Prince Madog cruise 32/04
POL Coastal Observatory cruise 20
11 – 12 August 2004

1. Objectives

1. At 53º 32´ N 3º 21.8´ W, half a mile west of the Mersey Bar Light Vessel –
To recover
a) A sea bed frame for a 600 kHz ADCP to measure the mean current profile, pressures and directional waves. A pressure recorder, a transmissometer / conductivity / temperature logger and a SeaBird MicroCAT were fitted to the frame.
b) A CEFAS SmartBuoy in a single point mooring with a SeaBird MicroCAT temperature, conductivity logger at 5m below the surface and an Aanderaa temperature and conductivity logger at 10 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 pressure recorder, a transmissometer / conductivity / temperature logger and a SeaBird MicroCAT were also fitted to the frame. A second ADCP (1.2 MHz, 10 minute sampling) and LinkQuest acoustic modem were fitted to the frame.
d) A CEFAS SmartBuoy in a single point mooring with a SeaBird MicroCAT temperature, conductivity logger at 5m below the surface and an Aanderaa temperature and conductivity logger at 10 m below the surface.
e) A single point toroid mooring to telemeter ADCP data with LinkQuest acoustic modem, GPS receiver and Orbcomm transmitter.

2. To conduct a CTD / LISST survey of 35 stations 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.

3. To collect 10 vertical net hauls at the mooring site.

2.1 Scientific personnel

Mike Burke
John Howarth (principal)
John Kenny
Sara O'Donnell
Mike Smithson
Neil Upton (BODC)
Naomi Greenwood (CEFAS)
Dave Sivyer (CEFAS)
Anne Hammerstein (School of Ocean Sciences)
Kaisa Kantola (School of Ocean Sciences)

2.2 Ship's officers and crew

Alan Price (Master)
(Second Officer)
Arfon Williams (Chief Engineer)
(Second Engineer)
Tommy Roberts (Bosun)
David Williams (A.B.)
(A.B.)
Eifion Pritchard (Cook)

3. Narrative (times in GMT)

The SmartBuoy toroid, telemetry toroid, anchor chain, sea-bed frame and instrumentation were loaded onto RV Prince Madog on the afternoon of 10 August 2004. (The toroids were rolled down the walkway.) The ADCP frame was set up on the afterdeck and dunk tested to ensure it floated given the amount of instrumentation fitted to it. The test was successful but since the reserve buoyancy appeared limited and since the waves ADCP also records pressure, the pressure recorder was left off. The tower and instruments were fitted to the SmartBuoy toroid and similarly for the telemetry toroid.

RV Prince Madog left Menai Bridge at 07:15 on 11 August in calm conditions. There was an abundance of jellyfish in the Menai Strait. Recording of surface sampling and of the ship's ADCP started at 08:11, near Puffin Island, see Figure. 1 for the cruise track.

On arrival at the mooring site at 11:00 the transmissometer CTD calibration (number 1) was carried out. The ADCP was released at 11:34, was on deck at 11:44 and its ballast weight recovered by 11:52. There was no growth on the frame or transmissometer, possibly because this deployment was only three weeks long. The telemetry toroid was deployed at 12:20 followed by the replacement ADCP at 12:30, 230 m to the south. The SmartBuoy was deployed between 12:44 and 12:48. The original SmartBuoy was recovered between 12:57 and 13:05. The wave buoy was still in position.

After tidying the deck, CTD 2 was recorded and surface and bed water samples obtained for nutrient determination and filtering for suspended sediments. There followed 10 vertical net hauls for zooplankton, between 13:45 and 14:36, the first five with a 1 m diameter hoop and 60 mpi mesh and the second five with a 0.5 m diameter hoop and 200 mpi mesh. The volume of water flowing through the net during the haul was recorded with a flowmeter. Cleaning of the buoy, frame and instruments was greatly facilitated by using the ship's jet wash.

