Liverpool Bay Observatory cruise 80 [11/07]

Dates: 8th–10th November 2011
Ship: R.V. Marisa (Liverpool Univ. Research Vessel)
Principal Scientist (days 1& 2): Matthew Palmer (NOC)
Principal Scientist (day 3): Andy Lane (NOC)

The science driver for the Liverpool Bay Observatory is '*to monitor and understand the impacts of natural and anthropogenic forcing of a shelf sea, and to provide a framework for research into the functioning of a shelf-sea in a changing climate*'.

Started in 2002, the Observatory integrates (near) real-time measurements with coupled models into a pre-operational coastal prediction system, results of which are displayed online at http://cobs.pol.ac.uk/ . Further details about the Observatory may be found on this website.

1. Cruise and scientific objectives

1.1 Mooring deployment and recovery (*days 1 & 2*)

Two moorings are maintained at the Mersey Bar Station (MBS) marked in Figure 1. Instruments are mounted in a sea bed frame, and at 5 m below a spar buoy and along its mooring chain. Maintaining a long time series of observations will ultimately facilitate the determination of natural and anthropogenic variability within Liverpool Bay. The primary aim of the cruise is to recover and redeploy this instrumentation.

Mersey Bar Station, 53° 32' N, 3° 21.8' W (*MBS*, *formerly Site A*)
To recover:

a) A sea bed frame containing a 600 kHz RDI ADCP (acoustic Doppler current profiler, measuring mean current profile, pressures and directional waves), SeaBird SBE 16*plus* (with pumped conductivity sensor), Digiquartz pressure sensor, a SeaPoint turbidity sensor with wiper and SeaBird SBE 16*plus* with an Aanderaa oxygen Optode.

b) Spar buoy single point mooring with a frame attached at 5 m below the surface containing a WET Labs ac-s unit (measuring spectra of absorption and attenuation), WET Labs Triplet (including fluorescence, backscatter and CDOM sensors) and SeaBird MicroCAT. Temperature mini-loggers are attached to the mooring wire at 7.5 m below the surface, with a SeaBird MicroCAT temperature and conductivity logger at 10 m below the surface.

To deploy:

c) A sea bed frame containing a 600 kHz RDI ADCP (measuring mean current profile, pressures and directional waves), SeaBird SBE 16*plus* (with pumped conductivity sensor), Digiquartz pressure sensor, a SeaPoint turbidity sensor with wiper and SeaBird SBE 16*plus* with an Aanderaa oxygen Optode.

d) Spar buoy single point mooring with a frame attached at 5 m below the surface containing a WET Labs ac-s unit (measuring spectra of absorption and attenuation), WET Labs Triplet (including fluorescence, backscatter and CDOM sensors), and SeaBird MicroCAT. Temperature mini-loggers

are attached to the mooring wire at 7.5 m and 15 m below the surface, with a SeaBird MicroCAT temperature and conductivity logger at 10 m below the surface.

1.2 CTD survey at the mouth of the River Mersey (*days 1 & 2*)

The second cruise objective is to undertake conductivity, temperature and depth (CTD) profiles at a number of stations surrounding the mooring site and along the mouth of the River Mersey. In addition to a SeaBird CTD, the CTD's frame also included three Niskin bottles with firing at pre-programmed depths, a WET Labs ac-s instrument with Triplet and a DH4 logger. Water samples were obtained in Niskin bottles for determining concentrations of: suspended particulate matter (SPM), chlorophyll-*a* and chromophoric or coloured dissolved organic matter (CDOM) and nutrients near the sea bed (or 20 m), and near-surface (2 m).

Nutrients are essential for phytoplankton growth; therefore, understanding the magnitude and changes in sources and inputs of nutrients into Liverpool Bay gives us some understanding of the maximum potential phytoplankton growth in the region and thus potential for carbon sequestration. In addition, monitoring nutrient levels over the long term in Liverpool Bay may provide an early indicator of the risk of eutrophication in this region heavily influenced by river-inputs.

Water samples were taken at each site for determining concentrations of SPM as part of a long term Observatory requirement for total, inorganic and organic suspended sediment concentrations. The data are also required for marine optics, and for comparisons of absorption and scattering with the ac-s instrument. Chlorophyll-*a* and CDOM samples are taken as part of the marine optics study.

Discrete samples for the determination of nutrients and salinity also provide calibration points for the CTD and moored sensors.

