Fission of internal solitary waves over shoaling topography cascades tidal energy to turbulence

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The tides are a major energy source of small-scale turbulence, and therefore diapycnal mixing, in the world's oceans. An understanding of the processes responsible for the cascade of energy from tides to turbulence is important in identifying when and where this mixing will take place. Internal solitary waves (ISWs) generated by tide-topography interactions are ubiquitous in the world's oceans and are thought to be important sources of mixing. Whilst the understanding of the dynamics and energetics of ISWs have been greatly advanced in the past a few decades, identification of the processes and mechanisms responsible for their dissipation is limited. Here we present velocity and turbulence measurements from the South China Sea, together with process-orientated numerical simulations, to demonstrate the key role of ISW fission, into groups of high-frequency internal waves over rough topography, in the dissipation of tidal energy. The results show that, as a result of the fission, wave-induced velocity shear is elevated over significant time periods coincident with a period of enhanced turbulent dissipation. We suggest that the enhanced dissipation is a result of instability and breaking of the high-frequency internal waves. The finding reveals an important pathway of tides-to-turbulence cascade and generation of turbulence and mixing in the ocean interior, having important implications for understanding ocean dynamics as well as its ecological and climatic impacts.

Keywords: internal solitary waves, tides, turbulence, energy cascade, fission

