

The coastal ocean atmospheric boundary layer and air-sea interaction

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Background

Liverpool Bay is part of the northern Irish Sea, lying between NW England and N Wales, in which an intensive oceanographic observation and modelling programme is taking place as part of the POL Coastal Observatory (<http://cobs.ac.uk>). Long-term measurements of waves and currents are being made from moored instruments and shore-based radars. Measurements of the marine atmospheric boundary layer are being made at a tower on Hilbre Island, where the X-band radar is based which measures waves and bathymetry over a region of radius several kilometres. Detailed models of tides, wind-driven and density-driven currents, waves and sediments are being developed in this area and the coastal impacts of storm waves and surges have been studied over many years.

Project

Model winds are routinely supplied from the UK Met Office mesoscale model (presently at 12km resolution) but the local effects of the land-sea boundary layer and the mountains of Snowdonia will have important local effects. Various local area wind models are available, including the PSU/NCAR mesoscale model known as MM5 (<http://www.mmm.ucar.edu/mm5/>) and the NCEP/NCAR WRF model which is now widely used by many research groups. These are limited-area, nonhydrostatic, terrain-following sigma-coordinate models designed to simulate or predict mesoscale atmospheric circulation. The project will investigate the capabilities of an appropriate mesoscale model and implement it for the Liverpool Bay area. Details of the atmospheric boundary layer in the coastal ocean will be the primary focus of the study, investigating the air-sea momentum exchange to waves and currents, with impacts on coastal flooding and erosion in extreme storms. This model will be used to drive the POLCOMS-WAM hydrodynamic and wave model system and results will be compared with the available measurements to investigate the local variability of winds, waves and currents in Liverpool Bay. This project will link to a new EU project – FIELD_AC – which aims to improve nearshore oceanographic forecasts using state-of-the-art models applied to four test areas; one of which is Liverpool Bay. As part of this project the Barcelona Supercomputing Center will be setting up mesoscale atmospheric models and their experience will be available to facilitate setting up the atmospheric model for Liverpool Bay. Supervisors at the University of Leeds Atmospheric Dynamics group working on boundary layer modeling will also assist in model setup and investigation.

Workplan

- Background reading on ocean-atmosphere interactions
- Literature Review
- Familiarisation with POLCOMS-WAM model
- Set up WRF model
- Implement atmosphere-ocean interactions
- Validate model system against available data
- Design model experiments to investigate the importance of the wave coupling in the atmosphere-ocean momentum exchange in the nearshore zone
- Write up results

Training

The student will divide their time between Leeds and Liverpool. The student will receive training in modelling techniques as well as basic research skills and have the opportunity to become familiar with data analysis of various instruments for measuring wind and waves. The supervisors will provide guidance in the development of a solid grounding in atmosphere and ocean dynamics, especially coastal oceanography and the atmospheric boundary layer. A good degree in the physical sciences as well as mathematical aptitude is required.



Liverpool Bay and the Coastal Observatory: blue squares are regular CTD stations, yellow squares are fixed moorings or coastal tide gauges.

References/background reading

Brown, J. and Wolf, J. 2009 Coupled wave and surge modelling for the eastern Irish Sea and implications for model wind-stress. *Continental Shelf Research* 29 (10), 1329–1342.

Gill, A.E. 1982 *Atmosphere-ocean dynamics*. Academic Press.