# Cruise Report

**RRS *Charles Darwin***

# CD173

**15th July – 6th August 2005.**

**Compiled by Jonathan Sharples, Proudman Oceanographic Laboratory, UK**

## Contents.

# 1. Introduction

Jonathan Sharples (POL)

Cruise CD173, aboard the RRS *Charles Darwin*, was the second cruise carried out as part of the NERC responsive-mode project "Physical-Biological Control of New Production within the Seasonal Thermocline", co-funded by the Defence Science and Technology Laboratory.

The vessel sailed from Falmouth, UK, on July 15th 2005, and returned to Fairlie, UK, on August 6th 2005. There was a brief port call in Cobh on July 25th 2005 to rendezvous with the RV *Prince Madog*.

The cruise was split into two legs. Leg 1 (July 15th – July 25th) was primarily focused on the shelf edge of the Celtic Sea, in an investigation of the spring-neap variability in the vertical mixing of nutrients by the breaking internal tide. Leg 2 (July 25th – August 6th) was carried out jointly with the RV *Prince Madog* in an investigation of the effects of seabed banks on the generation of internal mixing and the response of the primary producers.

The project is a collaboration between the Proudman Oceanographic Laboratory (www.pol.ac.uk), the National Oceanography Centre (www.noc.soton.ac.uk), and the University of Wales, Bangor (www.sos.bangor.ac.uk).

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**Acknowledgements:**
Our thanks to the crew of RRS *Charles Darwin* for their expertise and help with the cruise. Particular thanks for the tireless efforts of the onboard UKORS technical staff who coped admirably with an intense mooring programme, rapid turnaround CTD casts, and dodgy Seasoar behaviour. On shore we are indebted to Colin Day (UKORS) and Andy Louch (RSU) for cruise organisation, and to Darren Young (cruise mobilisation). Thanks also to Stephanie Bates (work experience student from West Kirby Grammar School) who helped with investigation of the CTD fluorometer calibration, collation of satellite images, and also with putting together this cruise report.

**Cruise Participants:**

| Name | Leg | Affiliation |
|---|---|---|
| Jonathan Sharples (PSO) | 1, 2 | Proudman Oceanographic Laboratory |
| Patrick Holligan | 1, 2 | National Oceanography Centre |
| Mark Moore | 1, 2 | National Oceanography Centre |
| Jacqui Tweddle | 1, 2 | National Oceanography Centre |
| Anna Hickman | 1, 2 | National Oceanography Centre |
| Young-Nam Kim | 1, 2 | National Oceanography Centre |
| Mike Lucas | 1, 2 | National Oceanography Centre |
| Duncan Purdie | 2 | National Oceanography Centre |
| Eric Achterburg | 2 | National Oceanography Centre |
| Mohammed Qurban | 2 | National Oceanography Centre |
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| Jon Short | 1, 2 | UKORS National Oceanography Centre |
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| Alan Sherring | 1, 2 | UKORS National Oceanography Centre |

## 2. CD173 Cruise Narrative

Jonathan Sharples (POL)

**TIMES ARE ALL SHIP TIME (BST).**

**July 15th 2005.**
Sail from Falmouth on time at 0800. Proceed at reduced revs towards U2. Muster station at 1030, followed by science briefing to ship's crew.
1430 heave to carry out CTD001 shakedown cast, including testing of acoustic releases and PES.
1830 arrive U2 and begin to deploy seabed adcp.
1902 adcp deployed.
1910 begin CTD002.
2000 end CTD002. Carry out Satlantic optics cast.
2030 start steam to Seasoar line.

**July 16th 2005.**
0630 Seasoar deployment begins.
0730 Seasoar running.
Approx. 0830 Seasoar hits seabed as the bed was shoaling gradually onto Jones Bank. There appears to be a bug in the control software that randomly re-sets the maximum dive depth to something greater than planned – probably the worst thing it could do when running in shallow water. Seasoar behaviour altered quite dramatically. Seasoar recovered about 0930; lower half of tail and the opc had been torn off.
Continue steaming towards shelf edge.
1800 CTD 003 at 48° 53.0′ N, 9° 5.0′ W.
2140 CTD 004 at CS2 (48° 33.0′ N, 9° 30.0′ W).

**17th July 2005.**
0056 CTD 005 at 48° 13.2′ N, 9° 30.0′ W.
0430 47° 50.0′ N, 9° 30.0′ W. The surfmet data shows that we have clearly entered the low chl surface water of the Atlantic Ocean.
0630 test casts with optics rigs.
0800 begin optics casts.
0920 optics casts complete. Begin steam back to CS2.
1100 passing through lots of surface slicks. Porpoises, fishing boats, and seabirds. Very clear, strong slicks at about 1200.
1400 arrive CS2 and do some release tests. Catch a fishing long line with the releases. Steam about 1 nm NW to find 200m depth away from the fishing.

First mooring: thermistor chain.
1545 surface torroid away.
1628 subsurface buoy away.
1649 bottom anchor away at: 48° 34.2645′ N, 09° 30.5802′ W, depth = 201m.

Second mooring: Subsurface 300 kHz ADCP.
1838 mooring released at: 48° 34.346′ N, 09° 30.659′ W, depth = 194m.

Third mooring: Seabed 300 kHz ADCP.
1911 mooring released at: : 48° 34.340′ N, 09° 30.479′ W, depth = 196m.

2000 first CTD (CTD007) of 25 hr CTD+FLY station.

**18th July 2005.**
Considerable amount of fishing activity overnight.
Weather worsening.
0400 CTD wire came out of sheave and was damaged. Re-termination and load testing required, which took until 0800. Approx 4 – 5 hours downtime (2 CTD casts lost from time series). Decided to limit the number of CTD casts and concentrate more on FLY, eventually using the T-N relation to get at the nitrate fluxes.
Afternoon weather SW'ly 5 – 6.
2130 last FLY cast out of water.
2205 150 kHz ADCP deployed.
Guard buoy deployed.
Steam for U2.

**19th July 2005.**
Arrive U2 1400.
1527 thermistor mooring away.
CTD015 + optics.
1700 steam for start of Seasoar line.

**20th July 2005.**
0400? CTD016
0450 Seasoar deployed and transmitting data.
Run over Jones bank complete at 0930. Data shows elevated bottom layer chlorophyll on slopes of bank, allowing identification of mooring positions.
1100 turn and Seasoar to site Bank2 (49° 53.73′ N, 07° 52.32′ W).
1330 Seasoar recovery begins. On recovery see that Seasoar lower tail missing, damage to fairing for several meters near Seasoar, and the FRRF has been shunted back in the Seasoar body.
1500 optics and CTD017.
1700 begin deployment of thermistor mooring at Bank2.
1835 mooring away successfully.
Steam to 49° 57.5′ N, 7° 31.5′ W NE of Jones Bank and await Seasoar repairs.

**21st July 2005.**
0000 (approx) Seasoar re-deployed on a shorter cable. Flies OK from surface to 60m. There are some data communication problems that require Penguin to be shut down and re-started – typically getting 15 minutes good data followed by a 5 minute gap as the shutdown-restart of completed. Not ideal, but better than nothing so decision made to continue Seasoaring as planned.
1930 Seasoar recovered.
2130 begin CTD station T1 in 3800m depth.

**22nd July 2005.**
CTD transect continues.
Lots of surface slicks and evidence of convergences around 1530 – 1630 (T5 to T6).
1615 muster drill.
2300 approx finish CTD transect and steam to CS2.

**23rd July 2005.**
0300 begin 25 hr station. Immediately get problems with FLY cable, which is replaced. Lots of long-line fishing to get tangled in!

Approx 1600 a train of internal waves is clear on the ship's radar. Fly series in progress extended to 7 casts to try to catch them. 3 or 4 of the waves appear to pass during the FLY series.

**24th July 2005.**

0550 CTD – FLY station finished.
0630 mooring recoveries begin. Weather awful – W'ly 30 – 35 knots and large waves. Decision made to try guard buoy first as no instrumentation to damage.
0715 guard buoy onboard.
1000 surface torroid onboard and temperature loggers begin to be retrieved.
1105 all loggers onboard.
1300 subsurface ADCP released.
1330 subsurface ADCP onboard.
Weather begins to ease; 20 – 25 knots.
1700 150 kHz seabed ADCP released.
1720 150 kHz ADCP onboard.
1800 300 kHz ADCP released (after perhaps 1 or 2 unsuccessful attempts).
1815 300 kHz ADCP onboard.
Begin steam to Cobh. Total of approx 5 hours lost due to weather.

**25th July 2005.**

Steaming to Cobh all day. Weather eased to NE'ly 15 – 20 knots.
1700 arrive Cobh. Transfer equipment and personnel to the Prince Madog, and take on 3 new scientists.
1930 leave Cobh and start steam to Jones Bank.

**26th July 2005.**

0920 begin deployment of temperature logger mooring at Bank1.
1030 mooring deployed. Begin steam to Bank2.
1130 arrive Bank2.
1145 contact Prince Madog – they have deployed the seabed ADCP and are about to deploy temperature logger mooring at Bank3.
Weather NE'ly 20 knots.
1237 sub-surface 600 kHz ADCP deployed.
1345 seabed 300 kHz ADCP deployed.
1500 first CTD cast of 25 hour station (CTD035). Prince Madog working nearby with FLY.
1800 CTD missed because the PRR optical rig data cable became stuck in the rudder. Freed (i.e. snapped) in time for 1900 CTD. Approx 1 hour downtime (1 lost CTD cast from time series).

**27th July 2005.**

0900 CTD wire jumps out of sheave again, requiring re-termination. Approx. 2 hours downtime (2 CTD casts lost from time series).
0930 called the Prince Madog to request additional CTDs if they were able – sea conditions may prevent this.
1125 CTD back in action.
1600 last CTD of station.
Deploy guard buoy at Bank2.
Steam to Bank1.
1812 seabed 300 kHz ADCP deployed.
2130 Seasoar deployed.
2230 Pass through position B1 and begin Seasoar box survey.
2300 Seasoar behaving well, 0 – 62 m.

**28th July 2005.**
0500 Seasoar having problems reaching the surface during turns. Seasoar recovered – no obvious problems, just the state of the sea we think. Wind about 30 – 35 knots from North. Heavy seas. Ship heaves to. Approx 5 hours downtime.
0830 decide to go to position JB3 and try a 13 hour CTD station.
1030 first CTD on JB3.
2330 last CTD on JB3.

**29th July 2005.**
0300 begin CTD transect JB1 – JB9 along Jones Bank.
Weather moderated to about 15 knots NW'ly.
0930 work stops due to engine problems. Approx 1.5 hours downtime.
1100 CTDs resume at JB6.
1630 CTD line finished.
Optics carried out at 1730.
1900 deploy Seasoar.
1920 Seasoar running well at 7 knots.
1940 we hear that a French trawler has picked up one of the ADCPs – hardly to be blamed too much as the navigation warning we keep asking for still has not been issued, and he wants to give it back!

**30th July 2005.**
0330 Seasoar recovered.
0430 CTD081 fully sampled for production experiments (station P1).
0700 – 0800 CTD082 and CTD083 either side of a vertical Seasoar profile (minipack370 and frrf261). Minipack pressure on deck = -0.3m.
0845 optics starts.
1000 Seasoar deployed and transect continued towards Labadie Bank.
1900 reach the end of transect (LS4), recover Seasoar.
Steam to Bank2.

**31st July 2005.**
0300 arrive Bank2.
0420 first CTD cast of 25 hr station. Prince Madog close by.
0520 break work to meet fishing boat (Le Cedre Bleu) for transfer of ADCP.
0625 2nd CTD cast of station.
0900 captain notices that the guard buoy at the Bank2 mooring site has gone. The seabed ADCP and sub-surface ADCP respond OK to the release pinger.

**1st August 2005.**
0500 last CTD of station. Note last 3 CTDs were without bottles due to rosette failure.
0650 Seasoar deployment starts near CB5.
0720 Seasoar undulating.
0930 pass through CB6.
Approx 1030 make turn towards OB.
1125 pass through OB.
1230 begin to recover Seasoar.
CTD has been swapped for spare unit.
On station OB 1410, but CTD requires re-termination. Prince Madog started FLY at 1400. Termination appears complete 1520, but replacement CTD will not work. Another re-termination required.
1720 first CTD cast following re-termination (about 3 hours downtime).

**2nd August 2005.**
Last CTD at 1500 on station OB.
Within 10 minutes, remainder of cruise plan collapses!

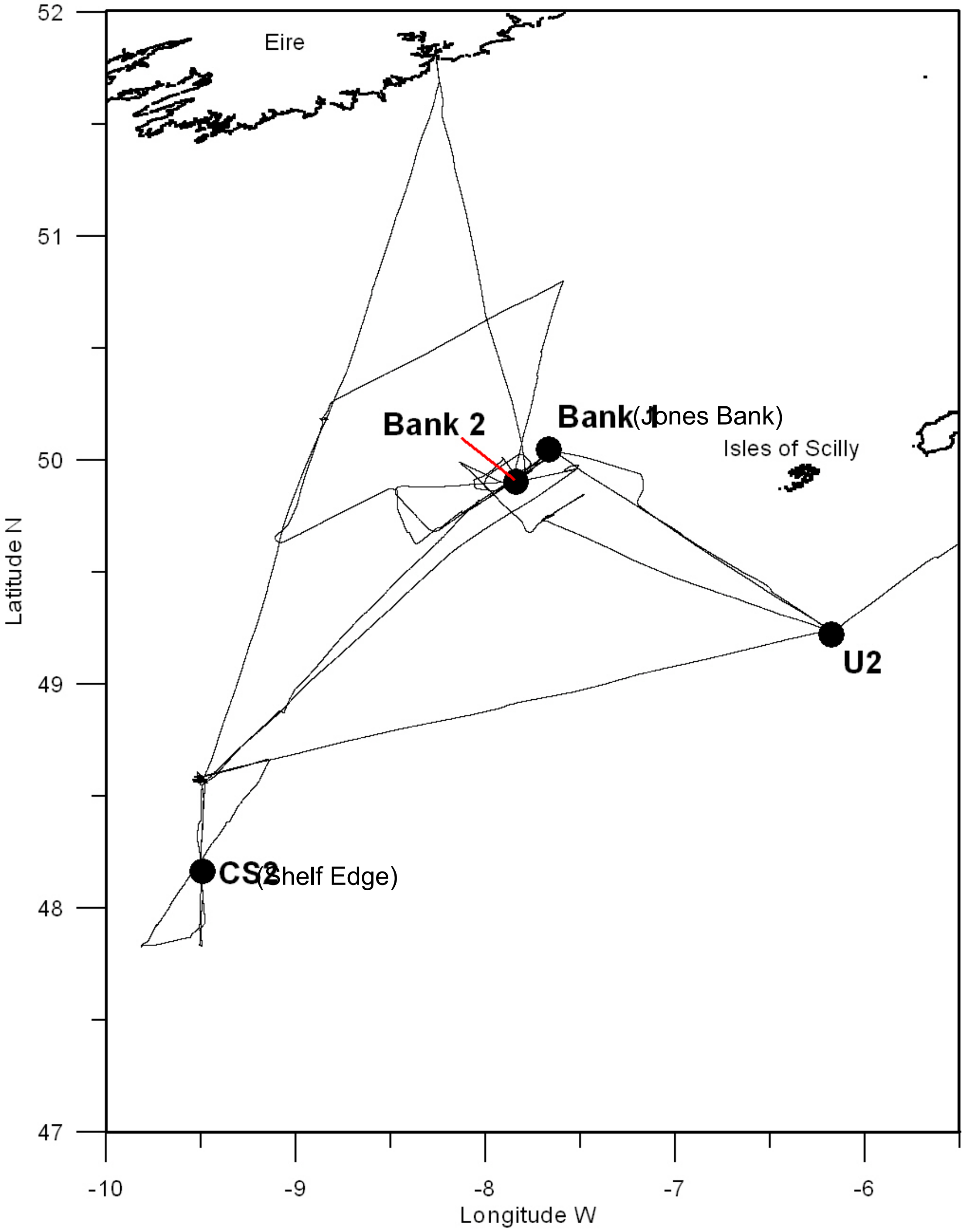
- The guard buoy found by the Navy is from U2, meaning there could be some of the mooring left sub-surface.
- The Madog does not have the manpower available to drag for moorings, so decision made that Darwin will recover all of U2 mooring. Madog will remain at Jones Bank to try FLY transect, and also to recover all of Bank3 moorings.
- Boat transfer required to collect acoustic release controller from the Prince Madog.
- At the same time – errant Bank2 guard buoy sighted 3 miles away from Charles Darwin, so we go to pick it up.

1730 begin steam to U2.

**3rd August 2005.**
0300 arrive U2.
0400 CTD cast.
0530 begin dragging for mooring. First attempt (using a long wire in a circle about 400m diameter) seemed to catch something at the U2 original position. Second attempt made right over U2 with a shorter wire. Unsuccessful. Returning to U2 to attempt mooring recovery has taken about 1.5 days out of our programme.
Optics casts begin 1500.
1600 begin steam back to Jones Bank. Decision made to not Seasoar overnight – only 3 hours available, so better to start moorings as early as possible and use any extra time for the Seasoar work on the way back to Fairlie.

**4th August 2005.**
0600 begin recovery of Bank2 moorings.
Torroid and temperature loggers onboard by 0700.
Sub-surface ADCP and seabed ADCP onboard by 0845.
Prince Madog recovered Bank3 temperature loggers yesterday, but have been unable to contact the release on the seabed ADCP.
Steam to Bank1.
No sign of the surface torroid. But we seem to pick up a consistent echo from what may be the sub-surface buoy. Decision made to drag for the mooring.
Dragging begins 1140.
Dragging ends about 1800 Unsuccessful. (7 hours lost).
Steam towards start of Seasoar line for transect through St Georges Channel and towards Fairlie. Time constraints means the line has to start closer to St Georges Channel than planned.

**5th August 2005.**
0500 (?) Seasoar deployed.
0800 apparent that Seasoar flight is very erratic.
0845 Seasoar incapable of diving. Decision made to recover Seasoar and investigate.
0915 Seasoar found to have a defunct hydraulic unit. No point trying to fix it with the time available, so 0930 begin steam for Fairlie.




CD173 Cruise Track and Main Positions

## 3. Main Station Positions

Jonathan Sharples (POL)

**Shelf Edge:**

| | | | |
|---|---|---|---|
| CS2: | 48° 34.26′ N, 09° 30.58′ W | depth = 201m | Mooring, 25 hour station |

**Cross Shelf Edge CTD Transect:**

| | | |
|---|---|---|
| T1 | 47° 50.06′ N | 9° 48.62′ W |
| T2 | 47° 55.57′ N | 9° 44.16′ W |
| T3 | 48° 01.08′ N | 9° 39.70′ W |
| T4 | 48° 06.59′ N | 9° 35.24′ W |
| T5 | 48° 12.10′ N | 9° 30.78′ W |
| T6 | 48° 17.61′ N | 9° 26.32′ W |
| T7 | 48° 23.12′ N | 9° 21.86′ W |
| T8 | 48° 28.63′ N | 9° 17.40′ W |
| T9 | 48° 33.14′ N | 9° 12.94′ W |
| T10 | 48° 39.65′ N | 9° 08.48′ W |

**Jones Bank:**

| | | | |
|---|---|---|---|
| Bank1: | 49° 56.39′ N, 07° 47.53′ W | depth = 122m | Mooring |
| Bank2: | 49° 53.73′ N, 07° 52.32′ W | depth = 114m | Mooring, 25 hour station |
| Bank3: | 49° 51.21′ N, 07° 56.87′ W | depth = 78m | Mooring |
| OB: | 49° 44.87’ N, 07° 40.10’ W | depth = 110m | 25 hour station |

**Along Jones Bank CTD Transect:**

| | | |
|---|---|---|
| JB1: | 50° 02.7′ N | 07° 38.3′ W |
| JB2: | 49° 57.7′ N | 07° 47.1′ W |
| JB3: | 49° 56.0′ N | 07° 50.0′ W |
| JB4: | 49° 54.3′ N | 07° 53.0′ W |
| JB5: | 49° 51.7′ N | 07° 57.5′ W |
| JB6: | 49° 48.8′ N | 08° 02.7′ W |
| JB7: | 49° 45.9′ N | 08° 07.9′ W |
| JB8: | 49° 42.0′ N | 08° 14.5′ W |
| JB9: | 49° 37.6′ N | 08° 22.3′ W |

**Western English Channel:**

| | | | |
|---|---|---|---|
| U2: | 49° 14.00’ N, 06° 10.00’ W | depth=120m | Mooring |

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## 4. CTD Casts and Calibration Information

Jonathan Sharples (POL)

A Seabird 911 CTD with a rosette of 24 x 20 litre bottles was used throughout the cruise. The CTD was interfaced with a Chelsea Instruments Aquatracka chlorophyll fluorometer, a Seatech transmissometer, and a Seabird dissolved oxygen sensor. Three channels of a SUV6 in situ nitrate spectrophotometer was also connected to the CTD, though at the time of writing this report it is not clear how the data was managed by the CTD. Two stand-alone Chelsea Instruments Fast Repetition Rate Fluorometers were attached to the CTD frame, but not interfaced with the CTD.

A total of 133 CTD casts were conducted during the cruise. The time and position details are as follows:

| CTD File | Date | Start Time (UTC) | Latitude (N) | Longitude (W) |
|---|---|---|---|---|
| **U2** | | | | |
| CTD002 | Jul 15 2005 | 18:08:29 | 49 14.23 | 06 09.84 |
| **Near shelf edge** | | | | |
| CTD003 | Jul 16 2005 | 17:01:35 | 48 52.96 | 09 04.98 |
| CTD004 | Jul 16 2005 | 20:37:25 | 48 33.10 | 09 30.12 |
| CTD005 | Jul 16 2005 | 23:51:12 | 48 13.10 | 09 30.12 |
| CTD006 | Jul 17 2005 | 03:33:42 | 47 49.94 | 09 29.85 |
| **25 hr station at CS2** | | | | |
| CTD007 | Jul 17 2005 | 18:57:19 | 48 34.50 | 09 30.86 |
| CTD008 | Jul 17 2005 | 21:15:34 | 48 34.51 | 09 30.90 |
| CTD009 | Jul 17 2005 | 23:07:22 | 48 34.57 | 09 30.65 |
| CTD010 | Jul 18 2005 | 00:58:02 | 48 34.52 | 09 30.08 |
| CTD011 | Jul 18 2005 | 07:19:51 | 48 34.08 | 09 30.14 |
| CTD012 | Jul 18 2005 | 12:02:22 | 48 34.09 | 09 30.69 |
| CTD013 | Jul 18 2005 | 16:23:30 | 48 34.23 | 09 29.53 |
| CTD014 | Jul 18 2005 | 18:39:05 | 48 34.12 | 09 28.94 |
| **U2** | | | | |
| CTD015 | Jul 19 2005 | 14:44:26 | 49 13.83 | 06 10.40 |
| **NE of Jones Bank** | | | | |
| CTD016 | Jul 20 2005 | 02:56:11 | 50 02.26 | 07 38.05 |
| **Bank 2** | | | | |
| CTD017 | Jul 20 2005 | 14:03:00 | 49 53.74 | 07 53.00 |

| | | | | |
|---|---|---|---|---|
| **Cross-shelf edge transect** | | | | |
| CTD018 | Jul 21 2005 | 20:25:16 | 47 49.95 | 09 48.77 |
| CTD019 | Jul 22 2005 | 02:15:24 | 47 55.54 | 09 44.29 |
| CTD020 | Jul 22 2005 | 07:03:25 | 48 01.16 | 09 39.68 |
| CTD021 | Jul 22 2005 | 10:59:23 | 48 06.60 | 09 35.20 |
| CTD022 | Jul 22 2005 | 13:36:16 | 48 11.79 | 09 30.84 |
| CTD023 | Jul 22 2005 | 15:33:35 | 48 17.64 | 09 26.43 |
| CTD024 | Jul 22 2005 | 17:05:37 | 48 23.16 | 09 21.70 |
| CTD025 | Jul 22 2005 | 18:38:24 | 48 28.57 | 09 17.26 |
| CTD026 | Jul 22 2005 | 20:02:53 | 48 32.96 | 09 12.80 |
| CTD027 | Jul 22 2005 | 21:30:12 | 48 39.65 | 09 08.48 |
| **25 hr station at CS2** | | | | |
| CTD028 | Jul 23 2005 | 03:00:28 | 48 34.30 | 09 29.38 |
| CTD029 | Jul 23 2005 | 07:18:53 | 48 34.25 | 09 29.24 |
| CTD030 | Jul 23 2005 | 10:32:24 | 48 34.71 | 09 30.19 |
| CTD031 | Jul 23 2005 | 15:25:23 | 48 34.64 | 09 28.88 |
| CTD032 | Jul 23 2005 | 20:00:51 | 48 34.57 | 09 29.38 |
| CTD033 | Jul 23 2005 | 23:07:28 | 48 34.85 | 09 30.37 |
| CTD034 | Jul 24 2005 | 04:04:09 | 48 34.95 | 09 30.72 |
| **25 hr station at Bank 2** | | | | |
| CTD035 | Jul 26 2005 | 14:04:38 | 49 53.75 | 07 52.58 |
| CTD036 | Jul 26 2005 | 15:16:58 | 49 53.84 | 07 52.66 |
| CTD037 | Jul 26 2005 | 16:12:39 | 49 53.52 | 07 52.74 |
| CTD038 | Jul 26 2005 | 18:03:43 | 49 53.78 | 07 52.78 |
| CTD039 | Jul 26 2005 | 19:00:53 | 49 53.99 | 07 52.30 |
| CTD040 | Jul 26 2005 | 20:08:57 | 49 53.81 | 07 52.49 |
| CTD041 | Jul 26 2005 | 21:08:10 | 49 53.87 | 07 52.51 |
| CTD042 | Jul 26 2005 | 22:01:15 | 49 53.66 | 07 52.67 |
| CTD043 | Jul 26 2005 | 22:57:26 | 49 53.54 | 07 52.72 |
| CTD044 | Jul 26 2005 | 23:55:24 | 49 53.85 | 07 52.83 |
| CTD045 | Jul 27 2005 | 00:56:36 | 49 54.04 | 07 52.87 |

| | | | | |
|---|---|---|---|---|
| CTD046 | Jul 27 2005 | 01:56:30 | 49 53.96 | 07 52.86 |
| CTD047 | Jul 27 2005 | 02:55:32 | 49 53.82 | 07 52.75 |
| CTD048 | Jul 27 2005 | 04:15:50 | 49 53.71 | 07 53.04 |
| CTD049 | Jul 27 2005 | 05:15:48 | 49 53.93 | 07 52.82 |
| CTD050 | Jul 27 2005 | 06:03:49 | 49 53.63 | 07 52.62 |
| CTD051 | Jul 27 2005 | 07:14:36 | 49 54.10 | 07 52.89 |
| CTD052 | Jul 27 2005 | 10:23:03 | 49 53.45 | 07 52.93 |
| CTD053 | Jul 27 2005 | 11:00:45 | 49 53.43 | 07 53.02 |
| CTD054 | Jul 27 2005 | 12:04:38 | 49 53.82 | 07 53.12 |
| CTD055 | Jul 27 2005 | 12:58:34 | 49 53.58 | 07 53.16 |
| CTD056 | Jul 27 2005 | 13:59:02 | 49 54.07 | 07 53.50 |
| CTD057 | Jul 27 2005 | 15:01:23 | 49 54.10 | 07 52.76 |
| **13 hr station at JB3** | | | | |
| CTD058 | Jul 28 2005 | 09:28:17 | 49 55.77 | 07 50.06 |
| CTD059 | Jul 28 2005 | 10:30:42 | 49 55.97 | 07 50.07 |
| CTD060 | Jul 28 2005 | 11:28:21 | 49 56.05 | 07 50.51 |
| CTD061 | Jul 28 2005 | 12:28:24 | 49 55.95 | 07 50.55 |
| CTD062 | Jul 28 2005 | 13:31:10 | 49 55.87 | 07 50.01 |
| CTD063 | Jul 28 2005 | 14:26:53 | 49 56.13 | 07 50.38 |
| CTD064 | Jul 28 2005 | 15:33:18 | 49 56.08 | 07 50.07 |
| CTD065 | Jul 28 2005 | 16:33:53 | 49 56.17 | 07 49.88 |
| CTD066 | Jul 28 2005 | 17:32:36 | 49 55.85 | 07 49.99 |
| CTD067 | Jul 28 2005 | 18:40:36 | 49 56.00 | 07 49.88 |
| CTD068 | Jul 28 2005 | 19:27:01 | 49 56.13 | 07 49.78 |
| CTD069 | Jul 28 2005 | 20:25:20 | 49 55.91 | 07 49.89 |
| CTD070 | Jul 28 2005 | 21:21:26 | 49 55.96 | 07 49.56 |
| CTD071 | Jul 28 2005 | 22:25:53 | 49 55.84 | 07 49.83 |
| **Transect along Jones Bank** | | | | |
| CTD072 | Jul 29 2005 | 01:59:05 | 50 02.36 | 07 38.28 |
| CTD073 | Jul 29 2005 | 03:52:20 | 49 57.59 | 07 47.33 |
| CTD074 | Jul 29 2005 | 04:50:24 | 49 56.01 | 07 49.76 |

| | | | | |
|---|---|---|---|---|
| CTD075 | Jul 29 2005 | 05:58:05 | 49 54.15 | 07 52.62 |
| CTD076 | Jul 29 2005 | 07:06:27 | 49 51.82 | 07 57.16 |
| CTD077 | Jul 29 2005 | 10:01:28 | 49 48.85 | 08 02.73 |
| CTD078 | Jul 29 2005 | 11:31:28 | 49 46.07 | 08 07.50 |
| CTD079 | Jul 29 2005 | 13:10:28 | 49 41.94 | 08 14.60 |
| CTD080 | Jul 29 2005 | 14:42:08 | 49 37.61 | 08 22.15 |
| | | | | |
| **Mid Celtic Sea primary production** | | | | |
| CTD081 | Jul 30 2005 | 03:54:04 | 50 11.15 | 08 51.76 |
| | | | | |
| **Mid Celtic Sea Seasoar calibration** | | | | |
| CTD082 | Jul 30 2005 | 06:04:01 | 50 10.94 | 08 50.66 |
| CTD083 | Jul 30 2005 | 06:57:38 | 50 11.15 | 08 50.94 |
| | | | | |
| **25 hr station at Bank 2** | | | | |
| CTD084 | Jul 31 2005 | 03:18:35 | 49 54.29 | 07 52.13 |
| CTD085 | Jul 31 2005 | 05:26:12 | 49 53.54 | 07 52.93 |
| CTD086 | Jul 31 2005 | 06:06:58 | 49 53.79 | 07 52.96 |
| CTD087 | Jul 31 2005 | 07:00:31 | 49 53.21 | 07 52.49 |
| CTD088 | Jul 31 2005 | 08:00:12 | 49 53.19 | 07 52.83 |
| CTD089 | Jul 31 2005 | 08:56:23 | 49 53.29 | 07 52.88 |
| CTD090 | Jul 31 2005 | 09:57:19 | 49 53.11 | 07 53.03 |
| CTD091 | Jul 31 2005 | 10:58:25 | 49 52.93 | 07 53.11 |
| CTD092 | Jul 31 2005 | 12:01:09 | 49 53.15 | 07 53.16 |
| CTD093 | Jul 31 2005 | 13:03:55 | 49 52.92 | 07 53.34 |
| CTD094 | Jul 31 2005 | 14:01:24 | 49 53.33 | 07 53.12 |
| CTD095 | Jul 31 2005 | 14:59:05 | 49 53.42 | 07 53.35 |
| CTD096 | Jul 31 2005 | 16:02:32 | 49 53.34 | 07 52.86 |
| CTD097 | Jul 31 2005 | 17:08:14 | 49 53.13 | 07 52.43 |
| CTD098 | Jul 31 2005 | 18:01:07 | 49 53.26 | 07 52.86 |
| CTD099 | Jul 31 2005 | 18:56:01 | 49 53.47 | 07 52.25 |

| | | | | |
|---|---|---|---|---|
| CTD100 | Jul 31 2005 | 19:56:19 | 49 53.60 | 07 52.92 |
| CTD101 | Jul 31 2005 | 20:56:40 | 49 53.70 | 07 53.07 |
| CTD102 | Jul 31 2005 | 21:55:45 | 49 53.77 | 07 52.95 |
| CTD103 | Jul 31 2005 | 22:56:58 | 49 53.84 | 07 52.81 |
| CTD104 | Jul 31 2005 | 23:59:46 | 49 53.62 | 07 52.92 |
| CTD105 | Aug 01 2005 | 00:58:25 | 49 53.82 | 07 52.90 |
| CTD106 | Aug 01 2005 | 02:11:00 | 49 53.36 | 07 52.59 |
| CTD107 | Aug 01 2005 | 03:05:39 | 49 53.38 | 07 52.64 |
| CTD108 | Aug 01 2005 | 04:03:57 | 49 53.53 | 07 52.83 |
| **25 hr station at OB** | | | | |
| CTD109 | Aug 01 2005 | 16:16:57 | 49 44.87 | 07 40.10 |
| CTD110 | Aug 01 2005 | 17:03:56 | 49 44.81 | 07 40.22 |
| CTD111 | Aug 01 2005 | 18:15:36 | 49 44.88 | 07 40.65 |
| CTD112 | Aug 01 2005 | 18:55:30 | 49 44.68 | 07 40.63 |
| CTD113 | Aug 01 2005 | 19:56:48 | 49 44.99 | 07 40.26 |
| CTD114 | Aug 01 2005 | 20:56:22 | 49 44.89 | 07 40.91 |
| CTD115 | Aug 01 2005 | 21:56:33 | 49 44.99 | 07 40.22 |
| CTD116 | Aug 01 2005 | 22:57:03 | 49 45.10 | 07 40.47 |
| CTD117 | Aug 01 2005 | 23:56:55 | 49 44.98 | 07 40.54 |
| CTD118 | Aug 02 2005 | 00:56:40 | 49 45.02 | 07 40.71 |
| CTD119 | Aug 02 2005 | 01:58:00 | 49 45.20 | 07 40.26 |
| CTD120 | Aug 02 2005 | 02:58:11 | 49 45.14 | 07 39.93 |
| CTD121 | Aug 02 2005 | 04:19:06 | 49 44.95 | 07 39.87 |
| CTD122 | Aug 02 2005 | 05:03:06 | 49 44.92 | 07 39.99 |
| CTD123 | Aug 02 2005 | 06:02:55 | 49 44.55 | 07 40.50 |
| CTD124 | Aug 02 2005 | 06:58:23 | 49 44.91 | 07 39.94 |
| CTD125 | Aug 02 2005 | 07:56:58 | 49 45.01 | 07 39.94 |
| CTD126 | Aug 02 2005 | 08:56:29 | 49 45.00 | 07 39.88 |
| CTD127 | Aug 02 2005 | 09:56:59 | 49 44.96 | 07 39.65 |
| CTD128 | Aug 02 2005 | 11:11:59 | 49 45.38 | 07 39.03 |
| CTD129 | Aug 02 2005 | 12:23:12 | 49 44.92 | 07 39.83 |
| CTD130 | Aug 02 2005 | 13:01:53 | 49 45.03 | 07 40.19 |
| CTD131 | Aug 02 2005 | 14:03:43 | 49 45.03 | 07 40.04 |

| | | | | |
|---|---|---|---|---|
| **U2** | | | | |
| CTD132 | Aug 03 2005 | 03:05:43 | 49 13.95 | 06 10.05 |
| CTD133 | Aug 03 2005 | 03:56:50 | 49 14.08 | 06 10.14 |

***CTD Problems.***
During the cruise it became clear that there was a significant problem with the quality of the CTD data. The problem showed up as a consistent apparent spiking in temperature and salinity as the CTD passed through the pycnocline, in a way not normally expected from a CTD. Closer inspection showed that this spiking was a periodic signal (see Fig. 4.1 below) associated with a periodic variability in the winch veer speed.

