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MORPHODYNAMICS OF THE BAKALSKAYA SPIT OF THE BLACK SEA

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The Karkinitsky Bay of the Black Sea and The Bakalskaya Spit

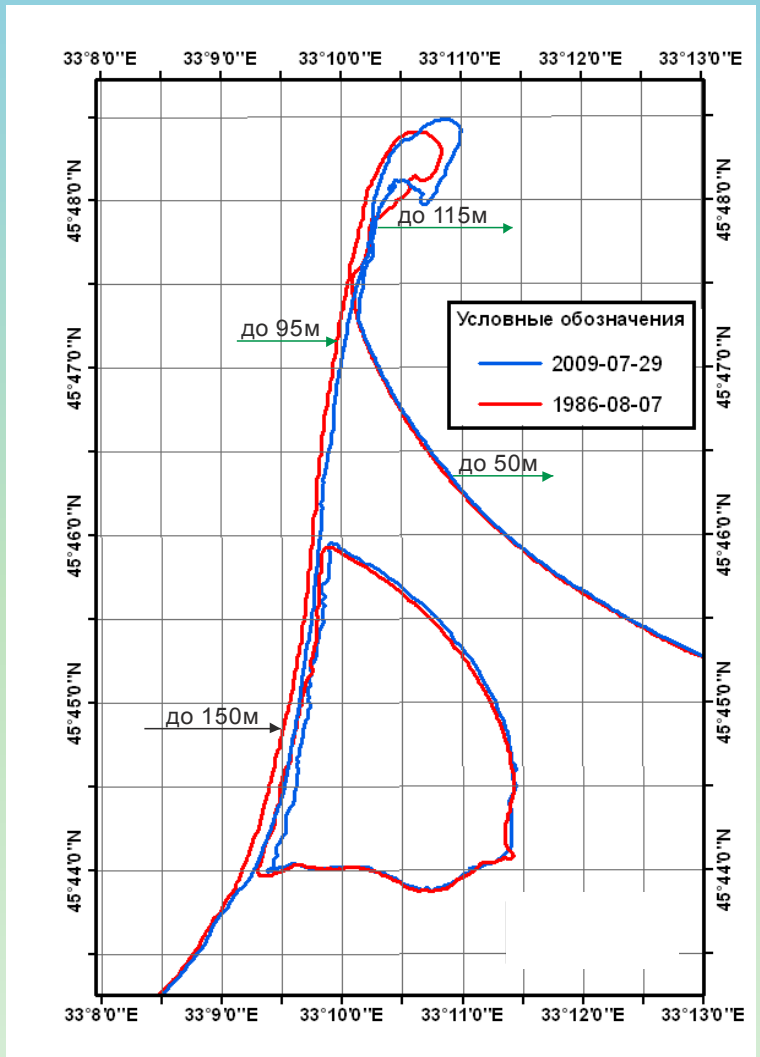
The Karkinitsky Bay of the Black Sea due to its morphological features (10 – 35 m depths, sandy and muddy bottom structure with the addition of shell limestone, the presence of islands and spits) is an area of intense morphodynamic processes.

The Bakalskaya Spit which juts out into the Karkinitsky Bay at 8 km distance is characterized by special dynamic activity.

