Prince Madog cruise 01/08
POL Coastal Observatory cruise 50
10-11th January 2008

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 was fitted to the frame. The frame was fitted with a SonTek ADV.
b) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring. Attached to the mooring wire are SeaBird MicroCat temperature, conductivity loggers at 5 and 10m below the surface and VEMCO thermistor miniloggers at 7.5 and 15 m 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, a SeaPoint turbidity sensor and a SonTek ADV were fitted to the frame.
d) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring. Attached to the mooring wire are Sea-Bird MicroCat temperature, conductivity loggers at 5 and 10m below the surface and miniloggers at 7.5 and 15 m below the surface.

2. At 53º 27´ N 3º 38.6´ W (site 21, second site, B)
To recover
e) 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 1200 kHz telemetry ADCP was fitted to the frame.
f) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring. Attached to the mooring wire are Sea-Bird MicroCat temperature, conductivity loggers at 5 and 10m below the surface and miniloggers at 7.5 and 15 m below the surface.
g) A telemetry toroid.

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, a SeaPoint turbidity sensor were fitted to the frame. A 1200 kHz telemetry ADCP was fitted to the frame.
i) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring. Attached to the mooring wire are Sea-Bird MicroCat temperature, conductivity loggers at 5 and 10m below the surface and miniloggers at 7.5 and 15 m below the surface.
j) A telemetry toroid.

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. Collect 10 vertical net hauls at mooring site A.

5. Collect sediment samples at each of the CTD sites.

6. To deploy a Waverider buoy at the mouth of the Dee Estuary, position 53^{o}23' N 3^{o}14.3' W

2.1 Scientific personnel

Matthew Palmer (Principal Scientist)
Chris Balfour
John Kenny
Terry Doyle
Ray Edun
Dave Pearce (CEFAS)
Neil Needham (CEFAS)
Anne Hammerstein (School of Ocean Sciences)
Conrad Chapman (Liverpool University)
Clare Davis (Liverpool University)

2.2 Ship's officers and crew

Eric Lloyd (Master)
Nick Davies (Chief Officer)
Arfon Williams (Chief Engineer)
Andy Westmore (Second Engineer)
Tommy Roberts (A.B.)
Hefin Griffiths (A.B.)
Mick Callaghan (A.B.)
Eifion Pritchard (Cook)

3. Narrative (times in GMT)

The anchor chain clumps, two sea-bed frames and instrumentation were loaded onto RV Prince Madog on the morning of 8th January 2008, around high water between 1000 and 1200. The ADCP frames were set up on the afterdeck by POL engineers and the tower and instruments fitted to the SmartBuoy toroid by CEFAS personnel.

Extreme bad weather was forecast for the following few days and it was decided to delay departure from Menai Bridge until 10th January to avoid forecasted force 8 to 9 westerly gales. The originally planned cruise dates of 9th-10th January were therefore changed to 10th-11th.

Prince Madog left Menai Bridge at 1030 on 10th January 2008. Weather was still poor when leaving port (forecast force 7 to 9 SW decreasing to 4). MetOffice forecasts predict easing of

winds in the afternoon. The ship's underway pCO_2, surface monitoring and ADCP were switched on at 1115 at Puffin Island. The relative humidity sensor was still not working.

We arrived at the main mooring site at 1430 and remained on site until 1530 but despite conditions easing to force 5 it was considered too rough for deployment. With failing light the CTD grid was started at 1650 (10/01/08) visiting stations 10, 35, 2, 4, 8, 9, 11, 12, 21, 20, 19, 14, 13 and 1(9) consecutively. Stations 3, 5, 6 and 7 were abandoned due to bad sea conditions. SPM and nutrient samples were taken at each station visited. Despite an improving sea state, it was not possible to take sediment grab samples until the end of the CTD survey at station 1, when conditions allowed for reordering of the deck space sufficient to allow access to the grab. Time restrictions also prevented the collection of any planned net hauls at mooring site A. The following water samples were collected on the CTD rosette: bottles used: 3 – salinity; 4 -SPM bottom; 9 - SPM top; 10 – DON (UoL), 11 – surface (Cefas); 8 – Trace metals (UoL).

