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Jersey Shoreline Management Plan

Hydraulic Modelling Report: Wave Model Calibration (Appendix F)

Government of Jersey

Project number: 60580871

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Quality information

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Revision History

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1	February 2019	Draft	February 2019	Mark Davin	Associate Director
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F.1 Model Approach

AECOM has applied the MIKE21 Flexible Mesh Spectral Wave (SW) model to provide wave conditions for the Jersey Shoreline Management Plan (SMP). The MIKE21 software was developed by the Danish Hydraulics Institute (DHI). It is a state-of-the-art wave transformation model based on triangular mesh elements which are able to provide enhanced resolution covering important features such as local variations in bathymetry. The model simulates growth, decay and transformation of wind-generated waves and swells in offshore and coastal areas. The model is capable of reproducing the combined effects of shoaling, refraction, diffraction, reflection, wave breaking and directional spreading.

An existing wave model (Figure F-1) was developed by WSP (2016) to transform offshore waves to the Jersey coastline under various combinations of wave, wind and water level. However, the wave model was not calibrated and the accuracy of wave transformation is unknown. In the present study, AECOM has calibrated the existing model for selected storm events against the local wave buoy data to provide an improved model performance.

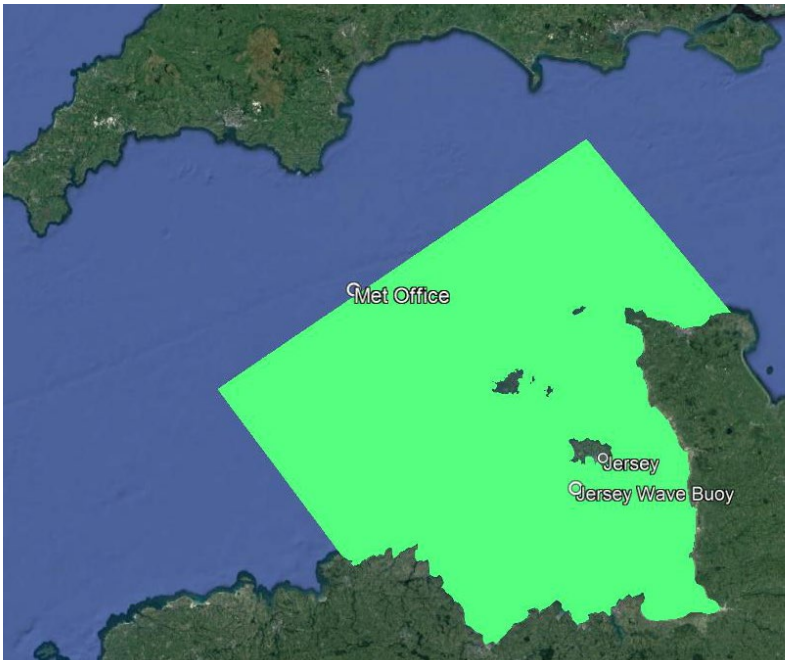

Figure F-1: Model Domain and Data Points

F.2 Wave and Wind Data

Offshore Wave and Wind

For the model calibration, AECOM purchased hindcast offshore wave data and wind conditions from the UK Met Office (UKMO). The time-series data is available at hourly intervals for the years 2008, 2016 and 2017. The grid point from the UKMO model at the offshore boundary (labelled 'Met Office') is shown in Figure F-1.

Figure F-2 and Figure F-3 show wave and wind roses for the UKMO data point. The directional resolution in each rose plot is 30°. The wave rose indicates that prevailing waves come from south-west and west. The wind rose shows wind coming from all directions although the strongest winds are from the sector between south-west and north-west.

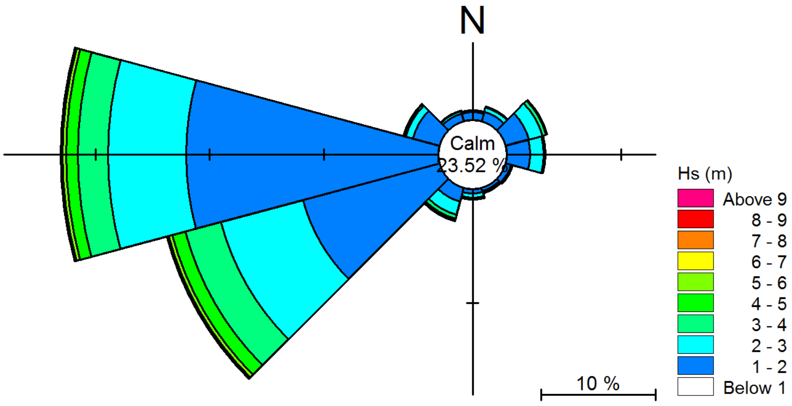

Figure F-2: Wave Rose for UKMO data (significant wave height, Hs)