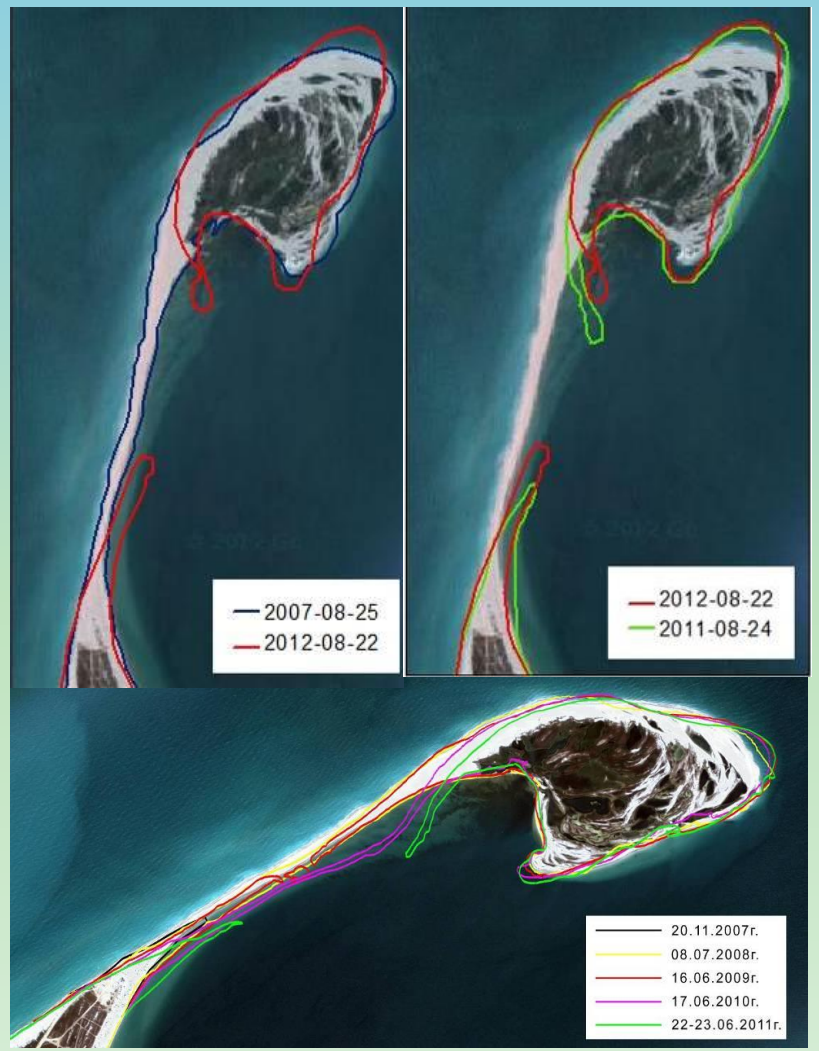
The width of the spit western branch is 30 – 80 m, of the eastern branch – 1200 – 2000 m. A narrow underwater sandbank extends at up to 40 km distance to the North.

The depths above its peak reach 3.5 – 4 m.

Investigation of the dynamics of the Bakalskaya Spit coastal zone



Shoreline position of the Bakalskaya Spit from the Landsat satellite data



Configuration changes of the distal part according Satellite Landsat (top), GPS-shooting (below)

(Yu.N. Goriachkin, L.V. Kharitonova, and V.V. Dolotov, 2009)

The Karkinitsky Bay of the Black Sea and The Bakalskaya Spit

The main morphodynamic processes in the area of the Bakalskaya Spit are
- the erosion of the spit western coast;
- the extension of its distal part into the Karkinitsy Bay water area in the north-east direction;

-reduction of the spit width in the area of the isthmus, which connects the main part of the spit with its distal part;
- separation of distal part from the main part of the spit.

After the storms which took place in autumn, 2010 the isthmus was eroded and has not recovered yet, and the distal part of the spit became an island.

THE FIELDS OF INTEREST

The dynamics of sediments in the Bakalskaya Spit region depends on wind waves and sea level oscillations, which should be reasonably taken into account during the numerical simulation.

