Prince Madog cruise 29/06
POL Coastal Observatory cruise 39
21-22 September 2006

1. Objectives

1. At 53º 32´ N 3º 21.8´ W, half a mile west of the Mersey Bar Light Vessel (site A)
To recover
a) A sea bed frame for a 600 kHz ADCP (waves ADCP) to measure the mean current profile, pressures and directional waves. A Sea-Bird SBE 16*plus* with pumped conductivity sensor, digiquartz pressure sensor and a SeaPoint turbidity sensor were fitted to the frame. The frame is fitted with a SonTek ADV.
b) A CEFAS SmartBuoy (with cellulose rope) in a single point mooring with Sea-Bird MicroCAT temperature, conductivity loggers at 5m and 10m below the surface.
c) A sea bed frame for a nutrient analyser measuring nitrate and phosphate four times a semi-diurnal tidal cycle.

To deploy
d) A sea bed frame for a 600 kHz ADCP (waves ADCP) to measure the mean current profile, pressures and directional waves. A Sea-Bird SBE 16*plus* with pumped conductivity sensor, digiquartz pressure sensor and a SeaPoint turbidity sensor were fitted to the frame.
e) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring with Sea-Bird MicroCAT temperature, conductivity loggers at 5m and 10m below the surface.

2. At 53º 27´ N 3º 38.6´ W (site 21, second site, B)
To recover
f) A sea bed frame for a 600 kHz ADCP (waves ADCP) to measure the mean current profile, pressures and directional waves. A Sea-Bird SBE 16*plus* with pumped conductivity sensor, digiquartz pressure sensor and a SeaPoint turbidity sensor are fitted to the frame. A 1.2 MHz telemetry ADCP was fitted to the frame.
g) A CEFAS SmartBuoy (with cellulose rope and trace metal monitor) in a single point mooring.

To deploy
h) A sea bed frame for a 600 kHz ADCP (waves ADCP) to measure the mean current profile, pressures and directional waves. A Sea-Bird SBE 16*plus* with pumped conductivity sensor, digiquartz pressure sensor and a SeaPoint turbidity sensor were fitted to the frame. A 1.2 MHz telemetry ADCP was fitted to the frame.
i) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring.

3. To conduct a CTD / LISST survey of 34 sites every 5 miles covering the eastern Irish Sea between the North Wales coast and Blackpool and the Lancashire coast and the Great Orme, to determine the effects of the rivers Dee, Mersey and Ribble on Liverpool Bay. To obtain calibration samples for salinity, transmittance, suspended sediment and for chlorophyll at selected stations. To obtain near surface and bed water samples for nutrient and suspended sediment determination.

4. To obtain trace metal water samples at sites 12, 13, 20, 21, 22, 23, 24, 25 and two sites furthest away from the coast (28, 29).

5. Collect 10 vertical net hauls at mooring site A.

6. To deploy a directional wave buoy at 53º 23.5´ N 3º 14.3´ W, off Hilbre Island.

7. To collect grab samples for benthos study.

2.1 Scientific personnel

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Emlyn Jones
Chris Balfour
John Kenny
Stewart Cutchey (CEFAS)
Paul Hudson (CEFAS)
Anne Hammerstein (School of Ocean Sciences)
Conrad Chapman (Liverpool University)
Martin Preston (Liverpool University)
Heidi Tillin (Liverpool University)

2.2 Ship's officers and crew

Steve Duckworth (Master)
Brendan Harris (Chief Officer)
Alan Thompson (Chief Engineer)
Les Black (Second Engineer)
Phil Jones (A.B.)
Dave Leigh (A.B.)
Liam Burke (A.B.)
Terry Gordon (Cook)

3. Narrative (times in GMT)

The SmartBuoy, anchor chain clumps, two sea-bed frames, wave buoy and instrumentation were loaded onto RV Prince Madog on the morning of 21 September 2006. Loading was completed by 12:30. The ADCP frames were set up on the afterdeck and the tower and instruments fitted to the SmartBuoy toroid. The sediment grab sampler and sieving table were also loaded.