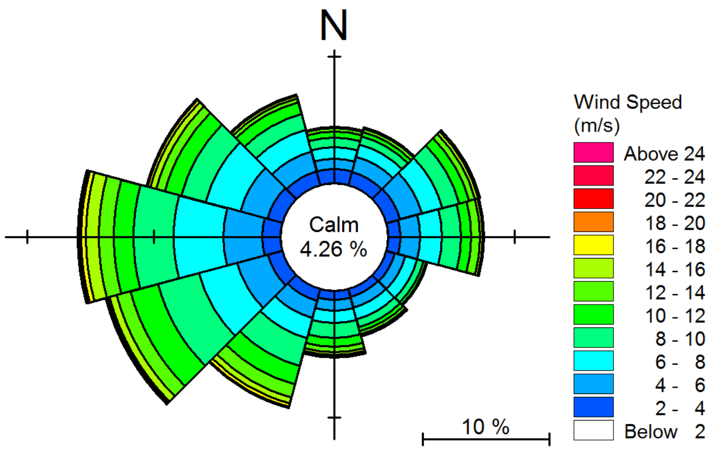

Figure F-3: Wind Rose for UKMO data

Measured Wave Data

Measured nearshore wave data has been provided by the client for the Jersey Wave Buoy location (Figure F-1). The data covers a period from 1996 to 2017 at hourly intervals, although data for 2008 is missing. The recorded measurements include significant wave height, wave period and direction. The wave buoy was located approximately 12km from St Aubin's Bay and has been used as the primary calibration point. The water depth at the wave buoy is approximately 30m. A wave rose plot for the Jersey Wave Buoy data is presented in Figure F-4.

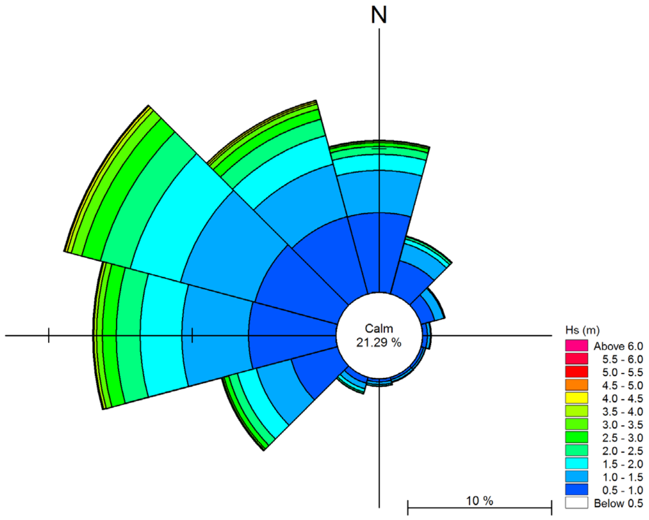

Figure F-4: Wave Rose at Jersey Wave Buoy (significant wave height, Hs)

F.3 Wave Model Domain and Mesh

The model domain covers the entire Channel Islands, as indicated by the green shaded area in Figure F-1 and is based on WSP's existing bathymetric data to transform offshore waves into the shallow water area. These datasets were interpolated onto the model mesh. The bathymetry is referenced to JTM / ETRS89 horizontal projection with levels referred to the OD (Local) vertical datum.

The flexible mesh of triangular elements was generated using the MIKE-Zero Mesh Generator. Figure F-5 shows the full extent of the model mesh. Resolution across the model domain is variable with high resolution around the coastline of both Jersey and Guernsey. In the offshore area, this resolution is around 4000m increasing to 20m for the areas of greatest interest (Figure F-6).

