ICCE 2018
36TH INTERNATIONAL CONFERENCE ON COASTAL ENGINEERING 2018
Baltimore, Maryland | July 30 – August 3, 2018
The State of the Art and Science of Coastal Engineering

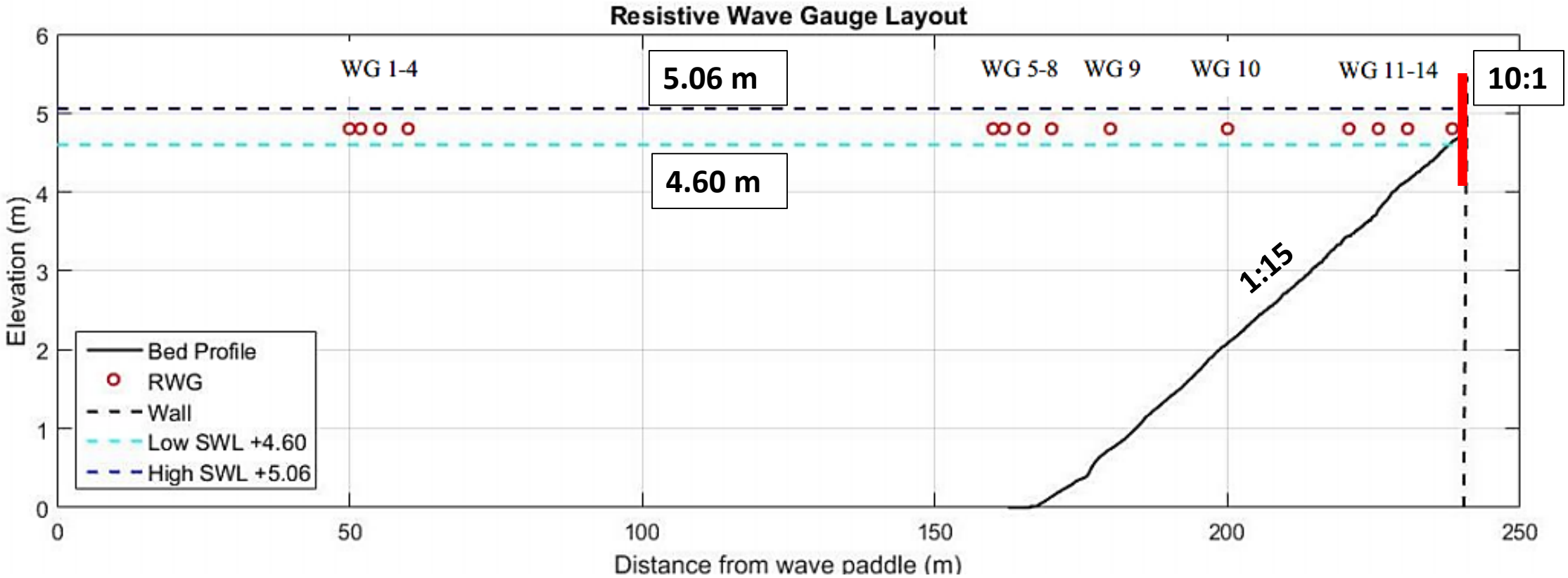
WAVE OVERTOPPING WITH A CHANGING STEEP SANDY FORESHORE, CONVENTIONAL AND NUMERICAL ANALYSIS OF RESULTS

Jentsje van der Meer *IHE Delft and Van der Meer Consulting, NL*
Rizki Akbar *Former student IHE Delft, NL*
Ryard Mukhdiar *Former student IHE Delft, NL*
Riccardo Briganti *University of Nottingham, UK*
Rosaria Ester Musumeci *University of Catania, IT*
Alessandro Romano *University La Sapienza, IT*
Tomohiro Suzuki *Flanders Hydraulics Research, BE*
Corrado Altomare *University of Ghent, BE*

HydraLab ICODEP team




Longitudinal section of the Groβer Wellenkanal in Hannover, DE



A short impression

Storms (S1 and S2) and storm clusters (C1-C3)

Wave Characteristics				
Hm0 [m]	Tp [s]	Water Level [m]	Duration [min]	No. of Waves
0.51	3.40	4.60	32	565
0.58	3.60	4.60	32	533
0.64	3.70	5.06	32	519
0.60	3.60	5.06	32	533
0.55	3.50	4.60	32	549
0.51	3.40	4.60	32	565

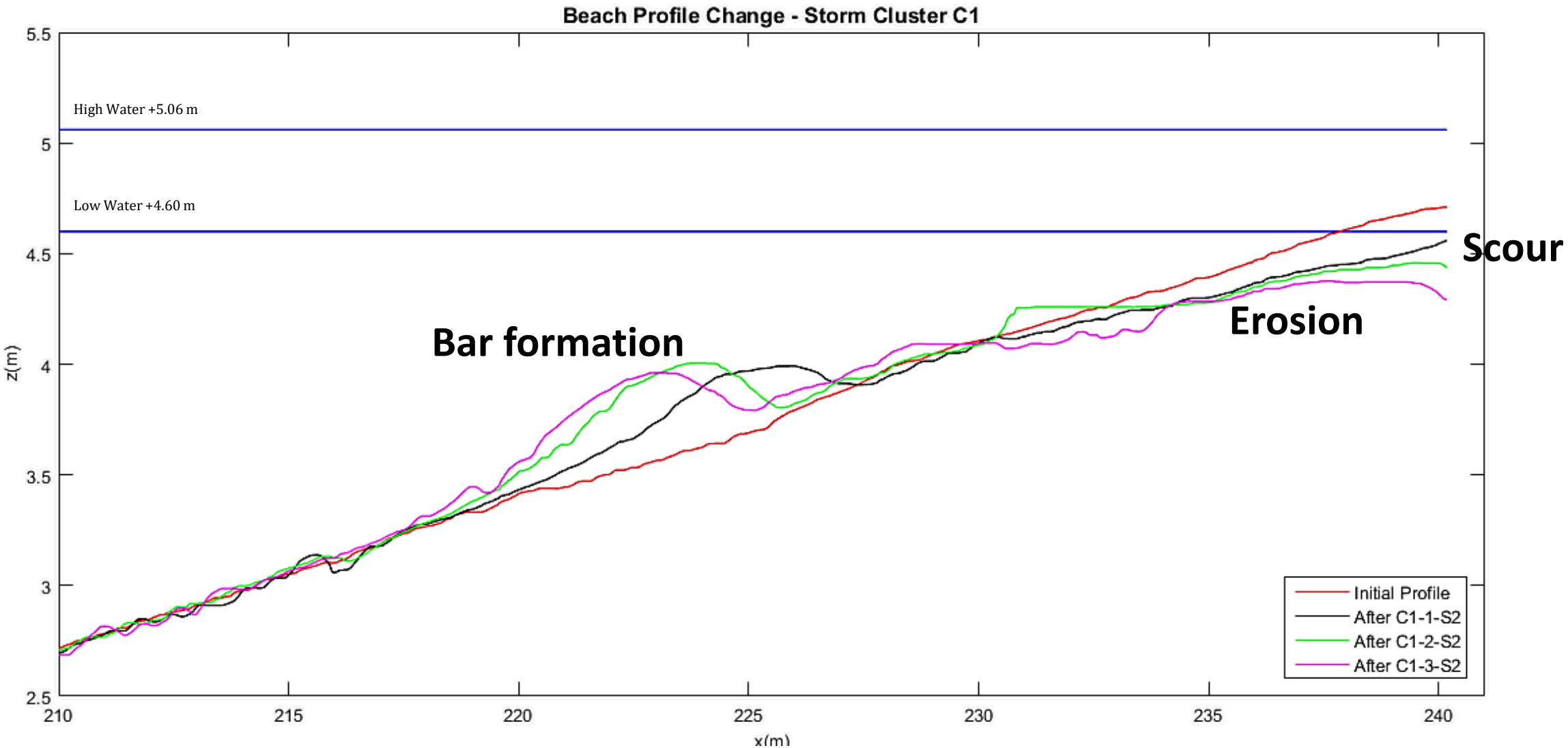
Storm S1

Wave Characteristics				
Hm0 [m]	Tp [s]	Water Level [m]	Duration [min]	No. of Waves
0.64	3.90	4.60	32	492
0.72	4.20	4.60	32	457
0.80	4.50	5.06	32	427
0.75	4.30	5.06	32	447
0.69	4.10	4.60	32	468
0.64	3.90	4.60	32	492

