Abstract View

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On Vertically Propagating Coastal Kelvin Waves at Low Latitudes

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ABSTRACT

Vertically propagating coastal internal Kelvin waves (IKWs) forward by the alongshore component of the wind at the coast are studied, utilizing an f-plane model of a continuously stratified ocean with a vertical eastern boundary. With an infinitely deep ocean, several initial value problems that illustrate the basic properties of the forced flow are presented. For a wind stress at the surface that is localized in time and space, changes in amplitude and frequency with depth are predicted. Far from the forcing region, the response represents a non-uniform wavetrain of free IKWs characterized by local frequencies and wavenumbers. The group velocity vector is directed downward and poleward while the phase propagation is upward and pole-ward. For forcing by a traveling wind with fixed frequency σ and horizontal wavenumber l and with step functions at an alongshore location $y = 0$ and at $t = 0$, the response near and far from $y = 0$ has a different qualitative behavior. Near $y = 0$ a maximum in alongshore velocity v propagates downward until it intersects the ray path that passes through $y = 0$ at the surface for a free IKW with frequency σ. Subsequently the maximum remains on the ray path. Far from $y = 0$, a traveling wave wind stress forces a component that decays with depth from the surface and that is trapped within a Rossby radius of the coast. For a poleward traveling wind, an additional component is forced, which represents a coastally trapped IKW with negative vertical group velocity and upward phase propagation. The two limits $|ly| \ll 1$ and $|ly| \gg 1$ approximately model forcing near and far from the equator. The model with an infinitely deep ocean applies for initial value problems before disturbances generated at the surface reach the bottom. For longer time, the model applies for frequencies and wavenumbers where motions are damped by internal dissipation before they reach the bottom. A solution obtained with a bottom at $z = -H$ shows that, for forcing with a step function at $y = 0$, the results obtained with an infinitely deep ocean apply for $|z| \ll H$ and $|ly| \gg 1$.

top

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