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A novel set of wave equations for internal waves in a two-fluid system

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A novel set of wave equations for internal waves in a two-fluid system is derived. Inspired by the idea of Boussinesq equations for a single-layer fluid, two depth parameters which make the present model more flexible appear in the new equations. No smallness assumption on the nonlinerity is made and only the leading-order dispersive effect is retained in present equations. Comparing the linear dispersion relationship with the exact solution in the form of the (2,2) Padé approximation, the optimal model is generated to extend the applicable range from shallow water to deep water. Linear particle velocities are compared to the exact solutions. The second-order forced waves induced by primary waves are derived for examining the nonlinear behavior of the present optimal model. It is found that the Boussinesq-type equations not only increase the accuracy of wave properties, specially the dispersion relationship in deeper water configuration, but provide a novel aspect of the study of internal waves. The main goal of present study is to analytically construct a foundation for further numerical simulations..