Prince Madog cruise 38/09
POL Coastal Observatory cruise 64
14-17 September 2009

1. Cruise objectives

1. At site A 53° 32'N, 3° 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) CEFAS SmartBuoy in a single point mooring. Attached to the mooring wire are Sea-Bird MicroCat temperature, conductivity loggers at 5m 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 SeaPoint turbidity sensor with wiper; Sea-Bird 16*plus* with an Aanderra oxygen optode, and 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)

f) Carry out Benthic survey (5 grabs)

2. At site B 53° 27'N, 3° 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 5m and 10m below the surface and miniloggers at 7.5 and 15 m below the surface. AIS (Automatic Identification System), a collision avoidance system, attached to SmartBuoy.

b) 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 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. AIS (Automatic Identification System), a collision avoidance system, attached to SmartBuoy.

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 fitted with a wiper.

f) Carry out Benthic survey (5 grabs)

3. CTD and LISST survey

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 (nitrate, phosphate, silicate) 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. Sediment samples

Collect sediment samples at each CTD site with a Day grab for Andy Plater (University of Liverpool)

2. Cruise Personnel

Scientific Personnel

Phil Knight (Principal Scientist)
John Kenny
Andy Lane
Terry Doyle
Emlyn Jones
Katherine Nisbet (Liverpool University)
Kristoff Gibbon-Walsh (Liverpool University)
Anne Hammerstein (University of Wales, Bangor)
Tom Hull (CEFAS)
Dave Sivyer (CEFAS)

Ships 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.)
Gary Heeman (A.B.)
Colin Hughes (Cook)

3. Narrative

(All times in GMT)

The day grab and table, anchor chain clumps, two sea-bed frames with instrumentation and a SmartBuoy were loaded onto the RV Prince Madog at Vittoria Wharf, Birkenhead by 19:00 on 14 September 2009.

The RV Prince Madog left Birkenhead at 05:30 on 15 September 2009. The underway surface monitoring system, pCO_2 system, ADCP and Environment systems were switched on at 06:37 while passing the Crosby Radar Tower.

At 08:00 the first CTD cast at site 1 was recorded. The ADCP frame and ballast weight were recovered by 08:31 and the new ADCP frame deployed at 08:46. The new SmartBuoy was deployed at 09:04 (wire wrapped around buoy on deployment; microcats are likely to be recording higher up in the water column) and the old buoy recovered between 09:20 and 09:25. A CTD was then recorded with a full suite of samples. The first benthic survey was carried out by filtering five sediment grabs for biological content. At 10:40 this was followed by vertical zooplankton net hauls (5 with the small net, NO samples were taken with large net). During deployment and recovery of the ADCP frames and SmartBuoy together with the additional work the wind speeds were NNE Force 4.

