DY021 Cruise Report
UK SSB Benthic Programme
RRS Discovery
1st – 26th March 2015

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Contents

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Scientific Objectives

The Shelf Sea Biogeochemistry research programme directly relates to the delivery of the NERC Earth system science theme and aims to provide evidence that supports a number of marine policy areas and statutory requirements, such as the Marine Strategy Framework Directive and Marine and Climate Acts.

The shelf seas are highly productive compared to the open ocean, a productivity that underpins more than 90 per cent of global fisheries. Their importance to society extends beyond food production to include issues of biodiversity, carbon cycling and storage, waste disposal, nutrient cycling, recreation and renewable energy resources.

The shelf seas have been estimated to be the most valuable biome on Earth, but they are under considerable stress, as a result of anthropogenic nutrient loading, overfishing, habitat disturbance, climate change and other impacts.

However, even within the relatively well-studied European shelf seas, fundamental biogeochemical processes are poorly understood. For example: the role of shelf seas in carbon storage; in the global cycles of key nutrients (nitrogen, phosphorus, silicon and iron); and in determining primary and secondary production, and thereby underpinning the future delivery of many other ecosystem services.

Improved knowledge of such factors is not only required by marine policymakers; it also has the potential to increase the quality and cost-effectiveness of management decisions at the local, national and international levels under conditions of climate change.

The Shelf Sea Biogeochemistry research programme will take a holistic approach to the cycling of nutrients and carbon and the controls on primary and secondary production in UK and European shelf seas, to increase understanding of these processes and their role in wider biogeochemical cycles. It will thereby significantly improve predictive marine biogeochemical and ecosystem models over a range of scales.

The scope of the programme includes exchanges with the open ocean (transport on and off the shelf to a depth of around 500m), together with cycling, storage and release processes on the shelf slope, and air-sea exchange of greenhouse gases (carbon dioxide and nitrous oxide).

The DY021 cruise is the first of the 2015 Benthic SSB cruises to investigate the 4 main ‘representative’ sites in the Celtic Sea that will represent all the various sediment types found in the whole area, these being Mud, San, Sandy-Mud and Muddy-Sand. The cruise will also carry out complimentary sampling at the Pelagic SSB programme main site called CANDYFLOSS in the central Shelf area in order to better link the Benthic and Pelagic programmes.

Cruise Diary, Malcolm Woodward PSO, Plymouth Marine Laboratory

Sunday 1st March 2015:
After 2 days of mobilisation and loading equipment, finally everything was deemed to be on board and ready to go.
1015: RRS Discovery sailed on cruise DY021, the first of the 2015 benthic cruises.
Out into the Solent the wind and sea picked up and once through the Needles there was a considerable above 5m sea, and force 7 winds. The non-toxic seawater supply was turned on outside of the Needles, but the system was extremely anoxic and had to be left to flush overnight to clear out the pipes.
Overnight and into Monday we made progress down the Channel towards the Celtic Sea.

Monday 2nd March
Originally the plan was for a trial station at E1 off Plymouth, part of the PML Western Channel Observatory, this was to link with sampling alongside the Plymouth Ship the RV. Plymouth Quest on her regular E1 sampling day. However, the weather was very poor with 5-6 m seas and force 8 winds, so the decision was taken to continue on course straight past Plymouth heading for Station G in the Celtic Deep to deploy the NOC-L for the first time. The Captain decided that the conditions were too severe for launching that rig and so we changed plans and we headed instead straight to Site A, which is the Muddy sediment type site, with the plan to start with the NIOZ coring on arrival in the morning, this corer could be deployed even with the difficult weather conditions.

Tuesday 3rd March:
Despite strong wind and a big swell the first sampling at Site A commenced with a stainless steel CTD at 0700 for the benthic bottom water required for the core experiments, unfortunately this was delayed 45 minutes by a winch problem. Coring itself then commenced at 0857 but only after a further delay because of the winch changeover. Problems still apparent with the winch system despite weeks of 'trials' off Madeira. Over the morning we took 8 NIOZ cores, and then switched to the 'midday' Stainless steel water column CTD, which went into the water at 1229. There then followed a trace metal free Titanium CTD deployment for a full water column sampling, that was deployed at 1347.
Then after the retrieval of that CTD it was back to the NIOZ coring, starting at 1427 over the side and there then followed 26 further successful cores to complete our requirements at Station A, this was complete by 2200.

Wednesday 4th March
The day started at 0615 with a trace metal CTD for bottom water for the trace metal core experiments. There was then a further titanium CTD for sampling the water column which deployed at 0744. We then deployed the Stainless steel CTD for 2 casts for radium sampling through the water column, these were at 0902 and 1017.
On completion of that the coring restarted with the SMBA corer where we successfully achieved 5 good cores over the next couple hours.
An Autosub first deployment was scheduled for the afternoon as the weather had improved, but this was eventually cancelled due to issues with the sub telemetry, and finally was postponed until the next day.
There was then a 'bow-tie' SPI survey of the Site A box, with 5 SPI drops between 1500 and 2030.
This gave good image quality and was an improvement on the output from DY008 last year.
The Megacorer was then rigged with core tubes and was deployed at 2111 and 2223 to obtain sufficient cores, (more than 8), for the Trace metal team experiments.
We then departed for Site G at about 2300 and carried out one Spatial survey site on the way. The spatial survey is a grid of 75 sites for CeFaS designed to show gradations of sediment type between sites A and G, G and I, and I and H. It involves carrying out a SPI dip plus 2 NIOZ cores for sampling and sediment fauna identification plus pore waters and experiments, at each site.

Thursday 5th March:
The NOC-L Lander was not yet prepared despite an initial plan for deployment, but there was a test of the acoustic release system over the stern of the ship to be sure it would work.
Work then began on Autosub launch preparations, initially a mini mission was carried out and all outputs monitored on board until the team were happy all was well, this carried on through the afternoon until finally the sub was released onto its first Mission at Site G and made its first dive at 1745.
Following the successful launch the ship steamed back to Site A, and on arrival carried out a Stainless Steel water column CTD at 2030 for all parameters.

Next the Benthic Flume from Portsmouth University was deployed at 2130. This is tethered to the ship and it deployed for 2-3 hours taking samples as the flume operates on the sea floor.

Friday 6th March:
At 0100 Chem SPI was successfully deployed at Site A.
Then spatial survey sampling (2 further stations) continued until breakfast.
The NOC-L lander was finally ready for launching today; the oxygen probe was working well and all other sensors were checked and operational.
This commenced after breakfast and was a slick operation with the lander being deployed safely despite growing seas and wind. Once down to the bottom the acoustic release was fired successfully to free the Lander.
The mooring cable was paid out and finally the weight and riser were deployed over the side and the surface float was sent out. All complete just after 1000.
It was then planned to service the Celtic Deep CeFas buoy and Lander, but the sea state worsened over the morning to a 5.1 m swell and 30 knot winds. The decision was taken by the Captain that it was not safe to continue. This activity was put on hold.
There was then a steam to Site G to recover Autosub after her 24 hour mission. Experiments and analysis of cores and nutrients and oxygen continued in the laboratories on the ship.
By 1400 we were in the vicinity of Autosub, then on schedule before 1500 she popped up to the surface with identity successful by satellite, and then finally by eye.
There then followed a difficult process to recover the Autosub back on board the Discovery because of the fairly rough seas and strong winds. The sub had a minor collision into the ships side before being grappled and the recovery lines made safe and attached to the recovery cradle on the stern of the ship. Despite the big seas the recovery was a success and she was soon connected happily back to the ship with fairly minor damage.
The ship then re-deployed to the most south-west point of the spatial survey sites and the overnight survey commenced, with the scientists working in shifts to maximise the available time. The usual 2 NIOZ cores and a SPI dip were carried out through the night. Science people were in 2 watches to ease the working schedules.

Saturday 7th March:
The spatial survey continued overnight, but progress was slow as it took longer than expected (30-40mins) to transit between sites and to set up ready to work. It appears this spatial survey is an extremely ambitious programme and could have taken a cruise in its own right.
The science watch changed before breakfast and we moved back to the centre of A with the intention to do trawling, recover the Lander and deploy Autosub. Weather conditions were worse than last night and mooring work was declared unsafe, and also the trawl would bounce too much to launch.
So we returned to the spatial survey and started again at 0915. During the first deployment of the SPI the coring winch with NIOZ corer attached suddenly started up for no reason and lifted itself from the deck. The ratchet strap was ripped apart securing it and the core lifted upwards. Then it stopped just short of the sheave luckily and was hanging and swinging in the air. I informed the captain of what had happened and investigations started shipside. Meanwhile the SPI was still being deployed. All science was stopped and urgent action taken to return the corer to the deck. Obvious potentially severe safety considerations existed, with a great risk if a winch can just start up, particularly if there were scientists all over the corer taking samples. Shore-side were consulted and an answer was awaited as they contacted Rolls Royce. 2 winches operating simultaneously should not occur, a serious problem.
Decision was taken to just continue with SPI'ing down one transect and then change over the systems and return with coring back the other way. That way completely isolating everything else other than the one system with being used.
SPI work re-commenced at 1230 along the 'D' line running east.
Finally after much discussing and consulting the ship base at NOC, it became apparent that it was actually 'human error' due to wrong screen selection and subsequent operating of the coring warp by accident. It was concluded that both winches had not operated at the same time !
Thankfully as far as safety was concerned we were now free to continue with multiple winch operations, so after dinner SPI and NIOZ coring continued and the 'only SPI'd' stations would be filled in during the early hours.
Still rough seas at 4-5m swell, and strong winds (7-8), although they were abating during the evening.

Sunday 8th March:

Spatial survey SPI and NIOZ coring continued overnight.
First Stainless steel CTD in water at 0500 for Radium sampling, samples taken, and second CTD down at 0610 for remainder of water column samples. At 0700 the Water column Trace metal sampling with the Titanium CTD was undertaken. The CTD was switched and at 0930 we sampled for benthic bottom water from the Stainless system, followed at 1030 by the full water column CTD for all parameters.
There then followed a strange Metrological event as the sky turned blue rather than the normal grey, and then a big yellow object appeared above us. Sunshine for the first time!! and nice to feel the warmth for a change. Seas still dropping in height, now down to about 2 metres, also the wind dropped down to a force 3-4. It will be good to receive a satellite image from RSDAS that is not just mostly black due to cloud cover !
CTD operations completed and unit stowed by 1115, before the ship affected the transit to Station A to collect NOC-L Lander. At 1400 the pellet float was captured and the recovery operation commenced. 1450 and the Lander was back on deck. Ship then sailed to change over the Celtic Deep mooring, Lander and Smart buoy.
Buoy collected safely and stowed to deck. But Weather conditions now progressively getting worse despite the hoped for improvements of earlier !.
Return to Site G for NIOZ coring.
Commence NIOZ coring at G after dinner. Initial cores at centre showed poor sediment with too much gravel and stone. Ship redeployed to North West corner of the grid at 2130 where next core gave successful results.
Commence overnight coring with NIOZ corer.

Monday 9th March:
NIOZ continued overnight and in all 30-40 cores were taken successfully and completed in very good time in the early morning.
Weather conditions very bad again with force 7 winds and 4m swell, no go for buoy redeployment.
Commence SPI survey around G at 0900.
Completed at 1430, weather now rapidly improving even sun coming out, sea state improving also. Weather all over the place ! Decision taken to go for an Autosub deployment at A. Flash problem with camera is hoped to have been fixed. 2.5 hour steam to A. Autosub deployed and in water at 1800, systems checked before sending finally on its Mission. Carry out deck rearrangements ready for CeFas buoy deployments in the morning first light. Then passage back to Site G north-west corner.

Tuesday 10th March
CeFaS Smart Buoy into the water at 0745. There then followed the CeFaS Lander deployment commencing at 0815 and finally completed at 1100. This involved the long cable and chain and sensors as well being deployed.
Emergency Ship drill at 1100.
There was then a Stainless Steel CTD water column CTD at 1200 which was a calibration for the Lander and also acted as the second CTD at the G site.
We departed for Site A at 1245. Arrival at 1515 with the intention of recovering Autosub.
It did not return initially as programmed and so the fallback was at 1830 when the mission would abort, the weights would drop of and the unit would surface, then allowing recovery.
Nothing happened and no sign was seen or heard from her. Obviously with a full science programme to continue, but aware of the importance of Autosub to the whole programme, after discussions with the on ship Autosub leader Miles Pebody we decided on an initial extra window of searching up until midnight. Contact and discussions were made with Martin Solan and Phil Williamson from SSB. After that it was decided to gift Autosub more time for searching until 0800 tomorrow (Wednesday) morning. The search continued with listening devices hoping to hear the ‘pinger’ unit.

Wednesday 11th March:
No luck overnight with the extensive racetrack search of whole mission area for Autosub.
Discussions were occurring back at NOC within NMF, and attempts were made by email to get the leader of Benthic SSB, Martin Solan, into the discussions. This failed for reasons unknown.
A telephone conversation to the ship at 1200 from NMF (6-7 senior members of the management there, led by Leigh Storey, Head of NMFSS) to the Captain of Discovery. Myself and Miles Pebody were present but unfortunately the telephone refused to allow a speakerphone discussion. So essentially I was told by Leigh Storey that we would have to delay the cruise at this site for 48 hours to search for Autosub. This was apparently the life left in Autosub batteries and hence how long the pinger would still work for

searching. There was little consultation, no discussions with the NERC SSB programme manger or Head of the Benthic programme, despite Phil Williamson specifically requesting that Martin Solan had an input to any decisions affecting the cruise. As an appeasement I was told that I could extent the cruise up to 48 hours at the end to compensate.
I called a full scientific meeting, having to wake up many of the scientists who were on night shift. I gave them the facts and asked who could not extend the end of the cruise from the 26th March. 8 people said they could not, which hence made the decision for me to reject the offer of time extension to the cruise. I emailed Leigh Storey with this decision, also pointing out this could affect the Candyfloss site and the potential Glider recovery and deployments. As this would leave little contingency left in the programme.
Whilst at A and waiting for a search survey plan to be unfolded from NMF, plus also to let Miles and Rachel to get some sleep, we took the opportunity for some trawling with the 2m Jennings Beam trawl. First trawl yielded a good catch, but the second trawl was twisted on recovery. The third trawl was successful. Once complete we moved to G to use up the waiting time and started coring at G at 1500. This did not go well and the only one successful trawl, which actually yielded a great catch including a Monkfish, but was outside the box for site G, hence not a valid result. Finally we had to return to Site A to continue the Autosub search.
We have been given permission now to use 3 main engines so as to increase our cruising speed up to about 12 knots and I requested that we should have this for the whole of the rest of the cruise when required and this was agreed. This should gain back some important time on the transects, and also the return to Southampton.
At about 1745 we commenced the search survey for Autosub, initially doing a Swath survey of the sea floor in the box grid area at A.
The end of searching will be 1200 on Friday 13th March
This searching continued through the night

Thursday 12th March:
Searching continues with the ship being moved from site to site and then listening for the ‘chirp’ went on to ascertain the position relative to the actual sub. By a process of elimination we hope to come to a position relatively above the downed autosub on the sea floor. It is a slow time consuming process. The other scientists are working up samples and completing experiments from the last station, also preparing equipment and analysers ready to start other science again tomorrow, or hopefully sooner if the search is concluded. Weather again bad today, force 7 winds and 3-4m seas. Dull and grey skies, raining.

Friday 13th March
Sunshine and blue skies to start the day, a complete contrast, and hopefully the bright start to getting back to the cruise science programme again.
The Autosub had been traced to a precise position overnight and we spent the few hours refining this. Because we were within 1500m the team could talk to the sub and download some information. A swath survey was conducted also and pinpointed the sub as well in the same position as decided from audio detection.
At 1050 we carried out a SPI dip, this is benthic unit with a camera on it, the first deployment was unsuccessful and we changed the camera angle and tried again, despite a good image the range of site of the camera is too small, only a metre or so, and we would have had to be extremely lucky to have got images of the sub, but we did attempt that. At that point the Captain called a halt and we completed the survey for Autosub and were happy the position was exact, this was relayed to the ship’s base. At 1145 we were underway for Site A for trawling.
1230, first trawl at A, this was successful, with many nephrops and a couple monkfish plus other benthic species.
Trawl back in at 1300, the aft deck was made safe and the benthic Lander moved into position to be prepared for launching later today. We transited to the deployment site south of G where there was an existing notice to mariners and waited for the preparations to be completed for deployment. A first deployment was terminated as a ratchet strap flew across and smashed the oxygen probe and so a new one had to be prepped, and calibrated. The second attempt went successfully with no mishaps and the Lander went into the water at 1845. The weights and marker buoy etc were then paid out to complete the deployment.
The after deck was then prepared for trawling and the ship repositioned to the north-west corner of the Site G box.
Trawling at Site G, 3 complete trawls completed successfully.

Saturday 14th March

Overnight Spatial Survey between G and I, 2 full stations carried out.
Reposition ship to be at Site I for 0500.
Unfortunately the old ship issue with winches saw us being delayed by over 2 hours because of a scrolling problem, which has been with the ship since last year on DY008. Plainly this was not fixed over the last year.
Finally at 0640 the Chief Engineer was called and he then agreed to deploy the CTD even though the problem was not fully identified. The system worked safely and at 0710 the first Radium CTD went down. This was processed and at 0820 the second was deployed and again sampled in good time.
The Titanium trace metal CTD went over at 0915 and recovered, with the bottles being taken through into the Clean Trace Metal laboratory for processing and sampling.
Then the system was switched back to the Stainless Steel CTD and this as deployed at 1030 to take bottom water for the Benthic team for their core experiments. Finally the 'Midday' CTD went over at 1120 for full water column sampling of all parameters, although the water column system is still fully mixed from top to bottom at this site. 6 depths were taken and sampled as before.
After this the NIOZ corer was rigged and moved into position and at 1220 the NIOZ coring commenced for the rest of the afternoon and into the evening, 20 cores were successfully taken.
Unfortunately one of the strands of the coring warp became fractured and so the NIOZ was postponed until this was fixed. So the effort was turned to the SMBA and Multi-corers.
The coring continued through the night.

Sunday 15th March

During the night there were 40 successful NIOZ cores taken, 4 x MBA cores, and 2 x Multicore drops for the trace metal sampling team
The ship then repositioned for recovery of the NOC-L Lander.
The first attempt to catch the surface line failed but in the process the ship port azimuth thruster cut the down line from the surface buoy and so we lost all possibility to recover the buoy. We have the position and so it is hoped that it can be recovered as soon as possible so as to allow the NOC-L people to turn the Lander around in time for the May cruise. It is not damaged as far as we know just unable to be recovered from the Discovery.
There was now the fear that some of the rope has got wrapped around the thruster and although there are viewing panels out to see such a thing down in the engineering spaces, unfortunately the designers had not considered algal growth on the outside of the windows and so it was not possible to ascertain if the thruster was fouled due to bio-fouled viewing ports.
After talk of heading to Cork, Ireland, to have things checked on the other thruster (starboard) the idea to try to see using a Go-Pro camera unit could check the condition. Thanks then to Amber Annett who volunteered her camera which was strapped to a long pole and this held over the side to take video footage of the underside of the ship. After 3 attempts and viewing the video the Captain and Chief Engineer were happy that no rope fouling was evident and so we were free to continue with scientific operations.
This was the third occasion where a small ROV unit on board the ship would have saved a lot of time and aided searches and identification. Firstly Autosub where we would have liked to have checked the situation of the unit, secondly the Lander whereby an ROV with a claw unit could well have maybe got the cut line and enabled a recovery. And then having a unit to inspect the underside of the ship would save thousands as using the Go-Pro saved at least 24 hours of lost science time, fuel to Cork and back, harbour dues, an emergency diver crew to come out, plus ships agents fees etc. I think a quite large bill has been saved from NMF by this action. Maybe a small ROV (some compact units are available for £10-15k) kept on board would soon save its cost and then some, probably many times over !
Once we were back underway we returned to Site I and recommenced the planned science programme. NIOZ coring for 2 cores was completed and then the SPI 'bow-tie' was carried out at the 5 stations of the I box. Then the Chem SPI was deployed later in the night.
Monday 16th March
The night team continued through the night with a benthic Flume deployment for 3 hours at I, which once completed then left just the 3 Trawls to be taken before all the benthic work was completed. These were successful and we then moved back to the centre of theI box and deployed the Stainless Steel CTD at 0815, which was back on deck at 0900.
Once all was secure we then proceeded with the Spatial Survey sampling of 2 x NIOZ cores and a SPI at each designated site. The first site was successful but the second gave large rocks and so was aborted.

The day continued with another 3 completed sites. The night shift then continued the sampling and successfully completed 7 more sites.

Tuesday 17th March

Overnight spatial survey was ceased to allow the ship to re-position to the CeFas Lander site at East of Haig Frais. This was to recover a CeFas Lander that had been launched previously on a different cruise but had not actually been turned on! The Lander recovery started at 0715 and continued through the morning until complete at about 1030.
The first CTD was Stainless steel at 1100 was a calibration CTD for the Lander unit.
Following this there was the transit to Site H to start the science sampling at that site.
The station started with the first Stainless steel Radium cast at 1200, followed by the second at 1250.
Once all this water had been sampled the next CTD was the Titanium trace metal free cast which was the full water column and was deployed at 1405. Next was the Stainless steel CTD again at 1515 which was just for the benthic bottom water for experiments with the cores to be obtained later in the day.
The last of the series was a full water column stainless steel CTD for all parameters, which went down at 1600, and recovered back to the deck for sampling at 1630.
For once the programme was slightly ahead of schedule and so we tried to carry out the central SPI dip at 1045. Unfortunately the camera flash failed due to the battery being dead. On return this was successfully replaced leaving the unit ready for later use.
The NIOZ coring started after dinner at about 1830 and continued through the evening and night.

Wednesday 18th March:

The night team NIOZ coring went very well, with greater than 20 successful cores obtained, in the early hours this was followed up with a full SPI bow-tie survey of the Site H box. That complete there were then 6 SMBA cores to complete the requirements.
The Team Iron ladies were called at 0330 in readiness for their Multi-coring, which was again successful and samples obtained for experiments on iron species.
The dawn and sun-rise gave us at last a sunny start to the day, even though a hazy sunshine this was welcomed by all, and the chance to feel some warmth from the sun after a week or more with grey overcast skies and cold winds.
The day team for coring came on watch and again went through their series of cores of again over 20 successful drops.
After that there was the midday stainless CTD (in water at 1245) for water column parameters at H, and then we re-positioned for a bonus couple of Spatial survey sites close to site H. These were both successful with 2 NIOZ cores and SPI carried out at both.
The ship then re-positioned again to the centre of H and the Flume was deployed (3ish hours), CHEMSPI, and finally 3 successful trawls were carried out.
That then completed Site H and all 4 of the main benthic sites for the SSB programme !
But this excludes sadly both Autosub and Lander data which of course we cannot obtain fully this cruise!

Thursday 19th March:

Following the completion of activities at H there was time for one more Spatial survey station overnight.
The day team then completed 2 more spatial sites before the wire came of from the sheave on the end of the bull-horn due to wire angle. This occurred when the NIOZ carer was coming back from a core drop.
About 45 minutes was lost as it happened a second time again after being repositioned. Finally that site was completed and we then had to depart for the Lander retrieval at about 1100, finally arriving at site G at 1340. The rescue boat was launched to go and search for the remaining rope from the Lander that it was hoped would be seen from the surface. This was not successful and so the Discovery started to drag for the Lander at 1440.
This was unsuccessful and with fading light and tidal conditions it was decided not to try again today.
We then repositioned to restart the Spatial survey grid at 1730 at position 11B.
The series of 2 x NIOZ cores and a SPI survey then continued overnight

Friday 20th March:

4 successful Spatial sites were carried out until the day team took over and continued with another couple before we left the survey pattern and returned to site G to make a second attempt at snagging the Lander.
Highlight of the morning was the partial solar eclipse which started at about 0830 and we witnessed 70-80% of the sun being blocked out by the moon. Many people were out trying to film the event but only a

couple with the better cameras managed to get anything other than glare. A ships welders mask made the ideal viewing window to watch events and this was eagerly passed around.

The science still continued though with a SPI being run alongside the solar event.
We started the Lander recovery attempt at 1415 and were successful in getting the wire between the mooring weight and the Lander on the first drag at 1545. This was lifted to the deck and then a long careful process of securing both ends of the wire to enable further lifting of both sides to finally bring the Lander itself and associated ground weight back on board began.
Finally the Lander returned safely with all sensors intact and Discovery left to restart the Spatial survey grid.
Huge thanks to Steve and the deck crew plus the NMF team who were all totally professional in retrieving the Lander.
The Spatial survey continued again into the night, but was hitting a number of sites that were very rocky and cores were impossible to take. So each time we moved on to the next designated site.

Saturday 21st March
The spatial survey continued through the night and the day team took over the duties of SPI'ing and NIOZ coring.
The coring and SPI'ing continued through the day until we reached Spatial site 57 at about 1515, and this became the final site and marked the end of a huge commitment from the 2 coring teams here on DY021, plus all the associated people running samples from the cores like Nutrients etc.
Once the 2 good cores were taken and the SPI survey then the ship departed for Candyfloss at 1630, with the first action in the morning being the launching of the Shallow Gliders at 0430.

Sunday 22nd March:
The 2 shallow gliders were launched successfully and both set of on their initial holding pattern close to the ship. A calm sea today with initial blue skies and sunshine.
0635 was the first Radium CTD, CTD029, and event 419, with one of the bottles fired at 15m to act as part of the calibration of the gliders. The second Radium CTD followed and was back on deck at 0800.
The water was taken and then the Titanium CTD for the trace metal sampling was prepared and then went in at 0900, with it being back on deck at 0930. All the bottles were moved to the clean chem. Room for sampling the water and the Stainless CTD was moved into position again.
1018 was a calibration CTD for the gliders with samples for CDOM, salts, chlorophyll and Oxygen taken at 3 depths: 15m, 45m, and 100m.
Next at 1202 was a full water column Stainless CTD for all parameters, which acted as another calibration CTD.
The glider #345 was then searched for prior to recovery and the good weather conditions aided this and it was spotted at 1315. The ship manouvered and she was recovered onto the deck at 1340.
As the ship returned to the original CTD sampling site at Candyfloss we had a large number of Dolphins with us swimming around the ship and giving some great photos for the assembled bank of photographers on the side rail and the bow.
The final CTD was at 1500 which was again a calibration CTD for the gliders and also provided bottom water for the sediment cores that were next to be samples.
These commenced at around 1620 and the very sandy sediment was initially difficult to obtain a good core and those that were, were fairly short.
This continued between the day shift and the night shift took over. Unfortunately we received a call from NOC that one of the gliders we had launched had begun to leak and so needed an emergency recovery if possible. Even though it was nearly dark at 1915 the coring was suspended as we headed the 2 miles to its position to attempt to recover.
A new position fix allowed us to get close and then it was picked out by the ships spotlight. Recovery was then safely carried out at 2010 and we proceeded back to the original coring site to continue with the remaining NIOZ cores etc.
The NIOZ coring continued as it had done through the evening and night throughout the cruise.

Monday 23rd March
SMBA coring was completed and a ChemSPI was attempted but failed to get good penetration into the sandy sea bed as the ship was failing to keep position, so this was abandoned. Next the Flume was deployed to sit on the seabed for 32 hours but again due to unstable ship position and movement this also had to be abandoned as there was drag on the unit rendering the activity a failed deployment. What

the issues were are not sure as there was said to be no problems with the DP but the ship was not maintaining position! Finally the coring was undertaken by the night watch and very interesting species of hermit crab and starfish were caught, an interesting and varied haul.
The final day shift people came on and decided against SPI'ing due to the solid nature of the ocean floor and so the turnaround of the CeFaS Smart buoy was started after breakfast, retrieving the old unit to the deck, turning around the sensors and loggers was carried out, during the mooring before finally the new buoy was redeployed by 1130.
There was then a calibration CTD at 1300 and we departed from Candyfloss at 1400 with the extra benthic objectives well met. Although as a note many of the samples do not have funding to have them analysed and so this needs to be addressed by the steering committee once this cruise ends.
The Shelf Edge site was reached at about 2100 and the ship held position overnight

Tuesday 24th March
The Titanium CTD cast went into the water at 0415, and returned to the deck at 0500. The bottles were removed to the clean room and then the stainless steel CTD was prepared and deployed at 0545 into the 210m deep waters at the Shelf Edge.
This was back on deck and being sampled by 0615 and we left the Shelf edge site for deep waters over a 1000m in order to deploy the deep gliders. The seas were 4-5m in size, and a force 5-6 wind with choppy seas and a big swell. Grey overcast skies welcomed the dawn today, but as the morning progressed the skies cleared to sunny spells in the grey clouds.
We arrived into 1000m at 0800 and stopped the ship as the position where 1000m was reached, there was no specific position.
The first deep glider was deployed at 0915. However we then had engine problems and 2 of the 3 main engines were turned off because of overheating, along with the forward retractable thruster.
At 1020 it was reported the problem had been solved so the second glider was then prepared. This was delayed due to computer programme information coming from the base at NOC and it did not finally go for launching until1140. This was one of the iRobot units with a long antenna and this was broken on deployment and so the deployment was aborted before the holding strops were released.
The CTD was then deployed at 1300 to 1000m, and this returned onto the deck at 1400. This was purely for calibration of the unit and for the glider deployed earlier. Oxygen, CDOM, chlorophyll and DOM were sampled for.
Unfortunately at 1400 we were informed from NOC that the first deep glider that had been launched was having problems and needed to be recovered. So the ship headed for the last known position, the unit was spotted and a very quick recovery was undertaken. And that was that for the gliders with both units failing after all the effort taken to get here, a really sad end.
With that at 1500 there was no other science to be carried out and so the Discovery turned and made best speed on the course back to Southampton and cruise end.
Packing equipment and cruise report writing were now the order of the day for the majority of the scientists on board along with completing experiments and starting to clean up.
In the evening the traditional RPC was held by the PSO

Wednesday 25th
Steaming home up the Channel was interrupted due to a serious illness on board and a naval helicopter was called resulting in a medical evacuation of the patient to Trelisk hospital, Truro.
The ship then continued east to Southampton for a late night arrival

Thursday 26th:
Demob day and go home !

Individual Cruise Reports

1 NMF-SS Sensors Cruise Report, Jeff Benson & James Burris

1 March – 26 March 2015

CTD system configurations

1) Two CTD systems were prepared. The first water sampling arrangement was a 24-way titanium frame system (s/n SBE CTD TITA1), and the initial sensor configuration was as follows:

Sea-Bird 9plus underwater unit, s/n 09P-71442-1142
Sea-Bird 3P temperature sensor, s/n 03P-4593, Frequency 0 (primary)
Sea-Bird 4C conductivity sensor, s/n 04C-2164, Frequency 1 (primary)
Digiquartz temperature compensated pressure sensor, s/n 124216, Frequency 2
Sea-Bird 3P temperature sensor, s/n 03P-5494, Frequency 3 (secondary)
Sea-Bird 4C conductivity sensor, s/n 04C-4140, Frequency 4 (secondary)
Sea-Bird 5T submersible pump, s/n 05T-3085, (primary)
Sea-Bird 5T submersible pump, s/n 05T-6196, (secondary)
Sea-Bird 32 Carousel 24 position pylon, s/n 32-60380-0805
Sea-Bird 11plus deck unit, s/n 11P-34173-0676 (main)
Sea-Bird 11plus deck unit, s/n 11P-24680-0589 (back-up logging)

2) The auxiliary input initial sensor configuration was as follows:

Sea-Bird 43 dissolved oxygen sensor, s/n 43-0862 (V0)
Chelsea 2pi-PAR irradiance sensor, DWIRR, s/n 02 (V2)
Chelsea 2pi-PAR irradiance sensor, UWIRR, s/n 02 (V3)
Benthos PSA-916T altimeter, s/n 62679 (V4)
WETLabs light scattering sensor, s/n BBRTD-758R (V5)
Chelsea Alphatracka MKII transmissometer, s/n 161049 (V6)
Chelsea Aquatracka MKIII fluorometer, s/n 088244 (V7)

3) Sea-Bird 9*plus* configuration file DY021_tita_NMEA.xmlcon was used for the titanium frame CTD casts.

The second water sampling arrangement was a 24-way stainless steel frame system (s/n SBE CTD1), and the initial sensor configuration was as follows:

Sea-Bird 9plus underwater unit, s/n 09P-24680-0637
Sea-Bird 3P temperature sensor, s/n 03P-2674, Frequency 0 (primary)
Sea-Bird 4C conductivity sensor, s/n 04C-2571, Frequency 1 (primary)
Digiquartz temperature compensated pressure sensor, s/n 79501, Frequency 2
Sea-Bird 3P temperature sensor, s/n 03P-2919, Frequency 3 (secondary)
Sea-Bird 4C conductivity sensor, s/n 04C-3258, Frequency 4 (secondary)
Sea-Bird 5T submersible pump, s/n 05T-5247, (primary)
Sea-Bird 5T submersible pump, s/n 05T-6320, (secondary)
Sea-Bird 32 Carousel 24 position pylon, s/n 32-31240-0423
Sea-Bird 11plus deck unit, s/n 11P-34173-0676 (main)
Sea-Bird 11plus deck unit, s/n 11P-24680-0589 (back-up logging)

5) The auxiliary input initial sensor configuration was as follows:

Sea-Bird 43 dissolved oxygen sensor, s/n 43-2575 (V0)
WETLabs light scattering sensor, s/n BBRTD-1055 (V2)
Benthos PSA-916T altimeter, s/n 59493 (V3)
Chelsea Alphatracka MKII transmissometer, s/n 161048 (V4)
Chelsea Aquatracka MKIII fluorometer, s/n 88-2615-124 (V5)
Biospherical QCP Cosine PAR irradiance sensor, UWIRR, s/n 70510 (V6)

Biospherical QCP Cosine PAR irradiance sensor, DWIRR, s/n 70520 (V7)

6) Sea-Bird 9*plus* configuration file DY021_stainless_NMEA.xmlcon was used for all stainless steel frame CTD casts.

Total number of casts – 8 titanium frame, 30 S/S frame.
Casts deeper than 2000m - 0 titanium frame, 0 S/S frame.
Deepest casts - 200m titanium frame, 1017m S/S frame.

<u>Appendix A:</u> Technical detail report

TITANIUM CTD

Water sampler number 19 bottom end cap lanyard snapped prior to deployment DY021_031, and was repaired before the cast.

S/S CTD

NMEA data stopped at 94m on upcast during deployment DY021_014, and then resumed at 22m. No detrimental effect on data collection. NMEA data failed again at the start of DY021_024, but resumed when CTD was at the surface, prior to the downcast.

AUTOSAL

A Guildline 8400B, s/n 71126, was installed in the Salinometer Room as the main instrument for salinity analysis. A second Guildline 8400B, s/n 71185, was installed in the Salinometer Room as a spare instrument. The Autosal set point was 24C, and samples were processed according to WOCE cruise guidelines: The salinometer was standardized at the beginning of the first set of samples, and checked with an additional standard analysed prior to setting the RS. Once standardized the Autosal was not adjusted for the duration of sampling, unless the set point was changed. Additional standards were analysed every 24 samples to monitor & record drift. These were labeled sequentially and decreasing, beginning with number 999. Standard deviation set to 0.00002

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FASTOCEAN FRRF

One instrument, serial number 14-9615-001, was installed in the Underway Laboratory, as a flow-through bench-top sensor.

<u>Appendix B:</u> Configuration files

<u>Titanium CTD frame:</u>

Date: 03/01/2015

Instrument configuration file: C:\Program Files\Sea-Bird\SeasaveV7\DY021\DY021_tita_NMEA.xmlcon

Configuration report for SBE 911plus/917plus CTD

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

Surface PAR voltage added : No
Scan time added : Yes

1) Frequency 0, Temperature

Serial number : 03P-4593
Calibrated on : 3 July 2014
G : 4.35405284e-003
H : 6.44561015e-004
I : 2.17709996e-005
J : 1.75890257e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 04C-2164
Calibrated on : 6 May 2014
G : -1.02203562e+001
H : 1.40877221e+000
I : -2.45278999e-003
J : 2.41005660e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 129735
Calibrated on : 12 March 2014
C1 : -6.064446e+004
C2 : 6.966022e-001
C3 : 1.971200e-002
D1 : 2.882500e-002
D2 : 0.000000e+000
T1 : 3.029590e+001
T2 : -6.713679e-005
T3 : 4.165400e-006
T4 : 0.000000e+000
T5 : 0.000000e+000
Slope : 1.00000000
Offset : 0.00000
AD590M : 1.279181e-002
AD590B : -8.821250e+000

4) Frequency 3, Temperature, 2

Serial number : 03P-5494
Calibrated on : 6 May 2014
G : 4.32421678e-003
H : 6.25972479e-004
I : 1.94252613e-005
J : 1.47692004e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 04C-4140
Calibrated on : 6 May 2014
G : -9.84144365e+000
H : 1.48564552e+000
I : -2.50353162e-003
J : 2.75975478e-004
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

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

Serial number : 43-0862
Calibrated on : 4 July 2014
Equation : Sea-Bird
Soc : 4.69200e-001
Offset : -5.03400e-001
A : -3.27820e-003
B : 1.33040e-004
C : -2.09790e-006
E : 3.60000e-002
Tau20 : 1.71000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

7) A/D voltage 1, Free

8) A/D voltage 2, PAR/Irradiance, Biospherical/Licor

Serial number : PAR 02
Calibrated on : 7 May 2013
M : 0.47913900
B : 1.05925300
Calibration constant : 100000000000.00000000
Multiplier : 0.99960000
Offset : 0.00000000

9) A/D voltage 3, PAR/Irradiance, Biospherical/Licor, 2

Serial number : PAR 04
Calibrated on : 21 November 2013
M : 0.43427300
B : 1.61542400
Calibration constant : 100000000000.00000000
Multiplier : 0.99950000
Offset : 0.00000000

10) A/D voltage 4, Altimeter

Serial number : 62679
Calibrated on : 27 March 2014
Scale factor : 15.000
Offset : 0.000

11) A/D voltage 5, Turbidity Meter, WET Labs, ECO-BB

Serial number : BBRTD-758R
Calibrated on : 3 June 2013
ScaleFactor : 0.002903
Dark output : 0.043100

12) A/D voltage 6, Transmissometer, Chelsea/Seatech

Serial number : 161049
Calibrated on : 21 January 2015
M : 23.8589
B : -0.2622
Path length : 0.250

13) A/D voltage 7, Fluorometer, Chelsea Aqua 3

Serial number : 088244
Calibrated on : 6 August 2014
VB : 0.236800
V1 : 2.151000
Vacetone : 0.305900
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

Scan length : 45

Stainless CTD frame:

Date: 03/01/2015

Instrument configuration file: C:\Program Files\Sea-Bird\SeasaveV7\DY021\DY021_ss_NMEA.xmlcon

Configuration report for SBE 911plus/917plus CTD

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

1) Frequency 0, Temperature

Serial number : 03P-2674
Calibrated on : 2 July 2013
G : 4.35676163e-003
H : 6.42212011e-004
I : 2.34566628e-005
J : 2.30042028e-006
F0 : 1000.000

Slope : 1.00000000
Offset : 0.0000

2) Frequency 1, Conductivity

Serial number : 04C-2571
Calibrated on : 25 March 2014
G : -1.02792261e+001
H : 1.59384550e+000
I : 5.35402090e-004
J : 7.28824525e-005
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

3) Frequency 2, Pressure, Digiquartz with TC

Serial number : 79501
Calibrated on : 6 January 2015
C1 : -6.052595e+004
C2 : -1.619787e+000
C3 : 1.743190e-002
D1 : 2.819600e-002
D2 : 0.000000e+000
T1 : 3.011561e+001
T2 : -5.788717e-004
T3 : 3.417040e-006
T4 : 4.126500e-009
T5 : 0.000000e+000
Slope : 0.99985000
Offset : -1.66130
AD590M : 1.293660e-002
AD590B : -9.522570e+000

4) Frequency 3, Temperature, 2

Serial number : 03P-2919
Calibrated on : 19 October 2013
G : 4.31707545e-003
H : 6.44577848e-004
I : 2.29060192e-005
J : 2.15522463e-006
F0 : 1000.000
Slope : 1.00000000
Offset : 0.0000

5) Frequency 4, Conductivity, 2

Serial number : 04C-3258
Calibrated on : 25 March 2014
G : -1.06578783e+001
H : 1.36091110e+000
I : 4.63625319e-007
J : 7.38590860e-005
CTcor : 3.2500e-006
CPcor : -9.57000000e-008
Slope : 1.00000000
Offset : 0.00000

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

Serial number : 43-2575
Calibrated on : 10 April 2014
Equation : Sea-Bird
Soc : 4.45400e-001
Offset : -4.68400e-001
A : -3.27450e-003
B : 2.06980e-004
C : -2.85420e-006
E : 3.60000e-002
Tau20 : 1.47000e+000
D1 : 1.92634e-004
D2 : -4.64803e-002
H1 : -3.30000e-002
H2 : 5.00000e+003
H3 : 1.45000e+003

7) A/D voltage 1, Free

8) A/D voltage 2, Turbidity Meter, WET Labs, ECO-BB

Serial number : BBRTD-1055
Calibrated on : 13 March 2013
ScaleFactor : 0.002365
Dark output : 0.061000

9) A/D voltage 3, Altimeter

Serial number : 59493
Calibrated on : 25 March 2013
Scale factor : 15.000
Offset : 0.000

10) A/D voltage 4, Fluorometer, Chelsea Aqua 3

Serial number : 88-2615-124
Calibrated on : 21 January 2015
VB : 0.463400
V1 : 2.044300
Vacetone : 0.474400
Scale factor : 1.000000
Slope : 1.000000
Offset : 0.000000

11) A/D voltage 5, Transmissometer, Chelsea/Seatech

Serial number : 161048
Calibrated on : 24 July 2012
M : 23.5172
B : -0.0861
Path length : 0.250

12) A/D voltage 6, PAR/Irradiance, Biospherical/Licor

Serial number : 70510
Calibrated on : 6 January 2015
M : 1.00000000

B : 0.00000000
Calibration constant : 20200000000.00000000
Multiplier : 1.00000000
Offset : -0.05051050

13) A/D voltage 7, PAR/Irradiance, Biospherical/Licor, 2

Serial number : 70520
Calibrated on : 6 January 2015
M : 1.00000000
B : 0.00000000
Calibration constant : 19500000000.00000000
Multiplier : 1.00000000
Offset : -0.05251338

Scan length : 45

CTD deck bottle sampling log

(Master log to be used on deck to record all bottles sampled and by whom)

CRUISECODE	DY021	Date on deck (UTC)	03-Mar-15
GEARCODE	CTD	Time on deck (UTC)	07:15
STNNBR	1	Latitude	51 12.697
CASTNO	DY021_001	Longitude	6 7.979
Bottom depth (m)	109		

Comm	STAINLESS STEEL

Sampling order ->

Niskin bottle position	Niskin Serial No. (SERNUM)	Target sample depth (m)	Oxygen	SPM	DIC	DOM	CDOM	Amino Acids	DOC/TDN	d15n	pom d15n	pc / pn	pop	nutrients	Chris Balfour	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype
1	1	99																					
2	2	98																					
3	3	99																					
4	4	99																					
5	5	99																					
6	6	99																					
7	7	99												X									
8	8	99																					
9	9	100																					
10	10	100																					
11	11	100																					
12	12	100																					
13	13	99	X											X									
14	14	99																					
15	15	99																					
16	16	99																					
17	17	100																					
18	18	99																					
19	19	100																					
20	20	99																					
21	21	100																					
22	22	100																					
23	23	99																					
24	24	100													X								

CTD deck bottle sampling log

(Master log to be used on deck to record all bottles sampled and by whom)

CRUISECODE	DY021		Date on deck (UTC)	05-Mar-15
GEARCODE	CTD		Time on deck (UTC)	20:57
STNNBR	62		Latitude	51 12.682
CASTNO	DY021_008		Longitude	6 7.864
Bottom depth (m)	109			

Comm: STAINLESS STEEL

Sampling order ->

Niskin bottle position	Niskin Serial No. (SERNUM)	Target sample depth (m)	Oxygen	SPM	Nutrients	DOM/ d15n	CDOM	DOC/ TDN	Chl a	HPLC	datype	datype	datype	datype	datype	datype	datatype	datatype	datatype	datatype	datatype	datatype	datatype
1	1	99	X	X	X	X	X	X	X	X													
2	2	99																					
3	3	99																					
4	4	99																					
5	5	80	X	X	X	X	X	X		X													
6	6	80																					
7	7	80																					
8	8	80																					
9	9	61	X	X	X	X	X	X		X													
10	10	60																					
11	11	60																					
12	12	61																					
13	13	40	X	X	X	X	X	X	X	X													
14	14	40																					
15	15	41																					
16	16	41																					
17	17	21	X	X	X	X	X	X		X													
18	18	20																					
19	19	20																					
20	20	20																					
21	21	6	X	X	X	X	X	X	X	X													
22	22	6																					
23	23	5																					
24	24	5																					

CTD deck bottle sampling log

(Master log to be used on deck to record all bottles sampled and by whom)

CRUISECODE	DY021		Date on deck (UTC)	03-Mar-15
GEARCODE	CTD		Time on deck (UTC)	12:48
STNNBR	10		Latitude	51 12.700
CASTNO	DY021_002		Longitude	6 7.976
Bottom depth (m)	109			

Comm: STAINLESS STEEL

Sampling order ->

Niskin bottle position	Niskin Serial No. (SERNUM)	Target sample depth (m)	Oxygen	SPM	DIC/ Alk	DOM	CDOM	Amino Acids	DOC/TDN	d15n	pom d15n	pc / pn	pop	nutrients	CH4	N20	lugols	PIC	Chl a	Sf Chl	PSI	datype	datatype
1	1	97	X	X	X									X	X	X							
2	2	98				X	X	X	X	X	X	X	X					X	X	X	X		
3	3	97																					
4	4	97																					
5	5	82	X	X	X									X	X	X							
6	6	82				X	X	X	X	X	X	X	X					X	X	X	X		
7	7	82																					
8	8	82																					
9	9	62	X	X	X									X	X	X							
10	10	61				X	X	X	X	X	X	X	X					X	X	X	X		
11	11	62																					
12	12	62																					
13	13	41	X	X	X									X	X	X							
14	14	42				X	X	X	X	X	X	X	X					X	X	X	X		
15	15	42																					
16	16	42																					
17	17	21	X	X	X									X	X	X							
18	18	22				X	X	X	X	X	X	X	X					X	X	X	X		
19	19	21																					
20	20	22																					
21	21	6	X	X	X									X	X	X							
22	22	6				X	X	X	X	X	X	X	X				X	X	X	X	X		
23	23	6																					
24	24	6																					

CTD deck bottle sampling log

(Master log to be used on deck to record all bottles sampled and by whom)

CRUISECODE	DY021
GEARCODE	CTD
STNNBR	73
CASTNO	DY021_009
Bottom depth (m)	100

Date on deck (UTC)	06-Mar-15
Time on deck (UTC)	11:39
Latitude	51 9.149
Longitude	6 33.161

Comm: STAINLESS STEEL

Sampling order ->

Niskin bottle position	Niskin Serial No. (SERNUM)	Target sample depth (m)	Oxygen	SPM	Nutrients	Chl a	CDOM
1	1						
2	2						
3	3						
4	4						
5	5						
6	6						
7	7						
8	8						
9	9						
10	10						
11	11						
12	12						
13	13	5m	X	X	X	X	X
14	14						
15	15						
16	16						
17	17						
18	18						
19	19						
20	20						
21	21						
22	22						
23	23						
24	24						

CTD deck bottle sampling log

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

Cruise (CRUISECODE)	DY021
Station ID (STNNBR)	120
Cast number (CASTNO)	14
Sea floor depth (m)	102
NMF ID	DY021_014

