University of Utrecht

Morphodynamics of Wave-dominated Coasts
GEO4-4434
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Practical 5

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1 5.2 : Data/model comparison for Egmond

- *Create three figures, one for each tide, each of them divided in three sub-plots:*

  - in the top part, plot the cross-shore evolution of Hrms predicted by the BJ model. Add also the wave height data.

  - in the middle part, plot the modelled mean alongshore current as well as the measured values.

  - in the bottom part plot the cross-shore evolution of the bed profile.

Figure (1.1), Figure (1.2) and Figure (1.3) demonstrate the cross-shore evolution of the root mean square(H_{rms}) predicted by the BJ model, the modelled and measured values of the mean alongshore current and the bed profile. Each figure covers different tide condition, from low to mid and eventually high tide respectively.

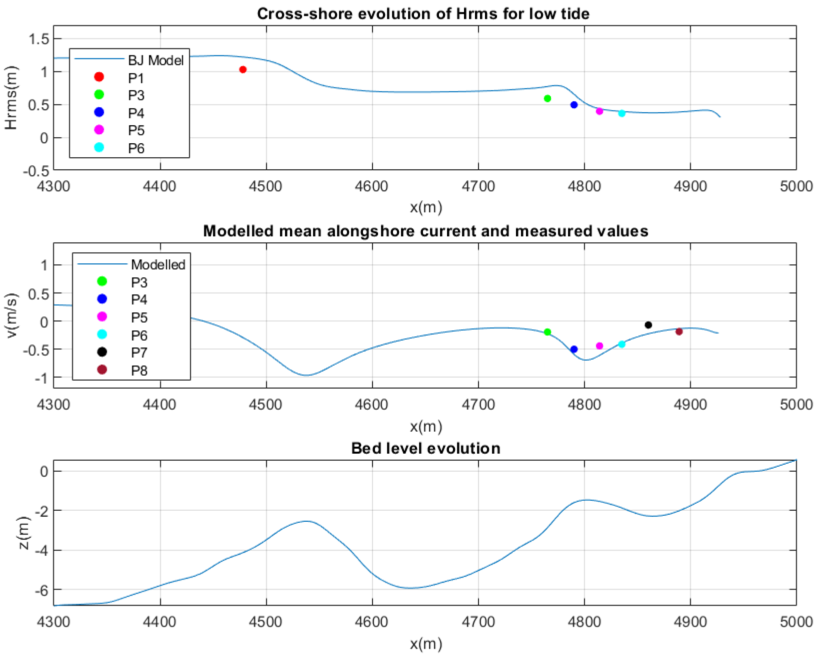

Figure 1.1: Top subplot: Cross-shore evolution of observed and modelled H_{rms} for low tide. Middle subplot: modelled and observed alongshore current v for low tide. Bottom subplot: cross-shore bed level evolution.

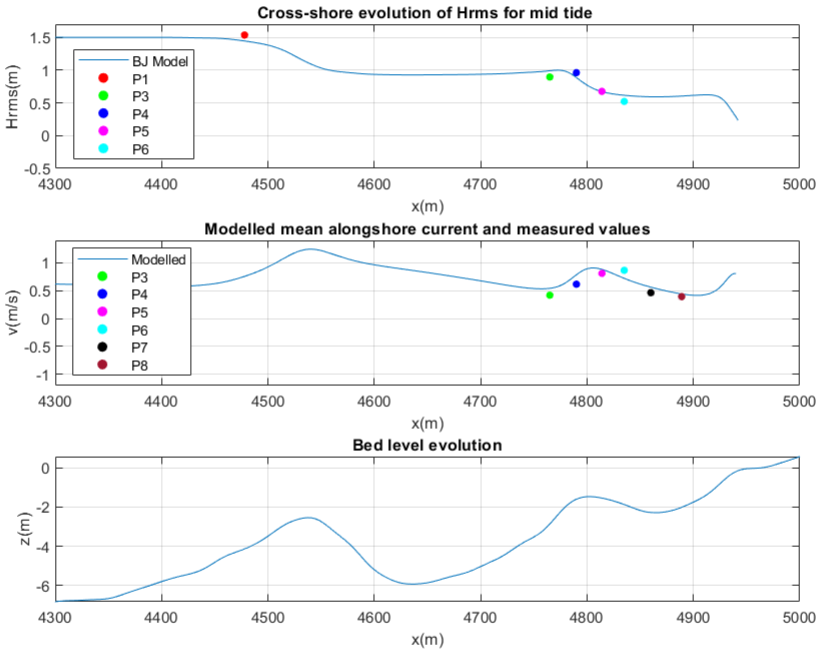

Figure 1.2: Top subplot: Cross-shore evolution of observed and modelled H_{rms} for mid tide. Middle subplot: modelled and observed alongshore current v for mid tide. Bottom subplot: cross-shore bed level evolution.