1.3 CTD and LISST six-hour station with ac-s (*day 3*)

An additional objective is to complete a six-hour station of half-hourly CTD profiles. Water samples were obtained during on-the-hour profiles for determining concentrations of: suspended particulate matter (SPM), chlorophyll-*a*, CDOM and nutrients near the sea bed (or 20 m), 10 m below the sea surface, and near-surface (2 m).

2. Cruise narrative

(All times are in GMT throughout this report)

Note that there is no Milli-Q system on board, so all deionised water needed (40 litres) has to be brought from the laboratory on each day.

Tuesday, 8th November 2011

A bedframe, CTD and other equipment were loaded on the R.V. Marisa at Bramley Moore Dock. There were six scientists and two crew members on board. Departing at 08:30, Marisa entered Langton Lock at 09:55 and into the River Mersey at 10:25 (1 hour after HW). Conditions were slight to moderate with winds of 15 knots (force 4) from E (the forecast was for increasing wind speeds from E to SE). The flow-through system was not available because of technical problems.

At the Mersey Bar Station (11:30), a pre-recovery CTD profile was conducted at 12:03; unfortunately the Niskin bottles did not fire. A second successful CTD profile was taken at 12:30, after which the ADCP bedframe was deployed at 12:47.

Recovery of the old bedframe began at 13:05 with the sending of an acoustic release signal. The frame was seen at the sea surface at 13:09 and recovered on deck at 13:31, having collided a few times with ship's A-frame. The ballast frame was lost as the spool line had rubbed on the ship's side and detached.

CTD profiles and water samples were collected at near bed and near surface for nutrient analysis and for determining concentrations of: SPM, chlorophyll and CDOM. Starting at 13:49 with station S, this was followed by station N, then stations W, MBS, E1, E2, E3, and finally station E4 at 16:19 (approx. LW). As the time between stations was short, water samples were stored in HDPE (high-density polyethylene) containers (kept in the dark) while waiting for previous samples to finish filtering.

Marisa returned to Bramley Moore Dock, arriving at approximately 18:30.

Wednesday, 9th November

There were two additional scientists on this voyage. The wind speed was 18 knots (force 5) and 0.9 m waves were recorded at the Mersey Bar.

The spar buoy and additional scientific supplies were loaded. Marisa departed from Bramley Moore Dock at 09:30, entered the River Mersey at 10:30 from Langton Lock (½ hour after HW), and arrived at MBS at 11:31 via the Rock Channel.

Deployment of the spar buoy started at 11:36 in a moderate/ rough sea state, with the anchor clump dropped at 11:46. The previous spar buoy was not recovered because of the poor conditions (it was subsequently recovered at 10:30 on Tuesday 22nd November). The post-deployment CTD profile series starting at station S was not carried out. However, at the additional station E2(A), a CTD profile with water samples was taken at 12:54. Worsening conditions prompted the early end of activities at 13:53. Marisa headed back to Langton Lock, arriving at 14:45.

Thursday, 10th November

A six-hour CTD and ac-s station was planned at MBS during daylight hours. While at the quayside, a baseline check of the ac-s using Milli-Q water (at 13.6°C) was performed (08:20).

Marisa set out with four scientists on board, arriving at Langton Lock at 08:35. In the River Mersey at 09:12 (approx. 1 hr before HW), the journey to the Mersey Bar was again via the Rock Channel. In contrast to the previous two days, the weather was calm and sunny, while the sea state was slight.

Arriving at 10:14, the first half-hourly CTD and ac-s profile started at 10:25. Water samples were collected on the on-the-hour profiles near the bed, at 10 m from the surface and near the surface. These were for nutrient analysis and for determining concentrations of: SPM, chlorophyll and CDOM. A further set of filters were taken for obtaining spectra of particle absorption. The final profile was at 16:59, and the anchor station finished at 17:20 (LW).

The ship returned to Langton Lock at 18:31, only to have to wait for another vessel; mooring at Bramley Moore Dock at 20:00.

