EIA23EV1297109

Significant wave height – ERA5 vs buoy

Matthew H. Bullard & Beanan O'Loughlin | UL Solutions | Matthew.Bullard@UL.com & Beanan.OLoughlin@UL.com

November 14, 2023

INTRODUCTION

Significant wave height (SWH) characteristics at a site can play a role in offshore wind energy estimates of turbine availability as well as planning for measurement deployment and floating platform performance. While networks of buoy data are comprehensive in some regions, they may not cover all areas of interest and may be inconsistent in measurement periods and performance.

ERA5 SWH VALIDATION VS. NDBC BUOYS

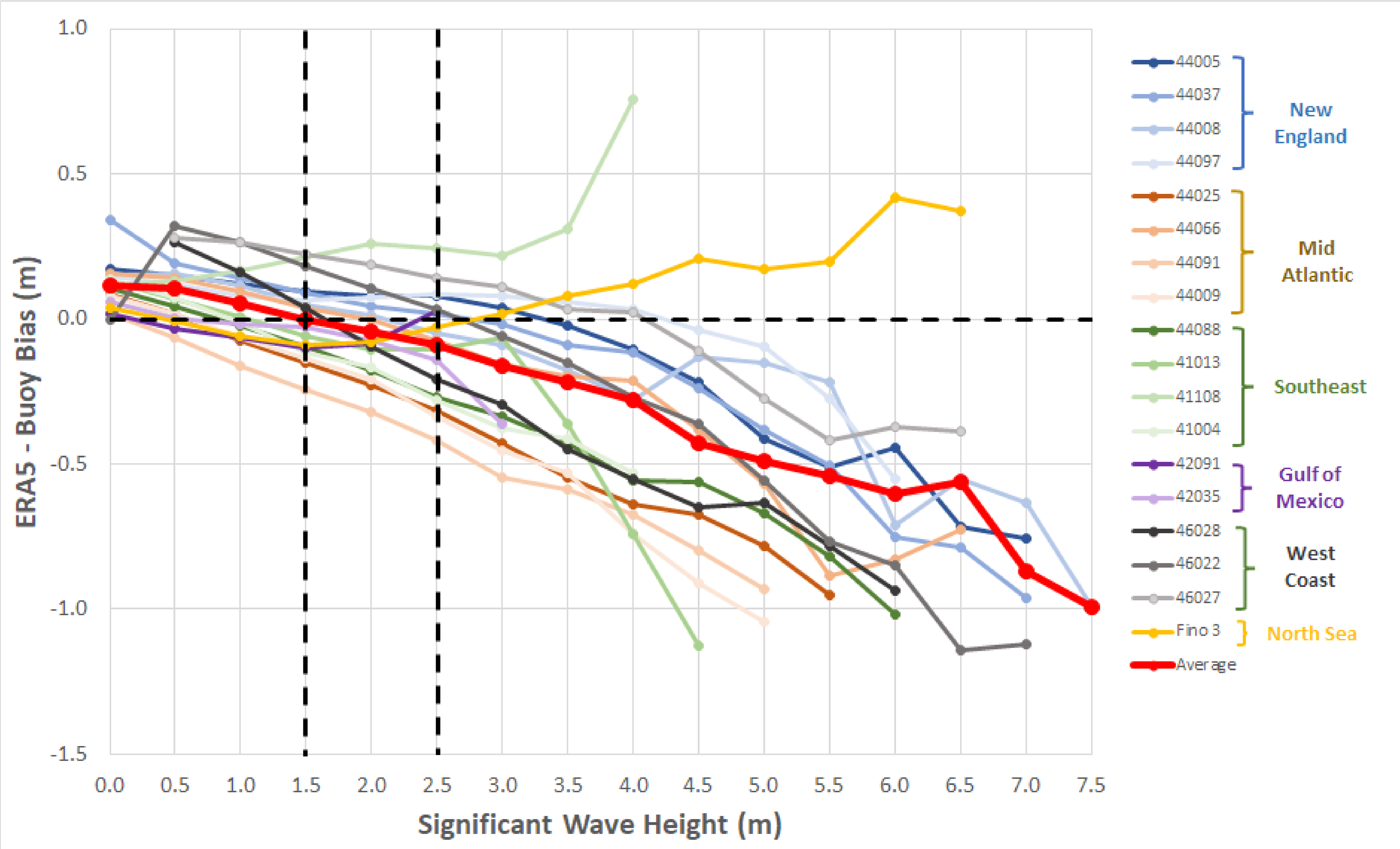
UL Solutions performs a validation of the ERA5 SWH (combined waves and swell) parameter against concurrent National Data Buoy Center (NDBC) buoy measurements off the east and west coasts of the USA and against the FINO3 mast in the North Sea. The average biases in model performance are quantified as is model performance by region and with varying proximity to shore.

Concurrent ERA5 and measured SWH data were compared. The following table summarizes the average SWH bias of ERA5 compared to measured data along with the bias of the frequency of SWH greater than 1.5 m and 2.5 m, the range of SWH applicable for offshore wind energy development and operation.

