Prince Madog cruise 29/08
POL Coastal Observatory cruise 56
10 – 12 September 2008

1. Objectives

1. At Site A 53º 32´ N 3º 21.8´ W, (CTD station 1 and 9)

To recover
a) A sea bed frame containing a 600kHz ADCP (waves ADCP) to measure the mean current profile, pressures and directional waves, Sea-Bird SBE 16*plus* with pumped conductivity sensor, digiquartz pressure sensor and a SeaPoint turbidity sensor, SonTek ADV and Aanderra oxygen optode.

b) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring. Attached to the mooring wire are SeaBird MicroCat temperature, conductivity loggers at 5 and 10m below the surface and miniloggers at 7.5 and 15 m below the surface.

To deploy
c) an identical bedframe to that which was recovered.
d) an identical CEFAS smartbuoy to that which was recovered

e) Collect 10 vertical zooplankton net hauls (CEFAS).

2. At Site B 53º 27´ N 3º 38.6´ W, (CTD station 21)

To recover
a) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring. Attached to the mooring wire are Sea-Bird MicroCat temperature, conductivity loggers at 5 and 10m below the surface and miniloggers at 7.5 and 15 m below the surface.

b) 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 1200 kHz telemetry ADCP was fitted to the frame.

c) A telemetry buoy.

To deploy
d) A CEFAS SmartBuoy (with cellulose bags) in a single point mooring. Attached to the mooring wire are Sea-Bird MicroCat temperature, conductivity loggers at 5 and 10m below the surface and miniloggers at 7.5 and 15 m below the surface.

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. A 1200 kHz telemetry ADCP was fitted to the frame.

f) A telemetry buoy fitted with an ACS and Sea-Bird MicroCat.

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 sediment samples at each of the CTD sites.

5. Collect near surface water samples for Elena Stoica at stations 1, 21 & the most offshore station. Some of these samples are to be 'fixed' using provided formaldehyde solutions and frozen at -20ºC and others left in the fridge.

6. To conduct a benthic survey at site 1 and site 21 (five grab samples at each site).

2.1 Scientific personnel

Phil Knight (Principal Scientist)
Andy Lane
Terry Doyle
Chris Balfour
Emlyn Jones
Joanne Hopkins
Dave Pearce (CEFAS)
Jenny Keable (CEFAS)
Anne Hammerstein (School of Ocean Sciences)
Katherine Nisbet (University of Liverpool)

2.2 Ship's officers and crew

Steve Duckworth (Master)
David Shaw (Chief Officer)
Les Black (Chief Engineer)
Meikle Mackay (2nd Engineer)
Martin Ansley (A.B.)
Mick Callaghan (Bosun)
Steve Lewis (A.B.)
Richard Ederle (Cook)

3. Narrative (times in GMT)

The anchor chain clumps, two sea-bed frames and instrumentation were loaded onto RV Prince Madog between 15:30 and 17:00 on 9 September 2008. The frames had already been partly fitted out with ADCP and SeaBird loggers in the pavilion. The tower and instruments were fitted to the SmartBuoy toroid by CEFAS personnel. The main survey CTD was found to be faulty and taken off for repair.

Prince Madog left Menai Bridge at 06:00 on 10 September 2008. The ship's surface monitoring, pCO_2 system and ADCP were switched on at 07:00 near to Puffin Island. Site A was reached at 09:48 on the 10 September 2008 and a surface water sample taken for CEFAS. At site A the ADCP release was fired at 10:01 and surfaced at 10:02. The replacement ADCP was then deployed at 11:22. The replacement SmartBuoy was deployed at 11:55 and the old buoy recovered between 12:06 and 12:32. This was followed by two water samples (surface and bottom) for CEFAS and six sediment grabs.

Site B was reached at 14:50 and the ADCP recovered between 14:54 and 15:13 on 10 September 2008. On inspection the frame was found to be missing two ADCP's. No damage was evident, which suggested that they had not been correctly bolted on to the frame bases. The telemetry buoy was recovered between 15:37 and 15:53. It was found to be damaged and could not be refurbished with new telemetry units and the planned ACS with CTD unit underneath. The replacement ADCP was then deployed at 16:27. The replacement SmartBuoy was deployed at 17:23. Prince Madog then headed back to Menai Bridge to pick up a replacement CTD (Sea-Bird 19). The surface monitoring, ADCP and pCO_2 system were switched off passing Puffin Island at 19:32. Prince Madog arrived at Menai Bridge at 20:15 on 10 September 2008.

