National Oceanography Centre, Southampton

Cruise Report No. 49

RRS *James Clark Ross* Cruise 221

26 MAY-05 JUN 2010

PAP observatory development

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2010

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ABSTRACT

This very short cruise was primarily to deploy a novel moored observatory at PAP (NE Atlantic), a long term study site at which a variety of observations have been made over the past 20 years with increasing levels of intensity and sophistication. This new design was in collaboration with the UK Met Office.

In addition to this, a benthic lander was to be deployed which would transmit data by an acoustic link to the surface buoy and hence to land by satellite link. Unfortunately this was lost due to an imploding sphere.

A number of equipment trials were also carried out to good effect. In addition studies were made on the effects of high CO_2 of calcifying phytoplankton. A team of photographers were present to in order to increase public awareness of observational oceanography and numerous interviews were completed. In addition a daily web diary was maintained by the EuroSITES outreach team.

KEYWORDS

ISSUING ORGANISATION

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14	Joanna Gregory	Doctor
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16	Derek Jenkins	Bosun
17	Clifford Mullaney	SG1
18	Paul Backhouse	SG1
19	John O'Duffy	SG1
20	James McIlhatton	SG1
21	Mark Robinshaw	MG1
22	Carl Moore	MG1
23	Keith Walker	Cook
24	Glen Ballard	2nd Cook
25	Keneth Weston	Steward
26	James Newall	Steward
27	Derek Lee	Steward
28	Thomas Patterson	Steward

Itinerary

Sailed Vigo	2230h GMT on 26th May 2010
Arrived PAP site	2130h on 28th May
Departed PAP	1018h on 2nd June
Arrive near Southampton	1600h on 4th June
Arrive Immingham	0942h on 6th June

Objectives

The main objective of this very short cruise was to deploy a novel moored observatory at PAP (NE Atlantic), a long term study site at which a variety of observations have been made over the past 20 years with increasing levels of intensity and sophistication. This new design was in collaboration with the UK Met Office.

In addition to this, a benthic lander was to be deployed which would transmit data by an acoustic link to the surface buoy and hence to land by satellite link.

A number of equipment trials were also carried out to good effect. In addition studies were made on the effects of high CO_2 of calcifying phytoplankton. A team of photographers were present to in order to increase public awareness of observational oceanography and numerous interviews were completed. In addition a daily web diary was maintained by the EuroSITES outreach team.

Narrative

James Clark Ross slipped its moorings in Vigo at 2230h GMT on 26th May 2010 after a number of delays due to ship-side technical problems such as with the stabilising system and one of the engines. However, once on our way, we made excellent progress towards the PAP site stopping once when we reached deep water for a CTD deployment so that some of the experimental work could proceed. The weather was consistently good during the entire cruise and no time was lost due to this. On reaching the PAP area (4840-4850m water depth), we took advantage of the fact that the coring site is on the southern side of the area and we were thus able to make two successful deployments of the "Megacorer" and a shallow CTD for calibration of some of the sensors to be used on the main observatory mooring. "Bathysnap", the benthic time lapse camera system was deployed without problems and the novel wave buoy was used on a number of occasions when other overside activities were taking place such as CTD and megacorer drops and this was an excellent use of ship time. The greatest problems and disappointment of the cruise concerned the BOBO lander and the associated MODOO acoustic telemetry system. This was an entirely new approach designed to transmit data from seabed sensors to the instrument package on the main observatory mooring and from there by satellite to land. This demanded that the two structures were within 800m of each other and the plan was to deploy BOBO and then attempts to deploy the main mooring very close to it. Unfortunately there were significant problems with the acoustic telemetry system which meant that BOBO had to be retrieved after the first deployment for repairs. These were accomplished and it was deployed again. Sometime after triangulating its position, the system stopped transmitting and even the acoustic releases could not be located. By extraordinary coincidence, a device attached to BOBO which was designed to come to the surface 20 hours after landing was spotted by a deck hand right beside the ship. On recovery it was found to have suffered a major trauma and the conclusion drawn was that one or all of the buoyancy spheres on BOB had imploded and destroyed the acoustic release system. Another technical problem was associated with the drifting sediment traps PELAGRA. The buoyancy mechanism for these had just had a major update by the manufacturers and the objective on this cruise was to check that these upgrades had been carried out according to specification and that the traps continued to work as well as they have in the past. Unfortunately the manufacturers have introduced some serious flaws and the traps repeatedly malfunctioned. This is an important discovery as they are needed on a science cruise later in the year by which time, the faults will have been rectified.

The major success of the cruise and its main focus was the deployment of the PAP#1 mooring. This is a very much stronger mooring than has ever been used at the site and is based on the UK Met Office moorings and was constructed in collaboration with them. This involved a very large ODAS buoy at the surface and demanded much larger rope and winch system and even this could not accommodate all 5500m of rope. A flawless deployment was carried out in much shorter time than expected and the data were very soon being transmitted

to NOC and presented on the PAP web site. This has been a major achievement of the cruise and the skill of a wide variety of people in making this happen is greatly appreciated.
Another success story has been incubation experiments to examine the effects of abyssal water with high concentrations of nutrients and carbon dioxide on the growth of various strains of calcifying phytoplankton. Although the data are not yet available, the indications are that this has been highly successful.
We were very fortunate to have a team of five persons from National Geographic who are making a film about oceanography and although some found this an unusual experience, most people soon became comfortable with camera lenses and microphones in close proximity even at times of stress. We are all optimistic that this will enhance the profile of oceanography and improve public understanding of this important topic of research.
Although five days at the PAP site was anticipated, the loss of the BOBO lander and the rapid and successful deployment of the PAP observatory meant that all the work for which we were prepared was achieved in a shorter period and the science program ended on 02/06/2010 at 1018h GMT enabling an earlier arrival in the UK.
Although the cruise ends in Immingham, a boat transfer of most of the scientific party has been arranged off Southampton for 1430h on Friday 4th.

Richard Lampitt

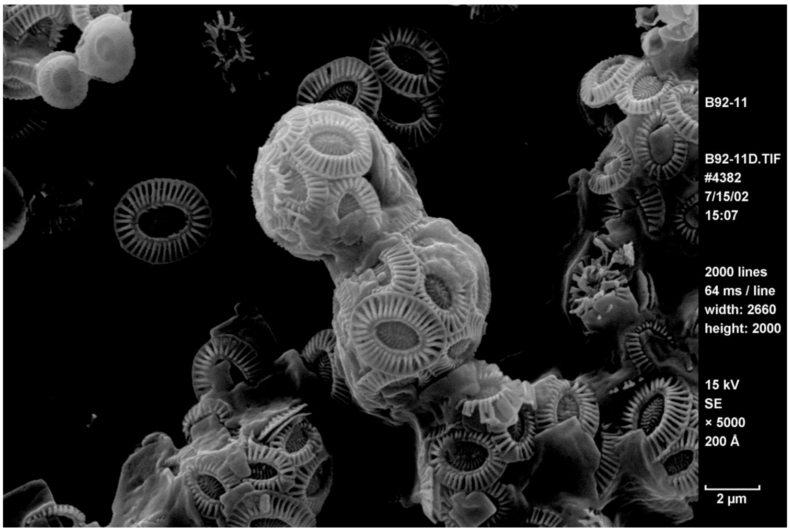
Reports

Adaptation of coccolithophores to deep high-CO2 seawater

Recent concern about the effect of the long term fate of anthropogenic CO_2 on marine calcifiers has prompted biologists to turn our attention to the effect of carbonate chemistry on cell physiology. We conducted two sets of incubation experiments using *in situ* naturally high CO_2 water instead of relying on experimental manipulation of the carbon chemistry. A CTD was used to retrieve water from different depths [chlorophyll maximum depth (typically between 10 and 50 m), 500, 1000, and ~4,700 m], which represent water masses of different carbonate chemistries. For each depth incubation, we used an inoculum of one strain of coccolithophores or the mixed cell community of the chlorophyll maximum (see Table 1). Each depth incubation was conducted in triplicate.

	Incubation 1			**Incubation 2**	
Strain ID	NZEH	88E	Mixed population	NZEH	1212

Water samples were collected in triplicate for dissolved inorganic carbon, total alkalinity, oxygen, and nutrients at each depth. Particulate inorganic carbon and particulate organic carbon will be analysed in Southampton. Samples for scanning electron microscopy were collected at the start of the experiment and at the time of harvesting.



M. Debora Iglesias-Rodriguez, Bethan M. Jones, Sonia Blanco-Ameijeiras, Mario Lebrato.

Zooplankton

2 Vertical profiles of 100-0 m were conducted at the PAP site using the NOCS WP2 Zooplankton net (200 µm mesh).

Sampling protocol

Zooplankton hauls were conducted after dark between 11pm and 1 am for two principle reasons; firstly because zooplankton undergo vertical migration to the surface at night and any vertical profile of the surface 0-200 m at this time would catch the highest abundance of Zooplankton possible; secondly because the darkness minimises the chance of 'net avoidance' by the Zooplankton.

The WP2 net was attached to a winch and the lid for the collecting bucket was secured tightly. The net was then lowered into the water using the winch to a depth of 100m. The net was then hauled to the surface at a rate of 0.2 m/s, catching Zooplankton on its way to the surface. Once on the surface, the net was suspended over the side of the ship and the outside of the net was hosed down with seawater to make sure all captured Zooplankton slid down the inside of the net and entered the collecting bucket. The collecting bucket was then opened into a large white bucket cleaned with seawater. Comments and observations were made on the full catch and then the catch was transferred into 2L glass jars using a plastic funnel. Latex gloves and protective eyewear were worn and 10% formalin was added to preserve the samples. The jars were then gently shaken to distribute the formalin throughout the jar. The jars were labelled appropriately with date, station/series number, depth and mesh size. Samples will be returned to NOCS and analysed for species abundance and diversity.

Richard Lampitt, Thanos Gkritzalis

Phytoplankton Sampling

The Biodiscovery sampling (phytoplankton) was undertaken by Fiona Grant (OSS, Marine Institute). We are partners in the European Seafloor Observatories Network (ESONET) project which aims to develop a number of deep sea observatories at twelve sites on the European margin. Experience gained in technological developments and deployments at the PAP site will provide invaluable knowledge to other European researchers wishing to set up similar seafloor observatories.

The aim of the phytoplankton Biodiscovery research is to investigate the possibility that phytoplankton species in seawater can produce biologically active compounds (bioactives) of significance for use as human medicines.

On June 1st, sea water samples were collected using the CTD and a phytoplankton sampling net. Data from the CTD fluorometer showed that the highest concentrations of phytoplankton were at ~35m below the surface. Seven bottles were fired at this depth.

01/06/2010 17:18	CTD 4	48.99715	-16.3824	CTD on deck
01/06/2010 17:17	CTD 4	48.99718	-16.3824	CTD at the surface
01/06/2010 17:11	CTD 4	48.99713	-16.3824	CTD at depth 100m. Commenced recovery
01/06/2010 17:05	CTD 4	48.99715	-16.3824	CTD deployed
01/06/2010 17:03	CTD 4	48.99714	-16.3824	CTD off the deck
01/06/2010 16:56		48.99716	-16.3824	Gantry unlashed

After this, we deployed the phytoplankton net and towed it vertically through the water column from a depth of 50m.

01/06/2010 17:32	Phytoplankton Net 1	48.99717	-16.3824	Phytoplankton net recovered
01/06/2010 17:26	Phytoplankton Net 1	48.99714	-16.3824	Phytoplankton net deployed

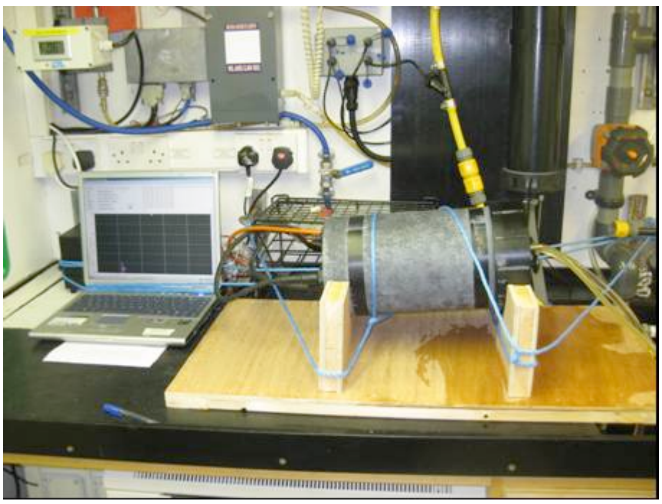
The samples were then filtered using a 200μm and 20μm mesh to isolate the phytoplankton. These underwent serial dilution and 1ml of F2 media were added to each centrifuge tube before placing the samples in a light controlled incubator at 14°C. The samples will undergo further analysis in the Biodiscovery laboratory in the Marine Institute.