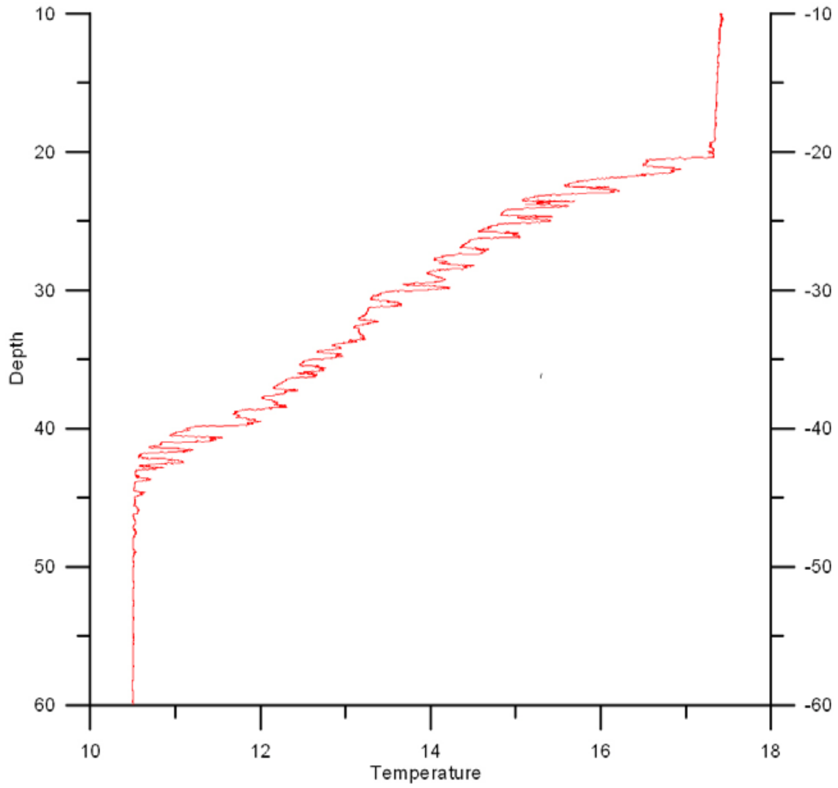


**Figure 4.1**: Example of raw CTD temperature data through the thermocline, illustrating the periodic spiking of the CTD temperature signal.

Discussion with the ship's personnel highlighted a known problem with the winch veer rate at shallow depths (i.e. <500 metres). We also noted that the problem was worse for sensors near the centre of the CTD package, and less bad for sensors near the periphery. Given the known difficulty of efficient flushing of the heavily-instrumented package as it travels down through the water, the most likely cause of the signal error is the periodic presentation of an amount of "old" seawater to the sensors pushing out of the base of the CTD package as the veer rate slows. As the veer rate increases, this old water is pushed pack up through the CTD package and "new" seawater is sampled by the sensors.

This is a major error in the CTD measurements, particularly given the focus of the project on the structure of the thermocline. A normal bin-averaging analysis of the data will smooth the periodic signal and result in, for instance, thermocline temperatures consistently higher than reality at each depth. Instead analysis of down-cast data needs to identify the low points of the temperature signal; such a method using the lowest 10 measurements from the secondary temperature sensor as identifying the best CTD data appeared to work satisfactorily (see Fig. 4.2).

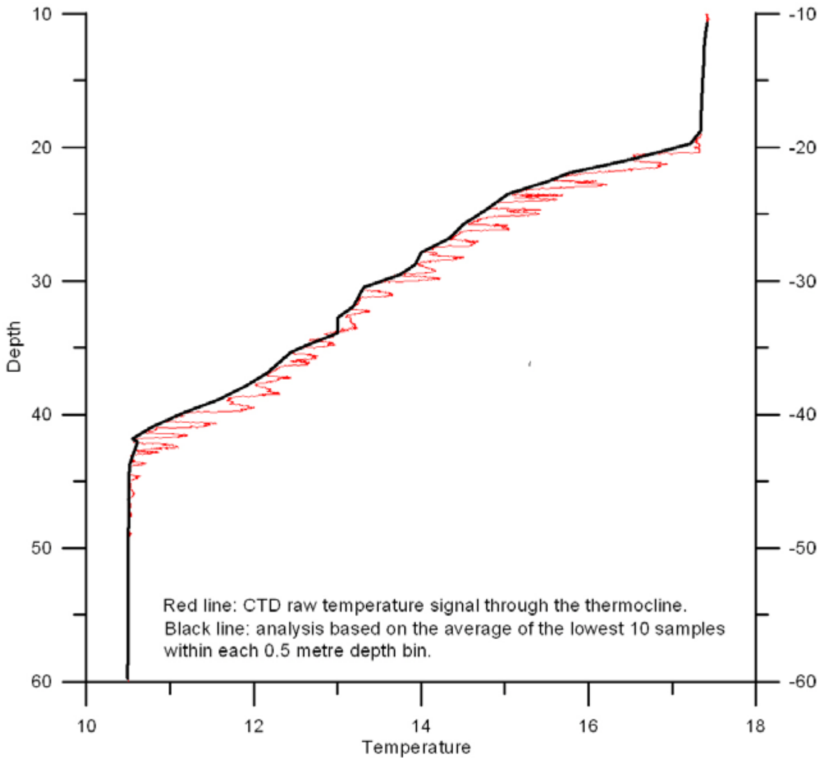


**Figure 4.2**: The same raw temperature data as in Fig. 4.1 (red line), with the analysis based on averaging the lowest 10 readings within each 0.5 metre depth bin (black line).

It is difficult to quantify the temperature and salinity errors within the pycnocline. The poor data quality also suggests that overturns and a Thorpe scale analysis of the cruise CTD data is not possible. Post processing with the Seabird processing software needs to be considered very carefully. Using the Seabird filters on the raw temperature and salinity data with a time constant of 0.5 seconds effectively removed the oscillation in the data, but in doing so offset the data from the troughs of the oscillations (i.e. introducing the same error as normal bin-averaging). At the time of writing the best analysis appears to be the "lowest 10 readings" method on the unfiltered raw data. Note also that correcting for the thermal mass of the conductivity sensor (using the Seabird software) had negligible effect on the data.

***Salinity Calibration Data***

Salinity sample bottles were only available for Leg 2 of the cruise. The following table summarises the calibration information available based on sample analysis with a Guildline Autosal salinometer. Preliminary assessment of the CTD salinity data against these salinity samples suggests that the raw CTD salinity from the primary sensors requires the addition of an offset of -0.007, resulting in salinity data accurate to +/- 0.003 (PSS78). Note that this analysis excludes two outliers (in italics in the following table).

| sample bottle | bottle salinity | CTD cast | sample depth |
|---|---|---|---|
| 217 | 35.388 | 114 | 73m |
| *218* | *35.385* | *114* | *34m* |
| 219 | 35.388 | 124 | 53m |
| 220 | 35.347 | 124 | 2m |

| | | | |
|---|---|---|---|
| 49 | 35.358 | 58 | 117m |
| 50 | 35.346 | 58 | 13m |
| 51 | 35.355 | 60 | 70m |
| 52 | 35.349 | 62 | 50m |
| 53 | 35.337 | 60 | 2m |
| 54 | 35.328 | 62 | 2m |
| 55 | 35.345 | 64 | 70m |
| 56 | 35.344 | 64 | 50m |
| 57 | 35.412 | 79 | 70m |
| 58 | 35.345 | 79 | 2m |
| 59 | 35.405 | 78 | 100m |
| 60 | 35.341 | 78 | 2m |
| 61 | 35.335 | 66 | 51m |
| 62 | 35.341 | 66 | 70m |
| 63 | 35.343 | 64 | 32m |
| *64* | *35.343* | *66* | *34m* |
| 65 | 35.388 | 93 | 70m |
| 66 | 35.335 | 93 | 2m |
| 67 | 35.373 | 104 | 70m |
| 68 | 35.330 | 104 | 2m |
| 69 | 35.382 | 110 | 122m |
| 70 | 35.382 | 110 | 102m |
| 71 | 35.387 | 118 | 55m |
| 72 | 35.328 | 118 | 2m |

***Chlorophyll Calibration.***

The details of the chlorophyll calibration procedure can be found in the section on Phytoplankton Pigment Measurements and Sampling. In summary the raw CTD chlorophyll data requires two separate calibrations, one for the shelf edge water and one for the Celtic Sea shelf water (Fig. 4.3).

Based on the regression in Fig 4.3 the CTD chlorophyll *a* concentration can be calibrated by:

At the shelf edge:

**Chlorophyll *a* = 1.4 x CTDchl – 0.1 μg litre$^{-1}$**

rms error = +/- 0.2 μg litre$^{-1}$

On the shelf:

**Chlorophyll *a* = 1.8 x CTDchl + 0.0 μg litre$^{-1}$**

rms error = +/- 0.1 μg litre$^{-1}$

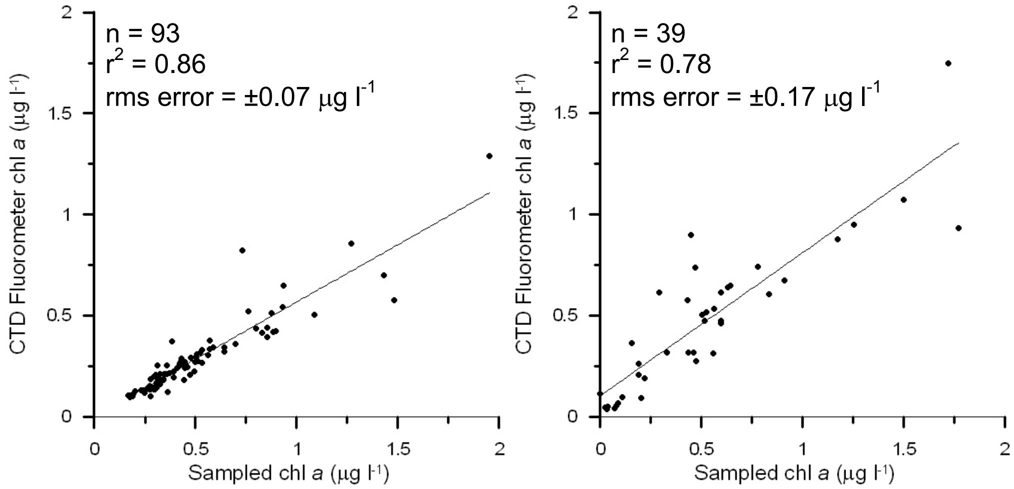


**Figure 4.3**: CTD raw chlorophyll *a* versus the corresponding analyses of bottle samples for the Celtic Sea shelf water (left) and the shelf edge (right).

Note that CTD002 contained an incorrect calibration file, so the above calibration equations are not applicable to it.

***Dissolved Oxygen Calibration.***
Details of the dissolved oxygen calibration procedure can be found in the section of Dissolved Oxygen Measurements. In summary, the dissolved oxygen in the raw CTD data can be calibrated via:

**Calibrated DO = 1.0 x CTD_DO + 9.0 $\mu$mol kg$^{-1}$**

rms error = +/- 4.0 $\mu$mol kg$^{-1}$

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## 5. Turbulence Measurements

Matthew Palmer.

An important part of the project requires knowledge of turbulent dissipation rates and the vertical eddy diffusivity. Time series of turbulence were collected using FLY, from the RRS *Charles Darwin* during leg 1 of the cruise and from the RV *Prince Madog* (close to the *Charles Darwin*) during leg 2.

The FLY profiler (figure 5.1) is a free-falling probe, capable of measuring velocity shear on two independent sensors, pressure, temperature and salinity developed by Dewey *et al* (1987). The instrument is capable of measurement over almost all of the water column, from the near surface, depending on noise from surface disturbance and ship noise, to within 15cm of the seabed, restricted by the guard ring protecting the probe sensors which is removable in studies where the near bottom measurement is not required. Contained within the pressure casing of the instrument are the signal amplifiers, analogue to digital electronics and an internal battery power supply. Digital signals are relayed via two ‘fast’ channels, sampling at 274 Hz, and eight slow channels, sampling at 34 Hz. Typically the two shear sensors transmit on the fast channels, which, with a typical fall speed of 0.7-8ms$^{-1}$, produce shear measurements approximately every 3mm of water depth.

For isotropic turbulence regimes, the dissipation rate per unit volume () can be derived from the variance of the mean shear, estimated from the power spectrum of the shear signal:

$$\varepsilon = 7.5\mu\overline{\left(\frac{\partial u'}{\partial z}\right)^2} \quad \left(\mathrm{Wm^{-3}}\right)$$

where μ is the dynamic viscosity of seawater. The mean square shear is calculated first by derivation of the power spectrum for each depth interval of a cast by detrending of the shear data to give zero mean and cosine tapering in order to allow for fast Fourier transform (FFT).

**Figure 5.1**. The FLY profiler ready for deployment.
The shear and CTD sensors are at the left of the picture, within the projective cage.

All of the FLY casts, from both the *Charles Darwin* and from the *Prince Madog*, are listed in the following table.

| Cast id | Year | month | day | hour | minute | Degrees N | Degrees W |
|---|---|---|---|---|---|---|---|
| CS2 shelf edge station 1 (Charles Darwin) | | | | | | | |
| CE001001 | 2005 | 7 | 17 | 20 | 7 | 48.578 | 9.507 |
| CE001002 | 2005 | 7 | 17 | 20 | 19 | 48.578 | 9.505 |
| CE001003 | 2005 | 7 | 17 | 20 | 28 | 48.577 | 9.503 |
| CE001004 | 2005 | 7 | 17 | 20 | 36 | 48.578 | 9.501 |
| CE001005 | 2005 | 7 | 17 | 20 | 44 | 48.578 | 9.499 |
| CE002006 | 2005 | 7 | 17 | 21 | 49 | 48.573 | 9.515 |
| CE002007 | 2005 | 7 | 17 | 21 | 57 | 48.571 | 9.515 |
| CE002008 | 2005 | 7 | 17 | 22 | 6 | 48.569 | 9.515 |
| CE002009 | 2005 | 7 | 17 | 22 | 15 | 48.567 | 9.515 |
| CE002010 | 2005 | 7 | 17 | 22 | 25 | 48.565 | 9.515 |
| CE003011 | 2005 | 7 | 17 | 23 | 45 | 48.579 | 9.504 |
| CE003012 | 2005 | 7 | 17 | 23 | 54 | 48.577 | 9.499 |
| CE003013 | 2005 | 7 | 18 | 0 | 1 | 48.576 | 9.496 |
| CE003014 | 2005 | 7 | 18 | 0 | 9 | 48.575 | 9.491 |
| CE003015 | 2005 | 7 | 18 | 0 | 14 | 48.574 | 9.488 |
| CE004016 | 2005 | 7 | 18 | 1 | 29 | 48.574 | 9.500 |
| CE004017 | 2005 | 7 | 18 | 1 | 37 | 48.573 | 9.502 |
| CE004018 | 2005 | 7 | 18 | 1 | 46 | 48.571 | 9.503 |
| CE004019 | 2005 | 7 | 18 | 1 | 55 | 48.570 | 9.505 |
| CE004020 | 2005 | 7 | 18 | 2 | 4 | 48.569 | 9.506 |
| CE005021 | 2005 | 7 | 18 | 3 | 11 | 48.566 | 9.512 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CE005022 | 2005 | 7 | 18 | 3 | 23 | 48.567 | 9.517 |
| CE006023 | 2005 | 7 | 18 | 4 | 21 | 48.572 | 9.487 |
| CE006024 | 2005 | 7 | 18 | 4 | 30 | 48.572 | 9.489 |
| CE006025 | 2005 | 7 | 18 | 4 | 39 | 48.571 | 9.492 |
| CE006026 | 2005 | 7 | 18 | 4 | 48 | 48.571 | 9.495 |
| CE006027 | 2005 | 7 | 18 | 4 | 56 | 48.571 | 9.497 |
| CE007028 | 2005 | 7 | 18 | 5 | 34 | 48.572 | 9.485 |
| CE007029 | 2005 | 7 | 18 | 5 | 45 | 48.571 | 9.487 |
| CE007030 | 2005 | 7 | 18 | 5 | 54 | 48.571 | 9.490 |
| CE007031 | 2005 | 7 | 18 | 6 | 5 | 48.570 | 9.496 |
| CE007032 | 2005 | 7 | 18 | 6 | 14 | 48.570 | 9.498 |
| CE008033 | 2005 | 7 | 18 | 8 | 37 | 48.568 | 9.512 |
| CE008034 | 2005 | 7 | 18 | 8 | 47 | 48.569 | 9.518 |
| CE008035 | 2005 | 7 | 18 | 8 | 57 | 48.571 | 9.525 |
| CE008036 | 2005 | 7 | 18 | 9 | 7 | 48.572 | 9.529 |
| CE008037 | 2005 | 7 | 18 | 9 | 17 | 48.572 | 9.534 |
| CE009038 | 2005 | 7 | 18 | 10 | 26 | 48.566 | 9.512 |
| CE009039 | 2005 | 7 | 18 | 10 | 36 | 48.567 | 9.515 |
| CE009040 | 2005 | 7 | 18 | 10 | 47 | 48.568 | 9.521 |
| CE009042 | 2005 | 7 | 18 | 11 | 7 | 48.571 | 9.528 |
| CE009043 | 2005 | 7 | 18 | 11 | 17 | 48.573 | 9.530 |
| CE010044 | 2005 | 7 | 18 | 12 | 58 | 48.570 | 9.516 |
| CE010045 | 2005 | 7 | 18 | 13 | 8 | 48.571 | 9.519 |
| CE010046 | 2005 | 7 | 18 | 13 | 18 | 48.571 | 9.522 |
| CE010047 | 2005 | 7 | 18 | 13 | 29 | 48.572 | 9.525 |
| CE011048 | 2005 | 7 | 18 | 14 | 48 | 48.568 | 9.521 |
| CE011049 | 2005 | 7 | 18 | 14 | 50 | 48.568 | 9.521 |
| CE011050 | 2005 | 7 | 18 | 15 | 0 | 48.568 | 9.525 |
| CE011051 | 2005 | 7 | 18 | 15 | 32 | 48.575 | 9.512 |
| CE011052 | 2005 | 7 | 18 | 15 | 41 | 48.574 | 9.514 |
| CE011053 | 2005 | 7 | 18 | 15 | 50 | 48.575 | 9.516 |
| CE012054 | 2005 | 7 | 18 | 17 | 16 | 48.572 | 9.481 |
| CE012055 | 2005 | 7 | 18 | 17 | 20 | 48.571 | 9.482 |
| CE012056 | 2005 | 7 | 18 | 17 | 29 | 48.571 | 9.485 |
| CE012057 | 2005 | 7 | 18 | 17 | 38 | 48.572 | 9.489 |
| CE012058 | 2005 | 7 | 18 | 17 | 48 | 48.572 | 9.492 |
| CE012059 | 2005 | 7 | 18 | 18 | 2 | 48.572 | 9.496 |
| CE013060 | 2005 | 7 | 18 | 19 | 42 | 48.568 | 9.510 |
| CE013061 | 2005 | 7 | 18 | 19 | 52 | 48.567 | 9.516 |
| CE013062 | 2005 | 7 | 18 | 20 | 1 | 48.567 | 9.522 |
| CE013063 | 2005 | 7 | 18 | 20 | 12 | 48.568 | 9.528 |
| CE013064 | 2005 | 7 | 18 | 20 | 22 | 48.568 | 9.534 |
| FLY calibration series (Charles Darwin) | | | | | | | |
| CE014065 | 2005 | 7 | 20 | 19 | 42 | 49.960 | 7.532 |
| CE014066 | 2005 | 7 | 20 | 19 | 44 | 49.960 | 7.532 |
| CE014067 | 2005 | 7 | 20 | 19 | 47 | 49.960 | 7.534 |
| CE014068 | 2005 | 7 | 20 | 19 | 51 | 49.960 | 7.536 |
| CE014069 | 2005 | 7 | 20 | 0 | 1 | 49.959 | 7.541 |
| CE014070 | 2005 | 7 | 20 | 20 | 48 | 49.956 | 7.564 |
| CE014071 | 2005 | 7 | 20 | 20 | 53 | 49.956 | 7.568 |
| CE014072 | 2005 | 7 | 20 | 20 | 58 | 49.956 | 7.572 |
| CS2 shelf edge station 2 (Charles Darwin) | | | | | | | |
| CE015073 | 2005 | 7 | 23 | 2 | 13 | 48.572 | 9.491 |
| CE015074 | 2005 | 7 | 23 | 2 | 21 | 48.572 | 9.491 |
| CE016075 | 2005 | 7 | 23 | 4 | 31 | 48.573 | 9.484 |
| CE016076 | 2005 | 7 | 23 | 4 | 41 | 48.572 | 9.483 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CE016077 | 2005 | 7 | 23 | 4 | 50 | 48.571 | 9.481 |
| CE016078 | 2005 | 7 | 23 | 5 | 0 | 48.570 | 9.479 |
| CE016079 | 2005 | 7 | 23 | 5 | 10 | 48.569 | 9.476 |
| CE016080 | 2005 | 7 | 23 | 5 | 19 | 48.567 | 9.475 |
| CE017081 | 2005 | 7 | 23 | 6 | 24 | 48.573 | 9.486 |
| CE017082 | 2005 | 7 | 23 | 6 | 33 | 48.572 | 9.485 |
| CE017083 | 2005 | 7 | 23 | 6 | 41 | 48.572 | 9.485 |
| CE017084 | 2005 | 7 | 23 | 6 | 50 | 48.571 | 9.486 |
| CE017085 | 2005 | 7 | 23 | 6 | 59 | 48.571 | 9.486 |
| CE017086 | 2005 | 7 | 23 | 7 | 8 | 48.571 | 9.487 |
| CE018087 | 2005 | 7 | 23 | 8 | 16 | 48.581 | 9.491 |
| CE018088 | 2005 | 7 | 23 | 8 | 23 | 48.581 | 9.491 |
| CE018089 | 2005 | 7 | 23 | 8 | 31 | 48.580 | 9.493 |
| CE018090 | 2005 | 7 | 23 | 8 | 40 | 48.581 | 9.493 |
| CE018091 | 2005 | 7 | 23 | 8 | 48 | 48.581 | 9.494 |
| CE018092 | 2005 | 7 | 23 | 8 | 56 | 48.580 | 9.494 |
| CE019093 | 2005 | 7 | 23 | 9 | 40 | 48.580 | 9.498 |
| CE019094 | 2005 | 7 | 23 | 9 | 49 | 48.580 | 9.499 |
| CE019095 | 2005 | 7 | 23 | 9 | 57 | 48.579 | 9.500 |
| CE019096 | 2005 | 7 | 23 | 10 | 5 | 48.579 | 9.501 |
| CE019097 | 2005 | 7 | 23 | 10 | 13 | 48.579 | 9.502 |
| CE019098 | 2005 | 7 | 23 | 10 | 21 | 48.578 | 9.502 |
| CE020099 | 2005 | 7 | 23 | 11 | 12 | 48.580 | 9.505 |
| CE020100 | 2005 | 7 | 23 | 11 | 20 | 48.580 | 9.507 |
| CE020101 | 2005 | 7 | 23 | 11 | 27 | 48.580 | 9.508 |
| CE020102 | 2005 | 7 | 23 | 11 | 34 | 48.581 | 9.509 |
| CE020103 | 2005 | 7 | 23 | 11 | 42 | 48.581 | 9.508 |
| CE021104 | 2005 | 7 | 23 | 12 | 53 | 48.587 | 9.504 |
| CE021105 | 2005 | 7 | 23 | 12 | 59 | 48.590 | 9.503 |
| CE021106 | 2005 | 7 | 23 | 13 | 6 | 48.592 | 9.502 |
| CE021107 | 2005 | 7 | 23 | 13 | 15 | 48.594 | 9.500 |
| CE021108 | 2005 | 7 | 23 | 13 | 23 | 48.593 | 9.500 |
| CE022109 | 2005 | 7 | 23 | 14 | 16 | 48.579 | 9.482 |
| CE022110 | 2005 | 7 | 23 | 14 | 24 | 48.578 | 9.482 |
| CE022111 | 2005 | 7 | 23 | 14 | 32 | 48.578 | 9.482 |
| CE022112 | 2005 | 7 | 23 | 14 | 41 | 48.578 | 9.482 |
| CE022113 | 2005 | 7 | 23 | 14 | 50 | 48.578 | 9.481 |
| CE022114 | 2005 | 7 | 23 | 14 | 58 | 48.577 | 9.481 |
| CE022116 | 2005 | 7 | 23 | 15 | 9 | 48.577 | 9.481 |
| CE023117 | 2005 | 7 | 23 | 16 | 13 | 48.575 | 9.481 |
| CE023118 | 2005 | 7 | 23 | 16 | 22 | 48.574 | 9.480 |
| CE023119 | 2005 | 7 | 23 | 16 | 25 | 48.574 | 9.480 |
| CE023120 | 2005 | 7 | 23 | 16 | 33 | 48.573 | 9.479 |
| CE023121 | 2005 | 7 | 23 | 16 | 42 | 48.574 | 9.480 |
| CE023122 | 2005 | 7 | 23 | 16 | 51 | 48.574 | 9.480 |
| CE024123 | 2005 | 7 | 23 | 17 | 31 | 48.575 | 9.473 |
| CE024124 | 2005 | 7 | 23 | 17 | 40 | 48.575 | 9.475 |
| CE024125 | 2005 | 7 | 23 | 17 | 49 | 48.576 | 9.477 |
| CE024126 | 2005 | 7 | 23 | 17 | 58 | 48.575 | 9.477 |
| CE024127 | 2005 | 7 | 23 | 18 | 7 | 48.575 | 9.477 |
| CE025128 | 2005 | 7 | 23 | 18 | 53 | 48.568 | 9.486 |
| CE025129 | 2005 | 7 | 23 | 19 | 2 | 48.569 | 9.487 |
| CE025130 | 2005 | 7 | 23 | 19 | 12 | 48.570 | 9.488 |
| CE025131 | 2005 | 7 | 23 | 19 | 21 | 48.570 | 9.489 |
| CE025132 | 2005 | 7 | 23 | 19 | 30 | 48.570 | 9.489 |
| CE026133 | 2005 | 7 | 23 | 20 | 32 | 48.573 | 9.493 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| CE026134 | 2005 | 7 | 23 | 20 | 40 | 48.573 | 9.494 |
| CE026135 | 2005 | 7 | 23 | 20 | 48 | 48.573 | 9.494 |
| CE026136 | 2005 | 7 | 23 | 20 | 56 | 48.573 | 9.495 |
| CE026137 | 2005 | 7 | 23 | 21 | 4 | 48.572 | 9.496 |
| CE026138 | 2005 | 7 | 23 | 21 | 12 | 48.572 | 9.496 |
| CE027139 | 2005 | 7 | 23 | 21 | 57 | 48.583 | 9.498 |
| CE027140 | 2005 | 7 | 23 | 22 | 4 | 48.583 | 9.498 |
| CE027141 | 2005 | 7 | 23 | 22 | 16 | 48.583 | 9.498 |
| CE027142 | 2005 | 7 | 23 | 22 | 25 | 48.583 | 9.499 |
| CE027143 | 2005 | 7 | 23 | 22 | 34 | 48.583 | 9.500 |
| CE027144 | 2005 | 7 | 23 | 22 | 43 | 48.582 | 9.502 |
| CE028146 | 2005 | 7 | 24 | 0 | 30 | 48.588 | 9.508 |
| CE028147 | 2005 | 7 | 24 | 0 | 38 | 48.588 | 9.511 |
| CE028148 | 2005 | 7 | 24 | 0 | 46 | 48.588 | 9.516 |
| CE028149 | 2005 | 7 | 24 | 0 | 57 | 48.588 | 9.522 |
| CE028150 | 2005 | 7 | 24 | 1 | 4 | 48.589 | 9.525 |
| CE028151 | 2005 | 7 | 24 | 1 | 12 | 48.589 | 9.530 |
| CE029152 | 2005 | 7 | 24 | 1 | 58 | 48.593 | 9.507 |
| CE029153 | 2005 | 7 | 24 | 2 | 7 | 48.597 | 9.510 |
| CE029154 | 2005 | 7 | 24 | 2 | 10 | 48.598 | 9.510 |
| CE029155 | 2005 | 7 | 24 | 2 | 19 | 48.602 | 9.513 |
| CE029156 | 2005 | 7 | 24 | 2 | 26 | 48.604 | 9.517 |
| CE029157 | 2005 | 7 | 24 | 2 | 31 | 48.605 | 9.518 |
| CE029158 | 2005 | 7 | 24 | 2 | 39 | 48.608 | 9.520 |
| CE030159 | 2005 | 7 | 24 | 3 | 17 | 48.581 | 9.509 |
| CE030160 | 2005 | 7 | 24 | 3 | 25 | 48.581 | 9.512 |
| CE030161 | 2005 | 7 | 24 | 3 | 33 | 48.582 | 9.513 |
| CE030162 | 2005 | 7 | 24 | 3 | 41 | 48.581 | 9.513 |
| CE030163 | 2005 | 7 | 24 | 3 | 43 | 48.581 | 9.513 |
| CE030164 | 2005 | 7 | 24 | 3 | 50 | 48.581 | 9.513 |
| Jones Bank station 2 series 1 (Prince Madog) | | | | | | | |
| CE031165 | 2005 | 7 | 26 | 13 | 34 | 49.890 | 7.880 |
| CE031166 | 2005 | 7 | 26 | 13 | 38 | 49.890 | 7.879 |
| CE031167 | 2005 | 7 | 26 | 13 | 43 | 49.890 | 7.878 |
| CE031168 | 2005 | 7 | 26 | 13 | 48 | 49.890 | 7.877 |
| CE031169 | 2005 | 7 | 26 | 13 | 48 | 49.890 | 7.877 |
| CE031170 | 2005 | 7 | 26 | 13 | 53 | 49.890 | 7.876 |
| CE031171 | 2005 | 7 | 26 | 13 | 58 | 49.890 | 7.875 |
| CE032172 | 2005 | 7 | 26 | 14 | 32 | 49.892 | 7.882 |
| CE032173 | 2005 | 7 | 26 | 14 | 38 | 49.892 | 7.880 |
| CE032174 | 2005 | 7 | 26 | 14 | 43 | 49.892 | 7.877 |
| CE032175 | 2005 | 7 | 26 | 14 | 49 | 49.891 | 7.874 |
| CE032176 | 2005 | 7 | 26 | 14 | 55 | 49.890 | 7.872 |
| CE032177 | 2005 | 7 | 26 | 15 | 0 | 49.890 | 7.871 |
| CE033178 | 2005 | 7 | 26 | 15 | 31 | 49.892 | 7.874 |
| CE033179 | 2005 | 7 | 26 | 15 | 33 | 49.892 | 7.874 |
| CE033180 | 2005 | 7 | 26 | 15 | 39 | 49.892 | 7.871 |
| CE033181 | 2005 | 7 | 26 | 15 | 50 | 49.892 | 7.866 |
| CE033182 | 2005 | 7 | 26 | 16 | 1 | 49.891 | 7.862 |
| CE034183 | 2005 | 7 | 26 | 16 | 31 | 49.894 | 7.862 |
| CE034184 | 2005 | 7 | 26 | 16 | 36 | 49.894 | 7.860 |
| CE034185 | 2005 | 7 | 26 | 16 | 41 | 49.894 | 7.857 |
| CE034186 | 2005 | 7 | 26 | 16 | 47 | 49.893 | 7.855 |
| CE034187 | 2005 | 7 | 26 | 16 | 53 | 49.891 | 7.853 |
| CE034188 | 2005 | 7 | 26 | 16 | 59 | 49.890 | 7.851 |
| CE035189 | 2005 | 7 | 26 | 17 | 31 | 49.893 | 7.864 |

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|---|---|---|---|---|---|---|---|
| CE035190 | 2005 | 7 | 26 | 17 | 38 | 49.893 | 7.861 |
| CE035191 | 2005 | 7 | 26 | 17 | 44 | 49.893 | 7.859 |
| CE035192 | 2005 | 7 | 26 | 17 | 49 | 49.893 | 7.857 |
| CE035193 | 2005 | 7 | 26 | 17 | 55 | 49.892 | 7.855 |
| CE036194 | 2005 | 7 | 26 | 18 | 33 | 49.891 | 7.870 |
| CE036195 | 2005 | 7 | 26 | 18 | 38 | 49.891 | 7.867 |
| CE036196 | 2005 | 7 | 26 | 18 | 43 | 49.890 | 7.863 |
| CE036197 | 2005 | 7 | 26 | 18 | 48 | 49.890 | 7.859 |
| CE036198 | 2005 | 7 | 26 | 18 | 53 | 49.890 | 7.856 |
| CE036199 | 2005 | 7 | 26 | 19 | 0 | 49.889 | 7.851 |
| CE037200 | 2005 | 7 | 26 | 19 | 39 | 49.896 | 7.864 |
| CE037201 | 2005 | 7 | 26 | 19 | 44 | 49.895 | 7.861 |
| CE037202 | 2005 | 7 | 26 | 19 | 49 | 49.894 | 7.858 |
| CE037203 | 2005 | 7 | 26 | 19 | 55 | 49.893 | 7.854 |
| CE037204 | 2005 | 7 | 26 | 20 | 1 | 49.891 | 7.850 |
| CE038205 | 2005 | 7 | 26 | 21 | 2 | 49.894 | 7.862 |
| CE038206 | 2005 | 7 | 26 | 21 | 7 | 49.892 | 7.859 |
| CE038207 | 2005 | 7 | 26 | 21 | 14 | 49.890 | 7.855 |
| CE038208 | 2005 | 7 | 26 | 21 | 20 | 49.888 | 7.852 |
| CE038209 | 2005 | 7 | 26 | 21 | 26 | 49.886 | 7.849 |
| CE039210 | 2005 | 7 | 26 | 22 | 1 | 49.899 | 7.869 |
| CE039211 | 2005 | 7 | 26 | 22 | 2 | 49.899 | 7.869 |
| CE039212 | 2005 | 7 | 26 | 22 | 8 | 49.896 | 7.865 |
| CE039213 | 2005 | 7 | 26 | 22 | 13 | 49.894 | 7.862 |
| CE039214 | 2005 | 7 | 26 | 22 | 19 | 49.892 | 7.859 |
| CE039215 | 2005 | 7 | 26 | 22 | 19 | 49.892 | 7.859 |
| CE039216 | 2005 | 7 | 26 | 22 | 24 | 49.890 | 7.857 |
| CE039217 | 2005 | 7 | 26 | 22 | 25 | 49.889 | 7.856 |
| CE039218 | 2005 | 7 | 26 | 22 | 32 | 49.886 | 7.853 |
| CE040219 | 2005 | 7 | 26 | 23 | 4 | 49.880 | 7.870 |
| CE040220 | 2005 | 7 | 26 | 23 | 14 | 49.883 | 7.869 |
| CE040221 | 2005 | 7 | 27 | 0 | 2 | 0.000 | 0.000 |
| CE040222 | 2005 | 7 | 27 | 0 | 9 | 0.000 | 0.000 |
| CE040223 | 2005 | 7 | 27 | 0 | 15 | 0.000 | 0.000 |
| CE040224 | 2005 | 7 | 27 | 0 | 22 | 0.000 | 0.000 |
| CE040225 | 2005 | 7 | 27 | 0 | 29 | 0.000 | 0.000 |
| CE040226 | 2005 | 7 | 27 | 0 | 35 | 0.000 | 0.000 |
| CE041227 | 2005 | 7 | 27 | 1 | 3 | 0.000 | 0.000 |
| CE041228 | 2005 | 7 | 27 | 1 | 8 | 0.000 | 0.000 |
| CE041229 | 2005 | 7 | 27 | 1 | 14 | 0.000 | 0.000 |
| CE041230 | 2005 | 7 | 27 | 1 | 20 | 0.000 | 0.000 |
| CE041231 | 2005 | 7 | 27 | 1 | 27 | 0.000 | 0.000 |
| CE042232 | 2005 | 7 | 27 | 2 | 5 | 0.000 | 0.000 |
| CE042233 | 2005 | 7 | 27 | 2 | 11 | 0.000 | 0.000 |
| CE042234 | 2005 | 7 | 27 | 2 | 17 | 0.000 | 0.000 |
| CE042235 | 2005 | 7 | 27 | 2 | 24 | 0.000 | 0.000 |
| CE042236 | 2005 | 7 | 27 | 2 | 32 | 0.000 | 0.000 |
| CE043237 | 2005 | 7 | 27 | 3 | 3 | 49.882 | 7.875 |
| CE043238 | 2005 | 7 | 27 | 3 | 11 | 49.884 | 7.875 |
| CE043239 | 2005 | 7 | 27 | 3 | 17 | 49.886 | 7.874 |
| CE043240 | 2005 | 7 | 27 | 3 | 22 | 49.887 | 7.874 |
| CE043241 | 2005 | 7 | 27 | 3 | 28 | 49.887 | 7.873 |
| CE044243 | 2005 | 7 | 27 | 4 | 9 | 49.887 | 7.863 |
| CE044244 | 2005 | 7 | 27 | 4 | 14 | 49.888 | 7.862 |
| CE044245 | 2005 | 7 | 27 | 4 | 20 | 49.888 | 7.860 |
| CE044246 | 2005 | 7 | 27 | 4 | 26 | 49.888 | 7.858 |

