University of Utrecht

Morphodynamics of Wave-dominated Coasts
GEO4-4434
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Practical 2

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1 2.1 Computation of the density spectrum

- *Compute the variance density spectrum for the most offshore location at low tide using only one block. Plot the spectrum and lines representing the confidence interval.*

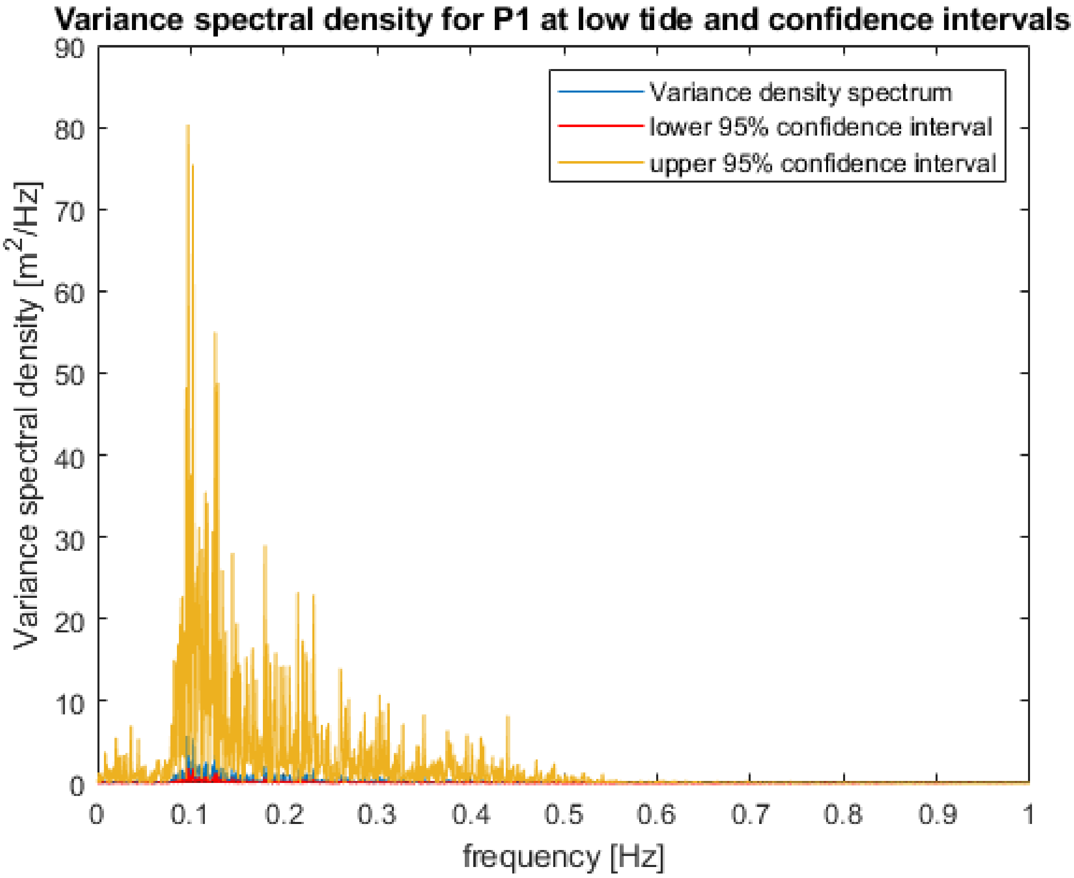

Figure 1.1: The variance density spectrum for P1 at low tide with the upper and lower 95% confidence interval(green and red).

- *Compare with the spectra obtained using 3, 7, 15, 31 blocks. Before starting the computations, determine carefully the block length nfft for each case, keeping in mind the* 50% *overlap.*

Taking into account the 50 percent overlap, we will have that the block length will be defined as

$$\frac{2n}{\#blocks + 1} \tag{1.1}$$

Figure 1.2 shows the variance density spectrum for the most offshore location at low tide using $3, 7, 15$ and 31 blocks each time. It can be observed that by increasing the amount of blocks the 95% confidence interval is getting smaller and the spectra analysis becomes more accurate. However, the fluctuations of the signal are decreasing, the spectrum becomes less noisy and as a result more information is lost.

- *What seems to be an optimal block size for our signal and why?*

As mentioned above, an increase in the number of blocks results in reliability of the variance density but also reduces the spectral resolution. Hence the challenge is to determine which figure has the highest number of blocks while maintaining the required spectral resolution. Choosing 15 blocks($nfft = N/8$) is the best representation of the variance density spectrum. The confidence interval is reasonable and adequate information can be derived for all the frequencies. Also, it is less noisy than the 7 blocks graph and it has higher resolution when compared to the 31 blocks figure.