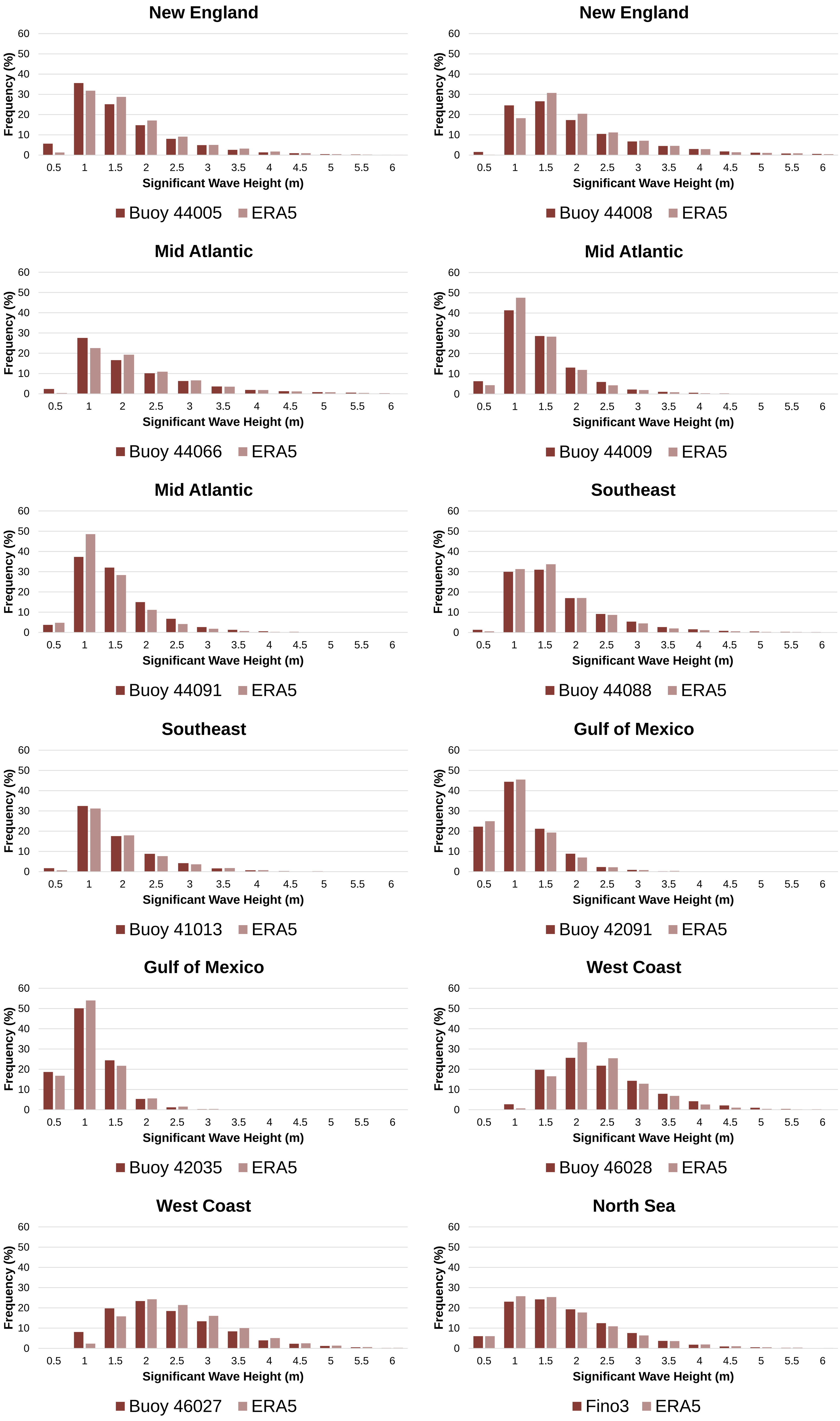
	Bias (m)	Frequency Bias, SWH > 1.5 m	Frequency Bias, SWH > 2.5 m	Distance to Coast (km)
Average	0.02	1.2%	-0.3%	54
Average, <50 km	0.01	1.8%	-0.5%	27
Average, ≥50 km	0.03	0.7%	-0.1%	75
New England	0.09	4.2%	0.5%	75
Mid Atlantic	-0.06	-3.5%	-1.0%	54
Southeast	0.02	0.2%	-0.5%	54
Gulf of Mexico	-0.01	-0.6%	0.1%	41
West Coast	0.07	-0.5%	-0.5%	24
FINO3	-0.04	-3.9%	0.4%	80

Positive bias indicates ERA5 SWH is higher than measured buoy data. Overall SWH bias is low with some regional differences. There are more pronounced differences in the frequency of waves greater than 1.5 m between ERA5 and measured buoy data, particularly in the New England and Mid Atlantic regions. These differences are less pronounced when comparing the frequency of SWH greater than 2.5 m.

The following graph shows the bin-wise deviation of ERA5 SWH compared to 17 NDBC buoys and the FINO3 mast in the North Sea. ERA5 tends to overpredict buoys at lower SWH and underpredict during more extreme conditions.



FREQUENCY DISTRIBUTION COMPARISON



The ERA5 and measured buoy SWH frequency distribution graphs for a subset of the study areas shown above illustrate the sensitivity of the modeled SWH distributions around the 1.5-2.5 m SWH that are relevant for crew transport vessel operation for offshore wind energy. The graphs further illustrate the regional differences in SWH frequency distributions that will impact estimates of site access loss and turbine availability.

CONCLUSIONS

The validation of the ERA5 SWH parameter against 17 North American measurement locations and a single North Sea location indicates that the modeled datasets reasonably reproduce observed conditions including the mean and distribution of SWH. There is sensitivity in the modeled distributions from 1.5-2.5 m, the range most applicable to the offshore wind industry, as well as with regional differences.

The validation supports the use of the ERA5 SWH parameter in the absence of or to augment measured SWH data for the purpose of characterizing site conditions, crew transport vessel capabilities, and other conditions related to offshore wind energy development and operation.

UL Solutions

Safety. Science. Transformation.™