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Sediment bed destabilization induced by oscillating horizontal pressure gradients

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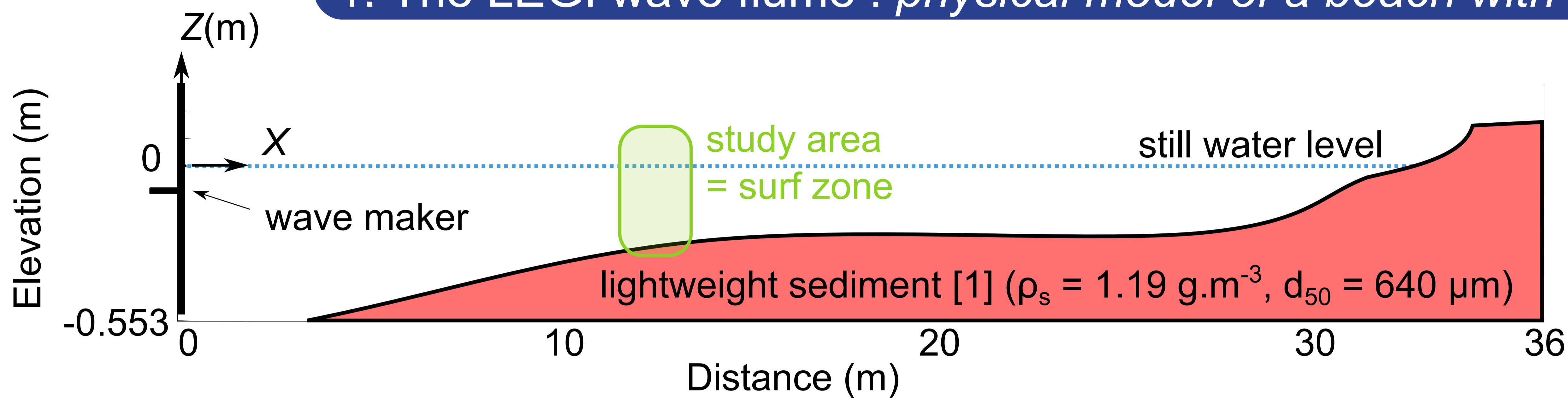
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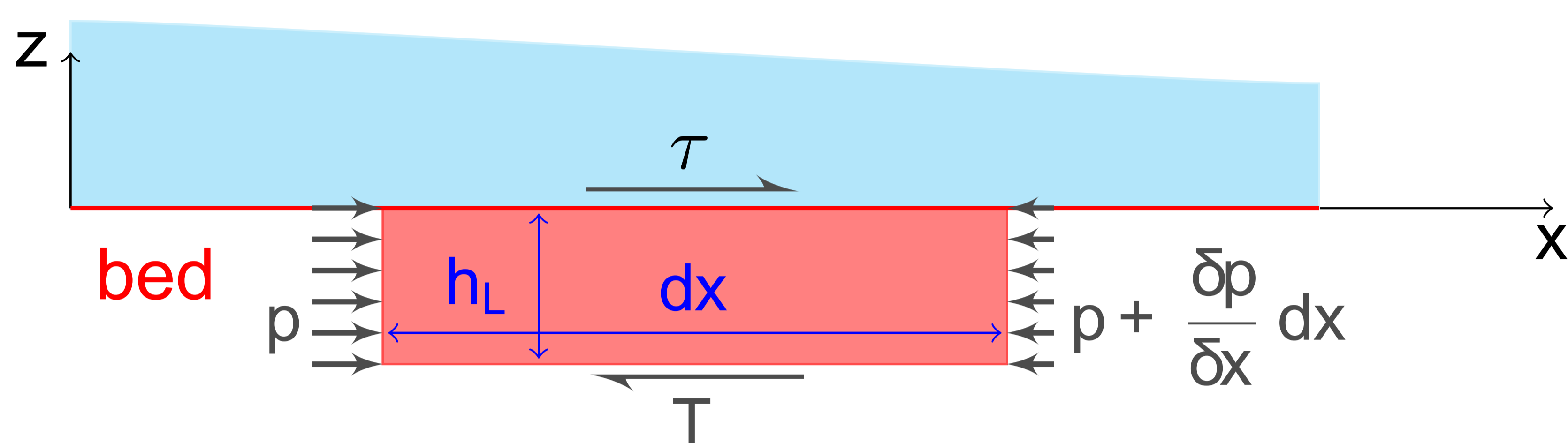
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1. The LEGI wave flume : physical model of a beach with Shields and Rouse scaling