Mooring recovery/deployment at the main mooring site started at 0700, 11/01/08. The weather had calmed considerably (SW force 2, slight seas and low swell conditions). The replacement SmartBuoy was deployed at 0755 in poor light and the old SmartBuoy recovered at 0810. The ADCP lander release was fired at 0832 and the lander frame was recovered by 0846, with the ballast weight recovered soon after (0852). The ADV was removed from the recovered lander from which data was downloaded. The ADV was refurbished and attached to the new ADCP lander frame which was redeployed at 1046. A CTD profile was taken at site 1 at 1046 prior to leaving.

We arrived at the second mooring site, station 21, at 1206 in with relatively calm weather (NNE force 4), sea state was moderate with low swell conditions. Following a CTD profile at 1209 the refurbished SmartBuoy recovered from the main mooring site was redeployed at 1219 with a 'trace metal monitoring probe' attached (UoL). The old SmartBuoy was recovered by 1228. The ADCP lander frame was recovered at 1302 however the ballast weight became detached and was not recoverable. The recovery line showed signs of chaffing, most likely by contact with the hull of the ship during recovery.

The new ADCP lander was deployed at 1308. At 1316 the telemetry buoy was successfully recovered for refurbishment onboard. During this time a sediment grab sample and CTD profile were taken. The telemetry buoy was initially deployed at 1420 however the aerial became entangled in the deployment line and it was necessary to recover the buoy for inspection. The aerial appeared to suffer no critical damage but was a little bent. It was decided by Chris Balfour (OETG) to be suitable for redeployment. The telemetry buoy was successfully deployed at 1440.

Following the mooring deployment station 24 was visited for a CTD profile and sediment grab sample. Water from the CTD was used for trace metal analysis and a surface nutrient sample was taken. The surface monitoring system, ship's ADCP and pCO_2 system were switched off at 1639 (11/01/08), by Puffin Island, and Prince Madog docked at Menai Bridge at 1720.

Despite what was truly atrocious weather on the arranged cruise dates we were able to accomplish the majority of the cruise objectives by utilising the 11th January contingency day;

- a reduced (14/34) CTD survey was carried out.

- All mooring objectives were accomplished at the two permanent observation sites.
- Only a limited (3) number of sediment samples were collected.
- The Dee waverider buoy was not able to be deployed due to time restrictions.

