Prince Madog cruise 22/06
POL Coastal Observatory cruise 37
26-27 July 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 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. The frame is fitted with a SonTek ADV.
b) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring with Sea-Bird MicroCAT temperature, conductivity loggers at 5m and 10m 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 Sea-Bird SBE 16*plus* with pumped conductivity sensor, digiquartz pressure sensor and a SeaPoint turbidity sensor were fitted to the frame. The frame is fitted with a SonTek ADV.
d) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring with Sea-Bird MicroCAT temperature, conductivity loggers at 5m and 10m below the surface.

2. At 53º 27´ N 3º 38.6´ W (site 21, second site, B)
To recover
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 a SeaPoint turbidity sensor were fitted to the frame.
f) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring.

To deploy
g) 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 was fitted to the frame.
h) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring.
i) A telemetry surface buoy.

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.

5. To recover a directional wave buoy at 53º 22.6´ N 3º 14.1´ W, off Hilbre Island.

2.1 Scientific personnel

John Howarth (Principal)
Ray Edun
John Kenny
Mike Smithson
Naomi Greenwood (CEFAS)
Paul Hudson (CEFAS)
Anne Hammerstein (School of Ocean Sciences)
Nikki Lloyd (Liverpool University, student)
Denise Bunting (School of Ocean Sciences, student)
Mark Jones (School of Ocean Sciences, student)

2.2 Ship's officers and crew

Eric Lloyd (Master)
Andy Wallis (Chief Officer)
Arfon Williams (Chief Engineer)
Stephen Baily (Second Engineer)
Tommy Roberts (A.B.)
Dave Williams (A.B.)
William Cummings (A.B.)
Eifion Pritchard (Cook)

3. Narrative (times in GMT)

The SmartBuoy and telemetry toroids, anchor chain clumps, two sea-bed frames and instrumentation were loaded onto RV Prince Madog on the afternoon of 25 July 2006, just after high water – the telemetry toroid was floated out. Loading was completed by 14:00. The ADCP frames were set up on the afterdeck and the tower and instruments fitted to the SmartBuoy toroid.

Prince Madog left Menai Bridge at 07:45 on 26 July 2006 – the start was delayed by half an hour in order to obtain some formaldehyde, needed to preserve the zooplankton samples, from the School of Ocean Sciences stores, since the usual supply had been forgotten. Surface sampling and the ship's ADCP were switched on at 08:45, by Puffin Island. The telemetry toroid at site B was deployed first, at 10:24, to make space on the deck. The Mersey Bar mooring site was reached at 11:39, a CTD recorded and the ADCP recovered between 11:52 and 12:08. Since there was no replacement ADV the plan was to refurbish the recovered ADV and transfer it to the new ADCP frame. However, the battery case was of a style very difficult to open without workshop facilities so since the next deployment was short, about three weeks, the ADV was redeployed without changing the batteries. Also since the data download would take over 12 hours, redeployment of the ADCP frame was delayed until the next day. The new SmartBuoy was deployed by 12:55 and the old one recovered by 13:08. The zooplankton net hauls were obtained, a CTD recorded and the CTD / water sample survey started with stations 35, 2 - 9, 11 - 17, 28 - 30, 27, 18 – 21 (site B).

At site B the ADCP frame was deployed close to the telemetry buoy at 07:51 on 27 July; the new SmartBuoy deployed between 08:00 and 08:09 and the old SmartBuoy recovered, 08:18

– 08:21. Finally the acoustic release on the old ADCP frame was fired at 08:38 and the frame and ballast weight recovered by 09:00. Both the frame and the SmartBuoy were clean, with no growth. A second CTD was recorded and a course set for the Mersey Bar. The ADCP frame was deployed at site A at 10:15 and a CTD recorded (number 28). A close visual inspection of the SmartBuoy showed nothing obviously amiss, although its data telemetry system was not to working. A CTD was recorded at site 10 before entering the mouth of the Dee to recover the wave buoy. Recovery was hindered because the stray line was wrapped round the mooring underneath the buoy. The buoy was lassoed and on deck by 12:28, with the recovery completed by 12:32. The buoy was covered with barnacles beneath the waterline and the rope section of the mooring, beneath the rubber cord, was covered in weed.

