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Joint Distribution of Wave Height and Wave Crest Velocity from Reconstructed Data with Application to Ringing

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ABSTRACT

A statistical procedure for reconstructing missing or spurious data points of a recorded time series is presented. The application of the result is illustrated by using the whole data set to achieve a more accurate estimate of the joint distribution of the maximum of crest front (rise) and crest rear (fall) speed and the corresponding wave height, which is relevant to ringing.

INTRODUCTION

Recently attention has been given to higher-order burst-type forcing known as ringing. This is a transient effect similar to a sound-level trace output by a bell after it has been struck by its clapper. This unwanted hydrodynamic load has been observed for gravity-based structures and tension leg platforms in model tests as well as offshore (Krokstad and Stansberg, 1995; Langen et al., 1998). This load is excited by nonlinear wave effects, and the most important contribution to the phenomenon is believed to come from high waves with a steep front or a steep rear in slightly non-Gaussian sea-states (Bitner-Gregersen et al., 1995). Thus it is important to assess the probability of a wave to exceed a specified height and a specified steepness. Joint probability distributions of the wave parameters such as the maximum of crest front (rise) and crest rear (fall) speed and the corresponding wave height may thus be applied to the design and safety evaluation of offshore structures.

By establishing the joint distribution based on recorded time series, the problem of having a contaminated data set (i.e., missing data or outliers) may be encountered. Obviously uncritical use of the data may lead to unsatisfactory large bias of the estimated joint distribution.

This paper addresses this problem and presents a statistical procedure to reconstruct the data using a transformed Gaussian random process. The joint distribution of the velocity and the corresponding wave height obtained from the reconstructed data set will serve as an example of application relevant to ringing.

DATA DESCRIPTION

The wave data considered here were measured December 24, 1989 at the Gullfaks C platform in the North Sea with a sampling frequency of 2.5 Hz (Figs. 1 and 2). The water depth of 218 m is regarded as deep water for the most important wave components. Here the data recorded from 17.00 to 21.20, except for the missing period from 20.00 to 20.20, are considered. The data used here are obtained from the EMI laser sensor 219, which is located in the northwest corner approximately 2 platform leg diam away from the closest leg (Fig. 2). Thus the wave elevation is not expected to be significantly affected by diffraction effects for incoming waves in the western sector. However, some difficulties in calibration of the instruments have been reported. The example in Fig. 3 shows several consecutive measured values being equal or nearly equal in an observed data set. According to Krogstad and Barstow (1999), the EMI laser is sensitive to spray and loose track, resulting in a constant signal. Here an unclear lens is also contributing to the observed deficiencies.

Wind data from the Statfjord A field the same day are given in

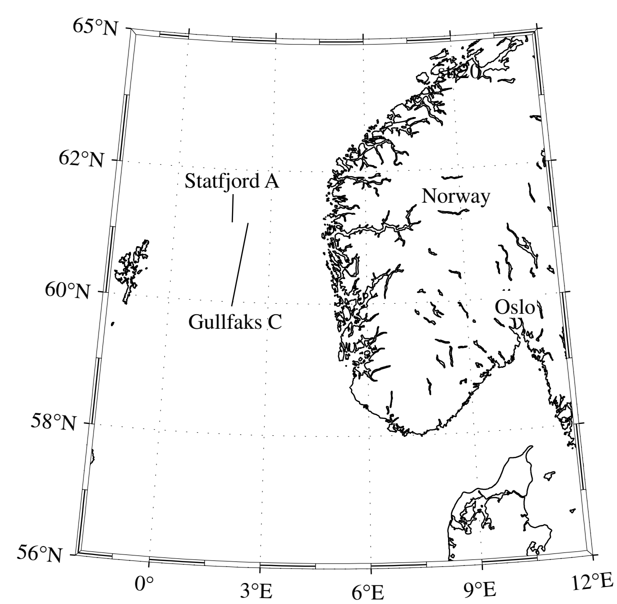

Fig. 1 Positions of Gullfaks C (61.2° N; 02.3° E) and Statfjord A (61.2° N; 01.8° E) platforms.

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KEY WORDS: Joint distribution, wave height, wave crest velocity, ringing, missing observations, outliers.