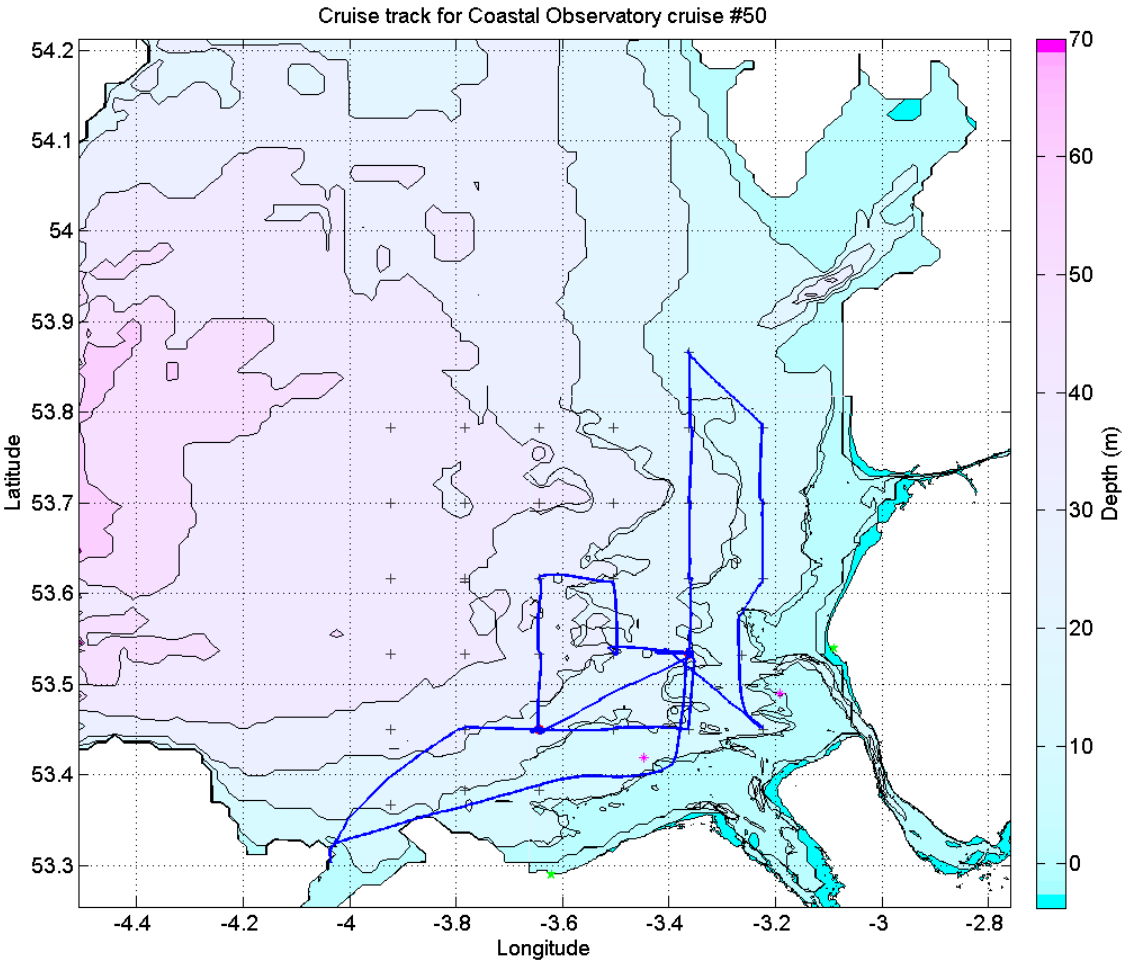

Figure 1. Cruise track.

4. **Moorings** (times in GMT)

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

Site A

a) 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.
Clock reset at 11:45 on 20 November; delayed start 18:00:00 on 20 November 2007.
Clock stopped at 12:49:35 an 14th January 2008.

Sea-Bird 16plus S/N 4737 on base of frame with pumped conductivity sensor underneath. SeaPoint turbidity sensor 10489 taped to roll bar; set up for **0 - 500 FTU range**.
Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5s, 1 s delay.
Clock set at 10:57:00 on 20 November 2007; delayed start at 08:00:00 on 21 November 2007.
Stopped at 10:38:00 on the 16th January 2008.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger G250; head B252.
Distance from center of three prong head on ADV transmitter to deck was 1.305m (i.e. above sea bed). Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s. Time reset to 14:15 on 20 November 2007, logging set to start at 10:00:00 on 21 November 2007. Clock stopped on 11th January 2008.

The frame D6 was fitted with two Benthos releases 72382 – Rx 10.0 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.
Sea-Bird MicroCat temperature, conductivity and pressure recorder Serial number 2081 at 5m below the surface. Sample interval 600s.
Clock set at 12:05:00 on 20 November 2007. Delayed start 08:00:00 on 21 November 2007.
Clock is 9s fast
Stopped Jan 18 2008 15:17:28.

Sea-Bird MicroCat temperature and conductivity recorder Serial number 4998 at 10m below the surface. Sample interval 600s.
Clock set at 12:31 on 20 November 2007. Delayed start 08:00:00 on 21 November 2007.
Stopped Jan 18 2008 12:55:06.

VEMCO Mini-logger Serial number 6024 at 7.5 m below the surface set to record at 600s intervals. Delayed start at 08:00:00 on 21 November 2007.
Stopped at 10:41 on the 11th January 2008.

VEMCO Mini-logger Serial number 6026 at 15 m below the surface set to record at 600s intervals. Delayed start at 08:00:00 on 21 November 2007.
Stopped a 10:49 on the 11th January 2008.

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 bags for the determination of bacterial degradation.

Site B
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 1Gbyte PCMCIA memory; hourly wave recording enabled.

Clock reset at 15:08:00 on 2 October; delayed start 08:00:00 on 3 October 2007.
Stopped early at 08:59:37 on the 28th November 2007, corrupt second memory card was corrupt.

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). Using 512Mb memory.
Earth co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Clock reset at 15:17:00 on 2 October; delayed start 08:00:00 on 3 October 2007.
LinkQuest acoustic modem set for transmission of ADCP data every hour.
Stopped at 12:49:59 on the 14th January 2008.

Sea-Bird 16plus S/N 4597 on base of frame with pumped conductivity sensor underneath.
SeaPoint turbidity sensor 10471; set up for 0 - 125 FTU range.
Aanderaa type 4120 C&T sensor serial number 187.
Sample interval 600 s; digiquartz integration time 40s, range 400; run pump 0.5s, 1 s delay.
Clock set at 17:13:00 on 2 October 2007; delayed start at 08:00:00 on 3 October 2007.
Stopped before recovery on 6th of December 2007 due to exhausted battery.

