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PIV investigation on lock-exchange gravity currents propagating over smooth and rough beds

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Gravity currents performed through lock-release of a brine solution into a fixed volume of fresh water, in a rectangular cross-section Perspex tank, are investigated. Four experiments are performed by changing the roughness of the bed material, maintaining constant all other experimental variables. Particle Image Velocimetry is used to measure the instantaneous velocities of the flow in a vertical plane positioned along the tank centerline. Gravity currents here performed are in the inertial phase of development when entering the visualization window. Two regions of quasi-steady streamwise velocity are detected within the head and the body of the current and their main characteristics are assessed through the analysis of the velocity, vorticity and Reynold stresses profiles. The flow in these regions result from the interaction between the mean flow and the flow structures generated in both bottom and interfacial shear layers. As the gravity current head passes, the effect of the interfacial shear layer vanishes due to overall reduction of streamwise velocity, being the flow mainly dominated by the bottom generated vorticity. Bed roughness is seen to reduce the front velocity and the streamwise velocity within the current, due to extra drag induced by the roughness elements, and to homogenize the velocity distribution within the current, reducing the maximum velocity gradient. Striking differences are observed in the velocity and vorticity fields between gravity currents developing over smooth bed and over the highest bed roughness tested, confirming that the size and porosity of the bed material play a role in the gravity current kinematics.