

Cruise Report



RRS *Charles Darwin*

CD173



15th July – 6th August 2005.

Compiled by Jonathan Sharples, Proudman Oceanographic Laboratory, UK

Contents.

Section	Page
1. Introduction	3
2. Cruise Narrative.	5
3. Main station positions	11
4. CTD casts and calibration information	11
5. Turbulence Measurements.	20
6. Moorings	35
7. Seasoar	56
8. Phytoplankton pigment measurements and sampling	59
9. Nutrient measurements	63
10. P vs E Primary production experiments (^{14}C)	65
11. Phytoplankton ^{15}N and ^{13}C uptakes rates	67
12. Fast repetition rate fluorometer measurements	69
13. Dissolved oxygen measurements	74
14. POC	77
15. Satellite imagery	78
16. Optical and particle size measurements	80
17. Other data	82

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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Cruise Participants:

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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 frf261). 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.

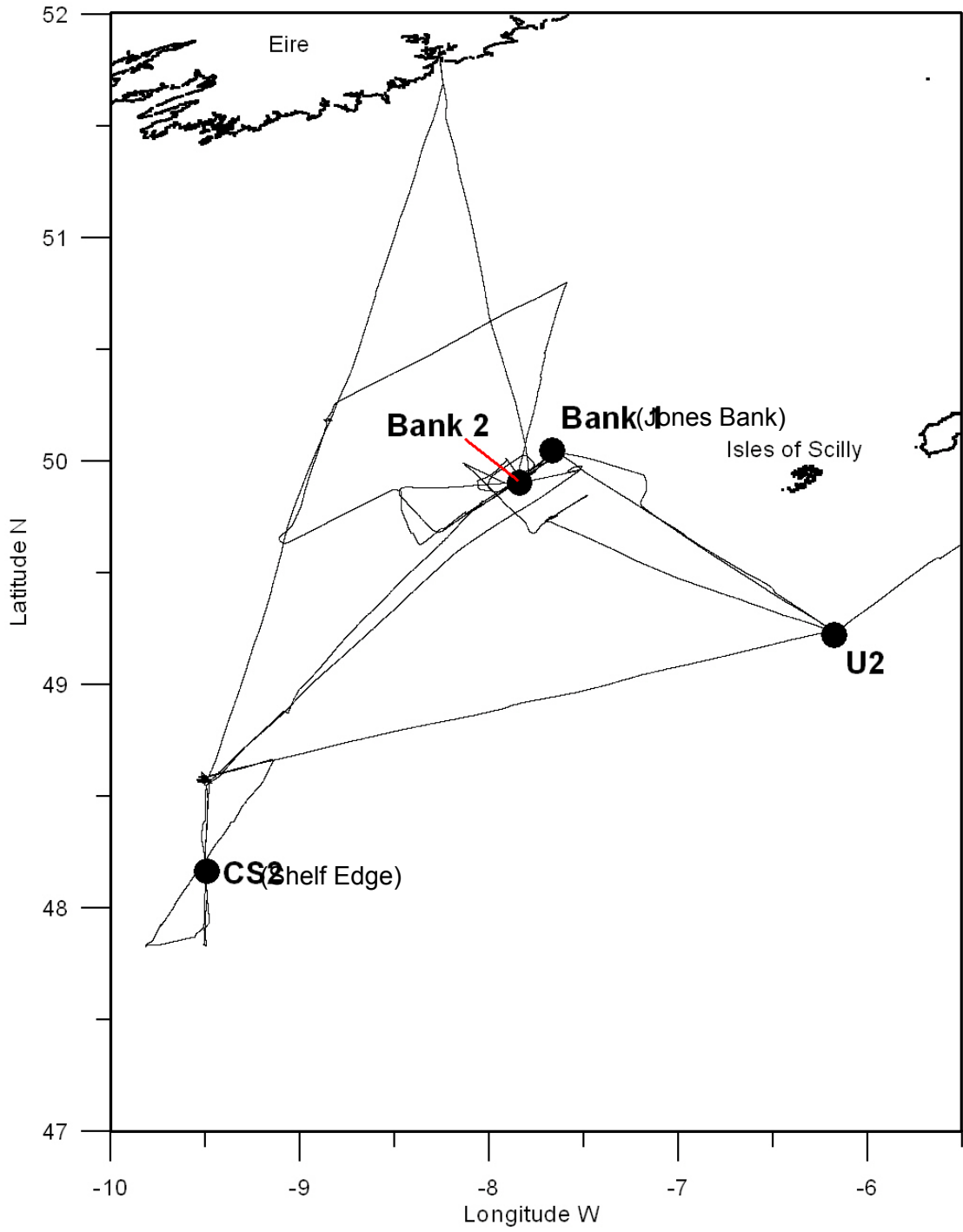
5th August 2005.

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

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.

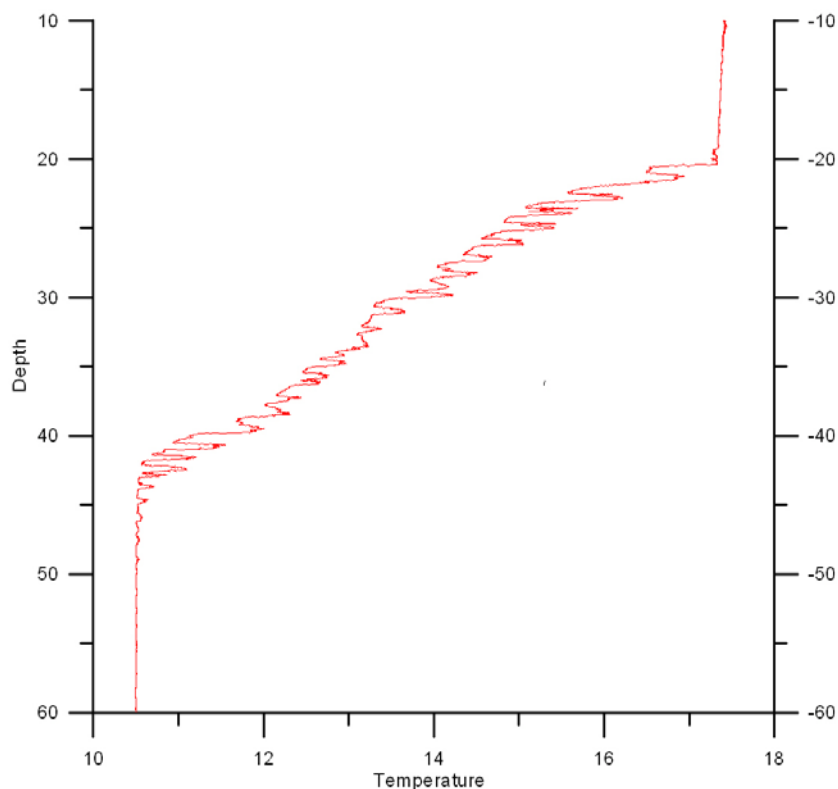


Figure 4.1: Example of raw CTD temperature data through the thermocline, illustrating the periodic spiking of the CTD temperature signal.

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).

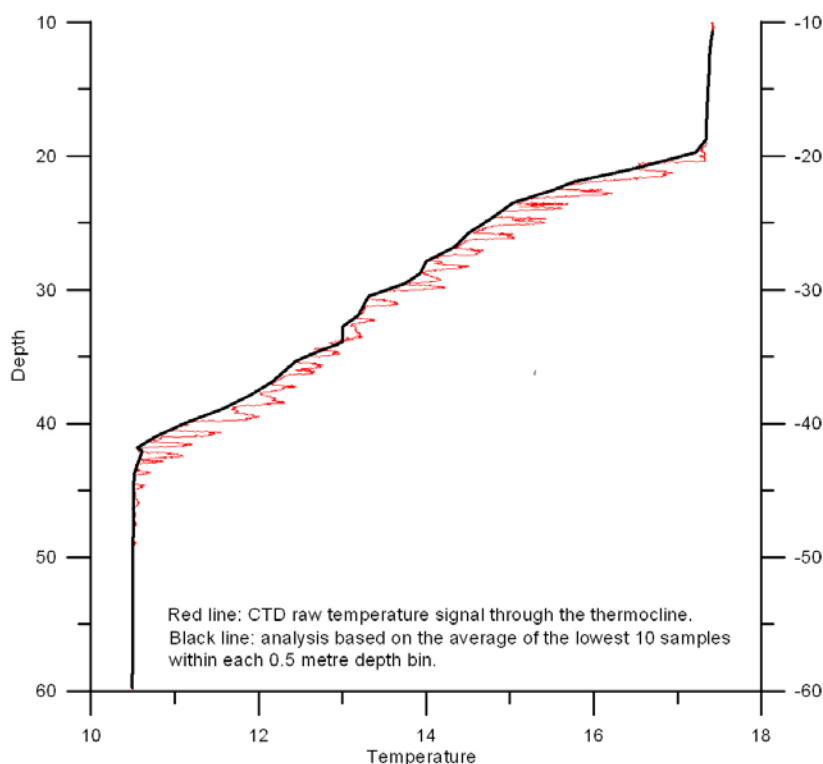


Figure 4.2: The same raw temperature data as in Fig. 4.1 (red line), with the analysis based on averaging the lowest 10 readings within each 0.5 metre depth bin (black line).

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 Autosol 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	<i>114</i>	<i>34m</i>
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:

$$\text{Chlorophyll } a = 1.4 \times \text{CTDchl} - 0.1 \mu\text{g litre}^{-1}$$

$$\text{rms error} = \pm 0.2 \mu\text{g litre}^{-1}$$

On the shelf:

$$\text{Chlorophyll } a = 1.8 \times \text{CTDchl} + 0.0 \mu\text{g litre}^{-1}$$

$$\text{rms error} = \pm 0.1 \mu\text{g litre}^{-1}$$

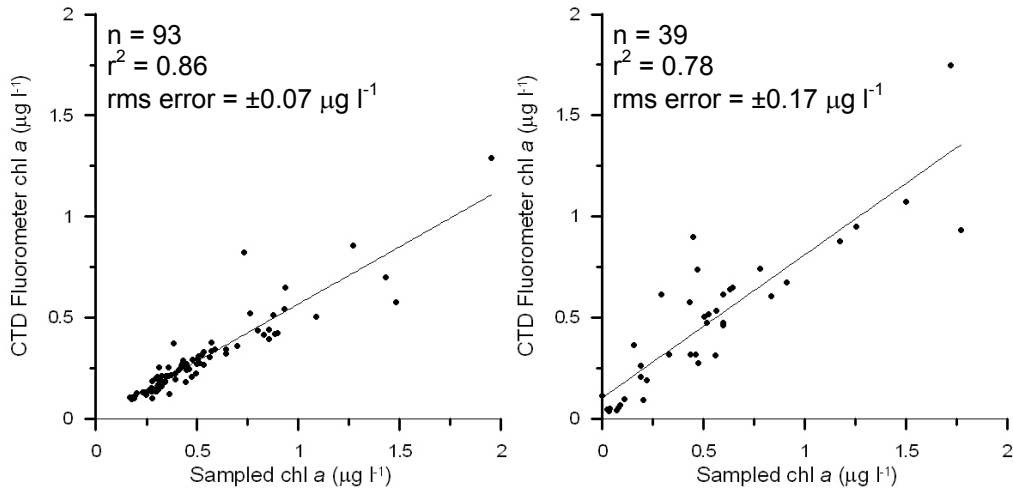


Figure 4.3: CTD raw chlorophyll a versus the corresponding analyses of bottle samples for the Celtic Sea shelf water (left) and the shelf edge (right).

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:

$$\text{Calibrated DO} = 1.0 \times \text{CTD_DO} + 9.0 \quad \mu\text{mol kg}^{-1}$$

$$\text{rms error} = \pm 4.0 \mu\text{mol kg}^{-1}$$

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 (ε) can be derived from the variance of the mean shear, estimated from the power spectrum of the shear signal:

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

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

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

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

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

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

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

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

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

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

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

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

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: 49°14.151'N, 6°09.941'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

EBO

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: 48°34.259'N, 9°30.585'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: 48°34.362'N, 9°30.602'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

Bed-frame 300ADCP mooring (see fig. 6.5)

300kHz RDI WH Sentinel s/n:1903
Deployed: 18.11 on 17/7/05
Depth: 196m
Position: 48°34.338'N, 9°30.486'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

Bed-frame 150ADCP mooring (see fig. 6.6)

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: 48°34.281'N 9°30.437'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

Guard Buoy (see fig. 6.7)

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.

Guard Buoy

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

Vemco thermistor chain

Recovered: 08.55 – 10.06 on 24/7/05
All instruments intact and recorded for the full period. Anchor also recovered.

Sub-surface 300ADCP mooring

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.

Bed-frame 150ADCP mooring

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.

Bed-frame 300ADCP mooring

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

Vemco thermistor chain (see fig.6.8)

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.

