Prince Madog cruise 24/09
POL Coastal Observatory cruise 62
17 - 19 June 2009

1. At Site A 53º 32´ N 3º 21.8´ W, (CTD station 1 and 9)

To recover
a) A sea bed frame containing a 600kHz ADCP (waves ADCP) to measure the mean current profile, pressures and directional waves; Sea-Bird SBE 16*plus* with pumped conductivity sensor, digiquartz pressure sensor and a SeaPoint turbidity sensor with wiper; Sea-Bird SBE 16*plus* with an Aanderra oxygen optode.

b) A CEFAS SmartBuoy 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.

To deploy
c) A sea bed frame containing a 600kHz ADCP (waves ADCP) to measure the mean current profile, pressures and directional waves; Sea-Bird SBE 16*plus* with pumped conductivity sensor, digiquartz pressure sensor and a SeaPoint turbidity sensor with wiper; Sea-Bird SBE 16*plus* with an Aanderra oxygen optode; FSI CTD.

d) CEFAS SmartBuoy 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.

e) Collect 10 vertical zooplankton net hauls (CEFAS).

2. At Site B 53º 27´ N 3º 38.6´ W, (CTD station 21)

To recover
a) A CEFAS SmartBuoy 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.

b) A sea bed frame containing 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 fitted with a wiper.

To deploy
c) A CEFAS SmartBuoy 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.

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 with a wiper.

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 obtain surface samples for a Defra pH study by David Hydes (NOCS). To obtain mid-depth water samples for trace metal analysis (on board for Arsenic III and Antimony III).

4. Collect sediment samples at each of the CTD sites with a Day grab.

2.1 Scientific personnel

John Howarth (Principal Scientist)
Mike Burke
Terry Doyle
Jo Hopkins
Dave Sivyer (CEFAS)
Jennie Keable (CEFAS)
Pascal Salaun (Liverpool University)
Zhaoshun Bi (Liverpool University)
Ray Wilton(School of Ocean Sciences)

2.2 Ship's officers and crew

Steve Duckworth (Master)
David Shaw (Chief Officer)
Leslie Black (Chief Engineer)
Meikle Mackay (2nd Engineer)
Phil Jones (Bosun)
Dave Leigh (A.B.)
Robert Stainton (A.B.)
Colin Hughes (Cook)

3. Narrative (times in GMT)

The Day grab and table, anchor chain clumps, two sea-bed frames with instrumentation and a SmartBuoy were loaded onto RV Prince Madog at Vittoria Wharf, Birkenhead, shortly after she berthed at 14:30.

RV Prince Madog left Birkenhead at 05:00 on 17 June 2009. The ship's surface monitoring, pCO_2 system and ADCP were switched on at 05:51 on passing the radar tower at Crosby.

When site A was reached, at 07:09, the first CTD was recorded (with one bottle sample, for trace metal analysis). The ADCP frame and ballast weight were recovered by 07:43 and the dissolved oxygen Optode sensor transferred to the

replacement frame, which was deployed at 07:57. The SmartBuoy was deployed by 08:29, followed by the second CTD, at CEFAS's request whilst both buoys were in the water. The SmartBuoy was recovered by 09:06 and a CTD recorded with a full suite of water bottles. The grab sample was then obtained, followed by the vertical zooplankton net hauls (with the large net only – it is thought the small net might be at CEFAS for repair).

Since the wind was blowing at 10 m s^{-1} from the south, the grid was started close to the Welsh coast, at station 22, proceeding in reverse order along east – west lines from south to north. - 22, 23, 34, 33, 24. During the evening conditions improved as the wind weakened slightly and veered to be from the west. The CTD grid continued through the night (at 21, 12, 11, 10, 35, 9, 13, 20, 25, 32, 31, 26, 19, 14, 8, 2, 3, 7, 15, 18). Conditions worsened slightly for the last few CTDs, so that grab samples were not possible at the last three. A course was then made due south to the second mooring site.

