Geophysical Research Abstracts
Vol. 20, EGU2018-3542, 2018
EGU General Assembly 2018

Conditions of applicability of depth-integrated equations to the description of tsunami waves

Mikhail Nosov

M.V. Lomonosov Moscow State University, Faculty of Physics, Moscow, Russian Federation

The so-called depth-integrated equations are widely used for tsunami simulations. Under assumption that wave length is large enough in comparison with water depth the original 3D hydrodynamic problem reduces to the 2D problem by the integration of equations along the vertical coordinate. The simplest version of the depth-integrated equations are referred as long-wave or shallow water equations. Phase and group velocities of long waves are equal to each other and do not depend on wavelength or frequency, i.e. long waves are not subjected to phase dispersion. In contrast to the model object “long wave”, real surface gravity waves in the ocean, including tsunamis, are dispersive waves. Manifestations of tsunami wave dispersion are well observed in measurements of tsunamis in the open ocean by bottom pressure sensors and satellite altimeters. Thus, the neglecting of phase dispersion must be considered as a serious disadvantage of the theory of long waves. When tsunamis cover long distances, dispersion, that exhibit the property of accumulating, are capable of essentially altering the amplitude and the structure of the wave perturbation. In order to describe slightly dispersive waves one can employ a more complicated kind of depth-integrated equations which are known as Boussinesq equations. Along with the long-wave equations, Boussinesq equations are just a model. And all the models have certain restrictions. The main purpose of this study is to quantify these restrictions and to specify conditions of applicability of depth-integrated models to the description of tsunami waves. Our approach employs the concept of distance of dispersive destruction, i.e. the distance, at which manifestations of dispersion effects should turn out to be quite significant. This distance we determine as the product of the velocity of long waves by the time, required for a wave packet to lag behind the front at a distance equal to the wavelength. Ultimately, the sought applicability conditions are formulated as a low limit for wave period which can be easily calculated from the size of calculating area and average ocean depth within this area. This work was supported by the Russian Foundation for Basic Research, projects 16-55-50018, 16-05-00053.