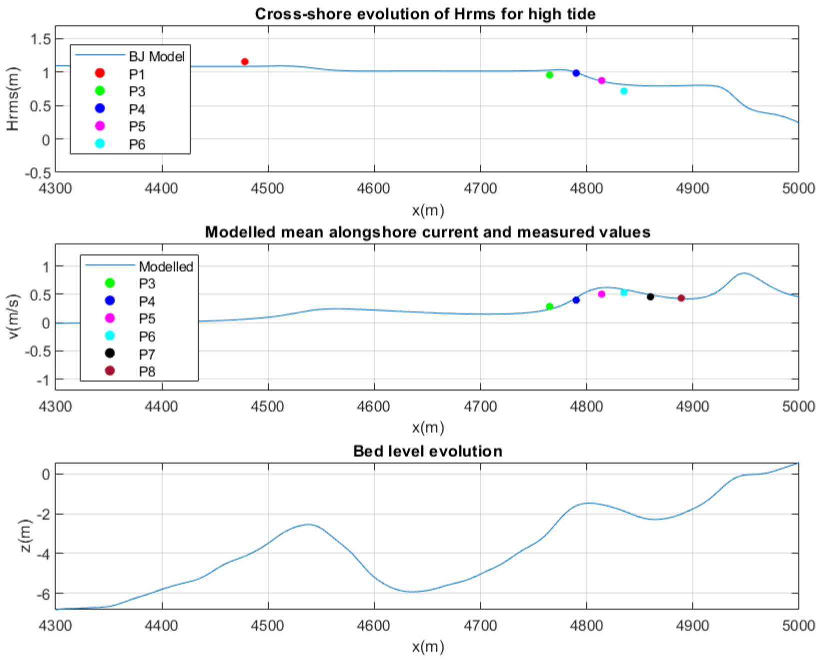

Figure 1.3: Top subplot: Cross-shore evolution of observed and modelled H_{rms} for high tide. Middle subplot: modelled and observed alongshore current v for high tide. Bottom subplot: cross-shore bed level evolution.

- *Discuss the differences between the three cases (direction of the current, intensity of the peaks).*

  In Chapter 4, the evolution of H_{rms} was discussed thoroughly. As can be seen here, it follows the same behaviour. In addition, from the figures above, the influence of the bed elevation on the alongshore current can be observed. For all tide conditions, it is noticed that an increase in bed elevation leads to a decrease in H_{rms} while the alongshore current is affected by shoaling and breaking of the waves. At the points where the bed is steep, a peak is observed in the alongshore current. This happens because the rise of bed elevation results in wave breaking and the enlargement of the current compensates for the energy of the wave that dissipates.

  The increase of alongshore currents when H_{rms} declines is clearly observed for the mid and high tide conditions. On the other hand, for the low tide situation the BJ model predicts an increase in the negative values, meaning that the alongshore current switches direction. This is related to the angle of incidence of the wave which is negative ($\theta = -36°$) for the low tide condition. In mid tide, the model predicts a slight increase in the current as the wave hits the coast. This could be a result as the longshore current compensates for the roller dissipation. During high tide the alongshore current increases towards the coast. Due to the increased water height, the effect of the breaking is diminished resulting in a decrease of the alongshore current.

  Overall, it can be concluded that the measurements are in accordance with the model in the majority of the points of observation.

- *Compute the rms errors (RMSE) for the alongshore current for the low, mid and high tides.*

  The root mean square error for low, mid and high tide are shown in Table 1.

Type of tide	RMSE (m/s)
Low tide	$1.04 \cdot 10^{-1}$
Mid tide	$1.17 \cdot 10^{-1}$
High tide	$6.01 \cdot 10^{-2}$

Table 1: Root mean square errors for the different tides.

2 5.3 : Complementary analysis

- *Compare the results of simulations with and without considering wind effects. Discuss the importance of wind forcing.*

  The top subplot of Figure 2.1 shows a comparison of the simulations with and without wind forcing. No clear difference between the two lines is depicted indicating that the role of wind forcing is rather small. In detail, calculating the wind forcing for low tide condition gives a result in the order of $O(-5)$ and can be considered negligible.

