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Individual wave celerity in the surf zone

Motivation

- Remote-sensing techniques increasingly popular to monitor morphodynamic changes in coastal areas
- Estimation of bathymetry from video images often based on wave celerity

Video images → *Celerity (C)*
C = f (h,T,...)
→ *Water depth (h)*

- Good parameterization of celerity is essential, but relatively large discrepancies remain in the inner surf zone.

→ **Influence of infragravity waves on short-wave celerity in the surf zone?**

Methods

- Wave-by-wave analysis based on 2 high-resolution laboratory datasets (GLOBEX and Van Noorloos data)
  → 11 bichromatic wave conditions, 2 beach slopes (1/80 and 1/35)
- For each condition, waves identified and followed based on a simple crest-tracking method (see Fig. 1)
- Computation of individual wave characteristics

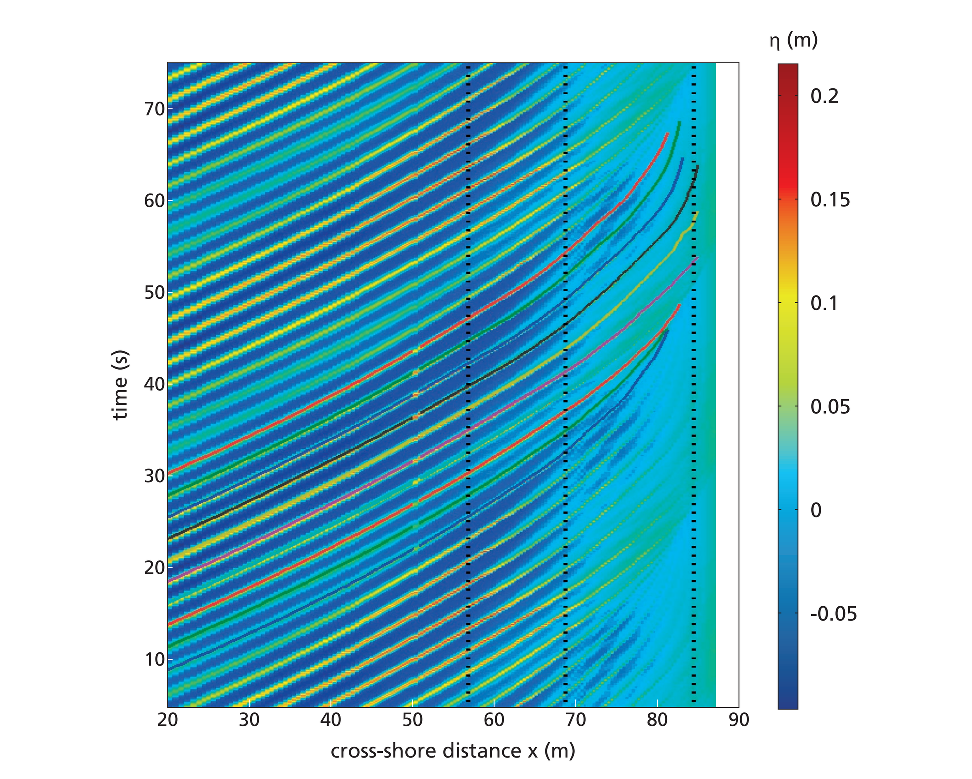

Figure 1: Time-space diagram of free-surface elevation (case B3, Globex data). The colored lines are the crest trajectories; The 3 vertical lines represent, from left to right, the outer breakpoint, the inner breakpoint, and the start of the swash zone.

Results

Individual wave celerity

- Strong variability of celerity in the surf zone (x>57 m, Fig. 2a)
- Fastest waves propagate on the infragravity wave crests (e.g. cyan line, Fig. 2): positive elevation (Fig. 2b) and onshore-directed current (Fig. 2c)

Crest convergence and bore-merging

- Variability in celerity leads to the convergence of the crests, and, potentially, to their merging (see trajectories in Fig. 1, and divergence of the individual periods in Fig. 2d)
- Convergence rate depends on infragravity wave characteristics (Fig. 3)

Cross-shore change in period:

$$CV(x) = \sqrt{\frac{1}{n_{wave}} \sum_{i=1}^{n_{wave}} \left(\frac{T_i(x) - T_i(0)}{\overline{T}(0)} \right)^2}$$

In the inner surf zone:

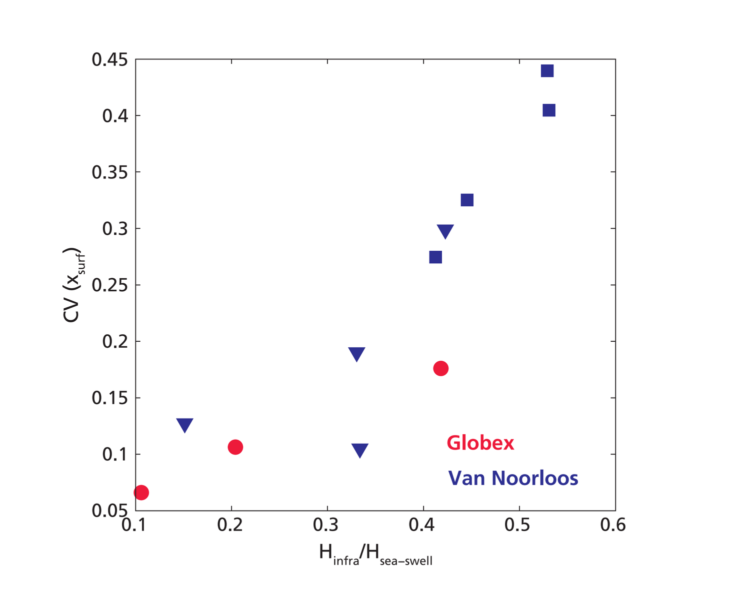

Figure 3: CV as a function of the ratio of infragravity to sea-swell wave height for the 11 conditions.

