

Prince Madog cruise 09/08
POL Coastal Observatory cruise 52
16-17 April 2008

1. Objectives

Coastal Observatory

1. At 53° 32' N 3° 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, a SeaPoint turbidity sensor and Aanderaa optode was fitted to the frame. The frame was fitted with a SonTek ADV.

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) 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, a SeaPoint turbidity sensor and Aanderaa optode was fitted to the frame. The frame was also fitted with a SonTek ADV.

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.

2. At 53° 27' N 3° 38.6' W (site 21, second site, B)

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

b) 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. (Miniloggers at fitted)

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, a SeaPoint turbidity sensor were fitted to the frame. A 1200 kHz telemetry ADCP was fitted to the frame.

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.

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. Collect sediment samples at each of the CTD sites.
6. Collect water samples from one of the outer CTD stations

2.1 Scientific personnel

Phil Knight (Principal Scientist)
Chris Balfour
John Kenny
Ray Edun
Terry Doyle
Emmer Litt (SOS Bangor & PML)
Katherine Nisbet (LU)
Matt Brown (CEFAS)
Naomi Greenwood (CEFAS)
Anne Hammerstein (School of Ocean Sciences)

2.2 Ship's officers and crew

Eric Lloyd (Master)
Nick Davies (Chief Officer)
Arfon Williams (Chief Engineer)
Andy Westmore (Second Engineer)
Tommy Roberts (Bosun)
Mick Callaghan
Hefin Griffiths
Efin Pritchard (Cook)

3. Narrative (times in GMT)

The anchor chain clumps, two sea-bed frames and instrumentation were loaded onto RV Prince Madog, on the morning of 15 April 2008. The ADCP frames were set up on the afterdeck by POL engineers and the tower and instruments fitted to the SmartBuoy toroid by CEFAS personnel. The new sediment grab was successfully tested whilst next to the berth. The lids closed and brought up plenty of sediment.

Prince Madog left Menai Bridge at 06:00 on 16 April 2008. Conditions were fair with winds of Force 4 from the SE and wave heights minimal. The ship's underway pCO₂, surface monitoring and ADCP were switched on between 06:42-06:45. Due to a poor weather forecast for the following day the plan was changed to carry out all moorings work on the first day.

We arrived at site A at 09:26 on the 16 April 2008 at carried out and a CTD recorded. The following CTD bottle numbers were used for water samples: (1st CTD: 3 for salinity, 4-bottom, 9-top for SPM and 9-Bottom, 10-top for Cefas. FURTHER CTDs: 3 for salinity, 4-bottom, 9-top for SPM and 10-top, 11-bottom for Cefas). The ADCP release was fired at 09:40, however the frame did not surface. After a few more attempts we decided to leave it while we serviced the SmartBuoy. The replacement SmartBuoy was deployed at 10:33 and the old buoy recovered between 10:42 and 10:51. At 2:20 we began to drag for ADCP with a wire loop. After about 10 drags over the mooring position we hooked the frame. It surfaced on the end of the wire at 12:50. The ADCP and its ballast weight were on deck by 12:58. The replacement ADCP was then deployed at site A at 13:21. A second CTD was recorded at 13:32. This was followed by a Benthos survey (For Biological department, LU); Five grabs were carried out and samples filtered. Some sediment from the first grab was also bagged and labelled Grab Sample 1 (For Geography, LU).

At site B (site 21) the ADCP at site 21 was recovered between 15:48 and 16:05. The replacement ADCP was deployed at 16:27. A CTD was then recorded. The replacement SmartBuoy was redeployed at 16:51 and the old SmartBuoy recovered between 17:14 and 17:22. Another CTD was recorded at site 21.

The CTD survey was then started, visiting stations 12, 11, 10, 35, 2, 3, 4, 5, 6, 7, 8, 13, 20, 24, 32 (Water samples taken for Earth Sciences), 33 and 34. SPM, nutrient and grab samples were attempted (See Tables 3-4 for success rates). A large barge was located at site 22 and therefore a CTD was not recorded. Ten vertical net hauls were carried out during the night at mooring site A. Another Benthos survey was carried out at site B. Five sediment grabs were taken and sifted to remove sediment, and the remainder (biological samples) stored.

