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Modelling of wind waves on the lake-like basin of Gorky Reservoir with WAVEWATCH III

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Simulation of ocean waves and sea waves is nowadays a generally adopted technique of operational meteorology. Such well-known models as WAVEWATCH, WAM, SWAM are aimed primarily at describing ocean waves including coastal (nearshore) zones. Meanwhile, wave modelling is less developed for moderate and small inland water reservoirs and lakes, though being of considerable interest for inland navigation.

In this paper test numerical experiments on simulating waves on the lake-like basin of the Gorky Reservoir using WAVEWATCH III are reported. We aimed to evaluate the applicability of the model to the waves on a mid-sized inland reservoir.

Gorky Reservoir is an artificial lake in the central part of the Volga River formed by a hydroelectric dam of Gorky Hydroelectric Station between the towns of Gorodets and Zavolzhye. It spans for 427 km from the dam of Rybinsk to the dam of Gorodets through several regions of Central Russia. While it is relatively narrow and follows the natural riverbed of Volga in the upper part, it becomes up to 15 km wide downstream the town of Yuryevets. Its maximum depth is 22 m, the surface area is 1590 km^2, the accumulated water volume amounts to 8.71 km^3.

In the series of calculations we considered moderate winds of different directions blowing steadily all over the surface of the reservoir and the waves developing from calm conditions or from some initial seeding spectral distribution that is Gaussian in frequency and space, cosine in direction.

The results of wave simulation are compared then with the data collected by the field in-situ observations and measurements. The field experiments were carried out in the south part of the Gorky reservoir from the boat. In the course of the experiment we simultaneously measured profiles of wind speed and surface wave spectra using instruments placed on the Froude buoy, which measures the following parameters: i) the module and the direction of the wind speed using ultrasonic wind sensor WindSonic Gill instruments, located on the 4 levels from 0.1 to 5 m long; ii) profile of the surface waves with 3-channel string wave-gauge with the base of 5 cm, iii) the temperature of the water and air with a resistive sensor. 3D spectra of surface waves were retrieved by Fourier dimensional method developed in [1]. Wind velocity parameters (wind friction velocity and roughness height) were retrieved from wind velocity profiles averaged over 10 minutes.

To conclude, we discuss applicability of the several parameterizations for the wave action source terms available in WAVEWATCH III.

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Reference

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