National Oceanography Centre

Cruise Report No. 26

RRS *James Cook* Cruise 85
14 - 29 APR 2013

Porcupine Abyssal Plain: sustained ocean observation

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2014

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ABSTRACT

The oceanic water column and the underlying seabed change on a variety of temporal and spatial scales. The objective of the PAP observatory is to provide high temporal resolution (hours) 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 for over 20 years and during that time, substantial changes have been observed in the benthic 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 objective of the cruise was primarily to service the infrastructure required for continuous sustained observation, and to put these into context using observations from the ship which as yet cannot be carried out autonomously. In addition substantial sampling of the seabed was also a major objective.

KEYWORDS

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8	BENNETT	ALEXANDER	3/E
9	ULBRICHT	SEBASTIAN MARTIN	ETO
10	ROGERS	MARK ALAN	ETO
11	McDOUGALL	PAULA ANNE	PCO
12	HARRISON	MARTIN ANDREW	CPOS
13	ALLISON	PHILIP	CPOD
14	SMITH	PETER	CPO
15	GREGORY	NATHANIEL JAMES	SG1A
16	DEAL	RICHARD	SG1a
17	OSBORNE	ADAM VICTOR MURRAY	SG1A
18	HOPLEY	JOHN	SG1A
19	CONTEH	BRIAN	ERPO
20	HAUGHTON	JOHN	H/Chef
21	LINK	WALTER JOHN THOMAS	Chef
22	ROBINSON	PETER WAYNE	Stwd
23	PIPER	CARL	A/Stwd

1 Itinerary

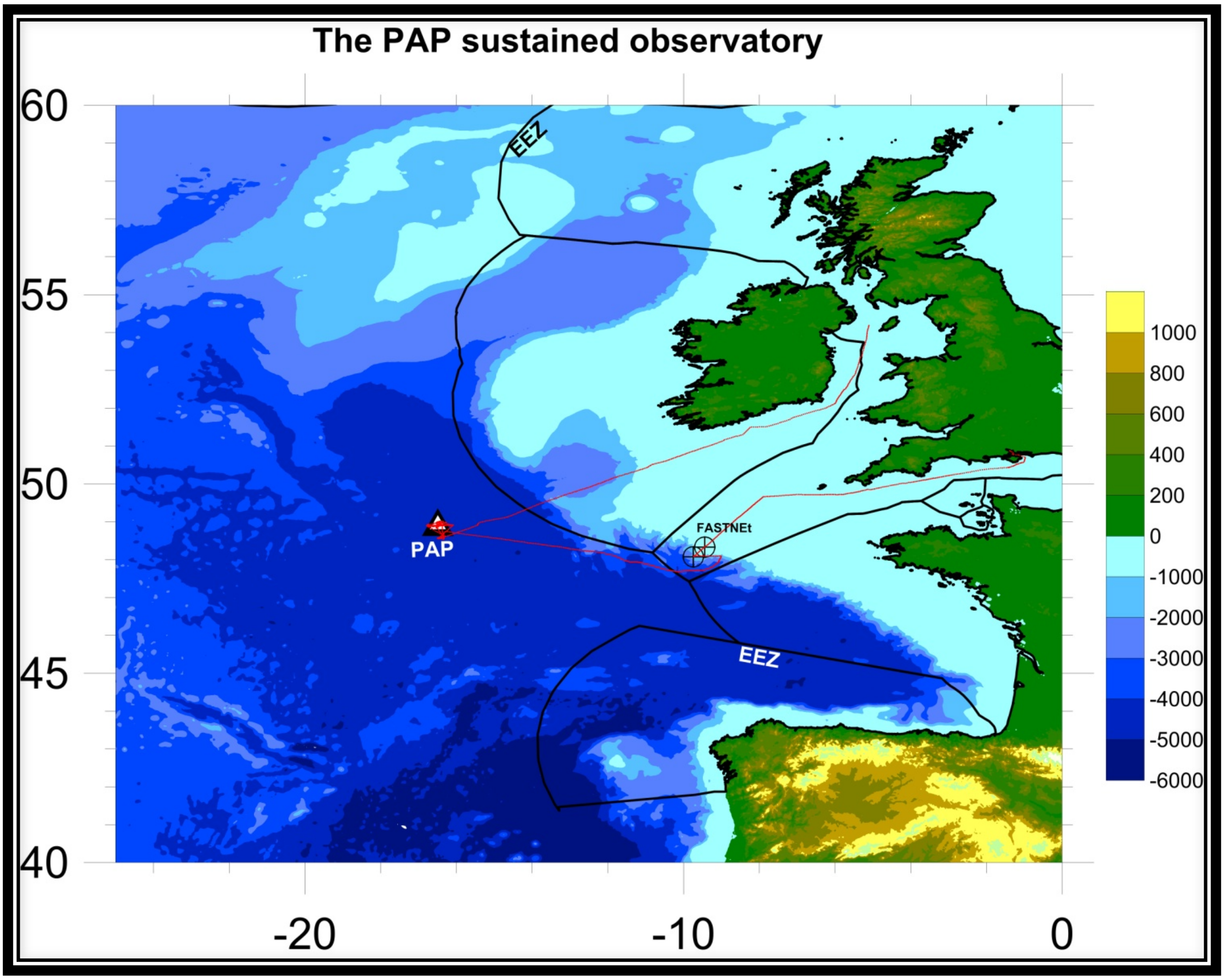


Figure 1: Cruise Track (red) and Exclusive Economic Zone Boundaries (black)

2 Background & Objectives

The oceanic water column and the underlying seabed change on a variety of temporal and spatial scales. The objective of the PAP observatory is to provide high temporal resolution (hours) 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 for over 20 years and during that time, substantial changes have been observed in the benthic 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 objective of the cruise was primarily to service the infrastructure required for continuous sustained observation, and to put these into context using observations from the ship which as yet cannot be carried out autonomously. In addition substantial sampling of the seabed was also a major objective.

3 In situ Sensors and Samplers on PAP#1 Mooring

Thanos Gkritzalis, Jon Campbell, Corinne Pebody, Andrew Gravelle

3.1.1 Introduction

The PAP-SO deep ocean mooring sustains a sensor frame which is located at 30m below the surface and holds a number of sensors and instruments that are providing the data (near real time) for the observatory. One of the main objectives of JC085 was to recover the mooring and turn around (prepare, calibrate setup) the instruments that were deployed on JC071.

The main instruments deployed on JC071 are presented in the following table:

Sensor make/model	Serial no.
Seaguard	219
ISUS	269
ECO-FLNTUSB	238
Star Oddi DST-CTD	5771, 5772, 5774, 5777, 5778
SBE37-IMP IDO	09030
SBE37-IMP	6915
NAS 3x	2673
proOceanus pCO2	29-095-45
proOceanus GTD	29-100-15
Seafet pH Sensor	8
OCR-507ICSW	225
OCR-507R10W	102

Table 1: Main Instruments

3.1.2 PAP#1 Recovery

The mooring that was deployed in May 2012 during JC071 broke on 29/12/12 and when the surface ODAS buoy was recovered a few weeks later, it was evident that the sensors frame was detached from the buoy and had sunk. The mooring was equipped with a subsurface float with 0.9tn lifting capacity, located at approximately 1,200m from the surface, which indicates that the sensor frame would be located at approx. 2,000m. As most of the sensors on the frame are pressure rated to 1000m, it was very possible that most of them would be destroyed. However it was very important to locate the broken part of the mooring and if possible recover it.

The broken mooring was successfully located and recovered on 20/04/13. Upon retrieval of the sensor frame it was evident that all instruments that exceeded their pressure ratings were destroyed (see Figure 2). It is worth mentioning that the data and communication HUB that was on the frame was lost and its brackets were seriously damaged.

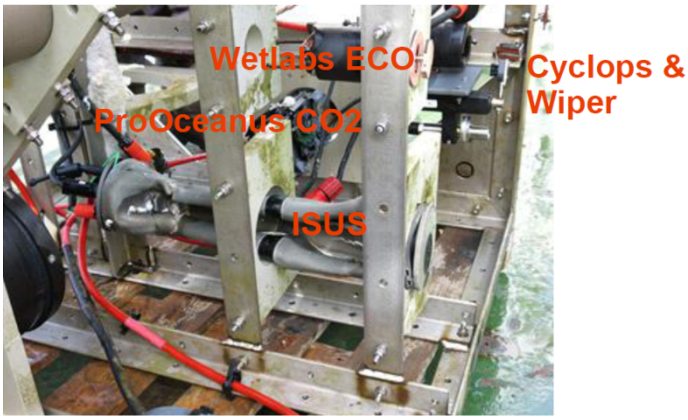


Figure 2: Recovered PAP#1 sensor frame, with some of the destroyed instruments

The instruments that survived and managed to provide data:

- Seabird Microcat SBE37-IMP DO
- Seabird Microcat SBE37-IMP
- McLane Zooplankton Sampler. The ZPS was damaged (mushroom dome missing, belt motor housing leaking oil, cables were damaged) but can be repaired and become functional.
- Satlantic Battery Pack (S/N 212) that was used to power the Satlantic Seafet pH sensor. The fact that the battery pack had survived is remarkable and strange as it was next to the ISUS Satlantic battery pack which is identical and was completely destroyed.

3.1.3 Preparation of Sensors

The sensors that were prepared for deployment on JC085 on the PAP#1 were:

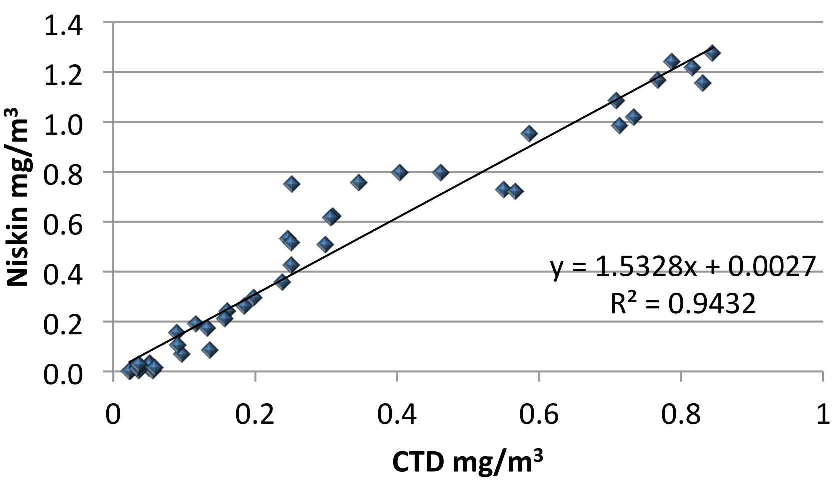
Sensor make/model	**Serial no.**	**Calibration cast**
Seaguard	217	CTD002
ISUS	59	CTD002
ECO-FLNTUSB	3050	CTD002
Star Oddi DST-CTD	6782, 6784, 6785, 6786, 6788, 6789, 6790, 6792	CTD002
SBE37-IMP ODO	10535	CTD003
SBE37-IMP	6912, 6909	CTD003
CYCLE-PO4	164	No
proOceanus pCO2	33-146-45	No
proOceanus GTD	33-152-16	No
Seafet pH Sensor	24	No
OCR-507ICSW	200	No
OCR-507R10W	095	No
Osmotic Sampler	N/A	No

Table 2: PAP#1 Sensors Deployed on JC085

3.1.4 CTD Calibration[1]

The sensors are calibrated against the ships CTD (Seabird 9+). The Seabird 9+ sensors for salinity, oxygen and chlorophyll fluorescence were calibrated against samples collected from the Niskin bottles. Oxygen and chlorophyll samples were analysed during the cruise, while the salinity samples were to be analysed during JC086. The samples were accidentally discarded during JC086.

The calibration of the CTD fluorescence and oxygen sensors are presented in Figure 3.



[1] Oxygen samples were collected and analysed by Umberto Binetti; Chorophyll samples were collected by Corinne Pebody and Andrew Gravelle and analysed by Thanos Gkritzalis.

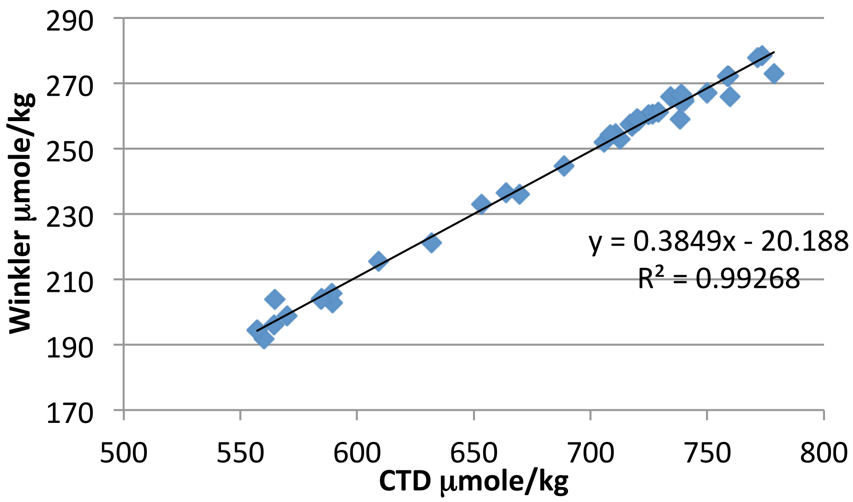


Figure 3: Calibration of CTD chlorophyl and oxygen sensors (for Chl-a measurements and calibration see file \\cookfs.cook.local\Public\JC085 Data\PAP_1_2_Data\Chla_measurements\Chla_measurements.xlsx)

3.1.5 Seaguard 217

The Seaguard 217 platform is equipped with the following sensors nodes:

- Oxygen optode 4330
- pCO2 optode, beta version of the sensors as this is not a commercially available sensor and AADI has kindly accepted to test the sensor at the PAP-SO
- Cyclops fluorometer
- DCS current meter

As shown on Table the Seaguard was deployed on CTD cast CTD002 in order to calibrate the two optodes and the fluorometer against the CTD parameters and manually collected DIC/TA samples.

The results from the calibration of the Cyclops fluorometer and the oxygen 4330 optode are presented in Figure 4 and Figure 5.

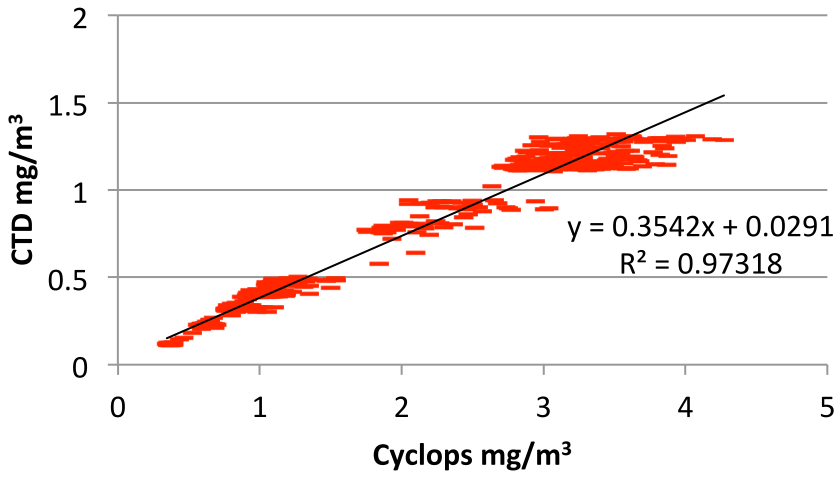


Figure 4: Cyclops Fluorometer Calibration

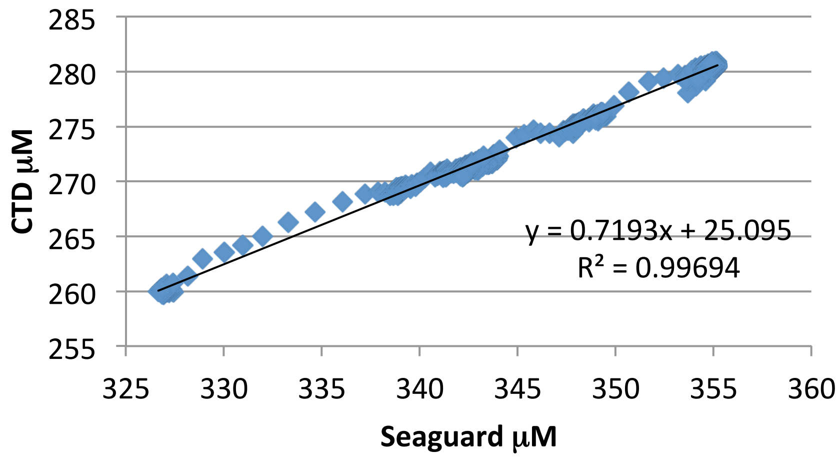


Figure 5: Optode 4330 Calibration

The pCO2 optode will be calibrated against values from DIC/TA samples that were collected from the Niskin bottles. The samples were collected by Thanos Gkritzalis and will be analysed in NOC (Vindta analyser). The pCO2 profile is illustrated in Figure 6.

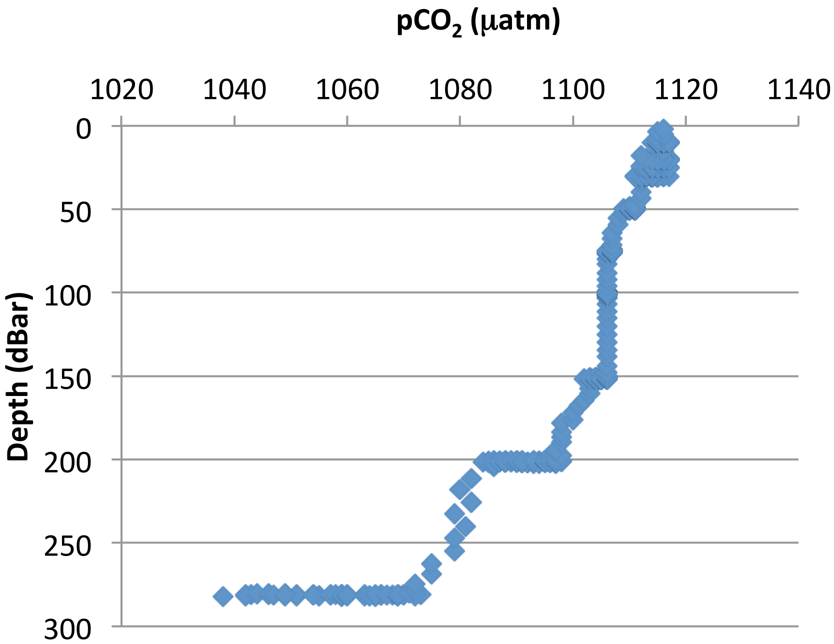


Figure 6: pCO_2 optode profile during CTD002

After the calibration CTD the Seaguard was set for deployment. A new set of lithium batteries was installed and the Seaguard was set to start measurements on 24/04/13, 18:50GMT with a 1 hour sampling frequency. The Cyclops Fluorometer was positioned on the Zebratech Wiper which was set to start at 24/04/2013, 16:46 GMT and will operate every 9 hours.

Since the new mooring was deployed the Seaguard is producing data from all its sensors.

3.1.6 ISUS Nitrate Sensor

The ISUS (S/N 59) UV nitrate sensor was deployed on cast CTD002 and it will be calibrated against Total Oxidised Nitrogen ($TON=NO_2 + NO_3$) values from the samples collected from the Niskin bottles.

Before the CTD deployments the ISUS was calibrated in the lab using the 1 point calibration method that is suggested by Satlantic. The nitrate profile produced from ISUS during the CTD002 cast is shown in Figure . The first impression from the profile is that the TON values are high (especially at the top 30m) and also the noise levels are high (±3 mM). After the calibration cast the ISUS was recalibrated using the 1 point calibration and was set for deployment on the mooring. The ISUS will produce 10 samples every 2 hours at 50 minutes past the hour. Since its deployment the ISUS is operating as expected.

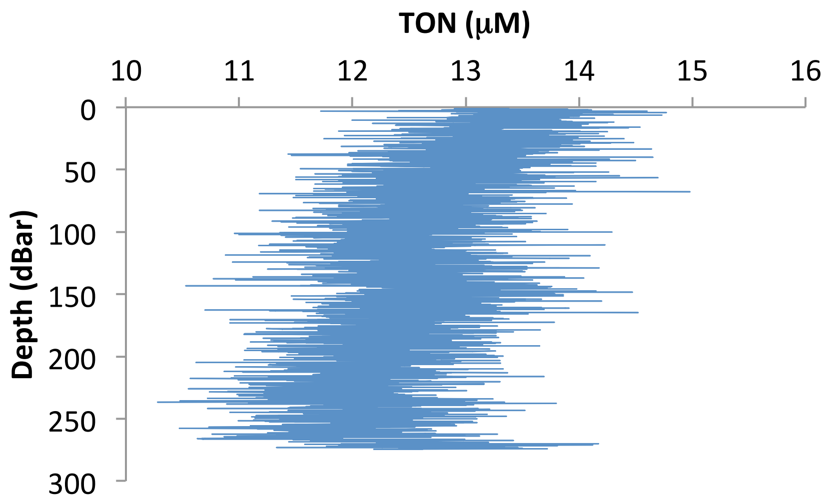


Figure 7: Profile of Total Oxidised Oxygen Obtained from ISUS 59 during CTD002 Cast

3.1.7 Wetlabs Fluorometer

ECO-FLNTUSB (S/N: 3050)

The ECO_FLNTUSB fluorometer was calibrated on CTD cast CTD002. The calibration results are presented in Figure 8.

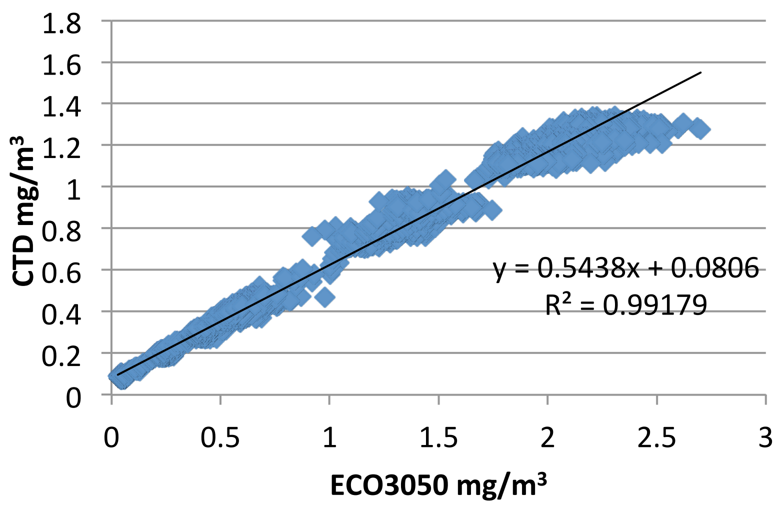


Figure 8: ECO-FLNTUSB 3050 Calibration

After the calibration the instrument was set up for the mooring deployment. The ECO will produce 8 measurements every 4 hours. The instrument started at 24/04/203, 16:25 GMT. Since it was deployed the ECO is performing as expected.

3.1.8 Star Oddi

The Star Oddi DST-CTD sensors (SN: 6782, 6784, 6785, 6786, 6788, 6789, 6790, 6792) were deployed on CTD cast CTD002 and calibrated against the Seabird 9+ CTD. They were set to sample every 10 sec and all of them were deployed at the same height on the CTD rosette frame. Andrew Gravelle performed a first calibration of the sensors. Some of the calibration results (differences between the SO and the CTD) are presented in Table 3.

