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Linear and Nonlinear Rogue Wave Statistics in the Presence of Random Currents

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We review recent progress in modeling the probability distribution of wave heights in the deep ocean as a function of a small number of parameters describing the local sea state. Both linear and nonlinear mechanisms of rogue wave formation are considered. First, we show that when the average wave steepness is small and nonlinear wave effects are subleading, the wave height distribution is well explained by a single "freak index" parameter, which describes the strength of (linear) wave scattering by random currents relative to the angular spread of the incoming random sea. When the average steepness is large, the wave height distribution takes a very similar functional form, but the key variables determining the probability distribution are the steepness, and the angular and frequency spread of the incoming waves. Finally, even greater probability of extreme wave formation is predicted when linear and nonlinear effects are acting together.