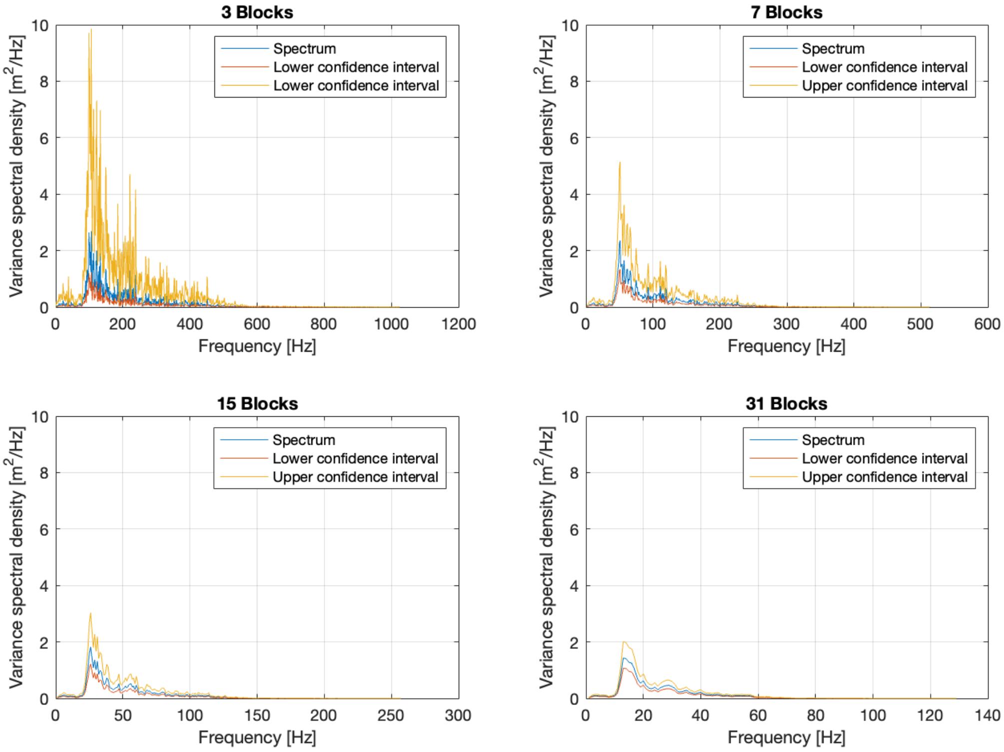

Figure 1.2: Change of the spectrum for 3, 7, 15 and 31 blocks.

- *Plot on a new figure (vertical subplots) the spectra at the positions P1 to P6 for the low tide Egmond data. Ensure that all axes have the same range on the x- and y-directions.*

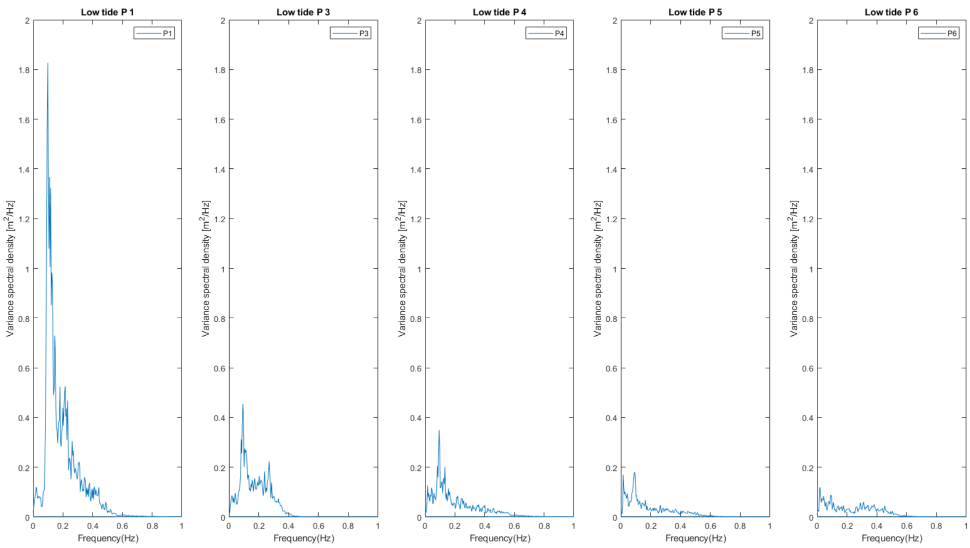

Figure 1.3: The variance density spectrum of low tide data for 15 blocks for the different observation points.