	Median	Average	Min	Max	
6782	-76.4332	-75.9919	-80.5629	-68.1051	ΔP(SO-CTD) (dBar)
	-0.0036	-0.00573	-0.05114	0.0285	ΔT(SO-CTD) (^{o}C)
	-2.70081	-2.76777	-7.0295	-2.39658	ΔS(SO-CTD) (PSU)
6784	10.233	10.26523	4.719	13.436	ΔP(SO-CTD) (dBar)
	-0.0198	-0.01846	-0.0571	0.0602	ΔT(SO-CTD) (^{o}C)
	-3.4005	-3.51165	-9.0295	-3.2002	ΔS(SO-CTD) (PSU)
6785	-2.77	-2.62267	-8.905	6.02	ΔP(SO-CTD) (dBar)
	-0.027	-0.02281	-0.0681	0.0192	ΔT(SO-CTD) (^{o}C)
	-4.2989	-4.37888	-4.9851	-4.0295	ΔS(SO-CTD) (PSU)
6786	-3.504	-3.35376	-10.005	4.291	ΔP(SO-CTD) (dBar)
	-0.0288	-0.02799	-0.0791	0.0392	ΔT(SO-CTD) (^{o}C)
	-1.3005	-1.43697	-2.0856	-1.0295	ΔS(SO-CTD) (PSU)
6789	9.58	9.513193	2.112	17.195	ΔP(SO-CTD) (dBar)
	-0.0193	-0.0165	-0.0524	0.0273	ΔT(SO-CTD) (^{o}C)
	-2.8004	-2.91925	-3.5849	-2.5295	ΔS(SO-CTD) (PSU)
6790	6.399	6.674655	2.919	12.528	ΔP(SO-CTD) (dBar)
	-0.0278	-0.02922	-0.0692	0.0222	ΔT(SO-CTD) (^{o}C)
	-1.4994	-1.60645	-4.0295	-1.201	ΔS(SO-CTD) (PSU)

Table 3: Calibration Results of Star Oddis

The calibration data will be further analysed in NOC.

After the calibration cast the SO's were prepared for the mooring deployment. They were programmed to start at 24/04/2013 15:00GMT and sample every one hour. Since it was possible to recover approx. 200m of mooring line the SO were positioned at the following depths:

Nominal target depth (m)	Nominal depth below frame (m)
10	
20	
25	
40	10
55	25
70	40
120	90
220	190

Table 4: Depth of Deployment of the Star Oddi Temperature Loggers

3.1.9 Microcats

SBE37-IMP (S/N: 6909, 6912) and SBE37-IMP-ODO (S/N: 10535)

The SBE37 microcats were calibrated on CTD003. During calibration they sampled every 10 seconds and their data will be calibrated against the Seabird 9+ sensors. The data will be processed by Maureen Pagnani in NOC.

After calibration the microcats were prepared for the mooring deployment and the sampling frequency was set to 30 minutes.

Since their deployment on 24/04/2013 the microcats are producing near real time data, but the inductive link communication between the sensor frame and the surface buoy seems to be erratic.

3.1.10 Phosphate Sensor

Wetlabs CYCLE-PO_4 (S/N: 164)

The CYCLE-PO_4 in situ PO4 sensor will be deployed first time at the PAP site. The instruments response time and the pressure rating prevent it to be calibrated on a CTD, but the system was characterised in the lab.

The QC tests were performed using phosphate standards. The standards used were a 10 μM, 1 μM and 0.1 μM PO_4 standards. The performance of the instrument during the lab tests was very good and the accuracy and precision from this tests was similar to the one quoted by the manufacturer.

Results are presented in Figure .

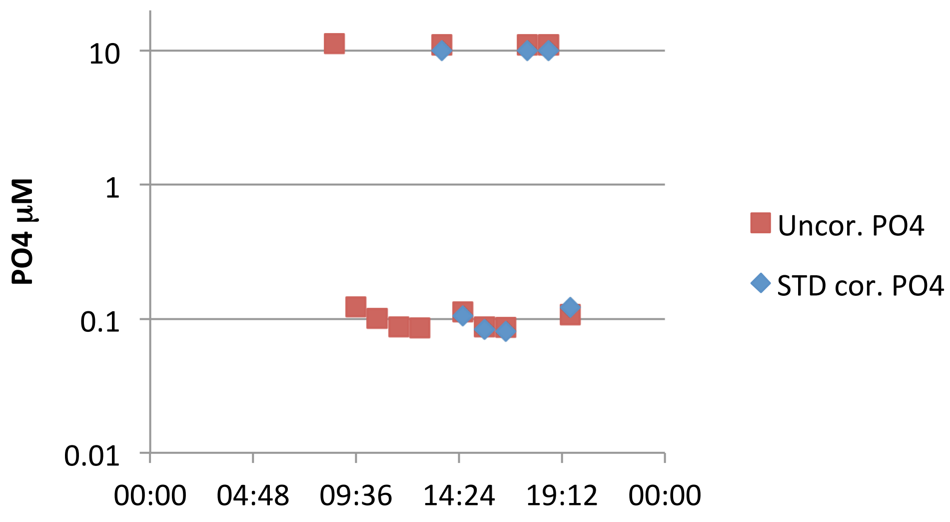


Figure 9: Lab Tests for QC of Cycle-PO4 In situ Sensor

The sensor was set up to start sampling at 24/04/2013 23:50 GMT (System prime was set to commence at 23:30 GMT the same day). The sampling frequency was set to 3 samples per day and a calibration internal standard will be analysed at every 12 samples. Since it was deployed the CYCLE is operating as expected.

3.1.11 Osmotic Sampler

The osmotic sampler was calibrated (Flow rate v. Temperature) in NOC in a temperature controlled water bath. The flow rate measurements are presented in the following table:

Temperature (°C)	Flow rate (ml/d)
8	1.00
10	1.15
12	1.19
16	1.36

Table 5: Flow Rate vs Temperature

The samples will be collected in a 500m, Ø 2mm i.d FEP tube that is filled with MQ water. Assuming an average temperature at the PAP site of 12°C (i.e. 1.19 ml/d flow rate → daily sample will occupy 1.5 m of the sampling tube), the sampler will collect samples for 330 days. The samples are preserved with a 2% HCl (analar) that is constantly injected via a mini osmotic pump that is working on reverse (HCl to sample ratio 1:12).

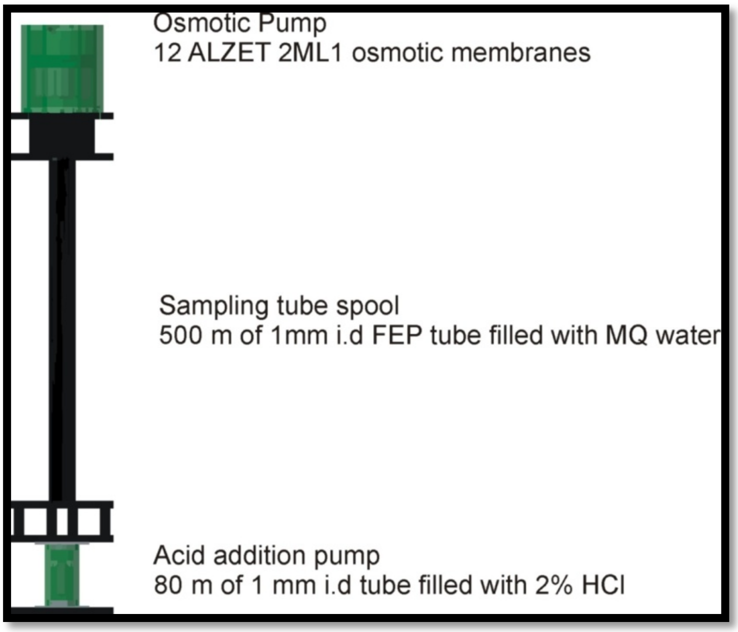


Figure 10: Osmotic Sampler Configuration

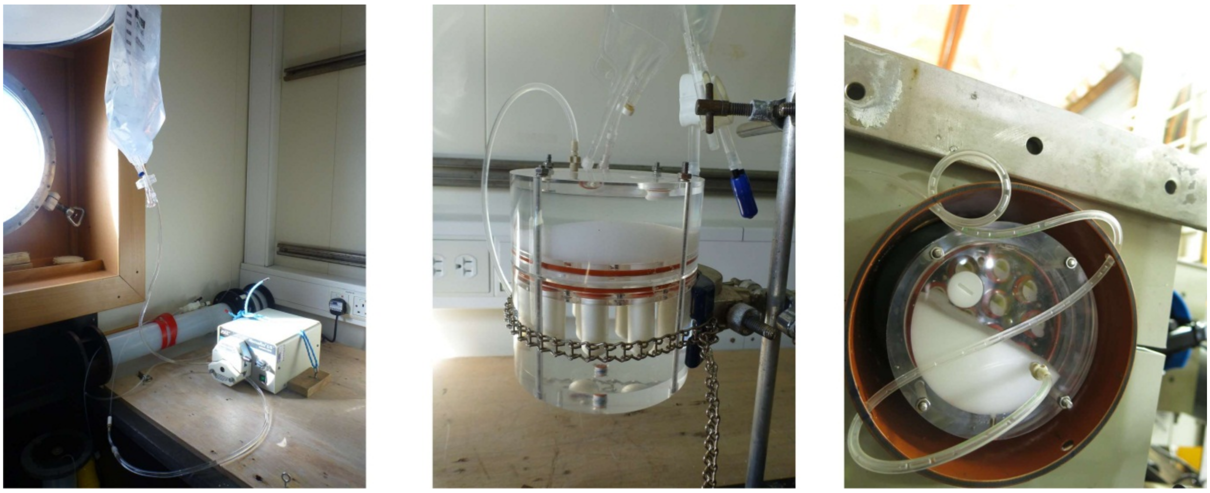


Figure 11: Osmotic sampler preparation A) Filling the sampling tube with MQ water; B) Osmotic Pump; C) Sampler on the frame

4 Mooring Servicing

Daniel Comben, Christian Crow and Nick Rundle

4.1 Overview

The objectives during this cruise were:

1. Bring inboard the ODAS buoy currently at PAP which had been deployed on January 24th 2013 by Celtic Explorer without a sensor frame; The "PAP#1 light" mooring.
2. Replace this buoy with a new buoy and deploy with a fully equipped sensor frame; PAP#1.

3. Recover the remains of the PAP#1 mooring which had parted in December 2012 leaving the sensor frame, subsurface, lines and acoustic release in situ.
4. Recover the PAP#3 sediment trap mooring deployed in 2012.
5. Deploy a new PAP#3 sediment trap mooring.

4.2 PAP #1 ODAS Buoy Parted Mooring Recovery

4.2.1 Operations Summary

The parted PAP#1 mooring was initially ranged on the 19th April at 18:54 GMT to establish two things, was the remaining mooring still in situ and was the acoustic release in a vertical position.

There was a positive answer to both questions!

The mooring was released at 10:36 on 20th April 2013 ($48^0$00.10'N, $16^0$22.70'W) using an IXSEA TT801 connected through the single element transducer on the (raised) drop keel by a patch cable. The mooring was monitored during the buoyant ascent; due to inconstant communication an assent rate could not be measured. The mooring was initially spotted at 10:22 with the single subsurface buoyancy package visible. Buoyant Polypropylene rope was spotted on the surface (acoustic release side). This continued to rise and stream into a large bite. This continued to rise and a decision was made to approach the subsurface float after it was clear that the windward side could be accessed without risk of entanglement with the vessel.

The approach was made by backing up to the package and hooking on the port quarter, this was at approximately 1400hrs GMT.

The deck setup for the mooring recovery used a Romica 1.5 ton large Seismic streamer winch mounted well forward on the aft deck with the mooring line with a long lead to a sheave suspended from the port aft pedestal crane. A chain stopper and boss hook was attached to the deck in the 'red zone for stopping off the mooring.

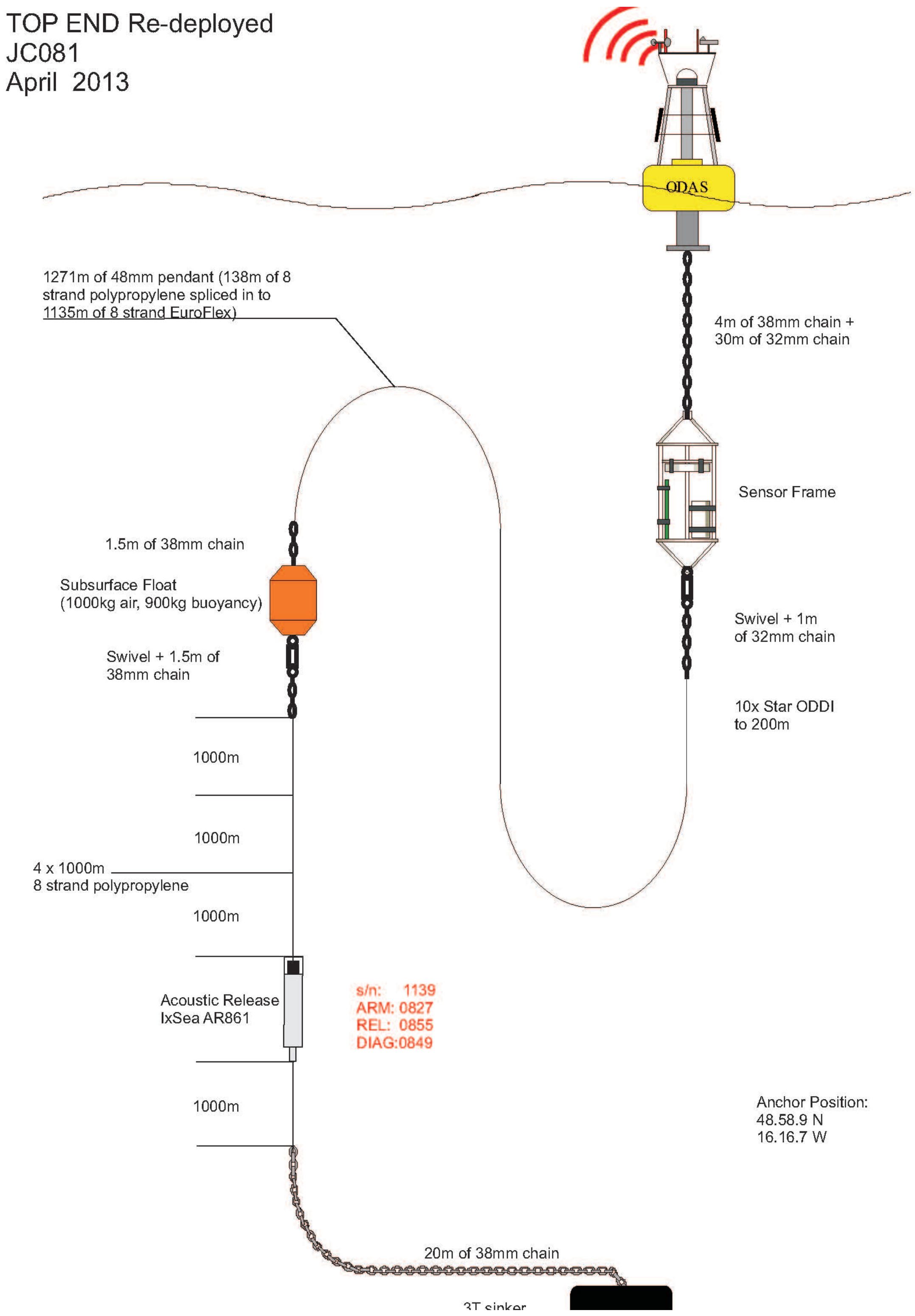
A large Yale grip rope stopper and two small Yale grip stoppers were ready on deck to be used if needed.

The mooring was recovered from the 1 ton syntactic sub surface float. The acoustic release section was made fast on deck and the sensor frame was then recovered with the vessel moving ahead at 0.5 knot to allow the acoustic release section to stream out.

After the sensor frame was recovered to deck, the acoustic release section was then recovered. Two 1000m sections of rope were tangled and had to be stopped and cut to enable recovery. After recovery the mooring rope was left on the winch drum for return to NOC.

The recovered instruments on the sensor frame were not in a good condition (see report produced by John Campbell below).

4.2.2 Mooring Diagram



PAP1 ODAS Parted Mooring Recovered

4.2.3 Instrumentation

All of the recovered STAR ODDI's were in good condition and in working order.

Acoustic release TT861 was in good condition.

1) Observations, problems and recommendations

It was assumed that the mooring would be badly tangled to the time of parting, 21st January 2013 to the recovery on 20th April 2013 but in reality it was in a better condition than had been expected.
The last two 1000m sections of 48mm polypropylene rope had to be cut and stopped to enable recovery.

4.3 PAP 3 Sediment Trap Mooring Recovery

4.3.1 Operations Summary

The PAP 3 sediment trap mooring was ranged on the 20th April at 18:18 GMT At no point during the ranging and subsequent releasing of this mooring did the release communicate. No usable ranges were obtained using both IXSEA TT801 deck units and an IXSEA TT300 connected through the single element transducer on the (raised) drop keel or the over the side transducer or the super transducer.

The mooring was sent a released command at 18:31 on 20th April 2013 (48^{0}59.75'N, 16^{0}30.27'W) using an IXSEA TT801 connected through the single element transducer, then subsequently using the second TT801 and the TT300 and the super and standard over the side transducers.

At 18:48 no further attempts to release the mooring were made due to the impending darkness. Spotters were sent to the bridge and the mooring was seen on the surface at 20:26.

The mooring was grappled on the strb side at 21:46 and the release was recovered on deck at 23:10.

4.3.2 Instrumentation

RCM11, s/n 522, showed no signs of damage, corrosion or fouling, and was continuing to sample. The instrument was started at 17:00 on 04/05/2012 with a 30 minute sampling frequency for 8 channels. The acoustic sampling was averaged at 300pings throughout the 30min sampling window. The temperature range was set to 'wide' and the conductivity to '0-74 ms/cm'. The instrument was stopped logging:

Word count 3:0454 on Burst mode. Stopped 21stApril 2013 15:41:40 GMT with a time difference of -10miuntes 43 seconds.

RCM11, s/n 423, showed no signs of damage, corrosion or fouling, and was continuing to sample. The instrument was started at 17:00 on 04/05/2012 with a 30 minute sampling frequency for 8 channels. The acoustic sampling was averaged at 300pings throughout the 30min sampling window. The temperature range was set to 'wide' and the conductivity to '0-74 ms/cm'.

The instrument was stopped logging.

Word count 3:7550. Stopped. 22nd April 10:59:20gmt with a time difference of 3 minutes 53 seconds.

SeaBird Microcat SBE37IMP s/n 9477, showed no signs of damage, corrosion or fouling, and was continuing to sample. It was set to sample every 600seconds. The instrument was stopped logging at 14:10:40 GMT on 21/04/2013. It had logged 165853.

Parflux sediment trap, s/n 13432-03, showed no signs of damage, corrosion or fouling, and had completed its full sampling schedule. All sample bottles had rotated according to the schedule and contained varying amounts of sample.

Parflux sediment trap, s/n 520, showed no signs of damage, corrosion or fouling, and had completed its full sampling schedule. All sample bottles had rotated according to the schedule and contained varying amounts of sample.

Parflux sediment trap, s/n 12432-04, showed no signs of damage, corrosion or fouling, and had completed its full sampling schedule. All sample bottles had rotated according to the schedule and contained varying amounts of sample.

2) Observations, problems and recommendations

The mooring was recovered without incident although the acoustics proved to be very unreliable. The acoustic release AR861 s/n 1470 did not provide one return range during the whole operation. With hindsight, it may have been a little late to send the last release command with the daylight fading.

4.4 PAP#3 Deployment

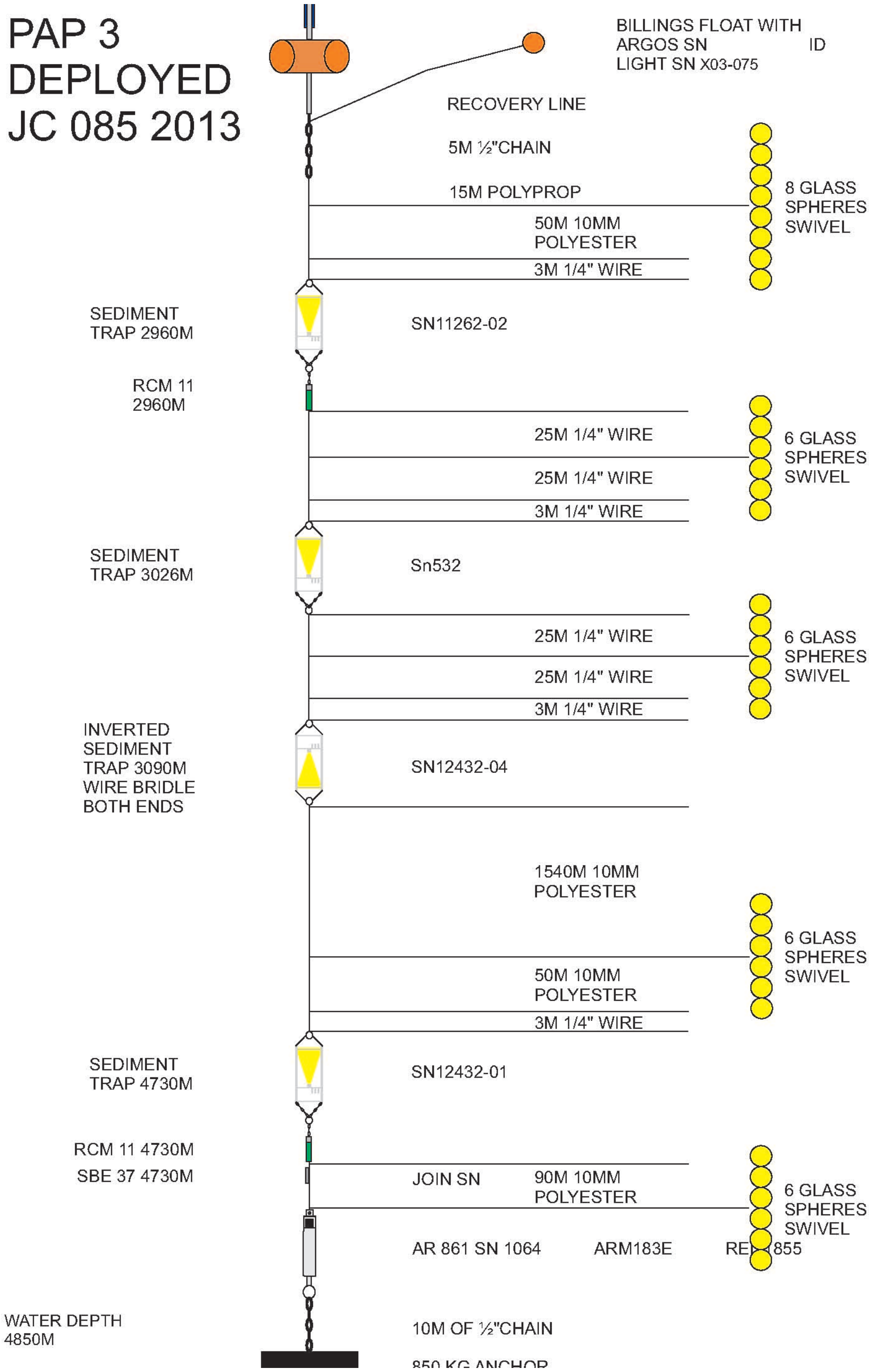
4.4.1 Mooring Operations Summary

The mooring operation commenced at 18:17 on 21st April 2013. The mooring was deployed top first and streamed as the vessel approached the anchor release point. The ships speed was between 1 and 1.5 knots. Due to the uniformity of the seabed, the exact deployment position was not critical, however a 2nm run in was allowed for approaching the approximate anchor position. The mooring took 130 minutes to deploy and the anchor was released at 20:27 GMT (59^{0}41.17'N, 29^{0}23.20'W) using a SeaCatch hook. The release was interrogated (using an IXSEA TT801 connected through the vessels single element transducer) as it fell to the seabed at a very approximate descent speed of 90m/min.

Communication with the release post deployment was very inconsistent.

The mooring was deployed in a different configuration to the previously recovered PAP3 mooring, with 4 sediment traps one of which was inverted.

4.4.2 Mooring Diagram



PAP3 Deployed Mooring

4.4.3 Instrumentation

RCM11, s/n 425, had a fresh battery installed and the DSU had been erased and the time set to GMT. The instrument was started at 10:00 on 15/04/2013 with a 30 minute sampling frequency for 8 channels. The acoustic sampling was averaged at 600pings throughout the 30min sampling window. The temperature range was set to 'wide'.

RCM11, s/n 419, had a fresh battery installed and the DSU had been erased and the time set to GMT .The set up was identical. Both units were sampling over two days before being sealed within their housings.

SeaBird Microcat SBE37IMP s/n 4460, had a fresh battery installed and the memory had been erased and the time set to GMT. The instrument was started at 12:00:00 on 24/04/2013 with a 15 minute (900 seconds) sampling frequency.

SEDIMENT TRAPS X4

SN:11262-02 (21-WAY) , 532(13-WAY), 12432-04(21) , 12432-01(21).

