Empirical Parameterization of the Wind-induced Drift Currents

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Abstract

Results of measurements of the drift currents induced by waves and wind at the wavy water surface are presented. The measurements were executed by means of surface floats in a large tank with the dimensions of 32.5x1x2 m^3. Three cases were studied: (i) regular (narrow-band) mechanical waves; (ii) irregular (wide-band) mechanical waves; and (iii) wind waves.

The measured surface-drift currents induced by mechanical waves, U_d, are compared with the Stokes drift at the surface, U_{St}, estimated by the well-known formula with the integral over a wave spectrum. In this case, it was found that ratio U_d / U_{St} is varying in the range 0.5 – 0.93 and slightly growing with the decrease of wave steepness, having no visible dependence on the breaking intensity. These estimations are used to separate the wind-induced drift current, U_{dw}, from the total drift at the presence of a wind.

In the case of wind waves, the wind-induced part of the surface drift, U_{dw}, is compared with the friction velocity, u_*. In our measurements, the ratio U_{dw} / u_* varies systematically in the range 0.65 – 1.2.

Taking into account the percentage of wave breaking, Br, the wave age, A, and the wave steepness, $\sigma = ak_p$, it was found the parameterization: $U_{dw} = (Br + \sigma A)\, u_*$, which corresponds to the observations with the mean error less than 10%. For the first time, this ratio provides the dependence of the surface wind drift on the surface wave parameters.

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