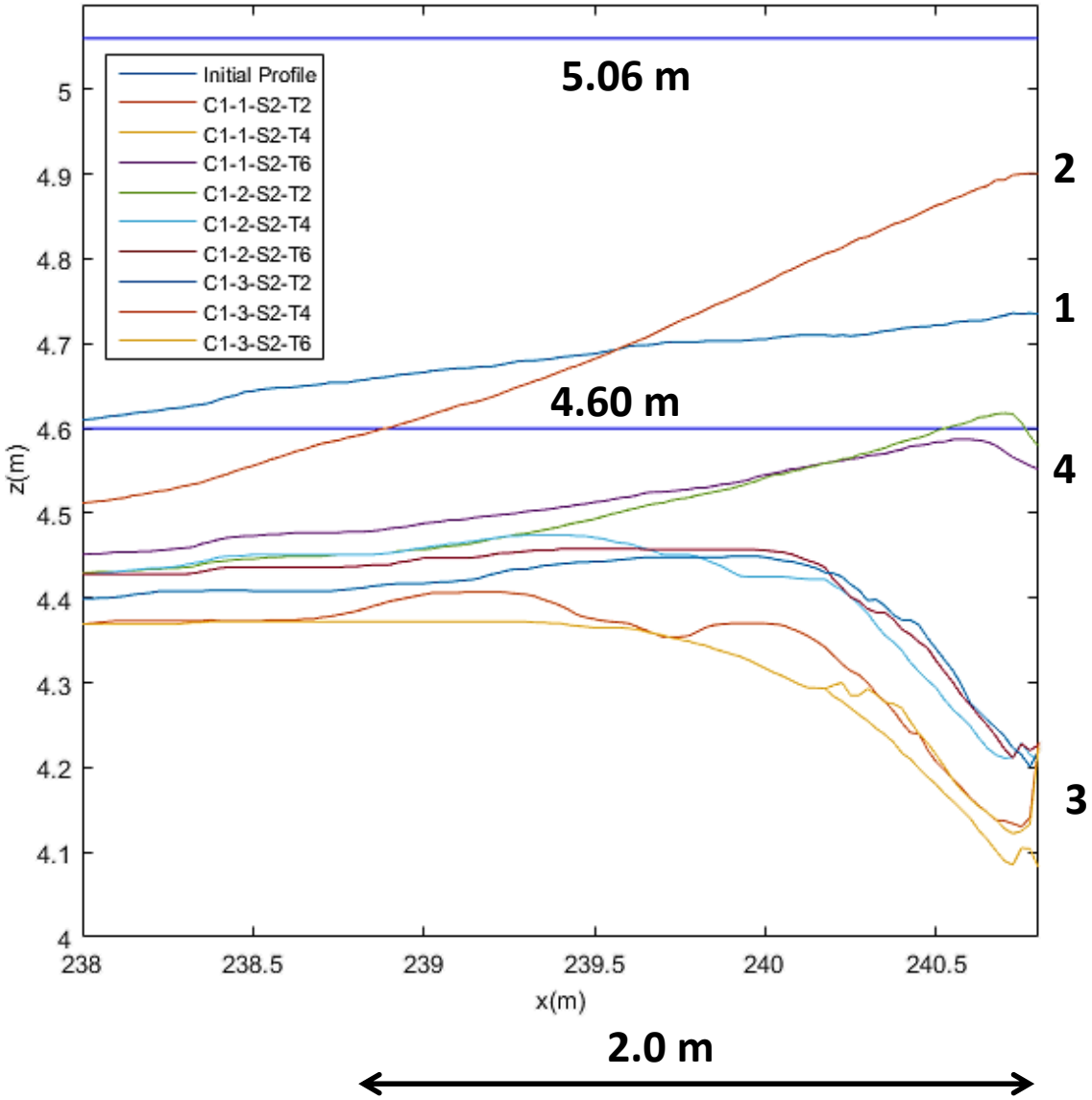
Storm S2

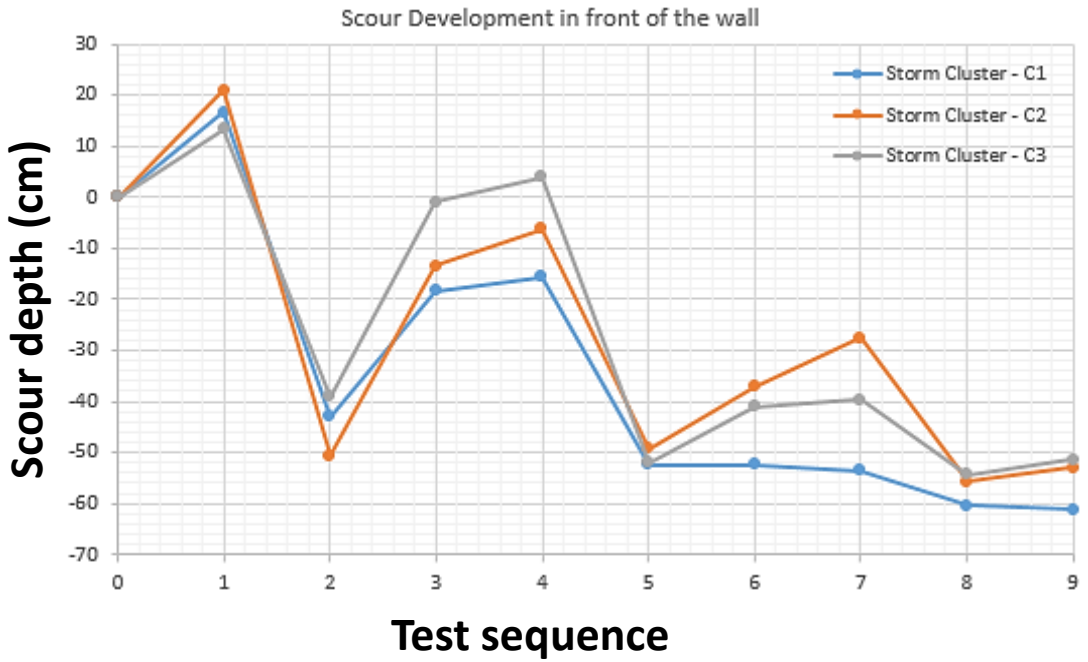
Cluster Name	Storm Name	Foreshore Profile
C1	S2	Planar Slope 1:15
	S2	Changing foreshore due to previous S2
	S2	Changing foreshore due to previous S2
C2	S2	Planar Slope 1:15
	S1	Changing foreshore due to previous S2
	S2	Changing foreshore due to previous S1
C3	S1	Planar Slope 1:15
	S2	Changing foreshore due to previous S1
	S1	Changing foreshore due to previous S2

Reshaping foreshore



Scour


Initial Profile
C1-1-S2-T2
C1-1-S2-T4
C1-1-S2-T6
C1-2-S2-T2
C1-2-S2-T4
C1-2-S2-T6
C1-3-S2-T2
C1-3-S2-T4
C1-3-S2-T6
5.06 m
4.60 m
2
1
4
3
z(m)
x(m)
2.0 m


Scour Development in front of the wall
Storm Cluster - C1
Storm Cluster - C2
Storm Cluster - C3
Scour depth (cm)
Test sequence

Research objectives

The ideal world:

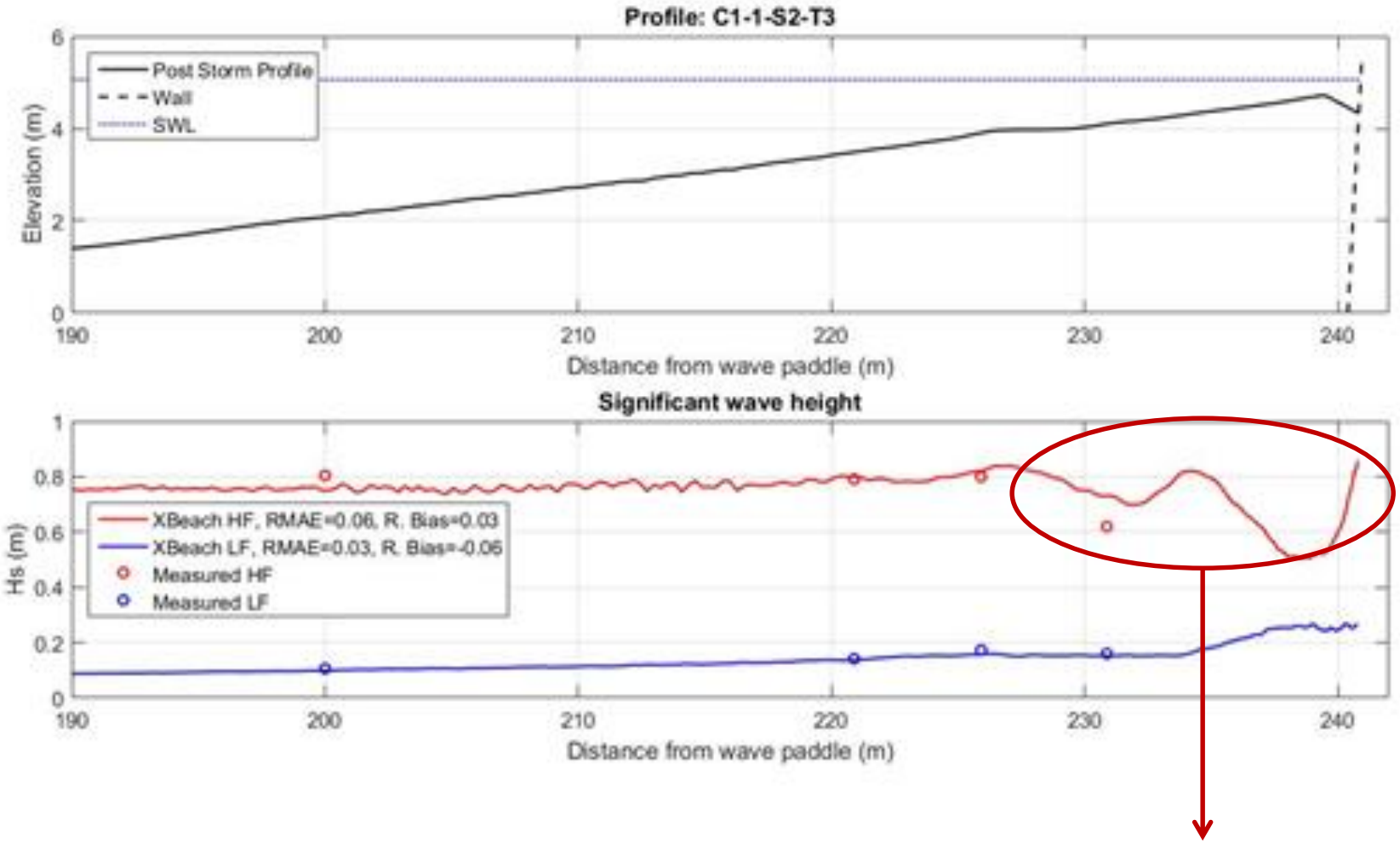
- We can calculate and predict the foreshore changes for each sea state
- For each foreshore we can calculate and predict wave overtopping

First analysis:

- A first try with XBeach on foreshore changes
- EurOtop (2016) for wave overtopping:
  - We need the wave height at the toe of the structure
  - With a given foreshore we can estimate H_{m0}
  - and calculate wave overtopping (EurOtop – Sections 7.3.2 and 7.3.3)

Hydrodynamics by XBeach (non-hydrostatic)

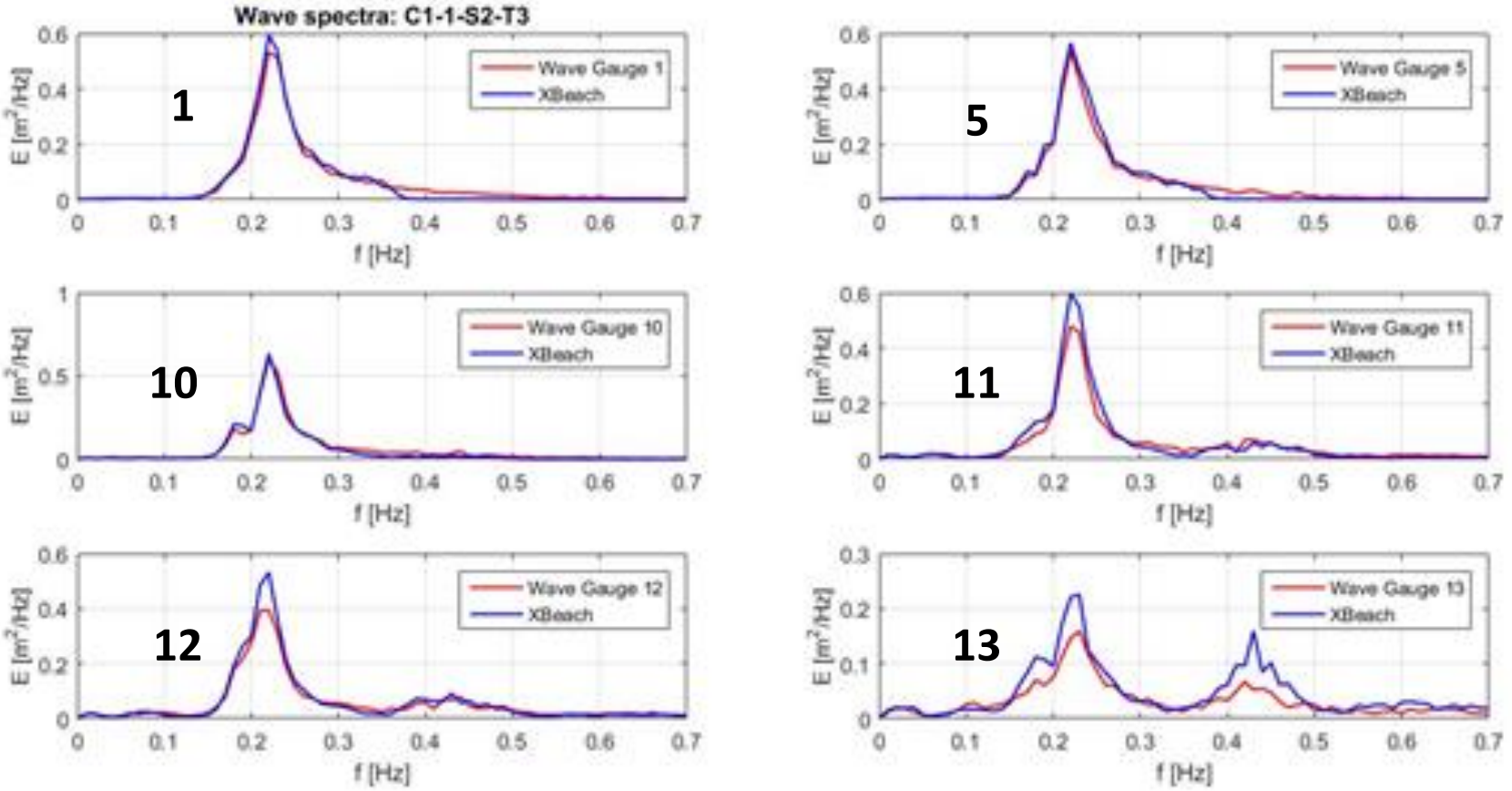
Significant wave height comparison of a high SWL case (C1-1-S2-T3)



Total wave heights, including reflection!