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

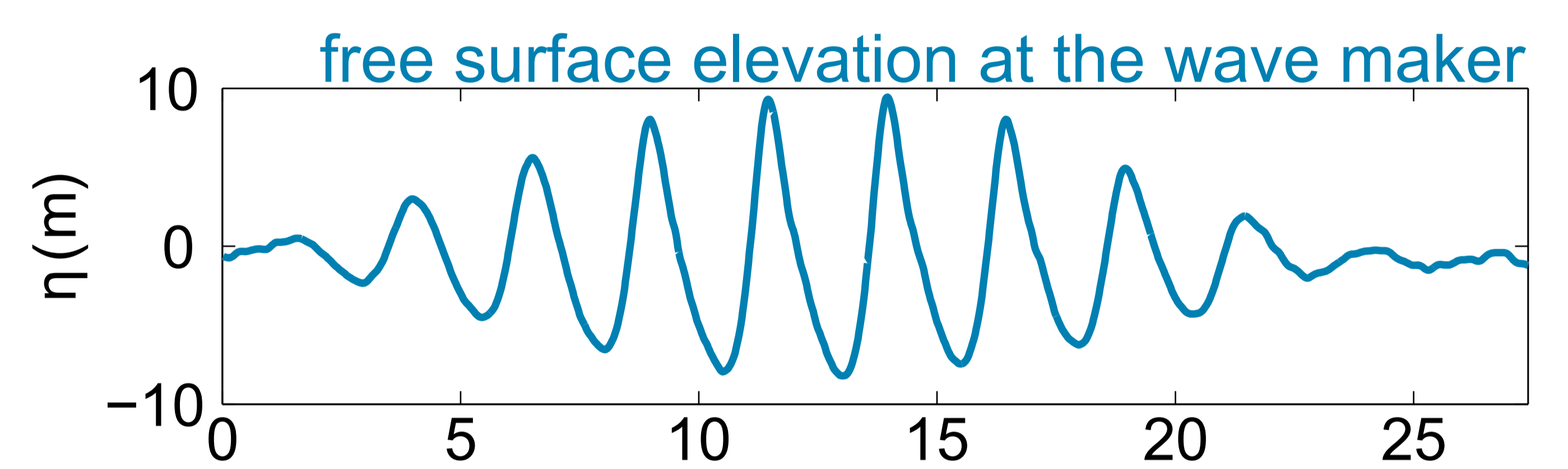
Motion occurs if [2]

$$\left| \frac{d_{50}}{h_L} \theta - S \right| \geq K_f C^* \quad \text{condition for plug flow initiation}$$

