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Free Surface Behavior in Turbulent Open-Channel Flows

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Laboratory experiments were conducted to investigate characteristics of the free surface behavior and its influences on turbulence structures in an open-channel shear flow. A simultaneous image measurement method was used to measure instantaneous velocity vectors and the corresponding water surface profile in a vertical cross section of the open-channel flow. The proper orthogonal decomposition of the water surface fluctuations successfully reveals that most of the principal components are sinusoidal wave shapes. Then, interactions between the predominant surface fluctuations and the turbulence structures are examined by calculating their space correlations. The result shows that there is a thin surface influence layer near the water surface, and also that there is the specific interaction between the water surface fluctuations and the large-scale turbulence structures having the same longitudinal scale. Moreover, the streamwise spectrum of the water surface fluctuations and the influence range of the free surface are discussed in detail.

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