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|---|---|---|---|---|---|---|---|
| CE044247 | 2005 | 7 | 27 | 4 | 31 | 49.888 | 7.856 |
| CE045248 | 2005 | 7 | 27 | 5 | 1 | 49.880 | 7.870 |
| CE045249 | 2005 | 7 | 27 | 5 | 6 | 49.882 | 7.869 |
| CE045250 | 2005 | 7 | 27 | 5 | 13 | 49.885 | 7.868 |
| CE045251 | 2005 | 7 | 27 | 5 | 19 | 49.887 | 7.867 |
| CE045252 | 2005 | 7 | 27 | 5 | 26 | 49.891 | 7.865 |
| CE046253 | 2005 | 7 | 27 | 6 | 0 | 49.905 | 7.875 |
| CE046254 | 2005 | 7 | 27 | 6 | 7 | 49.904 | 7.873 |
| CE046255 | 2005 | 7 | 27 | 6 | 12 | 49.903 | 7.870 |
| CE046256 | 2005 | 7 | 27 | 6 | 15 | 49.903 | 7.869 |
| CE046257 | 2005 | 7 | 27 | 6 | 19 | 49.902 | 7.868 |
| CE046258 | 2005 | 7 | 27 | 6 | 24 | 49.901 | 7.865 |
| CE047259 | 2005 | 7 | 27 | 7 | 0 | 49.900 | 7.876 |
| CE047260 | 2005 | 7 | 27 | 7 | 3 | 49.900 | 7.874 |
| CE047261 | 2005 | 7 | 27 | 7 | 5 | 49.899 | 7.873 |
| CE047262 | 2005 | 7 | 27 | 7 | 10 | 49.899 | 7.871 |
| CE047263 | 2005 | 7 | 27 | 7 | 16 | 49.899 | 7.867 |
| CE047264 | 2005 | 7 | 27 | 7 | 21 | 49.899 | 7.867 |
| CE047265 | 2005 | 7 | 27 | 7 | 26 | 49.899 | 7.867 |
| CE048266 | 2005 | 7 | 27 | 8 | 13 | 0.000 | 0.000 |
| CE048267 | 2005 | 7 | 27 | 8 | 18 | 0.000 | 0.000 |
| CE048268 | 2005 | 7 | 27 | 8 | 24 | 49.895 | 7.858 |
| CE048269 | 2005 | 7 | 27 | 8 | 29 | 49.893 | 7.855 |
| CE049270 | 2005 | 7 | 27 | 9 | 4 | 49.901 | 7.877 |
| CE049271 | 2005 | 7 | 27 | 9 | 8 | 49.900 | 7.875 |
| CE049272 | 2005 | 7 | 27 | 9 | 14 | 49.899 | 7.873 |
| CE049273 | 2005 | 7 | 27 | 9 | 19 | 49.897 | 7.870 |
| CE049274 | 2005 | 7 | 27 | 9 | 24 | 49.895 | 7.868 |
| CE049275 | 2005 | 7 | 27 | 9 | 29 | 49.894 | 7.866 |
| CE050276 | 2005 | 7 | 27 | 9 | 58 | 49.891 | 7.859 |
| CE050277 | 2005 | 7 | 27 | 10 | 4 | 49.894 | 7.860 |
| CE050278 | 2005 | 7 | 27 | 10 | 10 | 49.896 | 7.861 |
| CE050279 | 2005 | 7 | 27 | 10 | 17 | 49.899 | 7.863 |
| CE050280 | 2005 | 7 | 27 | 10 | 22 | 49.901 | 7.865 |
| CE050281 | 2005 | 7 | 27 | 10 | 29 | 49.903 | 7.867 |
| CE051282 | 2005 | 7 | 27 | 10 | 58 | 49.903 | 7.872 |
| CE051283 | 2005 | 7 | 27 | 11 | 3 | 49.901 | 7.871 |
| CE051284 | 2005 | 7 | 27 | 11 | 8 | 49.899 | 7.869 |
| CE051285 | 2005 | 7 | 27 | 11 | 14 | 49.897 | 7.867 |
| CE051286 | 2005 | 7 | 27 | 11 | 20 | 49.895 | 7.865 |
| CE051287 | 2005 | 7 | 27 | 11 | 26 | 49.892 | 7.864 |
| CE051288 | 2005 | 7 | 27 | 11 | 33 | 49.890 | 7.862 |
| CE052289 | 2005 | 7 | 27 | 12 | 3 | 49.890 | 7.866 |
| CE052290 | 2005 | 7 | 27 | 12 | 9 | 49.890 | 7.867 |
| CE052291 | 2005 | 7 | 27 | 12 | 14 | 49.890 | 7.867 |
| CE052292 | 2005 | 7 | 27 | 12 | 19 | 49.891 | 7.868 |
| CE052293 | 2005 | 7 | 27 | 12 | 25 | 49.892 | 7.868 |
| CE052294 | 2005 | 7 | 27 | 12 | 31 | 49.892 | 7.869 |
| CE053295 | 2005 | 7 | 27 | 13 | 1 | 49.884 | 7.864 |
| CE053296 | 2005 | 7 | 27 | 13 | 6 | 49.882 | 7.863 |
| CE053297 | 2005 | 7 | 27 | 13 | 11 | 49.881 | 7.862 |
| CE053298 | 2005 | 7 | 27 | 13 | 17 | 49.880 | 7.860 |
| CE053299 | 2005 | 7 | 27 | 13 | 23 | 49.878 | 7.859 |
| CE053300 | 2005 | 7 | 27 | 13 | 28 | 49.877 | 7.858 |
| CE054302 | 2005 | 7 | 27 | 14 | 6 | 49.890 | 7.873 |
| CE054303 | 2005 | 7 | 27 | 14 | 12 | 49.891 | 7.872 |

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|---|---|---|---|---|---|---|---|
| CE054304 | 2005 | 7 | 27 | 14 | 17 | 49.892 | 7.870 |
| CE054305 | 2005 | 7 | 27 | 14 | 17 | 49.892 | 7.870 |
| CE054306 | 2005 | 7 | 27 | 14 | 21 | 49.893 | 7.869 |
| CE054307 | 2005 | 7 | 27 | 14 | 27 | 49.894 | 7.867 |
| CE054308 | 2005 | 7 | 27 | 14 | 33 | 49.895 | 7.865 |
| First attempt at the Jones bank transect, aborted (Prince Madog) | | | | | | | |
| CE056313 | 2005 | 7 | 27 | 22 | 10 | 49.940 | 7.766 |
| CE057314 | 2005 | 7 | 28 | 0 | 11 | 49.851 | 7.907 |
| CE057315 | 2005 | 7 | 28 | 0 | 18 | 49.852 | 7.904 |
| CE057316 | 2005 | 7 | 28 | 0 | 24 | 49.854 | 7.902 |
| CE057317 | 2005 | 7 | 28 | 0 | 24 | 49.854 | 7.902 |
| CE058318 | 2005 | 7 | 28 | 1 | 18 | 49.872 | 7.874 |
| CE058319 | 2005 | 7 | 28 | 1 | 24 | 49.872 | 7.873 |
| CE058320 | 2005 | 7 | 28 | 1 | 30 | 49.873 | 7.871 |
| CE058321 | 2005 | 7 | 28 | 1 | 36 | 49.873 | 7.870 |
| CE058322 | 2005 | 7 | 28 | 1 | 42 | 49.874 | 7.868 |
| CE059323 | 2005 | 7 | 28 | 2 | 40 | 49.896 | 7.833 |
| CE059324 | 2005 | 7 | 28 | 2 | 46 | 49.897 | 7.831 |
| CE059325 | 2005 | 7 | 28 | 2 | 53 | 49.898 | 7.828 |
| CE059326 | 2005 | 7 | 28 | 3 | 0 | 49.900 | 7.825 |
| CE059327 | 2005 | 7 | 28 | 3 | 6 | 49.901 | 7.823 |
| CE060328 | 2005 | 7 | 28 | 3 | 56 | 49.917 | 7.792 |
| CE060329 | 2005 | 7 | 28 | 4 | 4 | 49.919 | 7.789 |
| CE060330 | 2005 | 7 | 28 | 4 | 4 | 49.919 | 7.789 |
| CE060331 | 2005 | 7 | 28 | 4 | 4 | 49.919 | 7.788 |
| Jones Bank station 2 series 2 (Prince Madog) | | | | | | | |
| CE061333 | 2005 | 7 | 31 | 3 | 3 | 49.891 | 7.872 |
| CE062335 | 2005 | 7 | 31 | 3 | 30 | 49.895 | 7.867 |
| CE062336 | 2005 | 7 | 31 | 3 | 36 | 49.892 | 7.868 |
| CE062337 | 2005 | 7 | 31 | 3 | 42 | 49.889 | 7.870 |
| CE062338 | 2005 | 7 | 31 | 3 | 48 | 49.887 | 7.871 |
| CE062339 | 2005 | 7 | 31 | 3 | 53 | 49.884 | 7.872 |
| CE062340 | 2005 | 7 | 31 | 3 | 59 | 49.885 | 7.873 |
| CE063341 | 2005 | 7 | 31 | 4 | 30 | 49.898 | 7.865 |
| CE063342 | 2005 | 7 | 31 | 4 | 36 | 49.895 | 7.866 |
| CE063343 | 2005 | 7 | 31 | 4 | 42 | 49.892 | 7.866 |
| CE063344 | 2005 | 7 | 31 | 4 | 48 | 49.889 | 7.866 |
| CE063345 | 2005 | 7 | 31 | 4 | 54 | 49.885 | 7.866 |
| CE063346 | 2005 | 7 | 31 | 5 | 1 | 49.882 | 7.866 |
| CE064347 | 2005 | 7 | 31 | 5 | 30 | 49.888 | 7.865 |
| CE064348 | 2005 | 7 | 31 | 5 | 37 | 49.890 | 7.864 |
| CE064349 | 2005 | 7 | 31 | 5 | 43 | 49.892 | 7.864 |
| CE064350 | 2005 | 7 | 31 | 5 | 49 | 49.894 | 7.863 |
| CE064351 | 2005 | 7 | 31 | 5 | 55 | 49.897 | 7.863 |
| CE065352 | 2005 | 7 | 31 | 6 | 32 | 49.898 | 7.860 |
| CE065353 | 2005 | 7 | 31 | 6 | 37 | 49.898 | 7.863 |
| CE065354 | 2005 | 7 | 31 | 6 | 43 | 49.898 | 7.865 |
| CE065355 | 2005 | 7 | 31 | 6 | 48 | 49.898 | 7.868 |
| CE065356 | 2005 | 7 | 31 | 6 | 53 | 49.897 | 7.870 |
| CE065357 | 2005 | 7 | 31 | 6 | 58 | 49.897 | 7.872 |
| CE066358 | 2005 | 7 | 31 | 7 | 31 | 49.897 | 7.883 |
| CE066359 | 2005 | 7 | 31 | 7 | 36 | 49.898 | 7.879 |
| CE066360 | 2005 | 7 | 31 | 7 | 43 | 49.898 | 7.875 |
| CE066361 | 2005 | 7 | 31 | 7 | 49 | 49.898 | 7.871 |
| CE066362 | 2005 | 7 | 31 | 7 | 55 | 49.898 | 7.867 |
| CE066363 | 2005 | 7 | 31 | 8 | 0 | 49.898 | 7.863 |

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|---|---|---|---|---|---|---|---|
| CE067364 | 2005 | 7 | 31 | 8 | 29 | 49.898 | 7.859 |
| CE067365 | 2005 | 7 | 31 | 8 | 34 | 49.898 | 7.861 |
| CE067366 | 2005 | 7 | 31 | 8 | 40 | 49.898 | 7.864 |
| CE067367 | 2005 | 7 | 31 | 8 | 46 | 49.898 | 7.867 |
| CE067368 | 2005 | 7 | 31 | 8 | 52 | 49.898 | 7.869 |
| CE067369 | 2005 | 7 | 31 | 8 | 58 | 49.898 | 7.871 |
| CE068370 | 2005 | 7 | 31 | 9 | 30 | 49.898 | 7.880 |
| CE068371 | 2005 | 7 | 31 | 9 | 32 | 49.898 | 7.878 |
| CE068372 | 2005 | 7 | 31 | 9 | 36 | 49.898 | 7.875 |
| CE068373 | 2005 | 7 | 31 | 9 | 42 | 49.898 | 7.871 |
| CE068374 | 2005 | 7 | 31 | 9 | 46 | 49.898 | 7.868 |
| CE068375 | 2005 | 7 | 31 | 9 | 52 | 49.898 | 7.864 |
| CE068376 | 2005 | 7 | 31 | 9 | 58 | 49.898 | 7.859 |
| CE069377 | 2005 | 7 | 31 | 10 | 31 | 49.894 | 7.847 |
| CE069378 | 2005 | 7 | 31 | 10 | 38 | 49.894 | 7.850 |
| CE069379 | 2005 | 7 | 31 | 10 | 43 | 49.894 | 7.853 |
| CE069380 | 2005 | 7 | 31 | 10 | 50 | 49.894 | 7.854 |
| CE069381 | 2005 | 7 | 31 | 10 | 56 | 49.895 | 7.857 |
| CE070382 | 2005 | 7 | 31 | 11 | 32 | 49.901 | 7.869 |
| CE070383 | 2005 | 7 | 31 | 11 | 36 | 49.901 | 7.871 |
| CE070384 | 2005 | 7 | 31 | 11 | 41 | 49.901 | 7.874 |
| CE070385 | 2005 | 7 | 31 | 11 | 47 | 49.901 | 7.877 |
| CE070386 | 2005 | 7 | 31 | 11 | 52 | 49.898 | 7.879 |
| CE070387 | 2005 | 7 | 31 | 11 | 58 | 49.894 | 7.877 |
| CE071388 | 2005 | 7 | 31 | 12 | 31 | 49.889 | 7.855 |
| CE071389 | 2005 | 7 | 31 | 12 | 31 | 49.889 | 7.855 |
| CE071390 | 2005 | 7 | 31 | 12 | 34 | 49.891 | 7.854 |
| CE071391 | 2005 | 7 | 31 | 12 | 37 | 49.892 | 7.854 |
| CE071392 | 2005 | 7 | 31 | 12 | 43 | 49.894 | 7.853 |
| CE071393 | 2005 | 7 | 31 | 12 | 49 | 49.897 | 7.853 |
| CE071394 | 2005 | 7 | 31 | 12 | 54 | 49.899 | 7.852 |
| CE071395 | 2005 | 7 | 31 | 13 | 0 | 49.901 | 7.852 |
| CE072396 | 2005 | 7 | 31 | 13 | 30 | 49.900 | 7.868 |
| CE072397 | 2005 | 7 | 31 | 13 | 35 | 49.899 | 7.871 |
| CE072398 | 2005 | 7 | 31 | 13 | 41 | 49.898 | 7.876 |
| CE072399 | 2005 | 7 | 31 | 13 | 46 | 49.897 | 7.880 |
| CE072400 | 2005 | 7 | 31 | 13 | 52 | 49.896 | 7.885 |
| CE072401 | 2005 | 7 | 31 | 13 | 57 | 49.895 | 7.889 |
| CE072402 | 2005 | 7 | 31 | 14 | 3 | 49.894 | 7.894 |
| CE073403 | 2005 | 7 | 31 | 14 | 30 | 49.896 | 7.890 |
| CE073404 | 2005 | 7 | 31 | 14 | 36 | 49.896 | 7.887 |
| CE073405 | 2005 | 7 | 31 | 14 | 41 | 49.897 | 7.884 |
| CE073406 | 2005 | 7 | 31 | 14 | 46 | 49.897 | 7.881 |
| CE073407 | 2005 | 7 | 31 | 14 | 51 | 49.898 | 7.878 |
| CE073408 | 2005 | 7 | 31 | 14 | 56 | 49.898 | 7.875 |
| CE074409 | 2005 | 7 | 31 | 15 | 28 | 49.903 | 7.857 |
| CE074410 | 2005 | 7 | 31 | 15 | 35 | 49.904 | 7.854 |
| CE074411 | 2005 | 7 | 31 | 15 | 41 | 49.904 | 7.850 |
| CE074412 | 2005 | 7 | 31 | 15 | 47 | 49.903 | 7.845 |
| CE074413 | 2005 | 7 | 31 | 15 | 53 | 49.903 | 7.841 |
| CE074414 | 2005 | 7 | 31 | 15 | 58 | 49.903 | 7.838 |
| CE075415 | 2005 | 7 | 31 | 16 | 30 | 49.901 | 7.850 |
| CE075416 | 2005 | 7 | 31 | 16 | 36 | 49.901 | 7.855 |
| CE075417 | 2005 | 7 | 31 | 16 | 41 | 49.900 | 7.860 |
| CE075418 | 2005 | 7 | 31 | 16 | 46 | 49.900 | 7.865 |
| CE075419 | 2005 | 7 | 31 | 16 | 52 | 49.900 | 7.869 |

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|---|---|---|---|---|---|---|---|
| CE075420 | 2005 | 7 | 31 | 16 | 57 | 49.900 | 7.873 |
| CE076421 | 2005 | 7 | 31 | 17 | 29 | 49.898 | 7.878 |
| CE076422 | 2005 | 7 | 31 | 17 | 34 | 49.900 | 7.876 |
| CE076423 | 2005 | 7 | 31 | 17 | 39 | 49.901 | 7.874 |
| CE076424 | 2005 | 7 | 31 | 17 | 44 | 49.903 | 7.873 |
| CE076425 | 2005 | 7 | 31 | 17 | 49 | 49.904 | 7.872 |
| CE076426 | 2005 | 7 | 31 | 17 | 54 | 49.906 | 7.870 |
| CE077427 | 2005 | 7 | 31 | 18 | 34 | 49.895 | 7.865 |
| CE077428 | 2005 | 7 | 31 | 18 | 39 | 49.897 | 7.866 |
| CE077429 | 2005 | 7 | 31 | 18 | 45 | 49.900 | 7.867 |
| CE077430 | 2005 | 7 | 31 | 18 | 50 | 49.902 | 7.867 |
| CE077431 | 2005 | 7 | 31 | 18 | 56 | 49.904 | 7.868 |
| CE077432 | 2005 | 7 | 31 | 19 | 1 | 49.906 | 7.868 |
| CE078433 | 2005 | 7 | 31 | 19 | 31 | 49.891 | 7.864 |
| CE078434 | 2005 | 7 | 31 | 19 | 37 | 49.894 | 7.865 |
| CE078435 | 2005 | 7 | 31 | 19 | 44 | 49.897 | 7.866 |
| CE078436 | 2005 | 7 | 31 | 19 | 50 | 49.900 | 7.866 |
| CE078437 | 2005 | 7 | 31 | 19 | 56 | 49.903 | 7.867 |
| CE078438 | 2005 | 7 | 31 | 20 | 2 | 49.906 | 7.867 |
| CE079439 | 2005 | 7 | 31 | 20 | 29 | 49.888 | 7.866 |
| CE079440 | 2005 | 7 | 31 | 20 | 35 | 49.890 | 7.865 |
| CE079441 | 2005 | 7 | 31 | 20 | 40 | 49.892 | 7.865 |
| CE079442 | 2005 | 7 | 31 | 20 | 46 | 49.895 | 7.864 |
| CE079443 | 2005 | 7 | 31 | 20 | 53 | 49.897 | 7.864 |
| CE079444 | 2005 | 7 | 31 | 20 | 59 | 49.900 | 7.863 |
| CE080445 | 2005 | 7 | 31 | 21 | 30 | 49.888 | 7.867 |
| CE080446 | 2005 | 7 | 31 | 21 | 36 | 49.890 | 7.866 |
| CE080447 | 2005 | 7 | 31 | 21 | 38 | 49.892 | 7.865 |
| CE080448 | 2005 | 7 | 31 | 21 | 44 | 49.894 | 7.864 |
| CE080449 | 2005 | 7 | 31 | 21 | 50 | 49.896 | 7.863 |
| CE080450 | 2005 | 7 | 31 | 21 | 56 | 49.899 | 7.861 |
| CE080451 | 2005 | 7 | 31 | 22 | 2 | 49.902 | 7.860 |
| CE081452 | 2005 | 7 | 31 | 22 | 28 | 49.901 | 7.858 |
| CE081453 | 2005 | 7 | 31 | 22 | 29 | 49.901 | 7.859 |
| CE081454 | 2005 | 7 | 31 | 22 | 32 | 49.900 | 7.859 |
| CE081455 | 2005 | 7 | 31 | 22 | 36 | 49.898 | 7.860 |
| CE081456 | 2005 | 7 | 31 | 22 | 42 | 49.896 | 7.862 |
| CE081457 | 2005 | 7 | 31 | 22 | 48 | 49.893 | 7.863 |
| CE081458 | 2005 | 7 | 31 | 22 | 54 | 49.891 | 7.865 |
| CE082459 | 2005 | 7 | 31 | 23 | 31 | 49.890 | 7.863 |
| CE082460 | 2005 | 7 | 31 | 23 | 37 | 49.892 | 7.863 |
| CE082461 | 2005 | 7 | 31 | 23 | 43 | 49.895 | 7.862 |
| CE082462 | 2005 | 7 | 31 | 23 | 49 | 49.898 | 7.861 |
| CE082463 | 2005 | 7 | 31 | 23 | 54 | 49.900 | 7.861 |
| CE082464 | 2005 | 7 | 31 | 23 | 59 | 49.902 | 7.860 |
| CE082465 | 2005 | 8 | 1 | 0 | 32 | 49.896 | 7.856 |
| CE082466 | 2005 | 8 | 1 | 0 | 37 | 49.893 | 7.855 |
| CE082467 | 2005 | 8 | 1 | 0 | 44 | 49.890 | 7.854 |
| CE082468 | 2005 | 8 | 1 | 0 | 50 | 49.887 | 7.854 |
| CE082469 | 2005 | 8 | 1 | 0 | 56 | 49.885 | 7.853 |
| CE082470 | 2005 | 8 | 1 | 1 | 2 | 49.882 | 7.852 |
| CE084471 | 2005 | 8 | 1 | 1 | 31 | 49.885 | 7.850 |
| CE084472 | 2005 | 8 | 1 | 1 | 36 | 49.887 | 7.849 |
| CE084473 | 2005 | 8 | 1 | 1 | 43 | 49.890 | 7.849 |
| CE084474 | 2005 | 8 | 1 | 1 | 48 | 49.893 | 7.849 |
| CE084475 | 2005 | 8 | 1 | 1 | 54 | 49.895 | 7.849 |

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|---|---|---|---|---|---|---|---|
| CE084476 | 2005 | 8 | 1 | 2 | 0 | 49.898 | 7.849 |
| CE084477 | 2005 | 8 | 1 | 2 | 6 | 49.901 | 7.849 |
| CE085478 | 2005 | 8 | 1 | 2 | 35 | 49.907 | 7.851 |
| CE085479 | 2005 | 8 | 1 | 2 | 41 | 49.904 | 7.850 |
| CE085480 | 2005 | 8 | 1 | 2 | 46 | 49.902 | 7.849 |
| CE085481 | 2005 | 8 | 1 | 2 | 51 | 49.899 | 7.848 |
| CE085482 | 2005 | 8 | 1 | 2 | 57 | 49.897 | 7.847 |
| CE085483 | 2005 | 8 | 1 | 3 | 1 | 49.894 | 7.847 |
| CE086484 | 2005 | 8 | 1 | 4 | 6 | 49.883 | 7.845 |
| CE086485 | 2005 | 8 | 1 | 4 | 10 | 49.885 | 7.846 |
| CE086486 | 2005 | 8 | 1 | 4 | 13 | 49.887 | 7.847 |
| CE086487 | 2005 | 8 | 1 | 4 | 19 | 49.890 | 7.848 |
| CE086488 | 2005 | 8 | 1 | 4 | 26 | 49.894 | 7.849 |
| CE086489 | 2005 | 8 | 1 | 4 | 33 | 49.897 | 7.850 |
| CE086490 | 2005 | 8 | 1 | 4 | 39 | 49.901 | 7.852 |
| CE086491 | 2005 | 8 | 1 | 4 | 46 | 49.904 | 7.854 |
| CE086492 | 2005 | 8 | 1 | 4 | 52 | 49.906 | 7.858 |
| OB station (Prince Madog) | | | | | | | |
| CE087493 | 2005 | 8 | 1 | 13 | 2 | 49.747 | 7.656 |
| CE087494 | 2005 | 8 | 1 | 13 | 8 | 49.750 | 7.658 |
| CE087495 | 2005 | 8 | 1 | 13 | 15 | 49.753 | 7.661 |
| CE087496 | 2005 | 8 | 1 | 13 | 21 | 49.755 | 7.662 |
| CE087497 | 2005 | 8 | 1 | 13 | 27 | 49.758 | 7.664 |
| CE087498 | 2005 | 8 | 1 | 13 | 32 | 49.760 | 7.665 |
| CE088499 | 2005 | 8 | 1 | 14 | 0 | 49.773 | 7.672 |
| CE088500 | 2005 | 8 | 1 | 14 | 5 | 49.775 | 7.674 |
| CE088501 | 2005 | 8 | 1 | 14 | 11 | 49.778 | 7.675 |
| CE088502 | 2005 | 8 | 1 | 14 | 17 | 49.780 | 7.677 |
| CE088503 | 2005 | 8 | 1 | 14 | 23 | 49.782 | 7.679 |
| CE088504 | 2005 | 8 | 1 | 14 | 29 | 49.785 | 7.680 |
| CE089505 | 2005 | 8 | 1 | 15 | 0 | 49.779 | 7.679 |
| CE089506 | 2005 | 8 | 1 | 15 | 6 | 49.777 | 7.678 |
| CE089507 | 2005 | 8 | 1 | 15 | 11 | 49.775 | 7.676 |
| CE089508 | 2005 | 8 | 1 | 15 | 17 | 49.773 | 7.675 |
| CE089509 | 2005 | 8 | 1 | 15 | 23 | 49.770 | 7.674 |
| CE089510 | 2005 | 8 | 1 | 15 | 28 | 49.768 | 7.672 |
| CE090511 | 2005 | 8 | 1 | 15 | 59 | 49.760 | 7.671 |
| CE090512 | 2005 | 8 | 1 | 16 | 5 | 49.761 | 7.672 |
| CE090513 | 2005 | 8 | 1 | 16 | 10 | 49.762 | 7.672 |
| CE090514 | 2005 | 8 | 1 | 16 | 15 | 49.763 | 7.673 |
| CE090515 | 2005 | 8 | 1 | 16 | 21 | 49.765 | 7.674 |
| CE090516 | 2005 | 8 | 1 | 16 | 26 | 49.766 | 7.675 |
| CE091517 | 2005 | 8 | 1 | 17 | 1 | 49.767 | 7.678 |
| CE091518 | 2005 | 8 | 1 | 17 | 6 | 49.764 | 7.677 |
| CE091519 | 2005 | 8 | 1 | 17 | 12 | 49.762 | 7.675 |
| CE091520 | 2005 | 8 | 1 | 17 | 17 | 49.759 | 7.674 |
| CE091521 | 2005 | 8 | 1 | 17 | 23 | 49.757 | 7.673 |
| CE091522 | 2005 | 8 | 1 | 17 | 28 | 49.754 | 7.671 |
| CE092523 | 2005 | 8 | 1 | 18 | 4 | 49.744 | 7.667 |
| CE092524 | 2005 | 8 | 1 | 18 | 10 | 49.746 | 7.666 |
| CE092525 | 2005 | 8 | 1 | 18 | 16 | 49.748 | 7.665 |
| CE092526 | 2005 | 8 | 1 | 18 | 21 | 49.749 | 7.665 |
| CE092527 | 2005 | 8 | 1 | 18 | 27 | 49.750 | 7.664 |
| CE092528 | 2005 | 8 | 1 | 18 | 32 | 49.751 | 7.664 |
| CE093529 | 2005 | 8 | 1 | 19 | 0 | 49.756 | 7.665 |
| CE093530 | 2005 | 8 | 1 | 19 | 6 | 49.757 | 7.666 |

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|---|---|---|---|---|---|---|---|
| CE093531 | 2005 | 8 | 1 | 19 | 12 | 49.759 | 7.667 |
| CE093532 | 2005 | 8 | 1 | 19 | 19 | 49.760 | 7.668 |
| CE093533 | 2005 | 8 | 1 | 19 | 25 | 49.762 | 7.669 |
| CE093534 | 2005 | 8 | 1 | 19 | 26 | 49.762 | 7.669 |
| CE093535 | 2005 | 8 | 1 | 19 | 32 | 49.763 | 7.670 |
| CE094536 | 2005 | 8 | 1 | 20 | 2 | 49.762 | 7.676 |
| CE094537 | 2005 | 8 | 1 | 20 | 9 | 49.758 | 7.675 |
| CE094538 | 2005 | 8 | 1 | 20 | 15 | 49.755 | 7.673 |
| CE094539 | 2005 | 8 | 1 | 20 | 22 | 49.752 | 7.672 |
| CE094540 | 2005 | 8 | 1 | 20 | 28 | 49.749 | 7.671 |
| CE095541 | 2005 | 8 | 1 | 21 | 1 | 49.743 | 7.672 |
| CE095542 | 2005 | 8 | 1 | 21 | 8 | 49.747 | 7.672 |
| CE095543 | 2005 | 8 | 1 | 21 | 14 | 49.749 | 7.673 |
| CE095544 | 2005 | 8 | 1 | 21 | 20 | 49.751 | 7.673 |
| CE095545 | 2005 | 8 | 1 | 21 | 26 | 49.753 | 7.674 |
| CE095546 | 2005 | 8 | 1 | 21 | 32 | 49.755 | 7.674 |
| CE096547 | 2005 | 8 | 1 | 22 | 0 | 49.758 | 7.677 |
| CE096548 | 2005 | 8 | 1 | 22 | 7 | 49.756 | 7.674 |
| CE096549 | 2005 | 8 | 1 | 22 | 14 | 49.754 | 7.671 |
| CE096550 | 2005 | 8 | 1 | 22 | 20 | 49.753 | 7.668 |
| CE096551 | 2005 | 8 | 1 | 22 | 27 | 49.752 | 7.665 |
| CE096552 | 2005 | 8 | 1 | 22 | 34 | 49.750 | 7.661 |
| CE097553 | 2005 | 8 | 1 | 23 | 0 | 49.751 | 7.659 |
| CE097554 | 2005 | 8 | 1 | 23 | 6 | 49.753 | 7.662 |
| CE097555 | 2005 | 8 | 1 | 23 | 13 | 49.755 | 7.665 |
| CE097556 | 2005 | 8 | 1 | 23 | 19 | 49.756 | 7.668 |
| CE097557 | 2005 | 8 | 1 | 23 | 25 | 49.758 | 7.671 |
| CE097558 | 2005 | 8 | 1 | 23 | 31 | 49.759 | 7.674 |
| CE098559 | 2005 | 8 | 2 | 0 | 1 | 49.756 | 7.664 |
| CE098560 | 2005 | 8 | 2 | 0 | 7 | 49.754 | 7.658 |
| CE098561 | 2005 | 8 | 2 | 0 | 14 | 49.753 | 7.654 |
| CE098562 | 2005 | 8 | 2 | 0 | 20 | 49.752 | 7.650 |
| CE098563 | 2005 | 8 | 2 | 0 | 26 | 49.751 | 7.646 |
| CE098564 | 2005 | 8 | 2 | 0 | 32 | 49.750 | 7.642 |
| CE099565 | 2005 | 8 | 2 | 1 | 1 | 49.749 | 7.651 |
| CE099566 | 2005 | 8 | 2 | 1 | 8 | 49.750 | 7.657 |
| CE099567 | 2005 | 8 | 2 | 1 | 15 | 49.750 | 7.662 |
| CE099568 | 2005 | 8 | 2 | 1 | 21 | 49.750 | 7.667 |
| CE099569 | 2005 | 8 | 2 | 1 | 29 | 49.750 | 7.672 |
| CE099570 | 2005 | 8 | 2 | 1 | 36 | 49.749 | 7.676 |
| CE100571 | 2005 | 8 | 2 | 2 | 1 | 49.750 | 7.691 |
| CE100572 | 2005 | 8 | 2 | 2 | 3 | 49.751 | 7.691 |
| CE100573 | 2005 | 8 | 2 | 2 | 9 | 49.754 | 7.692 |
| CE100574 | 2005 | 8 | 2 | 2 | 15 | 49.757 | 7.693 |
| CE100575 | 2005 | 8 | 2 | 2 | 22 | 49.761 | 7.694 |
| CE100576 | 2005 | 8 | 2 | 2 | 28 | 49.763 | 7.694 |
| CE100577 | 2005 | 8 | 2 | 2 | 33 | 49.766 | 7.695 |
| CE101578 | 2005 | 8 | 2 | 3 | 4 | 49.774 | 7.683 |
| CE101579 | 2005 | 8 | 2 | 3 | 11 | 49.775 | 7.677 |
| CE101580 | 2005 | 8 | 2 | 3 | 17 | 49.775 | 7.670 |
| CE101581 | 2005 | 8 | 2 | 3 | 24 | 49.776 | 7.663 |
| CE101582 | 2005 | 8 | 2 | 3 | 31 | 49.776 | 7.657 |
| CE101583 | 2005 | 8 | 2 | 3 | 37 | 49.776 | 7.651 |
| CE102584 | 2005 | 8 | 2 | 4 | 0 | 49.768 | 7.635 |
| CE102585 | 2005 | 8 | 2 | 4 | 5 | 49.767 | 7.634 |
| CE102586 | 2005 | 8 | 2 | 4 | 10 | 49.765 | 7.632 |

