National
Oceanography Centre
NATURAL ENVIRONMENT RESEARCH COUNCIL

National Oceanography Centre

Cruise Report No. 42

RV *Meteor* Cruise 108

06 - 24 JUL 2014

Cruise to the Porcupine Abyssal Plain sustained observatory

Principal Scientist

R S Lampitt

2017

National Oceanography Centre, Southampton
University of Southampton Waterfront Campus
European Way
Southampton
Hants SO14 3ZH
UK

Tel: +44 (0)23 8059 6347
Email: R.Lampitt@noc.ac.uk

DOCUMENT DATA SHEET

AUTHOR	*PUBLICATION DATE*
LAMPITT, R S et al	2017

TITLE

RV *Meteor* Cruise 108, 06 - 24 Jul 2014. Cruise to the Porcupine Abyssal Plain sustained observatory.

REFERENCE

Southampton, UK: National Oceanography Centre, Southampton, 127pp.
(National Oceanography Centre Cruise Report, No. 42)

ABSTRACT

The Porcupine Abyssal Plain Observatory is a sustained, multidisciplinary observatory in the North Atlantic coordinated by the National Oceanography Centre, Southampton. For over 20 years the observatory has provided key time-series datasets for analysing the effect of climate change on the open ocean and deep-sea ecosystems. As is normally the case during cruises which are needed to refurbish the observatory, a wide range of other activities were carried out during the cruise.

The main mooring of the observatory broke in December 2013 during the horrendous winter storms which destroyed a number of Met Office moorings around the UK. However we were fortunate that the break occurred just below the main sensor frame and as a result we were able to recover it along with the massive Ocean Data Acquisition System (ODAS) buoy after it had drifted towards Ireland. We were therefore able to recover all of the sensors and, most importantly, the data stored in them. Prior to *Meteor* cruise 108 they were all refurbished and were deployed during M108 along with some additional sensors. In addition we recovered a set of sediment traps which had been collecting sinking material in the lower part of the water column for the previous 12 months and a new set was deployed.

Furthermore some entirely novel research was carried out on the distribution and characteristics of marine snow particles in the top few hundred meters of the water column. These are inanimate particles which are the principle vehicles by which material sinks out of the upper sunlit zone down to the abyss, taking carbon down with them and out of contact with the atmosphere for centuries. We used optical methods to characterise their distribution and collected samples using the Marine Snow catcher thereby providing material for a variety of experiments with colleagues from Bremen.

The Bathysnap time-lapse camera system which had been taking photos of the seabed at 4800m was recovered to give an assessment of the behaviour of the benthic animals and how the seabed appearance changes in response to deposition of material. A new module was deployed.

Temporal variability of the water column and seabed fauna - a task which is difficult or impossible to do autonomously was assessed using nets and cores.

KEYWORDS

ISSUING ORGANISATION **National Oceanography Centre**
University of Southampton Waterfront Campus
European Way
Southampton SO14 3ZH UK
Tel: +44(0)23 80596116 Email: nol@noc.soton.ac.uk

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

This page intentionally left blank

Contents

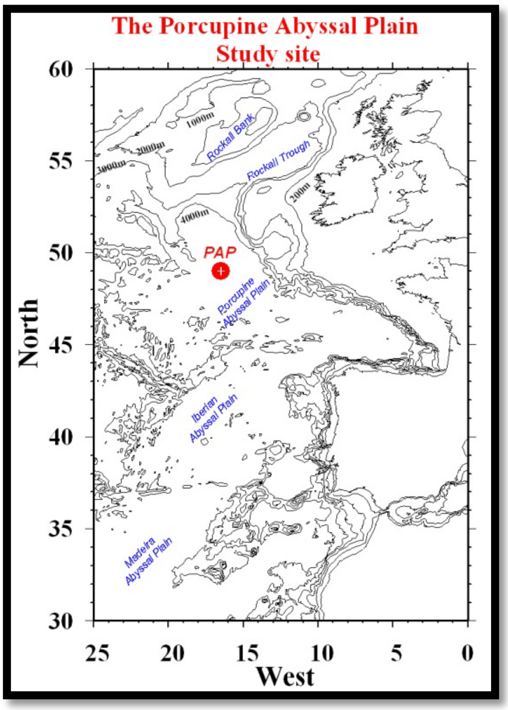
Scientific Personnel:

	8. Family Name	9. Given Names	10. Rank or Rating
1	LAMPITT	RICHARD STEPHEN	PSO
2	CAMPBELL	JONATHAN MICHAEL	Technician
3	PEBODY	CORINNE ANNE	Scientist
4	PABORTSAVA	KATSIARYNA	Scientist
5	BETT	BRIAN JAMES	Scientist
6	MORRIS	ANDREW	Scientist
7	STEFANOUDIS	PARIS VASILEIOS	Scientist
8	BRASIER	MADELEINE	Scientist
9	GUNTON	LAETITIA	Scientist
10	IVERSEN	MORTEN	Scientist
11	FUSSEL	JESSIKA	Scientist
12	PASTOR	JENNIFER	Scientist
13	PLATT	WILLIAM	Technician
14	CHILDS	DAVID	Technician
15	MCLACHLAN	ROB	Technician
16	PROVOST	PAUL	Technician

Ships Master:

Captain Michael Schneider

1 Background

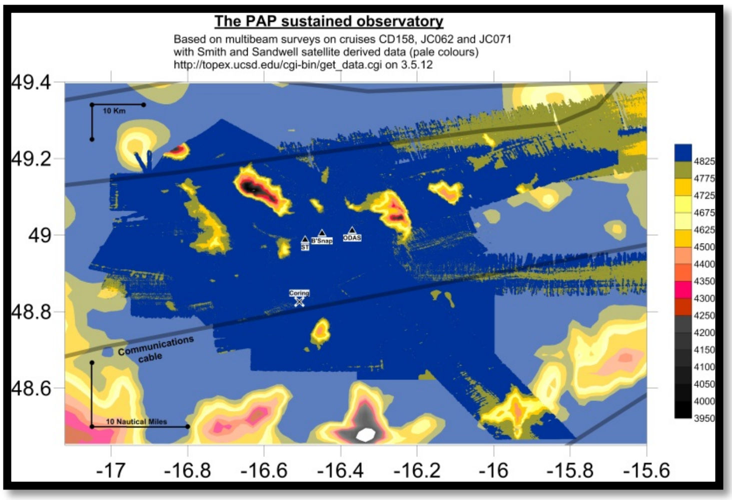


The Porcupine Abyssal Plain Observatory is a sustained, multidisciplinary observatory in the North Atlantic coordinated by the National Oceanography Centre, Southampton. For over 20 years the observatory has provided key time-series datasets for analysing the effect of climate change on the open ocean and deep-sea ecosystems.

More information on PAP can be found in NOC's website at: http://noc.ac.uk/pap where the most current data can be found at:http://noc.ac.uk/pap/data

PAP is one of the 23 fixed-point open ocean observatories included in the Europe-funded project FixO3, coordinated by Professor Richard Lampitt at NOC: http://www.fixo3.eu/

The 4-year project started in September 2013 with the aim to integrate the open ocean observatories operated by European organizations and is a collaboration of 29 partners from 10 different countries.



The PAP sustained observatory is about 300m southwest of Ireland. Since 1989, this environmental study site in the Northeast Atlantic has become a major focus for international and interdisciplinary scientific research and monitoring including water column biogeochemistry, physics and seafloor biology. The first autonomous equipment included the sub-surface sediment trap mooring and the Bathysnap seafloor time-lapse camera system (both since 1989). Since 2002, a full depth multidisciplinary mooring has been in place with sensors taking a diverse set of biogeochemical and physical measurements of the upper 1000m of the water column. In 2010, collaboration between the Natural Environment Research Council (NERC) and the UK Met Office led to the first atmospheric measurements at the site and this has continued since then to great effect.

The main mooring of the observatory broke last December during the horrendous winter storms which destroyed a number of Met Office moorings around the UK. However we were fortunate that the break occurred just below the main sensor frame and as a result we were able to recover it along with the massive Ocean Data Acquisition System (ODAS) buoy after it had drifted towards Ireland. We were therefore able to recover all of the sensors and, most importantly, the data stored in them. Prior to Meteor cruise 108 they were all refurbished and ready for deployment at PAP along with a few additional sensors. It is, in fact, one of our most sophisticated deployments to date with additional sensors and samplers and new ways of managing and transmitting data to the surface and from there by satellite to NOC. In addition we plan to recover a set of sediment traps which have been collecting sinking material in the lower part of the water column for the past 12 months and we will then deploy a new set. The Bathysnap time-lapse camera system which has been taking photos of the seabed at 4800m will be recovered as well to give an assessment of the behaviour of the benthic animals and how the seabed appearance changes in response to deposition of material. A new one will then be deployed ready for recovery next year.

These are the autonomous systems we will work on, but as is usually the case with our trips to PAP, we will also make observations on the temporal variability of the water column and seabed fauna - a task which is difficult or impossible to do autonomously. Furthermore we will on this occasion carry out some entirely novel research into the distribution and characteristics of marine snow particles in the top few hundred meters of the water column. These are inanimate particles which are the principle vehicles by which material sinks out of the upper sunlit zone down to the abyss, taking carbon down with them and out of contact with the atmosphere for centuries. Not only will we characterise the particles in situ using three different optical systems but we will collect them using the Marine Snow catcher and will then carry out a variety of experiments on them with colleagues from Bremen.

Overview of cruise

Richard Lampitt

On Sunday 6th July we set off from Las Palmas towards PAP. It was a slow start with a slight delay leaving Las Palmas and a stiff head wind on the way north. We did a CTD and acoustic release test on passage which was successful and on 11th July just before midnight we started in earnest with a couple of deployments of the megacorer. On 11th July we also carried out a very successful CTD deployment attached to which was the Underwater Vision Profiler (UVP5) kindly loaned to us by Rainer Kiko at IFM-GEOMAR, Kiel which was to give one of the three optical assessments of particle concentration, size distribution and characteristics. The other two were on a "snow camera system" being the HoloCam and the P-Cam each with different water volumes sampled and size categories detectable. The Marine Snow Catcher or "Snatcher" and drifting sediment traps were deployed on a number of occasions, the former (a large water bottle) to collect marine snow particles at one instant in time and the latter to collect an integrated flux of material over several hours or days. Morten Iversen from the University of Bremen has a team working on various aspects of aggregates in the laboratory as well as material collected by the drifting sediment traps.

.

Jon Campbell and others preparing the ODAS buoy (PAP 1) for deployment.

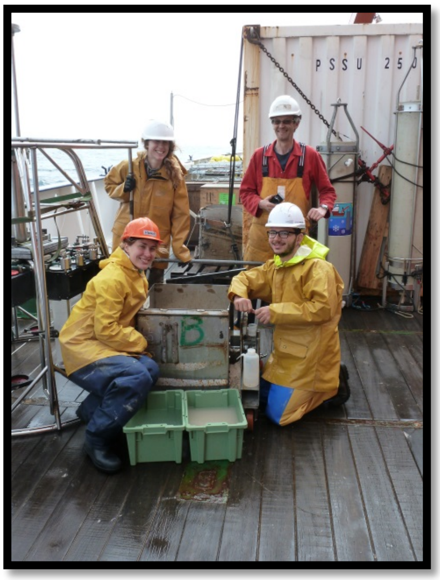
The team on board is far too small in number, which is a challenge but everyone, from the ship side and the scientific complement worked in a highly integrated, harmonious and professional manner.

The Parflux sediment traps which are a pivotal element of the PAP observatory were prepared on passage and the sensors for the ODAS mooring (PAP 1) were also assembled into the integrated system on deck (see photo above).

Deployment of the ODAS buoy and PAP 1 mooring was delayed till Tuesday 15th so that some fine tuning of the software could be carried out and at the end of this, the entire complex system was working very well on deck. Fresh data immediately started to be transmitted to the PAP website with excellent support from Maureen Pagnani at NOC.

The snow camera system.

The long term moored sediment trap mooring was recovered with perfect samples for promising analysis back at NOC and a new mooring was deployed for another year of sampling. The Bathysnap time lapse camera was also successfully recovered with some stunning images of the seabed every 8 hours over the past year and this was re-deployed for another year. All conductivity, temperature and depth (CTD) profiles achieved a 100% success rate giving essential insights into the water structure from the perspective of biogeochemistry and physics. We deployed a megacorer and box core on several occasions with some of the highest success rate to date at PAP.



Brian Bett and the benthic team, happy to have a perfect sample of sediment in the box corer.

This was partly due to the very calm weather which makes such deployments more reliable.

The weather has been perfect but rather cloudy therefore no satellite data is available at this time.

2 Sensors and Moorings

Dave Childs, Paul Provost, Billy Platt, Rob Mclachlan

2.1 Mooring Operations Summary

The main mooring objectives of this cruise are as follows:

1) Deploy the PAP#1 telemetry ODAS buoy.
2) Deploy the PAP 3 sediment trap mooring.
3) Recover the PAP 3 sediment trap mooring deployed last year.
4) Recover the remains of the PAP 1 telemetry that parted.

The winch used for deployment and recovery is the Base Engineering Streamer Winch, this took around 1.5 days to build and commission. All of the PAP 1 ropes were wound prior to sailing with the exception of the bottom 700m, however it look as though the 700m length may well have fitted on the drum, see photos in cruise file.

The winch was positioned just off the centre line due to the layout of the ship.

Deployment of the ODAS buoy was completed using the AFT A frame with a winch attached to the A frame. Using the Sea Catch release hook on the winch wire and the A frame to lift and move the buoy over the stern.

The PAP 3 mooring was also deployed using the Streamer winch, utilising a floating block from the A frame.

Recovery of the parted PAP1 mooring commenced with the firing of the release. The sub surface buoy was hooked and recovered on to the STBD deck where the two ends were stopped off on deck. The links were then cut off as the shackles had been welded.

The top section of the mooring was then taken to the stern and recovered on the Streamer winch. Once this was complete the lower sections of the mooring were recovered from the stern.

The failure mode of the PAP1 mooring was due to the splice of the rope in the thimble directly below the sensor frame being chaffed through and parting the rope at the thimble entry. This is shown in the photo of the recovered rope below. The splice is intact, but the rope has parted at the start of the tucks in the throat of the splice where chaffing on the thimble occurred.

Dates and positions of events:

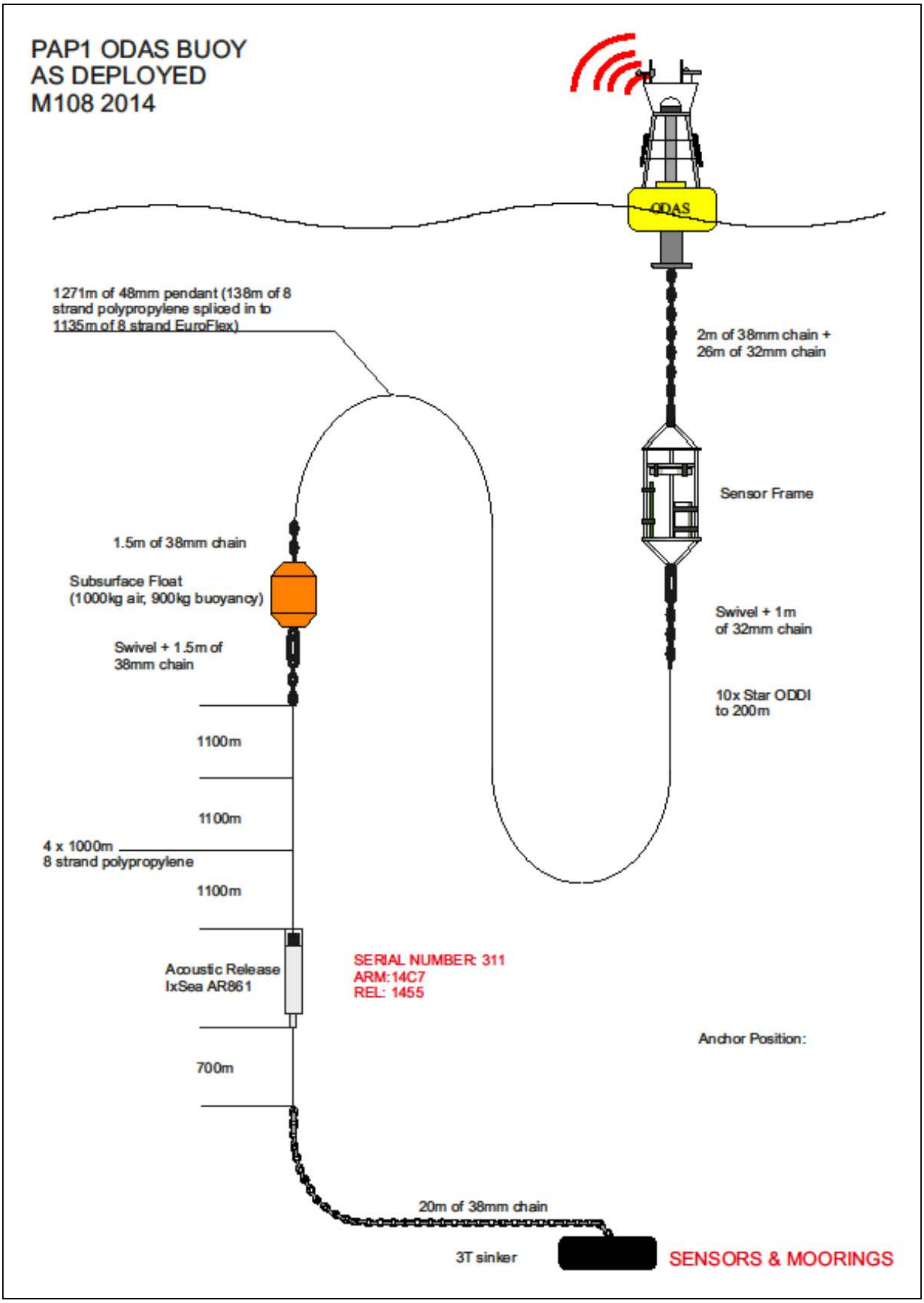
PAP 1 ODAS mooring
Deployed 15th July 2014
49°01.786’ N,

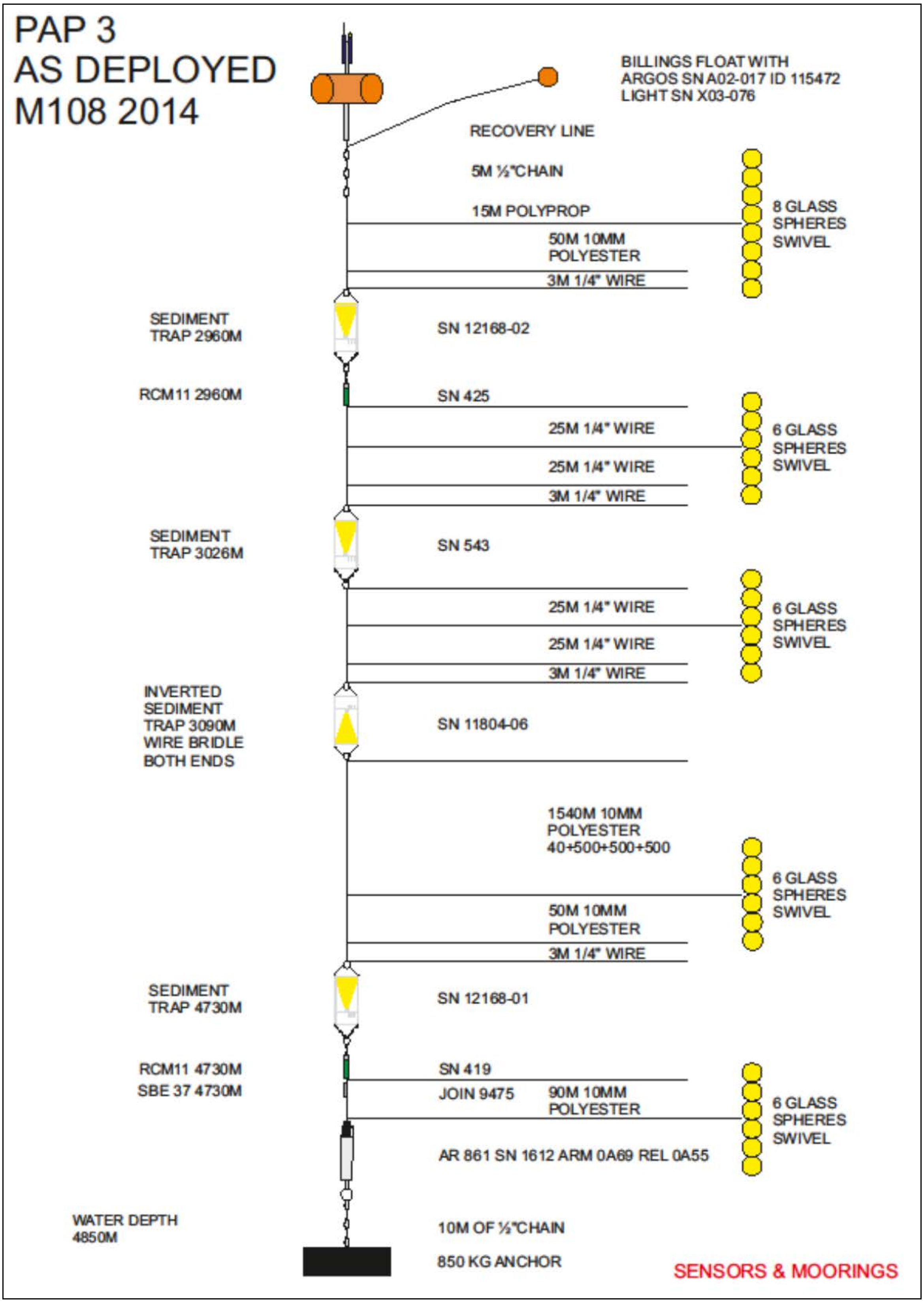
16°19.138 W.

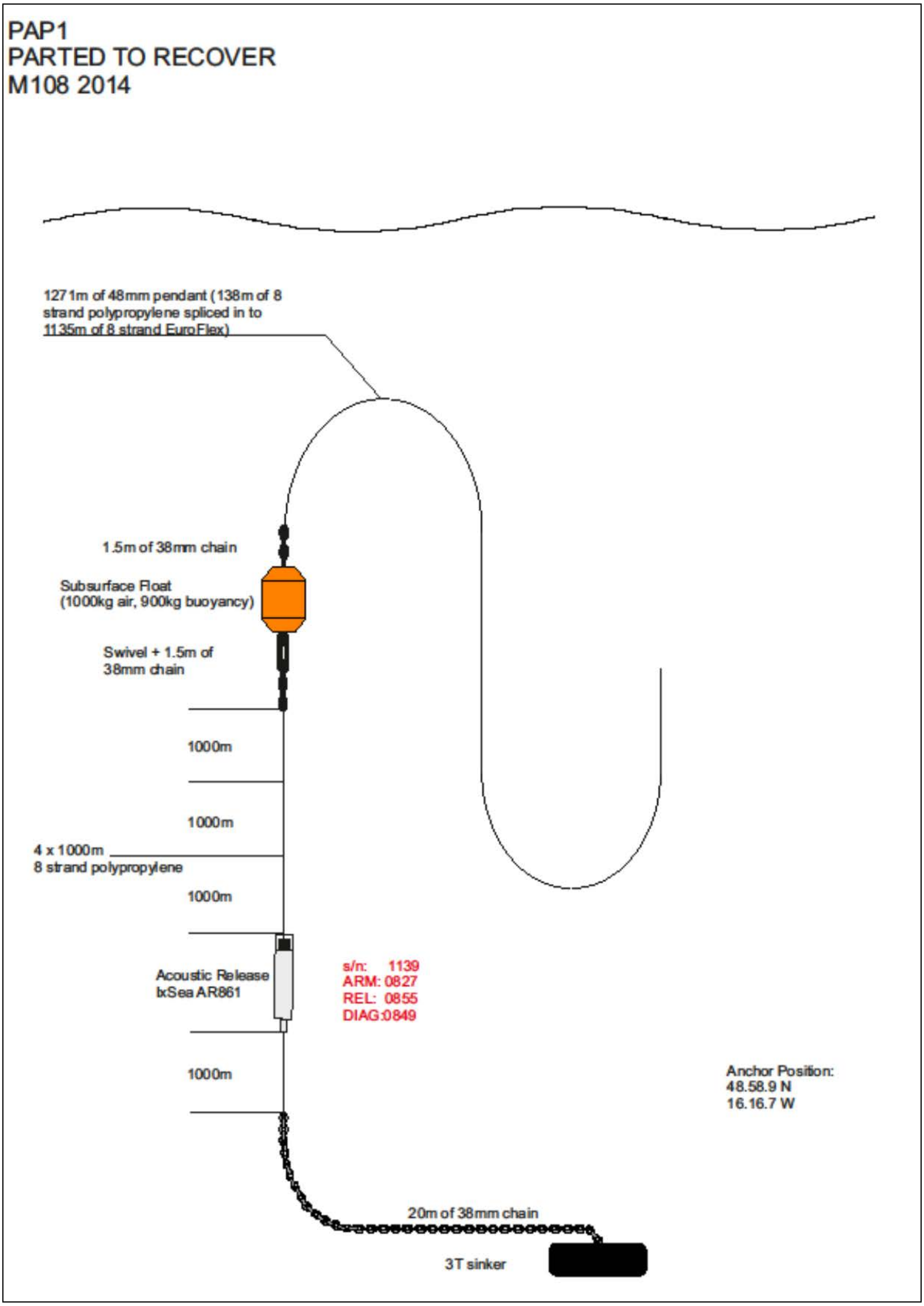
PAP 3 mooring
Recovered 16th July 2014
48°59.46’ N,
16°26.54’W

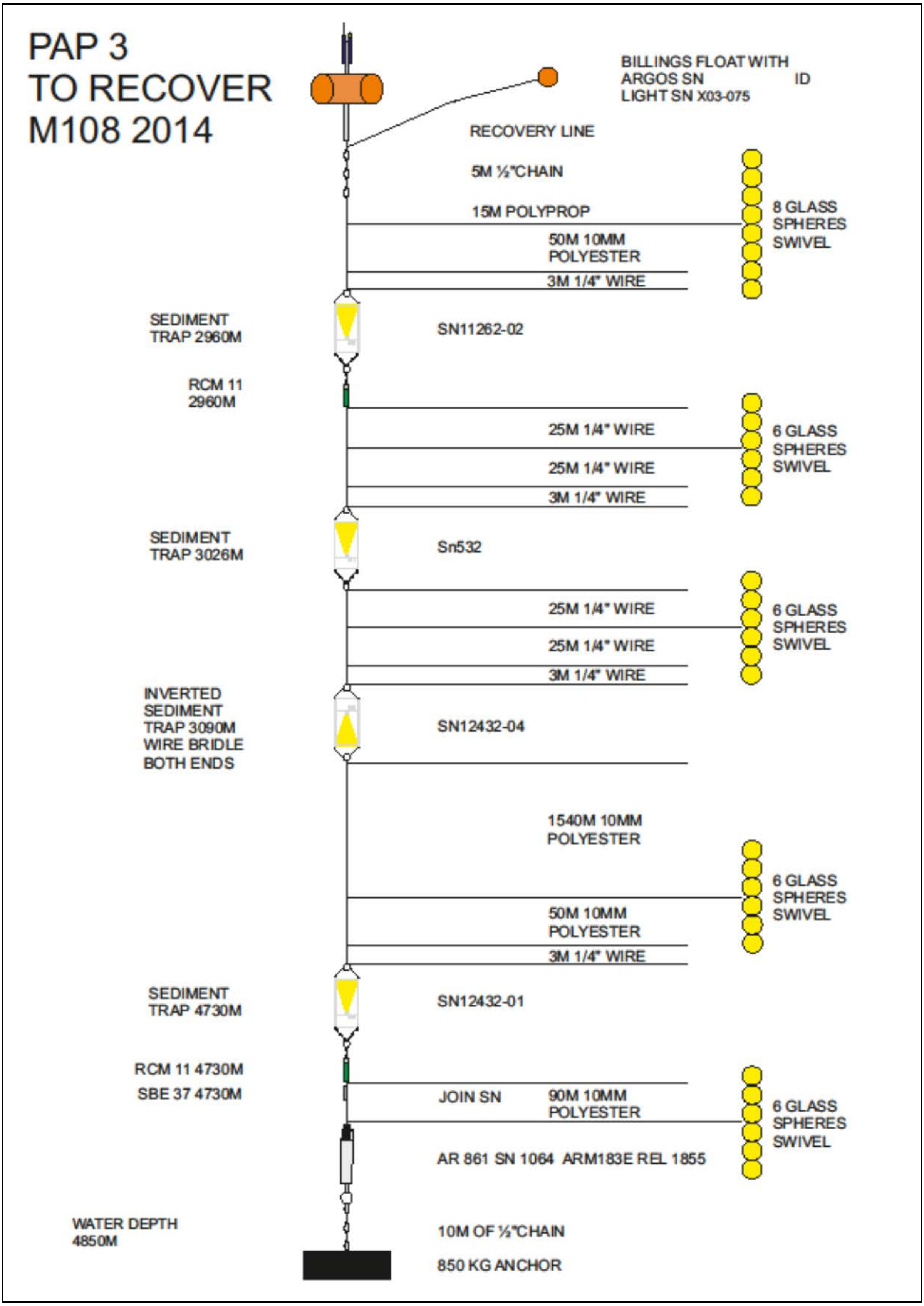
PAP 3 mooring
Deployed 18th July 2014
48°59.42’ N,
16°24.85’W

Parted PAP 1 mooring
Recovered 18th July 2014
48°58.90’ N,
16°16.00’W


PAP1 ODAS BUOY
AS DEPLOYED
M108 2014
ODAS
1271m of 48mm pendant (138m of 8 strand polypropylene spliced in to 1135m of 8 strand EuroFlex)
2m of 38mm chain +
26m of 32mm chain
Sensor Frame
1.5m of 38mm chain
Subsurface Float
(1000kg air, 900kg buoyancy)
Swivel + 1.5m of
38mm chain
Swivel + 1m
of 32mm chain
10x Star ODDI
to 200m
1100m
1100m
4 x 1000m
8 strand polypropylene
1100m
Acoustic Release
IxSea AR861
SERIAL NUMBER: 311
ARM:14C7
REL: 1455
Anchor Position:
700m
20m of 38mm chain
3T sinker
SENSORS & MOORINGS


PAP 3
AS DEPLOYED
M108 2014
BILLINGS FLOAT WITH
ARGOS SN A02-017 ID 115472
LIGHT SN X03-076
RECOVERY LINE
5M ½"CHAIN
15M POLYPROP
8 GLASS
SPHERES
SWIVEL
50M 10MM
POLYESTER
3M 1/4" WIRE
SEDIMENT
TRAP 2960M
SN 12168-02
RCM11 2960M
SN 425
25M 1/4" WIRE
6 GLASS
SPHERES
SWIVEL
25M 1/4" WIRE
3M 1/4" WIRE
SEDIMENT
TRAP 3026M
SN 543
25M 1/4" WIRE
6 GLASS
SPHERES
SWIVEL
25M 1/4" WIRE
3M 1/4" WIRE
INVERTED
SEDIMENT
TRAP 3090M
WIRE BRIDLE
BOTH ENDS
SN 11804-06
1540M 10MM
POLYESTER
40+500+500+500
6 GLASS
SPHERES
SWIVEL
50M 10MM
POLYESTER
3M 1/4" WIRE
SEDIMENT
TRAP 4730M
SN 12168-01
RCM11 4730M
SBE 37 4730M
SN 419
JOIN 9475
90M 10MM
POLYESTER
6 GLASS
SPHERES
SWIVEL
AR 861 SN 1612 ARM 0A69 REL 0A55
WATER DEPTH
4850M
10M OF ½"CHAIN
850 KG ANCHOR
SENSORS & MOORINGS


PAP1
PARTED TO RECOVER
M108 2014
1271m of 48mm pendant (138m of 8 strand polypropylene spliced in to 1135m of 8 strand EuroFlex)
1.5m of 38mm chain
Subsurface Float
(1000kg air, 900kg buoyancy)
Swivel + 1.5m of 38mm chain
1000m
1000m
4 x 1000m
8 strand polypropylene
1000m
Acoustic Release
IxSea AR861
s/n: 1139
ARM: 0827
REL: 0855
DIAG:0849
1000m
Anchor Position:
48.58.9 N
16.16.7 W
20m of 38mm chain
3T sinker



PAP 3
TO RECOVER
M108 2014
BILLINGS FLOAT WITH
ARGOS SN ID
LIGHT SN X03-075
RECOVERY LINE
5M ½"CHAIN
15M POLYPROP
8 GLASS
SPHERES
SWIVEL
50M 10MM
POLYESTER
3M 1/4" WIRE
SEDIMENT
TRAP 2960M
SN11262-02
RCM 11
2960M
25M 1/4" WIRE
6 GLASS
SPHERES
SWIVEL
25M 1/4" WIRE
3M 1/4" WIRE
SEDIMENT
TRAP 3026M
Sn532
25M 1/4" WIRE
6 GLASS
SPHERES
SWIVEL
25M 1/4" WIRE
3M 1/4" WIRE
INVERTED
SEDIMENT
TRAP 3090M
WIRE BRIDLE
BOTH ENDS
SN12432-04
1540M 10MM
POLYESTER
6 GLASS
SPHERES
SWIVEL
50M 10MM
POLYESTER
3M 1/4" WIRE
SEDIMENT
TRAP 4730M
SN12432-01
RCM 11 4730M
SBE 37 4730M
JOIN SN
90M 10MM
POLYESTER
6 GLASS
SPHERES
SWIVEL
AR 861 SN 1064 ARM183E REL 1855
WATER DEPTH
4850M
10M OF ½"CHAIN
850 KG ANCHOR

2.2 PAP 1 deployment (ODAS Buoy)

Three SeaBird CTD's were deployed on the PAP1 ODAS Buoy mooring, one fixed to the keel of the surface ODAS Buoy and two were fixed inside the sub surface instrumentation frame, approximately 30m below the surface.

All three of the SBE 37's were inductive, and were therefore setup with a SeaBird Inductive Modem in the lab. Serial number 6915 was set to log at an interval of 900 seconds whilst serial numbers 9030 and 10315 were set up to sample at an interval of 1800 seconds. All three instruments were set to start logging data at 15:00 GMT on the 11th of July 2014.

Prior to deployment each SBE 37 had a new battery pack fitted, had all o-rings checked and cleaned and all external screws checked for tightness.

The final triangulated positon for PAP 1 is

49°01.786' N,

16°19.138 W.

2.3 PAP 3 Recovery

Upon recovery of the PAP 3 sediment trap mooring all instrumentation was washed in fresh water then dried before being opened or connected to a PC for downloading. Two Aanderaa RCM 11 current meters and one SeaBird 37 CTD in addition to the four Mclane Sediment Traps were successfully recovered. Aanderaa RCM current meters had serial numbers of 419 and 425, whilst the SeaBird had a serial number of 4460.