The wind became stronger (from the E, Force 6-7, with moderate swell) and made CTD's and sediment grabs difficult at the outer sites. The ship's underway pCO₂, surface monitoring and ADCP were switched off between 17:10-17:19 on 17 April 2008. All the major moorings objectives were accomplished. However, CTD sites were missed out due to increasingly poor weather conditions.

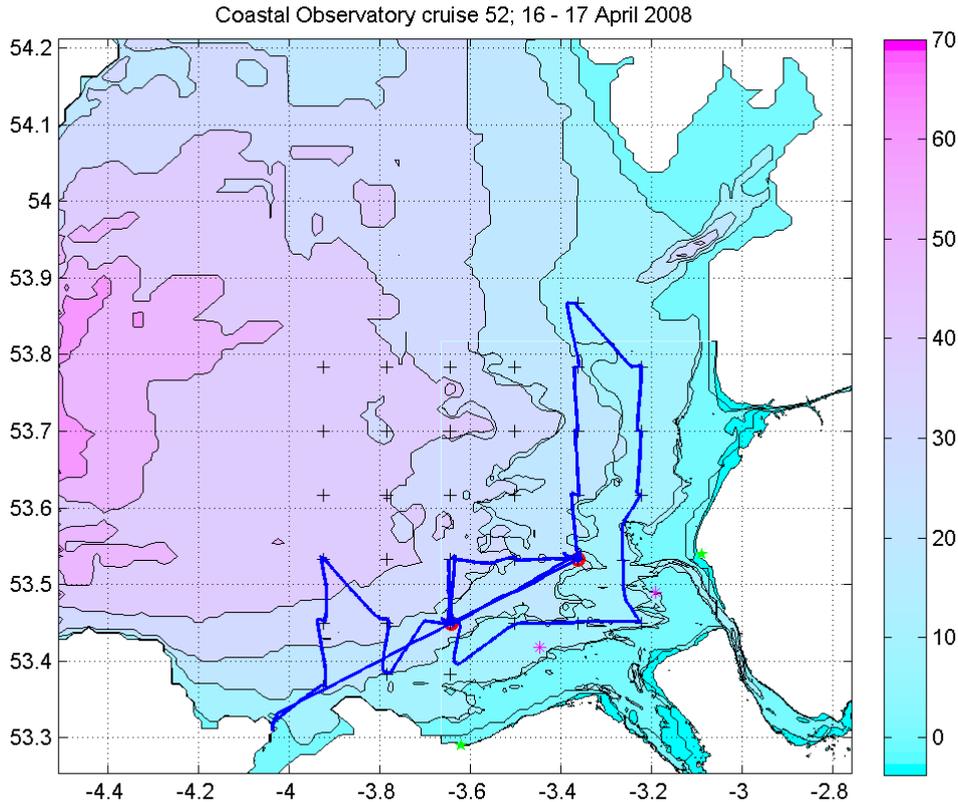


Figure 1. Cruise track.

4. Moorings (times in GMT)

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

Site A

a) 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). 1Gb memory.

Beam co-ordinates - speeds, correlation, echo intensity, % good.

Sound velocity calculated from temperature, depth and salinity of 32.

Clock set at 16:21:20 on 10 March 2008; delayed start 06:00:00 on 11 March 2008.

Break issued; no response. Probably run out of battery power.

Sea-Bird 16plus S/N 5309 (RS232) on base of frame with pumped conductivity sensor underneath. Sample interval 600s. Attached Aanderaa Optode 675

SeaPoint turbidity sensor 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.

Clock set at 15:44:00 on 10 March 2008; delayed start at 06:00:00 on 11 March 2008.

Stopped at 20:41 on 16 April 2008. Clock drift = GMT+2s.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger G250; head B252.

Distance from center of three prong head on ADV transmitter to deck was 1.195m (i.e. above sea bed). Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length

1200s. Time reset to 10:00:00 on 14 March 2008, logging set to start at 11:00:00 on 14 March 2008. Break issued at 22:59 on 16 April 2008. Clock = GMT+17s at 23:00 on 16 April 2008.

