Liverpool Bay Observatory cruise 82 [12/02]

Dates: 14th–17th February 2012
Ship: R.V. Prince Madog (cruise 13/12)
Principal Scientist: 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

Two moorings are maintained at the Mersey Bar Station (MBS) marked in Figures 1 and 2. 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 and 15 m below the surface, with a SeaBird MicroCAT temperature and conductivity logger at 10 m below the surface.

c) A 'lost' sea bed frame similar to that in (a) which was deployed at 53° 31.822′ N, 3° 21.525′ W on 8th November 2011. It has a suspected acoustic release failure or the frame may be overturned.

To deploy:

d) 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.

e) 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 a fluorometer, backscatter and CDOM), SeaBird MicroCAT and Satlantic SUNA nutrient analyser. A SeaBird MicroCAT temperature and conductivity logger is attached at 10 m below the surface.

1.2 CTD and LISST 13-hour station with ac-s

The second cruise objective is to complete a 13-hour station of half-hourly conductivity, temperature and depth (CTD) profiles, and running concurrent to the start of the spar buoy deployment. Water samples were obtained in Niskin bottles at on-the-hour profiles for determining concentrations of: suspended particulate matter (SPM), chlorophyll-*a* and chromophoric or coloured dissolved organic matter (CDOM) and nutrients near the sea bed, 5 m below the sea surface, and near-surface.

After the half-past-the-hour CTD profile, a frame containing a WET Labs ac-s and SeaBird CTD was deployed: after an initial four-minute flushing time for the ac-s at 10 m, measurements were taken for approximately two-minutes each at near-bed (or 20 m), 10 m and 5 m below the surface, and near-surface.

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 nutrients and salinity also provide calibration points for the CTD and moored sensors.

2. Cruise narrative

(All times are in GMT throughout this report)

Tuesday, 14th February 2012

Prince Madog berthed at Vittoria Wharf at 13:30. Instrumentation and equipment were loaded. Some participants (from NOC and Bangor) stayed on board. The planned departure at 05:30 on the following day was postponed until 15:00 because force 5 NW winds and large wave heights greater than 1.7 m were forecast.

Wednesday, 15th February

Review of the weather situation: overnight wave heights recorded near to the Mersey Bar Lightship at the Liverpool Bay WaveNet site (see www.cefas.defra.gov.uk/our-science/observing-and-modelling/monitoring-programmes/wavenet.aspx) were above 2.4 m, and winds were force 5 to 6 from NW. At 09:00 the wave height was still above 2 m, but had reduced to 1.6 m by midday and was expected to continue falling.

Permission to anchor in the no-anchor area surrounding the Mersey Bar Lightship was received at 09:40.

The ship left the quay at 14:55 and entered the River Mersey (via Alfred Lock) at 15:32, about 1¼ hours before high water. The surface monitoring system and the ship's ADCP were switched on at 16:00 on passing the radar tower at Seaforth.

Arriving at 17:35, Prince Madog dropped anchor approximately 500 m SE of the Mersey Bar Lightship. For training purposes, CTD profiles (with water sampling at near sea bed, 5 m below the surface and near the surface) were taken at 18:00 and 19:00, and without sampling at 18:30 and 19:30. A dip frame containing an ac-s and a CTD was deployed after the first CTD, and again after the third and fourth. The 13-hour CTD station will take place after completing the moorings recovery and deployment work on Thursday, during which, nutrients and other samples at 5 m depth will be obtained for comparison with the Satlantic SUNA nutrient analyser and the ac-s instrument on the newly deployed spar buoy.

Thursday, 16th February

The anchor was raised at 08:11. Prince Madog set off towards the spar buoy location and a pre-recovery CTD profile was completed at 08:39. Winds were force 4 from the W with wave heights of 0.8 m. The new spar buoy was deployed at 08:52 (2 hours after high water); the old spar buoy (Figures 3 and 4) was recovered by 09:14. The ADCP frame deployed in January 2012 was recovered successfully by 09:43 – this frame will be refurbished for deployment later in the day, however the link pint on the ballast frame had sheared, so the ballast frame section from the yet to be recovered ADCP frame will be used.