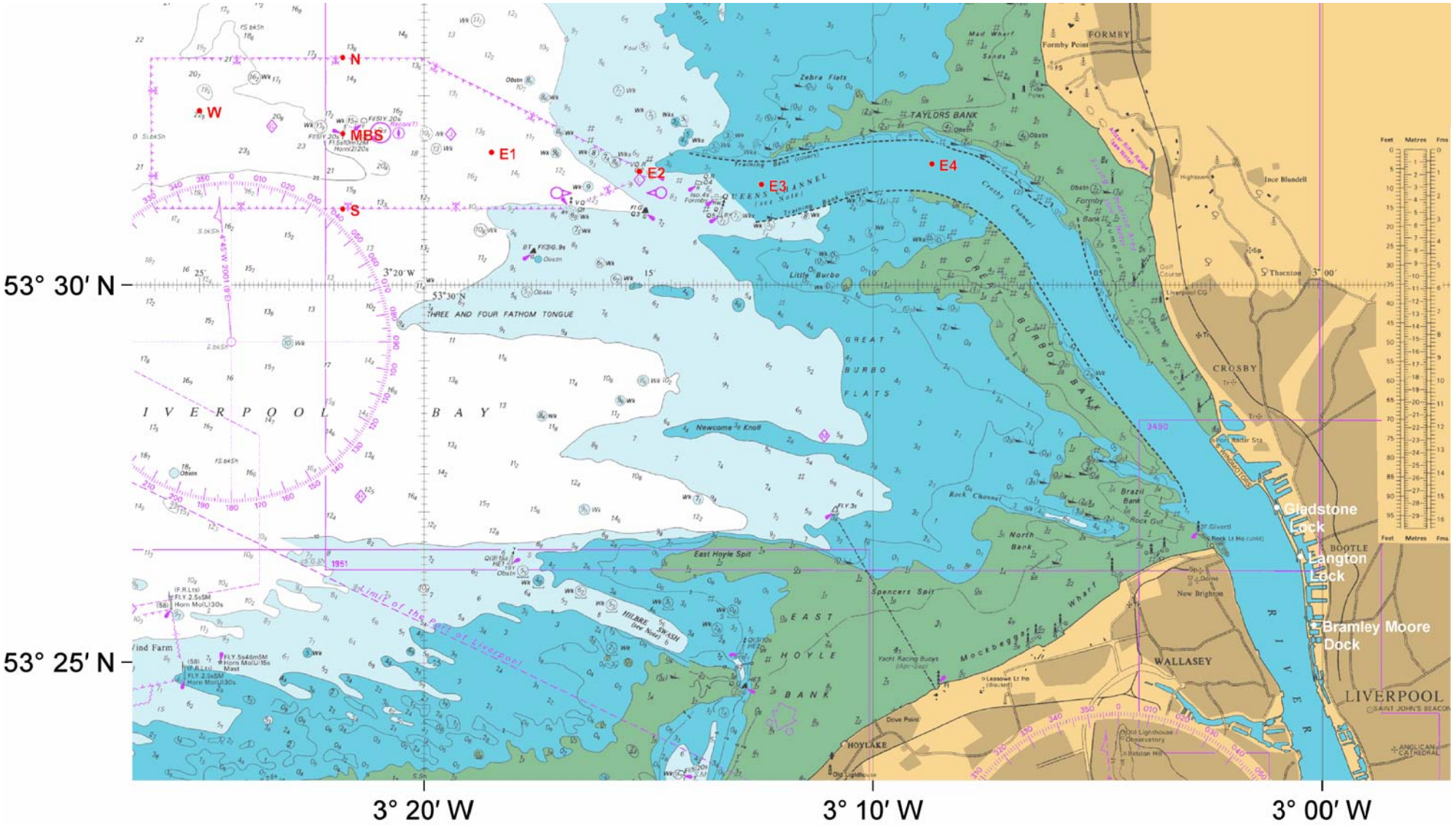

Figure 1. Liverpool Bay Observatory cruise 80, CTD stations, 8–10th November 2011

3. Moorings

3.1 Recovered instrumentation

Site MBS bedframe

Table 2 lists the instruments mounted on the sea bed frame recovered from Site MBS. The frame was fitted with a fizz link, a spooler with 50 m of rope for recovery of the ballast weight and two Benthos releases: S/N 69676 (Rx=11.5 kHz, Tx=12.0 kHz, RC=C), S/N 72378 (Rx=10.5 kHz, Tx=12.0 kHz, RC=A).