- *The separation between infragravity-wave and sea-swell frequencies is often set to* 0.05 *Hz. Based on the spectra at the most off-shore sensor, do you feel that this choice is appropriate for Egmond?*

Looking closer at the spectrum of the location P1, it can be seen that the local minimum that separates the infra-gravity and swell waves is approximately at 0.058 Hz. Therefore the choice of 0.05 Hz is appropriate for Egmond.

- *Comment the cross-shore evolution of the spectra.*

In Figure 1.3, the variance density spectrum at the positions P1 to P6 for the low tide Egmond data is plotted using the optimal amount of blocks. Moving landwards(P1 $\longrightarrow$ P6) it can be noticed that the energy of the swell waves is decreasing significantly. This is happening mainly due to the bed friction which increases with the bed elevation towards P6, and results in the breaking of the waves. Eventually, after P6 a few waves remain which will break when the bed elevation reaches 0.

2 2.2 Computation of spectral wave characteristics

- *Compare these values to the significant wave height* $H_{\frac{1}{3}}$ *computed during the previous practical* $(H_{\frac{1}{3}} \approx H_{m0})$

The total wave height H_{m0} for the 5 time series during all tides is shown in Figure 2.1 where it is compared to the significant wave height $H_{1/3}$ at the different sensor locations. It is observed that both the H_{m0} and the $H_{1/3}$ decrease with cross-shore position, as expected. Furthermore, it is shown that H_{m0} and $H_{1/3}$ are always nearly equal to each other for the different tides at the different locations. To verify whether $H_{m0} \approx H_{1/3}$, H_{m0} is plotted against $H_{1/3}$ and a linear fit is produced using the *polyfit* function in Matlab. Figure 2.2 shows the linear fit together with the wave height measurements for the different tides. From the plot, it can indeed be concluded that $H_{m0} \approx H_{1/3}$.

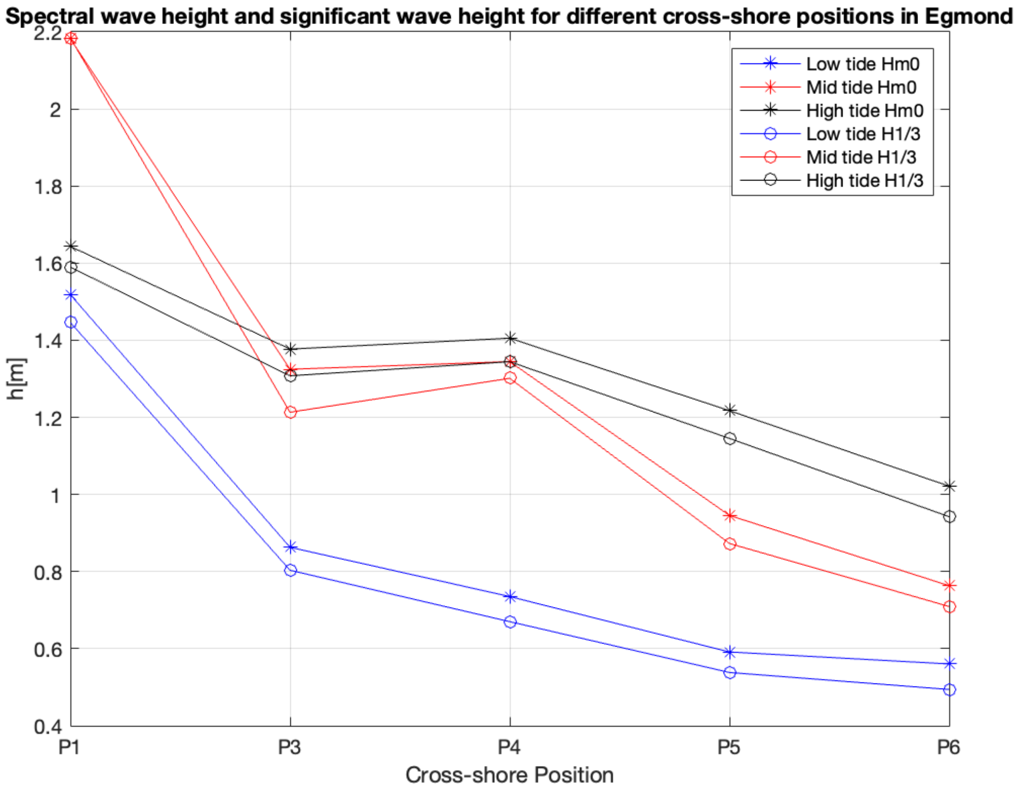

Figure 2.1: Spectral wave height and significant wave height for different cross-shore positions in Egmond for low, mid and high tide.

