**Prince Madog cruise 02/09**
**POL Coastal Observatory cruise 59**
**5th – 6th February 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 with a SeaPoint turbidity sensor, Sea-Bird SBE 16*plus* with pumped conductivity sensor, digiquartz pressure sensor with a Aanderra oxygen optode and a SonTek ADV.

b) 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. An ACS optical instrument is also attached at 5m for trial purposes.

To deploy
c) an identical bedframe to that which was recovered. An additional YSI provided multiparameter (C, T, O2, Fl, OBS) sensor is also attached for trial.
d) an identical CEFAS smartbuoy to that which was recovered minus the AC-S logger.

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 (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.

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 were fitted to the frame.

To deploy
c) 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.

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.

**3. At CTD station 12, 53°27'N 3°30'W**

To deploy a sea bed frame on behalf of Alex Souza (POL) containing:

- a 600 kHz ADCP fast sampling (1Hz) for 20 minutes every hour measuring along beam velocities for derivation of turbulent parameters.
- A Sea-Bird SBE 16*plus* with pumped conductivity sensor, and digiquartz pressure sensor.

**4.** 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).

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

**6.** Collect near surface water samples for Elena Stoica at stations 1, 21 & the most offshore station.

**7.** To collect and analyse water samples along a line EW to station 1 (carried out by Anouska Bailey and Davis from LU.

## 2.1 Scientific personnel

Matthew Palmer (Principal Scientist)
Emlyn Jones
John Kenny
Terry Doyle
Jenny Brown
Tom Hull (CEFAS)
Naomi Greewood (CEFAS)
Anne Hammerstein (School of Ocean Sciences)
Peter Hughes (School of Ocean Sciences)
Anouska Bailey (Liverpool University)

## 2.2 Ship's officers and crew

Eric Lloyd (Master)
Nick Davies (Chief Officer)
Arfon Williams (Chief Engineer)
Andrew Westmore (2nd Engineer)
Tom Roberts (A.B.)
Mick Callaghan (A.B)
Don Smith (A.B.)
Eifion Pritchard (Cook)

## 3. Narrative (times in GMT)

4th February 2009:

The anchor chain clumps, three sea-bed frames with instrumentation and SmartBuoy were loaded onto RV Prince Madog at 18:00 on 4th February 2009 at Vittoria Dock, Birkenhead immediately following demoilisation of the POL Dee cruise led by Alex Souza.

5th February 2009:

RV Prince Madog left Birkenhead at 06:50 on 5th February 2009. The ship's surface monitoring, $pCO_2$ system and ADCP were switched on at 0718 at the Mersey radio tower in entrance to the river Mersey. Weather was good, force 3 SE sea state calm, predicted to worsen, increasing force 4-5 N-NW by midday Friday. The cruise plan was therefore altered to front load the mooring recoveries and deployments at the beginning of the cruise (details in table 1 & 2).

Following a single CTD cast, the site A bedframe was recovered at 0854 5/2/09 and the replacement frame was deployed at 0947. The site A CEFAS SmartBuoy was deployed at 1026 and the previously deployed SmartBuoy was recovered and inboard at 1039. A post deployment CTD was made at station 1 at 1057 and bed sediment sample made using the day grab at 1154.

At station 12; the bedframe was deployed at 1205 following a bed sediment grab sample and a post deployment CTD made at 1210.

At station 21; following a pre-recovery CTD and a bed sediment grab sample the site B bedframe was recovered at 1314. during recovery of the anchor the connecting Kevlar recovery line was briefly ensnared on the ship's rudder and damaged. Despite some fraying of the Kevlar line the anchor was successfully recovered at 1325. The replacement bedframe was deployed at 1341 and the site B CEFAS SmartBuoy deployed at 1402. The previously deployed SmartBuoy was recovered at 1411 and a post recovery CTD made at 1427.