All traps were serviced at NOC, batteries fitted on board and rotated for topping up. The traps were fitted with a fresh set of batteries and programmed for deployment.

All starting 04/22/13 12:00:00(GMT) and finishing on 07/06/14 12:00:00 (back to open hole).

Sn:12432-04 was a recovered trap which had to be re deployed , as sediment trap sn:12432-05 supplied was found to have a power drain, which on closer inspection showed signs of water ingress (condensation?) over parts of the battery compartment and electronics board.

Initially all were set to start a day earlier. The plan changed and all were restarted a day later.

Further details are in subsequent section by Corinne Pebody.

4.4.4 Observations, problems and recommendations

It should be Noted that the Inverted sediment trap had the effect of a sea anchor, extra care had to be taken once it was in the water and this affected the deployment time.

4.5 PAP#1: Recovery of Top Buoy

1) Operational Summary

The buoy was approached by backing up with the propellers disengaged on the azimuth thrusters. A large load snap hook was fixed to an aluminium pole connected to the trawl warp. The rails were up at this point.

Once attached to the warp the slack was taken up and two 12mm polyester lines were placed around horizontally apposing legs of the Buoy. It was our intention to attach both 5ton winches to the Keel shackle points but in practice this proved too difficult to achieve.

The two 5 ton winches were therefore both connected to the front point to make sure that on recovery the keep chain and slot were properly aligned for landing the buoy. The rails were then removed and the buoy landed on deck towards the end of the red area.

4.6 PAP1 Deployment

4.6.1 Operations Summary

Prior to the commencement of deployment operations the 200m of upper rope was wound into the drum. The ship was moving ahead at 0.2 knots at this time to enable the attachment of STAR ODDI's.

The new buoy and sensor frame were positioned on the 'red zone' aft working deck. A large SeaCatch hook (SWL 17t) was fitted to the port side aft crane connected into the lifting eye of the buoy. The chain inbetween the buoy and the frame was flaked along the deck in a bite and the sensor frame was deployed and lowered using the stab side 5ton LeBus winch , using a series of stopping off operations.

Once the weight of the chain was on the keel of the buoy, the buoy was lifted from the deck and floated outboard using hand controlled steadying ropes attached to the inside of the crane pedestals to prevent swing. The keel was dragged outboard by the weight of the mooring chain and this weight also prevented the keel from swinging side to side.

4.7 Sensor Frame and Telemetry System

Jon Campbell

4.7.1 Overview

The PAP telemetry system comprises a buoy telemetry electronics unit and a data concentrator hub in the sensor frame. Schematic drawings of these two units as configured for the latest deployment are shown at the end of this section.

Data are transmitted via the Iridium satellite system every 4 hours (typically) and are automatically displayed on the EuroSITES website: http://www.eurosites.info/pap/data.php

Short status messages are also sent via the Iridium SBD (Short Burst Data) email system every 4 hours (typically). The SBD email system is also used to send commands to the buoy to change sampling intervals, disable/enable sensors and to vary other settings.

The buoy also houses an entirely separate system provided by the UK Met Office which has its own Iridium telemetry system and a suite of meteorological sensors measuring wind velocity, wave spectra and atmospheric temperature, pressure and humidity. Data from these sensors are telemetered to the Met Office every hour.

The two tasks on this cruise were to recover the remains of the broken mooring deployed on JC71, and to replace Met Office buoy with a combined MO/NOC buoy and sensor frame.

4.7.2 Previous Deployment History

The previous PAP Observatory system was deployed on 6th May 2012 on cruise JC71.

The Satlantic SeaFET pH sensor and Pro-Oceanus GTD sensor both stopped working within 10 days of deployment.

Two months after deployment contact was lost with the sensors in the frame when the RS-422 and inductive communications links failed in quick succession. It subsequently transpired that both armoured cables had parted just under the buoy keel because they had been clamped with insufficient slack.

On the 29th December 2012 the mooring itself parted at the height of the worst storm of the winter, with the buoy recording wave heights up to 16m. The drifting buoy was tracked and recovered by R/V Celtic Explorer on 24th January 2013. This revealed that the break had occurred at the top of the sensor frame, when the six M10 bolts attaching the large eye to the top of the frame broke.

Unfortunately a break at this point meant that the sensor frame sank to a depth of around 2000m which destroyed virtually all the sensors.
Tables 6 and 7 list the sensors fitted and those that survived.

4.7.3 System Recovery and Inspection

The acoustic release (1000m above the seafloor) on the broken mooring was released on 20 April 2013 and the 1-ton subsurface buoyancy block came to the surface. This was grappled and recovered along with around 5000m of rope and the sensor frame.

The frame itself was in good condition although the sacrificial anodes had completely disappeared. The top eye bolt holes showed signs of wear (see Figure 13), indicating that the bolts had become loose before breaking.

The data hub had been lost with the penetrators having been ripped out of the Delrin end caps. This must have occurred before the mooring parted, as once separated from the buoy, the frame would not be subject to violent motions.

Most of the sensors had imploded or flooded, the exceptions being the two Seabird MicroCATs and the McLane ZPS.

The three main lessons from this deployment are:-

1. The frame attachment points need to be stronger and more robust
2. The data hub needs to be better secured
3. The armoured cables need to be fastened with enough slack to avoid excess loading

4.7.4 Preparation of New Observatory

The unexpected failure of the frame attachment point prompted a redesign of the way in which the mooring load passes through the frame. Nick Rundle in Sea Systems undertook this redesign at short notice and the newly fabricated parts were delivered shortly before JC85 sailed.

In the new design the mooring load is entirely carried by a new, massive, central rod made of mild steel with an eye welded at either end. This means that the frame itself does not take any of the loads from the mooring, and there are no bolts or other fastenings in the mooring line. The frame is attached to the central rod with clamps that incorporate rubber shock absorbers that also provide electrical isolation between the stainless steel frame and the mild steel mooring components (see Figures 14 and 15).

The second significant change this year is the addition of a third armoured cable running between the buoy controller and the data hub. This provides a redundant power and RS-422 communications link and the two cables (referred to as channel A and channel B) can be selected remotely. The new cable is plastic coated and 21mm in diameter, making it significant larger than the 8mm Seasoar cable used previously. Because of this, new clamps were designed for securing all 3 cables to the chain (see Figure 17).

The suite of sensors (see tables 8 and 9) is similar to the 2012 deployment but with an additional Pro-Oceanus CO2-Pro sensor fitted to the buoy keel, and with a WETLabs Cycle phosphate sensor replacing the NAS nitrate sensor. The Pro-Oceanus CO2-Pro and GTD-Pro sensors fitted in the sensor frame now have internal data loggers and controllers and dedicated battery packs located in the frame making them autonomous.

The data hub electronics was rebuilt with remotely switchable power supplies for the Satlantic OCR radiometers, Satlantic ISUS, CO2-Pro, GTD-Pro and Satlantic SeaFET sensors. The new board automatically detects which of the two armoured cables is powered and uses the correct RS-422 communications channel. It also incorporates a 3-axis accelerometer and a humidity sensor.

A new board was added to the buoy controller to provide a separate power supply and communications channel for the new armoured cable, and a dedicated power supply for the CO2-Pro sensor on the buoy keel. The controller housing was fitted with a new end cap containing the extra connectors required.

4.7.5 Deployment and Initial Performance

The Met Office buoy was recovered on 24 April 2013 and the PAP sensor frame and buoy were attached to its mooring and deployed later the same day. Figure 18 shows the sensor frame being lowered over the stern shortly before the replacement buoy was deployed.

Data telemetered to NOC from the buoy were accessed via FTP using the ship's Internet connection and indicated that all the sensors were functioning with the exception of the Satlantic SeaFET and the Pro-Oceanus CO2-Pro in the sensor frame.

The SeaFET had been configured to sample every hour and it had been doing this on deck, but nothing further was received once it was in the water suggesting that it may have flooded as happened last year.

The CO2-Pro with integrated logger/controller had been running on a one hour sampling cycle but was reconfigured for a 12-hour sampling cycle shortly before deployment. No data were received following this change and a hurried investigation showed that although the sensor had switched on at the correct time and gone through its warm-up cycle, it had not actually sent any data. Unfortunately due to the poor design of the user interface it was not possible to reconfigure the sensor in the time remaining before deployment. An explanation of this apparent failure will be sought from Pro-Oceanus in due course.

It quickly became apparent after deployment that the inductive telemetry system was not working as effectively as it had in the past, with only about 40% of sensor interrogations being successful. Since all three MicroCATs are equally affected, it seems likely that there is a bad connection somewhere on the buoy itself.

Figure 13: Recovered Frame Top Eye Attachment Point

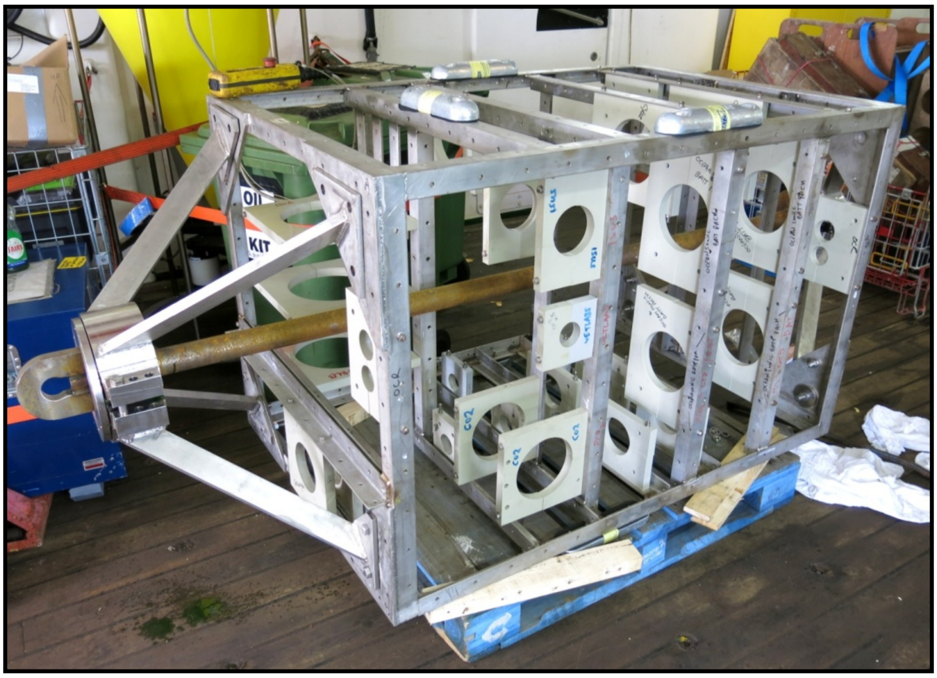


Figure 14: Modified Sensor Frame Showing Central Rod

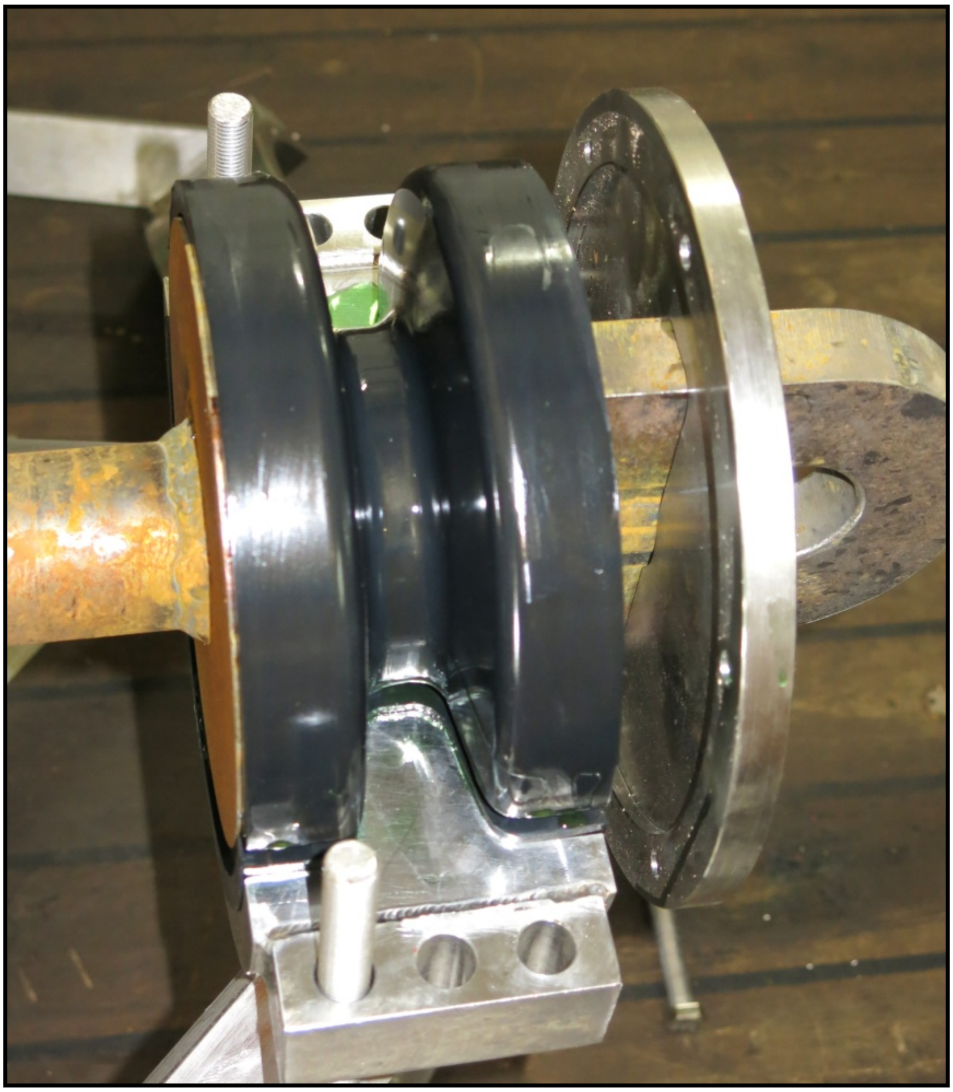


Fig.15: Rubber Shock Absorber during Assembly

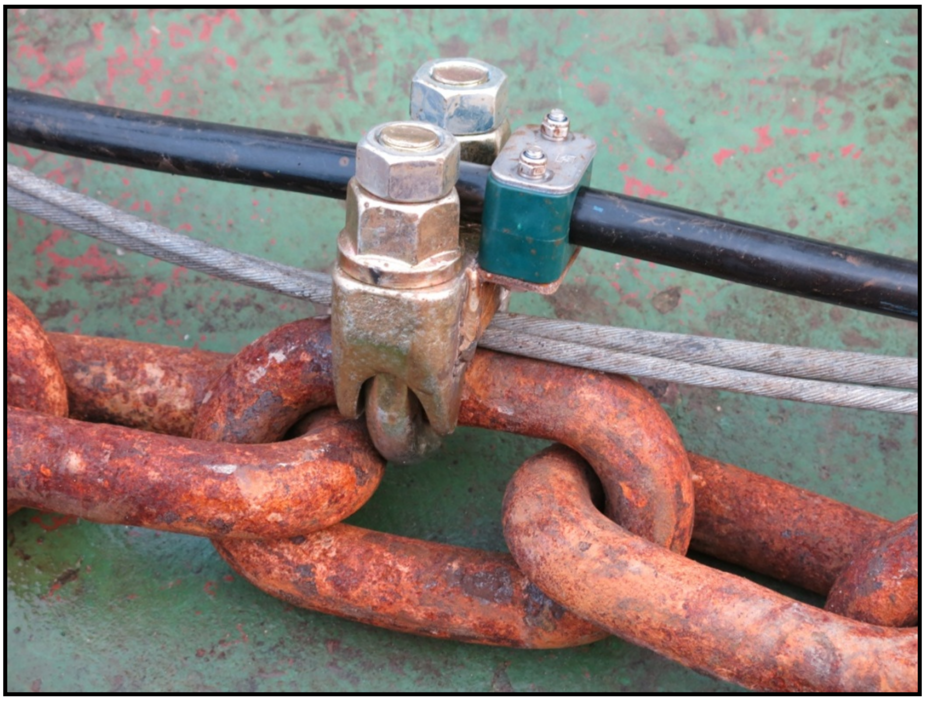


Figure 16: Modified Cable Clamp

Figure17:5 Pro-Oceanus CO2-Pro and Seabird MicroCAT Sensors Fitted to Buoy Keel

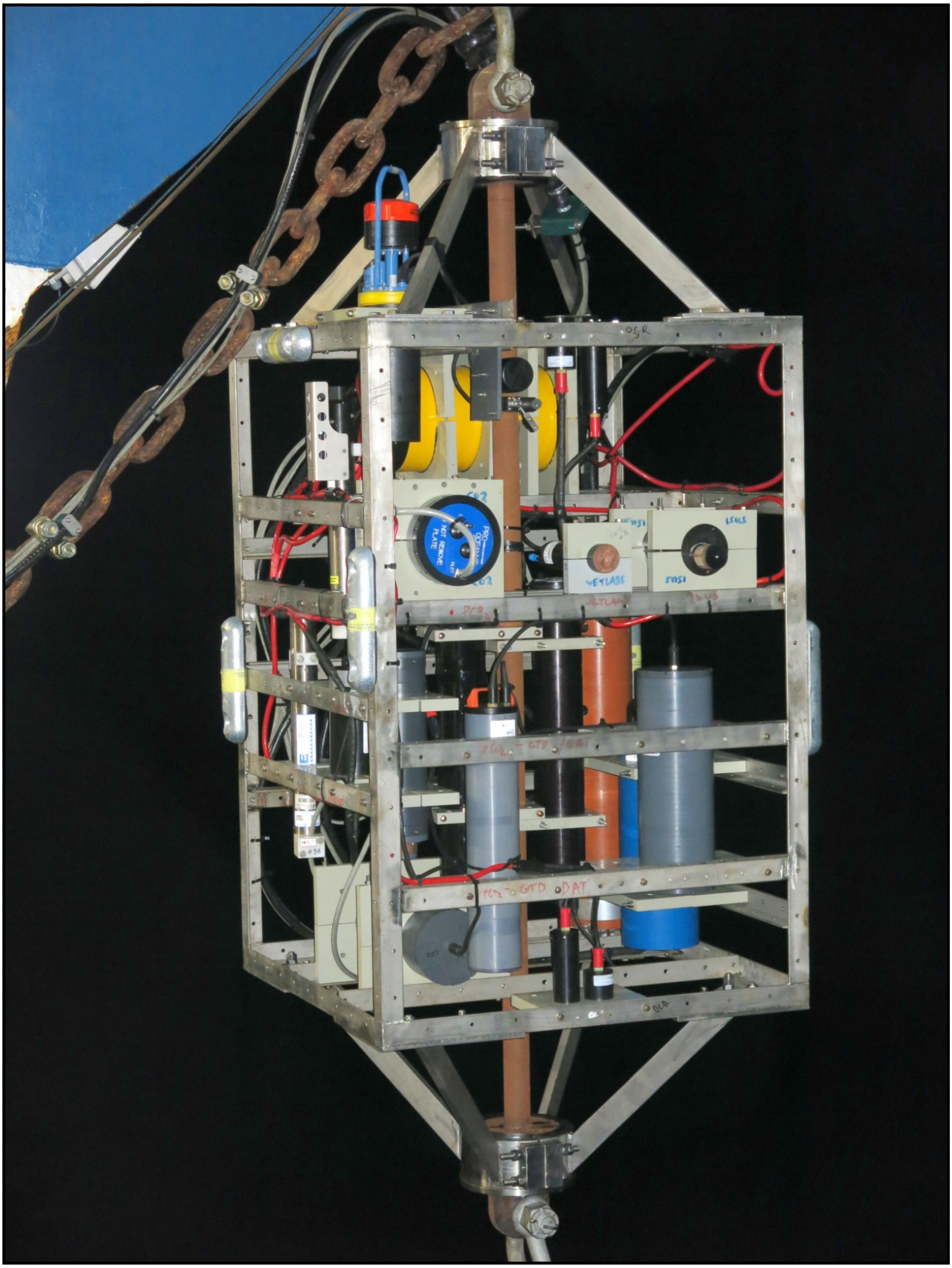


Figure18: Sensor Frame Being Deployed Shortly Before the Buoy

PAP May 2012 Configuration	S/N	depth rating m	Recovery notes	Internal sample interval	Offset from hour	Remote control sampling interval
IN SENSOR FRAME						
SeaBird SBE-37IMP-DO MicroCAT	9030	1000	Survived, but pressure sensor likely to be damaged	30 mins	0	
SeaBird SBE-37IMP MicroCAT (frame)	6915	1000	Survived, but pressure sensor likely to be damaged	15 mins	0	
WETLabs FLNTUSB	238	300	Destroyed	4 hours	0	
Satlantic ISUS V3	238	1000	Destroyed	1 hour	20	
Satlantic 102Ah battery pack	212	1000	Destroyed			
Satlantic SeaFET pH	8	70	Destroyed	1 hour	55	
Satlantic 102Ah battery pack	211	1000	Destroyed			
Aanderaa Seaguard	219	300	Destroyed	1 hour	46	
ZebraTech Wiper for Cyclops		100	Destroyed	6 hours		
NAS-3X	2673	100	Destroyed	24 hours		
McLane ZPS	ML12860-01	5500	Working but some superficial damage			

Satlantic OCR-507 ICSW	225	350	Destroyed	1Hz	17	1 hour
Satlantic OCR-507 R10W	102	350	Destroyed	1Hz	17	1 hour
Pro-Oceanus CO2-Pro	29-095-45	200	Destroyed	None	19	12 hours
Seabird 5T pump	55301	10500	Working but inlet fitting broken			
Pro-Oceanus GTD-Pro	29-100-15	500	Destroyed	None	19	12 hours

Table 6: Sensors Fitted in Sensor Frame during May 2012 to April 2013 Deployment

PAP May 2012 Configuration	S/N	depth rating m	Recovery notes	Internal sample interval	Offset from hour	Remote control sampling interval
ON BUOY						
SeaBird SBE-37IMP MicroCAT (buoy keel)	6916	1000	Recovered Jan 2013 - undamaged	15 mins	0	
Satlantic OCR-507 ICSA (buoy)	226	N/A	Damaged during buoy recovery Jan 2013	1Hz	17	1 hour
ON MOORING CHAIN/ROPE						
Star-Oddi loggers	S5771	800	Recovered Jan 2013 - undamaged	15 mins	0	
	S5772	800	Destroyed	15 mins	0	
	S5774	800	Recovered Jan 2013 - undamaged	15 mins	0	
	S5777	800	Recovered Jan 2013 - undamaged	15 mins	0	
	S5778	800	Recovered Jan 2013 - undamaged	15 mins	0	
PAP 3 MOORING						
SeaBird SBE-37IMP MicroCAT (PAP3)	9477	7000		30 mins	0	

Table 7 Sensors Fitted Elsewhere during May 2012 to April 2013 Deployment

PAP April 2013 sensor configuration	Serial number	Notes	Internal sample interval	Offset from hour	Remote control sampling interval	Depth rating m
IN SENSOR FRAME						
SeaBird SBE-37IMP-ODO MicroCAT	10535	New sensor. Calibrated on CTD	30 mins	0		2000
SeaBird SBE-37IMP MicroCAT	6912	Calibrated on CTD	15 mins	0		1000
WETLabs FLNTUSB	3050	New sensor. Calibrated on CTD	4 hours	0		300
Satlantic ISUS V3	59	Calibrated on CTD	2 hours	20		1000
Satlantic 102Ah battery pack		Old housing repainted				1000
Satlantic SeaFET pH	24	New sensor	1 hour	55		70
Satlantic 102Ah battery pack	211	New housing				1000
Aanderaa Seaguard	217	Serviced and recalibrated by Aanderaa March 2013. Calibrated on CTD	1 hour	46		300
Aanderaa 4797 CO2 optode	27	Serviced and recalibrated by Aanderaa March 2013. Calibrated on CTD				6000
Aanderaa 4330 optode	125	Serviced and recalibrated by Aanderaa March 2013. Calibrated				6000

		on CTD				
Turner Cyclops Fluorometer	2100989	Serviced and recalibrated by Aanderaa March 2013. Calibrated on CTD				600
ZebraTech Wiper for Cyclops			6 hours			30
Satlantic OCR-507 ICSW	200	Serviced and recalibrated by Satlantic December 2012	1Hz	17	30 mins	350
Satlantic OCR-507 R10W	95	Serviced and recalibrated by Satlantic December 2012	1Hz	17	30 mins	350
Pro-Oceanus Logging CO2-Pro	33-146-45	New sensor with integral logger/controller	12 hours	19		200?
OceanSonics battery housing	2303	New housing				30
Seabird 5P pump	56800	New				600
Pro-Oceanus Logging GTD-Pro	33-152-16	New sensor with integral logger/controller	12 hrs	19		1000
OceanSonics battery housing	2304	New housing				30
Osmosampler		New				
WETLabs CYCL-P Phosphate Analyser	164	New sensor	8 hrs			200
WETLabs BPA50 50Ah battery pack	252	New housing				200