Prince Madog left Menai Bridge at 06:15 on 11 September 2008. The ship's surface monitoring, pCO_2 system and ADCP were switched on at 07:19 near to Puffin Island.
The SmartBuoy at site B was recovered between 09:06 and 09:13. Surface water samples were taken for Elena Stoica and CEFAS. This was followed by six sediment grabs and one CTD dip.

Prince Madog reached the Hilbre Channel at 12:14. The wave buoy was recovered between 15:18 and 15:37 during slack water conditions. The wave buoy was vented immediately once on deck. Site A was reached at 17:16 and CTD's and water samples taken for Elena Stoica. This was followed by zooplankton net hauls. The last CTD was taken at site 33 together with water samples for Elena Stoica.

The surface monitoring, ADCP and pCO_2 system were switched off passing Puffin Island at 22:00. Prince Madog arrived at Menai Bridge at 23:15 on 11 September 2008. All the major moorings objectives were accomplished with the exception of the telemetry buoy deployment. However, a comprehensive CTD survey was not possible because of the fault with the main CTD.
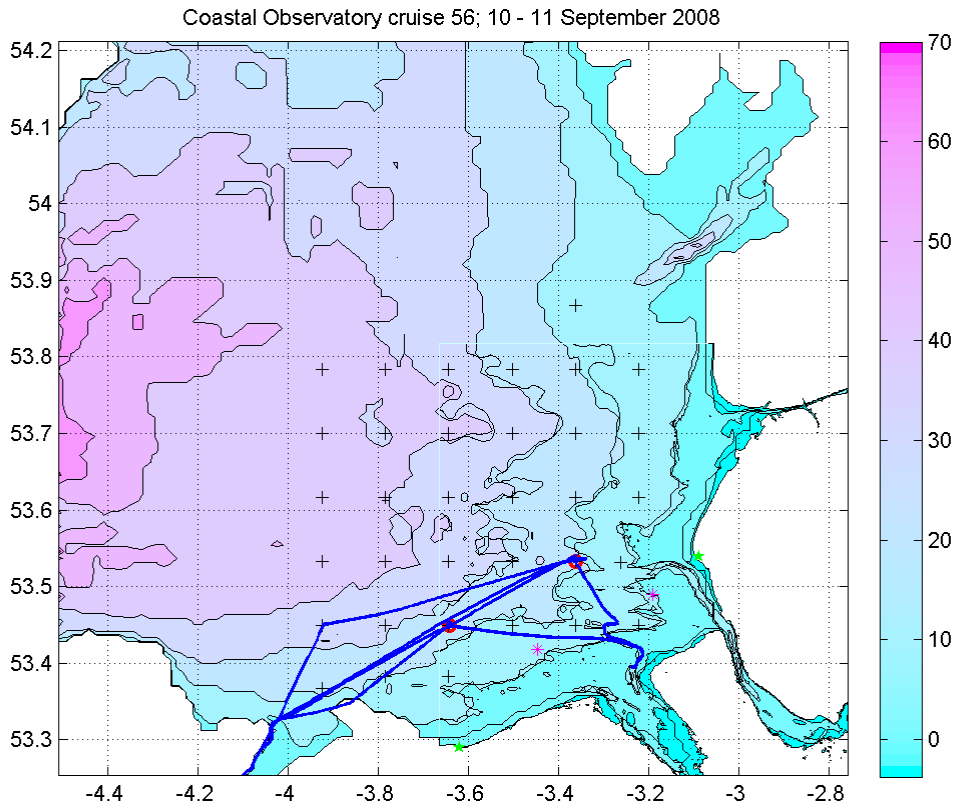
Figure 1. Cruise track.