The CTD survey then started at 15:33, going round stations 10, 35, 2 – 9, 11 - 34 (see Figure 1, showing track and CTD locations) and Table 3. Water samples were obtained from near surface and near bed bottles for nutrient analysis by David Hydes at SOC and for suspended sediment determination. Since the previous cruise surface waters had warmed up by up to 2 – 3 ºC, with a maximum value of 20ºC, and surface salinities had freshened by up to 0.5 psu, a consequence of the recent rain? The water column was stratified by up 2.5ºC and 1.6 psu, and there was often a mid-water chlorophyll fluorescence peak. Surface sampling and the ship mounted ADCP were switched off at 14:00 on 12 August, near Puffin Island. RV Prince Madog was alongside at Menai Bridge at 15:05 and equipment was unloaded.

All the cruise objectives were accomplished since conditions were good and the sea was relatively calm throughout (winds ranged up to 15 m s^{-1} (on the morning of 12 August) principally from the east).

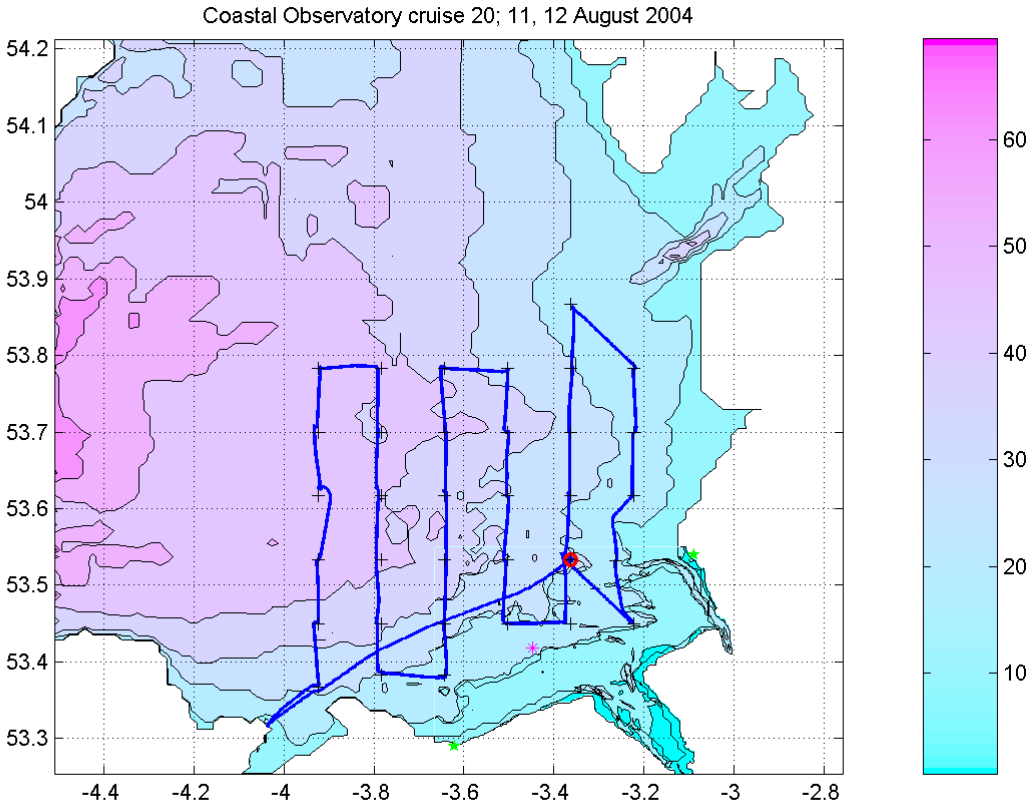

Figure 1. Cruise track

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

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

a) Mean ADCP 600 kHz RDI 2391; battery case 0250. Part used.
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 1 Gbyte memory; hourly wave recording enabled.
Clock reset at 14:00:00 on 19 July 2004; delayed start 07:00:00 on 20 July 2004.
Stopped at 16:10:12 on 11 August 2004.

Aanderaa pressure recorder BPR 444, DSU 3944: 10 minute sampling.
Clock set at 14:40:30 on 19 July; started 14:50:00 on 19 July.
Switched off at 17:51:00 11 August 2004; clock 3 s slow; 16799 words.

