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A 3D Optimal Interpolation Assimilation Scheme of HF Radar Current Data into a Numerical Ocean Model

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In this work a technique for the 3D assimilation of ocean surface current measurements into a numerical ocean model based on data from High Frequency Radar (HFR) systems is presented. The technique is the combination of supplementary forcing on the surface and of and Ekman layer projection of the correction in the depth. Optimal interpolation through BLUE (Best Linear Unbiased Estimator)
of the model predicted velocity and HFR observations is computed in order to derive a supplementary forcing applied at the surface boundary. In the depth the assimilation is propagated using an additional Ekman pumping (vertical velocity) based on the correction achieved by BLUE.

In this work a HFR data assimilation system for hydrodynamic modelling of Galway Bay in Ireland is developed; it demonstrates the viability of adopting data assimilation techniques to improve the performance of numerical models in regions characterized by significant wind-driven flows.

A network of CODAR Seasonde high frequency radars (HFR) deployed within Galway Bay, on the West Coast of Ireland, provides flow measurements adopted for this study. This system provides real-time synoptic measurements of both ocean surface currents and ocean surface waves in regions of the bay where radials from two or more radars intersect. Radar systems have a number of unique advantages in ocean modelling data assimilation schemes, namely, the ability to provide two-dimensional mapping of surface currents at resolutions that capture the complex structure related to coastal topography and the intrinsic instability scales of coastal circulation at a relatively low-cost. The radar system used in this study operates at a frequency of 25MHz which provides a sampling range of 25km at a spatial resolution of 300m.A detailed dataset of HFR observed velocities is collected at 60 minute intervals for a period chosen for comparison due to frequent occurrences of highly-energetic, storm-force events. In conjunction with this, a comprehensive weather station, tide gauge and river monitoring program is conducted. The data are then used to maintain density fields within the model and to force the wind direction and magnitude on flows. The Data Assimilation scheme is then assessed and validated via HFR surface flow measurements.