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# Modelling Belgian Coast: ScaldisCoast

Sub report 2 – Updates ScaldisCoast 2025

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# Modelling Belgian Coast: ScaldisCoast

## Sub report 2 – Updates ScaldisCoast 2025

Wang, L.; Kolokythas, G.; Breugem, W.A.; De Maerschalck, B.

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This publication should be cited as follows:

**Wang, L.; Kolokythas, G.; Breugem, W.A.; De Maerschalck, B.** (2026). Modelling Belgian Coast: ScaldisCoast: Sub report 2 – Updates ScaldisCoast 2025. Version 4.0. FH Reports, 21\_104\_2. Flanders Hydraulics: Antwerp

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## Document identification

|                    |                                                                                                                                                                                                                                 |                  |                 |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|-----------------|
| Customer:          | Flanders Hydraulics                                                                                                                                                                                                             | Ref.:            | WL2026R21_104_2 |
| Keywords (3-5):    | Coastal modelling, sediment transport                                                                                                                                                                                           |                  |                 |
| Knowledge domains: | Hydraulics and sediment > Hydrodynamics > Waves > Numerical modelling<br>Hydraulics and sediment > Hydrodynamics > Tides > Numerical modelling<br>Hydraulics and sediment > Sediment > Sediment transport > Numerical modelling |                  |                 |
| Text (p.):         | 35                                                                                                                                                                                                                              | Appendices (p.): | 7               |
| Confidential:      | <input checked="" type="checkbox"/> No <input checked="" type="checkbox"/> Available online                                                                                                                                     |                  |                 |

|            |                                                             |
|------------|-------------------------------------------------------------|
| Author(s): | Wang, L.; Kolokythas, G.; Breugem, W.A.; De Maerschalck, B. |
|------------|-------------------------------------------------------------|

## Control

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|-----------------|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Reviser(s):     | Breugem, A.        | Getekend door:Breugem Willem Alexand<br>Getekend op:2026-04-01 16:08:11 +02:0<br>Reden:I approve this document<br><br><i>Breugem Alexander</i>                                                                                        |
| Project leader: | De Maerschalck, B. | Getekend door:De Maerschalck Bart<br>Getekend op:2026-04-01 16:09:42 +02:0<br>Reden:Ik keur dit document goed<br><br><i>De Maerschalck Bart</i>  |

## Approval

|                   |               |                                                                                                                                                                                                                                         |
|-------------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Head of Division: | Bellafkih, K. | Getekend door:Bellafkih Abdelkarim<br>Getekend op:2026-04-01 19:10:28 +02:0<br>Reden:Ik keur dit document goed<br><br><i>Bellafkih Abdelkarim</i>  |
|-------------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

# Abstract

This report documents the latest release of the ScaldisCoast numerical model, developed to simulate both long- and short-term morphological evolution along the Belgian coast under varying hydrodynamic and meteorological conditions. Key developments include the transition from the SISYPHE to the GAIA sediment transport module and the upgrade of the TELEMAC modelling system to version v8p4. In addition to ensuring consistency across modules and versions, particular attention was given to the adoption of the Flather formulation as the default wind drag formulation in the new version of TELEMAC system, which significantly improved hydrodynamic accuracy during the Ciara Storm event. The wave model TOMAWAC was also updated with an optimized numerical scheme, resulting in a 35% reduction in computation time and improved numerical stability.

Comprehensive validation of the morphological model was carried out using historical data and recent measurements from representative locations, including Zeebrugge, Wenduine, and Blankenberge. The model demonstrated satisfactory agreement with both long-term morphological trends and short-term storm-induced sediment dynamics.

These results confirm the ScaldisCoast model as a robust and efficient tool for operational and strategic applications, supporting coastal defense planning, sediment management, and climate adaptation along the Belgian coast.



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# 1 Introduction

## 1.1 Background

The Belgian coastal zone is a dynamic and complex system shaped by the interactions of tides, waves, wind, and sediment transport. With ongoing sea level rise and the increasing frequency of extreme weather events, the threat to coastal safety continues to grow. In order to strengthen the coastal defense and investigate different future scenarios in an efficient, flexible and integrated way, a reliable estimate of the sediment transport in the coastal zone remains of considerable practical importance. Flanders Hydraulics Research has been at the forefront of developing and refining coastal models to support these objectives. The ScaldisCoast model is a key component of this initiative, designed to simulate the long-term morphological evolution of the Belgian Coast.

Recent advancements in the TELEMAC modelling system, particularly the transition from SISYPHE to GAIA modules and the upgrade to version v8p4, have enabled more robust and efficient simulations. These improvements are critical for capturing both long-term morphological trends and short-term storm-induced changes, which are important for coastal resilience planning.

## 1.2 Objectives

This report presents the release notes for the ScaldisCoast 2025 model, detailing the technical updates, validation efforts, and performance evaluations associated with the latest version. The primary objectives are to:

- document the transition to TELEMAC v8p4 and the GAIA sediment transport module;
- evaluate the impact of updated wind shear formulations on hydrodynamic and sediment transport simulations;
- validate the model against historical and recent morphological changes, including storm events and long-term coastal evolution;
- provide a comprehensive overview of model settings and configurations.

## 1.3 Scope

The report focuses on the technical development and validation of the ScaldisCoast model. It includes comparisons across different TELEMAC versions, sensitivity analyses of wind effects, and validation against observed data from representative locations such as Zeebrugge, Wenduine, and Blankenberge. Both hydrodynamic and morphological aspects are addressed, with emphasis on model accuracy and computational efficiency.

## 1.4 Structure of the Report

The document is organized as follows:

Chapter 1 provides an introduction of the study.

Chapter 2 outlines the model updates, including version transitions and the implementation of new formulations.

Chapter 3 presents a detailed overview of the model settings used in the 2025 release.

Appendices include model configuration files (CAS-files) and an overview of model run ID's of the runs used for this report and uploaded to the WL model subversion repository.

## 2 Model updates

### 2.1 Update to TELEMAC v8p4

#### 2.1.1 SISYPHE run with v8p3

The ultimate objective of the project is to develop a reliable morphology model using the new module GAIA in the version v8p4 of TELEMAC. In order to ensure the smooth progression of the project, the module SISYPHE was first examined in the earlier v8p3 version of TELEMAC.

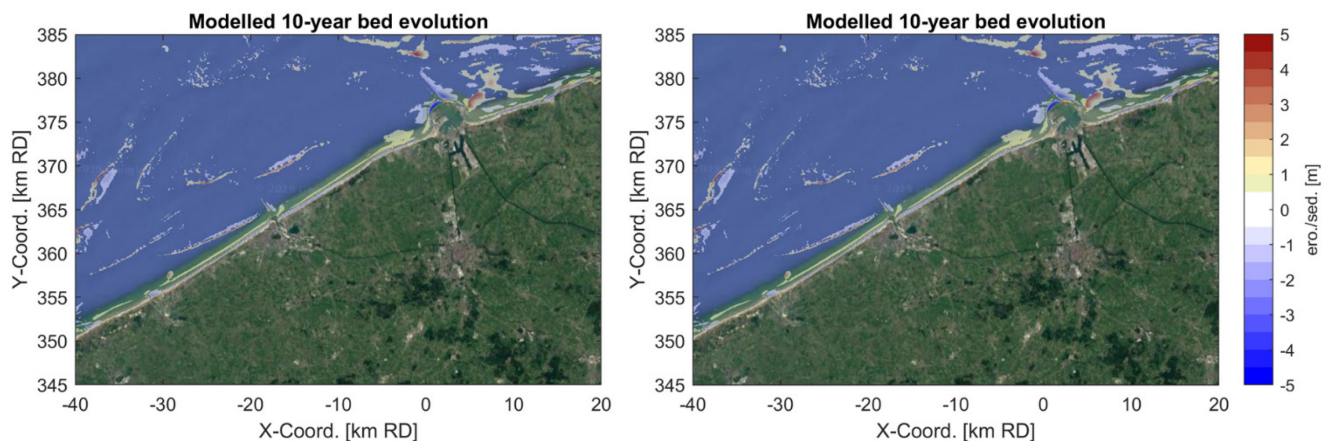


Figure 1: ten-year bed evolution along the Belgian Coast. Left: SISYPHE, v7p2 (HSW113\_slurm), right: SISYPHE, v8p3 (HSW113b\_BK\_layer\_GT\_update)

In the Belgian coastal zone, the morphological results from both versions of SISYPHE are almost identical, as displayed in Figure 1. Additionally, the two versions of the model demonstrate a high level of consistency in estimating longshore transport, as shown in Figure 2. A more detailed comparison is conducted in the vicinity of Wenduine (Figure 3). It reveals that the new version still produces nearly the same results as the old one. A calculation of net erosion is performed within the magenta box, which gives a value of 227,300 m<sup>3</sup> for the new version, only 0.18% larger than 226,900 m<sup>3</sup> obtained using the old version.

However, if the intercomparison is carried out in the full domain of the model, a substantial sedimentation can be found at the northeast boundary for the new version (indicated by a dash circle in Figure 4), but not for the old version. The reason for this difference is currently unclear yet, but this difference does not seem to impact the results in the area of our interest.

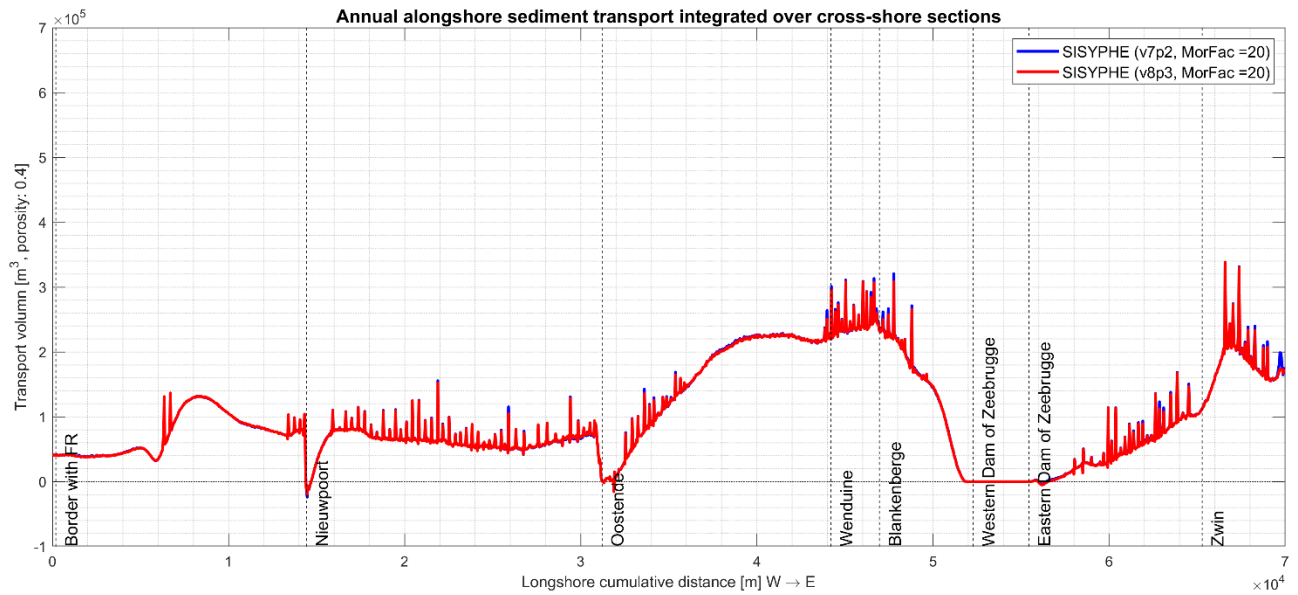


Figure 2: Comparison of modelled net longshore sediment transport between v7p2 (HSW113\_slurm) and v8p3 of SISYPHE (HSW113b\_BK\_layer\_GT\_update).

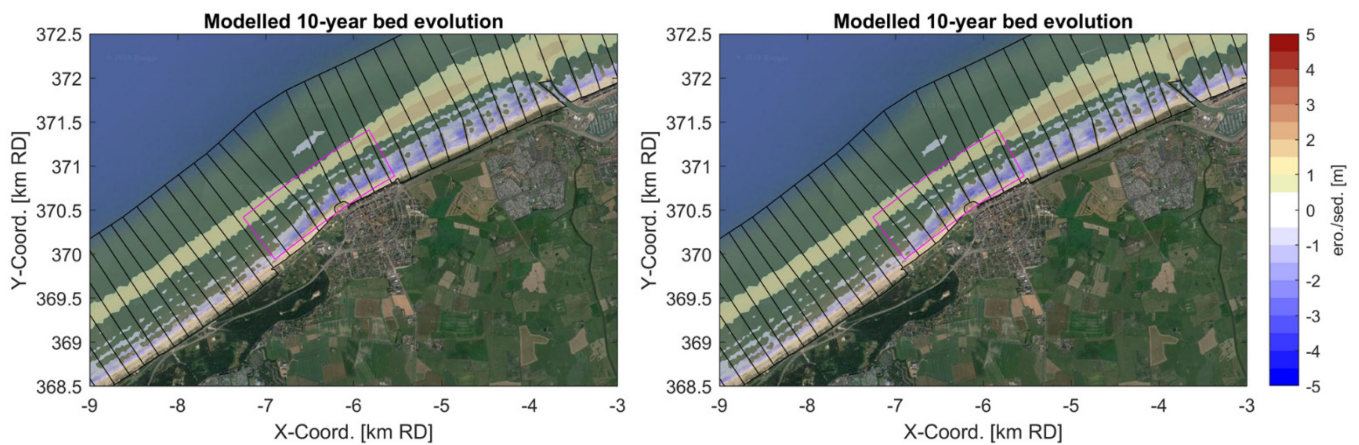


Figure 3: ten-year bed evolution around Wenduine. Left: SISYPHE, v7p2 (HSW113\_slurm), right: SISYPHE, v8p3 (HSW113b\_BK\_layer\_GT\_update)

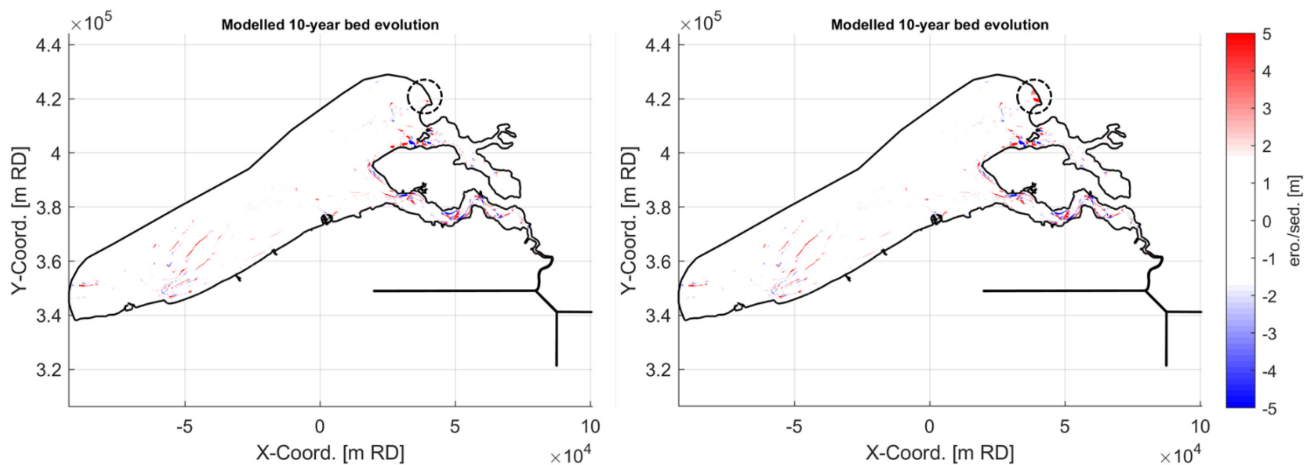


Figure 4: ten-year bed evolution in the full domain of the model. Left: SISYPHE, v7p2 (HSW113\_slurm), right: SISYPHE, v8p3 (HSW113b\_BK\_layer\_GT\_update)

### 2.1.2 GAIA run with v8p3

Except for the significant sedimentation at the northeast boundary, the new version of SISYPHE appears to reproduce the results of the old version sufficiently well. Furthermore, a comparison was performed between SISYPHE and GAIA using version v8p3.

SISYPHE and GAIA show nearly identical morphological results in the Belgian coastal zone (Figure 5). Moreover, GAIA demonstrates an excellent agreement with SISYPHE in estimating longshore transport, although the fluctuations around groynes are weaker than SISYPHE (Figure 6). A detailed comparison is also performed in the vicinity of Wenduine (Figure 7). GAIA is found to produce nearly identical results as SISYPHE. A calculation of the net erosion within the magenta box yields a value of 236,000 m<sup>3</sup> for GAIA, only 3.8% larger than 227,300 m<sup>3</sup> obtained from SISYPHE.

However, like the new version of SISYPHE, GAIA also shows a significant sedimentation at the northeast /boundary (Figure 8).