Bed-frame 300ADCP mooring (see fig. 6.5)

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

Guard Buoy (see fig. 6.11)

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		

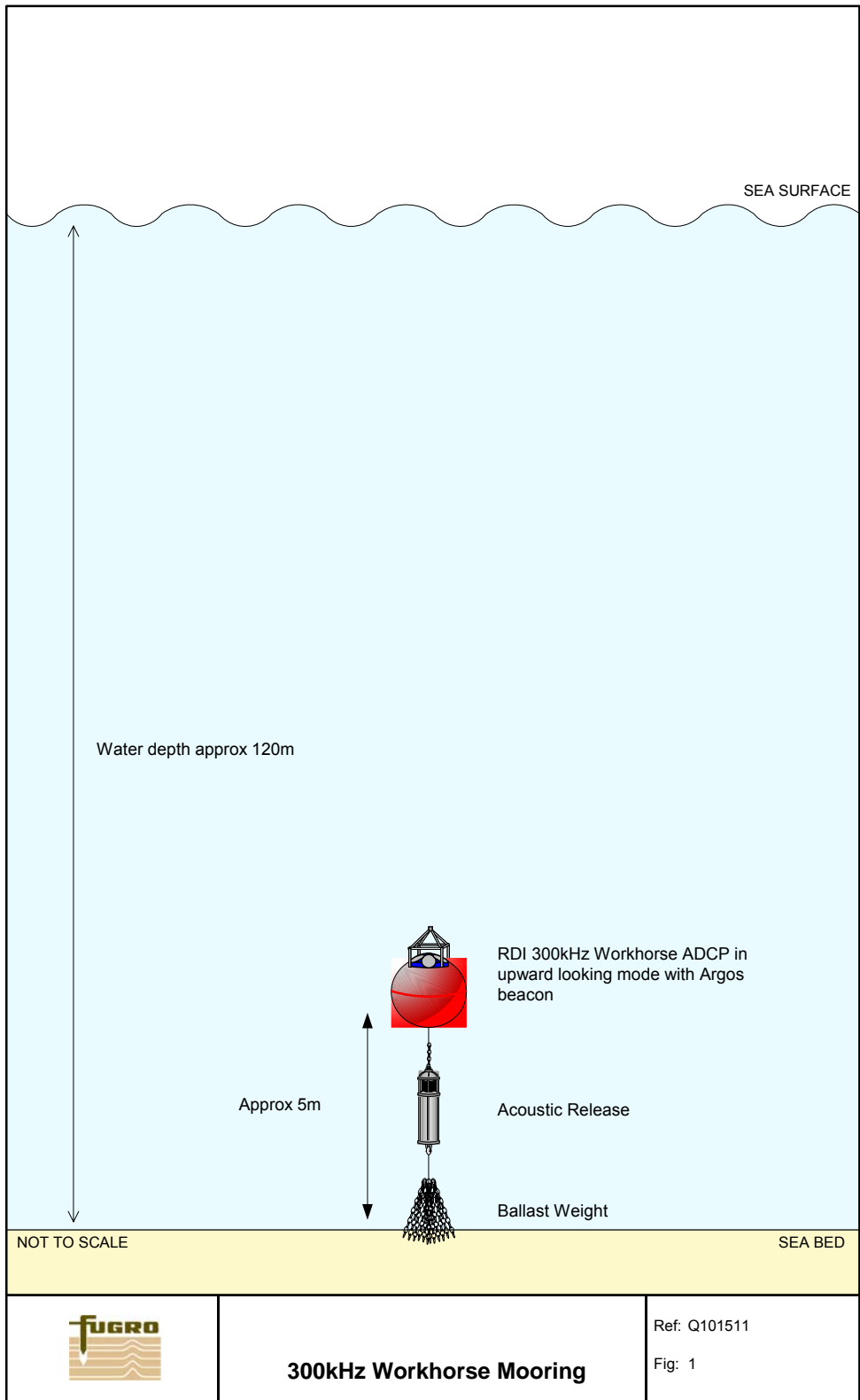


Figure 6.1

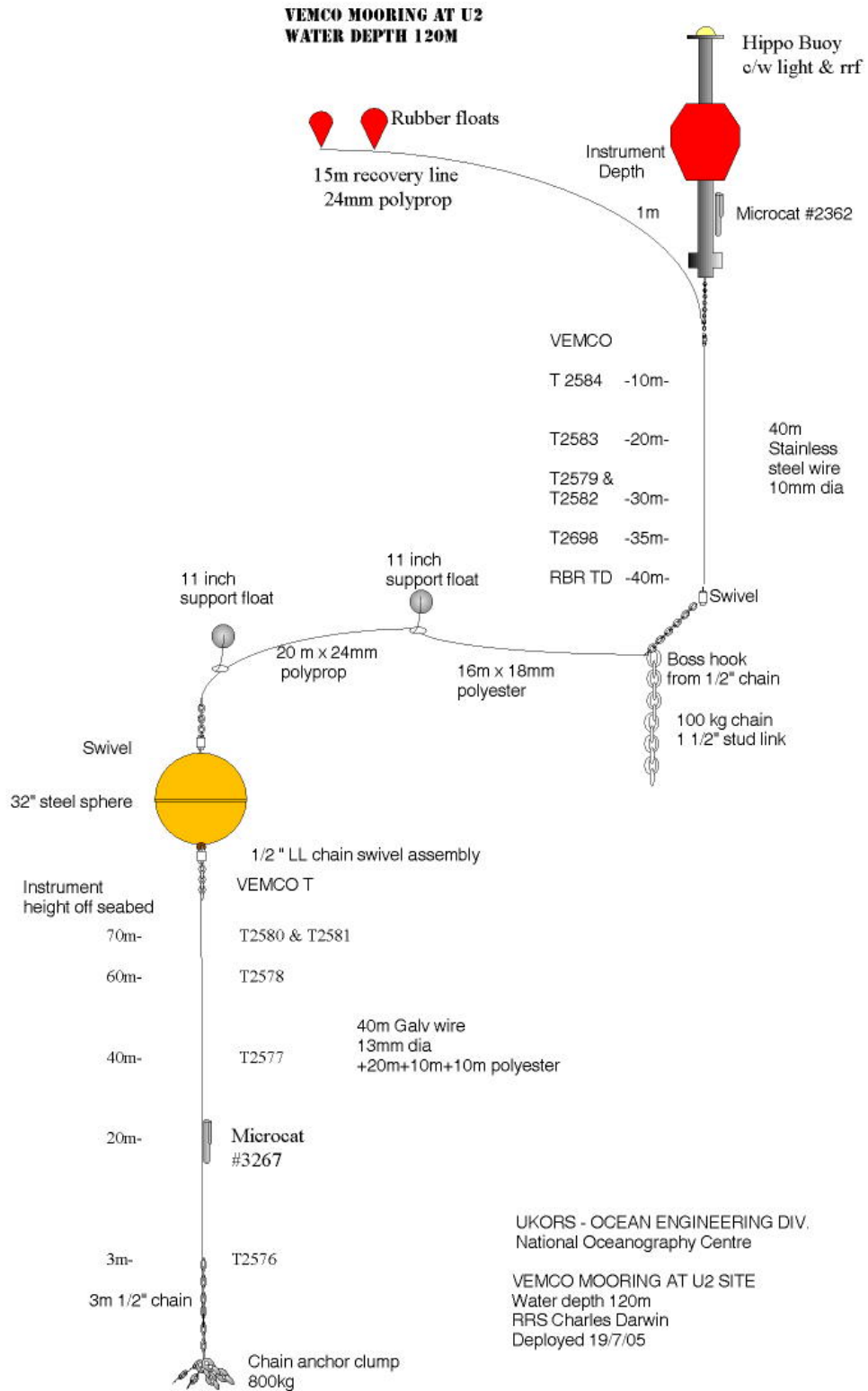


Figure 6.2

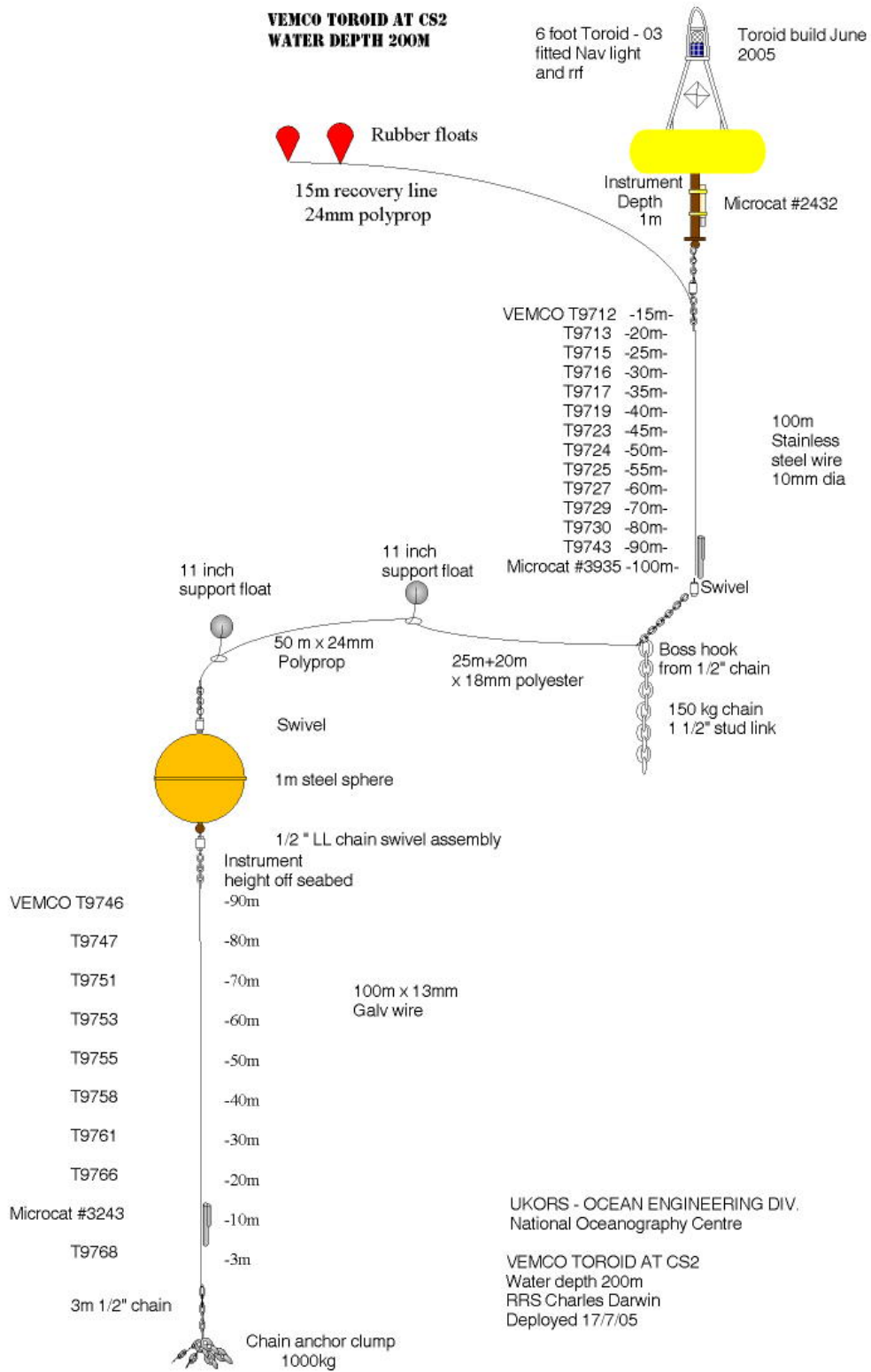
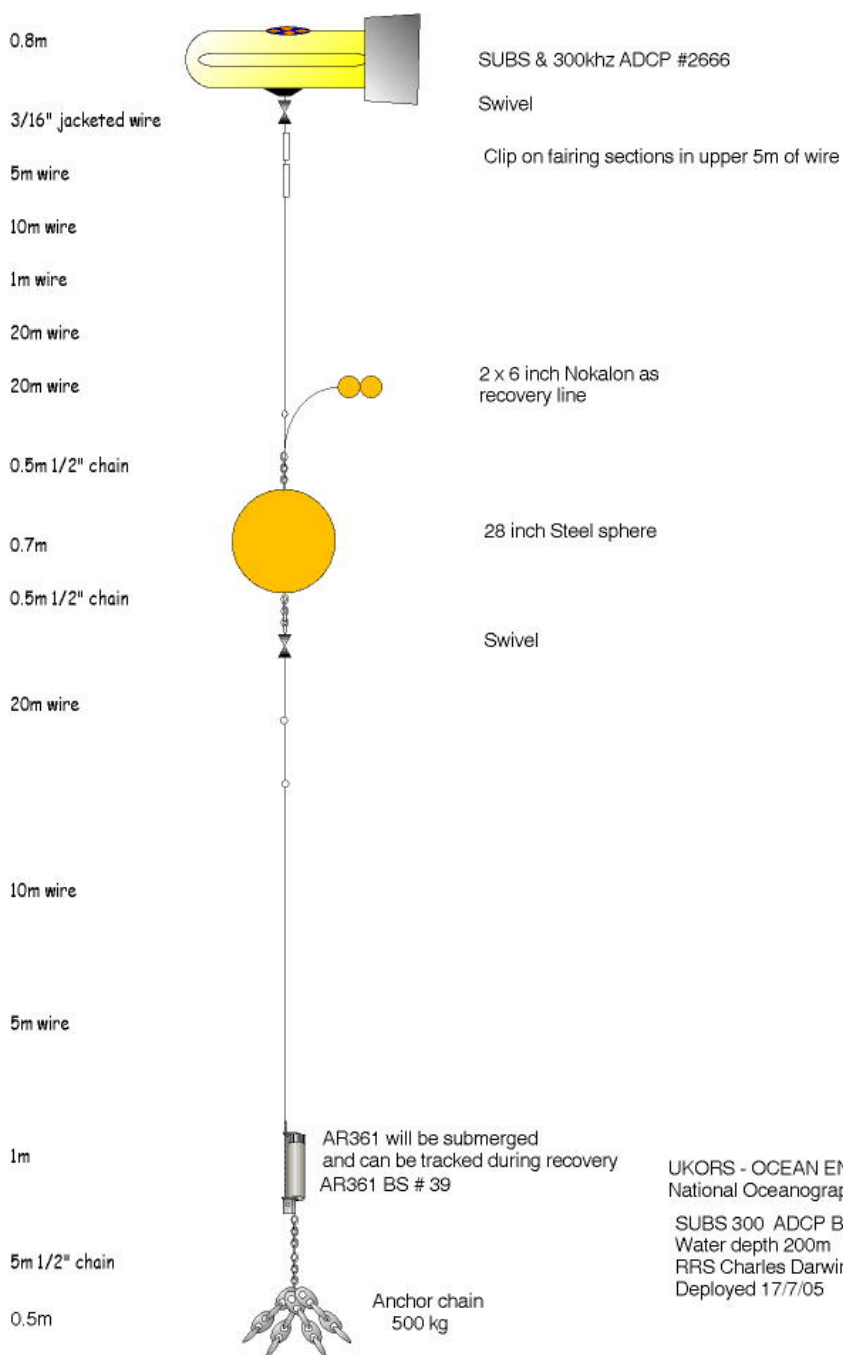