Fiona Grant

CO2 analysis and assessment

Ocean plays an important role in global carbon cycle and the North Atlantic Ocean is reported as one of the strongest CO_2 sinks. Our main goal for this cruise is to install a CO_2 sensor (ProOceanus PSI CO2-Pro^{TM}, refer to ProCO2) and a sensor for total gas tension (ProOceanus GTD, refer to ProGTD) on the mooring frame. The data are transmitted to NOC by satellite and presented on the PAP web site, and the sampling frequency can be adjusted remotely. The continuous monitoring of seawater pCO_2 allows us to assess the air-sea CO_2 flux and examine surface CO_2 variability in this area. Benefited from the multidisciplinary parameters measured by other sensors on the mooring frame (such as nutrient, Chl-a, PAR et al.), we can study the seasonal variability and its controlling mechanism, and inter-annual variability could also be examined by comparing to the historical data.

ProCO2 sensors on the mooring frame



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Underway seawater pCO_2 measurement by ProCO2 sensor

During this cruise, we use the ProCO2 sensors measured the underway pCO_2 and try to compare the results with the onboard PML system using a traditional equilibrator. But the PML gave abnormal readings in seawater pCO_2 possible because of block in the gas line, and the atmospheric pCO_2 results of PML were accurate. Although we can not do the inter-comparison between ProCO2 and PML system for seawater pCO_2, air-sea CO_2 flux could be estimated from different in pCO_2 (air CO_2 measured by PML system and seawater pCO_2 data from ProCO2 sensor) and wind speed. The CO_2 flux calculated from empirical equation can be compared to the flux directly measured by Margaret Yelland by eddy correlation
DIC/TA samples were collected from CTD casts during the cruise to get the knowledge of the vertical distribution of the carbonate system. Underway DIC/TA samples were also collected, and pCO_2 calculated from DIC and TA could be a quality control to the CO_2 sensor. When the ship stayed at PAP site, the diurnal variability of the carbonate system was examined by our time-series observation: seawater pCO_2 was continuously monitored and DIC/TA discrete samples were collected every 4 hours.

Zongpei Jiang

Coring

Our goal for JR221 was the continuation of the time-series at the Porcupine Abyssal Plain site by observing long-term changes in deep-sea communities in the Northeast Atlantic Ocean. The deep-sea floor is linked intimately to ocean surface processes and rapid, large-scale changes can occur in deep-sea ecosystems. For example, it has been suggested that the North Atlantic Oscillation affects the quantity and quality of carbon exported to the deep sea at the PAP site, which is reflected in changes in abundances observed in all components of the benthic community including meio, macro, and megafauna.

On this cruise, undisturbed sediment samples were obtained using a Megacorer. Samples were collected for macrofauna, metazoan meiofauna, and Foraminifera from five deployments (see Table 1). For each deployment, the corer was fitted with eight core tubes of 100 mm internal diameter by 600 mm long (Table 2). The objective was to collect a minimum of three cores for metazoan meiofauna and Foraminifera obtaining one core per deployment. For macrofauna one full sample consists of eight cores from one or two deployments.

Station ID	**Deployment date**	**Start time**	**End time**	**Depth (m)**	**Start lat/long ($^oN/^oW$)**	**End lat/long ($^oN/^oW$)**
22104	28/05/2010	23:31	04:38	4891 m	48^o82558, 16o50791	48^o82557, 16^o50789
22105	29/05/2010	05:31	09:40	4866 m	48^o82560, 16o50789	48^o82560, 16^o50792
22119	31/05/2010	06:05	10:07	4833 m	48^o82581, 16^o50757	48^o82582, 16^o50761
22120	31/05/2010	10:33	14:28	4811 m	48^o82581, 16^o50765	48^o82577, 16^o50762
22134	02/06/2010	02:20	06:29	4813 m	48^o82687, 16^o50848	48^o82596, 16^o50776

Table 1: Megacore deployments on JR221.

Station ID	# of cores deployed	# of cores recovered	Core IDs	Core description (vertical span)	Comments
22104	8	4	1xF1, 1xMeio1, 3xMacro1	F1: 33 cm, Meio1: 40 cm, Macro1: 42, 41, and 40 cm	Significant bioturbation; no surface detritus
22105	8	5	1xF2, 1xMeio2, 3xMacro1	F2: 42 cm, Meio2: 41 cm, Macro1: 41, 41, and 42 cm	Significant bioturbation; no surface detritus
22119	8	0	-	-	-
22120	8	4	1xF3, 1xMeio3	F3: 40cm, Meio3: 39cm	Significant bioturbation; no surface detritus
22134	8	3	1xF4, Meio4	F4: 44 cm, Meio4: 39 cm	Significant bioturbation; phytodetritus on the surface of both cores

Table 2: Station IDs and the number of core tubes deployed and processed after each recovery. F1-F4= Foraminifera samples 1-4; Meio1-4= Metazoan meiofauna samples 1-4; Macro1 = Macrofauna samples. Vertical span refers to the height of the sediment in each core tube.

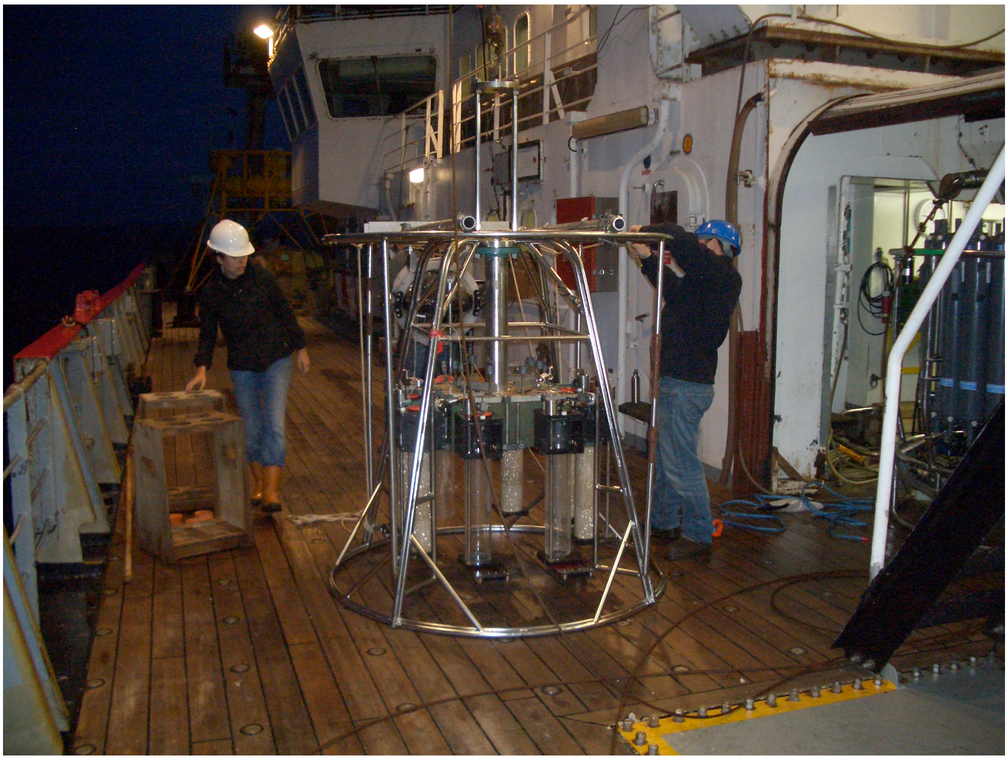
After each recovery, cores were selected for Foraminifera, metazoan meiofauna, and macrofauna based on an undisturbed sediment surface and a minimum sediment height between 10 and 20 cm. Sediment cores selected for Foraminifera and metazoan meiofauna were sectioned down to 5.0 cm in 0.5 cm and 1.0 cm intervals (Table 3). Prior to slicing the bottom-water top sediment was siphoned off and preserved. All sediment was fixed in 10% buffered Formalin.

Macrofauna cores were also sectioned down to 5 cm in 1 and 2 cm intervals (Table 3). Prior to fixation, macrofauna samples were split using sieves with mesh sizes 500 µm and 300 µm. Each size group was consequently fixed in 10% buffered formalin.

Core ID	Vertical span (cm)	Segment depth (cm)
Foraminifera + Metazoan meiofauna	BWTS	
	0.0-0.5	0.5
	0.5-1.0	0.5
	1.0-1.5	0.5
	1.5-2.0	0.5
	2.0-3.0	1.0
	3.0-4.0	1.0
	4.0-5.0	1.0
	5.0-6.0	1.0
	6.0-7.0	1.0
	7.0-8.0	1.0
	8.0-9.0	1.0
	9.0-10.0	1.0
Macrofauna	0.0-1.0	1.0
	1.0-3.0	2.0
	3.0-5.0	2.0

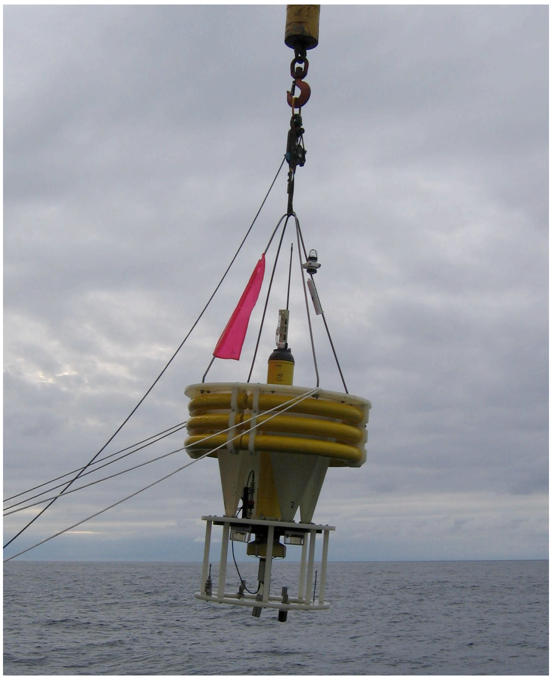
Table 3: Core sections for each faunal group sampled during JR221. BWTS = Bottom-water top sediment.

Overall, five deployments yielded four cores for both Foraminifera and metazoan meiofauna each (F1-4, Meio1-4). In addition, one samples set for macrofauna was collected consisting of six cores and combined from two deployments (Macro1). In the laboratory at the National Oceanography Centre, Southampton, sediment samples will be stained and analyzed using light microscopy to assess abundance and diversity of Foraminifera, metazoan meiofauna, and macrofauna at the Porcupine Abyssal Plain.



Nina Rothe, Hanna Schuster

PELAGRA - neutrally buoyant sediment traps



The APEX profiling floats used as control vehicles for the PELAGRA neutrally buoyant sediment traps have recently undergone major upgrades. JR221 has provided the first opportunity to trial the traps in their new configuration.

The APEX upgrades consisted of:

- Addition of GPS positioning
- Addition of Iridium satellite telemetry
- Firmware modification to enable acquisition of a sigma-theta value once the programmed park depth has been obtained.
- Firmware modification to enable automatic activation of 'recovery mode' should the trap surface before the scheduled end-of-mission time.

Additionally, new grille panels designed to cover the funnel mouths and prevent ingress of larger organisms (e.g. jellyfish) were available. These were fitted to funnels 1 and 3 of all deployed traps in order to provide a comparison of collected sediment mass compared with the uncovered funnels.

Telemetry trial, 29 May 2010

P6 was deployed in recovery mode with no sensors or ballast weights fitted to maximise buoyancy. The ship stood off for approximately one hour whilst telemetry of GPS positions was verified. GPS fixes were obtained at 10 minute intervals as expected.

Trial deployment PAP1, 29 May 2010

P5 and P7 were set up for identical 36 hour missions:

Target depth:	250m
Sink time:	93 minutes
Down time:	36 hours
Stabilisation period:	18 hours

However, in order to test the new automatic 'recovery mode' feature, the timer on P7 was deliberately set to close the pots and release the end-of-mission weight after 30 hours.