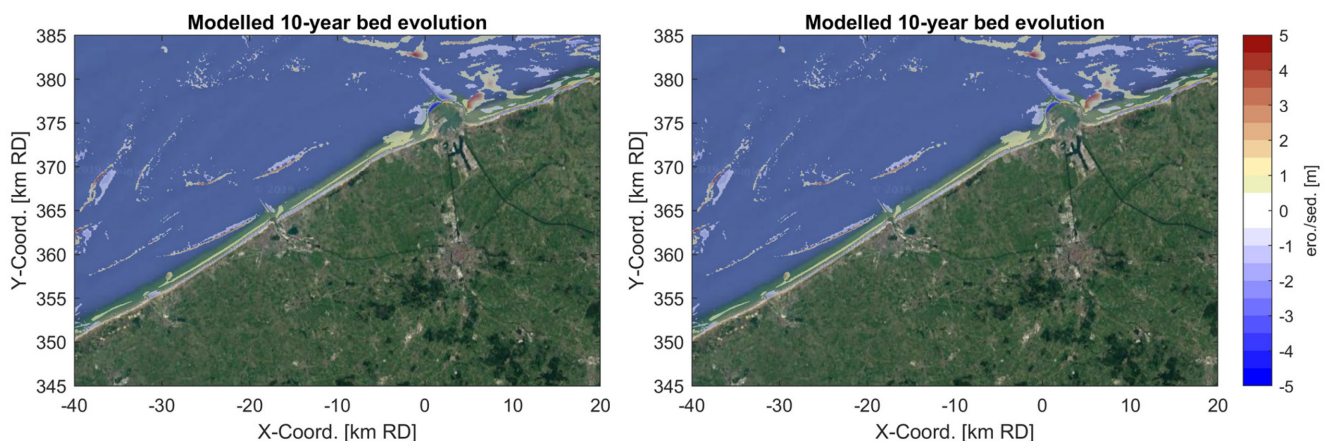


Figure 5: ten-year bed evolution along the Belgian Coast. Left: SISYPHE, v8p3 (HSW113b\_BK\_layer\_GT\_update) ; right: GAIA, v8p3 (HSW113\_I06).



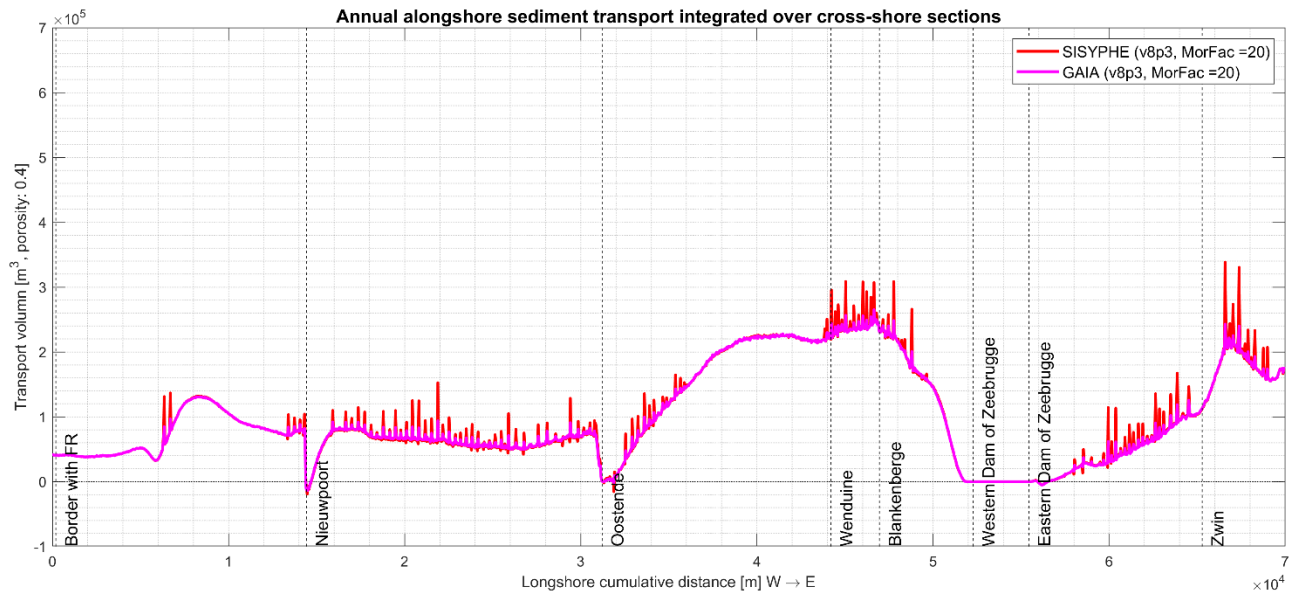


Figure 6: Comparison of modelled net longshore sediment transport between SISYPHE (HSW113b\_BK\_layer\_GT\_update) and GAIA (HSW113\_J06) on v8p3.

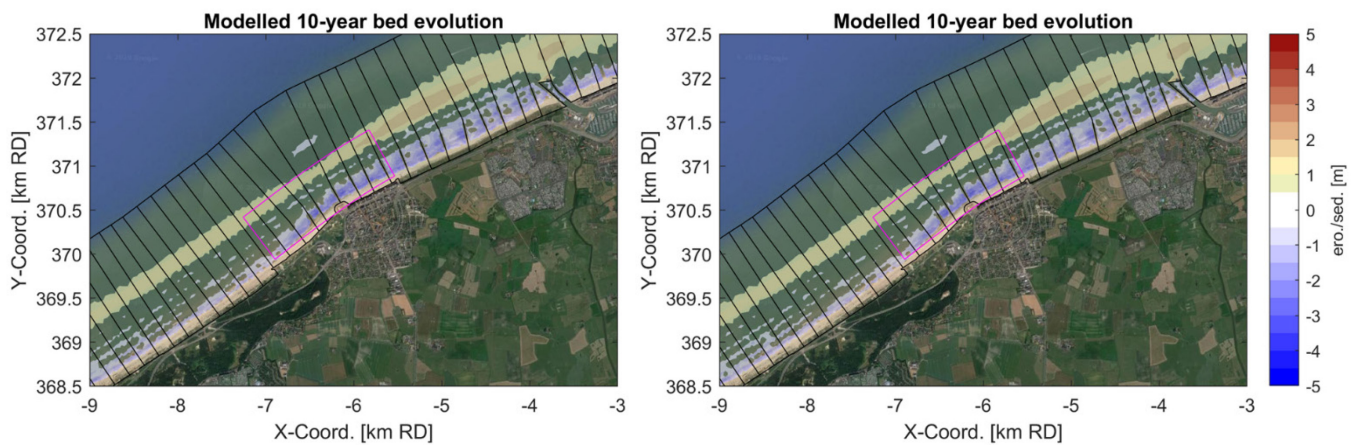


Figure 7: ten-year bed evolution around Wenduine. Left: SISYPHE, v8p3 (HSW113b\_BK\_layer\_GT\_update) ; right: GAIA, v8p3 (HSW113\_J06).

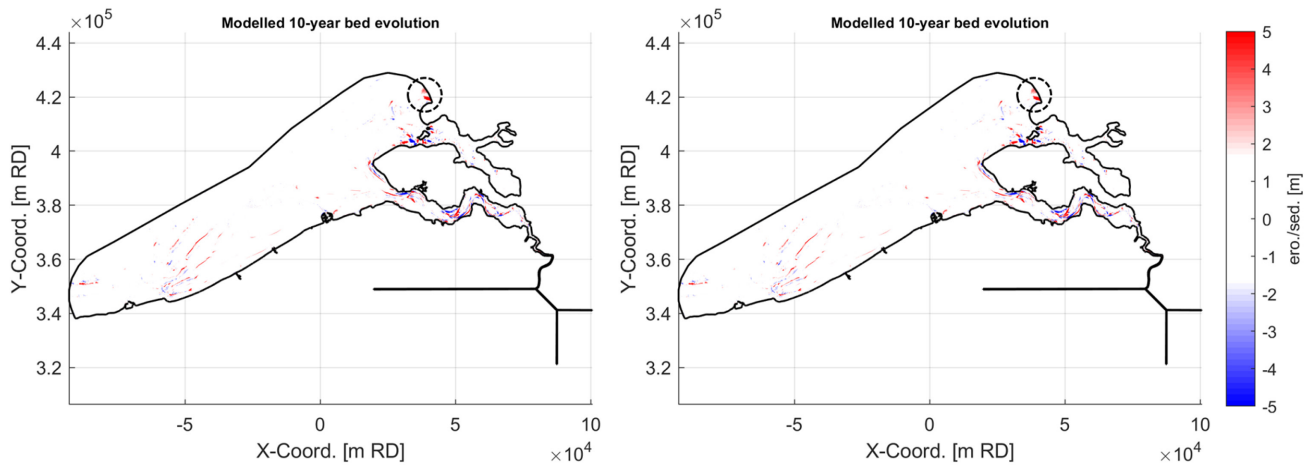


Figure 8: ten-year bed evolution in the full domain of the model. Left: SISYPHE, v8p3 (HSW113b\_BK\_layer\_GT\_update) ; right: GAIA, v8p3 (HSW113\_J06).

### 2.1.3 GAIA run with v8p4

Following the comparisons between v7p2 and v8p3 for SISYPHE, between SISYPHE and GAIA in v8p3, a further comparison between v8p3 and v8p4 was carried out for GAIA.

The two versions of GAIA yield visually identical results not only in the sedimentation/erosion map for the full domain (Figure 9) but also in the detailed sedimentation/erosion map around Wenduine (Figure 11). A calculation of the net erosion within the magenta box indicates a value of 222,000 m<sup>3</sup> for v8p4, only 6.0% lower than 236,000 m<sup>3</sup> obtained from v8p3.

In addition, there is a good agreement between v8p4 and v8p3 in estimating longshore transport although v8p4 gives a slightly lower magnitude (Figure 10).

However, like the earlier version v8p3, version v8p4 also shows a significant sedimentation at the northeast boundary (Figure 12). More investigation is required to find the cause for this issue, or a workaround is needed to fix this issue. But this issue does not seem to impact the results in the area of our interest of the model.

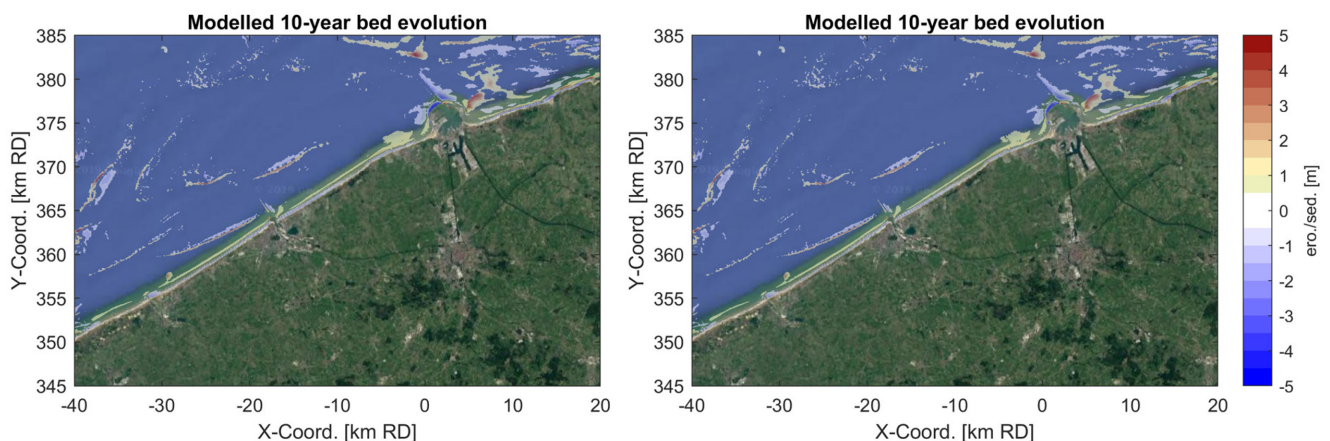


Figure 9: ten-year bed evolution along the Belgian Coast. Left: GAIA, v8p3 (HSW113\_J06); right: GAIA, v8p4 (HSW113\_K03).

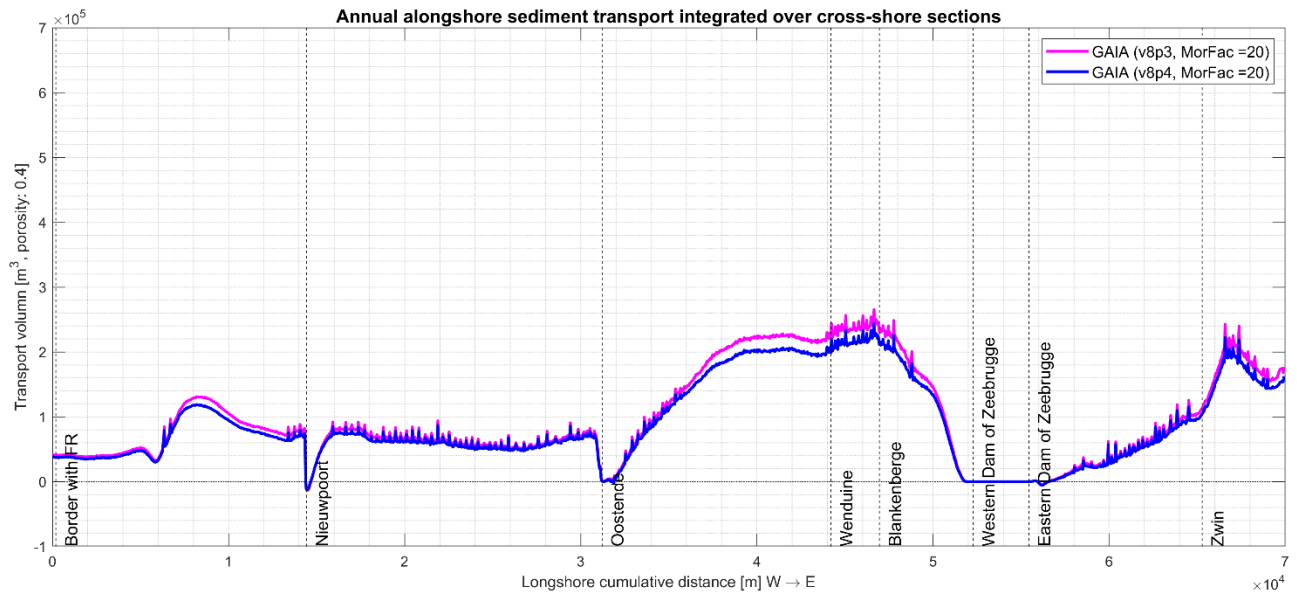


Figure 10: Comparison of modelled net longshore sediment transport between v8p3 (HSW113\_J06) and v8p4 (HSW113\_K03) of GAIA.

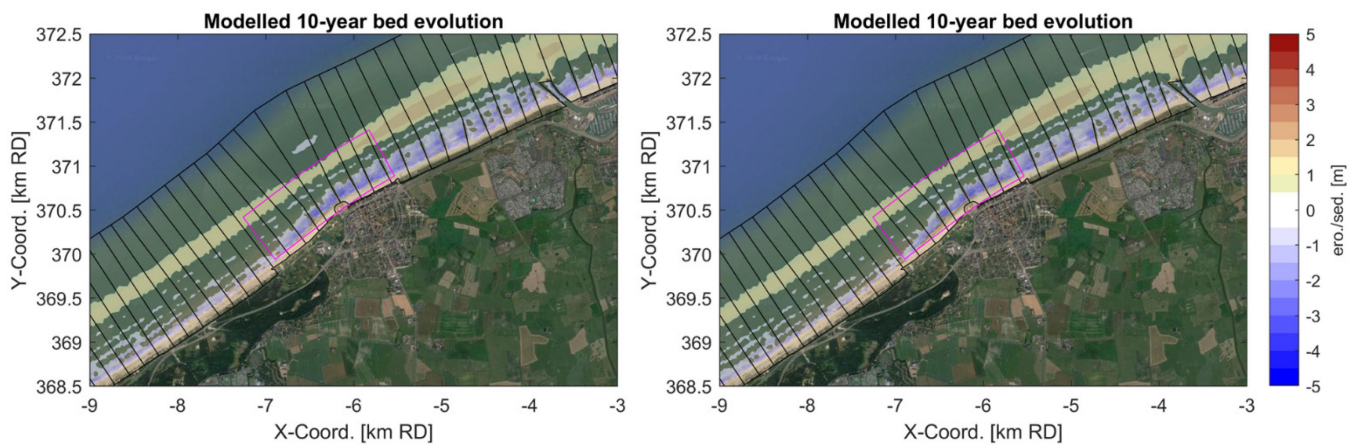


Figure 11: ten-year bed evolution around Wenduine. Left: GAIA, v8p3 (HSW113\_J06); right: GAIA, v8p4 (HSW113\_K03).



