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Turbulence, submesoscales, and the spin down of ocean fronts

JOHN TAYLOR, Department of Applied Mathematics and Theoretical Physics, University of Cambridge — Ocean fronts, regions of strong horizontal density gradients, are important for many processes in the ocean, including heat transport, CO2 uptake, water mass formation, and biological productivity. Unlike non-rotating flow, where a horizontal density gradient would lead to gravitational slumping, many ocean fronts are balanced by an along-front flow known as the "thermal wind." However, this equilibrium is unstable to a variety of instabilities, some of which generate O(1-10km) features known as submesoscales, a major focus of recent work. Despite recent progress, several important questions remain, including: How do submesoscales interact with boundary layer turbulence, and how effective are they at transferring energy to smaller scales, thereby completing a down-scale route to dissipate frontal energy. Here, we will discuss two areas of research that address these questions. First, horizontal straining by submesoscale eddies enhances horizontal density gradients. When forced by surface cooling, these regions generate localized pockets of intense turbulence. Second, wind forcing can generate time-dependent currents that trigger "symmetric instability," which is efficient at extracting frontal kinetic energy and enhances small-scale turbulent dissipation.

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