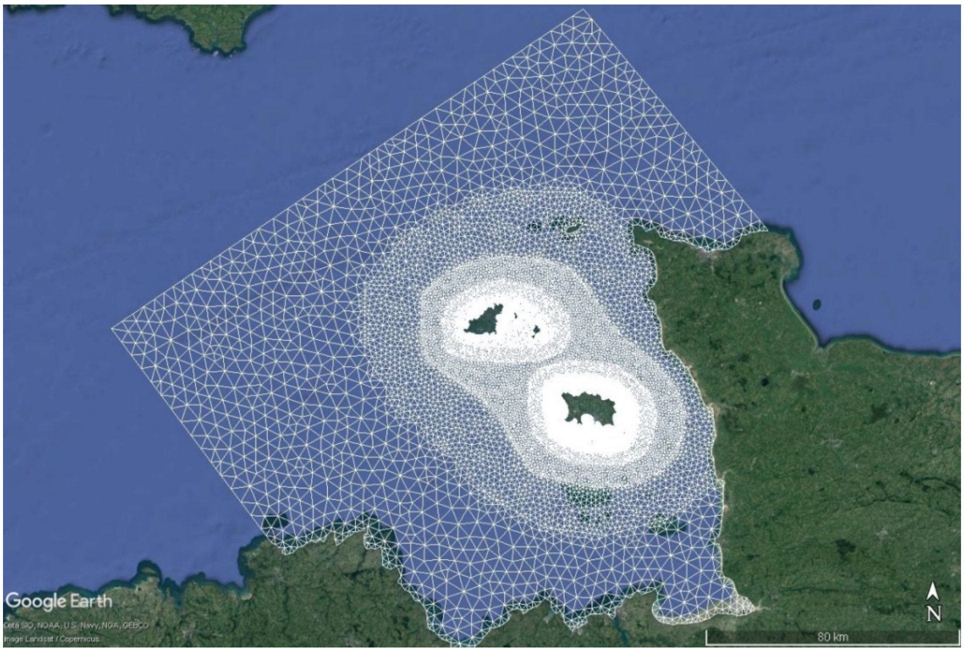

Figure F-5: Full Extent of Wave Model Mesh

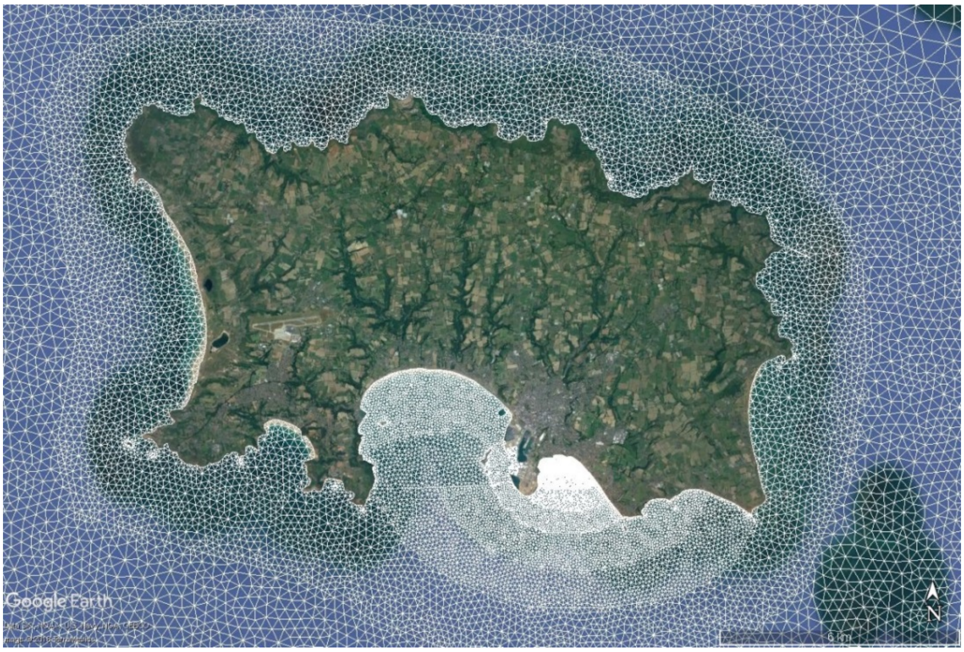

Figure F-6: Model Mesh Refinement around Jersey Coastline

F.4 Wave Model Calibration

Calibration of the MIKE21 Spectral Wave (SW) model involves fine-tuning of the model parameters (breaking index, friction, dissipation and wind air-sea interaction) to provide the best agreement between simulated and measured significant wave height, wave period and direction. To demonstrate the improvement that has been achieved with the AECOM model set-up, the results from the WSP model are also included in our presentation of model calibration for a comparison purpose.

Time-varying wave conditions from the UKMO model were applied along the offshore boundary and transformed to the Jersey Wave Buoy with a time-varying wind field also applied over the model domain. To include the influence of varying water depth on wave transformation, AECOM applied measured water levels in the model (tide and surge) from the operational gauge at St Helier, Jersey. The dataset was made available by the British Oceanographic Data Centre *(*BODC) and covers a period of 25 years from 1993 to 2018 with data provided at 15 minute intervals. The wave model calibration was carried out for the following four separate storm events in 2016, 2017 and 2018.

- **Event 1** - February 2016
- **Event 2** - February & March 2017
- **Event 3** - October 2017
- **Event 4** - December 2017 and January 2018

Comparisons of the model prediction from the AECOM and WSP model set-ups with the measured data are shown in Figure F-7 to Figure F-18.

