

A sensitivity analysis of the bottom-up algorithm for the segmentation of H_S -time series

Takvor H. Soukissian

Hellenic Center for Marine Research Athens, Greece

Christiana S. Photiadou

National Technical University of Athens, Greece

ABSTRACT

This paper deals with the effect of the maximum allowed error (MAE) on the segmentation of significant wave height time series using the bottom up approach. This approach was implemented in Soukissian, Samalekos (2006), who adopted a constant MAE in order to identify and analyze the developing, decaying and stationary H_S -sea states and their associated durations. The MAE corresponds to the representation error (obtained from the method of least squares) and determines the length of each segment (i.e., the sea state duration) and the overall quality of the linear fit. Different values of the MAE provide different populations of developing, decaying and stationary sea states and associated durations. In this paper a detailed sensitivity analysis of the effect of the MAE on the duration and intensity statistics of the obtained sea states is made.

KEY WORDS: developing, decaying, stationary sea states; time series segmentation; duration statistics.

INTRODUCTION

The analysis of large amount of wave data accumulated over long-time intervals (as e.g., some decades) is a critical task in extracting useful information about the variability of wave conditions at a particular site. Duration statistics of sea states extracted from historical H_S data can provide important information for marine operations and can be used as a complementary tool in operational wave forecasting, wave climate studies and extreme wave analysis.

In the relevant scientific literature two types of sea state duration analysis can be found: i) Duration of stationary sea states and ii) duration (persistence) of storms. In the first case, H_S -time series is treated as a piecewise stationary process; see e.g., Labeyrie (1990), Athanassoulis and Soukissian (1991), Athanassoulis, Vranas and Soukissian (1992), Soukissian and Theochari (2001). In the second case, the persistence (duration) of sea states above a given threshold level is considered; see e.g. Graham (1982), Mathiesen (1994) Anastasiou, Tsekos (1996), Tsekos, Anastasiou (1996), Sobey, Orloff (1999) and Jenkins (2001). Let us note that the first approach is more general and includes the second as a special case. In Soukissian, Samalekos (2006) another approach has been introduced for describing the sea-state duration. More specifically, sea states are classified into

three types, namely developing, decaying and stationary. The classification criterion was the slope of the regression line in appropriately selected segments of the H_S -time series. A positive slope corresponds to a developing sea state, a negative slope corresponds to a decaying sea state and a slope close to zero to a stationary sea state. The segments of the H_S -time series had been produced by using the bottom-up approach. An important parameter in this approach is the maximum allowed error (MAE), i.e., the error which should not be exceeded by the least-square error obtained after fitting a regression line in each of the candidate segments. The value of the MAE is critical since it determines the length of each segment (i.e., the sea-state duration) and the overall quality of the linear fit. Different values of the MAE provide different time segments (durations) and break points, resulting, in this way, in different duration populations of developing, decaying and stationary sea states.

In this work, a sensitivity analysis of the effect of the MAE on the obtained results is made. More precisely, the bottom-up approach is applied with different values of the MAE and the effect of the later on the obtained results is examined. Since the bottom-up approach does not produce directly stationary sea states, they are extracted from the population of developing and decaying sea states by applying a criterion for the H_S variation. Duration statistics can then be estimated using the database of the extracted sea states.

Regarding the mean sea state duration, in Jenkins (2001) (see also Soukissian and Theochari (2001)), it is suggested that this measure is not well defined, since it is strongly dependent on the recording interval. In this work, instead of using only the classical mean duration, we also present results referring to the so-called “useful mean duration”, which has the advantage of remaining almost constant for certain ranges of recording intervals. The concept for treating the sea-state duration in terms of the useful mean duration has been introduced by Jenkins (2001). The useful mean duration is estimated from the relation

$$\bar{\tau}^u = \frac{\left(\sum_{i=1}^n \Delta \tau_i^2 \right)}{\left(\sum_{i=1}^n \Delta \tau_i \right)}, \quad (1)$$