Prince Madog cruise 25/06
POL Coastal Observatory cruise 38
15 - 16 August 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 bags) in a single point mooring with Sea-Bird MicroCAT temperature, conductivity loggers at 5m and 10m below the surface.

To deploy
c) 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.
d) 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.
e) A sea bed frame for a nutrient analyser measuring nitrate and phosphate four times a semi-diurnal tidal cycle.

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 were fitted to the frame. A 1.2 MHz telemetry ADCP was fitted to the frame.
g) A CEFAS SmartBuoy (with cellulose bags) 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 are fitted to the frame. A 1.2 MHz telemetry ADCP was fitted to the frame.
i) A CEFAS SmartBuoy (with cellulose bags and trace metal monitor) 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.

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.

2.1 Scientific personnel

John Howarth (Principal)
Mike Burke
Chris Balfour
John Kenny
Huagen Chen (Casey)
Dave Sivyer (CEFAS)
Jo Foden (CEFAS)
Anne Hammerstein (School of Ocean Sciences)
Conrad Chapman (Liverpool University)
Martin Preston (Liverpool University)

2.2 Ship's officers and crew

Steve Duckworth (Master)
Dean Atkinson (Chief Officer)
Roger Lawn (Chief Engineer)
Jimmy Donnelly (Second Engineer)
Phil Jones (A.B.)
Dave Leigh (A.B.)
Mike Callaghan (A.B., joined at Rhyl)
Terry Gordon (Cook)

3. Narrative (times in GMT)

The SmartBuoy, anchor chain clumps, three sea-bed frames, wave buoy and instrumentation were loaded onto RV Prince Madog on the afternoon of 14 August 2006. Loading was completed by 14:00. The ADCP frames were set up on the afterdeck and the tower and instruments fitted to the SmartBuoy toroid.

Prince Madog left Menai Bridge at 07:25 on 15 August 2006, but without a full complement of deck crew. The third AB, necessary for the Coastal Observatory cruises, had not turned up and a substitute could not be found in time for sailing. If one were not available, the combination of mooring operations and 24 hour working would not be possible. Before we reached the Mersey Bar a seaman had been found and arrangements made to pick him up by small boat transfer at Rhyl at 16:00.

Surface sampling and the ship's ADCP were switched on at 08:21, by Puffin Island. The Mersey Bar site was reached at 10:56 and the first CTD profile recorded. Mooring operations on the deck were short staffed. The nutrient analyser frame was deployed at 11:27. The first attempt to release the ADCP frame, at 11:30, failed but the second attempt 10 minutes later was successful. However the frame surfaced so close to the ship that the ship drifted over it. The frame was caught at 11:55 and recovered. However the spooler line both caught in the

cheeks of a deck block, parting, and also underneath the ship, perhaps on the rudder. After about half an hour the line was lost and so the frame's ballast weight was not recovered.

The SmartBuoy was deployed at 12:49 and the old SmartBuoy recovered, 13:00 – 13:06. The ADV was now taken off the ADCP frame to turn round, since there was no replacement at POL. The case is difficult to open but we had come prepared and managed it. The batteries were changed and a new memory card fitted. Whilst this was being done the zooplankton net hauls were carried out, 13:30 – 14:40. Although the ADCP and ADV frame was now ready for deployment it was time to leave the site to collect the third AB. The ship arrived off Rhyl at 16:00 and the AB was on board by 16:30. CTD profiles were recorded at stations 12 and 11, starting at 17:19, on the way to the Mersey Bar to deploy the ADCP frame. Station 10 was omitted because at this stage it was hoped there would be enough time to deploy the wave buoy in the Dee the next day. This proved not to be possible because of various time pressures, some related to the tide for access to the Dee and for unloading the ship on Thursday morning, required to be finished by 07:30 before the tide level fell too far and since the next cruise would be loading on Thursday afternoon, and also because of time lost picking up the AB.