The CTD survey was started at the most northwesterly point, station 29. The survey was conducted in E-W lines progressing south (figure 1). All planned stations were visited except the outlying station 5 and most southerly stations 34, 23 and 22 as weather reports indicated a tight window to achieve our goals, force 6 predicted by mid afternoon on 6th February, and Anouska Bailey's priority to achieve an uninterrupted transect from station 32 to 35. At each station a single CTD cast was made and samples taken for SPM (surface and bed), nutrient (surface and bed), bed sediment, surface pH.

6th February 2009:

The CTD survey terminated at station 10 at 1550 when the ship sailed for Birkenhead. The surface monitoring, ADCP and $pCO_2$ systems were switched off at 1504. Prince Madog arrived at Vittoria Dock, Birkenhead at 1727 on 11 December 2008 and unloaded. All the major moorings objectives were completed. Most of the CTD

survey was completed. The ship returned to Menai Bridge the following morning in poor weather.

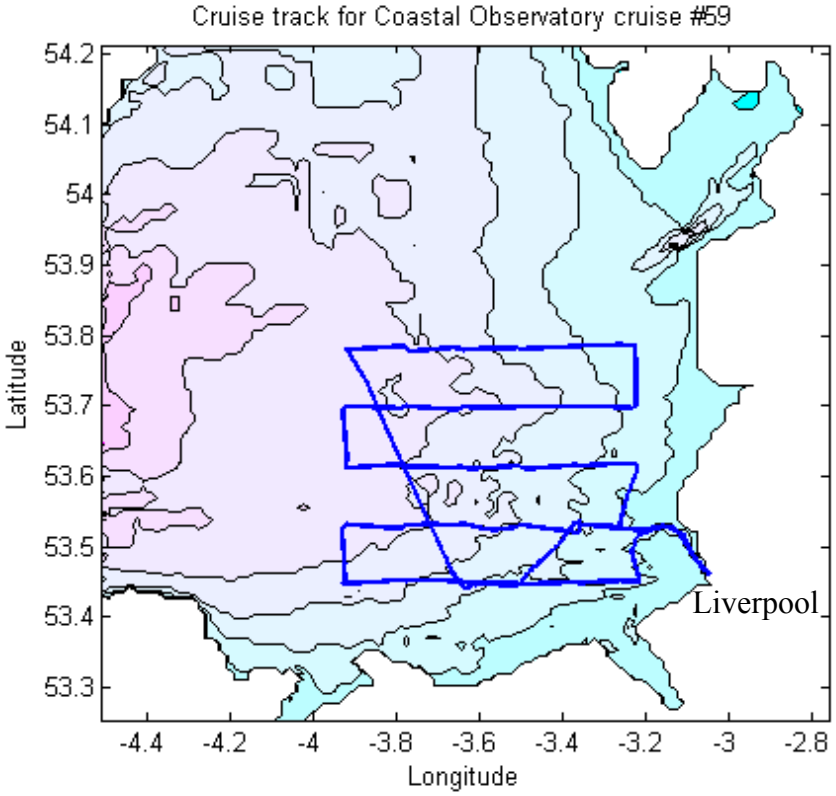


Figure 1. Cruise track.

**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 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). 1 Gb of memory.
Beam co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Clock reset at 15:25:30 on 9 December 2008.
Logging set to start at 06:00 on 10 December 2008.
Stopped at 10:09 on 05/02/09.

Sea-Bird 16plus S/N 5309 (RS232) on base of frame with pumped conductivity sensor underneath. Sample interval 600s. SeaPoint turbidity sensor (S/N 10471) taped to roll bar; set up for 0 - 125 FTU range. Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5s, 1 s delay. Clock reset at 16:20 on 9 December 2008. Logging set to start at 06:00 on 10 December 2008.
Stopped at 10:30 on 13/02/09.

Sea-Bird 16plus S/N 4741 on top of frame with pumped conductivity sensor underneath. Sample interval 600s; digiquartz integration time 40 s, range 400; pump 0.5s, 1 s delay. Aanderaa optode S/N 674. Clock reset at 15:50 on 9 December 2008. Logging set to start at 06:00 on 10 December 2008.
Stopped at 11:30 on 13/02/09.