in our experiments $K_f C^* \sim 0.3$

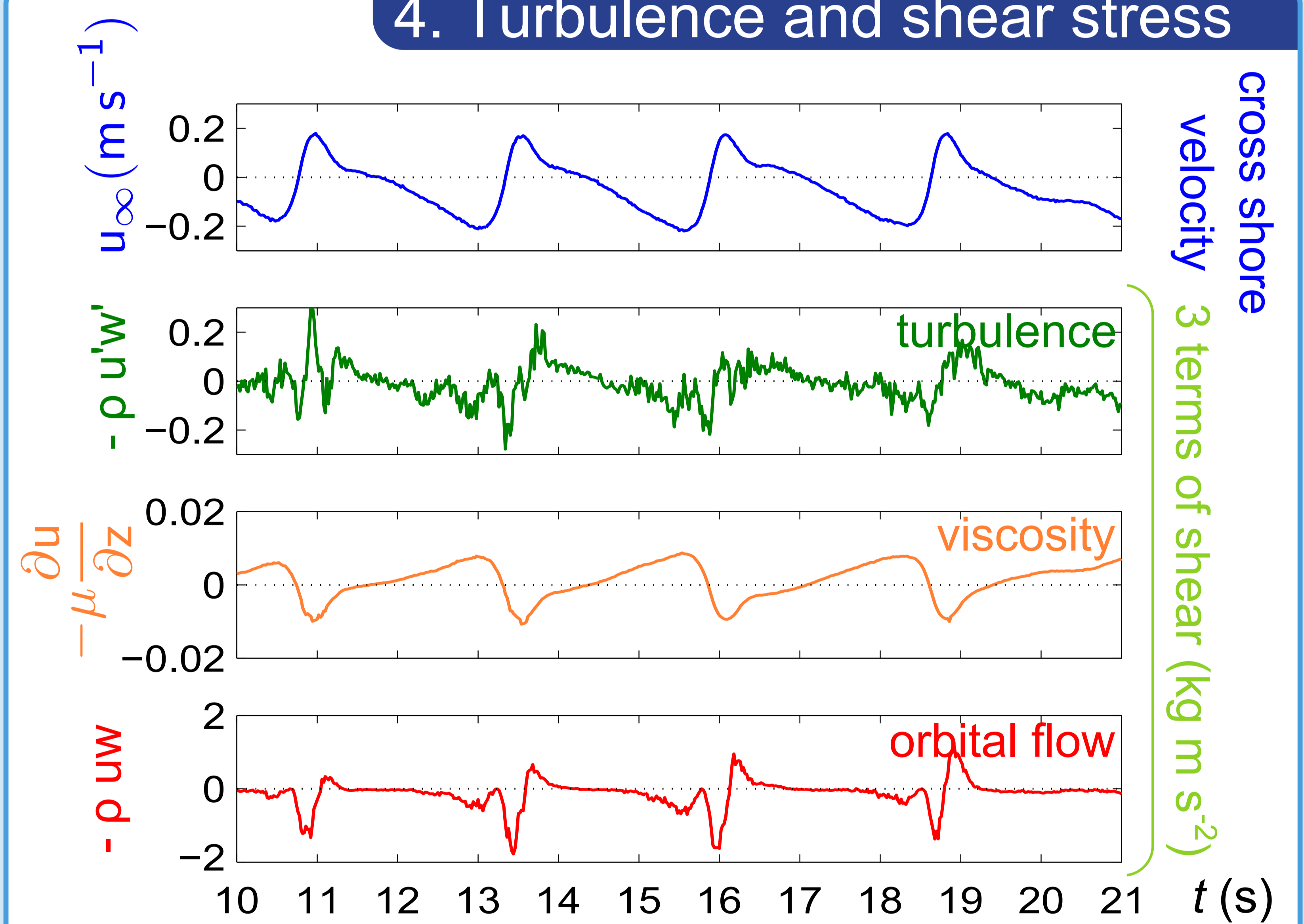
where $S = \frac{\partial p}{\partial x} / ((\rho_s - \rho)g)$; $\theta = \frac{\tau}{(\rho_s - \rho)g d_{50}}$

