Tidal rectification as a retention mechanism for tracers and marine organisms at isolated topographic features

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Many seamounts and submarine banks are known as oceanic areas with increased biomass and biodiversity and thus act as unique ecosystems that may also exhibit a significant level of endemism. There are strong indications that the biogeochemical dispersion patterns are profoundly influenced by two principal physical processes: Taylor cap formation through a steady impinging flow and non-linear flow rectification through tidal forcing.

In the present study we concentrate on two isolated topographic features of particular scientific interest: Porcupine Bank, an isolated shelfbreak bank located west of Ireland and Great Meteor Seamount in the North Atlantic.

Biogeochemical observations are combined with the numerical ocean circulation model SPEM (S-coordinate Primitive Equation Model) adapted to the study areas to investigate the impact of the three-dimensional flow on the observed biogeochemical distribution patterns. To take into account the different aspects of the flow dynamics, a high resolution and a combined steady and tidal forcing were introduced.

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Signatures of waves and mean flow were separated and interpreted. Tidal forcing is the dominant process at both areas, leading to internal wave generation, trapped waves, flow rectification and a system of closed circulation cells. We use passive tracers to confirm and quantify the idea that there exist areas which are largely isolated from the surroundings. Lagrangian particle trajectories are used to test and quantify the potential for retention.

We found that passively advected tracers and organisms (nutrients, phytoplankton) are more likely to remain in the near surface layers with increased residence times above the summits than actively migrating organisms (zooplankton, larvae) who might escape from the retention areas. Finally, the importance of strong wind events on the distribution of particles is illustrated.

References

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