25 cm Sea-Tech Transmissometer, ST557, recording in Aanderaa logger (RCM7 11814 / DSU 8122) fitted with temperature (low temperature setting) and conductivity sensors. 10 minute sampling.
Clock set at 15:19:20 on 19 July 2004; started at 15:20 on 19 July 2004.
First air reading at 16:10 on 19/07/2004
Last air reading at 06:30 on 20/07/2004
First blocked path reading at 06:40:00 on 20/07/2004.
Last blocked path reading at 10:10:00 on 20/07/2004.
CTD calibration, CTD 1 at 11:10 and 11:20 on 20 July 2004.
Switched off at 17:23:00 on 11 August 2004; 20094 words.

SeaBird MicroCAT temperature, conductivity recorder (37SM32218 –2991, ID=01).
10 minute sampling. Reference pressure 25dB.
Clock set at 16:48:30 on 19 July 2004; delayed start at 07:00 on 20 July 2004.
Stopped at 16:30 on 11 August 2004. No sensible data.

The frame was fitted with two Benthos releases 52302 - 11.5 kHz 4B, pyro OTD101 and 44068 - 11.5 kHz 4A, pyro OTD111, and a spooler with 200m of rope for recovery of the ballast weight. Release OTD111 was fired.

b) SmartBuoy Mooring.
SeaBird MicroCAT temperature, conductivity recorder (37IM29828-2506 – ID=03) at 5 m below the surface. 10 minute samples. Fitted with a pressure sensor.
Clock set at 16:20:00 on 19 July 2004. Delayed start 07:00 on 20 July 2004.
Stopped at 22:04 on 11 August 2004. Clock 6 s fast. Samplenum = 3259.
Calibration dip CTD 16 – station 14. Clock reset at 23:48:25 on 11 August.
10 s sampling delayed start at 00:05:00 12 August.
Stopped at 00:29:16; samplenum = 3405.

Aanderaa current meter RCM7 9959 / DSU 8123 without fin at 10 m below the surface to log temperature (low temperature setting) and conductivity: 10 minute samples.
Clock set at 14:51:00 on 19 July 2004; started at 15:00:00 on 19 July 2004.
Switched off at 17:47:00 11 August; clock 8 s slow; 20118 words.

The CEFAS SmartBuoy is fitted with 2 surface CTDS, light sensors at 1 and 2 m below the surface, a water sampler which obtains water samples once per day for laboratory nutrient (nitrate, nitrite, phosphate) 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 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)	Deployment Time	Date
Waves ADCP	53º 32.078′	3º 21.559′	22.5	11:34	11/08/04
SmartBuoy	53º 32.060′	3º 21.661′	22	12:57	11/08/04

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

c) Waves ADCP 600 kHz RDI 2390.
Battery case 0254; new batteries shared with telemetry ADCP.
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 1 Gbyte memory; hourly wave recording enabled.
Clock reset at 15:44:00 on 10 August 2004; delayed start 06:00:00 on 11 August 2004. OK.

No BPR fitted because of doubts about the frame's buoyancy.

25 cm Sea-Tech Transmissometer, ST637, recording in Aanderaa logger (RCM7 11820 / DSU 13101) fitted with temperature (low temperature setting) and conductivity sensors. 10 minute sampling.
Clock set at 15:59:20 on 10 August 2004; started at 16:10 on 10 August 2004.
First air reading at 16:30 on 10/08/2004
Last air reading at 21:40 on 10/08/2004
First blocked path reading at 21:50 on 10/08/2004.
Last blocked path reading at 05:30:00 on 11/08/2004.
CTD calibration, CTD 1 at 11:10 and 11:20 on 11 August 2004.

SeaBird MicroCAT temperature, conductivity recorder (2081, ID=02).
10 minute sampling. Reference pressure 25dB.
Clock set at 16:47:00 on 10 August 2004; delayed start at 06:00:00 on 11 August 2004.

