COMPARISON OF FIELD AND FORECAST METOCEAN DATA IN THE GERMAN BIGHT

Lukas Froehling, Leibniz University Hannover, froehling@lufi.uni-hannover.de
Thilo Grotebrune, Leibniz University Hannover, grotebrune@lufi.uni-hannover.de
Arndt Hildebrandt, Leibniz University Hannover, hildebrandt@lufi.uni-hannover.de

INTRODUCTION

Offshore wind energy can contribute significantly to achieve greenhouse gas neutrality in the near future. But the planning, construction and operation of offshore wind parks is associated with high costs. In particular, the operation and maintenance (O&M) costs account for a major fraction and in turn are also dependent on appropriate weather windows in which working vessels can operate. A precise knowledge of how wind, sea state and currents affect each other, as well as the most accurate possible prediction of the development, is essential to maximize these periods and reduce the resulting costs. For the German Bight, the high-resolution coastal wave model (CWAM) is often used for this purpose. The CWAM is based on WAM (Hasselmann et al. 1988) and was developed by the German Meteorological Service (DWD) and German Maritime and Hydrographic Agency (BSH) in cooperation with the Helmholtz-Zentrum Hereon. Compared to other WAM models it offers the advantages of higher resolution, as well as the consideration of current speeds and tide-dependent water depths. The BSH also operates multiple measuring stations in the German Bight, which enable real-time investigation of sea state parameters. The general objective of this study is to compare historical data sets from in situ measurements in the German Bight with numerical forecast data and to identify which factors influence the accuracy of the CWAM and why deviations occur.

METHODOLOGY

In order to better understand the site-specific differences between in situ measurements and the forecasted sea state data, historical CWAM data sets are investigated and the relevant information is extracted at the respective measurement sites. The focus of the evaluation thereby lies on the significant wave height, since operating limits for working vessels are primarily based on this parameter. For the evaluation, data sets for the period January 2021 to August 2022 are available for multiple measuring sites. With a temporal resolution of 30 minutes this leads to a maximum of about 29.000 valid data pairs for each location. Figure 1 shows an overview of the German Bight and the measurement sites as well as quantile-quantile plots for each site, depicting the deviation of the CWAM forecast from the actual measured significant wave heights. The general CWAM performance for most sites is precise and high correlation factors can be identified. However, there is a slight overestimation of CWAM compared to in situ measurements. To address the factors affecting these deviations, the data sets are analyzed from various aspects. These include the boundary conditions such as the bathymetry on which the model is based as well as the input 10m-winds of the atmospheric model ICON (DWD) that drive the numerical forecasts. The sea state in the German Bight can also be strongly dominated by swell, which is why the influence of swell and wind sea and the general directional dependence on the model accuracy are also investigated. To assess the results of the evaluated aspects, scaling factors describing the ratio of measured to numerically calculated parameters are introduced. An interpolation method for scattered data (Amidror 2002) is used to extend the scaling factors from site-specific to spatial information to cover a larger area of the German Bight.

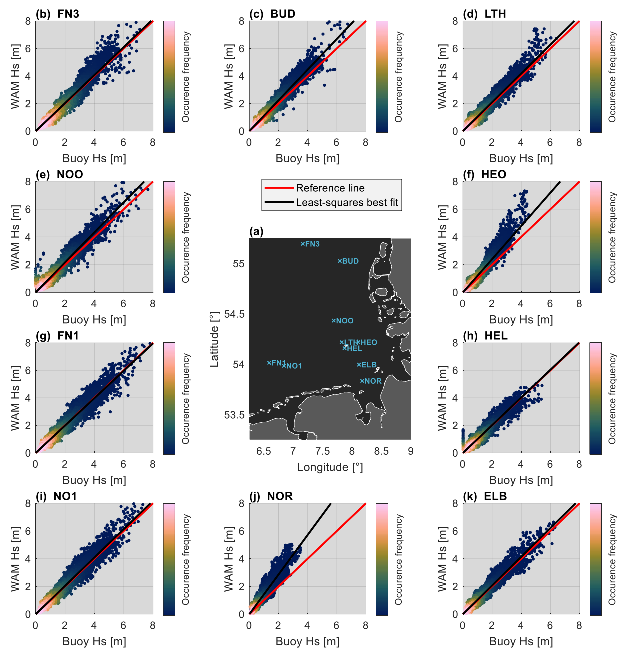

Figure 1 – Q-Q plots of DWR buoy measurements and CWAM forecasts with **(a)** Overview measuring sites German Bight and **(b)** – **(k)** density scatter plots for measured (buoy) significant wave heights as reference and modelled (CWAM) significant wave heights from January 2021 to August 2022; black lines indicate the least-squares best fit and the red lines indicate the 45° reference.

RESULTS

Based on the comparisons of the data sets, the locations and sea state conditions where deviations in the CWAM model occur could be located. By using the developed approaches, sea state maps for the German Bight could be extended and refined as a combination of measured data and numerical forecast data.

REFERENCES

Amidror (2002): Scattered data interpolation methods for electronic imaging systems: a survey. Journal of Electronic Imaging, vol. 11, Issue 2, pp. 157-176

Hasselmann et al. (1988): The WAM model - a third generation ocean wave prediction model, Journal of Physical Oceanography, vol. 18, Issue 12, pp. 1775-1810