Unfortunately, once in the lab the SBE 37 failed to connect and no data could be immediately downloaded from the instrument. It was found that the fitted internal battery pack had gone flat, from its nominal voltage of 7 volts down to around 0.5 volts. A new battery pack was made and then fitted, at which point the instrument connected. Due to the flat battery the internal clock had reset and the instrument showed no logged samples.

Resetting the sample number manually to an initial value to 40000 revealed some saved data remained saved in the instrument so this was downloaded via the instruments inductive head and an external inductive modem. On inspection of the data it was found the instrument had started logging and continued to log at 900 second intervals until the 17th of March 2014, where the battery pack failed and the instrument stopped logging.

Both Aanderaa RCM 11 current meters were opened and were found to be still logging. Each instrument was then switched off to stop it logging and the internal data storage units (DSU) removed. One at a time, both DSU's were downloaded using an Aanderaa DSU Reader and the Aanderaa 5059 Data Reading Program. After downloading each of the DSU's, the data was saved and backed up ready for post processing.

2.4 PAP 3 Deployment

Two Aanderaa RCM 11 current meters and one SeaBird 37 CTD were used in the re deployment of the PAP 3 Sediment Trap mooring, in addition to the four sediment traps.

Sediment trap programming was completed by the scientific party, all hardware rigging and battery fitting was completed by the technical party. New cells were fitted to each of the sediment traps after they had been setup but prior to programming.

Both Aanderaa RCM 11 current meters (SN: 419 and 425) had new battery packs fitted, had their o-rings cleaned and checked and anodes replaced as required. The internal DSU's were checked, had their clocks adjusted to GMT and then fitted back into the instruments. New battery packs were made and fitted, and the instruments started. A final check on the morning of deployment was made to ensure both instruments were logging. Once confirmed, the instruments were sealed and fitted into their deployment frames.

All sensor setting remained unchanged from their recovered settings, the sample time was left at 30 minutes, temperature range was set to low and the conductivity sensor was set to sample in wide mode.

The SeaBird 37 (SN: 9475) had a new battery pack made and fitted, its o-rings checked and cleaned and all external screws tightened prior to deployment.

A capture file was created showing the settings used in the instruments deployment as well as a record of the current calibration coefficients. A 30 minute sample interval was used and the instrument was set to start logging immediately.

On the top Billings buoyancy a Novatech Light and Argos Beacon were fitted. Both were serviced and tested before deployment. The Novatech Light had a serial number of X03-076 whilst the Argos had a serial number of A02-017 and an ID of 115472.

Releases

The releases from both PAP 3 and the remains of PAP1 ODAS gave good ranges and released without issue.

The three releases sent from NOCS were the following serial numbers:

SN 311
SN 1612
SN 1610

SN's 311 and 1612 both worked well on the CTD test to 4500m and they were consequently used on PAP 1 and PAP 3.

SN 1610 did not work on the CTD test. No good ranges were received and the return ping could not be heard. On deck the release would work but still no return ping heard. Investigation when returned to NOC required.

3 PAP Buoy Telemetry System and Sensor Frame

Jon Campbell

3.1 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 primary task on this cruise was to deploy a complete PAP1 mooring with new rope and refurbished buoy and sensor frame. The remains of the previous PAP1 mooring deployed on JC85 were to be recovered if possible.

3.2 Previous deployment history

The previous PAP Observatory system was deployed on 24 April 2013 on cruise JC85. Communication with the Data Hub in the sensor frame was lost only 20 days after deployment and the mooring rope parted just under the sensor frame on 20 December 2013. The drifting buoy and sensor frame were recovered by the Celtic Explorer on 18 January 2014, and a detailed account of this deployment and recovery is to be found in a NOC report by Mark Hartman.

3.3 Design modifications for new observatory

The unexpectedly early recovery of the previously deployed system afforded the opportunity to examine the system components and modify items where weaknesses had been exposed. In particular the Data Hub and the cable connecting it to the buoy had both failed in the two previous deployments. Funding was also available to permit a complete redesign of the electronics in the Hub and the Telemetry Unit on the buoy.

3.3.1 Connecting cable

Previous deployments used armoured ‘Seasoar’ and ‘CTD’ cables to provide power, RS-422 and inductive communications between the buoy and the sensor frame. However, the system recovered in January had suffered fairly severe corrosion to these cables, so for this deployment a single, polyurethane sheathed cable was used to carry a 30V power supply, RS-232 communications and inductive communications between the buoy and the Data Hub. Additional protection is provided by fitting the cable inside steel-reinforced hydraulic hosing and this hosing is clamped to the mooring chain with plastic clamps (see Fig. 1). A few metres of large diameter hydraulic hose was also placed over the mooring chain immediately above the sensor frame, to prevent the chain collapsing and striking the frame in severe weather (see Fig. 2).

3.3.2 Data Hub

The previous Data Hub housing had leaked on its two last deployments, so this year a completely new housing was purchased from Develogic in Hamburg, featuring a glass-reinforced plastic tube with titanium end caps and four large, 16-way Subconn connectors to carry signals to the sensors and the buoy. The housing also incorporates a substantial battery pack which could be used to power the hub in the event that the cable to the buoy was damaged. A pair of LinkQuest acoustic modems was also purchased to provide an acoustic communications link between the Hub and the buoy in the event of a cable failure. However, there proved to be insufficient time to develop and test this ‘backup’ system prior to deployment, so the battery compartment in the Hub was left empty and the modems were not fitted.

A new printed circuit board (PCB) was designed and manufactured to fit in the Develogic housing. This board carries a Persistor CF2 microcomputer, two 8-channel UART (Universal Asynchronous Receiver transmitter) devices providing 16 serial communication ports, switched power supplies for some of the sensors and a triaxial accelerometer. A small compass, pitch and roll board is mounted on the main PCB, along with temperature and humidity sensors.

Figure 1 Buoy-to-Hub cable inside hydraulic hose clamped to mooring chain

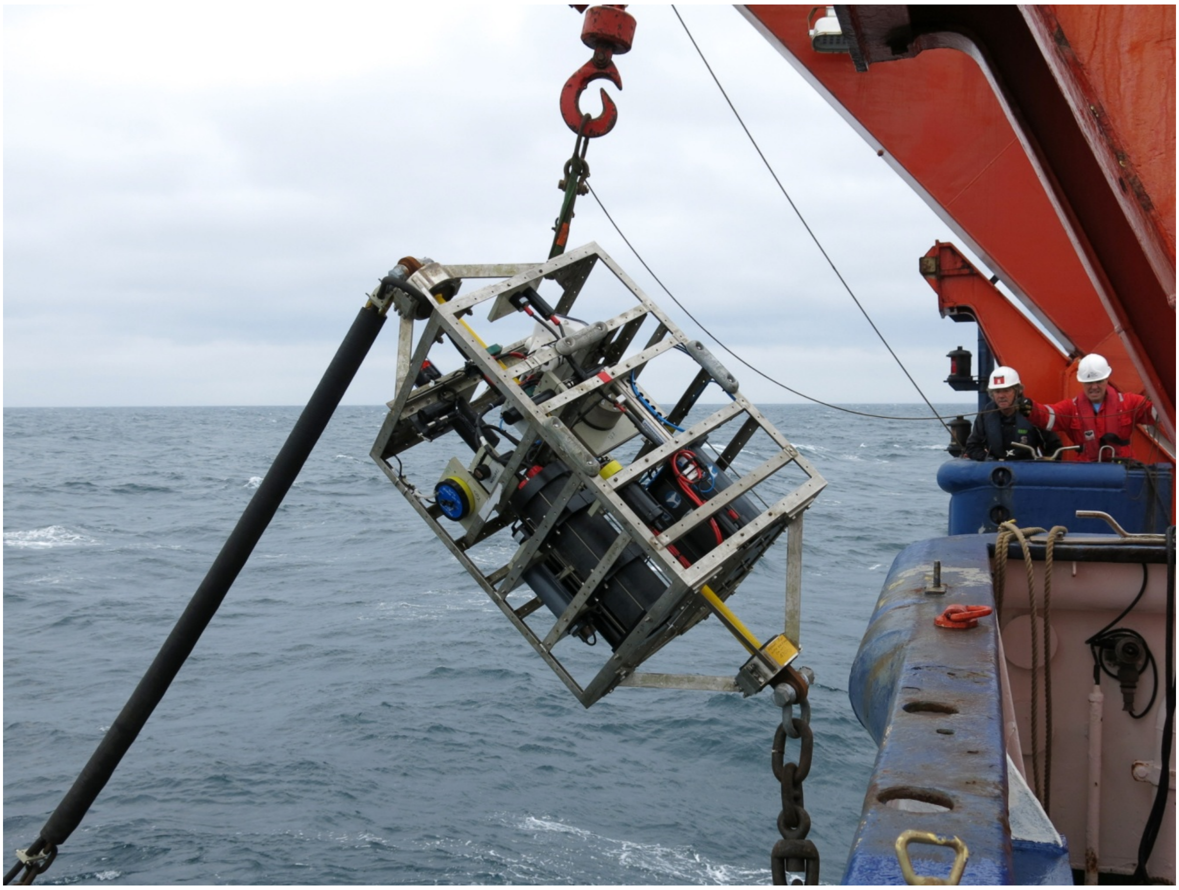


Figure 2 Sensor frame being deployed showing large hydraulic hose over mooring chain

3.3.3 Sensor frame

The sensor frame modifications carried out prior to the previous deployment proved effective at withstanding the severe weather experienced in December 2013, and this frame was used again for the 2014 deployment. Nick Rundle designed new clamps to secure three OceanSonics battery housings at the bottom of the frame (one had been lost in the previous deployment), and also to hold the new Data Hub. The ZPS plankton sampler was mounted in a new location and extra bracing was provided for its substantial battery housing.

3.3.4 Buoy Telemetry Unit

Two new PCBs were designed and built for the Telemetry Unit. The first of these boards has many of the same features as the new data Hub board including the twin 8-channel UARTs. The second board carries a number of DC-DC converter modules to provide a 30V supply to the Data Hub and 12V and 15V supplies to assorted sensors on the buoy keel and mast.

3.3.5 System software

In order to accommodate the new UART devices, it was necessary to re-write the low level serial communication functions. Changes to the sensor suite for this deployment, including the addition of two new sensor types (Sensor Lab pH and Satlantic SUNA) required changes to sensor data handling functions in the Hub, Buoy and the software running on the Iridium server PC at NOC. This software was tested and developed further during the passage from Las Palmas to the PAP site. A significant change was made to the way data are passed from the Hub to the buoy – data are now buffered in a temporary file and sent to the buoy according to a schedule which can be remotely adjusted. This allows data transfers to be confined to times when the buoy controller is not busy with other tasks.

Extra functionality was added to the email command list to allow remote control of some sensor power supplies and sampling regimes.

3.4 Deployment and initial performance

The PAP1 deployment commenced at 0900 on 15th July and proceeded smoothly with the anchor being released at 1405. 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. Once the frame was in the water, email commands were sent to switch on the Data Hub, the Satlantic OCR irradiance sensors, the CO2 and Sensor Lab pH sensor on the keel and the GTD sensor in the frame. The sampling regimes of these sensors may be altered by sending further email commands.

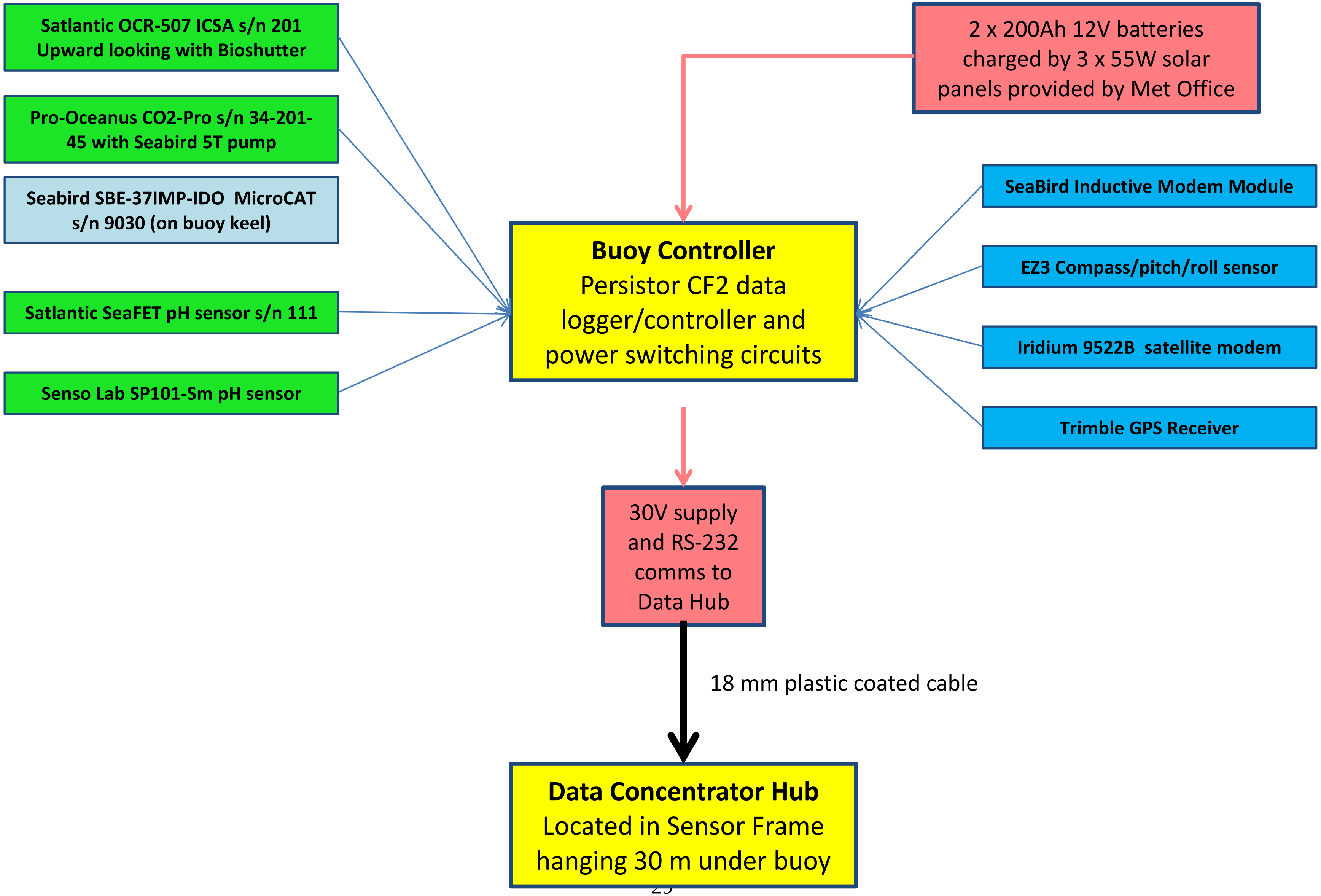
A new version of the buoy8proc.c program for the Iridium server PC at NOC was emailed to Maureen Pagnani to correct a few mistakes in the processing of the telemetered data, and near real time data from all the sensors were soon appearing on the Eurosites website.

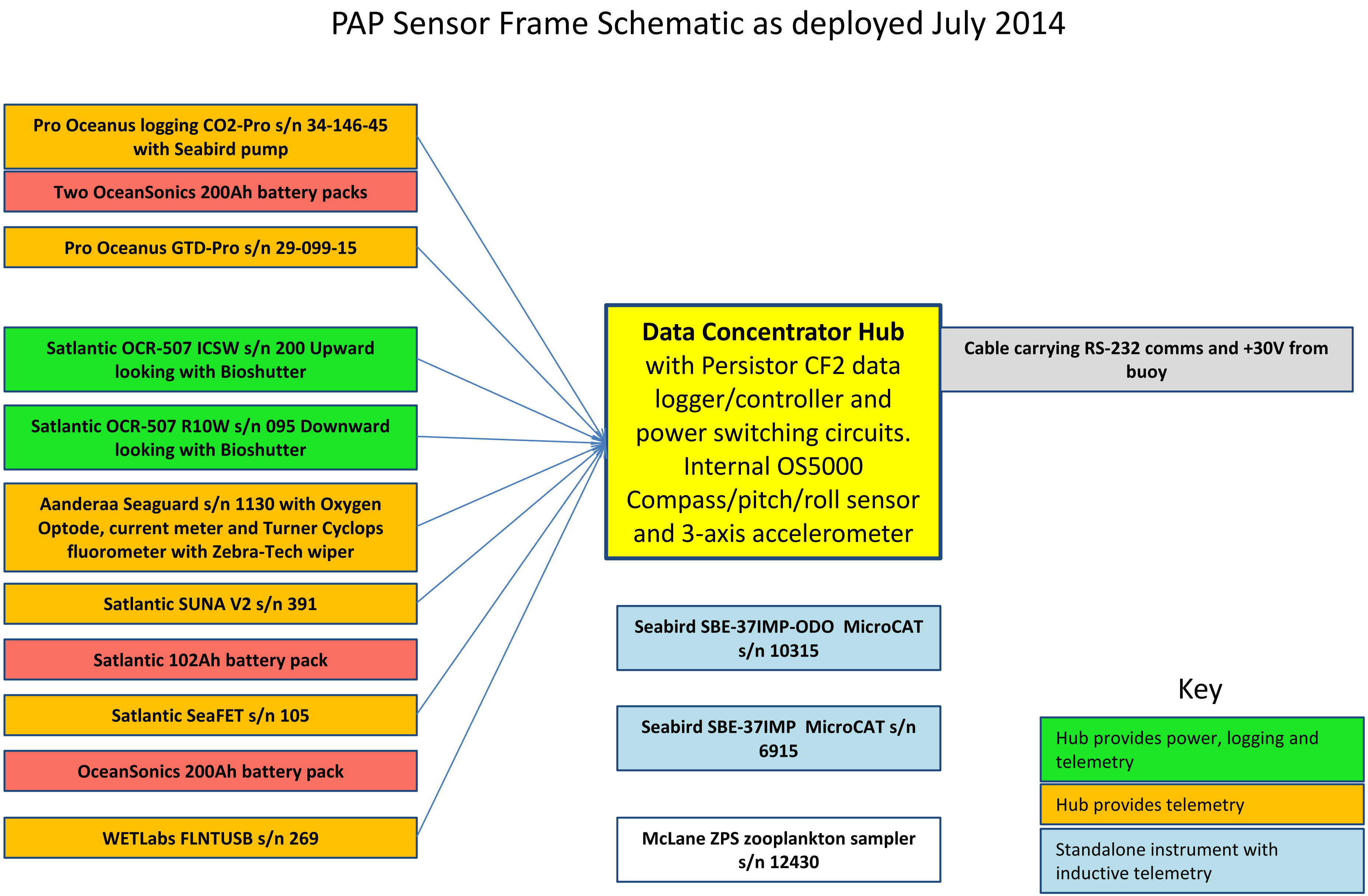
PAP April 2014 sensor configuration	**Serial number**	**Sample interval**	**Minutes past the hour**	**Power source**
ON BUOY		Highlighted are remotely adjustable		
Pro-Oceanus CO2-Pro	34-201-45	12 hrs	19	Buoy
SeaBird SBE-37IMP IDO MicroCAT	9030	30 mins	0	Internal batteries
Satlantic OCR-507 ICSA (buoy)	201	30 mins	17	Buoy
Satlantic SeaFET pH	111	30 mins	27	Pro-Oceanus 266Ah battery housing
Sensor Lab SP101-Sm pH sensor	on loan	3 hrs	26	Buoy
IN SENSOR FRAME				
SeaBird SBE-37IMP-ODO MicroCAT	10315	30 mins	0	Internal batteries
SeaBird SBE-37IMP MicroCAT	6915	15 mins	0	Internal batteries
WETLabs FLNTUSB Fluorometer	269	4 hrs	0	Internal batteries
Satlantic SUNA V2 Nitrate sensor	391	1 hr	20	Satlantic 102Ah battery pack
Satlantic SeaFET pH sensor	105	30 mins	23	OceanSonics 200Ah battery housing

Aanderaa Seaguard	1130	1 hr	30	Internal batteries
Aanderaa 4330 optode in Seaguard	1339			
Turner Cyclops Fluorometer in Seaguard	2102108			
ZebraTech Wiper for Cyclops		6 hrs	0	Internal batteries
Satlantic OCR-507 ICSW irradiance	200	30 mins	17	Buoy via Data Hub
Satlantic OCR-507 R10W radiance	95	30 mins	17	Buoy via Data Hub
Pro-Oceanus Logging CO2-Pro	33-146-45	12 hrs	59	Two OceanSonics 200Ah battery housings
Pro-Oceanus GTD-Pro	29-099-15	6 hrs	56	Buoy via Data Hub
Data Hub in Develogic battery housing				Buoy
McLane ZPS plankton sampler	12860-01	Various		McLane battery housing
Star-Oddi DST TILT	H454	1Hz bursts		Internal batteries

Table 1. Sensors fitted on buoy and sensor frame for July 2014 deployment.

PAP Telemetry Buoy Schematic as deployed July 2014




PAP Sensor Frame Schematic as deployed July 2014
Pro Oceanus logging CO2-Pro s/n 34-146-45 with Seabird pump
Two OceanSonics 200Ah battery packs
Pro Oceanus GTD-Pro s/n 29-099-15
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 1130 with Oxygen Optode, current meter and Turner Cyclops fluorometer with Zebra-Tech wiper
Satlantic SUNA V2 s/n 391
Satlantic 102Ah battery pack
Satlantic SeaFET s/n 105
OceanSonics 200Ah battery pack
WETLabs FLNTUSB s/n 269
Data Concentrator Hub with Persistor CF2 data logger/controller and power switching circuits. Internal OS5000 Compass/pitch/roll sensor and 3-axis accelerometer
Cable carrying RS-232 comms and +30V from buoy
Seabird SBE-37IMP-ODO MicroCAT s/n 10315
Seabird SBE-37IMP MicroCAT s/n 6915
McLane ZPS zooplankton sampler s/n 12430
Key
Hub provides power, logging and telemetry
Hub provides telemetry
Standalone instrument with inductive telemetry

4 Acoustic Modem Trial for the RAPID programme

Jon Campbell

The RAPID pop-up capsule telemetry system currently under development at NOC Liverpool and Southampton employs a pair of acoustic modems to transfer data from instruments on a mooring to a lander on the seafloor with releasable data capsules.

The LinkQuest UWM3000 modems currently used have a stated maximum operating range of 3000m. The purpose of this trial was to see what ranges and data transfer rates could be achieved in deep water.

4.1 Experimental set up

The lander modem, modem battery pack and lander modem controller housing were all clamped to the ship's CTD frame and a program called 'raprange.c' was started on the modem controller. This program switches on the lander LinkQuest modem and listens for incoming connection requests or data. It is assumed that a data transfer will start with an 8-character header containing the ASCII decimal number of bytes in the following message, e.g. 00001040. The raprange program reads this number and then waits until this number if bytes have been received or a timeout value is reached. It then replies with the number of bytes received, e.g. RCVD00001040. This is the only indication the surface operator receives that the data transfer has been successful.

On the ship the other LinkQuest modem was dangled in the sea on a dunking cable so that it was approximately 20m below the sea surface. This modem was connected to a laptop and a bench power supply, and was controlled by running LinkQuest command line programs to establish a connection (the mdm_sync command) or to change between low and high power settings. A simple terminal program (Tera Term) was used to send files to the modem and display any responses.

Fig. 3 shows one of the modems attached to the CTD frame.

Figure 3 LinkQuest UWM3000 modem attached to CTD frame

4.2 Results

Table 1 gives the sequence of events during the trial, together with the signal strengths and estimated ranges returned by the LinkQuest mdm_sync program. All modem sync attempts were successful but all were classed as 'very demanding' by the mdm_sync program, even those at relatively short range. The program classifications are 'good', 'fair', 'demanding', and 'very demanding'. This indicates an underlying problem with noise or reflections that impeded all communications. In spite of this most file transfers were successful and some where no reply was received at the surface were in fact successful received by the modem on the CTD. Fig.4 shows a plot of data transfer speed versus range. The speeds were calculated using the eventlog file recorded in the modem controller on the CTD, which records the time a file transfer header was received and the time that the last data in the file were received.

4.3 Conclusions

Although communication was possible up to the maximum specified range of 3000m, the data transfer rates were slower than expected and were often too low to be usable in the application envisaged for RAPID. If more time had been available it would have been interesting to lower the surface modem to a depth of say 100m to get it below the thermocline and away from the ship and wave noise at the surface.

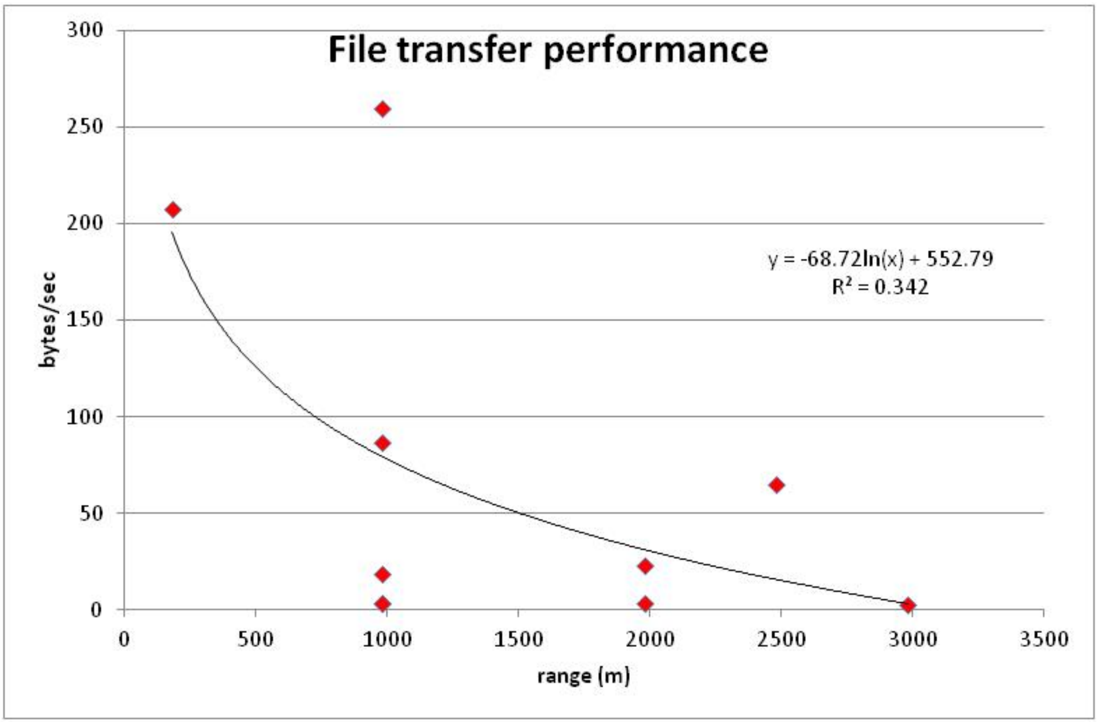


Figure 4 Data transfer performance

Table 2 Log of events

Time	CTD depth	Event	Sync file	range	Top modem Rx level	CTD modem Rx level
13:55:00	0	Normal power (190-200mA @ 23V)				
14:04:00	200	Dunking xducer at 20m.				
14:10:00	200	mdm_sync command	r4.txt	182.4	2157	2142
14:12:00	200	Sent 1040 byte file				
14:13:00	200	RCVD OK				
14:30:00	1000	mdm_sync command	r6.txt	979.2	1692	1611
14:31:00	1000	Sent 1040 byte file				
14:32:00	1000	RCVD OK				
14:32:45	1000	Sent 10840 byte file				
14:57:00	1000	Stopped transfer - taking too long				
14:59:00	1000	mdm_sync command	r7.txt	978.0	1722	1691
15:00:00	1000	Set to high power (590-600mA @ 23V)	r8.txt	979.2	1869	1833
15:03:00	1000	Sent 1040 byte file				
15:05:00	1000	Garbage reply - sent again				
15:09:00	1000	No reply				
15:09:30	1000	Set to low power				
15:10:00	1000	mdm_sync command	r9.txt	980.4	1677	1590
15:11:30	1000	Sent 1040 byte file				
15:14:00	1000	RCVD OK - a few bytes missing				
15:15:00	1000	Descending to 2000m				
15:30:05	2000	mdm_sync command (83 sec to complete)	r10.txt	1980.0	1473	1386
15:31:28	2000	sync complete				
15:32:07	2000	Sent 1040 byte file				
15:40:00	2000	No reply				
15:41:00	2000	Set to high power (590-600mA @ 23V)				
15:41:36	2000	mdm_sync command	r11.txt	1978.8	1662	1647

15:43:00	2000	sync complete				
15:43:27	2000	Sent 1040 byte file				
15:48:10	2000	RCVD OK (5 mins)				
15:48:30	2000	Descending to 3000m				
16:05:53	3000	mdm_sync command	r12.txt	2974.8	1536	1401
16:07:50	3000	sync complete				
16:08:22	3000	Sent 1040 byte file				
16:19:05	3000	RCVD 872 bytes				
16:22:00	3000	Coming up to 2500m				
16:32:50	2500	mdm_sync command	r13.txt	2478.0	1554	1515
16:34:18	2500	sync complete				
16:34:46	2500	Sent 1040 byte file				
16:49:18	2500	RCVD OK (15 mins)				
16:49:30	2500	Coming up to 2000m				
16:59:15	2000	mdm_sync command	r14.txt	1980.0	1917	1387
17:00:42	2000	sync complete				
17:01:01	2000	Sent 1040 byte file				
17:07:00	2000	Stopped sending but no reply				
17:08:00	2000	Coming back to surface				
17:10:30		RCVD 1006 bytes				
17:12:00		Set to low power				
		Retrieved dunking modem				

5 PAP#1 Sensors

Corinne Pebody, Katsia Pabortsava, Andrew Morris, Jon Campbell

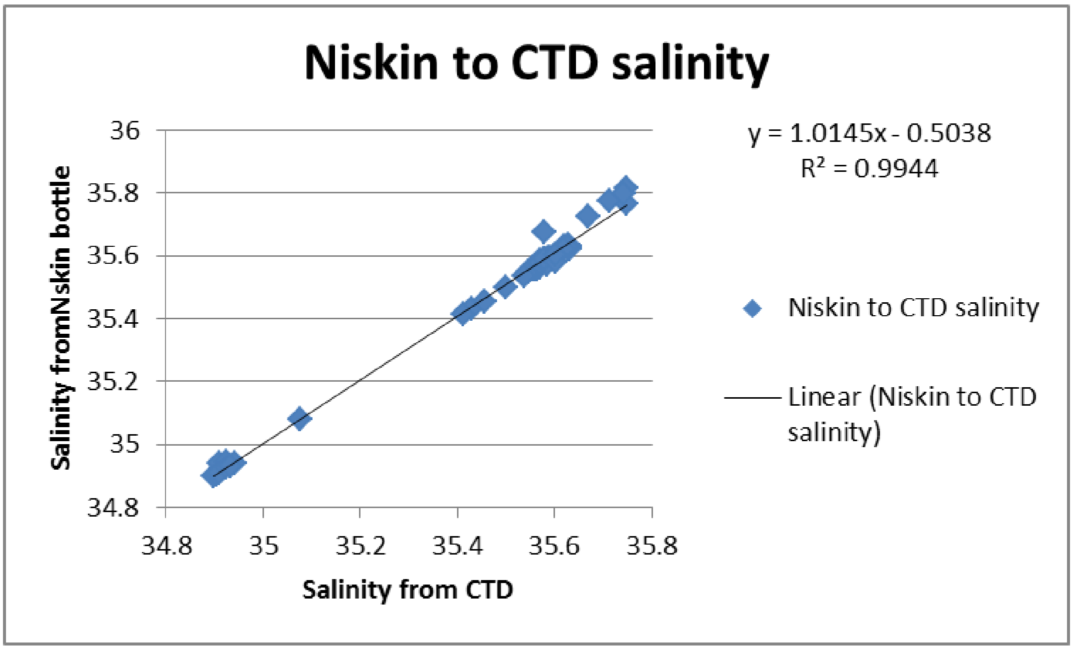
5.1 Calibrations

Corinne Pebody, Andrew Morris, Katsia Pabortsava

The sensors were 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 chlorophyll and salinity samples were analysed during the cruise.

5.1.1 Salinity Calibrations

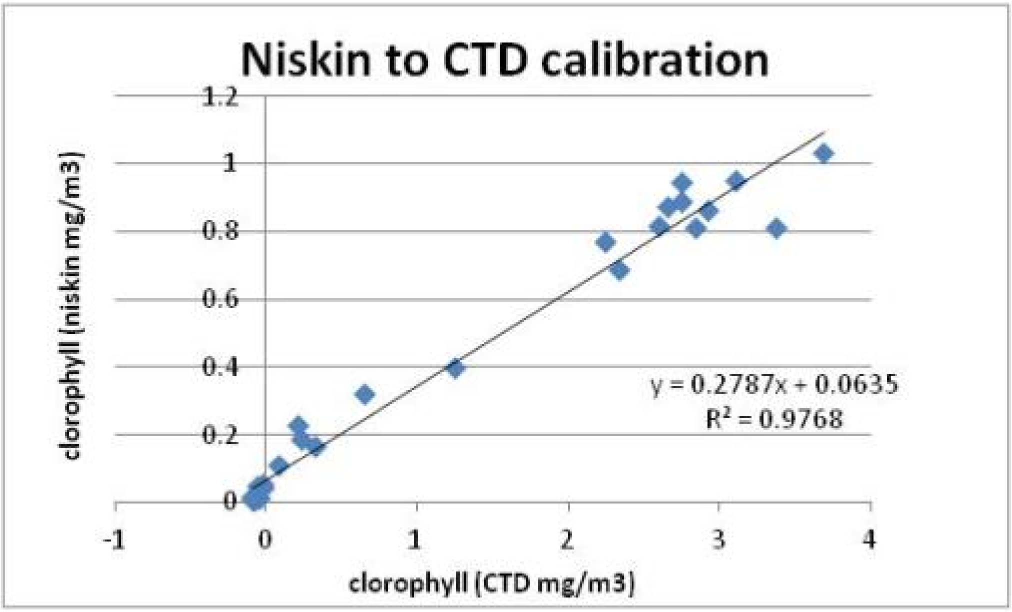
Salinity samples were collected on CTD casts 1,2,4 & 8 and run on board on the NMEP salinometer SN 32507, using SSW batch 157 by Dave Childs.