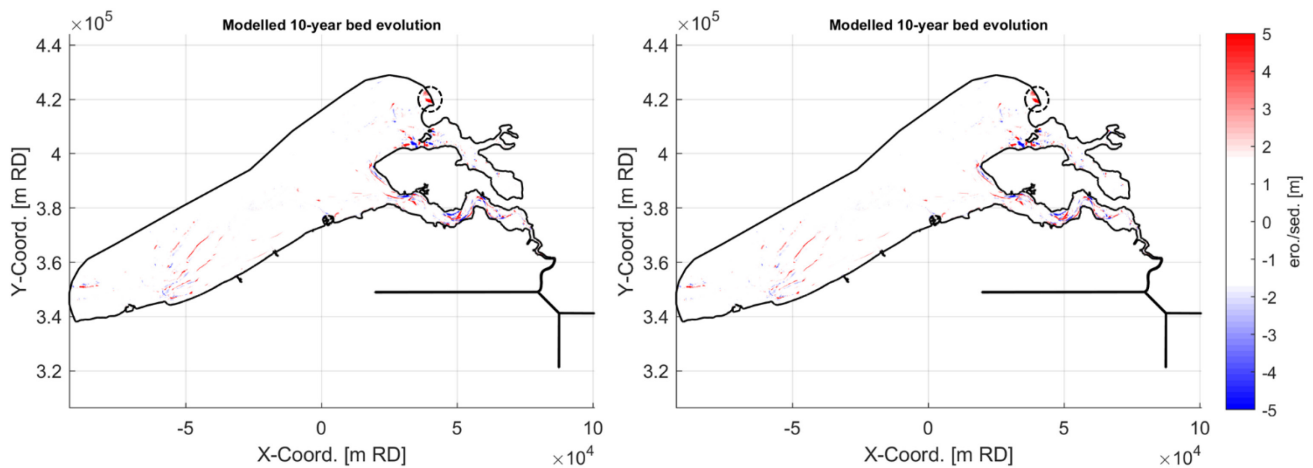


Figure 12: ten-year bed evolution in the full domain of the model. Left: GAIA, v8p3 (HSW113\_J06); right: GAIA, v8p4 (HSW113\_K03).

## 2.2 Wind shear force formulation in v8p4

### 2.2.1 Effects of the wind drag coefficient on alongshore sediment transport

For the current study, a notable change has been made to the default formulation of the wind drag coefficient, as illustrated by the red solid line in Figure 13. In the current version v8p4, the formulation of Flather is used by default, in which, the drag coefficient remains consistently low at  $0.565 \times 10^{-3}$ , when the wind speed remains below 5m/s. As the wind speed increases beyond 5m/s but stays below 19.22m/s, the drag coefficient increases linearly with the wind speed. From 19.22m/s, the drag coefficient stabilizes at  $2.513 \times 10^{-3}$ .

However, in the older versions (e.g. v7p2), the default wind coefficient is independent of the wind speed, and kept at a very low level of  $0.565 \times 10^{-3}$ , as depicted as the blue dash line in Figure 13. Such a low drag coefficient significantly limits the impact of wind on hydrodynamics, leading to an insignificant effect on the alongshore sediment transport, as indicated by the blue and cyan lines in Figure 14). Therefore the effect of wind on hydrodynamics was switched off in the previous parameter setup of the ScaldisCoast model.

With the implementation of the new default formulation for the wind drag coefficient in version v8p4, the impact of wind on the alongshore sediment transport can no longer be ignored, as evidenced by the red and green lines in Figure 14. Notably, the alongshore sediment transport has increased by over 50% in many locations along the coast west of Zeebrugge after switching the wind effect on in the ScaldisCoast model.

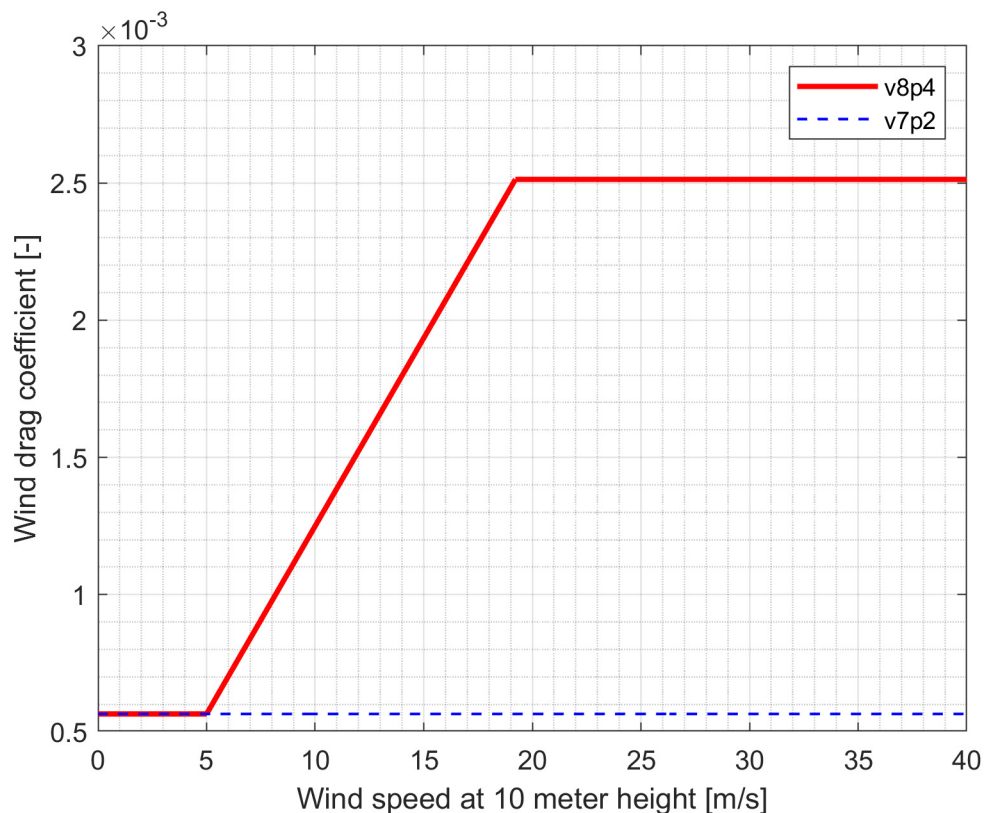


Figure 13: Wind drag coefficient depending on wind speed in the version v8p4.

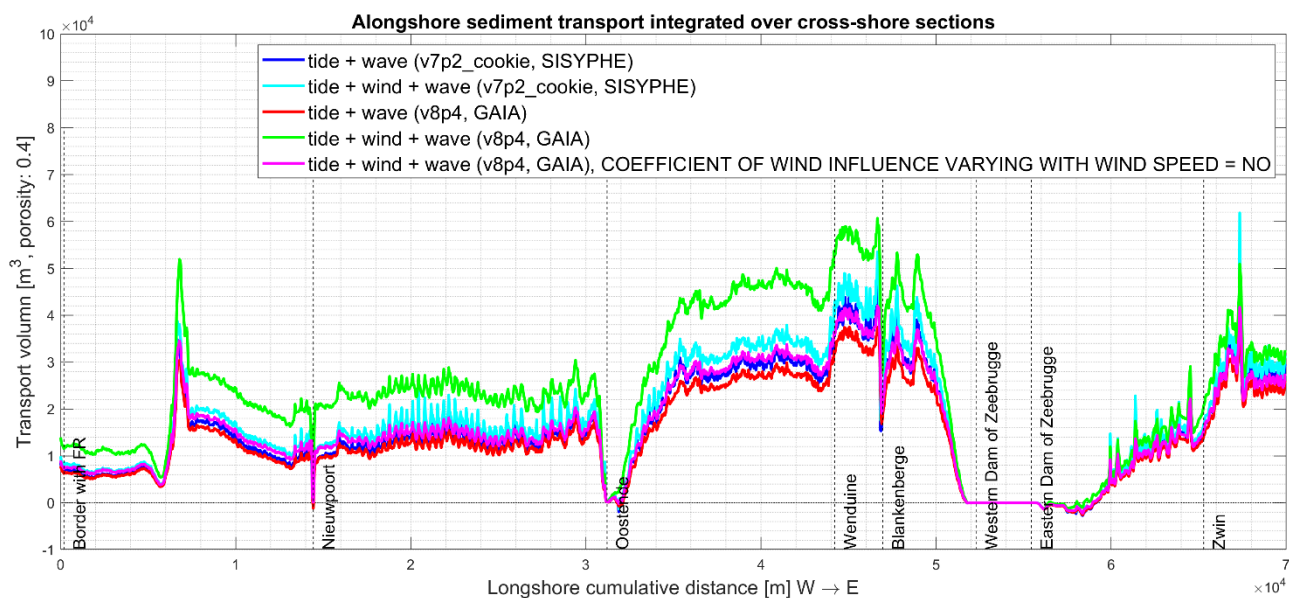


Figure 14 : Modelled annual net alongshore sediment transport integrated over the cross-shore profiles with sensitivity tests for effects on hydrodynamics in the old version v7p2 and the latest version v8p4.

### 2.2.2 Hydrodynamic validation

After the effect of wind on hydrodynamics is activated, the model gives much larger alongshore sediment transport than the previous one without the effect of wind on hydrodynamics. In order to understand this effect better, and to determine which of the two formulations is more reliable, a hydrodynamic validation is carried out for the ScaldisCoast model, using the Ciara storm as validation period (between 6<sup>th</sup> and 13<sup>th</sup> February 2020)

In the Ciara storm, the wave comes from the southwest and the significant wave height exceeds 4 meter at the measurement station Westhinder. At the same location the wind speed reaches nearly 25m/s (Figure 15).

The model was validated based on two measurement stations Bol van Heist and Scheur Wielingen (Figure 16). First, the water level validation was performed at Bol van Heist (Figure 17). The left panel shows the modelled water level without effects of wind on hydrodynamics, and the right one shows the modelled water level with the effects of wind on hydrodynamics switch on. The difference between these is hardly visible, but the one with the effect of wind on hydrodynamics shows slightly better statistical results (RMSE<sub>0</sub>: 0.12 vs. 0.15, R<sup>2</sup>: 1.00 vs. 0.99).

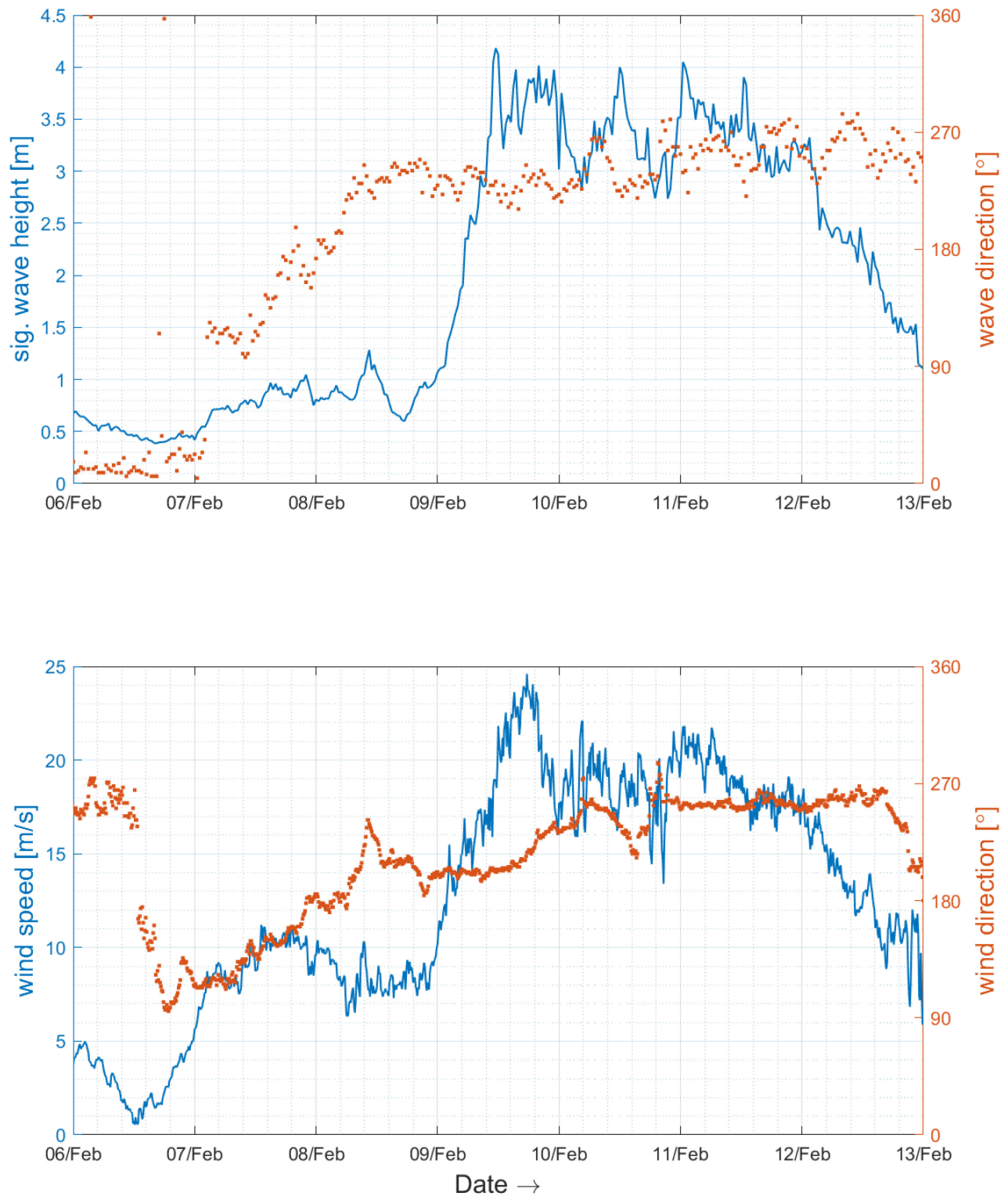


Figure 15: The significant wave height (blue solid line) and mean wave direction (red dots) in the upper panel, the 10m-height wind speed (blue solid line) and direction (red dots) in the lower panel, at the station Westhinder.



Figure 16: Location of the measurement stations Bol van Heist and Scheur Wielingen for the model validation.

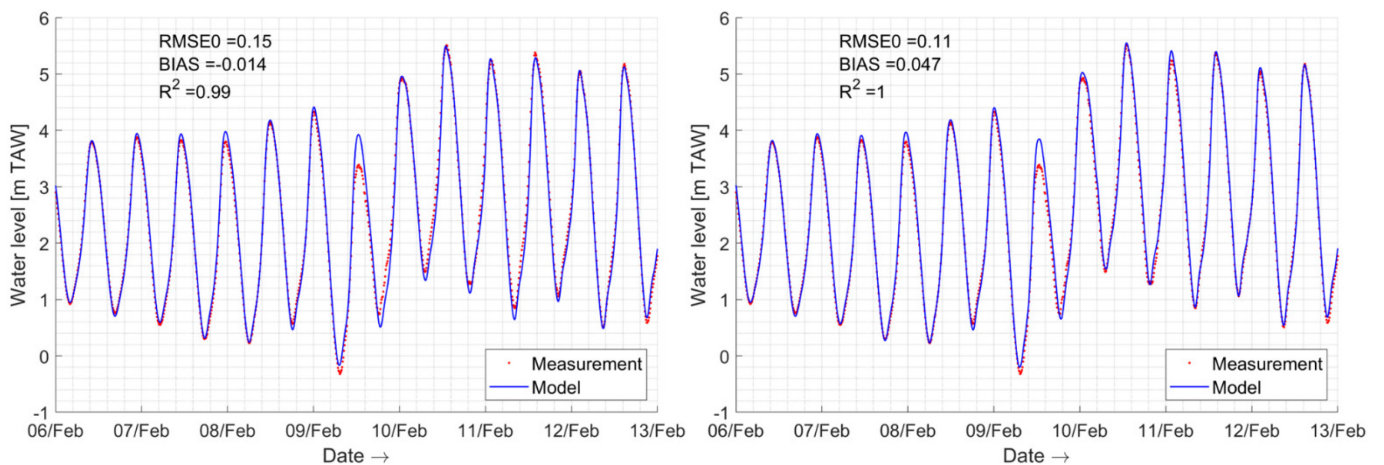


Figure 17: Water level validation without (left panel, SKG\_D01) and with (right panel, SKG\_D02) effects of wind on hydrodynamics.

Another validation was carried out for the modelled current velocities at the measurement stations of Bol van Heist and Scheur Wielingen (Figure 18 and Figure 19). From Figure 18, it can be observed that the modelled current velocity at the station Bol van Heist improve significantly after the effect of wind on hydrodynamics is taken into account using the Flather wind drag formulation. The peaks of flood current around 10<sup>th</sup> February are captured much more accurately by the model. Meanwhile, the two peaks of the ebb current are also better reproduced by the model. In particular, during the ebb prior to 10<sup>th</sup> February, the observed flow direction shifted toward the flood direction due to strong opposing winds.