The ADCP frame was deployed at 18:40 and the CTD survey commenced with stations 8 to 2 in decreasing order, 35, 13 – 21, the second mooring site. Here the ADCP frame and ballast weight were recovered between 07:32 and 07:51 on 16 August. The SmartBuoy, fitted with a trace metal monitor was deployed at 08:25 and old SmartBuoy recovered by 08:45. Whilst the buoys were being recovered the ADCP frame was refurbished with a new 600kHz ADCP and SeaBird 16+ and new batteries for the acoustic modem. The 1.2 MHz telemetry ADCP was restarted (its data was not downloaded) and the frame redeployed close to the telemetry toroid at 09:17. The rest of the CTD grid, 21 – 34, was carried out, finishing at 18:25.

Surface logging and the ship's ADCP were stopped at 8:48, near Puffin Island, and Prince Madog berthed at Menai Bridge at 19:50.

The weather was fair to good so that nearly all the objectives were met. However because of the time pressures described above, and the time lost collecting the third seaman, the wave buoy was not redeployed in the Dee and hence also one CTD station (10) was missed out.

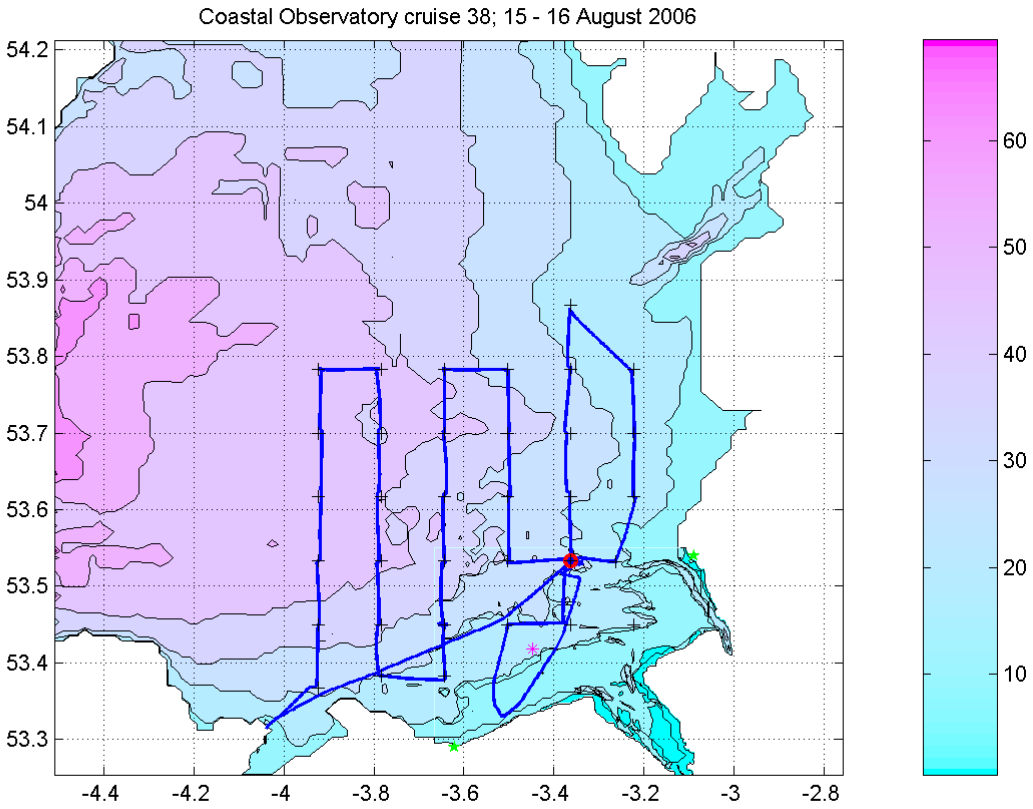

Figure 1. Cruise track.

4. Moorings (times in GMT)

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

c) Waves ADCP 600 kHz RDI 5807**;** battery pack 3285
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 13:51:00 on 25 July; delayed start 07:00:00 on 26 July 2006; started ok.
Logging was stopped 20:32:20 on 15 August 2006; clock drift 31s fast.

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 40 s, range 400; pump 0.5s, 1 s delay.
Clock set at 17:15:00 on 25 July 2006; delayed start at 07:00:00 on 26 July 2006.
Logging stopped at 22:30 on 15 August; clock 2s slow; 2974 samples.

