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Boundary-layer structure of shallow free-surface flows with high relative roughness OLIVIER EIFF, EMMA FLORENS, FRÉDÉRIC MOULIN, U. of Toulouse / CNRS — The boundary-layer structure of shallow free-surface flows over very rough walls is investigated with particle image velocimetry (PIV) both within the canopy and above, without disturbing the flow, by gaining complete optical access. This enabled reliable estimates of the double-averaged mean and turbulence profiles to be obtained by minimizing and quantifying the usual errors introduced by limited temporal and spatial sampling. It is shown that poor spatial sampling can lead to erroneous vertical profiles in the roughness sublayer. In order to better define and determine the roughness-sublayer height, a methodology based on the measured spatial dispersion is proposed which takes into account temporal sampling errors. The results reveal values well below the usual more ad hoc estimates. Then, the double-averaged statistics were used to investigate the effect of low relative submergence of the roughness elements on the friction velocity and the logarithmic law. The measurements show that the dispersive stresses are necessary to estimate correctly the total shear stress above the canopy top. The logarithmic law is shown to persist for submergence ratios at least as high as 0.33, even though the roughness sublayer largely extends into it. A dependence of the roughness length on submergence is observed, but not for the displacement height.

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