National Oceanography Centre

RRS Discovery Cruise 130

25 March – 14 April 2021

UK

Time-series studies at the Porcupine Abyssal Plain Sustained Observatory

Susan E. Hartman

2021

Cruise report number 74

<NOL Blank>

Document Data Sheet

Author	*Publication Date*
Susan E. Hartman et al.	*2021*

Title

RRS Discovery Cruise 130 /25 Mar – 15 Apr 2021 / Time-series studies at the Porcupine Abyssal Plain Sustained Observatory / UK

Reference

Southampton, UK: National Oceanography Centre, Southampton, 187 pp. (National Oceanography Centre Cruise Report, No. 74)

Abstract

RRS Discovery cruise 130 departed Southampton 25th March 2021, operated in the Whittard Canyon (28th-29th March) and the Porcupine Abyssal Plain Sustained Observatory area (30th March – 11th April 2021), returning to Southampton 15th April 2021. 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. Additional goals were to service a mooring at Whittard Canyon and start the EXPORTS programme by deployment of a UK (iFADO) and 2 USA (EXPORTS) gliders. The ongoing Covid-19 pandemic limited to operations to some extent with reduced staff on board but DY130 was a more complete cruise than DY116. 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 and collaborate with the USA EXPORTS programme.

The new Met Office Mobilis buoy was successfully recovered and it was redeployed with a sensor frame at 30m, restarting the time series of subsurface measurements. The sediment traps were successfully turned around at both PAP and the Whittard canyon. 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. The benthic time series was continued with a series of seafloor photographic surveys, sediment core sampling, amphipod traps and trawling. A series of zooplankton nets were collected en route at PAP-SO. Underway data were collected and a Met Office Biogeochemistry Argo float was deployed. We deployed two gliders for the NASA led USA EXPORTS and a UK glider (GOCART, iFADO projects). The 3 gliders surveyed nearby features to the north west, north east and south of PAP. All three gliders were validated at sea, with additional sampling from the CTD rosettes following EXPORTS protocols. The gliders were retrieved in May 2021 on the EXPORTS cruises.

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).

Keywords

Porcupine Abyssal Plain, Whittard Canyon, Ocean Observation, ICOS, EMSO, NASA, EXPORTS, iFADO, Met Office, GOCART, Gliders, Biogeochemistry, time series

Issuing Organisation

National Oceanography Centre

European Way

Southampton

SO14 3ZH, UK

Tel: +44(0)23 80596116 Email: nol@noc.soton.ac.uk

A pdf of this report is available for download at: http://eprints.soton.ac.uk

(This page intentionally left blank)

<NOL Blank>

Contents

1. Personnel

No.	Family Name	Given Names	Rank or Rating
1	GATTI	ANTONIO	Master
2	OVENDEN	ROBERT JOHN	C/O
3	STRINGFELLOW	GRAHAM ROBERT	2/O
4	ASTELL	RACHEL KATHLEEN	3/O
5	ARTHUR	GREGOR FRASER	C/Eng
6	KEMP	CHRISTOPHER MARTIN	2/E
7	NICHOLSON	GAVIN	3/E
8	ROONEY	SEAN ROBERT	3/E
9	BRAZIER	THOMAS PHILIP	ETO
10	FORBES-SIMPSON	VALERIJA	Purser
11	MACLEAN	ANDREW	CPOD
12	LAPSLEY	CRAIG JAMES	CPOS
13	MACKINNON	MARSHALL STEWART	POD
14	GILFILLAN	CRAIG ROSS	POS
15	DEVITT	CHRISTOPHER GERARD	SG1A
16	BURKE	TERRY	SG1A
17	MCMASTER	COLIN	SG1A
18	WILLIAMS	EMLYN GORDON	ERPO
19	ASHFIELD	MARK JAMES	H/Chef
20	RAY	CHARLOTTE JAYNE	Chef
21	PIPER	CARL	Stwd
22	MC MAHON	MELISSA	A/Stwd
23	HARTMAN	SUSAN ELIZABETH	PSO
24	GATES	ANDREW RUSSELL	Scientist
25	PEBODY	CORINNE ANNE	Scientist
26	DOUGLAS	CLARA CELESTINE	Scientist
27	WARDELL	CATHERINE ANN	Scientist
28	FLOHR	ANITA	Scientist
29	KOKUHENNADIGE	HASHAN NIROSHANA	Scientist
30	MIGUEL CARVALHO	ANA FILIPA	Scientist
31	FELTHAM	CHRISTOPHER NIGEL	Scientist
32	RUNDLE	NICHOLAS JAN	STO
33	ROBERTS	THOMAS	Tech
34	PLATT	WILLIAM ROBERT	Tech
35	LEADBEATER	ANDREW JOHN	Tech
36	VIERA RIVERO	JOSUE DANIEL	Tech
37	MC DONAGH	STEPHEN JOSEPH	Tech
38	COTMORE	ANDREW JOHN	Tech
39	HENDERSON	PAUL ROBERT	Tech
40	ARNOTT	JACK MATTHEW	Tech
41	PEDDER	JOSHUA ANTHONY	Tech
42	YEOMANS	MARTIN	Tech
43	NEMETH	ZOLTAN	SST

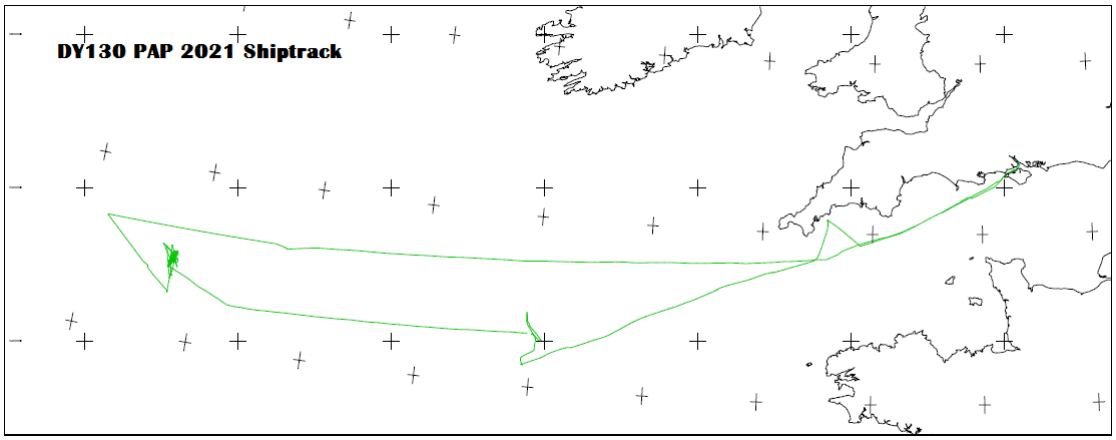
2. Itinerary

Onboard from 21/3/21. Sail NOC, Southampton, UK 25 Mar 2021.

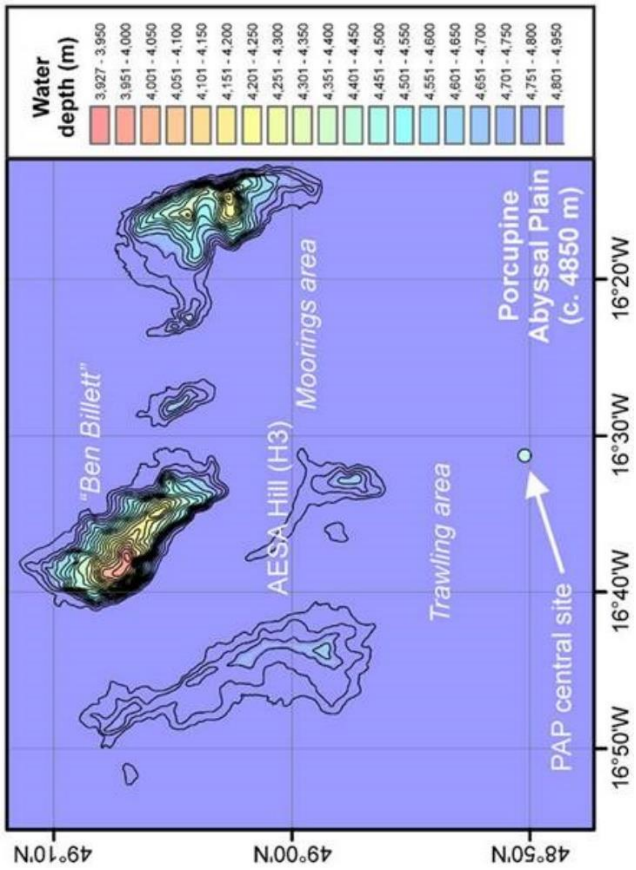
Operations at Whittard Canyon, 28-29 Mar 2021

Operations at the Porcupine Abyssal Plain Sustained Observatory, 30 Mar-11 Apr 2021

Dock, Southampton, UK 14 Apr 2021.



Map of DY130 cruise track



General chart of the Porcupine Abyssal Plain Sustained Observatory operations area for RRS Discovery cruise 130, 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 Discovery cruise 130 (DY130) 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 start the field programme of the USA EXPORTS study and enhance collaboration with the Met Office.

The specific objectives of DY130 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 new Met Office buoy with surface ocean biogeochemistry sensors at PAP-SO
8. Deployment of 3 gliders at PAP-SO (EXPORTS, GO-CART, IFADO)
9. Photography of the seabed using an ROV (HyBIS)

10. Megacore sampling of the seabed
11. Amphipod trap deployment and recovery
12. Short Agassiz trawls
13. WP2 zooplankton nets
14. ADCP survey of possible EXPORTS eddy en route to PAP-SO
15. Other associated CTDs at PAP-SO and in an eddy to the east of PAP-SO (for EXPORTS)
16. Deployment of Met Office BGC Argo float (Euro Argo) in an eddy to the east of PAP-SO

4. Narrative

Preparation for DY130 was unusual in that it was very close in time to DY116 (November 2020) and we had limited access to NOC prior to the cruise due to covid-19 precautions. Prior the cruise we have all undergone home Covid-19 tests to allow us to join the cruise

Cruise diary

24/3/21 Wed – We all joined the ship by the 21/3/21 with masks, segregation and temperature checks in place. Photos of gliders dockside and Portsmouth school outreach in morning. We have 4 decorated polystyrene heads from 2 schools (IOW and Portsmouth). Science meetings for the cruise and with the USA EXPORT teams ashore. NEODAAS satellite information arriving (EU project iFADO).

25/3/21 Thurs – RRS *Discovery* set sail from Southampton following negative Covid-19 tests by all personnel and a period of quarantine on board. Planning of the activities on the cruise was weather dependent because of the time of year. 1st station after 1 hour, a ship calibration of multibeam systems near the Needles overseen by Cat and Zoltan (for Tim le Bas ashore). Sampling meetings and a safety drill. The original plan to work at PAP-SO looks unworkable for the foreseeable future. Whittard Canyon might be workable sooner. We will in the shelter offered near Falmouth until more suitable weather is predicted at PAP. Underway water was on from 12:00 and Anita set up 2 CO_2 systems. Started zooplankton nets for midnight and midday whilst in UK waters.

26/3/21 Fri – Shelter near Falmouth, continuing the microplastic nets for Dan Mayor (ashore) and some of us took part in a quiz.

27/3/21 Sat – We depart Falmouth and head out into strong winds and heavy seas toward Whittard Canyon and PAP-SO. Progress is slow but there is a weather window on the horizon and we must take advantage of such opportunities. Continuing the nets with gannets around. Preparations and checks of the PAP1 frame sensors and other equipment.

28/3/21 Sun- In deep waters near Whittard canyon we carry out a CTD cast to test the acoustic release for the deployment of a replacement mooring, removing Niskins to test microcats with sampling at teatime. Overnight multibeam survey of Whittard canyon, heading North at 5 knots (some loss of items in the galley and duty mess in the early hours).

29/3/21 Mon –On arrival at Whittard Canyon the weather conditions are suitable to recover the mooring deployed in 2020, it was released and successfully recovered by breakfast. The weather and sea state are still suitable and by late morning we complete successful deployment and triangulate the position of a replacement mooring in the same location at Whittard Canyon. A 1-hour mammal watch was completed (Corinne) so that the multibeam could go back on. PAP1 (~24 hour away) – with plans to do an ADCP transit through the C4 EXPORTS eddy.

30/3/21 Tue – Arrival at PAP, approaching via the southern eddy (to ADCP and send data to USA). Relatively calm and sunny day to prepare for retrieving the PAP1 buoy on the 1st. Saw a few whales blow. Fire drill and evening 100m shallow CTD for PAP1 microcats. HyBIS Dive 1 overnight.

31/3/21 Wed – Early morning deep CTD, sampling and checks on the PAP3 microcats and releases. New PAP3 sediment trap is deployed and triangulated at the PAPSO site but we had some difficulty on the final triangulation (that took nearly 2 hours). Night shift Megacore, aim to do 2 but there were winch issues (GP winch cabinet - traced to a fan).

1/4/21 Thursday- Start with 100m CTD and prep the Amphipod trap. Filipa prepared a glider on deck. Completed a calibration of the ship's meteorological sensors against the PAP surface buoy ("met cal" for Mags Yelland ashore). Then move to Amphipod trap location just north of PAP1 watch circle. Plan a glider deployment north of amphipod trap (5mile from trap position) – waiting for it to surface and maintaining contact with the USA EXPORTS team. PAP1 retrieval (the deployment video was useful as the team had not lifted Mobilis onboard before). HyBIS overnight and an Easter egg contest onboard arranged by the purser.

2/4/21 Good Fri – 1000m CTD (near the glider position) and day nets. PAP1 preps in day followed by an evening quiz and night time Coring.

3/4/21 sat –A weather window has materialised and it is possible to deploy the new Mobilis MO buoy - the largest mooring at the PAP-SO site. The deployment of the mooring is successfully completed by lunchtime. The PAP1 mooring has the surface Met Office buoy with NOC biogeochemistry sensors on the keel and atmospheric CO2 on the mast. We included a 30m frame with additional sensors that had not been deployed on DY116 but has been used in our time series. Real-time data can be seen coming in for most sensors

https://projects.noc.ac.uk/pap/data/pap with some delay on the ODO. Move to Amphipod trap site for midday nets and ping to recover: 1.45 mins estimate to deck (after ~53 hours at depth). Use the time to deploy seaglider 2 (however we had to rescue it). Then deploy the Slocum. HYBIS night dive survey.

4/4/21 Easter Sunday – Weather window used to validate the glider with a 1000m CTD cast (and an earlier 100m cast at PAP1 to validate sensors there). Deploy glider 2 again, it had a bit of damage to the conductivity. Cores the afternoon and through the night. Had a safety drill combined with an egg hunt which was illuminating. Night net and 4 Cores done (deployments start during day shift) though we realised this may be a bit much in a single night watch.

5/4/21 mon –Glider cal cast at breakfast (slight delay due to core 4). Deploy the Amphipod trap again, after midday and watch the decent rate. It will likely get 48 hours a bad weather is predicted (5m swells). Recover PAP3 while mooring operations are possible. It appears to have collected another good dataset to add to the long-running PAP time series. 2 'met cals' after this then a HyBIS night. We are seeing some lovely images from the HyBIS that were shared on a blog.

6/4/21 tue- Deep CTD (with school outreach as well as sampling in mind). Core early in the afternoon and through the night, interspersed with a zooplankton net. An interesting ships quiz organised by our lovely purser and egg contest winners were announced. A wagtail joined us for the rest of the cruise at this point.

7/4/21 wed- Deep CTD delayed a bit due to issues with the last core. Likewise, some issues with the CTD, and the next one will need to be a deep one to sort this out. Recover Amphipod Trap late afternoon (was at depth ~47.5 hours). Pilot whales spotted from the bridge along with a kestrel sheltering on foredeck. Multibeam survey on an abyssal hill to south, which was then surveyed by HyBIS through the night.

8/4/21 thur- All gliders have now gone off to eddies to the North east, west, and to the south. Had a morning deep CTD to allow winch spool and take deep samples. Bottle 4 had been playing up and was replaced with 19. Agassiz trawls from mid-afternoon, the catch was light in the 1st and the net ripped for the 2nd trawl.

9/4/21 fri- Trawl processing then a second PAP1 calibration cast now that the ODO is sending data back. Sub bottom profiling north west of PAP central. Followed by 2 trawls from mid-afternoon and through the night, with a last night net. Trawl 4 as the best so far

10/4/21 sat- Increased wind. Had a 3000m Deep CTD to collect water for sub standards. Afternoon coring near Ben Billett – in the sunshine! (2 to slice, others to store whole). Multibeam survey south of hill then HYBIS up to north.

11/4/21 sun- Leave PAP ~6am with plans for an ADCP survey to northwest (A5) then to eastern A2 eddy

12/4/21 mon- Aim for 00:30 at the A2 eddy, to spot the Slocum glider (it has a strobe light so was spotted from the bridge). Had a 1000m 'EXPORTS style' CTD site to validate the glider and as pre-deployment validation for the Argo BGC Navis float (deployed by 03:30). The float is part of the EuroArgo programme and part of a wider collaboration between NOC and the UK Met office. Head back to Southampton with a day of filtering and analysis.

13/4/21 tue – In transit collating cruise reports, clearing the labs and packing up equipment. Underway system off around midday, near Cornwall.

14/4/21 wed- Last station is a multibeam survey near the needles. Arrive back in Southampton. Scientists and technicians disembark RRS Discovery and demobilisation begins.

DY130 cruise photograph

Links to outreach and news stories from the DY130 cruise:

National Oceanography Centre is leading the DY130 campaign - iFADO

DY130 cruise visit PAP | OTC Carbon Portal (icos-cp.eu)

NOC extends 36-year climate change study in the Northeast Atlantic Ocean | National Oceanography Centre

DY130 cruise sets out – Porcupine Abyssal Plain Observatory (wordpress.com)

DY130 cruise is in full swing with sediment traps – Porcupine Abyssal Plain Observatory (wordpress.com)

Net sampling on DY130 – Porcupine Abyssal Plain Observatory (wordpress.com)

#DY130 sampling starts – Porcupine Abyssal Plain Observatory (wordpress.com)

#DY130 cruise at Whittard Canyon – Porcupine Abyssal Plain Observatory (wordpress.com)

#DY130 at the PAP-SO – Porcupine Abyssal Plain Observatory (wordpress.com)

#DY130 PAP-SO – PAP and Met Office Mobilis buoy and sensors recovered and deployed – Porcupine Abyssal Plain Observatory (wordpress.com)

#DY130 Exploring the abyssal seabed – Porcupine Abyssal Plain Observatory (wordpress.com)

#DY130 is the first cruise for this lab technician: – Porcupine Abyssal Plain Observatory (wordpress.com)

#DY130 Hampshire schools get their heads in the game – Porcupine Abyssal Plain Observatory (wordpress.com)

#DY130- Amazing assemblages of amphipods – Porcupine Abyssal Plain Observatory (wordpress.com)

5. NMF technical report Sensors and Moorings

Nick Rundle (Senior Technical Officer), Tom Roberts

DY130 the PAP 2021 cruise was programmed to mobilise only four and a half months after completing the asset-recovery focused DY116 at PAP (see cruise report for details), which was delayed due to the COVID 19 pandemic. The science team was still not at full capacity for DY130 and access to the NOC site and facilities was still restricted, even more so than during preparation for DY116. All the cruises during the pandemic have been sensors and moorings focused so that the available technical team has been spread as thin as conceivably possible to support the cruise program. The PAP1 mooring is a collaborative effort involving three NOC groups, OBG, OTEG and NMF and two external organisations, the Met Office (who were working 50% capacity on site) and Campbell Ocean Data (COD). Additionally, on DY130 OBG and NMF are supporting the EXPORTS glider deployments which come with significant CTD calibration/deployment requirements.

The PAP 1 mooring deployed on DY116 was a trimmed version of the planned system, comprising of a MOBILIS surface buoy fitted with surface and atmospheric CO_2 sensors, two MicroCats, an oxygen optode, a fluorometer and an OCR on the buoy halo. There were also Star Oddis on the 26m of chain below the buoy. The PAP 1 mooring deployed on DY130, 5 months, later was complete with full sensor cage suspended at 30m with near real time data. It also trialled an acoustic modem as a back-up for the NRT data.

As with the DY116 cruise in November, the weather conditions at PAP in March for DY130 were likely to be changeable with high probability of downtime as a result. Unfavourable conditions in 2020 resulted in the deployment of the Whittard Canyon mooring on the way out to the PAP site and again on DY130 in 2021 due to a weather front moving across the Atlantic at the start of the cruise.

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 MOBILIS buoy is still limited to the one deployment. 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 was such that all mooring operations could be comfortably accomplished with two 5Tonne deck winches, the gantry and ship's cranes. The only other stern operation, the Agassiz trawl, only used one of the deck winches.

Whittard Canyon

The conditions at Whittard on arrival were as workable as the forecast had suggested; 2 to 3m 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.

DY116 Whittard Canyon Mooring Recovery

The set up for recovery was to use a basic direct pull method through a sheave block on the port pedestal crane to the 5 Tonne winch fitted forward and starboard on the work deck. The starboard crane fitted with a pendant was used for releasing the mooring.

A recovery rope was attached to the 5T winch and run around the aft of the ship and up the starboard bulwark. The mooring was released at 8:55am and took approximately 30 minutes to fully 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 at 09:29.

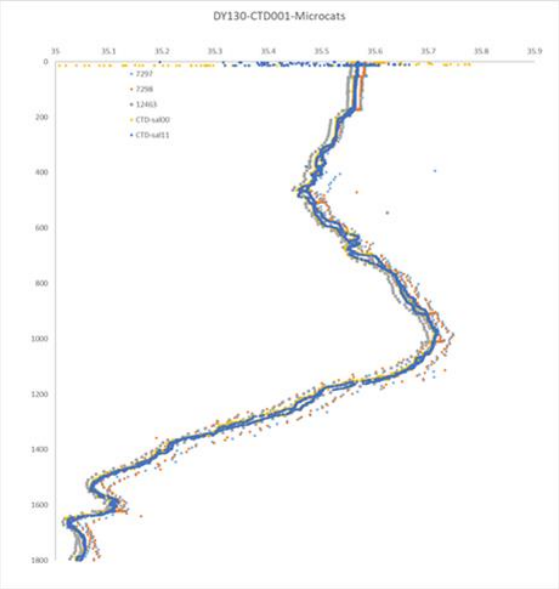
The pellet float was removed from the recovery line and the line attached to the recover rope. The line was then slowly walked aft while the winch took the slack and the ship started to move off slowly at 0.5Knots.

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

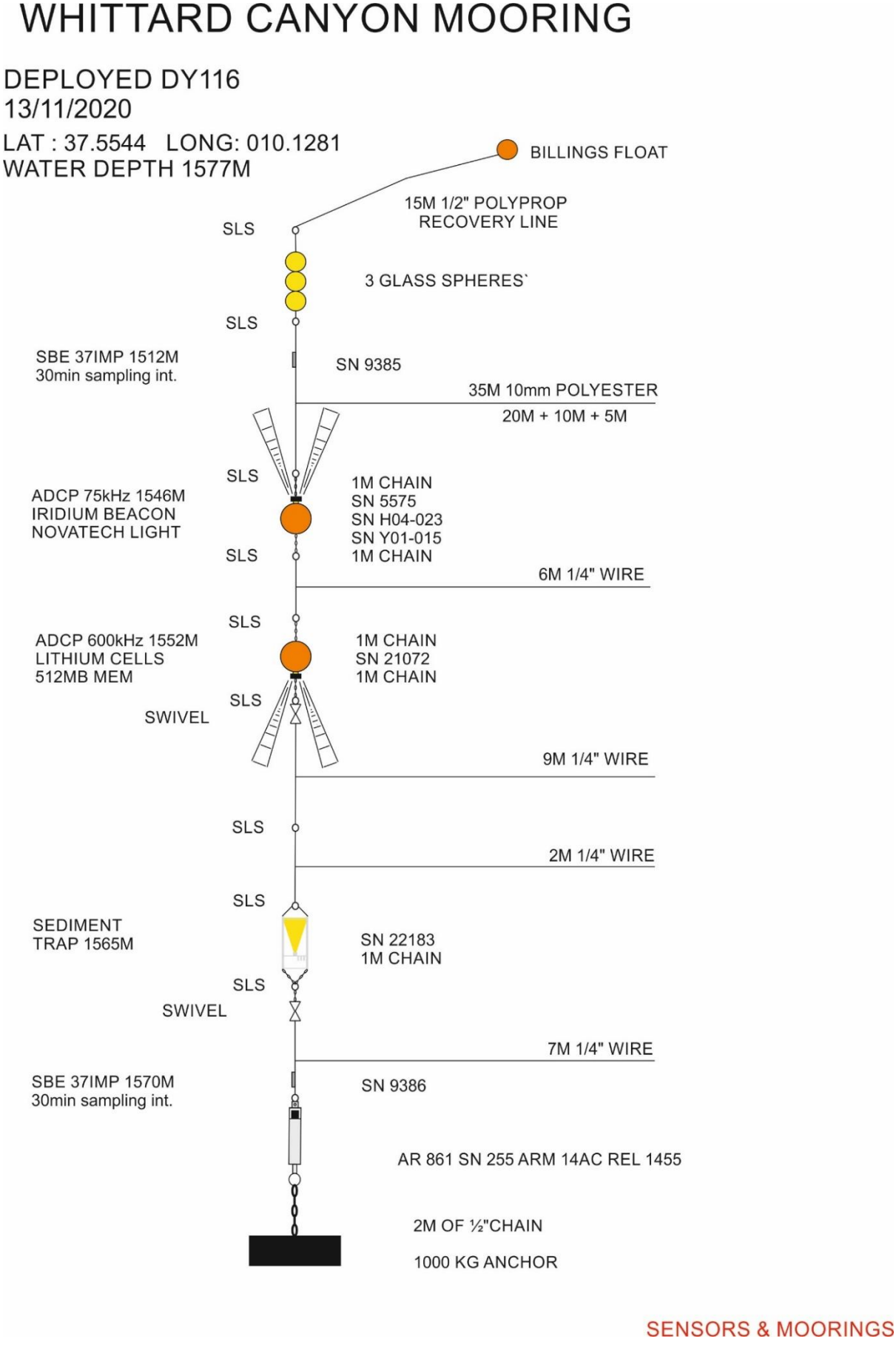
As with the 2019 deployment the sediment trap funnel was blocked with an unknown deposit on retrieval. Although it was significantly less than was present in the 2019 mooring, the quantity was still significant enough to prevent any of the bottles of the trap from indexing.

The mooring release landed on deck at 9.53am. The two SeaBird 37 CTD 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.

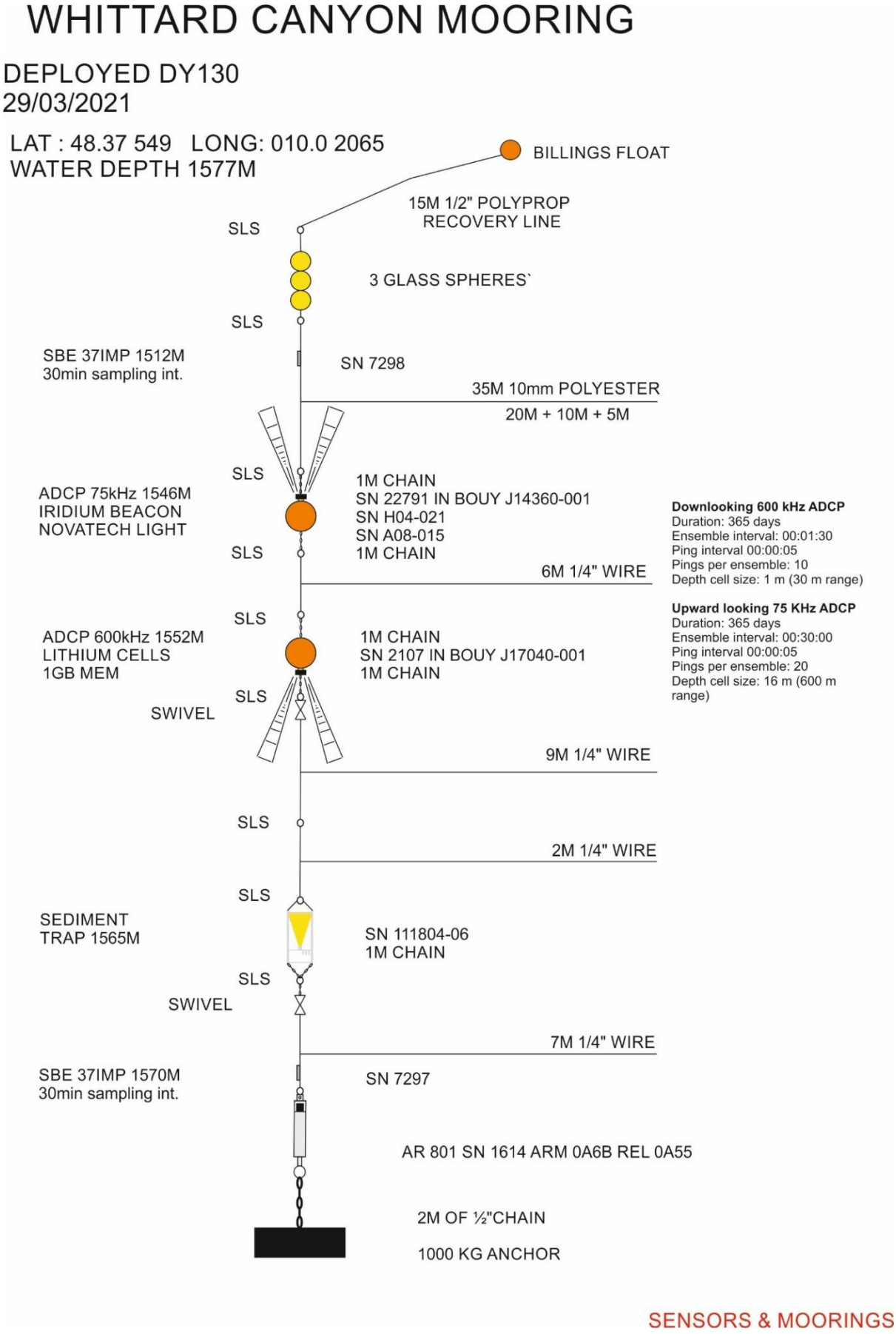
Prior to moored deployment three SeaBird MicroCat 37 CTDs were validated on CTD cast along with two IXSEA releases. From the data SBE 7297 and 7298 were selected for deployment and S/N 1614 was the selected release.



Whittard SeaBird pre-deployment validation



DY130 Whittard Canyon Mooring Deployment



It appears that the SBE 37 S/N 7297 which was deployed at 1570m was not changed from the 10 second sample interval used on the validation cast (CTD1) and unfortunately may not have enough memory or battery to last a full year's deployment.

SBE 7297 set up

DS
SBE37SM-RS232 3.0h SERIAL NO. 7297 29 Mar 2021 11:18:15
vMain = 6.97, vLith = 3.06
samplenumber = 5, free = 559235
logging
sample interval = 10 seconds
data format = converted engineering
output salinity
transmit real-time = no
sync mode = no
pump installed = yes, minimum conductivity frequency = 3000.0
<Executed/>

SBE 7298 set up

DS
SBE37SM-RS232 3.0h SERIAL NO. 7298 29 Mar 2021 11:14:31
vMain = 6.90, vLith = 3.08
samplenumber = 0, free = 559240
logging
sample interval = 1800 seconds
data format = converted engineering
output salinity
transmit real-time = yes
sync mode = no
pump installed = yes, minimum conductivity frequency = 3000.0
<Executed/>

The 75kHz and 600 kHz ADCPs were assembled at base and programmed in the deck lab before deployment. With the following given parameters (see appendix for deployment file)

Downward looking 600 kHz ADCP

Duration: 365 days

Ensemble interval: 00:01:30

Ping interval 00:00:05

Pings per ensemble: 10

Depth cell size: 1 m (30 m range)

Upward looking 75 KHz ADCP

Duration: 365 days

Ensemble interval: 00:30:00

Ping interval 00:00:05

Pings per ensemble: 20

Depth cell size: 16 m (600 m range)

The mooring rope was wound onto the starboard deck winch. The anchor chain was placed to the edge of the red zone, outside the run of the deployment.

The mooring was payed out buoy first with the first SeaBird just below the top 3 glass spheres. 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.

The mooring was successfully streamed aft whilst the ship maintained a heading at 0.5knotts on a heading to give a 200m run into the drop site with a 50m fall back. The mooring was released from the starboard crane by Seacatch at 11:58am. The mooring was followed down acoustically and then the ship was manoeuvred to triangulate the mooring giving a final resting position of 48 37.5492Lat 010 0.2065Long.

Buoy Anchor Position Calculator

Mooring Name:	Whittard Canyon					
Buoy Deployment Method:	Buoy First					
	LATITUDE			LONGITUDE		
	Degrees	Minutes	Quad	Degrees	Minutes	Quad
Planned Seabed Position For Anchor:	48°	37.5740'	N	010°	00.2520'	W
Water Depth At Planned Seabed Anchor Position:	1,577 m					
Calculated Fall Back Distance :	225 m					
Vessels Track:	280.0°					
	LATITUDE			LONGITUDE		
	Degrees	Minutes	Quad	Degrees	Minutes	Quad
Anchor Release Position (At The Stern):	48°	37.6000'	N	010°	00.3000'	W
	LATITUDE			LONGITUDE		
	Degrees	Minutes	Quad	Degrees	Minutes	Quad
Estimated Fall Back Seabed Position:	48°	37.5789'	N	010°	00.1188'	W

	LATITUDE			LONGITUDE		
	Degrees	Minutes	Quad	Degrees	Minutes	Quad
First Buoy Ranging Position:	48°	37.3450'	N	010°	00.2520'	W
First Ranging Position Ping Distance:	1,628 m					
Calculated Horizontal Distance:	404 m					
	LATITUDE			LONGITUDE		
	Degrees	Minutes	Quad	Degrees	Minutes	Quad
Second Buoy Ranging Position:	48°	37.7210'	N	009°	59.8280'	W
Second Ranging Position Ping Distance:	1,677 m					
Calculated Horizontal Distance:	570 m					
	LATITUDE			LONGITUDE		
	Degrees	Minutes	Quad	Degrees	Minutes	Quad
Third Buoy Ranging Position:	48°	37.7940'	N	010°	00.4220'	W
Third Ranging Position Ping Distance:	1,645 m					
Calculated Horizontal Distance:	468 m					

Arc Sampling Interval:	0.50° = 4.2 m steps on the arc.					
Accuracy:	Low					
1st and 2nd Range Arc Intersection Calculated:	Yes					
2nd and 3rd Range Arc Intersection Calculated:	Yes					
3rd and 1st Range Arc Intersection Calculated:	Yes					
	LATITUDE			LONGITUDE		
	00°	00.'0000	Quad	000°	00.'0000	Quad
Calculated Seabed Position	48°	37.5492'	N	010°	00.2065'	W

PAP3 Mooring

The PAP 3 sediment trap mooring is normally deployed before recovery of the previous deployment with the exception of the 2020 DY103 recovery on DY116, as this was asset focussed. This is to ensure overlap and continuity of data.

PAP 3 DEPLOYMENT

The PAP 3 mooring has 3 sediment traps, 2 NORTEK current meters and a SeaBird 37 MicroCAT (SN 12455). The sediment traps were bottled and index at base and programmed on the ship prior to deployment.

The NORTEKS have a standard setup as defined on the PAP 3 mooring drawing.

```
============================================================
Deployment   : 21PAP3
Current time : 31/03/2021 08:42:40
Start at     : 31/03/2021 15:00:00
Comment:

------------------------------------------------------------
Measurement interval  (s) : 1800
Average interval      (s) : 30
Blanking distance     (m) : 0.35
Measurement load      (%) : 9
Power level               : HIGH
Diagnostics interval(min) : 720
Diagnostics samples       : 20
Compass upd. rate     (s) : 600
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
File wrapping             : OFF
Serial output/TellTale    : OFF
------------------------------------------------------------
Assumed duration   (days) : 365.0
Battery utilization   (%) : 91.0
Battery level         (V) : 14.0
Recorder size        (MB) : 9
Recorder free space  (MB) : 8.973
Memory required      (MB) : 1.3
Vertical vel. prec (cm/s) : 1.4
Horizon. vel. prec (cm/s) : 0.9
------------------------------------------------------------
Instrument ID             : AQD13585
Head ID                   : A6L 8337
Firmware version          : 3.39
------------------------------------------------------------
Aquadopp Version 1.30
Copyright (C) Nortek AS
============================================================
============================================================
Deployment   : 21PAP3
Current time : 31/03/2021 08:45:08
```

Start at : 31/03/2021 15:00:00
Comment:

Measurement interval (s) : 1800
Average interval (s) : 30
Blanking distance (m) : 0.35
Measurement load (%) : 9
Power level : HIGH
Diagnostics interval(min) : 720
Diagnostics samples : 20
Compass upd. rate (s) : 600
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
File wrapping : OFF
Serial output/TellTale : OFF

Assumed duration (days) : 365.0
Battery utilization (%) : 91.0
Battery level (V) : 13.7
Recorder size (MB) : 9
Recorder free space (MB) : 8.973
Memory required (MB) : 1.3
Vertical vel. prec (cm/s) : 1.4
Horizon. vel. prec (cm/s) : 0.9

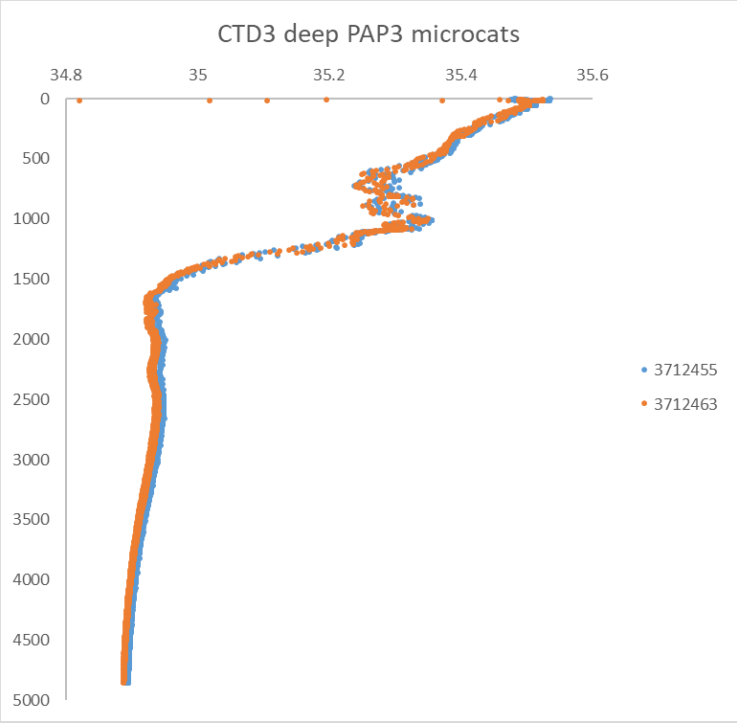
Instrument ID : AQD13569
Head ID : A6L 8332
Firmware version : 3.39

Aquadopp Version 1.30
Copyright (C) Nortek AS
==========
ds
SBE37SM-RS232 v4.1 SERIAL NO. 12455 30 Mar 2021 19:33:55
vMain = 13.54, vLith = 2.88
samplenumber = 0, free = 559240
not logging, waiting to start at 31 Mar 2021 06:30:00
sample interval = 10 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = yes, minimum conductivity frequency = 2912.9

Two SeaBird 37 MicroCats were put on a validation cast (‘pre cal PAP3’ cast CTD 3, station 21) to 4800m. The memories are wiped and the sample frequency set to every 10 seconds as standard for a validation dip on the CTD rosette. Also on this dip were 3 ISEA releases to be tested at depth.

S>ds
SBE37SM-RS232 v4.1 SERIAL NO. 12463 30 Mar 2021 18:33:54
vMain = 13.56, vLith = 3.14
samplenumber = 739, free = 558501
not logging, stop command

sample interval = 10 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = yes, minimum conductivity frequency = 3009.4
<Executed/>
samplenumber=0
this command will modify memory pointers
repeat the command to confirm
<Executed/>
samplenumber=0
<Executed/>
startdatetime=03312021063000
<start dateTime = 31 Mar 2021 06:30:00/>
<Executed/>
startlater
<!--start logging at = 31 Mar 2021 06:30:00, sample interval = 10 seconds-->
<Executed/>
ds
SBE37SM-RS232 v4.1 SERIAL NO. 12463 30 Mar 2021 18:35:16
vMain = 13.62, vLith = 3.14
samplenumber = 0, free = 559240
not logging, waiting to start at 31 Mar 2021 06:30:00
sample interval = 10 seconds
data format = converted engineering
transmit real-time = no
sync mode = no
pump installed = yes, minimum conductivity frequency = 3009.4
<Executed/>



PAP3 SeaBird 37 MicroCat validation data (CTD3)

As both sets of data from the MicroCats looked good, the S/N 12455 was used for deployment being arbitrarily labelled the primary sensor.

Of the three releases tested S/N 1919 and S/N 2329 gave the most consistent responses. S/N 1470 did release, but was intermittent on responding to signals. S/N 2329 was used on PAP 3 and S/N 1919 was used on the Amphipod trap.

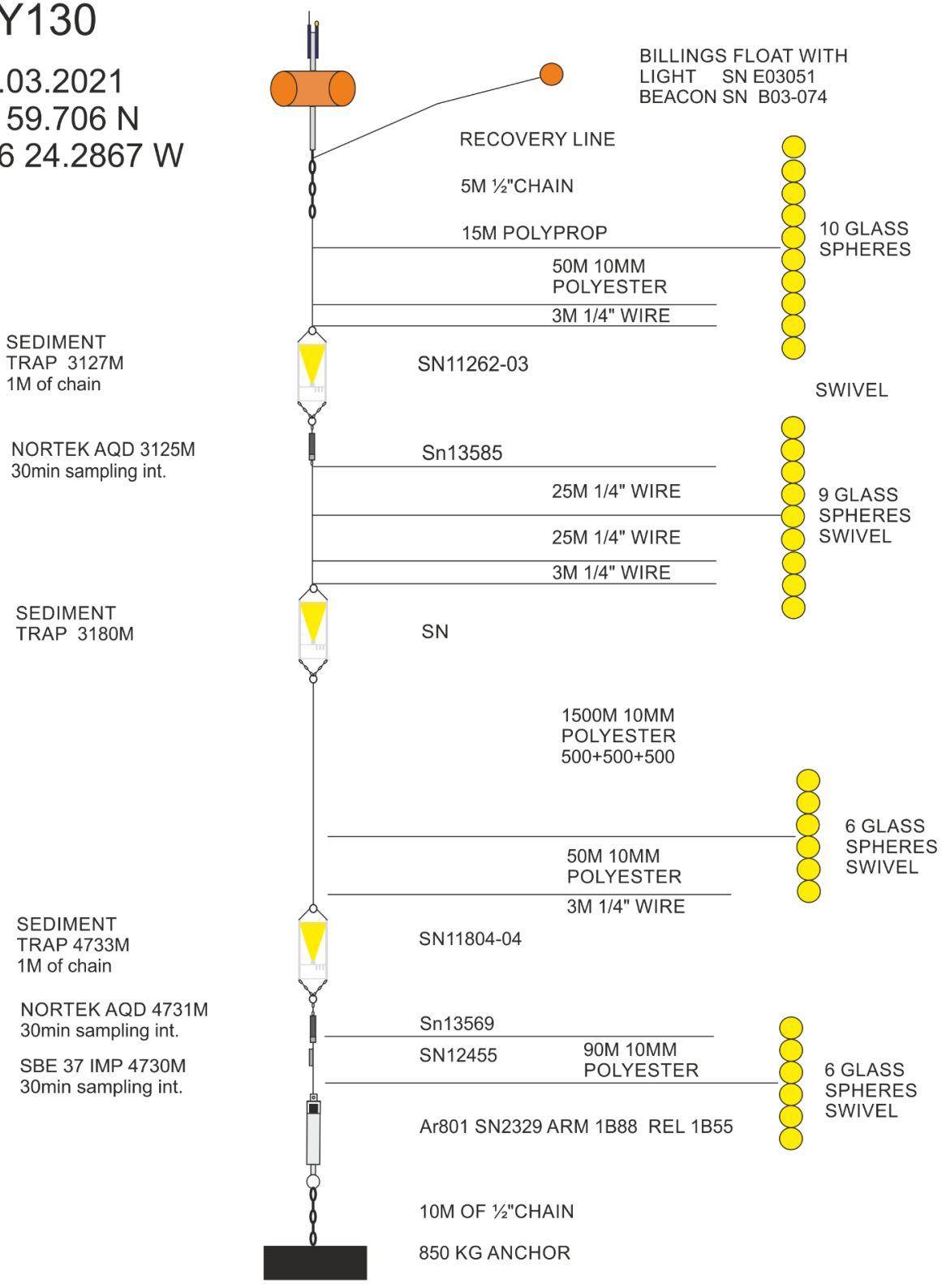
Deployment Set-up and Procedure

The rope and wire were spooled onto the port 5T deck winch with the lead passing through a block on the port pedestal crane. The rope, wire and glass were deployed directly over the aft deck using a deck stop to hold the line while the benthos floats were shackled inline. PAP 3 is deployed float first, the billings and pellet float deployed manually to start. The swivel was missed off the first 10 glass spheres so was added after the first sediment trap S/N11262-03. Each of the sediment traps was released off the starboard crane using a Seacatch, as was the anchor when the mooring was deployed. The mooring is streamed at approximately 0.5Knotts and the run up was 2000Metres with a 200m fall back allowance.

The mooring deployment commenced on the afternoon of 31st March at 13:20 and the anchor was released at 15:33. The PAP3 mooring has considerable buoyancy and takes over an hour to reach the seabed. Once the anchor was on the bottom, a triangulation was attempted. As with many previous PAP3 deployments the triangulation was not entirely successful achieving a low level of accuracy, but adequate for the scientific requirement.

PAP 3
DEPLOYED 2021
DY130

31.03.2021
48 59.706 N
016 24.2867 W



SENSORS & MOORINGS

Buoy Anchor Position Calculator

Mooring Name:	DY130 024 - PAP3					
Buoy Deployment Method:	Buoy First					
	LATITUDE			LONGITUDE		
	Degrees	Minutes	Quad	Degrees	Minutes	Quad
Planned Seabed Position For Anchor:	48°	59.7860'	N	016°	23.9750'	W
Water Depth At Planned Seabed Anchor Position:	4,844 m					
Calculated Fall Back Distance :	692 m					
Vessels Track:	039.0°					
	LATITUDE			LONGITUDE		
	Degrees	Minutes	Quad	Degrees	Minutes	Quad
Anchor Release Position (At The Stern):	48°	59.7870'	N	016°	23.9760'	W
	LATITUDE			LONGITUDE		
	Degrees	Minutes	Quad	Degrees	Minutes	Quad
Estimated Fall Back Seabed Position:	48°	59.4966'	N	016°	24.3344'	W

	LATITUDE			LONGITUDE		
	Degrees	Minutes	Quad	Degrees	Minutes	Quad
First Buoy Ranging Position:	49°	00.1822'	N	016°	23.4692'	W
First Ranging Position Ping Distance:	5,030 m					
Calculated Horizontal Distance:	1,355 m					
	LATITUDE			LONGITUDE		
	Degrees	Minutes	Quad	Degrees	Minutes	Quad
Second Buoy Ranging Position:	48°	59.8957'	N	016°	24.8586'	W
Second Ranging Position Ping Distance:	4,878 m					
Calculated Horizontal Distance:	575 m					
	LATITUDE			LONGITUDE		
	Degrees	Minutes	Quad	Degrees	Minutes	Quad
Third Buoy Ranging Position:	48°	59.7865'	N	016°	23.1648'	W
Third Ranging Position Ping Distance:	5,002 m					
Calculated Horizontal Distance:	1,247 m					

Arc Sampling Interval:	0.50°	=	9.2 m steps on the arc.			
Accuracy:	Low					
1st and 2nd Range Arc Intersection Calculated:	Yes					
2nd and 3rd Range Arc Intersection Calculated:	No					
3rd and 1st Range Arc Intersection Calculated:	Yes					
	LATITUDE			LONGITUDE		
	00°	00.'0000	Quad	000°	00.'0000	Quad
Calculated Seabed Position	48°	59.7060'	N	016°	24.2867'	W

WARNING! One Or More Of The Ping Ranging Distances Is In Error. The Seabed Position Of The Mooring Has Therefore Been Calculated With Limited Accuracy

PAP 3 Recovery

The PAP3 mooring was released on the morning of Monday 5th April about lunch time. It is estimated that the billings float reaches the surface in about 45 minutes, once on the surface the ship manoeuvred alongside and hooked the billings float at 13:54.