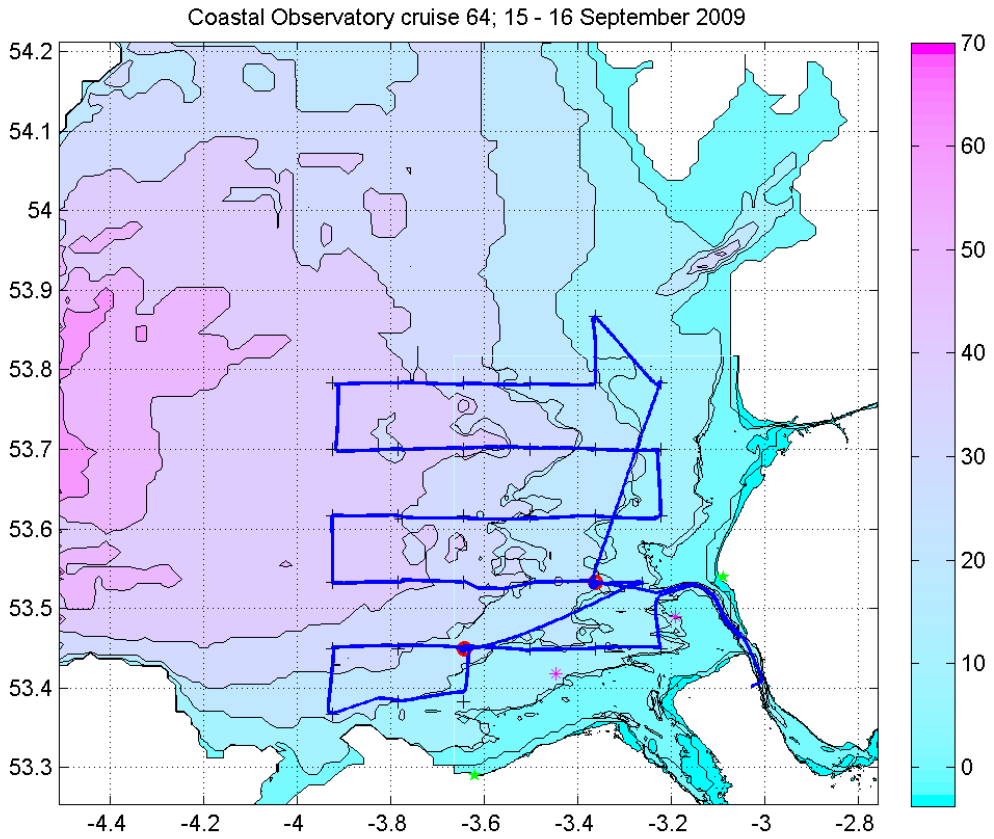
The CTD grid was then started by visiting sites 4, 5, 6, 16, 17, 28, 29, 30, 27, 18, 15, 7, 3, 2, 8, 14, 19, 26, 31, 32, 25, 20, 13, 9, 35.

The RV Prince Madog arrived at site B at 08:20 on the 16 September 2009 and a CTD was carried out. On approaching site B no signal could be detected with the ship AIS receiver from the AIS transmitter attached to old SmartBuoy. The ADCP frame was recovered and on deck at 08:50 and the replacement frame deployed at 09:19. The SmartBuoy (+ new AIS system) was deployed at 09:35. On deck the AIS system did not show up on the RV Prince Madog receiver. This was thought to be caused by interference due to the close proximity of transmitter to receiver. However after deployment it was still not being picked up by the ship even at distance. The old SmartBuoy was recovered between 09:42 and 09:47. A CTD was then recorded. The second benthic survey was then carried out by filtering sediment grab samples, however only one good grab sample from the first five attempts was obtained. Five good samples were eventually obtained by moving the ship to another location still within the site B area.

The CTD grid was restarted from site 22 at 11:20 followed by sites 23, 34, 33, 24, 21, 12, 11, 10, and the return leg to Birkenhead. The ADCP, pCO_2, surface monitoring and Environment

systems were stopped at 18:35 on 16 September 2009. The RV Prince Madog docked at Vittoria Wharf at 20:37. The weather conditions were good throughout the trip which allowed for all the stations to be visited and the moorings to be successfully serviced.

Figure 1. Cruise track



4. Moorings

4.1. Recovered instruments

The setup of the **recovered** instruments (all times in GMT) was as follows:
Site A: Bedframe

Waves ADCP 600kHz RDI S/N 5806
Mode 1: 100 pings every 10 minutes.
35 x 1m bins (2.65-36.65 m above the bed)
Beam coordinates – speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Clock set at10:00:00 on 02/08/2009. Delayed start at 06:00:00 on 03/08/2009.
Stopped logging at 12:27:00 on 18/09/2009. Clock drift + 1minute 23 seconds.

SeaBird 16*plus* S/N 4736 on base of frame with pumped conductivity sensor and SeaPoint turbidity sensor (S/N 10537) taped to roll bar; setup for 0-125 FTU range and fitted with wiper. Sample interval 600s; digiquartz integration time 40s, range 400; pump 0.5s, 1 s delay.

Clock set at 15:09:00 on 02/08/2009. Delayed start at 06:00:00 on 03/08/2009. Stopped logging at 11:02:00 on 18/09/2009. Clock drift -30 seconds.

