The study of the influence of the surface waves formation conditions and rain on the acoustic waves backscattering by the water surface applied to remote sensing of the sea surface

Yuriy Titchenko*[(1)], Vladimir Karaev[(1)], and Eugeniy Meshkov[(1)]
(1) Institute of Applied Physics of RAS, Nizhny Novgorod, Russian Federation,
http://www.ipfran.ru

The study addresses to the problem of ground calibration and verification of satellite measurements of the surface waves characteristics. For measurements we propose to use the Doppler underwater acoustic wave gauge of a special design, which can directly measure the sea wave statistical characteristics that effect on the electromagnetic wave backscatter of the same wavelength. The main features of the acoustic wave gauge are the use of Doppler ultrasound sonar and antennas with different antenna patterns. In the experiment, measurements are carried out by sonar submerged to the bottom and antennas oriented vertically upwards. Retrieval algorithms are based on the dependence of the Doppler spectrum of the reflected acoustic signal from the water surface statistical characteristics. This method allow to measure all second-order statistical parameters of sea waves, namely, the variance of the vertical orbital velocity component, the variance of slopes in two mutually perpendicular directions, and the cross-correlation coefficients of slopes and the vertical orbital velocity component. Currently, especially important is the possibility of measuring the variance of slopes of the water surface, the same as measured by radar systems.

The advantage of this approach is the ability to measure the parameters of the water surface in any water body and in any weather conditions (e.g. storm or rain). It should be noted that raindrops in the atmosphere have a significant impact on the scattering of electromagnetic waves and effect on the accuracy of the retrieval algorithms. To estimate the contribution to the electromagnetic waves scattering of precipitation in the atmosphere is necessary to know the contribution to the scattering of water surface modified by the action of fallen drops. Thus, an accurate measurement of the water surface statistical characteristics is necessary when measuring precipitation by radar methods from aircraft and satellites.

The results of studies of the characteristics of the acoustic signal reflected by the water surface under different conditions of waves formation (wind speed, wind acceleration length and intensity of the rain). Empirical log-Gaussian model was used for numerical simulation of wave spectrum generated by the rain. Numerical study of the effect of rain on the scattering characteristics were carried out and the method of detecting rain according to the acoustic wave gauge was proposed.

Field measurements with the acoustic wave gauge were performed in the laboratory of the Institute of Applied Physics, at the Gorky Reservoir and at the Black Sea. The measurements showed high correlation with the simulation results and confirmed the efficiency of the proposed approach.