The site was reached at 10:05 on 18 June 2009 and a CTD recorded. Conditions were not favourable for mooring operations – winds 10 to 12 m s^{-1} from 250°, and corresponding seas. After a wait until nearer to slack water the bottom frame was released at 11:40, surfacing very close to the ship. The frame and ballast weight were on deck by 11:55. The replacement ADCP frame was deployed at 12:15. Deployment and recovery of the buoy and mooring, however, was not possible so a CTD was recorded and a course set for station 27.

On arrival at station 27 at 14:25 the sea was too rough for CTD deployment or grab samples so the rest of the grid (27, 30, 29, 28, 17, 16, 6, 5, 4) was followed taking surface underway and pCO_2 measurements only, finishing at22:10. At each site surface nutrient, salinity and where appropriate CEFAS samples were taken from the underway sampling system. Although too rough for CTD the only difficulty encountered following the grid was experienced steaming westward.

The surface monitoring, ADCP and pCO_2 systems were switched off at 05:09 on 19 June 2009. Prince Madog docked at 05:30 at Vittoria Wharf. All the moorings objectives were achieved except the turn round of the surface buoy mooring at site B and three quarters of the CTD and grab survey accomplished. The remainder of the CTD grid was steamed, obtaining surface samples only. Weather conditions were marginal throughout (winds between 10 and 12 m s^{-1}).

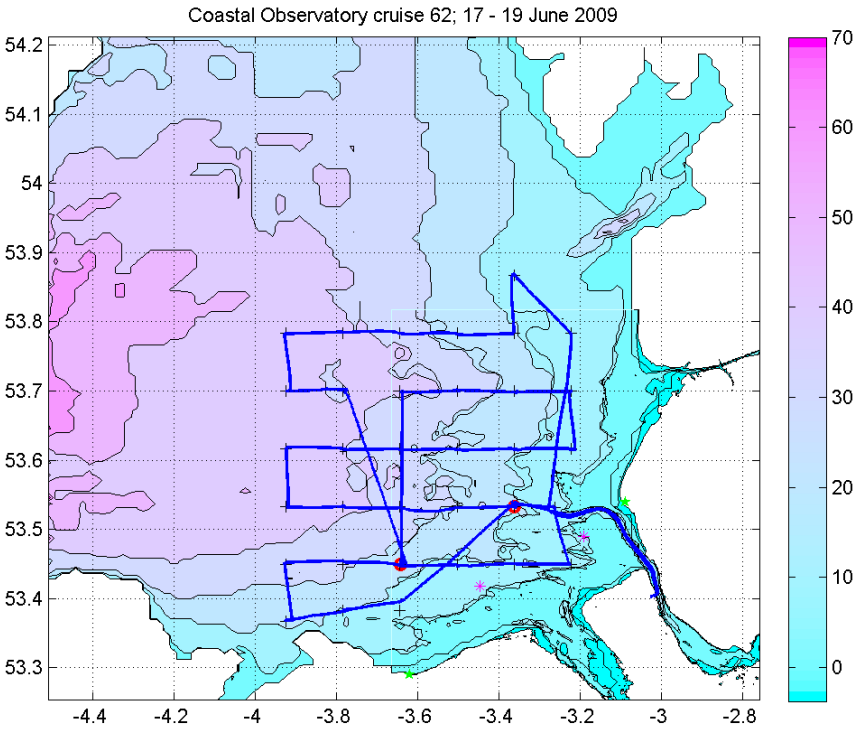

Figure 1. Cruise track.

4. Moorings (times in GMT)

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

Site A

Bedframe

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 12:37:00 on 7 May 2009. Delayed start at 14:00:00 on 11 May 2009.
Stopped at 07:19:00 on 19 June 2009; clock drift +78 s.

Sea-Bird 16plus S/N 4738 on base of frame with pumped conductivity sensor. Sample interval 600s. SeaPoint turbidity sensor No. 10538 taped to roll bar; set up for 0 - 125 FTU range; fitted with wiper. Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5s, 1 s delay. Clock set at 08:03:00 on 7 May 2009. Delayed start at 14:00:00:00 on 11 May 2009.
Stopped at 09:34:00 on 19 June 2009; clock drift +8 s. RS485 communication 'locked up' mid communication. Its batteries were removed and the internal reset pressed to restore communication.