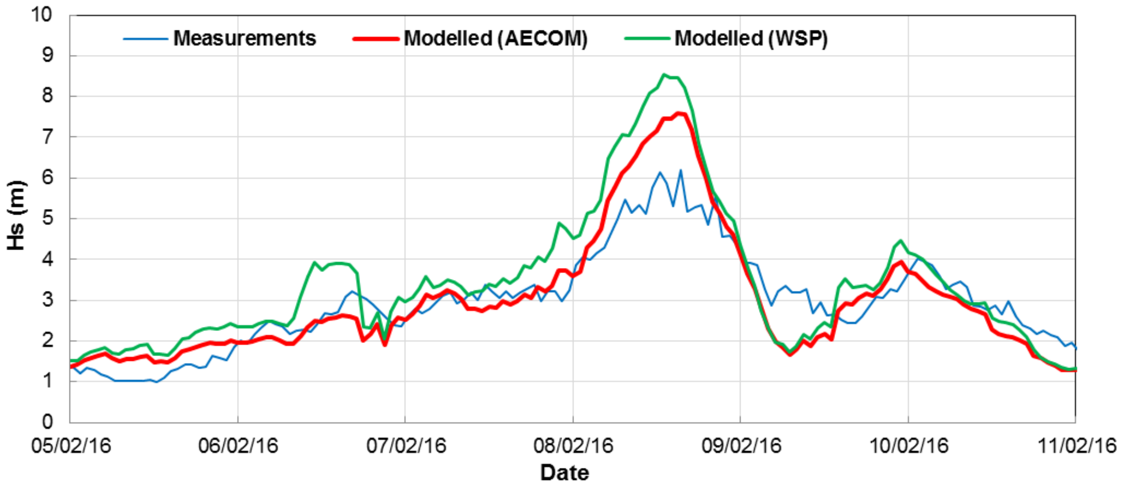

Figure F-7: Calibration of Significant Wave Height (Event 1 - February 2016)

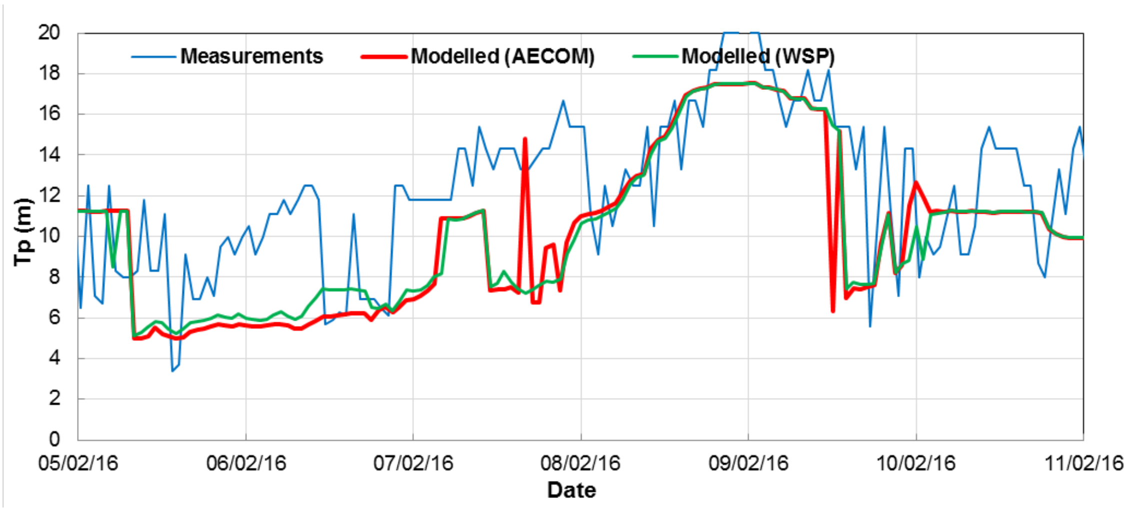

Figure F-8: Calibration of Wave Period (Event 1 - February 2016)

