**Prince Madog cruise 37/06**
**POL Coastal Observatory cruise 41**
**13-15 December 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.
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
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. The frame is fitted with a SonTek ADV.
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 telemetry torroid (equipped with an Orbcomm satellite system and an acoustic modem).
g) 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.
h) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring.

To deploy
i) A refurbished telemetry buoy (equipped with an Orbcomm satellite system and an acoustic modem).
j) 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.
k) A CEFAS SmartBuoy (with cellulose bags and trace metal sampler) in a single point mooring with Sea-Bird MicroCAT temperature, conductivity loggers at 5m and 10m below the surface.

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. To collect trace metal samples at selected sites.

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

### 2.1 Scientific personnel

Phil Knight (Principal)
Mike Smithson
Chris Balfour
Ray Edun
John Kenny
Martin Poulton
Conrad Chapman
Naomi Greenwood (CEFAS)
Neil Needham (CEFAS)
Anne Hammerstein (School of Ocean Sciences)

### 2.2 Ship's officers and crew

Steve Duckworth (Master)
Keith Tate (Chief Officer)
Alan Thompson (Chief Engineer)
Les Black (Second Engineer)
Phil Jones (Bosun)
Dave Leigh (A.B.)
Mike Callaghan (A.B.)
Terry Gordon (Cook)

## 3. Narrative (times in GMT)

The SmartBuoy, anchor chain clumps, two sea-bed frames and instrumentation were loaded onto RV Prince Madog on the afternoon of 12 December 2006. Loading was completed by 15:00. The ADCP frames were set up on the afterdeck and the tower and instruments fitted to the SmartBuoy toroid.

Due to SW winds of Force 7/8/9, with wave heights at the Liverpool Bar of up to 2.7m and the subsequent weather forecast on 13 December 2006, it was decided to wait for favourable conditions. Prince Madog eventually left Menai Bridge at 09:35 on 14 December 2006 and moved up the coast to find shelter (wind gusts of over 50 knots were recorded on the ship), ready for an early start on 15 December when weather conditions were forecast to improve.

Surface sampling and the ship's ADCP were switched on at 10:11 in the Menai Strait just before Puffin Island (due to the anticipated rough seas at the entrance). The pCO2 sensor was switched on between 10:30 and 11:00 on 14 December 2006. Prince Madog reached the sheltered area of Colwyn Bay at 12:00 and the surface sampling, ship's ADCP and pCO2 sensor were switched off. Prince Madog remained at anchor throughout the afternoon and into the early morning of 15 December 2006.

The Prince Madog left Colwyn Bay at 06:00 on 15 December 2006, with surface sampling, ship's ADCP and the pCO2 sensor switched on at 06:10, 06:11 and 06:20 respectively. The

Mersey Bar site was reached at 07:57 and the first CTD profile recorded. The ADCP was recovered at 08:18 with the weights on board by 08:34. The replacement ADCP was deployed at 09:06 The SmartBuoy was deployed at 09:39 and the previous SmartBuoy recovered, 09:52 – 10:09. When the SmartBuoy anchor clump was lifted a previously lost ADCP ballast frame was attached. A calibration CTD was then carried out.

No time was available to carry out the full CTD survey. Site B was reached at 10:13 and another CTD profile recorded. The telemetry buoy was recovered at 12:00. It was then refurbished (Only one battery pack instead of two was used since the second battery pack had a fault. This may reduce the telemetry life time to only one month duration) and re-deployed at 13:51. The ADCP was recovered at 14:01 with the weights on board by 14:20. The replacement ADCP was deployed at 14:38. The SmartBuoy was deployed at 14:53 and the previous SmartBuoy recovered, 15:01 – 15:07. This was followed by a final CTD at site B, before heading back to Menai Bridge.

All the moorings work was successfully accomplished, however only four CTD's were completed. Due to time constraints related to the weather conditions, nutrient samples were not taken and sediment filtering not carried out at any of the sites. Trace metal samples were taken at both mooring sites.

Surface logging, ship's ADCP and the pCO2 sensor logging were stopped at 17:11, near Puffin Island, and RV Prince Madog berthed at Menai Bridge at 18:05 on 15 December 2006.