The billings float line was connected to the recovery line, which fed along the bulwark and round the back of the port pedestal. The retrieval was a direct pull with the recovery line connected to the 5T deck winch and passed through the block on the port crane.

As with most PAP3 recoveries, the line was tangled on the sediment traps. This is due to the amount of buoyancy spheres used to keep the sediment traps vertical, the middle trap usually being the most susceptible to tangling.

Other than a small amount of tangling the mooring came in quite easily until the end when it was noticed that the last set of buoyancy spheres and the release were missing. The rope had parted about two thirds of the way down. The cause of this is likely to be the line being snagged either on deployment or on the just after the mooring is released and parting under light tow load during retrieval. A quick check with the acoustic deck unit showed that the release was at the surface and should be visible within a few hundred metres of the ship. The end of the mooring was spotted and brought on deck at 15:45.

Instruments

The SeaBird 37 MicroCat S/N 12462 came in with a low battery warning. This is not to be expected from a five-month deployment when a normal deployment would typically be a year or more with the same settings.

Two sediment traps also had power issues, trap A and trap C (see science report for PAP3). They failed to manage a complete deployment due to low battery voltage.

NORTEK

Both NORTEKs S/N 8351 and S/N 6178 produced quality data.

S/N 8351 Header

Number of measurements	6529
Number of checksum errors	0
Time of first measurement	20/11/2020 14:00:00
Time of last measurement	05/04/2021 14:00:50

User setup

Measurement interval	1800 sec
Sampling rate	NORMAL
Average interval	30 sec
Measurement load	9 %
Transmit pulse length	0.75 m
Blanking distance	0.37 m
Compass update rate	600 sec
Diagnostics measurements	ENABLED
Diagnostics - Interval	43200 sec
Diagnostics - Number of samples	20
Diagnostics - Cell number	1
Diagnostics - Number of pings	20
Analog input 1	NONE
External input 2	NONE

Power output DISABLED
Powerlevel HIGH
Coordinate system ENU
Sound speed MEASURED
Salinity 35.0 ppt
Distance between pings 10.00 m
Number of beams 3
Number of pings per burst 2
Software version 1.30
Deployment name P
Wrap mode OFF
Deployment time 20/11/2020 14:00:00
Comments
Hardware configuration

Serial number AQD 8351
Internal code version 0
Revision number 4
Recorder size 9 MByte
Firmware version 3.37
Velocity range NORMAL
Power output 12V
Sync signal data out delay 0 sec
Sync signal power down delay 0 sec

Head configuration

Pressure sensor YES
Compass YES
Tilt sensor YES
System 1 1
Head frequency 2000 kHz
Serial number A6L 5308
Transformation matrix 0.7356 -0.3677 -0.3677
0.0000 -0.6370 0.6370
0.7888 0.7888 0.7888
Pressure sensor calibration 0 13 64024 5740
Number of beams 3

S/N 6178

Number of measurements 6534
Number of checksum errors 0
Time of first measurement 20/11/2020 14:00:00
Time of last measurement 05/04/2021 16:30:00

User setup

Measurement interval 1800 sec
Sampling rate NORMAL
Average interval 30 sec
Measurement load 9 %
Transmit pulse length 0.75 m
Blanking distance 0.37 m
Compass update rate 600 sec
Diagnostics measurements ENABLED
Diagnostics - Interval 43200 sec
Diagnostics - Number of samples 20
Diagnostics - Cell number 1

Diagnostics - Number of pings 20
Analog input 1 NONE
External input 2 NONE
Power output DISABLED
Powerlevel HIGH
Coordinate system ENU
Sound speed MEASURED
Salinity 35.0 ppt
Distance between pings 10.00 m
Number of beams 3
Number of pings per burst 2
Software version 1.30
Deployment name PAP3B
Wrap mode OFF
Deployment time 20/11/2020 14:00:00
Start command Recorder deployment
CRC download ON

Hardware configuration

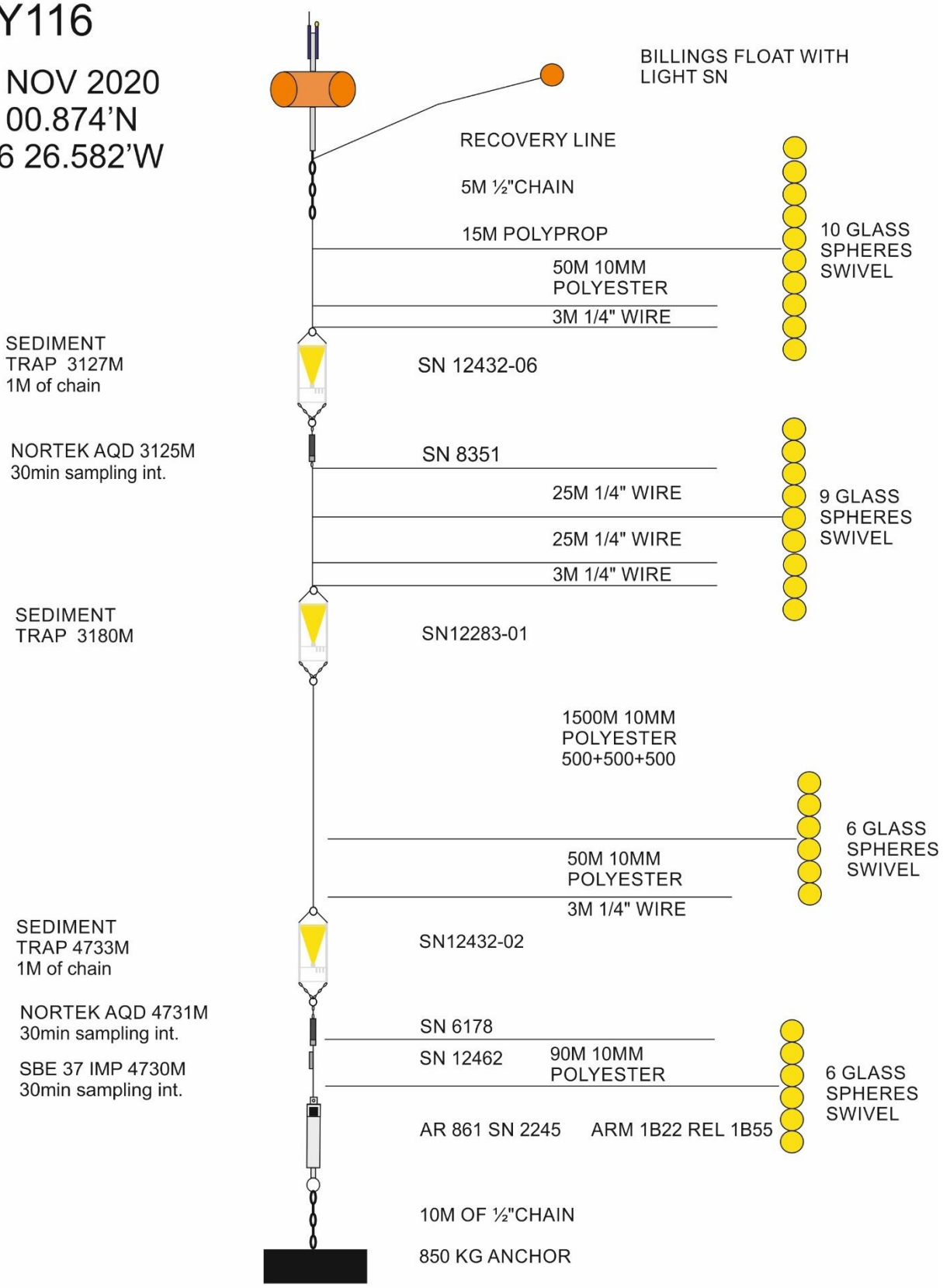
Serial number AQD 6178
Internal code version 0
Revision number 3
Recorder size 9 MByte
Firmware version 3.37
Velocity range NORMAL
Power output BATTERY
Analog input #1 calibration (a0, a1) -1471, 8826
Analog input #2 calibration (a0, a1) -1471, 8826
Sync signal data out delay 0 sec
Sync signal power down delay 0 sec

Head configuration

Pressure sensor YES
Compass YES
Tilt sensor YES
System 1 1
Head frequency 2000 kHz
Serial number A6L 3859
Transformation matrix 0.7356 -0.3677 -0.3677
0.0000 -0.6370 0.6370
0.7888 0.7888 0.7888
Pressure sensor calibration 0 11 60992 5921
Number of beams 3

PAP 3
DEPLOYED 2020
DY116

20 NOV 2020
49 00.874'N
016 26.582'W



SENSORS & MOORINGS

PAP 1 MOORING

The PAP1 mooring deployed on DY130 was the first complete platform using the MOBILIS surface buoy. The first deployment of the MOBILIS buoy on DY116 being recovered on this cruise did not have a sensor frame at 30m (see mooring diagrams). Although both buoys have a modified keel skirt, the DY116 modification is double the mass of the one being deployed on DY130 moving the centre of balance and buoyancy. This is the starting point for developing a procedure for future PAP 1 deployments.

PAP 1 Recovery

The PAP1 mooring was approached from the stern to bring the MOBILIS 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 0.5m above sea level.

The ships plasma line was passed through the main block on the gantry and shackled to a snap hook on an aluminium section recovery pole. This was the longest recovery pole available and only just able to reach the buoy recovery loops. The rail in the red zone was removed, the swell was about 2m making it awkward to hook the buoy. When hooked the gantry was positioned outboard before any load was transferred. The original plan was to use two extra snap hooks to put tag lines on, unfortunately only one hook worked.

As the load came onto the plasma rope the buoy turned with the load on the chain to the seabed streaming aft, this is when the buoy tower impacted the ship and the solar panel was damaged, had the gantry been out further this would not have happened. The buoy was lifted from the water and the gantry brought in slowly, due to the swell and only having one tag line, which was quite ineffective on its own. As it lifted out of the water the buoy was turned by the one tag line so that as it came inboard the meteorological instruments on the tower halo snagged in the ropes on the smaller gantry block on the starboard side with minimal damage.

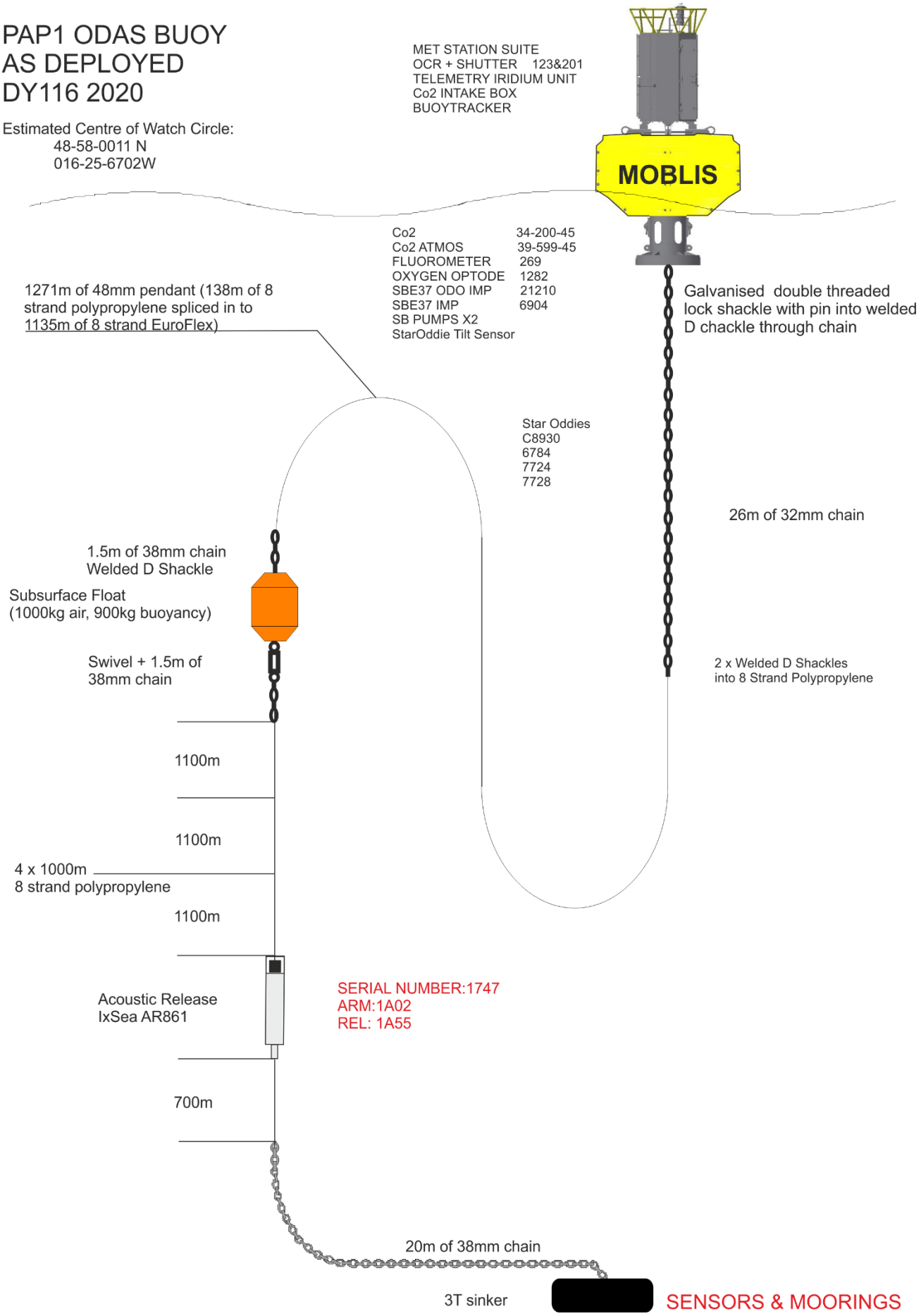
The buoy was then landed on deck, the 5tonne deck winches were connected to the loops at the side quadrants so that the buoy could be pulled forward whilst being lifted on the top loop by main warp. The buoy was landed clear of the red zone and firmly secured with ratchet straps.

The 28m of chain below the buoy was pulled in by the starboard winch and a deck stopper until the thimble of the main braided rope was on deck. The thimble eye was stoppered off on the red zone port side and a disc cutter used to cut off the welded shackle separating the buoy from the mooring.

Using a pallet truck, the guard buoy (with pellet float) 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 the main warp with a strop and a Seacatch. The buoy was then lifted and disconnected from the slack deck stopper and taken outboard on the gantry, lowered to the water and released.

PAP1 ODAS BUOY
AS DEPLOYED
DY116 2020

Estimated Centre of Watch Circle:
48-58-0011 N
016-25-6702W



PAP 1 Deployment

Recovery of the PAP1 buoy from DY116 provoked a rethink of how to recover the DY130 mooring. Discussions with the CPOS and crew, resulted in the addition of a plasma rope strop being made to be shackled between two lifting loops on adjacent quadrants. Able Seaman Marshal spliced and crafted a strop that could be cable tied up the rail on one side of the tower ladder ending with a loop in a plastic sleeve protruding from the halo. Assuming the line remain, cable tied in position, it should be much easier and safer to retrieve next year as the buoy can be hooked in a much more accessible position. Should the cable ties not hold, then the rope will be loose around the floatation and fairly easy to grapple. In theory!

The buoy was positioned in the red zone, with the keel pointing aft and fully strapped down. The 26m 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 dia 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 and landed on a pallet. The retrieval line was run through the small sheave on the starboard side and attached to the 5tonne winch on the same side. With just enough space for the guard buoy to sit between the sensor frame and and the MOBILIS buoy, the mooring rope thimble was stopped off on the deck while being reconnected to the bottom end of the frame. The guard buoy was moved out of the way with a pallet truck.

The frame was lifted on the 5Tonne attached with a SeaCatch. 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 catch released. The flaked chain was then paid out until the load was transferred to the cross bar in the buoy keel.

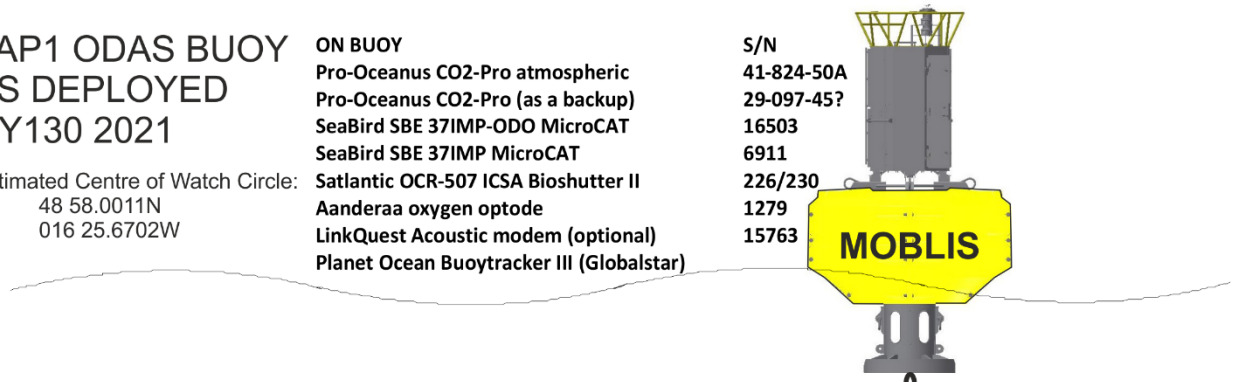
The plasma line through the main sheave on the gantry was connected to the lifting loop on the top quadrant of the buoy using a strop going back onto the large SeaCatch. Both 5Tonne winches were attached to the lifting loop in the bottom quadrant of the buoy. Tag lines were also looped round the halo to keep the top from swinging when lifted. The ratchets on the MOBILIS 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 to full extension and the buoy lowered to the water where it was release from the SeaCatch.

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)	



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

700m

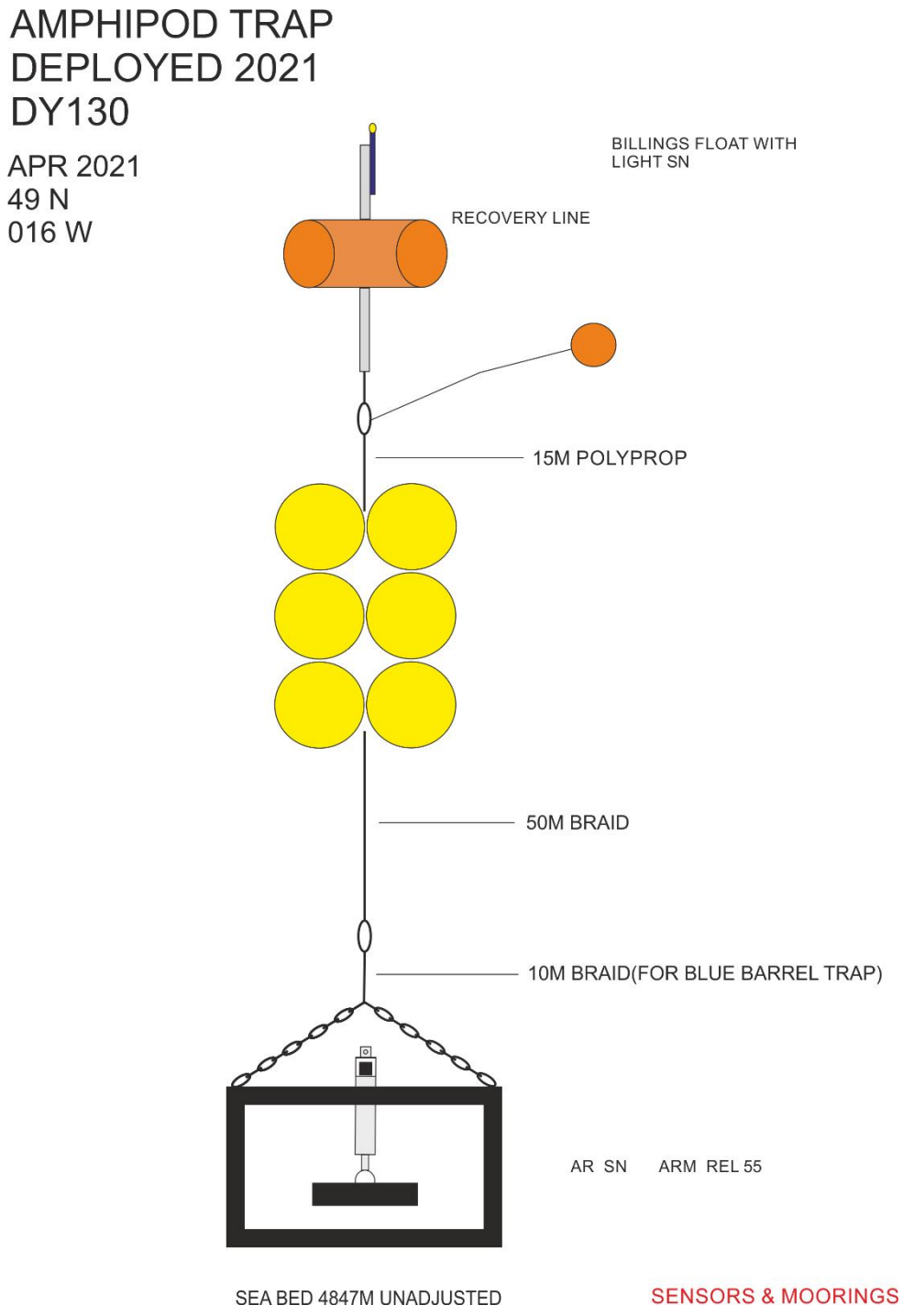
IN FRAME	S/N
Pro-Oceanus Logging CO2-Pro CV	33-146-45
Pro-Oceanus Mini TDGP sensor	39-616-31
SeaBird SBE 37-IMP-ODO MicroCAT	21549
SeaBird SBE-37IMP MicroCAT	6909
Satlantic SUNA-V2 Nitrate sensor	698
Aanderaa Seaguard	2075
Aanderaa Optode	1299
Turner Cyclops Fluorometer in Seaguard	21100373
Satlantic 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

20m of 38mm chain

3T sinker [redacted] SENSORS & MOORINGS

Amphipod Trap

There were two amphipod trap deployments of approximately 48hrs each. These moorings are handballed off the back deck and released by SeaCatch from the starboard crane.



6 HyBIS technical report

Josue Viera Rivero, Stephen McDonagh & Martin Yeomans (NMF-MARS)

Photo of HyBIS equipment on DY130

The Hydraulic Benthic Interactive Sampler (HyBIS) is a modular, versatile, robotic underwater vehicle used during DY130 for HD video and stills survey at PAP.

No. of dives DY130 (Dive nos. HY63 to HY69)	7
Water Depths	4840m
Total time at seabed or survey depth:	36:03 hrs
HyBIS total time in water:	59:48 hrs
Total Video (Apple ProRes 422)	HD 2.88 TB
	Tooling 2.79 TB
Scorpio Images	29430 images – 96.4 GB

Master #1 Lacie Raid unit SER# 81498CB59408C3FAD00C0041000 will be installed in the NOC media room for BODC to archive and provide access for scientists post cruise.

Backup #1 Lacie Raid unit SER# F8067CB534C0C3FAA20E10D000 will be retained by the ROV team until BODC have archived the Master unit. The mobilisation of Hybis in preparation for DY130 was conducted only by the HyBIS team on-board due to COVID restrictions. On Sunday 21th the Evergrip termination was installed on the deep tow cable. The HyBIS monitors and control rack were also assembled on the first bay (furthest forward) of the main lab, with the winch operator's CLAM and CCTV monitors mounted at the end of the bench.


On Monday, the HyBIS HV power supply unit was mounted on top of the portable table, inside of the High Voltage Cage, using a pallet truck on deck to move the PSU. The HYBIS team were given responsibility of the HV cage keys.


The termination was load tested to four Tonnes, in one Tonne increments holding for 5min intervals. When the cable was being held during the intervals, the loading reduced approximately 50kg-80kg as the EVERGRIP settled, a drop over 100kg would result in the load being applied again to the nearest tonne though this was not required. As a last visual check, tape was applied to the wraps in line with the top of the body so we could measure any slippage, at the end of the load test, the total slippage was 5mm.

After a successful electrical test, new fibre optic tails were spliced onto the cable. The results of the electrical and optical testing are shown below:

Optical readings were taken from the Main Lab Junction box to the terminated end of the Deep Tow.

Power meters (ref is -7 dBm):

	1310 nm	1550 nm
Red	-20.4 dBm / -13.2 dB	-21.0 dBm / -13dB
Black	-19.0 dBm / -11.6dB	-18.5 dBm / -11.2dB
Grey	-18.8 dBm / -11.5dB	-17.8 dBm / -10.50dB

OTDR readings:

	1310 nm	1550 nm
Red	9.85 km	9.84 km
Black	9.84 km	9.84 km
Grey	9.9 km	9.83 km

The termination was then connected to HyBIS with the black fibre used for telemetry (black cable tie) and the grey fibre used for the Scorpio camera (red cable tie). The vehicle was then tested using the 240V deck lead followed by the HV supply and all functions worked correctly.

The electrical conductor readings were taken from the Deep Tow in the ships workshop.

Continuity of Conductors & Earth	**Test Results Ω**
L1 – L2	91
L1 – L3	91
L2 – L3	91
L1 – Earth	49.5
L2 – Earth	49.7
L3 – Earth	49.6
Insulation Resistance Test	**Test Results (GΩ)**
L1 – L2	5.48
L1 – L3	4.46
L2 – L3	4.49
L1 – Earth	3.1
L2 – Earth	3.90
L3 – Earth	3.74

RRS Discovery deep tow cable test results

De-Mobilisation

After the last HyBIS dive, the system was isolated and an isolation certificate was completed and given to the bridge. During the de-mobilisation another deep tow wire inspection was made and the fibre optic power values and insulation resistance readings were taken and uploaded to IMS system. The HyBIS system was prepared for demobilisation during the transit back to NOC Southampton. The vehicle was stripped of lights and sensors and the cages were packed so that the HyBIS system was ready to be lifted off the ship.

Usually, the Evergrip termination is cut off after this step, at the end of the trip. However, on this occasion the termination was left fitted as a CTD backup termination for the next cruise. (EXPORTS). The CTD group have their own Evergrip which can be used in the unlikely event the termination needs to be replaced. The Evergrip body is to be returned back to us.

The crew will try to bring the Evergrip up to the high-top hanger through the sheeve of the Hydraboom. It is not confirmed this is possible. If finally, it cannot be done, this will mean that for future cruises, the Evergrip termination cannot be reused for the next following cruise, and a full termination has to be done on the mobilisation of any cruise.

Umbilical Termination

During DY130, HyBIS was the only piece of equipment attached to the deep tow cable underneath the hydra-boom, so no wire swapping was required**.** There is now a working fusion splicing kit, OTDR, optical power

meters and associated tools and consumables on board the Discovery, located in aluminium boxes in the technician's lab.

Suggestions/Recommendations

- Re-test the umbilical cable during the de-mob. TBC: Remove Evergrip termination from the umbilical and return to ROV hangar for refurbishment.

Active Heave Compensation

On the previous cruise (DY108), the Active Heave Compensation (AHC) of the deep tow cable was tested successfully. The ACH therefore was used for every HyBIS dive on DY130 and improved the image stability and video quality substantially. The AHC compensated well for the heave of the ship and HyBIS maintained a constant altitude off the sea bed (± ~0.5m) providing stable video footage and reducing the constant winch adjustments that are normally required.

For the AHC operation, HyBIS was deployed and stopped at 110m, where the AHC was turned on. The descent was then done at 0.5m/s (30m/min) until 500m depth to allow the winch to get some load. After the 500m mark, the speed was increase to 0.8m/s (48m/min) until 200m before the seabed (typically 4600m). At this point, the control of the Deep Tow was moved from the main console to the belly-box. The rest of the descent was done at lower speed checking the HyBIS altimeter (should start getting hits at 100m from seabed).

On recoveries, HyBIS was recovered at 0.8m/s until the 110m depth, with the AHC was disabled.

High Voltage Operations

As with previous cruises, the HV operations were discussed and agreed with the Chief Engineer and the ETO prior to sailing. The key to the HV cage key remained in the possession of the HyBIS HV appointed person for the duration of the trip. The HV was turned on at 110m depth, which allowed just one stop during descent and was also the depth that the Active Heave Compensation (AHC) could be turned on.

During recovery, the power to HyBIS was turned off at 200m depth and the bridge was notified when this was done so that HyBIS could be recovered to deck. A permit to work/Isolation certificate was filled out to show that the vehicle was isolated and HV probes were used each time the HV JB was opened. This was only done at the end of the cruise since no faults happened during the cruise.

Suggestions/Recommendations

The HV cage on the ship should be modified so that the front panel does not need to be dismantled each time when the HV portable system and table is installed and removed.

It would be highly recommended that the 230V supply in the HV cage be changed to a switched socket for isolation and lockout/tag out purposes. Add to DY Refit Confluence page.

HyBIS System

During DY130 the HyBIS vehicle was stowed inside the hangar, aft of the CTD slot. It was sat on a pallet and manoeuvred out under the hydra-boom prior each launch using the over-crane gantry to safely bring HyBIS out on deck. It was then lifted and deployed successfully without opening the bulwarks doors.

The associated HyBIS spares boxes and consumables were stowed in cages in the main hangar. Deck testing was achieved using the 240V AC deck lead plugged into a socket in the hanger; note this did not utilise clean electricity. The deep tow cable was not removed from the vehicle during DY130 so during deck testing, communications were done using the deep tow fibres.

Vehicle

The hydraulic system was not used on this cruise.

Suggestions/Recommendations

- Flush and replace hydraulic oil before next HyBIS cruise.

Thrusters

The thrusters were used occasionally during DY130 to correct the heading. They worked well.

Suggestions/Recommendations

- Drain all thrusters. Strip and check for signs of wear.
- TBC from DY108: Fix oil leak on starboard thruster.

Modules

The downward video frame was used for all of the dives during DY130.

Cameras

Two Super Scorpio HD cameras were made available for DY130 from the Isis ROV equipment. Unit Serial# SSC103 was mounted onto HyBIS for all the cruise. Unit SSC102 was always kept as a spare.

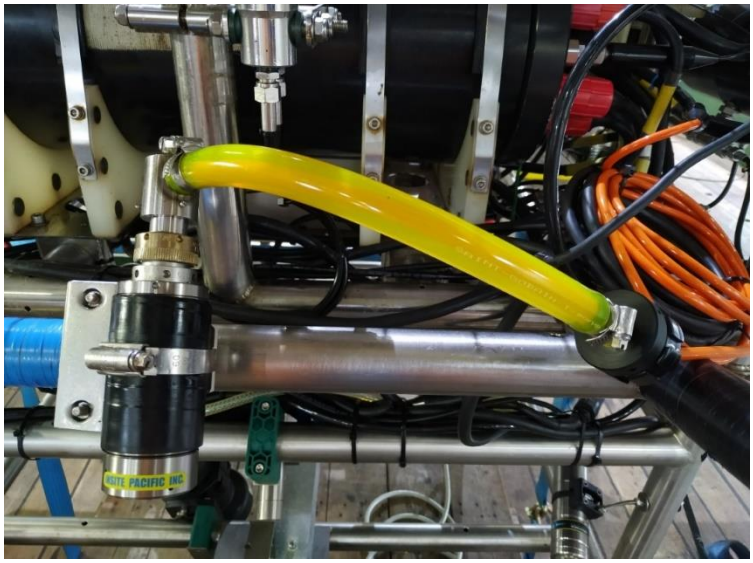
To prevent the issues related losing the camera settings, the camera was powered using the 24V power brick for an hour if there were no dives planned for the next three days. This was also done at the beginning of the cruise for both cameras, to top up the charge of the rechargeable battery.

During DY130, white balancing was not required as this was done by post processing of the video and images. The stills were done on a five second auto-timer. Finally, the download of images was done with a laptop and a power supply in the hanger.

For this cruise, one Bowtech PAL camera was available as part of the HyBIS equipment. An Aurora PAL camera was also installed on HyBIS. This camera has a DGO connector, so a special cable lead was built in-house to connect the rubber “Pie” connector to an oil filled DGO.

Pinout:

Pie Connector	DGO connector
2 – GND	A – GND
3 – Power **+12V**	B – **Power +15 to 30V** (datasheet)
Not Available	F – Coax SHLD (NOT CONNECTED to HyBIS)
1 – Signal	G – Coax Main



During the first dive HY63, after approximately four hours, the camera started to show some noise/patterns. It was still operational until the recovery, where it started to lose the signal and also cause a power issue on the other tooling camera. HyBIS was powered off at 1400m to prevent major issues. On the post-dive, it was found the Tygon tube had water ingress. This eventually started to cause a short between the power pin and signal. Upon further inspection, the Pin B of the DGO bulkhead of the camera had suffered some arcing, the pin was slightly deformed and even physical damage of the gold material was "eaten". The DGO tail also had suffered some damage. The connection was cleaned and checked. An extra jubilee clip was added to the Tygon tube since it is suspected the water had gone in through the plastic dorn fitting with the Tygon tube. The camera was checked on the pre-dive and worked correctly.

(Just as an extra note: on the pre-dive, the Focal unit had to be powered cycled. Only the compass feed and one of the tooling cameras was coming up the telemetry fibre. The joybox was not responsive, so the lights switch was not turning on the Cathx lights. Upon power cycle of the Top Focal Unit, everything was back to normal operation. Probably the Focal mainboard had not synced correctly with the subsea unit).

Extra note relating Aurora. If Pin B suffers further damage/brakes, this camera can be repaired with the following options:

a) Change the bulkhead DGO.
b) Rewire the camera to use another pin for the +ve power. This would make the camera incompatible with ISIS standard DGO, but could be relabelled as specially rewired for HYBIS.

On dive HY64, no issues were found on the Aurora DGO tail with no further leak, working correctly for the whole dive.

Dive HY65 the DGO camera started to show erratic behaviour at 200m depth. It was agreed that the best option was to abort the dive since it had just started. The other option would have been: continuing the dive, getting to the bottom and possibly suffering a power issue was a high risk, with a longer downtime. After the quick recovery, the camera was removed and the vehicle was promptly put back into the water for dive HY66. After inspection, it was found the previously damaged gold pin (pin 'B') had completely broken off. The camera had not been touched or reconnected after dive HY64, it is suspected the pin failed due to pressure being applied to the tygon hose and applying forces onto the pin. *NOTE*: If not for the first issue with water ingress from dive HY63 causing initial damage to the DGO connector, this setup from dive HY64 should be sufficient.

Suggestions/Recommendations

- Rewire the Aurora camera, using another DGO pin for the power and mark as Test unit. Annotate Serial number and IMS number (edit IMS description/notes).
- Check voltage rating of procured Auroras (datasheet says 15-30V). Isis is 24V, but HyBIS is 12V so operating outside range (MPUS is 24V).
- Return Auroras cameras to Isis/MPUS spares
- Check the Dornin black plastic cover of Scorpios is in correct position of both cameras (need to check them inside water, not on air).
- Charge and test both Scorpio cameras prior to next cruise.

Super Scorpio Specs:

HD: 1920 x 1080 / (50P), **50i,** 25p

12.3 MEGA-PIXEL quality for Ultra-High Definition (4672 x 2628-pixel) Still Images

Sensor: Exmor Back-illuminated CMOS 1/2.88" (6.2mm)

10X Optical Zoom Lens (26.3mm - 263mm in 35mm format)

Focal Distance= f= 3.8mm – 38mm

Aperture: F1.8 - F9.6

64GB Internal Flash Memory

On recovery deck download of images (Ethernet deck cable)

Lights

During video transect dives, three Cathx Aphos lights were pointed downwards to illuminate the Scorpio camera and two DSPL Lumos LED lights faced forwards for the PAL tooling camera. The rear starboard Cathx light was slightly reoriented after dive HY63 to reduce the vignette on the bottom right corner of the Scorpio image.

Suggestions/Recommendations

- Return Cathyx lights to ISIS spares container and DSPL Lumos LED lights to MPUS spares.

Scaling Lasers

Two NOC lasers were used for DY130 with two spares. The lasers worked well for the duration of the cruise. On predive of HY68 it was found that they were not powering on. After some diagnostics checking the cables, connectors and voltage output, it was found that the connection on the bulkhead of the endcap has suffered fatigue damage, if the connector was held towards the outside of the tube, there was a power shortage, if positioned inwards towards the centre of the tube, there was a stable power connection. The connectors were cleaned and secured using a cable tie to hold inwards.

Suggestions/Recommendations

- Check lasers for damage and replace seals as part of their routine maintenance.
- Check bulkhead (connectors and cabling) of low power tube endcap.
- Check Solid state relay inside tube (preferably replace it).
- Procure if required another spare laser Y-splice harness.

Valeport VA500 Pressure / Altimeter transducer

The pressure/altimeter transducer worked well for most of DY130 and proved very useful to the winch driver during bottom operations.
Occasionally, the altimeter did not return a signal to the GUI PC for a short period. The signal then re-appeared of its own accord. This is normal behaviour due to the interference with the thrusters when they are used or due to electrical noise.
The AUV 6000m Tritech sonar was used throughout DY130 and worked successfully for the duration of the cruise. The HyBIS 4000m unit was kept as a spare, but due to the depth of the dives, is not suitable.
The Xsense MTi-30 AHRS compass worked well during DY130. The compass offset is now set to zero and this seemed to correctly reflect the vehicles movements during video transects.

No issues with the 240v power lead from the transformer to the High power tube (see DY108 report)

Suggestions/Recommendations

- Check if there is a full spare for the transformer lead after the replacement of DY108.

The rack unit and lab set-up was identical to that of HyBIS cruise DY103 & DY108.

Mini HP GUI Machine

The GUI PC was used to run the Labview status displays for HyBIS. For this cruise, the new Scorpio GUI written on QT by Emre was tested on all dives. It worked successfully with no bugs.

Suggestions/Recommendations

- Reduce margins/change font size of the new Scorpio GUI to reduce the overall size.
- Add on the “Auto-set” function to set the “File Number” to “reset”.
- Modify the “Auto-set” function to activate and select the minutes on the Date/Time set screen.
- Backup Labview code.

- Update Windows to latest version and create a full backup.
-

Mini HP OFOP Machine

The OFOP PC and monitor were used to run the OFOP software. A second monitor was provided for science logging of ocean floor observations.

On the last dive, the new OFOP version was tested and worked correctly (now shows a timer when the tape countdown reaches 0 minutes).

Suggestions/Recommendations

- Procure a new 22"/24" unit (it is old and science have complained it is difficult to read).
- Backup Labview code.
- Update Windows to latest version and create a full backup.
-

AJA KiPro video recorders

Two AJA Rackmounted KiPro units were used to record video. The Top unit was assigned to the Scorpio HD camera. The lower unit was connected to the 720P50 quad which was connected to the PAL tooling camera. The copying of the KiPro disks to the Lacie units was done by the HyBIS team.

HD Video Overlay

The new modified HYBIS video overlay worked well during DY130 with no freezing or crashes.

Using the HDMI splitter, the Scorpio feed was duplicated to the main lab TV. A further feed was sent to the Bridge using a BlackBox with HDMI/DVI input.
Walkie talkie: Unit #2 had its battery replaced before the cruise. Unit #1 started to have power issues during the cruise.

Suggestions/Recommendations

- Replace battery on unit #1 for next cruise.

Football Floats

The football floats were not required for this cruise since only the downward module was used.

It should be noted that when deploying HyBIS using the hydra-boom, there is not sufficient height above the Evergrip termination to attach floats prior to deployment.

Sonardyne Beacon

One of the ROV Sonardyne WMT beacons (2709) was used for each HyBIS deployment on DY130. The Starboard USB pole was used and the beacon tracked well.
The beacon was removed from the vehicle after each dive and connected to the charger and HyBIS laptop in preparation for the next dive.
After the final dive, the beacon was safely stored and the battery was disconnected via the software (so it does not autodischarge).

Suggestions/Recommendations

- Check beacon after every 6 months.
- Check life expectancy of the rechargeable battery and budget for a spare one (e.g.: procure one with the C5 batteries)

HyBIS Dive Summary

Dives HY63 to HY67 were successfully done on the AESA grid, covering over 2.5km per dive (about 2.5 lines). Dive HY65 was aborted shortly after the deployment due to the malfunctioning of the tooling camera that was being tested on this cruise. This was quickly turned around and the vehicle was again in the water in approx. 30 min. HyBIS performed outstanding as usual, with great communications and planning with the Science party.

Dive HY68 was done on a new site, Southwest of the HyBIS PAP survey area to explore a 400m hill (from 4670m to 4380m), 1200m radius. Dive HY68 was done from the East side, going upslope at 0.2 knots and exploring the top. The first 500m were constant slope with sandy areas. The following 300m were a little more rocky with occasional big boulders (flying at 5-6m height they were not an issue). The rest of the dive was again sandy with no issues on navigation or piloting.

This was a success, discovering that the biodiversity was quite different to the previous survey area and adding evidence that more anemones reside on these mounds due to an increase in water flow bringing more food.

Finally, Dive HY69 was a flat transect south of this hill.

HyBIS Media Data

	Scorpio Video	Tooling Cams	Stills:	Files	Data
HY63	505.6	497.6		3721	12.4
HY64	507.8	519.7		6266	20.0
HY65_Abort	0.0	0.0		0	0.0
HY66	517.9	488.7		4869	16.0
HY67	531.9	504.1		6389	20.8
HY68	508.0	487.2		5844	19.2
HY69	380.6	356.5		2341	8.0
GB	2951.8	2853.8	# Files:	29430	96.4
TB	2.88	2.79			0.09

total storage used (GB)	5902.0	
total storage used (TB)	**5.76**	TB

HyBIS Dive Hr Summary

Dive 1 30/03/2021 Depth: 4830

	HY63	GMT	Difference between times
In Water	19:15:00	Hr	

	Seabed	21:23:00	Hr	02:08:00	In Water Time	10:10:00		
	Off Seabed	03:30:00	Hr	6:07:00			On Bottom Time	06:07:00
	On Surface	05:25:00	Hr	01:55:00				

Dive 2	01/04/2021	Depth:	4840					
	HY64	GMT		Difference between times				
	In Water	18:43:00	Hr					
	Seabed	20:44:00	Hr	02:01:00	In Water Time	10:37:00		
	Off Seabed	03:28:00	Hr	6:44:00			On Bottom Time	06:44:00
	On Surface	05:20:00	Hr	01:52:00				

Dive 3	03/04/2021	Depth:	Abort					
	HY65	GMT		Difference between times				
	In Water	18:47:00	Hr					
	Seabed	18:47:00	Hr	00:00:00	In Water Time	00:25:00		
	Off Seabed	18:47:00	Hr	0:00:00				
	On Surface	19:12:00	Hr	00:25:00				

Dive 4	03/04/2021	Depth:	4030					
	HY66	GMT		Difference between times				
	In Water	19:18:00	Hr					
	Seabed	21:17:00	Hr	01:59:00	In Water Time	10:04:00		
	Off Seabed	03:30:00	Hr	6:13:00				
	On Surface	05:22:00	Hr	01:52:00				

Dive 5	05/04/2021	Depth:	4835					
	HY67	GMT		Difference between times				
	In Water	18:39:00	Hr					
	Seabed	20:39:00	Hr	02:00:00	In Water Time	10:58:00		
	Off Seabed	03:32:00	Hr	6:53:00				
	On Surface	05:37:00	Hr	02:05:00				

Dive 6	07/04/2021	Depth:	4670 to 4380					
	HY68	GMT		Difference between times				
	In Water	19:34:00	Hr					
	Seabed	21:30:00	Hr	01:56:00	In Water Time	09:55:00		
	Off Seabed	03:46:00	Hr	6:16:00				
	On Surface	05:29:00	Hr	01:43:00				

Dive 7	10/04/2021	Depth:	4820

HY69	GMT		Difference between times		
In Water	21:56:00	Hr			
Seabed	23:53:00	Hr	01:57:00	In Water Time	07:39:00
Off Seabed	03:43:00	Hr	3:50:00		
On Surface	05:35:00	Hr	01:52:00		

Total Water Time	2.491667
Total Water Time	**59:48:00**

7. CTD systems

Billy Platt, Paul Henderson, Sensors & Moorings Group, NMF, NOC, Southampton

Primary SBE3P, SBE4C and SBE43 sensors were located inside the frame attached to the 9plus, and secondary sensors on the vane. CTD1 was used for all casts.

Currently it gives an insulation figure of > 999MΩ o/c and a s/c value of 63.8Ω through the swivel. MDS swivel s/n: 1246-2 was used for all casts. There were a few issues with winch scrolling which meant that the upcast had to be slowed down on several casts so as to manually adjust the scrolling gear.

The CTD sensors operated well and no changes to the main sensors were required during the cruise. Several of the 20litre water bottles failed to close during the casts. Adjustments were made to bottle 9's lanyard as it was too tight. It operated well after this. Bottle 4 closed correctly but the science party reported that the temperature of the water inside was too warm meaning it had closed at the wrong depth. This was reported several times and efforts to tweak the bottle's lanyards and clean the SBE32 made no improvement. The bottle was swapped out for another bottle.

Two PAR sensors were used on casts shallower than 500m and removed for all casts deeper than this. The Florometer used was a user supplied WetLabs FLBBRTD. This was used so that the florescence data could be better compared to that on the gliders and on the following EXPORTS cruise.

SENSOR INFORMATION

FORWARDING INSTRUCTIONS / ADDITIONAL INFORMATION:
Main Stainless Steel 24-way CTD frame on board DY130

Instrument / Sensor	Manufacturer/ Model	Serial Number	Channel	Casts Used
Primary CTD deck unit	SBE 11plus	11P-24680-0588	n/a	All casts
CTD Underwater Unit	SBE 9plus	09P-54047-0943	n/a	All casts
Stainless steel 24-way CTD frame	NOCS	SBE CTD6	n/a	All casts
Primary Temperature Sensor	SBE 3P	03P-5494	F0	All casts
Primary Conductivity Sensor	SBE 4C	04C-3768	F1	All casts
Digiquartz Pressure sensor	Paroscientific	110557	F2	All casts
Secondary Temperature Sensor	SBE 3P	03P-5785	F3	All casts
Secondary Conductivity Sensor	SBE 4C	04C-4139	F4	All casts
Primary Pump	SBE 5T	05T-6320	n/a	All casts

Secondary Pump	SBE 5T	05T-6916	n/a	All casts
24-way Carousel	SBE 32	32-31240-0423	n/a	All casts
Primary Dissolved Oxygen Sensor	SBE 43	43-2831	V0	All casts
Secondary Dissolved Oxygen Sensor	SBE 43	43-0862	V1	All casts
Chelsea PAR Light Sensor	DownWIRR	004	V2	Casts 2, 4, 6
Chelsea PAR Light Sensor	UpWIRR	005	V3	Casts 2, 4, 6
Altimeter	BENTHOS	59494	V4	All casts
AMT pH-combined sensor	AMT Deep	346	V5	Cast 001
AMT pH-combined sensor	AMT Deep	347	V5	Casts 002 - 003
WETLabs FLBBRTD	FLBBRTD	3522	V6 + V7	All casts
Titanium EM CTD Swivel	Machinery Development Services/V2_2	1246-2	n/a	All casts
20L Water Samplers	Ocean Test Equipment	n/a	n/a	All casts

The AMT deep pH sensor was trailed again after cable wiring changes had been made to try to resolve the issues experienced during DY120. The signal ground was wired to the common. Two sets of cables were tried with two different instruments but both yielded poor results. Upon deployment it would go to full signal and show a pH of 20. During the cast the signal would alter down to pH 2 at times, but increase again. pH was not used after cast 003.