Site MBS mooring

Table 3 lists the instruments that would be recovered later from the spar buoy mooring at Site MBS on Monday 21st November. This is a single point mooring with a frame attached at 5 m below the surface

Table 1. Recovered mooring positions and times

	Latitude (N)	Longitude (W)	Water depth (m)	Date	Time (GMT)
ADCP frame	53° 31.761	3° 21.627	-	08/11/2011	13:31
Spar buoy	53° 32.120	3° 21.600	-	22/11/2011	10:30

Table 2. Instruments recovered from the Site MBS bedframe

Instrument	S/N	Notes	Clock set	Delayed start	Stopped logging	Clock drift (secs)
RDI 600 kHz ADCP	2390	1 GB memory. Mode 1: 100 pings every 10 minutes 35 × 1 m bins (2.65–36.65 m above the bed, WNO 35). Beam coordinates – speeds, correlation, echo intensity, % good. Sound velocity calc. from temp., depth & sal. of 32. Beam separation 20°.	15:35:15 18/09/2011	06:00:00 19/09/2011	14:07:30 11/11/2011	+101
SeaBird SBE 16*plus*	4736	Mounted on frame base with pumped conductivity sensor and SeaPoint turbidity sensor (see below). Sample interval 600 s; Digiquartz integration time 40 s, range 400; pump 0.5 s, 1 s delay.	15:50:00 18/09/2011	06:00:00 19/09/2011	15:48:30 14/11/2011	+4
SeaPoint turbidity sensor	10538	Taped to roll bar and setup for 0–125 FTU range; fitted with wiper.	-	-	-	-
SeaBird logger / power	4738	Mounted with Aanderaa Optode oxygen sensor S/N 674. Sample rate 4 Hz, interval 600 s, record time 40 s.	15:57:00 18/09/2011	06:00:00 19/09/2011	15:52:30 14/11/2011	+5

Table 3. Instruments recovered from the Site MBS spar buoy mooring

Instrument	S/N	Notes	Instrument depth (m)	Clock set	Delayed start	Stopped logging	Clock drift (secs)
SeaBird MicroCAT	5791	Temperature and conductivity recorder on ac-s frame.	5	14:11:30 18/09/2011	06:00:00 19/09/2011	10:29:15 24/11/2011	−12
WET Labs ac-s	060	DH4 data logger S/N 140.	5	15:19:00 18/09/2011	06:00:00 19/09/2011	09:52:30 24/11/2011	+2
WET Labs Triplet	1513	(Fluorometer) attached to ac-s frame.	5	14:11:30 18/09/2011	06:00:00 19/09/2011	11:54:30 29/11/2011	+51
StarOddi Mini-logger	2842	Set to record at 600 s intervals.	7.5	N/A	06:00:00 19/09/2011	13:46:50 29/11/2011	+9
SeaBird MicroCAT	5792	Temperature and conductivity recorder.	10	14:29:00 18/09/2011	06:00:00 19/09/2011	10:32:50 24/11/2011	+56

containing a WET Labs ac-s unit, WET Labs Triplet and SeaBird MicroCAT. A temperature mini-logger was attached to the mooring wire at 7.5 m with SeaBird MicroCAT temperature and conductivity loggers at 10 m and 15 m below the surface. The mooring is anchored by a half tonne clump of scrap chain connected by a ½″ long link chain.

3.2 Deployed instrumentation

Site MBS bedframe

Table 5 lists the instruments on the sea bed frame (Figure 2) deployed at Site MBS. The frame is fitted with a fizz link, a spooler with 50 m of rope for recovering the ballast weight and two Benthos releases: S/N 72381 (Rx=11.0 kHz, Tx=12.0 kHz, RC=Bv), S/N 72382 (Rx=10.0 kHz, Tx=12.0 kHz, RC=A).

Site MBS mooring

Table 6 lists the instruments on the spar buoy mooring deployed at Site MBS. This is a single point mooring with a frame attached at 5 m below the surface containing a WET Labs ac-s unit, WET Labs Triplet and SeaBird MicroCAT. A temperature mini-logger was attached to the mooring wire at 7.5 m with SeaBird MicroCAT temperature and conductivity loggers at 10 m and 15 m below the surface. The mooring is anchored by a half tonne clump of scrap chain connected by a ½″ long link chain.

Table 4. Deployed mooring positions and times

	Latitude (N)	Longitude (W)	Water depth (m)	Date	Time (GMT)
ADCP frame	53°31.822	3°21.525	24.1	08/11/2011	12:47
Spar buoy	53°32.113	3°21.702	-	09/11/2011	11:46

Figure 2. Deploying the new style sea bed frame from the R.V. Marisa, 8th November 2011.