This phenomenon was successfully captured by the model when the effect of wind on hydrodynamics is considered during the simulation. The  $\text{RMSM}_0$  reduced from 0.18 to 0.10 and the  $R^2$  value increased from 0.80 to 0.95.

At the other station (Scheur Wielingen), the improvement on the modelled velocity is less than that at the station Bol van Heist. The  $\text{RMSE}_0$  reduced from 0.13 to 0.12 and the  $R^2$  is increased from 0.91 to 0.93. The peaks of flood and ebb currents around 10<sup>th</sup> February are also better captured by the model when the wind effects on hydrodynamics is activated in the simulation.

In addition to the Flather formulation, the Charnock formulation (Charnock, 1955) was also tested to determine the wind drag coefficient. However, it did not show any improvement in the modelled results for this validation case. Therefore, the Flather formulation will continue to be used in the model settings for other simulations.

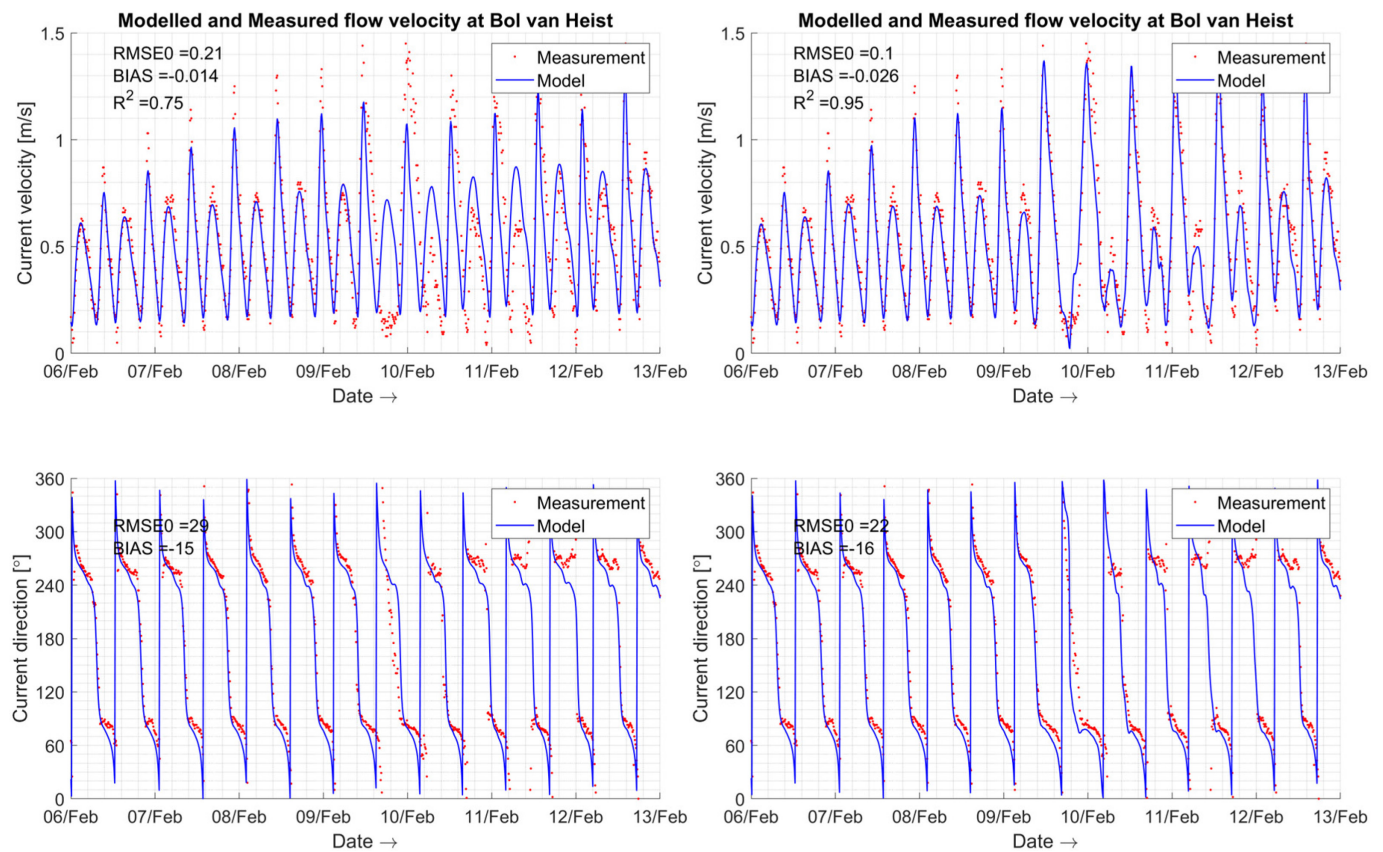


Figure 18: Current velocity validation at Bol van Heist without (left panel, SKG\_D01) and with (right panel, SKG\_D02) effects of wind on hydrodynamics.



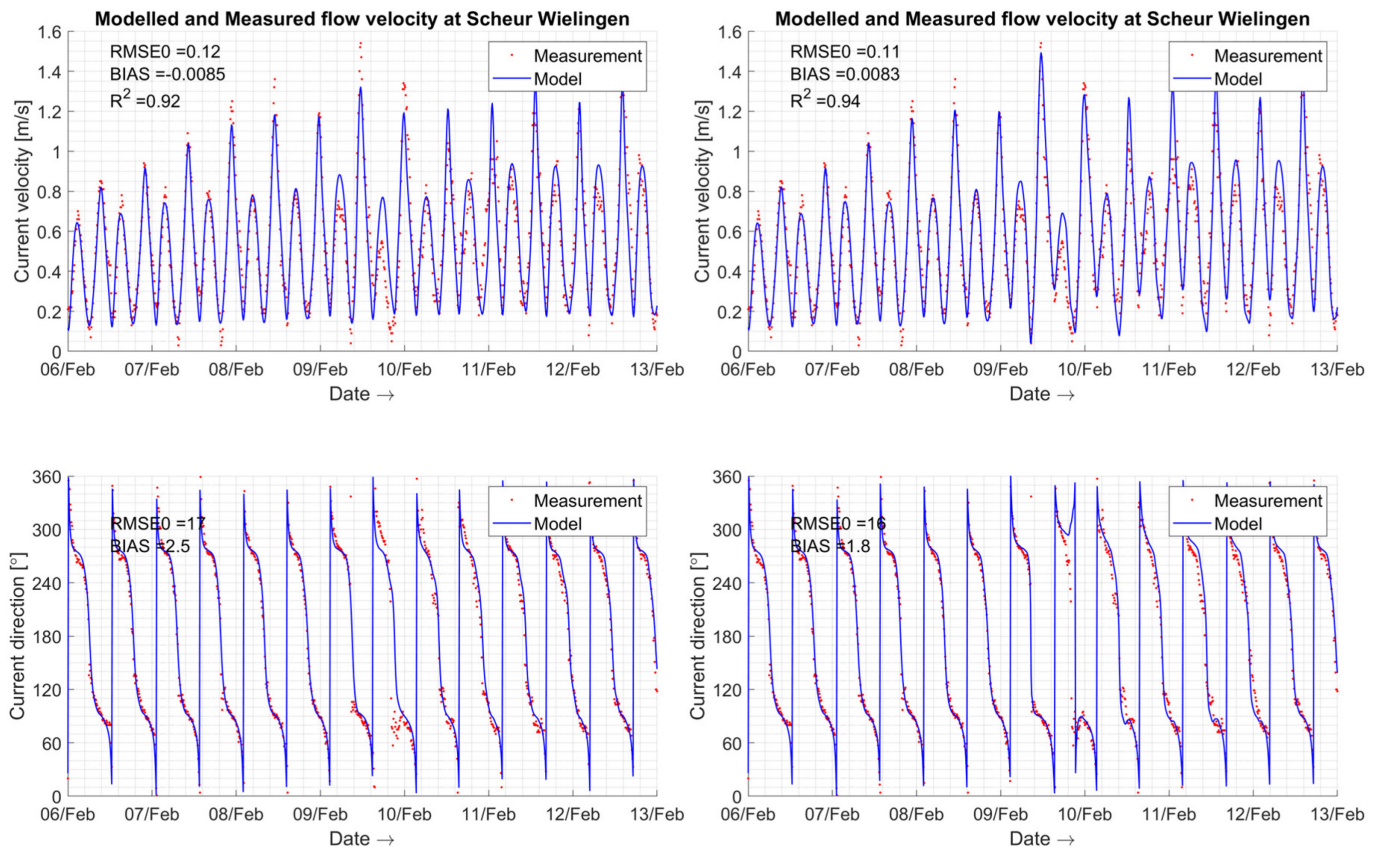


Figure 19: Current velocity validation at Scheur Wielingen without (left panel, SKG\_D01) and with (right panel, SKG\_D02) effects of wind on hydrodynamics.

## 2.3 Time step in the wave model

### 2.3.1 Numerical scheme

The wave model TOMAWAC employs a fractional step approach. For advection, the method of characteristics is used, which is fast and unconditionally stable, yet poses issues in forms of numerical diffusion (especially for smaller time steps) and does not conserve energy; for the source terms, a sub-time step is applied for rapidly varying processes (depth-induced breaking and triad interactions). The method leads to a time-step restriction, which while not needed for stability is needed to obtain accurate results, thus significantly increasing the computational costs.

To overcome these limitations, a new architecture of TOMAWAC ~~has been~~ was introduced (Breugem et al., 2021). The current numerical scheme was optimized through the segregation of slow and fast physical processes in the source terms, allowing for the use of different time steps. This approach resulted in a substantial reduction in computation time.

A more comprehensive discussion of the methods and results could be found in Breugem et al (2021). In this study, the wave model based on the optimized numerical scheme had been validated.

### 2.3.2 Wave validation with the optimized numerical scheme

Like the validation of the previous wave model (Wang et al, 2021), the wave model based on the optimized numerical scheme was validated against the measurement data from the Broersbank project (Komijani et al, 2017).

In the Broersbank project, there are seven measurement stations (Figure 20). The measurement data from the Westhinder station are used to provide boundary conditions to drive the model, and the data from the other six stations is used to validate the model. The validation period is between 17<sup>th</sup> and 24<sup>th</sup> November, 2015. This period was chosen, because it contains two storm events, one from the west and one from the northeast.



Figure 20: Location of measurement station in the Broersbank project.

In the left part of Figure 21, the seven figures present the modelled significant wave height in the seven measurement stations obtained using the previous non-optimized numerical scheme, while in the right part the results based on the latest optimized numerical scheme. At the BRB5DB station, the performances of the two numerical scheme are almost identical compared. At the other more nearshore stations, wave peaks are captured slightly better by the previous numerical scheme, especially at station BRB2DB. From statistical point of view, the previous numerical scheme given slightly better values for the  $RMSE_0$  and  $R^2$ . However, the difference on the statistical numbers between the two numerical schemes is quite minor. The largest difference on  $RMSE_0$  is only 0.04m, increasing from 0.25 to 0.29m at the station BRB3GB. The largest difference on  $R^2$  is 0.03, decreasing from 0.94 to 0.91 at the station BRB2DB.

Like Figure 21, the modelled mean wave period obtained using the previous numerical scheme is presented in the left part, and that obtained using the latest numerical scheme is presented in the right part. Contrary to the modelled significant wave height, at the three more nearshore stations (TRGGB1, BRB2DB and BRB1GB), the latest numerical scheme gives slightly better results for both peak values and statistical numbers than the previous numerical scheme. The largest improvement on  $RMSE_0$  takes place at station BRB2DB, with a decrease from 0.46s to 0.34s, and the largest improvement on  $R^2$  takes place at two stations: BRB2DB with an increase from 0.91 to 0.92, and BRB1GB with an increase from 0.87 to 0.88.

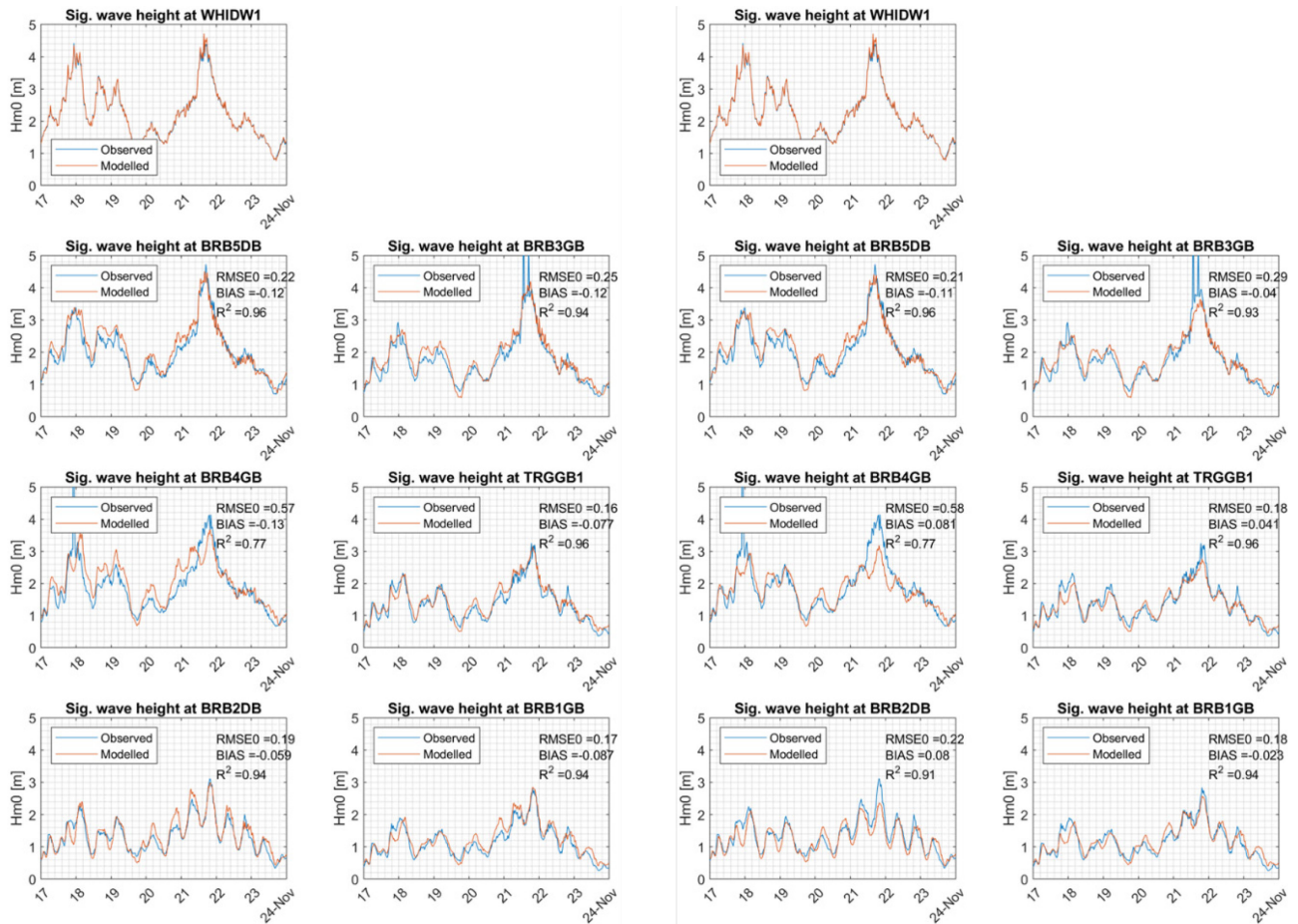


Figure 21: Significant wave height validation using the previous non-optimized (left, SKGT\_B003) and latest optimized (right, SKGT\_B004) numerical schemes.