3. Bichromatic waves conditions



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

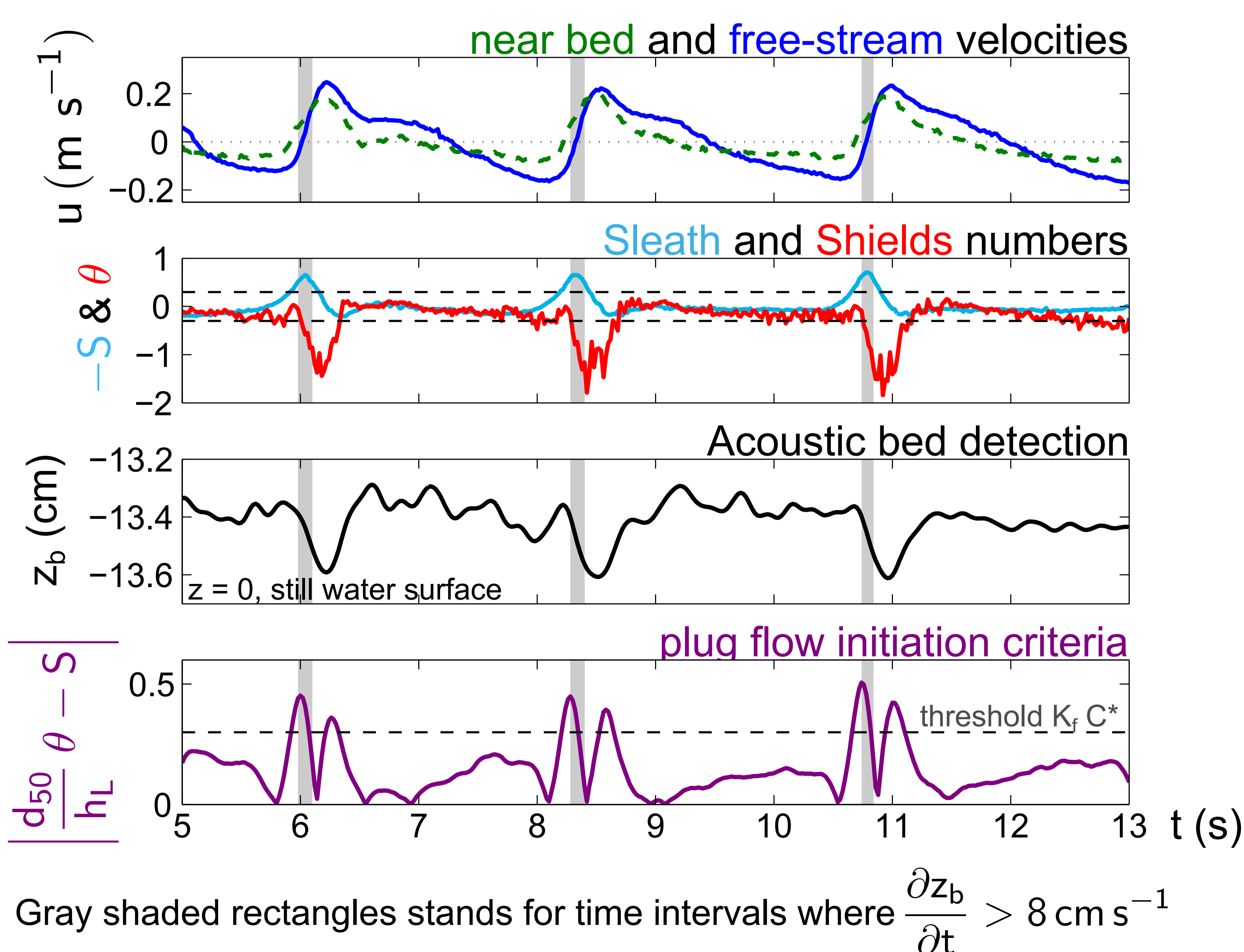
4. Turbulence and shear stress



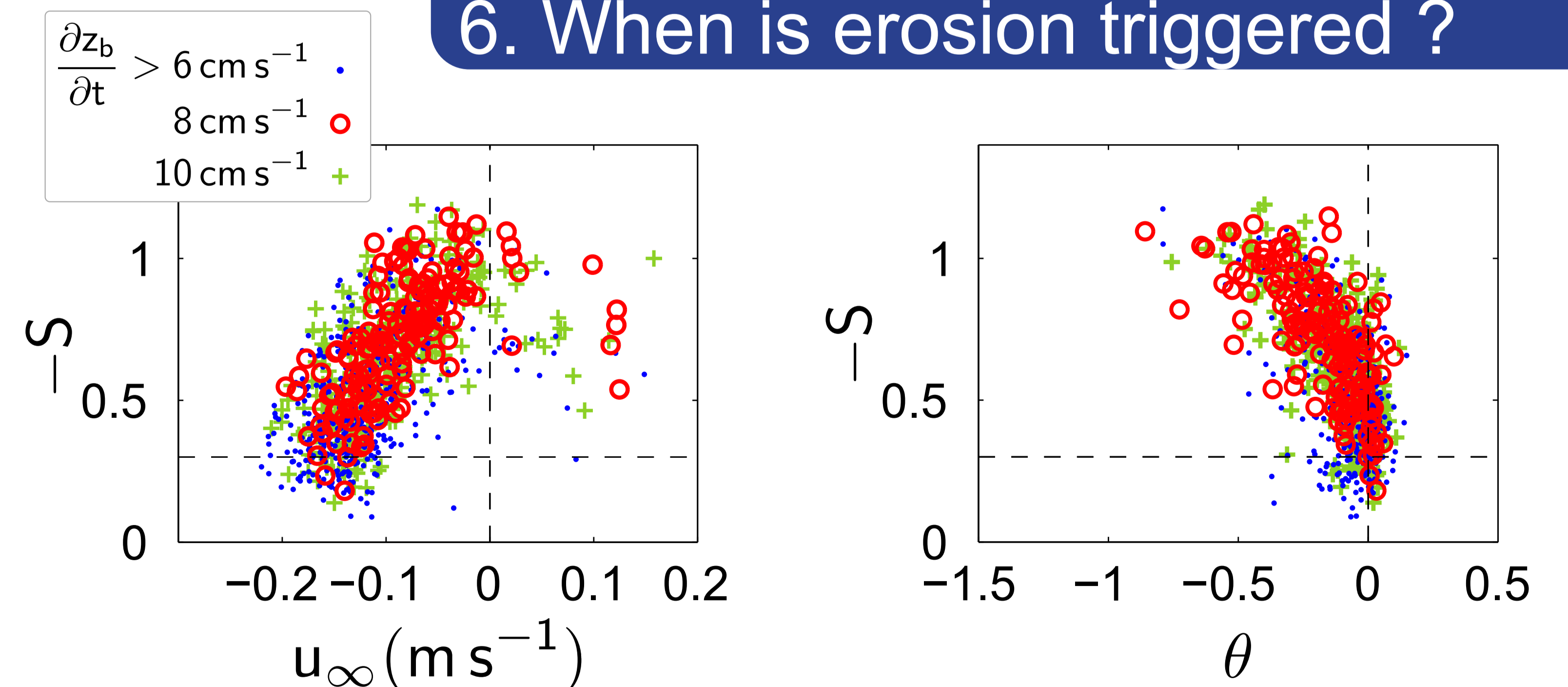
Decomposition of shear stress in 3 terms [4].
Predominance of the orbital term; viscous and turbulence terms can be neglected.

$$\tau \approx -\rho u w$$

5. Time series



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.

[1] Grasso, F., Michallet, H., Barthélemy, E. & Certain, R. (2009) Physical modeling of intermediate cross-shore beach morphology: Transients and equilibrium states. J. Geophys. Res., 114, C09001 114.

[2] Sleath, J. F. A. (1999) Conditions for plug formation in oscillatory flow. Continental shelf Res. 19 (13), 1643-1664.

[3] Berni, C., Barthélemy, E. & Michallet, H. (2013) Surf zone cross-shore boundary layer velocity asymmetry and skewness: an experimental study on a mobile bed. J. Geophys. Res.: Oceans 118, 2188-2200.

[4] Nielsen, P. (1992) Coastal Bottom Boundary Layers and Sediment Transport. Singapore: World Scientific.

[5] Foster, D. L., Bowen, A. J., Holman, R. A. & Natto, P. (2006) Field evidence of pressure gradient induced incipient motion. J. Geophys. Res., 111, C05004.

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