Both traps initially descended as planned (P5 390m and P7 382m; deeper than intended) and unexpectedly returned to the surface after approximately 7 hours. It was later discovered that a standard feature of the new APEX floats is that they will carry out a CTD profile shortly after end of sink time. This is undesirable for our application and will be taken up with the float manufacturers for rectification. No communication was received from either float at this time so recover mode was not activated.

30 hours after deployment, GPS fixes began to arrive from P7 which indicated that the float had surfaced and activated 'recovery mode' as expected. Nothing was heard from P5 until the scheduled end-of-mission time, also as expected.

On recovery both depressor weights and both end-of-mission weights were absent and the over-depth abort weights were present, as expected.

Inspection of the data post-recovery has revealed that after surfacing for the initial profile ascent, P7 descended to 422m and recovered to the intended 250m target depth. However, the sample pots were opened approximately 3 hours before reaching 250m. P5 remained on (or just under) the surface for the remainder of the mission time.

It is evident that P7 managed to get a GPS fix after the initial profile but did not successfully communicate with the NOCS server, however the GPS fix was enough to activate the next mission sequence and it descended to continue the mission. P5 however was unable to make any satellite contact and so remained on the surface attempting to communicate until the scheduled mission end time.

Both traps were successfully located and recovered within a period of 45 minutes.

P7 appeared to collect suitable samples and these were retained for future analysis. At first glance the pots under the grille panels appeared to contain less sediment than the other two but this is to be confirmed.

Trial deployment PAP2, 31 May 2010

All four traps were deployed as follows:

P4 and P7

Target depth:	350m
Sink time:	182 and 176 minutes respectively
Down time:	36 hours
Stabilisation period:	18 hours

P5 and P6

Target depth:	250m
Sink time:	85 and 93 minutes respectively
Down time:	36 hours
Stabilisation period:	18 hours

Due to the initial descent of both P5 and P7 on deployment PAP1 being deeper than intended a decision was made to reduce ballast by 100g for the next deployments. It was also felt that the reduced ballast (i.e. increased buoyancy) would enable the floats to ride higher at the surface and improve telemetry success.

The four traps descended as follows:

P4: 206m
P5: 208m
P6: 199m
P7: 242m

These were all shallower than intended suggesting the 100g ballast adjustment was too great; a 50g adjustment should be applied for future deployments.

At this point it was thought that the previous deployments had not activated 'recovery mode' after the initial profile because the mission algorithm did not allow this at this time in the schedule. However on surfacing after the initial profile all four traps established communication with the NOCS server and activated recovery mode. It is now clear that had communication been established for deployment PAP1 then these traps too would have activated recovery mode.

All four traps were successfully located and recovered within an hour of each other.

Table 1 Deployment summary (all times GMT)

Trap ID	Target depth (m)	Deployment time	Deployment position	Recovery time	Recovery position
PAP1 P5	250	29.05.10 22:33	49.003ºN 16.455ºW	31.05.10 16:12	48.831ºN 16.211ºW
PAP1 P7	250	29.05.10 22:50	49.003ºN 16.455ºW	31.05.10 16:58	48.843ºN 16.319ºW
PAP2 P7	350	31.05.10 21:36	48.996ºN 16.396ºW	01.06.10 07:53	48.945ºN 16.328ºW
PAP2 P4	350	31.05.10 22:09	48.996ºN 16.396ºW	01.06.10 06:58	48.957ºN 16.302ºW
PAP2 P5	250	31.05.10 22:32	48.997ºN 16.397ºW	01.06.10 07:23	48.950ºN 16.307ºW
PAP3 P6	250	31.05.10 23:03	48.997ºN 16.397ºW	01.06.10 07:10	48.957ºN 16.307ºW

Figure 1 Deployment, recovery and surface drift overview

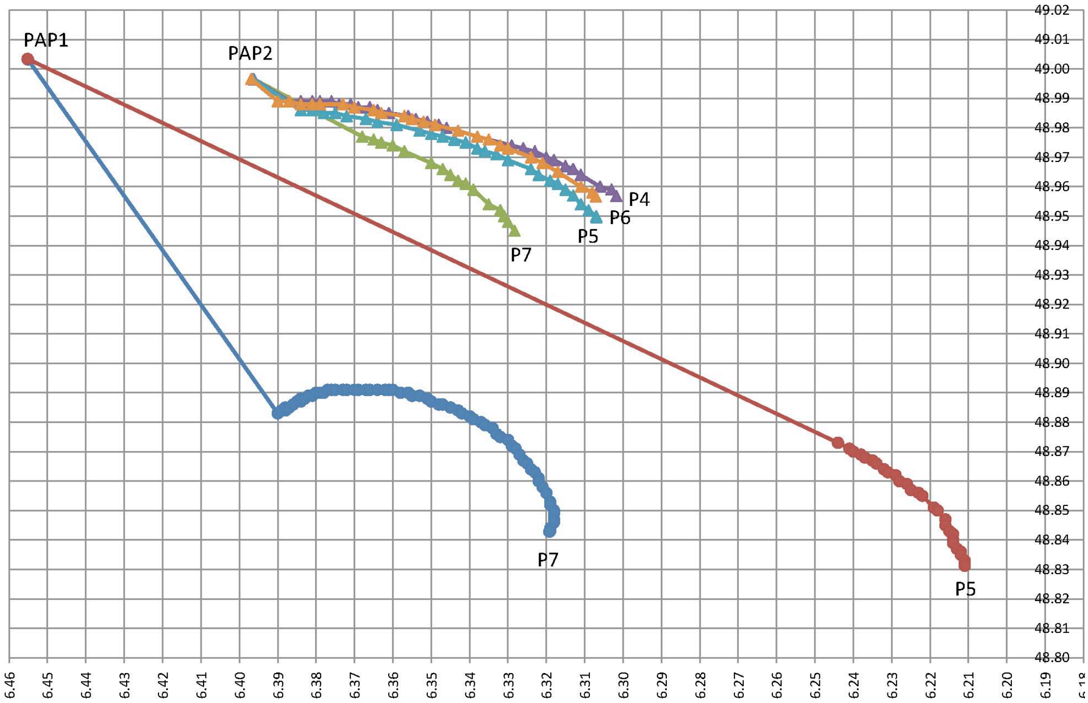
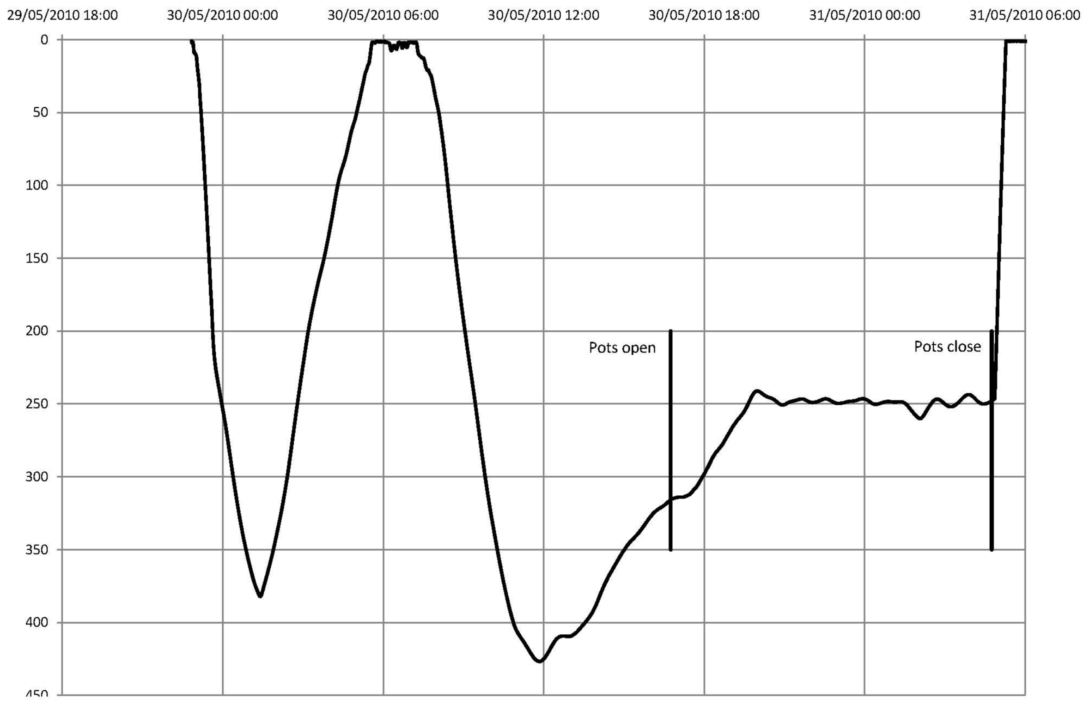


Figure 2 PAP1 P7 deployment



Kevin Saw, Sam Ward

Waves, Aerosol and Gas Exchange Study "WAGES".

"WAGES" is a £1.1M NERC standard grant project which involves a number of staff at NOC and Leeds University. The project aims to improve our understanding of the air-sea fluxes of CO_2, sea-spray aerosol, sensible heat, latent heat and momentum. To achieve this it is necessary to obtain direct measurements of the fluxes themselves, along with the various physical parameters which drive the fluxes such as: the mean air-sea differences in CO_2 concentration (for the CO_2 flux), temperature (sensible heat flux) and humidity (latent heat flux); wind speed (all fluxes); sea state and whitecap fraction (CO_2 and aerosol fluxes in particular). To obtain a sufficiently large data set the fluxes and underlying parameters will be measured continuously using instrumentation deployed on the *RRS James Clark Ross* from May 2010 to at least September 2012. In addition to the continuous measurements WAGES will also involve 5 or 6 intensive observation periods (IoPs) during which WAGES staff will sail on the *JCR* in order to deploy a novel spar buoy to obtain wave breaking information and an aerial camera system to obtain whitecap coverage over a wide area. The IoPs will be piggy-backed on cruises which involve significant on-station work and will include up to about 5 days dedicated ship time for WAGES activity: these cruises have the designator JR254A, JR254B etc.

Prior to the PAP cruise JR221 the autonomous air-sea flux system "AutoFlux" (Yelland et al., 2009) was installed on *JCR* during the port call in Vigo from Sunday 23th May to Wednesday 26th May 2010. The ship sailed around midnight on the night of the 26/27th. Details of the AutoFlux sensors and systems as deployed on *JCR* can be found in the WAGES JR254A cruise report (Yelland and Pascal, 2010). During the refit of the *JCR* later in the summer of 2010 a wave radar system will be installed on the bridge top and a whitecap camera will be installed in the bridge.

During the cruise a new 4 m spar buoy was deployed on a number of occasions (Table below). This spar buoy is a small version of the 11m buoy deployed during two previous UK-SOLAS cruises on the *RRS Discovery* (Pascal et al., 2010). It was the first time that the 4 m buoy had been tested and it was very pleasing to see that the buoy systems worked well, and the behaviour of the buoy was good, i.e. it followed the long-period waves well and did not oscillate rapidly about the vertical. The ship's staff were happy with the method of deploying and recovering the buoy from the port side Effer crane and with the behaviour of the buoy during its deployment on a buoyant tether (approximately 50 to 100m long).

Mean wave parameters were calculated from the buoy wave spectra, obtained by adding the tilt-corrected heave spectra to the surface elevation spectra derived from the wave wires. The table below shows the mean significant wave height (Hs) and zero-upcrossing period (Tz) for each deployment., along with the mean wind speed and direction ranges.

jday	Dep. N^o	logger start	in water	out water	duration (minutes)	Hs (m)	Tz (s)	wind speed	wind direction
147	Test	22:42:54	22:51	22:59	8				
149	1	05:59:22	06:20	10:20	240	2.1	3.9	8 - 4	270
149	2	16:45:28	17:00	19:00	120	2.0	5.9	6 - 8	240
150	3	14:58:08	15:00	20:00	300	2.3	5.6	11 - 8	280
151	4	11:45:29	12:05	14:05	120	2.4	6.5	8 - 6	240 - 270
151	5	18:35:26	18:37	20:45	128	2.2	6.2	7	260 - 240
152	6	16:19:13	16:20	19:00	160	2.9	8.4	5	160

Summary of spar buoy deployments. Times are GMT. Jday is day of year, with noon on 1st January being jday 1.5. The 10 minute averaged true wind speed (m/s) and wind direction (degrees from) ranges are shown.