Prince Madog left Menai Bridge at 07:12 on 21 September 2006. Surface sampling and the ship's ADCP were switched on at 08:10, by Puffin Island.

The Mersey Bar site was reached at 10:40 and the first CTD profile recorded. The ADCP was recovered at 11:16 with the weights on board by 11:32. The replacement ADCP was deployed at 11:51. The SmartBuoy was deployed at 12:07 and the previous SmartBuoy recovered, 12:15 – 12:29. The nutrient analyser frame was recovered at 12:47, however the weights were lost when the rope snapped due to the weights being stuck under the ship.

Zooplankton net hauls were then carried out between 13:20 – 14:30. This was followed by 6 grab samples taken for the benthos study, between 15:00 -15:18.

The CTD survey commenced with stations 1, 35, 10, 12, 22, 24 and 34. The order was dictated by gale warnings with strong southerly winds forecast for the Irish Sea (Force 9-10). The Prince Madog took shelter in Colwyn Bay when winds reached up to 25ms^{-1}(50 knots). Surface sampling and the ship's ADCP were switched off 22:17. By 05:00 on 23 September the winds had moderated and surface sampling and the ship's ADCP were switched back on at 05:08. A CTD was carried out at station 23. This was followed by a further CTD at station 21. However, during the CTD the telemetry torroid aerial was damaged when it became entangled with the CTD. Whilst doing the CTD in the strong winds the ship had drifted too close to the torroid.

At 08:53 the telemetry buoy was recovered in order to change the batteries, and now replace the aerial. It was re-deployed at 08:53, however the new aerial was damaged whilst the buoy was being lifted into position ready for deployment. This was repaired with tape since there were no other spare aerials available. The replacement SmartBuoy was deployed 09:32 – 09:34. The previous SmartBuoy was recovered 09:52 – 09:58. Between 10:00 and 10:20 the deck was tided. At 10:20 the ADCP was recovered. At 11:28 the replacement ADCP was deployed. A CTD was again carried out at station 21. This was followed by 7 sediment grabs taken for the benthos study 11:33 – 11:47, of which only 5 returned sediment samples.

The wave buoy was then prepared whist on route to the Hilbre Channel deployment site. It was deployed at 13:53. The CTD survey was then re-commenced starting from stations 2-9, 13-20, 25-33. At stations 28 and 29 samples were taken for trace metal analysis using a pole/container at station 28 and line/container at 29 (since the pole broke).

Surface logging and the ship's ADCP were stopped at 10:38, near Puffin Island, and Prince Madog berthed at Menai Bridge at 11:38 on 23 September.

The weather was stormy throughout the cruise (Force 6 - 9), however since the winds were from the south and south-east all of the moorings work was successful achieved. In addition all of the CTD stations were carried out as winds moderated late Friday and during Saturday (Force 6).

