A NUMERICAL STUDY ON BEACH EROSION UNDER STORMS AND SEA LEVEL RISE

Nghi H. Tran[a,b,*], A. Vila-Concejo[a], T. Salles[a], R. J McCaroll[a]

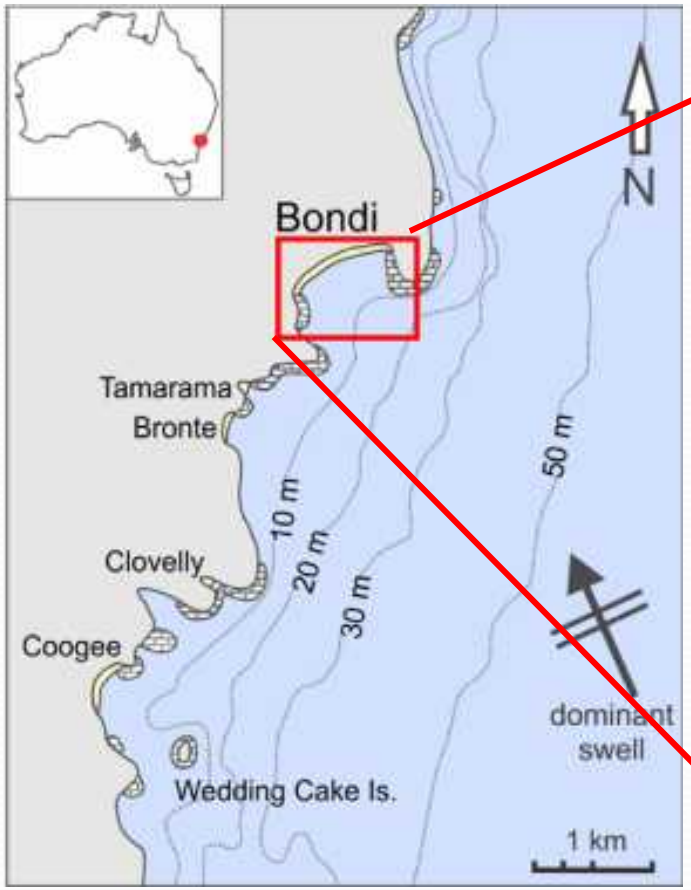
a: Geocoastal Research Group, School of Geosciences, The University of Sydney, NSW, Australia
b: Faculty of Civil Engineering, Thuyloi University, Hanoi, Vietnam
[*]Corresponding author-E-mail address: huu.tran@sydney.edu.au

CONTENTS:

- INTRODUCTION
- METHODS
- MODEL RESULTS (1-D; 2-D)
- CONCLUSIONS & FUTURE WORKS

I.INTRODUCTION

• I.1.The study site



(Modified from Maccaroll et al., 2016 and Matt Lauderf, nd.)

- 850m; headlands controlled; micro tidal;
- closed compartment of sand (Bruce Thom, 2014);
- S-SE wave dominance (McCarroll et al., 2016); Hsig=1.5-1.6m; Tsig=9.4-9.7s (T D Shand et al.,);

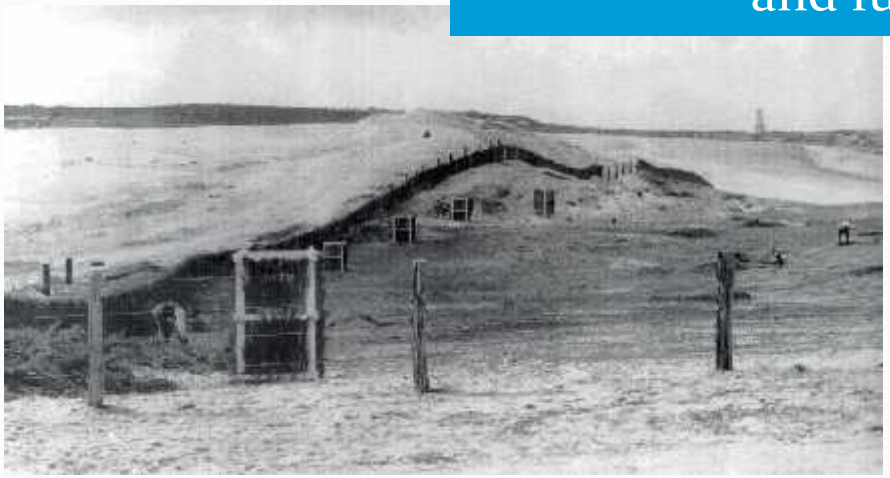
I.2.Research issues

-History of coastal developments:

Bondi beach-1875 (http://ww

's blog, 2013)

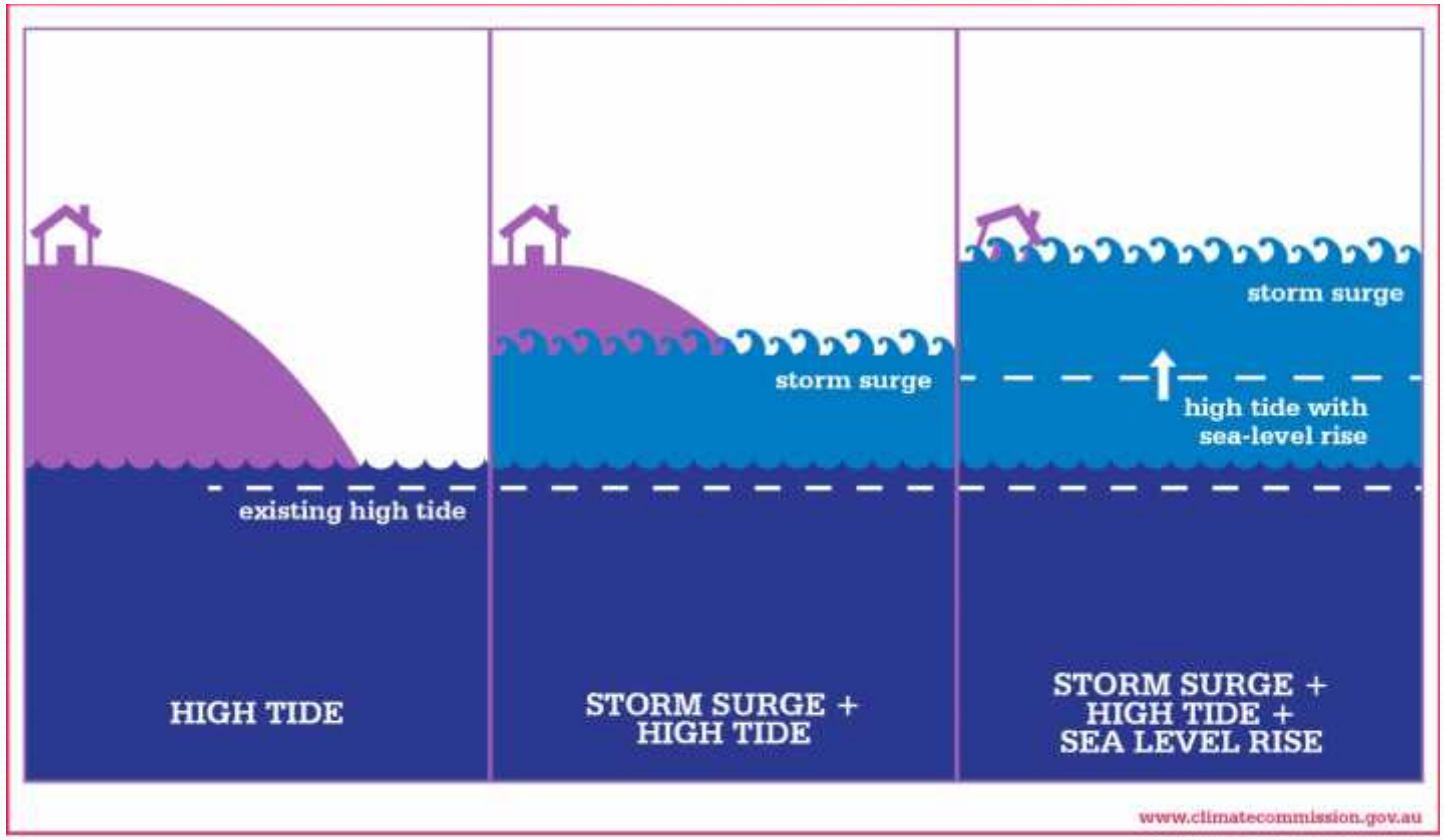
What will happen to Bondi beach under storms and future sea level rise?



19th century (Bruce Thom's blog, 2013)

Present (Matt Lauderf, nd.)

I.3.Research objectives



Beach erosion under storms and sea level rise

-Changes of shoreline position

-Quantification of beach erosion volumes

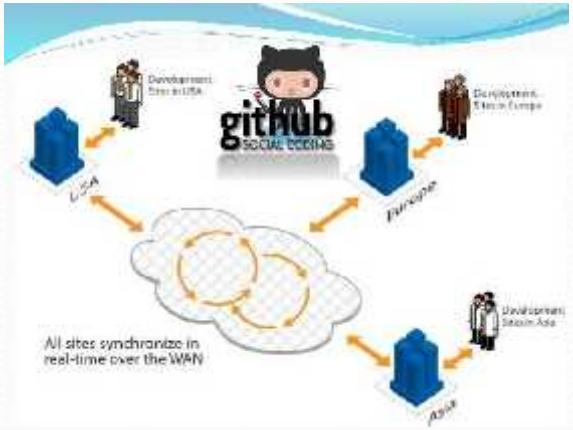
-Accuracy of the 1-D model vs. the 2-D model

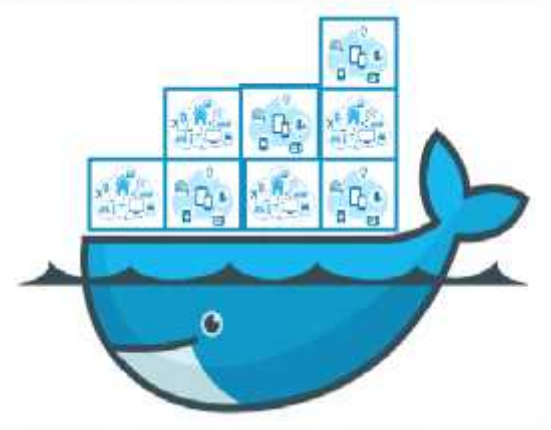
II. METHODS

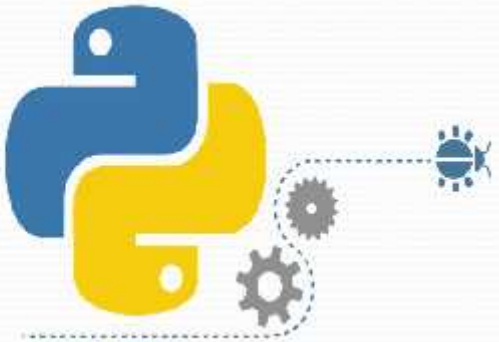
II.1.General description of methodology

-Step 1: Using open-source technologies

- Github; Docker containers; Python







-Step 2: Simulate a past storm event (ECL-August, 2012)

