

Internal tide induced turbulence observed in the coastal region near Izu-Oshima Island

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Internal waves are known as the important agents to mix the stratified interior oceans. The internal tides generated by the barotropic tidal flows over topography can not only induced turbulent mixing proximity to their generation sites, but also propagate to induce remote turbulence when they are broken and dissipated. A recent study by Masunaga et al. (2017) showed that the K1 internal tide can be trapped as the internal Kelvin wave propagating clockwise around the Izu-Oshima Island, and more importantly that these Kelvin waves are often intensified when the preexisting diurnal Kelvin wave is amplified by superposition with the newly generated diurnal Kelvin waves during stratified seasons. With this amplification, K1 internal tide frequently exhibits larger wave amplitudes compared to M2 internal tides. Although these results imply that turbulent mixing near the Izu-Oshima island is influenced dominantly by K1 internal tide/Kelvin wave, direct turbulence measurements are scarce in these regions. In this study, microstructure observations are conducted near the Izu-Oshima Island during May 2017 to directly measure turbulence induced by K1 internal tides, which are then compared to the numerical simulations. The results from the observations show that thermocline oscillates vertically with an amplitude of about 20 m caused by the internal Kelvin waves. The measured turbulence was intensified below the crest of the thermocline displacement at 30-40 m with the turbulent dissipation rates of $O(10^{-6} \text{ Wkg}^{-1})$. Also, turbulent dissipation rates became as strong as $O(10^{-7} \text{ Wkg}^{-1})$ above the trough of the thermocline displacement at 20 m depth. Based on the EOF analyses and the vertical mode decomposition, the former very strong turbulence is attributed mostly to the vertical shear of the first baroclinic mode of the Kelvin waves, while the latter is caused both by the first and the second baroclinic modes. The estimated eddy diffusivity reaches $O(10^{-3} \text{ m}^2\text{s}^{-1})$ within these turbulent layers.

Keywords: Internal Tide, Microscale Turbulent Mixing, Internal Kelvin Wave