Trawling for the 'lost' ADCP frame started at 10:28 (1¾ hours before low water): this involved suspending a cable down to the sea bed from the port stern and extending it beyond the starboard side using the crane. The frame was sighted after the first pass at 10:35 and recovered by 10:48 (Figure 5). During this operation, a hydraulic hose on the crane ruptured; it was subsequently repaired.

The first ADCP frame recovered was stripped down and rebuilt with a fresh set of instrumentation (13:50) and was deployed at 14:16. This was followed with a post-recovery CTD profile at 14:26, which included water samples.

All the moorings recovery and deployment work was completed in a shorter time than allocated in the cruise plan, which allowed an early start to the 13-hour anchor station at approximately 350 m SE of the Mersey Bar Lightship. Half-hourly CTD profiles began at 15:01. On-the-hour CTDs included water bottle samples for SPM, chlorophyll and CDOM, nutrients. Water samples were not taken during the half-past-the-hour CTD profiles.

The deployment of a separate dipping frame (see Figure 6) was carried out after the half-past-the-hour CTD. This frame contained a CTD as well as an ac-s to measure absorption and scattering spectra at 20 m, 10 m and 5 m below the surface and near-surface (the ECO Triplet was not available for use).

Friday, 17th February

At 04:00, the final CTD profile was made, ending the anchor station. Prince Madog headed for port at 04:12, entering Alfred Lock at 06:25 (½ hour before high water) and was alongside at Vittoria Wharf by 06:52. The ship's surface monitoring and ADCP were switched off at 05:26.

Unloading started immediately. Prince Madog departed for Menai Bridge at 08:30.