Sea-Bird 16plus S/N 4490 upright on top of frame (NOT pumped) conductivity sensor underneath. Sample interval 600s. Aanderaa optode S/N 674. Clock set at 09:07:30 on 7 May 2009. Delayed start at 14:00:00 on 11 May 2009.
Stopped at 07:32:00 on 19 June 2009. Clock drift +9 s.

The frame was fitted with a fizz link, a spooler with 50m of rope for recovery of the ballast weight and two Benthos releases s/n 71919 (Rx 10.5 kHz, Tx 12.0 kHz, release C) and s/n 72863 (Rx 13.5 kHz, Tx 12.0 kHz, release A).

SmartBuoy Mooring

Sea-Bird MicroCat temperature, conductivity and pressure recorder s/n 5792 at 5m below the surface. Sample interval 600s. Clock set at 13:27:00 on 7 May 2009. Delayed start at 14:00:00 on 11 May 2009.
Stopped at 08:18:00 on 19 June 2009; clock drift +47 s.

Sea-Bird MicroCat temperature, conductivity and pressure recorder s/n 5433 at 10m below the surface. Sample interval 600s. Clock set at 13:10:00 on 7 May 2009. Delayed start at 14:00:00 on 11 May 2009.
Stopped at 08:23:30 on 19 June 2009; clock drift +9 s.

Mini-logger (StarOddi) s/n 2842 at 7.5 m below the surface set to record at 600s intervals. Delayed start at 14:00:00 on 11 May 2009.
Stopped at 08:36:30 on 19 June 2009; clock drift +7 s.

Mini-logger (StarOddi) s/n 2843 at 15 m below the surface set to record at 600s intervals. Delayed start at 14:00:00 on 11 May 2009.
Stopped at 08:44:50 on 19 June 2009; clock drift +7 s.

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 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

Bedframe

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. Clock reset at 12:49:00 on 7 May 2009. Logging set to start at 14:00:00 on 11 May 2009.
Stopped at 07:13:00 on 19 June 2009; clock drift +69 s.

Sea-Bird 16plus S/N 4736 on base of frame with pumped conductivity sensor underneath and SeaPoint turbidity sensor (Serial No. 10320) taped to roll bar; set up for 1 - 125 FTU range, fitted with wiper. Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5s, 1 s delay. Clock reset at 08:20:30 on 7 May 2009. Logging set to start at 14:00:00 on 11 May 2009.
Stopped at 07:47:30 on 19 June 2009; clock drift + 9 s.

The frame was fitted with a fizz link, a spooler with 50m of rope for recovery of the ballast weight and two Benthos releases s/n 70355 (Rx 10.0 kHz, Tx 12.0 kHz, release B) and s/n 72378 (Rx 10.5 kHz, Tx 12.0 kHz, release A).

Table 1. Recovered mooring positions and times.

	Latitude (N)	Longitude (W)	Water Depth (m)	Recovered Time	Date
ADCP frame (Site A)	53º 32.040′	3º 21.539′	24.9	07:26	17/06/09
SmartBuoy (Site A)	53º 32.021′	3º 21.652′	23.4	08:57	17/06/09
ADCP frame (Site B)	53º 26.981′	3º 38.419′	23.5	11:40	18/06/09

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

Site A

Bedframe

Waves 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 07:29:00 on 12 June 2009. Delayed start at 06:00:00 on 17 June 2009.

Sea-Bird 16plus S/N 4737 on base of frame with pumped conductivity sensor and SeaPoint turbidity sensor No. 10537 taped to roll bar; set up for 0 - 125 FTU range, fitted with a wiper. Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5s, 1 s delay. Clock set at 08:52:00 on 12 June 2009. Delayed start at 06:00:00 on 17 June 2009.

Sea-Bird 16plus S/N 4741 upright on top of frame (NOT pumped) conductivity sensor underneath. Sample interval 600 s. Aanderaa optode S/N 674. Clock set at 08:31:00 on 12 June 2009. Delayed start at 06:00:00 on 17 June 2009.

FSI CTD S/N 2195. Sample interval 600 s; sample rate 4 Hz, sample average 40s; record time 40 s. Clock set at 07:59:00 on 12 June 2009. Delayed start at 06:00:00 on 12 June 2009.