Date on deck (UTC)	08/03/2015
Time on deck (UTC)	11:04
Latitude	51 04.344
Longitude	6 34.862
Titanium cast	
Stainless steel cast	X

SITE: G

Comm:

Sampling order ->

Niskin bottle position	Niskin Serial No. (SERNUM)	Nominal sample depth (m)	Oxygen	CH_4	N_2O	Nutrients	DIC/ Alk	DOM/ d15n	CDOM	Amino acids	DOC/ TDN	POM d15 N	PC/ PN	POP	Chl a	Sf Chl	PIC	PSI	lugols	HPLC	SPM	Datatype	Datatype
1	1		X	X	X	X	X													X	X		
2	2							X	X	X	X	X	X	X	X	X	X	X					
3	3																						
4	4																						
5	5		X	X	X	X	X														X		
6	6							X	X	X	X	X	X	X									
7	7																						
8	8																						
9	9		X	X	X	X	X														X		
10	10							X	X	X	X	X	X	X	X	X	X	X					
11	11																						
12	12																						
13	13		X	X	X	X	X														X		
14	14							X	X	X	X	X	X	X									
15	15																						
16	16																						
17	17		X	X	X	X	X														X		
18	18							X	X	X	X	X	X	X									
19	19																						
20	20																						
21	21		X	X	X	X	X								X	X	X	X	X		X		
22	22							X	X	X	X	X	X	X									
23	23																						
24	24																						

CTD deck bottle sampling log

(Master log to be used on deck to record all bottles sampled and by whom)

Comm	STAINLESS STEEL

CRUISECODE	DY021		Date on deck (UTC)	10-Mar-15
GEARCODE	CTD		Time on deck (UTC)	12:45
STNNBR	175		Latitude	51 8.011
CASTNO	DY021_15		Longitude	6 34.514
Bottom depth (m)	99			

Sampling order ->

Niskin bottle position	Niskin Serial No. (SERNUM)	Target sample depth (m)	Oxygen	CH_4	N_2O	Nutrients	DOM	d15n	CDOM	Amino acids	DOC/TDN	POM d15n	PC/ PN	POP	SPM	Chl a	HPLC	Radium	datatype	datatype	datatype	datatype	datatype
1	1	91	X	X	X	X									X	X	X	X					
2	2	90					X	X	X	X	X	X	X	X									
3	3	90																					
4	4	91																					
5	5	82	X	X	X	X									X		X	X					
6	6	82					X	X	X	X	X	X	X	X									
7	7	82																					
8	8	81																					
9	9	62	X	X	X	X									X		X	X					
10	10	61					X	X	X	X	X	X	X	X									
11	11	63																					
12	12	62																					
13	13	42	X	X	X	X									X		X						
14	14	41					X	X	X	X	X	X	X	X									
15	15	42																					
16	16	42																					
17	17	22	X	X	X	X									X	X	X	X					
18	18	23					X	X	X	X	X	X	X	X									
19	19	23																					
20	20	23																					
21	21	6	X	X	X	X									X	X	X						
22	22	7					X	X	X	X	X	X	X	X									
23	23	6																					
24	24	6																					

CTD deck bottle sampling log

(Master log to be used on deck to record all bottles sampled and by whom)

Comm	STAINLESS STEEL

CRUISECODE	DY008		Date on deck (UTC)	14-Mar-15
GEARCODE	CTD		Time on deck (UTC)	11:52
STNNBR	198		Latitude	50 34.534
CASTNO	DY021_020		Longitude	7 6.284
Bottom depth (m)	114			

Sampling order ->

Niskin bottle position	Niskin Serial No. (SERNUM)	Target sample depth (m)	oxygen	CH_4	N_2O	Nutrients	DIC	SPM	DOM d15n	CDOM	Amino acids	DOC/ TDN	POM d15n	PC/ PN	POP	total Chl a	SF Chl 2 um	SF Chl 20 um	PIC	PSI	HPLC pigments	lugols	datatype
1	1	103	X	X	X	X	X	X															
2	2	103							X	X	X	X	X	X	X	X	X	X	X	X			
3	3	103																					
4	4	103																					
5	5	80	X	X	X	X	X	X															
6	6	80							X	X	X	X	X	X	X								
7	7	80																					
8	8	80																					
9	9	60	X	X	X	X	X	X															
10	10	60							X	X	X	X	X	X	X								
11	11	60																					
12	12	60																					
13	13	40	X	X	X	X	X	X															
14	14	40							X	X	X	X	X	X	X	X	X	X	X	X			
15	15	40																					
16	16	40																					
17	17	20	X	X	X	X	X	X															
18	18	20							X	X	X	X	X	X	X								
19	19	20																					
20	20	20																					
21	21	5	X	X	X	X	X	X															
22	22	5							X	X	X	X	X	X	X	X	X	X	X	X		X	
23	23	5																					
24	24	5																					

CTD deck bottle sampling log

(Master log to be used on deck to record all bottles sampled and by whom)

CRUISECODE	DY008	Date on deck (UTC)	16-Mar-15
GEARCODE	CTD	Time on deck (UTC)	09:11
STNNBR	262	Latitude	50 34.555
CASTNO	DY021_021	Longitude	7 6.301
Bottom depth (m)	111		

Comm: STAINLESS STEEL

Sampling order ->

Niskin bottle position	Niskin Serial No. (SERNUM)	Target sample depth (m)	oxygen	CH_4	N_2O	Nutrients	SPM	total Chl a	DOM d15n	CDOM	DOC/ TDN	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype
1	1	101																					
2	2	101	X	X	X	X	X	X															
3	3	101							X	X	X												
4	4	101																					
5	5	80																					
6	6	80	X	X	X	X	X																
7	7	80							X	X	X												
8	8	80																					
9	9	60																					
10	10	60	X	X	X	X	X																
11	11	60							X	X	X												
12	12	60																					
13	13	40																					
14	14	40	X	X	X	X	X	X															
15	15	40							X	X	X												
16	16	40																					
17	17	20																					
18	18	20	X	X	X	X	X																
19	19	20							X	X	X												
20	20	20																					
21	21	5																					
22	22	5	X	X	X	X	X	X															
23	23	5							X	X	X												
24	24	5																					

CTD deck bottle sampling log

(Master log to be used on deck to record all bottles sampled and by whom)

CRUISECODE	DY008	Date on deck (UTC)	17-Mar-15
GEARCODE	CTD	Time on deck (UTC)	11:07
STNNBR	301	Latitude	30 35.562
CASTNO	DY021_022	Longitude	7 0.770
Bottom depth (m)	109		

Comm: STAINLESS STEEL

Sampling order ->

Niskin bottle position	Niskin Serial No. (SERNUM)	Target sample depth (m)	oxygen	nutrients	SPM	Chl a	CDOM	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype
1	1	99																					
2	2																						
3	3																						
4	4																						
5	5																						
6	6																						
7	7																						
8	8																						
9	9	99	X	X	X	X	X																
10	10																						
11	11																						
12	12																						
13	13																						
14	14																						
15	15																						
16	16																						
17	17	99																					
18	18																						
19	19																						
20	20																						
21	21																						
22	22																						
23	23																						
24	24																						

CTD deck bottle sampling log

(Master log to be used on deck to record all bottles sampled and by whom)

Comm	STAINLESS STEEL

CRUISECODE	DY008
GEARCODE	CTD
STNNBR	306
CASTNO	DY021_027
Bottom depth (m)	112

Date on deck (UTC)	17-Mar-15
Time on deck (UTC)	16:27
Latitude	50 31.374
Longitude	7 2.201

Sampling order ->

Niskin bottle position	Niskin Serial No. (SERNUM)	Target sample depth (m)	oxygen	CH_4	N_2O	Nutrients	DOM d15n	CDOM	Amino Acids	DOC/ TDN	POM d15n	PC/ PN	POP	DIC / Alk	SPM	Chl a	SF Chl 2um	SF Chl 20 um	PSI	PIC	lugols	datatype	datatype
1	1	102																					
2	2	101												X	X	X	X	X	X	X			
3	3	101					X	X	X	X	X	X	X										
4	4	102																					
5	5	80																					
6	6	80												X	X								
7	7	80					X	X	X	X	X	X	X										
8	8	80																					
9	9	60																					
10	10	60												X	X								
11	11	60					X	X	X	X	X	X	X										
12	12	60																					
13	13	40																					
14	14	40												X	X								
15	15	40					X	X	X	X	X	X	X										
16	16	40																					
17	17	20																					
18	18	20												X									
19	19	20					X	X	X	X	X	X	X		X	X	X	X	X	X			
20	20	20																					
21	21	5																					
22	22	5												X	X	X	X	X	X	X	X		
23	23	5					X	X	X	X	X	X	X										
24	24	5																					

CTD deck bottle sampling log

(Master log to be used on deck to record all bottles sampled and by whom)

Comm	STAINLESS STEEL

CRUISECODE	DY008
GEARCODE	CTD
STNNBR	366
CASTNO	DY021_028
Bottom depth (m)	112

Date on deck (UTC)	18-Mar-15
Time on deck (UTC)	13:03
Latitude	50 31.339
Longitude	7 2.162

Sampling order ->

Niskin bottle position	Niskin Serial No. (SERNUM)	Target sample depth (m)	Nutrients	DOM d15n	CDOM	DOC/ TDN	SPM	Chl a	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype
1	1	100																					
2	2	100																					
3	3	100	X	X	X	X	X	X															
4	4	100																					
5	5	80																					
6	6	80																					
7	7	80	X	X	X	X	X																
8	8	80																					
9	9	60																					
10	10	60																					
11	11	60	X	X	X	X	X																
12	12	60																					
13	13	40																					
14	14	40																					
15	15	40	X	X	X	X	X																
16	16	40																					
17	17	20																					
18	18	20																					
19	19	20	X	X	X	X	X	X															
20	20	20																					
21	21	5																					
22	22	5																					
23	23	5	X	X	X	X	X	X															
24	24	5																					

CTD deck bottle sampling log

(Master log to be used on deck to record all bottles sampled and by whom)

Comm	STAINLESS STEEL

CRUISECODE	DY021
GEARCODE	CTD
STNNBR	472
CASTNO	DY021_32
Bottom depth (m)	150

Date on deck (UTC)	22/03/2015
Time on deck (UTC)	10:35
Latitude	49 23.992
Longitude	8 36.011

Sampling order ->

Niskin bottle position	Niskin Serial No. (SERNUM)	Target sample depth (m)	SPM	DOM d15n	CDOM	Amino acids	DOC / TDN	POM d15n	PC / PN	POP	DIC / ALK	Chl a	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype
1	1	100			X							X											
2	2	100	X	X		X	X	X	X	X	X												
3	3																						
4	4																						
5	5																						
6	6																						
7	7																						
8	8																						
9	9	46			X							X											
10	10	46	X																				
11	11																						
12	12																						
13	13																						
14	14																						
15	15																						
16	16																						
17	17	16			X							X											
18	18	16	X																				
19	19																						
20	20																						
21	21																						
22	22																						
23	23																						
24	24																						

CTD deck bottle sampling log

(Master log to be used on deck to record all bottles sampled and by whom)

Comm	STAINLESS STEEL

CRUISECODE	DY021
GEARCODE	CTD
STNNBR	473
CASTNO	DY021_033
Bottom depth (m)	148

Date on deck (UTC)	22/03/2015
Time on deck (UTC)	12:33
Latitude	49 24.756
Longitude	8 35.367

Sampling order ->

Niskin bottle position	Niskin Serial No. (SERNUM)	Target sample depth (m)	oxygen	N_2O	CH_4	Nutrients	DOM d15n	CDOM	Amino acids	DOC / TDN	SPM	POM d15n	PC / PN	POP	DIC / ALK	PSI	PIC	SF Chl	Chl a	datatype	datatype	datatype	datatype
1	1	140	X	X	X	X					X				X								
2	2	140					X	X	X	X		X	X	X									
3	3	140																					
4	4	110	X	X	X	X					X				X								
5	5	110					X	X	X	X		X	X	X		X	X	X	X				
6	6	110																					
7	7	80	X	X	X	X					X				X								
8	8	80					X	X	X	X		X	X	X									
9	9	80																					
10	10	60	X	X	X	X					X				X								
11	11	60					X	X	X	X		X	X	X									
12	12	60																					
13	13	45	X	X	X	X					X				X								
14	14	45					X	X	X	X		X	X	X		X	X	X	X				
15	15	45																					
16	16	30	X	X	X	X					X				X								
17	17	30					X	X	X	X		X	X	X									
18	18	30																					
19	19	15	X	X	X	X					X				X								
20	20	15					X	X	X	X		X	X	X		X	X	X	X				
21	21	15																					
22	22	5	X	X	X	X					X				X								
23	23	5					X	X	X	X		X	X	X									
24	24	5																					

CTD deck bottle sampling log

(Master log to be used on deck to record all bottles sampled and by whom)

Comm	STAINLESS STEEL
CRUISECODE	DY021
GEARCODE	CTD
STNNBR	475
CASTNO	DY021_034
Bottom depth (m)	152
Date on deck (UTC)	22/03/2015
Time on deck (UTC)	15:27
Latitude	49 24.726
Longitude	8 35.939

Sampling order ->

Niskin bottle position	Niskin Serial No. (SERNUM)	Target sample depth (m)	CDOM	SPM	Chl a	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype
1	1																						
2	2																						
3	3																						
4	4																						
5	5																						
6	6																						
7	7																						
8	8																						
9	9																						
10	10																						
11	11																						
12	12																						
13	13	100	X	X	X																		
14	14	100																					
15	15	100																					
16	16	100																					
17	17	45	X	X	X																		
18	18	45																					
19	19	45																					
20	20	45																					
21	21	15	X	X	X																		
22	22	15																					
23	23	15																					
24	24	15																					

CTD deck bottle sampling log

(Master log to be used on deck to record all bottles sampled and by whom)

Comm	STAINLESS STEEL
CRUISECODE	DY021
GEARCODE	CTD
STNNBR	506
CASTNO	DY021_035
Bottom depth (m)	150
Date on deck (UTC)	23/03/2015
Time on deck (UTC)	13:37
Latitude	49 24.599
Longitude	8 35.776

Sampling order ->

Niskin bottle position	Niskin Serial No. (SERNUM)	Target sample depth (m)	oxygen	CH_4	Nutrients	DOM d15n	CDOM	SPM	Chl a	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype
1	1	138	X	X	X	X	X	X	X														
2	2	138																					
3	3	137																					
4	4	111	X	X	X	X	X	X															
5	5	112																					
6	6	111																					
7	7	82	X	X	X	X	X	X															
8	8	82																					
9	9	82																					
10	10	62	X	X	X	X	X	X															
11	11	62																					
12	12	62																					
13	13	47	X	X	X	X	X	X															
14	14	46																					
15	15	47																					
16	16	32	X	X	X	X	X	X	X														
17	17	31																					
18	18	32																					
19	19	17	X	X	X	X	X	X															
20	20	17																					
21	21	17																					
22	22	5	X	X	X	X	X	X	X														
23	23	5																					
24	24	5																					

CTD deck bottle sampling log

(Master log to be used on deck to record all bottles sampled and by whom)

Comm	STAINLESS STEEL	CRUISECODE	DY008
		GEARCODE	CTD
		STNNBR	508
		CASTNO	DY021_037
		Bottom depth (m)	201
Date on deck (UTC)	24/03/2015		
Time on deck (UTC)	06:14		
Latitude	48 34.241		
Longitude	9 30.556		

Sampling order ->

Niskin bottle position	Niskin Serial No. (SERNUM)	Target sample depth (m)	Nutrients	DOM d15n	CDOM	Amino acids	DOC / TDN	SPM	POM d15n	PC / PN	POP	DIC / ALK	Chl a	PSI	PIC	SF Chl	datatype	datatype	datatype	datatype	datatype	datatype	datatype
1	1	198	X					X				X	X	X	X	X							
2	2	197		X	X	X	X		X	X	X												
3	3	197																					
4	4	160	X					X				X											
5	5	160		X	X	X	X		X	X	X												
6	6	161																					
7	7	120	X					X				X											
8	8	121		X	X	X	X		X	X	X												
9	9	121																					
10	10	91	X					X				X											
11	11	92		X	X	X	X		X	X	X												
12	12	92																					
13	13	61	X					X				X	X	X	X	X							
14	14	61		X	X	X	X		X	X	X												
15	15	61																					
16	16	42	X					X				X											
17	17	42		X	X	X	X		X	X	X												
18	18	44																					
19	19	22	X					X				X											
20	20	22		X	X	X	X		X	X	X												
21	21	21																					
22	22	6	X					X				X	X	X	X	X							
23	23	6		X	X	X	X		X	X	X												
24	24	6																					

CTD deck bottle sampling log

(Master log to be used on deck to record all bottles sampled and by whom)

Comm	STAINLESS STEEL	CRUISECODE	DY008
		GEARCODE	CTD
		STNNBR	511
		CASTNO	DY021_038
		Bottom depth (m)	1015
Date on deck (UTC)	24/03/2015		
Time on deck (UTC)	13:55		
Latitude	48 26.748		
Longitude	9 45.331		

Sampling order ->

Niskin bottle position	Niskin Serial No. (SERNUM)	Target sample depth (m)	CDOM	SPM	Chl a	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype	datatype
1	1	1017	X	X	X																		
2	2	1017																					
3	3	1018																					
4	4	1018																					
5	5	700	X	X	X																		
6	6	701																					
7	7	701																					
8	8	701																					
9	9	401	X	x	X																		
10	10	400																					
11	11	400																					
12	12	401																					
13	13	101	X	X	X																		
14	14	101																					
15	15	101																					
16	16	102																					
17	17	102																					
18	18	101																					
19	19	21	X	X	X																		
20	20	21																					
21	21	21																					
22	22	21																					
23	23	21																					
24	24	22																					

CTD Calibration Reports

2571 calibration & report 10 April 2015.pdf

2674 calibration & report 10 April 2015.pdf

2919 calibration & report 10 April 2015.pdf

3258 calibration & report 10 April 2015.pdf

2164 calibration & report 21 July 2015.pdf

4140 calibration & report 21 July 2015.pdf

4593 calibration & report 21 July 2015.pdf

5494 calibration & report 21 July 2015.pdf

2 NOC Liverpool mini-STABLE lander, Chris Balfour & Richard Cooke

Overview

During DY021 the NOC Liverpool (NOCL) mini-STABLE lander successfully completed a deployment at the benthic A survey site and a further deployment at the benthic G survey site. A brief description of the suite of sensors that were fitted to the lander is listed in table 1, and a labelled picture of the lander is shown in figure 1. The remaining information in this section is a tabulation of the instrumentation setups used for each deployment. Preliminary summaries of the recovered data sets from each deployment are also provided.

Table 1 – NOCL benthic survey lander sensors and systems	
Sensor	**Brief description**
Sequoia LISST 100X	laser in-situ transmissometry for sediment particle size.
Sequoia LISST HOLO	Holographic sediment imaging camera.
Marine Electronics 3D ripple profiler	Acoustic seabed scanning sonar.
Satlantic Suna	Optical dissolved nutrient sensor.
FSI/Teledyne Citadel NXIC CTD	CTD with a robust shielded inductive conductivity cell.
Nortek Aquadop	High resolution downwards facing water velocity meter.
Aquatec Aquascat	Acoustic downwards facing sensor for sediment particle size and concentration measurements.
Upward facing 1200KHz TRDI ADCP	Acoustic water current meter in a gimbal.
A McLane RAS 100 water sampler	24 x 100ml water sample bags for nutrient measurement and 24 suspended particulate matter (SPM) inline filters.
Unisense eddy correlation/dissolved oxygen flux sensing system	High resolution dissolved oxygen micro-sensor, Aanderaa optode reference dissolved oxygen sensor and a Nortek Vector high speed acoustic water velocity meter.
Teledyne Benthos XT6001	Acoustic underwater range finder.

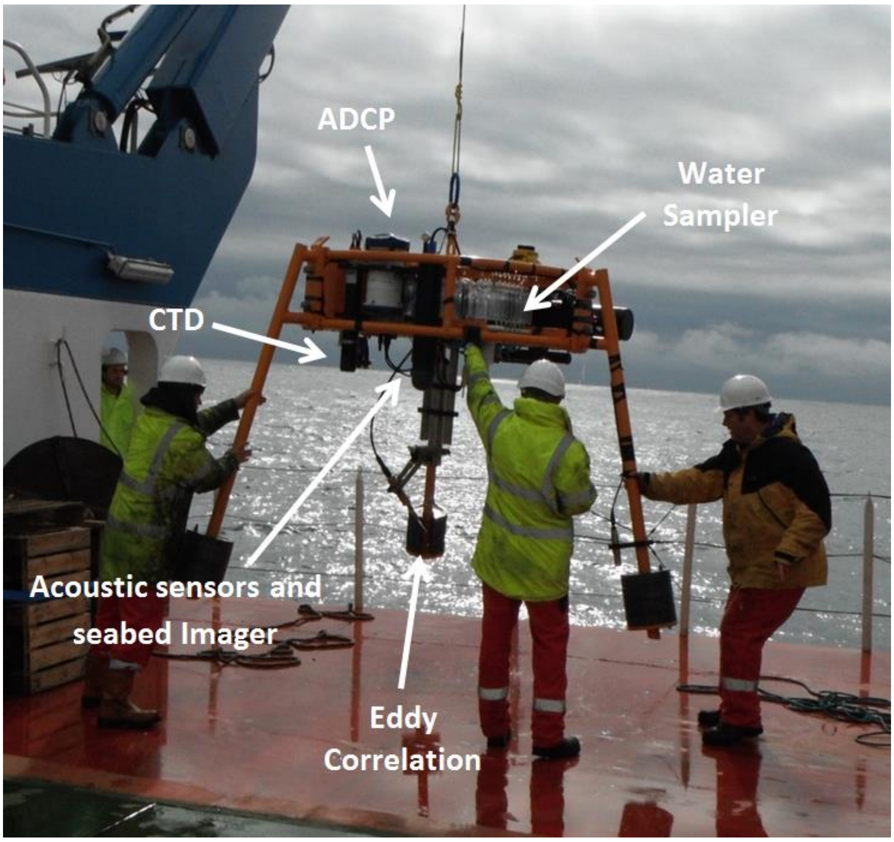


Figure 1 – Basic layout of the NOCL mini-STABLE benthic survey lander

Deployment 1 Summary

DY021 benthic site A (51° 12.685"N, 6° 8.028"W) – miniSTABLE Lander deployment 1 Out 06/03/15 at 07:55, recovered at 14:49 on 08/03/15, 51° 12.685"N, 6° 8.028"W, nom. water depth 108m	
NOCL component	**Details**
Benthos XT6000 acoustic range finder (pinger)	SN72858, RX 14.5, TX 12.0, Release A. This was only used for range finding – the release function was not used.
McLane RAS 100 Water Sampler, SN ML12500-02 at ~-108m – New pump SN13392-0 installed	Clock reset to 14:19, on 05/03/15. Set for 24 evenly time spaced samples of 80 ml from 11:00 on 06/03/15 to 11:27 on 07/03/15 (~64 minute interval). Bags pre-spiked with 20ul mercuric chloride. Pre sample 10ml 10% HCL flush (500ml reservoir) + 100ml H_2O flush. Each sample was 80ml. Also SPM filters installed in-line with the sample collection lines.
*1200 kHz RDI ADCP, SN12224	Double external battery pack and 3GB of internal memory, no pressure sensor. Clock reset and logging set to start at 06:00 on 06/03/15. Clock drift GMT + 2s at 12:19 on 09/03/15
Unisense Eddy Correlation System, AZA 13, Controller 17, Nortek Vector, Nortek order no P23865, Head ID Vec 4716 with SN1370 Aanderaa Optode	Vector clock set to 14:00 on 26/02/15 and salinity parameter set to 35PSU (close to well mixed seabed readings from CTD), 64Hz sampling, continuous mode. Eddy Correlation system clock reset to 09:27 on 05/03/15, logging started at 07:08 on 06/03/15. Calibration setup described in the metadata with the recovered measurement data set. Clock GMT -4 seconds at 22:03 on 08/03/15
3D Ripple Profiler, SN161.	Clock reset to 15:54 on 05/03/14 set to 4m range, 120 degrees swath angle/ark, hourly sample interval, 4m maximum swath depth and ~10-15 minutes per bed scan. Blanking distance 0.3m, start range 0.3m, pulse length 10us and speed of sound correction set to 1480m/s. logging configured from 06:00 on 06/03/15 to 06:00 on 08/03/15.
LISST 100X, SN1199	Laser transmissometer that is switched on by moving the external control lever to the 1 position. Fixed sample rate mode with a sample interval of 10 seconds, average of 3 samples. Clock reset to 19:13:46 on 04/03/15 and switched on at 06:48 on 06/03/15. Clock GMT -8 seconds at 16:09 on 08/03/15.
LISST HOLO, SN1416	Configured to acquire images at 5 minute intervals, with logging being initiated by moving the front control lever to the 1 position. Clock reset to 19:43:00 on 04/03/15 and switched on at 06:51 on 06/03/15. Clock GMT +2 seconds at 08:37:18 on 09/03/15.
FSI CTD SN2097 with Satlantic Suna nutrient sensor SN114.	Clock reset to 06:28 on 06/03/15 with logging started at 06:30 on 06/03/15. Sample measurements at 4Hz for 5 seconds and output average every 5 seconds. The Satlantic Suna optical nutrient sensor was connected to the third 0-5V analogue input channel of the bank of four analogue voltage inputs of the CTD. logging stopped at 10:15 on 09/03/15 – clock drift GMT was -5S.
Aquascat 1000 SN 910-084	Clock reset to 05:53 on 06/03/15 with logging set to start at 06:00 on 06/03/15. 1cm bins with 1, 2, 3 and 4MHz transducers on consecutive channels, 32Hz pulse repetition rate. Recording auxiliary pressure channel, profile range 2m, start bin 1cm end bin 201cm, burst length 55 minutes and burst interval 60 minutes. Averaging over four samples for an output rate of 8Hz, auxiliary channels (pressure) also recorded at 8Hz. Clock GMT +15 seconds at 15:38:15 on 08/03/15.

Nortek Aquadop SN P24977-1	Along beam coordinates, 2MHz with 1800s burst interval, 100mm cell size, pulse distance 2.098m resulting in a profile range of 1.8m with 4800 burst samples at 4Hz with 3 beams. Blanking distance 1.111m. Recording for 20minutes every 30 minute interval. Salinity parameter set to 35. Clock reset to 15:38 on 05/03/15. Logging set to start at 06:00 on 06/03/15. Clock GMT 0 seconds at 15:53:00 on 08/03/15.

* Script file/parameters available upon request

Summary of Recovered Data Sets – Deployment 1

Instrument	Preliminary data quality check
McLane RAS 100	24 water samples collected OK. 24 SPM filters recovered, most filters had damage to the outer edges.
1200KHz RDI ADCP	Full data return
Eddy Correlation	Full data return for ~2 days the sensor buried in sediment due to frame sinking ~50cm into the seabed based sediment shortly after the deployment. The oxygen sensor was broken during recovery.
3D Ripple Profiler	Full data return
LISST 100X	Full data return
LISST HOLO	Full data return
FSI (CTD) + Suna	Full data return
AQUASCAT 1000	Full data return
NORTEK AQUADOP	Full data return

Deployment 2 Summary

DY021 benthic site 'G' - (51° 2.223"N, 6° 35.667"W) – miniSTABLE Lander deployment 2 Out 13/03/15 at 18:45, recovered at 16:48 on 20/03/15, 51° 2.223"N, 6° 35.667"W, nom. water depth 105m. This was deployed at the CEFAS Nymphe Bank site where a notice to mariners is in force until the end of March 2015 and a guard buoy is at 51° 2.596"N, 6° 35.997"W.	
NOCL component	**Details**
Benthos XT6000 acoustic range finder (pinger)	SN72858, RX 14.5, TX 12.0, Release A. This was only used for range finding – the release function was not used.
McLane RAS 100 Water Sampler, SN ML12500-02 at ~-103m – New pump SN13392-0 installed	Clock reset to 09:54:29 GMT on 13/03/15. Set for 24 evenly time spaced samples of 80 ml over 25 hours from 22:00 on 13/03/15 to 22:27 on 14/03/15 (~104 minute interval). Bags pre-spiked with 20ul mercuric chloride. Pre sample 10ml 10% HCL flush (500ml reservoir) + 100ml H_2O flush. Each sample was 80ml. Also SPM filters installed in-line with the sample collection lines.
1200kHz RDI ADCP, SN12224	Double external battery pack and 3GB of internal memory, no pressure sensor. Clock reset at and logging set to start at 12:00 on 13/03/15. Clock drift GMT + 3s at 08:07 on 21/03/15
Unisense Eddy Correlation System, AZA 13, Controller 17, Nortek Vector, Nortek order no P23865, Head ID Vec 4716 with SN1370 Aanderaa Optode	Vector clock set to 19:13 on 11/03/15 and salinity parameter set to 35PSU (close to well mixed seabed readings from CTD), 64Hz sampling, continuous mode. Eddy Correlation system clock reset to 15:28:55 on 13/03/15, logging started at 18:19 on 13/03/15. Calibration setup described in the metadata with the recovered measurement data set. Clock GMT +1 second at 20:11 on 20/03/15
3D Ripple Profiler SN161	Clock reset to 10:01 on 13/03/14 set to 4m range, 120 degrees swath angle/ark, hourly sample interval, 4m maximum swath depth and ~10-15 minutes per bed scan. Blanking distance 0.3m, start range 0.3m, pulse length 10us and speed of sound correction set to 1480m/s. logging configured from 14:00 on 13/03/15 to 14:00 on

	15/03/15. Clock drift not checked due to leakage of memory card seal.
LISST 100X, SN1199	Laser transmissometer that is switched on by moving the external control lever to the 1 position. Fixed sample rate mode with a sample interval of 10 seconds, average of 3 samples. Clock reset to 10:46:50 on 13/03/15 and switched on at 16:25 on 13/03/15. Clock GMT -16 seconds at 21:04 on 20/03/15.
LISST HOLO, SN1416	Configured to acquire images at 5 minute intervals, with logging being initiated by moving the front control lever to the 1 position. Clock reset to 11:24:15 on 13/03/15 and switched on at 16:30 on 13/03/15. Switched off at 21:13 on 20/03/15. Clock GMT +66 seconds at 09:29:11 on 21/03/15.
FSI CTD SN2097 with Satlantic Suna nutrient sensor SN114.	Clock reset to 14:44 on 13/03/15 with logging started at 14:46 on 06/03/15. Sample measurements at 4Hz for 5 seconds and output average every 5 seconds. The Satlantic Suna optical nutrient sensor was connected to the third 0-5V analogue input channel of the bank of four analogue voltage inputs of the CTD. logging stopped at 10:21 on 21/03/15 – clock drift GMT was -50s.
Aquascat 1000 SN 910-084	Clock reset to 10:15:15 on 13/03/15 with logging set to start at 14:00 on 13/03/15. 1cm bins with 1, 2, 3 and 4MHz transducers on consecutive channels, 32Hz pulse repetition rate. Recording auxiliary pressure channel, profile range 2m, start bin 1cm end bin 201cm, burst length 55 minutes and burst interval 60 minutes. Averaging over four samples for an output rate of 8Hz, auxiliary channels (pressure) also recorded at 8Hz. Clock GMT +42 seconds at 20:33:10 on 20/03/15.
Nortek Aquadop SN P24977-1	Along beam coordinates, 2MHz with 1800s burst interval, 100mm cell size, pulse distance 2.098m resulting in a profile range of 1.8m with 4800 burst samples at 4Hz with 3 beams. Blanking distance 1.111m. Recording for 20minutes every 30 minute interval. Salinity parameter set to 35. Clock reset to 10:35:30 on 13/03/15. Logging set to start at 14:00 on 13/03/15. Clock GMT +1 second at 20:18:01 on 20/03/15.

* Script file/parameters available upon request

<u>Summary of Recovered Data Sets – Deployment 2</u>

Instrument	Preliminary data quality check
McLane RAS 100	24 water samples collected OK. 24 SPM filters recovered, most filters had damage to the outer edges
1200KHz TRDI ADCP	Full data return
Eddy Correlation	Full data return for ~2.65 days before internal battery endurance was reached. The glass oxygen micro-sensor survived a trawl recovery.
3D Ripple Profiler	Recorded 32 hours of data before a memory card problem occurred
LISST 100X	Full data return
LISST HOLO	Full data return
FSI (CTD) + Suna	Full data return
AQUASCAT 1000	Full data return
NORTEK AQUADOP	Only first day of deployment data due to a battery problem

3 Impact of sediment resuspension events on nutrient fluxes. Sarah Reynolds, School of Earth & Env Sciences, University of Portsmouth

During DY021 work was conducted to cover three main objectives:

(i) Study sediment resuspension over the main SSB process sites encompassing pumped and diffusive sediment types;

(ii) Utilise DET gel probes to examine the phosphorus, iron and alkalinity biogeochemistry of all diffusive sediment types;

(iii) Examine the capacity of permeable/advective sediments in their ability to remineralise organic matter and gain further understanding of their biogeochemistry through the use of flow through reactors.

1. Sediment Resuspension

In order to examine the impact of sediment resuspension events on nutrient fluxes two methods were employed. A large in-situ benthic Voyager flume was deployed at all four process sites as well as at Candyfloss. At the diffusive process sites (A, I and H) core mini-flume incubations were conducted. From both of these techniques employed samples were collected for nutrients (analysed on board by Malcolm Woodward and Amadine Sabadel), dissolved organic carbon (DOC) and particulate organic carbon and nitrogen (to be analysed by the University of Portsmouth). Please see Dr. Charlie Thompson's cruise report for full details of the experiments conducted and samples taken.

Sampling, Core mini flume

Date	Station	Core ID	Time Point	Time	Voltage	Volume filtered (ml)	Samples Taken
04/03/2015	A	36	T0	12:57	0	20	DY021_DOC_001
			T1	13:17	500	20	DY021_DOC_002
			T2	13:37	1000	20	DY021_DOC_003
			T3	13:57	1500	20	DY021_DOC_004
05/03/2015	A	35	T0	12:05	0	20	DY021_DOC_005
			T1	12:27	500	20	DY021_DOC_006
			T2	12:47	1000	20	DY021_DOC_007
			T3	13:07	1500	20	DY021_DOC_008
			T4	13:27	2000	20	DY021_DOC_009
			T5	13:47	2500	20	DY021_DOC_010
			T6	14:07	3000	20	DY021_DOC_011
			T7	14:27	4000	20	DY021_DOC_012
			T8	14:47	5000	20	DY021_DOC_013
05/03/2015	A	34	T0	15:44	0	20	DY021_DOC_014
			T1	16:03	500	20	DY021_DOC_015
			T2	16:22	1000	20	DY021_DOC_016
			T3	16:42	1500	20	DY021_DOC_017
			T4	17:02	2000	20	DY021_DOC_018
			T5	17:22	2500	20	DY021_DOC_019
			T6	17:42	3000	20	DY021_DOC_020
			T7	18:02	4000	20	DY021_DOC_021
			T8	18:22	5000	20	DY021_DOC_022

Date	Station	Core ID	Time Point	Time	Voltage	Volume filtered (ml)	Samples Taken
05/03/2015	A	33	T0	18:52	0	20	DY021_DOC_023
			T1	19:12	500	20	DY021_DOC_024
			T2	19:32	1000	20	DY021_DOC_025
			T3	19:52	1500	20	DY021_DOC_026
			T4	20:12	2000	20	DY021_DOC_027
			T5	20:32	2500	20	DY021_DOC_028
			T6	20:52	3000	20	DY021_DOC_029
			T7	21:12	4000	20	DY021_DOC_030
			T8	21:32	5000	20	DY021_DOC_031
15/03/2015	i	247	T0	14:16	0	20	DY021_DOC_062
			T1	14:47	500	20	DY021_DOC_063
			T2	15:07	1000	20	DY021_DOC_064
			T3	15:27	1500	20	DY021_DOC_065
			T4	15:47	2000	20	DY021_DOC_066
			T5	16:07	2500	20	DY021_DOC_067
			T6	16:27	3000	20	DY021_DOC_068
			T7	16:27	4000	20	DY021_DOC_069
			T8	17:07	5000	20	DY021_DOC_070
15/03/2015	I	246	T0	18:14	0	20	DY021_DOC_071
			T1	18:32	500	20	DY021_DOC_072
			T2	18:52	1000	20	DY021_DOC_073
			T3	19:12	1500	20	DY021_DOC_074
			T4	19:32	2000	20	DY021_DOC_075
			T5	19:52	2500	20	DY021_DOC_076
			T6	20:12	3000	20	DY021_DOC_077
			T7	20:32	4000	20	DY021_DOC_078
			T8	20:52	5000	20	DY021_DOC_079
15/03/2015	I	245	T0	21:12	0	20	DY021_DOC_080
			T1	21:32	500	20	DY021_DOC_081
			T2	21:52	1000	20	DY021_DOC_082
			T3	22:12	1500	20	DY021_DOC_083
			T4	22:32	2000	20	DY021_DOC_084
			T5	22:52	2500	20	DY021_DOC_085
			T6	23:12	3000	20	DY021_DOC_086
			T7	23:22	4000	20	DY021_DOC_087
			T8	23:52	5000	20	DY021_DOC_088
18/03/2015	H	327	T0	14:00	0	20	DY021_DOC_104
			T1	14:32	1000	20	DY021_DOC_105
			T2	14:52	2000	20	DY021_DOC_106
			T3	15:12	2500	20	DY021_DOC_107
			T4	15:32	3000	20	DY021_DOC_108
			T5	15:52	4000	20	DY021_DOC_109
			T6	16:12	5000	20	DY021_DOC_110

Date	Station	Core ID	Time Point	Time	Voltage	Volume filtered (ml)	Samples Taken
			T7	16:32	6000	20	DY021_DOC_111
			T8	16:52	7000	20	DY021_DOC_112
18/03/2015	H	323	T0	19:27	0	20	DY021_DOC_113
			T1	19:48	1000	20	DY021_DOC_114
			T2	20:08	2000	20	DY021_DOC_115
			T3	20:28	2500	20	DY021_DOC_116
			T4	20:48	3000	20	DY021_DOC_117
			T5	21:08	3500	20	DY021_DOC_118
			T6	21:28	4000	20	DY021_DOC_119
			T7	21:48	5000	20	DY021_DOC_120
			T8	21:08	6000	20	DY021_DOC_121
18/03/2015	H	322	T0	22:20	0	20	DY021_DOC_122
			T1	22:40	1000	20	DY021_DOC_123
			T2	23:00	2000	20	DY021_DOC_124
			T3	23:20	2500	20	DY021_DOC_125
			T4	23:40	3000	20	DY021_DOC_126
			T5	00:00	3500	20	DY021_DOC_127
			T6	00:20	4000	20	DY021_DOC_128
			T7	00:40	5000	20	DY021_DOC_129
			T8	01:00	6000	20	DY021_DOC_130

Sampling, Voyager Benthic Flume

Date	Station	Event	Time on seabed	Time Point	Time	Voltage	Volume filtered (ml)	Samples Taken
05/03/2015	A	63	21:28	T1	22:10	15	20	DY021_DOC_032
				T2	22:20	26	20	DY021_DOC_033
				T3	22:30	32	20	DY021_DOC_034
				T4	22:40	38	20	DY021_DOC_035
10/03/2015	G	172	03:02	T0	03:21	0	20	DY021_DOC_037
				T3	03:41	32	20	DY021_DOC_038
				T4	03:51	38	20	DY021_DOC_039
				T8	04:31	62	20	DY021_DOC_040
16/03/2015	I	258	03:07	T1	03:42	15	20	DY021_DOC_089
				T3	04:05	32	20	DY021_DOC_090
				T5	04:23	42	20	DY021_DOC_091
				T7	04:42	52	20	DY021_DOC_092
				T8	04:52	62	20	DY021_DOC_093
18/03/2015	H	357	19:20	T0	19:40	0	20	DY021_DOC_131
				T1	19:49	15	20	DY021_DOC_132
				T2	19:59	26	20	DY021_DOC_133
				T3	20:09	32	20	DY021_DOC_134
				T4	20:19	38	20	DY021_DOC_135

2. DET gel probes.

In-situ gel probes have been used over the last 20 years to determine high vertical resolution (200 μm to mm's) pore water profiles of various chemical species in soft sediments in a number of aquatic environments (shelf, coastal, estuarine and lake). Recent advancements in colorimetric techniques have also enabled the determination of 2D images of certain determinants on an mm^2 scale.

Method

During DY021, 1D and 2D gels probes were deployed in NIOZ cores collected at the diffusive sites (A, I and H). Initially, gels were deoxygenated overnight by placing in artificial seawater and bubbling with N_2 gas. Upon deployment gels were pushed into the sediment ensuring the sediment water interface was around three quarters from the bottom of the gel face. The gel probes were left in the sediment for around 24 hours with the overlying water being continuously bubbled with air throughout the deployment. When recovered the gels were analysed using colorimetric techniques and image scanning for iron II, alkalinity and phosphate following methods described by Pagès et al (2011), Bennett et al (2012) and Bennett et al (2015). Further image and data processing is required for quantification and this will be conducted at the University of Portsmouth.

Unfortunately, the gel work was not as successful as hoped and numerous problems occurred. Firstly, the phosphate method was deemed not sensitive enough to quantify the phosphate in the pore waters in a shelf sea environment where concentrations rarely exceed 10 $\mu mol\ L^{-1}$. It was decided that the phosphate biogeochemistry would not be pursued using the gel method for this cruise. Discussion is currently underway between Dr Gary Fones and Dr William Bennett (Griffith University, Australia) in an attempt to develop this method further so that it can be used in low nutrient sediments and on future SSB cruises. Secondly, during the processing of the gels from benthic station H, the laptop suffered a serious malfunction, which meant scanning of the gels was not possible. This took a couple of days to rectify but a laptop was found and the software was downloaded and installed which enabled the last benthic station (I) to be processed.

Sampling, DET gels

Station	Event Core ID	Date & Time gel deployed	Date & Time gel retrieved	Gel ID	Comments
A	32	03/03/2015 09:30	04/03/2015 20:08	DY021_ALK_1D_01	Gel broke, not scanned
		03/03/2015 09:30	04/03/2015 20:08	DY021_ALK_1D_02	Scanned
		03/03/2015 09:30	04/03/2015 20:22	DY021_ALK_2D_01	Scanned
		03/03/2015 09:30	04/03/2015 20:22	DY021_Fe_2D_01	Gel tore, scanned
		03/03/2015 09:30	04/03/2015 20:45	DY021_Fe_2D_02	Scanned
		03/03/2015 09:30	04/03/2015 20:45	DY021_ALK_2D_02	Scanned
I	243	15/03/2015 09:30	16/03/2015 15:20	DY021_Fe_1D_01	Scanned
		15/03/2015 09:30	16/03/2015 15:20	DY021_ALK_1D_03	Scanned
		15/03/2015 09:30	16/03/2015 15:44	DY021_Fe_1D_02	Scanned
		15/03/2015 09:30	16/03/2015 15:44	DY021_ALK_1D_04	Scanned
		15/03/2015 09:30	16/03/2015 16:36	DY021_Fe_2D_03	Laptop failed, no scan
		15/03/2015 09:30	16/03/2015 16:36	DY021_ALK_2D_03	Laptop failed, no scan
		15/03/2015 09:30		DY021_Fe_2D_04	No scan
		15/03/2015 09:30		DY021_ALK_2D_04	No scan
H	321	18/03/2015 11:00	19/03/2015 15:27	DY021_ALK_2D_05	Gel broke, not scanned
		18/03/2015 11:00	19/03/2015 15:27	DY021_Fe_2D_05	Scanned
		18/03/2015 11:00	19/03/2015 15:40	DY021_ALK_2D_06	Gel tore, scanned
		18/03/2015 11:00	19/03/2015 15:40	DY021_Fe_2D_06	Gel tore, scanned
		18/03/2015 11:00	19/03/2015 16:06	DY021_Fe_1D_03	Gel tore, scanned
		18/03/2015 11:00	19/03/2015 16:06	DY021_ALK_1D_05	Gel tore, scanned
		18/03/2015 11:00	19/03/2015 16:23	DY021_ALK_1D_06	Gel tore, scanned
		18/03/2015 11:00	19/03/2015 16:23	DY021_Fe_1D_04	Gel tore, scanned
		18/03/2015 10:00	19/03/2015 16:42	DY021_Fe_1D_05	Scanned
		18/03/2015 10:00	19/03/2015 16:42	DY021_Fe_1D_06	Scanned

3. Flow through reactors – Remineralisation of organic matter in permeable sediments

Sandy, permeable marine sediments found in shelf seas have been found to and exhibit substantial respiration rates and contribute significantly to dinitrogen production (Rao et al, 2007). To examine these processes within the Shelf Sea Biogeochemistry programme, an approach, which involved where incubations were conducted using flow through reactors.

Method

Surface sediment (>5 cm) was collected from benthic site G from NIOZ cores (events 131, 132, 134, 135, 136). Only surface sediment was collected in an attempt to mimic the natural environment and the advective processes associated with permeable sediments. Sediment was homogenised and placed into 3, 15 cm clear acrylic tubes with an internal diameter of 8.1 cm. Care was taken to ensure that the sediment was well packed and no large pockets of air remained. Fittings to the top and bottom of the tube were placed sealing the sediment in. To the bottom of the reactors a line in from a carboy containing aerated bottom seawater (from event 118, at 60 m; collected under trace metal clean conditions and filtered at 0.2 μm) was fitted. Using a peristaltic pump, seawater was continuously pumped through the sediment cores at a flow rate of 1 ml min^{-1}. Initial measurements were made from the influent seawater for oxygen (Unisense, flow through oxygen microsensor) and pH (Unisense, flow through pH microsensor) and samples were collected for nutrients (analysed on board by Malcolm Woodward and Amadine Sabadel) and DOC (to be analysed by the University of Portsmouth). Additional samples were also collected by Vas Kitidis from PML for analysis of O_2/Ar and N_2/Ar to monitor respiration and denitrification. The same suite of measurements/samples collected, were made from the outflow at time points over the course of two weeks.