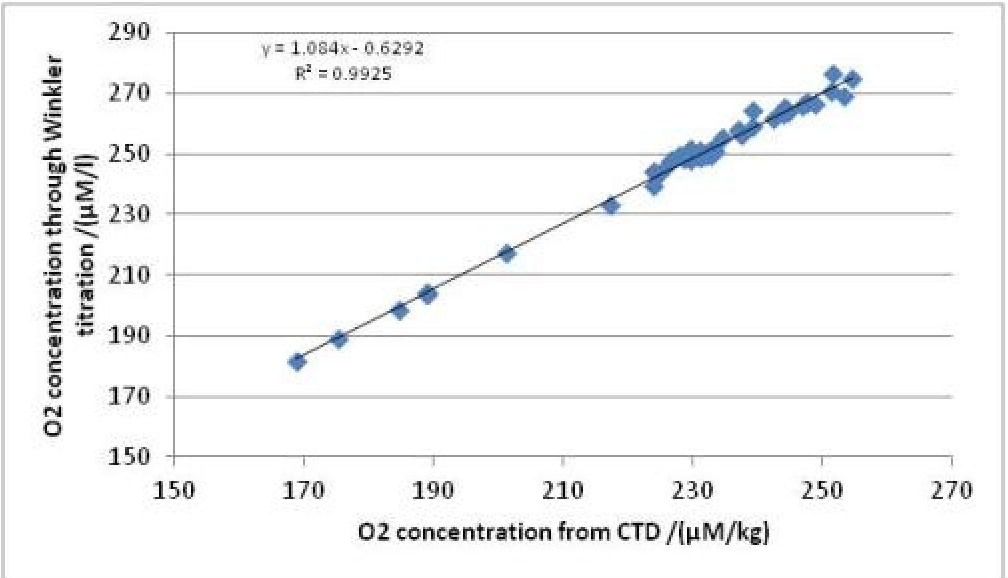


The graph shows salinity from sample versus the ships CTD (Seabird 9). The microcat was not calibrated on board due to the change in protocols.

5.1.2 Fluorescence and oxygen

The calibration of the CTD fluorescence and oxygen sensors are presented below.





Calibration of CTD chlorophyll and oxygen sensors (for Chl-a measurements and calibration see file M108/chlorophyll/chlorophyll calibrations

5.1.3 Seaguard

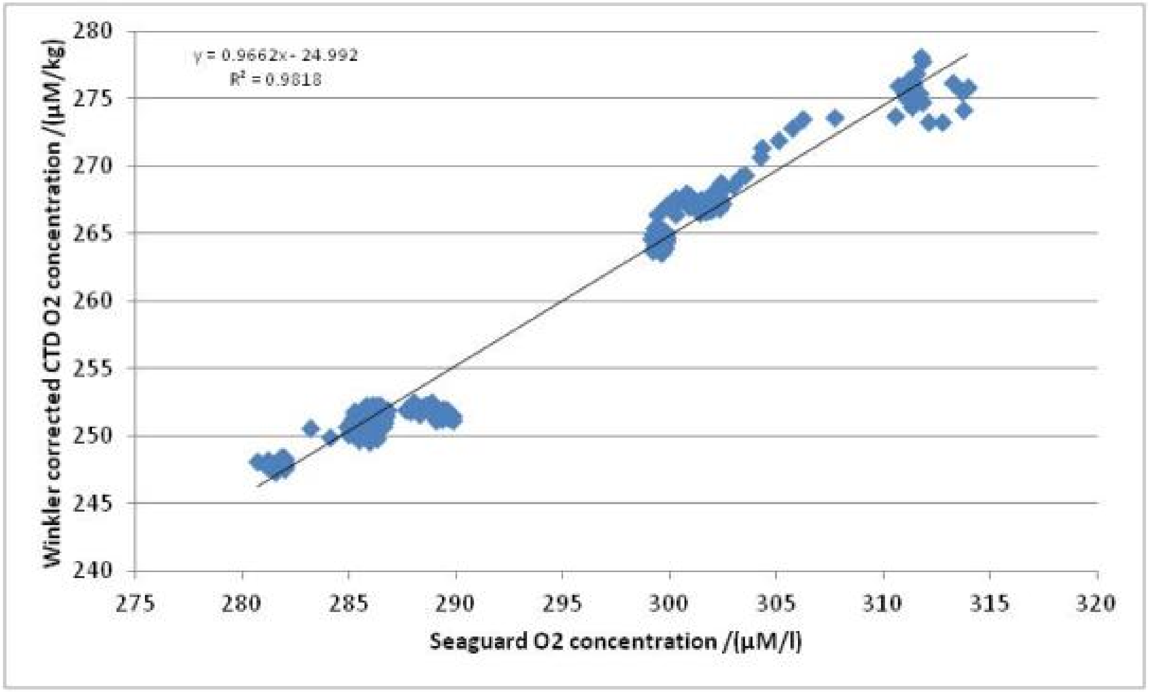
Aanderaa s/n1130

The Seaguard platform (SN 1130) is equipped with the following sensor nodes:

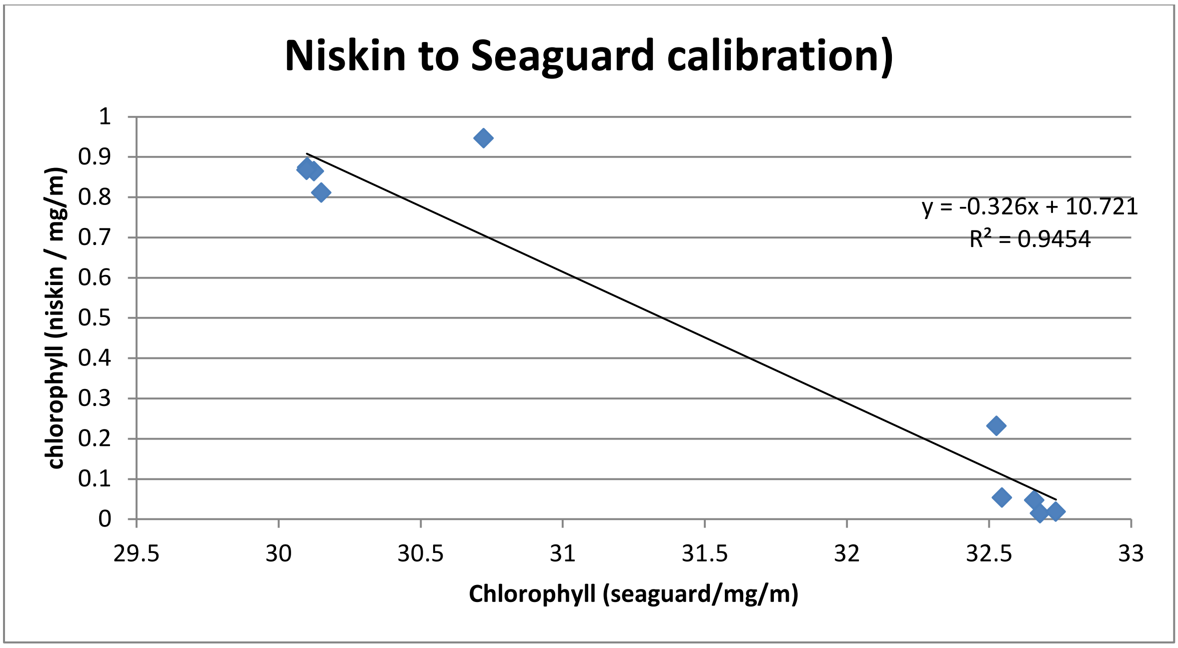
- Aanderaa 4339 oxygen optode (SN 1339)
- Turner Cyclops fluorometer (SN 2102108)
- DCS current meter (SN 536)

The Seaguard was deployed on CTD cast 002 in order to calibrate the oxygen optode and fluorometer against the CTD sensors.

The results from the calibration of the oxygen 4330 optode are presented in the figure below.



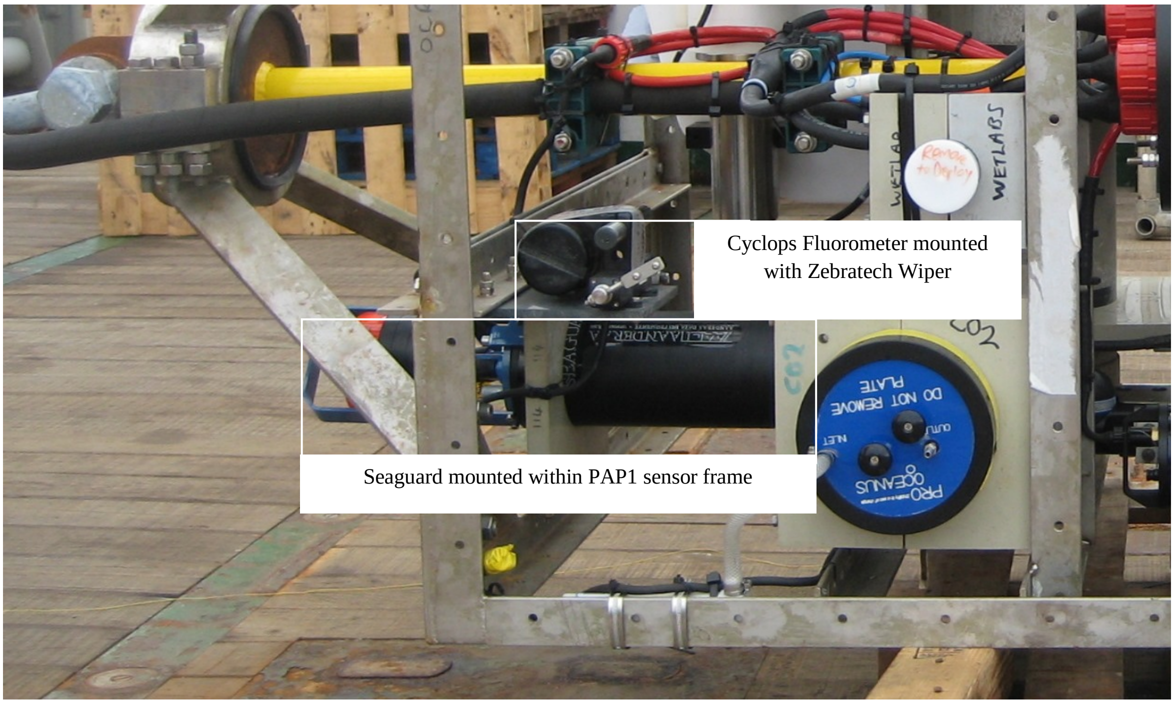
Optode 4339 Calibration and Seaguard chlorophyll Calibration



Seaguard Chlorophyll Calibration

For the calibration of the Seaguard only the data collected whilst the CTD rosette was held at depth (i.e. not in transit) was considered to reduce the effects of any time response differences between the pumped CTD sensors and the passively sampling Seaguard.

After the calibration CTD the Seaguard was set for deployment. A new set of alkaline batteries was installed as well as a new SD card for local data storage. The Seaguard was set to make measurements with all its sensors every hour, on the half hour. The Seaguard was armed to start recording at 12.30 GMT, 13/07/2014 and then mounted within the PAP1 sensor frame. The Cyclops Fluorometer was positioned on the Zebratech Wiper which was started at 18:00, 14/07/2014 and will operate every six hours. The picture below shows the Seaguard with Zebratech Wiper in the PAP1 sensor frame.



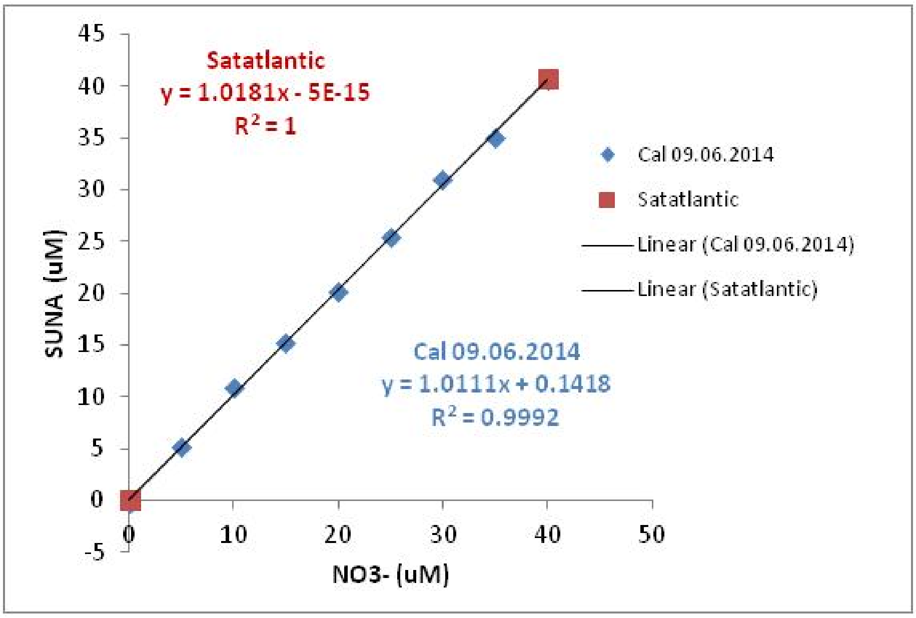
Seaguard mounted in what will be pointing vertically up and out of the main sensor frame following deployment. Please note safety covers on some instruments within image are still in place but were removed for deployment.

The Seaguard and Wetlabs fluorometers were bench tested prior to the cruise (see Appendix 1. The Seaguard output from this trial seemed much more as expected, however when the calibration coefficient is applied the regression seems to work adequately.

5.1.4 SUNA V2 Nitrate Sensor

Satlantic (S/N: 391)

The SUNA in situ Nitrate (NO_3^-) sensor was deployed on the PAP sensor frame (deployment depth of 30 m) for the first time. The sensor was calibrated in the lab at NOC (09.06.2014) using one point calibration method, involving addition of 5 mL of 5µM nitrate standard into 1 L of ultra-pure (Milli-Q/DI) water every 10 min. The calibration was performed by Katsiaryna Pabortsava. The calibration in the lab agreed well with the calibration by the manufacturer (Fig. 6).



Lab Calibration of the SUNA nitrate sensor in the ultra-pure (Milli-Q/DI) water.

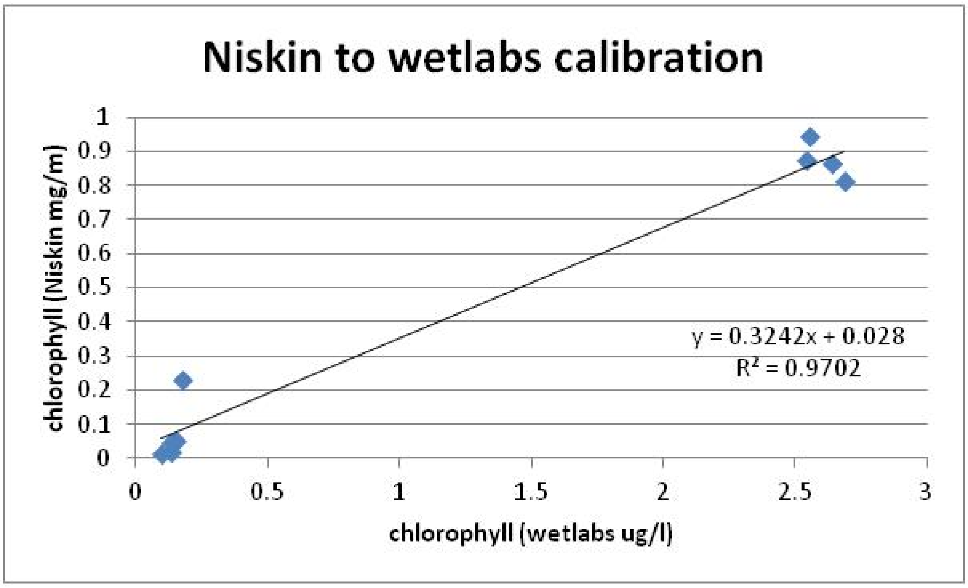
On the sensor frame deployed at 30 m, the SUNA Nitrate sensor was configured to sample in a periodic mode/frame based operation. The sampling interval was set to 1 hour with 1200 sec (20 min) offset past the hour. Within the sampling interval, the acquisition duration was given by the number of frames. For this deployment, the chosen 1 frame operation outputs 1 dark frame then 1 light frame which is the average of 10 samples. This gives an estimated frame rate of 0.1587 frames per second (6.3 sec/frame). The integrated wiper was enabled.

The SUNA measurements will be calibrated against the Total Oxidised Nitrogen measurements (TON=NO_3^- +NO_2^-) from the Niskin bottles.

5.1.5 Wetlabs Fluorometer

ECO-FLNTUSB (S/N: 269)

The ECO_FLNTUSB fluorometer was calibrated on CTD cast CTD002. The calibration results are presented in the figure below



ECO-FLNTUSB 269 Calibration

During the calibration the pressure sensor stopped functioning correctly, however as it was the only wetlabs fluorometer available for the cruise and the fluorometer seemed to functioning correctly it was deployed . After the calibration the instrument was set up for the mooring deployment. The ECO will produce a set of 8 measurements every 4 hours. The instrument started at 15/07/2014, Since it was deployed the ECO is performing as expected.

5.1.6 Pro-Oceanus Dissolved gas sensors

A new CO2-Pro CO2 sensor (s/n 34-201-45) was attached to the buoy keel and is powered and controlled by the buoy Telemetry Unit. Unlike previous CO2-Pro sensors, this one needed to be configured to automatically perform an Auto Zero Point Calibration (AZPC) every time it is switched on by the buoy. Unfortunately this setting was not correctly saved before the unit was deployed and as a result the unit will not perform any AZPC cycles during the deployment. This means that the ‘zero

CO2' reference point will gradually drift during the course of the deployment, but hopefully the data can be partially corrected after the sensor has been recovered and an AZPC performed.

A self-logging CO2-Pro (s/n 33-146-45) was attached to the sensor frame and was configured to sample every 12 hours at midnight and noon. The real time clock battery was fully charged shortly before deployment. This sensor is powered by two, 200Ah OceanSonics battery housings connected in parallel, which each had one layer of cells removed to provide a voltage of approximately 14.4V. The ascarite CO2 absorbent in this sensor was replaced at NOC shortly before the cruise.

A GTD-Pro gas tension sensor (s/n 29-099-15) was also attached to the sensor frame and is powered and recorded by the Data Hub.

The Data Hub switches on the GTD-Pro every 6 hours and the buoy controller switches the buoy CO2-Pro on every 12 hours to coincide with the other CO2-Pro in the sensor frame.

5.2 pH sensors

A Sensor Lab SP101-Sm pH sensor on loan from Melchor González Dávila at ULPGC on Gran Canaria was attached to the buoy keel, along with a Satlantic SeaFET pH sensor (s/n 111). The SP101 was checked and serviced in Gran Canaria shortly before the cruise began.

A second SeaFET (s/n 105) is fitted in the sensor frame at 30m, and both SeaFETs are powered from dedicated battery packs in separate housings.

Both SeaFETs were configured to sample every 30 minutes, producing 3 frames with each frame being an average of 10 readings.

In the first 7 days after deployment all 3 sensors produced good data but the SP101 is occasionally unable to produce a pH reading. This may be because air is getting into the narrow bore intake tube.

5.3 Irradiance sensors

A Satlantic OCR-507 ICSA irradiance sensor (s/n 201) was fitted to the buoy mast and is controlled by the Telemetry Unit. The Data Hub controls an OCR-507 ICSW upward-looking irradiance sensor (s/n 200) and an OCR-507 R10W downward-looking radiance sensor (s/n 095). All 3 sensors were commanded to sample every 30 minutes at the same time so that their data are coincident.

5.4 Star Oddi

5.4.1 Deployment on a CTD frame

Star ODDI (SO) DST CTD (S/N: S7561, S7562, 6790, 5774, 6789, 5777, 5771, 7566, 7563, 7564, 7565) and DST tilt (H453, H454, H457) sensors were deployed on CTD cast ME108 CTD002 and calibrated against the Seabird 9+ CTD . They were programmed to start at 12/07/14 at 09:30:00 GMT and were set to sample every 10 sec. All of the SO sensors were deployed on nearly the same height on a CTD frame. The calibration results (difference (Δ) between the CTD and SO readings is given in the table below.

Calibration results of Star ODDIs

Star ODDI	Median	Average	Min	Max	CTD-SO
7561	-0.1797	-0.1787659	-0.9725	0.6381	**ΔP/bar**
	0.0153	-0.0139725	-1.94525	1.1549	**ΔT/°C**
	2.5288667	2.5274031	1.7581333	3.5020333	**ΔS/psu**
7562	0.062	0.0568099	-0.7725	0.8584	**ΔP/bar**
	0.0153	-0.0139725	-1.94525	1.1549	**ΔT/°C**
	2.6297667	2.5542718	1.6581333	4.0857	**ΔS/psu**
6790	-0.1701	-0.2029073	-1.0846	0.6806	**ΔP/bar**
	0.0241	-0.0046028	-2.00325	1.3109	**ΔT/°C**
	0.9314667	0.9146758	-0.6394667	2.4857	**ΔS/psu**
6789	-0.8214	-0.8048265	-1.5866	0.1624	**ΔP/bar**
	0.01935	-0.0590857	-2.21425	0.8849	**ΔT/°C**
	3.7491333	3.8156859	3.0409333	5.9857	**ΔS/psu**
5774	-69.5034	-66.246241	-73.0433	-52.6689	**ΔP/bar**

	0.0443	-0.0533806	-2.45525	1.0109	ΔT/°C
	29.379567	29.504777	29.049167	30.186633	ΔS/psu
5777	-0.5298	-0.5286446	-1.2325	0.1619	**ΔP/bar**
	0.03835	0.024377	-1.82225	1.2169	**ΔT/°C**
	1.0305333	1.0843728	0.0605333	2.2857	**ΔS/psu**
5771	0.1007	0.0892745	-0.7225	0.8206	**ΔP/bar**
	1.8213	1.8083305	-0.12725	2.9419	**ΔT/°C**
	-1.1679	-1.1247181	-2.2394667	0.1857	**ΔS/psu**
7566	0.1936	0.1888907	-0.5825	0.9106	**ΔP/bar**
	0.0213	-0.0300392	-2.01525	0.91955	**ΔT/°C**
	3.0192667	3.016292	2.1409333	5.3857	**ΔS/psu**
7563	-0.0088	-0.0156547	-0.8825	0.7781	**ΔP/bar**
	0.0391	-0.0229887	-2.05625	0.9829	**ΔT/°C**
	2.5302333	2.5255849	1.7409333	3.8857	**ΔS/psu**
7564	-1.2801	-1.2880588	-2.1325	-0.5119	**ΔP/bar**
	0.02105	-0.0022453	-1.90325	1.2269	**ΔT/°C**
	2.3617333	2.3512415	1.4605333	3.4857	**ΔS/psu**
7565	-0.2961	-0.2992103	-1.1425	0.4981	**ΔP/bar**
	0.0161	-0.04652	-2.09425	0.9449	**ΔT/°C**
	2.2210333	2.206191	1.4409333	4.6857	**ΔS/psu**
H453	0.2827	0.2781634	0.1177	0.5019	**ΔP/bar**

	0.00365	-0.0220594	-1.71125	0.97655	**ΔT/°C**
	NA	NA	NA	NA	**ΔS/psu**
H454	0.1952	0.1984261	-0.1125	0.5169	**ΔP/bar**
	0.0053	-0.0091099	-1.91225	0.98855	**ΔT/°C**
	NA	NA	NA	NA	**ΔS/psu**
H457	-0.2678	-0.2965436	-0.6022	-0.0791	**ΔP/bar**
	-0.00345	-0.0385725	-1.86825	0.94055	**ΔT/°C**
	NA	NA	NA	NA	**ΔS/psu**

Only the SO DST CTD 5774 collected poor-quality pressure and salinity data, while the temperature data from this sensor were reasonably good. The SOs calibration data will be further analysed at NOCS.

5.4.2 Deployment on the mooring

After the calibration cast the SOs were prepared for the mooring deployment (on the ODAS buoy, sensor frame and sub-surface buoy).

Set-up for the mooring deployment of the Star-ODDI sensors

Star-ODDI	Type	Deployment depth, m	Position	Interval type	Interval
6789	DST CTD	5	Below Buoy	Fixed	30 min
6790	DST CTD	10	Below Buoy	Fixed	30 min
5777	DST CTD	15	Below Buoy	Fixed	30 min
5771	DST CTD	20	Below Buoy	Fixed	30 min
5774	DST CTD	25	Below Buoy	Fixed	30 min
7561	DST	50	Below	Fixed	30 min

	CTD		Frame		
7562	DST CTD	75	Below Frame	Fixed	30 min
7563	DST CTD	100	Below Frame	Fixed	30 min
7564	DST CTD	150	Below Frame	Fixed	30 min
7565	DST CTD	250	Below Frame	Fixed	30 min
7566	DST CTD	400	Below Frame	Fixed	30 min
H453	DST tilt	15	Chain	Multiple Interval	**Tilt:** 1sec x 60 measurements; **Temperature:** 30 min x 48 measurements
H454	DST tilt	30	Frame	Multiple Interval	**Tilt:** 1sec x 60 measurements; **Temperature:** 30 min x 48 measurements
H457*	DST tilt	1000	Sub-surface buoy	Fixed interval	45 min

*depth rated to 3000m

The SO sensors were programmed to start on 14/07/2014 at 12:00 GMT. The sampling set up for each SO sensor is given the table above.

5.5 Microcats

The microcats were not calibrated on this cruise in accordance with the latest guidance.

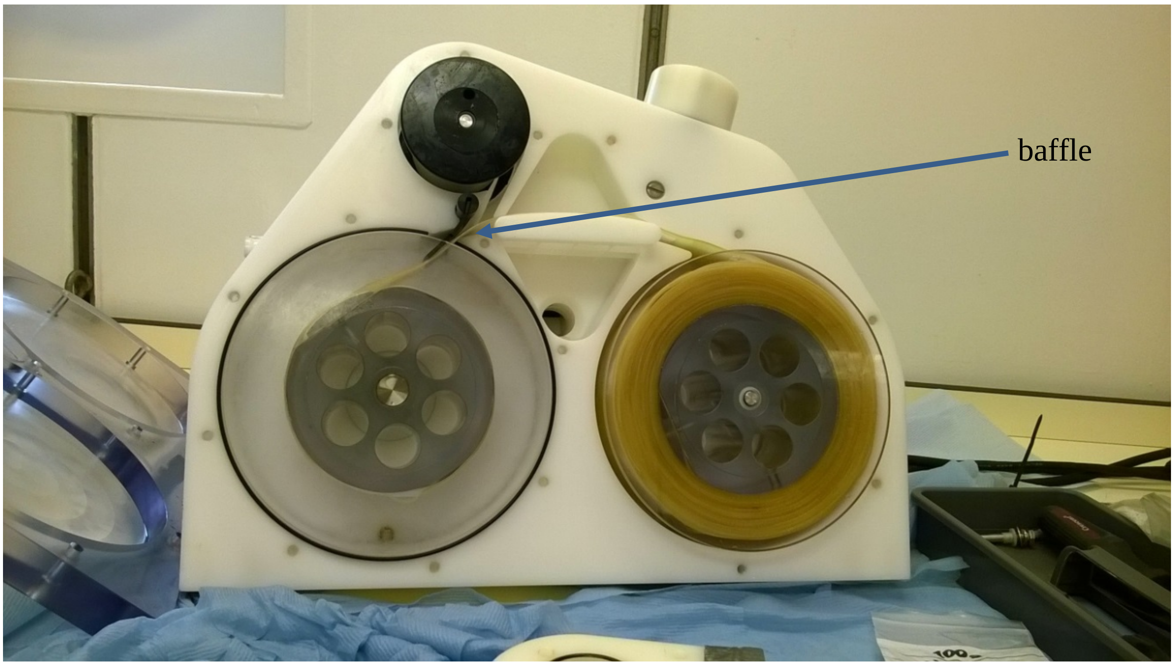
A table of CTD cats is listed in section 8.1

5.6 Zooplankton Sampler

McLane Labs ZPS s/n ML12860-01

The ZPS consists of a pump which draws water across a mesh window then through the pump itself, also a motor which winds on the mesh windows and cover gauze from two passive reels. The logger allows 50 samples at user defined intervals over a year's deployment. The wound on mesh is bathed in a hyper saline formalin preservative for subsequent sample retrieval. The logger also records engineering data for example voltage levels and pumping rates and volumes.

The ZPS required new cables and a new intake dome after the 2012/13 deployment. Due to a series of issues the intake deployed was not sealed and parafilm was used to keep the formalin in the horizontal ZPS until the point of deployment. This and the baffle which seals the formalin in the active spool would benefit from improving before re deploying next year.



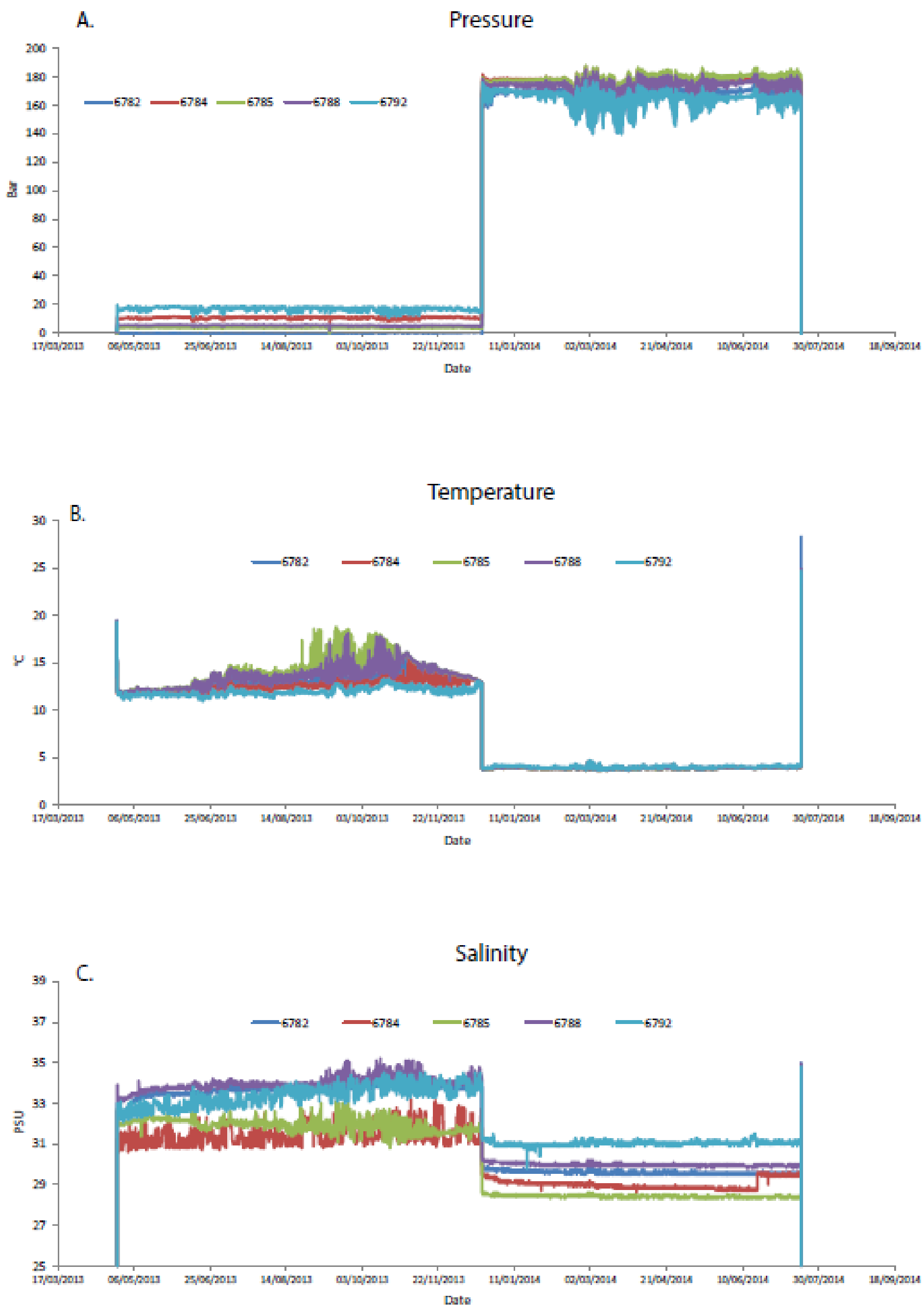
ZPS

The ZPS programme summary is attached as appendix 2

6 PAP 1 Recovered sensors

Katsia Pabortsava

The remains of the PAP1 mooring deployed on 24th April 2013 on JC85 were recovered on 18th July 2014. Five Star-Oddi DST CTD sensors (S/N: 6782, 6784, 6785, 6788, 6792) were retrieved from the top end of the mooring rope and their data downloaded. The sensors were programmed to sample every 30 min, commencing on 24/04/2013 at 12:00:00. The preliminary time-series data on pressure, temperature, and salinity are shown in Figure 1 and clearly show when the mooring rope parted on 20 December 2013. The Star-Oddi datasets will be further analysed at NOCS.


A.
Pressure
6782
6784
6785
6788
6792
Bar
0
20
40
60
80
100
120
140
160
180
200
17/03/2013
06/05/2013
25/06/2013
14/08/2013
03/10/2013
22/11/2013
11/01/2014
02/03/2014
21/04/2014
10/06/2014
30/07/2014
18/09/2014
Date
Temperature
B.
6782
6784
6785
6788
6792
°C
0
5
10
15
20
25
30
17/03/2013
06/05/2013
25/06/2013
14/08/2013
03/10/2013
22/11/2013
11/01/2014
02/03/2014
21/04/2014
10/06/2014
30/07/2014
18/09/2014
Date
Salinity
C.
6782
6784
6785
6788
6792
PSU
25
27
29
31
33
35
37
39
17/03/2013
06/05/2013
25/06/2013
14/08/2013
03/10/2013
22/11/2013
11/01/2014
02/03/2014
21/04/2014
10/06/2014
30/07/2014
18/09/2014
Date

7 Sediment Trap Mooring PAP#3

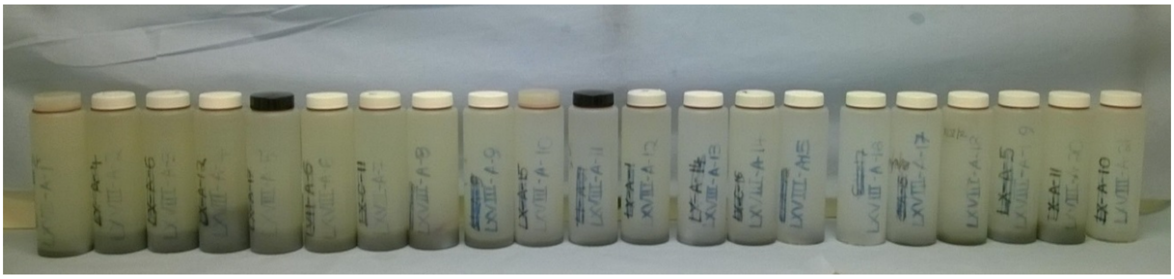
Corinne Pebody

7.1 Recovery

The PAP#3 sediment trap mooring was recovered on 16th July 2014. Traps A, B, C and D 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 that although there had been some relatively very high flux in summer 2013, there was only a small amount of flux from spring and early summer 2014.

On recovery, the bottles were removed and a lid screwed on before removing to the chemical lab.

