Mixing Over Rough Topography

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LONG-TERM GOALS

To understand quantify diapycnal mixing in the ocean.

OBJECTIVES

To understand mixing over rough topography.

APPROACH

To supplement NRL's Mixing Over Rough Topography (MORT) measurements over East Flower Garden Bank on the Texas continental shelf in late 2012. Specifically, at NRL's request, we operated SWIMS3, a depth-cycling towed body to 1) Assess hydraulic control along lines crossing the bank, and 2) Measure turbulent dissipation rates over the bank.

WORK COMPLETED

The measurements were made, analyzed, and published.

RESULTS

Some of the most intense turbulence in the ocean occurs in hydraulic jumps formed in the lee of sills where flows are hydraulically controlled, usually by the first internal mode. Observations on the outer Texas-Louisiana continental shelf reveal hydraulic control of internal mode-2 lasting more than three hours over a 20-meter-high ridge on the 100-meter-deep continental shelf. When control began the base of the weakly stratified surface layer bulged upward and downward, a signature of mode-2. As the westward flow producing control was lost, large-amplitude disturbances, initially resembling a bore in the weakly stratified layer, began propagating eastward. Average dissipation rates inferred from density inversions over the ridge were 1e-8 and 1e-7 W/kg, one to two decades above local background. Corresponding diapycnal diffusivities were 1e-4 to 1e-3 meter-squared per second. Short-term mixing averages did not evolve systematically with hydraulic control, possibly owing to our inability to observe small overturns in strongly stratified water directly over the ridge.

To test the feasibility of our interpretation of the observations, hydrostatic runs with a three-dimensional MITgcm simulated mode-2 control and intense mixing over the ridge below the interface.

Details differed from observations, principally because we lacked three-dimensional density fields to initialize the model which was forced with currents observed by a bottom-mounted ADCP several kilometers east of the ridge. Consequently, the model did not capture all flow features around the bank. The principal conclusion is that hydraulic responses to higher modes can dominate flows around even modest bathymetric irregularities.

IMPACT/APPLICATIONS

Increasing evidence demonstrates that mixing at the ocean's boundaries is of major importance to the large-scale dynamics of ocean basins. Developing accurate models first requires understanding and quantifying how mixing occurs on the boundaries. These results are one of many steps needed.

RELATED PROJECTS

I am retired and have no related projects.

PUBLICATIONS

Gregg and Klymak (2014) Mode-2 hydraulic control of flow over a small ridge on a continental shelf. J. Geophys. Res., 119, 8093-8108

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14. ABSTRACT

Measurements with a depth-cycling towed body and microstructures over and near East Flower Garden Bank were made as part of NRL's Mixing Over Rough Topography (MORT) program, funded by ONR. Our major result was observing the evolution of mode-2 hydraulic control over a ridge on the north slope of the bank. Because ridges like this are common on continental shelves, these observations point to the need to include mixing driven by hydraulic controls over many bottom irregularities.

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