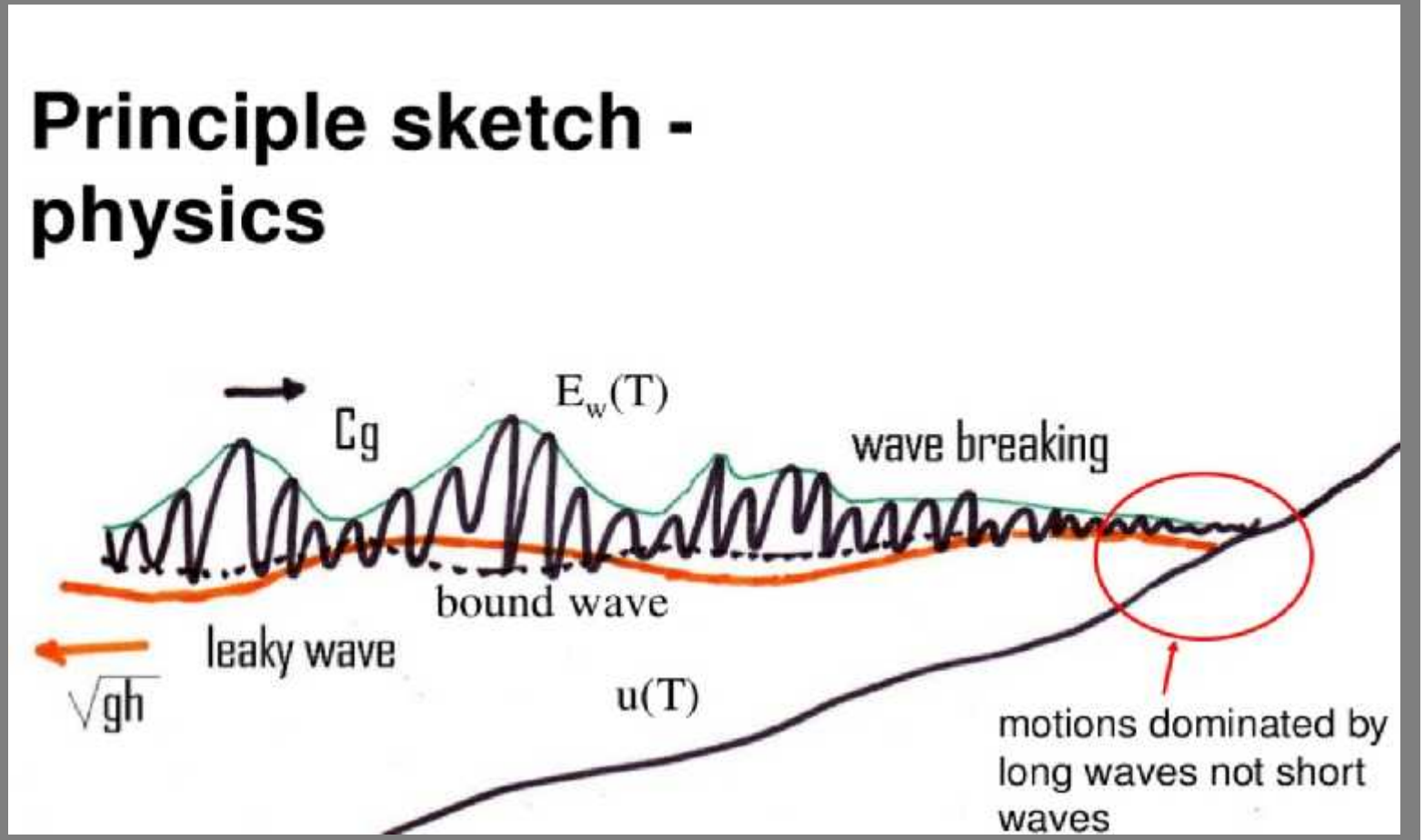
- Calibrate the model;
- Evaluate the accuracy of 1-D model and 2-D model;

-Step 3: Forecast impacts of sea level rise on beach erosion

- Scenarios of 2050 and 2090 for Sydney from CSIRO;

- **II.2.Numerical model:**

XBeach (Roelvink et al., 2009)



(Roelvink, DSD-INT 2017)

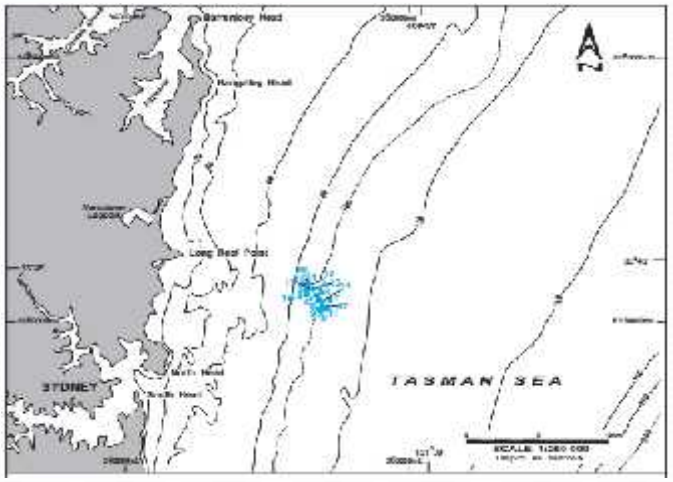
- Hydrodynamics, sediment transport and morphological changes;
- All physical processes of non-linearity waves;

II.3.Data Collection

-Waves:

Offshore Sydney Waverider Buoy

(Manly Hydraulic Laboratory)



-Tides:

Middle Head Tide Gauge

(Manly Hydraulic Laboratory)

-Sediment characteristics:

Sand samples (back beach to low-tide)

-Topography and bathymetry:

-RTK-GPS: back beach to 1m below low-tide

-JetSki: 1m below low-tide to 20m depth

II.4.Model calibration method

Calibration cases	Major impact factors		Minor impact factors				Assessment criteria		
	Waves skewness (facua)	Wave Breaking models (break)	Breaking parameter (gamma)	Threshold of wet and dry cells (esp)	Under water slope avalanch (wetslp)	Threshold of undertow (hmin)	error volume for whole profile (m^3)	error volume for beach section (m^3)	Dissimilarity in shape between model result surveyed profile
Default	-	-	-	-	-	-			
Calibrating for the facua parameter	0.00	3	0.50	0.01	0.30	0.01			
	0.01								
	0.015								
	0.02								
	0.03								
	0.05								
	0.08								
	0.1								
	0.15								
	0.3								
Calibrating for the break parameter	Selected facua parameters	1							

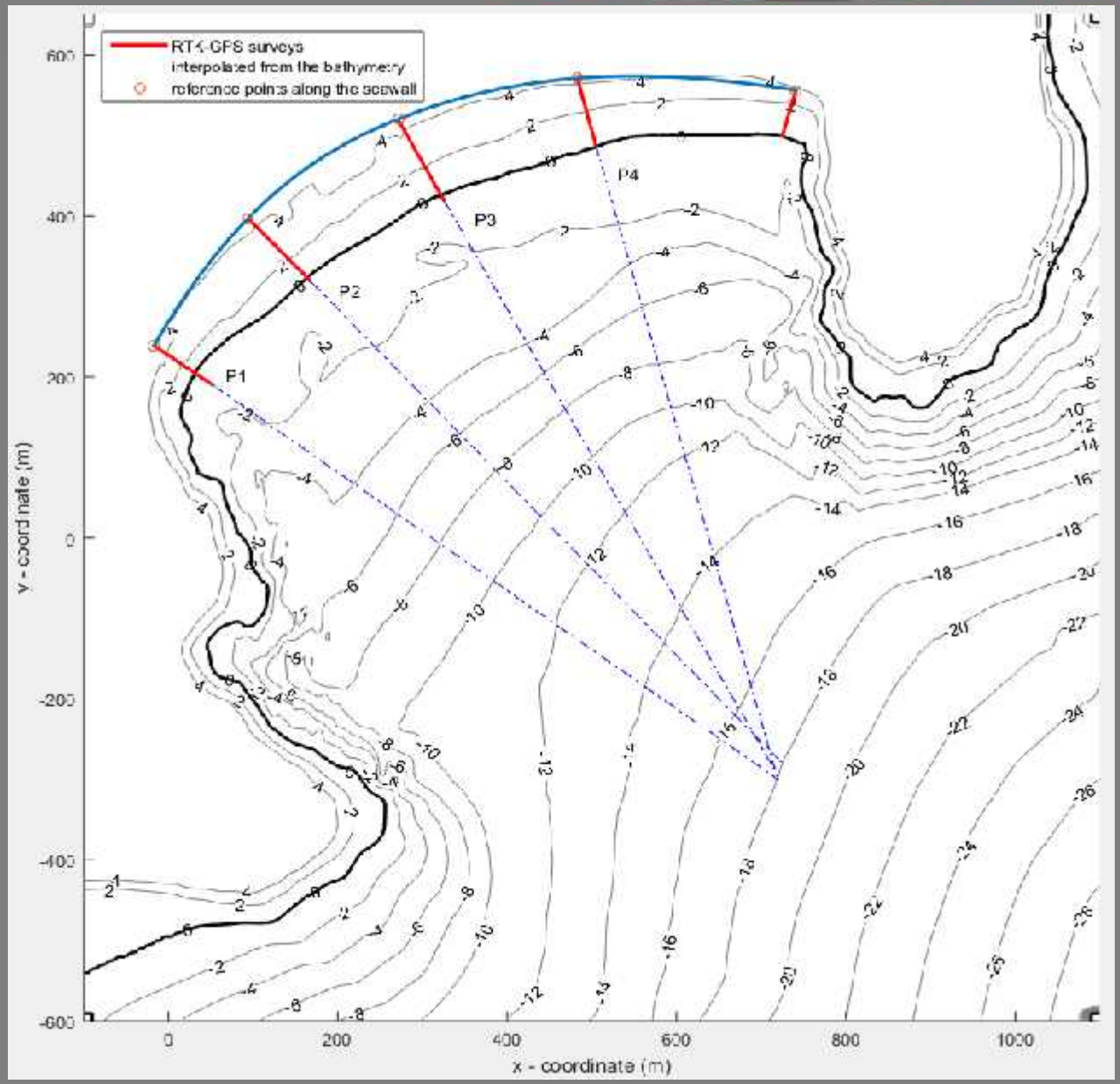
III.4.Model calibration results

Calibration cases	Major impacted factors		Minor impacted factors				Total error volume for whole profile (m^3)	Error volume for beach section (m^3)	Dissimilarity in shape (Kolmogorov-Smirnov factor)
	facua	break	gamma	esp	wetslp	hmin			
Default	-	-	-	-	-	-	288.00	25.53	-
Calibrating for the facua parameter	0.00	3	0.50	0.01	0.30	0.01	117.00	11.28	-
	0.01						*115.10*	*8.81*	*0.1296*
	0.015						*115.28*	*8.47*	*0.1296*
	0.02						*116.21*	*8.84*	*0.1296*
	0.03						119.97	10.68	-
	0.05						133.46	16.97	-
	0.08						157.38	23.77	-
	0.1						175.40	27.66	-
	0.15						371.66	37.87	-
	0.3						372.33	37.14	-
Calibrating for the break parameter	0.01	1					111.77	9.05	0.1296
	0.015						111.83	8.93	0.1296
	0.02						112.21	9.20	0.1296