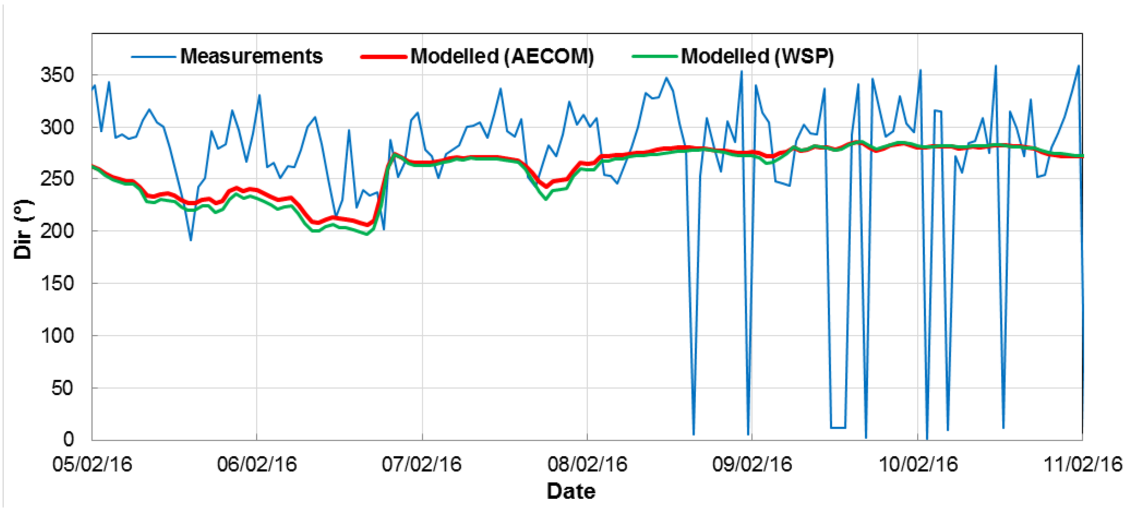

Figure F-9: Calibration of Wave Direction (Event 1- February 2016)

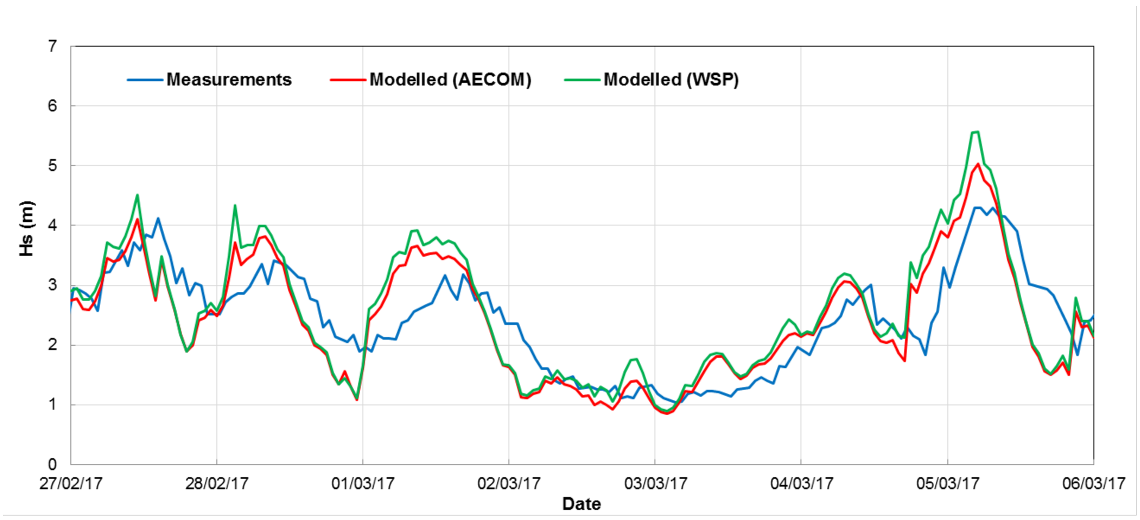

Figure F-10: Calibration of Significant Wave Height (Event 2 – February & March 2017)

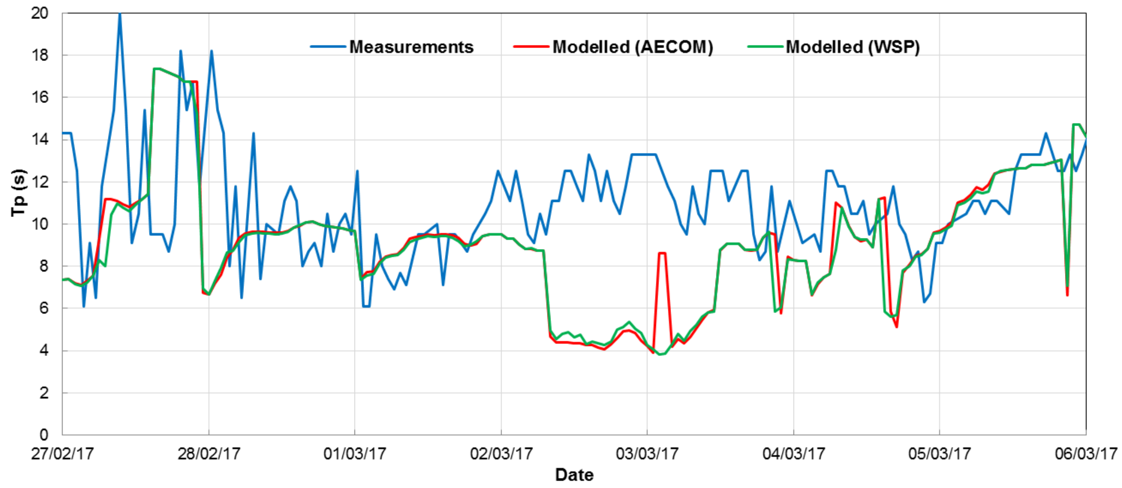

Figure F-11: Calibration of Wave Period (Event 2 – February & March 2017)

