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The Liverpool Bay Coastal Observatory

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A pre-operational Coastal Observatory has been functioning since August 2002 in Liverpool Bay, Irish Sea. Its rationale is to develop the science underpinning the ecosystem based approach to marine management, including distinguishing between natural and man-made variability, with particular emphasis on eutrophication and predicting responses of a coastal sea to climate change. Liverpool Bay has strong tidal mixing, receives fresh water principally from the Dee, Mersey and Ribble estuaries, each with different catchment influences, and has enhanced levels of nutrients. Horizontal and vertical density gradients are variable both in space and time. The challenge is to understand and model accurately this variable region which is turbulent, turbid, receives enhanced nutrients and is productive.

The Observatory has three components, for each of which the goal is some (near) real-time operation – measurements; coupled 3-D hydrodynamic, wave and ecological models; a data management and web-based data delivery system which provides free access to the data, http://cobs.pol.ac.uk.

The integrated measurements are designed to test numerical models and have as a major objective obtaining multi-year records, covering tidal, event (storm / calm / bloom), seasonal and interannual time scales. The four main strands on different complementary space or time scales are:-
a) fixed point time series (in situ and shore-based); very good temporal and very poor spatial resolution. These include tide gauges; a meteorological station on Hilbre Island at the mouth of the Dee; two in situ sites, one by the Mersey Bar, measuring waves and the vertical structure of current, temperature and salinity. A CEFAS SmartBuoy whose measurements include surface nutrients is deployed at the Mersey Bar site.
b) regular (nine times per year) spatial water column surveys on a 9 km grid; good vertical resolution for some variables, limited spatial coverage and resolution, and limited temporal resolution. The measurements include nutrients and on board pCO2.
c) HF radar for surface currents and waves; very good temporal resolution, limited spatial resolution (4 km grid) and range ($\sim$75 km).
d) an instrumented ferry between Birkenhead and Dublin; along track 100 m resolution, crossing there and back most days.
These are supplemented by weekly composite (because of cloud cover) satellite images of sea surface temperature, suspended sediment and chlorophyll; excellent horizontal resolution for surface properties, poor temporal coverage.

A suite of coupled 3-D hydrodynamic, wave and ecological models forced by forecast meteorology is being developed. The model domains are nested from a 12 km grid ocean / shelf domain, 1.8 km Irish Sea and finally to 180 m for Liverpool Bay. Making real time forecasts for comparison with measurements is difficult since the forecast is only as good as the forcing data, for instance the meteorology should be on spatial and temporal scales comparable with the oceanographic models' and real-time river flow data is needed (climatological mean data are not good enough, especially for local models).

The Observatory's design naturally involved compromises where model predictions can help, for instance should the detailed coverage be wider, including more of the Irish Sea, and / or should it extend closer to the shore, where biologically activity is greater? How many cruises should there be per year - nine visits will over-sample for a well defined seasonal cycle, such as temperature, but not for a variable with a more unpredictable or shorter

time scale, such as salinity or phytoplankton? After seven years the main scientific challenges remain both to understand the processes and to translate this into predictive models whose accuracy has been quantified. The challenges relate to physics (salinity, circulation in Liverpool Bay, the flow through the Irish Sea, flushing events); the role of sediments in the optical characteristics of the water column; the ecosystem and eutrophication.