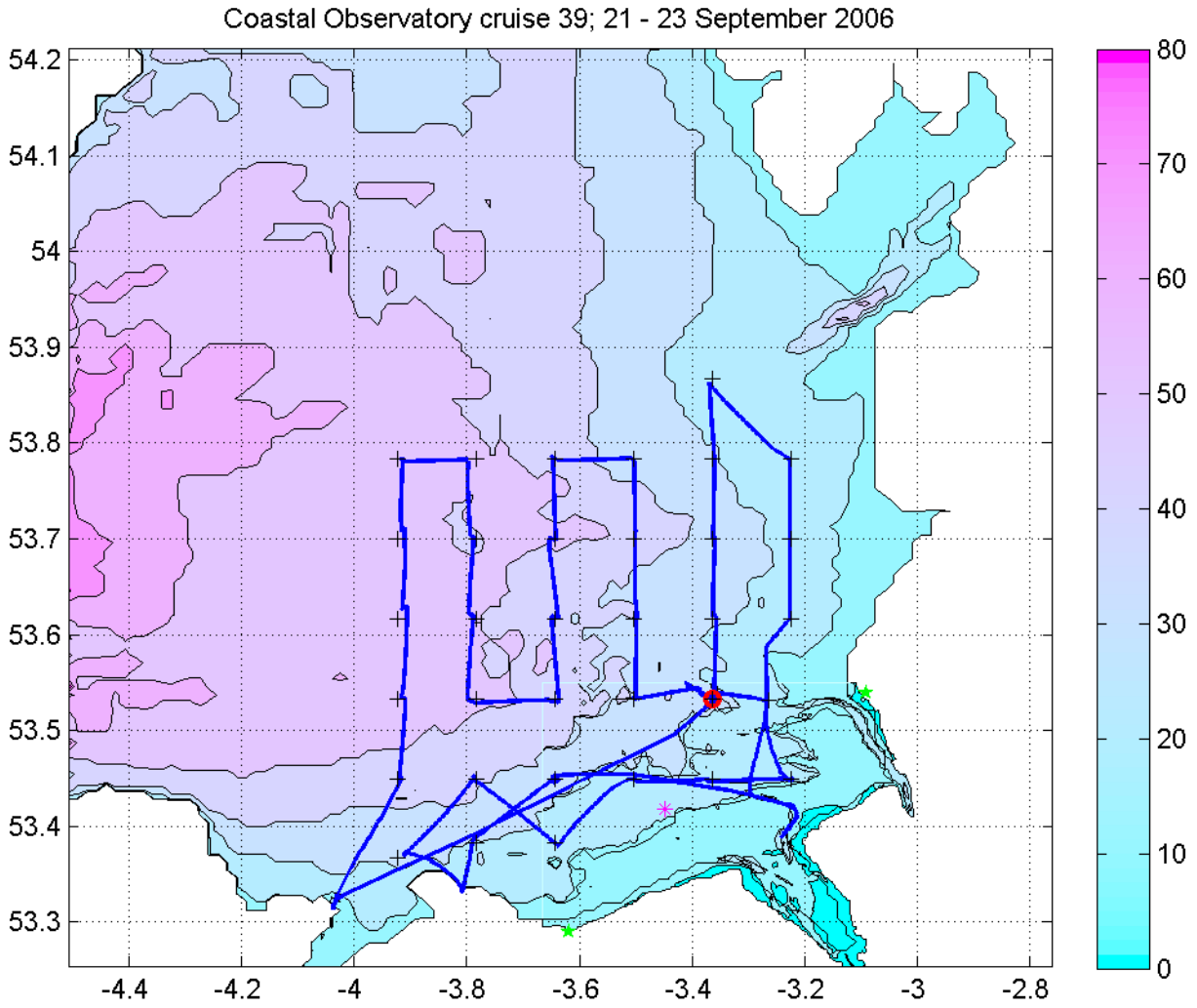

Figure 1. Cruise track.

4. Moorings (times in GMT)

4.1 The set up of the recovered instruments was as follows:
Site A

a) Waves ADCP 600 kHz RDI 2391**.**
Mode 1: 100 pings every 10 minutes (velocity standard deviation 0.007 m s^{-1}).
35 x 1 m bins (2.65 – 36.65 m above the bed).
Beam co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Fitted with a pressure sensor and 1 Gbyte PCMCIA memory; hourly wave recording enabled.
Clock reset at 15:04:55 on 14 August; delayed start 06:00:00 on 15 August 2006; started ok.
No time recorded for stopped. Processed OK.

Sea-Bird 16plus S/N 4596 on base of frame with pumped conductivity sensor underneath. SeaPoint turbidity sensor S/N 10487 taped to roll bar; set up for 0 - 125 FTU range.
Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5s, 1 s delay.
Clock set at 15:20:00 on 14 August 2006; delayed start at 06:00:00 on 15 August 2006.
Stopped 10:15:10 on 23 September. Samples = 5642.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger 258
Sensor height above bed 1.305m. Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s. Compass orientation note: Red mark on prong pointing along scaffold pole away from the ADCP frame, -90° relative to ADCP beam 3.
Delayed start at 16:00 on 15 August 2006.
The batteries and memory card were changed on board ship.

