



## Field Observations of Rip Currents in Wind-sea Dominated Environments

G. Winter, A.R. van Dongeren, M.A. de Schipper, J.S.M. van Thiel de Vries, Andrew Pomeroy



### Motivation

- The lifeguards in the Netherlands (e.g. in Egmond aan Zee) identify rips as an issue for swimmer safety.
- Characteristic conditions at the Dutch Coast:
  - Wind-sea dominated
  - Strong tidal longshore currents

→ Do rip currents behave differently at the Dutch Coast?

Rip Current Rescue Exercise of the lifeguards at Egmond aan Zee  
Photos: Willem Verbeek (2011)




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### Overview

**Objectives:**

- identify and describe the rip current flow patterns at Egmond aan Zee;
- identify the governing parameters;
- evaluate the suitability of XBeach for modelling rip currents
  - Assess its potential for operational forecasting

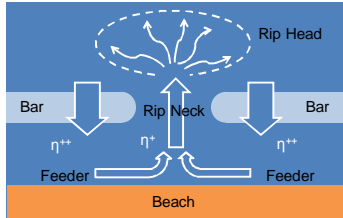
**Outline of the presentation:**

- Background: Rip Current Generation
- Field Study
- Numerical Study Results
- Conclusions




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### Rip Current Generation

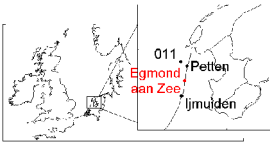
$$-\frac{\partial S_{xx}}{\partial x} = \rho g (h + \bar{\eta}) \frac{\partial \bar{\eta}}{\partial x}$$


η+: low or no set-up  
η++: high set-up



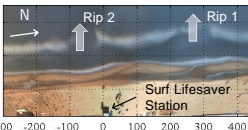

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### Field Site



**Egmond aan Zee**

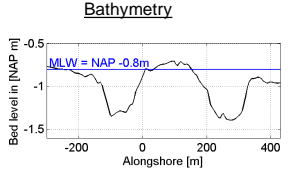
- Coast of North-Holland
- Meso-tidal environment
- Three bar system
- Two distinct channels in the first surf zone bar

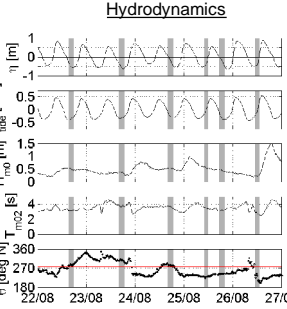
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### Field Conditions


#### Bathymetry



#### Hydrodynamics



- Channel depth ~ 0.5 m (long year average 1 m)
- Neap tide
- Moderate wave conditions



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### Drifter Instruments

**Lagrangian measurements of surf zone currents**

- Drifter instruments tracked with GPS
- Deployment in alongshore and cross-shore arrays


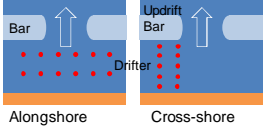



Photo: Willem Verbeek (2011)



Alongshore      Cross-shore



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### Human Drifter


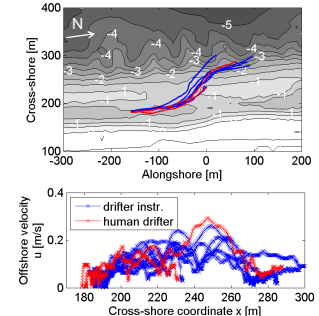


Photo: Willem Verbeek (2011)

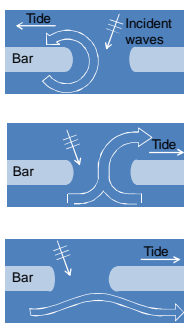
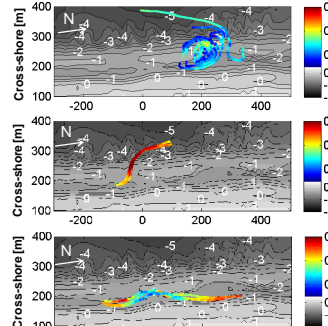
- Equipped with the same GPS
- Floated passively (with life vests)



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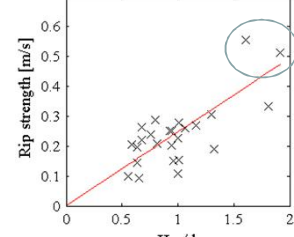
### Observed Flow Patterns

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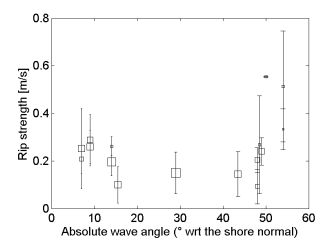
### Correlation to Wave Height and Water Level

$$H_{m0}/d = \frac{\text{Offshore wave height}}{\text{Water depth over the updrift bar}}$$


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### Correlation to the Wave Angle