The CTD survey resumed with station 22 at 14.22 and was completed by 19:56. The ship's ADCP and the surface monitoring system were switched off at 20:38 at Puffin Island and the Prince Madog docked at 21:30. Unloading on 28 July waited for the tide, starting at 09:30 and completed by 11:15.

Because of the excellent weather throughout all the cruise objectives were accomplished.

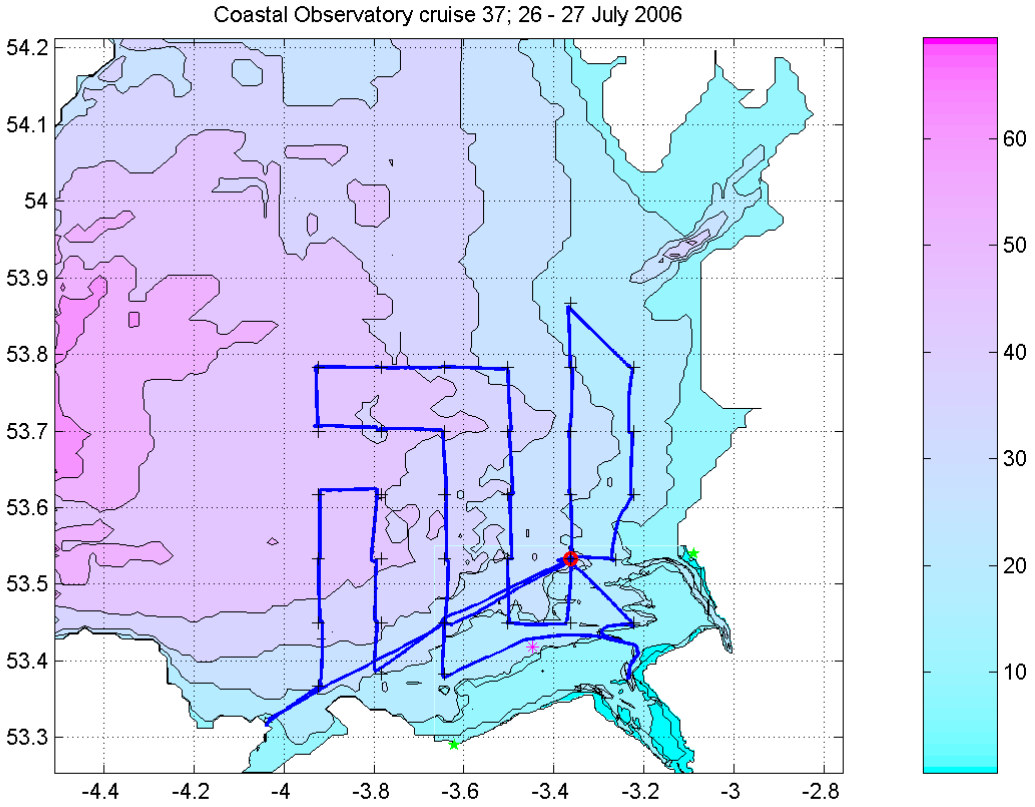

Figure 1. Cruise track.

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**;** battery pack #2
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 PCMCIA memory; hourly wave recording enabled.
Clock reset at 09:31:30 on 20 June; delayed start 06:00:00 on 21 June 2006; started ok.
Stopped at 17:52:00 on 26 July 2006. 3 files generated, last file of currents only. Virtually no wave data.

