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Influence of wind on rogue waves due to modulational instability

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Rogue wave generation can be explained on the basis of modulational instability. The paper reports on a series of numerical simulations designed to analyze the action of wind on the Fermi-Pasta-Ulam recurrence cycle (modulation/demodulation cycle).

A Stokes wave of steepness $\epsilon_0 = a_0 k_0 = 0.1$, computed by using the Longuet-Higgins' method (Longuet-Higgins, 1987, *J. Fluid Mech.*), is considered. This Stokes wave is perturbed by adding an infinitesimal perturbation corresponding to the most unstable Benjamin-Feir instability or modulational instability. For relatively small steepness of finite-amplitude Stokes waves, the wavenumber δk of the most unstable perturbation is given by $\delta k/k_0 = 2\epsilon_0$

The spatio-temporal evolution of the perturbed Stokes wave is computed numerically by using the pseudo-spectral numerical method developed by (Dommermuth & Yue, 1987, *J. Fluid Mech.*). The Fermi-Pasta-Ulam recurrence cylce is obtained, and a freak wave is observed at the maximum of modulation.

Following Jeffreys (Jeffreys, 1925, *Proc. Roy. Soc. Lond. A*), a pressure term is then added, in order to model the action of wind on the dynamic of the freak wave event. The previous evolution of the waves is now considered under the action of the Jeffreys' sheltering mechanism. It is observed that the effect of wind on the freak wave event is twofold : (i) it increases weakly its amplitude, and (ii) it increases its time of duration. This means that the Jeffreys' sheltering mechanism may sustain longer rogue waves by increasing their time of occurrence. This phenomenon has already been observed for rogue wave generated by linear dispersive focusing (Touboul *et al*, 2006, *Eur. J. Mech. B/Fluids*), and can be extended to rogue waves generated by modulational instability.