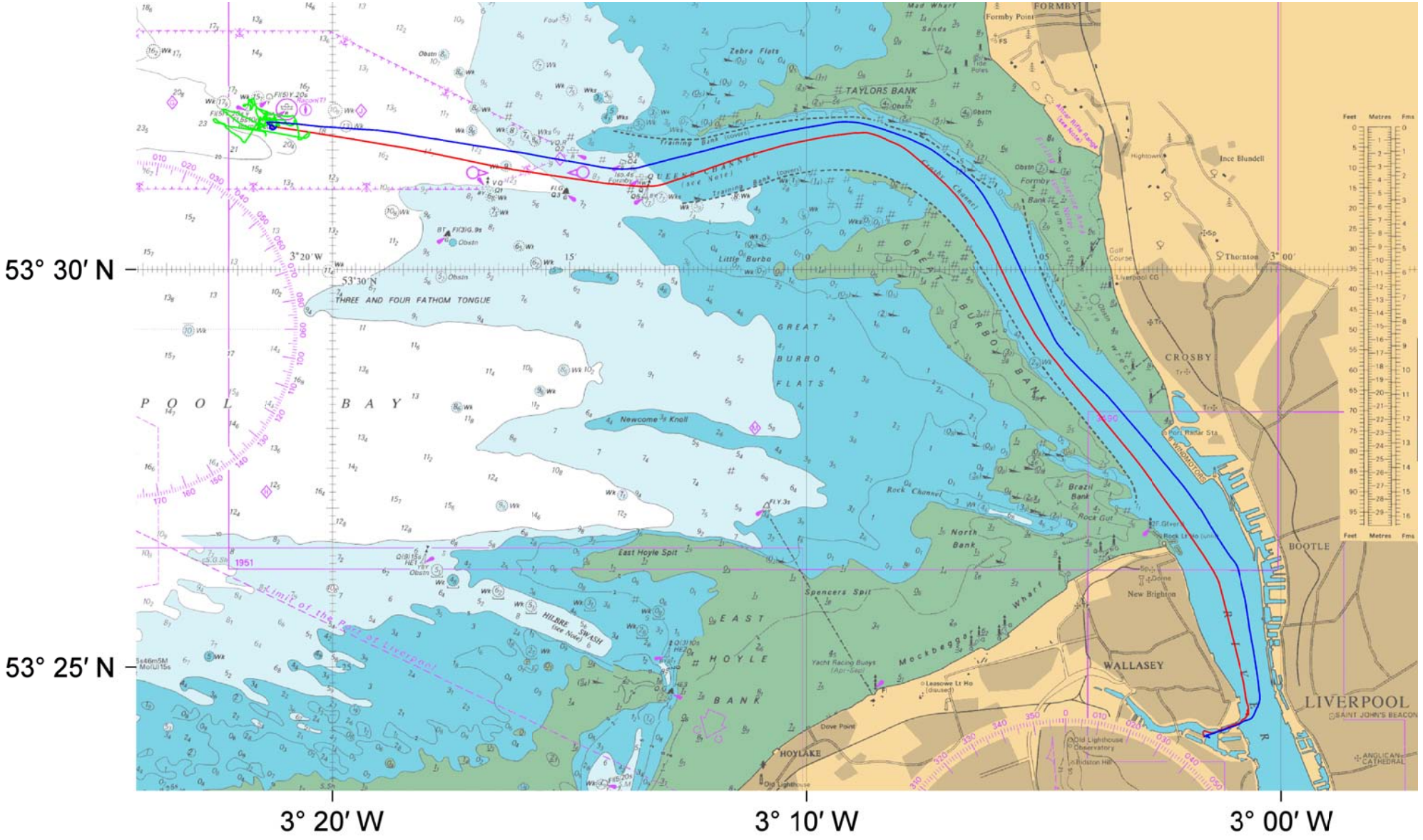

Figure 1. Liverpool Bay Observatory cruise 82 track, 15th (blue), 16th (green) & 17th (red) February 2012