SeaBird 16*plus* S/N 4490 upright on top of frame and (not pumped) conductivity sensor underneath. Sample interval 600s. Aanderaa optode (S/N 675)
Clock set at 11:24:00 on 02/08/2009. Delayed start at 06:00:00 on 03/08/2009. Stopped logging at 12:18:00 on 18/09/2009. Clock drift +6 seconds.

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 kHz, Tx=12kHz, RC=B) and S/N 71919 (Rx=10.5kHz, Tx=12kHz, RC=C).

Site A: SmartBuoy Mooring

SeaBird microcat temperature and conductivity recorder S/N 4966 at 5m below the surface.
Clock set at 11:11:00 on 02/08/2009. Delayed start at 06:00:00 on 03/08/2009. Stopped at 14:21:00 on 25/09/2009. Clock + 5seconds.

SeaBird microcat temperature and conductivity recorder S/N 5792 at 10m below the surface.
Clock set at 11:04:00 on 02/08/2009. Delayed start at 06:00:00 on 03/08/2009. Stopped at 13:03:40 on 25/09/2009.

Mini-logger (StarOddi) S/N 2843 at 7.5 m below the surface. Set to record at 600s intervals. Delayed start at 06:00:00 on 03/08/2009. Stopped recording at 13:17 on 18/09/2009. Clock +7 seconds.

Mini-logger (StarOddi) S/N 2842 at 15 m below the surface. Set to record at 600s intervals. Delayed start at 06:00:00 on 03/08/2009. Stopped recording at 13:23:00 on 18/09/2009. Clock +8 seconds.

The CEFAS SmartBuoy is fitted with sensors for conductivity, temperature and optical back scatter at 1m below surface, light sensors at 1 and 2 m below the surface, a fluorometer (SeaPoint), oxygen sensor (Aanderaa Optode), an in-situ NAS2E nutrient analyzer and a water sampler which obtains samples every fourth day for laboratory analysis (TOXN and silicate) and every eighth day (phytoplankton species, composition and abundance). The conductivity, temperature, optical back scatter 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 600kHz RDI S/N 2390
Mode 1: 100 pings every 10 minutes.
35 x 1m bins (2.65-36.65 m above the bed)
Beam coordinates – speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Clock reset at 09:53:00 on 02/08/2009. Delayed start at 06:00:00 on 03/08/2009.
Stopped logging at 12:34:00 on 18/09/2009. Clock drift + 1 minute 35 seconds.

SeaBird 16*plus* S/N 4738 on base of frame with pumped conductivity sensor and SeaPoint turbidity sensor (S/N 10538) taped to roll bar; setup for 0-125 FTU range and fitted with wiper. Sample interval 600s; digiquartz integration time 40s, range 400; pump 0.5s, 1 s delay.
Clock reset at 15:04:00 on 02/08/2009. Delayed start at 06:00:00 on 03/08/2009. Stopped logging at 12:06:00 on 18/09/2009. Clock drift -30 seconds.

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 72378 (Rx=10.5kHz, Tx=12kHz, RC=A) and S/N 72863 (Rx=13.5kHz, Tx=12kHz, RC=A).

Site B: SmartBuoy Mooring + AIS

SeaBird microcat temperature and conductivity recorder S/N 5433 at 5m below the surface.
Clock set at 11:15:00 on 02/08/2009. Delayed start at 06:00:00 on 03/08/2009. Stopped at 13:22:50 on 25/09/2009. Clock drift +7 seconds.

SeaBird microcat temperature and conductivity recorder S/N 5434 at 10m below the surface.
Clock set at 11:07:00 on 02/08/2009. Delayed start at 06:00:00 on 03/08/2009. Stopped logging at 10:56:00 on 25/09/2009. Clock drift +3 seconds.

Mini-logger (StarOddi) S/N 2852 at 7.5 m below the surface. Set to record at 600s intervals. Delayed start at 06:00:00 on 03/08/2009. Stopped logging at 13:28:00 on 18/09/2009. Clock drift +8 seconds.

Mini-logger (StarOddi) S/N 2844 at 15 m below the surface. Set to record at 600s intervals. Delayed start at 06:00:00 on 03/08/2009. Stopped logging at 13:32:00 on 18/09/2009. Clock drift +8 seconds.

