Slumping regime in lock-release turbidity currents

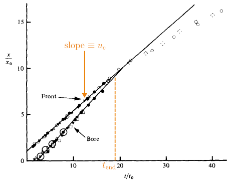
Introduction

Snow avalanche, Zinal, Switzerland @Zacharie Grossen

Dust storm, Phoenix, USA @Alan Stark

natural hazards → reliable predictive models?

- saline currents, horizontal bottom:

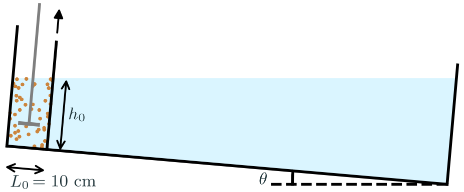


Rottman et al. 1983

- $u_c \simeq 0.5 u_0 = 0.5\sqrt{g' h_0}$
- $t_{\rm end} \simeq 20 t_0 = 20 L_0/u_0$
- constant prefactors

dynamics of particle-ladden currents on slopes?

Methods



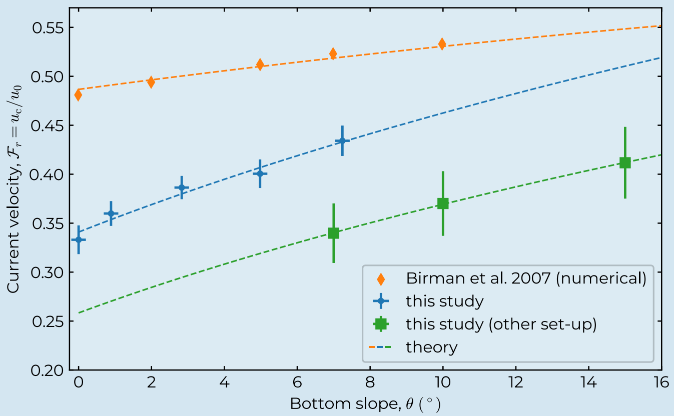
Sketch of the experimental set up

- Systematic parameter space exploration:
  - 2 different set ups: $\theta \in [0^\circ, 15^\circ]$, $h_0 \in 20, 30$ cm
  - 5 different particle diameters + saline water
  - particle volume fraction $\phi \in [0.5, 15]$ %

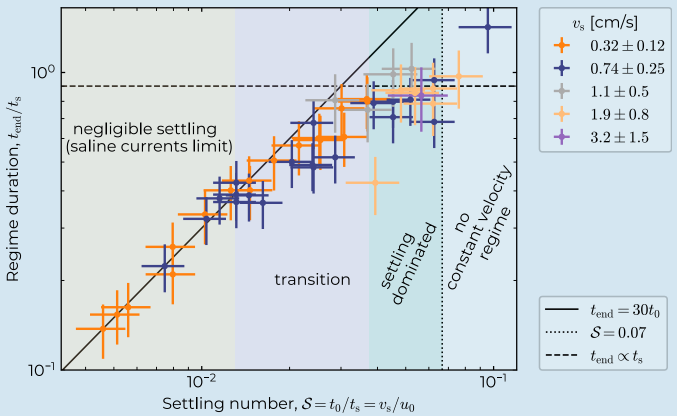
Slumping of a suspension of silica sand ($d \sim 180~\mu$m).

Bottom slope and **particle settling** matter for **turbidity current** slumping dynamics!

Bottom slope increases velocity



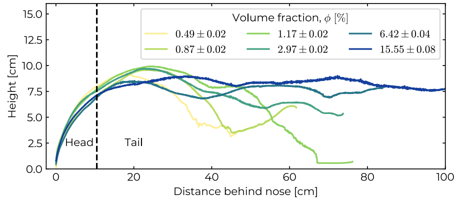
Settling decreases regime duration



C. Gadal, M. Mercier and L. Lacaze. Institut de Mécanique des Fluides de Toulouse (IMFT), France

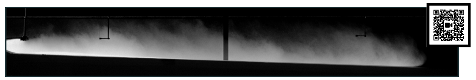
Results

- Existence of a constant-velocity regime on a sloping bottom → slope-induced acceleration occurs later (Birman et al. 2007)
- Bottom slope increases this velocity
- Settling decreases the constant-velocity regime duration
- Current head shape ($\sim L_0$ behind nose) independant of ϕ, v_s and θ



Discussion/Perspectives

- Origin of the influence of θ on $\mathcal{F}r$? (early times)
- How to include this on depth-averaged models? (to be tested)
- Influence of lock aspect-ratio (h_0/L_0) on velocity?
- What about steady-influx turbidity currents on slopes?



Steady injection of a suspension building a deposit over time.

Definitions

- slumping regime: first, constant-velocity, phase of current propagation (see introduction)
- $u_0 = \sqrt{(\delta\rho/\rho_f)\phi g h_0}$, characteristic slumping velocity
- $\delta\rho = \rho_p - \rho_f$, excess particle density
- $t_0 = L_0/u_0$, characteristic slumping time
- v_s, particle settling velocity
- $t_s = h_0/v_s$, characteristic settling time