Prince Madog cruise 12/06
POL Coastal Observatory cruise 34
5 – 6 April 2006

1. Objectives

1. At 53º 32´ N 3º 21.8´ W, half a mile west of the Mersey Bar Light Vessel (site A)
To recover
a) A directional wave buoy.

To deploy
b) A directional wave buoy.
c) A nutrient analyser in a sea bed frame measuring nitrate and phosphate four times a semi-diurnal tidal cycle.

2. At 53º 27´ N 3º 38.6´ W (site 21, second site, B)
To recover
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. A 1.2 MHz telemetry ADCP was fitted to the frame.
e) A CEFAS SmartBuoy in a single point mooring.

To deploy
f) A sea bed frame for a 600 kHz ADCP (waves ADCP) to measure the mean current profile, pressures and directional waves. A Sea-Bird SBE 16*plus* with pumped conductivity sensor, digiquartz pressure sensor and a SeaPoint turbidity sensor are fitted to the frame. A 1.2 MHz telemetry ADCP is fitted to the frame.
g) A CEFAS SmartBuoy in a single point mooring.

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.

2.1 Scientific personnel

John Howarth (Principal)
Mike Burke
John Kenny
Miguel Morales-Maqueda
Mike Smithson
Dave Pearce (CEFAS)
Anne Hammerstein (School of Ocean Sciences)

Martin Preston (Liverpool University)
Conrad Chapman (Liverpool University)

2.2 Ship's officers and crew

Steve Duckworth (Master)
Dean Atkinson (Chief Officer)
Aneurin Griffin(Chief Engineer)
Les Black (Second Engineer)
Phil Jones (A.B.)
Leon Evans (A.B.)
William Cummings (A.B.)
Bernard Cannon (Cook)

3. Narrative (times in GMT)

The SmartBuoy toroid, anchor chain clumps, two sea-bed frames and instrumentation were loaded onto RV Prince Madog on the afternoon of 4 April 2006, after low water. Loading of the heavy gear was delayed until a mechanic had come to fix the tractor brakes. The SmartBuoy toroid was rolled down the walkway. The ADCP and nutrient frames were set up on the afterdeck and the tower and instruments fitted to the SmartBuoy toroid.

RV Prince Madog left Menai Bridge at 07:00 on 5 April; see Figure 1 for the cruise track. Recording of surface sampling and the ship's ADCP were started at 07:57, near Puffin Island but the pump for the underway sampling was not switched on until 08:37. Mooring site B (CTD station 21) was reached at 09:50 and the first CTD recorded. The ADCP release was fired at 10:05 but the ADCP did not surface. The ship manoeuvred closer (75 m) to the deployed site and the releases were fired again. The ADCP did not surface. There was no indication that the ADCP had moved since deployment. Several passes were made with a loop of wire behind the ship and although it is possible the ADCP frame was seen on the echo sounder, it did not surface. On about the tenth pass the ADCP finally surfaced at 12:30, although the weak link in the dragging loop had not broken. It appeared that the pellet line had been caught as this was now severed. One of the pellets was recovered (the other had no rope through it) followed by the frame at 12:46 and the ballast weight at 12:50. There was no indication as to why the frame had failed to surface although only one burn wire had been activated. (There was also no indication why the second burn wire had not melted.) The replacement ADCP was deployed at 13:16 and the SmartBuoy at 13:34. The original SmartBuoy was recovered at 13:39 – it had possibly moved as the recovery position appeared to be about 1.4 km east of the deployed position. The second CTD was recorded.

The Mersey Bar site was reached at 15:14 and the nutrient analyser frame deployed. The wave Buoy was recovered between 15:30 and 15:45 and the replacement buoy deployed at 16:13. A CTD was recorded followed by ten vertical net hauls for zooplankton, five with a 1 m diameter ring and five with a 0.5 m diameter ring. The CTD survey then commenced with sites 10, 35, 2 – 15. By this time (08:00 on 6 April) the weather and sea state had become marginal for CTD operations so site 18 was next visited. However it was too rough and a southward course made down to 22, where a CTD was possible. Although the Welsh coastline was followed westward in the hope that Anglesey would provide shelter from the west south west gales it was too rough at station 23 but ok at 34. After a couple of hours

sheltering in Conwy and Llandudno Bay the conditions were tested and found to be much improved so the remaining CTDs, except for site 16, were recorded, finishing at 03:08 on 7 April. Surface monitoring and the ship's ADCP were switched off a 05:07 and she was alongside at Menai Bridge at 05:45.

