OFFSHORE WINDPOWER

Validating Regional WRF Modeling for Offshore Wind Assessment

K. CONFER [1] , T. SPALDING [1], C. ZIESLER [1],
1 Natural Power Consultants, Seattle, USA

natural power

BACKGROUND

Accurate determination of the wind resource for offshore development areas in the US is difficult compared with Northern Europe where there are numerous high-quality sources of measured meteorological data available at heights relevant to modern turbines. To help fill this gap it is necessary in the US to use modeling approaches to build on the sources of measured data available and provide accurate insights into the offshore wind resource.

OBJECTIVES

- Understand the benefits of using WRF meso-scale models calibrated against available offshore meteorological data sources to determine the wind resource across an area of development interest.
- Use the WRF output data sets that NREL[1] made publicly available to help characterize the wind resource for their particular project area.

METHODS

We conducted a comprehensive analysis of three model datasets: Raw ERA5, NREL WRF-LES[2], and Vortex-LES[3], in comparison with data collected from four in-situ observational sites. These sites are positioned on offshore oil rigs spanning the Gulf of Mexico, including Sabine, High Island, East Cameron, and West Cameron. To further validate the modeled datasets, we vertically adjusted the observational data from their original measurement heights to a uniform 160 meters, employing a shear coefficient of 0.10.

VORTEX-LES is an NWP-CFD on-line coupled framework based on the Weather Research and Forecasting (WRF) model coupled with the large eddy simulation (LES).

NREL employed floating lidar data to validate six WRF-LES simulations in the Gulf of Mexico. These simulations featured distinct variations in planetary boundary layer (PBL), surface layer, and land surface schemes. The schemes exhibiting the highest correlation with the lidar data were subsequently chosen, published, and integrated into our study.

