Large scale experiments on sand-filled geosystems and rock as erosion control measures

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2nd COB Seminar
GreenBridge, Oostende
06 February 2020

Scour development modelling in coastal and offshore waters

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Scour development modelling in coastal and offshore waters

- Empirical calculations
- Limited field measurements
- Physical model tests

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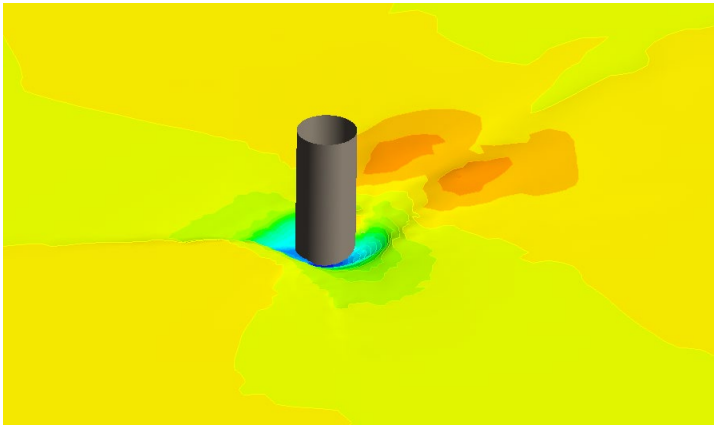
Scour development modelling in coastal and offshore waters

PhD: Scour development modelling in coastal and offshore waters using CFD



Scientific research aims:

- Improve the current state of scour development modelling using CFD – OpenFOAM
- Include scour specific physical processes such as backfilling, edge scour (in case of scour protection), etc. while developing the CFD model
  - Improve the way near bed sediment concentration physics are included in the equations with a focus on time development of scour around vertical pile
- Calibrate CFD model extensively based on physical model datasets available at UGent, DTU and IMDC
- Develop a parametric model based on calibrated and validated CFD calculations which can provide fast and accurate results in practical applications

Scour development modelling in coastal and offshore waters

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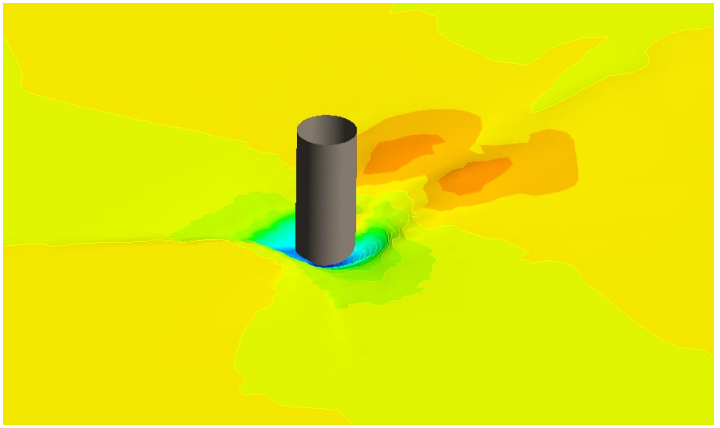

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  - Improve the way near bed sediment concentration physics are included in the equations with a focus on time development of scour around vertical pile
- **Calibrate CFD model extensively based on physical model datasets available at UGent, DTU and IMDC** → High quality physical modelling required
- Develop a parametric model based on calibrated and validated CFD calculations which can provide fast and accurate results in practical applications

Rock scour protection around offshore monopiles

Continuing research collaboration

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Rock scour protection around offshore monopiles

Leen De Vos (2008)

- *Extensive dataset used as base for continuing research*

UGent (2011-2012)

- Extend dataset for more extreme condition: Atlantic ocean, climate change, …

Marinet (2012-2014)

- Can we achieve a dynamically stable scour protection?
  - Allow stone movement without failure
  - Development of equilibrium profile for design purpose

Hydralab+ Proteus (2018-2020)

- Intermediate and large scale experiments
- Wide vs normal graded material

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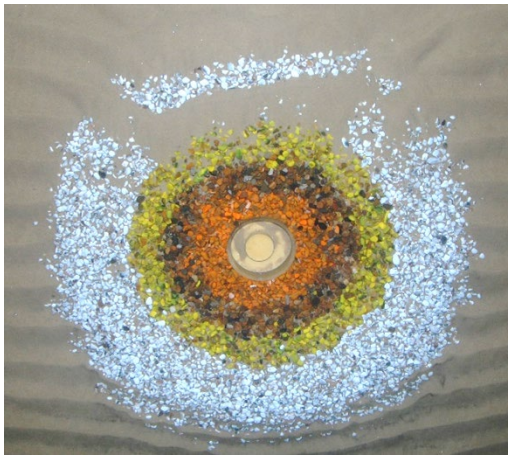
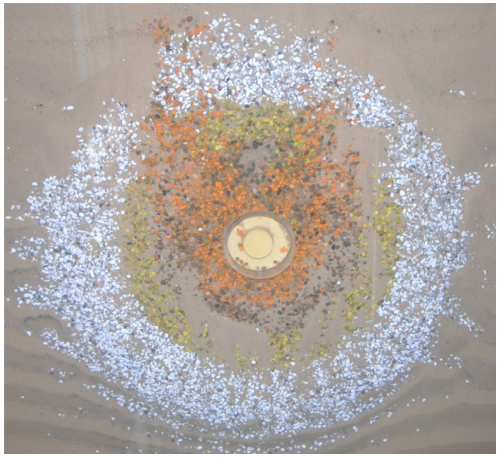
Dynamic behaviour of scour protection

