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Characterizing ocean gyres formation within a bay using vorticity and HF radar measurements

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In situations in which wind forcing plays a dominant role in surface currents it becomes important to understand its correlation with parameters that can be used to characterise circulation patterns within a bay. These datasets can then be used in the detection and characterisation of ocean gyres. A network of high frequency radars (NUIG CODAR) is deployed within Galway Bay, on the West Coast of Ireland as a backbone system within an integrated coastal ocean observation system. This system provides real-time synoptic measurements of both ocean surface currents and surface waves across the entire bay.

In this work, vorticity is identified as a defining quantity for the characterisation of circulating flow patterns (in particular for the detection of ocean gyres) and it is directly calculated from the measured velocity vectors of NUIG CODAR. A correlation study with wind and tide measurements is then undertaken in order to investigate the dependencies between vorticity and those parameters. A comprehensive NUIG CODAR, weather station and tide gauge monitoring program was conducted over a 30 days period and the data collected analysed for the correlation with the computed vorticity. Tidal information from the FES2004 Global tidal atlas defined surface elevations at the open sea boundaries in the west and in the south. Data from a tide gauge deployed within the bay, which provided real-time tidal data at 6 minute intervals, was used to fine-tune model elevations. A weather station located at National University of Ireland, Galway provided measured wind data for the model.

The NUIG CODAR coastal observation system detects strong, non-persistent, gyre formation within Galway Bay. During periods of relatively large tidal ranges (order 4m) and light wind conditions well defined, cyclonic circulation is developed within the bay. The correlation analysis shows that the gyres tend to form soon after high tide and last until the next low water; the gyre structure is transported about the bay with the bulk advection of tidal motion. This is the first time this feature has been observed and the significance of its consequences on water circulation will be the subject of future research.