Total number of casts: 14; Casts deeper than 2000m: 5; Deepest cast: 4750m

CTD Data Processing

Basic post-processing of the CTD cast data was done to guidelines established with BODC (ref. Moncoiffe 7th July 2010). Additionally, CTD2MET processing was carried out for each cast as well as processing to obtain sound velocity profiles for the multibeam system.

8. Scientific Ship Systems

Joshua Pedder & Zoltan Nemeth, Ship Scientific Systems, NMF, NOC

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)

Scientific computer systems

Underway data acquisition

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

A copy of these two drives are written to the end-of-cruise disks that are provided to the Principal Scientist and the British Oceanographic Data Centre (BODC).

List of logged ship-fitted scientific systems:
`/Cruise_Reports/DY130_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.

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/RAM`
	Test	Netcdf + Ascii RAW+QC	`/RVDAS/NCC`
Env_Temp	Continuous	NetCDF + Ascii	`/Env_Temp`
Magnetics	Unused	NetCDF + Ascii	`/Magnetics`
Gravity	Unused	NetCDF + Ascii	`/Gravity`
Kongsberg SIS (EM122)	Discrete	Kongsberg .all	`/Acoustics/EM-122/`
Kongsberg SIS (EM710)	Discrete	Kongsberg .all	`/Acoustics/EM-710/`
Kongsberg SBP	Discrete	Raw + Segy	`/Acoustics/SBP-120/`
Kongsberg EA640	Continuous	xyz, redirected to Techsas/RVDAS RAM	`/Acoustics/EA-640/`

Data acquisition system	*Usage*	*Data products*	*Directory system name*
Kongsberg EK60/80	Unused		`/Acoustics/EK-60/`
UHDAS (ADCPs)	Continuous	ASCII raw, RBIN, GBIN, CODAS files	`/Acoustics/ADCP/`
VMDAS (ADCPs)	Unused		`/Acoustics/ADCP/`
Sonardyne Ranger2	Discrete	None, 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

TechSAS logger DY130 mission started on 2021-03-24 08:36:15

RVDAS RAM Acquisition started on 2021-03-24 09:14:01

Level-C acquisition started on 2021-03-24 13:20:01

Wamos Waveredar was non-functional at the beginning of the cruise.

Started on 2021-04-01 21:37:52

Data gaps:

Acoustic sensor routinely switched off/on during trilateration or mooring release or deployment tests, these events recorded with the eventlogger, data available in Documentation/Eventlogs folder.

bash-3.00$ gaps -ldbw surfmet

time gap : 21 102 11:28:30 to 21 102 11:31:48 (3.3 mins)

time gap : 21 102 12:03:12 to 21 102 12:04:36 (84 s)

bash-3.00$

Sensor	From:	To:	Length:	Issue:	Reason:
EA640	2021-03-30 00:10:00	2021-03-30 06:20:00	06:10	Invalid Data	Maximum depth setting was lower than the actual depth.
Surfmet	2021-04-12 11:28:30	2021-04-12 11:31:48	03:20	Gap	New Software test required reboot
Surfmet	2021-04-12 11:28:30	2021-04-12 12:04:30	36:00	Invalid Data	New Software Malfunction
Surfmet	2021-04-12 12:03:12	2021-04-12 12:04:36	01:24	Gap	Restarted with original software

Internet provision

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

While underway, the ship operated with bandwidth controls to prioritise business use.

Instrumentation

Coordinate reference

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

Origin (RRS Discovery)

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

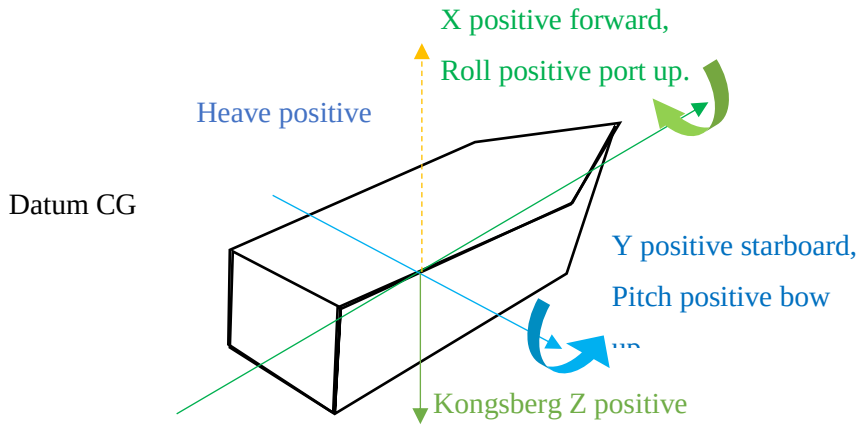
The ship's survey (Parker Maritime, 2013) defines two systems of reference point using two different central reference points (CRPs):

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

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

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

Multibeam



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) 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

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/RAM/* NCC: */Ship_Systems/Data/RVDAS/NCC*		
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. With L2 correction from CNAV3050 within 0.15 m.
Kongsberg Seapath 330	Secondary GPS and attitude.	Serial and UDP NMEA to acquisition systems and multibeam	Positional accuracy within 1 m. With L2 correction from Fugro within 0.15m.
Oceaneering CNav 3050	Correction service for primary and secondary GPS and dynamic positioning.	Correction to primary GPS	Positional accuracy within 0.15 m.
Fugro Seastar / MarineStar	Correction service for primary and secondary GPS and dynamic positioning.	Correction to secondary GPS	Positional accuracy within 0.15 m.
Meinberg NTP Clock	Provide network time	NTP protocol over the local network.	Time accuracy within microseconds

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/* NCC: */Ship_Systems/Data/RVDAS/NCC*	
Data description	*/Ship_Systems/Documentation/TechSAS* */Ship_Systems/Documentation/RVDAS*	
Underway events and other documentation	*/Ship_Systems/Documentation/Surfmet*	
Calibration info	See Ship Fitted Sensor sheet for calibration info for each sensor.	
Component	*Purpose*	*Outputs*
Inlet temperature probe (SBE38)	Measure temperature of water at hull inlet	Serial to Interface Box
Drop keel temperature probe (SBE38)	Measure temperature of water in drop keel space	Not installed yet.
Thermosalinograph (SBE45)	Measure temperature, salinity, conductivity and sound velocity at sampling board	Serial to Interface Box
Interface Box (SBE 90402)	Signals management	Serial to Moxa
Debubbler	Reduces bubbles through instruments.	No recorded output
Transmissometer (CST)	Measure of transmittance	Analogue to NUDAM
Fluorometer (WS3S)	Meausure of fluorescence	Analogue to NUDAM
Flowmeter (Litremeter)	Measure of flow	Analogue to NUDAM
Air temperature and humidity probe (HMP155)	Temperature and humidity at met platform	Analogue to NUDAM
Ambient light sensors (PAR, TIR)	Ambient light and energy at met platform	Analogue to NUDAM
Barometer (PTB210)	Atmospheric pressure at met platform	Analogue to NUDAM
Anemometer (Windsonic)	Wind speed and direction at met platform	Analogue to NUDAM
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

All underway events are recorded in the underway.pdf in:

/Ship_Systems/Documentation/Surfmet

The system was cleaned prior to the cruise on 25/03/2021 at 06:49.

Transmissometer open air measurement: 4.9760, close measurement: 0.008

TechSAS logger started: 24/03/2021 08:36:15

RVDAS logger started: 24/03/2021 09:17:48

TSG Data Acquisition valid from: 25/03/2021 12:00:00

TSG Data Acquisition terminated: 13/04/2021 12:00:00

TechSAS logger terminated: 14/04/2021 10:00:00

RVDAS logger terminated: 14/04/2021 10:08:00

Wave radar

System	**WAMOS Wave Radar**		
Statement of Capability	*/Ship_Systems/Documentation/Wamos*		
Data product(s)	NetCDF: */Ship_Systems/Data/TechSAS/NetCDF/* Raw NMEA: */Ship_Systems/Data/RVDAS/RAM/* NCC: */Ship_Systems/Data/RVDAS/NCC*		
Data description	*/Ship_Systems/Documentation/TechSAS* */Ship_Systems/Documentation/RVDAS*		
Other documentation	*/Ship_Systems/Documentation/Wamos*		
Component	*Purpose*	*Outputs*	*Headline Specifications*
Rutter OceanWaves WAMOS	Measure wave height, direction, period and spectra.	Summary statistics in NMEA to TechSAS and RVDAS. Spectra files.	
Furuno Radar	Measures radar reflection on sea surface.	Radar data to WAMOS.	

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

Hydroacoustic systems

System	**Acoustics**		
Statement of Capability	*/Ship_Systems/Documentation/Acoustics*		
Data product(s)	Raw: */Ship_Systems/Data/Acoustics* NetCDF (EA640, EM122cb): */Ship_Systems/Data/TechSAS* NMEA (EA640, EM122cb): */Ship_Systems/Data/RVDAS*		
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 sounder	NMEA over serial, raw files	Continuous Triggered by K-Sync
12 kHz Multibeam (Kongsberg EM-122)	Full-ocean-depth multibeam swath.	Binary swath, centre-beam NMEA, *.all files, optional water column data	Discrete Triggered by K-Sync
60-100 kHz Multibeam (Kongsberg EM-710)	Coastal/shallow multibeam swath.	Binary swath, centre-beam NMEA, *.all files.	Discrete Triggered by K-Sync
2.5–6.5 kHz Sub-bottom Profiler (Kongsberg SBP-120)	Multi-frequency echogram to provide along-track sub-bottom imagery.	BMP, raw files, optional water column data.	Discrete
Drop keel sound velocity sensor	Provide sound velocity at transducer depth	Value over serial to Acoustics System.	Continuous
Sound velocity profilers (Valeport Midas, Lockheed XBT)	Direct measurement of sound velocity in water column.	ASCII pressure vs sound velocity files. Manually loaded into Kongsberg SIS or Sonardyne Ranger2.	Discrete (See deployment event log, below)
75 kHz ADCP (Teledyne OS75)	Along-track ocean current profiler	(via UHDAS)	Continuous Free running
150 kHz ADCP (Teledyne OS150)	Along-track ocean current profiler	(via UHDAS)	Continuous Free running
USBL (Sonardyne Ranger2)	Underwater positioning system to track deployed packages or vehicles.	NMEA over serial	Discrete (See deployment event log, below)
CARIS	Post-processing	CARIS Project file. CARIS Vessel files	Discrete
MB-System	Post-processing	XYZ, mb files	Not Used

Marine Mammal Protection

`/Ship_Systems/Documentation/Acoustics/MMOs`

System	*Actions taken to protect mammals, in compliance with NERC and JNCC protocols*
12 kHz Multibeam (Kongsberg EM-122)	60-minute bridge observation. Marine mammal protection soft start initiated at 45 minutes into observation if no mammals sighted. Clock restarted if mammals sighted.
Sub-bottom Profiler (Kongsberg SBP-120)	60-minute bridge observation. Marine mammal protection soft start initiated at 45 minutes into observation if no mammals sighted. Clock restarted if mammals sighted.

MMO surveys were performed before use of EM122 and SBP120.

Sound velocity profiles

Sound velocity profiles were derived from CTD or calculated with the Kongsberg software and from the WOA13 model using Ifremer DORIS.

Path of sound velocity profile data on the cruise datastore:
`/Ship_Systems/Data/Acoustics/Sound_Velocity`

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

Sound velocity profiles.

Date	Method	Filename:
28/03/2021 15:50	Midas SVP profiler s/n: 22563	FILE3.000
06/04/2021 11:13	SVP from CTD009	DY130_009_SV_100m_ASCII_thinned.asvp/pro
07/04/2021 13:17	SVP from CTD010	dy130-ctd010-svp-50m-bin-20210407_thinned.asvp/pro
08/04/2021 15:17	SVP from CTD011	DY130_011_SV_50m_ASCII _thinned.asvp/pro
10/04/2021 13:55	SVP from CTD013	DY130-ctd013_svp_ST076-20210410_thinned_Updated.asvp/pro

Equipment-specific comments

ADCPs

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

Attribute	*Value*
Acquisition software	UHDAS
Frequencies used	75 kHz, 150 kHz
Running mode	Free-running untriggered by K-Sync
Configuration details	os150: Narrow band 40 bins, length 8m, 4m blanking, os75: narrow band, 60 bins, length 16m, 8m blanking Bottom tracking was run from leaving Southampton from 25/03/2021 10:14 to 27/03 18:45 then, used water tracking mode from 27/03/2021 18:46 to dd/mm/yyyy hh:mm, then used bottom tracking again from dd/mm/yyyy to dd/mm/yyyy. Survey name: DY130pre until 10/04/2021 17:08 then with the new requested scale factor DY130_pre_part2. DY130_pre_part2 recording terminated 14/04/2021 04:08.

EM-122 Configuration and Surveys

Path of Multibeam data on the cruise datastore:
`/Ship_Systems/Data/Acoustics/EM-122`

From 2020-September-30 patch test

Item	*X (m, + Forward)*	*Y (m, + Starboard)*	*Z (m, + Down)*
Tx transducer	39.910	0.885	7.426
Rx transducer	35.219	-0.005	7.438
Att 1 (Applanix)	0.00	0.00	0.00
Att 2 (Seapath)	0.00	0.00	0.00
Waterline (distance from Att 1 to Waterline)			1.34

Item	*Roll (deg)*	*Pitch (deg)*	*Yaw (deg)*
Tx transducer	0.07	0.15	0.05
Rx transducer	0.05	0.37	359.98
Att 1 (Applanix)	-0.10	0.00	-0.85
Att 2 (Seapath)	0.00	0.00	0.00

Survey information – note any particular transducer settings (e.g. beam spacing) in comments, Applanix PosMV used for providing position and attitude data.

Survey Site Name	*SIS Survey Name*	*Datetime Start*	*Total time of Logging*	*Vessel survey speed (kts)*	*SVP(s) Used (Filename)*	*Comments*
Underway	DY130 EM122 posmv test	20210324 065143	00:49:15 (hh:mm:ss)	0-10kn	default_salinity_03500.asvp	2 lines, cellsize 1m
Near to Isle of Wight	DY130 EM122 posmv backscatter calibration	20210324 141114	02:23:49 (hh:mm:ss)	5-9kn	default_salinity_03500.asvp	10 lines, cellsize 1m
English Channel to Whittard Canyon	DY130 posmv to whittard	20210325 111244	56:03:46 (hh:mm:ss)	0-10kn	Various profiles used see the SVP table	119 lines, cellsize 10m
PAP	DY130-PAP	20210328 131033	257:33:35 (hhh:mm:ss)	0-10kn	Various profiles used see the SVP table	Xxx lines, cellsize: 150m
English Channel	DY130 em122 posmv gsbank to needles	20210412 160014	35:58:33 (hh:mm:ss)	9-12kn	Profile from CTD013	72 lines, cellsize: 5m
Near Needles	dy130 em122 2nd backscatter calibration	20210414 040345	04:09:21 (hh:mm:ss)	9-12kn	Profile from CTD013 and Survace SVP sensor	10 lines, cellsize 1.0 m

EM-710 Configuration and Surveys

Path of Multibeam data on the cruise datastore:
`/Ship_Systems/Data/Acoustics/EM-710`

Item	*X (m, + Forward)*	*Y (m, + Starboard)*	*Z (m, + Down)*
Tx transducer	37.570	-1.994	7.425
Rx transducer	36.819	-2.051	7.427
Att 1 (Applanix)	0.00	0.00	0.00
Att 2 (Seapath)	0.00	0.00	0.00
Waterline (distance from Att 1 to W/L)			1.34

Item	*Roll (deg)*	*Pitch (deg)*	*Yaw (deg)*
Tx transducer	-0.07	0.33	0.22
Rx transducer	0.01	0.12	359.7
Att 1 (Applanix)	-0.14	-0.40	-1.00
Att 2 (Seapath)	0.00	0.00	0.00

Survey information – note any particular transducer settings (e.g. beam spacing) in comments, Applanix PosMV used for providing position and attitude data.

Survey Site Name	*SIS Survey Name*	*Datetime Start*	*Total time of Logging*	*Vessel survey speed (kts)*	*SVP(s) Used (Filename)*	*Comments*
Empress Dock	DY130 test	20210324 064045	00:07:39 (hh:mm:ss)	0kn	default_salinity _03500.asvp	1 line, cellsize 0.5m
Near to Isle of Wight	DY130 EM710 posmv backscatter calibration	20210324 141114	01:58:28 (hh:mn:ss)	5-9kn	default_salinity _03500.asvp	7 lines, cellsize 0.5m
Goban Spur - English Channel	DY130 em710 posmv goban spur	20210412 083811	42:19:22 (hh:mm:ss)	8-12kn	SVP from CTD013	94 lines, cellsize: 5m
Near Needles	Dy130-em710 2nd backscatter calibration	20210414 040618	04:06:24 (hh:mm:ss)	6-12kn	SVP from CTD013 and Surface SVP sensor	12 lines, cellsize 0.5 m

USBL Configuration and deployments

Path of USBL calibration information on the cruise datastore: **`/Ship_Systems/Data/Acoustics/USBL`**

Attribute	*Value*
Number of deployments	1
Datetime of last CASIUS	15 August 2019 12:41:24
Starboard Head 1DRMS	See in the included Casius report
Port Head 1DRMS	See in the included Casius report

Deployment information:

Deployment name	*Head used*	*Beacon(s) used*	*Date*
Simulation	Stbd	2707	2021-04-03 17:59-18:01
Hybis st21	Stbd	2704	2021-03-30 19:11-2021-03-31 05:25
Simulation	STBD	2707	2021-03-31 17:59-2021-03-31 18:01
MGC1 st27	STBD	2707	2021-03-31 19:09-2021-04-01 05:10
Hybis st33	STBD	2704	2021-04-01 18:43-2021-04-02 05:21
MGC2 st37	STBD	2707	2021-04-02 15:10-2021-04-02 18:47
MGC3 st38	STBD	2707	2021-04-02 19:27-2021-04-02 23:06
MGC4 st39	STBD	2707	2021-04-02 23:40-2021-04-03 03:53
Hybis st36	STBD	2704	2021-04-03 18:42-2021-04-04 05:23
MGC5 st50	STBD	2707	2021-04-04 14:13-2021-04-04 18:00

Deployment name	*Head used*	*Beacon(s) used*	*Date*
MGC6 st51	STBD	2707	2021-04-04 18:39-2021-04-04 22:20
MGC7 st53	STBD	2707	2021-04-04 23:35-2021-04-05 03:13
MGC8 st54	STBD	2707	2021-04-05 03:47-2021-04-05 07:27
Hybis st59	STBD	2704	2021-04-05 18:39-2021-04-06 05:37
MGC9 st63	STBD	2707	2021-04-06 15:06-2021-04-06 18:48
MGC10 st64	STBD	2707	2021-04-06 19:45-2021-04-06 23:25
MGC11 st67	STBD	2707	2021-04-07 01:33-2021-04-07 05:14
CTD010 st68	STBD	3003	2021-04-07 06:53-2021-04-07 11:42
Hybis st71	STBD	2704	2021-04-07 19:34-2021-07-08 05:31
CTD011 st72	STBD	3003	2021-04-08 08:11-2021-04-08 13:06
TRAWL1 st73 (150m up wire)	STBD	2707	2021-04-08 15:15-2021-04-08 21:10
TRAWL2 st74 (150m up wire)	STBD	2707	2021-04-08 22:07-2021-04-09 04:33
TRAWL3 st77 (400m up wire)	STBD	2707	2021-04-09 15:32-2021-04-09 23:20
TRAWL4 st79 (400m up wire)	STBD	2707	2021-04-10 00:02-2021-04-10 08:30
CTD013 st80	STBD	3003	2021-04-10 09:52-2021-04-10 12:36
MGC12 st81	STBD	2707	2021-04-10 14:24-2021-04-10 17:26
Hybis st83	STBD	2707	2021-04-10 21:58-2021-04-11 05:36
Simulation	PORT	3003	2021-04-11 14:51-2021-04-11 14:59
CTD014 st84	PORT	3003	2021-04-12 01:24-2021-04-12 03:02

Cable Logging and Monitoring

Winch activity is monitored and logged using the CLAM system.

9. PAP 1 Mooring - scientific report

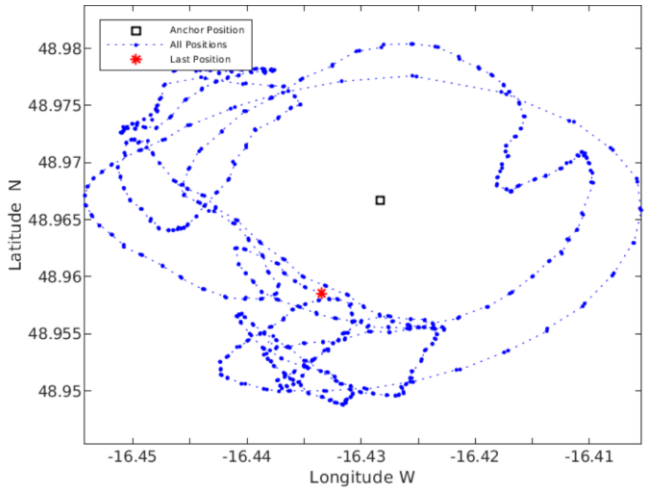
Nick Rundle, Sue Hartman, Corinne Pebody, Chris Cardwell (OTEG ashore), Jon Campbell (COD, ashore)

The PAP1 system comprises sensors connected to either a buoy telemetry electronics unit or a frame data hub unit and their data is sent using Iridium to our server at NOC. The telemetry communication is intended to provide remote quasi-real time data. The buoy also hosts an entirely separate system provided by the UK Met Office, which has its own telemetry unit and a suite of meteorological sensors measuring wind velocity, humidity, wave spectra and atmospheric pressure.

Recovered buoy on left

PAP1 Recovery

The last PAP1 system was deployed 21st November 2020 on RRS *Discovery* cruise DY116. The anchor position was 48° 58.0565, 16° 26.149.

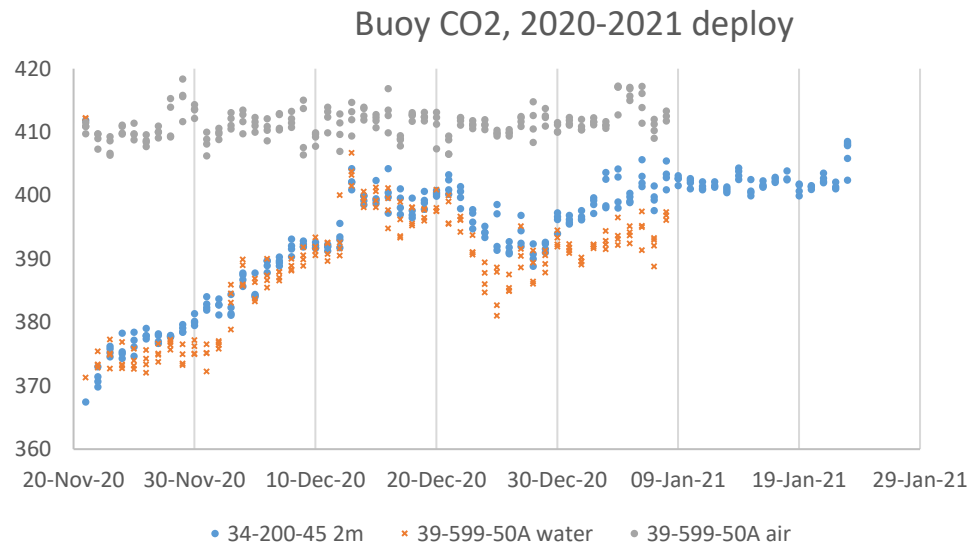


Watch circle of the buoy from the PAP web page (positions in decimal degrees).

Summary of sensors deployed on DY116 and recovered on DY130

PAP1 DY116 Buoy sensor list 2020	Serial number	Battery housing	Notes	Schedule
Pro-Oceanus CO2-Pro atmos	39-599-50A	Old grey OS (part remote)	Recal Oct 2019.	6 hours at 05:27, 11:27, 17:27, 23:27
Pro-Oceanus CO2-Pro	34-200-45	Old grey OS (part remote)	Recal Nov 2019.	6 hours at 02:58, 08:58, 14:58, 20:58
SeaBird SBE 37IMP-ODO MicroCAT	21210	internal	New (260006425)	30 mins at 00 and 30
SeaBird SBE 37IMP MicroCAT	6904	internal		15 minutes at 00, 15, 30, 45
Satlantic OCR-507 ICSA (Bioshutter)	201 (122)	None (remote operate)	last cal 29 Sep 2017	30 mins at 17 and 47, sampling at 1Hz for 2 mins
WETLabs FLNTUSB Fluorometer	269	internal	On buoy skirt	3 hours at 25 past
Aanderaa oxygen optode	1282	None (remote operate)	Full cal spring ‘19, 2 point 20th nov ‘19. Power & log @ controller	30 mins at 14 and 44, sampling every 15 sec for 65secs
Star Oddi Tilt (+5 others between 5m and 30m)	H0833 8930 7724 6784 7728 5761	none	Temperature and tilt, mounted inside buoy	4 hours starting on 28/11/2020

The Pro-CO2 sensors (39-599-50A and 34-200-45) from the November DY116 deployment worked for a couple of months.



Data from the ProOceanus sensors DY116 deployment

Jon Campbell (from COD) had configured both CO_2 sensors to sample once per hour and perform a zero (AZPC) every 12 hours. However, the buoy controller only switches power to each sensor every 6 hours.

The atmospheric sensor was configured to sample at 27 minutes past the hour so it should wake up at 7 minutes past. The buoy controller switches the sensor on according to this schedule:

ON at 05:05:00 - OFF at 05:35:00

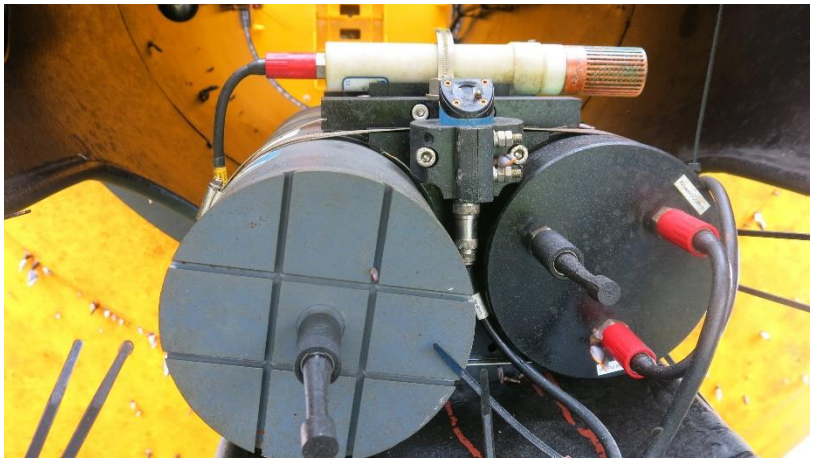
ON at 11:05:00 - OFF at 11:35:00

ON at 17:05:00 - OFF at 17:35:00

ON at 23:05:00 - OFF at 23:35:00

So the sensor was powered on 2 minutes before it wakes up and powered off around 6 minutes after it goes to sleep. This worked fine for 48 days and then the sensor stopped talking. Jon sent a command to the buoy to switch on the sensor power continuously (confirmed by a slight increase in the buoy supply current) but the sensor did not send any further messages.

The second ("spare") CO_2 sensor used a similar schedule, though offset by a couple of hours. It missed a message after 52 days and another after 58 days. Then after 62 days it stopped talking and Jon sent a command for the buoy controller to power it continuously. Amazingly the sensor then started sending hourly messages. As this duty cycle would drain the buoy batteries, Jon then sent a command to switch the sensor on every 3 hours but after that we heard nothing. The MicroCATs and the WETLabs fluorometer were still recording internally, and data was retrieved from both these sensors on DY130.



Optode (and CO2 sensor) recovered on DY130

Another issue was noted by Jon on the 19th Feb 2021, that that the NOC buoy controller (aka telemetry unit) had restarted for the first time in the 90 days since deployment, suggesting an issue with its power supply. The controller defaults to switching off all the sensors it controls and requires email commands to restart these sensors (in this case the oxygen optode and irradiance sensor).

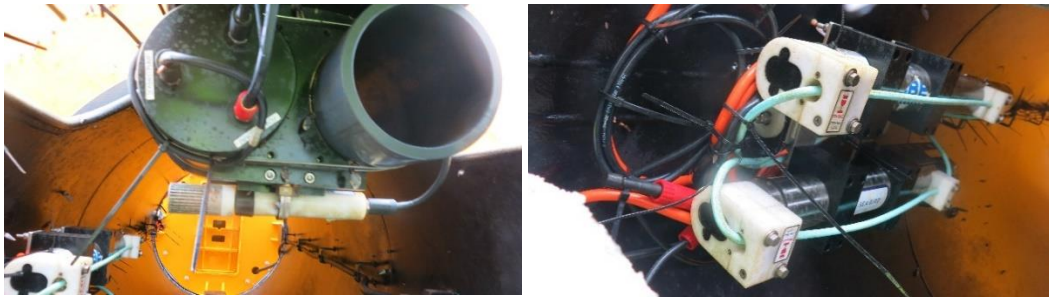
Further controller restarts occurred in the early hours on the 20th Feb 2021 and no messages were received after 06:30. The Met Office system appeared to be functioning normally (it has an identical, but completely separate power supply). It is possible that water has reached some part of the power supply, as there was an unexpected decline in battery voltage shortly before the messages stopped. The main 12V batteries are housed in non-watertight containers so this may be an issue. As ever, we wouldn't know exactly what has happened until the buoy was inspected.

Steve Lankester (MO) was able to examine the buoy at NOC, at the end of June 2021. After removing the mast from the recovered PAP buoy, he examined the fault displayed on the MO solar charge controller. The fault was a load overcurrent fault recorded on 20th Feb 2021, which ties in with the date the sensors failed. The way the controller works in this situation is to cut power to the load then try to reconnect 10 seconds later. If the overcurrent is still in place it will make a second reconnection attempt in another 10 seconds. If the second attempt fails the load is permanently disconnected until power to the controller is removed and re-applied.

The OTEG systems connect to the load terminals on the charge controller in the Mobilis buoy. On the old system they connected directly to the batteries via a fused junction box. The max load current for the charge controller is 15A so the overcurrent would have to be in excess of this to cause this issue. This is the fourth time in five deployments that the buoy power supply to the NOC system has failed and it is highly recommended that someone from OTEG or MO look into the issues or ideally join the cruise.

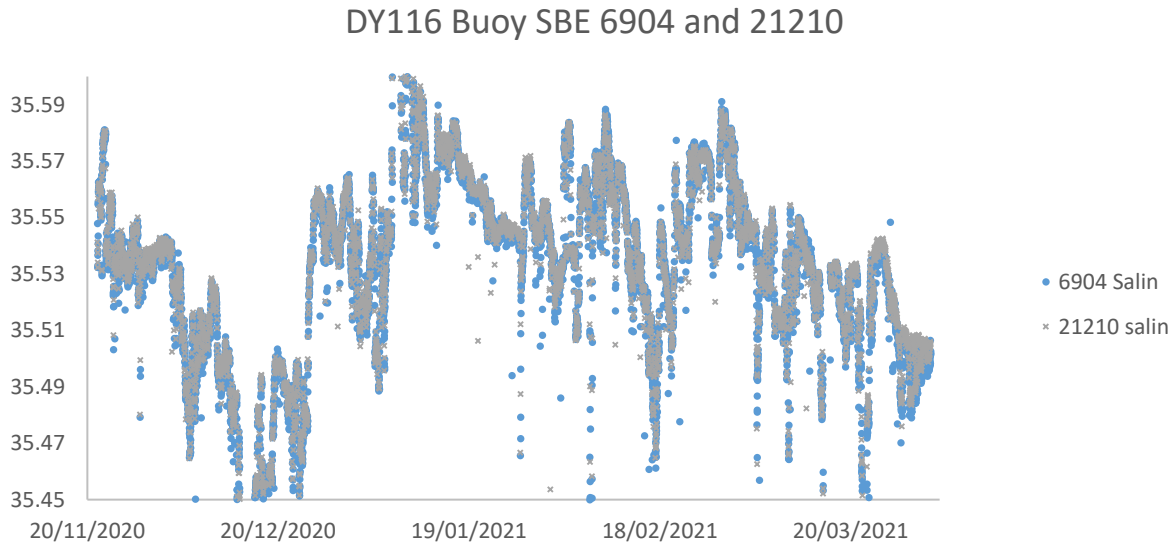
The Pro-Oceanus sensors (CO2-atmos and CO2-Pro), 1m optode and the irradiance sensors were not retrieved at sea but were removed by Jon Campbell back at NOC. Jon set up the telemetry unit outside the electronics lab with the two CO2 sensors and optode inside the lab. He configured the two CO2 sensors to sample every 4 hours with real time data files recorded in \ascdata\PAP\PAP_2020_deploy\concat\Nov2020_test_Jul2021.

This allowed a test of the system with the telemetry unit "magic plug" and despite soaking and vigorous waggling it refused to show any sign of malfunction, so the cause of the buoy solar regulator unhappiness is still a mystery. If the current test setup does not offer any clues after a week or two the next step may be to hook up to the actual buoy power supply in the yard (once the Met Office have reset their regulator) as suggested by Steve. This testing may also shed some light on the reason the 'spare' CO_2 sensor stopped sampling, as so far, no problems have been found with it.

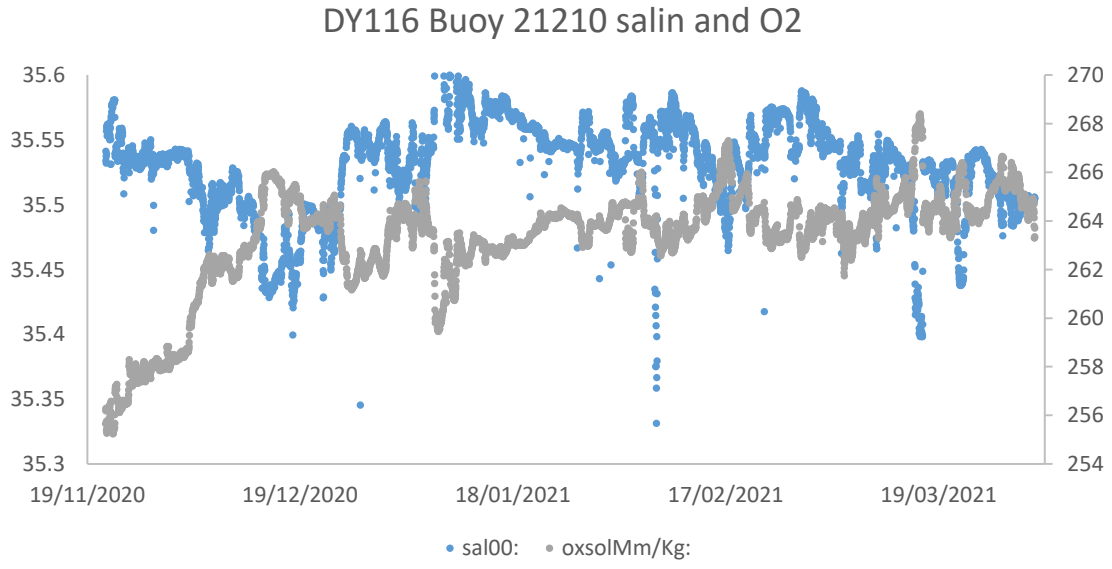


One of the CO_2 sensors and the microCATs on the DY116 buoy as recovered DY130

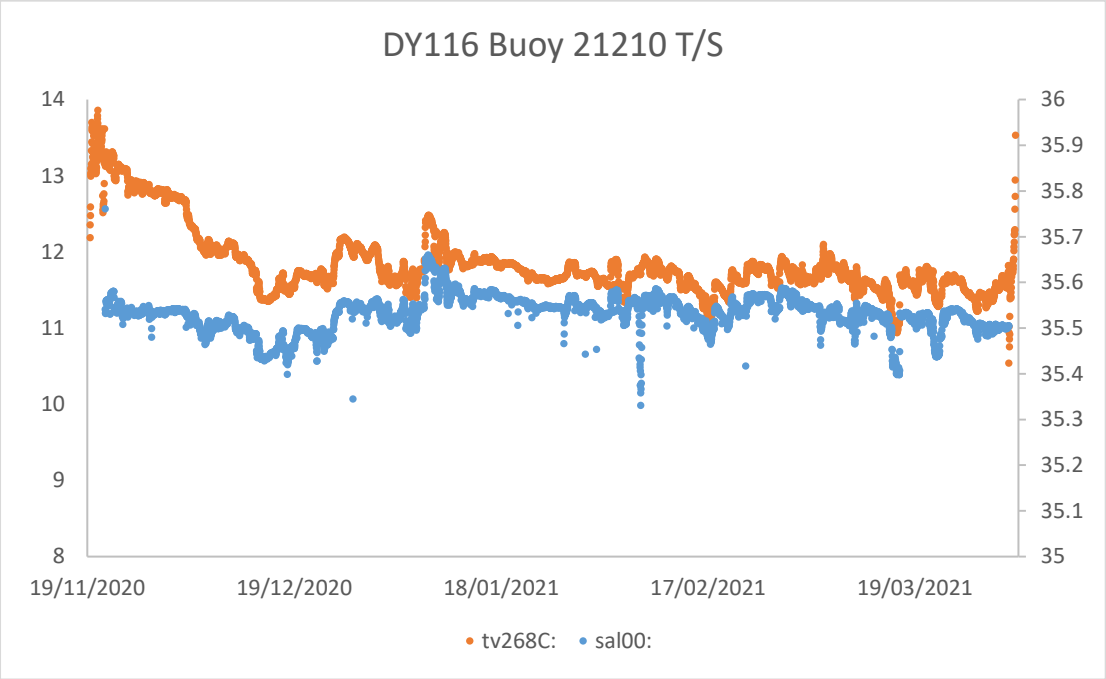
Data from both of the DY116 microCATs was recovered and will be calibrated ashore with bottle salinity once the CTDs have been calibrated.



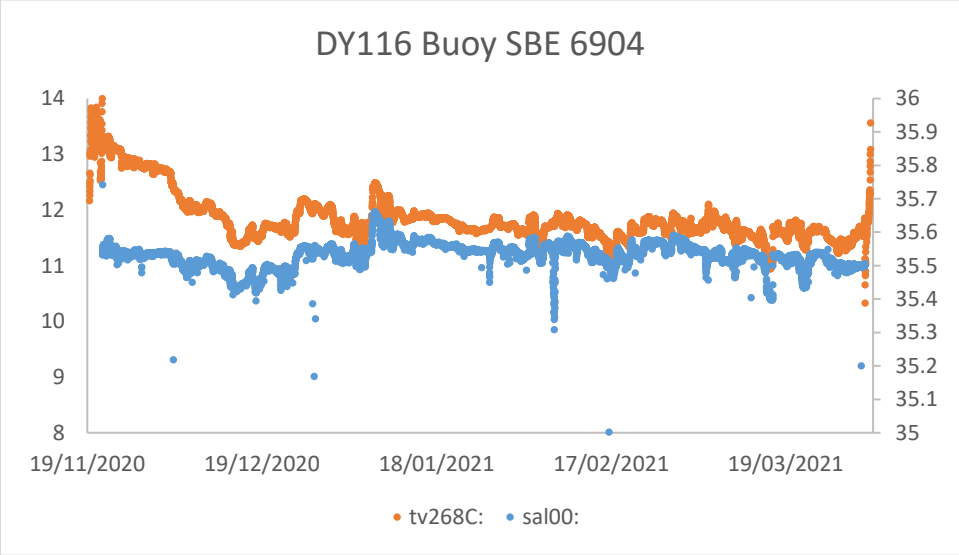
A comparison of raw salinity data from both 1m microCATs, DY116 deployment



Raw salinity and oxygen data from the 1m ODO microCAT, DY116 deployment

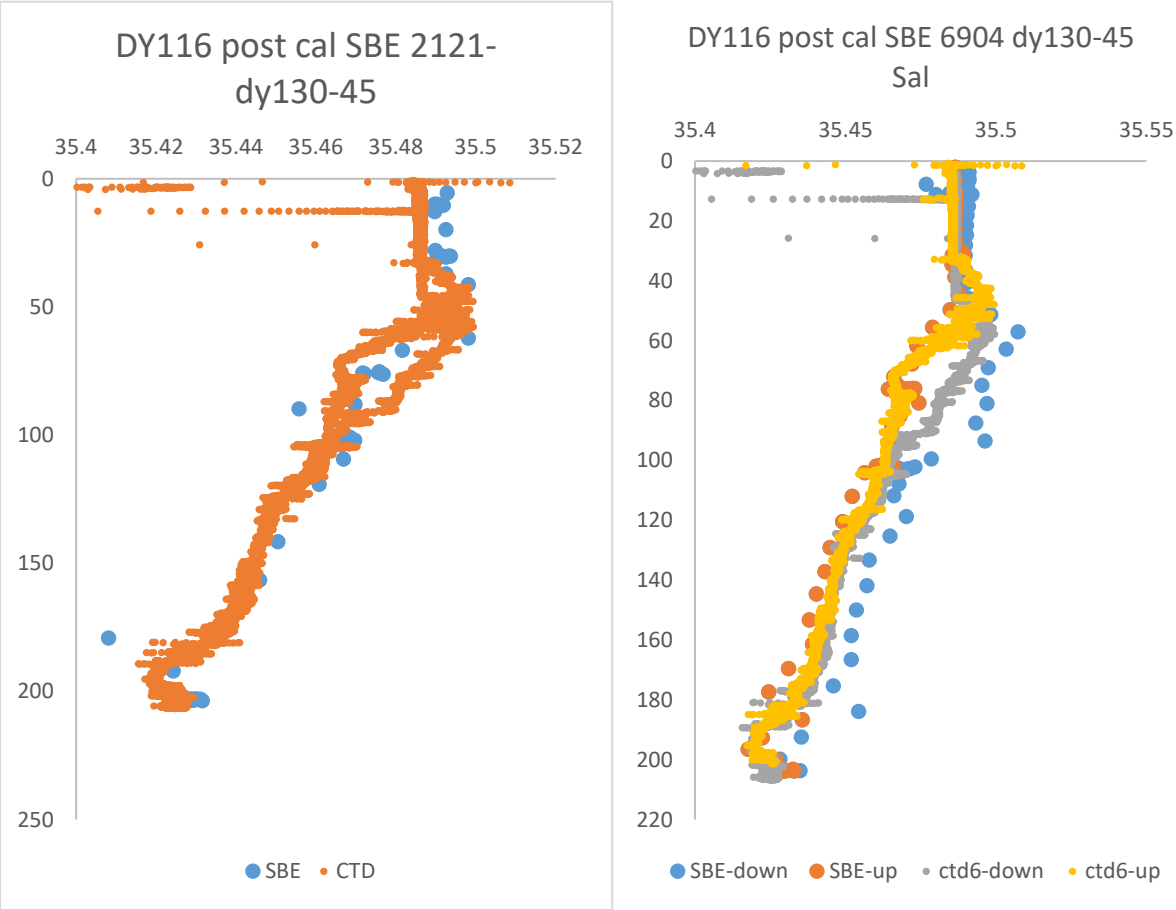


Raw salinity and temperature data from the 1m ODO microCAT, DY116 deployment



Raw salinity and temperature data from the 1m IMP microCAT, DY116 deployment

The microCATs sensors SBE (SN 6904, and SN 21210) were attached to the CTD frame on station 45 (CTD6). This 'post PAP1 cal cast' had 2 long stops (~10 minutes) at both 200 and 30m to assist data validation. We are yet to calibrate the data with the bottle salinity and oxygen data which we will do ashore once the CTD data are calibrated with the assistance of MPOC.



Raw salinity data from the CTD and microcats (station 45)

Wetlabs fluorometer recovered

Corinne Pebody

Wetlabs fluorometer recovered SN 269 looked operational on the buoy and the shutter was showing good anti fouling. It was recovered and washed in warm fresh water. The data was downloaded. And the factory calibrations applied:

Factory cal:

The Characterization sheet is as follows: SN 269

Thermistor calibration: temperature= (output x slope) + intercept

Where slope = -0.0057 °C/count and intercept = 71.5456° C

Pressure sensor calibration: pressure= (output x slope) + intercept

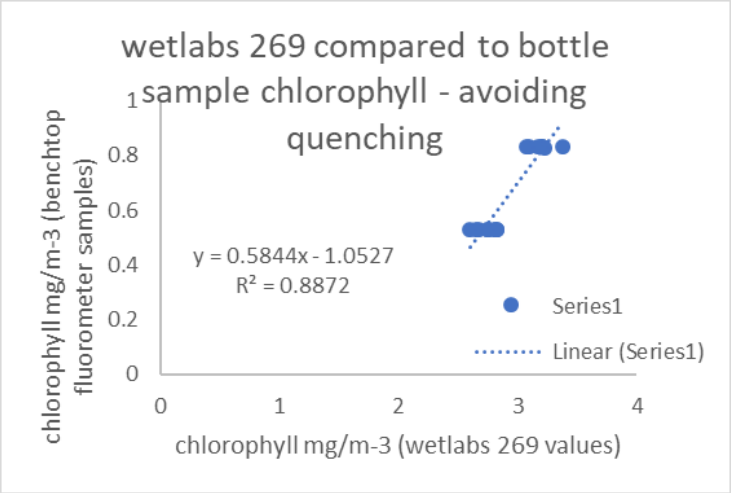
Where slope = 0.033 dBar/count and intercept = -4.61 dBar.

Chlorophyll Scale Factor: Chl(µg/l) = Scale Factor x (output – dark counts)

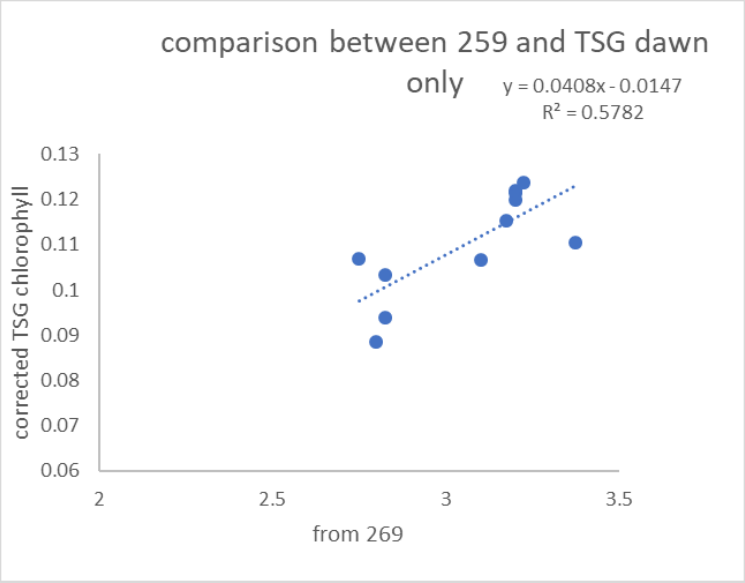
Where scale factor = 0.025, dark counts = 59

Nephelometric Turbidity Unit (NTU) Scale Factor = Scale Factor x (output – dark counts). Where scale factor = 0.0071, dark counts = 75

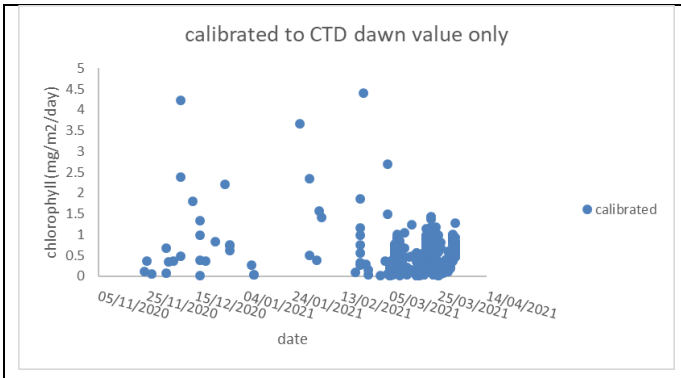
Step1: calibrate CTD dip bottle chlorophyll (10m ref) – only three CTD near PAP1 when 269 in water and one discounted because samples at mid-afternoon will have been subjected to quenching.