Figure 6.3

**SUBS 300 KHZ ADCP AT CS2
 WATER DEPTH 200M
 SUBS SET TO 100M DEPTH**



UKORS - OCEAN ENGINEERING DIV.
 National Oceanography Centre
 SUBS 300 ADCP Buoy AT CS2
 Water depth 200m
 RRS Charles Darwin CD173
 Deployed 17/7/05

Figure 6.4

300 kHz ADCP Lander CD173

OUTLINE OF 300 KHZ LANDER

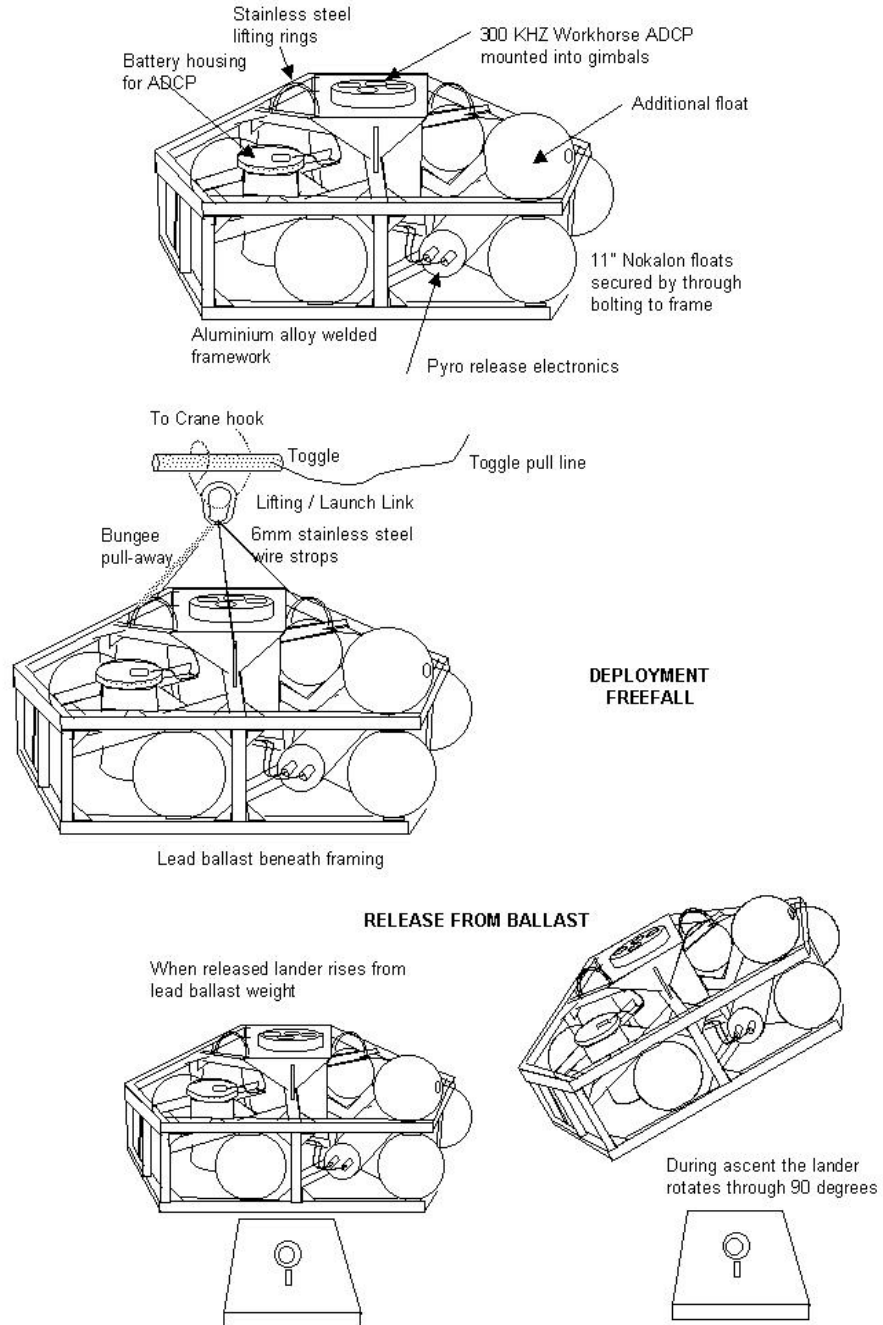
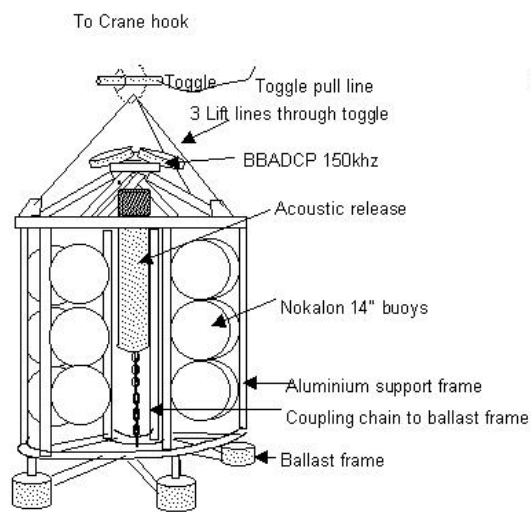
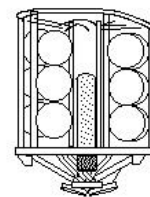


Figure 6.5

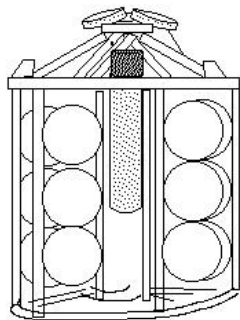
150 kHz SCBBADCP Lander CD173



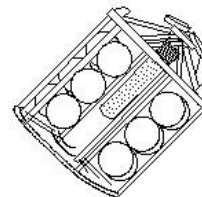
150 KHZ BBADCP LANDER



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

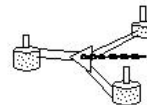
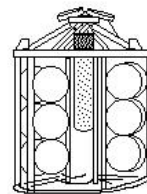
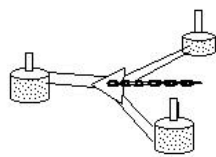