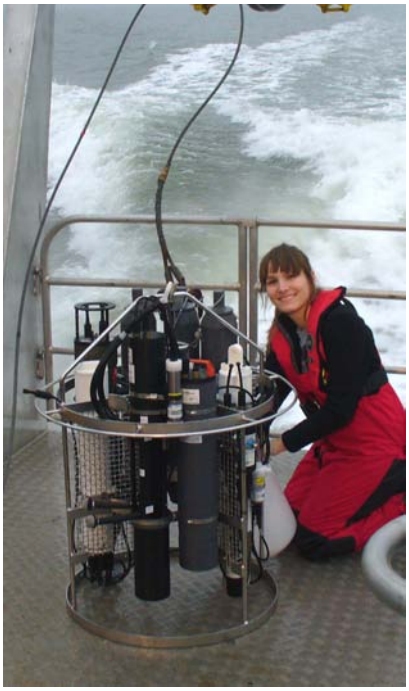

Figure 3. Frame with CTD, ac-s ECO triplet and bottles.

Figure 4. Preparing to deploy the new spar buoy mooring from the R.V. Marisa, 9th November.

Figure 5. Phil with one of the day's catch, 10th Nov.

4. CTD/LISST with ac-s: survey and six-hour station

Table 7 lists instrumentation mounted on the CTD rosette frame. Water samples were taken to calibrate the CTD salinity. Analysis is by a Guildline Autosal 8400 at the University of Liverpool.

CTD profiles were taken at each station listed in Table 8 on the first two days with water samples at near bed and near surface.

Table 5. Instruments deployed on the Site MBS bedframe

Instrument	S/N	Notes	Clock set	Delayed start
RDI 600 kHz ADCP	5807	1.0 GB memory. Mode 1: 100 pings every 10 minutes 35 × 1 m bins (2.65–36.65 m above the bed, WNO 35). Beam coordinates – speeds, correlation, echo intensity, % good. Sound velocity calc. from temp., depth & sal. of 32. Beam separation 20°.	14:14:00 07/11/2011	09:00:00 08/11/2011
FSI CTD	2278	Mounted on frame base with pumped conductivity sensor and SeaPoint turbidity sensor (see below). Sample interval 600 s; Digiquartz integration time 40 s, range 400; pump 0.5 s, 1 s delay.	15:07:15 07/11/2011	09:00:00 08/11/2011
SeaPoint turbidity sensor	10471	Taped to roll bar and setup for 0–125 FTU range; fitted with wiper	-	-
SeaBird logger / power	4596	Mounted with Aanderaa Optode oxygen sensor S/N 675. Sample rate 4 Hz, interval 600 s, record time 40 s.	14:28:00 07/11/2011	09:00:00 08/11/2011

Table 6. Instruments deployed on the Site MBS spar buoy mooring

Instrument	S/N	Notes	Instrument depth (m)	Clock set	Delayed start
SeaBird MicroCAT	2991	Temperature and conductivity recorder on ac-s frame.	5	11:34:30 07/11/2011	09:00:00 09/11/2011
WET Labs ac-s	059	DH4 data logger S/N 119	5	09:01:30 09/11/2011	09:05:00 09/11/2011
WET Labs Triplet	800	Attached to ac-s frame	5	-	-
StarOddi Mini-logger	2836	Set to record at 600 s intervals.	7.5	N/A	09:00:00 09/11/2011
SeaBird MicroCAT	5790	Temperature and conductivity recorder	10	12:15:00 07/11/2011	09:00:00 09/11/2011
SeaBird MicroCAT	5433	Temperature and conductivity recorder	15	12:11:00 07/112011	09:00:00 09/11/2011

Samples were taken from the following 4-litre Niskin bottles:
near-bed bottle 1 – nutrients, SPM, chlorophyll, CDOM
near-surface bottle 2 – nutrients, salinity
near-surface bottle 3 – SPM, chlorophyll, CDOM

On the final day, profiles were every half-hour with water samples on-the-hour at MBS for: SPM, chlorophyll and CDOM (see section 5), and nutrients (section 6). A WET Labs ac-s with a ECO Triplet and a DH4 logger were also mounted on the CTD frame. The instruments were deployed (after the half-

past-the-hour CTD profile) from the ship's A-frame using a rope marked at 5-metre intervals. At the start of each deployment, the frame was lowered to 10 m for four minutes while the ac-s flushed its intake tubes. This was followed by two minutes of measurements at each position: near-bottom or 20 m from the surface, 10 m, and near-surface.