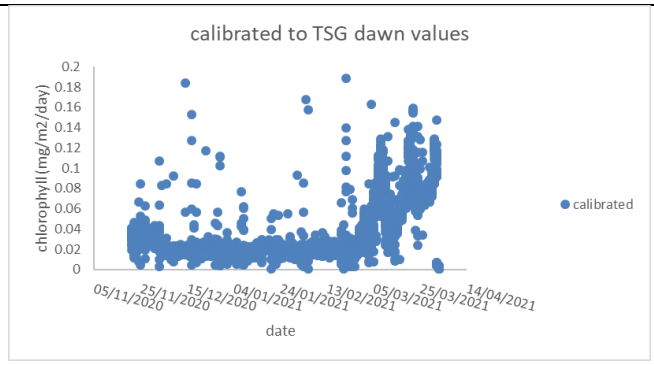


Step2: calibrate underway TSG (5m ref), identify lat longs near to PAP1, first comparison very poor, second comparison using dawn values only. The TSG data was volts, corrected with bottle samples taken from the TSG at dawn.



Step3: compare 269 calibrated by TSG and CTD values together

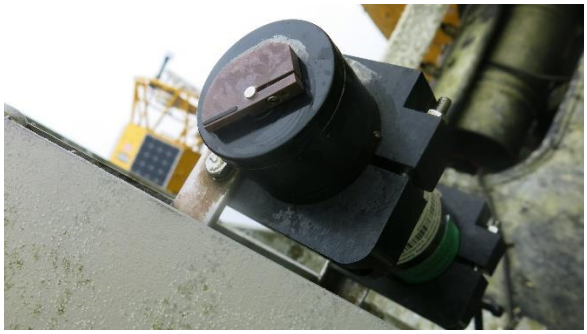




The CTD data gives a better r^2 but the TSG is more believable because the data is at least positive.

Step 4: generate a calibration for the whole deployment.

The best calibration is from the TSG y =0.0408x - 0.0147 (r^2 = 0.5782).



Wetlab Fluorometer recovered

Star Oddi

Star Oddi sensors recovered on DY130 (Corinne):

Type	Serial number	Deployment depth (m)	Depth rating (m)	Frequency (hours)	% Battery remaining	File start date
DST CENTI	8930	30	100	4	65	28/11/2020
DST CTD	7724	20	300	4	26	28/11/2020
DST CTD	6784	15	???	4	18	28/11/2020
DST CTD	7728	10	300	4	15	28/11/2020
DST CTD	5761	05	???	4	60	28/11/2020
DST TILT	H0833	30	100	4	51	28/11/2020

Star oddi tilt on Buoy

PAP1 Deployed

On DY130 the plan was to add the 30m frame and exchange the DY116 Mobilis buoy for another new one. The two most significant changes for this deployment were fitting internal batteries in the data hub and testing acoustic communications between the sensor frame and the buoy. Both these modifications were designed to circumvent the failure of the umbilical cable carrying power and communications between the buoy and the hub.

A pair of LinkQuest UWM1000 modems was purchased for the PAP project back in 2014, but this was their first deployment. Prior to deployment both modems are powered off. When the data hub detects that it is in the sea (using a conductivity sensor) it switches on the acoustic modem battery pack and will send a file of hub data to the modem every 6 hours.

The modem on the buoy is switched on via an email command which also tells the buoy modem to 'synchronise' with the hub modem. This establishes a communications channel between the two modems and from then on RS232 data sent to the hub modem should be received and output by the buoy modem. This was tested in the lab with the modems in air and worked well.

The data hub's underwater housing (supplied by develogic) holds 95 lithium D cells providing around 230 Ah @ 18V. This will power the hub if the normal 30V supply from the buoy is not present. In order to avoid opening the hub housing at sea, the internal battery was connected to the controller some weeks prior to deployment. The hub software was modified so that the Persistor microcomputer would spend most of its time asleep consuming very little power,

waking once an hour to check whether the 30V supply was present, or if a conductivity sensor reported it was in the sea, or if a 'backstop' deployment date had been passed.

It was necessary to make a slight modification to the inductive communications wiring on the buoy to provide a connection between the telemetry unit housing and the sea. This was not required on the old Balmoral buoys which had a metal framework that automatically connected the housing to the sea.

The sensors were set up on the buoy and frame by Jon (COD) and Chris (OTE) prior to the cruise. As the MO buoy was assembled just a few days before the cruise there was a slight delay in starting the internal wiring and preparations continued right up to departure. By that time all sensors apart from the MicroCATs had been tested and configured for deployment and all the cabling has been tested. The telemetry unit and data hub were effectively 'deployed' so could be activated by email commands from ashore. The sensors were then attached to the buoy and frame with some adjustment at sea. The SeaFET pH sensor did not arrive in time for deployment. However, we had some capital investment in a new fluorometer, Atmos CO2 sensor and a wet chemistry nitrate analyser (to run in stand-alone mode). The PAP buoy was deployed at 12:00 on the 3rd April 2021 (day 093). DY130 has deployed the only remaining persistor-based data hub.

PAP1 sensor list for DY130	Serial number	Battery housing	Notes
ON BUOY			
Pro-Oceanus CO2-Pro water and atmospheric option	41-824-50A	none	Last cal 8 Jan 2021. Checked OK Jan 21
Pro-Oceanus CO2-Pro (backup)	29-097-45	none	old blue one, internal logging - cal 23 Feb 2021
SeaBird SBE 37IMP-ODO M'cat	16503	internal	servicing + recal. Last cal 23 Dec 2017
SeaBird SBE 37IMP MicroCAT	6911	internal	
Satlantic OCR-507 ICSA (buoy)	226/230	none	Last cal 29 Sep 2017. Checked OK Jan 21
Aanderaa oxygen optode	1279	none	Last cal 8 Jan 2021. Checked OK Jan 21
LinkQuest Acoustic modem	15763	none	Powered and controlled by buoy controller.

StarMon	4771		(buoy)
IN SENSOR FRAME			
Pro-Oceanus CO2-Pro CV	33-146-45	Blue OS200	Last cal 8 Jan 2020. New clock battery.
Pro-Oceanus Mini TDGP sensor	39-616-31	BPA50 wetlab	New clock battery. Checked OK Jan 21
SeaBird SBE 37-IMP-ODO M'cat	21549	internal	New Dec 2019. Note 8 hours slow on DY130
SeaBird SBE-37IMP MicroCAT	6909	internal	Needs servicing + recal
WETLab FLNTUSB Fluorometer	6702	internal	New, good to go
Satlantic SUNA-V2 Nitrate sensor	698	Blue OS200	Last cal 29 Jan 2020. Ready
Aanderaa Seaguard	2075	Internal	New anode + O-ring 20 Nov 2019. Ready
Aanderaa Optode	1299		Part of Seaguard. Last cal 8 Jan 2021. Checked OK Jan 21
Turner Cyclops Fluorometer	21100373		Part of Seaguard
ZebraTech Wiper for Cyclops		Internal	For Seaguard fluorometer
Satlantic OCR-507 ICSW irradiance with Bioshutter II	200/231	None	Checked OK Jan 21 - last cal 29 Sep 2017
Clearwater/OTEG Nitrate	new one	Blue OS200	Will be standalone
LinkQuest Acoustic modem	15762	Old OS 18V	Powered from 18V OS controlled by hub
Aanderaa 3919 Conductivity	139	none	Used to detect when frame is in the sea
On Chain			
StarMons	see notes		SN4218 frame, 4766-70 (25, 20, 15, 10, 5m)

A checklist was used before deployment of the PAP1 mooring and is reproduced here as it may be of use on future cruises.

Tasks before deployment

- Release test
- Dip all microcats (x4) and download data
- Reset microcats – buoy ODO 30 mins at 00 and 30
- Reset microcats – buoy T/S 15 mins at 00 15, 30 and 45
- Reset microcats – frame ODO 30 mins at 00 and 30
- Reset microcats – T/S 15 mins at 00 15, 30 and 45
- Buoy Air intake box – attach to bars and attach tubes
- Attach buoy irradiance sensor and connect
- Secure umbilical cable inside buoy tower
- Secure umbilical cable inside keel tube
- Secure umbilical cable in frame
- 2 microcats to add to frame
- 2 microcats to add to buoy
- Start Zebratech on frame, on the hour (every 6 hours) – special tool/manual
- Check both OCR copper shutters operate correctly once they are switched on (17 and 47 past the hour)
- Check that buoy tracker works and attach to buoy mast
- Starmons to buoy
- Starmons to frame
- Starmons to chain

Last minute tasks before deployment

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
- Remove optode cover (buoy)
- Switch on buoy navigation light

FRAME

- Remove FLNTUSB cover (on frame only 2021)
- Jump plug FLNTUSB on frame, aim: every 3 hours on the 00
- Remove optode cover (frame)
- Plug in SeaBird pumps (on frame every 8 hours at 04:45, 12:45, 20:45)
- Plug Clearwater in on frame (samples noon and midnight)
- All brackets to check

Notes on the sensors deployed on PAP1 on DY130

Sensors in the Buoy:

On the buoy we deployed two ProOceanus CO_2 sensors, the CO2-Pro with atmospheric option and a Pro-CO2 as a back-up. Both using seabird pumps. An Aanderaa oxygen optode also deployed on the buoy (as on DY116) as were two microCATs. The microCATs were a SeaBird SBE 37IMP-ODO (sn16503) and a SeaBird SBE IMP (sn 6911) for ancillary T, S, and O_2 data.

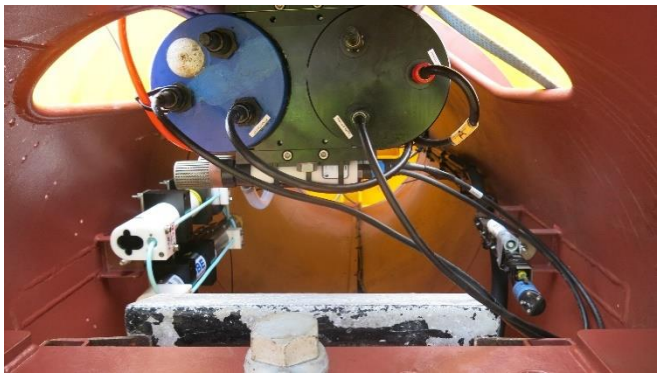
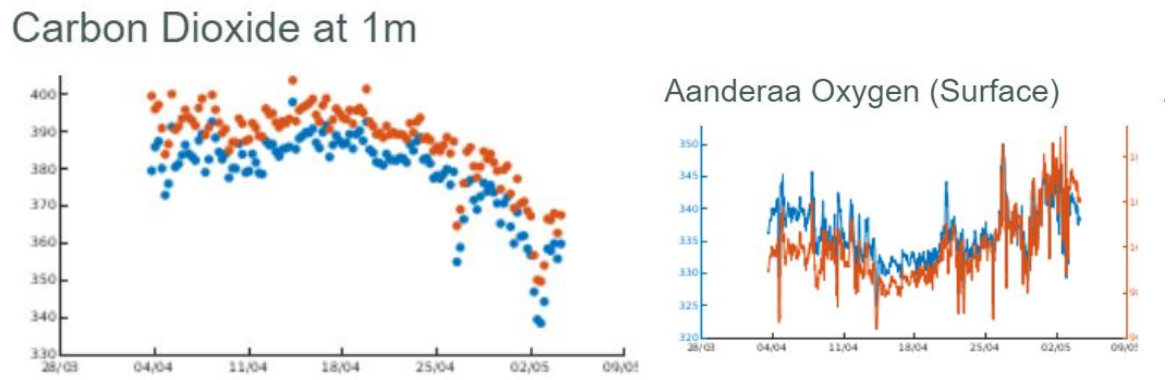


Photo shows 2 microcCATs, Atmos CO2 (to right) and blue CO2 Pro plus optode and Starmon sensor in Buoy DY130



Examples of 1m real time data for CO2 and O2 (up to 03/05/2021)

Photo shows the Satlantic OCR-507 ICSA) with Bioshutter II (top of the buoy

LinkQuest Acoustic modem

The acoustic modems, on the buoy and at 30m, appeared to successfully establish a communication link at the first attempt with an estimated range of 27.5 m, but no data has actually been transferred. No NOC control over the modem in the frame so can't even power-cycle it (originally planned to program in this kind of functionality, but ran out of time). Perhaps something has leaked, or there is some subtle difference in how the software behaves between the testing in the lab and the actual operation. Or it could be that there are acoustic problems preventing data transfer. It may be hard to unpick this even after the system has been recovered. Every PAP 1 deployment is also a trials deployment. Hopefully in the not too distant future the platform will be reliable enough that we are trialling minor improvements and new sensors and capabilities rather than still trialling a functional system. This deployment provides learing opportunities for future development of PAP1. There will be time to look at this before the next PAP cruise and see how well acoustic communications can be integrated into our new hub system.

Sensors on the 30m Frame

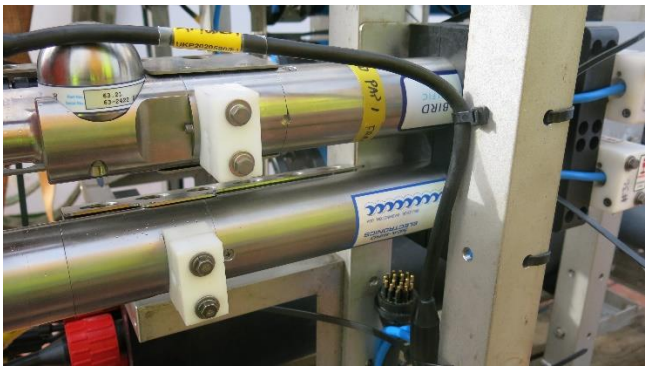


Photo of the DY130 sensor frame and the microcats on the frame

On DY130 we did not redeploy a fluorometer at 1m but continued the old 30m time series.

The fluorometer s/n 6702 was run in the labs at NOC to get familiarisation to new model (doesn't include pressure or temperature sensors) then programmed at NOC and switched off until power was reapplied the day before deployment.

It was noted that power must be applied at the time of sampling and the factory cals applied:

Factory cal: February 16, 2021

Chlorophyll Scale Factor

Chlorophyll concentration expressed in µg/l can be derived using the equation:

CHL (µg/l) = Scale Factor x (Output - Dark Counts)

	Analog		Digital	
Dark Counts	0.060	V	45	counts
Scale Factor (SF)	6	µg/l/V	0.0073	µg/l/count
Maximum Output	4.99	V	4130	counts
Resolution	0.7	mV	1.0	counts
Ambient temperature during calibration	21.3	°C		

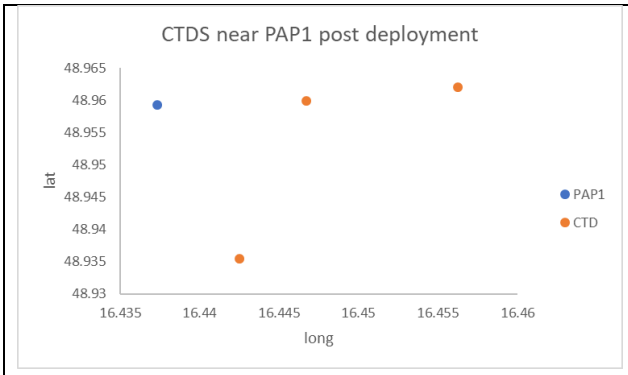
Nephelometric Turbidity Unit (NTU) Scale Factor

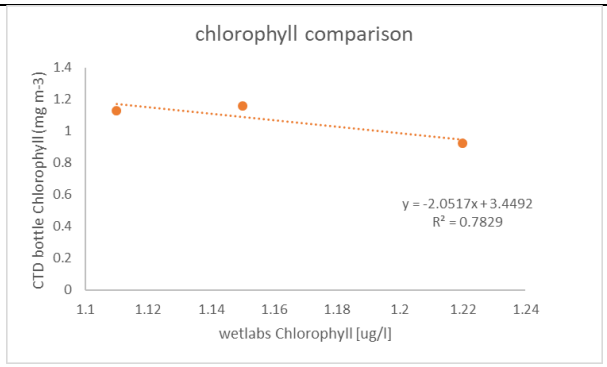
Turbidity units expressed in NTU can be derived using the equation:

NTU = Scale Factor x (Output - Dark Counts)

	Analog		Digital	
Dark Counts	0.073	V	48	counts
NTU Solution Value	3.22	V	2612	counts
Scale Factor (SF)	2	NTU/V	0.0024	NTU/count
Maximum Output	4.99	V	4130	counts
Resolution	1.0	mV	1.0	counts
Ambient temperature during calibration	21.3	°C		

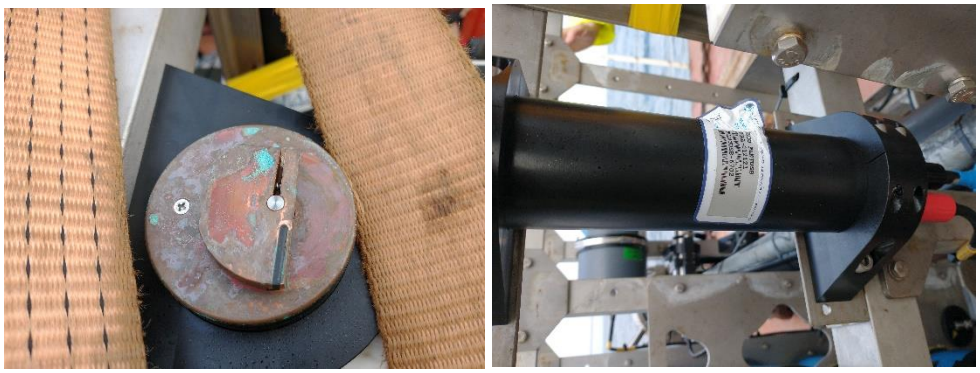
Step1: compare 6702 and CTD values together. There are only 3 CTDs where the ship was relatively nearby after PAP1 was deployed.





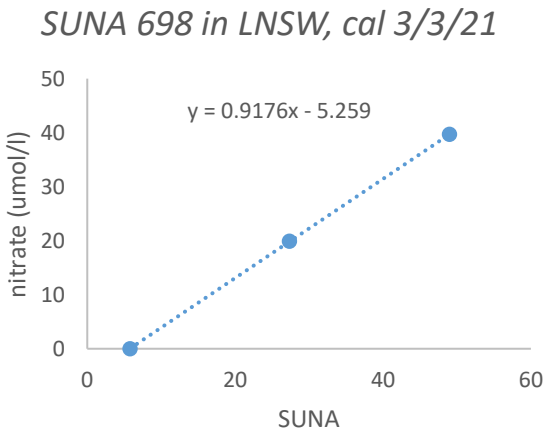
Step 2: generate a calibration for the whole deployment.

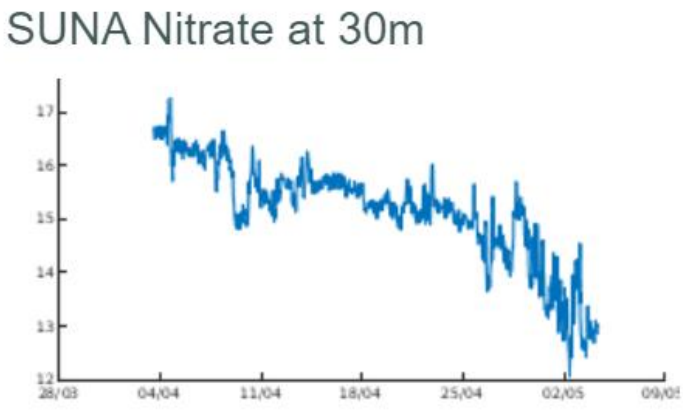
The best calibration is y =0.2.0517x +3.4492 (r^2 = 0.782).



Photos of the new Fluorometer

The 30m SUNA (submersible UV nitrate analyser) nitrate UV sensor (SN 698) was validated at NOC (see below) and
frame prior to DY130.





Pre cruise validation (in the lab at NOC) of the SUNA nitrate sensor and real time data

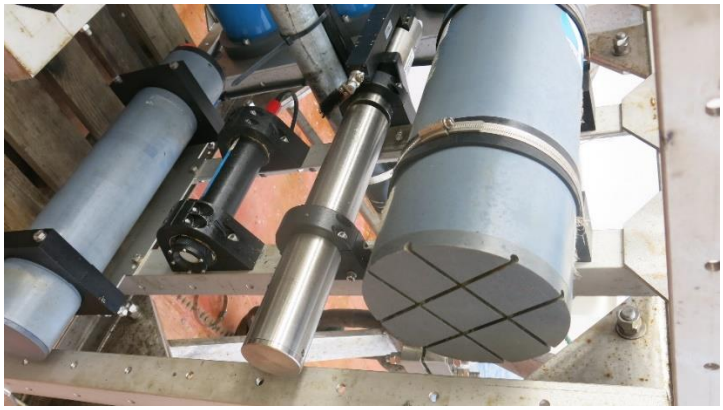
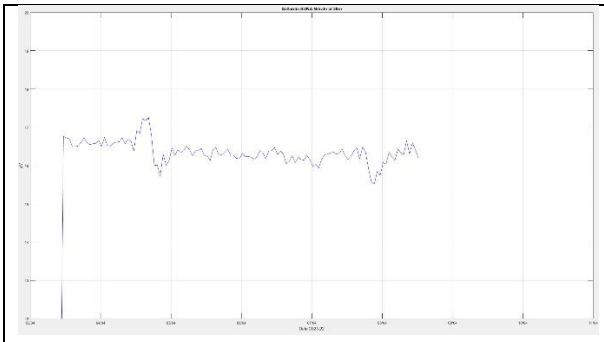


Photo of the Satlantic SUNA, the GTD and batteries in DY130 frame

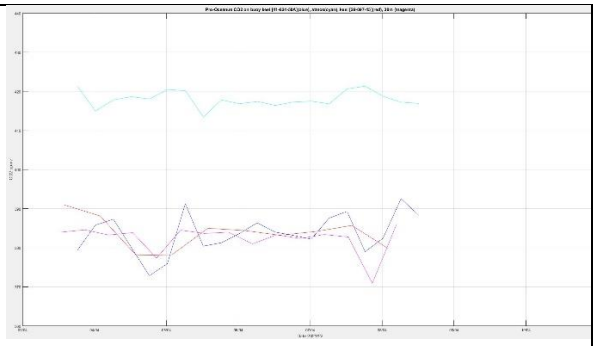
The Aanderaa Seaguard was deployed with an optode, Turner fluorometer, Zebratech wiper (but no current meter).

Photos of the Turner fluorometer and optode on the seaguard

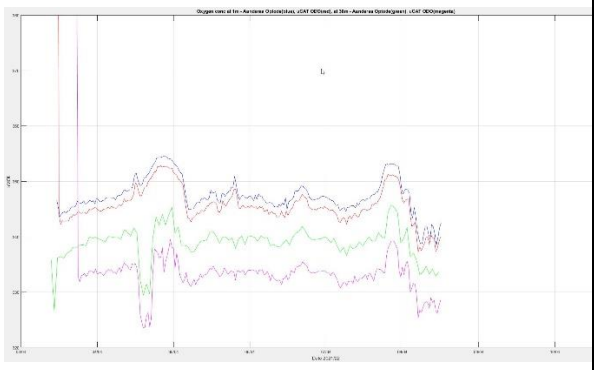
The two Seabird microcats were validated at sea on CTD cast 2 (station 19) with 3 long stops of 10 minutes. A full calibration of these instruments will be done ashore once the CTD calibrations have been completed. The instruments used were an ODO sn 21549 and an SBE-37 IMP (sn 6909). Real time data https://projects.noc.ac.uk/pap/data/pap-apr-2021 from MicroCAT ODO 21549 was delayed, it seems that the internal clock is around 8 hours slow, so it started sampling when it thought the time was 1000. The fluorometer s/n 6702 was run in the labs at NOC to get familiarisation to new model (doesn't include pressure or temperature sensors) then programmed at NOC and switched off until power was reapplied the day before deployment. On the real-time data feed the WETLabs data have had the manufacturer's coefficients applied.



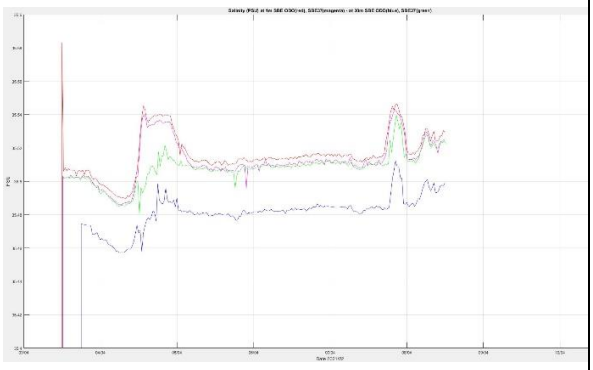
Nitrate



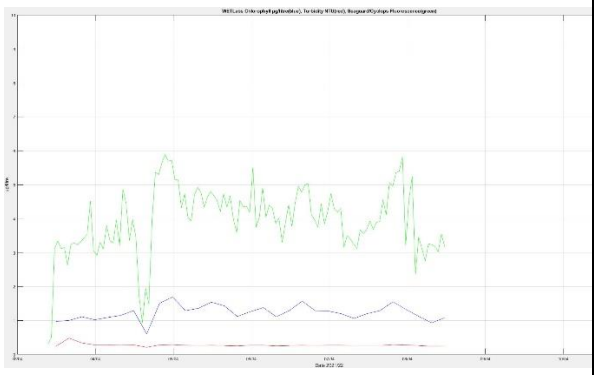
CO2



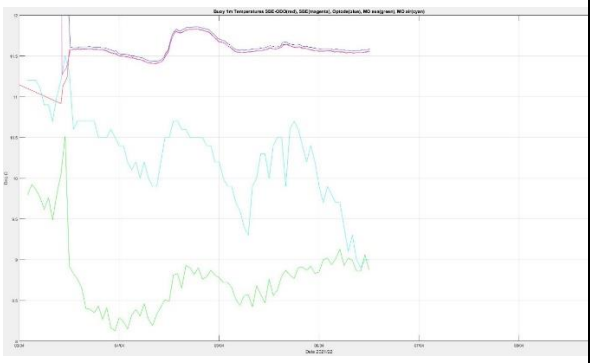
O2 optode



ODO



CHL



Temp

Some initial plots from Jon at COD showing real time data and NOC vs MO temperature

Near real time data issues from deployment 2021:

- SN 21549 is ~8 hours slow
- internal clock in SN 6909 is around an hour fast.

Both problems can easily be corrected in the data processing (for the plots a time stamp was applied from the telemetry unit, with a small offset).

- From ~20th May inductive communications system was gradually failing, causing an increasing number of corrupt and missing messages from the sbe and sbo sensors. Possibly mechanical damage to the cable carrying the inductive comms (so will rely on recorded data logged in the sensors themselves).
- The MicroCAT oxygen data is output in ml/l so Jon applied a (very large) 'fix-it' factor of 56.0 to plot them together with the optode data in micro moles.
- Issue with NRT data from Pro-Oceanus Total Dissolved Gas Pressure sensor (aka TDGP or GTD) which stopped data ~23rd May with no sign of anything untoward in its last message. However, Jon sent a command to power it from the hub (instead of its battery) and got it working again
- The atmospheric CO2 sensor on the buoy stopped sending real time data early on 15th May. This coincided with a marked increase in the current drawn by the telemetry unit. Jon sent a command to switch off the atmospheric CO2 sensor power supply, which was received at 1200 on the 15th, and from then on, the current level returned to normal. Later on, the 15th he sent another command to switch on the CO2 sensor again, and it resumed sampling normally. This kind of malfunction has not been seen in our CO2 sensors before, so something to keep an eye on
- A difference was seen in sea temperature readings, between Met office sensor and NOC. NOC have 3 sensors within about 30 cm of each other giving very similar readings, whereas the Met Office sensor seems to be reading 2 – 3 degrees cooler.
- Wind sonic failed ~21st May, which coincided with an increase in current values reported in the MO engineering messages (by around 60mA) at the same time as the sensor failed which suggests water ingress.

10. CTD profiles for calibration and water sampling

The CTDs were used primarily to test sensors and releases although samples were also taken to look at typical profiles in the region. The first cast was in the first deep water off the shelf and was used to test the CTD and ship side systems. The glider calibration casts are described in the 'Gliders' section.

CTD (station number)	CTD depth (water depth) m	Notes on CTD number and reason for cast (for location see station list at the end of this report)
DY130-016	2750	CTD1 WC + test to 1800m, plus releases
DY130-019	100	CTD2 near HYBIS, pre dep SBE 16503, 21549, 9469, 3757-616, 6911, 609 (3x 10min)
DY130-021	4750	CTD3 near PAP1, SBE cal - redo SN 12463, cal 12455 to use on PAP3 (3x 10min)
DY130-027	200	CTD4 validation cast for post pap1 (no extra instruments)
DY130-032	1000	CTD5 USA seaglider1 - cal cast & NOC intercal. Now 2 min stops
DY130-045	200	CTD6 Post PAP1 cal cast SBE SN 6904, SN 21210. Long stop 200 and 30m
DY130-046	1000	CTD7 iFADO/GOCART Slocum, SL305, cal cast. Bottles 4, 10 missfire
DY130-053	4845	CTD8 Cal USA glider2 SN237. Bottle 4 missfire
DY130-057	4750	CTD9 bottle 4 missfire
DY130-065	4750	CTD10 post pap3 sbe12462 (cal fail). Some winch issues, missfire bottle 2 + 4
DY130-068	4750	CTD11 SBE PAP3 microcat 12462, 2 10 min stops (no active heave compensation)
DY130-071	200	CTD12 pre cal cast for PAP1 (very near buoy)
DY130-076	4000	CTD13 1 depth for DIC/TA sub standards
DY130-081	1000	CTD14 near slocum sl305 and pre-dep Argo in A2 eddy

Bottles were fired at several depths throughout the water column, and water samples were collected directly from the rosette (in this order) for:

1. Oxygen – PAP analysed on DY130 & EXPORTS (EXPORTS PI: Nicholson, WHOI)
2. DIC – PAP (preserved for analysis ashore, described in a report below)
3. TOC/TOC – PAP & EXPORTS (EXPORTS PI: Carlson, UCSB)
4. Nutrients (NUTS) – PAP (frozen for analysis ashore) & EXPORTS (filtered and frozen, EXPORTS PI: Siegel, UCSB)
5. Salts (analysed by NMF at sea) – PAP

Water was then collected in larger volumes:

- 2L dark bottle: HPLC (EXPORTS PI: Siegel, UCSB)
- 550ml dark bottle: Chl – PAP (analysed on DY130)
- 5L Carboy:
  - Genomics (EXPORTS PI: Rynearson, UCSB)

- POC (inc regression approach for 1 depth above and 1 depth below the MLD and blanks – PAP & EXPORTS (EXPORTS PI: Siegel, UCSB) – 1 cast where we followed both PAP & EXPORTS protocols for comparison

- 10L cubitainers: Po/Pb (EXPORTS PI: Buesseler, WHOI)

Further information can be found on the deck and sampling logs for these casts (Appendix) and in the Glider report. DIC samples were preserved with100ul of saturated mercuric chloride and will be analysed on the NOC Vindta at NOC for Dissolved Inorganic Carbon (DIC) and Total Alkalinity (TA). Duplicates were taken from each station (usually from the deepest Niskin fired). Nutrient samples were collected in small white (acid washed) nutrient pots and frozen for analysis of inorganic nutrients (NO2+NO3, phosphate and silicate) using the Quattro auto-analyser at NOC. Sufficient sample was taken for duplicate analysis. POC and HPLC samples were flash-frozen in liquid-N2 following filtering. They were removed from Liquid N2 on April 13 and placed right away in the -80 freezer for long-term storage. All of these EXPORTS samples were left onboard for analysis on DY131. Stable isotope sampling by Hashan is described below, followed by separate sections on the onboard analysis of dissolved Oxygen, salinity and Chlorophyll.

Stable carbon isotope Sampling

Hashan Niroshana Kokuhennadige, Ocean and Earth Science, NOC, Southampton

Background and Objectives

Research on the effects of rising anthropogenic CO_2 levels in the atmosphere on carbon sequestration in the ocean and marine carbon cycle is ongoing. However, the results have been limited by the ability to study all carbon pools in parallel. Using unique methods to measure the isotopes of carbon in marine samples can help in elucidating the carbon cycle in more detail.

The Porcupine Abyssal Plain (PAP) site in the North Atlantic Ocean exhibits a relatively high uptake of CO_2 from the atmosphere and considered as a perennial CO_2 sink, which makes this site an important oceanic region to understand the effect of anthropogenic CO_2 on the marine carbon cycle. In this study, the marine carbon cycle, carbon fluxes and processes in the North Atlantic Ocean, particularly at the Porcupine Abyssal Plain (PAP) site will be studied using stable carbon isotopes to understand how these oceanic processes react to increasing CO_2 levels in the atmosphere. This work will add value to the existing data set by adding carbon isotope data to the database, opening up new insights to the long running carbon system work done there.

Sample collection

$\delta^{13}C$ of dissolved inorganic carbon ($\delta^{13}C_{DIC}$):

A total of 14 CTDs stations were sampled at PAP during the DY130 research cruise. Seawater samples for $\delta^{13}C_{DIC}$ were collected following the best practice standard operating procedure (Dickson et al., 2007; McNichol et al., 2010). Seawater samples for $\delta^{13}C_{DIC}$ measurements were collected from most depths at all CTDs stations (except CTD 4 and 13) directly from Niskin bottles using a piece of silicone tube into pre-cleaned 40 mL Clean Borosilicate glass vials (with plastic screw caps and PTFE/silicone septa) and preserved by adding 0.02% of the sample vial volume of saturated $HgCl_2$ using a Thermo Scientific 10-100 µL finnipette pipette. After poisoning, vials were sealed air-tight with screw caps and then gently inverted for several times to mix the poison and stored at 4 ºC in the dark environment until further laboratory analysis. Duplicates were taken from each station. $\delta^{13}C_{DIC}$ in seawater samples will be measured at the National Oceanography Centre Southampton (NOCS), University of Southampton, using a Thermo Scientific Delta V Advantage Continuous Flow Isotope Ratio Mass Spectrometer (CF-IRMS) attached to a Thermo Scientific GasBench II system and a CTC Analytics PAL Autosampler in a continuous flow condition, following the standard best practice procedures (Torres et al., 2005; Humphreys et al., 2016).

$\delta^{13}C$ of dissolved organic carbon ($\delta^{13}C_{DOC}$):

Seawater samples for the measurements of $\delta^{13}C_{DOC}$ were collected from most depths at all CTDs stations (except CTD 1, 4 and 13). Seawater samples were collected from Niskin bottles using a silicone tube into 20 mL pre-combusted (450 °C for 4 hours) clean Borosilicate glass vials (with plastic screw caps and PTFE/silicone septa) by filtering through a polycarbonate inline filter holder in which a pre-combusted (450 °C for 4 hours) Whatman GF/F filter (47 mm diameter, 0.7 µm pore size) was placed. Before collecting samples into glass vials, care was taken to wash the filter in place and filter holder with the seawater sample. Then samples were immediately preserved by acidifying with 100 µL of 4M HCl to reduce the pH<2 (Sharp et al., 1993), and vials were then sealed tightly and stored at 4 ºC in a dark environment. Duplicates were taken from each station. $\delta^{13}C_{DOC}$ in seawater samples will be measured at NOCS, University of Southampton, using the high temperature combustion method using a Thermolax TOC-TN analyzer attached to a Thermo Scientific Delta V Advantage Continuous Flow Isotope Ratio Mass Spectrometer.

$\delta^{13}C$ of particulate organic carbon ($\delta^{13}C_{POC}$) & $\delta^{13}C$ PIC ($\delta^{13}C_{PIC}$):

Seawater samples for the measurements of $\delta^{13}C_{POC}$ and $\delta^{13}C_{PIC}$ were collected from most depths at all CTDs stations (except CTD 1, 4, 6 and 13). Seawater sample were first collected into 5 L polypropylene bottles and 2 L Nalgene large narrow mouth bottles, and then samples were immediately filtered through pre-combusted (450 °C for 4 hours) Whatman GF/F filters (25 mm

diameter, 0.7 µm pore size and shipped in aluminium foil pouches) by filtering 1-2 L of volume of seawater using a low vacuum pump. Filters were then folded and wrapped in pre-combusted (450 °C for 4 hours) aluminium foil pouches and stored deep frozen at -80 °C in a freezer until laboratory analysis (Liu et al., 2007, Brown et al., 2014). $\delta^{13}C_{POC}$ and $\delta^{13}C_{PIC}$ in seawater samples will be measured at NOCS, University of Southampton, using the high temperature combustion method using a Thermo Scientific Flash 2000 Elemental analyzer attached to a Thermo Scientific Delta V Advantage Continuous Flow Isotope Ratio Mass Spectrometer.

Reference:

Brown, K.A., McLaughlin, F., Tortell, P.D., Varela, D.E., Yamamoto-Kawai, M., Hunt, B. and Francois, R., 2014. Determination of particulate organic carbon sources to the surface mixed layer of the Canada Basin, Arctic Ocean. *Journal of Geophysical Research: Oceans*, *119*(2), pp.1084-1102.

Dickson, A.G., Sabine, C.L. and Christian, J.R., 2007. *Guide to best practices for ocean CO2 measurements*. North Pacific Marine Science Organization.

Humphreys, M.P., Greatrix, F.M., Tynan, E., Achterberg, E.P., Griffiths, A.M., Fry, C.H., Garley, R., McDonald, A. and Boyce, A.J., 2016. Stable carbon isotopes of dissolved inorganic carbon for a zonal transect across the subpolar North Atlantic Ocean in summer 2014. *Earth System Science Data*, *8*(1), pp.221-233.

Liu, K.K., Kao, S.J., Hu, H.C., Chou, W.C., Hung, G.W. and Tseng, C.M., 2007. Carbon isotopic composition of suspended and sinking particulate organic matter in the northern South China Sea—from production to deposition. *Deep Sea Research Part II: Topical Studies in Oceanography*, *54*(14-15), pp.1504-1527.

McNichol, A. P., Quay, P. D., Gagnon, A. R., and Burton, J. R. 2010. Collection and Measurement of Carbon Isotopes in Seawater DIC. IOCCP Report No. 14, ICPO Publication Series No. 134, Version.

Sharp, J.H., Peltzer, E.T., Alperin, M.J., Cauwet, G., Farrington, J.W., Fry, B., Karl, D.M., Martin, J.H., Spitzy, A., Tugrul, S. and Carlson, C.A., 1993. Procedures subgroup report. *Marine Chemistry*, *41*(1-3), pp.37-49.

Torres, M.E., Mix, A.C. and Rugh, W.D., 2005. Precise δ13C analysis of dissolved inorganic carbon in natural waters using automated headspace sampling and continuous-flow mass spectrometry. *Limnology and Oceanography: Methods*, *3*(8), pp.349-360.

Salinity measurement

Billy Platt and Paul Henderson

A Guildline Autosal 8400B salinometer, s/n: 68426, was used for salinity measurements. The salinometer was sited in the Salinometer lab. Initially, the bath temperature was set at 21°C, the ambient temperature being approximately 19°C. The salinometer was standardised at the beginning of the first set of samples, and checked with an additional standard analysed after setting the RS. Once standardised the Autosal was not adjusted for the duration of sampling. A standard was analysed before and after each crate of samples to monitor & record drift. Standards were recorded in the spreadsheet as '0' and had a standard salinity value of 34.994. Standard deviation was set to 0.00002. A bespoke program written in Labview called "Autosal" was used as the data recording program for salinity values.

Salinity samples were taken by the pelagic team and analysed by NMF. They were taken from most casts and the results tabulated in a spreadsheet SALFORM_SS.xlsx. Salinometer failed mid crate on 13th April. Computer did not respond when salinometer was switched from standby to read. Computer

then went to blue screen with massage: ‘This device is not working properly’ and restarted. Salinometer worked as normal after restart.

Chlorophyll

Corinne Pebody

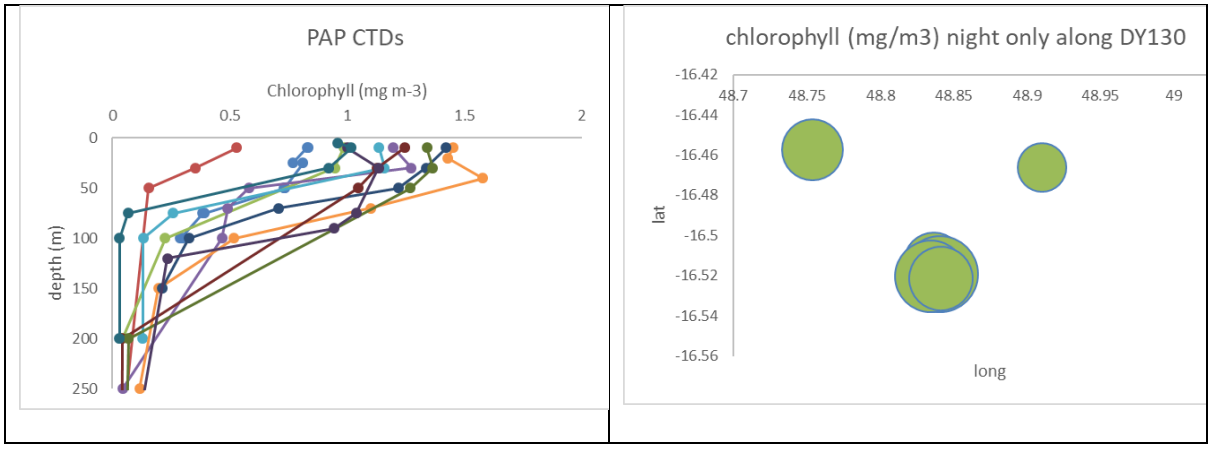
Chlorophyll samples were taken from both CTD (Whittard canyon, PAP-SO and glider sites) and underway systems.

CTD samples were 500ml volumes and underway 250ml volumes to ensure sufficient chlorophyll in samples.

Where possible samples were taken at pre-dawn and dawn to avoid quenching in the TSG and CTD fluorometers with which they samples will be compared. They were kept cool and dark and were filtered as soon as possible.

Samples were shaken then poured into the filter rigs through 25mm GFFs and transferred to 8ml of 90% acetone. From each sample, two lots of 250ml were filtered. After approx. twenty-four hours they were run the Trilogy BLACK-02: (calibrated August 2018) for each sample, the trilogy was run twice, and results recorded.

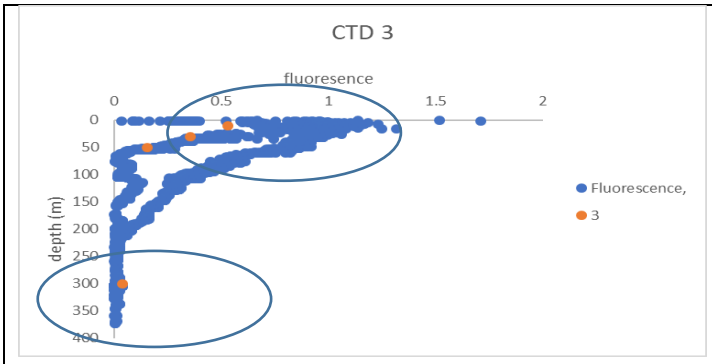
Results

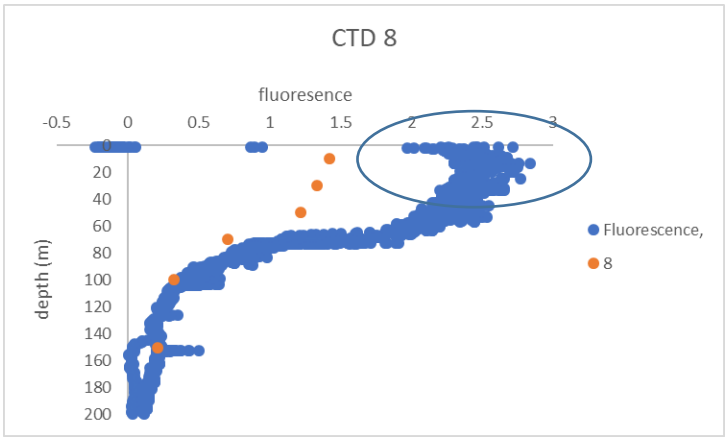


Calibrations:

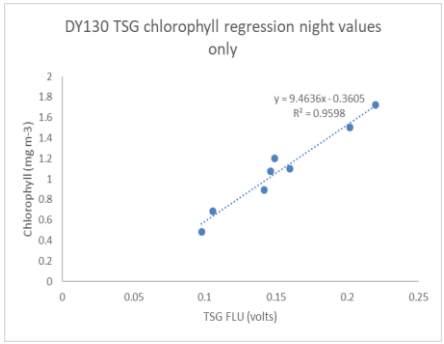
The chlorophyll calibrations are yet to be applied to the CTD data.

Comparison plots below show that the fluorescence is over estimated by the CTD mounted fluorometer at higher values, underestimated at low values, and shows quenching in day light hours in the top 30m.





Underway (TSG)



Dissolved oxygen analysis on board

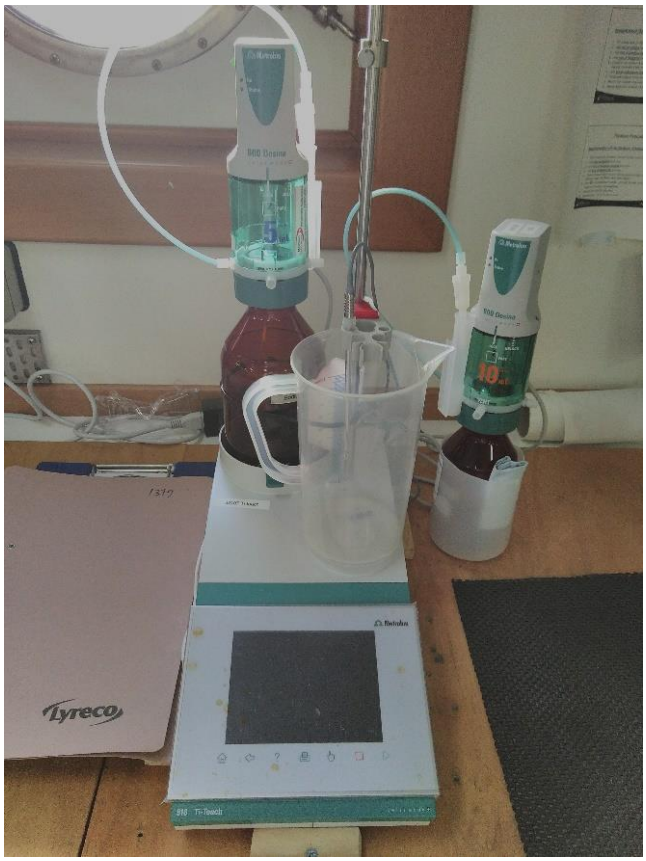
Anita Flohr

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. The preparation of reagents as well as the sampling and analysis of DO samples followed standard operation procedures (Dickson, 1995;Langdon, 2010).

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 (FisherScientific, RTD Pt Thermometer, S/N: 140212361). 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 four to 6 hours of sample collection.

Oxygen 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 mol L^{-1} certified iodate standard (OSIL) in MilliQ for each set of analyses, respectively. Following Langdon (2010), a set of blanks were measured in seawater from 4750 m, 2000 m, 825 m, 200 m, 50 m, 30 m.



The Metrohm Ti-touch 916 setup used for dissolved oxygen analysis on DY130.

