# Identifying ever-growing disturbances leading to freak waves

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Physicists now better understand wave systems exhibiting unusual disturbances by identifying growing localised patterns as early indicators of such disturbances

Physicists like to study unusual kinds of waves, like freak waves found in the sea. Such wave movements can be studied using models designed to describe the dynamics of disturbances. Theoretical physicists, based in France have focused on finding ways of best explaining how wave disturbance occurs under very specific initial conditions that are key to the genesis of these disturbances. They looked for solutions to this puzzle by resolving a type of equation, called the nonlinear Schrödinger equation. It is solved by applying a method designed for studying instabilities tailored to these initial conditions. Their approach makes it possible to locate exactly where and how pertinent information used to identify disturbance patterns can be extracted from localised disturbances' characteristics. The findings have been published in *EPJ D* by Saliya Coulibaly, from the University of Lille, and colleagues.

The team focused on analysing the dynamics of a specific kind of disturbance, called realistic spatially localised perturbations. They relied on the theory of evolution of localised disturbances bifurcating from unstable basic state, also known as the theory of absolute and convective instabilities. This approach has been developing since the early 1950s. It makes it possible to compute how localised disturbances are amplified in space and to determine their speed as a group.

Coulibaly and colleagues then combined this theoretical approach - including numerical and analytical treatment - with signal processing tools. To do so, they relied on two types of initial conditions: one with a localised disturbance and one with random noise acting as disturbance. They found their predictions were in excellent agreement with numerical results. Therefore, their findings may contribute to a better understanding of the complex dynamics of systems subjected to such disturbances. For example, they could be used to better understand waves appearing on fluid surfaces, whose evolution is influenced by gravity, or light waves propagated in optical fibres.

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