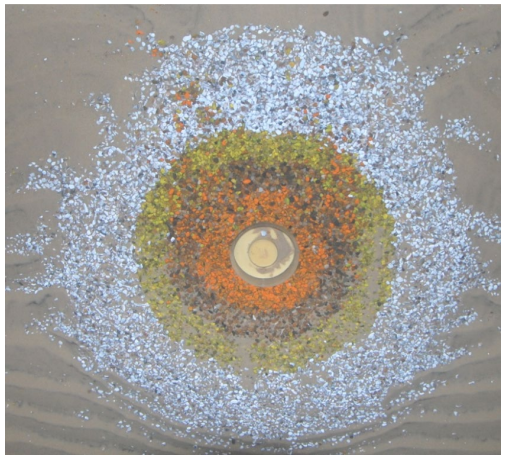
D_{n50} ↘
t_a =

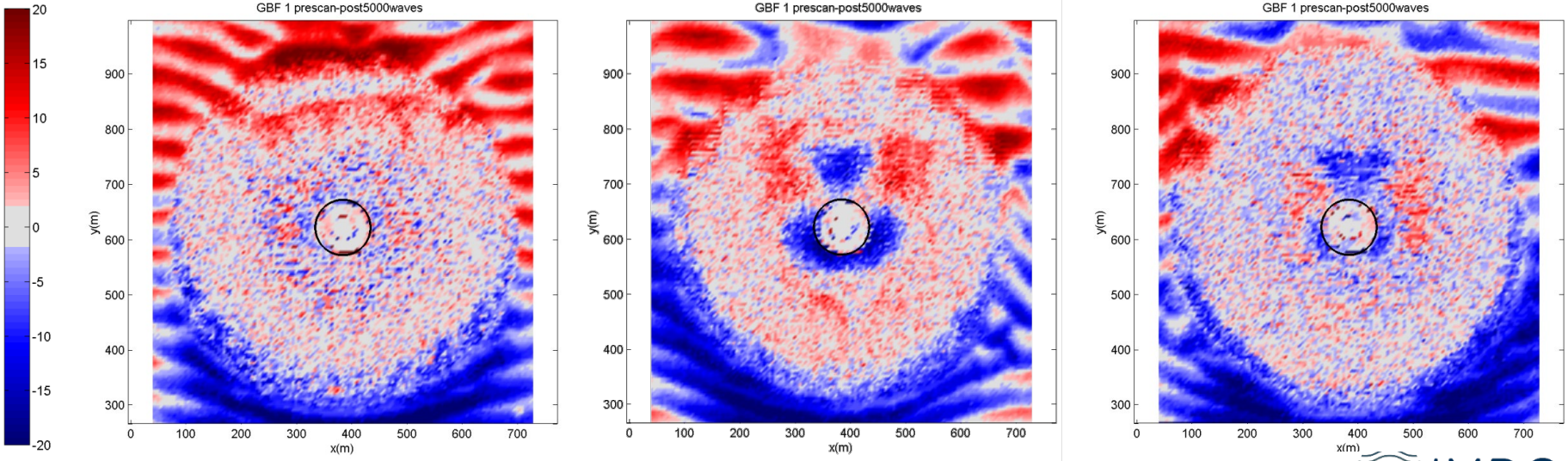
D_{n50} =
t_a ↗

Static | **Failure** | **Dynamic**









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Dynamic behaviour of scour protection

Static
Dynamic
Failure

Test series	Armour 1	Armour 2	Armour 3	Armour 4
s1	$4D_{50}$	$2D_{50}$	$2D_{50}$ $3D_{50}$	$8D_{50}$
s2	$2D_{50}$	$2D_{50}$	$3D_{50}$ $4D_{50}$	$8D_{50}$
s3		$2D_{50}$	$2D_{50}$ $3D_{50}$ $4D_{50}$	$4D_{50}$ $6D_{50}$ $8D_{50}$

Material	D_{50} [mm]	ρ [kg/m³]	$D_{50,proto}$ [m]	$D_{n50,proto}$ [m]
Armour 1	7.500	2650	0.375	0.315
Armour 2	6.015	2564	0.301	0.253
Armour 3	4.135	2597	0.207	0.174
Armour 4	2.686	2564	0.134	0.113

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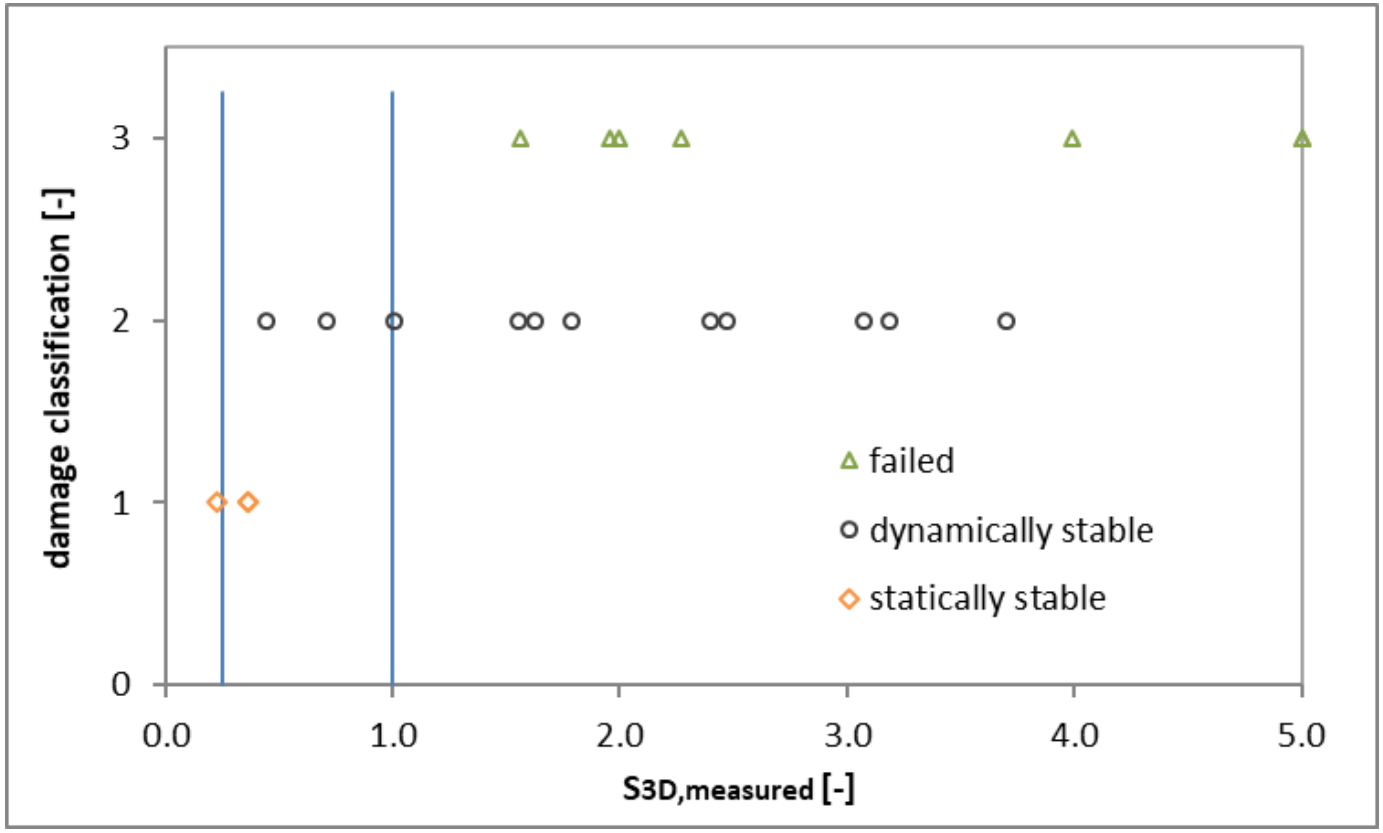
Dynamic behaviour of scour protection