(-): No assessment/Calculation

III. 1-D MODEL

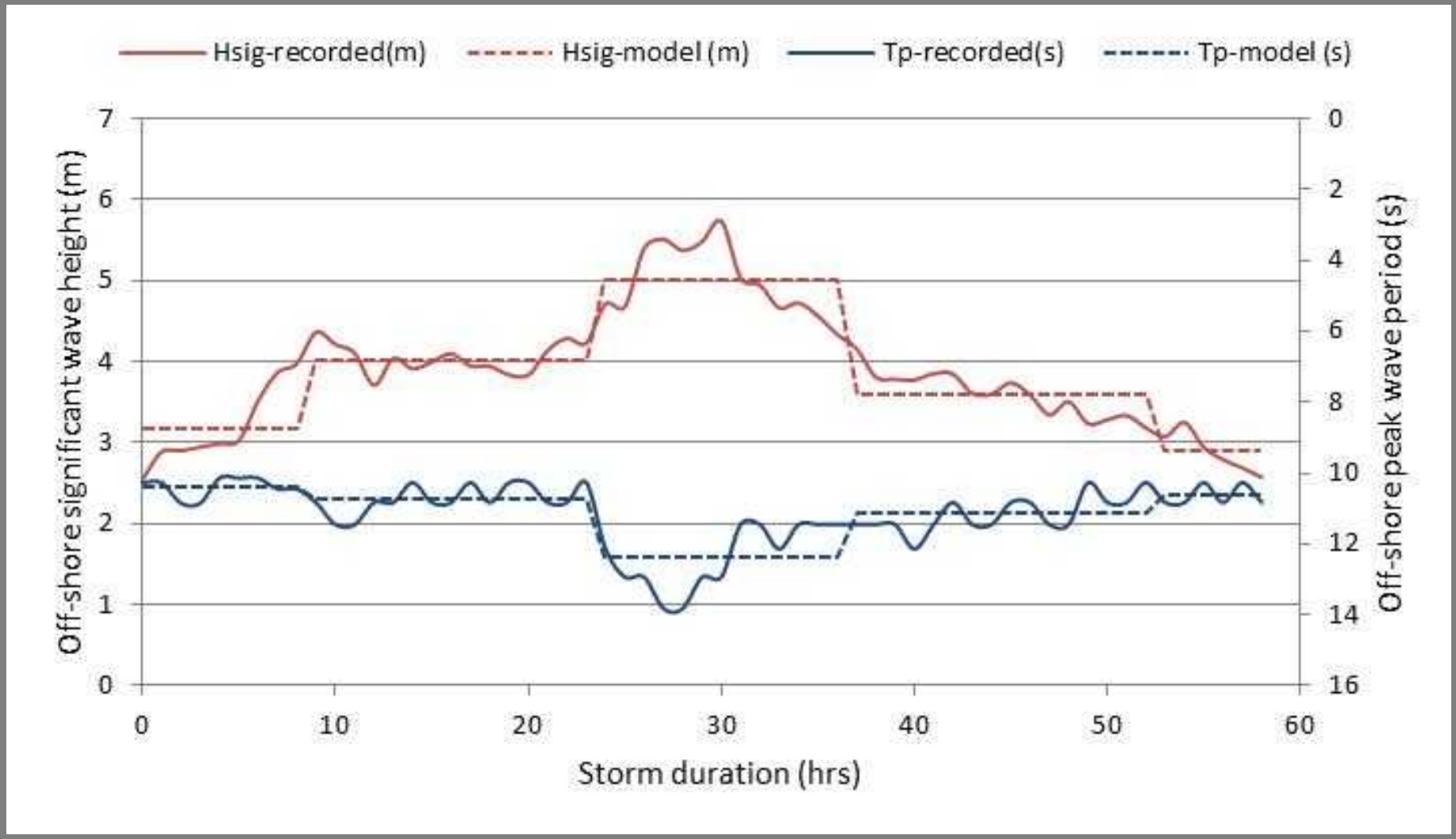
III.1.Model setup: Studying profile positions



(Bathymetry data from ARC Linkage Project LP110200134, McCarroll et al., 2016)

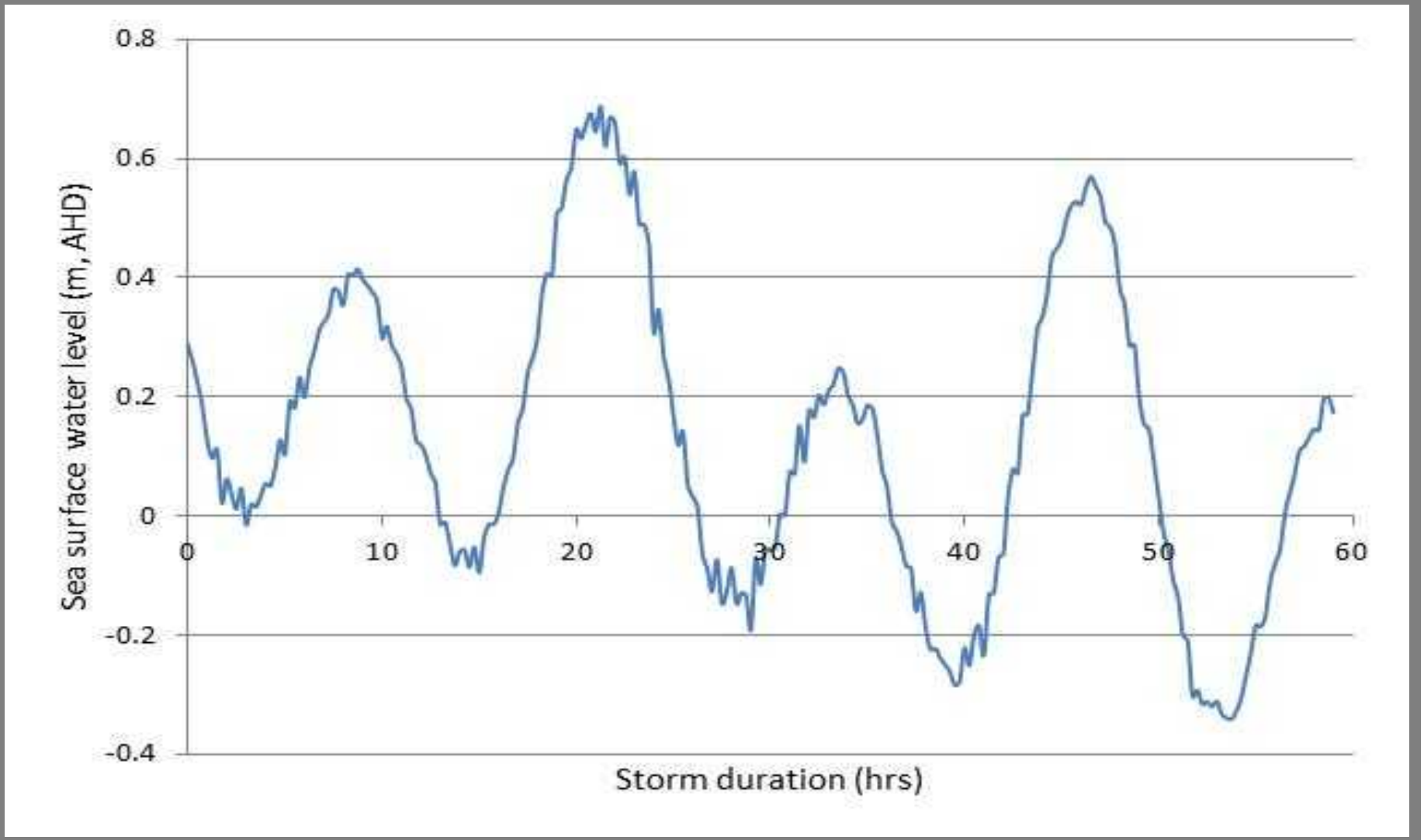
III.2.Boundary conditions: Waves

- H_{max}=10.9(m); Tp_{max}=14.13(s); Dir=174(deg TN); category 2 of tropical storms

