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Wind waves modelling on the water body with coupled WRF and WAVEWATCH III models

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Simulation of ocean and sea waves is an accepted instrument for the improvement of the weather forecasts. Wave modelling, coupled models modelling is applied to open seas [1] and is less developed for moderate and small inland water reservoirs and lakes, though being of considerable interest for inland navigation. Our goal is to tune the WAVEWATCH III model to the conditions of the inland reservoir and to carry out the simulations of surface wind waves with coupled WRF (Weather Research and Forecasting) and WAVEWATCH III models. Gorky Reservoir, an artificial lake in the central part of the Volga River formed by a hydroelectric dam, was considered as an example of inland reservoir.

Comparing to [2] where moderate constant winds (u10 is up to 9 m/s) of different directions blowing steadily all over the surface of the reservoir were considered, here we apply atmospheric model WRF to get wind input to WAVEWATCH III. WRF computations were held on the Yellowstone supercomputer for 4 nested domains with minimum scale of 1 km.

WAVEWATCH III model was tuned for the conditions of the Gorky Reservoir. Satellite topographic data on altitudes ranged from 56,6° N to 57,5° N and from 42.9° E to 43.5° E with increments 0,00833 ° in both directions was used. 31 frequencies ranged from 0,2 Hz to 4 Hz and 30 directions were considered. The minimal significant wave height was changed to the lower one. The waves in the model were developing from some initial seeding spectral distribution (Gaussian in frequency and space, cosine in direction).

The range of the observed significant wave height in the numerical experiment was from less than 1 cm up to 30 cm. The field experiments were carried out in the south part of the Gorky reservoir from the boat [2, 3]. 1-D spectra of the field experiment were compared with those obtained in the numerical experiments with different parameterizations of flux provided in WAVEWATCH III both with constant wind input and WRF wind input. For all the considered cases, wave amplitude characteristics calculated with constant wind input were overestimated, and spectral maxima showed the downshifting comparing with the measured data. WRF wind input improved the coincidence, but extra tuning of WAVEWATCH III model is required.

To conclude, we discuss the applicability of WRF wind input: it increases the accuracy of the simulations and makes possible the application of this technique for getting the forecasts of wind over all the water bodies and surface wind waves on it. Also the conclusion of necessity of the new parameterization of flux for wind wave modelling in inland reservoirs and lakes is made.

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