During the 6-hour station, samples were taken from the following bottles:
near-bed bottle 1 – nutrients, salinity, SPM, chlorophyll, CDOM
10 m from srf bottle 2 – SPM, chlorophyll, CDOM
near-surface bottle 3 – nutrients, SPM, chlorophyll, CDOM

Table 7. Instruments mounted on the CTD rosette frame

Instrument	S/N	Notes
SeaBird SBE 55 Eco water sampler controller	66	Controlling three water sample bottles
SeaBird SBE 19*plus* CTD	6650	Pumped conductivity sensor and SeaPoint turbidity sensor (S/N 10320)
WET Labs ac-s	095	Set up in 'profile' mode, delay 1 minute, pre-warm up 0 s, warm up 2 minutes, flush 0 s, sample period 15 minutes at 4 Hz (DH4 logger S/N 161)
WET Labs Triplet	801	Fluorescence sensor
Sequoia Scientific LISST-ST particle sizer	1110	Internal logging www.sequoiasci.com/products/fam_LISST_ST.aspx

5. SPM, chlorophyll and CDOM sampling (Liverpool Bay Observatory)

Water at near-surface (2 m), 10 m from the surface and near-bed (3 m above sea bed) were taken to determine concentrations of SPM, chlorophyll-*a* and CDOM. Pre-processing, sampling and post-processing steps are summarised below.

5.1 Suspended particulate matter (*SPM*)

Pre-processing: Whatman 0.7 µm pore size 47 mm diameter glass fibre (GF/F) filters. Use tweezers to handle filters at edges. (a) Examine filters for damage, etc. Rinse to remove loose fibres and plasticiser; place in aluminium dishes and dry in the oven at 75°C for 2 hours. (b) Check filters do not stick to the dishes; transfer to muffle furnace and combust at 400°C for 4 hours. (Above 450°C may alter the filter matrix.) (c) Place in desiccator for half hour before weighing (5-figure balance in grams).

Sample collection: (d) Use clean buckets placed beneath Niskin bottles on the CTD frame, taking entire contents. (e) Stir sample before measuring out, typically 1 litre required, less (500 ml) if turbid conditions. (f) Place pre-weighed filter on to holder and assemble the funnel. Switch on vacuum pump, ensuring suction <0.4 bar (<0.2 bar if done at same time as chlorophyll sample). Add sample in stages – do not allow filter to go dry. (g) Before final 50 ml goes through add 250 ml deionised water; repeat. (h) Put filter back in appropriate dish/bag and store in freezer at −18°C.

Post-processing: (i) Dry filters at 75°C for 3 hours before weighing as in c) above. (j) Dry again at 75°C for a further 1 hour before weighing again. (k) Repeat step j) if weights are not the same. Difference in weight from original filter weight divided by the sample volume gives concentration of total SPM. (l) Combust at 500°C for 3 hours to remove organic fraction, then weigh. Differences in weights from original divided by volume gives inorganic SPM concentration.

5.2 Chlorophyll-a

Pre-processing: (m) Clean test tubes with screw-caps, numbered and placed in rack.

Sample collection: Whatman 0.7 µm pore size 47 mm diameter GF/F filters (straight from box). Use tweezers to handle filters at edges. (n) Use the same water sample as for SPM d) to f), except measure out 500 ml (less if water is turbid) and filter through with vacuum <0.2 bar. Do not rinse. (o) Put filter in the test tube, replace cap, and wrap in aluminium foil with label, then store in freezer at −18°C.

Post-processing: (p) Fluorometric method: make the chlorophyll standard and calibrate the fluorometer (Turner Designs, USA). (q) Take test tubes from freezer, add 5 ml of cold 90% acetone, place foil-wrapped tubes in a polypropylene beaker with water and sonicate in the water bath for 15 minutes. Do not allow the samples to warm up, and avoid exposing them to high light levels. (r) Remove filters leaving the pigmented acetone, analyse in the fluorometer as soon as possible. Add one drop of 10% hydrochloric acid to convert chlorophyll to phaeophytin and analyse again.

5.3 Coloured dissolved organic matter (*CDOM*)

Pre-processing: (s) Start with a stock of clean glass bottles and caps. Rinse with 1-N hydrochloric acid and then rinse at least twice with Milli-Q water and air-dry before use.

Sample collection: (t) Collect seawater in a clean container, as in d) above. (u) Use tweezers to place a Whatman 0.2 µm pore size 25 mm diameter polycarbonate filter in a clean polypropylene filter holder, replace the sealing ring and screw-on section. Rinse and fill a clean glass beaker with the sample; rinse a 20 ml glass syringe by drawing and discarding some of the sample. Fill the syringe from the beaker and insert the luer tip carefully into the filter holder. Slowly filter enough water to rinse the sample storage bottles. Using the same filter, obtain further filtrate to fill the 50 ml Pyrex bottles. (v) Cap bottles, label and wrap in aluminium foil, then store in freezer at −18°C or refrigerate at 4°C if analysing on ship.