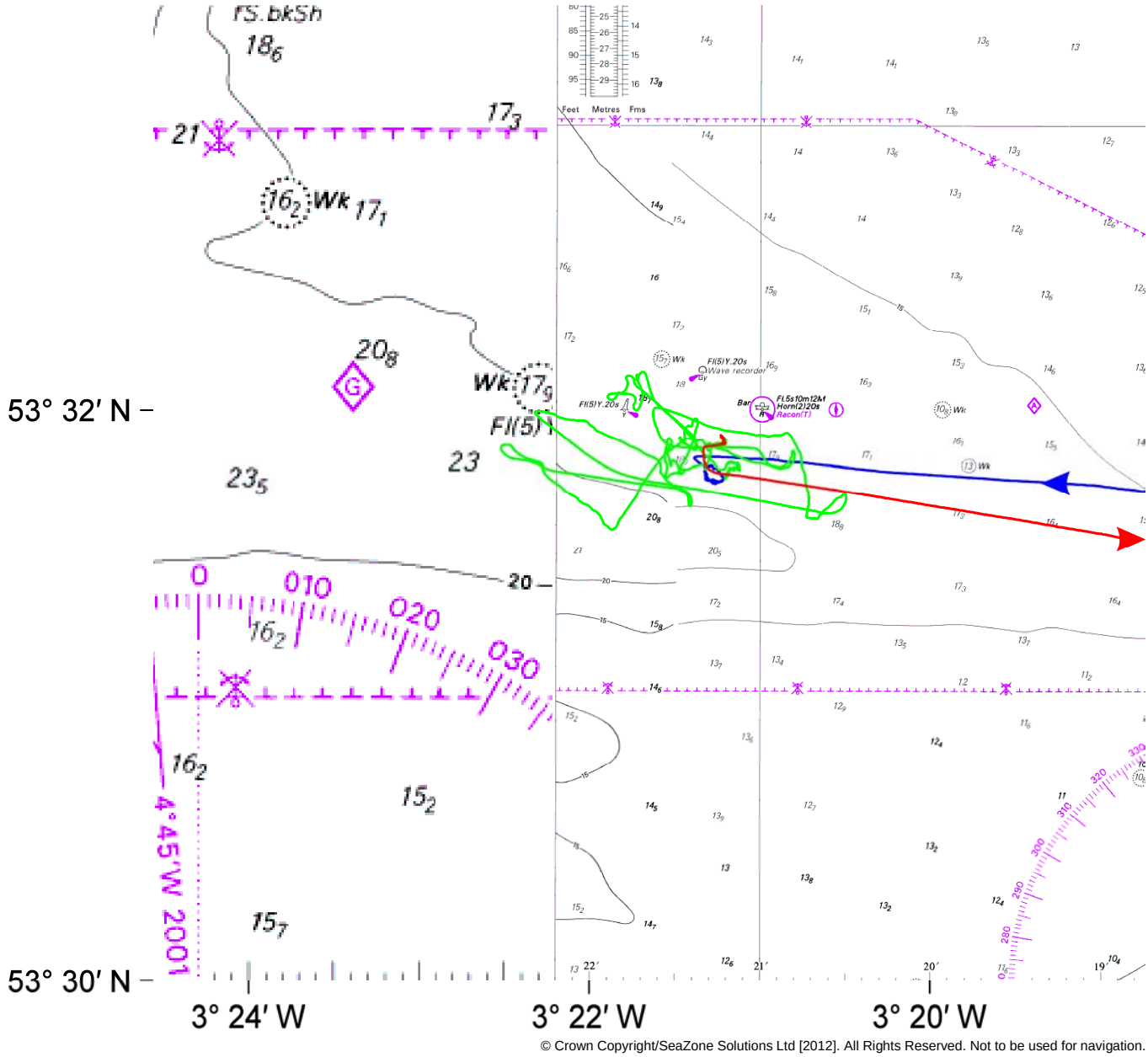

Figure 2. Liverpool Bay Observatory cruise 82 track at the Mersey Bar Station, 15th (blue), 16th (green) & 17th (red) February 2012

3. Moorings

3.1 Recovered instrumentation

Site MBS bedframes

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=10.5 kHz, Tx=12.0 kHz, RC=C), S/N 72378 (Rx=10.5 kHz, Tx=12.0 kHz, RC=A).

Table 3 lists the instruments mounted on the sea bed frame recovered from Site MBS (deployed during cruise 80, 9th November 2011). 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 72381 (Rx=11.0 kHz, Tx=12.0 kHz, RC=B), S/N 72382 (Rx=10.0 kHz, Tx=12.0 kHz, RC=A).

Site MBS mooring

Table 4 lists the instruments that were recovered from the spar buoy mooring 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 1. Recovered mooring positions and times

	Latitude (N)	Longitude (W)	Water depth (m)	Date	Time (GMT)
Spar buoy	53° 32.132	3° 21.719	23.0	16/02/2012	09:06
ADCP frame	53° 31.923	3° 21.443	22.4	16/02/2012	09:43
'Lost' ADCP frame	53° 31.797	3° 21.459	22.3	16/02/2012	10:48

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°.	12:37:00 09/01/2012	09:00:00 10/01/2012	12:30:00 16/02/2012	+56
SeaBird SBE 16*plus*	4738	Mounted on frame base with pumped conductivity sensor and Aanderaa Optode oxygen sensor S/N 674. Sample interval 600 s; Digiquartz integration time 40 s, range 400; pump 0.5 s, 1 s delay.	13:21:00 09/01/2012	09:00:00 10/01/2012	14:38:00 20/02/2012	+5
Teledyne Citadel CTD	2277	Mounted with SeaPoint turbidity sensor (see below). Sample rate 4 Hz, interval 600 s, record time 40 s.	13:00:00 09/01/2012	09:00:00 10/01/2012	14:51:00 20/02/2012	+1
SeaPoint turbidity sensor	12113	Taped to roll bar and setup for 0–125 FTU range; fitted with wiper.	-	-	-	-

Table 3. Instruments recovered from the Site MBS 'lost' bedframe, deployed during cruise 80

Instrument	S/N	Notes	Clock set	Delayed start	Stopped logging	Clock drift (secs)
RDI 600 kHz ADCP	5807	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°.	14:14:00 07/11/2011	09:00:00 07/11/2011	13:26:00 23/02/2012 (battery depleted)	+11
SeaBird SBE 16*plus*	4596	Mounted on frame base with pumped conductivity sensor and Aanderaa Optode oxygen sensor S/N 675. Sample interval 600 s; Digiquartz integration time 40 s, range 400; pump 0.5 s, 1 s delay.	14:28:00 07/11/2011	09:00:00 08/11/2011	16:30:03 06/02/2012 (battery depleted)	+18
Teledyne Citadel CTD	2278	Mounted with SeaPoint turbidity sensor (see below). Sample rate 4 Hz, interval 600 s, record time 40 s.	15:07:15 07/11/2011	09:00:00 08/11/2011	12:50:00 21/02/2012	+19
SeaPoint turbidity sensor	10471	Taped to roll bar and setup for 0–125 FTU range; fitted with wiper.	-	-	-	-

