Waves and vortices in stratified turbulence with little or no rotation

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Abstract

Strongly stratified flows are composed of vortical motion (with PV) and internal gravity waves. At the largest scales of the atmosphere and ocean where Coriolis effects are strong, vortical motion dominates and the flow is described well by quasigeostrophic turbulence theory and a downscale cascade of inertial-gravity wave energy. Moving into the atmospheric mesoscale and oceanic submesoscale, rotational effects weaken. In the (inviscid) limit of strong stratification without rotation, the vertical scale of the vortical motion collapses, and large-scale dynamics reduce to decoupled layerwise two-dimensional turbulence. In a real fluid, of course, the scale does not collapse: it is limited by viscosity, small-scale turbulence, or rotation. Previous results on stratified turbulence both with and without rotation will briefly be recalled. In this talk, the focus is on simulations of turbulence forced by vortical motion for a wide range of stratifications. An additional goal is to explore the gap between stratified and QG turbulence by examining how the flow varies as the Rossby number goes from infinity to $O(1)$. Implications for "realistic" atmosphere/ocean modelling will be discussed. The observed predominance of resonant interactions suggests improving temporal resolution of fast wave modes rather than using numerical schemes designed to permit excessively large time steps.

Join work with Michael L. Waite, McGill University.