Hydrodynamics by XBeach (non-hydrostatic)

Wave spectra comparison of a high SWL case (C1-1-S2-T3)



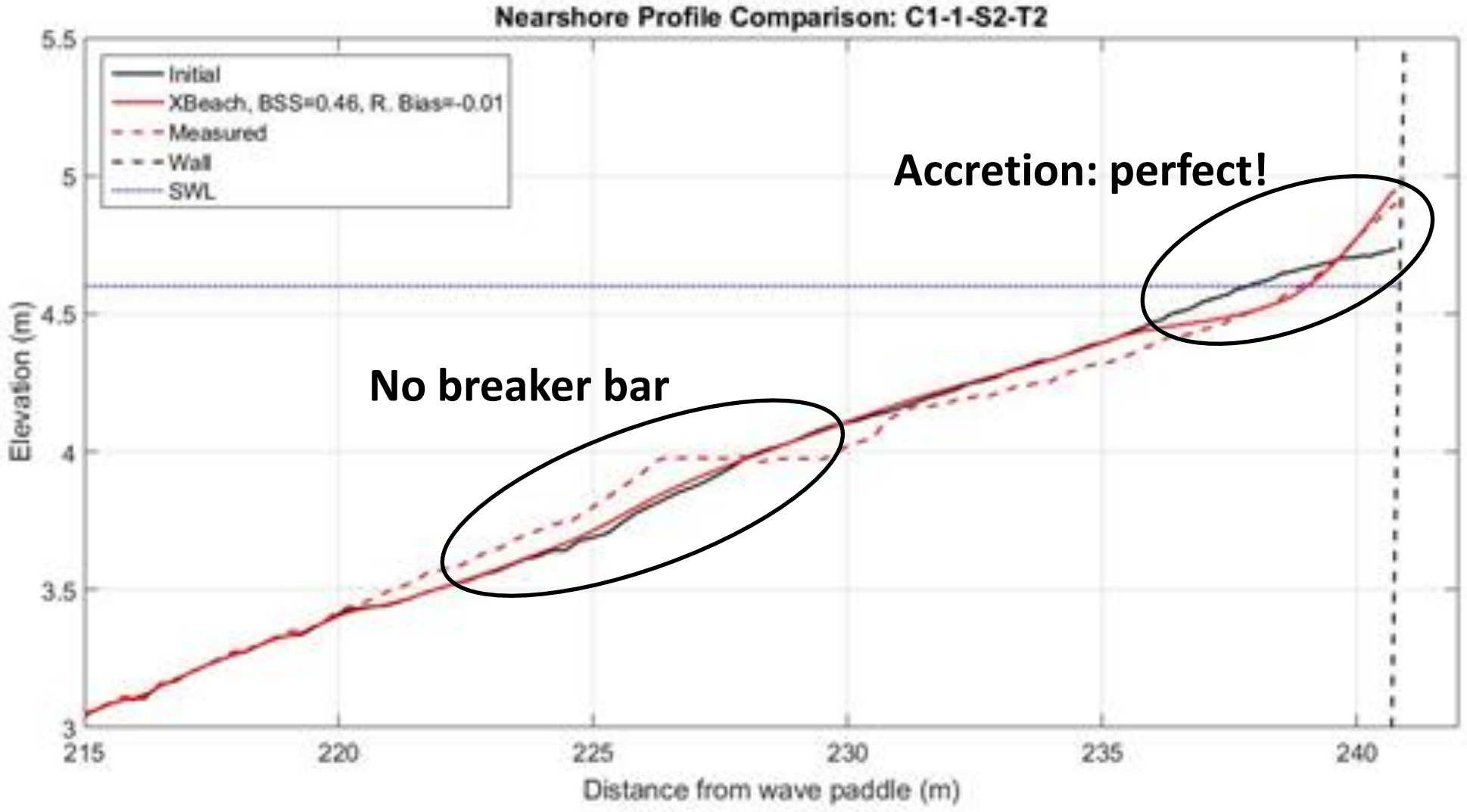
Conclusions:

Total short wave heights: reasonable to good

Total long wave heights: excellent

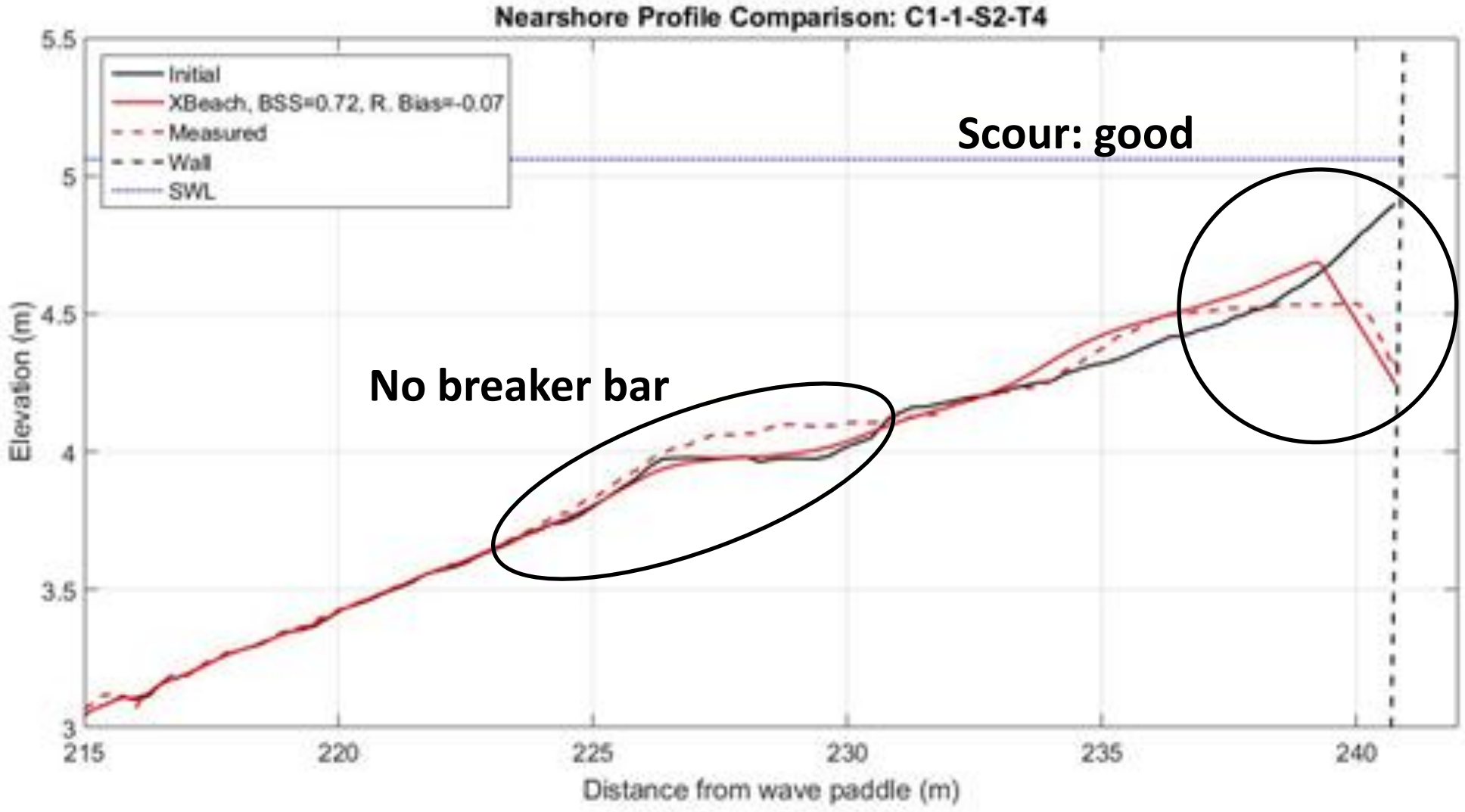
Morphodynamics by XBeach (morphological non-hydrostatic)