Table 4. 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	2991	Temperature and conductivity recorder on ac-s frame.	5	11:34:30 07/11/2011	09:00:00 09/11/2011	14:11:15 21/02/2012	+38
WET Labs ac-s	059	DH4 data logger S/N 119.	5	09:01:30 09/11/2011	09:05:00 09/11/2011	14:00:00 21/02/2012	−1
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	11:59:30 22/02/2012	+9
SeaBird MicroCAT	5790	Temperature and conductivity recorder.	10	12:15:00 07/11/2011	09:00:00 09/11/2011	14:19:00 21/02/2012	+30
SeaBird MicroCAT	5433	Temperature and conductivity recorder.	15	12:11:00 07/11/2011	09:00:00 09/11/2011	14:24:30 21/02/2012	+25

Figure 3. Recovering the spar buoy (deployed 8th November 2011 on cruise 80), with loop and boathooks.

Figure 4. Frame with CTD, ac-s, and Triplet (at 5 m below buoy).

Figure 5. Recovering the 'lost' bedframe (deployed 8th November 2011 on cruise 80).

Figure 6. Dipping frame with CTD, ac-s (Triplet not used).

3.2 Deployed instrumentation

Site MBS bedframe

Table 6 lists the instruments on the sea bed frame 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 69676 (Rx=11.5 kHz, Tx=12.0 kHz, RC=C), S/N 72378 (Rx=10.5 kHz, Tx=12.0 kHz, RC=A).

Table 5. Deployed mooring positions and times

	Latitude (N)	Longitude (W)	Water depth (m)	Date	Time (GMT)
Spar buoy	53°32.039	3°21.730	23.0	16/02/2012	08:52
ADCP frame	53°31.980	3°21.440	23.6	16/02/2012	14:16

Table 6. Instruments deployed on the Site MBS bedframe

Instrument	S/N	Notes	Clock set	Delayed start
RDI 600 kHz ADCP	5803	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°.	13:43:00 16/02/2012	15:00:00 16/02/2012
SeaBird SBE 16*plus*	5310	Mounted with Aanderaa Optode oxygen sensor S/N 674. 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.	12:11:30 16/02/2012	15:00:00 16/02/2012
SeaPoint turbidity sensor	12113	Taped to roll bar and setup for 0–125 FTU range and fitted with wiper	-	-
Teledyne Citadel CTD	2097	Sample rate 4 Hz, interval 600 s, record time 40 s.	13:11:15 16/02/2012	15:00:00 16/02/2012

Table 7. Instruments deployed on the Site MBS spar buoy mooring

Instrument	S/N	Notes	Instrument depth (m)	Clock set	Delayed start
SeaBird MicroCAT	5791	Temperature and conductivity recorder on ac-s frame.	5	07:33:30 16/02/2012	09:00:00 16/02/2012
WET Labs ac-s	060	DH4 data logger S/N 140	5	08:11:20 16/02/2012	08:15:00 16/02/2012
WET Labs Triplet	801	Attached to ac-s frame	5	-	-
Satlantic SUNA	060	Nutrient analyser on ac-s frame (SeaBird logger/power S/N 4490)	5	07:25:30 16/02/2012	09:00:00 16/02/2012
SeaBird MicroCAT	5792	Temperature and conductivity recorder	10	07:18:00 16/02/2012	09:00:00 16/02/2012

Note: the link pin/bolt on recovered the ballast frame had sheared, so the ballast frame section from the 'lost' ADCP frame was used instead.

Site MBS mooring

Table 7 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, SeaBird MicroCAT and Satlantic SUNA. A SeaBird MicroCAT temperature and conductivity logger was attached to the mooring wire at 10 m below the surface. The mooring is anchored by a half tonne clump of scrap chain connected by a ½″ long link chain.