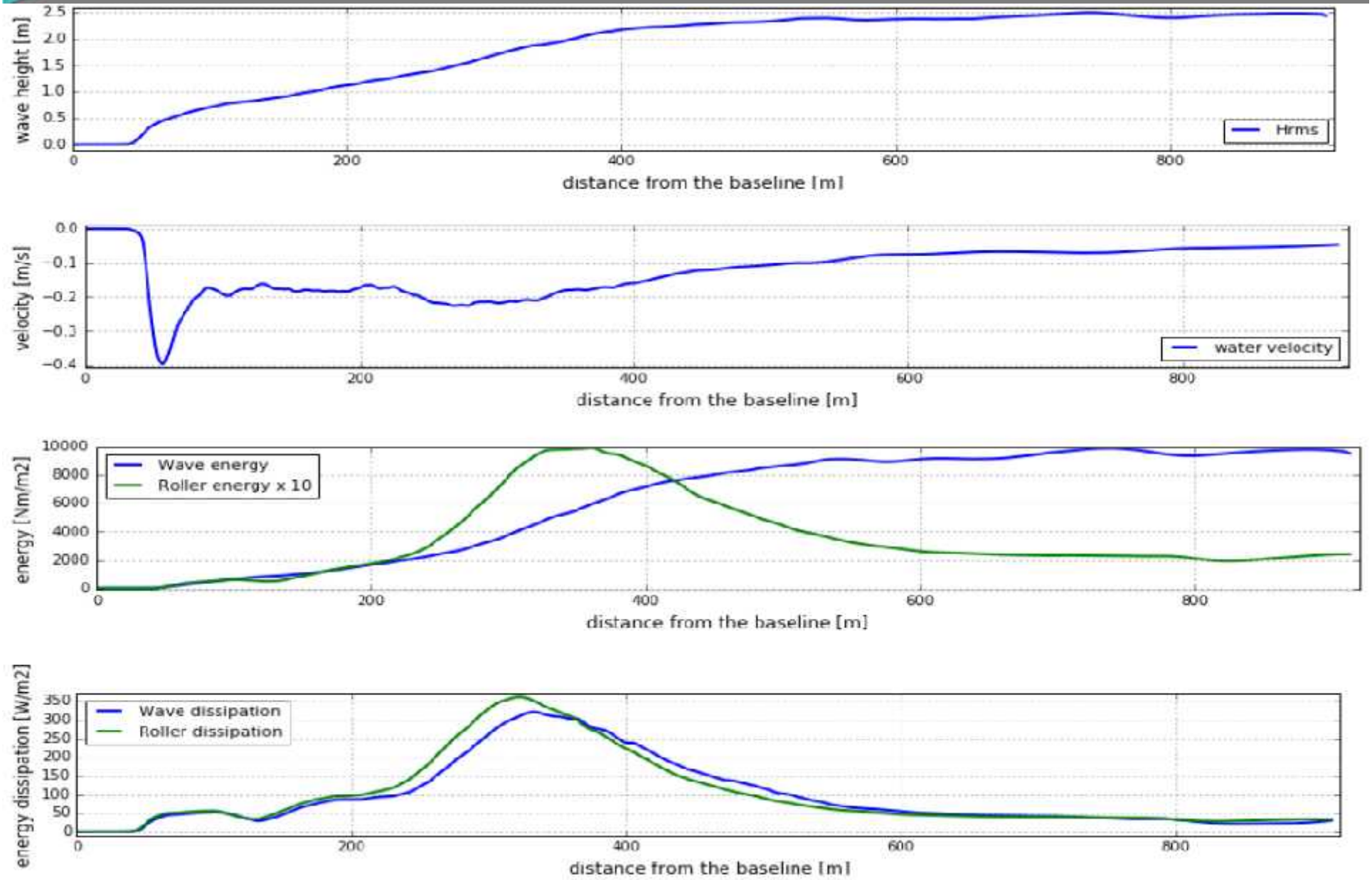


III.2.Boundary conditions: Tide

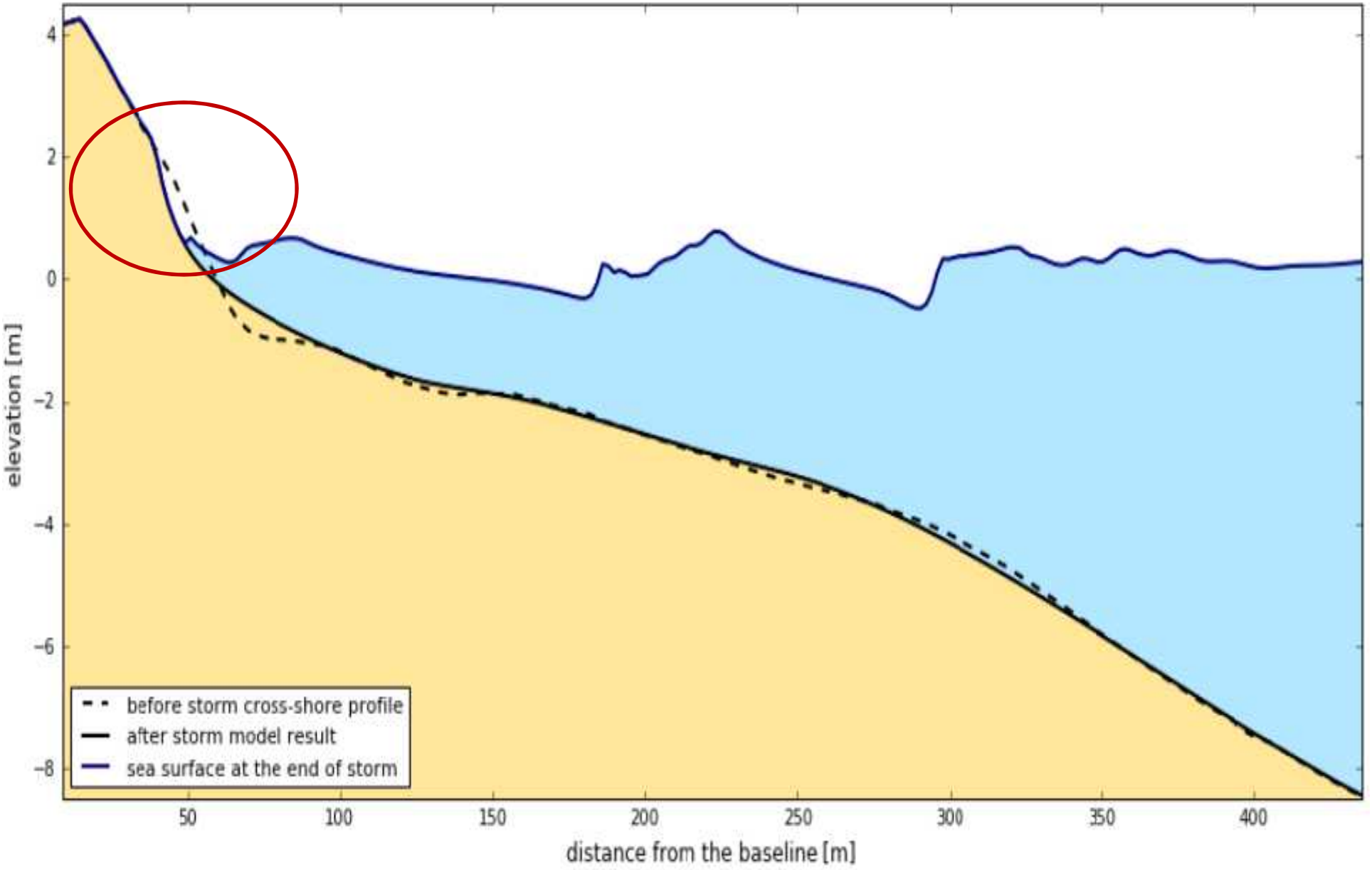
-Tidal conditions during storm



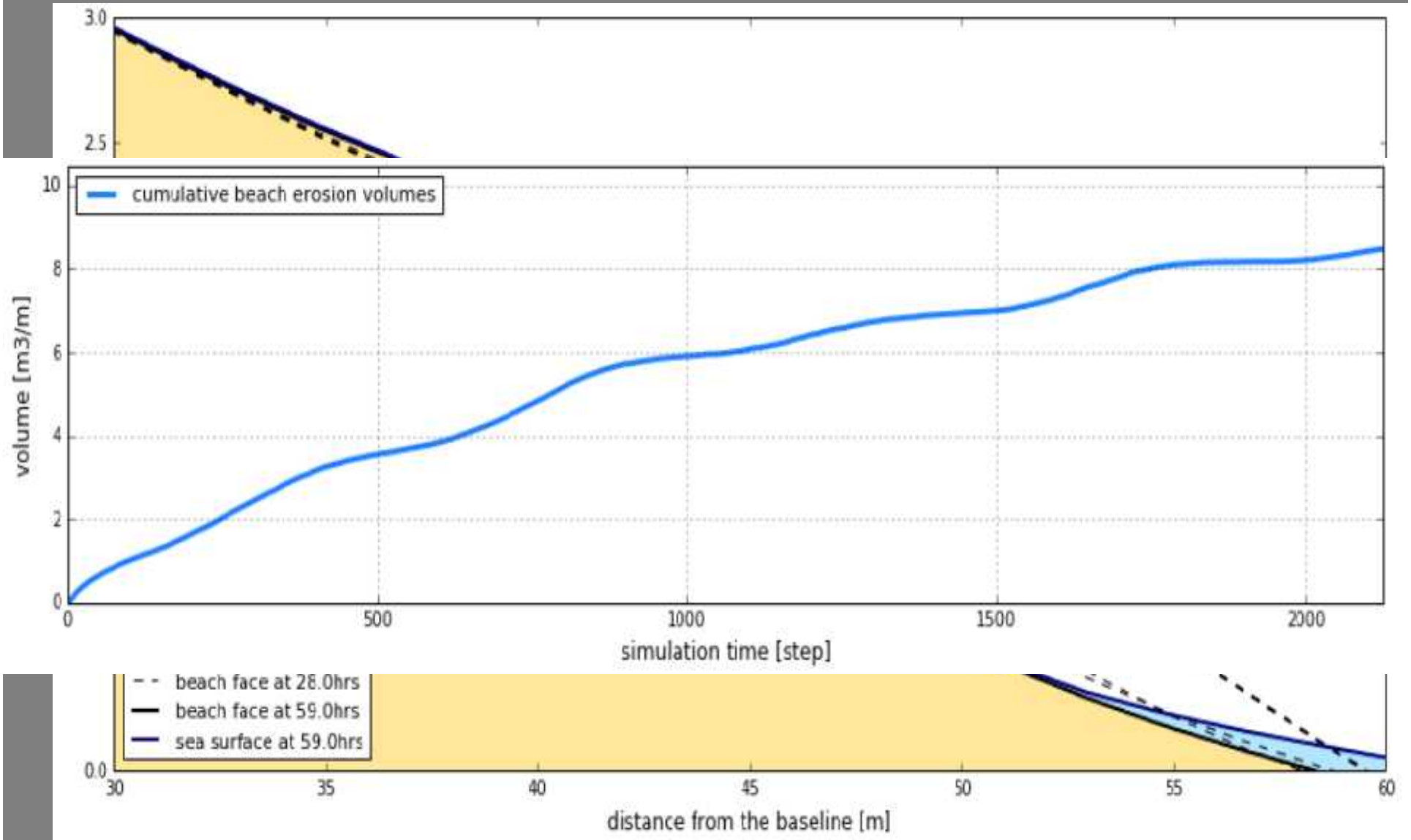
III.3.Model results: Hydrodynamics



III.3.Model results: Bed profile change

