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Mixing mechanics governing the density current propagation in the presence of waves

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A systematic set of flume experiments on the classical lock exchange release in the presence of regular surface waves is used to investigate the mixing mechanics induced by the oscillatory motion. Reference experiments in quiescent ambient fluid condition are also performed.

The set of experiments consisted in the generation of gravity currents in full depth lock-exchange problems (lock depth about 0.20 m) accounting for different wave conditions (i.e. wave height range H_w 1.5-4.3 cm, wave period range T_w 0.7-1.3 s), different reduced gravity configurations all of them restricted to be Boussinesq-type (range of g' 0.04-0.15 m/s^2), and different lock distance configurations characterized by aspect ratio of 0.04 and 0.07. The experimental apparatus adopted ensures the observation of steady gravity currents.

Results in terms of density profiles show that the concentration gradually changes from the interface to the bottom if surface regular waves are superimposed, with the mixing process affecting the entire gravity current depth. The two extreme conditions in the concentration profile development are obtained during the zero-upcrossing wave phase and zero down-crossing wave phase. The mixing processes are more intense in the case of lower reduced gravity showing a reduction of 25$\%$ in terms of concentration. For the understanding of the physics governing the mixing in the presence/absence of waves, the comparison between density profiles acquired at a section relatively close to the front (Section I, located 0.5 H upstream), and at another section located at a further distance (Section II, located 1.5H from the front) are performed. Results show that in the presence of quiescent ambient fluid the concentration profile acquired at the two sections (section I and Section II) are comparable when scaled by the local gravity current depth hf. On the other hand, in the presence of waves the behaviour at section I is quite similar to that observed in the case of quiescent ambient fluid, while at section II the fluid is more mixed out, suggesting that the change of the concentration profiles observed in the presence of waves is mainly governed by the orbital motion of the water particles.