Oxygen results

A total of 193 samples were analysed for DO. The blank ranged from 0.0021 to 0.0039 mL (average: 0.0031±0.0006 mL, n=36). Blanks measured in seawater showed higher values ranging from 0.0070 mL in deep water to 0.005 mL in shallower water (50 m). The average $Na_2S_2O_3$ standardisation value was 0.4631±0.0010 mL (n=9). Standard deviations of replicates ranged from 0.02 to 1.3 µmol L^{-1} and were on average 0.23 µmol L^{-1} (≤0.1%, n=58). The DO data will be used to calibrate the DO sensors (CTD, moored sensors) upon return will be analysed upon return to the National Oceanography Centre, Southampton.

DY130 dissolved oxygen results.

cruise-ctd#	sample date	niskin bottle#	depth (m)	c_{O2} (µmol/L)	average (µmol/L)	sd (µmol/L)	rsd (%)	comment
DY130-001	28/03/2021	1	1800	261.976				
DY130-001	28/03/2021	2	1800	260.137	261.06	1.30	0.50	
DY130-001	28/03/2021	3	1600	252.783				
DY130-001	28/03/2021	4	1600	252.723	252.78	0.04	0.02	
DY130-001	28/03/2021	5	1000	196.205				
DY130-001	28/03/2021	6	1000	196.804	196.50	0.42	0.22	
DY130-001	28/03/2021	7						
DY130-001	28/03/2021	8						
DY130-001	28/03/2021	9	900	193.240				
DY130-001	28/03/2021	10	900	193.916				
DY130-001	28/03/2021	11	500	225.542				
DY130-001	28/03/2021	12	500	225.509	225.53	0.02	0.01	
DY130-001	28/03/2021	13	370	243.472				
DY130-001	28/03/2021	14	370	242.821	243.15	0.46	0.19	
DY130-001	28/03/2021	15	350	240.799				
DY130-001	28/03/2021	16	350	241.275	241.04	0.34	0.14	
DY130-001	28/03/2021	17	170	273.891				
DY130-001	28/03/2021	18	170	274.235	274.06	0.24	0.09	
DY130-001	28/03/2021	19	100	273.558				

DY130-001	28/03/2021	20	100	273.459	273.51	0.07	0.03	
DY130-001	28/03/2021	21	50	272.731				
DY130-001	28/03/2021	22	50	272.377	272.55	0.25	0.09	
DY130-001	28/03/2021	23	10	271.142				
DY130-001	28/03/2021	24	10					misfire
DY130-002	30/03/2021	4	100	272.795				
DY130-002	30/03/2021	4	100	272.930	272.86	0.10	0.04	
DY130-002	30/03/2021	8	75	272.953				
DY130-002	30/03/2021	8	75	273.775	273.36	0.58	0.21	
DY130-002	30/03/2021	12	50	274.004				
DY130-002	30/03/2021	12	50	274.139	274.07	0.10	0.03	
DY130-002	30/03/2021	16	25	277.197				
DY130-002	30/03/2021	16	25	277.196	277.20	0.00	0.00	
DY130-002	30/03/2021	20	10	277.696				
DY130-002	30/03/2021	20	10	277.808	277.75	0.08	0.03	
DY130-003	31/03/2021	2	4750	248.995				
DY130-003	31/03/2021	2	4750	248.790				
DY130-003	31/03/2021	2	4750	248.910	248.90	0.10	0.04	
DY130-003	31/03/2021	4	3000	257.913				
DY130-003	31/03/2021	6	2500	266.855				
DY130-003	31/03/2021	8	1800	278.123				
DY130-003	31/03/2021	8	1800	277.775				
DY130-003	31/03/2021	8	1800	278.214	278.04	0.23	0.08	
DY130-003	31/03/2021	10	1000	212.627				
DY130-003	31/03/2021	12	800	200.640				
DY130-003	31/03/2021	14	300	263.896				
DY130-003	31/03/2021	14	300	263.921				
DY130-003	31/03/2021	14	300	262.773	263.53	0.66	0.25	2 types of bottles
DY130-003	31/03/2021	16	50	257.194				
DY130-003	31/03/2021	18	30	260.427				
DY130-003	31/03/2021	20	10	265.361				

DY130-004	01/04/2021	2	200	267.899				
DY130-004	01/04/2021	2	200	267.475	267.69	0.30	0.11	
DY130-004	01/04/2021	8	100	271.267				
DY130-004	01/04/2021	8	100	271.438	271.35	0.12	0.04	
DY130-004	01/04/2021	14	30	276.507				
DY130-004	01/04/2021	14	30	276.256	276.38	0.18	0.06	
DY130-004	01/04/2021	18	10	276.584				
DY130-004	01/04/2021	18	10	276.960	276.77	0.27	0.10	
DY130-005	02/04/2021	3	1000	220.285				
DY130-005	02/04/2021	3	1000	220.174				
DY130-005	02/04/2021	3	1000	219.832	220.10	0.24	0.11	
DY130-005	02/04/2021	5	900	210.018				
DY130-005	02/04/2021	7	800	203.529				
DY130-005	02/04/2021	9	500	264.604				
DY130-005	02/04/2021	9	500	264.433				
DY130-005	02/04/2021	9	500	264.227	264.42	0.19	0.07	
DY130-005	02/04/2021	10	250	268.642				
DY130-005	02/04/2021	13	100	276.274				
DY130-005	02/04/2021	15	70	275.417				
DY130-005	02/04/2021	17	50	273.847				
DY130-005	02/04/2021	19	30	278.060				
DY130-005	02/04/2021	21	10	278.231				
DY130-006	04/04/2021	4	200	271.347				
DY130-006	04/04/2021	4	200	271.994	271.67	0.46	0.17	
DY130-006	04/04/2021	8	100	272.940				
DY130-006	04/04/2021	8	100	272.168	272.55	0.55	0.20	
DY130-006	04/04/2021	12	75	272.297				
DY130-006	04/04/2021	12	75	272.381	272.34	0.06	0.02	
DY130-006	04/04/2021	16	30	280.796				
DY130-006	04/04/2021	16	30	280.322	280.56	0.34	0.12	
DY130-006	04/04/2021	21	10	280.311				

DY130-006	04/04/2021	21	10	281.069	280.69	0.54	0.19	
DY130-007	04/04/2021	2	800	199.489				
DY130-007	04/04/2021	2	800	199.866				
DY130-007	04/04/2021	2	800	199.894	199.75	0.23	0.11	
DY130-007	04/04/2021	3	600	235.147				
DY130-007	04/04/2021	6	400	267.124				
DY130-007	04/04/2021	6	400	266.853				
DY130-007	04/04/2021	6	400	266.729	266.90	0.20	0.07	
DY130-007	04/04/2021	8	250	271.243				
DY130-007	04/04/2021	9	150	272.551				
DY130-007	04/04/2021	12	100	275.956				
DY130-007	04/04/2021	14	70	280.265				
DY130-007	04/04/2021	16	40	282.254				
DY130-007	04/04/2021	16	40	280.200				
DY130-007	04/04/2021	16	40	279.993	280.096	0.14	0.052	2 types of bottles
DY130-007	04/04/2021	18	20	279.052				
DY130-007	04/04/2021	20	10	279.335				
DY130-008	05/04/2021	2	825	201.750				
DY130-008	05/04/2021	2	825	201.406				
DY130-008	05/04/2021	2	825	201.616	201.59	0.17	0.085	
DY130-008	05/04/2021	3	600	241.253				sampled last
DY130-008	05/04/2021	4		274.603				misfire
DY130-008	05/04/2021	6	400	267.749				
DY130-008	05/04/2021	6	400	267.816				
DY130-008	05/04/2021	6	400	267.961	267.84	0.10	0.04	
DY130-008	05/04/2021	8	250	267.082				
DY130-008	05/04/2021	8	250	266.893				
DY130-008	05/04/2021	8	250	267.193	267.05	0.15	0.06	
DY130-008	05/04/2021	10	150	275.322				
DY130-008	05/04/2021	12	100	274.966				
DY130-008	05/04/2021	14	70	278.525				

DY130-008	05/04/2021	16	50	277.601				
DY130-008	05/04/2021	18	30	277.597				
DY130-008	05/04/2021	20	10	278.080				
DY130-009	06/04/2021	2	4750	249.926				
DY130-009	06/04/2021	2	4750	249.902	249.91	0.01	0.01	
DY130-009	06/04/2021	3	3000	258.524				
DY130-009	06/04/2021	3	3000	258.353	258.43	0.12	0.05	
DY130-009	06/04/2021	6	2500	270.929				
DY130-009	06/04/2021	8	1800	281.350				
DY130-009	06/04/2021	10	800	203.813				
DY130-009	06/04/2021	12	750	203.772				
DY130-009	06/04/2021	14	450	268.027				
DY130-009	06/04/2021	16	200	265.807				
DY130-009	06/04/2021	16	200	265.887	265.84	0.06	0.02	
DY130-009	06/04/2021	18	50	278.904				
DY130-009	06/04/2021	20	30	279.596				
DY130-009	06/04/2021	21	10	280.183				
DY130-010	07/04/2021	1	4750	249.660				
DY130-010	07/04/2021	1	4750	249.367	249.51	0.21	0.08	
DY130-010	07/04/2021			249.530				misfire
DY130-010	07/04/2021			250.004	249.77	0.33	0.13	misfire
DY130-010	07/04/2021	3	3000	258.014				
DY130-010	07/04/2021	6	2500	269.838				
DY130-010	07/04/2021	8	1800	280.097				
DY130-010	07/04/2021	10	800	202.294				
DY130-010	07/04/2021	12	750	203.842				
DY130-010	07/04/2021	12	750	203.199	203.52	0.45	0.22	
DY130-010	07/04/2021	14	450	267.367				
DY130-010	07/04/2021	14	450	266.898	267.13	0.33	0.12	
DY130-010	07/04/2021	16	200	268.342				
DY130-010	07/04/2021	18	50	279.534				

DY130-010	07/04/2021	20	30	280.386				
DY130-010	07/04/2021	21	10	281.100				
DY130-011	08/04/2021	2	4750	249.638				
DY130-011	08/04/2021	2	4750	249.615	249.63	0.02	0.01	
DY130-011	08/04/2021	4	3500	252.994				
DY130-011	08/04/2021	6	3000	258.055				
DY130-011	08/04/2021	8	2000	277.529				
DY130-011	08/04/2021	8	2000	277.401	277.46	0.09	0.03	
DY130-011	08/04/2021	10	1500	274.081				
DY130-011	08/04/2021	12	825	200.011				
DY130-011	08/04/2021	14	400	266.609				
DY130-011	08/04/2021	16	120	270.884				
DY130-011	08/04/2021	18	90	277.082				
DY130-011	08/04/2021	18	90	276.634	276.86	0.32	0.11	
DY130-011	08/04/2021	20	75	277.167				
DY130-011	08/04/2021	22	30	279.255				
DY130-011	08/04/2021	23	10	278.801				
DY130-012	09/04/2021	2	200	261.351				
DY130-012	09/04/2021	6	100	258.893				
DY130-012	09/04/2021	6	100	258.745				
DY130-012	09/04/2021	6	100	259.064	258.90	0.16	0.06	
DY130-012	09/04/2021	10	75	262.177				
DY130-012	09/04/2021	14	30	275.057				
DY130-012	09/04/2021	14	30	275.417	275.24	0.25	0.09	
DY130-012	09/04/2021	18	10	275.930				
DY130-012	09/04/2021	22	5	275.193				
DY130-014	10/04/2021	2	900	202.337				EXPORTS A-1
DY130-014	10/04/2021	2	900	202.485	202.41	0.10	0.05	A-2
DY130-014	10/04/2021	4	500	260.464				A-3
DY130-014	10/04/2021	4	500	260.724	260.59	0.18	0.07	A-4

DY130-014	10/04/2021	6	400	267.370				A-7
DY130-014	10/04/2021	6	400	266.945	267.16	0.30	0.11	A-9
DY130-014	10/04/2021	8	300	268.158				
DY130-014	10/04/2021	8	300	268.472	268.32	0.22	0.08	
DY130-014	10/04/2021	10	250	268.143				A-10
DY130-014	10/04/2021	10	250	267.921	268.03	0.16	0.06	A-11
DY130-014	10/04/2021	12	150	270.313				A-12
DY130-014	10/04/2021	12	150	270.263	270.29	0.03	0.01	A-13
DY130-014	10/04/2021	14	100	266.077				A-14
DY130-014	10/04/2021	14	100	266.053	266.07	0.02	0.01	A-15
DY130-014	10/04/2021	16	75	271.728				A-16
DY130-014	10/04/2021	16	75	271.588	271.66	0.10	0.04	A-17
DY130-014	10/04/2021	18	50	280.499				
DY130-014	10/04/2021	18	50	280.729	280.61	0.16	0.06	
DY130-014	10/04/2021	20	30	283.328				A-18
DY130-014	10/04/2021	20	30	283.058	283.19	0.19	0.07	A-19
DY130-014	10/04/2021	22	10	283.802				A-20
DY130-014	10/04/2021	22	10	283.097	283.45	0.50	0.18	A-21
DY130-014	10/04/2021	24	5	280.910				A-22
DY130-014	10/04/2021	24	5	281.066	280.99	0.11	0.04	A-23

Reference

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.

10. Underway sampling and CO_2 measurements

Anita Flohr

Two systems were connected to the underway non-toxic seawater supply in the deck lab for continuous pCO2 measurements (ProOceanus CV (1.) and SubCtech (2.) connected to the non-toxic seawater supply during DY130. Both systems were installed in the deck lab. Discrete water samples for analyses of total alkalinity (TA) and dissolved inorganic carbon (DIC) concentration, dissolved nutrient concentration, salinity and chlorophyll *a* concentration were taken normally twice a day from the outlet

water flow of the underway system. Salinity and chlorophyll *a* samples were measured on board. The TA/DIC and nutrient samples will be analysed upon return to the National Oceanography Centre, Southampton.

Underway systems connected to the non-toxic seawater supply during DY130

Manufacturer	Model	Serial Number	Parameter	Location	Period running
SubCTech	OceanPack MK2 Flow-Through Analyzer	CO2-DLZEGAMK2-19-0-1803-01	pCO2	Deck Lab	25/03 13:00 – 13/04/2021 07:45
Pro-Oceanus CV	CO2-Pro CV Flow-Through	40-774-75	pCO2	Deck Lab	25/03 15:00 - 13/04/2021 07:45

ProOceanus CV (1.) and SubCtech (2.) connected to the non-toxic seawater supply during DY130

SubCtech Ocean Pack

The system was installed on 25/03/2021 and ran on non-toxic seawater supply from ~13:00 UTC. The water flow into the system was set to 10±2 L/min. Air bubbles were observed in the in the water stream until ~13:30. 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 DY130.

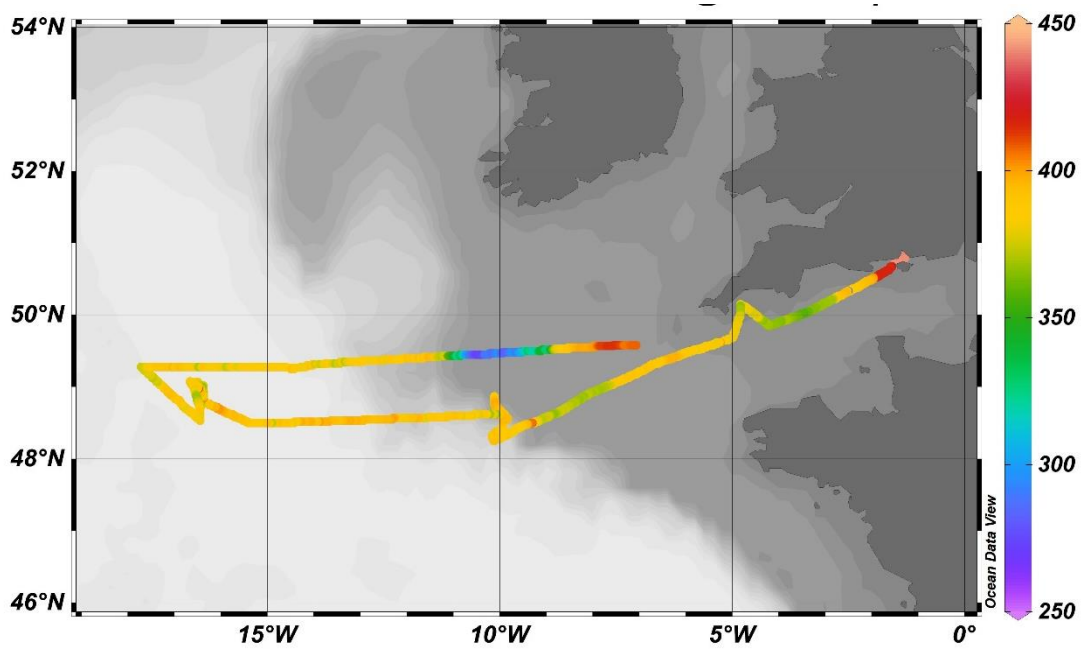
Due to seawater damage on DY129 causing failure of the internal memory, the data had to be streamed and logged and the calibration had to be done manually. Communication to the sensor was established using the SubCtech Ocean View Software, which was used to adjust settings (e.g., sampling interval)

and to visualise the continuous pCO_2 data stream. The data was streamed and logged to a laptop at 1 datapoint per minute.

The system connected to single standard gas (422 ppm) located in rack a in ship's hangar via stainless steel tubing. Manual calibration (usually once a day) involved running (i) zero CO_2 (10-15 mins) followed by (ii) a reference gas measurement (10-15 mins) (422 ppm). Due to the memory issues, only raw, uncalibrated data were output and logged. The data will be processed after cruise. The discrete TA/DIC samples along with the TSG underway temperature and salinity data (logged from Grafana) will be used to calculate the pCO_2 and calibrate the sensor's pCO_2 data. Problems encountered: the flow rate in water measurement mode fluctuated between 490 and 560 mL/min. The system will be sent for repair upon return to the National Oceanography Centre, Southampton.

ProOceanus CV

The system was installed on 25/03/2021 and ran on non-toxic seawater supply from ~15:00 UTC. The water flow into the flow-through head was set to 2±0.8 L/min. Communication to the sensor was established using the Oceanus View software, which was used to start the sensor, to adjust settings (e.g., sampling interval) and to visualise the continuous pCO_2 data stream. The data logging interval on the sensor's internal data logger was set to 1 datapoint per minute. In addition, the data was also streamed and logged to a laptop at 1 datapoint per second. The ProOceanus CV does not allow measurement of reference gas but the system ran a zero every 12 hours. The logged data will be processed after the cruise.



Raw underway pCO2 data from DY130

The discrete TA/DIC samples along with the TSG underway temperature and salinity data (logged from Grafana) will be used to calculate the pCO_2 and calibrate the sensor's pCO_2 data.

Protocol of calibrations and discrete sampling from the underway system.

Date	Time UTC	Lat (deg min.sec)	Long (deg min.sec)	Temp TSG (°C)	Temp_SubCtech outflow (°C)	Salinity TSG (PSU)	Fluores TSG (V)	SubCtech CO_2 (ppm)	proOceanus CO_2 (ppm)	TSG crate #	Sal bottle #	Fluorescnce	Nutrients	DIC/TA #	Comments
25/03/2021	12:00														Non-toxic water supply on, SubCtech running (9.25 L/min) and logging from ~12:30, ProOceanus running (water flow 2 L/min) and logging from ~14:10; filling pressure reference gas for SubCtech is 60 bar
25/03/2021	20:16	49 59.95	3 35.92	9.92	9.94	35.268	0.130			2	49	✓	✓	167	Underway
26/03/2021	10:30	50 9.1741	4 49.374	9.62	9.64	34.917	0.092	381	396	2	50	✓	✓	199	Hiding from bad weather off Falmouth
26/03/2021	16:30	50 9.1625	4 49.350	9.65	9.68	34.933		375	395	2	51	✓	✓	212	Hiding from bad weather off Falmouth
27/03/2021	10:16	49 36.628	5 21.709	10.32	10.34	35.246	0.095	381	406	2	52	✓	✓	226	Underway
27/03/2021	10:32														SubCtech manual calibration (zero Co2 and span1) until 10:52; 5 min for each phase is too short for stable reading, thus left it for ~10mins
27/03/2021	16:30	49 22.207	6 30.126	10.48	10.58	35.245	0.124	396	414	2	53	✓	✓	250	Underway
28/03/2021	10:00	48 30.72	9 16.371	11.63	1.62	35.536	0.141	373	395	2	54	✓	✓	164	Underway
28/03/2021	10:51														SubCtech manual calibration (zero Co2 and span1) until 11:30; changed time back to UTC (changed automatically to summer time)
28/03/2021	16:30														At CTD001 station, no discrete samples from the underway system
29/03/2021	13:30	48 37.795	10 0.424	11.72	11.84	35.547	0.105	393	396	2	55	✓	✓	196	Triangulation after Whittard Canyon deployment

29/03/2021	14:13														SubCtech manual calibration (zero Co2 and span1) until 14:33; chnaged time back to UTC (changed automatically to summer time)
29/03/2021	16:18	48 36.820	10 38.820	12.07	12.11	35.571	0.103	385	393	2	56	✓	✓	207	Transit from Whittard Canyon to PAP
30/03/2021	08:45	48 30.571	14 39.547	11.36	11.38	35.482	0.142	383	389	2	57	✓	✓	224	
31/03/2021	09:45	48 56.147	16 26.527	11.89	11.9	35.536	0.091	404	403	2	58	✓	✓	248	Stationary, CTD003 close to PAP1
31/03/2021	17:25														Stationary, SubCtech manual calibration (zero Co2 and span1) until 18:00
01/04/2021	06:10	48 54.61	16 27.96	11.72		35.51	0.13	398	401	2	59				Underway
01/04/2021	10:10	48 59.584	16 26.233	11.76	11.87	35.51	0.121	392	396	2	60	✓	✓	162	Stationary, close to where the amphipod trap and the glider is being deployed
01/04/2021	15:22														SubCtech manual calibration (zero Co2 and span1) until 15:45
02/04/2021	05:43	48 51.26	16 30.46	11.74		35.5	0.14			2	61				
02/04/2021	15:05	48 50.377	16 31.255	11.69	11.73	35.501	0.126	383	393	2	62	✓	✓	180	Stationary (mega corer, CTD005)
02/04/2021	16:30														SubCtech manual calibration (zero Co2 and span1) until 16:55, at station (Mega corer, CTD005 stn)
03/04/2021	05:35	48 50.464	16 31.1614	11.22		35.511	0.146	385					✓		Night watch sampling
03/04/2021	08:50	48 57.446	16 26.440	11.75	11.76	35.511	0.182	380	398	2	63	✓	✓	202	Stationary, PAP1
03/04/2021	16;30	48 59.299	16 26.631	11.78	11.78	35.512	0.161	380	392	2	64	✓	✓	216	Stationary, PAP1
04/04/2021	05:36	48 50.3456	16 30.7312	11.76		35.512	0.145	383					✓		Night watch sampling
05/04/2021	06:57														SubCtech manual calibration (zero CO2 and span1) until 07:21, at station (mega cores)

05/04/2021	10:30	48 52.334	16 31.557	12.05	12.03	35.568	0.182	379	392	2	65	✓	✓	244	Stationary (CTD008)
05/04/2021	16:05	48 0 0.323	16 27.807	11.88	11.96*	35.514	0.225	369	382	2	66	✓	✓	161	*new thermometer
06/04/2021	16:20	48 50.269	16 31.385	11.72	11.84	35.520	0.184	374	385	2	67	✓	✓	176	Stationary, mega corer after CTD009
06/04/2021	18:03														SubCtech manual calibration (zero Co2 and span1) until 18:25, at station (mega cores), at station, mega corer after CTD009
07/04/2021	09:30	48 59.989	16 30.01	11.73	11.8	35.518	0.132	376	385	2	68	✓	✓	201	Stationary CTD010
08/04/2021	14:45	48 51.994	16 29.976	11.95	12.06	35.542	0.155	365	375	2	69	✓	✓	215	Stationary CTD011
08/04/2021	20:13														SubCtech manual calibration (zero Co2 and span1) until 20:38
09/04/2021	10:05														SubCtech manual calibration (zero Co2 and span1) until 11:27
09/04/2021	17:30	48 54.011	16 27.975	12.22	12.35	35.551	0.192	378	376	2	70	✓	✓	229	Trawling
10/04/2021	10:10														SubCtech manual calibration (zero Co2 and span1) until 10:46
10/04/2021	15:00	49 3.371	16 3.371	12.21	12.34	35.582	0.129	387	385			✓	✓		At station (mega corer)
11/04/2021	11:00	49 7.417	17 26.716	12.09	12.33	35.502	0.104	391	386	2	71	✓	✓	135	Transit to eddy structure
11/4/2021	17:30	49 17.947	16 23.955	12.31	12.32	35.568	0.143	383	380				✓	X017	Transit to eddy structure
12/4/2021	13:00	49 24.309	11 59.721	12.00	11.92	35.561	0.104	389	389	2	72		✓	6-13B	Transit to Southampton
13/4/2021	07:45														Switched off proOceanus and SubCtech

11. Met Office Biogeochemistry Argo float

Andrew Gates, 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 will support the Met Office work on the Argo programme and will provide greater temporal resolution to NOC's monitoring at the observatory, at least while it remains near PAP. The delayed mode Argo float data can quality controlled against CTD casts done during DY130 and can help to validate data from the PAP-1 mooring. The float is a Navis BGCi F1241 with the WMO number 6903756. 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. 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.

The biogeochemistry Argo float was deployed on 12th April, at 03:21, location in the A2 eddy at 49 15.48N, 14 30.08W. The float was lowered into the water on a line from the starboard side of the stern of the ship. Sadly, even by May we have not seen any Iridium transmissions since the float was deployed, so the float may have failed after deployment.

12. PAP 3 sediment traps and sensors

Corinne Pebody, Nick Rundle

Science report – for mooring details see mooring report

Recovery:

Mooring deployed on DY116 recovered on DY130 05/04/2021.

Mooring was alongside 14:00 and all in by 15:30. Recovery included 3 traps, 2 Nortek current meters and 1 x microcat CTD and 1 x release, all apparently working well.

On recovery it was apparent that not all traps had operated as programmed. All batteries appeared ok on deployment see file excerpts but A and C were low before the first event.

There is a mismatch between serial numbers on the sediment traps. The serial numbers listed here are from the loggers. The numbers on the mooring diagram are from the trap themselves. They differ because at some point the loggers have been swapped between traps.

Trap A stopped after 2 events

Dep file excepts

```
System status:

 10/15/2020 13:48:07   20.8 Vb    26 øC aligned


Caution:  Deployment will overwrite the
        EEPROM data backup cache.

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

Rec file excepts

```
Event 01

Scheduled start time:  11/29/2020 12:00:00
Event start time:      11/29/2020 12:00:00
Event stop time:       11/29/2020 12:00:25

      Aligned    Battery    Temperature
Start:    Y        17.7         3 C
Stop:     Y        13.9         3 C
```

```
Event 02
Scheduled start time:  01/03/2021 12:00:00
Event start time:      01/03/2021 12:00:00
Event stop time:       01/03/2021 12:00:25

       Aligned    Battery    Temperature
Start:    Y         16.5         3 C
Stop:     Y          6.3         3 C

Schedule was not completed.
Low battery shutdown in effect.
```

Trap B operated correctly (14 events)

Trap C stopped after 4 events

Dep file excepts

```
 System status:


  10/15/2020 14:54:12   21.2 Vb    24 øC  aligned


 Caution:  Deployment will overwrite the
         EEPROM data backup cache.

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

Rec file excepts

```
Event 01

Scheduled start time:  11/29/2020 12:00:00
Event start time:      11/29/2020 12:00:00
Event stop time:       11/29/2020 12:00:25
       Aligned    Battery    Temperature
Start:    Y         18.7         3 C
Stop:     Y         18.7         3 C

Event 02
```

Scheduled start time: 12/13/2020 12:00:00
Event start time: 12/13/2020 12:00:00
Event stop time: 12/13/2020 12:00:25

	Aligned	Battery	Temperature
Start:	Y	18.5	3 C
Stop:	Y	18.4	3 C

Event 03

Scheduled start time: 12/27/2020 12:00:00
Event start time: 12/27/2020 12:00:00
Event stop time: 12/27/2020 12:00:25

	Aligned	Battery	Temperature
Start:	Y	18.3	3 C
Stop:	Y	13.2	3 C

Event 04

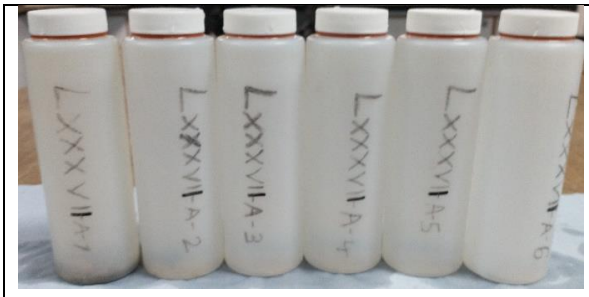
Scheduled start time: 01/10/2021 12:00:00
Event start time: 01/10/2021 12:00:00
Event stop time: 01/10/2021 12:00:25

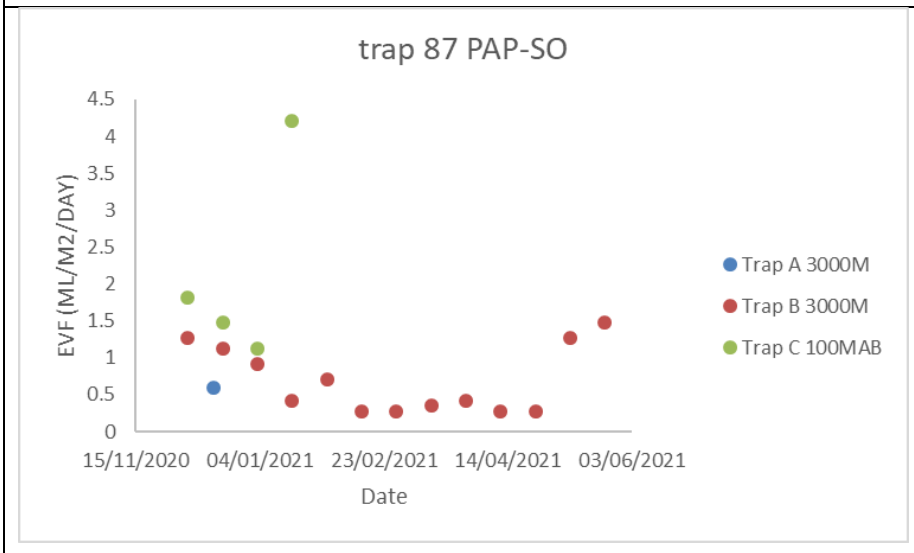
	Aligned	Battery	Temperature
Start:	Y	17.9	3 C
Stop:	Y	6.5	3 C

Schedule was not completed.

Low battery shutdown in effect.

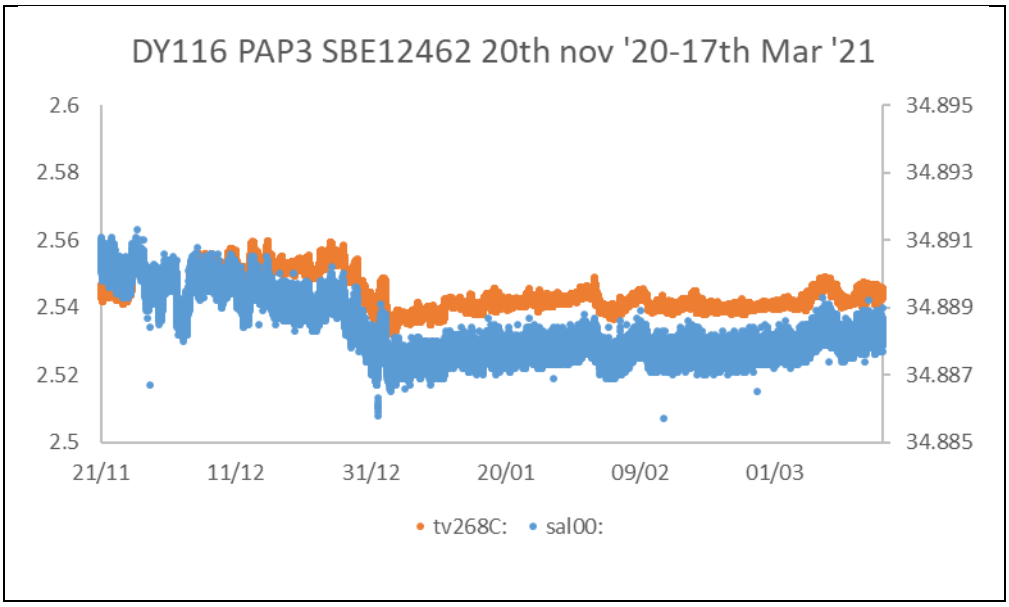
EVF was calculated from recovered bottles. Bottles were photographed and the pH checked and recorded before 1ml buffered formalin added to ensure preservation.





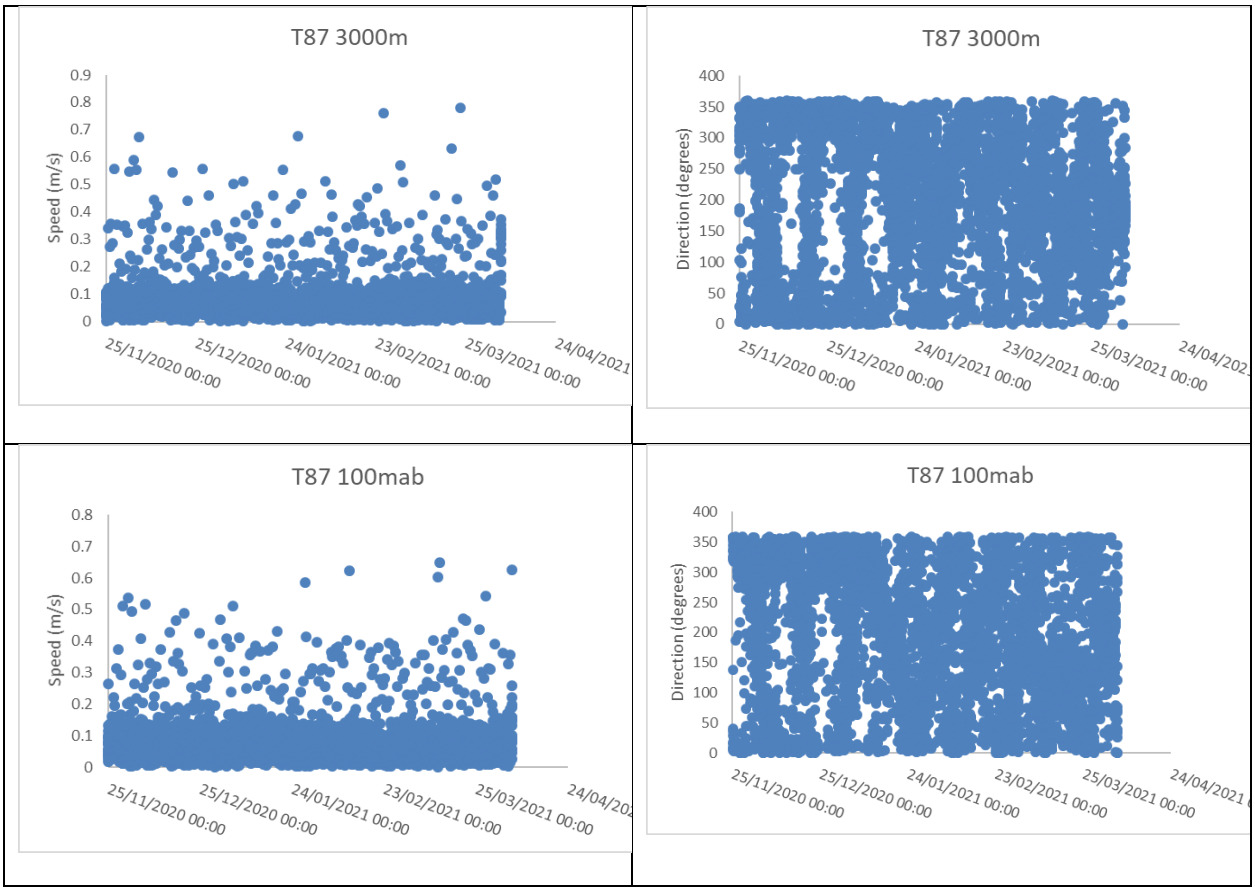
The EVF was calculated for the three traps and plotted as above.

Downloaded data from the current meters at 3000m and 100mab show



DY116 deployed, DY130 recovered PAP3 Uncalibrated Microcat (sn 12462) temperature and salinity data

Downloaded data from the current meters at 3000m and 100mab data is as below



PAP3 mooring deployed on DY130

Mooring was deployed on 31/03/2021 and the triangulated position is 49° 59.70602 16° 24.28667 station number DY130-024. The PAP3 deep Microcat SN12455 was validated on CTD 3 (station DY130-021).

13. Zooplankton Nets

Corinne Pebody, Christopher Feltham and other helpful people

The WP2, 200µm nets were deployed with two different collections in mind. One set was to extend the day/night paired time series at PAP-SO, the second to collect zooplankton along a transect from NOC to the PAP-SO as far as DipClear allowed. This second set of samples were for Dan Mayor and Kathryn Cook.

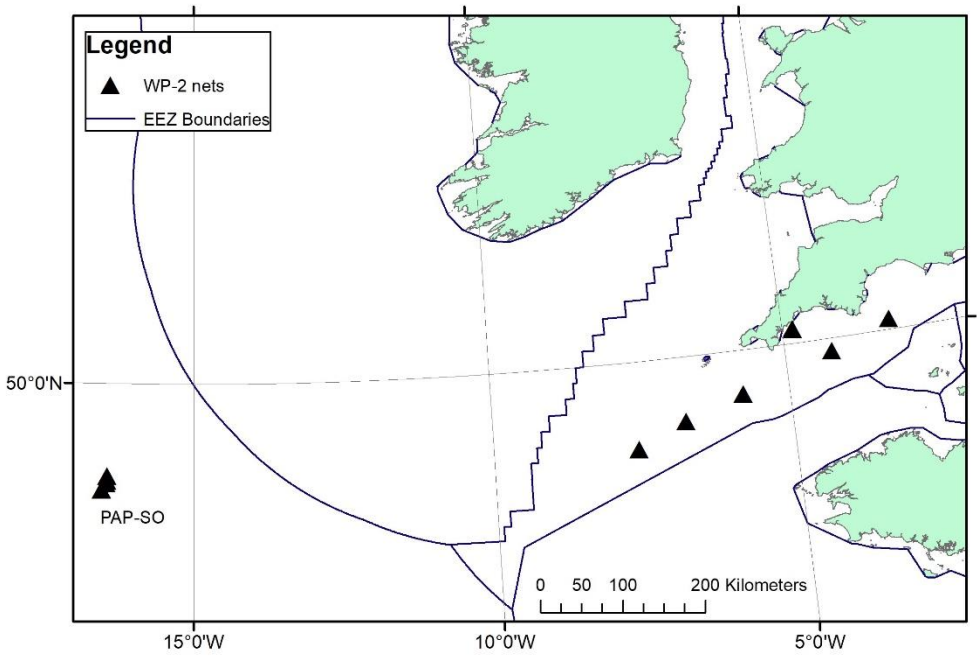
Transect samples:

The WP2 net was deployed to 50m (shallow water along channel) in a series of vertical hauls, using the Rexroth winch over the starboard side. The 200m dedicated rope was marked at 50m intervals. Winch speeds were as per sampling protocol from Dan. Samples were sieved and preserved in filtered seawater with borax buffered formalin to an approximate concentration of 10%.

PAP-SO samples:

The WP2 net was deployed to 200m in a series of vertical hauls, using the Rexroth winch over the starboard side. The 200m dedicated rope was marked at 50m intervals. Winch speeds were approximately 15m/minute. Samples were either preserved or sieved and preserved in filtered seawater with borax buffered formalin to an approximate concentration of 10%.

		"Start"		Latitude	Longitude		"End"		Latitude	Longitude			
Station	Gear	Date	Time	dd	ddd	Depth	Date	Time	dd	ddd	Depth	Comment 1	Comment 2
DY130-002	WP2	25/03/2021	18:07	50.112	3.187817	67	25/03/2021	18:15	50		67	net # 1 (50m haul)	wp2 200um net sample for Dan Mayor
DY130-003	WP2	25/03/2021	23:12	49.8603	4.217283	76.7	25/03/2021	23:21	49.8595	4.218513	76.7	net # 2 (50m haul)	wp2 200um net sample for Dan Mayor
DY130-004	WP2	26/03/2021	12:07	50.1517	4.822355	66.9	26/03/2021	12:16	50.1526	4.822375	62.5	net # 3 (50m haul)	wp2 200um net sample for Dan Mayor
DY130-005	WP2	26/03/2021	12:21	50.1525	4.822652	70.4	26/03/2021	12:32	50.1576	4.822618	70.8	net # 4 paint in sample bu	wp2 200um net sample for Dan Mayor
DY130-006	WP2	26/03/2021	18:01	50.1526	4.822073	63	26/03/2021	18:11	50.1526	4.821618		net # 5 (50m haul)	wp2 200um net sample for Dan Mayor
DY130-007	WP2	26/03/2021	18:14	50.1526	4.821612	63.8	26/03/2021	18:22	50.1526	4.82136		net # 6 (50m haul)	wp2 200um net sample for Dan Mayor
DY130-008	WP2	26/03/2021	22:58	50.1524	4.821217	61	26/03/2021	23:06	50.1524	4.821871	61	net # 7 (50m haul)	wp2 200um net sample for Dan Mayor
DY130-009	WP2	26/03/2021	23:11	50.1524	4.822039	59	26/03/2021	23:18	50.1522	4.822661	59	net # 8 (50m haul)	wp2 200um net sample for Dan Mayor
DY130-010	WP2	27/03/2021	12:08	49.5243	5.776834	103	27/03/2021	12:17	49.5242	5.77716	103	net # 9 (50m haul)	wp2 200um net sample for Dan Mayor
DY130-011	WP2	27/03/2021	12:21	49.5242	5.777482	103	27/03/2021	12:30	49.5242	5.778121	102.3	net # 10 (50m haul)	wp2 200um net sample for Dan Mayor
DY130-012	WP2	27/03/2021	18:02	49.3007	6.773195	122.2	27/03/2021	18:12	49.2995	6.771545	121.5	net # 11 (50m haul)	wp2 200um net sample for Dan Mayor
DY130-013	WP2	27/03/2021	18:16	49.2989	6.771297	121.4	27/03/2021	18:33	49.2959	6.769685	240.9	net # 12 (100m haul)	wp2 200um net sample for Dan Mayor
DY130-014	WP2	27/03/2021	22:59	49.0488	7.594129	141.6	27/03/2021	23:09	49.0485	7.594532	141.5	net # 13 small vol of samp	wp2 200um net sample for Dan Mayor
DY130-015	WP2	27/03/2021	23:12	49.0483	7.594798	141.5	27/03/2021	23:30	49.0477	7.595772	141.7	net # 14 small vol of samp	wp2 200um net sample for Dan Mayor
DY130-022	WP2	31/03/2021	11:13	48.9357	16.43763	4809	31/03/2021	11:40	48.9361	16.44509	4809	net 15 for Corinne (200m haul)	
DY130-023	WP2	31/03/2021	11:48	48.9363	16.44518	4809	31/03/2021	12:12	48.9366	16.44705	4809	net 16 for Corinne (200m haul)	
DY130-033	WP2	02/04/2021	11:57	48.8396	16.52098	4807.9	02/04/2021	12:22	48.8387	16.52349	4807.9	net 17 for Corinne (200m	preserved in formalin
DY130-034	WP2	02/04/2021	12:28	48.8385	16.52394	4807.9	02/04/2021	12:57	48.8375	16.52653	4807.9	net 18 for Corinne (200m	sieved through 200um and preserved in forn
DY130-039	WP2	03/04/2021	12:44	48.9921	16.43842	4810.9	03/04/2021	13:15	48.9921	16.43842	4810.7	net 19 for Corinne (200m	preserved in formalin
DY130-040	WP2	03/04/2021	13:19	48.9921	16.43842	4810.8	03/04/2021	13:56	48.9921	16.43842	4810.8	net 20 for Corinne (200m	sieved through 200um and preserved in forn
DY130-050	WP2	04/04/2021	22:50	48.8383	16.52182	4810	04/04/2021	23:15	48.8382	16.52251	4809.7	net 21 for Corinne (200m haul)	
DY130-062	WP2	07/04/2021	00:06	48.841	16.52137	4810	07/04/2021	00:00	48.8419	16.52377	4810	net 22 for Corinne (200m haul)	
DY130-063	WP2	07/04/2021	00:39	48.842	16.5238	4810	07/04/2021	01:06	48.8428	16.52601	4810	net 23 for Corinne (200m haul)	
DY130-074	WP2	09/04/2021	22:47	48.9112	16.44698	4809.7	09/04/2021	23:16	48.9094	16.44846	4812.4	net 24 for Corinne (200m	Last nets? All rinsed with freshwater and hu



Map of net sampling positions on DY130

Thank you to Cat, Clara, Andy, Andy, Jack, Craig, Marshal and Colin

14. Glider operations

Filipa Carvalho (NOC).

NOC: Filipa Carvalho, Stephanie Henson (OBG); Stephen Woodward, Adeniyi Adenaya (MARS)

UW: Craig Lee, Geoff Shilling, Jason Gobat, Ben Jokinen

Pilots: Adeniyi Adenaya (MARS), Geoff Shilling (UW)

Glider operations on DY130 consisted of supporting a collaboration between ERC GOCART (Gauging Ocean organic Carbon fluxes using Autonomous Robotic Technologies), EU iFADO (Innovation in the Framework of the Atlantic Deep Ocean) and the NASA funded EXPORTS (EXport Processes in the Ocean from Remote Sensing) project aiming to deploy gliders in a retentive eddy in the North Atlantic around the Porcupine Abyssal Plain (PAP) observatory.

- 2 Seagliders from the University of Washington (UW): SG219 and SG237
- 1 Teledyne Webb Research Slocum glider from MARS (NOC): Unit-305

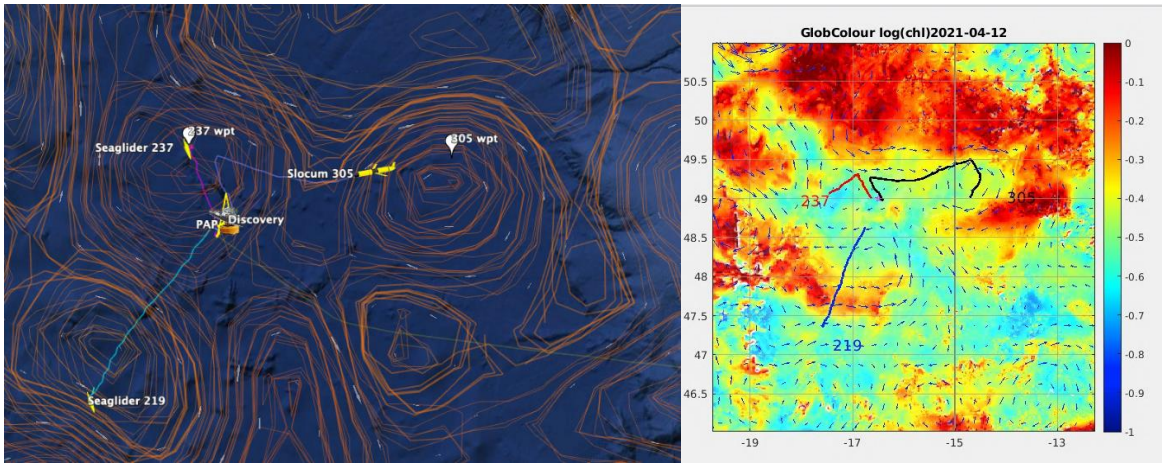
Mission details can be found at https://mars.noc.ac.uk/missions/exportsatpap and

https://iop.apl.washington.edu/seaglider/index.php?mission=EXPORTS_Apr21 for the Slocum and Seagliders, respectively.