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|---|---|---|---|---|---|---|---|
| CE102587 | 2005 | 8 | 2 | 4 | 15 | 49.764 | 7.630 |
| CE102588 | 2005 | 8 | 2 | 4 | 21 | 49.762 | 7.628 |
| CE102589 | 2005 | 8 | 2 | 4 | 27 | 49.759 | 7.626 |
| CE103590 | 2005 | 8 | 2 | 5 | 0 | 49.744 | 7.618 |
| CE103591 | 2005 | 8 | 2 | 5 | 4 | 49.744 | 7.620 |
| CE103592 | 2005 | 8 | 2 | 5 | 10 | 49.745 | 7.622 |
| CE103593 | 2005 | 8 | 2 | 5 | 15 | 49.745 | 7.625 |
| CE103594 | 2005 | 8 | 2 | 5 | 20 | 49.746 | 7.628 |
| CE103595 | 2005 | 8 | 2 | 5 | 26 | 49.746 | 7.631 |
| CE104596 | 2005 | 8 | 2 | 5 | 59 | 49.749 | 7.650 |
| CE104597 | 2005 | 8 | 2 | 6 | 5 | 49.749 | 7.653 |
| CE104598 | 2005 | 8 | 2 | 6 | 10 | 49.749 | 7.657 |
| CE104599 | 2005 | 8 | 2 | 6 | 16 | 49.750 | 7.661 |
| CE104600 | 2005 | 8 | 2 | 6 | 22 | 49.750 | 7.665 |
| CE104601 | 2005 | 8 | 2 | 6 | 28 | 49.750 | 7.669 |
| CE105602 | 2005 | 8 | 2 | 7 | 1 | 49.750 | 7.675 |
| CE105603 | 2005 | 8 | 2 | 7 | 8 | 49.753 | 7.675 |
| CE105604 | 2005 | 8 | 2 | 7 | 14 | 49.755 | 7.675 |
| CE105605 | 2005 | 8 | 2 | 7 | 21 | 49.758 | 7.676 |
| CE105607 | 2005 | 8 | 2 | 7 | 32 | 49.761 | 7.676 |
| CE106608 | 2005 | 8 | 2 | 8 | 1 | 49.761 | 7.673 |
| CE106609 | 2005 | 8 | 2 | 8 | 7 | 49.760 | 7.672 |
| CE106610 | 2005 | 8 | 2 | 8 | 13 | 49.758 | 7.670 |
| CE106611 | 2005 | 8 | 2 | 8 | 19 | 49.757 | 7.669 |
| CE106612 | 2005 | 8 | 2 | 8 | 25 | 49.756 | 7.667 |
| CE107613 | 2005 | 8 | 2 | 9 | 1 | 49.744 | 7.649 |
| CE107614 | 2005 | 8 | 2 | 9 | 7 | 49.745 | 7.651 |
| CE107615 | 2005 | 8 | 2 | 9 | 12 | 49.745 | 7.653 |
| CE107616 | 2005 | 8 | 2 | 9 | 18 | 49.745 | 7.656 |
| CE107617 | 2005 | 8 | 2 | 9 | 24 | 49.745 | 7.658 |
| CE108618 | 2005 | 8 | 2 | 10 | 1 | 49.749 | 7.672 |
| CE108619 | 2005 | 8 | 2 | 10 | 6 | 49.750 | 7.674 |
| CE108620 | 2005 | 8 | 2 | 10 | 11 | 49.751 | 7.675 |
| CE108621 | 2005 | 8 | 2 | 10 | 17 | 49.752 | 7.677 |
| CE108622 | 2005 | 8 | 2 | 10 | 23 | 49.753 | 7.679 |
| CE108623 | 2005 | 8 | 2 | 10 | 29 | 49.754 | 7.682 |
| CE109624 | 2005 | 8 | 2 | 11 | 0 | 49.755 | 7.672 |
| CE109625 | 2005 | 8 | 2 | 11 | 6 | 49.754 | 7.668 |
| CE109626 | 2005 | 8 | 2 | 11 | 12 | 49.753 | 7.664 |
| CE109627 | 2005 | 8 | 2 | 11 | 18 | 49.753 | 7.661 |
| CE109628 | 2005 | 8 | 2 | 11 | 24 | 49.752 | 7.657 |
| CE110629 | 2005 | 8 | 2 | 12 | 4 | 49.761 | 7.640 |
| CE110630 | 2005 | 8 | 2 | 12 | 10 | 49.761 | 7.643 |
| CE110631 | 2005 | 8 | 2 | 12 | 16 | 49.761 | 7.647 |
| CE110632 | 2005 | 8 | 2 | 12 | 23 | 49.761 | 7.651 |
| CE110633 | 2005 | 8 | 2 | 12 | 29 | 49.762 | 7.655 |
| CE110634 | 2005 | 8 | 2 | 12 | 35 | 49.762 | 7.659 |
| CE111635 | 2005 | 8 | 2 | 13 | 2 | 49.756 | 7.654 |
| CE111636 | 2005 | 8 | 2 | 13 | 9 | 49.753 | 7.651 |
| CE111637 | 2005 | 8 | 2 | 13 | 15 | 49.751 | 7.647 |
| CE111638 | 2005 | 8 | 2 | 13 | 21 | 49.748 | 7.644 |
| CE111639 | 2005 | 8 | 2 | 13 | 28 | 49.746 | 7.640 |
| CE111640 | 2005 | 8 | 2 | 13 | 35 | 49.744 | 7.637 |
| CE111641 | 2005 | 8 | 2 | 13 | 41 | 49.741 | 7.633 |
| Jones Bank transect (Prince Madog) | | | | | | | |
| CE112642 | 2005 | 8 | 2 | 18 | 55 | 49.852 | 7.918 |

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|---|---|---|---|---|---|---|---|
| CE112643 | 2005 | 8 | 2 | 18 | 56 | 49.853 | 7.917 |
| CE112644 | 2005 | 8 | 2 | 19 | 1 | 49.854 | 7.916 |
| CE112645 | 2005 | 8 | 2 | 19 | 7 | 49.855 | 7.915 |
| CE113646 | 2005 | 8 | 2 | 19 | 32 | 49.884 | 7.898 |
| CE113647 | 2005 | 8 | 2 | 19 | 37 | 49.885 | 7.897 |
| CE113648 | 2005 | 8 | 2 | 19 | 42 | 49.887 | 7.896 |
| CE114649 | 2005 | 8 | 2 | 20 | 9 | 49.912 | 7.855 |
| CE114650 | 2005 | 8 | 2 | 20 | 14 | 49.913 | 7.853 |
| CE114651 | 2005 | 8 | 2 | 20 | 20 | 49.914 | 7.852 |
| CE115652 | 2005 | 8 | 2 | 20 | 42 | 49.934 | 7.818 |
| CE115653 | 2005 | 8 | 2 | 20 | 48 | 49.935 | 7.815 |
| CE115654 | 2005 | 8 | 2 | 20 | 55 | 49.936 | 7.813 |
| CE116655 | 2005 | 8 | 2 | 21 | 18 | 49.956 | 7.774 |
| CE116656 | 2005 | 8 | 2 | 21 | 24 | 49.957 | 7.773 |
| CE116657 | 2005 | 8 | 2 | 21 | 29 | 49.957 | 7.772 |
| CE117658 | 2005 | 8 | 2 | 22 | 2 | 49.937 | 7.809 |
| CE117659 | 2005 | 8 | 2 | 22 | 7 | 49.935 | 7.812 |
| CE117660 | 2005 | 8 | 2 | 22 | 13 | 49.933 | 7.817 |
| CE118661 | 2005 | 8 | 2 | 22 | 38 | 49.916 | 7.847 |
| CE118662 | 2005 | 8 | 2 | 22 | 43 | 49.915 | 7.849 |
| CE118663 | 2005 | 8 | 2 | 22 | 49 | 49.913 | 7.853 |
| CE119664 | 2005 | 8 | 2 | 23 | 19 | 49.894 | 7.889 |
| CE119665 | 2005 | 8 | 2 | 23 | 24 | 49.893 | 7.894 |
| CE119666 | 2005 | 8 | 2 | 23 | 28 | 49.892 | 7.897 |
| CE119667 | 2005 | 8 | 2 | 23 | 33 | 49.890 | 7.901 |
| CE119668 | 2005 | 8 | 2 | 23 | 38 | 49.889 | 7.905 |
| CE120669 | 2005 | 8 | 3 | 0 | 6 | 49.867 | 7.936 |
| CE120670 | 2005 | 8 | 3 | 0 | 8 | 49.866 | 7.936 |
| CE120671 | 2005 | 8 | 3 | 0 | 10 | 49.866 | 7.936 |
| CE120672 | 2005 | 8 | 3 | 0 | 12 | 49.865 | 7.937 |
| CE120673 | 2005 | 8 | 3 | 0 | 17 | 49.865 | 7.937 |
| CE120674 | 2005 | 8 | 3 | 0 | 21 | 49.864 | 7.938 |
| CE121675 | 2005 | 8 | 3 | 0 | 59 | 49.891 | 7.893 |
| CE121676 | 2005 | 8 | 3 | 1 | 4 | 49.892 | 7.890 |
| CE121677 | 2005 | 8 | 3 | 1 | 9 | 49.893 | 7.887 |
| CE122678 | 2005 | 8 | 3 | 1 | 43 | 49.918 | 7.848 |
| CE122679 | 2005 | 8 | 3 | 1 | 46 | 49.918 | 7.846 |
| CE122680 | 2005 | 8 | 3 | 1 | 51 | 49.919 | 7.843 |
| CE122681 | 2005 | 8 | 3 | 1 | 58 | 49.920 | 7.839 |
| CE123682 | 2005 | 8 | 3 | 2 | 33 | 49.939 | 7.811 |
| CE123683 | 2005 | 8 | 3 | 2 | 38 | 49.940 | 7.807 |
| CE123684 | 2005 | 8 | 3 | 2 | 44 | 49.942 | 7.804 |
| CE124685 | 2005 | 8 | 3 | 3 | 15 | 49.960 | 7.777 |
| CE124686 | 2005 | 8 | 3 | 3 | 20 | 49.961 | 7.774 |
| CE124687 | 2005 | 8 | 3 | 3 | 25 | 49.962 | 7.771 |
| CE124688 | 2005 | 8 | 3 | 3 | 30 | 49.963 | 7.768 |
| CE125690 | 2005 | 8 | 3 | 4 | 23 | 49.937 | 7.814 |
| CE125691 | 2005 | 8 | 3 | 4 | 28 | 49.935 | 7.815 |
| CE125692 | 2005 | 8 | 3 | 4 | 33 | 49.933 | 7.816 |
| CE125693 | 2005 | 8 | 3 | 4 | 38 | 49.931 | 7.818 |
| CE125694 | 2005 | 8 | 3 | 4 | 44 | 49.929 | 7.819 |
| CE126695 | 2005 | 8 | 3 | 5 | 11 | 49.915 | 7.848 |
| CE126696 | 2005 | 8 | 3 | 5 | 16 | 49.914 | 7.851 |
| CE126697 | 2005 | 8 | 3 | 5 | 22 | 49.912 | 7.854 |
| CE127698 | 2005 | 8 | 3 | 5 | 50 | 49.894 | 7.889 |
| CE127699 | 2005 | 8 | 3 | 5 | 55 | 49.892 | 7.892 |

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|---|---|---|---|---|---|---|---|
| CE127700 | 2005 | 8 | 3 | 6 | 0 | 49.891 | 7.895 |
| CE127701 | 2005 | 8 | 3 | 6 | 2 | 49.890 | 7.897 |
| CE127702 | 2005 | 8 | 3 | 6 | 2 | 49.890 | 7.897 |
| CE128703 | 2005 | 8 | 3 | 6 | 29 | 49.870 | 7.933 |
| CE128704 | 2005 | 8 | 3 | 6 | 32 | 49.869 | 7.935 |
| CE128705 | 2005 | 8 | 3 | 6 | 36 | 49.868 | 7.938 |
| CE129706 | 2005 | 8 | 3 | 7 | 17 | 49.890 | 7.899 |
| CE129707 | 2005 | 8 | 3 | 7 | 22 | 49.890 | 7.897 |
| CE129708 | 2005 | 8 | 3 | 7 | 27 | 49.891 | 7.896 |
| CE129709 | 2005 | 8 | 3 | 7 | 32 | 49.891 | 7.894 |
| CE130710 | 2005 | 8 | 3 | 8 | 3 | 49.910 | 7.857 |
| CE130711 | 2005 | 8 | 3 | 8 | 9 | 49.911 | 7.855 |
| CE130712 | 2005 | 8 | 3 | 8 | 15 | 49.912 | 7.853 |
| CE130713 | 2005 | 8 | 3 | 8 | 20 | 49.913 | 7.851 |
| CE131714 | 2005 | 8 | 3 | 8 | 50 | 49.935 | 7.816 |
| CE131715 | 2005 | 8 | 3 | 8 | 56 | 49.936 | 7.814 |
| CE131716 | 2005 | 8 | 3 | 9 | 1 | 49.936 | 7.813 |
| CE132717 | 2005 | 8 | 3 | 9 | 31 | 49.955 | 7.777 |
| CE132718 | 2005 | 8 | 3 | 9 | 36 | 49.956 | 7.776 |
| CE132719 | 2005 | 8 | 3 | 9 | 42 | 49.956 | 7.774 |
| CE132720 | 2005 | 8 | 3 | 10 | 19 | 49.937 | 7.807 |
| CE132721 | 2005 | 8 | 3 | 10 | 24 | 49.936 | 7.812 |
| CE132722 | 2005 | 8 | 3 | 10 | 30 | 49.935 | 7.816 |
| CE133723 | 2005 | 8 | 3 | 10 | 55 | 49.915 | 7.846 |
| CE133724 | 2005 | 8 | 3 | 11 | 1 | 49.912 | 7.849 |
| CE133725 | 2005 | 8 | 3 | 11 | 6 | 49.910 | 7.851 |
| CE134726 | 2005 | 8 | 3 | 11 | 44 | 49.894 | 7.889 |
| CE134727 | 2005 | 8 | 3 | 11 | 49 | 49.893 | 7.891 |
| CE134728 | 2005 | 8 | 3 | 11 | 54 | 49.891 | 7.893 |
| CE135729 | 2005 | 8 | 3 | 12 | 34 | 49.872 | 7.933 |
| CE135730 | 2005 | 8 | 3 | 12 | 38 | 49.871 | 7.934 |
| CE135731 | 2005 | 8 | 3 | 12 | 42 | 49.870 | 7.935 |
| CE135732 | 2005 | 8 | 3 | 12 | 47 | 49.868 | 7.937 |
| CE136733 | 2005 | 8 | 3 | 13 | 26 | 49.890 | 7.898 |
| CE136734 | 2005 | 8 | 3 | 13 | 31 | 49.890 | 7.895 |
| CE136735 | 2005 | 8 | 3 | 13 | 35 | 49.891 | 7.891 |
| CE137736 | 2005 | 8 | 3 | 14 | 13 | 49.918 | 7.854 |
| CE137737 | 2005 | 8 | 3 | 14 | 19 | 49.919 | 7.849 |
| CE137738 | 2005 | 8 | 3 | 14 | 25 | 49.921 | 7.845 |
| CE138739 | 2005 | 8 | 3 | 14 | 53 | 49.935 | 7.818 |
| CE138740 | 2005 | 8 | 3 | 14 | 59 | 49.936 | 7.814 |
| CE138741 | 2005 | 8 | 3 | 15 | 6 | 49.938 | 7.809 |
| CE139742 | 2005 | 8 | 3 | 15 | 41 | 49.958 | 7.775 |
| CE139743 | 2005 | 8 | 3 | 15 | 46 | 49.960 | 7.771 |
| CE139744 | 2005 | 8 | 3 | 15 | 51 | 49.961 | 7.768 |
| CE140745 | 2005 | 8 | 3 | 16 | 38 | 49.939 | 7.808 |
| CE140746 | 2005 | 8 | 3 | 16 | 44 | 49.937 | 7.810 |
| CE140747 | 2005 | 8 | 3 | 16 | 50 | 49.934 | 7.812 |
| CE141748 | 2005 | 8 | 3 | 17 | 20 | 49.915 | 7.850 |
| CE141749 | 2005 | 8 | 3 | 17 | 25 | 49.913 | 7.852 |
| CE141750 | 2005 | 8 | 3 | 17 | 30 | 49.911 | 7.854 |
| CE142751 | 2005 | 8 | 3 | 17 | 58 | 49.892 | 7.890 |
| CE142752 | 2005 | 8 | 3 | 18 | 3 | 49.890 | 7.893 |
| CE142753 | 2005 | 8 | 3 | 18 | 7 | 49.888 | 7.895 |
| CE143755 | 2005 | 8 | 3 | 18 | 33 | 49.872 | 7.930 |
| CE143756 | 2005 | 8 | 3 | 18 | 37 | 49.870 | 7.933 |

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|---|---|---|---|---|---|---|---|
| CE143757 | 2005 | 8 | 3 | 18 | 41 | 49.869 | 7.935 |
| CE144758 | 2005 | 8 | 3 | 19 | 17 | 49.888 | 7.897 |
| CE144759 | 2005 | 8 | 3 | 19 | 21 | 49.888 | 7.897 |
| CE144760 | 2005 | 8 | 3 | 19 | 26 | 49.889 | 7.896 |
| CE145761 | 2005 | 8 | 3 | 20 | 0 | 49.913 | 7.853 |
| CE145762 | 2005 | 8 | 3 | 20 | 6 | 49.915 | 7.851 |
| CE145763 | 2005 | 8 | 3 | 20 | 12 | 49.916 | 7.851 |
| CE146764 | 2005 | 8 | 3 | 20 | 42 | 49.933 | 7.818 |
| CE146765 | 2005 | 8 | 3 | 20 | 48 | 49.934 | 7.817 |
| CE146766 | 2005 | 8 | 3 | 20 | 54 | 49.935 | 7.817 |
| CE147767 | 2005 | 8 | 3 | 21 | 32 | 49.954 | 7.780 |
| CE147768 | 2005 | 8 | 3 | 21 | 38 | 49.955 | 7.778 |
| CE147769 | 2005 | 8 | 3 | 21 | 44 | 49.956 | 7.776 |

# 6. Moorings

John Wynar (UKORS, NOC)

All times in the mooring report below are in GMT.

***Acoustic testing***

A wire test was conducted on the 15th July using the CTD frame to hang two acoustic releases from. They were an Oceano AR361 s/n: 39 and a Sonardyne DORT. Initially the DORT test failed because the wrong address for the release was given in the notes and no contact could be made. This was later rectified and operation validated. A TT301 deck unit was used to test the AR361 at a depth of 80m. A range of 83m was obtained and the release command executed successfully.

Further testing was carried out on the 17th July when the two RT361 pyro releases (s/n: 316 and 469) were attached to the top frame of a toroidal buoy and lowered to 190m. On retrieval of the releases, the puffers connected to both channels of the RT's were confirmed to have blown and verified operation of the units.

***U2 (Flat site) mooring deployments***

ADCP Mooring

On the 15th July the ADCP mooring supplied by Fugro for UCNW was deployed at the 'U2' site. It comprised of a sub-surface buoy mounted 300kHz RDI ADCP mooring supplied entirely by Fugro Geos (see figure 6.1).

Deployed: 17.58 on 15/07/05
Depth: 121m
Position: 49º14.151'N, 6º09.941'W

Sonardyne acoustic release address '88'
ADCP s/n: 186
Argos beacon activated prior to release and confirmed by Lisa Feighery (Fugro)

Configuration file for ADCP supplied by Matthew Palmer (SOS, UCNW):
CR1
CF11101
EA0
EB0

```
ED1200
ES35
EX00000
EZ1111111
WB0
WD111000000
WF176
WN30
WP1
WS400
WV130
TE00:00:02.00
TP00:02.00
CK
CS
;
;Instrument       = Workhorse Sentinel
;Frequency        = 307200
;Beam angle       = 20
;Temperature      = 9.00
;Deployment hours = 504.00
;Battery packs    = 1
;Automatic TP     = NO
;Memory size [MB] = 1000
;
;Consequences generated by PlanADCP version 2.01:
;First cell range = 6.02 m
;Last cell range = 122.02 m
;Max range = 108.51 m
;Standard deviation = 3.18 cm/s
;Ensemble size = 624 bytes
;Storage required = 566.09 MB
;Power usage = 432.77 Wh
;Battery usage 1.0
```

VEMCO thermistor chain (see Figure 6.2):
Deployed: 14.11 on 19/7/05
Depth: 120m
Position: 49°13.98'N, 6°10.00'W

***CS2 (shelf edge) mooring deployments***

VEMCO thermistor chain (see Figure 6.3):
Deployed: 1549 on 17/07/05
Depth: 201m
Position: 48º34.259'N, 9º30.585'W

Study ID: CD173 CS2
All Vemco's are 12-bit Minilog-T 32kb sampling at 1-minute intervals, maximum duration: 15 days.

Vemco's and Microcats put in water tank for pre-deployment calibration @1151-1355.

Sub-surface 300ADCP mooring (see Figure 6.4):
300kHz RDI WH Sentinel s/n:2666
Acoustic release AR361 s/n: 39

Deployed: 17.42 on 17/07/05
Depth: 194m
Position: 48º34.362'N, 9º30.602'W

Config. file supplied by Matthew Palmer(SOS, UCNW)

```
CR1
CF11101
EA0
EB0
ED1000
ES35
EX00000
EZ1111111
WB0
WD111000000
WF176
WN55
WP3
WS200
WV130
TE00:00:02.00
TP00:00.66
TF05/07/17 11:59:00
CK
CS

;Instrument       = Workhorse Sentinel
;Frequency        = 307200
;Beam angle       = 20
;Temperature      = 9.00
;Deployment hours = 192.00
;Battery packs    = 1
;Automatic TP     = YES
;Memory size [MB] = 1000
;
;Consequences generated by PlanADCP version 2.01:
;First cell range = 4.38 m
;Last cell range = 112.38 m
;Max range = 99.81 m
;Standard deviation = 3.07 cm/s
;Ensemble size = 1024 bytes
;Storage required = 353.89 MB
;Power usage = 437.83 Wh
;Battery usage 1.0
```

<u>Bed-frame 300ADCP mooring (see fig. 6.5)</u>
300kHz RDI WH Sentinel s/n:1903
Deployed: 18.11 on 17/7/05
Depth: 196m
Position: 48º34.338'N, 9º30.486'W

Config file supplied by Matthew Palmer(SOS, UCNW)

```
CR1
CF11101
EA0
EB0
ED2000
ES35
```

```
EX00000
EZ1111111
WB0
WD111000000
WF176
WN55
WP4
WS200
WV130
TE00:00:02.00
TP00:00.50
TF05/07/17 11:59:00
CK
CS
;
;Instrument       = Workhorse Sentinel
;Frequency        = 307200
;Beam angle       = 20
;Temperature      = 9.00
;Deployment hours = 432.00
;Battery packs    = 1
;Automatic TP     = YES
;Memory size [MB] = 1000
;
;Consequences generated by PlanADCP version 2.01:
;First cell range = 4.38 m
;Last cell range = 112.38 m
;Max range = 100.46 m
;Standard deviation = 2.66 cm/s
;Ensemble size = 1024 bytes
;Storage required = 796.26 MB
;Power usage = 1311.67 Wh
;Battery usage 2.9
```

<u>Bed-frame 150ADCP mooring (see fig. 6.6)</u>
RDI 150kHz BB ADCP s/n: 1184
Acoustic release RT361 s/n: 54 (mode B)
Novatech strobe light and Novatech Argos beacon ptt: 59620

Deployed with aft crane and a Sea-catch release hook used to slip a short strop around the frame.

Deployed: 21.06 on 18/7/05
Depth: 202m
Position: 48º34.281'N 9º30.437'W

Config. supplied by J Wynar (NOC):

```
WP00010
WD111110000
WN050
WS0400
WF0400
WM4
TP00:00.00
WV200
BP001
BM3
BX1200
```

TE00:01:00.00
ET0500
ES35
ED2000
EZ1111111
EX11111
CF11111

<u>Guard Buoy (see fig. 6.7)</u>
Hippo Buoy with radar reflector, solar powered nav. light and strobe light.
Deployed: 22.09 on 18/7/05
Depth: 186m
Position: 48°34.51'N, 9°30.73'W

***CS2 moorings recovery***
Recoveries began in marginal weather conditions (wind-speed of 30 knots, and a long swell). The weather improved slowly but steadily throughout the day.

<u>Guard Buoy</u>
Recovered: 06.15 – 06.50 on 24/7/05
The mooring was recovered in its entirety including the anchor.

<u>Vemco thermistor chain</u>
Recovered: 08.55 – 10.06 on 24/7/05
All instruments intact and recorded for the full period. Anchor also recovered.

<u>Sub-surface 300ADCP mooring</u>
Ranges obtained using a TT301 (s/n: 140) through the fish single element: 508, 511, 506.
Release command sent: 11.51; range: 498m; depth: 185m
Recovered: 12.00 – 12.30 on 24/7/05
The 300kHz ADCP recorded for the full period, stopped:1310 on 24/07/05.

<u>Bed-frame 150ADCP mooring</u>
Ranges obtained (as above): 420, 430, 478
Release command sent: 15.50; range: 436m; depth: 186m
Recovered: 16.00 – 16.15 on 24/7/05
One glass sphere had broken free from the bed-frame and was observed on the surface before the bed-frame itself was sighted. The plastic plates attaching the sphere to the frame had broken. Another sphere had similar damage but was still fixed to the frame because it was partly bolted directly to the frame. The ADCP was not pinging when brought on deck.

<u>Bed-frame 300ADCP mooring</u>
Ranges obtained (as above): 654, 477.
Pyro command sent at 16.43;
Subsequent ranges at 16.47, 323m
16.49, 313m
16.50, 310m
It was now assumed that as there had been no visual sighting and no significant reduction in range to indicate the bed-frame was rising, that the pyro release had failed. The "release1" command was then sent at 16.55 giving a range of 295m.
Subsequent ranges at 16.57, 254m
17.00, 121m – now observed on the surface.

Recovered: 17.15

On inspection it was found that the pyro which failed to fire had fractured the upper plastic section but without giving sufficient freedom to the mechanism to release. The fault was in the pyro link itself and not in the RT unit as further testing verified.

### *Jones Bank 1 moorings deployment*

<u>Vemco thermistor chain (see fig.6.8)</u>
Deployed: 08.52 – 09.39 on 26th July
Depth: 118m
Position: 49°56.3'N, 7°47.5'W

Toroid equipped with radar reflector, solar-rechargeable navigation light and strobe light. Mooring instrumented with Vemco mini-logs and Seabird 37 CTDs.

<u>Bed-frame 300ADCP mooring (see fig. 6.5)</u>
Acoustic release (pyro): RT361 s/n: 316
Novatech flashing light and Novatech Argos beacon ptt: 59620
RDI WH Sentinel 300kHz ADCP started at 14.46 on 27/7/05

Config. supplied by M Palmer (SOS, UCNW):

```
CR1
CF11101
EA00000
EB0
ED1000
ES35
EX00000
EZ1111111
TE00:00:01.00
TP00:00.25
WB0
WD111100000
WF176
WN50
WP4
WS200
WV130
CK
CS
;
;Instrument       = Workhorse Sentinel
;Frequency        = 307200
;Beam angle       = 20
;Temperature      = 9.00
;Deployment hours = 216.00
;Battery packs    = 2
;Automatic TP     = YES
;Memory size [MB] = 1000
;
;Consequences generated by PlanADCP version 2.01:
;First cell range = 4.38 m
;Last cell range = 102.38 m
;Max range = 99.81 m
;Standard deviation = 2.66 cm/s
;Ensemble size = 1148 bytes
```

;Storage required = 706.24 MB
;Power usage = 1000.42 Wh
;Battery usage 2.2

Deployed: 17.12 on 27/7/05
Depth : 118m
Position: 49°56.16'N, 7°47.51'W

***Jones Bank 2 moorings deployment***

Vemco thermistor chain (see fig. 6.9)
Deployed: 16.35 – 17.33 on 20th July
Depth: 114m
Position: 49°53.7'N, 7°52.3'W

Sub-surface 600ADCP mooring (see fig.6.10)
Acoustic release AR361 s/n: 39
RDI WH Sentinel 600kHz s/n: 3725

Config. supplied by M Palmer (SOS, UCNW):-

```
CR1
CF11101
EA0
EB0
ED0
ES35
EX11111
EZ1111111
WA50
WB0
WD111100000
WF88
WN45
WP1
WS100
WV175
TE00:00:01.00
TP00:01.00
CK
CS
;
;Instrument         = Workhorse Sentinel
;Frequency          = 614400
;Water Profile      = YES
;Bottom Track       = NO
;High Res. Modes    = NO
;High Rate Pinging  = NO
;Shallow Bottom Mode= NO
;Wave Gauge         = NO
;Lowered ADCP       = NO
;Beam angle         = 20
;Temperature        = 5.00
;Deployment hours   = 216.00
;Battery packs      = 1
;Automatic TP       = YES
;Memory size [MB]   = 16
;Saved Screen       = 1
;
```

;Consequences generated by PlanADCP version 2.02:
;First cell range = 2.08 m
;Last cell range = 46.08 m
;Max range = 42.62 m
;Standard deviation = 6.11 cm/s
;Ensemble size = 1048 bytes
;Storage required = 777.17 MB (814924800 bytes)
;Power usage = 195.14 Wh
;Battery usage = 0.4

Deployment: 11.35 on 26th July
Depth: 112m
Position: 49°52.58'N, 7°52.18'W

Bed-frame 300ADCP mooring (see fig. 6.5)
Acoustic release (pyro): RT361 s/n: 469
RDI WH Sentinel 300kHz ADCP s/n: 1903 started at 11.50 on 26/7/05

Config. supplied by M Palmer (SOS, UCNW):-

```
CR1
CF11101
EA00000
EB0
ED1000
ES35
EX00000
EZ1111111
TE00:00:01.00
TP00:00.25
WB0
WD111100000
WF176
WN50
WP4
WS200
WV130
CK
CS
;
;Instrument = Workhorse Sentinel
;Frequency = 307200
;Beam angle = 20
;Temperature = 9.00
;Deployment hours = 216.00
;Battery packs = 2
;Automatic TP = YES
;Memory size [MB] = 1000
;
;Consequences generated by PlanADCP version 2.01:
;First cell range = 4.38 m
;Last cell range = 102.38 m
;Max range = 99.81 m
;Standard deviation = 2.66 cm/s
;Ensemble size = 1148 bytes
;Storage required = 706.24 MB
;Power usage = 1000.42 Wh
;Battery usage 2.2
```

Deployed: 12.54 on 26/7/05

Depth :     110m
Position:   49°53.63'N, 7°52.39'W

<u>Guard Buoy (see fig. 6.11)</u>
Deployed: 16.07 on 27/7/05
Depth:      114m
Position:   49°53.4'N, 7°52.3'W

***Jones Bank 3 moorings deployment/recovery***
The two moorings (Vemco thermistor chain and trawl-proof adcp 300kHz) were both deployed and recovered by the RV Prince Madog.

***Jones Bank 1 moorings recovery***

Bed-frame 300ADCP mooring
The mooring was reported as trawled by a French fishing boat on the 29/7/05. It was recovered from the fishing boat on the 31/7/05 unscathed and with the ADCP still pinging. The PS decided against re-deploying the bed-frame.

Vemco thermistor chain
On arriving on site on the 4/8/05 the toroid could not be detected and as there had been fishing activity in the area, it was assumed the mooring had been trawled. A dragging operation carried out the same day yielded nothing – all instrumentation was lost.

***Jones Bank 2 moorings recovery***

Vemco thermistor chain
Recovered: 06.00 on 4/8/05.
Flashing light was damaged during recovery, but all other instrumentation recovered intact. Vemco mini-logs s/n: 9750 and 9765 could not be read out, and the data from the SBE39 s/n: 0390 appeared suspect.

Sub-surface 600ADCP mooring
Ranges obtained using a TT301 (s/n: 140) through the fish single element: 293, 296.
Release command sent: 07.00; range: 367m.
Recovered: 07.24 on 4/8/05
The ADCP was not pinging when recovered. Later this was found to be because the battery was exhausted.

Bed-frame 300ADCP mooring
Ranges (obtained as above): 404m.
Release1 command sent: 07.38; range: 406m.
Recovered: 08.03 on 4/8/05
ADCP not pinging when recovered. ADCP memory was full.

Guard buoy
This was recovered adrift on the 2/8/05. The buoy's polyester anchor line had been cut approximately 30m from the buoy.

***U2 moorings recovery***

ADCP mooring
Released using Sonardyne equipment at 04.55, address: 88.
Ranges: 267, 268, and 271m.
The ADCP's data was downloaded through a serial link as there seemed to be a compatibility problem with PCMCIA memory card.

Vemco thermistor chain
The buoy was reported recovered by the HMS Enterprise on the 1/8/05 south of the Scilly Isles. The buoy showed some damage and the microcat fixed to its keel was missing. The steel rope was reported as cut approximately 20m down the line, possibly with an acetylene torch. Two Vemco mini-logs were still attached to this line.

A dragging operation was attempted on the deployment site on 3/8/05 but without success.