Sea-Bird 16*plus* S/N 4736 on base of frame with pumped conductivity sensor underneath.
SeaPoint turbidity sensor: S/N 10490 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 set at 08:25:40 on 20 June 2006; delayed start at 06:00:00 on 21 June 2006.
Stopped at 04:25:30 on 27 July 2006. 5175 samples recorded.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger 258
Sensor height to middle of fork 1.59m. Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s. Compass orientation note: Red mark on prong pointing along scaffold pole towards the ADCP frame. Delayed start at 06:00 on 21 June 2006.
Data downloaded 14:00 26 to 03:00 27 July 2006.

The frame D4 was fitted with two Benthos releases 72850 – Rx 11.5 kHz, Tx 12.0 kHz, release C and 72381 – Rx 11.0 kHz, Tx 12.0 kHz, release B 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 and conductivity recorder Serial number 2081 at 5 m below the surface. Sample interval 600s. ID #02
Clock set at 07:57:10 on 20 June 2006. Delayed start 06:00:00 on 21 June 2006.
Stopped at 01:08:24 on 27 July 2006; clock 1s fast. 5155 samples.

Sea-Bird MicroCAT temperature and conductivity recorder Serial number 2010 at 10 m below the surface. Sample interval 600s. ID #01
Clock set at 08:02:00 on June 2006. Delayed start 06:00:00 on 21 June 2006.
Stopped at 02:18:17 on 27 July 2006; clock 9 s fast. 5162 samples.

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 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.

Site B

e) Site B. Waves ADCP 600 kHz RDI 3644; battery pack #1
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 09:44:13 on 20 June; delayed start 06:00:00 on 21 June 2006.

Sea-Bird 16*plus* S/N 4596 on base of frame with pumped conductivity sensor underneath.
SeaPoint turbidity sensor: SN 10487 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 08:18:00 20 June 2006; delayed start at 06:00:00 on 21 June 2006.
Stopped at 15:00:30 on 27 July 2006; clock 6 s fast. 5238 samples recorded.

The frame D3 was fitted with two Benthos releases 70356 – Rx 10.5 kHz, Tx 12.0 kHz, release D and 72382 – Rx 10.0 kHz, Tx 12.0 kHz, release A both with a fizz link, and a spooler with 200m of rope for recovery of the ballast weight.

f) 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 1. Recovered mooring positions and times.

	Latitude (N)	Longitude (W)	Water Depth (m)	Recovered Time	Date
Waves ADCP (Site A)	53º 31.959′	3º 21.623′	26.7	11:52	26/07/06
SmartBuoy (Site A)	53º 32.007′	3º 21.581′	26.3	13:02	26/07/06
Waves ADCP (Site B)	53º 26.918′	3º 38.340′	24.1	08:38	27/07/06
Smart Buoy (Site B)	53º 26.970′	3º 38.439′	23.1	08.18	27/07/06

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

Site A

c) Waves ADCP 600 kHz RDI 5807**;** battery pack 3285
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 PCMCIA memory; hourly wave recording enabled.
Clock reset at 13:51:00 on 25 July; delayed start 07:00:00 on 26 July 2006; started ok.

Sea-Bird 16plus S/N 4597 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 40 s, range 400; pump 0.5s, 1 s delay.
Clock set at 17:15:00 on 25 July 2006; delayed start at 07:00:00 on 26 July 2006.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger 258
Sensor height above bed 1.305m. Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s. Compass orientation note: Red mark on prong pointing along scaffold pole away from the ADCP frame, -90° relative to ADCP beam 3.
Clock set at 03:07:10 on 27 July 2006. Delayed start at 06:00 on 27 July 2006.
Batteries not changed because of difficulty opening case.