The frame was fitted with two Benthos releases s/n 70355 – Rx 10.0 kHz, Tx 12.0 kHz, release B and s/n 72858 – Rx 14.5 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.

b) SmartBuoy Mooring.

Sea-Bird MicroCat temperature, conductivity and pressure recorder s/n 5790 at 5m below the surface. Sample interval 600s.

No note in log book for date/times for clock reset and delayed start.

Clock drift = GMT +8s at 15:35 on 16 April 2008. Stopped at 15:36 on 16 April 2008.

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

Clock set at 16:10 on 10 March 2008. Delayed start 06:00 11 March 2008.

Clock = GMT+45s at 15:20 on 16 April 2008. Stopped logging at 15:22 on 16 April 2008.

Mini-logger s/n 6023 at 7.5 m below the surface set to record at 600s intervals. Delayed start at 08:00:00 on 13 March 2008. No stop time recorded in log book.

Mini-logger s/n 6027 at 15 m below the surface set to record at 600s intervals. Delayed start at 08:00:00 13 March 2008. No stop time recorded in log book.

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 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.

Site B

a) Waves ADCP 600 kHz RDI 5803

(Note: This was on previous cruise and was re-deployed due to a shortage of other ADCPs)

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). 1 Gb memory.

Beam co-ordinates - speeds, correlation, echo intensity, % good.

Sound velocity calculated from temperature, depth and salinity of 32.

Clock set at 13:28:50 on 14 March 2008; delayed start 14:00:00 on 14 March 2008.

Break issued at 18:42 on 17 April 2008. Clock drift = GMT+54s.

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 16:41:00 on 10 March; delayed start 06:00:00 on 13 March 2008.
 LinkQuest acoustic modem set for transmission of ADCP data every hour.
 Break issued at 18:34:00 on 17 April 2008. Clock drift = GMT – 15s.

Sea-Bird 16plus S/N 5310 (RS232) on base of frame with pumped conductivity sensor underneath. Sample interval 600s. SeaPoint turbidity sensor 10320 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 15:35:00 on 10 March 2008; delayed start at 06:00:00 on 11 March 2008. Logging stopped at 18:23 on 17 April 2008, clock drift = GMT+5s.

The frame was fitted with two Benthos releases s/n 72382 – Rx 10.0 kHz, Tx 12.0 kHz, release A and s/n 71922 – Rx 11.5 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.

b) SmartBuoy mooring.

Sea-Bird MicroCat temperature, conductivity recorder s/n 5791 at 5 m below the surface. Sample interval 600s.

Clock set at 16:07:20 on 10 March 2008. Delayed start 06:00:00 on 11 March 2008.
 Clock drift = GMT +4s at 18:09 on 16 April 2008. Stopped at 18:10 on 16 April 2008.

Sea-Bird MicroCat temperature, conductivity recorder s/n 5793 at 10 m below the surface. Sample interval 600s.

Clock set at 16:03:30 on 10 March 2008. Delayed start 06:00:00 on 11 March 2008.
 Clock drift = GMT +12s at 18:28 on 16 April 2008. Stopped at 18:29 on 16 April 2008.

Mini-logger **NOT FITTED** at 7.5 m below the surface set to record at 600s intervals.

Mini-logger **NOT FITTED** at 15 m below the surface set to record at 600s intervals.

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.

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.

| | <u>Latitude</u> (N) | <u>Longitude</u> (W) | <u>Water</u> <u>Depth (m)</u> | <u>Recovered</u> <u>Time</u> | <u>Date</u> |
|---------------------|------------------------|-------------------------|----------------------------------|---------------------------------|-------------|
| ADCP (Site A) | 53° 32.024′ | 3° 21.414′ | 20.1 | 12:50 | 16/4/2008 |
| SmartBuoy (Site A) | 53° 32.017′ | 3° 21.491′ | 20.3 | 10:42 | 16/4/2008 |
| ADCP (Site B) | 53° 26.970′ | 3° 38.526′ | 25.3 | 15:48 | 16/4/2008 |
| Smart Buoy (Site B) | 53° 26.896′ | 3° 38.313′ | 22.0 | 17:14 | 16/4/2008 |

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

Site A

a) ADCP 600 kHz RDI 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). 1Gb memory.

