Abstract View

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On the Propagation of Free Topographic Rossby Waves near Continental Margins. Part 1: Analytical Model for a Wedge

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ABSTRACT

An analytical model has been constructed to study the propagation of free waves of subinertial frequency in an infinite wedge filled with a uniformly stratified fluid. The problem is found to transform into the corresponding surface gravity wave problem in a nonrotating homogeneous fluid with the roles of the surface and bottom boundaries interchanged. Analytical solutions are thus available for waves that are either progressive or trapped in the cross-wedge direction, forming respectively continuous and discrete spectra in frequency space. The separation occurs when the nondimensional wave frequency a (scaled by the inertial frequency *f*) equals the Burger number *S*, defined here as $(N/f)\tan\theta^*$, where *N* is the Brunt-Väisälä frequency and $\tan\theta^*$ is the bottom slope. Since an infinite wedge has no intrinsic length scale, the only relevant nondimensional parameters are the wave frequency σ and the Burger number *S*. Thus, stratification and bottom slope play the same dynamical role, and the analysis is greatly simplified.

For the progressive waves, asymptotic solutions are obtained for both the far field and small *S*. Since the surface boundary condition is neglected in the far field, the solution there is similar to the edge wave solution found by Rhines (1970) in an infinitely deep ocean. The asymptotic solution for small *S*, on the other hand, clearly shows the refraction phenomenon and the presence of amplitude minimum as the apex is approached. Since the asymptotic solutions cheek very well with the calculations of the general solution, the qualitative behavior of the progressive waves are fairly predictable over the parameter range $S \gg O(1)$. The various wave properties associated with the general solution can be understood to a great extent by assuming quasi-geostrophy. The rigid upper surface is found to account for the onshore heat flux generated by these incoming waves.

For the trapped waves, the eigenfrequencies decrease when *S* decreases and approach the value $(2n + 1)^{-1}$ when *S* approaches zero where *n* is the mode number. The modal structure broadens as *S* increases to some critical value above which no such coastally trapped modes exist.

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