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The role of physical processes for biomass dispersion over submarine banks: a study at two locations in the Northeast Atlantic Ocean.

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Extended Abstract

The effect of the circulation at Porcupine Bank and Rockall Bank, two submarine banks in the Northeast Atlantic, are investigated for implications for the marine ecosystem, using a combination of observations and results from numerical ocean circulation modeli simulations. Passive tracers confirm the idea that there exist areas over the banks which a isolated from its surroundings. Lagrangian particle trajectories are used to test and quantify the potential for retention. We find that passively advected organisms are more likely to remain in the near surface layers above the banks than actively migrating organisms, who might escape from the area. Finally, the response to extreme wether events is illustrated and typical time scales of retention are quantified.

Many seamounts and submarine banks are known as areas with increased biomass which may act to promote distinct ecosystems (*Rogers*, 1994; *Genin*, 2004). From a number of observational and model studies at different sites across the world ocean there is evidence that biogeochemical dispersion patterns are profoundly influenced by two physical processes: Taylor cap formation through steady impinging flow (*Chapman and Haidvogel*, 1992) and non-linear flow rectification through tidal forcing (*Brink*, 1989, 1990). These processes are able to generate a variety of dynamical features like topographically trapped waves, flow amplification and closed circulation cells. In the present study we concentrate on two isolated topographic features in the Northeast Atlantic which are of particular scientific interest : Porcupine Bank, an isolated shelf break bank located west of Ireland and Rockall bank, a large topographic feature separating the Irminger basin from the Rockall Trough. Biochemical observations are combined with results from tracer simulations with a three-dimensional ocean circulation model adapted to the study areas. We investigate the flow dynamics and its potential for the retention of passively advected tracers (nutrients, phytoplankton) and actively vertically migrating particles (zooplankton, larvae) as well as the effect of extreme weather events (storms) on the tracer distribution patterns.

In this study we present a combined observational and modelling approach. Hydrographic and chemical in situ observations of available field surveys as well as SeaWiFS (Seaviewing

Wide Field-of-view Sensor) imagery, routinely processed at NERC Remote sensing Services a the Plymouth Marine Laboratory, are used to describe the biophysical characteristics. To investigate the effect of the flow dynamics on biochemical dispersion patterns, the 3-dimensional ocean circulation model SPEM (S-coordinate primitive equation model, *Haidvogel et al.* (1993)) was adapted to the study area. The model domain spans the area from 47°N to 60°N and 22°W to 6°W. The model grid contains 320 x 190 grid points covering an area of 1280 x 760 km with 20 vertical levels. The initialisation of model model was prescribed for a typical early summer situation assuming high biological productivity and strong background stratification of the oceanic far field. The model forcing includes the main semidiurnal (M_2, S_2) and diurnal (K_1, O_1) constitents taken from the inverse tidal model TPX05.1 (*Egbert et al.*, 1994). In addition a mean background flow was introduced representing the poleward flowing slope current found at the southern Rockall Trough margin.

This study is part of the ongoing Irish HEA PTRLI cycle 3 marine program *Physical processes and transport pathways at the continental margin and deep water west of Ireland*.

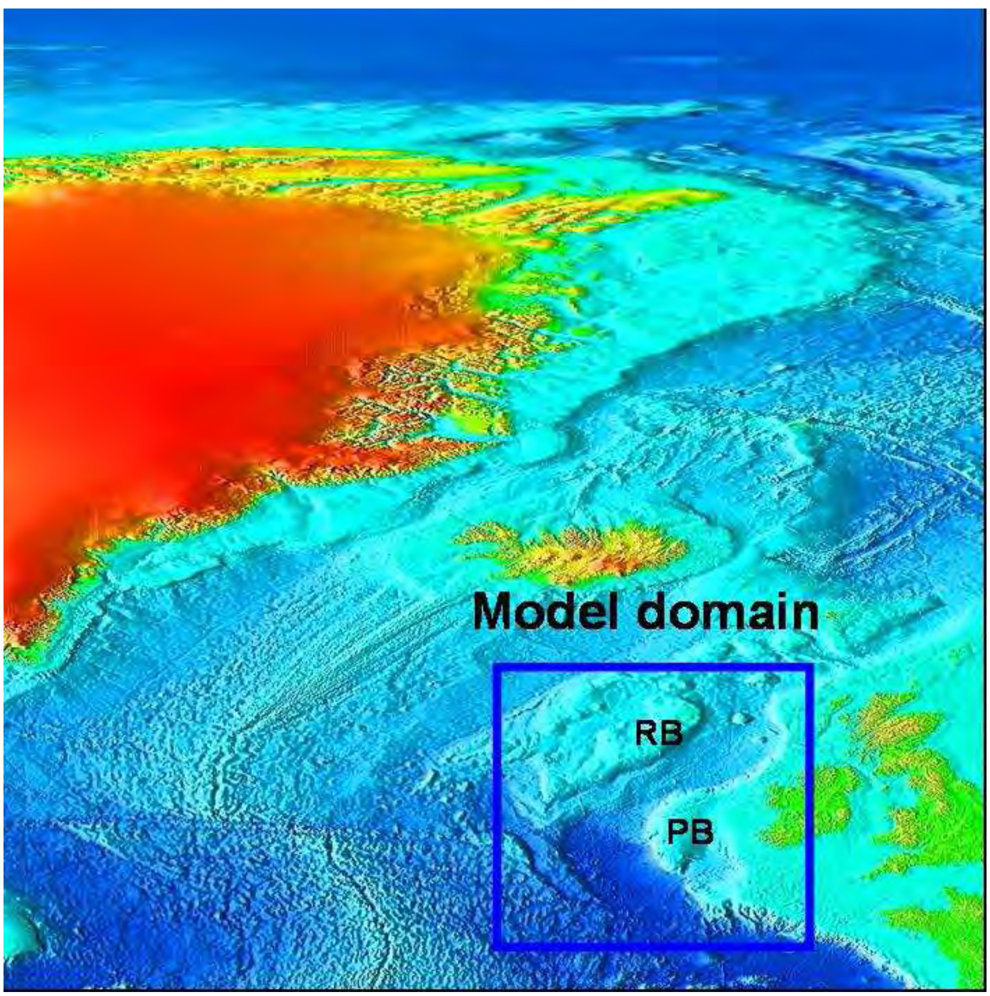

Figure 1: Study area and model domain (RB = Rockall Bank, PB = Porcupine Bank

References

Brink, K. H., The effect of stratification on seamount - trapped waves, *Deep-Sea Research*, *36*, 825–844, 1989.

Brink, K. H., On the generation of seamount - trapped waves, *Deep-Sea Research*, *37*, 1569–1582, 1990.

Chapman, D. C., and D. B. Haidvogel, Formation of Taylor caps over a tall, isolated seamount in a stratified ocean, *Geophysical and Astrophysical Fluid Dynamics*, *64*, 31–65, 1992.

Egbert, G., H. Bennett, and M. Foreman, TOPEX/POSEIDON tides estimated using a global inverse model, *Journal of Geophysical Research*, *99*, 24,821–24,852, 1994.

Genin, A., Bio-physical coupling in the formation of zooplankton and fish aggregation over abrupt topographies, *Journal of Marine Systems*, p. in press, 2004.

Haidvogel, D. B., A. Beckmann, D. C. Chapman, and R.-Q. Lin, Numerical simulation of flow around a tall isolated seamount. Part II: Resonant generation of trapped waves, *Journal of Physical Oceanography*, *23*, 2373–2391, 1993.

Rogers, A. D., The biology of seamounts, *Advances in Marine Biology*, *30*, 305–350, 1994.