Surface Manifestation of Internal Waves Emitted by Submerged Localized Stratified Turbulence
Qi Zhou
Civil and Environmental Engineering, Cornell University

The internal waves (IW) radiated by the turbulent wake of a sphere of diameter D towed at speed U, in a linearly stratified Boussinesq fluid with buoyancy frequency N. The study focuses on a broad range of wave characteristics in the far-field of the turbulent wave source, specifically at the sea surface (as modeled by a free-slip rigid lid) where the IWs reflect. Six simulations are performed at Reynolds numbers \( \text{Re} \equiv U D/\nu \in \{5 \times 10^3, 10^5\} \) and Froude numbers \( \text{Fr} \equiv 2U/(ND) \in \{4, 16, 64\} \), with the wave-emitting wake located at a fixed distance of 9D below the surface. As the wake evolves for up to \( O(300) \) units of buoyancy time scale \( 1/N \), IW characteristics, such as horizontal wavelength \( \lambda_H \) and wave period \( T \), are sampled at the sea surface via wavelet transforms of surface horizontal divergence signals. The statistics of amplitudes and orientations of IW-induced surface strains are reported. IW-driven phenomena at the surface that are of interest to an observer, such as the local enrichment of surfactant and the transport of ocean surface tracers, are also discussed. The local enrichment ratio of surface scalar scales linearly with the steepness of IWs that reach the surface and often exceeds a possible visibility threshold. The nonlinear Lagrangian drifts of ocean tracers create a local divergence in lateral mass transport right above the wake centreline, an effect that intensifies strongly with increasing Fr.