Equatorial wave-current interactions

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Abstract

The ocean flow in equatorial regions is complicated due to stratification (with lower-density fluid overlying an abyssal fluid region that is practically motionless at great depths) and to the presence of underlying currents with flow-reversal. Gravity water waves occur at the surface, while large internal waves propagate as oscillations of the thermocline (the interface separating the two layers of different constant density). We will discuss the development of a Hamiltonian approach to gain insight into the nonlinear dynamics of equatorial wave-current interactions. Of special interest are the observed equatorial solitary-like waves (localised waves that maintain their coherence, propagating with constant speed and unaltered shape) since these wave patterns are not captured by linear theory. A Hamiltonian formulation of the governing equations leads to structure-preserving (and even structure-enhancing) models in the weakly nonlinear shallow-water regime, thus opening up new possibilities for in-depth studies. In particular, an observed behaviour of internal waves that is reminiscent of soliton theory – large waves that occur in wave packets and disintegrate into trains of solitary waves, with the distances between the waves, and their amplitudes, decreasing from front to rear – is of interest.