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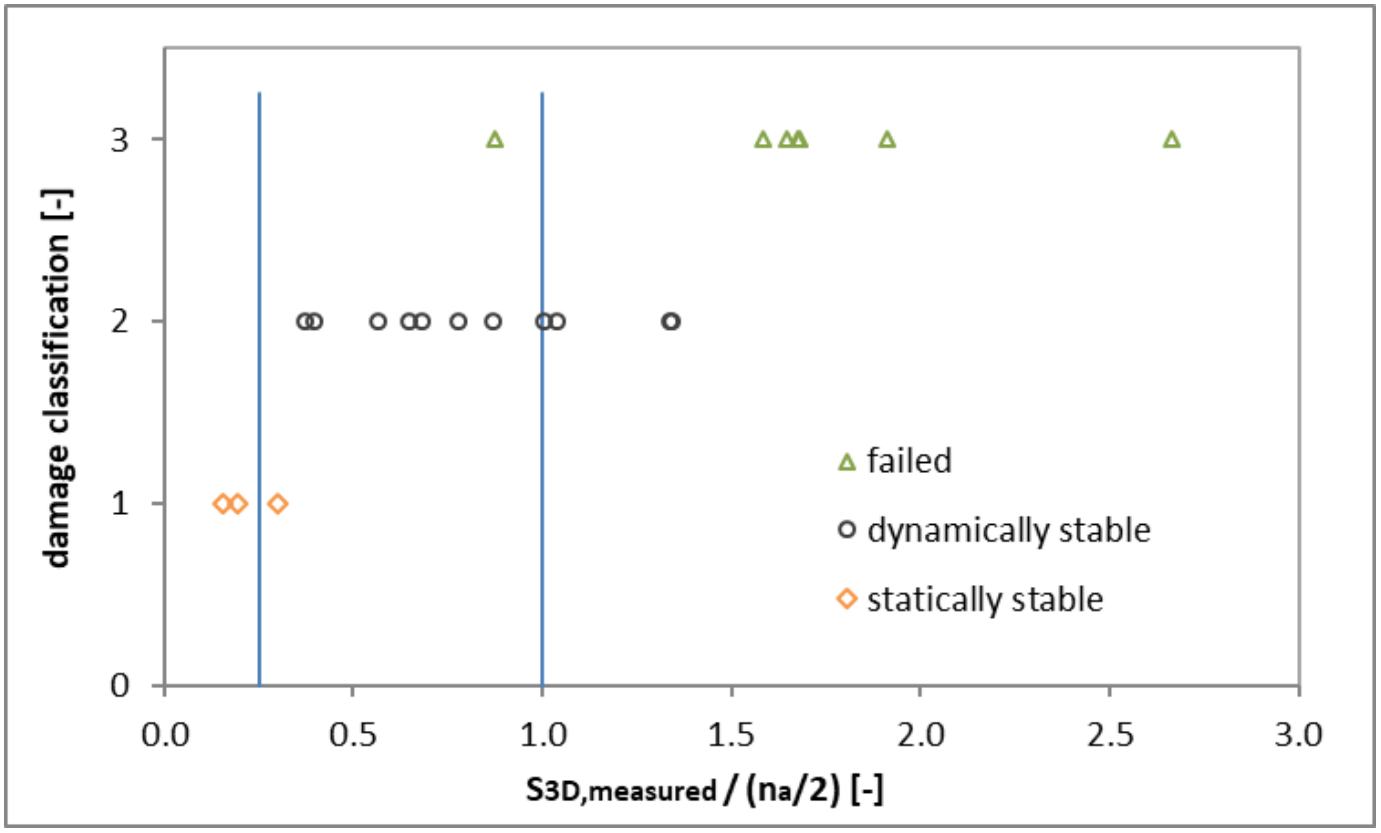
Dynamic behaviour of scour protection



