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Low-Frequency Baroclinic Waves off Coastal Boundaries

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ABSTRACT

The behavior of low-frequency baroclinic Rossby wave motion in the vicinity of coastal boundaries is investigated using linearized modulated wave theory in a stratified, constant-depth, equatorial β-plane ocean. A primary objective is to obtain an equation that describes large-scale, low-frequency pressure fluctuations along variable geometry ocean boundaries at all latitudes for use in the analysis of coastal sea level observations. Both eastern and western boundaries are considered, and the effect of direct wind stress forcing at the coast is included; but our major interest concerns the response along eastern ocean boundaries to incident baroclinic equatorial Kelvin waves. In that case, for an incident wave at a fixed frequency &0mega;, a critical latitude, with Coriolis parameter $|f| = f_c$, exists such that for $|f| < f_c$, the response consists of offshore-propagating Rossby waves, whereas for $|f| > f_c$ the waves are coastally trapped. The magnitude of f_c, depends on ω and on the angle of the coastline, decreasing ω increases and as the orientation departs from straight north-south. The behavior and energetics of these waves are examined and the nature of the transition from offshore propagation to coastal trapping in the ocean interior around the critical latitudes is described. The derived amplitude and phase variations of coastal pressure are qualitatively different below and above the critical latitude. The phase is constant for $|f| < f_c$, but varies linearly with distance alongshore asymptotically for $|f| \gg f_c$. The amplitude decreases equatorward for $|f| < f_c$, but in a different manner for western and eastern boundaries, while in both cases it varies as $|f|^{1/2}$ for $|f| > f_c$. Values of f_c calculated as a function of frequency and along-coast distance from the equator for the eastern Pacific Ocean show strong dependence on coastline geometry and illustrate the potential usefulness of the derived relations for the interpretation of observations.

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