The frame was fitted with two Benthos releases 71922 – Rx 11.5 kHz, Tx 12.0 kHz, release A and 67879 – 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.

b) SmartBuoy Mooring.
Sea-Bird MicroCat temperature, conductivity recorder serial number 5434 at 5 m below the surface. Sample interval 600s.
Clock set at 12:43:00 on 20 November 2007. Delayed start 08:00 on 22 November 2007.
Stopped Jan 21 2008 12:21:44.

Sea-Bird MicroCat temperature, conductivity and pressure recorder serial number 5433 at 10m below the surface. Sample interval 600s.
Clock set at 12:39:00 on 20 November 2007. Delayed start 08:00:00 on 22 November 2007.
Stopped Jan 18 2008 14:55:10.

VEMCO Mini-logger Serial number 6025 at 7.5 m below the surface set to record at 600s intervals. Delayed start at 15:30:00 on 21 November 2007.
Stopped on 12:12:59 on the 21st January 2008.

Mini-logger Serial number 6027 at 15 m below the surface set to record at 600s intervals.
Delayed start at 15:30:00 on 21 November 2007.
Stopped at 12:12:59 on the 21st January 2008.

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.

Table 1. Recovered mooring positions and times.

	Latitude (N)	Longitude (W)	Water Depth (m)	Recovered Time	Date
ADCP (Site A)	53º 31.967´	3º 21.753	22.4	08:46	11/1/8
SmartBuoy (Site A)	53º 32.054´	3º 21.484´	20.4	08:04	11/1/8
ADCP (Site B)	53º 26.974´	3º 38.413´	29.3	13:02	11/1/8
Smart Buoy (Site B)	53º 26.896´	3º 38.689´	29.1	12:24	11/1/8
Telemetry toroid (Site B)	53º 27.037´	3º 38.421´	29.0	13:16	11/1/8

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

Site A

a) ADCP 600 kHz RDI 5803**.**
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.
Clock set at 14:20 on 8th January 2008; delayed start 12:00:00 on 09th January 2008.

Sea-Bird 16plus S/N 4848 on base of frame with pumped conductivity sensor underneath.
Sample interval 600s.
Clock set at 13:57:00 on 8th January 2008; delayed start at 12:00:00 on 9th January 2008.

SeaPoint turbidity sensor 10538 taped to roll bar; set up for **0 - 500 FTU range**.
Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5s, 1 s delay.
Clock set at 13:57:00 on 8th January 2008; delayed start at 12:00:00 on 9th January 2008.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger G250; head B252.
Distance from center of three prong head on ADV transmitter to deck was 1.220m (i.e. above sea bed). Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s. Time reset to 10:01:00 on 11th January 2008, logging set to start at 11:00:00 on 11th January 2008.

The frame was fitted with two Benthos releases s/n 70358 – Rx 11.0 kHz, Tx 12.0 kHz, release A and s/n 71919 – Rx 10.5 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, conductivity and pressure recorder s/n 4966 at 5m below the surface. Sample interval 600s.
Clock set at 14:48:00 on 8th January 2008. Delayed start 10:00:00 on 9th January 2008.

Sea-Bird MicroCat temperature and conductivity recorder s/n 2991 at 10m below the surface. Sample interval 600s.
Clock set at 15:41 on 8th January 2008. Delayed start 10:00 9th January 2008.

Mini-logger s/n 6028 at 7.5 m below the surface set to record at 600s intervals. Clock set at 15:30:21 8th January 2008. Delayed start at 10:00:00 9th January.

Mini-logger s/n 0142 at 15 m below the surface set to record at 600s intervals. Clock set at 07:07:00 8th January 2008. Delayed start at 08:00:00 11th January.

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 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 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.
Clock set at 14:14 on 8th January 2008; delayed start 10:00:00 on 09th January 2008.

Sea-Bird 16plus S/N 4596 on base of frame with pumped conductivity sensor underneath.
Sample interval 600s.
Clock set at 13:37:00 on 8th January 2008; delayed start at 10:00:00 on 9th January 2008.

SeaPoint turbidity sensor 10487 taped to roll bar; set up for **0 - 500 FTU range**.
Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5s, 1 s delay.
Clock set at 13:37:00 on 8th January 2008; delayed start at 10:00:00 on 9th January 2008.

b) SmartBuoy mooring.

Sea-Bird MicroCat temperature, conductivity recorder s/n 2010 at 5 m below the surface. Sample interval 600s.
Clock set at 10:00:00 11th January 2008. Delayed start 10:20:00 11th January 2008.