RESULTS

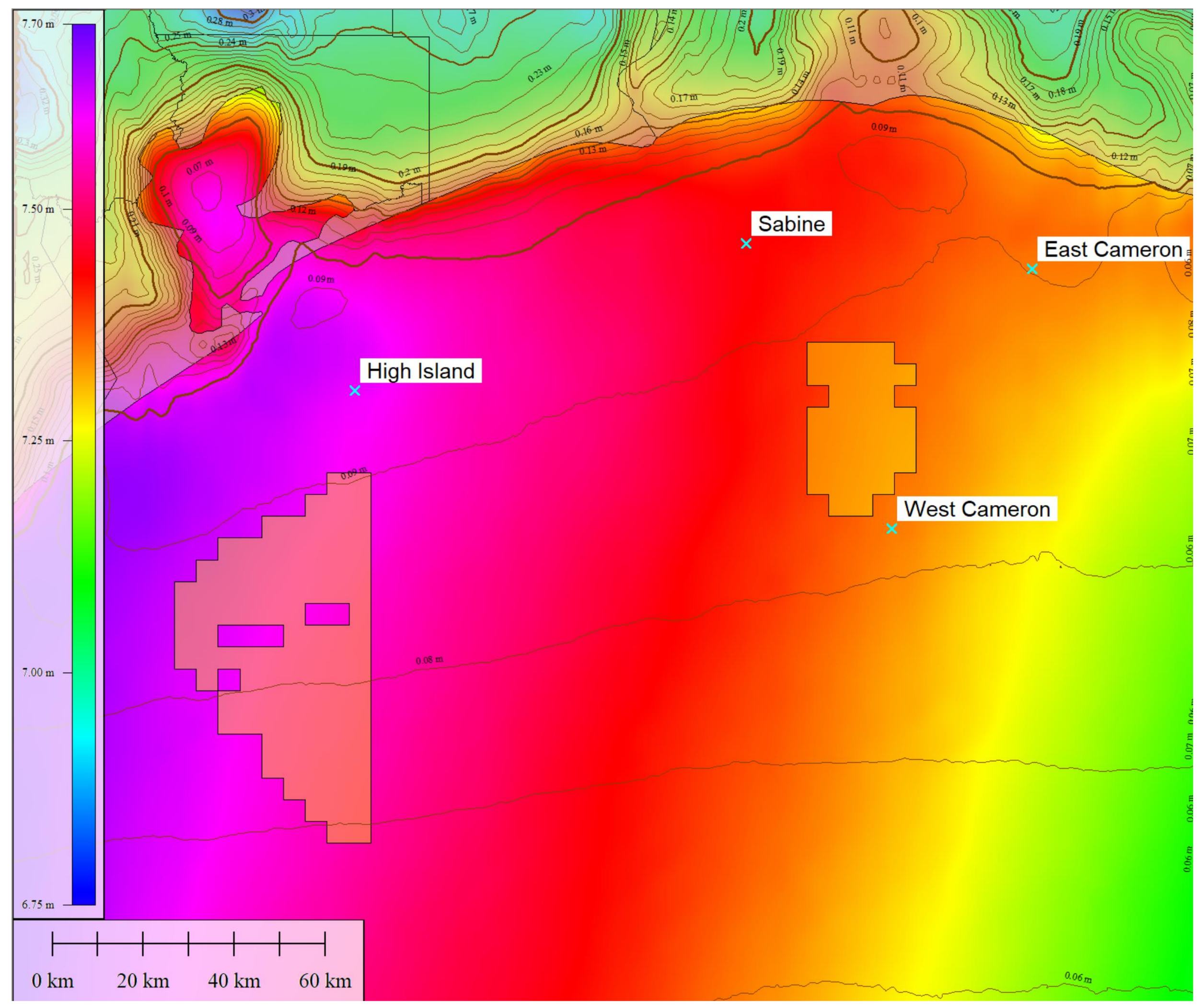

Figure 1. VORTEX MAP 160m ASL wind speed (m/s) and shear exponent contours

Table 1. Observed and predicted 160m ASL long-term mean wind speed (m/s)

	Sabine	East Cameron	High Island	West Camerson
Observed[1]	5.9	6.9	6.2	6.3
Vortex MAP	7.4	7.4	7.6	7.3
Vortex LES [2]	7.4	7.4	7.5	7.4
NREL WRF LES [2]	7.6	7.5	7.6	7.5

1. Observed data for High Island, Sabine, West Cameron, and East Cameron were at 75m, 34m, 34m, and 30m, respectively, has been sheared up to 160m using modeled shear, and long term adjusted regional reanalysis data
2. Temporal LES data have been generated for 2011 consistent with observational periods, and long term adjusted using regional reanalysis data