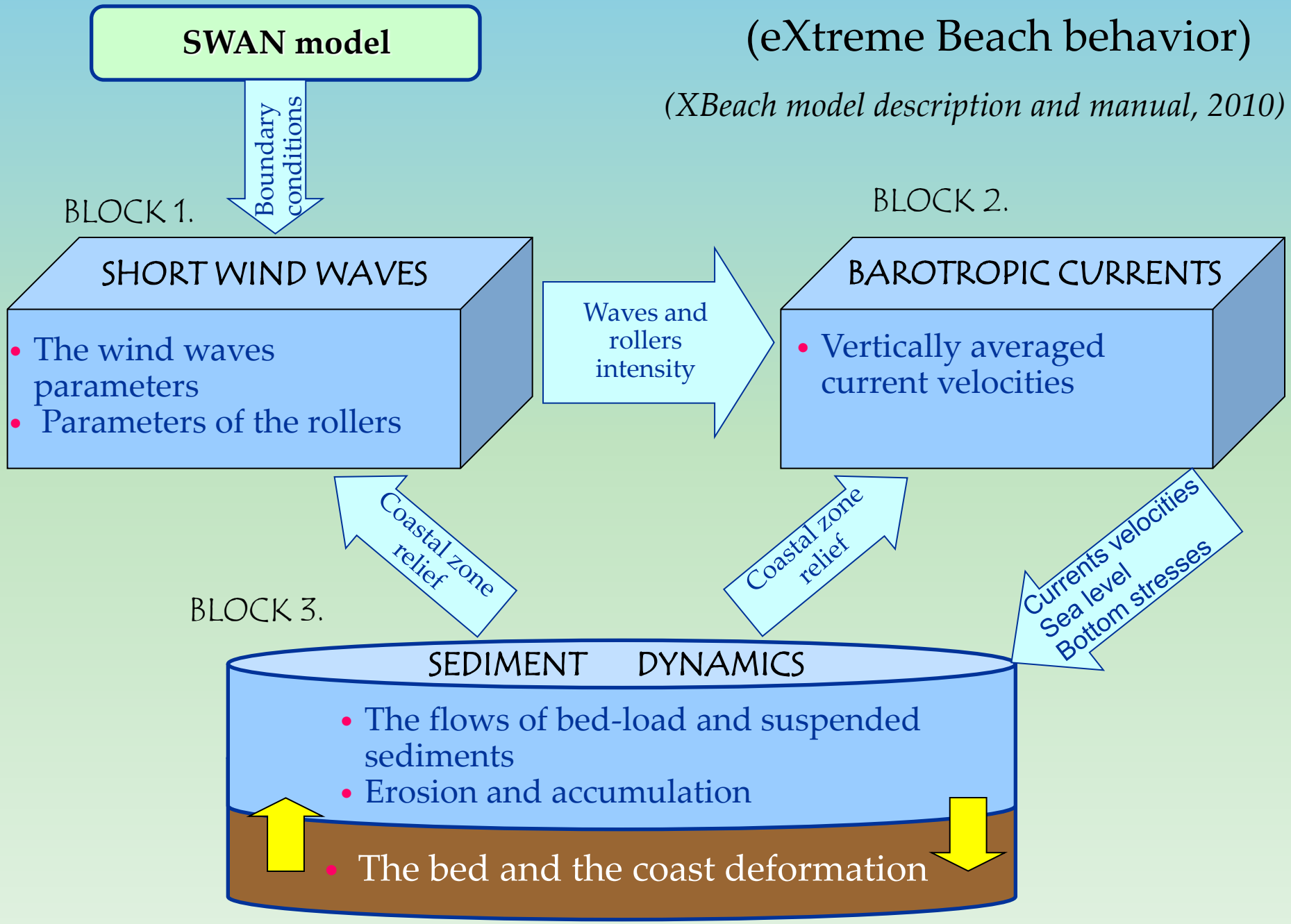
The setting of these parameters based on the field data or numerical calculations always contain some uncertainty.

So the estimation of the dependences of morphodynamic process simulation occuring in the Bakalskaya Spit region on the variations of wind wave parameters and the sea level is of interest.

In this work such estimations are carried out on the basis of XBeach (eXtreme Beach behavior) numerical hydrodynamic model.