***Acoustic Release Codes***

| S/N | 39 | 54 | 316 | 469 |
|---|---|---|---|---|
| MODE | A | B | A | A |
| WINDOW | | | 9535 | 6971 |
| RELEASE | A617 | EA56 | (W) 9585 | (W) 6985 |
| PYRO | | | (W) 9591 | (W) 6991 |
| PINGER | | | 9540 | 6976 |
| OFF/DISABLE | | EA55 | 9537 | 6973 |
| INTERROGATE | A618 | | | |
| DIAGNOSTIC | | | (W) 9587 | (W) 6987 |
| ENABLE | | EA54 | | |
| | | | | |

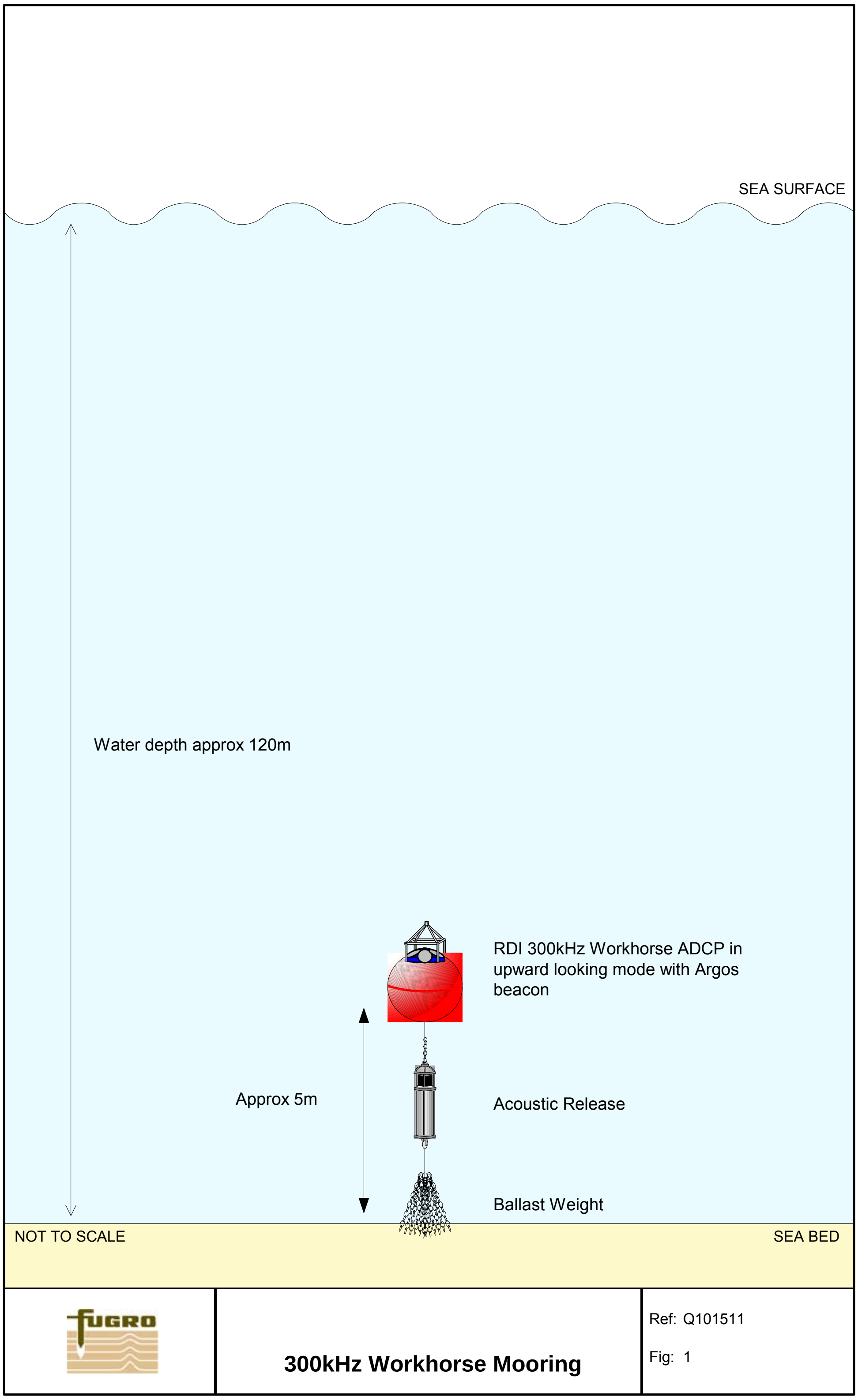

SEA SURFACE
Water depth approx 120m
RDI 300kHz Workhorse ADCP in upward looking mode with Argos beacon
Approx 5m
Acoustic Release
Ballast Weight
NOT TO SCALE
SEA BED
300kHz Workhorse Mooring
Ref: Q101511
Fig: 1

**Figure 6.1**

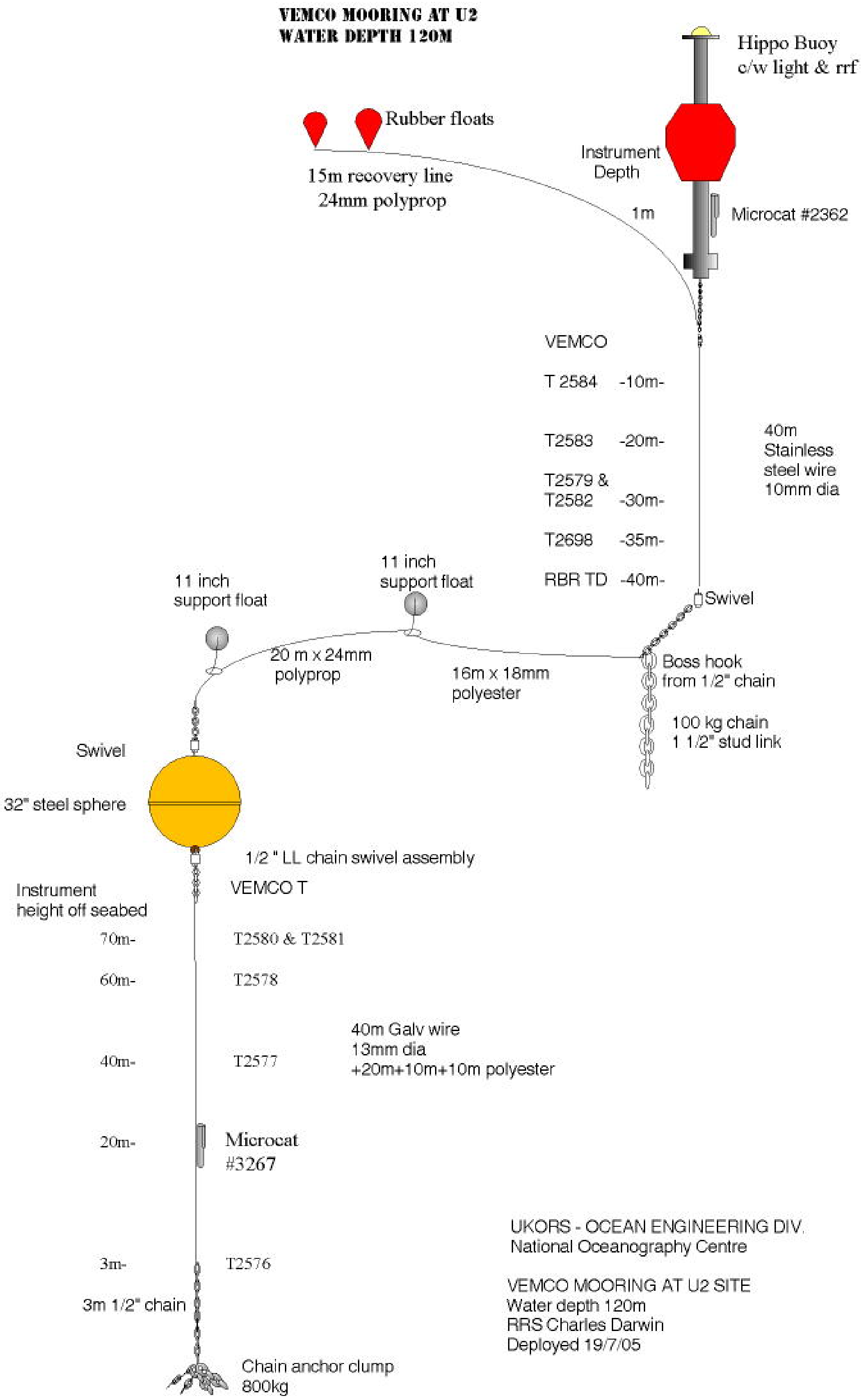

VEMCO MOORING AT U2
WATER DEPTH 120M
Hippo Buoy
c/w light & rrf
Rubber floats
15m recovery line
24mm polyprop
Instrument
Depth
1m
Microcat #2362
VEMCO
T 2584 -10m-
T2583 -20m-
T2579 &
T2582 -30m-
T2698 -35m-
RBR TD -40m-
40m
Stainless
steel wire
10mm dia
Swivel
11 inch
support float
11 inch
support float
20 m x 24mm
polyprop
16m x 18mm
polyester
Boss hook
from 1/2" chain
100 kg chain
1 1/2" stud link
Swivel
32" steel sphere
1/2 " LL chain swivel assembly
Instrument
height off seabed
VEMCO T
70m-
T2580 & T2581
60m-
T2578
40m Galv wire
13mm dia
+20m+10m+10m polyester
40m-
T2577
20m-
Microcat
#3267
UKORS - OCEAN ENGINEERING DIV.
National Oceanography Centre
3m-
T2576
3m 1/2" chain
VEMCO MOORING AT U2 SITE
Water depth 120m
RRS Charles Darwin
Deployed 19/7/05
Chain anchor clump
800kg

**Figure 6.2**

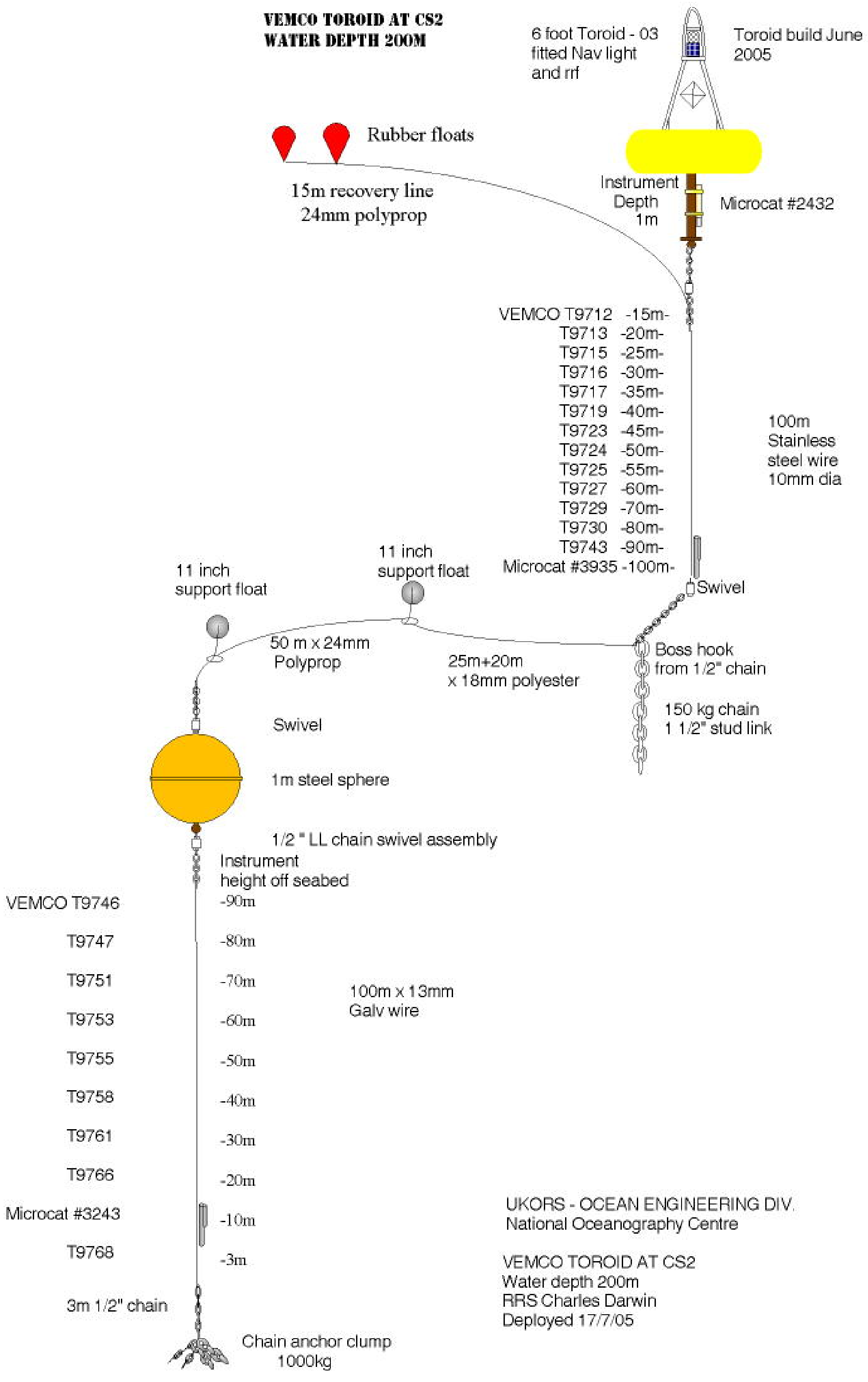

VEMCO TOROID AT CS2
WATER DEPTH 200M
6 foot Toroid - 03 fitted Nav light and rrf
Toroid build June 2005
Rubber floats
15m recovery line
24mm polyprop
Instrument Depth 1m
Microcat #2432
VEMCO T9712 -15m-
T9713 -20m-
T9715 -25m-
T9716 -30m-
T9717 -35m-
T9719 -40m-
T9723 -45m-
T9724 -50m-
T9725 -55m-
T9727 -60m-
T9729 -70m-
T9730 -80m-
T9743 -90m-
Microcat #3935 -100m-
100m Stainless steel wire 10mm dia
11 inch support float
11 inch support float
Swivel
50 m x 24mm Polyprop
25m+20m x 18mm polyester
Boss hook from 1/2" chain
150 kg chain 1 1/2" stud link
Swivel
1m steel sphere
1/2 " LL chain swivel assembly
Instrument height off seabed
VEMCO T9746 -90m
T9747 -80m
T9751 -70m
T9753 -60m
T9755 -50m
T9758 -40m
T9761 -30m
T9766 -20m
Microcat #3243 -10m
T9768 -3m
100m x 13mm Galv wire
3m 1/2" chain
Chain anchor clump 1000kg
UKORS - OCEAN ENGINEERING DIV.
National Oceanography Centre
VEMCO TOROID AT CS2
Water depth 200m
RRS Charles Darwin
Deployed 17/7/05

**Figure 6.3**

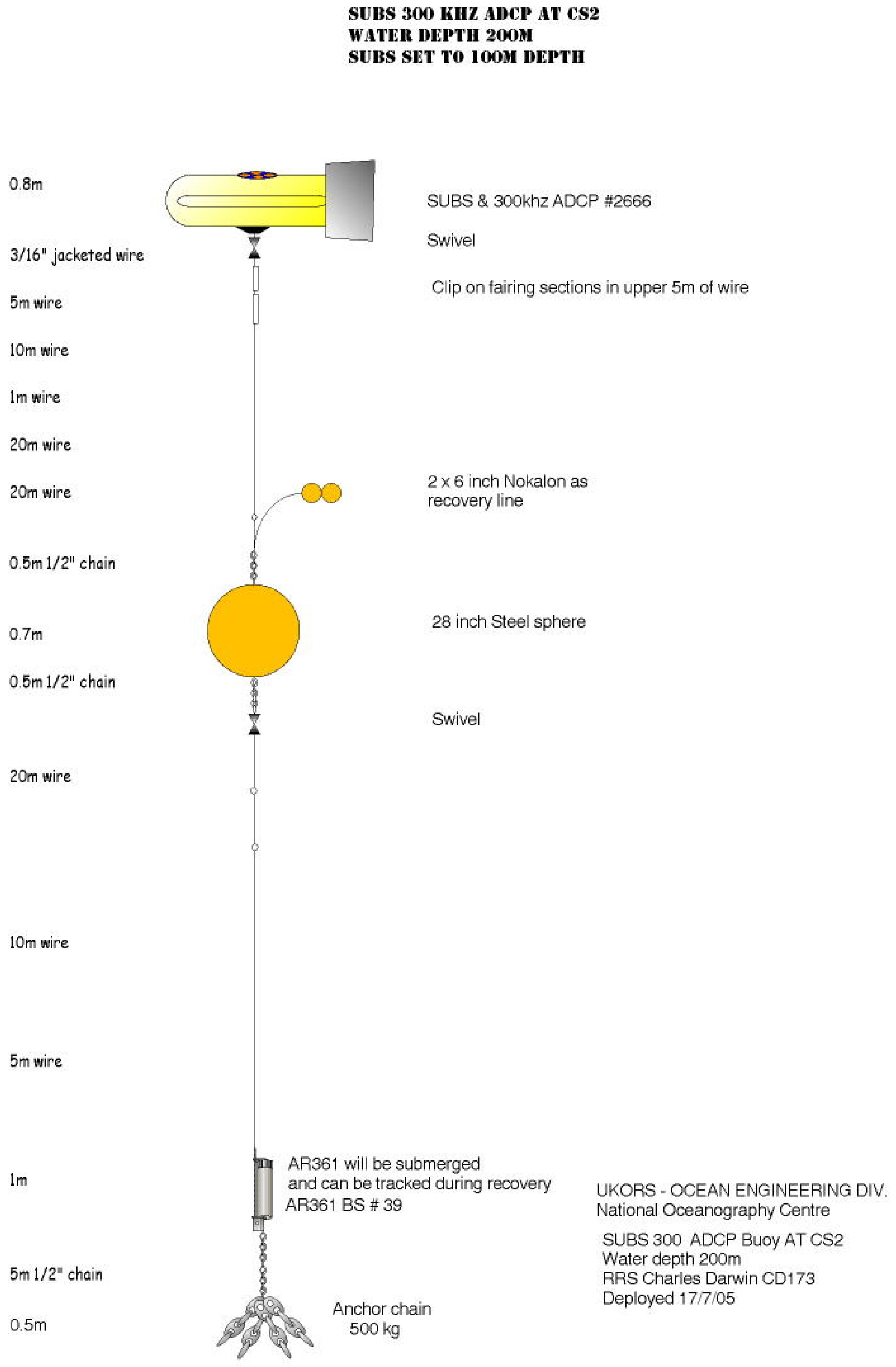



**Figure 6.4**

### 300 kHz ADCP Lander CD173

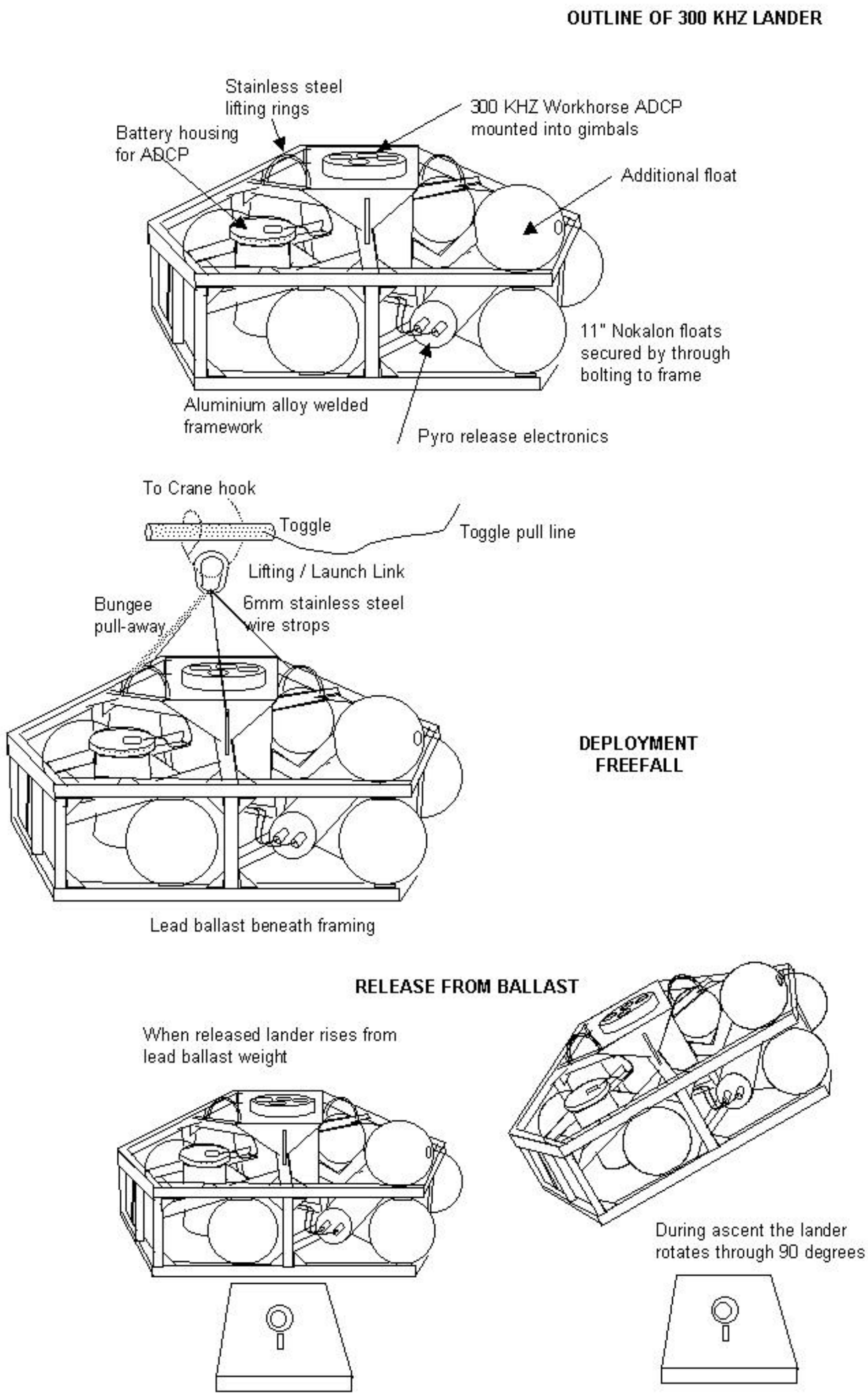



**Figure 6.5**

**150 kHz SCBBADCP Lander CD173**

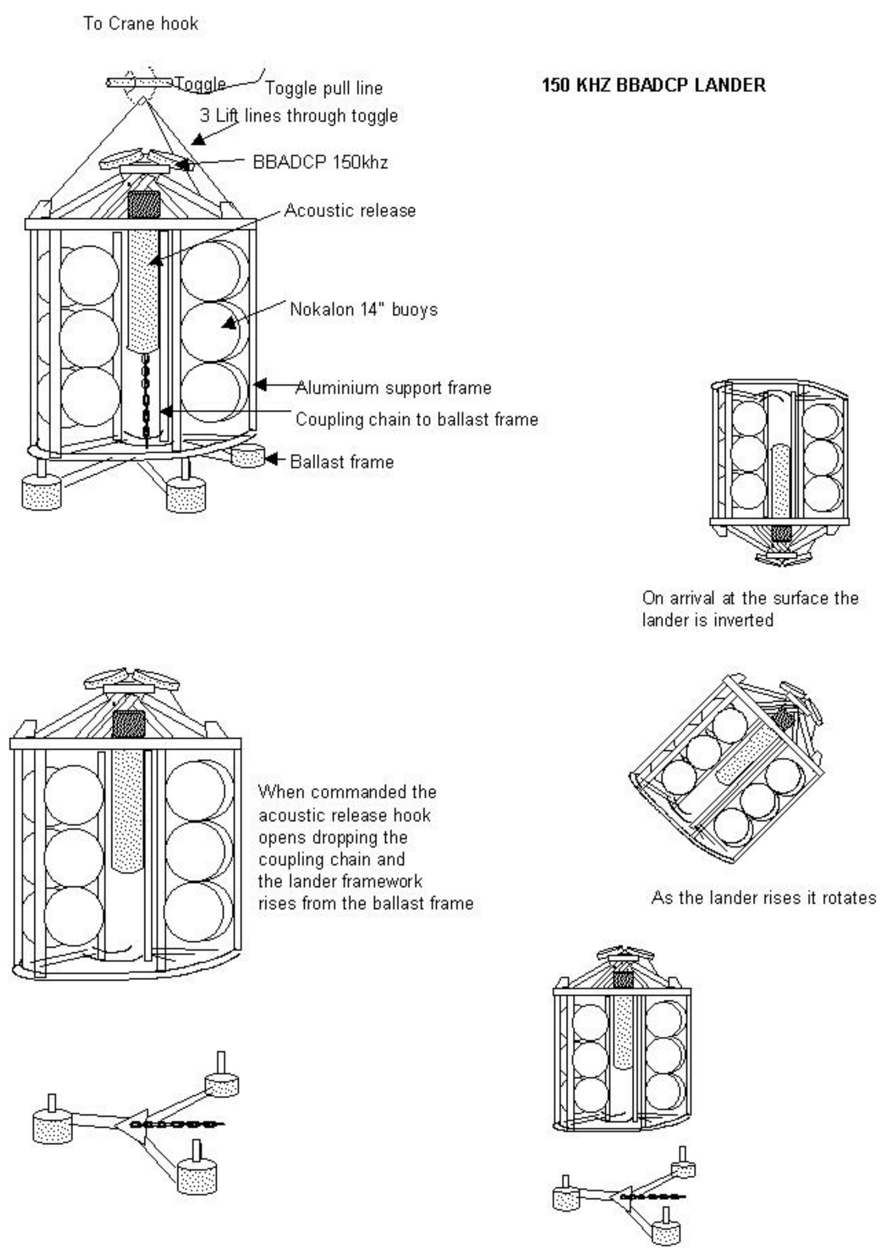

To Crane hook
Toggle
Toggle pull line
3 Lift lines through toggle
BBADCP 150khz
Acoustic release
Nokalon 14" buoys
Aluminium support frame
Coupling chain to ballast frame
Ballast frame
150 KHZ BBADCP LANDER
On arrival at the surface the
lander is inverted
When commanded the
acoustic release hook
opens dropping the
coupling chain and
the lander framework
rises from the ballast frame
As the lander rises it rotates

**Figure 6.6**

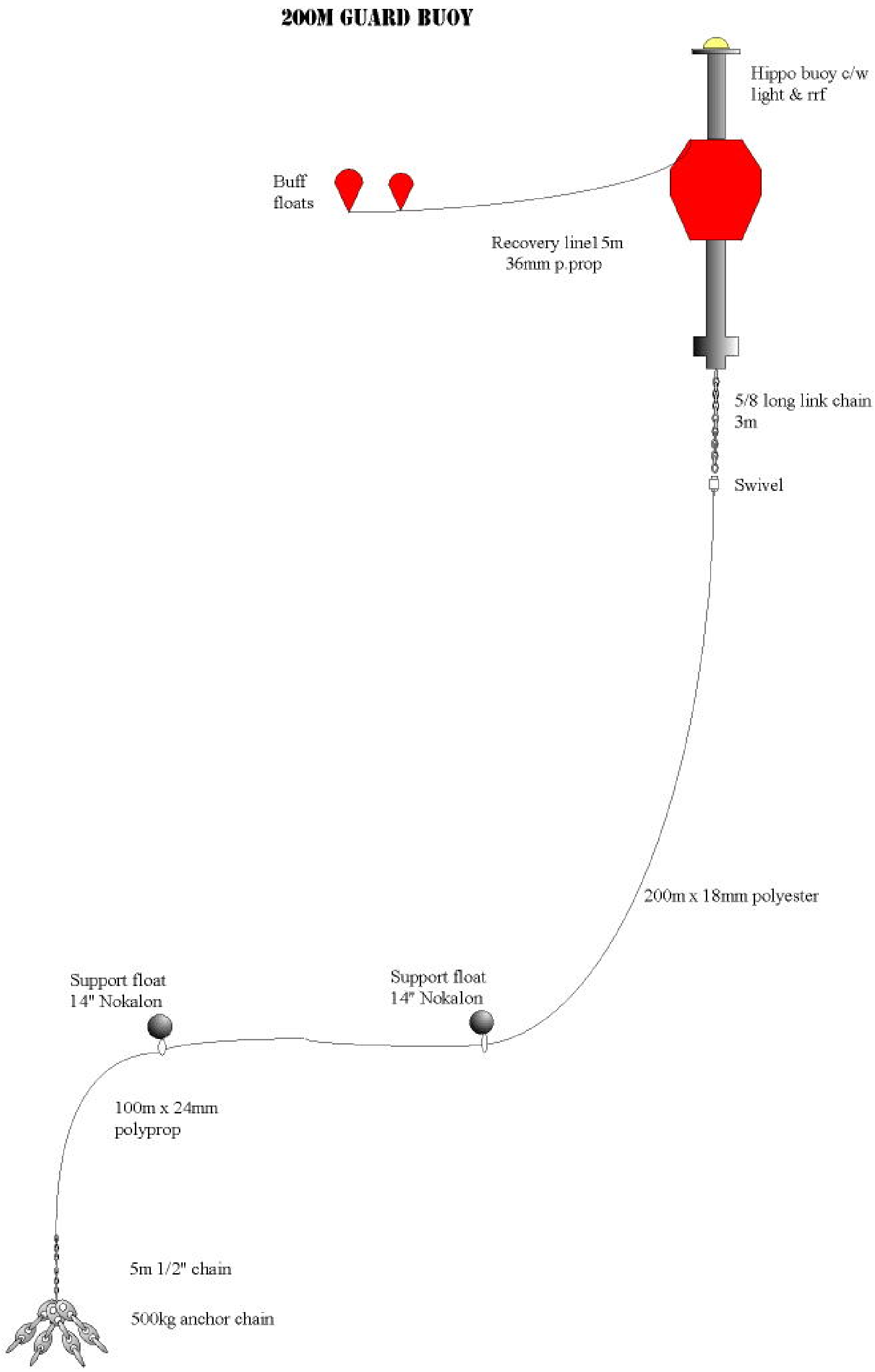

200M GUARD BUOY
Hippo buoy c/w
light & rrf
Buff
floats
Recovery line15m
36mm p.prop
5/8 long link chain
3m
Swivel
200m x 18mm polyester
Support float
14" Nokalon
Support float
14" Nokalon
100m x 24mm
polyprop
5m 1/2" chain
500kg anchor chain

**Figure 6.7**

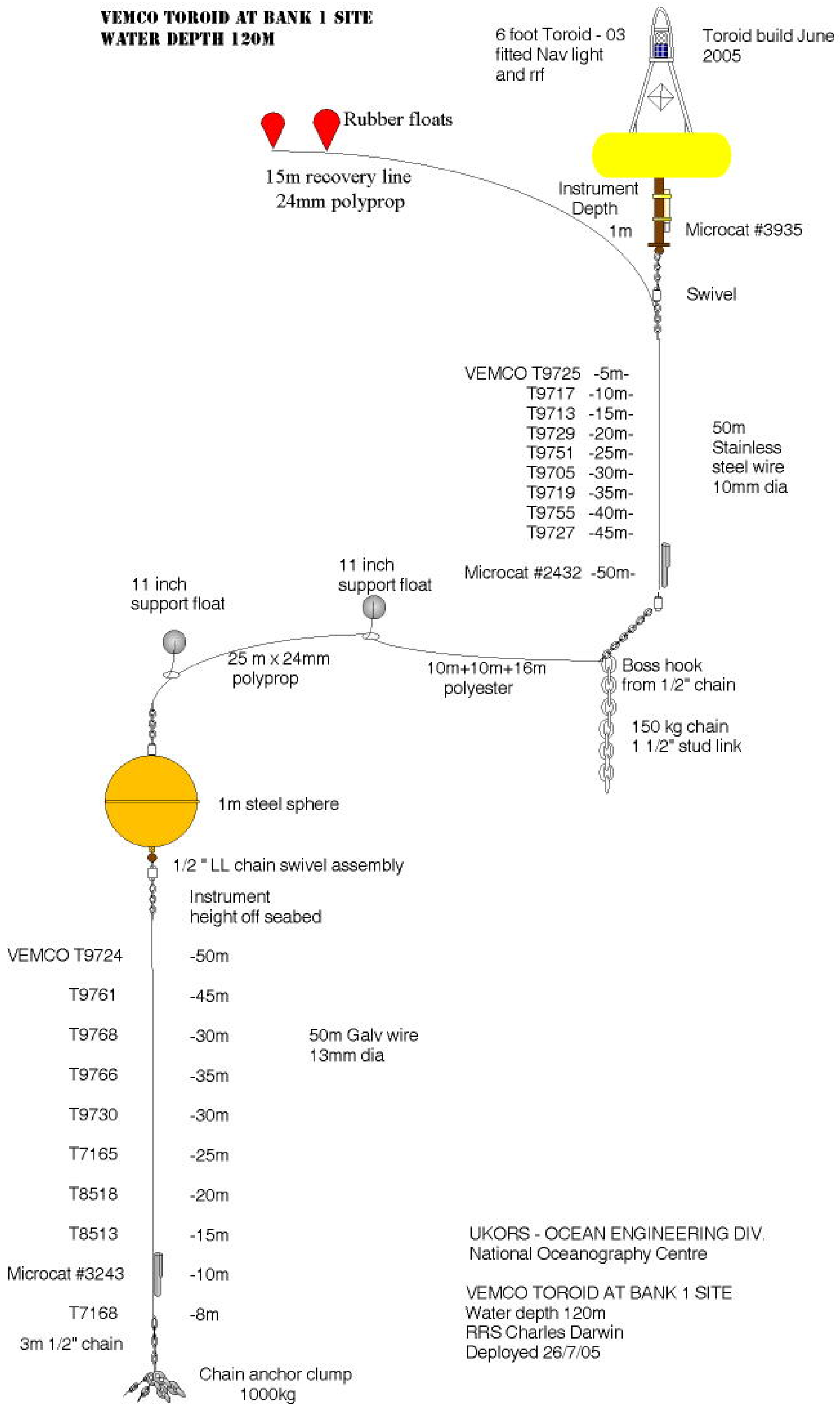
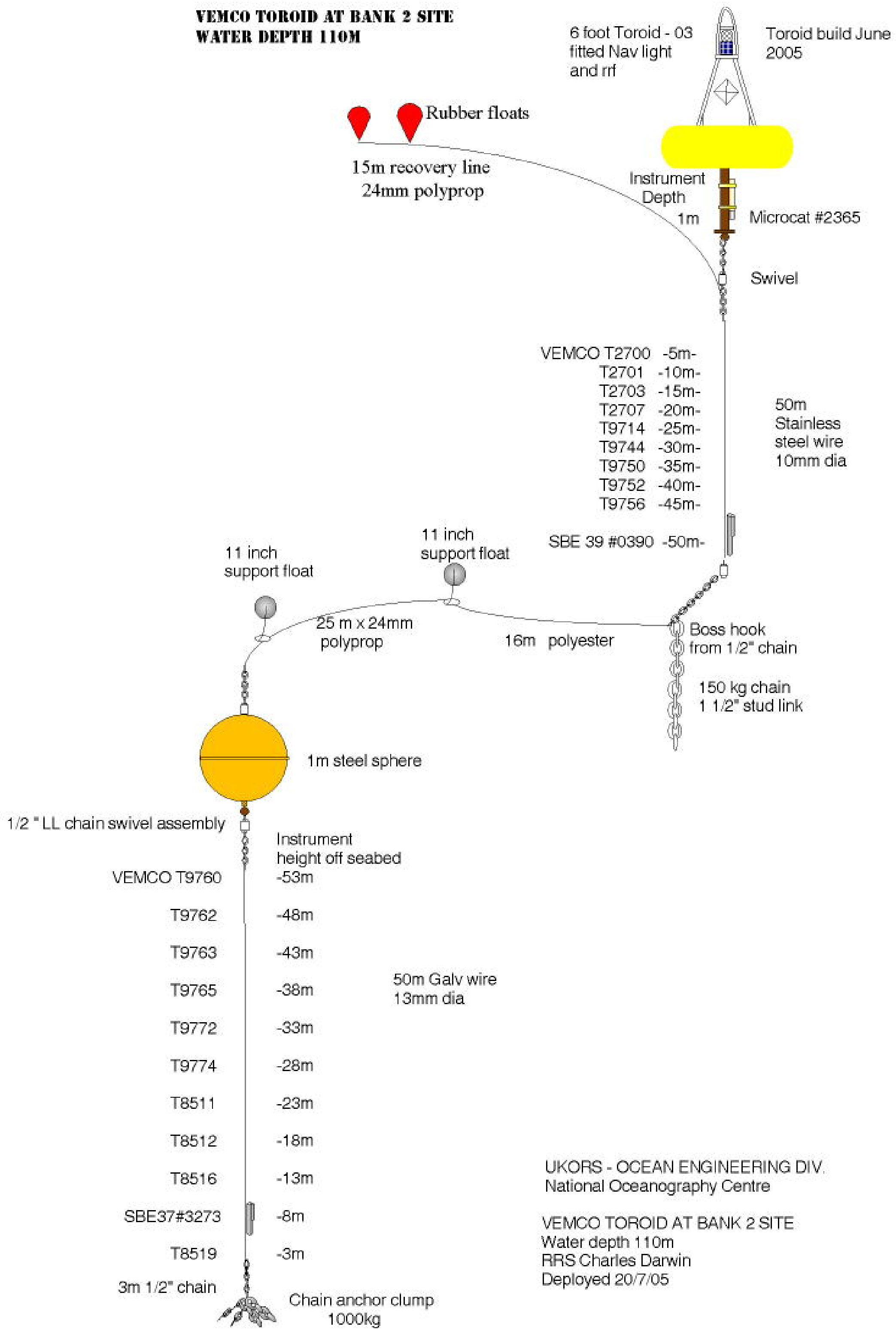

VEMCO TOROID AT BANK 1 SITE
WATER DEPTH 120M
6 foot Toroid - 03 fitted Nav light and rrf
Toroid build June 2005
Rubber floats
15m recovery line
24mm polyprop
Instrument Depth
1m
Microcat #3935
Swivel
VEMCO T9725 -5m-
T9717 -10m-
T9713 -15m-
T9729 -20m-
T9751 -25m-
T9705 -30m-
T9719 -35m-
T9755 -40m-
T9727 -45m-
50m Stainless steel wire 10mm dia
Microcat #2432 -50m-
11 inch support float
11 inch support float
25 m x 24mm polyprop
10m+10m+16m polyester
Boss hook from 1/2" chain
150 kg chain
1 1/2" stud link
1m steel sphere
1/2 " LL chain swivel assembly
Instrument height off seabed
VEMCO T9724 -50m
T9761 -45m
T9768 -30m
T9766 -35m
T9730 -30m
T7165 -25m
T8518 -20m
T8513 -15m
Microcat #3243 -10m
T7168 -8m
50m Galv wire 13mm dia
3m 1/2" chain
Chain anchor clump 1000kg
UKORS - OCEAN ENGINEERING DIV.
National Oceanography Centre
VEMCO TOROID AT BANK 1 SITE
Water depth 120m
RRS Charles Darwin
Deployed 26/7/05