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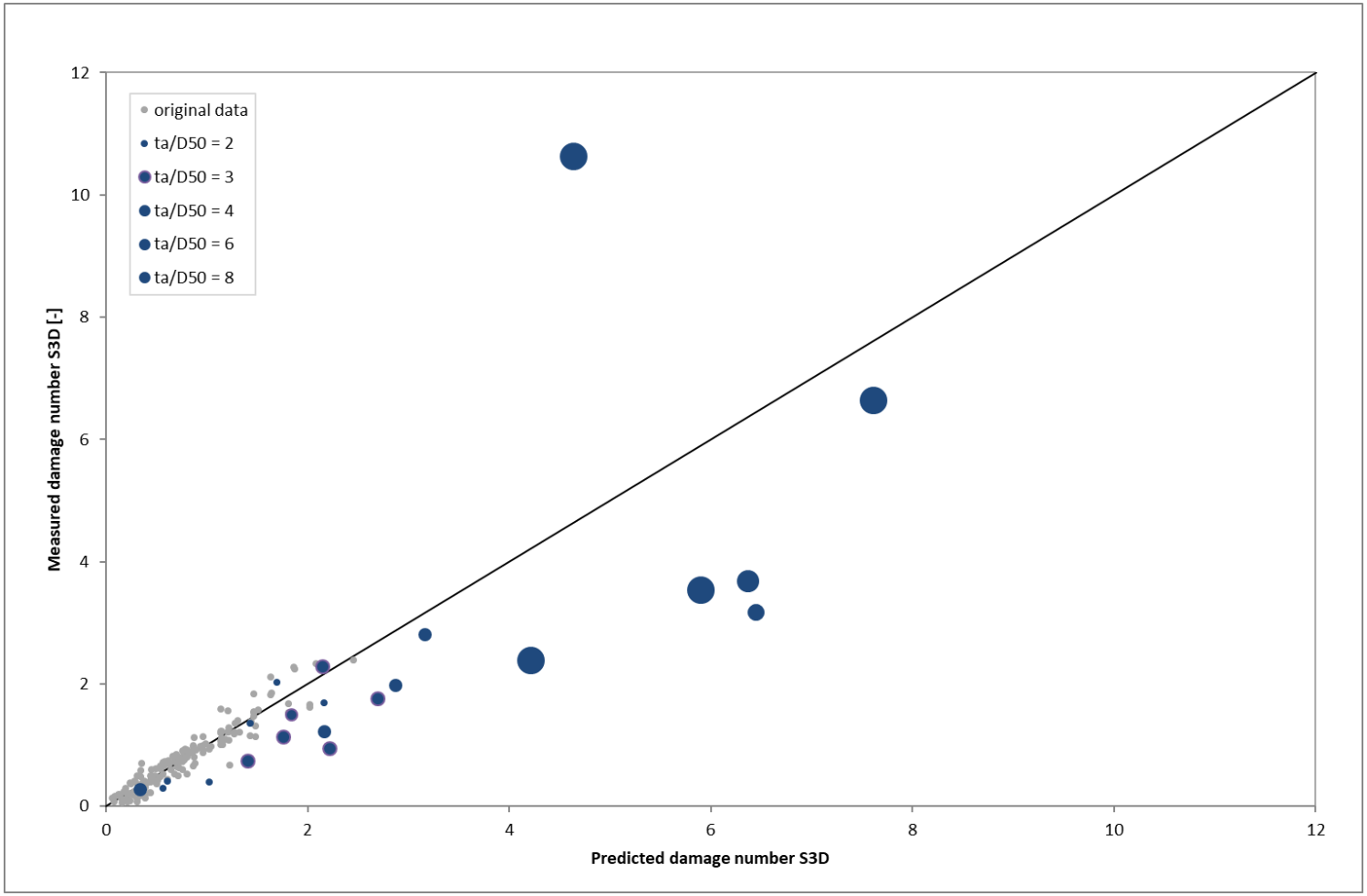
Dynamic behaviour of scour protection



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Sand-filled geosystems as beach erosion control measure

Research objectives

- **Evaluate 'sand-filled geosystem' concept as coastal protection measure**

- **(i)** Effect on nearshore coastal processes (wave transformation, and sediment transport) and wave structure interactions?
- **(ii)** Effect on flooding, erosion and recovery of coastal areas when erosion is limited by the 'sand-filled geosystem'?
- **(iii)** How to conceive a dynamic coastal protection that can easily adapt to climate change?

GHENT UNIVERSITY IMDC UPC

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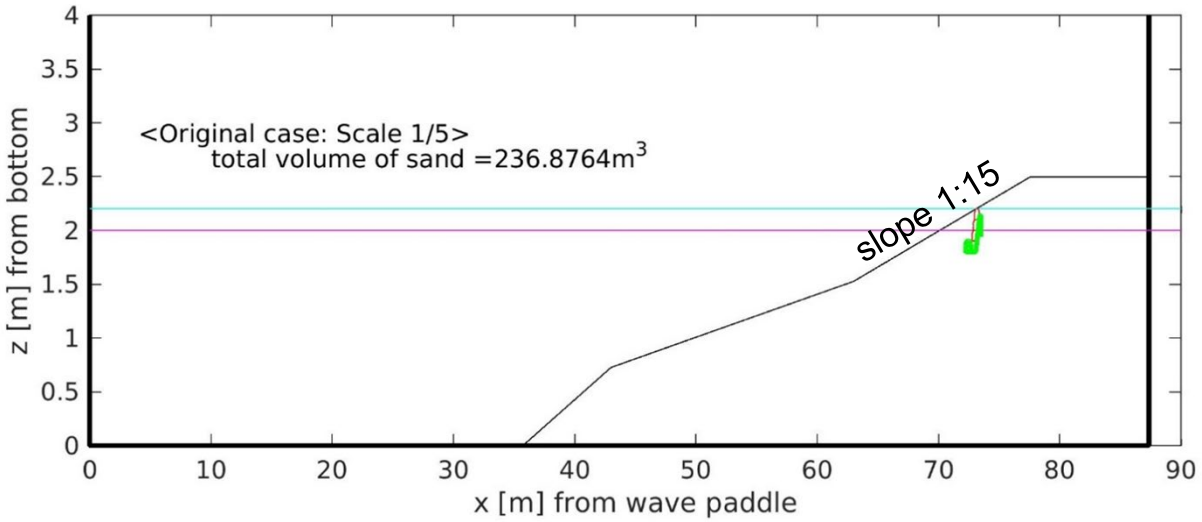
Model set-up and test program



