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Parameterizing turbulence over abrupt topography[1]

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Stratified flow over abrupt topography generates a spectrum of propagating internal waves at large scales, and non-linear overturning breaking waves at small scales. For oscillating flows, the large scale waves propagate away as internal tides, for steady flows the large-scale waves propagate away as standing "columnar modes". At small-scales, the breaking waves appear to be similar for either oscillating or steady flows, so long as in the oscillating case the topography is significantly steeper than the internal tide angle of propagation. The size and energy lost to the breaking waves can be predicted relatively well from assuming that internal modes that propagate horizontally more slowly than the barotropic internal tide speed are arrested and their energy goes to turbulence. This leads to a recipe for dissipation of internal tides at abrupt topography that is quite robust for both the local internal tide generation problem (barotropic forcing) and for the scattering problem (internal tides incident on abrupt topography). Limitations arise when linear generation models break down, an example of which is interference between two ridges. A single "super-critical" ridge is well-modeled by a single knife-edge topography, regardless of its actual shape, but two supercritical ridges in close proximity demonstrate interference of the high modes that makes knife-edfe approximations invalid. Future direction of this research will be to use more complicated linear models to estimate the local dissipation. Of course, despite the large local dissipation, many ridges radiate most of their energy into the deep ocean, so tracking this low-mode radiated energy is very important, particularly as it means dissipation parameterizations in the open ocean due to these sinks from the surface tide cannot be parameterized locally to where they are lost from the surface tide, but instead lead to non-local parameterizations.

[1]US Office of Naval Research; Canadian National Science and Engineering Research Council