Table 8: Sensors Fitted in Sensor Frame for April 2013 Deployment

PAP April 2013 sensor configuration	Serial number	Notes	Internal sample interval	Offset from hour	Remote control sampling interval	Depth rating m
ON BUOY						
Pro-Oceanus CO2-Pro	29-097-45	Serviced and recalibrated by Pro-Oceanus February 2013		19	6 hours	200
Seabird 5T pump	54414					10500
SeaBird SBE-37IMP MicroCAT	6909	Calibrated on CTD	15 mins	0		1000
Satlantic OCR-507 ICSA (buoy)	201	Serviced and recalibrated by Satlantic December 2012	1Hz	17	30 mins	N/A
ON MOORING CHAIN/ROPE						
Star-Oddi CTD loggers	6782	New. Calibrated on CTD	30 mins	0		2000
SO-DST CTD, 2000m, 13 to 50mS/cm	6784	New. Calibrated on CTD	30 mins	0		2000
	6785	New. Calibrated on CTD	30 mins	0		2000
	6786	New. Calibrated on CTD	30 mins	0		2000
	6788	New. Calibrated on CTD	30 mins	0		2000
	6789	New. Calibrated on CTD	30 mins	0		2000

	6790	New. Calibrated on CTD	30 mins	0		2000
	6792	New. Calibrated on CTD	30 mins	0		2000
PAP 3 MOORING						
SeaBird SBE-37IMP MicroCAT (PAP3)	4460	Calibrated on CTD	30 mins	0		7000

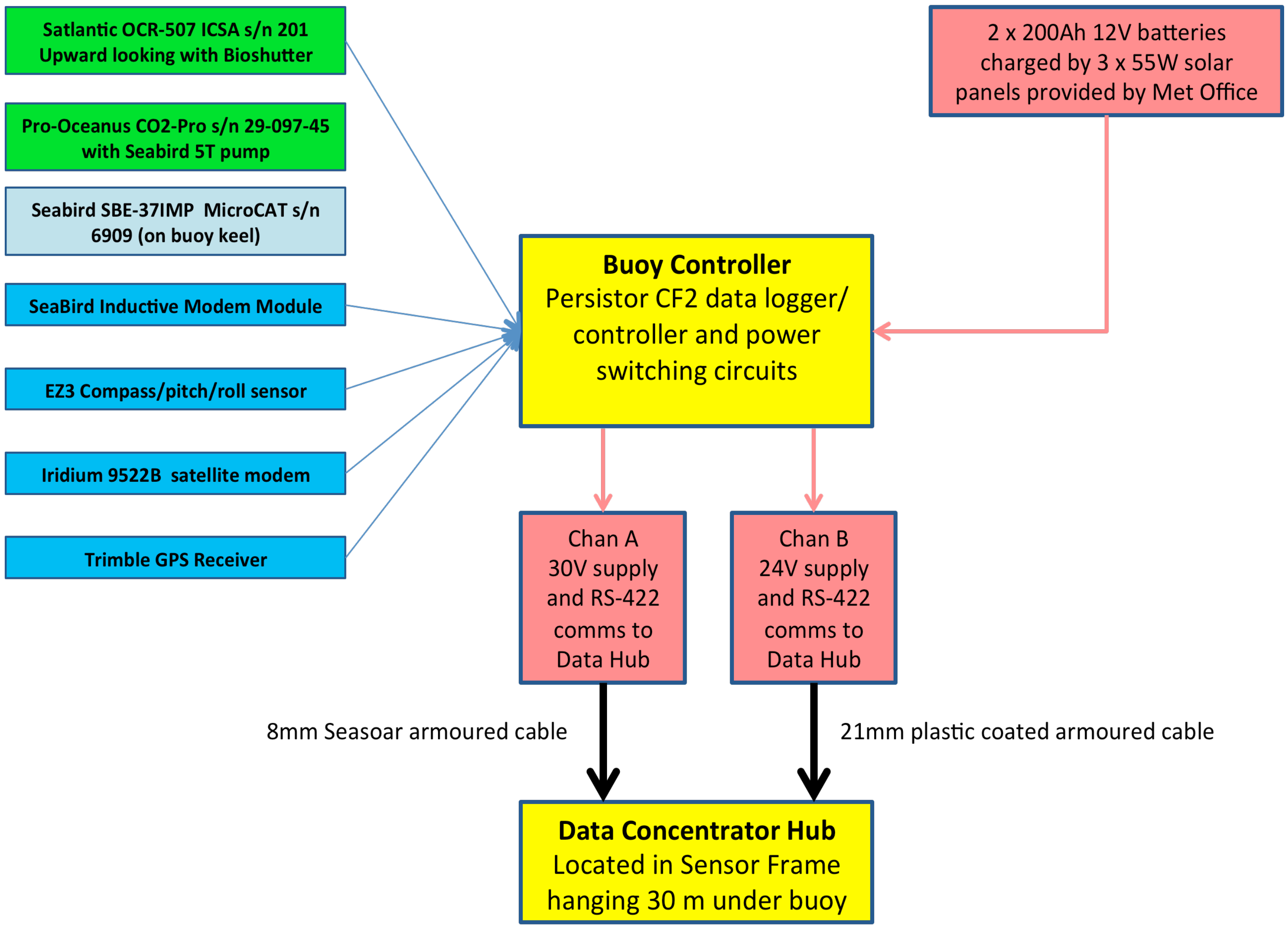
Table 9: Sensors Fitted Elsewhere for April 2013 Deployment

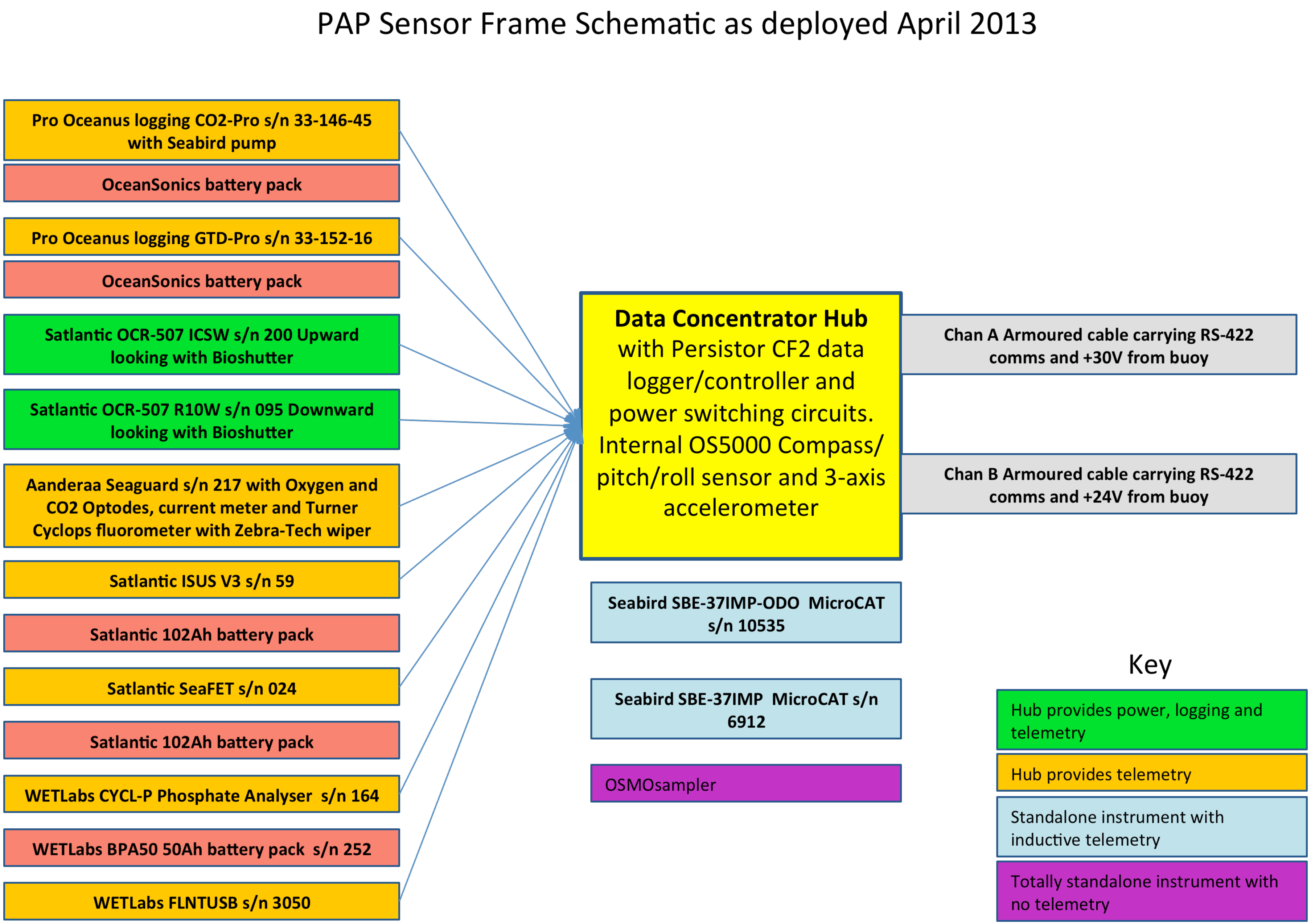
PAP Sensors CTD Calibrations/Comparisons Apr 2013					
Sensor	**S/N**	**Pre-deployment CTD**	**Date**	**Post-deployment CTD**	**Date**
SeaBird SBE-37IMP MicroCAT on buoy keel	6909	JC85-21 CTD3	23-Apr-13		
SeaBird SBE-37IMP-ODO MicroCAT	10535	JC85-21 CTD3	23-Apr-13		
SeaBird SBE-37IMP MicroCAT in frame	6912	JC85-21 CTD3	23-Apr-13		
WETLabs FLNTUSB fluorometer	3050	JC85-13 CTD2	21-Apr-13		
Satlantic ISUS V3	59	JC85-13 CTD2	21-Apr-13		
Aanderaa Seaguard	217	JC85-13 CTD2	21-Apr-13		
Aanderaa 4797 CO2 optode	27	JC85-13 CTD2	21-Apr-13		
Aanderaa 4330 optode	125	JC85-13 CTD2	21-Apr-13		
Turner Cyclops Fluorometer	2100989	JC85-13 CTD2	21-Apr-13		
Star-Oddi loggers	6782	JC85-13 CTD2	21-Apr-13		
SO-DST CTD, 2000m, 13 to 50mS/cm	6784	JC85-13 CTD2	21-Apr-13		
	6785	JC85-13 CTD2	21-Apr-13		
	6786	JC85-13 CTD2	21-Apr-13		

	6788	JC85-13 CTD2	21-Apr-13		
	6789	JC85-13 CTD2	21-Apr-13		
	6790	JC85-13 CTD2	21-Apr-13		
	6792	JC85-13 CTD2	21-Apr-13		
SeaBird SBE-37IMP MicroCAT (PAP3) recovered	9477	none		none	
SeaBird SBE-37IMP MicroCAT (PAP3) deployed	4460	JC85-01 CTD1	19-Apr-13		

Table 10: Pre and Post Deployment Sensor Calibration CTDs

PAP Telemetry Buoy Schematic as deployed April 2013





PAP Sensor Frame Schematic as deployed April 2013
Pro Oceanus logging CO2-Pro s/n 33-146-45 with Seabird pump
OceanSonics battery pack
Pro Oceanus logging GTD-Pro s/n 33-152-16
OceanSonics battery pack
Satlantic OCR-507 ICSW s/n 200 Upward looking with Bioshutter
Satlantic OCR-507 R10W s/n 095 Downward looking with Bioshutter
Aanderaa Seaguard s/n 217 with Oxygen and CO2 Optodes, current meter and Turner Cyclops fluorometer with Zebra-Tech wiper
Satlantic ISUS V3 s/n 59
Satlantic 102Ah battery pack
Satlantic SeaFET s/n 024
Satlantic 102Ah battery pack
WETLabs CYCL-P Phosphate Analyser s/n 164
WETLabs BPA50 50Ah battery pack s/n 252
WETLabs FLNTUSB s/n 3050
Data Concentrator Hub with Persistor CF2 data logger/controller and power switching circuits. Internal OS5000 Compass/ pitch/roll sensor and 3-axis accelerometer
Chan A Armoured cable carrying RS-422 comms and +30V from buoy
Chan B Armoured cable carrying RS-422 comms and +24V from buoy
Seabird SBE-37IMP-ODO MicroCAT s/n 10535
Seabird SBE-37IMP MicroCAT s/n 6912
OSMOsampler
Key
Hub provides power, logging and telemetry
Hub provides telemetry
Standalone instrument with inductive telemetry
Totally standalone instrument with no telemetry

4.8 PAP#1 Sensors

Thanos Gkritzalis, Jon Campbell, Corinne Pebody

As an overview, Tables 6 and 7 above list the sensors deployed on JC071, Tables 8 and 9 the sensors deployed on JC085 and Table 10 the calibration CTDs for both sets of sensors.

4.8.1 Sensors Recovered (Originally Deployed on JC071)

4.8.1.1 Pro-Oceanus CO2-Pro s/n 29-095-45

This sensor worked for 59 days until the power connection to the data hub parted on 4 July 2012. It was destroyed when the sensor frame sank on 29th December 2012.

The SeaBird 5T pump was recovered in working order, although the inlet hose fitting had snapped off.

4.8.1.2 Pro-Oceanus GTD-Pro s/n 29-100-15

This sensor only worked for 10 days before it started sending erroneous data. It was destroyed when the sensor frame sank on 29th December 2012.

4.8.1.3 Satlantic OCR-507 R10W downward-looking radiometer s/n 102 and OCR-507 ICSW upward-looking radiometer s/n 225

These sensors worked for 59 days until the power connection to the data hub parted on 4th July 2012. They were destroyed when the sensor frame sank on 29th December 2012.

4.8.1.4 Satlantic OCR-507 ICSA upward-looking radiometer s/n 226

This radiometer was mounted on the topmost rail of the buoy mast and was dependent on the buoy telemetry unit for power and data logging. It functioned correctly throughout the entire deployment, but was damaged when the drifting buoy was recovered by R/V Celtic Explorer on 7th January 2013.

4.8.1.5 SeaBird SBE37-IMP-IDO MicroCAT CTD sensor s/n 9030 with dissolved oxygen sensor

The MicroCAT with dissolved oxygen was configured to sample every 30 minutes. This sensor's pressure port was inadvertently covered by one of the securing clamps and so the pressure sensor readings should be disregarded for this deployment.

Data were returned via the inductive telemetry system for the first 60 days of the deployment until the inductive telemetry cable parted under the buoy on 5th July 2012.

The unit survived sinking to 2000m although its 1000m rated pressure sensor may have been damaged.

4.8.1.6 SeaBird SBE37-IMP MicroCAT CTD Sensor s/n 6915

This MicroCAT was configured to sample every 15 minutes. Data were returned via the inductive telemetry system for the first 60 days of the deployment until the inductive telemetry cable parted under the buoy on 5 July 2012.

The unit survived sinking to 2000m although its 1000m rated pressure sensor may have been damaged.

4.8.1.7 Satlantic pH Sensor

SeaFET pH sensor s/n 008

This prototype pH sensor was configured to sample once per hour, taking 5 samples each time. Within an hour of entering the water the internal humidity sensor was reporting that the humidity had increased from 10% to 60%, and within 3 days this had reached 100%. Two days after deployment at 13:05 on 9th May, the SeaFET sensor suddenly changed from scheduled, hourly sampling to continuous sampling. After 14 days, no further data were received from the sensor and it seems very likely that the sensor had flooded. Figure 19 shows a plot of internal humidity.

The sensor was destroyed when the sensor frame sank on 29 December 2012.

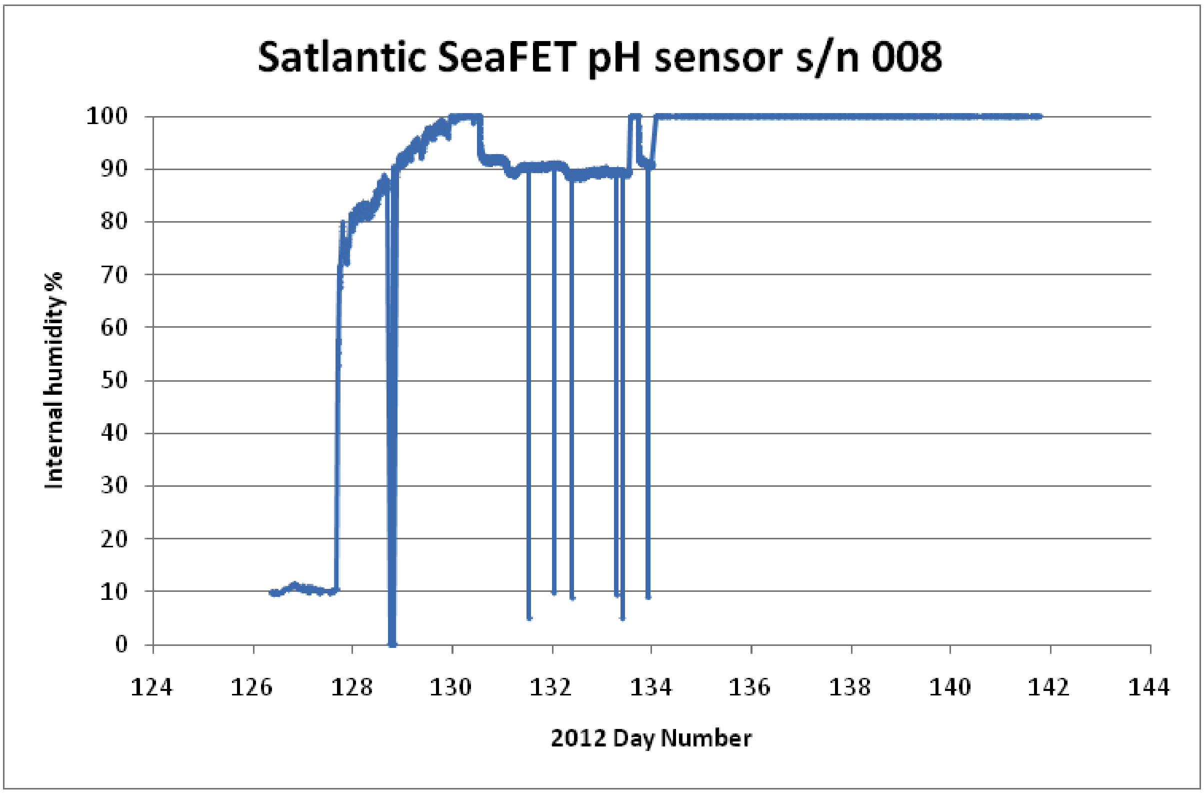
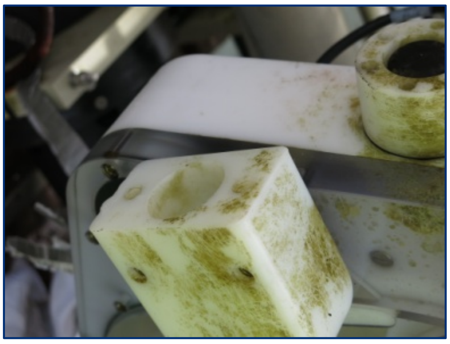


Figure 19: SeaFET Internal Humidity Readings

4.8.1.8 Zooplankton Sampler

McLane Labs ZPS s/n ML12860-01

The ZPS is 6000m rated so it was hoped that it would be working at >1750m when suspended by the sub surface float. On recovery initial observations comprised the mushroom attachment to adjust flow on pumping was missing but it was otherwise unaffected. Further inspection however showed that 2 of the 3 cables were damaged. The cables connected to the winding mechanism, was water logged and the hose was leaking oil. The combination of this damage left the ZPS unsafe to re deploy. The winding mechanism appeared to have wound on a number of samples. The spools were removed and preserved in formalin for further analysis at NOC.



The logger responded to interrogation and it appears that the ZPS had sampled as per the deployment log, detailed below. Sample 16 recorded as pump would not start, but this was because we had recovered the instrument in between the 15th and 16th samples.

```
Configuration: ZPS-30G                  CF2 V2_00 of Apr 11 2012
                McLane Research Laboratories, USA
                       ZooPlankton Sampler
                            ML12860-01
               _________________________________
                            Main Menu
                _________________________________
                    Sat Apr 20 16:53:33 2013
                       Belt is NOT aligned
            <1> Set Time             <5> Create Schedule
            <2> Diagnostics          <6> Deploy System
            <3> Manual Operation     <7> Offload Data
           <4> Sleep                <8> Contact McLane
                Selection [] ? 7
________________________________________________________________
Configuration: ZPS-30G                  CF2 V2_00 of Apr 11 2012
                _________________________________
                    Offload/Display Data File
                _________________________________
                    Sat Apr 20 16:53:51 2013
                <1> Display all data
                <2> Display summary data
                <3> Display pump data
                <4> EEPROM backup cache
                <M> Main Menu

               Selection [] ? 1
To copy the instrument data file to a disk file, initiate
your communication program's file logging command now and
then press any key to start the transfer.  The instrument
data file will remain resident and is not erased by this
offload procedure.
Configuration:     ZPS-30G
Software version:  ZPS-2_00.c
Compiled:          Apr 11 2012 09:37:53
Electronics S/N:   ML12860-01
Data recording start time: 05/06/12 10:03:54
```

```
Data recording  stop time: 04/20/13 16:53:23
HEADER
______
ZPS004
PAP 2012_13
JC071
SAMPLE PARAMETERS
_________________
Initial flow rate:     25 liters/minute
Minimum flow rate:     10 liters/minute
Sample volume:        500 liters
Time limit:            45 minutes
Back flush volume:      5 liters
Back flush interval:  720 minutes
Sample delay:           5 minutes
SCHEDULE
________
Event 01 of 50 @ 05/10/12 00:00:00
Event 02 of 50 @ 05/10/12 06:00:00
Event 03 of 50 @ 05/10/12 12:00:00
Event 04 of 50 @ 05/10/12 18:00:00
Event 05 of 50 @ 03/31/13 00:00:00
Event 06 of 50 @ 03/31/13 06:00:00
Event 07 of 50 @ 03/31/13 12:00:00
Event 08 of 50 @ 03/31/13 18:00:00
Event 09 of 50 @ 04/01/13 00:00:00
Event 10 of 50 @ 04/07/13 00:00:00
Event 11 of 50 @ 04/14/13 00:00:00
Event 12 of 50 @ 04/14/13 06:00:00
Event 13 of 50 @ 04/14/13 12:00:00
Event 14 of 50 @ 04/14/13 18:00:00
Event 15 of 50 @ 04/15/13 00:00:00
Event 16 of 50 @ 04/21/13 00:00:00
Event 17 of 50 @ 04/28/13 00:00:00
Event 18 of 50 @ 04/28/13 06:00:00
Event 19 of 50 @ 04/28/13 12:00:00
Event 20 of 50 @ 04/28/13 18:00:00
Event 21 of 50 @ 04/29/13 00:00:00
Event 22 of 50 @ 05/05/13 00:00:00
Event 23 of 50 @ 05/12/13 00:00:00
Event 24 of 50 @ 05/12/13 06:00:00
Event 25 of 50 @ 05/12/13 12:00:00
Event 26 of 50 @ 05/12/13 18:00:00
Event 27 of 50 @ 05/13/13 00:00:00
Event 28 of 50 @ 05/19/13 00:00:00
Event 29 of 50 @ 05/26/13 00:00:00
Event 30 of 50 @ 05/26/13 06:00:00
Event 31 of 50 @ 05/26/13 12:00:00
Event 32 of 50 @ 05/26/13 18:00:00
Event 33 of 50 @ 05/27/13 00:00:00
Event 34 of 50 @ 06/02/13 00:00:00
Event 35 of 50 @ 06/09/13 00:00:00
Event 36 of 50 @ 06/09/13 06:00:00
Event 37 of 50 @ 06/09/13 12:00:00
Event 38 of 50 @ 06/09/13 18:00:00
Event 39 of 50 @ 06/10/13 00:00:00
Event 40 of 50 @ 06/16/13 00:00:00
Event 41 of 50 @ 06/23/13 00:00:00
Event 42 of 50 @ 06/23/13 06:00:00
Event 43 of 50 @ 06/23/13 12:00:00
Event 44 of 50 @ 06/23/13 18:00:00
Event 45 of 50 @ 06/24/13 00:00:00
Event 46 of 50 @ 06/30/13 00:00:00
Event 47 of 50 @ 07/07/13 00:00:00
Event 48 of 50 @ 07/07/13 06:00:00
Event 49 of 50 @ 07/07/13 12:00:00
Event 50 of 50 @ 07/07/13 18:00:00
```

