Enabled
Instrument Power	Instr 2	Enabled
Instrument Power	Instr 3	Enabled
Instrument Power	Instr 4	Enabled
Instrument Power	Instr 5	Enabled, interval=30 mins, delay=17 mins, duration=2 mins
Instrument Power	Instr 6	Enabled
Instrument Power	Instr 7	Enabled
Instrument Power	Instr 8	Enabled
Instrument Power	Instr 9	Enabled, interval=30 mins, delay=14 mins, duration=2 mins
Instrument Power	Instr 10	Enabled
Instrument Power	Instr 11	Disabled
Instrument Power	Instr 12	Disabled
Instrument Power	Instr 13	Disabled

Configuration for sensors on the frame hub (GUI) for 2022 deployment

The frame controller consists of the controller PCB (part number: A7359 v1.0c) inside a titanium pressure house, with six Subconn connectors on the endcap for connection to sensors and power sources. Four big 21-way connectors (Subconn MCBH21MSS) provide connections to all 14 instruments (power and comms). For the 2022 deployment, the instruments are connected via 3 of these big connectors (connectors G1 to G3) and added USB connection (on connector G4) which is blanked off for the duration of the deployment.



Frame controller PCB mounted on the end-cap with 3D-printed standoff



Frame controller end cap with connectors, and labelling

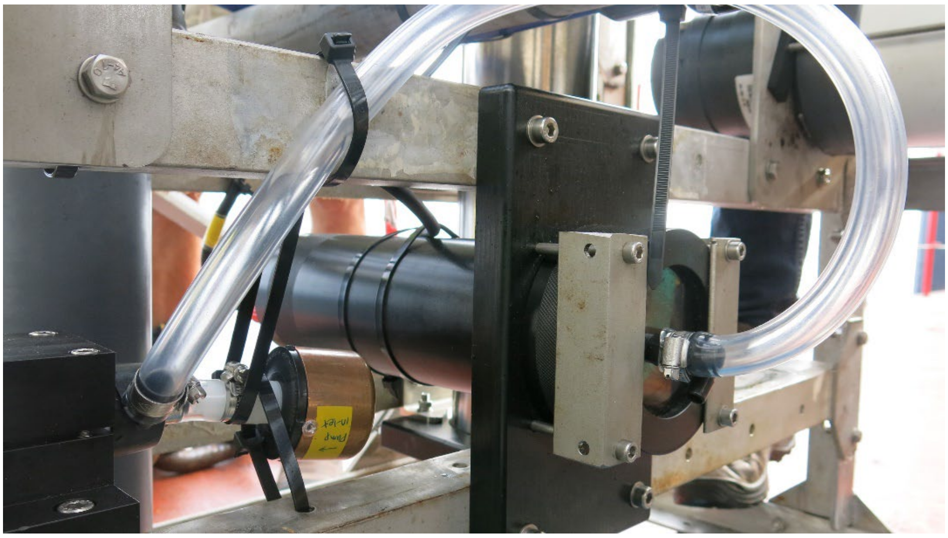
Additionally, the frame controller has an in-built compass to give the orientation of the frame controller; a 32gb SD card to back up all the sensor and telemetry data and USB port for easy access for debugging and data collection. Note that the compass was not functional on this deployment.

List of sensors fitted on the 30m sensor frame

Following are all the sensors that are fitted on the sensor frame for the JC231 deployment. Please refer to Table 2 for the details on the sensor serial number and sampling time setup.

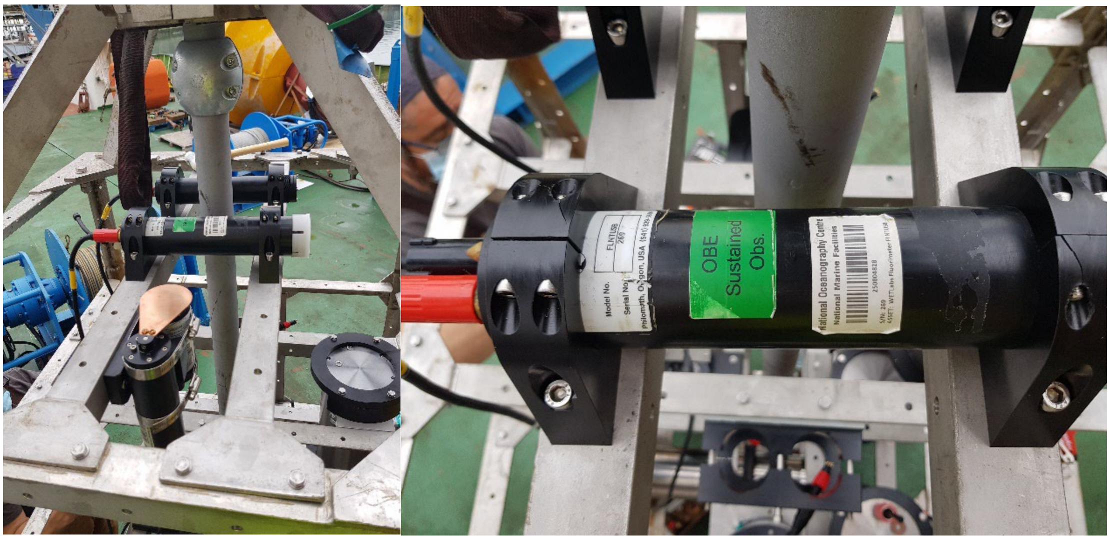
Pro-Oceanus CO2-Pro CV (Cu and pump attached)

Pro-Oceanus CO2 Pro CV is the Compact Version of the larger CO2 Pro, it has no internal battery, so must be externally powered. It has additional power backup with SubCTech battery ('Big Jim XL'). The deployed configuration for the frame CO2-Pro CV is a burst of 10 samples every 480 minutes (6hrs). There is a copper cap connected to the in-take of the pump to reduce biofouling (see Figure 7).



Frame CO2-Pro CV with pump (and copper cap)

WETLabs FLNTUSB Fluorometer



WETLabs FLNTUSB in the middle

Pro-Oceanus Mini TDGP sensor

The mini TDGP (measuring Total Dissolved Gas Pressure) was set to run every 30min, and it can be seen mounted on the top level of the frame in Figure 8 in the far end. It was noted that the copper mesh on the input was missing from the deployed sensor.

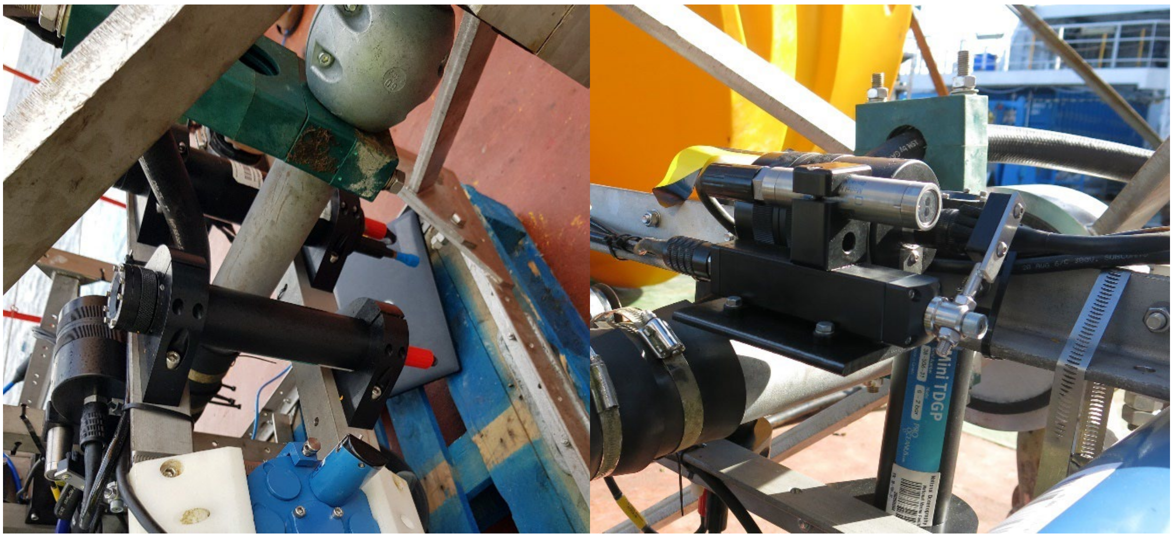
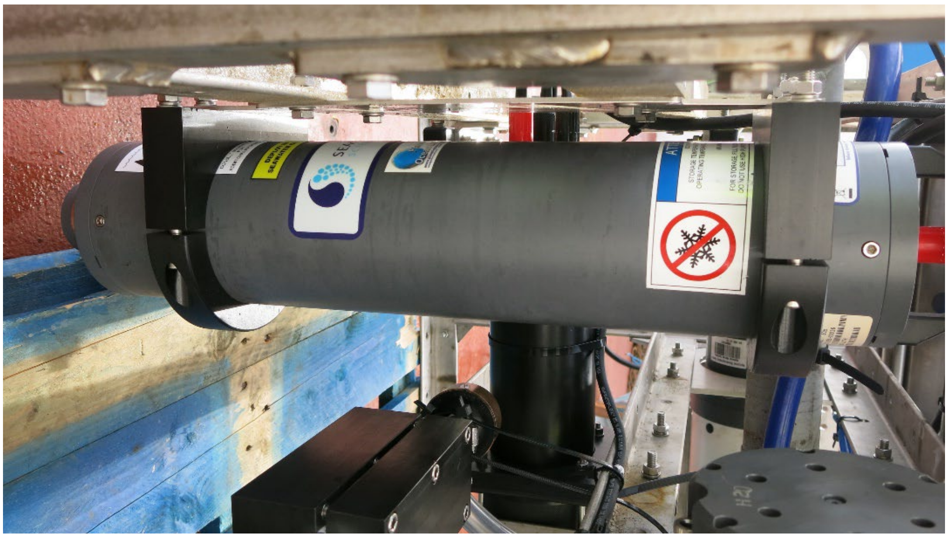


Photo showing the mini TDGP on the frame, right photo shows the Seaguard’s fluorometer (and Zebratech wiper)

SeaFET v2 pH



The SeaFET v2 pH sensor has internal batteries for backup and powered through the frame hub. It was configured at NOC to run every 30min.

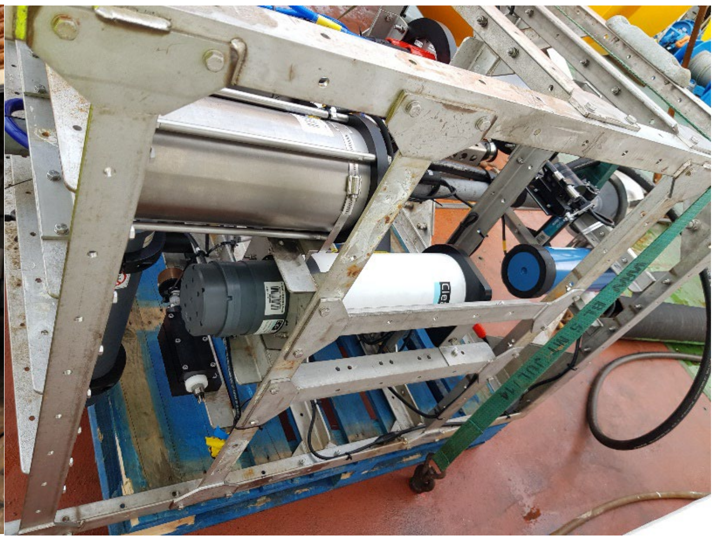
Satlantic OCR-507 ICSA radiance with Bioshutter II

There was a last-minute change on the OCR mounted on the frame. Initially a 'Satlantic OCR-507 R10W' was marked for this deployment but it must be mounted downwards pointing. As the bracket for the frame is meant for an upward-facing Satlantic OCR-507 ICSA, the OCR (S/N 200) that was recovered from the previous deployment was re-deployed (untested).

The bio-shutter on the frame stopped working on the day before deployment, despite working non-stop throughout the extensive bench test. As a result, the copper shield was removed prior to the buoy being deployed which will affect the length or quality of the data receive in the long term.

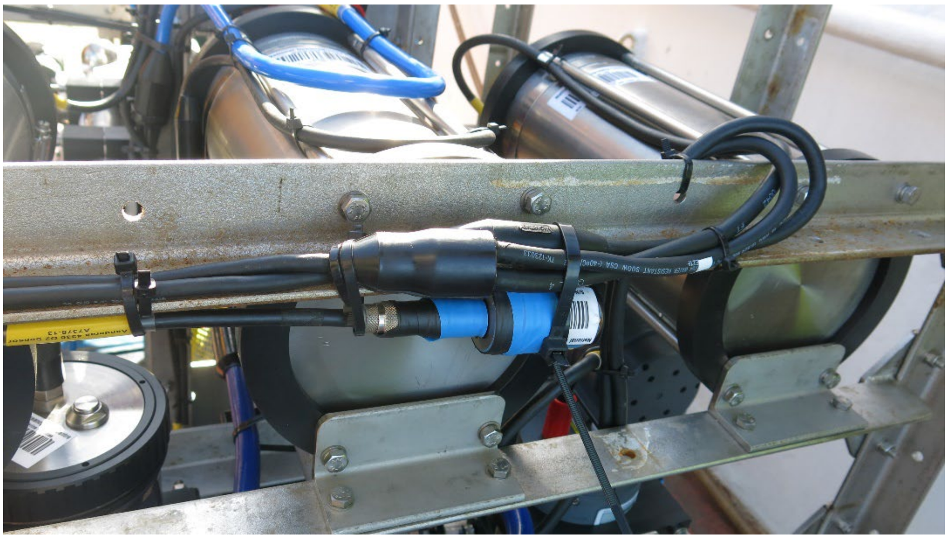
Clearwater Sensors Nitrate and Phosphate

Both the Clearwater Sensors nitrate and phosphate sensors are setup to run every 12 hours, and the nitrate sensor has battery backup (from SubCTech battery). The nitrate sensor was drawing extensive current in the first week of deployment and had to be turned out to conserve the buoy solar power.



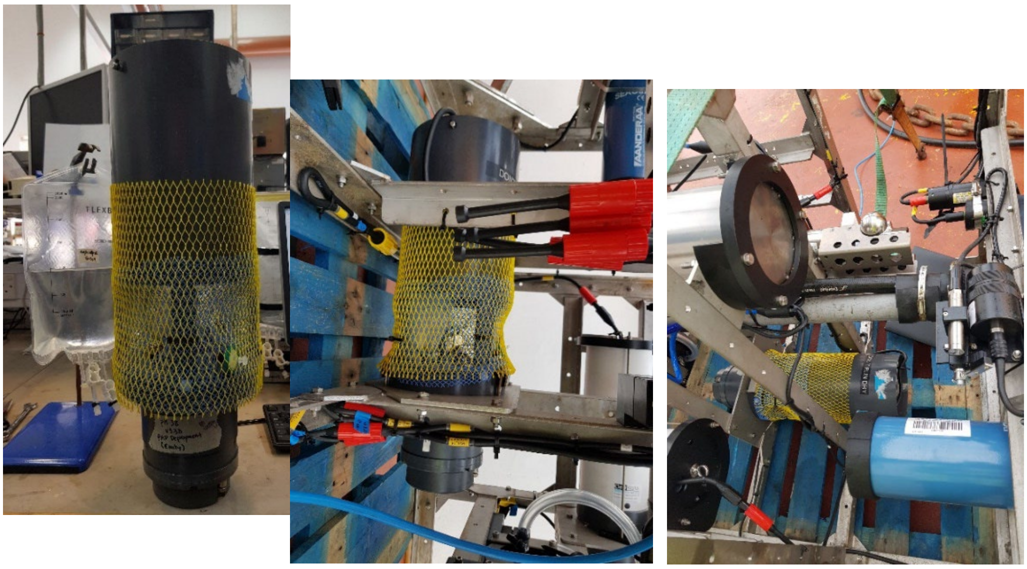
Aanderaa 4330 oxygen optode

The Aanderaa 4330 oxygen optode (S/N 1298) was scheduled to run every 30min for 15 seconds by the hub.



OTE pH

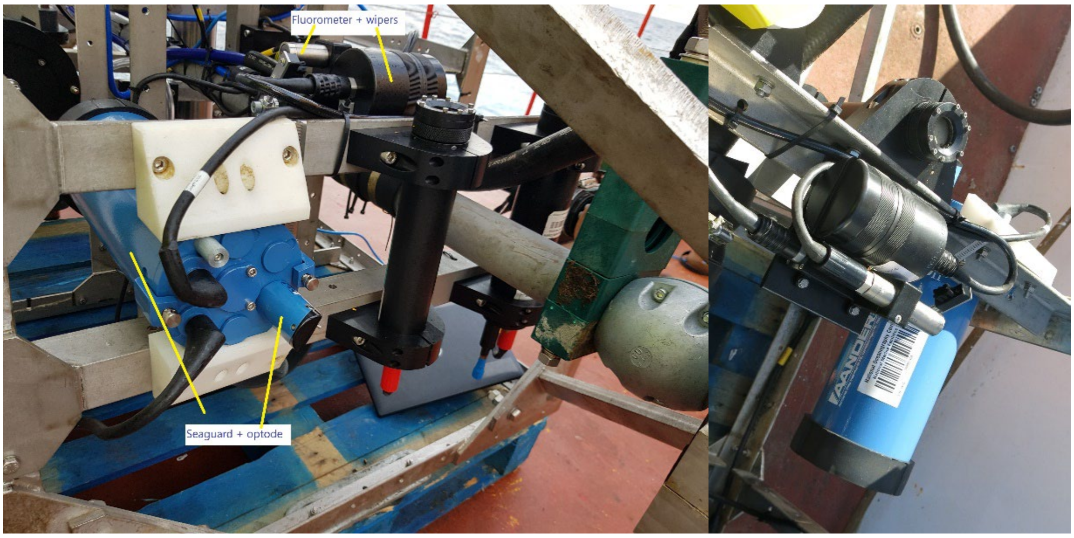
The NOC in-house OTE pH sensor was validated back at NOC and was set to run every 6 hours, at 0000, 0600, 1200 and 1800hr. Photos below show the OTE pH sensor as on the bench (left most in Figure 10) mounted on the sensor frame during testing before deployment (right 2). The pH sensor has started to draw a lot of current after the frame was deployed, and after attempts to restart, it must be turned off to conserve the buoy power.



OTE pH sensor - on the bench and fitted on the sensor frame

Aanderaa SeaGuard (with Turner fluorometer + optode)

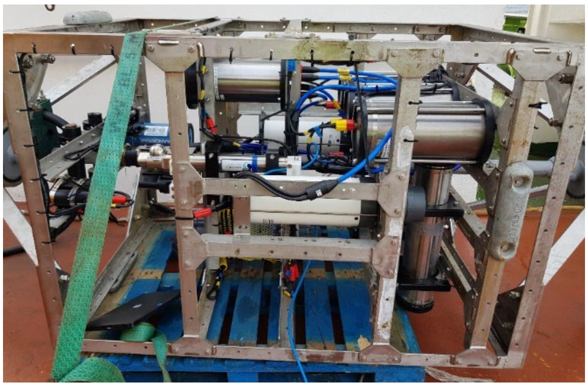
The Aanderaa Seaguard is deployed with the turner fluorometer, Zebratech wipers and an optode. Seaguard has internal batteries, but also powered externally. The sensor is configured to run an hourly sample with a 30-minute delay.

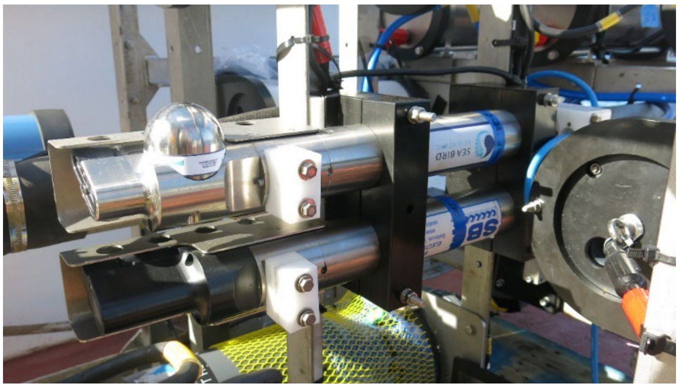


Seaguard is mounted on the top level of frame, with the fluorometer (and the Zebratech wiper) next to it

SeaBird SBE 37IMP-ODO MicroCAT

Covered in earlier chapters, "PAP Instrumentation Report" by Dave Childs.





SeaBird MicroCATs on the frame

SeaBird SBE 37IMP MicroCAT

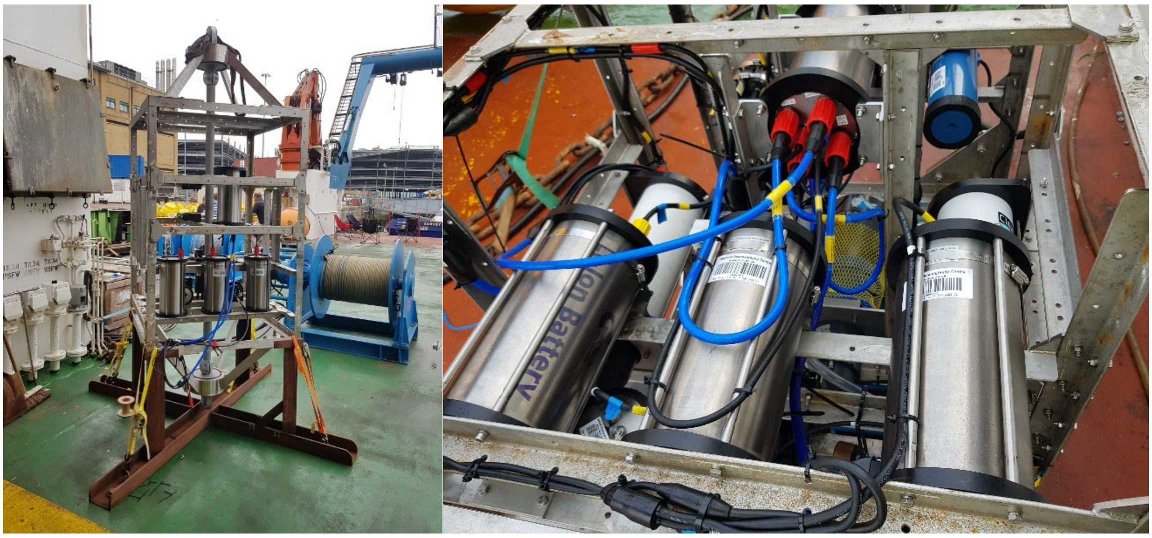
Covered in earlier chapters, "PAP Instrumentation Report" by Dave Childs.

Backup batteries

There is a total of four battery packs on the deployed frame, one is the Develogic DW-TH battery pack and three SubCTech batteries (big Jim XL) on the sensor frame, to provide backup power when the buoy power is lost.

SubCTech batteries

Three new SubCTech (Big Jim XL) battery packs, serial number PP-LI-14.4-140-Ti-300-2202-01 to -03, are deployed on the sensor frame, acting as the backup batteries for the frame CO2 Pro-CV, Clearwater Sensors nitrate and NOC in-house OTE pH sensors. These batteries are high-performance li-ion pack inside a titanium subsea housing, which had a nominal capacity of 140Ah at 14.4V. They were all cycled (discharged and charged) at least once before the deployment for optimal capacity.



Three SubCTech batteries mounted in a row on the sensor frame

Develogic DW-TH battery pack

The Develogic DW-TH battery pack (S/N: 2712) provides the backup power for the frame hub controller. It has 48 SAFT LSH20 batteries (12 parallel 4 series), which gives a nominal capacity of 156Ah at 14.8V.

Checklist of PAP1 Tasks onboard

- Release test – only on full turn around N/A
- Dip all microcats (x4) and download data -done CTD 001
- Reset microcats – buoy ODO 30 mins at 00 and 30 -Dave Childs 4/5/22
- Reset microcats – buoy T/S 15 mins at 00 15, 30 and 45 -Dave Childs 4/5/22
- Reset microcats – frame ODO 30 mins at 00 and 30 -Dave Childs 4/5/22
- Reset microcats – T/S 15 mins at 00 15, 30 and 45 -Dave Childs 4/5/22
- Buoy Air intake box – check attached to bars and attached tubes (at NOC-Jon)
- Attach buoy irradiance sensor and connect – no data 3/5/22 (Jon)
- Secure umbilical cable inside buoy tower - Nick

- Secure umbilical cable inside keel tube - Nick
- Secure umbilical cable in frame - Nick
- 2 microcats to add to frame - Nick
- 2 microcats to add to buoy – Nick (last min checks on buoy microcat – no data to NOC)
- All BGC sensors, harness and batteries to add to frame (2022) -Daisy and Nick done
- Attach zebratech to seaguard fluorometer - done
- Start Zebratech on frame, on the hour (every 6 hours) – special tool/manual (setting 8) - actually set to go 9am 7th Daisy)
- Check both OCR copper shutters operate correctly once they are switched on (17 and 47 past the hour) - didn't see shutters on Buoy (powered off) – frame intermittent so Cu removed (Daisy Anita checked)
- Check that buoy tracker works and attach to buoy mast (last min Nick, Ed – use DY130 bracket)
- star oddi to buoy (no)
- Star oddi to chain – all on chain 5m-23m
- Secure CO2 sensor mount in keel tube
- Secure optode to holder (screws missing!!)
- The inductive comms cable to go through the MicroCAT couplers on the buoy is the turquoise cable coiled inside the keel and terminated with a sea earth. It's much longer than you need so you'll need to lose some
- WETLabs to add to the buoy -Richie
- and the two MicroCATs to add to the buoy.
- Set up wetlabs fluorometer – add magic plug at correct time for start up ** - Corinne checked it was set up
- The WETLabs cable is also coiled inside the keel, and is also a bit on the long side.
- Everything on the buoy mast is secured and ready to go.
- There are loose cables on the floor of the buoy tower which will need securing along with the excess umbilical cable.
- The Met Office have given us two sets of aluminium bolts for the buoy door. They are in plastic bags secured to the door frame.
- Seaguard
    - Turn on the wiper motor (switch inside the housing)

BUOY

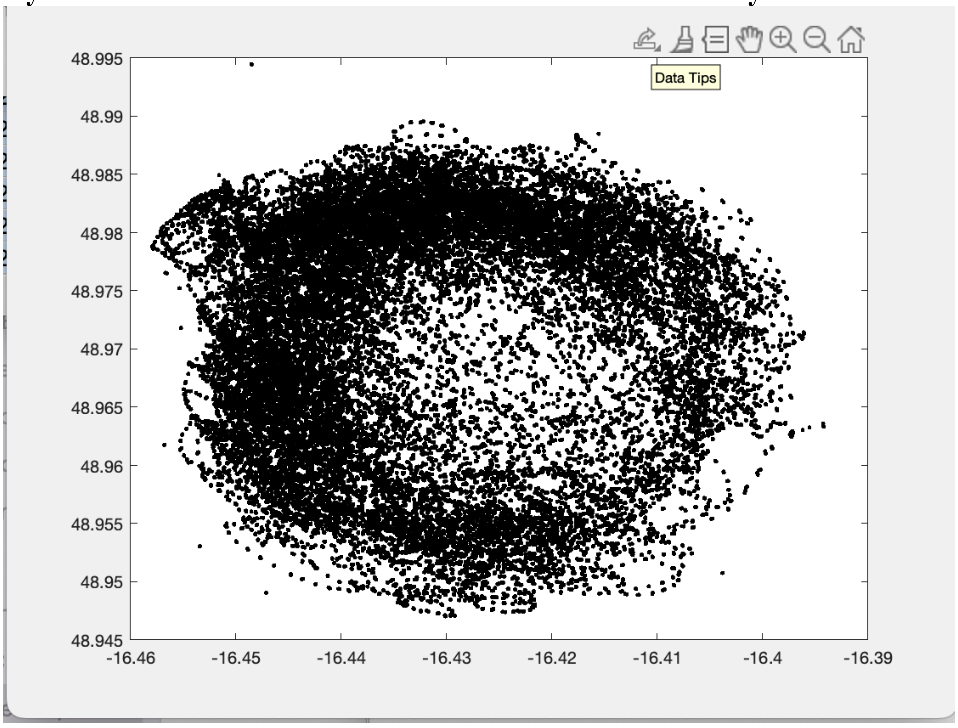
- Plug in SeaBird CO2 pumps (on buoy atmos 05:25, 11:25, 17:25, 23:25), (on buoy B/U 01:55, 13:55)
- NOTE Buoy CO2 sensors/pumps can be switched off remotely, but frame CO2 sensor is always running. Pumps are switched on 20 mins before sample time.
- Check buoy pumps and copper hats are secure, and secure cables
- All brackets to check
- OCR copper to check
- Jump plug (blue) FLNTUSB on at the time it is scheduled to sample ie 08:00 or 12:00 or 16:00 etc
- Remove optode cover (buoy)
- Switch on buoy navigation light
- Switch on AIS
-

FRAME

- Remove FLNTUSB cover (on frame and buoy)
- Jump plug (blue) FLNTUSB on frame, aim: every 4 hours on the 00
- Remove optode cover (frame)

- SeaFET – use magnet screwdriver to turn on internal battery? ***
- SeaFET – remove the cap and replace with copper guard
- Plug in SeaBird pumps (on frame every 8 hours at 04:45, 12:45, 20:45)
- Check in-take for Clearwater and OTE sensors (nitrate, phosphate and pH)
- Copper cover to add to SeaFET (remove solid cover – special tool in lab)
- All brackets, harness, connections to check
- Check pump tubing secured
- remove the optode and flurometer covers (Seaguard)
- Photograph absolutely everything

PAP1 deployed DY116 – watch circle. Screenshot from Helen 10th May



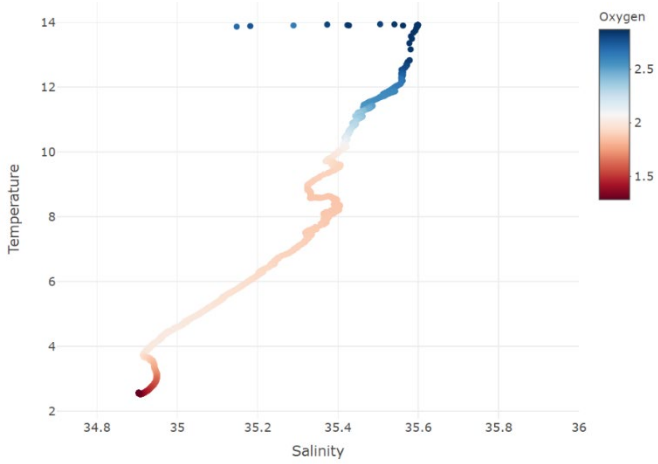
Top tips for NEXT YEAR:

Set up early. Camera on frame/buoy for growth and UV lights to reduce fouling. Bracket pump to CO2 (robust tubes). New style Copper 2022) – could screw directly on. Collate all PAP related CTDs on line (Like JETZON MSC/Adrian Martin Google Doc). Collate protocols on PAP web site/online – remove Borax, should not be used at all (see Sari/Corinne). In future we need 2 trakka brackets.

10. CTD profiles and water sampling

Sue, Anita, Ed, Sari, Eloise

Samples were taken at all 11 CTD casts for validation of sensors as well as for process studies. A T/S plot from a deep CTD cast is shown here in relation to dissolved oxygen as an overview. The first samples taken were for later analysis of dissolved inorganic carbon and total alkalinity (on a VINDTA back at NOC). 250ml samples were preserved with mercuric chloride and stored in the dark. Other samples included dissolved oxygen, chlorophyll, inorganic nutrients, organic carbon and Po as described in the following sub sections. Salinity samples were taken on each cast for NMF salinometer analysis onboard as described in section 8.



Dissolved oxygen analysis

Anita Flohr

Dissolved oxygen (DO) samples were collected to calibrate the CTD's dissolved oxygen sensor as well as the DO sensors (pre- and post-deployment) deployed on and recovered from moorings. In addition, DO was sampled (CTD-003) as part of a storage experiment to determine whether storage of DO samples of up to 20 days affects the dissolved O_2 concentration. This was inspired by an inter comparison between NOC, Southampton and the Nicholson lab, WHOI, US done during last year's joint DY130 (PAP-SO) and DY131 (EXPORTS) cruises that found differences of ~2% in duplicate samples analysed during DY130 (storage time ~5 hrs) and DY131 (storage period 20 days).
The preparation of reagents as well as the sampling and analysis of DO samples followed standard operation procedures (Dickson, 1995;Langdon, 2010).

Reagents

The preparation of reagents followed standard operation procedures (Dickson, 1995; Langdon 2010). The following reagents were prepared prior to the cruise at the National Oceanography Centre, Southampton:

- Manganous chloride solution ($MnCl_2 \cdot 5H_2O$) (3 M)
- Sodium hydroxide (NaOH) (8M) / Sodium iodide (NaI) (4M) solution
- Sulfuric acid solution (H_2SO_4) (5M)

Sodium thiosulfate ($Na_2S_2O_3$) (0.11 M) was weighed into 27.4 g portions at NOCS. The $Na_2S_2O_3$ solutions were made on board and left to settle for at least two days before first use. For thiosulfate standardisation a certified potassium iodate (KIO_3) (0.00167 M) standard was used (OSIL).

Sampling

Seawater was collected directly into pre-calibrated Pyrex titration flasks (with flared necks) using silicon tubing, avoiding formation of air bubbles and allowing >3 times the bottle volume to overflow. The bottle was flushed several times before the sample was drawn. The temperature of the water was recorded with a handheld thermometer (HANNA instruments, S/N:TA03080096). The sample was immediately fixed with 1 mL of manganous chloride ($MnCl_2$) followed by 1 mL of sodium hydroxide/sodium iodide solution (NaOH/NaI) using calibrated dispensers. The lid was added carefully, the sample was thoroughly shaken and stored dark to allow the precipitate to settle. All samples were shaken again after approximately 30 mins to ensure that the reaction was complete. To prevent ingress of air the flared necks were filled with a Milli-Q water seal. Analyses were carried out normally within 3 to 8 hours of sample collection.

A total of 21 DO samples (7 bottles each from 3 niskin bottles) (Figure 14) where sampled from CTD-003 for the storage experiment and were analysed on day 0, 5, 10, 15, 20 and 25.

CTD deck sampling log

(List parameters sampling from CTD in header and tick relevant box if bottle sampled)

SITE	Near PAP1
Comments	log 2/2

Cruise number	JC231
Station ID	JC231_012
Cast number	CTD 003
Sea floor depth (m)	4811
Cast depth (m)	200
Event number	

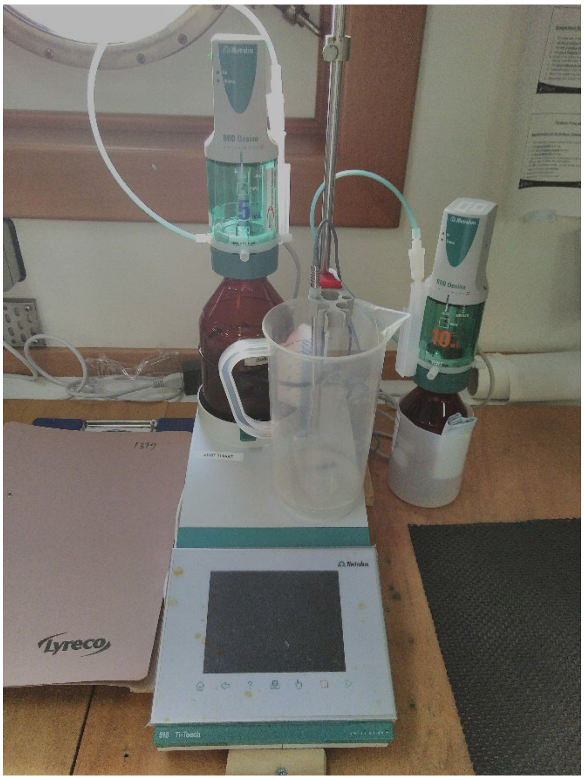
Date (UTC)	05/05/2022
Time in (UTC)	07:39
Time out (UTC)	08:06
Latitude	48° 57.372 N
Longitude	16° 23.944 W
Stainless steel cast	

Niskin No	Depth (m)	Bottle No.	O_2 bottle Rep 1	O_2 bottle Rep 2	O_2 bottle Rep 3	O_2 bottle Rep 4	O_2 bottle Rep 5	O_2 bottle Rep 6	O_2 bottle Rep 6	O_2 Temp.	Nutrients PAP	SALTS Crate-bottle	5 L carboy					Po Bottle (Fe3)	Po Bottle (Fe2)	2nd 5L (spare)	Fv/FF	Comments
													CHL	PIC	POC	Bsi	Lugol					
1	200		1015	1043	1051	1013	1069	1009	17	11.7												1. O2 storage exp.
2	200		1047	1023	1056	1012	22	1031	1049	11.8												2. O2 storage exp.
3	200		1044	1016	1018	1005	1034	1068	1035	11.8												3. O2 storage exp.
4																						4.
5																						5.
6																						6.
7																						7.

Extract of deck sampling log sheet of DO sampling for the storage experiment.

Analysis

Except for the sodium thiosulfate ($Na_2S_2O_3$) all chemicals were prepared prior to the cruise at the National Oceanography Centre, Southampton. The DO was measured by Winkler titration based on an amperometric end point method using a Metrohm Ti-touch 916 instrument (S/N: 30107). For titration, the Milli-Q seal was dried, the stopper of the flask was carefully removed, a 1 mL aliquot of 5 M sulfuric acid was dispensed into the flask and a clean magnetic stirrer was added. The flask was then placed on the stir plate and the electrode and burette tip were carefully inserted. The initial volume of $Na_2S_2O_3$ for each sample was 0.3 mL before continuing to be titrated at 0.0005 mL intervals using an electrode with amperometric end-point detection (Culberson and Huang, 1987) with an end current of 0.1 x 10^{-6} A. Once the titration was finished, the resultant volume of $Na_2S_2O_3$ titrant was recorded both manually and by logging on the Metrohm Ti-touch 916. At least 4 blank checks of the reagents and 4 standardisations of the sodium thiosulfate were measured using 1 mL (blank) and 5 mL (standardisation) additions of a 1.667 mmol L^{-1} certified iodate standard (OSIL) in MilliQ for each set of analyses, respectively. Following Langdon (2010), reagent blanks were measured in seawater to determine the variability and magnitude of seawater blanks. Reagent blanks were measured in seawater from 30, 44, 55, 1750, 184, 2000 and 3000 m depth covering, among others, salinity, oxygen and fluorescence minima and maxima. Reagent blanks were not included in the calculations, i.e. oxygen concentrations are based on reagent blanks in MilliQ.