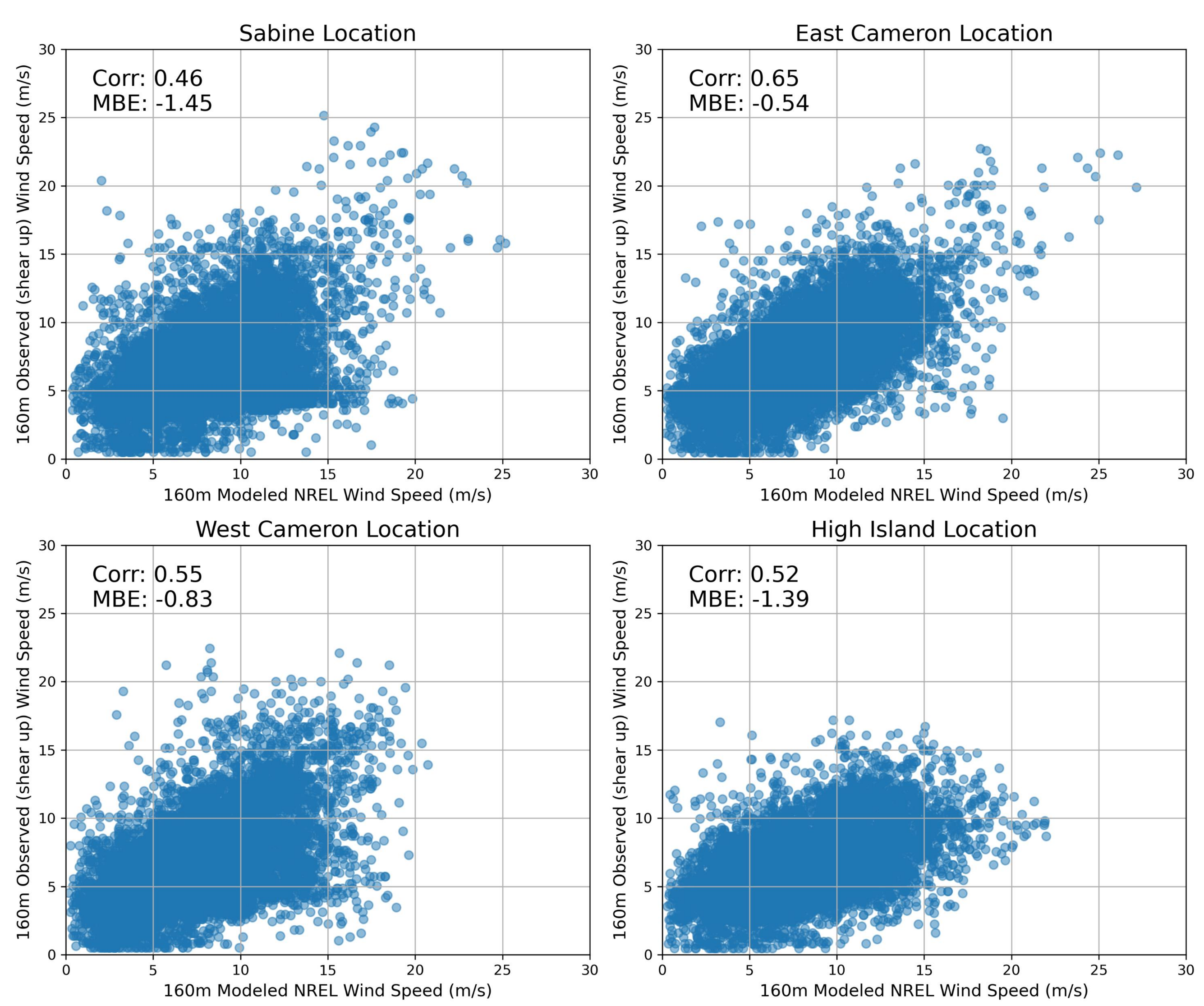

Figure 2. Scatter plots for each observation site comparing 160m wind speeds in 2011. Each subplot contains the correlation coefficient and the mean bias error (MBE).

