On the propagation of gravity currents past a submerged array of cylinders

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Abstract. In this study, the propagation of lock-exchange gravity currents in a horizontal channel containing a submerged array of cylindrical obstacles are investigated using laboratory experiments and large eddy simulations. Excellent agreement on the flow structure and front velocity between the experimental and numerical results is found. A thorough three-dimensional parametric study is performed in which the array density ϕ is varied continuously from 0 (flat-bed) to 1 (solid-slab), and the submergence ratio is varied from 1 (emergent) to 10 (deeply submerged). A decomposition of the array density into a new two-dimensional parameter space consisting of a streamwise array density μ_x and a spanwise array density μ_y is proposed to provide a more quantitative and unambiguous description of the current propagation dynamics. The various flow regimes arising from the current-array interaction and their mutual transitions are investigated in detail. Two possible current acceleration mechanisms are identified with the underlying physics interpreted.