Sediment bed destabilization induced by oscillating horizontal pressure gradients

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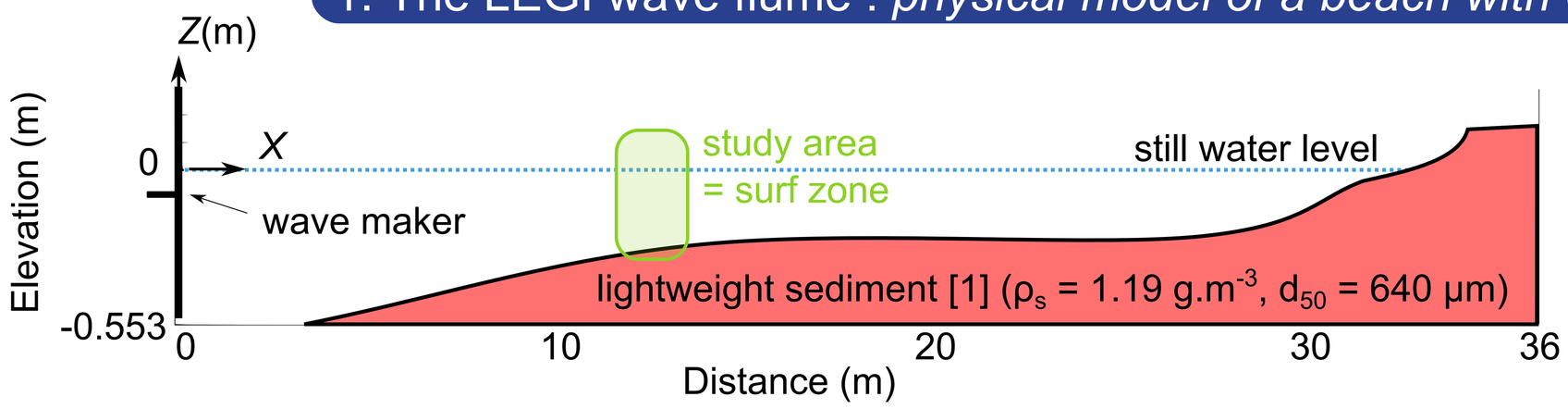
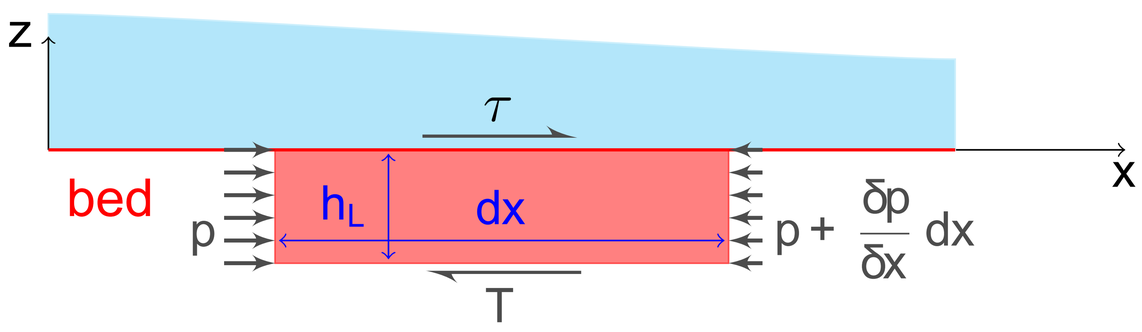
1. The LEGI wave flume : *physical model of a beach with Shields and Rouse scaling*



Measure of
- velocity (ADVP)
- pore pressure
- bed destabilization (acoustic & optical)
- free-surface elevation

2. Sleath model of plug flow



p	pore pressure,	T	friction on the still bed,
h_L	height of the plug,	τ	shear stress

Horizontal equilibrium : $-h_L \frac{\partial p}{\partial x} dx + \tau dx - T\,dx = 0$

Friction law : $|T| = K_f \times C^*(\rho_s - \rho) g h_L$

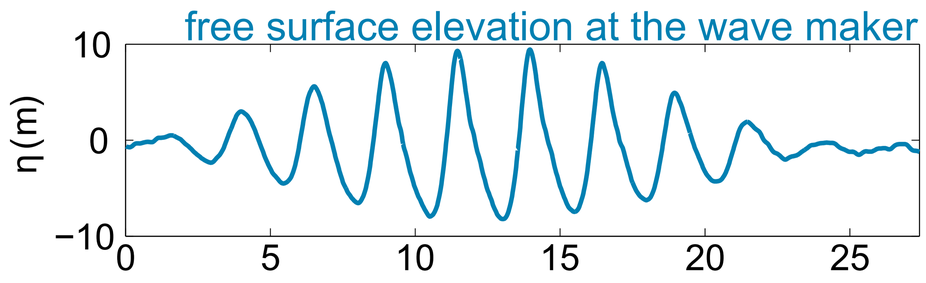
Motion occurs if [2]