The cruise had been very successful considering the time of year, with all the major objectives met and the CTD grid completed, except for one site. Some sites showed a high degree of saline stratification, up to 3 psu.

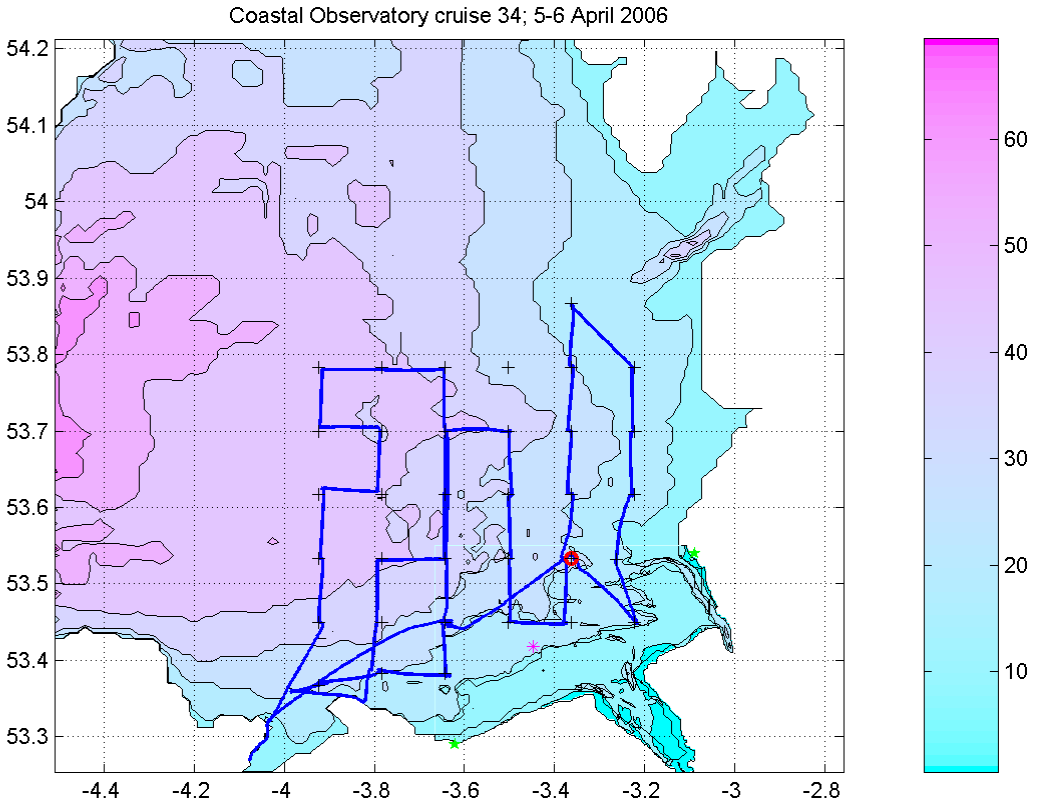

Figure 1. Cruise track.

4. Moorings (times in GMT)

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

Site B

d) Site B. 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.
Fitted with a pressure sensor and 1Gbyte PCMCIA memory; hourly wave recording enabled.
Clock reset at 16:36:00 on 2 February 2006; delayed start 08:00:00 on 6 February 2006.
Stopped at 19:00:00 on 5 April 2006. Record length 270,576 kbytes.

Sea-Bird 16*plus* S/N 4737 on base of frame with pumped conductivity sensor underneath.
SeaPoint turbidity sensor: S/N 10489 taped to roll bar; set up for 0 - 125 FTU range.
Sample interval 600 s;
Clock set at 17:214:00 on 5 February; delayed start at 11:00:00 on 6 February 2006.
Last sample at 16:00:03 on 19 April 2006. Record length 11667 samples.