Figure 6.6

200M GUARD BUOY

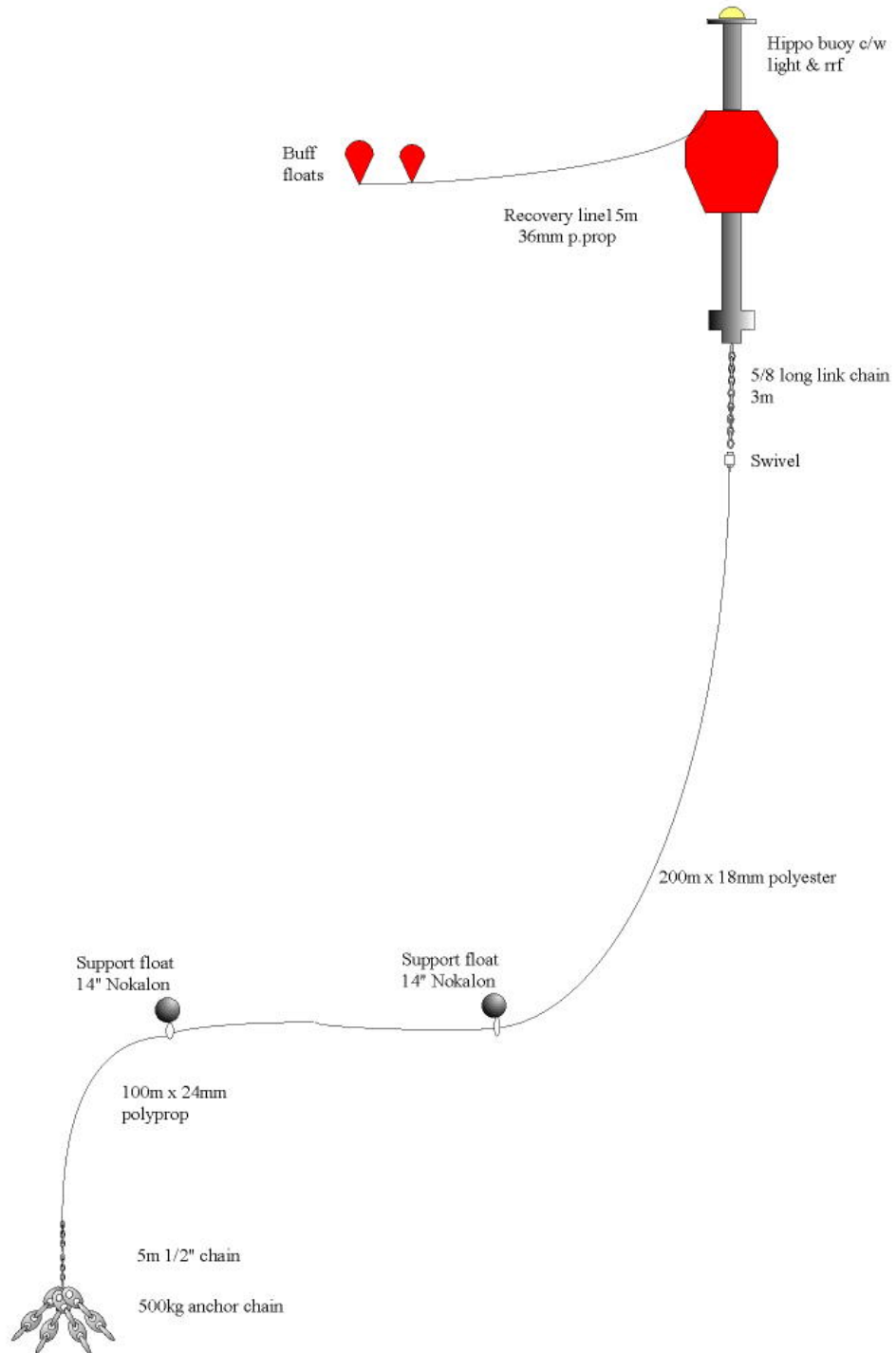


Figure 6.7

**VEMCO TOROID AT BANK 1 SITE
WATER DEPTH 120M**

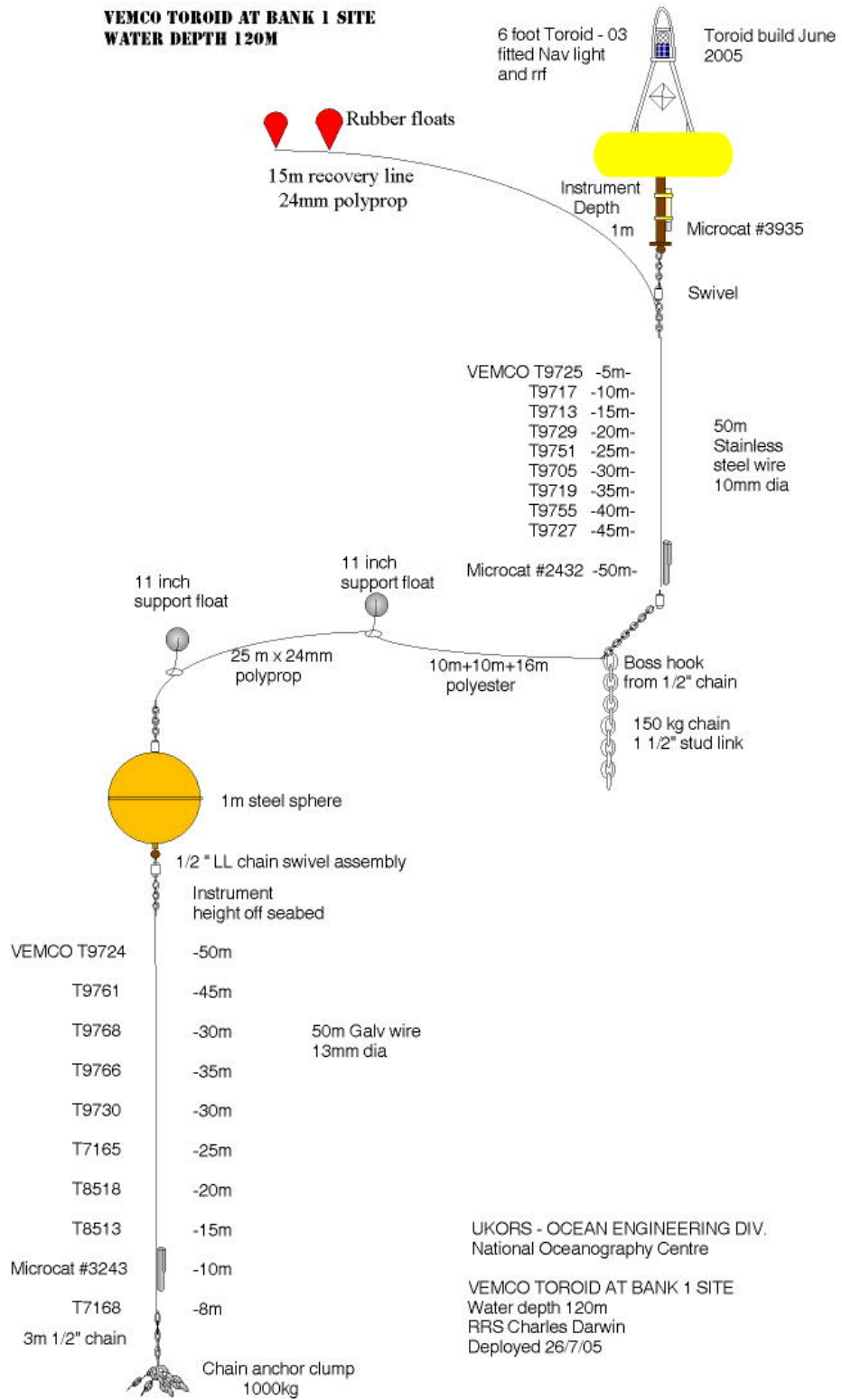


Figure 6.8

**VEMCO TOROID AT BANK 2 SITE
WATER DEPTH 110M**

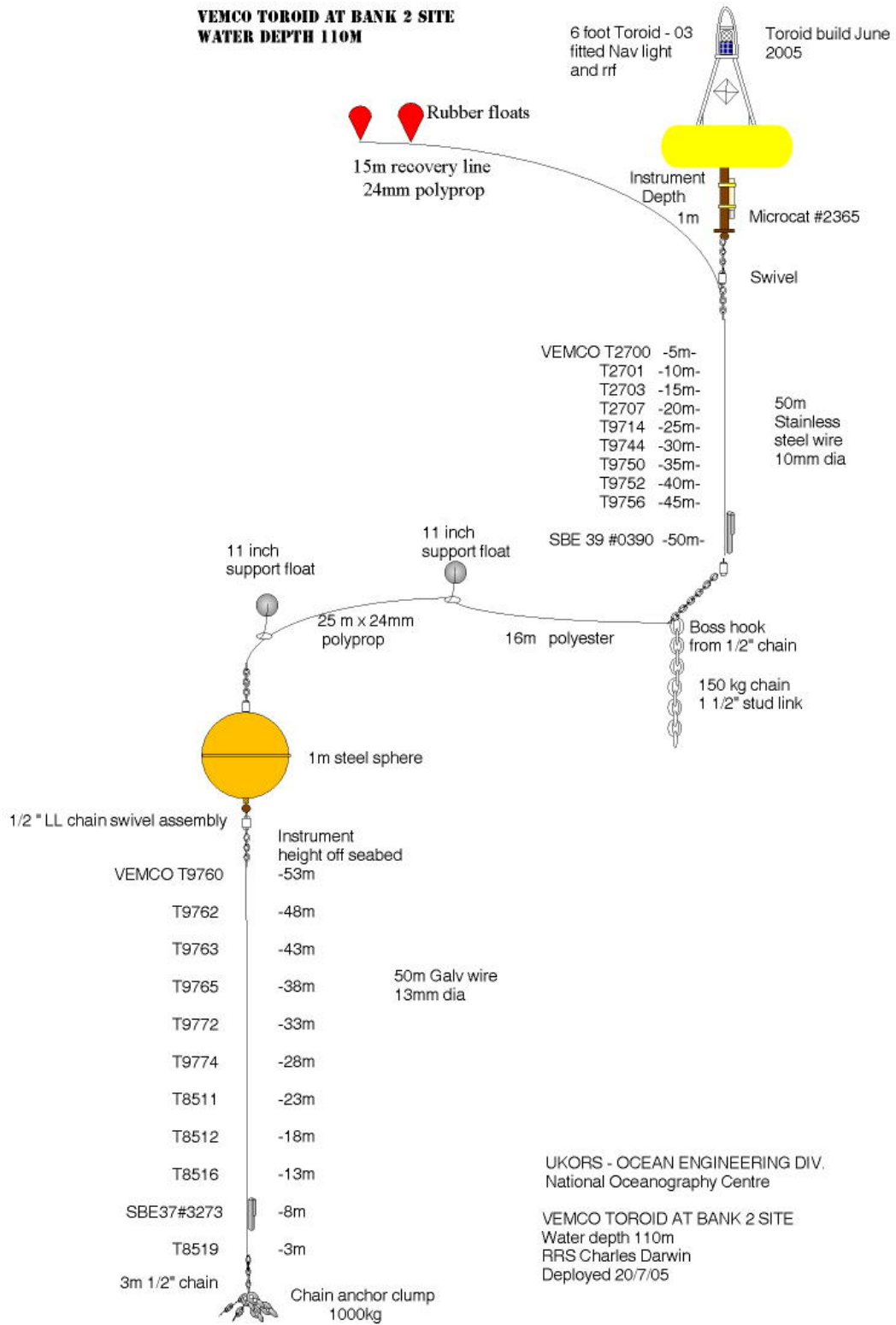


Figure 6.9

**SUBS 600 KHZ ADCP AT BANK 2 SITE
 WATER DEPTH 112M
 SUBS SET TO 56M DEPTH**

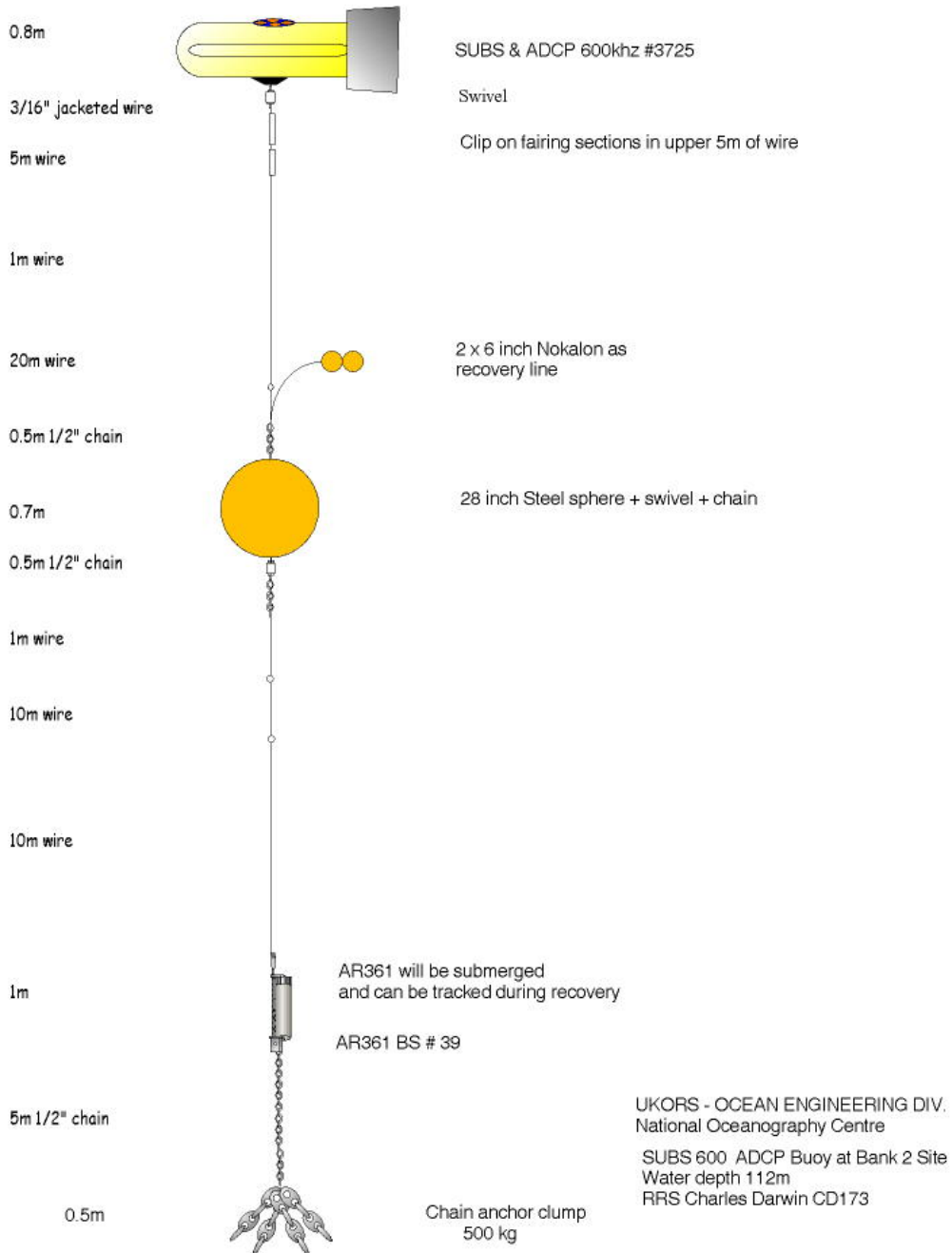


Figure 6.10

100M GUARD BUOY

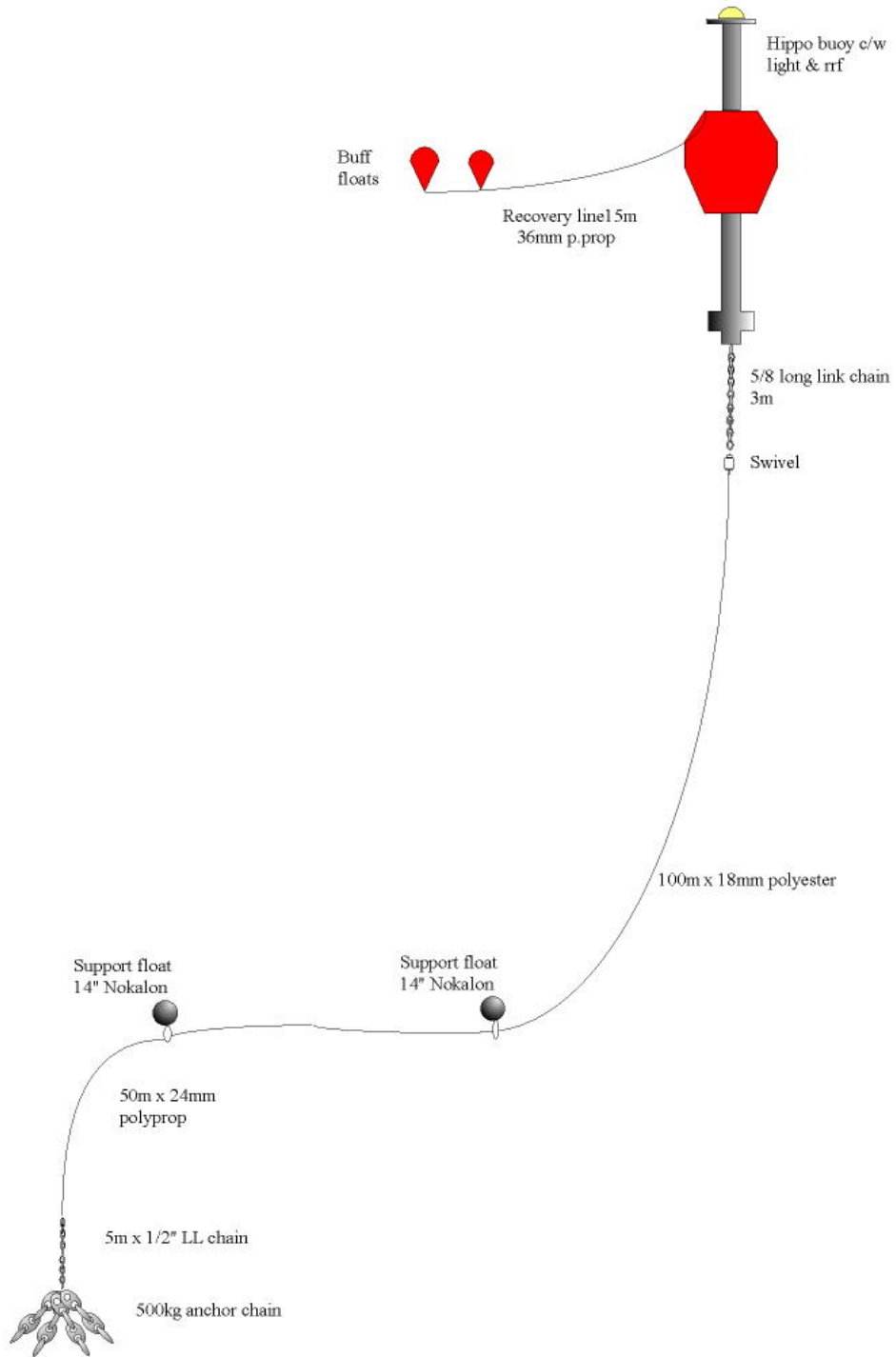


Figure 6.11

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 Fastracka (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.

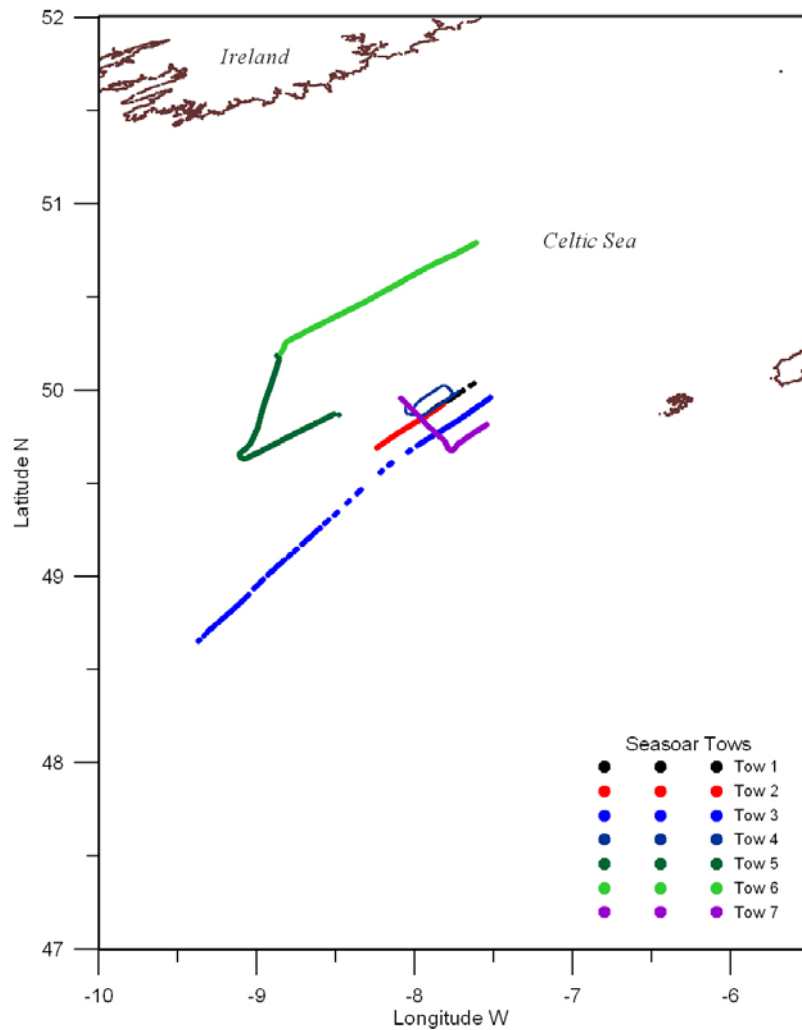


Figure 7.1. Seasoar transect lines.