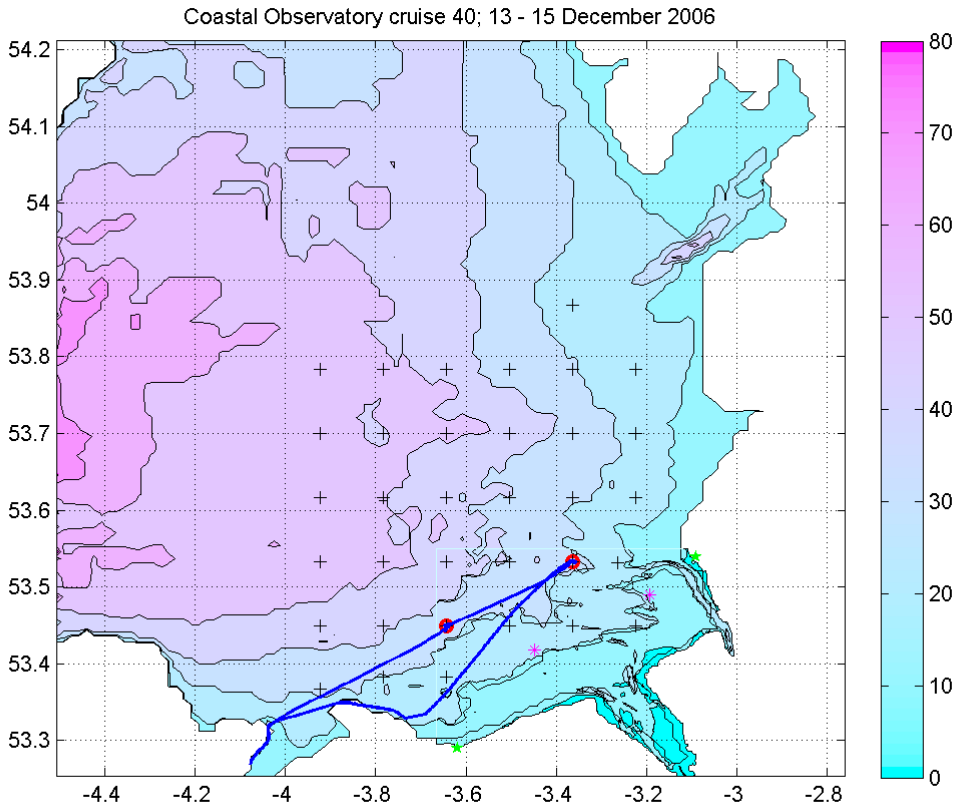


Figure 1. Cruise track.

**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 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 1 Gbyte PCMCIA memory; hourly wave recording enabled.
Clock set at 09:33:00 GMT on 31 October; delayed start 07:00:00 on 1 November 2006.
Stopped at 14:29:00 on 19 December 2006.

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; pump 0.5s, 1 s delay.
Clock set at 09:13:00 on 31 October 2006; delayed start at 08:00:00 on 1 November 2006.
Stopped at 13:06:00 on 19 December 2006.

SonTek ADV (Acoustic Doppler Velocimeter): ADV Logger G458, sensor A823. Sensor height to the point of intercept of the three probes was 1.470m. The red mark on one of the probes pointed away from the frame across one of the shortest sides (red mark aligned with beam 3 from the ADCP). 1 Gbyte of memory for 101.08 days of operation. Time set at 10:07:0 on 31 October 2006; deployed start at 08:00:00 on 1 November 2006.
Stopped at 15:17:00 on 19 December 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 100m of rope for recovery of the ballast weight.

b) SmartBuoy Mooring.
Sea-Bird MicroCAT temperature and conductivity recorder Serial number 2010 at 5m below the surface. Sample interval 600s. Reference pressure = 25dB.
Clock set at 09:41:10 on 31 October 2006. Delayed start 08:00:00 on 1 November 2006.
Stopped at 15:04:00 on 19 December 2006.

Sea-Bird MicroCAT temperature and conductivity recorder Serial number 2081 at 10m below the surface. Sample interval 600s. Reference pressure = 25dB.
Clock set at 09:33:45 on 31 October 2006. Delayed start 08:00:00 on 1 November 2006.
Stopped at 13:54:00 on 19 December 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 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 1Gbyte PCMCIA memory; hourly wave recording enabled.
Time set at 09:46:00 on 31 October 2006, delayed start at 07:00:00 on 1 November 2006.
Stopped at 14:18:00 on 19 December 2006.