Sea-Bird MicroCat temperature, conductivity recorder s/n 2506 at 10 m below the surface. Sample interval 600s.
Clock set at 10:11:00 11th January 2008. Delayed start 11:00:00 11th January 2008.

VEMCO Mini-logger s/n 6024 at 7.5 m below the surface set to record at 600s intervals.
Clock set at 10:47:14 11th January 2008. Delayed start at 11:00:00 11th January 2008.

VEMCO Mini-logger s/n 6026 at 15 m below the surface set to record at 600s intervals.

Clock set at 11:00:08 11th January 2008. Delayed start at 11:10:00 11th January 2008.

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. A 'trace metal monitoring probe' was attached to the buoy by Conrad Chapman (University of Liverpool).

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
ADCP (Site A)	53º 32.024´	3º 21.435´	25.4	10:46	11/1/8
SmartBuoy (Site A)	53º 32.024´	3º 21.484´	20.4	07:57	11/1/8
ADCP (Site B)	53º 26.977´	3º 38.487´	29.3	13:08	11/1/8
Smart Buoy (Site B)	53º 26.896´	3º 38.689´	29.1	12:19	11/1/8
Telemetry toroid (Site B)	53º 27.077´	3º 38.439´	27.6	14:40	11/1/8

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.

CTD Number	Station	Nutrient bottle number Top/bottom	Latitude (N)	Longitude (W)	Water depth (m)	Temperature (^{o}C) Top/bottom	Salinity (psu) top/bot	Cefas chlorophyll, Nu & spm?	Bed sediment grab sample?	UoL trace metal sample?	UoL Nu?
001	10	2/1	53º27.1	3º13.5	14.8	-	-				Yes
002	35	4/3	53º32.2	3º16.0	11.7	6.14/6.47	31.47/32.06				
003	2	6/5	53º37.0	3º13.4	10.0	6.77/6.78	32.28/32.29				
004	----	Cancelled	-----	-----	----	----	----				
005	4	8/7	53º47.1	3º13.5	-	6.29/6.45	31.43/31.89				
006	8	10/9	53º37.0	3º21.7	24.5	7.89/7.89	33.48/33.48	Yes			
007	9	12/11	53º31.8	3º21.6	28.6	7.64/7.64	33.26/33.26	Yes			
008	11	14/13	53º27.0	3º21.8	21.4	7.38/7.39	33.07/33.08	Yes			Yes
009	12	16/15	53º27.1	3º30.1	22.3	7.91/7.91	33.46/33.45			Yes	Yes
010	21	18/17	53º27.1	3º38.6	28.5	8.45/8.55	33.76/33.79				Yes
011	20	19/20	53º32.1	3º38.5	37.1	8.62/8.63	33.85/33.85			Yes	Yes
012	19	21/22	53º36.9	3º38.5	31.8	8.50/8.50	33.81/33.81				Yes
013	14	24/23	53º36.8	3º30.3	27.7	8.28/8.29	33.69/33.68				Yes
014	13	25/26	53º32.1	3º30.1	29.2	7.70/7.86	33.32/33.41			Yes	Yes
015	1	27/28	53º32.1	3º22.0	21.2	6.79/NA	32.30/NA	Yes	Yes		
016	1	NONE	53º31.8	3º21.5	26.9	7.57/7.56	33.24/33.24	Yes			
017	21	NONE	53º26.8	3º38.3	29.1	8.47/8.48	33.77/33.78	Yes		Yes	
018	21	NONE	53º27.0	3º38.8	28.1	8.35/NA	33.72/NA	Yes	Yes	Yes	Yes
019	24	NONE	53º27.2	3º46.9	34.2	8.47/8.47	33.76/33.77		Yes	Yes	

Table 3: CTD and sample information
*Nu = nutrient sample, spm = suspended particulate matter sample, UoL = University of Liverpool

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 (not currently operational), 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 pCO_2 sensor was incorporated into the surface sampling system.

A sonic anemometer was fitted. No PAR data were recorded and the relative humidity sensor recorded bad data. The transmittance, fluorescence and turbidity were all recorded as voltages.

Underway (including navigation) data, pCO2 and ships ADCP data were recorded every minute from 1115 on 10th January 2008 until 1639 on January 2008, starting and ending at Puffin Island. 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.

Acknowledgements
The assistance of the master, officers, and crew contributed greatly to the success and safety of the cruise and there experience in extreme weather conditions was much appreciated.