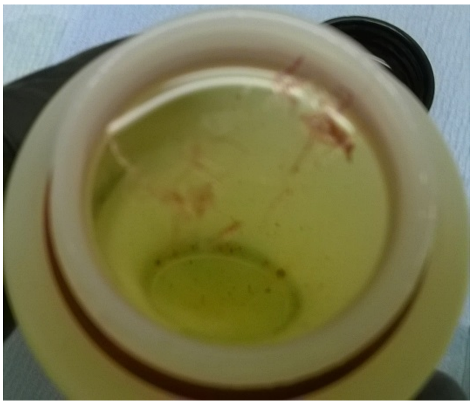
The bottles were photographed (see figures below), the pH checked and the height of the flux measured. Then 1ml of formalin was added before the bottles were sealed with parafilm, the lids replaced and samples stored in the fridges.



Bottles from 2013 – 2014 with greatest flux in bottle 4(May 2013) and much less in bottles 18 and 19 (May 2014) which are corresponding samples.

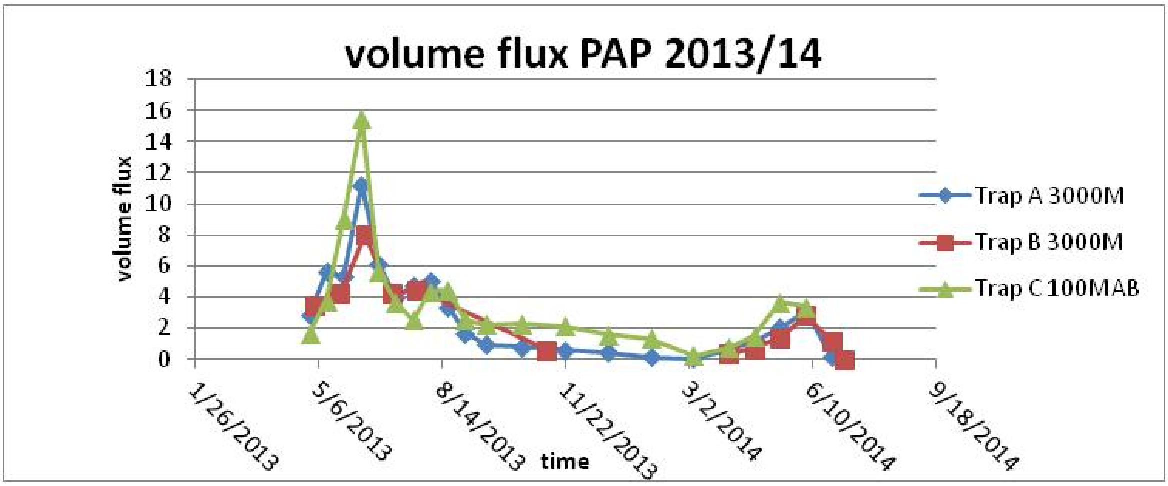
Trap D samples

Trap D was inverted at 3000m in order to capture any upward moving particles, for example the larval stage of benthic organisms dispersing in the pelagic plankton before resettling elsewhere on the seafloor. As can be seen in figure 2 only three of the bottles showed signs of particles, two contained an amphipod which may well be a swimmer but one did contain some particles shown here.



Trap D also showed a lower pH (7) than the other traps (pH 8)suggesting that there had been more mixing of the hypo saline solution than of the hyper saline solution. Although it will increase the possibility of cell lysis increasing the freshness of the water further should be considered for the 2015 deployment.

Both traps A (3000m) and C (100mab) show similar flux profiles, but unusually trap C showed higher levels than trap A



Estimated volume flux 2013-2014

7.2 Deployment

Deployment of PAP#3 was on 18/07/14 , this was apparently successful. This included trap (A) was deployed inverted and the preservative was prepared using hypo saline Sediment trap preservative.

8 CTD Report

Dave Childs, Billy Platt

8.1 CTD Operations

All CTD operations were conducted using the onboard instrumentation and frame provided by the Meteor. All sensors used on the CTD were provided by the ship, with the frame ready assembled for our use.

The initial stainless sensor configuration was as follows:

- Sea-Bird 9*plus* underwater unit, SN: 0979
- Frequency 1 - Sea-Bird 3 Premium temperature sensor, SN: 3P-5283
- Frequency 2 - Sea-Bird 4 conductivity sensor, SN: 4C-3734
- Frequency 3 - Digiquartz temperature compensated pressure sensor, SN: 0979
- Frequency 4 - Sea-Bird 3 Premium temperature sensor, SN: 3P-5272
- Frequency 5 - Sea-Bird 4 conductivity sensor, SN: 4C-4090
- V0 – Oxygen Sensor, SBE 43 SN: 431818
- V1 - Free
- V2 – Fluorimeter, WetLabs SN: 1713
- V3 - Free
- V4 - Altimeter SN: 49563
- V5 - Free
- V6 – PAR Sensor QSP2300, SN: 70279

Ancillary instruments & components:

- Sea-Bird 11*plus* deck unit
- Sea-Bird 24-position Carousel
- 24 x Ocean Test Equipment 10L water samplers.
- Primary Pump: Sea-Bird 5T, SN: 5605
- Secondary Pump: Sea-Bird 5T, SN: 5910

All sensors, deck unit's, and PC's used were supplied by the ship.

CTD operations mainly consisted of shallow casts to either 300m or 500m, whilst only 4 casts were deep casts. A total of 18 CTD "casts" were completed on this cruise numbered sequentially. Station numbers were issued by the ship on a per event basis.

Between casts, samples were taken by the scientific party on board, with different people sampling from different bottles as required. During this time, log sheets were completed, data was downloaded and backed up and the CTD data processed.

There were no issues with either the mechanical or electrical CTD termination whilst on board; additionally there were no winch or wire issues, with all casts being conducted without incident.

For each cast the ship's crew deployed the CTD package once permission was granted from the officer on watch. Deck crew assisted in getting the CTD over the bulwark and into or out of the water, the crew was ready in advance of the deployment time, helping to ensure casts were completed as efficiently as possible.

Crew also drove the winch for every cast, responding to bottle stop requests via the ship's intercom system.

The carousel was fitted with a complete set of 24 water samplers, numbered 1 through to 24. Not all bottles were fired during some of the casts, however where possible two bottles were fired at each depth allowing for any seal or misfire problems. Luckily throughout the 18 casts completed no bottles failed to fire and no bottles showed any signs of leaking. All taps worked as expected and proved trouble free for the scientific party taking samples. A thorough investigation of the CTD system prior to its first use identified a few o-rings that needed to be replaced on some of the taps as they had become brittle and broken.

Cast depths ranged from approximately 100 meters through to 3500 meters, aiming to get as close to the seabed as possible, making full use of the fitted altimeter.

All bottle firing depths were chosen by the scientific party however several casts were conducted where no bottle stops were requested affording the technical party the joy of picking their own.

A cast summary is shown in the table below:

Cast Number	*Station Number*	*Latitude (W)*	*Longitude (N)*	*Depth (M)*
001	ME108/742	39 30.916	15 57.515	4500
002	ME108/747	48 59.994	16 29.995	200
003	ME108/756	48 49.410	16 31.166	1000
004	ME108/761	48 43.274	16 41.042	300
005	ME108/766	49 0.379	16 26.432	500
006	ME108/769	49 3.180	16 21.534	500
007	ME108/774	49 0.004	16 29.993	120
008	ME108/778	48 58.526	16 27.452	4500
009	ME108/783	48 53.292	16 25.369	500
010	ME108/789	48 51.281	16 25.111	300
011	ME108/799	48 58.667	16 16.298	500
012	ME108/808	48 52.267	16 18.142	300
013	ME108/810	48 50.906	16 17.414	300

014	ME108/812	48 49.565	16 17.701	300
015	ME108/819	48 59.946	16 29.824	200
016	ME108/820	48 59.916	16 29.752	2500
017	ME108/823	48 59.181	16 29.819	500
018	ME108/830	48 54.902	16 22.235	500

8.2 Sensor Failures

Prior to the first proper cast a test cast was conducted, during this cast a fault was found with a conductivity sensor, this was removed and a replacement fitted. During all casts all of the CTD sensors worked as expected, and no replacements we used.

8.3 Data Processing

CTD cast data was post-processed using SBE Data Processing (V7.20g) software. The raw data files were converted through the following steps as recommended by BODC basic on-board data processing guidelines for SBE-911 CTD (version 1.0, October 2010):

- Data Conversion (DatCnv)
- Bottle file generation (BottleSum)
- Filter
- AlignCTD
- Cell Thermal Mass (CellTM)
- Loopedit
- Derive
- Bin Average to 1m intervals (BinAve)
- Strip

All CTD data was saved locally on the CTD PC to the D drive, in the M108 cruise folder. Raw data was saved in a raw data folder whilst processed data was saved in the processed data folder. Once processing had been completed on the local PC, all data was backed up onto the ships network and was then available for use by the scientific party.

8.4 Salinity Sample Processing

All salinity samples were taken by the scientific party, using standard 24 bottle sample crates. Once each crate had been filled it was left in the salinometer room for a period of at least 24 hours before being processed.

A Guildline Portasal SN: 62507 was setup at the beginning of the cruse and was the only salinometer used for processing all of the samples.

A standardization procedure was carried out before each crate was processed using IAPSO Standard Seawater (SSW) following the manufactures recommendations.

Log sheets were completed for every crate; these have been scanned and saved for future reference.

9 Zooplankton Net Sampling

Corinne Pebody

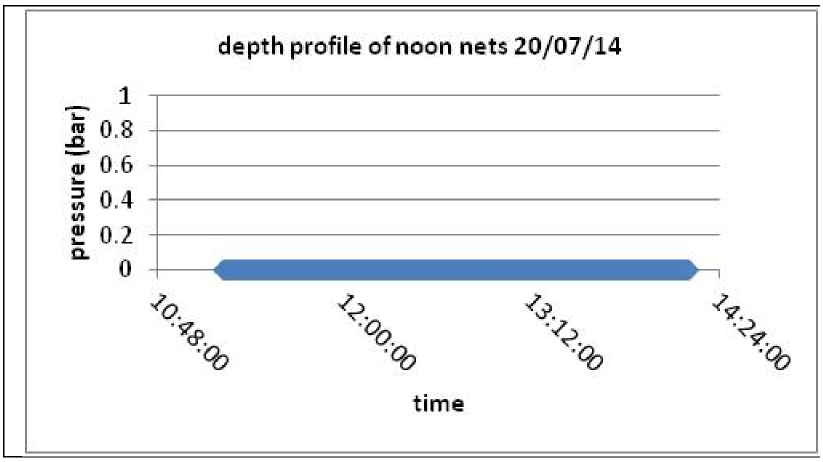
The WP2, 200µm net was weighted with approximately 8kg of weight, the bridles were wire, but the strings at the side permitted only a small amount of weight. The net was checked for twists and that the tap was closed, then the net was lowered over the side. Maximum depth was 200meters where the deployment was paused for a minute to allow the net to hang straight before the being brought up at approx. 0.2 metres per second on winch 4.

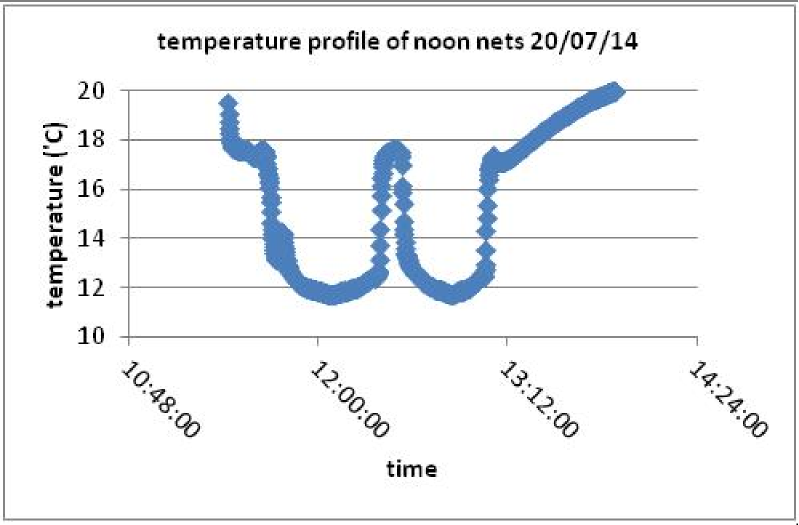
On recovery the net was hosed down from the outside with seawater and the cod end emptied into a white bucket. Hosing was repeated and time allowed for zooplankton to settle into the bottom of the cod end. Samples were then either, transferred to 1 litre bottles and preserved by adding borax buffered formalin to an approximate concentration of 5%. Alternatively the sample was sieved through a series of meshes, 2mm, 1mm, 200µm and 63 µm and transferred to cryo vials and stored in the -80°C freezer.

Deployed net

<u>Star Oddi depth check</u>

The nets are deployed nominally to 200m, but as this is 200m wire out the depth is always somewhat less depending on how far from vertical the wire is. To measure the depth a Star Oddi DST was attached to the net and deployed on a midnight and a noon haul. Unfortunately the unit was one recovered from PAP1 and the pressure sensor was not recording properly as can be seen in the figures below.





Star Oddi profiles

<u>Future work:</u>
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						
ME108-762	noon sample	preserved in formalin 7 bottles				Water depth
net shot		14/07/14	12:39	48 43.24 N	16 41.74 W	4819 ucm
at surface		14/07/14	12:59	49 43.18 N	16 41.25 W	4823.0 ucm
ME108-763	noon sample	Sieved into >2mm; ,<2mm; >1mm; <1mm>200µm; <200µm>63 µm			frozen at - 80°C	
net shot		14/07/14	13:00	49 0.08 N	16 29.98 W	4823.0 ucm
at surface		14/07/14	13:56	49 0.13 N	16 29.89 W	4821.6 ucm
ME108-771	midnight sample	preserved in formalin 2 bottles				Water depth
net shot		15/07/14	23:42	48 50.08 N	16 31.17 W	5016.5 ucm
at surface		16/07/14	00:20	48 50.08	16 31.17	4825.6

				N	W	ucm
ME108-772	midnight sample	Sieved into >2mm; ,<2mm; >1mm; <1mm>200µm; <200µm>63 µm			frozen at - 80°C	Water depth
net shot		16/07/14	00:25	48 50.08 N	16 31.17 W	4821.2 ucm
at surface		16/07/14	01:09	48 50.07 N	16 31.17 W	4825.3 ucm
ME108-785	noon sample	Sieved into >2mm; ,<2mm; >1mm; <1mm>200µm; <200µm>63 µm			frozen at - 80°C	Water depth
net shot		17/07/14	12:10	48 52.48 N	16 25.57 W	4824 ucm
at surface		17/07/14	12:55	48 52.13 N	16 25.63 W	4825 ucm
ME108-786	midnight sample	preserved in formalin 2 bottles				Water depth
net shot		17/07/14	12:57	48 52.11 N	16 25.64 W	4826 ucm
at surface		17/07/14	13:49	48 51.92 N	16 25.53 W	4823 ucm
ME108-793	midnight sample	Sieved into >2mm; ,<2mm; >1mm; <1mm>200µm; <200µm>63 µm			frozen at - 80°C	Water depth
net shot		18/07/14	00:23	49 00.04 N	16 30.01 W	4825 ucm
at surface		18/07/14	01:12	49 00.08 N	16 29.96 W	4821 ucm
ME108-794	midnight sample	preserved in formalin 4 bottles				Water depth
net shot		18/07/14	01:15	49 00.08 N	16 29.95 W	4823 ucm
at surface		18/07/14	01:57	49 00.13 N	16 29.89 W	4821 ucm
ME108-803	midnight sample	Sieved into >2mm; ,<2mm; >1mm; <1mm>200µm; <200µm>63 µm			frozen at - 80°C	Water depth
net shot		19/07/14	00:47	48 58.23 N	16 16.49 W	4824.4 ucm
at surface		19/07/14	01:37	48 58.22 N	16 16.5 W	4825.1 ucm

ME108-804	midnight sample	preserved in formalin 3 bottles				Water depth
net shot		19/07/14	01:39	48 58.22 N	16 16.50 W	4826.1 ucm
at surface		19/07/14	02:38	48 58.2 N	16 16.50 W	4823.0 ucm
ME108-817	noon sample	Sieved into >2mm; ,<2mm; >1mm; <1mm>200µm; <200µm>63 µm			frozen at - 80°C	Water depth
net shot		20/07/14	11:38	48 59.99 N	16 29.83 W	4826.2 ucm
at surface		20/07/14	12:27	49 00.01 N	16 29.85 W	4824.5 ucm
ME108-818	noon sample	preserved in formalin 4 bottles				Water depth
net shot		20/07/14	12:28	49 00.00 N	16 29.85 W	4824.4 ucm
at surface		20/07/14	13:08	48 59.95 N	16 29.82 W	4825.0 ucm

10 In situ particle characterisation

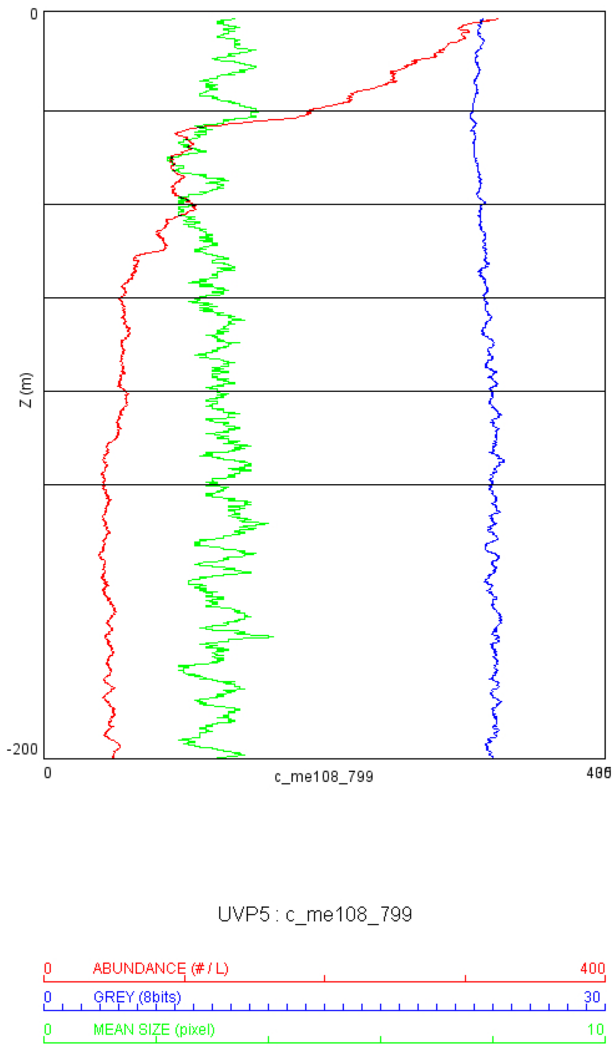
An understanding of particle characteristics is important if one is to appreciate the factors which determine the downward flux of material in the ocean and the degradation processes which affect this. During this cruise we were fortunate to have three completely different devices for observing marine snow particles in situ in addition to the marine snow catcher to obtain samples of them. The three in situ systems to characterise marine snow particles were the UVP kindly loaned to us by Dr Rainer Kiko (IFM-GEOMAR), the HoloCam (LISST-HOLO) and the P-Cam (PELAGRA Camera).

10.1 Underwater Vision Profiler (UVP)

Morten Iversen, Rainer Kiko (Not on cruise), Richard Lampitt

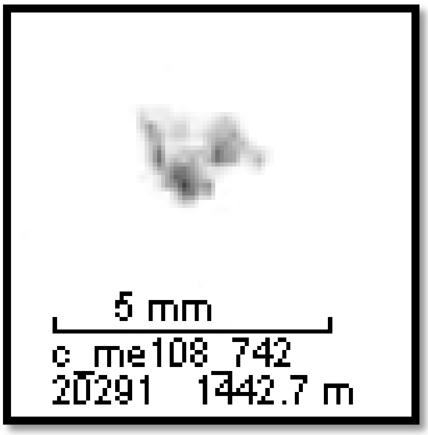
The Underwater Vision Profiler (UVP) is an in situ plankton and particle camera which was lent to us by Rainer Kiko from GEOMAR. Before the cruise start Rainer introduced us to the system in Las Palmas and he mounted the UVP on the CTD-Rosette. The UVP was activated during all CTD casts, but during the CTD casts ME108_761, ME108_766, and ME108_769 no images were obtained with the UVP (see CTD cruise report). The system only collected images during the downcasts of 13 CTD profiles. The sample volume of the UVP was 0.88 L and obtained an image every second.

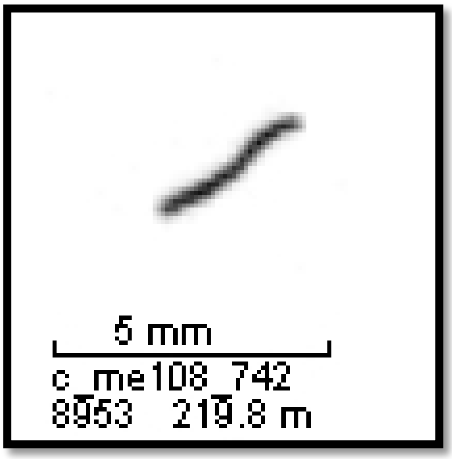
Some preliminary results show a rapid decrease in particle abundance within the upper 50 m of the water column while the mean pixel size of the particles remains more or less constant see figure below



Vertical profile of particle abundance, grey value, and mean pixel size of the particles captured by the UVP during CTD cast ME108_799.

Below are some images of the particles and plankton captured by the UVP; from upper left to lower right: marine snow, faecal pellet, copepod, and a shrimp-like organism . The further data analysis will be done in collaboration with Rainer Kiko.





Examples of the particles and zooplankton captured by the UVP.

10.2 LISST-HOLO operations

Brian Bett

The Ocean Biogeochemistry & Ecosystems division of the National Oceanography Centre purchased a Sequoia Scientific Inc. "LISST-HOLO" instrument shortly prior to the present cruise. This has been our first opportunity to gain operational field experience of the instrument. It was also to be hoped that the instrument would contribute useful data to the cruise's wider scope of upper ocean particle distribution studies.

The LISST-HOLO is a submersible digital holographic camera, during the present cruise it was operated in a self-contained mode powered from an external battery pack. The instrument records in-line holographic images that are stored in internal flash memory or an 'external memory module' (EMM). These .PGM (portable grey map) images also code supporting data, date, time, temperature, depth, and instrument details in the file structure (see Sequoia manual section 12, p65 for details). This supporting data can be read in plain text at the end of the file using the 'HEXview' option in Irfanview (convenient software for opening and viewing the .PGM files). This is a useful feature where the file's original timestamp may have been lost on copying of file transfer (occurs, though can be prevented, when using FileZilla to download images from the camera's internal memory).

The notional capability of the instrument is the detection and volume measuring of particles in the size range 25-2500μm equivalent spherical diameter, through a path length of 50mm, having a sampled volume of 1.86cm^3. Optical sections of the recorded image are reconstructed mathematically from the interference fringes produced by the interaction of particles with the laser illumination. Summary statistics are provided in terms of total particle volume concentration and volume concentration in size bins (note that four different bin size scales are offered – for processing onboard this cruise, the 'LISST-100X RANDOM type C' was uniformly employed).

10.2.1 Pre-cruise preparation

10.2.1.1 Software

Image reconstruction and data generation requires use of Sequoia supplied software:

- HOLO_Batch for batch processing and data generation
- HOLO_Detail for processing individual holograms and viewing image slices

Only the former was used during the present cruise. Installation of both is not a 'fully automated' process, the installation procedure outlined in section 4 (p13-15) of the manual must be followed. (Note that a computer reboot / start may be needed to get the software to run after initial installation).

Other software is also effectively required for practical application:

- An image viewer that can read .PGM files, Sequoia suggest "OpenSeeIt", for the present cruise "Irfanview" was employed.
- An FTP utility for mass downloading of images from the instrument's internal memory. Sequoia suggest "FileZilla", this was successfully used during the present cruise.
- An image editor ("COREL Paint", "Adobe Photoshop", etc.), for 'adjusting' and presenting individual images.

To review and manipulate data files generated by HOLO_Batch, consider also:

- "Excel" (or similar spreadsheet) will be effective with the "Save particle statistics (CSV)", i.e. comma separated values, option.

- "Matlab", is not specifically required, but a Matlab output option is available ["Save particle statistics (MAT)"]. Note, HOLO_Batch and HOLO_Detail are compiled Matlab code, and that Matlab may be useful in the further automation of subsequent data processing. Additional Matlab code of relevance may be available from the 'LISST-HOLO User's Community' (http://holoproc.marinephysics.org/).

- "R", may be equally suitable (and vastly cheaper) for the further automation of subsequent data processing.

10.2.1.2 Battery pack

For the present cruise, the LISST-HOLO instrument was powered from the LISST-HOLO External Battery Case, fitted with Sequoia supplied battery packs (two packs were consumed though neither was tested to exhaustion, it would appear that the claimed battery life of 10,000 holograms is likely conservative in the PAP operating environment). Note that just prior to mobilising the present cruise, the Sequoia website showed contradictory and out of date information on the LISST-HOLO battery pack. Sequoia have, however, supplied us with the appropriate wiring diagram (HOLO Fig. 1), and note that "our battery packs are assembled from cells that do not have the typical 'button' contact on the top that cells for consumers do, and therefore they are slightly shorter. The total length of the assembled pack, including the insulation on the ends, is 11.5" (29 cm). A pack assembled from standard button-top cells would likely be too tall for the threaded support rods inside the housing. If you do decide to build your own, you will need to find shorter cells (most likely through a company that specializes in making battery packs), or modify the mounting rods to accommodate a longer pack."

Battery fitting is not covered in the supplied manual but is straight forward. The process is illustrated and described in HOLO Fig. 2.

10.2.1.3 Lab set-up

The LISST-HOLO case provides a good bench-top base of operations (HOLO Fig. 3), and with a laptop alongside will require 2m of bench top. Hologram recording and processing were briefly tested onboard using the supplied sample test chamber (HOLO Fig. 4), note that the o-rings are loose and easily displaced, and that the 'wedge plate' must be fitted as shown to achieve a useful seal.

Currently the LISST-HOLO and its router (required for programming, setting clock, memory maintenance, offloading images from internal memory) are powered from US transformers, with the consequent need for adaptors. These should be replaced with UK versions at the earliest opportunity. Indeed, a new (second) UK router would be a wise investment, given the essential nature of the router.

Bench set-up is essentially as described in the supplied manual (section 3, p7-9), though note that the router we have is a different model (ports are in different orientation, and is not a WiFi model). The appropriate ports and all cable connections have been labelled during the present cruise. The exact order of connection and powering up is not likely to be significant. Everything needs to be powered and connected before communications can be achieved with a PC.

The general set-up employed at the start of the cruise was as follows

- ☐ Magnetic switch to '0'
- ☐ Connect Ethernet cable (via router to PC)
- ☐ Connect power supply
    - ☐ LISST-Holo should boot (LED flash yellow for 30 seconds[-ish], then blink green every 5 seconds)
- ☐ Open browser, navigate to http://192.168.0.150/ (may be wise to turn off PC's WiFi and / or disconnect any wired LAN connection, to avoid any confusion)
    - ☐ LISST-Holo homepage should appear
- ☐ Set start condition for programme 1 (magnetic switch option)
- ☐ Set sampling rate for programme 1 (fixed rate 5 seconds)
- ☐ Set stop condition for programme 1 (magnetic switch option)
- ☐ Select programme (programme 1)
- ☐ Put the Holo-cam to sleep
    - ☐ Confirm green LED changes to blinking every 30-seconds
- ☐ Disconnect Ethernet cable
- ☐ Disconnect power supply
- ☐ Connect external memory module (EMM) using threaded locking component

Use of the EMM is certainly the most convenient option, enabling images to be offloaded by USB cable transfer without having to dismount the instrument and return it to the lab. Note that the EMM should only be fitted or removed from the LISST-HOLO when it is 100% powered off (magnetic switch 'off' and no LED activity for >1 minute) or when it is confirmed to be 'asleep' (magnetic switch 'off' and one green LED flash every c. 60-seconds). The method of fitting the EMM is not dealt with in the manual and may not be immediately obvious – see HOLO Fig. 5 for details.

During the present cruise, the first seven deployments (ME108/748, 751, 755, 757, 759, 764, 767) were successfully completed using the EMM, with recorded images readily downloaded via USB connect to the EMM. However, at instrument start-up for the following deployment (ME108/770), the instrument failed to complete boot-up, with continuous flashing yellow LED. The LISST-HOLO was returned to the lab, communication through the router indicated that it required memory (internal presumably) maintenance, this was scheduled and carried out. The instrument still failed to boot when the EMM was reattached. The supplied manual indicates (section 10, p59) that continuous flashing yellow LED suggests that the internal flash memory has failed. It was assumed this may also apply to the EMM. Via USB, all files on the EMM were then deleted. This did not change the situation. The EMM was then reformatted to 'device defaults', then FAT32, and finally 'NTFS' – the instrument continued to fail to boot after each of these attempts. Sequoia Scientific Inc. will be contacted for further advice on this matter. At time of writing, the most likely explanation would seem to be a 'corruption' of the EMM memory resulting from removal of the EMM from the LISST-HOLO before it was 'asleep' or removal from a PC without safe ejection.

Subsequent communication with Sequoia indicates that reformatting of the EMM is not (currently) possible by the science user, it requires use of / addition of Linux files. A second pre-formatted EMM, or its internal memory unit would therefore be a useful addition.

All subsequent LISST-HOLO deployments, ME108/770 to /828, were carried out with recording to the instrument's internal memory. Downloading these images was effectively and efficiently achieved using FileZilla. One point of note: the default download settings may result in the loss of original file timestamps – this can be avoided by selecting the "preserve time stamps" option in FileZIlla.

10.2.2 Deck operations

The LISST-HOLO and external battery case were mounted on the "red camera frame", also referred to as SNOW-CAM in joint use with PELAGRA-CAM, the general arrangement is shown in HOLO Fig. 6. On one occasion the LISST-HOLO was deployed alone (ME108/759). The "red camera frame" was deployed on the starboard hydro-gantry on a CTD cable (HOL Fig. 7.), note that no electrical or data connection was made to the instruments, both were operated in self-powered and self-logging modes. Station data and individual deployment notes and data outcomes are given in HOLO Tabs 1 & 2.

10.2.3 Hologram batch processing

At cruise report writing 'cut-off time' deployments ME108/748 to /822 inclusive had been run through the HOLO_Batch software. Note that no HOLO_Detail processing was undertaken onboard. Of those deployments taken to the processing stage two had failed – (i) ME108/751, no holograms were recorded; (ii) ME108/770, images recorded but apparently not valid holograms (? needs further investigation). In both cases, it seems most likely that incorrect start-up of the instrument was the cause of the failure. Only the very briefest review of the holograms and resultant summary reconstructions has been possible onboard – in two cases (ME108/780 and / 792) it is possible the camera widow carried a smudge at least during the early parts of the deployments. It is suggested that the camera and laser windows are given a light soapy clean with a fingertip and then rinsed off prior to each deployment – this was not uniformly the case during the present cruise.

HOLO_Batch ran robustly (no hangs or crashes) throughout the cruise. Individual image processing time invariably starts in the 10-15 second range, but by the end of a large batch (e.g. 1000 holograms) may have increased to 1-minute [this is presumed to result from software or MS Windows poor house-keeping of memory – it may be worth consulting Sequoia or the 'L ISST -HOLO User's Community' to see if this can be avoided / improved] . Consequently, running a large batch can take many hours. It is therefore advisable to keep good records of when the camera enters and leaves the water to avoid processing large numbers of holograms shot in air.

Example output images and data

There was no time onboard to review the holograms or processed output images, three examples of the processing chain are illustrated in HOLO Fig. 8. These represent (left to right) (i) the original hologram, (ii) the "-dep" image, colour coded to particles' depth of focus, (iii) the "-mon" image, a greyscale montage of particles detected in all focus depths, and (iii) an enlarged view of selected particle on the "-mon" image (manual user created).

The data output files may not be entirely as described in the supplied manual [see annotation added to the manual for details – note this was only checked for 'CSV' outputs not 'MAT'], however, it is obvious and straightforward to interpret. The CSV output summary file "-all" would benefit from a header row, but this is easily added by the user.

An example of manipulated LISST-HOLO batch processed day is given in HOLO Fig. 9. as a day / night comparison of particle concentration with depth. This is a very preliminary observation and should be treated with great caution!

10.2.4 Standard operating procedure

10.2.3.1 Pre-cruise

- ☐ Acquire battery packs (see details above).
  Sequoia suggest 10,000 hologram endurance – this seems reasonable. Maximum depth of operation is 300m, maximum acquisition rate is 0.2Hz, (profiling) speed through water should be <0.5ms^{-1}.
- ☐ Acquire, install, and test all required software (see notes above).

Suggest full home lab set-up of instrument, router, and 'PC' – test communications, FTP, and HOLO_batch processing.

10.2.3.2 Cruise, lab set-up

- ☐ Fit battery pack (see details above) and battery cable.
  Test voltage on the cable (pins 1 and 2 – as marked on cable end; 1 is GND and 2 is nominal +12V), a new battery should be 15V, thus far we have not taken a battery below 12.5V in field operation.
- ☐ Power-up router and connect to PC (turn off PC's WiFi and / or disconnect any wired LAN connection, to avoid any network confusion)
- ☐ Set LISST-HOLO magnetic switch to '0' [i.e. off]
- ☐ Connect instrument to router
- ☐ Attach instrument lab power supply and power-up
  - o LISST-HOLO should boot (LED flash yellow for 30 seconds[-ish], then blink green every 5 seconds)
- ☐ Open web browser on PC, navigate to http://192.168.0.150/ [bookmark for later ease]
  - o LISST-HOLO homepage should appear (router power light should be on; both used Ethernet ports should have blinking lights)
- ☐ Check for red headline warnings on home page
  - o Most likely is need for internal memory storage maintenance – if so go to tools page – click schedule maintenance – wait for page to update – then click reboot.

    In general, be aware that these are static web pages, be sure to press 'apply' where needed, and check that pages update.
- ☐ On the home page – select the programme 1 radio button and press apply.
- ☐ Check and amend as necessary the programme 1 settings (start / stop conditions, sampling mode, and sampling rate).
  It is likely to be most convenient and practical to set 'magnetic switch' as the start and stop condition; fixed rate sampling, and 5-second sampling rate (this provides the highest possible acquisition and storage rate).
- ☐ Check and amend as necessary the programmes 2-4 settings.

For safety, it is likely most sensible to set programmes 1-4 identically, in case of accidental activation of an unintended programme.

☐ Go to the tools page

- Set / re-set 'deployment number'; set / reset 'image number'; set / reset 'comment

  Note that 'deployment number ' does not auto -increment, it is in effect just extra digits prefixing the image number ('deployment number ' does increment when image number reaches 9999, i.e. 001-9999, becomes 002-0000 at the next shot). For simplicity it may be best to increment the 'deployment number ' by 1 0 at each lab check of the instrument during a cruise. Comment is most likely best set to cruise name / number consistently.

