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Gravity Currents and Internal Waves in a Stratified Fluid BRIAN L. WHITE, KARL R. HELFRICH, Woods Hole Oceanographic Institution — Properties of a gravity current of uniform density ρ_c, propagating into a stratified ambient with a general density profile, $\rho(z)$, are studied numerically and theoretically. For a gravity current of height h, the isopycnal displacement and steady propagation speed, U_c, can be calculated using Long's equation and a flow force balance (c.f., Ungarish 2006). However, such methods neglect unsteady internal waves. Solutions do exist for internal solitary waves with a trapped core of stagnant fluid, which reach a finite amplitude limit unique to each $\rho(z)$, known as the conjugate state (c.f., Lamb and Wilkie 2004). We show that the conjugate state is equivalent to the energy-preserving gravity current solution. Numerical simulations of the dam-break initial value problem using a two-dimensional non-hydrostatic model verify that the gravity current can excite large amplitude internal waves. The interaction between the waves and the current depends on the Froude number, $Fr = U_c/U_{cs}$, where U_{cs} is the conjugate state wave speed. When the available potential energy (APE) of the dammed fluid is comparable to or larger than the total energy of the conjugate state, we find that $Fr \to 1$, and the current speed is well-predicted by the energy-preserving theory. However, when the APE is smaller, the gravity current is subcritical ($Fr < 1$), and internal waves are present ahead of the current. The results illustrate the connection between the gravity current and the wave-guide characteristics of the ambient stratification.

Karl R. Helfrich
Woods Hole Oceanographic Institution

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