Numerical Study of the Impacts of Ocean Bottom Roughness and Tidal Flow Amplitude on Abyssal Mixing

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Although an accurate representation of ocean mixing processes in global circulation models is essential for accurate climate predictions, parameterization of mixing over rough bathymetry remains uncertain. We perform here a series of eikonal calculations for a wide range of physical parameters to investigate the transfer of energy from upward propagating internal waves generated by tide-topography interactions to dissipation through nonlinear interaction with background three-dimensional Garrett-Munk-like internal waves.

Following the previous study (Mohri et al., 2010) and using a fixed N value, we assume that internal waves generated by tide-topography interactions can be classified into linear internal tides when $kU_0/\omega<1$ and quasi-steady lee waves when $kU_0/\omega>1$, where U_0 is the tidal flow amplitude, k the benthic bathymetric wavenumber, N the buoyancy frequency and ωthe semidiurnal tidal frequency. Of special note is that the vertical group velocity C_{gz} is inversely proportional to k for linear internal tides and proportional to kU_0^2 for quasi-steady lee waves, although the resonant interaction time is roughly inversely proportional to k for both cases. As a result, the resulting mixing hotspot becomes more restricted to the ocean bottom as bottom roughness increases for $kU_0/\omega<1$, independent of the tidal flow amplitude, but it extends upward as the tidal flow amplitude increases for $kU_0/\omega>1$, independent of the bottom roughness. In both cases, we can find a trade-off relationship between the energy dissipation rate at the ocean bottom and its vertical extent.

The accuracy of global circulation models will be improved by reflecting these results in the parameterization of mixing over rough bathymetry.

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