

**Prince Madog cruise 52/04**  
**POL Coastal Observatory cruise 23**  
**15-16 December 2004**

## **1. Objectives**

1. At 53° 32' N 3° 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.

To deploy

- 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 SeaPoint turbidity sensor and a Sea-Bird MicroCAT were fitted to the frame.
- e) 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.
- f) A sea bed frame for a 1.2 MHz ADCP (telemetry ADCP) set to 10 minute sampling and a LinkQuest acoustic modem.
- g) A single point toroid mooring to telemeter ADCP data with LinkQuest acoustic modem, GPS receiver and Orbcomm transmitter (previously deployed mooring was recovered at Fleetwood in early December).

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**

Roger Proctor (Principal)  
Mike Burke  
John Kenny  
Sara O'Donnell  
Mike Smithson

Duncan Stirling  
Stuart Cutchey (CEFAS)  
Marc Childs (CEFAS)  
Anne Hammerstein (School of Ocean Sciences)  
Vladimir Krivtsov (School of Ocean Sciences)

## **2.2 Ship's officers and crew**

Alan Price (Master)  
Nick Davies (Chief Officer)  
Arfon Williams (Chief Engineer)  
D Gibb (Second Engineer)  
Tommy Roberts (A.B.)  
David Williams (A.B.)  
Ben Smith (A.B.)  
Eifion Pritchard (Cook)

## **3. Narrative (times in GMT)**

The SmartBuoy toroid, telemetry toroid, anchor chain clumps, two sea-bed frames, spare frame ballast weight and instrumentation were loaded onto RV Prince Madog on the afternoon of 14 December 2004 in poor weather (SW winds ~20 knots, raining). (The toroids were rolled down the walkway.) The ADCP frames and the telemetry toroid and instruments were set up on the afterdeck and the tower and instruments fitted to the SmartBuoy toroid.

Telemetry ADCP switched on at 06:50, Waves ADCP switched on at 07:00 on 15 December. RV Prince Madog left Menai Bridge at 08:25. Recording of surface sampling and of the ship's ADCP started at 09:18, near Puffin Island.

The mooring site was reached at 11:40 and a CTD recorded; no water samples were taken. The telemetry toroid was deployed at 12:21. After a few attempts, the waves ADCP was released at 12:41, was on deck at 12:48 and its ballast weight recovered by 12:58. There was some growth on the frame and turbidity sensor, many whelks and clusters of egg cases. The replacement ADCP was deployed at 13:15. Attempts to release the telemetry ADCP failed, even though both releases fired. There was some suspicion that, as the telemetry toroid had been recovered at the coast, the ADCP had been trawled and was may be not in the correct position. It was decided to deal with the SmartBuoy and then drag for the ADCP. The SmartBuoy was deployed at 13:58. The original SmartBuoy was recovered between 14:08 and 14:15, partly covered in slime. At 14:30 a drag for the ADCP was attempted but appeared to be unsuccessful. The captain was concerned about the proximity of the ADCP site to the telemetry buoy and the SmartBuoy with the possibility of dragging either of these instead. At 14:49 a second drag was carried out at the ADCP was seen at the surface, quite probably the result of the first drag. The telemetry ADCP was recovered and on deck at 15:00 followed by the ballast weight at 15:08. Similar fouling to the Waves ADCP (i.e. whelks and egg cases) was evident. At 15:38 the replacement telemetry ADCP was deployed. Zooplankton hauls, one with the 1m net and 60mpi mesh, and one with the ½ m net and 200mpi mesh were made at 16:02 and 16:16 respectively. The 60mpi mesh contained very few animals, the 200mpi mesh contained a reasonable sample. Only one haul with each mesh size, instead of five, was collected because we wanted to get on with the survey in view the

forecast bad weather. 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.