The frame was fitted with a fizz link, a spooler with 50m of rope for recovery of the ballast weight and two Benthos releases s/n 69676 (Rx 11.5 kHz, Tx 12.0 kHz, release C) and s/n 72858 (Rx 14.5 kHz, Tx 12.0 kHz, release A).

SmartBuoy Mooring

Sea-Bird MicroCat temperature and conductivity recorder s/n 2081 at 5m below the surface. Sample interval 600s. Clock set at 09:17:00 on 12 June 2009. Delayed start at 06:00:00 on 17 June 2009.

Sea-Bird MicroCat temperature, conductivity and pressure recorder s/n 5790 at 10m below the surface. Sample interval 600s. Clock set at 09:24:30 on 12 June 2009. Delayed start at 06:00:00 on 17 June 2009.

Mini-logger (StarOddi) s/n 2838 at 7.5 m below the surface set to record at 600s intervals. Delayed start at 06:00:00 on 17 June 2009.

Mini-logger (StarOddi) s/n 2841 at 15 m below the surface set to record at 600s intervals. Delayed start at 06:00:00 on 17 June 2009.

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 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

Bedframe

Waves ADCP 600 kHz RDI 12239
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 07:41:00 on 12 June 2009. Delayed start at 06:00:00 on 17 June 2009.

Sea-Bird 16plus S/N 5309 on base of frame with pumped conductivity sensor underneath and SeaPoint turbidity sensor (Serial No. 10471) taped to roll bar; set up for 0 - 125 FTU range, fitted with a wiper. Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5s, 1 s delay. Clock reset at 08:42:00 on 12 June 2009. Delayed start at 06:00:00 on 17 June 2009.

The frame was fitted with a fizz link, a spooler with 50m of rope for recovery of the ballast weight and two Benthos releases s/n 70356 (Rx 10.5 kHz, Tx 12.0 kHz, release D) and s/n 67679 (Rx 11.5 kHz, Tx 12.0 kHz, release B).

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Sea-Bird MicroCat temperature, conductivity and pressure recorder s/n 5793 at 5 m below the surface. Sample interval 600s. Clock reset at 13:31:00 on 7 May 2009. Delayed start at 14:00:00 on 11 May 2009.

Sea-Bird MicroCat temperature, conductivity and pressure recorder s/n 5791 at 10 m below the surface. Sample interval 600s. Clock reset at 13:19:30 on 7 May 2009. Delayed start at 14:00:00 on 11 May 2009.

Mini-logger (StarOddi) s/n 2847 at 7.5 m below the surface set to record at 600s intervals. Delayed start at 14:00:00 on 11 May 2009.

Mini-logger (StarOddi) s/n 2849 at 15 m below the surface set to record at 600s intervals. Delayed start at 14:00:00 on 11 May 2009.

The CEFAS SmartBuoy is fitted with a surface CTD (including turbidity sensor and fluorometer). 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.

Table 2. Deployed mooring positions and times.

	Latitude (N)	Longitude (W)	Water Depth (m)	Deployed Time	Date
ADCP frame (Site A)	53º 32.018´	3º 21.416´	24.1	07:57	17/06/09
SmartBuoy (Site A)	53º 32.037´	3º 21.572´	23.7	08:29	17/06/09
ADCP frame (Site B)	53º 26.993´	3º 38.476´	23.5	12:15	18/06/09
(SmartBuoy (Site B)	53º 27.091´	3º 38.348´	23.5	06:04	14/05/09)

5. CTD

The Sea-Bird 911 CTD recorded downwelling PAR light levels, temperature, conductivity, oxygen concentration, transmittance and fluorescence at 24 Hz. The frame was fitted with an altimeter. The CTD temperature data was checked against a Sea-Bird SBE35 precision thermometer. Water samples were taken from a near bed (3mab) bottle for calibration of the CTD salinity data by Anne Hammerstein (SOS). Water samples were taken from the near surface (1m) and near bed (3mab) bottles and filtered to determine suspended sediment load concentration, nutrient concentration, ammonia oxidation/nitrification rate assessment, surface pH (DEFRA) and for CEFAS calibration. A LISST-25 particle sizer was fitted to the CTD and its data logged on the Sea-Bird data logging system. A LISST100-C particle sizer with internal logging was attached to the CTD frame.