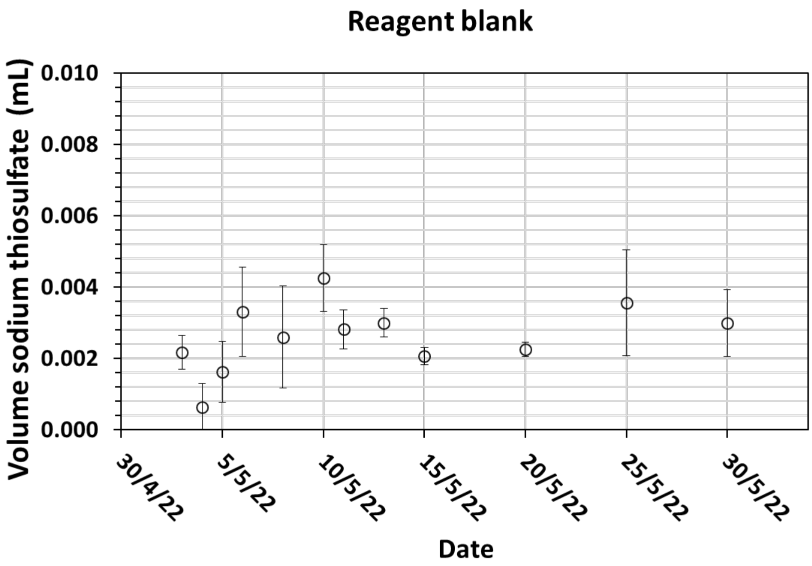


The Metrohm Ti-touch 916 setup used for dissolved oxygen analysis.

Oxygen results

A total of 199 samples were analysed for DO. The reagent blank ranged from 0.0006 to 0.0043 mL (median: 0.0026 mL, n=38) (Figure 16). Blanks measured in seawater ranged from 0.0030 mL to 0.0143 mL (Table 3). The $Na_2S_2O_3$ standardisation volumes ranged from 0.4553 to 0.4595 mL (n=9) (Figure 17). To account for the impact of the variability in $Na_2S_2O_3$ standardisation volumes, the average of all $Na_2S_2O_3$ standardisation volumes measured during the cruise (0.4566±0.0016 mL) was used for calculation of the final DO concentrations.

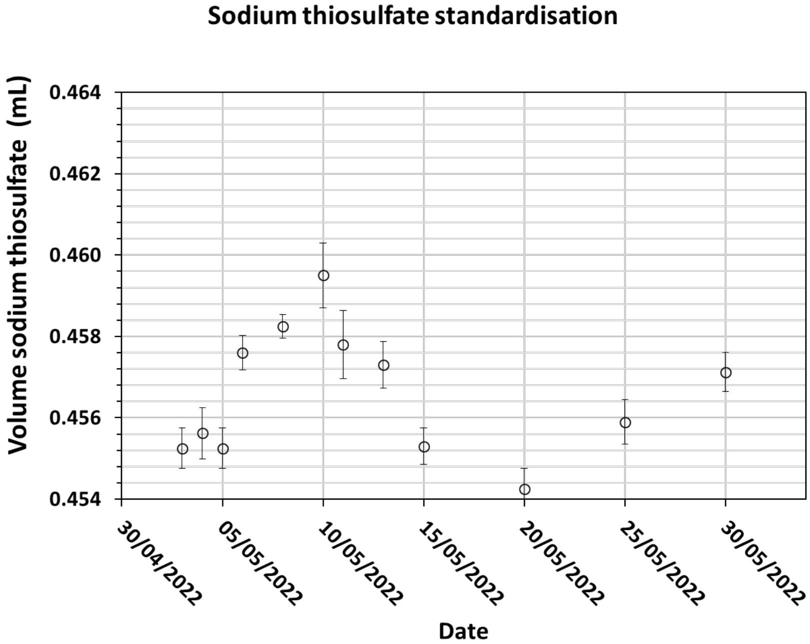
Standard deviations (SD) of duplicate samples (same niskin) ranged from ±0.0 to ±0.50 µmol L-1 O2 (average: ±0.15 µmol L-1, median: ±0.13 µmol L-1, n=25). Standard deviations of replicate samples (different niskin, same depth) ranged from ±0.0 to ±0.81 µmol L-1 O2 (average: ±0.19 µmol L-1, median: ±0.10 µmol L-1, n=26). The DO results will be used to calibrate the CTD's dissolved oxygen sensors after the cruise.



Results of reagent blank measurements in Milli-Q.

Results of blank measurements in seawater

Date sampling	CTD#	Depth (m)	Date analysis	Blank titre (mL)
04/05/2022	JC231-002	30	04/05/2022	0.0030
04/05/2022	JC231-002	2000	04/05/2022	0.0048
04/05/2022	JC231-002	30	05/05/2022	0.0058
04/05/2022	JC231-002	2000	05/05/2022	0.0093
11/05/2022	JC231-007	55	11/05/2022	0.0068
11/05/2022	JC231-007	1750	11/05/2022	0.0070
15/05/2022	JC231-009	44	15/05/2022	0.0068
15/05/2022	JC231-011	1847	15/05/2022	0.0103
15/05/2022	JC231-011	3000	15/05/2022	0.0143



Results of sodium thiosulfate standardisation.

Results of sodium thiosulfate standardisation.

Date	Cast	ID	$Na_2S_2O_3$ standardisation volumes (mL)					Average (mL)	Stdev (±mL)	RSD (%)
03/05/2022	CTD001	1	0.4555	0.4555	0.4555	0.4545		0.4553	0.0005	0.11
04/05/2022	CTD002	2	0.4555	0.4550	0.4565	0.4555		0.4556	0.0006	0.14
05/05/2022	CTD003	3	0.4555	0.4555	0.4555	0.4545		0.4553	0.0005	0.11
06/05/2022	CTD004	4	0.4575	0.4580	0.4580	0.4570	0.4575	0.4576	0.0004	0.09
08/05/2022	CTD005	5	0.4580	0.4585	0.4585	0.4580		0.4583	0.0003	0.06
10/05/2022	CTD006	6	0.4600	0.4595	0.4590	0.4605	0.4585	0.4595	0.0008	0.17
11/05/2022	CTD007	7	0.4565	0.4580	0.4585	0.4585	0.4575	0.4578	0.0008	0.18
13/05/2022	CTD009	8	0.4570	0.4565	0.4575	0.4580	0.4575	0.4573	0.0006	0.12
15/05/2022	CTD10/11	9	0.4555	0.4560	0.4550	0.4550	0.4550	0.4553	0.0004	0.10
20/05/2022	CTD003	10	0.4545	0.4545	0.4535	0.4545		0.4543	0.0005	0.11
25/05/2022	CTD003	11	0.4560	0.4560	0.4565	0.4550	0.4560	0.4559	0.0005	0.12
30/05/2022	CTD003	12	0.4575	0.4575	0.4565	0.4570	0.4575	0.4571	0.0005	0.10
								0.4566	0.0016	0.34

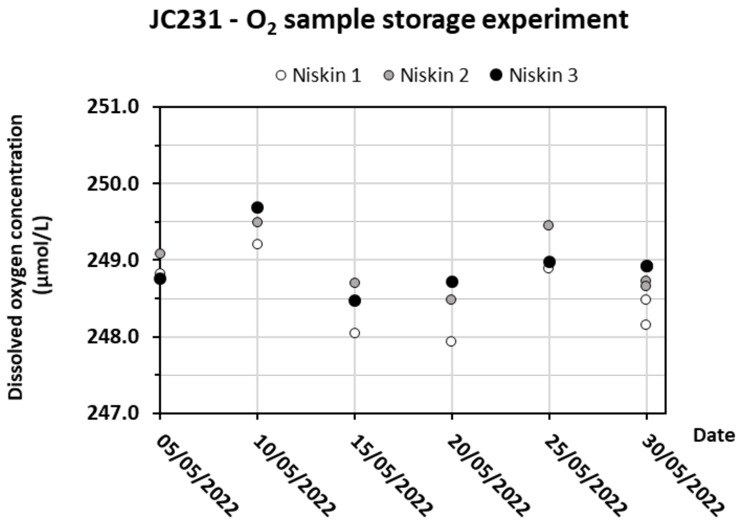
Oxygen sample storage experiment

Analyses of replicate t0 samples across 5 niskin bottles resulted in an average DO concentration of 248.63±0.57 µmol L^{-1} (n=5). Subsequent analyses of replicates across 3 niskin bottles on t1 to t5 agreed

within <±0.46 µmol L^{-1}, which is lower than the SD of t0 and is within the range of all replicates measured during JC231 (Table 5).
Standard deviations of duplicate samples ranged from ±0.0 to ±0.23 µmol L^{-1} (n=3) (Table 5) and are thus within the range of standard deviations measured in duplicate samples throughout the cruise.
The results suggest that DO samples keep for 20 days if stored dark and with a Milli-Q water seal.

Composite of results of DO storage experiment

Date sampling	Niskin bottle	O2 bottle	Date analysis	C_O2 (umol/L)	Average (µmol/L)	SD (±µmol/L)	RSD (%)	Comment
05/05/2022	1	1015	05/05/2022	249.16				t0-1
05/05/2022	1	1043	10/05/2022	249.20				t1-1
05/05/2022	1	1051	15/05/2022	248.05				t2-1
05/05/2022	1	17	20/05/2022	247.94				t3-1
05/05/2022	1	1013	25/05/2022	248.90				t4-1
05/05/2022	1	1069	30/05/2022	248.47				t5-1-1
05/05/2022	1	1009	30/05/2022	248.15	248.31	0.23	0.09	t5-1-2
05/05/2022	2	1012	05/05/2022	249.08				t0-2
05/05/2022	2	22	10/05/2022	249.49				t1-2
05/05/2022	2	1031	15/05/2022	248.70				t2-2
05/05/2022	2	1023	20/05/2022	248.47				t3-2
05/05/2022	2	1047	25/05/2022	249.45				t4-2
05/05/2022	2	1056	30/05/2022	248.73				t5-2-1
05/05/2022	2	1049	30/05/2022	248.65	248.69	0.05	0.02	t5-2-2
05/05/2022	3	1035	05/05/2022	248.76				t0-3
05/05/2022	3	1068	10/05/2022	249.68				t1-3
05/05/2022	3	1034	15/05/2022	248.47				t2-3
05/05/2022	3	1044	20/05/2022	248.72				t3-3
05/05/2022	3	1018	25/05/2022	248.98				t4-3
05/05/2022	3	1016	30/05/2022	248.92				t5-3-1
05/05/2022	3	1005	30/05/2022	248.93	248.92	0.00	0.00	t5-3-2



Results of O_2 sample storage experiment

Dissolved oxygen references

Culberson, C. H., and Huang, S.: Automated amperometric oxygen titration, Deep-Sea Research Part I, 34, 875-880, 10.1016/0198-0149(87)90042-2, 1987.

Dickson, A. G.: Determination of dissolved oxygen in seawater by Winkler titration. WOCE Operations Manual, Part 3.1.3 Operations & Methods, WHP Office Report WHPO 91-1., 1995.

Langdon, C.: Determination of dissolved oxygen in seawater by Winkler titration using the amperometric technique. IOCCP Report No. 14, ICPO Publication Series No. 134, Version 1, 2010.

CTD Filtration

Eloïse Savineau

CTDs were categorized as either "shallow" or "deep" cast. Niskin bottles were fired at 6 depths throughout the water column and water samples collected from the rosette. For shallow cast CTDs 2 × 5 L carboy were collected at each depth. For deep cast CTDs, a 5 L carboy was collected at each depth + 1 extra 5 L carboy for the deep chlorophyll maxima (DCM) depth.

Filtration rig set-up

Particulate Organic Carbon

Eloïse Savineau

Seawater samples for particulate organic carbon (POC) were collected into 5 L carboys for 6 depths and immediately taken to the chemistry lab for filtering. Samples were gently shaken (slowly turned upside down in a circular motion 3 times), 1000 ml measured out and filtered through a 25 mm diameter pre-combusted, 0.7 µm pore size GFF filter using a low-pressure pump (max -20 kPa). Once finished filtering, the filtration tower was rinsed with approximately 10 ml of filtered seawater and filtered through the samples to remove any salt residue. The filters were then placed into individual petri slides, labelled and placed in the dry oven overnight at 40 ˚C. Samples were then removed from the dry oven, the petri slides taped shut and stored in a plastic bag in a dry, dark cupboard of the chemistry lab for later analysis back on land.

A total of 53 POC samples were taken. Several of the seawater samples from CTD casts appeared to have a high abundance of gelatinous organisms (mostly identified as salps). This caused the filtration to take much longer than normal for seawater samples of 1000 ml. JC231-095 CTD #11, Niskin #22 (30 m) spent 3 days filtering and still had 200 ml of water to filter (a total of 1000 ml was put through for filtration). The filtration was stopped, and the sample was discarded as the filter was covered in salps and had been sitting on the rig for 3 days. JC231-026 CTD #4, Niskin #19 (10 m) also took a long time to filter (~12 hours). It may therefore be sensible to first filter the seawater samples through a mesh (e.g. 200 µm mesh or larger) to remove gelatinous organisms such as salps that may interfere with the filtration.

Particulate Inorganic Carbon

Eloïse Savineau

Seawater samples for particulate inorganic carbon (PIC) were collected into 5 L carboys for 6 depths and immediately taken to the chemistry lab for filtering. Samples were gently shaken (slowly turned upside down in a circular motion 3 times), 500 ml measured out and filtered through a 25 mm diameter, 0.8 µm Nucleopore™ polycarbonate filter using a low-pressure pump (max -20 kPa). Once finished filtering, the filtration tower was rinsed with approximately 10 ml of ammonia pH adjusted MilliQ water and filtered through the samples to remove any residue on the sides of the filtration tower. The filters were then placed into individual 50 ml centrifuge tubes, labelled, and placed in the dry oven overnight at 40 ˚C. Samples were then removed from the dry oven and stored in a plastic bag in a dry, dark cupboard of the chemistry lab for later analysis back on land. A total of 53 PIC samples were taken.

JC231-026 CTD #4, Niskin #19 (10 m) PIC took ~15 hours to filter (due to gelatinous organisms on filter).

JC231-095 CTD #11, Niskin #22 (30 m) PIC took ~30 hours to filter (due to gelatinous organisms on filter).

Particulate Silicate

Eloïse Savineau

Seawater samples for particulate silicate ($bSiO_2$) were collected into 5 L for 6 depths and immediately taken to the chemistry lab for filtering. Samples were gently shaken (slowly turned upside down in a circular motion 3 times), 500 ml measured out and filtered through a 25 mm diameter, 0.8 µm Nucleopore™ polycarbonate filter using a low-pressure pump (max -20 kPa). Once finished filtering, the filtration tower was rinsed with approximately 10 ml of filtered seawater and filtered through the samples to remove any residue on the sides of the filtration tower. The filters were then placed into individual 15 ml centrifuge tubes, labelled and placed in the dry oven overnight at 40 ˚C. Samples were then removed from the dry oven and stored in a plastic bag in a dry, dark cupboard of the chemistry lab for later analysis back on land. A total of 53 $bSiO_2$ samples were taken.

JC231-026 CTD #4, Niskin #19 (10 m) $bSiO_2$ took ~15 hours to filter (due to gelatinous organisms on filter).

JC231-095 CTD #11, Niskin #22 (30 m) $bSiO_2$ took ~40 hours to filter (due to gelatinous organisms on filter).

Lugols

Eloïse Savineau

Seawater samples for lugols were collected for 6 depths at all shallow cast CTDs and 3 samples at a deep CTD (see CTD filtration table) Seawater samples were collected into 5 L carboys and immediately taken to the chemistry lab. Samples were gently shaken (slowly turned upside down in a circular motion 3 times). 200 ml was measured out and carefully poured into 200 ml amber bottles. 2 ml of lugol was added to each sample (to make up 1% of sample volume). Bottled were labelled and stored in the cold lab.

During the last shallow CTD (JC231-092, CTD #10), the 200 ml amber bottles ran out and 100 ml amber bottles used instead (with 1 ml of lugol added accordingly).

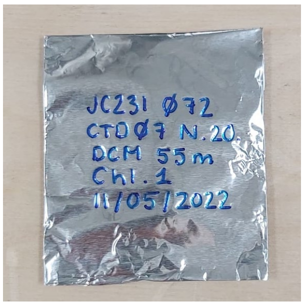
A total of 15 lugol samples were taken.

HPLC

Eloïse Savineau

HPLC samples were collected for 6 depths at all the shallow CTD stations for analysis via iFADO (Vanda, Portugal). Seawater samples were collected into 5 L carboys, covered in a black plastic bag (to block out light) and immediately taken to the chemistry lab for filtering (if not filtered immediately, they were placed in the cold lab). Samples were gently shaken (slowly turned upside down in a circular motion 3 times). 2000 ml was measured out and filtered through a 25 mm diameter, 0.7 µm pore size GFF filter using a low-pressure pump (max -20 kPa). Once finished, the filters were gently folded in half, wrapped in aluminium foil pouches and immediately flash frozen in liquid nitrogen to be stored at -80 ˚C in a freezer for later analysis.

A total of 12 HPLC samples were taken. The HPLC sample from JC231-092, CTD #10, Niskin #16 (depth of 10 m) took more than 24 hours to filter through 2 L of seawater on a GFF. This is due to a high abundance of gelatinous organisms (e.g. salps) in the seawater. No prefiltration was applied.



Aluminium foil pouch example for HPLC and DCM chlorophyll samples.

DCM Chlorophyll and paired lugol

Eloïse Savineau

A seawater sample was collected into a 5 L carboy at the Deep Chlorophyll Maxima (DCM) depth determined by the CTD. Samples were taken from all deep CTDs starting on the 10/05/2022 onwards (see CTD filtration table). The carboy was covered in a black plastic bag (to block out light) and immediately taken to the chemistry lab for filtering (if not filtered straight away, then placed in the cold lab). The sample was gently shaken (slowly turned upside down in a circular motion 3 times), 1000 ml measured out and filtered through a 25 mm diameter pre-combusted, 0.7 µm pore size GFF filter using a low-pressure pump (max -20 kPa). This was repeated two more times to create triplicates for the sampled seawater. Once finished, the filters were gently folded in half, wrapped in aluminium foil pouches, flash frozen in liquid nitrogen and stored at -80 ˚C in a freezer for later analysis. A 100 ml seawater sample from the same bottle was also poured into a 100 ml amber glass bottle with 1ml of lugol, to be paired with the 3 DCM chlorophyll samples from each CTD. The lugol sample was labelled and stored in the cold lab. The samples were taken for Marc-Andre Cormier at Oxford University.

A total of 15 DCM Chlorophyll samples and 5 lugols were taken.

Total Chlorophyll

Eloïse Savineau

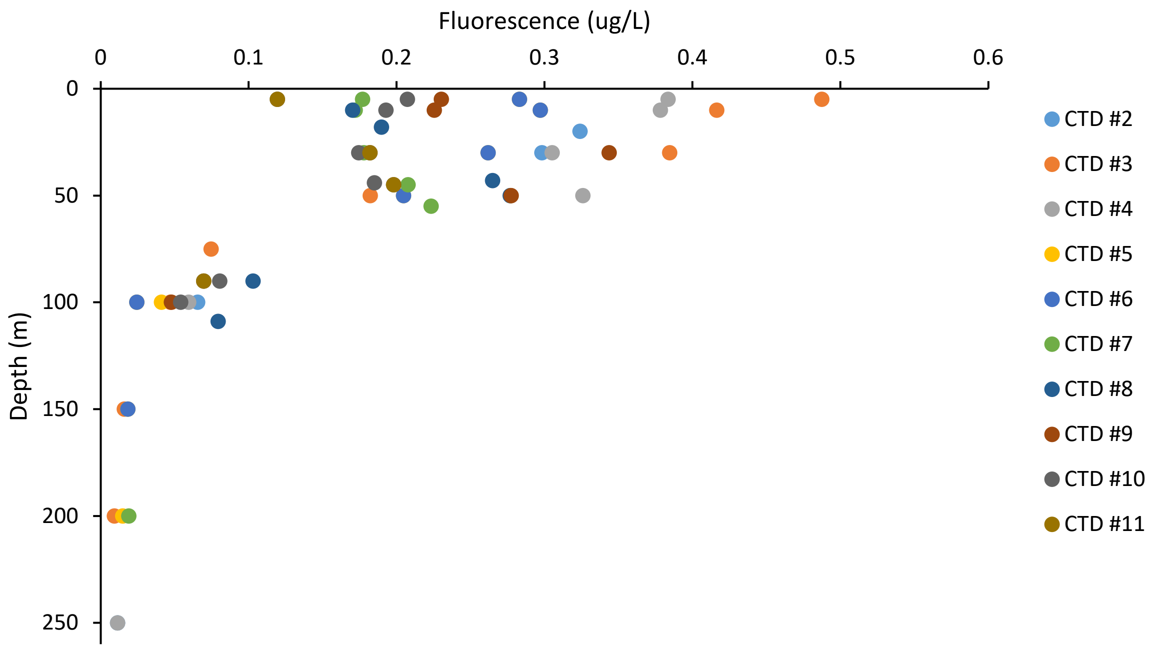
Samples for chlorophyll were collected for 6 depths at all CTD stations and through the ship's underway system. CTD seawater samples were collected into 5 L carboys, covered with a black plastic bag to block out light and immediately taken to the chemistry lab for filtering (or placed into the cold lab if not being filtered straight away). Underway samples were placed into 500 ml deep brown bottles and stored in the cold room to be filtered later in the day.

CTD samples were gently shaken (slowly turned upside down in a circular motion 3 times), 500 ml measured out and filtered through a 25 mm diameter, 0.7 µm pore size GFF filter using a low-pressure pump (max -20 kPa). Duplicates were taken for every depth. If samples from a CTD took a long time to filter through, the volume of remaining samples (shallower depths) was decreased to 200 ml. Once finished filtering, the filters were transferred into glass vials with 6 ml of 90 % acetone and stored at -20 ˚C in a freezer for 20-24 hours. After 20-24 hours, the samples were removed from the freezer and placed in a dark drawer for 1 hour to allow the sample to acclimatize to room temperature. Fluorescence readings were taken using a bench fluorometer (Black Trilogy Turner marked as 'No.1.' SN 720000877 (model 7200-000). Module 7200-046 CHL-A-NA). Three solid standard readings (to check for instrument drift) followed by one blank 90 % acetone only sample were run through the fluorometer. The chlorophyll samples were then run through the fluorometer. Each sample was run twice, and the average recorded.

The same general protocol was followed for the underway samples. Underway samples filtered measured 200 ml.

58 paired CTD chlorophyll samples were taken, for a total of 116 samples.

A total of 10 paired underway chlorophyll samples were taken, for a total of 20 samples. Samples were taken to validate the PAP1 fluorometer and CTD fluorescence sensors.



Change in fluorescence concentration (ug/L) in the upper 250 m of the water column at the PAP-SO, April-May 2022, JC231. Fluorescence values obtained with calibration calculated from precious years, but needs to be updated.

Size-fractionated Chlorophyll

Eloïse Savineau

Seawater samples of chlorophyll were collected into 5 L carboys for 6 depths at all shallow cast CTD stations, covered with a black plastic bag to block out light and immediately taken to the chemistry lab for filtering (or placed into the cold lab if not being filtered straight away).

CTD samples were gently shaken (slowly turned upside down in a circular motion 3 times) and for each depth, 500 ml of seawater was filtered through 3 different filter sizes using a low-pressure pump (max -20 kPa):

- 25 mm diameter, 0.2 µm polycarbonate filter;
- 25 mm diameter, 2.0 µm polycarbonate filter;
- 47 mm, 20.0 µm polycarbonate filter.

If samples for a CTD took a long time to filter through, the volume of remaining samples to be filtered (shallower depths) were decreased to 200 ml (and noted accordingly). Once finished filtering, the filters were transferred into glass vials with 6 ml of 90 % acetone and stored at -20 ˚C in a freezer for 20-24 hours. After 20-24 hours, the samples were removed from the freezer and placed in a dark drawer for 1 hour to allow the sample to acclimatize to room temperature. Fluorescence readings were taken using a bench fluorometer (Black Trilogy Turner marked as 'No.1.' SN 720000877 (model 7200-000). Module 7200-046 CHL-A-NA). Three solid standard readings (to check for instrument drift) followed by one blank 90 % acetone only sample were run through the fluorometer. The chlorophyll samples were then run through the fluorometer. Each sample was run twice, and the average recorded.

A total of 12 CTD size-fractionated chlorophyll samples were taken for each of the 3 size-fractions (total of 36 size-fractionated samples).

JC231 CTD filtration log sheet

Date	Station	Cast	Niskin	Depth (m)	POC (ml)	PIC (ml)	bSiO2 (ml)	HPLC (ml)	Lugol (ml)	Chl. 1 GFF (ml)	Chl.2 GFF (ml)	Chl 0.2 um (ml)	Chl 2.0 um (ml)	Chl 20.0 um (ml)	DCM Chl.1 (ml)	DCM Chl. 2 (ml)	DCM Chl.3 (ml)	DCM Lugol (ml)	Notes
02/05/2022	1	1	13	-	-	-	-	-	-	500	500	-	-	-	-	-	-	-	
02/05/2022	1	1	16	-	-	-	-	-	-	200	200	-	-	-	-	-	-	-	
02/05/2022	1	1	19	-	-	-	-	-	-	200	200	-	-	-	-	-	-	-	
04/05/2022	3	2	17	750	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
04/05/2022	3	2	19	250	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
04/05/2022	3	2	21	100	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
04/05/2022	3	2	22	30	1000	500	500	-	-	200	200	-	-	-	-	-	-	-	
04/05/2022	3	2	23	20	1000	500	500	-	-	200	200	-	-	-	-	-	-	-	
05/05/2022	12	3	4	200	1000	500	500	2000	200	500	500	500	500	500	-	-	-	-	
05/05/2022	12	3	6	150	-	-	-	-	-	500	500	-	-	-	-	-	-	-	
05/05/2022	12	3	10	100	-	-	-	-	-	500	500	-	-	-	-	-	-	-	
05/05/2022	12	3	12	75	1000	500	500	2000	200	500	500	200	500	500	-	-	-	-	
05/05/2022	12	3	14	50	1000	500	500	2000	200	500	500	200	500	500	-	-	-	-	
05/05/2022	12	3	16	30	1000	500	500	2000	200	500	500	200	200	500	-	-	-	-	
05/05/2022	12	3	19	10	1000	500	500	2000	200	500	500	200	200	500	-	-	-	-	
05/05/2022	12	3	22	5	1000	500	500	2000	200	500	500	200	200	500	-	-	-	-	
06/05/2022	26	4	11	250	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	Niskin 19 POC took 12h to filter, PIC and bSiO2 ~15h. Potentially some gelatinous organism blocking the filter
06/05/2022	26	4	13	100	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
06/05/2022	26	4	15	50	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
06/05/2022	26	4	17	30	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
06/05/2022	26	4	19	10	1000	500	500	-	-	200	200	-	-	-	-	-	-	-	
06/05/2022	26	4	21	5	1000	500	500	-	-	200	200	-	-	-	-	-	-	-	
08/05/2022	47	5	19	200	1000	500	500	-	200	500	500	-	-	-	-	-	-	-	Niskin 19 PIC/bSiO2 filtering leaked a bit (2-5ml).
08/05/2022	47	5	20	100	1000	500	500	-	200	200	200	-	-	-	-	-	-	-	
08/05/2022	47	5	21	50	1000	500	500	-	200	200	200	-	-	-	-	-	-	-	

08/05/2022	47	5	22	35	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Niskin 22, 23 and 24 misfired.
08/05/2022	47	5	23	25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
08/05/2022	47	5	24	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
10/05/2022	66	6	11	150	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
10/05/2022	66	6	13	100	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
10/05/2022	66	6	15	50	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
10/05/2022	66	6	17	30	1000	500	500	-	-	500	500	-	-	-	1000	1000	1000	100	
10/05/2022	66	6	18	10	1000	500	500	-	-	200	200	-	-	-	-	-	-	-	
10/05/2022	66	6	20	5	1000	500	500	-	-	200	200	-	-	-	-	-	-	-	
11/05/2022	72	7	19	200	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
11/05/2022	72	7	29	55	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
11/05/2022	72	7	21	45	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
11/05/2022	72	7	22	30	1000	500	500	-	-	500	500	-	-	-	1000	1000	1000	100	
11/05/2022	72	7	23	10	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
11/05/2022	72	7	24	5	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
13/05/2022	83	8	19	109	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
13/05/2022	83	8	20	90	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
13/05/2022	83	8	21	50	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
13/05/2022	83	8	22	43	1000	500	500	-	-	500	500	-	-	-	1000	1000	1000	100	
13/05/2022	83	8	23	18	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
13/05/2022	83	8	24	10	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
14/05/2022	89	9	13	100	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
14/05/2022	89	9	15	50	1000	500	500	-	-	500	500	-	-	-	1000	1000	1000	100	
14/05/2022	89	9	17	30	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
14/05/2022	89	9	19	10	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
14/05/2022	89	9	21	5	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
14/05/2022	92	10	1	100	1000	500	500	2000	200	500	200	200	200	500	-	-	-	-	Niskin 16 POC and bSiO2 took ~18-20h to filter. Gelatinous organisms on filter.
14/05/2022	92	10	4	90	1000	500	500	2000	200	500	500	200	200	500	-	-	-	-	
14/05/2022	92	10	8	44	1000	500	500	2000	200	200	200	200	200	500	-	-	-	-	

14/05/2022	92	10	12	30	1000	500	500	2000	100	200	200	200	200	500	-	-	-	-	Niskin 16 HPLC took over 24 h. Niskin 20 PIC took ~4 hours to filter.
14/05/2022	92	10	16	10	1000	500	500	2000	100	200	200	200	200	500	-	-	-	-	
14/05/2022	92	10	20	5	1000	500	500	2000	100	200	200	200	200	500	-	-	-	-	
15/05/2022	95	11	20	90	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	Niskin 22 full of salps (around ~15 in the POC water). Niskin 22 bSiO2 took around 24h, PIC around 30h to filter. Niksin 22 POC took more than 3 days and still had ~200 ml left to filter. Filtration was terminated and sample discarded as not useful anymore (filter was covered in salps and stopping water being filtered through).
15/05/2022	95	11	21	45	1000	500	500	-	-	500	500	-	-	-	1000	1000	1000	100	
15/05/2022	95	11	22	30	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	
15/05/2022	95	11	24	5	1000	500	500	-	-	500	500	-	-	-	-	-	-	-	

Inorganic Nutrients

Edward Mawji

A 4-channel Seal Analytical (QuAAtro 39) segmented flow-analyser with XY autosampler was set up in the Chemistry lab of the *RRS James Cook* for the analysis of micro-molar concentrations of dissolved inorganic nutrients (silicate, phosphate, nitrate plus nitrite and nitrite).

Nutrient sampling and Analysis

Samples were collected directly from the 24 x 20 L stainless steel rosette after the TA/DIC into pre-labelled 15ml centrifuge tubes (rinsed three times with water from the same Niskin). Samples were analysed directly from the collection tubes within 1-8 hour and measured from the lowest to the highest concentration (surface to deep) to reduce any carry over effects. Milli-Q water was used for the baseline and wash solution during each run. All unique sampling depths were sampled and analysed.

Seal Analytical chemistry and cleaning procedure protocols used during JC231 were

1. Silicate in seawater method No. Q-066-05 Rev. 5
2. Phosphate in water method No. Q-064-05 Rev. 8
3. Nitrate and nitrite in seawater method No. Q-068-05 Rev.11
4. Nitrite in seawater method No. Q-070-05 Rev. 6

Standards

Standards were prepared for every day of analysis by diluting the stock solutions of the different nutrients in low nutrient seawater or artificial sea water (ASW).

Each run of the system had an 8-point calibration series (first value was ASW + 7 working solutions). Prior to analysis all samples and standards were brought to room temperature of ~22◦C. Concentrations of the working standards were as per Table below which was based upon the concentrations range of the nutrients expected.

The standard concentrations used for each chemistry during JC231 analyses.

Standard	NO3 +NO2 (µM)	NO2 (µM)	PO4 (µM)	SiO2 (µM)
1	0.3	0.05	0.05	0.5
2	0.6	0.1	0.1	1
3	1.7	0.2	0.2	5
4	6.4	0.4	0.4	10
5	12.8	0.8	0.8	20
6	26.04	1	1.6	35
7	41.55	1.5	2.0	50

QC of analyses

To test the accuracy and precision of the analyses, CRMs from The General Environmental Technos Co., Ltd., (KANSO) were measured in triplicates at the start, middle and end of every run. For the analyses of JC231 samples KANSO CRMs lot CL and CJ were used; certified concentrations against the run concentrations are shown in Table below.

Certified concentrations converted from µmol kg^{-1} to µmol L^{-1} of KANSO CRMs used during JC231 and our results for each lot (in umol L^{-1}), n=40

	Nitrate	Silicate	Phosphate
KANSO CL	5.604 ± 0.15	14.14 ± 0.0.3	0.435 ± 0.019
KANSO CJ	16.6 ± 0.2	39.43 ± 0.4	1.22 ± 0.02
Measured CL	5.64 ± 0.03	14.25 ± 0.122	0.435 ± 0.0047
Measured CJ	16.51 ± 0.102	39.32 ± 0.22	1.24 ± 0.014

The WHP bottle parameter data quality flags.

Flag	Description
1	Sample for this measurement was drawn from water bottle but analysis not received.
2	Acceptable measurement.
3	Questionable measurement.
4	Bad measurement.

DOC/TN Sampling

Ed Mawji

A total of three stations (CTDs 6, 7 and 10) were sampled for DOC and TN during JC231. Before sampling the following procedures were carried out;

- Pre-combusted glass sample vials (combusted ashore at 450°C for ≥4 hours) were labelled with relevant cast/niskin number.
- Wearing clean nitrile gloves, filter holders and silicon tubing were removed from the 10% HCL acid bath and rinsed with Milli-Q water and placed on a clean surface of aluminium foil. With forceps a pre combusted glass fiber filter (GF/F) was placed in each filter holder and a length of silicon tubing was attached to the filter inlet, each end of the filter and tubing were covered with aluminium foil.

DOC sample Collection

DOC was sampled after the gases (oxygen, DIC/TA) and sampled from deep to shallow. The silicon tubing with filter cartridge was attached to the niskin, water was then allowed to flow through the filter for around 1 minute, sample vials were rinsed three times with the sample water and vials were filled with no head space

Once in the lab, each sample was acidified with 100 µL of 4N HCl and stored in the fridge for latter analysis on shore.

210Po-210Pb profiles

Sari Giering

Scientific motivation

^{210}Pb ($T_{1/2}$ = 22.3 years) and its daughter ^{210}Po ($T_{1/2}$ = 138.4 days) are natural particle reactive radioisotopes that can be used as tracers of particle cycling in the upper ocean. Both radioisotopes have a strong affinity for particles, but whereas ^{210}Pb is only adsorbed on particle surfaces, ^{210}Po is also incorporated into the cytoplasm of some phytoplankton and bacteria. Its partitioning is similar to that of protein and sulphur within the cell. These differences result in ^{210}Po being more efficiently removed from surface waters than ^{210}Pb via sinking particles. Hence, disequilibrium between the two radionuclides occurs when biological activity is high. ^{210}Pb-^{210}Po disequilibrium has different characteristics than that of the more commonly used pair ^{234}Th-^{238}U. ^{234}Th attaches to the surface of the particles, whereas ^{210}Po is incorporated into organic matter. Thus, it is expected that ^{210}Po-^{210}Pb disequilibrium allows us to more accurately estimate POC fluxes, albeit over a longer time scale (several months). The degree of disequilibrium between ^{210}Pb and ^{210}Po and the dynamics of association to particles can be used to assess scavenging rates, particle fluxes, sinking velocities and remineralisation rates. POC contents measured in sinking particles will be used to convert ^{210}Po fluxes into POC fluxes.

Specific aims of the polonium work during this cruise were (1) to test a new precipitation protocol and (2) to see whether the particles collected using the Marine Snow Catcher provides sufficient material to derive a Po-POC ratio. Previously, we used Fe^{3+} to scavenge and precipitate the ^{210}Po radioisotopes. During this cruise, we also precipitated the ^{210}Po – in parallel – following an alternative protocol using Fe^{2+}. Previously, for the Po-POC ration, we typically used the Stand-Alone Pumping Systems (SAPS) to collect sufficient material to derive the conversion. Here, we collected samples to see whether the material collected using a Marine Snow Catcher is sufficient to derive the conversion.

Po Sampling methodology and sampling treatment on board

Samples for ^{210}Po and ^{210}Pb analysis were collected from 20-L Niskin bottles mounted on the stainless steel CTD rosette. 5 L water samples were collected from up to 9 depths between 5-1000 m (see Table). For Fe^{3+} procedure, uncertainties on the measurements were estimated by taking triplicate samples from 1000 (Station 066 – CTD 005). Three blanks were prepared by treating 5 L MilliQ the same as a sample. Unfortunately, we did not have enough chemicals for triplicates and blanks for the Fe^{2+} procedure.

From each depth, 5 L of water were collected in acid-cleaned (solution: 500 mL MilliQ + 500 mL HNO_3 65% + 10 mL H_2O_2) and MilliQ-rinsed carboys that were pre-rinsed with the sample. The 5-L line was marked on the carboys, so the volume measurements are not super precise. Samples were immediately acidified (10 mL HNO_3) and vigorously shaken. All carboys were then spiked with 200 µL ^{209}Po tracer. For the Fe^{3+} protocol, 10 mL FeHCl was added. For the Fe^{2+} protocol, 1.25 g $FeSO_4$ and 2.5 g $K_2S_2O_5$ were added. The samples were again vigorously shaken. After 6-12 hours, 15 mL NH_4OH was added to neutralize the solution (to a final pH of 8.5). The solution was shaken vigorously, and the pH checked. Samples were allowed to precipitate and settle for at least 24 h.

After settling, as much supernatant as possible was removed by carefully siphoning. The precipitate was transferred into 1-L HDPE bottles and left to settle for at least another 24 h. Again, the supernatant was carefully siphoned off, and the precipitate transferred into 250-mL HDPE bottles. For sample transfer, carboys/bottles were rinsed with MilliQ water.

The radiochemical analysis of these samples will be carried out at the Universidad de Sevilla.

Deployments. Details of the collected three profiles. * marks depth with corresponding Marine Snow Catcher deployment.

