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Centrifugal Instability and Mixing in the California Undercurrent

William Dewar (1), James McWilliams (2), and Jeroen Molemaker (2)

(1) Florida State University, Department of Earth, Ocean and Atmospheric Science, Tallahassee, FL, United States (dewar@ocean.fsu.edu, +1-(0)850-6442581), (2) AOS, UCLA, Los Angeles, CA

A regional numerical study of the California Current System near Monterey Bay, California is conducted using both hydrostatic and non-hydrostatic models. Frequent sighting of strong anticyclones ('Cuddies') have occurred in the area, and previous studies have identified it as an apparent region of strong unbalanced flow generation. Here by means of a down-scaling exercise, a domain just downstream of Point Sur is analyzed and argued to be a preferred site of diapycnal mixing. The scenario suggested by the simulations involves the generation of negative relative vorticity in a topographically attached boundary layer by interactions of the California Undercurrent with the California continental shelf break. At Point Sur, the current separates from the coast and moves into deep waters where it rapidly develops finite amplitude instabilities. These manifest as isopycnal overturnings, but in contrast to the normal Kelvin-Helmholtz paradigm for mixing, we argue the instability is primarily centrifugal. The evidence for this comes from comparisons of the model with linear results for ageostrophic instabilities.

Mixing increases the potential energy of the fluid, either by negatively buoyant fluids being lifted and positively buoyant fluids deepened by overturnings or buoyancy being conducted deeper into the fluid by explicit diffusion. We argue the regional potential energy generation near Point Sur in the upper few hundred meters is comparable to and possibly larger than that typically estimated for the open ocean. We compute diapycnal fluxes and estimate turbulent diffusivities in two ways; both argue mixing by centrifugal instability is characterized by diffusivities of (2-4)x10-4m2/s.