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Analysis and simulation of freak waves in the North Sea

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Six freak events registered in the North Sea during a storm are studied. They may be split into two parts: single freak waves and freak groups; they provide somewhat different results of the investigation. The spatial evolution of the freak waves backward and forward the wave propagation is simulated within the framework of the Dysthe equations. The lifetimes and travel distances of the freak waves are determined basing on the results of the simulations. A freak wave lives from several seconds up to a minute and a half and may oscillate many times. The wave evolution predicted by the Dysthe model is compared with simulations of the nonlinear Schrodinger and kinematic equations. The contribution of effects of the modulational (Benjamin - Feir) instability is estimated with the help of the nonlinear Schrodinger approximation and the Inverse Scattering Technique. It is found that 'freak groups' contain intensive long-living nonlinear wave packets (solitons). The contribution of quasi-linear wave grouping is discovered with the help of the linear theory. It is found that although the modulational instability is important for the description of the freak wave evolution, the significant wave enhancement by itself may be achieved even in the linear approximation.