Post-processing: Samples should be analysed on ship, or transferred frozen to the laboratory and processed as soon as possible. Significant deterioration in quality can occur in hours or days. (w) Allow the sample and a bottle of Milli-Q water to reach room temperature (important). Switch on the spectrophotometer (Shimadzu, Japan) and allow it to warm up (takes about 1 hour). (x) Use clean glass syringes, filter the sample as in u) above; rinse twice and fill two 10 cm path length cuvettes ensuring no air bubbles on the inside, no scratches. Wipe smears/prints off the outside. (y) Obtain a baseline first: fill both cuvettes with Milli-Q water and place them in the appropriate light path in the spectrophotometer sample chamber. (z) Fill the cuvette with the sample (filter again) and leave the other with Milli-Q water as a reference blank. Carry out optical density or ‘absorbance’ scans from 380 nm to 750 nm at 0.5 nm spacing (slit width 1 or 2 nm); repeat five times every 300 seconds for each of (three) samples per site.

6. Nutrient sampling (Claire Mahaffey, University of Liverpool)

Water samples were taken from the near-surface (1 m) and near-bed (3 m above the sea bed) for the analyses of nitrate, nitrite, phosphate and silicate. Sampling locations are indicated in Table 10.

Samples are collected directly from the 4-litre Niskin bottles into acid-washed, deionised water rinsed 125 ml HDPE screw cap bottles. Bottles are rinsed three times and filled with ~100 ml of sample. Samples are capped, labelled and placed in a −18°C freezer and frozen upright. Samples are transported frozen to the University of Liverpool for analysis. Samples are defrosted overnight in the dark prior to analysis and analyzed within one week of collection using a Bran and Luebbe QuAAtro Pro 5-channel nutrient analyser (purchased by NOC).

7. Data quality control (from John Howarth, NOC)

Preliminary assessment of moored data deployed in September and recovered in November 2011
Coastal Observatory cruises 79, 80: Prince Madog cruise 25/11, recovered by RV Marisa: duration 50 days for frame; 63 days for mooring

Site MBS – Frame NOCL rig ID 1132 (deployment in new style frame)

600 kHz ADCP S/N 2390: The data look OK.

SeaBird 16*plus* S/N 4736 with SeaPoint turbidity S/N 10538 mounted horizontally with pumped conductivity sensor. The temperature and salinity data look OK.

SeaBird 16*plus* S/N 4735 with Aanderaa Optode S/N 674 mounted horizontally with pumped conductivity sensor. The temperature data and salinity look OK. There was one salinity spike, with magnitude 0.58. The oxygen data look ok (maybe low by 30 μM l^{-1}).

The salinity records from the two 16*plus*ses agree to within 0.01, with a mean difference of 0.005. There is a mean difference between the 16*plus*ses and the MicroCAT at −10 m of 0.08 when the water column is well mixed.

Pressure records from the two 16*plus*ses differ at the end, for the last 5 days. Biggest differences are at mid-tide (maximum difference is 0.45 decibars), implying a phase difference (due to sediment clogging of the orifice?). Comparison with the ADCP pressure record indicates that the error occurs with S/N 4736.

Site MBS – Mooring NOCL rig ID 1131 (surface buoy: spar buoy)

MicroCATs S/Ns 5791 & 5792, nominally at 5 and10 m below surface. No MicroCAT deployed at −15 m.

Maximum depths recorded by 5791 and 5792 are 6.2 and 11.6 m, respectively. The temperature and salinity data look OK; when the water column is well mixed the MicroCATs agree to ~0.001°C for temperature and ~0.002 for salinity.

StarOddi S/N 2842 at 7.5 m below surface. When the water column is well mixed the temperature values agree to within 0.005°C with the MicroCATs.

MJH, 13th December 2011

8. Cruise participants and acknowledgements

The assistance of the master and crew of the R.V. Marisa and all scientists is appreciated in ensuring the success of this cruise.

