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Statistical estimates of characteristics of long wave runup on a beach

Anna Sergeeva (1), Irina Didenkulova (1,2), and Efim Pelinovsky (1)

(1) Institute of Applied Physics RAS, Nonlinear geophysical processes, Russian Federation, (2) Institute of Cybernetics, Tallinn, Estonia

The runup of irregular long sea waves on a beach of a constant slope is studied within nonlinear shallow water theory. This problem has been solved for deterministic waves (periodic waves and pulses) using Legendre (hodograph) transformation. With the use of the same approach it is also possible to obtain a rigorous solution for the displacement of the moving shoreline in the case of irregular waves as a superposition of independent harmonics with random phases. Such solution allows to find statistical moments of runup characteristics. It is shown that statistical properties of wave velocity do not depend on nonlinearity, but nonlinear parameter affects statistical moments of the water displacement. In particular randomness of the wave field leads to an additional set-up on the beach and decrease of standard deviation of the displacement. The skewness of surface elevation is always positive and rises with the amplitude increase. The kurtosis, calculated through the fourth moment, is positive for small values of wave amplitude and negative for large values of wave amplitude. All this demonstrates that the process of wave run-up is more significant, than the process of wave run-down, at least, for waves of weak amplitude, when the incident wave field is represented as a Gaussian stationary process with zero mean. The probability of wave breaking during the process of wave runup is calculated and conditions of validity of the model are discussed.