Sampling, FTRs

				Samples Taken			
Date	Time point	Time	Column	Nutrients	DOC	Fe	N_2/Ar & O_2/Ar
10/03/2015	T0	08:00	CARBOY	FTR_T0_CARBOY	DY021_DOC_36	T0 CARBOY	233
	T1	09:40	A	T1_FTR_A	DY021_DOC_41	T1 A	232
			B	T1_FTR_B	DY021_DOC_42	T1 B	235
			C	T1_FTR_C	DY021_DOC_43	T1 C	234
	T2	18:32	A	T2_FTR_A	DY021_DOC_44	T2 A	
			B	T2_FTR_B	DY021_DOC_45	T2 B	
			C	T2_FTR_C	DY021_DOC_46	T2 C	
11/03/2015	T3	08:13	A	T3_FTR_A	DY021_DOC_47	T3 A	236
			B	T3_FTR_B	DY021_DOC_48	T3 B	237
			C	T3_FTR_C	DY021_DOC_49	T3 C	238
			CARBOY				
	T4	18:36	A	T4_FTR_A		T4 A	
			B	T4_FTR_B		T4 B	
			C	T4_FTR_C		T4 C	
12/03/2015	T5	09:53	A	T5_FTR_A	DY021_DOC_50	T5 A	239
			B	T5_FTR_B	DY021_DOC_51	T5 B	240
			C	T5_FTR_C	DY021_DOC_52	T5 C	241
	T6	18:32	A	T6_FTR_A		T6 A	
			B	T6_FTR_B		T6 B	
			C	T6_FTR_C		T6 C	
13/03/2015	T7	08:21	A	T7_FTR_A	DY021_DOC_53	T7 A	242
			B	T7_FTR_B	DY021_DOC_54	T7 B	243
			C	T7_FTR_C	DY021_DOC_55	T7 C	244
	T8	18:24	A	T8_FTR_A		T8 A	
			B	T8_FTR_B		T8 B	
			C	T8_FTR_C		T8 C	
14/03/2015	T9	08:21	A	T9_FTR_A	DY021_DOC_56	T9 A	245
			B	T9_FTR_B	DY021_DOC_57	T9 B	246
			C	T9_FTR_C	DY021_DOC_58	T9 C	247

				Samples Taken			
Date	Time point	Time	Column	Nutrients	DOC	Fe	N_2/Ar & O_2/Ar
15/03/2015	T10	08:28	A	T10_FTR_A	DY021_DOC_59	T10 A	266
			B	T10_FTR_B	DY021_DOC_60	T10 B	267
			C	T10_FTR_C	DY021_DOC_61	T10 C	268
16/03/2015	T11	09:48	A	T11_FTR_A	DY021_DOC_95	T11 A	269
			B	T11_FTR_B	DY021_DOC_96	T11 B	270
			C	T11_FTR_C	DY021_DOC_97	T11 C	271
			CARBOY	T11_CARBOY	DY021_DOC_97	T11 CARBOY	272
17/03/2015	T12	09:10	A	T12_FTR_A	DY021_DOC_98	T12 A	273
			B	T12_FTR_B	DY021_DOC_99	T12 B	274
			C	T12_FTR_C	DY021_DOC_100	T12 C	275
18/03/2015	T13	08:23	A	T13_FTR_A	DY021_DOC_101	T13 A	276
			B	T13_FTR_B	DY021_DOC_102	T13 B	277
			C	T13_FTR_C	DY021_DOC_103	T13 C	278
19/03/2015	T14	10:10	A	T14_FTR_A	DY021_DOC_138	T14 A	280
			B	T14_FTR_B	DY021_DOC_139	T14 B	281
			C	T14_FTR_C	DY021_DOC_140	T14 C	282
			CARBOY	T14_CARBOY	DY021_DOC_137	T14 CARBOY	279
20/03/2015	T15	06:51	A	T15_FTR_A	DY021_DOC_141	T15 A	283
			B	T15_FTR_B	DY021_DOC_142	T15 B	284
			C	T15_FTR_C	DY021_DOC_143	T15 C	285
21/03/2015	T16	06:20	A	T16_FTR_A	DY021_DOC_144	T16 A	286
			B	T16_FTR_B	DY021_DOC_145	T16 B	287
			C	T16_FTR_C	DY021_DOC_146	T16 C	288
22/03/2015	T17	09:03	A	T17_FTR_A	DY021_DOC_147	T17 A	19
			B	T17_FTR_B	DY021_DOC_148	T17 B	20
			C	T17_FTR_C	DY021_DOC_149	T17 C	21
23/03/2015	T18	06:54	A	T18_FTR_A	DY021_DOC_150	T18 A	40
			B	T18_FTR_B	DY021_DOC_151	T18 B	41
			C	T18_FTR_C	DY021_DOC_152	T18 C	42

Additional Samples Collected

In addition to the above work, 10 cm cores were collected from each site apart from benthic G. These were frozen at -20°C and will be analysed at the University of Portsmouth for organic carbon, organic nitrogen and phosphorus speciation (following Ruttenberg et al, 1992).

Event	Site	Number of subcore's collected
12	A	1
15	A	1
203	I	1
204	I	1
353	H	1
354	H	1
49	Candyfloss	1

References

Bennett, W. W., D.T. Welsh, A. Serriere, J. G. Panther and P. R. Teasdale (2015). A colorimetric DET technique for the high-resolution measurement of two-dimensional alkalinity distributions in sediment porewaters. *Chemosphere*, **119**, 547 – 552.

Bennett, W. W., P. R. Teasdale, D.T. Welsh, J. G. Panther and D. F. Jolley (2012). Optimization of colorimetric DET technique for the in situ, two-dimensional measurement of iron(II) distributions in sediment porewaters. *Talanta*, **88**, 490 – 495.

Pagès, A., Teasdale, P.R.,. Robertson, D., Bennett, W.W., Schafer, J., and Welsh, D.T. (2011). Representative measurement of two-dimensional reactive phosphate distributions and codistributed iron(II) and sulphide in seagrass sediment porewaters. *Chemosphere*, **85**, 1256-1261.

Rao, A. M. F., M. J. McCarthy, W. S. Gardner and R. A. Jahnke (2007). Respiration and denitrification in permeable continental shelf deposits in the South Atlantic Bight: Rates of carbon and nitrogen cycling from sediment column experiments. *Continental Shelf Research*, **27**, 1801 – 1819.

Ruttenberg, K. C. (1992) Development of a sequential extraction method for different forms of phosphorus in marine sediments. *Limnology and Oceanography*, **37**, 1460-1482.

4 Shelf sources of Fe to the Ocean. Jessica K Klar & Heather Goring-Harford (University of Southampton) and Amber Annett (University of Edinburgh)

Iron (Fe) is an essential micronutrient for marine phytoplankton. The continental shelf is an important source of Fe to oceanic waters. Here we study the cycling of Fe in the sediments and the transport of Fe from the sediments to the overlying water column on the shelf and into the open ocean. The main WP3 objectives of this benthic SSB cruise were to collect seafloor material from stations with different sediment types at key process sites and incubate sediments in seawater on the ship. Additionally, the intention was to collect water column samples the ultra-clean CTD system (UCCTD) at all main benthic process sites.

1. Sediment sampling and sediment-seawater mixing experiments

Multicore samples were collected at sites A (cohesive), I (sandy mud) and H (muddy sand). See table 1 for a summary of sediment sampling activities. At each site the Oxygen Penetration Depth (OPD) was measured in three sediment cores using high resolution microsensors (Unisense). An additional 3 to 4 cores were used for porewater extraction using the Rhizon technique (Seeberg-Elverfeldt, *et al*., 2005). Porewaters were analysed on board for dissolved Fe(II), total dissolved Fe (II and III) (using the ferrozine technique, Stookey, 1970; Gibbs, 1976) and nutrients. Preliminary results can be seen in Figure 1. Porewaters were subsampled for storage and analysis of Fe isotopes and DOP in the home lab. Core top water was collected from 4 cores at each site for dissolved Fe, Fe isotopes and nutrients. One core from each site was sliced and frozen for solid phase analysis in the home laboratory. Additional cores were used to collect core top water and porewater for Ra analysis (Amber Annett).

At process station I, the surface layer sediment (0.5 cm) and the Fe(II) maximum layer (collected under N_2 in a glove bag) were subsampled from one core and stored frozen and air-tight (in a Mylor bag) for synchrotron analysis (University of Plymouth).

Shipboard sediment – seawater incubations were carried out at sites A and H to mimic sediment resuspension events. The surface oxic layer (0.5 cm at station A and 1 cm at station H) of several sediment cores was collected, combined and homogenised. Known amounts of sediment were added to carboys containing 25 L of seawater from the same process station. The carboys were kept at bottom water temperature (9° C) in the dark and shaken periodically. Seawater was subsampled and filtered at several time points over a period of 36 hours, collecting samples for nutrients, dissolved Fe, soluble Fe, Fe-ligands, Fe isotopes, dissolved trace metals, Ra and Nd.

Table 1. Summary of sediment sampling activities for WP3 during DY021

Station number / date	location	Coring device	Experiments with sediments
053-054 04/03/15	Benthic A Cohesive /muddy site	Megacorer	Oxygen profiles 3 cores; Porewater extraction 4 cores; Sediment - seawater incubation experiment; sectioning for solid phase geochemistry 1 core
225-226 14/03/15	Benthic I Sandy mud	Megacorer	Oxygen profiles for 3 cores; Porewater extraction 3 cores; sectioning for solid phase geochemistry 1 core; solid phase synchrotron samples 1 core
340-342 18/03/15	Benthic H Muddy sand	Megacorer	Oxygen profiles 3 cores; Porewater extraction 3 cores; sectioning for solid phase geochemistry; sediment – seawater incubation experiment
353 18/03/15	Benthic H Muddy sand	Push core from NIOZ corer	Modified “SPI core”: photography, 1D DET Gel work and porewater extraction

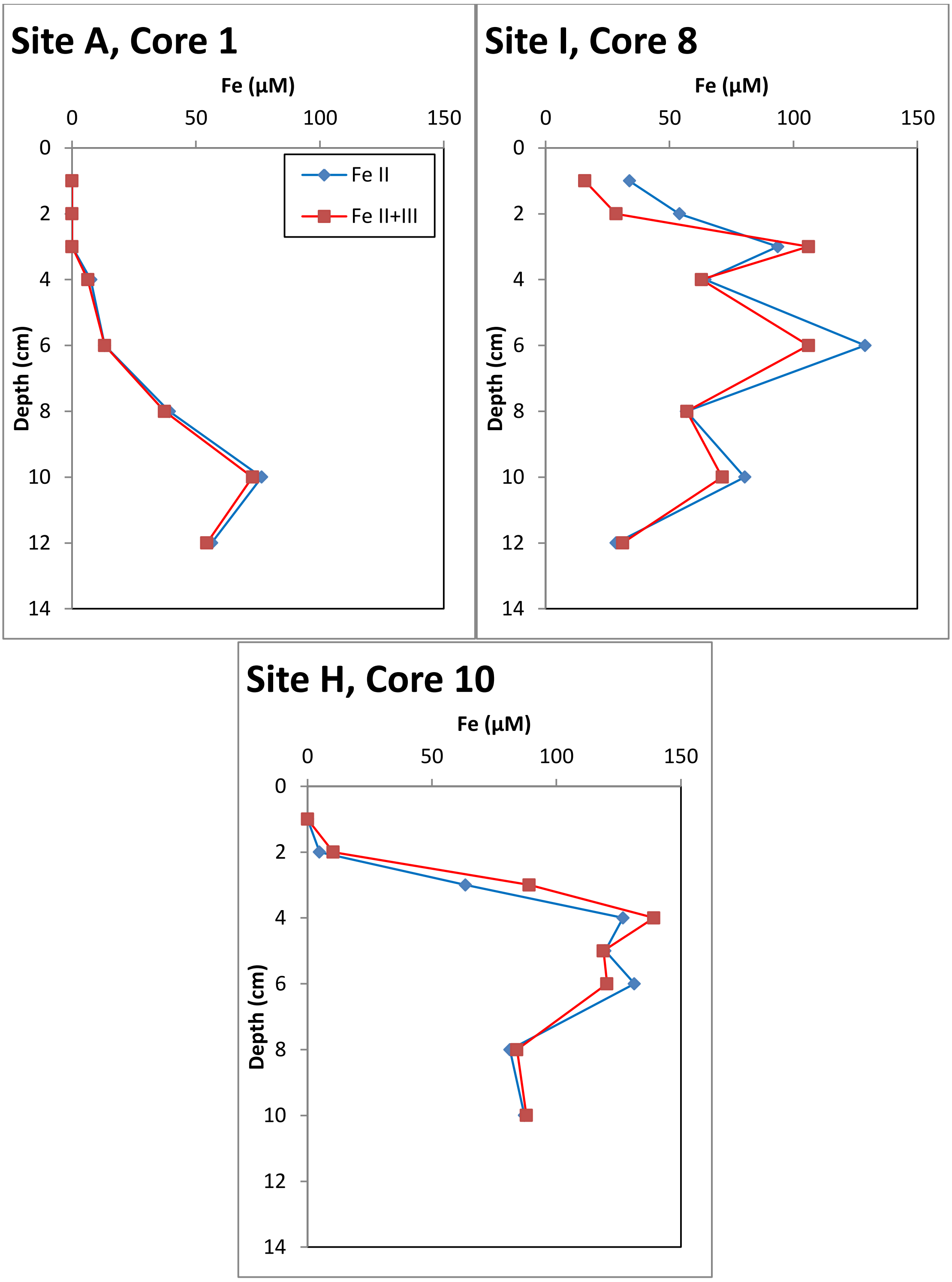


Figure 1. Preliminary results of Fe concentrations in porewaters of cores collected at process sites A, I and H during DY021

2. Release of Fe(II) and Fe(III) from FTR experiment

In collaboration with the University of Portsmouth, daily subsamples from flow-through reactors (FTR; assembled with sediment collected at sandy site G by Sarah Reynolds) were analysed on board for their Fe(II) content using the ferrozine technique. A portion of these subsamples were collected for storage and analysis for total dissolved Fe (II and III) in the home laboratory.

3. Geochemical characterization of SPI (sediment profile imager) data and 1D DET Gel probes

In discussion with CEFAS colleagues (Dr Ruth Parker) it was planned to compare SPI images with geochemical properties of collected cores. It was also planned to compare Fe(II) measurements using 1D DET Gel probes (in collaboration with Sarah Reynolds and Gary Fones, University of Portsmouth) with Fe(II) directly measured in porewaters, sampled using the Rhizon technique.

For these purposes, a 10 cm core tube was modified to have a flat Perspex face on one side and drilled holes for Rhizon work on two sides adjacent to the flat face. This modified tube was pushed into sediment material collected with the NIOZ corer at site H (muddy sand) and on retrieval and cleaning of the exterior, the flat face was photographed with a Canon camera (courtesy of R. Hale), image to be processed at CEFAS. Thereafter, a 1D DET Gel probe was inserted into the sediment and left equilibrating for approx. 24 hours. Before recovery of the Gel probe, Rhizon sampling was carried out on the core at 2 cm depth intervals at 8 depths in total, collecting porewaters for dissolved Fe(II), total dissolved Fe (II and III) and nutrients.
Unfortunately, the DET Gel probe was unsuccessful (possibly due to the high sand contents in the sediments). it is planned to repeat this experiment at muddy site A during the upcoming benthic SSB cruises. A direct comparison of the photographic image and geochemistry is going to be investigated.

4. Fe release from bioturbation and bioirrigation (collaboration with R Hale)

In collaboration with Rachel Hale (University of Southampton) it was planned to monitor the release of Fe into the overlying water due to bioturbation and bioirrigation. To this extend, three Perspex tanks were filled with surface sediment (containing the local fauna) from site I and filled with bottom water, collected using the UCCTD. A layer of coloured sands (luminophores) placed on the surface layer of the sediment in each tank was used to monitor the bioirrigation/bioturbation. A control tank containing luminophores and seawater but no sediment was also set-up. The overlying water was changed once after the first day.

Dissolved Fe samples (60 ml for University of Plymouth and 5 ml for University of Southampton for preliminary data) were taken from each tank once a day for 7 days. Samples are stored for analysis in the home laboratory.

5. Water column sampling

In order to study the link of the biogeochemical cycling of Fe in shelf sediments with the cycling of Fe in the shelf sea, water column samples were collected using the UCCTD (10 L OTE bottles with external springs for trace metal work, mounted onto a Ti frame, Kevlar wire) at all main benthic process sites (A, G, I and H), as well as at the Central Celtic Shelf (CCS) and the Shelf Edge stations (6 profiles in total). After recovery of the UCCTD, OTE bottles were immediately moved into the clean bottle sampling lab, where these were subsampled using clean lab procedures (suits, gloves, etc.).

Water depths ranged from 106 to 208 m and the water column was sampled at 5 to 9 depths. Selected depths were sampled for suspended particulate matter (SPM), oxygen, and salinity, on each cast to calibrate the transmissiometer, oxygen and conductivity sensors mounted on the Ti frame. Nutrient samples were taken from each cast at all depths. The following trace metal samples were taken at selected stations and depths: dissolved, soluble, particulate and total dissolvable iron (dFe, sFe, pFe, tdFe) (Maeve Lohan, University of Plymouth), dissolved and particulate iron isotopes (Jessy Klar, University of Southampton), dissolved and total dissolvable trace metals (dTM and tdTM), particulate samples for SEM, XRF and synchrotron work (Maeve Lohan, University of Plymouth), dissolved and particulate chromium isotopes, Cr III (Heather Goring-Harford, University of Southampton) and dissolved neodymium isotopes (Torben Stichel, University of Southampton).

Additional samples were taken at CCS to calibrate the sensors on the gliders deployed and recovered at this site. Oxygen, SPM, CDOM and Chl-a were sampled at 4 depths in the water column, as well as salinity at all depths.

Table 2. Summary of water column sampling with the UCCTD during DY021

Station number	Purpose	Date	Water depth (m)	Number of depths sampled
011	To clean OTE bottles and CTD test	03/03/2015	109	1 (24 bottled fired)
038	Site A bottom water for sed-seawater incubation experiment	04/03/2015	112	1 (14 bottles fired)
039	Site A water column trace metal work	04/03/2015	110	5 (23 bottles fired)
118	Site G water column trace metal work; bottom water for FTR experiment	08/03/2015	106	6 (21 bottles fired)
196	Site I water column trace metal work; bottom water bioturbation experiment	14/03/2015	113	5 (18 bottles fired)
304	Site H water column trace metal work; bottom water for Sed-seawater incubation experiment	17/03/2015	113	5 (16 bottles fired)
471	CCS trace metal water column work	22/03/2015	146	8 (24 bottles fired, 1 leaked)
507	Shelf Edge water column trace metal work	24/03/2015	208	9 (20 bottles fired)

Further improvements to the clean bottle room:

- The newly fitted bottle racks at the start of the cruise by NMF are not strong enough to hold the weight of the bottles when they are full with seawater. Out of a total 4 racks, the two racks in the centre were the first to sink and cause the bottles to hook off the top holder. To enable continuing to work with water sampling, we drilled holes into the top holder to tie the bottles to it with rope. This was proven a difficult operation when handling very heavy full bottles. The two external racks are starting to sink as well. A long term solution needs to be found to
- Windows in the external doors to enter the lobby. Only one door should be opened at the same time to keep the clean environment in the lab. It is impossible to check if the internal door is closed or opened when standing on the outside of the lobby.
- The internal handle on the door between the clean lab and the lobby is very hard to open. It is necessary to punch it with a fist with very much force. All scientists working in this lab ended up with bruises on their hands. A normal door handle is required.
- The Milli-Q water system is in a very unpractical position, too far away from the sink. This makes it difficult to rinse things with Milli-Q, water being splashed everywhere on the floor. In addition there is a major leak coming from the Milli-Q system.

Acknowledgements for support of WP3 activities.

All NMF personnel provided excellent support under difficult conditions. We are particularly grateful to Jeff Benson for looking after the CTD operations.

References:

Seeberg-Elverfieldt, J, Schluter, M, Feseker, T, Kolling, M, 2005, Rhizon sampling of porewaters near the sediment-water interface of aquatic systems. Limnol. Oceanogr.: Methods 3, 361-371.

Stookey, L.L., 1970. Ferrozine: a new spectrophotometric reagent for iron. Anal. Chem. 42, 779±781.

Gibbs, C.R., 1976. Characterization and application of ferrozine iron reagent as a ferrous iron indicator. Anal. Chem. 48, 1197– 1201.

5 Radium Sampling, Amber Annett, University of Edinburgh

Objectives:

Radium (Ra) is produced continuously in sediments from the decay of thorium (Th) and is occurs naturally as four radioactive isotopes: ^{223}Ra, ^{224}Ra, ^{226}Ra and ^{228}Ra. As Ra is not particle reactive, it accumulates in the pore waters of sediment, and diffuses into overlying waters. The four isotopes have different half-lives (11.4 d, 3.66 d, 1600 y and 5.75 y, respectively) spanning a range of time scales relevant to both vertical fluxes of micronutrients out of sediments, and horizontal advection.

Decreasing concentrations of each short-lived isotope away from the source (sediments) can be used in conjunction with its half-life to constrain eddy diffusivity and flux rates. These fluxes will be coupled to macro- and micro-nutrient concentrations to assess the role of sediment release as a nutrient source to the Celtic Sea shelf. As part of the pelagic WP3 sampling, an extensive water column data set was collected in November and will be repeated in April. A key parameter linking benthic fluxes to pelagic processes is constraining end member Ra concentrations and ratios in pore waters. Thus the key aim of the work during DY021 was to sample pore waters from multicorer samples, as well as core-top water, to obtain coupled measurements of Ra, iron (Fe), and nutrients. These were complemented by water column profiles with enhanced resolution towards the sediment-water interface.

A secondary aim was to investigate the release of Ra over time from different sediments, and compare this to the release and speciation of Fe. For this we carried out an incubation experiment, tracking changes in Ra concentrations over a 36 h period in bottom waters incubated with sediment. One run used mud from Site A, and the other used muddy sand from Site H.

Sampling Protocol:

Ra sampling in the water column requires very large volumes of water, as Ra activities are typically very low away from sediment sources. Samples of 60 – 100 L were collected from the stainless steel CTD system on-board the RRS Discovery at all four sediment type stations, as well as at the CANDYFLOSS station, and stored in 20 L collapsible plastic containers. These sample bottles were washed with 10% HCl prior to the cruise, and rinsed with Milli-Q between samples. At each depth processed, a subsample was collected into acid-clean 125 mL LDPE bottles for analysis of the long-lived ^{226}Ra by mass spectrometry at the University of Edinburgh.

Cores were obtained using the multi-corer, and both overlying (core-top) water and pore waters were sampled. Pore waters were collected using Rhizon sampling at 1cm intervals (see Trace Metal section for full methodology) and were pooled from the top 5cm of sediment from 4 to 5 cores to obtain adequate Ra for analysis. Core-top water was siphoned from the top of each core immediately prior to Rhizon sampling, and was also pooled from all cores sampled. Subsamples for iron, nutrients and 226Ra were collected from pore and core-top waters prior to Ra analysis.

At stations where multicoring was not possible due to high sand content, core-top water was collected from cores obtained for incubations. At the end of the incubations, 3-6 cores were sampled as above for core-top water. I am very grateful to Natalie Hicks, Dave Sivyer and Helen Smith for donating their core-top water for Ra analysis!

Each sample was weighed using a beam scale, and samples were then passed through a column holding 20 g of MnO_2-coated acrylic fiber, which strongly binds Ra. The fibers were then rinsed with Milli-Q and loaded into a Ra Delayed Coincidence Counter (RaDeCC; Scientific Computer Instruments, USA) system purged with He gas, and decay of Ra was counted for 6-10 h to quantify ^{223}Ra and ^{224}Ra content. Following decay of the short-lived isotopes, the fibres will be re-analysed using the RaDeCC to determine the activity of the parent isotopes (^{227}Ac and ^{228}Th). Mass spectrometry or gamma spectrometry can then be used to measure ratios and concentrations of the two long-lived isotopes, for which we hope to obtain funding.

Samples Collected:

Site A: 40 m 101 L 60 m 80.8 L 80 m 80.5 L 87 m 78.2 L 92 m 80.1 L 97 m 60.1 L Core-top 9.6 L Pore water 198m L	**Site G:** 20 m 98.9 L 40 m 80.7 L 60 m 102 L 75 m 60.7 L 85 m 82.2 L 93 m 61.8 L Core-top 1 3.9 L Core-top 2 5.1 L	**Site I:** 40 m 103 L 60 m 81.8 L 80 m 75.6 L 90 m 78.8 L 97 m 61.1 L 102 m 61.1 L Core-top 7.95 L Pore water 177 mL
Site H: 40 m 103 L 60 m 80.7 L 80 m 81.9 L 90 m 82.1 L 95 m 81.8 L 100 m 61.5 L Core-top 8.84 L Pore water 183 mL	**CANDYFLOSS:** 50 m 92.2 L 75 m 80.3 L 100 m 81.9 L 125 m 81.0 L 135 m 82.8 L 142 m 61.5 L Core top 10.9 L	

Preliminary Results:

Note that all data presented here are uncorrected for long-lived parent isotopes (^{228}Ra, ^{228}Th, ^{227}Ac) and interference from higher activity isotopes (^{224}Ra). Once the samples have been allowed to decay, repeated analyses are performed to make these corrections; all reported activities will thus be revised downwards due to these corrections.

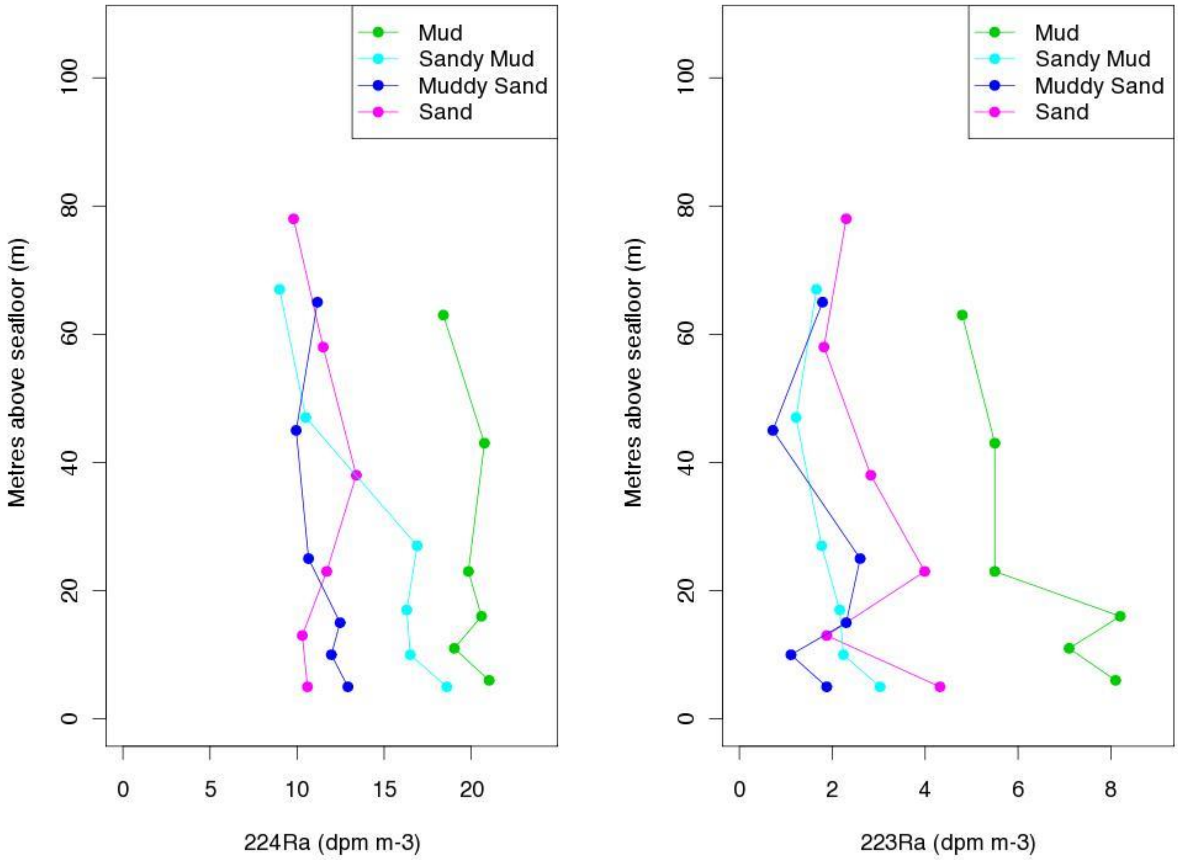


Figure 1: Short lived Ra activities (uncorrected) above the benthic process sites.

First analyses of water column profiles show consistent and similar concentrations of both short-lived Ra isotopes above the sand and muddy sand sites (Figure 1). The sandy mud displayed slightly higher ^{224}Ra at depth, and both isotopes show enrichment above Site A (mud). In general, the water columns are well mixed, especially relative to concentrations measured last November, when there was strong stratification.

In comparison to water column samples, Ra concentrations are very high in both core-top water and pore water (2 and 3 orders of magnitude higher than water column, respectively). Figure 2 compares pore waters, core-top waters, and CTD samples at the four process stations.

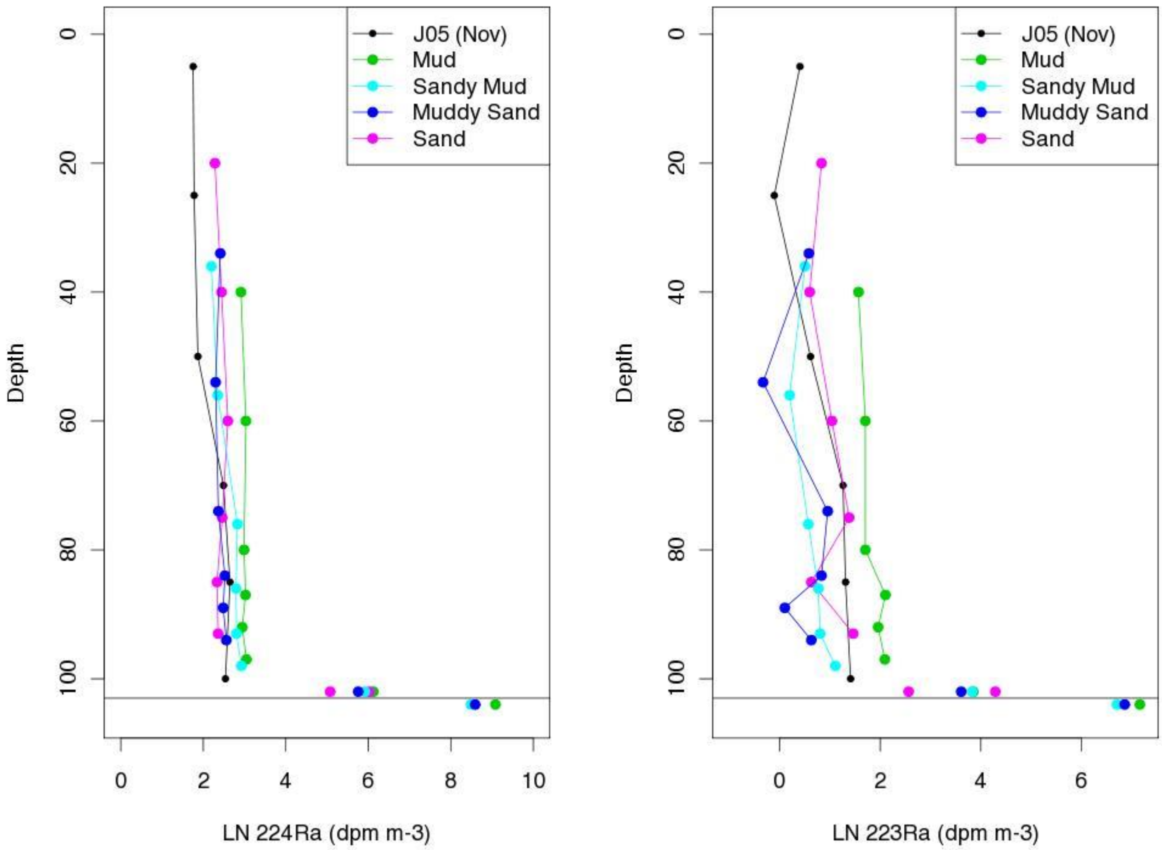


Figure 2: Short-lived Ra isotope concentrations in pore and core-top waters, relative to water column samples. Also shown for comparison are initial RaDeCC results for station J05, the closest station sampled in November.

Incubation Experiments:

The top 0.5 cm of sediment from several cores were combined into a slurry, and 30 mL of this was added to triplicate carboys containing 25 L of 60 m water. A control was also performed without addition of sediment. The carboys were incubated at ~ 9 ^{o}C, in the dark.

Subsamples of 3 L were collected at each time point using a vacuum, and filtered through 0.2 □m acid-washed polycarbonate filters in a laminar flow hood. For each of the four carboys, samples were collected for oxygen concentration, pH, nutrients, dissolved and soluble Fe, Fe ligands and trace metals. One carboy each was additionally sampled for Fe isotopes, Ra isotopes, and neodymium (Nd) isotopes.

Time points were 0, 1, 4, 12, 24 and 36 hours after sediment addition. For Ra, the 1 and 4 hour samples were combined to yield a higher signal, and at the end of the incubation all remaining water was collected to obtain as high a signal as possible in the detectors. Due to sample processing constraints (primarily the time to filter samples) and sampling capacity, some parameters were only analysed at 3 or 4 time points.

Incubation experiments were performed with samples from site A (mud), and from site H (muddy sand).

Results from the incubation experiments display a linear rate of Ra enrichment with time (Figure 3). For both short-lived Ra isotopes, the rate of enrichment is ~two-fold higher from mud than from muddy sand.

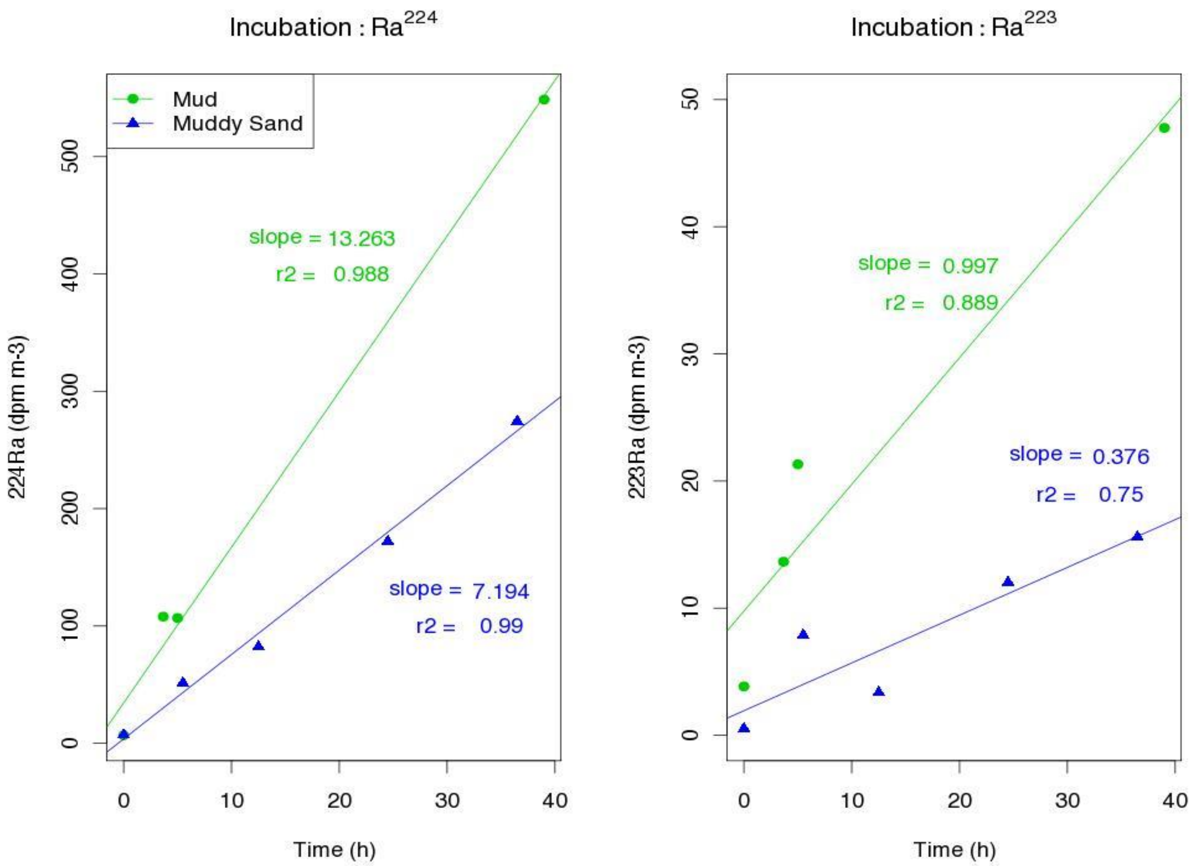


Figure 3: Short-lived Ra isotope concentrations versus time during incubation experiments.

Acknowledgements

Thank you to the officers, engineers and crew of RRS Discovery for keeping the ship and scientists fueled and running. Many thanks to the NMF technicians and crew for help with the multicorer, as well as their good company during the many CTD casts and coring. Thanks also to all the scientists who helped out with hauling around large volume radium sampling and with fixing equipment. Special thanks to Natalie, Dave and Helen for sharing core-top water samples with me, to Jessy and Heather for letting me join the trace metal team and being great company during long hours in cold rooms and clean rooms, and Malcolm for cheerful provision of caffeine whenever it was needed.

Appendix I:

Event numbers for water column samples

DY021_040	Site A
DY021_041	Site A
DY021_116	Site G
DY021_117	Site G
DY021_194	Site I
DY021_195	Site I
DY021_302	Site H
DY021_303	Site H
DY021_040	Candyfloss
DY021_040	Candyfloss

Event numbers for core samples

DY021_054	Site A	(Core-top water from cores 5, 6, 7, 8, 9, 10, 11 and 12)
DY021_055	Site A	(Pore water from cores 5, 6, 7, 8 and 9)
DY021_----	Site G	
DY021_----	Site G	(Cores from Dave Sivyer, core-top water)
DY021_145	Site G	
DY021_146	Site G	(Cores from Natalie Hicks, core-top water)
DY021_225	Site I	(Core top water from cores 1, 2, 4 and 7)
DY021_226	Site I	(Pore water from cores 1, 2, 4 and 7)
DY021_340	Site H	
DY021_341	Site H	(Core top water from cores 1, 2, 3 and 7)
DY021_342	Site H	(Pore water from cores 1, 2, 3, and 7)
DY021_477	Candyfloss	
DY021_478	Candyfloss	
DY021_479	Candyfloss	(Cores from Helen Smith, core-top water)
DY021_480	Candyfloss	
DY021_482	Candyfloss	
DY021_483	Candyfloss	

6 Sediment N cycling; faunal and microbial community structure and biomass; underway pCO_2 analyser, Steve Widdicombe & Vas Kitidis (PML)

Macrofaunal sampling from 0.1m² NIOZ box corer - At stations A, G, H, I and Candyfloss, 5 x 0.1m² sediment cores were collected using the NIOZ corer. The sediment within the NIOZ core was sieved over a nest of 2 sieves (1mm and 0.5mm) and the residues placed into separate pots and preserved with 10% buffered formaldehyde solution. This reside will be returned to PML where the ***macrofauna*** (organisms >1mm, or >0.5mm) will be extracted, identified and biomassed. At station G, only the 1mm mesh was used due to the course nature of the sediment.

Meiofaunal sampling from 0.1m² NIOZ box corer - At stations A, G, H, I and Candyfloss, 5 x 0.1m² sediment cores were collected using the NIOZ corer. The overlying water was drained off to reveal the sediment surface. In each core, three 50ml syringe corers were then pushed into the sediment to a depth of approximately 10cm. The sediment from these 3 x 50ml cores was pooled into a pot and preserved with 10% buffered (borax) formaldehyde solution. These samples will be returned to Plymouth Marine Laboratory (PML) where the **meiofauna** (organisms >63µm) will be extracted, identified and biomassed.

Megafaunal sampling from 0.5m² SMBA boxer corer - At stations A, G, H, I and Candyfloss, 5 x 0.5m² sediment cores were collected using the SMBA boxer corer. Each sample was sieved through a 1cm mesh and the residue placed into a pot and preserved with 10% buffered formaldehyde solution. This reside will be returned to PML where the ***megainfauna*** (organisms >1cm) will be extracted, identified and biomassed.

Epifaunal sampling from 2m Jennings trawl – At stations A, G, H, I and Candyfloss, epifauna were collected from 3 replicate 2m Jennings beam-trawl tows. Each tow was conducted for 5 minutes at a ship speed of 1knot. The trawl was paid out at a winch speed that kept the tension off the wire until 300m (450m at Candyfloss) of cable had been deployed. The pay-out was then halted and the timing for the trawl was started at this time. After 5 minutes the trawl recovery started (approx. 0.5m per second) and this point constituted the end of the trawl time. At the start and end of the trawl period location and time were recorded). On recovery the fauna from the trawl cod end were placed in a 5 litre bucket and preserved with 10% buffered formaldehyde solution. This reside will be returned to PML where the **epifauna** will be identified and biomassed. These data will be used to quantify the community structure and biomass of large epifaunal organisms at each of the 4 main benthic sites.

Microbial community structure sampling from 0.1m² NIOZ box corer – At stations A, G, H, I and Candyfloss, 8 samples were taken for ***microbial community structure*** analysis. Once the overlying water had been gently drained off the NIOZ core, a 50ml syringe (which had been previously sprayed with ethanol) was pushed into the sediment to a depth of approximately 10cm. The microbial cores were then extracted from the sediment, sealed and immediately frozen at -80°C.

Microbial biomass sampling from 0.1m² NIOZ box corer – 5 replicate samples were taken at stations A, G, H, I and Candyfloss. Each sample was split into 4 depths to yield a total of 20 ***microbial biomass*** samples per site. Once the overlying water had been gently drained off the NIOZ core, 30ml syringes (which had been previously sprayed with ethanol) were pushed into the sediment to a depth of approximately 10cm. Each syringe core was sectioned into 4 depths: surface sediment (0 – 1cm), 1 – 2.5 cm, 2.5 – 5 cm and 5 – 10 cm. From each of the 20 sediment samples, approximately 0.5 ml of sediment was added to a 2 ml tube and mixed with a spatula. Then, 1ml of 5 mM CTC was added to sediment in each tube, this was vortex mixed and incubated at sediment temperature for 1 hour. The tubes were then centrifuged at 5000 g for 1 minute. The CTC solution was then removed from each tube and replaced with 1ml 4 % paraformaldehyde. The tubes were then sealed with parafilm and stored at – 20°C.

"Spatial Survey" sampling for macrofauna and meiofauna - At 51 stations distributed around the Celtic Sea sampling area, mostly located between the main process stations, macrofauna and meiofauna samples were collected from NIOZ cores using the same methodology as described above, with the exception that meiofauna and macrofauna samples were taken from separate NIOZ cores and that pore water samples were taken from the macrofauna cores prior to sieving. These faunal samples will complement the physical and chemical samples and the SPI images taken at each of the spatial survey stations.

Microbial sampling from bioturbation experiments – 4-6 replicate samples were taken from each bioturbation experiment tank at stations A, G, H, I. At the end of bioturbation experiments, surface sediment was sampled using a 5 mL syringe (which had been previously sprayed with ethanol). Bioturbated and non-bioturbated sediment was specifically targeted in each tank. The sediment was immediately transferred into a 4 mL Eppendorf vial with 2 mL soil preservation solution and frozen at -20°C.

Pigment sampling from 0.1m^2 NIOZ box corer – At stations A, G, H, I and Candyfloss, 6 replicate samples were taken. Once the overlying water had been gently drained off the NIOZ core, a 50ml taped (blacked out) syringe was pushed into the sediment to a depth of approximately 10cm. The sediment ***pigment cores*** were then extracted from the sediment, sealed and immediately frozen at -80°C.

Nitrification rates from NIOZ cores – At stations A, G, H, I and Candyfloss, 12 replicate samples of surface sediment were collected in pre-weighed, 14 mL glass vials (surface scrapings of top 0.5 cm). Approximately 2-3 mL of sediment was collected in each vial and filled with bottom water to create a slurry. Subsets of the slurries were ammended with 0.1 mL of 1M zinc chloride ($ZnCl_2$; n=3), 0.1 mL of 1M allylthiourea (ATU; n=3) and 0.1 mL of 1M sodium chlorate ($NaClO_3$; n=6) and incubated in the CT-room at bottom temperature for ca. 24 hours. A parallel incubation without sediment (bottom water + treatments) was conducted at the same time. At the end of the incubation period, 0.1 mL of 1M $ZnCl_2$ was added to all the bottles for preservation. Ammonium oxidation rates will be measured as rates of nitrite accumulation in the $NaClO_3$-treated samples compared to the ATU-treated samples. The initial $ZnCl_2$-treatment acts as the starting point. Sediment rates will be corrected for ammonium oxidation in bottom water.

Denitrification/Anammox rates from NIOZ cores – At stations A, G, H, I and Candyfloss, 12 replicate cores were collected (i.d. 7 cm) from 5-6 separate NIOZ cores. Each core-tube had approximately 15-20 cm of sediment and 10-15 cm of overlying water. Overlying water was discarded from each core and replaced with bottom water ammended with $^{15}NO_3^-$ (Three treatments: +0 µM, +50 µM, +200 µM $^{15}NO_3^-$). The +0 treatment was homogenized with a power tool and the slurry decanted into 125 mL glass bottles. 1 mL of 1M ZnCl2 was added for preservation and the bottles were sealed with Teflon-lined rubber septa and Al-crimps. The remaining two treatments were incubated in the CT-room, at bottom water temperature for ca. 24 hours. Magnetic flees were suspended in the core tubes and agitated by an external electromagnetic circuit. After the incubation period, the cores were homogenized and preserved as above. Denitrification and Anammox rates will be determined post-cruise by membrane inlet mass spectrometry.

Underway pCO_2 analyser – A PML-Dartcom Live pCO_2 instrument was set up in the meteorological laboratory on the boat deck (hereafter met-lab). Gas standards (BOC Ltd.; nominal mixing ratios 250, 380, 450 ppmv in synthetic air; calibrated against NOAA primaries) were located in the gas bottle rack in the forward moorings area on the boat deck (port-side) and an air sampling line was taken from the met-lab to the foremast. The system comprises a showerhead equilibrator vented through a second equilibrator, in-line oxygen optode and platinum resistance thermometer, nafion dryer, non-dispersive infrared detector (LiCOR, LI-840) and associated hardware and electronics. A series of water leaks related to the ship's plumbing impeded continuous operation, as previously on DY008 (March 2014).

Station	**STN A**	**STN H**	**STN I**	**STN G**	**Candyfloss**
Sediment type	Mud	Muddy sand	Sandy Mud	Sand	Sand
Date sampled	3rd–4th March	17th-19th March	14th-16th March	8th–9th March	22nd-23rd March
Microbial community structure	6 reps	6 reps	6 reps	6 reps	6 reps
Microbial biomass	5 reps (4 depths)	5 reps (4 depths)	5 reps (4 depths)	5 reps (4 depths)	5 reps (4 depths)
Meiofauna (>63µm)	5 reps	5 reps	5 reps	5 reps	5 reps
Macrofauna (>1mm	5 reps	5 reps	5 reps	5 reps	5 reps
Megainfauna (>1cm)	5 reps	5 reps	5 reps	5 reps	5 reps
Epifauna	3 reps	3 reps	3 reps	3 reps	3 reps
Sediment pigments	8 reps	8 reps	8 reps	8 reps	8 reps
Nitrification	6 reps	6 reps	6 reps	6 reps	6 reps
Denitrification	4 reps	4 reps	4 reps	4 reps	4 reps

Table 1: Samples collected for further analysis at Plymouth Marine Laboratory on DY021.

Figure 1: A variety of benthic sampling equipment was deployed on DY021: (main picture from left to right) SMBA 0.5m^2 box-corer, NIOZ 0.1m^2 corer, Sediment Profile Image (SPI)camera, ChemSPI; (top right) Voyager II benthic *in situ* flume; (bottom right) 2m Jennings Beam trawl.

Figure 2: Smiles all round as the last NIOZ core is collected. On behalf of the scientists on DY021, a massive thank you to all the coring support team – Steve, Willie, Raoul and Howard (pictured above) plus Greg, Bob, Gary, Dickie, Owain and Richie (not in the picture).

