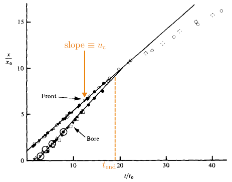
Slumping regime in lock-release turbidity currents

- Introduction


Snow avalanche, Zinal, Switzerland @Zacharie Grossen


Dust storm, Phoenix, USA @Alan Stark

- saline currents, horizontal bottom:

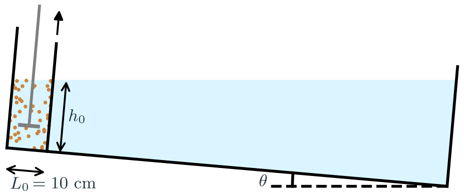


Rottman et al. 1983

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

? dynamics of particle-ladden currents on slopes ?

- Methods



Sketch of the experimental set up

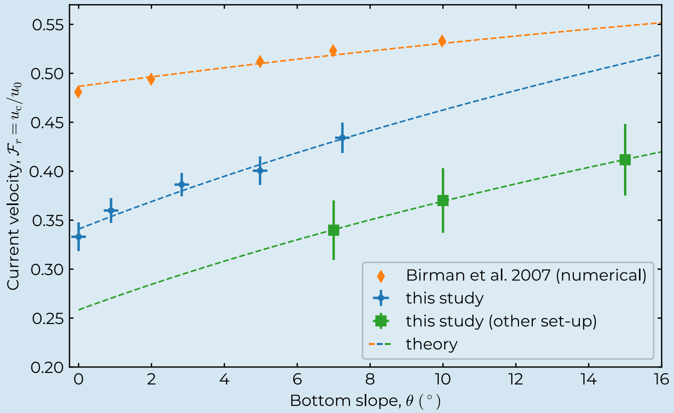
Systematic parameter space exploration:

- 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 $\phi \in [0.5, 15]$ %

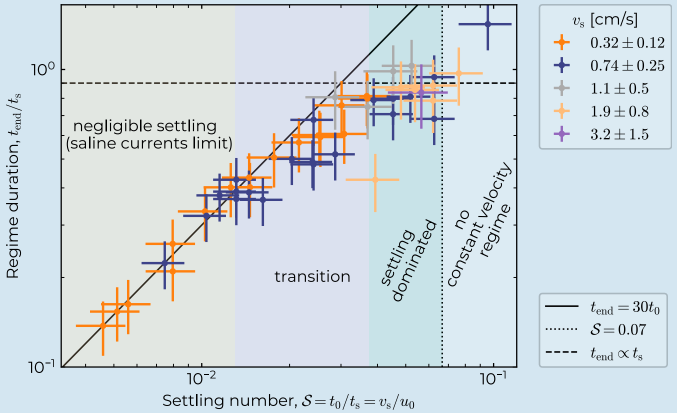

Slumping of a suspension of silica sand ($d \sim 180$ μm).

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

Bottom slope increases velocity



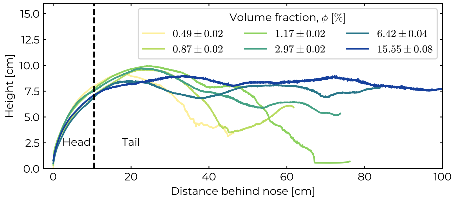
Settling decreases regime duration



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

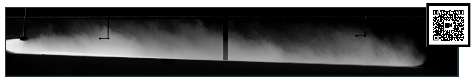
- Results

- 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 intro)
- $u_0 = \sqrt{(\delta\rho/\rho_f)\phi g h_0}$: 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