5th workshop on waves and wave-coupled processes

Enhancing Wave Modelling Accuracy Using a High-Resolution Wind Model

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Scope of study

- SWAN wave model is employed to generate wave fields. Model inputs include Copernicus wave data and wind data from two distinct sources for comparative analysis: the Copernicus ERA5 wind data and the high-resolution Vortex wind model data.
- The implementation of high-resolution wind fields aims to enhance the performance of the wave model.
- Wave model results are compared to field measurements to assess model accuracy.

EOLOS buoy

Figure 1. EOLOS FLS200 buoy. Wave sensor is mounted on buoy.

EOLOS wave measurements

Wave accelerometer sensor

Principle: Accelerometer, compass & yaw-pitch-roll.
Location: Placed on EOLOS FLS200 buoy.

TNO LEG platform

Radac for wave measurements

Principle: Radar (measures distance).
Location: Placed on LEG platform.

Wind modelling

Vortex model

Principle: ERA 5 reanalysis downscaled with WRF
Resolution: 1 km **Height**: 10 m

Study site & wave model set-up

Netherlands

Figure 3. Domain of study. Validation point at 51°55'30"N, 3°40'06"E

Domain of simulation

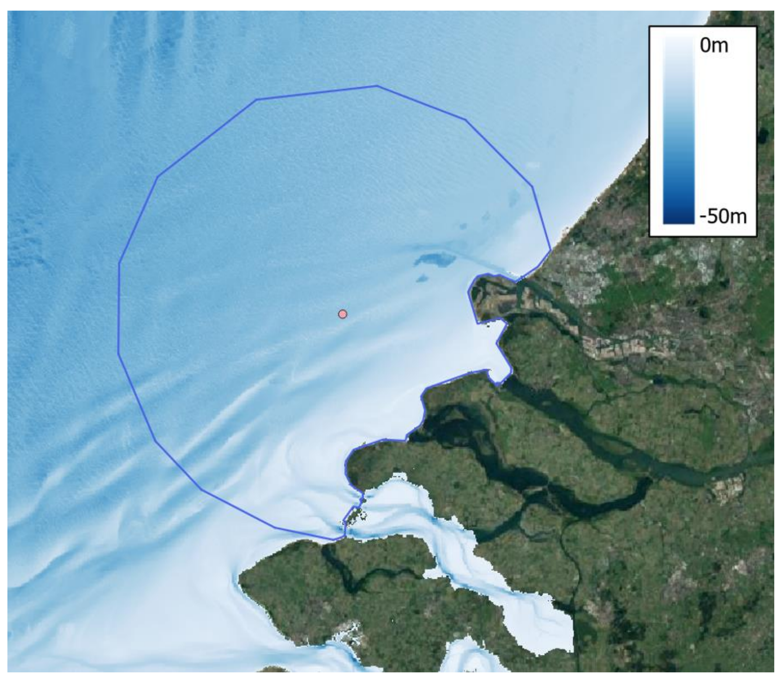

Figure 4. Domain. EMODnet bathymetry.

Computational grid

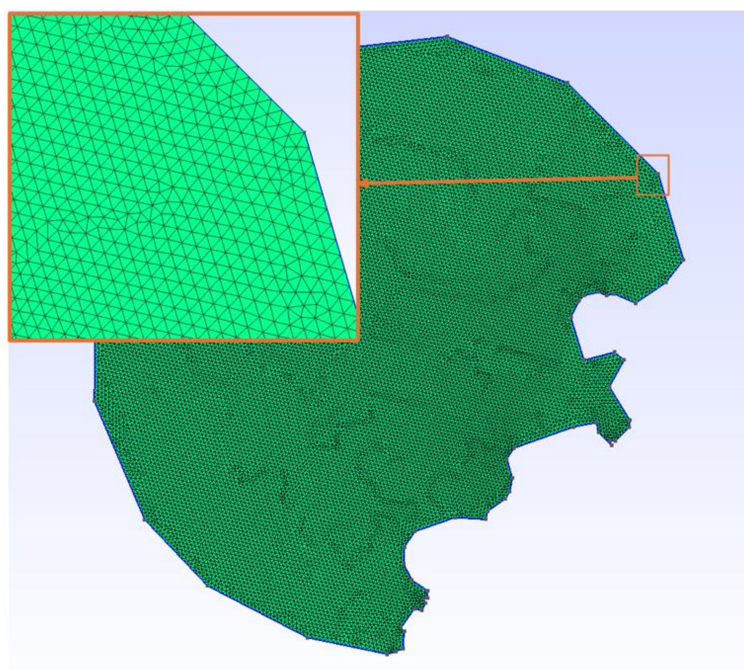

Figure 5. Unstructured grid. 10 offshore boundaries.