**Figure 6.8**



VEMCO TOROID AT BANK 2 SITE
WATER DEPTH 110M
6 foot Toroid - 03 fitted Nav light and rrf
Toroid build June 2005
Rubber floats
15m recovery line
24mm polyprop
Instrument Depth
1m
Microcat #2365
Swivel
VEMCO T2700 -5m-
T2701 -10m-
T2703 -15m-
T2707 -20m-
T9714 -25m-
T9744 -30m-
T9750 -35m-
T9752 -40m-
T9756 -45m-
50m Stainless steel wire 10mm dia
SBE 39 #0390 -50m-
11 inch support float
11 inch support float
25 m x 24mm polyprop
16m polyester
Boss hook from 1/2" chain
150 kg chain
1 1/2" stud link
1m steel sphere
1/2 " LL chain swivel assembly
Instrument height off seabed
VEMCO T9760 -53m
T9762 -48m
T9763 -43m
T9765 -38m
T9772 -33m
T9774 -28m
T8511 -23m
T8512 -18m
T8516 -13m
SBE37#3273 -8m
T8519 -3m
50m Galv wire 13mm dia
3m 1/2" chain
Chain anchor clump 1000kg
UKORS - OCEAN ENGINEERING DIV.
National Oceanography Centre
VEMCO TOROID AT BANK 2 SITE
Water depth 110m
RRS Charles Darwin
Deployed 20/7/05


**Figure 6.9**

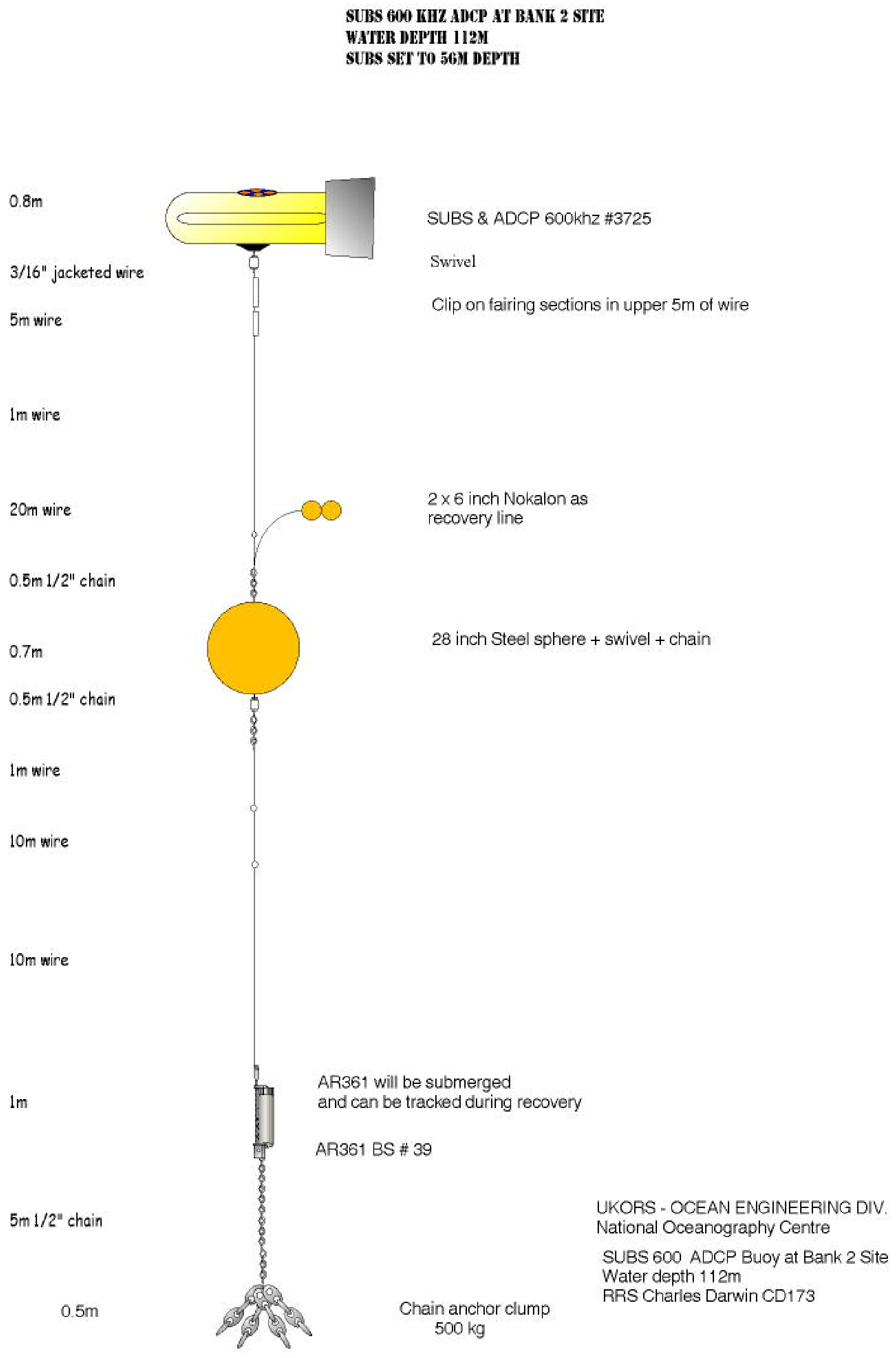
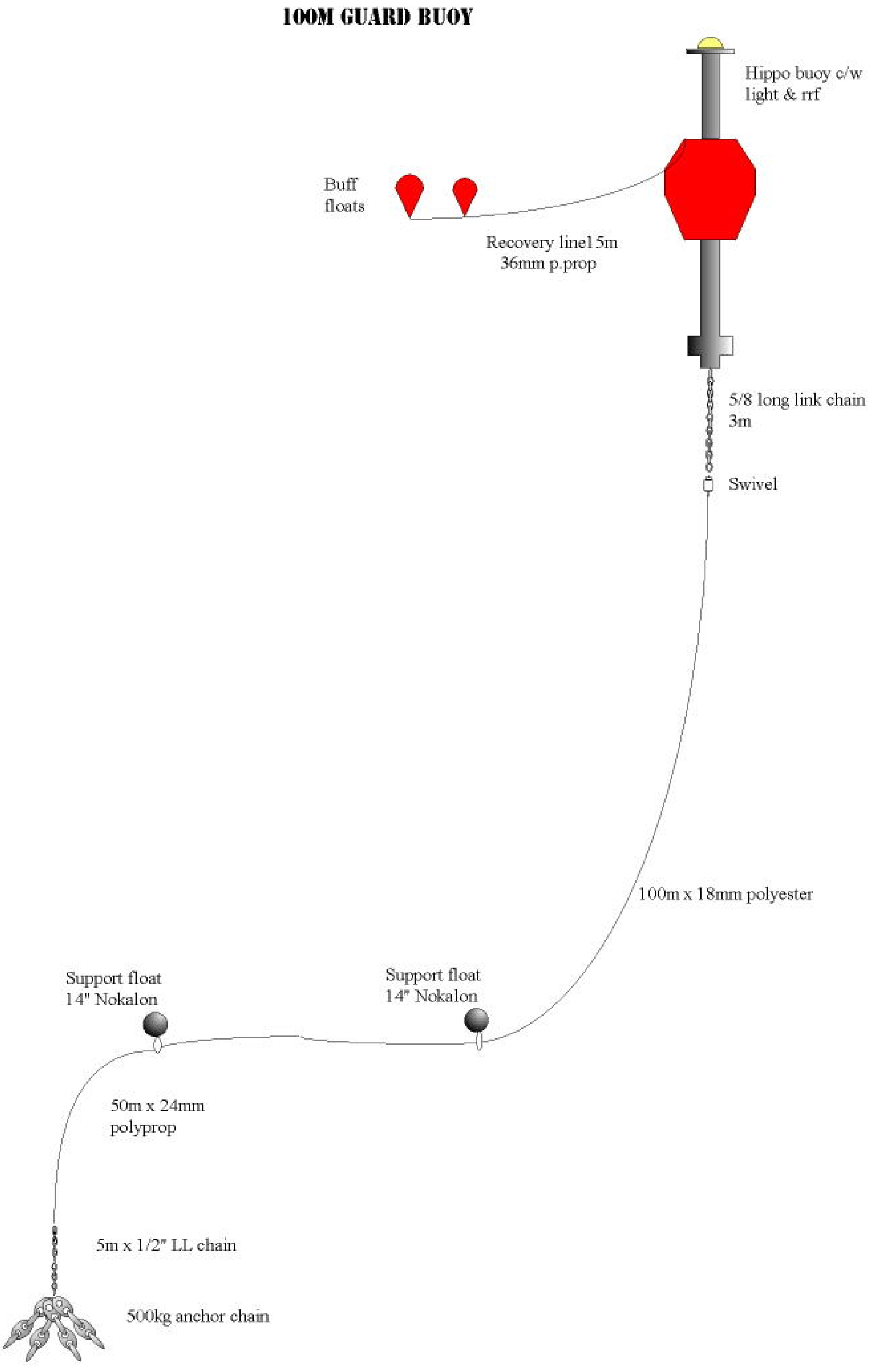

SUBS 600 KHZ ADCP AT BANK 2 SITE
WATER DEPTH 112M
SUBS SET TO 56M DEPTH
0.8m
SUBS & ADCP 600khz #3725
3/16" jacketed wire
Swivel
5m wire
Clip on fairing sections in upper 5m of wire
1m wire
20m wire
2 x 6 inch Nokalon as
recovery line
0.5m 1/2" chain
0.7m
28 inch Steel sphere + swivel + chain
0.5m 1/2" chain
1m wire
10m wire
10m wire
1m
AR361 will be submerged
and can be tracked during recovery
AR361 BS # 39
5m 1/2" chain
UKORS - OCEAN ENGINEERING DIV.
National Oceanography Centre
SUBS 600 ADCP Buoy at Bank 2 Site
Water depth 112m
RRS Charles Darwin CD173
0.5m
Chain anchor clump
500 kg

**Figure 6.10**



100M GUARD BUOY
Hippo buoy c/w
light & rrf
Buff
floats
Recovery line1 5m
36mm p.prop
5/8 long link chain
3m
Swivel
100m x 18mm polyester
Support float
14" Nokalon
Support float
14" Nokalon
50m x 24mm
polyprop
5m x 1/2" LL chain
500kg anchor chain


**Figure 6.11**

# 7. Seasoar

Jonathan Sharples

***Seasoar Tows.***

Seasoar was used throughout the cruise as a means to collect horizontally well-resolved observations of the vertical structure of temperature, salinity and chlorophyll. Seasoar was instrumented with a Chelsea Instruments Minipack for CTD and chlorophyll a measurements, and a Chelsea Instruments Fasttracka (with PAR sensor) for measurements of phytoplankton photo-physiology.

A number of significant problems were encountered with Seasoar:

- Flight control was very poor, resulting in two damaging seabed collisions and generally inadequate depth control for most of the cruise. Sufficient data was collected to illustrate the thermocline structure, but the repeatability of the flight profile was poor and the maximum depth possible was shallow and unreliable. The poor flight characteristics appear to have been the result of both the control software and a gradual decay of the hydraulic unit.
- The poor flight also manifested as very fast dive and rise speeds of the vehicle. The main problem resulting from this is very spiky salinity data within the thermocline. Given the sharpness of the thermocline over most of the study region very few data points were collected within it, and so de-spiking the salinity to provide accurate salinity profiles appears to be impossible. Rise speeds were slower than dive speeds, and so it is advisable to take only the upward profiles from the instruments.
- Communication problems with the Penguin data acquisition system on Seasoar caused significant data losses early in the cruise (e.g. necessitating frequent re-boots and subsequent patchy data return on the cross-shelf tow number 3). These problems were solved prior to the second leg of the cruise by some creative re-writing of the Penguin software by UKORS staff.

Transect areas, and general comments are listed in table 7.1 and transect lines are summarised in Fig. 7.1.

| Tow | Description | Comments |
|---|---|---|
| 1 | Along Jones Bank. | Collision with seabed led to early recovery. |
| 2 | Along Jones Bank. | Data used to position Jones Bank moorings. On recovery it was clear that the vehicle had again collided with the seabed. |
| 3 | Cross shelf to shelf edge. | Patchy data return due to frequent need to re-boot Penguin. |
| 4 | Repeated 25 hr box survey around Jones Bank moorings. | 25 hour survey aborted after 5 hours due to poor vehicle behaviour in heavy seas. |
| 5 | Small bank SW of Jones Bank and flat seabed. | - |
| 6 | Continuation of tow 5 over Labadie Bank. | - |
| 7 | Across Jones Bank and through station OB. | - |

**Table 7.1.** Summary of Seasoar tow areas.

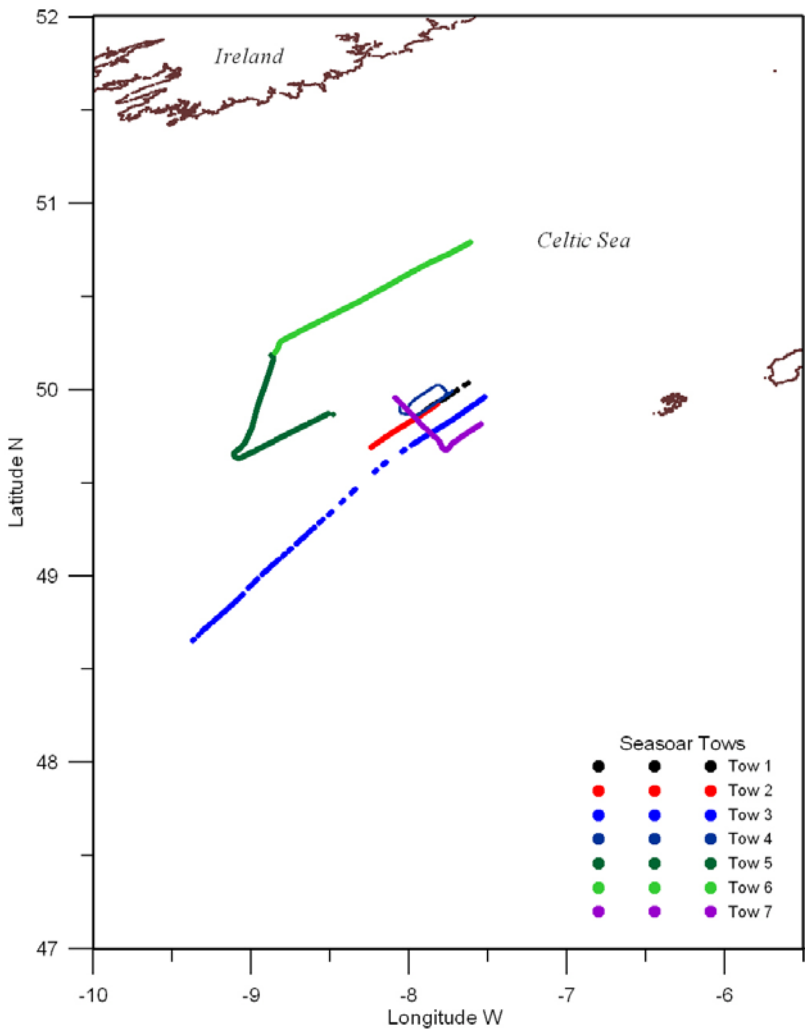



**Figure 7.1**. Seasoar transect lines.

***Seasoar Calibration.***
Seasoar data was calibrated by conducting CTD082 on 30th July, immediately followed by a vertical haul of Seasoar. Calibrations have been carried out by comparing the Seasoar (Minipack CTD) data with the calibrated CTD data from CTD082.

Time stamp of Seasoar data:
The correct time stamp for each minipack measurement is the Julian day supplied by the Penguin data acquisition system. The Minipack day, month, year, hour, etc. were not correct. The only exception to this is tow 7, when the Penguin time was not re-set. An offset of 1.4598846 days needs to be added to the Julian day in the raw data for this tow.

Depth calibrations:
On deck pressure data from CTD082 and the Seasoar Minipack on July 30th showed that the Seasoar Minipack pressure sensor was 0.09 dBar less than the CTD pressure sensor. For each Seasoar tow minipack pressure data is therefore calibrated by applying a pressure offset based on the average on-deck measurements from the nearest CTD casts before and after the Seasoar tow, then corrected by the 0.09 dBar Minipack-CTD offset. Table 7.2 lists the relevant pressure offsets applied to each of the Seasoar tows.

| Seasoar tow | Mean CTD pressure offset | Total calibration applied to Minipack pressure data |
|---|---|---|
| 1 | -0.374 | +0.28 |
| 2 | -0.286 | +0.20 |
| 3 | -0.375 | +0.29 |
| 4 | -0.524 | +0.43 |
| 5 | -0.404 | +0.31 |
| 6 | -0.405 | +0.31 |
| 7 | -0.059 | -0.03 |

**Table 7.2**. Pressure calibrations applied to the Seasoar tows.

Salinity Calibration:
Seasoar Minipack salinity was calibrated by taking the surface and bottom mixed layer data from CTD082 and comparing with the corresponding Minipack data from the vertical haul of Seasoar.

**Calibrated salinity = Seasoar_sal – 0.03 ± 0.02 (PSS78)**

Temperature Calibration:
Seasoar Minipack tempertaure was calibrated by taking the surface and bottom mixed layer data from CTD082 and comparing with the corresponding Minipack data from the vertical haul of Seasoar.

**Calibrated temperature = Seasoar_temp – 0.006 ± 0.007 °C**

Chlorophyll calibration:
Seasoar Minipack chlorophyll *a* was calibrated by comparing the data collected through the subsurface chlorophyll maximum collected by CTD082 and the adjacent vertical haul of Seasoar. Fig. 7.2 illustrates the regression between the two data sets. Note that the surface and bottom layer data were NOT included to prevent the regression being driven by large numbers of low chlorophyll data points.

Using the regression of Fig. 7.2, the Seasoar chlorophyll *a* measurements are calibrated via:

**Calibrated chlorophyll *a* = 0.09 x Seasoar_chl + 0.02 ±0.06 mg $m^{-3}$**

*Note: there was an error in the calibration reported in an earlier cruise report.*

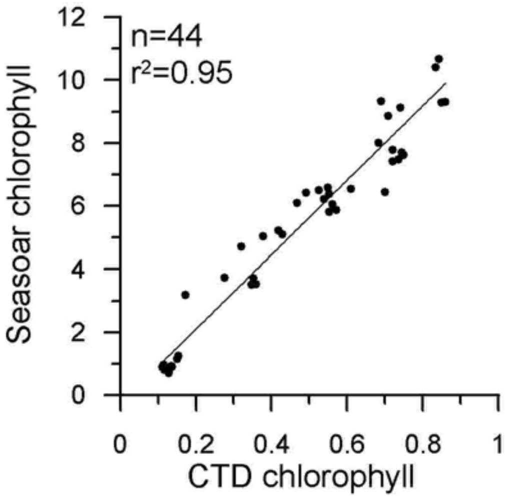



**Figure 7.2**: Comparison between the CTD and Seasoar Minipack chlorophyll a fluorescence data through the thermocline of the central Celtic Sea.

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## 8. Phytoplankton Pigment Measurements and Sampling

Patrick Holligan and Young-Nam Kim

All chlorophyll *a* measurements (4-10 for most CTD casts) were made following the fluorescence method of Welschmeyer (1984), with GFF filters extracted in 90% acetone at ~4°C in the dark for at least 24h. The fluorometer was calibrated against a standard solution of pure chlorophyll *a* (Sigma Chemical Co.). Values given in this report are provisional, subject to laboratory confirmation the standard concentration and to comparison with HPLC (159 samples taken during cruise) chlorophyll *a* values. Two sets of replicate samples (n=6) gave ranges of variation about the mean of 2.1 and 4.6% for chlorophyll maximum and surface samples respectively.

The range of chlorophyll concentrations observed during the cruise is shown in Table 8.1. Surface values were higher at the shelf break than for the shelf stations except JB3, confirming the general pattern shown by satellite ocean colour imagery. The very low levels at two oceanic stations (CTDs 18 and 19) are notable. A general decrease in values at the shelf edge was observed during the transition from neap to spring tides. A subsurface chlorophyll maximum was observed at all stations, and was particularly pronounced at U2 at the start of the cruise following a period of fine weather.

| Station | Surface | Chlorophyll Maximum | Deep (~70m) |
|---|---|---|---|
| CS2 neap (CTDs 07-14) | 0.62 (4) | 1.58 (4) | variable |
| CS2 spring (CTDs 28-34) | 0.54 (5) | 0.89 (5) | variable |
| JB 1 (CTDs 35-57) | 0.29 (11) | 1.22 (14) | 0.38 (14) |
| JB 2 (CTDs 58-71) | 0.61 (7) | 1.09 (6) | 0.24 (7) |
| JB 3 (CTDs 84-108) | 0.43 (9) | 0.88 (9) | 0.27 (11) |
| OB (CTDs 110-130) | 0.30 (11) | 0.92 (11) | 0.18 (9) |
| Ocean (CTD 18) | 0.06 | 0.22 | 0.10 |
| U2 (CTD 02) | 0.32 | 9.45 | 0.35 |
| U2 (CTD 133) | 0.22 | 1.37 | 0.33 |
| P1 (CTD 81) | 0.38 | 1.25 | 0.10 |

**TABLE 8.1**: Average chlorophyll *a* values (mg $m^{-3}$) for main stations (numbers in brackets indicate number of determinations when more than one CTD profile was made).

The size distribution of phytoplankton was examined by filtration of 40 water samples from the surface and chlorophyll maximum through 20, 10, 5 and 2µm membrane filters. Recovery of chlorophyll was >90% (Fig. 8.1), and picoplankton (<2µm) formed the major component of all samples except at the shelf edge where large cells (20µm) were abundant. On the shelf cells in the size range 2-10µm were also important in water from both the chlorophyll and surface.

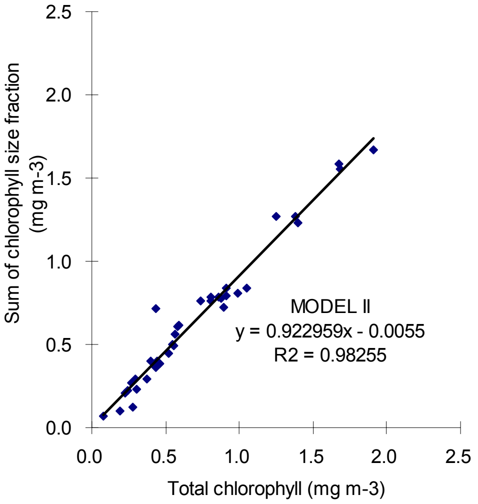



**Figure 8.1.** Comparison of total chlorophyll to the sum of chlorophyll size fractions (<2, 2-5, 5-10, 10-20, >20mm )

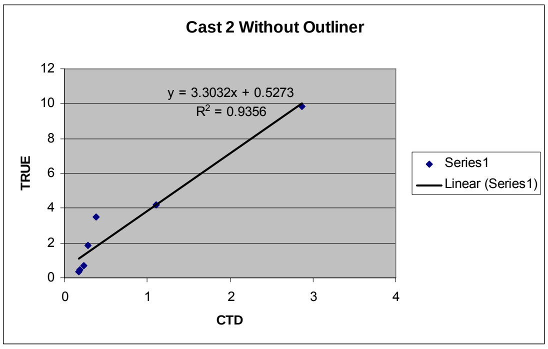
Preserved samples of phytoplankton were collected for examination in the laboratory by flow cytometry (312 samples fixed with paraformaldehyde) and light microscopy (~140 samples fixed with lugols solution and buffered formalin).

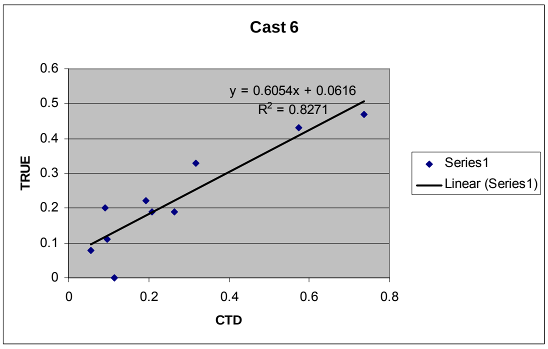
In support of the primary production and FRRF measurements water was also filtered for measurements of particulate C and N (125 samples) and particle light absorption (80 samples).

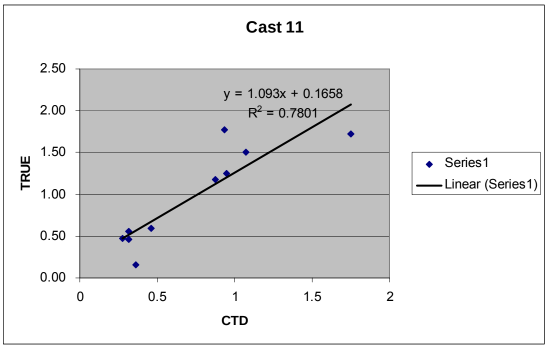
***A Detailed look at the spatial variability of CTD Fluorometer Calibration.***

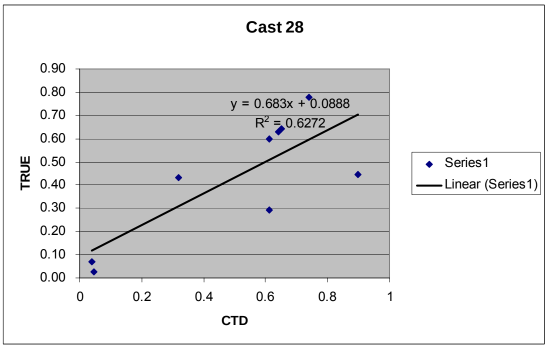
Stephanie Bates (West Kirby Grammar School)

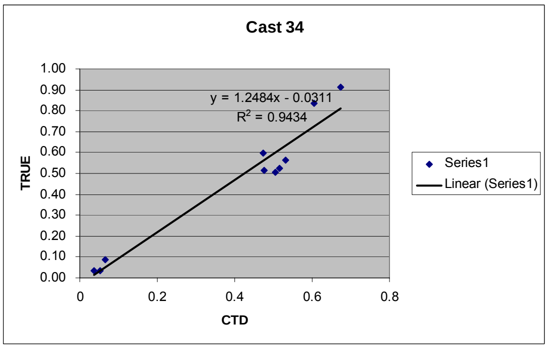
To assess the variability of the chlorophyll calibration across the shelf sea and shelf edge, calibrations were carried out separately on all CTD casts with 8 or more chlorophyll samples. The following plots illustrate the correlations between the CTD fluorometer measurements and the analysed bottle samples.

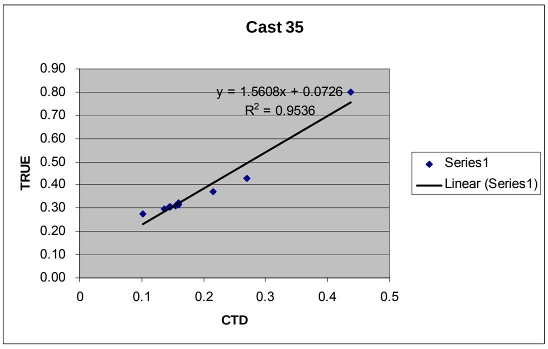


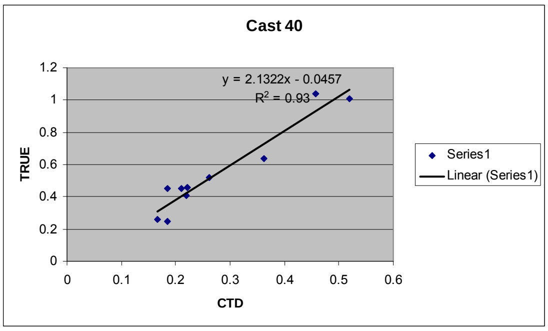



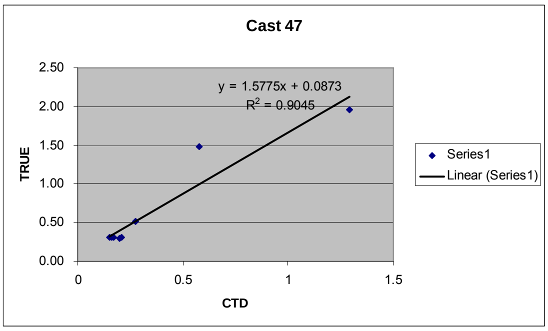

Cast 11
y = 1.093x + 0.1658
R2 = 0.7801
TRUE
CTD
Series1
Linear (Series1)

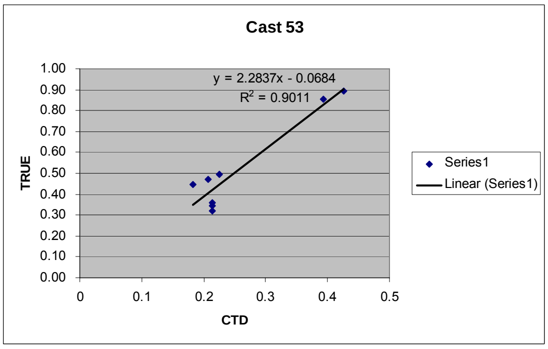

Cast 28
y = 0.683x + 0.0888
R2 = 0.6272
TRUE
CTD
Series1
Linear (Series1)

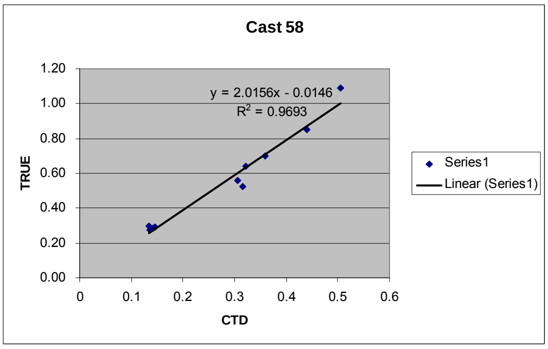

Cast 34
y = 1.2484x - 0.0311
R2 = 0.9434
TRUE
CTD
Series1
Linear (Series1)

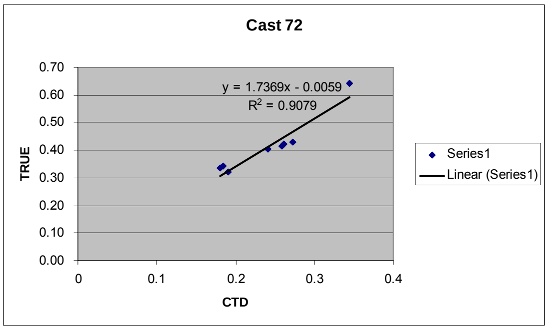

Cast 35
y = 1.5608x + 0.0726
R2 = 0.9536
TRUE
CTD
Series1
Linear (Series1)

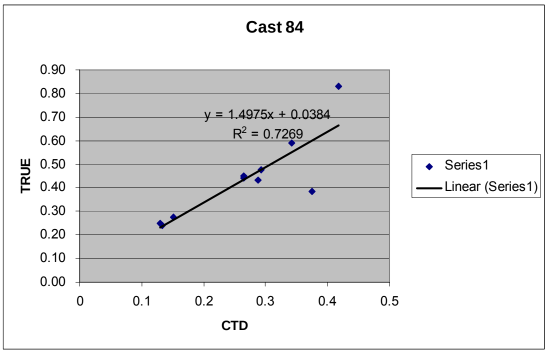

Cast 40
y = 2.1322x - 0.0457
R2 = 0.93
TRUE
CTD
Series1
Linear (Series1)

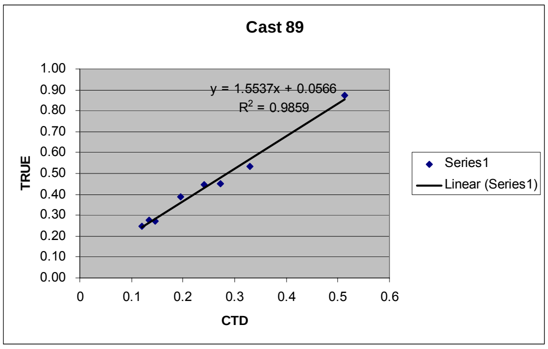

Cast 47
y = 1.5775x + 0.0873
R2 = 0.9045
TRUE
CTD
Series1
Linear (Series1)

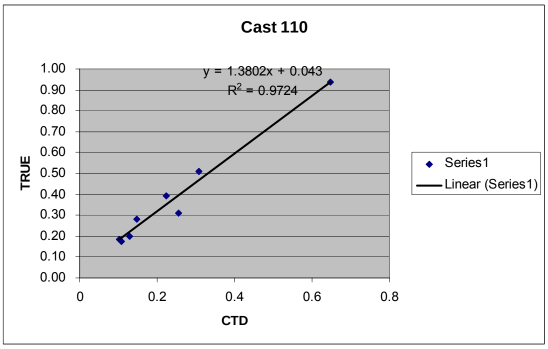

Cast 53
y = 2.2837x - 0.0684
R2 = 0.9011
TRUE
CTD
Series1
Linear (Series1)

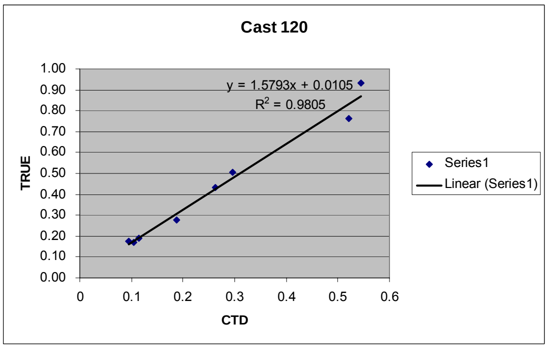

Cast 58
y = 2.0156x - 0.0146
R2 = 0.9693
TRUE
CTD
Series1
Linear (Series1)

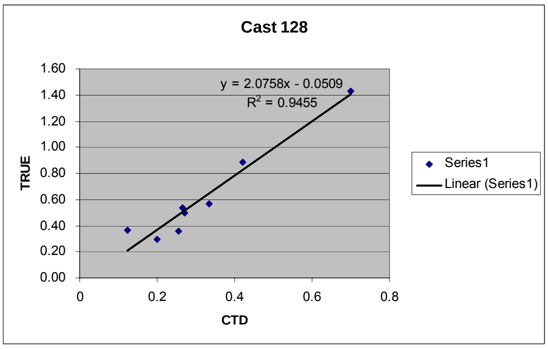

Cast 72
y = 1.7369x - 0.0059
R2 = 0.9079
TRUE
CTD
Series1
Linear (Series1)

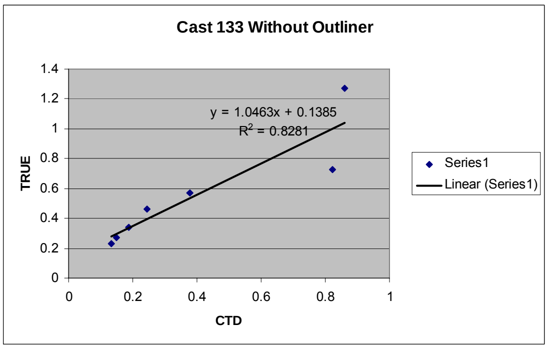

Cast 84
y = 1.4975x + 0.0384
R2 = 0.7269
TRUE
CTD
Series1
Linear (Series1)



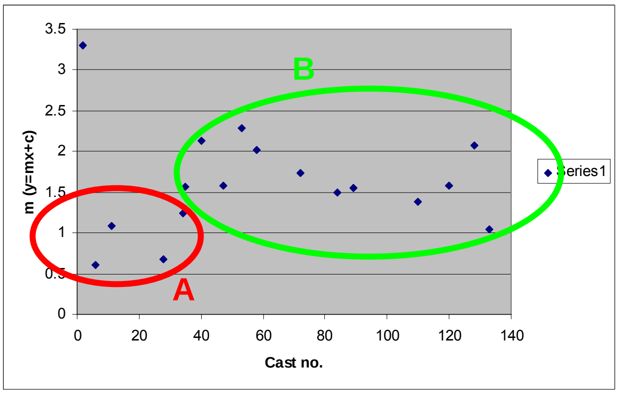



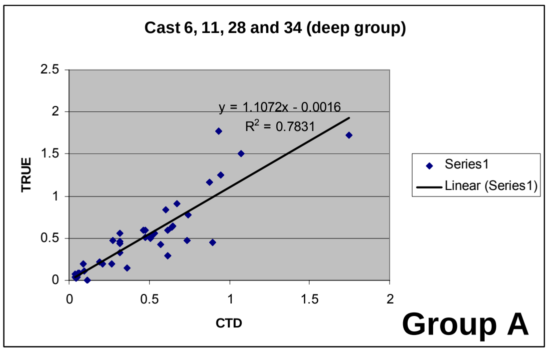



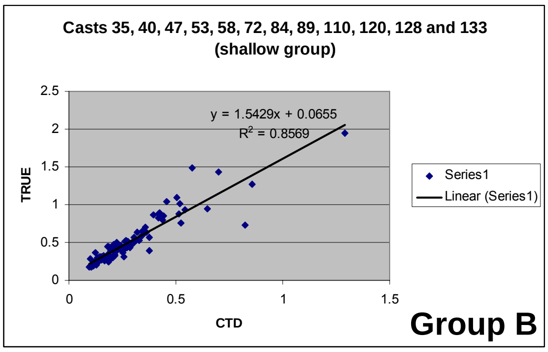




Collecting the regression information and plotting the slope of the regression for each CTD cast number suggests that the CTD calibrations broadly fit into two groups (see below).




