Research article

Numerical simulation of hydrodynamic wave processes in the Sea of Azov based on the WAVEWATCH III wind-wave model

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The article is devoted to the study of the possibilities of the modern version of the third-generation wind-wave model WAVEWATCH III (WW3). The basic equations of the model are given and the software implementation is described. A retrospective analysis of the characteristics of wind waves in the Sea of Azov was carried out, and the simulation results were compared with the data from long-term observations of coastal hydrometeostations of the Sea of Azov, presented in the Unified Interdepartmental Federal Information System (ESIMO) databases. In the predictive model, the computational domains approximating the shoreline configuration and the bathymetry of real marine basins are regular latitude-longitude grids consisting of elements of size 1.2×1.2 degree ($\sim 2 \times 2$ km). The bathymetry and the corresponding land-sea mask (a two-dimensional array with values determining the belongingness of an element to ground or sea) required to do calculations for each of the basins were constructed using navigation maps. In the retrospective analysis, climatic data for a multi-year month (2008-2023) on wind speed were used to generate input wind data at grid nodes. Based on the WW3 spectral model, the forecast of wind wave parameters in the Sea of Azov was carried out. Prognostic maps of the average period, average length and heights of the waves prevailing at different points in time were constructed. The meteorological fields (wind speed, water and air temperature) necessary for calculations were taken from the databases of the Hydrometeorological Center of Russia and NCEP/NOAA. Parallel efficiency indicators for hybrid parallelization (MPI–OpenMP) were calculated, and scalability was determined for both MPI and hybrid launches.

Keywords: mathematical modelling, model WAVEWATCH III, hybrid parallelization, retrospective analysis, wind waves, predictive maps

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