4. Moorings (times in GMT)

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

Site A

a) Frame setup at POL prior to cruise
Waves ADCP 600 kHz RDI (S/N 5806)**.**
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.
Break at 12:03 on 11 September 2008 (clock drift +23s). Only recorded 195Mb of data on first 512Mb original sandisk card.

Sea-Bird 16plus S/N 4848 on base of frame with pumped conductivity sensor underneath.
Sample interval 600s. SeaPoint turbidity sensor (S/N 10489) 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. Aanderaa oxygen optode S/N 674.
Clock settings not noted.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger G479; head A984.
Distance from center of three prong head on ADV transmitter to deck was 1.262m (i.e. above

sea bed). Red prong aligned to ADCP beam 3. Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s. Time reset to 14:00:00 on 29 July 2008, logging set to start at 09:00:00 on 30 July 2008. Logging stopped at 09:02 on 11 September 2008.

The frame was fitted with a fizz link, a spooler with 50m of rope for recovery of the ballast weight and two Benthos releases s/n 71904 (Rx 10.0 kHz, Tx 12.0 kHz, release C) and s/n 70358 (Rx 11.0 kHz, Tx 12.0 kHz, release A).

b) SmartBuoy Mooring. (Loggers set up at POL prior to cruise)
Sea-Bird MicroCat temperature, conductivity and pressure recorder s/n 2991 at 5m below the surface. Sample interval 600s. Logging stopped at 13:52 on 10 September 2008.

Sea-Bird MicroCat temperature and conductivity recorder s/n 2506 at 10m below the surface. Sample interval 600s.
Clock settings not noted.

Mini-logger s/n 6020E at 7.5 m below the surface set to record at 600s intervals. Clock settings not noted.

Mini-logger s/n 6028E at 15 m below the surface set to record at 600s intervals.
Clock settings not noted.

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 frame was fitted with bags of material supplied by University of Liverpool for the determination of bacterial degradation.

The single point mooring was composed 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

a) Waves ADCP 600 kHz RDI 2390, 1GB memory**.**
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.
Clock set at 13:35:20 on 24 June 2008; delayed start 06:00 on 25 June 2008.
LOST

Telemetry ADCP 1200 kHz RDI 3052**.**
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). 1 Gb memory.
Earth co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Clock reset at 13:46:10 on 24 June 2008; delayed start 15:50:00 on 24 June 2008.

LinkQuest acoustic modem sn008602 set for transmission of ADCP data every hour.
LinkQuest tx at 16:00:00 on 24 June 2008.
LOST

Sea-Bird 16plus S/N 4596 (RS485) on base of frame with pumped conductivity sensor underneath. SeaPoint turbidity sensor 10533 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. Sample interval 600s.
Clock set at 13:22:50 on 24 June 2008; delayed start at 06:00 on 25 June 2008.

The frame was fitted with a fizz link, a spooler with 50m of rope for recovery of the ballast weight and two Benthos releases s/n 67679 (Rx 11.5 kHz, Tx 12.0 kHz, release B) and s/n 70356 (Rx 10.5 kHz, Tx 12.0 kHz, release D).

b) Telemetry buoy
Recovered and not re-deployed because one of the telemetry mounting holes had snapped off the frame during the previous deployment.

c) SmartBuoy Mooring. (Loggers set up at POL prior to cruise)

Sea-Bird MicroCat temperature, conductivity recorder s/n 2010 at 5 m below the surface. Sample interval 600s. Clock settings not noted.

Sea-Bird MicroCat temperature, conductivity recorder s/n 4966 at 10 m below the surface. Sample interval 600s. Logging stopped at 10:20 on 11 September 2008 (clock drift 8s).

VEMCO Mini-logger s/n 0142E at 7.5 m below the surface set to record at 600s intervals. Clock settings not noted.

NO VEMCO Mini-logger at 15m.

The CEFAS SmartBuoy is fitted with a surface CTD (including turbidity sensor and fluorometer). The frame was fitted with bags for the determination of bacterial degradation. 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)	Deployed Time	Date
ADCP frame (Site A)	53° 32.096′	3° 21.562′	21.1	10:01	10/09/08
SmartBuoy (Site A)	53° 32.044′	3° 21.796′	23.0	12:06	10/09/08
Telemetry toroid	53° 27.070′	3° 38.635′	23.0	15:37	10/09/08
ADCP (Site B)	53° 27.118′	3° 38.604′	24.3	14:54	10/09/08
SmartBuoy (Site B)	53° 26.889′	3° 38.730′	28.0	09:01	11/09/08
WaveBuoy (Hilbre Channel)	53° 23.624′	3° 14.168′	10.0	15:18	11/09/08

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

Site A

a) Waves ADCP 600 kHz RDI 5803

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.