As observed on previous cruises considerable variability is observed in the relationship between *in vivo* fluorescence and extracted chlorophyll which is explained partly by sampling effects (diel variability in fluorescence, differences in the depths of the fluorometer and water bottles on steep gradients) and partly by significant regional differences in fluorescence yields (eg between the shelf edge and shelf stations). Group A were all collected at the shelf edge, and group B were from within the Celtic Sea. Thus calibration data was then grouped into A and B to produce two separate calibration equations for the shelf edge and the Celtic Sea.

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# 9. Nutrients Measurements

Young-Nam Kim and Mohammed Qurban (NOCS)

***Objectives***
To investigate the spatial and temporal variations in levels of inorganic nutrients (nitrate, phosphate, and silicate) in continental shelf and shelf edge waters of the Celtic Sea.

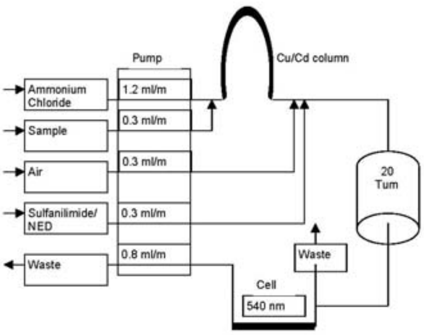
***Methodology***
The measurements were made with standard colorimetric methods with a Skalar Autoanalyser. The manifold layouts are illustrated in Figure 9.1. Separate primary standards were prepared and stored on 125 ml Nalgene polycarbonate bottles in refrigerator, as follows:

Weights in 500ml distilled water
Silicate 0.96g sodium fluorosilicate
Phosphate 0.681g Potassium hydrogen phosphate
Nitrate 0.510g Potassium Nitrate
Nitrite 0.345g Sodium Nitrate

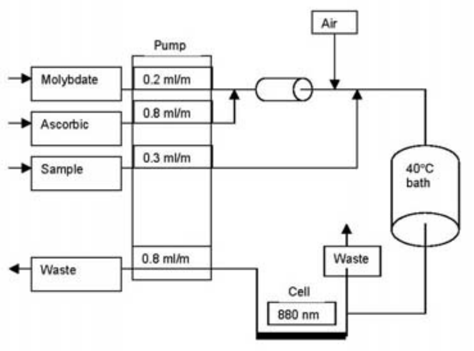
A combined Silicate, Phosphate and Nitrate secondary standard was prepared from 25 ml of primary silicate solution and nitrate solution and 5 ml primary phosphate solution, diluted to 100ml. 1ml of this standard gave a top concentration working standard of 10 uM Si and NO3 and 2uM PO4 when diluted in 250ml of 40g/l sodium chloride solution.

***Results***
Samples were collected daily and analysed within 24hours. Detailed nutrient profiles for the main FLY and for station U2 are shown in Figure 9.2. At station, nutrients was low in the surface mixed layer, due to their uptake by primary producers with nitrate being most depleted relative to bottom concentrations. The shelf edge station (CS2) shows relatively low surface silicate values and perhaps due to the presence of diatoms. A sharp increase in the nutrient concentrations was found across the seasonal thermocline. The nutricline was generally steeper at shelf stations (B2, OB, and U2) than at the shelf edge (CS2) as shown by plots of nitrate concentration against temperature (Figure 9.3). Strong tidal mixing at spring tide appeared to lead a near surface increase in nitrate at CS2. The higher scatter in the nitrate-temperature relationship at B2 reflects sampling difficulties over a steep gradient which were related to vertical displacement between CTD sensors and water bottles, and to disturbance of the water column around the CTD frame.

**Nitrate**




**Phosphate**




**Silicate**

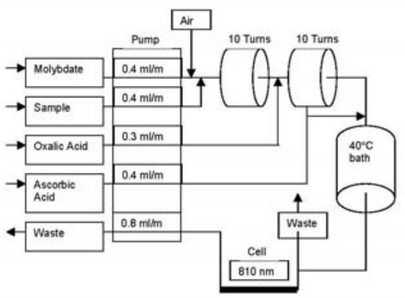



**Figure 9.1**. Manifold Diagrams for Skalar Autoanalyser

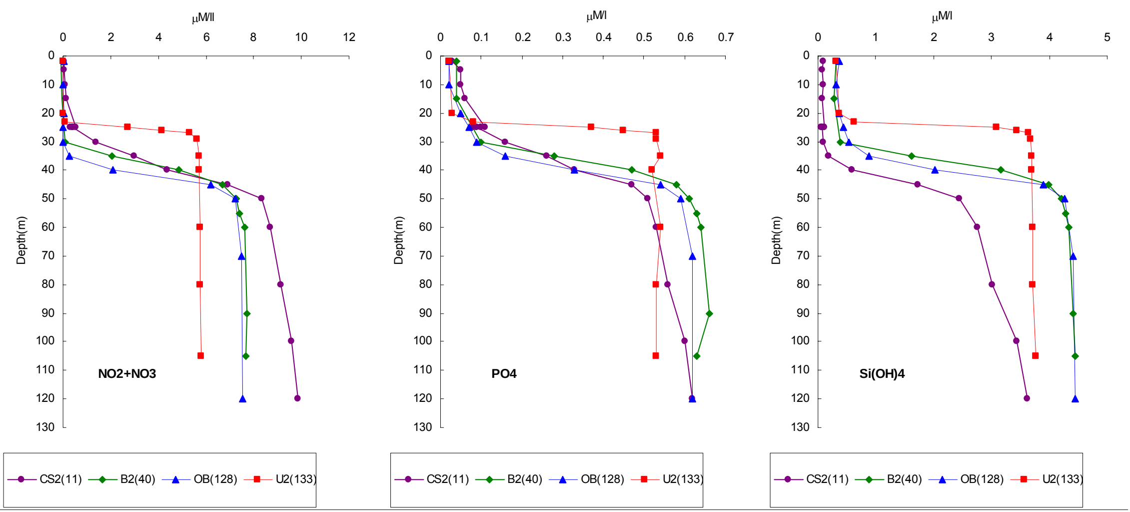



**Figure 9.2.** Representative vertical nutrients profiles for shelf (U2, B2, OB) and shelf edge (CS2) stations

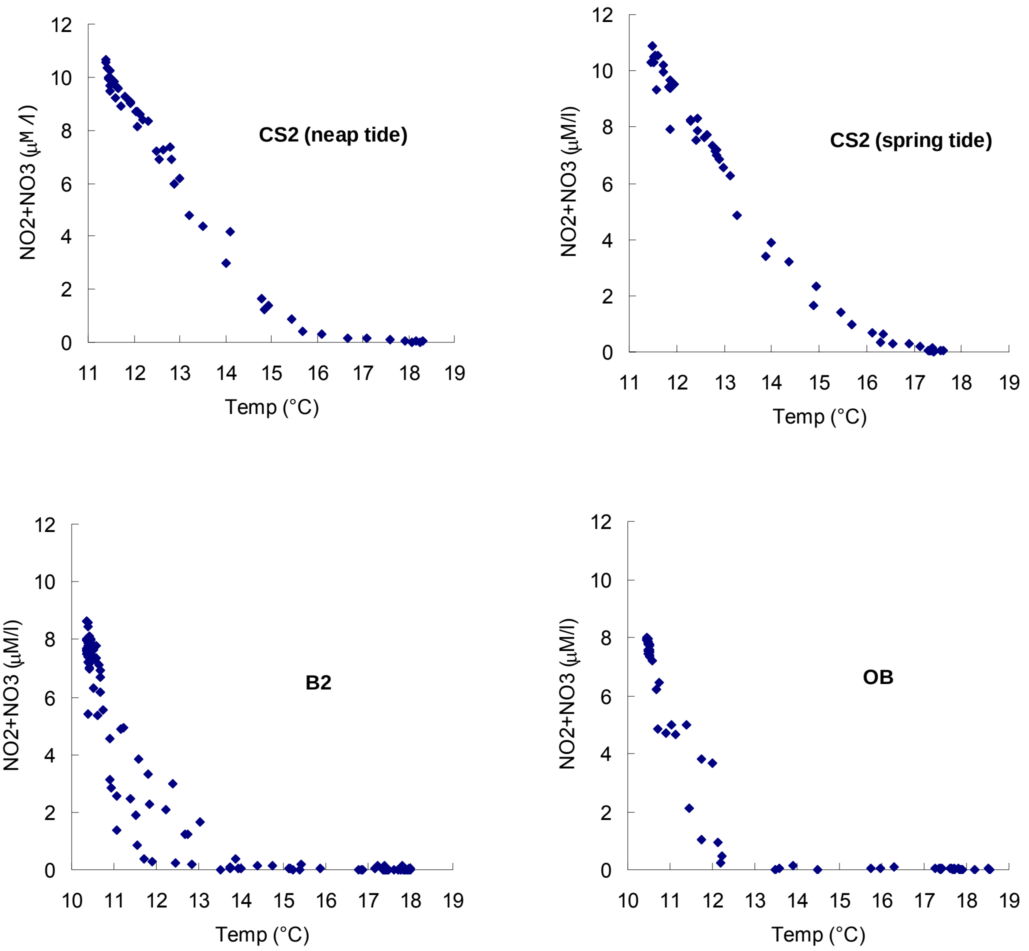



**Figure 9.3**. Plots of nitrate (NO3+NO2) against temperature for the 25 hr stations

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## 10. P vs E Primary production experiments ($^{14}C$).

Anna Hickman

***Sampling***

Water was collected at 4 depths from pre-dawn CTD casts. The four depths were chosen to sample the surface, mid-to-lower surface mixed layer, upper thermocline and subsurface fluorescence maximum. PE incubations were for the duration of two hours, and samples held as close as possible to in-situ temperature by flushing with either surface sea water or water chilled to mid-thermocline temperature. For each depth 15 x 73ml bottles were incubated in the gradational light field along with 3 dark bottles. One incubation (PE11) was carried out with samples taken at midday from four depths within the thermocline.

| Expt. | CTD | Date | Time (GMT) | Depths (m) | Location |
|---|---|---|---|---|---|
| PE01 | 6 | 17.07.05 | 03.00 | 2,20,35,50 | Oceanic |
| PE02 | 11 | 18.0.705 | 07.30 | 2,10,25,35 | CS2 |
| PE03 | 16 | 20.07.05 | 03.00 | 7,15,25,35 | Flat Shelf |
| PE04 | 19 | 22.07.05 | 03.00 | 0,20,40,60 | Oceanic-CS2 |
| PE05 | 28 | 23.07.05 | 03.00 | 2,20,30,60 | CS2 |
| PE06 | 47 | 27.07.05 | 03.00 | 2,15,25,33 | Bank Edge |
| PE07 | 72 | 29.07.05 | 03.00 | 2,10,20,30 | Flat Shelf |
| PE08 | 81 | 30.07.05 | 04.00 | 2,10,30,50 | Flat Shelf |
| PE09 | 84 | 31.07.05 | 03.00 | 2,10,25,35 | Bank Edge |
| PE10 | 120 | 02.08.05 | 03.00 | 2,20,40,45 | Flat Shelf |
| PE11 | 128 | 02.08.05 | 11.00 | 25,30,35,40 | Flat Shelf SCM |
| PE12 | 133 | 03.08.05 | 04.00 | 2,20,23,25 | U2 |

### *14C PE Experimental Protocol*

<u>Working Stock</u>
Working stock solution was prepared by separating 10mCi stock into daily 1ml ampoules of activity 730uCi, made up in autoclaved and pH-adjusted milli-q. These daily stocks were then diluted in 7.4ml freshly filtered sea water to provide a working stock solution for each experiment. The spike added to each of the 73ml sample bottles was 10uCi in 100ul working stock.

<u>Standards</u>
100ul of working stock was added to 9.9mls Carbosorb. From this, 5 replicates of 100ul were placed in 6ml pony vials to which 5mls Permafluor scintillation cocktail were added.

For experiment PE1, where this method was not possible, spike activity was obtained by taking a sub-sample of 200ul from six of the 73ml sample bottles. To the sub-samples 1.6ml Carbosorb and then 3ml Permafluor were added.

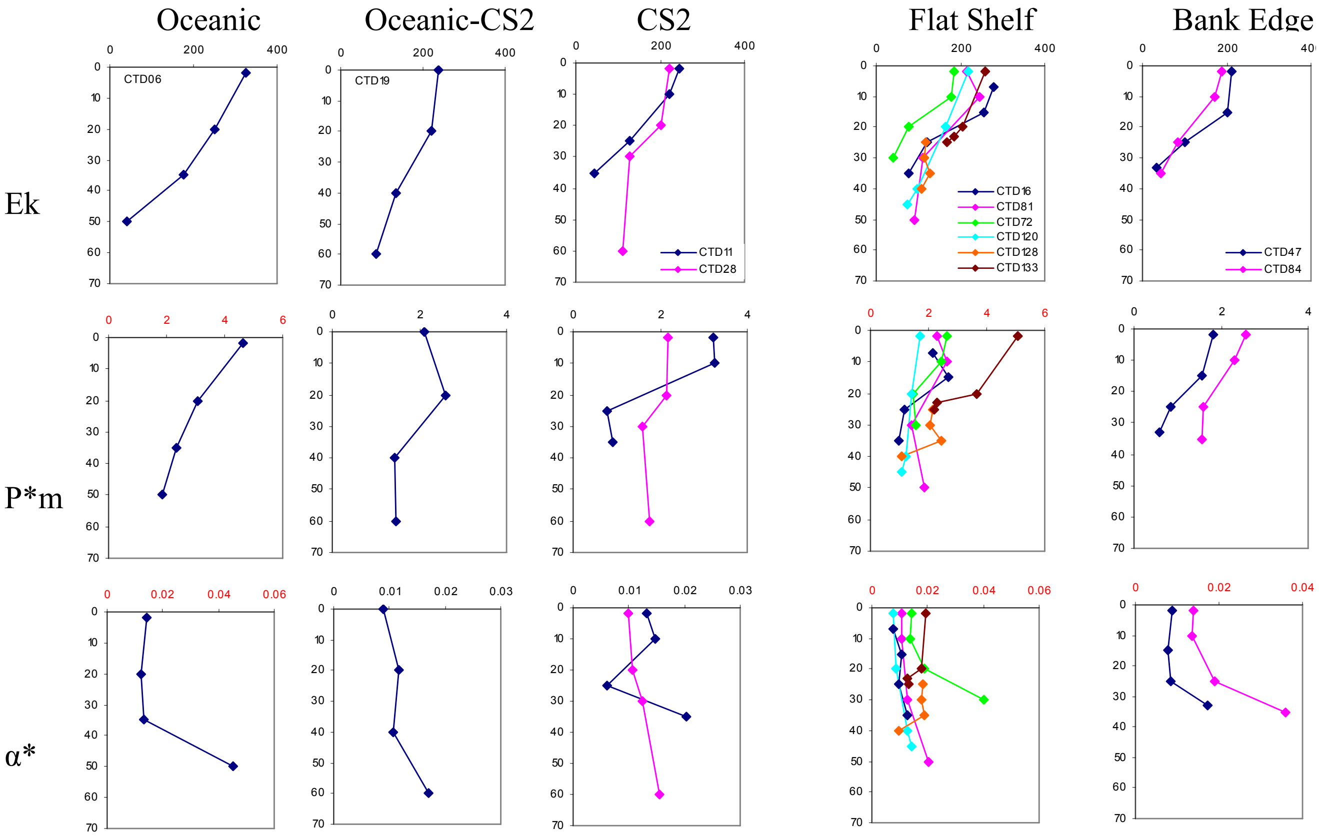
<u>Experimental Protocol</u>

1. Water from each depth was separated into 18 x ~73ml sample bottles, providing 15 light bottles and 3 darks for each depth.
2. 10µCi was added to each of the 73ml sample bottles.
3. The light and dark samples were incubated for 2hrs, at either sea surface or mid-thermocline temperature.
4. After incubation samples were filtered onto 25mm 0.2µm polycarbonate filters.
5. Filters were then fumed with concentrated HCl to remove inorganic $^{14}C$ for at least two hours.
6. Filters were placed in 6ml pony vials into which 5ml Opti-Phase HiSafe scintillation cocktail was added.
7. All standards and samples were counted using the scintillation counter on the ship (using Ultima-Gold quench curve).
8. Between experiments 73ml sample bottles were soaked in 10% HCl and rinsed three times with milli-q.

Water samples were kept under dim red light at all times and kept in the cool and dark as much as possible during handling.

<u>Light levels</u>
Light levels in the PE incubator were measured periodically during the cruise using a PAR sensor.

***Initial Results***
Plots below are the PE parameters Ek [mmol photons $m^{-2}$ $s^{-1}$], P*m [mg C (mg Chl)$^{-1}$ $hr^{-1}$] and α* [mg C (mg Chl)$^{-1}$ $hr^{-1}$ (mmol photons $m^{-2}$ $s^{-1}$)] with depth at the locations sampled.




## <u>11. Phytoplankton $^{15}N$ & $^{13}C$ Uptake Rates</u>

Mike Lucas.

***Rationale***
The vertical structure of the Celtic Sea in summer is typically dominated by a strong thermocline and associated deep chlorophyll maximum (DCM). Surface waters are nutrient impoverished. Phytoplankton within the DCM have access to limited nutrients injected from below the thermocline by tidal and internal wave mixing but experience a low ambient light field; particularly at the base of the DCM. Phytoplankton community structure (diatoms / flagellates), physiological status and productivity will depend on relative light and nutrient availability. The problem for phytoplankton is how to achieve a balance between light and nutrient requirements in a turbulent environment. If they are mixed below the thermocline,

they are lost from the DCM in a light limited environment. However, if they are too far above the thermocline, they will be nutrient limited, but not light limited. The major goal of the $^{15}N$ & $^{13}C$ tracer studies was to simultaneously measure phytoplankton production ($^{13}C$ fixation) and "new" nitrate based production within the DCM to elucidate how phytoplankton resolve the balance between $NO_3$ and light demands. A further goal was to match the upward turbulence-driven $NO_3$ flux (calculated from "FLY" deployments) with "new" nitrate based production.

Rates of new production depend not only on ambient $NO_3$ concentrations and supply rates, but also on the available light to drive $NO_3$ uptake ($\rho NO_3$). This makes it important to measure $\rho NO_3$ in response to both $NO_3$ and light gradients.

***Approach***

A. P vs E Measurements

To understand how carbon fixation and $\rho NO_3$ are controlled by light and ambient $NO_3$ concentration, P vs E response curves were generated simultaneously for $\rho NO_3$ and carbon fixation using stable isotope tracers ($^{13}C$ and $^{15}N$) at both low (~20-50nM) and high, saturating (~5µM) $NO_3$ concentrations. Water was obtained from the top of the DCM where ambient $NO_3$ concentrations were between zero (undetectable) and ~ 50nM. P vs E incubations in response to saturating $NO_3$ concentrations were achieved by adding sufficient $NO_3$ to bring the final incubation $NO_3$ concentration to ~ 5µM. Once, water was also obtained from the base of the DCM where the $NO_3$ concentration was ~4.5µM, so that no $NO_3$ addition was required.

For $\rho NO_3$ and $^{13}C$ incubations, 2 x (14 x 1.0L) polycarbonate bottles were incubated for 4 hours in 2 light boxes cooled to 13°C. Stable isotope nutrient "spikes" (Cambridge Isotope Laboratories, Inc., MA, USA: $K^{15}NO_3$, 98%+15N and $NaH^{13}CO_3$, 99% 13C) additions were made at ~10% of the ambient nutrient concentration. Corrections for potential dark uptake were made by similarly spiking and incubating (dark @ 13°C) 7-9 x 1.0L bottles covering a $NO_3$ gradient from ~20nM to ~5µM created with appropriate $NO_3$ additions.

The light sources were two 500W halogen lamps. The spectral quality was corrected to remove red light using a "Misty Blue" (061) Lee filter. Light attenuation within the light boxes ranged from approx. 500µE to 8µE.

At the end of the incubation period, 100mls from each P vs E bottle was removed for chlorophyll analysis. The remaining phytoplankton were recovered onto 25mm Whatman GF/F (ashed) filters. These were stored frozen (-20°C) prior to analysis for $^{15}N$ & $^{13}C$ on a Mass Spec at NOC.

B. Nutrient Uptake Kinetics

The object of these experiments was to determine the rate of $NO_3$ uptake as a function of a $NO_3$ concentration gradient at two fixed light depths, corresponding roughly to the upper (HL ~71µE) and lower (LL ~15µE) DCM. Incubations were performed in 1.0L bottles with the same water used for the P vs E experiments. Incubation boxes were covered with appropriate layers of Lee Neutral Density and Misty Blue filters and illuminated with 500W Halogen lamps. Incubations were maintained at 14°C in the constant temperature lab.

The ambient $NO_3$ gradient was constructed by making $NO_3$ additions aimed to achieve final incubation concentrations of 40, 75, 100, 150, 200, 500nM and 1, 2 and 5 µM. As before, "spikes" of $^{15}N$-$NO_3$ and $^{13}C$ bicarbonate were made at ~10% of the final ambient nutrient concentration, although at the low nano-molar range, $^{15}N$ spike additions were closer to 100% to ensure sufficient measurable isotope incorporation.

By combining P vs E and uptake kinetic experiment results, we hope to construct curves of carbon fixation and $\rho NO_3$ as a simultaneous function of both light and $NO_3$ gradients experienced by phytoplankton in the DCM.

***Measurements***
Experiments were performed only at the 25hour "FLY" deployment stations. Water was usually collected from the dawn (~4am) CTD cast where supporting physics, optical, FRRf, biomass and other rate measurements were collected.

| **Exp.** | **Date** | **Station** | **CTD No** | **Bottles** | **Depth (m)** | **T°C** | **Chl-a ($\mu g\ l^{-1}$)** | **Initial $NO_3$ (µM)** |
|---|---|---|---|---|---|---|---|---|
| 1 | 18/07 | CS2 | 11 | 13-16 | 25 | NA | 1.68 | 0.43 |
| 2 | 23/07 | CS2 | 28 | 15-19 | Surf. | NA | 0.69 | 0.04 |
| 3 | 27/07 | Bank 2 | 47 | 15-18 | 25 | 13.4 | 0.47 | 0.08 |
| 4 | 31/07 | Bank 2 | 85 | 4-8 | 40 | 11.2 | 1.05 | 0.21 |
| 5 | 02/08 | OB | 120 | 14-17 | 45 | 10.8 | 1.04 | 4.66 |
| 6 | 02/08 | OB | 128 | 17-19** | 30 | 13.4 | 0.51 | 0.027* |

* mean of 10 replicates
** bottle 16 did not seal
NA = not available on CTD deck sheet

*Sample Analyses*

I anticipate analysing the 15N &13C samples (~360) during the latter half of August with results being available in late August / early September.

*Acknowledgements*

The timely provision of excellent nutrient data by Young Nam Kim & Mohammed Qurban was very greatly appreciated on this cruise. Many thanks are also due to Jonathan Sharples, Patrick Holligan and Mark Moore for providing me with the opportunity to participate on the cruise. Special thanks also to Patrick and Mark for chlorophyll data and water respectively! Filtering is such fun!

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## 12. Fast Repetition Rate Fluorometery Measurements

Mark Moore, Jacqui Tweddle, Young-Nam Kim

***Methods***
Measurements of variable chlorophyll fluorescence were performed throughout the cruise using a number of Chelsea Scientific Instruments Fasttracka™ Fast Repetition Rate (FRR) fluorometers. In situ instruments were deployed on both the CTD package and the SeaSoar towed undulator. Measurements of discrete water samples collected using the CTD package were also performed under controlled conditions using a third instrument in the constant temperature laboratory.

***CTD deployments***
The instrument (sn 182043) on the CTD package was interfaced with a depth sensor and $2\pi$ PAR sensor. The instrument was configured to record internally and data was subsequently downloaded from the flashcard after approximately 5-10 casts. A total of 122 vertical profiles were collected using the instrument on the CTD package. Intermittent battery problems resulted in the loss of data from a number of profiles (listed in appendix,

Jonathan, you may want to remove the appendix as is a bit dry). The problem was eventually tracked to a faulty battery (sn 182039) which was not charging.

***Seasoar deployments***

The instrument (sn 182041) flown on the Seasoar package was interfaced with a 2$\pi$ PAR sensor and the Penguin data acquisition system. Data was recorded using the 'verbose mode' setting on the FRR fluorometer and recorded on the Penguin hard drive. Subsequent data processing revealed some initial problems with data formatting during the early part of the cruise when Penguin communication problems were apparent. Recovery of this data will require new software to be written. Later deployments appeared to be free of these formatting problems, however complete reprocessing of the seasoar FRR fluorometer data will be necessary on shore.

***Laboratory measurements***

The laboratory instrument (sn 182039) was set up within the constant temperature (CT) laboratory, held at 14°C throughout the cruise. Discrete samples were collected from the CTD, principally from the early morning (0300-0400 GMT) casts associated with the $^{14}C$ P vs E incubations (see section by Hickman). Samples were collected into darken bottles and stored in the CT lab until analysis. Samples were run on fixed gains, choosing the highest setting that did not saturate the fluorometer response. Samples were run using a number of protocols which principally differed in the timing between the relaxation flashlets used to measure down chain electron transport from photosystem II (PSII). The standard protocol used a relaxation sequence lasting around 2 ms. Samples from depths associated with $^{14}C$ P vs E experiments were subsequently run on a further set of protocols with relaxation sequences ranging from 1.4 to 4 ms. Blanks were generated for each discrete sample by gentle sequential filtration through a Whatmann GF/F filter followed by a 0.2 $\mu$m filter. These blanks were analysed on identical instrument protocols to the samples. FRR fluorescence measurements were also repeated on size-fractionated water samples from the surface and chlorophyll maximum. An aliquot of 200ml to 250 ml was filtered by gravity through 5 $\mu$m polycarbonate (Poretics U.K.) filters and then gently resuspended in 100 ml of the original seawater sample filtered through 0.22$\mu$m polycarbonate (Poretics U.K.) filters. This procedure generated the >5 and <5$\mu$m size classes. Blanks for each depth were obtained as described above. FRR fluorescence from the filtrates was measured at fixed gain settings and subtracted from the sample values.

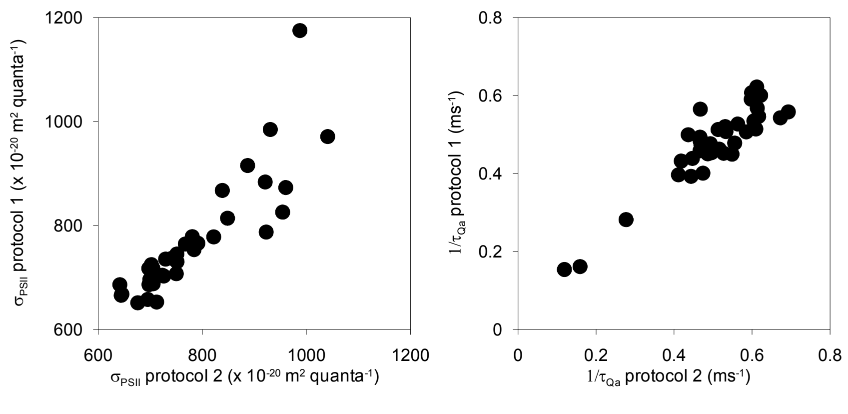



**Figure 12.1.** Comparison of FRRf data measured on discrete samples using two different protocols, one with a relaxation sequence lasting ~2 ms and one lasting ~4 ms. Calculated values of the functional absorption cross section (left) and the down chain rate of electron transport (right) are highly correlated ($r^2 > 0.77$, $p < 0.001$) and comparable.

***Preliminary results***

Initial analysis indicated little protocol dependency for the measurements of electron turnover or photosynthetic cross section (Figure 12.1). This observation lends confidence to the recovery of the absolute values of both these parameters from FRRf measurements.

An example of vertical profiles of physiological parameters reconstructed using discrete FRR fluorometer measurements compared to measurements made in situ is presented in Figure 12.2. Again consistency between methods provided confidence in the observations. The profile presented in Figure 12.2 was obtained at the far oceanic station and is unusual in that a marked minimum in $F_v/F_m$ associated with a maximum in $\sigma_{PSII}$ was observed within the SCM. Such a pattern has not previously been observed and contrasts with the typical shelf situation (Moore et al. 2003, Submitted). The cause of the mid-water drop in $F_v/F_m$ is particularly difficult to explain at present. In contrast, on shelf data was consistent with many of the previous conclusions reached by this research group subsequent to work on the JR98 cruise (Moore et al. Submitted). Vertical profiles of $\sigma_{PSII}$ and $1/\tau_{Qa}$ indicated that the former varied relatively little with depth in and above the SCM, while the later typically increased towards the surface, presumably representing a photo acclimation response (Figure 12.3). Calculated values of the saturation light intensity of electron transport ($E_{k,\ ETR}$) also increased towards the surface. Interesting new observations included marked diel variability in $1/\tau_{Qa}$ apparent within the surface layer at OB (Figure 12.3). Additionally a small increase of $\sigma_{PSII}$ was observed within the SCM at U2. Finally, photophysiological parameters calculated from complementary $^{14}C$ P vs E measurements (see section by Hickman) contrasted with a number of parameters measured by FRRf. The physiological/ecological basis of these observations is currently unclear.

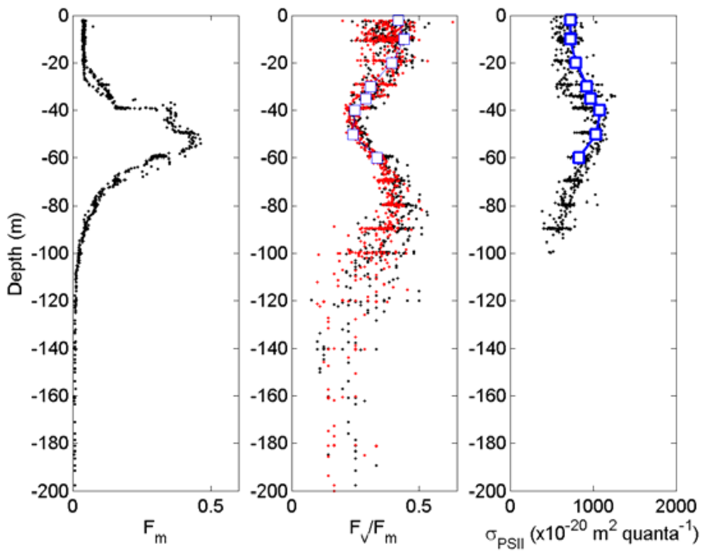



**Figure 12.2.** FRRf measurements of the maximal fluorescence, a proxy for the chlorophyll concentration (far left), the photochemical quantum efficiency ($F_v/F_m$, middle) and the PSII functional absorption cross section ($\sigma_{PSII}$, right). Measurements made in situ using profiling instrument on CTD frame (closed symbols) are compared with discrete measurements made under controlled conditions in the CT lab (open symbols). The in situ profile was performed pre dawn hence the ratio of variable to maximal fluorescence measured in the two sampling areas of the in situ instrument (red enclosed, blue open) were identical.

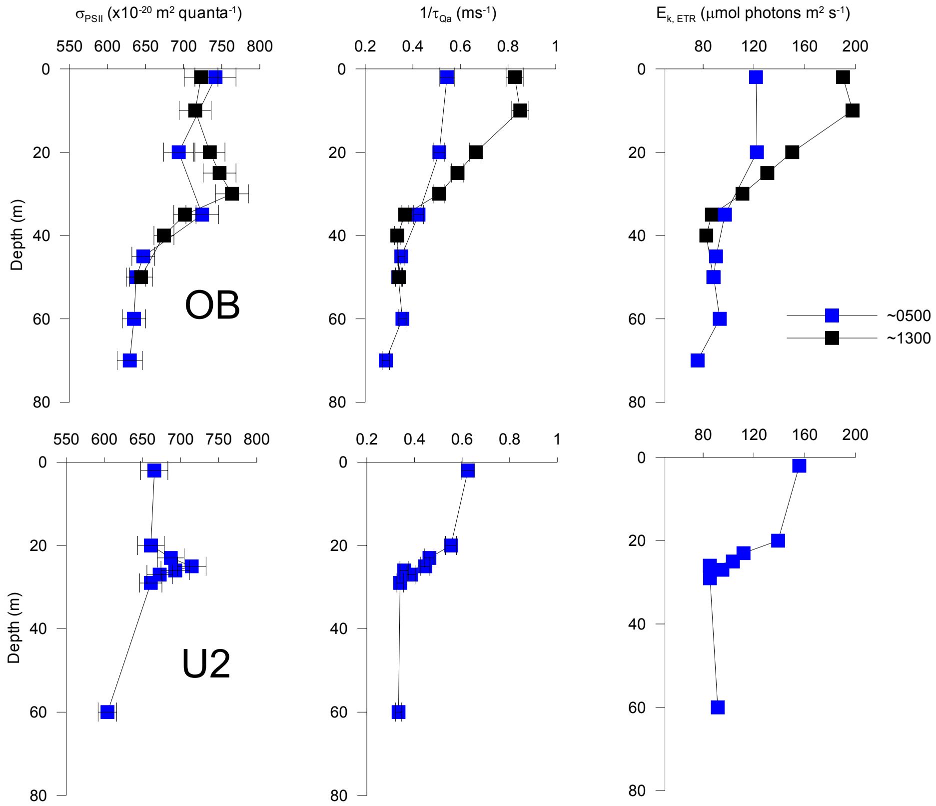



**Figure 12.3** Vertical profiles of FRRf derived physiological parameters reconstructed from measurements on discrete samples. Samples were collected pre-dawn at stations OB and U2 (blue). An additional vertical profile was collected at 1300 at OB (black).