The frame D4 was fitted with two Benthos releases 72382 – Rx 10.0 kHz, Tx 12.0 kHz, release A and 72850 – Rx 11.5 kHz, Tx 12.0 kHz, release C both with a fizz link, and a spooler with 200m of rope for recovery of the ballast weight.

b) SmartBuoy Mooring.
Sea-Bird MicroCAT temperature and conductivity recorder Serial number 2081 at 10 m below the surface. Sample interval 600s. Reference pressure = 25dB.
Clock set at 14:40:30 on 14 August 2006. Delayed start 06:00:00 on 15 August 2006.
Stopped at 14:07:53 on 22 September 2006. 5521 samples. Clock is 1s fast.

Sea-Bird MicroCAT temperature and conductivity recorder Serial number 2010 at 5 m below the surface. Sample interval 600s. Reference pressure = 25dB.
Clock set at 14:47:10 on 14 August 2006. Delayed start 06:00:00 on 15 August 2006.
Stopped at 15:07:10 on 22 September 2006. 5527 samples. Clock is 6s fast.

The CEFAS SmartBuoy is fitted with one surface CTD, light sensors at 1 and 2 m below the surface, a water sampler which obtains water samples once per day for laboratory nutrient (TOXN and silicate; no filtration therefore no phosphate), fluorometer (SeaPoint), oxygen (Aanderaa Optode) and chlorophyll determination and an in situ NAS2E nutrient analyser. The CTD and light data are transmitted back to CEFAS via Orbcomm. The frame was fitted with a rope loop for the determination of bacterial degradation.

The single point mooring was composed mainly of ½" long link chain, marked by a 1.8 m diameter toroid and anchored by a half tonne clump of scrap chain.

c) Ecolab nutrient analyser measuring nitrate and phosphate four times in a semi-diurnal tidal cycle.

The frame was fitted with two Benthos releases 70356 – Rx 10.5 kHz, Tx 12.0 kHz, release D and 72381 – Rx 11.0 kHz, Tx 12.0 kHz, release B both with a fizz link, and a spooler with 200m of rope for recovery of the ballast weight.

Site B
a) Waves ADCP 600 kHz RDI 3644.
Mode 1: 100 pings every 10 minutes (velocity standard deviation 0.007 m s^{-1}).
35 x 1 m bins (2.65 – 36.65 m above the bed).
Beam co-ordinates - speeds, correlation, echo intensity, % good.

Sound velocity calculated from temperature, depth and salinity of 32.
Fitted with a pressure sensor and 1Gbyte PCMCIA memory; hourly wave recording enabled.
Time set at 08:30:00 on 16 August, delayed start at 11:00:00 on 16 August.
Stopped at 21:55:00 on 22 September 2006.

Telemetry ADCP 1200 kHz RDI 0572**.**
Mode 1: 100 pings every 10 minutes (velocity standard deviation 0.003 m s^{-1}).
30 x 1 m bins (2.15 – 31.15 m above the bed).
Earth co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
The ADCP was stopped and reset between 08:00 and 09:00 on 16 August 2006.
Delayed start at 11:00:00 on 16 August.
LinkQuest acoustic modem set for transmission of ADCP data every hour.
Stopped at 21:55:00 on 22 September 2006.

Sea-Bird 16plus S/N 4736 on base of frame with pumped conductivity sensor underneath.
SeaPoint turbidity sensor taped to roll bar S/N 10490; set up for 0 - 125 FTU range.
Sample interval 600 s; digiquartz integration time 40s, range 400; run pump 0.5s, 1 s delay.
Clock set at 14:30:00 on 14 August 2006; delayed start at 06:00:00 on 15 August 2006.
Stopped at 09:37:50 on 23 September 2006. 5638 samples. Downloaded OK.

The frame D3 was fitted with two Benthos releases 70358 – Rx 11.0 kHz, Tx 12.0 kHz, release A and 71904 – Rx 10.0 kHz, Tx 12.0 kHz, release C both with a fizz link, and a spooler with 200m of rope for recovery of the ballast weight.

b) SmartBuoy Mooring.
The CEFAS SmartBuoy is fitted with a surface CTD (including turbidity and fluorescence sensors). The frame was fitted with a rope loop for the determination of bacterial degradation and a trace metal monitor.