Glider deployment description

Gliders were deployed at PAP, and each glider was tasked to scout different eddies:

- Unit 305: survey eddy 'A2', located NE of PAP
- SG-237: survey eddy 'A5', located NW of PAP
- SG-219: survey eddy SW of PAP



left: Google Earth overlaying sea surface height (SSH), the PAP surface mooring, RRS Discovery, and the three gliders (Slocum 305, Seagliders 2019 and 237). Right: Glider tracks (black: SL-305, blue: SG-219, red: SG-237) overlaid on a global chlorophyll product

Glider deployment characteristics.

GLIDER	DEPLOYMENT	RECOVERY	EDDY SCOUTING
SG-219	*DY130_030* *2021-04-01; 11:00 GMT* *LAT: 49°0.691′N* *LON: 016°25.393′W*	*N/A*	*SW OF PAP*
SG-237	*DY130_041* *2021-04-03; 14:20 GMT* *LAT: 48°59.584′N* *LON: 016°26.233′W*	*DY130_041* *2021-04-03; 16:20 GMT* *LAT: 48°59.584′N* *LON: 016°26.233′W*	*RECOVERED AND REDEPLOYED*

DOLOMITE UNIT-305	*DY130_042* *2021-04-03; 15:20 GMT* *LAT: 48°59.584′N* *LON: 016°26.233′W*	*N/A*	*'A2', NE OF PAP*
SG-237	*DY130_047* *2021-04-04; 12:40 GMT* *LAT: 48°50.785′N* *LON: 016°30.787′W*	*N/A*	*'A5', NW OF PAP*

Seaglider 237 experienced some communication issues and had to be recovered – see section below.

Glider sensor Packages

Slocum glider were fitted with a custom made Wetlabs Environmental Characterization (ECO) Triplet puck Eco Puck, measuring backscatter at 532 and 700 nm together with the standard chlorophyll fluorescence. A fluorometer measuring chlorophyll fluorescence and Turbidity from UW was used on the CTD rosette during the cruise to provide good calibrations between the gliders, cruise CTD and in situ POC samples.

Slocum DOLOMITE (unit-305)

Sensor	S/N	Last cal	Variables measured
SeaBird CTD	9106	19/03/2019	Conductivity, Temperature, Depth
Wetlabs Eco Puck	BB2FLSLC 1612	26/07/2018	bbp at 532, 700 nm; chl fluorescence
Aanderaa Optode	4831-122	04/10/2020	Dissolved oxygen
Satlantic PAR	430	01/04/2019	Photosynthetic Available Radiation

Seaglider SG-219

Sensor	S/N	Last cal	Variables measured
SeaBird CTD			Conductivity, Temperature, Depth
Wetlabs Eco Puck			bbp at 532, 700 nm; chl fluorescence
Aanderaa Optode			Dissolved oxygen
Seabird Radiometer	OCR504		Irradiance at 4 wavelengths

SG-237

Sensor	S/N	Last cal	Variables measured
SeaBird CTD			Conductivity, Temperature, Depth
Wetlabs Eco Puck			bbp at 532, 700 nm; chl fluorescence
Aanderaa Optode			Dissolved oxygen
Seabird Radiometer	OCR504-		Irradiance at 4 wavelengths

Seagliders were also fitted with a Nortek ADCP, but it is not recording data during this deployment

Glider pre-deployment and deployment operations

Seagliders arrived disassembled in several boxes. Filipa and Nick assembled them on the dockside still in Southampton on March 23rd, ahead of the cruise, following the instructions provided by Ben Jokinen (Exports_219_237_assembly_deployment_beacon_instructions_ 2021.pdf). These were followed up by self-tests the following night by Filipa. Both gliders passed their tests and were brought on board the following day and strapped down on the hangar.

top: Seagliders SG219 (left) and SG237 (right) fully assembled at the dockside. Bottom: both seagliders during self-testing (left) and science party with all 3 gliders (right) ahead of cruise depart from Southampton.

Glider deployments were staggered. Given the unlikely ability to recover and redeploy the Slocum, the first glider to be deployed was SG219. Starting to survey with this glider would provide extra information for the selection of the eddy.

SG-219

Another round of self-tests on the Seaglider SG219 were conducted on board by Filipa on the morning of the deployment, April 1st, in coordination with Geoff, the UW pilot. The glider checked out ok, so it was deployed before the recovery of PAP1 mooring – given the need to have some room to play around for the recovery of the mooring, the glider was deployed 5 km North of the PAP1 location. We used the supplied mechanism from UW, a simple rope with a loop and a seacatch. Rope was put around the glider's rudder (weight bearing), and glider was hoisted up using the P-frame (starboard gantry). We have deployed using the P-frame and it seems to work a lot better as the anti-pendulum roller provides more control and prevents the glider from moving sideways. Glider was successfully deployed but hanged around the PAP site for a calibration cast the following morning.

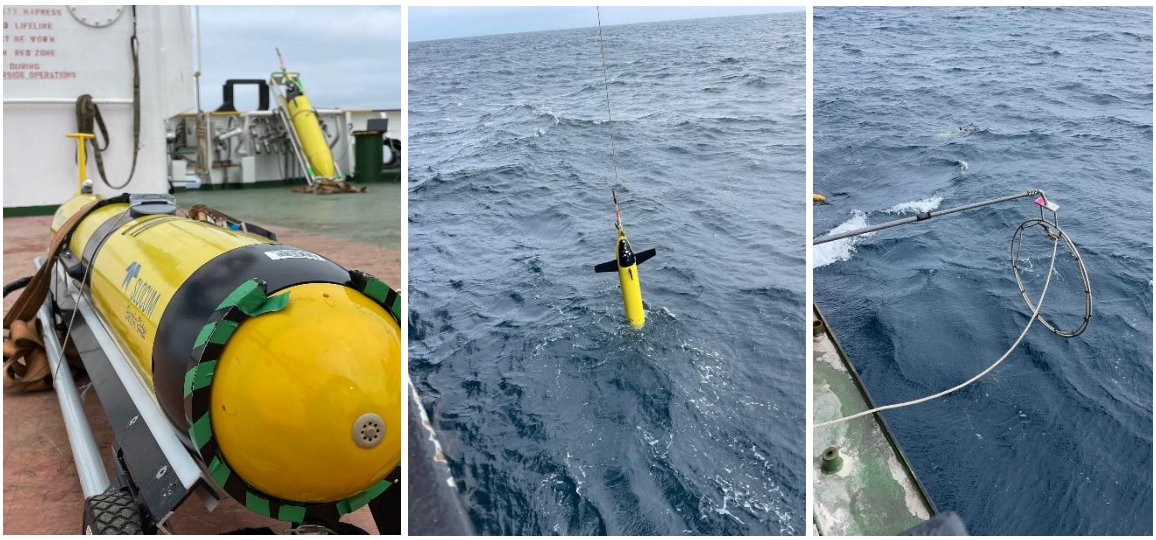
SG-219 next to the PAP1 surface buoy during self-tests on the day of deployment and deployment shots later that morning.

SG-237

A double deployment (Seaglider SG237 and Slocum SL-305) took place a couple days later, on April 3rd. Another pre-deployment check was conducted prior to deployment. SG-237, a newer SGX model, is heavier and the nose section has a different shape than the 'classical' Seaglider. Seaglider passed the self-testing on deck and was deployed. Upon trying to task the glider to do its first dive, the glider stopped taking commands, so the pilot asked us to have it recovered. Recovery efforts started right away, using the MARS supplied recovery pole with a hoop.

The sea conditions weren't bad, but it was choppy, so several attempts at recovering the Seaglider were necessary. Finally, Seaglider was recovered when the techs opened the side doors of the ship reducing this way, the need for the full length of the pole. After some tests from the pilots and on deck testing, the glider was given the OK for re-deployment. Communication protocols on the base station were identified and

fixed, which allowed the quick re-deployment of the Seaglider the following day. The conductivity cell of the CTD may have been broken upon recovery, so the glider is not providing salinity data.



Deployment and recovery of SGX-237

SL-305 (Dolomite)

Like the Seagliders, functional tests were conducted on the Slocum glider on the deployment morning. Given the double back-to-back deployment, functional checks on the Slocum were conducted on the deployment day by the pilot, Adeniyi, via iridium.

Deployment of MARS Slocum glider SL-305 using the deployment cart with a float releasing mechanism

After recovering Seaglider SG237, the NOC Slocum glider was deployed. The new deployment cart (with the float release system) was used and resulted in a smooth deployment. There was an error on the waypoint recognition on the glider, so the glider headed North instead of hanging around the PAP site as tasked. For the following morning calibration cast we ended up meeting the glider about 7 km North of PAP.

Glider calibration casts

Calibration casts were conducted, in most cases, the mooring following the deployment of that glider in coordination with the respective glider pilot. Gliders were tasked to wait at the surface at the cast time. Ship would manoeuvre to get the glider as close to the CTD rosette as possible, <50 m off the starboard side. When the ship's CTD was ready to go down, glider was sent on a deep (1000 m) dive. Apart from the last cast, where the fact of being night time and for safety reason, the glider dove ~100-150m from the ship.

Calibration casts between the ship's rosette and some of the gliders

Detail of the 4 calibration casts between the 3 gliders and the ship's CTD

	Calibration 1	Calibration 2	Calibration 3	Calibration 4
Date	2021-04-02	2021-04-04	2021-04-05	2021-04-12
Time	07:11 UTC	09:09 UTC	09:15 UTC	01:34 UTC
Latitude	48° 56.39' N	49° 04.67' N	48° 52.33' N	49° 15.60' N
Longitude	16°27.9' W	16°30.79' W	16° 31.56' W	14° 30.20' W
Station no	032	046	053	080

CTD cast	CDT005	CTD007	CTD008	CTD014
Glider involved/ Notes	SG-219 deployment cast	SL-305 deployment cast	SG-237 deployment cast	SL-305 Eddy 'A2' cast

Sampling on the calibration casts is summarised in the table below (And described in the CTD sampling report).

Sampling report for the different properties as requested by the different EXPORTS PIs

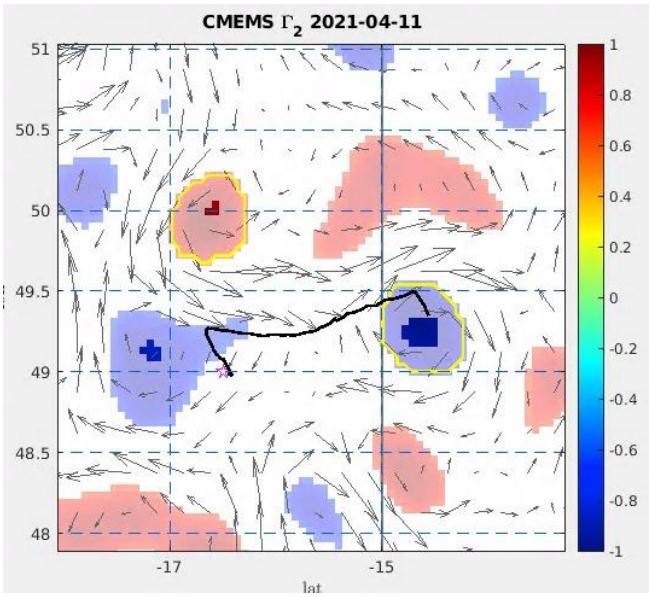
CTD	Niskin	Depth (m)	POC	HPLC	TOC	DOC	OXYGEN (fixed)	NUTS	GENOMICS	OXYGEN (NOC)	Pb/Po
005	3	1000	YES	YES	YES	YES	NO	YES	YES	YES	NO
005	5	900	YES	YES	YES	YES	NO	YES	YES	YES	NO
005	7	800	YES	YES	YES	YES	NO	YES	YES	YES	NO
005	9	500	YES	YES	YES	YES	NO	YES	YES	YES	NO
005	10	250	YES	YES	YES	YES	NO	YES	YES	YES	NO
005	13	100	YES	YES	YES	YES	NO	YES	YES	YES	NO
005	15	70	YES	YES	YES	YES	NO	YES	YES	YES	NO
005	17	50	YES	YES	YES	YES	NO	YES	YES	YES	NO
005	19	30	YES	YES	YES	YES	NO	YES	YES	YES	NO
005	21	10	YES	YES	YES	YES	NO	YES	YES	YES	NO
007	2	800	YES	YES	YES	YES	NO	YES	NO	YES	NO
007	3	600	YES	YES	YES	YES	NO	YES	NO	YES	NO
007	6	400	YES	YES	YES	YES	NO	YES	NO	YES	NO
007	8	250	YES	YES	YES	YES	NO	YES	NO	YES	NO
007	9	150	YES	YES	YES	YES	NO	YES	NO	YES	NO
007	12	100	YES	YES	YES	YES	NO	YES	NO	YES	NO
007	14	70	YES	YES	YES	YES	NO	YES	NO	YES	NO
007	16	40	YES	YES	YES	YES	NO	YES	NO	YES	NO
007	18	20	YES	YES	YES	YES	NO	YES	NO	YES	NO
007	20	10	YES	YES	YES	YES	NO	YES	NO	YES	NO
008	2	825	YES	YES	NO	NO	NO	YES	YES	YES	NO
008	3	600	YES	YES	NO	NO	NO	YES	YES	YES	NO
008	6	400	YES	YES	NO	NO	NO	YES	YES	YES	NO
008	8	250	YES	YES	NO	NO	NO	YES	YES	YES	NO
008	10	150	YES	YES	NO	NO	NO	YES	YES	YES	NO
008	12	100	YES	YES	NO	NO	NO	YES	YES	YES	NO

008	14	70	YES	YES	NO	NO	NO	YES	YES	YES	NO
008	16	50	YES	YES	NO	NO	NO	YES	YES	YES	NO
008	18	30	YES	YES	NO	NO	NO	YES	YES	YES	NO
008	20	10	YES	YES	NO	NO	NO	YES	YES	YES	NO
014	2	900	YES	YES	YES	YES	YES	YES	YES	YES	NO
014	4	500	YES	YES	YES	YES	YES	YES	YES	YES	YES
014	6	400	YES	YES	YES	YES	YES	YES	YES	YES	YES
014	8	300	YES	YES	YES	YES	NO	YES	YES	YES	NO
014	10	250	YES	YES	YES	YES	YES	YES	YES	YES	YES
014	12	150	YES	YES	YES	YES	YES	YES	YES	YES	YES
014	14	100	YES	YES	YES	YES	YES	YES	YES	YES	YES
014	16	75	YES	YES	YES	YES	YES	YES	YES	YES	YES
014	18	50	YES	YES	YES	YES	NO	YES	YES	YES	YES
014	20	30	YES	YES	YES	YES	YES	YES	YES	YES	YES
014	22	10	YES	YES	YES	YES	YES	YES	YES	YES	YES

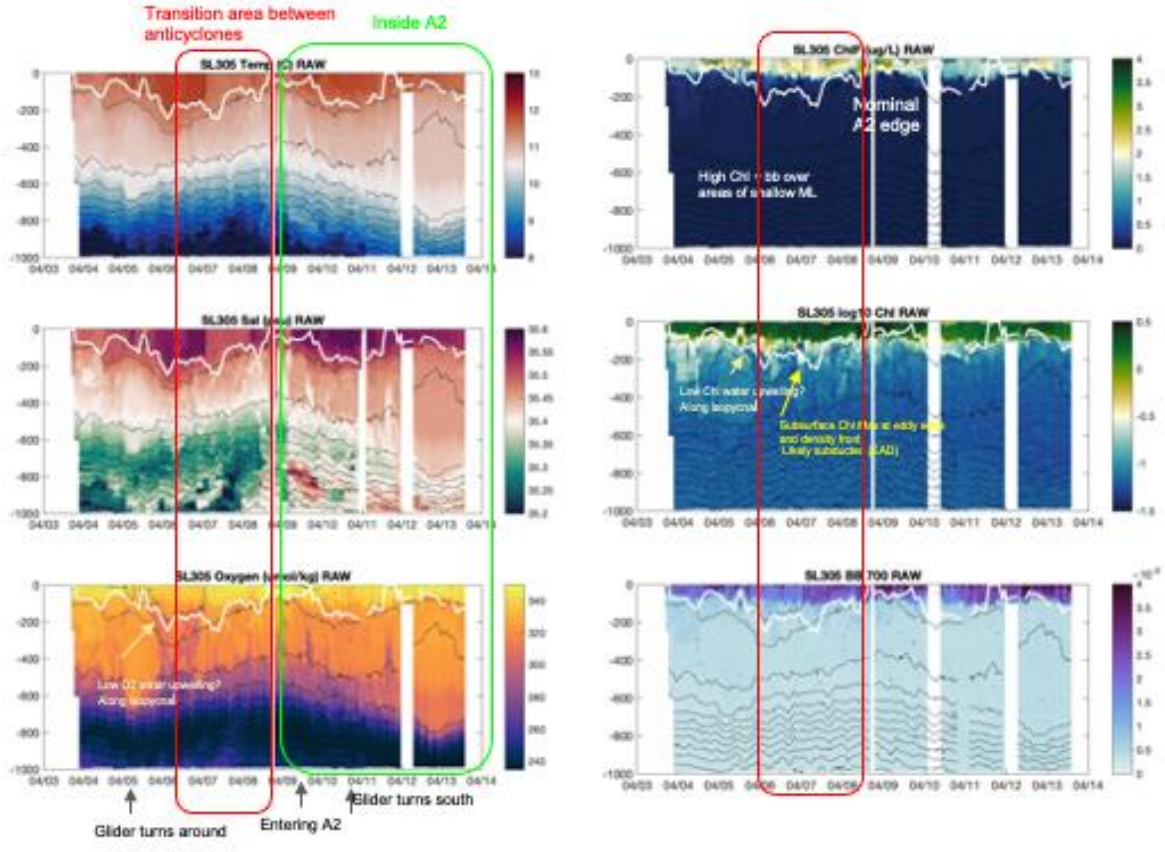
Preliminary Glider data

Data processing has been done automatically on the UW basestations for the 2 Seagliders. The Slocum does not yet have its processing automated. Until permission issues to access the new MARS system, C2, gets sorted, the data has been and will be provided daily by email by the pilot, Adeniyi. He has also kindly put the data in the NOC server to reduce the bandwidth issues on the ship. Binary files are converted to ascii using a shell script ProcessDbd.sh on maelstrom. Data is then copied to Filipa's computer and processed locally in Matlab.

Some plots from the Slocum glider follow:



SL-305 path on top of SSH and geostrophic currents. Eddy 'A2' highlighted in yellow. Glider was deployed west and travelled east, turning south when hitting the eddy. Final CTD cast was conducted at the core of this eddy with the glider.



Bottom: cross-sections of temperature, salinity, oxygen, chlorophyll and backscattering.

15. Benthic systems and sampling

Andrew Gates, Catherine Wardell, Clara Douglas & Christopher Feltham

The benthic group aboard RRS *Discovery* cruise 130 consisted of only four members because of the coronavirus restrictions. This is a considerable reduction on previous years (e.g. a team of 10 on DY103) and explains some of the differences in sampling protocols carried out on DY130 compared to previous PAP cruises. The aim of the of the work was to continue time series observations of the seafloor and benthic organisms at the PAP-SO site. The objectives included i) continuation of routine seafloor photography at the PAP central site using the HyBIS system, (ii) a replicated set of seabed samples collected by megacorer from the PAP central location, predominantly for analysis of macrofauna, iii) duplicate amphipod trap sample sets (with additional trap 15 m above the bottom, first incorporated in on DY103 in 2019) and iv) the use of an Agassiz trawl to collect samples of the megabenthos to serve a variety of purposes.

The objectives listed above were all met. The use of the Agassiz trawl in place of the OTSB14 typically deployed at PAP-SO was a result of the reduced personnel on DY130 and produced smaller catches than OTSB14 sampling. It was a useful trial as operations at PAP-SO begin to focus more on photography for observation of the megabenthos. Some additional tasks were carried out including multibeam mapping and HyBIS deployments south of the PAP central site and a sub-bottom profile survey and megacorer sample to the west of the Ben Billett abyssal hill to gather information for a future study of a landslide. There were no Bathysnap operations on DY130 because the last remaining system was flooded when it was recovered on DY116.

16. Amphipod Trap:

The amphipod trap (ATRAP) is a small bottom-moored system carrying five simple baited traps for short-term deployments (1-2 days). It was deployed on 2 occasions during DY130.

The four double parlour acrylic amphipod traps loaded with one standard mackerel (*Scomber scombrus*) each per deployment (~300-400g). Each mackerel was attached to the base of the traps (nearest the mesh bottom) securely with cable ties. The traps were then reassembled, checked that they were fastened securely, and then placed onto the frame (securely holding all four traps). The barrel trap (located ~12m above seabed when deployed, further described in DY103 cruise report) was also loaded with one standard mackerel for the first deployment and two mackerel for the second deployment (~400g per fish). In the first deployment, the bait in the barrel trap was wrapped in the non-slip material which possibly hindered the amphipods reaching the entirety of the fish. For the second deployment of the barrel trap, one fish was wrapped more

loosely in the nonslip material, and the other was attached to one side of the non-slip material (not wrapped at all).

Trap sample processing

Each trap was photographed with the Station ID and Sample ID number and then subsequently removed from the frame. Nitrile gloves were used at all times. The position of each trap on the frame was recorded (Top 1, Top 2, Bottom 1, Bottom 2, Barrel [trap 12 m off bottom]), processed and preserved separately, one at a time. All amphipods were removed from the trap by gentle washing with filtered seawater (trap cylinder, funnel, mesh) at the sieve table, followed by picking those missed by washing with forceps. Trays were used to rinse the trap and keep the pieces of each trap together to allow each trap to be rebuilt. 250µm sieves were also used to prevent any loss of specimens. The bait fish were examined closely and rinsed. The specimens were then transferred directly to cold ethanol in 1500 ml UN certified plastic bottles and kept in the 5˚C temperature-controlled lab.

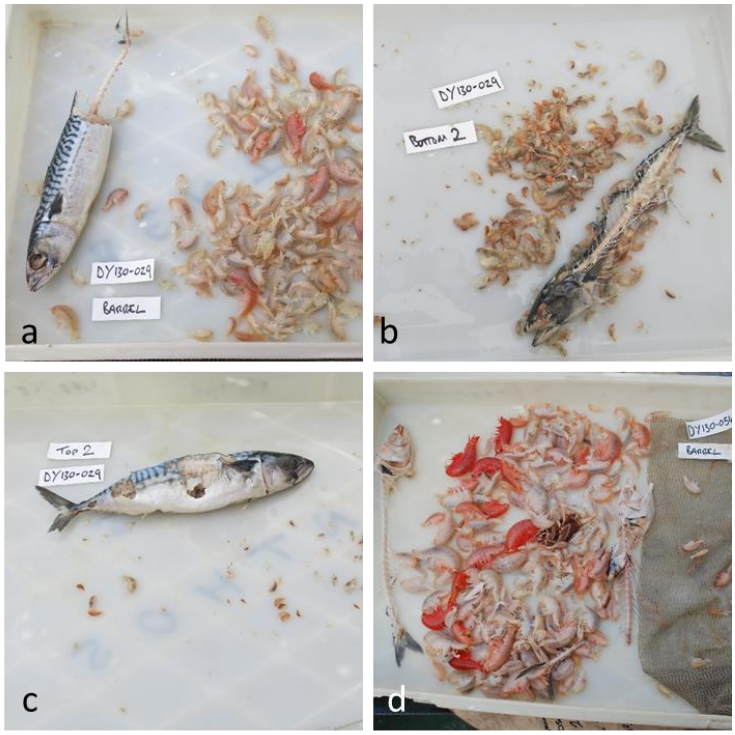
Amphipod trap deployment data

Stn number	Deploy lat	Deploy lon	Deploy time		Mooring descent rate	Release time		Soak time (hrs)
DY130-029	48˚ 59.584	016˚ 26.233	10:05	01/04/2021	Not recorded	15:40	03/04/2021	Approx. 51.5
DY130-054	49˚ 1.269	016˚ 23.845	12:20	05/04/2021	58m min^{-1} Seabed ~ 14:00	13:22	07/04/2021	47.5

Amphipod trap bait and sample data

Station number	Sample	Bait Initial weight (g)	Bait recovery weight (g)	Samples retained
DY130-029	Top 1	403.2	377.8	1500ml bottle – all specimens in 95% Ethanol
	Top 2	348.8	320.8	1500ml bottle – all specimens in 95% Ethanol
	Bottom 1	352.0	198.8	1500ml bottle – all specimens in 95% Ethanol
	Bottom 2	465.0	64.0	1500ml bottle – all specimens in 95% Ethanol
	~12 m off bottom	447.6	345.0*	1500ml bottle - WHITE specimens in 95% Ethanol
				1500ml bottle - PINK specimens in 95% Ethanol
DY130-054	Top 1	426.6	375.0	1500ml bottle – all specimens in 95% Ethanol
	Top 2	371.0	347.2	1500ml bottle – all specimens in 95% Ethanol
	Bottom 1	438.4	346.0	1500ml bottle – all specimens in 95% Ethanol
	Bottom 2	414.8	221.4	1500ml bottle – all specimens in 95% Ethanol
	~12 m off bottom	768.0	52.0 (just bones)	1500ml bottle - WHITE specimens in 95% Ethanol
				1500ml bottle - PINK specimens in 95% Ethanol
				1500ml bottle - RED specimens in 95% Ethanol
				1500ml bottle - PINK/WHITE WITH PINK LEGS in 95% Ethanol

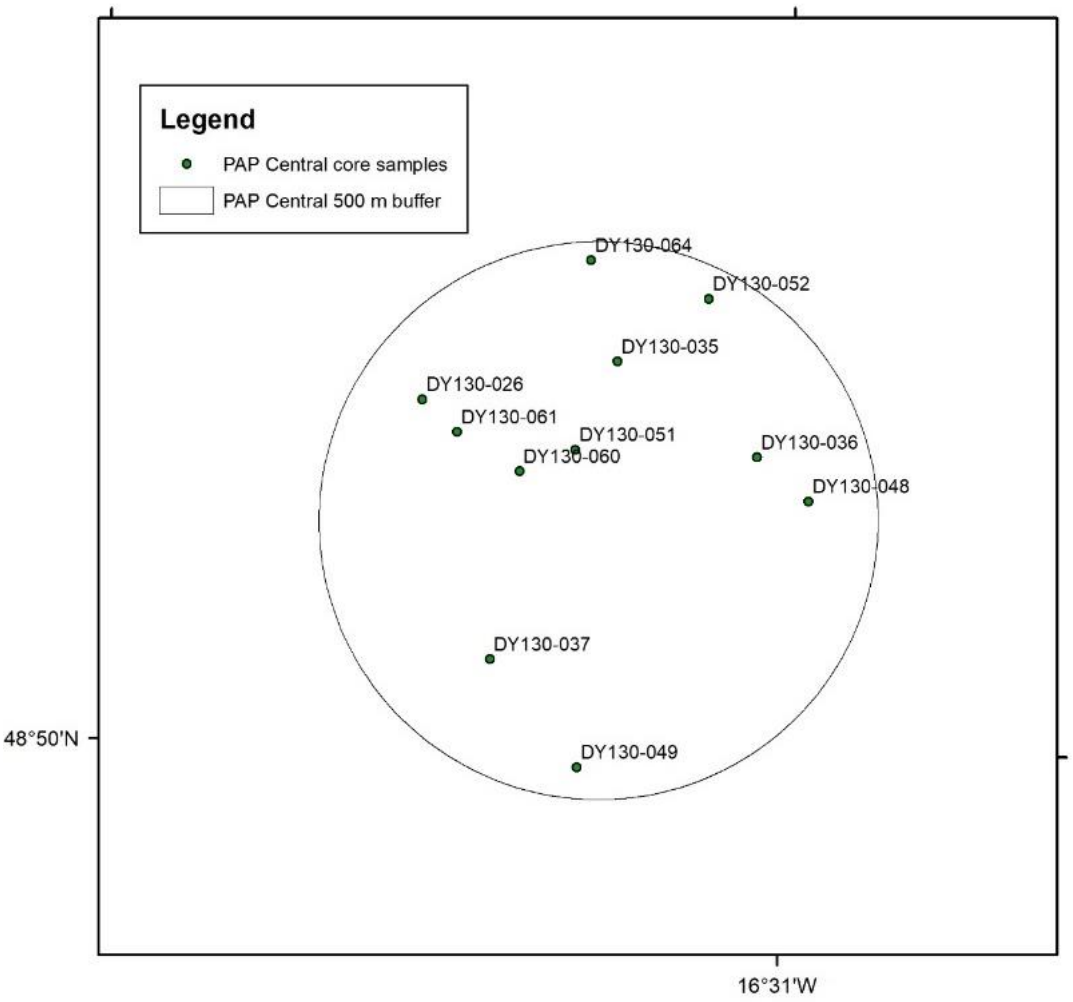
*Well wrapped. All exposed fish was consumed (see image below)



Amphipod trap deployment, a) remains of bait and sample from first barrel trap deployment (note access to whole fish may have been restricted by the non-slip material, so only lower half was consumed within the time), b) example of good catch on the lower traps, c) example of catch from upper trap, d) remains of bait and sample from second barrel trap deployment

17. Megacorer

The NOC-NMFS Bowers & Connelly megacorer was used at 11 randomly selected sites at PAP central for collection of sediment for various analyses. The first deployment failed before reaching the bottom because of an overheating winch. Deployments used either 8 large core tubes (10 cm diameter) (MgC-08), 8 large core tubes and 2 small tubes (MgC-08+2) or 10 large tubes (MgC-10). One further core deployment was at a site along a Sub Bottom Profile survey line near the "Ben Billet" abyssal hill.

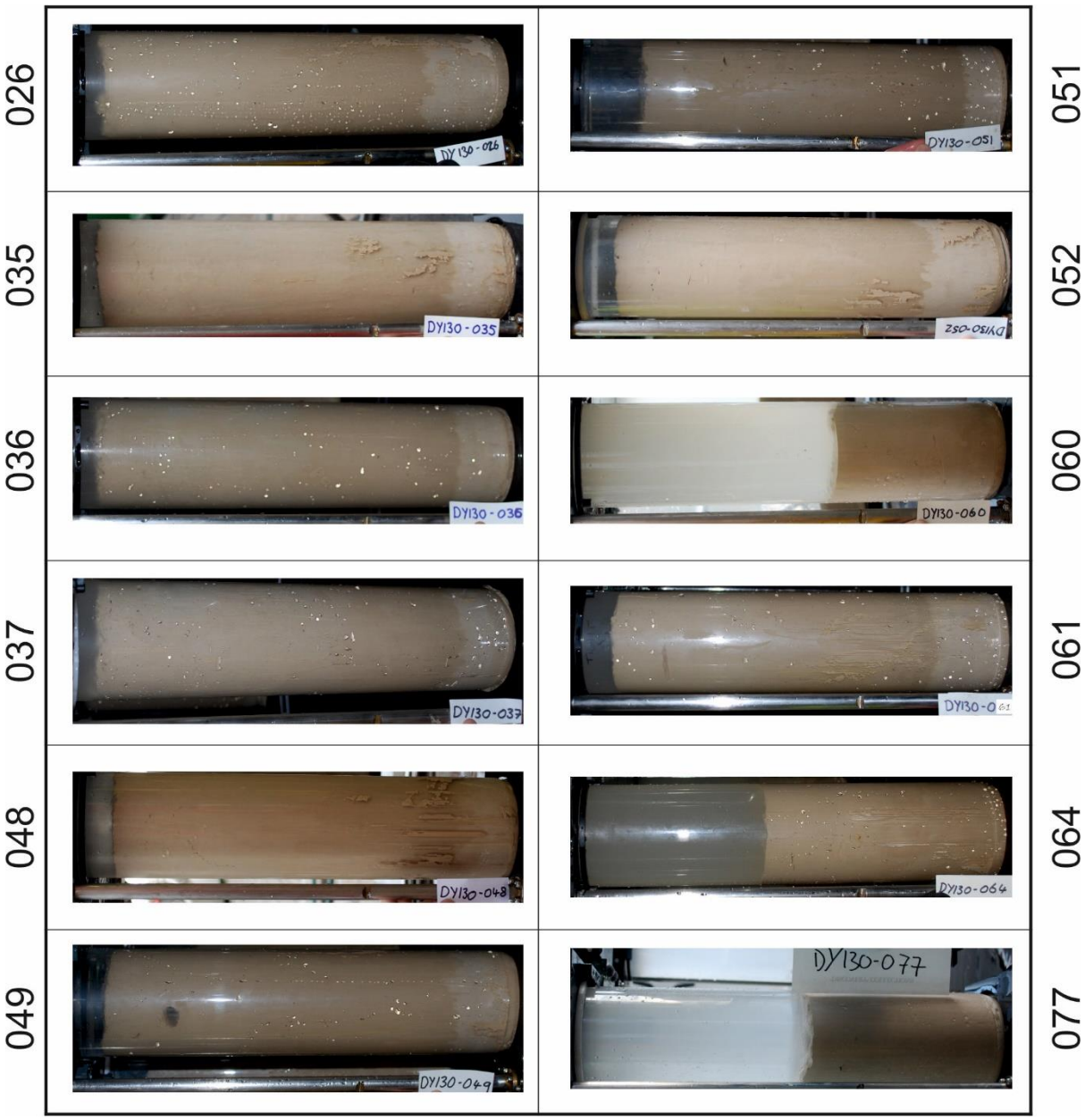


Randomly selected sites at PAP Central for collection of sediment for various analyses

Megacorer deployments on DY130

Station	Gear	USBL Lon	USBL Lat	Depth (m)	Typical length (cm)	Pull out Tension (T)	Return	Samples retained
DY130-025	MgC08	-	-	n/a	n/a	-	Winch fail on descent	n/a
DY130-026	MgC08	48° 50.334	16° 31.531	4838	40	5.18	6/8 good cores	6 x macrofauna
DY130-035	MgC08	48° 50.374	16° 31.247	4841	41	5.10	8/8 good cores	8 x macrofauna
DY130-036	MgC08+2	48° 50.285	16° 31.041	4844	39	5.10	8/10 good cores	7 x macrofauna, 1 x carbon isotope*
DY130-037	MgC08	48° 50.084	16° 31.425	4842	39	5.12	6/8 fair cores	6 x macrofauna
DY130-048	MgC10	48° 50.243	16° 30.964	4843	40	5.19	10/10 good cores	9 x macrofauna, 1 x carbon isotope
DY130-049	MgC10	48° 49.981	16° 31.295	4844	39	5.09	10/10 good cores	8 x macrofauna, 1 x biogeochemistry, 1 x carbon isotope
DY130-051	MgC10	48° 50.288	16° 31.306	4843	41	5.36	10/10 good cores	9 x macrofauna, 1 x biogeochemistry
DY130-052	MgC10	48° 50.437	16° 31.115	4844	40	5.10	9/10 good cores	9 x macrofauna, 1 x biogechemistry
DY130-060	MgC10	48° 50.266	16° 31.387	4840	17	5.57	5/10 poor cores	5 x macrofauna
DY130-061	MgC10	48° 50.303	16° 31.480	4840	40	5.24	10/10 good cores	8 x macrofauna, 1 x biogeochemistry, 1 x carbon isotope
DY130-064	MgC10	48° 50.472	16° 31.289	4838	15	5.14	6/10 poor cores	5 x macrofauna, 1 x biogeochemistry
DY130-077	MgC08	49° 3.348	16° 36.399	-	23	-	6/8 fair cores	2 x sliced to 2 cm horizons. 4 x returned to NOC in core tube

*Carbon isotope samples for Hashan Niroshana Kokuhennadige



Example core images, one from each successful megacorer deployment

On deck: Once the megacorer was recovered to deck the cores were examined for overlying water clarity, disturbance and cracks in the core and notable layers or patches in the sediment. Failed cores were recorded and possible failure causes were rectified to improve the following deployment. This was rare on DY130. The short core (DY130-060) was taken during poor weather conditions. The length of core sediment retention was measured and example core profiles were photographed. They were then removed from the megacorer and allocated to analysis type.

Lab processing: Once the cores were removed from the megacorer they were processed by two teams of two. One person held the core in position while the other sliced the sediment. Details of slicing procedures to acquire the necessary sediment horizons are detailed in the table and summarised below.

Macrofauna: Macrofauna samples were the priority for the megacorer deployments. The overlying top water was siphoned through a 250 µm sieve and then transferred into the sample container (syringes were used to extract the small volume of remaining water). Slicing rings were used to measure the 0 – 5.0 cm section and it was cut with a slicing plate. Samples from 2 core tubes were placed in each 5 L bucket, which was labelled on the lid and the side. A paper label was placed inside the bottle. Samples were preserved in 4% borax buffered formaldehyde made up with filtered seawater. The number of slices in this macrofauna protocol was reduced from other PAP-SO cruises owing to reduced personnel (see earlier cruise reports).

Biogeochemistry: Four sections were taken at 0.5 cm horizons to 2 cm. Sediment in contact with the core tube was removed using a knife rinsed in Milli-Q water and the remaining material preserved in muffled foil (preserving as much as possible the integrity of the slice) held inside labelled petri dishes, placed inside a single labelled bag per sample and frozen at -80°C straight away. Nitrile gloves were worn at all stages. Phytodetritus was not observed in the samples but if it had been present the protocol would include collection by pipette and freezing in a separate foil-lined petri dish.

Labelling: All samples were labelled with Cruise ID (DY130), Station number, Date the megacorer reached the seabed, sediment horizon, analysis type and preservation method. The outside of every container was labelled (top and side if possible) and a paper label was placed inside the container.

Sample processing equipment. Megacorer equipment for a team of two persons processing a core comprised: a large, tall, bucket, in which a plunger (small or large depending on sample type) was placed to process the core; nitrile gloves (biogeochemistry); a tube, a syringe, and/or a pipette, to extract the overlying water into a 250-µm sieve; slicing rings (small or large depending on sample) marked at 0.5, 1.0, 2.0, 5.0 cm; slicing plates; a funnel to pass the sediment inside the UN certified bottles (500 mL, 1500 mL); a knife or a spatula to slice the sediment horizon directly inside the bottle; at least two wash bottles filled with filtered seawater (meio- and macrofauna), and extra bottles filled with ethanol and Milli-Q (eDNA, microplastics, biogeochemistry); tweezers for extracting opportunistic specimens; three 5-L canisters filled with filtered seawater to re-fill the squeezy bottles; ethanol/waterproof pens to write on the paper labels.

18. Trawling

An Agassiz trawl was used on DY130 instead of the OTSB-14 more typically used at PAP-SO. The main reason for the change was the reduced personnel on board because of the COVID restrictions. The Agassiz trawl is smaller so has a smaller catch to process than an OTSB-14, requiring fewer people. The deployments are also shorter because the trawl is lowered to the seabed much closer to the ship than the OTSB-14, which can have 12 km of cable out when it reaches the seabed. This was the first attempt to use the Agassiz trawl at PAP but the benthic team had operated it on JC120 in 2015. We anticipate that it could be deployed twice in a 12-hour shift.

The trawl was a NMFSS-supplied 3 m Agassiz trawl. It was rigged with a 250 m pennant wire. The trawl was monitored with a USBL beacon, initially placed at 150 m up the wire (400 m from the trawl net) after 2 trawls it was clear that the USBL beacon was getting too close to the seabed and it was moved to 400 m up the wire, 650 m from the trawl net. The trawl is deployed to c. 100mab with the ship holding station. It then began to tow at 0.5 knots and wire is paid out at 0.2 m/s. Bottom contact should be detectable as a slight reduction in tension but this was difficult to identify. A slow pay out was continued throughout the deployment rather than stopping at c. 1.06 scope at the request of the scientific bosun. The trawl was fished at 1-1.5 knots. The first trawl was 30 minutes estimated seabed time but after a very small catch this was increased to 1 hour and then 2 hours.

On the first deployment, very few specimens were caught and the net was very clean so it appeared that it had not spent very long on the seabed. The second deployment showed a large peak in tension on the CLAM system and on recovery the trawl bar was bent and the net torn. A few specimens remained in the net. The trawl was swapped for the spare for the final two deployments and the catches were much better. Station data recorded were the time and net (USBL) position at the midway point of the fishing phase of the deployment.

DY130-069	08/04/2021	18:02	48° 51.9822	16° 30.017	4830	poor catch, short bottom time
DY130-070	09/04/2021	01:30	48° 53.9711	16° 31.876	4837	no catch, net damaged
DY130-073	09/04/2021	18:30	48° 54.0547	16° 27.9736	4809	Small catch
DY130-075	10/04/2021	04:16	48° 53.6087	16° 26.1160	4839	Largest catch

The Agassiz trawl seems to be a good system for collecting a reduced number of specimens but the methodology needs some refinement it this is to be a regular sampling method at PAP in future. With the technicians and scientists available on DY130 two trawls overnight made it challenging to keep some technicians and scientists within hours of rest. In future this will require additional thought to stagger the shifts of the teams involved.

Details of Agassiz Trawl operations at PAP

DY130-069: set up - 250 m Pennant Wire USBL 150 m up wire = 400 m from AT, attempt 30 min trawl									
Date	**time**	**USBL depth**	**mwo**	**USBL Lat**	**USBL Lon**	**Ship Lat**	**Ship Lon**	**pay out/ haul (ms^{-1})**	**Operational Note**
08/04/21	15:15	0				48° 51.9902	16° 29.9731	0.29	off deck
	17:40								ship forward at 1 knt
	17:44	4541	4690	48° 51.9937	16° 30.0466	48° 51.9764	16° 29.9146		
	17:55	4715		48° 51.9866	16° 29.7867				AT on bottom?
	18:02	4837	5000	48° 51.9822	16° 30.0174			-0.2	
	18:25	4624	4813	48° 51.9559	16° 29.9316	48° 51.9188	16° 29.6828	-0.2	end of trawl
	18:53							-0.7	
	21:10					48° 51.9186	16° 29.6829		AT on deck
Poor catch - 2 x specimens.									
DY130-070: Set up - 250 m Pennant Wire USBL 150 m up wire = 400 m from AT, attempt 1 hour trawl									
date	**time**	**USBL depth**	**mwo**	**USBL Lat**	**USBL Lon**	**Ship Lat**	**Ship Lon**	**pay out/haul (m s-1)**	**Operational Note**
08/04/2021	22:15					48° 53.967	16° 32.069		off deck
	22:31		150						USBL on wire
09/04/2021	00:36			48° 53.8776	16° 31.6177			0.24	on seabed?
	01:02	4840	5516	48° 53.9976	16° 32.0893	48° 53.7590	16° 31.0340		alert winch cab about USBL depth
	01:06			48° 53.7372	16° 30.9320			-0.22	
	01:25			48° 54.1261	16° 31.9654			-0.32	
	01:30	4837		48° 53.9711	16° 31.8756			-0.32	
	01:35			48° 53.7373	16° 30.9309			-0.33	tension drop - off bottom?
	01:44	4572		48° 53.9379	16° 31.7527				
	02:05	4272		48° 53.8624	16° 31.3644			-0.67	increase rate of haul
	03:33	905		48° 53.7419	16° 30.9948	48° 53.7376	16° 30.9310		
	04:02	0				48° 53.7374	16° 30.9310		USBL removed
	04:32					48° 53.7380	16° 30.9306		AT on deck
Trawl frame bent, tear in the net. Poor catch.									
DY130-073: set up - 250 m Pennant Wire USBL 400 m up wire = 650 m from AT, attempt 1 hour trawl									
date	**time**	**USBL depth**	**mwo**	**USBL Lat**	**USBL Lon**	**Ship Lat**	**Ship Lon**	**pay out/haul (m s-1)**	**Operational Note**
09/04/2021	15:33					48° 54.0118	16° 27.976		off deck
	18:00	4228	4621	48° 54.002	16° 28.025			0.38	on bottom, ship forward at 1 knt
	18:15	4533		48° 54.014	16° 28.0239	48° 54.1924	16° 27.6570	0.37	
	18:25	4722		48° 54.0363	16° 27.9967	48° 54.2890	16° 27.4845	0.2	slow pay out
	18:30	4785		48° 54.0547	16° 27.9736	48° 54.3643	16° 27.3545		
	18:35	4816		48° 54.0625	16° 27.9540	48° 54.4066	16° 27.2809	0.1	slow pay out
	18:49	4793	5418	48° 54.0891	16° 27.9080	48° 54.5741	16° 26.9670		

	19:00			48° 54.1130	16° 27.8650	48° 54.6725	16° 26.8186	-0.2	Begin recovery
	20:02	4200		48° 54.4071	16° 27.2529	48° 54.6709	16° 26.8146		increase haul
	22:20					48° 54.6692	16° 26.8136		AT on deck
Better catch 11 x bottles/buckets of variety of specimens									
DY130-075: set up - 250 m Pennant Wire USBL 400 m up wire = 650 m from AT, attempt 2 hour trawl									
date	**time**	**USBL depth**	**mwo**	**USBL Lat**	**USBL Lon**	**Ship Lat**	**Ship Lon**	**pay out/haul (m s-1)**	**Operational Note**
10/04/2021	00:03					48° 53.2109	16° 26.1015		off deck
	02:14	4100	4500	48° 53.2034	16° 26.1180	48° 53.2106	16° 26.1014	0.2	stop fast pay out, ship forward 1 knt
	03:15	4751		48° 53.4973	16° 26.1320	48° 54.2329	16° 26.1320		at bottom?
	03:24	4768	5420	48° 53.5167	16° 26.1342	48° 54.3508	16° 25.81999		
	03:38	4724	5542	48° 53.5191	16° 26.1225	48° 54.5898	16° 25.7614		
	03:45	4722	5640	48° 53.5230	16° 26.1423	48° 54.7108	16° 25.7319		
	04:05	4716	5893	48° 53.5852	16° 26.1245	48° 55.0212	16° 25.6553	0.22	
	04:16	4742	6000	48° 53.6087	16° 26.1160	48° 55.1719	16° 25.6184	-0.2	
	04:20	4741	5971	48° 53.6676	16° 26.0999	48° 55.1719	16° 25.6181		
	04:30	4736	5890	48° 53.77847	16° 26.0644	48° 55.1767	16° 25.6179		
	04:55	4702	5593	48° 54.0899	16° 25.9684	48° 55.17223	16° 25.6179		
	05:00	4676	5496	48° 54.1782	16° 25.9400	48° 55.17199	16° 25.6182		
	05:15	4616	5326	48° 54.32812	16° 25.8961	48° 55.1715	16° 25.6180	-0.2	plan to be off bottom
	05:30	4539	5166	48° 54.4481	16° 25.8730	48° 55.1716	16° 25.6182		
	05:48	4417	4946	48° 54.6286	16° 25.8323	48° 54.6386	16° 25.8294	-0.07	
	06:15	4147	4581	48° 54.8700	16° 25.7696	48° 54.1730	16° 25.6212	-0.4	
	08:28					48° 55.1723	16° 25.6198		AT on deck
Better catch 14 x bottles/buckets of variety of specimens									

Trawl sample processing:

On recovery to deck, the Agassi Trawl catches were spilled into boxes. The catch was then transferred for washing through the sieving table and sorting to broad taxonomic group. The net was examined in detail and the specimens found were added to the catch.

In all trawls the catch was a fairly typical haul of megabenthic invertebrates from PAP. The holothurians *Psychropotes* sp. and *Oneirophanta* sp., actiniarians and asteroids (*Styracaster* sp.) were the most abundant of the larger organisms. The specimens were preserved and the catch stored in containers labelled with the station number and listed in the table.

Thick gloves were used during the washing to avoid injury with glass and clinker. Specimens were washed and preserved as soon as possible to ensure the best quality for future identification in the lab.. Clinker, litter and artefacts were much reduced on OTSB-14 samples.

A subset of arthorpods in good condition were preserved in 100 % ethanol. Other taxa were preserved in 4% borax-buffered formaldehyde. The outside of every container was labelled (top and side if possible) and a paper label was placed inside the container.