	06-May-22			**10-May-22**			**14-May-22**	
	St 026	CTD004		St 066	CTD005		St 087	CTD009
Depth	**Niskin**		**Depth**	**Niskin**		**Depth**	**Niskin**	
	Fe3	Fe2		Fe3	Fe2		Fe3	Fe2
5	22	22	5	21	21	5	22	22
10	20	20	10	19		10	20	20
30	18	18	50*	16	16	50*	16	16
50*	16	16	100	14		100	14	14
100	14	14	150*	12	12	150*	11	11
250*	12	12	250	19		250	9	9
400	10	10	400	8		400	7	7
600	8	8	600	6		600	5	5
			1000	2, 2, 3	3			

11. Underway measurements

Anita Flohr

Continuous underway measurements

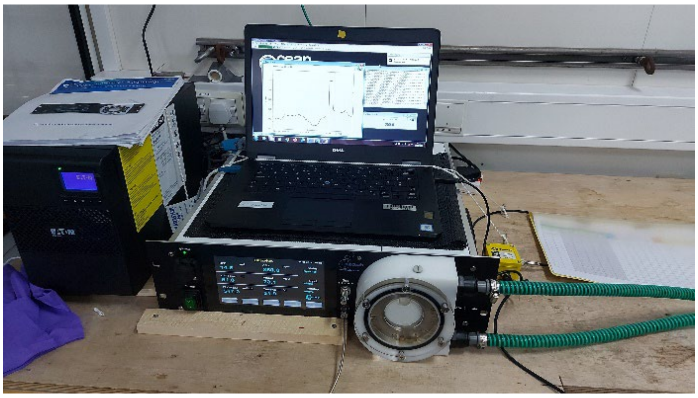
A SubCtech OceanPack MK2 Flow-Through Analyzer (SN: CO2-DLZEGAMK2-19-0-1803-01) was connected to the underway seawater supply in the chemistry lab for continuous pCO_2 measurements (Figure below). The system had been serviced prior to the cruise (new membrane, new micro air pump, refilled zero filter, calibration). The system was installed on 01/05/2022 and connected to the non-toxic seawater supply from ~13:06 UTC at 12 L/min and from 18:33 UTC onwards at 14 L/min (Table below). The system was switched off on 18/05/2022 at 14:30 UTC.

The system was powered via an uninterruptible power supply to eliminate problems thought to occur in response to power spikes/drops that caused system to reset on DY116. No resets were detected during JC231.

The water temperature was measured and logged at the analysers' outflow at 1 min intervals (Tinytag TGP-4204 PT1000, resolution: 0.01°C, accuracy: 0.65°C).

The system connected to single standard gas (422 ppm, BOC) via stainless steel tubing. The measurement cycle included running a calibration (zero CO_2, span 1) twice a day and running the reference gas once a day (Table below).

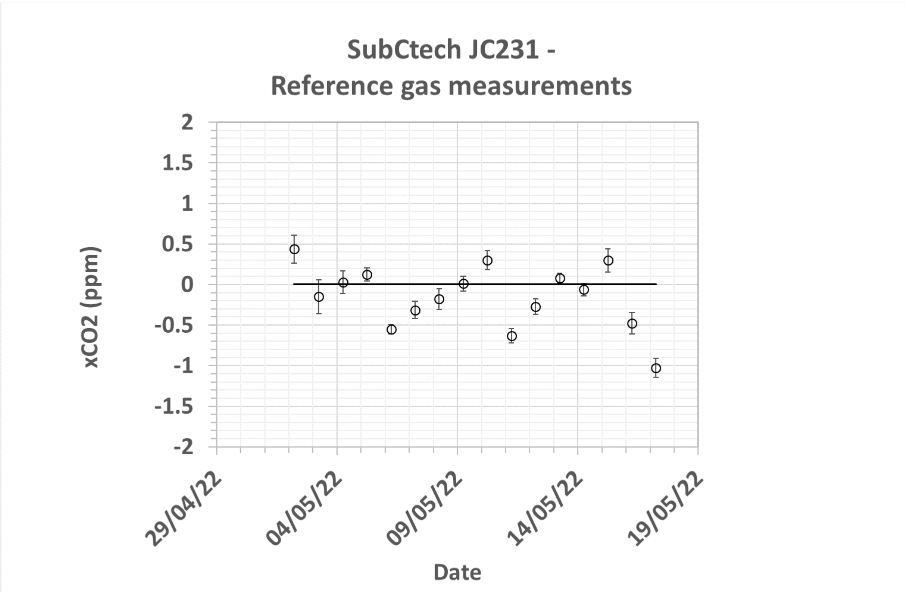
The data was streamed and logged to a laptop at 1 min intervals (using OceanView Software, SubCtech). In addition, the data was logged to the ship's file server and merged with selected parameters from the ship's fitted systems (see pCO2 SelectedFields Data description.docx). Huge thanks to Joshua Pedder and Josue Daniel Viera Rivero (NMF) for setting this up.



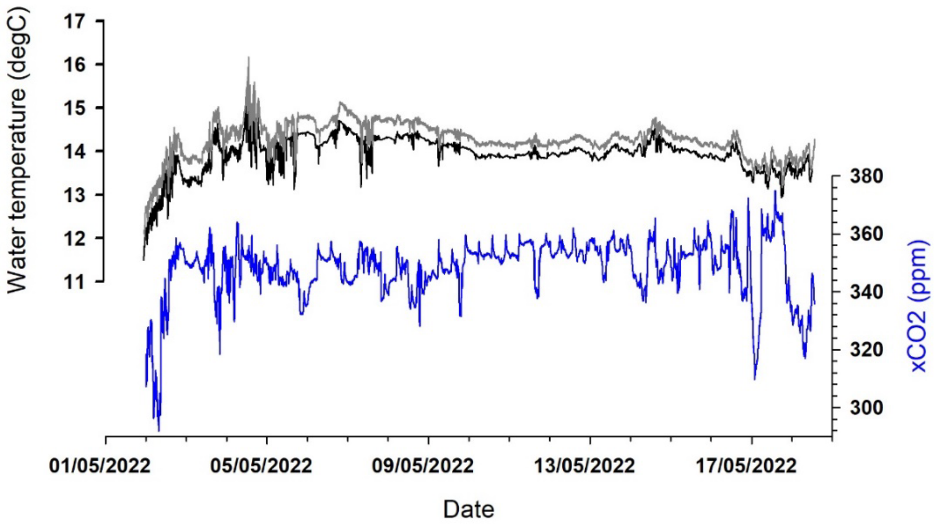
SubCtech connected to the seawater supply in the chemistry lab during JC231

SubCtech measurement cycle during JC231

Phase	Mode	Hrs	Phase end UTC
1	operate	07:30:00	04:58
2	zero CO2	00:15:00	05:13
3	span 1	00:15:00	05:28
4	operate	07:45:00	13:13
5	ref gas	00:15:00	13:28
6	operate	07:30:00	20:58
7	zero CO2	00:15:00	21:13
8	span1	00:15:00	21:28



Results of reference gas measurements (phase 5). Shown are the means and SD of differences from the certified value of the reference gas (last 10 mins of 15 mins of reference gas measurements).



Underway SST ((SBE38, black line) and temp sensor at SubCtech outflow (grey line, adjusted for time lag)) and raw xCO2 measured during JC231

Discrete underway water sampling

Discrete water samples for analyses of dissolved inorganic carbon (DIC) concentration and total alkalinity (TA), dissolved nutrient concentration, salinity, chlorophyll *a* (Chl) concentration and biogenic silica (BSi) were taken normally twice a day from the outlet water flow of the underway system. Nutrients, salinity and chlorophyll *a* samples were measured onboard. The DIC/TA and biogenic silica samples will be analysed upon return to the National Oceanography Centre, Southampton.

Protocol of discrete sampling from the underway system (chem lab) during JC231.

Date Time (UTC)	Comment	Lat (dec)	Long (dec)	Ground Speed (knot)	Multibeam Depth (m)	Water Fluores. (V)	Relative Wind Speed (m/s)	Relative Wind Direction (degree)	Air Temp. (°C)	Relative Air Humidity (100*Pa/Pa)	Air Pressure (mbar)	Water Salinity (PSU)	Water Temp. (°C)
01/05/2022 13:06	SubCtech switched on, connected to non-toxic water supply	50.44824	-2.07586	15.9	35.13	0.0772	6.949	2.196	9.65	77.58	1021.645	34.9756	11.0987
01/05/2022 13:26	SubCTech water flow rate at 12 L/min	50.4266	-2.20983	16	40.51	0.0949	6.798	15.3936	9.5	81.63	1021.51	34.9494	11.2067
01/05/2022 18:33	SubCtech water flow rate adjusted to 14 L/min	50.02584	-3.85901	10.9	68.96	0.146	5.583	353.8944	9.7	81.6	1019.804	35.099	11.3867
02/05/2022 10:24	SubCTech discrete samples: 2 x DIC/TA (bottles 16, 11)	48.90367	-8.51776	13.4	121.36	0.0615	9.973	2.232	12.35	91.43	1019.742	35.3313	12.9328
03/05/2022 14:29	SubCtech water flow rate check: 13.8 L/min	48.69422	-11.1276	10.1	1478.21	0.0708	8.241	23.7528	13.1	69.66	1021.598	35.5962	13.883
03/05/2022 15:03	Underway discrete samples: 2 x TA/DIC (bottles 20, 6), nuts (UW_1)	48.70113	-11.279	10.4	1572.45	0.0935	7.088	30.7584	13.04	74.48	1021.692	35.5915	13.7018
04/05/2022 06:56	Underway discrete samples: 2 x TA/DIC (bottles 354, N24), nutrients (Nut_UW_2), Chl (Chl_UW_1), BSi (BSi_UW_1)	48.91976	-15.5647	10.6	4806.82	0.1401	10.867	32.7168	13.21	95.67	1022.097	35.606	13.9501
04/05/2022 19:36	Underway discrete samples: 2 x TA/DIC (bottles 544, 504), nutrients (Nut_UW_3), Chl (Chl_UW_2), BSi (BSi_UW_2)	48.8805	-16.4566	11.1	NaN	0.1453	8.908	352.836	14.92	87.81	1022.836	35.5629	14.7453
07/05/2022 09:00	adjusted SubCtech SST set-up until ~10 am, SST might be a bit off	48.96165	-16.4361	0.2	4835.15	0.0824	9.036	343.6992	14.43	87.39	1022.071	35.5455	13.6049
08/05/2022 08:06	Underway discrete samples: 2 x TA/DIC (bottles 541, 536), nutrients (Nut_UW_4),	48.99113	-16.4348	9.4	4831.87	0.0943	11.397	310.572	14.26	88.87	1018.774	35.577	14.3603

	Chl (Chl_UW_3), BSi (BSi_UW_3)												
08/05/2022 08:15	SubCtech flow rate 14 L/min	48.99808	-16.4676	8.8	4829.92	0.0905	11.636	308.6136	14.32	89.11	1018.889	35.5997	14.328
09/05/2022 11:13	Underway discrete samples: 2 x TA/DIC (bottles N15, 502), nutrients (Nut_UW_5), Chl (Chl_UW_4), BSi (BSi_UW_4), salinity (bottle 81)	48.97095	-16.3968	0.5	4837.15	0.0792	11.829	344.6856	14.03	70.34	1013.242	35.5644	14.1613
09/05/2022 11:30	SubCtech flow rate 14 L/min	48.97097	-16.3968	0.5	NaN	0.0899	13.405	332.6328	14.08	68.77	1013.647	35.5648	14.1559
09/05/2022 16:25	nutrients (Nut_UW_6)	48.95701	-16.4962	7.3	NaN	0.0731	13.907	345.8088	13.86	77.18	1014.375	35.5728	14.1505
09/05/2022 16:50	nutrients (Nut_UW_7)	48.95656	-16.566	6.4	4797.57	0.0923	16.394	343.7424	13.13	77.8	1014.027	35.5646	14.2036
09/05/2022 17:31	nutrients (Nut_UW_8)	48.95664	-16.6783	6.2	NaN	0.1047	14.281	350.748	13.09	84.47	1014.146	35.5714	13.9944
09/05/2022 18:30	nutrients (Nut_UW_9)	48.95661	-16.8289	6.4	NaN	0.1588	12.77	326.8728	12.25	88.49	1014.843	35.5912	14.0564
10/05/2022 08:15	Underway discrete samples: 2 x TA/DIC (bottles 289, 586), nutrients (Nut_UW_10), Chl (Chl_UW_5), BSi (BSi_UW_5)	48.95453	-16.4849	0.6	4832.18	0.0822	8.986	338.8176	13.57	80.12	1013.788	35.5619	13.8811
11/05/2022 08:09	Underway discrete samples: 2 x TA/DIC (bottles 249, 540), nutrients (Nut_UW_11), Chl (Chl_UW_6), BSi (BSi_UW_6), salinity (bottle 84)	48.95057	-16.4774	0.6	4832.79	0.078	8.961	3.8088	12.4	66.67	1015.337	35.5821	13.9167
12/05/2022 16:30	Underway discrete samples: 2 x TA/DIC (bottles 539, 538), nutrients (Nut_UW_12), Chl (Chl_UW_7), BSi (BSi_UW_7)	48.88412	-16.1354	5.6	4840.67	0.0607	12.904	316.7784	13.5	60.93	1020.303	35.5791	14.0878

14/05/2022 07:10	Underway discrete samples: 2 x TA/DIC (bottles 549, 545), nutrients (Nut_UW_13), Chl (Chl_UW_8), BSi (BSi_UW_8)	48.70751	-17.1232	1.5	4677.37	0.1523	7.849	310.5864	13.83	80.14	1015.628	35.6173	14.1467
14/05/2022 07:15	SubCtech flow rate 14.5 L/min	48.70636	-17.1261	2.3	4743.82	0.1517	6.671	317.7144	13.89	82.11	1015.956	35.6153	14.1291
15/05/2022 18:23	Underway discrete samples: 2 x TA/DIC (), nutrients (Nut_UW_14), Chl (Chl_UW_9), BSi (BSi_UW_9), salinity (bottle #90)	49.1611	-16.1216	3.9	NaN	0.1067	11.893	50.9328	14.24	96.15	992.7484	35.5821	13.9052
16/05/2022 09:00	SubCtech flow rate 13.8 L/min	48.96199	-16.3906	6.6	4833.1	0.0801	10.881	77.9472	14.18	75.62	996.1596	35.5763	13.8101
16/05/2022 10:35	Underway discrete samples: 2 x TA/DIC (), nutrients (Nut_UW_15), Chl (Chl_UW_10), BSi (BSi_UW_10)	48.99461	-15.9658	11	4836.7	0.0961	15.981	62.8992	14.43	79.83	995.39	35.5959	13.9389
16/05/2022 19:10	Underway discrete samples: 2 x TA/DIC (), nutrients (Nut_UW_16), Chl (Chl_UW_11), BSi (BSi_UW_11)	49.0695	-14.0698	3.1	NaN	0.103	22.981	1.6776	-39.24	41.67	988.812	35.598	13.768
17/05/2022 09:10	Underway discrete samples: 2 x TA/DIC (no ID, 272), nutrients (Nut_UW_17)	48.68059	-13.9046	13.5	4489.15	0.0679	10.73	102.0096	8.23	136.73	1001.869	35.589	13.5009
17/05/2022 17:30	Underway discrete samples: 2 x TA/DIC (no ID, 102), nutrients (Nut_UW_18)	49.12882	-11.57	12	955.06	0.0766	10.733	113.0904	-31.93	119.34	1005.062	35.5562	13.4994
18/05/2022 07:15	Underway discrete samples: 1 x TA/DIC (X065), nutrients (Nut_UW_19)	49.41113	-7.58706	12.7	132.5	0.1128	14.168	57.0312	-39.47	0.87	1011.416	35.2865	13.5591
18/05/2022 07:20	SubCtech flow rate 14 L/min	49.41228	-7.56179	11.2	133.25	0.1044	12.793	56.0088	-39.45	0.87	1012.352	35.2828	13.5718

18/05/2022 14:16	SubCtech: stopped logging data	49.59014	-5.56426	11.4	92.07	0.1321	12.387	76.8528	-39.45	0.9	1012.763	35.3297	13.8084
18/05/2022 14:18	disconnected seawater supply, started flushing SubCtech with tap water for 10 mins	49.59176	-5.55454	11.7	91.26	0.1318	10.405	74.8152	-39.45	0.9	1013.335	35.3282	13.8019
18/05/2022 14:30	SubCtech switched off	49.6014	-5.49561	11.2	91.82	0.0513	10.078	76.8528	-39.45	0.9	1012.93	0.3751	13.7442

12. Met Office Biogeochemistry Argo float

Sue Hartman

To increase collaboration on ocean biogeochemistry between Met Office and NOC at the PAP-SO, the Met Office provided a Bio-geochemical Argo float (BGC Argo) to take regular water column profiles while in the vicinity of the PAP site. The data generated were to support the Met Office work on the Argo programme and provide greater temporal resolution to NOC's monitoring at the observatory. The delayed mode Argo float data was quality controlled against a CTD cast (JC231-047) and can help to validate data from the PAP-1 mooring. The float is a Navis BGCi f1242. It carries the following sensors:

- SBE-41N CTD head,
- SBE-63 dissolved oxygen sensor,
- MCOMS three channel optical sensor (standard channels 1 bbp (700 nm), 1 chl, and 1 CDOM).
- SUNA

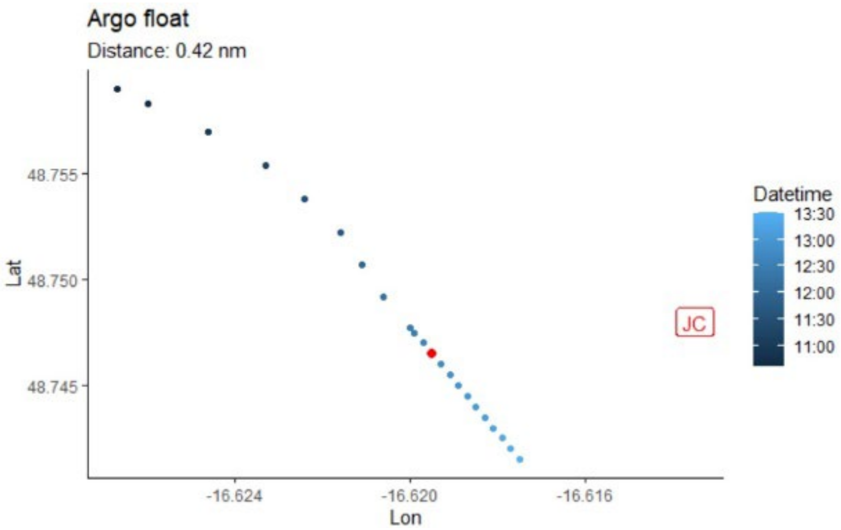
The float was provided in 'pressure-activation' mode to self-activate after sinking below 25 dbar. Deployment is simple and only required lowering the float gently into the water, releasing it while the ship is stationary. Require the position of the deployment, to notify it with OceanOPS and get the data flowing to BODC.

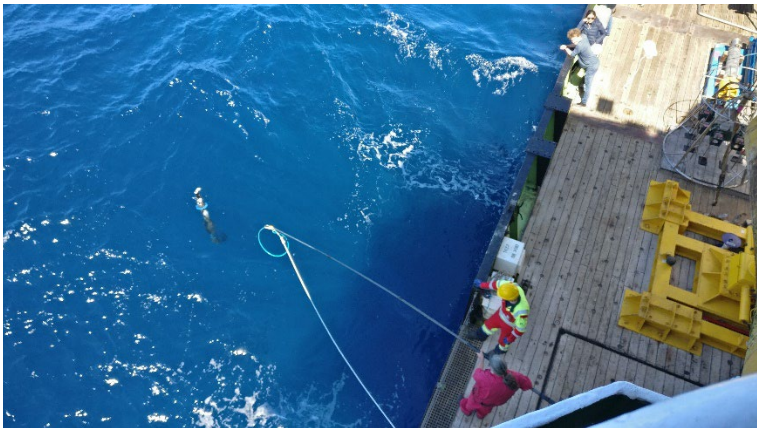
Navis BGC float f1242 deployed at PAP 2022 **on 8th May at 49 0.322 N 16 30.094 W.** The float was lowered into the water on a line from the starboard side of the stern of the ship on 8/5/22, deployment stations JC231-048. Dave Childs deployed it while we sampled the cal cast – CTD 5 (station JC231-047). All caps removed and float lowered into the water as the ship moved away from station JC231-047. This was a deep CTD station, with samples taken to validate the float. The float was programmed to sink on deployment, self-activate at 25dbar, rise to the surface for a short mission prelude transmission then descend to maximum depth (2,000 m) and profile from 2,000 m.

The first profile was expected <15 hours after deployment. After that the float was programmed on a 5-day cycle while it was in the vicinity of the mooring to collect maximum data in the region. It will be switched to a standard 10-day cycle remotely once it has moved away. John Hankins had contacted Seabird to query failure of bench tests prior to JC231, and SeaBird insisted it was good to deploy. However, when it resurfaced the nitrate data was missing so a recovery was carried out on the 14th May.

It was set to a short cycle, and then bring it to the surface for pickup later. It wasnt due back on the surface to be put into recovery mode until late afternoon on 14th. Turned out to surface earlier – 10:30 on 14th. 0.3 knots towards southeast. Moving at 200m per min – so Sari plotted it and ship position. Captain was alerted and crew at the ready – plus the MMO on bridge, and we turned around ~ 10 miles away.

Recovery involved a real team effort of coordination – from the crew rigging up a lasoo, to getting frequent Whatapp updates of the location, and many people on look out. Until it was spotted by Jade and recovered by Martin (to a round of applause). It is 30kg in air (so required 2 people to haul over inboard). A few attempts to catch before Martin got it onboard.



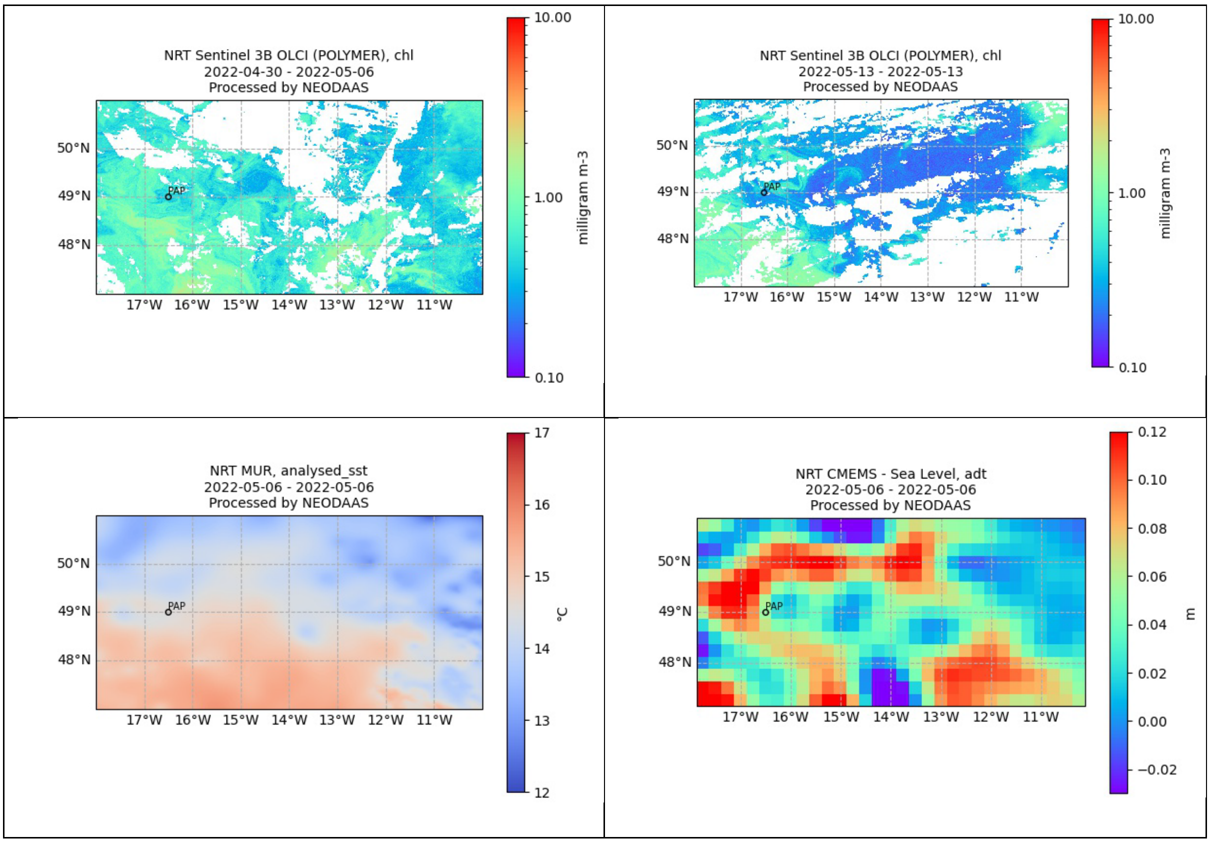


13. Satellite data

Satellite data was obtained from NEODAAS help desk, via iFADO funds, daily from 27 April until 20 May. The files are available via FTP (example here for 27 April) and via HTTPS: ftp://neodaas23:oophoh6bu4ooz8eiveeP4@ftp.rsg.pml.ac.uk/2022/04/27
https://data.neodaas.ac.uk/files/22_01/2022/04/27

There was heavy cloud cover throughout the cruise which limited the coverage and Chlorophyll-a from Sentinel 3b OLCI coverage. SLSTR SST and MUR Sea Surface Temperature images (and later SSH) were also obtained. Some meander or cyclonic eddy-looking dynamics were seen to the southeast of PAP's position, associated with a tongue of warm water. 7-day composite image of Chlorophyll-a from Sentinel 3b OLCI sometimes had better spatial coverage of the two OLCI composite images.

Example images of chl-a at the start and end of JC231, an image of SST and SSH



SST scale change from 6th May. Sea surface height was provided from the 0.25 x 0.25 degree CMEMS Global Sea Level product [1] with two variables:

- adt: The absolute dynamic topography is the sea surface height above geoid; the adt is obtained as follows: adt=sla+mdt where mdt is the mean dynamic topography

- sla: The sea level anomaly is the sea surface height above mean sea surface; it is referenced to the 1993 - 2012 period.

14. Zooplankton Nets

Eloïse Savineau, Chris Feltham

Zooplankton were sampled at the PAP-SO at both midday and midnight using a 200 µm mesh WP2 net. The 200 µm mesh WP2 net was deployed to a depth of 200 m and vertically hauled back to the surface at a speed of 15 m/min. The zooplankton sample obtained from the cod end of the net was then sieved through a 200 µm sieve to reduce the volume of water in the sample and stored in a 250 ml plastic bottle with approximately 10 % borax buffered formalin (225 ml sample and 25 ml of borax buffered formalin). The bottles were labelled and stored in the cold room. A total of 3 midday and 3 midnight nets were sampled.

An extra midday and midnight 200 µm mesh WP2 net and a 60 µm mesh WP2 net were performed. The 200 µm mesh WP2 net and a 60 µm mesh WP2 samples were then sieved through a 200 µm sieve and 60 µm sieve respectively to remove the sea water from the sample. The samples were placed into individual plastic freezer bags and frozen at -80 ˚C (the midday 60 60 µm mesh WP2 net sample was small enough to store in a cryovial tube).

A midnight 200 µm mesh WP2 net was also done on the 14/05/2022 to be paired with the red camera frame.

Larval octopus or squid. From the 200 µm mesh WP2 midday net sample 09/05/2022.

Copepod sampled from the 200 µm mesh WP2 net at midday (07/05/2022).

Sieved 200 µm mesh WP2 midday net sample 09/05/2022. Sample included a small octopus (see close-up above).

Sieved 200 µm mesh WP2 midnight net sample (12/05/2022). Potential viper fish.

200 µm mesh WP2 midday net being deployed from the rear starboard side of the ship (07/05/2022).

JC231 Zooplankton net sampling log

JC231-009 **Net #01**	Midnight sample	200 µm mesh WP2 net. Tow depth = 200 m Preserved in a 250 ml bottle with formalin			
Deployment		05/05/2022	00:52	48˚50.29’N	016˚31.54’W
Recovery		05/05/2022	01:14	48˚50.18’N	016˚31.46’W
JC231-013 **Net #02**	Midday sample	200 µm mesh WP2 net. Tow depth = 200 m Preserved in 2 × 250 ml bottles with formalin			
Deployment		05/05/2022	12:43	48˚57.8006’N	016˚23.9185’W
Recovery		05/05/2022	12:59	48˚57.7868’N	016˚23.9000’W
JC231-032 **Net #03**	Midnight sample	200 µm mesh WP2 net. Tow depth = 200 m Preserved in a 250 ml bottle with formalin			
Deployment		07/05/2022	00:16	48˚50.32’N	016˚31.15’W
Recovery		07/05/2022	00:38	48˚50.21’N	016˚31.09’W
JC231-033 **Net #04**	Midnight sample	200 µm mesh WP2 net. Tow depth = 200 m Frozen in -80 ˚C freezer.			
Deployment		07/05/2022	00:48	48˚50.27’N	016˚31.12’W
Recovery		07/05/2022	01:08	48˚50.16’N	016˚31.07’W
JC231-037 **Net #05**	Midday sample	200 µm mesh WP2 net. Tow depth = 200 m Preserved in a 250 ml bottle with formalin			
Deployment		07/05/2022	12:33	49˚0.0046’N	016˚30.0355’W
Recovery		07/05/2022	12:47	49˚0.0055’N	016˚30.0317’W
JC231-038 **Net #06**	Midday sample	200 µm mesh WP2 net. Tow depth = 200 m Frozen in -80 ˚C freezer.			
Deployment		07/05/2022	13:01	49˚0.0041’N	016˚30.0270’W
Recovery		07/05/2022	13:15	49˚0.0056’N	016˚30.0349’W
JC231-xx **Net #07**	Midnight sample	200 µm mesh WP2 net. Tow depth = 200 m Unable to deploy net due to wind.			
JC231-xx **Net #08**	Midnight sample	60 µm mesh WP2 net. Tow depth = 200 m Unable to deploy net due to wind.			
JC231-053 **Net #09**	Midday sample	200 µm mesh WP2 net. Tow depth = 200 m Preserved in a 250 ml bottle with formalin. Sample had a small octopus. Very windy			
Deployment		09/05/2022	11:20	48˚58.26’N	016˚23.81’W
Recovery		09/05/2022	11:35		
JC231-074 **Net #10**	Midnight sample	200 µm mesh WP2 net. Tow depth = 200 m Preserved in a 250 ml bottle with formalin.			
Deployment		12/05/2022	01:04	48˚50.09’N	016˚31.33’W
Recovery		12/05/2022	01:27	48˚50.04’N	016˚31.34’W
JC231-075 **Net #11**	Midnight sample	60 µm mesh WP2 net. Tow depth = 200 m Frozen in -80 ˚C freezer. Not much visible in sample			
Deployment		12/05/2022	01:37	48˚50.09’N	016˚31.32’W
Recovery		12/05/2022	02:06	48˚50.05’N	016˚31.34’W
JC231-080 **Net #12**	Midday sample	60 µm mesh WP2 net. Tow depth = 200 m Frozen in -80 ˚C freezer. Not much visible in sample			
Deployment		12/05/2022	12:17	49˚0.0009’N	016˚30.0140’W
Recovery		12/05/2022	12:39	49˚0.0032’N	016˚30.0488’W
JC231-094 **Net #13**	Midnight sample	200 µm mesh WP2 net. Tow depth = 200 m Preserved in a 250 ml bottle with formalin.			
Deployment		14/05/2022	22:52	48˚58.665’N	016˚27.65’W
Recovery		14/05/2022	23:24	48˚58.76’N	016˚27.79’W

15. ANTICS – Marine Snow catcher and Red Camera frame

Sari Giering. Marika Takeuchi, Jack Williams, Will Major (ashore)

Objectives and aims

The aim of the cruise was to continue both the water column and benthic biological sampling of the Porcupine Abyssal Plain sustained observatory (PAP-SO), which constitutes the longest open-ocean, multidisciplinary measurements from the oceans around Europe (Hartman *et al.,* 2012). Previous pelagic work at the PAP-SO site has focused on linking upper ocean physical and biogeochemical processes (Hartman *et al.,* 2010), sinking fluxes of POC to the deep ocean (Lampitt *et al.,* 2010), and the remineralization of sinking particulates (Belcher et al., 2016). Continuing with these research themes on this cruise, we deployed Marine Snow Catchers to sample marine particulates, and address the following aims:

- Determine export fluxes (MLD+10m) and particulate fluxes at MLD+110m, to calculate transfer efficiencies in the upper 100m of the mesopelagic (POC, BSi, PIC, Chl).
- Measure sinking velocities of individual particles, compare with Po-derived sinking velocities and validate flux calculations from camera systems
- Examine the distribution of POC, BSi, PIC and Chl between suspended, slow-, and fast-sinking pools.
- Separate particles into sinking and suspended fractions for genomic analyses of the AtlantECO project.
- Carry out field trials of prototype MSC to compare with original MSC model.

The MSC team (from left to right): Yuki, Old2, Old1).

MSC Methods

Sampling strategy and particle collection

MSCs were typically deployed to sample two depths below the mixed layer depth (MLD), at a depth of MLD+10 m (typically 50 m) and at a depth of MLD+110 m (typically 150 m). At each depth, MSCs were usually deployed in pairs, with the new prototype MSC (christened "Yuki") deployed immediately before or after one of the old MSCs, to enable comparison between old and new models.

A full description of the MSC, its assumptions, and established protocols are described in Riley *et al.* (2012), Giering *et al.,* (2016), and Baker *et al.* (2017). Briefly, the MSC is a large volume (95L) water sampler with a removeable base section (8 L), and a removeable tray at the bottom of the base section. Once returned to deck, 5 L was decanted from the top of the MSC to provide a "time-zero" (Tzero) measurement. After a 2 h settling period, suspended material was sampled by draining another 5 L from the top of the MSC (MSC "top" measurement"). After sampling of suspended material, a lower tap above the base section was opened to slowly drain the remaining suspended water, without resuspension of any slow-sinking material in the base. Draining the MSC typically took ~20 minutes for old MSCs, and 25 minutes for Yuki. The top section of the MSC was then be removed.

After removing top section of the MSC, slow sinking particles residing within the base section of the MSC were sampled from the base section of the MSC ("base" measurement), from water held within the base section of the MSC but above the lip of the tray. Fast sinking material was assumed to have settled into the tray at the bottom of the MSC base section; a lid was placed on this tray which was then removed ("tray" fraction). For old MSCs, tray volumes were approximately 1 L, with the volume of new prototype Yuki trays approximately 2 L. In a small number of cases where additional water was required for genomics sampling, slow- and fast- sinking fractions were pooled to yield a sinking fraction, and water from above the lip of the tray and around the outside of the tray was collected to provide this sample.

A full list of all MSC deployments with parameters measured is shown in the table.

MSC Sample filtration, preservation, analysis

Particular Organic Carbon (POC) and Nitrogen (PON)

Samples were filtered through precombusted (24 hours, 450 °C) glass fibre filters (GF/F, 0.7 µm, 25 mm diameter, Whatman) and rinsed with filtered seawater. Typically for Tzero, suspended, and slow-sinking fractions, 1000 mL were typically filtered in duplicates, with 250 – 400 mL typically filtered in duplicate for the smaller tray samples. Filters were then placed into Petrislides, and dried in an oven (at least 24 hours, 40 °C) before being stored at room temperature for analysis back on land. Blanks were prepared by filtering duplicates of 1800 mL, 600 mL, and 200 mL of filtered seawater, before placing these filters into petrislides and drying as described above.

Biogenic Silica (BSi)

Samples were filtered onto polycarbonate filters (0.8 µm, 25 mm diameter, Whatman) and rinsed with filtered seawater. For each of the time-zero, suspended and slow-sinking fractions, 500 mL of sample were filtered and for the fast-sinking fraction, 100 – 150 mL was typically filtered. Filters were placed into 15 mL corning tubes, dried (at least 24 hours, 40°C) before being stored at room temperature for analysis back on land.

Particulate Inorganic Carbon (PIC)

Samples were filtered onto polycarbonate filters (0.8 µm, 25 mm diameter, Whatman) and rinsed with pH-adjusted (pH 8.5, using ammonium) MilliQ water. For each of the time-zero, suspended and slow-sinking fractions, 500 mL of sample were filtered and for the fast-sinking fraction, 100 – 150 mL was typically filtered. Filters were placed into 50 mL corning tubes, dried (at least 24 hours, 40°C) before being stored at room temperature for analysis back on land.

Total Chlorophyll

Samples were filtered onto GF/F filters (nominal pore-size 0.7 µm, 25 mm diameter, Whatman), placed into glass vials filled with 6 mL acetone (90%, HPLC), and stored at -20 °C for analysis onboard. For each of the time-zero, suspended and slow-sinking fractions, 200 mL of sample were filtered and for the fast-sinking fraction, 50 – 150 mL was typically filtered. Fluorescence was analysed on board using a Turner Designs Trilogy fluorometer calibrated with a blank and a solid standard.

Additional MSC sampling

Alongside the core MSC analyses for particulate fluxes carried out during the cruise, a number of additional analyses were carried out, outlined below.

Genomic analyses

A number of MSCs were deployed with the aim of collecting water samples for genomic analyses. The aim was to deploy a pair of MSCs to MLD+10 m and MLD+110 m, on three occasions throughout the cruise. Water was filtered) from both the top and the base (including around the tray) sections of MSC, to provide samples for genomic analyses of suspended and sinking particles respectively. Samples were filtered through polycarbonate track-etched filters (0.2 µm, (typically) 25mm diameter, Whatman) and subsequently placed in a -80C freezer. Three sets of MSC pairs were successfully deployed throughout the cruise and are visible in Table 1. Analyses marked x denote successful analyses, analyses in brackets (x) denote unsuccessful analyses or analyses of questionable quality (1: insufficient water volume (tray)

& excessive time taken to filter (top), 2 & 3: mistakenly placed in oven with POC samples instead of frozen). Frozen samples will be sent to Sandy Thomalla, South Africa, for analysis as part of the AtlantECO project.

Sinking velocity analyses

From a number of MSCs (typically Yuki deployments), a small number of aggregates and faecal pellets were picked from the tray fraction using a wide bore pipette, for the purpose of measuring their sinking velocity. Particles were kept within a temperature-controlled room (5 °C), placed on a Sedgewick-Rafter counting tray, and photographed through an ocular microscope within 24 hours (almost always, exceptions noted) of sampling. Sinking velocity measurements were conducted using a 1000 mL borosilicate glass settling column, with 2.5cm increments marked vertically down the column. The column was filled with seawater from MSC-5 (Yuki, 50 m) which had been kept in the temperature-controlled room so that temperature of the water n the column could equilibrate with the room and particles being measured. Particles were transferred to just below the surface of the water using the pipette, approximately 5cm above the first marker. Time elapsed was recorded for particles to sink three 2.5cm increments (7.5cm in total), yielding three sinking velocity measurements. Due to an overwritten file, sinking velocity data from MSCs 19, 29 and 33 was lost; however, the remaining dataset nonetheless contains measurements of sinking velocity for 84 particles (49 aggregates, 35 faecal pellets).