In addition to the buoy, a kite system was trialed as a platform for the aerial camera system. This was a single string "NightHawk" kite provided by colleagues at Leeds, along with a waterproof digital camera (Pentax Optio W80). During the first two days of the cruise while the ship was on passage the winds were very light, and the forecast was for those conditions to continue. The kite needs a minimum wind speed of 10 knots (maximum 50 knots) in order to fly so it was decided to try it out while the ship was steaming at about 12 knots. The kite was launched from the aft most part of the port side so that if it failed it would land in the water rather than on deck since the deck was full of equipment waiting to be deployed at the PAP site. Unfortunately the turbulence generated aft of the ship made it impossible to fly the kite: when it landed in the water the eyelet was torn from the body of the kite which was subsequently lost (the camera was not attached for the test flight). A kite-making competition was declared but the only entrant was also unsuccessful. Lessons learned were:

a) only deploy a kite when the ship is on station since it will then survive landing in the water.
b) when the wind is on the bow, deploying from the fore deck would be preferable to the aft deck.
c) if possible, get the ship to turn off the wind during launch and recovery.
d) try different platforms such as a more steerable kite (as used by kite surfers) or a balloon.

Acknowledgments.

WAGES is funded by NERC standard grants (NE/G003696/1 and NE/G00353X/1) and by Oceans 2025 and is a follow on project from various NERC UK-SOLAS projects (NE/F007442/1, NE/C001826/1, NE/C001869/1, NE/C001834/1, NE/G000115/1, NE/G000123/1). We are grateful to BAS for providing technical and logistical support to the project and to Captain Graham Chapman and his crew for their help and enthusiasm. Doug Willis' (BAS ICT) help was invaluable in integrating the ship's data streams into the AutoFlux logging system. Underway mean pCO_2 data is provided by the CASIX system (Nick Hardman-Mountford, PML) which is supported by BAS AME and the ship's Deck Engineer (Simon Wright).

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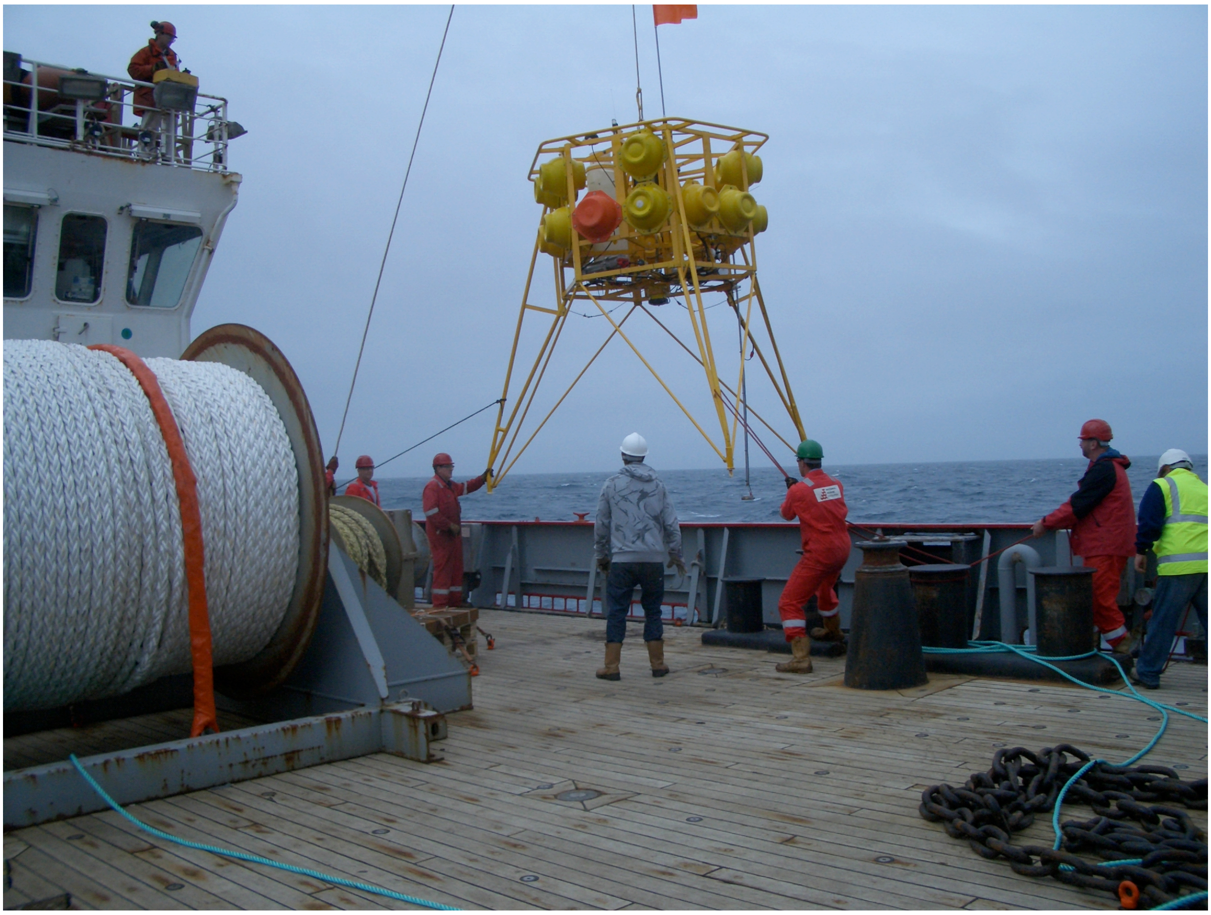
Yelland M.J., R. W. Pascal, P. K. Taylor, and B. I. Moat, 2009: AutoFlux: an autonomous system for the direct measurement of the air-sea fluxes of CO2, heat and momentum. *Journal of Operational Oceanography,* 2, (1), 15-23.

Margaret J. Yelland and Robin W. Pascal

BOBO lander



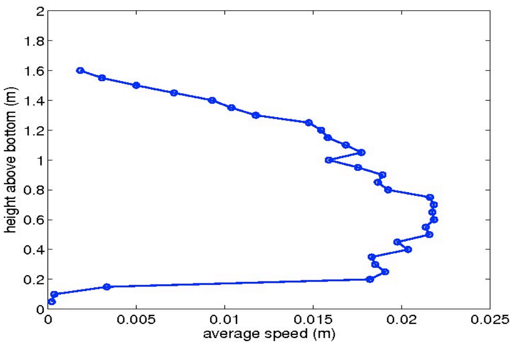
The BOBO benthic lander of NIOZ (van Weering et al., 2000) was used as a platform for deploying an instrument package on the seabed at the PAP site, with acoustic link to the moored ODAS buoy at the surface for relaying the collected data. The lander consists of a 4-m high aluminium tripod frame with Benthos floatation spheres fixed on its upper part and three 100-kg iron anchor weights attached to the legs, held by two Benthos acoustic releases. An Argos beacon and flashlight were mounted on top of the lander for locating it upon recovery. Some instruments, specified below, were connected to a data logger / acoustic modem combination. The modem connects to a second modem mounted on the biogeochemical instrument frame of the PAP mooring form which the data is transferred to the surface buoy and send via satellite telemetry to NOC,S.

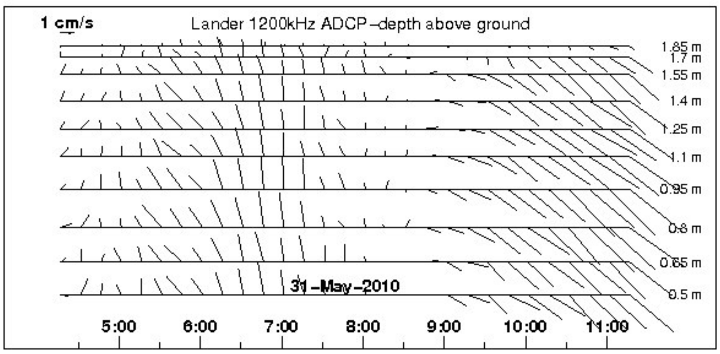
Instrument	Measured parameter	Connected to underwater modem
RDI 1200 kHz ADCP	Current velocity, Intensity, temperature	yes
Seabird CT sensor	Temperature, conductivity	yes
Wetlabs fluorometer	Turbidity, Chlorophyll	yes
PPS4/3 Sediment trap	Downward particle flux	no
Seabird pressure sensor	Bottom Pressure, temperature	yes
Oceanlab hydrophone	Underwater sound	no
Seismometer	Seismic waves	no
Dropcamera	Seabed imagery	no

The lander was deployed 2 times: a first time in free-fall mode on 30 May 2010 at 01:58 UTC, at position 48°59.780'N 016°23.730'W and in 4850 m water depth. Ranging of the acoustic releases at regular intervals showed that the lander descended at a constant rate of about 50 m per minute, and arrival of the lander on the sea bottom was confirmed at 03:34 UTC. By acoustic ranging from three different positions 5 km away from the deployment site, the position of the lander at the sea bottom was determined to be 48°59.668'N 016°23.553'W, 298 m SE of the deployment site. With the upper acoustic modem attached to the gravity corer and lowered over the side of the ship to 30 m depth, two-way acoustic communication could be successfully established during descent of the lander and until 15 minutes after arrival on the sea bottom. After that time, communication failed, as it turned out later due to power failure of the lower transducer. In order to repair the defect, the lander was released at 11:25 UTC and recovered on deck at 13:18 UTC.

The lander was deployed a second time in free-fall mode on 01 June 2010 at 01:02 UTC, at position 48°59.790’N 016°23.720’W and in 4850 m water depth. This time it descended at a slower rate of 30 m per minute, suggesting that either one of the anchor weights had fallen off immediately after deployment, or that the anchors, which were from a different batch than the previous set, were of a different weight. Arrival on the sea bottom was confirmed at 03:58 UTC, and acoustic ranging yielded a landing position of 48°59.403’N 016°23.388’W, 821 m SE of the deployment site. Despite all efforts to make the acoustic modem work again, no signal was received this time. But worse, 14.5 hours after deployment, when the lander was ranged again to re-confirm its position, no reply was received whatsoever from the acoustic releases. Assuming that the lander might have lost a second or possibly all its weights and was floating away from the landing site, repeated attempts were made during the rest of the afternoon and until the next morning to range it from different positions nearby and further off the deployment site, but to no result. By chance the National Geographic “dropcam” which had been mounted on top of the lander to record the deployment and landing at the sea bottom was spotted at the surface at 48°59.32’N 016°18.77’W, more than 6 km E from the deployment site while the ship nearly ran over it.

No signal had been received from the BOBO lander Argos beacon to indicate where and when it had surfaced, and neither did the flashlight function. Upon recovery on board ship, the glass sphere housing the camera appeared to be full with glass chips that had come off the periphery of both halves, and electronics showed extensive damage. Of special note is that the pressure sensor mounted on the outside of the sphere was completely destroyed. The nature of damage to the camera seems to indicate that it was impacted by a violent pressure wave resulting from implosion of one or more of the glass floats or electronics spheres on the lander. Very likely the acoustic releases, modem and other instruments have been damaged on the same event, explaining why no reply was received from the lander.





Although the fate of the lander component of the MODOO installation is unknown and therefore the mooring component was not installed a number of important achievements can be reported from this cruise. Namely the synchronous recording of data from very different instruments on to one platform with a common time could be demonstrated. In addition from the 1st deployment it became clear that the modems were able to “hear” each other even about 5nm horizontal distance and 5km above from the nominal lander position away. The hope is that the lander could be recovered with a different gear at a later time to learn more on what happened with it and to recover the data records.

Some example data from the first deployment is shown in the figures based on the data downloaded from the BOBO lander ADCP. The tidal cycle can be clearly identified in the data as well as the bottom currents shear, influenced by the bottom as well as by lander main body.

Figure: (left) average current speed profile, (right) time series of currents at selected depth above sea floor.

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Sensors Report

Task: Preparation of instruments to be deployed on the PAP mooring sensor frame

Attached files:

- ZPS JR221 setup deployment (txt. File)
- CTD discrete sample log JR221-3.docx
- NOCS PAP mooring deployment.doc

Activity 1: Setting up the sensors in ships lab

Two instruments were set up on the ships lab. The Satlantic ISUS nitrate sensor (s/nr: 60) and the NAS 3x nutrient analyser (s/nr 2675).

