

EVOLUTION OF SURFACE WAVE SPECTRA IN EXTREME SEA STATES ALONG THE EASTERN ADRIATIC OPEN SEA AND CHANNEL AREAS

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Abstract

Measurements of the wind-generated surface waves along the eastern part of the Adriatic Sea in coastal areas are rare; most earlier measurements have been carried out in the open sea. As a part of the scientific and research program – „The Adriatic Sea Monitoring Program“, long-term wave measurements were carried out between November 2007 and December 2008 at two stations: in the open sea north area (V1) and in the channel area of the middle Adriatic (V2). Spectral characteristics of waves in extreme sea states are presented and compared.

Keywords: *Adriatic Sea, Waves*

Introduction

The process of formation and development of surface waves may be considered as a function of three basic variables: wind direction and speed, fetch over which the wind blows and duration of wind of a particular direction. Occurrence of a fully developed model of wind waves is unusual in the Adriatic, which is a semi-enclosed sea of limited fetches. However, instrumental measurements and visual onboard observations of surface wave elements show that during strong gale force winds of longer fetches (SE, W, SW and NE) wave models of respectable dimensions may be developed in the Adriatic Sea. Absolute maximum of wave height $H_{max}=10.8$ m was measured in the north (V1) and extreme expected value of Adriatic wave height is about 14 m [1].

Materials and methods

Wind generated surface waves were measured at V1 ($\varphi=44^{\circ}44.5'$ N; $\lambda=3^{\circ}10.2'$ E) in the open part of the north Adriatic and in the Bracki Channel area of the middle Adriatic at V2 ($\varphi=43^{\circ}29.3'$ N; $\lambda=16^{\circ}27.9'$ E; Fig.1).

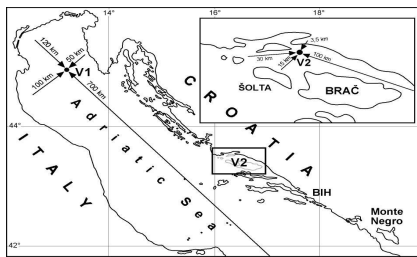


Fig. 1. Location of waverider stations: V1 in the open part of the north Adriatic and V2 in the Bracki channel.

This was undertaken in the time interval from 11.2007 to 12.2008, by using Datawell waveriders with all its components. For the analysis and description of extreme sea states maximum recorded wave height H_{max} and significant wave height $H_{1/3}$ and associated wave spectra will be presented.

Results and discussion

The measurement results show that much larger waves appear in the northern Adriatic compared to the middle Adriatic channel area. This is attributed to a significantly larger fetch of predominant winds in the north (Fig. 1). The maximum wave height of 7.27 m, which corresponds to significant wave height of 4.22 m, was measured at V1 on 10.12.2008. At V2, significantly smaller values were measured, with a maximum wave height of 2.84 m (3.12.2007), which corresponds to significant wave height of 0.92 m. The spectral characteristics of extreme surface waves at V1 are very similar to the observed wave spectra for the open sea [2, 3]. Fig. 2 shows the density spectrum of energy of surface waves for strong and gale southeasterly wind (Sirocco) in V1 on 10.12.2008 when the maximum measured wave height was 7.27 m. It is clear that the maximum density spectrum of energy $S(f)=42.52$ m^2/Hz corresponds to wave period of 9.1 s, matching the significant wave height $H_{1/3}=3.75$ m. The figure also shows the evolution of the spectrum for the period of increase of energy up to maximum (Fig. 2a) and for the period of decrease of energy (Fig. 2b). During the period of increasing wind speed, an increase of wave spectral energy density and its maximum were observed. Simultaneously, the maximum of the spectrum moves toward the lower frequencies. During decreasing wind speed, $S(f)$ decreased and the maximum in spectrum moved slightly toward the lower frequencies. At V2, wave spectra evolution during strong Sirocco differs

significantly from open sea (Figs. 2c, 2d). The difference is observed for the period of decreasing wind speed and wave energy, when the maximum in spectrum is shifted in time toward the higher frequencies (Fig. 2d). It can be concluded that in enclosed seas of very small fetches (Bracki Channel), the evolution of surface wave spectra in extreme wave conditions is considerably different than in open sea area. The wave spectra evolution for the open Adriatic is very well known [1], while for the channel area it is presented here for the first time. The occurrence of extreme sea states in this channel area is not possible, as confirmed by these results, although this time-series of measurement is not representative. Fetch is the major limiting factor in sea state development in the channel area.

Acknowledgements

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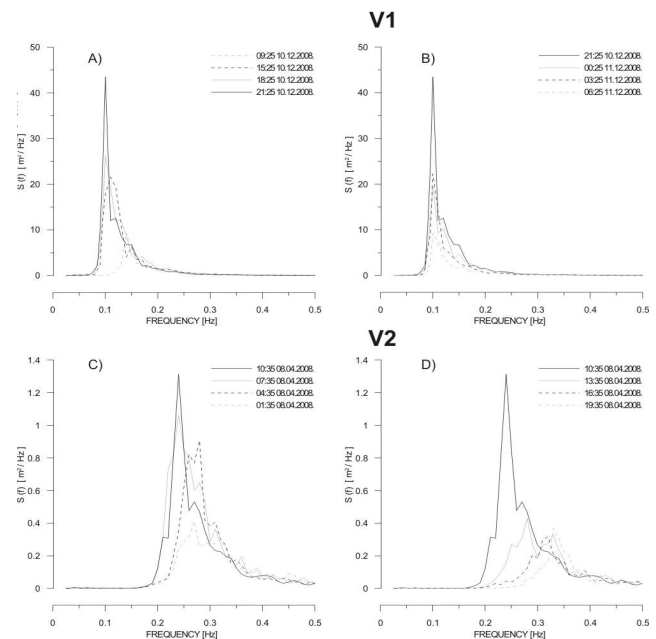


Fig. 2. Evolution of the spectrum for the period of increase of energy up to maximum (A,C) and for the period of decrease of energy (B,D) at station V1 (10.12.2008) and V2 (8.4.2008).

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