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Spatiotemporal Variability of the Black Sea Wave
Climate in the Last 37 Years

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Abstract

The main objective of our work is analysis of spatiotemporal variability of the Black Sea wave climate from 1979 to 2015. The analysis is based on mathematical modeling using the modern DHI MIKE 21 SW spectral wave model. Verification of the wave model was performed using numerous data of instrumental observations of wind wave parameters in the Black and Azov seas. Our studies revealed climatic trends in the spatial distribution of wave energy and made possible determining the main frequencies of wave energy fluctuations.

Keywords

Wave climate; Black Sea; Numerical modeling; Wave power; Wave spectra; Spatiotemporal variability

1. Introduction

Wind waves are among the main factors determining the marine transport development, exploration of the shelf, dynamical processes in the coastal zone of the sea that influence the coastal infrastructure, ecology, and recreation potential. Despite the fact that the Black Sea is a closed sea it is a part of the global climatic system. The fact of climate variations is not currently doubted by anyone. At the same time, the nature of these variations and possible tendencies of climatic fluctuations are the themes of debates.

A large number of works dedicated to various aspects of mathematical modeling of the Black Sea wave climate have been published recently (Akpınar A., Ponce de León, 2016; Rusu, 2015; Arkhipkin et al., 2014; Akpınar A., Ihsan Kömürçü, 2013; Aydoğan et al. 2013; Galabov, 2013; Polonsky et al., 2011; Rusu, 2009; Cherneva et al., 2008). Various models of wind waves were used in the research (WAM, WAVEWATCH, SWAN) as well as different initial fields of surface wind were applied; numerical experiments with tuning of model parameters were carried out. The conclusions of these works can be hardly called identical; however, all the authors agree that the correctness of model simulations are completely determined by the input data quality (wind forcing) and the ability of the wave model to reproduce the characteristics of strong and extremely strong storms.

We analyzed the results of the published works and conclude that one issue deserves our attention, namely: the problems of climatic trends in the wave climate dynamics. A weak negative trend in the duration and number of storms over the Black Sea was revealed in (Arkhipkin et al., 2014); however, their conclusion is based on the calculations using quite rough spatiotemporal wind field, which do not adequately describe the synoptic situations characteristic of the Black Sea. The same obvious problem (underestimation of strong storms) is seen in (Akpınar A., Ihsan Kömürçü, 2012), which gives an estimate of the linear trends in the wave potential at several locations of the southeastern coast of the Black Sea. A conclusion about impossibility of unambiguous interpretation of climatic trends in the terms of intensification-

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