Test-series	Protection	SWL (m)	H_s (m)	T_p (s)
1	none (benchmark)	2.2	0.5	4
2	Tube	2.2	0.5	4
3	Tube	2.0	0.5	4
4	Bags	2.2	0.5	4

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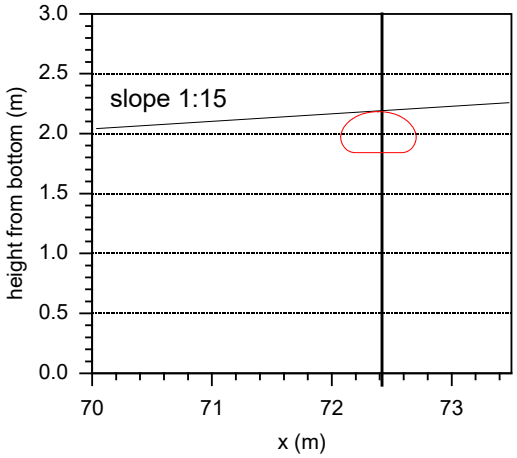

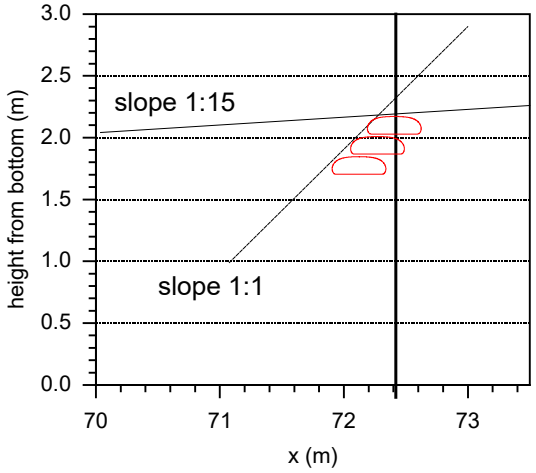

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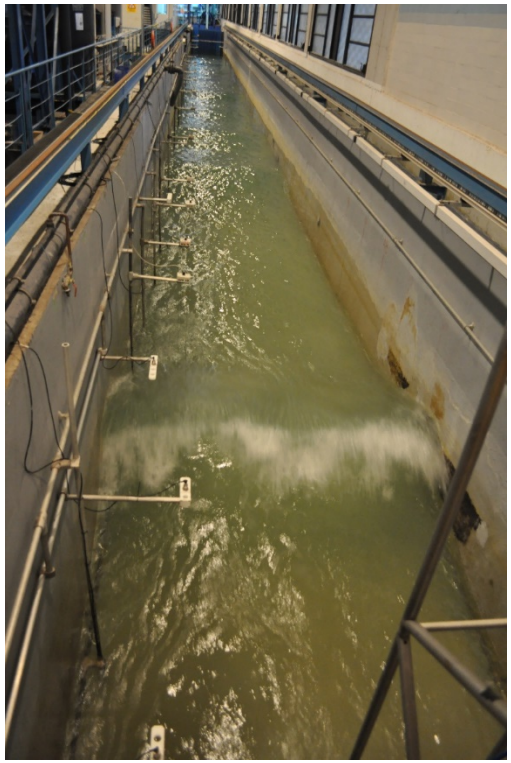