SWAN wave model

Stationary mode
3h temporal resolution

Input boundary waves
Copernicus: Global Ocean Waves Analysis and Forecast - 0.083º resolution

Each node wind data
Scenario 1: ERA5 wind - 31km resolution
Scenario 2: Vortex wind - 1km resolution

Model outputs

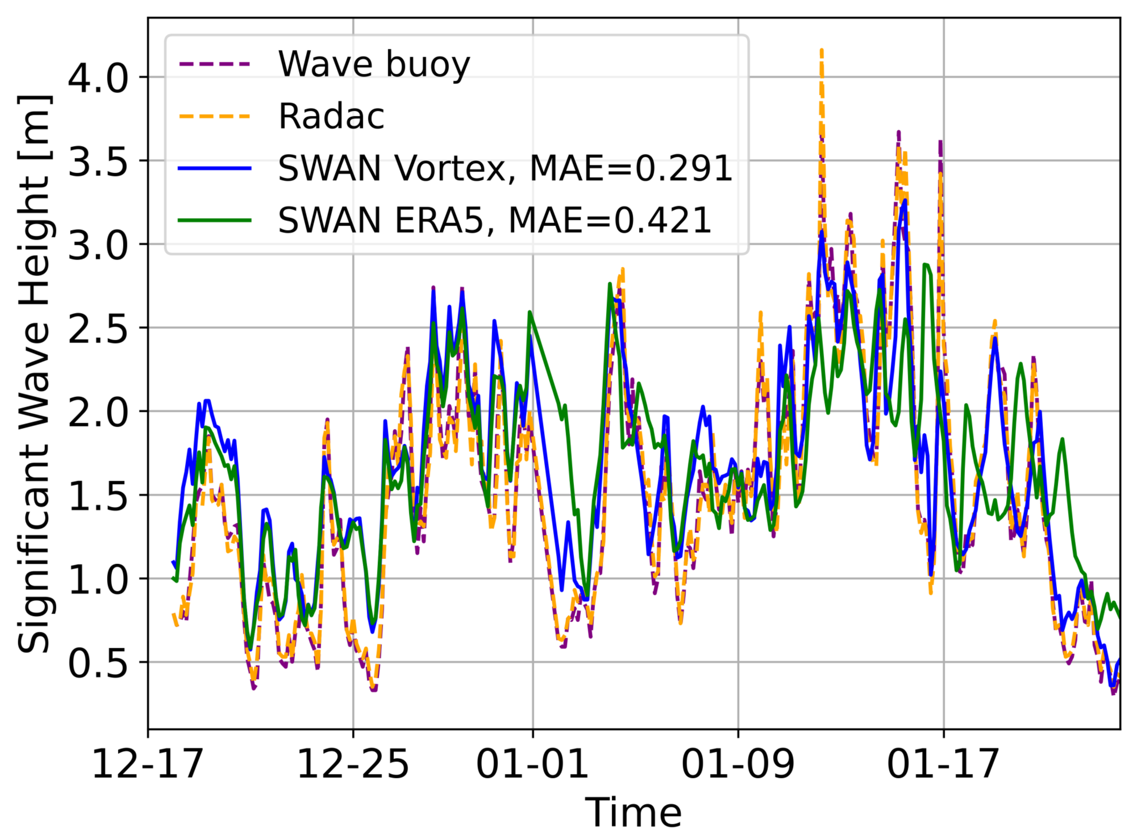

Figure 6. SWAN with ERA5 vs SWAN with vortex. Significant wave height mean absolute error.

