Generation of baroclinic tide energy in a global three-dimensional numerical model with different spatial grid resolutions

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The baroclinic tides are one of the most important energy sources for the deep ocean mixing that maintains the thermohaline circulation and the abyssal density stratification. In this study, we examine the global distribution of energy conversion rates from barotropic to baroclinic tides using a hydrostatic sigma-coordinate numerical model with a special attention to the dependence on the model grid resolution as well as the model topography resolution. The series of numerical experiments show that the baroclinic tidal energy conversion rate increases almost exponentially with the decrease of the horizontal grid spacing, namely from 1/5° to 1/20°.

The baroclinic tidal energy conversion rates for the semidiurnal tidal constituents (M_2, S_2) are more sensitive to the horizontal grid spacing than those for the diurnal tidal constituents (K_1, O_1), reflecting the difference of their horizontal wavelengths. The sensitivity of the baroclinic tidal energy conversion rate to the horizontal grid spacing is also dependent on the generation sites of baroclinic tides; it becomes very sensitive in the regions characterized by geologically young seafloor having numerous small-scale rough topographic features such as the Mid-Atlantic Ridges, the eastern Pacific Ridges, and the Mid-Indian Ocean Ridges, whereas it is less sensitive in the regions such the Indonesian Archipelago, and the western Pacific Ocean. The difference of the sensitivity can be best explained in terms of the value of the forcing function that is proportional to the square of the vertical velocity caused by barotropic tidal currents interacting with high-pass filtered bottom topography. Using the extrapolated value of the forcing function that takes into account all the topographic features generating baroclinic tides, we present the global distribution of the baroclinic tidal energy conversion rates in the limit of zero horizontal grid spacing.

Keywords: Baroclinic tides, Internal gravity waves, Turbulent mixing

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