- *Keeping the wind forcing off, compare now simulations with and without considering tidal forcing. Discuss the influence of tidal forcing.*

  A comparison of the simulations with and without tidal forcing, keeping the wind forcing off, is shown in the middle subplot of Figure 2.1. Large differences in the alongshore current is depicted for x ranging between 0 and 4500, where the alongshore current of the simulation with tidal forcing is always higher than the alongshore current without tidal forcing. The simulation without tidal forcing shows that the alongshore current v is zero up to $x \approx 4400$ meter, after which it starts to decrease. Small differences are depicted in the range 4500 m $< x <$ 5000 m, indicating that the influence of tidal forcing is important at more offshore locations. This is due to the fact that the tides define the current at this location.

- *Set wind and tide back to their actual values and run a simulation with waves arriving normally to the shore. Analyse the results.*

  The bottom subplot of Figure 2.1 shows a comparison between the simulations run with $\theta = -36°$ and $\theta = 0°$. Clearly, changing θ has only effect in the range 4500$< x <$5000, i.e. onshore locations.

The alongshore current with $\theta = 0°$ is higher at the onshore locations. Furthermore, a negative angle of incidence results in negative onshore velocities, while an angle of incidence of 0 degrees results in positive onshore velocities. This means that the current flows in different directions.

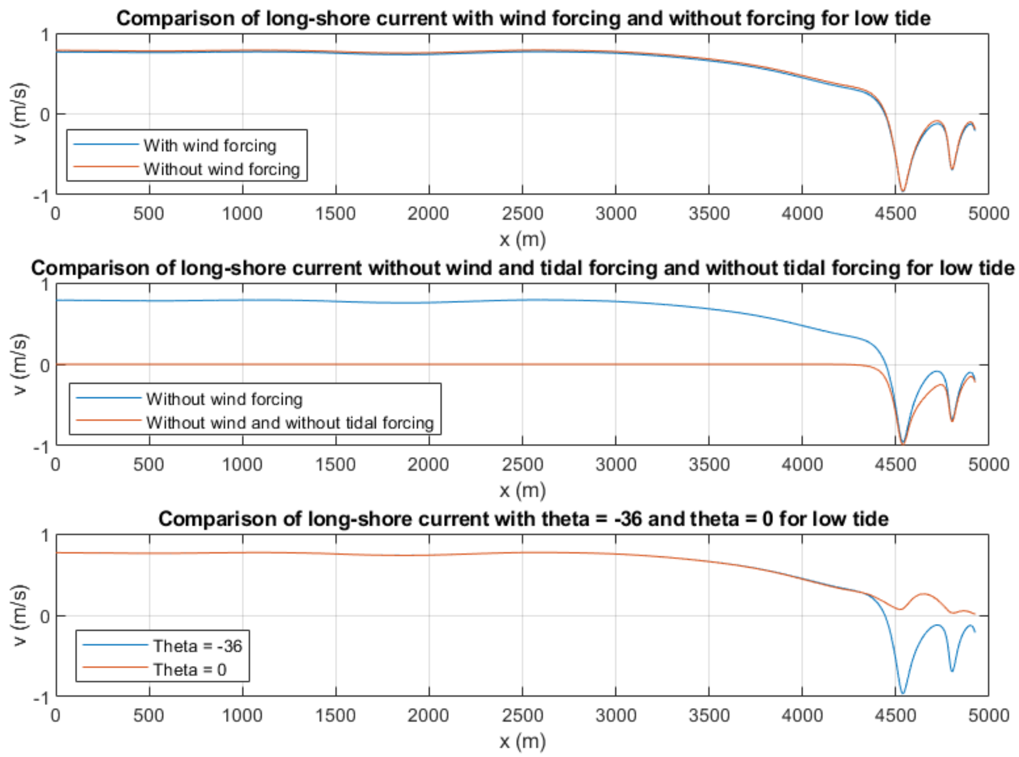

Figure 2.1: Top subplot: Comparison of alongshore current (v) with and without wind forcing in case of low tide. Middle subplot: Comparison of alongshore current (v) without wind forcing and without wind and tidal forcing in case of low tide. Bottom subplot: Comparison of alongshore current (v) with $\theta = -36°$ and $\theta = 0°$ in case of low tide.

- *Conclude on the relative importance of the different forcing terms. Where are each of them important?*

  Wind forcing has no clear effect on the alongshore current, while tidal forcing and the angle of incidence do. Tidal forcing results in a higher alongshore current at offshore locations, while a higher angle of incidence results in higher alongshore currents at onshore locations. Furthermore, the angle of incidence has an influence on the direction of the onshore current. A negative angle of incidence corresponds to a negative alongshore current in the onshore region, while an angle of incidence of 0 degrees results in a positive current. It can therefore be concluded that the offshore locations are tide dominated and the onshore locations wave dominated.