Geophysical Research Abstracts
Vol. 17, EGU2015-12894, 2015
EGU General Assembly 2015

Characterization and statistics of rogue waves in random sea states

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Rogue waves are frequently modeled using the nonlinear Schrodinger (NLS) equation and it's higher order extensions due to Dyste and Trulsen (HONLS). In [2] Sura shows that the kurtosis (κ) and skewness (s) of deep ocean field data obey the quadratic inequality $\kappa \geq 3/2s^2 + \kappa_0$ which is not satisfied by Gaussian or double exponential noise. Here we show that sea states modeled using the HONLS equation and random phase JONSWAP initial data exhibit a significant deviation from Gaussianity and satisfy Sura's relation between the skewness and kurtosis, thus providing a realistic picture of sea surface height variability.

In [1] we introduced the "splitting distance", δ, between two consecutive simple points in the Floquet spectrum of the associated Zakharov-Shabaat problem of the NLS equation, as a spectral measure of proximity to instabilities in the wavefield and correlated the development of localized rogue waves in random sea states characterized by JONSWAP spectra with δ. Here we take a closer look at the nonlinear spectral decomposition and characterization of JONSWAP solutions of the NLS equation. For the HONLS equation, δ evolves in time. We determine both the initial splitting distance δ_0 and the time averaged splitting distance δ_{avg}. From a practical standpoint the use of δ_{avg} doesn't allow for a useful predictive tool as one must follow the evolution of $\delta(t)$. However, we show $\delta(t)$ remains close to δ_0 and the the maximum strength, skewness, and kurtosis of the sea states are well predicted by the initial δ_0.

References

[1] A.L. Islas and C.M. Schober, Predicting rogue waves in random oceanic sea states, Phys. Fluids **17** (2005).

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