Example Agassiz Trawl catches from the 3rd and 4th deployments (DY103-073 and DY130-075)

Samples retained from trawls DY130-069, DY130-070, DY130-073 and DY130-075

Station Number	Label	Bottle type	preservative
DY130-069	Pycnogonid	500 ml UN Bottle	ETOH
DY130-069	Red decapod	500 ml UN Bottle	ETOH
DY130-070	Psychropotes	5 L bucket	4% formaldehyde
DY130-070	other holothurians	5 L bucket	4% formaldehyde
DY130-073	Worm tubes	500 ml UN Bottle	4% formaldehyde
DY130-073	Iosactis	500 ml UN Bottle	4% formaldehyde
DY130-073	Polychaetes	500 ml UN Bottle	4% formaldehyde
DY130-073	Mollusca	500 ml UN Bottle	4% formaldehyde
DY130-073	Misc	500 ml UN Bottle	4% formaldehyde
DY130-073	Pycnogonid	500 ml UN Bottle	4% formaldehyde
DY130-073	Decapod	500 ml UN Bottle	4% formaldehyde
DY130-073	Barnacle	500 ml UN Bottle	ETOH
DY130-073	Echinoderms	Small 1 L bucket	4% formaldehyde
DY130-073	Holothurians	5 L bucket	4% formaldehyde
DY130-073	Parasicyonic biotrans	500 ml UN Bottle	4% formaldehyde
DY130-075	Iosactis	500 ml UN Bottle	4% formaldehyde
DY130-075	Worms	500 ml UN Bottle	4% formaldehyde
DY130-075	Indet mixed stalked	500 ml UN Bottle	4% formaldehyde
DY130-075	Decapods	500 ml UN Bottle	4% formaldehyde
DY130-075	Pycnogonid	500 ml UN Bottle	4% formaldehyde
DY130-075	Misc	500 ml UN Bottle	4% formaldehyde
DY130-075	Mollusca	500 ml UN Bottle	4% formaldehyde
DY130-075	Tubeworms	500 ml UN Bottle	4% formaldehyde
DY130-075	Anemones	1500 ml UN Bottle	4% formaldehyde
DY130-075	Holothurians	1500 ml UN Bottle	4% formaldehyde
DY130-075	Echinoderms	Small 1 L bucket	4% formaldehyde

In total the following were frozen for Rachel Jeffreys

Molpadiodemas x 5
Oneirophanta x 5
Psychropotes x 2
Hyphalaster x 4
Iosactis x 10

19. HyBIS seafloor photography

The HyBIS system was used in seabed photographic survey mode for four transects at the PAP Central Coring location and two transects at locations to the south of PAP Central. At PAP Central, seafloor transects followed the route of randomly selected AESA grid vertices in a similar manner to HyBIS operations on JC165 and DY103 (see map below). The two additional HyBIS missions to the south of the PAP Central area were to investigate an abyssal hill (DY130-043) and a flat area to the south of that hill (DY130-067). The two new areas were mapped using MBES prior to the HyBIS deployments (Section 19).

HyBIS set up and operation

Ship speed of 0.3 knots was maintained during HyBIS operations. In order to ensure optimal lighting and resolution of organisms in images the target vehicle altitude range for HyBIS is 2-4 mab. With heave compensation in operation, it is considerably easier to maintain this altitude and generally the vehicle was kept between 2-3 mab. The heave compensation is a significant improvement over previous use of HyBIS at PAP-SO.

Still images (JPEG format) were captured with a downward-facing Scorpio camera. The lens was mounted 53 cm below the altimeter. Images were collected at 5-second intervals and lighting of the downward frame was by three downward facing CathX Aphos lights. There were challenges to locate the lights in order to avoid shadowing in the images. Video was captured with the same Scorpio camera. Video was also recorded during the water column descent as exemplar material of particulates in the water column.

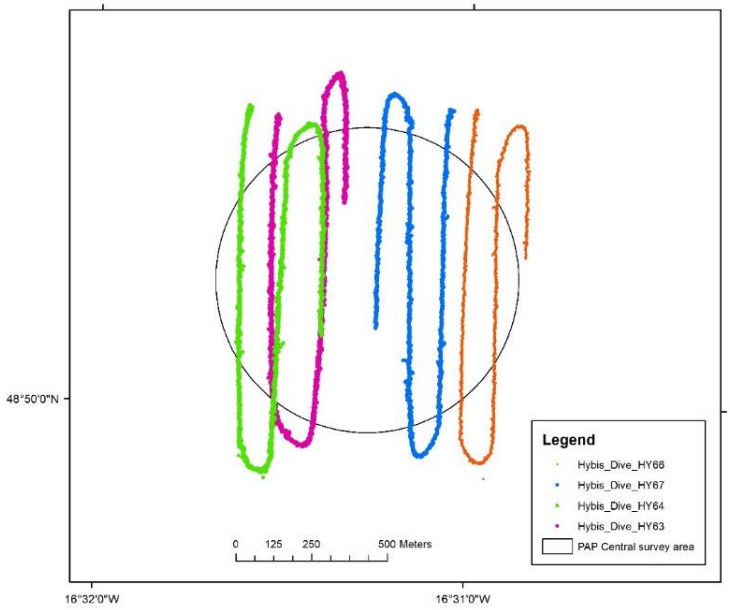
The forward-facing oblique PAL video camera (PAL-1) was mounted at 45° from the vertical (lens 10 cm below the altimeter) with 2 DSPL LED matrix lights used for forward lighting. A second forward facing camera failed after Station number 43 and was no longer used.

After daytime operations were completed (around 1800) the ship transited to the PAP central site and HyBIS was ready for deployment at around 1900 or shortly after. HyBIS was typically recovered in time to allow transit to PAP mooring area for operations to begin at around 0700 (leave seabed at approx. 0330). Timing was slightly different at the other HyBIS sites to allow time for mapping. At PAP Central this method allowed time for each dive to cover approximately 2.5 x 1 km AESA N-S fine vertical survey line with a ship speed of 0.3 knots.

PAP Central

PAP Central seafloor photography transects have been repeated on a number occasions since Autonomous Ecological Surveying of the Abyss in 2012 (AESA, D377) and now form part of the PAP time series studies.

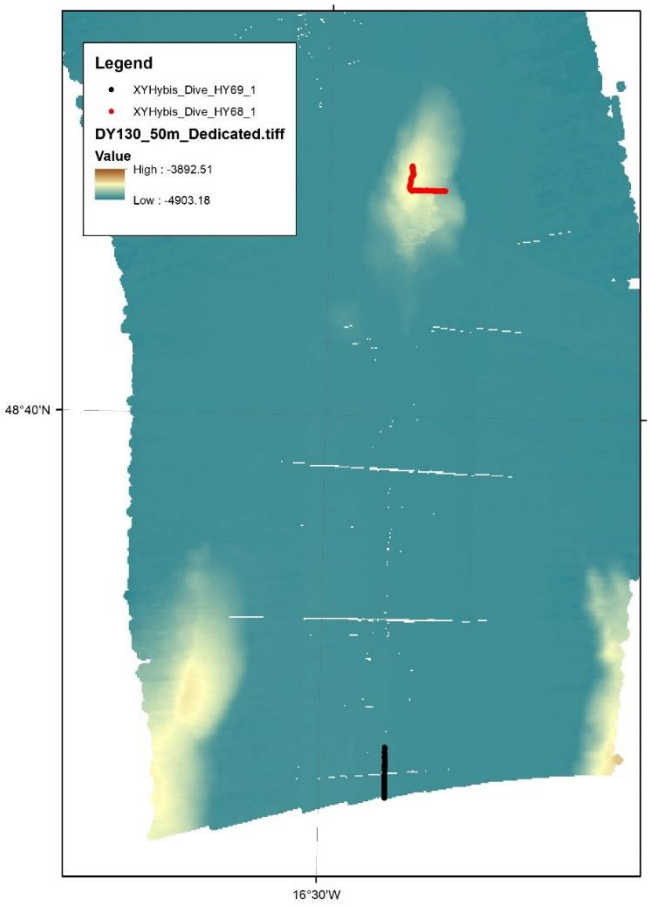
On DY130 four HyBIS dives were completed at PAP Central and one additional dive was aborted because of a problem with the forward-looking camera. Observations of fauna and the seabed seemed typical for the area. Trawl scars from previous PAP operations were observed in all transects and some of these had accumulated organic material and litter.



Hybis survey lines over the PAP central coring location following randomly selected AESA vertices.

Additional HyBIS dives

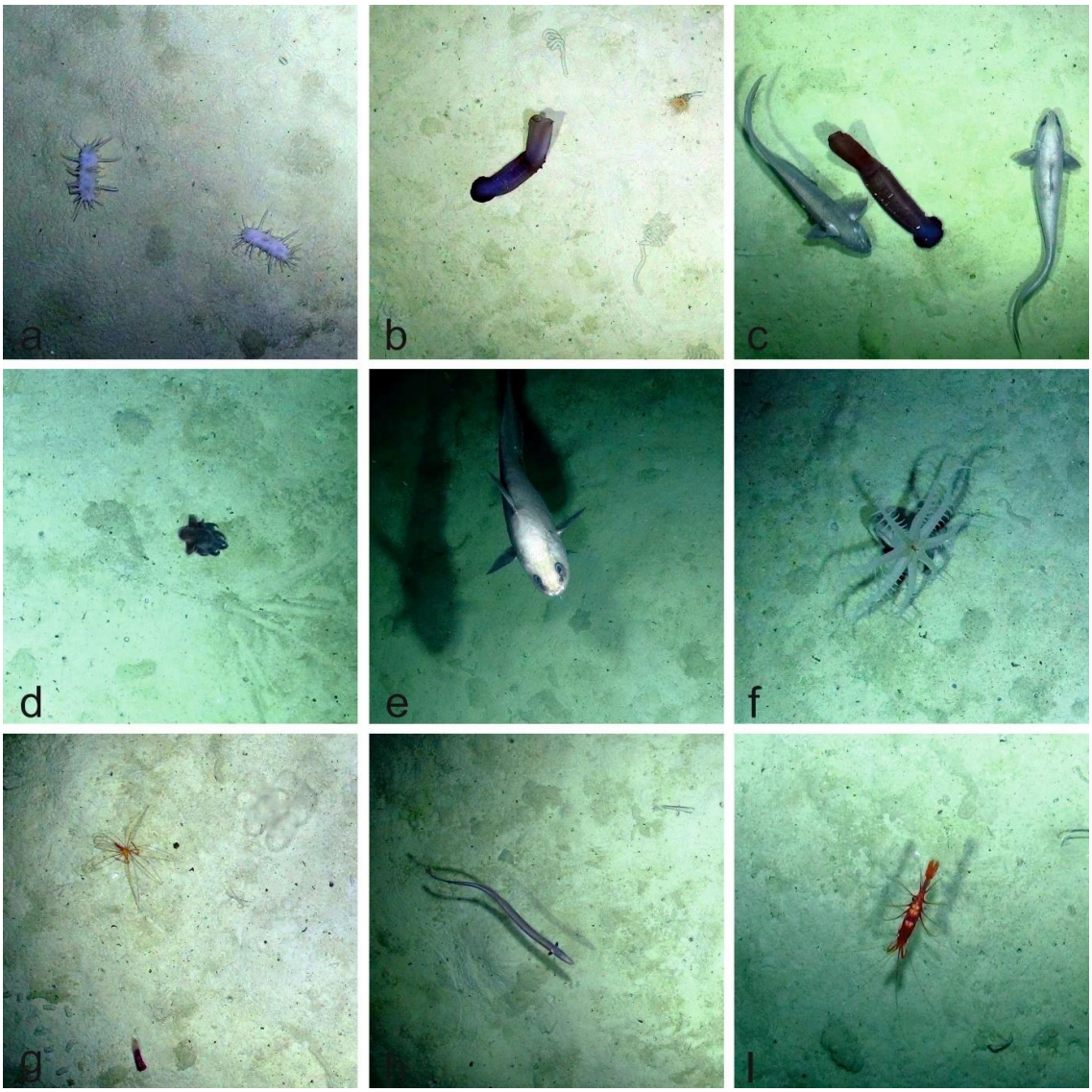
One survey was carried out on an abyssal hill to the south of PAP Central to add to ecological data from other abyssal hills around the PAP-SO area. The transect travelled up the hill from east to west and turned to the north after reaching the summit. It covered some steep areas of the slope where exposed rock was common. The final survey was carried out on a flat area to the south of the hill. The ship completed a MBES survey heading south, immediately after which HyBIS was launched and travelled north over the newly mapped seabed.



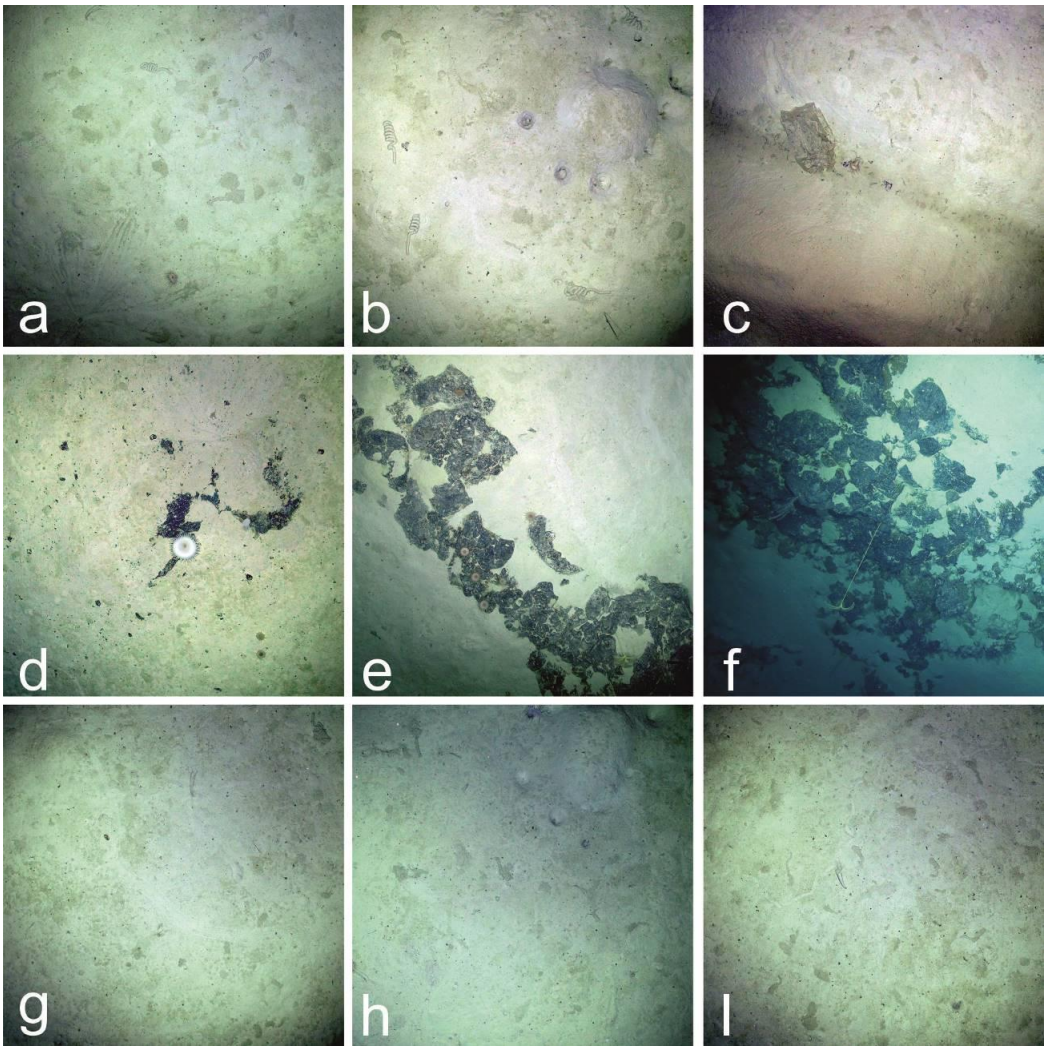
Track of additional HyBis dives DY130-067 and DY130-078 over seabed mapped during DY130

Summary data from HyBIS seabed operations carried out during DY130

Station No.	Hybis dive	Lat at seabed	Lon at seabed	date at seabed	time at seabed	date off seabed	time off seabed	No. seabed images
DY130-020	HY63	48° 50.504	16° 31.497	30/3/2021	21:23	31/3/2021	03:30	3703
DY130-031	HY64	48° 50.523	16° 31.595	01/4/2021	20:44	02/4/2021	03:28	4078
DY130-044	HY66	48° 50.524	16° 30.982	03/4/2021	21:17	04/4/2021	03:29	3804
DY130-056	HY67	48° 50.523	16° 31.044	05/4/2021	20:39	06/4/2021	03:32	4230
DY130-067	HY68	48° 44.678	16° 26.434	07/4/2021	21:30	08/4/2021	03:46	3843
DY130-078	HY69	48° 32.109	16° 27.959	10/4/2021	23:53	11/4/2021	03:43	2431



Highlight images from HyBIS dives at PAP on DY130: a) Two Oneirophanta holothurians b) Psychropotes holothurian c) 2 macrourids and a large Psychropotes holothurian d) cirrate octopod, e) Macrourid, f) Umbellula, g) Pycnogonid, h) possibly a synaphobranchid eel, i) natant decapod



Observations of the seafloor at a)-c) PAP Central, d)-f) abyssal hill and g)-i) plain to the south of abyssal hill: a) typical seabed with holothurian casts and spoke burrow, b) large structure observed frequently at PAP central (mound surrounded by holes), c) trawl mark with accumulated organic material and litter. d)-f) differing amounts of hard substratum and sessile invertebrates at the Abyssal Hill site (DY130), g)-i) typical seabed at the flat plain to the south of the Abyssal Hill including h) a structure similar to b)

20. Acoustic mapping & profiling

Catherine Wardell

Shipboard Multibeam Systems: EM122 and EM710

The RRS *Discovery* has two Kongsberg multibeam echosounders, an EM122 (12kHz) and an EM710 (70kHz), mounted on the hull. A 1 hour of cetacean watch was performed before the systems were started, no cetaceans were observed and the systems were started in dock. Sound velocity profiles were taken from CTD casts and entered into each system. The EM122 was recorded throughout the cruise but the EM710, a shallow water system, was only recorded where depths allowed along the transit. Once depths exceeded

the system capabilities, the EM122 was the sole system. The EM122 mode was set to automatic and filters were applied throughout acquisition, with a strong penetration filter strength due to the soft seabed at PAP, to help bottom tracking and reduce noise. Offsets, lever arms and calibration values were already inserted into the Seafloor Information System (SIS) acquisition software from a calibration conducted on DY087 cruise in 2018, values were then confirmed from a patch test conducted on the 20th September 2020.

Preliminary processing of the bathymetry was done in CARIS HIPS and SIPS v10.4, using a vessel reference file with offsets. This will be corrected once on land. Zero tide was applied, as depth errors of 1% in 4800m were assumed to be higher than tidal range. Noise was removed in subset and swath editors. Bad weather and ship velocity affected data quality.

As the ship left Southampton on the 25th March, a dedicated MBES survey was conducted across the backscatter calibration site in the Western Solent (Roche et al., 2018); the ship was transiting at 8 knots, possibly rendering the data unusable. On the return journey, a second pass of the calibration site was done. This data will be processed using FMGT once on shore. Whilst waiting for daylight to deploy the sediment traps at the Whittard Canyon, a dedicated EM122 survey was conducted overnight along the eastern branch of the Whittard Canyon. The weather was poor during acquisition, resulting in lower data quality and limited adherence of the ship to proposed lines.

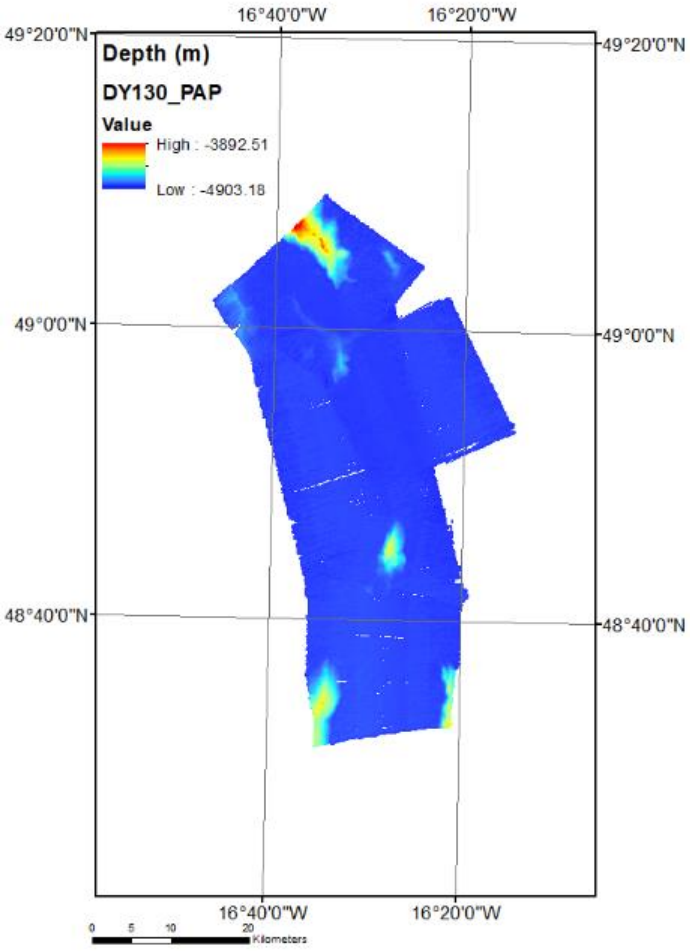
At PAP, two dedicated MBES surveys were conducted at 6 knots to investigate the terrain before deploying HyBIS. The initial survey was conducted over an abyssal hill, to increase resolution the beam angles were set to 40 º on port and starboard. The second survey was conducted with 62 º beam angles to increase coverage over a suspected flat area. A Sub Bottom Profiler line was also acquired at PAP at 6 knots, so the MBES data was included in the dedicated PAP survey.

Dedicated multibeam surveys in the PAP area

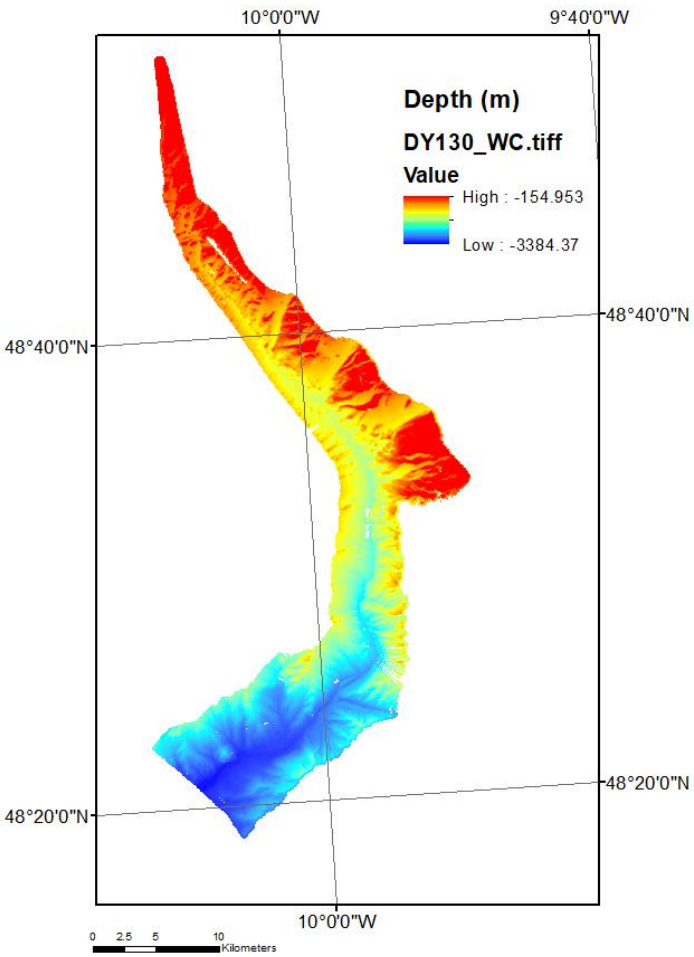
	Multibeam Start	**Multibeam End**	**Purpose**
1	25/03/2021 1009	25/03/2021 1014	Backscatter Calibration
2	28/03/2021 1910	29/03/2021 0545	Whittard Canyon Survey
3	07/04/2021 1718	07/04/2021 1802	Abyssal Hill Survey for HyISs deployment (beams 40 º/40º)
4	09/04/2021 1026	09/04/2021 2121	Sub Bottom Profile Data acquired at survey speed
5	10/04/2021 1946	10/04/2021 2121	Southern Abyssal Hill Survey for HyBIS deployment

Sub Bottom Profiling

A dedicated SBP line was run on the SBP120 ship system to investigate a possible landslide at PAP, using power -30dB, gain 0, frequency 6.5-2.5kHz.



PAP area bathymetry



Whittard Canyon area bathymetry

21. Whittard Canyon sediment traps

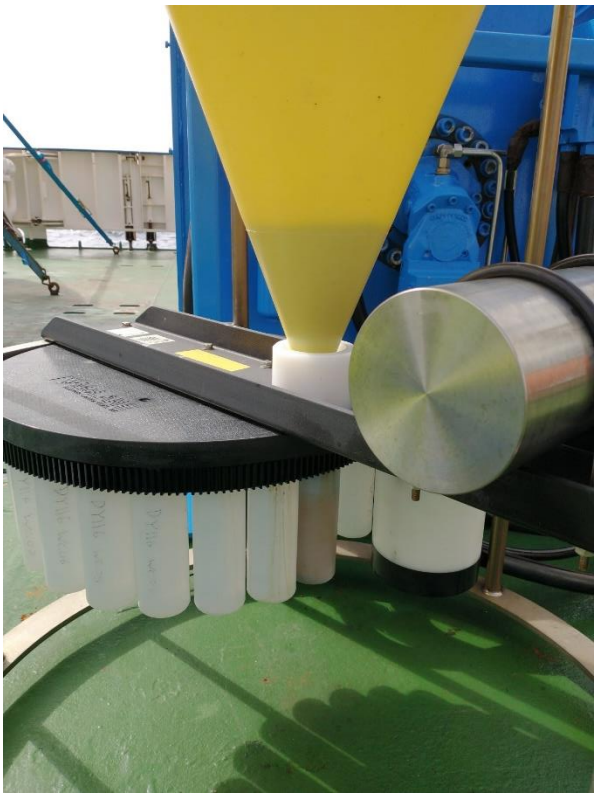
Corinne Pebody

Science report – for mooring details see mooring report

Mooring deployed on DY116 recovered on DY130 29/03/2021

Mooring was released at 9:00, on surface 10:20, alongside 11:00 and all in by 11:30.

On recovery the trap was spilling water, evidence that it was not on open hole and it had not moved past the first bottle with sediment filling the bottle and part way up the funnel as occurred in the trap recovered on DY116.



The bottles were removed but the mud was too thick to pour out. The downloaded log suggested that 3 bottles had been programmed to turn all 22 events had happened on time and all finished on 22/09/20 as programmed. So the sediment either ended on bottle 1 or on open hole and somehow forced the trap round to bottle 1 again. The possibility of the bottles being put on in reverse was investigated and found not so because bottle 18 being under the topping up hole (bottle 17+1). The ADCP and microcat data will give more information on the timing and scale of the event, but the trap has collected sediment in a downslope.

Mooring deployed on DY116 13/11/2020

Top float was deployed at 10:45, weight in at 12:05. Trap was deployed to sample at 18 day frequency as per deployment record below.

S/N: ML12168-04

Event 01

Scheduled start time: 12/01/2020 12:00:00
Event start time: 12/01/2020 12:00:00
Event stop time: 12/01/2020 12:00:25

	Aligned	Battery	Temperature
Start:	Y	19.2	6 °C
Stop:	Y	18.9	6 °C

Event 02

Scheduled start time: 12/19/2020 12:00:00
Event start time: 12/19/2020 12:00:00
Event stop time: 12/19/2020 12:00:28

	Aligned	Battery	Temperature
Start:	Y	19.0	6 °C
Stop:	N	18.7	6 °C

Event 03

Scheduled start time: 01/06/2021 12:00:00
Event start time: 01/06/2021 12:00:00
Event stop time: 01/06/2021 12:00:25

	Aligned	Battery	Temperature
Start:	N	17.9	6 °C
Stop:	N	17.4	6 °C

Event 04

Scheduled start time: 01/24/2021 12:00:00
Event start time: 01/24/2021 12:00:00
Event stop time: 01/24/2021 12:00:25

	Aligned	Battery	Temperature
Start:	N	17.1	6 °C

Stop: N 16.6 6 °C

Event 05

Scheduled start time: 02/11/2021 12:00:00

Event start time: 02/11/2021 12:00:00

Event stop time: 02/11/2021 12:00:25

	Aligned	Battery	Temperature
Start:	N	17.7	6 °C
Stop:	N	17.2	6 °C

Event 06

Scheduled start time: 03/01/2021 12:00:00

Event start time: 03/01/2021 12:00:00

Event stop time: 03/01/2021 12:00:25

	Aligned	Battery	Temperature
Start:	N	17.9	6 °C
Stop:	N	17.5	6 °C

Event 07

Scheduled start time: 03/19/2021 12:00:00

Event start time: 03/19/2021 12:00:00

Event stop time: 03/19/2021 12:00:25

	Aligned	Battery	Temperature
Start:	N	18.0	6 °C
Stop:	N	17.5	6 °C

Schedule was not completed.

22. 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. So, a 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 on a few occasions by the bridge, resulting in various circles at different speeds. Timestamped data was collated by Zoltan 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.discovery.local/#!/bridgelog

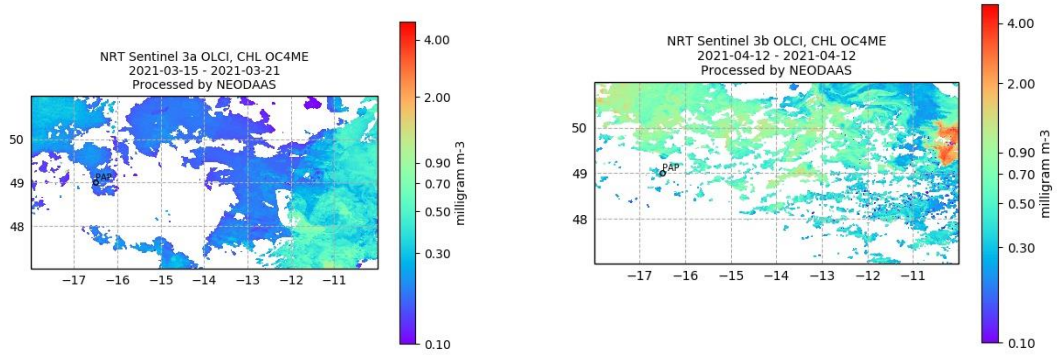
Start and end times:

"Start"		**"End"**	
01/04/2021	08:00	01/04/2021	09:52
05/04/2021	16:32	05/04/2021	17:25
06/04/2021	10:39	06/04/2021	11:37
06/04/2021	11:56	06/04/2021	13:00

23. Satellite data

The 1km data are available at https://www.oceancolour.org/portal/. Under “Indicators" choose Chlorophyll Indicators / Chl-a V5 1km. The data are currently daily but NEODAAS produced and sent 8-day composites too. Largely Sentinel Chl products (and some NOAA-20 VIIRS) as there was more coverage.

They uploaded the latest satellite data to the FTP server and site below:
ftp://neodaas23:oophoh6bu4ooz8eiveeP4@ftp.rsg.pml.ac.uk/2021/04/09;
https://data.neodaas.ac.uk/files/19_16/2021/04/09/high_resolution.



Example images near the start and end of DY130, as the bloom developed to the east

24. Station list

The following tabulation provides basic metadata for all operations during RRS *Discovery* cruise 130. ***In the case of benthic operations, please refer to the tabulation of benthic station data provided in the body of this cruise report for the full metadata that should be used / reported in any subsequent work (reports / publications).***

Station	Unique deployment identifier "DY", RRS Discovery IV, "130" 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
BSNAP	"Bathysnap", time-lapse camera system [new Kongsberg camera and flash, Oceanlab Oceanback]; plus larval traps and colonisation substrates	Times given are estimated arrivals / departures from seabed
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	ODAS Mobilis buoy and instrument frame	
PAP3	Sediment trap array; (previously included larval traps and colonisation substrates), Deep microcat	
WCM	Whittard Canyon mooring: 2 x ADCP + 1 x sediment trap and microcat SBE	
ARGO	Met Office Navis float, part of BGC Argo programme	
MBES	Multibeam mapping	
MgC	Megacore	Time and position refer to the time of bottom contact

glider	On DY130 refers to 2 USA EXPORTS Sea gliders, 1 UK slocum glider
SBP	sub bottom profile
Hybis	HyBIS ROV with cameras
Agassiz	Trawl used on DY130 instead of Otter trawl
METCAL	Met data PAP1/ship intercalibration
Atrap	Amphipod trap
WP2	Zooplankton nets

Time and position refer to centre of fished area

Station	Gear	Date	Time	Position (N)		Position (W)		Depth	Comments	
DY116-002	WCM	13/11/2020	12:05	48	37.574	10	0.252	1577	MicroCAT took a hit on deployment	
		29/03/2021	09:53	48	37.2400	10	0.59	1212	Recovery position and depth	
DY116-007	PAP3	20/11/2020	17:34	49	0.905	16	26.542	4835	long tow. Release time/position.	
		05/04/2021	12:52	49	0.6840	16	26.583	4811	Assent ~94 m/min, most on deck 15:00	
DY116-008	PAP1	21/11/2020	18:04	48	58.0565	16	26.149	4810	DY116 position odd (48° 57.24, 16° 19.75), use anchor	
		01/04/2021	14:20	48	57.3868	16	26.316	4810	Retrieve 5 star oddi, solar panel and sonic hit	
DY130-001	MBES	25/03/2021	10:09	50	46.052	1	20.184	20	Multibeam Backscatter calibration	
		25/03/2021	10:14	50	45.6940	1	20.948	20	Run at 8 knots, EM710 file 6, EM122 File 8	
DY130-002	WP2	25/03/2021	18:07	50	6.72	3	11.269	67	net # 1	
		25/03/2021	18:15	50				67	wp2 200um net sample for Dan Mayer	
DY130-003	WP2	25/03/2021	23:12	49	51.617	4	13.037	76.7	net # 2	
		25/03/2021	23:21	49	51.5700	4	13.111	76.7	wp2 200um net sample for Dan Mayer	
DY130-004	WP2	26/03/2021	12:07	50	9.1	4	49.341	66.9	net # 3	
		26/03/2021	12:16	50	9.1547	4	49.343	62.5	wp2 200um net sample for Dan Mayer	
DY130-005	WP2	26/03/2021	12:21	50	9.15144	4	49.359	70.4	net # 4	
		26/03/2021	12:32	50	9.4531	4	49.357	70.8	wp2 200um net sample for Dan Mayer	
DY130-006	WP2	26/03/2021	18:01	50	9.156944	4	49.324	63	net # 5	
		26/03/2021	18:11	50	9.1540	4	49.297		wp2 200um net sample for Dan Mayer	
DY130-007	WP2	26/03/2021	18:14	50	9.15372	4	49.297	63.8	net # 6	
		26/03/2021	18:22	50	9.1568	4	49.282		wp2 200um net sample for Dan Mayer	
DY130-008	WP2	26/03/2021	22:58	50	9.14579	4	49.273	61	net # 7	
		26/03/2021	23:06	50	9.1439	4	49.312	61	wp2 200um net sample for Dan Mayer	
DY130-009	WP2	26/03/2021	23:11	50	9.1419	4	49.322	59	net # 8	
		26/03/2021	23:18	50	9.1333	4	49.36	59	wp2 200um net sample for Dan Mayer	
DY130-010	WP2	27/03/2021	12:08	49	31.45584	5	46.61	103	net # 9	
		27/03/2021	12:17	49	31.4534	5	46.63	103	wp2 200um net sample for Dan Mayer	
DY130-011	WP2	27/03/2021	12:21	49	31.45362	5	46.649	103	net # 10	
		27/03/2021	12:30	49	31.4545	5	46.687	102.3	wp2 200um net sample for Dan Mayer	
DY130-012	WP2	27/03/2021	18:02	49	18.04182	6	46.392	122.2	net # 11	
		27/03/2021	18:12	49	17.9721	6	46.293	121.5	wp2 200um net sample for Dan Mayer	
DY130-013	WP2	27/03/2021	18:16	49	17.93484	6	46.278	121.4	net # 12	
		27/03/2021	18:33	49	17.7544	6	46.181	240.9	wp2 200um net sample for Dan Mayer	
DY130-014	WP2	27/03/2021	22:59	49	2.92866	7	35.648	141.6	net # 13 small vol of sample. Need repair, not sealing	
		27/03/2021	23:09	49	2.9077	7	35.672	141.5	wp2 200um net sample for Dan Mayer	
DY130-015	WP2	27/03/2021	23:12	49	2.89788	7	35.688	141.5	net # 14 small vol of sample.	
		27/03/2021	23:30	49	2.8606	7	35.746	141.7	wp2 200um net sample for Dan Mayer	
DY130-016	CTD	28/03/2021	15:14	48	15.46	10	8.85	2750	CTD1 WC + test to 1800m, plus releases	
		28/03/2021	17:13	48	15.4600	10	8.85	3398	release and microcat x3 s/n 7297 / 7298 / 12463	
DY130-017	MBES	28/03/2021	19:10	48	21	10	9	3220	MBES survey of Whittard Canyon,	
		29/03/2021	05:45	48	36.7884	9	58.425	1545	Eastern Branch, File 16-38, SVP from CTD cast	
DY130-018	WCM	29/03/2021	11:58	48	37.5492	10	0.2065	1572	Triangulated position. Actual depth from MB	
DY130-019	CTD	30/03/2021	16:51	48	49.01	16	26.53	100	CTD2 near HYBIS, pre dep SBE16503,	
		30/03/2021	17:41	48	49.0100	16	26.53	10	21549, 9469, 3757-616, 6911, 609 (3x 10min)	
DY130-020	Hybis	30/03/2021	19:13	48	50.504	16	31.497	4832	2.5 x AESA north south transects	
		31/03/2021	05:26	48	50.2414	16	31.348	4810		

DY130-021	CTD	31/03/2021	06:48	48	56.14	16	26.52	4750	CTD3 near PAP1, Microcat cal - redo SN 12463,	
		31/03/2021	08:14	48	56.1400	16	26.52	10	cal 12455 to use on PAP3 (3x 10mins)	
DY130-022	WP2	31/03/2021	11:13	48	56.14494	16	26.258	4809	PAP net 15 for Corinne	
		31/03/2021	11:40	48	56.1686	16	26.705	4809		
DY130-023	WP2	31/03/2021	11:48	48	56.17596	16	26.711	4809	PAP net 16 for Corinne	
		31/03/2021	12:12	48	56.1946	16	26.823	4809		
DY130-024	PAP3	31/03/2021	15:20	48	59.70602	16	24.287	4844	Anchor in water 15:19	
DY130-025	MgC08	31/03/2021							Failed at 1200m depth due to winch overheating	
DY130-026	MgC08	01/04/2021	03:04	48	50.334	16	31.531	4808	5.18 tension, 6/8 good cores	
DY130-027	CTD	01/04/2021	07:06	48	56.964	16	26.645	200	CTD4 validation cast for post pap1	
		01/04/2021	07:46	48	56.9640	16	26.645	10	(no extra instruments)	
DY130-028	METCAL	01/04/2021	08:00	48	56.9655	16	26.646	0	Met data for M.Yelland.	
		01/04/2021	09:52	48	59.5666	16	26.252		To compare with MO data DY116-PAP1	
DY130-029	ATRAP	01/04/2021	10:05	48	59.584	16	26.233	4811	1.45 hours to surface	
		03/04/2021	14:45	48	59.4900	16	26.466			
DY130-030	Glider	01/04/2021	11:00	49	0.691	16	25.393	4810	USA seaglider1 - SN: SG219	
DY130-031	Hybis	01/04/2021	18:42	48	50.511	16	31.58	4837	2.5 x AESA north south transects	
		02/04/2021	05:20	48	50.1200	16	31.388		change to E-W lines, as kiting away from ship	
DY130-032	CTD	02/04/2021	07:11	48	56.39	16	27.9	1000	CTD5 USA seaglider1 - cal cast & NOC intercal.	
		02/04/2021	09:13	48	56.3900	16	27.9	10	Now 2 min stops	
DY130-033	WP2	02/04/2021	11:57	48	50.3781	16	31.259	4808	net 17 for Corinne	
		02/04/2021	12:22	48	50.3216	16	31.409	4808	preserved in formalin	
DY130-034	WP2	02/04/2021	12:28	48	50.31144	16	31.437	4808	net 18 for Corinne	
		02/04/2021	12:57	48	50.2523	16	31.592	4808	sieved through 200um and preserved in formalin	
DY130-035	MgC08	02/04/2021	16:55	48	50.374	16	31.247	4841	5.1 tension on pull out, 8/8 good cores	
DY130-036	MgC08+2	02/04/2021	21:16	48	50.285	16	31.041	4844	5.1 tension. 8/8 good large cores, 0/2 small cores.	
DY130-037	MgC08	02/04/2021	01:29	48	50.084	16	31.425	4840	5.12 tension on pull out. 6/8 good large cores	
DY130-038	PAP1	03/04/2021	11:55	48	57.55926	16	26.241	4811	Frame in 11:05, buoy 11:55	
DY130-039	WP2	03/04/2021	12:44	48	59.52678	16	26.305	4811	net 19 for Corinne	
		03/04/2021	13:15	48	59.5275	16	26.305	4811	preserved in formalin	
DY130-040	WP2	03/04/2021	13:19	48	59.52744	16	26.305	4811	net 20 for Corinne	
		03/04/2021	13:56	48	59.5277	16	26.305	4811	sieved through 200um and preserved in formalin	
DY130-041	Glider	03/04/2021	14:20	48	59.527	16	26.305	4810	USA seaglider2, SG237 - mission	
		03/04/2021	16:20	48	59.5270	16	26.305	4810	abandoned, bring onboard	
DY130-042	Glider	03/04/2021	15:50	48	59.527	16	26.305	4810	iFADO/GOCART Slocum, SL305, to collect on DY131	
DY130-043	Hybis	03/04/2021	18:45	48	52.5264	16	30.974	4840	Fwd camera fail. Recover at 200 m	
		03/04/2021	19:12	48	52.5264	16	30.974	4840		
DY130-044	Hybis	03/04/2021	19:18	48	50.5256	16	30.974	4840		
		04/04/2021	05:23	48	50.1910	16	30.834			
DY130-045	CTD	04/04/2021	06:53	48	57.596	16	26.804	200	CTD6 Post PAP1 cal cast SBE SN 6904,	
		04/04/2021		48	57.5960	16	26.804	10	SN 21210. long stop 200 and 30m	
DY130-046	CTD	04/04/2021	09:09	49	4.67	16	30.89	1000	CTD7 iFADO/GOCART Slocum, SL305,	
		04/04/2021		49	4.6700	16	30.89	10	cal cast. 4, 10 missfire	
DY130-047	Glider	04/04/2021	12:40	48	50.7849	16	30.788	4810	USA seaglider2, SG237, redeploy - collect on DY131	
DY130-048	MgC10	04/04/2021	16:03	48	50.243	16	30.964	4843	5.19 tension, 10/10 large cores	
DY130-049	MgC10	04/04/2021	20:28	48	49.981	16	31.295	4844	Tension 5.09, 10/10 good cores	
DY130-050	WP2	04/04/2021	22:50	48	50.29644	16	31.309	4810	net 21 for Corinne	
		04/04/2021	23:15	48	50.2930	16	31.351	4810		
DY130-051	MgC10	05/04/2021	01:26	48	50.288	16	31.306	4843	Tension 5.36. 10/10 good cores	
DY130-052	MgC10	05/04/2021	05:36	48	50.437	16	31.115	4844	9 good cores. 8 macrofauna, 1 biogeochem	
DY130-053	CTD	05/04/2021	09:15	48	52.33	16	31.56	4845	CTD8 Cal USA glider2 SN237. 4 missfire	
		05/04/2021	10:48	48	52.3300	16	31.56			
DY130-054	ATRAP	05/04/2021	12:20	49	1.269	16	23.845	4811	decent 58m/min. Assent 13:22, 42 m/min (~47.5 hrs)	
		07/04/2021	13:22	49	1.2690	16	23.845	4811		
DY130-055	METCAL	05/04/2021	16:32	48	57.62502	16	28.55	0	Met data for M.Yelland	
		05/04/2021	17:25	48	57.6092	16	28.592	0		
DY130-056	Hybis	05/04/2021	18:40	48	50.5238	16	31.056	4840	Hybis Transect 5	

		06/04/2021	05:37	48	50.0520	16	13.222	4840		
DY130-057	CTD	06/04/2021	06:50	48	56.126	16	26.55	4750	CTD9 bottle 4 missfire	
		06/04/2021	08:14	48	56.1300	16	26.54	4750		
DY130-058	METCAL	06/04/2021	10:39	48	56.24346	16	26.21	0	Met data for M.Yelland	
		06/04/2021	11:37	48	55.7924	16	27.34	0		
DY130-059	METCAL	06/04/2021	11:56	48	56.41182	16	25.527	0	Met data for M.Yelland	
		06/04/2021	13:00	48	56.2671	16	24.882	0		
DY130-060	MgC10	06/04/2021	16:55	48	50.266	16	31.387	4842	Tension 5.57. 5/10 short cores	
DY130-061	MgC10	06/04/2021	21:36	48	50.303	16	31.480	4844	Tension 5.24. 10/10 cores (1 short)	
DY130-062	WP2	07/04/2021	00:06	48	50.46234	16	31.282	4810	net 22 for Corinne	
		07/04/2021	00:00	48	50.5163	16	31.426	4810		
DY130-063	WP2	07/04/2021	00:39	48	50.51748	16	31.428	4810	net 23 for Corinne	
		07/04/2021	01:06	48	50.5673	16	31.561	4810		
DY130-064	MgC10	07/04/2021	03:25	48	50.472	16	31.289	4838	5.14 tension. 6/10 short cores	
DY130-065	CTD	07/04/2021	06:55	48	59.99	16	30.01	4750	CTD10 post pap3 sbe12462 (cal fail).	
		07/04/2021	11:40	48	59.9890	16	30.01	4750	Some winch issues, missfire 2 + 4	
DY130-066	MBES	07/04/2021	17:18	48	47.255	16	26.604		File 505-506, 40/40 beams, feature to south.	
		07/04/2021	18:02	48	42.9002	16	27.889		Survey at 5 knot (requested start end)	
DY130-067	Hybis	07/04/2021	19:33	48	44.683	16	26.444	4624	hybis over hill mapped above.	
		08/04/2021	03:46	48	45.1789	16	27.46	4385	end time is end of dive	
DY130-068	CTD	08/04/2021	10:02	49	0.012	16	30.03	4750	CTD11 SBE PAP3 microcat 12462, 2 10 min stops	
		08/04/2021	13:07	48	59.9900	16	30.02	10	(no active heave compensation)	
DY130-069	Agassiz	08/04/2021	18:02	48	51.9822	16	30.017	4830	poor catch, short bottom time	
DY130-070	Agassiz	09/04/2021	01:30	48	53.9711	16	31.876	4837	no catch, net damaged	
DY130-071	CTD	09/04/2021	08:29	48	57.72504	16	27.374	200	CTD12 pre cal cast for PAP1 (very near buoy)	
		09/04/2021	09:16	48	57.7286	16	27.373	200		
DY130-072	SBP	09/04/2021	10:26	48	51.0258	16	22.009		Sub bottom profile, turn at 49N, 16.5W	
		09/04/2021	13:40	49	4.2292	16	39.543	4817		
DY130-073	Agassiz	09/04/2021	18:30	48	54.0547	16	27.9736	4809	Small catch	
DY130-074	WP2	09/04/2021	22:47	48	54.67038	16	26.819	4810	net 24 for Corinne	
		09/04/2021	23:16	48	54.5618	16	26.907	4812	Last nets? All rinsed and hung up	
DY130-075	Agassiz	10/04/2021	04:16	48	53.6087	16	26.1160	4839	Largest catch	
DY130-076	CTD	10/04/2021	09:51	48	59.692	16	29.992	4000	CTD13 1 depth for DIC/TA sub standards	
		10/04/2021	12:39	48	59.964	16	29.994	4000		
DY130-077	MgC08	10/04/2021	15:53	49	3.348	16	36.399	4811	Tension not recorded. 6/8 short cores	
DY130-078	MBES	10/04/2021	19:46	48	42.22506	16	27.996	4828	Files 657-660, survey south of abyssal hill, EM122	
		10/04/2021	21:21	48	32.2881	16	27.954			
DY130-080	Hybis	10/04/2021	19:58	48	32.1032	16	27.966	4826	transect south of abyssal hil	
		11/04/2021	05:42	48	32.2091	16	27.969	4828		
DY130-081	CTD	12/04/2021	01:27	49	15.62	14	30.22	1000	CTD14 near slocum sl305 and	
		12/04/2021	01:54	49	15.48	14	30.09	5	pre-dep Argo in A2 eddy	
DY130-082	ARGO	12/04/2021	03:21	49	15.48288	14	30.085	4506	BGC Argo SN 1241	
DY130-083	MBES	14/04/2021	09:08	50	45.746	1	20.904	22	EM122 file 9, EM710 file 11, backscatter	
		14/04/2021	09:12	50	46.0810	1	20.122	22	calibration, run at 8.5 knots	

25. Acknowledgements

We thank all the crew of the RRS *Discovery* and the NMF technicians who kept us working to deliver our sometimes rather challenging science programme. The catering was exceptional and we were well looked after. 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). iFADO supported servicing of PAP1 sensors and provision of a glider (along with the GOCARTS project). EXPORTS (NASA) supplied 2 further gliders to survey the area. 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 DY130. Thanks to colleagues in OTEG and Campbell Ocean data (COD) for initial PAP1 setup ashore.

