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Numerical modelling of the internal tide near a continental shelf

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We model numerically the nonlinear, non hydrostatic dynamics of the internal tide resulting from the interaction of the barotropic tide with a continental shelf. The finite-volume numerical code developed at MIT is used for this purpose. The stratification is uniform and the fields do not depend upon the along-slope direction. The latter simplification allows for the use of a horizontal grid size as small as 100 m along the cross-slope direction, while taking into account Coriolis effects. We shall present the flow behavior for three different latitudes (i) at the equator, (ii) just below the so-called "critical latitude", poleward of which the M2 mode cannot become parametrically unstable (ignoring any mean current transport or non traditional effects), and (iii) at mid-latitude (45 degrees). In this simplified situation, the internal tide organizes as a rectilinear wave beam of frequency M2 tangent to the topography and making an angle with the horizontal predicted by linear theory. The M2 internal tide energy is thus transported away from the coast through successive reflections at the bottom and at the surface of the ocean. We shall show that, below the critical latitude, the M2-beam may become unstable to a parametric sub-harmonic instability (PSI), at frequency M2/2, that develops all along the beam almost from the generation region. The development of PSI is most striking close to the critical latitude, as we shall explain it, which suggests that local analysis may fail at detecting this instability equatorward of the critical latitude. Once the M2-beam reflects at the bottom, harmonics are generated, which weaken the reflected beam. We shall discuss the conditions under which PSI may still develop on the reflected beam. If time is available, the mixing properties associated with the occurrence of this instability will be addressed.