Prince Madog cruise 48/04
POL Coastal Observatory cruise 22
29 – 30 October 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 (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 SeaPoint turbidity sensor and a Sea-Bird MicroCAT were fitted to the frame.
b) A CEFAS SmartBuoy in a single point mooring with a Sea-Bird MicroCAT temperature, conductivity logger at 5m below the surface and an Aanderaa temperature and conductivity logger at 10 m below the surface.
c) A sea bed frame for a 1.2 MHz ADCP (telemetry ADCP) set to 10 minute sampling and a LinkQuest acoustic modem.
d) A single point toroid mooring to telemeter ADCP data with LinkQuest acoustic modem, GPS receiver and Orbcomm transmitter.

To deploy
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 SeaPoint turbidity sensor and a Sea-Bird MicroCAT were fitted to the frame.
f) A CEFAS SmartBuoy in a single point mooring with a Sea-Bird MicroCAT temperature, conductivity logger at 5m below the surface and an Aanderaa temperature and conductivity logger at 10 m below the surface.
g) A sea bed frame for a 1.2 MHz ADCP (telemetry ADCP) set to 10 minute sampling and a LinkQuest acoustic modem.
h) 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.

4. To obtain grab and water samples (50 – 75% from surface) from as many of sites 5-9; 11-16; 20, 21, 26, 27, 32, 33, 23, 24 and 30 as possible for Vanessa Holden (Edge Hill College).

2.1 Scientific personnel

John Howarth (Principal)
Mike Burke
John Kenny
Sara O'Donnell
Mike Smithson
Mark Hebden (BODC)
Jo Foden (CEFAS)
Dave Sivyer (CEFAS)
Anne Hammerstein (School of Ocean Sciences
Vladimir Krivtsov (School of Ocean Sciences)

2.2 Ship's officers and crew

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

3. Narrative (times in GMT)

The cruise was delayed by one day because of bad weather. The SmartBuoy toroid, anchor chain clumps, sea-bed frame, spare frame ballast weight and instrumentation were loaded onto RV Prince Madog on the afternoon of 28 October 2004. (The toroid was rolled down the walkway.) The ADCP frame was set up on the afterdeck and the tower and instruments fitted to the SmartBuoy toroid.

RV Prince Madog left Menai Bridge at 07:35 on 29 October. Recording of surface sampling and of the ship's ADCP started at 08:27 and 08:28 respectively, near Puffin Island, see Figure 1 for the cruise track.

The mooring site was reached at 11:00 and a CTD recorded; no water samples were taken. The waves ADCP was released at 11:17, was on deck at 11:23 and its ballast weight recovered by 11:33. There was some growth on the frame and turbidity sensor. The replacement ADCP was deployed at 11:52 and the SmartBuoy between 12:11 and 12:14. The original SmartBuoy was recovered between 12:20 and 12:26, covered in slime. The telemetry ADCP was recovered by 12:53 after two attempts to fire the release – the first, at 200 m, was followed by a successful attempt at 95 m. Pyro releases were fired on both ADCP frames, these being the last two; burn wires will be used in future for all deployments. The ADCP ballast weight was not recovered as the spooler line parted under strain. The telemetry toroid was recovered between 13:05 and 13:19. The wave buoy was still in position. During the afternoon, as the CTD circuit was being steamed, the buoy, frames and instruments were cleaned with the ship's jet wash and then disassembled.

No vertical net hauls were obtained because the flow meter was bent. Therefore the CTD survey started at 13.38 when CTD 2 was recorded. Surface and bed water samples were taken at this and all subsequent dips for suspended sediment and nutrient determination. Grab samples were obtained at the sites shown in Table 3. The survey track followed a similar order to September's cruise, again in order to be back at the mooring site the next morning to redeploy the telemetry system. The order was 10, 35, 2 – 8, 14 - 17, 28 - 30, 27, 18, 19, 26, 31, 32, 25, 20, 13 (see Figure 1, showing track and CTD locations) and Table 3. The mooring site was reached at 08:50 on 30 October, where a seal was observed lying in the sun on the SmartBuoy toroid. There was a slight delay for a tanker to clear the mooring site – it passed right through the intended position for the telemetry system. The telemetry toroid was deployed by 09:03, followed by the ADCP at 09:09 and a CTD. The CTD survey was concluded in sunny, calm conditions with sites 11, 12, 21 - 23, 33, 34. All sites except 24 were visited during the cruise; this station was omitted in order to dock before low water spring tides.

Very few stations were stratified. The water had cooled down appreciably and horizontal temperature gradients were small. There were however large salinity gradients with fresh, turbid water close to the Lancashire coast. There was no sign of phytoplankton growth. Surface sampling and the ship mounted ADCP were switched off at 14:46 on 30 October, near Puffin Island and RV Prince Madog was alongside at Menai Bridge at 15:38.

Nearly all the cruise objectives were accomplished – vertical net hauls were not obtained because the flowmeter was not working and station 24 was not visited. The weather was good throughout, especially so on 30 October.

