Abstract

It is apparent that most waves in a random sea behave for most of the time in a manner consistent with simple 2nd order models based on linear dynamics. As a consequence, the average shape of a large wave crest, the scaled auto-correlation function NewWave, becomes a useful model. It captures considerable information about the overall statistical properties of the sea-state into a single isolated wave group.

The average shapes of large deep-water waves measured during severe winter storms at Tern, a northern North Sea platform in 170m of water, are shown to be entirely consistent with the NewWave model. Both the simple case of a single point measurement of surface elevation in time and the more complex case of the simultaneous time history at a second location given a wave crest of given size at an adjacent point were studied. The prediction of this latter case required directional sea-state information obtained from a directional wave-rider buoy. For small waves, the full solution by Lindgren for the average shape of waves is required. However, in the limit of a large event ($A/s > 2$, where $A$ is the individual wave amplitude and $s$ is the rms surface elevation), this exact Lindgren solution tends to the auto-correlation function. As well as being a good model for the average shape of large wave crests on deep water, analysis of wave data measured in 17m water depth during the recent WACSIS joint industry project confirms the validity of this approach for steep waves on intermediate water depth in winter storms.

Beyond 2nd order there is interesting non-linear dynamics to be explored. Both experiments and numerical simulations show that the evolution of directionally spread wave fields is qualitatively different to that of uni-directional waves. The important role played by soliton-type non-linear wave groups in uni-directional wave evolution seems to be absent from the physics of directionally spread seas. Thus, efforts to explain the occurrence of rogue or freak waves should reflect the directional spreading of waves obvious in nature.