First storm after 2 sea states



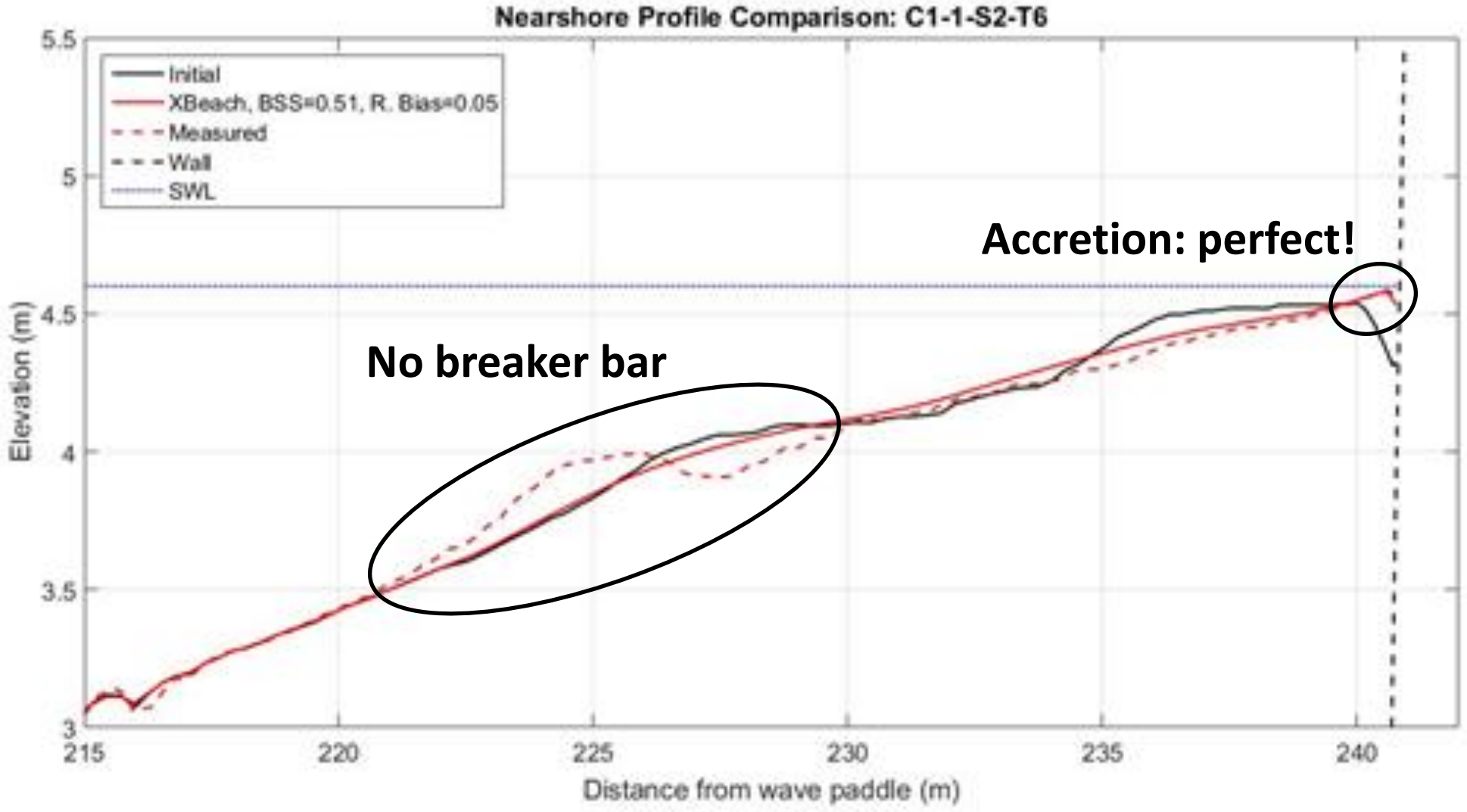
Morphodynamics by XBeach (morphological non-hydrostatic)

First storm after 4 sea states



Morphodynamics by XBeach (morphological non-hydrostatic)

First storm after 6 sea states



Predicting morphological behaviour

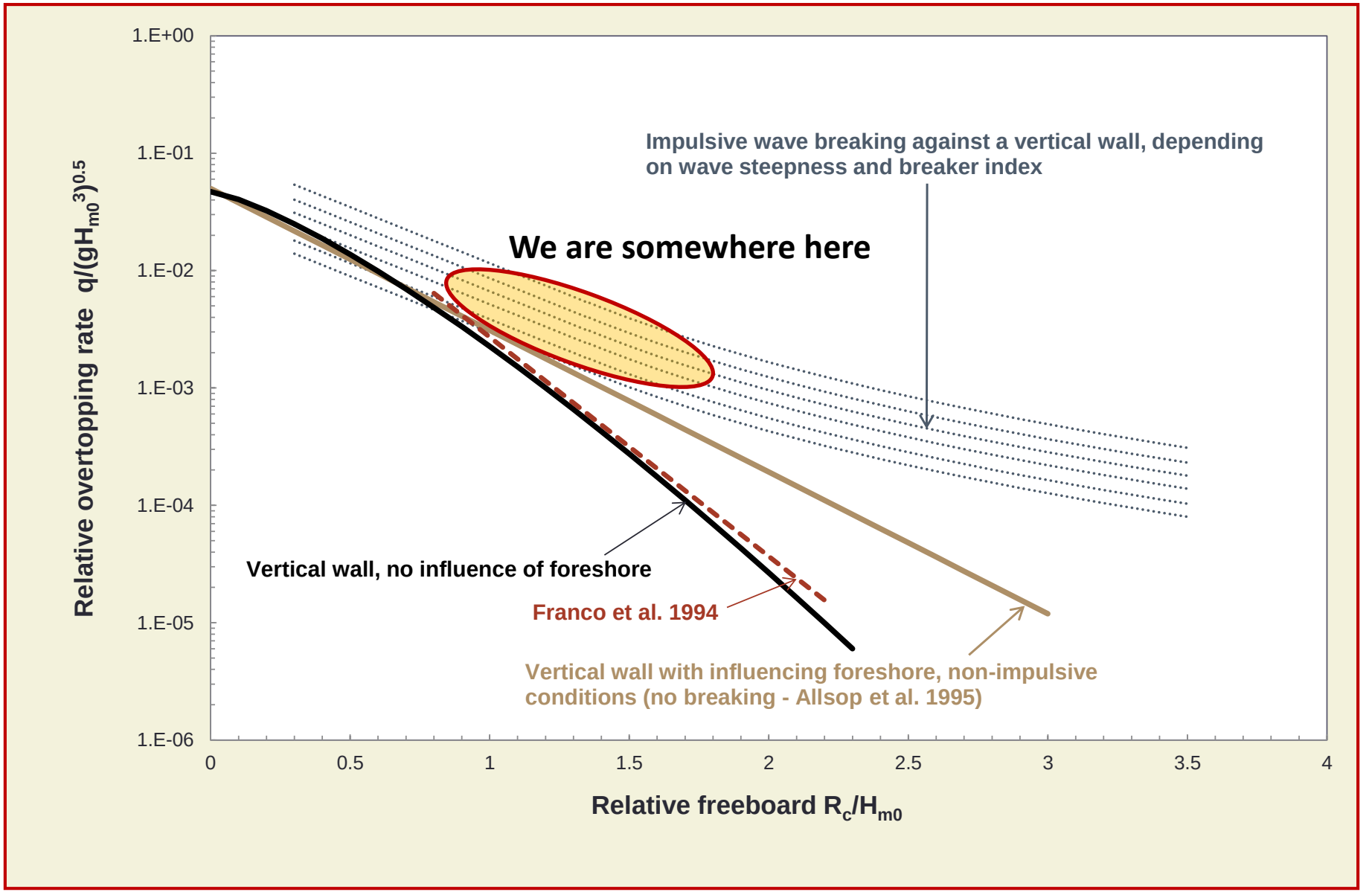
Applying XBeach from start to end of 3 storms, 18 sea states:

- no comparison at all!
- here are the challenges for the future!

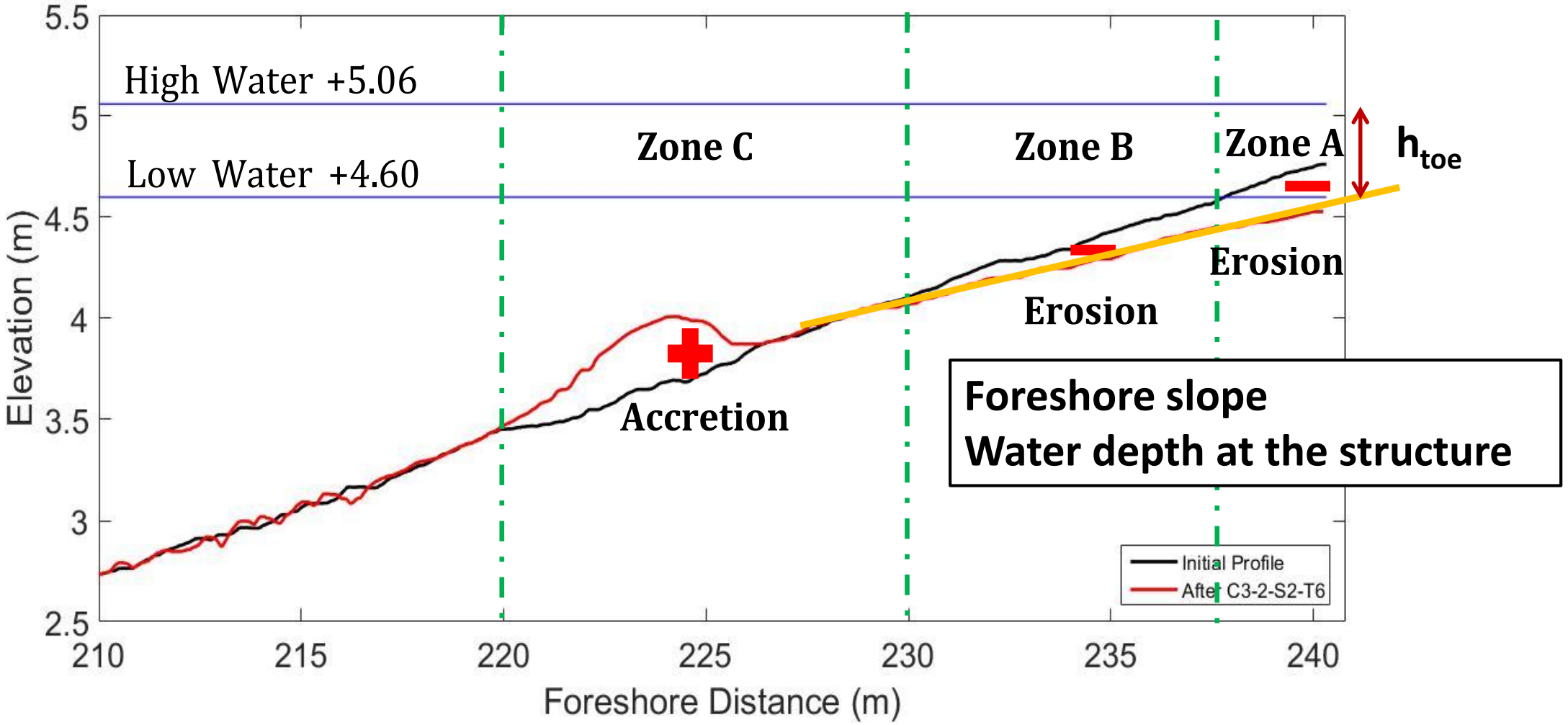
Applying XBeach with given reshaped foreshore with 2 sea states:

- perfect scour/accretion behaviour (first 2-5 m from the structure)
- no formation of the breaker bar:
  - wave induced return flow (reflection)?
  - wave breaking induced turbulence?
  - XBeach uses depth-averaged approach
  - here is the first challenge for the future

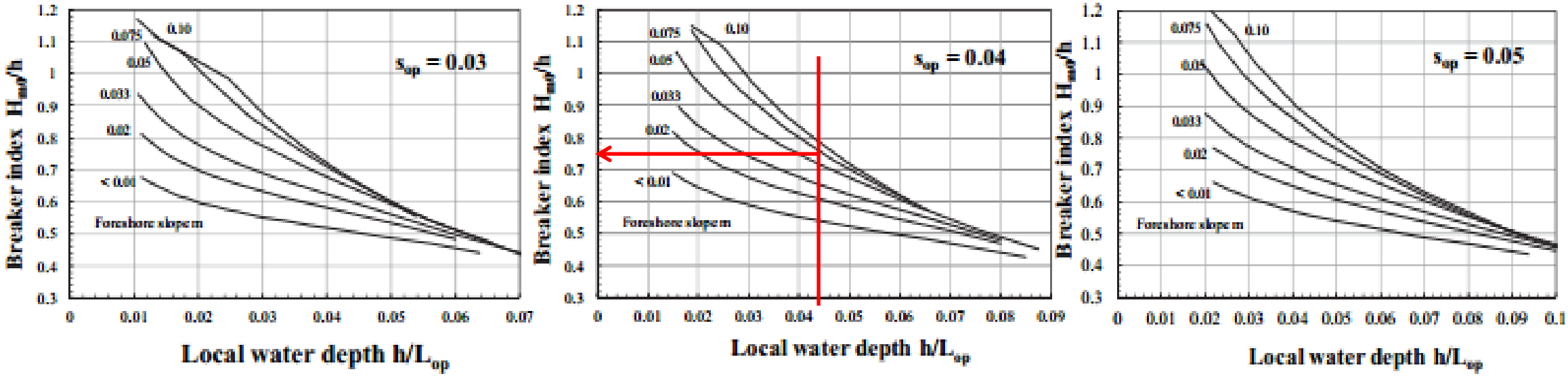
Wave overtopping: EurOtop (2016) for vertical walls