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).
Earth co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
1 GByte memory.
Clock reset at 15:36:30 on 10 August 2004, delayed start 06:50:00 on 11 August.

The ADCP recorded 10 minutes averages internally and sent a sub-set of east & north component data (PD12 format) every hour (on the hour) via a LinkQuest modem S/N UWM9f 07337 to the telemetry buoy. LinkQuest recommend that the acoustic modem should not be used in air at full power. Therefore it was plugged into its battery pack just before deployment.

The frame D6 was fitted with two Benthos releases 44056 - 13.5 kHz 5A, pyro OTD103 and 40266 - 11.0 kHz 3A, pyro OTD105, and a spooler with 200m of rope for recovery of the ballast weight.

d) SmartBuoy Mooring.
SeaBird MicroCAT temperature, conductivity recorder (2010 – ID=01) at 5 m below the surface. 10 minute samples. Reference pressure set at 25 dB.
Clock set at 16:40:00 on 10 August 2004. Delayed start 06:00:00 on 11 August 2004.

Aanderaa current meter RCM7 9631 / DSU 8117 without fin at 10 m below the surface to log temperature (low temperature setting) and conductivity: 10 minute samples.
Clock set at 16:09:00 on 10 August 2004; started at 16:20:00 on 10 August 2004.

The CEFAS SmartBuoy is fitted with 2 surface CTDS, light sensors at 1 and 2 m below the surface, a water sampler which obtains water samples once per day for laboratory nutrient (nitrate, nitrite, phosphate) 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 mainly of ½" long link chain, marked by a 1.8 m diameter toroid and anchored by a half tonne clump of scrap chain.

e) Telemetry buoy
A LinkQuest acoustic modem S/N UWM9f 07336 and battery pack, a GPS receiver and an Orbcomm satellite system and battery pack were fixed to a toroid. The Orbcomm system was setup to send e-mails once an hour, containing data from the ADCP (Format PD12) received by the acoustic modem link. First transmission should be at 13:00 on 11 August.

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)	Deployment Time	Deployment Date
(Wave buoy	53º 32.171′	3º 21.522′)			
Waves ADCP	53º 31.988′	3º 21.824′	22.2	12:30	11/08/04
Telemetry toroid	53º 32.114′	3º 21.835′	22.4	12:20	11/08/04
SmartBuoy	53º 32.168′	3º 22.156′	21.8	12:48	11/08/04

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. 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 SOC (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. Copies of the Sea-Bird binary files were taken off for processing and calibration at BODC / POL.

Two CTDs were recorded during mooring operations. No water samples were obtained during the first which was primarily to calibrate the transmissometer about to be deployed on the ADCP frame.

Table 3. Nominal CTD positions.

Site	Latitude (N)	Longitude (W)	Visited on this cruise	Chlorophyll & nutrients	Suspended Sediments/ nutrients
1	53º 32′	3º 21.8′	yes	yes	yes
2	53º 37′	3º 13.4′	yes		yes
3	53º 42′	3º 13.4′	yes		yes
4	53º 47′	3º 13.4′	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
11	53º 27′	3º 21.8′	yes	yes	yes
12	53º 27′	3º 30.2′	yes		yes
13	53º 32′	3º 30.2′	yes		yes
14	53º 37′	3º 30.2′	yes		yes
15	53º 42′	3º 30.2′	yes		yes
16	53º 47′	3º 30.2′	yes		yes
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
21	53º 27′	3º 38.6′	yes		yes
22	53º 23′	3º 38.6′	yes		yes
23	53º 23′	3º 47.0′	yes		yes
24	53º 27′	3º 47.0′	yes		yes
25	53º 32′	3º 47.0′	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
35	53º 32′	3º 15.9′	yes		yes

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.

Data were recorded every minute from 08:12 on 11 August until 14:00 on 12 August starting and ending at Puffin Island. 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 between 08:11 on 11 August and 14:00 on 12 August. The record is intermittent since the system hung up several occasions.

Acknowledgements
The assistance of the Captain, officers, bosun, and crew contributed greatly to the success of the cruise.