The ISUS was recalibrated (using MQ water; file mydocuments\thanos\jr221\calibration files\DIVE 10 on the Ergo Mercury 3 laptop. The calibration file created is the ISUS060M.cal file in the same folder). After calibration the following nitrate standard solutions were measured: 1 uM, 5 uM, 10 uM. Manual samples from the standards are kept frozen and will be analysed on the Autoanalyser in NOCS. The behaviour of the ISUS after calibration was satisfactory. The

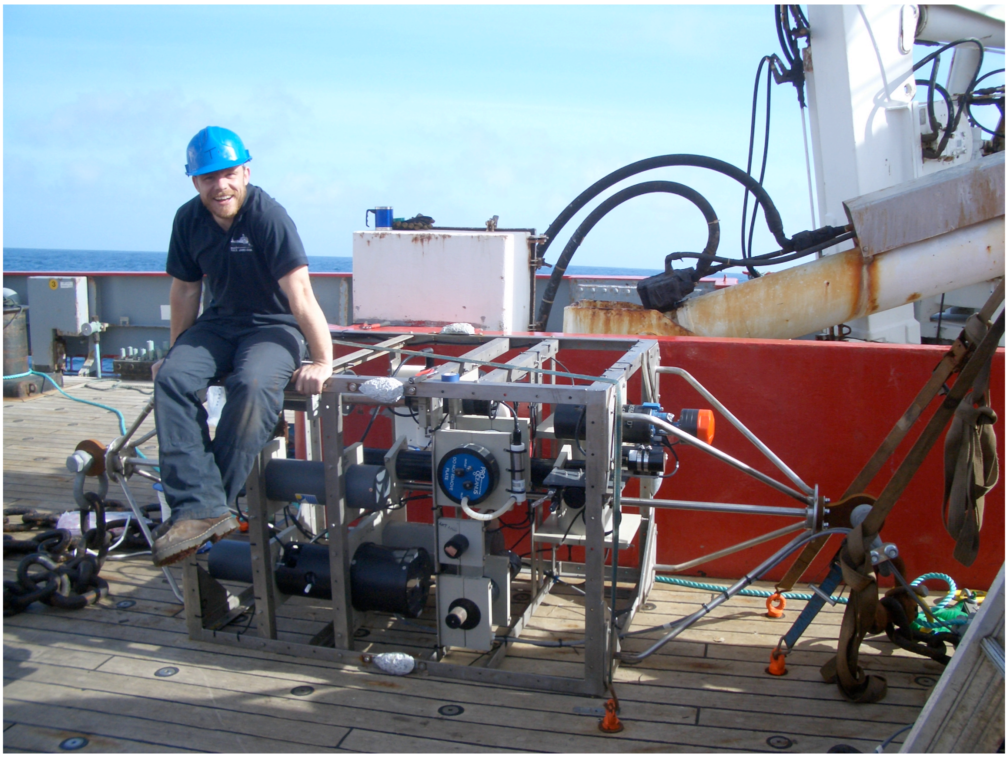
data from this exercise are stored in the same folder (DIVE11). This exercise finished on the 24/05/2010. After that the instrument was ready for deployment (calibration cast on the CTD and deployment on the PAP mooring).
The NAS 3x analyser (s/nr: 2675) was set up in the lab to check the granular cadmium column efficiency and the linearity. The efficiency of the column is calculated by analysing a nitrite (NO_2) standard that has the same concentration as the nitrate (NO_3) standard. Five measurements of each standard were made and the efficiency of the column was above 98%. After that the linearity of the photometer was tested by analysing a series of standards (1-5-10-15 uM). The same standards will be analysed in NOCS Autoanalyser. The exercise finished on the 26/05/2010. On the 28/05/10, new reagents and standards were prepared that will be the ones to be deployed. All reagents and standards were placed in new blood bags. Samples of the standards (OBS) were taken from the blood bag and will be analysed on the NOCS Autoanalyser. After that the NAS 3x was secured in the ships lab and is ready to be programmed and deployed. The script to be used is the MACRO_PAPODAS_JR221.ndp, with sampling intervals as follows:
00:00 Standard; 04:00 – 08:00 – 12:00 – 16:00 – 20:00 sample
The NAS will be programmed just before the deployment, when the NAS is powered by the NAS battery on the frame.

Activity 2: Sensors calibration CTD cast

The following sensors were deployed on a CTD rosette so that they can be compared against the CTD instruments and manually collected samples. The CTD cast took place on 28/05/2010 at 21:10. The PAP sensors that were mounted on the CTD were:

- ISUS 60 with battery pack setup for continuous sampling with 1 Hz frequency,
- Seaguard 217 with 5s sampling frequency,
- Wetlabs FLNTUSB 238 fluorometer (1 Hz continuous sampling).
- Seabird 6905 and 6901 at 10s sampling interval

The rosette was deployed to 250 m. Niskin bottles were fired on the upcast. Details of the CTD cast are on the attached CTD log sheet. Manual samples for DIC, Nutrients, Chlorophyll and Salinity were collected from all depths. Nutrient and chlorophyll samples were collected from all Niskin bottles. Samples were stored on the -20^{o}C freezer and will be analysed in NOCS. CTD data were processed using the associated seabird data processing software. Data from the sensors were downloaded immediately after the CTD cast and secured. Data comparison and analysis between the CTD data, manual samples and sensor data will be performed in NOCS.



Activity 3: Sensor preparation for mooring deployment;

Mooring deployment was planned for 01/06/2010 08:00. The sensors were prepared as followed:

- ISUS 60. The ISUS clock was synchronised with the ships clock (GMT). The operation of the ISUS was switched from continuous to schedule with operational frequency every 1hr (real GMT hour not 1 after the sensor was powered up). All previous data were cleared from the sensor. The sensor was mounted on the sensor frame, and connected with its battery and the HUB unit.
- NAS 3x. The NAS 3x was mounted on the sensor frame. The NAS clock was synchronised with the ships clock (GMT). After it was connected with its battery it was programmed to operate using the following script:
    - MACRO_PAPODAS_JR221.ndp, with sampling intervals as follows:
    - 00:00 Standard; 04:00 – 08:00 – 12:00 – 16:00 – 20:00 sample

  All previous data were cleared from the instruments memory

- Wetlabs 238 FLNTUSB: All previous data were cleared from the memory. The clock was synchronised with the ships clock and the sampling interval was set to 00:59:52, with 8 sampling points/operation.
- Seaguard 217: The clock was synchronised with the ships clock. Data were erased from the memory card. All sensors were activated. Speed of sound for the DCS was set to 1500 m/s. The ping counts

were set to 600. The sampling interval was set to 15min. This gave a battery life expectancy of 250 days. Serial communication was activated to allow communication with the data HUB. The Cyclops fluorometer was placed on the Zebratech wiper holding position. New batteries (Duracell alkaline) were installed on the Zebra tech wiper and the cleaning frequency was set to 4hr.

- ProOceanus CO2 analyser and Gas tension Device (GTD): The CO2 sensor and Gas Tension Device were installed on the frame. Their operation is controlled by the HUB unit (Jon Campbell and Zongpei Jiang are deciding of the sampling rate). Zongpei Jiang has calibrated the instrument before deployment. During the first days of the cruise the CO2 sensor was compared against the PML underway CO2 system that is installed on the ship (more on Zongpie Jiang's report).
- Radiometers: One radiometer is installed on the surface buoy (crow's nest) measuring the air's light intensity. The other two radiometers are installed on the sensor frame facing upwards and downwards measuring irradiance and radiance intensity. Their sampling frequency is controlled by Jon Campbell through the data HUB.
- Seabird Microcat (s/n 6905): All previous data were erased from the sensors memory. Clock was synchronised with the ships one and the sampling interval was set to 15min. The sensor is connected to the surface buoy via an inductive link.
- Southampton Continuous Autonomous Water Sampler (SCAWS – NOCS Osmosampler): The SCAWS was placed on the sensor frame and is expected to sample continuously during deployment. It is equipped with a 360m 1mm ID PTFE sampling tube filled with degassed MQ water. The samples that will be collected will be analysed for dissolved inorganic nutrients using a customised analysis protocol that will facilitate the small sample volumes that will be generated. The flow rate – sample segmentation will be deduced from the temperature record obtained by the Seabird Microcat. The inlet is connected to a 0.22 uM in line filter (aquarium type). The outlet is connected to a 400m, 1mm ID PTFE tube that is filled with 36% formalin. This is connected to the MacLane ZPS and is expected to replenish the ZPS's storage compartment with formalin and maintain preservation conditions for the zooplankton collected samples. It was evident before deployment that "fresh" formalin was injected into the ZPS's sample storage compartment. This application will be fully assessed after recovery.
- McLane Zooplankton Sampler: The ZPS was equipped with a new battery pack. New 9V D cell battery was installed as well. The clock was synchronised with the ships clock. The belt was aligned before deployment. The sampler can collect 50 samples. It was decided to operate the sampler every three days at 00:30h. During the deployment period there are three days when the sampler will collect 4 samples (00:30, 06:00, 12:00 and 18:00) and 2 days that samples will be collected at 00:30 and 12:00h. The samplers schedule was recorded while the sampler was programmed. The sample storage compartment was filled up to ¾ with a 7% formalin solution (buffered with borax). As the sensor frame was positioned horizontally before deployment, for H&S reasons the sample storage compartment was filled up to ¾ with a 7% formalin solution and as mentioned above a continuous flow of 36% formalin is provided by the SCAWS. The sensor frame was immersed vertically with the

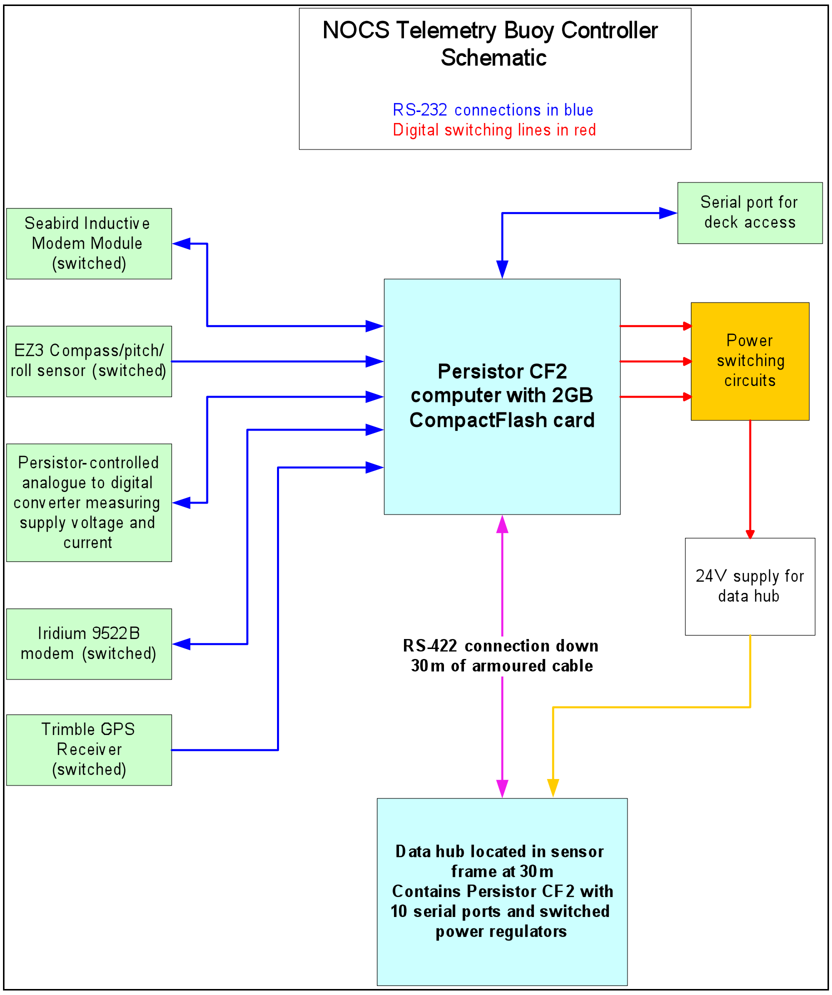
ships crane and when released (while all underwater) it was flipped (upside down) in the water. It's expected that before it was released the sample storage compartment was filled completely with water and when flipped upside down new water could not replace the existing one because of density differences.

The mooring was deployed on 01/06/2010 at 10:15 and the sensor frame was immersed at 11:00. The operation was flawless and after a few hours all sensors were communicating via the iridium telemetry system. Unfortunately after a few hours the ISUS battery voltage dropped below the recommended value and communication with the ISUS was lost.