FSI NXIC S/N 2195 on top of frame with pumped conductivity sensor underneath. Sample interval 600s. Clock reset at 15:08 on 9 September 2008. Logging set to start at 08:00 on 10 September 2008.
Stopped at 12:08 on 24/02/09.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger G527; head A943.
Distance from center of three prong head on ADV transmitter to deck was 1.350m (i.e. above sea bed). Red prong aligned to ADCP beam 3. Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s. Time reset to 15:00:00 on 8 December 2008, logging set to start at 06:00:00 on 10 December 2008.
Stopped at 14:51 on 17/02/09.

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 71922 (Rx 11.5 kHz, Tx 12.0 kHz, release A) and s/n 72381 (Rx 11.0 kHz, Tx 12.0 kHz, release B).

b) SmartBuoy Mooring.
Sea-Bird MicroCat temperature, conductivity and pressure recorder s/n 5790 at 5m below the surface. Sample interval 600s.
Clock reset to 16:08:00 on 9 December 2008.
Set to start sampling at 06:00 on 10 December 2008.
Stopped at 14:10 on 24/02/09.

Sea-Bird MicroCat temperature and conductivity recorder s/n 2081 at 10m below the surface. Sample interval 600s.
Clock reset to 16:37 on 9 December 2008.
Set to start sampling at 06:00 on 10 December 2008.
Stopped at 09:58 on 16/02/09.

Mini-logger (Star ODi) s/n 2838 at 7.5 m below the surface set to record at 600s intervals.
Set to start sampling at 06:00 on 10 December 2008.
Stopped at 10:13 on 17/02/09.

Mini-logger (Star ODi) s/n 2841 at 15 m below the surface set to record at 600s intervals.
Set to start sampling at 06:00 on 10 December 2008.
Stopped at 12:17 on 17/02/09.

AC-S s/n 060 at 5m below the surface set to record with 300s intervals and 10s sampling. Clock set at 16:57:00 on 9/12/08. Set to start sampling at 06:00:00 on 10/12/08. The AC-S was not running on recovery.

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 of material supplied by University of Liverpool for the determination of bacterial degradation.

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**

a) 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). 1 Gb of memory.
Beam co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Clock reset to 15:18:00 on 8 December 2008.
Set to start at 06:00:00 logging on 10 December 2008
Stopped at 13:09 on 12/02/09.

Sea-Bird 16plus S/N 4737 (RS485) on base of frame with pumped conductivity sensor underneath. Sample interval 600s. SeaPoint turbidity sensor taped to roll bar; set up for 1 - 125 FTU range. Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5s, 1 s delay. Clock reset at 15:50 on 9 December 2008. Set to start at 06:00:00 logging on 10 December 2008.
Stopped at 10:30 on 13/02/09

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).

b) SmartBuoy Mooring.

Sea-Bird MicroCat temperature, conductivity recorder s/n 5434 (RS 232) at 5 m below the surface. Sample interval 600s. Clock reset to 16:13 on 9 December 2008. Set to start at 06:00:00 logging on 10 December 2008.
Stopped at 15:38 on 13/02/09.

Sea-Bird MicroCat temperature, conductivity recorder s/n 4998 (RS 232) at 10 m below the surface. Sample interval 600s. Clock reset to 16:18 on 9 December 2008. Set to start at 06:00:00 logging on 10 December 2008.
Stopped at 14:50 on 13/02/09.

Mini-logger (Star ODi) s/n 2844 at 7.5 m below the surface set to record at 600s intervals.
Set to start at 06:00:00 logging on 10 December 2008.
Stopped at 13:43 on 17/02/09.

Mini-logger (Star ODi) s/n 2852 at 15 m below the surface set to record at 600s intervals.
Set to start at 06:00:00 logging on 10 December 2008.
Stopped at 13:55 on 17/02/09.

