Tidally driven mixing and dissipation in the stratified boundary layer above steep submarine topography

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Abstract

Motivated by the observation that most of the energy converted from barotropic tides to baroclinic internal waves radiates away from steep ridge systems (Ray and Mitchum [1997], Klymak et al, [2006]), we examine the near-boundary flow induced by a low-mode internal tide impinging on a sloping boundary via three-dimensional numerical simulation. Here we consider the 'deep-ocean' case relevant to continental slopes where the topography is supercritical, i.e. steeper than the inclination angle of energy propagation for internal tides. We focus on this regime specifically to exclude the special dynamics associated with critical reflection or the breaking of internal lee waves near the crest of isolated topographic features. The simulations resolve spatial scales within the inertial subrange; the grid spacing is about 1/25th the Ozmidov scale based on the maximum dissipation rate.

Spatial and temporal features of the near boundary flow are presented and the structure observed in the simulations is compared with high-resolution mooring data from above the slope in the Bay of Biscay (van Haren [2006]).The diapycnal diffusivity of the near-boundary flow is estimated by means of a synthetic dye release experiment along with the dissipation rate of kinetic energy. When scaled to ocean conditions, the values obtained are in reasonable agreement with the direct microstructure measurements of Kunze at al [2012]. The overall mixing efficiency is estimated to be 0.15, in good agreement with estimates in the stably-stratified atmospheric boundary layer (Lozovatsky and Fernando, [2013]).

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