The CTD survey started at 16:29 when CTD 2 was recorded. Surface and bed water samples were taken at this and all subsequent dips for suspended sediment and nutrient determination. Water samples were also taken by CEFAS at stations 1, 5-9 and 11 for chlorophyll, suspended sediment and nutrient analysis. No grab samples were collected this cruise. The survey track followed the standard order to begin with i.e. 10, 35, 2 – 13 but was then abandoned because of bad weather (gusting 60 knots, WSW) (see Figure 1, showing track and CTD locations) and Table 3. Some stations were stratified, these being stations 1, 3, 4, 7 and 8. The water was 2-3C cooler than last cruise and from the limited survey it appeared the east-west horizontal temperature gradient was ~0.5C/station (e.g. stations 2 and 8). There were also 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 09:05 on 16 December, near Puffin Island and RV Prince Madog was alongside at Menai Bridge at 10:00.

All the cruise objectives were accomplished for the mooring work, but a reduced number of vertical net hauls were collected at station 1 and the ctd survey was truncated after station 13 because of bad weather. Fortunately, the weather was surprisingly good on 15 December.

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

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

a) Waves ADCP 600 kHz RDI 2390.

Mode 1: 100 pings every 10 minutes (velocity standard deviation  $0.007 \text{ m s}^{-1}$ ).

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.

Stopped at 19:10:14 on 15 December 2004.

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 was performed after recovery.

Sample interval 600 s; diquartz 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.

Stopped at 21:43:00 on 15 December 2004. Clock 55s fast. Sample no. 6827.

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.

Stopped at 18:42:40 on 15 December 2004. Sample number = 6845. Clock 65s fast.

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.

b) 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.

Stopped at 23:35:20 on 15 December 2004. Sample number = 6874. Clock 68s fast.

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.

Switched off at 12:55:05 on 4 January 2005. Clock set one hour fast. Plus 46 sec fast.

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<sup>-1</sup>).

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.

Switched off at 20:15:00 on 15 December 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 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.

Table 1. Recovered mooring positions and times.

	<u>Latitude</u> (N)	<u>Longitude</u> (W)	<u>Water</u> <u>Depth</u> (m)	<u>Recovery</u> <u>Time</u>	<u>Date</u>
ADCP frame	53° 31.920'	3° 21.938'	25.5	12:48	15/12/04
SmartBuoy	53° 31.961'	3° 22.240'	25.7	14:15	15/12/04
Telemetry ADCP	53° 31.891'	3° 22.469'	25.0	15:08	15/12/04

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

e) Waves ADCP 600 kHz RDI 2391.

New batteries.

Mode 1: 100 pings every 10 minutes (velocity standard deviation  $0.007 \text{ m s}^{-1}$ ).

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 15:17:00 on 14 December; delayed start 07:00:00 on 15 December 2004. OK.

Sea-Bird 16*plus* S/N 4597 on base of frame with pumped conductivity sensor underneath. SeaPoint turbidity sensor S/N 10471 taped to roll bar. The calibration CTD cast will be performed after recovery.

Sample interval 600 s; diquartz integration time 40 s

1 s delay before sampling, pump on for 0.5 s before sampling.

Clock set at 07:27:00 on 15 December; delayed start at 12:00:00 on 15 December 2004.

The frame D1 was fitted with two Benthos releases 72378 – 10.5 kHz Receive, 11.0 kHz Transmit, enable B, release B and 71919 – 10.5 kHz Receive, 11.0 kHz enable B, release C, and a spooler with 200m of rope for recovery of the ballast weight.

f) SmartBuoy Mooring.

Sea-Bird MicroCAT temperature, conductivity and pressure recorder (2506 – ID=03) at 5 m below the surface. 10 minute samples.

Clock set at 07:41:00 on 15 December 2004. Delayed start 12:00:00 on 15 December 2004.

Aanderaa current meter RCM7 9959 without fin at 10 m below the surface to log temperature (low temperature setting) and conductivity: 10 minute samples.

Started at 08:06:32 on 15 December 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  $\frac{1}{2}$ " long link chain, marked by a 1.8 m diameter toroid and anchored by a half tonne clump of scrap chain.

g) Telemetry ADCP 600 kHz RDI 3644.

