Small-Scale Structure of Strongly Stratified Turbulence

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ABSTRACT

The small-scale structure of turbulence subjected to strong stratification is analyzed with rapid distortion theory to evaluate the performance of formulas for predicting dissipation of turbulent kinetic energy and dissipation of scalar variance. The approach is restricted to weak turbulence in strong stratification, like that in the thermocline or the abyssal ocean. Flows with and without mean shear are considered. For unsheared turbulence, the small scales are axisymmetric about the vertical axis, as others have previously assumed. The calculations here complement and extend previous work because they can be used to compute errors in dissipation estimates, develop simpler formulas, and examine the effects of shear and other parameters. For example, effects of the initial conditions can be significant. For sheared turbulence, the small-scale velocity and buoyancy fields are neither isotropic nor axisymmetric about the vertical axis. Although dissipation formulas based on isotropy work relatively well for unsheared turbulence, some can be incorrect by more than a factor of 3 for sheared turbulence. However, if the mean flow direction can be identified, then a simple and useful dissipation formula can be proposed.

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