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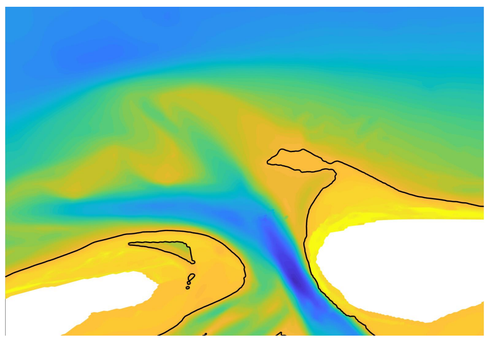
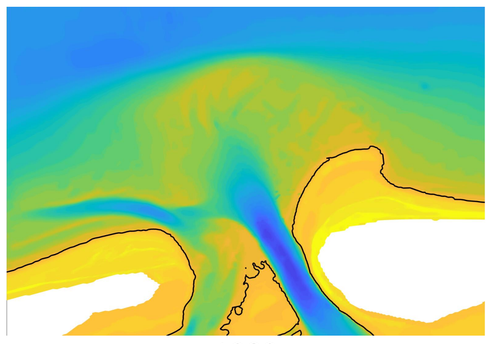
# Cyclic behavior of ebb-tidal deltas from model simulations: the role of waves and tides

## Introduction

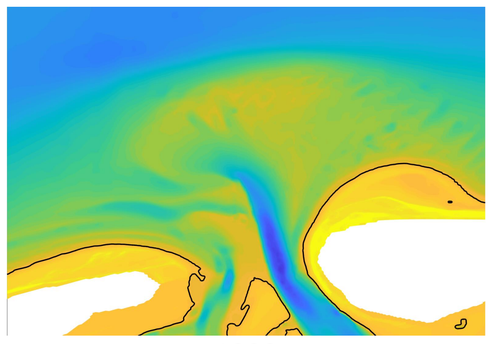
- Ebb-tidal deltas are shallow sandy features located seaward of tidal inlets and are important for coastal safety in barrier systems.
- They act as a shield for incoming (storm) wave energy and they are a source of sediment for the barrier islands and the back-barrier basin.
- Often, cyclic behavior of shoal formation, migration and attachment to the downdrift island is observed.
- The Ameland Inlet changes from a one-channel-system to a two-channel-system and back during one cycle.