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.

$$\text{Calibrated salinity} = \text{Seasoar_sal} - 0.03 \quad \pm 0.02 \text{ (PSS78)}$$

Temperature Calibration:

Seasoar Minipack temperature 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.

$$\text{Calibrated temperature} = \text{Seasoar_temp} - 0.006 \quad \pm 0.007 \text{ }^\circ\text{C}$$

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:

$$\text{Calibrated chlorophyll } a = 0.09 \times \text{Seasoar_chl} + 0.02 \quad \pm 0.06 \text{ mg m}^{-3}$$

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

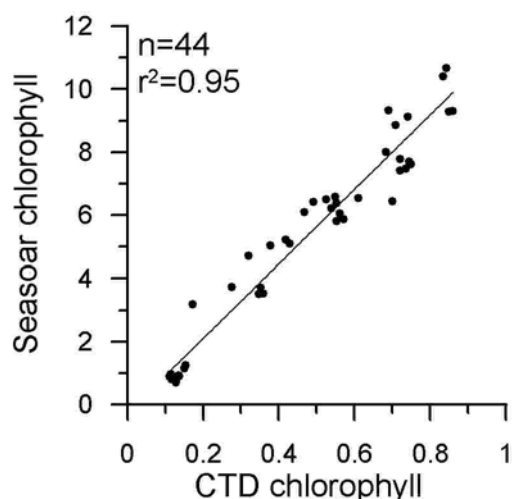


Figure 7.2: Comparison between the CTD and Seasoar Minipack chlorophyll a fluorescence data through the thermocline of the central Celtic Sea.

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.

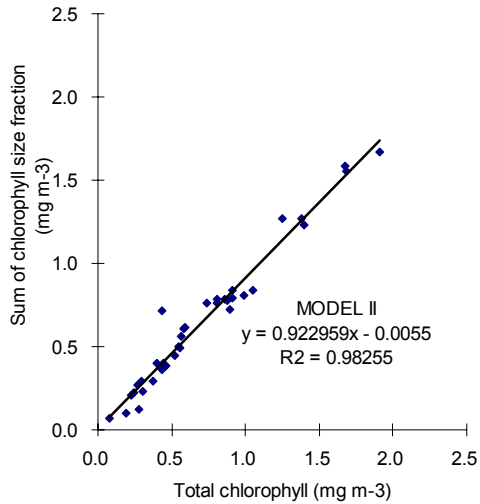


Figure 8.1. Comparison of total chlorophyll to the sum of chlorophyll size fractions (<2, 2-5, 5-10, 10-20, >20mm)

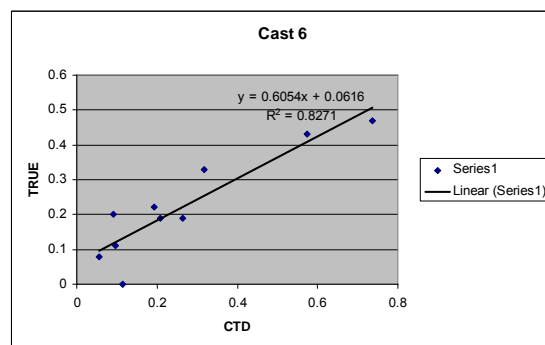
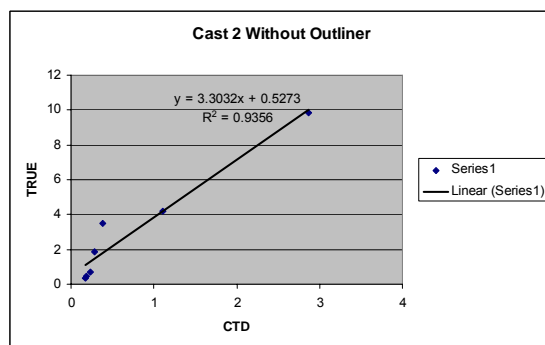
Preserved samples of phytoplankton were collected for examination in the laboratory by flow cytometry (312 samples fixed with paraformaldehyde) and light microscopy (~140 samples fixed with lugols solution and buffered formalin).

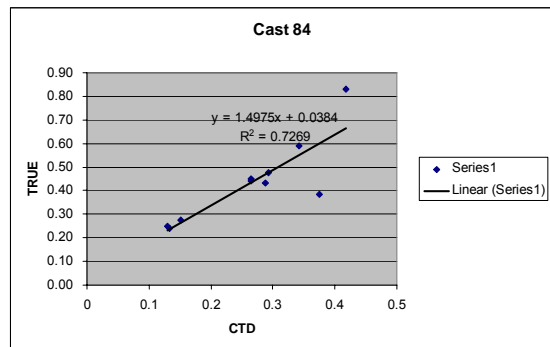
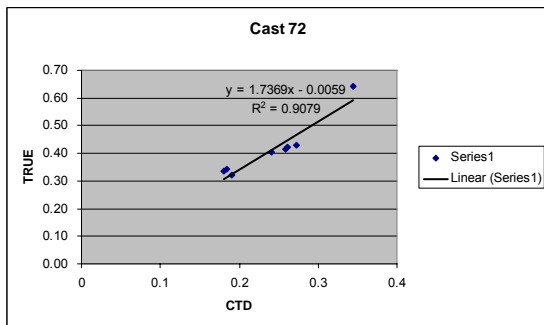
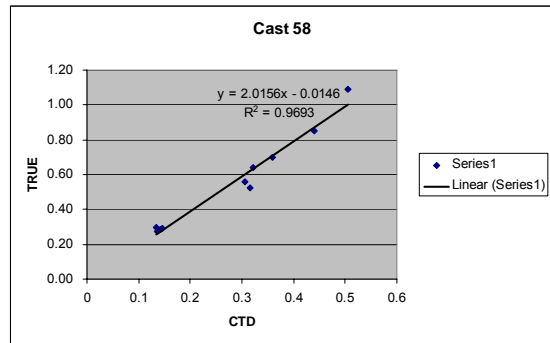
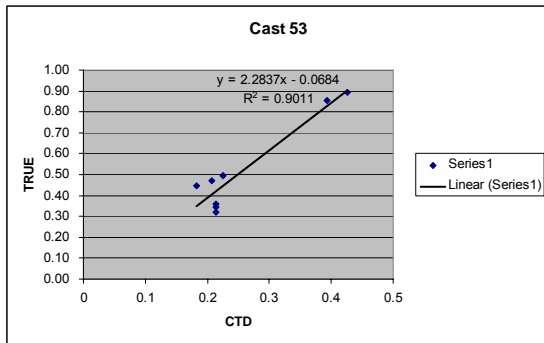
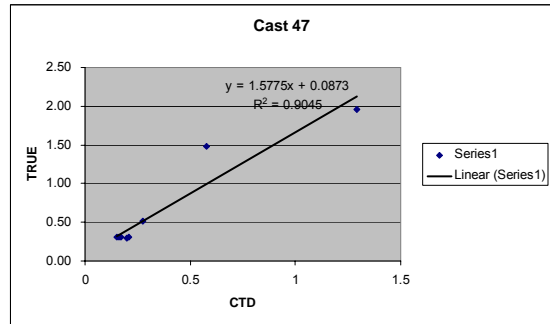
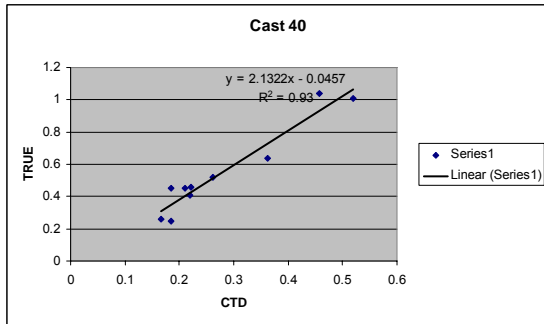
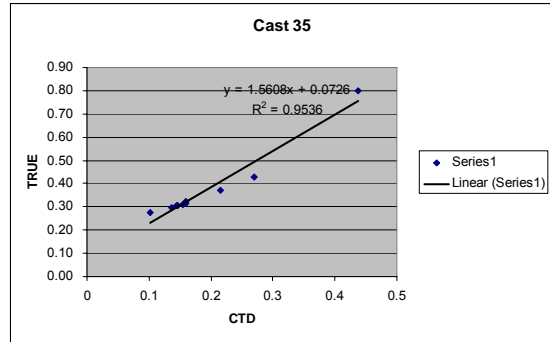
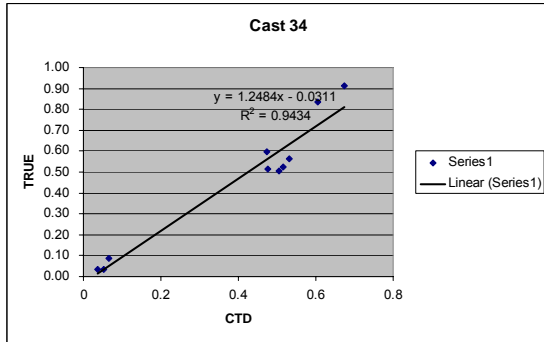
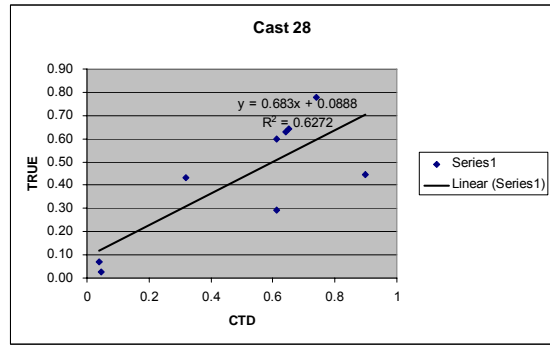
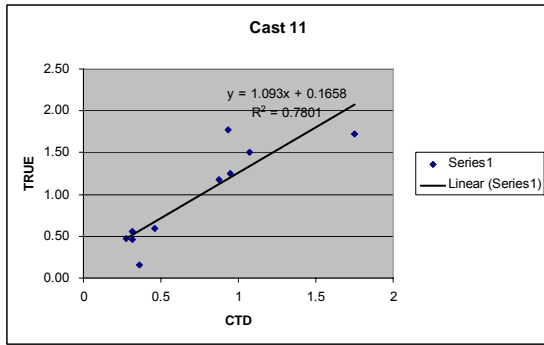
In support of the primary production and FRRF measurements water was also filtered for measurements of particulate C and N (125 samples) and particle light absorption (80 samples).

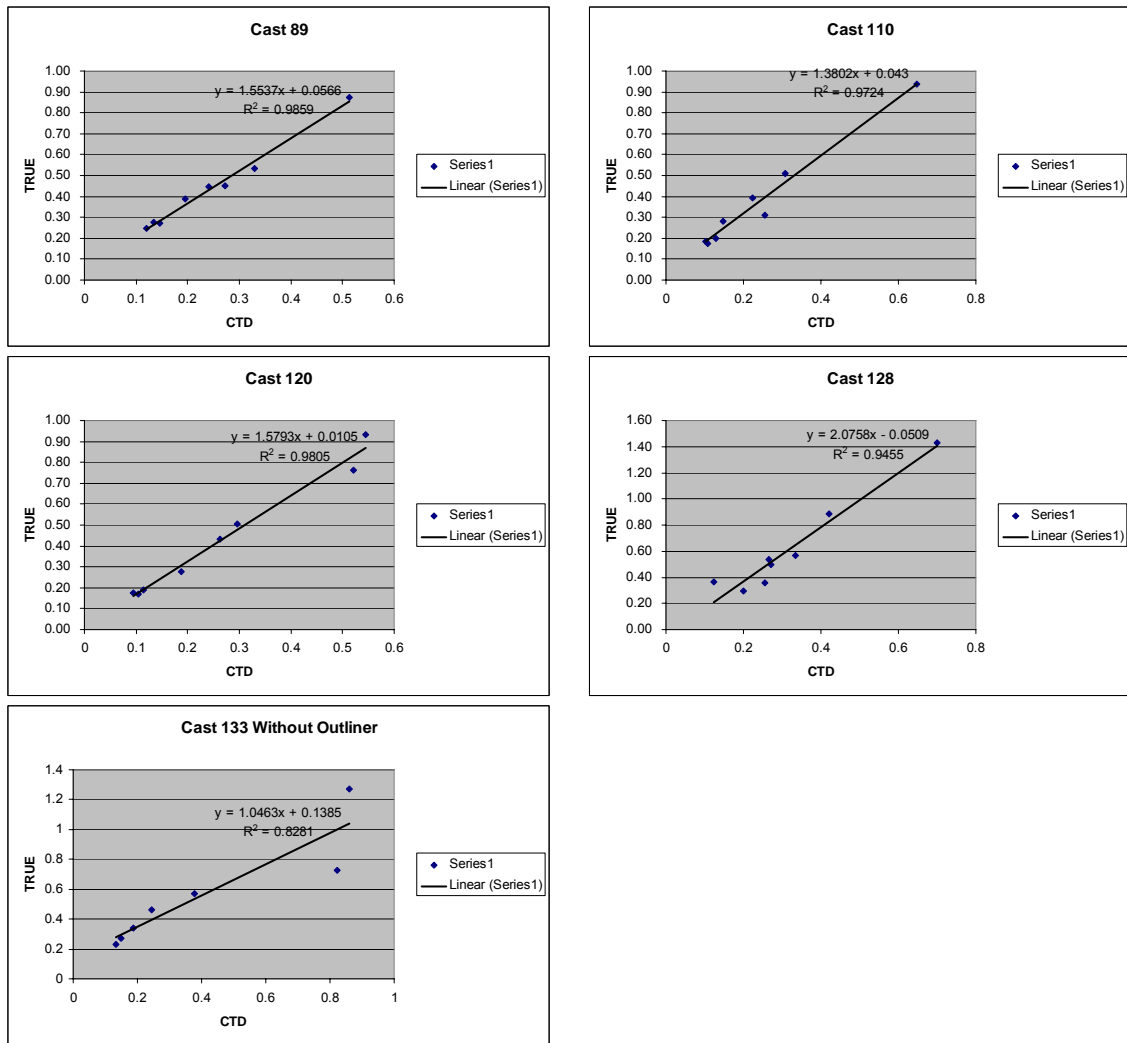
A Detailed look at the spatial variability of CTD Fluorometer Calibration.