Telemetry ADCP 1.2 MHz RDI 0572.
Mode 1: 100 pings every 10 minutes (velocity standard deviation 0.003 m s^{-1}).
30 x 1 m bins (2.15 – 31.65 m above the bed).
Earth co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Fitted with a pressure sensor and 512 Mbyte PCMCIA memory.
Clock reset at 16:27:00 on 2 February 2006; delayed start 11:50:00 on 8 February 2006.
Last sample at 18:50 on 5 April 2006. Record length 3,047,424 bytes.

Linquest modem 008602.

The frame (no number) was fitted with two Benthos releases (SN 72858) – Rx 14.5 kHz, Tx 12.0 kHz, release A and (S/N 72863) – Rx 12.0 kHz, Tx 13.5 kHz, release A both with burn wire, and a spooler with 200m of rope for recovery of the ballast weight.

e) SmartBuoy Mooring.
The CEFAS SmartBuoy is fitted with a surface CTD (including turbidity and fluorescence sensors). Bags for measurement of bacterial activity were fitted to the frame.

There was no other instrumentation on the mooring.

The single point mooring was composed mainly of ½" long link chain, marked by a 1.8 m diameter toroid and anchored by a half tonne clump of scrap chain.

Table 1. Recovered mooring positions and times.

	Latitude (N)	Longitude (W)	Water Depth (m)	Recovery Time	Date
Wave buoy (Site A)	53º 31.991´	3º 21.204´	25.0	15:30	05/04/06
Waves ADCP (Site B)	53º 26.863´	3º 38.186´	24.6	10:05	05/04/06
Smart Buoy (Site B)	53º 26.624´	3º 37.215´	23.8	13:39	05/04/06

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

Site A
c) Ecolab nutrient analyser measuring nitrate and phosphate four times in a semi-diurnal tidal cycle.

The frame D1 was fitted with two Benthos releases 72850 – Rx 11.5 kHz, Tx 12.0 kHz, release C and 67679 – Rx 11.5 kHz, Tx 12.0 kHz, release B both with a burn wire, and a spooler with 200m of rope for recovery of the ballast weight.

Site B

f) Site B. Waves ADCP 600 kHz RDI 5806; battery case xxxx.
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 13:31:00 on 4 February; delayed start 06:00:00 on 5 April 2006.

Sea-Bird 16*plus* S/N 4736 on base of frame with pumped conductivity sensor underneath. SeaPoint turbidity sensor taped to roll bar; set up for 0 - 125 FTU range.
Sample interval 600 s; digiquartz integration time 40s, range=400; run pump 0.5s, 1 s delay.
Clock set at 07:39:30 on 5 April 2006; delayed start at 11:00:00 on 5 April 2006.

Telemetry ADCP 1.2 MHz RDI 3052.
Mode 1: 100 pings every 10 minutes (velocity standard deviation 0.003 m s^{-1}).
35 x 1 m bins (2.65 – 36.65 m above the bed).
Earth co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Fitted with a pressure sensor and 1 Gbyte PCMCIA memory.
Clock reset at 13:09:30 on 4 April 2006; delayed start 11:50:00 on 5 April 2006.

The frame D5 was fitted with two Benthos releases 72381 – Rx 11.0 kHz, Tx 12.0 kHz, release B 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.

g) SmartBuoy Mooring.
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.

No other instrumentation was fitted to the mooring.

The single point mooring was composed mainly of ½" long link chain, marked by a 1.8 m diameter toroid and anchored by a half tonne clump of scrap chain.

Table 2. Deployed mooring positions and times.

	Latitude (N)	Longitude (W)	Water Depth (m)	Deployed Time	Deployed Date
Wave buoy (Site A)	53º 32.022´	3º 21.259´	25.5	16:13	05/04/06
Nutrient frame (Site A)	53º 32.277´	3º 21.288´		15:14	05/04/06
(Waves ADCP (Site A)	53º 31.968´	3º 21.595´)			
(SmartBuoy (Site A)	53º 32.156´	3º 21.843´)			
Waves ADCP (Site B)	53º 26.861´	3º 38.283´	25.0	13:16	05/04/06
Smart Buoy (Site B)	53º 26.730´	3º 37.675´	25.0	13:34	05/04/06
(Telemetry toroid	53º 26.898´	3º 38.226´)			

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) and by two to accommodate a bottle with reversing thermometers. Two water bottles were fired near bed and two near the surface, when needed. One of the near bed bottles was fitted with two electronic thermometers to check the CTD temperature data. Water samples were taken from this bottle for calibration of the CTD salinity data. (At the CEFAS stations, see below, this bottle was fired near the surface). 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, 5 – 9 and 11 were filtered for chlorophyll and suspended sediment determination and some filtrate was preserved with mercuric chloride for nutrient determination by CEFAS. A LISST-25 particle sizer was fitted to the CTD and its data logged on the Sea-Bird data logging system. A LISST-100 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.