No relation between rip strength and wave angle

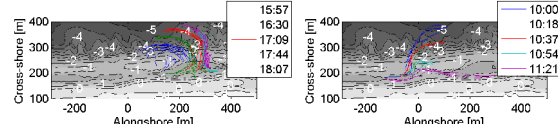
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### Tidal Modifications

During ebb tide (August 23)      During flood tide (August 25)

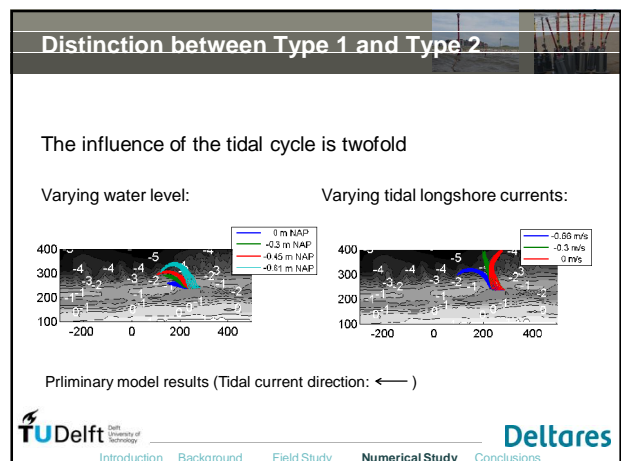
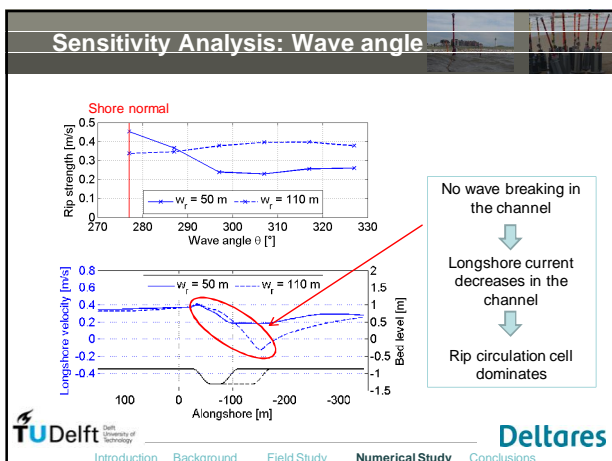
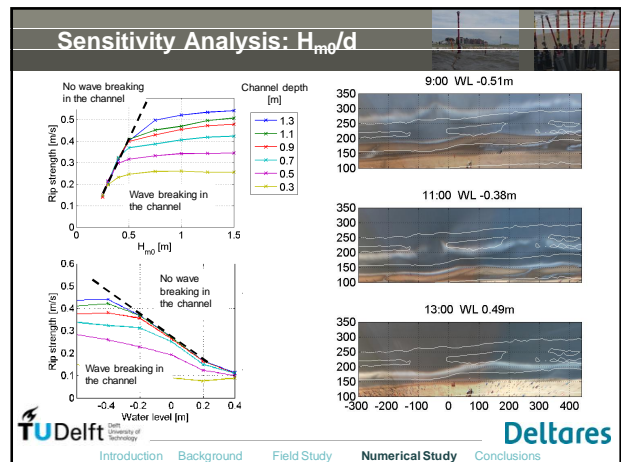
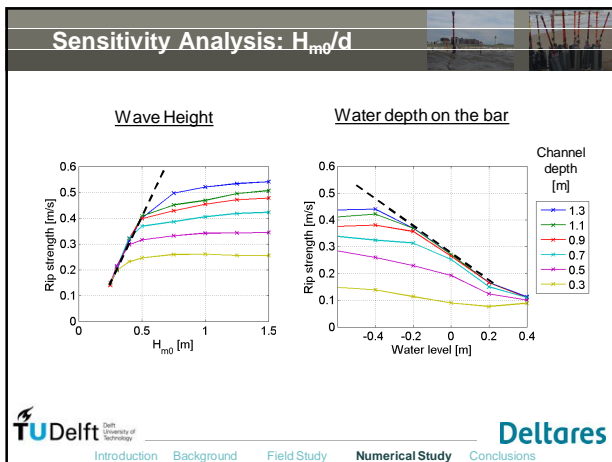
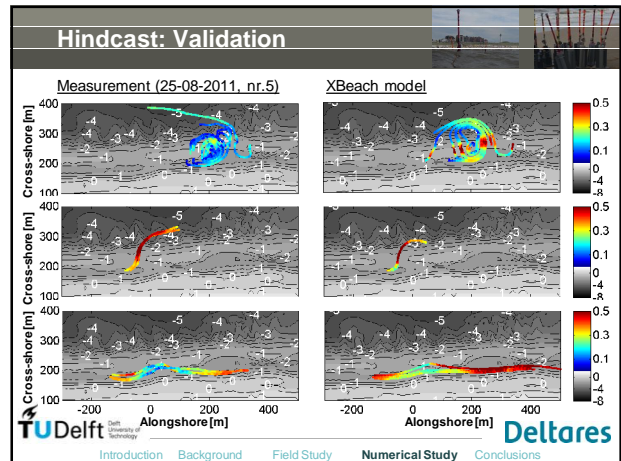
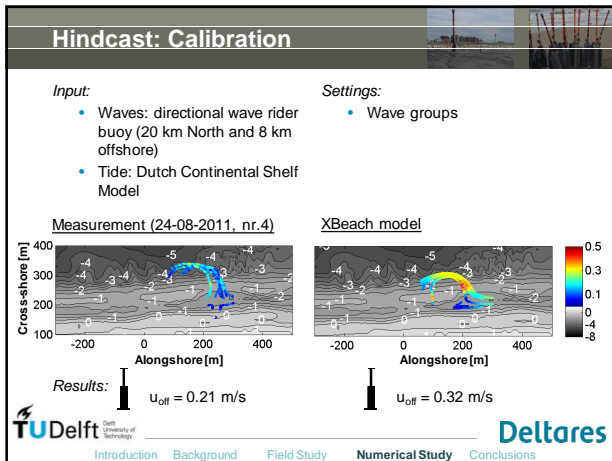
Tidal current direction: ←      Tidal current direction: →