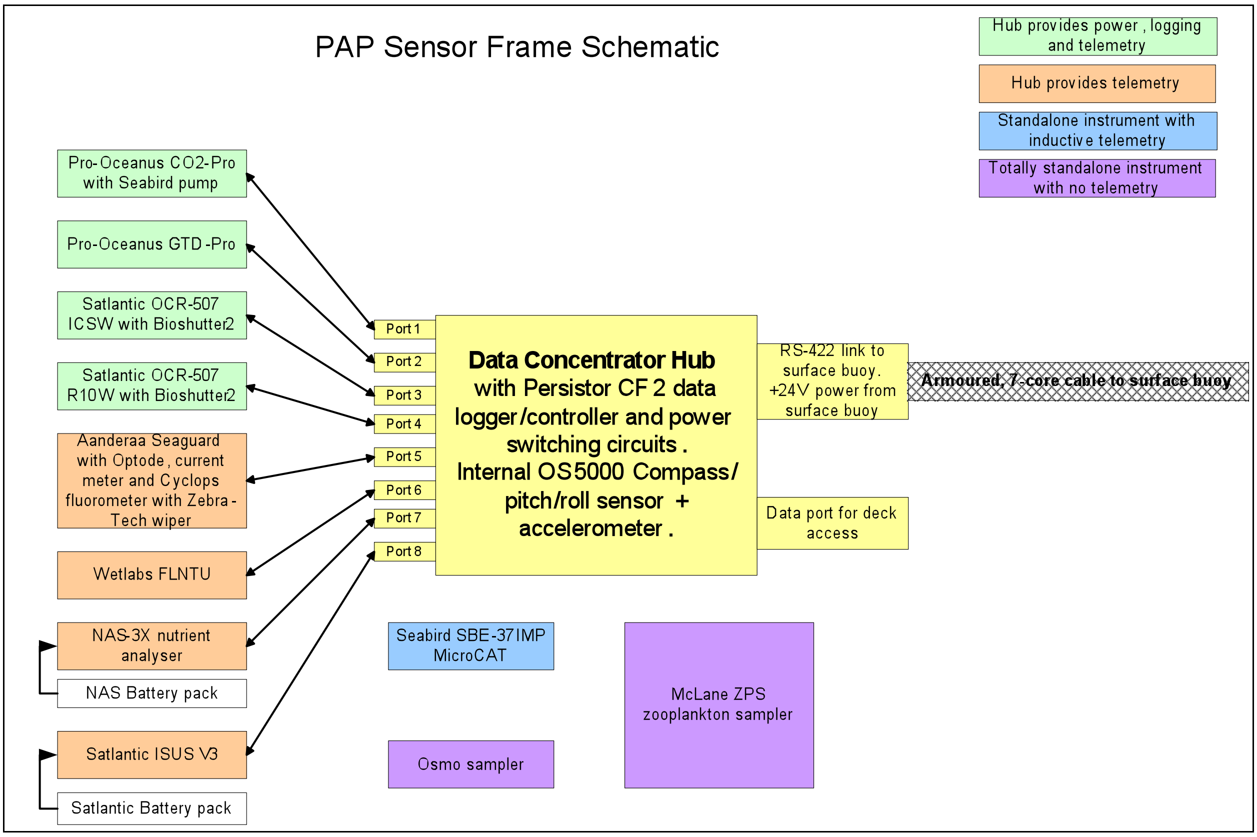
Thanos Gkritzalis

Iridium Telemetry System

The schematic below describes the NOCS telemetry unit that was mounted on top of the Met Office buoy for this deployment. This unit was originally developed for the RAPID programme but was extensively rebuilt before this deployment.



The buoy controller transfers science data in binary format using Iridium satellite dial-up messages which are typically sent every few hours. The Iridium Short Burst Data (SBD) email system is used to send short status messages, and to send command messages from NOCS to the buoy. Commands can also be sent (via the buoy controller) to the Data Concentrator Hub located in the sensor frame. This permits remote control of the sensors shown in green in the schematic below.



Jon Campbell

Mooring technology

Diary of events

23rd and 24th May
Mobilisation of ship undertaken.

2 of the 1000m lengths of polypropylene and the nylon pennant were wound on to the winch; this is all that would fit. Rope diameter is actually around 60mm instead of 48mm. the ropes were supplied coiled on pallets, this meant that we had to suspend the pallets from the crane and rotate them whilst winding on to the winch, from the outside of the coil in.
The pennant was supplied in such a way that we would have to wind from the middle of the coil out; this would not work with the crane method so it was decided that we would flake the pennant along the key wall and then wind on with the rope going through a block on the crane suspended very high.
The remaining two 1000m lengths of polypropylene were coiled on deck in a figure of eight configuration around three cages clamped to the deck. These were to be wound on to the winch during deployment when we will have the mooring stopped off on deck.
We assembled the frame, flaked the chain out and attached the power and comms. cables using the bulldog grips with double nuts.
The swivels were attached to the bottom of the sensor frame and the bottom of the subsurface buoy, an additional length of chain was attached to the top of the subsurface to assist stopping off and connecting in line.
The ODAS buoy was assembled and the instrumentation fitted and connected, emails containing the data files were received confirming that all was working well. The NAV light was left disconnected and was to be connected shortly before deployment.

25th May 2010
Mobilisation complete, all equipment secured ready for sea, sailing delayed due to problems with the stabilisers.

26th May
The problems with the ship's stabilisers were resolved and the ship sailed at midnight.

27th
We bench tested the two releases, both worked fine so we shackled them to the CTD frame along with the release from the bathy snap.

SN 1139, ARM 0827 REL 0855. AR861.
SN 1134, ARM 0822 REL 0855. AR861.
SN 332, ON A282, REL1 A281 + A224. RT 661.
REL 2 A281 + A286, DIAGNOSTICS A281 + A285.

The CTD was deployed at around 11:00, but was recovered shortly afterwards due to winch problems.
The Seabird CTD's had their batteries installed and were tested with the modem, ID's were assigned.

We started assembling some of the instruments and associated equipment in to the sensor frame. It is advisable to clamp the ZPS control unit in to the frame BEFORE the strengthening bar is assembled, it can be done retrospectively but it is more than a little awkward.

28th May

The problems with the CTD winch were resolved so a deployment was undertaken to conduct a wire test of releases.

We received no response from any of the releases despite numerous attempts. All equipment that could create noise from the ship were turned off, still no response.

Further investigation revealed that the connector on the transducer cable had loose wires. These were repaired.

Another CTD deployment was carried out with the releases on. All of the releases gave excellent ranges and all confirmed that they had released. Upon recovery it was confirmed that all had released.

29th May

It has been decided that the Dutch Lander, Bobo will be deployed today, followed by the PAP1 mooring in the morning. So we started readying deck for the mooring deployment in the morning.

During the afternoon we assembled and deployed the Bathy-snap.

Problems with the Lander communications have been ongoing, namely the acoustic modem. This was eventually fixed and the Lander deployed in the early hours.

30th

The acoustic modem on the Lander had worked on deck and whilst on the way down to the sea floor but subsequently stopped communication when at working depth.

The mooring deployment was then cancelled and the Lander recovered.

Investigation in to the modem failure is now underway.

Mooring deployment scheduled for the morning.

Over the past few days we have been designing and building a kite to carry a camera and take photos of the waves. The test flight was carried out today. Due to erratic winds, flight was impossible and the test terminated.

31st May

The day has been spent investigating the Lander modem failure.

Mega cores were under taken as well as wave buoy deployments and CTD’s.

1st June

The Dutch Bobo Lander was deployed; it was acoustically followed to the seabed and it was noted that the descent rate was somewhat slower than previous deployments; possibly one of the weights may have come off. The Lander was then triangulated. We conducted some further Pelagra deployments.

Upon arriving at the deployed Bobo site communication was attempted with the releases but with no luck. Several attempts were made both with the releases and the modem but the Lander could not be found.

We decided not to fit the modem in to the sensor frame as there was no chance of it communicating with the Lander.

The mooring was then readied for deployment.

Deployment table

TIME	LAT N	LON W	COMMENTS
08:47	48’ 59.12	16’ 17.17	Vessel all stopped on DP ready for mooring deployment.
10:09	48’ 59.12	16’ 17.17	Commenced deployment of PAP mooring.
10:10	48’ 59.12	16’ 17.17	ODAS buoy in the water.
10:13	48’ 59.12	16’ 17.17	ODAS buoy released.
10:18	48’ 59.12	16’ 17.17	Cage in water and released.
10:22	48’ 59. 12	16’ 17.18	Commenced paying out of the pendant.
10:34	48’ 59.21	16’ 17.89	Vessel speed increased to 1 knot.
11:00	48’ 59.21	16’ 17.91	Reduced speed for subsurface buoy.
11:17	48’ 59.22	16’ 18.01	Subsurface float in water and released.
12:11	48’ 59.40	16’ 19.48	Stopping rope of to transfer weight.
12:13	48’ 59.40	16’ 19.51	Rope stopped off and load transferred to auxiliary winch whilst remaining rope was wound on to winch.
13:47	48’ 59.53	16’ 20.56	Completed winding rope on to winch. Transferred load to mooring rope.
13:48	48’ 59.53	16’ 20 56	Commenced paying out mooring rope.
14:42	48’ 59.70	16’ 22.01	Load transferred to deck stop. Chain and sinker attached to mooring.
15:08	48’ 59.76	16’ 22.49	Preparing to hang sinker over stern.
15:19	48’ 59.78	16’ 22.63	Sinker over stern.
15:22	48’ 59.79	16’ 22.67	Load transferred to deployment line ready for sinker deployment.
15:33	48’ 59.83	16’ 22.91	Sinker released. Heading 280 (T), COG 288 (T), SOG 1 knot. Buoy SOG 0.8 knot. Buoy BRG 108 (T) X 2.9 NM.

The mooring release was acoustically followed through the water column giving a decent rate of 80m/min.

The mooring release was then triangulated giving a final position of 48’ 59.592N 16’ 22.168W.

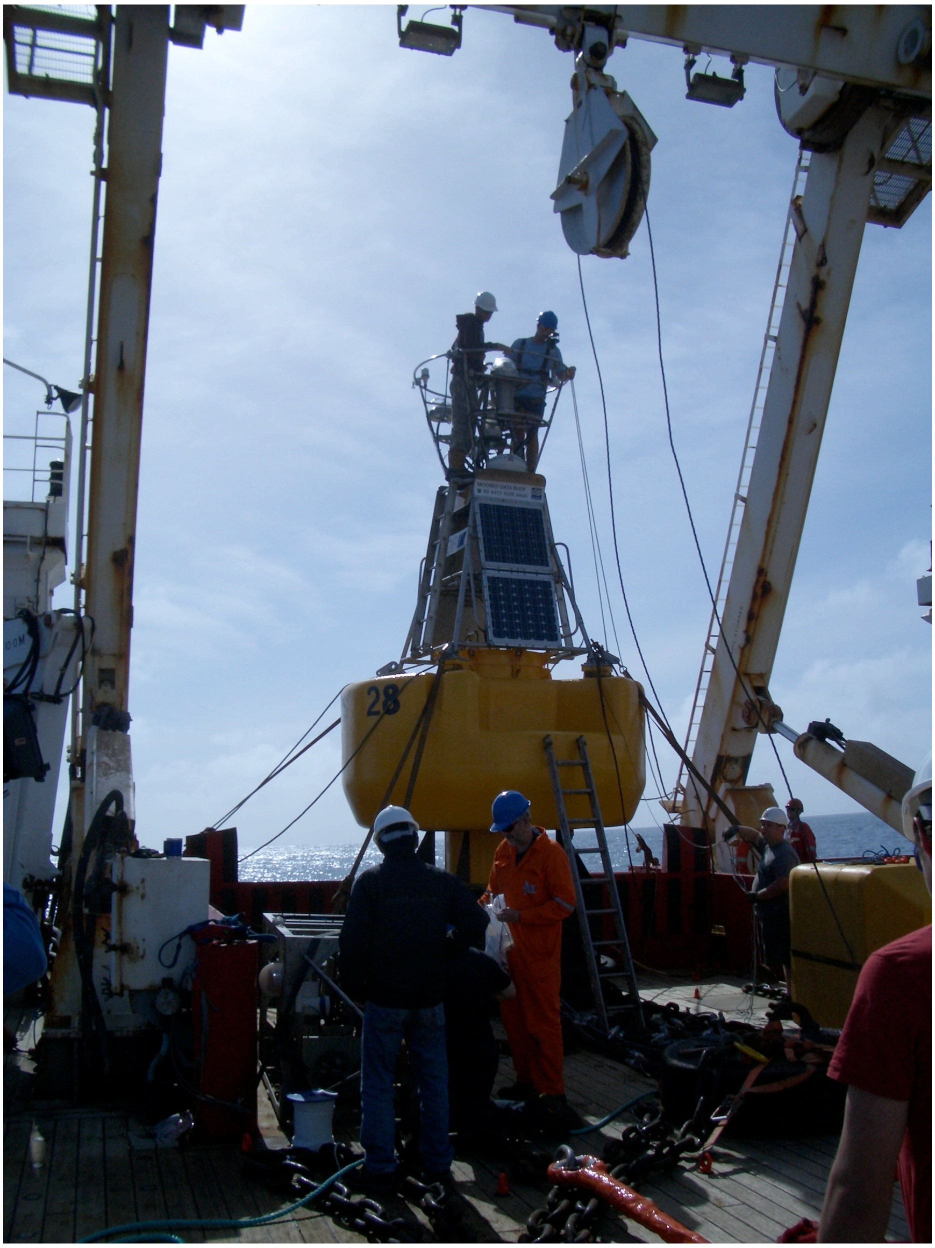
This gave the mooring fallback at 984m from anchor drop position.