- Time setting (instrument did appear to keep time very well during ME108)

  Set time zone to '0' and apply

  Set date and time a little in the future and press apply as that time arrives – *note you will need to refresh the page to check any time update has taken.*

- Power profile lab – when on lab power supply (*and particularly when running FTP download*) make sure the box is ticked and press apply (i.e. instrument remains fully powered and does not sleep)

  Power profile deployment – when ready for deployment, untick the box and press apply – instrument will now be able to go to sleep and save power when not sampling / switched off.

- If necessary, and safe to do so, click on "Delete all images" on the tools page. (Images can also be bulk deleted using the FTP process, see manual; individual images can be deleted on the "Images" page)

☐ Put the Holo-cam to sleep [untick and apply power profile, then click on sleep button

- Confirm green LED changes to blinking every 30-seconds

☐ Disconnect Ethernet cable

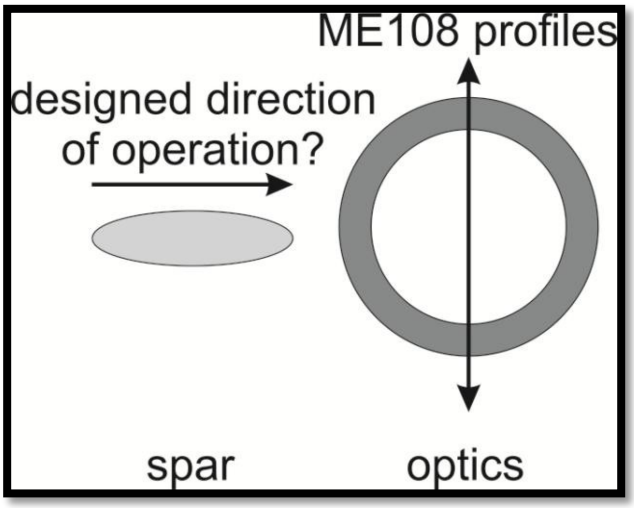
☐ Disconnect power supply

☐ Connect external memory module (EMM) using threaded locking component OR Fit Ethernet blanking plug (if running on internal memory)

10.2.3.3 *Cruise, deck set-up*

☐ Mount Holo-cam and battery case on deployment platform (e.g. 'red camera frame').

Sequoia do not seem to offer any guidance on orientation – the spar between camera and laser optics has a profiled cross-section that might suggest:



☐ The orientation adopted for ME108 profiles, perhaps provides consistent bidirectional imaging conditions?

☐ Connect (or leave blanked) the battery case to the LISST-HOLO (note we do not have a cable blanking plug – during ME108, I disconnected when out off use for hours, blanking the cable with a small polythene bag – physical disconnection of the power may not be strictly necessary, i.e. instrument should go to sleep after c. 10-minutes; however, this may be a sensible precaution when working from a limited battery supply).

☐ For deployment:

- o Light soapy finger wash and rinse of optical windows.
- o Connect / confirm connection of battery power supply (if connected the LED should be on slow green blink 30-60 second intervals; if connecting the LED should fast flash orange, for 30-seconds-ish, as the instrument boots up, then change to green blink every 5-seconds.

  When deployment imminent, start the instrument, move magnetic switch from '0' to '1' – within 1-minute the instrument should begin active sampling confirm by observing:

  ☐ LED should change to fast green (1-second interval), then orange as laser fires [with5-second sampling you should see GREEN-GREEN-GREEN-GREEN- ORANGE- GREEN-GREEN-GREEN-GREEN-ORANGE etc]

- ☐ Red laser activation should be visible at programmed interval [5-seconds], looking obliquely at the laser window
- o If correct start-up is not observed, return the magnetic switch to ‘0’ briefly and try again.
- o Once confirmed sampling, deploy the instrument, noting time of water entry
- o To avoid blurred images, through water speed should be less than 0.5 ms^{-1} / 30 $mmin^{-1}$ / 1 knot.
- o On recovery, note water exit time, and:
  - ☐ Move magnetic switch from ‘1’ to ‘0’
  - ☐ Rinse instrument with freshwater
  - ☐ If to be unused for some time disconnect (and blank) power supply
  - ☐ Let the system rest ‘a while’ then measure and record battery voltage [new 15 V, dead ? 12 V]

10.2.3.4 Image off-load and housekeeping

- ☐ If using the EMM – I would suggest offloading images after each deployment – and only deleting images from the EMM when it is necessary and safe to do so – this will enable batch processing to hopefully keep pace with instrument deployments.
- ☐ If using the instrument’s internal memory – a daily offload routine might be the sensible option (again only deleting images when it is necessary and safe to do so).
- ☐ Using either memory option – it may be sensible to regularly (few days?) remove the instrument to the lab to check its status:
  - o Confirm / reset clock (and other settings)
  - o Perform memory maintenance – this seems to be suggested by the instrument every half-dozen / dozen deployments (reboots)
    - ☐ In strict terms this relates only to the internal memory – and without maintenance the capacity of the internal memory does seem to decline somewhat.
    - ☐ Operating for a large number of deployments without memory maintenance is beyond our current experience – it is conceivable that it could ultimately impact on instrument performance even when operating with EMM.
    - ☐ Therefore, a routine check of the system in the lab would seem to be the sensible option.

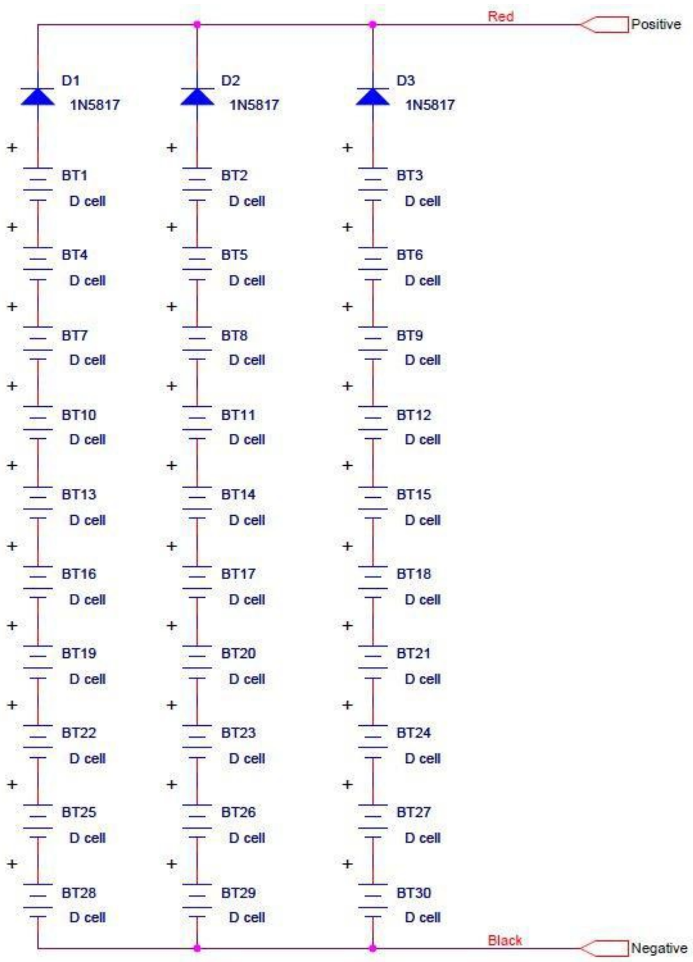
- Thus far we have insufficient experience to recommend particular deployment, processing, or analysis strategies, but you might consider:
  - Particle count (abundance / density / concentration), mass (volume concentration), and size distribution (by count and mass), might be expected to vary with (a) water depth, (b) day-night cycle, (c) longer-term and larger-scale biological and physical processes. It may therefore be sensible to attempt to collect equitable numbers of holograms from each condition (depth bins; day-night; day-night-twilight; water mass A and B; cruise start and end; etc. etc.) – i.e. a stratified sampling scheme.
    - Keeping a running tally of successful holograms per condition might aid the evolution of a field programme.
  - Given that the precision of instrument data may be governed by particle numbers analysed, and that particle numbers are likely to decline rapidly with depth:
    - It may be sensible to bias data collection with depth (i.e. collecting proportionately more holograms at depth) – again keeping some sort of running tally may help with developing a field programme.

HOLO Tab. 1. LISST-HOLO station list. Start and end date and times are given together with soundings at those times (1. Ship's recorded sounding; 2. Approximate correction to sounding, i.e. +25m to account for incorrect sound velocity profile employed). Maximum cable deployed and the number of vertical profiles carried out are also indicated. See also HOLO Tab. 2 for additional details.

Station ME10	Gea	Start Date	Time	Position		Sound (m) 1.	Sound. (m) 2.	E da	time	Position		Sound (m) 1.	Sound. (m) 2.	M wire	No. profiles
748	SNOW-	12	12:4	48° 60.00'	16° 30.00'	4821.	4847	1	13:0	48° 59.96'	16° 30.01'	4817.	4843	2	1
751	SNOW-	12	20:4	48° 59.99'	16° 29.98'	4822	4847	1	21:5	48° 59.99'	16° 29.98'	4822.	4848	2	2
755	SNOW-	13	13:3	48° 49.43'	16° 31.19'	4826.	4852	1	14:4	48° 49.20'	16° 31.45'	4826.	4851	2	2
757	SNOW-	13	22:2	48° 49.40'	16° 31.16'	4825.	4850	1	23:4	48° 49.40'	16° 31.16'	4825.	4850	2	2
759	SNOW-	14	04:5	48° 49.94'	16° 32.00'	4824.	4850	1	06:5	48° 49.94'	16° 32.00'	4826.	4852	2	2
764	SNOW-	14	14:2	48° 43.05'	16° 41.48'	4818.	4844	1	15:0	48° 43.00'	16° 42.00'	4824.	4849	2	1
767	SNOW-	14	20:5	49° 00.39'	16° 26.42'	4825.	4851	1	22:5	49° 00.39'	16° 26.41'	4827.	4853	2	3
770	SNOW-	15	18:0	49° 03.15'	16° 21.52'	4823.	4849	1	19:4	49° 02.81'	16° 21.39'	4827.	4852	2	4
775	SNOW-	16	10:4	49° 00.00'	16° 29.99'	4824.	4850	1	12:1	48° 59.95'	16° 29.93'	4822.	4847	2	2
779	SNOW-	16	23:2	48° 57.79'	16° 26.59'	4824.	4850	1	00:0	48° 57.79'	16° 26.59'	4824.	4849	2	1
780	SNOW-	17	00:3	48° 57.79'	16° 26.59'	4824.	4849	1	01:1	48° 57.49'	16° 26.37'	4824.	4850	2	1
784	SNOW-	17	10:2	48° 53.01'	16° 25.38'	4826.	4851	1	11:5	48° 52.49'	16° 25.57'	4826.	4852	2	2
791	SNOW-	17	18:4	49° 00.49'	16° 19.23'	4826.	4852	1	19:3	49° 00.49'	16° 19.23'	4820.	4846	2	2
792	SNOW-	17	22:5	48° 59.95'	16° 30.12'	4826.	4852	1	00:1	49° 00.04'	16° 30.02'	4823.	4849	2	2
801	SNOW-	18	20:1	48° 58.30'	16° 16.52'	4825.	4850	1	21:4	48° 58.28'	16° 16.52'	4825.	4851	2	2
802	SNOW-	18	23:5	48° 58.23'	16° 16.49'	4825.	4851	1	00:3	48° 58.23'	16° 16.49'	4825	4850	2	1
809	SNOW-	19	15:0	48° 51.63'	16° 17.69'	4823.	4849	1	16:2	48° 51.05'	16° 17.54'	4823.	4848	2	3
811	SNOW-	19	17:1	48° 50.47'	16° 17.19'	4822.	4848	1	18:4	48° 49.70'	16° 17.78'	4821	4846	2	3
814	SNOW-	19	20:2	48° 49.35'	16° 17.69'	4823.	4849	1	21:4	48° 49.34'	16° 17.68'	4823.	4848	2	2
815	SNOW-	19	22:1	48° 49.34'	16° 17.68'	4824	4849	1	23:3	48° 49.35'	16° 17.68'	4823	4848	2	2
822	SNOW-	20	18:5	48° 59.63'	16° 27.66'	4824.	4850	2	20:2	48° 59.31'	16° 27.09'	4829	4854	2	2
824	SNOW-	20	21:5	48° 58.73'	16° 25.88'	4826.	4851	2	23:1	48° 58.19'	16° 25.05'	4825.	4851	2	2
825	SNOW-	21	00:0	48° 57.96'	16° 24.67'	4825.	4851	2	01:2	48° 57.36'	16° 23.91'	4827.	4852	2	2
826	SNOW-	21	02:1	48° 57.01'	16° 23.65'	4823.	4849	2	03:3	48° 56.40'	16° 23.06'	4824	4849	2	2
827	SNOW-	21	04:0	48° 56.26'	16° 22.81'	4825.	4851	2	05:2	48° 55.68'	16° 22.90'	4823.	4849	2	2
828	SNOW-	21	06:0	48° 55.65'	16° 22.77'	4824.	4849	2	07:2	48° 55.24'	16° 22.56'	4824.	4850	2	2

HOLO Tab. 2. LISST-HOLO station list. Notes and data outcome details of individual deployments – as far as processed onboard. "U/W holograms" refers to
the number of holograms processed where the recorded depth is >=1m. See also HOLO Tab. 1 for additional details.

Station ME108/	Notes	LISST-HOLO memory used	U/W holograms
748		EMM	174
751	No holograms recorded	EMM	na
755		EMM	485
757		EMM	632
759	LISST-HOLO only; depth-staged deployment	EMM	992
764		EMM	330
767		EMM	962
770	No real holograms recorded ?	IM	na
775		IM	801
779		IM	390
780	?lens smudge - data caution ?	IM	386
784		IM	826
791		IM	441
792	?lens smudge - data caution ?	IM	817
801		IM	824
802		IM	385
809		IM	762
811		IM	840
814		IM	765
815		IM	722
822		IM	815
824	not run yet	IM	not run yet
825	not run yet	IM	not run yet
826	not run yet	IM	not run yet
827	not run yet	IM	not run yet
828	not run yet	IM	not run yet



HOLO Fig. 1. LISST-HOLO battery wiring diagram as supplied by Sequoia Scientific Inc. Which also specifies: 1. All batteries are D cells. 2. Arrange in six columns, five batteries each. 3. Shape shall be triangular, the same as the LISST-100X batteries. 4. Pack shall be encased with white shrink wrap, the same as the LISST-100X pack. 5. Wires shall be 20 or 22AWG. 6. Wires shall extend 6" beyond the shrink wrap.

HOLO Fig. 2. LISST-HOLO battery fitting.

Remove three endcap machine screws (9/64” Alan key, not supplied).

Pull out endcap with battery attached – note this may require substantial force – pressure locked.

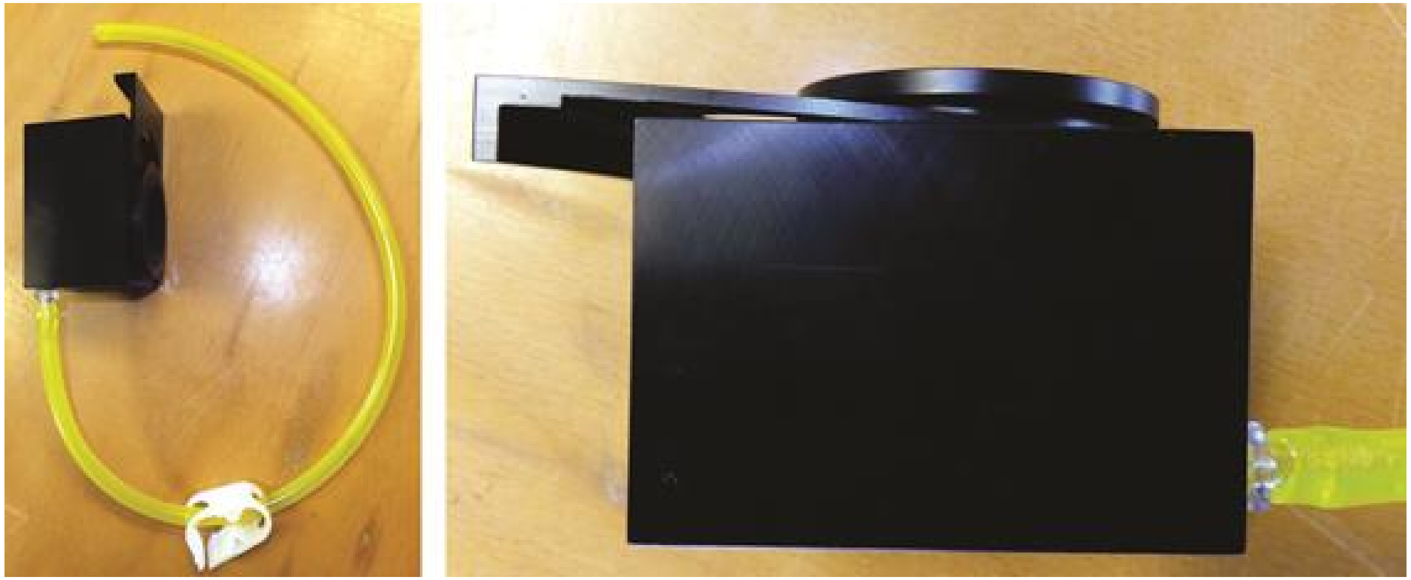
Disconnect battery wiring connectors.

Note connector has a fits one-way-only latch.

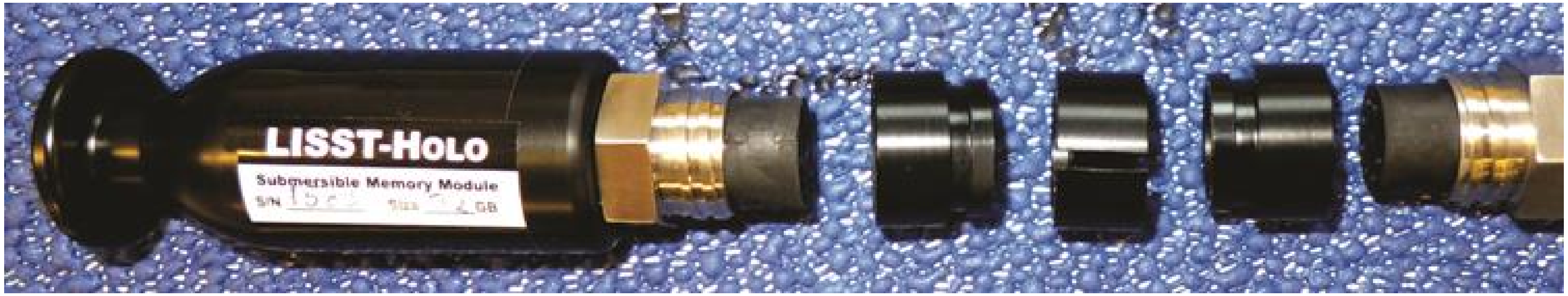
Remove battery retaining end plate (3 nuts and washers – M11 spanner, not supplied).

Reverse process to refit.

HOLO Fig. 3. Bench top set-up.



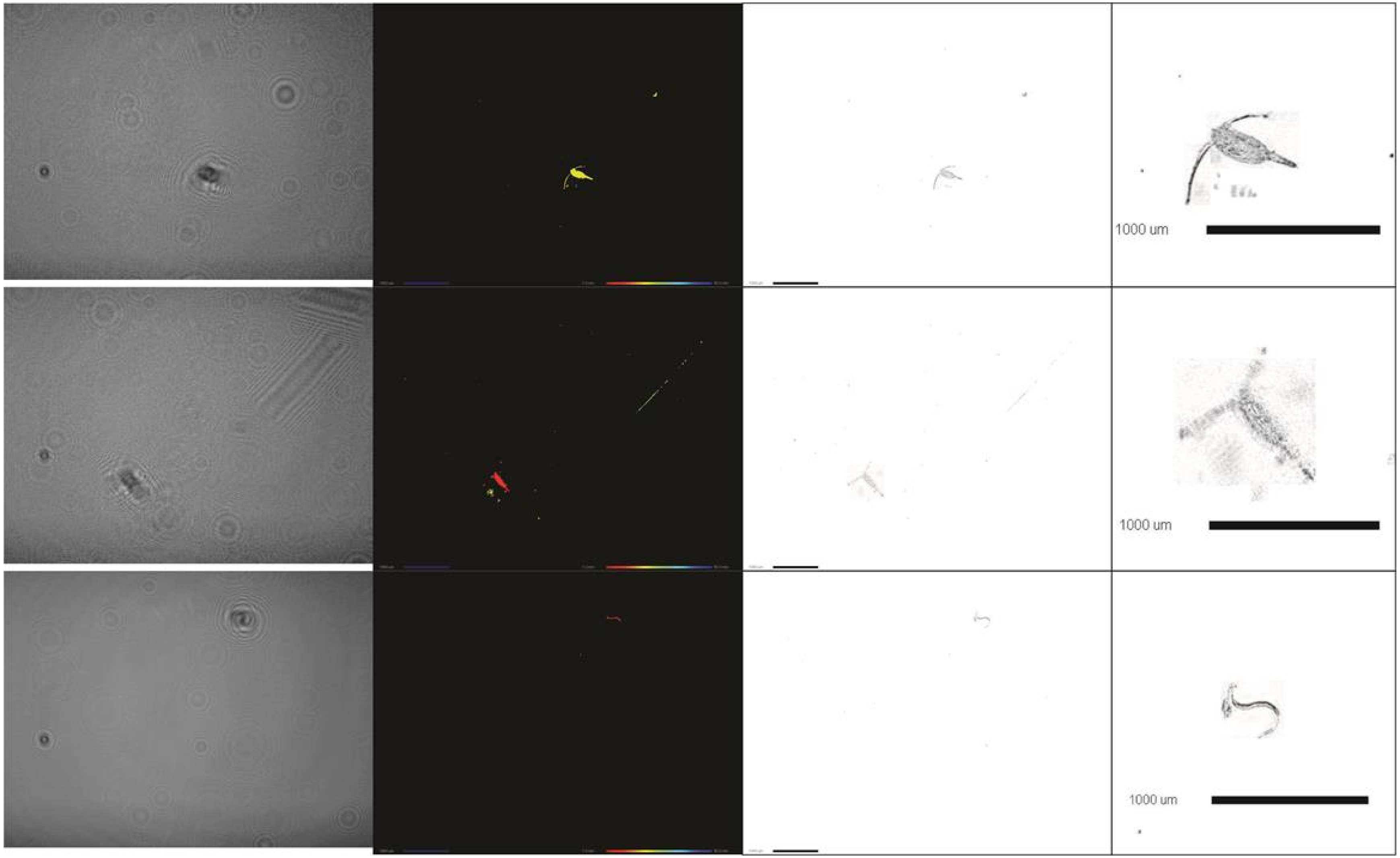
HOLO Fig. 4. LISST-HOLO sample test chamber, and detail of ‘wedge plate’ fitting.



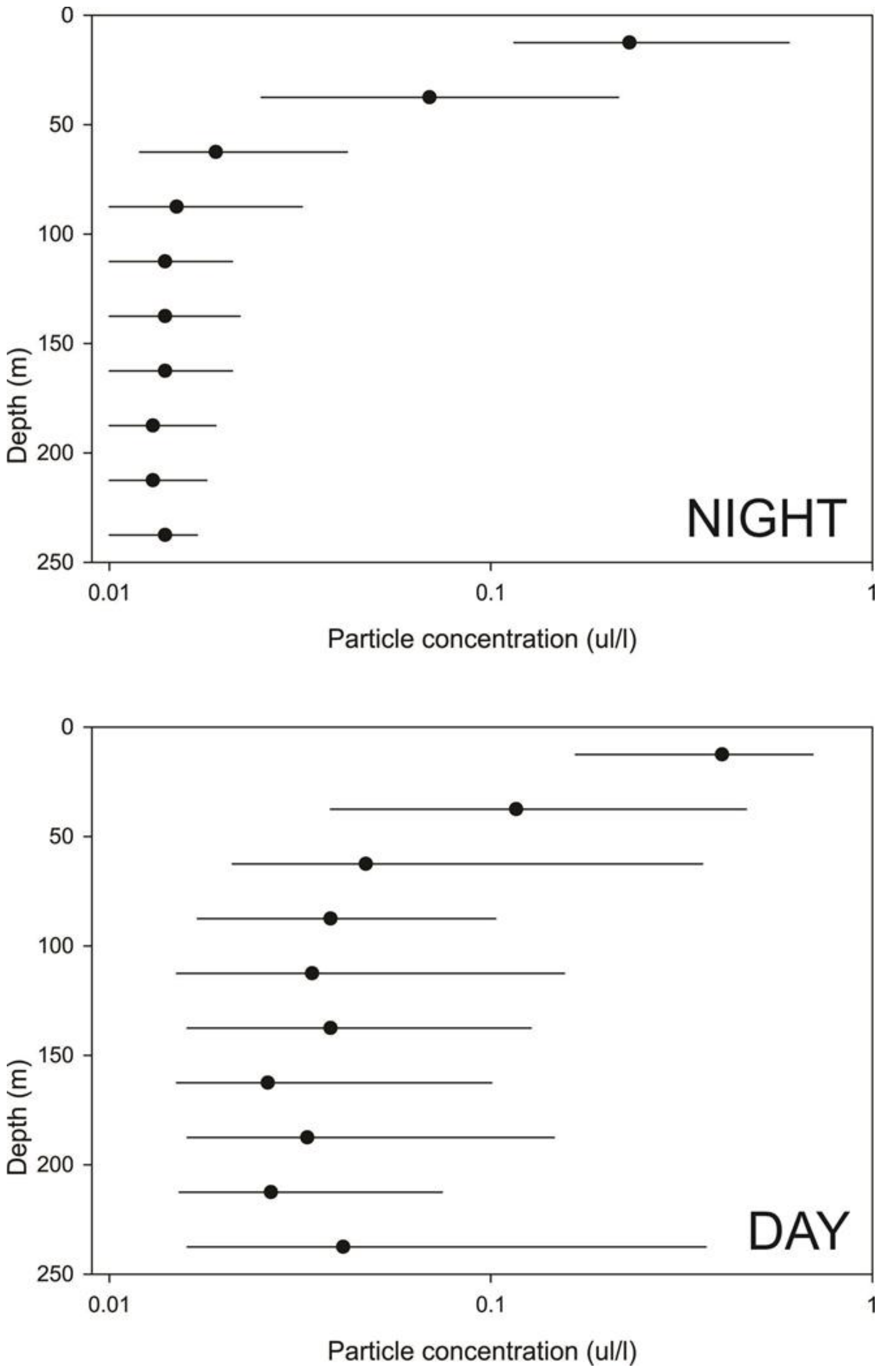
HOLO Fig. 5. LISST-HOLO EMM connection. Left to right: EMM; screw-on connector fitting; locking- ring; screw-on connector; LISST-HOLO bulkhead connector (not illustrated is a male connector). To fit to instrument, fit screw-on connectors to both parties, fit the locking-ring to the EMM (use fingernail to lever open); align and offer up EMM to bulkhead connector pins; push on to pins partially, lever open (fingernail) locking ring and push fully home, confirm locking ring is fully mated with both parties (will rotate smoothly).

HOLO Fig. 6. LISST-HOLO and external battery case mounting arrangement on “red camera frame” (SNOW-CAM).

HOLO Fig. 7. LISST-HOLO deployment (with PELAGA-CAM on “red camera frame”).



HOLO Fig.8. LISST-HOLO example holograms and corresponding processed image outputs, with enlargements of zooplankters.

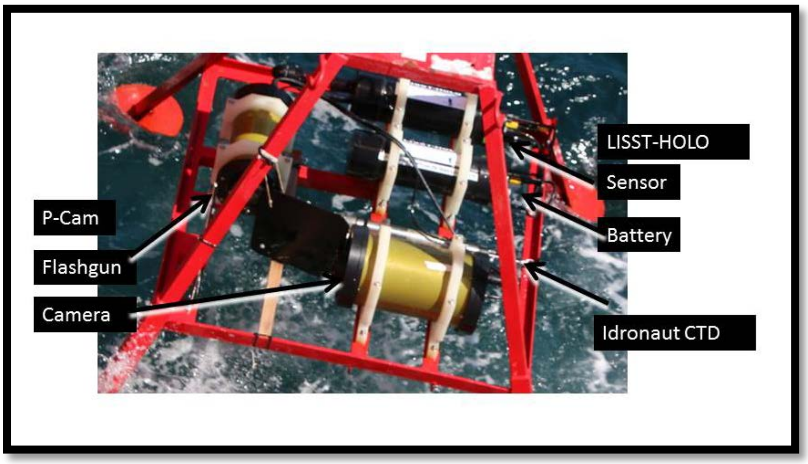


HOLO Fig.9. LISST-HOLO example- very preliminary day- night comparison of particle concentration with depth. (Data are illustrated as median and interquartile range in 25m depth bins, where day is 07- 20:00 and night 20-07:00).

10.3 **P-Camera operations**

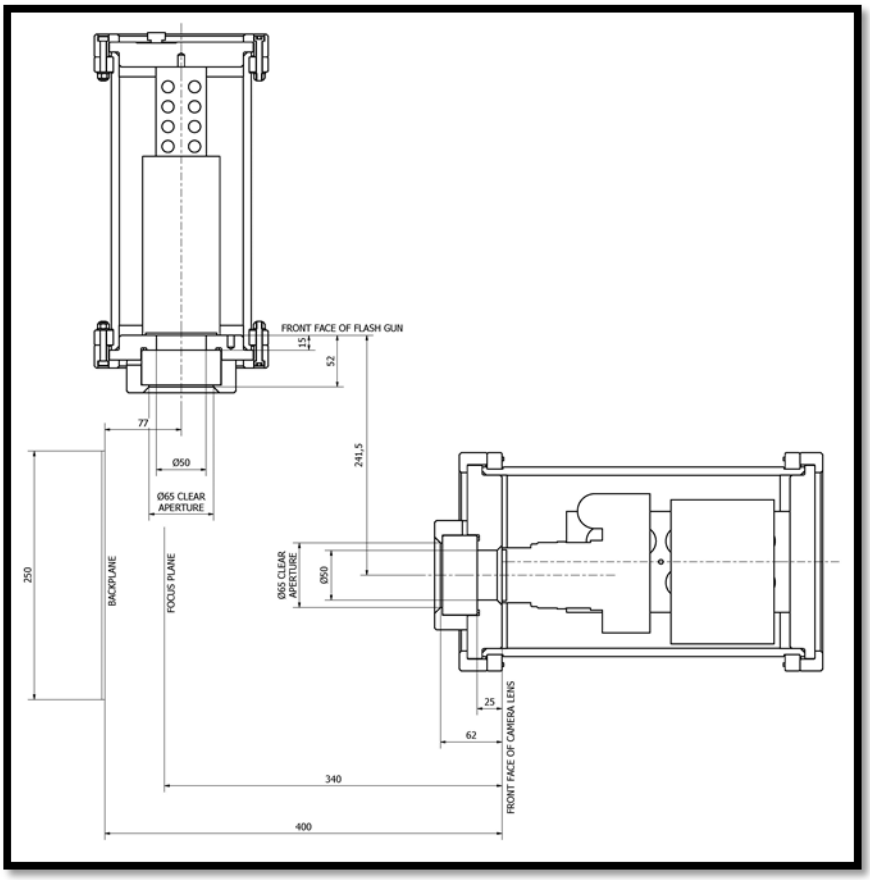
Richard Lampitt, Morten Iversen

The Marine Snow Camera comprises three independent self-recording sensors; A standard camera system (P-Cam) photographing under dark ground illumination 7 litres of water every 5 seconds, a Holographic system (LISST-HOLO) imaging 1.8mls of water every 5 seconds and a CTD (Idronaut) sampling once per second.



The system was lowered to 250m depth and raised at approximately 0.2m/sec giving one exposure of P-Cam and LISST-HOLO every meter.

10.3.1 P-Cam description



- This comprised:
  - Canon EOS 6D digital SLR camera
  - Canon Speedlite 600EX-RT flash gun
  - Quantum Turbo 3 battery pack
  - Hahnel Giga T Pro II remote timer
  - Lens: 50mm

The camera was in general started in the Main Lab with a 15 minute delay in order to install the camera in the pressure case and fix it to the frame on deck. The camera settings were:

Frame interval: 5 sec
Apperture: f32
ISO: 10,000
Shutter speed: 1/180 sec
Flash energy: 35mm focal length

10.2.2 P-Cam data processing

Images were batch processed using "Image J" software after increasing the Virtual memory of the laptop to 20GB. Processing lasted about 1 hour. The processing sequence used was:

1: File/Import/Image Sequence
2: Image/ Type/ 8 bit
3: Image / Adjust/ Threshold……………. Set to 35
4: Process / Binary / Make Binary
5: Analyse / Set Scale ………………….. 32.15 pixels/mm
6: Analyse / Analyse particles

Summary data were immediately exported to Excel for visualisation. The full data set with characteristics of each particle will be carried out after the cruise.