The CEFAS SmartBuoy is fitted with a sensors for conductivity, temperature and optical back scatter and a fluorometer at 1m below surface. 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.

The AIS was fitted to the SmartBuoy frame.
MMSI number: 992351051.
Name: POL_Scientific_Buoy_B1

Table 1. Recovered mooring positions and times (GMT)

	Latitude (N)	**Longitude (W)**	**Water depth (m)**	**Date**	**Time**
ADCP frame (Site A)	53° 32.023'N	3° 21.402'W	23.0	15/09/09	08:18
SmartBuoy (Site A)	53° 32.041'N	3° 21.822'W	24.4	15/09/09	09:20
ADCP frame (Site B)	53° 26.984'N	3° 38.468'W	24.7	16/09/09	08:50

SmartBuoy (Site B)	53° 26.940'N	3° 38.555'W	24.3	16/09/09	09:42

4.2. Deployed instruments

The setup of the **deployed** instruments (all times in GMT) was as follows:

Site A: Bedframe

Waves ADCP 600kHz RDI S/N 12239
Mode 1: 100 pings every 10 minutes.
35 x 1m bins (2.65-36.65 m above the bed)
Beam coordinates – speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Clock set at 14:06:00 on 14/09/2009. Delayed start at 06:00:00 on 15/09/2009.

SeaBird 16*plus* S/N 4737 on base of frame with pumped conductivity sensor and SeaPoint turbidity sensor (S/N 10537) taped to roll bar; setup for 0-125 FTU range and fitted with wiper. Sample interval 600s; digiquartz integration time 40s, range 400; pump 0.5s, 1 s delay.
Clock set at 13:25:00 on 14/09/2009. Delayed start at 06:00:00 on 15/09/2009

SeaBird 16*plus* S/N 4741 upright on top of frame and (not pumped) conductivity sensor underneath. Sample interval 600s. Aanderaa optode (S/N 675)
Clock set at 13:33:30 on 14/09/2009. Delayed start at 06:00:00 on 15/09/2009

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 70355 (Rx=10 kHz, Tx=12kHz, RC=B) and S/N 71919 (Rx=10.5kHz, Tx=12kHz, RC=C).

Site A: SmartBuoy Mooring

SeaBird microcat temperature and conductivity recorder S/N 5791 at 5m below the surface.
Clock set at 15:16:00 on 14/09/2009. Delayed start at 06:00:00 on 15/09/2009.

SeaBird microcat temperature and conductivity recorder S/N 2081 at 10m below the surface.
Clock set at 14:49:00 on 14/09/2009. Delayed start at 06:00:00 on 15/09/2009.

Mini-logger (StarOddi) S/N 2836 at 7.5m below the surface. Set to record at 600s intervals. Delayed start at 06:00:00 on 15/09/2009. Serial number not noted during deployment. This will need to be recorded upon recovery.

Mini-logger (StarOddi) S/N 2838 at 15m below the surface. Set to record at 600s intervals. Delayed start at 06:00:00 on 15/09/2009. Serial number not noted during deployment. This will need to be recorded upon recovery.

The CEFAS SmartBuoy is fitted with sensors for conductivity, temperature and optical back scatter at 1m below surface, light sensors at 1 and 2 m below the surface, a fluorometer (SeaPoint), oxygen sensor (Aanderaa Optode), an in-situ NAS2E nutrient analyzer and a water sampler which obtains samples every fourth day for laboratory analysis (TOXN and silicate) and

every eighth day (phytoplankton species, composition and abundance). The conductivity, temperature, optical back scatter 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 600kHz RDI S/N 5807
Mode 1: 100 pings every 10 minutes.
35 x 1m bins (2.65-36.65 m above the bed)
Beam coordinates – speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Clock reset at 14:00:00 on 14/09/2009. Delayed start at 06:00:00 on 15/09/2009

SeaBird 16*plus* S/N 5309 on base of frame with pumped conductivity sensor and SeaPoint turbidity sensor (S/N 10471) taped to roll bar; setup for 0-125 FTU range and fitted with wiper. Sample interval 600s; digiquartz integration time 40s, range 400; pump 0.5s, 1 s delay.
Clock reset at 13:40:30 on 14/09/2009. Delayed start at 06:00:00 on 15/09/2009

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 72378 (Rx=10.5kHz, Tx=12kHz, RC=A) and S/N 72863 (Rx=13.5kHz, Tx=12kHz, RC=A).