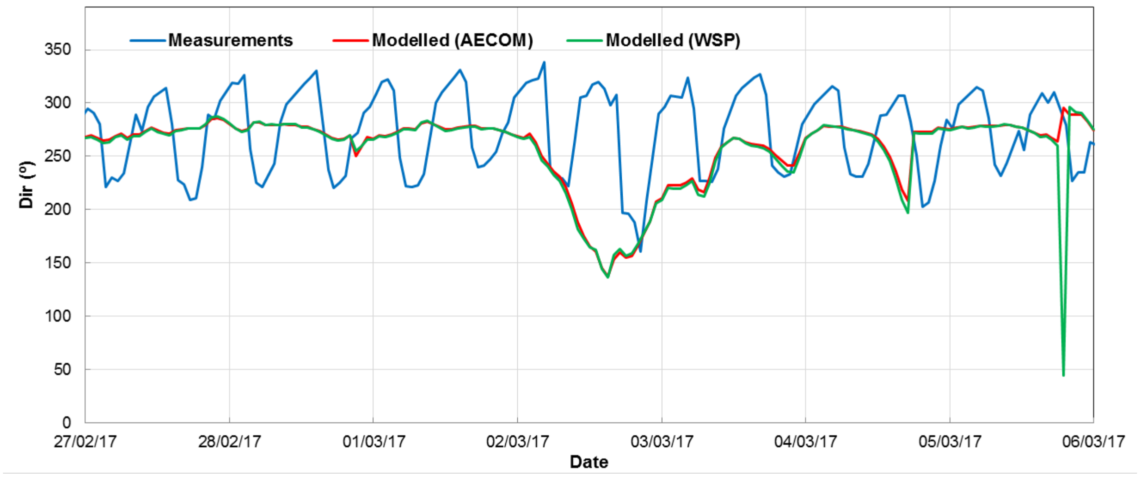

Figure F-12: Calibration of Wave Direction (Event 2 – February & March 2017)

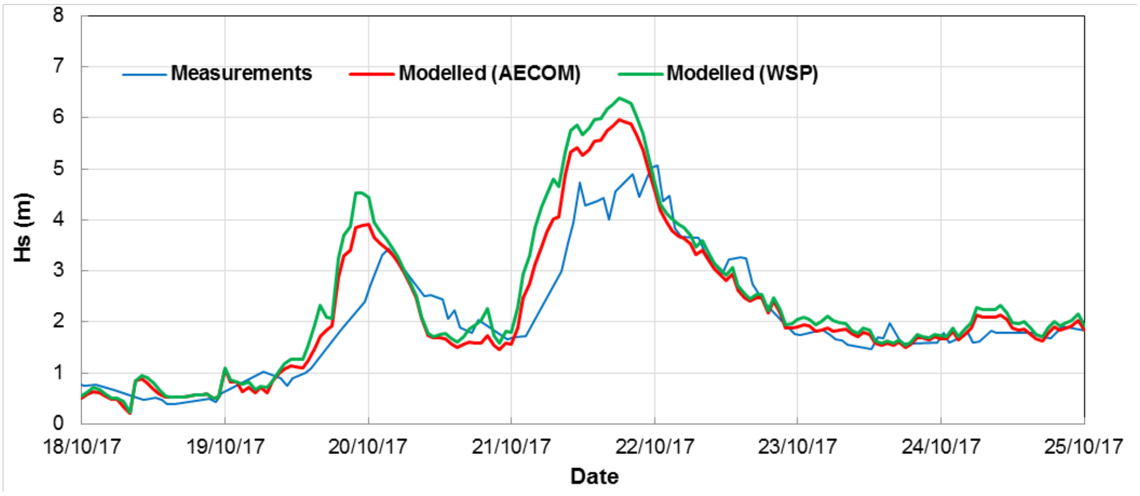

Figure F-13: Calibration of Significant Wave Height (Event 3 – October 2017)