Station A - Macrofauna and meiofauna samples

Rep	Event	Date	Latitude	Longitude	Depth (m)	Comments
1	18	3rd March 2015	51 12.701	6 7.994	112	Good core
2	19	3rd March 2015	51 12.702	6 7.996	112	Good core
3	27	3rd March 2015	51 12.699	6 8.014	110	Good core
4	29	3rd March 2015	51 12.698	6 8.014	109	Good core
5	30	3rd March 2015	51 12.698	6 8.104	110	Good core

Station A - Megafauna samples

Rep	Event	Date	Latitude	Longitude	Depth (m)	Comments
1	42	4th March 2015	51 12.696	6 8.024	108	Good core
2	43	4th March 2015	51 12.696	6 8.024	107	Good core
3	44	4th March 2015	51 12.696	6 8.023	108	Good core
4	45	4th March 2015	51 12.695	6 8.024	108	Good core
5	46	4th March 2015	51 12.696	6 8.024	109	Good core

Station G - Macrofauna samples

Rep	Event	Date	Latitude	Longitude	Depth (m)	Comments
1	127	8th March 2015	51 4.473	6 35.007	104	Good core – pw
2	129	8th March 2015	51 4.473	6 35.001	103	Good core – pw
3	133	8th March 2015	51 4.476	6 35.007	104	Good core – pw
4	137	9th March 2015	51 4.475	6 35.007	102	Good core +meio
5	138	9th March 2015	51 4.470	6 35.004	102	Good core + meio

Station G - Meiofauna samples

Rep	Event	Date	Latitude	Longitude	Depth (m)	Comments
1	137	9th March 2015	51 4.475	6 35.007	102	Good core + macro
2	138	9th March 2015	51 4.470	6 35.004	102	Good core + macro
3	139	9th March 2015	51 4.473	6 34.999	101	Good core +Vas
4	143	9th March 2015	51 4.477	6 35.014	102	Good core + Vas
5	144	9th March 2015	51 4.470	6 35.003	102	Good core + Vas

Station G - Megafauna samples

Rep	Event	Date	Latitude	Longitude	Depth (m)	Comments
1	166	9th March 2015	51 4.457	6 34.988	105	Good core – very little life
2	167	9th March 2015	51 4.457	6 34.991	102	Good core – very little life
3	168	9th March 2015	51 4.461	6 34.990	102	Good core – very little life
4	169	9th March 2015	51 4.455	6 34.997	102	Good core - no fauna
5	170	9th March 2015	51 4.458	6 35.009	102	Good core – very little life

Station H - Macrofauna and meiofauna samples

Rep	Event	Date	Latitude	Longitude	Depth (m)	Comments
1	311	17th March 2015	50 31.351	7 2.201	110	
2	316	17th March 2015	50 31.346	7 2.195	109	
3	320	17th March 2015	50 31.343	7 2.192	109	
4	325	17th March 2015	50 31.339	7 2.188	110	
5	328	17th March 2015	50 31.338	7 2.189	110	

Station H - Megafauna samples

Rep	Event	Date	Latitude	Longitude	Depth (m)	Comments
1	330	17th March 2015	50 31.335	7 2.186	110	No Fauna
2	331	17th March 2015	50 31.335	7 2.185	110	

3	332	17th March 2015	50 31.335	7 2.187	111	No fauna
4	333	17th March 2015	50 31.335	7 2.187	111	
5	334	17th March 2015	50 31.335	7 2.187	111	No fauna

Station I - Macrofauna samples

Rep	Event	Date	Latitude	Longitude	Depth (m)	Comments
1	219	14th March 2015	50 34.546	7 6.273	112	With pore waters
2	227	14th March 2015	50 34.548	7 6.263	113	With pore waters
3	232	15th March 2015	50 34.550	7 6.255	114	With pore waters
4	237	15th March 2015	50 34.550	7 6.248	114	Meiofauna
5	242	15th March 2015	50 34.553	7 6.239	111	Meiofauna

Station I - Meiofauna samples

Rep	Event	Date	Latitude	Longitude	Depth (m)	Comments
1	233	15th March 2015	50 34.551	7 6.257	115	
2	235	15th March 2015	50 34.550	7 6.258	114	
3	236	15th March 2015	50 34.548	7 6.256	114	
4	237	15th March 2015	50 34.550	7 6.248	114	
5	242	15th March 2015	50 34.553	7 6.239	111	

Station I - Megafauna samples

Rep	Event	Date	Latitude	Longitude	Depth (m)	Comments
1	220	14th March 2015	50 34.546	7 6.271	111	No fauna
2	221	14th March 2015	50 34.540	7 6.270	111	
3	222	14th March 2015	50 34.545	7 6.271	112	
4	223	14th March 2015	50 34.546	7 6.272	112	
5	224	14th March 2015	50 34.545	7 6.273	113	

Candyfloss – Macrofauna and Meiofauna

Rep	Event	Date	Latitude	Longitude	Depth (m)	Comments
1	487	22nd March 2015	49 24.706	8 35.813	153	
2	489	22nd March 2015	49 24.702	8 35.812	153	
3	491	22nd March 2015	49 24.665	8 35.733	151	
4	493	22nd March 2015	49 24.664	8 35.732	150	
5	495	22nd March 2015	49 24.665	8 35.732	151	

Candyfloss – Megafauna

Rep	Event	Date	Latitude	Longitude	Depth (m)	Comments
1	496	22nd March 2015	49 24.657	8 35.737	149	
2	497	22nd March 2015	49 24.652	8 35.746	149	
3	498	22nd March 2015	49 24.646	8 35.754	150	
4	499	22nd March 2015	49 24.668	8 35.733	149	No fauna
5	500	22nd March 2015	49 24.668	8 35.734	149	

Table 2: Faunal sampling details from DY021

Station A – Epifauna trawls

Rep	Event	Date	Latitude	Longitude	Depth (m)	Comments
1	176	11th March 2015	51 12.620	6 8.220	110	Start at 10.39h
			51 12.520	6 8.220		End at 10.45h
2	178	11th March 2015	51 12.545	6 8.100	110	Start at 12.37h
			51 12.440	6 8.100		End at 12.42h

3	183	13th March 2015	51 12.738	6 7.835	110	Start at 12.48h
			51 12.819	6 7.849		End at 12.53h 2 small angler fish.
Station G – Epifauna trawls						
Rep	Event	Date	Latitude	Longitude	Depth (m)	Comments
1	185	13th March 2015	51 4.135	6 35.036	105	Start at 20.43h South of box
			51 4.224	6 35.033		End at 20.48h
2	186	13th March 2015	51 4.446	6 35.009	105	Start at 21.25h NW corner
			51 4.528	6 35.008		End at 21.30h
3	187	13th March 2015	51 4.463	6 35.002	105	Start at 22.11h NW corner
			51 4.544	6 35.003		End at 22.16h
Station H – Epifauna trawls						
Rep	Event	Date	Latitude	Longitude	Depth (m)	Comments
1	375	18th March 2015	50 31.355	7 2.112	109	Start at 22.55h
			50 31.416	7 2.016		End at 23.00h
2	376	18th March 2015	50 31.324	7 2.170	109	Start at 23.38h
			50 31.381	7 2.077		End at 23.43h Net caught so not trawling fully open.
3	377	19th March 2015	50 31.372	7 1.961	110	Start at 00.30h
			50 31.421	7 1.862		End at 00.35h
4	378	19th March 2015	50 31.366	7 1.990	111	Start at 01.33h
			50 31.415	7 1.887		End at 01.38h
Station I – Epifauna trawls						
Rep	Event	Date	Latitude	Longitude	Depth (m)	Comments
1	259	16th March 2015	50 34.568	7 6.405	110	Start at 06.11h
			50 34.570	7 6.269		End at 06.16h
2	260	16th March 2015	50 34.587	7 6.080	110	Start at 06.56h
			50 34.588	7 6.214		End at 07.01h
3	261	16th March 2015	50 34.591	7 6.455	110	Start at 07.41h
			50 34.591	7 6.307		End at 07.46h
Candyfloss						
Rep	Event	Date	Latitude	Longitude	Depth (m)	Comments
1	503	22nd March 2015	49 24.731	8 36.918	154	Start at 05.03h
			49 24.678	8 37.018		End at 05.08h
2	504a	22nd March 2015	49 24.712	8 36.939	153	
			49 24.659	8 37.038		
3	504b	22nd March 2015	49 24.177	8 37.982	154	
			49 24.124	8 38.089		

Table 3: 2m Jennings trawl sampling details Dy021

Macrofauna						
Rep	Event	Date	Latitude	Longitude	Depth (m)	Comments
S1	55	4th March 2015	51 16.371	6 15.396	124	
S2	65	6th March 2015	51 14.683	6 18.535	114	

S3	68	6th March 2015	51 13.891	6 13.715	130	
S4	76	6th March 2015	51 5.716	6 30.308	109	
S5	79	6th March 2015	51 7.130	6 26.032	107	
S6	83	6th March 2015	51 8.588	6 21.502	107	
S7	86	7th March 2015	51 9.126	6 16.953	112	
S8	90	7th March 2015	51 11.139	6 13.181	132	
S9	92	7th March 2015	51 12.403	6 18.228	125	
S10	110	8th March 2015	51 11.064	6 22.867	105	
S11	112	8th March 2015	51 9.674	6 27.351	100	
S12	114	8th March 2015	51 8.247	6 31.819	99	
S13	101	7th March 2015	51 0.665	6 27.505	109	
S14	103	7th March 2015	51 2.073	6 22.961	103	
S15	108	7th March 2015	51 2.952	6 20.008	106	
S16	188	13th March 2015	50 58.818	6 39.420	103	
S17						Station 17 abandoned
S18	264	16th March 2015	50 36.696	7 9.190	112	Day
S19	266	16th March 2015	50 39.092	7 7.187	114	Day
S20						Station 20 abandoned
S21	272	16th March 2015	50 40.165	7 3.454	109	Day
S22	274	16th March 2015	50 38.298	7 5.017	108	Day
S23	279	16th March 2015	50 35.396	7 7.429	112	
S24	281	16th March 2015	50 33.006	7 9.383	112	
S25	288	17th March 2015	50 30.609	7 11.399	112	
S26	290	17th March 2015	50 29.626	7 9.360	115	
S27	294	17th March 2015	50 31.632	7 7.670	115	
S28	296	17th March 2015	50 33.978	7 5.797	114	
S29	367	18th March 2015	50 30.425	7 5.752	112	Day
S30	371	18th March 2015	50 32.661	7 3.927	114	Day
S31	379	19th March 2015	50 36.961	6 59.847	114	
S32	384	19th March 2015	50 36.847	6 57.690	111	
S33	386	19th March 2015	50 34.784	6 54.990	113	Day
S34	392	19th March 2015	50 32.751	6 52.755	106	Day
S35	395	19th March 2015	51 4.620	6 24.442	115	
S36	399	19th March 2015	51 5.911	6 20.582	114	
S37	401	19th March 2015	51 7.364	6 15.557	106	
S38	405	20th March 2015	51 8.865	6 9.909	108	
S39	407	20th March 2015	51 6.233	6 9.346	103	
S40	413	20th March 2015	51 4.844	6 14.026	112	
S41						Abandon site, too rocky
S42	418b	20th March 2015	50 51.270	6 41.297	105	Day
S43	422	20th March 2015	50 55.344	6 46.925	104	Day
S44	424	20th March 2015	51 2.937	6 45.039	100	Day
S45	431	20th March 2015	51 0.888	6 42.023	104	
S46						Abandon site, too rocky
S47						Abandon site, too rocky
S48	438	20th March 2015	50 49.947	6 51.407	105	
S49	442	21st March 2015	50 46.731	6 58.824	108	
S50	444	21st March 2015	50 44.415	6 55.837	109	
S51	448	21st March 2015	50 42.406	6 53.021	112	
S52	450	21st March 2015	50 47.814	6 48.578	109	Day
S53	454	21st March 2015	50 45.767	6 45.907	106	Day
S54	459	21st March 2015	50 40.505	6 50.742	104	Day
S55	463	21st March 2015	50 38.242	6 47.680	104	Day
S56						Abandon site, too rocky
S57	466	21st March 2015	50 36.390	7 3.687	112	Day
Meiofauna						

Rep #	Event	Date	Latitude	Longitude	Depth (m)	Comments
S1	56	4th March 2015	51 16.371	6 15.396	123	
S2	66	6th March 2015	51 14.683	6 18.535	110	
S3	69	6th March 2015	51 13.891	6 13.719	127	
S4	78	6th March 2015	51 5.724	6 30.307	106	
S5	80	6th March 2015	51 7.129	6 26.031	108	
S6	85	6th March 2015	51 8.589	6 21.502	112	
S7	87	7th March 2015	51 9.913	6 16.953	112	
S8	91	7th March 2015	51 11.138	6 13.180	134	
S9	93	7th March 2015	51 12.402	6 18.229	126	
S10	111	8th March 2015	51 11.063	6 22.867	105	
S11	113	8th March 2015	51 9.673	6 27.352	98	
S12	115	8th March 2015	51 8.246	6 31.819	101	
S13	102	7th March 2015	51 0.664	6 27.506	108	
S14	104	7th March 2015	51 2.074	6 22.963	107	
S15	109	7th March 2015	51 2.952	6 20.008	106	
S16	189	14th March 2015	50 58.820	6 39.423	105	
S17						Station 17 abandoned
S18	265	16th March 2015	50 36.696	7 9.188	112	
S19	267	16th March 2015	50 39.092	7 7.188	113	
S20						Station 20 abandoned
S21	273	16th March 2015	50 40.165	7 3.454	109	
S22	276	16th March 2015	50 38.298	7 5.017	108	
S23	280	16th March 2015	50 35.396	7 7.429	112	
S24	285	16th March 2015	50 33.008	7 9.378	113	
S25	289	17th March 2015	50 30.610	7 11.399	112	
S26	291	17th March 2015	50 29.626	7 9.359	115	
S27	295	17th March 2015	50 31.632	7 7.669	115	
S28	297	17th March 2015	50 33.980	7 5.795	113	
S29	368	18th March 2015	50 30.425	7 5.752	112	
S30	372	18th March 2015	50 32.660	7 3.927	114	
S31	380	19th March 2015	50 36.962	6 59.847	114	
S32	385	19th March 2015	50 36.847	6 57.690	111	
S33	388	19th March 2015	50 34.782	6 54.989	113	Day
S34	393	19th March 2015	50 32.746	6 52.777	106	Day
S35	396	19th March 2015	51 4.620	6 24.441	114	
S36	400	19th March 2015	51 5.911	6 20.582	113	
S37	401	19th March 2015	51 7.364	6 15.558	106	
S38	406	20th March 2015	51 8.865	6 9.909	108	
S39	408	20th March 2015	51 6.233	6 9.346	103	
S40	414	20th March 2015	51 4.843	6 14.025	113	
S41						Abandon site, too rocky.
S42	418c	20th March 2015	50 51.271	6 41.298	104	Day
S43	423	20th March 2015	50 35.335	6 46.941	104	Day – very small sample?
S44	426	20th March 2015	51 2.945	6 45.024	104	Day
S45	432	20th March 2015	51 0.888	6 42.024	104	
S46						Abandon site, too rocky
S47						Abandon site, too rocky
S48	439	20th March 2015	50 49.947	6 51.407	105	
S49	443	21st March 2015	50 46.731	6 58.824	109	
S50	445	21st March 2015	50 44.414	6 55.835	110	
S51	449	21st March 2015	50 42.409	6 53.013	112	
S52	451	21st March 2015	50 47.830	6 48.570	109	Day
S53	455	21st March 2015	50 45.767	6 45.907	105	Day
S54	460	21st March 2015	50 40.482	6 50.784	104	Day

S55	464	21st March 2015	50 38.242	6 47.680	104	Day
S56						Abandon site, too rocky
S57	467	21st March 2015	50 36.390	7 3.687	112	Day

Table 4: Spatial survey faunal sampling details from DY021

Box coring notes
Station A – Very soft mud. 2 layers of weight. Bottom of stopper placed 15cm above upper pin position.
Station G, full weights, stopping bracket should be about 30cm above safety pin.
Station H and I, 3 weights, stopping bracket 30cm above safety pin.

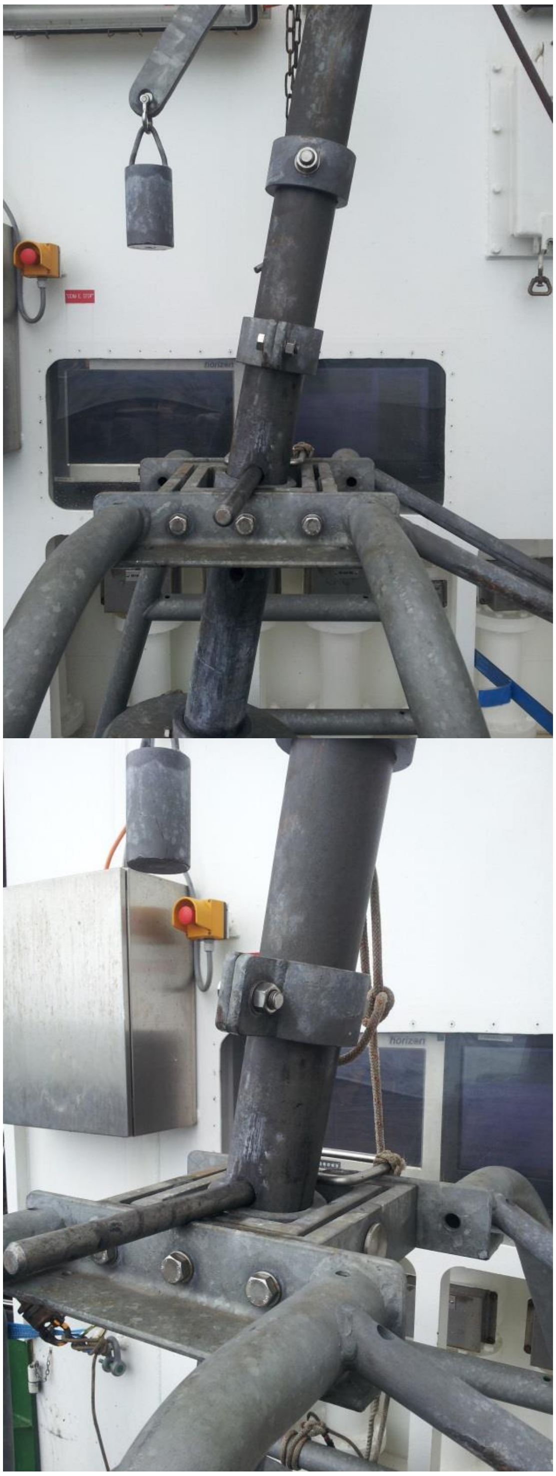
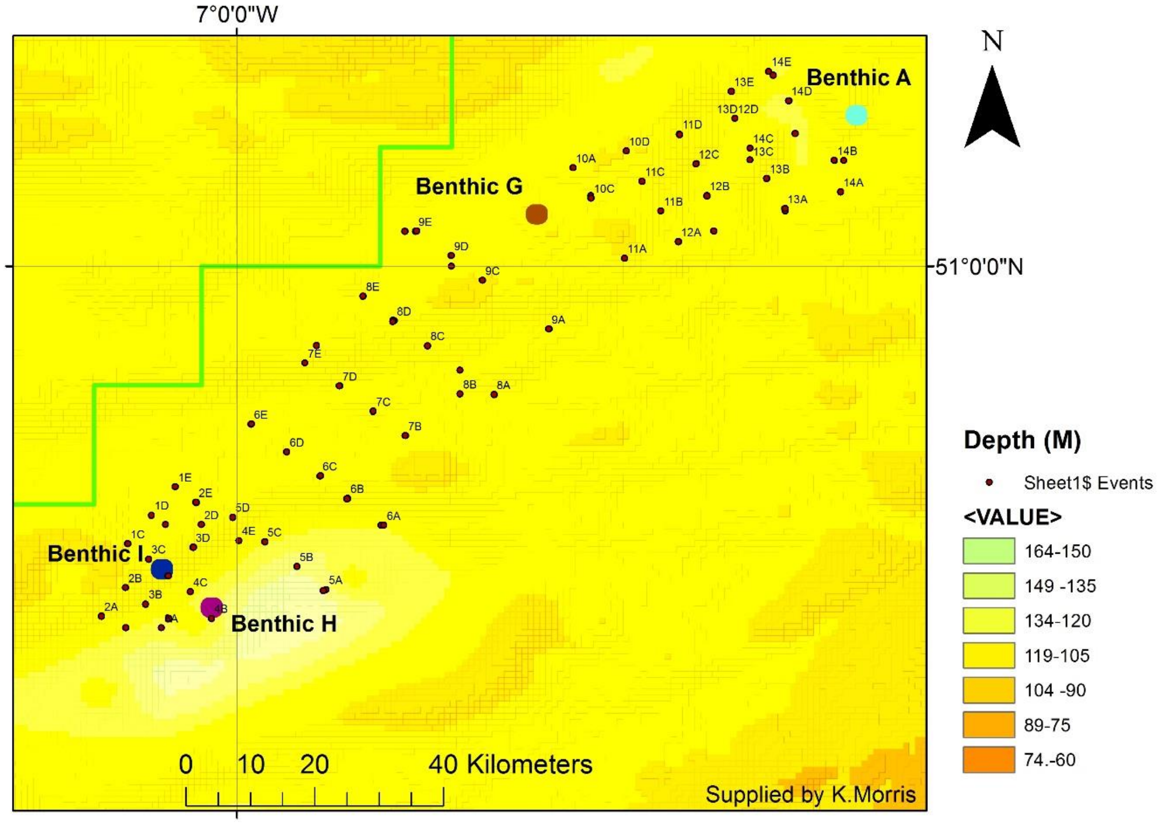


Figure 1: NIOZ corer showing position of pin and stopping bracket.

Trawling – tow for 5 minutes at 1knot. Pay out 300m of cable. Start is when winch is stopped and end is when the winch starts to pull in ($0.5ms^{-1}$)

7 CEFAS Cruise Report, Dave Sivyer & Briony Silburn

Work was completed successfully at process sites A, G, H and I, at Candyfloss and at 57 of the planned 70 spatial survey sites.



Sediment Profile Imagery (SPI) was collected at all four main sites, as well as across the Celtic Sea area for the spatial survey. The images produced are a slice through the sediment, showing the sediment water interface and undisturbed layering below the sediment surface. These images will be analysed at both Cefas and NOC for penetration depth, apparent redox potential depth (aRPD), surface roughness and changing grain size with depth. The Chem SPI was used at the four main sites and Candyfloss. In addition to the usual image analysis, the Chem SPI has a pH gel probe attached to the face plate and was left in position on the sea bed for 10 minutes per hop. Image analysis of the probe will determine an in-situ pH profile through the sediment from colour changes in the gel. Samples for sediment characterisation were collected from the NIOZ corer at the four main sites, as well as across the Celtic Sea area for the spatial survey. Particle size analysis (PSA)/Organic carbon and Nitrogen (OCN) and Porosity/Chlorophyll sub-cores were sliced to depths of 0-5cm and 5-10cm and will be processed in the Cefas labs. Rapid fines assessment (RFA) was collected at a depth of 0-5cm using a syringe and processed onboard giving an initial indication of the percentage of fines to sand at each site. A sub-core was profiled using a Unisense 500µm Oxygen Microelectrode to find the oxygen penetration depth and 500µm pH Microelectrode to provide a pH profile. PH gel probes were also inserted by hand into the sub-core and then photographed. These will be processed through image analysis to provide a pH profile. These methods will be used in conjunction with the SPI to assess the physical and biogeochemical parameters of the sediment.

Pore water was collected directly from a NIOZ core using sipper probes in triplicate at the four main process sites and a single replicate at Candyfloss and throughout the area as part of the spatial survey. The probes were inserted into the core to known depths and around 10ml of water was extracted using a vacuum motor. Samples range from 0-20cm, providing a profile through the sediment. Once extracted, the water was syringe filtered (0.2µm) and analysed for nutrients using the onboard scalar. Please see Malcolm Woodward for preliminary results.

A 24 hour nutrient flux incubation was run at the four main process sites and an additional incubation was run at Candyfloss. This involved taking a sub core from 5 different NIOZ cores, as well as 3 litres of the overlying water. These 5 sub-cores were then sealed, aerated and submerged in a water filled incubation tank set to 9.0°C, along with three 1 litre bottles of aerated overlying water. 20ml of the cores surface water, and from the bottles of overlying water, was extracted using a syringe at known steps along a time series. These were then syringe filtered (0.2µm) and analysed for nutrients using the onboard scalar. Please see Malcolm Woodward for preliminary results. At the end of the 24 period, all cores were photographed and the depth of the sediment, remaining overlying water and air space were noted. From this we can determine the flux of nutrients out of the sediment and into the water column over time.

A 24 hour resuspension incubation was run at the four main process sites. Sediment samples were collected using syringes at depths of 0-2cm, 0-4cm and 0-6cm from a NIOZ core. These we then added to bottles of bottom water that had previously been collected by CTD and incubated in a water filled tank set to 9.0°C. Magnetic stirrers were used to keep the sediment in suspension throughout the incubation. A control sample and one replicate bottle for each sediment depth were monitored for O_2 consumption using Firesting Oxy Dots and were sealed for the entire duration of the incubation and only sampled at the final time step. Two control replicates and two replicate samples from each sample depth were tested at know steps along a time series for nutrients and chlorophyll. Nutrient samples were syringe filtered (0.2µm) and analysed for nutrients on-board. Please see Malcolm Woodward for preliminary results. Chlorophyll samples filtered using GFFs and frozen at -80^{o}C will be analysed at cefas. SPM samples were collected at the final time step and filtered using weighed filter papers. These will also be analysed at Cefas.

Long –term Moorings
Celtic Deep SmartBuoy
This instrumented buoy was lifted at 17:00 on 08/03/2015. The main surface instrumentation was intact and still operational, the CT sensors on the mooring wire were all present (NOCL for details), but unfortunately the mid tether ADCP frame was missing – with no sign of what may have happened to it. The SmartBuoy was re-deployed with all new surface instrumentation and the mooring wire array downloaded and re-deployed. The clump weight (900kg) was deployed at 51 8.230N 006 34.103W 07:46 10/03/2015. Also deployed in this array was a newly instrumented (Cefas and NOCL) Cefas minilander (the old one was recovered on RV Cefas Endeavour 2 weeks previously). The lander was lowered on a 22m polyprop rope with an IxSea acoustic release fired from the deck. After a successful release the 300m 12mm steel wire was carefully deployed to maintain tension and prevent piling up on the seabed. At the end of the wire a 200kg clump was added and the 220m polyprop rope was connected with, finally, three surface floats (two red and one yellow at the bitter end) the lander position is 51 8.159N 006 34.057W with the clump at 50 35.564N 007 01.021W.

Cefas East of Haig Fras minilander
This lander was recovered 17/03/2015 and quickly re-deployed once the instrumentation had been correctly configured. Deployment method was identical to the Celtic Deep site with the lander at 50 35.564N 007 01.021W and the clump at 50 35.564N 007 00.998W.

Cefas CandyFloss SmartBuoy
The SmartBuoy was recovered 08:30 23/03/2015 with all sensors and instruments intact, although the radar reflector was missing. The NOCL and PML thermistors were downloaded and new batteries fitted were necessary. The new SmartBuoy was deployed at 11:45 at 49 24.113N 08 36.244W. Both SmartBuoys were observed to be working. The synoptic data is available in near real time on the Cefas website (http://cefasmapping.defra.gov.uk/Smartbuoy/Map).

SPI Camera		
Station number	Sample ID	Number of photos
47	A1	10
49	A2	10
50	A3	10
51	A4	10
52	A5	10
64	ChemSPI	18

Nutrient Flux Incubation - Nutrient samples								
Station Number	Sample ID	Date and Time sampled						
2	Flux #1	T=0 03/03/15 12:30	T=1 03/03/15 13:40	T=2 03/03/15 14:40	T=3 03/03/15 17:00	T=4 03/03/15 20:30	T=5 04/03/15 06:25	T=6 04/03/15 15:30
3	Flux #2							
4	Flux #3							
5	Flux #4							
6	Flux #5							
	H_2O #1							
	H_2O #2							
	H_2O #3							

Pore Water Sippers - Nutrient samples											
Station Number	Sample ID	Sample Depth (cm)									
20	NIOZ #1	0	1	2	3	4	5	7.5	10	14		
28	NIOZ #2	0	1	2	3	4	5	7.5	10	14		
31	NIOZ #3	0	1	2	3	4	5	7.5	10	14		

Sediment Characterisation		
Station Number	Sample ID	Sample(s) taken
16	PSA/OCN	0-5cm, 5-10cm
	RFA	3 x 0-5cm
	Porosity/ Chlorophyl l	0-5cm, 5-10cm
	Oxygen Profile	2 x profile
	pH Profile	2 x profile
	pH Gel Probe	2 x probes

Resuspension Experiment								
Station Number	Sample ID	Date and Time sampled						
1	Incubation Water	T=0 03/03/15 13:45(Nuts, Chl, SPM)						
16	O2 Con							T=7 04/03/15 18:00 (Nuts, Chl, SPM)
	O2 V1							
	O2 V2							
	O2 V3							
	Rep B Con	T=1 03/03/15 17:05 (Nuts)	T=2 03/03/15 17:25 (Nuts)	T=3 03/03/15 18:00 (Nuts, Chl)	T=4 03/03/15 20:10 (Nuts)	T=5 03/03/15 23:05 (Nuts)	T=6 04/03/15 06:05 (Nuts)	
	Rep B V1							
	Rep B V2							
	Rep B V3							
	Rep C Con							
	Rep C V1							
	Rep C V2							
	Rep C V3							

SPI Camera		
Station number	Sample ID	Number of photos
160	G1	10
161	G2	10
162	G3	10
163	G4	10
164	G5	8
171	ChemSPI	32

Nutrient Flux Incubation - Nutrient samples								
Station Number	Sample ID	Date and Time sampled						
153	Flux #1	T=0 09/03/15 06:30	T=1 09/03/15 07:30	T=2 09/03/15 08:40	T=3 09/03/15 10:35	T=4 09/03/15 17:20	T=5 09/03/15 22:50	T=6 10/03/15 07:50
155	Flux #2							
157	Flux #3							
158	Flux #4							
159	Flux #5							
	H_2O #1							
	H_2O #2							
	H_2O #3							

Pore Water Sippers - Nutrient samples												
Station Number	Sample ID	Sample Depth (cm)										
127	NIOZ #1	0	1	2	3	4	5	7.5	10	14	17	20
129	NIOZ #2	0	1	2	3	4	5	7.5	10	14	17	20
133	NIOZ #3	0	1	2	3	4	5	7.5	10	14	17	20

Sediment Characterisation		
Station Number	Sample ID	Sample(s) taken
128	PSA/OCN	0-5cm, 5-10cm
	RFA	3 x 0-5cm
130	Porosity/ Chlorophyl l	0-5cm, 5-10cm
	Oxygen Profile	2 x profile
	pH Profile	2 x profile
	pH Gel Probe	2 x probes

Resuspension Experiment								
Station Number	Sample ID	Date and Time sampled						
119	Incubation Water	T=0 08/03/15 19:15 (Nuts, Chl, SPM)						
128	O2 Con							T=7 09/03/15 23:10 (Nuts, Chl, SPM)
	O2 V1							
	O2 V2							
	O2 V3							
	Rep B Con	T=1 08/03/15 23:05 (Nuts)	T=2 08/03/15 23:20 (Nuts)	T=3 08/03/15 23:50 (Nuts, Chl)	T=4 09/03/15 01:50 (Nuts)	T=5 09/03/15 05:20 (Nuts)	T=6 09/03/15 11:30 (Nuts)	
	Rep B V1							
	Rep B V2							
	Rep B V3							
	Rep C Con							
	Rep C V1							
	Rep C V2							
	Rep C V3							

SPI Camera		
Station number	Sample ID	Number of photos
335	H1	10
336	H2	10
337	H3	10
338	H4	10
339	H5	10
373	ChemSPI	20

Nutrient Flux Incubation - Nutrient samples								
Station Number	Sample ID	Date and Time sampled						
344	Flux #1	T=0 18/03/15 10:25	T=1 18/03/15 11:35	T=2 18/03/15 12:35	T=3 18/03/15 14:55	T=4 18/03/15 19:10	T=5 19/03/15 02:45	T=6 19/03/15 12:30
345	Flux #2							
349	Flux #3							
350	Flux #4							
352	Flux #5							
	H_2O #1							
	H_2O #2							
	H_2O #3							

Pore Water Sippers - Nutrient samples												
Station Number	Sample ID	Sample Depth (cm)										
309	NIOZ #1	0	1	2	3	4	5	7.5	10	14	17	20
363	NIOZ #2	0	1	2	3	4	5	7.5	10	14	17	20
365	NIOZ #3	0	1	2	3	4	5	7.5	10	14	17	20

Sediment Characterisation		
Station Number	Sample ID	Sample(s) taken
312	PSA/OCN	0-5cm, 5-10cm
	RFA	3 x 0-5cm
	Porosity/ Chlorophyll	0-5cm, 5-10cm
	Oxygen Profile	2 x profile
	pH Profile	2 x profile
	pH Gel Probe	2 x probes

Station Number	Sample ID	Date and Time sampled						
305	Incubation Water	T=0 17/03/15 18:00 (Nuts, Chl, SPM)						
312	O2 Con							T=7 18/03/15 21:15 (Nuts, Chl, SPM)
	O2 V1							
	O2 V2							
	O2 V3							
	Rep B Con	T=1 17/03/15 21:15 (Nuts)	T=2 17/03/15 21:30 (Nuts)	T=3 17/03/15 22:00 (Nuts, Chl)	T=4 18/03/15 00:00 (Nuts)	T=5 18/03/15 03:00 (Nuts)	T=6 18/03/15 09:15 (Nuts)	
	Rep B V1							
	Rep B V2							
	Rep B V3							
	Rep C Con							
	Rep C V1							
	Rep C V2							
	Rep C V3							

SPI Camera		
Station number	Sample ID	Number of photos
252	I1	10
253	I2	10
254	I3	10
255	I4	10
256	I5	10
257	ChemSPI	29

Nutrient Flux Incubation - Nutrient samples								
Station Number	Sample ID	Date and Time sampled						
201	Flux #1	T=0 14/03/15 16:20	T=1 14/03/15 17:30	T=2 14/03/15 19:05	T=3 14/03/15 21:25	T=4 15/03/15 01:05	T=5 15/03/15 08:00	T=6 15/03/15 16:15
202	Flux #2							
202	Flux #3							
203	Flux #4							
204	Flux #5							
	H_2O #1							
	H_2O #2							
	H_2O #3							

Pore Water Sippers - Nutrient samples												
Station Number	Sample ID	Sample Depth (cm)										
219	NIOZ #1	0	1	2	3	4	5	7.5	10	14	17	20
227	NIOZ #2	0	1	2	3	4	5	7.5	10	14	17	20
232	NIOZ #3	0	1	2	3	4	5	7.5	10	14	17	20

Sediment Characterisation		
Station Number	Sample ID	Sample(s) taken
229	PSA/OCN	0-5cm, 5-10cm
	RFA	3 x 0-5cm
	Porosity/ Chlorophyll	0-5cm, 5-10cm
	Oxygen Profile	2 x profile
	pH Profile	2 x profile
	pH Gel Probe	2 x probes

Station Number	Sample ID	Date and Time sampled						
197	Incubation Water	T=0 14/03/15 21:45 (Nuts, Chl, SPM)						
229	O2 Con							T=7 16/03/15 01:10 (Nuts, Chl, SPM)
	O2 V1							
	O2 V2							
	O2 V3							
	Rep B Con	T=1 15/03/15 00:55 (Nuts)	T=2 15/03/15 01:10 (Nuts)	T=3 15/03/15 01:40 (Nuts, Chl)	T=4 15/03/15 03:50 (Nuts)	T=5 15/03/15 06:30 (Nuts)	T=6 15/03/15 12:30 (Nuts)	
	Rep B V1							
	Rep B V2							
	Rep B V3							
	Rep C Con							
	Rep C V1							
	Rep C V2							
	Rep C V3							

Station number	Station Code	Samples collected									
		Pore Water Profile	PSA/ OCN	Porosity/ Chlorophyll	RFA	Oxygen Profile	pH Profile	pH Gel Probe	Bulk PSA	SPI	Number of SPI Photos
55, 56, 57	Spatial 1	x	x	x	x	x	x	x		x	10
65, 66, 67	Spatial 2	x	x	x	x	x	x	x		x	10
68, 69, 70	Spatial 3	x	x	x	x	x	x	x		x	6
75, 76, 78	Spatial 4	x	x	x	x	x		x		x	8
79, 80, 81	Spatial 5	x	x	x	x	x	x	x		x	10
82, 83, 85	Spatial 6	x	x	x	x	x	x	x		x	10
86, 87, 88	Spatial 7	x	x	x	x	x	x	x		x	8
89, 90, 91	Spatial 8	x	x	x	x	x	x	x		x	10
92, 93, 94	Spatial 9	x	x	x	x	x	x	x		x	10
95, 110, 111	Spatial 10	x	x	x	x	x		x		x	10
96, 112, 113	Spatial 11	x	x	x	x	x		x		x	12
97, 114, 115	Spatial 12	x	x	x	x	x		x		x	10
100, 101, 102	Spatial 13	x	x	x	x	x	x	x		x	9
103, 105, 106	Spatial 14	x	x	x	x	x	x	x		x	10
107, 108, 109	Spatial 15	x	x	x	x	x		x		x	10
188, 189, 190	Spatial 16	x	x	x	x	x	x	x		x	10
191, 193	Spatial 17								x	x	10
263, 264, 265	Spatial 18	x	x	x	x	x	x	x		x	10
266, 267, 268	Spatial 19	x	x	x	x	x	x	x		x	10
269	Spatial 20									x	2
270, 272, 273	Spatial 21	x	x	x	x	x	x	x		x	10
274, 276, 277	Spatial 22	x	x	x	x	x		x		x	10
278, 279, 280	Spatial 23	x	x	x	x	x	x	x		x	10
281, 285, 286	Spatial 24	x	x	x	x	x	x	x		x	10
287, 288, 289	Spatial 25	x	x	x	x	x	x	x		x	10
290, 291, 292	Spatial 26	x	x	x	x	x	x	x		x	10
293, 294, 295	Spatial 27	x	x	x	x	x	x	x		x	10
296, 297, 298	Spatial 28	x	x	x	x	x	x	x		x	10
367, 368, 369	Spatial 29	x	x	x	x	x	x	x		x	10
370, 371, 372	Spatial 30	x	x	x	x	x	x	x		x	10
379, 380, 381	Spatial 31	x	x	x	x	x	x	x		x	10
382, 384, 385	Spatial 32	x	x	x	x	x	x	x		x	10
386, 388, 389	Spatial 33	x	x	x	x	x	x	x		x	10
390, 392, 393	Spatial 34	x	x	x	x	x	x	x		x	10
395, 396, 397	Spatial 35	x	x	x	x	x	x	x		x	10
398, 399, 400	Spatial 36	x	x	x	x	x	x	x		x	10
401, 402, 403	Spatial 37	x	x	x	x	x	x	x		x	10
404, 405, 406	Spatial 38	x	x	x	x	x	x	x		x	4
407, 409, 410	Spatial 39	x	x	x	x	x	x	x		x	10
411, 413, 414	Spatial 40	x	x	x	x	x	x	x		x	10
416	Spatial 41								x		
418b, 418c, 419	Spatial 42	x	x	x	x					x	6
420, 422, 423	Spatial 43	x	x	x						x	10
424, 426, 427	Spatial 44	x	x	x	x	x		x		x	10
431, 432, 433	Spatial 45	x	x	x	x	x	x	x		x	10
434	Spatial 46									x	2
437	Spatial 47								x		
438, 439, 440	Spatial 48	x	x	x	x	x				x	10
441, 442, 443	Spatial 49	x	x	x	x	x	x	x		x	10
444, 445, 446	Spatial 50	x	x	x	x	x	x	x		x	6
447, 448, 449	Spatial 51	x	x	x	x	x	x	x		x	10
450, 451, 452	Spatial 52	x	x	x						x	10
453, 454, 455	Spatial 53	x	x	x	x			x		x	10
459, 460, 461	Spatial 54	x	x	x	x	x	x	x		x	10
462, 463, 464	Spatial 55	x	x	x	x	x	x	x		x	10
465	Spatial 56								x		
466, 467, 468	Spatial 57	x	x	x	x	x	x	x		x	10

SPI Camera		
Station number	Sample ID	Number of photos
489	ChemSPI	2

Nutrient Flux Incubation - Nutrient samples								
Station Number	Sample ID	Date and Time sampled						
476	Flux #1	T=0 22/03/15 19:40	T=1 22/03/15 20:35	T=2 22/03/15 21:50	T=3 22/03/15 23:30	T=4 23/03/15 03:35	T=5 23/03/15 12:25	T=6 23/03/15 20:50
477	Flux #2							
478	Flux #3							
479	Flux #4							
480	Flux #5							
	H_2O #1							
	H_2O #2							
	H_2O #3							

Pore Water Sippers - Nutrient samples												
Station Number	Sample ID	Sample Depth (cm)										
489	NIOZ #1	0	1	2	3	4	5	7.5	10	14		

Sediment Characterisation		
Station Number	Sample ID	Sample(s) taken
488	PSA/OCN	0-5cm
	RFA	3 x 0-5cm
	Porosity/ Chlorophyl l	0-5cm
	Oxygen Profile	2 x profile
	pH Profile	2 x profile

8 Quantification of inorganic and organic carbon, Natalie Hicks, Scottish Association for Marine Science

Introduction:

Benthic carbon cycling plays a disproportionally important role on the continental margins. Intense recycling of organic matter in the sediment supplies the overlying water with nutrients and inorganic carbon which can be re-used for primary production. Furthermore, continental shelf sediments have been proven to be one of the most important sinks for carbon globally. Once buried in the sediment, carbon is removed from the marine carbon cycle over geological time scales.

The aim with the work carried out on DY021 (and subsequent cruises, following on from DY008) is to quantify how much of the inorganic and organic carbon is remineralised in the sediments and released back into the overlying water, and how much remains buried in the sediments. This will be done for 4 different sediment types in the Celtic Sea (mud, sandy mud, muddy sand and sand) as their different properties will affect their sequestering and remineralisation capacity.

Methods:

Sediment incubations – 6 NIOZ cores (10 cm i.d.) were collected from each of the 4 main stations (Benthic A, G, H, I) and incubated for ~24hr at in situ temperature in the CT room (Fig1). Water samples were taken from the overlying water (for Dissolved Inorganic Carbon (DIC), Total Alkalinity (TA) and Dissolved Organic Carbon (DOC)) before the cores were closed with a tight fitting lid and incubated. Each core was individually stirred using a magnetic stirrer system, and the oxygen uptake (Total Oxygen Uptake – TOU) was measured over time by an internal oxygen optode (using Firesting technology by Pyroscience) in each of the 6 cores to estimate respiration rates at the respective site. At the end of each incubation period, water samples were again taken from each core (DIC, TA, and DOC) to quantify the efflux of these parameters from the sediment to the overlying water.

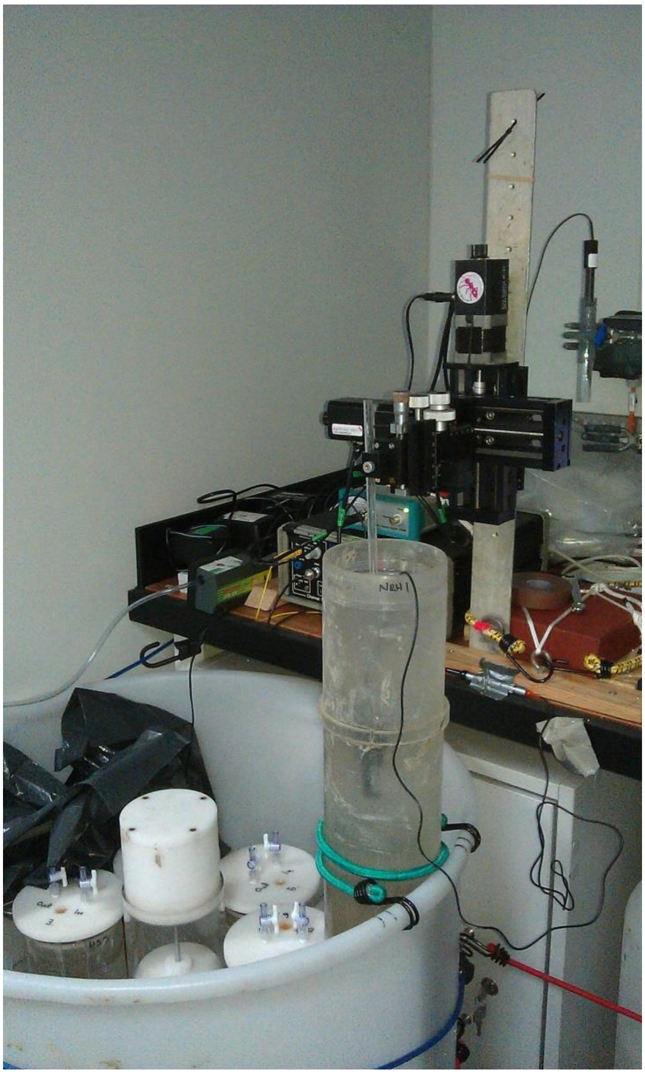


Figure 1 Showing the sediment incubation and profiling setup in the CT room

Microprofiling -After the flux incubations, the cores were re-aerated using an aquarium pump and air stone ready for oxygen micro-profiling. 3-4 oxygen microprofiles (Fig 2), were taken in each of the 6 sediment cores, to study the penetration depth and distribution of oxygen in the respective sediment type. A very fine microelectrode with a tip of 50 µm was used in steps of 200 µm until the oxygen dropped to zero. From these profiles a Diffusive Oxygen Uptake (DOU) will be calculated, reflective of the microbial contribution to the oxygen uptake. Comparison of the DOU and TOU will quantify the importance of the faunal contribution to the overall oxygen flux within each sediment type / study site. In general, deeper oxygen penetration was seen in the sandy sediment (Station G), with shallower depths in the muddy station (A) and the muddy/sandy mixed sediments (Stations H and I). The sandy station G was not easy to oxygen profile, and two sensors were broken trying to measure the oxygen penetration depth due to the coarse sediment type.