4. CTD/LISST with ac-s, 13-hour station

CTD profiles were taken every half-hour with water samples on-the-hour for SPM, chlorophyll and CDOM (see section 5), and nutrients (section 6).

A WET Labs ac-s and a SeaBird SBE 16*plus* CTD were mounted on a dipping frame together with a DH4 logger. The instruments (listed in Table 8) were deployed (after the half-past-the-hour CTD profile) from the ship's A-frame using a rope marked at 5-metre intervals wound around a power-assisted capstan. 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, 5 m below the sea surface, and near-surface.

Table 9 lists instrumentation mounted on the CTD rosette frame. Water samples were taken at 3 m above the sea bed to calibrate the CTD salinity. Analysis is by a Guildline Portasal 8410A at Bangor University.

Samples were taken from the following 5-litre Niskin bottles:

near-bed	bottle 4	– SPM, chlorophyll, CDOM
	bottle 5	– nutrients and salinity
5 m from srf	bottle 8	– SPM, chlorophyll, CDOM
	bottle 9	– nutrients
near-surface	bottle 10	– SPM, chlorophyll, CDOM
	bottle 11	– nutrients

Table 8. Instruments mounted on the ac-s dipping frame*

Instrument	S/N	Notes
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)
SeaBird SBE 16*plus*	5434	5 minute sampling. Clock set 15:30:00 15/02/2012 for delayed start at 17:00:00. Stopped logging at 06:20:00 on 17/02/2012 with+3 s clock drift.

* The ECO Triplet was not available

Table 9. Instruments mounted on the CTD rosette frame

Instrument	S/N	Notes
SeaBird temperature sensor (SBE 3)	P4100	
SeaBird conductivity sensor (SBE 4)	2543	
SeaBird 43 oxygen sensor	1491	
LI-COR LI 192SB	26	Downwelling PAR/irradiance sensor
Turner SCUFAII fluorometer	262	
SeaTech T1000 transmissometer	T1021	0.2 m path
SeaBird SBE35 precision thermometer	0041	
Sequoia Scientific LISST-100X particle sizer	1291	Internal logging www.sequoiasci.com/products/part_LISST_100.aspx

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

Water at near-surface (1 m), 5 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 transmissometer on CTD indicates 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), 5 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 5-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. Surface/underway sampling

Underway sea surface measurements, meteorological variables and ship's navigation were recorded between 16:00 on 15/02/2012 and 05:26 on 17/02/2012. The intake of the surface sampling system is located about 3 m below the water line of R.V. Prince Madog. The parameters recorded every minute by the WS Oceans system and found in the underway file are:

- time (GMT), latitude and longitude
- heading (°), track, ground speed (m s^{-1}), water speed (m s^{-1}) and depth (m)
- air temperature (°C), humidity and pressure (mbar)
- solar radiation (W m^{-2}) and PAR (photosynthetically active radiation, µmol m^{-2} s^{-1})
- current velocities components U, V
- relative wind speed (m s^{-1}), relative wind direction (° where zero indicates wind on the bow), true wind speed (m s^{-1}), true wind direction (°) and gusts (m s^{-1})
- sea temperature (°C) and salinity
- thermosalinograph (TSG) temperature (°C) and TSG conductivity
- transmissance
- oxygen
- turbidity
- fluorescence
- flow

The ship was fitted with a 300 kHz ADCP set to record current velocity 25 × 2 m bins (bin nearest the surface at 5.1 m depth), every 30 s with 29 pings per ensemble. Data were recorded between 16:00 on 15/02/2012 and 05:26 on 17/02/2012.

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

Preliminary assessment of moored data deployed on 8, 9 November 2011 and 13 January 2012, and recovered on 16 February 2012

Coastal Observatory cruises 80, 81, 82: deployed on RV Marisa (twice), recovered on Prince Madog 12/02. Durations are 99 or 34 days.