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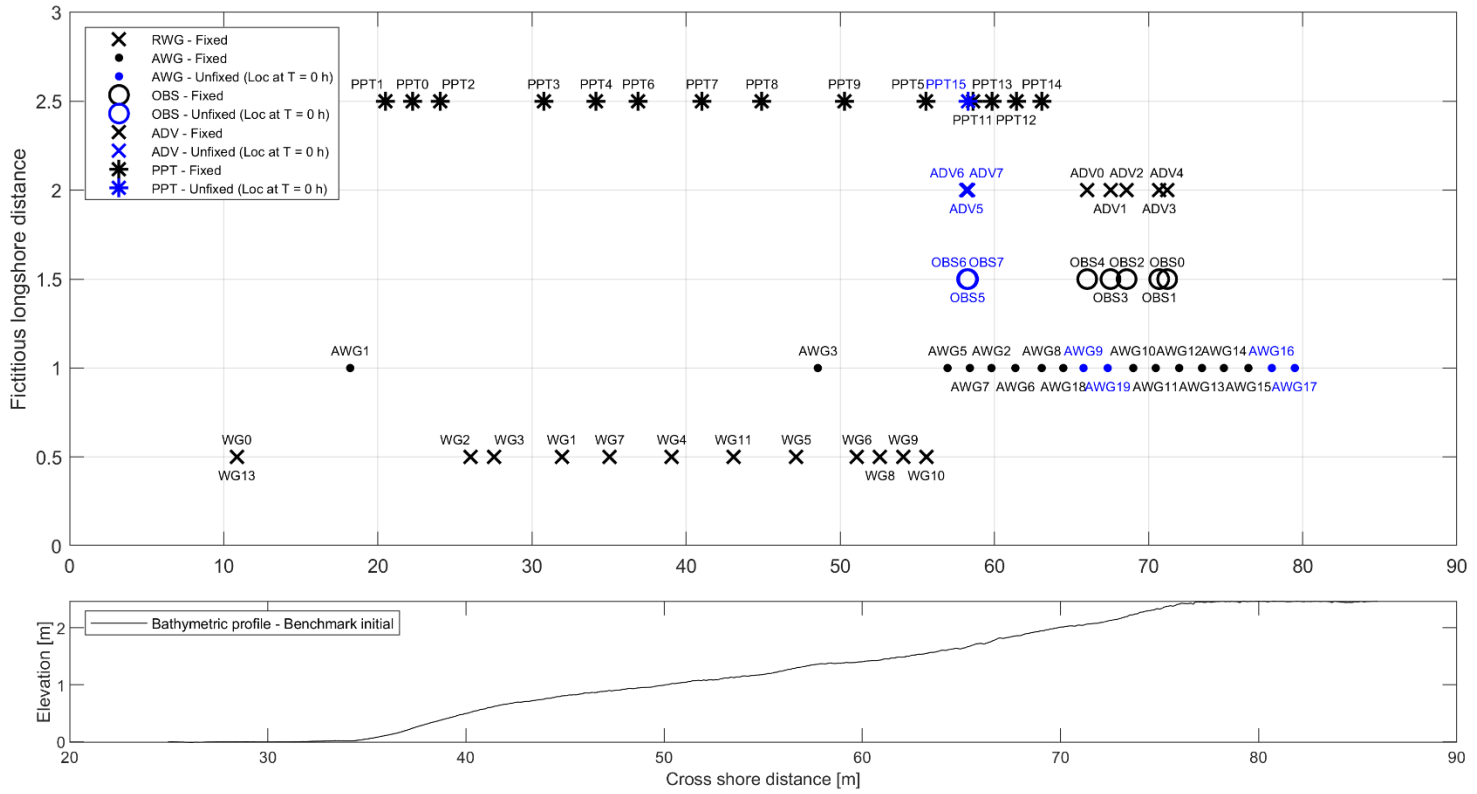
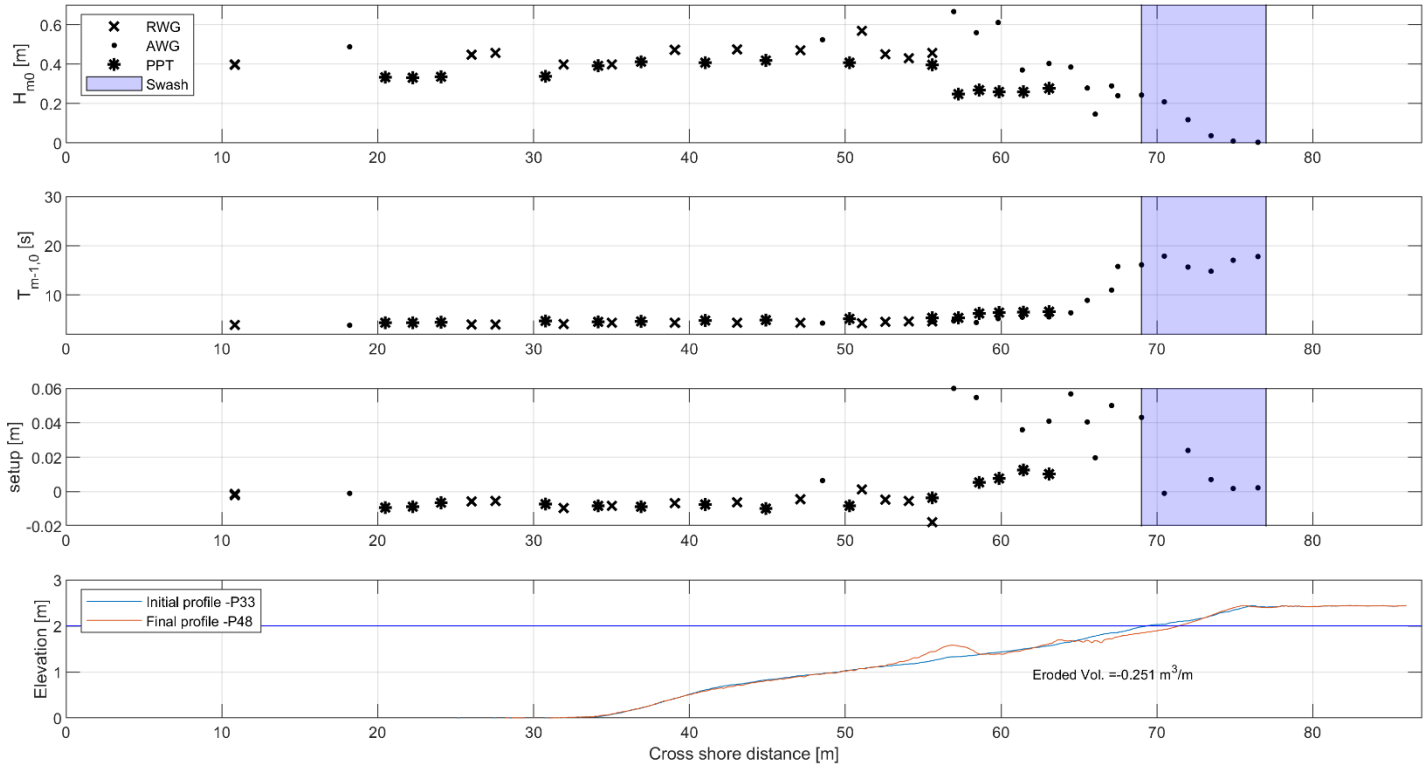
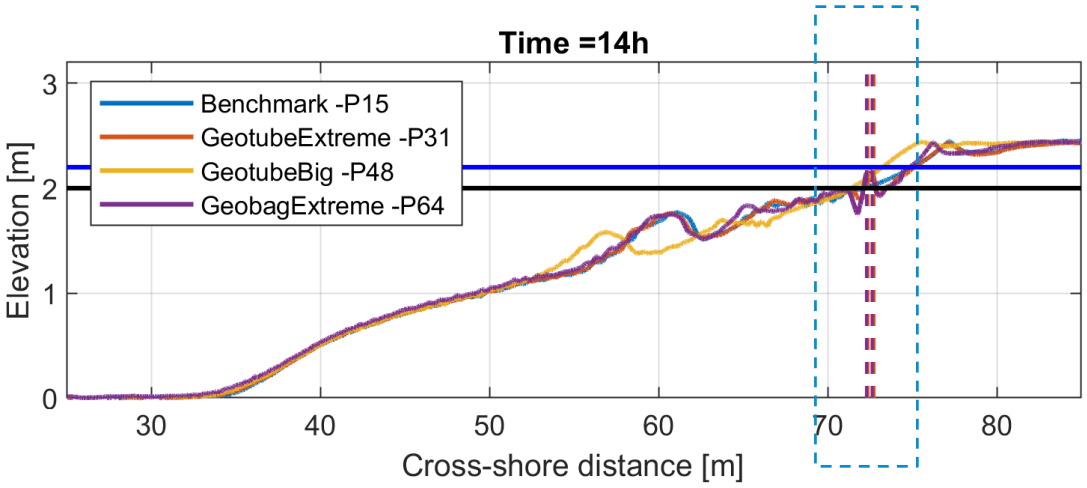
Set-up of measurement equipment