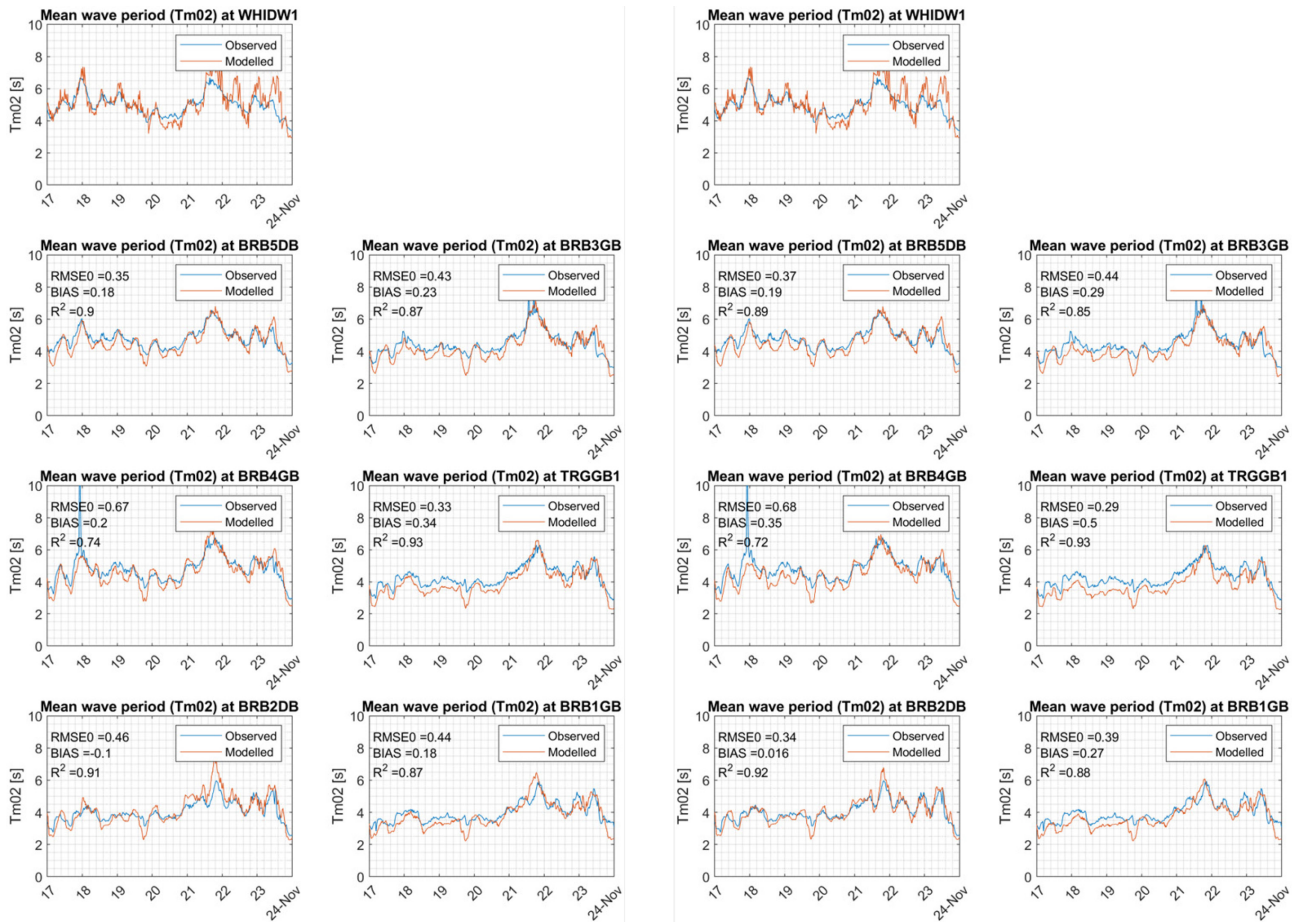


Figure 22: Mean wave period validation using the previous non-optimized (left, SKGT\_B003) and latest optimized (right, SKGT\_B004) numerical schemes.

In addition to the comparison of time series data at stationary locations, the spatial distribution of the wave field has also been examined to evaluate the two numerical schemes. Figure 23 shows maps of modelled significant wave height using both the non-optimized and optimized schemes. While both simulations capture the large-scale wave height patterns offshore, with comparable values reaching up to 2.0 m, notable differences are observed in the nearshore area. The optimized scheme (right panel) produces a smoother wave field with more gradual spatial transitions from offshore to nearshore. Consequently, the simulation based on the optimized scheme (right panel of Figure 24) results in more continuous and uniform depth contours. In contrast, the non-optimized scheme (left panel of Figure 24) exhibits artificial oscillations, commonly referred to as numerical wiggles, in the nearshore zone. These spurious features are undesirable and should be avoided in morphological simulations.

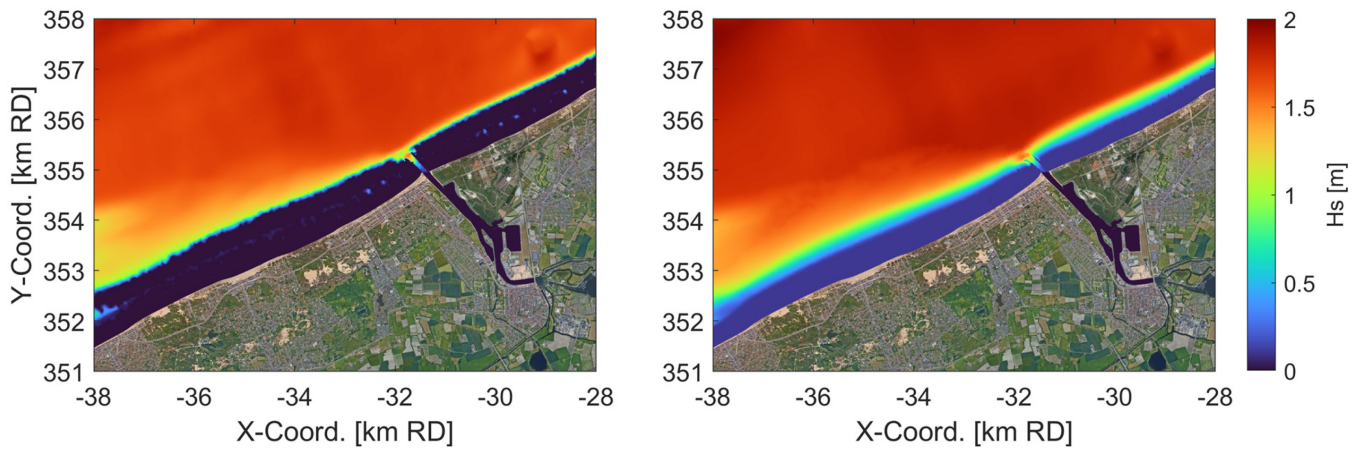


Figure 23: Significant wave height map based on using the previous non-optimized (left, SKGT\_B003) and latest optimized (right, SKGT\_B004) numerical schemes.

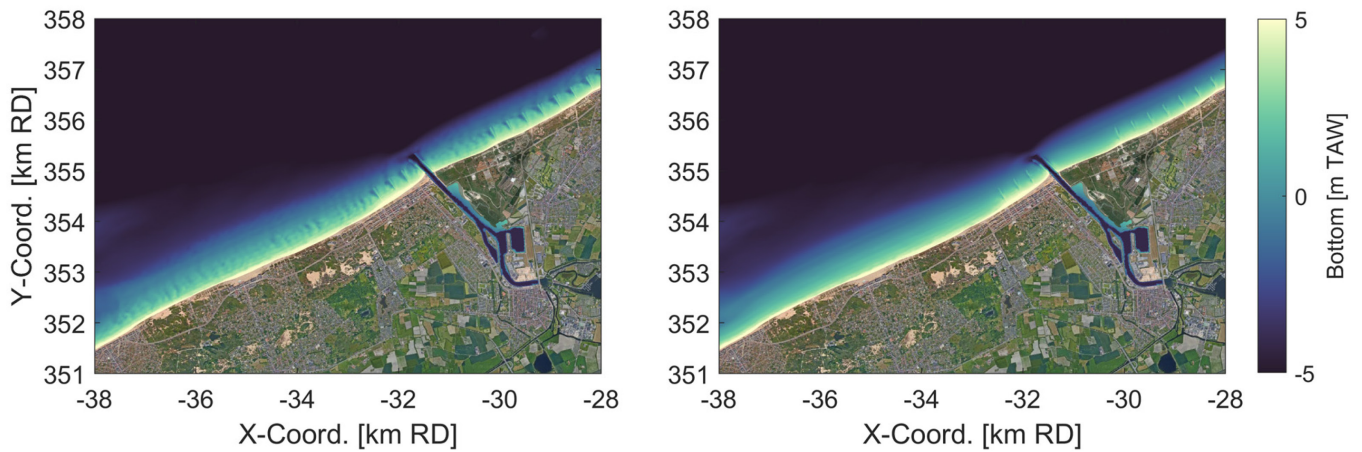


Figure 24: Bathymetry map based on using the previous non-optimized (left, SKGT\_B003) and latest optimized (right, SKGT\_B004) numerical schemes.

In summary, the latest optimized numerical scheme achieved a significant reduction in computation time, decreasing the runtime from 3.86 to 2.5 hours for the validation period. This corresponds to an improvement approximately 35% in computational efficiency relative to the previous non-optimized scheme. Although the modelled significant wave height shows a slight decline in accuracy compared to the previous non-optimized scheme, the differences are minimal: the maximum increase in  $RMSE_o$  is less than 0.04 m, and the maximum reduction in  $R^2$  is less than 0.03. These variations are small relative to the overall model error and can be considered negligible. As a result, additional calibration of the latest optimized numerical scheme is deemed unnecessary. Spatial analysis of significant wave height distributions showed that both schemes similarly captured offshore wave patterns; however, the optimized scheme produced a smoother nearshore wave field and more continuous depth contours, whereas the non-optimized scheme showed undesirable numerical instabilities.



### 3 Morphology model validation with the new settings

The ScaldisCoast model has been validated in terms of hydrodynamics and waves with new settings. The morphology validation was undertaken with the new settings for five cases in separated sections below (the run ID has been also given in brackets):

1. Bed evolution next to Western dam of Zeebrugge (HSW113\_K17a)
2. Zeebrugge hindcast since 1986 (ZB1986\_C02a)
3. Erosion in front of Wenduine (HSW015b\_C01)
4. Annual sedimentation at Blankenberge (HSW113\_L09)
5. Storm-induced siltation at Blankenberge (HSW071\_D12)

#### 3.1 Bed evolution next to the western dam of Zeebrugge

In the study of Verwaest et al. (2011), the area near the western dam of Zeebrugge is divided to three zones: green, red and pink polygons (Figure 23). The erosion (in blue) and sedimentation (in brown) volumes are given in this study area. The total littoral drift is estimated based on the measured volumetric trends with an assumption that no sediment is brought into the longshore zone from offshore areas.

The objective of this test is to validate the calculated long term longshore transport rate (due to waves and currents) in the model.

The modelled sedimentation/erosion map is given in Figure 24. It can be observed that the model reproduces the sedimentation/erosion pattern in the green box fairly well, although it underestimates the net sedimentation volume by 35% compared with the volume given in the study of Verwaest et al. (2011): 240,000 vs. 370,000 m<sup>3</sup>/y (Table 1). In the red polygon, the net sedimentation volume was overestimated by 52%: 73,000 vs. 35,000 m<sup>3</sup>/y. In the pink polygon, even though the erosion pattern was captured by the model, the model suggested net sedimentation which is opposite to net erosion reported by Verwaest et al. (2011): 7,000 vs. -5000 m<sup>3</sup>/y.

In a recent study, Houthuys et al. (2022) assumed that all alongshore transport contributes to morphological accretion near the western dam of Zeebrugge for the entire active zone, and the average alongshore transport is estimated to be approximately 239,635 m<sup>3</sup>/y. In another earlier study, Houthuys et al. (2014) suggested a larger alongshore transport 355,000 m<sup>3</sup>/y, which was calculated over a shorter period (1997 – 2007). But the calculations in these two studies were not conducted in exactly the same area. The result of the alongshore transport is certainly depending on the area involved to the calculations. Although the three studies suggested varying numbers for the alongshore transport which results in the sedimentation near the western dam of Zeebrugge, the morphology model demonstrates a good capability to capture these reported numbers.

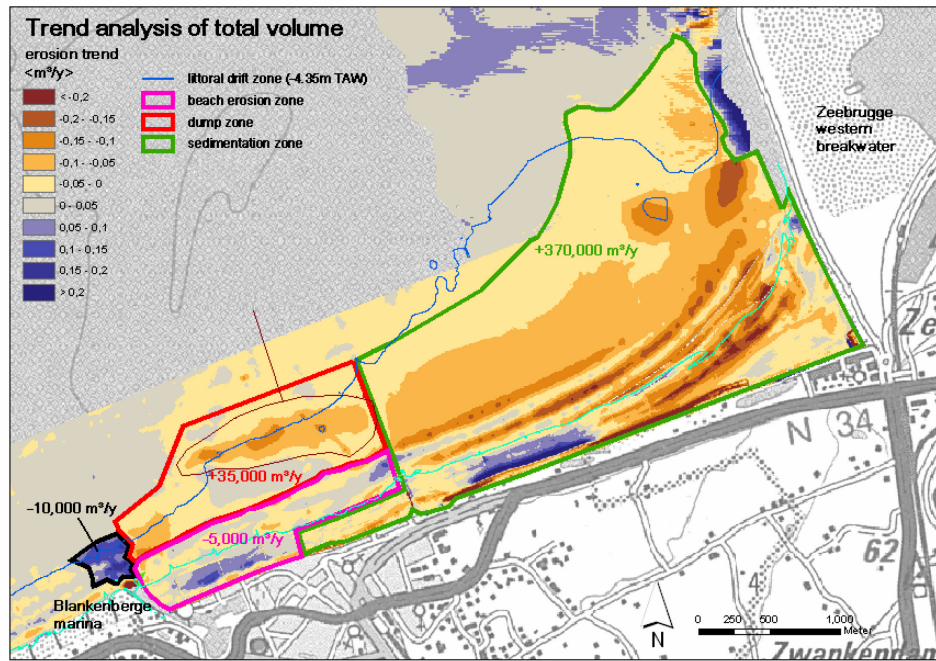


Figure 25: Measured tenten-year bed evolution between 1999 and 2009, in the area next to the western dam of Zeebrugge (reproduced from Verwaest et al., 2011).

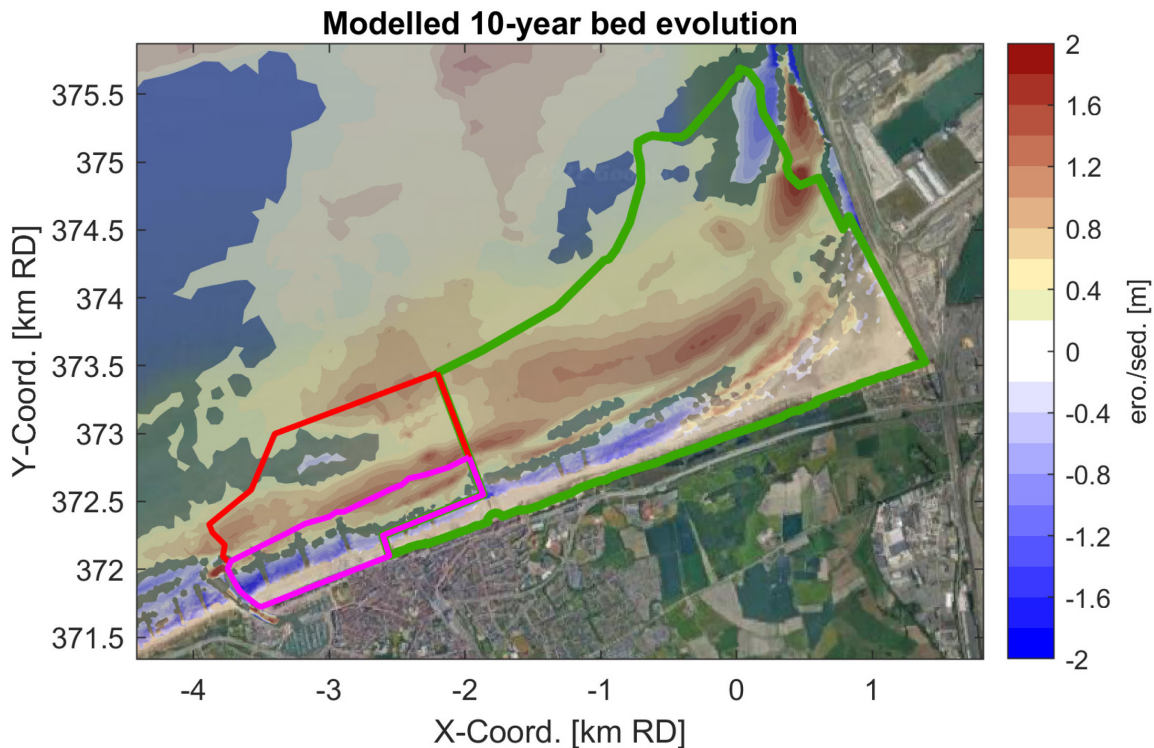


Figure 26: Modelled tenten-year bed evolution with representative tide and wave/wind over a half year (MorFac =20), in the area next to the western dam of Zeebrugge (HSW113\_K17a).

Table 1: Comparison between measured and modelled net volume change within different polygons for the validation case: bed evolution next to the Western dam of Zeebrugge.

|                       | Net volume change (m <sup>3</sup> /y) in |             |              |
|-----------------------|------------------------------------------|-------------|--------------|
|                       | Green polygon                            | Red polygon | Pink polygon |
| Verwaest et al., 2011 | 370,000                                  | 35,000      | -5,000       |
| HSW113_K17a           | 240,000                                  | 73,000      | 7,000        |

## 3.2 Zeebrugge hindcast since 1986

In addition to the long-term morphological simulation for the bed evolution next to the western dam of Zeebrugge. The performance of the morphological model is also evaluated by another long-term hindcasting case. The objective of this test case is to validate the offshore sediment transport rate, which is mainly influenced by tide and wind driven currents, but to a much lesser extent by waves.