Table 3. Nominal CTD positions.

Site	Latitude (N)	Longitude (W)	Visited on this cruise	Chlorophyll & nutrients	Suspended Sediments/ nutrients	Trace metal
1	53º 32´	3º 21.8´	yes	yes	yes	yes
2	53º 37´	3º 13.4´	yes		yes	yes
3	53º 42´	3º 13.4´	yes		yes	yes
4	53º 47´	3º 13.4´	yes		yes	yes
5	53º 52´	3º 21.8´	yes	yes	yes	
6	53º 47´	3º 21.8´	yes	yes	yes	
7	53º 42´	3º 21.8´	yes	yes	yes	
8	53º 37´	3º 21.8´	yes	yes	yes	
9	53º 32´	3º 21.8´	yes	yes	yes	
10	53º 27´	3º 13.4´	yes		yes	yes
11	53º 27´	3º 21.8´	yes	yes	yes	
12	53º 27´	3º 30.2´	yes		yes	yes
13	53º 32´	3º 30.2´	yes		yes	yes
14	53º 37´	3º 30.2´	yes		yes	yes
15	53º 42´	3º 30.2´	yes		yes	yes
16	53º 47´	3º 30.2´	no			
17	53º 47´	3º 38.6´	yes		yes	
18	53º 42´	3º 38.6´	yes		yes	
19	53º 37´	3º 38.6´	yes		yes	
20	53º 32´	3º 38.6´	yes		yes	yes
21	53º 27´	3º 38.6´	yes	yes	yes	yes
22	53º 23´	3º 38.6´	yes		yes	yes
23	53º 23´	3º 47.0´	yes		yes	yes

24	53º 27´	3º 47.0´	yes	yes	yes
25	53º 32´	3º 47.0´	yes	yes	yes
26	53º 37´	3º 47.0´	yes	yes	
27	53º 42´	3º 47.0´	yes	yes	
28	53º 47´	3º 47.0´	yes	yes	
29	53º 47´	3º 55.4´	yes	yes	
30	53º 42	3º 55.4´	yes	yes	
31	53º 37´	3º 55.4´	yes	yes	
32	53º 32´	3º 55.4´	yes	yes	
33	53º 27´	3º 55.4´	yes	yes	
34	53º 22´	3º 55.4´	yes	yes	yes
35	53º 32´	3º 15.9´	yes	yes	yes