Site MBS – Frame: NOCL rig ID 1133 (deployment in new style frame, 99 days)

600 kHz ADCP S/N 5807. The data look OK for the full duration. The frame orientation changed significantly on two occasions during stormy weather (significant wave heights greater than 3.5 m, by 15° on 8 December and by 25° on 29 December). On each occasion there was no detectable pressure change. There was no detectable pressure, orientation, tilt or roll change on 13 January when the acoustic releases were fired during the recovery attempt on Marisa. The frame was recovered at the first dragging pass on 16 February.

SeaBird 16*plus* S/N 4596 with Aanderaa Optode S/N 675 mounted horizontally with pumped conductivity sensor. Gaps appeared in the record on 2 February (after 85 days) and the record ended on 6 February 2012 due to low battery. Before the record failed there were two negative jumps in salinity, by ~0.2 g kg^{-1} on 5 January and by a further ~0.3 g kg^{-1} on 21 January 2012 (by comparison with the MicroCAT at −15 m).

The pressure and oxygen records end at 20:30 on 28 January. The oxygen data are low throughout, starting at 90% saturation. After 20 days, values decrease so that at the end they are between 75 and 80% saturation. For the time of year these are unrealistic.

FSI NXIC S/N 2278 with SeaPoint turbidity S/N 10471 on 0–500 FTU range; mounted horizontally about 0.25 m below the SeaBird. The temperature and pressure data look OK. The temperature data appear to be 0.006°C higher compared with the SBE 16*plus* on this deployment and both CT loggers deployed on the frame for 81. There is an immediate decrease in salinity, by 0.16, over the first 3 hours. Thereafter the record looks OK for 42 days (up to 20 December) and then progressively deteriorates.

Site MBS – Mooring: NOCL rig ID 1134 (surface buoy spar buoy, 99 days)

MicroCATs S/Ns 2991, 5790, 5433 nominally at 5, 10 and 15 m below the surface.

The depth ranges recorded by 5790 and 5433 are 12.1–9.5 m and 16.6–11.9 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 ~0.003 g kg^{-1} for salinity (after adding 0.009 to salinity for 5790, a correction deduced for its previous deployment (78)).

StarOddi S/N 2836 at 7.5 m below the surface. When the water column is well mixed the temperature values agree to within 0.005°C with the MicroCATs above and below it. (The StarrOddi digitization interval is 0.012°C.)

Site MBS – Frame: NOCL rig ID 1135 (deployment in new style frame, 34 days)

600 kHz ADCP S/N 2390. The data look OK. There is an 8° difference in heading between the overlapping ADCP deployments. Since the two frames were about 230 m apart and overlapped for 34 days the two ADCP speed records can be compared to estimate uncertainties – the standard deviation of the current speed differences increased from 0.027 m s^{-1} for the near bed bin to 0.069 m s^{-1} for bin 17.

SeaBird 16*plus* S/N 4738 with Aanderaa Optode S/N 674 mounted horizontally with pumped conductivity sensor. The temperature and pressure data look OK. There is an offset of 0.05 g kg^{-1} in salinity by comparison with the MicroCAT at −15 m.

The oxygen data appear low throughout by a constant amount, at ~90±1.5% saturation.

FSI NXIC S/N 2277 with SeaPoint turbidity S/N 12113 on 0–500 FTU range mounted horizontally about 0.25 m below the SeaBird. The temperature and pressure data look OK. The salinity data appear OK for about 15 days, until 28 January. It is disappointing that the FSI salinity record deteriorated for both deployments.

MJH, 14th March 2012

9. Cruise participants and acknowledgements

The assistance of the master, officers and crew of the R.V. Prince Madog and all scientists is appreciated in ensuring the success of this cruise.

Scientific personnel	*Ship's officers and crew*
Andy Lane (NOC), Principal Scientist	Steve Duckworth (Master)
Mathilde Bue (Bangor Univ.)	Robert Bassi (Chief Officer)
Terry Doyle (NOC)	Phil Jones (Bosun/AB)
Anne Forbes-Brook (Bangor Univ.)	Dave Leigh (AB)
John Kenny (NOC)	Tom Roberts (AB)
Nathan King (Bangor Univ.)	Les Black (Chief Engineer)
Jack Phelps (NOC)	Meikle Mackay (2nd Engineer)
Juliane Wihsgott (NOC)	Colin Hughes (Cook)