No other instrumentation was fitted to the mooring.

The single point mooring was composed mainly of ½" long link chain, marked by a 1.8 m diameter toroid and anchored by a half tonne clump of scrap chain.

Table 1. Recovered mooring positions and times.

	Latitude (N)	Longitude (W)	Water Depth (m)	Recovered Time	Date
Waves ADCP (Site A)	53º 32.026´	3º 21.527´	26.1	11:16	21/09/06
SmartBuoy (Site A)	53º 31.994´	3º 21.799´	25.5	12:15	21/09/06
Nutrient frame (Site A)	53º 32.019´	3º 21.764´	25.0	12:47	21/09/06
Waves ADCP (Site B)	53º 26.987´	3º 38.626´	23.1	10:20	22/09/06
Smart Buoy (Site B)	53º 27.047´	3º 38.451´	23.6	09:52	22/09/06
Telemetry toroid	53º 26.956´	3º 38.666´	27.7	06:49	22/09/06

4.2 The set up of the deployed instruments was as follows:

Site A

a) Waves ADCP 600 kHz RDI 5806**.**
Mode 1: 100 pings every 10 minutes (velocity standard deviation 0.007 m s^{-1}).
35 x 1 m bins (2.65 – 36.65 m above the bed).
Beam co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Fitted with a pressure sensor and 1 Gbyte PCMCIA memory; hourly wave recording enabled.
Clock reset at 12:50:30 GMT on 20 September; delayed start 06:00:00 on 21 September 2006.

Sea-Bird 16plus S/N 4737 on base of frame with pumped conductivity sensor underneath.
SeaPoint turbidity sensor S/N 10489 taped to roll bar; set up for 0 - 125 FTU range.
Sample interval 600 s; pump 0.5s, 1 s delay.
Clock set at 12:22:50 on 20 September 2006; delayed start at 07:00:00 on 21 September 2006.

The frame D6 was fitted with two Benthos releases 72863 – Rx 13.5 kHz, Tx 12.0 kHz, release A and 71922 – Rx 11.5 kHz, Tx 12.0 kHz, release A both with a fizz link, and a spooler with 200m of rope for recovery of the ballast weight.

b) SmartBuoy Mooring.
Sea-Bird MicroCAT temperature and conductivity recorder Serial number 2991 at 5m below the surface. Sample interval 600s. Reference pressure = 25dB.
Clock set at 12:50:00 on 20 September 2006. Delayed start 07:00:00 on 21 September 2006.

Sea-Bird MicroCAT temperature and conductivity recorder Serial number 2506 at **10**m below the surface. Sample interval 600s. Reference pressure = 25dB.
Clock set at 12:58:00 on 20 September 2006. Delayed start 07:00:00 on 21 September 2006.

The CEFAS SmartBuoy is fitted with one surface CTD, light sensors at 1 and 2 m below the surface, a water sampler which obtains water samples once per day for laboratory nutrient (TOXN and silicate; no filtration therefore no phosphate), fluorometer (SeaPoint), oxygen (Aanderaa Optode) and chlorophyll determination and an in situ NAS2E nutrient analyser. The CTD and light data are transmitted back to CEFAS via Orbcomm. The frame was fitted with cellulose bags for the determination of bacterial degradation.

The single point mooring was composed mainly of ½" long link chain, marked by a 1.8 m diameter toroid and anchored by a half tonne clump of scrap chain.

Site B
a) Waves ADCP 600 kHz RDI 5807.
Mode 1: 100 pings every 10 minutes (velocity standard deviation 0.007 m s^{-1}).
35 x 1 m bins (2.65 – 36.65 m above the bed).
Beam co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Fitted with a pressure sensor and 1Gbyte PCMCIA memory; hourly wave recording enabled.
Time set at 15:08:00 on 20 September 2006, delayed start at 23:00:00 on 21 September 2006.