Telemetry ADCP 1200 kHz RDI 572.
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 10:23:00 on 31 October 2006.
Delayed start at 07:00:00 on 1 November 2006.
LinkQuest acoustic modem set for transmission of ADCP data every hour.
Stopped at 14:16:00 on 19 December 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 09:17:00 on 31 October 2006; delayed start at 08:00:00 on 1 November 2006.
Stopped at 13:13:00 on 19 December 2006.

The frame 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 100m 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. Recovered mooring positions and times.

| | Latitude (N) | Longitude (W) | Water Depth (m) | Recovered Time | Date |
|---|---|---|---|---|---|
| Waves ADCP (Site A) | 53º 32.037´ | 3º 21.472´ | 22.0 | 08:18 | 15/12/06 |
| SmartBuoy (Site A) | 53º 32.024´ | 3º 21.794´ | 26.7 | 09:52 | 15/12/06 |

| | | | | | |
|---|---|---|---|---|---|
| Waves ADCP (Site B) | 53º 27.007´ | 3º 38.644´ | 23.2 | 14:01 | 15/12/06 |
| Smart Buoy (Site B) | 53º 27.049´ | 3º 38.446´ | 23.4 | 15:01 | 15/12/06 |
| Telemetry Buoy | 53º 26.922´ | 3º 38.648´ | 26.7 | 12:00 | 15/12/06 |

**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 set at 15:25:15 GMT on 12 December 2006; delayed start 08:00:00 on 13 December 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 14:11:50 on 12 December 2006; delayed start at 08:00:00 on 13 December 2006.

SonTek ADV (Acoustic Doppler Velocimeter): ADV Logger G250, sensor B252H. Sensor height to the point of intercept of the three probes was 1.26m. Sample rate 16Hz, burst interval 3600s. Changed compass orientation to up. Time set at 15:55:00 on 12 December 2006; delayed start at 08:00:00 on 13 December 2006.

The frame D6 was fitted with two Benthos releases 71922 – Rx 11.5 kHz, Tx 12.0 kHz, release A and 72858 – Rx 14.5 kHz, Tx 12.0 kHz, release A both with a fizz link, and a spooler with 150m 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 15:36:10 on 12 December 2006. Delayed start 08:00:00 on 13 December 2006.

Sea-Bird MicroCAT temperature and conductivity recorder Serial number 4998 at 10m below the surface. Sample interval 600s.
Clock set at 15:14:00 on 12 December 2006. Delayed start 08:00:00 on 13 December 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 15:35:30 on 12 December 2006, delayed start at 08:00:00 on 13 December 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 15:44:10 on 12 December 2006.
Delayed start at 08:00:00 on 13 December 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 14:25:10 on 12 December 2006; delayed start at 08:00:00 on 13 December 2006.

The frame D5 was fitted with two Benthos releases 67679 – Rx 11.5 kHz, Tx 12.0 kHz, release B and 72853 – Rx 13.5 kHz, Tx 12.0 kHz, release A both with a fizz link, and a spooler with 100m 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 and a trace metal sensor (Conrad Chapman, Liverpool University)

Sea-Bird MicroCAT temperature and conductivity recorder Serial number 2506 at 5m below the surface. Sample interval 600s. Reference pressure = 25dB.
Clock set at 14:52:00 on 12 December 2006. Delayed start 08:00:00 on 13 December 2006.

Sea-Bird MicroCAT temperature and conductivity recorder Serial number 4966 at 10m below the surface. Sample interval 600s.
Clock set at 15:19:00 on 12 December 2006. Delayed start 08:00:00 on 13 December 2006.

