Rogue waves and wave focusing – speculations on theory, numerical results and observations

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This review will discuss recent work on the question of rogue waves on the open ocean. Observations of waves on the open sea are consistent with weakly non-linear modifications to a linear random process, at least most of the time even in violent storms[1]. The occurrence of large waves might then be attributable to the random alignment of many small independent components. Extracted from a random background, this process would then look like the linear focusing of an initially dispersed wave group.

The focusing of uni-directional groups can produce dramatic extra surface elevation consistent with contraction of the group in the direction of motion. Simulations with the numerical scheme of Bateman[2] with significant directional spreading show that much of the extra elevation is lost. However, considerable elongation of the group structure along the wave crests can occur. 2-D and 1-D evolution is also different in that, although the non-linear dynamics occur over a much shorter period in 2-D and require steeper waves for much to happen, the spectral content well after focus in 2-D is markedly different to that before even in the absence of wave breaking. For this type of focusing event, simple models based on the nonlinear Schrodinger equation reveal the importance of the Benjamin-Feir index in 1-D and suggest that directional spreading should be incorporated into the index.

Recent work by Segur[3] shows that the Benjamin-Feir instability is significantly affected by small amounts of dissipation. The review will end by pointing out that most work with phase resolved wave models neglects both energy input and dissipation. Does this invalidate our conclusions?

References

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3. Segur, H. Stabilizing the Benjamin-Feir Instability. Talk at Workshop on Free Surface Water Waves, held at the Fields Institute, Toronto, June 2004