$$\left| \frac{d_{50}}{h_L} \theta - S \right| \geq K_f\, C^*$$

condition for plug flow initiation
in our experiments Kf C*~ 0.3

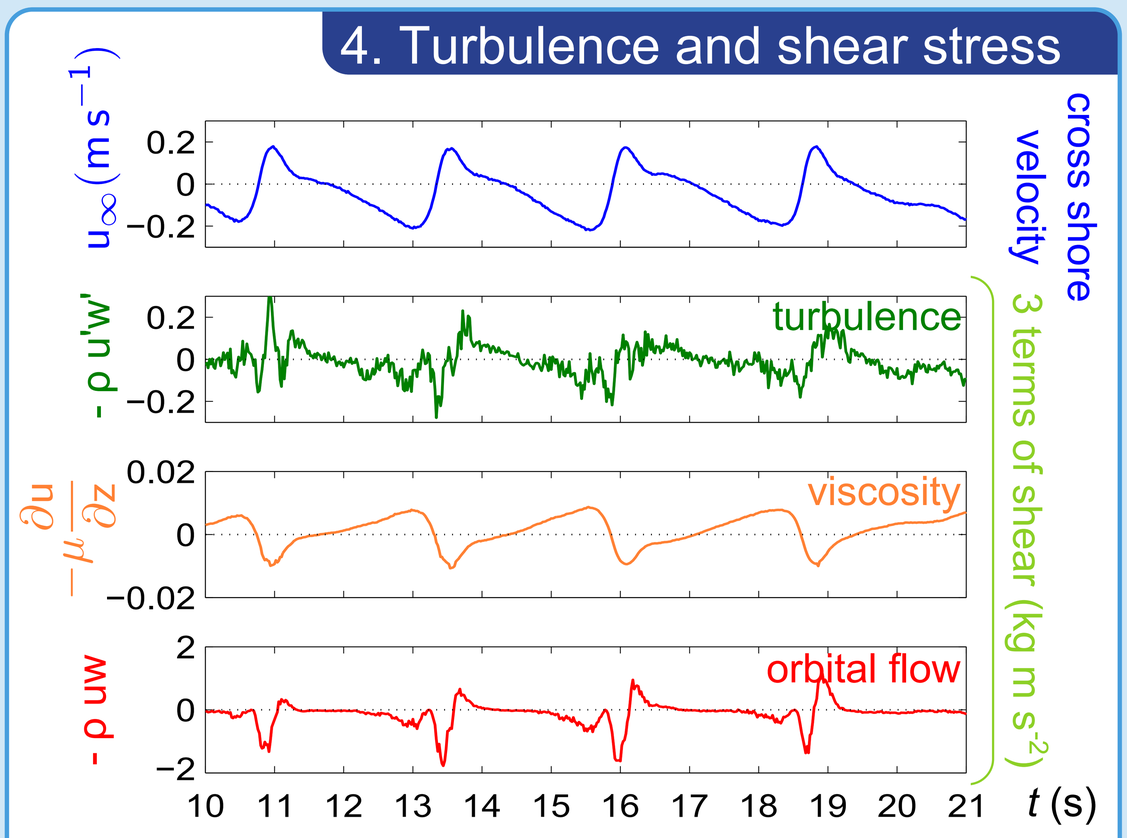
where $S = \frac{\frac{\partial p}{\partial x}}{(\rho_s - \rho) g}$; $\theta = \frac{\tau}{(\rho_s - \rho) g d_{50}}$

3. Bichromatic waves conditions



sequence repeated (>50 times) ⇒ ensemble averaged [3]:
turbulence and orbital flows