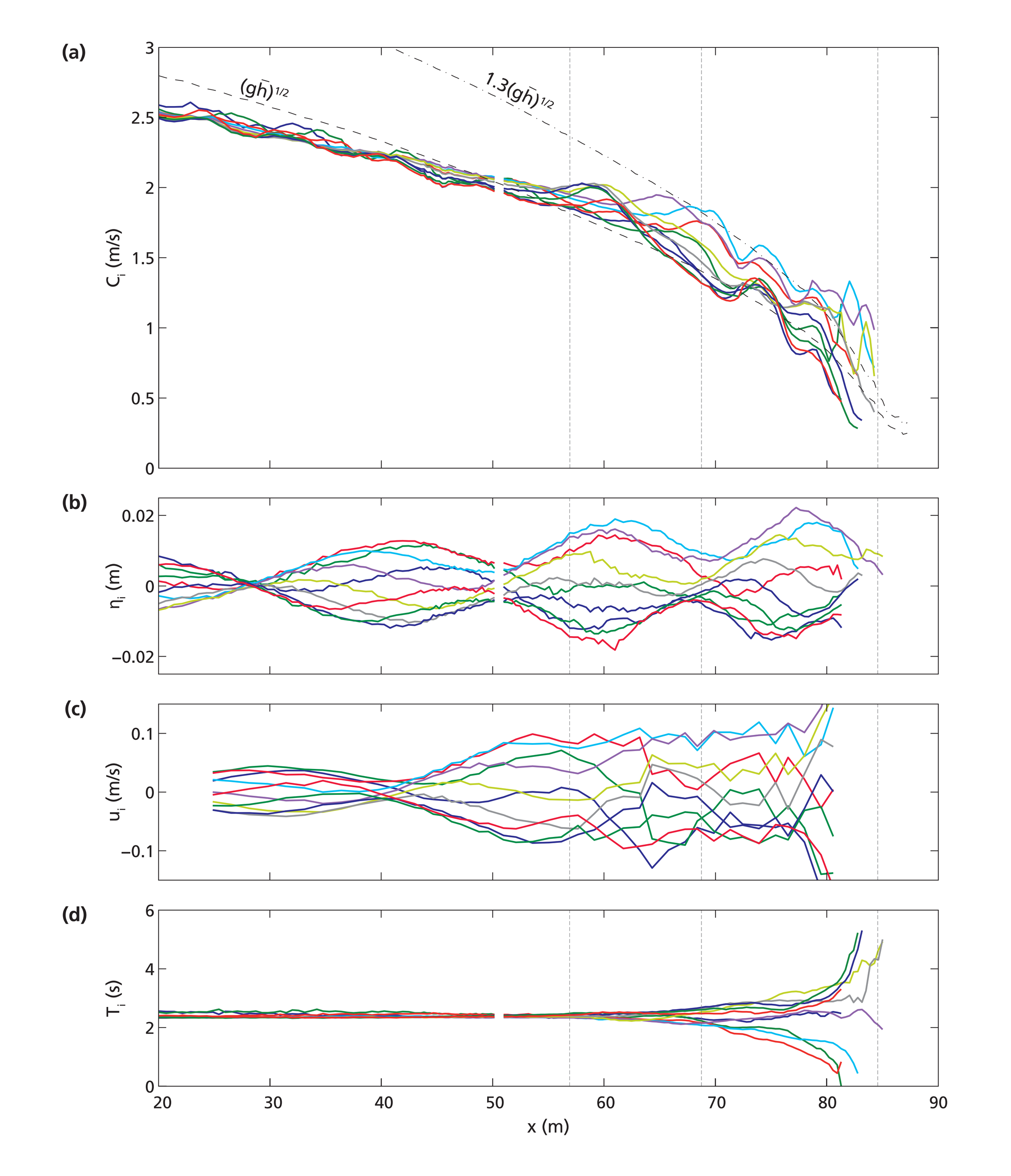

Figure 2: Cross-shore evolution of the wave celerity (a), local water level (b), local velocity (c) and period (d) for each individual wave (case B3). One line = one wave. Vertical lines: see Fig. 1.

Conclusions

- Large intra-wave variability of celerity observed in the inner surf zone (up to 90% of the mean celerity!)
- This variability can be explained, in a large part, by the variations of water level and velocity induced by the infragravity waves;

→ **Consequences for depth-inversion? (quantification errors due to the large intra-wave variability in celerity and period)**

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