DEPLOYMENT DATA

```
  1  05/10/12 00:00:02  37.9 Vb   13 °C
     Intake flush    5.00 L       16 sec  34.3 Vbl  Volume reached
     Sample        502.19 L     1257 sec  33.8 Vbl  Volume reached
     05/10/12 00:26:32  35.5 Vb   22 °C
     Sample successfully sealed
  2  05/10/12 06:00:02  37.1 Vb   13 °C
     Intake flush    5.00 L       16 sec  33.8 Vbl  Volume reached
     Sample        502.32 L     1258 sec  33.3 Vbl  Volume reached
     05/10/12 06:26:32  34.9 Vb   22 °C
     Sample successfully sealed
  3  05/10/12 12:00:02  36.5 Vb   13 °C
     Intake flush    5.00 L       16 sec  33.8 Vbl  Volume reached
     Sample        255.40 L      645 sec  33.2 Vbl  Min flow reached
     05/10/12 12:16:21  35.0 Vb   20 °C
     Sample successfully sealed
  4  05/10/12 18:00:02  36.3 Vb   13 °C
     Intake flush    5.01 L       16 sec  33.1 Vbl  Volume reached
     Sample        502.19 L     1257 sec  32.6 Vbl  Volume reached
     05/10/12 18:26:31  34.3 Vb   21 °C
     Sample successfully sealed
  5  03/31/13 00:00:02  34.9 Vb    4 °C
     Intake flush    5.00 L       16 sec  29.1 Vbl  Volume reached
     Sample        502.14 L     1257 sec  27.7 Vbl  Volume reached
     03/31/13 00:26:31  31.5 Vb    8 °C
     Sample successfully sealed
  6  03/31/13 06:00:01  34.3 Vb    4 °C
     Intake flush    5.00 L       16 sec  28.4 Vbl  Volume reached
     Sample        502.14 L     1257 sec  26.9 Vbl  Volume reached
     03/31/13 06:26:29  31.1 Vb    9 °C
     Sample successfully sealed
  7  03/31/13 12:00:02  34.0 Vb    4 °C
     Intake flush    5.00 L       16 sec  28.0 Vbl  Volume reached
     Sample        502.13 L     1257 sec  26.3 Vbl  Volume reached
     03/31/13 12:26:31  30.7 Vb    9 °C
     Sample successfully sealed
  8  03/31/13 18:00:02  33.7 Vb    4 °C
     Intake flush    5.00 L       16 sec  27.6 Vbl  Volume reached
     Sample        502.13 L     1257 sec  26.0 Vbl  Volume reached
     03/31/13 18:26:30  30.5 Vb    8 °C
     Sample successfully sealed
  9  04/01/13 00:00:02  33.5 Vb    4 °C
     Intake flush    5.00 L       16 sec  27.4 Vbl  Volume reached
     Sample        502.00 L     1256 sec  25.7 Vbl  Volume reached
     04/01/13 00:26:30  30.3 Vb    8 °C
     Sample successfully sealed
 10  04/07/13 00:00:02  34.1 Vb    4 °C
     Intake flush    5.00 L       16 sec  27.9 Vbl  Volume reached
     Sample        502.00 L     1256 sec  26.3 Vbl  Volume reached
     04/07/13 00:26:30  30.6 Vb    8 °C
     Sample successfully sealed
 11  04/14/13 00:00:02  34.0 Vb    4 °C
     Intake flush    5.00 L       17 sec  27.7 Vbl  Volume reached
     Sample        502.00 L     1256 sec  26.1 Vbl  Volume reached
     04/14/13 00:26:30  30.5 Vb    9 °C
     Sample successfully sealed
 12  04/14/13 06:00:02  33.4 Vb    4 °C
     Intake flush    5.00 L       16 sec  27.2 Vbl  Volume reached
     Sample        502.00 L     1256 sec  25.4 Vbl  Volume reached
     04/14/13 06:26:30  30.1 Vb    8 °C
     Sample successfully sealed
 13  04/14/13 12:00:02  33.1 Vb    4 °C
     Intake flush    5.00 L       17 sec  26.7 Vbl  Volume reached
     Sample        501.99 L     1256 sec  24.9 Vbl  Volume reached
     04/14/13 12:26:30  29.8 Vb    8 °C
     Sample successfully sealed
 14  04/14/13 18:00:02  32.8 Vb    4 °C
```

```
     Intake flush    5.00 L       16 sec  26.5 Vbl  Volume reached
     Sample        501.99 L     1256 sec  24.2 Vbl  Volume reached
     04/14/13 18:26:29  29.6 Vb    8 °C
     Sample successfully sealed
 15  04/15/13 00:00:02  32.7 Vb    4 °C
     Intake flush    5.00 L       17 sec  26.0 Vbl  Volume reached
     Sample        501.99 L     1256 sec  24.0 Vbl  Volume reached
     04/15/13 00:26:29  29.4 Vb    8 °C
     Sample successfully sealed
 16  04/20/13 16:47:10  33.5 Vb   14 °C
     Intake flush   -0.08 L        2 sec  33.3 Vbl  Pump would not start
     Sample         -0.13 L        3 sec  33.3 Vbl  Pump would not start
     04/20/13 16:53:23  33.4 Vb   15 °C
     Sample successfully sealed
Schedule was not completed.
PUMPING DATA
____________
Sample interval: 1 minute
event  L/min  Liters  Vbat
  'much pump rate data excluded for report'
```

4.8.2 Sensors Deployed

4.8.2.1 Pro-Oceanus Logging CO2-Pro s/n 33-146-45 with SeaBird 5P Pump

This is a new sensor with built-in data logger and controller. It is connected to a dedicated battery pack (OceanSonics housing with 60 LSH20 cells giving 150Ah at 18V), and can also be powered from the hub when this pack is exhausted. With the sensor configured to sample twice per day, this pack should last around 9 months.

During testing the CO2-Pro had been running on a one hour sampling cycle but was reconfigured for a 12-hour sampling cycle shortly before deployment. No data were received following this change and a hurried investigation showed that although the sensor had switched on at the correct time and gone through its warm-up cycle, it had not actually sent any data. Unfortunately due to the poor design of the user interface it was not possible to reconfigure the sensor in the time remaining before deployment. An explanation of this apparent failure will be sought from Pro-Oceanus in due course.

The sensor's internal clock was set 10 minutes fast so that sampling would occur 10 minutes before the hour. The sensor's user interface is so basic that this is the only way to control the sampling time.

4.8.2.2 Pro-Oceanus logging GTD-Pro s/n 33-152-16

This is a new sensor with built-in data logger and controller. It is connected to a dedicated battery pack (OceanSonics housing with 60 LSH20 cells giving 150Ah at 15V), and can also be powered from the hub when this pack is exhausted. With the sensor configured to sample twice per day, this pack should only last around 6 months, as the sensor's sleep current is ridiculously high at 30mA.

The sensor's internal clock was set 20 minutes fast so that sampling would occur 20 minutes before the hour. The sensor's user interface is so basic that this is the only way to control the sampling time.

4.8.2.3 Satlantic OCR-507 R10W downward-looking radiometer s/n 095and OCR-507 ICSW upward-looking radiometers s/n 200 and 201

These sensors were serviced by Satlantic in November 2012. The radiometers are powered and logged by the hub which can be configured remotely. The radiometers themselves are configured to sample at 1Hz. The two radiometers in the sensor frame were secured by a new design of clamp which should afford better protection to the copper shutters when they open.

4.8.2.4 Satlantic SeaFET pH sensor s/n 024

This is a new sensor that was configured to sample every hour at 22 minutes past the hour. It was run for several days prior to deployment and performed as expected. A few days before deployment, an advisory note was received from Satlantic warning of a potential lockup problem when operating the sensor in periodic mode (as we are). Since the fix involves a firmware update and a modification to the electronics, it was not practical to attempt to fix this problem which we had not experienced during testing. The sensor continued to output data as expected and its wet cap was replaced with the anti-fouling guard around an hour before deployment. This resulted in an abrupt change in the pH readings. The sensor entered the water at 22:03 and should have sampled at 22:22, but no data have been received since 21:22. This is extremely disappointing and suggests that the sensor may have flooded.

4.8.2.5 SeaBird SBE37-IMP-ODO MicroCAT CTD sensor s/n 10535 with dissolved oxygen sensor

This is a new sensor and was also compared with the ship's CTD on CTD cast 3. It was configured to sample every 30 minutes.

4.8.2.6 SeaBird SBE37-IMP MicroCAT CTD sensors s/ns 6909, 6912

Both units were calibrated on the ship's CTD cast 3, and were configured to sample once every 15 minutes. 6909 is clamped to the buoy's keel and 6912 is in the sensor frame.

4.8.2.7 Pro-Oceanus CO2-Pro s/n 29-097-45 with SeaBird 5T pump on buoy keel

This sensor was serviced and calibrated by Pro-Oceanus in February 2013. It was clamped to the buoy's keel as shown in Figure 17, with a SeaBird 5T pump 'pushing' water through the sensor head. The water inlet and outlet holes were protected with copper mesh to reduce fouling.

This sensor and the pump are controlled by the buoy telemetry unit which is currently configured to sample every 6 hours, allowing 25 minutes for equilibration and a further 15 minutes for sampling. These values can be changed remotely via email.

5 OSMOSIS Seaglider Turnaround

Gareth Lee, Louise Biddle, Umberto Binetti, Tahmeena Aslam, Sam Ward

The plan for OSMOSIS is to deploy ocean Seagliders in pairs for a period of a full year. Each glider deployment will last four months. The Seagliders are measuring conductivity, temperature, depth (CTD), dissolved oxygen, chlorophyll *a* concentrations and Photosynthetically Active Radiation (PAR). Careful monitoring and planning will be required to maintain sufficient battery power throughout the four months. Initial estimates seem to show that the 10V science battery will most likely be the limiting factor. The plan was to depart from Southampton, UK on 14th April 2013 and steam to the Porcupine Abyssal Plain (PAP) monitoring station to recover Seagliders SG502 and SG579, deploy two gliders from SG510, SG566 and SG533 and take ship-borne measurements for conductivity, temperature, dissolved oxygen, chlorophyll *a* from the ship deployed CTD rosette, to calibrate the sensors on the Seagliders.

The OSMOSIS project entailed two Seagliders flying in a 'Butterfly' formation through five waypoints in reverse direction to one another as detailed below.

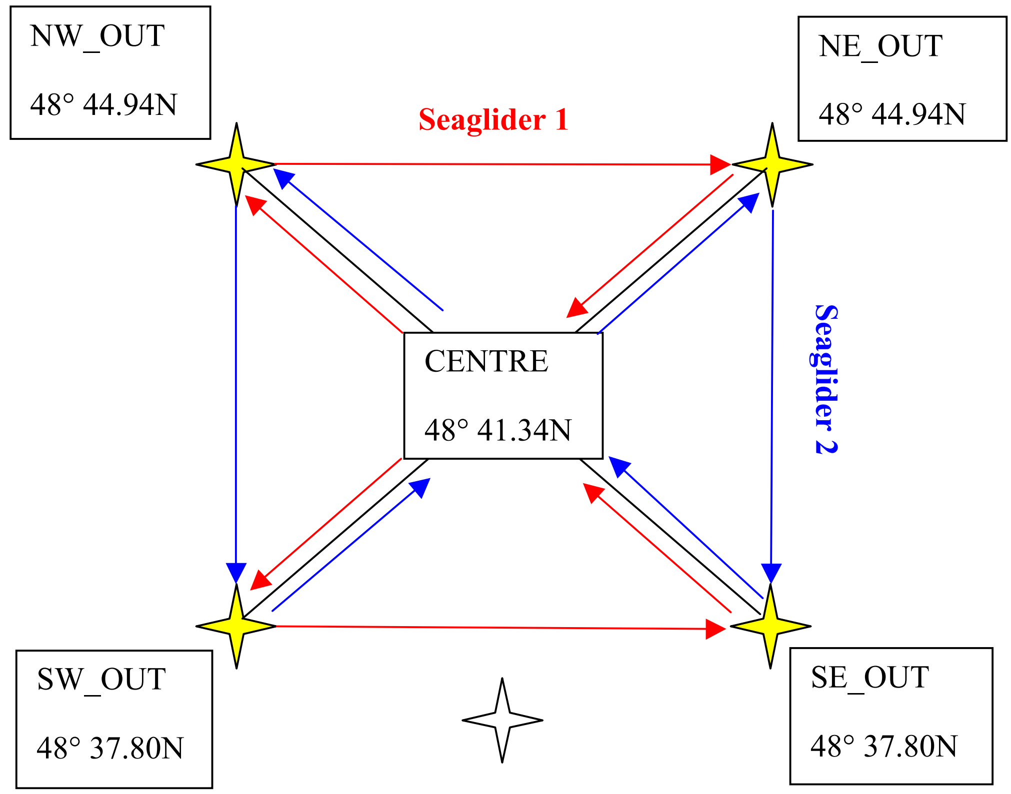


Figure 22: Seagliders flight path during the OSMOSIS campaign

Deployment Timeline

14th Apr 2013	Sailed from Southampton, UK Set up dissolved oxygen winkler titration system
15th Apr 2013	Re-ballasting of SG566 to account for lower seawater density Self tests and assembly of SG510 and SG566
16th Apr 2013	ARGOS tag setup, assembly of SG510 and SG566
17th Apr 2013	System checkout of self tests and simulated dives for SG510 and SG566 to check for pre-deployment errors
18th Apr 2013	Day lost to bad weather
19th Apr 2013	**Deployment of SG510 and SG566** Station 001, Cast 001 ship deployed CTD to 4795 m for Seaglider and ODAS buoy sensor calibration
21st Apr 2013	Station 002, cast 002 ship deployed CTD to 300 m for microcat and Seaglider calibration
23rd Apr 2013	**Recovery of SG579 and SG502** Station 21, cast 003 ship deployed CTD to 1000 m for Seaglider and ODAS buoy sensor calibration
25th Apr 2013	Station 30 cast 004-006 yo-yo ship deployed CTD to 1000m for Seaglider SG510 sensor calibration Station 31 cast 007-009 ship deployed yo-yo CTD to 1000m for Seaglider SG566 sensor calibration
26th Apr 2013	Simulated dives and self tests of SG533 in preparation for a deployment in June 2013 as part of JC087

	Begin transit to Govan, Glasgow for the end of cruise demobilisation.
29th Apr 2013	Dock in Govan, Glasgow

19th Apr 2013 <u>Deployment Day</u>

07:12 GMT	Self test on SG566 filename: <130419_SG566_prelaunchselftest.log>
08:00	Self test on SG510 filename: <130419_SG510_prelaunchselftest.log>
09:52	Sea-launch started for SG566. Problems encountered. Seaglider could not see PAR sensor. Sea-launch aborted
10:35	Sea-launch started for SG510. No problems encountered. Confirmed ready to launch at 11:10 GMT
11:53	SG510 deployed using the Rigid Rope technique **SG510 Deployment location: 48° 40.50N** **16° 20.19W**
13:00	Reinstalled QSP PAR sensor software on Seaglider as per *iRobot* technical bulletin 4383589
13:55	Self test on SG566 filename: <130419_SG566_prelaunchselftest2.log>
14:03	Sea-launch started for SG566. No problems encountered. Confirmed ready to launch at 14:14 GMT
15:02	SG566 deployed using the Rigid Rope technique, following a buoyancy test. **SG566 Deployment location: 48° 39.50N 16° 20.16W**

CTD JC085 Station 001 Cast 001

Ship deployed CTD to 4795m for 19th April 2013 06:38 to 11:01 ODAS buoy and Seaglider sensor calibration

Position of CTD **48° 40.51N**
16° 20.19W

Maximum depth of CTD 4795 m (bottom)

Depth (m)	Niskin fired	Oxygen sampled Niskin
4795	1,2,3,4	1
4000	5	5
3000	6	6
2000	7	7
1500	8	8
1000	9	9
860	10, 11	10
720	12	12
610	13, 14	13
430	15	15
200	16	16
110	17, 18	18
50	19, 20	19
30	21	
20	22	
15	23	
5	24	24

CTD JC085 Station 002 Cast 002

Ship deployed CTD to 300m for 21st April 2013 21:10 to 23:25 Microcat and Seaglider sensor calibration

Position of CTD **48° 59.46N**
16° 28.85W

Maximum depth of CTD 300 m

Depth (m)	Niskin No's	Oxygen sampled Niskin
280	1,2,3	1
200	4, 5, 6	4
150	7, 8	
100	9, 10	9
75	11, 12	
50	13, 14	
30	15, 16	15
25	17, 18	

20	19, 20	
10	21, 22	
surface	23, 24	

23rd April 2013 <u>Recovery Day</u>

13:51 to 16:35 **CTD JC085 Station 021 Cast 003**
Ship deployed CTD to 1000 m for Seaglider sensor calibration
Position of CTD **48° 37.082N**
16° 17.89W
Maximum depth of CTD 1000 m

Depth (m)	**Niskin No's**	**Oxygen sampled Niskin**
1000	1,2	1
900	3	3
840	4	4
750	5	5
610	6, 7	7
480	8	8
400	9, 10	10
320	11	11
230	12, 13	13
180	14, 15	15
100	16	16
97	17	
75	18	
50	19	19
30	20, 21	20
20	22	
10	23, 24	23

18:15 SG579 recovered using the Looped Lasso technique
SG579 Recovery position: 48° 32.875N
16° 20.048W

20:03 SG502 recovered using the Looped Lasso technique
SG502 Recovery position: 48° 33.228N
16° 27.334W

25th April 2013 YO-YO CTDs to calibrate Seaglider sensors

17:36 **CTD JC085 Station 030 Cast 004-006**

Ship deployed CTD to calibrate sensors on SG510. CTD was yo-yo'ed three times to 1000 m and back to surface, with Niskins fired on the final ascent.

Position of CTD	**48° 35.145N**
	16° 21.664W
Maximum depth of CTD	1000 m

Depth (m)	**Niskin No's**	**Oxygen sampled Niskin**
1000	1,2	1
820	3,4	3
630	5,6	5
420	7,8	7
350	9,10	9
260	11,12	11
180	13	
150	14, 15	14
120	16	
90	17	
70	18	
30	19, 20	19
10	21	

22:36 **CTD JC085 Station 031 Cast 007-009**

Ship deployed CTD to 1000 m to calibrate sensors on SG566 CTD was yo-yo'ed three times to 1000 m and back to surface, with Niskins fired on the final ascent.

Position of CTD	**48° 33.556N**
	16° 28.706W
Maximum depth of CTD	1000 m

Depth (m)	**Niskin No's**	**Oxygen sampled Niskin**
1000	1,2	1
790	3,4	3
600	5,6	5
440	7,8	7
370	9,10	9
260	11,12	11
200	13	
150	15, 16	15
100	17	
75	18	
30	19, 20	19
20	21	

10	22	
5	23	

Re-ballasting of SG566

SG566 had previously been deployed at the OSMOSIS site from September 2012 to January 2013 and then taken back to University of East Anglia for refurbishments and battery change. Previously SG566 had been ballasted for a seawater density of 1.0277 and required re-ballasting for the current seawater density of 1.0272. The calculated reduction in lead ballast required to compensate for this density change was 50 g. The fairings were removed on SG566 to locate the syntactic foam and lead ballast strips and a lead strip weighing 174.9 g was replaced with a lead strip weighing 130.0 g. The lead strip was located in exactly the same position on the pupae to avoid differences in flight characteristics. The lead strip was attached using double sided adhesive strip and scotch weatherproof tape to fasten securely. The fairings were re-installed and the Seaglider was ready for deployment. The Seaglider requires a buoyancy test before deployment to ensure the re-ballasting has been calculated correctly.

Deployment and Recovery Techniques

Deploying and recovering Seagliders is always best achieved with the use of a small boat. The boat transports the Seaglider to the desired deployment location and the Seagliders can then be hand lowered or cradled into the water and held (or tethered) whilst the fairings fill with water. Buoyancy tests can be carried out whilst the Seaglider is still tethered and, when the deployment team and pilots are ready; the Seaglider can simply be un-tethered and begin its mission. Where the use of a small boat is not possible, and Seagliders are deployed from ships, a winch is required to lower them into the water. On the RRS *James Cook*, the 5 tonne Rotzler winch (located on the Starboard A frame aft) was used to lower them into the water. This poses risk of damage to the Seaglider and a more reliable method of deployment from ships is required.

Deployment – The Rigid Rope Technique

Following the problems encountered with the deployment techniques on the previous OSMOSIS Seaglider cruise CE13001 a new technique was adopted.

On previous deployments, the rope has wound around the antenna of the seaglider and, on occasion snapped the antenna through the rolling motion of the ship. A method was required which enabled the safe deployment of Seagliders whilst minimising damage

The Rigid Rope technique involves passing a length of rope through two 2 m lengths of 25mm flexi-pipe, as used in household plumbing. The 2 m lengths of flexi-pipe act as a sheath to keep the rope rigid and eliminate tangling around the antenna. Loops are tied at either to act as a means of fixing the sling to the Sea-Catch release mechanism. The Seaglider then sits between the two lengths of pipe, creating a sling through which the Seaglider can be supported during winch operations. A sea-catch release hook is attached to the end of the winch and one loop of the sling is permanently fixed to the wire with a shackle and cannot be released. The other loop is attached to the release eye of the sea-catch. When the deployment team is satisfied that the Seaglider is ready to deploy, the sea-catch releases the Seaglider. On these deployments the Seaglider released from the sling immediately upon the fairing filling with water and the Sea-catch release was not required. It should however, be noted that if the Seaglider needs to be recovered for any reason (e.g buoyancy testing), then a heavy duty cable tie should be used to bind the two ropes together and prevent release of the Seaglider. This buoyancy test method was used for the buoyancy tests on SG566 and was extremely successful.

