**Ocean to Coast: Impact of Deep Ocean on UK Coastal Sea Level**

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**Aims**: Investigate the impact of open ocean changes in sea level on the coastal environment.

**Background**: By 2050 there will be 9 billion people on the Earth. With populations growing fastest in coastal mega-cities, many will be vulnerable to flooding due especially to rising sea levels. Global mean sea level is predicted to rise by 56-200cm by 2100, but it is coastal sea level that is of most relevance to society, and yet there are fundamental questions still to be answered concerning what determines coastal sea level.

The project draws together two of the key pillars of excellence from the National Oceanography Centre that has emerged from a long history of world-class sea level and shelf sea science at Liverpool.

![North Atlantic bathymetry](image1)

![Sea level height snapshot](image2)

‘shelf seas’. The shelf seas meet the open ocean at the shelf break where the sea bed plummets from shallow seas $O(200m)$ into the deep $O(3000m)$ open ocean. (right) Sea level height snapshot. Note the difference in many regions between coastal and nearby deep ocean sea level. For example, the instantaneous ‘variability’ associated with the Gulf stream extension is deflected northwards along the Hebridean shelf break.

Shallow coastal oceans are separated from the deep ocean by a steep continental slope. This slope acts as a waveguide and a barrier, insulating coastal regions from deep ocean changes (Huthnance, 2004; Hughes and Williams, 2010; Bingham and Hughes, 2012) and trapping wind-driven changes on the shelf region (Smith, 1978). It has only recently become possible to run ocean basin scale numerical models with fine enough grids to resolve the slope region, and the dynamics that occur there (Fig. 1).

Theory suggests (Huthnance, 2004) that the slope should act as a filter, removing short wavelength variability and only allowing variability with wavelengths of more than about 1000 km to penetrate into shallow water, but such theory is yet to be married to our understanding of the deep ocean circulation. It is not yet clear how the coast would respond to open ocean sea level changes, which are driven by heating or wind stress.

Understanding the coupling between the open ocean and shelf sea is critical to understanding the impact of global mean sea level rise on the UK coastline.

**Project Summary / Research Strategy**: This project will use a range of ocean models, from simple theoretical studies up to state of the art simulations of the northern North
Atlantic (using NEMO 1/12 degree, with free surface and hybrid z-sigma levels). These simulations are run on the national high performance computer facility - 1 model year integration per 24 hours using 1024 processors.

The project has the following testable hypotheses:
1) Open ocean sea level changes influence sea level at the coast.
2) That influence is strongly affected by the presence of a steep continental slope.
3) The smoothing effect of the continental slope is determined by the speed of propagation of waves along the slope, and by friction.
4) Similar trapping limits how shallow water processes influence deep water sea level.

Year 1 - Classes; Literature review; Familiarise with model output and diagnostic methods - using a 25 year simulation investigate the dependence of coastal and open ocean sea level to shelf edge sea level over a range of sub-tidal frequencies (weekly to annual).
Year 2 - Run models with varying degrees of realism to investigate the impact of bottom friction on shelf edge wave properties (namely wavelength and impact on shelf edge mean sea level).
Year 3 - Simulate a number of IPCC sea level rise scenarios. Diagnose the connection between open ocean sea level, shelf edge wave activity and coastal mean sea level.

Training & opportunities: The student will also benefit from a comprehensive training programme provided by NOC and the Universities of Manchester and Liverpool (see http://www.liv.ac.uk/studentships-earth-atmosphere-ocean/training/). This training is designed to develop each student to their full potential as a researcher and equip them to compete for the very best jobs and research opportunities. The student will have opportunities to present their research results at postgraduate workshops and international conferences.

Eligibility: Applicants should possess, or expect to graduate with, a first class or upper 2nd class degree in a numerate science, such as physics, mathematics, physical oceanography or meteorology, and have an enthusiasm to engage in numerical modelling. Previous knowledge of ocean sciences is not essential. Some experience of computer programming is essential. Funding for this studentship is restricted to UK and EU nationals who fulfill NERC’s eligibility requirements. More information is available from the NERC website: http://www.nerc.ac.uk/funding/available/postgrad/eligibility.asp

References:
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Smith (1978). Low-frequency fluxes of momentum, heat, salt, and nutrients at the edge of the Scotian Shelf, JGR-Oceans, doi:10.1029/JC083iC08p04079
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