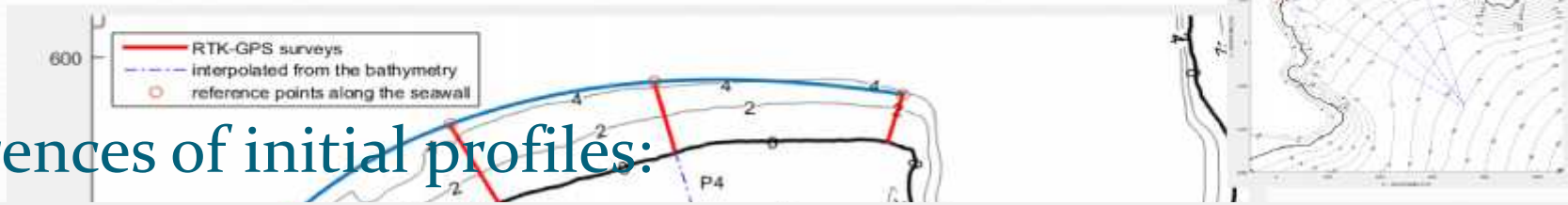


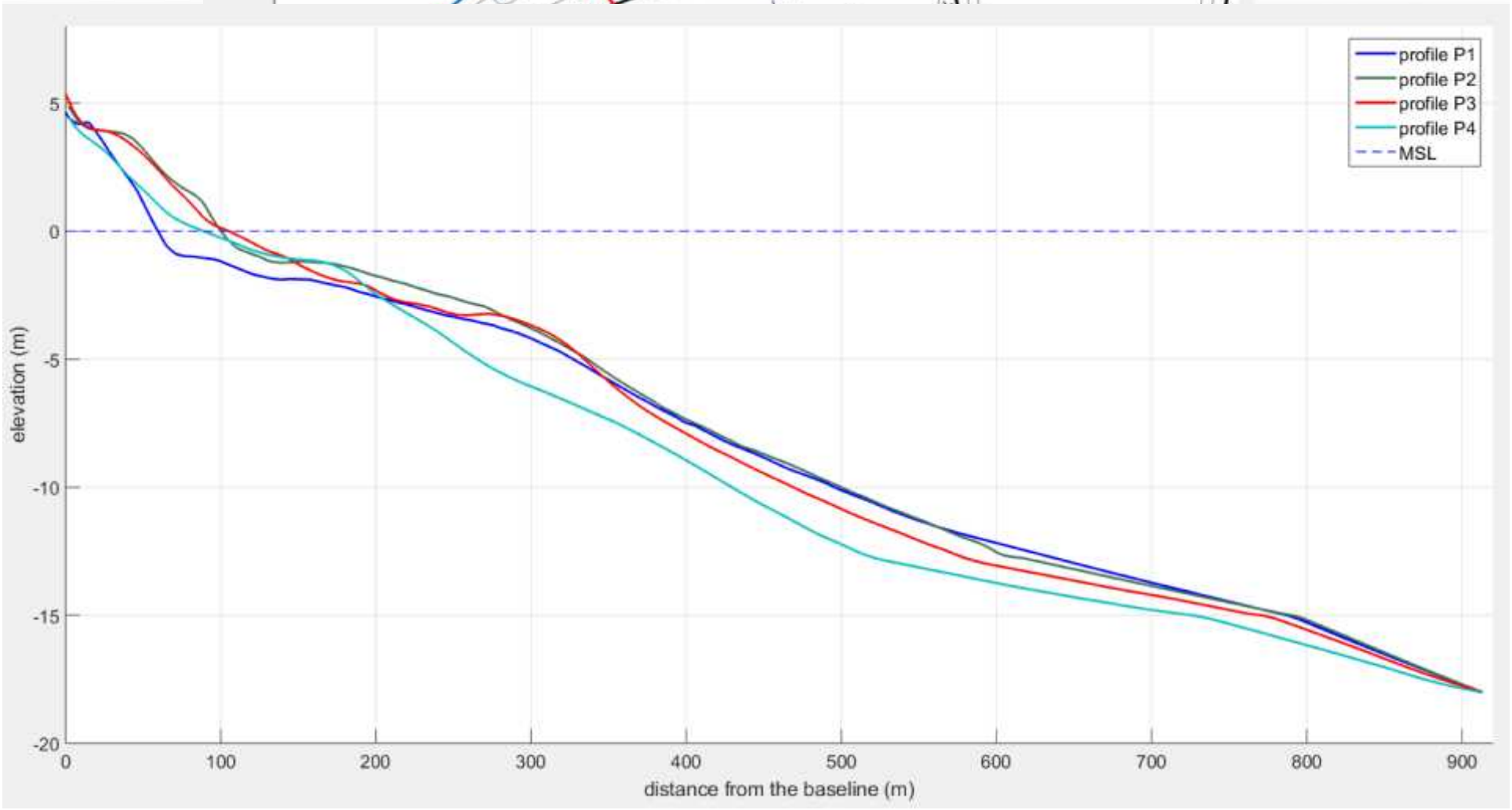
III.3.Model results: Beach erosion through times



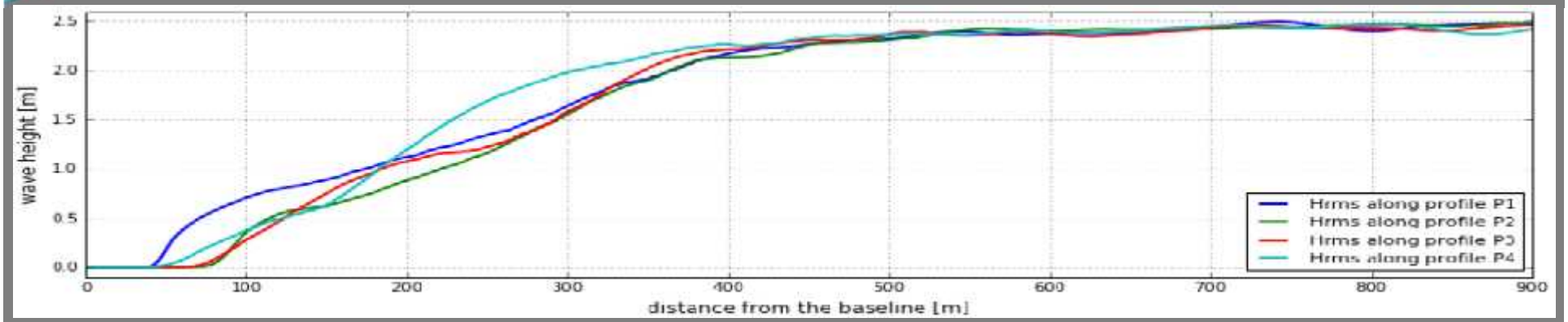
IV. COMPARISION OF MODEL RESULTS BETWEEN PROFILES

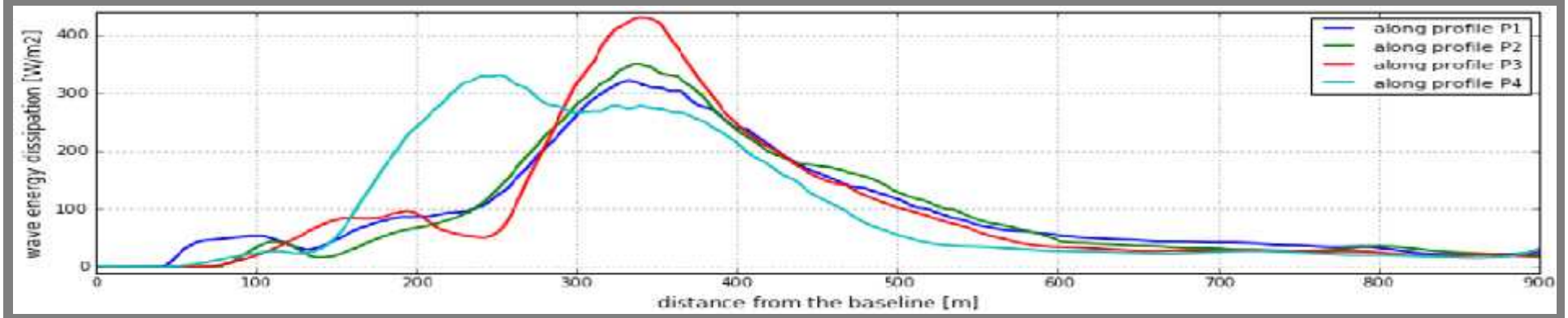
- Differences of initial profiles:

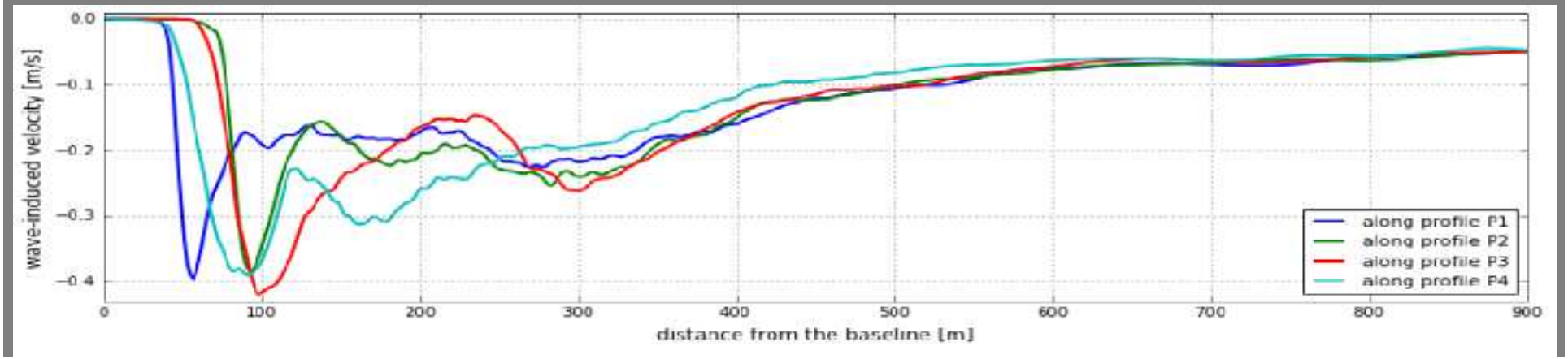




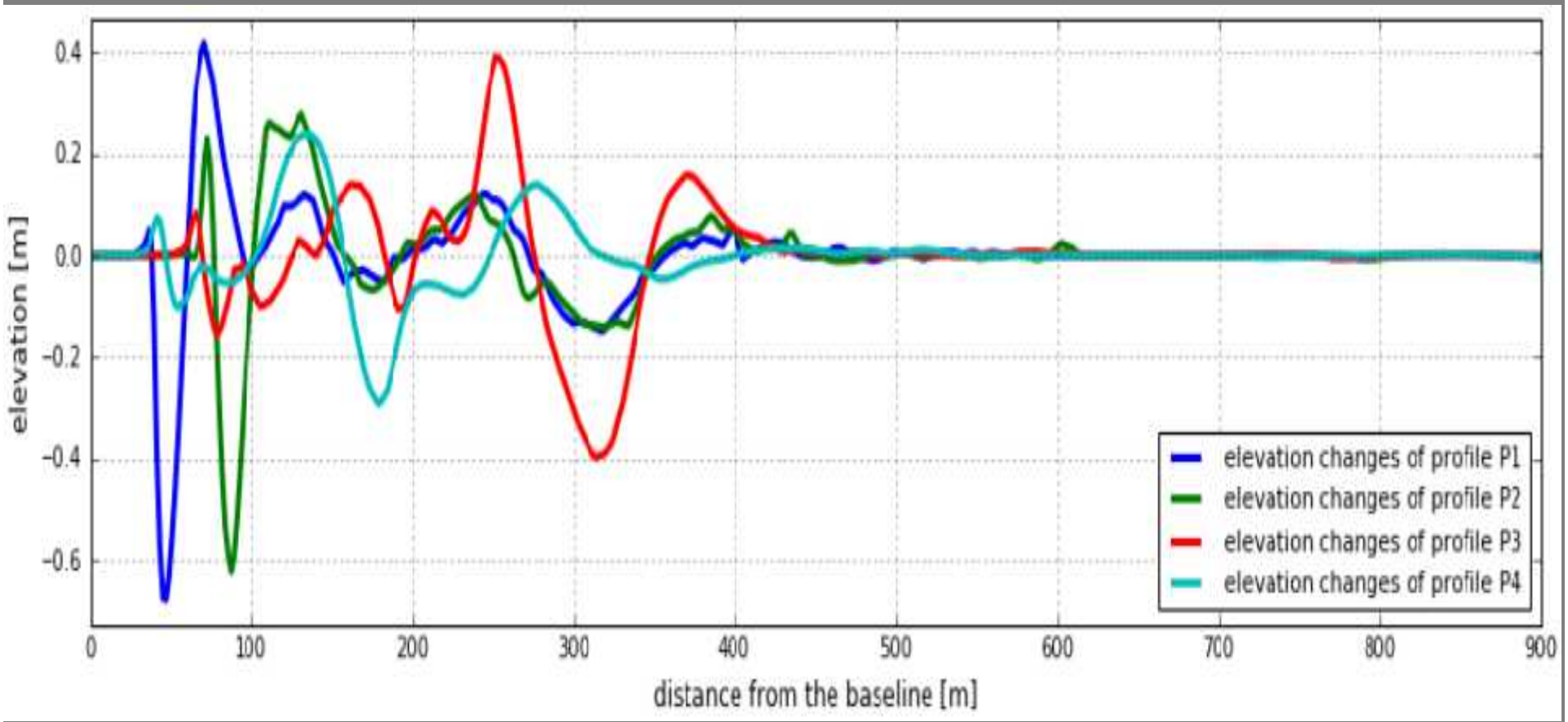
IV.1. Hydrodynamic differences



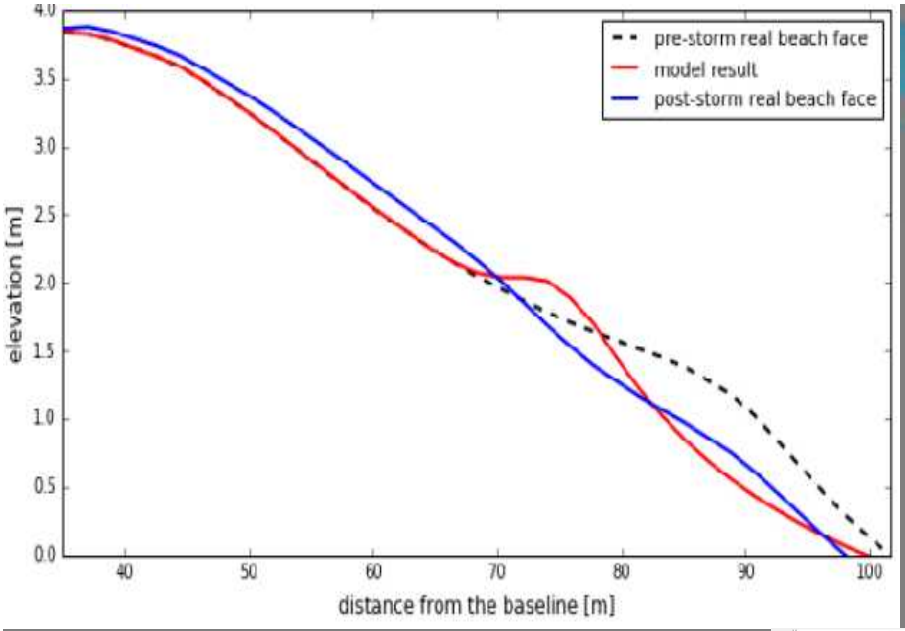




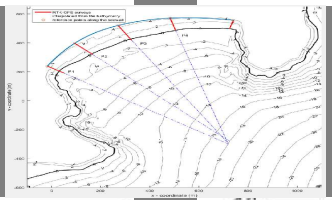
IV.2. Bed elevation changes

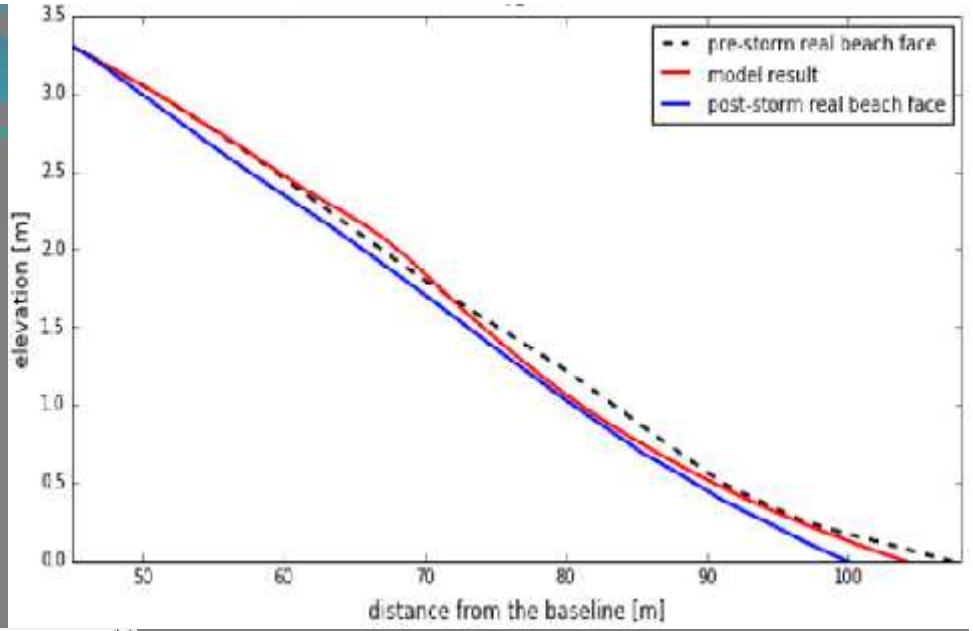


V. MODEL RESULTS vs. SURVEY DATA



P2

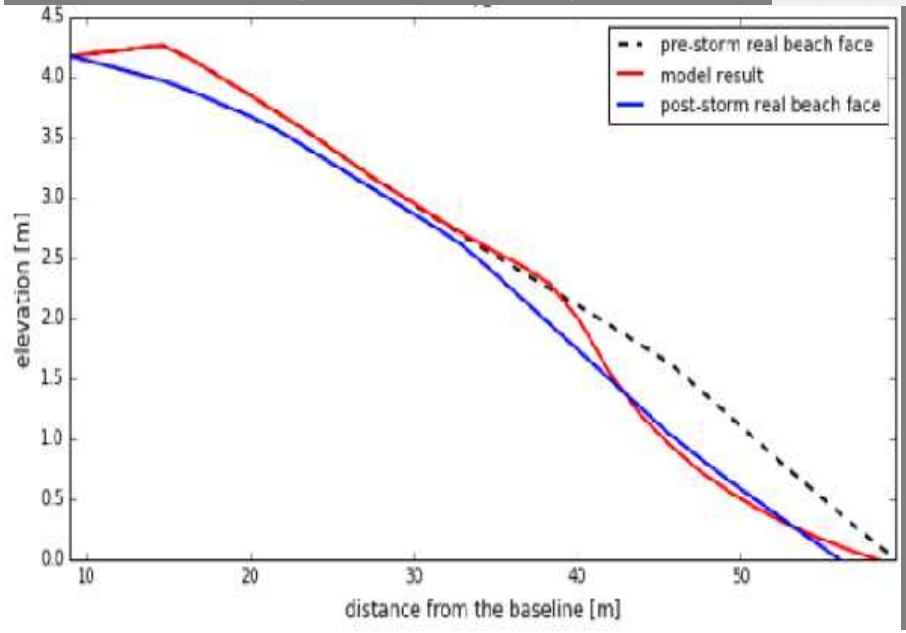


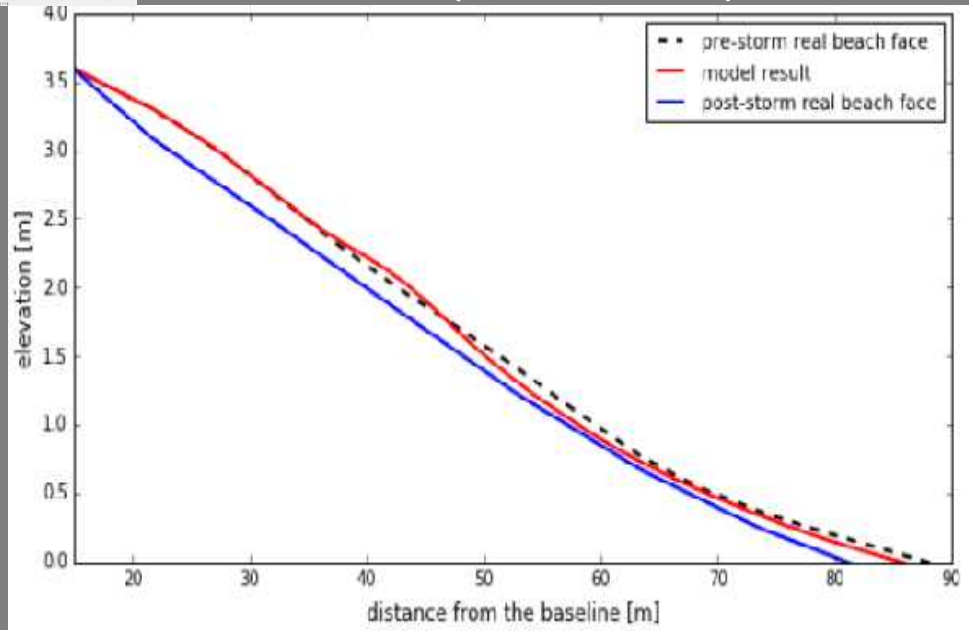


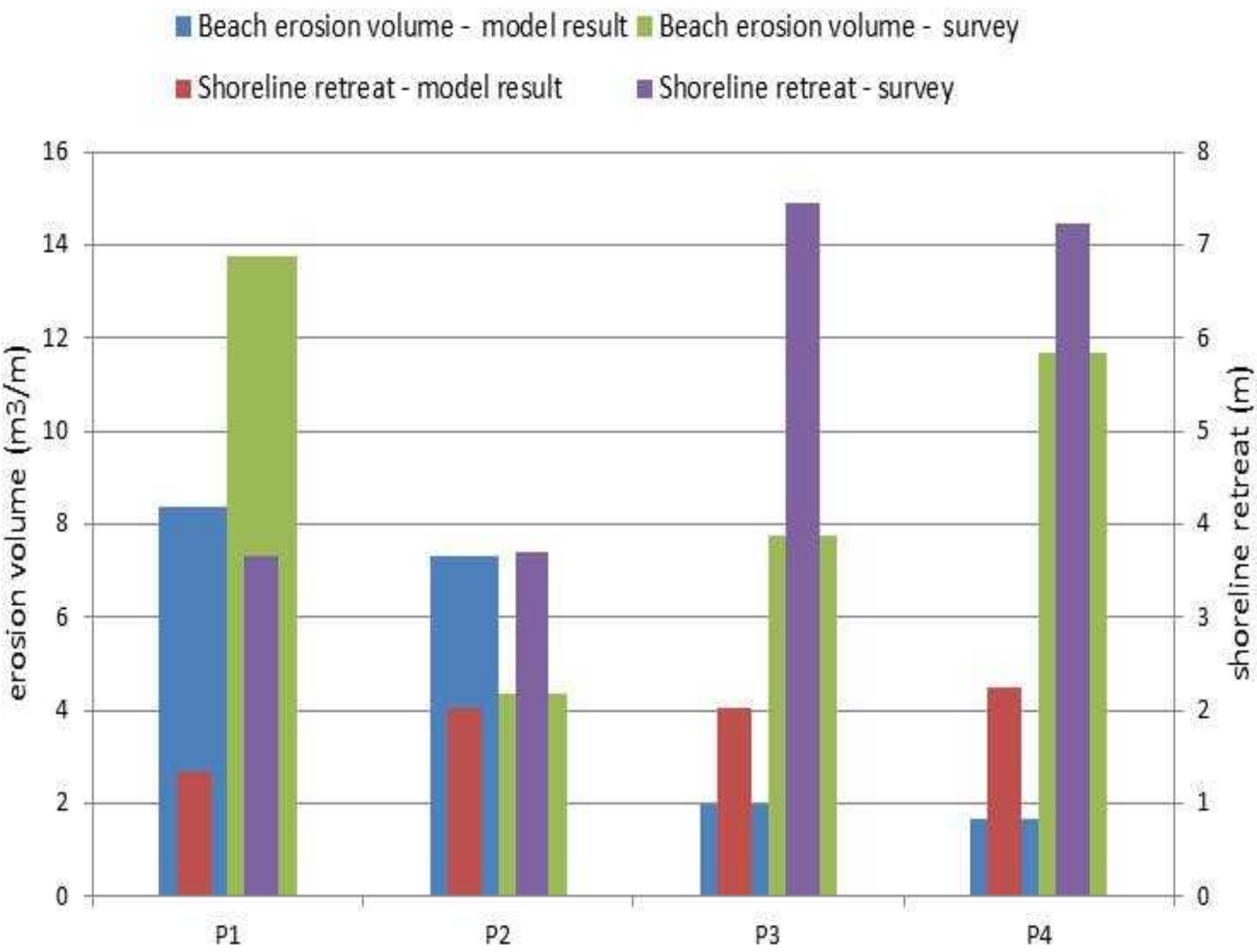
P3

P1(southern end)

P4(northern end)






Beach erosion volume - model result
Beach erosion volume - survey
Shoreline retreat - model result
Shoreline retreat - survey
erosion volume (m3/m)
shoreline retreat (m)
0
2
4
6
8
10
12
14
16
0
1
2
3
4
5
6
7
8
P1
P2
P3
P4

IV.5.Contribution factors to the errors

