Universiteit Utrecht
Department of Physical Geography

Sand suspension beneath sea-swell waves in the shoaling and surf zone

Joost Brinkkemper, Anouk de Bakker and Gerben Ruessink

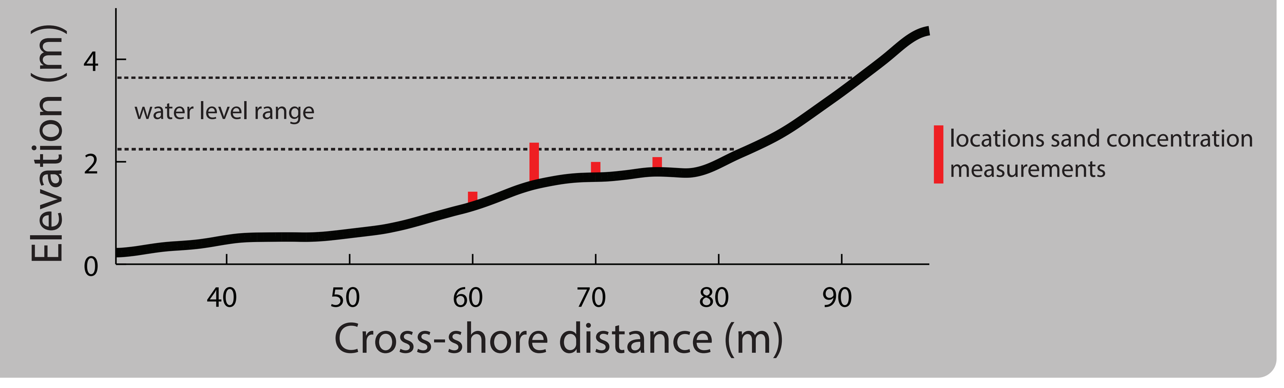
Motivation

Breaking waves and bores inject large amounts of turbulence into the water column as vortices, which can travel downward and entrain sand from the bed. **The timing of sand entrainment with respect to the wave orbital motion determines the magnitude and direction of sand transport by sea-swell waves.** Coastal evolution models rarely include the effect of this surface-induced turbulence on sand suspension and subsequent transport to predict surf-zone morphodynamics.

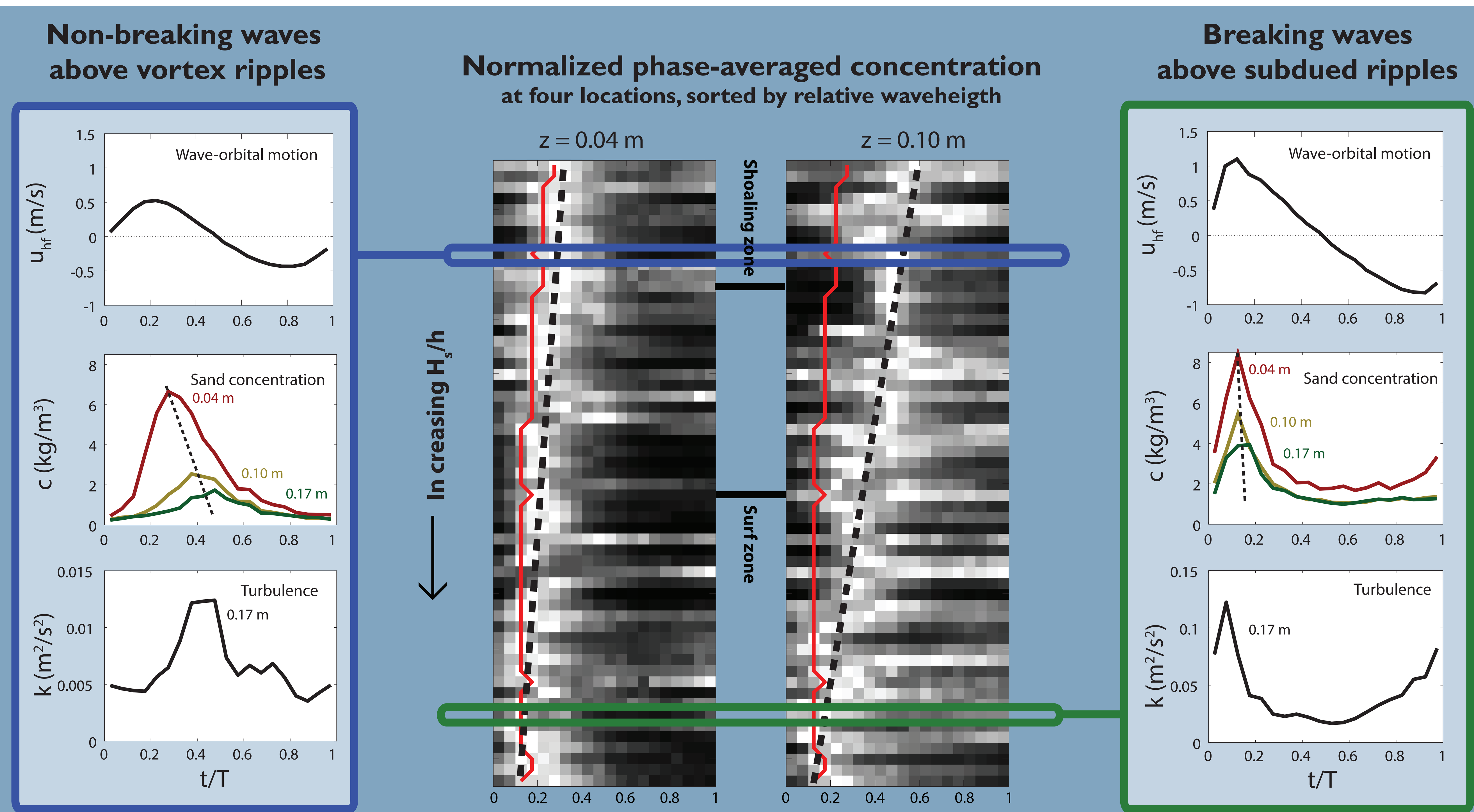
Here, we compare sand stirring by breaking waves to non-breaking waves above ripples by using laboratory measurements collected during the Barrier Dynamic Experiment II (BARDEXII).

