Internal tide generation due to topographically adjusted barotropic tide

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We model internal tides generated by the interaction of a barotropic tide with variable topography. For the barotropic part, an asymptotic solution valid over the variable topography is considered. The resulting non-uniform ambient flow is used as a prescribed barotropic forcing for the baroclinic equations (linearized, non-hydrostatic, Euler equations within the Boussinesq approximation).

The internal-tide generation problem is reformulated by means of a Coupled-Mode System (CMS) based on the decomposition of the baroclinic stream function in terms of vertical basis functions that consistently satisfy the bottom boundary condition. The proposed CMS is solved numerically with a finite difference scheme and shows good convergence properties, providing efficient calculations of internal tides due to 2D topographies of arbitrary height and slope. We consider several seamounts and shelf profiles and perform calculations for a wide range of heights and slopes. Our results are compared against existing analytical estimates on the far-field energy flux in order to examine the limit of validity of common simplifications (Weak Topography Approximation, Knife edge). For subcritical cases, local extrema of the energy flux exist for different heights. Non-radiating topographies are also identified for some profiles of large enough heights. For supercritical cases, the energy flux is in general an increasing function with increasing height and criticality, and does not compare well against analytical results for very steep idealized topographies. The effect of the adjusted barotropic tide in the energy flux and the local properties of the baroclinic field is investigated through comparisons with other semi-analytical methods based on a uniform barotropic tide (Green's function approach). A method for estimating the sea-surface signature of internal tides is also provided.