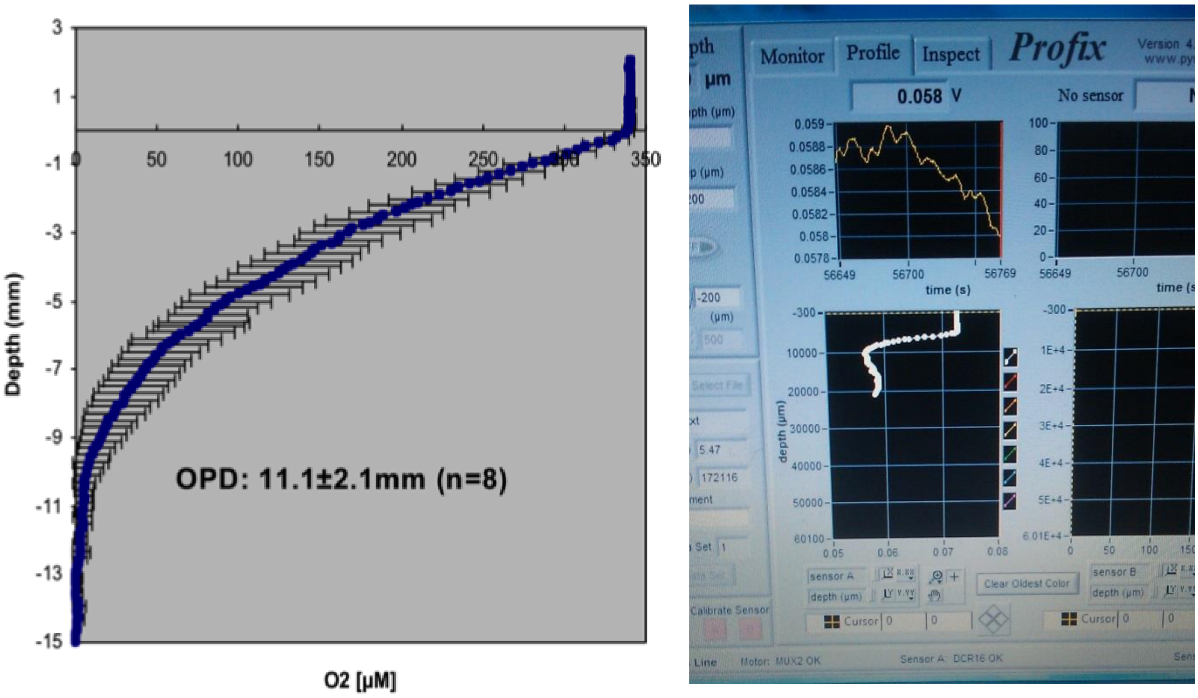


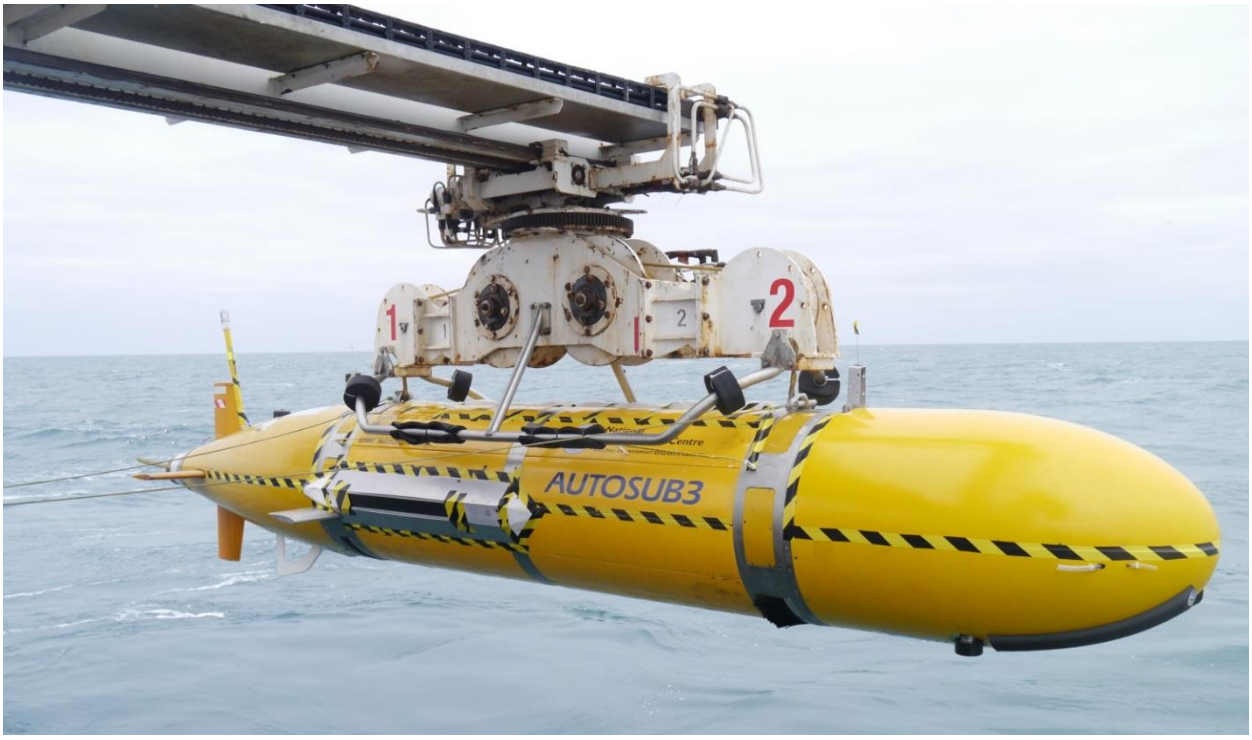
Figure 2 Example of average sediment oxygen micro-profile showing the average oxygen penetration and distribution (left) and profiling under way in one of the sandy cores (right)

Sediment solid phase – 3 undisturbed megacores (10 cm i.d.) were collected from each of the 4 process stations using the NIOZ corer. The cores were then sliced down to 25 cm depth (Interval: 0.5-1, 1-1.5, 1.5-2, 2-3, 3-4, 4-5, 5-6, 6-7, 7-8, 8-9, 9-10, 10-11, 11-12, 12-13, 13-14, 14-15, 15-17, 17-19, 19-21, 21-23, 23-25) and frozen in plastic (polyethylene) bags for later analysis of solidphase POC, PIC, ^{210}Pb and grainsize back at SAMS. These parameters will be used to sediment accumulation rates (from ^{210}Pb), and ultimately burial rates of organic and inorganic carbon in the sediments (using the sediment accumulation rates together with the downcore POC and PIC concentrations).

Candyfloss site – unlike the DY008 cruise, the DY021 cruise included an extra station at ‘Candyfloss’. NIOZ coring was used to sample the sediment, but the depth was insufficient for incubations and oxygen penetration depth (the sediment is sandy and the risk of breaking microelectrodes was deemed too high). Three cores were collected for slicing, and these cores were so shallow that by 10cm depth there was no further sediment. The slices were collected as in the solid phase sampling for the previous four stations, and will be taken back to SAMS in the event there is an opportunity and funding available for further analysis of PIC, POC, grainsize and ^{Pb}210.

Cruise	Event #	Station	Method	Date	Time	Latitude			Longitude			Depth	Cores used in experiments / analysis
DY021	007	A	Nioz Core	03/03/2015	10:56	51	12	698	6	7	978		Natalie Core 1 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	008	A	Nioz Core	03/03/2015	11:12	51	12	699	6	7	978		Natalie Core 2 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	012	A	Nioz Core	03/03/2015	14:27	51	12	700	6	7	979	112	Natalie Cores 3 & 4 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	013	A	Nioz Core	03/03/2015	14:42	51	12	700	6	7	987	109	Natalie Core 5 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	014	A	Nioz Core	03/03/2015	14:58	51	12	711	6	7	996	110	Natalie Core 6 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	015	A	Nioz Core	03/03/2015	15:09	51	12	702	6	7	994	110	Natalie - cores for slicing (POC, PIC, grainsize, Pb210)
DY021	145	G	Nioz Core	09/03/2015	02:32	51	4	478	6	35	015	101	Natalie Cores 1-2 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	146	G	Nioz Core	09/03/2015	02:43	51	4	478	6	35	019	101	Natalie Cores 3-4 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	147	G	Nioz Core	09/03/2015	02:53	51	4	477	6	35	021	102	Natalie Cores 5-6 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	149	G	Nioz Core	09/03/2015	03:15	51	4	478	6	35	021	102	Natalie - core for slicing (POC, PIC, grainsize, Pb210)
DY021	151	G	Nioz Core	09/03/2015	03:38	51	4	473	6	35	022	103	Natalie - cores for slicing (POC, PIC, grainsize, Pb210)
DY021	206	I	Nioz Core	14/03/2015	14:20	50	34	536	7	6	274	112	Natalie Core 1 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	209	I	Nioz Core	14/03/2015	15:43	50	34	534	7	6	277	112	Natalie Core 2 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	210	I	Nioz Core	14/03/2015	15:51	50	34	540	7	6	276	112	Natalie Core 3 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	211	I	Nioz Core	14/03/2015	16:05	50	34	541	7	6	269	112	Natalie Core 4 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	213	I	Nioz Core	14/03/2015	16:30	50	34	541	7	6	269	111	Natalie Core 5 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	214	I	Nioz Core	14/03/2015	16:42	50	34	541	7	6	270	112	Natalie Core 6 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	215	I	Nioz Core	14/03/2015	16:55	50	34	546	7	6	273	112	Natalie - core for slicing (POC, PIC, grainsize, Pb210)
DY021	216	I	Nioz Core	14/03/2015	17:06	50	34	546	7	6	273	112	Natalie - cores for slicing (POC, PIC, grainsize, Pb210)
DY021	354	H	Nioz Core	18/03/2015	08:41	50	31	321	7	2	153	110	Natalie Core 1 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	355	H	Nioz Core	18/03/2015	08:52	50	31	320	7	2	152	110	Natalie Core 2 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	356	H	Nioz Core	18/03/2015	09:02	50	31	328	7	2	155	110	Natalie Core 3 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	357	H	Nioz Core	18/03/2015	09:12	50	31	328	7	2	155	110	Natalie Core 4 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	358	H	Nioz Core	18/03/2015	09:28	50	31	329	7	2	156	110	Natalie Core 5 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	360	H	Nioz Core	18/03/2015	09:49	50	31	328	7	2	155	110	Natalie Core 6 - oxygen incubations (pre and post water samples for DOC, DIC, TA) and microprofiling
DY021	361	H	Nioz Core	18/03/2015	10:00	50	31	334	7	2	157	110	Natalie - core for slicing (POC, PIC, grainsize, Pb210)
DY021	362	H	Nioz Core	18/03/2015	10:10	50	31	334	7	2	157	110	Natalie - cores for slicing (POC, PIC, grainsize, Pb210)
DY021	485	CANDYFL	Nioz Core	22/03/2015	18:16	49	24	706	8	35	814	153	Natalie - core for slicing (POC, PIC, grainsize, Pb210)
DY021	486	CANDYFL	Nioz Core	22/03/2015	18:28	49	24	706	8	35	813	153	Natalie - cores for slicing (POC, PIC, grainsize, Pb210)

9 Autonomous underwater vehicle (AUV) Autosub3 surveys, Kirsty Morris, NOC Southampton



Objectives

The main objectives of the study where to collect both Bathymetric and side scan data of the four benthic study sites (Figure x) and beyond, to allow further characterisation of the site. It was also planned that a photographic survey would also be undertaken to aid in the characterisation of sediments both within the survey box and in its surrounding area, as well to allow an assessment of the benthic megafaunal community. Ultimately this will aid in the assessment of the carbon utilisation of the benthic community within the area, and allow a comparison to the results obtained from Autosub600 during the 2014 cruise Dy008.

Unfortunately it was not possible to complete the planned missions due to the loss of Autosub3 during its second mission at Benthic site A. Below is a summary of the information that was possible to collect as well as the format of the planned survey.

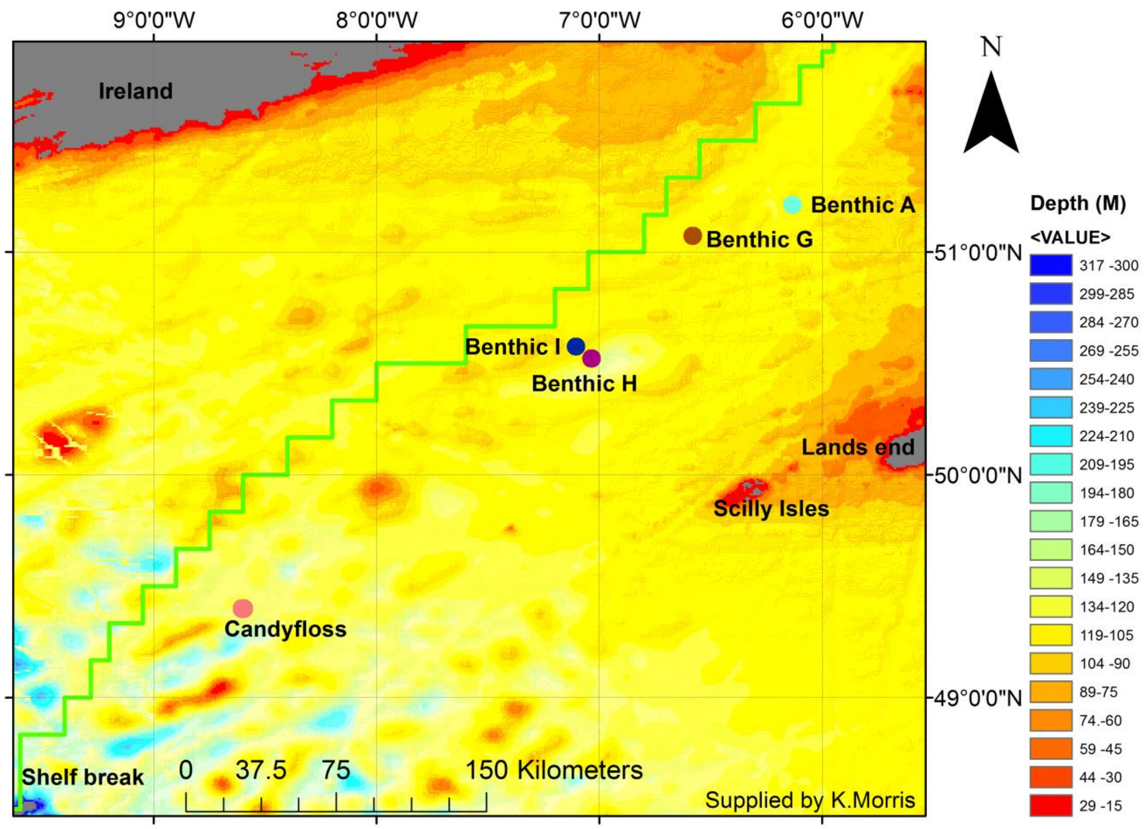


Figure 1 position of the Benthic survey areas in relation to Ireland and the Scilly Isles

Mission planning
It was decided to try and enhance the coverage of the benthic sites achieved last year by covering an area of 5 Km^2 throughout each mission centred on the benthic station box (figure x) in comparison to the 2.56km^2 covered during surveys in DY008.

Each survey was designed to last up to 24 hours in duration and consisted of three different legs: Swath, sidescan and Photography. The Swath mission was planned at an altitude of 50m from the seabed with a line spacing of 150 m, the sidescan was set at high frequency with an altitude of 15m and a line spacing of 180 m. The photography was set at an altitude of 2.7m for the first mission with subsequent missions being planned at 2.2m, with a line spacing of 75m and a photographic rate of 1 every 0.89 seconds.

Data collected
Autosub3 was deployed at site G on 5/3/2015 for a 24 hour mission (M451) following a short mini mission to assess the subs performance (M450). During M451 Side scan and bathymetric data from site G (Event no's 61 and 74), were successfully retrieved. It was not possible to collect images from this mission as there was an issue with the flash which propagated at the beginning of the mission and continued to deteriorate throughout the mission until the point where it no longer worked. Unfortunately as the AUV reached the point of the photographic portion of the mission the flash was no longer working and thus no photographs of the seabed were captured.

Following the repair of the flash it was decided to make the photographic portion of the mission first with an altitude of 2.2m compared with the 2.7 of the previous mission. This was decided to increase the chance of being able to view the seabed through any suspended particles and from the resultant data indicating the AUV was flying with good altitude control. With the change in setting the Autosub3 was deployed at site A (M452, Event 165). Regrettably when it came time to recover the vehicle it was not where expected. Once the time was passed in which it was expected the AUV should have surfaced following an emergency abort (3 hours following expected mission end time) it was concluded that the AUV was damaged in some way and a search was implemented.

Mission Summary Table

Mission	Area	Date	Distance	Notes on the data
450	G	6/3/15	6.3 km	Autosub no issues. Engineering data to asses control performance prior to M451. Side-scan HF, EM2000 data and mid-water camera images were gathered..
451	G	6/3/15	127km	Autosub no issues. EM2000 data was gathered at 50m altitude on a 150m line spacing with 5km line length. Sidescan HF data collected at 15m altitude on a 180m line spacing with 5km line length. Camera images – flash failed.
452	A	9/3/15	- km	Data not yet recovered.

Location search

Following the loss of Autosub3 and the immediate post mission search, a 48 hour extensive search was undertaken. This was the expected time period for which the main batteries would last. This search involved the use of the LXT tracking system and a hydrophone listening for signals from the emergency beacon on board the AUV.

The LXT read outs were monitored while the ship was underway, looking for changes in pattern which would indicate that we were near the AUV. Periodically the ship was stopped at different positions and the long range hydrophone deployed to listen for the AUV's emergency beacon. This was done following the outline of the survey box (figure x) and through the centre of the survey box. After no positive readouts were identified a larger box which expanded 1km on either edge of the programmed survey area was then covered. No signals were picked up. A swath survey of the mission area was carried out with the hydrophone being deployed, to listen for the chirp from the AUV emergency beacon which is set to sound every 10 minutes. The difference in time recorded by the hydrophone system between subsequent deployments provides an indication of the change in relative distance to the Autosub. Over a straight line series of hydrophone deployments it is possible to calculate the closest approach of the ship. Another series of hydrophone deployments is then made at right angles to the first set and the location of the AUV calculated.

The first chirp was recorded at 51 ^{o} 21.1N 6 ^{o} 8.1 W. Following this a search pattern, mainly focusing on the east:west location was completed determined on the signal strength at each position, with a minimum of five chirps being recorded at each location (Figure x).

As a result of the AUV and the hydrophone times not being synchronised it was not possible to use the absolute reading as an estimation of the distance to the AUV. Rather, the differences in mean times of chirps at each station were used to identify if the AUV was closer or further away. These data were then plotted with time V distance, from the furthest point East. This allowed a curve to be drawn with the minima identified (figure x). This minimum was then assumed to be the time lag between the AUV and computer clocks and thus the new zero for distance estimation. Pythagoras theorem was subsequently employed to estimate the position of the AUV

This resulted in an estimated position of 51^{o} 12.9222 N 6 ^{o} 12.6184 W (WP14 figure x). Once this location was reached it was possible to communicate with the AUV using the telemetry system, indicating that the ship was within 500 m of the AUVs position. Using the telemetry and USBL readouts it was possible position the ship to within +/-15m over the Autosub's location. Following this, the Autosub's position was boxed in with USBL data being gathered around a 100m sided rectangle of the best estimated position. The ship Swath (EM710) was used to identify possible targets within this box. From these targets and the telemetry position the expected position of the AUV on the seabed was identified as within 10-15m of, 51 ^{o} 13.028 N 6 ^{o} 13.039 W. The SPI camera was deployed over the expected position but was unable to view the AUV on the seabed. Subsequent processing of the USBL data suggests a final best estimate position of 51 ^{o} 13.045 N, 6 ^{o} 13.025 W. This position will be used in subsequent searches for the vehicle.

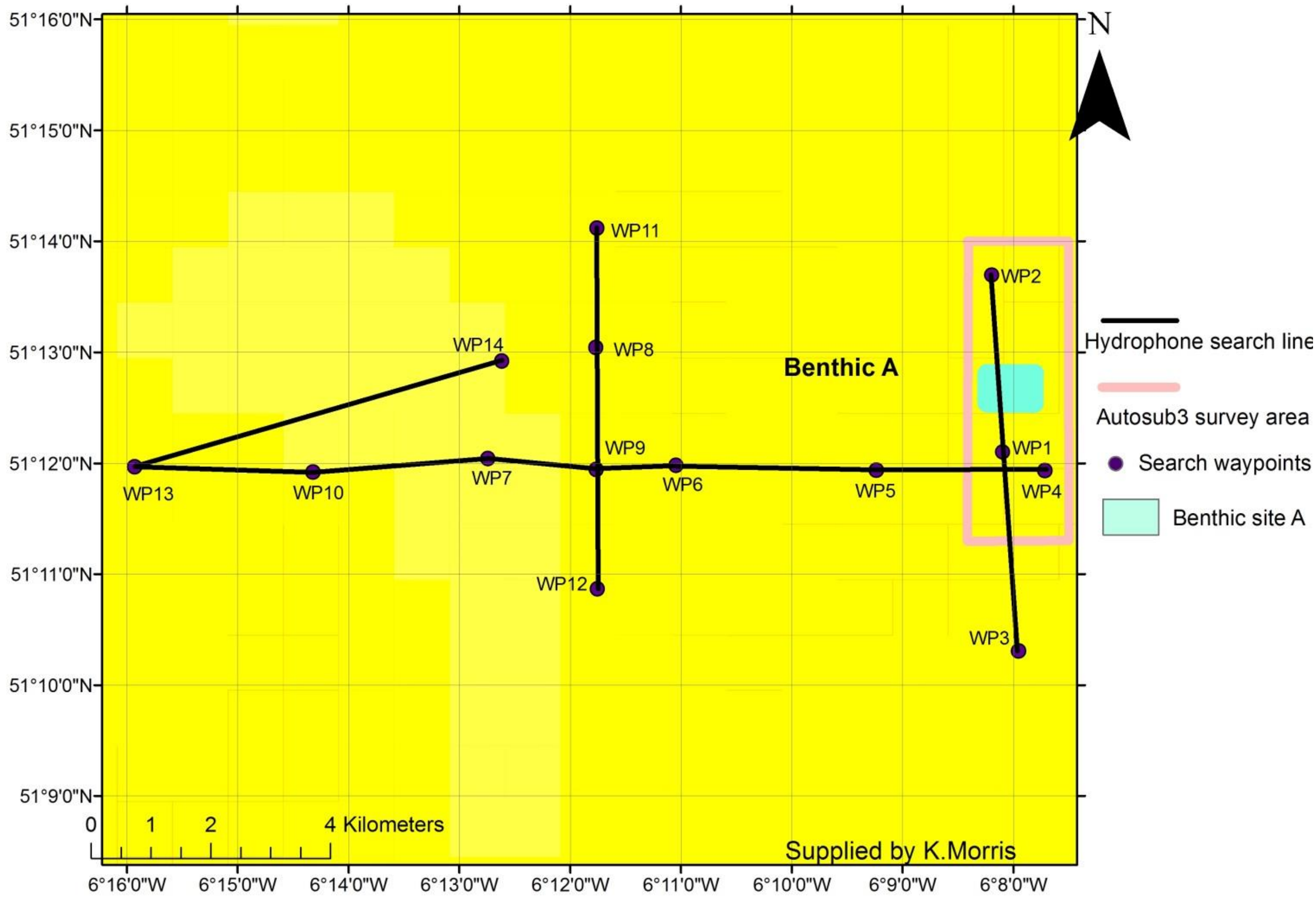


Figure2. Waypoints visited during Autosub3 hydrophone search. Autoub3 is believed to be located within 10-15m of, 51 ° 13.028 N 6 ° 13.039 W.

10 Assessment of sediment particle reworking and bioirrigation, Rachel Hale, University of Southampton

Replicate sediment cores (n = 5) of size 20 cm by 20 cm and depth 12 cm were collected using a Perspex subcorer from NIOZ cores taken at the 4 process sites (Mud, site A; Sandy Mud, site G; Muddy Sand, site H; and Sand, site I) in the Celtic Sea. At Site I, three additional subcores were collected for additional iron sampling in collaboration with Work Package 3 (Iron). These sediment cores were transferred to clear perspex mesocosms and placed in randomised locations in the controlled temperature laboratory on board the RRS Discovery and covered with 20 cm of unfiltered seawater. All cores were aerated and maintained at approximately 9 °C in the dark. Fine sediment suspended during composition of the cores was allowed to settle out of the overlying seawater. After 24 hours this water was replaced with fresh unfiltered seawater to remove the mesocosm assembly nutrient flux due to sediment disturbance.

On the first day of the incubation nutrient samples of 30 ml (0.45 µm filtered) were taken. These samples were analysed by Malcolm Woodward and Amandine Sabadel on board. To assess sediment particle reworking and bioturbation by fauna autoclaved luminophores (fluorescent green, 215 g dry weight), fluorescently labelled sand-based particulate tracers, were added evenly to the cores to a depth of 2 – 3 mm to assess bioturbation. The luminophores were pre-soaked prior to distribution and vigorously shaken to prevent particle aggregation and flotation during application.

After 5 days, T5 nutrient samples were taken as described above. To assess bio-irrigation the mesocosms were inoculated with 8.231 g of sodium bromide dissolved in 20 ml of seawater. Five millilitre overlying water samples were then taken after 0, 4 and 6 hours and filtered to remove suspended particles and allow colorimetric analysis upon return to shore. The samples will be analysed for the change in Br^- concentration ($\Delta[Br^-]$, $mg.l^{-1}$) using a Tecator flow injection auto-analyser (FIA Star 5010 series).

After 6 days, sediment surface samples for microbial analysis were taken from each core in bioturbated areas, where obvious burrows or sediment reworking had occurred, and non-bioturbated areas, where there was no obvious sediment reworking. These samples will be analysed by Karen Tait at Plymouth Marine Laboratory for bacterial and archaebacterial abundance and activity.

Faunal mediated sediment particle reworking in the square cores was estimated non-invasively using a sediment profile imaging camera (Canon 400D set to ISO 400, 13 second exposure, aperture f5.6; image size 3888 × 2592 pixels, i.e. 10.1 megapixels effective resolution 56 × 56 µm per pixel). The camera was optically modified to allow preferential imaging of the luminophores under ultra-violet (UV) light (Figure 1). Images of all four sides of each core were taken in a UV illuminated imaging box. The redistribution of the tracers can be determined from stitched composite images (RGB colour, JPEG compression) using a custom-made semi-automated macro that runs within ImageJ (Version 1.47), a java-based public domain computer program developed at the US National Institutes of Health. The macro returns a binary value depending on whether luminophores are present at each pixel (value = 1) or absent (value = 0) using the sediment water interface as the uppermost row. From these data, the total luminophores in each row are summed to obtain the vertical mixing profile. The median (${}^{f\text{-}SPI}L_{med}$, typical short-term depth of mixing), maximum (${}^{f\text{-}SPI}L_{max}$, maximum extent of mixing over the long-term), and mean (${}^{f\text{-}SPI}L_{mean}$, time dependent indication of mixing) mixed depth of particle redistribution can then be calculated from this profile. In addition, the maximum vertical deviation of the sediment-water interface (upper – lower limit = surface boundary roughness, SBR) can provide an indication of surficial activity.

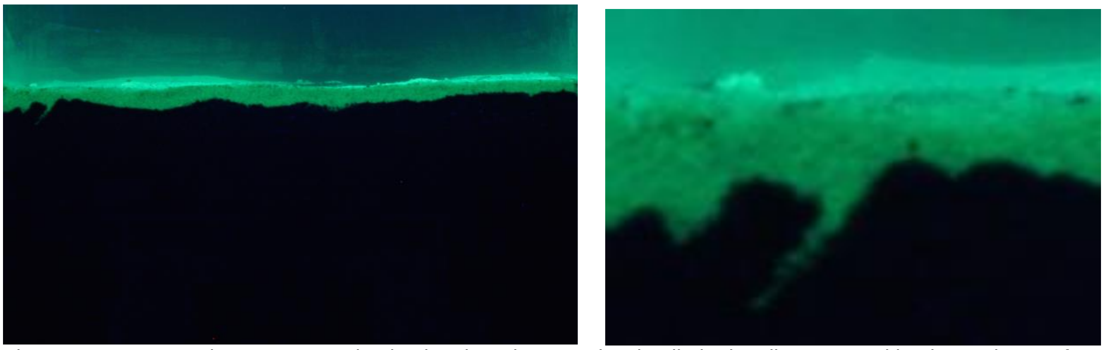


Figure 1. Representative pre-processing luminophore images showing limited sediment reworking in sand cores from Site G of a) a whole core and b) a close-up of sediment reworking where particles have been drawn down below the sediment surface due to faunal activity.

After photographing the whole sediment core was transferred to labelled 10 litre buckets and preserved in 4 % formalin for sieving (500 µm) and community analysis upon return to Southampton.

To investigate the effect of sediment reworking and bioirrigation on sediment iron release three extra cores were taken at Site I. The overlying water used for these cores came from a depth of 60 m from the titanium CTD to avoid contamination caused by collecting surface water through the boat's pumps. Iron samples were taken from these cores daily during the week long incubation. A control core was set up to test the effect of the addition of luminophores to the sediment. Iron samples were analysed by Jessy Klar on board.

COLLECTION									
Site		Event	Date	Time	Latitude	Longitude	Depth	Pull_Tens	Picture
A	A1	17	03 March 2015	15.30	51' 12.7017	6' 7.9981	111	1.51	5381/5382
A	A2	21	03 March 2015	16.16	51' 12.702	6' 7.996	110	0.94	5384
A	A3	23	03 March 2015	16.42	51' 12.702	6' 7.995	111	0.36	5386
A	A4	24	03 March 2015	17.03	51' 12.701	6' 7.996	111	1.33	5388
A	A5	25	03 March 2015	17.33	51' 12.701	6' 8.003	110	1.63	5389
G	G1	131	08 March 2015	21.56	51' 4.4713	6' 35.0064	104.1	1	
G	G2	132	08 March 2015	22.16	51' 4.47042	6' 35.00760	104.3	1.1	5393
G	G3	134	08 March 2015	22.49	51' 4.475	6' 35.009	103	1.4	5391
G	G4	135	08 March 2015	23.01	51' 4.475	6' 35.007	103	1	
G	G5	136	08 March 2015	23.19	51' 4.476	6' 35.006	103	1.5	5392
I	I1	233	15 March 2015	00.17	50' 34.551	7' 6.257	115	0.77	5416
I	I2	234	15 March 2015	00.30	50' 34.550	7' 6.256	114	1.74	5415
I	I3	235	15 March 2015	00.43	50' 34.550	7' 6.258	114	0.76	
I	I4	236	15 March 2015	00.55	50' 34.548	7' 6.256	114	1.46	
I	I5	238	15 March 2015	01.18	50' 34.550	7' 6.247	114	1.77	5413
I	I6	239	15 March 2015	01.28	50' 34.550	7' 6.250	113	1.98	5414
I	I7	240	15 March 2015	01.39	50' 34.550	7' 6.248	114	1.59	
I	I8	241	15 March 2015	01.48	50' 34.550	7' 6.249	114	1.98	
Iron Control									
H	H1	308	17 March 2015	18.25	50' 31.35138	7' 2.19990	110	0.84	
H	H2	314	17 March 2015	19.38	50' 31.34532	7' 2.19570	109	0.75	
H	H3	315	17 March 2015	19.48	50' 31.34622	7' 2.19438	109	1.23	
H	H4	317	17 March 2015	20.13	50' 31.34196	7' 2.19096	108	0.98	
H	H5	319	17 March 2015	20.42	50' 31.34370	7' 2.19198	108	0.8	

		Nutrients		TOC/PSA	FSPI						
Site		T0	T5		L_added	Photos	Folder	Side1	Side2	Side3	Side4
A	A1	05 March 2015	10 March 2015	04 March 2015	05 March 2015	11 March 2015	150311_1851test	test0011	test0013	test0014	test0015
A	A2	05 March 2015	10 March 2015	04 March 2015	05 March 2015	11 March 2015	150311_1851test	test0028	test0030	test0031	test0033
A	A3	05 March 2015	10 March 2015	04 March 2015	05 March 2015	11 March 2015	150311_1851test	test0021	test0022	test0023	test0025
A	A4	05 March 2015	10 March 2015	04 March 2015	05 March 2015	11 March 2015	150311_1851test	test0016	test0017	test0019	test0020
A	A5	05 March 2015	10 March 2015	04 March 2015	05 March 2015	11 March 2015	150311_1851test	test0035	test0036	test0037	test0038
G	G1	10 March 2015	15 March 2015	10 March 2015	10 March 2015	16 March 2015	150316_1844test	test0002	test0004	test0005	test0006
G	G2	10 March 2015	15 March 2015	10 March 2015	10 March 2015	16 March 2015	150316_1844test	test0014	test0015	test0016	test0019
G	G3	10 March 2015	15 March 2015	10 March 2015	10 March 2015	16 March 2015	150316_1844test	test0020	test0021	test0023	test0024
G	G4	10 March 2015	15 March 2015	10 March 2015	10 March 2015	16 March 2015	150316_1844test	test0025	test0026	test0027	test0028
G	G5	10 March 2015	15 March 2015	10 March 2015	10 March 2015	16 March 2015	150316_1844test	test0007	test0011	test0012	test0013
I	I1	17 March 2015	22 March 2015	16 March 2015	17 March 2015	23 March 2015	150323_0150test	test0039	test0040	test0043	test0044
I	I2	17 March 2015	22 March 2015	16 March 2015	17 March 2015	23 March 2015	150323_0150test	test0007	test0008	test0009	test0010
I	I3	17 March 2015	22 March 2015	16 March 2015	17 March 2015	23 March 2015	150323_0150test	test0033	test0034	test0035	test0067
I	I4	17 March 2015	22 March 2015	16 March 2015	17 March 2015	23 March 2015	150323_0150test	test0028	test0029	test0030	test0032
I	I5	17 March 2015	22 March 2015	16 March 2015	17 March 2015	23 March 2015	150323_0150test	test0017	test0018	test0019	test0020
I	I6	17 March 2015	22 March 2015	16 March 2015	17 March 2015	23 March 2015	150323_0150test	test0011	test0012	test0013	test0015
I	I7	17 March 2015	22 March 2015	16 March 2015	17 March 2015	23 March 2015	150323_0150test	test0022	test0023	test0024	test0026
I	I8	17 March 2015	22 March 2015	16 March 2015	17 March 2015	23 March 2015	150323_0150test	test0003	test0004	test0005	test0006
Iron Control		N/A	N/A	N/A	17 March 2015	N/A	N/A	N/A	N/A	N/A	N/A
H	H1	20 March 2015	25 March 2015	18 March 2015	20 March 2015	26 March 2015					
H	H2	20 March 2015	25 March 2015	18 March 2015	20 March 2015	26 March 2015					
H	H3	20 March 2015	25 March 2015	18 March 2015	20 March 2015	26 March 2015					
H	H4	20 March 2015	25 March 2015	18 March 2015	20 March 2015	26 March 2015					
H	H5	20 March 2015	25 March 2015	18 March 2015	20 March 2015	26 March 2015					

		Bromide							Microbial	Preserved
Site		Date	T0		T4		T6		Date	Date
A	A1	10 March 2015	A9	20.55	A6	00.55	A11	02.55	12 March 2015	12 March 2015
A	A2	10 March 2015	A4	21.08	A1	01.08	A14	03.08	12 March 2015	12 March 2015
A	A3	10 March 2015	A3	21.03	A8	01.03	A13	03.03	12 March 2015	12 March 2015
A	A4	10 March 2015	A2	21.00	A7	01.00	A12	03.00	12 March 2015	12 March 2015
A	A5	10 March 2015	A5	21.10	A10	01.10	A15	03.10	12 March 2015	12 March 2015
G	G1	15 March 2015	G2	19.16	G7	23.16	G12	01.16	16 March 2015	16 March 2015
G	G2	15 March 2015	G4	19.21	G9	23.21	G14	01.12	16 March 2015	16 March 2015
G	G3	15 March 2015	G3	19.18	G8	23.18	G13	01.18	16 March 2015	16 March 2015
G	G4	15 March 2015	G1	19.12	G6	23.12	G11	10.12	16 March 2015	16 March 2015
G	G5	15 March 2015	G5	19.23	G10	23.23	G15	01.23	16 March 2015	16 March 2015
I	I1	22 March 2015	I8	20.31	I16	00.31	I24	02.31	23 March 2015	23 March 2015
I	I2	22 March 2015	I1	20.11	I9	00.11	I17	02.11	23 March 2015	23 March 2015
I	I3	22 March 2015	I7	20.27	I15	00.27	I23	02.27	23 March 2015	23 March 2015
I	I4	22 March 2015	I2	20.14	I10	00.14	I18	02.14	23 March 2015	23 March 2015
I	I5	22 March 2015	I5	20.21	I13	00.21	I21	02.21	23 March 2015	23 March 2015
I	I6	22 March 2015	I4	20.18	I12	00.18	I20	02.18	23 March 2015	23 March 2015
I	I7	22 March 2015	I3	20.17	I11	00.17	I19	02.17	23 March 2015	23 March 2015
I	I8	22 March 2015	I6	20.25	I14	00.25	I22	02.25	23 March 2015	23 March 2015
Iron Control		N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	H1									
H	H2									
H	H3									
H	H4									
H	H5									

		Iron								
Site		Sampled	T0	T1	T2	T3	T4	T5	T6	T7
A	A1	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
A	A2	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
A	A3	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
A	A4	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
A	A5	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	G1	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	G2	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	G3	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	G4	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
G	G5	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	I1	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	I2	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	I3	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	I4	Y	16 Mar	17 Mar	18 Mar	19 Mar	20 Mar	21 Mar	22 Mar	23 Mar
I	I5	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	I6	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
I	I7	Y	16 Mar	17 Mar	18 Mar	19 Mar	20 Mar	21 Mar	22 Mar	23 Mar
I	I8	Y	16 Mar	17 Mar	18 Mar	19 Mar	20 Mar	21 Mar	22 Mar	23 Mar
Iron Control		Y	16 Mar	17 Mar	18 Mar	19 Mar	20 Mar	21 Mar	22 Mar	23 Mar
H	H1	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	H2	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	H3	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	H4	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
H	H5	N	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Tube number	Site	Bt Core	Features					
			Bt/No-Bt	Depth	Animal type	Description	Operator	
1	A	A4	Bioturbated	1-1.5cm	N/A	N/A	VK	
2	A	A4	Bioturbated	1-1.5cm	N/A	N/A	VK	
3	A	A4	Unbioturbate	1-1.5cm	N/A	N/A	VK	
4	A	A4	Unbioturbate	1-1.5cm	N/A	N/A	VK	
5	A	A1	Bioturbated	1.5cm	N/A	N/A	VK	
6	A	A1	Unbioturbate	1.5cm	N/A	N/A	VK	
7	A	A1	Unbioturbate	1.5cm	N/A	N/A	VK	
8	A	A3	Bioturbated	1.5cm	N/A	N/A	VK	
9	A	A3	Bioturbated	1.5cm	Tube builder	N/A	VK	
10	A	A3	Bioturbated	N/A	N/A	N/A	VK	
11	A	A3	Unbioturbate	N/A	N/A	N/A	VK	
12	A	A3	Unbioturbate	N/A	N/A	N/A	VK	
13	A	A2	Bioturbated	N/A	N/A	N/A	VK	
14	A	A2	Bioturbated	N/A	N/A	N/A	VK	
15	A	A2	Unbioturbate	N/A	N/A	N/A	VK	
16	A	A2	Unbioturbate	N/A	N/A	N/A	VK	
17	A	A5	Bioturbated	N/A	N/A	N/A	VK	
18	A	A5	Bioturbated	N/A	N/A	N/A	VK	
19	A	A5	Unbioturbate	N/A	N/A	N/A	VK	
20	I	I3	Bioturbated	1-1.5cm	N/A	Mud burrow (	RH	
21	I	I3	Bioturbated	1-1.5cm	N/A	Mud burrow (	RH	
22	I	I3	Unbioturbate	1-1.5cm	N/A	N/A	RH	
23	I	I3	Unbioturbate	1-1.5cm	N/A	N/A	RH	
24	I	I6	Bioturbated	1-1.5cm	N/A	Luminophore	RH	
25	I	I6	Unbioturbate	1-1.5cm	N/A	N/A	RH	
26	I	I5	Bioturbated	1-1.5cm	N/A	Long thin stri	RH	
27	I	I5	Bioturbated	1-1.5cm	N/A	Mud burrow (	RH	
28	I	I5	Bioturbated	1-1.5cm	N/A	Long thin stri	RH	
29	I	I5	Unbioturbate	1-1.5cm	N/A	N/A	RH	
30	I	I5	Unbioturbate	1-1.5cm	N/A	N/A	RH	
31	I	I5	Unbioturbate	1-1.5cm	N/A	N/A	RH	
32	I	I4	Bioturbated	1-1.5cm	N/A	Large burrow	RH	
33	I	I4	Bioturbated	0.5cm	N/A	Large burrow	RH	
34	I	I4	Unbioturbate	1-1.5cm	N/A	N/A	RH	
35	I	I2	Bioturbated	1-1.5cm	N/A	Long thin stri	RH	
36	I	I2	Bioturbated	1-1.5cm	N/A	Long thin stri	RH	
37	I	I2	Unbioturbate	1-1.5cm	N/A	N/A	RH	
38	I	I2	Unbioturbate	1-1.5cm	N/A	N/A	RH	
39	I	I1	Bioturbated	1-1.5cm	N/A	Small residue	RH	
40	I	I1	Unbioturbate	1-1.5cm	N/A	N/A	RH	
41	I	I1	Unbioturbate	1-1.5cm	N/A	N/A	RH	
42	I	I1	Bioturbated	1-1.5cm	N/A	Robust burrow built above surface with l		

11 Glider report, James Burris, NOC Southampton

During DY021, several autonomous underwater gliders were scheduled to be deployed as part of the ongoing shelf seas biogeochemistry program and the sensors on gliders project.
One glider was scheduled to be recovered. A summary of the gliders and their sensors is listed below;
To deploy at Candy Floss Array:
Slocum 419. CTD, PAR sensor, Aanderaa optode Wetlabs triplet puck (this is for chlorophyll, CDOM and Backscatter detection.
Slocum 400. CTD, DTAG passive acoustic sensor, Aanderaa optode Wetlabs triplet puck.
To recover:
Slocum 345. CTD, Aanderaa optode Wetlabs triplet puck.

To deploy at Shelf edge:
Slocum 437. CTD, PAR sensor, Aanderaa optode Wetlabs triplet puck.
SeaGlider SG 533. CTD, PAR sensor, Aanderaa optode, Wetlabs triplet puck.

Sunday 22nd March 2015.
Prior to deployment, checks were re run on the gliders (this included science sensor checks, engineering check for battery status etc.). 400 were fitted with a DTAG (passive acoustic recording device) this was armed at 03:29 UTC 22nd March and then fitted to the aft section of the glider.
419 has a PAR sensor bay installed. Both of these gliders are 200m Slocum gliders.
400 (Drake) was deployed at 04:30 UTC 22nd March 2015. Position: 49 deg 24.985'N 008 deg 36.009'W.
Wind and sea state; F2-F3, sea state approx. 1m. Conditions were good and the deployment went well.
419 (49'er) was deployed in position 49 deg 24.9'N 008 deg 36.033'W at 05:10 UTC, 22nd March 2015.
Once the glider pilot was happy that the initial in water tests were going well, the ship then dropped back 1nm to the South to position 49 deg 24.0'N 008 deg 36.0'W.
This was to give room for testing the gliders while the calibration CTDs were carried out.
During the deployments glider 345 (Cabot) was circling to the NE of the ship at a range of approx. 4km.

Calibration CTDs:
The first of the calibration CTD's was CTD 029 (Stainless steel frame). This was deployed at 06:35, Position: 49 deg 24.213'N 008 deg 35.799' W.
Water samples were taken at 142m, 100m, 50m, and 15m. These samples were taken for salinity calibration. The sample at 15m was then also used for chlorophyll concentration and CDOM calibration.
Glider 345s most recent position relating to this CTD was at 05:48 UTC Position 49 deg 26.74'N 008 deg 34.44'W. (This was at a range of approx. 4.7Km bearing 020 deg (Note: Bearing is in relation to North) from the CTD location.)

The second calibration CTD was CTD 030 (Stainless steel frame). This was deployed at 07:35, Position: 49 deg 23.989'N 008 deg 35.994' W.
Water samples were taken at 135m, 125m and 75m. These samples were taken for salinity calibration. On this CTD no samples were taken for chlorophyll concentration and CDOM calibration. This was due to water requirements of the other scientists.
Glider 345s most recent position relating to this CTD was at 07:35 UTC Position 49 deg 26.07'N 008 deg 33.36'W. (This was at a range of approx. 4.6Km bearing 042 deg from the CTD location.)
At this time 345 was still set to do 5 yos at a time.

The third calibration CTD was CTD 031 (Titanium frame). This was deployed at 08:57, Position: 49 deg 23.989'N 008 deg 36.006' W.
Water samples were taken at 140m, 120m, 110m, 90m, 70m, 50m, 40m and 25m. These samples were taken for salinity calibration. Samples were taken for chlorophyll concentration and CDOM calibration. These were taken at 140m, 90m 50m and 25m.

Glider 345s most recent position relating to this CTD was at 08:24 UTC Position 49 deg 25.49'N 008 deg 33.39'W. (This was at a range of approx. 4Km bearing 051 deg from the CTD location.)

The fourth calibration CTD was CTD 032 (Stainless Steel frame). This was deployed at 10:18, Position: 49 deg 23.991'N 008 deg 36.011' W.
Water samples were taken at 100m, 45m and 15m. These samples were taken for salinity calibration. Samples were taken for chlorophyll concentration and CDOM calibration. These were taken at 100m, 45m and 15m.
Glider 345s most recent position relating to this CTD was at 09:54 UTC Position 49 deg 24.44'N 008 deg 34.44'W. (This was at a range of approx. 1.9 Km bearing 065 deg from the CTD location.)

At 11:08 the ship was moved to a new position (this was due to the Captain's concerns about the ships previous proximity to deployed equipment around the candy floss site).
The new ships position was 49 deg 24.410'N 008 deg 35.561'W.

The fifth calibration CTD was CTD 033 (Stainless Steel frame). This was deployed at 12:02, Position: 49 deg 24.413'N 008 deg 35.563' W.
Water samples were taken at 110m, 80m, 45m and 15m. These samples were taken for salinity calibration. Samples were taken for chlorophyll concentration and CDOM calibration. These were taken at 100m, 80m, 45m and 15m.
Glider 345s most recent position relating to this CTD was at 12:06 UTC Position 49 deg 23.41'N 008 deg 37.22'W. (This was at a range of approx. 2.6 Km bearing 215 deg from the CTD location.)

Glider 345 was then recovered at 13:40 in location: 49 deg 23.617'N 008 deg 39.213'W.

The sixth calibration CTD was CTD 034 (Stainless Steel frame). This was deployed at 15:02, Position: 49 deg 24.726'N 008 deg 36.087' W.
Water samples were taken at 141m, 100m, and 45m. These samples were taken for salinity calibration. Samples were taken for chlorophyll concentration and CDOM calibration. These were taken at 141m, 100m, and 45m.

Glider 400 and 419 were by this time uploading their position information to the web page.
Glider 400s most recent position relating to this CTD was at 14:50 UTC Position 49 deg 23.45'N 008 deg 38.86'W. (This was at a range of approx. 3.9 Km bearing 057 deg from the CTD location.)
Glider 419s most recent position relating to this CTD was at 14:31 UTC Position 49 deg 23.57'N 008 deg 39.52'W. (This was at a range of approx. 4.5 Km bearing 065 deg from the CTD location.)

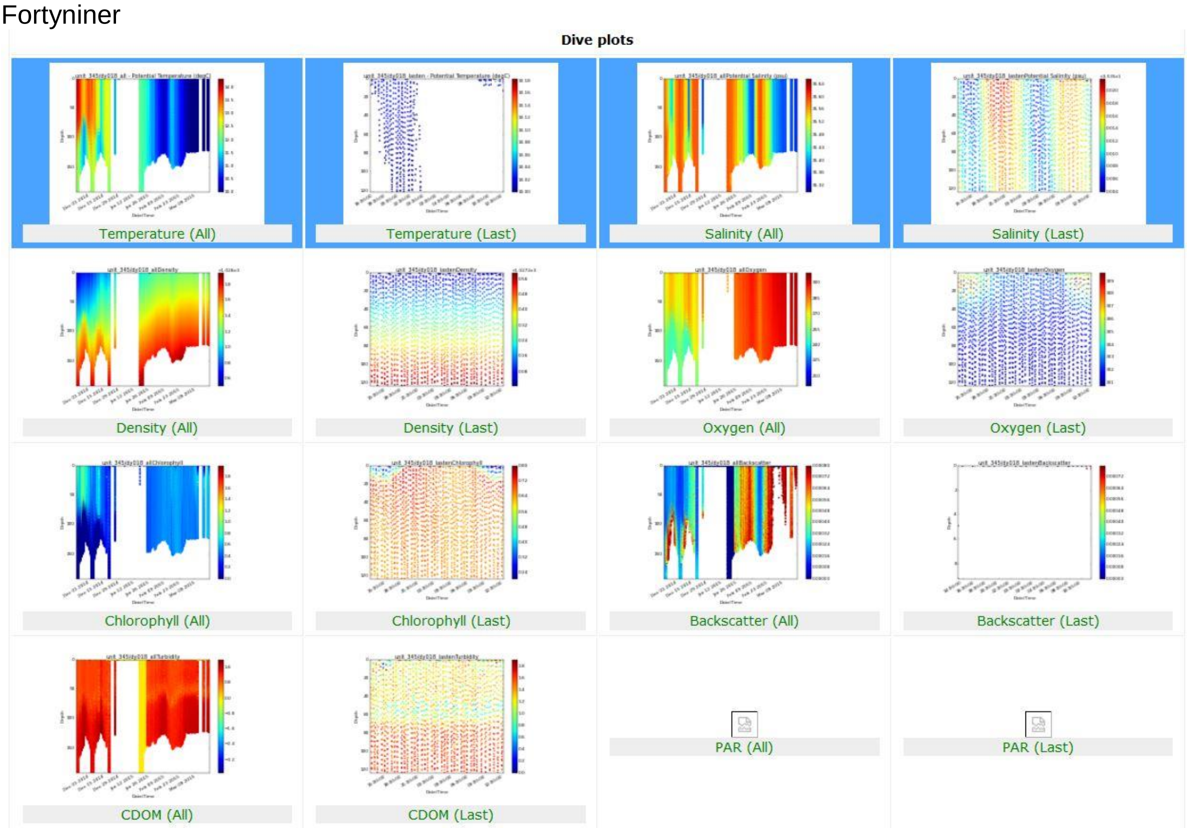
Around 1800 Glider 400 reported a leak detect in the forward compartment, the ship then moved into recover the glider which was brought back on deck at 20:01 UTC, at position 49 deg 25.4'N 008 deg 32.7'W.