Methods

- Field-scale laboratory experiment, irregular waves
- One imposed tidal cycle
- Turbulence at three heights above the bed at one location
- Sand concentration at 3-7 heights above the bed at 4 locations
- Coupling with cross-shore wave-orbital motion (u_{hf}) through phase-averaging



Results



Non-breaking waves above vortex ripples

- phase-lag between u_{hf} and c positive and increases upward
- c and k peak simultaneously
- wave-driven transport onshore only close to bed

timing max u_{hf}
trend max c

Breaking waves above subdued ripples

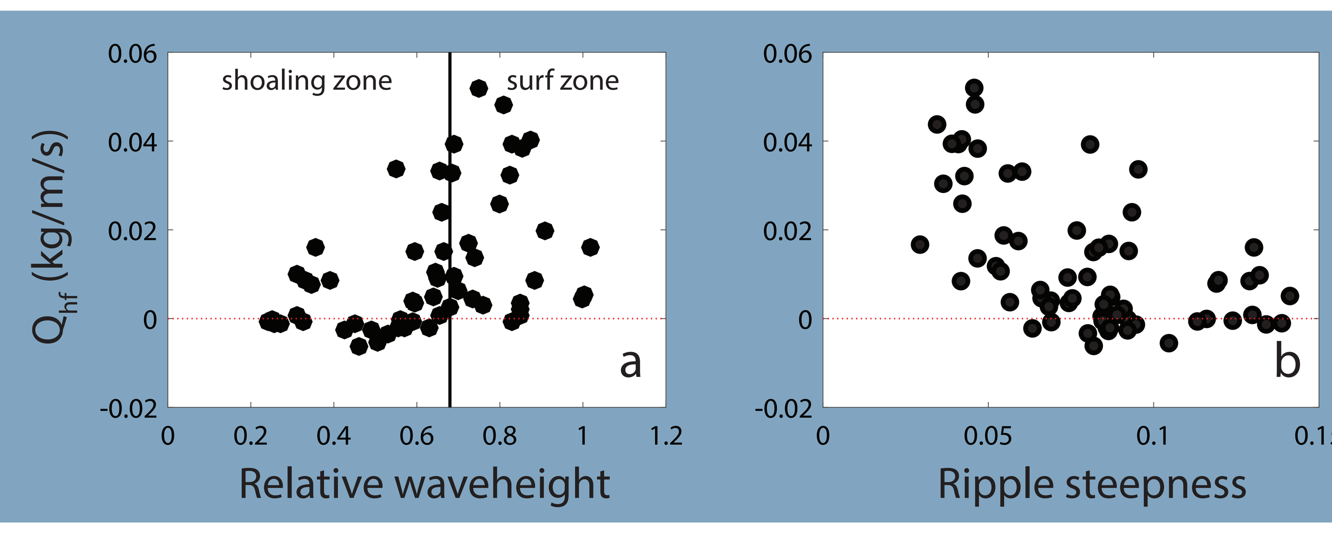
- phase-lag between u_{hf} and c negative
- peak in k preceeds peak in c
- wave-driven transport onshore throughout water column

Cumulative transport between z = 0.04 and 0.10 m

$$Q_{hf} = \langle C_{hf} u_{hf} \rangle$$

$$C = \int_{0.04m}^{0.10m} c(z)\,dz$$

- maximum in outer surf-zone (a)
- decreases with ripple steepness (b)



Conclusions

Non-breaking waves above ripples:
- phase-lag increases upwards
- thus only (onshore) wave-driven sand transport close to bed
- cumulative transport is close to zero

Breaking waves:
- small negative phase-lag
- during offshore phase only suspension close to the bed
- onshore wave-driven transport throughout the water column
- max onshore transport in outer surf-zone

Magnitude and direction of short-wave suspended sand transport depends highly on turbulence characteristics and ripple steepness.

← *Plunging breaker during BARDEXII in the Delta Flume.*