A new parameterization of turbulent mixing caused by tidal flow over abyssal rough bathymetry

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It is believed that tidal interaction with abyssal rough bathymetry can create mixing hotspots extending upward from the ocean bottom. Although there exist parameterizations of bottom-enhanced tidal mixing, they do not take into account that the internal waves generated by tide-topography interactions transform from internal tidal waves to quasi-steady internal lee waves as $k_H U_0 / \omega$ increases and exceeds unity ($k_H$ is the horizontal wavenumber of the bottom topography; $U_0$ is the amplitude of the tidal flow; $\omega$ is the tidal frequency) (Mohri et al., 2010).

In this study, we formulate a new parameterization of tidal mixing over abyssal rough bathymetry in which the vertical decay scale of the energy dissipation rate ($\varepsilon$) is estimated by multiplying the theoretically obtained vertical group velocity of the internal tidal wave or the quasi-steady internal lee wave by the time scale of its nonlinear interaction (induced diffusion) with the background Garrett-Munk (GM) internal wave field (McComas and Müller, 1981). The resulting parameterization explicitly shows that the vertical decay scale of $\varepsilon$ becomes independent of $U_0$ but inversely proportional to $k_H$ squared when $k_H U_0 / \omega < 1$ and independent of $k_H$ but proportional to $U_0$ squared when $k_H U_0 / \omega > 1$.

It is confirmed that the formulated parameterization predicts the vertical distribution of $\varepsilon$ in agreement with that obtained from the eikonal calculation for the internal tidal wave or the quasi-steady internal lee wave propagating from the ocean bottom up into the background GM internal wave field (Iwamae et al., 2009; Hibiya et al., 2017).

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