Station ME108/	Start Date	Start Time GMT	Flash ID	Flash Output	Camera ISO	Lowering Speed m/sec	Heaving Speed m/sec	Idronaut ID	Idronaut Data set ID	Idronaut No of records	GMT out of water between casts	Duration in water	Max images in water	Comments
748	12	12:45		1/64	250	0.4	0.4	P2		27331		00:22	276	
751	12	20:49		1/64	1000	0.2	0.4	P2				01:01	744	
755	13	13:37		1/16	1000	0.2	0.2	P2	"004	4051	14:14	01:03	768	
757	13	22:25		1/16	1000	0.2	0.2	P4				01:21	984	Back plate buffed before deployment
759	14	04:52										02:02	1476	Holocam only
764	14	14:28		1/16	1000	0.2	0.2	P4				00:40	492	
767	14	20:56	P7	1/16	1000	0.2	0.2	P4		7559	21:36 and 22:19	02:02	1476	New flash batteries
770	15	18:04		1/16	1000	0.2	0.2	P4	"006	6207	18:51	01:41	1224	With marked cord in frame at 30cm from window + and - 1cm intervals
775	16	10:48		1/16	1000	0.2	0.2	P4	"007	5134		01:24	1020	Camera moved 2.5 cm closer to back plate, baffle constructed to reduce flash stray light
779	16	23:20		1/16	1000	0.2	0.2		"008	2794		00:42	516	
780	17	00:33		1/16	10000	0.2	0.2	P4	"009	2474		00:40	492	
784	17	10:28		1/16	10000	0.2	0.2	P2	"007	5403		01:27	1056	
791	17	18:43	P7	1/16	10000	0.2	0.2	P4	"011	2834		00:48	588	No flash on recovery due to dry joint failure on back of camera housing.
792	17	22:50	P4	1/16	10000	0.2	0.2	P4	"012	5239	20:55	01:27	1056	
801	18	20:13	P4	1/16	10000	0.2	0.2	P4	"014	5084		01:28	1068	
802	18	23:56	P7	1/16	10000	0.2	0.2	P4	"015	2438		00:42	516	
809	19	15:02		1/16	10000	0.2	0.4	P4	"017	4897		01:20	972	
811	19	17:18	P4	1/16	10000	0.2	0.2	P4	"018	5484		01:29	1080	
814	19	20:21		1/16	10000	0.2	0.2	P2	"009	5131	21:04	01:21	984	
815	19	22:17	P4	1/16	10000	0.2	0.2	P2	"010	4380		01:16	924	
822	20	18:56	P7	1/16	10000	0.2	0.2	P4	"020	5154	19:39	01:24	1020	
824	20	21:59	P4	1/16	10000	0.2	0.2	P4	"021	4481		01:15	912	
825	21	00:05	P7	1/16	10000	0.2	0.2	P2	"014	4873		01:20	972	
826	21	02:13	P4	1/16	10000	0.2	0.2	P2	"015	4928	02:52	01:19	960	Flash batteries replaced
827	21	04:02	P7	1/16	10000	0.2	0.2	P4	"023	5258	04:45	01:26	1044	Flash batteries replaced, Idronaut batteries replaced
828	21	06:01	P4	1/16	10000	0.2	0.2	P4	"024	5630	06:45	01:27	1056	

*** Flash rotated 90 deg so now in vertical position and subsequently.

Idronaut at 1 second sampling

Camera at 5 second frame rate, F32, 1/200th second

Idronaut clock tests on 11.7.14

P2 was 15 seconds slower than the "Thanos Laptop" after synchronisation

P4 was 5 seconds slower than the "Thanos Laptop" after synchronisation

Idronaut clock tests on 20.7.14

P2 was 27 seconds slower than the "Thanos Laptop" after synchronisation

Thanos laptop clock tests on 20.7.14

Laptop was 1 second behind ship clock

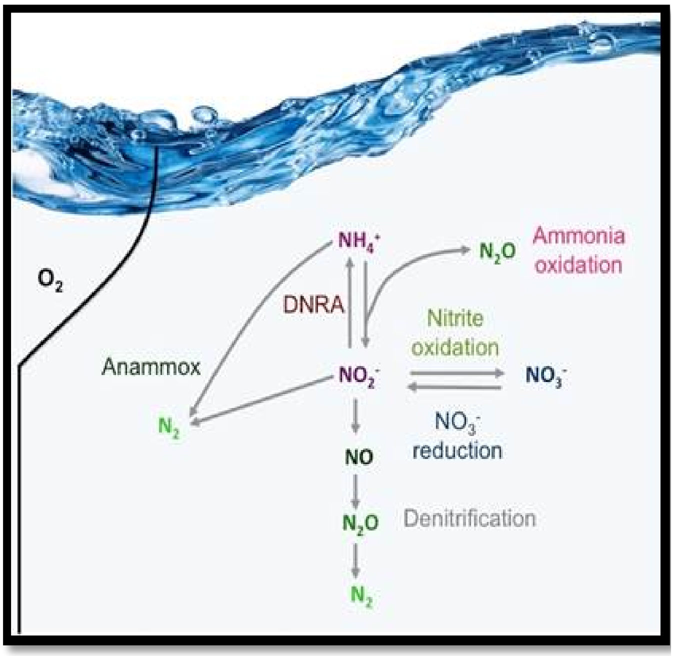
P7 Camera clock tests on 20.7.14

P7 camera was 8 seconds faster than ship clock

11 Nitrogen cycling in marine aggregates

Jessika Füssel, Morten Iversen

Microbially mediated redox processes of the marine nitrogen cycle constitute major energy conserving pathways in the ocean and influence the availability of fixed nitrogen in the surface ocean. While the anaerobic processes of the nitrogen cycle are supposedly limited to oxygen depleted oceanic environments, such as oxygen minimum zones (OMZs) sinking marine aggregates might provide oxygen reduced microniches and thus facilitate the occurrence of e.g. nitrate reduction, anammox or denitrification within the oxygenated ocean (Figure 1). Moreover, aggregates are hot spots of organic matter degradation and are enriched in nutrients such as ammonia and nitrite. Thus, marine aggregates might harbor highly active nitrifying communities. So far, very little is known about the importance of aggregates in the marine nitrogen cycle or about the microorganisms involved.



Oxygen minimum zones are supposedly the only environments in the pelagic ocean allowing for the co-occurrence of aerobic and anaerobic N-cycling processes. These processes include ammonia and nitrite oxidation as well as nitrate reduction and DNRA. Alternatively, nitrite is reduced via anammox or denitrification, resulting in N_2 production and N-loss. Sinking marine aggregates might provide suboxic to anoxic microniches under elevated oxygen concentrations in the surrounding water and thus facilitate the occurrence N-loss in oceanic environments that have so far been neglected as areas of N-loss.

This study aims to investigate nitrogen cycling processes occurring in marine aggregates from the Porcupine Abyssal Plain (PAP) long term Observatory. We obtained aggregates with marine snow catchers (MSC) that were deployed to the depth of the highest aggregate density (~ 50 m), where 95 litres of sea water were collected. After recovery, the MSCs were left upright on deck for at least two hours to allow the marine aggregates to sink to the bottom section of the MSC. Subsequently, the top ~85 litres of seawater were drained, the MSC was opened, the bottom section containing the marine snow was removed and the aggregates were directly utilized (M108-749; M108-787) (Table below). Alternatively, marine snow was collected with drift traps for 24 h and the freshly obtained particulate organic matter was transferred to roller tanks for ~ 12-16 h to allow for re-aggregation (M108-754/760; M108-776/790; M108-799/813) (see report "drifting sediment traps" for further details). Prior to incubation, we measured size, sinking velocity and O_2 fluxes to the aggregates using O_2 microsensors and a flow system for sinking velocity measurements. For each experiment, two incubations with three and six aggregates were set up. The aggregates were added to incubation vessels that had been filled with sterile filtered seawater amended with ^{15}N labelled inorganic nitrogen compounds to measure rates of ammonia and nitrite oxidation, nitrate reduction, anammox, denitrification and dissimilatory nitrite reduction to ammonia (DNRA) (Table below).

Table 1: ^{15}N incubation experiments conducted to measure rates of N-cycling. Prior to the analyses for the targeted products listed, $^{15}N^{15}N$:$^{14}N^{14}N$ and $^{14}N^{15}N$:$^{14}N^{14}N$ ratios of the produced N_2 were determined in all treatments in order to measure denitrification and anammox rates.

^{15}N-cylce process	*$^{15}NH_4^+$ [µM]*	*$^{15}NO_2^-$ [µM]*	*$^{15}NO_3^-$ [µM]*	*$^{14}NO_2^-$ [µM]*	*$^{14}NH_4^+$ [µM]*	*targeted ^{15}N product*
NO_2^- oxidation/Denitrification		2				$^{15}NO_3^-$
NH_4^+ oxidation/Anammox	2			2		$^{15}NO_2^-$
NO_3^- reduction			10	2		$^{15}NO_2^-$
DNRA		2			2	$^{15}NH_4^+$

To investigate the regulatory influence of oxygen concentrations on nitrogen cycling processes within marine aggregates, oxygen concentrations within the incubations were adjusted to ~ 50 µM and ~20 µM O_2. Oxygen was removed from the sea water by helium purging for ~30-45 min, to obtain 50 and 20 µM O_2 within the incubations, calculated amounts of oxygenated seawater were added. The resulting O_2 concentrations were measured with an O_2 microsensor in each incubation vessel. To assess the relative influence of oxygen on nitrogen cycling in marine aggregates, parallel incubations under ambient oxygen levels were conducted. The aggregates were incubated for up to

38 h and biological activity was stopped by the addition of mercuric chloride. To compare the relative importance of aggregate associated nitrogen cycling processes with the activity of free living nitrogen cycling microorganisms, we simultaneously incubated water collected with a CTD rosette. The water was obtained from the same depths as the marine snow and identical incubation conditions, regarding oxygen concentrations as well as the addition of ^{15}N labeled inorganic nitrogen compounds, were provided (M108-747; M108-761; M108-789; M108-808) (Table below). Rate measurements will be conducted on an isotopic ratio mass spectrometer (IRMS) in a land based laboratory.

To investigate the diversity and abundance of N-cycling microorganisms, single aggregates were fixed in 2% PFA over night, destroyed and filtered onto polycarbonate filters (pore size: 0.2 µm). Catalyzed-amplified-reporter-deposition *in situ* fluorescence hybridization (CARD FISH) with specific probes targeting groups of N-cycling microorganisms will be conducted in a land based laboratory.

Overview of deployment and recovery dates for the MSC and CTD rosettes that have been utilized for marine nitrogen cycling incubation experiments.

Station	*Lat* *N*	*Long* *W*	*Time* *UTC*	*Equipment*
M108-749	48° 59.99' N	16° 29.98' W	13:58	MSC
M108-787	48° 51.72' N	16° 25.32' W	14:25	MSC
M108-747	48° 59.99' N	16° 29.99' W	10:43	CTD rosette
M108-761	48° 43.28' N	16° 41.04' W	10:37	CTD rosette
M108-789	48° 50.93' N	16° 24.68' W	15:44	CTD rosette
M108-808	48° 52.04' N	16° 18.14' W	14:37	CDT roselle

12 Drifting sediment traps

Morten Iversen, Jessika Füssel, and Jennifer Pastor

Background

Vertical export of organic matter is typically dominated by marine snow aggregates and zooplankton fecal pellets (Fig. below). Since zooplankton migrate from depths below the photic zone to the surface water to feed every night, it must be assumed that the relative dominance of the two particle types is diurnal. However, it is still unclear how this influences the efficiency of the biological pump. Grazing on marine snow by zooplankton can have several implications for the vertical flux; e.g. marine snow aggregates can be completely removed by ingestion of whole aggregates, their size can decrease due to fragmentation and partly ingestion, and the sinking particles can be repacked from marine snow to fecal pellets. Both repackaging and changes in aggregate sizes will change the sinking velocity of the aggregates, either to slower velocities in case of fragmentation and partly ingestion or potentially higher velocities when repackaged into dense fecal pellets. Hereby, the retention time of sinking particles in the upper water column may be strongly influenced by the presence of zooplankton. By investigating the composition of vertical fluxes at high resolution in the upper water column, we hope to reveal the processes determining the deep ocean fluxes.

Work at sea

The export fluxes in the upper 300 m of the water column were collected by surface-tethered free-drifting sediment traps. Four deployments were carried out during the cruise; three deployments during a 24 h period (DF-11, DF-12, and DF-13) and one deployment only collected during night (DF-14), see position, deployment, and recover times in table 1. Each deployment had four cylindrical traps at 100 and 300 m. At each depth three of the four trap cylinders collected bulk fluxes while the fourth cylindrical trap was equipped with a viscous gel that preserved the sinking organic particles in their original shape. One or two of the bulk flux collections from DF-11, DF-12, and DF-13 were re-aggregated in roller tanks and used to study the nitrogen cycling within the marine aggregates (see report "Nitrogen cycling in marine aggregates"). The rest of the bulk fluxes were preserved and will be used to determine mass fluxes of carbon, nitrogen, biogenic opal, calcium carbonate, and lithogenic material The different particle types collected in the gel were photographed using a digital camera and will be used to create particle size distribution of the flux. To quantify the primary production, we further equipped the DF-12 trap array with a light and dark bottle filled with sea water collected at 28, 67, 95, and 111 m depth and labelled with $H^{13}CO_3$ and $^{15}NO_3$.

Overview of deployment and recovery dates for the four drifting sediment trap deployments DF-11, DF-12, DF-13, and DF-14.

Trap name/ Ship St..	Deployment / Recovery	Lat N	Long W	Time UTC	Equipment
DF-11:					
ME108_754	13.07.14	48°50.07'	48°43.59'	10:15	Traps at 100 and 300m
ME108_760	14.07.14	16°31.16'	16°40.77'	10:10	
DF-12:					
ME108_776	16.07.14	48°59.94'	16°29.93'	13:15	Traps at 100 and 300m
ME108_790	17.07.14	48°50.66'	16°25.11'	16:00	Primary production (28, 67, 95, and 111m)
DF-13:					
ME108_800	18.07.14	48°58.53'	16°16.31'	20:00	Traps at 100 and 300m
ME108_813	19.07.14	48°49.58'	16°17.59'	19:29	
DF-14:					
ME108_821	20.07.14	48°59.51'	16°28.00'	18:30	Traps at 100 and 300m
ME108_829	21.07.14	48°55.03'	16°22.42'	08:15	

Preliminary Results

A first glimpse into the material collected in the gel traps showed that faecal pellets from copepods, euphausiids, and amphipods were comment in the export material but that marine snow aggregates seemed to be dominating the export flux.

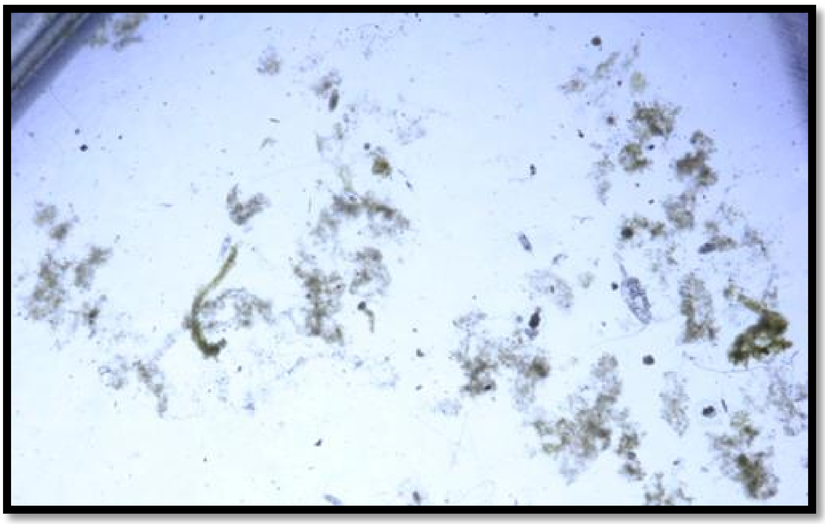


Image taken from the gel trap deployed at 300 m during DF-11. The collected material consists of degraded faecal pellets and marine snow aggregates.

13 PARASOUND Profiling

Morten Iversen, Benedict Preu†, Hanno Keil†

†Not present on cruise

During most of the time at the PAP site, the hull-mounted echo sounder system PARASOUND was used in a 24 hour watch partly automatic mode. The system was used to image the upper 1000 m of the water column in order to detect sinking organic aggregates and follow the vertical migration of zooplankton. The PARASOUND system was switched on the 9th of July 2014 and switched off in the evening on the 21st of July. It was only switched off when other acoustic equipment were tested or used and the system had a failure between 9:32 and 15:59 on the 10th of July.

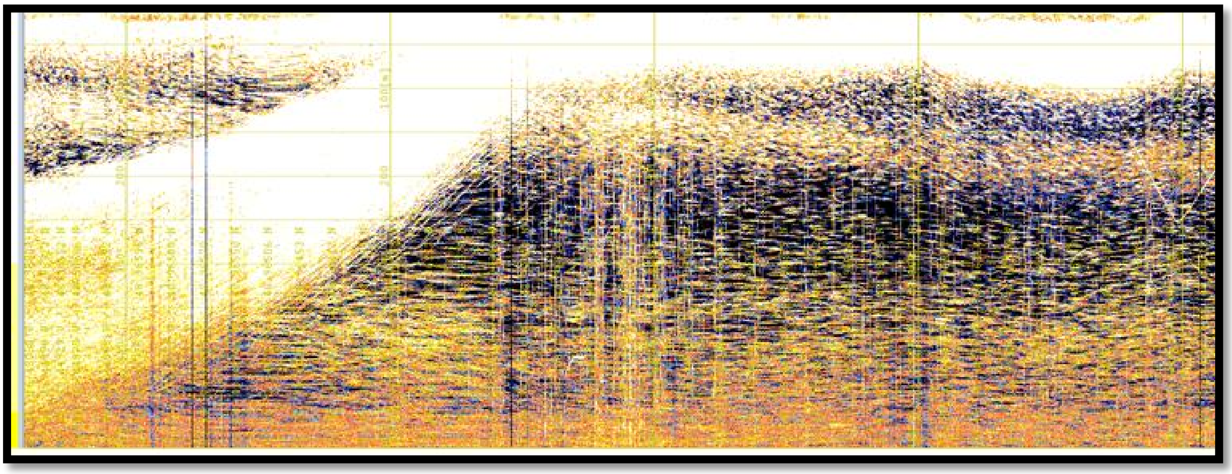
The PARASOUND system P70 (ATLAS HYDROGRAPHIC) is permanently installed on Meteor. It uses the parametric effect, which occurs when very high (finite) amplitude sound waves are generated. If two waves of similar frequencies are generated simultaneously, also the sum and the difference of the two primary frequencies are emitted. For the PARASOUND System, 18 kHz is one fixed primary frequency, which distributes energy within a beam of 4.5° for a transducer of ~1 m length. The second primary frequency can be varied between 18.5 and 24 kHz, resulting in frequencies varying from 0.5 to 6.0 kHz. This signal travels within the narrow 18 kHz beam, which is much narrower than e.g. a 4 kHz signal emitted from the same transducer directly (30°). Therefore, a higher lateral resolution can be achieved and imaging of small scale structures is superior to conventional systems. As another consequence, the signal bandwidth is also increased and much shorter signals can be generated with improved vertical resolution. However, due to the very narrow beam, it is necessary to control beam direction to compensate the ship's movement and to send the energy vertically downwards. The system treats three signals separately: the primary high frequency signal (18 kHz; PHF), the secondary low frequency signal (selectable 0.5 to 6.0 kHz; SLF) and the secondary high frequency (selectable 36.5 to 42 kHz; SHF). All three signals are recorded separately. Alternatively, also exclusively a low frequency signal (PLF; 3 or 12 kHz) can be emitted at much lower energy levels, at which sound emission energy levels have to be limited (e.g. for mammal protection).

The PARASOUND system uses three different computer systems at minimum. Two of them control in real-time signal generation and data acquisition through a Linux and a Windows XP system. The third PC is available for the operator. This Operator-PC hosts the Hydromap Database Server, the Hydromap Control Software and the ParaStore 3 Software. The Hydromap Control Software is responsible for all system settings and for communication with the other computers in real-time. For visualization, online processing and storage, the

ParaStore Software Package is used. Data can be stored in the PARASOUND own file format (ASD), but also in the more common PS3 or SEG-Y format. Several windows can be used to display and record different signals (PHF, SLF, SHF) with different scaling and/or processing parameters. This allows adapting the visualization for specific purposes, as e.g. to image the sediment cover of just the upper 20 m, to choose a full penetration plot, which also allows coverage of the topography, or to study the complete water column.

The system can either be used in the single pulse mode, when a single pulse is emitted, and the water column and sediment response are recorded before the next pulse is sent, or in the pulse train mode, by which the two-way travel time of the signal through the water column until the first return is used to emit more signal at regular intervals. Doing so, the signal density can be increased by as much as a factor of 16, if the time interval between the pings in relation to the water depths allows this procedure. The system was used most of the time in single pulse mode to acquire data from the entire water column. Recording length and ping rate was controlled automatically by the system using the water depth provided by the EM120 multi-beam system.

The PHF signal of the PARASOUND system was used to image areas of high backscatter within the water column. Main objectives were to acquire information about the vertical migration of zooplankton during the cruise and later to correlate the acoustic imaging with the particle data acquired with the UVP, PelagraCam, and the LISST-HOLO (see the cruise reports for those instruments).



PHF image acquired on the 16th of July in the evening showing the ascend of the zooplankton from 300 to 500 meter depth and up to the surface ocean. Their ascend started at around 21:00 in the evening and the zooplankton remained in the surface waters until 05:30 in the morning where they descended to depths between 300 and 500 meters again.

14 Underway testing of Seaguard pCO2 sensor

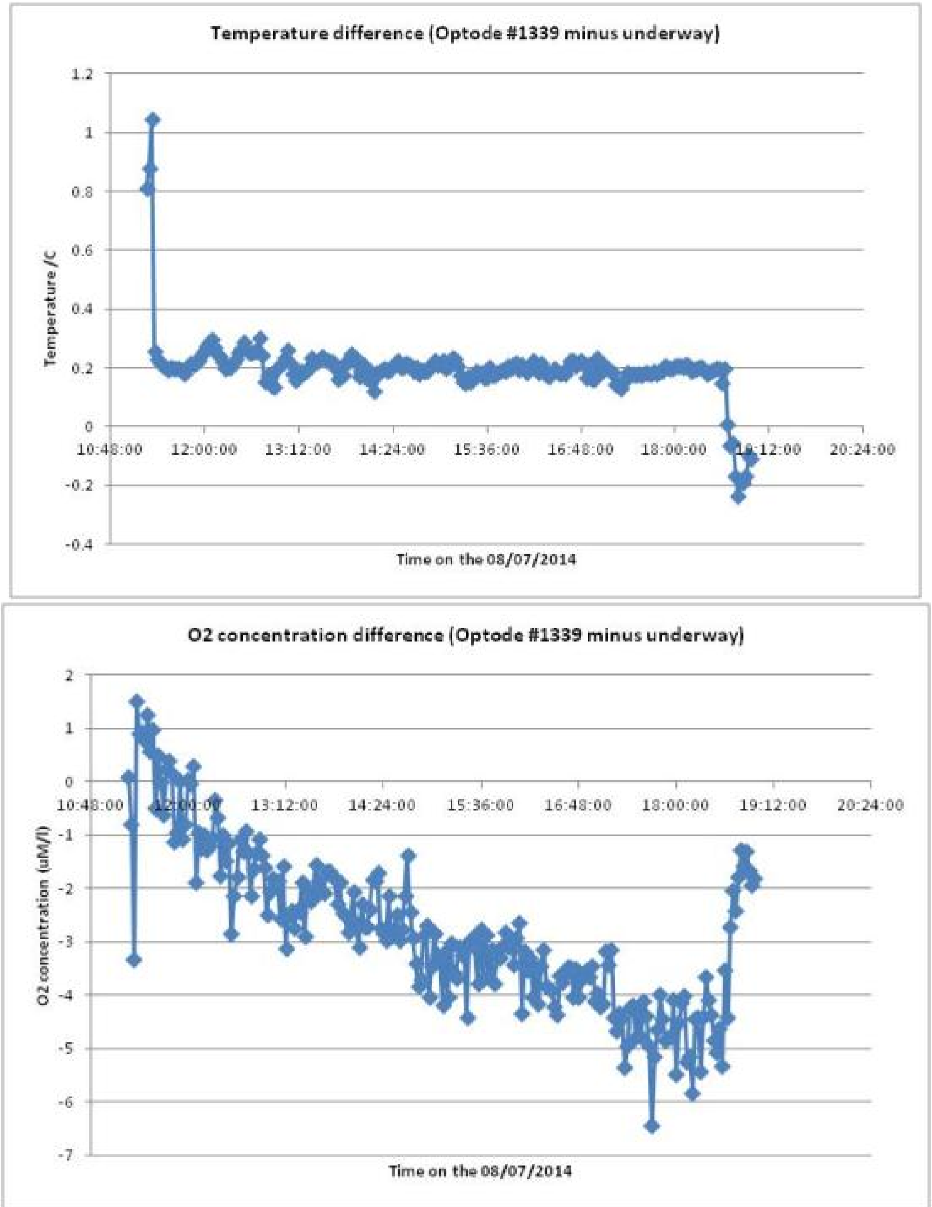
Andrew Morris

On board Meteor an underway system, principally for monitoring pCO_2, was running through multiple research cruises, including M108. Underneath the main underway system a water trough enabled sampling of conductivity and oxygen concentration with a temperature senor placed in the reservoir feeding the trough. The opportunity was taken to place the Seaguard within the water trough as a potential additional calibration to the planned calibration CTD cast.

Unfortunately the temperature sensor for the underway system could not be co-located with the Seaguard and noticeable biological growth was noted within the water trough used to sample from figure below.

Image of water trough used to house sensors other than those for pCO_2 in underway system. Biological growth is seen to be present throughout. Seaguard not shown.

The Seaguard was placed within the underway system for approximately six hours to gauge the efficacy of the set-up as an additional calibration for the Seaguard before later deployment on the PAP1 sensor frame. Unfortunately, owing to the observed biological growth and the temperature sensor of the underway system not being co-located to the water trough, the confidence in the initial results was not high enough to commit to a calibration. Differences between the Seaguard temperature and oxygen concentrations with that of the underway systems are given in figure below



Differences between Seaguard temperature and oxygen concentration readings to those from the underway system.

Meteor also benefitted from seawater being supplied to wet laboratory spaces by membrane pump, ensuring the delivered sea water was relatively unchanged. An investigation of using such a supply to enact an additional proxy underway system was investigated but could not be enacted in full on this occasion. However, such a system may prove valuable if it could be put in place early within the cruise schedule.

15 Benthic studies introduction

Brian Bett, Madeleine Brasier, Laetitia Gunton, and Paris Stefanoudis

The primary objective of the benthic team was to continue long-term time-series observations of the benthos at the Porcupine Abyssal Plain Sustained Observatory site. This programme dates back to RRS *Discovery III* 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. The present cruise was intended to be made by RRS *Discovery IV*, however, failure to commission her main winches precluded that option. As a consequence, planned otter trawl sampling had to be abandoned from the outset, FS *Meteor* not being equipped with a wire rope suitable for trawling at abyssal depths. Our primary benthic sampling aims were therefore limited to (i) macrobenthos, and (ii) foraminifera, via Megacorer operations. Other aims were: (iii) recovery (Stn. JC085-011) and redeployment of a "Bathysnap" time-lapse camera system, (iv) to gain first field experience of (and in doing so contribute to upper ocean water column particle studies) a new instrument, the LISST-HOLO, and (v) to obtain other samples and data opportunistically as proved possible.

As detailed further below, all aims were met or exceeded:

i. Five, full protocol, sets of replicate macrobenthos samples were obtained from the 'PAP Central' coring site. In addition, a reduced protocol replicate sample was obtained from the same site.
ii. Four, full protocol, sets of replicate foram samples were obtained from the 'PAP Central' coring site. In addition, two additional reduced protocol replicate samples were obtained from the same site.
iii. "Bathysnap" (Stn. JC085-011) was successfully recovered, yielding continuous (8-hour interval) time-lapse footage from 21.IV.2013 to 14.VII.2014, some 1348 seabed photographs covering almost 15-months. The record captures the arrival of phytodetritus in both 2013 and 2014 (in both cases peaking in early June), and the identity and behaviour of several species of megabenthos. The camera system, with some refurbishment, was successfully re-deployed as FS *Meteor* station ME1080/782.
iv. Valuable field experience was gained in the operation of the LISST-HOLO instrument, enabling the manufacturer supplied manual to be 'improved' and 'extended', and a standard operating procedure to begin to be developed. Useful data on upper water column particle distributions also appears to have been generated (see details below).
v. (a) Five replicate metazoan meiobenthos samples were obtained from the 'PAP Central' coring site. (b) Three box core macrobenthos samples (ethanol preserved; for DNA bar-coding and stable isotope analysis) were obtained from 'PAP Central' coring site. (c) An additional box core macrobenthos sample was obtained from abyssal hill site "H4-4" (established RRS *James Cook* cruise 062), and a small (1-core) Megacore macrobenthos (ethanol preserved) was obtained from the summit of "Ben Billett", the largest of the abyssal hills in the PAP area. (d) Most core samples were additionally surface picked for large protozoans (e.g. xenophyophores, mudballs, and related taxa), dropstone samples were also retained from "H4-4" and "Ben Billett" for further studies of attached forams. (e) Some *ad hoc* swathe bathymetry (Kongsberg EM122) was also logged during the cruise [i. covers abyssal hills to south of PAP; ii. flanks and summit of "Ben Billett"; iii. area of site "H4".

16 Bathysnap

Bathysnap is a free-fall mooring / lander equipped with a digital still camera (Imenco) operated in time-lapse mode, capable of long-term (1-year+) full ocean depth (6000m) operations. The present cruise aimed to recover a system deployed from RRS *James Cook* cruise 085 on 21 Apr 2013, and to redeploy the instrument for further long-term observation.

16.1 Recovery

(Stn. JC085-011 / ME108/765)
Recovery operations took place on Monday 14 July 2014. No ‘sensible’ telemetry could be acquired from the Bathysnap release unit (MORS RT6x1 s/n 332), despite the use of three separate MORS / IXSEA deck-units, and three separate MORS / IXSEA transducers. FS *Meteor* held station over the Bathysnap position until the likely time of surfacing, assuming first release commands had been received and executed. The mooring surfaced at the expected time and was recovered without incident (recorded as FS *Meteor* station number ME1080/765).

At the surface the main buoyancy pack appeared low in the water, and when alongside the ship practically submerged. Later inspection revealed that one glass sphere had lost a large ‘flake’ of glass from its surface, although had not obviously leaked – it was marked for subsequent disposal a NOC. The mooring was generally in good condition, some shackles showed appreciable corrosion, thimbles on the main mooring line were significantly corroded, and the dan buoy pole beneath its clamps had suffered crevice corrosion. The rear end-cap of the Imenco camera had substantial rust staining – potential crevice corrosion in bulkhead connector fittings. The screw thread on the camera’s main bulkhead connector was appreciably corroded.

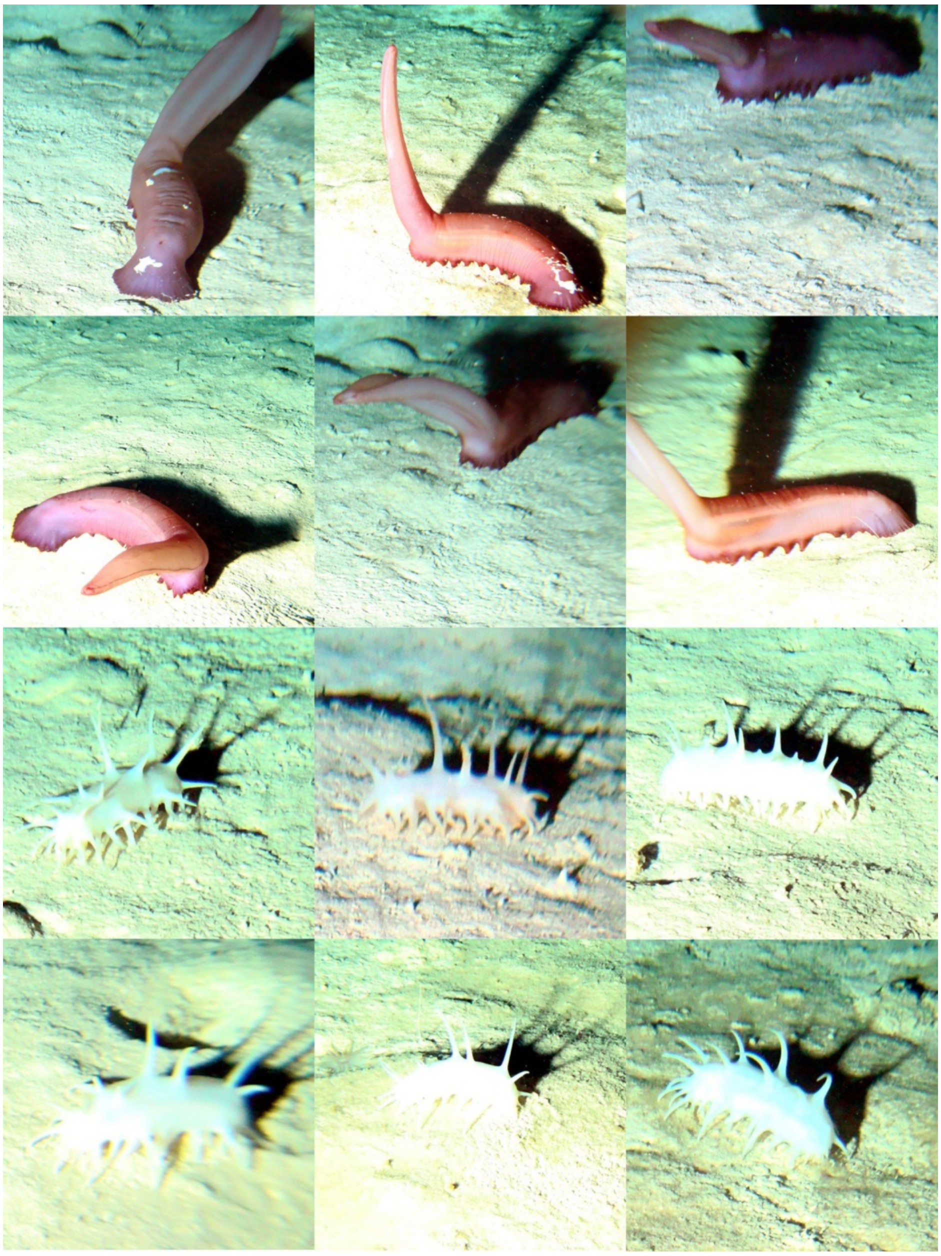
At time of download of images the camera’s clock showed 15.VII.2014 12:48:47 at a corresponding GPS / UTC time of 15.VII.2014 13:03:20, a 00:14:33 timing loss on the camera. A total of 1348 seabed photographs were downloaded from the camera, there were a few black frames recorded, the latter were in no apparent sequence and were presumed to be random occurrences. The seafloor footage was briefly reviewed onboard, and preliminary observations made as follows below.