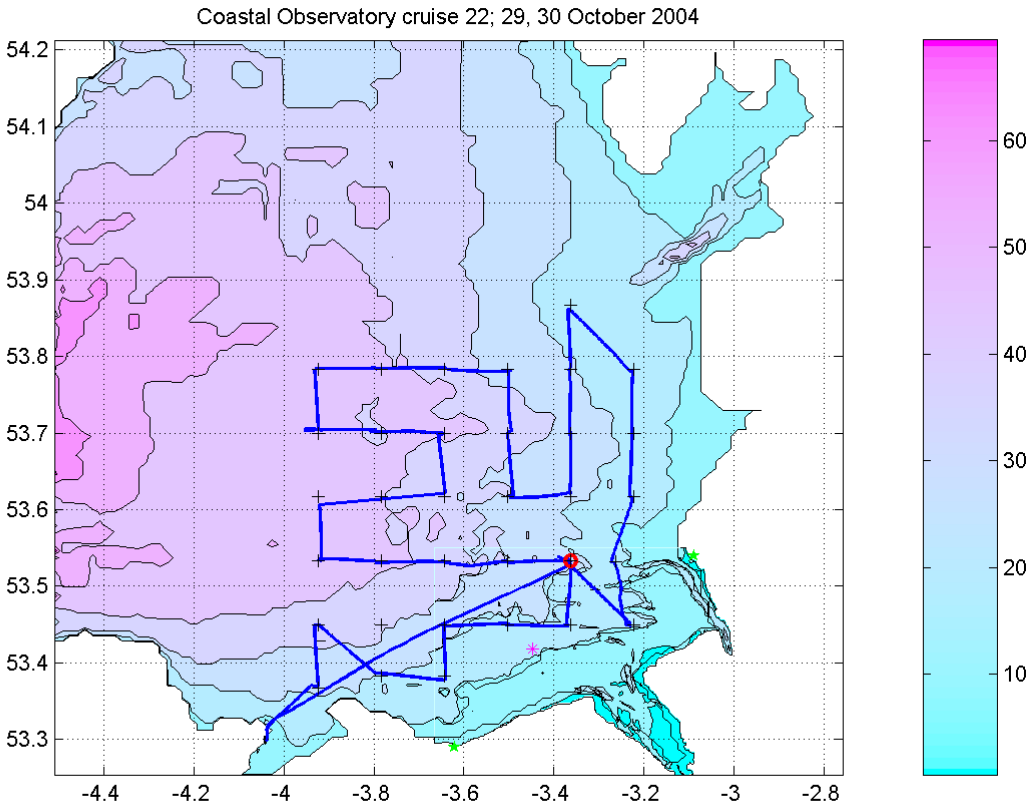

Figure 1. Cruise track

4. Moorings (times in GMT)

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

a) Waves ADCP 600 kHz RDI 2391.
Battery cases 0250 and 3070 combined fitted with used batteries since supplier failed to deliver new batteries.
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 14:03:30 on 7 September; delayed start 06:00:00 on 8 September 2004. OK.
Stopped at 03:21:00 on 30 October 2004.

Sea-Bird 16*plus* S/N 4597 on base of frame with pumped conductivity sensor underneath. SeaPoint turbidity sensor S/N 10223 taped to roll bar. The calibration CTD cast was performed after recovery – CTD 35 at site 34.
Sample interval 600 s; diqiquartz integration time 40 s.
Clock set at 16:08:30 on 7 September; delayed start at 12:00:00 on 8 September 2004.
Stopped at 07:28:45 on 30 October 2004. Sample number = 7452.

SeaBird MicroCAT RS485 temperature, conductivity recorder S/N 2991 on spider (ID=01).
10 minute sampling. Reference pressure 25dB.
Clock set at 14:53:00 on 7 September 2004; delayed start at 12:00:00 on 8 September 2004.
Stopped at 03:51:30 on 30 October 2004. Sample number = 7440. Clock 11s fast.

The frame was fitted with two Benthos releases 44068 - 11.5 kHz 4A, pyro OTD101 and 69676 - 11.5 kHz enable F, release D with a fizz link, and a spooler with 200m of rope for recovery of the ballast weight. The pyro was fired.

b) SmartBuoy Mooring.
SeaBird MicroCAT temperature, conductivity and pressure recorder (25060 – ID=03) at 5 m below the surface. 10 minute samples.
Clock set at 14:37:00 on 7 September 2004. Delayed start 12:00:00 on 8 September 2004.
Stopped at 07:28:45 on 30 October 2004. Sample number = 7461.

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 15:08:00 on 7 September 2004; started at 15:20:00 on 7 September 2004.
Switched off at 07:40:00 on 30 October 2004. 45840 words. Clock set one hour slow.

