Center for Environmental & Applied Fluid Mechanics

"Vortical and Wave Modes in Rotating Stratified Turbulence"

Presented by
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Utilizing an eigenfunction decomposition, we study the growth and spectra of energy in the vertical (geostrophic) and wave (ageostrophic) modes of a three-dimensional (3D) rotating stratified fluid as a function of _ = f/N, where f is the Coriolis parameter and N is the Brunt-Vaisala frequency. Working in regimes characterized by moderate Burger numbers, i.e. Bu = 1/_2 < 1 or Bu _ 1, our results indicate profound change in the character of vortical and wave mode interactions with respect to Bu = 1. As with the reference state of _ = 1, for _ < 1 the wave mode energy saturates quite quickly and the ensuing forward cascade continues to act as an efficient means of dissipating ageostrophic energy. Further, these saturated spectra steepen as _ decreases: we see a shift from k−1 to k−5/3 scaling for kf < k < kd (where kf and kd are the forcing and dissipation scales, respectively). On the other hand, when _ > 1 the wave mode energy never saturates and comes to dominate the total energy in the system. In fact, in a sense the wave modes behave in an asymmetric manner about _ = 1. With regard to the vortical modes, for _ _ 1, the signatures of 3D quasigeostrophy are clearly evident. Specifically, we see a k−3 scaling for kf < k < kd and, in accord with an inverse transfer of energy, the vortical mode energy never saturates but rather increases for all k < kf. In contrast, for _ > 1 and increasing, the vortical modes contain a progressively smaller fraction of the total energy indicating that the 3D quasigeostrophic subsystem, though always present, plays an energetically smaller role in the overall dynamics.

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11:00 a.m., 110 Maryland Hall