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Feasibility of wind wave simulations in the Black Sea deep and shallow water areas

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Sea state is an essential element of the closely coupled atmosphere – ocean system. Wind waves are one of the phenomena that determine it and represent the surface splitting these two most important subsystems regulating the climate dynamics. Moreover, they affect many human activities such as navigation, design of hydro-technical constructions, production and transport of oil and gas, marine tourism, and are one of the main factors for environmental security in the coastal zone and shore areas. Therefore, wind waves gain strategic geophysical significance and their observation and forecasting are relatively well-developed.

Numerical modelling is one of the most useful tools for simulation and understanding of the wave evolution. Indispensable requirement for reliable diagnostic and forecasting entails the use of the third generation wave models. On the other hand, availability of realistic input information on wind spatial and temporal distribution affects significantly accuracy of wave model output. Number of studies, based on comparison of measurements and model computations, has arrived to the conclusion that the wind fields derived from global models either in operational mode or by means of reanalysis of all available information underestimate the real ones. This is especially relevant both for storm events and for regions where wind measurements are irregular or scarce. Therefore, the aim of the present study is to explore the applicability of different sources of wind forcing data for the Black Sea region where long-term observations in deep water areas are extremely rare. This implies selection of proper regional model capable of interpolating and eventually increasing the quality of the input driving fields. The major reanalysis of ECMWF and NCEP/NCAR with 2.5 degree resolution are used as such. Data originated from standard synoptic maps are considered to resolve the extreme storm events as well.

Three of wave models with wide application for diagnostic and prognostic studies – WAM cycle 4, Tolman's WAVEWATCH – III and Davidan's spectral-parametric model (SPM) – are adopted to resolve the wave field in deep water with 0.5 degree resolution. It is found that more realistic wave fields are simulated using the atmospheric pressure field reanalysis rather than the reanalysis of surface wind. The results obtained for different areas are compared with buoy measurements. The use of SPM as source of boundary conditions for calculation of waves in shallow water is substantiated. Further, transformation of waves in shallow water is simulated with the SWAN model. It is implemented in a 2 min grid and verified for the Western Black Sea shelf and coastal zone against available platform measurements of wave parameters.