Beam co-ordinates - speeds, correlation, echo intensity, % good.

Sound velocity calculated from temperature, depth and salinity of 32.

Clock set at 10:17:30 on 15 April 2008; delayed start 06:00:00 on 16 April 2008.

Sea-Bird 16plus S/N 4848 (RS232) on base of frame with pumped conductivity sensor underneath. Sample interval 600s. Attached Aanderaa Optode 674.

SeaPoint turbidity sensor 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.

Clock set at 09:30:40 on 15 April 2008; delayed start at 06:00:00 on 16 April 2008.

SonTek ADV (Acoustic Doppler Velocimeter); ADV Logger G479; head A984.

Distance from center of three prong head on ADV transmitter to deck was 1.23m (i.e. above sea bed). Sample rate 16Hz; burst interval 3600s; samples in each burst 19200; burst length 1200s. Clock set at 11:37:00 on 15 April 2008; delayed start 06:00:00 on 16 April 2008.

The frame was fitted with 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 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 s/n 2010 at 5m below the surface. Sample interval 600s.

Clock set at 11:04:00 on 15 April 2008. Delayed start 06:00:00 on 16 April 2008.

Sea-Bird MicroCat temperature and conductivity recorder s/n 2506 at 10m below the surface. Sample interval 600s.

Clock set time not noted. Delayed start 06:00 16 April 2008.

Mini-logger s/n 6020 at 7.5 m below the surface set to record at 600s intervals. Clock set at 11:57:40 on 15 April 2008. Delayed start at 06:00:00 on 16 April 2008.

Mini-logger s/n 0142 at 15 m below the surface set to record at 600s intervals. Clock set at 11:55:11 on 15 April 2008. Delayed start at 06:00:00 16 April 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 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.

Site B

b) 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). 1 Gb memory.
Beam co-ordinates - speeds, correlation, echo intensity, % good.
Sound velocity calculated from temperature, depth and salinity of 32.
Clock set at 10:08:00 on 15 April 2008; delayed start 06:00:00 on 16 April 2008.

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 10:21:00 on 15 April 2008; delayed start 15:50:00 on 15 April 2008.
LinkQuest acoustic modem set for transmission of ADCP data every hour.

Sea-Bird 16plus S/N 4596 (RS485) on base of frame with pumped conductivity sensor underneath. Sample interval 600s. SeaPoint turbidity sensor 10538 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 11:50:00 on 15 April 2008; delayed start at 06:00:00 on 16 April 2008.

The frame was fitted with two Benthos releases s/n 70356 – Rx 10.5 kHz, Tx 12.0 kHz, release D and s/n 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.

b) SmartBuoy mooring.

Sea-Bird MicroCat temperature, conductivity recorder s/n 2991 at 5 m below the surface.
Sample interval 600s.
Clock set at 12:03:00 on 15 April 2008. Delayed start 06:00:00 on 16 April 2008.

Sea-Bird MicroCat temperature, conductivity recorder s/n 4966 at 10 m below the surface.
Sample interval 600s.
Clock set at 10:39:00 on 15 April 2008. Delayed start 06:00:00 on 16 April 2008.

Mini-logger s/n 6024 at 7.5 m below the surface set to record at 600s intervals. Clock set at 11:53:10 on 15 April 2008. Delayed start at 06:00:00 on 16 April 2008.

Mini-logger s/n 6028 at 15 m below the surface set to record at 600s intervals. . Clock set at 12:00:00 on 15 April 2008. Delayed start at 06:00:00 on 16 April 2008.

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.