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
PAR	photosynthetically active radiation
SPM	suspended particulate matter
TSG	thermosalinograph

Table 10. CTD and ac-s station log

Station	CTD #	Date & Time	Latitude (N)	Longitude (W)	Depth (m)	SPM	Chl	CDOM	Nutrients	ac-s
P1	1	15/02/12 18:04	53° 31.783′	3° 21.228′	>20.9	✓	✓	✓	✓	
P2	2	15/02/12 18:34	53° 31.758′	3° 21.228′	27.0					✓
P3*	3	15/02/12 19:02	53° 31.753′	3° 21.257′	24.5	✓*	✓*	✓*	✓*	
P4	4	15/02/12 19:32	53° 31.766′	3° 21.291′	24.9					✓
MBS	5	16/02/12 08:39	53° 32.067′	3° 21.816′	23.7					
MBS	6	16/02/12 14:26	53° 31.877′	3° 21.339′	23.5	✓	✓	✓	✓	
1-1	7	16/02/12 15:01	53° 31.899′	3° 21.206′	24.5	✓	✓	✓	✓	
1-2	8	16/02/12 15:36	53° 31.893′	3° 21.202′	24.1					✓
1-3	9	16/02/12 16:02	53° 31.900′	3° 21.205′	25.7	✓	✓	✓	✓	
1-4	10	16/02/12 16:32	53° 31.906′	3° 21.206′	25.2					✓
1-5	11	16/02/12 17:00	53° 31.904′	3° 21.208′	>20.2	✓	✓	✓	✓	
1-6	12	16/02/12 17:30	53° 31.906′	3° 21.211′	26.3					✓
1-7	13	16/02/12 18:01	53° 31.907′	3° 21.212′	26.2	✓	✓	✓	✓	
1-8	14	16/02/12 18:31	53° 31.914′	3° 21.215′	24.9					✓
1-9	15	16/02/12 19:01	53° 31.909′	3° 21.212′	25.7	✓	✓	✓	✓	
1-10	16	16/02/12 19:32	53° 31.908′	3° 21.215′	25.9					✓
1-11	17	16/02/12 20:01	53° 31.905′	3° 21.215′	25.0	✓	✓	✓	✓	
1-12	18	16/02/12 20:30	53° 31.901′	3° 21.211′						✓
1-13	19	16/02/12 20:01	53° 31.900′	3° 21.209′	23.5	✓	✓	✓	✓	
1-14	20	16/02/12 21:30	53° 31.908′	3° 21.217′	23.9					✓
1-15	21	16/02/12 22:01	53° 31.904′	3° 21.213′	23.6	✓	✓	✓	✓	
1-16	22	16/02/12 22:30	53° 31.911′	3° 21.227′	22.6					✓
1-17	23	16/02/12 23:00	53° 31.905′	3° 21.214′	22.4	✓	✓	✓	✓	
1-18	24	16/02/12 23:32	53° 31.896′	3° 21.211′	21.8					✓
1-19	25	17/02/12 00:00	53° 31.895′	3° 21.207′	21.5	✓	✓	✓	✓	
1-20	26	17/02/12 00:30	53° 31.902′	3° 21.211′	21.7					✓
1-21	27	17/02/12 01:02	53° 31.897′	3° 21.208′	21.4	✓	✓	✓	✓	
1-22	28	17/02/12 01:30	53° 31.900′	3° 21.206′	21.7					✓
1-23	29	17/02/12 02:03	53° 31.894′	3° 21.204′	22.2	✓	✓	✓	✓	
1-24	30	17/02/12 02:30	53° 31.894′	3° 21.202′	22.0					✓
1-25	31	17/02/12 03:00	53° 31.893′	3° 21.205′	22.5	✓	✓	✓	✓	
1-26	32	17/02/12 03:30	53° 31.895′	3° 21.203′	23.6					✓
1-27	33	17/02/12 04:00	53° 31.893′	3° 21.203′	24.3	✓	✓	✓	✓	

* 5 m from surface and near-bed only (no surface samples on third CTD profile)

Andy Lane, 22nd February 2012
Revised 15th March 2012