- The locations of off-shore boundary in model vs. reality;
- Normal incident waves vs. oblique incident waves;
- Averaging wave data into stages;
- Averaging sediment samples for the whole profiles;
- The pre and post storm surveys were taken several days before and after the storm.

Besides, Rip-currents and alongshore sediment transport may play a significant role in the errors. The 2D-model is necessary.

Future works

- 2D-model for the past storm event

- 2D-model for various scenarios of sea level rise in 2050 and 2090

Thank you!


LIFEGUA

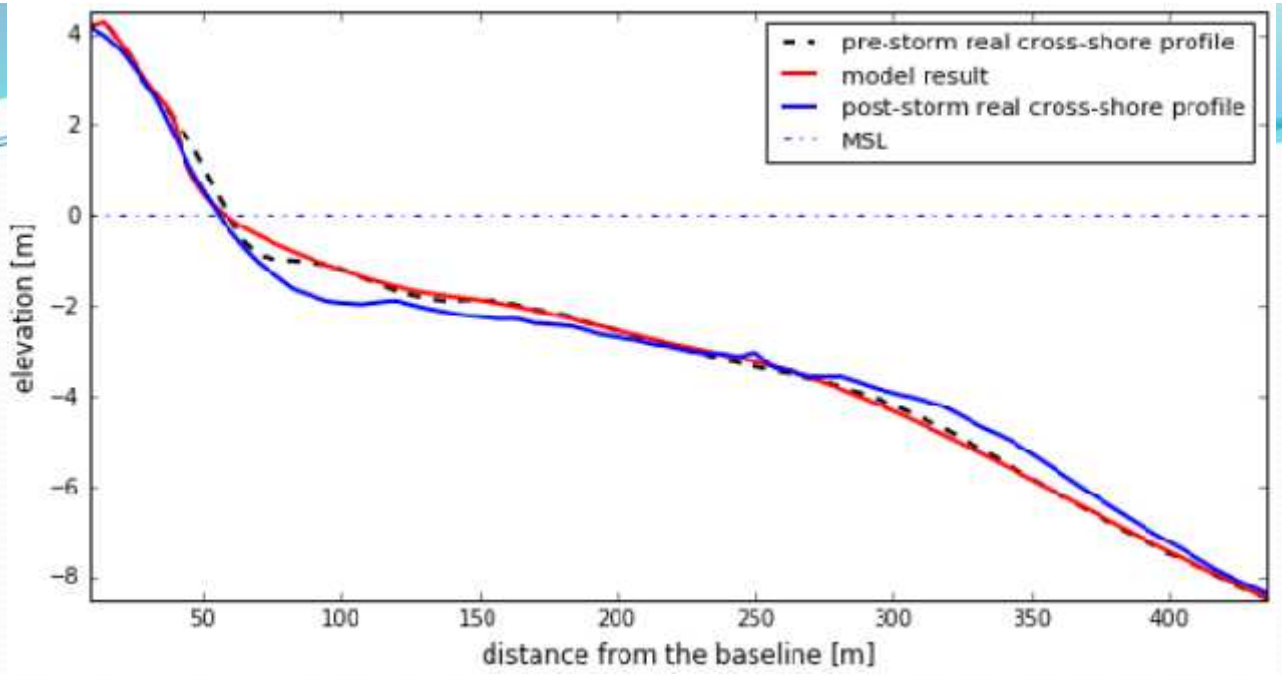
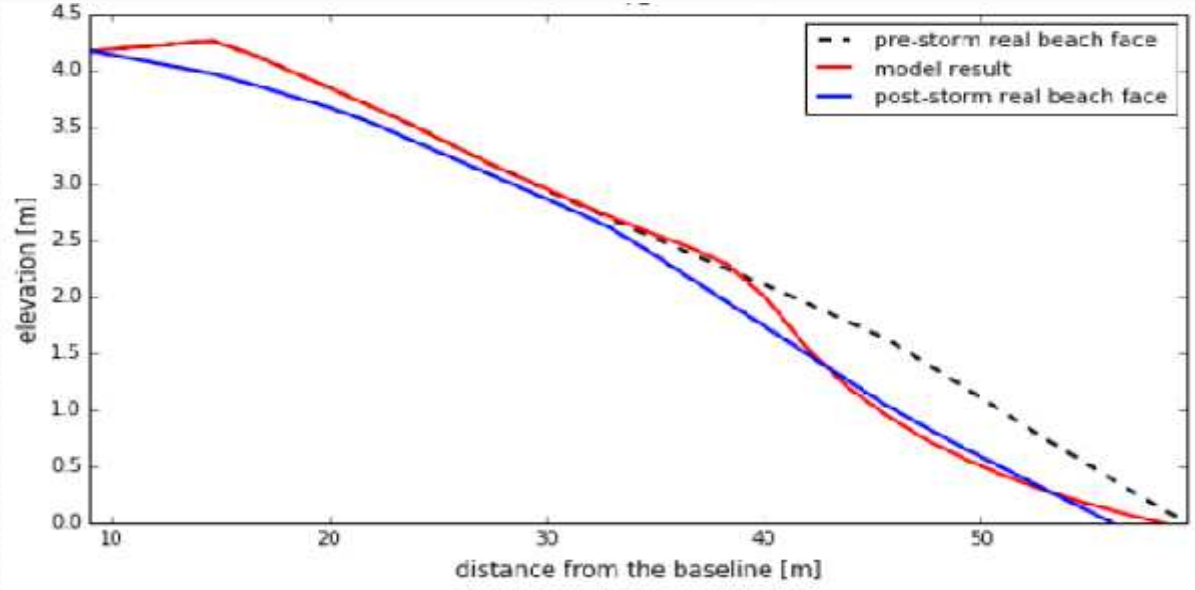


Figure: The difference about cross-shore profile changes between model result and surveyed data of P1.