The introduced historical bathymetry is a compilation of data from or around the year 1986, depending on the availability. This period coincides with the completion of the extension of the port of Zeebrugge (construction of breakwaters), which affected the morphological evolution substantially in the surrounding area. The morphological changes triggered by the human intervention at the coast provides an excellent case to validate the morphological model.

More details about the historical bathymetric data can be found in an earlier report (Kolokythas et al., 2020). The measured ten-year bed evolution, derived from the difference of historical bathymetries between 1986 and 1996, is presented in Figure 25. Figure 26 shows the modelled ten-year bed evolution starting from 1986, based on the representative wave/wind climate over a half year using the morphological acceleration factor MorFac equal to 20. It is found that the general sedimentation/erosion pattern was captured by the model, such as the sedimentation next to the western dam of Zeebrugge, the erosion in front of the breakwaters at the port of Zeebrugge. According to the measured data, significant sedimentation also took place near the eastern dam of Zeebrugge. However, the model was unable to reproduce the sedimentation which occurs at the corner of the eastern dam. This sedimentation is considered to mainly consist of mud from the Scheldt Estuary, which is not considered in the model. This issue has been extensively discussed in a previous report (Wang et al., 2015).

In order to quantify the performance of the model in predicting morphological changes at specific coastal areas of interest, sediment volume changes were calculated in the three polygons shown in Figure 26, which correspond to the highly eroded areas in front of Zeebrugge port breakwaters (red and pink polygons in Figure 26) and the extensive area around Paardenmarkt (green polygon in Figure 26). In Table 2, the modelled sediment volume changes are compared to the measured ones within each of the polygons. It is indicated that the model significantly overestimates the erosion and sedimentation in the pink and green polygons respectively, while slightly underestimates the erosion in the red polygon. The discrepancy between the modelled results and measured data can be attributed to a few factors:

- The representative tide and wave/wind climate was determined by the residual alongshore transport rate and volume change in the surf zone area. It is a question that this representative tide and wave/wind climate is still representative enough in the area of the polygons defined for the hindcasting case.

- The representative wave/wind climate was derived from the ten-year run between 2009 and 2019. However, the hindcast is executed from 1986 to 1996. The representative wave/wind climate of the period between 1986 and 1996 might be different from that between 2009 and 2019.
- The new default formulation (Flather) of the wind drag coefficient might exaggerate wind impacts in this more offshore area, because of the larger depth here than in the surf zone.

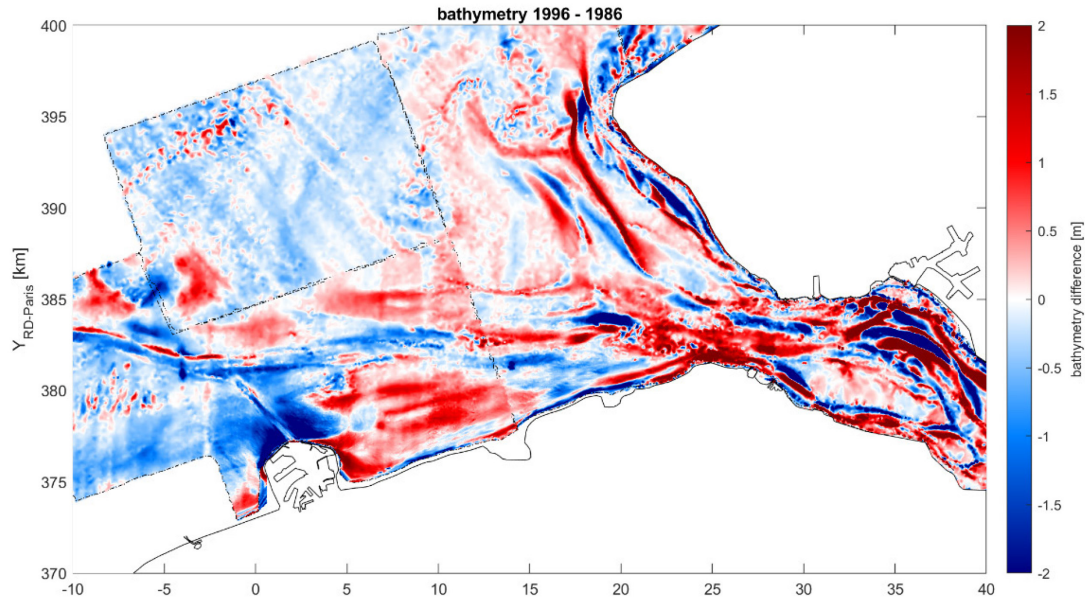


Figure 27: Measured ten-year bed evolution between 1986 and 1996.

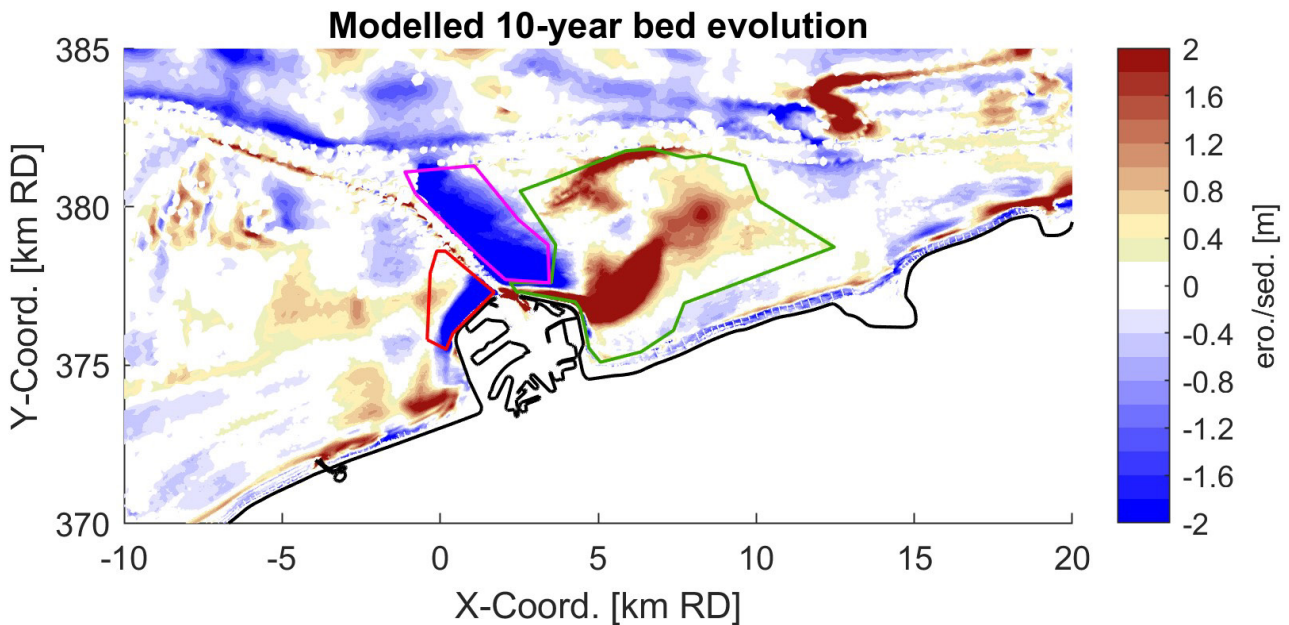


Figure 28: Modelled ten-year bed evolution with representative tide and wave/wind over a half year (MorFac=20), in the area around Zeebrugge (ZB1986\_C03a).



Table 2: Comparison between measured and modelled net volume changes within different polygons for the validation case: Zeebrugge hindcast since 1986.

|             | Net volume change ( $10^6 \text{ m}^3$ ) in |              |               |
|-------------|---------------------------------------------|--------------|---------------|
|             | Red polygon                                 | Pink polygon | Green polygon |
| Measurement | -7.4                                        | -9.0         | +14.5         |
| ZB1986_C03a | -6.37                                       | -19.6        | +25.9         |

### 3.3 Erosion in front of Wenduine

The objective of this test is to validate the performance of the model on medium-long time scales (one year) for a situation where longshore sediment transport is important.

The morphological model was run with brute force wave and wind conditions in combination with real spring-neap tidal forcing during the period between 01 June 2014 and to 01 June 2015. The spring-neap tidal boundaries were obtained from nesting with the regional ZUNO model (Maximova *et al.*, 2016). The modelled bed evolution was validated with net volume change in the closed pink box along the coast (Figure 27 and Figure 28). The period is characterised by strong erosion of the recently nourished foreshore and beach nourishment at Wenduine.

Figure 28 displays the modelled morphological change over one year. The observed morphological change was calculated based on the difference between lidar and foreshore surveys of spring 2014 and spring 2015 (Figure 27). Both the model and the measurement display strong erosion in front of Wenduine, as the initial bathymetry (spring 2014) includes a recent nourishment executed in February-March 2014. The observed erosion volume within the pink box reaches  $146\,000 \text{ m}^3$  which is well represented by the model:  $128\,000 \text{ m}^3$ . However, the location of the erosion is a little different in the model. The modelled erosion occurs more offshore than the observed one. In this 2D model, cross-shore processes are not implemented yet, thus on- and offshore transport due to Stokes drift and Undertow do not exist (L.C van Rijn *et al.*, 2003; Walstra *et al.*, 2012). This could be considered as a major reason for the different location of the erosion between the measurement and model.



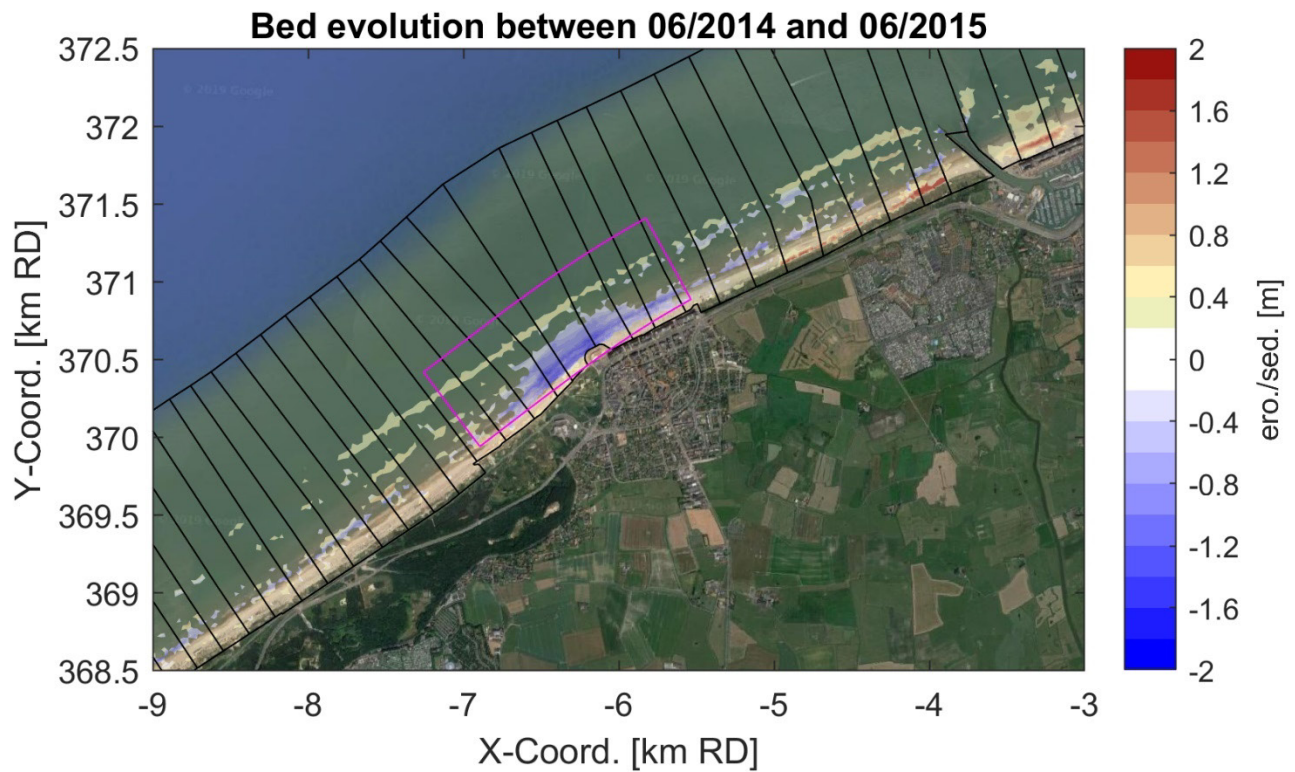


Figure 29: Measured one-year morphological change at Wenduine.

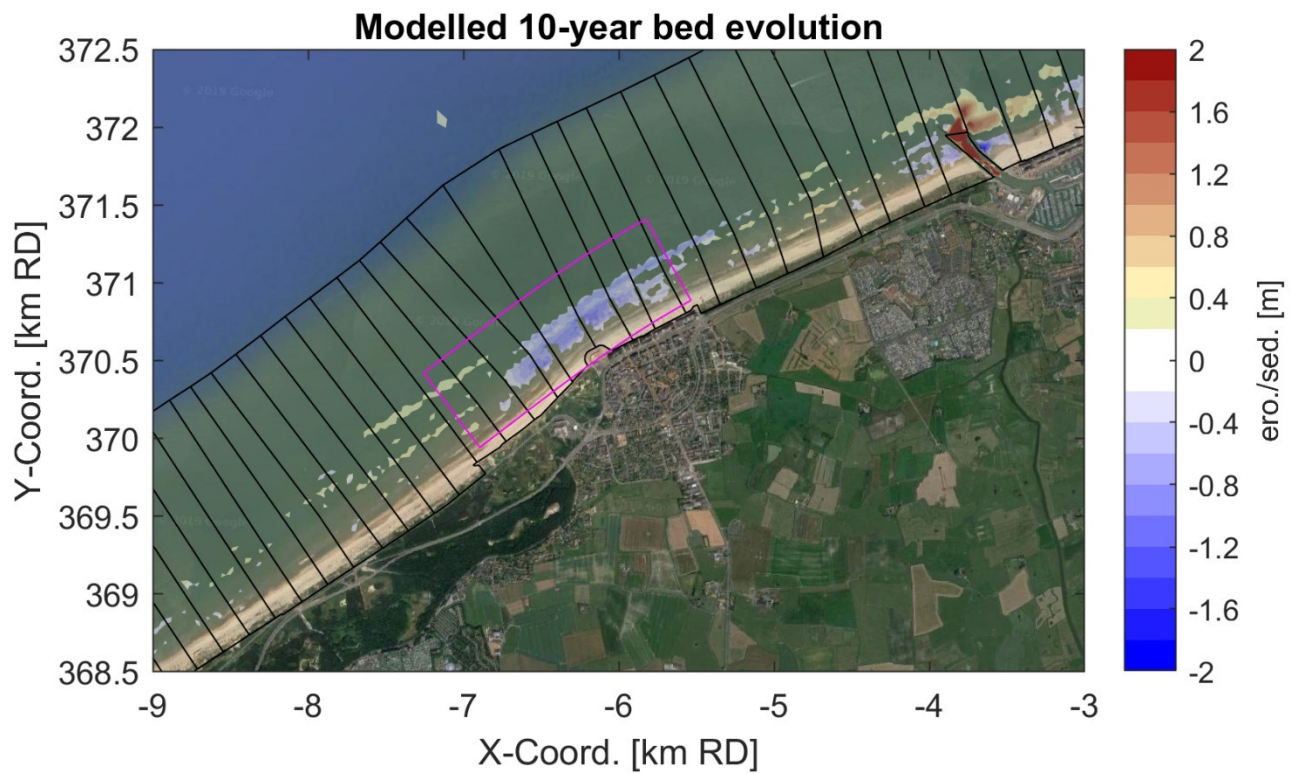


Figure 30: Modelled one-year morphological change at Wenduine (HSW015b\_C01).

### 3.4 Annual sedimentation at Blankenberge

The objective of this test is to validate the performance of the model on medium-long time scales (one year) for a situation where longshore sediment transport is important.

In addition to the constant structural erosion occurring at Wenduine, the port of Blankenberge experiences strong sedimentation in its entrance channel requiring frequent dredging. In order to capture the wave characteristics more accurately within the entrance channel, where significant sedimentation occurs, the wave mesh was refined in the port area and aligned with the flow mesh (pink lines in Figure 29).