Taxonomic, Fv/Fm, and Polonium analyses

When sufficient water was available (typically from Yuki MSC deployments), taxonomic samples were taken from both the top (suspended fraction) and tray (fast-sinking fraction) sections of the MSC. In each case, 50 mL of seawater was transferred to a 100 mL amber glass sirop bottle, and 2.5 mL of 40% formalin added (2% formalin final dilution) to preserve samples for later analysis.

For a number of MSC deployments, subsamples of each MSC fraction were analysed for parameters pertaining to photosynthetic physiology of the phytoplankton community, namely photosynthetic energy transfer efficiency (Fv/Fm), which can provide a proxy for the overall photosynthetic “health” of the phytoplankton community. The goal of this work was to examine whether photosynthetic health differed between MSC fractions, but as an additional add-on to the core targets of MSC deployments, these measurements were often neglected in some MSC fractions and some MSC deployments with the filtration of MSC samples being prioritised. For this reason, Fv/Fm measurements were made for all MSc fractions in just 3 MSCS: MSCs where incomplete samples were taken are also illustrated in Table 1. For Polonium analyses, 1 L of MSC tray samples were fixed with 5 L of nitric acid.

MSC Yuki sampling issues

One of the goals of the MSC deployments on JC231 was to test the operation of the new MSC prototype, christened Yuki on the JC231 cruise. Compared with the older MSC, Yuki has the advantage of being far more straightforward to assemble, as well as a modified lid and closing mechanism at the bottom of the base section. These latter mechanical adjustments allow for a much more straightforward flow of water into the MSC, designed to keep turbulence to an absolute minimum, reducing disturbance to particles as water enters the MSC.

However, a few issues with the Yuki protype did become apparent throughout the cruise. One issue was the release wire tended to get washed to one side and become caught on the red clamps securing the base section of the MSC to the top. When this occurred, the lid failed to properly close, and the base failed to properly shut, resulting in failure of the MSC deployment. This issue can be rectified by holding the wire in place with a pair of cable ties attached to the metal outer frame of the MSC, which stops the wire drifting and becoming caught.

Another issue was that the upper lid of the MSC would sometimes fail to close. If not securely tightened, the upper lid has the potential firstly to come loose, preventing closure, and to rotate about the centre. Care must be taken to ensure the central pin attaching the upper lid to the central pole of the MSC release is securely tightened to prevent lid rotation and tightened in a position such that the white valve on top of the lid does not fall under the horizontal bars of the frame. This can be done by unscrewing the grey part of the lid from the metallic plate in the middle (via 6 screws, use an Allen key) and tightening the screw in the centre of the pole. The remaining plastic part of the lid can then be screwed back into the now tightened metal plate using the Allen key and 6 screws.

The final issues related to the closing mechanism of the MSC base. Easy issues to fix involve a couple of loose O-rings in the seal, which could be glued down. Another issue concerned the butterfly closure valve, which was temperamental. On a couple of occasions, the butterfly valve came loose, resulting in a rotation of the base and failure of the base to close. After this had occurred a couple of times, Yuki had begun to leak from the bottom of the tray, as a complete seal was not forming around the edge of the bottom plate. Having identified these issues with the new prototype, Yuki was retired for the last few deployments of the cruise, and a second old (Old2) MSC used in tandem with the first old (Old1) MSC.

Details of MSC deployments from JC231 cruise along with parameters sampled from each. X indicates a parameter was sampled during an MSC deployment.

Date	Station	MSC #	MSC ID	Depth (m)	Old vs Yuki Pair	Lat		Lon		Time triggered	Purpose	POC	PIC	BSi	Chl	tax	Frrf	Sinking vel.	Po	genomics	Comments	Genomics volumes: Top, Base
04/05/2022	006	1	Yuki	60	1	48	58.15	16	22.05	18:24	Fluxes	x	x	x	x	x	--	--	--	--		
04/05/2022	007	2	Old	60	1	48	58.15	16	22.05	18:47	Fluxes	x	x	x	x	--	--	--	--	--		
05/05/2022	014	3	Yuki	150	2	48	57.75	16	23.85	13:23	Fluxes	x	x	x	x	--	Tz	--	--	--	Error Y1	
05/05/2022	015	4	Old	150	2	48	57.75	16	23.85	13:51	Fluxes	x	x	x	x	--	Tz	--	--	--		
05/05/2022	017	5	Yuki	50	3	48	57.75	16	23.85	16:31	Fluxes	x	x	x	x	tray only	Tz	x	--	--		
05/05/2022	018	6	Old	50	3	48	57.75	16	23.85	16:55	Fluxes	x	x	x	x	--	Tz	--	--	--		
06/05/2022	021	7	Old	11		49	0.00	16	29.99	09:05	--	--	--	--	--	--	--	--	--	--	Error O1	
06/05/2022	022	8	Old	50		49	0.00	16	29.99	09:15	--	--	--	--	--	--	--	--	--	--	Error O2	
06/05/2022	023	9	Old	50		49	0.00	16	29.99	09:26	--	--	--	--	--	--	--	--	--	--	Error O2	
06/05/2022	024	10	Old	50	4	49	0.00	16	29.99	09:40	Genomics	x	--	--	--	--	--	--	--	(x)		(3000, NA)
06/05/2022	025	11	Yuki	50	4	49	0.00	16	29.99	09:55	Polonium	x	--	--	x	x	--	--	x	--		
06/05/2022	027	12	Old	150	5	48	59.80	16	30.29	15:32	Genomics	x	--	--	x	--	--	--	--	x		2400, 2700
06/05/2022	028	13	Yuki	150		48	59.80	16	30.29	15:57	--	--	--	--	--	--	--	--	--	--	Error Y2	
06/05/2022	029	14	Yuki	150	5	48	59.80	16	30.29	16:14	Polonium	x	--	--	x	top only	--	--	x	--		
06/05/2022	030	15	Yuki	100		48	59.79	16	30.30	18:55	Polonium	x	--	--		--	--	--	x	--		
07/05/2022	039	16	Old	50	6	49	0.00	16	30.03	13:55	Genomics	x	x	x	x	--	Tz, Top	x	--	x		1800, 1400
07/05/2022	040	17	Yuki	50		49	0.00	16	30.03	14:08	--	--	--	--	--	--	--		--	--	Error Y2	
07/05/2022	041	18	Yuki	50	6	49	0.00	16	30.00	14:19	Fluxes	x	x	x	x	x	All	x	--	--		
09/05/2022	051	19	Old	50	7	48	58.27	16	23.80	09:54	Fluxes	x	x	x	x	--	All	(x)	--	--	Error Y3	
09/05/2022	052	20	Yuki	50	7	48	58.26	16	23.80	10:08	Fluxes	x	x	x	x	x	All	--	--	--		
09/05/2022	054	21	Old	150		48	58.25	16	23.80	12:55	Fluxes	x	x	x	x	x	Tz,Top	--	--	--		
09/05/2022	055	22	Yuki	150		48	58.25	16	23.80	13:59	--	--	--	--	--	--	--	--	--	--	Error Y4	
09/05/2022	056	23	Yuki	150		48	58.25	16	23.80	14:20	--	--	--	--	--	--	--	--	--	--	Error Y4	
09/05/2022	057	24	Yuki	150		48	58.25	16	23.81	14:55	--	--	--	--	--	--	--	--	--	--	Error Y5	
09/05/2022	058	25	Yuki	150		48	58.25	16	23.81	15:20	--	--	--	--	--	--	--	--	--	--	Error Y5	
10/05/2022	063	26	Old	50	8	48	59.90	16	27.00	13:42	Genomics	x			x	--	Tz,Top,Bot	--	--	(x)		(1800, 1800)
10/05/2022	064	27	Yuki	50		48	59.89	16	27.00	14:37	--	--	--	--	--	--	--	--	--	--	Error Y6	
10/05/2022	065	28	Yuki	50	8	48	59.89	16	27.00	15:02	Polonium	x	--	--	x	x	Tz	--	x	--		
10/05/2022	067	29	Old	150		48	59.87	16	27.48	18:05	Genomics	x	--	--	x	--		(x)	--	(x)	Potential misfire	(2400, 1800)
10/05/2022	068	30	Yuki	150		48	59.87	16	27.48	18:20	--	--	--	--	--	--	--	--	--	--	Error Y7	
10/05/2022	069	31	Yuki	150		48	59.70	16	27.48	18:40	Polonium	x	--	--	x	top only	--	--	x	--	Error Y8	
12/05/2022	077	32	Old	150		49	0.00	16	30.01	08:55	Genomics	x	x	x	x	--	--	--	--	x		2120, 2000
12/05/2022	078	33	Old2	50		49	0.00	16	30.00	09:15	Genomics	x	x	x	x	--	--	(x)	--	x		2250, 1570
14/05/2022	087	34	Old2	50		48	58.42	16	28.09	15:10	Polonium	x	--	--	x	--	Tz, Top, Bo	--	x	--		
14/05/2022	088	35	Old	150		48	58.43	16	28.09	15:35	Polonium	x	--	--	x	--	--	--	x	--		
14/05/2022	090	36	Old2	50		48	58.61	16	28.09	18:34	Genomics	x	x	x	x	--	Tz,Top,Bot	--	--	x		2000, 1850
14/05/2022	091	37	Old	150		48	58.60	16	28.09	18:51	Genomics	x	x	x	x	--	--	--	--	x		2000, 2110
15/05/2022	096	38	Old	50		49	0.00	16	30.00	13:10	Particles	--	--	--	--	--	--	x	--	--	Error O2	
	Error Y1	[User erro	MSC deployed with tray lid on. Lid snapped in halves. Sample lost.											Error Y6	[Equip faili	Leak from bottom. Top lid was loose.						
	Error Y2	[Equip fail	Release wire caught around handle. Top lid did not close.											Error Y7	[Equip faili	Base plate rotated and did not close.						
	Error Y3	[Equip fail	Spacer in base came off. Could not remove tray.											Error Y8	[Equip faili	Leak from bottom plate. Half of water lost after 2 hours.						
	Error Y4	[Equip fail	Leak from bottom. O-ring was loose.																			
	Error Y5	[Equip fail	Release mechanism failed. Top lid did not close.											Error O1	[User erro	Misscommunication about sampling depth.						
														Error O2	[User erro	Leak from between top and bottom section. Insufficient pressure on the clamps.						

MSA References

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A comparison of the old and new MSC:

The purpose of the Marine Snow Catcher (MSC) is to separate sinking from non-sinking particles. The MSC is a large water bottle (2 m height) that is allowed to stand on deck in an upright position to let particle sink into the bottom section of the device. After the settling period (typically 2 hours), the top unit (containing non-sinking particles) and base unit (containing sinking particles) are separated and sampled. The MSC operation involves 4 phases:

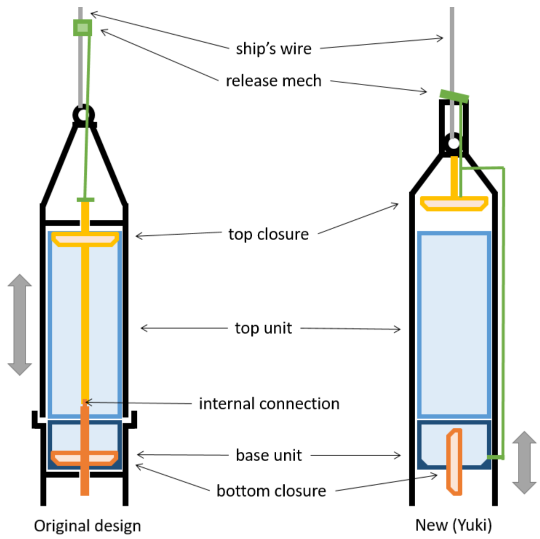
1. Assembly
2. Deployment/recovery
3. Sampling of top unit and draining
4. Disassembly and sampling of base unit

The new design of the MSC, named 'Yuki' after the Japanese word for snow or referred to as 'Mark II', is principally the same as the old version. However, the modifications (1) make Yuki more user friendly, (2) improve the safety, (3) reduce reliance on crew involvement and (4) improve scientific quality. The following sections highlight the main modifications and associated improvements.

MSC- General differences

The key differences in the two designs are:

1. The release mechanism is now integrated into the MSC frame rather than attached to the ship's wire (old design). The ship's wire now shackles directly onto the frame structure (Yuki).
2. The internal pole has been removed, making it easier to separate the top and bottom units.
3. The closure mechanism in the base unit is changed from a plunger, which had to be attached to/detached from the central pole in the top unit, to a butterfly valve entirely contained in the base unit.
4. To connect the two units, the base unit is now lifted towards the top unit by hand (Yuki), while in the old design the top unit had to be lowered onto the base unit by winch/crane (old design). Likewise, for disassembly, the base unit is now lowered by hand (Yuki) rather than the top unit lifted by winch/crane (old design).



Comparison of MSC design. Left: original design (closed state). Right: new design (opened state).

Phase 1 – assembly

Old design	**Yuki**
Personnel involved: scientist, crew	Personnel involved: scientist
Initial setup takes place while the top unit lies on deck. **Top unit has to be prevented from rolling at all time.** Plunger is attached to top unit by sliding plunger into internal pole and securing with R-pin. Central pole is then pushed into its loaded position and secured with R-pin on the top. Ship's wire is attached to MSC frame. Release mechanism is attached to the ship's wire, the release wire is attached to the mechanism, and the mechanism positioned to allow optimum tension. The exact position for the mech varies from MSC to MSC and also depends on the shackle used to attach the wire to the MSC frame. Correct set up has to be checked just before deployment, and the mech position may have to be adjusted. Now the top unit can be lifted to an upright position using the winch/crane. During this process, the bottom of the top unit has to be supported to avoid damage to the plunger. **Two people are needed for this task (heavy lifting).** Once upright, the base unit is positioned and aligned underneath the swinging top unit. **The suspended top unit has to be secured by hand at anyone time to avoid excessing swinging.** The o-ring of the bottom unit needs to be checked now for proper alignment; **care has to be taken as fingers may be positioned between top and base unit**. The top unit is then carefully lowered onto the base unit, **during**	The MSC Yuki does not require support by the crew for this step. The base unit is set up by securing the particle tray to the base plate and opening the aperture. The aperture should be opened by pulling the centre screw upwards, **negating the need to tip the base unit hence minimizing the risk of trapping fingers.** The release bar on the base unit must not be moved after this point. The base unit is then positioned underneath the top unit by sliding it along the slider. Using opposing latches, the base unit is lifted towards the top unit. Once secured, the slider is removed. The air valve in the top closure must be closed. The top closure is then opened by pulling the turnbuckle and securing the release wire onto the release arm on the base unit using a small R-pin. When opening the top closure, and when the closure is open, **care has to be taken not to place fingers/hands around the top closure as they may be accidentally trapped.** All taps need to be closed. The MSC Yuki is now ready for deployment.

which a scientist will have to put their hand through the bottom of the MSC base to guide the central pole into the correct position. For this step, the loading R-pin must be in place and two people have to secure the MSC from excessive swinging. Once in position, the top and base unit are fastened using the clamps. All taps need to be closed. Once this set up is completed, the top R-pin is pulled (putting some tension on the wire helps to remove the pin) and the MSC should be ready for deployment. (Note, the release mech may have to be adjusted if the bottom aperture is not sufficiently opened).	

Phase 2 – deployment/recovery

This phase is nearly identical for both designs.

Old design	**Yuki**
Involved personnel: crew, scientist	Involved personnel: crew, scientist
      The MSC is lowered into the water. The MSC should flood and 'sink' readily. If it does not, the release mechanism is positioned incorrectly and the plunger not opened properly. The MSC should be retrieved and set up	The wire is attached to the lifting shackle. During this step, care has to be taken not to trigger the MSC. **Care has to be taken not to place fingers/hands around the top closure as they may be accidentally trapped.** The MSC is lowered into the water.

correctly. Do not attach an additional weight to 'force' the MSC to sink.	

Veering/hauling speed can be as fast as conditions allow. When the target depth is reached, the wire is brought close to the deck and grabbed. A messenger is attached to the wire and released. The wire should be held during this period to check for correct triggering. Once the triggering has been confirmed, the MSC is retrieved and - if the deployment was successful - lashed to a secure point (e.g. railing). The wire can be disconnected from the MSC now. During deployment/ recovery, **standard safety procedures apply.** Scientists should be advised on the **dangers of holding onto the wire (e.g. risk of trapping limbs particularly in rough weather), and time spent under the live wire should be minimized.**

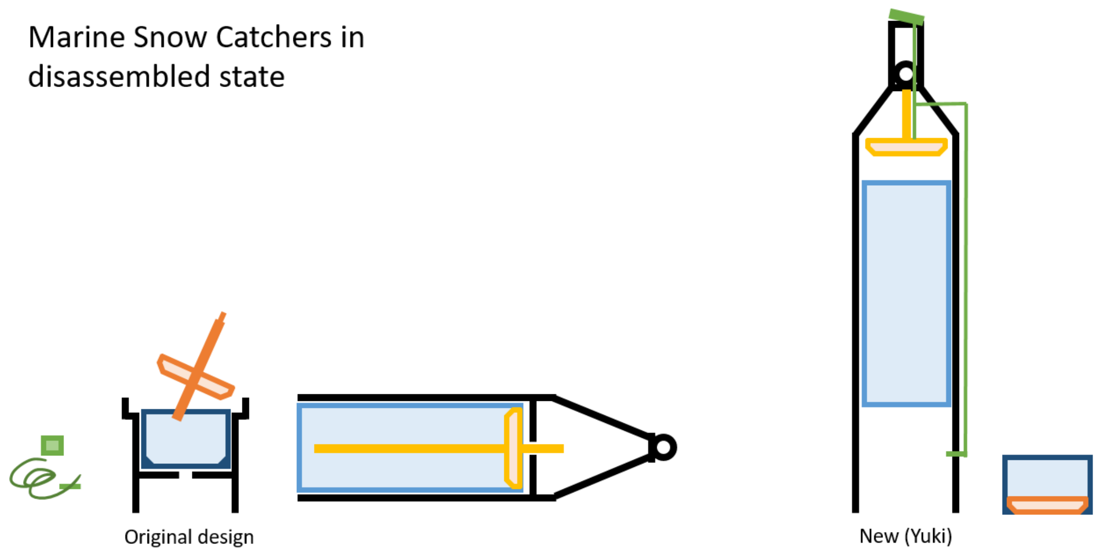
Phase 3 – sampling top unit/draining

Old design	**Yuki**
Personnel involved: scientist	Personnel involved: scientist
After the settling period (typically 2 hours), a sample is taken from the top unit, and the top unit is then drained on deck. Draining can take up to 30 min. **Attention has to be paid to other activities carried out in vicinity and associated dangers.**	After the settling period (typically 2 hours), a sample is taken from the top unit (air valve has to be opened), and the top unit is then drained on deck. Draining can take up to 30 min. **Attention has to be paid to other activities carried out in vicinity and associated dangers.**

Phase 4 – disassembly/sampling of base unit

Old design	**Yuki**
Personnel involved: scientist, crew	Personnel involved: scientist
The top unit has to be removed. Particular care has to be taken during the detachment process. A crane should be used to assist lifting. The	The slider is placed underneath the base unit. The release wire is detached from the base unit. Using opposing latches, the base unit is unlocked and then, using the second set of

ship's wire is attached to the MSC frame. **Two people are required to ensure that the top section does not swing**. The clamps are loosened. To detach the top unit from the base unit, which are still connected via the internal pole, the top unit has to be lifted by 3-5 cm and the R-pin that connects the poles inside pulled. To remove the pin, a metal hook must be used and **hands must not be inserted into the MSC**. The top section is lifted a further 3-5 cm to fully detach the inside poles, carefully tipped over and safely stored on deck. **Two people are needed for this task (heavy lifting).**	latches, lowered. The base unit is carefully removed from underneath the top unit. The water and tray within the base unit can now be sampled. **Attention has to be paid to other activities carried out in vicinity and associated dangers.**



Comparison of MSC design in disassembled state ready for storage.
Left: original design. Right: new design.

Red Camera Frame

Marika Takeuchi

We deployed the Red Camera Frame (RCF) that carries 3 imaging devices (LISST HOLO2, CPICS, UVP5), backscatter and fluorescence sensor (ECOTRIPLET3) and CTD (RBR Concerto) (Figure 1). These high-resolution imaging devices allow us to capture images of naturally occurring marine snow in the water column without destroying them. Each imaging device has different resolution and size range that can measure, hence measuring marine snow size in wide size range is difficult when only one imaging device is applied. Our main aim is developing full size spectra that can cover µm scale to cm scale by combining multiple imaging devices. We also deployed RCF both daytime and nighttime to explore the impacts of zooplankton activity such as grazing and production of faecal pellets.

LISST HOLO2 and CPICS were mounted horizontally on the frame. Imaging sensors are on the side where no frames underneath so that water go through the sample volume with little disturbance. Since the brackets for LISST HOLO2 external battery were in wrong size, we did not use LISST HOLO2 battery. ECOTRIPLET was also horizontally mounted to the frame, sensor facing to outside (Figure). UVP5 and RBR concerto were mounted vertically on the frame. Since UVP5 needs to go in the middle of the frame, fixing UVP5 first is the easiest way. Fix the position of CPICS before mounting ECOTRIPLET, otherwise it is difficult to tighten the bolts on CPICS brackets. We kept RCF on a pallet in the hangar. Deck unit for UVP5 was set at the corner of the deck lab, the small space closest to the hangar. UVP5 communication cable, power cable and CPICS communication/charging cable ran through the hole over the door and kept outside throughout the cruise.

Left: Red Camera Frame set up. UVP5 and RBR Concerto in the middle, LISST HOLO2 on the left hand side, ECOTRIPLET and CPICS are on the right hand side. Right: Deck unit setup in deck lab.

Deployment method and settings

Deployments of RCF was conducted by Romica winch wire through a block on the starboard aft crane over the starboard side for first 7 deployments. Due to the overheat of hydraulic systems on the ship, last deployment was conducted through the middle deck. To reduce turbulence created around the frame, we decided to set deployment speed at 0.5 m/s. To compare downcast and upcast, we retrieved RCF at 0.5 m/s. We sent RCF to 22 m and stopped for ~60 s then brought it back to the surface to activate UVP5 before sending RCF to target depth. Sampling rate of each instrument remained same during the cruise. UVP5 was set at 20 Hz, RBR concerto was set at 0.3 Hz and other instruments were set at 10 Hz.

Deployment details. Bold in data status indicates the profile we modified settings.

Date	Time	RCF #	Event #	Profile Depth (m)	Echo Depth (m)	Latitude		Longitude		Wind speed (knots)	Sea state	Air temp (degC)	SST (degC)	Data status				
														UVP	CPICS	LISST HOLO 2	ECO TRIPLET	RBR
04/05/2022	17:13	1	JC231-005	600	4812	48	58.14	16	22.05	6.18	2	NA	NA	Y (Down)	Y	Y	N: Corrupt	N
05/05/2022	01:40	2	JC231-010	300	4770	48	59.27	16	31.48	16.3	4	NA	NA	Y (Down)	N	Y	N: Corrupt	N
05/05/2022	14:08	3	JC231-016	600	4807	48	57.75	16	23.85	12.8	4	NA	NA	Y (Down)	N	Y	N: Corrupt	N
07/05/2022	01:23	4	JC231-034	600	4780	48	50.31	16	31.14	6.1	4	14.7	14.2	Y (D/U)	Y	Y	N: Corrupt	N
12/05/2022	09:25	5	JC231-079	600	4808	48	0	16	30.01	16.5	5	13.1	16.5	Y (D/U)	Y	Y	N: Corrupt	Y
12/05/2022	14:45	6	JC231-081	100	4809	48	57.24	16	28.66	14	4	13.1	14	Y (D/U)	Y	Y	N: Corrupt	Y
13/05/2022	12:12	7	JC231-084	100	4786	49	0.5	16	28.69	19.2	5	13.3	13.9	Y (D/U)	Y	Y	N: Corrupt	Y
14/05/2022	22:30	8	JC231-093	150	4804	48	58.74	16	27.77	21	NA	14.2	14.2	Y (D/U)	Y	Y	Y	Y

NOTES

RCF#1: Time on CPICS was incorrect (2019/09/08)

RCF#2: We did not have time to check data or change settings for next deployment after this.

RCF#3: Time on CPIC was still incorrect and no data was saved. We emailed Prof. S. Gallager for some advice.

RCF #4: Turned off upturn flag on UVP5 and set it to stop recording when it reaches 15m from surface during ascending, so that it collects data during upcast. We checked ECOTRIPLET and RBR concerto data and found that ECOTRIPLET data was corrupt and RBR did not record any data.

RCF #5: Start/ stop condition of RBR concerto was changed from twist activation to conductivity trigger (start: conductivity >10, stop conductivity <10).

No data was saved on ECOTRIPLET. CPICS data was too few for 600m measurements.

RCF #6: Corrupt data on ECOTRIPLET.

RCF #7: Changed threshold setting on CPICS to lower the image quality but increase quantity.

Intensity threshold: 0.5 (default: 2.0)

Min Area Threshold: 10 (default: 1000)

Focus Threshold: 0.2 (default: 0.4)

Corrupt data on ECOTRIPLET. Contacted Sea Bird technical support.

RCF #8: We replaced USB adaptor and communication cable for ECOTRIPLET. CPICS battery was not fully charged despite the battery charger showed fully charged status. This caused delay in deployment. Hydraulic systems on the ship overheated and deployments over Romica winch was not available. We deployed RCF from the middle deck.

*Problems we encountered with each instrument are described with solutions in instrument sections.

We assembled UVP5 and light units at the main lab and carried it to the deck to mount on the frame. It is better to assemble UVP5 and light units at the deck, as close as the frame, to avoid any risk of damaging light units.

The frame was too light and swung a lot when the ship was rolling. Deployments under bad weather was not possible due to the risk of collision to the ship. We need weights to stabilize the system.

We also need to change the bolts and nuts to dead-end on the backside of brackets. Since we need to squeeze a ratchet wrench to hold nuts to tighten the brackets, there is a potential risk of damaging UVP5 lights. Finally, we need a cover to protect UVP5 lights and entire RCF.

Instruments description

LISST HOLO2

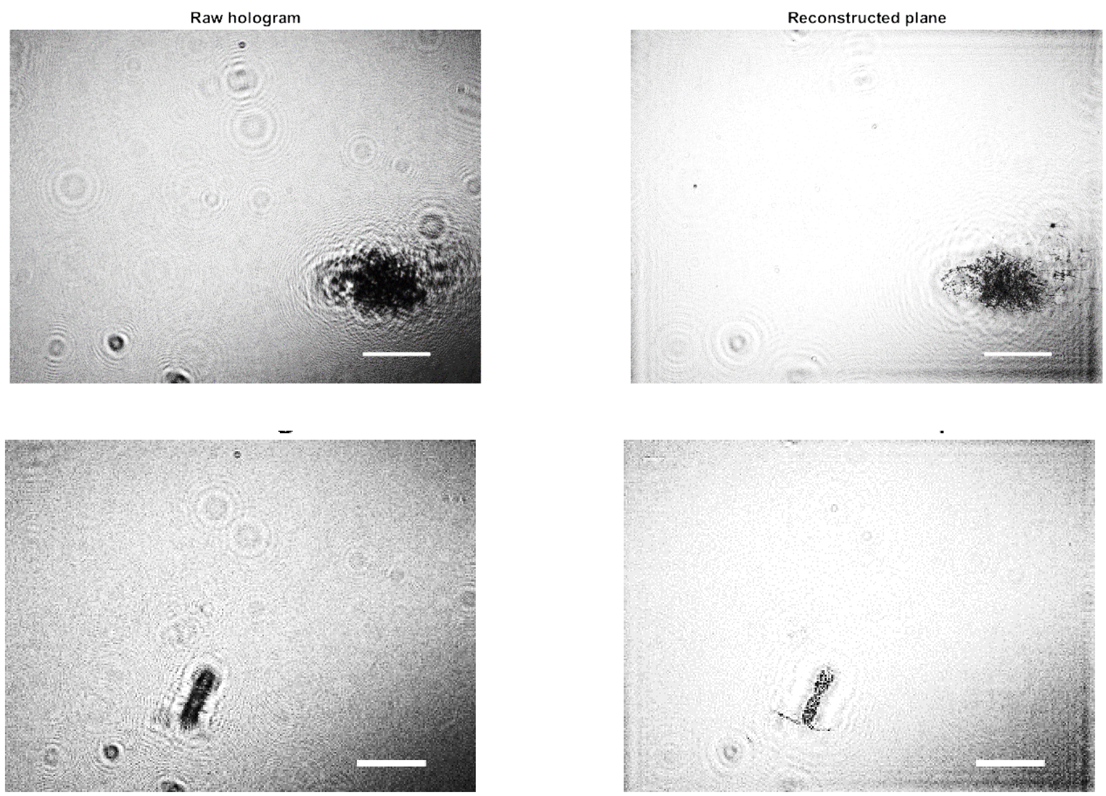
LISST HOLO2 (Sequoia Scientific, Inc.) is a standalone instrument carries internal battery that lasts up to 20 hours. Although we had external battery, the brackets were too big, and we could not mount the external battery on RCF. Holographic images of particles that go through its sample volume (1.86 cm^3, Figure) were taken at 10 Hz (maximum sampling rate) and saved in the internal memory. Each hologram is 1600 x 1200 pixel with 4.5 µm and we can resolve particles larger than 25 µm. Sampling started when LISST HOLO2 was below 5 m and sampling was manually stopped when RCF was recovered on the deck, so that images during both descending and ascending are obtained. Since we need to send RCF to 22m and bring back to the surface to activate UVP5 before sending RCF to the full target depth (600m), we decided not to use depth trigger to stop LISST HOLO2. We used the default setting for image names such as 070-0001, however, using time stamp may also be a good idea as matching with other instruments.

Data transfer and battery charge

Since deep cast deployment (600m) captured ~30,000 holograms, we transferred holograms after each deployment to clear the internal memory for next deployment. It is important to disable automatic sleep mode from tools page, otherwise, it goes to sleep mode during transferring images. LISST HOLO2 5G WiFi is much faster to transfer images, so make sure your laptop is connected to 5 G band. We also charged battery when it was as low as 14 V. It only required charging twice throughout the cruise. The LED indicator on battery to show charging status is very confusing. The colour looks like yellow is orange and the one looks like orange is red. If you are not sure, look at the indicator through camera on your phone. You will see red and green alternatively flashing when LED indicator is showing “orange”.

Reconstruction

We digitally reconstructed holograms using holopy, python-based tool developed by Manoharan Lab at Harvard University. Depth data was also extracted from metadata using python. Focus quality depends on the number of slices you are dividing the sample volume into. The example image used only 51 slices. It is recommended to check depth after deployment and reconstruct a few holograms.

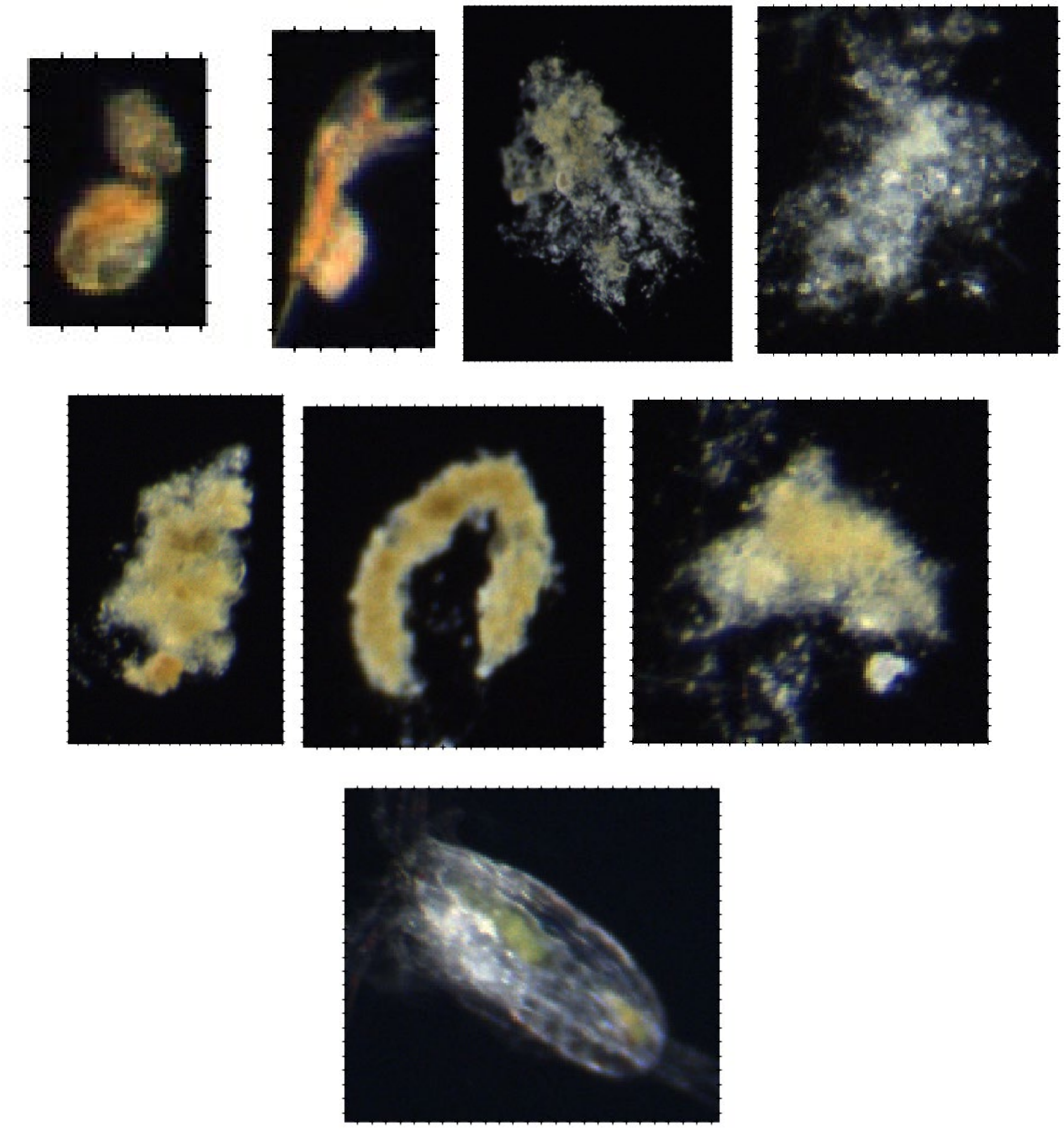


Examples of raw holograms (on left) and reconstructed image (on right). White bar in right corner indicates 1mm.

CPICS

Continuous Plankton Imaging and Classification (Coastal Ocean Vision) continuously record images in the sample volume (330 mm^3 with filed view of 15 x 11 mm). It automatically detects particles in focus, crop the in-focus particles (region of interest, ROI) and save the cropped images. Saving full frames is available, however, it will consume memories a lot and we decided to save only ROIs. Start and end of recording was controlled by CPICS viewer that requires communication between CPICS and laptop via ethernet cable, thereby recording starts and ends on deck.

Initially, threshold to detect particles were set at high and it only picked up particles clearly in focus and discarded blur and dark images. Hence there were only 1000 ROIs were detected for 600 m deployment. We changed setting to lower threshold (details are described in deployments section), so blur and dark particles are still saved. Number of ROIs increased to 900 for 100 m deployment. Although the image quality becomes poorer, it still gives sufficient information to us such as colour, shape and size.



Examples images from CPICS. Ticks indicates 50 µm.

Data transfer and battery

Data transfer is done via Ethernet connection. Once RCF is recovered and secured on the deck, plug 13 pins Ethernet cable to battery pack to communicate with CPICS. Open CPICS viewer to stop the software, then transfer ROIs using WinSCP.

Batteries should last up to 6 hours and full charge will only take up to 4 hours. We charged the battery after every deployment, however, it turned out there was a connection issue with battery charger and battery was not charged (details in following problems section).

Problems and solutions

We encountered multiple issues with CPICS during the cruise. Firstly, the time in CPICS was not correct for the first deployment, therefore ROIs were saved under wrong directory. New setting was erased from the CPICS once we disconnect CPICS from the battery and time went back to September 8th 2019. Second and third deployment showed same issue and ROIs were not even saved. According to Prof. S. Gallager of WHOI, this may be because the battery inside CPICs to run the software is too low and we may need a replacement. The solution to this problem is communicate with CPICS before every deployment and set the time and start software from CPICS viewer. Once you set time and start software, do not disconnect battery from CPICS but disconnect communication cable, plug the dummy, then deploy.

Secondly, we encountered issues with battery charging. Sleeves of banana plugs were slightly loose, and pin was not pushed in all the way to the end. The display on battery charger showed charging status but it was weaker than expected – I assumed this is because battery is not low in voltage, and it does not require fast charging. After half an hour or less, the battery charger beeped and showed "fully charged" on the display and CPICS viewer showed 12-13 V as battery status. However, the battery voltage was as low as 8V when we checked voltage using current meter. Due to this issue, we could not operate 8th deployment as scheduled. Battery status on charger and CPICS viewer can show false status, so it is important to check the battery voltage using current meter. Also, we must make sure banana plugs are not loose!

Thirdly, the CPICS uses the battery even when the software is stopped. After the deployment and transferring ROIs, we need to remember to power off CPICS and disconnect battery from CPICS.

UVP5

Underwater Video Profiler 5 (UVP5, Hydroptics), pressure rated to 3000m, continuously record images in the sample volume (field view of 22 x 18 cm). All images are recorded in the internal memory that can store up to 100 profiles. Fully charged internal battery lasts up to 7 hours with recording mode. The system automatically detects particles in focus, crop the in-focus particles (vignettes) and save the vignettes. We modified data acquisition setting after 3rd deployment as described in deployment section, but other setting remained as default.

Problems and solutions

Throughout the cruise, we did not experience major operation issues with UVP5.

ECOTRIPLET3

The 1000-m rated standalone Wetlabs Environmental Characterization Optics (ECO) Triplet Fluorometer and Backscattering Sensor measures backscatter at 2 wavelengths (532nm and 700 nm) and chlorophyll fluorescence. This instrument does not have a pressure sensor, so it relies on the time variable that is then matched to the RBR). During both deployment types, the instrument is attached horizontally, facing the outside.

We checked the data after 3rd deployments and found that data was corrupt. We erased memory, reset all setting, tested at lab and data looked fine. However, no data was recorded for the 4th deployment which could be human error as I may have forgot to turn logging on. We still had corrupt data after 5th deployment. We contacted technical support at Sea Bird and their suggestion was replacing USB adaptor and communication cable because it is likely a communication issue. They also suggested erasing memory. For the 8th deployment, we replaced USB adaptor and communication cable. We also erased memory and set all parameters just before the deployment. Data collection was finally successful! We need to replace USB adaptor and communication cable to new ones for next cruise. Since we lose a lot of deployments if the communication failure causes corrupt data, I personally recommend downloading data after every deployment.