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.
Clock set at 03:07:10 on 27 July 2006. Delayed start at 06:00 on 27 July 2006.
Since the batteries were not changed on deployment, the record ended at 08:00 on 9 August.

The frame D4 was fitted with two Benthos releases 72863 – Rx 13.5 kHz, Tx 12.0 kHz, release A and 67679 – Rx 11.5 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.

d) SmartBuoy Mooring.
Sea-Bird MicroCAT temperature and conductivity recorder Serial number 2991 (RS485) at 5m below the surface. Sample interval 600s. Reference pressure = 25dB.
Clock set at 17:49:00 on 25 July 2006. Delayed start 07:00:00 on 26 July 2006.
Logging stopped at 10:55:00 on 16 August; 1 s fast; 3048 samples.

Sea-Bird MicroCAT temperature and conductivity recorder Serial number 2506 at 10m below the surface. Sample interval 600s. Digiquartz pressure sensor.
Clock set at 17:38:30 on 25 July 2006. Delayed start 07:00:00 on 26 July 2006.
Logging stopped at 10:11:00 on 16 August 2006; 15s fast; 3044 samples.

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 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
g) Waves ADCP 600 kHz RDI 2390.
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.
Clock reset at 14:17:00 on 25 July; delayed start 07:00:00 on 27 July 2006.
Logging stopped ~08:30 on 16 August 2006. File size 92,744 kB.

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.
Clock reset at 14:39:00 on 25 July; delayed start 15:50:00 on 27 July 2006.
The ADCP was stopped and reset between 08:00 and 09:00 on 16 August 2006.
LinkQuest acoustic modem set for transmission of ADCP data every hour.

Sea-Bird 16plus S/N 4737 on base of frame with pumped conductivity sensor underneath. SeaPoint turbidity sensor taped to roll bar S/N 10489; 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 17:00:10 on 25 July 2007; delayed start at 07:00:00 on 26 July 2006.
Stopped at 16:32:30 on 16 August 2006. 3069 samples.

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.

h) SmartBuoy Mooring.
The CEFAS SmartBuoy is fitted with a surface CTD (including turbidity and fluorescence sensors). The frame was fitted with 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 1. Recovered mooring positions and times.

	Latitude (N)	Longitude (W)	Water Depth (m)	Recovered Time	Date
Waves ADCP (Site A)	53º 31.938´	3º 21.247	24.2	11:40	15/08/06
SmartBuoy (Site A)	53º 31.997´	3º 21.607´	25.2	13:00	15/08/06
Waves ADCP (Site B)	53º 26.998´	3º 38.660´	23.5	07:32	16/08/06
Smart Buoy (Site B)	53º 26.884´	3º 38.739´	23.6	08.43	16/08/06

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

Site A

c) 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.

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.

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.

d) 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.

Sea-Bird MicroCAT temperature and conductivity recorder Serial number 2010 at 5m 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.

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.

e) 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
g) 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.

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.

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.

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.

h) 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 2. Deployed mooring positions and times.

	Latitude (N)	Longitude (W)	Water Depth (m)	Deployed Time	Date
Waves ADCP (Site A)	53º 32.026´	3º 21.527´	23.5	18:40	15/08/06
SmartBuoy (Site A)	53º 31.994´	3º 21.799´	25.5	12:50	15/08/06
Nutrient frame (Site A)	53º 32.019´	3º 21.764´	22.5	11:27	15/08/06
(Wavebuoy (Site A)	53º 32.022´	3º 21.258´)			
Waves ADCP (Site B)	53º 26.987´	3º 38.626´	23.1	09:17	16/08/06
Smart Buoy (Site B)	53º 27.047´	3º 38.451´	23.6	08:26	16/08/06
(Telemetry toroid	53º 26.956´	3º 38.666´	27.7	10:24	26/07/06)

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-25 particle sizer was fitted to the CTD and its data logged on the Sea-Bird data logging system. A LISST-100 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.

Data from the LISST 25 are faulty.

