Possible extension of wave forecasts to individual extreme waves

The EU-FP5 Project MaxWave

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200 supercarriers, more than 200 meters long, have been lost during the last 20 years, and the causes of accidents are in many cases believed to be 'rogue waves'. Such waves are believed to be peripheral phenomena not yet well understood by conventional wave science. Some areas seem to be more exposed, such as the Gulf Stream, Agulhas Current, Kuroshio Current, Nantucket Shoals, Cape Horn and others. Their primary generation mechanisms are believed to be: wave-current interaction, refraction around shoals, diffraction around islands, superposition and phasing of many wave modes.
Eye witnesses of individual extreme waves in deep water mention single high waves or several successive high waves (three sisters).
In shallow water , with respect to beach accidents, or erosion problems, and for damages on coastal constructions especially very long waves are dangerous. They grow by shoaling , reach deep into the water with their orbital velocities and they tend to induce resonance effects in floating vessels or buildings in contact with the water.
An aim of this study is therefore to investigate the occurrence of low frequency wave energy and extreme individual wave crests in deep and shallow water in regional seas for which the occurrence of freak waves or low frequency waves are reported.

The Maxwave-project aims to combine new oceanographic knowledge and ocean wave data resources with new approaches to vessel and marine construction design and operation. It further addresses the needs of coastal engineers and port designers/operators in terms of influence and impacts of extreme ocean waves. The overall goal is to provide a quality based oceanographic information product for the benefit of both high sea and coastal zone operating industry and authorities. The core problem will be the occurrence and nature of extreme waves and their impacts on vessels, constructions and coastal management in general.

The next generation of high sea operating vessels will be designed to withstand what in a general sense is known to occur of atmospheric and sea state conditions, including storm conditions. One significant and crucial gap remains: The occurrence of unexpectedly steep and violent waves, at times suddenly and without forewarnings in certain sea areas. This phenomenon has caused accidents not only for smaller and medium size ships, but also, to an astonishing degree, for modern, larger bulk carriers. Due to its nature, the exact incident conditions are inadequately recorded. The prevailing conditions, such as interpreted from weather maps, can be analysed in hindcast studies, but there are not always unique relations between the hindcasted sea state and the direct cause of the accidents. This is obvious , since the product of numerical wave prediction at weather-centers is an estimate for significant wave height, a parameter that describes the average seastate, whereas the assumed direct cause of the ship accident, the occurrence of singular individual extreme waves is not a prediction

parameter. The described kind of accidents seem to be concentrated in certain areas of the world ocean, and there exists a comprehensive documentation on accidents that have been investigated around the world.
In shallow water the individual extreme waves cause accidents on beaches and damages on coastal constructions. They occur either as a single flooding event of several ten minutes or as very low frequency swell (periods around 30 seconds).
In order to reduce this risk element in times , when harbours have to become more secure and when ships are getting larger and demanded to be more operationally efficient, it is proposed to develop an information product for the benefit (among others) of improved safety on the ocean. This serves marine designers and operators and other marine applications, and will be a contribution to the UN programme Global Maritime Distress Safety System. This product will describe the geographical occurrence, the statistical nature and the predictability of this phenomenon, and if possible provide a warning service.
Therefore four successive steps will be taken:

1.Confirmation of existence
The detection of extreme individual waves and there regional frequency of occurrence.
a. by modern measuring technology and
b. by the analysis of ship accidents.

2. Forecast
Development of
a. forecast criteria and
b. proposals for improved ship design.

3. Improved security
a. The development of forecast parameters for the occurrence of extreme individual waves,
b. the proposal of navigational aids for shipmasters.

4. Measures for dissemination and exploitation

It is believed that the project objectives can only be achieved through co-operation between experts from the marine design/operation side and experts from the wave science and ocean remote sensing side. It is also believed realistic to conquer new grounds of knowledge, because today we have access to many new sources and tools of information and methodology to facilitate the progress.