RBR

RBR failed activation when we tested at the lab during the preparation time. This was because activation pin on RBR (Figure) was in the wrong position. We fixed this problem by rotating exterior, so that the activation pin on RBR touches the pin on the end cap when we screw the end cap in.

We checked the data after 3rd deployments and found that no data was recorded. We checked the sensors by connecting RBR to laptop and monitoring the variables. We did not observe any issues with sensors as temperature, fluorescence and turbidity responded to any change. We disconnected RBR and tested recording data same way as field measurements. Although RBR vibrates and indicates start and end of recording, it still failed recording data. We then tested conductivity trigger to start and end recording data, and it successfully recorded data. Since activation pin was in wrong position in the beginning, it may have caused some issues in twist activation. We decided to use conductivity trigger instead of twist activation for rest of deployments. Conductivity trigger may be a better setting than twist activation because it does not record unnecessary data on the deck.

16. Benthic systems and sampling

Brian Bett, Alice Carter-Champion, Christopher Fletcher, Emma J. Curtis, Olmo Miguez-Salas, Raphaela Gracie, Christopher Feltham

The benthic group aboard *RRS James Cook* cruise 231 aimed to continue time-series observations of the benthos and seafloor of the Porcupine Abyssal Plain Sustained Observatory site, originally initiated in 1985. Standard objectives for the 2022 cruise included: (i) a replicated set of seabed samples collected by Megacore from the PAP central location for macrobenthos studies, (ii) duplicate otter trawl samples for megabenthos studies; and (iii) duplicate amphipod trap sample sets. Note that no seafloor photographic surveys were planned for this cruise, and that it is hoped that that work will be undertaken by *RRS James Cook* cruise 237 later in the year (August / September). In addition, cruise JC231 hosted the Climate Linked Atlantic Sector Science early career researcher fellowship of Dr Olmo Miguez-Salas, Humboldt Fellow, Division of Marine Zoology, Senckenberg Research Institute, Frankfurt, in undertaking a study of seafloor bioturbation (see separate section below).

Overall, benthic operations were very successful, and largely achieved all objectives, we only fell short by one amphipod trap sample set as a result of the loss of the mooring at the seafloor.

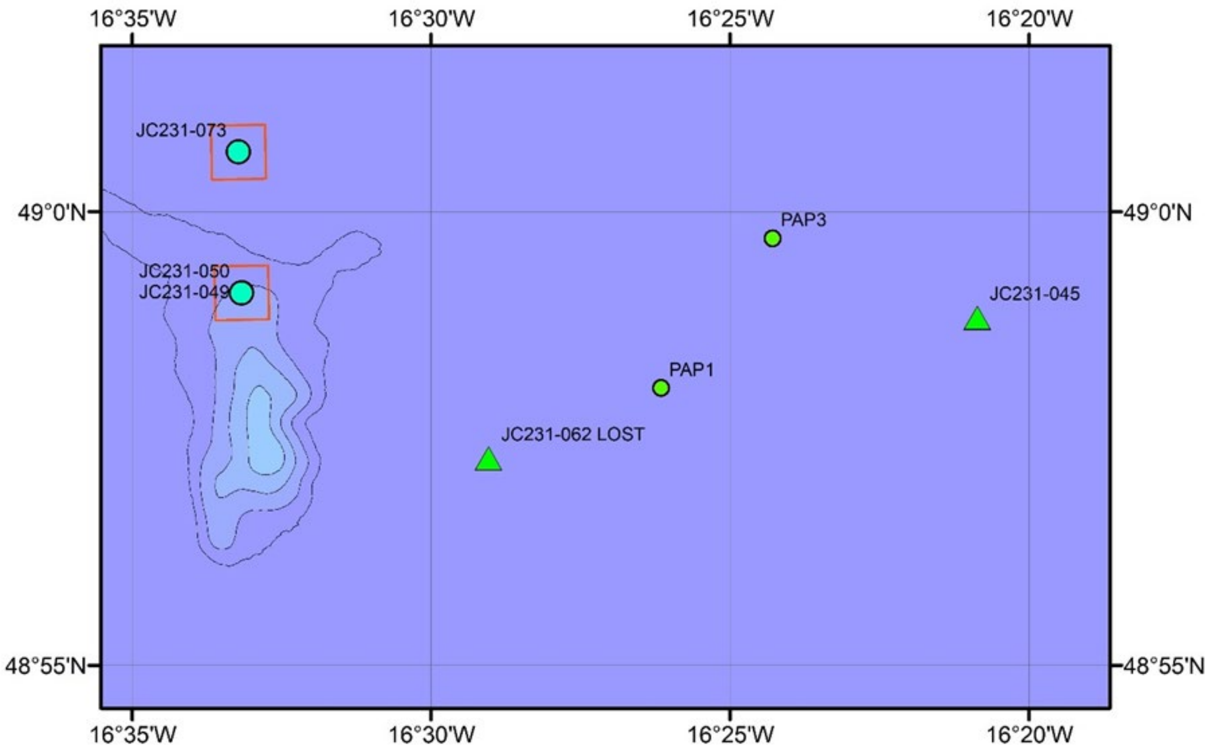
a. Moorings

Only the “Amphipod trap” (ATRAPx) was operated this year – it is hoped that a new “Bathysnap” time-lapse camera system, being trialled later this year (DY152), will be available next year. The OBG upgraded DEMAR amphipod trap (carrying four double parlour acrylic traps) was deployed in conventional manner with an additional ‘blue barrel’ trap added at about 15 mab on the mooring. The parlour traps were each baited with a ‘standard British mackerel’ and the barrel trap with two mackerel. The mooring was of the conventional form: lazy float – 15 m polyprop – Billings dan buoy – 15 m polyprop – 10 m braid - 6-ball main buoyancy pack – 50 + 10 m braid – IXSEA Oceano 2500 B2S type release. Mooring descent rate was estimated at c. 60 m min^{-1}, and ascent rate at c. 40 m min^{-1}. Summary tabulation for single successful deployment:

Station	Start time		End time		Depth (m)	Soak time
JC231-045	08/05/2022	08:12	09/05/2022	06:34	4845	22 hours

The amphipod trap mooring was redeployed as Stn JC231-061 but was released in error when attempting to range for descent speed, and successfully recovered shortly after. The mooring was reset and redeployed as Stn JC231-062 but failed to rise when release was attempted the following day. Further attempts were made later in the day and subsequently to no avail, and the mooring is considered lost at the seabed (though note, the release command was received and executed, consequently the mooring could rise at any time).

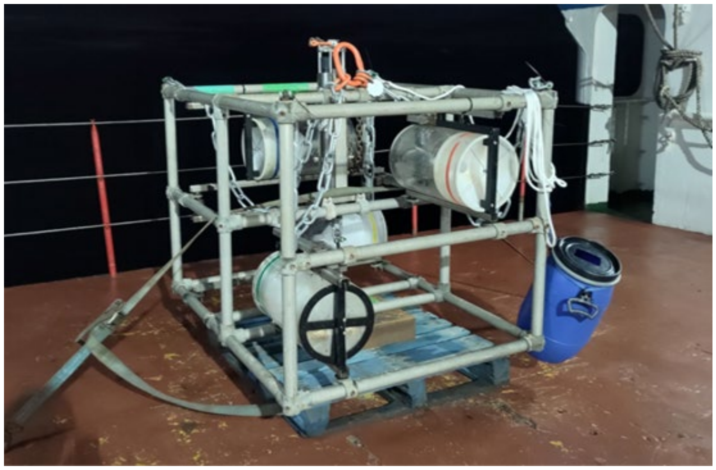
Lost mooring - Amphipod trap
Position: 48° 57.279´ N 016° 29.036´ W
Sounding: 4850 m



Amphipod trap deployments.

Sample processing: Top, bottom, and barrel trap specimens were processed and preserved separately. Amphipods were removed from the traps by washing the traps through with seawater and collecting the amphipods on a 250 µm sieve. The top traps had a low number of amphipods, while the bottom and barrel traps had moderate numbers of amphipods in them. Bait fish were rinsed and examined for any additional amphipods before being discarded.

From the barrel trap, large *Eurythenes* specimens were selected and sorted into 'red' or 'pink' colour morphs and stored in 95% ethanol in separate 1500 ml UN bottles. The rest of the barrel catch was stored in another 1500 ml collection bottle with ethanol. The top trap amphipods and bottom trap amphipods were stored in separate 1500 ml collection bottles. All bottles were kept in the 5 °C temperature-controlled lab.



Amphipod trap set up prior to deployment at station JC231-045.

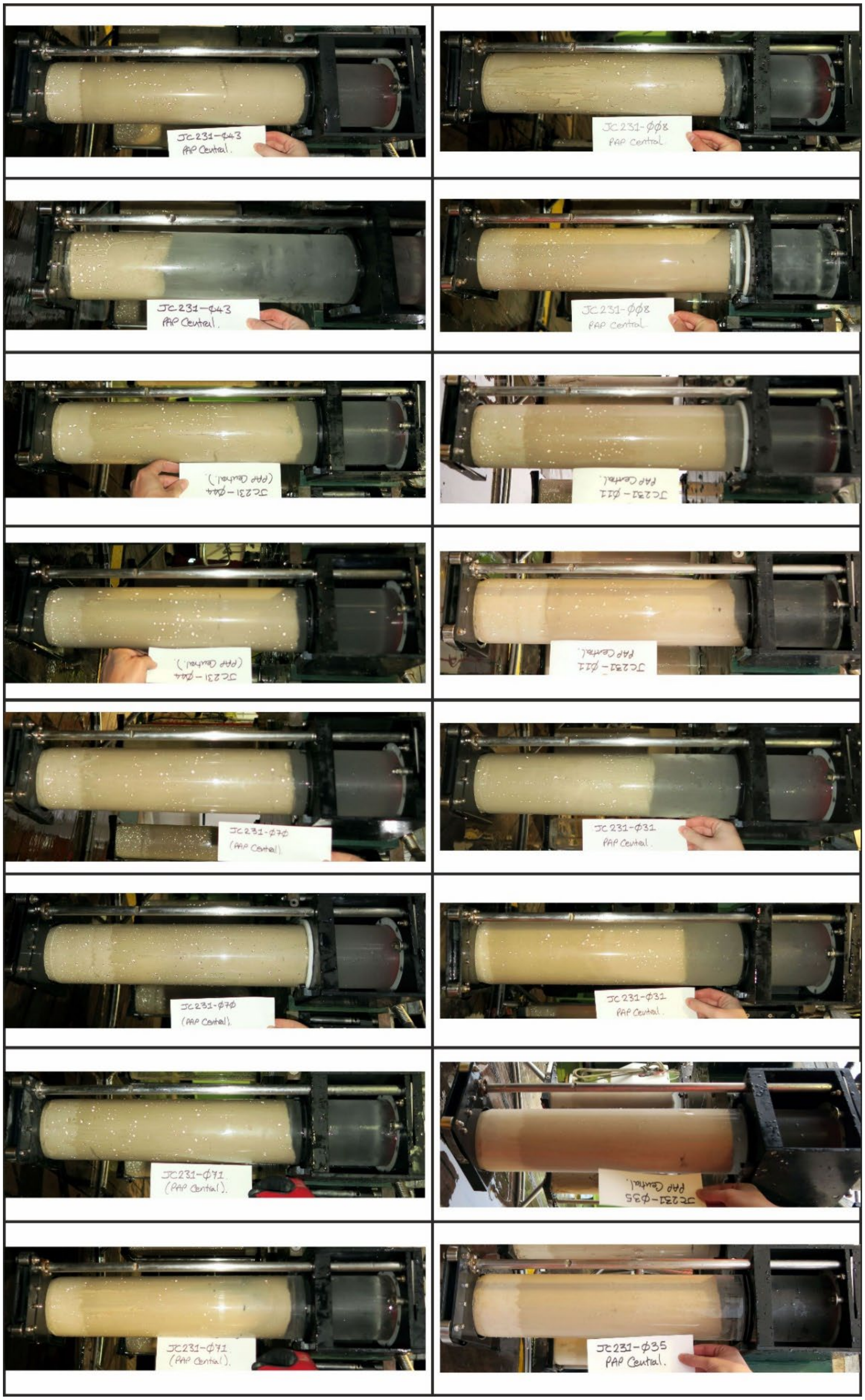
Example photograph of the JC231-045 barrel trap catch.

b. Wire deployments

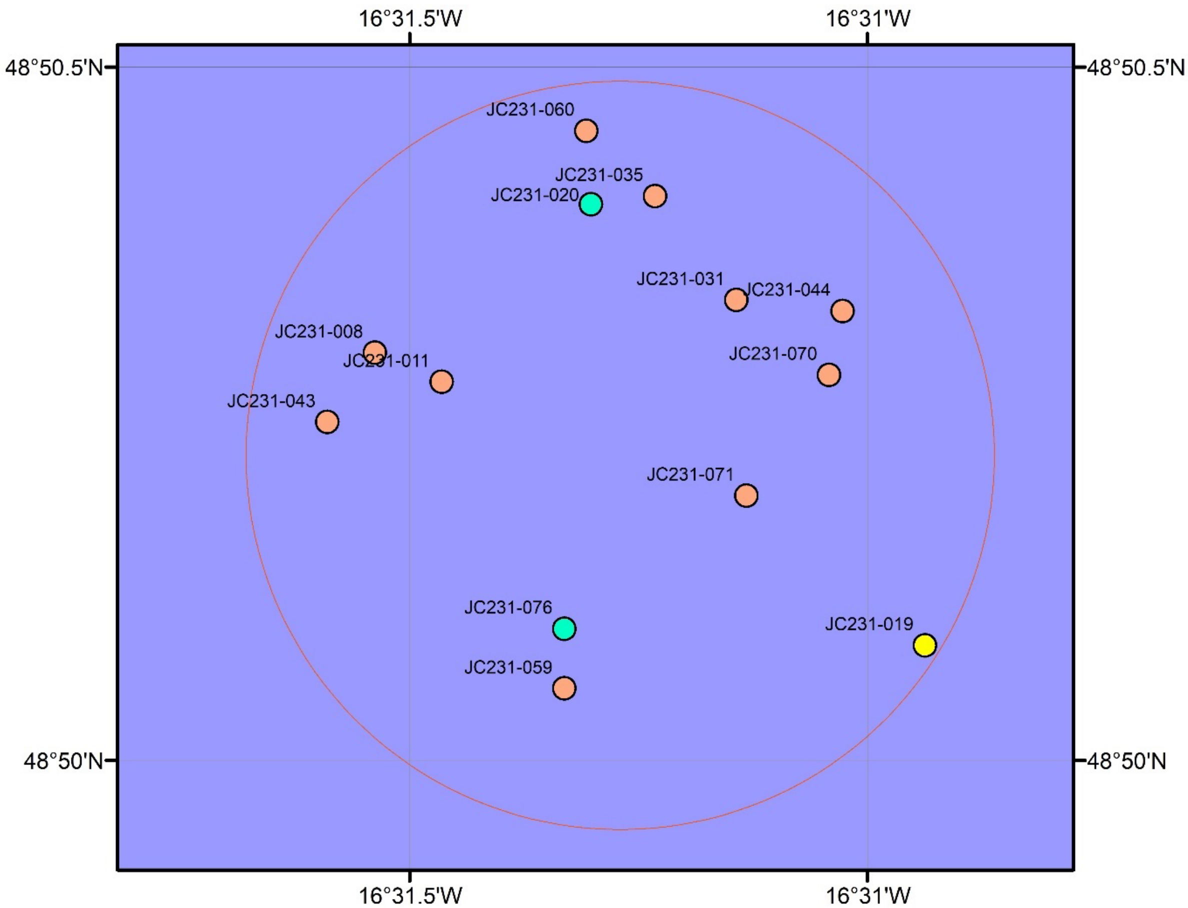
Megacore

Coring operations at the PAP Central site were based on randomly selected points (ArcMAP 10.8 native function) within a 500 m radius buffer (geodesic; ArcMAP 10.8 native function) of the nominal centre of the "central coring area", 48° 50.22′ N 016° 31.27′ W. The NMF Megacore was rigged (three extra layers of lead plate) and operated in conventional fashion. Monitoring was successfully achieved via a Sonardyne USBL beacon mounted directly on the frame. Uniformly eight "large" (100 mm ID) coring units were deployed throughout, as identified in the Station List in the conventional manner (MgC08). General performance is noted in the following table:

Station	Pull out tension (T)	Return	Typical length (cm)*	Samples retained
JC231-008	5.2	8/8 good	43	8 × 5 cm MAC
JC231-011	5.2	8/8 good	42	8 × 5 cm MAC
JC231-031	5.0	7/8 good	33	4 × 5 cm, 3 × 10 cm MAC
JC231-035	5.2	7/8 good	41	7 × 5 cm MAC
JC231-043	5.1	8/8 good	16	8 × 5 cm MAC
JC231-044	5.4	8/8 good	42	8 × 5 cm MAC
JC231-059	5.4**	2/8 fair	25	1 × 5 cm, 1 × 10 cm MAC
JC231-060	5.5**	2/8 good	20	1 × 5 cm, 1 × 10 cm MAC
JC231-070	5.3	7/8 good	43	7 × 5 cm MAC
JC231-071	5.3	7/8 good	41	7 × 5 cm MAC
* representative length of successful large cores				
** on the swell				



Example core profile photographs from all Megacore deployments in the PAP Central area.



Megacore stations in the 'PAP Central' coring area (orange), also shown gravity core (green) and box core (yellow) station.

Megacore processing: Once recovered, cores were examined for disturbances, burrows or cracks in the core and top water clarity. Several failed or highly disturbed cores were observed and excluded, particularly during poor weather conditions. The length of core sediment retention was measured, and example cores photographed. Cores were removed from the Megacore and a plunger was used to remove the sediment sample for the core tube. Slicing rings and slicing plates were used to measure and cut the top 0 – 5.0 cm section.

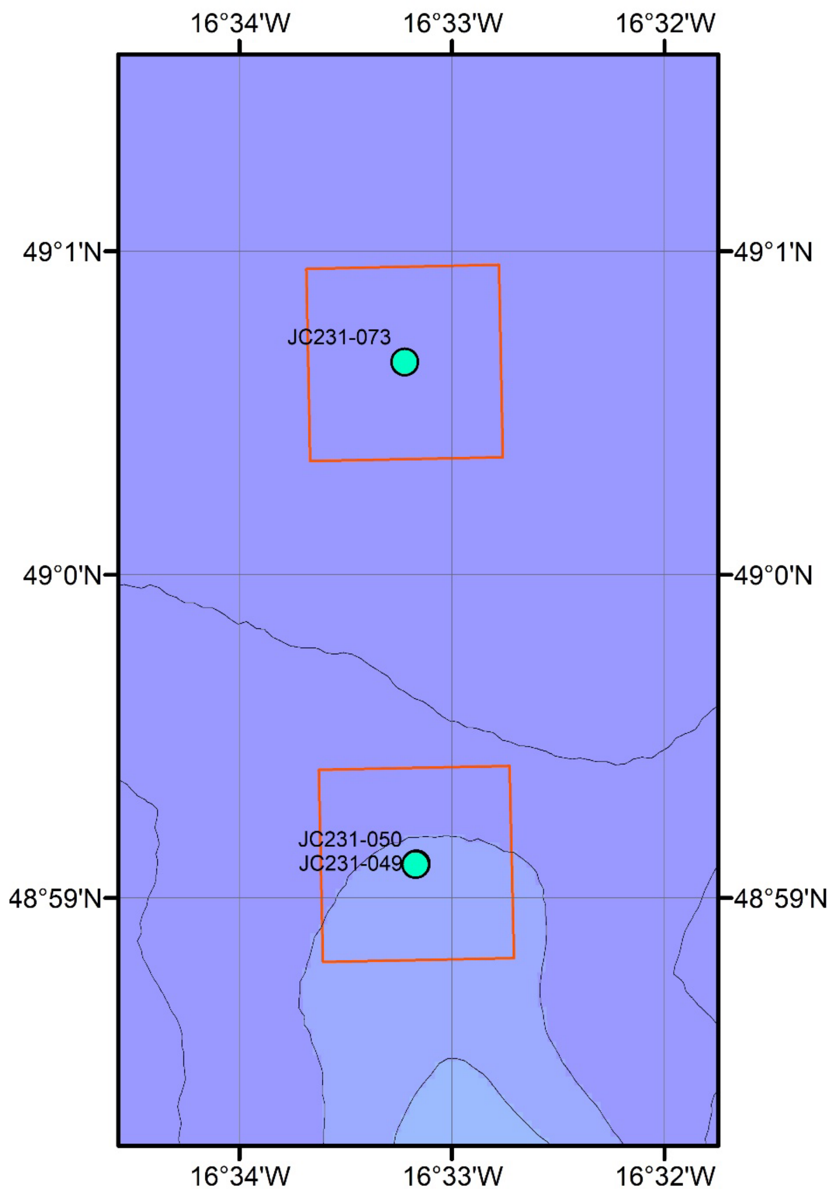
Samples from two core tubes were placed in 5 L white buckets which were labelled with the station number (JC231-XXX) on both the side and lid. Buckets containing only one 5.0 cm core sample were labelled 1 x 5 cm. A paper label with the station number, gear, date and depth was included in each bucket. Samples were preserved in 4% borax buffered formaldehyde made up with seawater, by adding 8% borax buffered formaldehyde to the sample at a ratio of 50:50.

Where core sediment retention was so low that it was not viable to successfully remove a 0 – 5.0 cm section intact, the sample was measured and then placed in a 5 L bucket and the length of the core recorded, usually approximately 10.0 cm. Top water was drained and passed through a 250 μm sieve and placed in the same 5 L bucket. These buckets were labelled with the length of core successfully sampled.

Equipment used: Equipment used for processing the Megacore samples included: large bucket to fit plunger, plunger, slicing rings marked at 5.0 cm, slicing plates, wash bottles, permanent marker and 2B pencils, paper labels, 5 L plastic buckets.

Box core and gravity core

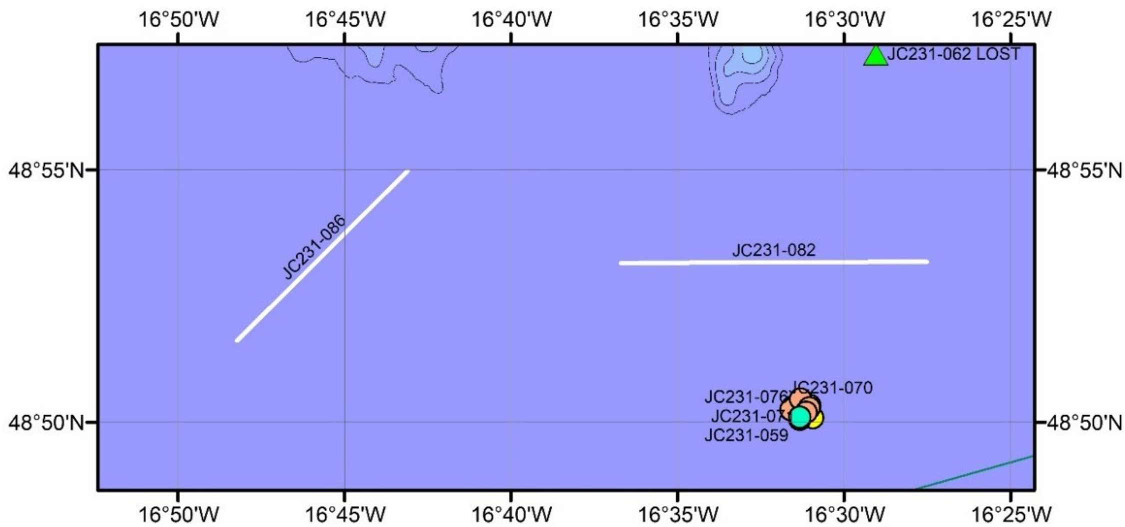
A NOC NMF supplied USNEL Mk II-type spade box core (BC), rigged and operated in conventional fashion was used for two deployments (JC231-019 at 'PAP Central'; JC231-049 at 'AESA hill'), returning a good core in both cases. A NOC NMF supplied gravity core (GC), rigged, and operated in conventional fashion was used for four deployments (JC231-020 'PAP central'; JC231-050 'AESA hill'; JC231-073 'AESA north plain'; JC231-076 'PAP central'), using a 3 m barrel, returning useful samples in all cases. Note that cores JC231-020 and JC231-073 over-penetrated, i.e., sampled to greater than 3 m. Further detail of this material is given in the bioturbation section below.



Box core and gravity core deployments in the 'AESA hill' and 'AESA north plain' areas (red outlines).

Otter trawl

The NMF-supplied OTSB14 (semi-balloon otter trawl, 14 m headrope) was rigged and fished in conventional fashion. Note, as per DY077 and JC165, this net appears to be a slight variant on the original pattern, having a different codend closure (no sewn in rings) and lazy decky attachment (strangling rings, not sewn in netting strop). No particular problems were encountered during launch, fishing, or recovery phases of the operations. Two trawls were successfully completed (JC231-082, JC231-086).



Approximate seabed tracks fished by the two otter trawls.

Trawl sample processing: Trawl catches were recovered to deck and spilled into boxes. Specimens that were not initially removed from the net (larger grenadiers, general megabenthos and fish) were recovered and added to the catch. The catch was transferred onto the sieving table for washing and sorting into broad taxonomic groups. Clinker, glass, and other debris were removed from the catch. Crustaceans (except for Malacostraca, which were accidentally preserved in formaldehyde), ophiuroids and asteroids were preserved in 95% ethanol, whilst the rest of the catch was preserved in 4% borax-buffered formaldehyde. Phyla were preserved separately when possible but remaining specimens at the end of the trawl processing were preserved together in 4% borax-buffered formaldehyde.

The holothurians *Psychropotes longicauda, Oneirophanta mutabilis*, *Amperima* sp., *Molpadiodemas villosus* and *Pseudostichopus aemulatus* (sorted together), actinarians and the asteroid *Hyphalaster inermis* were the most abundant megabenthos in both trawls. Specimens and other items of note from the trawls include the following:

- One specimen of umbrella octopus belonging to the family Opisthoteuthidae found in each trawl and preserved in 4% borax-buffered formaldehyde.
- One large red *Eurythenes* spp. specimen found in each trawl which were preserved in 95% ethanol with their colour recorded on the collection bottles.
- A lizardfish from JC231-082 which was preserved in 4% borax-buffered formaldehyde.
- Several macrourids (grenadiers) from both trawls and two fish belonging to the class Actinopteri from JC231-086 that were too large to preserve.
- Some mid-water fish and invertebrates that were mostly discarded unless they were taken for genetic sampling.
- *Umbellula monocephalus,* juvenile and adult specimen both found in JC231-086 and preserved in 4% borax-buffered formaldehyde. The adult specimen's stalk needed to be broken to be preserved.
- Two glass bottles made before mass-manufacturing recovered intact from JC231-082, and a newer (mass-manufactured) glass bottle from JC231-086.

Example images from trawls JC231-082 and JC231-086. Select specimen photos taken by Chris Fletcher for the Darwin Tree of Life Project.

Length-weight relationship measurements (Emma J. Curtis).

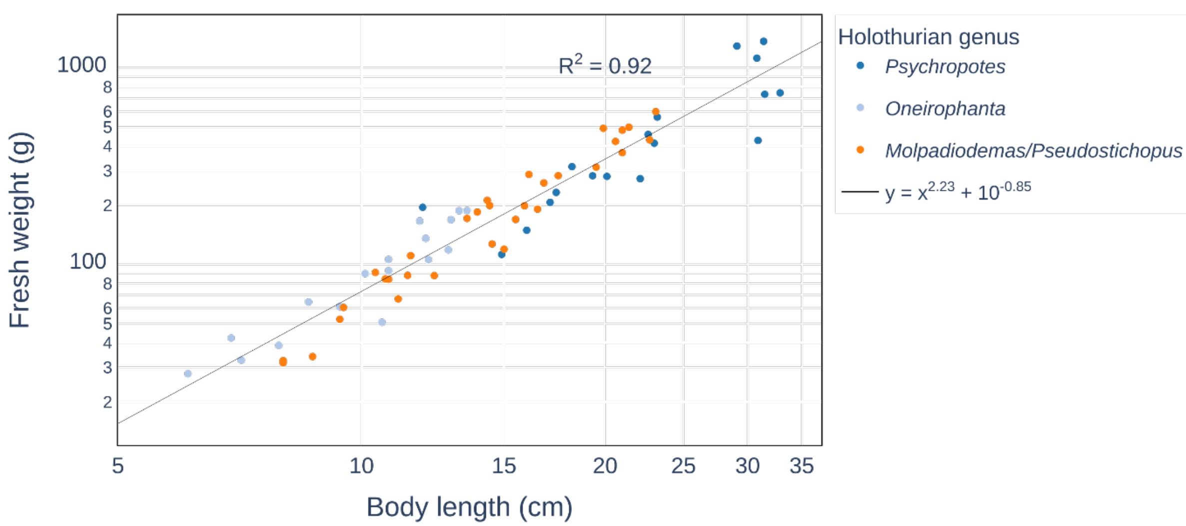
A total of 67 holothurians were selected over the two trawls (30 from JC231-082, 37 from JC231-086) for length-weight relationship measurements. Replicates of size classes for *P. longicauda* (S, M, L), *O. mutabilis* (S, M, L), *M. villosus* and *P. aemulatus* (selected together, S/M, L) were chosen, patted semi-dry with paper towel and the body length (without tail for *P. longicauda*) and fresh weight of each specimen was recorded. Specimens were given a unique name (EJC_XX) and bagged separately before being preserved in 4% borax-buffered formaldehyde with the rest of the trawl catch. Due to *P. longicauda*'s large size and tails, it was difficult to measure their weight on the scales from the first trawl (JC231-082). For the second trawl (JC231-086), *P. longicauda* were weighed in a bucket for ease of measuring.

Table of holothurian length-weight relationship measurements from JC231-062 and JC231-068 trawls.

Station	Species	Specimen ID	Body length (cm)	Fresh weight (g)
JC231-082	Psychropotes longicauda	EJC_01	22.6	458
JC231-082	Psychropotes longicauda	EJC_02	32.9	745.5
JC231-082	Psychropotes longicauda	EJC_03	30.8	1119
JC231-082	Psychropotes longicauda	EJC_04	31.5	733

JC231-082	Psychropotes longicauda	EJC_05	18.2	314.2
JC231-082	Psychropotes longicauda	EJC_06	22.1	273
JC231-082	Psychropotes longicauda	EJC_07	17.4	232.4
JC231-082	Oneirophanta mutabilis	EJC_08	13.2	187.4
JC231-082	Oneirophanta mutabilis	EJC_09	13.5	188
JC231-082	Oneirophanta mutabilis	EJC_10	12	135.6
JC231-082	Oneirophanta mutabilis	EJC_11	11.8	166.6
JC231-082	Oneirophanta mutabilis	EJC_12	10.1	89.8
JC231-082	Oneirophanta mutabilis	EJC_13	9.4	61
JC231-082	Oneirophanta mutabilis	EJC_14	8.6	64.4
JC231-082	Oneirophanta mutabilis	EJC_15	7.9	38.8
JC231-082	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_16	20.6	422
JC231-082	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_17	21	481.8
JC231-082	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_18	22.7	430
JC231-082	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_19	21	370.2
JC231-082	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_20	19.5	312
JC231-082	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_21	15.5	169.4
JC231-082	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_22	16.8	259.6
JC231-082	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_23	16.5	191
JC231-082	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_24	14.5	127
JC231-082	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_25	15	119.6
JC231-082	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_26	10.7	84.4
JC231-082	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_27	11.4	88
JC231-082	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_28	11.5	110.8
JC231-082	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_29	10.8	84
JC231-082	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_30	9.4	52.6
JC231-086	Psychropotes longicauda	EJC_31	29.1	1289.5
JC231-086	Psychropotes longicauda	EJC_32	31.4	1363
JC231-086	Psychropotes longicauda	EJC_33	30.9	427
JC231-086	Psychropotes longicauda	EJC_34	23.2	561.4
JC231-086	Psychropotes longicauda	EJC_35	23	413
JC231-086	Psychropotes longicauda	EJC_36	20.1	280.2
JC231-086	Psychropotes longicauda	EJC_37	17.1	206.8
JC231-086	Psychropotes longicauda	EJC_38	16	149.2
JC231-086	Psychropotes longicauda	EJC_39	14.9	112.4
JC231-086	Psychropotes longicauda	EJC_40	19.3	282.4
JC231-086	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_41	23.1	598.4
JC231-086	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_42	19.9	492
JC231-086	Psychropotes longicauda	EJC_43	11.9	195.2
JC231-086	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_44	21.4	498.8
JC231-086	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_45	17.5	282.8
JC231-086	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_46	13.5	171.4
JC231-086	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_47	14.4	199.4

JC231-086	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_48	16.1	287
JC231-086	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_49	15.9	198.6
JC231-086	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_50	14.3	211.8
JC231-086	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_51	13.9	184.8
JC231-086	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_52	12.3	87.8
JC231-086	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_53	10.4	91
JC231-086	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_54	11.1	66.8
JC231-086	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_55	9.5	60.4
JC231-086	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_56	8.7	34
JC231-086	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_57	8	31.6
JC231-086	Molpadiodemas villosus / Pseudostichopus aemulatus	EJC_58	8	32.4
JC231-086	Oneirophanta mutabilis	EJC_59	12.1	105.8
JC231-086	Oneirophanta mutabilis	EJC_60	12.9	168.8
JC231-086	Oneirophanta mutabilis	EJC_61	12.8	118.6
JC231-086	Oneirophanta mutabilis	EJC_62	10.8	106
JC231-086	Oneirophanta mutabilis	EJC_63	10.8	92.8
JC231-086	Oneirophanta mutabilis	EJC_64	10.6	50.8
JC231-086	Oneirophanta mutabilis	EJC_65	6.9	42.2
JC231-086	Oneirophanta mutabilis	EJC_66	6.1	27.8
JC231-086	Oneirophanta mutabilis	EJC_67	7.1	32.6



Plotted fresh length-weight relationship of measured holothurian specimens collected from JC231 trawls. Both axes logged and line of best fit for all genera.

c. **Tissue sampling** (Christopher Fletcher).

As part of the Darwin Tree of Life Project to genome sequence all eukaryotic life from around the British Isles, 260 tissue samples were taken from 69 selected faunal specimens, covering 45 putative species (see table below).

Specimens were mainly collected from trawls but also from amphipod traps, 'leftover' box core sediment and mooring hardware. Each specimen was given a preliminary identification, photographed, and dissected to remove tissue samples. Part of the tissue sample from each specimen was placed into a plate well with 100 µl Voucher of 95% ethanol for DNA barcoding, with the rest of the sampled tissue placed into 0.7 ml cryovials and preserved at -85°C (with no fixative) for whole genome sequencing. The remainder of the specimen (voucher) was then preserved in appropriate fixative solution and will be taken to the NOC for further identification and stored in the *Discovery Collections*. DNA barcoding and Whole Genome Sequencing will take place at the Natural History Museum, London and the Sanger Institute, Cambridge respectively.

List of specimens and tissues sampled by CF (NHM) for molecular analysis.