Appendix 1. Ship-fitted instruments:

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

Manufacturer	Model	Function/data types	Logged? (Y/N)	Comments
Meinberg	M300	GPS network time server (NTP)	N	Not logged but feeds times to other systems
Applanix	POS MV320 V5	Position/attitude	Y	Primary scientific GPS
C-Nav	3050	DGNSS	Y	DGNSS (for Applanix)
Kongsberg Seatex	Seapath 330	Position/attitude	Y	Secondary scientific GPS
Fugro	Fugro 9205 DGNSS Seastar	DGNSS	Y	DGNSS (for Seapath330)
iXSea	PHINSIII	Inertial Navigation System	Y	
Sonardyne	Fusion USBL	USBL	Y	2707, 3003, 2704
Sperry Marine	NAVITVIN IV	Ship gyrocompasses x 3	Y	
Kongsberg Maritime	Simrad EA640	Single beam echo sounder (STDB Drop-Keel)	Y	10(active) & 12KHz (in passive mode) logged
Kongsberg Maritime	Simrad EM122	Multibeam echo sounder (deep)	Y	MMO rules, continuous mode
Kongsberg Maritime	Simrad EM710	Multibeam echo sounder (shallow)	Y	MMO rules, not continuous mode
Kongsberg Maritime	Simrad SBP120	Sub bottom profiler	Y	MMO rules, Not continuous mode
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	DL850	Skipper log (ship's velocity)	Y	
OceanWaveS GmbH	WaMoS II	Wave Radar	Y (non calibrated)	Logged by Techsas and RAM
Teledyne RD Instruments	Ocean Observer 75 kHz	VM-ADCP	Y	UHDAS BT in shallow
Teledyne RD Instruments	Ocean Observer 150 kHz	VM-ADCP	Y	UHDAS BT in shallow
Microg Lacoste	Air-Sea System II	Gravity	N	

Appendix 2 CTD

PSA file:

C:\Users\sandm\Documents\Cruises\DY130\SeaSave setup files\DY130_SS_nmea_PAR.psa

Date: 04/02/2021

Instrument configuration file: C:\Users\sandm\Documents\Cruises\DY130\SeaSave setup files\DY130_SS_nmea_ No PAR.xmlcon

Configuration report for SBE 911plus/917plus CTD

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

1) Frequency 0, Temperature
Serial number : 03P-5494
Calibrated on : 11 July 2018
G : 4.32421234e-003
H : 6.26025634e-004
I : 1.94626464e-005
J : 1.48486445e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity
Serial number : 04C-3768
Calibrated on : 25 July 2018
G : -1.02284081e+001
H : 1.49861592e+000
I : -1.33719830e-003
J : 1.94341809e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000

Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 110557

Calibrated on : 21 September 2018
C1 : -6.010548e+004
C2 : -1.565601e+000
C3 : 1.823090e-002
D1 : 2.668300e-002
D2 : 0.000000e+000
T1 : 3.020528e+001
T2 : -6.718318e-004
T3 : 4.457980e-006
T4 : 1.203850e-009
T5 : 0.000000e+000
Slope : 1.00002000
Offset : 2.14950
AD590M : 1.280700e-002
AD590B : -9.299640e+000

4) Frequency 3, Temperature, 2

Serial number : 03P-5785
Calibrated on : 14 February 2019
G : 4.33667005e-003
H : 6.27899513e-004
I : 1.95462370e-005
J : 1.44258806e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 04C-4139
Calibrated on : 14 February 2019
G : -9.89572830e+000
H : 1.45992719e+000
I : -4.60288486e-004
J : 1.24094742e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

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

Serial number : 43-2831

Calibrated on : 20 August 2019
Equation : Sea-Bird
Soc : 4.89100e-001
Offset : -4.82600e-001
A : -4.73590e-003
B : 2.06550e-004
C : -3.00620e-006
E : 3.60000e-002
Tau20 : 1.32000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

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

Serial number : 43-0862
Calibrated on : 13 March 2019
Equation : Sea-Bird
Soc : 5.47800e-001
Offset : -5.02600e-001
A : -4.97970e-003
B : 1.74410e-004
C : -3.03980e-006
E : 3.60000e-002
Tau20 : 1.50000e+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, Free

9) A/D voltage 3, Free

10) A/D voltage 4, Altimeter

Serial number : 59494
Calibrated on :
Scale factor : 1.000
Offset : 0.000

11) A/D voltage 5, Free

12) A/D voltage 6, Fluorometer, WET Labs ECO-AFL/FL
Serial number : 3522
Calibrated on : 9th May 2018
Dark output : 0.0860

Scale factor : 9.00000000e+000

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

Serial number : 3522
Calibrated on : 9 May 2018
ScaleFactor : 0.001400
Dark output : 0.078000

Scan length : 45

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

Data Acquisition:
Archive data: YES
Delay archiving: NO
Data archive: C:\Users\sandm\Documents\Cruises\DY130\Data\Raw Data\DY130_005.hex
Timeout (seconds) at startup: 60
Timeout (seconds) between scans: 20

Instrument port configuration:
Port = COM4
Baud rate = 19200
Parity = N
Data bits = 8
Stop bits = 1

Water Sampler Data:
Water Sampler Type: SBE Carousel
Number of bottles: 36
Port: COM5
Enable remote firing: NO
Firing sequence: User input
Tone for bottle fire confirmation uses PC sound card.

Header information:
Header Choice = Prompt for Header Information
prompt 0 = Ship: RRS Discovery
prompt 1 = Cruise: DY130
prompt 2 = Cast:
prompt 3 = Station:
prompt 4 = Julian Day:
prompt 5 = Date:
prompt 6 = Time (GMT):
prompt 7 = Latitude:
prompt 8 = Longitude:
prompt 9 = Depth (uncorrected m):

```
    prompt 10 = Principal Scientist: Sue Hartman
    prompt 11 = Operator: BP/PH
-------------------------------------------
TCP/IP - port numbers:
  Data acquisition:
    Data port:          49163
    Status port:        49165
    Command port:       49164
  Remote bottle firing:
    Command port:       49167
    Status port:        49168
  Remote data publishing:
    Converted data port:  49161
    Raw data port:      49160
-------------------------------------------
Miscellaneous data for calculations
  Depth, Average Sound Velocity, and TEOS-10
    Latitude when NMEA is not available:  48.000000
    Longitude when NMEA is not available: 0.000000
  Average Sound Velocity
    Minimum pressure [db]:            20.000000
    Minimum salinity [psu]:           20.000000
    Pressure window size [db]:        20.000000
    Time window size [s]:             60.000000
  Descent and Acceleration
    Window size [s]:                  2.000000
  Plume Anomaly
    Theta-B:                        0.000000
    Salinity-B                      0.000000
    Theta-Z / Salinity-Z              0.000000
    Reference pressure [db]           0.000000
  Oxygen
    Window size [s]:                  2.000000
    Apply hysteresis correction:      0
    Apply Tau correction:             1
  Potential Temperature Anomaly
    A0:                             0.000000
    A1:                             0.000000
    A1 Multiplier:                  Salinity
-------------------------------------------
Serial Data Output:
  Output data to serial port: NO
-------------------------------------------
Mark Variables:
  No variables are selected.
-------------------------------------------
Shared File Output:
  Output data to shared file: NO
-------------------------------------------
TCP/IP Output:
  Raw data:
```

Output raw data to socket: NO
XML wrapper and settings: NO
Seconds between raw data updates: 0.000000
Converted data:
Output converted data to socket: NO
XML format: NO

SBE 11plus Deck Unit Alarms
Enable minimum pressure alarm: NO
Enable maximum pressure alarm: NO
Enable altimeter alarm: NO

SBE 14 Remote Display
Enable SBE 14 Remote Display: NO

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

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

Appendix 3. *CTD sampling Logs*

SITE	Whittard Canyon
Comments	- test to 1800m, plus releases - release and microcat x3 s/n 7297, 7298, 12463

Cruise number	DY130
Station ID	DY130_016
Cast number	001
Sea floor depth (m)	2750
Cast depth (m)	1800
Event number	016

Niskin No	Depth (m)	Bottle No.	O_2bottle Rep 1	O_2Temp. Rep 1	O_2bottle Rep 1	O_2Temp. Rep 2	O_2bottle Rep 3	O_2Temp. Rep 3	DIC/TA Rep 1	DIC/TA. Rep 2	^{13}C DIC x2 REPS	TOC EXPORTS	DOC EXPORTS	TOC PAP	DOC PAP	Nutrients EXPORT	Nutrients PAP	δ^{13}C DOC X2 REPS	SALTS Crate-bottle	FILL 5L carboy	FILL 5L carboy	Fill 2L bottle	Fill 2L HPLC bottle	
1	1800	----	6.0	1098	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
2	1800	1	6.0	1081	----	----	----	----	X084	X081	✓	----	----	----	----	----	✓	----	12-308	1	----	----	----	
3	1600	----	6.5	1095	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
4	1600	2	6.6	1094	----	----	----	----	X082	----	✓	----	----	----	----	----	✓	----	12-309	2	----	----	----	
5	1000	----	9.7	1091	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
6	1000	3	9.8	1093	----	----	----	----	X086	----	✓	----	----	----	----	----	✓	----	12-310	3	----	----	----	
7	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
8	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
9	900	----	10.0	1085	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	

10	900	4	10.0	1080	----	----	----	----	X088	X093	✓	----	----	----	----	----	✓	----	12-311	4	----	----	----	10.
11	500	----	10.8	1079	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	11.
12	500	5	10.8	1077	----	----	----	----	X094	----	✓	----	----	----	----	----	✓	----	12-312	5	----	----	----	12.
13	370	----	11.2	1083	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	13.
14	370	6	11.2	1084	----	----	----	----	X101	----	✓	----	----	----	----	----	✓	----	12-313	6	----	----	----	14.
15	350	----	11.2	1090	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	15.
16	350	7	11.3	1075	----	----	----	----	X083	----	✓	----	----	----	----	----	✓	----	12-314	7	----	----	----	16.
17	170	----	11.7	1076	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	17.
18	170	8	11.7	1096	----	----	----	----	X087	----	✓	----	----	----	----	----	✓	----	12-315	8	----	----	----	18.
19	100	----	11.7	1087	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	19.
20	100	9	11.7	1092	----	----	----	----	X092	----	✓	----	----	----	----	----	✓	----	12-316	9	----	----	----	20.
21	50	----	11.7	1097	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	21.
22	50	10	11.7	1089	----	----	----	----	X095	----	✓	----	----	----	----	----	✓	----	12-317	10	----	----	----	22.
23	10	11	11.8	1088	----	----	----	----	X102	----	✓	----	----	----	----	----	✓	----	12-318	11	----	----	----	23.
24	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	10.
Analyst		----	A	F	A	F	----	----	H	----	H	----	----	H	H	----	C	H	S	C,A	----	----	----	
Comments		MLD~170 m; no POC sampling																						

SITE	near PAP central
Comments	shallow cast PAP1 near HYBIS, pre dep SBE 16503, 21549, 9469, 3757- 616, 6911, 609; * 3x10 mins stops

Cruise number	DY130
Station ID	DY130_019
Cast number	002
Sea floor depth (m)	4830
Cast depth (m)	100
Event number	019

Niskin No	Depth (m)	Bottle No.	O_2bottle Rep 1	O_2Temp. Rep 1	O_2bottle Rep 1	O_2Temp. Rep 2	O_2bottle Rep 3	O_2Temp. Rep 3	DIC/TA Rep 1	DIC/TA. Rep 2	^{13}C DIC x2 REPS	TOC EXPORTS	DOC EXPORTS	TOC PAP	DOC PAP	Nutrients EXPORT	Nutrients PAP	δ^{13}C DOC x 2 REPS	SALTS Crate-bottle	FILL 5L carboy	FILL 5L carboy	Fill 2L bottle	Fill 2L HPLC bottle	
1	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1.
2	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	2.
3	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	3.
4	100	1	11.2	1098	11.3	1081	----	----	✓	----	✓	----	----	✓	✓	----	✓*	✓	12-319	✓	----	----	----	4. nitrile gloves for NUTS
5	75	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	5.
6	75	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	6.
7	75	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	7.
8	75	2	11.4	1095	11.4	1082	----	----	✓	----	✓	----	----	✓	✓	----	✓	✓	12-320	✓	----	----	----	8.
9	50	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	9.
10	50	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	10.

11	50	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	11.
12	50	3	11.5	1091	11.5	1093	----	----	✓	----	✓	----	----	✓	✓	----	✓	✓	12-321	✓	----	----	----	
13	25	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
14	25	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
15	25	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
16	25	4	11.6	1085	11.6	1080	----	----	✓	----	✓	----	----	✓	✓	----	✓	✓	12-322	✓	----	----	----	
17	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
18	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
19	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
20	10	5	11.6	1079	11.6	1077	----	----	✓	----	✓	----	----	✓	✓	----	✓	✓	12-323	✓	----	----	----	
21	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
22	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
23	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
24	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Analyst		----	A	F	A	F	----	----	H	----	H	----	----	H	H	----	C	H	S	C,A	----	----	----	
Comments																								

SITE	near PAP1
Comments	PAP3 pre-deployment microcats cal * microcats at 4750m, 2500m, 300m (redo SN 12463, cal 12455 for PAP3)

Cruise number	DY130
Station ID	DY130_021
Cast number	003
Sea floor depth (m)	4836
Cast depth (m)	4750
Event number	021

Niskin No	Depth (m)	Bottle No.	O_2 bottle Rep 1	O_2 Temp. Rep 1	O_2 bottle Rep 1	O_2 Temp. Rep 2	O_2 bottle Rep 3	O_2 Temp. Rep 3	DIC/TA Rep 1	DIC/TA Rep 2	δ^{13}C DIC x2	TOC EXPORTS	DOC EXPORTS	TOC PAP	DOC PAP	Nutrients EXPORT	Nutrients PAP	δ^{13}C DOC X 2 REPS	SALTS Crate-bottle	FILL 5L carboy	FILL 5L carboy	Fill 2L bottle	Fill 2L HPLC bottle
1	4750	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1	----	----	----
2	4750	1	1084	5.5	1090	5.8	1088	5.5	✓	✓	✓✓	----	----	✓	✓	----	✓	✓✓	12-324	----	----	----	----
3	3000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	2	11	----	----
4	3000	2	1075	5.1	----	----	----	----	✓	----	✓✓	----	----	✓	✓	----	✓	✓✓	12-325	----	----	----	----
5	2500	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	3	----	----	----
6	2500	3	1076	5.4	----	----	----	----	✓	----	✓✓	----	----	✓	✓	----	✓	✓✓	12-326	----	----	----	----
7	1800	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	4	----	----	----
8	1800	4	1096	5.8	1087	6.0	1092	6.4	✓	----	✓✓	----	----	✓	✓	----	✓	✓✓	12-327	----	----	----	----
9	1000 MISFIRE	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
10	1000	5	1097	8.3	----	----	----	----	✓	----	✓✓	----	----	✓	✓	----	✓	✓✓	12-328	5	----	----	----

11	800	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	6	----	----	----
12	800	6	1089	9.0	----	----	----	----	✓	----	✓✓	----	----	✓	✓	----	✓	✓✓	12-329	----	----	----	----
13	300	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	7	----	----	----
14	300	7	1088	10.7	1078	10.7	48	10.7	✓	✓	✓✓	----	----	✓	✓	----	✓	✓✓	12-330	----	----	----	----
15	50	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	8	----	----	----
16	50	8	55	11.3	----	----	----	----	✓	----	✓✓	----	----	✓	✓	----	✓	✓✓	12-331	----	----	----	----
17	30	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	9	14	----	----
18	30	9	76	11.3	----	----	----	----	✓	----	✓✓	----	----	✓	✓	----	✓	✓✓	16-404	----	----	----	----
19	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	10	----	----	----
20	10	10	42	11.5	----	----	----	----	✓	----	✓✓	----	----	✓	✓	----	✓	✓✓	16-405	----	----	----	----
21	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
22	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
23	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
24	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Analyst		A	F	A	F	A	F	H	H	H	H	----	----	A	H	----	A	H	S	A	----	----	----
Comments		water for filtering was collected from odd Niskins																					

SITE	PAP1
Comments	validation cast for post pap1 (no extra instruments)

Cruise number	DY130
Station ID	DY130_027
Cast number	004
Sea floor depth (m)	4841
Cast depth (m)	200
Event number	027

Niskin No	Depth (m)	Bottle No.	O_2bottle Rep 1	O_2Temp. Rep 1	O_2bottle Rep 1	O_2Temp. Rep 2	O_2bottle Rep 3	O_2Temp. Rep 3	DIC/TA Rep 1	DIC/TA Rep 2	δ^{13}C DIC x2	TOC EXPORTS	DOC EXPORTS	TOC PAP	DOC PAP	Nutrients EXPORT	Nutrients PAP	δ^{13}C DOC X2 REPS	SALTS Crate-bottle	FILL 5L carboy	FILL 5L carboy	Fill 2L bottle	Fill 2L HPLC bottle
1	200	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
2	200	1	1098	11.1	1081	10.8	----	----	----	----	----	----	----	----	----	----	✓	----	16-406	1	----	----	----
3	200	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
4	200	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
5	200	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
6	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
7	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
8	100	2	1095	10.0	1082	11.1	----	----	----	----	----	----	----	----	----	----	✓	----	16-407	2	----	----	----
9	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
10	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
11	30	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

12	30	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
13	30	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
14	30	3	1091	11.2	1093	11.6	----	----	----	----	----	----	----	----	----	----	----	✓	----	16-408	3	----	----	----
15	30	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
16	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
17	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
18	10	4	1085	11.3	1080	11.3	----	----	----	----	----	----	----	----	----	----	✓	----	16-409	4	----	----	----	----
19	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
20	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
21	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
22	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
23	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
24	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Analyst		----	A	C	A	C	----	----	----	----	----	----	----	----	----	----	A	----	C	C	----	----	----	
Comments	Filtering for POC and Chl																							

SITE	
Comments	SG219 cal cast. Very close ctd 0.5m/s, 2 min stops

Cruise number	DY130
Station ID	DY130_032
Cast number	005
Sea floor depth (m)	4811
Cast depth (m)	1000
Event number	032

Niskin No	Depth (m)	Bottle No.	O_2bottle Rep 1	O_2Temp. Rep 1	O_2bottle Rep 2	O_2Temp. Rep 2	O_2bottle Rep 3	O_2Temp. Rep 3	DIC/TA Rep 1	DIC/TA. Rep 2	δ^{13}C DIC x2	TOC EXPORTS	DOC EXPORTS	TOC PAP	DOC PAP	Nutrients EXPORT	Nutrients PAP	δ^{13}C DOC X 2 REPS	SALTS Crate-bottle	FILL 5L carboy	FILL 5L carboy	Fill 2L bottle	Fill 2L HPLC bottle	
1	1000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1. Andy M. sample
2	1000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	2.
3	1000	1	1077	8	1083	8.3	1084	8.4	X090	X097	✓✓	✓	✓	✓	✓	✓	✓	✓✓	16-410	1	----	✓	2	3.
4	900	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	4. MISFIRE
5	900	2	1090	8.5	----	----	----	----	✓	----	✓✓	✓	✓	✓	✓	✓	✓	✓✓	16-411	2	----	✓	2	5.
6	800	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	6.
7	800	3	1075	9.2	----	----	----	----	✓	----	✓✓	✓	✓	✓	✓	✓	✓	✓✓	16-412	3	----	✓	3	7.
8	500	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	11	----		8. Andy M. sample
9	500	4	1076	10.6	1096	10.7	1087	10.6	✓	----	✓✓	✓	✓	✓	✓	✓	✓	✓✓	16-413	4	----	✓		9.
10	250	5	1097	11.1	----	----	----	----	✓	----	✓✓	✓	✓	✓	✓	✓	✓	✓✓	16-414	5	----	✓		10. Only 1 bottle @250m

11	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		11.
12	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
13	100	6	1092	11.2	----	----	----	----	✓	----	✓✓	✓	✓	✓	✓	✓	✓	✓	✓✓	16-415	6	----	✓	
14	70	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
15	70	7	1089	11.4	----	----	----	----	✓	----	✓✓	✓	✓	✓	✓	✓	✓	✓	✓✓	16-416	7	----	✓	
16	50	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
17	50	8	1088	11.5	----	----	----	----	✓	----	✓✓	✓	✓	✓	✓	✓	✓	✓	✓✓	16-417	8	----	✓	
18	30	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
19	30	9	1078	11.5	----	----	----	----	✓	----	✓✓	✓	✓	✓	✓	✓	✓	✓	✓✓	16-418	9	NaN	✓	
20	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
21	10	10	1079	11.6	----	----	----	----	X074	----	✓✓	✓	✓	✓	✓	✓	✓	✓	✓✓	16-419	10	----	✓	
22	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
23	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
24	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	
Analyst		A,S	F	A,S	F	A,S	F	H	H	H	H	A	H	A	H	C,A	A	H	S	C,S	C,S	C,S		
Comments																								

SITE	PAP1
Comments	

Cruise number	DY130
Station ID	DY130_045
Cast number	006
Sea floor depth (m)	4811
Cast depth (m)	200
Event number	045

Niskin No	Depth (m)	Bottle No.	O_2bottle Rep 1	O_2Temp. Rep 1	O_2bottle Rep 1	O_2Temp. Rep 2	O_2bottle Rep 3	O_2Temp. Rep 3	DIC/TA Rep 1	DIC/TA Rep 2	δ^{13}C DIC x2	TOC EXPORTS	DOC EXPORTS	TOC PAP	DOC PAP	Nutrients EXPORT	Nutrients PAP	δ^{13}C DOC X2 REPS	SALTS Crate-bottle	FILL 5L carboy	FILL 5L carboy	Fill 2L bottle	Fill 2L HPLC bottle
1	200	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
2	200	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
3	200	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
4	200	1	1098	11.1	1081	10.8	----	----	X080	X076	✓✓	----	----	----	----	----	✓	✓✓	16-420	1	----	----	----
5	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
6	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
7	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
8	100	2	1095	10.8	1082	10.9	----	----	XO6	----	✓✓	----	----	----	----	----	✓	✓✓	16-421	2	----	----	----
9	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
10	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
11	30	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

12	30	3	1098	11.1	1081	10.8	----	----	X077	----	✓✓	----	----	----	----	----	✓	✓✓	16-422	3	----	----	----
13	30	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
14	30	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
15	30	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
16	10	4	1098	11.1	1081	10.8	----	----	X068	----	✓✓	----	----	----	----	----	✓	✓✓	16-423	4	----	----	----
17	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
18	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
19	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
20	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
21	10	5	1098	11.1	1081	10.8	----	----	X073	----	✓✓	----	----	----	----	----	✓	✓✓	16-424	5	----	----	----
22	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
23	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
24	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Analyst		----					----	----		----		----	----	----	----	----					----	----	----	
Comments																								

SITE	
Comments	Slocum unit-305 glider cal cast

Cruise number	DY130
Station ID	DY130_046
Cast number	007
Sea floor depth (m)	4809
Cast depth (m)	1000
Event number	046

Niskin No	Depth (m)	Bottle No.	O_2bottle Rep 1	O_2Temp. Rep 1	O_2bottle Rep 2	O_2Temp. Rep 2	O_2bottle Rep 3	O_2Temp. Rep 3	DIC/TA Rep 1	DIC/TA. Rep 2	δ^{13}C DIC x2	TOC EXPORTS	DOC EXPORTS	TOC PAP	DOC PAP	Nutrients EXPORT	Nutrients PAP	δ^{13}C DOC X 2 REPS	SALTS Crate-bottle	FILL 5L carboy	FILL 5L carboy	Fill 2L bottle	Fill 2L HPLC bottle
1	800	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
2	800	1	1084	9.1	1090	9.2	1075	9.3	X075	X067	✓✓	----	----	✓	✓	✓	✓	✓✓	16-425	1	----	1	1
3	600	2	1092	10.2	----	----	----	----	✓	----	✓✓	✓	✓	✓	✓	✓	✓	✓✓	----	2	----	2	2
4	600 MISFIRE	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
5	400	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	11	----	----
6	400	3	1096	10.6	1087	10.6	1092	10.6	X063	----	✓✓	✓	✓	✓	✓	✓	✓	✓✓	16-426	3	----	3	3
7	250	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
8	250	4	1097	10.8	----	----	----	----	X072	----	✓✓	✓	✓	✓	✓	✓	✓	✓✓	16-427	4	----	4	4
9	150	5	1089	10.9	----	----	----	----	✓	----	✓✓	✓	✓	✓	✓	✓	✓	✓✓	----	5	----	5	5
10	150 MISFIRE	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----

11	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
12	100	6	1088	11.0	----	----	----	----	X071	----	✓✓	✓	✓	✓	✓	✓	✓	✓✓	30-740	6	----	6	6
13	70	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
14	70	7	1083	11.1	----	----	----	----	X100	----	✓✓	✓	✓	✓	✓	✓	✓	✓✓	30-741	7	----	7	7
15	40	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
16	40	8	1079	11.2	55	11.2	76	11.2	✓	----	✓✓	✓	✓	✓	✓	✓	✓	✓✓	30-742	8	----	8	8
17	20	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
18	20	9	42	11.2	----	----	----	----	✓	----	✓✓	✓	✓	✓	✓	✓	✓	✓✓	30-743	9	12	9	9
19	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
20	10	10	45	11.2	----	----	----	----	✓	----	✓✓	✓	✓	✓	✓	✓	✓	✓✓	30-744	10	----	10	10
21	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
22	removed	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
23	removed	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
24	removed	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Analyst		A	F	A	F	A	F	H,S	H	H,S	H	A	H	A	H	C	C	H	S	C,A	C,A	C,A	C,A
Comments																							

SITE	
Comments	SG237 glider cal cast upcast≠ downcast ~ 150-250 m

Cruise number	DY130
Station ID	DY130_053
Cast number	008
Sea floor depth (m)	4845
Cast depth (m)	1000
Event number	053

Niskin No	Depth (m)	Bottle No.	O_2bottle Rep 1	O_2Temp. Rep 1	O_2bottle Rep 2	O_2Temp. Rep 2	O_2bottle Rep 3	O_2Temp. Rep 3	DIC/TA Rep 1	DIC/TA. Rep 2	δ^{13}C DIC x2	TOC EXPORTS	DOC EXPORTS	TOC PAP	DOC PAP	Nutrients EXPORT	Nutrients PAP	δ^{13}C DOC X 2 REPS	SALTS Crate-bottle	FILL 5L carboy	FILL 5L carboy	Fill 2L bottle Fill 2L HPLC bottle	
1	825	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	30-745	----	----	----	1
2	825	1	1098	9.0	1081	9.1	1095	9.1	✓	✓	✓✓	----	----	----	----	✓	✓	✓✓	----	1	----	1	
3	600	2	1092	10.2	----	----	----	----	✓	✓	✓✓	----	----	----	----	✓	✓	✓✓	----	2	----	2	2
4	600 MISFIRE	----	1082	11.2	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
5	400	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
6	400	3	1091	10.8	1093	10.8	1085	10.8	✓	----	✓✓	----	----	----	----	✓	✓	✓✓	30-746	3	3	3	3
7	250	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
8	250	4	1080	11.0	1078	11	1077	11	✓	----	✓✓	----	----	----	----	✓	✓	✓✓	30-747	4	----	4	4
9	150	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
10	150	5	1084	11.0	----	----	----	----	✓	----	✓✓	----	----	----	----	✓	✓	✓✓	30-748	5	----	5	5

11	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
12	100	6	1090	11.1	----	----	----	----	✓	----	✓✓	----	----	----	----	✓	✓	✓✓	30-749	6	----	6	6
13	70	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
14	70	7	1075	11.3	----	----	----	----	✓	----	✓✓	----	----	----	----	✓	✓	✓✓	30-750	7	----	7	7
15	50	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
16	50	8	1076	11.6	----	----	----	----	✓	----	✓✓	----	----	----	----	✓	✓	✓✓	30-751	8	----	8	8
17	30	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
18	30	9	1096	11.6	----	----	----	----	✓	----	✓✓	----	----	----	----	✓	✓	✓✓	30-752	9	----	9	9
19	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
20	10	10	1087	11.6	----	----	----	----	✓	----	✓✓	----	----	----	----	✓	✓	✓✓	30-753	10	----	10	10
21	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
22	removed	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
23	removed	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
24	removed	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Analyst			A	F	A	F	A	F	H,A	H	H,A	----	----	----	----	C	C	H	S	C,A	C,A	C,A	C,A
Comments																							

CTD deck sampling log

SITE	
Comments	deep cast

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

(List

Cruise number	DY130
Station ID	DY130_057
Cast number	009
Sea floor depth (m)	4810
Cast depth (m)	4750
Event number	057

Date (UTC)	06/04/2021		
Time in (UTC)	06:50		
Time out (UTC)	10:30		
Latitude	48 56.126 N		
Longitude	16 26.55 W		
Titanium cast		**Stainless steel cast**	X

Niskin No	Depth (m)	Bottle No.	O_2bottle Rep 1	O_2Temp. Rep 1	O_2bottle Rep 2	O_2Temp. Rep 2	DIC/TA Rep 1	DIC/TA. Rep 2	δ^{13}C DIC x2	TOC EXPORTS	DOC EXPORTS	TOC PAP	DOC PAP	Nutrients EXPORT	Nutrients PAP	δ^{13}C DOC X 2 REPS	SALTS Crate-bottle	FILL 5L carboy	FILL 5L carboy	Fill 2L bottle	Fill 2L HPLC bottle	Comments
1	4750	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1.
2	4750	1	1098	4.3	1081	4.6	✓	✓	✓✓	----	----	✓	✓	----	✓	✓✓	30-754	1	----	1	1	2.
3	3000	2	1095	4.5	1082	5.1	✓	----	✓✓	----	----	✓	✓	----	✓	✓✓	----	2	----	2	2	3.
4	3000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	4. MISFIRE
5	2500	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	5.
6	2500	3	1091	4.9	----	----	✓	✓	✓✓	----	----	----	----	----	✓	✓✓	30-755	3	----	3	3	6. *oxygen bottle 1091
7	1800	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	7.
8	1800	4	1093	5.4	----	----	✓	----	✓✓	----	----	✓	✓	----	✓	✓✓	30-756	4	----	4	4	8.
9	800	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	9.
10	800	5	1085	8.7	----	----	✓	----	✓✓	----	----	----	----	----	✓	✓✓	30-757	5	----	5	5	10.
11	750	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	11.

12	750	6	1080	9.3	----	----	✓	----	✓✓	----	----	✓	✓	----	✓	✓✓	30-758	6	----	6	6	12.
13	450	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	13.
14	450	7	1078	10.6	----	----	✓	----	✓✓	----	----	----	----	----	✓	✓✓	30-759	7	----	7	7	14.
15	200	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	15.
16	200	8	1077	11.1	1084	11	✓	----	✓✓	----	----	✓	✓	----	✓	✓✓	30-760	8	----	8	8	16.
17	50	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	17.
18	50	9	1090	11.3	----	----	✓	----	✓✓	----	----	----	----	----	✓	✓✓	30-761	9	----	9	9	18.
19	30	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	19.
20	30	10	1075	11.3	----	----	✓	----	✓✓	----	----	✓	✓	----	✓	✓✓	30-762	10	----	10	10	20.
21	10	11	1076	11	----	----	✓	----	✓✓	----	----	----	----	----	✓	✓✓	30-763	11	12	----	11	21.
22	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	22. niskin removed
23	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	23. niskin removed
24	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	24. niskin removed
Analyst			A	F	A	F	H,A	H	H	----	----	A	H	----	C	H	C,S	C,A,S	C,A,S	C,A,S	C,A,S	
Comments	* chemicals outside cap O2 bottle 1091 (R1); filtering for PAP: POC, PIC, Bsi, chl; new thermometer for oxy sampling																					

SITE	
Comments	deep cast, nice sunrise this morning. SBE37 cal dip microcat PAP3 10 min stops @3000, 2500, 750m post pap3 sbe12462 (cal fail). Some winch issues

Cruise number	DY130
Station ID	DY130_065
Cast number	010
Sea floor depth (m)	4809
Cast depth (m)	4750
Event number	065

Niskin No	Depth (m)	Bottle No.	O_2bottle Rep 1	O_2Temp. Rep 1	O_2bottle Rep 2	O_2Temp. Rep 2	O_2bottle Rep 3	O_2Temp. Rep 3	DIC/TA Rep 1	DIC/TA. Rep 2	δ^{13}C DIC x2	TOC EXPORTS	DOC EXPORTS	TOC PAP	DOC PAP	Nutrients EXPORT	Nutrients PAP	δ^{13}C DOC X2 REPS	SALTS Crate-bottle	FILL 5L carboy	FILL 5L carboy	Fill 2L bottle	Fill 2L HPLC bottle
1	4750	----	1082	5.6	1091	5.9	----	----	✓	----	✓✓	----	----	----	----	----	✓	----	29-716	----	----	----	----
2	4750 MISFIRE	1	1098	6.4	1081	6.4	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
3	3000	2	1095	5.7	----	----	----	----	----	----	----	----	----	----	----	----	----	----	29-717	----	----	----	----
4	3000 MISFIRE	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
5	2500	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
6	2500	3	1093	5.9	----	----	----	----	✓	----	✓✓	----	----	----	----	----	✓	?	29-718	?	----	----	----
7	1800	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----✓	----	----	----	----	----	----
8	1800	4	1085	6.2	----	----	----	----	✓	?	✓✓	----	----	----	----	----	✓	?	29-719	?	----	----	----
9	800	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----✓	----	----	----	----	----	----

10	800	5	1080	9.1	----	----	----	----	✓	----	✓✓	----	----	----	----	----	✓	?	29-720	?	----	----	----
11	750	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----✓	----	----	----	----	----	----
12	750	6	1078	9.5	1077	9.6	----	----	✓	?	✓✓	----	----	----	----	----	✓	?	29-721	?	----	----	----
13	450	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----✓	----	----	----	----	----	----
14	450	7	1084	10.6	1090	10.6	----	----	✓	----	✓✓	----	----	----	----	----	✓	?	29-722	?	----	----	----
15	200	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----✓	----	----	----	----	----	----
16	200	8	1075	11.1	----	----	----	----	✓	----	✓✓	----	----	----	----	----	✓	?	29-723	?	----	----	----
17	50	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----✓	----	----	----	----	----	----
18	50	9	1076	11.3	----	----	----	----	✓	----	✓✓	----	----	----	----	----	✓	?	29-724	?	----	----	----
19	30	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----✓	----	----	----	----	----	----
20	30	10	1096	11.3	----	----	----	----	✓	----	✓✓	----	----	----	----	----	✓	?	29-725	?	----	----	----
21	10	11	1087	11.3	----	----	----	----	✓	----	✓✓	----	----	----	----	----	✓	?	29-726	?	----	----	----
22	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----✓	----	----	----	----	----	----
23	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
24	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Analyst																							
Comments																							

SITE	
Comments	no AHC (Active Heave Compensation); PAP3 microcat

Cruise number	DY130
Station ID	DY130_068
Cast number	011
Sea floor depth (m)	4808
Cast depth (m)	4750
Event number	068

Niskin No	Depth (m)	Bottle No.	O_2bottle Rep 1	O_2Temp. Rep 1	O_2bottle Rep 2	O_2Temp. Rep 2	O_2bottle Rep 3	O_2Temp. Rep 3	DIC/TA Rep 1	DIC/TA. Rep 2	δ^{13}C DIC x2	TOC EXPORTS	DOC EXPORTS	TOC PAP	DOC PAP	Nutrients EXPORT	Nutrients PAP	δ^{13}C DOC X 2 REPS	SALTS Crate-bottle	FILL 5L carboy	FILL 5L carboy	Fill 2L bottle	Fill 2L HPLC bottle
1	4750	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
2	4750	1	1098	4.6	1081	4.9	----	----	✓	----	✓✓	----	----	----	----	----	✓	✓✓	29-727	1	----	----	1
3	3500	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
4	3500	2	1095	4.7	----	----	----	----	✓	----	✓✓	----	----	----	----	----	✓	✓✓	29-728	2	----	----	2
5	3000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
6	3000	3	1082	4.9	----	----	----	----	✓	----	✓✓	----	----	----	----	----	✓	✓✓	29-729	3	----	----	3
7	2000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
8	2000	4	1091	5.3	1093	5.5	----	----	✓	✓	✓✓	----	----	----	----	----	✓	✓✓	29-730	4	----	----	4
9	1500	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
10	1500	5	1085	5.8	----	----	----	----	✓	----	✓✓	----	----	----	----	----	✓	✓✓	29-731	5	----	----	5

11	825	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
12	825	6	1080	9.2	----	----	----	----	✓	----	✓✓	----	----	----	----	----	✓	✓✓	29-732	6	----	----	6
13	400	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
14	400	7	1078	10.8	----	----	----	----	✓	----	✓✓	----	----	----	----	----	✓	✓✓	29-733	7	----	----	7
15	120	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
16	120	8	1077	11.4	----	----	----	----	✓	?	✓✓	----	----	----	----	----	✓	✓✓	29-734	8	----	----	8
17	90	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
18	90	9	1084	11.5	1090	11.5	----	----	✓	----	✓✓	----	----	----	----	----	✓	✓✓	29-735	9	----	----	9
19	75	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
20	75	10	1075	11.5	----	----	----	----	✓	----	✓✓	----	----	----	----	----	✓	✓✓	29-736	10	----	----	10
21	30	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
22	30	11	1076	11.5	----	----	----	----	✓	----	✓✓	----	----	----	----	----	✓	✓✓	29-737	11	----	----	11
23	10	12	1096	11.5	----	----	----	----	✓	----	✓✓	----	----	----	----	----	✓	✓✓	29-738	12	----	----	12
24	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Analyst									H,A	H,A	H,A						C		C				
Comments	Bottle 22. 29-739																						

SITE	PAP1
Comments	pre cal cast for PAP1 (very near buoy)

Cruise number	DY130
Station ID	DY130_071
Cast number	012
Sea floor depth (m)	4809
Cast depth (m)	200
Event number	071

Niskin No	Depth (m)	Bottle No.	O_2bottle Rep 1	O_2Temp. Rep 1	O_2bottle Rep 2	O_2Temp. Rep 2	O_2bottle Rep 3	O_2Temp. Rep 3	DIC/TA Rep 1	DIC/TA. Rep 2	δ^{13}C DIC x2	TOC EXPORTS	DOC EXPORTS	TOC PAP	DOC PAP	Nutrients EXPORT	Nutrients PAP	δ^{13}C DOC X 2 REPS	SALTS Crate-bottle	FILL 5L carboy	FILL 5L carboy	Fill 2L bottle	Fill 2L HPLC bottle
1	200	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
2	200	1	40	11.6	----	----	----	----	✓	----	✓✓	----	----	----	----	----	✓	✓✓	42-1028		----	----	----
3	200	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
4	200	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
5	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
6	100	2	42	11.8	94	11.8	92	11.8	✓	----	✓✓	----	----	----	----	----	✓	✓✓	42-1029		----	----	----
7	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
8	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
9	75	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
10	75	3	120	11.8	----	----	----	----	✓	----	✓✓	----	----	----	----	----	✓	✓✓	42-1030		----	----	----

11	75	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
12	75	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
13	30	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
14	30	4	118	11.8	117	11.8	----	----	✓		✓✓	----	----	----	----	----	✓	✓✓	42-1031		----	----	----
15	30	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
16	30	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
17	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
18	10	5	111	11.9	----	----	----	----	✓	----	✓✓	----	----	----	----	----	✓	✓✓	42-1032		----	----	----
19	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
20	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
21	5	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
22	5	6	110	11.9	----	----	----	----	✓	----	✓✓	----	----	----	----	----	✓	✓✓	42-1033		----	----	----
23	5	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
24	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Analyst			A	F	A	F	A	F	H		H						C	H	S				
Comments																							

SITE	
Comments	Alkalinity cal deep cast

Cruise number	DY130
Station ID	DY130_076
Cast number	013
Sea floor depth (m)	4809
Cast depth (m)	4000
Event number	076

Niskin No	Depth (m)	Bottle No.	O_2bottle Rep 1	O_2Temp. Rep 1	O_2bottle Rep 2	O_2Temp. Rep 2	O_2bottle Rep 3	O_2Temp. Rep 3	DIC/TA Rep 1	DIC/TA. Rep 2	δ^{13}C DIC x2	TOC EXPORTS	DOC EXPORTS	TOC PAP	DOC PAP	Nutrients EXPORT	Nutrients PAP	δ^{13}C DOC X2 REPS	SALTS Crate-bottle	FILL 5L carboy	FILL 5L carboy	Fill 2L bottle	Fill 2L HPLC bottle	
1	4000	----	----	----	----	----	----	----	AF-42		----	----	----	----	----	----	----	----	----	----	----	----	----	1. 5 bottles
2	4000	----	----	----	----	----	----	----	AF-42		----	----	----	----	----	----	----	----	----	----	----	----	----	2. 5 bottles
3	4000	----	----	----	----	----	----	----	AF-42		----	----	----	----	----	----	----	----	----	----	----	----	----	3. 5 bottles
4	4000	----	----	----	----	----	----	----	AF-42		----	----	----	----	----	----	----	----	----	----	----	----	----	4. 5 bottles
5	4000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	5.	
6	4000	----	----	----	----	----	----	----	AF-32		----	----	----	----	----	----	----	----	----	----	----	----	----	6. 10 bottles
7	4000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	7.	
8	4000	----	----	----	----	----	----	----	AF-32		----	----	----	----	----	----	----	----	----	----	----	----	----	8. 10 bottles
9	4000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	9.	
10	4000	----	----	----	----	----	----	----	AF-40		----	----	----	----	----	----	----	----	----	----	----	----	----	10. 10 bottles

11	4000	----	----	----	----	----	----	----	AF-40		----	----	----	----	----	----	----	----	----	----	----	----	----	----	11. 10 bottles
12	4000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	12.	
13	4000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	13.	
14	4000	----	----	----	----	----	----	----	AF-39		----	----	----	----	----	----	----	----	----	----	----	----	----	----	14. 10 bottles
15	4000	----	----	----	----	----	----	----	AF-39		----	----	----	----	----	----	----	----	----	----	----	----	----	----	15. 10 bottles
16	4000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	.	16.
17	4000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	.	17. MISFIRE
18	4000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	.	18.
19	4000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	.	19.
20	4000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		20.
21	4000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		21.
22	4000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----		
23	4000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	23.	
24	4000	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	24.	
Analyst																									
Comments	AF-42: Hashan; AF-32: Filipa; AF-40: Anita; AF-39: Corinne																								

SITE	centre of eddy 'A2'
Comments	Slocum SL-305 cal cast at the core of the eddy 'A2'

Cruise number	DY130
Station ID	DY130_080
Cast number	014
Sea floor depth (m)	4503
Cast depth (m)	1000
Event number	80

Niskin No	Depth (m)	Bottle No.	O_2 bottle Rep 1	O_2 Temp. Rep 1	O_2 bottle Rep 2	O_2 Temp. Rep 2	O_2 bottle Pickled Rep 1	O_2 Temp. Pickled Rep 1	O2 bottle Pickled Rep 2	O_2 Temp. Pickled Rep 2	DIC/TA Rep 1	DIC/TA Rep 2	δ^{13}C DIC x2	TOC EXPORTS	DOC EXPORTS	Nutrients EXPORT	Nutrients PAP	δ^{13}C DOC X 2 REPS	SALTS Crate-bottle	FILL 5L carboy	FILL 5L carboy	Fill 10L cubitainer	Fill 2L HPLC bottle	Comments
1	900	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	42-1034	----	----	1	----	1. T=9.8
2	900	1	1098	9.9	1081	9.9	A1	9.9	A2	9.9	✓	----	✓✓	✓	✓	✓	✓	✓✓	*	1	----	----	1	2.
3	500	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	42-1035	----	2	2	----	3.
4	500	2	1095	10.7	1082	10.8	A3	10.8	A4	10.8	✓	----	✓✓	✓	✓	✓	✓	✓✓	*	2	----	----	2	4.
5	400	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	42-1036	----	----	3	----	5.
6	400	3	1091	10.8	1093	10.9	A7	10.9	A9	10.9	✓	✓	✓✓	✓	✓	✓	✓	✓✓	*	3	----	----	3	6.
7	300	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	7. MISFIRE
8	300	4	1085	10.9	1080	----	----	----	----	----	✓	----	✓✓	✓	✓	✓	✓	✓✓	*	4	----	----	4	8. no Po/Pb at 300m
9	250	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	42-1037	----	----	5	----	9. T=10.6
10	250	5	1078	10.9	1077	----	A10	----	A11	----	✓	----	✓✓	✓	✓	✓	✓	✓✓	*	5	----	----	5	10.

11	150	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	42-1038	----	----	6	----	11. T=10.9
12	150	6	1084	11.1	1090	----	A12	----	A13	----	✓	----	✓✓	✓	✓	✓	✓	✓✓	*	6	----	----	6	12.
13	100	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	42-1039	----	----	7	----	13. T=11.1
14	100	7	1075	11.2	1076	----	A14	----	A15	----	✓	----	✓✓	✓	✓	✓	✓	✓✓	*	7	----	----	7	14.
15	75	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	42-1040	----	----	8	----	15. T=11.1
16	75	8	1096	11.2	1087	----	A16	----	A17	----	✓	----	✓✓	✓	✓	✓	✓	✓✓	*	8	----	----	8	16.
17	50	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	42-1041	----	----	9	----	17. T=11.2
18	50	9	1092	11.1	1097	----	----	----	----	----	✓	----	✓✓	✓	✓	✓	✓	✓✓	*	9	----	----	9	18.
19	30	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	42-1042	----	10	10	----	19. T=11.2
20	30	10	1089	11.1	1083	----	A18	----	A19	----	✓	----	✓✓	✓	✓	✓	✓	✓✓	*	10	----	----	10	20.
21	10	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	11	----	21. T=11
22	10	11	1088	11.2	1079	----	A20	----	A21	----	✓	----	✓✓	✓	✓	✓	✓	✓✓	----	11	----	----		22.
23	5	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	12		23.
24	5	12	55	11.3	76	-	A22	-	A23	-	✓	----	✓✓	✓	✓	✓	✓	✓✓	----	12	----	----		24.
Analyst		-	A	F	A	F	A	F	A	F	H	H	H	H	H,A	C	C	H,A						
Comments																								