Site B: SmartBuoy Mooring + AIS

SeaBird microcat temperature and conductivity recorder S/N 5793 at 5m below the surface.
Clock set at 15:10:00 on 14/09/2009. Delayed start at 06:00:00 on 15/09/2009.

SeaBird microcat temperature and conductivity recorder S/N 5790 at 10m below the surface.
Clock set at 15:05:30 on 14/09/2009. Delayed start at 06:00:00 on 15/09/2009.

Mini-logger (StarOddi) S/N 2841 @7.5 m below the surface. Set to record at 600s intervals. Delayed start at 06:00:00 on 15/09/2009.

Mini-logger (StarOddi) S/N 2849 @15 m below the surface. Set to record at 600s intervals. Delayed start at 06:00:00 on 15/09/2009.

The CEFAS SmartBuoy is fitted with a sensors for conductivity, temperature and optical back scatter and a fluorometer at 1m below surface. 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.

The AIS was fitted to the SmartBuoy frame.
MMSI number: 992351051.
Name: POL_Scientific_Buoy_B1

Table 2. Deployed mooring positions and times (GMT)

	Latitude (N)	Longitude (W)	Water depth (m)	Date	Time
ADCP frame (Site A)	53° 32.003'N	3° 21.453'W	25.5	15/09/09	08:46
SmartBuoy (Site A)	53° 32.023'N	3° 21.583'W	25.8	15/09/09	09:04
ADCP frame (Site B)	53° 26.972'N	3° 38.468'W	27.6	16/09/09	09:19
SmartBuoy (Site B)	53° 26.955'N	3° 38.347'W	27.3	16/09/09	09:35

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. A bottle at 7m was fired to obtain samples for trace metal analysis.

Bottles used on the CTD were as follows:
Bottle 3: bottom nutrients
Bottle 4: bottom SPM
Bottle 5: bottom CEFAS
Bottle 8: trace metals at ~7m below surface
Bottle 9: surface SPM
Bottle 10: surface nutrients and pH
Bottle 11: surface CEFAS
Bottle 12: surface CEFAS

Table 3. Nominal CTD positions. (nuts = nutrients, SPM = suspended sediments)

Site	Latitude (N)	Longitude (W)	Done cruise	CEFAS	POL nuts	POL SPM	Grab. No.	pH
1	53º 32´	3º 21.8´	yes	-	yes	yes	1	yes
2	53º 37´	3º 13.4´	yes	-	yes	yes	15	yes
3	53º 42´	3º 13.4´	yes	-	yes	yes	14	yes
4	53º 47´	3º 13.4´	yes	-	yes	yes	2	yes
5	53º 52´	3º 21.8´	yes	-	yes	yes	3	yes
6	53º 47´	3º 21.8´	yes	-	yes	yes	4	yes
7	53º 42´	3º 21.8´	yes	-	yes	yes	13	yes
8	53º 37´	3º 21.8´	yes	-	yes	yes	16	yes
9	53º 32´	3º 21.8´	yes	-	yes	yes	see site 1	yes
10	53º 27´	3º 13.4´	yes	-	yes	yes	34	yes
11	53º 27´	3º 21.8´	yes	-	yes	yes	33	yes
12	53º 27´	3º 30.2´	yes	-	yes	yes	32	yes
13	53º 32´	3º 30.2´	yes	-	yes	yes	24	yes
14	53º 37´	3º 30.2´	yes	-	yes	yes	17	yes
15	53º 42´	3º 30.2´	yes	-	yes	yes	12	yes
16	53º 47´	3º 30.2´	yes	-	yes	yes	5	yes
17	53º 47´	3º 47.0´	yes	-	yes	yes	6	yes
18	53º 42´	3º 38.6´	yes	-	yes	yes	11	yes
19	53º 37´	3º 38.6´	yes	-	yes	yes	18	yes
20	53º 32´	3º 38.6´	yes	-	yes	yes	23	yes
21	53º 27´	3º 38.6´	yes	-	yes	yes	26	yes
22	53º 23´	3º 38.6´	yes	-	yes	yes	27	yes
23	53º 23´	3º 47.0´	yes	-	yes	yes	28	yes
24	53º 27´	3º 47.0´	yes	-	yes	yes	31	yes
25	53º 32´	3º 47.0´	yes	-	yes	yes	22	yes
26	53º 37´	3º 47.0´	yes	-	yes	yes	19	yes
27	53º 42´	3º 47.0´	yes	-	yes	yes	10	yes
28	53º 47´	3º 47.0´	yes	-	yes	yes	7	yes
29	53º 47´	3º 55.4´	yes	-	yes	yes	8	yes
30	53º 42´	3º 55.4´	yes	-	yes	yes	9	yes
31	53º 37´	3º 55.4´	yes	-	yes	yes	20	yes
32	53º 32´	3º 55.4´	yes	-	yes	yes	21	yes
33	53º 27´	3º 55.4´	yes	-	yes	yes	30	yes
34	53º 22´	3º 55.4´	yes	-	yes	yes	29	yes
35	53º 32´	3º 15.9´	yes	-	yes	yes	25	yes