Label ID	**NHM ID**	**Class**	**Preliminary Identification**	**Tissue Sampled**
DY130-038-001	NHMUK014453668	Thecostraca	*Lepas anatifera*	Feeding legs
DY130-038-002	NHMUK014453669	Thecostraca	*Lepas anatifera*	Feeding legs
JC231-045-001	NHMUK014453672	Malacostraca	*Eurythenes* sp.	Pleopods
JC231-045-002	NHMUK014453673	Malacostraca	*Eurythenes* sp.	Pleopods
JC231-045-003	NHMUK014453674	Malacostraca	*Eurythenes* sp.	Pleopods
JC231-045-004	NHMUK014453676	Malacostraca	*Eurythenes* sp.	Pleopods
JC231-045-005	NHMUK014453677	Malacostraca	*Eurythenes* sp.	Pleopods
JC231-045-006	NHMUK014453678	Malacostraca	*Paralicella caperesca*	Pleopods
JC231-045-007	NHMUK014453679	Malacostraca	*Paralicella caperesca*	Pleopods
JC231-045-008	NHMUK014453680	Malacostraca	*Paralicella caperesca*	Pleopods
JC231-045-009	NHMUK014453681	Malacostraca	Lysianassoidea	Pleopods
JC231-045-010	NHMUK014453682	Malacostraca	Lysianassoidea	Pleopods
JC231-049-001	NHMUK014453671	n/a	Golfingiidae	Muscle
JC231-082-001	NHMUK014453683	Cephalopoda	*Grimpoteuthis* sp.	Arm
JC231-082-002	NHMUK014453684	Malacostraca	*Munidopsis crassa*	Muscle
JC231-082-003	NHMUK014453685	Malacostraca	*Willemoesia leptodactyla*	Pleopods
JC231-082-004	NHMUK014453686	Pycnogonida	*Colossendeis* sp.	Leg
JC231-082-005	NHMUK014453687	Malacostraca	Amphipoda sp.1	Pleopods
JC231-082-006	NHMUK014453688	Malacostraca	Amphipoda sp.2	Pleopods
JC231-082-007	NHMUK014453689	Malacostraca	Decapoda sp. 1	Pleopods
JC231-082-008	NHMUK014453690	Malacostraca	Decapoda sp. 2	Pleopods
JC231-082-009	NHMUK014453691	Asteroidea	*Hyphalaster inermis*	Arm
JC231-082-010	NHMUK014453692	Asteroidea	*Dytaster grandis*	Arm
JC231-082-011	NHMUK014453693	Malacostraca	*Eurythenes obesus*	Pleopods
JC231-082-012	NHMUK014453694	Holothuroidea	*Psychropotes longicaudata*	Muscle
JC231-082-013	NHMUK014453695	Holothuroidea	*Parorizo prouhoi*	Muscle
JC231-082-014	NHMUK014453696	Holothuroidea	*Oneirophanta mutabilis*	Muscle
JC231-082-015	NHMUK014453697	Holothuroidea	*Molpadia blakei*	Muscle
JC231-082-016	NHMUK014453698	Holothuroidea	*Molpadiodemas villosus*	Muscle
JC231-082-017	NHMUK014453699	Asteroidea	Asteroidea	Arm
JC231-082-018	NHMUK014453700	Bivalvia	Bivalvia	Muscle
JC231-082-019	NHMUK014453625	Anthozoa	*Actinauge abyssorum*	Body-wall
JC231-082-020	NHMUK014453701	Malacostraca	Amphipoda sp. 3	Pleopods
JC231-082-021	NHMUK014453702	Pycnogonida	*Colossendeis sp.*	Leg
JC231-082-022	NHMUK014453703	Malacostraca	*Munidopsis crassa*	Muscle
JC231-082-023	NHMUK014453704	Actinopteri	Bathysauridae	Muscle

JC231-082-024	NHMUK014453705	Actinopteri	Chiasmodontidae	Muscle
JC231-082-025	NHMUK014453706	Holothuroidea	Amperima rosea	Muscle
JC231-082-026	NHMUK014453707	Asteroidea	Hyphalaster inermis	Arm
JC231-082-027	NHMUK014453708	Polychaeta	*Laetmonice* sp.	Mid-section
JC231-086-001	NHMUK014453627	Cephalopoda	*Grimpoteuthis* sp.	Arm
JC231-086-002	NHMUK014453628	Cephalapoda	?*Bathyteuthis* sp.	Arm
JC231-086-003	NHMUK014453629	Cephalopoda	Cephalopoda	Arm
JC231-086-004	NHMUK014453630	Malacostraca	Hyperiidae	Pleopods
JC231-086-005	NHMUK014453631	Malacostraca	*Munidopsis parfaiti*	Muscle
JC231-086-006	NHMUK014453632	Anthozoa	*Umbellula monocephalus*	Tentacle
JC231-086-007	NHMUK014453633	Asteroidea	*Styracaster* sp.	Arm
JC231-086-008	NHMUK014453634	Malacostraca	Decapoda sp. 1	Pleopods
JC231-086-009	NHMUK014453635	Malacostraca	Decapoda sp. 2	Pleopods
JC231-086-010	NHMUK014453636	Malacostraca	Decapoda sp. 3	Pleopods
JC231-086-011	NHMUK014453637	Malacostraca	?*Systellaspis* sp.	Pleopods
JC231-086-012	NHMUK014453638	Malacostraca	Decapoda sp. 3	Pleopods
JC231-086-013	NHMUK014453639	Malacostraca	Decapoda (juvenile)	Pleopods
JC231-086-014	NHMUK014453640	Malacostraca	*Willemoesia leptodactyla*	Pleopods
JC231-086-015	NHMUK014453641	Malacostraca	*Eurythenes obesus*	Pleopods
JC231-086-016	NHMUK014453642	Asteroidea	*Styracaster* sp.	Arm
JC231-086-017	NHMUK014453643	Actinopteri	*Argyropelecus olfersi*	Muscle
JC231-086-018	NHMUK014453644	Malacostraca	Amphipoda sp. 3	Pleopods
JC231-086-019	NHMUK014453645	Echinoidea	Spatangoida	Body-wall
JC231-086-020	NHMUK014453646	Bivalvia	Bivalvia sp.	Muscle
JC231-086-021	NHMUK014453647	Anthozoa	*Actinauge abyssorum*	Body-wall
JC231-086-022	NHMUK014453648	Polychaeta	*Laetmonice* sp.	Mid-section
JC231-086-023	NHMUK014453649	Malacostraca	Decapoda sp. 2	Pleopods
JC231-086-024	NHMUK014453650	Malacostraca	Decapoda sp. 3	Pleopods
JC231-086-025	NHMUK014453651	Actinopteri	*Scopeloberyx robustus*	Muscle
JC231-086-026	NHMUK014453652	Holothuroidea	*Paroriza prouhoi*	Muscle
JC231-086-027	NHMUK014453653	Holothuroidea	*Psychropotes longicaudata*	Muscle
JC231-086-028	NHMUK014453654	Holothuroidea	*Oneirophanta mutabilis*	Muscle
JC231-086-029	NHMUK014453655	Holothuroidea	*Molpadiodemas villosus*	Muscle

d. Deep-sea bioturbation

Olmo Miguez-Salas

A box core (BC) and gravity core (GC) were operated during the present cruise in the 'PAP central', 'AESA hill', and 'AESA north plain' areas (total 6 deployments, see Table below). The primary objective was to obtain samples to study contemporary bioturbation. Secondary aims included bioturbation analysis of trace fossils and gravity flow characterisation.

Box coring

An NMFD-supplied USNEL-type box core (50 × 50 × 50 cm) was used in the 'PAP central' and 'AESA hill' areas. The two deployments were successful, and the resulting sediment samples had a relatively undisturbed surface (see image below). On both occasions, the box core sediment depth was less than 40 cm. Then, each box core was subsampled with 25 plastic core liners of 65 cm height (core liners have an internal diameter of 65 mm and an external diameter of 72 mm; being their max. external diameter with caps fitted 80 mm). The 25 core liners were emplaced in a closely spaced 5 × 5 grid (see image below), maintaining a specific orientation between all of them (yellow T was drawn on the core liners to keep the original orientation). Yellow caps were used for the top of the core liners and red ones for the bottom. Finally, core liners were stored in the core racks in the controlled temperature laboratory (c. 6 °C).

Example box core surface (left) and 5 × 5 subsampling grid of core liners (right).

Gravity core

The gravity corer consisted of a head weight connected to a 3 m steel barrel (see image below). A plastic core liner, as used for the box core subsampling, was inserted into the barrel and the free end fitted with a core catcher ("fingers") and secured into the barrel with a core cutter. All four deployments were successful. On deck the core cutter was removed, the core liner pulled out and cut into 1 m sections. Three of the gravity cores were cut into 3 × 1 m sections. One of them had less than 2 m sediment thickness, thus, only two sections were retained. Yellow caps were used for the top of the core liners and red ones for the bottom. Finally, sections were stored in the core racks in the controlled temperature laboratory (c. 6 °C).

Recovery of gravity core.

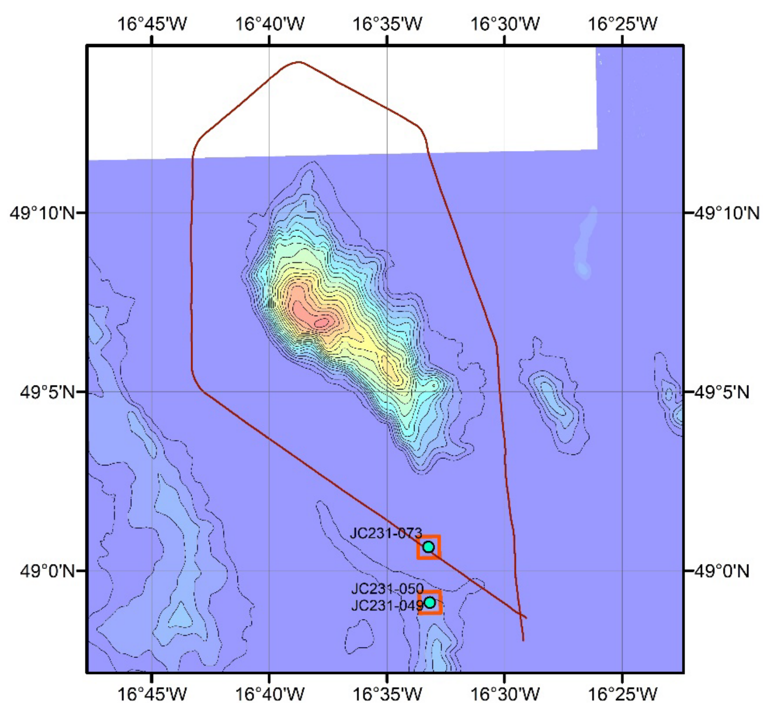
Summary of box core and gravity core samples retained

Station JC231-	Type	Date May '22	Site	Latitude	Longitude	Depth (m)	Subcores
019	BC	06	PAP Central	48° 50.401′ N	16° 31.302′ W	4842	25
020	GC	06	PAP Central	48° 59.105′ N	16° 33.167′ W	4842	3
049	BC	09	AESA Hill	48° 59.103′ N	16° 33.170′ W	4795	25
050	GC	09	AESA Hill	49° 00.657′ N	16° 33.221′ W	4795	2
073	GC	12	AESA N. Plain	48° 50.095′ N	16° 31.331′ W	4846	3
076	GC	12	PAP Central	48° 50.401′ N	16° 31.302′ W	4842	3

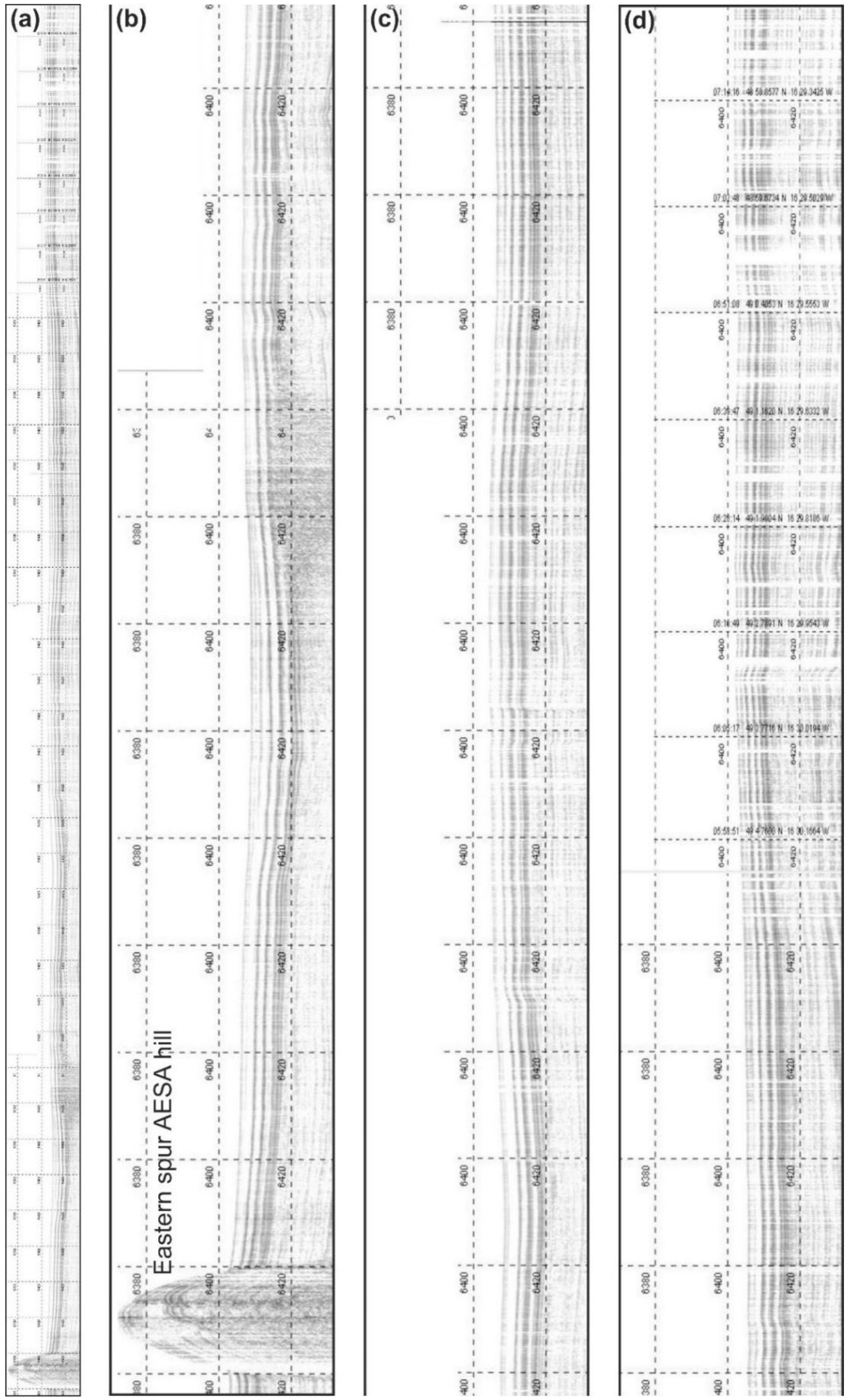
17. Opportunistic sub-bottom profiling

Brian Bett

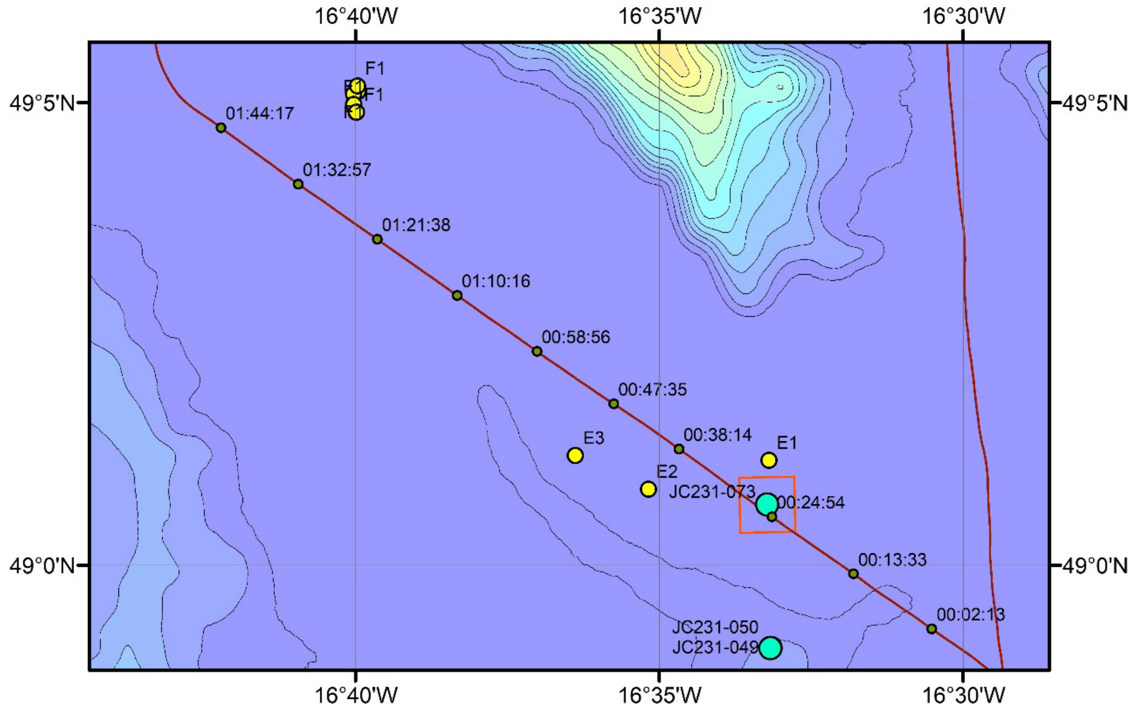
Two short stints of opportunistic sub-bottom profiling were undertaken with the ship's fitted Kongsberg SBP120 system using a linear chirp (2.9-7.0 kHz). The first, a line targeting the apparent fluid surface sediment area noted from previous Megacore core sampling (between "Ben Billett" and the AESA hill), that was extended to a complete circuit of the seamount "Ben Billett". The second, targeted a previously noted landslide run out area from a small abyssal hill to the west of "Ben Billett".



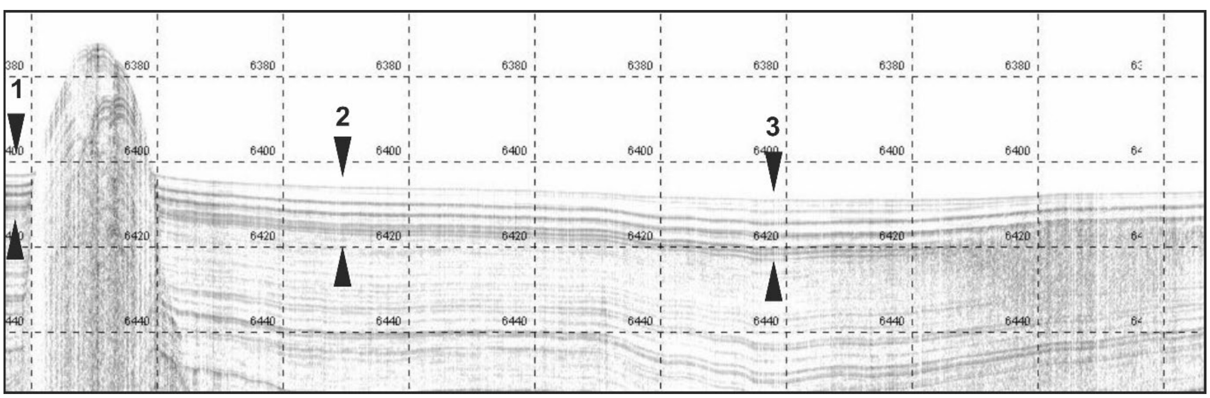
SBP circuit of "Ben Billett", beginning on NW line running through 'AESA north plain' (red box outline) area and site of gravity core JC231-073 (green symbol).



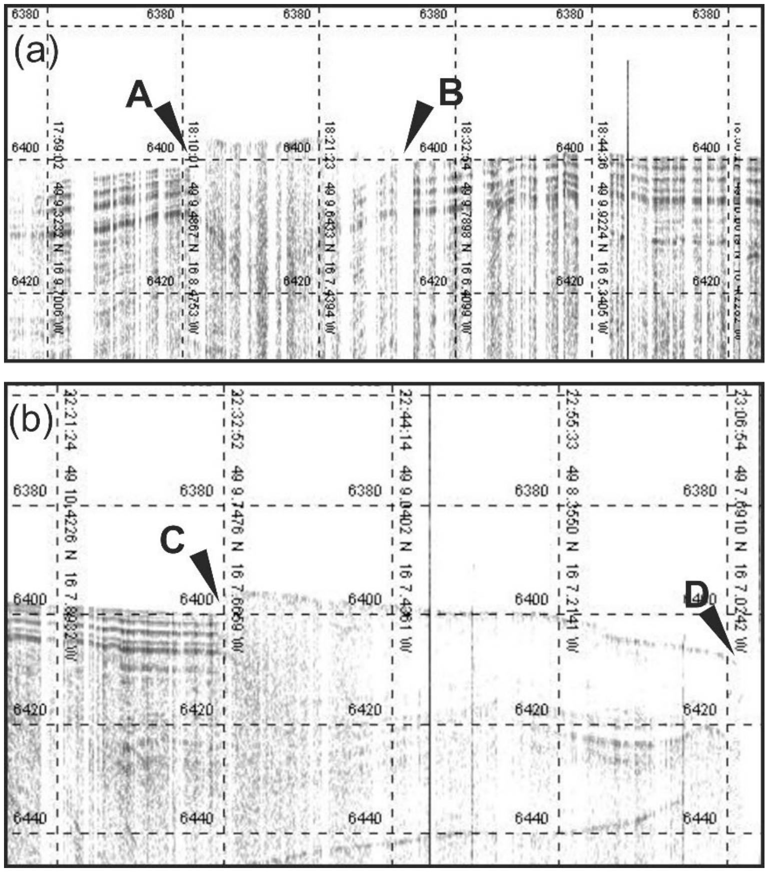
SBP record from circuit of "Ben Billett", (a) in toto, (b-d) in segments.



Detail of first line of SBP circuit of "Ben Billett", showing SBP time marks, and sites of prior coring that have returned 'unusually' fluid cores (yellow symbols; F1 of cruise JC060, E1-E3 of D377/8).



Detail of first line of SBP circuit of "Ben Billett", (1) may represent 'normal' condition, i.e., south of the AESA hill eastern spur, (2) potentially a thickened surface unit, and (3) an additional and / or thickened surface unit.



Potential landslide run out survey, (a) transverse line indicating potential extent (A-B), and longitudinal line indicating extent from extremity (C) to base of abyssal hill (D).

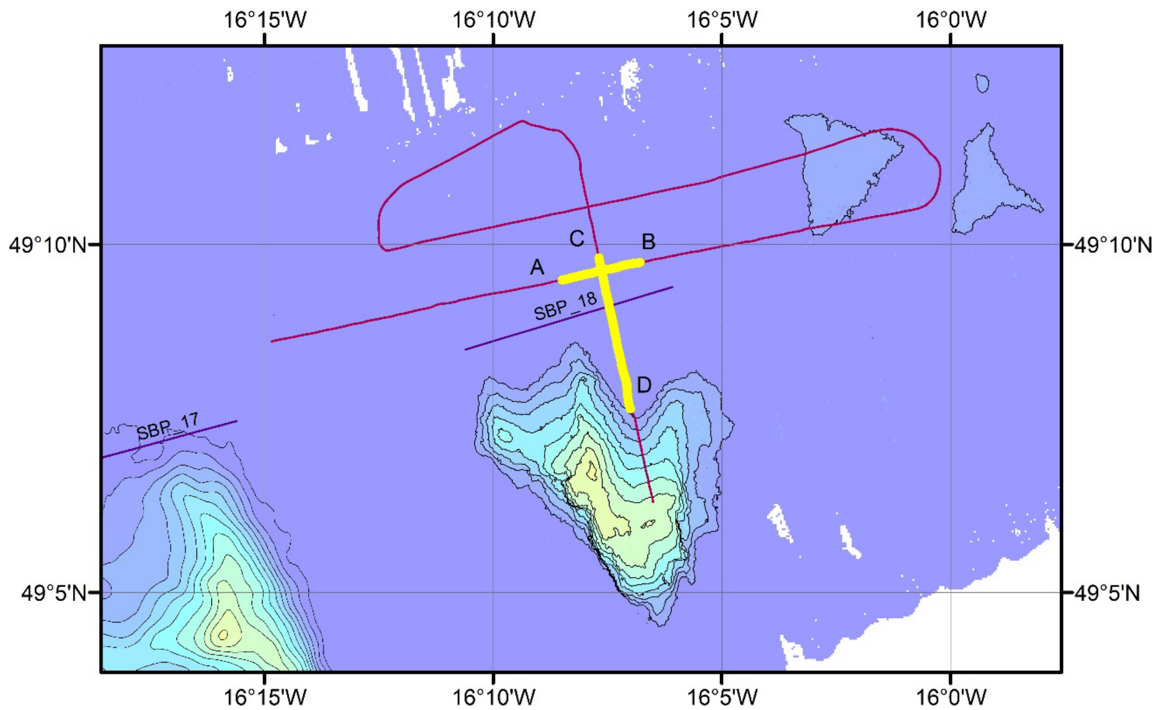
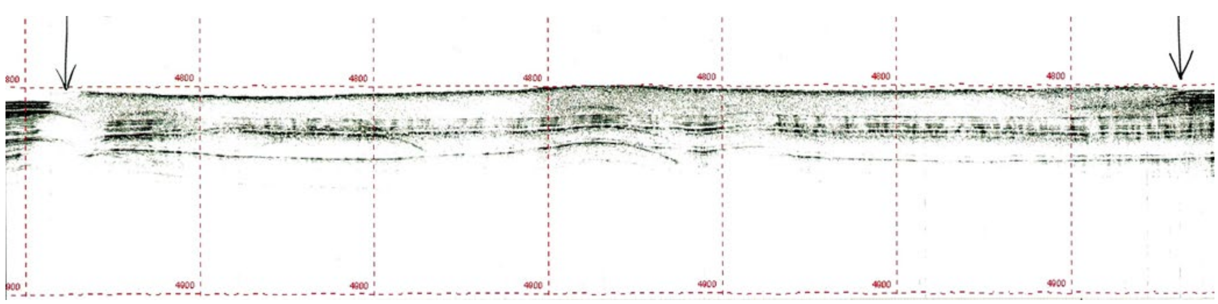


Chart of potential landslide run out survey, (a) transverse line indicating potential extent (A-B), and longitudinal line indicating extent from extremity (C) to base of abyssal hill (D); also shown, SBP line 18 from cruise JC060 (see below).



Scan of SBP line 18 from cruise JC060 indicating transverse extent of potential landslide deposit.

Multibeam echosounder (EM122, EM710) test patch western Solent

The test line was run approximately on Thursday 19 May 2022 06:54 – 07:00 UTC.

18. Meteorological Calibration

Mags Yelland (ashore) wanted to get as much information on the ships met sensors as possible due to high noise to signal ratio. The aim was to do the calibration when the ship was near to the existing and new PAP1 buoy, to make comparisons with the met and wave data from the mooring. As the existing buoy does not have a reliable wave sensor the 3 metcals were done after deployment of the PAP1 MO buoy.

The comparison of the ship and mooring wave data required getting data from both at the same time. Additionally, the aim was to try to get a handle on the distortion (acceleration/deceleration) of the air flow to the anemometer on the foremast. This distortion biases the measured wind speed, and the bias depends on (a) the angle of the ship to the wind and b) the speed of the ship relative to the wind speed. This required the ship to go around in circles - not round the buoy itself since this would interfere with the wind speed measurement on the buoy when the ship is upwind of it.

The Met cal was done by the bridge, resulting in various circles at different speeds. Timestamped data was collated by Joshua on the 1 sec as-measured winds and ships speed and heading. Note that the bridge log was a useful addition to the cruise and can be found when onboard on http://nmf-eventlogger.********l/#!/bridgelog

Unfortunately issue with the wave radar hardware was identified that has caused the wave direction and wave period data to be invalid for the met cals we have done. The wave height, however, is measured from a separate sensor so is unaffected

The data for speed over ground, heading, wind speed and wind direction are unaffected, and Josh can send this data along with the wave height data upon arrival back in Southampton.

"Start"		**"End"**	
07/05/2022	15:24	07/05/2022	17:23
08/05/2022	08:54	08/05/2022	10:16
16/05/2022	08:05	16/05/2022	08:55

19. Ship fitted information systems

Joshua Pedder & Josue Daniel Viera Rivero

BODC Ship-fitted Systems Information Sheet (James Cook)

The following table lists the logging status of ship-fitted instrumentation and suites.

Manufacturer	Model	Function/data types	Logged? (Y/N)	Comments
Steatite	MM3S	GPS network time server (NTP)	N	Not logged
Applanix	POS MV	DGPS and attitude	Y	
C-Nav	3050	DGPS and DGNSS	Y	
Kongsberg Seatex	DPS116	Ship's DGPS	N	Not logged
Kongsberg Seatex	Seapath 330+	DGPS and attitude	Y	
Sonardyne	Fusion USBL	USBL	Y	
Sperry Marine		Ship gyrocompasses x 2	Y	
Chernikeef Instruments	Aquaprobe Mk5	Electromagnetic speed log	Y	Needs Calibration
Kongsberg Maritime	Simrad EA640	Single beam echo sounder (hull)	Y	
Kongsberg Maritime	Simrad EM122	Multibeam echo sounder (deep)	Y	
Kongsberg Maritime	Simrad EM710	Multibeam echo sounder (shallow)	Y	
Kongsberg Maritime	Simrad SBP120	Sub bottom profiler	Y	
Kongsberg Maritime	Simrad EK60	Scientific echo sounder (fisheries)	N	
NMFSS	CLAM	CLAM system winch log	Y	
NMFSS	Surfmet	Meteorology suite	Y	
NMFSS	Surfmet	Surface hydrography suite	Y	
		Skipper log (ship's velocity)	Y	
OceanWaveS GmbH	WaMoS II	Wave Radar	N	
Teledyne RD Instruments	Ocean Observer 75 kHz	UHDAS	Y	
Teledyne RD Instruments	Ocean Observer 150 kHz	UHDAS	Y	
DGS	AT1M	Gravity	Y	Run for Engineering purposes, no tie-in
Micro g LaCoste	S84	Gravity	Y	Run for Engineering purposes, no tie-in

***bestnav* hierarchal ordering:**

The following table lists the order of navigational systems in the *bestnav* process for positional fix.

Rank	Order of positional fixes	Comment
1	posmvpos	(Primary input file) Gap before change = 0030S, Least status = 9
2	gps_cnav	(Second input file) Gap before change = 0030S, Least status = 9
3	dps116	(Third input file) Gap before change = 0030S, Least status = 9

Known Drift Velocity: magnitude 00000 knots: direction 000 degrees

Maximum acceptable drift magnitude 05.0_knots

Units of dist_run: nautical miles

Relmov* source*:

The following table lists the navigational systems that are used in the *relmov* process for ship's motion.

Navigational source of ship's motion	Comment
Input file: gyro (gyro_s)	Data rate 01S
Input file: log (log_chf)	(Chernikeef speed log)

RVS data processing:

The following table lists the RVS Level-C processing programs that were run.

Program	Was it run?	Comments
bestnav	Y	
*prodep***	Y	
protsg	N	
relmov	Y	
satnav	N	
windcalc	Y	

**Please state if sound velocity probes used for depth correction instead of *prodep*.

20. Appendix

a. Station list

Station	Unique deployment identifier "JC", *RRS James Cook*, "231"
	Consecutive cruise number, "-xxx" consecutive deployment number during cruise.
	Note that recoveries of moored or drifting systems retain the number of the initial deployment.
Gear	Abbreviated name of deployed equipment
Date	DD/MM/YYYY format date beginning of sample or data acquisition
Time	HH:MM format UTC time beginning of sample or data acquisition
Position Latitude	WGS84 latitude degrees beginning of sample or data acquisition
mm.mmm N	WGS84 latitude minutes beginning of sample or data acquisition
Position Longitude	WGS84 longitude degrees beginning of sample or data acquisition
mm.mmm W	WGS84 longitude minutes beginning of sample or data acquisition
Depth	Minimum water depth of sample or data acquisition
Comment	General comment on sample or data acquisition

Time - time or times given relate to entry into water, first arrival at or near the seafloor, recovery to deck as appropriate to the particular instrument operation. All times given are UTC.

GEAR	Description	Metadata notes
CTD	Conductivity, temperature, depth etc. instrument	Time and position refer to start and end of cast, depths refer to max. and min. of profile
PAP1	Mobilis buoy and instrument frame	
PAP3	Sediment trap array; Deep microcat	
WCM	Whittard Canyon mooring: 2 x ADCP + 1 x sediment trap and microcat SBE	
WCMA	Whittard Canyon mooring as above with Anderson sediment trap	
Argo	Met Office Navis float, part of BGC Argo programme	
MBES	Multibeam mapping	
MgC08	Megacore	
BC	Box Core	
GC	Gravity Core	For coring Time and position refer to the time of bottom contact
SBP	Sub bottom profiler	
OTSB14a	Otter trawl	For trawls the time and position refer to centre of fished area
METCAL	Met data PAP1/ship inter-calibration	
ATRAP	Amphipod trap (and 2nd version called ATRAP2)	
WP2	Zooplankton nets (size 200 and 60µm mesh)	
MSC	‘old’ marine snow catcher	
MSCY	New ‘Yuki’ Marine Snow catcher	
RCF2	New Red camera Frame	

Station	Gear	Date	Time	Latitude		Longitude		Depth (m)	Sounding (m)	Comment
DY130-018	WCM	29/03/2021	11:58	48	37.549	10	0.207	1572	1572	Triangulated position
		02/05/2022	15:38	48	37.549	10	0.207	1572		Rotated to bott. 15, ADCPs & microcat data
DY130-024	PAP3	31/03/2021	15:20	48	59.706	16	24.287	4844	4844	
		10/05/2022	09:27	48	59.61	16	24.2	4844		time of release
DY130-038	PAP1	03/04/2021	11:55	48	57.559	16	26.241	4844	4844	Frame in 11:05, buoy 11:55
		05/05/2022	10:02	48	57.559	16	26.241	4844		
JC231-001	CTD	02/05/2022	18:12	48	33.24	9	55.746	0	1897	WCM area
		02/05/2022	20:20	48	33.239	9	55.746	1850		Wire test releases & microcats
JC231-002	WCM(A)	03/05/2022	09:12	48	37.514	10	0.196	1584	1584	Anderson trap, 2 microcats, 2 ADCPs
JC231-003	CTD	04/05/2022	10:14	48	58.031	16	21.446	0	4842	
		04/05/2022	14:21	48	58.034	16	21.448	4816		
JC231-004	PAP3	04/05/2022	14:50	48	56.927	16	19.888			2 Nortek, 1 microcat
JC231-005	RCF2	04/05/2022	17:16	48	58.15	16	22.054	0	4845	camera to 600m
		04/05/2022	17:59	48	58.15	16	22.054	600		
JC231-006	MSCY	04/05/2022	18:24	48	58.149	16	22.05	60	4812	
JC231-007	MSC	04/05/2022	18:47	48	58.149	16	22.05	60	4802	
JC231-008	MgC08	04/05/2022	22:21	48	50.294	16	31.538	4848	4848	8/8 good cores
JC231-009	WP2(200)	05/05/2022	00:50	48	50.294	16	31.543	0		
			01:17	48	50.179	16	31.458	200		
JC231-010	RCF2	05/05/2022	01:37	48	50.298	16	31.538	0		
			02:04	48	50.233	16	31.457	300		

JC231-011	MgC08	05/05/2022	04:08	48	50.273	16	31.465	4849	4849	8/8 good cores
JC231-012	CTD	05/05/2022	07:39	48	57.372	16	23.994	0	4843	
		05/05/2022	07:47	48	57.372	16	23.995	200		
JC231-013	WP2(200)	05/05/2022	12:44	48	57.8	16	23.918	0		
			13:02	48	57.753	16	23.854	200		
JC231-014	MSCY	05/05/2022	13:23	48	57.75	16	23.85	150	4806	MSC deployed with tray lid on. Lid snapped in halves. Sample lost.
JC231-015	MSC	05/05/2022	13:51	48	57.75	16	23.85	150	4797	
JC231-016	RCF2	05/05/2022	14:11	48	57.75	16	23.85	0		
		05/05/2022	14:52	48	57.75	16	23.85	600		
JC231-017	MSCY	05/05/2022	16:31	48	57.75	16	23.85	50	4812	
JC231-018	MSC	05/05/2022	16:55	48	57.75	16	23.85	50	4789	
JC231-019	BC	05/05/2022	21:55	48	50.083	16	30.937	4842	4842	Good core; array subsampled
JC231-020	GC	06/05/2022	03:07	48	50.401	16	31.302	4842	4842	3 m barrel, overpenetrated
JC231-021	MSC	06/05/2022	09:05	49	0	16	30	11		Misfire. Miscommunication about sampling depth.
JC231-022	MSC	06/05/2022	09:15	49	0	16	29.99	50		Leak from between top and bottom section. Insufficient pressure on the clamps.

