Direct Numerical Simulation of Wave Interacting With a Turbulent Layer in a Stratified Domain

Numerical simulations of internal wave beams generated as a result of the barotropic tide passing over steep topography show reflected wave beams upon interacting with the surface. However, observations do not capture such wave reflection. Instead, they indicate that the incident wave beam exhibits high levels of turbulent dissipation and wave energy in the upper ocean. We hypothesize that incident waves are absorbed by stratified turbulence near the surface, inhibiting their reflection. In this study, we perform three-dimensional direct numerical simulations, a computational method for solving fluid flow where all turbulent scales of motion are resolved, to approach this problem. In our setup where stratified turbulence is generated in the top half and forcing is applied near the bottom, creating waves that travel toward the turbulent layer. DNS has high accuracy with no modeling assumptions, and it is a tool for finding detailed information for many fundamental studies and as a benchmark for validating other turbulence modeling approaches.We apply the Hilbert transform, distinguishing the upward and downward traveling waves to diagnose wave reflection, should it occur. We also examine the energy of turbulent flow, in the forms of the total kinetic energy as it evolves in time and the spectrum of horizontal kinetic energy with respect to horizontal wave numbers. We compare results for cases in which only turbulence is present with cases in which upward waves are launched in the same domain. Based on our results, we observed minimal reflection of the waves off of the interface between the turbulent and non-turbulent regions. No significant changes to the energy of the turbulent region are observed with and without waves.