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 1. Recovered mooring positions and times.**

| | Latitude (°N) | Longitude (°W) | Water Depth (m) | Date (time) |
|---|---|---|---|---|
| ADCP frame (Site A) | 53º 32.011´ | 3º 21.446´ | 25.2 | 5/2/09 (0854) |
| SmartBuoy (Site A) | 53º 32.216´ | 3º 21.423´ | 23.1 | 5/2/09 (1039) |
| ADCP frame (Site B) | 53º 26.994´ | 3º 38.642´ | 23.3 | 5/2/09 (1314) |
| SmartBuoy (Site B) | 53º 27.014´ | 3º 38.777´ | 25.6 | 5/2/09 (1411) |

**4.2 The set up of the deployed 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). 1 Gb of memory.
Beam co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Clock reset at 4/2/09 1850. Logging set to start at 5/2/09 0600.

Sea-Bird 16plus S/N 5310 on base of frame with pumped conductivity sensor. Sample interval 600s. SeaPoint turbidity sensor taped to roll bar; set up for 0 - 125 FTU range. Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5s, 1 s delay. Clock reset at 4/2/09 1529. Logging set to start at 5/2/09 0600.

Sea-Bird 16plus S/N 4490 upright on top of frame with pumped conductivity sensor underneath. Sample interval 600s; digiquartz integration time 40 s, range 400; pump 0.5s, 1 s delay. Aanderaa optode S/N 674. Clock reset at 4/2/09 1449. Logging set to start at 5/2/09 0600.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger G479; head A984.
Distance from center of three prong head on ADV transmitter to deck was 1.32m (i.e. above sea bed). Red prong aligned to ADCP beam 3. Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s. Clock reset at 4/2/09

1500. Logging set to start at 5/2/09 0600.

A YSI multiparameter sensor, 6600V2-0 S/N 06L1043AA, was attached in an upright position measuring C, T, O2, turbidity and fluorescence. This instrument was delivered preset from OSIL for a trial deployment, responsibility of Alex Souza (POL).

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 71904 (Rx 10.0 kHz, Tx 12.0 kHz, release C) and s/n 67679 (Rx 11.5 kHz, Tx 12.0 kHz, release B).

SmartBuoy Mooring

Sea-Bird MicroCat temperature, conductivity and pressure recorder s/n 5791 at 5m below the surface. Sample interval 600s. Clock reset at 4/2/09 1510. Logging set to start at 5/2/09 0600.

Sea-Bird MicroCat temperature and conductivity recorder s/n 5433 at 10m below the surface. Sample interval 600s. Clock reset at 4/2/09 1513. Logging set to start at 5/2/09 0600.

Mini-logger (Star ODi) s/n 2842 at 7.5 m below the surface set to record at 600s intervals. Logging set to start at 5/2/09 0600.

Mini-logger (Star ODi) s/n 2843 at 15 m below the surface set to record at 600s intervals. Logging set to start at 5/2/09 0600.

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 of material supplied by Jennifer Edwards, University of Liverpool for the determination of bacterial degradation.

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). 1 Gb of memory.
Beam co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32. Clock reset at 5/2/09 1221. Logging set to start at 5/2/09 1300.

Sea-Bird 16plus S/N 4738 on base of frame with pumped conductivity sensor underneath. Sample interval 600s. SeaPoint turbidity sensor taped to roll bar; set up for 1 - 125 FTU range. Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5s, 1 s delay. Clock reset at 4/2/09 1917. Logging set to start at 5/2/09 0600.

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 70356 (Rx 10.5 kHz, Tx 12.0 kHz, release D).

SmartBuoy Mooring.

Sea-Bird MicroCat temperature, conductivity recorder s/n 5793 at 5 m below the surface. Sample interval 600s. Clock reset at 4/2/09 1516. Logging set to start at 5/2/09 0600.

Sea-Bird MicroCat temperature, conductivity recorder s/n 5792 at 10 m below the surface. Sample interval 600s. Clock reset at 4/2/09 1507. Logging set to start at 5/2/09 0600.

Mini-logger (Star ODi) s/n 2847 at 7.5 m below the surface set to record at 600s intervals. Logging set to start at 5/2/09 0600.