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.

| <u>Latitude</u> | <u>Longitude</u> | <u>Water</u> | <u>Deployed</u> |
|-----------------|------------------|--------------|-----------------|
|-----------------|------------------|--------------|-----------------|

| | <u>(N)</u> | <u>(W)</u> | <u>Depth (m)</u> | <u>Time</u> | <u>Date</u> |
|---------------------|-------------|------------|------------------|-------------|-------------|
| ADCP (Site A) | 53° 32.082′ | 3° 21.527′ | 21.5 | 13:21 | 16/4/2008 |
| SmartBuoy (Site A) | 53° 32.017′ | 3° 21.722′ | 20.3 | 10:33 | 16/4/2008 |
| ADCP (Site B) | 53° 26.965′ | 3° 38.488′ | 23.4 | 16:27 | 16/4/2008 |
| Smart Buoy (Site B) | 53° 26.791′ | 3° 38.236′ | 23.1 | 16:53 | 16/4/2008 |

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 that allows for measurements to be taken down to 0.5m above the bed. The rosette will take twelve 10l water bottles although the capacity is reduced by one (for the LISST-25). One/two water bottles were fired near bed and one/two/three near the surface, when needed. The CTD temperature data was checked against a Sea-Bird SBE35 precision thermometer. Water samples were taken from a near bed bottle for calibration of the CTD salinity data. 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 bottom samples at station 1 were taken for oxygen analysis). A LISST-100C 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. A LISST-25 particle sizer was fitted to the CTD and its data logged on the Sea-Bird data logging system.

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

| <u>Site</u> | <u>Latitude</u> (N) | <u>Longitude</u> (W) | <u>Visited</u> <u>on this</u> <u>cruise*</u> | <u>Cefas</u> Chlorophyll & Nu & Ss | <u>POL</u> Nu | <u>POL</u> Ss | <u>Grab</u> No. |
|-------------|------------------------|-------------------------|--|--|------------------|------------------|--------------------|
| 1 | 53° 32′ | 3° 21.8′ | yes | yes+bottom | no | yes | 1 |
| 2 | 53° 37′ | 3° 13.4′ | yes | | yes | yes | 6 |
| 3 | 53° 42′ | 3° 13.4′ | yes | | yes | yes | 7 |
| 4 | 53° 47′ | 3° 13.4′ | yes | | yes | yes | 8 |
| 5 | 53° 52′ | 3° 21.8′ | yes | | yes | yes | 9 |
| 6 | 53° 47′ | 3° 21.8′ | yes | | | | |
| 7 | 53° 42′ | 3° 21.8′ | yes | | | | |
| 8 | 53° 37′ | 3° 21.8′ | yes | | yes | yes | 10 |
| 9 | 53° 32′ | 3° 21.8′ | yes | | | | |
| 10 | 53° 27′ | 3° 13.4′ | yes | yes | yes | yes | 4 |
| 11 | 53° 27′ | 3° 21.8′ | yes | yes | yes | yes | 3 |
| 12 | 53° 27′ | 3° 30.2′ | yes | yes | yes | yes | 2 |
| 13 | 53° 32′ | 3° 30.2′ | yes | | | | |

| | | | | | | | | |
|----|---------|----------|-----|-----|-----|-----|--|----|
| 14 | 53° 37' | 3° 30.2' | no | | | | | |
| 15 | 53° 42' | 3° 30.2' | no | | | | | |
| 16 | 53° 47' | 3° 30.2' | no | | | | | |
| 17 | 53° 47' | 3° 47.0' | no | | | | | |
| 18 | 53° 42' | 3° 38.6' | no | | | | | |
| 19 | 53° 37' | 3° 38.6' | no | | | | | |
| 20 | 53° 32' | 3° 38.6' | yes | | yes | yes | | |
| 21 | 53° 27' | 3° 38.6' | yes | yes | yes | yes | | |
| 22 | 53° 23' | 3° 38.6' | no | | | | | |
| 23 | 53° 23' | 3° 47.0' | yes | | | | | |
| 24 | 53° 27' | 3° 47.0' | yes | yes | yes | yes | | 11 |
| 25 | 53° 32' | 3° 47.0' | no | | | | | |
| 26 | 53° 37' | 3° 47.0' | no | | | | | |
| 27 | 53° 42' | 3° 47.0' | no | | | | | |
| 28 | 53° 47' | 3° 47.0' | no | | | | | |
| 29 | 53° 47' | 3° 55.4' | no | | | | | |
| 30 | 53° 42' | 3° 55.4' | no | | | | | |
| 31 | 53° 37' | 3° 55.4' | no | | | | | |
| 32 | 53° 32' | 3° 55.4' | yes | | | | | |
| 33 | 53° 27' | 3° 55.4' | yes | yes | yes | yes | | 12 |
| 34 | 53° 22' | 3° 55.4' | yes | yes | yes | yes | | 13 |
| 35 | 53° 32' | 3° 15.9' | yes | | yes | yes | | 5 |