Table 4. Surface (T) and bottom (B) parameters from CTD, noted in log book.

CTD No.	Site No.	Water depth(m)	Temp (^{o}C) Top / Bottom	Salnity (PSU) Top / Bottom
1	1	26.1	15.60/16.00	31.69/32.96
2	1	25.1	15.60/1600	31.69/32.96
3	4	15.3	15.60/16.00	31.69/32.96
4	5	13.8	15.90/15.85	32.36/32.36
5	6	18.2	16.04/15.85	32.05/32.37
6	16	23.7	16.07/15.88	32.50/32.83
7	17	33.9	15.94/15.80	32.22/33.37
8	28	40.8	16.11/15.72	32.77/33.51
9	29	40.9	15.82/14.92	33.54/33.65
10	30	43.3	15.63/15.58	33.93/33.94
11	27	43.7	15.85/15.68	33.36/33.81
12	18	38.5	15.87/15.74	32.80/33.74
13	15	41.1	16.05/15.81	32.70/33.58
14	7	27.4	15.73/15.89	31.96/33.38
15	3	19.6	15.71/15.95	31.98/32.90
16	2	14.2	15.76/15.89	31.77/32.46
17	8	25.9	15.69/16.00	31.77/33.01
18	14	27.3	15.75/15.95	32.04/33.17
19	19	29.2	15.86/15.90	32.81/33.56
20	26	38.2	15.76/15.73	32.57/33.80
21	31	43.1	15.70/15.70	33.88/33.88
22	32	44.0	15.80/15.69	33.73/33.91
23	25	41.9	15.66/15.81	32.49/33.70
24	20	33.0	15.56/15.91	31.64/33.51
25	13	30.1	15.63/15.93	31.67/33.10
26	9	23.8	15.61/16.01	31.70/32.70
27	35	14.6	15.57/15.85	31.52/32.15
28	21	28.1	15.85/15.84	33.33/33.39
29	21	27.1	15.88/15.85	33.24/33.42
30	22	17.1	15.79/15.77	32.89/32.90
31	23	15.8	15.76/15.75	33.30/33.34
32	34	22.7	15.89/15.86	33.31/33.36
33	33	36.7	15.91/15.86	33.62/33.66
34	24	30.4	15.88/15.86	33.33/33.46
35	21	22.4	15.88/15.86	32.83/33.12
36	12	15.6	15.89/15.89	32.45/32.47
37	11	15.8	15.84/15.88	32.22/32.35
38	10	13.0	15.81/15.85	31.71/31.80

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 and Conductivity sensor water temperature (ºC). 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) and 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 (bin nearest the surface at 5.1 m depth), every 30 seconds with 29 pings / ensemble. The systems ran continually beyond the Mersey radio tower between 06:37 on 15 September 2009 and 18:35 on 16 September 2009.

Acknowledgments

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