Liverpool Bay Observatory cruise 81 [12/01]

Dates: 10th & 13th January 2012
Ship: R.V. Marisa (Liverpool Univ. Research Vessel)
Principal Scientist (day 1): Matthew Palmer (NOC)
Principal Scientist (day 2): Joanne Hopkins (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 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 and 15 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

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. 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.

2. Cruise narrative

(All times are in GMT throughout this report)

Tuesday, 10th January 2012

The ACDP frame and other equipment were loaded at 08:30. At 09:30, wave heights at the Mersey Bar were reported to be 0.6 m increasing slowly, with force 3 winds (9 knots) forecast to increase to force 4. Marisa left Bramley Moore Dock at 09:39 to meet a lock time of 10:00. Meanwhile, reports of 0.8 m waves and high winds (force 5) at the Mersey Bar led to the decision to cancel the trip at 09:48.

Friday, 13th January

R.V. Marisa left Bramley Moore Dock at 09:00, entering Langton Lock at 09:52 and into the River Mersey at 10:13 (2¼ hours after LW). Wave heights were 0.6 m at 08:00 at the Mersey Bar. On station at E4 (10:56), a CTD profile was taken at 11:14; Niskin bottles did not fire. A second CTD profile was taken at 11:24, followed by profiles at E3 (12:01) and MBS (12:37). The ADCP bedframe was deployed at 13:07.

Recovery of the old bedframe began at 13:12 with the sending of an acoustic release signal at 13:22. The frame was not seen at the sea surface, so there was an unsuccessful attempt at trawling for it between 13:40 and 14:45. The Harbour Master and relevant authorities were informed of the position and nature of the potential hazard to shipping. Marisa headed to Gladstone Lock, arriving at 16:15. The ship returned to Bramley Moore Dock, having left the lock at 16:40.