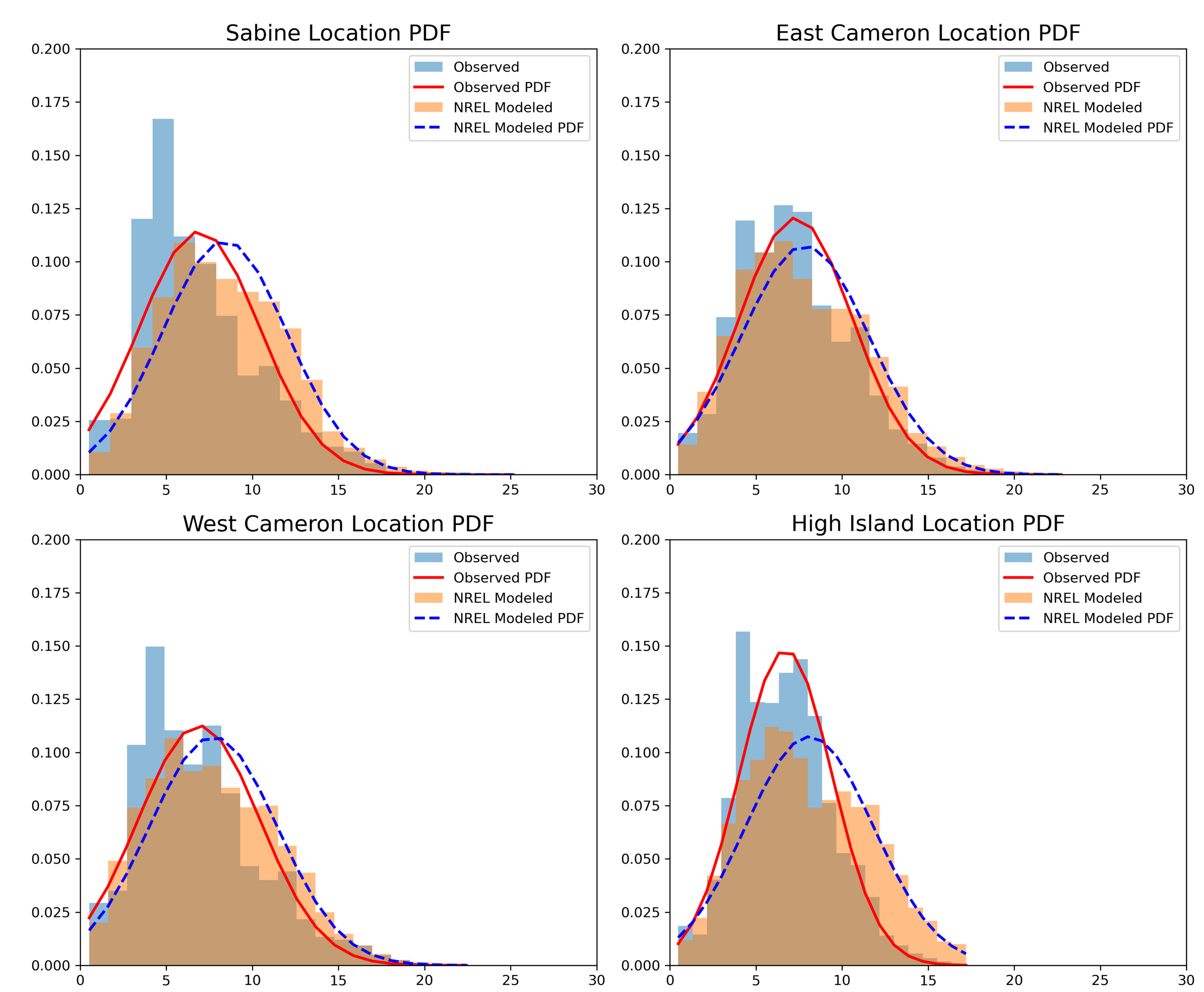

Figure 3. Probability density functions for each observation site using 160m wind speeds in 2011.

CONCLUSIONS

Consulting multiple model datasets can add value, where limited offshore measurement data are available.

Natural Power found that available modeled datasets in the vicinity of the Lake Charles and Galveston I/II lease areas[4] tended to overpredict the wind resource as compared with platform-observed wind data. Due to limited metadata[5], uncertainty exists with respect to the measurement equipment and configuration, such as mounting effects, that could impact observations.

Temporal VORTEX LES and NREL WRF-LES model results for 2011 were compared to platform observations for the same period, indicated reasonable correlation and upward model bias ranging nominally from 0.4 to 1.7 m/s across the four platform locations.

The VORTEX MAP result for the area of interest is shown in Figure 1. Median bias of the model was 1.2 m/s high relative to long term adjusted platform observations, with bias ranging from 0.5 m/s to 1.5 m/s.

Based on the results of this study, multiple models can prove useful for feasibility-level evaluations. Verification of platform-based observation equipment is important to understand potential biases due to non-standard mounting. Subsequent floating lidar deployments will aid in refining resource estimates in specific development areas, as well as understanding broader scale model biases.

ACKNOWLEDGEMENTS

This work was a collaborative effort of the Natural Power Analytics team, principally Taurin Spalding, Kaitlyn Confer and Garrett Wedam. It also would not have been possible without the help of the VORTEX.

REFERENCES

(1) Redfern, S, Bodini, N. Characterization of 20-year offshore wind resource potential in the Gulf of Mexico using the WRF Model. 103rd Meeting of the AMS, January, 2023.
(2) NREL WRF-LES: https://data.openei.org/submissions/4500
(3) VORTEX Products: https://vortexfdc.com/
(4) https://www.boem.gov/renewable-energy/state-activities/gulf-mexico-activities
(5) https://www.ncdc.noaa.gov/cdo-web/datasets/LCD/stations/WBAN:00255/detail

CONTACT INFORMATION

Dr Chris Ziesler, chrisz@naturalpower.com