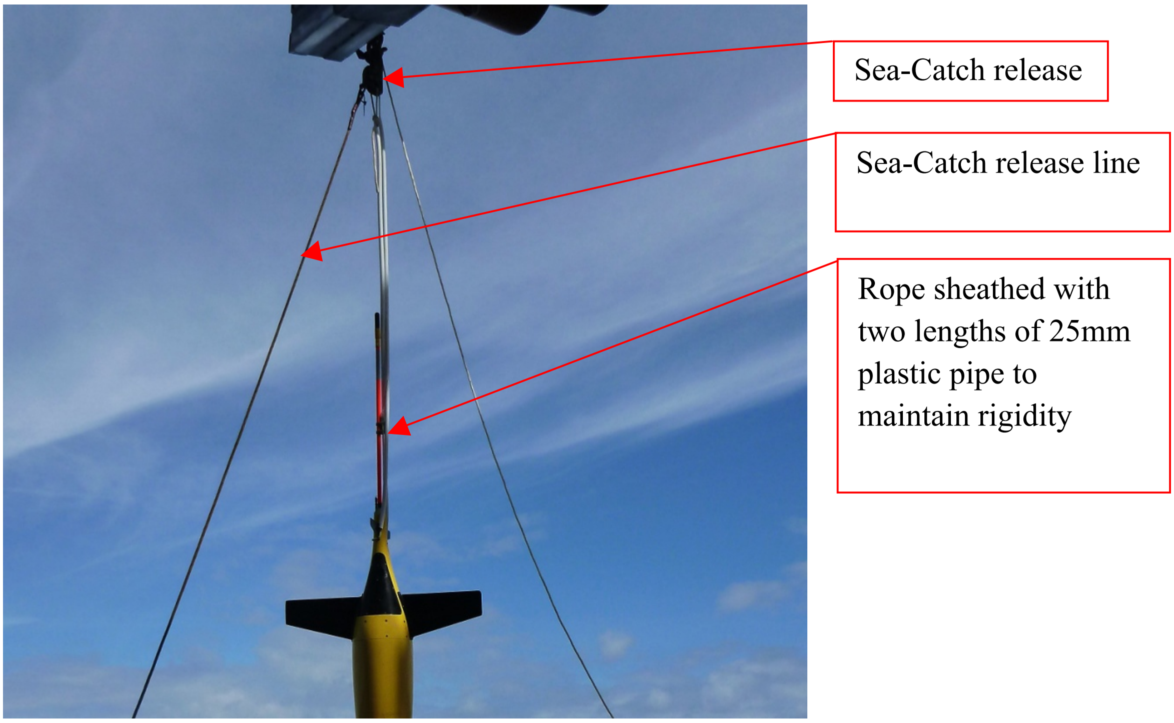


Figure 23: Deployment of SG510 Using Rigid Rope and Rotzler Winch

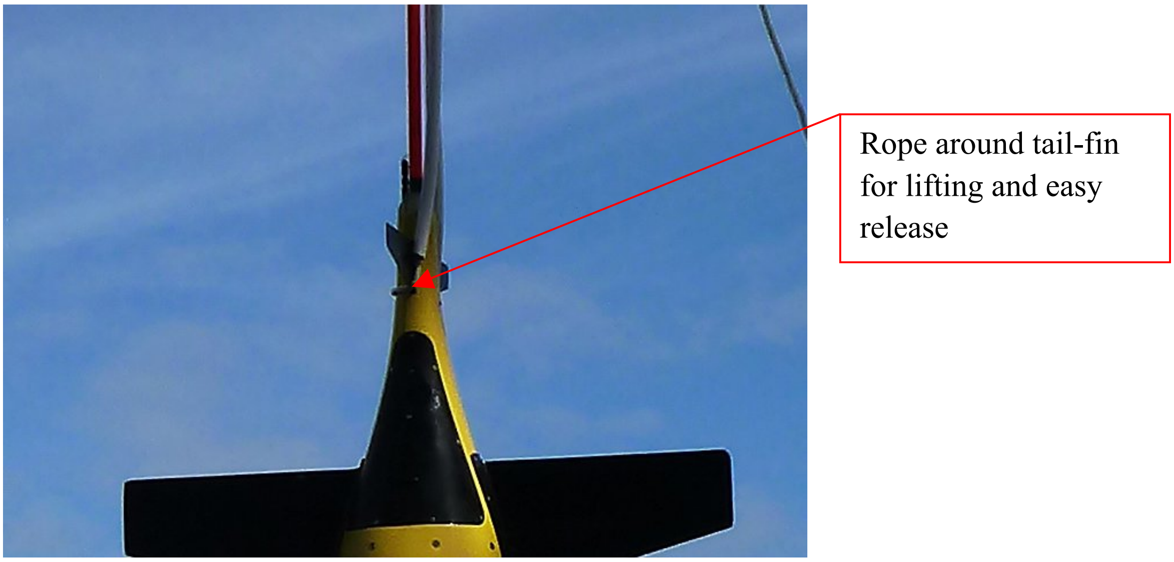


Figure 24: Close-up of Deployment Sling showing Attachment around Tail-fin for Ease of Release

Plastic tubing to stiffen rope.

The ropes are cable tied together to prevent the accidental release of the Seaglider during buoyancy testing.

Figure 25: Buoyancy Testing of SG566 Prior to Deployment

Recovery – The Recovery Loop

A 10m carbon fibre pole was modified to enable attachment of a plastic loop. The plastic loop was made from 15mm flexi pipe and had spring clips screwed inside the loop to hold the rope in place. The pole is extended to reach the water level and, once the Seaglider is alongside, the loop is placed over the Seagliders antenna, making sure to go beyond the tail-fin. The rope is then pulled to release it from the spring clips and tighten around the tailfin of the glider. Care should be maintained to avoid the Seaglider crashing against the side of the ship, while a loop is tied into the rope as a lifting point. The Seaglider can now be lifted on board the ship using the Rotzler winch. A cradle should be available to support the glider once on deck.

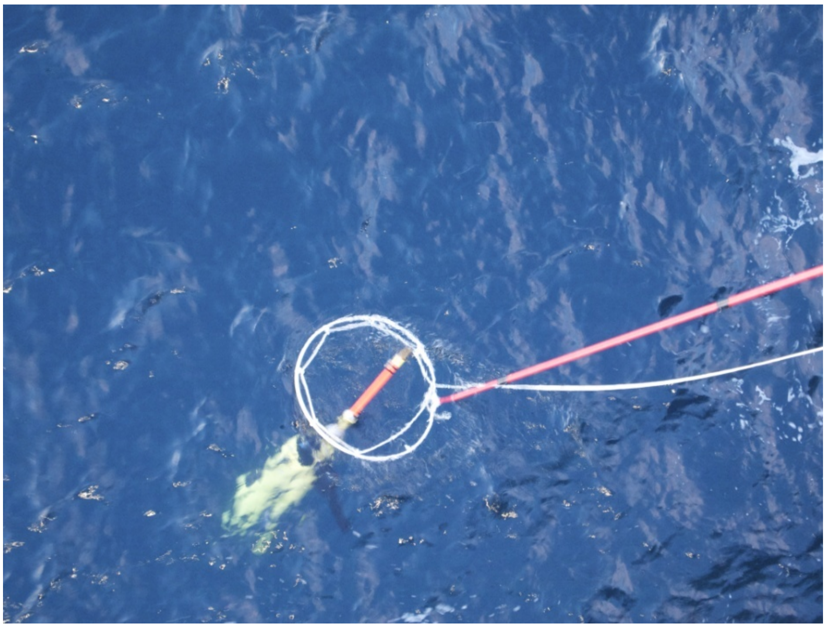


Figure 26: SG566 Recovered by the Recovery Loop

Chlorophyll Samples

Chlorophyll samples were taken from the ship deployed calibration CTDs used to calibrate the Wetlabs chlorophyll sensors on board the two Seagliders which were deployed and recovered.

Nutrient Samples

Nutrient samples were taken from the two stations around the Seaglider deployment/recovery area.

Oxygen Analysis

Oxygen samples were taken from five stations around the Seaglider deployment/recovery area. Samples were taken by inverting the glass bottle and rinsing it for 30-40 seconds with seawater from the same Niskin bottle as sampled. Once rinsed, the bottle was gently reoriented and completely filled with an amount of water 2-3 times the bottle volume. The excess of water was left to overflow, and the bottle was checked for the absence of bubbles. 1.00 cm^3 of 3.0 mol dm^{-3} Manganese Chloride Tetrahydrate ($MnCl_2$) and 1.00 cm^3 4.0 mol dm^{-3} Sodium Iodide/ 8.0 mol dm^{-3} Sodium Hydroxide (NaOH/NaI) was added to fix the oxygen. Bottles were subsequently sealed with the corresponding stopper and vigorously shaken to mix the reagent with the sample. The Shaking was repeated after

20-30 min and then the bottles were left for 12 hours -1 day to let the precipitate settle at the bottom. The stopper was then removed and 1.00 cm^3 of 5.0 mol dm^{-3} Sulphuric acid (H_2SO_4) was added to the sample together with a magnetic stir bar. The titration was performed with 0.20 mol dm^{-3} Sodium thiosulfate pentahydrate ($Na_2S_2O_3$. 5H2O) after most of the precipitate has dissolved, liberating iodine until the equivalence point was reached.

Burettes were flushed before each titration to get rid of the bubbles for at least 5 minutes (10 minutes when first unpacked).

Sodium thiosulfate standardization was performed three times during the cruise. In this case MilliQ water was poured into an iodine flask with a magnetic stirring bar. Then reagents were added in the order of 1.000 cm^3 of "standard" 23.36 mol dm^{-3} Potassium Iodide (KIO_3) solution by Dosimat, 1.00 cm^3 of H_2SO_4 5 mol dm^{-1}, 1.00 cm^3 of the NaOH/NaI and 1.00 cm^3 of $MnCl_2$. Flasks were then filled to the neck with MilliQ. Solution was titrated to the equivalence point with $Na_2S_2O_3$ and final volume of titrant added was recorded.

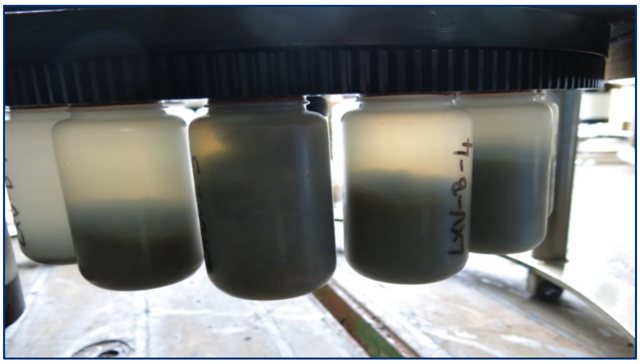
Blank determination was performed three times during the cruise. MilliQ water was poured into an iodine flask, together with a magnetic stirring bar. 1.000 cm^3 of "blank" KIO_3 solution (by pipette), 1.00 cm^3 of H_2SO_4 5 mol dm^{-1}, 1.00 cm^3 of the NaOH/NaI and 1.00 cm^3 of $MnCl_2$ was then added. The Flask was filled to the neck with MilliQ water. The Solution was titrated to the equivalence point with $Na_2S_2O_3$ and final volume of titrant added was recorded. An additional 1.000 cm^3 of "blank" KIO_3 was pipetted in the solution and the titration was repeated. Blank volume was measured as the difference between the first and second $Na_2S_2O_3$ titrant volume.

6 Sediment Trap Mooring PAP#3

Corinne Pebody

6.1 Recovery

The PAP#3 sediment trap mooring was recovered on 20th May 2013. Traps A, B and C were recovered successfully, although trap C was delayed a little by a tangle with the microcat which should have been deeper than the trap but was recovered first. It was apparent immediately that there had been some very high flux events during summer 2012, with bottles being very nearly full in corresponding bottles on all three traps.



The traps were recovered in the evening with trap C making it on deck at 23:02. The traps were covered and made safe so the bottles could be safely removed the following day.

The bottles were removed and a lid screwed on before removing to the chemical lab.

The bottles were photographed (see Figure 28), the pH checked and the height of the flux measured. Then 1ml of formalin was added before the bottles were sealed with parafilm, the lids replaced and samples stored in the fridges.

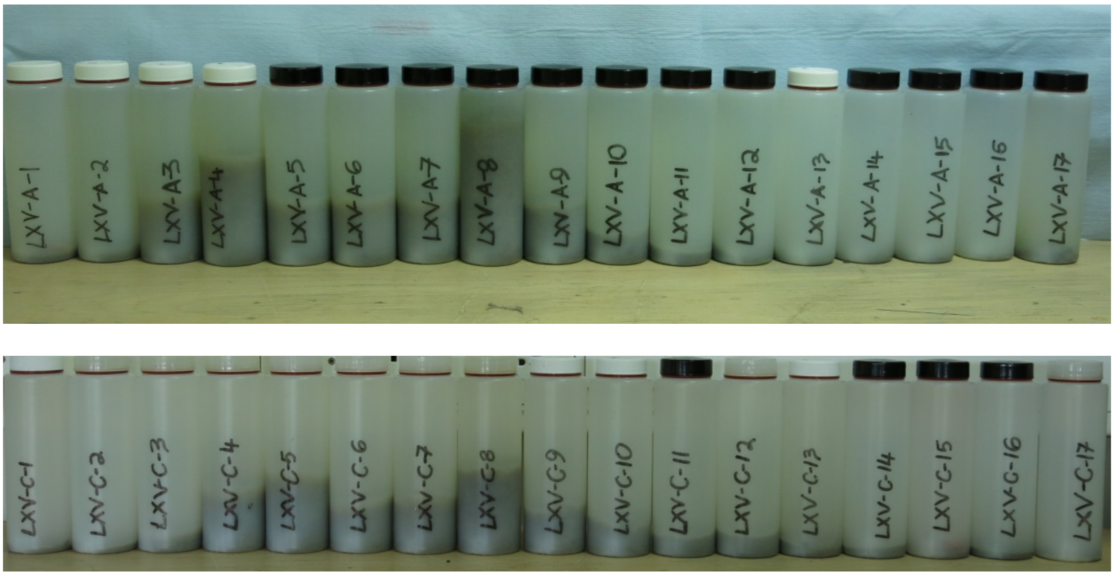


Figure 28: Bottles Recovered from Sediment Traps

Both traps A (3000m) and C (100mab) show similar flux profiles. In both traps the first nine bottles were programmed to trap for two weeks only, starting from May 2012. They show a slight flux initially increasing steadily until August when there was a large flux between 19th August 2012 and 2nd September 2012. These may turn out to be some of the largest fluxes we have ever recorded at PAP.

The data loggers were downloaded however, trap B (s/n 520) wouldn't download properly though it did appear to be on the correct bottle so has apparently turned as programmed throughout the deployment.

LXV trap A 3000m PAP

pap 2012-2013
JC071

Event 01 of 22 @ 05/06/2012 12:00:00
Event 02 of 22 @ 05/20/2012 12:00:00
Event 03 of 22 @ 06/03/2012 12:00:00
Event 04 of 22 @ 06/17/2012 12:00:00
Event 05 of 22 @ 07/01/2012 12:00:00
Event 06 of 22 @ 07/15/2012 12:00:00
Event 07 of 22 @ 07/29/2012 12:00:00
Event 08 of 22 @ 08/12/2012 12:00:00
Event 09 of 22 @ 08/26/2012 12:00:00
Event 10 of 22 @ 09/09/2012 12:00:00
Event 11 of 22 @ 09/30/2012 12:00:00
Event 12 of 22 @ 10/21/2012 12:00:00
Event 13 of 22 @ 11/25/2012 12:00:00
Event 14 of 22 @ 12/30/2012 12:00:00
Event 15 of 22 @ 02/03/2013 12:00:00
Event 16 of 22 @ 03/10/2013 12:00:00
Event 17 of 22 @ 04/07/2013 12:00:00
Event 18 of 22 @ 04/28/2013 12:00:00
Event 19 of 22 @ 05/19/2013 12:00:00
Event 20 of 22 @ 06/09/2013 12:00:00
Event 21 of 22 @ 06/30/2013 12:00:00
Event 22 of 22 @ 07/21/2013 12:00:00

LXV
PAP trap C 100mab
2012-2013

Event 01 of 22 @ 05/06/2012 12:00:00
Event 02 of 22 @ 05/20/2012 12:00:00
Event 03 of 22 @ 06/03/2012 12:00:00
Event 04 of 22 @ 06/17/2012 12:00:00
Event 05 of 22 @ 07/01/2012 12:00:00
Event 06 of 22 @ 07/15/2012 12:00:00
Event 07 of 22 @ 07/29/2012 12:00:00
Event 08 of 22 @ 08/12/2012 12:00:00
Event 09 of 22 @ 08/26/2012 12:00:00
Event 10 of 22 @ 09/09/2012 12:00:00
Event 11 of 22 @ 09/30/2012 12:00:00
Event 12 of 22 @ 10/21/2012 12:00:00
Event 13 of 22 @ 11/25/2012 12:00:00
Event 14 of 22 @ 12/30/2012 12:00:00
Event 15 of 22 @ 02/03/2013 12:00:00
Event 16 of 22 @ 03/10/2013 12:00:00
Event 17 of 22 @ 04/07/2013 12:00:00
Event 18 of 22 @ 04/28/2013 12:00:00
Event 19 of 22 @ 05/19/2013 12:00:00
Event 20 of 22 @ 06/09/2013 12:00:00
Event 21 of 22 @ 06/30/2013 12:00:00
Event 22 of 22 @ 07/21/2013 12:00:00

6.2 Deployment

Deployment of PAP#3 was on 21st April 2013, this was apparently successful. Three traps had initially been programmed to open at midday on 21st April 2013, but because they were unlikely to be in position by that time, they were all reprogrammed to open on 22nd April 2013 at midday. We are also deploying an additional inverted trap at 3000m. This trap (D) was deployed inverted and the preservative was prepared using hyposaline Sediment Trap Preservative. Its role is to attempt to collect any upward flux, for example buoyant eggs of benthic organisms. The fourth trap logging/control unit was unable to turn the carousel to top up the bottles.

When examined by sea systems (Chris Crowe) the circuit board was slightly corroded so the logger (S/N: ML12432-04) from a recovered trap was rebatteried and used for the 2013/4 deployment.

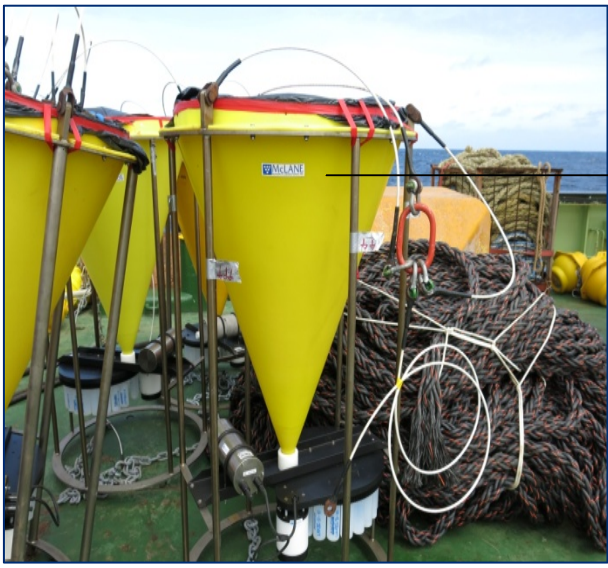


Figure 29: Trap D, inverted and using hyposaline STP, showing the 'this way up' labels to identify it for deployment.

LXVIII A
PAP 3000M JC085
2013/14

Event 1 of 22 = 04/22/113 12:00:00
Event 2 of 22 = 05/05/113 12:00:00
Event 3 of 22 = 05/19/113 12:00:00
Event 4 of 22 = 06/02/113 12:00:00
Event 5 of 22 = 06/16/113 12:00:00
Event 6 of 22 = 06/30/113 12:00:00
Event 7 of 22 = 07/14/113 12:00:00
Event 8 of 22 = 07/28/113 12:00:00
Event 9 of 22 = 08/11/113 12:00:00
Event 10 of 22 = 08/25/113 12:00:00
Event 11 of 22 = 09/08/113 12:00:00
Event 12 of 22 = 09/29/113 12:00:00
Event 13 of 22 = 11/03/113 12:00:00
Event 14 of 22 = 12/08/113 12:00:00
Event 15 of 22 = 01/12/114 12:00:00
Event 16 of 22 = 02/16/114 12:00:00
Event 17 of 22 = 03/23/114 12:00:00
Event 18 of 22 = 04/13/114 12:00:00
Event 19 of 22 = 05/04/114 12:00:00
Event 20 of 22 = 05/25/114 12:00:00
Event 21 of 22 = 06/15/114 12:00:00
Event 22 of 22 = 07/06/114 12:00:00

LXVIII B
PAP 3000M JC085
2013/14

Event 01 of 14 = 04/22/13 12:00:00
Event 02 of 14 = 05/12/13 12:00:00
Event 03 of 14 = 06/02/13 12:00:00
Event 04 of 14 = 06/23/13 12:00:00
Event 05 of 14 = 07/14/13 12:00:00
Event 06 of 14 = 08/04/13 12:00:00
Event 07 of 14 = 02/09/14 12:00:00
Event 08 of 14 = 03/02/14 12:00:00
Event 09 of 14 = 03/23/14 12:00:00

Event 10 of 14 = 04/13/14 12:00:00
Event 11 of 14 = 05/04/14 12:00:00
Event 12 of 14 = 05/25/14 12:00:00
Event 13 of 14 = 06/15/14 12:00:00
Event 14 of 14 = 07/06/14 12:00:00

LXVIII C
PAP 100MAB JC085
2013/14

Event 1 of 22 = 04/22/2013 12:00:00
Event 2 of 22 = 05/05/2013 12:00:00
Event 3 of 22 = 05/19/2013 12:00:00
Event 4 of 22 = 06/02/2013 12:00:00
Event 5 of 22 = 06/16/2013 12:00:00
Event 6 of 22 = 06/30/2013 12:00:00
Event 7 of 22 = 07/14/2013 12:00:00
Event 8 of 22 = 07/28/2013 12:00:00
Event 9 of 22 = 08/11/2013 12:00:00
Event 10 of 22 = 08/25/2013 12:00:00
Event 11 of 22 = 09/08/2013 12:00:00
Event 12 of 22 = 09/29/2013 12:00:00
Event 13 of 22 = 11/03/2013 12:00:00
Event 14 of 22 = 12/08/2013 12:00:00
Event 15 of 22 = 01/12/2014 12:00:00
Event 16 of 22 = 02/16/2014 12:00:00
Event 17 of 22 = 03/23/2014 12:00:00
Event 18 of 22 = 04/13/2014 12:00:00
Event 19 of 22 = 05/04/2014 12:00:00
Event 20 of 22 = 05/25/2014 12:00:00
Event 21 of 22 = 06/15/2014 12:00:00
Event 22 of 22 = 07/06/2014 12:00:00

LXVIII D INVERTED	Event 10 of 22 = 08/25/2013 12:00:00
PAP TRAP D3000M	Event 11 of 22 = 09/08/2013 12:00:00
JC085 2013/14	Event 12 of 22 = 09/29/2013 12:00:00
	Event 13 of 22 = 11/03/2013 12:00:00
Event 1 of 22 = 04/22/2013 12:00:00	Event 14 of 22 = 12/08/2013 12:00:00
Event 2 of 22 = 05/05/2013 12:00:00	Event 15 of 22 = 01/12/2014 12:00:00
Event 3 of 22 = 05/19/2013 12:00:00	Event 16 of 22 = 02/16/2014 12:00:00
Event 4 of 22 = 06/02/2013 12:00:00	Event 17 of 22 = 03/23/2014 12:00:00
Event 5 of 22 = 06/16/2013 12:00:00	Event 18 of 22 = 04/13/2014 12:00:00
Event 6 of 22 = 06/30/2013 12:00:00	Event 19 of 22 = 05/04/2014 12:00:00
Event 7 of 22 = 07/14/2013 12:00:00	Event 20 of 22 = 05/25/2014 12:00:00
Event 8 of 22 = 07/28/2013 12:00:00	Event 21 of 22 = 06/15/2014 12:00:00
Event 9 of 22 = 08/11/2013 12:00:00	Event 22 of 22 = 07/06/2014 12:00:00

7 Zooplankton Net Sampling

Corinne Pebody

The WP2, 200μm net was weighted with approximately 8kg of weight, the bridles were wire, but the strings at the side permitted only a small amount of weight. The net was checked for twists and that the tap was closed, then the net was lowered over the side. Maximum depth was 200meters where the deployment was paused for a minute to allow the net to hang straight before being brought up at approx. 10 metres per minute. The after starboard A frame Rotzler winch was used, with 225m of 8mm Kevlar rope. There was no speed indicator so the rate was therefore controlled by eye. On recovery the net was hosed down from the outside with filtered seawater and the cod end emptied into a white bucket. Hosing was repeated and time allowed for zooplankton to settle into the bottom of the cod end. Samples were then either, transferred to a1 litre bottle and preserved by adding borax buffered formalin to an approximate concentration of 5%. Alternatively the sample was sieved through a 200 μm mesh and transferred to cryo vials and stored in the -80°C freezer.

Figure 30:Deployment of Net

Future work:

At NOC, formalin preserved samples will be split with a Folsom splitter. A sub sample will be picked to remove zooplankton greater than 2mm. Remaining meso zooplankton will be analysed using flow cam technology.