- *Compute also $H_{m0,ss}$ and $H_{m0,inf}$. Examine their cross-shore evolution for the low tide data.*

Figure 2.3 shows the cross-shore evolution of the infragravity and sea-swell wave height. Clearly, the sea-swell wave height is much higher than the infragravity wave height. Furthermore, the sea-swell wave height decreases with cross-shore position while the infragravity wave height remains fairly constant. This is due to the fact that the sea-swell waves are affected by the presence of the bed which results in breaking of the waves. Infragravity waves, on the other hand, are too small to be affected by the increase in bed height.

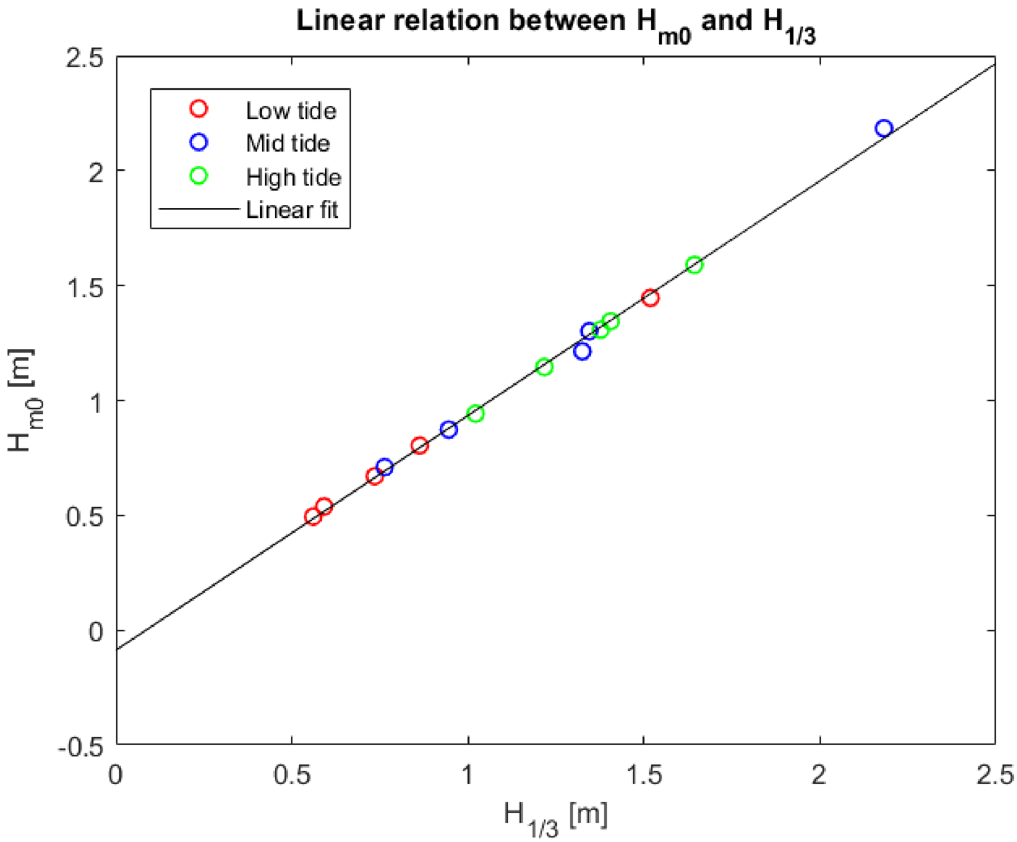

Figure 2.2: Spectral wave height plotted against the significant wave height for the different tides. The black line corresponds to the linear fit.

- *Compute the peak period for the different time-series. The peak period T_p is the period with the highest variance density. Discuss the computed values.*

The peak periods for the different time series are shown in Figure 2.4. It can be observed that the peak periods of the low tides are the highest at all positions. Furthermore, for all three tides, the peak period increases with cross-shore position. This is due to the fact that the variance density decreases with cross-shore position as the waves become less energetic.