16.1.1 Preliminary seabed observations

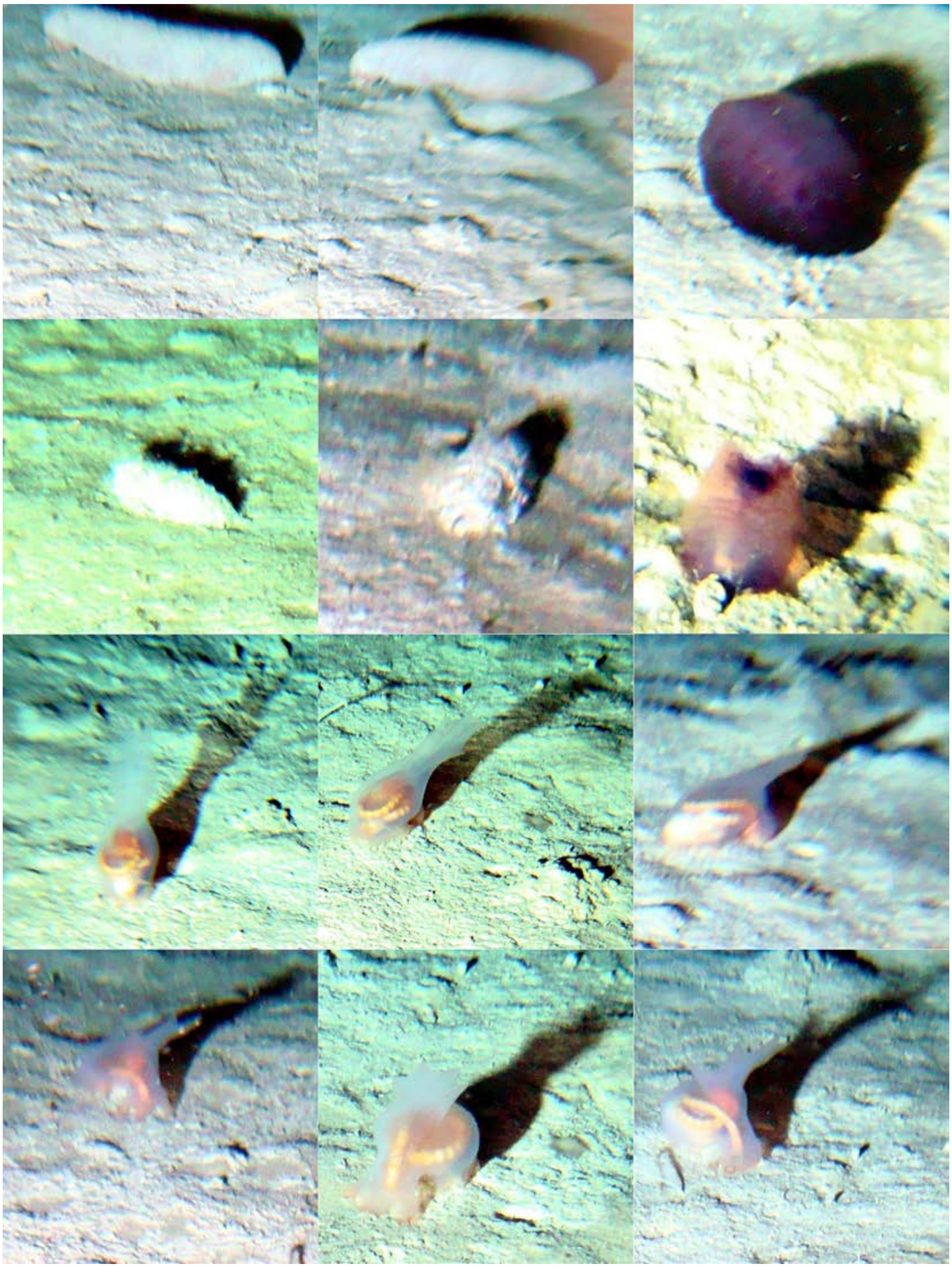
The seabed footage showed a significant abundance of large holothurians species, particularly *Psychropotes longicauda* and *Oneirophanta mutabilis* (BSNAP Fig. 1), other large holothurians were also observed (*Pseudostichopus*, *Benthothuria*; BSNAP Fig. 2). The small holothurian *Amperima rosea* (BSNAP Fig. 2) was relatively abundant, the population seemingly comprising predominantly larger specimens. Taken together these two observations (abundant large holothurian species, and moderately abundant large specimens of *Amperima*) may suggest the megabenthos are in an ‘intermediate *Amperima* event state’, i.e. that the *Amperima* population is in neither boom nor bust, and that the larger megabenthos are relatively abundant. Other fauna observed include the first appearance of a “dumbo octopus” in Bathysnap footage, giant sea spider, wandering anemone, squat lobster, starfish and rat tail fish (BSNAP Fig. 3.).

No particularly major sediment reworking or earthworks occur during the deployment (compare first and last images, BSNAP Fig. 4). There is, however, appreciable tracking by holothurians, particularly *P. longicauda*. An asteroid feeding imprint is formed early in the deployment and persists to the end of the deployment (top right of images, BSNAP Fig.5). The asteroid was clearly imaged just after trace formation and appears to have a feeding distended body. The sediment surface feeding activity of a relatively large echiuran is evident in the upper left of the field of view (the burrow opening being out of view), although the proboscis itself does not appear to have been imaged.

Phytodetritus aggregate deposition and accumulation on the seabed is observed for both 2013 and 2014. In both years the accumulation is modest (BSNAP Fig. 5) and of very similar timing, reaching an apparent maximum in early June (10th and 7th respectively).

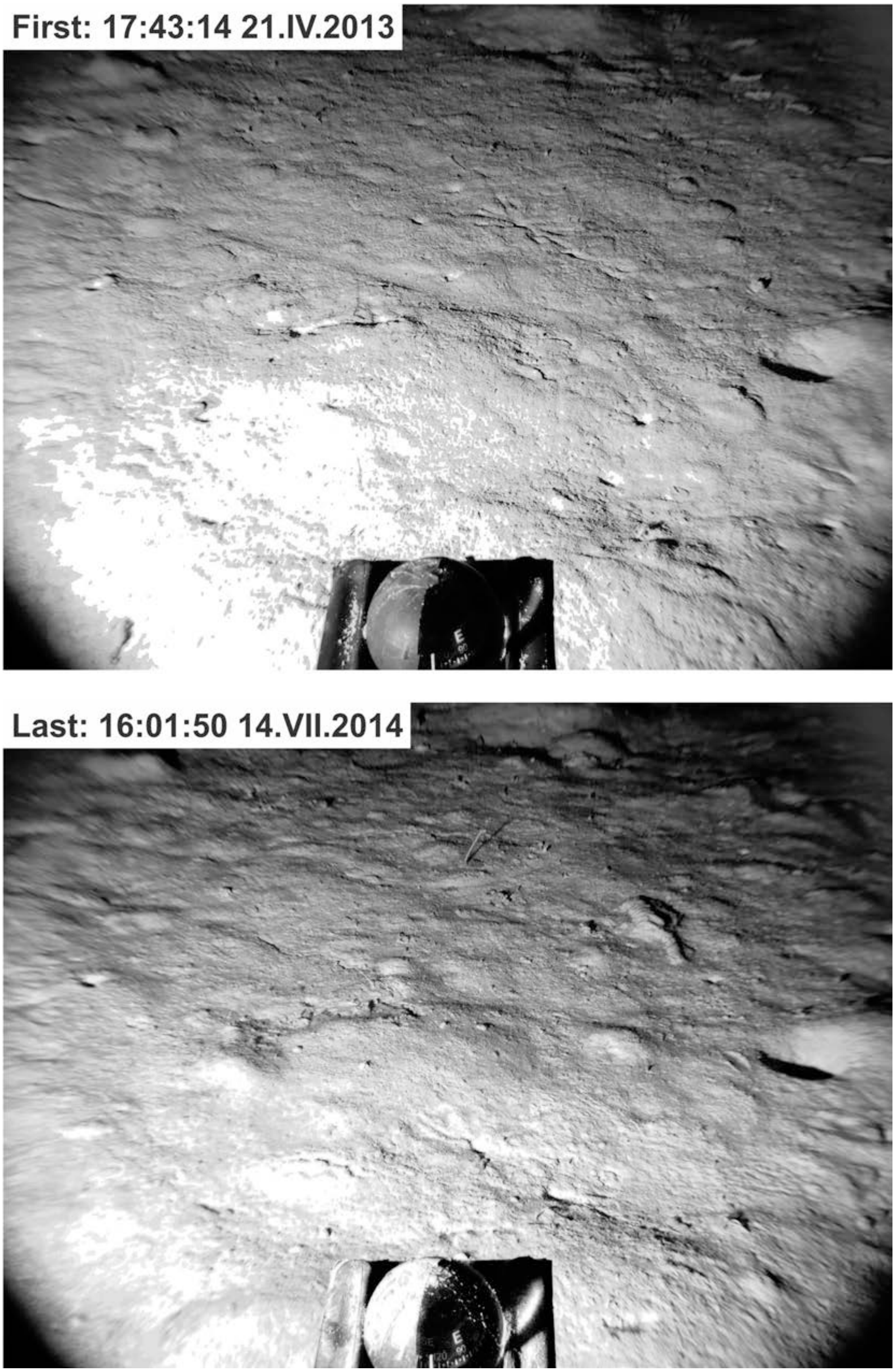


BSNAP Fig. 1. Selected portrait images from Bathysnap deployment JC085-011. Top rows *Psychropotes longicauda*, bottom rows *Oneirophanta mutabilis*.

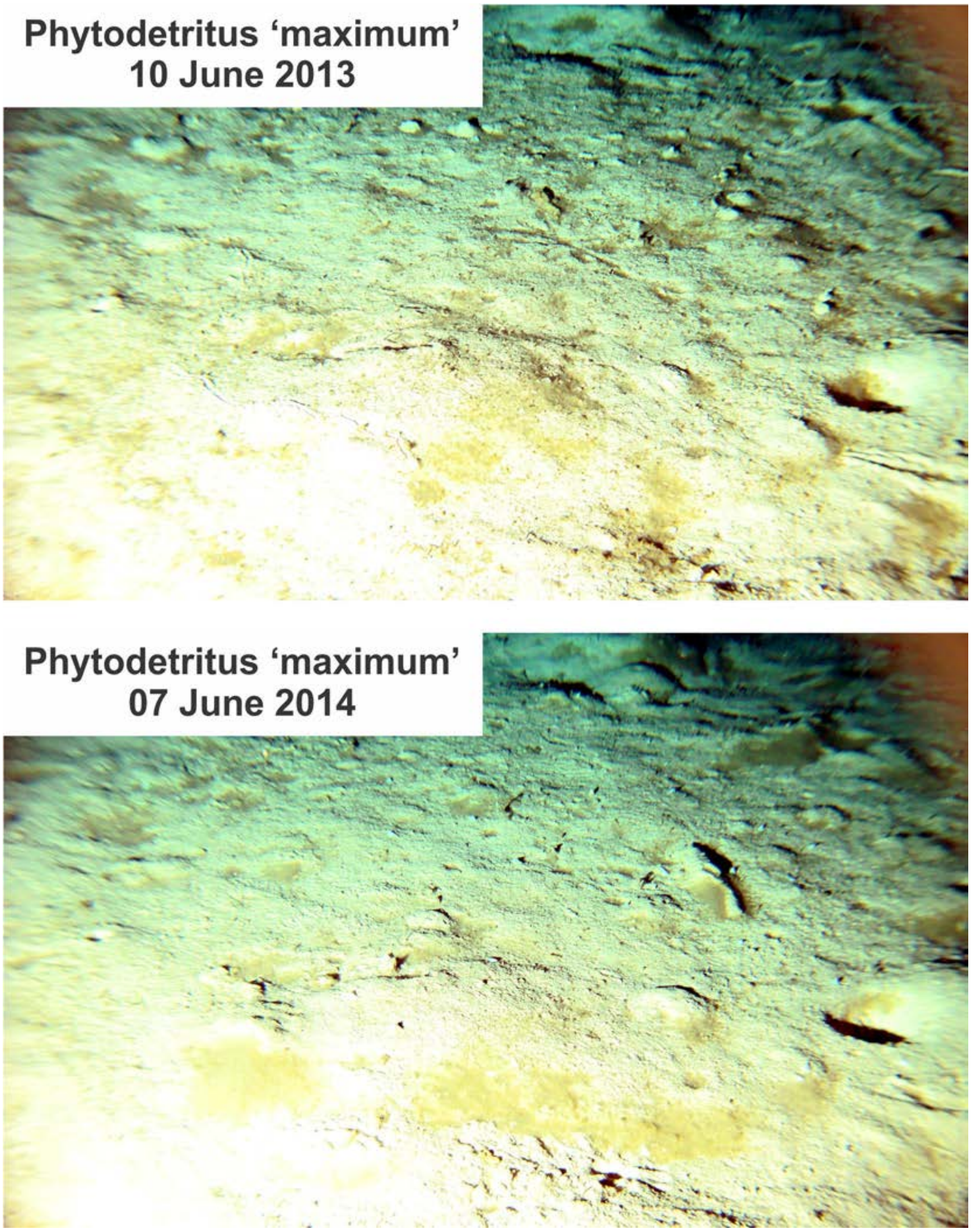


BSNAP Fig. 2. Selected portrait images from Bathysnap deployment JC085-011. Left to right, top to bottom: *Pseudostichopus* sp.1 (1, 2), *Benthothuria* (3), *Pseudostichopus* sp.2 (4, 5), ?damaged *Psychropotes*? (6), *Amperima rosea* (7-12).

BSNAP Fig. 3. Selected portrait images from Bathysnap deployment JC085-011. Left to right, top to bottom: *"dumbo octopus"* (1), *giant sea spider* (2), *wandering anemone* (3), squat lobster (4-6), *asteroid* (7), rat tail fish (8-9).



BSNAP Fig. 4. Bathysnap deployment JC085-011, first and last seabed images.



BSNAP Fig. 5. Bathysnap deployment JC085-011, apparent phytodetritus accumulation maxima.

16.2 Re-deployment

(Stn. ME108/782)

The redeployment acoustic release unit (IXSEA AR861B2S s/n 1186) was re-batteried and successfully wire tested during deep cast deployment ME108/743. The recovered mooring was partially re-used: upper mooring line was replaced with new 10m white braid; main mooring line was replaced with lightly used 50m white braid; all four main buoyancy pack glass spheres were replaced; dan buoy and main buoyancy chains were replaced; a selection of corroded shackles were replaced.

The recovered Imenco camera was replaced with the deepseas group 2nd Imenco camera, the 1st having appeared to have suffered significant corrosion around the main bulkhead connector. In offloading images from the 1st camera and setting-up the second camera the ‘usual’ difficulties with camera communications were encountered. It is possible, however, that these ‘usual’ difficulties may have resulted from a poor connection in the coaxial cable connecting the camera control unit to the monitor. Having swapped this cable (now marked ‘suspect’) with a spare, camera communications were efficient. Camera set-up for redeployment was as follows:

- Shutter speed 1/40
- Aperture F5.6
- Focus 3.0m
- Image size 12Mb
- Rec mode normal
- Colour mode normal
- ISO 200
- Metering mode multi
- White balance flash
- Flash level +/- zero
- Red eye off
- Contrast normal
- Sharpness normal
- Steady shot off
- Flash always on
- Camera time set to GPS / UTC
- Camera memory confirmed empty
- Timer values rest
- Timer interval set to 8-hour
- Timer settings updated
- Disconnect and camera off initiated

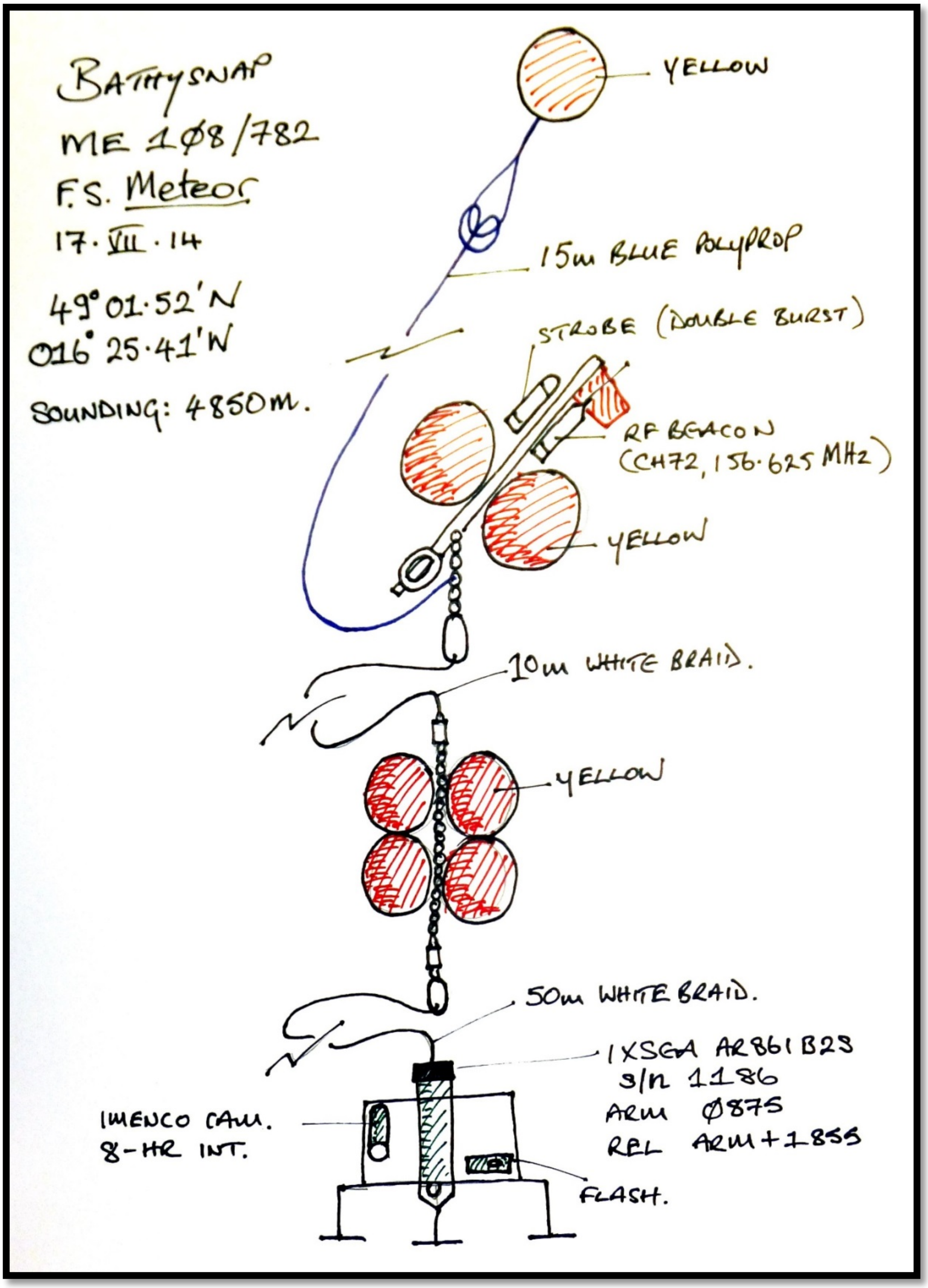
The recovered flash (fitted with polythene intensity reducing ‘filter’) was re-used. The flash was seen to fire on deck at 05:39 17.VII.2014, first seabed image expected at 13:39 17.VII.2014.

The Bathysnap system was redeployed on 17.VII.2014 as FS Meteor station ME108/782. The mooring was let go at 07:39, and with a measured descent rate of 66 m/min was expected on the seabed at 08:53. The acoustic release details are as follows:

- IXSEA OCEANO 2500 S-Universal, AR861B2S
- Serial number 1186
- “Mode B”
- ARM / RANGING 0875
- RELEASE ARM+1855
- RELEASE WITH PINGER ARM+1856

- PINGER ON ARM+1847
- PINGER OFF ARM+1844
- DIAGNOSTIC ARM+1849

The general arrangement of the mooring is given in BSNAP Fig. 6.



BSNAP Fig. 6. General mooring arrangement of Bathysnap deployed as FS Meteor station ME108/782

17 Seabed coring

Both the deepseas group Megacorer and the NMFD USNEL box core were operated during the present cruise (total 11 deployments, see CORING Table 1). Our primary objective was to obtain standard time series macrobenthos and foram samples from the PAP Central coring area. Secondary aims included obtaining ethanol preserved macrobenthos material, and to further investigate the influence of abyssal hill topography on the PAP benthos (see RRS *James Cook* cruise 085, and RRS Discovery cruise 377).

17.1 Megacoring

The 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 corer arrangement, i.e. with eight 10 cm ID tubes and two 59 mm ID tubes fitted (with the exception of station ME108/795, "Ben Billett", where a 6+2 arrangement was employed on expectation of hard ground). The first three deployments, ME108/745, 746, 752, were carried out using FS *Meteor*'s 'Posidonia' system (IXSEA USBL) to monitor corer depth. These deployments indicated that FS *Meteor*'s cable metering system was particularly accurate, and all subsequent coring operations were monitored by reference to cable out only. At the PAP Central coring site cable out at bottom contact varied only between 4848 and 4850m – a very accurate sounding lead.

17.1.1 Sampling protocols

Macrofauna: All available large tubes (10 cm in diameter) from each deployment were sliced for macrobenthos. The core was sliced into 5 layers: 0-1, 1-3, 3-5, 5-10 and 10-15 cm horizons. The first three layers were each placed in a 500 ml labelled container and the next two layers in a 1.5 L labelled container respectively. Water in the top of each core was syringed and added to the 0-1 cm horizon sample. All slicing material (cutting guide, slicing plate, funnel and knife) were washed into the sample containers with filtered seawater (mesh: 125 µm). Samples were fixed in 10% formalin. Visually conspicuous xenophyophores as well as stones with attached foraminifera were opportunistically picked from core surfaces and stored in small container with 10% buffered formalin for later analysis.

Foraminifera: One small tube (59 mm in diameter) from each deployment was sliced for foraminifera. The core was sliced into 12 layers: 0-0.5, 0.5-1, 1-1.5, 1.5-2, 2-3, 3-4, 4-5, 5-6, 6-7, 7-8, 8-9 and 9-10 cm horizons. Each layer was placed in a 500 ml labelled container and fixed in 10% buffered formalin. Water in the top of each core was syringed and added to the 0-0.5 cm horizon sample. All slicing material (cutting guide, slicing plate, funnel and knife) were washed into the sample containers with filtered seawater (mesh: 125 µm). Visually conspicuous xenophyophores as well as stones with attached foraminifera were opportunistically picked from core surfaces and stored in small 50 ml containers with 10% buffered formalin for later analysis.

Metazoan meiofauna: The second small tube (59 mm in diameter) from each deployment, if available, was sliced for later meiofaunal analysis. The 0-5 cm were sliced and placed in a 1.5 L contained and fixed in 10% buffered formalin. Visually conspicuous xenophyophores as well as stones with attached foraminifera were opportunistically picked from core surfaces and stored in small 50 ml containers with 10% buffered formalin for later analysis.

17.1.2 Deployments

ME108/745 (PAP central); 8/10 tubes returned fired and with samples (good core lengths 35-42 cm); 6 large tubes were sampled for macrobenthos. 1 small tube was sampled for foraminifera and 1 small tube for metazoan meiofauna. Mudballs and related foraminifera were picked out and preserved separately in small (50ml) containers with 10% buffered formalin.

ME108/746 (PAP central); 7/10 tubes returned fired and with samples (good core lengths 26-42 cm); 6 large tubes were sampled for macrobenthos. 1 small tube was sampled for foraminifera. Mudballs and related foraminifera were picked out and preserved separately in small 50 ml containers with 10% buffered formalin.

ME108/752 (PAP central); 9/10 tubes returned fired and with samples (good core lengths 19-44 cm); 7 large tubes were sampled for macrobenthos. 1 small tube was sampled for foraminifera and 1 small tube for metazoan meiofauna. Mudballs and related foraminifera were picked out and preserved separately in small 50 ml containers with 10% buffered formalin.

ME108/758 (PAP central); 9/10 tubes returned fired and with samples (good core lengths 26-44 cm); 7 large tubes were sampled for macrobenthos. 1 small tube was sampled for foraminifera and 1 small tube for metazoan meiofauna. Mudballs and related foraminifera were picked out and preserved separately in small 50 ml containers with 10% buffered formalin.

ME108/773 (PAP central); 9/10 tubes returned fired and with samples (good core lengths 23-42 cm); 7 large tubes were sampled for macrobenthos although not for all horizons (see appendix material). 1 small tube was sampled for foraminifera (up to 5 cm deep) and 1 small tube for metazoan meiofauna. One mudball was picked out and preserved separately in small 50 ml containers with 10% buffered formalin.

ME108/795 ("Ben Billett"); 2/10 tubes returned fired. One contained a small amount of sediment (core length c.10 cm) and 1 contained only some dropstones. Stones with attached foraminifera were picked out and preserved separately in small 50 ml containers with 10% buffered formalin.

ME108/805 (PAP central); 8/10 tubes returned fired and with samples (good core lengths 21-41 cm); 6 large tubes were sampled for macrobenthos. 1 small tube was sampled for foraminifera (up to 5 cm deep) and 1 small tube for metazoan meiofauna. One xenophyophore was picked out and preserved separately in a small 50 ml container with 10% buffered formalin.

Example core profile images are given in CORING Fig. 1.

CORING Fig. 1. Example core profile images from all FS Meteor cruise 108 Megacorer deployments at the PAP Central coring location. Note consistent profiles of overlying brown sediment over light grey clay with narrow dark interface band.

17.2 Box coring

An NMFD-supplied USNEL-type box core was used at three PAP central coring locations as well as the ‘H4-4’ (of RRS *James Cook* cruise 062) coring site for collecting macrofauna. It was rigged and operated in standard fashion (with penetration limiters fitted for PAP central deployment, removed for H4-4). Box core recovery to deck was achieved via an auxiliary wire run from a gantry head boom, this was hooked into the main lifting shackle while the core was outboard (at that time the spade arm was lashed to the central column for safety); this procedure enabled recovery without opening the bulwarks. All four deployments were successful. On three occasions the resulting sediment sample had a relatively undisturbed surface, while on one occasion the surface was heavily disturbed (ME108/781), likely the result of a double bottom contact.

17.2.1 Sample processing

The top layer (0-5 cm approximately) of sediment was removed and agitated in seawater to suspend organic material then sieved through a 300 µm mesh. Water on top of the sediment was siphoned off and sieved with the sediment. The material retained within the sieve was placed in 1.5 L labelled container and preserved in 100% ethanol. Samples will be transported to the Natural History Museum, London, where they will be sorted for polychaetes for DNA barcoding and stable isotope analysis. Prior to the removal of the upper sediment layer and during processing, visually conspicuous organisms (mudballs, xenophyophores, echinoderms) and stones with attached foraminifera, were opportunistically picked from the box corer surface and stored in small 50 ml containers with 10% formalin, for later analysis. During the sieving process visible polychaetes were picked and stored in 10ml specimen tubes for identification to family level from morphological characteristics.

17.2.1 Deployments

ME108/753 (PAP central); the sediment interface was undisturbed. Ten metazoan individuals have been preserved separately in small 50 ml containers or 10ml specimen tubes where appropriate in 100% alcohol (including 1 ophiuroid, 1 echinoid and 8 polychaetes). Mudballs and related foraminifera were picked out and preserved separately in 4 small containers with 10% buffered formalin.

ME108/781 (PAP central); the sediment interface was rather disturbed. Fifteen metazoan individuals have been preserved separately in 10ml specimen tubes in 100% alcohol (including polychaetes and other indeterminate organisms).

ME108/806 (PAP central); the sediment interface was relatively undisturbed. Three polychaete individuals have been preserved separately in 10ml specimen tubes in 100% alcohol as well as a bulk fixation of polychaete tubes.

ME108/816 (H4-4); the sediment interface was relatively undisturbed and included a quadrant of a large burrow mound (20cm topographic height; estimated diameter c. 50cm). Eleven individual polychaetes, a bulk fixation of polychaete tubes and a second bulk fixation of indeterminate polychaete fragments were preserved separately in one 10ml specimen tubes in 100% alcohol. Stones with attached foraminifera were picked out and preserved separately in 5 small 50 ml container in 10% buffered formalin.

Example core surface images are given in CORING Fig. 2.

CORING Fig. 2. Example box core surface images. Left ME108/753, PAP Central coring location, high quality core. Right ME108/816, Site “H4-4” (abyssal hill), note major burrow mound top left quadrant.

17.3 Coring operations

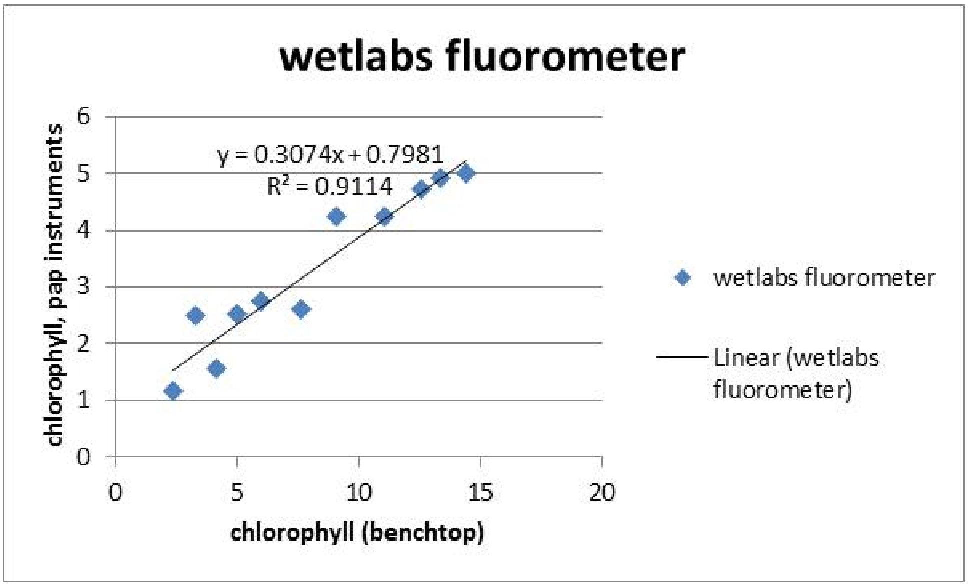
Station ME108/	Site	Gear	Date July 2014	Time (UTC)	LAT N	LONG W	Depth [m] 1.	Sounding (m) 2.	MWO at contact 3.	Pull out (kN)	Core recovery	MACROB	FORAM	MEIOB	EtOH MAC	Other
745	PC	MgC08+2	12	02:02	48° 50.08'	16° 31.15'	22.5	4826	4850	74	6/8+2/2, max. 42cm	6	1	1	-	X
746	PC	MgC08+2	12	06:47	48° 50.06'	16° 31.15'	4822.9	4825	4850	71	6/8+1/2, max. 48cm	6	1	-	-	X
752	PC	MgC08+2	13	01:45	48° 50.07'	16° 31.16'	4825.2	4826	4848	70	7/8+2/2, max. 44cm	7	1	1	-	X
753	PC	BC(l)	13	06:54	48° 50.07'	16° 31.16'	4822.5	4826	4849	69	Good core, c. 20cm	-	-	-	X	X
758	PC	MgC08+2	14	02:00	48° 50.01'	16° 31.15'	4823.6	4826	4850	69	7/8+2/2, max. 41cm	7	1	1	-	X
773	PC	MgC08+2	16	03:09	48° 50.05'	16° 31.16'	5136.9	4828	4850	70	7/8+2/2, max. 42cm	7R	1R	1	-	X
781	PC	BC(l)	17	04:00	48° 50.07'	16° 31.15'	4827.2	4826	4850	70	Rather disturbed core, c. 20cm	-	-	-	X	-
795	B. B.	MgC06+2	18	05:13	49° 06.92'	16° 37.81'	3882.3	3882	3903	60	1/8+0/2, max. 5cm	-	-	-	X	X
805	PC	MgC08+2	19	05:43	48° 50.07'	16° 31.18'	4822.5	4822	4848	71	6/8+2/2, max. 41cm	6	1R	1	-	X
806	PC	BC(l)	19	10:22	48° 50.10'	16° 31.20'	4823.5	4825	4848	71	Fair core, c. 20cm	-	-	-	X	-
816	H4-4	BC(nl)	20	03:41	49° 04.43'	16° 15.82'	4272.9	4275	4298	61	Good core, c. 40cm	-	-	-	X	X

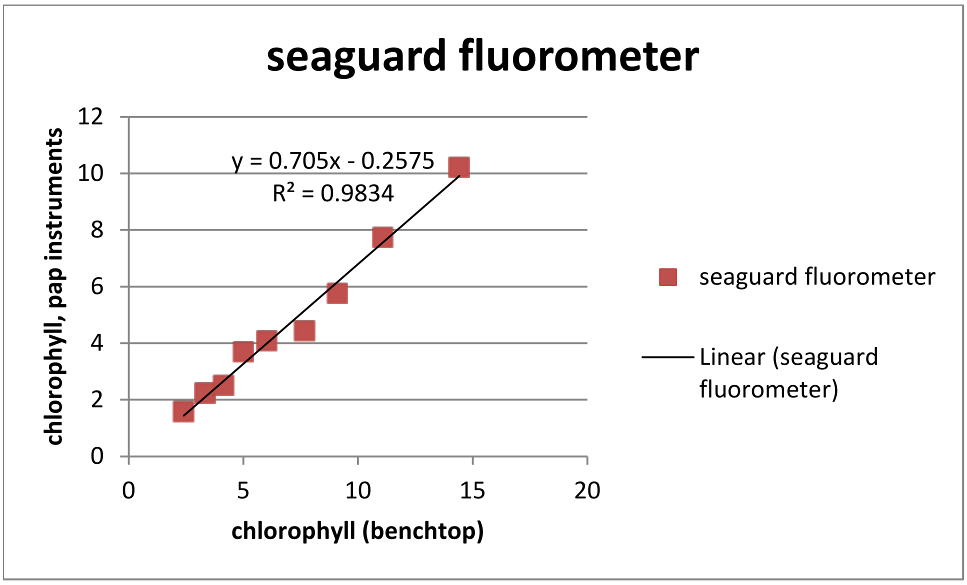
MACROB, standard PAP macrobenthos sample cores (R reduced protocol); FORAM, standard PAP foram sample cores (R reduced protocol); MEIOB, meiobenthos samples (0-5cm, 27cm^2); EtOH MAC, 300um sieved, ethanol preserved macrobenthos sample; Others, separately preserved material (e.g. surface picked forams). 1. DSHIP system recorded data; 2. Operator recorded data; 3. Recommended sounding to be used. XXXX, note erroneous sound velocity; XXXX, obviously spurious records; XXXX, good soundings.

18 APPENDIX

18.1 APPENDIX 1: Chlorophyll comparisons

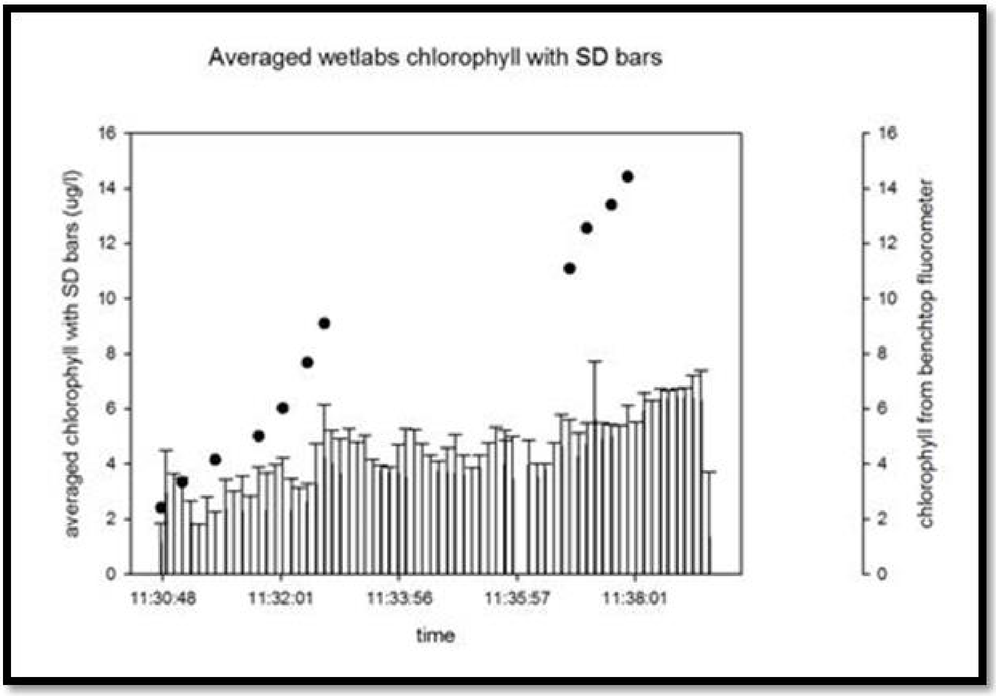
Prior to the cruise the Turner Cyclops on the SeaGuard and the wetlabs fluorometer were compared by placing in a tub containing 10l seawater. Sequential additions of Isocrysis culture were made and the solution mixed with a magnetic stirrer. After approximately 5 mins of mixing duplicate 100ml sub sample were filtered through 25mm gffs. Samples were then stored at -20'C until they were treated with 8ml of acetone, and placed in a fridge for 24 hours in accordance with the Shelf Seas BioChemistry Protocol. After 24hours sub samples were analysed using a turner bench top fluorometer.