Telemetry ADCP 1200 kHz RDI 3052**.**
Mode 1: 100 pings every 10 minutes (velocity standard deviation 0.003 m s^{-1}).
30 x 1 m bins (2.15 – 31.15 m above the bed).
Earth co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Time set at 15:12:00 on 20 September 2006.
Delayed start at 23:00:00 on 20 September 2006.
LinkQuest acoustic modem set for transmission of ADCP data every hour.

Sea-Bird 16plus S/N 4597 on base of frame with pumped conductivity sensor underneath. SeaPoint turbidity sensor taped to roll bar S/N 10471; set up for 0 - 125 FTU range.
Sample interval 600 s; digiquartz integration time 40s, range 400; run pump 0.5s, 1 s delay.
Clock set at 12:30:00 on 20 September 2006; delayed start at 07:00:00 on 21 September 2006.

The frame D5 was fitted with two Benthos releases 72858 – Rx 14.5 kHz, Tx 12.0 kHz, release A and 67679 – Rx 12.0 kHz, Tx 11.5 kHz, release B both with a fizz link, and a spooler with 200m of rope for recovery of the ballast weight.

b) SmartBuoy Mooring.
The CEFAS SmartBuoy is fitted with a surface CTD (including turbidity and fluorescence sensors). The frame was fitted with cellulose bags for the determination of bacterial degradation.

No other instrumentation was fitted to the mooring.

The single point mooring was composed mainly of ½" long link chain, marked by a 1.8 m diameter toroid and anchored by a half tonne clump of scrap chain.

Table 2. Deployed mooring positions and times.

	Latitude (N)	Longitude (W)	Water Depth (m)	Deployed Time	Deployed Date
Waves ADCP (Site A)	53º 32.030´	3º 21.520´	26.1	11:51	21/09/06
SmartBuoy (Site A)	53º 32.036´	3º 21.594´	25.4	12:09	21/09/06
Waves ADCP (Site B)	53º 27.000´	3º 38.635´	27.9	11:28	22/09/06
Smart Buoy (Site B)	53º 26.908´	3º 38.823´	27.3	09:34	22/09/06
Telemetry toroid	53º 26.922´	3º 38.648´	26.7	08:53	22/09/06
Wave buoy (Hilbre Channel)	53º 23.400´	3º 14.409´	17.1	13:53	22/09/06

5. CTD

The Sea-Bird 911 CTD recorded downwelling PAR light levels (CEFAS light sensor), temperature, conductivity, transmittance, oxygen (no calibration samples) and fluorescence at 24 Hz. The frame was fitted with an altimeter, which was not totally reliable, so that measurements were taken to within an estimated 3 m above the bed. The rosette will take twelve 10 l water bottles although the capacity is reduced by one (for the LISST-25).

One/two water bottles were fired near bed and one/two/three near the surface, when needed. The CTD temperature data was checked against a Sea-Bird SBE35 precision thermometer. Water samples were taken from a near bed bottle for calibration of the CTD salinity data. Water samples were taken from the near surface and near bed bottles and frozen for nutrient analysis by NOC (nitrate, phosphate, silicate), and also were filtered to determine suspended sediment load and calibrate the CTD transmissometer, by the School of Ocean Sciences. Water samples from the second near surface bottle from stations 1 and 21 were filtered for chlorophyll and suspended sediment determination and some filtrate was preserved with mercuric chloride for nutrient determination by CEFAS, (in addition samples at station 1 were taken for oxygen analysis). A LISST-100C particle sizer with internal logging was also attached to the CTD frame and its data periodically downloaded for analysis by SOS. Copies of the Sea-Bird binary files were taken off for processing and calibration at BODC / POL.

Not present due to a fault (A LISST-25 particle sizer was fitted to the CTD and its data logged on the Sea-Bird data logging system).