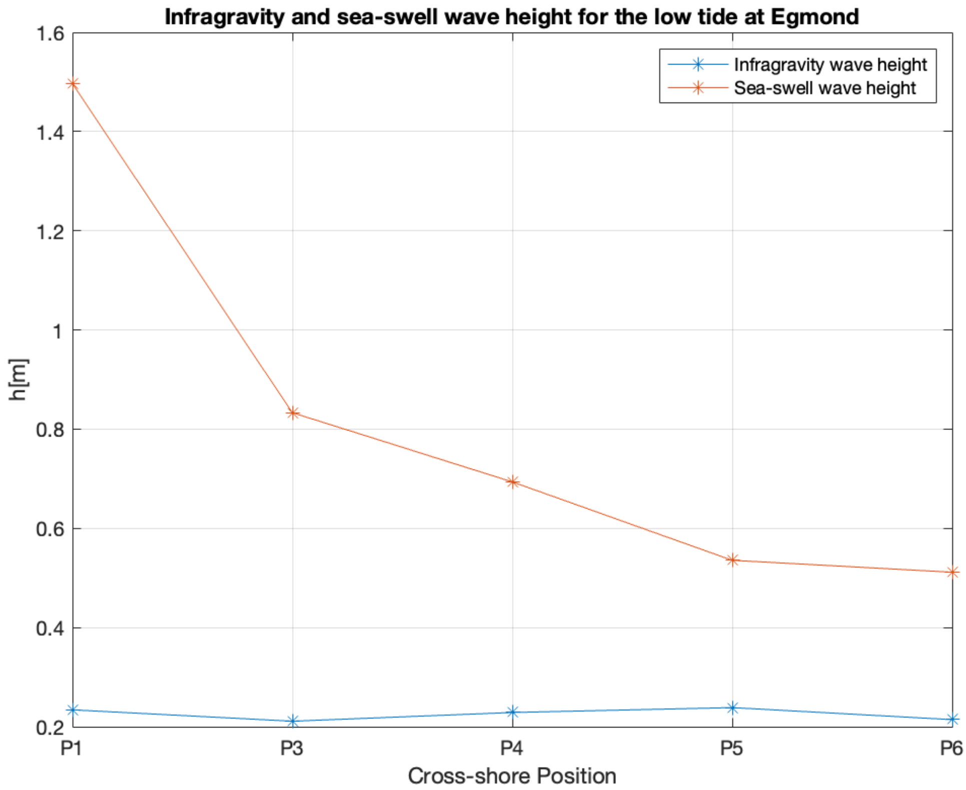

Figure 2.3: Cross-shore evolution of the sea-swell wave height and the infragravity wave height for the low tide in Egmond.

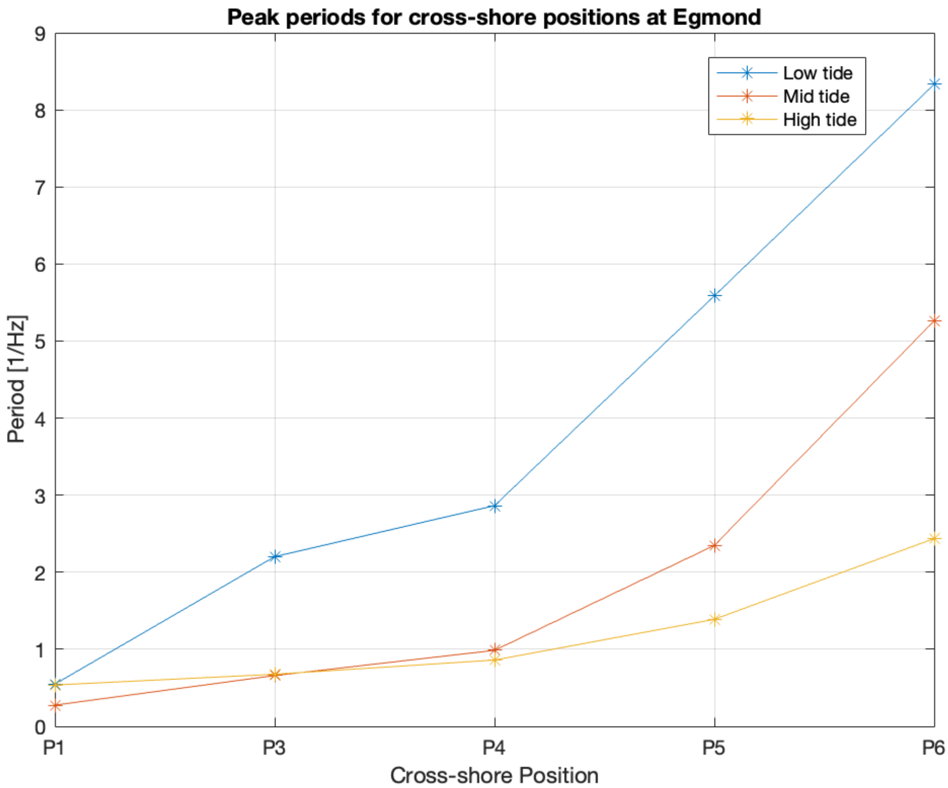

Figure 2.4: Peak periods of low, mid and high tide over cross-shore positions.