Mini-logger (Star ODi) s/n 2849 at 15 m below the surface set to record at 600s intervals. Logging set to start at 5/2/09 0600.

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 ($^{o}$N) | Longitude ($^{o}$W) | Water Depth (m) | Date (time) |
|---|---|---|---|---|
| ADCP site A | 53º 32.004′ | 3º 21.466′ | 24.2 | 5/2/09 (0947) |
| SmartBuoy site A | 53º 32.009′ | 3º 21.684′ | 23.7 | 5/2/09 (1026) |
| ADCP site B | 53º 26.977′ | 3º 38.612′ | 23.4 | 5/2/09 (1341) |
| SmartBuoy site B | 53º 27.108′ | 3º 38.725′ | 25.6 | 5/2/09 (1402) |
| ADCP station 12 | 53º 26.867′ | 3º 30.230′ | 17.5 | 5/2/09 (1205) |

## 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-100X particle sizer with internal logging was attached to the CTD frame. 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.
NB: CTD numbering during CObs#59 started at 095, continuing from the preceding Dee cruise.

Table 3: CTD and sample information
SPM = suspended particulate matter, S/B = surface/bottom, UoL = University of Liverpool

| CTD Number | Station | Date & Time | Latitude (N) | Longitude (W) | Water depth (m) | SPM bottle number S/B | Cefas bottle no. S/B | UoL Nutrients bottle no. S/B | DEFRA pH bottle no. (S) | Bed grab? | UoL Biological surface samples |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 95 | 1 | Feb 05 2009 08:36 | 53deg 32.046' | 03deg 21.329' | 25.1 | -/- | 2/10 +11($O_2$) | -/- | 5 | N | 4 |
| 96 | 1 | Feb 05 2009 10:57 | 53deg 32.130' | 03deg 21.969' | 23.3 | 8/3 | 10+11/- | 8/2 | 11 | Y | |
| 97 | 12 | Feb 05 2009 12:10 | 53deg 26.834' | 03deg 30.340' | 19.7 | 8/3 | | 8/2 | 11 | Y | |
| 98 | 21 | Feb 05 2009 12:54 | 53deg 26.934' | 03deg 38.754' | 19.5 | 8/3 | 10+11/- | 8/2 | 11 | Y | 5 |
| 99 | 21 | Feb 05 2009 14:27 | 53deg 26.948' | 03deg 38.752' | 25.6 | -/- | | -/- | -/- | N | |
| 100 | 29 | Feb 05 2009 | 53deg | 03deg | 30.8 | 8/3 | 10/- | 8/2 | 11 | Y | 5 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 17:05 | 46.855' | 55.053' | | | | | | | |
| 101 | 28 | Feb 05 2009 17:49 | 53deg 47.014' | 03deg 46.605' | 24.7 | 8/3 | 10/- | 8/2 | 11 | Y | |
| 102 | 17 | Feb 05 2009 18:40 | 53deg 46.889' | 03deg 38.671' | 18.5 | 8/3 | | 8/2 | 11 | Y | |
| 103 | 16 | Feb 05 2009 19:30 | 53deg 46.886' | 03deg 30.254' | 19.7 | 8/3 | | 8/2 | 11 | Y | |
| 104 | 6 | Feb 05 2009 20:14 | 53deg 47.035' | 03deg 21.792' | 19.5 | 8/3 | 10/- | 8/2 | 11 | Y | |
| 105 | 4 | Feb 05 2009 21:05 | 53deg 47.113' | 03deg 13.455' | 25.6 | 8/3 | | 8/2 | 11 | Y | |
| 106 | 3 | Feb 05 2009 21:49 | 53deg 41.991' | 03deg 13.612' | 30.8 | 8/3 | | 8/2 | 11 | Y | |