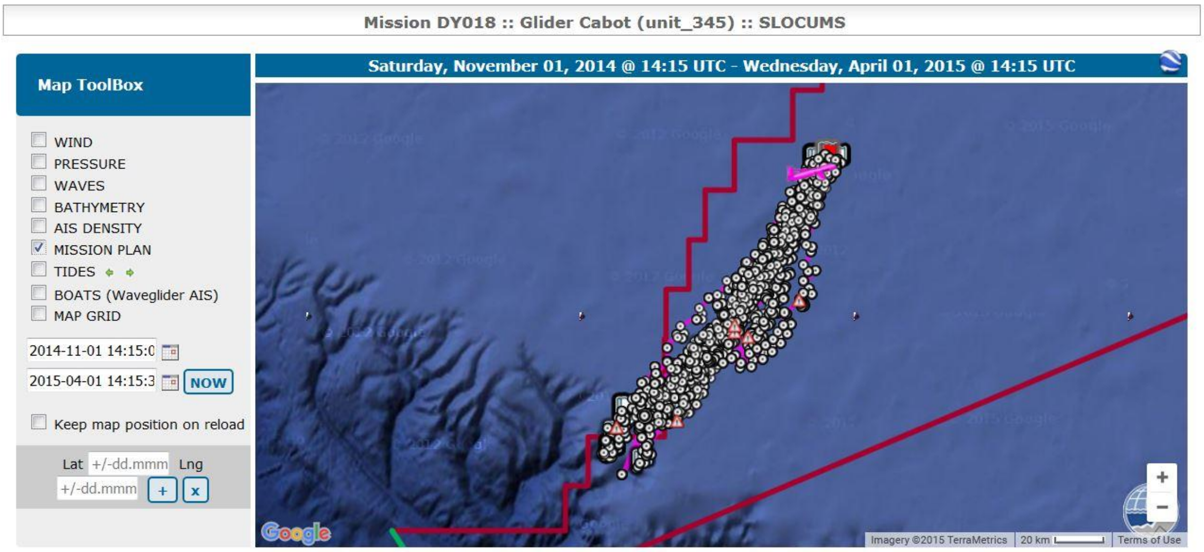
Tuesday 24th March 2015.
Prior to deployment, checks were re run on the gliders (this included science sensor checks, engineering check for battery status etc.).
Prior to deployment, an assessment of the weather and sea conditions was carried out. The sea state was marginal for deployment. The sea was estimated to be 3m with the occasional 3+m waves. F5-6.
The decision was made to go with the slocum glider first as it is more robust.
At 08:57 slocum 437 was deployed in position 48 deg 26.732' N 009 deg 44.960. The deployment went well in spite of the sea state.
Whilst preparing the Seaglider for deployment, the bridge notified they were having engine problems. There was a concern that if the sea glider were to be deployed (and had to be recovered quickly) the ship would not be able to manoeuvre for recovery.
Due to this, glider deployment was then on standby until further notice. At 09:49 the bridge called down to inform normal power was resumed and deployment could continue.
Seaglider SG 533 was attempted to be deployed at 11:58. (position: 48 deg 26.722'N 009 deg 45.058'W). However, whilst the glider was still in the lifting rig (this rig being different from the slocum

due to the requirement of vertical launch of the seagliders) the antenna snapped due to coming into contact with the rig.
As the glider was still in the rig, the glider was immediately recovered to deck. No further damage was done.
Due to this, the decision was made that the spare antenna would not be fitted, as it was clear that the sea state was not favourable for a vertical deployment of a sea glider, and to install the spare antenna and redeploy would most likely result in the same thing happening again.
Due to limited time on station, and the weather forecast, it was not viable to wait for the sea state to reduce.
The calibration CTD (CTD 038) was started at 12:45 in position 48 deg 26.715'N 009 deg 44.99'W. This was to a depth of 1000m.
Stops were carried out at 1017m, 700m, 400m, 100m and 20m. Water samples were taken for salinities, CDOM chlorophyll and suspended particulate mater.
The CTD was completed at 13:55 UTC.

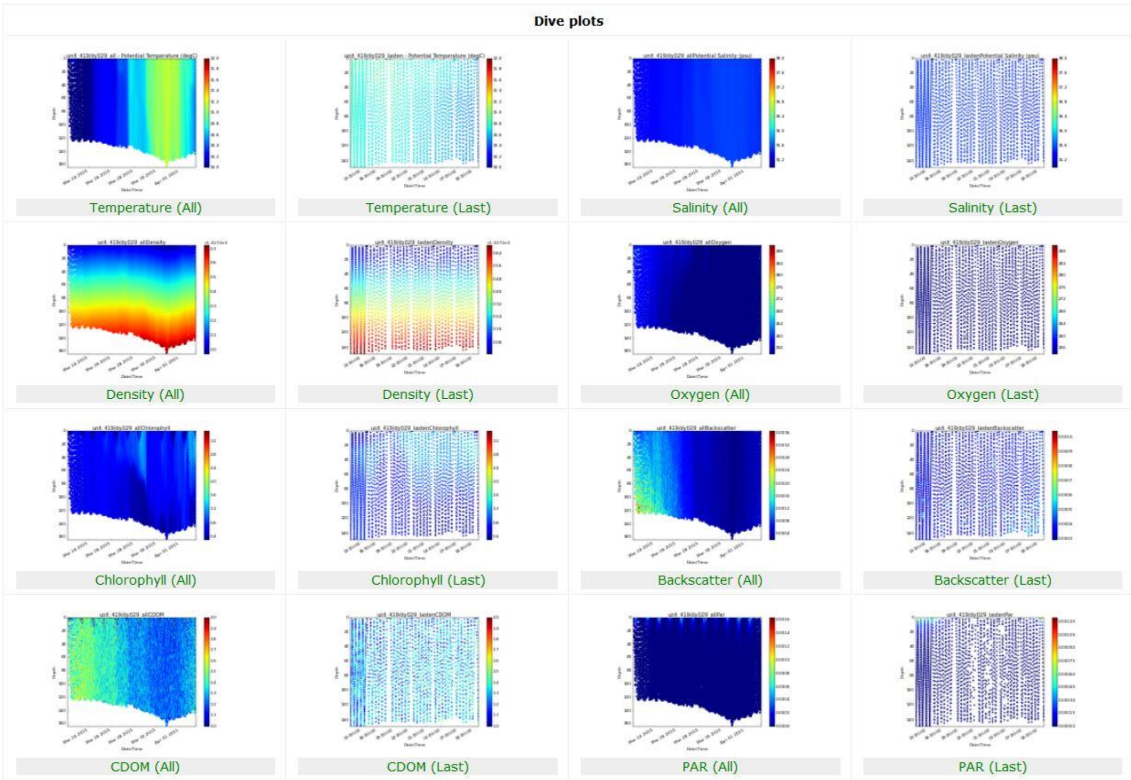
At approx. 14:00, the shore side pilots reported that 437 was reporting a leak in the aft compartment.
The resulted in the glider needing to be recovered. At 14:41 (position 48 deg 25.371'N 009 deg 46.548'W) the glider was safely recovered to deck.
Initial inspections showed that there was indeed an amount of water in the aft battery compartment. Investigations as to the cause are still on going, and will be carried out further once the glider is back at the lab in Southampton.
Given the time left on station before the ship was required to leave, the decision was made not to deploy the spare 1000m glider. The reasons for this being that there would not be time to get it to run several 1000m dives for checking prior to the ship leaving. The concern was that if the glider should abort once the ship had left site, then the glider would be drifting for several days before an attempted recovery would be possible.

Plots of the complete glider track and the thumbnail data plots from the web site for Cabot and Fortyniner

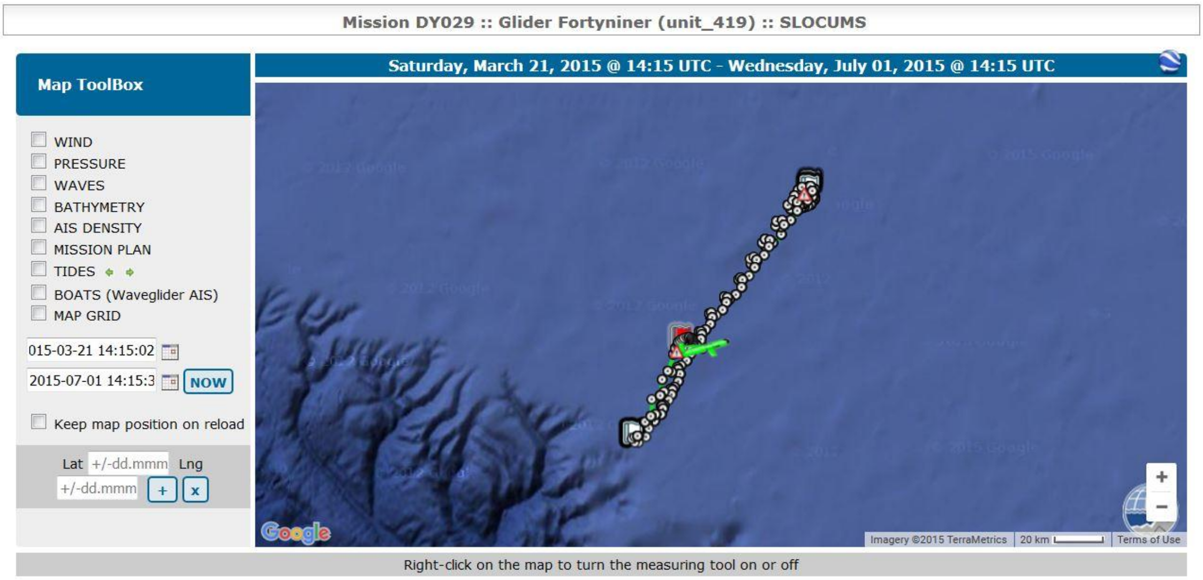




Mission DY018 :: Glider Cabot (unit_345) :: SLOCUMS
Map ToolBox
WIND
PRESSURE
WAVES
BATHYMETRY
AIS DENSITY
MISSION PLAN
TIDES
BOATS (Waveglider AIS)
MAP GRID
2014-11-01 14:15:0
2015-04-01 14:15:3
NOW
Keep map position on reload
Lat
+/-dd.mmm
Lng
+/-dd.mmm
Saturday, November 01, 2014 @ 14:15 UTC - Wednesday, April 01, 2015 @ 14:15 UTC
Imagery ©2015 TerraMetrics
20 km
Terms of Use



Dive plots
Temperature (All)
Temperature (Last)
Salinity (All)
Salinity (Last)
Density (All)
Density (Last)
Oxygen (All)
Oxygen (Last)
Chlorophyll (All)
Chlorophyll (Last)
Backscatter (All)
Backscatter (Last)
CDOM (All)
CDOM (Last)
PAR (All)
PAR (Last)


Mission DY029 :: Glider Fortyniner (unit_419) :: SLOCUMS
Map ToolBox
WIND
PRESSURE
WAVES
BATHYMETRY
AIS DENSITY
MISSION PLAN
TIDES
BOATS (Waveglider AIS)
MAP GRID
015-03-21 14:15:02
2015-07-01 14:15:3
NOW
Keep map position on reload
Lat
+/-dd.mmm
Lng
+/-dd.mmm
Saturday, March 21, 2015 @ 14:15 UTC - Wednesday, July 01, 2015 @ 14:15 UTC
Imagery ©2015 TerraMetrics
20 km
Terms of Use
Right-click on the map to turn the measuring tool on or off

12 Dissolved Oxygen – CTD calibration, Vassilis Kitidis, Plymouth Marine Laboratory

Rationale

Discrete seawater samples were collected from the stainless-steel and Titanium-frame hydrocasts (ss-CTD and Ti-CTD respectively) for the purpose of calibrating the Oxygen sensors. This activity was of interest to the wider Shelf Seas Biogeochemistry programme. Specifically: WP1 (O_2-budget, glider-calibration), WP2 (moorings, benthic landers) and WP3 (trace-metal redox reactions). The instrument that was going to be used on DY021 failed two days before the start of the cruise. Instead, a potentiometric system was used, on loan from Dr. Sinhue Torres-Valdes and Chris Daniels. This was arranged at very short notice (out of normal working hours) and I am very grateful to my colleagues at the National Oceanography Centre Southampton (NOCS) for facilitating this.

Instrumentation

Dissolved Oxygen (O_2) was determined by automated Winkler titration with potentiometric end-point (Williams and Jenkinson 1982) using a Metrohm 916 Ti-Touch controller, a Metrohm 801 magnetic stirrer unit and 2 Metrohm Dosino 800 units for dispensing Thiosulphate and Iodate solutions. A Metrohm Pt-Titrode electrode was used for detecting the potentiometric end-point of the titration. The titration sequence and data acquisition were controlled by Metrohm Tiamo software. This system was on loan from the NOCS after it was discovered that the photometric- system which was originally planned had suffered a non-repairable circuitry-failure.

Sampling

Seawater samples for dissolved oxygen concentration were directly collected from the Niskin bottles. For the ss-CTD, seawater was siphoned into 125 ml borosilicate glass bottles (nominal volume, actual volume was determined gravimetrically prior to the cruise), using silicone tubing and overflowing 2-3 times the bottle volume, and samples were immediately fixed. Oxygen in the samples was fixed with Manganese Sulphate and Alkaline Iodide solutions dispensed from calibrated pipettes. The fixing temperature was recorded on a NIST-traceable hand-held thermometer. Immediately after fixing, the samples were stored submerged in water until analysis. Titrations for dissolved oxygen determination were made within the following 24 h. The concentration of thiosulphate was calibrated every 2-4 days depending on sampling activity. Oxygen saturation was calculated from the equations for solubility in seawater of Benson and Krause (1984).

For the Ti-CTD, Niskin bottles were removed from the frame and carried into the Clean Chemistry (CC) laboratory onboard RRS Discovery, where Oxygen bottles were filled as above. Samples were fixed in a separate laboratory in order to avoid contamination of the CC-laboratory, particularly by the Manganese Sulphate reagent. The time interval between recovery of the Ti-CTD and fixing of the O_2 samples was in the order of 30-45 minutes.

Calibration results

A single Thiosulphate solution was prepared and calibrated against a 0.1 N KIO_3 standard (Fluka Analytical; FIXANAL; Lot: SZE93310). The concentration of Thiosulphate did not vary significantly during the cruise with a mean normality of 0.1921 ±0.0003 N (Figure 1A, n=56). The mean value was used for all samples. At the Oxygen concentrations encountered during DY021, the Thiosulphate concentration uncertainty of ±0.0003 N, equates to a 95% confidence interval (2 • standard deviation) of approximately 0.9 µmol/L (analytical uncertainty). Replicate samples from the same Niskin bottle had a 95% c.i. of 0.3-1.8 µmol/L (average 1.3 µmol/L; n=2-3 on 8 separate occasions, equivalent to ±0.4-0.6% saturation with respect to atmospheric equilibrium). Analytical uncertainty could therefore account for the majority (or all) of the total uncertainty in Oxygen determination by the Winkler method (i.e. including sampling). Blank titrations were carried out with each calibration and these accounted for 2.1±0.1% of the mean sample-titre volume. The mean 'blank' titre did not change significantly during the cruise (Figure 1B) and was therefore subtracted from each sample titre-volume as well as the respective standard titre-volume. Post-cruise, the Oxygen bottles were gravimetrically re-calibrated following EURAMET recommendations (European Association of National Metrology Institutes). A plot of $\Delta(O_{2\,WINKLER} - O_{2\,SEABIRD})$ against bottle number showed a constant offset across all bottles, suggesting that there was no systematic error in individual bottle volumes.

For the ss-CTD, O_2 determined by Winkler titration was positively correlated with O_2 measured by the SeaBird sensor on the ss-CTD frame (Figure 1C; *n*=81). The Ti-CTD also showed a correlation between O_2 determined by Winkler titration and O_2 measured by the SeaBird sensor on the Ti-CTD frame (Figure 1D; *n*=20). Further analysis was performed on the upcasts of successive Ti-CTD / ss-CTD pairs (at the same station and within 2 hours of each other). Oxygen concentrations from the respective CTD sensors were matched to the nearest point on a 1 m depth-sequence between 5 m and the maximum common depth of the CTD-pair. The Oxygen sensors were strongly correlated and in agreement with Winkler-data, providing an additional quality control for the less-frequently calibrated Ti-CTD (Figure 1D; both consecutive casts and Winkler data were used for the regression).

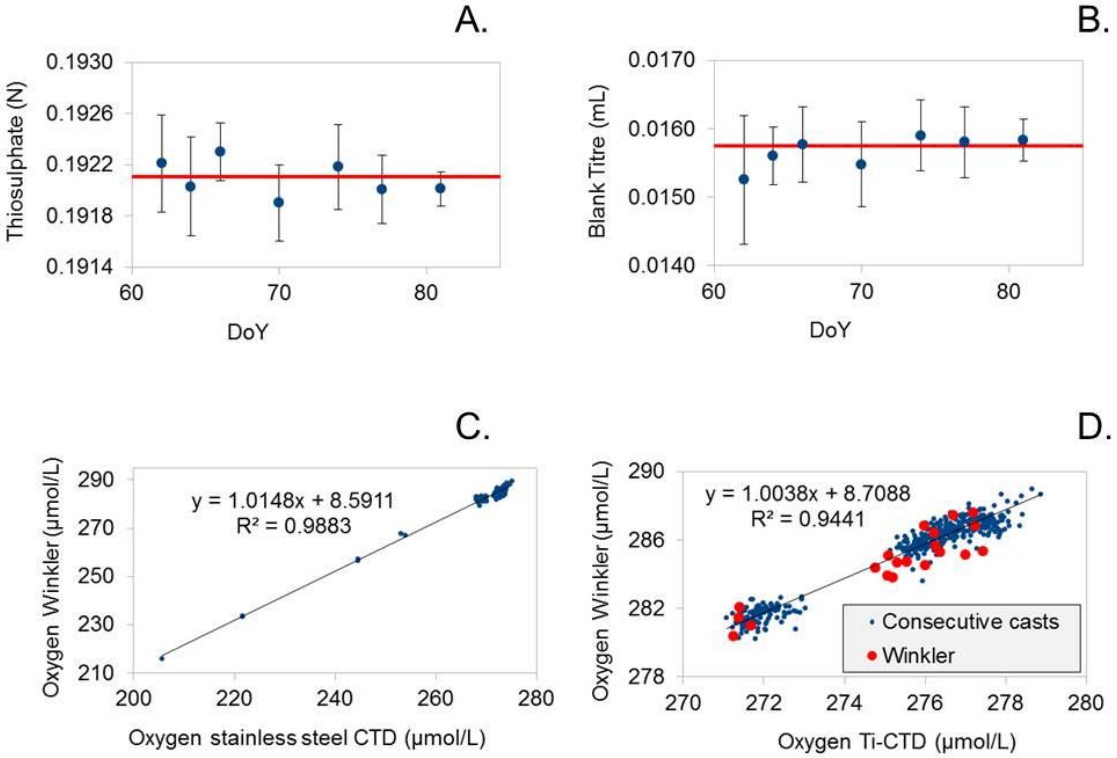


Figure 1: A: Thiosulphate concentration against Day of Year (noon on 1st Jan is DoY 1.5); B: Blank titre volume against DoY*; C: Oxygen concentration determined by Winkler against ss-CTD sensor; D: Oxygen concentration determined by Winkler against Ti-CTD sensor (red) and measured by consecutive ss-CTD / Ti-CTD casts (blue).*

References
Benson, BB and Krause DJr. (1984) Limnol. Oceanogr., 29, 630-632.
Williams, PJleB and Jenkinson NW (1982) Limnol. Oceanogr. 27, 576-584.

13 Eva McQuillan, Irish Observer: Cruise report

The foreign vessel observer scheme allows Irish people with a background in marine research to take part in scientific cruises on board foreign vessels which are conducting research in Irish waters. As an Irish foreign observer, this individual has official designation under UNCLOS to act as a representative of the Irish state. The role of an observer is to report on research activities carried out on the foreign vessel and document this information in a cruise report. The observer must also ensure that the research being carried out and the area in which it is being conducted conforms to the agreement between the country carrying out the research and the Irish government. The observer must also act as a channel of communication between the vessel and the Irish government and take an active part in the research being carried out on board the foreign vessel.

The activities which were taken part in during the duration of the cruise involved mostly spatial surveying work. Spatial surveying equipment included the NIOZ and SMBA corers, the SPI and CHEM SPI cameras, and the flume. Some filtering work for total chlorophyll, PIC and PSI was also carried out.

The cruise also provided an opportunity to trial the latest model of fast repetition rate fluorometer (FRRf) in situ, using a semi-automated continuous sampling approach. FRRfs can be used to obtain high resolution measurements of phytoplankton photophysiology and sampling continuously over the course of the cruise will allow insight into how variable these physiological parameters are over both spatial and temporal (diurnal) scales. The fluorometer system was set up prior to the ship setting sail and was monitered for the duration of the cruise and fixed or altered when required.

This cruise provided a valuable opportunity to experience working hands on with scientific equipment on board the vessel. It was an excellent chance to gain an insight into the scientific world and to learn essential skills from experienced scientific personnel.

Fast Repetition Rate Fluorometer (FRRf), Eva McQuillan

The cruise provided an opportunity to trial the latest model of fast repetition rate fluorometer (FRRf) in situ, using a semi-automated continuous sampling approach. FRRfs can be used to obtain high resolution measurements of phytoplankton photophysiology and sampling continuously over the course of the cruise will allow insight into how variable these physiological parameters are over both spatial and temporal (diurnal) scales.

14 Resuspension experiments and *in situ* measurements, Charlotte EL Thompson with Sarah Reynolds, University of Southampton, University of Portsmouth

In-Core Resuspension

The Core MiniFlume (CMF) is a small annular flume designed to fit into a NIOZ box core barrel. It is 20 cm in diameter, and consists of two acrylic tubes that form a 4.5cm wide working channel with water depth of 20-25 cm. A rotating lid turns 4 equidistant paddles, which are used to induce a flow within the flume. Fully calibrated, the flume is used to apply a shear stress to the bed in an increasing step-wise manner until and beyond the point where the bed begins to erode and resuspension occurs. During the cruise, 6 entire cores were taken from each site complete with barrels and shoes, to minimise disturbance. These were oxygenated and stored in a chilled container for a minimum of 12 hours to allow settlement of any sediment material resuspended during collection. One core was used to establish the physical stability of the bed and determine the critical erosion threshold. Once established, three cores were used to determine fluxes of inorganic nutrients, DOC, SPM and CHN during the resuspension experiments. GEL probes were inserted into one the remaining NIOZ cores, see Sarah Reynolds report for details. The additional two cores are used as backups in case of core-collapse/unsuitable surface, and where time/conditions allowed were used for replication of the physical stability experiment. In-core resuspension cannot be carried out for Benthic G, as a head of water cannot be maintained for sufficient time on advective sediments.

Post resuspension, the un-disturbed area in the centre of the core was used to collect sub-cores to be used for Particle Size Analysis (PSA: 10cm diameter) and Bulk Density (BD: 50ml syringe core). These were frozen for analysis in the laboratory.

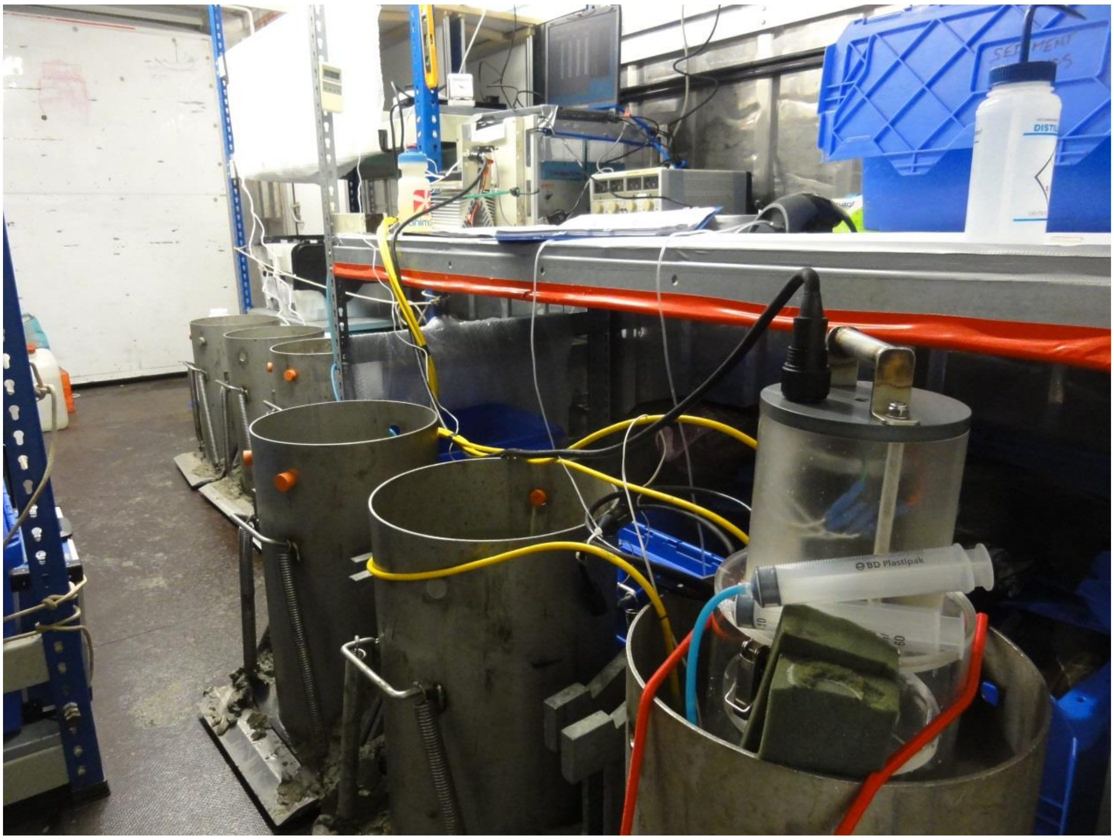


Figure 1: Core Mini Flume in place during the resuspension experiments from Benthic A.

Tables showing resuspension event summaries.

<u>Benthic A – Event 037</u>

DY021 – BOXCORE – 037 – 01 - Benthic A - NIOZ corer
On-Bed: 03/03/2015, 20:50; 50°21.700 6°8.022
Depth: 109

Time Step (minutes)	Motor Setting	Filter Number (SPM)	Amount Filtered (ml)
T_{zero}	0	F001	50
T_{10}	500	-	-
T_{20}	1000	F002	48
T_{30}	1500	-	-
T_{40}	2000	-	-
T_{50}	2500	-	-
T_{60}	3000	F003	50
T_{70}	3500	-	-
T_{80}	4000	-	-
T_{90}	4500	-	-
T_{100}	5000	F005	10
T_{110}	5500	-	-
T_{120}	6000	-	-
T_{130}	6500	F006	5.5
T_{140}	0	-	-

<u>Benthic A – Event 036</u>

DY021 – BOXCORE –036 –01- Benthic A - NIOZ corer
On-Bed: 03/03/2015, 20:39; 51°12.700 6°8.022
Depth: 110

Time Step (minutes)	Motor Setting	Filter Number (SPM)	Amount Filtered (ml)	Filter Number (DOC/POC)	Amount Filtered (ml)
T_{zero}	0	F007	31	DY021_CHN_001	20
T_{20}	500	-	-	DY021_CHN_002	50
T_{40}	1000	F008	32	DY021_CHN_003	20
T_{60}	1500	-	-	DY021_CHN_004	50
T_{80}	2000	F009	15	-	-
T_{100}	2500	-	-	DY021_CHN_005	15

**Motor Fault with Core Mini Flume meant test was stopped early*

<u>Benthic A – Event 035</u>

DY021 – BOXCORE –035–01- Benthic A - NIOZ corer
On-Bed: 03/03/2015, 20:28; 51° 21.700, 6° 8.022
Depth: 108

Time Step (minutes)	Motor Setting	Filter Number (SPM)	Amount Filtered (ml)	Filter Number (DOC/POC)	Amount Filtered (ml)
T_{zero}	0	F010	31	DY021_CHN_006	25
T_{20}	500	-	-	DY021_CHN_007	55
T_{40}	1000	F011	31	DY021_CHN_008	20
T_{60}	1500	-	-	DY021_CHN_009	55
T_{80}	2000	F012	31	DY021_CHN_010	20
T_{100}	2500	-	-	DY021_CHN_011	50
T_{120}	3000	F013	31	DY021_CHN_012	20
T_{140}	4000	-	-	DY021_CHN_013 DY021_CHN_014	15
T_{160}	5000	F014	16	DY021_CHN_015 DY021_CHN_016	10
T_{180}	0	-	-	-	-

Benthic A – Event 034

DY021 – BOXCORE –034–01- Benthic A - NIOZ corer
On-Bed: 03/03/2015, 20:18; 51 °12.699, 6 °8.012
Depth: 109

Time Step (minutes)	Motor Setting	Filter Number (SPM)	Amount Filtered (ml)	Filter Number (DOC/POC)	Amount Filtered (ml)
T_{zero}	0	F015	30	DY021_CHN_017	25
T_{20}	500	-	-	DY021_CHN_018	50
T_{40}	1000	F016	33	DY021_CHN_019	20
T_{60}	1500	-	-	DY021_CHN_020	50
T_{80}	2000	F017	30	DY021_CHN_021	20
T_{100}	2500	-	-	DY021_CHN_022	50
T_{120}	3000	F018	31	DY021_CHN_023	20
T_{140}	4000	-	-	DY021_CHN_024 DY021_CHN_026	20
T_{160}	5000	F019	14	DY021_CHN_025	18
T_{180}	0	-	-	-	-

Benthic A – Event 033

DY021 – BOXCORE –033–01- Benthic A - NIOZ corer
On-Bed: 03/03/2015, 20:07; 51 °12.697, 6 °8.015
Depth: 110

Time Step (minutes)	Motor Setting	Filter Number (SPM)	Amount Filtered (ml)	Filter Number (DOC/POC)	Amount Filtered (ml)
T_{zero}	0	F020	31	DY021_CHN_027	20
T_{20}	500	-	-	DY021_CHN_028	50
T_{40}	1000	F021	30	-	-
T_{60}	1500	-	-	DY021_CHN_030	50
T_{80}	2000	F022	31	DY021_CHN_031	20
T_{100}	2500	-	-	DY021_CHN_032	50
T_{120}	3000	F023	30	DY021_CHN_033	20
T_{140}	4000	-	-	DY021_CHN_034	37
T_{160}	5000	F024	15	DY021_CHN_035	20
T_{180}	0	-	-	-	-

Benthic I – Event 248

DY021 – BOXCORE –248–01- Benthic I - NIOZ corer
On-Bed: 15/03/2015, 03:09; 50°34.551, 7°6.238
Depth: 112

Time Step (minutes)	Motor Setting	Filter Number (SPM)	Amount Filtered
T_{zero}	0	F028	54
T_{10}	500	-	-
T_{20}	1000	-	-
T_{30}	1500	F029	51
T_{40}	2000	-	-
T_{50}	2500	-	-
T_{60}	3000	F030	35
T_{70}	3500	-	-
T_{80}	4000	-	-
T_{90}	4500	F031	31
T_{100}	5000	-	-
T_{110}	5500	-	-
T_{120}	6000	F033	10
T_{130}	6500	-	-
T_{140}	7000	-	-
T_{150}	0	-	-

Benthic I – Event 245
DY021 – BOXCORE –245–01- Benthic I - NIOZ corer
On-Bed: 15/03/2015, 02:37; 50°34.351, 7°6.239
Depth: 111

Time Step (minutes)	Motor Setting	Filter Number (SPM)	Amount Filtered (ml)	Filter Number (DOC/POC)	Amount Filtered (ml)
T_{zero}	0	F050	31	DY021_CHN_054	20
T_{20}	500	-	-	DY021_CHN_056	50
T_{40}	1000	F051	31	DY021_CHN_055	20
T_{60}	1500	-	-	DY021_CHN_057	50
T_{80}	2000	F052	31	DY021_CHN_058	20
T_{100}	2500	-	-	DY021_CHN_059	40
T_{120}	3000	F053	31	DY021_CHN_060	22
T_{140}	4000	-	-	DY021_CHN_061	20
T_{160}	5000	F054	22	DY021_CHN_062	15
T_{180}	0	-	-	-	-

Benthic I – Event 246
DY021 – BOXCORE –246–01- Benthic I - NIOZ corer
On-Bed: 15/03/2015, 02:48; 50°34.551, 7°6.240
Depth: 112

Time Step (minutes)	Motor Setting	Filter Number (SPM)	Amount Filtered (ml)	Filter Number (DOC/POC)	Amount Filtered (ml)
T_{zero}	0	F044	30	DY021_CHN_045	20
T_{20}	500	-	-	DY021_CHN_046	50
T_{40}	1000	F045	31	DY021_CHN_047	21
T_{60}	1500	-	-	DY021_CHN_048	50
T_{80}	2000	F046	30	DY021_CHN_049	20
T_{100}	2500	F047	32	DY021_CHN_050	21
T_{120}	3000	-	-	DY021_CHN_051	20
T_{140}	4000	F048	22	DY021_CHN_052	20
T_{160}	5000	F049	18	DY021_CHN_053	12
T_{180}	0	-	-	-	-

Benthic I – Event 247
DY021 – BOXCORE –247–01- Benthic I - NIOZ corer
On-Bed: 15/03/2015, 02:59; 50°34.551, 7°6.241
Depth: 113

Time Step (minutes)	Motor Setting	Filter Number (SPM)	Amount Filtered (ml)	Filter Number (DOC/POC)	Amount Filtered (ml)
T_{zero}	0	F037	30	DY021_CHN_036	21
T_{20}	500	-	-	DY021_CHN_037	50
T_{40}	1000	F038	30	DY021_CHN_038	20
T_{60}	1500	-	-	DY021_CHN_039	51
T_{80}	2000	F039	31	DY021_CHN_040	20
T_{100}	2500	-	-	DY021_CHN_041	51
T_{120}	3000	F041	31	DY021_CHN_042	20
T_{140}	4000	-	-	DY021_CHN_043	17
T_{160}	5000	F042	30	DY021_CHN_044	15
T_{180}	0	-	-	-	-

Benthic I – Event 244
DY021 – BOXCORE –244–01- Benthic I - NIOZ corer
On-Bed: 15/03/2015, 02:26, 50^{o}34.552, 7^{o}6.239
Depth: 113

Time Step (minutes)	Motor Setting	Filter Number (SPM)	Amount Filtered
T_{zero}	0	F073	51
T_{10}	500	-	-
T_{20}	1000	-	-
T_{30}	1500	-	-
T_{40}	2000	-	-
T_{50}	2500	F072	51
T_{60}	3000	-	-
T_{70}	3500	-	-
T_{80}	4000	-	-
T_{90}	4500	F074	33
T_{100}	5000	-	-
T_{110}	5500	-	-
T_{120}	6000	F075	9.9
T_{130}	6500	-	-
T_{140}	7000	-	-
T_{150}	7500	-	-
T_{160}	8000	-	-
T_{170}	0	F076	3.3

Benthic H – Event 329
DY021 – BOXCORE –329–01- Benthic H - NIOZ corer
On-Bed: 18/03/2015, 22:55, 50^{o}31.34514, 7^{o}2.18700
Depth: 110

Time Step (minutes)	**Motor Setting**	**Filter Number (SPM)**	**Amount Filtered**
T_{zero}	0	F077	51
T_{10}	500	-	-
T_{20}	1000	-	-
T_{30}	2000	F078	50
T_{40}	3000	-	-
T_{50}	4000	-	-
T_{60}	5000	F079	33
T_{70}	6000	-	-
T_{80}	7000	-	-
T_{90}	8000	F080	3.3
T_{100}	9000	-	-
T_{110}	10000	-	-
T_{120}	11000	F081	2.9
T_{130}	0	-	-

Benthic H – Event 327
DY021 – BOXCORE –327–01- Benthic H - NIOZ corer
On-Bed: 18/03/2015, 22:26; 50°31.33890, 7°2.18808
Depth: 104

Time Step (minutes)	Motor Setting	Filter Number (SPM)	Amount Filtered (ml)	Filter Number (DOC/POC)	Amount Filtered (ml)
T_{zero}	0	F082	30	DY021_CHN_065	20
T_{20}	1000	-	-	DY021_CHN_066	50
T_{40}	2000	F083	32	DY021_CHN_067	20
T_{60}	2500	-	-	DY021_CHN_068	52
T_{80}	3000	F084	31	DY021_CHN_069	24
T_{100}	4000	-	-	DY021_CHN_070	50
T_{120}	5000	F085	21	DY021_CHN_071	15
T_{140}	6000	-	-	DY021_CHN_072	20
T_{160}	7000	F086	5.1	DY021_CHN_073	10
T_{180}	0	-	-	-	-

Benthic H – Event 323
DY021 – BOXCORE –323–01- Benthic H - NIOZ corer
On-Bed: 18/03/2015, 21:38; 50°31.33872, 7°2.18880
Depth: 109

Time Step (minutes)	Motor Setting	Filter Number (SPM)	Amount Filtered (ml)	Filter Number (DOC/POC)	Amount Filtered (ml)
T_{zero}	0	F087	30	DY021_CHN_074	50
T_{20}	1000	-	-	DY021_CHN_075	20
T_{40}	2000	F088	30	DY021_CHN_076	40
T_{60}	2500	-	-	DY021_CHN_077	20
T_{80}	3000	F089	31	DY021_CHN_078	40
T_{100}	3500	-	-	DY021_CHN_079	20
T_{120}	4000	F090	31	DY021_CHN_080	20
T_{140}	5000	-	-	DY021_CHN_081	40
T_{160}	6000	F091	23	DY021_CHN_082	20
T_{180}	0	-	-	-	-

Benthic H – Event 322
DY021 – BOXCORE –322–01- Benthic H - NIOZ corer
On-Bed: 18/03/2015, 21:25; 50°33902, 7°2.18646
Depth: 110

Time Step (minutes)	Motor Setting	Filter Number (SPM)	Amount Filtered (ml)	Filter Number (DOC/POC)	Amount Filtered (ml)
T_{zero}	0	F092	30	DY021_CHN_083	20
T_{20}	1000	-	-	DY021_CHN_084	40
T_{40}	2000	F093	31	DY021_CHN_085	20
T_{60}	2500	-	-	DY021_CHN_086	42
T_{80}	3000	F094	30	DY021_CHN_087	20
T_{100}	3500	-	-	DY021_CHN_088	42
T_{120}	4000	F095	30	DY021_CHN_089	20
T_{140}	5000	-	-	DY021_CHN_090	40
T_{160}	6000	F096	9.2	DY021_CHN_091	10
T_{180}	0	-	-	-	-

Sub-cores collected

Site	*Event Number*	*PSA (10cm diameter)*	*Bulk Density (50ml syringe core)*
Benthic A	*037*		*X*
Benthic A	*033*	*X*	
Benthic A	*034*		*X*
Benthic A	*035*		*X*
Benthic I	*248*		*X*
Benthic I	*246*		*X*
Benthic I	*247*		*X*
Benthic I	*244*	*X*	
Benthic H	*327*		*X*
Benthic H	*329*		*X*
Benthic H	*323*		*X*
Benthic H	*326*	*X*	

In Situ Resuspension

Voyager II, an *in situ* benthic annular flume provided by Partrac Ltd, undertook a series of controlled resuspension events in situ. The flume consists of a working channel 0.15 m wide, and 0.2 m deep and has a total diameter of 2.2 m. Eight equidistantly spaced paddles on a rotating lid induce a current via a cogged drive, driven by a 0.6 hp, 24 V DC submarine motor and gearbox. The flume is instrumented with 3 optical backscatter sensors (OBS) which measure turbidity at three different heights, a Nortek Vectrino Velocimeter measuring velocity in the along channel (u), across channel (v) and vertical (w) directions 0.15 m above the nominal bed level, and an automated syringe sampling system taking calibration samples for the OBS. Data are logged directly to an on-board data logger, and an inboard computer controls the lid rotation and direction. The flume was lowered to the seabed, and the ship kept on station with the use of dynamic positioning and position holding confirmed via an attached drop-camera. A settling period of approx. 30 min was given to allow for settling of any material resuspended by deployment. The flume was pre-programmed with lid rotations in a stepwise increasing fashion in 10-minute increments, designed to resuspend and erode the bed. Water samples were collected at minute 9 of every velocity step and filtered on recovery and analysed for inorganic nutrients (see M. Woodward for details). “Failed” in the table indicates the water sampler fired, but did not draw up a sample.

Figure 2: Deployment of the Voyager in situ flume at Benthic A. Photo courtesy of Steve W.

Summary of in situ resuspension events

Benthic A - Event 063

DY021 – BENFLUME –063 – 01 - Benthic A - In-situ bed flume
On-Bed: 05/03/2015, 21:28; 51°12.64116, 6°7.90320
Depth: 110

Motor Setting (%)	Syringe Number	Filter Number	Amount Filtered
0	1	Failed	-
15	2	F025	55
26	3	F026	57
32	4	F032	50
38	5	FO34	55
42	6	Failed	-
47	7	Failed	-
52	8	Failed	-
57	9	Failed	-
62	10	Failed	-
0	11	Failed	-

Benthic G – Event 172

DY021 – BENFLUME –172 – 01 - Benthic G - In-situ bed flume
On-Bed: 10/03/2015, 03:02; 51°4.457, 6°35.025
Depth: 102

Motor Setting	Syringe Number	Filter Number	Amount Filtered
0	1	F035	58
15	2	Failed	-
26	3	F036	54
34	4	F027	55
38	5	Failed	-
42	6	Failed	-
47	7	Failed	-
52	8	F040	54
62	9	Failed	-
70	10	Failed	-
0	11	Failed	-

Benthic I – Event 258

DY021 – BENFLUME – 258– 01 - Benthic I - In-situ bed flume
On-Bed: 16/03/2015, 03:07; 50°34.56300, 7°6.26826
Depth:

Motor Setting	Syringe Number	Filter Number	Amount Filtered
0	1	Failed	-
15	2	F070	50
26	3	Failed	-
32	4	F067	55
38	5	Failed	-
42	6	F068	53
47	7	Failed	-
52	8	F071	55
62	9	F069	52
72	10	Failed	-
0	11	Failed	-

Benthic H – Event 374

DY021 – BENFLUME –374 – 01 - Benthic H - In-situ bed flume
On-Bed: 18/03/2015, 19:20; 50°31.32174, 7°2.14230
Depth: 110

Motor Setting	Syringe Number	Filter Number	Amount Filtered
0	1	F097	50
15	2	F098	53
26	3	F100	53
32	4	F101	54
38	5	F102	29
42	6	Failed	-
47	7	Failed	-
52	8	Failed	-
62	9	F099	-
70	10	Failed	37
0	11	Failed	-

Candyfloss – Event 501

DY021 – BENFLUME –501 – 01 - Candyfloss - In-situ bed flume
On-Bed: 23/03/2015, 01:03; 49°24.66666, 8°35.81034
Depth: 150

Unsuccessful deployment. Problems with positioning the ship resulted in the flume lifting from the seabed at 30, 45 and 95 minutes after deployment. This resulted in the deployment being abandoned with no data. Final position on recovery: 49°24.7286, 8°35.8065 (with 8 meters slack cable) indicates drift during the deployment (Wind F1/2; current 1kt).

15 Pulse chase sediment core incubations experiment, Helen Smith, University of Aberdeen

At stations A, G, H and I a ‘pulse chase’ sediment core incubations experiment was performed. At the Candyfloss site, sediment cores were collected for prokaryote and fauna analysis only.

Sediment cores were collected in 10 cm internal diameter tubes (sub-coring from the NIOZ) and were topped up with bottom seawater. The overlying water was air bubbled for a minimum of 1 hour through a core lid port and were acclimated to experimental conditions in the dark. Freeze-dried algae (Chaetocerous decipiens) that had been previously been cultured in isotopically enriched (^{13}C and ^{15}N) artificial seawater were resuspended using 10ml of bottom seawater and then gently pipetted onto the sediment surface of the cores. The experiment was run for 24 hours in total during which time the water in the microcosms was stirred with a rotating disc powered by electric motors at 40 rpm. The overlying water cores were maintained close to 100% air saturation for the initial 18 hours through bubbling for 15 minutes every 3 hours. After 18 hours the cores were sealed and were incubated for a further 6 hours to establish the oxygen uptake rate (measured using non-invasive sensor spots). Water samples were taken at the start, after 18 hours and at the end of the experiment and were preserved for later analysis of DI^{13}C, DI^{15}N and nutrients. Oxygen measurements were taken at the start and at frequent intervals throughout the incubation.

Sediment horizons (0-1 cm; 1-2 cm; 2-5 cm) were also preserved at the experiment end. From these, prokaryote and macrofauna biomass, and the uptake of isotopically labelled carbon and nitrogen will be determined.

Analysis of start and end samples of nutrients was carried out on board immediately following the experiments (Woodward).

Site	Cores incubated	Treatments (number of replicates)	Start	Intermediate	End
A, G, H, I	12	Control (6) Algae (6)	DIC (12) DIN (12) Nutrients (12) Oxygen	DIC (12) Nutrients (12) Oxygen	DIC (12) DIN (12) Nutrients (12) Oxygen Prokaryote (6) Fauna (6)
Candyfloss	n/a	Control (6)	n/a	n/a	Prokaryote (3) Fauna (3)

Details of sampling location and treatments are below.

