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Vertical structure of internal wave induced velocity for mode I and II solitary waves in two- and three-layer fluid

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With the use of the Gardner equation, or its variable-coefficient forms, the velocity components of fluid particles in the vertical section induced by a passage of internal waves can be estimated in weakly nonlinear limit. The horizontal velocity gives the greatest contribution into the local current speed. This is a typical property of long waves. This feature of an internal wave field may greatly contribute to the local sediment transport and/or resuspension.

The velocity field induced by mode I and II internal solitary waves are studied. The contribution from second-order terms in asymptotic expansion into the horizontal velocity is estimated for the models of two- and three-layer fluid density stratification for solitons of positive and negative polarity, as well as for breathers of different shapes and amplitudes.

The influence of the nonlinear correction manifests itself firstly in the shape of the lines of zero horizontal velocity: they are curved and the shape depends on the soliton amplitude and polarity while for the leading-order wave field they are horizontal. Also the wavefield accounting for the nonlinear correction for mode I waves has smaller maximal absolute values of negative velocities (near-surface for the soliton of elevation, and near-bottom for the soliton of depression) and larger maximums of positive velocities. Thus for the solitary internal waves of positive polarity weakly nonlinear theory overestimates the near-bottom velocities and underestimates the near-surface current. For solitary waves of negative polarity, which are the most typical for hydrological conditions of low and middle latitudes, the situation is the opposite.

Similar estimations are produced for mode II waves, which possess more complex structure.

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