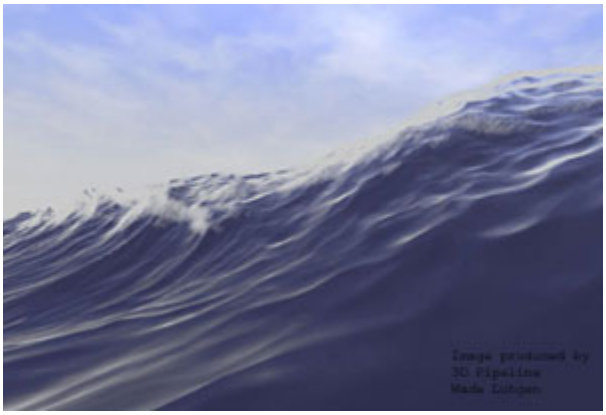
# Rogue Waves and Explorations of Coastal Wave Characteristics

**Primary Investigator:** Paul C. Liu - NOAA GLERL (Emeritus)

**Co-Investigators**: Alexander V. Babanin - Swineburne University of Technology, Australia, Keith R. MacHutchon - Liebenberg & Stander International, Cape Town, South Africa, Nobuhito Mori - Central Res. Institute Electric Power Industry, Japan, Uggo F. de Pinho - Federal University of Rio de Janeiro, Brazil, Chyng-Chu Teng - NOAA National Data Buoy Center, Chin H. Wu - Department of Civil engineering, University of Wisconsin

**Overview**

Freak waves are unusually large waves. They have been observed in the coastal and open oceans, and are hazardous to mariners because of their size and sudden appearance. As the cause of freak waves is still unknown, measurements and analysis of this phenomena are extremely rare.



Rogue waves, sometimes also known as freak waves, are a special kind of ocean waves that is distinguished by an instant, singular, and unexpected wave profile with an extraordinarily large and steep crest or trough. A chance of encounter with such a wave in the ocean or a lake would be terrifying for anyone but their existence had until recently been largely dismissed as sailors' tales. Only in recent decades has the conceptual existence of rogue waves been accepted. Now there are documented instances of rogue waves. They are a natural phenomena that is severely hazardous to merchant marines, offshore platforms, naval fleets, as well as other sea-going ventures.

Currently there are voluminous conventional wave measurements available worldwide but there are no available time series measurements of freak waves per se. The current practice of wave measurement, instituted perhaps over four decades ago, is based on the universal assumption of ocean wave process to be a stationary, Gaussian random process. This assumption is inconsistent with the existence of freak waves.

The most difficult aspect of studying rouge waves in the oceans today is the scarcity of actual field measurements of rogue waves. A few rogue waves have been recorded accidently and are widely cited as examples, but the reality is that there are no strong rogue waves data sets available that can be readily used to establish a realistic probability for rogue waves.

Academic interests may be satisfied by the theoretical simulation of an event of rogue wave occurrence, which is basically the state-of-the-art of rogue waves research currently, but the present ostensibly lacking of actual field measurements of rogue waves renders even the best formulated theories remain unverified.

**Research Plans**

We have acquired six years of wind and wave measurement from South Indian Ocean from an offshore oil drilling platform near South Africa in an area that's well known for having rouge/freak waves over the ages. With a lack of time series our preliminary analyses show we do not know how rogue waves really behave, and we also do not know the actual distinction between an extreme wave and a rogue wave. The presently available knowledge of rogue waves just does not seem to suffice.

We shall submit proposals to fund an appropriate rogue waves measurement and studies program and also attend relevant conferences to advocate the need for making field rogue waves measurements. We will also look for existing and available high-quality wave data sets because we are now convinced that there are plentiful rogue wave cases being ignored and overlooked in those data sets. We expect to continue our pursuing efforts of advocate for rogue wave measurement and seeking external funding. And we also expect to start seeking to explore alternative formulations of probability distributions of rogue wave to supersede the dated, inept, and Gaussian random process based approach for strengthened analysis and understanding of rogue waves

**Accomplishments**

We were able to to dispel one of the long held contentions regarding rogue wave - that they are of rare occurrence. We examined a short GLERL wave data set recorded from a research tower in Lake Erie in 1981 and a longer wave data set recorded from a deepwater buoy in the Campos Basin offshore from Brazil in South Atlantic Ocean during 1992-1995. We were suprised to find evidence of many rogue waves occurrences (defined as maximum trough to crest wave heights greater than two times of significant wave height) within in these two conventional intermittent wave measurement environments. Based on these studies, we think that rogue/freak waves occur with much greater frequency than has been historically believed. The kind of wave profile that characterize rogue waves can happen for significant wave heights of 15 m, or 5 m, or even 0.5 m. Is such an event still considered a rogue or freak wave when it occurs at 0.5 m significant wave height? It may not be considered a rare occurrence, but it still occurs unexpectedly.

To remedy the lack of wave data the GLERL deployed two bottomed-mounted, upward-looking Acoustic Doppler Current Profiler (ADCP) at depths of 20 m and 12 m to make wave measurements in eastern Lake Michigan in the late autumn of 2002. From the middle of October to the beginning of December, over 40 days of continuous, non-intermittent wave measurements were collected. While we might expect to capture some freaque waves from this extensive data set, preliminary analysis of these data show that waves with a ratio of maximum wave height to significant wave height greater than 2.2 turn up quite frequently. It is distinctively possible that the so called freaque waves are really an intrinsic part of the natural ocean wave process, only the paradigm we use for inferring the wave process in the last 50 years - the random Gaussian process and the frequency wave spectrum - actually prevented its total recognition.

Recent theoretical works have indicated that the statistical parameter kurtosis, which signifying strong nonlinearity and peakedness, is especially useful for studying freaque waves. We have found, by continuously calculating kurtosis through a well-sized moving window, there is a manifest sudden jump in kurtosis as well as skewness at the instance the freaque wave took place. This can conceivably become a simple technique for identifying freaque waves. Incidentally if it can be applied to an available continuous and interrupted wave measurement, this approach can be used to readily proclaim the occurrence of freaque waves in real time.

Efforts on the study of freak/rogue waves and collaborations continued with Nobuhito Mori of Japan and Chung-Chu Teng of NOAA/NDBC to explore possible development of a measurement program for the study of freak/rogue waves. Continued studies of wavelet transform analysis have also led to new collaborations.

## Products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