Structure of the XBeach numerical hydrodynamic model (eXtreme Beach behavior)

(XBeach model description and manual, 2010)

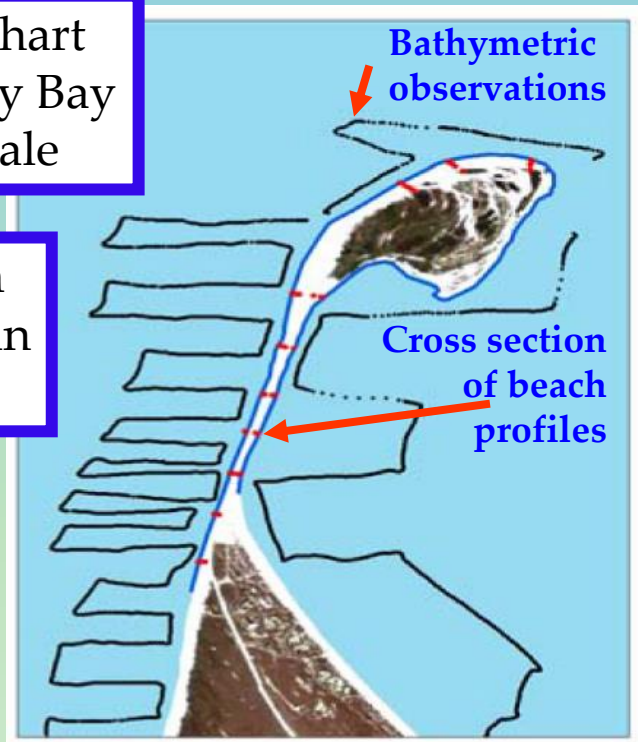


INPUT PARAMETERS: **Digital model of the studied region relief**

Navigation chart the Karkinitsky Bay 1:200 000 scale

The expedition data obtained in July, 2007

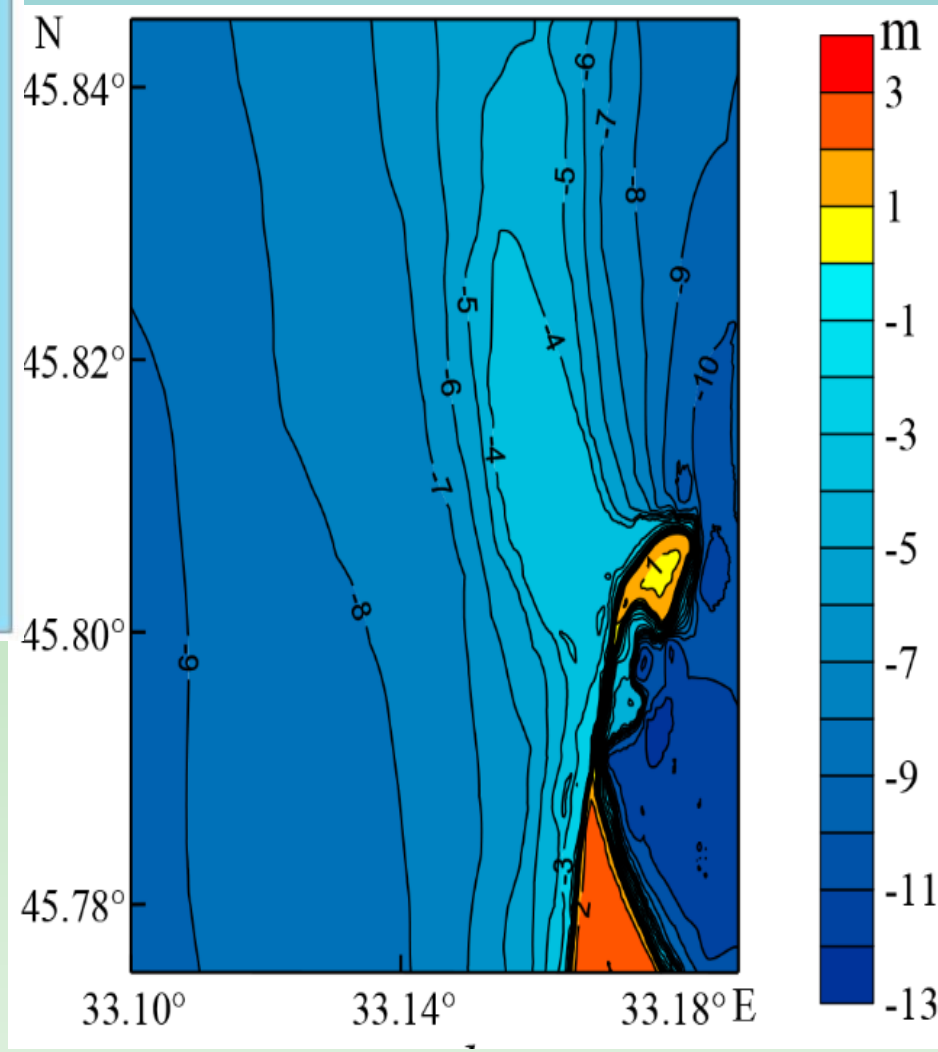
The height of isthmus - up to 0.9 m



Rectangular staggered grid

Dimensions 2.2×2.9 km

Grid steps x=17 m, y=19 m



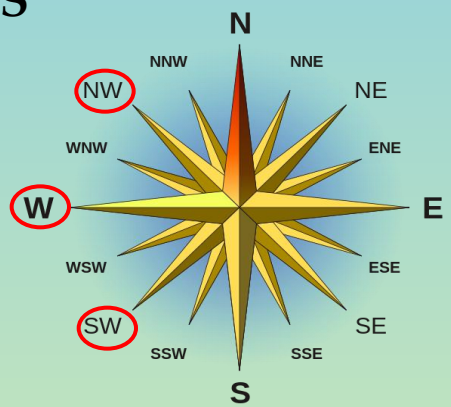
BOUNDARY PARAMETERS

- **in cell centers** - depth, level, sediment concentration, wave and roller energy
- **the middle of lateral boundaries** – current velocity components, sediment flows

INPUT PARAMETERS

WIND WAVE PARAMETERS

The storm wave running from



Data of Spectral wave model *SWAN* (*Simulating Waves Near Shore*) :

- the significant wave height = 4 m,
- the wave peak period = 6 s,
- the spectral peakedness = 3.3,
- the index of angular wave dissipation = 10

SEDIMENT PARAMETERS

The spit and the seabed consist of medium sand.