Clock reset at 15:47:00 on 9 September 2008.

Logging set to start at 17:00 on 9 September 2008.

Sea-Bird 16plus S/N 5309 (RS232) on base of frame with pumped conductivity sensor underneath. Sample interval 600s. SeaPoint turbidity sensor (S/N 10471) 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. Aanderaa optode S/N 674. Clock reset at 15:08 on 9 September 2008. Logging set to start at 08:00 on 10 September 2008.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger G527; head A983.

Distance from center of three prong head on ADV transmitter to deck was 1.390m (i.e. above sea bed). Red prong aligned to ADCP beam 3. Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s. Time reset to 17:18:00 on 9 September 2008, logging set to start at 08:00:00 on 10 September 2008.

The frame was fitted with a fizz link, a spooler with 50m of rope for recovery of the ballast weight and two Benthos releases s/n 71922 (Rx 11.5 kHz, Tx 12.0 kHz, release A) and s/n 72858 (Rx 14.5 kHz, Tx 12.0 kHz, release A).

b) SmartBuoy Mooring.

Sea-Bird MicroCat temperature, conductivity and pressure recorder s/n 5795 at 5m below the surface. Sample interval 600s.

Clock reset to 17:48:00 on 9 September 2008.

Sea-Bird MicroCat temperature and conductivity recorder s/n 5792 at 10m below the surface. Sample interval 600s.

Clock reset to 17:36 on 9 September 2008.

Mini-logger (Star ODi) s/n 2842 at 7.5 m below the surface set to record at 600s intervals. Set to start sampling at 08:00 on 10 September 2008.

Mini-logger (Star ODi) s/n 2843 at 15 m below the surface set to record at 600s intervals. Set to start sampling at 08:00 on 10 September 2008.

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 frame was fitted with bags of material supplied by University of Liverpool for the determination of bacterial degradation.

The single point mooring was composed 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
a) Waves ADCP 600 kHz RDI 3644
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.
Clock reset to 16:24:00 on 9 September 2008.
Set to start at 09:00:00 logging on 9 September 2008

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). 1 Gb memory.
Earth co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Clock reset at 16:29:00 on 9 September 2008; delayed start 17:00:00 on 9 September 2008.
LinkQuest acoustic modem set for transmission of ADCP data every hour.

Sea-Bird 16plus S/N 5310 on base of frame with pumped conductivity sensor underneath. Sample interval 600s. SeaPoint turbidity sensor (S/N 10320) taped to roll bar; set up for **0 - 500 FTU range**. Sample interval 600 s; digiquartz integration time 40 s, range 400; pump 0.5s, 1 s delay. Clock reset at 15:25 on 9 September 2008.

The frame was fitted with a fizz link, a spooler with 50m of rope for recovery of the ballast weight and two Benthos releases s/n 70355 (Rx 10.0 kHz, Tx 12.0 kHz, release B) and s/n 72382 (Rx 10.0 kHz, Tx 12.0 kHz, release A).

b) Telemetry buoy with ACS and SeaBird Microcat
This was not deployed, because one of the telemetry mounting holes had snapped off the recovered buoy during the previous deployment.

c) SmartBuoy Mooring.

Sea-Bird MicroCat temperature, conductivity recorder s/n 5791 (RS 232) at 5 m below the surface. Sample interval 600s. Clock reset to 17:59 on 9 September 2008. Logging set to start 08:00:00 on 10 September 2008.

Sea-Bird MicroCat temperature, conductivity recorder s/n 5433 (RS 232) at 10 m below the surface. Sample interval 600s. Clock reset to 18:07 on 9 September 2008. Logging set to start 08:00:00 on 10 September 2008.