The frame D4 was fitted with two Benthos releases 72863 – Rx 13.5 kHz, Tx 12.0 kHz, release A and 67679 – Rx 11.5 kHz, Tx 12.0 kHz, release B both with a fizz link, and a spooler with 200m of rope for recovery of the ballast weight.

d) SmartBuoy Mooring.
Sea-Bird MicroCAT temperature and conductivity recorder Serial number 2991 (RS485) at 5m below the surface. Sample interval 600s. Reference pressure = 25dB.
Clock set at 17:49:00 on 25 July 2006. Delayed start 07:00:00 on 26 July 2006.

Sea-Bird MicroCAT temperature and conductivity recorder Serial number 2506 at 10m below the surface. Sample interval 600s. Digiquartz pressure sensor.
Clock set at 17:38:30 on 25 July 2006. Delayed start 07:00:00 on 26 July 2006.

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 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.

Site B
g) 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 14:17:00 on 25 July; delayed start 07:00:00 on 27 July 2006.

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.
Clock reset at 14:39:00 on 25 July; delayed start 15:50:00 on 27 July 2006.

LinkQuest acoustic modem set for transmission of ADCP data every hour.

Sea-Bird 16plus S/N 4737 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 17:00:10 on 25 July 2006; delayed start at 07:00:00 on 26 July 2006.

The frame D3 was fitted with two Benthos releases 70358 – Rx 11.0 kHz, Tx 12.0 kHz, release A 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.

h) 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.

i) Telemetry toroid with LinkQuest acoustic modem, GPS receiver and Orbcomm transmitter

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
Waves ADCP (Site A)	53º 31.968´	3º 21.423´	24.9	10:15	27/07/06
SmartBuoy (Site A)	53º 32.000´	3º 21.609´	26.1	12:52	26/07/06
Waves ADCP (Site B)	53º 26.987´	3º 38.621´	22.3	07:51	27/07/06
Smart Buoy (Site B)	53º 26.868´	3º 38.708´	22.7	08:09	27/07/06
Telemetry toroid	53º 26.956´	3º 38.666´	27.7	10:24	26/07/06

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. One/two water bottles were fired near bed and one/two/three 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 and 21 were filtered for chlorophyll and suspended sediment determination and some filtrate was preserved with mercuric chloride for nutrient determination by CEFAS, (in addition samples at station 1 were taken for oxygen analysis). 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. (Ss – Suspended sediments, Nu – Nutrients)

Site	Latitude (N)	Longitude (W)	Visited on this cruise	Cefas Chloropyll & Nu & Ss	POL Nu	POL Ss
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	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	yes
10	53º 27′	3º 13.4′	yes		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 47.0′	yes		yes	yes
18	53º 42′	3º 38.6′	yes		yes	yes
19	53º 37′	3º 38.6′	yes		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	yes
27	53º 42′	3º 47.0′	yes		yes	yes
28	53º 47′	3º 47.0′	yes		yes	yes
29	53º 47′	3º 55.4′	yes		yes	yes
30	53º 42	3º 55.4′	yes		yes	yes
31	53º 37′	3º 55.4′	yes		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	yes
35	53º 32′	3º 15.9′	yes		yes	yes

