Highly-resolved simulations of gravity and turbidity currents: application to turbulence suppression leading to the emplacement of massive sand deposits

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OTE research group at IMFT invited seminar.

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Fully resolved direct numerical simulations and high quality experimental measurements have provided a wealth of information over the past two decades on the complex process and balance of turbulence production, transport and dissipation in a wall-bounded turbulent flow, and insight into the question of Reynolds number scaling. Of particular interest is the similar question of balance between turbulence production and dissipation in the context of wall turbulence driven by suspended particles. Powder snow avalanche, pyroclastic flows down a mountain slope, submarine turbidity currents and dust storms are some examples of such suspended particle-driven wall bounded turbulent flows. These are flows exhibiting fascinating physics as their sustained propagation depends on an tight interplay between the suspended particles and turbulence. The suspended particles drive the flow and the intensity of the flow sustains wall turbulence. In the case of turbidity currents, the flow turbulence is crucial since it enables resuspension of particles from the bed. If resuspension dominates over deposition the intensity of the current can increase, thereby further increasing resuspension and resulting in a runaway current. On the other hand, if deposition dominates over resuspension the current could laminarize, and without turbulence-induced resuspension all the suspended particles will settle resulting in a massive deposit. This work explores and explain conditions conducive to complete turbulence suppression in a turbidity current through the use of Direct Numerical Simulations (DNS). A simple criterion and Reynolds number scaling is proposed and contrasted against available experimental and field data. Finally, this findings are applied to explain the formation of massive sand deposits emplaced by turbidity currents.

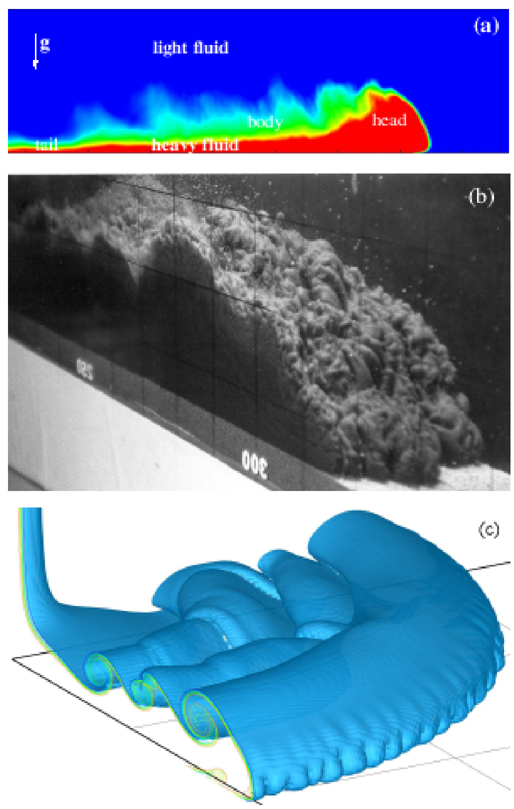

Fig. 1 Gravity current structure. Frame (a) shows schematically the structure of a gravity current. Frame (b) shows the front of a planar gravity current from a laboratory experiment. Picture courtesy of Marcelo H. García. Frame (c) shows a still of the flow in a circular sector of $\pi/2$ from the simulation of the cylindrical gravity current. The flow is visualized by a density isosurface.