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Trapped low frequency hydroacoustic modes and their possible contribution in tsunamis

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Mathematical models of tsunami waves widely use incompressible fluid theory. We had earlier shown that water compressibility plays significant role during tsunami generation by bottom displacements whereas tsunami propagation and run-up can be described in the framework of incompressible fluid theory. The behavior of a real compressible ocean differs from that of an incompressible one mostly by the formation of elastic oscillations of water layer (normal modes) with dominating period T=4H/c, where c is sound velocity in water, H is he ocean depth. In contrast to the T-phase (1-100 Hz) these oscillations have relatively low frequency (0.1 Hz) and do not propagate for a long distance from the source. Recently, the existence of low frequency elastic oscillations of water layer was confirmed by direct measurements in tsunami source (Tokachi-Oki 2003). Compressible water layer bounded by free surface and rigid bottom is a waveguide, so the cutoff frequency exists. Due to this feature, in case of variable depth, the lowest waveguide mode generated at a given point can not propagate upward the slope. This is why bottom depressions (holes, trenches) in a tsunami source can trap the hydroacoustic modes, promoting long lasting elastic oscillations of water layer. Due to non-linear energy transfer, the long lasting elastic oscillations may contribute the long gravitational waves (tsunamis). In this study we estimate such an extra contribution in tsunami energy and amplitude by means of numerical modeling.