Particle size – $D_{50} = 5*10^{-4}$
Density – 2650 kg/m^3

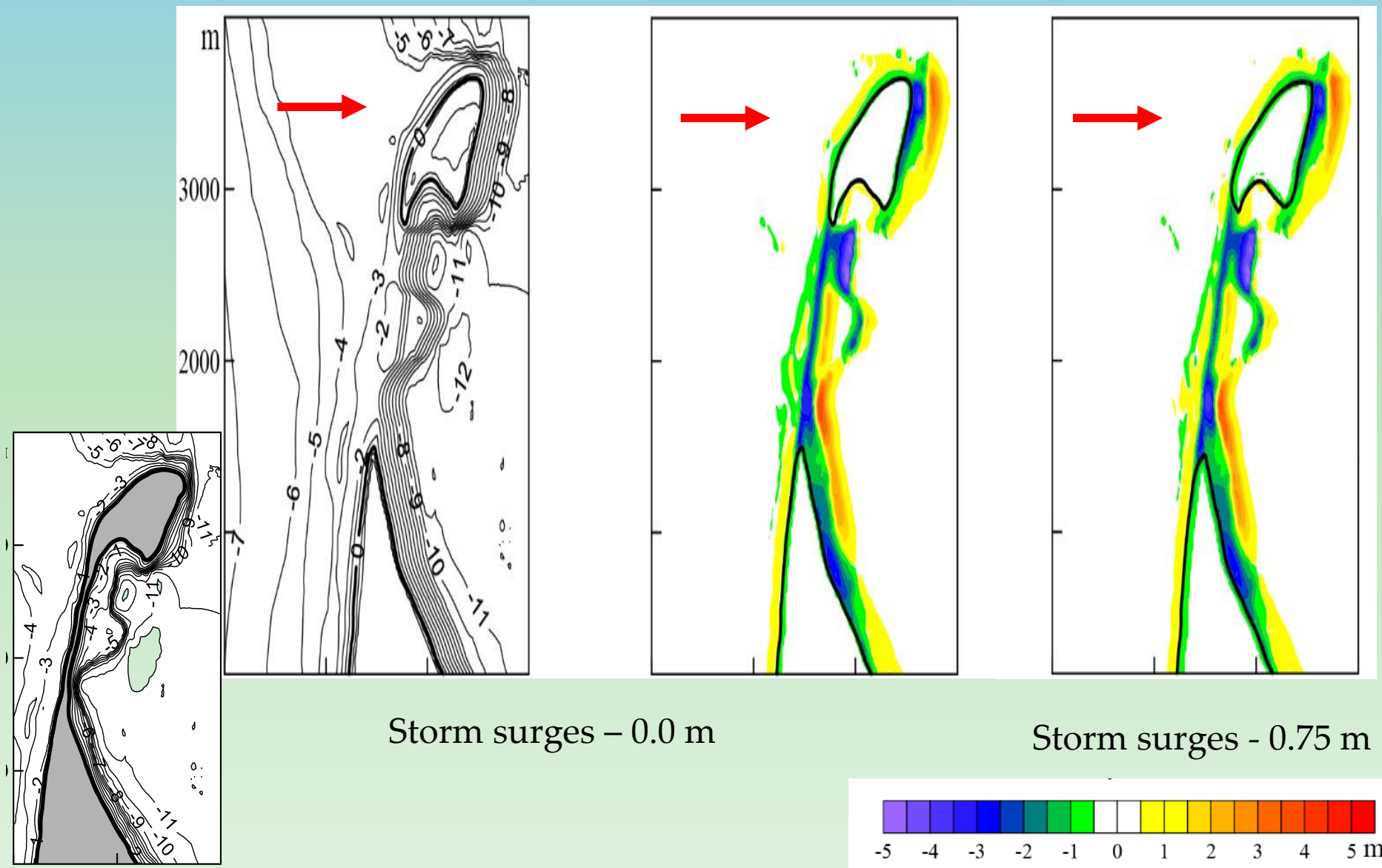
STORM SURGE PARAMETERS

5 constant in time values of surges:
0.00 ; 0.25; 0.50; 0.75; 1.00 m

(V.V. Fomin, D.V. Alekseev, L.V. Kharitonova, 2013)

