Run-up of narrow and wide-banded irregular waves on a beach

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The runup of initial Gaussian narrow-banded and wide-banded wave fields and its statistical characteristics are investigated using direct numerical simulations, based on the nonlinear shallow water equations. The bathymetry consists of the section of a constant depth, which is matched with the beach of constant slope. To address different levels of nonlinearity, the time series with five different significant wave heights are considered. The total time of each such calculated time-series is 1000 hours.

It is shown for narrow-banded wave signal that runup oscillations are no more distributed by the Gaussian distribution. The distribution is shifted to the right towards larger positive values of wave runup. Its mean value increases with an increase in nonlinearity, which reflects the known phenomenon of wave set-up. The higher moments of runup oscillations, skewness and kurtosis are negative. The skewness is decreasing with an increase in wave nonlinearity, while kurtosis is negative and varies non-monotonically with an increase in wave nonlinearity. For Gaussian wide-banded signal, the runup oscillations also deviate from Gaussian distribution. The distribution is also shifted to the right towards larger positive values of wave runup. Its mean values increase with an increase in nonlinearity, while all other higher moments change non-monotonically.

For the extreme wave runup heights, we conclude that the tail of the probability density function behaves like a conditional Weibull distribution if the incident random waves are represented by Gaussian narrow-banded or wide-banded spectrum. This distribution can be used for evaluation of wave inundation during extreme floods (rogue runups).