Stephanie Bates (West Kirby Grammar School)

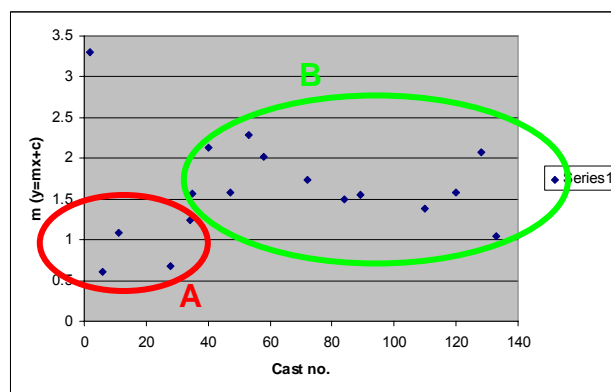
To assess the variability of the chlorophyll calibration across the shelf sea and shelf edge, calibrations were carried out separately on all CTD casts with 8 or more chlorophyll samples. The following plots illustrate the correlations between the CTD fluorometer measurements and the analysed bottle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





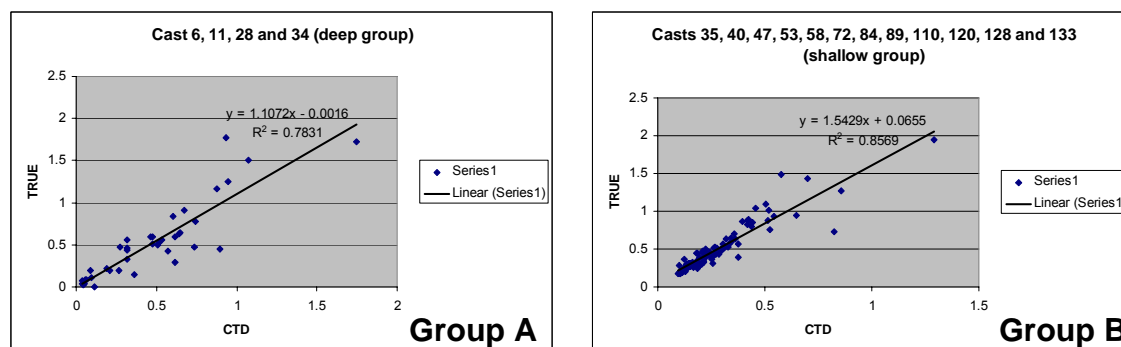


Collecting the regression information and plotting the slope of the regression for each CTD cast number suggests that the CTD calibrations broadly fit into two groups (see below).



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.



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 μM Si and NO_3 and 2 μM PO_4 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.

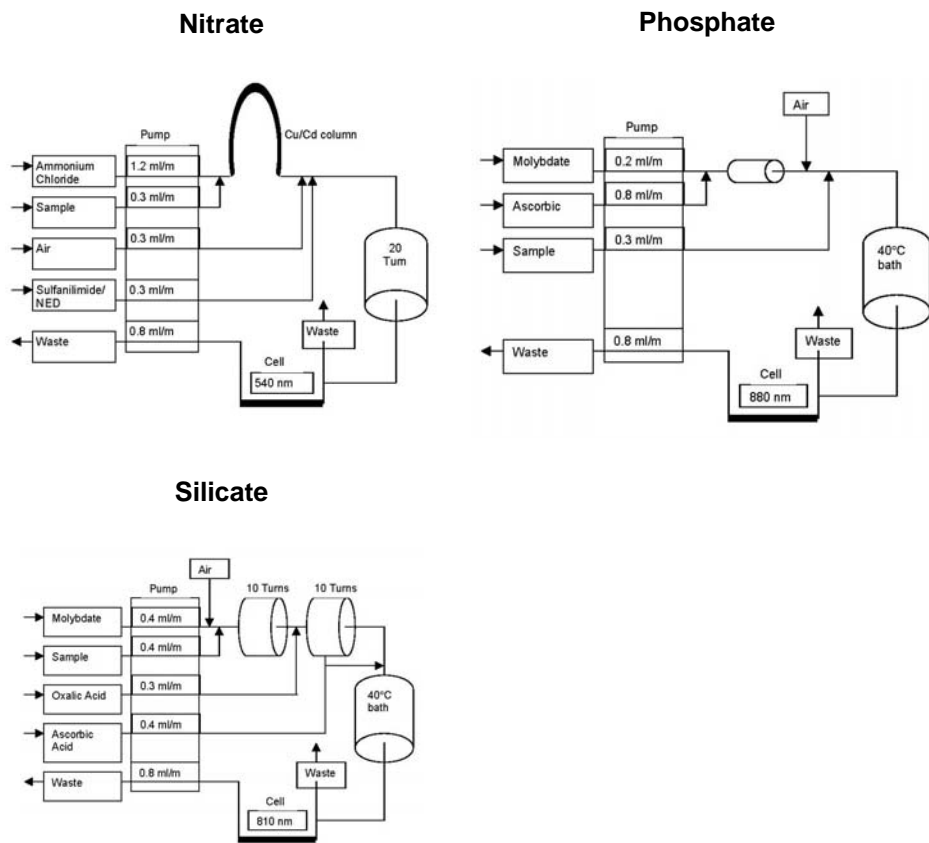


Figure 9.1. Manifold Diagrams for Skalar Autoanalyser

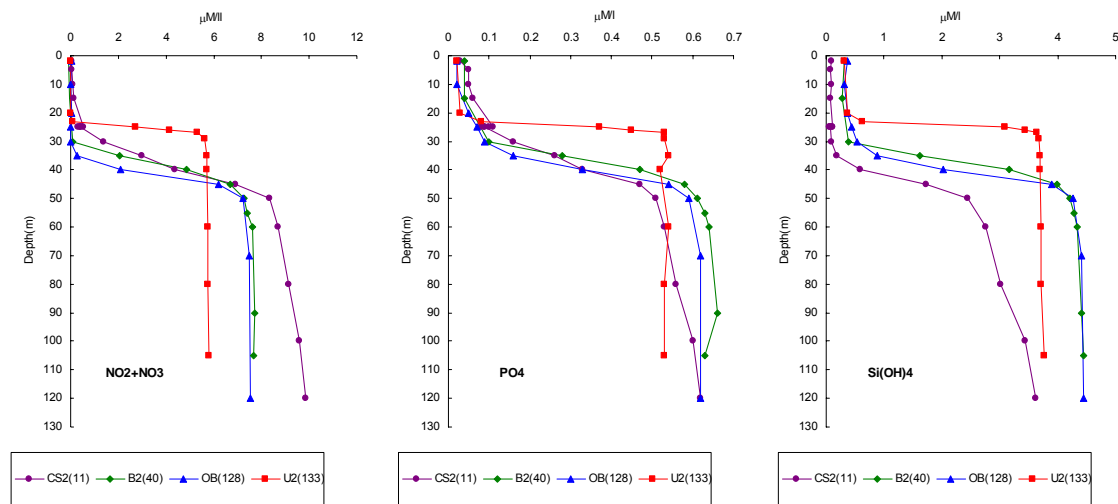


Figure 9.2. Representative vertical nutrients profiles for shelf (U2, B2, OB) and shelf edge (CS2) stations

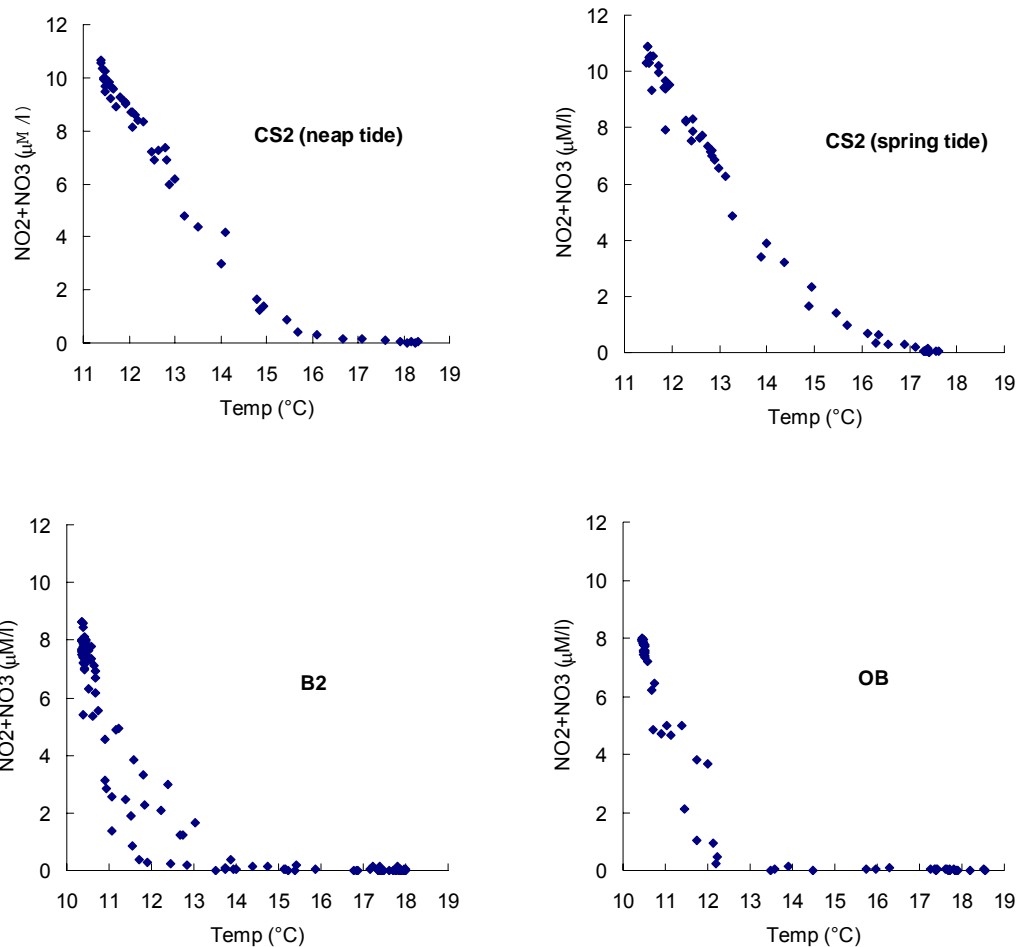


Figure 9.3. Plots of nitrate (NO₃+NO₂) against temperature for the 25 hr stations

10. P vs E Primary production experiments (¹⁴C).

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

Working Stock

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.

Standards

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.

Experimental Protocol

1. Water from each depth was separated into 18 x ~73ml sample bottles, providing 15 light bottles and 3 darks for each depth.
2. 10 μ Ci 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 0.2 μ m polycarbonate filters.
5. Filters were then fumed with concentrated HCl to remove inorganic ¹⁴C 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.