03.03.2015 Site A – muddy

Core #	Latitude (^{o}N)	Longitude (^{o}E)	Event #	Depth (m)	Treatment
1	51’ 12.6969	6’ 7.978	004	107	Control
2	51’ 12.6969	6’ 7.979	005	107	Control
3	51’ 12.6969	6’ 7.979	005	107	Algae
4	51’ 12.6975	6’ 7.9789	006	107	Control
5	51’ 12.6975	6’ 7.9789	006	107	Algae
6	51’ 12.6975	6’ 7.9789	007	107	Control
7	51’ 12.6975	6’ 7.9789	007	107	Algae
8	51’ 12.6991	6’ 7.9782	008	109	Control
9	51’ 12.6991	6’ 7.9782	008	109	Algae
10	51’ 12.6986	6’ 7.9773	009	109	Algae
11	51’ 12.6986	6’ 7.9773	009	109	Algae
12	51’ 12.6986	6’ 7.9773	009	109	Control

09.03.2015 Site G – sand

Core #	Latitude (°N)	Longitude (°E)	Event #	Depth (m)	Treatment
1	51’ 4.4731	6’ 35.0218	151	103	Algae
2	51’ 4.4731	6’ 35.0212	152	102	Control
3	51’ 4.4731	6’ 35.0212	152	102	Algae
4	51’ 4.4731	6’ 35.0212	152	102	Algae
5	51’ 4.4726	6’ 35.0210	153	104	Algae
6	51’ 4.4724	6’ 35.0211	154	104	Control
7	51’ 4.4724	6’ 35.0211	154	104	Algae
8	51’ 4.4724	6’ 35.0201	155	104	Control
9	51’ 4.4724	6’ 35.0201	155	104	Control
10	51’ 4.4728	6’ 35.0210	156	103	Control
11	51’ 4.4677	6’ 35.0191	157	102	Control
12	51’ 4.4677	6’ 35.0191	157	102	Algae

Site I – sandy mud

Core #	Latitude (°N)	Longitude (°E)	Event #	Depth (m)	Treatment
1	50’ 34.534	7’ 6. 284	203	112	Algae
2	50’ 34.536	7’ 6.276	204	112	Control
3	50’ 34.536	7’ 6.274	206	112	Algae
4	50’ 34.536	7’ 6.274	206	112	Control
5	50’ 34.534	7’ 6.277	209	112	Algae
6	50’ 34.536	7’ 6.274	210	112	Algae
7	50’ 34.536	7’ 6.274	210	112	Control
8	50’ 34.541	7’ 6.267	211	112	Control
9	50’ 34.541	7’ 6.269	212	112	Control
10	50’ 34.541	7’ 6.269	213	111	Algae
11	50’ 34.541	7’ 6.270	214	112	Algae
12	50’ 34.546	7’ 6.273	215	112	Control

18.03.2015 Site H – muddy sand

Core #	Latitude (°N)	Longitude (°E)	Event #	Depth (m)	Treatment
1	50’ 31.324	7’ 2.159	344	110	Algae
2	50’ 31.324	7’ 2.159	345	110	Algae
3	50’ 31.325	7’ 2.158	346	110	Control
4	50’ 31.324	7’ 2.158	348	110	Control
5	50’ 31.320	7’ 2.152	349	109	Algae
6	50’ 31.320	7’ 2.153	350	110	Control
7	50’ 31.320	7’ 2.153	352	110	Algae
8	50’ 31.321	7’ 2.152	353	110	Control
9	50’ 31.321	7’ 2.153	354	110	Algae
10	50’ 31.320	7’ 2.152	355	110	Control
11	50’ 31.328	7’ 2.155	356	110	Algae
12	50’ 31.328	7’ 2.155	357	110	Control

22.03.2015 Candyfloss – sand

Core #	Latitude (°N)	Longitude (°E)	Event #	Depth (m)
1	49’ 24.701	8’ 35.919	477	153
2	49’ 24.699	8’ 35.908	478	154
3	49’ 24.702	8’ 35.909	479	154
4	49’ 24.712	8’ 35.812	480	154
5	49’ 24.709	8’ 35.845	481	154

6	49’ 24.709	8’ 35.845	481	153
7	49’ 24.718	8’ 35.839	482	153
8	49’ 24.718	8’ 35.839	482	153
9	49’ 24.713	8’ 35.834	483	153
10	49’ 24.713	8’ 35.834	483	153
11	49’ 24.706	8’ 35.813	486	153
12	49’ 24.706	8’ 35.813	486	153

16 Sample collection for the Pelagic Work Package 1, Nealy Carr, University of Liverpool (UoL)

Aims during DY021

Aim: The aims of the organic nutrient biogeochemistry team were to collect water column samples at the four main benthic sampling sites and at the CANDYFLOSS and shelf edge sites to; determine (a) organic nutrients and the stable nitrogen and oxygen isotope composition (δ15N and δ18O-nitrate) in conjunction with pelagic sampling from SSB Work Package 1; (b) collect water samples for DIC/ALK (samples were collected by Louis Byrne of the British Oceanographic Data Centre), chlorophyll, PIC, PSi and phytoplankton community for NOC Southampton; (c) collect samples for calibration of fluorometer sensor attached to the CTD, sensors deployed on CEFAS smart buoy and lander; and (d) collect samples for calibration of sensors deployed on gliders.

1.2 Sampling

A series of sampling regimes were followed: (a) depth profiles using CTDs at six sites (Site A, G, I, H, CANDYFLOSS and shelf edge), and (b) sampling surface water from the uncontaminated seawater supply.

Table 1.1; Locations of sites sampled, approximate water depth, date sampled and corresponding CTD and event number.

Site	Latitude(N)	Longitude(W)	Water Depth (approx. m)	Date Sampled	CTD Number	Event Number
A	051° 12.700	006° 07.976	109	03/03/15	002	010
A	051° 12.688	006° 07.864	109	05/03/15	008	062
	051° 09.149	006° 33.161	100	06/03/15	009	073
G	051° 04.344	006° 34.862	102	08/03/15	014	120
Lander	051° 08.011	006° 34.514	99	10/03/15	015	175
I	050° 34.534	007° 06.284	113	14/03/15	020	198
I	050° 34.555	007° 06.301	111	16/03/15	021	262
Lander	050° 35.562	007° 00.770	109	17/03/15	022	301
H	050° 31.374	007° 02.201	112	17/03/15	027	306
H	050° 31.339	007° 02.162	112	18/03/15	028	366
CANDYFLOSS	049° 24.212	008° 35.802	149	22/03/15	029	469
CANDYFLOSS	049° 23.991	008° 36.012	149	22/03/15	032	472
CANDYFLOSS	049° 24.413	008° 35.563	149	22/03/15	033	473
CANDYFLOSS	049° 24.726	008° 36.089	152	22/03/15	034	475
Smart Buoy	049° 24.602	008° 36.784	149	23/03/15	035	506
Shelf Edge	048° 24.239	009° 30.558	209	24/03/15	037	508
Gliders	048° 26.715	009° 49.999	1014	24/03/15	038	511

1.3 Sample collection techniques and analytical methods

1.3.1 Dissolved organic nutrients: Seawater was collected in 1L pre-cleaned (10% HCl) HDPE bottles and vacuum filtered through a pre-combusted glass fibre filter (nominal pore size 0.7 µm) using a pre-cleaned glass filtration rig. Filtered seawater samples were collected into acid-washed HDPE bottles and frozen immediately at -20°C for determination of dissolved organic phosphorous using persulphate oxidation. Filtered seawater was also collected in 20 ml pre-combusted glass vials containing 20 μL of 50% hydrochloric acid for DOC and TDN analysis via high temperature catalytic oxidation.

1.3.2 Chromophoric/Fluorescent dissolved organic matter (CDOM/FDOM): Seawater from up to 8 depths was filtered from the same sample in the same manner as above for dissolved organic nutrients. The filtrate was then filtered through Durapore membrane filters (0.22 µm), collected in pre-cleaned 125 mL HDPE bottles and stored in the dark at 4°C until analysis. Samples were analysed on-board within 5 days of collection using a Shimadzu spectrophotometer (UV-1650 PC) and Horiba scanning spectrofluorometer (Fluoromax 4). Emission excitation matrices and spectral absorbance indices will be employed to determine the likely source of organic matter on the Celtic sea shelf.

1.3.3 Stable nitrogen and oxygen isotope composition of nitrate: Seawater from up to 8 depths was filtered from the same sample in the same manner as above for dissolved organic nutrients. The filtrate was collected in pre-cleaned (10% HCl) 175 mL HDPE bottles and immediately frozen at -20°C. The stable nitrogen and oxygen isotope composition of nitrate ($\delta^{15}N$ and $\delta^{18}O$ of nitrate, respectively) will be analysed according to methods described and updated by McIlvin and Casciotti 2011 using a Gas Bench attached to a Thermo Finnigan isotope ratio mass spectrometer. This stable isotope approach will provide insight into the source and cycling of
Nitrate in shelf seas.

1.3.4 Amino Acids: Seawater from up to 8 depths was filtered from the same sample in the same manner as above for dissolved organic nutrients. The filtrate was collected in pre-cleaned (10% HCl) and combusted 22 mL glass vials, capped and immediately frozen at -20°C. Isomeric ratios of amino acids present will be determined using high performance liquid chromatography, dissolved free and total hydrolysable amino will be determined using fluorometric techniques and will provide insight into the degradation state and lability of DOM across the shelf region.

1.3.5 Particulate Carbon/Nitrogen (PC/PN) and Particulate Organic Phosphorous (POP); Up to 2 L of seawater from between 6 to 8 depths were filtered through pre-combusted acid rinsed (10% HCl) glass fibre filter (nominal pore size 0.7 µm) using a pre-cleaned filtration rig. The filter was collected onto muffled foil in a pre-cleaned petri dish and immediately frozen at -20°C. PC/PN concentrations will be determined using standard methodology on a CHN analyser. POP will be measured following combustion and acid hydrolysis.

References:
Grasshoff (1999). Wiley-VCH. New York.
McIlvin, M. R. and Casciotti, K. L. (2011). Analytical Chemistry, **83**, 1850-1856.
Strickland, J.D.H. & T.R. Parsons, 1972: Fisheries Research Board of Canada.
Turnewitsch, R., et al., Mar. Chem., 2007, **105,** 208-228.
Llewellyn, C.A., et al., J. Plankt. Res., 2005, **27,** 103-119.
Dauwe, B. & J.J. Middelburg, Limnol. Oceanogr., 1998, **43,**
Kiriakoulakis, K., et al., Int. J. Earth Sci., 2007, **96,** 159-170.
Sheridan, C.C., et al., Deep Sea Res. I, 2002, **49,** 1983-2008.

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17 Nutrients Sampling and Analysis, Amandine Sabadel & Malcolm Woodward, PML & Otago University New Zealand

OBJECTIVES:
To investigate the spatial and temporal variations of the micromolar nutrient species; Nitrate, Nitrite, Silicate, Ammonium and Phosphate during the DY021 research voyage on RRS Discovery, in the Celtic Sea, Shelf and Shelf Edge off the West coast of the UK. To work alongside the Benthic biogeochemists investigating nutrient pore water distributions of the major nutrients and to sample for overlying waters and benthic re-suspension of the nutrients over various time-series experiments (Smith, Sivyer, Silburn, Thompson, Reynolds and Hale). Carry out nutrient analysis from benthic experiments for the WP3 trace metals group as part of the SSB programme (Klar, Annett and Goring-Harford). Also take samples from the Benthic Flume (Thompson) and the Benthic Lander (Balfour). The Benthic Lander samples were preserved with Mercuric Chloride. Please see individual cruise reports for these colleagues as to their individual sampling protocols.

SAMPLING and ANALYTICAL METHODOLOGY:
Sample preparation and procedure
There was absolutely minimal storage of the CTD water column samples except for the time waiting to be analysed in the laboratory. These samples were always run at lab temperature and were not filtered. 60m ml HDPE Nalgene bottles were used for all the nutrient sampling, these were aged, acid washed and cleaned initially, and stored with a 10% acid solution between sampling. Samples were taken from the Sea-Bird CTD systems on-board the RRS Discovery, both Stainless Steel and Titanium units. The sample bottle was washed 3 times before taking final sample, and capping tightly. This was then taken immediately to the analyzer in the lab, and analysis conducted as soon as possible after sampling. Nutrient free gloves (Duratouch and Semperguard) were used and other clean handling protocols were adopted as close to those according to the GO-SHIP protocols, (2010) as possible.

Sample Analysis
The micro-molar segmented flow auto-analyser used was the PML 5 channel (nitrate, nitrite, phosphate, silicate and ammonium) Bran and Luebbe AAIII system, using classical proven analytical techniques.
The instrument was calibrated with home produced nutrient standards and then compared regularly against Nutrient Reference Materials, from KANSO Technos, Japan (Batch BU). The results from this also being part of a global nutrient programme (the INSS, International Nutrient Scale System) to improve nutrient analysis data quality world-wide.
The analytical chemical methodologies used were according to Brewer and Riley (1965) for nitrate, Grasshoff (1976) for nitrite, Kirkwood (1989) for phosphate and silicate, and Mantoura and Woodward (1983) for ammonium.

References:

Brewer P.G. and Riley J.P., 1965. The automatic determination of nitrate in seawater. Deep Sea Research, 12, 765-72.
Grasshoff K., 1976. Methods of seawater analysis. Verlag Chemie, Weinheim and New York, 317pp.
Kirkwood D., 1989. Simultaneous determination of selected nutrients in seawater. ICES CM 1989/C:29.
Mantoura, R.F.C and Woodward E.M.S, 1983. Estuarine, Coastal and Shelf Science, 17, 219-224.

CTD Samples Analysed by AAIII Micromolar analysis:

Date	CTD	Event	Position	CTD bottle analysed
03/03/15	CTD_001	001	$51^0$12.701’N $06^0$07.981’W	Bottles 7,13 (depths: 99,99m)
03/03/15	CTD_002	010	$59^0$12.701’N $6^0$07.981’W	Bottles 1,5,9,13,17,21(depths: 97,80,60,40,20,5m)
04/03/15	CTD_005	039	$51^0$12.698’N $6^0$08.021’W	Bottles 19,15,10,6,1 (depths: 28,42,62,82,99m)
05/03/15	CTD_008	062	$51^0$12.689’N $6^0$07.820’W	Bottles 1,5,9,13,17,21(depths: 99,80,60,40,20,5m)

06/03/15	CTD_009	073	$51^0$09.149'N $6^0$33.162'W	Bottles 13(depths: 5m)
08/03/15	CTD_012	118	$51^0$04.349'N $6^0$34.864'W	Bottles 22,20,18,16,14,10(depths: 27,41,62,78,88,97m)
08/03/15	CTD_014	120	$51^0$04.344'N $6^0$34.862'W	Bottles 1,5,9,13,17,21(depths: 94,80,60,40,20,5m)
10/03/15	CTD_015	175	$51^0$08.010'N $6^0$34.510'W	Bottles 1,5,9,13,17,21(depths: 90,80,60,40,20,5m)
14/03/15	CTD_018	196	$50^0$34.533'N $7^0$06.281'W	Bottles 15,17,19,21,23 (depths: 26,41,61,81,104m)
14/03/15	CTD_019	197	$50^0$34.533'N $7^0$06.281'W	Bottles 24(depths: 103m)
14/03/15	CTD_020	198	$50^0$34.533'N $7^0$06.281'W	Bottles 1,5,9,13,17,21(depths: 103,80,60,40,20,5m)
16/03/15	CTD_021	262	$50^0$34.555'N $7^0$06.301'W	Bottles 2,6,10,14,18,22(depths: 101,80,60,40,20 5m)
17/03/15	CTD_022	301	$50^0$35.562'N $7^0$00.770'W	Bottles 9(depths: 99m)
17/03/15	CTD_025	304	$50^0$31.374'N $7^0$02.201'W	Bottles 20,21,22,23,24(depths: 25,80,60,40,20,100m)
17/03/15	CTD_026	305	$50^0$31.374'N $7^0$02.201'W	Bottles 24(depths: 102m)
17/03/15	CTD_027	306	$50^0$31.374'N $7^0$02.201'W	Bottles 2,6,10,14,18,22(depths: 101,80,60,40,20 5m)
18/03/15	CTD_028	366	$50^0$31.374'N $7^0$02.201'W	Bottles 3,7,11,15,19,23(depths: 100,80,60,40,20 5m)
22/03/15	CTD_031	471	$49^0$23.988'N $8^0$36.008'W	Bottles 1,4,6,9,11,13,16,17(depths: 140,131,111,91,70,51,41,26m)
22/03/15	CTD_033	473	$49^0$23.988'N $8^0$36.008'W	Bottles 1,4,7,10,13,16,19,22(depths: 140, 110,80,60,45,30,15,5m)
23/03/15	CTD_035	506	$49^0$24.602'N $8^0$35.784'W	Bottles 1,4,7,10,13,16,19,22(depths: 140, 110,80,60,45,30,15,5m)
24/03/15	CTD_036	507	$48^0$34.239'N $9^0$30.557'W	Bottles 2,6,7,9,11,16,19,20,21(depths: 200,181,171,152,102,82,62,41,27m)
24/03/15	CTD_037	508	$48^0$34.239'N $9^0$30.557'W	Bottles 1,4,7,10,13,16,19,22(depths: 198,160,120,90,60,40,20,5m)

Underway Non-toxic water system Samples Analysed by AAIII Micromolar analysis:

?	Non Toxic 1	
?	Non Toxic 2	
?	Non Toxic 3	
?	Non Toxic 4	
05/03/15: 0900	Non Toxic 5	
05/03/15: 1205	Non Toxic 6	
05/03/15: 1924	Non Toxic 7	$51^0$05N $6^0$35W
07/03/15: 1440	Non Toxic 8	
09/03/15: 1125	Non Toxic 9	
11/03/15: 1242	Non Toxic 10	
12/03/15: 1250	Non Toxic 11	
13/03/15: 1225	Non Toxic 12	
16/03/15: 1150	Non Toxic 13	
17/03/15: 1308	Non Toxic 14	
18/03/15: 1220	Non Toxic 15	

Nutrient Analysis of Experimental samples:

4th March:

- Helen Smith incubation samples = 12 samples
- Briony Silburn, NIOZ core pore water = 31 samples, O_2 incubation = 21 samples, and flux incubation = 56 samples
- Charlie Thompson, Flume samples (CMF) = 6 samples

5th March:

- Helen Smith incubation samples = 12 samples
- Briony Silburn, V incubation = 12 samples
- Spatial Survey = 7 samples
- Rachel Hale = 5 samples
- Jessy + Amber core top water = 4 samples
- Dave ‘acidified’ PO4 WP3 = 21 samples
- Charlie Thompson, Flume samples (CMF) = 18 samples
- Amber core top = 1 sample

6th March:

- Jessy + Amber core pore water = 24 samples
- Spatial Survey = 19 samples
- Charlie Thompson, Flume samples (CMF) = 9 samples
- Voyager = 4 samples
- Amber core top = 1 sample

7th March:

- Spatial Survey = 55 samples

8th March:

- Spatial Survey = 65 samples
- Peter PO4 ‘acidified’ = 24 samples

9th March:

- Briony Silburn, V incubation = 49 samples
- Dave pore water = 31 samples
- Jessy + Amber incubation = 4 samples
- Helen Smith incubation samples = 12 samples
- NOC Lander = 24 samples

10th March:

- Briony Silburn, flux incubation = 56 samples
- Dave pore water = 11 samples
- Jessy + Amber incubation = 10 samples
- Helen Smith incubation samples = 12 samples
- Sarah FTR = 4 samples
- Voyager = 4 samples

11th March:

- Helen Smith incubation samples = 12 samples
- Rachel Hale = 10 samples
- Sarah FTR = 6 samples
- Briony Silburn, V incubation = 12 samples

13th March:

- Sarah FTR = 12 samples
- Jessy + Amber incubation = 10 samples
- Amber core top = 1 sample

14th March:

- Sarah FTR = 6 samples
- Spatial Survey = 10 samples

15th March:
- Helen Smith incubation samples = 12 samples
- Dave ‘acidified’ PO4 WP3 = 8 samples
- Sarah FTR = 3 samples
- Briony Silburn, V incubation = 49 samples; pore water = 33 samples
- Jessy + Amber core top water = 4 samples

16th March:
- Helen Smith incubation samples = 24 samples
- Jessy + Amber pore water = 22 samples
- Amber core top = 1 sample; mixed pore water = 1 sample
- Voyager = 5 samples
- Rachel Hale = 5 samples
- Charlie Thompson, CMF = 27 samples
- Briony Silburn, V incubation = 12 samples; flux incubation = 50 samples
- Spatial Survey = 22 samples

17th March:
- Rachel Hale = 8 samples
- Sarah FTR = 7 samples
- Spatial Survey = 88 samples
- Peter PO4 ‘acidified’ = 6 samples

18th March:
- Sarah FTR = 3 samples
- Dave ‘acidified’ PO4 WP3 = 10 samples
- Briony Silburn, V incubation = 49 samples; pore water = 32 samples
- Jessy + Amber pore water = 20 samples
- Helen Smith incubation samples = 24 samples
- Amber core top = 1 sample

19th March:
- Charlie Thompson, CMF = 27 samples
- Spatial Survey = 63 samples
- Helen Smith incubation samples = 24 samples
- Briony Silburn, V incubation = 12 samples; flux incubation = 55 samples
- Voyager = 6 samples
- Sarah FTR = 4 samples
- Jessy + Amber WP3 inc = 8 samples

20th March:
- Helen Smith incubation samples = 24 samples
- Jessy + Amber incubation = 20 samples; core top water = 4 samples
- Amber core top = 1 sample
- Rachel Hale = 5 samples
- Spatial Survey = 92 samples
- Sarah FTR = 3 samples
- Peter PO4 ‘acidified’ = 5 samples

21st March:
- Spatial Survey = 96 samples
- Jessy + Amber incubation = 4 samples
- Sarah FTR = 3 samples

22nd March:

- Rachel Hale = 8 samples
- Sarah FTR = 3 samples

23rd March:

- Briony Silburn, pore water = 10 samples; flux incubation = 48 samples

24th March:

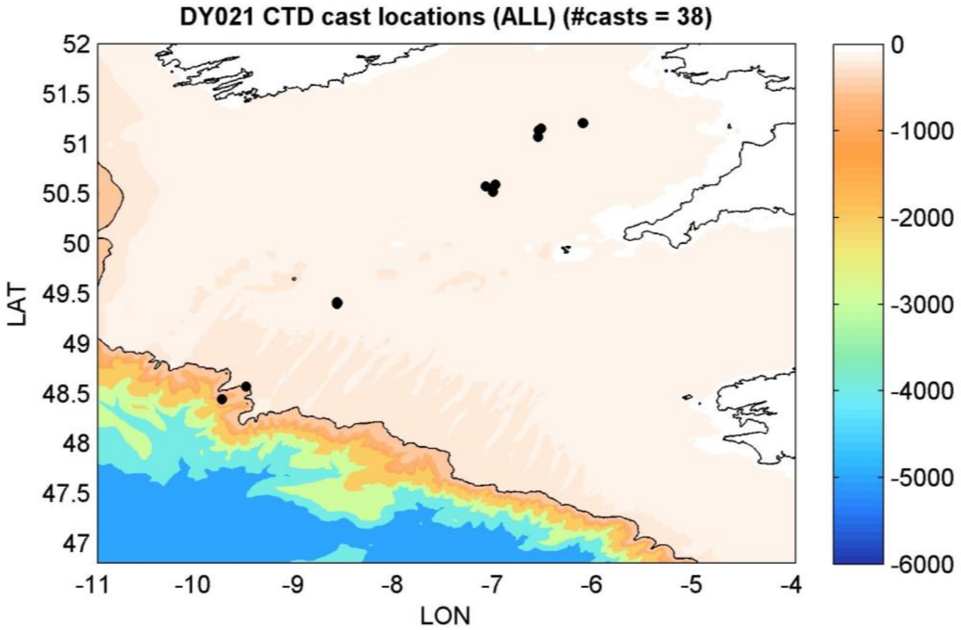
- Briony Silburn, flux incubation = 8 samples
- Sarah FTR = 3 samples
- NOC Lander = 24 samples

18 CTD processing report, Jo Hopkins, NOC Liverpool

A total of 30 casts with the stainless steel frame and 8 casts with the titanium CTD frame were completed. See technical reports for sensor serial numbers and channels.

Stainless cast numbers are 1-2, 6-11, 13-17, 19-24, 26-30, 32-35, and 37-38.
Titanium cast numbers are 3-5, 12, 18, 25, 31 and 36.

Map of CTD cast locations



Raw data files:

The following raw data files were generated:

DY021_001.bl (a record of bottle firing locations)
DY021_001.hdr (header file)
DY021_001.hex (raw data file)
DY021_001.con (configuration file)

Where _001 is the cast number (not STNNBR)

SBEDataProcessing steps

The following processing routines were run in the SBEDataProcessing software (Seasave Version 7.23.2):

1. **DatCnv:** A conversion routine to read in the raw CTD data file (.hex) containing data in engineering units output by the CTD hardware. Calibrations as appropriate though the instrument configuration file (.CON) are applied.

   Data Setup options were set to the following:

   Process scans to end of file: yes
   Scans to skip: 0
   Output format: ascii
   Convert data from: upcast & downcast
   Create file types: both bottle and data
   Source of scan range data: bottle log .BL file
   Scan range offset: -2.5 seconds for stainless, -1 second for titanium (fired on the fly)

Scan range duration: 5 seconds for stainless, 1 second for titanium (fired on the fly)

Merge separate header file: No

Apply oxygen hysteresis correction: yes (2 second window)

Apply oxygen Tau correction: yes

Selected output variables:

- Time [seconds]
- Pressure [db]
- Temperature [ITS-90, °C] and Temperature 2 [ITS-90, °C], referring to primary and secondary sensors)
- Conductivity and Conductivity 2 [S/m]
- Salinity and salinity 2 [PSU, PSS-78]
- Oxygen raw, SBE 43 [V0]
- Oxygen, SBE 43 [µmol/l]
- Beam attenuation [1/m]
- Fluorescence [µg/l]
- PAR/irradiance, downwelling [W m^2]
- Turbidity [m^{-1} sr^{-1}]
- Altimeter [m]
- Voltage channel 2: Light scattering BBRTD *[S/S],* Downwelling Irradiance (DWIRR) *[Ti]*
- Voltage channel 3: Altimeter *[S/S]*, Upwelling Irradiance (UWIRR) *[Ti]*
- Voltage channel 4: Fluorometer *[S/S],* Altimeter *[Ti]*
- Voltage channel 5: Transmissometer *[S/S]*, Light scattering BBRTD *[Ti]*
- Voltage channel 6: Upwelling Irradiance (UWIRR) *[S/S],* Transmissometer *[Ti]*
- Voltage channel 7: Downwelling Irradiance (DWIRR) *[S/S],* Fluorometer *[Ti]*

2. **Bottle Summary** was run to create a .BTL file containing the average, standard deviation, min and max values at bottle firings. .ROS files were placed in the same directory as the .bl files during this routine to ensure that bottle rosette position was captured in the .btl file.

   Output saved to DY021_001.btl

3. **Wild Edit:** Removal of pressure spikes
   Standard deviations for pass 1: 2
   Standard deviations for pass 2: 20
   Scans per black: 100
   Keep data within this distance of the mean: 0
   Exclude scans marked as bad: yes
4. **Filter:** Run on the pressure channel to smooth out high frequency data
   Low pass filter time B: 0.15 seconds
5. **AlignCTD:** Based on examination of different casts a 2 second advance was chosen for alignment of the oxygen sensor on the stainless steel CTD and 4 seconds for the titanium casts. Note that there was very little stratification during the cruise so these values were tricky to determine. This alignment is a function of the temperature and the state of the oxygen sensor membrane. The colder (deeper) the water the greater the advance needed. The above alignments were chosen as a compromise between results in deep (cold) and shallow (warmer) waters.

6. **CellTM:** Removes the effect of thermal inertia on the conductivity cells. Alpha = 0.03 (thermal anomaly amplitude) and 1/beta = 7 (thermal anomaly time constant) for both cells.

   Output of steps 1-6 above saved in DY021_001.cnv (24 Hz resolution)

7. **Derive:** Variables selected are
   Salinity and Salinty 2 [PSU, PSS-78]

Oxygen SBE43 [µmol/l]
Oxygen Tau correction: yes (2 second window)

Output saved to DY021_001_derive.cnv (24 Hz resolution)

8. **BinAverage:** Average into 2Hz (0.5 seconds),
   Exclude bad scans: yes
   Scans to skip over: 0
   Casts to process: Up and down

9. **Strip:** Remove salinity and oxygen channels from the 2 Hz file that were originally created by DatCnv, but then later regenerated by Derive.

   Output saved to DY021_001_derive_2Hz.cnv

Matlab processing steps
The following processing steps were performed in MATLAB:

(1) Create a .mat file of meta data extracted from the cruise Event Log with the following variables:

CRUISECODE e.g. DY021
STNNBR (as per BODC data management guidance for the Shelf Sea Biogeochemistry programme)
DATE and TIME of the cast at the bottom of the profile
LAT and LON when the CTD was at the bottom of the profile
DEPTH (nominal water depth in metres from echo sounder)
CAST (CTD cast number, e.g. 001)

File created: DY021_metadata.mat

(2) Extract data from 2Hz averaged files (e.g. DY021_001_derive_2Hz.cnv), merge with metadata and save into a matlab structure for each cast. Each file (DY021_001_derive_2Hz.mat) contains the following un-calibrated channels.

CTD001 =

CRUISE:	'DY021'	
CAST:	1	
STNNBR:	1	
DATE:	'03/03/2015'	
TIME:	'07:00:00'	
LAT:	51.2117	
LON:	-6.1330	
DEPTH:	109	[m]
CTDtime:	[4895x1 double]	[seconds]
CTDpres:	[4895x1 double]	[db]
CTDtemp1:	[4895x1 double]	[°C]
CTDtemp2:	[4895x1 double]	[°C]
CTDcond1:	[4895x1 double]	[S/m]
CTDcond2:	[4895x1 double]	[S/m]
CTDoxy_raw:	[4895x1 double]	[V]
CTDatt:	[4895x1 double]	[1/m]
CTDfluor:	[4895x1 double]	[µg/l]
CTDpar:	[4895x1 double]	[Wm^2]
CTDturb:	[4895x1 double]	[m^{-1} sr^{-1}]
CTDalt:	[4895x1 double]	[m]

CTDturb_raw:	[4895x1 double]	[V]
CTDalt_raw:	[4895x1 double]	[V]
CTDfluor_raw:	[4895x1 double]	[V]
CTDatt_raw:	[4895x1 double]	[V]
CTDpar_up_raw:	[4895x1 double]	[V]
CTDpar_dn_raw:	[4895x1 double]	[V]
CTDsal1:	[4895x1 double]	[PSU]
CTDsal2:	[4895x1 double]	[PSU]
CTDoxy_umoll:	[4895x1 double]	[µmol/l]
CTDflag:	[4895x1 double]	

(3) Extract data from 24Hz files (e.g. DY021_001_derive.cnv), merge with metadata and save into a matlab structure for each cast. Each file (DY008_001_derive.mat) contains the following <u>un-calibrated</u> channels.

CTD001 =

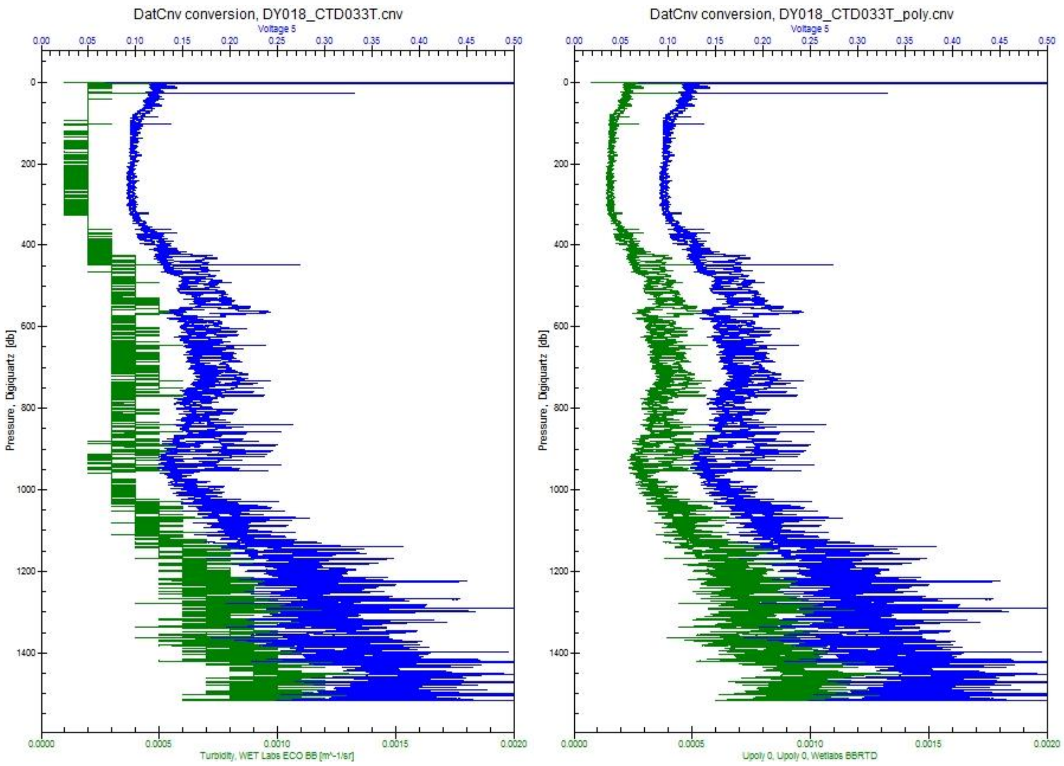
CRUISE:	'DY021'	
CAST:	1	
STNNBR:	1	
DATE:	'03/03/2015'	
TIME:	'07:00:00'	
LAT:	51.2117	
LON:	-6.1330	
DEPTH:	109	[m]
CTDtime:	[58732x1 double]	[seconds]
CTDpres:	[58732x1 double]	[db]
CTDtemp1:	[58732x1 double]	[°C]
CTDtemp2:	[58732x1 double]	[°C]
CTDcond1:	[58732x1 double]	[S/m]
CTDcond2:	[58732x1 double]	[S/m]
CTDsal1_1:	[58732x1 double]	[PSU]
CTDsal2_1:	[58732x1 double]	[PSU]
CTDoxy_raw:	[58732x1 double]	[V]
CTD_oxy_umoll_1:	[58732x1 double]	[µmol/l]
CTDatt:	[58732x1 double]	[1/m]
CTDfluor:	[58732x1 double]	[µg/l]
CTDpar:	[58732x1 double]	[Wm^{2}]
CTDturb:	[58732x1 double]	[m^{-1} sr^{-1}]
CTDalt:	[58732x1 double]	[m]
CTDturb_raw:	[58732x1 double]	[V]
CTDalt_raw:	[58732x1 double]	[V]
CTDfluor_raw:	[58732x1 double]	[V]
CTDatt_raw:	[58732x1 double]	[V]
CTDpar_up_raw:	[58732x1 double]	[V]
CTDpar_dn_raw:	[58732x1 double]	[V]
CTDsal1:	[58732x1 double]	[PSU]
CTDsal2:	[58732x1 double]	[PSU]
CTDoxy_umoll:	[58732x1 double]	[µmol/l]
CTDflag:	[58732x1 double]	

Note that '_1' for the first instances of salinity and oxygen in this file are variables before re-derivation in the SeaBird Processing routines.

As per DY018, inspection of the turbidity channel (CTDturb) and comparison to the original raw voltage (CTDturb_raw) revealed a potential bug in the SeaBird DatCnv conversion module. After correspondence with SeaBird, it was confirmed that the converted ECO-BB output was being reported to a fixed precision (see email chain in DY018 report). This is demonstrated below (left) where the raw voltage channel (blue) is compared to the SeaBird DatCnv output (green). Direct conversion using the scale factor (SF) and dark counts (DC) supplied in the manufacturer's calibration appears to rectify this problem (right plot). We therefore replace the original turbidity channel in the .cnv files with a corrected version using:

CTDturb = CTDturb_raw .* SF - (SF x DC);

This appears to reinstate the original resolution.



(4) Manual identification of the surface soak (while waiting for pumps to turn on) and the end of the downcast using the 2Hz files. Times to crop were saved to DY021_stainless_castcrop_times.mat and DY021_titanium_castcrop_times.mat

CAST:	[30x6 char]
STNNBR:	[30x1 double]
CTDstart:	[30x1 double]
CTDstop:	[30x1 double]

This was then used to crop both the 2Hz and 24Hz files and output (i.e. just the downcast recordings) saved to DY021_001_derive_2Hz_cropped.mat and DY021_001_derive_cropped.mat respectively.

(5) De-spiking of downcast 24 Hz data. The salinity, conductivity, temperature, oxygen, attenuation, turbidity and fluorescence channels were all de-spiked. The worst spikes were identified using an automated routine (similar to WildEdit) where the data was scanned twice and points falling outside a threshold of *nstd* x standard deviations from the mean within a set window size were removed (turned into NaNs).

Window size (#scans) and number of standard deviations from the mean (nstd) used for each channel.

Channel	*Pass 1 window*	*Pass 1 nstd*	*Pass 2 window*	*Pass 2 nstd*
Temperature, conductivity, fluorescence	100	3	200	3
Salinity, turbidity	200	2	200	3
Oxygen, attenuation	100	2	200	3

Auto-despiking saved to DY021_001_derived_cropped_autospike.mat

Manual de-spiking was then performed to remove larger sections of bad data or any remaining isolated spikes in each channel.

Large ‘spikes’ were often observed in the CT sensors lasting a few seconds, predominantly in the thermocline. This is a persistent problem in shallow water with strong property gradients (e.g. see for example D352, D376); particularly where a large CTD package carrying large volume bottles is used. The spikes coincide with a decrease in the decent rate of the CTD package and are therefore likely associated with inefficient flushing of water around the sensors. It is caused by the pitch and roll of the boat, so is accentuated in rough weather. As the decent rate of the CTD package slows on the downcast ‘old’ water (from above and therefore typically warmer) is pushed back passed the sensors. As the decent rate increases again ‘new’ water is flushed past the sensors. A similar problem can occur if the veer rate on the CTD winch varies (as was the case on CD173).

The largest and most significant anomalies identified in the primary and secondary CT sensors were removed. This was at times up to 5 m of the profile. The impact of smaller scale anomalies that were not removed is mostly minimised during the averaging processes, but care should be taken when interpreting smaller scale features, particularly through the thermocline. The casts are more than good enough for looking at large scale trends and anomalies but should probably not be used for Thorpe scale analysis and interpretation of fine scale structures. To achieve this in a shelf sea environment free fall profiling techniques are more suitable.

Although ‘old’ water would also have been flushed back past the auxiliary sensors (turbidity, oxygen, chlorophyll, attenuation) the coincident measurements in these channels were (a) not always anomalous and/or (b) any associated anomaly did not always exactly coincide (or could even be confidently identified, especially for oxygen). As such removal of data from auxiliary channels using scans flagged as bad in the primary/secondary CT channels was not always appropriate or did not improve data quality. The worst individual spikes within these channels however were manually identified and removed (NaN’d).

Output saved to DY021_001_derived_cropped_autospike_manualspike.mat

Additional channels added into this file:

Vectors of 0’s and 1’s indicating data that has been NaN’d (=1). Outputs depend on channels loaded and viewed so each column may have variable meaning and is saved for processing archive purposes only.

Pindex: [18900x3 double]
Sindex: [18900x3 double]
Aindex: [18900x4 double]

(6) Average 24Hz (cropped and de-spiked data) into 1 db. Linear interpolation used when no data available for averaging.

Files for each cast were created: DY021_001_1db_dn.mat

All the 1 db profiles (except PAR) are then further smoothed with a 10 m running median window.

File output: DY021_001_1db_dn_smth.mat

(7) Application of calibrations to salinity, chlorophyll and oxygen in 1db smoothed downcasts. Calibrated files saved to DY021_001_1db_dn_smth_calib.mat.

Sigma theta (σ_θ) (relative to 0 pressure) is also calculated at this stage using the matlab function sw_pden-1000 from the SEAWATER toolkit.

CTD001 =

CRUISE:	'DY021'	
CAST:	1	
STNNBR:	1	
DATE:	'10/11/2014'	
TIME:	'05:12'	
LAT:	49.4013	
LON:	-8.5802	
DEPTH:	151	
pres:	[140x1 double]	[db]
time:	[140x1 double]	[seconds]
temp1:	[140x1 double]	[°C]
temp2:	[140x1 double]	[°C]
sal1:	[140x1 double]	[PSU] - calibrated
sal2:	[140x1 double]	[PSU] - calibrated
cond1:	[140x1 double]	[S/m] – not calibrated
cond2:	[140x1 double]	[S/m] – not calibrated
oxy_umoll:	[140x1 double]	[µmol/l] – calibrated
fluor:	[140x1 double]	[µg/l] – S/S only calibrated*
par:	[140x1 double]	[Wm^2]
turb:	[140x1 double]	[m^{-1} sr^{-1}]
att:	[140x1 double]	[1/m]
sigma_theta:	[140x1 double]	

The calibrations were also applied to the 24 Hz data (cropped and de-spiked) and output to .mat files DY021_001_derive_cropped_autospike_manualspike_calib.mat containing the same variables as above.

* A calibration could not be determined for the titanium chlorophyll so this variable remains un-calibrated in these final files*

(8) Application of salinity, chlorophyll and oxygen calibrations to bottle firing data. A new file, DY021_stainless_btl_calib.mat/ DY021_titanium_btl_calib.mat, with variables CTDsal1_cal, CTDsal2_cal, CTDoxy_umoll_cal and CTDfluor_cal was created. **Note that the titanium CTD has NOT had a chlorophyll calibration so the CTDfluor_cal variable does not exist**

Notes:

TD009 (S/S) just a surface soak – no profile

Calibrations

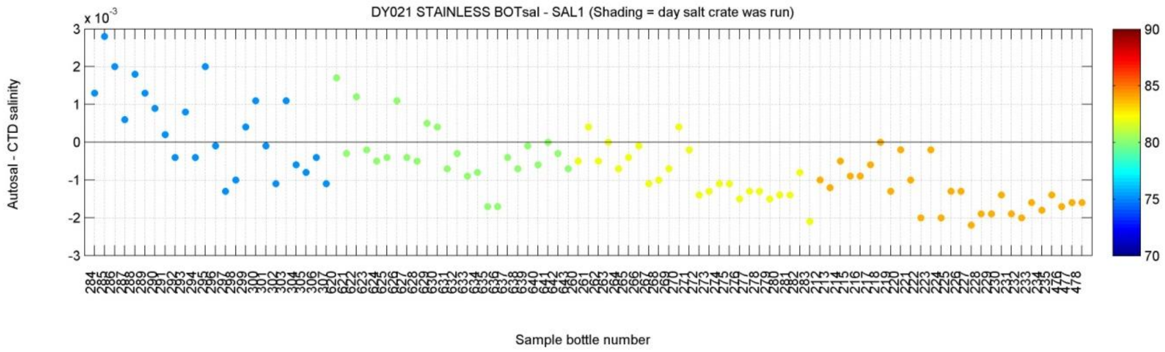
Salinity

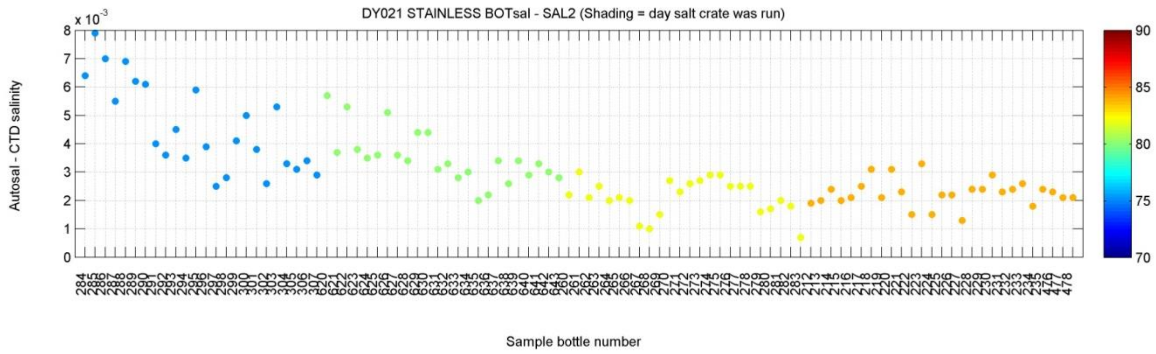
99 salinity samples were taken from the stainless steel CTD and 38 samples from the titanium and analysed on a Guildline 8400B Autosal salinometer (s/n 71126).

There was some uncertainty over which niskin bottles salinity samples from cast 12, 18 and 25 (titanium casts) were taken from. The bottle positions (ROSPOS) in the .btl files do not match the numbers recorded on the hand written log sheets from NMF. In some instances bottles supposedly sampled were not even fired. The best possile matches were found and used.

Stainless sensors

There was a drift in the Autosal – CTDsal salinities in both the primary and secondary conductivity senosors. The ‘drift’ in the stainless samples was O(0.005) PSU (see Figure below).



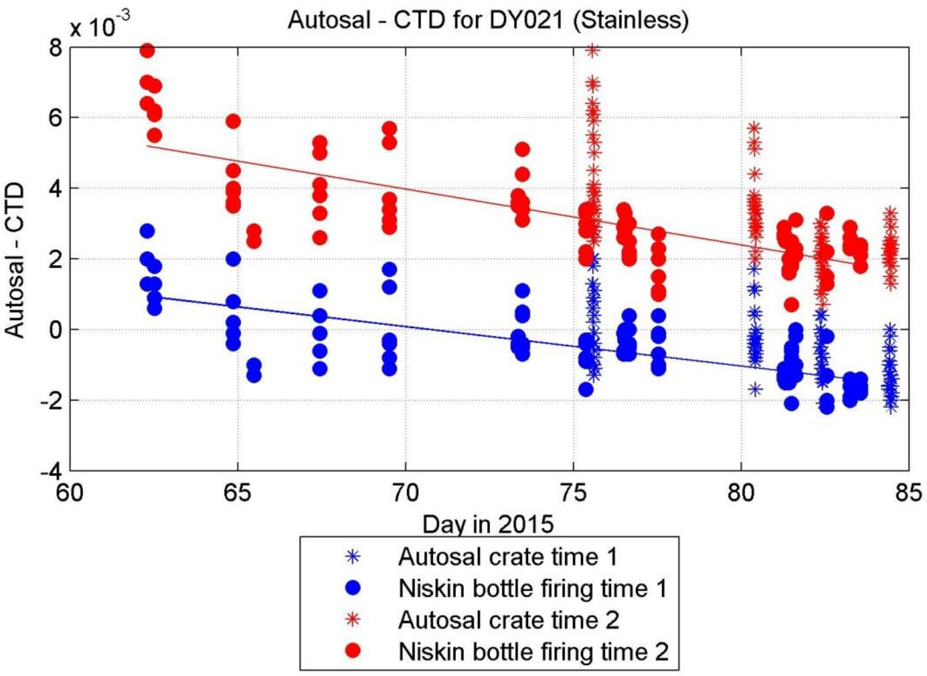


This magnitude of drift can not be accounted for by instability in the autosal readings. The table below shows the conductivity ratios and salinities of the standards run before and after each crate and the corresponding conductivities and salinities measured by autosal. The differences between them are an order of magnitude smaller than the drift. Correction for these small offsets does not remove the ‘drift’ in Autosal-CTDsal differences.

			STANDARD		MEASURED			Measured-Standard	
Date	Crate	Bottles	2 x K15	Salinity	2 x K15	Salinity		Sal. Offset	Average
16/03/15	TSG01		1.9997	34.994	1.99967	34.9936	Start	-0.0004	-0.00045
			1.9997	34.994	1.999664	34.9935	End	-0.0005	
16/03/15	CTD11	284-307	1.9997	34.994	1.99967	34.9936	Start	-0.0004	-0.00045
			1.9997	34.994	1.999664	34.9935	End	-0.0005	
21/03/15	CTD25	620-643	1.9997	34.994	1.999677	34.9938	Start	-0.0002	-0.00025
			1.9997	34.994	1.999672	34.9937	End	-0.0003	
21/03/15	CTD22	548-568	1.9997	34.994	1.999672	34.9937	Start	-0.0003	-0.00035
			1.9997	34.994	1.999669	34.9936	End	-0.0004	

23/03/15	CTD10	260-283	1.9997	34.994	1.999652	34.9933	Start	-0.0007	-0.0008
			1.9997	34.994	1.999641	34.9931	End	-0.0009	
25/03/15	TSG02		1.9997	34.994	1.999646	34.9931	Start	-0.0009	-0.0009
			1.9997	34.994	1.999645	34.9931	End	-0.0009	
25/03/15	CTD1819	452-478	1.9997	34.994	1.999645	34.9931	Start	-0.0009	-0.00075
			1.9997	34.994	1.999657	34.9934	End	-0.0006	
25/03/15	CTD08	212-235	1.9997	34.994	1.999657	34.9934	Start	-0.0006	-0.00065
			1.9997	34.994	1.999652	34.9933	End	-0.0007	

The trend is significant (pvalues << 0.05) and appears to be a temporal drift associated with each conductivty sensor. If the drift was in Autosal then the offsets within each crate should be more consistent/stable. There are also significant trends with CTD temperature and salinity although these are slightly weaker than for time and have potentilly been introduced coincidentally by the spatial sampling pattern on the cruise.