30 CTD profiles were recorded at 25 sites. Copies of the Sea-Bird binary files were

taken off for processing and calibration at BODC / POL.

Bottles used on the CTD were:
Near bed: 4 – nutrients; 5 – SPM; 6 – salinity
Near surface: 9 – nutrients / CEFAS; 10 SPM; 11 pH & salinity.
7m below surface: 12 – trace metal up to CTD 22; afterwards 8.

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

Site	Latitude (N)	Longitude (W)	Done on this cruise	Cefas Chloropyll & Nu & Ss	POL Nu	POL Ss	Grab No.	pH
1	53º 32′	3º 21.8′	yes	yes+bottom	yes	yes	1	yes
2	53º 37′	3º 13.4′	yes	yes	yes	yes	22	yes
3	53º 42′	3º 13.4′	yes		yes	yes	23	yes
4	53º 47′	3º 13.4′	no CTD		surf	no	no	no
5	53º 52′	3º 21.8′	no CTD	yes	surf	no	no	no
6	53º 47′	3º 21.8′	no CTD		surf	no	no	no
7	53º 42′	3º 21.8′	yes	yes	yes	yes	no	yes
8	53º 37′	3º 21.8′	yes		yes	yes	21	yes
9	53º 32′	3º 21.8′	yes	yes	yes	yes	12	yes
10	53º 27′	3º 13.4′	yes	yes	yes	yes	10	yes
11	53º 27′	3º 21.8′	yes		yes	yes	9	yes
12	53º 27′	3º 30.2′	yes		yes	yes	8	yes
13	53º 32′	3º 30.2′	yes		yes	yes	13	yes
14	53º 37′	3º 30.2′	yes		yes	yes	20	yes
15	53º 42′	3º 30.2′	yes		yes	yes	no	yes
16	53º 47′	3º 30.2′	no CTD		surf	no	no	no
17	53º 47′	3º 47.0′	no CTD	yes	surf	no	no	no
18	53º 42′	3º 38.6′	yes		yes	yes	no	yes
19	53º 37′	3º 38.6′	yes	yes	yes	yes	19	yes
20	53º 32′	3º 38.6′	yes	yes	yes	yes	14	yes
21	53º 27′	3º 38.6′	yes	yes	yes	yes	7	yes
22	53º 23′	3º 38.6′	yes		yes	yes	2	yes
23	53º 23′	3º 47.0′	yes		yes	yes	3	yes
24	53º 27′	3º 47.0′	yes		yes	yes	6	yes
25	53º 32′	3º 47.0′	yes		yes	yes	15	yes
26	53º 37′	3º 47.0′	yes		yes	yes	18	yes
27	53º 42′	3º 47.0′	no CTD		surf	no	no	no
28	53º 47′	3º 47.0′	no CTD		surf	no	no	no
29	53º 47′	3º 55.4′	no CTD		surf	no	no	no
30	53º 42	3º 55.4′	no CTD	yes	surf	no	no	no
31	53º 37′	3º 55.4′	yes		yes	yes	17	yes
32	53º 32′	3º 55.4′	yes	yes	yes	yes	16	yes
33	53º 27′	3º 55.4′	yes		yes	yes	5	yes
34	53º 22′	3º 55.4′	yes	yes	yes	yes	4	yes
35	53º 32′	3º 15.9′	yes		yes	yes	11	yes