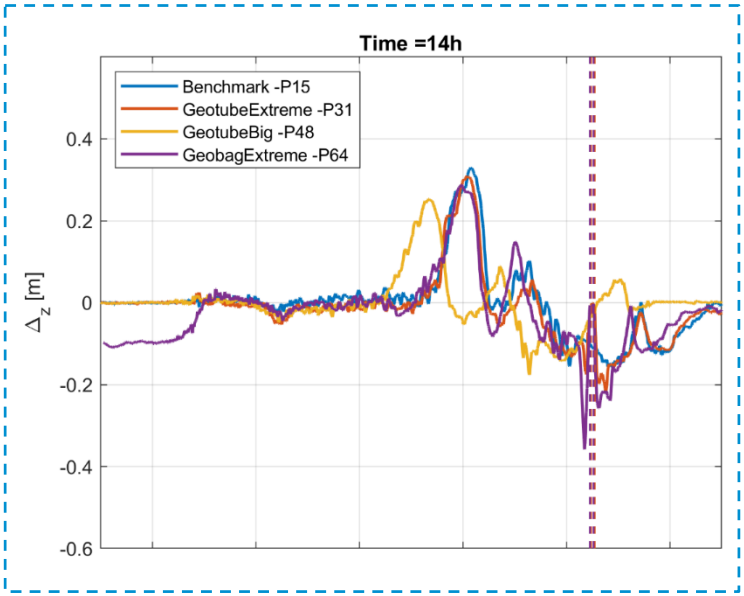


Wave transformation along flume and profile evolution



Cross-shore beach profile evolution





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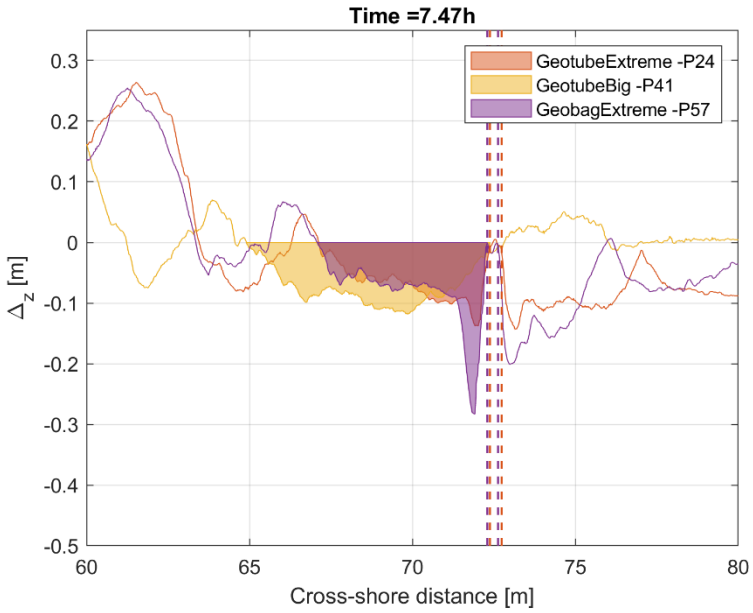
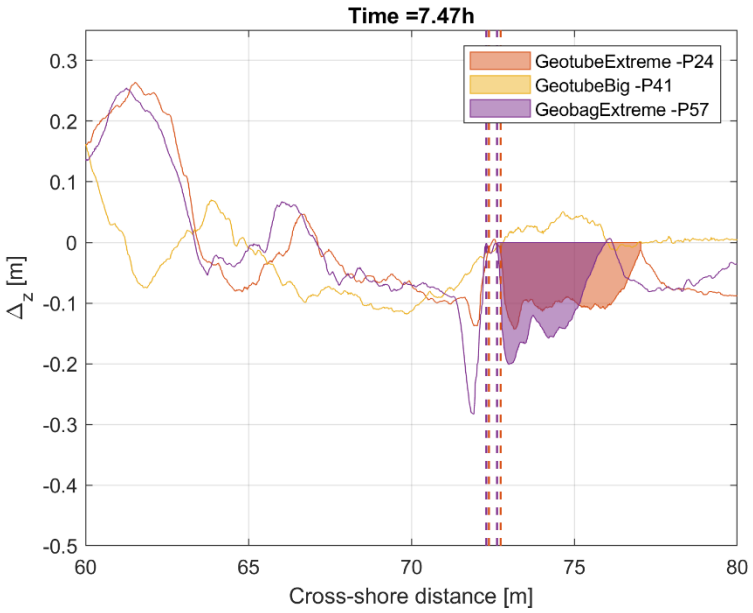
Scour volumes seaward and landward the sand-filled geosystem





