Transition to turbulence in large aspect ratio domains filled with stratified fluids

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Internal and inertial waves are ubiquitous in oceans, translation of global tidal energy input to smaller scales may impact the vertical mixing and global currents. Dynamics of internal and inertial waves in closed domains possess a remarkable property of focusing on the geometrical limit cycles called wave attractors. The significant growth of amplitude at wave attractors results in instabilities for viscous fluids. The scenarios of transition to turbulence and description of fully turbulent regimes differ substantially from the cases observed in closed domains in absence of wave attractors. Our previous studies demonstrated the key role of a cascade of triadic resonances as the route to fully developed wave turbulence, either with overturning events or not. In present report we first consider a shallow trapezium and the wave attractors with multiple reflections from the horizontal boundaries. The exact ray theory solution for the coordinates of such (n,1) wave attractors was obtained, as well as the expression for the calculation of the Lyapunov exponents. The saturation time of (n,1) wave attractors in laminar viscous fluids grows linearly with n if the wavemaker is located at the sidewall. Next we show that in a shallow elongated domain with small aspect (depth-to-length) ratio, the frequency spectrum of (1,1) wave attractor motion may exhibit significant peaks at integer and half-integer multiples of the forcing frequency. For the aspect ratio of about one tenth the temporal average of total kinetic energy grows monotonically with amplitude and have a bend at a particular amplitude. Below this amplitude the cascade transferring energy to superharmonic components prevails, while above this value the amplitudes of subharmonic and superharmonic waves are comparable. The spatial spectra of waves in the domains of the aspect ratio varying from small values to the values close to unity are compared. It is shown that in the former case (i.e. for elongated shallow domains) the spectrum has two zones at small and high wave numbers characterized by different slopes. The fully turbulent regimes show the trend toward long-term evolution leading to new regimes with complex resonant dynamics of large-scale coherent structures.