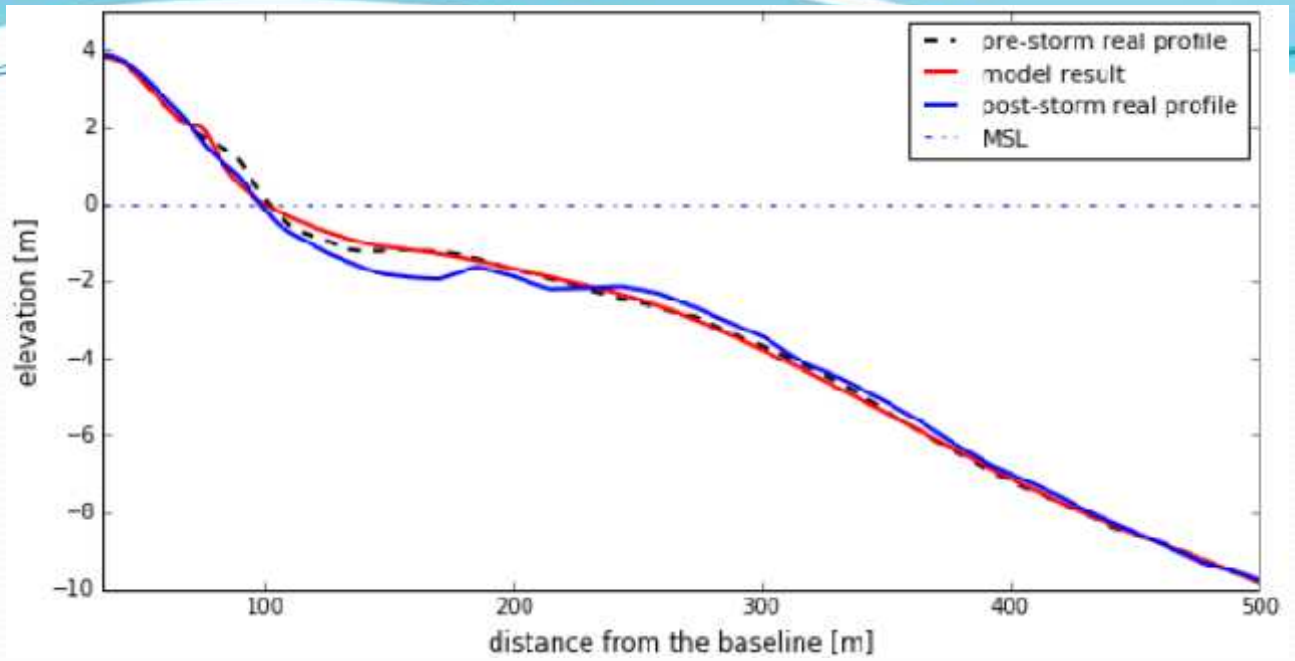
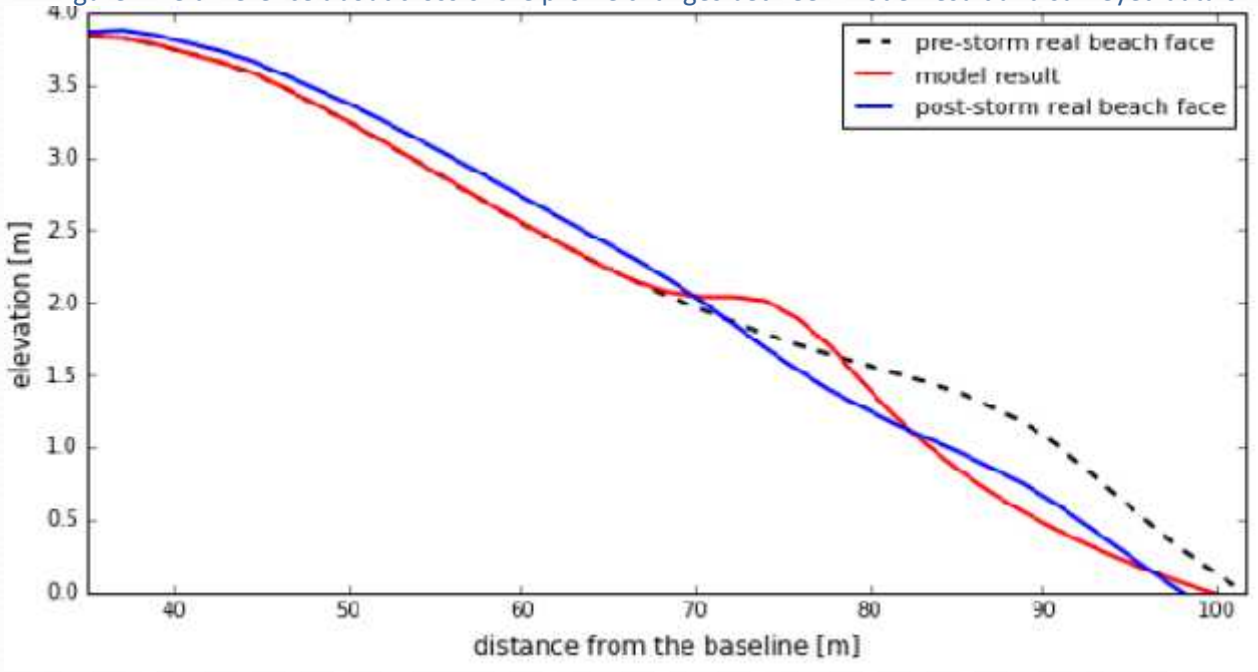


Figure: The difference about cross-shore profile changes between model result and surveyed data of P2.



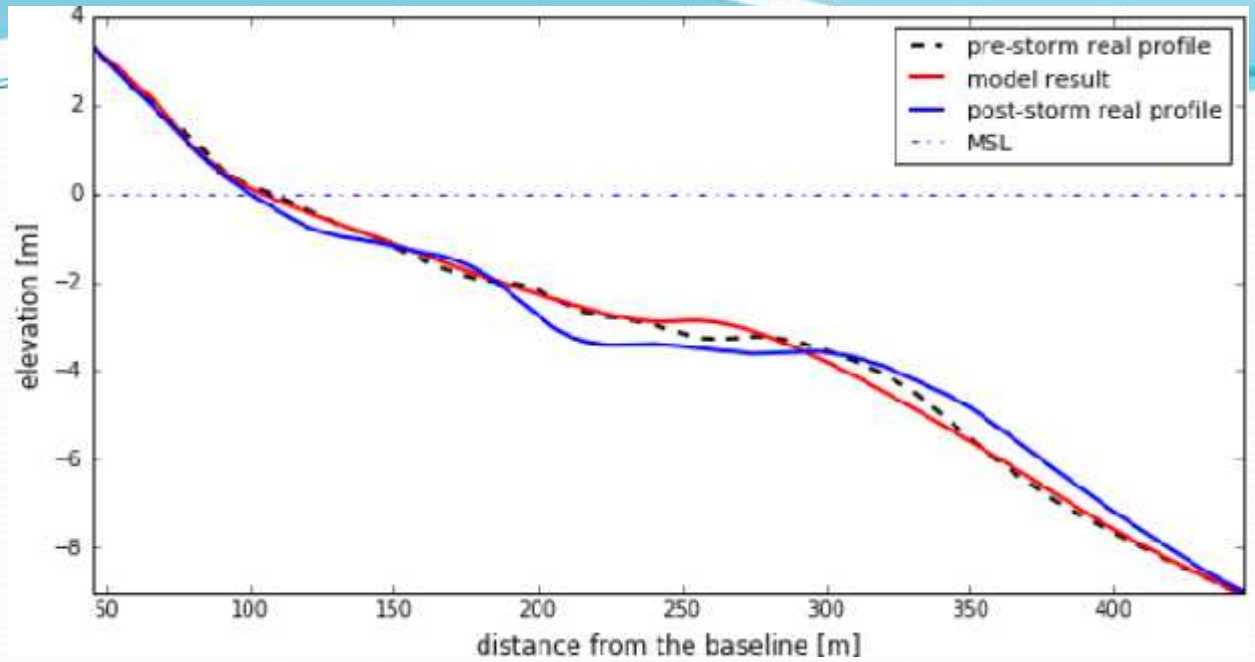
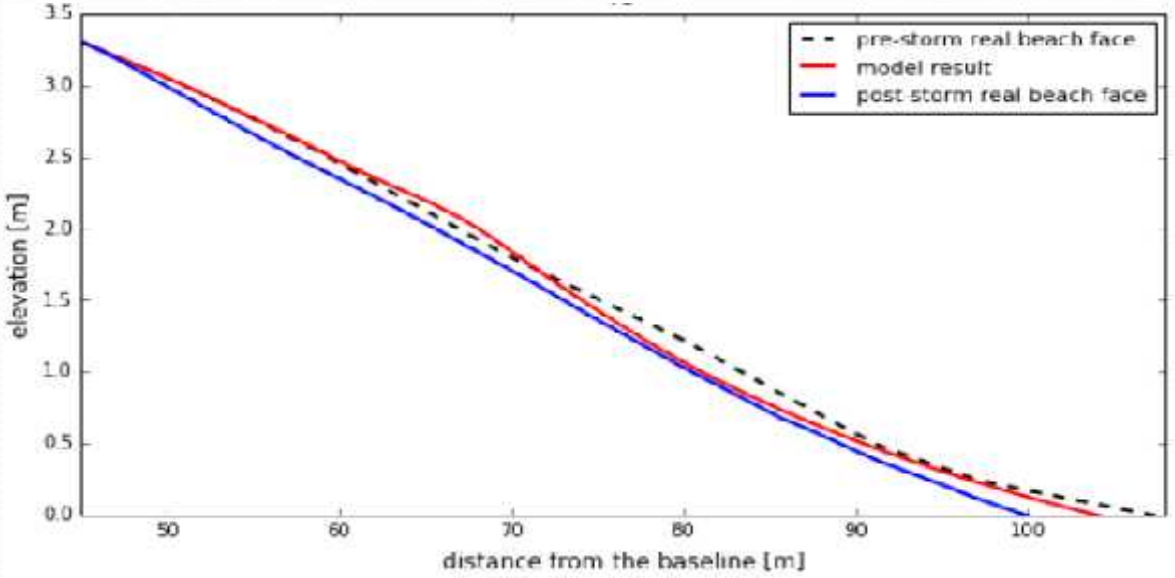


Figure: The difference about cross-shore profile changes between model result and surveyed data of P3.



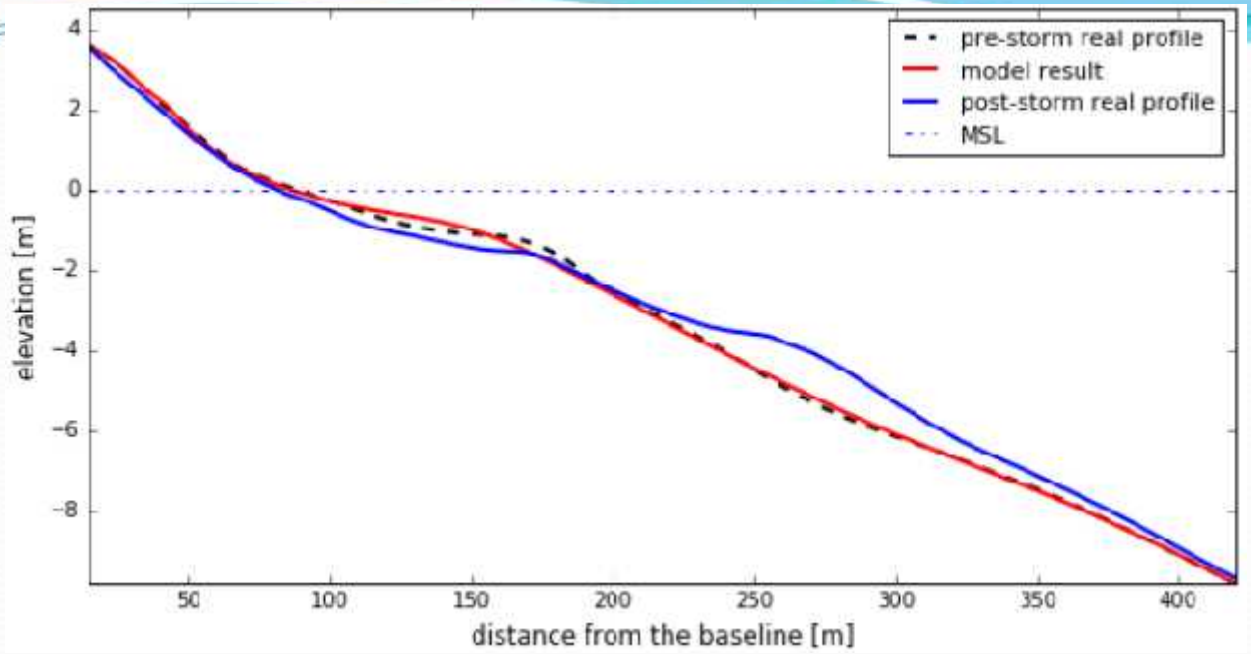


Figure: The difference about cross-shore profile changes between model result and surveyed data of P4.