The CEFAS SmartBuoy is fitted with two 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.

c) Telemetry ADCP 1200 kHz RDI 0572.
Battery case 0254 fitted with part used batteries.
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 14:46:00 on 8 September, delayed start 15:50:00 on 8 September 2004. OK.
Clock 47 s slow. 5,506,114 bytes of data downloaded.
Last scan at 14:50 on 29 October 2004.

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. LinkQuest battery pack had not been changed.

The frame D6 was fitted with two Benthos releases 44056 - 13.5 kHz 5A, pyro OTD103 and 70356 10.5 kHz enable C, release D with fizz link, and a spooler with 200m of rope for recovery of the ballast weight. The pyro was fired.

d) 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. The LinkQuest battery had not been changed.

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	Recovery Date
ADCP frame	53º 31.983′	3º 21.909′	28.0	11:17	29/10/04
SmartBuoy	53º 32.139′	3º 22.101′	26.8	12:20	29/10/04
Telemetry ADCP	53º 32.236′	3º 22.662′	27.4	12:47	29/10/04
Telemetry toroid	53º 32.124′	3º 22.333′	26.7	13:08	29/10/04

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

e) Waves ADCP 600 kHz RDI 2390.
New batteries.
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 14:32:00 on 28 October; delayed start 06:00:00 on 29 October 2004. OK.

Sea-Bird 16*plus* S/N 4596 on base of frame with pumped conductivity sensor underneath. SeaPoint turbidity sensor S/N 10320 taped to roll bar. The calibration CTD cast will be performed after recovery.
Sample interval 600 s; diqiquartz integration time 40 s (Paros unit=40)
1 s delay before sampling, pump on for 0.5 s before sampling.
Clock set at 15:10:20 on 28 October; delayed start at 12:00:00 on 29 October 2004.

Sea-Bird MicroCAT temperature, conductivity recorder S/N 2081 on spider (ID=02).
10 minute sampling. Reference pressure 25db.
Clock set at 14:13:05 on 28 October 2004; delayed start at 06:00:00 on 29 October 2004.

The frame D2 was fitted with two Benthos releases 70354 - 13.0 kHz enable C, release D and 70355 – 10.0 kHz enable C, release D both with a fizz link, and a spooler with 200m of rope for recovery of the ballast weight.

f) SmartBuoy Mooring.
Sea-Bird MicroCAT temperature, conductivity and pressure recorder (2010 – ID=01) at 5 m below the surface. 10 minute samples. Reference pressure 25 db.
Clock set at 14:23:20 on 28 October 2004. Delayed start 06:00:00 on 29 October 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.
Started at 14:40:00 on 28 October 2004.

The CEFAS SmartBuoy is fitted with two 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.

g) Telemetry ADCP 1200 kHz RDI 0572.
Battery case 0254 fitted with part used batteries.
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 15:57:15 on 29 October, delayed start 06:50:00 on 30 October 2004. OK.

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 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 was fitted with two Benthos releases 6976 - 11.5 kHz 5A, enable F, release D and 70356 10.5 kHz enable C, release D both with fizz link, and a spooler with 200m of rope for recovery of the ballast weight.

h) Telemetry buoy

A LinkQuest acoustic modem 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.

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. 3m chain added beneath buoy to aid recovery.

Table 2. Deployed mooring positions and times.

	Latitude (N)	Longitude (W)	Water Depth (m)	Deployment Time	Date
(Wave buoy	53º 32.171´	3º 21.522´)			
Waves ADCP	53º 31.954´	3º 21.993´	28.5	11:52	29/10/04
SmartBuoy	53º 31.992´	3º 22.146´	28.2	12:14	29/10/04
Telemetry toroid	53º 32.046´	3º 22.507´	26.3	09:03	30/10/04
Telemetry ADCP	53º 31.876´	3º 22.418´	27.0	09:09	30/10/04

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. 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	Grab & water sample
1	53º 32′	3º 21.8′	yes	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	yes
6	53º 47′	3º 21.8′	yes	yes	yes	yes
7	53º 42′	3º 21.8′	yes	yes	yes	yes
8	53º 37′	3º 21.8′	yes	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	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′	yes		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	yes
21	53º 27′	3º 38.6′	yes		yes	yes
22	53º 23′	3º 38.6′	yes		yes	
23	53º 23′	3º 47.0′	yes		yes	yes
24	53º 27′	3º 47.0′	no			
25	53º 32′	3º 47.0′	yes		yes	
26	53º 37′	3º 47.0′	yes		yes	yes
27	53º 42′	3º 47.0′	yes		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	yes
31	53º 37′	3º 55.4′	yes		yes	
32	53º 32′	3º 55.4′	yes		yes	yes
33	53º 27′	3º 55.4′	yes		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 08:27 on 29 October until 14:46 on 30 October starting and ending at Puffin Island. The pump was not switched on until 13:48 on 29 October and there was a gap between 04:21 and 05:41 on 30 October. 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 08:28 on 29 October and 14:46 on 30 October. There appeared to no problems with data recording on this cruise.

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