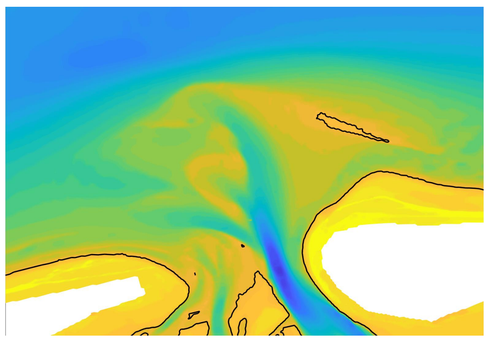
Ameland Inlet 1971



1989



1999

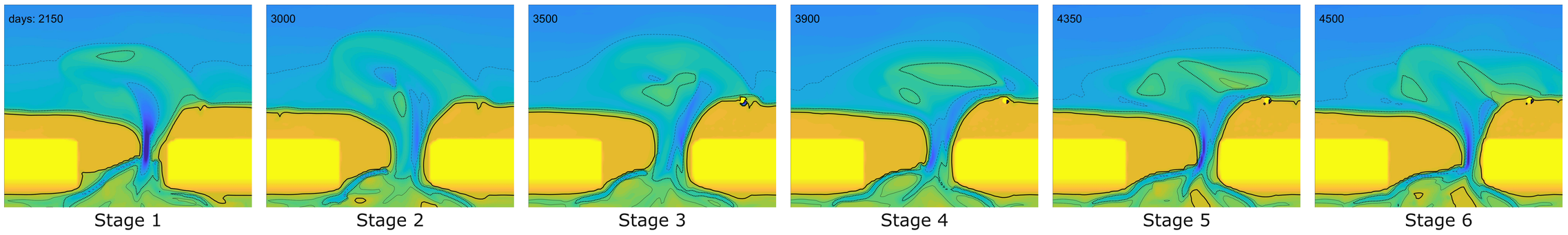


2011

## Main Question

**What are the mechanisms of the observed cyclic behavior?**

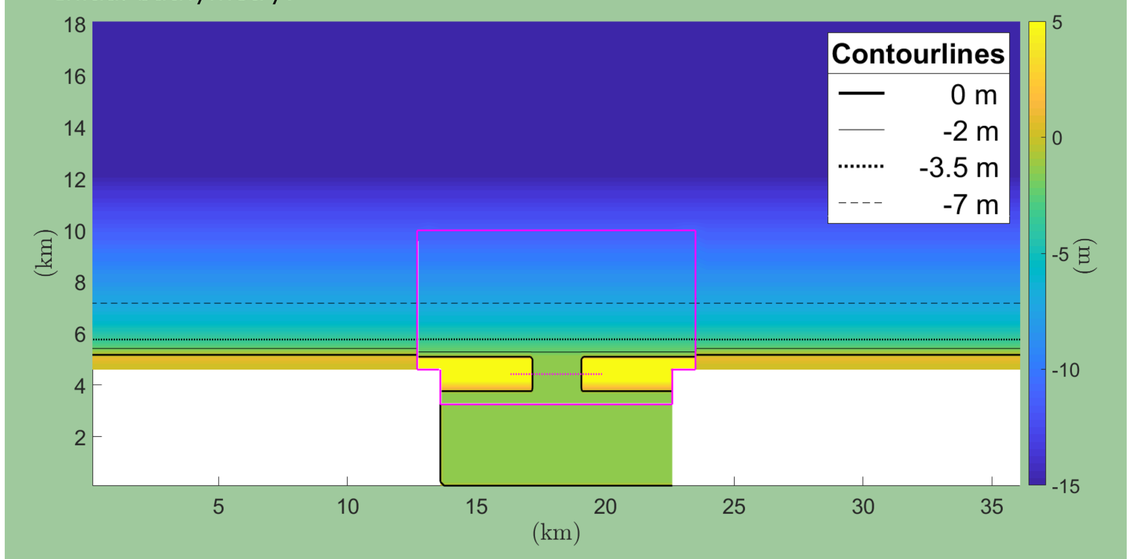
## Results




Stage 1 | Stage 2 | Stage 3 | Stage 4 | Stage 5 | Stage 6

## Methodology

- Modeling with Delft3D/SWAN
- Initial bathymetry:




- High spatial (50 m) and temporal (12 s) resolution.
- Hydrodynamic forcing: combination of tides and waves.
- Tides: semi-diurnal tidal wave with amplitude A =1,2 m.
- Waves from NW: wave height $H_s$ = 2 m and period $T_{m02}$ = 7,5 s.
- Sediment transport formulation: Van Rijn et al. (2004), bed-load and suspended load ($d_{50}$ = 0,25 mm). Morphological acceleration factor $M_{fac}$ = 20.

## Discussion

- The period between successive shoals decreases with decreasing tidal amplitude.
- Larger waves result in faster shoal dynamics and smaller time scales.

## Conclusions

**Changes in the inlet - similar to the one-channel/two-channel transformation of the Ameland Inlet - are an inherent feature of the modeled periodic shoal dynamics.**

**Model results suggest that the observed cyclic behavior is the result of feedbacks among the periodically changing inlet configuration, waves, tidal currents and import/export.**

During the modeled shoal migration, clockwise rotation of the main channel and subsequent channel breaching is found.

Stages in cyclic behavior:

1. Fully-developed ebb-tidal delta, one deep channel with **import of sediment**
2. Shoal formation forced by **export of sediment**, second channel forming
3. Shoal growth due to **wave action**, clockwise rotation channel
4. Seaward growth of shoal as a result of **ebb flow**, two-channel inlet
5. **Wave processes** forces shoal migration, breaching event provides a more **efficient channel position**
6. Shoal attachment, one updrift oriented deep channel