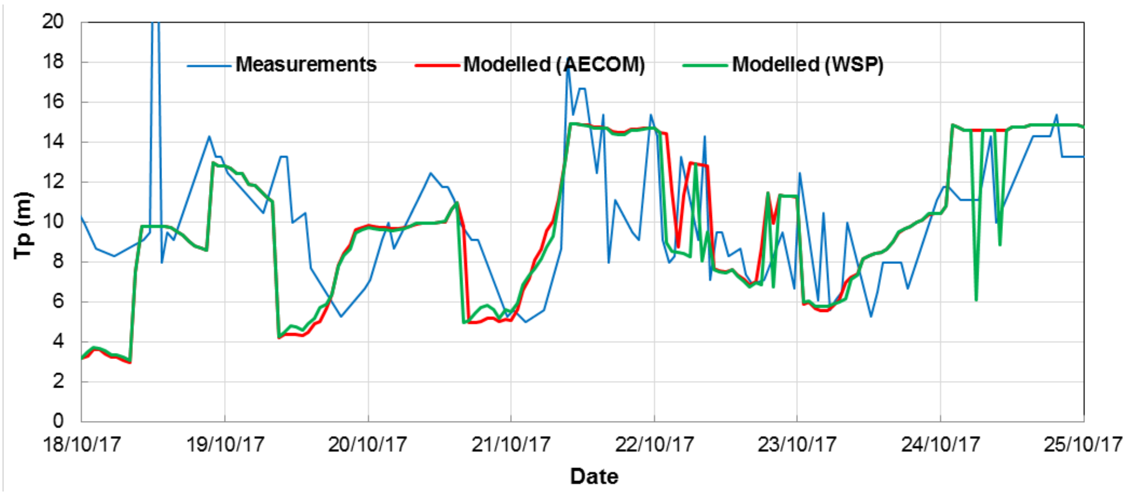

Figure F-14: Calibration of Wave Period (Event 3 – October 2017)

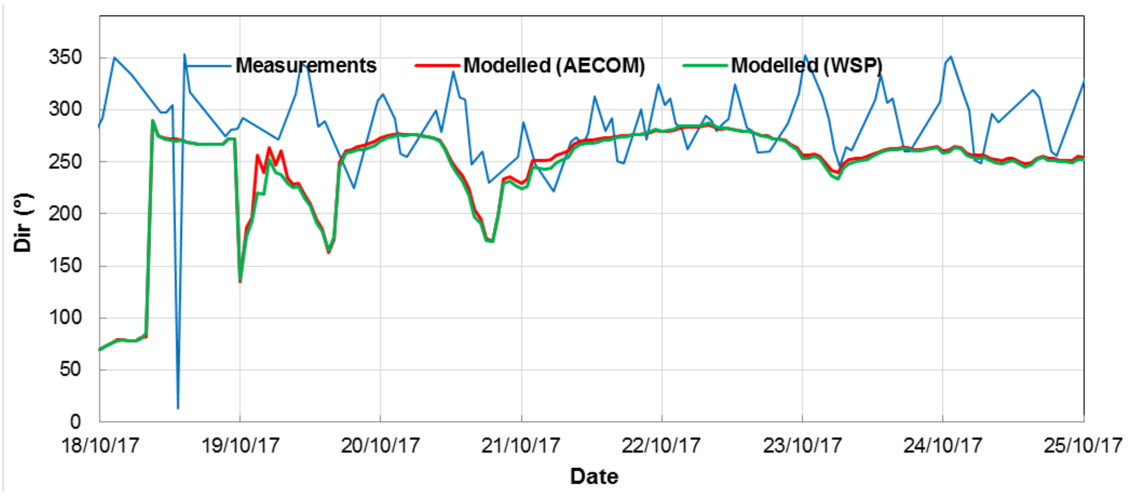

Figure F-15: Calibration of Wave Direction (Event 3 – October 2017)

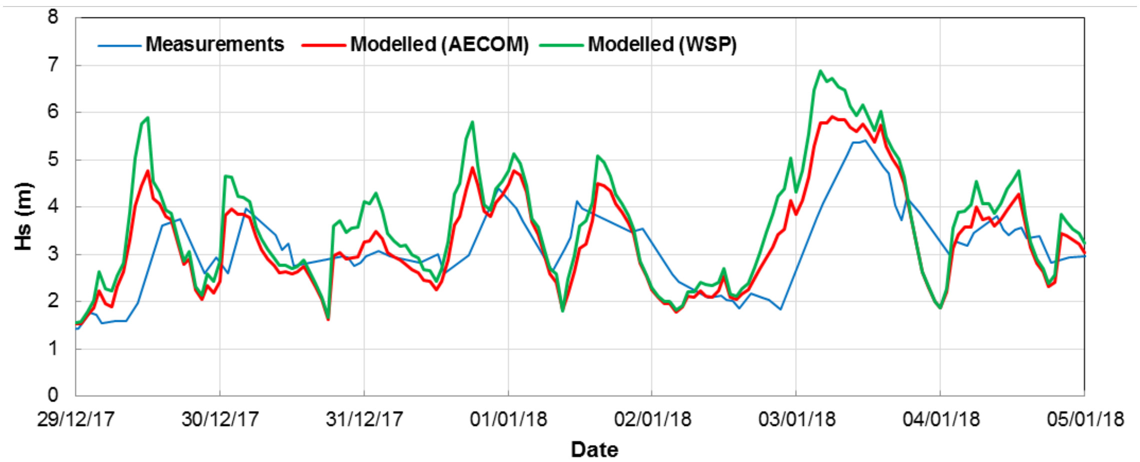

Figure F-16: Calibration of Significant Wave Height (Event 4 – December 2017 & January 2018)

