



An application of a queuing model for sea states

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Unimodal approaches in design practice have shown inconsistencies in terms of directionality and limitations for accurate sea states description. Spectral multimodality needs to be included in the description of the wave climate. It can provide information about the coexistence of different wave systems originating from different meteorological events, such as locally generated wind waves and swell systems from distant storms. A 20 years dataset (1989-2008) for a location on the North Sea (K13, 53.2⁰N 3.2⁰E) has been retrieved from the ECMWF ERA- Interim re-analysis data archive, providing a consistent and homogeneous dataset.

The work focuses on the joint and conditional probability distributions of wind sea and swell systems. For marine operations and design applications, critical combinations of wave systems may exist. We define a critical sea state on the basis of a set of thresholds, which can be not necessarily extreme, the emphasis is given to the dangerous combination of different wave systems concerning certain operations (i.e. small vessels navigation, dredging). The distribution of non-operability windows is described by a point process model with random and independent events, whose occurrences and lengths can be described only probabilistically. These characteristics allow to treat the emerging patterns as a part of a queuing system. According to this theory, generally adopted for several applications including traffic flows and waiting lines, the input process describes the sequence of requests for a service and the service mechanism the length of time that these requests will occupy the facilities. For weather-driven processes at sea an alternating renewal process appears as a suitable model. It consists of a sequence of critical events (period of inoperability), each of random duration, separated by calms, also of random durations. Inoperability periods and calms are assumed independent. In this model it is not possible more than one critical event occurring at the same time. The analysis is carried out taking into account the thresholds' selection and the seasonality.