Battery case 0254 fitted with part used batteries.

Mode 1: 100 pings every 10 minutes (velocity standard deviation  $0.003 \text{ m s}^{-1}$ ).

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 15:42:30 on 14 December, delayed start 06:50:00 on 15 December 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 69679 - 11.5 kHz Receive, 12 kHz, enable C, release D and 70358 11.0 kHz Receive, 12.0 kHz Transmit, 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.

	<u>Latitude</u> (N)	<u>Longitude</u> (W)	<u>Water</u> <u>Depth</u> (m)	<u>Deployment</u> <u>Time</u> <u>Date</u>	
Telemetry toroid	53° 31.968'	3° 22.508'	26.0	12:21	15/12/04
Waves ADCP	53° 31.918'	3° 22.036'	25.5	13:15	15/12/04
SmartBuoy	53° 31.850'	3° 22.229'	26.5	13:58	15/12/04
Telemetry ADCP	53° 31.910'	3° 22.673'	24.7	15:38	15/12/04

## 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.

<u>Site</u>	<u>Latitude (N)</u>	<u>Longitude (W)</u>	<u>Visited on this cruise</u>	<u>Chlorophyll &amp; nutrients</u>	<u>Suspended Sediments / nutrients</u>	<u>Grab &amp; water sample</u>
1	53° 32'	3° 21.8'	yes	yes	yes	
2	53° 37'	3° 13.4'	yes		yes	
3	53° 42'	3° 13.4'	yes		yes	
4	53° 47'	3° 13.4'	yes		yes	
5	53° 52'	3° 21.8'	yes	yes	yes	
6	53° 47'	3° 21.8'	yes	yes	yes	
7	53° 42'	3° 21.8'	yes	yes	yes	
8	53° 37'	3° 21.8'	yes	yes	yes	
9	53° 32'	3° 21.8'	yes	yes	yes	
10	53° 27'	3° 13.4'	yes		yes	
11	53° 27'	3° 21.8'	yes	yes	yes	
12	53° 27'	3° 30.2'	yes		yes	
13	53° 32'	3° 30.2'	yes		yes	
14	53° 37'	3° 30.2'				
15	53° 42'	3° 30.2'				
16	53° 47'	3° 30.2'				
17	53° 47'	3° 38.6'				
18	53° 42'	3° 38.6'				
19	53° 37'	3° 38.6'				
20	53° 32'	3° 38.6'				
21	53° 27'	3° 38.6'				
22	53° 23'	3° 38.6'				
23	53° 23'	3° 47.0'				
24	53° 27'	3° 47.0'				
25	53° 32'	3° 47.0'				
26	53° 37'	3° 47.0'				
27	53° 42'	3° 47.0'				
28	53° 47'	3° 47.0'				
29	53° 47'	3° 55.4'				
30	53° 42'	3° 55.4'				
31	53° 37'	3° 55.4'				
32	53° 32'	3° 55.4'				
33	53° 27'	3° 55.4'				
34	53° 22'	3° 55.4'				
35	53° 32'	3° 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 ( $\mu mols / m^2s$ ), Air Temperature ( $^{\circ}C$ ), Relative Humidity, Relative Wind Speed ( $m s^{-1}$ ), Relative Wind Direction ( $^{\circ}$ ) – zero indicates wind on the bow, Transmittance, Hull Temperature ( $^{\circ}C$ ), Barometric Pressure (mbar), Fluorescence, Turbidity, Salinity, Minimum Air Temp ( $^{\circ}C$ ), Maximum Air Temp ( $^{\circ}C$ ), Wind Gust ( $m s^{-1}$ ), GPS Time,

Latitude, Longitude, Barometric Pressure Minimum (mbar), Barometric Pressure Maximum (mbar), Conductivity sensor water temperature (°C). Sea surface temperature, salinity and transmittance were calibrated against the CTD by BODC.

Data were recorded every minute from 09:18 on 15 December until 09:00 on 16 December 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 09:18 on 15 December and 09:00 on 16 December. 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 and safety of the cruise.