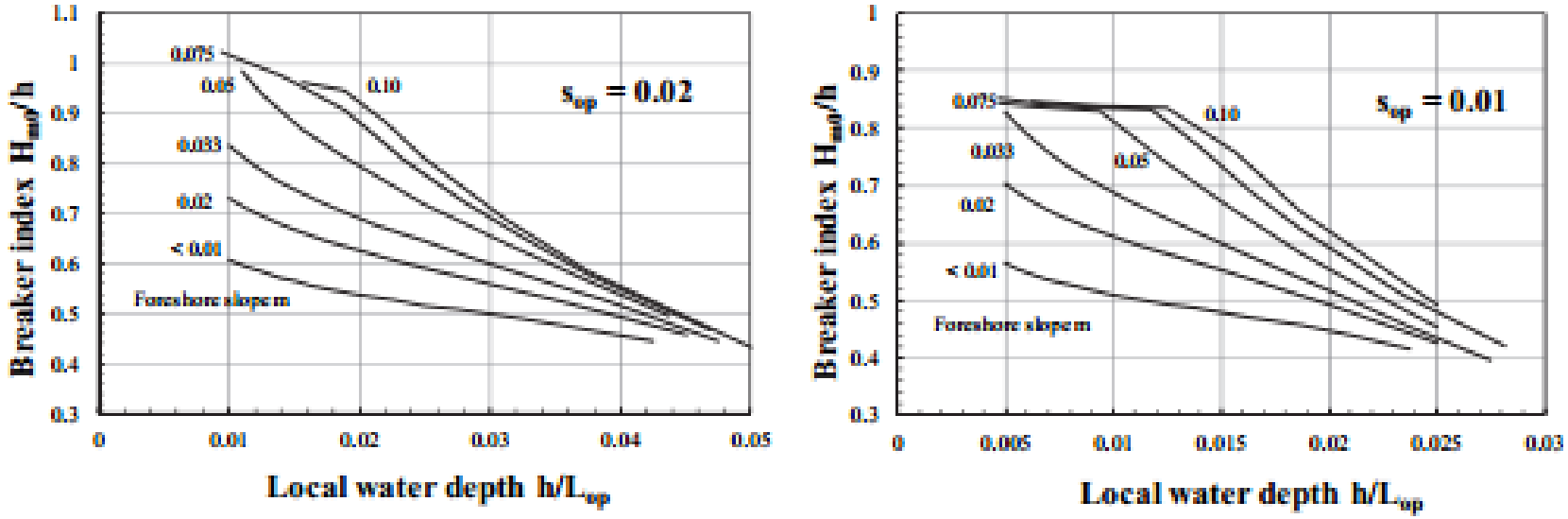


H_{m0} at the toe of the structure: schematise the foreshore

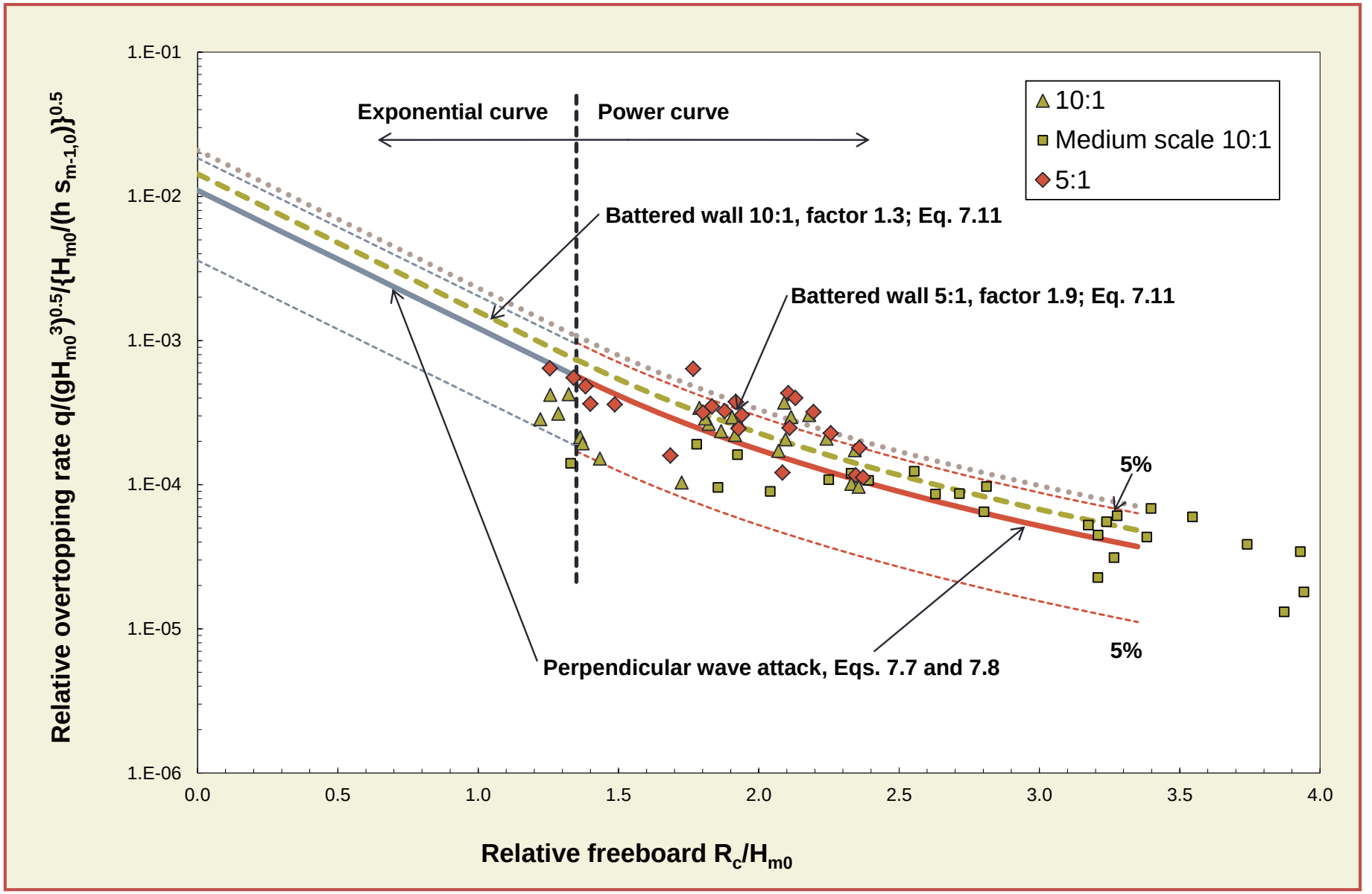


H_{m0} at the toe of the structure: EurOtop (2016) Section 2.3.2

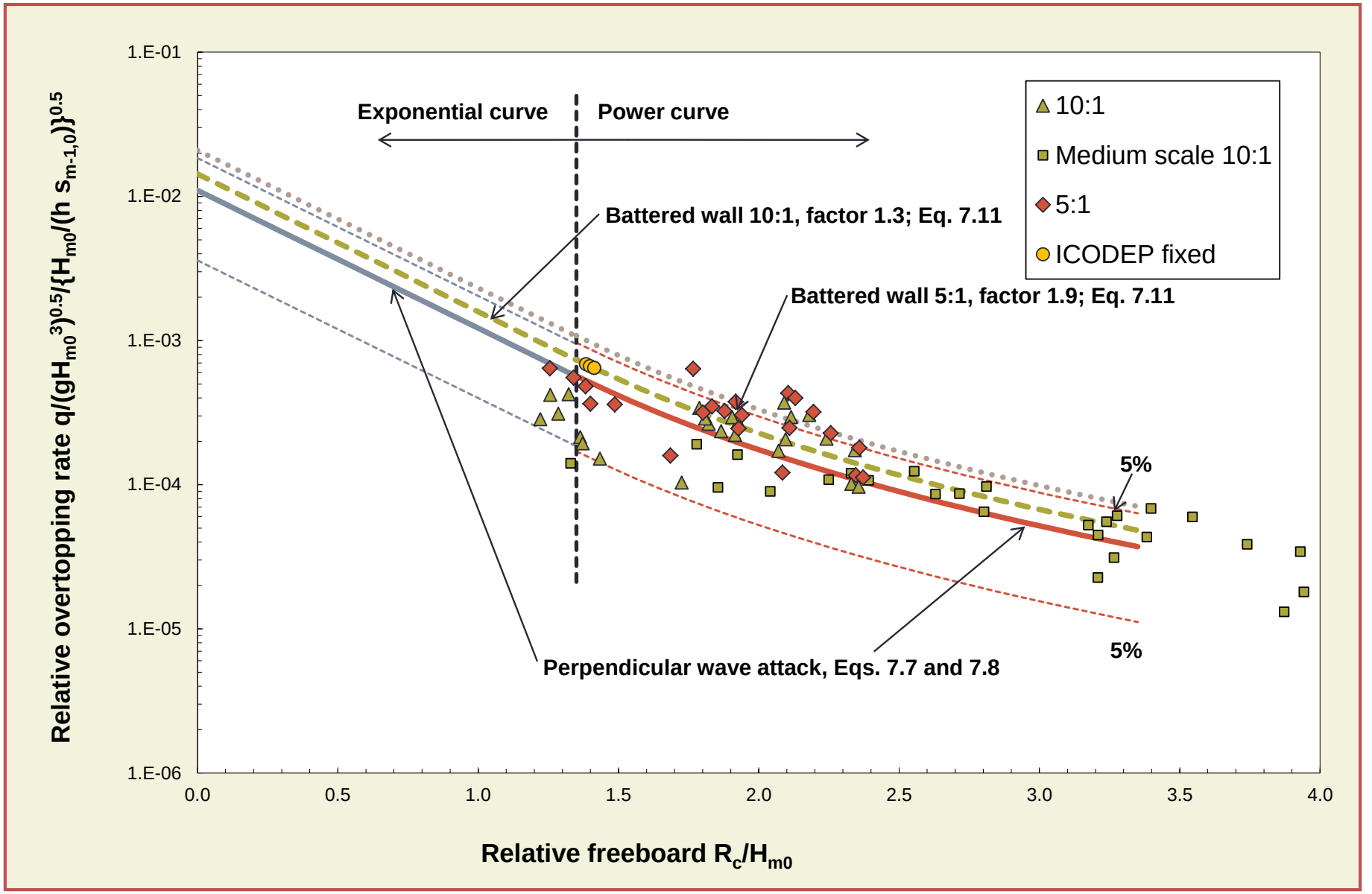




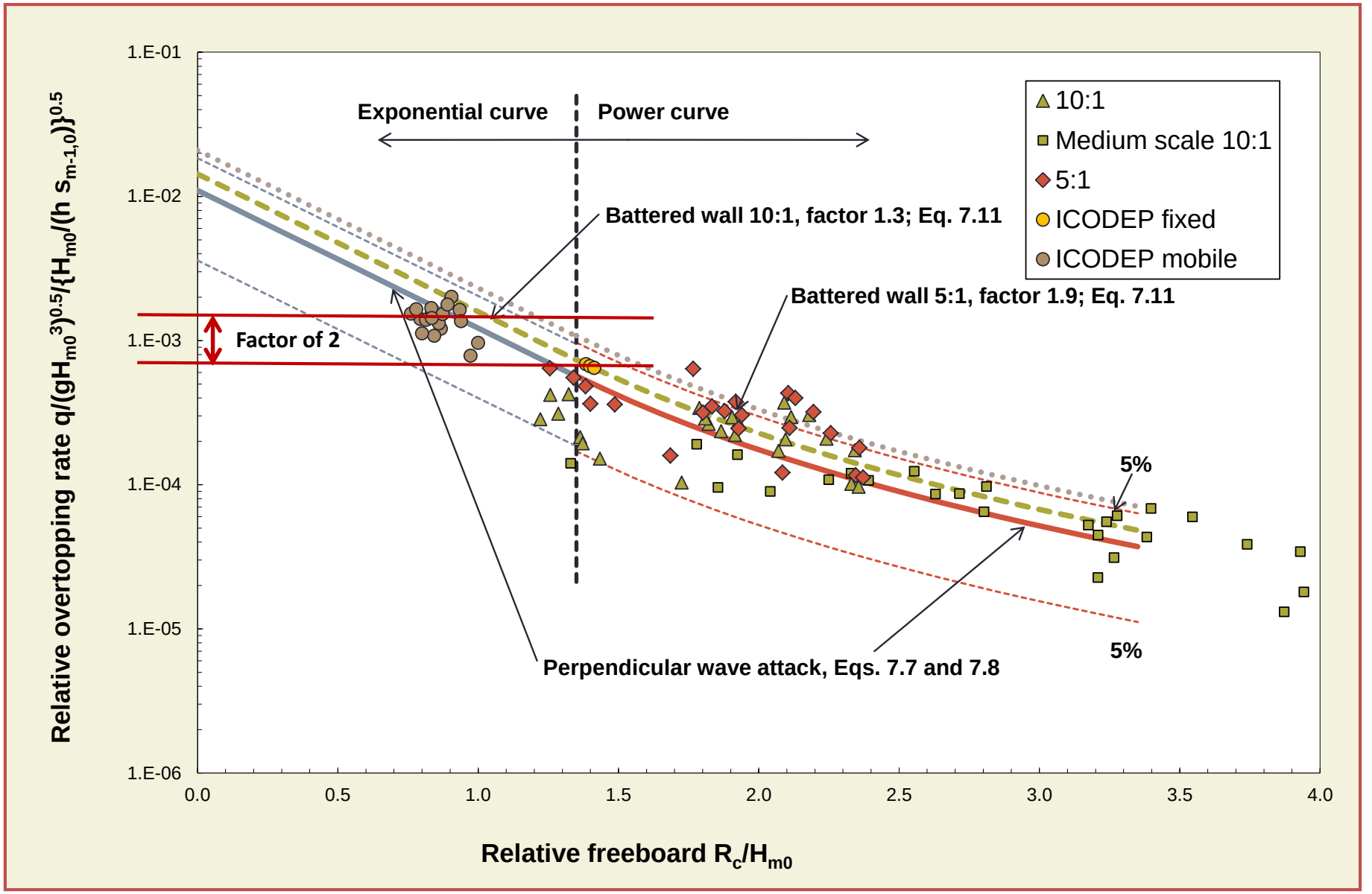
Wave overtopping: EurOtop (2016) Section 7.3.3



