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Approach to Rogue Wave Prediction Using Forecasting/Hindcasting Models for Fully Directional Sea States

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An important goal in wind-wave modeling is the implementation of methods for the prediction of *rogue waves in fully directional seas*. To this end:

(1) I develop a ***complete theory for rogue waves in a directionally spread sea state*** (formally in 2+1 (x, y, t) dimensions) based upon the nonlinear Schroedinger equation and extend it to the higher order Zakharov equation. The theory includes ***exact formulas for two-dimensional rogue wave breather packets***. The ***maximum height of the breather packets*** and other properties are also computed.

(2) I study the behavior of rogue waves in the frequency domain and apply the results to the power spectrum. The unique ***location of rogue wave packets and their properties in the power spectrum*** are determined.

(3) I develop an approach for the ***hyperfast computation of the full Boltzmann integral*** (FBI) in wind-wave models. The computer time necessary for computations is roughly about that required for the more commonly used DIA algorithm. ***The new approach thus allows fast forecasting/hindcasting capability with the FBI.***

(4) I use the above tools to ***hindcast several sea states using WaveWatch III with the FBI algorithm*** and give, for the first time, rogue wave estimates together with their wave height statistics and I compare to statistical predictions from the DIA algorithm and to Rayleigh.

(5) The results are applied to the ***wave forensics of the ship Prestige*** that was impacted by a large wave off the coast of Spain in 2002. The ship sank and left the largest oil spill in maritime history. I am the expert witness for wave forensics in the *Prestige* trial, now underway in Coruna, Spain.