Station ID					
JC085 - 04	midnight sample	preserved in formalin 2 bottles			
net shot		19/04/2013	22:10	48 50.329	16 31.127
at deepest point		19/04/2013	22:30		
at surface		19/04/2013	22:50	48 50.329	16 31.127

Station ID					
JC085 - 05	midnight sample	samples into freezer			
net shot		19/04/2013	22:53	48 50.329	16 31.127
at deepest point		19/04/2013	23:00		
at surface		20/04/2013	23:15	48 50.330	16 31.126

Station ID					
JC085 - 16	noon sample	preserved in formalin 2 bottles			
net shot		22/04/2013	12:50	48 59.31	16 30.00
at deepest point		22/04/2013	12:56		
at surface		25/04/2013	13:15	48 59.31	16 30.00

Station ID					
JC085 - 17	noon sample	preserved in freezer, but some jellies			
net shot		22/04/2013	14:35	48 59.31	16 30.00
at deepest point		22/04/2013	14:45		
at surface		22/04/2013	14:57	48 59.31	16 30.00

Station ID					
JC085 - 18	noon sample	preserved in formalin 2 bottles			
net shot		22/04/2013	15:03	48 59.31	16 30.00
at deepest point		22/04/2013	15:08		
at surface		25/04/2013	15:20	48 59.31	16 30.00

Station ID					
JC085 - 23	noon sample	preserved in formalin, nb long pause on deck to find hose			
net shot		24/04/2013	11:05	48 56.82	16 35.98
at deepest point		24/04/2013	11:11		
at surface		24/04/2013	11:44		

Station ID					
JC085 - 24	noon sample	samples into freezer			
net shot		24/04/2013	11:47	48 56.82	16 35.99
at deepest point		24/04/2013	11:50		
at surface		24/04/2013	12:03	48 56.82	16 35.99

Station ID					
JC085 - 26	midnight sample	preserved in formalin 3 bottles			
net shot		25/04/2013	00:28	48 50.140	16 31.604
at deepest point		25/04/2013	00:39	48 50.141	16 31.602
at surface		25/04/2013	00:48	48 50.141	16 31.604

Station ID					
JC085 - 27	midnight sample	preserved in formalin 2 bottles			
net shot		25/04/2013	00:54	48 50.139	16 31.600
at deepest point		25/04/2013	01:02	48 50.140	16 31.004
at surface		25/04/2013	01:15	48 50.139	16 31.604

8 Benthic Studies

Brian Bett, David Bailey, Stefanie Kaiser, Jen Durden, Zan Milligan, Matteo Ichino, Paris Stefanoudis and Madeleine Brasier

The primary objective of the benthic team was to continue long-term time-series observations of the benthos and demersal fish at the Porcupine Abyssal Plain Sustained Observatory site. This programme dates back to RRS *Discovery* cruise 185 in 1989, with earlier investigations of the site having been carried out from RRS *Challenger* cruises 6A (1985) and 8 (1986). In terms of the ecology of abyssal fauna, this site has an internationally unique longevity of study. Our planned operations should span the full size spectrum of the benthos, from prokaryotes to fish. The general location and setting of the study area, comprising abyssal plain and abyssal hills, is illustrated in the chart below (Figure 31).

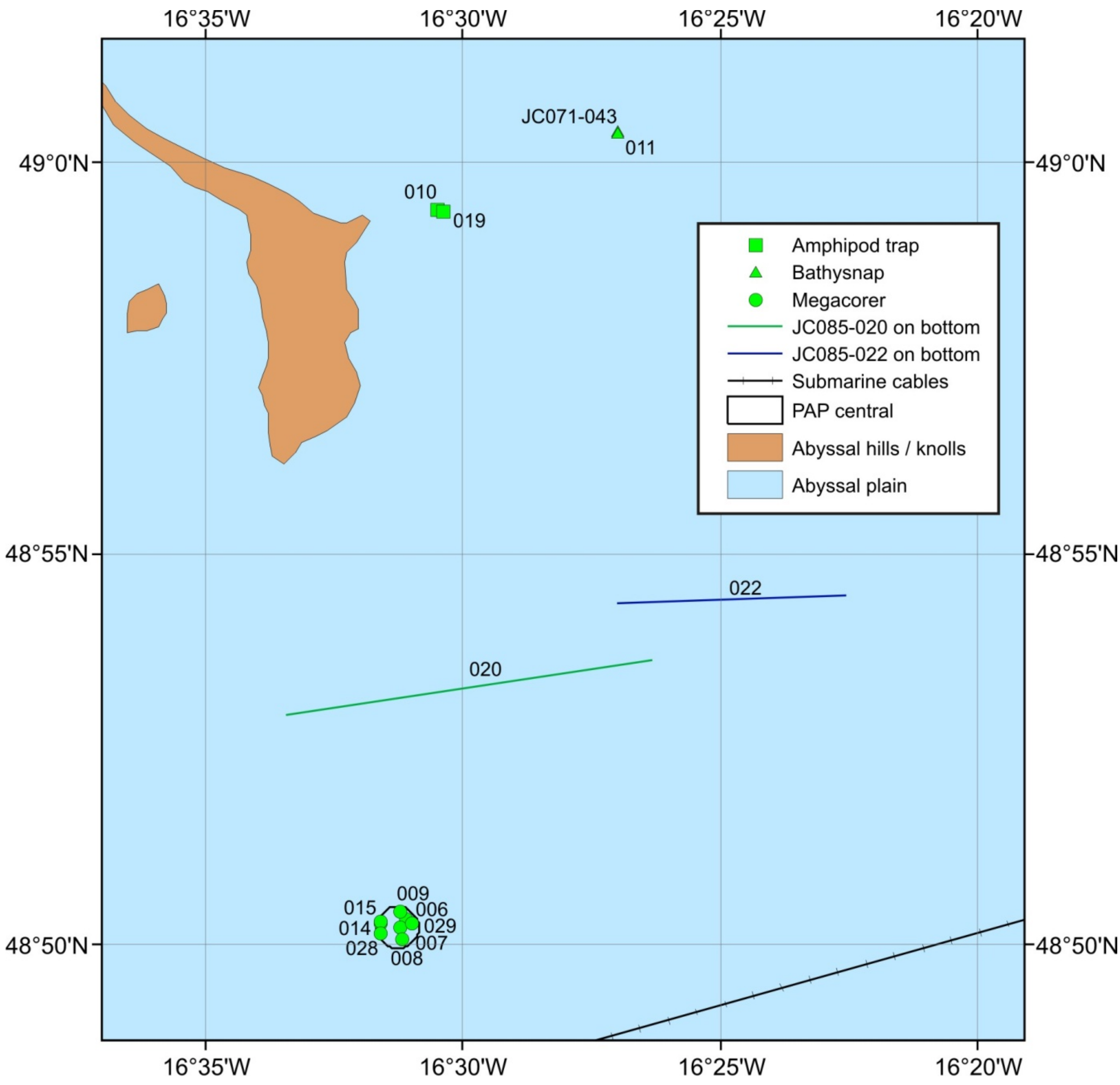


Figure 31: Chart of Study Area and Benthic Operations. (Location Numbering Refers to JC085-xxx Stations unless otherwise indicated).

8.1 Aims

- Five Megacore deployments at PAP central location
- Two Otter trawl (OTSB14) deployments in PAP trawl area
- Recover Bathysnap JC071-043 (deployed 6 May 2012 from JC071)
- Deploy long-term Bathysnap in PAP mooring area
- Two amphipod trap deployments in PAP mooring area

8.2 Megacorer

OBE Deepseas Group Megacorer was rigged and operated in conventional fashion (with 4 additional lead ballast plates fitted). The corer was deployed with an 8+2 core arrangement, i.e. with eight 10cm ID tubes and two 59mm ID tubes fitted. Ten randomly selected coring sites were identified within a 500m radius of the nominal coring centre point (48° 50.219' N 16° 31.266' W) using the random points function of ArcGIS (seven of these sites were subsequently sampled; see Figure 32).

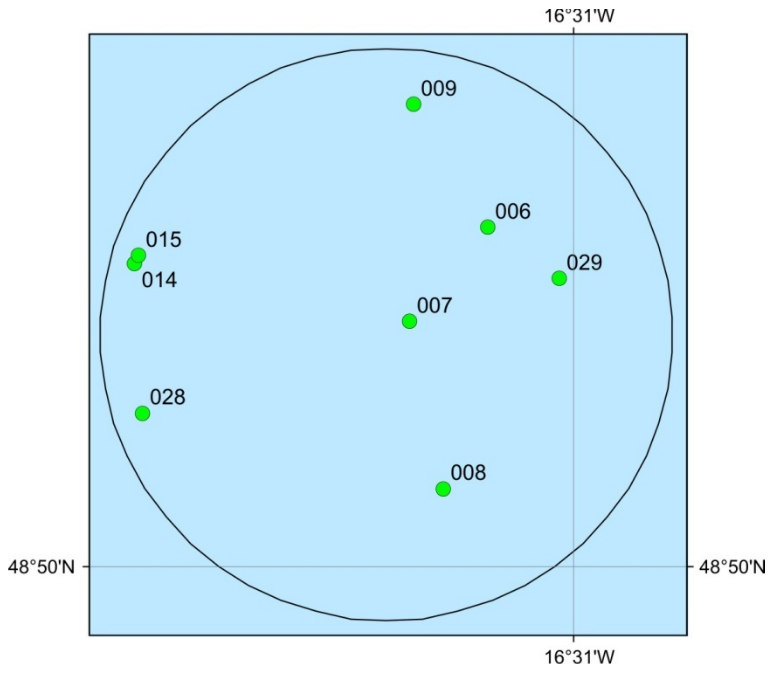


Figure 32: Chart of Megacorer Operations at the PAP Central location (scale: the indicated coring area is 1000m in diameter).

8.2.1 Sampling Protocols

Macrobenthos; all available 10cm ID core tubes from each drop were processed for macrobenthos. Water in the top of each core tube was siphoned / syringed out and run through a 300um sieve. Sieve residue was added to the 0-1cm horizon sample. The core was sliced into 0-1, 1-3, 3-5, 5-10 and 10-15cm horizons. Slices of 1 or 2cm thickness were placed in labelled 500mL containers, and 5cm slices were placed in labelled 1.5L containers. All slicing materials (knife, cutting guide, slicing plate, funnel) were washed into the sample containers with filtered seawater. Samples were preserved in 10% buffered formalin.

Forams; one 59mm ID tube was sliced for Foraminifera. Water immediately above the sediment was syringed out and added to the 0-0.5cm sample. The core was sliced into 0-0.5, 0.5-1.0, 1.0-1.5, 1.5-2.0, 2-3, 3-4, 4-5, 5-6, 6-7, 7-8, 8-9, 9-10cm horizons, and stored in 10% buffered formalin. All sampling equipment was washed with filtered seawater between slices.

Prokaryotes; when a second 59mm ID tube was recovered, it was processed for prokaryotes. Disposable gloves were worn for sample preparation. All slicing equipment was washed with ethanol prior to each slice. The core was sliced into 0-1, 1-2, 2-3, 3-5, 5-10 and 10-15cm horizons, and each was placed in a sealing plastic bag. All sample bags were double-bagged, then collected in a larger bag and placed in the -80 °C freezer.

8.2.2 Deployments

JC085-006; random site 1; 10/10 tubes returned fired and with samples (good core lengths 34-42cm); one small tube sample was discarded as too disturbed from core slippage (one bottom closer spring had snapped); 8 large tubes sampled for macrobenthos. 1 small tube sampled for forams.

JC085-007; random site 2; all tubes fired, but three empty and three with badly slipped and / or fractured sediment columns (good core lengths 22-42cm); 3 large tubes sampled for macrobenthos. 1 small tube sampled for forams (a little disturbed).

JC085-008; random site 3; 9/10 tubes returned fires and with samples (good core lengths 32- 42cm); one tube not fired; 7 large tubes sampled for macrobenthos, 1 for forams, and 1 for prokaryotes.

JC085-009; random site 4; 9/10 tubes returned fired, but one empty (good core lengths 38-42cm); 7 large tubes sampled for macrobenthos, and 1 for forams.

JC085-014; random site 5; up to 6m heave on the ship during near-bottom operations; returned with only 4 fired, 2 with samples; 6 did not fire and 2 fired but were empty (all strings were pulled); 1 small tube sampled for forams.

JC085-015; random site 5 (repeat deployment); all cores fired and sampled, but 3 slipped / cloudy; (good core lengths 14-41cm) 6 sampled for macrobenthos and 1 for forams.

JC085-028; random site 7; very nice cores; although 4 did not fire; (good core lengths 40-42cm); 5 sampled for macrobenthos, and 1 for forams.

JC085-029; random site 8; very nice cores; all fired and retained, but one small tube with big fracture in sediment column - discarded; (good core lengths 17-40cm); 8 sampled for macrobenthos, and 1 for forams.

All of the cores recovered had a 'typical' PAP central profile, light brown upper section (c. 30cm), over narrow (c. 2cm) darker band, with sharp discontinuity to cream-coloured clay below (see Fig. bjb3). Retained samples were as follows:

Station	Random site	Macrobenthos samples Cores (area, cm^2)	Foram samples Cores (area, cm^2)	Prokaryote samples
JC085-006	1	8 (628)	1 (27.3)	-
JC085-007	2	3 (236)	1 (27.3)	-
JC085-008	3	7 (550)	1 (27.3)	1
JC085-009	4	7 (550)	1 (27.3)	-
JC085-014	5	-	1 (27.3)	-
JC085-015	5	6 (471)	1 (27.3)	-
JC085-028	7	5 (393)	1 (27.3)	-
JC085-029	8	8 (628)	1 (27.3)	-

Figure 33: Example Core Profile Photographs from PAP Central Megacorer Deployments during JC085. (scale: core tubes have an internal diameter of 100mm; the white card in view has a length of 176mm).

8.3 Otter Trawl

A semi-balloon otter trawl (Marinovich-type) with a 14m headrope was employed (known as an OTSB14). The net and rigging were supplied by NMF-SS. The trawl doors and acoustic trawl monitor were supplied by OBE Deepseas group. The monitor's pressure transducer was 'wire tested' during CTD deployment JC085-001, and trace separation calibrated against metres of seawater as output from the CTD deck unit (see Figure 34). The tilt sensors in the monitor were assessed in the lab (see Figure 35).

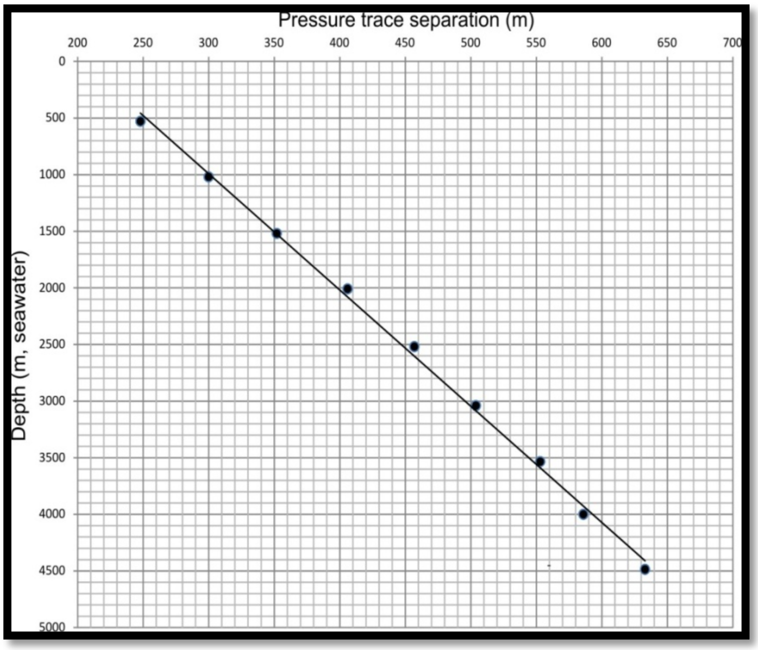


Figure 34: Acoustic trawl monitor pressure transducer calibration

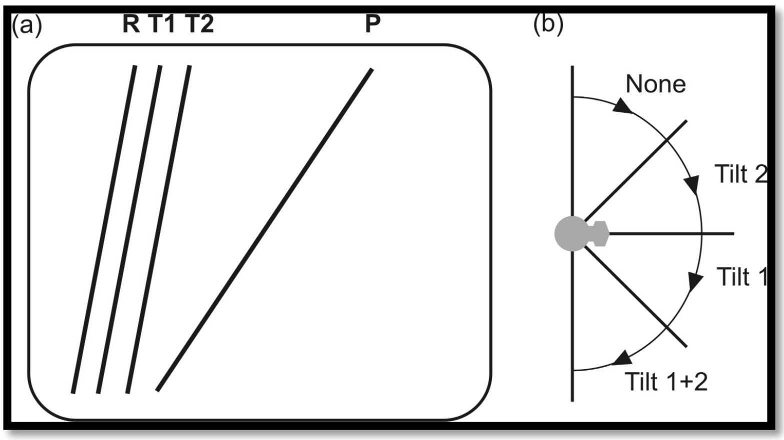


Figure 35: Acoustic trawl monitor tilt sensor responses. (a) Waterfall display representation, R – reference trace; T1 – tilt 1 (70m separation); T2 – tilt 2 (140m separation); P – pressure; (b) tilt angle diagram, e.g. with transducer mushroom horizontal to 45º below horizontal tilt 1 is activated etc.

8.3.1 Deployments

JC085-020; the payout phase was at ship's speed over the ground of c. 5kn and wire rate of 50m/min, this produced a rather high scope (5); ship's speed was reduced by half a knot and wire rate increased to 55 m/min to reduce the scope. Telemetry was lost at c. 9250 mwo, when scope was c. 4. Final wire out was 11400, and ship was slowed to 1knt for landing. Net landed about 30mins later. Ship's speed was increased to 1.5 knots. Wire tension increased quite rapidly to 7+T. Winch auto-rendered some wire. Ship's speed reduced to 1knt and later to just steerage to ease tension. Hauling rate was then slowly increased and the net recovered without further incident. A good if somewhat muddy catch of invertebrates was returned, fish were not well represented.

JC085-022; the payout phase was at ship's speed over the ground of c. 4knts and and wire rate of 50m/min, this produced a scope of c. 3.5. Telemetry was lost at c. 10000 mwo. Final wire out was 11000, ship's speed was reduced to 1.5knts for landing. The net landed c. 30 mins later. Ship's speed was increased to 2knts. The net lifted quite quickly (ship's speed 2knts, hauling rate 15 m/min, 10600 mwo). On recovery, some metal wreckage was caught in the starboard wing of the net and the codend seen to be strangled with the catch in the body of the net. On inspection it was found that the codend had looped twice through the loop of the lazy decky. The catch was very clean and rather limited in invertebrates; fish were better represented than stn. 020, and there was a fair haul of clinker.

Note the net design was a slight variant over that used in previous years in respect of the lazy decky arrangement. Previously, the lazy deck has been connected to two netting bridles sown into the body of the net. The pattern used during this cruise had the lazy decky run through a series of rings around the net (as per the codend closure) and made into a large soft eye. The previous pattern would carry a lesser risk of the codend being strangled as per stn. 022. As a future precaution with the current pattern of net it may be possible to tape the lazy decky to the outer netting while it is being stretched wide to prevent such strangulation.

Layback calculations for net positions and distance run on seabed were made using the 'buffer' command in ArcGIS.

8.3.2 Catch and Samples Comments

Invertebrate Nenthos – the catches appeared to be broadly comparable with those of recent (i.e. post-'*Amperima* event') years. The top five taxa in term of biovolume were: *Psychropotes*, *Pseudostichopus*, *Oneirophanta*, Actiniaria spp., and Asteroidea spp. The catch was rough sorted aboard and all material preserved in 10% Borax buffered formalin (3.8% formaldehyde) for return to the *Discovery Collections* (contact: Tammy Horton) at NOC.

Fish – (see Figure 36) demersal fish were collected from both trawls. As in JC062, the warp cable was too short (12km) to allow us to tow the net on the seabed at the preferred speed for catching fish, making comparison with previous catches difficult. The problems with winch tension in trawl JC085-20 will have had particular issues for fish capture as most fish in the net would have escaped when the net was stationary.

The specimens obtained did include the expected range of demersal fish, predominantly grenadiers (Macrouridae). JC085-020: The four demersal fish specimens were tentatively identified using Fishes of the North Atlantic and Mediterranean as *Coryphaenoides armatus* and *C. profundicolus*, although damage to the pelvic fins made definitive ID difficult for some specimens. JC085-022: Ten demersal specimens were collected. Tentative species IDs were *C. profundicolus, C. leptolepis, C. mediterraneus* and *Histiobranchus bathybius*. Pelagic species included specimens of gulper eels, angler fish (female), Nettastomatidae and hatchetfish. All fish were retained, preserved in formalin and will be curated by the Hunterian Museum at the University of Glasgow. Contact david.bailey@glasgow.ac.uk, 0141 330 8183 for details.

Figure 36: Examples of demersal fish collected during JC085:-

(a) Coryphaenoides armatus*;*
(b) Coryphaenoides profundicolus;
(c) Coryphaenoides mediterraneus*;*
(d) Coryphaenoides leptolepis;
(e) Histiobranchus bathybius

Clinker & artefacts– (see Figures 37 & 38)

JC085-020; Clinker 33kg, artefacts 11kg (cloth, gloves, cans, plastic pipette, glass bottles, plate, glass pieces, plastic items).

JC085-022; Clinker 68kg, artefacts 12kg (large metal item [not weighed], glass bottles, can, bubble wrap, crockery, misc. glass and plastic.

Figure 37: Example of Clinker Recovered in Trawls (stn. JC085-022)

Figure 38: Artefacts Recovered in Trawls

8.4 Bathysnap

8.4.1 Recovery

Deployed as JC071-043 on 6th May 2012. The mooring was released at 17:39 on 19th April 2013, and surfaced at c. 19:20. The system was successfully recovered and was in generally good condition throughout. The camera was downloaded and 1045 seabed photographs recovered (one black frame), the first recorded at 13:49 6th May 2012, and the last 12:30 19th April 2013. At time of download the camera clock was 02:22 behind ship's time (i.e. UTC; camera time 20:30, ship's time 22:52).

8.4.2 JC071-043 Observations

General fauna; (see Figure 39) as is to be expected at PAP, the observed benthic fauna was dominated by holothurians (*Amperima*, *Benthodytes, Enypniates, Oneirophanta, Peniagone, Pseudostichopus)*, with 'wandering' anemones and *Munidopsis* (squat lobster) also frequently observed. A single pycnogonid (giant sea spider) and a single rattail fish were also observed. A number of photographs captured the sediment surface feeding activity of an echiuran worm (green, bifurcate proboscis).

Echiuran activity; (see Figure 40) 16 images capture the sediment surface feeding activity of an echiuran worm, between 30/10/12 and 17/03/13. The burrow from which the proboscis emerges is not visible before the first image of the proboscis (13:09 30/10/12), in which there is also a very slight mounding of the sediment surface adjacent to the burrow opening. A further 14 images show the proboscis emerging from the same burrow until 04:55 01/01/13. A further image (12:38 17/03/13) shows, potentially, the same proboscis emanating from a new burrow outside the field of view of the camera.

Phytodetritus; (see Figure 41) significant phytodetritus accumulations are evident during this deployment; large aggregates are observed in June (2012), with small patches developing in July, an extensive carpet with further large aggregates is present in August, the carpet thins though September-November.

