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By-pass Laminar–Turbulent Transition of the Wind-Driven Free Surface Flow

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The laminar-turbulent transition of wind-induced spatially developing surface boundary layer in water at the entrance of a water tank is investigated experimentally. Observations of the velocity field were made both by flow visualisation techniques using dye injection and laser Doppler velocimeter measurements. Two stages in the development of the perturbations have been clearly identified. First, a slow growth of streamwise longitudinal vortices embedded into the laminar flow is followed by a rapid development of secondary instabilities till to breakdown. The picture is similar to the by-pass transition to turbulence of a rigid plate boundary layer. At the second stage, peculiar to this flow, an explosive deepening of the boundary layer and fast development of inflexional instabilities occur. The critical fetch, where the shear boundary layer collapses and the first turbulent spots appear, is not linked to any critical Reynolds number but was found to be inversely proportional to the friction velocity squared.

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