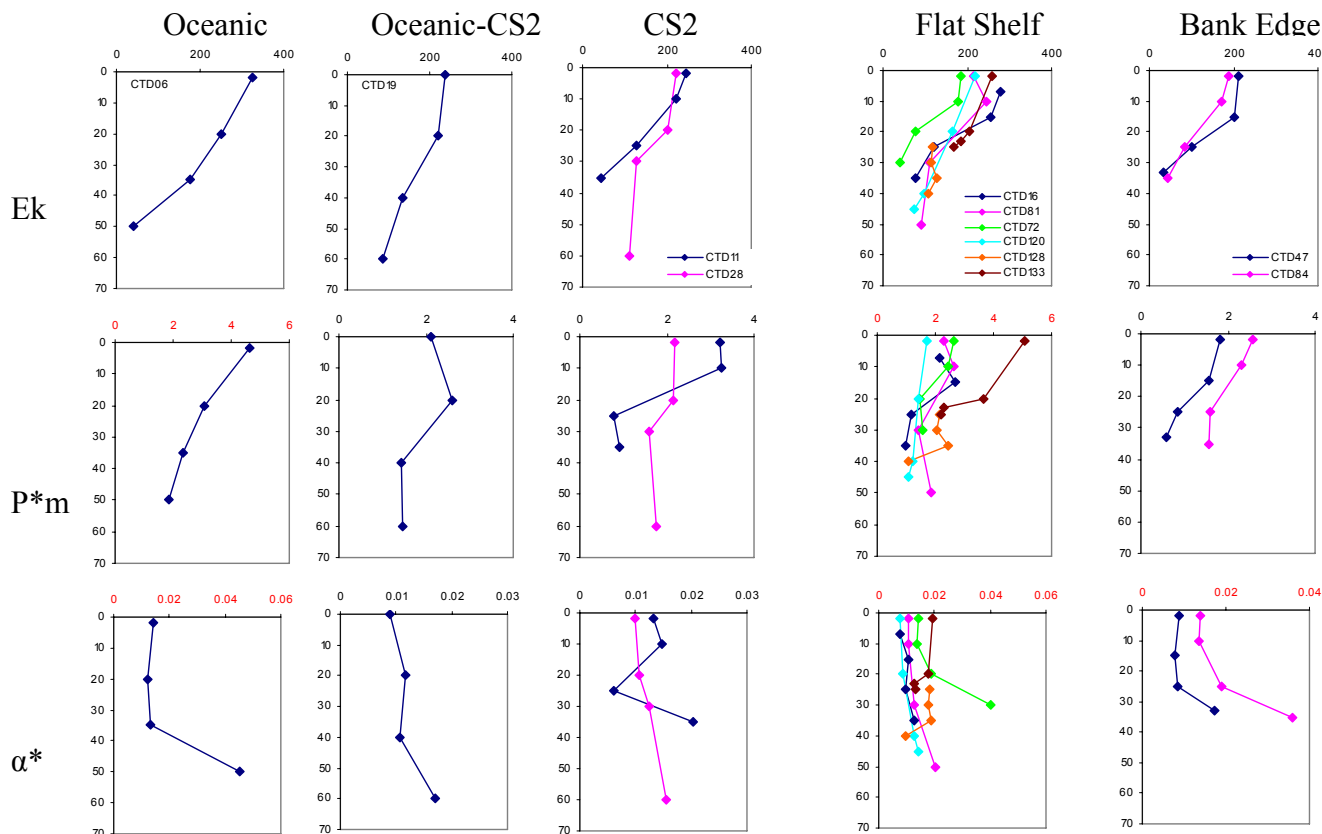
Water samples were kept under dim red light at all times and kept in the cool and dark as much as possible during handling.

Light levels

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

Initial Results

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



11. Phytoplankton ^{15}N & ^{13}C Uptake Rates

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 (ρNO_3). This makes it important to measure ρNO_3 in response to both NO_3 and light gradients.

Approach

A. P vs E Measurements

To understand how carbon fixation and ρNO_3 are controlled by light and ambient NO_3 concentration, P vs E response curves were generated simultaneously for ρNO_3 and carbon fixation using stable isotope tracers (^{13}C and ^{15}N) at both low (~20-50nM) and high, saturating (~5 μM) 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 ~5 μM . Once, water was also obtained from the base of the DCM where the NO_3 concentration was ~4.5 μM , so that no NO_3 addition was required.

For ρNO_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 $\text{NaH}^{13}\text{CO}_3$, 99% ^{13}C) 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 ~5 μM 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. 500 μE to 8 μE .

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 ~71 μE) and lower (LL ~15 μE) 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 ρNO_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 ($\mu\text{g l}^{-1}$)	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 ^{15}N & ^{13}C 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!

12. Fast Repetition Rate Fluorometry 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 2π 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 2π 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 μm 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 μm polycarbonate (Poretics U.K.) filters and then gently resuspended in 100 ml of the original seawater sample filtered through 0.22 μm polycarbonate (Poretics U.K.) filters. This procedure generated the >5 and <5 μm 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.

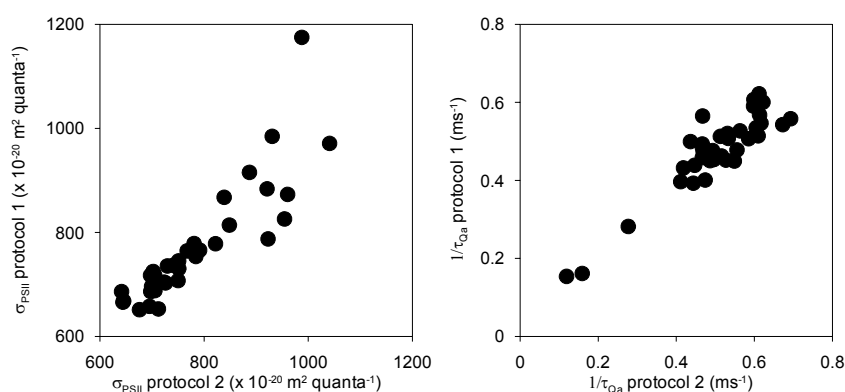


Figure 12.1. Comparison of FRRf data measured on discrete samples using two different protocols, one with a relaxation sequence lasting ~ 2 ms and one lasting ~ 4 ms. Calculated values of the functional absorption cross section (left) and the down chain rate of electron transport (right) are highly correlated ($r^2 > 0.77$, $p < 0.001$) 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 σ_{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 σ_{PSII} and $1/\tau_{Qa}$ indicated that the former varied relatively little with depth in and above the SCM, while the latter 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 σ_{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.

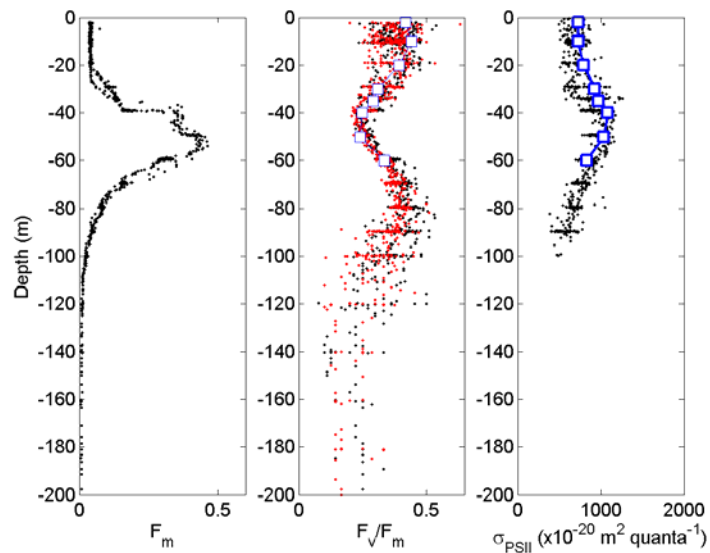


Figure 12.2. FRRf measurements of the maximal fluorescence, a proxy for the chlorophyll concentration (far left), the photochemical quantum efficiency (F_v/F_m , middle) and the PSII functional absorption cross section (σ_{PSII} , right). Measurements made in situ using profiling instrument on CTD frame (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.

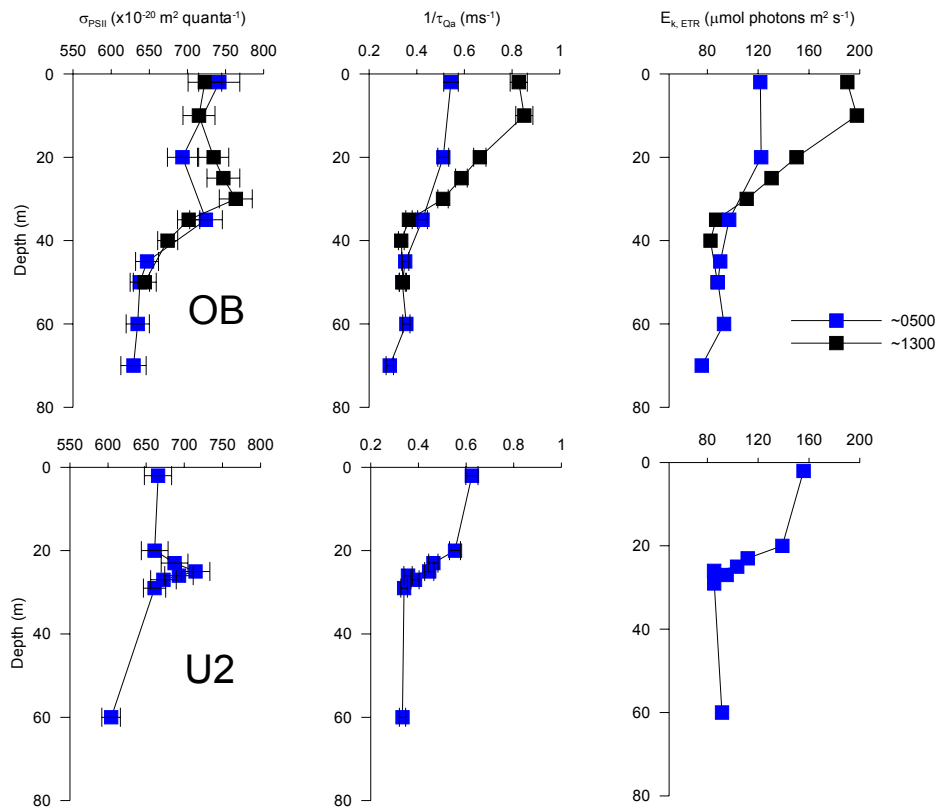


Figure 12.3 Vertical profiles of FRRf derived physiological parameters reconstructed from measurements on discrete samples. Samples were collected pre-dawn at stations OB and U2 (blue). An additional vertical profile was collected at 1300 at OB (black).

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 frf 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 +/- 1µmo/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 $\mu\text{mol}/\text{m}^2/\text{s}$. 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) Calibration of CTD O₂ electrode.

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 9 $\mu\text{mol}/\text{kg}$ (Electrode O₂ value = $0.965 \times \text{Winkler O}_2 \text{ value} - 8.699$). The regression equation can be used to convert all electrode values from all CTD data profiles to accurate oxygen concentration. 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.

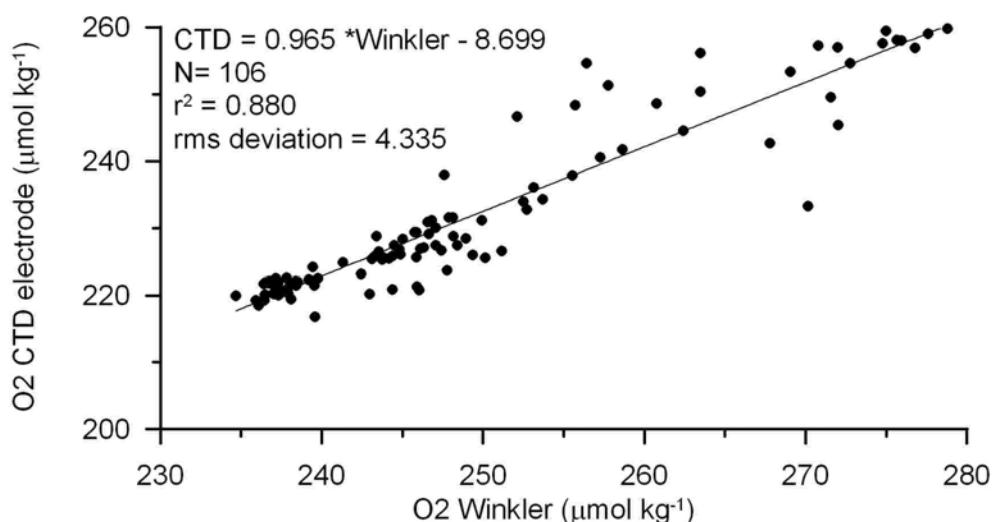


Figure 13.1. Comparison of Winkler and Electrode derived O₂ concentration values with linear regression equation.

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 13.2). 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).

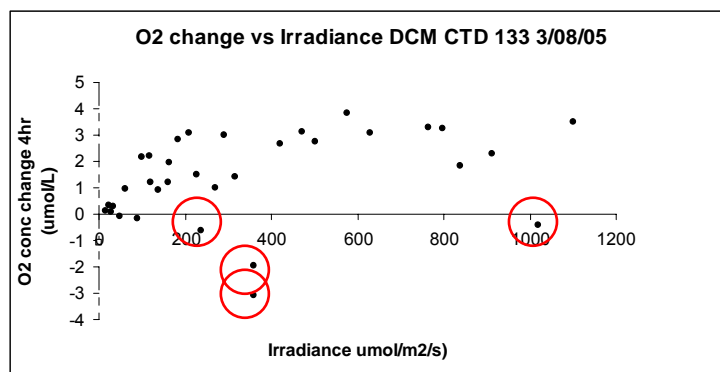


Figure 13.2. Photosynthesis vs. Irradiance for DCM population from 23m CTD133 measured using oxygen difference. (circled points had single large copepods in causing large oxygen loss due to respiration). Open square is respiration rate.

14. POC

Eric Achterberg

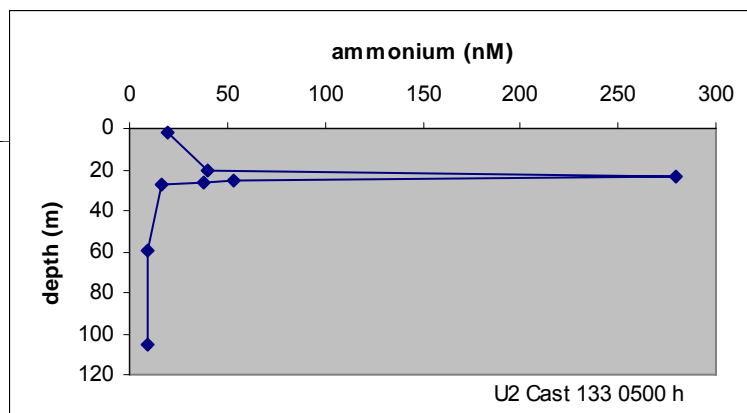
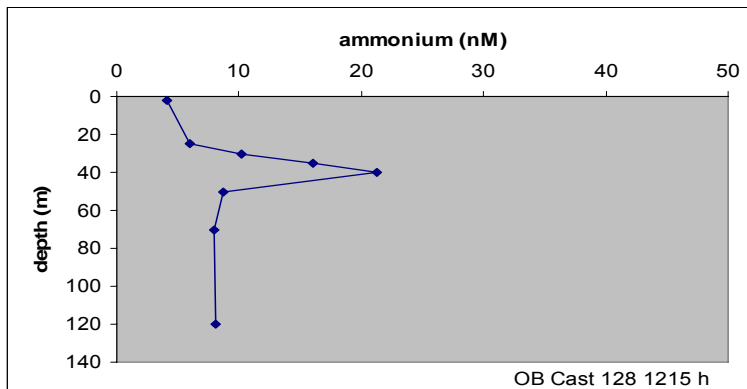
The main aim of my cruise participation was to undertake shipboard water column ammonium measurements, and collect samples for dissolved organic carbon (DOC), total dissolved nitrogen (TDN), amino acids and total dissolved phosphorus (TDP) for subsequent analyses in the laboratory at NOC.