Mini-logger (Star ODi) s/n 2847 at 7.5 m below the surface set to record at 600s intervals. Set to start sampling at 08:00 on 10 September 2008.

Mini-logger (Star ODi) s/n 2849 at 15 m below the surface set to record at 600s intervals. Set to start sampling at 08:00 on 10 September 2008.

The CEFAS SmartBuoy is fitted with a surface CTD (including turbidity sensor and fluorometer). The frame was fitted with bags for the determination of bacterial degradation. 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	Date
ADCP frame (Site A)	53º 32.106′	3º 21.564′	23.1	11:22	10/09/08
SmartBuoy (Site A)	53º 32.088′	3º 21.629′	22.7	11:55	10/09/08
ADCP frame (Site B)	53º 27.014′	3º 38.603′	24.6	16:27	10/09/08
SmartBuoy (Site B)	53º 26.889′	3º 38.639′	26.8	17:23	10/09/08

5. CTD

A Sea-Bird SBE 19-03 CTD (600m rated) was used, because of a fault with the standard Sea-Bird 911 CTD. The Sea-Bird 19 recorded internally and no external monitoring was available. Only one 0.7 litre water bottle was used which was attached to the wire. Two dips were required to obtain surface and bottom water samples. The water bottle lids were shut using a brass messenger which was free dropped down the CTD wire. The messenger was lost after the first CTD and temporary weights had to be used.

Table 3. Nominal CTD positions. (Ss – Suspended sediments, Nu – Nutrients)

Site	Latitude (N)	Longitude (W)	Visited on this cruise	Cefas Chloropyll & Nu	POL Nu	POL Ss	Grab No.
1	53º 32′	3º 21.8′	yes	yes+bottom	yes	yes	1
2	53º 37′	3º 13.4′					
3	53º 42′	3º 13.4′					
4	53º 47′	3º 13.4′					
5	53º 52′	3º 21.8′					
6	53º 47′	3º 21.8′					
7	53º 42′	3º 21.8′					
8	53º 37′	3º 21.8′					
9	53º 32′	3º 21.8′					
10	53º 27′	3º 13.4′					
11	53º 27′	3º 21.8′					
12	53º 27′	3º 30.2′					
13	53º 32′	3º 30.2′					
14	53º 37′	3º 30.2′					
15	53º 42′	3º 30.2′					
16	53º 47′	3º 30.2′					
17	53º 47′	3º 47.0′					
18	53º 42′	3º 38.6′					
19	53º 37′	3º 38.6′					
20	53º 32′	3º 38.6′					
21	53º 27′	3º 38.6′	yes	yes	yes	yes	2
22	53º 23′	3º 38.6′					
23	53º 23′	3º 47.0′					
24	53º 27′	3º 47.0′					

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

Surface water samples were obtained for Elena Stoica at sites 1 (CTD No.2-4), 21(CTD No.1) and 29 (CTD No.5).

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, Transmissance, Hull Temperature (ºC), Barometric Pressure (mbar), Fluorescence, Turbidity, Salinity, Conductivity sensor water temperature (ºC). Sea surface temperature, salinity and transmittance were calibrated against the CTD by BODC. In addition a pCO_2 sensor is incorporated into the surface sampling system.

Met package measures and records Barometric pressure (mbar), Solar Radiation (W m-2), PAR (µmols / m2s), Air Temperature (ºC), Relative Humidity, Relative Wind Speed (m s-1), Relative Wind Direction (º) – zero indicates wind on the bow, Minimum Air Temp (ºC), Maximum Air Temp (ºC), Wind Gust (m s-1). **** Wind spd/dir not working ****

Underway data, pCO_2 and ships ADCP data were recorded every minute. 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.   The systems were switched on at 07:00 on 10 September 2008 on passing Puffin Island. The ADCP, underway and pCO_2 systems were switched off at 19:32 on 10 September 2008 on passing Puffin Island. The systems were again switched on at 07:19 on 11 September 2008 on passing Puffin Island. The ADCP, underway and pCO_2 systems were finally switched off at 22:00 on 11 September 2008 on passing Puffin Island.

Acknowledgements
The assistance of the master, officers, and crew is appreciated in ensuring the success of this cruise.