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On the ubiquity of small-scale rogue waves in the ocean

J.L. Miller, D. Wang, and P. Hwang

Naval Research Laboratory, Oceanography Division, Stennis Space Center, U.S.A.
(jmiller@nrlssc.navy.mil / Phone: +1 228 688 5452)

The nonlinear Schrodinger equations on which theories of rogue waves are based have no inherent high wavenumber cut-off limitation other than at scales of capillary waves. Thus, the dynamics can support such waves at scales much smaller than those of the well-known killer waves that have amplitudes of tens of meters. Indeed, small rogue waves having amplitudes of tens of centimeters have been generated artificially in the laboratory using paddle wave making devices. Here we present the first evidence that they exist naturally in the ocean and are much more common than their large counterparts.

Wire gage data from the Naval Research Laboratory's Scanning Slope Sensor were analyzed for presence of waves exceeding twice the significant wave height. This sensor has 20 wire gages spaced 5 centimeters apart in a linear array sampling at 50 Hz and thus provides high spatial and temporal coverage in a 1 meter aperture. These data were high-pass filtered with a cut-off frequency of 0.9 Hertz to remove any effects of lower frequency waves. The resulting time series of sea surface height reveal presence of a rogue wave about 0.3 percent of the time on average — several orders of magnitude more frequently than estimated for large scale rogue waves. The kurtosis of the wave height probability distribution function is high during periods when the small rogue waves are more prevalent and this is consistent with theory recently used to describe large rogue waves. The instantaneous shape of small rogue waves using data from the 20 gage array is revealed.