Abstract View

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The Role of Wind-Generated Mixing in Coastal Upwelling

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ABSTRACT

A simple parameterization of mixing processes originally developed by Kraus and Turner (1967) is included in a two-dimensional, two-layer theory of wind-driven coastal upwelling. Mixed-layer deepening is a competition between entrainment due to wind stirring, stabilization due to surface beating, and upwelling vertical velocity. For longshore winds favorable to upwelling, the temperature of the surface water mass being pushed offshore by the wind is determined by that of the incoming subsurface water mass, by the surface heating, and by the mixing dynamics. An upwelling steady state is possible with surface heating. In this state, the vertical upwelling velocity is exactly matched by the entrainment velocity, and the resulting cold water flux into the mixed layer is balanced by surface heating; surface temperature increases linearly with distance offshore. Time-dependent numerical solutions exhibit a, tendency toward this steady-state solution. Winds favorable to downwelling cause detrainment of light water from the mixed layer into the quiescent lower layer, leading to conditions lacking any symmetry with those found for upwelling-favorable winds. This feature, observed in nature, is a consequence of the nonlinearity and irreversibility of the mixing processes in the theory. Computed model solutions for upwelling and downwelling bear reasonable resemblance to hydrographic observations made off Oregon during 1972 and 1973.