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

CTD no	Site	Nominal positions. Latitude (N)	Longitude (W)	Water depth (m)	Temp (deg) T / B	Salinity T / B
1	1-1	53º 32′	3º 21.8′	24	14.2 / 12.8	32.4 / 33.1
2	1-2	53º 32′	3º 21.8′	23	14.4 / 12.8	32.2 / 33.1
3	1-3	53º 32′	3º 21.8′	23	14.8 / 12.8	32.1 / 33.1
4	22	53º 23′	3º 38.6′	15	14.1 / 14.1	32.8 / 32.8
5	23	53º 23′	3º 47.0′	13	14.0 / 13.9	33.2 / 33.3
6	34	53º 22′	3º 55.4′	23	13.8 / 13.8	33.4 / 33.4
7	33	53º 27′	3º 55.4′	38	13.1 / 12.1	33.6 / 33.9
8	24	53º 27′	3º 47.0′	33	13.2 / 12.6	33.6 / 33.7
9	21-1	53º 27′	3º 38.6′	26	13.7 / 13.2	33.4 / 33.5
10	12	53º 27′	3º 30.2′	20	13.9 / 13.9	32.9 / 32.9
11	11	53º 27′	3º 21.8′	21	13.5 / 13.5	32.9 / 32.9
12	10	53º 27′	3º 13.4′	19	14.0 / 13.8	32.4 / 32.5
13	35	53º 31.9′	3º 15.9′	15	14.5 / 13.9	32.2 / 32.4
14	9	53º 32′	3º 21.8′	25	13.7 / 13.2	32.8 / 33.0
15	13	53º 32′	3º 30.2′	32	13.4 / 13.3	33.1 / 33.2
16	20	53º 32′	3º 38.6′	34	13.0 / 12.8	33.3 / 33.4
17	25	53º 32′	3º 47.0′	43	12.8 / 12.2	33.6 / 33.7
18	32	53º 32′	3º 55.4′	45	12.4 / 12.1	33.8 / 33.9
19	31	53º 37′	3º 55.4′	44	12.2 / 12.3	33.8 / 33.8
20	26	53º 37′	3º 47.0′	39	13.2 / 12.2	33.4 / 33.6
21	19	53º 37′	3º 38.6′	33	13.2 / 12.3	33.0 / 33.3
22	14	53º 37′	3º 30.2′	29	13.7 / 12.6	32.8 / 33.0
23	8	53º 37′	3º 21.8′	23	13.7 / 13.3	32.6 / 32.7
24	2	53º 37′	3º 13.4′	15	14.6 / 14.6	32.3 / 32.3
25	3	53º 42′	3º 13.4′	21	14.4 / 14.4	32.5 / 32.5
26	7	53º 42′	3º 21.8′	27	13.5 / 12.7	32.2 / 32.8
27	15	53º 42′	3º 30.2′	40	13.5 / 12.0	33.1 / 33.4
28	18	53º 42′	3º 38.6′	41	12.9 / 12.1	33.2 / 33.6
29	21-2	53º 27′	3º 38.6′	24	13.6 / 13.3	33.3 / 33.5
30	21-3	53º 27′	3º 38.6′	22	13.8 / 13.5	33.2 / 33.4
Surface values taken from underway system						
	27	53º 42′	3º 47.0′	40	12.4	33.2
	30	53º 42	3º 55.4′	42	12.3	33.7
	29	53º 47′	3º 55.4′	44	12.4	33.7
	28	53º 47′	3º 47.0′	42	12.2	33.5
	17	53º 47′	3º 38.6′	37	14.0	32.7
	16	53º 47′	3º 30.2′	28	14.2	32.6
	6	53º 47′	3º 21.8′	23	14.1	32.5
	5	53º 52′	3º 21.8′	18	14.1	32.7
	4	53º 47′	3º 13.4′	17	14.7	32.3

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, Transmissance, Hull Temperature (ºC), Barometric Pressure (mbar), Fluorescence, Oxygen concentration, Turbidity, Salinity, Conductivity sensor water temperature (ºC). Sea surface temperature, salinity and transmittance were calibrated against the CTD by BODC. In addition a pCO_2 sensor is incorporated into the surface sampling system.

Met package measures and records Barometric pressure (mbar), 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, Minimum Air Temp (ºC), Maximum Air Temp (ºC), Wind Gust (m s^{-1}).

Underway data, pCO_2 and ship's ADCP data were recorded every minute. 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. The systems ran continually beyond the Mersey radio tower between 05:51 on 17 June 2009 and 05:09 on 19 June 2009.

Acknowledgements
The assistance of the master, officers, and crew is appreciated in ensuring the success of this cruise.