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Sediment bed destabilization induced by oscillating horizontal pressure gradients

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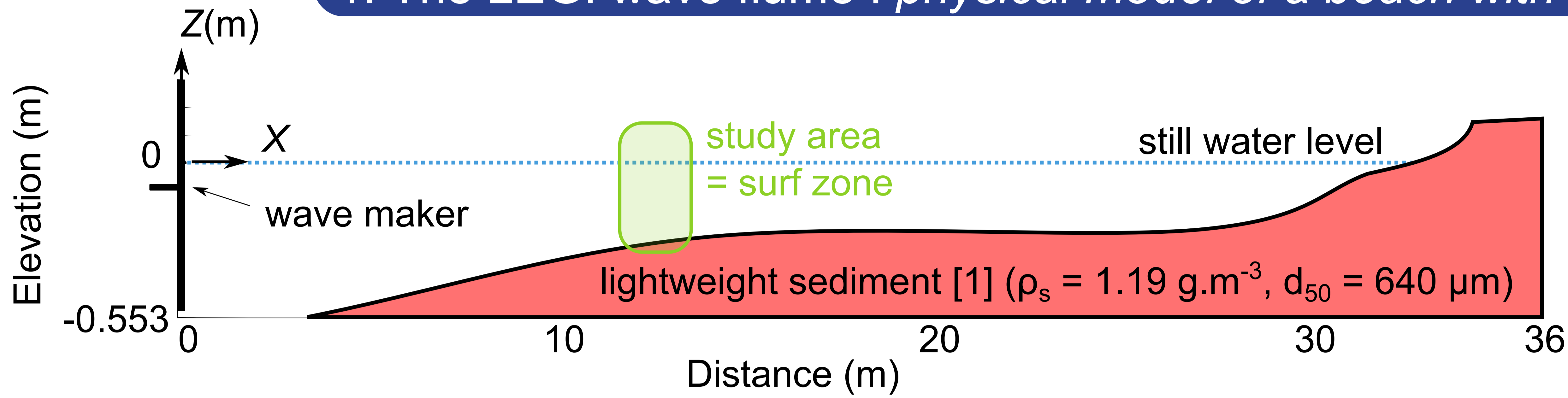
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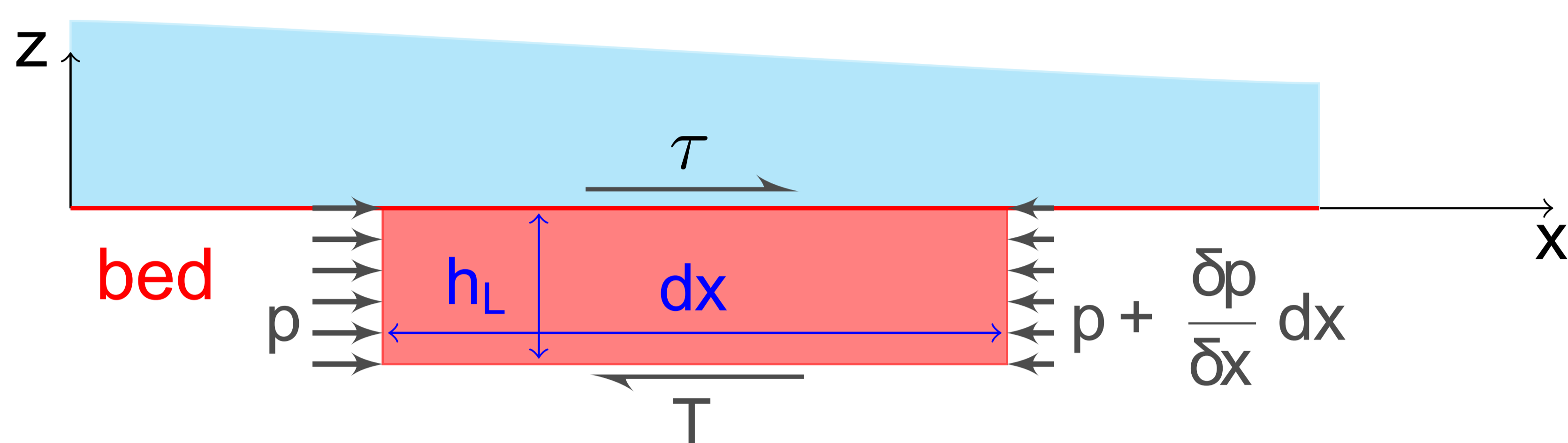
HAL Authorization