The results were disappointing for several reasons, too few samples taken at the lower concentrations relevant to the PAP site for example 2013 CTD calibrations gave readings below 2µg l^{-1}, too few duplicates taken at lower concentrations and an interval where the Cyclops was out of the water bath which was unnoticed.

Consequently more emphasis should be placed on the CTD casts as per usual and the bench top method refined next year.



18.2 APPENDIX 2: Programming details for ZPS 201/2015

Enter ^C now to wake up ... [^C]

Configuration: ZPS-30G CF2 V2_00 of Apr 11 2012
McLane Research Laboratories, USA
ZooPlankton Sampler
ML12860-01

Main Menu

Tue Jul 15 08:12:11 2014
Belt is aligned

<1> Set Time <5> Create Schedule
<2> Diagnostics <6> Deploy System
<3> Manual Operation <7> Offload Data
<4> Sleep <8> Contact McLane

Selection [] ? 2
Press ^C to exit - any other key to pause/continue display

07/15/14 08:12:34 34.8Vb 8mA 17.4°C Belt is aligned
07/15/14 08:12:35 35.4Vb 8mA 17.5°C Belt is aligned
07/15/14 08:12:36 35.6Vb 10mA 17.5°C Belt is aligned
07/15/14 08:12:37 35.8Vb 10mA 17.5°C Belt is aligned

Configuration: ZPS-30G CF2 V2_00 of Apr 11 2012

McLane Research Laboratories, USA
ZooPlankton Sampler
ML12860-01

Main Menu

Tue Jul 15 08:12:38 2014
Belt is aligned
<1> Set Time <5> Create Schedule
<2> Diagnostics <6> Deploy System
<3> Manual Operation <7> Offload Data
<4> Sleep <8> Contact McLane
Selection [] ? 6

Clock reads 07/15/14 08:12:46. Change [N] ? n

Existing deployment data file will be erased. Continue [N] ? y
Enter new deployment schedule [N] ? n
Schedule Verification

Event 1 of 50 at 07/20/14 00:00:00
Event 2 of 50 at 07/20/14 06:00:00
Event 3 of 50 at 07/20/14 12:00:00
Event 4 of 50 at 07/20/14 18:00:00
Event 5 of 50 at 07/26/14 00:00:00
Event 6 of 50 at 07/26/14 06:00:00
Event 7 of 50 at 07/26/14 12:00:00

```
Event  8 of 50 at 07/26/14 18:00:00
Event  9 of 50 at 04/01/15 00:00:00
Event 10 of 50 at 04/07/15 00:00:00
Event 11 of 50 at 04/14/15 00:00:00
Event 12 of 50 at 04/14/15 06:00:00
Event 13 of 50 at 04/14/15 12:00:00
Event 14 of 50 at 04/14/15 18:00:00
Event 15 of 50 at 04/15/15 00:00:00
Event 16 of 50 at 04/21/15 00:00:00
Event 17 of 50 at 04/28/15 00:00:00
Event 18 of 50 at 04/28/15 06:00:00
Event 19 of 50 at 04/28/15 12:00:00
Event 20 of 50 at 04/28/15 18:00:00
Event 21 of 50 at 04/29/15 00:00:00
Event 22 of 50 at 05/05/15 00:00:00
Event 23 of 50 at 05/12/15 00:00:00
Event 24 of 50 at 05/12/15 06:00:00
Event 25 of 50 at 05/12/15 12:00:00 Press any key to continue.
Event 26 of 50 at 05/12/15 18:00:00
Event 27 of 50 at 05/13/15 00:00:00
Event 28 of 50 at 05/19/15 00:00:00
Event 29 of 50 at 05/26/15 00:00:00
Event 30 of 50 at 05/26/15 06:00:00
Event 31 of 50 at 05/26/15 12:00:00
Event 32 of 50 at 05/26/15 18:00:00
Event 33 of 50 at 05/27/15 00:00:00
Event 34 of 50 at 06/02/15 00:00:00
Event 35 of 50 at 06/09/15 00:00:00
Event 36 of 50 at 06/09/15 06:00:00
Event 37 of 50 at 06/09/15 12:00:00
Event 38 of 50 at 06/09/15 18:00:00
Event 39 of 50 at 06/10/15 00:00:00
Event 40 of 50 at 06/16/15 00:00:00
Event 41 of 50 at 06/23/15 00:00:00
Event 42 of 50 at 06/23/15 06:00:00
Event 43 of 50 at 06/23/15 12:00:00
Event 44 of 50 at 06/23/15 18:00:00
Event 45 of 50 at 06/24/15 00:00:00
Event 46 of 50 at 06/30/15 00:00:00
Event 47 of 50 at 07/07/15 00:00:00
Event 48 of 50 at 07/07/15 06:00:00
Event 49 of 50 at 07/07/15 12:00:00
Event 50 of 50 at 07/07/15 18:00:00 Press any key to continue.
Modify an event [N] ? n
Header <1>
       <2>
       <3>
Flush  <4> Back flush volume   [   5 liters]
           & time limit   [   1 minutes]
       <5> Back flush interval [  12 hours]
       <6> Sample delay        [   5 minutes]

Sample <7> Sample volume       [ 100 liters]
       <8> Pumping flow rate   [  20 liters/minute]
       <9> Minimum flow rate   [  10 liters/minute]
       <A> Pumping time limit  [   9 minutes]]
Data   <B> Pump data period    [   1 minutes]
       <D> Done
```

```
        Selection [] ? d

Caution: Deployment will overwrite the EEPROM data backup cache.
System status: 07/15/14 08:13:30  35.7Vb  7mA  17.7°C  Belt is aligned
Proceed with the deployment [N] ? y
Warning: Programmed schedule will trigger a periodic
      back flushing event in 12 hours. This event
      will occur before the first scheduled sample
      event at 07/20/14 00:00:00. The ZPS system
      must be deployed before this back flush event
      occurs to avoid damage to the pump.
Proceed with the deployment [N] ? y
07/15/14 08:13:48
Erasing EEPROM entries ..........................
Remove communication cable and attach dummy plug.
System is ready to deploy.
Warning: Programmed schedule will trigger a periodic
      back flushing event in 12 hours. This event
      will occur before the first scheduled sample
      event at 07/20/14 00:00:00. The ZPS system
      must be deployed before this back flush event
      occurs to avoid damage to the pump.
07/15/14 08:13:51 Waiting for next periodic back flush @ 07/15/14 20:13:51
07/15/14 08:13:52 Suspending until 07/15/14 20:13:51 ...
```

18.3 APPENDIX 3: SeaBird CTD configuration file


```
<?xml version="1.0" encoding="UTF-8"?>
<SBE_InstrumentConfiguration SB_ConfigCTD_FileVersion="7.22.0.4" >
 <Instrument Type="8" >
  <Name>SBE 911plus/917plus CTD</Name>
  <FrequencyChannelsSuppressed>0</FrequencyChannelsSuppressed>
  <VoltageWordsSuppressed>0</VoltageWordsSuppressed>
  <ComputerInterface>0</ComputerInterface>
  <!-- 0 == SBE11plus Firmware Version >= 5.0 -->
  <!-- 1 == SBE11plus Firmware Version < 5.0 -->
  <!-- 2 == SBE 17plus SEARAM -->
  <!-- 3 == None -->
  <DeckUnitVersion>0</DeckUnitVersion>
  <ScansToAverage>1</ScansToAverage>
  <SurfaceParVoltageAdded>1</SurfaceParVoltageAdded>
  <ScanTimeAdded>0</ScanTimeAdded>
  <NmeaPositionDataAdded>1</NmeaPositionDataAdded>
  <NmeaDepthDataAdded>0</NmeaDepthDataAdded>
  <NmeaTimeAdded>0</NmeaTimeAdded>
  <NmeaDeviceConnectedToPC>1</NmeaDeviceConnectedToPC>
  <SensorArray Size="15" >
   <Sensor index="0" SensorID="55" >
    <TemperatureSensor SensorID="55" >
     <SerialNumber>5283</SerialNumber>
     <CalibrationDate>17-Aug-13</CalibrationDate>
     <UseG_J>1</UseG_J>
     <A>0.00000000e+000</A>
     <B>0.00000000e+000</B>
     <C>0.00000000e+000</C>
     <D>0.00000000e+000</D>
     <F0_Old>0.000</F0_Old>
     <G>4.41997009e-003</G>
     <H>6.41471827e-004</H>
     <I>2.23798094e-005</I>
     <J>1.98313578e-006</J>
     <F0>1000.000</F0>
     <Slope>1.00000000</Slope>
     <Offset>0.0000</Offset>
    </TemperatureSensor>
   </Sensor>
   <Sensor index="1" SensorID="3" >
    <ConductivitySensor SensorID="3" >
     <SerialNumber>4058</SerialNumber>
     <CalibrationDate>13-Aug-13</CalibrationDate>
     <UseG_J>1</UseG_J>
     <!-- Cell const and series R are applicable only for wide range sensors. -->
     <SeriesR>0.0000</SeriesR>
     <CellConst>2000.0000</CellConst>
     <ConductivityType>0</ConductivityType>
     <Coefficients equation="0" >
      <A>0.00000000e+000</A>
      <B>0.00000000e+000</B>
      <C>0.00000000e+000</C>
      <D>0.00000000e+000</D>
      <M>0.0</M>
      <CPcor>-9.57000000e-008</CPcor>
```

</Coefficients>
<Coefficients equation="1" >
<G>-1.00377741e+001</G>
<H>1.25100233e+000</H>
<I>-2.97791376e-003</I>
<J>2.70640629e-004</J>
<CPcor>-9.57000000e-008</CPcor>
<CTcor>3.2500e-006</CTcor>
<!-- WBOTC not applicable unless ConductivityType = 1. -->
<WBOTC>0.00000000e+000</WBOTC>
</Coefficients>
<Slope>1.00000000</Slope>
<Offset>0.00000</Offset>
</ConductivitySensor>
</Sensor>
<Sensor index="2" SensorID="45" >
<PressureSensor SensorID="45" >
<SerialNumber>0979</SerialNumber>
<CalibrationDate>09-Apr-10 </CalibrationDate>
<C1>-3.975541e+004</C1>
<C2>-9.561404e-001</C2>
<C3>1.346830e-002</C3>
<D1>3.486900e-002</D1>
<D2>0.000000e+000</D2>
<T1>3.039363e+001</T1>
<T2>-5.910270e-004</T2>
<T3>4.387880e-006</T3>
<T4>3.256450e-009</T4>
<Slope>1.00000000</Slope>
<Offset>0.00000</Offset>
<T5>0.000000e+000</T5>
<AD590M>1.283400e-002</AD590M>
<AD590B>-8.646580e+000</AD590B>
</PressureSensor>
</Sensor>
<Sensor index="3" SensorID="55" >
<TemperatureSensor SensorID="55" >
<SerialNumber>5272</SerialNumber>
<CalibrationDate>13-Aug-13</CalibrationDate>
<UseG_J>1</UseG_J>
<A>0.00000000e+000</A>
<B>0.00000000e+000</B>
<C>0.00000000e+000</C>
<D>0.00000000e+000</D>
<F0_Old>0.000</F0_Old>
<G>4.38819114e-003</G>
<H>6.39529431e-004</H>
<I>2.21409521e-005</I>
<J>1.97260710e-006</J>
<F0>1000.000</F0>
<Slope>1.00000000</Slope>
<Offset>0.0000</Offset>
</TemperatureSensor>
</Sensor>
<Sensor index="4" SensorID="3" >
<ConductivitySensor SensorID="3" >
<SerialNumber>4092</SerialNumber>
<CalibrationDate>13-Aug-13</CalibrationDate>
<UseG_J>1</UseG_J>

```
    <!-- Cell const and series R are applicable only for wide range sensors. -->
    <SeriesR>0.0000</SeriesR>
    <CellConst>2000.0000</CellConst>
    <ConductivityType>0</ConductivityType>
    <Coefficients equation="0" >
      <A>0.00000000e+000</A>
      <B>0.00000000e+000</B>
      <C>0.00000000e+000</C>
      <D>0.00000000e+000</D>
      <M>0.0</M>
      <CPcor>-9.57000000e-008</CPcor>
    </Coefficients>
    <Coefficients equation="1" >
      <G>-1.08152326e+001</G>
      <H>1.56290604e+000</H>
      <I>-1.18917568e-003</I>
      <J>1.51932300e-004</J>
      <CPcor>-9.57000000e-008</CPcor>
      <CTcor>3.2500e-006</CTcor>
      <!-- WBOTC not applicable unless ConductivityType = 1. -->
      <WBOTC>0.00000000e+000</WBOTC>
    </Coefficients>
    <Slope>1.00000000</Slope>
    <Offset>0.00000</Offset>
  </ConductivitySensor>
</Sensor>
<Sensor index="5" SensorID="38" >
  <OxygenSensor SensorID="38" >
    <SerialNumber>1818</SerialNumber>
    <CalibrationDate>20-Dec-12</CalibrationDate>
    <Use2007Equation>1</Use2007Equation>
    <CalibrationCoefficients equation="0" >
      <!-- Coefficients for Owens-Millard equation. -->
      <Boc>0.0000</Boc>
      <Soc>0.0000e+000</Soc>
      <offset>0.0000</offset>
      <Pcor>0.00e+000</Pcor>
      <Tcor>0.0000</Tcor>
      <Tau>0.0</Tau>
    </CalibrationCoefficients>
    <CalibrationCoefficients equation="1" >
      <!-- Coefficients for Sea-Bird equation - SBE calibration in 2007 and later. -->
      <Soc>4.6273e-001</Soc>
      <offset>-0.4867</offset>
      <A>-2.8470e-003</A>
      <B> 1.6307e-004</B>
      <C>-3.2629e-006</C>
      <D0> 2.5826e+000</D0>
      <D1> 1.92634e-004</D1>
      <D2>-4.64803e-002</D2>
      <E> 3.6000e-002</E>
      <Tau20> 1.4100</Tau20>
      <H1>-3.3000e-002</H1>
      <H2> 5.0000e+003</H2>
      <H3> 1.4500e+003</H3>
    </CalibrationCoefficients>
  </OxygenSensor>
</Sensor>
<Sensor index="6" SensorID="27" >
```

<NotInUse SensorID="27" >
<SerialNumber></SerialNumber>
<CalibrationDate></CalibrationDate>
<OutputType>2</OutputType>
<Free>1</Free>
</NotInUse>
</Sensor>
<Sensor index="7" SensorID="20" >
<FluoroWetlabECO_AFL_FL_Sensor SensorID="20" >
<SerialNumber>FLNTURTD-1713</SerialNumber>
<CalibrationDate>14-Apr-10</CalibrationDate>
<ScaleFactor>1.00000000e+001</ScaleFactor>
<!-- Dark output -->
<Vblank>0.0730</Vblank>
</FluoroWetlabECO_AFL_FL_Sensor>
</Sensor>
<Sensor index="8" SensorID="27" >
<NotInUse SensorID="27" >
<SerialNumber></SerialNumber>
<CalibrationDate></CalibrationDate>
<OutputType>2</OutputType>
<Free>1</Free>
</NotInUse>
</Sensor>
<Sensor index="9" SensorID="0" >
<AltimeterSensor SensorID="0" >
<SerialNumber>49563</SerialNumber>
<CalibrationDate>14-Apr-10</CalibrationDate>
<ScaleFactor>15.000</ScaleFactor>
<Offset>0.000</Offset>
</AltimeterSensor>
</Sensor>
<Sensor index="10" SensorID="27" >
<NotInUse SensorID="27" >
<SerialNumber></SerialNumber>
<CalibrationDate></CalibrationDate>
<OutputType>2</OutputType>
<Free>1</Free>
</NotInUse>
</Sensor>
<Sensor index="11" SensorID="27" >
<NotInUse SensorID="27" >
<SerialNumber></SerialNumber>
<CalibrationDate></CalibrationDate>
<OutputType>2</OutputType>
<Free>1</Free>
</NotInUse>
</Sensor>
<Sensor index="12" SensorID="27" >
<NotInUse SensorID="27" >
<SerialNumber></SerialNumber>
<CalibrationDate></CalibrationDate>
<OutputType>2</OutputType>
<Free>1</Free>
</NotInUse>
</Sensor>
<Sensor index="13" SensorID="27" >
<NotInUse SensorID="27" >
<SerialNumber></SerialNumber>

<CalibrationDate></CalibrationDate>
<OutputType>0</OutputType>
<Free>0</Free>
</NotInUse>
</Sensor>
<Sensor index="14" SensorID="51" >
<SPAR_Sensor SensorID="51" >
<SerialNumber>20353</SerialNumber>
<CalibrationDate>14-Apr-10</CalibrationDate>
<ConversionFactor>1732.00000000</ConversionFactor>
<RatioMultiplier>1.00000000</RatioMultiplier>
</SPAR_Sensor>
</Sensor>
</SensorArray>
</Instrument>
</SBE_InstrumentConfiguration>

18.4 APPENDIX 4: Bathysnap release build

3 BUILD SHEET

Type	: OCEANO 2500 S-Universal	Date of Manufacture	: 20/01/2010
S/N	: 1186	Customer	: NOC UK
P/N	: 392 9100	Representative	:
Function	: Acoustic Release	Job file	: 9B000159
Modification	:	Customer Approval	:

TECHNICAL SPECIFICATIONS

ELECTRONIC BOARD				ELECTRONIC SPECIFICATIONS
Reference	**Rev**	**Function**	**S/N**	Transmit width : **10** ms
392 2001	**3.6**	**AR 8x1 board**	**1186**	Transmit level : **191** ± 4 dB ref 1µPa at 1 m
		Firmware:		Pinger rate : **2** s
		PROM (U6) - ET8_V2.2		Pinger duration after release : **3** mn
		FPGA (U38) - REC_V1.0/3.3V		
		PROM (U32) - EM_V1.0		FR0 = **08.5** kHz
		FPGA (U33) - EM_V1.0/3.3V		FR1 = **12.5** kHz
				CAF = **12.0** kHz
				PFR = **12.0** kHz

FUNCTIONAL SPECIFICATIONS

Function / Code	TT301 / TT701 / TT801	Sequence
ARM / RANGING	**0875**	⇒ CAF Lock-out time = 4s Active time = 20s
The following acoustic codes must be preceded by an ARM code		
RELEASE	**0855**	⇒ CAF ⇒ CAF
RELEASE WITH PINGER	**0856**	⇒ CAF ⇒ CAF ⇒ PFR
PINGER ON	**0847**	⇒ CAF ⇒ PFR
PINGER OFF	**0848**	⇒ CAF
DIAGNOSTIC	**0849**	⇒ CAF_1 ⇒ CAF_2

MECHANICAL SPECIFICATIONS

Safe Working Load (SWL) = 2.5 T   Release Load (RL) = 2.5 T   Test Load (TL) = 5.0 T

18.5 APPENDIX 5: Corer deployment log

Station Number ME108/	Coring Site[1]	Date July 2014	Time at seabed UTC	Position at seabed DN DMN DW DMW	Sounding (m)[2]	Corer MgC / BC[3]	Comments
745	PAP Cent.	12	02:02	48° 50.08' N 016° 31.15' W	4850	MgC08+2	6/8+2/2, max. 42cm
746	PAP Cent.	12	06:47	48° 50.06' N 016° 31.15' W	4850	MgC08+2	6/8+1/2, max. 48cm
752	PAP Cent.	13	01:45	48° 50.07' N 016° 31.16' W	4848	MgC08+2	7/8+2/2, max. 44cm
753	PAP Cent.	13	06:54	48° 50.07' N 016° 31.16' W	4849	BC(l)	Good core, c. 20cm
758	PAP Cent.	14	00:00	48° 50.01' N 016° 31.15' W	4850	MgC08+2	7/8+2/2, max. 41cm
773	PAP Cent.	16	03:09	48° 50.05' N 016° 31.16' W	4850	MgC08+2	7/8+2/2, max. 42cm
781	PAP Cent.	17	00:00	48° 50.07' N 016° 31.15' W	4850	BC(l)	Rather disturbed core, c. 20cm
795	B. B.	18	05:13	49° 06.92' N 016° 37.81' W	3903	MgC06+2	1/8+0/2, max. 5cm
805	PAP Cent.	19	05:43	48° 50.07' N 016° 31.18'	4848	MgC08+2	6/8+2/2, max. 41cm

[1] PAP Cent., central coring site, approx. 48 50 N 016 31 W; B. B., “Ben Billett”, very large abyssal hill in north of PAP area; H4-4, abyssal hill in east of PAP area [site established during RRS *James Cook* cruise 062.

[2] Is based on length of cable deployed and prior knowledge of the area (not ship’s recorded sounding that has erroneous sound velocity correction)

[3] MgCxx+y, Bowers & Connelly Megacorer deployed with x large units and y small units; BC, USNEL-type box core; (nl), no penetration limiters fitted; (l) penetration limiter fitted.

				W			
806	PAP Cent.	19	10:22	48° 50.10' N 016° 31.20' W	4848	BC(l)	Fair core, c. 20cm
816	H4-4	20	03:41	49° 04.43' N 016° 15.82' W	4298	BC(nl)	Good core, c. 40cm

19 Station list

			Start				End				
Start	End	Station	Latitude		Longitude		Latitude		Longitude		Equipment
			North		West		North		West		
09/07/2014 09:14	09/07/2014 09:21	742	39	30.92	15	57.51	39	30.91	15	57.52	CTD/rosette water sampler
09/07/2014 10:05	09/07/2014 13:44	743	39	30.92	15	57.52	39	30.92	15	57.52	CTD/rosette water sampler
11/07/2014 17:43	11/07/2014 17:50	744	48	8.25	16	18.85	48	9.00	16	18.77	Expendable CTD
11/07/2014 23:40	12/07/2014 03:50	745	48	50.10	16	31.15	48	50.05	16	31.14	Megacorer
12/07/2014 04:33	12/07/2014 08:40	746	48	50.06	16	31.15	48	50.06	16	31.15	Megacorer
12/07/2014 10:25	12/07/2014 11:52	747	48	59.99	16	30.00	48	60.00	16	30.00	CTD/rosette water sampler
12/07/2014 12:45	12/07/2014 13:07	748	48	60.00	16	30.00	48	59.96	16	30.01	Marine Snow camera
12/07/2014 13:58	12/07/2014 14:09	749	48	59.99	16	29.98	48	59.99	16	29.98	Snowcatcher
12/07/2014 14:28	12/07/2014 14:35	750	48	59.99	16	29.98	48	59.99	16	29.98	Snowcatcher
12/07/2014 20:49	12/07/2014 21:50	751	48	59.99	16	29.98	48	59.99	16	29.98	Marine Snow camera
12/07/2014 23:41	13/07/2014 03:41	752	48	50.07	16	31.16	48	50.07	16	31.16	Megacorer
13/07/2014 04:58	13/07/2014 08:45	753	48	50.07	16	31.16	48	50.07	16	31.16	Box corer
13/07/2014 09:35	13/07/2014 10:15	754	48	50.07	16	31.16	48	49.62	16	30.99	Deploy drifting sediment traps
13/07/2014 13:37	13/07/2014 14:40	755	48	49.43	16	31.19	48	49.20	16	31.45	Marine Snow camera
13/07/2014 15:10	13/07/2014 15:58	756	48	49.41	16	31.17	48	49.25	16	31.33	CTD/rosette water sampler
13/07/2014 22:25	13/07/2014 23:46	757	48	49.40	16	31.16	48	49.40	16	31.16	Marine Snow camera
14/07/2014 00:15	14/07/2014 03:42	758	48	50.06	16	31.13	48	50.00	16	31.15	Megacorer
14/07/2014 04:52	14/07/2014 06:54	759	48	49.94	16	32.00	48	49.94	16	32.00	Marine Snow camera
14/07/2014 10:11	14/07/2014 10:37	760	48	43.59	16	40.77	48	43.36	16	41.02	Recover drifting sediment traps
14/07/2014 11:16	14/07/2014 12:25	761	48	43.28	16	41.04	48	43.22	16	41.12	CTD/rosette water sampler
14/07/2014 12:40	14/07/2014 13:16	762	48	43.24	16	41.08	48	43.18	16	41.25	WP2 Zooplankton net
14/07/2014 13:20	14/07/2014 13:56	763	48	43.18	16	41.25	48	43.06	16	41.46	WP2 Zooplankton net
14/07/2014 14:28	14/07/2014 15:08	764	48	43.05	16	41.48	48	43.00	16	42.00	Marine Snow camera
14/07/2014 17:20	14/07/2014 19:41	765	49	0.25	16	26.47	49	0.38	16	26.42	Recover Bathysnap
14/07/2014 19:59	14/07/2014 20:41	766	49	0.38	16	26.43	49	0.38	16	26.44	CTD/rosette water sampler
14/07/2014 20:56	14/07/2014 22:58	767	49	0.39	16	26.42	49	0.39	16	26.41	Marine Snow camera
15/07/2014 09:18	15/07/2014 16:15	768	49	5.66	16	18.49	49	1.77	16	19.14	Deploy PAP#1 mooring **
15/07/2014 16:46	15/07/2014 17:15	769	49	3.18	16	21.54	49	3.15	16	21.52	CTD/rosette water sampler

15/07/2014 18:04	15/07/2014 19:45	770	49	3.15	16	21.52	49	2.81	16	21.39	Marine Snow camera
15/07/2014 23:42	16/07/2014 00:20	771	48	50.08	16	31.17	48	50.08	16	31.17	WP2 Zooplankton net
16/07/2014 00:25	16/07/2014 01:09	772	48	50.08	16	31.17	48	50.07	16	31.17	WP2 Zooplankton net
16/07/2014 01:27	16/07/2014 04:51	773	48	50.07	16	31.17	48	50.05	16	31.17	Megacorer
16/07/2014 09:01	16/07/2014 09:56	774	49	0.00	16	29.99	49	0.00	16	29.99	CTD/rosette water sampler
16/07/2014 10:48	16/07/2014 12:12	775	49	0.00	16	29.99	48	59.95	16	29.93	Marine Snow camera
16/07/2014 12:31	16/07/2014 13:14	776	48	59.94	16	29.93	48	59.76	16	29.74	Deploy drifting sediment traps
16/07/2014 13:51	16/07/2014 18:08	777	48	59.47	16	26.59	48	57.83	16	27.37	Recover PAP#3 sediment trap mooring
16/07/2014 19:02	16/07/2014 22:42	778	48	58.53	16	27.45	48	57.79	16	26.59	CTD/rosette water sampler
16/07/2014 23:20	17/07/2014 00:02	779	48	57.79	16	26.59	48	57.79	16	26.59	Marine Snow camera
17/07/2014 00:33	17/07/2014 01:13	780	48	57.79	16	26.59	48	57.49	16	26.37	Marine Snow camera
17/07/2014 02:15	17/07/2014 05:47	781	48	50.04	16	31.07	48	50.06	16	31.15	Box corer
17/07/2014 07:31	17/07/2014 08:06	782	49	1.58	16	25.42	49	1.52	16	25.31	Deploy Bathysnap
17/07/2014 09:29	17/07/2014 10:01	783	48	53.31	16	25.36	48	53.11	16	25.37	CTD/rosette water sampler
17/07/2014 10:28	17/07/2014 11:55	784	48	53.01	16	25.38	48	52.49	16	25.57	Marine Snow camera
17/07/2014 12:10	17/07/2014 12:55	785	48	52.48	16	25.57	48	52.13	16	25.63	WP2 Zooplankton net
17/07/2014 12:57	17/07/2014 13:49	786	48	52.11	16	25.64	48	51.92	16	25.53	WP2 Zooplankton net
17/07/2014 14:11	17/07/2014 14:25	787	48	51.84	16	25.51	48	51.72	16	25.32	Snowcatcher
17/07/2014 14:43	17/07/2014 14:55	788	48	51.51	16	25.24	48	51.44	16	25.11	Snowcatcher
17/07/2014 15:13	17/07/2014 15:44	789	48	51.28	16	25.11	48	50.93	16	24.68	CTD/rosette water sampler
17/07/2014 16:01	17/07/2014 16:27	790	48	50.66	16	25.11	48	50.40	16	24.91	Recover drifting sediment traps
17/07/2014 18:43	17/07/2014 19:31	791	49	0.49	16	19.23	49	0.49	16	19.23	Marine Snow camera
17/07/2014 22:50	18/07/2014 00:17	792	48	59.95	16	30.12	49	0.04	16	30.02	Marine Snow camera
18/07/2014 00:23	18/07/2014 01:12	793	49	0.04	16	30.01	49	0.08	16	29.96	WP2 Zooplankton net
18/07/2014 01:15	18/07/2014 01:57	794	49	0.08	16	29.95	49	0.13	16	29.89	WP2 Zooplankton net
18/07/2014 03:42	18/07/2014 06:37	795	49	6.92	16	37.80	49	6.95	16	37.08	Megacorer
18/07/2014 08:21	18/07/2014 11:37	796	48	58.92	16	29.76	48	59.09	16	25.37	Deploy PAP#3 sediment trap mooring
18/07/2014 12:36	18/07/2014 13:00	797	48	58.86	16	18.41	48	58.86	16	18.41	Snowcatcher
18/07/2014 13:02	18/07/2014 17:26	798	48	58.86	16	18.41	48	58.62	16	18.98	Recover PAP#1 mooring
18/07/2014 18:48	18/07/2014 19:11	799	48	58.67	16	16.21	48	58.67	16	16.21	CTD/rosette water sampler
18/07/2014 19:24	18/07/2014 20:01	800	48	58.67	16	16.21	48	58.61	16	16.24	Deploy drifting sediment traps

18/07/2014 20:13	18/07/2014 21:41	801	48	58.30	16	16.52	48	58.28	16	16.52	Marine Snow camera
18/07/2014 23:56	19/07/2014 00:38	802	48	58.23	16	16.49	48	58.23	16	16.49	Marine Snow camera
19/07/2014 00:47	19/07/2014 01:37	803	48	58.23	16	16.49	48	58.22	16	16.50	WP2 Zooplankton net
19/07/2014 01:39	19/07/2014 02:28	804	48	58.22	16	16.50	48	58.20	16	16.50	WP2 Zooplankton net
19/07/2014 03:56	19/07/2014 07:32	805	48	50.07	16	31.18	48	50.07	16	31.18	Megacorer
19/07/2014 08:37	19/07/2014 12:12	806	48	50.07	16	31.18	48	50.09	16	31.16	Box corer
19/07/2014 13:42	19/07/2014 13:52	807	48	52.43	16	17.95	48	52.39	16	18.00	Snowcatcher
19/07/2014 14:09	19/07/2014 14:37	808	48	52.22	16	18.19	48	52.04	16	18.14	CTD/rosette water sampler
19/07/2014 15:02	19/07/2014 16:22	809	48	51.63	16	17.69	48	51.05	16	17.54	Marine Snow camera
19/07/2014 16:30	19/07/2014 16:57	810	48	50.92	16	17.41	48	50.76	16	17.48	CTD/rosette water sampler
19/07/2014 17:18	19/07/2014 18:47	811	48	50.47	16	17.19	48	49.70	16	17.78	Marine Snow camera
19/07/2014 18:54	19/07/2014 19:15	812	48	49.56	16	17.70	48	49.50	16	17.84	CTD/rosette water sampler
19/07/2014 19:29	19/07/2014 19:48	813	48	49.58	16	17.59	48	49.39	16	17.66	Recover drifting sediment traps
19/07/2014 20:21	19/07/2014 21:42	814	48	49.35	16	17.69	48	49.34	16	17.68	Marine Snow camera
19/07/2014 22:17	19/07/2014 23:33	815	48	49.34	16	17.68	48	49.35	16	17.68	Marine Snow camera
20/07/2014 02:07	20/07/2014 05:17	816	49	4.43	16	15.82	49	4.44	16	15.80	Box corer
20/07/2014 11:38	20/07/2014 12:27	817	48	59.99	16	29.83	49	0.01	16	29.85	WP2 Zooplankton net
20/07/2014 12:28	20/07/2014 13:08	818	49	0.00	16	29.85	48	59.95	16	29.82	WP2 Zooplankton net
20/07/2014 13:16	20/07/2014 13:41	819	48	59.95	16	29.83	48	59.90	16	29.59	CTD/rosette water sampler
20/07/2014 13:52	20/07/2014 17:50	820	48	59.92	16	29.75	48	59.44	16	28.13	CTD/rosette water sampler
20/07/2014 18:01	20/07/2014 18:32	821	48	59.43	16	28.11	48	59.51	16	27.85	Deploy drifting sediment traps
20/07/2014 18:56	20/07/2014 20:20	822	48	59.63	16	27.66	48	59.31	16	27.09	Marine Snow camera
20/07/2014 20:39	20/07/2014 21:25	823	48	59.19	16	26.85	48	58.87	16	26.23	CTD/rosette water sampler
20/07/2014 21:59	20/07/2014 23:14	824	48	58.73	16	25.88	48	58.19	16	25.05	Marine Snow camera
21/07/2014 00:05	21/07/2014 01:25	825	48	57.96	16	24.67	48	57.36	16	23.91	Marine Snow camera
21/07/2014 02:13	21/07/2014 03:32	826	48	57.01	16	23.65	48	56.40	16	23.06	Marine Snow camera
21/07/2014 04:02	21/07/2014 05:28	827	48	56.26	16	22.81	48	55.68	16	22.90	Marine Snow camera
21/07/2014 06:01	21/07/2014 07:28	828	48	55.65	16	22.77	48	55.24	16	22.56	Marine Snow camera
21/07/2014 08:15	21/07/2014 08:37	829	48	55.03	16	22.42	48	54.90	16	22.24	Recover drifting sediment traps
21/07/2014 08:45	21/07/2014 09:27	830	48	54.90	16	22.24	48	54.90	16	22.24	CTD/rosette water sampler