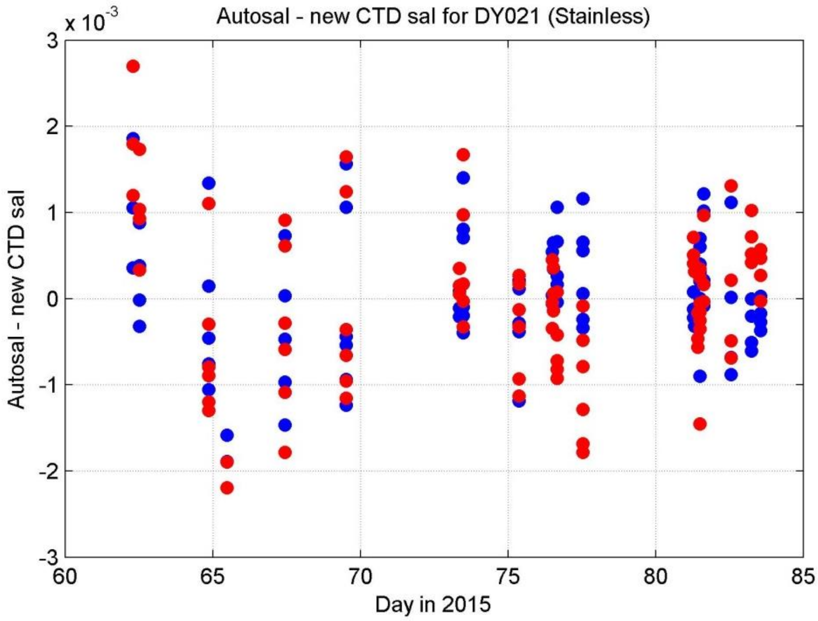
Regression applied for temporal dift to stainless sensors:

$$CTDsal\_cal1 = CTDsal + (intercept + (slope \times daynumber))$$

Primary intercept = 0.007896260752417
Primary slope = -1.116230843654996e-04

Secondary intercept = 0.015087956132598
Secondary slope = -1.586872897987173e-04

After the above temporal drift correction the mean and standard deviation of residuals (Autosal - CTD) from the primary and secondary sensors were 5.024e-16 ± 0.0007009 and -7.1772e-17 ± 0.0008825 respectively. The trends with temperature and salinity became insignificant after this correction.



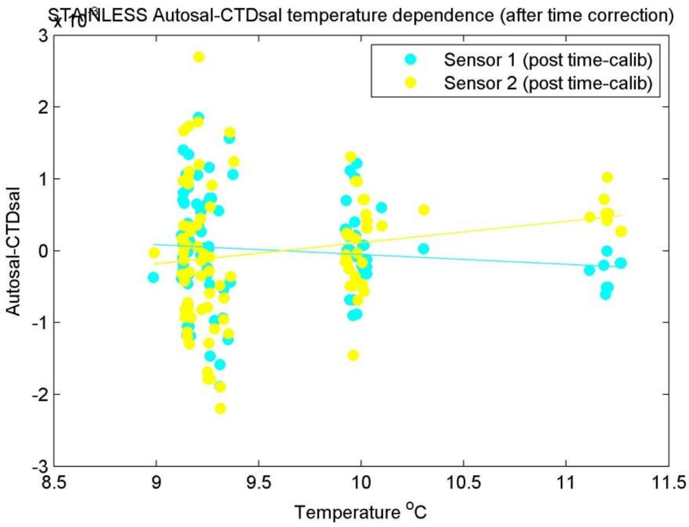
A correction for the slight temperture related drift however was applied in order to better align the readings between the primary and secondary sensors.

Regression applied for thermal dift to stainless sensors:

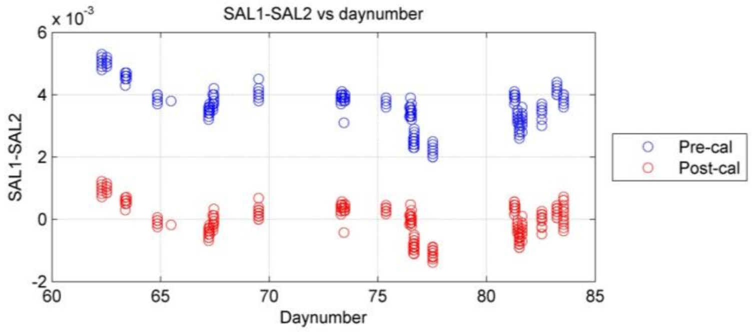
CTDsal_cal2 = CTDsal_cal1 + (intercept + (slope × temperature))

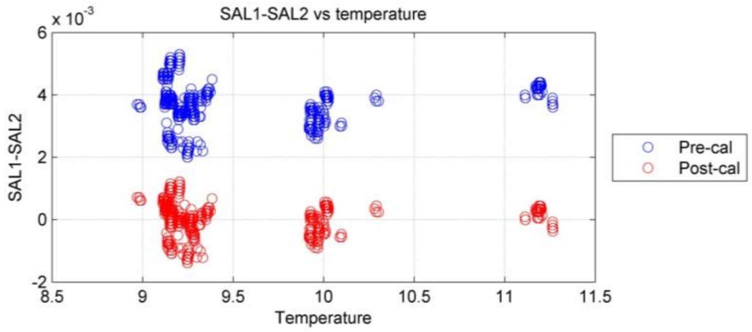
Primary intercept = 0.001308186425552
Primary slope = -1.360663649035130e-04

Secondary intercept = -0.002849682684898
Secondary slope = 2.963393480742600e-04

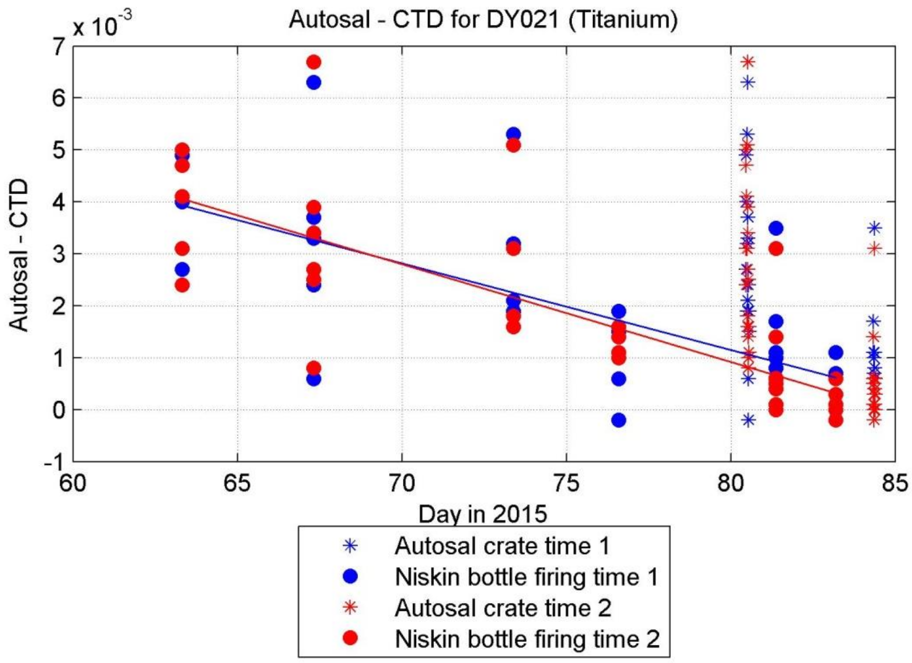


After these two corrections the mean difference between the primary and secondary sensors was 4.0603214e-05 (std = 0.00054561)





Titanium
A temporal drift was also present in the titanium sensors.



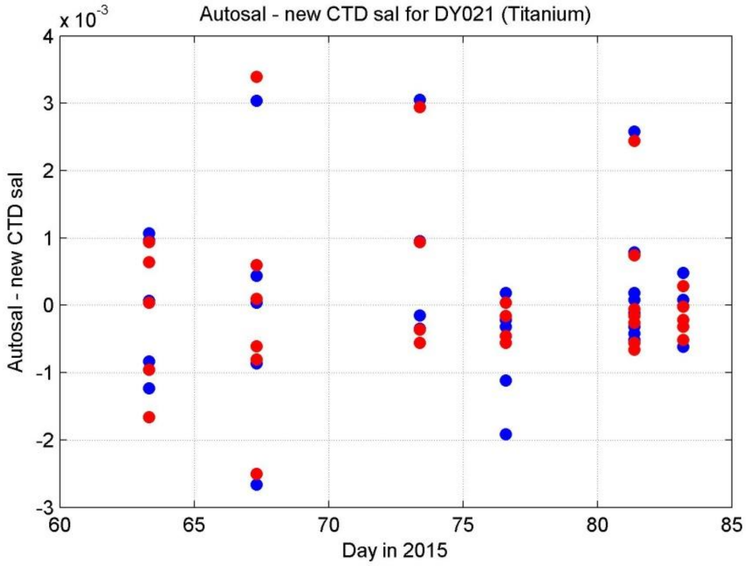
Regression applied for <u>temporal</u> dift to titanium sensors:

$$CTDsal\_cal = CTDsal + (intercept + (slope \times daynumber))$$

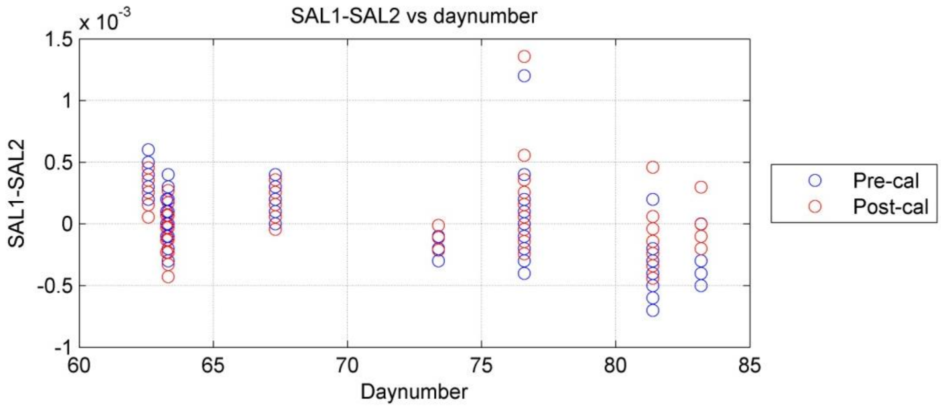
Primary intercept = 0.014492859793267
Primary slope = -1.668293686343925e-04

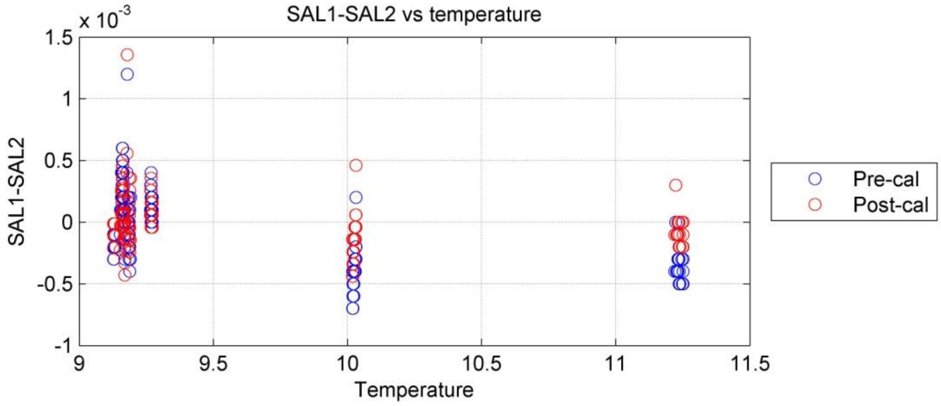
Secondary intercept = 0.015985420500784
Secondary slope = -1.883672231497256e-04

After the above temporal drift correction the mean and standard deviation of residuals (Autosal - CTD) from the primary and secondary sensors were 5.6095e-16 ± 0.0011251and -2.2438e-15 ± 0.00108 respectively. The trends with temperature and salinity became insignificant after this correction. No further corrections were applied.



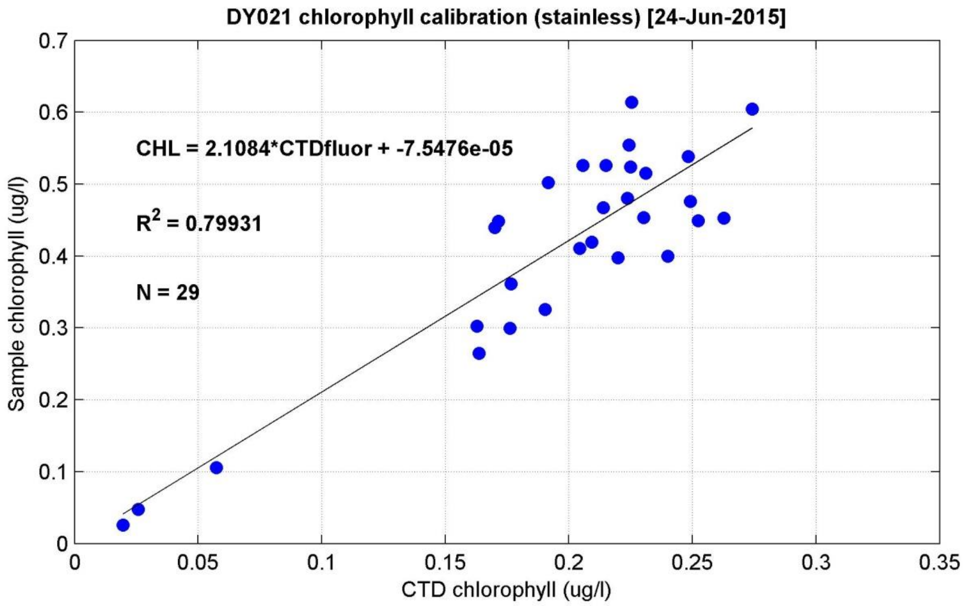
After calibration the mean difference between the primary and secondary sensors was 7.3301e-06 (std = 0.00022084).



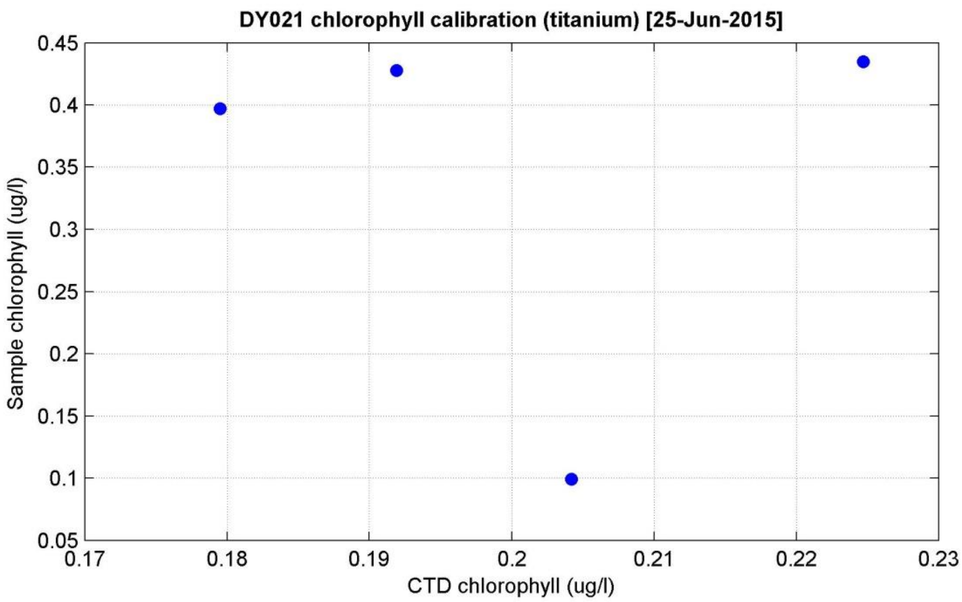


Chlorophyll

A total of 63 samples were taken for CTD calibration. For the stainless CTDs, after removal of samples taken during daylight in the surface 30 m, the following calibration was applied.

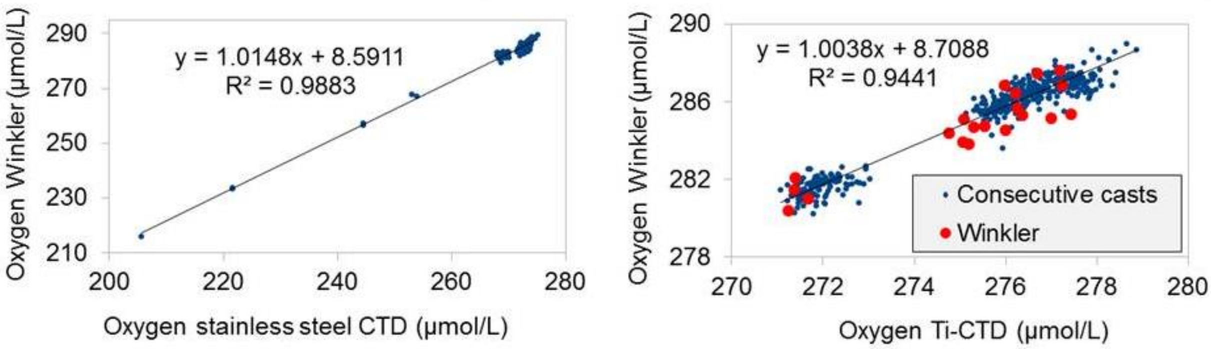


Of the 63 samples taken only 4 were from the titanium CTD (all from cast 31). This was not enough to perform a reliable calibration.



Oxygen

The necessary oxygen calibration for both CTDs was calculated by Vassilis Kitidis (PML). Full details can be found in his cruise report. His calibrations are shown in the plots below and are applied to the CTD profiles here.



Turbidity

Following discussion at a workpackage meeting the turbidity (Wetlabs Scatering BBRTD) sensor was not calibrated (to SPM in g/l). The scattering signal and therefore calibration is dependent upon (a) the wavelength of the sensor, which has not always remained consistent within or between cruises, (b) the size and shape of the scattering particles and (c) the angle at which the scattering is being measured.

It is thought that the attenuation (from the transmissometer) is potentially a better channel to calibrate using the SPM samples that are being taken. This needs further investigation.

19 Timetable of Events, Joanna Cox, Captain *RRS Discovery*

Start		End		Comment			
Date	**Time**	**Date**	**Time**	**All times Local time (GMT)**	**Activity**	**dd hh:mm**	**hours**
						0 00:00	0.00
25/02/2015	08:00	28/02/2015	17:00	Mobilisation for DY021 including storing, bunkering and crew change	DeM/Mob	3 09:00	81.00
28/02/2015	17:00	01/03/2015	10:00	Waiting to sail	Port	0 17:00	17.00
01/03/2015	10:00	01/03/2015	12:45	Pilotage and departure Solent via Needles Channel	Pass	0 02:45	2.75
01/03/2015	12:45	02/03/2015	20:00	Passage to science station A - Irish Sea	Pass	1 07:15	31.25
02/03/2015	20:00	03/03/2015	06:50	Waiting on weather, station A	DTWx	0 10:50	10.83
03/03/2015	06:50	03/03/2015	20:54	Station A - CTD's and NIOZ coring	Stat	0 14:04	14.07
03/03/2015	20:54	04/03/2015	06:06	Station A - Overnight processing of samples, no deployment	Stat	0 09:12	9.20
04/03/2015	06:06	04/03/2015	15:33	Station A - CTDs, SMBA coring, SPI	Stat	0 09:27	9.45
04/03/2015	15:33	04/03/2015	17:09	Autosub - repositioning and preparation for deployment. Deployment cancelled due to techincal issues with acoustic fish	RWP	0 01:36	1.60
04/03/2015	17:09	04/03/2015	22:34	Station A - SPI and megacorer deployments	Stat	0 05:25	5.42
04/03/2015	22:34	04/03/2015	23:30	Relocate to start of spatial survey	RWP	0 00:56	0.93
04/03/2015	23:30	05/03/2015	01:17	Spatial survey - Station 14E - NIOZ + SPI	Stat	0 01:47	1.78
05/03/2015	01:17	05/03/2015	03:47	Relocate to station G	RWP	0 02:30	2.50
05/03/2015	03:47	05/03/2015	06:00	Waiting for daylight to commence NOCL lander deployment	DTOther	0 02:13	2.22
05/03/2015	06:00	05/03/2015	10:00	Preparation for NOCL lander deployment. Technical issues and delays led to deployment been suspended	RWP	0 04:00	4.00
05/03/2015	10:00	05/03/2015	18:23	Autosub - Preparation and deployment - Station G	Gli	0 08:23	8.38
05/03/2015	18:23	05/03/2015	20:25	Relocate to station A	RWP	0 02:02	2.03
05/03/2015	20:25	06/03/2015	02:01	Station A - CTD, flume and SPI deployments	Stat	0 05:36	5.60
06/03/2015	02:01	06/03/2015	03:11	Relocate for spatial survey	RWP	0 01:10	1.17
06/03/2015	03:11	06/03/2015	04:40	Spatial survey - Station 13E - NIOZ + SPI	Stat	0 01:29	1.48
06/03/2015	04:40	06/03/2015	05:21	Reposition to 14D	RWP	0 00:41	0.68
06/03/2015	05:21	06/03/2015	06:44	Spatial survey - Station 14D - NIOZ + SPI	Stat	0 01:23	1.38
06/03/2015	06:44	06/03/2015	07:20	Relocate to station A	RWP	0 00:36	0.60
06/03/2015	07:20	06/03/2015	09:00	NOCL lander deployment at station A	Tow	0 01:40	1.67
06/03/2015	09:00	06/03/2015	11:17	Relocate to CEFAS mooring site	RWP	0 02:17	2.28
06/03/2015	11:17	06/03/2015	11:58	CTD in viicinity of CEFAS	Stat	0 00:41	0.68

				mooring - Conditions unsuitable for mooring pick up			
06/03/2015	11:58	06/03/2015	12:37	Relocate for autosub recovery	RWP	0 00:39	0.65
06/03/2015	12:37	06/03/2015	15:28	Autosub recovery	Gli	0 02:51	2.85
06/03/2015	15:28	06/03/2015	16:18	Relocate for spatial survey	RWP	0 00:50	0.83
06/03/2015	16:18	06/03/2015	19:00	Spatial survey - Station 10C - NIOZ + SPI	Stat	0 02:42	2.70
06/03/2015	19:00	06/03/2015	19:34	Reposition to 11C	RWP	0 00:34	0.57
06/03/2015	19:34	06/03/2015	21:15	Spatial survey - Station 11C - NIOZ + SPI	Stat	0 01:41	1.68
06/03/2015	21:15	06/03/2015	22:05	Reposition to 12C	RWP	0 00:50	0.83
06/03/2015	22:05	06/03/2015	23:50	Spatial survey - Station 12C - NIOZ + SPI	Stat	0 01:45	1.75
06/03/2015	23:50	07/03/2015	00:48	Reposition to 13C	RWP	0 00:58	0.97
07/03/2015	00:48	07/03/2015	02:27	Spatial survey - Station 13C - NIOZ + SPI	Stat	0 01:39	1.65
07/03/2015	02:27	07/03/2015	03:00	Reposition to 14C	RWP	0 00:33	0.55
07/03/2015	03:00	07/03/2015	05:06	Spatial survey - Station 14C - NIOZ + SPI	Stat	0 02:06	2.10
07/03/2015	05:06	07/03/2015	05:41	Reposition to 13D	RWP	0 00:35	0.58
07/03/2015	05:41	07/03/2015	06:55	Spatial survey - Station 13D - NIOZ + SPI	Stat	0 01:14	1.23
07/03/2015	06:55	07/03/2015	09:10	Reposition to 12D - Detour via station A to assess weather for trawling - Unsuitable	RWP	0 02:15	2.25
07/03/2015	09:10	07/03/2015	09:23	Problems deploying retractable azimuth thruster	DTShip	0 00:13	0.22
07/03/2015	09:23	07/03/2015	10:07	Spatial survey - Station 12D - SPI deployment. Winch change over incident	Stat	0 00:44	0.73
07/03/2015	10:07	07/03/2015	12:35	Science suspended while investigation carried out into winch incident	DTShip	0 02:28	2.47
07/03/2015	12:35	07/03/2015	13:00	Spatial survey - Station 12D - SPI	Stat	0 00:25	0.42
07/03/2015	13:00	07/03/2015	13:33	Reposition to 11D	RWP	0 00:33	0.55
07/03/2015	13:33	07/03/2015	14:39	Spatial survey - Station 11D - SPI	Stat	0 01:06	1.10
07/03/2015	14:39	07/03/2015	15:12	Reposition to 10D	RWP	0 00:33	0.55
07/03/2015	15:12	07/03/2015	15:54	Spatial survey - Station 10D - SPI	Stat	0 00:42	0.70
07/03/2015	15:54	07/03/2015	17:08	Reposition to 10A	RWP	0 01:14	1.23
07/03/2015	17:08	07/03/2015	19:26	Spatial survey - Station 10A - SPI + NIOZ	Stat	0 02:18	2.30
07/03/2015	19:26	07/03/2015	19:54	Reposition to 11A	RWP	0 00:28	0.47
07/03/2015	19:54	07/03/2015	21:59	Spatial survey - Station 11A - SPI + NIOZ	Stat	0 02:05	2.08
07/03/2015	21:59	07/03/2015	22:26	Reposition to 12A	RWP	0 00:27	0.45
07/03/2015	22:26	08/03/2015	00:09	Spatial survey - Station 12A- SPI + NIOZ	Stat	0 01:43	1.72
08/03/2015	00:09	08/03/2015	01:11	Reposition to 12D	RWP	0 01:02	1.03
08/03/2015	01:11	08/03/2015	01:41	Spatial survey - Station 12D - NIOZ	Stat	0 00:30	0.50
08/03/2015	01:41	08/03/2015	02:12	Reposition to 11D	RWP	0 00:31	0.52
08/03/2015	02:12	08/03/2015	02:40	Spatial survey - Station 11D -	Stat	0 00:28	0.47

				NIOZ			
08/03/2015	02:40	08/03/2015	03:12	Reposition to 10D	RWP	0 00:32	0.53
08/03/2015	03:12	08/03/2015	03:41	Spatial survey - Station 10D - NIOZ	Stat	0 00:29	0.48
08/03/2015	03:41	08/03/2015	04:30	Relocate to station G	RWP	0 00:49	0.82
08/03/2015	04:30	08/03/2015	11:10	Station G - CTDs	Stat	0 06:40	6.67
08/03/2015	11:10	08/03/2015	13:28	Relocate to station A for lander recovery	RWP	0 02:18	2.30
08/03/2015	13:28	08/03/2015	15:01	NOCL lander recovery at station A	Tow	0 01:33	1.55
08/03/2015	15:01	08/03/2015	17:00	Relocate to CEFAS smart buoy	RWP	0 01:59	1.98
08/03/2015	17:00	08/03/2015	18:00	CEFAS smart buoy recovery	Tow	0 01:00	1.00
08/03/2015	18:00	08/03/2015	18:35	Relocate to station G	RWP	0 00:35	0.58
08/03/2015	18:35	09/03/2015	14:47	Station G - NIOZ coring + SPI	Stat	0 20:12	20.20
09/03/2015	14:47	09/03/2015	16:59	Relocate to station A	RWP	0 02:12	2.20
09/03/2015	16:59	09/03/2015	19:25	Autosub deployment	Gli	0 02:26	2.43
09/03/2015	19:25	09/03/2015	20:00	On DP rigging deck for mooring deployment	RWP	0 00:35	0.58
09/03/2015	20:00	09/03/2015	22:41	Relocate to station G	RWP	0 02:41	2.68
09/03/2015	22:41	10/03/2015	05:24	Station G - SMBA, SPI, Flume	Stat	0 06:43	6.72
10/03/2015	05:24	10/03/2015	06:20	Reposition for mooring deployment	RWP	0 00:56	0.93
10/03/2015	06:20	10/03/2015	07:46	CEFAS smart buoy deployment	Tow	0 01:26	1.43
10/03/2015	07:46	10/03/2015	10:28	CEFAS lander preparation and deployment	Tow	0 02:42	2.70
10/03/2015	10:28	10/03/2015	10:40	A Frame problem delays lander deployment	DTShip	0 00:12	0.20
10/03/2015	10:40	10/03/2015	11:00	CEFAS lander deployment	Tow	0 00:20	0.33
10/03/2015	11:00	10/03/2015	12:57	CTD in viicinity of CEFAS mooring	Stat	0 01:57	1.95
10/03/2015	12:57	10/03/2015	15:00	Reposition to station 'A' for autosub recovery	RWP	0 02:03	2.05
10/03/2015	15:00	11/03/2015	10:10	Searching for autosub using acoustic fish and hydrophone	Gli	0 19:10	19.17
11/03/2015	10:10	11/03/2015	13:08	Trawling at site A	Tow	0 02:58	2.97
11/03/2015	13:08	11/03/2015	14:43	Reposition to site G	RWP	0 01:35	1.58
11/03/2015	14:43	11/03/2015	17:05	Station G - Trawling	Tow	0 02:22	2.37
11/03/2015	17:05	11/03/2015	19:00	Reposition to site A for autosub search	RWP	0 01:55	1.92
11/03/2015	19:00	12/03/2015	11:36	Searching for autosub using swath, acoustic fish and hydrophone	Gli	0 16:36	16.60
12/03/2015	11:36	12/03/2015	13:28	On passage to pump out grey water tank	DTShip	0 01:52	1.87
12/03/2015	13:28	13/03/2015	09:53	Searching for autosub using swath, acoustic fish and hydrophone	Gli	0 20:25	20.42
13/03/2015	09:53	13/03/2015	11:22	SPI camera deployments x 2 to try and get visual of autosub	Gli	0 01:29	1.48
13/03/2015	11:22	13/03/2015	12:25	Reposition to centre of 'A' for trawling	RWP	0 01:03	1.05
13/03/2015	12:25	13/03/2015	13:35	Trawling at station A	Tow	0 01:10	1.17
13/03/2015	13:35	13/03/2015	16:00	Transit to south of station G	RWP	0 02:25	2.42

				for NOCL lander deployment			
13/03/2015	16:00	13/03/2015	18:45	Preparation for NOCL lander deployment	RWP	0 02:45	2.75
13/03/2015	18:45	13/03/2015	19:44	NOCL lander deployment	Tow	0 00:59	0.98
13/03/2015	19:44	13/03/2015	20:13	Reposition for trawling	RWP	0 00:29	0.48
13/03/2015	20:13	13/03/2015	22:30	Trawling at station G	Tow	0 02:17	2.28
13/03/2015	22:30	13/03/2015	23:44	Reposition to 9C for spatial survey	RWP	0 01:14	1.23
13/03/2015	23:44	14/03/2015	00:52	Spatial survey - Station 9C - NIOZ + SPI	Stat	0 01:08	1.13
14/03/2015	00:52	14/03/2015	01:56	Reposition to 8C	RWP	0 01:04	1.07
14/03/2015	01:56	14/03/2015	02:56	Spatial survey - Station 8C - NIOZ + SPI	Stat	0 01:00	1.00
14/03/2015	02:56	14/03/2015	05:00	Relocate to station 'I'	RWP	0 02:04	2.07
14/03/2015	05:00	14/03/2015	07:10	Scrolling issues on MFCTD	DTShip	0 02:10	2.17
14/03/2015	07:10	15/03/2015	03:19	Station I - MFCTD, CTD, NIOZ coring, SMBA, mega coring, multi corer	Stat	0 20:09	20.15
15/03/2015	03:19	15/03/2015	04:10	Retractable azimuth, retraction failure	DTShip	0 00:51	0.85
15/03/2015	04:10	15/03/2015	07:30	Relocate for NOCL lander recovery	RWP	0 03:20	3.33
15/03/2015	07:30	15/03/2015	09:00	Retactable azimuth, deployment problems	DTShip	0 01:30	1.50
15/03/2015	09:00	15/03/2015	09:48	NOCL lander recovery - mooring contacted with port azi, parting mainline. Mooring not recovered	Tow	0 00:48	0.80
15/03/2015	09:48	15/03/2015	15:20	Recovering mooring float, investigation possible damage to azimuth thruster	DTShip	0 05:32	5.53
15/03/2015	15:20	15/03/2015	16:13	Retractable azimuth, retraction failure	DTShip	0 00:53	0.88
15/03/2015	16:13	15/03/2015	19:13	Relocate to station 'I'	RWP	0 03:00	3.00
15/03/2015	19:13	16/03/2015	09:12	Station I - NIOZ coring, SPI, chem SPI, Flume, trawling, CTD	Stat	0 13:59	13.98
16/03/2015	09:12	16/03/2015	10:03	Reposition to spatial survey site 1C	RWP	0 00:51	0.85
16/03/2015	10:03	16/03/2015	11:38	Spatial survey - Station 1C - NIOZ + SPI	Stat	0 01:35	1.58
16/03/2015	11:38	16/03/2015	12:05	Reposition to 1D	RWP	0 00:27	0.45
16/03/2015	12:05	16/03/2015	13:45	Spatial survey - Station 1D - NIOZ + SPI	Stat	0 01:40	1.67
16/03/2015	13:45	16/03/2015	14:11	Reposition to 1E	RWP	0 00:26	0.43
16/03/2015	14:11	16/03/2015	14:41	Spatial survey - Station 1E - NIOZ + SPI	Stat	0 00:30	0.50
16/03/2015	14:41	16/03/2015	15:02	Reposition to 2E	RWP	0 00:21	0.35
16/03/2015	15:02	16/03/2015	16:24	Spatial survey - Station 2E - NIOZ + SPI	Stat	0 01:22	1.37
16/03/2015	16:24	16/03/2015	16:52	Reposition to 2D	RWP	0 00:28	0.47
16/03/2015	16:52	16/03/2015	19:10	Spatial survey - Station 2D - NIOZ + SPI	Stat	0 02:18	2.30
16/03/2015	19:10	16/03/2015	19:40	Reposition to 2C	RWP	0 00:30	0.50
16/03/2015	19:40	16/03/2015	20:55	Spatial survey - Station 2C - NIOZ + SPI	Stat	0 01:15	1.25
16/03/2015	20:55	16/03/2015	21:30	Reposition to 2B	RWP	0 00:35	0.58
16/03/2015	21:30	17/03/2015	00:14	Spatial survey - Station 2B -	Stat	0 02:44	2.73

				NIOZ + SPI - 2 misfires, 1 x wire off sheeve			
17/03/2015	00:14	17/03/2015	00:42	Reposition to 2A	RWP	0 00:28	0.47
17/03/2015	00:42	17/03/2015	02:00	Spatial survey - Station 2A - NIOZ + SPI	Stat	0 01:18	1.30
17/03/2015	02:00	17/03/2015	02:17	Reposition to 3A	RWP	0 00:17	0.28
17/03/2015	02:17	17/03/2015	03:18	Spatial survey - Station 3A - NIOZ + SPI	Stat	0 01:01	1.02
17/03/2015	03:18	17/03/2015	03:42	Reposition to 3B	RWP	0 00:24	0.40
17/03/2015	03:42	17/03/2015	04:45	Spatial survey - Station 3B - NIOZ + SPI - 2 misfires, 1 x wire off sheeve	Stat	0 01:03	1.05
17/03/2015	04:45	17/03/2015	06:20	Reposition CEFAS Lander	RWP	0 01:35	1.58
17/03/2015	06:20	17/03/2015	10:15	CEFAS lander recovery and redeployment	Tow	0 03:55	3.92
17/03/2015	10:15	17/03/2015	11:11	CTD for CEFAS lander	Stat	0 00:56	0.93
17/03/2015	11:11	17/03/2015	11:49	Repostion to 'H'	RWP	0 00:38	0.63
17/03/2015	11:49	18/03/2015	13:15	Station H - CTD, SPI, NIOZ, SMBA, Multicore	Stat	1 01:26	25.43
18/03/2015	13:15	18/03/2015	13:45	Relocate to 4B for spatial survey	RWP	0 00:30	0.50
18/03/2015	13:45	18/03/2015	15:09	Spatial survey - Station 4B - NIOZ + SPI	Stat	0 01:24	1.40
18/03/2015	15:09	18/03/2015	15:34	Reposition to 4C	RWP	0 00:25	0.42
18/03/2015	15:34	18/03/2015	16:47	Spatial survey - Station 4C - NIOZ + SPI	Stat	0 01:13	1.22
18/03/2015	16:47	18/03/2015	17:11	Reposition to H	RWP	0 00:24	0.40
18/03/2015	17:11	19/03/2015	01:59	Station H - SPI, flume, trawling, NIOZ	Stat	0 08:48	8.80
19/03/2015	01:59	19/03/2015	02:48	Reposition to 4E	RWP	0 00:49	0.82
19/03/2015	02:48	19/03/2015	04:00	Spatial survey - Station 4E - NIOZ + SPI	Stat	0 01:12	1.20
19/03/2015	04:00	19/03/2015	04:20	Reposition to 5C	RWP	0 00:20	0.33
19/03/2015	04:20	19/03/2015	05:40	Spatial survey - Station 5C - NIOZ + SPI	Stat	0 01:20	1.33
19/03/2015	05:40	19/03/2015	06:06	Reposition to 5B	RWP	0 00:26	0.43
19/03/2015	06:06	19/03/2015	07:42	Spatial survey - Station 5B - NIOZ + SPI	Stat	0 01:36	1.60
19/03/2015	07:42	19/03/2015	08:10	Reposition to 5A	RWP	0 00:28	0.47
19/03/2015	08:10	19/03/2015	10:50	Spatial survey - Station 5A - NIOZ + SPI	Stat	0 02:40	2.67
19/03/2015	10:50	19/03/2015	13:37	Reposition for NOCL lander dragging operation	RWP	0 02:47	2.78
19/03/2015	13:37	19/03/2015	16:33	Dragging for NOCL lander - unsucessful	Tow	0 02:56	2.93
19/03/2015	16:33	19/03/2015	17:27	Reposition to 11B for spatial survey	RWP	0 00:54	0.90
19/03/2015	17:27	19/03/2015	18:47	Spatial survey - Station 11B - NIOZ + SPI	Stat	0 01:20	1.33
19/03/2015	18:47	19/03/2015	19:12	Reposition to 12B	RWP	0 00:25	0.42
19/03/2015	19:12	19/03/2015	20:27	Spatial survey - Station 12B - NIOZ + SPI	Stat	0 01:15	1.25
19/03/2015	20:27	19/03/2015	21:03	Reposition to 13B	RWP	0 00:36	0.60
19/03/2015	21:03	19/03/2015	22:21	Spatial survey - Station 13B - NIOZ + SPI	Stat	0 01:18	1.30
19/03/2015	22:21	19/03/2015	23:04	Reposition to 14B	RWP	0 00:43	0.72
19/03/2015	23:04	20/03/2015	00:22	Spatial survey - Station 14B - NIOZ + SPI	Stat	0 01:18	1.30

20/03/2015	00:22	20/03/2015	00:45	Reposition to 14A	RWP	0 00:23	0.38
20/03/2015	00:45	20/03/2015	01:51	Spatial survey - Station 14A - NIOZ + SPI	Stat	0 01:06	1.10
20/03/2015	01:51	20/03/2015	02:21	Reposition to 13A	RWP	0 00:30	0.50
20/03/2015	02:21	20/03/2015	03:32	Spatial survey - Station 13A - NIOZ + SPI	Stat	0 01:11	1.18
20/03/2015	03:32	20/03/2015	05:22	Reposition to 9A	RWP	0 01:50	1.83
20/03/2015	05:22	20/03/2015	05:58	Spatial survey - Station 9A - NIOZ	Stat	0 00:36	0.60
20/03/2015	05:58	20/03/2015	06:43	Reposition to 8A	RWP	0 00:45	0.75
20/03/2015	06:43	20/03/2015	07:04	Spatial survey - Station 8A - NIOZ	Stat	0 00:21	0.35
20/03/2015	07:04	20/03/2015	07:30	Reposition to 8B	RWP	0 00:26	0.43
20/03/2015	07:30	20/03/2015	08:32	Spatial survey - Station 8B - NIOZ + SPI	Stat	0 01:02	1.03
20/03/2015	08:32	20/03/2015	09:18	Reposition to 8D	RWP	0 00:46	0.77
20/03/2015	09:18	20/03/2015	10:58	Spatial survey - Station 8D - NIOZ + SPI	Stat	0 01:40	1.67
20/03/2015	10:58	20/03/2015	12:10	Reposition to 9E	RWP	0 01:12	1.20
20/03/2015	12:10	20/03/2015	13:20	Spatial survey - Station 9E - NIOZ + SPI	Stat	0 01:10	1.17
20/03/2015	13:20	20/03/2015	14:05	Reposition for NOCL lander dragging operation	RWP	0 00:45	0.75
20/03/2015	14:05	20/03/2015	17:19	Dragging for NOCL lander - successful	Tow	0 03:14	3.23
20/03/2015	17:19	20/03/2015	18:00	Reposition to 9D for spatial survey	RWP	0 00:41	0.68
20/03/2015	18:00	20/03/2015	19:36	Spatial survey - Station 9D - NIOZ + SPI	Stat	0 01:36	1.60
20/03/2015	19:36	20/03/2015	20:24	Reposition to 8E	RWP	0 00:48	0.80
20/03/2015	20:24	20/03/2015	21:16	Spatial survey - Station 8E - NIOZ + SPI	Stat	0 00:52	0.87
20/03/2015	21:16	20/03/2015	22:13	Reposition to 7E	RWP	0 00:57	0.95
20/03/2015	22:13	20/03/2015	22:44	Spatial survey - Station 7E - NIOZ	Stat	0 00:31	0.52
20/03/2015	22:44	20/03/2015	23:17	Reposition to 7D	RWP	0 00:33	0.55
20/03/2015	23:17	21/03/2015	00:32	Spatial survey - Station 7D - NIOZ + SPI	Stat	0 01:15	1.25
21/03/2015	00:32	21/03/2015	01:13	Reposition to 6E	RWP	0 00:41	0.68
21/03/2015	01:13	21/03/2015	02:13	Spatial survey - Station 6E - NIOZ	Stat	0 01:00	1.00
21/03/2015	02:13	21/03/2015	02:41	Reposition to 6D	RWP	0 00:28	0.47
21/03/2015	02:41	21/03/2015	03:32	Spatial survey - Station 6D - NIOZ + SPI	Stat	0 00:51	0.85
21/03/2015	03:32	21/03/2015	04:02	Reposition to 6C	RWP	0 00:30	0.50
21/03/2015	04:02	21/03/2015	05:06	Spatial survey - Station 6C - NIOZ	Stat	0 01:04	1.07
21/03/2015	05:06	21/03/2015	05:53	Reposition to 7C	RWP	0 00:47	0.78
21/03/2015	05:53	21/03/2015	07:10	Spatial survey - Station 7C - NIOZ	Stat	0 01:17	1.28
21/03/2015	07:10	21/03/2015	07:35	Reposition to 7B	RWP	0 00:25	0.42
21/03/2015	07:35	21/03/2015	08:46	Spatial survey - Station 7B - NIOZ	Stat	0 01:11	1.18
21/03/2015	08:46	21/03/2015	09:28	Reposition to 7A	RWP	0 00:42	0.70
21/03/2015	09:28	21/03/2015	09:58	Spatial survey - Station 7A - NIOZ	Stat	0 00:30	0.50
21/03/2015	09:58	21/03/2015	10:45	Reposition to 6B	RWP	0 00:47	0.78

21/03/2015	10:45	21/03/2015	11:50	Spatial survey - Station 6B - NIOZ + SPI	Stat	0 01:05	1.08
21/03/2015	11:50	21/03/2015	12:23	Reposition to 6A	RWP	0 00:33	0.55
21/03/2015	12:23	21/03/2015	13:15	Spatial survey - Station 6A - NIOZ + SPI	Stat	0 00:52	0.87
21/03/2015	13:15	21/03/2015	14:16	Reposition to 5D	RWP	0 01:01	1.02
21/03/2015	14:16	21/03/2015	14:26	Spatial survey - Station 5D - NIOZ - unsuccessful	Stat	0 00:10	0.17
21/03/2015	14:26	21/03/2015	15:00	Reposition to 3D	RWP	0 00:34	0.57
21/03/2015	15:00	21/03/2015	16:03	Spatial survey - Station 3D - NIOZ + SPI	Stat	0 01:03	1.05
21/03/2015	16:03	22/03/2015	01:30	Relocate to candyfloss	RWP	0 09:27	9.45
22/03/2015	01:30	22/03/2015	04:29	Waiting at Candyfloss for recommencement of science	RWP	0 02:59	2.98
22/03/2015	04:29	22/03/2015	06:34	2 x glider deployments	Gli	0 02:05	2.08
22/03/2015	06:34	22/03/2015	12:37	Candyfloss station - CTDs	Stat	0 06:03	6.05
22/03/2015	12:37	22/03/2015	13:20	Reposition for glider recovery	RWP	0 00:43	0.72
22/03/2015	13:20	22/03/2015	13:55	Glider recovery	Gli	0 00:35	0.58
22/03/2015	13:55	22/03/2015	14:55	Reposition to Candyfloss	RWP	0 01:00	1.00
22/03/2015	14:55	22/03/2015	19:10	Candyfloss station - CTDs, NIOZ	Stat	0 04:15	4.25
22/03/2015	19:10	22/03/2015	20:39	Emergency glider recovery	Gli	0 01:29	1.48
22/03/2015	20:39	23/03/2015	08:00	Candyfloss station - NIOZ, SMBA, Flume, Chem SPI, Trawling	Stat	0 11:21	11.35
23/03/2015	08:00	23/03/2015	11:43	CEFAS smart buoy recovery and redeployment	Tow	0 03:43	3.72
23/03/2015	11:43	23/03/2015	13:48	Candyfloss station CTD	Stat	0 02:05	2.08
23/03/2015	13:48	23/03/2015	21:00	Relocate to shelf edge site	RWP	0 07:12	7.20
23/03/2015	21:00	24/03/2015	04:19	Waiting on station for sample processing	RWP	0 07:19	7.32
24/03/2015	04:19	24/03/2015	06:23	CTDs at shelf edge	Stat	0 02:04	2.07
24/03/2015	06:23	24/03/2015	07:55	Transit to 1000m for glider deployments	RWP	0 01:32	1.53
24/03/2015	07:55	24/03/2015	12:00	1 x glider deployed, 2nd glider suffered damage to antenna so deployment aborted	Gli	0 04:05	4.08
24/03/2015	12:00	24/03/2015	13:56	Calibration CTD for glider	Stat	0 01:56	1.93
24/03/2015	13:56	24/03/2015	14:54	Recovery of glider due to leaking stern section	Gli	0 00:58	0.97
24/03/2015	14:54	24/03/2015	14:54	END OF SCIENCE _ begin passage to Southampton		0 00:00	0.00

20 Cruise Event Logs

DY021_events_log_1_to_204.pdf

DY021_events_log_205_to_400.pdf

DY021_events_log_400_to_511.pdf

titanium_frame_CTD_sample_logsheets.pdf