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

			Nominal positions.				
CTD no	Site	Nuts	Latitude (N)	Longitude (W)	Water depth (m)	Temp (deg)	Salinity
		T/ B				T / B	T / B
1	21	1/ 2	53º 27´	3º 38.6´	24	7.1 / 7.0	32.6 / 33.0
4	1	3/ 4	53º 32´	3º 21.8´	26	7.6 / 7.0	30.1 / 33.1
5	10	5/ 6	53º 27´	3º 13.4´	17	7.8 / 7.2	30.1 / 32.0
6	35	7/ 8	53º 31.9´	3º 15.9´	13	7.1 / 7.2	30.5 / 30.9
7	2	9/10	53º 37´	3º 13.4´	13	6.9 / 6.9	31.0 / 31.2
8	3	11/12	53º 42´	3º 13.4´	18	7.0 / 6.7	31.1 / 31.7
9	4	13/14	53º 47´	3º 13.4´	16	6.8 / 6.8	31.5 / 31.5
10	5	15/16	53º 52´	3º 21.8´	15	6.4 / 6.4	31.8 / 31.8
11	6	17/18	53º 47´	3º 21.8´	20	6.5 / x.x	31.7 / xx.x
12	7	19/20	53º 42´	3º 21.8´	25	7.1 / 6.8	31.5 / 32.9
13	8	21/22	53º 37´	3º 21.8´	28	7.2 / 6.9	30.9 / 32.4
14	9	23/24	53º 32´	3º 21.8´	29	7.3 / 7.0	30.4 / 33.1
15	11	25/26	53º 27´	3º 21.8´	20	7.1 / 7.0	32.2 / 32.5
16	12	27/28	53º 27´	3º 30.2´	21	7.1 / 7.1	32.8 / 32.8
17	13	29/30	53º 32´	3º 30.2´	33	7.3 / 7.0	32.2 / 33.2
18	14	31/32	53º 37´	3º 30.2´	30	7.1 / 7.2	32.1 / 33.4
19	15	33/34	53º 42´	3º 30.2´	38	6.9 / 6.9	32.1 / 33.1
20	22	35/36	53º 23´	3º 38.6´	11	7.6 / 7.6	32.5 / 32.5
21	34	37/38	53º 22´	3º 55.4´	24	7.3 / 7.3	33.1 / 33.1
22	23	39/40	53º 23´	3º 47.0´	20	7.3 / 7.3	33.3 / 33.3
23	24	41/42	53º 27´	3º 47.0´	35	7.3 / 7.3	33.5 / 33.5
24	25	43/44	53º 32´	3º 47.0´	45	7.4 / 7.4	33.8 / 33.8
25	20	45/46	53º 32´	3º 38.6´	36	7.3 / 7.3	33.6 / 33.7
26	19	47/48	53º 37´	3º 38.6´	34	7.1 / 7.3	33.4 / 33.7
27	18	49/50	53º 42´	3º 38.6´	40	6.9 / 7.0	32.0 / 33.4
28	17	51/52	53º 47´	3º 38.6´	36	6.7 / 6.9	31.8 / 33.4
29	28	53/54	53º 47´	3º 47.0´	41	6.9 / 7.1	32.4 / 33.6
30	29	55/56	53º 47´	3º 55.4´	42	7.1 / 7.2	33.6 / 33.7
31	30	57/58	53º 42	3º 55.4´	42	7.1 / 7.2	33.7 / 33.7
33	27	59/60	53º 42´	3º 47.0´	41	6.9 / 7.1	32.7 / 33.6

33	26	61/62	53º 37´	3º 47.0´	40	7.2 / 7.3	33.5 / 33.8
34	31	63/64	53º 37´	3º 55.4´	44	7.3 / 7.4	33.8 / 33.9
35	32	65/66	53º 32´	3º 55.4´	46	7.5 / 7.6	33.9 / 33.9
36	33	67/68	53º 27´	3º 55.4´	38	7.3 / 7.5	33.6 / 33.8

6. Surface sampling

The intake for the surface sampling system is located underneath RV Prince Madog, at about 3 m below sea level. The parameters recorded every minute by the WS Oceans system are: Date, Solar Radiation (W m^{-2}), PAR (μmols / m^2s), Air Temperature (ºC), Relative Humidity, Relative Wind Speed (m s^{-1}), Relative Wind Direction (º) – zero indicates wind on the bow, Transmissance, Hull Temperature (ºC), Barometric Pressure (mbar), Fluorescence, Turbidity, Salinity, Minimum Air Temp (ºC), Maximum Air Temp (ºC), Wind Gust (m s^{-1}), GPS Time, Latitude, Longitude, Barometric Pressure Minimum (mbar), Barometric Pressure Maximum (mbar), Conductivity sensor water temperature (ºC). Sea surface temperature, salinity and transmittance were calibrated against the CTD by BODC.

Met. data were recorded every minute from 07:58 on 5 April (underway data from 08:37 when the pump was switched on) until 05:07 on 7 April 2006 starting and ending at Puffin Island. There was a gap between 12:12 and 12:39 on 5 April. Copies of the data were taken off the ship as an Excel file, along with a copy of the ship's navigation data.

The ship was fitted with a 300 kHz ADCP set to record 25 x 2m bins, the bin nearest the surface was at 5.1 m depth, every 30 seconds with 29 pings / ensemble. Data were recorded from 07:57 on 5 April until 05:07 on 7 April 2006 starting and ending at Puffin Island.

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