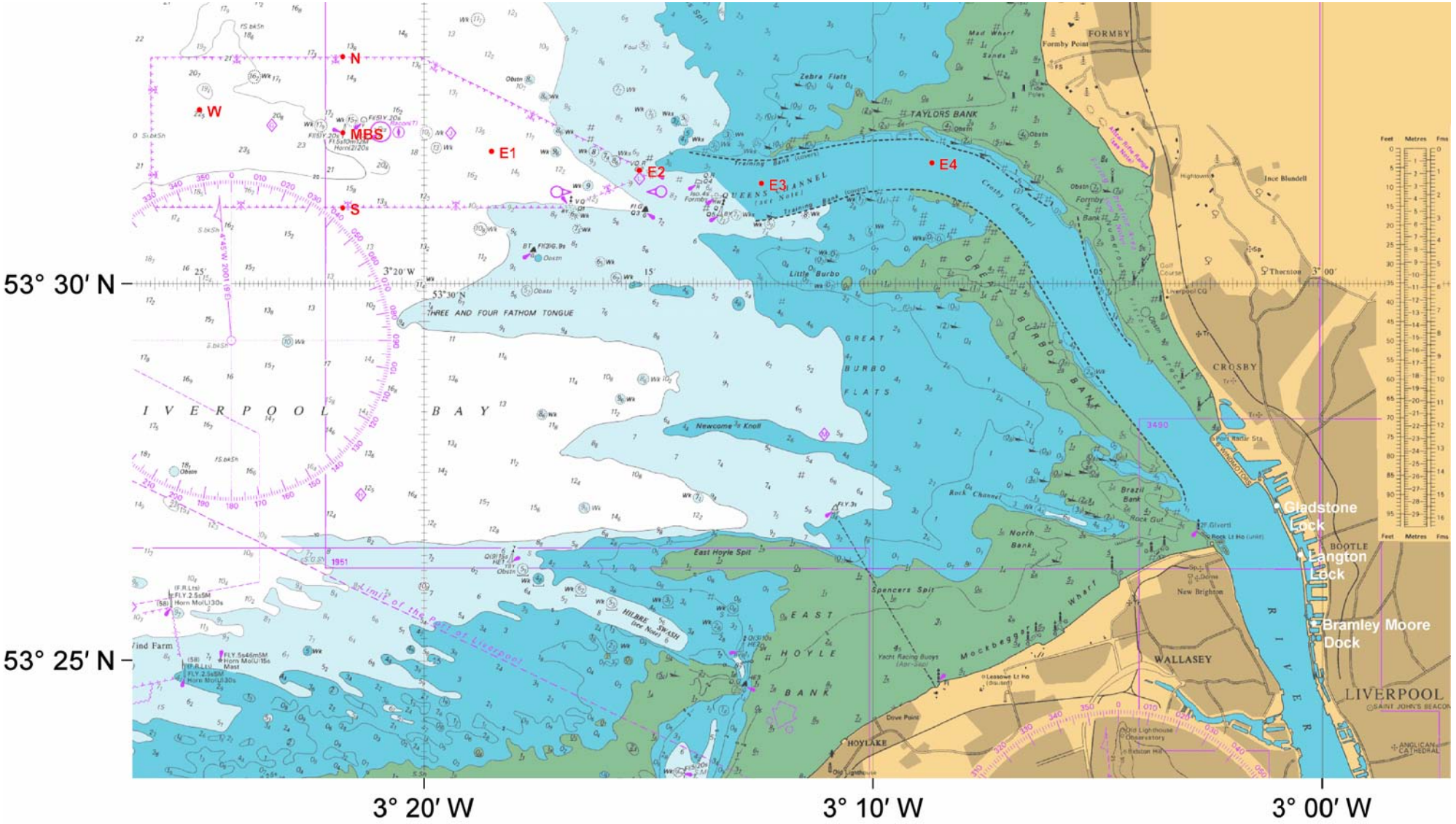

Figure 1. Liverpool Bay Observatory cruise 81, CTD stations, 10th & 13th January 2012

3. Moorings

3.1 Recovered instrumentation

There were no recoveries of instrumentation.

3.2 Deployed instrumentation

Site MBS bedframe

Table 2 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=10.5 kHz, Tx=12.0 kHz, RC=C), S/N 72378 (Rx=10.5 kHz, Tx=12.0 kHz, RC=A).

Table 1. Deployed mooring positions and times

	Latitude (N)	Longitude (W)	Water depth (m)	Date	Time (GMT)
ADCP frame	53°31.876	3°21.413	27.7	13/01/2012	13:07
Spar buoy (not deployed)	-	-	-	-	-

Table 2. Instruments deployed on the Site MBS bedframe

Instrument	S/N	Notes	Clock set	Delayed start
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
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
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
SeaPoint turbidity sensor	12113	Taped to roll bar and setup for 0–125 FTU range; fitted with wiper.	-	-

4. CTD/LISST survey

Table 3 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.

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

Table 3. 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) 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. 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, day 1
Matthew Palmer (NOC), Principal Scientist
Ray Edun (NOC)
Emlyn Jones (NOC)
John Kenny (NOC)
Katrien van Landeghem (Univ. Liverpool)
Danny McLaughlin (NOC)
Jack Phelps (NOC)
Juliane Wihsgott (NOC)

Scientific personnel, day 2
Joanne Hopkins (NOC), Principal Scientist
Ray Edun (NOC)
John Kenny (NOC)
Danny McLaughlin (NOC)
Jack Phelps (NOC)
Juliane Wihsgott (NOC)

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 4. 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 5. CTD station log

Station	CTD #	Date & Time	Latitude (N)	Longitude (W)	Depth (m)	SPM	Chl	CDOM	Nutrients
E4*	1	13/01/12 11:14	53° 31.765′	3° 08.777′	24.1				
E4	2	13/01/12 11:24	53° 31.829′	3° 08.974′	31.0	✓	✓	✓	✓
E3	3	13/01/12 12:01	53° 31.408′	3° 08.677′	15.0	✓	✓	✓	✓
MBS	4	13/01/12 12:37	53° 32.013′	3° 21.813′	27.7	✓	✓	✓	✓

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

Andy Lane, 22nd February 2012
Revised 5th March 2012