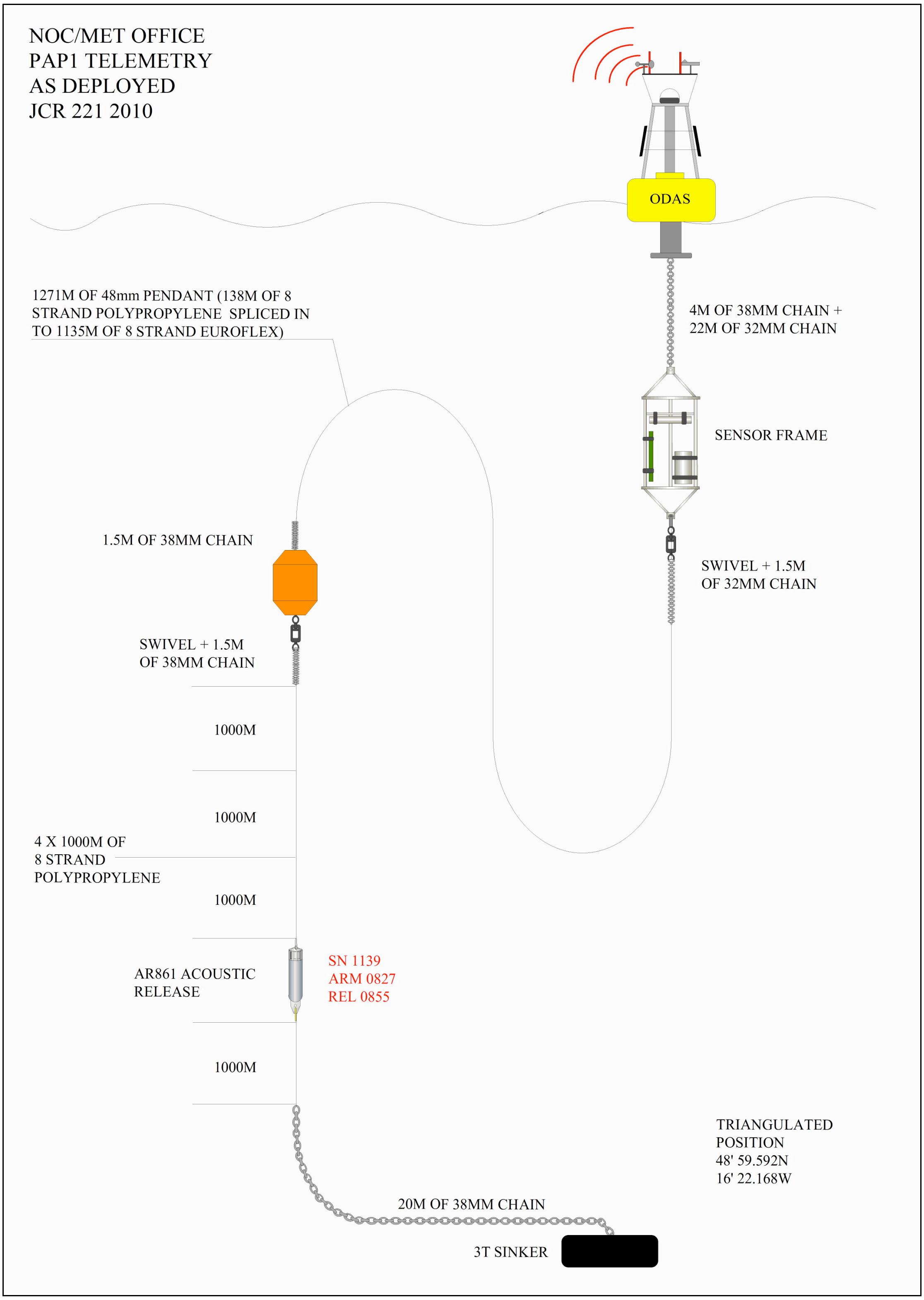
The ODAS buoy position when the sinker was deployed was 48’ 58.9683N

16’ 18.6467W.

After anchor release on freefall to the seabed, the ODAS buoy was recorded at travelling at a maximum speed of 2.5 knots through the water by the ships RADAR.

The MODOO BOBO Lander has been declared lost as no communication can be established and there have been no Argos alerts.





Mooring diagram

Instrumentation

SENSOR	SN	DEPTH M	SAMPLE INTERVAL	CTD TEST	COMMENTS
Seaguard	217	30	15 min.	04	Equipped with Optode 4330 (SN 125). Cyclops Fluorometer SN2100989.
Zebratech Wiper	146	30	4 hours		Used as wiper for Cyclops Fluorometer.
ISUS	60	30	1 hour	04	Sampling rate during deployment is 1 Hz.
NAS 3x	2675	30	4 hours		Sampling scheme: 00:00 – Std analysis; 04:00-08:00-12:00-16:00-20:00 Sample analysis.
SBE 37 IMP	6905	30	15 min.	04	
Wetlabs Flntusb	238	30	1 hour	04	Sampling rate during operation is 1 Hz.
Radiometer (buoy)	Ocr-507-201	0	4 hours		Sampling rate 1Hz. Can be changed remotely.
Radiometer (frame)	Ocr-507-095	30	4 hours		Sampling rate 1 Hz. Can be changed remotely.
Radiometer (frame)	Ocr-507-200	30	4 hours		Sampling rate 1 Hz. Can be changed remotely.
Mclane ZPS	12430-01	30	3 days		Sampling interval is variable during deployment period.
Pro Oceanus CO2	29-097-45	30	4 hours		Sampling rate can be changed remotely.
Pro Oceanus GTD	29-099-15	30	4 hours		Sampling rate can be changed remotely.
Osmosample		30	1 day		Water samples analyzed after recovery.

Deployment method statement

The ODAS buoy was deployed buoy first, anchor last.

Prior to deployment, two of the 1000m polypropylene rope sections were wound onto the BAS Net Drum Winch using a suitable pennant rope of sufficient length. On top of this we wound the 1271m of spliced nylon and polypropylene rope.
The remaining two sections of polypropylene were coiled on deck in a figure of eight configuration around three cages.

The mooring was deployed without the use of a block; instead the mooring was deployed by paying out the winch directly over the stern roller.

The system used for stopping off was the ships mooring line and winch, diverted round a sheave to the aft deck.

All but three of the shackles in the system are of the forelock types, which were fastened by placing the pin in and securing the cotter bar by bending the lugs back on themselves. No heat was applied during this process, or to the shackle, as it is intended to recover the mooring in twelve months time.

Prior to deployment the top of the ODAS buoy was secured in the TR10 release hook. The sensor frame was secured to a smaller release hook attached to the STBD crane and the 24m of chain was secured to the deck with ropes in such a fashion that the chain could be released in a controlled manner. We also placed a line through the chain just above the sensor frame so that when the buoy and chain were deployed there would be no snatch loads on the frame.

The ODAS buoy was then lowered in to the water using the TR10 release hook attached to the trawl wire leading through a block on the “A” frame. As the “A” frame was operated it lifted the buoy up and out, clear of the stern and subsequently in to the water where the release hook was operated.

Whilst this was happening, sections of the chain were released until all of the chain was out and the load was on the rope through the chain near the sensor frame, this rope was then slipped at the same time as the crane lifted the sensor frame up and in to the water where the release hook was operated.

The pendant rope was deployed going straight over the stern roller from the winch. At the end of the polypropylene section, we stopped off using a deck winch to take the load. The subsurface buoy was then shackled in line; the load transferred back to the mooring and then deployed using the release hook on a wire through the “A” frame.

The two sections of 1000m polypropylene were then deployed using the same method as before. Once we had reached the end the mooring was stopped off on deck. We then began winding on the remaining two sections of 1000m polypropylene on to the winch.
Once this was completed we transferred the load back on to the mooring and continued paying out to the join. The mooring was again stopped off and the acoustic release was shackled in line. The load was again transferred to the mooring and the final section of the mooring rope was deployed.

We then stopped off in order to shackle in the ground chain and sinker. The load was transferred to the deck winch with the release hook in place above the sinker. The chain was secured on deck at several points and was released in stages to avoid shock loadings.
The deck winch was then paid out until the sinker was in the water, the release hook was then operated and the sinker deployed.

The transducer for communicating with the release was deployed and the ranges received confirmed that the mooring was travelling at around 80 m/min.

The release was the triangulated using three way points to establish the exact position of the mooring.

Recommendations/observations

The rope being supplied coiled on pallets presented some problems. In future it is advised that we design and build a turntable that can be either suspended on a crane or deck mounted. Another option may be to make five of these and send them to the rope supplier so that they can be returned with the rope wound on.

The BAS net winch requires a hydraulic supply of 40 bar, 2133 l/min. Neither of the NMF managed vessels can supply this; their hydraulic supplies are up to 30l/min.
One solution may be to hire/buy a HPU to run on NMF vessels.
It is also worth highlighting that the mooring ropes do not fit on to the winch in one go. So when the recovery cruise takes place we will need to stop off the mooring on deck and then wind off all of the ropes, probably on deck, before continuing with the remainder of the mooring. This will then have to happen in reverse for the deployment. We will also need to carry spare ropes, so deck space is going to be an issue.
Alternatively we will need to find another solution to the mooring recovery/deployment. Such as a winch that can handle the mooring lengths.
Either way I think that there are going to be some purchases that will be essential.

A larger TR10 release hook is also recommended.