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

CTD no	Site	Nuts	Nominal positions. Latitude (N)	Longitude (W)	Water depth (m)	Temp (deg)	Salinity
		T/ B				T / B	T / B
1	1		53º 32′	3º 21.8′	27	17.6 / 16.6	32.8 / 32.9
2	1	1/ 2	53º 32′	3º 21.8′	25	19.7 / 16.7	32.2 / 32.9
3	35	3/ 4	53º 31.9′	3º 15.9′	12	20.6 / 20.6	32.1 / 32.1
4	2	5/ 6	53º 37′	3º 13.4′	11	20.6 / 20.0	32.3 / 32.3
5	3	7/ 8	53º 42′	3º 13.4′	15	20.6 / 19.8	32.4 / 32.4
6	4	9/10	53º 47′	3º 13.4′	14	19.5 / 19.4	32.5 / 32.3
7	5	11/12	53º 52′	3º 21.8′	13	19.4 / 19.4	32.6 / 32.6
8	6	13/14	53º 47′	3º 21.8′	18	19.6 / 19.0	32.5 / 32.5
9	7	15/16	53º 42′	3º 21.8′	23	19.8 / 16.0	32.4 / 33.0
10	8	17/18	53º 37′	3º 21.8′	26	20.2 / 16.4	32.3 / 32.9
11	9	19/20	53º 32′	3º 21.8′	24	20.2 / 17.0	32.1 / 32.6
12	11	21/22	53º 27′	3º 21.8′	20	17.5 / 17.5	32.7 / 32.7
13	12	23/24	53º 27′	3º 30.2′	21	17.5 / 17.5	33.0 / 33.0
14	13	25/26	53º 32′	3º 30.2′	34	17.8 / 16.0	33.0 / 33.2
15	14	27/28	53º 37′	3º 30.2′	32	18.7 / 15.6	32.8 / 33.1
16	15	29/30	53º 42′	3º 30.2′	41	17.9 / 15.0	33.2 / 33.4
17	16	31/32	53º 47′	3º 30.2′	28	20.0 / 15.2	32.4 / 33.3
18	17	33/34	53º 47′	3º 38.6′	36	19.7 / 14.9	32.5 / 33.4
19	28	35/36	53º 47′	3º 47.0′	43	18.4 / 14.9	33.1 / 33.7
20	29	37/38	53º 47′	3º 55.4′	42	14.8 / 14.6	33.8 / 33.8
21	30	39/40	53º 42	3º 55.4′	41	14.5 / 14.5	34.0 / 34.0
22	27	41/42	53º 42′	3º 47.0′	39	15.8 / 14.8	33.6 / 33.6
23	18	43/44	53º 42′	3º 38.6′	37	18.1 / 15.4	33.3 / 33.4
24	19	45/46	53º 37′	3º 38.6′	32	18.7 / 15.6	32.8 / 33.2
25	20	47/48	53º 32′	3º 38.6′	31	17.0 / 16.1	33.1 / 33.2
26	21	49/50	53º 27′	3º 38.6′	22	17.5 / 16.8	33.0 / 33.3
27	21	51/52	53º 27′	3º 38.6′	24	17.6 / 16.8	33.1 / 33.3
28	1		53º 32′	3º 21.8′	25	18.6 / 17.3	32.4 / 32.6
29	10	53/54	53º 27′	3º 13.4′	20	19.3 / 18.8	32.1 / 32.0
30	22	55/56	53º 23′	3º 38.6′	14	18.5 / 18.1	32.9 / 33.0
31	23	57/58	53º 23′	3º 47.0′	20	18.8 / 17.6	32.9 / 33.2
32	24	59/60	53º 27′	3º 47.0′	31	17.2 / 16.0	33.3 / 33.6
33	25	61/62	53º 32′	3º 47.0′	41	16.4 / 15.5	33.6 / 33.6
34	26	63/64	53º 37′	3º 47.0′	39	16.6 / 15.2	33.5 / 33.6
35	31	65/66	53º 37′	3º 55.4′	43	15.6 / 15.0	33.7 / 33.8
36	32	67/68	53º 32′	3º 55.4′	43	16.3 / 15.1	33.5 / 33.7
37	33	69/70	53º 27′	3º 55.4′	35	17.6 / 15.7	33.3 / 33.7
38	34	71/72	53º 22′	3º 55.4′	21	18.4 / 17.4	33.2 / 33.3

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.

Underway data were recorded every minute from 08:45 on 26 July until 20:38 on 27 July 2006, starting and ending at Puffin Island. Since atmospheric pressure was not being recorded at the start, the system was rebooted at 09:30 on 26 July. There were two short gaps when the logging system froze (18:02-18.54 on 26 July and 05:33-06:08 on 27 July). The relative humidity data, all values about -24.7, are wrong. 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 08:45 on 26 July to 20:38 on 27 July 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.