Figure 39: Examples of the fauna photographed from Bathysnap JC071-043

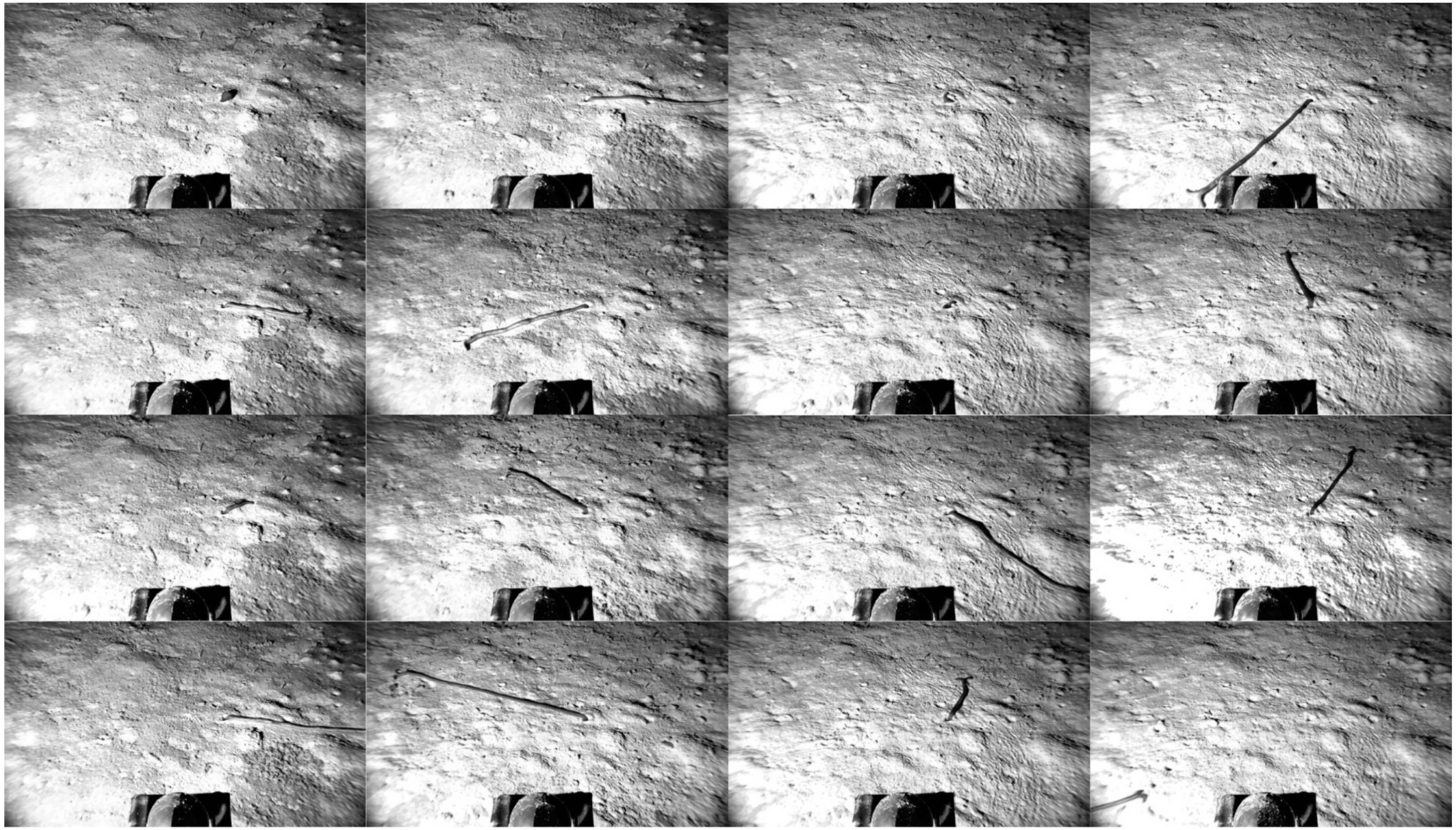


Figure 40: Echiuran proboscis activity observed during Bathysnap JC071-043

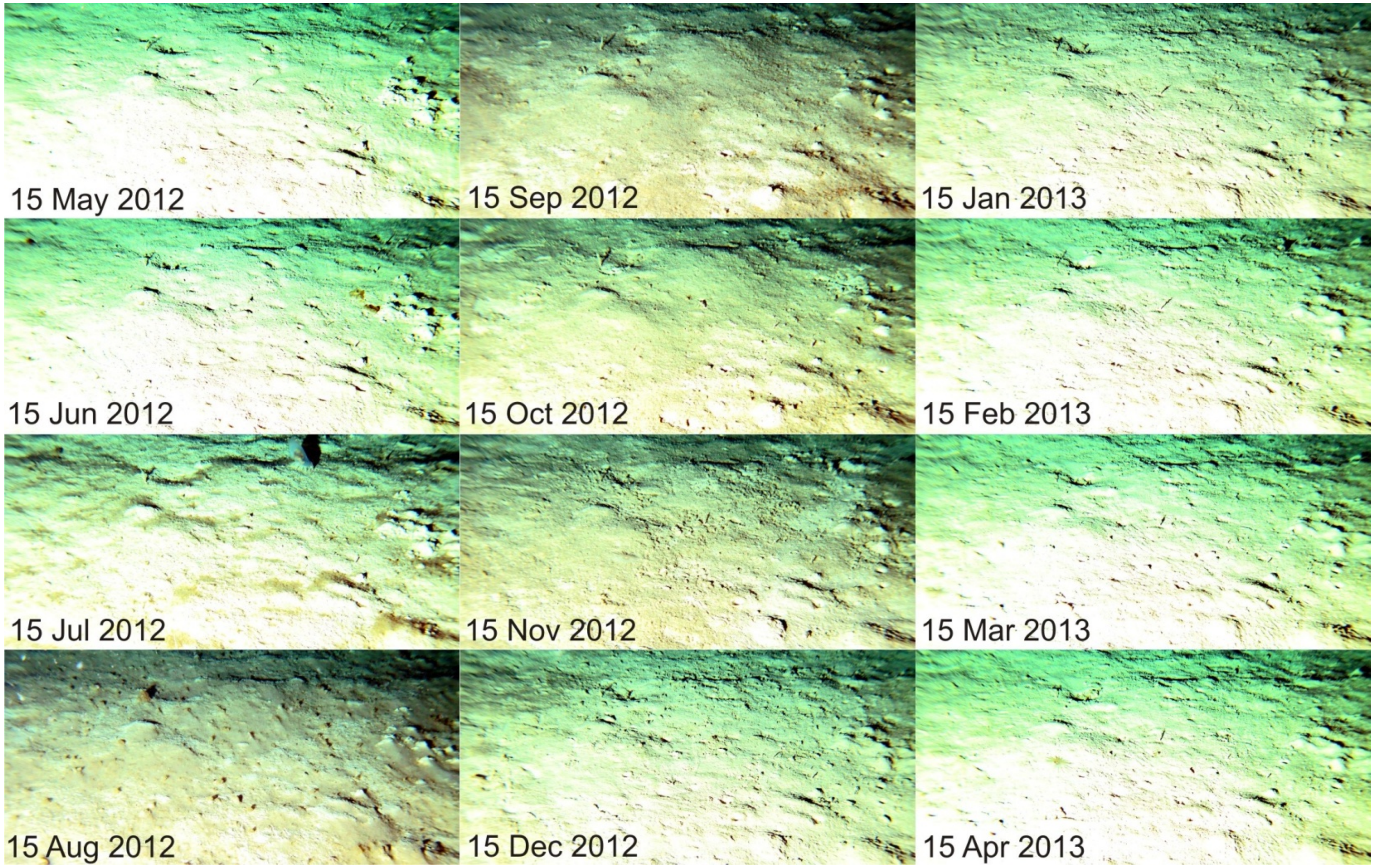


Figure 41: Seabed phytodetritus cover observed during Bathysnap JC071-043

8.4.3 Deployment

The system was redeployed on 21st April 2013 at station JC085-011. The mooring was let go at 15:03 in position 49 00.383 N 016 27.021 W, with a water depth of 4846m. The mooring was confirmed on the seabed at 16:40 by acoustic ranging. The release (successfully wire tested on CTD station JC085-001) is MORS RT6x1, serial number 332 (Mode A operation), codes: window A281, on A282, off A223, release (windowed) A224, diagnostic A285, pinger A294. The dan buoy carries beacons as follows: radio RF-700A1 (s/n X03-087) CH72 156.625 MHz; strobe ST400A (s/n X03-089) auto daylight off double burst flash.

The camera timer is set to 8-hour intervals, and the camera set-up as previously used (manual mode; 12Mb picture size; rec mode normal; ISO 200; multi-metering; white balance for flash; red eye off; sharpness 0; F2.8; colour mode normal; focus 3m; contrast 0; steady shot off; 1/40th second; flash always on.

The mooring was of 'standard' configuration (*see Figure 41*), single sphere pellet with dropper line, 15m blue polypropylene rope; two sphere dhan buoy carrying mast with strobe light, radio beacon and flag; 10m white braid rope; four sphere main buoyancy (with chain and swivels); 50m white braid rope; to Bathysnap seabed frame carrying release, camera, flash gun and deep sea power and light battery.

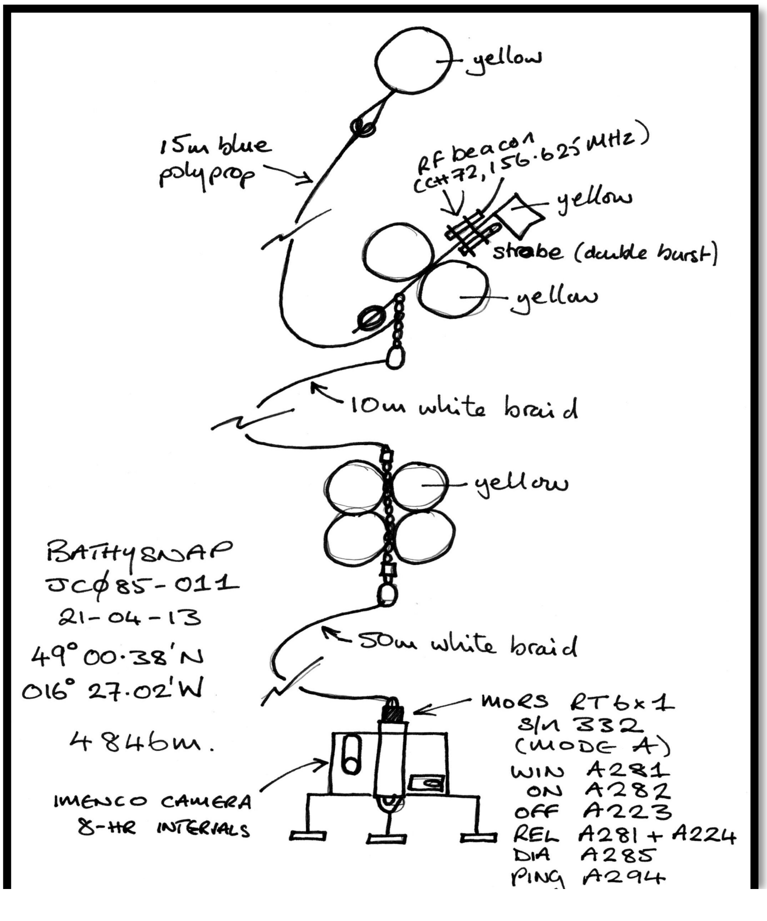


Figure 42: Mooring sketch – Bathysnap JC085-011.

8.5 Amphipod Trap

The current version of the OBE Deepseas bottom amphipod trap (formerly known as 'DEMAR') was rigged and operated in conventional fashion (see Figure 43). Each of the four traps was baited with one defrosted whole mackerel. The catch from each individual trap was preserved separately in ethanol (i.e. in total 8 samples will be returned to the *Discovery Collections* at NOC; contact Tammy Horton).

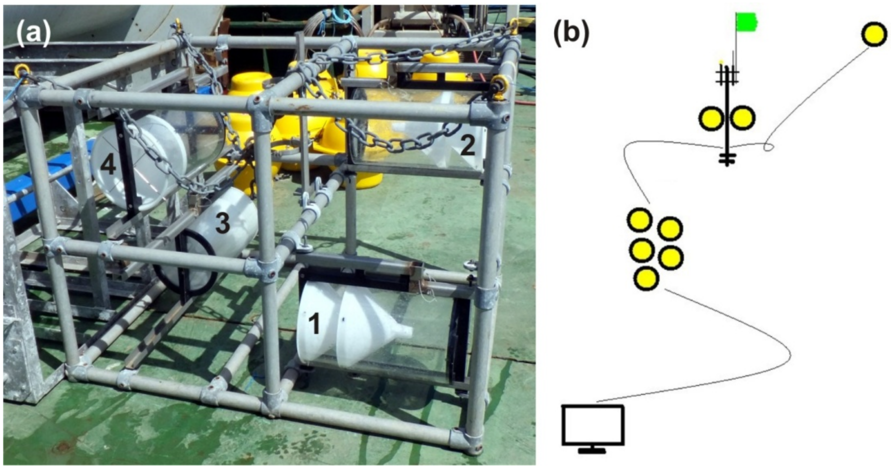


Figure 43: Amphipod Trap as Deployed during JC085 (stn.s 010, 019) (a) trap frame, (b) mooring sketch

8.5.1 Deployments:

JC085-010; 23-hour soak time; 4840m; 48º 59.406' N 016º 30.526' W.

JC085-019; 62-hour soak time; 4843m; 48º 59.367' N 016º 30.400' W (of note was highly variable bait consumption in the bottom traps of this long deployment, (see Figure 44).

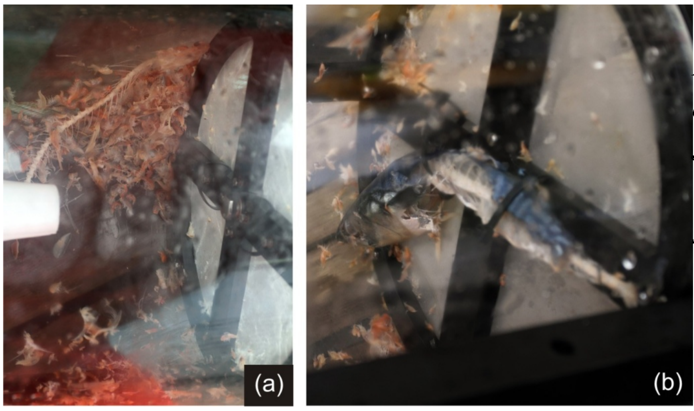


Figure 44: Variation in bait consumption in bottom traps of stn. JC071-019
(a) reduced to bones only, (b) substantial flesh remaining

8.6 Conclusions

RRS *James Cook* cruise 085 was certainly successful in terms of its benthic objectives:

- Five replicate samples of macrobenthos and forams were hoped for, with additional samples of prokaryotes as possible. Six good replicate samples of macrobenthos were obtained, with a seventh sample sample also retained. Seven good replicate samples of forams, and an additional duplicate sample, were obtained.
- Two trawl samples were hoped for. Two trawls were completed, the first yielding good invertebrate benthos material, though rather limited in its fish catch. The second produced a lesser haul of invertebrates and a somewhat better fish catch.
- Bathysnap JC071-043 was successfully recovered and yielded a good time-lapse photographic record.
- Bathysnap JC085-011 was successfully deployed.
- Two amphipod trap deployments were successfully completed, yielding good samples.

8.7 Benthic Stations

Times, dates, depths etc. relate to bottom operations (i.e. bottom contact of Megacorer; bottom contact and release of moorings; layback calculated details for trawl); all depths are corrected (from EM120 with contemporary sound velocity profile). Two line entries refer to start and end details.

Station	Gear	Date	Time	Position (D M.M)				Depth (m)	Comments (Samples)
JC071-043	BSNAP	06-05-2012	13:49	49	00.400	016	27.000	4844	(1045 images; 8-hr intervals)
		19-04-2013	12:30						
006	MEGA	20-04-2013	02:11	48	50.321	016	31.122	4844	9/10 good (mac, foram)
007	MEGA	20-04-2013	07:04	48	50.232	016	31.234	4839	4/10 good (mac, foram)
008	MEGA	21-04-2013	03:00	48	50.074	016	31.185	4843	9/10 good (mac, foram, prok)
009	MEGA	21-04-2013	07:24	48	50.436	016	31.228	4844	8/10 good (mac foram)
010	ATRAP	21-04-2013	12:32	48	59.406	016	30.526	4840	23-hr soak (apod)
		22-04-2013	11:37						
011	BSNAP	21-04-2013	16:25	49	00.383	016	27.021	4846	Long-term deployment
014	MEGA	22-04-2013	03:40	48	50.286	016	31.626	4842	1/10 good (foram)
015	MEGA	22-04-2013	08:02	48	50.294	016	31.620	4838	7/10 good (mac,foram)
019	ATRAP	22-04-2013	17:07	48	59.367	016	30.400	4843	62-hr soak (apod)

		25-04-2013	07:18						
020	OTSB14	23-04-2013	02:00	48	53.650	016	26.310	4841	Distance run: 4.76nm
		23-04-2013	06:00	48	52.930	016	33.440	4849	(benthos, fish)
022	OTSB14	24-04-2013	03:40	48	54.470	016	22.570	4840	Distance run: 3.0nm
		24-04-2013	05:10	48	54.380	016	27.030	4846	(benthos, fish)
028	MEGA	25-04-2013	03:49	48	50.145	016	31.615	4844	6/10 good (mac, foram)
029	MEGA	25-04-2013	13:01	48	50.273	016	31.020	4842	9/10 good (mac, foram)

Gear: BSNAP, Bathysnap; MEGA, Bowers & Connelly Megacorer; ATRAP, amphipod trap; OTSB14, 14m headrope otter trawl. Samples: apod, amphipod; mac, macrobenthos; foram, Foraminifera; prok, prokaryotes.

9 Station List

Deployment	Recovery	Station	Cast	Time GMT			Start position*		End position		Uncorrected	Corrected	Activity	Contact person	Other info
Date	Date (if different)		(if CTD)	OB / Start	Bottom*	IB / End	Lat (N)	Lon (W)	Lat (N)	Lon (w)	Sea floor depth (m)	Sea floor depth (m)			
19/04/2013		JC085-01	1	06:38	08:23	11:01	48° 40.514'	016° 20.195'	48° 40.513'N	016° 20.197'W	4795		CTD to 4700m depth	Thanos Gkritzalis	Cal. deep MicroCAT; test acostic releases; (O2, DIC, Nuts, Chl, S - samples)
19/04/2013		JC085-02	N/A	11:53	N/A	N/A	48° 40.51	016° 20.19	N/A	N/A	N/A	N/A	Glider deployed	Gareth Lee	
19/04/2013		JC085-03	N/A	15:02	N/A	N/A	48° 39.50	016° 20.16	N/A	N/A	N/A	N/A	Glider deployed	Gareth Lee	Position from glider - will update using ship's data-logger
19/04/2013		N/A	N/A	16:44	18:20	20:50	48° 53.5	016° 22.0	49° 00.63	016° 25.64	N/A	N/A	Recover BathySnap	Brian Bett	
19/04/2013		JC085-04	N/A	22:20	22:30	22:48	48° 50.329	016° 31.127	48° 50.329	016° 31.127	4804	4843	Zooplankton Net	Corinne Pebody	
19/04/2013		JC085-05	N/A	22:52	23:00	23:13	48° 50.329	016° 31.127	48° 50.330	016° 31.126	4804	4843	Zooplankton Net	Corinne Pebody	
20/04/2013		JC085-06	N/A	00:06	02:11	04:12	48° 50.321	016° 31.122	N/A	N/A		4844	Mega Core	Brian Bett	
20/04/2013		JC085-07	N/A	05:04	07:04	09:05	48° 50.232	016° 31.234	N/A	N/A		4839	Mega Core	Brian Bett	
20/04/2013		N/A	N/A	10:25	10:50	17:06	48° 00.1	016° 22.7	49° 00:23	016° 21.80	4808		Recover parted PAP#1	Richard Lampitt	13:53 Sub-surface buoy on deck; 14:52 Sensor Frame on deck
20/04/2013		N/A	N/A	18:27	18:52	23:10	48° 59.714	016° 30.277	48° 58.505	016° 27.276	4752	4836	Recover Sed. Trap mooring	Corinne Pebody	JC071-042
21/04/2013		JC085-08	N/A	00:46	03:00	04:52	48° 50.074	016° 31.185	N/A	N/A	4850	4843	Mega Core	Brian Bett	
21/04/2013		JC085-09	N/A	05:15	07:24	09:20	48° 50.436	016° 31.228	N/A	N/A	4844	4844	Mega Core	Brian Bett	
21/04/2013	22/04/2013	JC085-10	N/A	11:12	11:37	14:12	48° 59.406	016° 30.526	48° 59.745	016° 29.218		4840	A'pod Trap	Brian Bett	
21/04/2013		JC085-11	N/A	15:03	U/K	N/A	49° 00.390	016° 27.030	N/A	N/A	4807	4840	Deploy Bathysnap	Brian Bett	
21/04/2013		JC085-12	N/A	18:29	U/K	20:23	48° 59.438	016° 25.843	48° 59.415	016° 26.280	4805	4845	Deploy Sediment Trap	Corinne Pebody	
21/04/2013		JC085-13	2	21:10	21:23	23:25	48° 59.46'	016° 28.85'	48° 59.46	016° 28.85	4802		CTD to 280m depth	Thanos Gkritzalis	Cal. ISUS, SeaGuard, MicroCAT, Star-ODDIs (*8), WETLabs; (O2, DIC, Nuts, Chl, S - samples)
22/04/2013		JC085-14	N/A	01:50	03:40	05:40	80° 50.286	016° 31.626	N/A	N/A		4842	Mega Core	Brian Bett	
22/04/2013		JC085-15	N/A	06:03	08:02	09:54	80° 50.294	016° 31.620	N/A	N/A		4838	Mega Core	Brian Bett	
22/04/2013		JC085-16	N/A	12:50	12:56	13:15	48° 59.31	016° 30.00	48° 59.31	016° 30.00	4798		Zooplankton Net (200m)	Corinne Pebody	
22/04/2013		JC085-17	N/A	14:35	14:45	14:57	48° 59.31	016° 30.00	48° 59.31	016° 30.00	4798		Zooplankton Net (200m)	Corinne Pebody	
22/04/2013		JC085-18	N/A	15:03	18:08	15:20	48° 59.31	016° 30.00	48° 59.31	016° 30.00	4793		Zooplankton Net (100m)	Corinne Pebody	
22/04/2013	25/04/2013	JC085-19	N/A	15:42	07:18	09:00	48° 59.367	016° 30.400	48° 59.12	016° 30.39	4804	4843 (OLEX)	Deploy Amphipod Trap	Brian Bett	
22/04/2013	23/04/2013	JC085-20	N/A	21:00	02:50	10:10	48° 54.67	016° 07.65	48° 63.760	016° 47.383		4836 ; 4839	Trawl 1	Brian Bett	
23/04/2013		JC085-21	3	13:51	14:35	16:35	48° 37.078	016° 17.885	48° 36.33	016° 19.79	4804		CTD to 1000m	Corinne Pebody	cal. MicroCATS for PAP1 mooring and Gliders for recovery + deployed
23/04/2013		N/A	N/A	17:16	N/A	18:10	48° 32.27	016° 20.72	N/A	N/A	N/A	N/A	Glider recovery	Gareth Lee	
23/04/2013		N/A	N/A	18:50	N/A	20:12	48° 32.93	016° 28.00	N/A	N/A	N/A	N/A	Glider recovery	Gareth Lee	
23/04/2013	24/04/2013	JC085-22	N/A	23:25	N/A	06:26	48° 54.96	016° 07.02	48° 54.10	016° 38.00		4840	Trawl 2	Brian Bett	
24/04/2013		JC085-23	N/A	11:03	11:11	11:35	48° 56.82	016° 35.98	N/A	N/A	4802		Zooplankton Net (200m)	Corinne Pebody	
24/04/2013		JC085-24	N/A	11:45	11:50	12:00	48° 56.82	016° 35.99	N/A	N/A	4802		Zooplankton Net (200m)	Corinne Pebody	
24/04/2013		JC085-25	N/A	14:49	N/A	22:18	48° 58.56	016° 16.00	48° 58.67	016° 16.17	4802		Deploy PAP#1 mooring	Richard Lampitt	
25/04/2013		JC085-26	N/A	00:28	00:38	00:48	48° 50.140	016° 31.604	48° 50.140	016° 31.603	4791		Zooplankton Net (200m)	Corinne Pebody	
25/04/2013		JC085-27	N/A	00:54	01:02	01:15	48° 50.139	016° 31.600	48° 140	016° 31.604	4791		Zooplankton Net (200m)	Corinne Pebody	
25/04/2013		JC085-28	N/A	01:53	03:50	05:45	48° 50.145	016° 31.615	N/A	N/A		4844	Mega Core	Brian Bett	
25/04/2013		JC085-29	N/A	11:00	13:01	14:57	48° 50.273	016° 31.020	N/A	N/A		4842	Mega Core	Brian Bett	
25/04/2013		JC085-30	4	17:36	N/A	21:31	48° 35.235	016° 19.980	48° 35.095	016° 21.887	4555 / 4650		Yo-Yo CTD 1 (1000m)	Gareth Lee	
25/04/2013	26/04/2013	JC085-31	5	22:36	N/A	01:57	48° 33.772	016° 26.926	48° 33.349	016° 29.856	4793 / 4792		Yo-Yo CTD 2 (1000m)	Gareth Lee	

*Mega Core: Samples taken automatically once corer hits bottom - time at bottom is time of sample and corresponds to position recorded as 'start position'. Bottom time also given as time of release for acoustic-release units.

Corrected and uncorrected depths depend on water column density profile and speed of sound through water