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Low-frequency internal waves in Shiozu Bay, Lake Biwa: A numerical approach

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In this study, we present results from the three-dimensional unstructured numerical simulator SUNTANS, used to understand the dynamics of the low-frequency internal wave field inside Shiozu Bay, a bay in the Northern part of Lake Biwa. Initial conditions for a fine-scale grid were generated in using a coarse grid with measured heat fluxes and wind stress. After being compared against observational data, the simulation reproduced consistently the low-frequency internal wave field, (similar frequencies and waves features). Based on the analysis of integrated potential energy and integrated dissipated energy time series, this study shows that the low-frequency internal wave field that enters Shiozu Bay does not either completely dissipate or break. Moreover isotherm elevation associated to the internal the first horizontal mode and first vertical mode Kelvin wave highlights the cyclonic rotation pattern, which is characteristic of the Kelvin wave, within the bay. This result shows that the part of the Kelvin wave entering the bay goes in and out. Moreover the dynamic of the internal wave field within the bay displays an peculiar process at the narrowing of the bay. At the contraction of the bay, the flow speeds up and deep isotherms deepen further. These two processes generated turbulence by shear and strain; according to the turbulence model (Mellor and Yamada, 1982) turbulent kinetic dissipation rate reached 10^{-6} W kg^{-1}, occurring during the trough phase of the internal wave field. Additionally the occurrence of these enhanced turbulent events appears to depend on the amount of energy detained by the low frequency internal wave. When the internal wave field was energized by the wind the turbulent events were enhanced. Such events could modify the long-term distribution of material in the lake.

Keywords: wind forcing, internal waves, contraction, strain