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

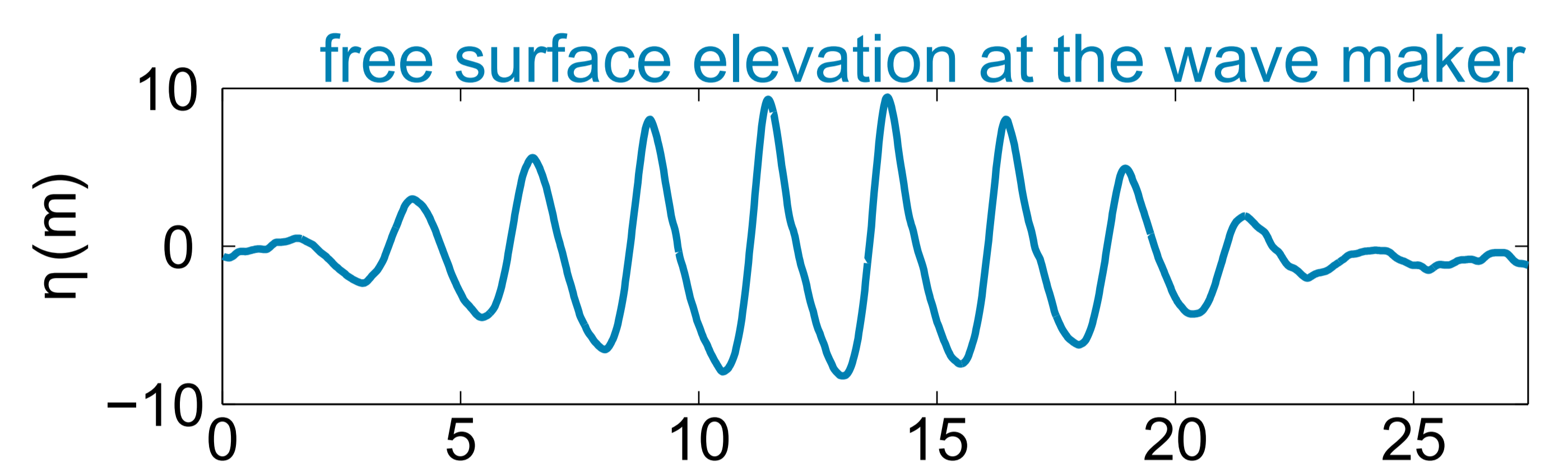
Motion occurs if [2]

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

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

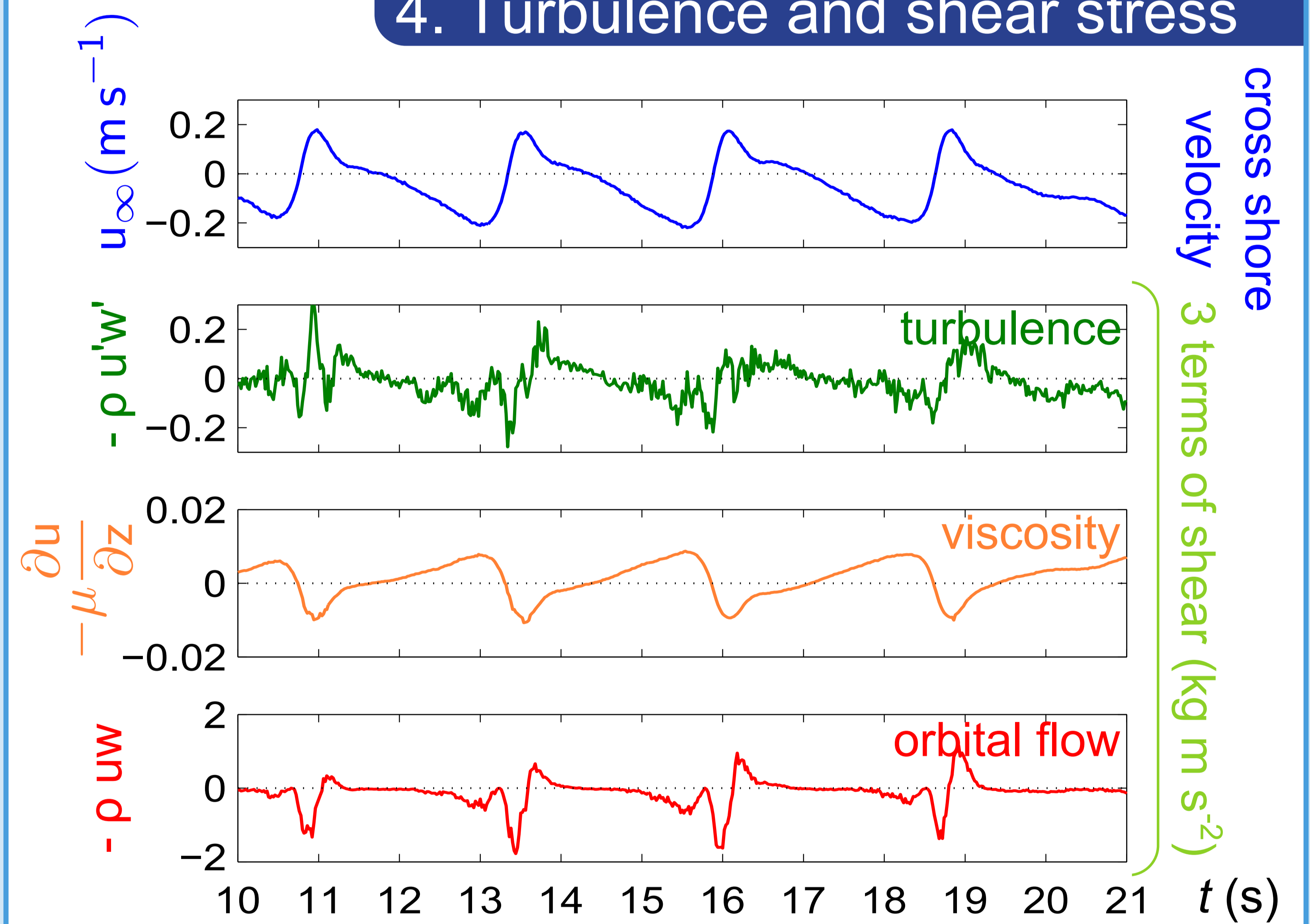
where $S = \frac{\partial p}{\partial x} / ((\rho_s - \rho)g)$; $\theta = \frac{\tau}{(\rho_s - \rho)g d_{50}}$