JC231-023	MSC	06/05/2022	09:26	49	0	16	29.99	50		Leak from between top and bottom section. Insufficient pressure on the clamps.
JC231-024	MSC	06/05/2022	09:40	49	0	16	29.99	50	4550	
JC231-025	MSCY	06/05/2022	09:55	49	0	16	29.99	50	4723	
JC231-026	CTD	06/05/2022	10:39	49	0	16	30	4810		
		06/05/2022	14:30	48	59.803	16	30.29	4810		
JC231-027	MSC	06/05/2022	15:32	48	59.8	16	30.29	150	4805	
JC231-028	MSCY	06/05/2022	15:57	48	59.8	16	30.29	150	4806	Release wire caught around handle. Top lid did not close
JC231-029	MSCY	06/05/2022	16:14					150	4805	
JC231-030	MSCY	06/05/2022	18:55	48	59.8	16	30.29	100	4807	
JC231-031	MgC08	06/05/2022	22:05	48	50.332	16	31.143	4843	4843	7/8 good cores
JC231-032	WP2(200)	07/05/2022	00:16	48	50.32	16	31.156			
		07/05/2022	00:43	48	50.22	16	31.1			
JC231-033	WP2(200)	07/05/2022	00:52	48	50.266	16	31.12			
		07/05/2022	01:12	48	50.167	16	31.08			
JC231-034	RCF2	07/05/2022	01:23	48	50.316	16	31.147			
		07/05/2022	02:08	48	50.31	16	31.147			
JC231-035	MgC08	07/05/2022	04:12	48	50.407	16	31.232	4842	4842	7/8 good cores
JC231-036	PAP1	07/05/2022	10:51	48	57.689	16	26.26			deploy new frame and buoy
JC231-037	WP2(200)	07/05/2022	12:21	49	0.003	16	30.03			
		07/05/2022	12:45	49	0.004	16	30.03			
JC231-038	WP2(200)	07/05/2022	12:52	49	0.006	16	30.03			
		07/05/2022	13:16	49	0.004	16	30.03			
JC231-039	MSCY	07/05/2022	13:55	49	0.004	16	30.03	50	4807	

JC231-040	MSCY	07/05/2022	14:08	49	0.005	16	30.03	50	4723	Release wire caught around handle. Top lid did not close
JC231-041	MSCY	07/05/2022	14:19	49	0.005	16	30.03	50	4721	
JC231-042	METCALS	07/05/2022	15:24	48	58.57	16	27.44	0		Bridge manouvers 0, 4 and 8 knots
		07/05/2022	17:23	49	0.88	16	28.77	0		
JC231-043	MgC08	07/05/2022	21:56	48	50.244	16	31.59	4843	4843	8/8 short, good cores
JC231-044	MgC08	08/05/2022	02:08	48	50.324	16	31.027	4842	4842	8/8 good cores
JC231-045	ATRAP	08/05/2022	08:12	48	58.829	16	20.86	4845		Descent rate 65 m/min
		09/05/2022	06:34	48	58.829	16	20.86	4845	4845	Soak time: 22.4 hours; modest catches
JC231-046	METCALS	08/05/2022	08:54	48	58.61	16	29.52	0		0,4,8 knot circles near PAP1
		08/05/2022	10:16	48	59.9	16	30.14	0		
JC231-047	CTD	08/05/2022	12:31	49	0.322	16	30.094	0	4840	Validation cast Argo
		08/05/2022	16:09	49	0.305	16	30.1	4810		
JC231-048	Argo	08/05/2022	16:17	49	0.287	16	30.126	0		Recovered due to faulty nitrate sensor
		14/05/2022	13:25	48	44.51	16	37.26	1000		
JC231-049	BC	08/05/2022	22:22	48	59.105	16	33.167	4795	4795	Good core; array subsampled

JC231-050	GC	09/05/2022	03:07	48	59.103	16	33.17	4795	4795	3 m barrel; fair core, 1.5 m recovered
JC231-051	MSC	09/05/2022	09:54	48	58.26	16	23.8	50	4804	Spacer in base came off; could not remove tray
JC231-052	MSCY	09/05/2022	10:08	48	58.26	16	23.81	50	4807	
JC231-053	WP2(200)	09/05/2022	11:09	48	58.26	16	23.81	0		
		09/05/2022	11:37	48	58.26	16	23.81	200		
JC231-054	MSC	09/05/2022	12:55	48	58.26	16	23.81	150	4810	
JC231-055	MSCY	09/05/2022	13:59	48	58.26	16	23.81	150	4806	Leak from base. O-ring loose
JC231-056	MSCY	09/05/2022	14:20	48	58.26	16	23.81	150	4800	Leak from base. O-ring loose
JC231-057	MSCY	09/05/2022	14:55	48	58.26	16	23.81	150	4809	Release mechanism failed. Top lid did not close
JC231-058	MSCY	09/05/2022	15:20	48	58.26	16	23.8	150	4800	Release mechanism failed. Top lid did not close
JC231-059	MgC08	09/05/2022	22:15	48	50.052	16	31.331	4843	4843	2/8 fair cores
JC231-060	MgC08	10/05/2022	02:14	48	50.454	16	31.307	4842	4842	2/8 good cores
JC231-061	ATRAP	10/05/2022	06:59	48	57.254	16	29.148	0		Accidental release
		10/05/2022	07:46	48	57.254	16	29.148	500	4844	Recovered and reset
JC231-062	ATRAP	10/05/2022	09:40	48	57.279	16	29.036	4850		Descent rate 65 m/min

		11/05/2022	06:35	48	57.279	16	29.036	4850	4850	Failed to rise. LOST AT SEABED
JC231-063	MSC	10/05/2022	13:42	48	59.89	16	27	50	4808	
JC231-064	MSCY	10/05/2022	14:37	48	59.89	16	27	50	4803	Leak from bottom. Top lid was loose
JC231-065	MSCY	10/05/2022	15:02	48	59.89	16	27	50	4808	
JC231-066	CTD	10/05/2022	15:39	48	59.89	16	27	0		
		10/05/2022	17:20	48	59.88	16	27.48	1000		
JC231-067	MSC	10/05/2022	18:05	48	59.87	16	27.48	150	4690	Check depth (potential misfire)
JC231-068	MSCY	10/05/2022	18:20	48	59.78	16	27.48	150	4805	Failed. Base plate rotated and did not close.
JC231-069	MSCY	10/05/2022	18:40	48	59.68	16	27.48	150	4802	Leak from bottom plate. Half of water lost after 2 hours.
JC231-070	MgC08	10/05/2022	22:15	48	50.278	16	31.042	4844	4844	7/8 good cores
JC231-071	MgC08	11/05/2022	02:17	48	50.191	16	31.132	4845	4845	7/8 good cores
JC231-072	CTD	11/05/2022	08:25	48	56.853	16	28.413	0	4843	
		11/05/2022	12:10	48	56.85	16	28.414	4827		
JC231-073	GC	11/05/2022	21:32	49	0.657	16	33.221	4846	4846	3 m barrel, overpenetrated
JC231-074	WP2(200)	12/05/2022	01:05	48	50.09	16	31.32			
		12/05/2022	01:31	48	50.05	16	31.35			
JC231-075	WP2(60)	12/05/2022	01:39	48	50.09	16	31.3			
		12/05/2022	02:09	48	50.05	16	31.34			
JC231-076	GC	12/05/2022	04:11	48	50.095	16	31.331	4843	4842	3 m barrel, 2.8 m recovery

JC231-077	MSC	12/05/2022	08:55	49	0	16	30.01	150	4804	
JC231-078	MSC	12/05/2022	09:15	49	0	16	30.01	50	4799	
JC231-079	RCF2	12/05/2022	09:27	49	0	16	30			
		12/05/2022	10:13	48	59.99	16	30			
JC231-080	WP2(60)	12/05/2022	12:04	49	0	16	30.01			
		12/05/2022	12:39	49	0	16	30.04			
JC231-081	RCF2	12/05/2022	14:44	48	57.23	16	28.66			Test
		12/05/2022	14:55	48	57.23	16	28.66			
JC231-082	OTSB14a	13/05/2022	00:01	48	53.176	16	27.503	4840	4842	Good catch
		13/05/2022	02:22	48	53.151	16	36.704	4844		Dist. run 6.05 nm
JC231-083	CTD	13/05/2022	13:19	49	0.48	16	28.78	0		
		13/05/2022	15:21	49	0.47	16	28.78	4810		
JC231-084	RCF2	13/05/2022	12:12	49	0.49	16	28.74			
			12:23	49	0.49	16				
JC231-085	ATRAP2	13/05/2022	15:42	49	0.461	16	28.811	0	4844	Ballast released without command
		13/05/2022	15:50	49	0.461	16	28.811	500		Cause unknown
JC231-086	OTSB14a	13/05/2022	23:34	48	54.974	16	43.11	4838	4840	Good catch
		14/05/2022	01:18	48	51.613	16	48.225	4841		Dist. run 4.76 nm
JC231-087	MSC	14/05/2022	15:10	48	58.43	16	28.09	50	4810	
JC231-088	MSC	14/05/2022	15:35	48	58.43	16	28.09	150	4802	
JC231-089	CTD	14/05/2022	16:10	48	58.43	16	28.09	0		
		14/05/2022	17:08	48	58.6	16	28.09	1000		
JC231-090	MSC	14/05/2022	18:34	48	58.61	16	28.08	50	4809	
JC231-091	MSC	14/05/2022	18:51	48	58.61	16	28.08	150	4705	
JC231-092	CTD	14/05/2022	20:12	48	58.41	16	27.22	0		
		14/05/2022	21:09	48	58.41	16	27.22	100		
JC231-093	RCF2	14/05/2022	22:24	48	58.66	16	27.65			
		14/05/2022	22:47	48	58.66	16.27	27.65			
JC231-094	WP2(200)	14/05/2022	22:57	48	58.67	16	27.66	0		P frame deploy

		14/05/2022	06:43	48	58.77	16	27.82	200		
JC231-095	CTD	15/05/2022	08:56	48	59.99	16	30			
		15/05/2022	12:30	48	59.99	16	29.99			
JC231-096	MSC	15/05/2022	13:10	48	59.99	16	29.99	50	4806	Leak from between top and bottom section. Insufficient pressure on the clamps.
JC231-097	METCALS	16/05/2022	08:05	48	58.2	16	23.3			4,8 knot circles near PAP1
		16/05/2022	08:55	48	57.9	16	23.45			

b. CTD deck logs

CTD deck sampling log

(List parameters sampling from CTD in header and tick relevant box if bottle sampled)

SITE	Whittard Canyon
Comments	-test to 1800m, plus releases '-release and microcat x6 (s/n: 9386, 9475, 21210, 9469, 23950, 9385)

Cruise number	JC231
Station ID	JC231_001
Cast number	CTD 001
Sea floor depth (m)	1897
Cast depth (m)	1850
Event number	

Date (UTC)	02/05/2022
Time in (UTC)	18:12
Time out (UTC)	20:20
Latitude	48° 33.240
Longitude	009° 55.746
Stainless steel cast	

Niskin No	Depth (m)	Bottle No.	O_2 bottle Rep 1	O_2 bottle Rep 2	O_2 Temp.	DIC/TA Rep 1	DIC/TA. Rep 2	DIC/TA. Rep 3	pH	DOC PAP	Nutrients PAP	SALTS Crate-bottle	5 L carboy					Po Bottle (Fe3)	Po Bottle (Fe2)	2nd 5L (spare)	Fv/FF	Comments
													CHL	PIC	POC	Bsi	Lugol					
1	1850		1010	1028	5.8	34					✓	35-860*				✓						1. *salt crate 35; 10 min stop
2	1850		27		5.8																	2.
3	1850																					3.
4	1500		1055		6.7	X135					✓											4.
5	1500		1024		6.7	215																5.
6	1500		1002		6.7	10																6.
7	700		1037		10.1	63s					✓	35-861										7. 10 min stop
8	700		1014		10.2																	8.
9	700																					9.
10	350		1061		10.9	159					✓	35-862										10. 10 min stop
11	350		1045		10.9																	11.
12	350																					12.
13	200		1011	1066	11.5	466	12	72			✓		✓			✓					✓	13.
14	200																					14.
15	200																					15.
16	55		1005		11.6	81					✓		✓			✓					✓	16. MISFIRE - temp, diss O2
17	55		3		12.2																	17.
18	55																					18.
19	15		1067		13.2	15					✓		✓			✓					✓	19.
20	15		1019		13.2																	20.
21	15																					21.
22																						22. Niskin removed
23																						23. Niskin removed
24																						24. Niskin removed
Sampling			AF	AF	ES	EM	EM	EM			EM	SH	MT, ES, JW			'MT, ES, JW					'MT, ES, JW	SH - log sheet
Notes	Euphotic zone down to 115 m, 6 x microcats (WC, PAP 1+3); greasy CTD wire																					

CTD deck sampling log

(List parameters sampling from CTD in header and tick relevant box if bottle sampled)

SITE	PAP3
Comments	-releases xxx, xxx; microcats xxx, xxx

Cruise number	JC231
Station ID	
Cast number	2
Sea floor depth (m)	4808
Cast depth (m)	
Event number	

Date (UTC)	04/05/2022
Time in (UTC)	10:14
Time out (UTC)	14:20
Latitude	48° 58.031
Longitude	16° 21.446
Stainless steel cast	

Niskin No	Depth (m)	Bottle No.	O_2 bottle Rep 1	O_2 bottle Rep 2	O_2 Temp.	DIC/TA Rep 1	DIC/TA. Rep 2	DIC/TA. Rep 3	pH	DOC PAP	Nutrients PAP	SALTS Crate-bottle	5 L carboy CHL	PIC	POC	Bsi	Lugol	Po Bottle (Fe3)	Po Bottle (Fe2)	2nd 5L (spare)	Fv/FF	Comments
1	4816		1020	1028	4	X01						863										1.
2	4816		27		4.1	X02	X03	X04														2.
3	4800											864										3.
4	4500		1037		4.2	Q05						865										4.
5	4250											866										5. Jellyfish
6	4000		1024		4.2	X05						867										6.
7	3500		3		4.3	X06						868										7. 5 min stop
8	3250											869										8.
9	3000		1061	1014	4.5	P46						870										9.
10	3000		1019		4.8	X07	X08	X09														10.
11	2500		1045		5	X10						871										11.
12	2000		1011		5.2	Q01						872										12.
13	1800		1066		5.3	76						873										13.
14	1250											874										14.
15	900		1010		8.7	X11						875										15. 5 min stop
16	750		1055		9.3							876										16.
17	750		1067		9.4	X12						877	✓	✓	✓	✓	✓					17. 5 min stop
18	400											878										18.
19	250		1002		11.5	X13						879	✓	✓	✓	✓	✓					19.
20	170											880										20.
21	100		1048		12	X14	X15	✓				881	✓	✓	✓	✓	✓					21.
22	30											882	✓	✓	✓	✓	✓					22.
23	20		1005		13.3	Q37						883	✓	✓	✓	✓	✓					23.
24																						24. Niskin removed
Sampling			AF		ES	EM	EM	EM				SH	ES, JW	ES, JW	ES, JW	ES, JW	ES, JW					SH - log sheet
Notes	Euphotic zone depth: 150 m; noisy oxy 1 sensor SBE43; greasy CTD wire																					

CTD deck sampling log

(List parameters sampling from CTD in header and tick relevant box if bottle sampled)

SITE	Near PAP1
Comments	log 1/2

Cruise number	JC231
Station ID	JC231_012
Cast number	CTD 003
Sea floor depth (m)	4811
Cast depth (m)	200
Event number	

Date (UTC)	05/05/2022
Time in (UTC)	07:39
Time out (UTC)	08:06
Latitude	48° 57.372 N
Longitude	16° 23.944 W
Stainless steel cast	

Niskin No	Depth (m)	Bottle No.	O_2 bottle Rep 1	O_2 bottle Rep 2	O_2 Temp.	DIC/TA Rep 1	DIC/TA. Rep 2	DIC/TA. Rep 3	pH	DOC PAP	Nutrients PAP	SALTS Crate-bottle	5 L carboy CHL	PIC	POC	Bsi	Lugol	Po Bottle (Fe3)	Po Bottle (Fe2)	2nd 5L (spare)	Fv/FF	pH	Comments
1	200																						1. separate log
2	200											O2 samples for Anita (separate protocol)											2. separate log
3	200																						3. separate log
4	200		1020		11.4	487					√	980	√	√	√	√	√					1451	4.
5	200		96		11.3						√												5.
6	150		1028		11.7	X127					√	981	√										6.
7	150										√												7.
8	150										√												8.
9	150										√												9.
10	100		27		11.9	C17					√	982	√										10.
11	100										√												11.
12	75		1037	1024	12	104					√	983											12.
13	75		3		12	18					√												13.
14	50		1061		12.3	92					√	984	√	√	√	√	√						14.
15	50										√												15.
16	30		1014	1019	12.8	141	99				√	985	√	√	√	√	√						16.
17	30		1045		12.9	216					√											1452, 1453	17.
18	30		1011		12.9	50					√												18.
19	10		1066		13.6	A02					√	986	√	√	√	√	√					1454	19.
20	10		1010		13.6	X130					√												20.
21	10		1055		13.6	486					√												21.
22	5		1067	1002	14.2	73					√	987	√	√	√	√	√					1455, 1456	22.
23	5		1048		14.1	40					√												23.
24	5		1022		14.1	√					√												24.
Sampling			AF		ES	EM					EW, ES, AF	SH	ES, JW	ES, JW	ES, JW	ES, JW	ES, JW					SH	AF, SH - log sheet

Notes	N1-3 for O2 sampling only (see separate logsheet); 5L carboy (N4-24) also used for HPLC and size fractionated chlorophyll analysis; greasy CTD wire

CTD deck sampling log

(List parameters sampling from CTD in header and tick relevant box if bottle sampled)

SITE	Near PAP1
Comments	log 2/2

Cruise number	JC231
Station ID	JC231_012
Cast number	CTD 003
Sea floor depth (m)	4811
Cast depth (m)	200
Event number	

Date (UTC)	05/05/2022
Time in (UTC)	07:39
Time out (UTC)	08:06
Latitude	48° 57.372 N
Longitude	16° 23.944 W
Stainless steel cast	

Niskin No	Depth (m)	Bottle No.	O_2 bottle Rep 1	O_2 bottle Rep 2	O_2 bottle Rep 3	O_2 bottle Rep 4	O_2 bottle Rep 5	O_2 bottle Rep 6	O_2 bottle Rep 6	O_2 Temp.	Nutrients PAP	SALTS Crate-bottle	5 L carboy					Po Bottle (Fe3)	Po Bottle (Fe2)	2nd 5L (spare)	Fv/FF	Comments
													CHL	PIC	POC	Bsi	Lugol					
1	200		1015	1043	1051	1013	1069	1009	17	11.7												1. O2 storage exp.
2	200		1047	1023	1056	1012	22	1031	1049	11.8												2. O2 storage exp.
3	200		1044	1016	1018	1005	1034	1068	1035	11.8												3. O2 storage exp.
4																						4.
5																						5.
6																						6.
7																						7.
8																						8.
9																						9.
10																						10.
11																						11.
12																						12.
13																						13.
14																						14.
15																						15.
16																						16.
17																						17.
18																						18.
19																						19.
20																						20.
21																						21.
22																						22.
23																						23.
24																						24.
Sampling			AF, EM	AF, EM	AF, EM	AF, EM	AF, EM	AF, EM	AF, EM	AF, EM												EM - log sheet

Notes: N1-3 for O2 sampling only, O2 sampling finished at 9:00 am; greasy CTD wire

CTD deck sampling log

(List parameters sampling from CTD in header and tick relevant box if bottle sampled)

SITE	PAP central
Comments	Polonium cast; microcats SN 21549, 7298, 7297

Cruise number	JC231
Station ID	26
Cast number	004
Sea floor depth (m)	4850
Cast depth (m)	4810
Event number	

Date (UTC)	06/05/2022
Time in (UTC)	10:39
Time out (UTC)	14:30
Latitude	49° 00.00 N
Longitude	16° 00.00 W
Stainless steel cast	

Niskin No	Depth (m)	Bottle No.	O_2 bottle Rep 1	O_2 bottle Rep 2	O_2 Temp.	DIC/TA Rep 1	DIC/TA. Rep 2	DIC/TA. Rep 3	pH	DOC PAP	Nutrients PAP	SALTS Crate-bottle	5 L carboy CHL	PIC	POC	Bsi	Lugol	Po Bottle (Fe3)	Po Bottle (Fe2)	2nd SL (spare)	Fv/FF	Comments
1	4810		1067	1048	4.3	43s	X002	X068			√	988										1.
2	4500		1028		4.4	X062					√											2.
3	4000		96		4.4	X078	122				√	989										3. 10 min stop
4	3000		1037	1014	4.8	237					√											4.
5	2000		1066		5.4	X069					√	990										5.
6	1000		1061		8	√					√											6. 10 min stop
7	600		1024	1019	9.9	√					√	991										7.
8	600																	√	√			8. Polonium sampling
9	400		1045		10.9	50s					√	992										9.
10	400																	√	√			10. Polonium sampling
11	250		27	1020	11.4	148					√	993	√	√	√	√	√					11.
12	250																	√	√			12. Polonium sampling
13	100		1010		11.9	X071					√	994	√	√	√	√	√					13. 10 min stop
14	100																	√	√			14. Polonium sampling
15	50		1055		12.4	√	271	216			√		√	√	√	√	√					15. Niskin drained slow
16	50																	√	√			16. Polonium sampling
17	30		1011		12.9	X100					√	995	√	√	√	√	√					17.
18	30																	√	√			18. Polonium sampling
19	10		1002		14.3	C24					√		√	√	√	√	√					19.
20	10																	√	√			20. Polonium sampling
21	5		3		14.4	242					√	996	√	√	√	√	√					21.
22	5																	√	√			22. Polonium sampling
23	---																					23. Niskin removed
24	---																					24. Niskin removed
Sampling			AF		ES	EM, AF	EM, AF	EM, AF			ES	SH, ES, JW	ES, JW, SG	ES, JW, SG	ES, JW, SG	ES, JW, SG	ES, JW, SG	ES, JW, SG	ES, JW, SG			SH, AF - log sheet
Notes	greasy CTD wire; micrcat 7297 ran out of battery (back on cast 6)																					

CTD deck sampling log

(List parameters sampling from CTD in header and tick relevant box if bottle sampled)

SITE	
Comments	-CTD wirehad been terminated, ARGO F1242 deployed here

Cruise number	JC231
Station ID	47
Cast number	5
Sea floor depth (m)	4820
Cast depth (m)	4810
Event number	

Date (UTC)	08/05/2022
Time in (UTC)	12:30
Time out (UTC)	
Latitude	49° 0.32 N
Longitude	16° 30.09 W
Stainless steel cast	

Niskin No	Depth (m)	Bottle No.	O_2 bottle Rep 1	O_2 bottle Rep 2	O_2 Temp.	DIC/TA Rep 1	DIC/TA. Rep 2	DIC/TA. Rep 3	pH	DOC PAP	Nutrients PAP	SALTS Crate-bottle	5 L carboy					Po Bottle (Fe3)	Po Bottle (Fe2)	2nd 5L (spare)	Fv/FF	Comments
													CHL	PIC	POC	Bsi	Lugol					
1	4810		1010		3.5	051s	54s	41s			√											1.
2	4250		1048	1024	3.5	X077					√											2.
3	4000		96		3.6	208					√	997										3.
4	3750		1037	1055	3.7	65s					√											4.
5	3500		1066		3.9	66s					√											5.
6	3250		1061		3.9	481					√											6.
7	3000		1002		4.1	46s					√	998										7.
8	2750		1019	1022	4.4	X074					√											8.
9	2500		27		4.5	√					√											9.
10	2250		1045		4.7	X061					√											10.
11	2000		1067		4.9	57s					√	999										11.
12	1750		1011	1014	5.1	89s	220	X070			√											12. O2 max
13	1500		3		5.5	118					√											13.
14	1250		1028		6.1	√					√											14.
15	1000		31		8.1	X132					√	1000										15.
16	750		1070		9.7	√					√											16.
17	600		35	29	10.1	193	191	164			√											17. O2 min
18	500		1026		10.6	152					√	1001										18.
19	200					√					√		√	√	√	√	√					19.
20	100		1058		12.1	202					√	1002	√	√	√	√	√					20.
21	50		1063		12.6	X138					√	1003	√	√	√	√	√					21.
22	35																					22. Not fired / Chl max
23	25																					23. Not fired
24	5																					24. Not fired
Sampling			AF	AF	ES, SH	EM, AF	EM, AF	EM, AF			ES	SH, ES	ES	ES	ES	ES	ES					SH - log sheet
Notes	PAR down to 170 m; greasy CTD wire																					

CTD deck sampling log

(List parameters sampling from CTD in header and tick relevant box if bottle sampled)

SITE	Amphipod trap site
Comments	new oxy 1 sensor on CTD

Cruise number	JC231
Station ID	72
Cast number	7
Sea floor depth (m)	
Cast depth (m)	4827
Event number	

Date (UTC)	11/05/2022
Time in (UTC)	08:25
Time out (UTC)	12:15
Latitude	49° 56.85 N
Longitude	16° 28.41 W
Stainless steel cast	

Niskin No	Depth (m)	Bottle No.	O_2 bottle Rep 1	O_2 bottle Rep 2	O_2 Temp.	DIC/TA Rep 1	DIC/TA. Rep 2	DIC/TA. Rep 3	pH	DOC PAP	Nutrients PAP	SALTS Crate-bottle	5 L carboy					Po Bottle (Fe3)	Po Bottle (Fe2)	2nd 5L (spare)	OXFORD	Comments
													CHL	PIC	POC	Bsi	Lugol					
1	4827		1010	1048	3.9	X088	X089			√	√	916										1.
2	4810		1024		4	√				√	√											2.
3	4800		96		4	√				√	√											3.
4	4500		1037		4.1	√				√	√	917										4.
5	4200		1055		4.1	X081				√	√											5.
6	4000		1066	1002	4.2	768	X085	48		√	√	918										6.
7	4000		1061		4.2	38				√	√											7.
8	3500					5-5B				√	√											8.
9	3250					√				√	√											9.
10	3000		1019		4.5	√				√	√	919										10.
11	2500					√				√	√											11.
12	2300					299				√	√											12.
13	2000		1022		5.1	√				√	√											13.
14	1750					√				√	√	920										14.
15	1250					√				√	√											15.
16	1000		27		8.1	36				√	√											16.
17	750					X086				√	√	921										17.
18	500		1020		10.9	484				√	√											18.
19	200					144				√	√		√	√	√	√	√					19.
20	55		1067		12.8	154	14			√	√	922	√	√	√	√	√				√	20.
21	45		1011		13.3	250				√	√		√	√	√	√	√					21.
22	30		1014		13.9	135				√	√	923	√	√	√	√	√					22.
23	10		3		13.9	X064				√	√		√	√	√	√	√					23.
24	5		1028		13.9	70	X128			√	√		√	√	√	√	√					24.
Sampling			AF	AF	ES	EM, AF				EM, AF	ES	SH, ES	ES	ES	ES	ES	ES				ES	SH - log sheet
Notes	greasy CTD wire; euphotic depth = 176 m @8:45 and 200m @12:00																					

CTD deck sampling log

(List parameters sampling from CTD in header and tick relevant box if bottle sampled)

SITE	PAP1
Comments	cal cast for PAP1; microcat ODO 16503

Cruise number	JC231
Station ID	92
Cast number	10
Sea floor depth (m)	4809
Cast depth (m)	100
Event number	

Date (UTC)	14/05/2022
Time in (UTC)	20:14
Time out (UTC)	20:21
Latitude	48° 58.414 N
Longitude	16° 27.224 W
Stainless steel cast	

Niskin No	Depth (m)	Bottle No.	O_2 bottle Rep 1	O_2 bottle Rep 2	O_2 Temp.	DIC/TA Rep 1	DIC/TA. Rep 2	DIC/TA. Rep 3	pH	DOC PAP	Nutrients PAP	SALTS Crate-bottle	5 L carboy CHL	PIC	POC	Bsi	Lugol	Po Bottle (Fe3)	Po Bottle (Fe2)	2nd SL (spare)	HPLC	Comments
1	100		1055		12.3					√	√	623	√	√	√	√	√				√	1. 10 min stop
2	100																					2.
3	100																					3.
4	90												√	√	√	√	√				√	4.
5	90									√	√											5. bottle leaks
6	90																					6.
7	90																					7.
8	44												√	√	√	√	√				√	8. 10 min stop
9	44									√	√	624										9.
10	44																					10.
11	44																					11.
12	30												√	√	√	√	√				√	12.
13	30		1014	35	13.8	471			1460	√	√											13.
14	30					8			1461													14.
15	30					921			1462													15.
16	10											625	√	√	√	√	√				√	16. 10 min stop
17	10									√	√											17.
18	10																					18.
19	10																					19.
20	5												√	√	√	√	√				√	20.
21	5		31		14.2	X134			1457	√	√											21.
22	5					488			1458													22.
23	5					667			1459													23.
24																						24.
Sampling			AF	AF	ES	EM, AF			AF, SH	EW	EW		ES	ES	ES	ES	ES				ES	
Notes	greasy CTD wire																					

CTD deck sampling log

(List parameters sampling from CTD in header and tick relevant box if bottle sampled)

SITE	2 miles from PAP1
Comments	Oxy 1 issues until now (offsets 14 umol)

Cruise number	JC231
Station ID	95
Cast number	11
Sea floor depth (m)	
Cast depth (m)	4825
Event number	

Date (UTC)	15/05/2022
Time in (UTC)	08:58
Time out (UTC)	12:28
Latitude	48° 0.0 N
Longitude	16° 30.00 W
Stainless steel cast	

Niskin No	Depth (m)	Bottle No.	O_2 bottle Rep 1	O_2 bottle Rep 2	O_2 Temp.	DIC/TA Rep 1	DIC/TA. Rep 2	DIC/TA. Rep 3	pH	DOC PAP	Nutrients PAP	SALTS Crate-bottle	5 L carboy CHL	PIC	POC	Bsi	Lugol	Po Bottle (Fe3)	Po Bottle (Fe2)	2nd SL (spare)	OXFORD	Comments
1	4825		1048	3	4	76	79				√	626										1.
2	4825		1024		4.1	X063					√											2.
3	4240					158					√											3.
4	3950		1026		4.2	X125					√											4.
5	300					√					√	627										5.
6	2580		1037		4.7	X73					√											6.
7	2450					478					√											7.
8	1847		1067	1066	5.2	X007					√											8.
9	1751					294					√											9.
10	1280					200					√											10.
11	1000					A25					√	628										11.
12	930					153					√											12.
13	785		1002	1070	9.4	X066					√											13.
14	785		1019		9.5	√					√											14.
15	719		1010		10	E46					√											15.
16	660					X075					√											16.
17	640		1020		10.5	289					√											17.
18	300		1022		11.7	63					√	629										18.
19	270					X080					√											19.
20	90		96		12.5	X089					√											20.
21	45					√					√											21.
22	30		35		13.7	96s	214				√	630										22.
23	30		31		13.7	√					√											23.
24	5		1014		13.9	E50					√	631										24.
Sampling																						
Notes																						

c. Event logs

i. Acquisition

time	entry#	event	comment	Latitude (degree_north)	Longitude (degree_east)	Ground Speed (knot)	Single Beam Depth (metre)	Multibeam Depth (m)	Winch Cable Out (metres)	Water Transmissivity (Volt)	Water Fluorescence (Volt)	Relative Wind Speed (m/s)	Relative Wind Direction (degree)	Air Temperature (degree_Celcius)	Relative Air Humidity (100*Pa/Pa)	Port Total Irradiance (centimilliVolt)	Starboard Total Irradiance (centimilliVolt)	Port PA Irradiance (centimilliVolt)	Starboard PA Irradiance (centimilliVolt)	Air Pressure (mbar)	Water Salinity (PSU)	Water Temperature (degree_Celsius)	Water Sound Velocity (m/s)
2022-04-28T14:39:53.000Z	0		log started	50.89179	-1.394954	0	NaN	NaN	0	2.5583	0.0407	0.647	111.4776	13.73	52.83	482.5	463.1	199.4	192	1028.228	0.009	17.1303	1473.212
2022-04-28T14:43:21.000Z	1		Primary TechSAS Started	50.891791	-1.394956	0	NaN	NaN	0	2.337	0.0397	0.729	160.1712	13.94	52.19	519.6	499.3	215.5	207.2	1028.228	0.0089	17.1327	1473.22
2022-04-28T15:01:30.000Z	2		Secondary TechSAS Started	50.89179	-1.394955	0	NaN	NaN	0	2.6984	0.0371	0.755	65.8512	14.05	51.39	636.6	613.9	254.7	245.1	1028.223	0.0089	17.1465	1473.265
2022-04-28T15:12:00.000Z	3		RAM Started	50.891788	-1.394954	0	NaN	NaN	0	2.7441	0.0383	1.26	48.8808	14.18	51.47	374.9	356.8	156.3	149.4	1028.119	0.0088	17.1537	1473.289
2022-04-29T09:22:53.000Z	4		Shutting down system on clean	50.891791	-1.394951	0	NaN	NaN	NaN	1.3997	0.0508	1.387	135.2088	11.88	57.69	835	770.6	333.4	301.5	1029.549	0.0073	16.7831	1472.054
2022-04-29T10:26:04.000Z	5		Stopped Data Acquisition on	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
2022-04-29T13:11:11.000Z	6		Re-Started Data Acquisition on	50.89179	-1.394952	0.1	NaN	NaN	-5.5	1.2384	0.0253	2.353	53.964	13.42	48.02	1122.9	1083.7	449.7	430.9	1028.816	0.0083	16.9926	1472.754
2022-04-30T11:02:36.000Z	7		Started Level-C acquisition	50.891798	-1.394951	0	NaN	NaN	0	1.4076	0.062	0.879	149.2416	11.36	65.34	946	895.1	386.8	370.5	1028.28	0	16.4814	1471.033
2022-05-04T12:00:00.000Z	18		WaMoS wave radar data not valid due to hardware issue with radar.	48.967221	-16.357463	0	NaN	NaN	4799.6	4.5154	0.1186	2.089	16.6536	14.32	89.05	732.6	695.2	307.3	295.9	1023.324	35.5785	14.6087	1506.109
2022-05-04T13:15:09.000Z	12		Wamos stopped due to work on	48.967235	-16.357462	0.1	4808.15	4824.53	1994.5	4.523	0.101	1.454	358.6176	14.61	87.45	658.6	626.4	282.9	269.8	1023.288	35.5815	14.703	1506.412
2022-05-04T14:10:10.000Z	13		Wamos acquisition restarted	48.96725	-16.357462	0.3	4811.05	4828.58	100.7	4.5367	0.1183	0.316	60.9048	15.44	84.08	655.4	628.5	278.5	267.8	1023.2	35.5775	14.1097	1504.509
2022-05-13T15:52:51.000Z	14		Wamos turned off. Wave radar	49.006929	-16.48336	0.3	4809.47	4835.05	0	4.4476	0.0755	8.485	328.7448	13.73	65.22	840	798.3	341.8	325.9	1019.128	35.5993	14.1408	1504.635
2022-05-15T03:43:51.000Z	15		REX wave data stopped due to	49.236315	-16.643448	5	NaN	4823.75	0	4.2844	0.1505	14.192	12.2472	13.76	79.91	0.3	0.3	0.6	0.9	1005.364	35.609	14.096	1504.502
2022-05-15T09:14:04.000Z	16		REX data feed to Techsas restarted.	48.999994	-16.500031	0.6	4802.95	NaN	519.9	4.4258	0.0658	11.095	338.796	13.57	86.04	268.4	253	115.1	109.6	1002.483	35.6098	14.0467	1504.343
2022-05-16T16:08:00.000Z	17		Issue with HMP45 air temperature and humidity reading. Possible	49.078348	-14.581998	9.9	4013.68	NaN	NaN	3.5428	0.1443	24.504	31.6944	-39.79	96.83	123	116.4	59.5	56.6	988.0632	35.5827	14.2106	1504.84
2022-05-18T14:19:23.000Z	19		Stopping underway sampling for	49.592861	-5.547795	11.9	98.07	91.53	0	3.6182	0.1311	12.273	66.8736	-39.45	0.9	181	170	82.2	75.7	1013.06	35.3277	13.8049	1503.228

ii. USBL

time	entry#	event	comment	Latitude (degree_north)	Longitude (degree_east)	Ground Speed (knot)	Single Beam Depth (metre)	Multibeam Depth (m)	Winch Cable Out (metres)	Water Transmissivity (Volt)	Water Fluorescence (Volt)	Relative Wind Speed (m/s)	Relative Wind Direction (degree)	Air Temperature (degree_Celcius)	Relative Air Humidity (100*Pa/Pa)	Port Total Irradiance (centimilliVolt)	Starboard Total Irradiance (centimilliVolt)	Port PA Irradiance (centimilliVolt)	Starboard PA Irradiance (centimilliVolt)	Air Pressure (mbar)	Water Salinity (PSU)	Water Temperature (degree_Celsius)	Water Sound Velocity (m/s)
2022-05-04T10:45:11.000Z	0		log started	48.96722	-16.3575	0.1	4808.15	4829.27	1242.1	4.5709	0.1045	1.401	60.9336	14.09	92.1	551.6	516.1	235.4	223.2	1023.205	35.5758	14.213	1504.84
2022-05-04T10:49:48.000Z	1		USBL Beacon test WMT 2004 on CTD Deep cast	48.96722	-16.3575	0.2	4808.08	4827.25	1519.1	4.5578	0.1048	2.679	53.964	14.12	91.43	693.4	660.7	287.6	275.7	1023.033	35.5762	14.2368	1504.916
2022-05-04T11:50:08.000Z	2		Acoustics turned off for release test	48.96723	-16.3575	0.1	NaN	NaN	4800.1	4.532	0.1102	2.141	1.7064	14.28	89	634.9	602.6	268.4	259.2	1023.288	35.5787	14.5296	1505.857
2022-05-04T11:54:24.000Z	3		CTD showing 4815m depth. USBL showing 4815m depth	48.96723	-16.3575	0.4	NaN	NaN	4799.5	4.4887	0.1297	2.255	19.7208	14.31	89.28	600	565.6	257.7	245.8	1023.366	35.579	14.5153	1505.812
2022-05-04T14:23:20.000Z	4		USBL Beacon onboard.	48.96724	-16.3575	0.2	NaN	NaN	-7	4.5682	0.1067	0.23	316.6056	16.4	79.22	636.9	607	276.9	263.4	1023.153	35.5799	14.1933	1504.781

iii. Zooplankton nets

time	entry#	event	comment	Latitude (degree_ north)	Longitude (degree_ east)	Ground Speed (knot)	Ground Course (degree)	Heading (degree)	Multibeam Depth (m)	Winch Cable Out (metres)	Water Transmissivity (Volt)	Water Fluorescence (Volt)	Relative Wind Speed (m/s)	Relative Wind Direction (degree)	Air Temperature (degree_ Celcius)	Relative Air Humidity (100*Pa/ Pa)	Water Salinity (PSU)	Water Temperature (degree_ Celsius)	Water Sound Velocity (m/s)
2022-05-07T00:16:00.000Z	1	JC231-032	WP2 200 Micron net	48.8388	-16.5193	0.2	80.1	286.6	4833.14	0	4.4434	0.1669	6.557	217.692	14.86	89.75	35.6167	14.5622	1506.006
2022-05-07T00:38:00.000Z	2	JC231-32	WP2 200 Micron net Recovery	48.83696	-16.5182	0.7	200	286.8	4830.04	0	4.494	0.1485	7.938	229.7376	14.84	89.65	35.6098	14.4799	1505.735
2022-05-07T00:48:00.000Z	3	JC231-33	WP2 200 micron net deployment	48.83796	-16.5188	0.1	141.5	297	4828.84	0	4.4434	0.1518	5.612	218.6064	14.86	89.48	35.6102	14.5343	1505.909
2022-05-07T01:08:00.000Z	4	JC231	WP2 200 micron net	48.83611	-16.518	0.6	208.6	294.5	4826.29	0	4.487	0.1396	6.432	238.9968	14.89	90.16	35.603	14.4638	1505.676
2022-05-07T11:12:50.000Z	0		log started	48.95435	-16.4484	8.2	284.3	284.7	4828.2	-15.2	4.6094	0.0793	11.421	265.0032	14.34	86.72	35.543	14.2576	1504.944
2022-05-07T12:12:00.000Z	5	JC231-37 Net at surface going down	zooplankton	49.00007	-16.5005	0.7	62.4	181.1	4834.05	0	4.5746	0.0806	8.485	356.76	14.4	89.19	35.5523	13.9669	1504.018
2022-05-07T12:33:00.000Z	6	JC231-37	Zooplankton net@ 200m	49.00008	-16.5006	0.1	38.1	192.2	4839.73	0	4.5778	0.1003	10.014	352.8504	14.09	86.35	35.5542	13.4794	1502.432
2022-05-07T12:47:00.000Z	7	JC231-37	Zooplankton recovery	49.00009	-16.5005	0.3	14.1	188.8	NaN	0	4.5842	0.1013	10.562	354.7584	14.46	86.7	35.551	14.1895	1504.735
2022-05-07T12:52:00.000Z	8	JC231-38	Zooplankton net @surface - going down	49.00011	-16.5005	0.2	73.5	190.2	4834.95	0	4.5584	0.0966	13.107	337.6656	14.43	88.03	35.5432	14.0829	1504.382
2022-05-07T13:01:00.000Z	9	JC231-38	Zooplankton net @ 200m	49.00007	-16.5005	0.4	81.9	179.8	4836.35	0	4.5651	0.1059	8.731	2.232	13.94	89.94	35.5465	13.9615	1503.993
2022-05-07T13:15:00.000Z	10	JC231-38	Zooplankton net recovery	49.00009	-16.5006	0.1	82.9	200.8	4826.68	50.9	4.55	0.1015	10.303	338.796	14.14	87.63	35.5401	14.0796	1504.368
2022-05-12T01:04:00.000Z	14	JC231-74	Deployment	48.83494	-16.5222	0.3	273	282.5	4828.8	0	4.4904	0.0835	7.318	336.708	13.13	68.5	35.5717	13.9154	1503.874
2022-05-12T01:27:00.000Z	13	JC231-74	Recovery	48.83414	-16.5225	0.1	302.8	280.4	4831.77	0	4.4936	0.0769	7.021	341.7408	12.95	71.04	35.5745	13.9242	1503.906
2022-05-12T01:37:00.000Z	12	JC231-75	Deployment	48.83495	-16.5221	0.4	251.4	284.1	4830.64	0	4.4641	0.0839	9.929	327.7296	12.87	70.59	35.5751	13.9287	1503.921
2022-05-12T02:06:10.000Z	11	JC231-75	Recovery	48.83417	-16.5225	0.4	275.2	284.1	4831.74	0	4.4772	0.0822	6.686	320.8752	12.87	72.48	35.578	13.9377	1503.953
2022-05-12T12:17:00.000Z	15		60 micron net at 200 m	49.00002	-16.5002	0.6	280.4	270.8	4840.11	0	4.4464	0.0885	6.862	1.7136	12.98	66.82	35.5923	13.9774	1504.099
2022-05-14T22:52:00.000Z	16	JC231-94	Deployment of Net	48.97776	-16.4609	0.2	171.7	136	4831.65	0	4.3684	0.0912	11.183	348.7176	14.17	76.58	35.6104	14.1876	1504.798
2022-05-14T23:24:30.000Z	17	JC231-94	Recovery of Net	48.97938	-16.4633	0.1	344.2	136.3	4832.45	0	4.3744	0.0848	10.591	354.78	14.17	78.55	35.611	14.1963	1504.827