- water level ↓
- tidal current velocity ↓
- water level ↑
- tidal current velocity ↑

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### Conclusions

**Rip Currents at the Northern Dutch coast:**

- Rip currents exist at the Dutch coast with velocities up to 0.6 m/s during moderate conditions
- Three distinct flow patterns
- Governing parameters: Wave height, water level and channel depth
- No dependency on the wave angle for channel widths at Egmond and typical wave heights during the field campaign
- Tidal current determines the drift direction outside the surf zone
- Horizontal and vertical tide steer the offshore extent of the rip current

**Capabilities of the Numerical Study XBeach:**

- Very good agreement with observations at acceptable run times
  - Usable in operational forecast systems



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### Conclusions & Acknowledgements

**Rip Currents at the Northern Dutch coast:**

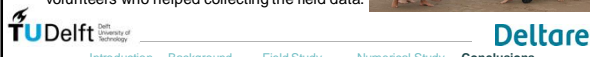

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**Acknowledgements:**

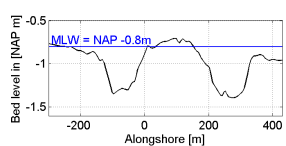
- TU Delft, Deltares, Shore Monitoring, Ecoshape, Floodrisk2012 and the 25 volunteers who helped collecting the field data.

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### Field Conditions

**Bathymetry**

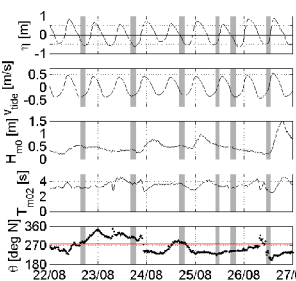



• Channel depth ~ 0.5 m (long year average 1 m)

• Neap tide

• Moderate wave conditions

**Hydrodynamics**



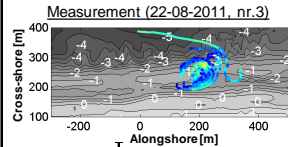


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### Hindcast: Validation Type 1

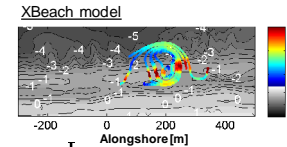
**Conditions:** 0.51 m wave height, 5 m/s wave speed, NAP -0.57 m water level, 0.3 m/s tidal current.

**Measurement (22-08-2011, nr.3)**




**Results:**  $u_{off} = 0.26$  m/s

**XBeach model**



**Results:**  $u_{off} = 0.43$  m/s

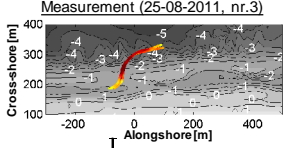


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### Hindcast: Validation Type 2

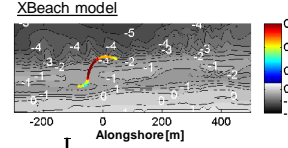
**Conditions:** 0.67 m wave height, 4 m/s wave speed, NAP -0.44 m water level, 0.08 m/s tidal current.

**Measurement (25-08-2011, nr.3)**




**Results:**  $u_{off} = 0.55$  m/s

**XBeach model**



**Results:**  $u_{off} = 0.64$  m/s

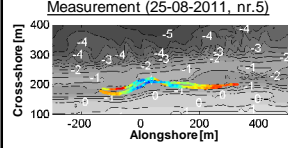


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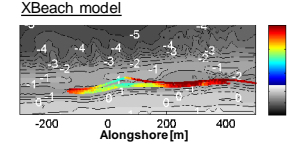
### Hindcast: Validation Type 3


**Conditions:** 0.58 m wave height, 6 m/s wave speed, NAP -0.17 m water level, 0.17 m/s tidal current.

**Measurement (25-08-2011, nr.5)**



**XBeach model**





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