Table 3. Nominal CTD positions. (Ss – Suspended sediments, Nu – Nutrients)

Site	Latitude (N)	Longitude (W)	Visited on this cruise	Cefas Chlorophyll & Nu & Ss	POL Nu	POL Ss	Trace metal
1	53º 32′	3º 21.8′	yes	yes	yes	yes	
2	53º 37′	3º 13.4′	yes		yes	yes	
3	53º 42′	3º 13.4′	yes		yes	yes	
4	53º 47′	3º 13.4′	yes		yes	yes	
5	53º 52′	3º 21.8′	yes	yes	yes	yes	
6	53º 47′	3º 21.8′	yes	yes	yes	yes	
7	53º 42′	3º 21.8′	yes	yes	yes	yes	
8	53º 37′	3º 21.8′	yes	yes	yes	yes	
9	53º 32′	3º 21.8′	yes	yes	yes	yes	
10	53º 27′	3º 13.4′	yes		yes	yes	
11	53º 27′	3º 21.8′	yes	yes	yes	yes	
12	53º 27′	3º 30.2′	yes		yes	yes	yes
13	53º 32′	3º 30.2′	yes		yes	yes	
14	53º 37′	3º 30.2′	yes		yes	yes	
15	53º 42′	3º 30.2′	yes		yes	yes	
16	53º 47′	3º 30.2′	yes		yes	yes	
17	53º 47′	3º 38.6′	yes		yes	yes	
18	53º 42′	3º 38.6′	yes		yes	yes	
19	53º 37′	3º 38.6′	yes		yes	yes	
20	53º 32′	3º 38.6′	yes		yes	yes	yes
21	53º 27′	3º 38.6′	yes	yes	yes	yes	yes
22	53º 23′	3º 38.6′	yes		yes	yes	yes
23	53º 23′	3º 47.0′	yes		yes	yes	yes
24	53º 27′	3º 47.0′	yes		yes	yes	yes
25	53º 32′	3º 47.0′	yes		yes	yes	yes
26	53º 37′	3º 47.0′	yes		yes	yes	
27	53º 42′	3º 47.0′	yes		yes	yes	
28	53º 47′	3º 47.0′	yes		yes	yes	yes

29	53º 47′	3º 55.4′	yes		yes	yes	yes
30	53º 42	3º 55.4′	yes		yes	yes	
31	53º 37′	3º 55.4′	yes		yes	yes	
32	53º 32′	3º 55.4′	yes		yes	yes	
33	53º 27′	3º 55.4′	yes		yes	yes	
34	53º 22′	3º 55.4′	yes		yes	yes	
35	53º 32′	3º 15.9′	yes		yes	yes	

Table 4. Surface and bottom parameters from CTD, noted in log book.

Nominal positions.