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 | Longitude | Water | Deployed |
|---|---|---|---|---|

| | (N) | (W) | Depth (m) | Time | Date |
|---|---|---|---|---|---|
| Waves ADCP (Site A) | 53º 32.038´ | 3º 21.469´ | 24.7 | 09:06 | 15/12/06 |
| SmartBuoy (Site A) | 53º 31.993´ | 3º 21.643´ | 24.4 | 09:39 | 15/12/06 |
| | | | | | |
| Waves ADCP (Site B) | 53º 26.983´ | 3º 38.631´ | 24.1 | 14:38 | 15/12/06 |
| Smart Buoy (Site B) | 53º 26.931´ | 3º 38.894´ | 24.8 | 14:53 | 15/12/06 |
| Telemetry Buoy (Site B) | 53º 26.917´ | 3º 38.656´ | 24.0 | 13:51 | 15/12/06 |

## 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. 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, Tr – Trace metal samples)

| Site | Latitude (N) | Longitude (W) | Visited on this cruise | Cefas Chlorophyll & Nu & Ss | POL Nu | POL Ss | LU Tr |
|---|---|---|---|---|---|---|---|
| 1 | 53º 32´ | 3º 21.8´ | yes | yes | no | no | yes |
| 2 | 53º 37´ | 3º 13.4´ | no | | | | |
| 3 | 53º 42´ | 3º 13.4´ | no | | | | |
| 4 | 53º 47´ | 3º 13.4´ | no | | | | |
| 5 | 53º 52´ | 3º 21.8´ | no | | | | |
| 6 | 53º 47´ | 3º 21.8´ | no | | | | |
| 7 | 53º 42´ | 3º 21.8´ | no | | | | |
| 8 | 53º 37´ | 3º 21.8´ | no | | | | |
| 9 | 53º 32´ | 3º 21.8´ | no | | | | |
| 10 | 53º 27´ | 3º 13.4´ | no | | | | |
| 11 | 53º 27´ | 3º 21.8´ | no | | | | |
| 12 | 53º 27´ | 3º 30.2´ | no | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 13 | 53º 32´ | 3º 30.2´ | no | | | | |
| 14 | 53º 37´ | 3º 30.2´ | no | | | | |
| 15 | 53º 42´ | 3º 30.2´ | no | | | | |
| 16 | 53º 47´ | 3º 30.2´ | no | | | | |
| 17 | 53º 47´ | 3º 47.0´ | no | | | | |
| 18 | 53º 42´ | 3º 38.6´ | no | | | | |
| 19 | 53º 37´ | 3º 38.6´ | no | | | | |
| 20 | 53º 32´ | 3º 38.6´ | no | | | | |
| 21 | 53º 27´ | 3º 38.6´ | yes | yes | no | no | yes |
| 22 | 53º 23´ | 3º 38.6´ | no | | | | |
| 23 | 53º 23´ | 3º 47.0´ | no | | | | |
| 24 | 53º 27´ | 3º 47.0´ | no | | | | |
| 25 | 53º 32´ | 3º 47.0´ | no | | | | |
| 26 | 53º 37´ | 3º 47.0´ | no | | | | |
| 27 | 53º 42´ | 3º 47.0´ | no | | | | |
| 28 | 53º 47´ | 3º 47.0´ | no | | | | |
| 29 | 53º 47´ | 3º 55.4´ | no | | | | |
| 30 | 53º 42 | 3º 55.4´ | no | | | | |
| 31 | 53º 37´ | 3º 55.4´ | no | | | | |
| 32 | 53º 32´ | 3º 55.4´ | no | | | | |
| 33 | 53º 27´ | 3º 55.4´ | no | | | | |
| 34 | 53º 22´ | 3º 55.4´ | no | | | | |
| 35 | 53º 32´ | 3º 15.9´ | no | | | | |

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 | none | 53º 32´ | 3º 21.8´ | 24 | 9.4 / 9.8 | 32.7 / 33.2 |
| 3 | 21 | none | 53º 27´ | 3º 38.6´ | 24 | 10.2 / 10.5 | 33.1 / 33.8 |

## 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 / $m^2$s), 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. In addition a pCo2 sensor was incorporated into the surface sampling system.

Underway data were recorded every minute from 10:11 on 14 December until 12:08 on 14 December 2006, and from 06:10 on 15 December until 17:11 on 15 December 2006. 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.

Data from the pCO2 system were recorded from 10:30-11:00 on 14 December until 12:08 14 December 2006 and from 06:20 on 15 December until 17:11 on 15 December 2006.

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 10:11 on 14 December until 12:08 on 14 December 2006 and from 06:11 on 15 December until 17:11 on 15 December 2006.

Recorded underway data are split into two periods, one from Puffin Island and ending at Colwyn Bay and the other starting at Colwyn Bay and ending at Puffin Island.

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