After 24 hours of 4 m height wave running from the west

Land and seabed relief (m) **Relief changes** **Relief changes**

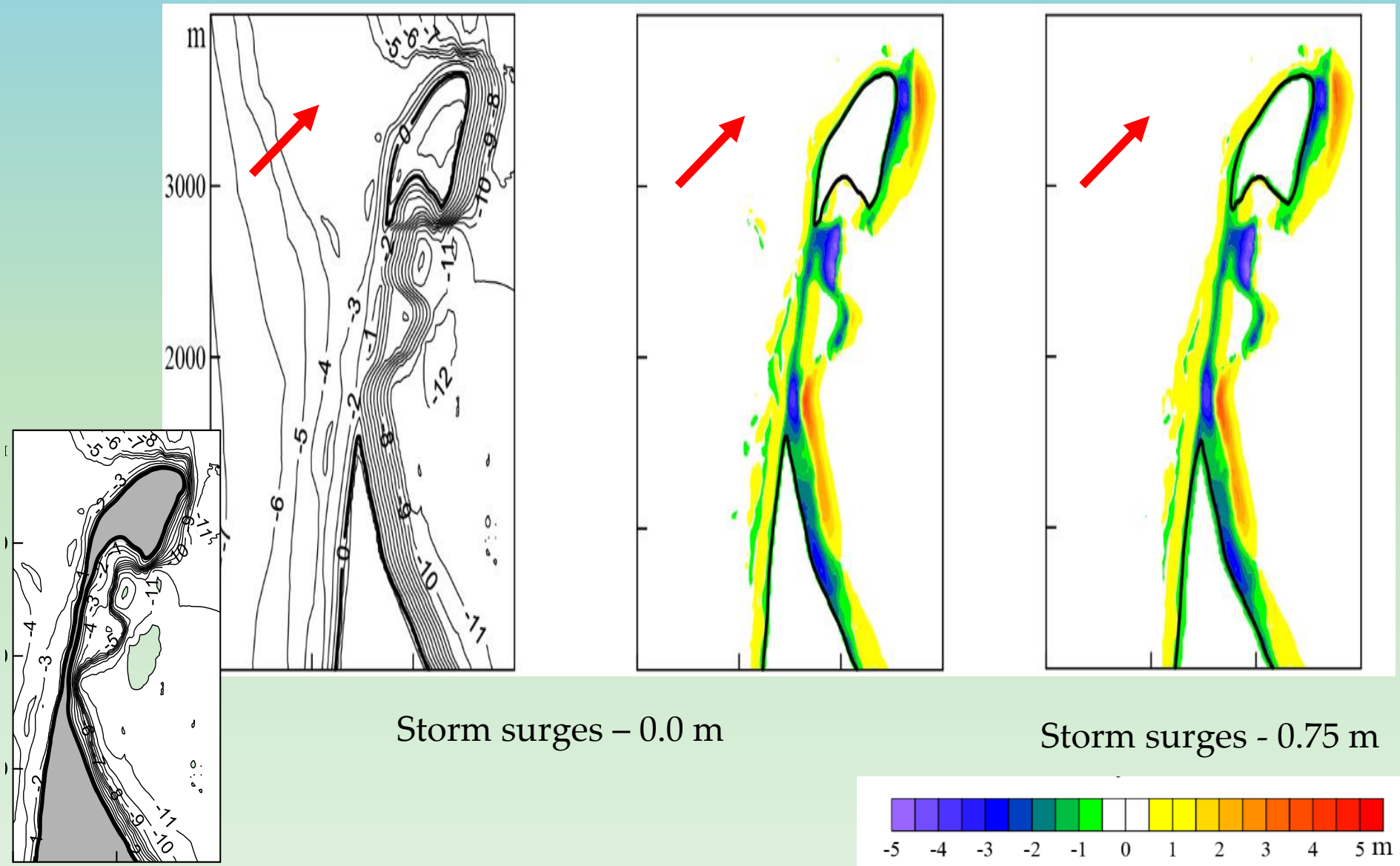


Storm surges – 0.0 m

Storm surges - 0.75 m

After 24 hours of 4 m height wave running from the south- west

Land and seabed relief (m) **Relief changes** **Relief changes**

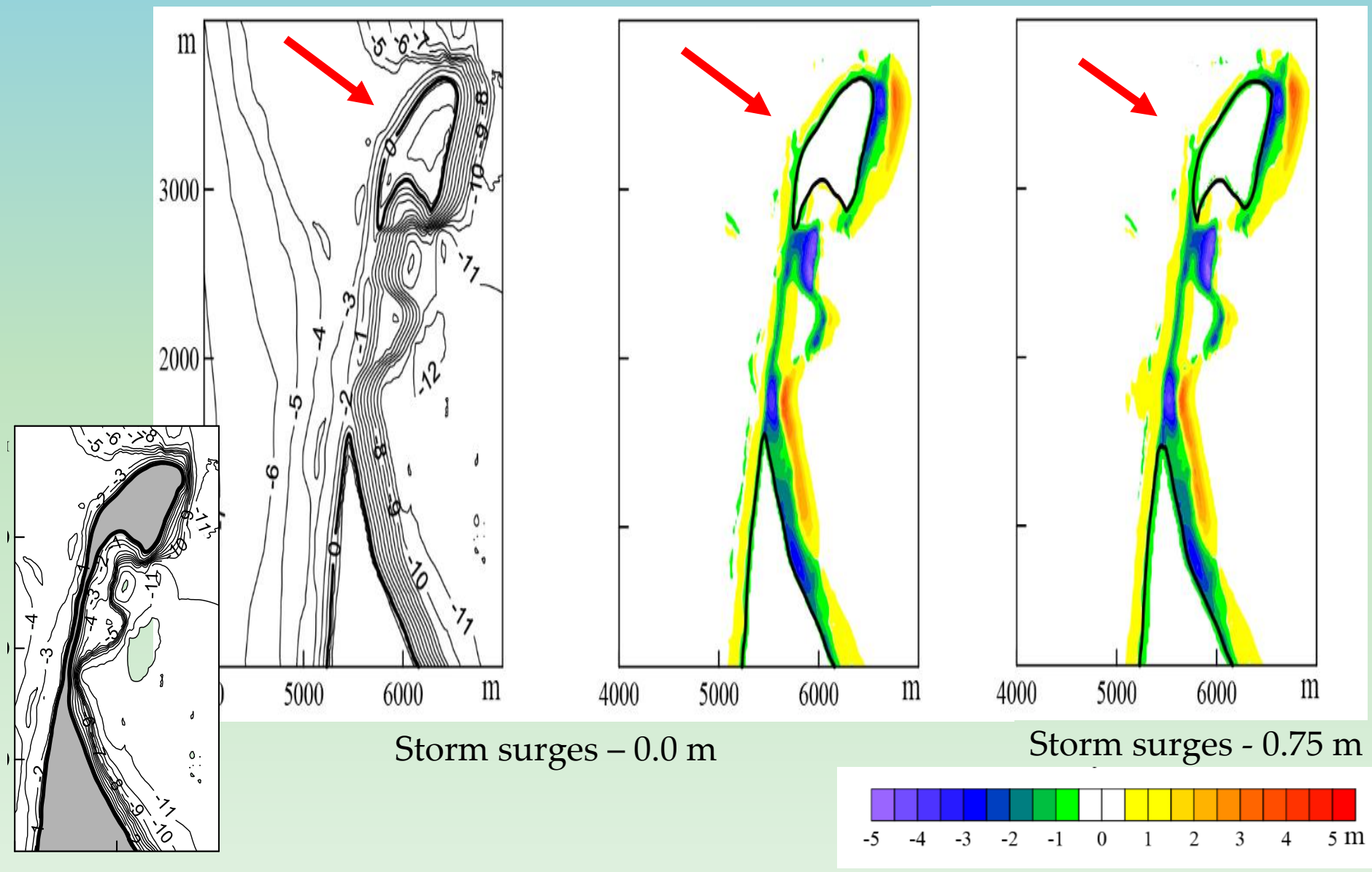


Storm surges – 0.0 m

Storm surges - 0.75 m

After 24 hours of 4 m height wave running from the north-west

Land and seabed relief (m) **Relief changes** **Relief changes**



Storm surges – 0.0 m

Storm surges - 0.75 m

CONCLUSIONS

✓ In all considered cases the *XBeach* model reproduces basic characteristics of the Bakalskaya Spit dynamics, obtained from the observational data analysis :
- spit head displacement in the north-west direction due to erosion of its western part and sediment accumulation near its north-eastern part;
- spit erosion in the area of the isthmus, which connects the main part of the spit with its distal part up to its separation.

CONCLUSIONS

The most intensive erosion of the isthmus between the Bakalskaya Spit head and main part in the absence of surges occurs at wave running from the west.

The wave running from the south-west and north-west causes erosion processes of almost equal intensity.

Seabed erosion occurs along the entire coastline of the spit with different intensity. Sediment accumulation takes place seawards of erosion areas, but not continuously along the entire coast. The areas of most significant sediment accumulation are located to the east from spit head and to the south-east from the scour.

CONCLUSIONS

✓Storm surge effect on the morphodynamic process characteristics depends on the direction of wave running.

In case of wave running from the south-west and north-west, seabed erosion intensity in the isthmus area increase with the surge height rising.

At wave running from the north-west the isthmus erosion is somewhat more intensive than at wave running from the south-west.

In case of wave running from the west, the increase of surge height results in the decrease of isthmus erosion depth.

The presence of surges has no effect on the location of erosion areas. Sediment accumulation areas at that extend seawards.