CTD no	Site	Nuts	Latitude (N)	Longitude (W)	Water depth (m)	Temp (deg)	Salinity
		T/ B				T / B	T / B
2	1	1/ 2	53º 32′	3º 21.8′	21	16.9 / 16.9	33.0 / 33.0
3	35	3/ 4	53º 31.9′	3º 15.9′	10	17.0 / 17.0	32.1 / 32.1
4	10	5/ 6	53º 27′	3º 13.4′	13	16.9 / 16.9	32.0 / 32.1
5	11	7/ 8	53º 27′	3º 21.8′	15	17.0 / 17.0	32.5 / 32.5
6	12	9/10	53º 27′	3º 30.2′	15	17.1 / 17.1	32.7 / 32.7
7	22	11/12	53º 23′	3º 38.6′	13	17.0 / 17.0	32.9 / 32.8
8	24	13/14	53º 27′	3º 47.0′	34	16.4 / 16.4	33.5 / 33.5
9	34	15/16	53º 22′	3º 55.4′	27	16.8 / 16.8	33.2 / 33.2
10	23	17/18	53º 23′	3º 47.0′	15	16.9 / 16.8	33.0 / 33.1
11	21	19/20	53º 27′	3º 38.6′	22	16.9 / 16.8	33.0 / 33.1
12	21	21/22	53º 27′	3º 38.6′	28	16.6 / 16.6	33.3 / 33.3
13	2	23/24	53º 37′	3º 13.4′	11	16.9 / 16.9	32.2 / 32.2
14	3	25/26	53º 42′	3º 13.4′	15	17.0 / 17.0	31.9 / 32.0
15	4	27/28	53º 47′	3º 13.4′	14	17.0 / 16.9	31.9 / 32.1
16	5	29/30	53º 52′	3º 21.8′	13	16.8 / 16.8	32.0 / 32.1
17	6	31/32	53º 47′	3º 21.8′	17	16.9 / 17.0	32.4 / 32.5
18	7	33/34	53º 42′	3º 21.8′	23	16.9 / 16.8	32.6 / 32.9
19	8	35/36	53º 37′	3º 21.8′	26	16.9 / 16.9	32.9 / 32.9
20	9	37/38	53º 32′	3º 21.8′	24	16.8 / 16.8	33.0 / 33.0
21	13	39/40	53º 32′	3º 30.2′	36	16.7 / 16.7	33.2 / 33.2
22	14	41/42	53º 37′	3º 30.2′	34	16.7 / 16.7	33.1 / 33.1
23	15	43/44	53º 42′	3º 30.2′	40	16.5 / 16.5	33.3 / 33.3
24	16	45/46	53º 47′	3º 30.2′	29	16.5 / 16.5	33.3 / 33.3
25	17	47/48	53º 47′	3º 38.6′	38	16.4 / 16.4	33.4 / 33.4
26	18	49/50	53º 42′	3º 38.6′	40	16.4 / 16.4	33.4 / 33.5
27	19	51/52	53º 37′	3º 38.6′	33	16.5 / 16.5	33.4 / 33.4
28	20	53/54	53º 32′	3º 38.6′	33	16.5 / 16.5	33.3 / 33.3
30	25	55/56	53º 32′	3º 47.0′	42	16.5 / 16.5	33.4 / 33.4
31	26	57/58	53º 37′	3º 47.0′	38	16.4 / 16.4	33.5/ 33.5
32	27	59/60	53º 42′	3º 47.0′	38	16.4 / 16.4	33.5 / 33.5
33	28	61/62	53º 47′	3º 47.0′	38	16.4 / 16.4	33.4 / 33.4
34	29	63/64	53º 47′	3º 55.4′	40	16.2 / 16.2	33.6 / 33.6
35	30	65/66	53º 42	3º 55.4′	41	16.1 / 15.7	33.7 / 33.9
36	31	67/68	53º 37′	3º 55.4′	44	16.1 / 16.0	33.6 / 33.8
37	32	69/70	53º 32′	3º 55.4′	46	16.1 / 16.1	33.7 / 33.7

38	33	71/72	53º 27′	3º 55.4′	40	16.3 / 16.3	33.6 / 33.6

6. Surface sampling

The intake for the surface sampling system is located underneath RV Prince Madog, at about 3 m below sea level. The parameters recorded every minute by the WS Oceans system are: Date, Solar Radiation (W m^{-2}), PAR (µmols / m^2s), Air Temperature (ºC), Relative Humidity, Relative Wind Speed (m s^{-1}), Relative Wind Direction (º) – zero indicates wind on the bow, Transmissance, Hull Temperature (ºC), Barometric Pressure (mbar), Fluorescence, Turbidity, Salinity, Minimum Air Temp (ºC), Maximum Air Temp (ºC), Wind Gust (m s^{-1}), GPS Time, Latitude, Longitude, Barometric Pressure Minimum (mbar), Barometric Pressure Maximum (mbar), Conductivity sensor water temperature (ºC). Sea surface temperature, salinity and transmittance were calibrated against the CTD by BODC.

Underway data were recorded every minute from 08:10 on 21 September until 22:17 on 21 September 2006, and 05:08 on 22 September 2006 until 10:38 on 23 September 2006, starting and ending at Puffin Island. The Relative Humidity data, all values about -24.7, are wrong. Copies of the data were taken off the ship as an Excel file, along with a copy of the ship's navigation data.

The ship was fitted with a 300 kHz ADCP set to record 25 x 2m bins, the bin nearest the surface was at 5.1 m depth, every 30 seconds with 29 pings / ensemble. Data were recorded from 08:10 on 21 September until 22:17 on 21 September 2006, and from 05:08 on 22 September until 10:38 on 23 September 2006 starting and ending at Puffin Island.

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