3. Bichromatic waves conditions



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

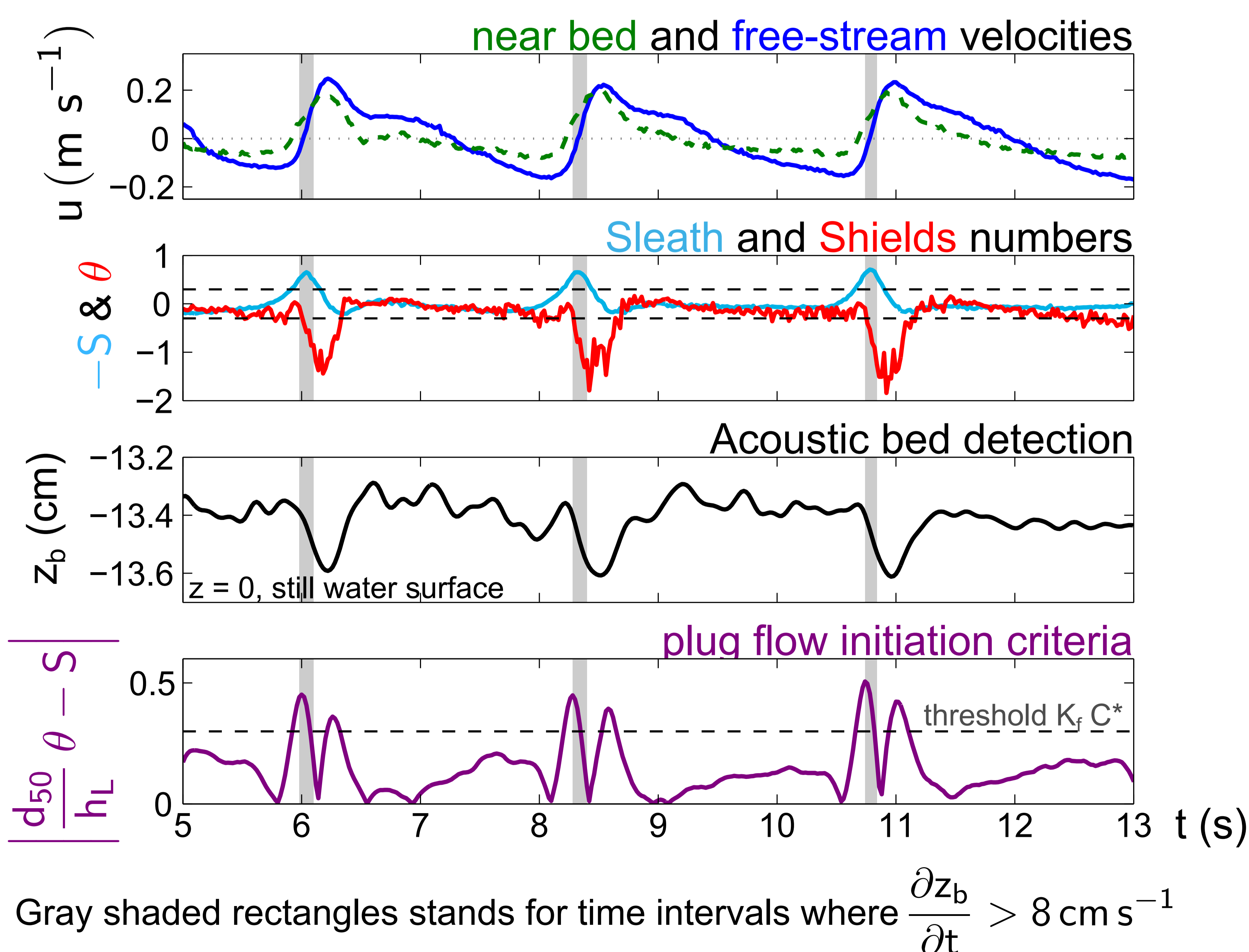
4. Turbulence and shear stress



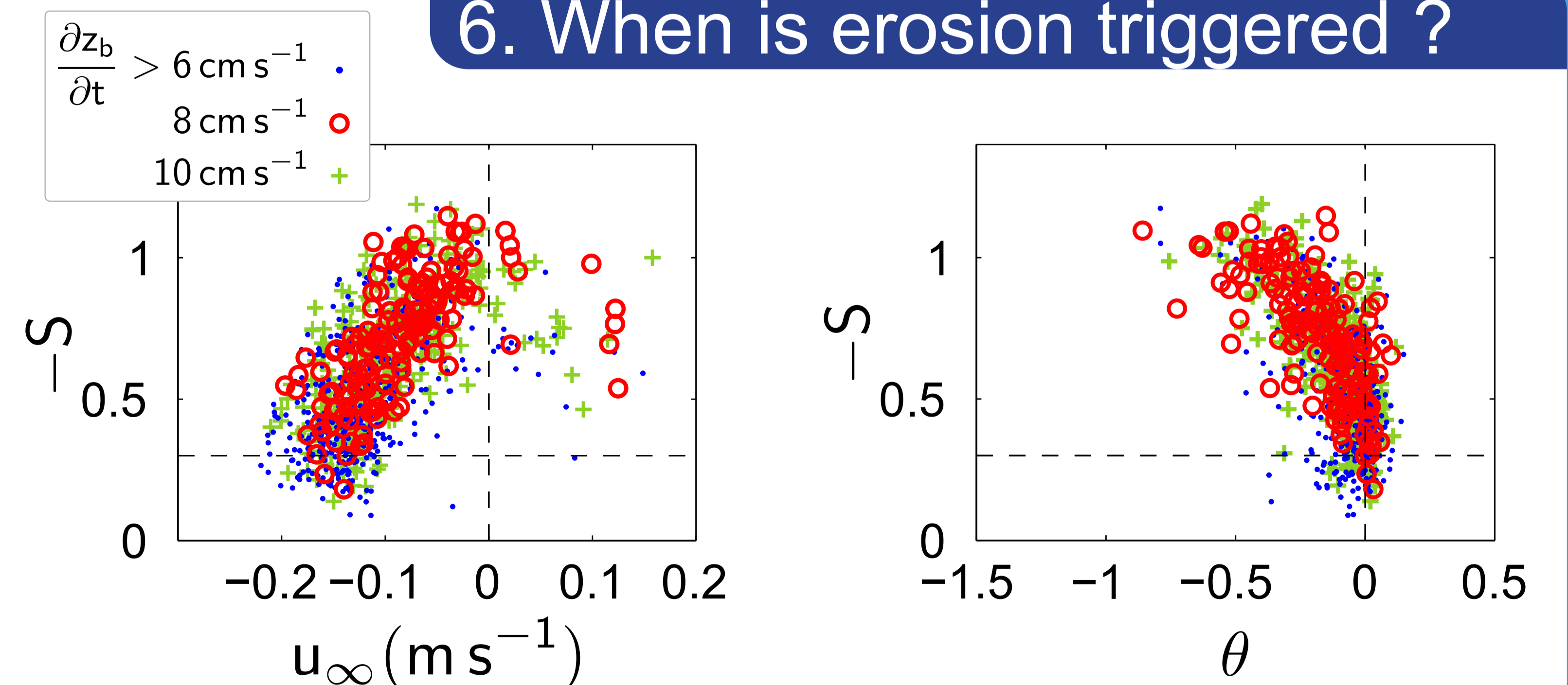
Decomposition of shear stress in 3 terms [4].
Predominance of the orbital term; viscous and turbulence terms can be neglected.

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

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.

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[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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