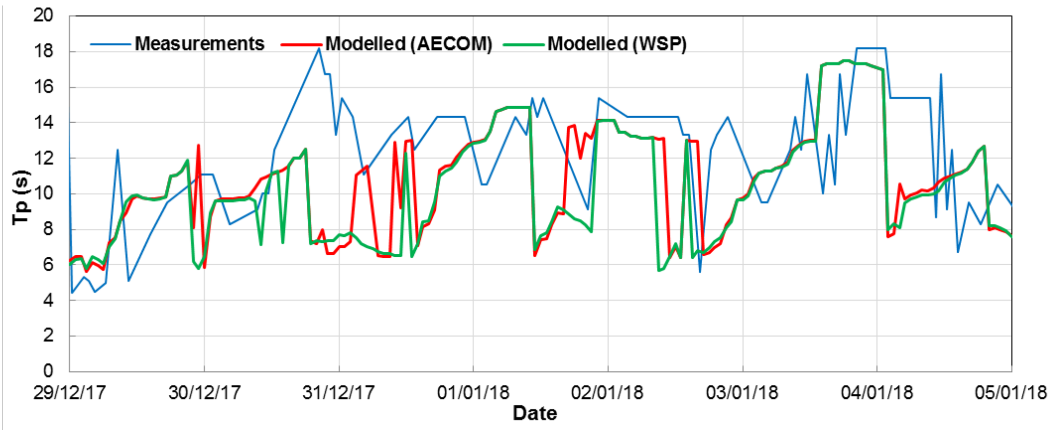

Figure F-17: Calibration of Wave Period (Event 4 – December 2017 & January 2018)

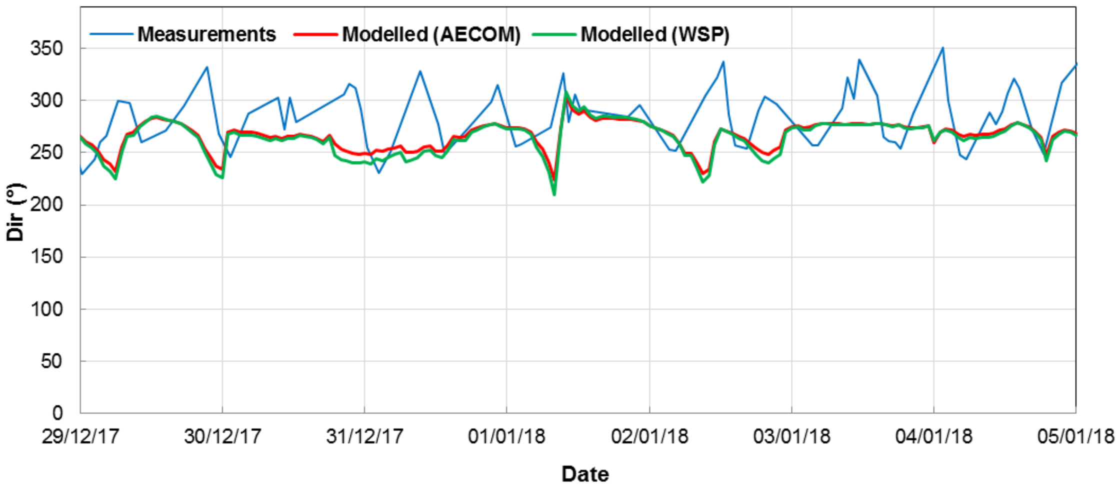

Figure F-18: Calibration of Wave Direction (Event 4 – December 2017 & January 2018)

F.5 Conclusions

It can be seen that both the AECOM and WSP models capture key features of all four storm events, particularly the growth and decay in wave height at the wave buoy location. In terms of wave period and direction, the two models demonstrate very similar performance. Overall, the visual comparison shows that AECOM model results are in better agreement with the wave buoy data than the existing WSP model demonstrating the value of undertaking the calibration exercise.

It is worth pointing out that the measured wave data has some oscillation in the wave period and direction whilst the two model results are relatively smooth. The oscillation looks very regular, it might be the wave buoy moving in the tide which caused the signal variation. As this study focused on the significant wave height during large storm events, the observed variability will have limited influence on the predicted extreme wave statistics. The differences between the measurements and modelled results remain relatively large for some events. Future efforts to improve the model performance should therefore focus on re-designing the model boundary and applying longer time series wave data from the UKMO model. However, this is beyond the scope of the present modelling study.

The improved AECOM model setup is considered to be suitable for the further investigation of extreme wave conditions, as required for subsequent stages of the Jersey SMP study.

F.6 References

WSP (2006) Jersey Coastal Model. Version 2 (Public), Project no. 70011112. January 2016.

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