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Transition in energy spectrum of stably stratified turbulence YOSHI KIMURA, Nagoya Univ., JACKSON HERRING, NCAR — Energy spectra for forced stably stratified turbulence are investigated numerically using the Direct Numerical Simulations (DNS) with 1024^3 grid points. The calculation is done by solving the 3D Navier-Stokes equations under the Boussinesq approximation pseudo-spectrally. Using toroidal-poloidal decomposition (Craya-Herring decomposition), the velocity field is divided into the vortex mode (ϕ_1) and the wave mode (ϕ_2). With the initial kinetic energy being zero, the ϕ_1 spectra as a function of horizontal wave numbers, $k_\perp$, first develops a $k_\perp^{-3}$ spectrum for the whole $k_\perp$ range, and then $k_\perp^{-5/3}$ part appears with rather a sharp transition wave number. Meanwhile the ϕ_2 spectra shows $k_\perp^{-2}$ first, and then $k_\perp^{-5/3}$ part appears with the same transition wave number. Spectra for different values of the Brunt– Väisälä frequency $N^2 = 1, 10, 50\text{and}100$ are investigated, and we found that the $k_\perp^{-3}$ part at the large scale in the phi_1 spectra is characterized as 2d turbulence, and that the whole spectrum has the form of $E(k_\perp) = a\eta_{\perp\phi_1}^{2/3} k_\perp^{-3} + C_K \varepsilon_{\perp\phi_1}^{2/3} k_\perp^{-5/3}$ where $\eta_{\perp\phi_1}$ is the horizontal enstrophy dissipation based on the ϕ_1 energy, and $\varepsilon_{\perp\phi_1}$ is the horizontal ϕ_1 energy dissipation. Meanwhile we obtain $E(k_\perp) = b\sqrt{N\varepsilon_{\perp\phi_2}} k_\perp^{-2} + C_K \varepsilon_{\perp\phi_2}^{2/3} k_\perp^{-5/3}$ for ϕ_2 where $\varepsilon_{\perp\phi_2}$ is the horizontal ϕ_2 energy dissipation. For both cases, $C_K \approx 1.2 \sim 2.0$ is obtained being close to the Kolmogorov constant.

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