Build Sheet

TYPE	:	**OCEANO 2500 S-UNIVERSAL**			Date of Manufacture
	:	**26/10/2009**			
S/N	:	**1139**	Customer	:	**NOC**
P/N	:	**392 9100**	Representative	:	
Function	:	**Acoustic Release**	Job file	:	**9B000111**
Modification	:		Customer approval	:	

TECHNICAL SPECIFICATIONS

ELECTRONIC BOARD				ELECTRONIC SPECIFICATIONS
Reference	**Rev**	**Function**	**S/N**	Transmit width : **10** ms
				Transmit level : **191** ± 4 dB ref 1µPa at 1 m
392 2001	**3.6**	AR 8x1 Board	**1139**	Pinger rate : **5** s
		Firmware:		Pinger duration after release : **3** mn
		PROM (U6) - ET8_V2.2		
		FPGA (U38) - REC_V1.0/3.3V		FR0 = **08.5** kHz
		PROM (U32) - EM_V1.0		FR1 = **12.5** kHz
		FPGA (U33) - EM_V1.0/3.3V		CAF = **12.0** kHz
				PFR = **12.0** kHz

FUNCTIONAL SPECIFICATIONS

Function / Code	**TT801/ TT701/ TT301**	**TT201**	**Sequence**
ARM/RANGING	**0827**	**N.A.**	⇒ CAF Lock-Out time = 4s Active time = 20s
The following acoustic codes must be preceded by an ARM code			
RELEASE	**0855**	**N.A.**	⇒ CAF ⇒ CAF
RELEASE WITH PINGER	**0856**	**N.A.**	⇒ CAF ⇒ CAF ⇒ PFR
PINGER ON	**0847**	**N.A.**	⇒ CAF ⇒ PFR
PINGER OFF	**0848**	**N.A.**	⇒ CAF
DIAGNOSTIC	**0849**	**N.A.**	⇒ CAF_1 ⇒ CAF_2

N.A. : Not applicable

Rob Mclachlan, Paul Provost, Dave Childs

Acknowledgements

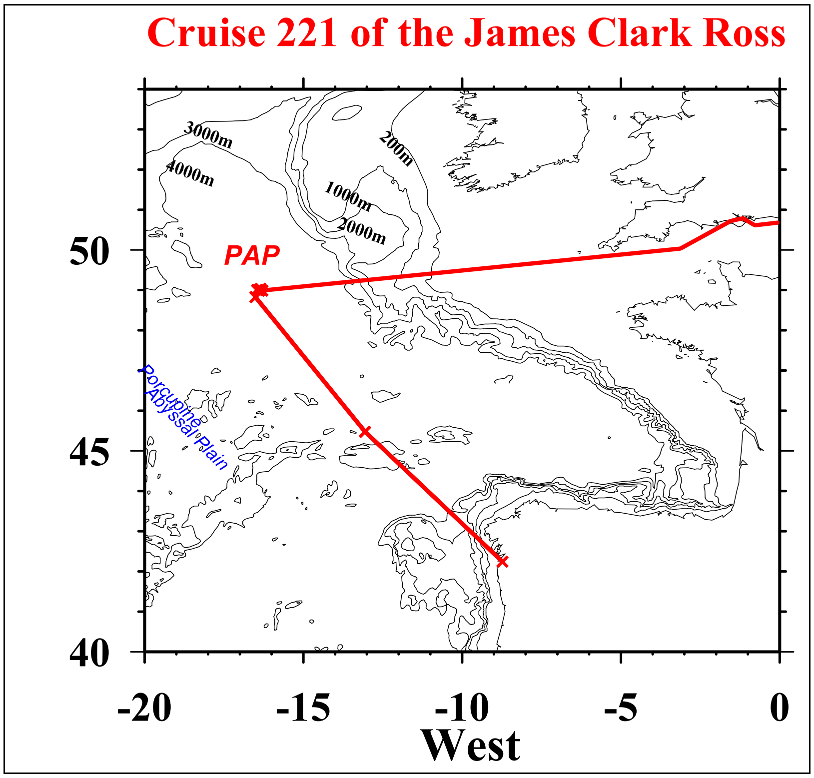
The PSO would like to acknowledge the tremendous support given by the ship side during this cruise. These thanks are warmly extended to all components including the deck hands, engineers, bridge officers and the galley staff. The “can-do” attitude by all of these is an example from which we can all learn and I look forward to further collaboration in the future.

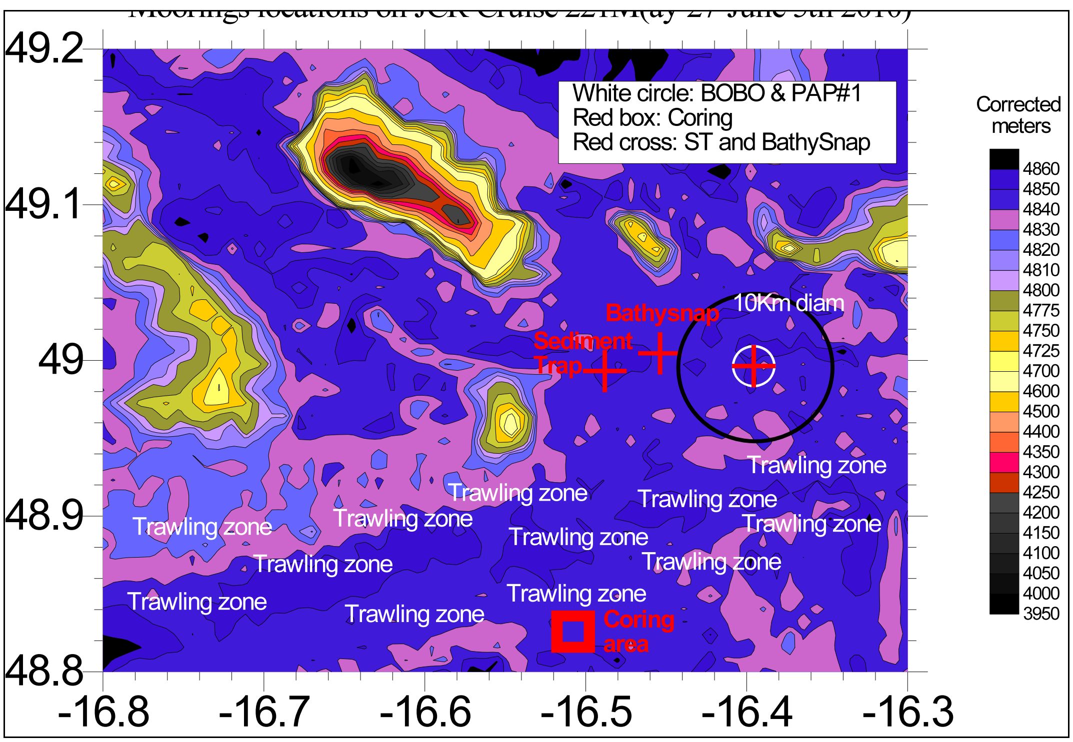
Station list

All times are GMT

Station log for JCR cruise 221												
Station Number	Start Time GMT	Time on seabed	End Time	Equipment	Sampling Max. depth meters	Start Lat	Start Lon	End Lat	End Long	Seabed Lat	Seabed Long	Comment
	26/05/2010 22:30					42.241667	-8.73					Leave Vigo
22101	27/05/2010 22:34		28/05/2010 02:20	CTD rosette	4740	45.47351	-13.05559	45.47346	-13.05562			Water sampling and acoustic release test
22102	27/05/2010 22:46		27/05/2010 23:01	Wave buoy test.		45.47352	-13.05558	45.47351	-13.05558			
22103	28/05/2010 21:38		28/05/2010 22:49	CTD rosette	250	48.82559	-16.50789	48.82559	-16.50791			Water sampling and cal. of sensors to be used on PAP#1
22104	28/05/2010 23:31	29/05/2010 02:24	29/05/2010 04:38	MegaCore	4845	48.82558	-16.50791	48.82557	-16.50789			
22105	29/05/2010 05:31		29/05/2010 09:40	MegaCore	4845	48.82560	-16.50789	48.82560	-16.50792			
22106	29/05/2010 06:28		29/05/2010 09:58	Wave-Buoy		48.82559	-16.50790	48.82559	-16.50790			
22107	29/05/2010 11:50		29/05/2010 13:03	PELAGRA	0	48.99613	-16.39547	48.99012	-16.38443			Surface test of GPS system; not designed to sink
22108	29/05/2010 16:38			Bathysnap		49.00301	-16.45217					
22109	29/05/2010 16:59		29/05/2010 19:06	Wave-Buoy		49.00259	-16.45176	49.00336	-16.45520			
22110	29/05/2010 20:09		29/05/2010 20:39	CTD rosette	150	49.00336	-16.45517	49.00336	-16.45518			
22111	29/05/2010 22:33		31/05/2010 16:12	PELAGRA P5	390	49.00338	-16.45519	48.83122	-16.21095			Scheduled 250m test of new software and hardware
22112	29/05/2010 22:50		31/05/2010 16:58	PELAGRA P7	382	49.00319	-16.45509	48.84281	-16.31920			Scheduled 250m test of new software and hardware
22113#1	30/05/2010 01:58	30/05/2010 03:39	30/05/2010 13:18	BOBO		48.99636	-16.39546	48.99072	-16.38674	48.9963333	-16.3955	Recovered due to communication failure
#2	30/05/2010 01:58	30/05/2010 03:39	30/05/2010 13:18	BOBO Drop-cam		48.99636	-16.39546	48.99072	-16.38674			Recovered at the same time and place as BOBO
22114	30/05/2010 15:14		30/05/2010 20:06	Wave-Buoy		48.99108	-16.38630	48.99099	-16.38651			
22115	30/05/2010 22:15		31/05/2010 23:32	Baited Drop-Cam		48.99097	-16.38653	48.98807	-16.38456			Damage to bait support device so limited field of view
22116	31/05/2010 00:05		31/05/2010 00:21	Zooplankton net	100	48.99096	-16.38650	48.99097	-16.38651			
22117	31/05/2010 00:24		31/05/2010 00:38	Zooplankton net	100	48.99097	-16.38651	48.99096	-16.38653			
22118	31/05/2010 00:42		31/05/2010 00:55	Zooplankton net	100	48.99095	-16.38654	48.99095	-16.38653			
22119	31/05/2010 06:05	31/05/2010 08:23	31/05/2010 10:07	MegaCore	4845	48.82581	-16.50765	48.82582	-16.50761			No samples
22120	31/05/2010 10:33	31/05/2010 12:41	31/05/2010 14:28	MegaCore	4845	48.82581	-16.50765	48.82577	-16.50762			4 cores
22121	31/05/2010 12:04		31/05/2010 14:10	Wave-Buoy		48.82579	-16.50763	48.82572	-16.50765			
22122	31/05/2010 18:44		31/05/2010 20:49	Wave-Buoy		48.99633	-16.39548	48.99646	-16.39619			
22123	31/05/2010 19:03		31/05/2010 22:20	CTD rosette	4815	48.99634	-16.39550	48.99656	-16.39655			
22124	31/05/2010 21:36		01/06/2010 07:53	PELAGRA P7	242	48.99647	-16.39619	48.94501	-16.32828			Surfaced prematurely
22125	31/05/2010 22:09		01/06/2010 06:58	PELAGRA P4	206	48.99647	-16.39622	48.95683	-16.30172			Surfaced prematurely
22126	31/05/2010 22:32		01/06/2010 07:23	PELAGRA P5	208	48.99656	-16.39652	48.94981	-16.30644			Surfaced prematurely
22127	31/05/2010 23:03		01/06/2010 07:07	PELAGRA P6	199	48.99656	-16.39691	48.95662	-16.30678			Surfaced prematurely
22128#1	01/06/2010 01:03	01/06/2010 04:02		BOBO		48.99642	-16.39541			48.98997	-16.38970	Presumed lost for ever after implosion of buoyancy spheres
#2	01/06/2010 01:03		01/06/2010 21:35	BOBO Drop-cam		48.99642	-16.39541	48.98861	-16.31287			Partially flooded. Evidence of massive shock wave
22129	01/06/2010 10:09		01/06/2010 15:33	PAP#1		48.98527	-16.28619	48.9971	-16.38182	48.9932	-16.36947	Flawless deployment
22130	01/06/2010 16:19		01/06/2010 19:05	Wave-buoy		48.99719	-16.38237	48.99718	-16.38245			
22131	01/06/2010 17:05		01/06/2010 17:18	CTD rosette	100m	48.99715	-16.38242	48.99715	-16.38244			Water sample for phytoplankton
22132	01/06/2010 17:26		01/06/2010 17:32	Phytoplankton net	50	48.99714	-16.38241	48.99717	-16.38241			
22133	01/06/2010 18:29		02/06/2010 09:08	Baited Drop-Cam		48.99718	-16.3824	49.0037	-16.3519			
22134	02/06/2010 02:20	02/06/2010 04:39	02/06/2010 06:29	Megacorer	4845	48.82687	-16.50848	48.82596	-16.50776	48.82596	-16.5077	
22135	02/06/2010 09:38		02/06/2010 10:05	Float cam		49.0333	-16.34698	49.03329	-16.34701			
	02/06/2010 10:18											End of science program
	04/06/2010 16:00											Boat transfer off Southampton
	06/06/2010 09:42											Dock at Immingham

Charts


Cruise 221 of the James Clark Ross
3000m
4000m
200m
1000m
2000m
PAP
Porcupine Abyssal Plain
50
45
40
-20
-15
-10
-5
0
West


White circle: BOBO & PAP#1
Red box: Coring
Red cross: ST and BathySnap
Bathysnap
10Km diam
Sediment Trap
Trawling zone
Coring area
Corrected meters
4860
4850
4840
4830
4820
4810
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4775
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4725
4700
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4500
4400
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4200
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4050
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3950
49.2
49.1
49
48.9
48.8
-16.8
-16.7
-16.6
-16.5
-16.4
-16.3