Ship's crew
David Annett (Master)
Phil Robson

Scientific personnel, days 1 & 2
Matthew Palmer (NOC), Principal Scientist
Terry Doyle (NOC)
Joanne Hopkins (NOC) (day 2)
Emlyn Jones (NOC)
John Kenny (NOC)
Andy Lane (NOC)
Jeni Moore (Univ. Strathclyde) (day 2)
Juliane Wihsgott (NOC)

Scientific personnel, day 3
Andy Lane (NOC), Principal Scientist
Terry Doyle (NOC)
Emlyn Jones (NOC)
Jeni Moore (Univ. Strathclyde)

We are grateful to the Port of Liverpool (Peel Ports / Mersey Docks and Harbour Company) for permission to undertake the CTD and ac-s station while at anchor.

Glossary

ac-s	an instrument recording spectra of: *a*, absorption; *c*, attenuation
ADCP	acoustic Doppler current profiler
CDOM	chromophoric or coloured dissolved organic matter
CTD	conductivity, temperature, depth
LISST	laser in situ scattering transmissometry – particle size analyser
NOC	National Oceanography Centre
SPM	suspended particulate matter

Table 8. Nominal positions of CTD stations

Station	Latitude (N)	Longitude (W)
MBS	53° 32.0′	3° 21.8′
S	53° 31.0′	3° 21.8′
N	53° 33.0′	3° 21.8′
W	53° 32.3′	3° 25.0′
E1	53° 31.75′	3° 18.5′
E2	53° 31.5′	3° 15.2′
E3	53° 31.325′	3° 12.5′
E4	53° 31.6′	3° 08.7′

Table 9. CTD and ac-s station log

Station	CTD #	Date & Time	Latitude (N)	Longitude (W)	Depth (m)	SPM	Chl	CDOM	Nutrients	ac-s
MBS*	1	08/11/11 12:03	53° 31.802′	3° 21.529′	25.4					
MBS	2	08/11/11 12:30	53° 31.799′	3° 21.375′	25.3	✓	✓	✓	✓	
S	3	08/11/11 13:49	53° 30.965′	3° 21.705′	18.7	✓	✓	✓	✓	
N	4	08/11/11 14:10	53° 33.014′	3° 22.065′	18.8	✓	✓	✓	✓	
W	5	08/11/11 14:29	53° 32.307′	3° 25.205′	26.2	✓	✓	✓	✓	
MBS	6	08/11/11 14:58	53° 31.960′	3° 21.754′	21.6	✓	✓	✓	✓	
E1	7	08/11/11 15:17	53° 31.772′	3° 18.647′	17.1	✓	✓	✓	✓	
E2	8	08/11/11 15:38	53° 31.491′	3° 15.164′	9.7	✓	✓	✓	✓	
E3	9	08/11/11 15:57	53° 31.237′	3° 12.093′	8.5	✓	✓	✓	✓	
E4	10	08/11/11 16:19	53° 31.771′	3° 08.667′	21.6	✓	✓	✓	✓	
E2(A)	11	09/11/11 12:54	53° 31.324′	3° 12.508′	12.1	✓	✓	✓	✓	
A1	12	10/11/11 10:25	53° 31.929′	3° 20.752′	26.1	✓	✓	✓	✓	✓
A2	13	10/11/11 11:05	53° 31.950′	3° 20.830′	26.0	✓	✓	✓	✓	✓
A3	14	10/11/11 11:35	53° 31.946′	3° 20.836′	25.6					
A4	15	10/11/11 12:05	53° 31.945′	3° 20.838′	25.0	✓	✓	✓	✓	✓
A5	16	10/11/11 12:35	53° 31.943′	3° 20.841′	24.5					
A6	17	10/11/11 13:18	53° 31.942′	3° 20.843′	23.5	✓	✓	✓	✓	✓
A7	18	10/11/11 13:37	53° 31.940′	3° 20.844′	23.0					
A8	19	10/11/11 14:02	53° 31.940′	3° 20.845′	22.3	✓	✓	✓	✓	✓
A9	20	10/11/11 14:32	53° 31.940′	3° 20.845′	21.5					
A10	21	10/11/11 15:02	53° 31.943′	3° 20.845′	21.0	✓	✓	✓		✓
A11	22	10/11/11 15:30	53° 31.946′	3° 20.842′	20.4					
A12	23	10/11/11 16:01	53° 31.945′	3° 20.842′	20.1	✓	✓	✓		✓
A13	24	10/11/11 16:31	53° 31.949′	3° 20.937′	19.7					
A14	25	10/11/11 16:59	53° 31.948′	3° 20.838′	19.8	✓	✓	✓		✓

* Water bottles did not fire (no samples on first CTD profile)

Andy Lane, 1st December 2011
Revised 5th March 2012