iv. Underway salinity sampling

time	entry#	event	comment	Latitude (degree_north)	Longitude (degree_east)	Ground Speed (knot)	Ground Course (degree)	Heading (degree)	Water Salinity (PSU)	Water Temperature (degree_Celsius)
2022-05-01T15:39:06.000Z	0		log started	50.234929	-3.030285	13.39999962	249.1000061	248.8999939	35.09030151	11.06949997
2022-05-01T15:39:55.000Z	1		Bottle number 73.	50.23382	-3.034735	13.5	249.6000061	249.5	35.09059906	11.06840038
2022-05-02T16:13:12.000Z	2		Bottle number 74	48.627956	-10.003447	0.699999988	47	343.7000122	35.59289932	13.34280014
2022-05-03T16:18:31.000Z	3		Bottle number 75	48.710366	-11.594604	9.600000381	271.5	275.3999939	35.59840012	13.85079956
2022-05-04T16:35:48.000Z	4		Bottle number 76	48.965106	-16.359786	0.699999988	316.7000122	313.2999878	35.57939911	14.78960037
2022-05-05T16:03:00.000Z	5		Bottle number 77	48.962519	-16.397521	0.100000001	256.3999939	230.6000061	35.57049942	14.43480015
2022-05-06T16:34:00.000Z	6		Bottle number 78	48.996732	-16.50482	0.200000003	29.70000076	240.3000031	35.55509949	14.41300011
2022-05-07T16:36:00.000Z	7		Bottle number 79	49.01662	-16.475526	4.199999809	67.40000153	80.5	35.55160141	14.30210018
2022-05-08T17:22:10.000Z	8		Bottle number 80	48.985065	-16.582147	8.300000191	275.6000061	269	35.59640121	14.43949986
2022-05-09T11:13:38.000Z	9		Bottle number 81 (sample taken in Chem lab)	48.970953	-16.396846	0.5	65.90000153	293	35.56439972	14.16129971
2022-05-09T16:47:55.000Z	10		Bottle number 82	48.956553	-16.560664	6.300000191	269.6000061	270.8999939	35.56230164	14.19209957
2022-05-10T16:26:45.000Z	11		Bottle Number 83	48.998082	-16.45278	0.600000024	286.8999939	265.7000122	35.5603981	13.90170002
2022-05-11T08:09:30.000Z	12		Bottle number 84 (sample taken in Chem lab	48.950568	-16.477381	0.600000024	117.3000031	314.3999939	35.58209991	13.91670036
2022-05-11T16:00:01.000Z	13		Bottle number 85	48.947976	-17.06608	7.099999905	267.6000061	272.6000061	35.6155014	13.95240021
2022-05-12T16:52:10.000Z	14		Bottle number 86	48.885476	-16.142224	0.200000003	219.6999969	272.3999939	35.57920074	14.03079987
2022-05-13T17:00:06.000Z	15		Bottle number 87	49.008139	-16.48993	1.200000048	344	240.8000031	35.59930038	14.12269974
2022-05-14T16:24:32.000Z	16		Bottle number 88	48.974229	-16.468241	0.5	311.8999939	144.1999969	35.60499954	14.02470016
2022-05-15T16:02:00.000Z	17		Bottle number 89	49.010265	-16.43131	9	43	51.40000153	35.60390091	13.9659996
2022-05-15T18:23:00.000Z	18		Bottle number 90 (sample taken in Chem lab	49.161099	-16.121556	3.900000095	77.5	90.19999695	35.58209991	13.9052
2022-05-16T09:26:15.000Z	19		Bottle Number 91	48.973019	-16.275745	10.30000019	88.30000305	83.90000153	35.58039856	13.83049965

v. Acoustic events

time	entry#	event	comment	Latitude (degree_north)	Longitude (degree_east)	Ground Speed (knot)	Ground Course (degree)	Heading (degree)	Multibeam Depth (m)	Relative Wind Speed (m/s)	Relative Wind Direction (degree)	Air Temperature (degree_Celcius)	Relative Air Humidity (100*Pa/Pa)	Port Total Irradiance (centimilliVolt)	Starboard Total Irradiance (centimilliVolt)	Port PA Irradiance (centimilliVolt)	Starboard PA Irradiance (centimilliVolt)	Air Pressure (mbar)	Water Salinity (PSU)	Water Temperature (degree_Celsius)	Water Sound Velocity (m/s)
2022-04-28T13:47:36.000Z	0		log started	50.89179	-1.394964	0	221.2	305.7	NaN	1.587	57.9096	13.33	55.24	249.9	235.300003	107.3000031	101.9	1028.45	0.0093	17.0849	1473.06
2022-05-01T09:47:09.000Z	1		Started EA640 Single beam echo sounder	50.886833	-1.39151	3.3	148.6	163.9	NaN	1.793	112.025	11.79	65.14	NaN	NaN	NaN	NaN	NaN	0.0078	16.7667	1472
2022-05-01T09:50:07.000Z	2		Started ADCPs	50.884435	-1.391905	4.1	189.1	189.2	NaN	2.858	38.772	11.82	65.14	253.6	238.300003	113.5	105.1	1022.34	0	16.7674	1471.99
2022-05-01T11:54:16.000Z	3		EM122 15 minutes softstart commenced (TX power: -10	50.615997	-1.704064	13.4	231.9	231.3	52.81	8.113	12.6648	10.02	81.01	341	321	153.5	145.3	1021.96	0.0082	11.5482	1453.32
2022-05-01T12:10:28.000Z	88		EM122 softstart completed	50.574913	-1.77701	14	227.9	225.9	50.07	7.138	14.6664	9.99	81.6	284.6	267.299988	128.6000061	122.7	1021.84	0.0083	11.469	1453.02
2022-05-01T12:40:21.000Z	4		Started Non-Toxic Underway Board	50.500907	-1.926155	15.3	233	229.9	34.27	7.657	4.7232	9.79	82.05	276.8	261.200012	125.6999969	118.4	1021.7	34.5631	11.3549	1494.08
2022-05-01T12:40:42.000Z	5		Started Acquiring EM122 Data. Line 0002	50.500028	-1.928015	15.3	233.3	230.4	34.92	7.364	7.668	9.77	81.95	272.5	257	123.5999985	116.3	1021.75	34.5635	11.3711	1494.14
2022-05-02T01:30:00.000Z	96		EA640 bad depth reading. Missing bottom	49.558419	-6.016654	12.8	258.4	256.7	96.39	8.307	1.6776	10.42	87.27	0	0.2	0.5	0.5	1019.37	35.3238	12.022	1497.29
2022-05-02T07:52:44.000Z	95		EA640 now reading correct depth	49.098139	-7.752199	12.8	245.3	248.7	135.62	9.087	2.9448	11.62	89.84	92.9	87.0999985	43.20000076	39.5	1019.01	35.3593	12.7019	1499.63
2022-05-02T08:51:00.000Z	6	SVP_2	EM122: SVP_2 (WOA13). Line 0023	49.01604	-8.04096	12.9	248.5	252.4	143.89	8.292	358.956	11.42	95.09	47.9	44.7000008	23	21.200001	1019.64	35.3937	12.7943	1499.97
2022-05-02T08:54:40.000Z	7		Started EM710	49.011437	-8.059604	13	249.7	253	146.4	8.267	5.688	11.41	95.31	96.3	90.1999969	43.5	40.599998	1019.46	35.4005	12.7616	1499.87
2022-05-02T14:20:18.000Z	10		EA640 lost bottom depth	48.637404	-9.726774	12.4	257.8	256.6	290.95	5.522	38.7576	12.81	86.38	892.9	863.599976	351.6000061	341	1020.4	35.5449	12.4758	1499.09
2022-05-02T15:20:00.000Z	12		EA640 Tracking bottom Depth	48.624519	-10.002641	0.4	298.3	323	1575.55	3.767	39.7512	12.96	87.66	784.6	769.299988	297.3999939	311.89999	1020.56	35.5988	13.3343	1502.01
2022-05-02T15:30:00.000Z	13		Starboard dropkeel dropped to by 2.5m. EA640 10Hz tra	48.624522	-10.002664	0	76.9	324.1	1588.16	3.383	57.0312	12.96	87.22	686.3	678.299988	283.5	276.89999	1020.44	35.5895	13.1068	1501.25
2022-05-02T15:35:00.000Z	8		EA640 & EM122 stopped to use moorings transducer	48.624532	-10.002666	0.1	20.8	323.8	1588.85	2.831	41.7816	13.05	87.92	590.7	603.5	284.3999939	268.10001	1020.57	35.5863	13.1942	1501.53
2022-05-02T15:43:30.000Z	9		EA640 and EM122 restarted. Gap from turning off EM12	48.624088	-10.002136	0.4	84.6	323.3	1591.52	3.14	28.7208	12.98	86.91	197.9	184.800003	88	83.199997	1020.59	35.5882	13.1079	1501.25
2022-05-02T15:59:45.000Z	11		ADCPs taken off bottom track	48.623464	-10.003448	0.2	28.9	328.3	1577.53	3.952	32.7312	13.01	86.17	696	676.900024	313.1000061	293.29999	1020.57	35.5892	13.501	1502.54
2022-05-02T18:58:36.000Z	14		Stopped EA640 and EM122 for moorings release tests	48.554	-9.929103	0.1	70.1	330.5	NaN	4.893	32.7312	12.92	87.98	66.7	60.7000008	29.79999924	25.5	1020.83	35.606	13.7445	1503.36
2022-05-02T19:05:26.000Z	15		Restarted EA640 and EM122. Gap in EM122 pinging less	48.553998	-9.929108	0.2	272.6	329.3	1898.23	4.907	33.8256	12.98	87.68	135	75.4000015	46.20000076	29.9	1020.9	35.605	13.4769	1502.48
2022-05-02T20:22:00.000Z	19	SVP_3	SVP_3: WOA13 Profile added to EM122: 48.554, -9.9291	48.55398	-9.929106	0.1	17.2	330.2	1906.06	4.507	39.7512	12.78	86.26	-1.4	-0.80000001	0.899999976	0.9	1021.36	35.6128	13.8445	1503.69
2022-05-03T09:22:13.000Z	16		EA640 & EM122 turned off for Moorings triangulation	48.627178	-10.004349	2.6	350.6	340.3	NaN	6.671	8.676	12.84	78.86	341.5	320.600006	145.3000031	139.8	1021.77	35.5991	13.3062	1501.92
2022-05-03T09:37:00.000Z	89		Start of MMO watch	48.62901	-10.000042	5	147.1	146.6	NaN	4.558	224.705	12.84	80.51	402.1	379.5	170.6000061	161.7	1021.97	35.5973	13.3114	1501.93
2022-05-03T10:11:15.000Z	17		EA640 restarted	48.625072	-10.033435	9.4	273.8	275.3	NaN	8.548	50.9328	12.6	79.82	531.3	501.100006	223.8000031	212.7	1021.75	35.5986	13.2337	1501.68
2022-05-03T10:37:00.000Z	90		MMO watch complete. No sightings. EM122 restarted	48.629812	-10.142148	10.1	274.2	275.8	NaN	8.841	38.772	12.69	79.44	569.5	538	239.6999969	228.60001	1021.69	35.5976	13.5329	1502.66
2022-05-03T12:31:48.000Z	18	SVP_4	SVP_4 uploaded to EM122. CTD Profile. Position: 48.554	48.649132	-10.633707	10.4	278.2	279.3	1241.04	8.995	37.7568	12.76	78	1016.8	986.200012	418.1000061	403.10001	1021.51	35.6062	13.6624	1503.09
2022-05-04T11:50:15.000Z	20		Acoustics turned off for release test	48.967231	-16.357458	0.3	29.5	301.5	NaN	2.33	8.6904	14.28	89.02	630.5	599.400024	266.8999939	256.29999	1023.32	35.5788	14.5233	1505.84
2022-05-04T12:00:06.000Z	21		Restarted EM122 after moorings release tests. Gap of	48.967223	-16.357462	0.1	71.2	300.4	4827.03	1.846	26.7192	14.32	89.02	719	680.5	307	291.29999	1023.29	35.5792	14.6074	1506.11
2022-05-04T13:39:21.000Z	22		Stbd Drop Keel now flush with the hull. Raised 2.5m	48.967233	-16.357454	0.2	59	300	4833.18	1.489	6.7032	14.76	85.89	651.6	619.700012	285.2999878	269.89999	1023.26	35.5798	15.4071	1508.63
2022-05-05T16:55:36.000Z	23	SVP_5	SVP_5: loaded to SIS. line 0107. SVP location 46 58.031	48.962513	-16.397526	0.1	199.6	229.2	4844.58	7.14	335.722	14.75	92.5	470.9	439	194.1999969	181	1023.16	35.5639	14.3323	1505.21
2022-05-06T16:49:27.000Z	24	SVP_6	SVP_6: loaded to SIS. line 0132. SVP location 48 59.99 N	48.99673	-16.504835	0.3	90.6	239.5	4827.66	6.244	327.636	14.95	93	638.6	583.200012	252.5	245.39999	1025.08	35.5539	14.4698	1505.64
2022-05-08T19:09:14.000Z	25		Changed EA640 pulse from 8.192 ms to 16.384ms (depth	48.985168	-16.715846	9.5	90.9	89.2	NaN	10.538	93.9528	14.23	96.02	37.5	35.0999985	14.5	15	1015.08	35.6036	14.3368	1505.27
2022-05-09T15:53:43.000Z	26		Poor acoustic data from EA640 and EM122 due to increa	48.963566	-16.408662	8	234	233.4	4842.26	16.327	4.7232	13.6	75.55	330.2	306.5	144.1999969	136.7	1014.48	35.5629	14.1452	1504.61
2022-05-10T08:18:20.000Z	27		Turned EA640 and EM122 off to use moorings transduc	48.954345	-16.485643	1.5	266.2	252.2	4840.8	11.147	346.73	13.53	76.6	273.7	261.399994	111.6999969	107.3	1013.95	35.5623	13.8808	1503.75
2022-05-10T08:23:16.000Z	28		EA640 and EM122 turned back on after using moorings	48.954253	-16.486065	0.2	259	250.4	4835.63	10.942	359.914	13.41	78.13	174.3	163.100006	75.5	71.400002	1013.67	35.5619	13.8821	1503.75
2022-05-10T09:27:00.000Z	32		Stb drop keel lowered by 2.5m to use moorings transdu	48.993428	-16.40346	0.5	229.7	253.1	NaN	11.308	335.75	13.67	75.32	372.3	356.600006	152.6999969	145.89999	1013.68	35.5739	13.9044	1503.84
2022-05-10T09:30:50.000Z	29		Turned EA640 and EM122 off to release buoy	48.993423	-16.403447	1.4	292.4	253.2	NaN	11.688	343.706	13.68	75.07	261.4	250.399994	112.8000031	108.9	1013.86	35.5739	13.8961	1503.81
2022-05-10T10:00:27.000Z	30		Started MMO watch	48.991986	-16.402643	0.8	265.5	251	NaN	10.742	357.826	13.68	74.86	423.3	404.100006	177.8000031	169.7	1013.55	35.5737	13.8894	1503.79
2022-05-10T10:41:20.000Z	31		Stb drop keel raised. Now flush with hull	48.995753	-16.407506	3.7	280.6	263.4	NaN	12.321	330.746	13.76	76.55	639.6	613.299988	266.8999939	256	1013.4	35.5729	13.9078	1503.85
2022-05-10T10:44:41.000Z	33		EA640 restarted	48.995546	-16.410104	2	256.1	268.4	NaN	13.684	323.813	13.73	75.24	571.4	549.599976	244.8000031	237	1013.2	35.5733	13.8936	1503.81

time	entry#	event	comment	Latitude (degree_north)	Longitude (degree_east)	Ground Speed (knot)	Ground Course (degree)	Heading (degree)	Multibeam Depth (m)	Relative Wind Speed (m/s)	Relative Wind Direction (degree)	Air Temperature (degree_Celcius)	Relative Air Humidity (100*Pa/Pa)	Port Total Irradiance (centimilliVolt)	Starboard Total Irradiance (centimilliVolt)	Port PA Irradiance (centimilliVolt)	Starboard PA Irradiance (centimilliVolt)	Air Pressure (mbar)	Water Salinity (PSU)	Water Temperature (degree_Celsius)	Water Sound Velocity (m/s)
2022-05-10T11:07:45.000Z	35		EM122 started	48.99578	-16.411965	1.1	84	266.1	NaN	12.614	318.809	13.8	74.92	509.5	482.899994	217.8999939	208.89999	1012.56	35.5722	13.8824	1503.77
2022-05-10T16:03:37.000Z	36		Lowering stbd USBL pole to test HPR on CTD frame	48.998194	-16.450792	0.4	230.4	265	4959.47	9.464	334.699	12.29	83.25	127.1	119.599998	56.59999847	54.900002	1010.34	35.5592	13.9149	1503.86
2022-05-10T17:16:29.000Z	37		Raised USBL pole	48.998052	-16.45756	0.9	73.1	278.5	4832.43	5.765	2.2176	12.75	83.51	194.2	182.5	84.19999695	79.699997	1009.05	35.5636	13.8835	1503.76
2022-05-11T06:22:31.000Z	43		Beginning MMO watch	48.950527	-16.477341	0.1	304.8	314.2	4833.53	8.269	357.869	12.52	66.89	105.3	84.0999985	42.09999847	36.900002	1014.2	35.5803	13.9264	1503.92
2022-05-11T06:29:00.000Z	41		EA640 & EM122 turned off to ping amphipod trap	48.950532	-16.47733	0.5	303.2	320.7	4831.05	8.54	337.723	12.52	69.78	119.8	95.5	53.70000076	46.5	1014.39	35.5802	13.9243	1503.91
2022-05-11T06:54:03.000Z	38		Stbd dropkeel lowered 2.5m use moorings transducer t	48.95056	-16.477382	0.5	308.9	318.1	NaN	7.761	352.872	12.75	67.25	211.9	175.899994	85.40000153	73.699997	1014.59	35.5819	13.9318	1503.94
2022-05-11T07:22:30.000Z	42		MMO watch complete. No sightings. EA640 & EM122 tur	48.950568	-16.477353	0.5	338.2	315	4827.67	8.786	348.754	12.67	72.63	60.1	56.2000008	27.89999962	25.5	1014.98	35.5811	13.9292	1503.93
2022-05-11T09:35:00.000Z	39		EA640 & EM122 turned off to use moorings transducer t	48.947521	-16.47353	0.3	113.7	314.6	NaN	9.59	341.719	12.81	70.92	146.2	136.300003	64.80000305	62.599998	1016.26	35.5836	13.9295	1503.93
2022-05-11T09:37:19.000Z	40		EA640 & EM122 turned back on. EM122 gap in pinging le	48.94751	-16.473557	0.3	220.7	317.2	NaN	9.512	342.727	12.61	72.86	129.2	120.5	59.79999924	56.799999	1016.65	35.5837	13.9293	1503.93
2022-05-11T12:27:53.000Z	44		EA640 and EM122 stopped to use mooring transducer t	48.947522	-16.473582	0.6	111.4	317.1	NaN	6.12	329.436	12.86	67.86	597.8	565.299988	252.6999969	238.8	1017.4	35.5871	13.9922	1504.14
2022-05-11T12:30:47.000Z	45		Restarted EA640 & EM122. Gap in EM122 pinging less th	48.947497	-16.473574	0.5	284.9	318.1	NaN	7.811	325.822	12.84	65.17	568.5	537.099976	241.6999969	227.8	1017.45	35.5873	13.9747	1504.08
2022-05-11T12:35:00.000Z	46		Stbd dropkeel raised. Now flush with the hull. Starting	48.947507	-16.47354	0.6	123.6	316.6	NaN	8.922	327.701	12.89	62.87	594.3	561.400024	252.5	237	1017.08	35.5873	13.9751	1504.08
2022-05-11T13:06:19.000Z	47		Reducing speed to 8kts for ADCP survey	48.948076	-16.563248	7.8	266.2	274.3	4836.32	10.791	6.984	13.04	68.22	494.8	467.200012	211	199.3	1017.42	35.5924	13.9545	1504.03
2022-05-11T16:22:26.000Z	48	SVP_7	SVP_7: time: 08:20:00 lat: 48 56.583N lon: 16 28.413W EM	48.947703	-17.13035	7.1	269.1	273.7	5337.15	12.234	12.6792	12.7	75.7	525.7	499.899994	218	207.39999	1017.68	35.6088	14.1076	1504.54
2022-05-11T16:32:07.000Z	49		Finished Pass of ADCP survey at 270Deg course. 170Deg	48.948644	-17.151494	6.4	73.3	72.2	4838.2	6.66	221.717	12.75	76.77	492.2	461.700012	205.6999969	191.8	1017.8	35.6093	14.1453	1504.66
2022-05-11T18:58:00.000Z	50		ADCP survey completed	49.010861	-16.553667	0.5	69.3	290.2	4843.79	7.698	341.741	12.75	75.2	72.6	69.3000031	32.29999924	29.9	1018.27	35.5998	13.8805	1503.79
2022-05-12T13:44:51.000Z	51		EA640 and EM122 off to use moorings transducer to att	48.953949	-16.477688	0.7	301.1	279.4	NaN	9.605	355.781	13.15	63.57	1056.1	1014.09998	402.3999939	367.39999	1020.66	35.6001	14.0073	1504.2
2022-05-12T13:48:29.000Z	52		EA640 and EM122 turned on. Gap in EM122 less than 10	48.953931	-16.477647	0.2	149.5	284.5	4842.66	8.745	345.773	13.13	63.31	1012.9	980.099976	392.5	375.5	1020.71	35.5972	14.0206	1504.24
2022-05-12T13:53:00.000Z	53		Stbd dropkeel lowered 2.5m for release retry of amphi	48.953951	-16.477704	0.6	325	283.7	4838.4	9.436	NaN	13.16	NaN	1022.6	990.799988	409.1000061	391.70001	1020.95	35.5938	14.0188	1504.23
2022-05-12T13:53:53.000Z	54		EA640 and EM122 turned off to use moorings transduce	48.953944	-16.477708	0	251.7	283.7	NaN	8.87	348.696	13.18	64.83	1016.5	981.099976	402.3999939	387.70001	1020.69	35.5937	14.0193	1504.24
2022-05-12T14:01:08.000Z	55		EA640 and EM122 restarted. Gap in EM122 pinging less	48.953932	-16.477719	0.6	313.4	282.4	4831.04	9.502	343.699	13.16	59.86	1006.2	974.599976	400.3999939	382.10001	1020.84	35.5943	14.0192	1504.24
2022-05-12T14:04:00.000Z	56		Stbd drop keel raised 2.5m. Now flush with the hull	48.953944	-16.47771	0.4	209.6	282.8	4832.73	9.54	337.666	13.19	62.38	993.7	963	383	369.29999	1020.71	35.5944	14.022	1504.24
2022-05-13T15:58:18.000Z	57		Stbd dropkeel lowered 2.5m to range of amphipod trap	49.006943	-16.483305	0.2	343.1	248.3	NaN	7.547	341.662	13.73	66.97	615.4	584.900024	324.8999939	322.89999	1019.15	35.5991	14.1703	1504.73
2022-05-13T16:00:51.000Z	58		EA640 and EM122 turned off to use moorings transduce	49.006929	-16.483365	0.6	304.8	248.7	NaN	7.013	344.65	13.76	68.73	845.9	805.5	340.6000061	322.29999	1019.35	35.5988	14.1526	1504.67
2022-05-13T16:07:18.000Z	59		EA640 and EM122 turned back on. Gap in EM122 pinging	49.006938	-16.483353	0.4	345.3	245.5	4832.42	7.077	342.662	13.74	67.79	414	379.299988	191.5	182.60001	1019.23	35.5986	14.1693	1504.73
2022-05-13T16:21:30.000Z	60		EA640 and EM122 off for mooring transducer to range a	49.006942	-16.483346	0.9	121	248.4	NaN	8.551	324.677	13.77	66.88	727.2	683.900024	294.5	280.60001	1018.74	35.5992	14.1022	1504.51
2022-05-13T16:23:31.000Z	61		EA640 and EM122 back on. Ranging unsuccessful d/t ea	49.006928	-16.483343	0.7	300.4	253.3	NaN	7.709	347.674	13.79	66.3	714.6	668.200012	286.2999878	275	1019.14	35.5992	14.1157	1504.55
2022-05-13T16:49:00.000Z	62		Drop keel raised and now flush with the hull	49.007648	-16.485731	1.7	264	242.1	4834.63	8.92	345.737	13.77	67.18	669.6	616.299988	277.7000122	264.70001	1018.72	35.5996	14.1223	1504.57
2022-05-14T09:01:31.000Z	63		Started Pinging on SBP for testing ahead of SBP survey.	48.702712	-17.153947	12.2	59.3	60	NaN	7.722	60.9336	14	77.71	397.9	367.600006	169.1000061	157.89999	1015.26	35.6115	13.9462	1504.02
2022-05-14T09:26:12.000Z	64		SBP ramp up complete. Full power	48.743349	-17.047507	12.2	62.4	58.8	4827.81	8.076	57.0312	14.11	76.19	738.5	667.400024	291.8999939	265.5	1014.9	35.6152	14.0505	1504.36
2022-05-14T11:13:50.000Z	65		SBP test complete. SBP turned off	48.915052	-16.590717	11	58.5	60	4833.79	7.607	59.9544	14	80.26	969.4	883.299988	391.2000122	356.60001	1015	35.6021	14.2476	1504.98
2022-05-14T12:21:19.000Z	66		SBP continued testing at -30dB	48.765958	-16.611353	11	185.4	185.3	NaN	11.574	346.687	14.17	79.45	778.2	728.5	321.3999939	305.29999	1014.93	35.5854	14.2473	1504.96
2022-05-14T14:03:38.000Z	67		Continuing testing SBP. Now up to full volume	48.838858	-16.535862	11	28	29.2	4831.8	4.674	87.9984	14.5	77.79	1018.4	947.400024	414.7000122	388.60001	1014.06	35.581	14.4577	1505.63
2022-05-14T14:31:51.000Z	68		SBP testing completed. SBP off	48.924239	-16.501096	11.3	16.3	19	4838.99	3.561	58.9752	14.55	77.59	963.9	909.099976	397.7999878	370.5	1014.02	35.5896	14.4347	1505.57
2022-05-14T20:20:00.000Z	69		Started SBP in -30dB to test data recording	48.973577	-16.45373	0.3	287.6	136.7	NaN	8.116	356.789	14.21	77.1	30.2	27	13.10000038	9.8999996	1011.45	35.6097	14.301	1505.16
2022-05-14T20:32:48.000Z	70		End of SBP test	48.973564	-16.453741	0.1	189.6	136.7	4831.15	10.64	355.795	14.11	73.41	8.7	9.5	4.099999905	4.6999998	1011.11	35.6102	14.2639	1505.04
2022-05-14T20:48:24.000Z	71		SBP softstart running at -30dB	48.973557	-16.453745	0.3	329.1	137	4840.86	7.851	350.726	14.15	78.48	1.7	1.5	0.899999976	1.8	1011.13	35.6105	14.2439	1504.98
2022-05-14T21:19:48.000Z	72		SBP now full power	48.973565	-16.453748	0.2	123.4	135.3	4830.48	10.605	345.794	14.14	76.03	0.2	0	1.100000024	1.2	1011.17	35.6111	14.2634	1505.04
2022-05-14T21:30:51.000Z	73		Updating SBP to fixed rate interval	48.973579	-16.45373	0.4	300.3	135.2	NaN	9.18	353.772	14.21	78.2	0.2	-0.2	0.600000024	0.8	1011.03	35.6111	14.2548	1505.02

time	entry#	event	comment	Latitude (degree_north)	Longitude (degree_east)	Ground Speed (knot)	Ground Course (degree)	Heading (degree)	Multibeam Depth (m)	Relative Wind Speed (m/s)	Relative Wind Direction (degree)	Air Temperature (degree_Celcius)	Relative Air Humidity (100*Pa/Pa)	Port Total Irradiance (centimilliVolt)	Starboard Total Irradiance (centimilliVolt)	Port PA Irradiance (centimilliVolt)	Starboard PA Irradiance (centimilliVolt)	Air Pressure (mbar)	Water Salinity (PSU)	Water Temperature (degree_Celsius)	Water Sound Velocity (m/s)
2022-05-15T07:40:34.000Z	91		SBP survey completed. SBP off	48.950286	-16.485539	4.8	172.6	161	NaN	17.381	317.743	13.63	81.85	56.6	53.2999992	26.89999962	24.6	1003.11	35.6062	14.0628	1504.39
2022-05-15T14:11:18.000Z	74		Lowering stbd drop keel 2.5m	48.955766	-16.492127	0.5	61.1	114.6	NaN	14.94	359.892	13.62	88.78	247.8	232.199997	113.8000031	108.8	997.101	35.6061	14.0052	1504.2
2022-05-15T14:17:47.000Z	75		Drop keel now lowered to 2.5m	48.955745	-16.492052	0.2	105.6	117.3	4837.28	10.767	359.899	13.65	89.74	129.7	121.800003	62.90000153	58	997.595	35.6074	14.0026	1504.2
2022-05-15T14:20:47.000Z	76		Acoustics off	48.955723	-16.492027	0.6	258.1	118.2	NaN	13.445	1.7136	13.56	89.72	164.2	153.699997	78.59999847	73.400002	997.033	35.6076	14.0023	1504.2
2022-05-15T15:03:35.000Z	77		Drop keel raised flush with hull	48.949912	-16.486234	0.1	118.1	115.5	NaN	14.307	354.816	13.28	95.46	96.4	90.5	47	42.299999	996.087	35.6073	14.0174	1504.25
2022-05-15T15:06:54.000Z	78		EA640 turned on	48.949905	-16.486253	0.3	280.2	115.9	NaN	13.821	352.879	13.27	95.61	126.5	118.900002	60.29999924	55.400002	996.191	35.6075	14.0163	1504.24
2022-05-15T15:28:06.000Z	79		Starting EM122 ramp up	48.949921	-16.48623	0.4	314.5	114.8	NaN	12.108	359.921	13.38	96.44	68.8	64.6999969	33	31.6	995.572	35.6075	14.0097	1504.22
2022-05-15T15:54:34.000Z	80		EM122 ramp up complete	48.996616	-16.450655	9.2	46.6	52.8	4840.78	14.478	50.9328	13.48	96.89	101.9	95.1999969	48.70000076	45	994.08	35.605	13.9514	1504.03
2022-05-15T17:00:53.000Z	81		Started SBP27 ramp up at -30dB	49.124835	-16.275727	9.5	33.3	45.4	4829.74	13.907	60.9408	13.8	97.18	64.8	61.2000008	31.60000038	28.200001	992.92	35.5888	13.9398	1503.97
2022-05-15T17:21:06.000Z	82		SBP ramp up complete	49.145688	-16.230418	5.2	78.9	88.2	NaN	14.76	33.804	13.92	96.98	29.1	27.2999992	14.30000019	13.1	993.248	35.5892	13.9083	1503.87
2022-05-15T17:41:53.000Z	83		Reducing speed to 4kts for SBP survey	49.151555	-16.18958	3.6	74	89	NaN	13.11	36.7488	14.17	96.65	47.1	44.2999992	23	21.5	993.159	35.5865	13.9084	1503.87
2022-05-16T10:00:00.000Z	85		Increase in sea conditions causes poor EM122 and EA6	48.985077	-16.124594	10.3	83.4	86.4	NaN	11.397	55.9944	14.24	80.2	321.8	298.600006	140.1999969	132.39999	996.232	35.586	13.8827	1503.79
2022-05-16T11:27:58.000Z	84	SVP_8	SVP_8: Uploaded to EM122. Lat: 49 0.00 N Lon: 16 30.0 W	49.008119	-15.725931	11.1	86.4	85.8	4832.34	18.483	52.9416	14.44	83.3	207.2	194.699997	93.80000305	91.900002	994.256	35.582	13.8816	1503.78
2022-05-17T14:09:02.000Z	86		EM122 lost track of bottom depth.	49.051567	-12.584024	11.1	79.9	84.4	1339.74	13.075	101.009	-3.7	153.31	572.7	537.900024	252.1999969	238.2	1001.52	35.5728	13.5376	1502.64
2022-05-17T16:10:06.000Z	87		EM122 now tracking depth. Data now good	49.101435	-11.982952	12.3	81.7	90.4	893.49	9.816	105.019	-12.81	147.98	164.2	151.699997	71.69999695	66.5	1003.63	35.5586	13.4696	1502.41
2022-05-18T12:52:16.000Z	92		EM710 softstart beginning	49.515519	-5.947051	11	84.8	86.1	98.89	12.282	57.0312	-39.45	0.87	246	232.100006	103.0999985	99.5	1013.05	35.1962	13.4723	1501.98
2022-05-18T12:55:27.000Z	93	SVP_9	SVP9: updated on EM122 (line 0428) and EM710 (line 00	49.516642	-5.932492	11.4	85.3	87.5	98.99	13.757	61.9056	-39.45	0.87	233.2	219.300003	98.90000153	95.5	1012.5	35.2368	13.4796	1502.06
2022-05-18T13:07:50.000Z	94		EM710 softstart complete. Beginning logging	49.520975	-5.875039	10.8	82.9	85.1	96.91	13.71	63.8496	-39.45	0.87	430.6	402.200012	177.8999939	167.5	1012.73	35.2626	13.6125	1502.52

vi. Marine mammal observer watches

time	entry#	event	comment	Latitude (degree_north)	Longitude (degree_east)	Ground Speed (knot)	Ground Course (degree)	Single Beam Depth (metre)	Multibeam Depth (m)	Air Pressure (mbar)	Water Salinity (PSU)	Water Temperature (degree_Celsius)	Water Sound Velocity (m/s)
2022-05-03T09:37:00.000Z	2		Start of MMO watch. EM122 Stopped due	48.62901	-10.000042	5	147.1000061	NaN	NaN	1021.967	35.5973	13.31140041	1501.93103
2022-05-03T10:37:00.000Z	1		End Of MMO watch. EM122 Restarted	48.629812	-10.142148	10.1	274.2000122	492.7200012	NaN	1021.686	35.5976	13.53289986	1502.657959
2022-05-03T10:40:44.000Z	0		log started	48.630495	-10.158173	10.1	274.7000122	497.4599915	495.56	1021.541	35.5987	13.49470043	1502.534058
2022-05-10T10:00:59.000Z	3		Started MMO watch after PAP3 release	48.991973	-16.402685	0.6	83.80000305	NaN	NaN	1013.106	35.5738	13.89929962	1503.823975
2022-05-10T11:06:05.000Z	4		MMO watch finished. All OK	48.995561	-16.411765	0.4	215.6000061	4586.160156	NaN	1012.909	35.5721	13.8803997	1503.760986
2022-05-15T14:23:00.000Z	5		Start of MMO watch	48.955709	-16.491985	0.6	328.6000061	NaN	NaN	997.0332	35.6072	14.00220013	1504.196045
2022-05-15T15:23:00.000Z	6		End of MMO watch. No sightings	48.94996	-16.486292	0.1	294.1000061	4809.390137	NaN	995.7592	35.6073	14.01309967	1504.232056

vii. Marine Mammal Report (excerpt of full report)

Anita Flohr

This report is an excerpt of the full report (which includes deck forms, certificate, MEMP etc.) that was sent to JNCC. It summarises the relevant project details and mitigation measures for research cruise JC231 on board *RRS James Cook*.

Reference	Cruise JC231 (SME 21/1528)
Operator	National Oceanography Centre, European Way, Southampton, SO14 3ZH, United Kingdom
Project details	The scientific cruise JC231 on *RRS James Cook* (29.04.-19.05.2022) to the Northeast Atlantic Ocean was a continuation of a long-term time-series of observations at the Porcupine Abyssal Plain Sustained Observatory (PAP-SO).
Cruise PI	Dr Andrew Gates, National Oceanography Centre, Southampton, Email: arg3@noc.ac.uk; Tel: +44 (0)23 8059 6363 Dr Sue Hartman, National Oceanography Centre, Southampton, Email: s.hartman@noc.ac.uk, Tel: +44 (0)23 8059 6343
MMO	Dr Anita Flohr, National Oceanography Centre, Southampton, Email: aflohr@noc.ac.uk, Tel: +44 (0)2380 599346 JNCC MMO training attended: 12th February 2019 non-dedicated MMO during cruise JC231 Joshua Pedder, National Oceanography Centre, Southampton, Email: joshua.pedder@noc.ac.uk, non-trained MMO during cruise JC231 Josue Daniel Viera Rivero, National Oceanography Centre, Southampton, Email: josue.viera.rivero@noc.ac.uk, non-trained MMO during cruise JC231
Sources	See acoustic events log (section 18.3.5 in the cruise report)
Mitigation	At-sea mitigation measures: *Swath Bathymetry:* • At water depths >200 m, 60 minutes of observation focusing on the mitigation zone (500 m from the acoustic source) should be undertaken. • If marine mammals are observed during the search, start-up should be delayed at least 20 minutes from the time of the last detection within the mitigation zone, or the vessel manoeuvred away. • A soft-start (as defined in Appendix 1) should be enacted if the equipment allows.

	• Any observations of marine mammals should be recorded on the forms provided by JNCC – an MMO is only necessary before and during the start-up of equipment, and not for the whole time it is running. Post-sea requirements: • Provide feedback to MEA regarding what mitigation measures were taken. *Sub-bottom Profiling:* Same as for Swath Bathymetry but in addition: • If water depth is <200 m, 30 minutes of observation focusing on the mitigation zone (500 m from the acoustic source) should be undertaken.
Summary	Guidelines were met, i.e. a trained non-dedicated JNCC MMO assisted by non-trained MMO carried out search of mitigation zone for 60 minutes before doing swath bathymetry and sub-bottom profiling in water depths >200 m. No marine mammals were sighted during the observations.
Annex	Annex 1: MMO Certificate_AFlohr Annex 2: JC231_recording form Annex 3: Eventlogger_MMO_JC231 Annex 4: Eventlogger_Acoustic events_JC231 Annex 5: MEMP_JC231

Date 19/07/2022

21. Acknowledgements

We thank all the crew of the *RRS James Cook* and the NMF technicians who kept us working to deliver our sometimes-challenging science programme. The catering was exceptional, and we were well looked after. This cruise (and the fellowship) was a contribution to the Climate Linked Atlantic Section Science (CLASS) project supported by the UK Natural Environment Research Council (grant number NE/R015953/1). iFADO supported additional servicing of PAP1 sensors, which also contribute to ICOS and to EMSO research infrastructures. The ANTICS team were supported by EC funding and EU AtlantECO project. We would like to acknowledge the Met Office for supply of the Mobilis buoy, and an ARGO float. With thanks to NEODAAS for satellite data throughout JC231. Thanks to OBG and OTE colleagues (ashore and at sea) and to Campbell Ocean data (COD) for initial PAP1 setup ashore and assistance from a distance.