## Appendix

FRRf vertical casts

| CTD CAST # | DATE | WEATHER | COMMENTS |
|---|---|---|---|
| 1 | 15/7 | O | Stopped flashing |
| 2 | 15/7 | O | |
| 3 | 16/7 | O | |
| 4 | 16/7 | Dusk | |
| 5 | 16/7 | D | |
| 6 | 17/7 | D | |
| 7 | 17/7 | D | |
| 8 | 17/7 | D | |
| 9 | 17/7 | D | |
| 10 | 18/7 | D | |
| 11 | 18/7 | O | Stopped flashing |
| 12 | 18/7 | S | |
| 13 | 18/7 | S | |
| 14 | 18/7 | S | Corrupt file |
| 15 | 19/7 | S | |
| 16 | 20/7 | D | |
| 17-27 | | | No frrf on CTD frame |
| 28 | 23/7 | | No file |
| | | | Reformatted flashcard |
| 29 | 23/7 | O | |
| 30 | 23/7 | O | |
| 31 | 23/7 | O | |
| 32 | 23/7 | O | |
| 33 | 23/7 | D | |
| 34 | 24/7 | D | |
| | | | Reformatted flashcard |
| 35 | 26/7 | S | |
| 36 | 26/7 | S | |
| 37 | 26/7 | S | |
| | | | Reformatted flashcard |
| 38 | 26/7 | O | |
| 39 | 26/7 | O | |

| | | | |
|---|---|---|---|
| 40 | 26/7 | O | |
| 41 | 26/7 | Dusk | |
| 42 | 26/7 | D | |
| 43 | 26/7 | D | |
| | | | Reformatted flashcard |
| 44 | 26/7 | D | |
| 45 | 27/7 | D | |
| 46 | 27/7 | D | |
| | | | Reformatted flashcard |
| 47 | 27/7 | | |
| 48 | 27/7 | | |
| 49 | 27/7 | Dawn | Stopped flashing |
| | | | Change battery |
| 50 | 27/7 | Dawn | |
| | | | Reformatted flashcard |
| 51 | 27/7 | O | |
| 52 | 27/7 | O | |
| 53 | 27/7 | O | |
| 54 | 27/7 | O | |
| | | | Reformatted flashcard |
| 55 | 27/7 | O | |
| 56 | 27/7 | O | |
| 57 | 27/7 | O | |
| 58 | 28/7 | O | |
| 59 | 28/7 | O | |
| 60 | 28/7 | O | |
| 61 | 28/7 | O | |
| 62 | 28/7 | O | |
| | | | Reformatted flashcard |
| 63 | 28/7 | 0 | |
| 64 | 28/7 | 0 | Short files |
| 65 | 28/7 | 0 | Short files |
| 66 | 28/7 | 0 | |
| 67 | 28/7 | 0 | Stopped flashing |
| 68 | 28/7 | 0 | |
| | | | Reformatted flashcard |
| 69 | 28/7 | 0 | |
| 70 | 28/7 | D | Switched off before entering water |
| 71 | 28/7 | D | Stopped flashing |
| | | | Reformatted flashcard & Changed Battery |
| 72 | 29/7 | D | |
| 73 | 29/7 | D | |
| 74 | 29/729/7 | Dawn | |
| 75 | 29/7 | S | |
| 76 | 29/7 | S | |
| 77 | 29/7 | S | |
| 78 | 29/7 | S | |
| 79 | 29/7 | S | |
| 80 | 29/7 | S | |
| 81 | 30/7 | D | |
| 82 | 30/7 | S | |
| 83 | 30/7 | S | |
| 84 | 31/7 | D | |
| 85 | 31/7 | Dawn | |
| 86 | 31/7 | O | |
| 87 | 31/7 | O | Stopped flashing |
| | | | Battery changed |
| 88 | 31/7 | O | |
| 89 | 31/7 | O | |
| 90 | 31/7 | O | |
| 91 | 31/7 | O | |
| 92 | 31/7 | O | Stopped flashing |
| 93 | 31/7 | O | Stopped flashing |
| | | | Reformatted flashcard & Battery changed |
| 94 | 31/7 | O | |
| 95 | 31/7 | O | |
| 96 | 31/7 | O | |
| 97 | 31/7 | O | |
| 98 | 31/7 | O | |
| 99 | 31/7 | Dusk | |
| 100 | 31/7 | Dusk | |

| | | | |
|---|---|---|---|
| 101 | 31/7 | D | |
| 102 | 31/7 | D | |
| 103 | 31/7 | D | |
| 104 | 1/8 | D | |
| 105 | 1/8 | D | |
| | | | Reformatted flashcard |
| 106 | 1/8 | D | |
| 107 | 1/8 | D | |
| 108 | 1/8 | Dawn | |
| 109 | 1/8 | S | |
| 110 | 1/8 | S | |
| 111 | 1/8 | S | |
| 112 | 1/8 | S | |
| 113 | 1/8 | Dusk | |
| 114 | 1/8 | Dusk | Stopped flashing |
| 115 | 1/8 | D | |
| 116 | 1/8 | D | |
| 117 | 2/8 | D | |
| 118 | 2/8 | D | |
| 119 | 2/8 | D | |
| | | | Reformatted flashcard |
| 120 | 2/8 | D | Stopped flashing |
| 121 | 2/8 | Dawn | Stopped flashing |
| | | | Battery changed |
| 122 | 2/8 | S | |
| 123 | 2/8 | S | |
| 124 | 2/8 | S | |
| 125 | 2/8 | S | |
| 126 | 2/8 | S | |
| 127 | 2/8 | S | |
| 128 | 2/8 | S | |
| 129 | 2/8 | S | |
| 130 | 2/8 | S | |
| 131 | 2/8 | S | |
| 132 | 3/8 | S | |
| 133 | 3/8 | S | |

D=Dark O=Overcast S=Sunny

## 13. Dissolved Oxygen Measurements

Dr Duncan A. Purdie (School of Ocean & Earth Science, NOCS)

### *Objectives*

The objective of this work was 1) to provide accurate and precise dissolved oxygen measurements from a number of CTD casts throughout the three week cruise to allow comparison with the CTD O2 electrode (Seabird) and 2) to determine the influence of irradiance on production of phytoplankton populations in the seasonal deep chlorophyll maximum in the Celtic Sea using the light and dark incubation procedure.

### *Methodology*

Oxygen concentration was determined using the Winkler assay with an automatic titration procedure providing routine high precision measurements. Duplicate 50ml glass oxygen bottles were filled from 20L CTD Niskin bottles immediately following arrival of CTD on deck and water temperature determined in oxygen bottles before addition of Winkler reagents. Oxygen samples were collected from 5 or 6 depths between 120 and 2m including the chlorophyll fluorescence maximum at CTD14, 20, 35, 40, 47, 53, 72, 74, 76, 80, 81, 84, 91, 96, 110, 120, 128, 133. At one deep station (CTD 20) at the shelf break bottles were sampled for dissolved oxygen from 1500, 1000, 800, 400, 200, 50 and 2m.depths. Precision of dissolved oxygen measurements was excellent and routinely +/- 1umo/L (0.3%).

Incubation experiments were conducted using water from both near surface and the chlorophyll maximum depths at 8 stations: CTD 47, 72, 81, 84, 110, 120, 123, 133. Surface water samples were only incubated from CTD 47 and 72 as chlorophyll biomass was very low in surface waters and changes in dissolved oxygen undetectable over periods of 3 or 4 hours. Water samples for incubation experiments were stored following collection in 25 L polycarbonate carboys in the dark at 12 deg for a few hours prior to setting up the incubations. A number of 50 mL glass oxygen bottles were filled with the water and 5 or 6 picked randomly and O2 fixed with Winkler reagents at beginning of incubation. 5 bottles were incubated in the dark to determine respiration rates. A light gradient incubator cooled with circulating water (chlorophyll max) or surface seawater (surface samples) was used to incubate up to 40 bottles over a range of irradiance levels from 10 to 1100 umol /m2/s. Incubations were left for 3 – 4 hours and irradiance levels determined at end of each experiment. At the end of the incubation both light and dark bottles were fixed with Winkler reagents and then analysed using the automated titration system.

***Results***

1) <u>Calibration of CTD O2 electrode.</u>

Figure 13.1 shows a comparison of dissolved oxygen measured made of water samples collected throughout the cruise using the Winkler method with values of dissolved oxygen from the CTD electrode (approx. 1m bin average). A highly significant regression relationship is indicated (Figure 13.2) with a slope approaching 1 and offset of about 10 umol/kg (Electrode O2 value = 0.965 x Winkler O2 value –8.699). The regression equation can be used to convert all electrode values from all CTD data profiles to accurate oxygen concentration. A comparison of O2 saturation % determined from Winkler analysis and value given by CTD software gave similar highly significant linear relationship (Figure 13.3). An analysis of the average slope of Winkler values to electrode values for each profile showed no clear indication in drift of the electrode calibration during the cruise. The percentage saturation should be recalculated from all CTD O2 electrode data once the electrode concentrations have been updated using the above equation.

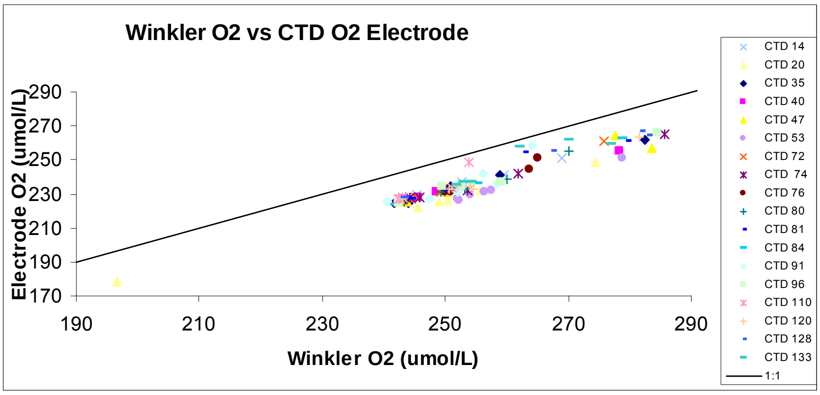



**Figure 13.1**. Comparison of Winkler and Electrode derived O2 concentration values from each CTD cast sampled

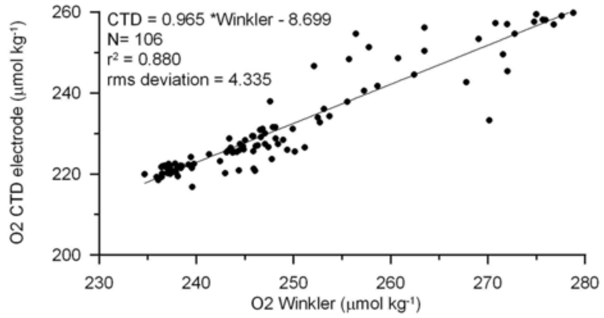



**Figure 13.2.** Comparison of Winkler and Electrode derived O2 concentration values with linear regression equation.

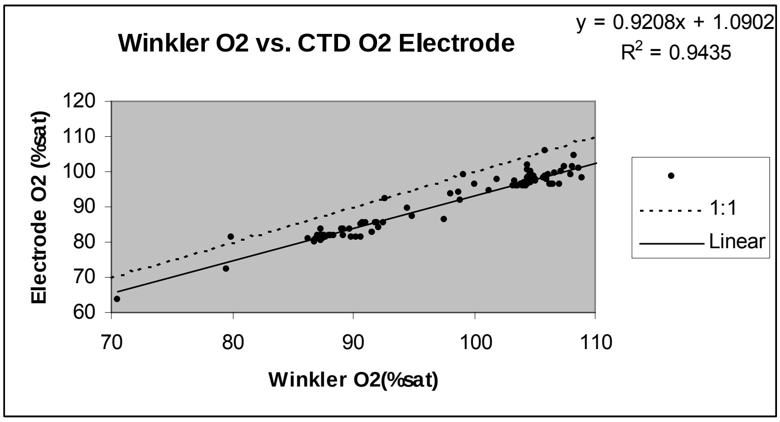



**Figure 13.3.** Comparison of Winkler and Electrode derived O2 satuaratation values

Photosynthesis vs. Irradiance Experiments.

Rates of production and respiration were low in all experiments and clearly detectable P vs E relationships were not obvious from all incubations due to the low chlorophyll levels. This was despite the precision of Winkler oxygen measurements being high. An example of results from a P vs E experiment conducted at CTD 133 (25m chlorophyll maximum is shown in Figure 13.4). Data from these experiments will be fitted to an empirical equation and Pmax, Ek and alpha derived. A comparison of photosynthetic parameters derived from each experiment will be made with 14C derived data (Hickman) and FRRF measurements (Moore).

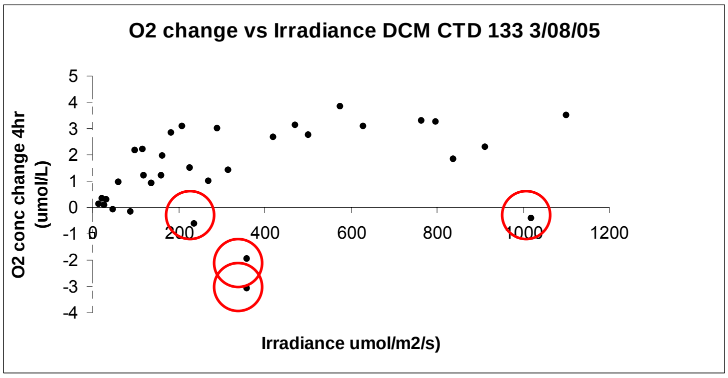



**Figure 13.4**. Photosynthesis vs. Irradiance for DCM population from 23m CTD133 measured using oxygen difference.(circled points had single large copepods in causing large oxygen loss due to respiration). Open square is respiration rate.

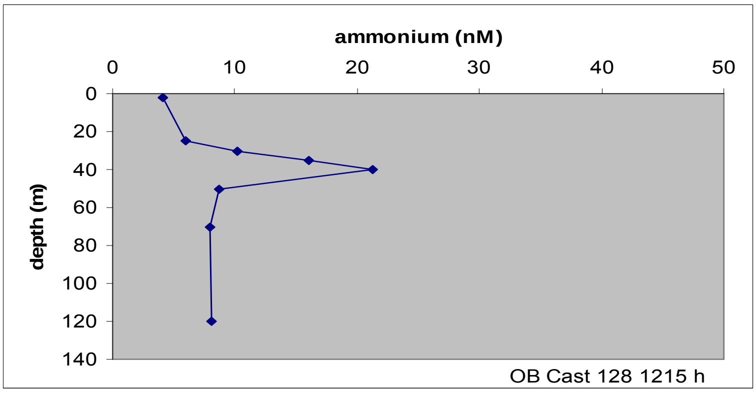
## 14. POC

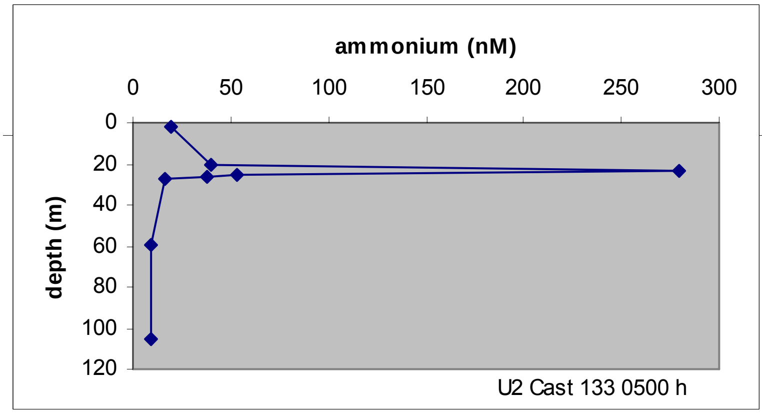
Eric Achterberg

The main aim of my cruise participation was to undertake shipboard water column ammonium measurements, and collect samples for dissolved organic carbon (DOC), total dissolved nitrogen (TDN), amino acids and total dissolved phosphorus (TDP) for subsequent analyses in the laboratory at NOC.

Samples for the above mentioned variables have been collected from the 20 litre OTE bottles mounted on the CTD rosette. Samples for DOC, TDN and TDP analyses have been filtered using a glass filtration apparatus and ashed GFF filters. The samples for DOC and TDN have been acidified and stored in sealed glass ampoules. Samples for TDP and amino acids have been stored frozen in polystyrene vials.

A total of 16 water column profiles have been analysed for ammonium on the cruise with typically 8 samples for each profile. The ammonium measurements have been successful, with low nanomolar concentrations throughout the water column. Distinct maxima were observed at the chlorophyll maximum (20-40 nM) at the majority of the casts. Two casts showed concentrations exceeding 250 nM at the chlorophyll maximum. Typical examples of depth profiles for ammonium are shown below.
For DOC, TDN, TDP and amino acids samples have been collected for 16 water column profiles (typically 8 samples for each profile). Sample analyses will be conducted over the coming months in Southampton. Furthermore, samples have been collected (for Dr. M. Gledhill) for porphyrin and chlorophyll analyses in the laboratory at NOC using novel HPLC techniques. 1500 ml of water has filtered over GFF filters and the filters were subsequently frozen at -80ºC.  A total of 10 casts have been sampled, with 6 depths per profile.



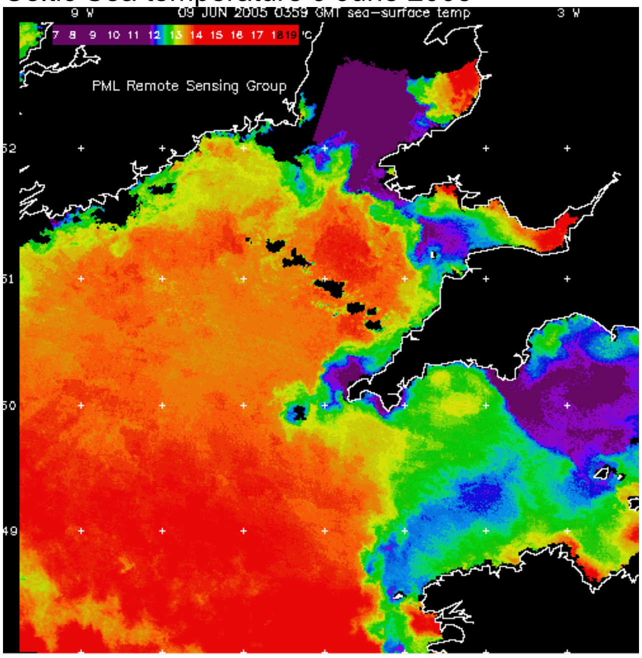



## 15. Satellite Images

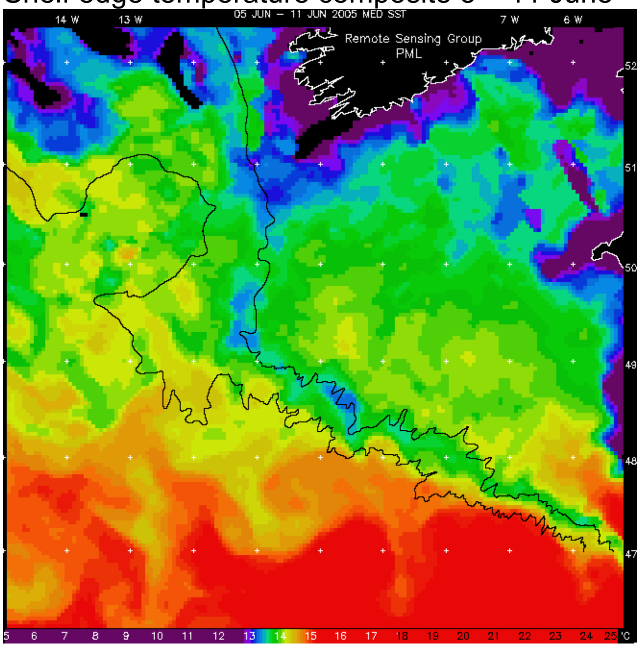
Jonathan Sharples and Stephanie Bates.

Satellite imagery was provided every day direct to the ship from the Remote Sensing Data Analysis Service (Plymouth Marine Laboratory, UK). Weather during the cruise was remarkably poor for summer, so very few clear images were available. The following images, mainly from just prior to the cruise, illustrate the conditions in the Celtic Sea and at the shelf edge.

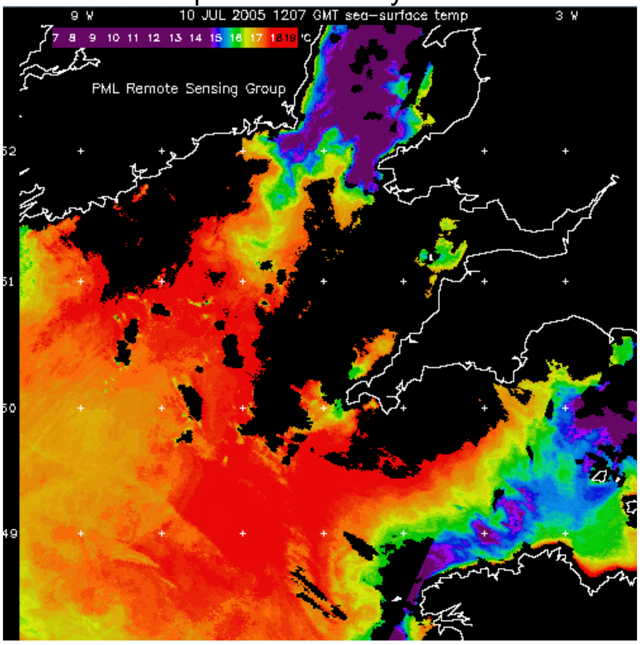
Celtic Sea temperature 9 June 2005



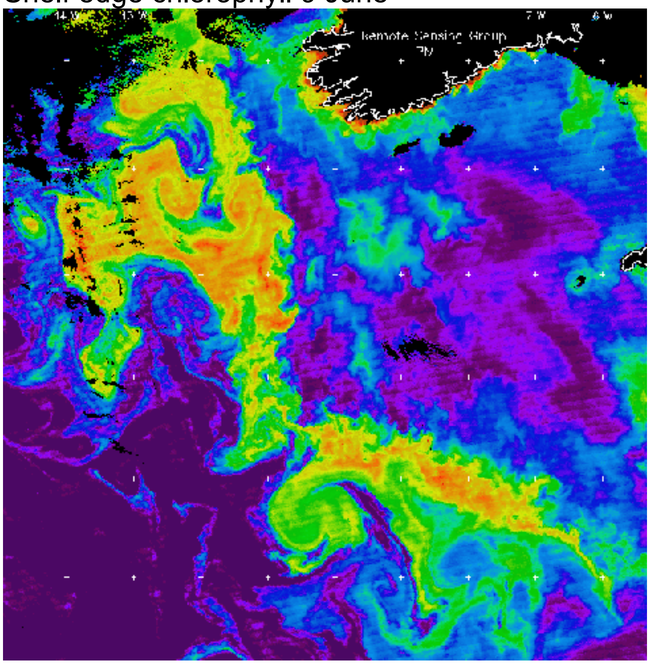

Shelf edge temperature composite 5 – 11 June



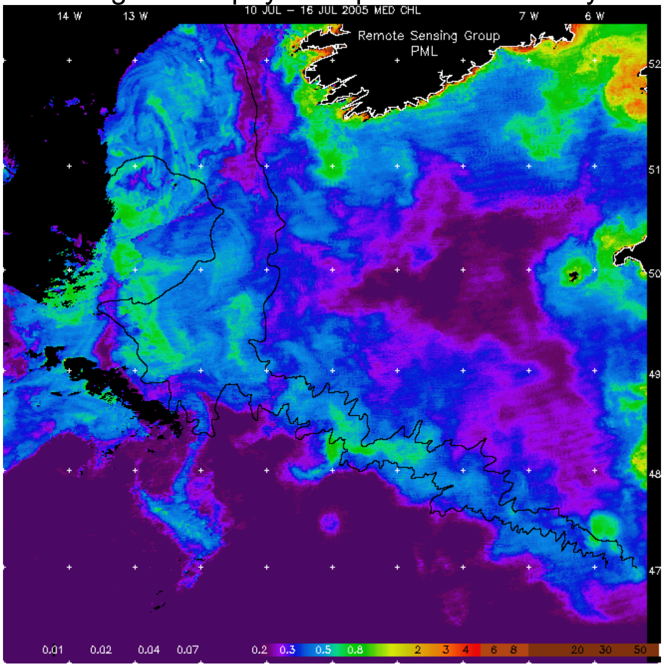
Celtic Sea temperature 10 July



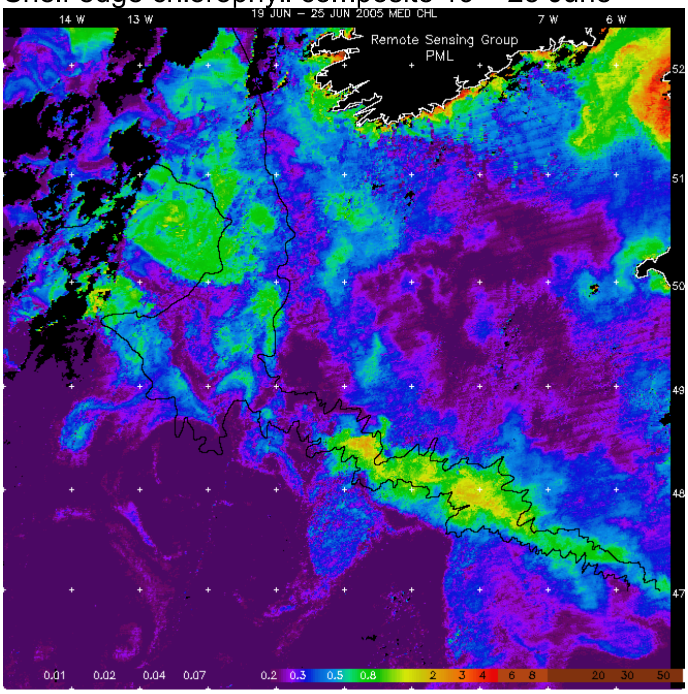

Shelf edge chlorophyll 9 June



Shelf edge chlorophyll composite 10 – 16 July




Shelf edge chlorophyll composite 19 – 25 June

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## 16. Optical and Particle Size Measurements.

Vladimir Krivtsov

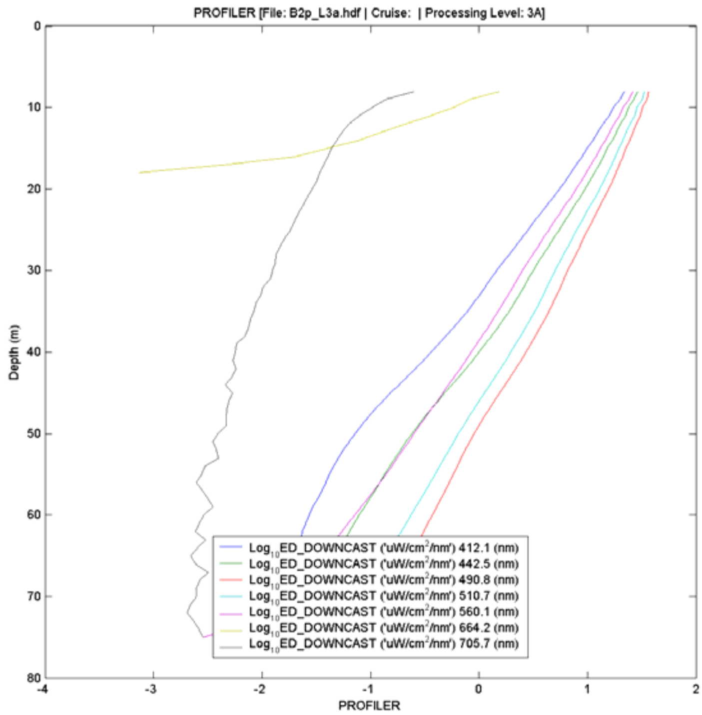
***Optical measurements***

Optical measurements were performed on both legs of the cruise using 2 types of profiling optical instruments: a free fall optical profiler Satlantic, and a profiling radiometer PRR.

Specifically, optical casts were carried on 15 Jul (stn U2, 3 casts), 17 Jul (stn Oceanic, 4 casts), 18 Jul (stn CS2,  8 casts), 19 Jul (2 casts), 20 Jul (8 casts), 22 Jul (4 casts), 23 Jul (8 casts), 26 Jul (4 casts), 27 Jul (7 casts), 29 Jul (3 casts), 30 Jul (4 casts), 31 Jul (11 casts), 1 Aug (4 casts), 2 Aug (7 casts), 3 Aug (3 casts).

The absolute majority of the measurements were carried out using the Satlantic, mainly due to time constraints, but also because of the technical problems with the PRR, whose cable during one of the deployments (on 26 Jul, right at the beginning of leg 2) was dragged under the rudder and fouled, subsequently parted and had to be repaired; eventually, the repairs were carried out successfully
No in depth data processing was attempted on board due to time constraints. However, the profiles of downwelling irradiance (observed during deployments) exhibited characteristic decrease with depth (Fig.16.1), which at least at some of the wavelengths appeared to accelerate at the thermocline, with  levels of 1% saturation reached approximately just below subsurface Chl maxima (NB – subject to confirmation by further analysis).

**Figure 16.1.**
Example of optical data.




***Particle size measurements***
Particle size measurements were carried out by a LISST_C instrument (Laser in Situ Scattering Transmissometer), which records data on 32 particle size classes ranging between 2.5 and 500 microns. The instrument was installed on the CTD frame, and was routinely activated to collect data during the CTD casts (NB leg 2 only), thus providing data simultaneously with the other instruments on the CTD frame. The data were normally downloaded every 3-5 casts. However, data from a few casts (exact number to be confirmed) have been lost, due to operators' errors and memory overflow.

About 50% of the data have been processed on board (see an example of a cast in Fig. 16.2). Typically, both total SPM volume and  median particle d showed a characteristic dramatic increase in the thermocline, and so did the majority of the volumes of the coarser size fractions. However, total volumes of the smaller fractions (and in particular most consistently of 2.5 – 5 microns fraction) was observed to decrease at the thermocline. Most peculiarly, this decrease appeared to coincide with an increase both in total Chl, and, in particular, in Chl associated with 2.5-5 microns size fractions. Interstingly, it appears that once converted to biovolumes, the max in the Chl associated with 2.5 – 5 microns size fraction seems to match the corresponding min in the LISST data. Thus the pattern observed suggests that whilst at the sites studied phytoplankton itself constitutes only a relatively minor proportion of suspended particulate matter, it may help to promote (i.e. biologically induce) flocculation at the subsurface Chl maximum, leading to a dramatic increase in the median diameter. A great proportion of SPM there might be associated with detritus, and a considerable contribution of larger-sized heterotrophic organisms is also likely. In addition, precipitation and subsequent binding of inorganic compounds due to photosinthetically induced changes in physicochemical parameters (e.g. pH and oxygen) cannot be ruled out. The decrease of median diameter and recorded SPM volumes below the thermocline might have been caused by the increased turbulence. It is hoped that further analysis may help to characterise these points in somewhat better detail, thus contributing to furthering our understanding of the overall system dynamics.

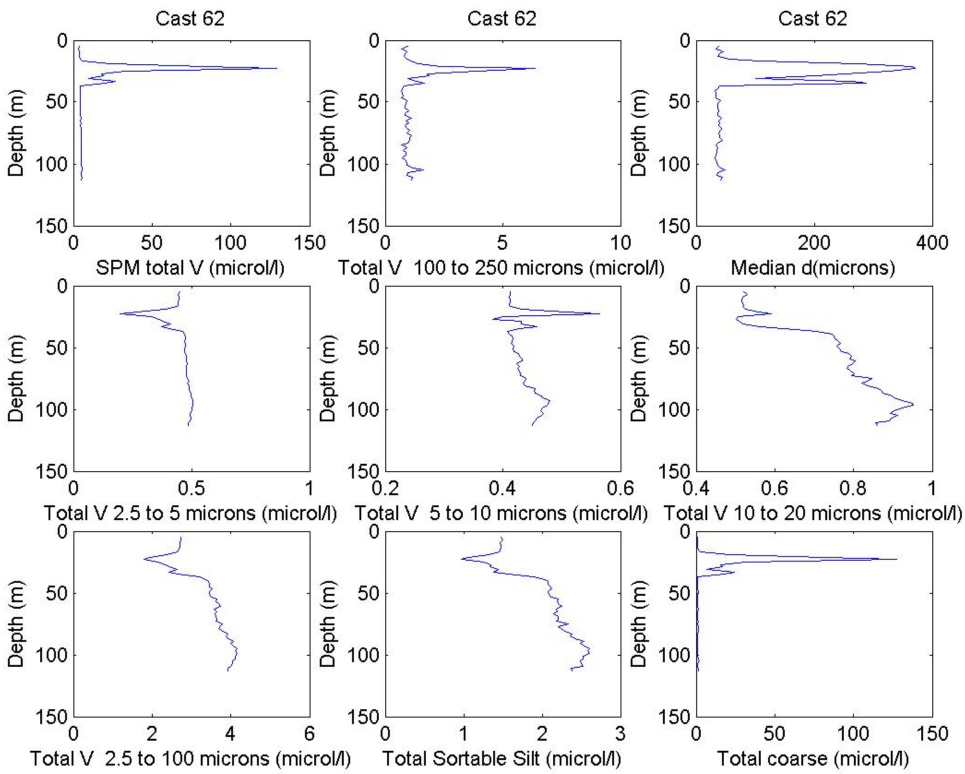



**Figure 16.2.** Example of LISST data.

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## 17. Other Data.

Jonathan Sharples

Ship's navigation data was stored every 10 seconds throughout the cruise.

The ship's surfmet system recorded data every 30 seconds (though sometimes this becomes every 60 seconds). Parameters recorded by the surfmet system were:

Sea surface temperature, sea surface salinity, sea surface chlorophyll fluorescence, sea surface transmittance, air pressure, PAR (Port sensor), PAR (starboard sensor), total irradiance (port sensor), total irradiance (starboard sensor), air temperature, humidity, absolute wind speed, absolute wind direction.

At the time of writing this report no calibrations have been carried out on this data. Note also that the ship's heading and speed have not been corrected for in the surfmet wind data.

Total water depth was recorded every 2 – 3 seconds from the ship's EA500 echosounder.

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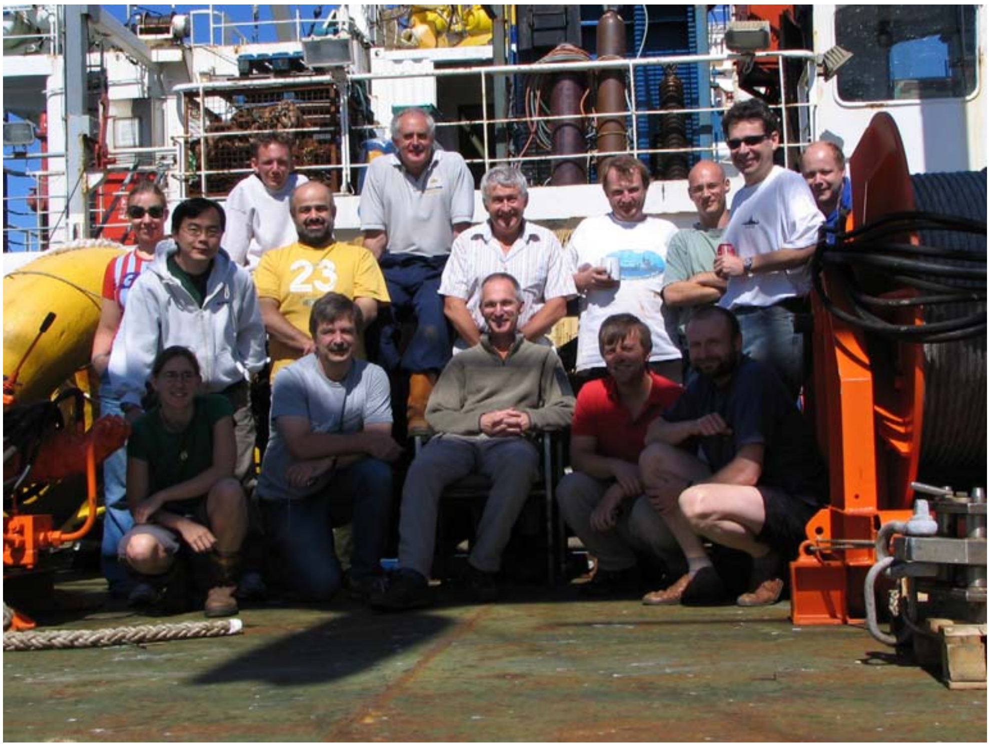

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