Bottom pressure induced by the long nonlinear internal waves

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The bottom pressure sensors are widely used for the purpose of registration of the sea surface movement. They are particularly efficient to measure long surface waves like tsunami and storm surges. The bottom pressure gauges can be also used to record internal waves in coastal waters. For instance, the potential system of the internal wave warning in the Andaman Sea is based on the bottom pressure variation data.

η

Here we investigate theoretically the relation between long internal waves and induced bottom pressure fluctuations.

From Euler equations

$$\frac{\partial w}{\partial t} + \frac{1}{\rho(z)}\frac{\partial p(z)}{\partial z} = -g \quad \Rightarrow \quad p(z) = p_{atm} - \int_z^H \rho(z) g dz - \int_z^H \rho(z)\frac{\partial w}{\partial t} dz$$

Non-hydrostatic component on bottom

$$p_{nhs}(x,t) = -\int_0^H \rho'(z,x,t) g dz - \int_0^H \rho_0(z)\frac{\partial w}{\partial t} dz - \int_0^H \rho'(z,x,t)\frac{\partial w}{\partial z} dz$$

Long wave approximation

$$p_{bot}(x,t) = g\eta \int_0^H \rho_0 N^2(z)\Phi(z) dz - \frac{\partial^2 \eta}{\partial t^2}\int_0^H \rho_0(z)\Phi(z) dz$$

Φ(z) – modal function, and KdV or Gardner equations