| 107 | 7 | Feb 05 2009 22:32 | 53deg 42.013' | 03deg 21.987' | 24.7 | 8/3 | 10/- | 8/2 | 11 | Y | |
| 108 | 15 | Feb 05 2009 23:12 | 53deg 42.016' | 03deg 30.345' | 18.5 | 8/3 | | 8/2 | 11 | Y | |
| 109 | 18 | Feb 05 2009 23:54 | 53deg 41.965' | 03deg 38.685' | 19.7 | 8/3 | | 8/2 | 11 | Y | |
| 110 | 27 | Feb 06 2009 00:38 | 53deg 42.062' | 03deg 46.827' | 19.5 | 8/3 | | 8/2 | 11 | Y | |
| 111 | 30 | Feb 06 2009 01:27 | 53deg 41.968' | 03deg 55.553' | 24.7 | 8/3 | | 8/2 | 11 | Y | |
| 112 | 31 | Feb 06 2009 02:15 | 53deg 36.984' | 03deg 55.399' | 18.5 | 8/3 | | 8/2 | 11 | Y | |
| 113 | 26 | Feb 06 2009 03:06 | 53deg 36.950' | 03deg 46.624' | 19.7 | 8/3 | 10/- | 8/2 | 11 | Y | |
| 114 | 19 | Feb 06 2009 03:51 | 53deg 36.836' | 03deg 38.424' | 19.5 | 8/3 | | 8/2 | 11 | Y | |
| 115 | 14 | Feb 06 2009 04:41 | 53deg 36.809' | 03deg 30.046' | 25.6 | 8/3 | 10/- | 8/2 | 11 | Y | |
| 116 | 8 | Feb 06 2009 05:25 | 53deg 36.941' | 03deg 21.677' | 24.7 | 8/3 | | 8/2 | 11 | Y | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 117 | 2 | Feb 06 2009 06:09 | 53deg 36.963' | 03deg 13.324' | 18.5 | 8/3 | 10/- | 8/2 | 11 | Y | |
| 118 | 35 | Feb 06 2009 06:54 | 53deg 31.882' | 03deg 15.829' | 19.7 | 8/3 | | 8/2 | 11 | Y | |
| 119 | 9 | Feb 06 2009 07:29 | 53deg 31.903' | 03deg 21.583' | 19.5 | 8/3 | 10/- | 8/2 | 11 | Y | |
| 120 | 13 | Feb 06 2009 09:07 | 53deg 31.960' | 03deg 30.294' | 24.7 | 8/3 | | 8/2 | 11 | Y | |
| 121 | 20 | Feb 06 2009 09:50 | 53deg 32.033' | 03deg 38.694' | 18.5 | 8/3 | | 8/2 | 11 | Y | |
| 122 | 25 | Feb 06 2009 10:32 | 53deg 31.918' | 03deg 46.895' | 19.7 | 8/3 | | 8/2 | 11 | Y | |
| 123 | 32 | Feb 06 2009 11:17 | 53deg 31.956' | 03deg 55.373' | 19.5 | 8/3 | | 8/2 | 11 | Y | |
| 124 | 33 | Feb 06 2009 12:11 | 53deg 27.042' | 03deg 55.583' | 24.7 | 8/3 | | 8/2 | 11 | Y | |
| 125 | 24 | Feb 06 2009 13:06 | 53deg 27.186' | 03deg 46.755' | 18.5 | 8/3 | | 8/2 | 11 | Y | |
| 126 | 21 | Feb 06 2009 13:51 | 53deg 26.993' | 03deg 38.563' | 19.7 | 8/3 | 10/- | 8/2 | - | N | |
| 127 | 12 | Feb 06 2009 14:31 | 53deg 26.874' | 03deg 30.166' | 19.5 | 8/3 | | 8/2 | - | N | |
| 128 | 11 | Feb 06 2009 15:13 | 53deg 27.000' | 03deg 21.693' | 25.6 | 8/3 | | 8/2 | 11 | Y | |
| 129 | 10 | Feb 06 2009 15:53 | 53deg 27.024' | 03deg 13.244' | 30.8 | 8/3 | 10/- | 8/2 | 11 | Y | |

## 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 ships 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 5/2/09 0718 and 6/2/09 1504.

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