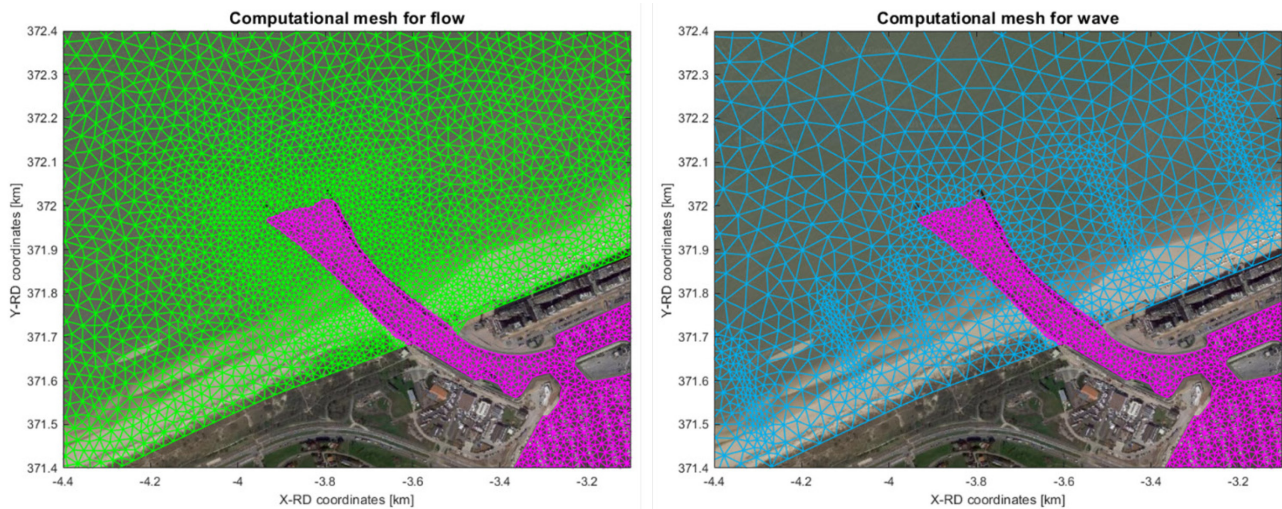


Figure 31: Flow (left) and wave (right) meshes in area around Blankenberge.

From the comparison between Figure 30 and Figure 31, it can be found that the sedimentation pattern is similar in general, although the sedimentation in front of the channel entrance (zone A) is underestimated by the model. The sum of the sedimentation in Zone A, B and D is estimated at 165 000 m<sup>3</sup>/year based to the of dredging volumes over the past 30 years (1980-2010), while the modelled sedimentation in the dashed polygon is 176 000 m<sup>3</sup>/year (Figure 31). The sedimentation in Zone C is mainly caused by aeolian transport which is not yet considered in the morphologic model.



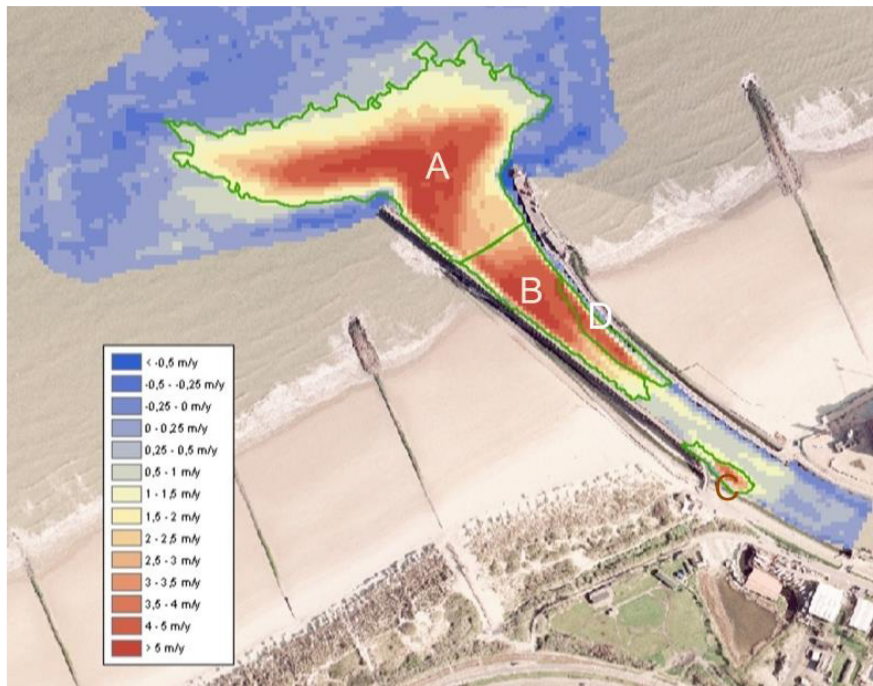


Figure 32: Estimated annual sedimentation in the entrance channel for the port of Blankenberge (reproduced from Teurlincx et al., 2009).

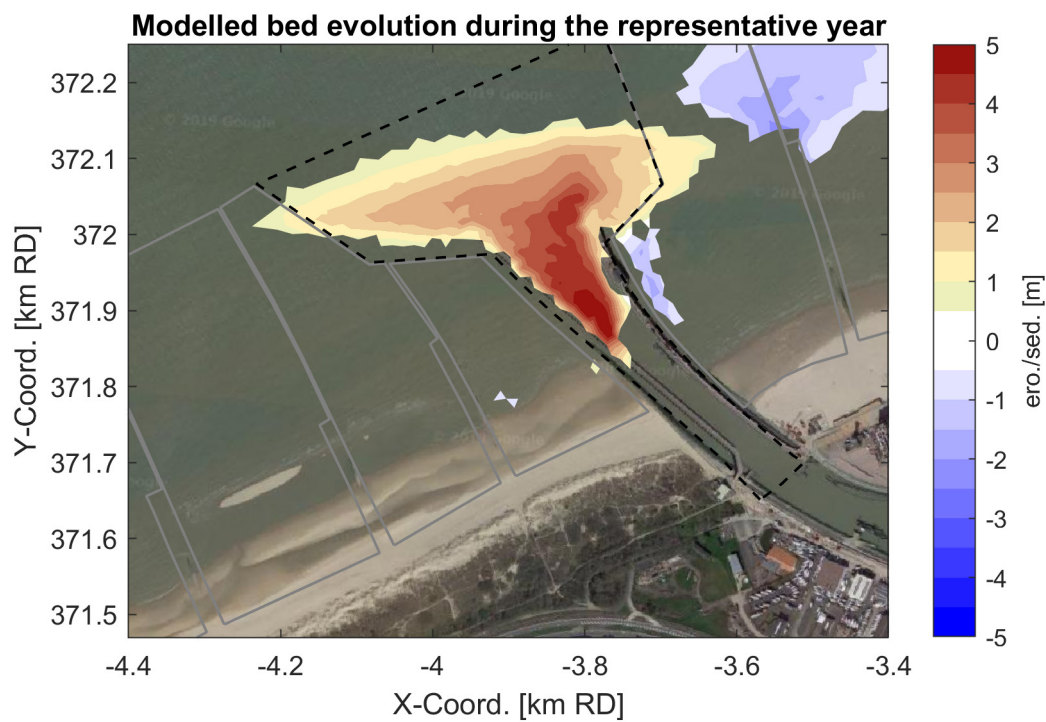


Figure 33: Modelled 1-year bed evolution with representative tide and wave/wind over a half year (MorFac =2), in the area around the port of Blankenberge.

### 3.5 Storm-induced siltation at Blankenberge

The objective of this test case is to validate the short term morphodynamic behaviour during a storm for a situation where longshore transport is the main physical process leading to sedimentation of an entrance channel.

The storm Ciara which took place in February 2020, provides another good case to further validate the morphological model. Bathymetric surveys for the port of Blankenberge were conducted on 6 and 14 February 2020, respectively before and after the storm. The bed evolution during the storm could be calculated from the two bathymetric surveys (Figure 32). The model successfully reproduced a similar spit-shaped sedimentation pattern formed during the storm (Figure 33).

A further quantitative comparison is presented in Table 3. The measured net and gross sedimentation volumes in the zone “Voorplein” are slightly underestimated by the model, while those in the zone “Geul” are overestimated. The model gives 55,400 and 55,900 m<sup>3</sup> for the total gross and net sedimentation volumes respectively, which are consistent with the measured values of 43,600 and 47,700 m<sup>3</sup>. A part of the difference between the model and measurements might be associated with the bathymetric data applied in the model, because outside the black dash polygons the bathymetric data is from the survey undertaken in early 2019, almost one year before the storm.

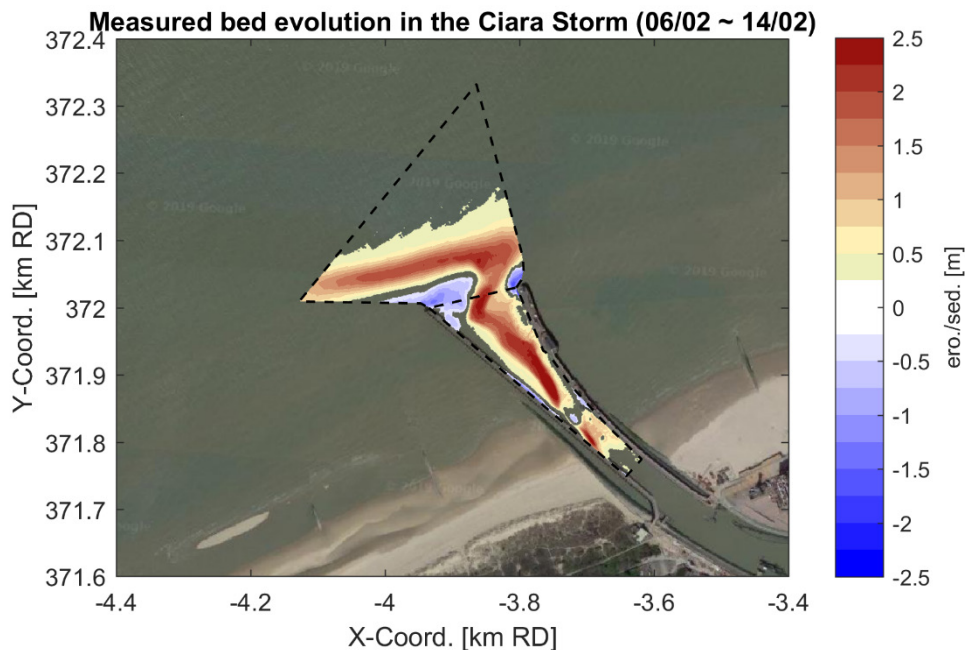


Figure 34: Measured sedimentation in the entrance channel for the port of Blankenberge during the Ciara Storm.



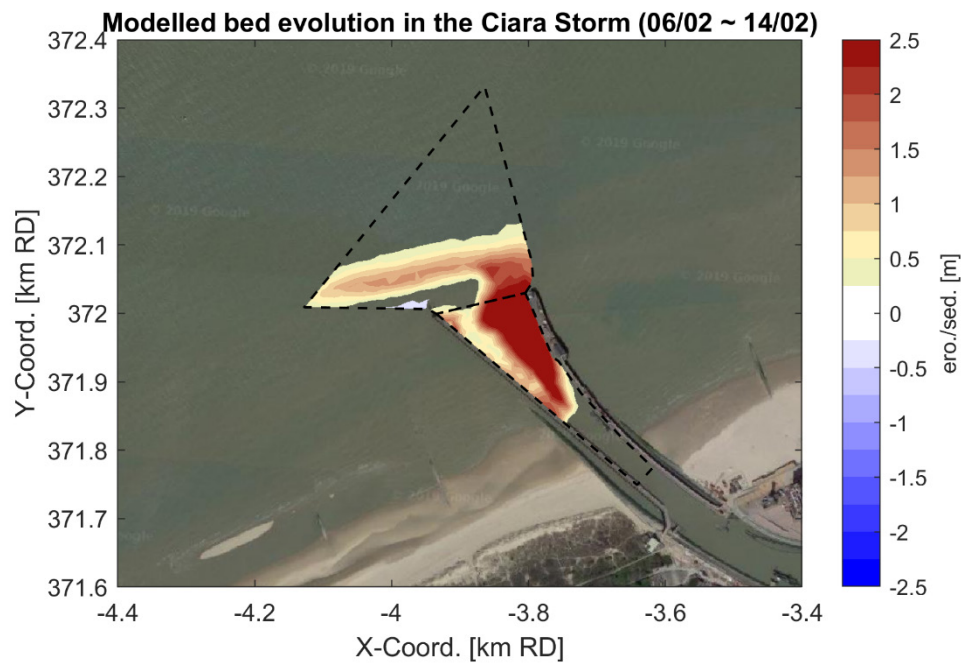


Figure 35: Modelled sedimentation in the entrance channel for the port of Blankenberge during the Ciara Storm.

Table 3: Comparison between measured and modelled net and gross volume changes within separated zones for the validation case: storm-induced siltation at Blankenberge.

|             | Volume change (m <sup>3</sup> )<br>in Voorplein |          | Volume change (m <sup>3</sup> )<br>in Geul |          | Total volume change<br>(m <sup>3</sup> ) |          |
|-------------|-------------------------------------------------|----------|--------------------------------------------|----------|------------------------------------------|----------|
|             | Net                                             | Gross    | Net                                        | Gross    | Net                                      | Gross    |
| Measurement | 2.71E+04                                        | 2.98E+04 | 1.65E+04                                   | 1.79E+04 | 4.36E+04                                 | 4.77E+04 |
| Model       | 2.44E+04                                        | 2.49E+04 | 3.10E+04                                   | 3.10E+04 | 5.54E+04                                 | 5.59E+04 |

## 4 Conclusions

- There were successful validations from version v7p2 to v8p3 for SISYPHE, and then from v8p3 SISYPHE to v8p3 GAIA, finally from v8p3 to v8p4 for GAIA. Since v8p3 SISYPHE, the modelled results all show a significant sedimentation at the northeast boundary, which requires further investigation. This issue does not seem to affect the area of our interest in the current model.
- The new default formulation (Flather) of the wind drag coefficient significantly enhances model performance in hydrodynamic simulations, particularly during storm conditions with high wind speeds.
- The wave model has been revalidated using the optimized numerical scheme, which speeded up computation of the numerical model by 35%. Additionally, the optimized scheme produces a more stable wave field with fewer instabilities compared to the original scheme.
- The morphological model has been thoroughly validated by five different cases. These include both long-term morphological changes over a ten-year period and short-term changes over one year. The model is even tested under an extreme condition to simulate rapid siltation in an access channel to a port during a storm event. These validation cases have shown that the model performs well under various conditions

## 5 Overview model settings ScaldisCoast version 2025

Table 4: Summary of the parameters used in the T2D model

|                                              |             |
|----------------------------------------------|-------------|
| WAVE DRIVEN CURRENTS                         | YES         |
| TIME STEP                                    | 6           |
| COUPLING PERIOD FOR TOMAWAC                  | 300         |
| MASS-BALANCE                                 | YES         |
| INFORMATION ABOUT SOLVER                     | YES         |
| FRICTION COEFFICIENT                         | 0.02        |
| LAW OF BOTTOM FRICTION                       | 4           |
| TURBULENCE MODEL                             | 4           |
| VELOCITY DIFFUSIVITY                         | 1           |
| CORIOLIS                                     | YES         |
| CORIOLIS COEFFICIENT                         | $1.14^E-04$ |
| ADVECTION                                    | YES         |
| TYPE OF ADVECTION                            | 1;5         |
| SUPG OPTION                                  | 0;1         |
| NUMBER OF SUB-ITERATIONS FOR NON-LINEARITIES | YES         |
| PROPAGATION                                  | 0.9         |
| FREE SURFACE GRADIENT COMPATIBILITY          | 0.6         |
| IMPLICITATION FOR DEPTH                      | 0.6         |
| IMPLICITATION FOR VELOCITY                   | 1           |
| INITIAL GUESS FOR H                          | 1           |
| TREATMENT OF THE LINEAR SYSTEM               | 2           |

|                                         |                       |
|-----------------------------------------|-----------------------|
| MATRIX STORAGE                          | 3                     |
| TREATMENT OF NEGATIVE DEPTHS            | 1                     |
| SOLVER ACCURACY                         | 1.00 <sup>E</sup> -05 |
| DISCRETIZATIONS IN SPACE                | 11;11                 |
| SOLVER                                  | 7                     |
| SOLVER OPTION                           | 5                     |
| MAXIMUM NUMBER OF ITERATIONS FOR SOLVER | 300                   |
| MASS-LUMPING ON H                       | 1                     |
| CONTINUITY CORRECTION                   | YES                   |
| MASS-LUMPING ON VELOCITY                | 0                     |
| WIND                                    | YES                   |
| OPTION FOR WIND                         | 2                     |

