Worldwide estimates of internal-tide-driven mixing at small-scale abyssal hills

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Abstract

The breaking of internal tides is believed to provide a large part of the power needed to mix the abyssal ocean and sustain the meridional overturning circulation. Both the fraction of internal tide energy that is dissipated locally and the resulting vertical mixing distribution are crucial for the ocean state, but remain poorly quantified. Here [1] we present a first worldwide estimate of mixing due to internal tides generated at small-scale abyssal hills. Our estimate is based on linear wave theory, a non-linear parameterization for wave breaking and uses quasi-global abyssal hill bathymetry, stratification and tidal data.

We show that a large fraction of abyssal-hill generated internal tide energy is locally dissipated over mid-ocean ridges in the Southern Hemisphere. Significant dissipation occurs above ridge crests, and, upon rescaling by the local stratification, follows a monotonic exponential decay with height off the bottom, with a non-uniform decay scale. We however show that a substantial part of the dissipation occurs over the smoother flanks of mid-ocean ridges, and exhibits a mid-depth maximum due to the interplay of wave amplitude with stratification.

Current tidal parameterizations only account for waves generated at large-scale satellite-resolved bathymetry. Our results suggest that the presence of small-scale, mostly unresolved abyssal hills could significantly enhance the spatial inhomogeneity of tidal mixing, particularly above mid-ocean ridges in the Southern Hemisphere. We link the three-dimensional map of dissipation to abyssal hills characteristics, ocean stratification and tidal forcing, and discuss its potential implementation in time-evolving parameterizations for global climate models.

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