Regularized shallow-water equations as a model for a solitary wave generation

T.G. Elizarova and M.A. Istomina
Keldysh Institute of Applied Mathematics RAS, Moscow, Russia, e-mail m_ist@mail.ru

Among wave motions in seas and oceans, the birth and behavior of large-amplitude solitary waves (called in the literature extreme, or giant, waves) are of great interest. According to modern concepts and observational experience, in some cases, these waves can be generated by wind and act as a solitary wave or a group of solitons [1,2]. The mechanism of generation of wave–wind solitons has not been fully understood because this study in the real world is very difficult. Some aspects of this phenomenon was observed and investigated experimentally in a wind-water annular tunnel in, e.g. [3].

In this study, we show the results of direct numerical simulation of the evolution of an isolated wind–wave soliton. Numerical modeling is done on the basis of the regularized shallow-water equations [4]. These equations can be regarded as a generalization of the classical Saint-Venant system, that is accomplished by strongly non-linear additional terms with a small parameter as a coefficient. The corresponding numerical solutions correctly reflect the main characteristics of the generation and behavior of solitary waves observed in the experiment [3]. The wind strength and friction forces are taken into account. The example of soliton formation in the wind-water tunnel of the 6m length is shown on the figures below. The last figure shows the resulting solitary wave.

In the full presentation the form of regularized shallow-water equations will be shown together with the numerical algorithm, details of computational results and comparisons with theoretical investigations of the problem based on the analytical solution of Saint-Venant system.

References

1.E.N. Pelinovsky, Tsunami Wave Hydrodynamics. Institute Applied Physics Press, Nizhny Novgorod. 1996
2. B. V. Levin and M. A. Nosov, *Physics of Tsunamis* (Yanus_K, Moscow, 2005) [in Russian].
3. N. K. Shelkovnikov, “Induced Soliton in a Fluid,” JETP Lett. **82** (10), 638–641 (2005).
4. T.G. Elizarova, M.A. Istomina and N.K. Shelkovnikov. Numerical simulation of solitary wave generation in a wind-water annular tunnel, mathematical models and computer simulations, 2012, N 6, 552-559