Morphodynamics of a double sandbar system

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Background
- Nearshore sandbars continuously change shape in response to wave conditions.
- In double sandbar systems the alongshore variations in inner-bar shape may be similar to those of the outer bar: morphological coupling (Fig. 1).
- Coupling may lead to localised beach and dune erosion.
- Angle of wave incidence $\theta$ likely affects morphological coupling, but unclear how.

Aim: To quantitatively understand the morphological coupling in double sandbar systems.

Observations
- Field data
  - Gold Coast, Queensland, Australia
  - Argus: over 9 years of daily time-exposure images (Fig. 2)
- Sandbar morphology
  - Outer bar: morphological coupling (Fig. 1)
  - Inner bar: $44\%$ in time shore-attached terrace
- Morphological coupling
  - $40\%$ in time
  - $5$ coupling types (Fig. 3)
- Hydrodynamics
  - $\theta$ and $\theta$ affect current patterns (cell-circulation vs. meandering alongshore current) and type of coupling.
  - $\theta > 30^\circ$ leads to sandbar straightening and de-coupling.

Modelling
- Model
  - 2D morphodynamic model
  - 2D hydrodynamic inner bar
  - Constant (averaged) wave forcing
  - Crescentic outer bar
  - Alongshore-uniform inner bar
  - Realistic bathymetrical data, assimilated from video images (Fig. 4)

Flow patterns inner bar
- Small $\theta$ (Fig. 5) $\rightarrow$ Circulation patterns with rip channels (coupling types $Idr$ and $Odt$)
- Increasing $\theta$ (Fig. 6) $\rightarrow$ Meandering alongshore current (coupling types $Idt$ and $Out$)
- Quantification: Swirling strength

Conclusions
- Morphological coupling is an integral part of double sandbar systems.
- Type of coupling controlled by wave angle-dependent flow pattern and degree in alongshore variability of outer sandbar.

Note