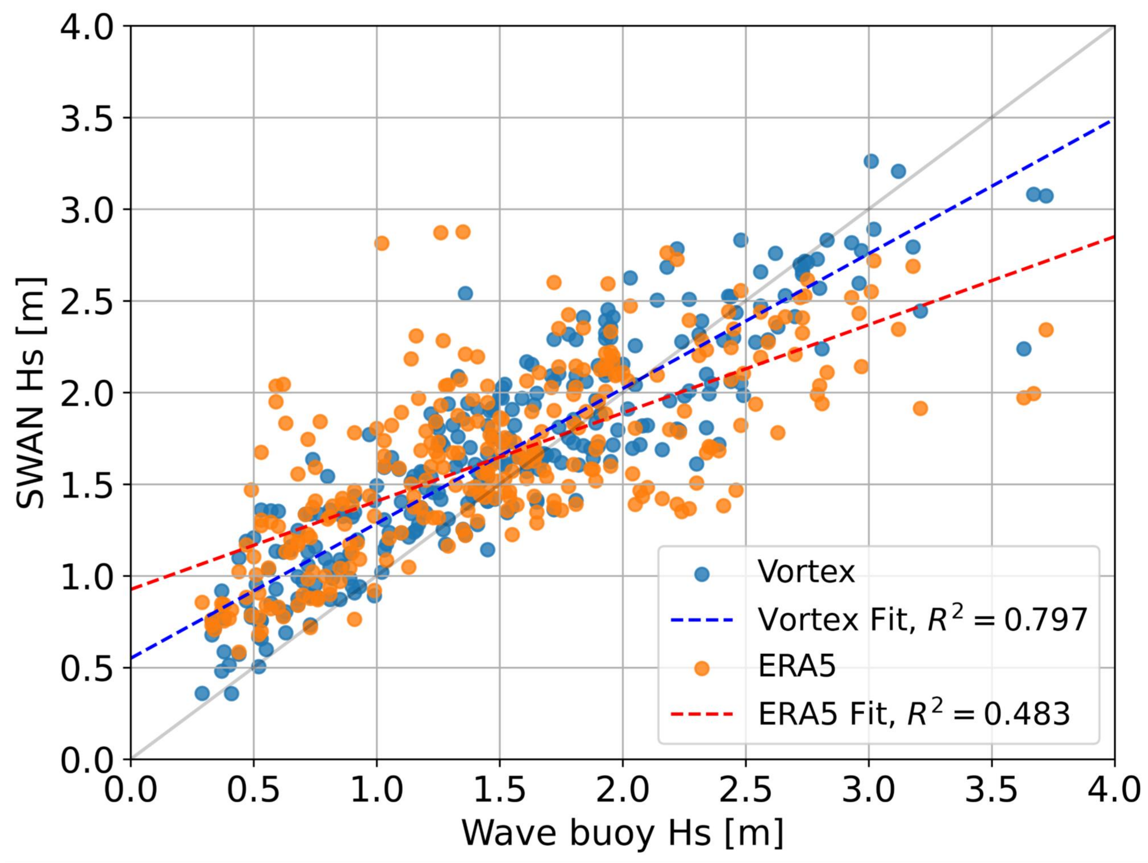

Figure 7. SWAN with ERA5 vs SWAN with vortex. R2 compared to buoy measurements

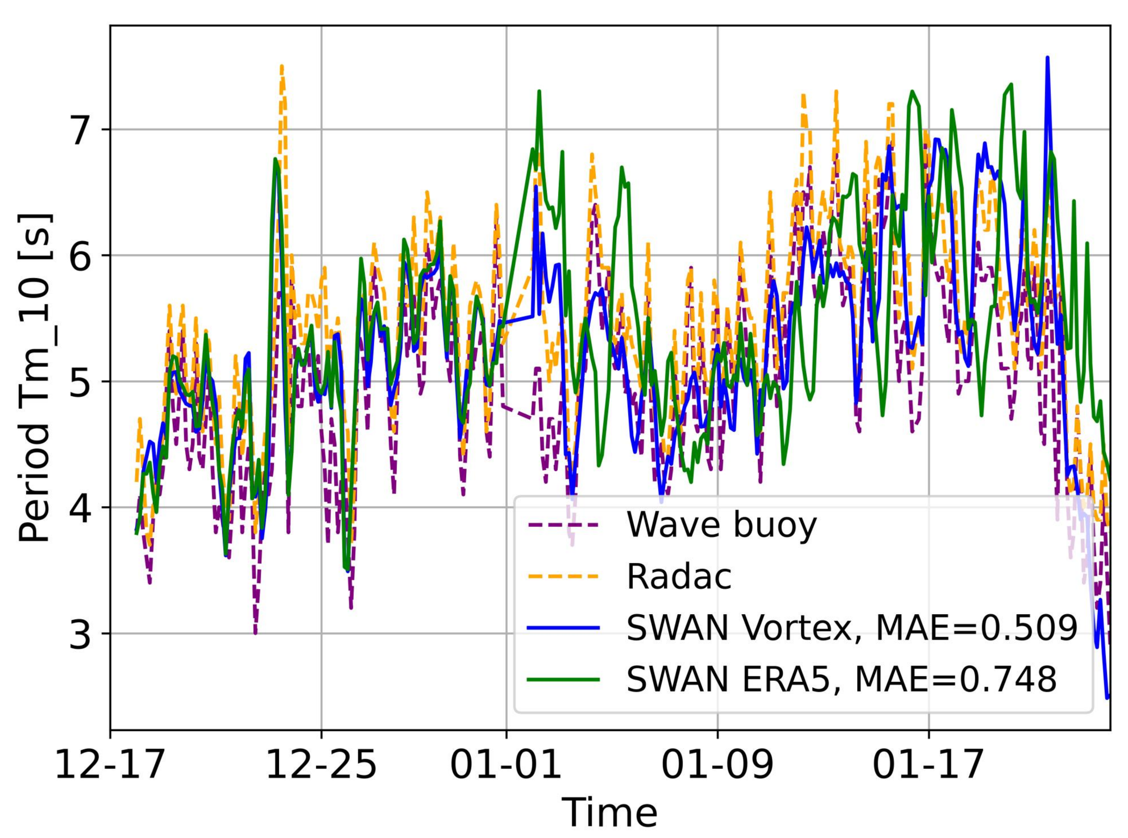

Figure 8. Spectral moment Tm(-1,0) wave period. SWAN with ERA5 vs SWAN with vortex. Mean Absolute Error.

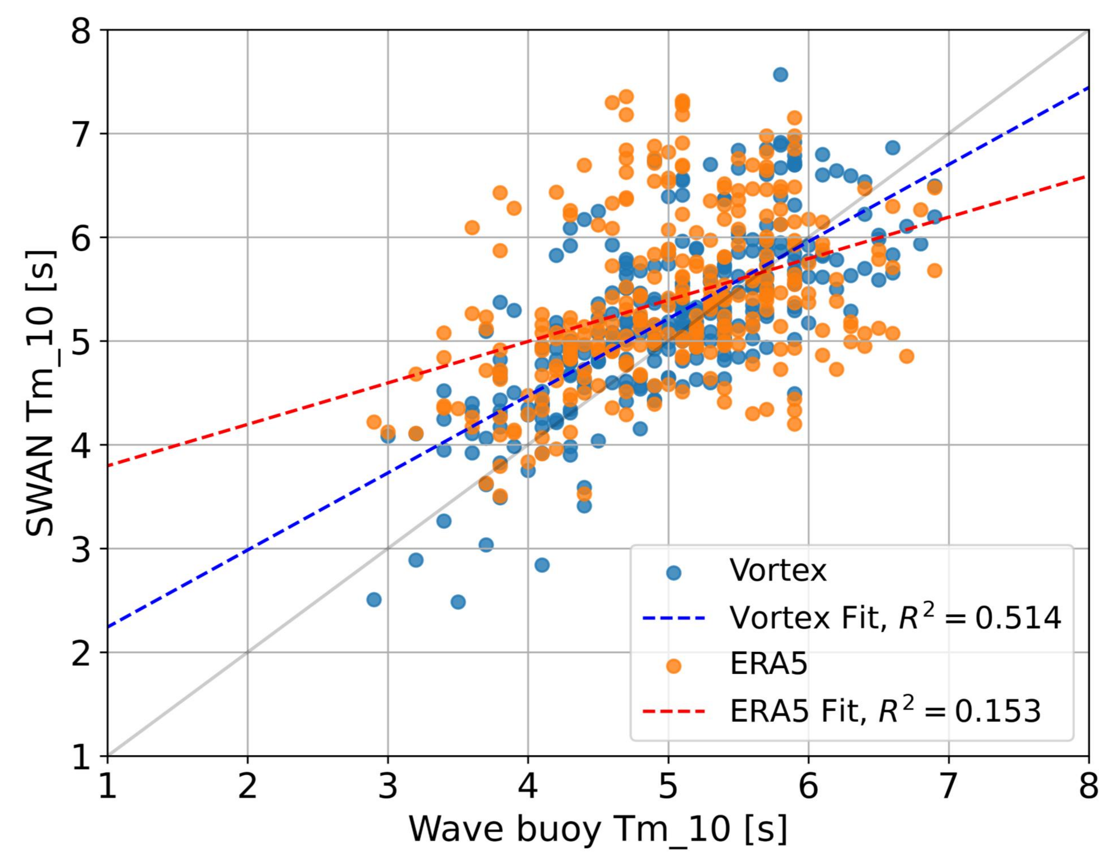

Figure 9. SWAN with ERA5 vs SWAN with vortex. R2 compared to buoy measurements

Conclusions

- Buoy wave measurements have been cross-referenced with Radac wave measurements to enhance their reliability and credibility.
- The numerical model makes a good approach to wave measurements for Hs. Further refinement is required to enhance the accuracy of the modelled period.
- Utilizing the SWAN model driven by Vortex wind input enhances the accuracy of model outcomes compared to employing SWAN forced with ERA5 wind input data.

Further development

- Enable the creation of 2D wave propagation maps within offshore wind farm regions. This includes generating potential scenarios and conducting statistical analyses based on historical events.
- The calibration of the wave model will be conducted using wave buoy measurements.
- Evaluate the performance of the model in shallow waters conditions and various geographical locations.