Table 5: Summary of the parameters used in TOMAWAC

|                                                |      |
|------------------------------------------------|------|
| NUMBER OF DIRECTIONS                           | 36   |
| MINIMAL FREQUENCY                              | 0.05 |
| NUMBER OF FREQUENCIES                          | 24   |
| TIME STEP                                      | 600  |
| NUMBER OF ITERATIONS FOR SMALL SCALE PROCESSES | 20   |
| FREQUENTIAL RATIO                              | 1.1  |
| BOUNDARY DIRECTIONAL SPREAD 1                  | 2    |
| TYPE OF BOUNDARY DIRECTIONAL SPECTRUM          | 6    |
| LIMIT SPECTRUM MODIFIED BY USER                | YES  |
| CONSIDERATION OF A WIND                        | YES  |
| LINEAR WAVE GROWTH                             | 1    |
| WIND GENERATION                                | 3    |



|                                                     |     |
|-----------------------------------------------------|-----|
| STATIONARY WIND                                     | NO  |
| MINIMUM WATER DEPTH                                 | 0.1 |
| CONSIDERATION OF SOURCE TERMS                       | YES |
| TRIAD INTERACTIONS                                  | 0   |
| WHITE CAPPING DISSIPATION                           | 2   |
| NON-LINEAR TRANSFERS BETWEEN FREQUENCIES            | 1   |
| BOTTOM FRICTION DISSIPATION                         | 1   |
| SURFACE ROLLERS                                     | NO  |
| DEPTH-INDUCED BREAKING DISSIPATION                  | 10  |
| DEPTH-INDUCED BREAKING 1 (BJ) HM COMPUTATION METHOD | 2   |
| DEPTH-INDUCED BREAKING 1 (BJ) COEFFICIENT GAMMA2    | 0.8 |
| DEPTH-INDUCED BREAKING 1 (BJ) COEFFICIENT GAMMA1    | 0.8 |
| DEPTH-INDUCED BREAKING 1 (BJ) COEFFICIENT ALPHA     | 0.8 |
| NUMBER OF ITERATIONS FOR THE SOURCE TERMS           | 1   |
| NUMBER OF BREAKING TIME STEPS                       | 4   |
| NUMBER OF SURFACE ROLLER TIME STEPS                 | 20  |
| REMOTE STORAGE OF CHARACTERISTICS                   | YES |

Table 6: Summary of parameters used in the GAIA model

|                                             |           |
|---------------------------------------------|-----------|
| MASS-BALANCE                                | YES       |
| FINITE VOLUMES                              | NO        |
| TYPE OF WAVES                               | 1         |
| NUMBER OF LAYERS FOR INITIAL STRATIFICATION | 1         |
| CLASSES TYPE OF SEDIMENT                    | NCO;NCO   |
| CLASSES SEDIMENT DENSITY                    | 2650;2650 |
| BED LOAD FOR ALL SANDS                      | YES       |

|                                          |               |
|------------------------------------------|---------------|
| SUSPENSION FOR ALL SANDS                 | NO            |
| BED-LOAD TRANSPORT FORMULA FOR ALL SANDS | 4             |
| CLASSES SETTLING VELOCITIES              | -9;-9         |
| CLASSES SHIELDS PARAMETERS               | -9;-9         |
| CLASSES SEDIMENT DIAMETERS               | 0.0002;0.0005 |
| LAYERS INITIAL THICKNESS                 | 100.;0.       |
| LAYERS NON COHESIVE BED POROSITY         | 0.4;0.4       |
| SLOPE EFFECT                             | YES           |
| FORMULA FOR SLOPE EFFECT                 | 1             |
| SEDIMENT SLIDE                           | YES           |
| EFFECT OF WAVES                          | YES           |
| BETA                                     | 1.6           |
| FORMULA FOR DEVIATION                    | 2             |
| PARAMETER FOR DEVIATION                  | 1.6           |

## References

- Breugem, W.A., Doorme, S., Bakhtiari, A., Figard, J., & Di Lauro, E. (2021). Speeding up TOMAWAC by means of improved numerical methods. *Proceedings of the XXVIIIth TELEMAC-MASCARET User Conference, 14th to 15th October 2021, Antwerp*
- Charnock, H. (1955). Wind stress on a water surface. *Quarterly Journal of the Royal Meteorological Society*, 81(350), 639–640.
- Komijani, H., Ortega Y.H., Zhang, Q., & Monbaliu, J. (2017). *Vergelijkende modellering. Monitoring Broersbank – Opstellen van een hydrodynamische modellensuite TELEMAC-TOMAWAC voor de Broersbank. Broersbank\_214341\_R06 in opdracht van Afdeling Kust - Agentschap Maritieme Dienstverlening en Kust - Vlaamse Overheid. Laboratorium voor Hydraulica, KU Leuven: Leuven*
- Wang, L., Kolokythas, G., Fonias, S., De Maerschalck, B., Vanlede, J., & Mostaert, F. (2021). *Modelling Belgian Coastal zone and Scheldt mouth area Modelling Belgian Coastal zone and Scheldt mouth area Sub report 13: Model setup and validation of the wave propagation model.*

## Appendix A CAS-files

### A.1 T2D cas files: hydr\_t2d\_gai.cas

```

PARALLEL PROCESSORS = 48
/-----/
/ TELEMAC2D Version V7P2r2 /
/-----/
TITLE ='Scaldis_Coast Morphological Model - ref001'

/-----/
/                               INPUT-OUTPUT, FILES /
/-----/
FORTRAN FILE           = 'user_fortran'
GEOMETRY FILE          = 'meshTelemac_2000.slf'
BOUNDARY CONDITIONS FILE = 'BC_tel.cli'
RESULTS FILE           = 'resultsHD.slf'
FORMATTED DATA FILE 1  = 'OBC_representative_tide137.txt'

WAVE DRIVEN CURRENTS      = YES
COUPLING WITH              = 'TOMAWAC2;GAIA'
TOMAWAC STEERING FILE     = 'wave_t2d_gai.cas'
COUPLING PERIOD FOR TOMAWAC = 300
GAIA STEERING FILE        = 'sed_t2d_gai.cas'

/-----/
/                               INPUT-OUTPUT, TIME STEP, GRAPHICS AND LISTING /
/-----/
TIME STEP                = 6.0
DURATION                  = 16070400
GRAPHIC PRINTOUT PERIOD   = 7450
LISTING PRINTOUT PERIOD   = 1800
NUMBER OF FIRST TIME STEP FOR GRAPHIC PRINTOUTS = 0
NUMBER OF FIRST TIME STEP FOR LISTING PRINTOUTS = 0

VARIABLES FOR GRAPHIC PRINTOUTS = U,V,H,S,B,N,O,R
NUMBER OF PRIVATE ARRAYS        = 3
NAMES OF PRIVATE VARIABLES      =
'WAVE HEIGHT HM0 M             ' ;
'PEAK PERIOD TPR5S              ' ;
'MEAN DIRECTION DEG             '

ORIGINAL DATE OF TIME          = 2017;12;30
ORIGINAL HOUR OF TIME          = 00;00;00

MASS-BALANCE                   = YES
INFORMATION ABOUT SOLVER       = YES

/-----/
/                               EQUATIONS, INITIAL CONDITIONS /
/-----/
INITIAL ELEVATION              = 1
INITIAL CONDITIONS              = 'CONSTANT ELEVATION'

```



```

/-----/
/              EQUATIONS, BOUNDARY CONDITIONS              /
/-----/
PRESCRIBED VELOCITIES                      =0;0;0;0;0;0;0
PRESCRIBED ELEVATIONS                      =1;1;1;1;1;1;1
OPTION FOR LIQUID BOUNDARIES                =1;1;1;1;1;1;1
TREATMENT OF FLUXES AT THE BOUNDARIES      =2;2;2;2;2;2;1

/-----/
/              FRICTION              /
/-----/
FRICTION COEFFICIENT                      =0.02
LAW OF BOTTOM FRICTION                    =4 / Manning

/-----/
/              TURBULENCE              /
/-----/
TURBULENCE MODEL                          =4
VELOCITY DIFFUSIVITY                      =1.0
CORIOLIS                                  =YES
CORIOLIS COEFFICIENT                      =1.13522E-04

/-----/
/              ADVECTION              /
/-----/
ADVECTION                                  =YES
TYPE OF ADVECTION                         =1;5
SUPG OPTION                              =0;1
NUMBER OF SUB-ITERATIONS FOR NON-LINEARITIES =1

/-----/
/              PROPAGATION              /
/-----/
PROPAGATION                               =YES
FREE SURFACE GRADIENT COMPATIBILITY        =0.9
IMPLICITATION FOR DEPTH                    =0.6
IMPLICITATION FOR VELOCITY                 =0.6
INITIAL GUESS FOR H                       =1

/-----/
/              TIDAL FLATS              /
/-----/
TIDAL FLATS                               =YES
OPTION FOR THE TREATMENT OF TIDAL FLATS    =1

/-----/
/              NUMERICAL PARAMETERS              /
/-----/
TREATMENT OF THE LINEAR SYSTEM              = 2
MATRIX STORAGE                             = 3
TREATMENT OF NEGATIVE DEPTHS                = 1
SOLVER ACCURACY                             = 1.E-5
DISCRETIZATIONS IN SPACE                    = 11;11
SOLVER                                       = 7
SOLVER OPTION                               = 5
MAXIMUM NUMBER OF ITERATIONS FOR SOLVER     = 300
MASS-LUMPING ON H                           = 1
CONTINUITY CORRECTION                       = YES

```

```

MASS-LUMPING ON VELOCITY                                = 0

/-----/
/                                WIND                    /
/-----/
WIND                                                    = YES
OPTION FOR WIND                                          = 2
COEFFICIENT OF WIND INFLUENCE                          = 0.565E-6
ASCII ATMOSPHERIC DATA FILE                          ='wind.txt'

&FIN

```

## A.2 TOMAWAC cas files: wave\_t2d\_gai.cas

```

PARALLEL PROCESSORS : 48

/-----/
/                                TOMAWAC - SCALDIS_COAST  /
/-----/
FORTRAN FILE              = 'user_fortran1'
GEOMETRY FILE             = 'meshWac.slf'
BOUNDARY CONDITIONS FILE  = 'BC_wac.cli'
2D RESULTS FILE          = resultsWAV.slf

/-----/
/                                GENERAL OPTIONS          /
/-----/
TITLE                    = 'SCALDIS_COAST Wave spectrum model'
DATE OF COMPUTATION BEGINNING = 201712300000
NUMBER OF DIRECTIONS     = 36
MINIMAL FREQUENCY        = 0.05
NUMBER OF FREQUENCIES    = 24
TIME STEP                = 600
NUMBER OF ITERATIONS FOR SMALL SCALE PROCESSES = 20
NUMBER OF TIME STEP      = 26784
FREQUENTIAL RATIO        = 1.1
PERIOD FOR GRAPHIC PRINTOUTS = 149
PERIOD FOR LISTING PRINTOUTS = 149
VARIABLES FOR 2D GRAPHIC PRINTOUTS =
HM0, TMOY, TPR5, TM02, DMOY, SPD, DBR, UWB

/-----/
/                                BOUNDARY CONDITIONS      /
/-----/
BOUNDARY SIGNIFICANT WAVE HEIGHT = 0.0
BOUNDARY DIRECTIONAL SPREAD 1    = 2
TYPE OF BOUNDARY DIRECTIONAL SPECTRUM = 6
LIMIT SPECTRUM MODIFIED BY USER = YES

/-----/
/                                PHYSICAL PARAMETERS      /
/-----/
CONSIDERATION OF A WIND          = YES
LINEAR WAVE GROWTH               = 1
WIND GENERATION                  = 3
STATIONARY WIND                  = NO

```

```

MINIMUM WATER DEPTH                      = 0.1
CONSIDERATION OF SOURCE TERMS            = YES

TRIAD INTERACTIONS                       = 0
WHITE CAPPING DISSIPATION                 = 2
NON-LINEAR TRANSFERS BETWEEN FREQUENCIES = 1
BOTTOM FRICTION DISSIPATION               = 1

SURFACE ROLLERS = NO
BETA S SURFACE ROLLERS                    = 0.07

DEPTH-INDUCED BREAKING DISSIPATION        = 10
DEPTH-INDUCED BREAKING 1 (BJ) HM COMPUTATION METHOD = 2
DEPTH-INDUCED BREAKING 1 (BJ) COEFFICIENT GAMMA2  = 0.80
DEPTH-INDUCED BREAKING 1 (BJ) COEFFICIENT GAMMA1  = 0.80
DEPTH-INDUCED BREAKING 1 (BJ) COEFFICIENT ALPHA   = 0.8

/-----/
/          NUMERICAL OPTIONS
/-----/
NUMBER OF ITERATIONS FOR THE SOURCE TERMS = 1
NUMBER OF BREAKING TIME STEPS = 4
NUMBER OF SURFACE ROLLER TIME STEPS = 20
REMOTE STORAGE OF CHARACTERISTICS = YES

&FIN

```

### A.3 GAIA cas files: sed\_t2d\_gai.cas

```

/-----/
/    FICHIER DES PARAMETRES DE GAIA
/-----/
BOUNDARY CONDITIONS FILE = 'BC_sis.cli'
GEOMETRY FILE            = 'meshTelemac_2000.slf'
RESULTS FILE             = 'resultsSED.slf'
FORTRAN FILE             = 'user_fortran2'

/-----/
/  PARAMETRES DE SORTIE
/-----/
VARIABLES FOR GRAPHIC PRINTOUTS      : E,A,G,D50
NUMBER OF PRIVATE ARRAYS              : 2
NAMES OF PRIVATE VARIABLES           :
'SOLID DISCH XAVGKG/M/S              ' ;
'SOLID DISCH YAVGKG/M/S              '
MASS-BALANCE                         = YES

/-----/
/  PARAMETRES NUMERIQUES
/-----/
FINITE VOLUMES                      = NO
MORPHOLOGICAL FACTOR ON TIME SCALE   = 20
TYPE OF WAVES: 1
SPINUP TIME FOR BED UPDATING: 86400

```

```

/-----
/ PARAMETRES PHYSIQUES
/-----
NUMBER OF LAYERS FOR INITIAL STRATIFICATION = 1
CLASSES TYPE OF SEDIMENT                  = NCO;NCO
CLASSES SEDIMENT DENSITY                   = 2650.;2650.
BED LOAD FOR ALL SANDS                     = YES
SUSPENSION FOR ALL SANDS                   = NO
BED-LOAD TRANSPORT FORMULA FOR ALL SANDS   = 4
CLASSES SETTLING VELOCITIES                = -9;-9
CLASSES SHIELDS PARAMETERS                 = -9;-9
CLASSES SEDIMENT DIAMETERS                 = 0.0002;0.0005
LAYERS INITIAL THICKNESS                    = 100.;0.
LAYERS NON COHESIVE BED POROSITY            = 0.4;0.4
SLOPE EFFECT                              = YES
FORMULA FOR SLOPE EFFECT                    = 1 / Koch and Flokstra
SEDIMENT SLIDE                             = YES
EFFECT OF WAVES                            = YES
BETA                                       = 1.6
FORMULA FOR DEVIATION                      =2
PARAMETER FOR DEVIATION                   =1.6

/-----
/                                     NESTOR
/-----
NESTOR ACTION FILE                        = _DigActions.dat
NESTOR POLYGON FILE                       = _DigPolys.dat
NESTOR SURFACE REFERENCE FILE             = _DigWsp_Prof_00.dat
NESTOR = YES
ORIGINAL DATE OF TIME                     =2017;12;30
ORIGINAL HOUR OF TIME                      =00;00;00

&ETA

```

## Appendix B Overview of model runs

### B.1 Overview reported validationruns

Overview of the model runs used in this report

[repoSpNumMod/TELEMAC/Scaldis-Kust/21\\_104\\_Release\\_Scaldis-Kust\\_2025/Valodationruns\\_report\\_WL2024R21\\_104\\_2 — VisualSVN Server](#)

Update to TELEMAC v8p2

| Run description | Path                       | Run ID                     |
|-----------------|----------------------------|----------------------------|
| SISYPHE, v7p2   | \01-VersionTest\OldVersion | HSW113_slurm               |
| SISYPHE, v8p3   | \01-VersionTest\NewVersion | HSW113b_BK_layer_GT_update |
| GAIA, v8p3      | \04-GaiaTest               | HSW113_J06                 |
| GAIA, v8p4      | \04-GaiaTest               | HSW113_K03                 |

Wind shear force formulation in v8p2

| Run description                          | Path     | Run ID  |
|------------------------------------------|----------|---------|
| without effects of wind on hydrodynamics | \08_Wind | SKG_D01 |
| with effects of wind on hydrodynamics    | \08_Wind | SKG_D02 |

Timestep in the wave model

| Run description               | Path     | Run ID    |
|-------------------------------|----------|-----------|
| previous non-optimized scheme | \12_Wave | SKGT_B003 |
| latest optimized scheme       | \12_Wave | SKGT_B004 |

Morphology model validation

| Run description                                | Path          | Run ID      |
|------------------------------------------------|---------------|-------------|
| Bed evolution next to Western dam of Zeebrugge | \04-GaiaTest  | HSW113_K17a |
| Zeebrugge hindcast since 1986                  | \07_Zeebrugge | ZB1986_C02a |



|                                         |              |             |
|-----------------------------------------|--------------|-------------|
| Erosion in front of Wenduine            | \04-GaiaTest | HSW015b_C01 |
| Annual sedimentation at Blankenberge    | \04-GaiaTest | HSW071_D13  |
| Storm-induced siltation at Blankenberge | \04-GaiaTest | HSW113_L09  |

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