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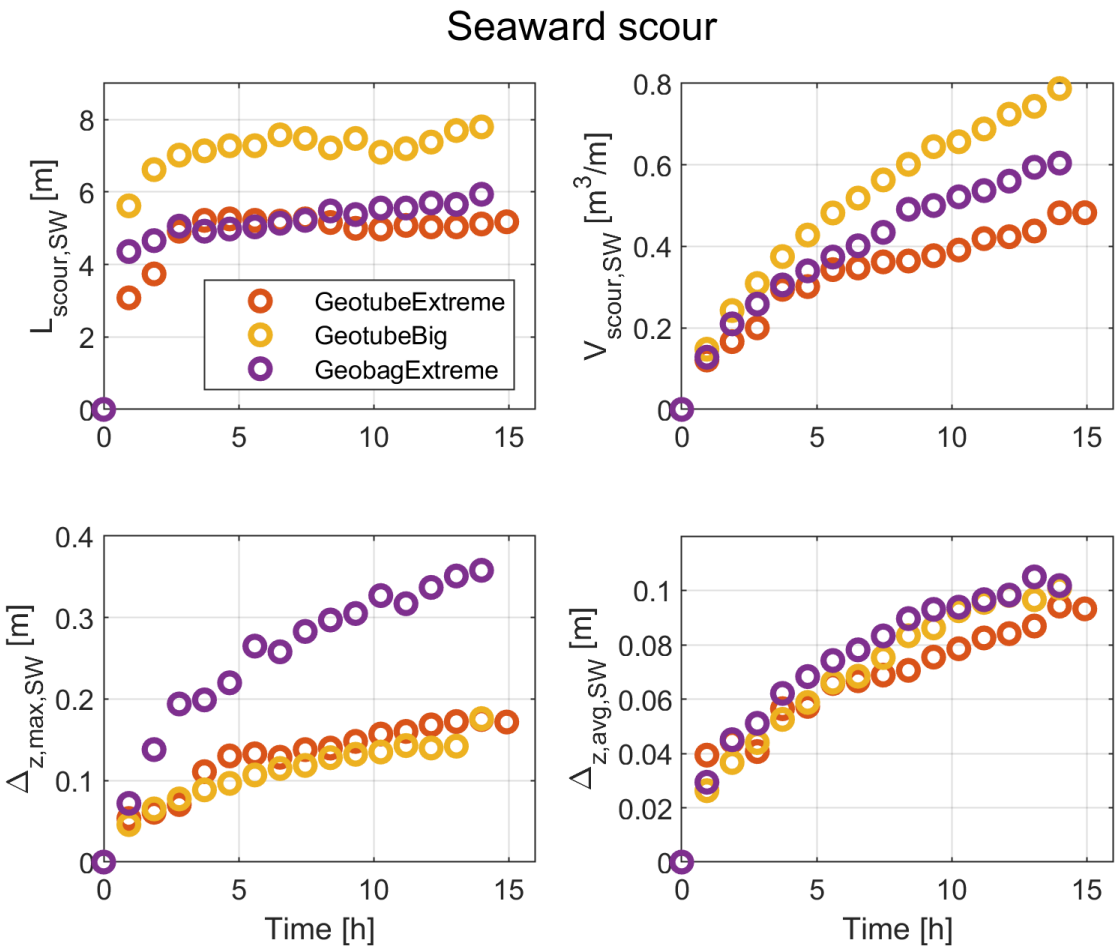
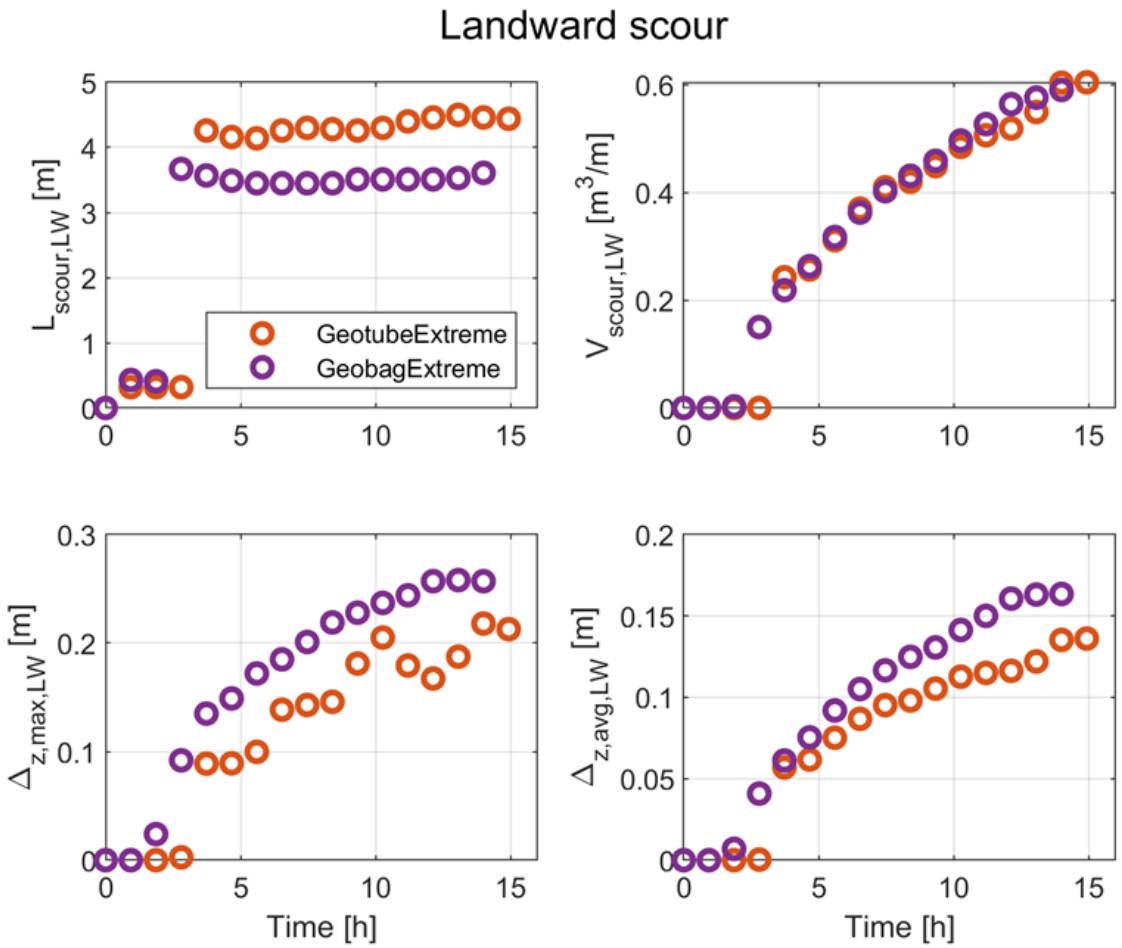
Scour evolution over time - seaward



Scour evolution over time - landward



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