Geophysical Research Abstracts
Vol. 16, EGU2014-8335, 2014
EGU General Assembly 2014

Restoration of Surface Waves Elevation Using the 5-th Order Stokes Waves Approximation

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It is very useful from the engineering point of view to get the way to recalculate the pressure values measured inside the liquid to the elevation of the free surface. Up to now this problem, despite its obvious importance, has not received any satisfactory solution. This is mostly due to the fact that the waves on the surface may have a different nature and complex degree of description.
In our study, we examined both theoretically and experimentally the ability to restore the elevation of the free surface, using the data for the pressure within the fluid in the case of nonlinear periodic waves. We have seen how the wave surface elevation restores using the first, third, and fifth approximations for Stokes waves. The algorithm of wave height restoration is presented for each order from the list above. We examined how the measurements errors propagate through our algorithms of wave height restoration with Monte-Carlo techniques.
The experiments were fulfilled in the hydro flume having 40 m length, 1.0 m width, and 1.2 m height. The depth of fluid was 0.6 m. The shield-type wavemaker produced the periodic waves having large amplitude. The wave height was varied in the range of 4 to 22 cm. The wave periods were from 1.0 to 2.6 sec. The wave steepness was from 0.006 to 0.064. Depth of the liquid was 66 cm. In the experiments, we have measured the pressure wave at about half the depth (more precisely, at a depth of 26.5 cm) and at the bottom. The free surface elevation was measured directly by wavemeter.
The comparison of experimental and numerical data shows clearly that theoretical results describe satisfactory the physics of the problem. The rules for the selection of varying order of approximation depending on the measurement accuracy of the initial parameters are proposed.