Wave overtopping: EurOtop (2016) Section 7.3.3

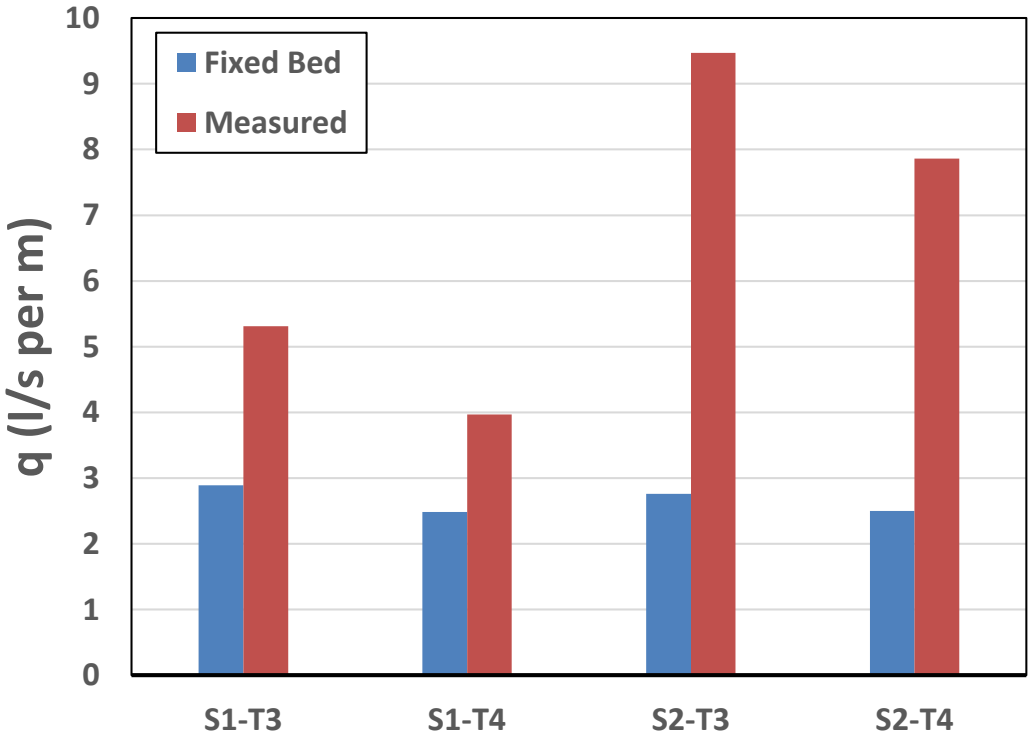


Wave overtopping: EurOtop (2016) Section 7.3.3

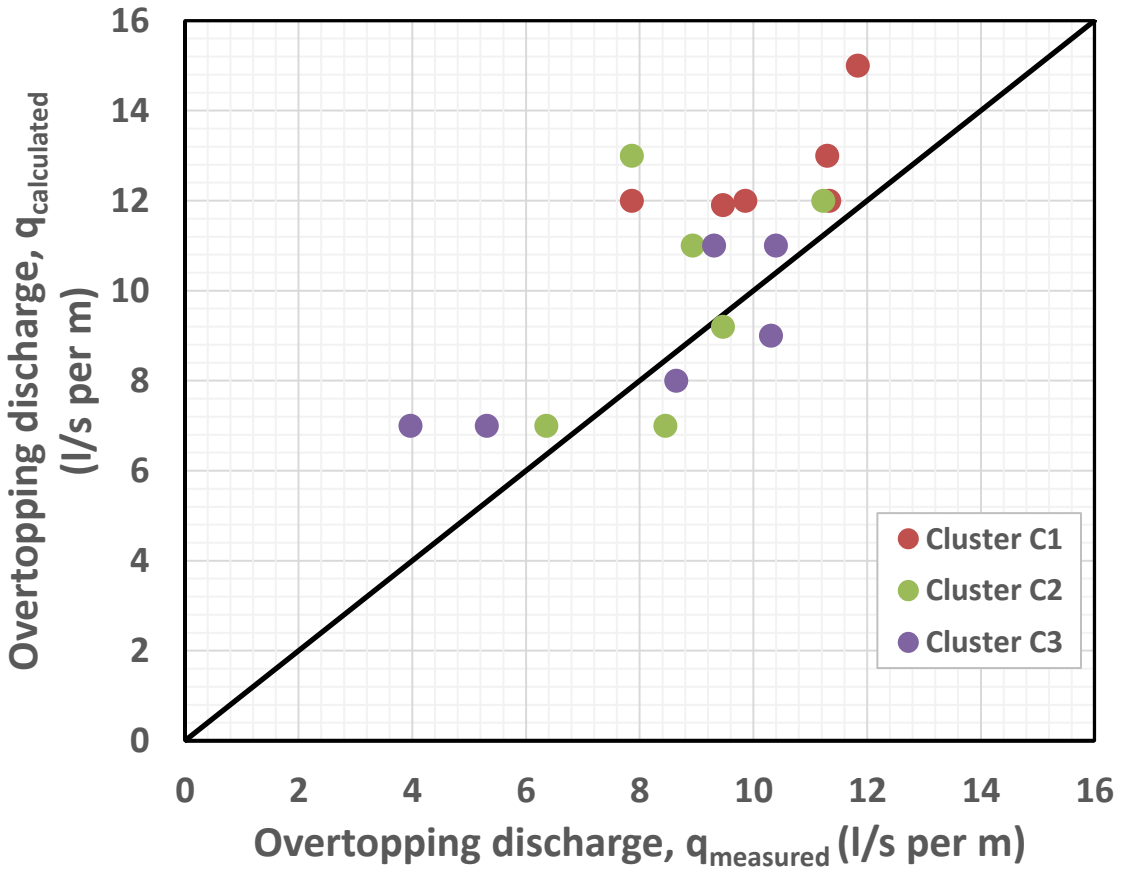


Comparison of wave overtopping predictions

Initial slope 1:15



Mobile slope, schematised



Conclusions

XBeach *hydrodynamics*:

- total short wave heights: reasonable to good;
  but a lot to understand the influence of reflection
- total long wave heights: excellent

XBeach *morphodynamics*:

- not able to model behaviour of a full cluster
- with given reshaped foreshore with 2 sea states:
  - perfect scour/accretion behaviour (first 2-5 m from the structure)
  - no formation of the breaker bar:
- here are challenges for the future

EurOtop (2016) *wave overtopping*:

- with initial 1:15 foreshore at least a factor of 2 underprediction
- with given reshaped foreshore reasonably good (slight overprediction)

Thank you