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 -80°C. A total of 10 casts have been sampled, with 6 depths per profile.

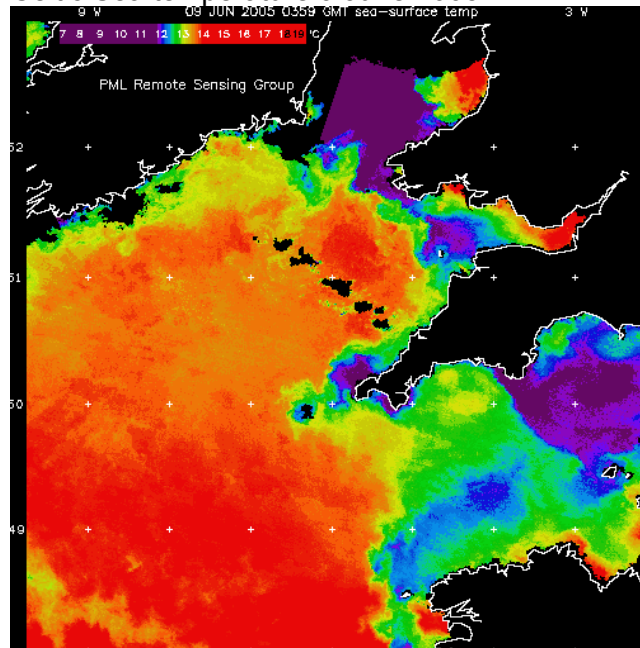


15. Satellite Images

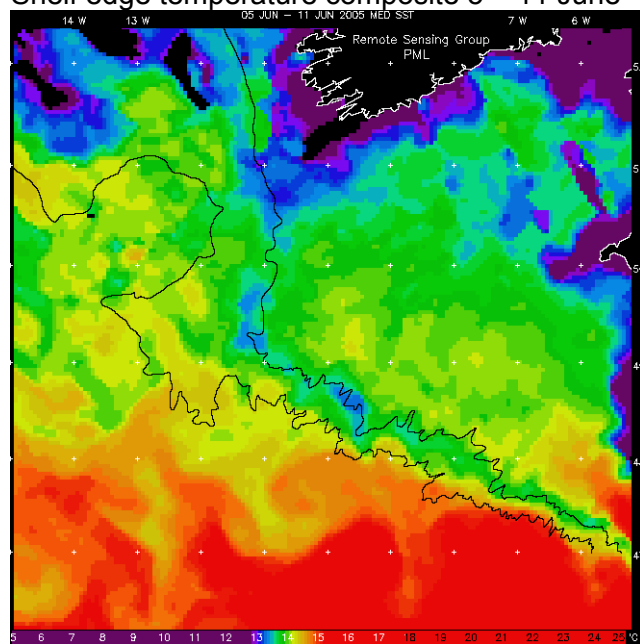
Jonathan Sharples and Stephanie Bates.

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.

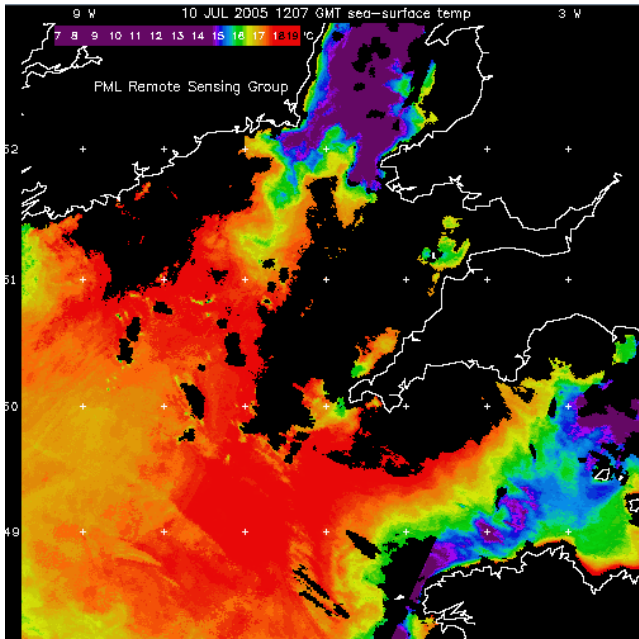
Celtic Sea temperature 9 June 2005



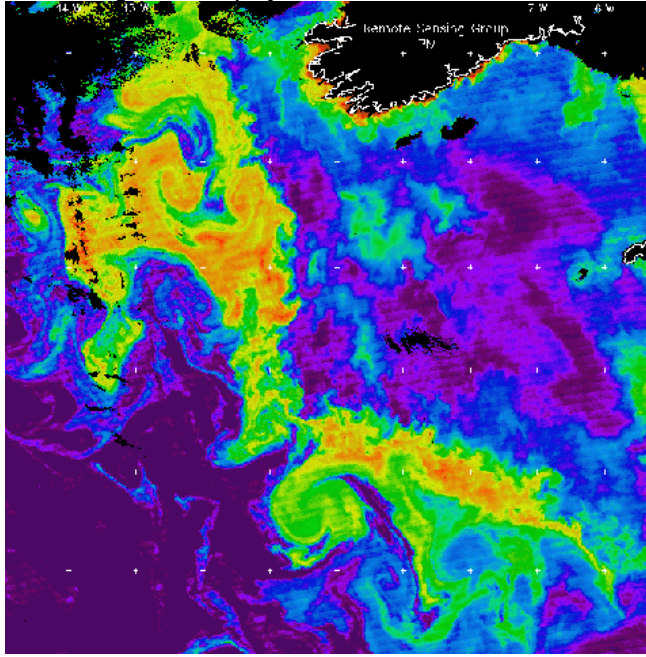
Shelf edge temperature composite 5 – 11 June



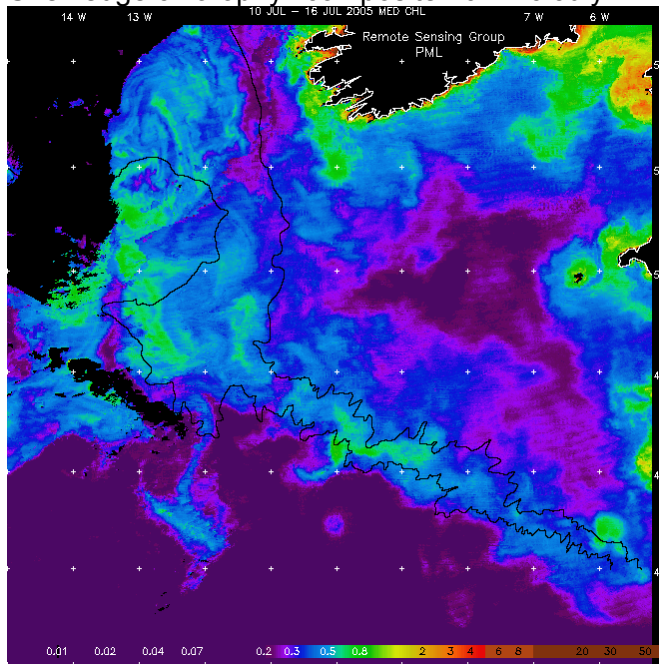
Celtic Sea temperature 10 July



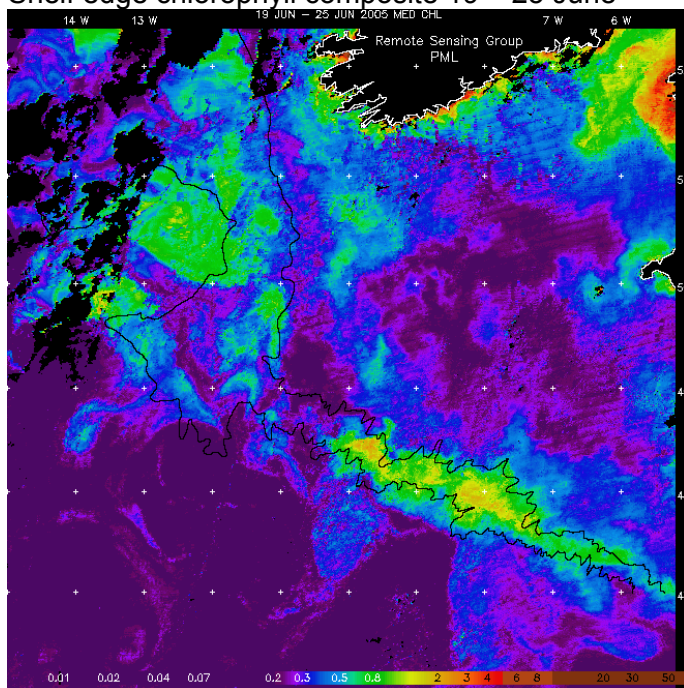
Shelf edge chlorophyll 9 June



Shelf edge chlorophyll composite 10 – 16 July



Shelf edge chlorophyll composite 19 – 25 June



16. Optical and Particle Size Measurements.

Vladimir Krivtsov

Optical measurements

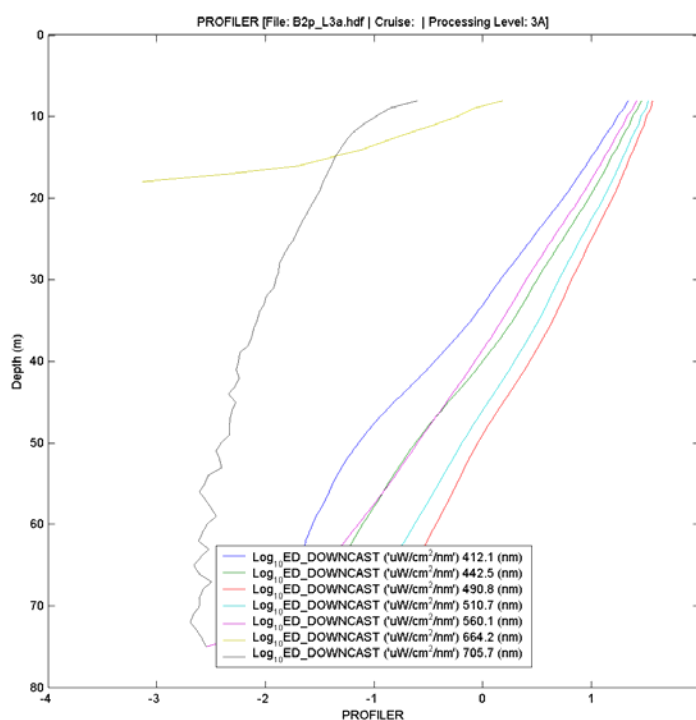
Optical measurements were performed on both legs of the cruise using 2 types of profiling optical instruments: a free fall optical profiler Satlantic, and a profiling radiometer PRR.

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. Interestingly, 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 photosynthetically 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.

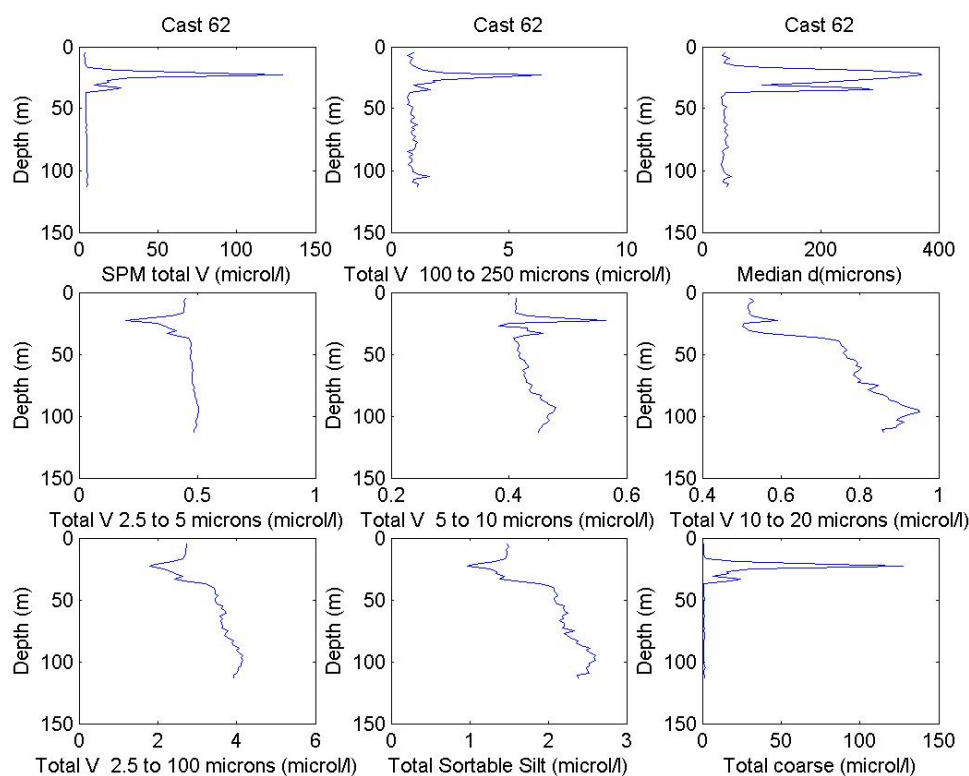


Figure 16.2. Example of LISST data.

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.

