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Medium term modelling of coupled hydrodynamics, turbulence and sediment pathways in a region of freshwater influence.

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Liverpool Bay, in the northwest of the UK, is a shallow, hypertidal region of freshwater influence. In this region, baroclinic processes significantly affect the residual circulation, which in turn influences the long term transport of sediment. A nested modelling system is implemented to simulate the coupled hydro and sediment dynamics in the bay.

We use the Proudman Oceanographic Laboratory Coastal Ocean Modelling System (POLCOMS), which is based on a three-dimensional baroclinic numerical model formulated in spherical polar terrain-following coordinates. The hydrodynamic model solves the three-dimensional, hydrostatic, Boussinesq equations of motion separated into depth-varying and depth-independent parts to allow time splitting between barotropic and baroclinic components. This model is coupled to the General Ocean Turbulence Model (GOTM), to the WAve Model (WAM), and includes state-of-the-art Eulerian and Lagrangian sediment transport models.

We implement POLCOMS to Liverpool Bay at a horizontal resolution of approximately 180 m. The bathymetry consists of digitized hydrographic charts combined with LIDAR and multibeam data. Three-dimensional baroclinic effects, river inputs, surface heating and offshore density structure are all considered. Liverpool Bay is subjected to a spring tidal range in excess of 10 m and thus intertidal areas are significant. Wetting and drying algorithms are therefore also implemented. A nesting approach is employed to prescribe offshore boundary conditions for elevations, currents, temperature and salinity. Boundary values are obtained from numerical simulations for the entire Irish and are then used to force the three-dimensional hydrodynamics in the Liverpool Bay domain. Atmospheric forcing consists of hourly wind velocity and atmospheric pressure, and three-hourly cloud cover, humidity and air temperature. We focus here on numerical simulations for a full year, 2008, which is considered to be a typical year for atmospheric, riverine and coastal conditions.

We will assess the model's capabilities for currents, water column vertical structure and sediment dynamics via comparisons of numerical results with coastal observations. The observational data were collected at several locations in Liverpool Bay from two moorings, which were part of the National Oceanographic Centre's Coastal Observatory, and from month-long deployments of two bottom-instrumented tripods near the mouth of the Dee Estuary. In turn, the validated numerical results will be interrogated for spatial information on sediment dynamics and pathways in Liverpool Bay, which are difficult to obtain solely from few point measurements.