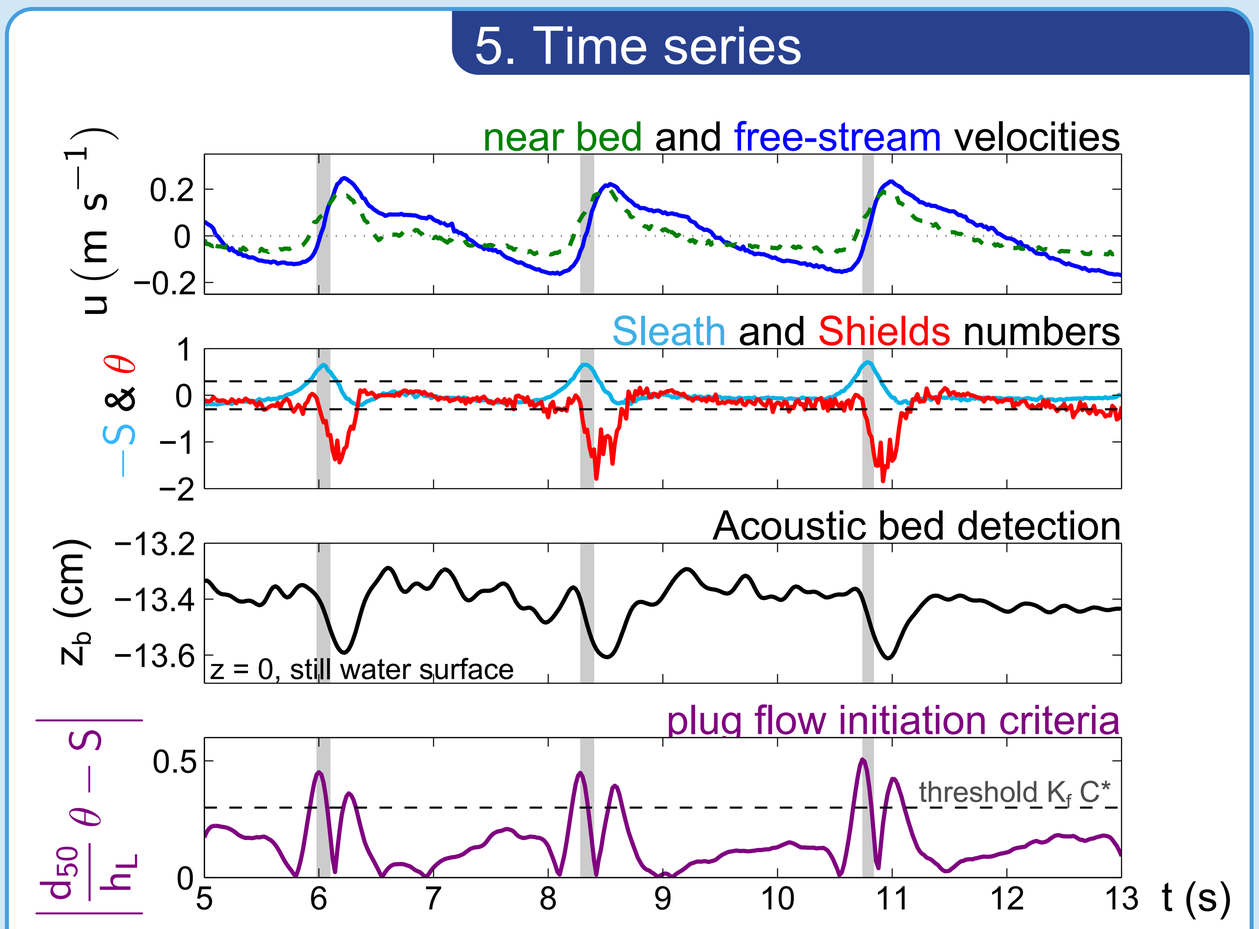
4. Turbulence and shear stress



Decomposition of shear stress in 3 terms [4].
Predominance of the orbital term; viscous and turbulence terms can be neglected.

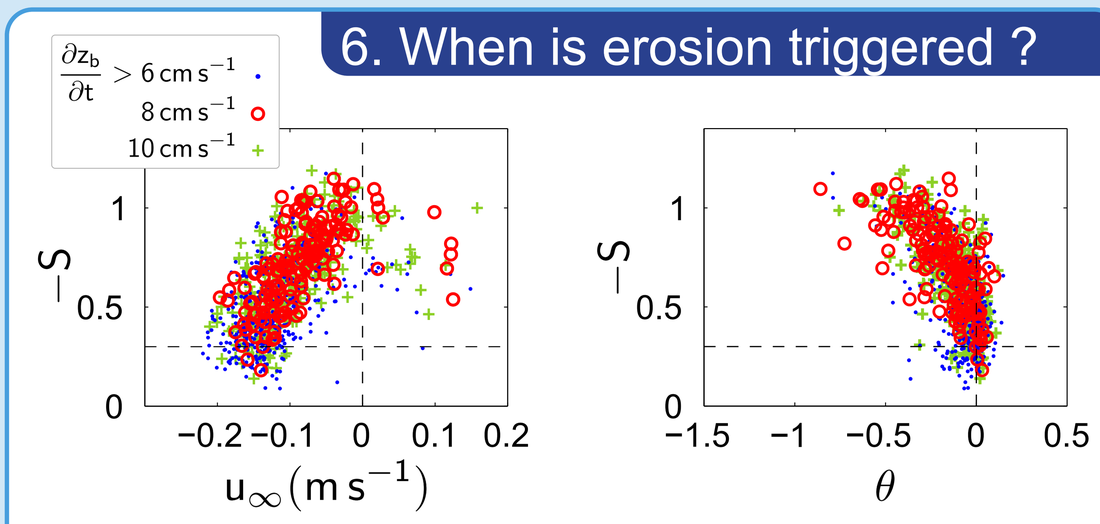
$\tau \approx -\rho uw$

5. Time series



Gray shaded rectangles stands for time intervals where $\frac{\partial z_b}{\partial t} > 8\,\mathrm{cm\,s^{-1}}$

6. When is erosion triggered ?



Erosion is triggered by high S (in agreement with the field study [5]), mostly in the wave troughs, even for low shear.

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[4] Nielsen, P. (1992) Coastal Bottom Boundary Layers and Sediment Transport. Singapore: World Scientic.
[5] Foster, D. L., Bowen, A. J., Holman, R. A. & Natoo, P. (2006) Field evidence of pressure gradient induced incipient motion. J. Geophys. Res., 111, C05004 .

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