* Aborted CTD's and sediment grabs with show up as *Site visited/No samples noted*

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

| <u>CTD</u> <u>no</u> | <u>Nutrients*</u> | | <u>Water</u> <u>depth</u> <u>(m)</u> | <u>Temp</u> S / B | <u>Salinity</u> S / B |
|-------------------------|-------------------|---------|--|--------------------------|------------------------------|
| | Surface/ | Bottom | | | |
| 3 | 52_21_S / | 52_21_B | 23 | 8.1 / 7.8 | 32.2 / 32.6 |
| 5 | 52_12_S / | 52_12_B | 20 | 7.9 / 7.9 | 32.2 / 32.2 |
| 6 | 52_11_S / | 52_11_B | 21 | 7.9 / 7.9 | 31.9 / 32.0 |
| 7 | 52_10_S / | 52_10_B | 19 | 8.3 / 7.9 | 30.5 / 31.4 |
| 8 | 52_35_S / | 52_35_B | 15 | 8.3 / 7.9 | 30.9 / 31.5 |
| 9 | 52_2_S / | 52_2_B | 16 | 8.4 / 8.0 | 30.5 / 31.4 |
| 10 | 52_3_S / | 52_3_B | 20 | 8.1 / 7.9 | 31.5 / 31.7 |
| 11 | 52_4_S / | 52_4_B | 19 | 8.1 / 8.1 | 31.8 / 31.8 |
| 12 | 52_5_S / | 52_5_B | 16 | 8.1 / 8.1 | 32.0 / 32.0 |
| 13 | 52_8_S / | 52_8_B | 25 | 7.9 / 7.7 | 31.3 / 32.3 |
| 14 | 52_20_S / | 52_20_B | 37 | 7.7 / 7.9 | 32.8 / 33.2 |
| 15 | 52_24_S / | 52_24_B | 33 | 7.9/7.9 | 32.8 /33.1 |
| 16 | 52_33_S / | 52_33_B | 33 | 8.0 / 8.0 | 32.9 / 33.4 |
| 17 | 52_34_S / | 52_34_B | 22 | 8.2 / 8.1 | 32.1 / 32.3 |

* e.g. File names made from Cruise 52, Station 34, S for surface, B for bottom e.g. 52_34_S.

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 ($\mu\text{mols / m}^2\text{s}$), Air Temperature ($^{\circ}\text{C}$), Relative Humidity (not currently operational), Relative Wind Speed (m s^{-1}), Relative Wind Direction ($^{\circ}$) – zero indicates wind on the bow, Transmittance, Hull Temperature ($^{\circ}\text{C}$), Barometric Pressure (mbar), Fluorescence, Turbidity, Salinity, Minimum Air Temp ($^{\circ}\text{C}$), Maximum Air Temp ($^{\circ}\text{C}$), Wind Gust (m s^{-1}), GPS Time, Latitude, Longitude, Barometric Pressure Minimum (mbar), Barometric Pressure Maximum (mbar), Conductivity sensor water temperature ($^{\circ}\text{C}$). Sea surface temperature, salinity and transmittance were calibrated against the CTD by BODC. In addition a pCO_2 sensor was incorporated into the surface sampling system.

A sonic anemometer was fitted. The transmittance, fluorescence and turbidity were all recorded as voltages.

Underway (including navigation) data, pCO_2 and ships ADCP data were recorded every minute starting and ending at Puffin Island:

- Underway from 06:42 on 16 April 2008 until 17:10 on 17 April 2008
- pCO_2 from 06:42 on 16 April 2008 until 17:19 on 17 April 2008
- ADCP from 06:45 on 16 April 2008 until 17:10 on 17 April 2008

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.

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