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

Site	Latitude (N)	Longitude (W)	Visited on this cruise	Cefas Chloropyll & 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′	no				
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	
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
1	1		53º 32′	3º 21.8′	23	17.6 / 17.3	32.7 / 32.8
2	12	1/ 2	53º 27′	3º 30.2′	20	18.0 / 18.0	32.6 / 32.6
3	11	3/ 4	53º 27′	3º 21.8′	20	17.7 / 17.7	32.6 / 32.6
4	9	5/ 6	53º 32′	3º 21.8′	23	17.6 / 17.4	32.7 / 32.7
5	8	7/ 8	53º 37′	3º 21.8′	24	17.3 / 17.2	32.8 / 32.9
6	7	9/10	53º 42′	3º 21.8′	23	16.7 / 16.4	33.0 / 33.1
7	6	11/12	53º 47′	3º 21.8′	18	16.2 / 16.2	33.1 / 33.1
8	5	13/14	53º 52′	3º 21.8′	13	16.2 / 16.2	33.1 / 33.1
9	4	15/16	53º 47′	3º 13.4′	14	16.1 / 16.1	33.1 / 33.1
10	3	17/18	53º 42′	3º 13.4′	16	16.6 / 16.6	33.0 / 33.0
11	2	19/20	53º 37′	3º 13.4′	12	17.0 / 17.0	32.9 / 32.9
12	35	21/22	53º 31.9′	3º 15.9′	13	17.2 / 17.2	32.7 / 32.6
13	13	23/24	53º 32′	3º 30.2′	33	17.7 / 17.7	32.8 / 32.8
14	14	25/26	53º 37′	3º 30.2′	33	16.7 / 16.7	33.0 / 33.0
15	15	27/28	53º 42′	3º 30.2′	40	16.6 / 16.5	33.0 / 33.0
16	16	29/30	53º 47′	3º 30.2′	28	16.6 / 16.6	33.0 / 33.0
17	17	31/32	53º 47′	3º 38.6′	38	16.4 / 16.4	33.1 / 33.1
18	18	33/34	53º 42′	3º 38.6′	41	16.5 / 16.5	33.1 / 33.1
19	19	35/36	53º 37′	3º 38.6′	34	16.9 / 16.9	33.0 / 33.0
20	20	37/38	53º 32′	3º 38.6′	35	17.4 / 17.2	32.9 / 33.0
21	21	39/40	53º 27′	3º 38.6′	26	17.7 / 17.7	32.7 / 32.8
22	21	41/42	53º 27′	3º 38.6′	22	17.9 / 17.9	32.7 / 32.7
23	22	43/44	53º 23′	3º 38.6′	11	17.7 / 17.6	32.4 / 32.4
24	23	45/46	53º 23′	3º 47.0′	14	17.5 / 17.5	32.6 / 32.7
25	24	- /48	53º 27′	3º 47.0′	30	17.5 / 17.4	32.9 / 32.9
26	25	49/50	53º 32′	3º 47.0′	43	17.1 / 16.8	33.0 / 33.1
27	26	51/52	53º 37′	3º 47.0′	40	16.8 / 16.6	33.1 / 33.1
28	27	53/54	53º 42′	3º 47.0′	42	16.6 / 16.4	33.1 / 33.1
29	28	55/56	53º 47′	3º 47.0′	42	16.4 / 16.3	33.2 / 33.2
30	29	57/58	53º 47′	3º 55.4′	42	16.2 / 16.1	33.4 / 33.4
31	30	59/60	53º 42	3º 55.4′	44	16.4 / 16.2	33.3 / 33.3
32	31	61/62	53º 37′	3º 55.4′	47	16.4 / 16.4	33.3 / 33.3
33	32	63/64	53º 32′	3º 55.4′	49	16.5 / 16.5	33.4 / 33.4
34	33	65/66	53º 27′	3º 55.4′	39	17.1 / 16.9	33.1 / 33.2
35	34	67/68	53º 22′	3º 55.4′	24	17.4 / 17.1	32.8 / 33.1

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), Re3ative 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 08:21 on 15 August until 18:48 on 16 August 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 08:22 on 15 August to 18:48 on 16 August 2006, starting and ending at Puffin Island.

Acknowledgements
The assistance of the master, officers, and crew contributed greatly to the success and safety of the cruise.