How does modeled wind data publicly available measure up?

J. Mault, The Renewables Consulting Group (RCG)

Renewables Consulting Group
an ERM Group company

Offshore 2022 WINDPOWER
OCTOBER 18-19 | PROVIDENCE, RI

Background

With up to seven lease auctions expected over the next three years, the potential wind resource is important driver in understanding a lease area's potential and its development cost. The first lease auctions off the U.S. east coast relied mainly on model data, whereas the recent New York auctions had the advantage of a robust measurement campaign prior to auction, providing better certainty and a more competitive environment. While it is unlikely new measurement systems will be deployed in time for each wind development area auction, there now exists significantly more measurement data than in years past which can be used to understand the performance of available model sources.

The mesoscale model data sources often relied upon in the U.S. for early-stage offshore wind development include NREL's WIND ToolKit and the Global Wind Atlas 3.0, both available publicly. In this study we present findings comparing these popular industry model datasets with that of measured data from various floating lidars sited offshore on the west and east coasts of the U.S. The comparison includes a review of long-term annual average wind speed, shear, and wind speed variation between sites.

Data

Publicly available mesoscale model datasets for wind resource assessment utilized in this study are summarized in the table below. Large scale reanalysis datasets such as MERRA-2 and ERA5 are not compared but are useful in adjusting measurement data to reflect the long-term annual wind resource.

Dataset	Global Wind Atlas 3.0	NREL WIND ToolKit	NREL WIND ToolKit LED
Resolution	0.25 km	2.0 km	2.0 km
Period	2008 – 2017	2007 – 2013	2000 – 2020
Temporal frequency	Annual (1-year)	Annual (1-year) / 5-minute select U.S. locations	5 / 15 / 30 / 60 minute
Regional availability	Global	North America	U.S. offshore areas
Height [m]	10, 50, 100, 150, 200	10, 40, 60, 80, 100, 120, 140, 160, 200	10, 40, 60, 80, 100, 120, 140, 160, 180, 200, up to 500
Year released	2019	2014	2020 - 2023

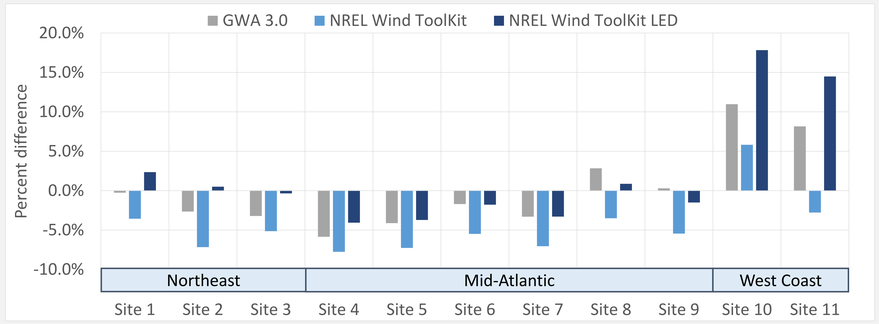
Results

Measured wind resource data from 11 sites are compared to the three mesoscale model datasets. These measured datasets consist of publicly available data from DOE and NYSERDA as well as other sources. As the data periods of the measured datasets do not fully overlap with each mesoscale model data, the measured data have been adjusted to reflect the long-term wind regime considering sources such as MERRA-2 and ERA5, providing a comparison of the estimated long-term wind regime consistent with industry best practices to that of the mesoscale model datasets.

LONG-TERM ANNUAL AVERAGE WIND SPEED COMPARISON

Difference between long-term adjusted measured wind speed vs. mesoscale model long-term wind speed.

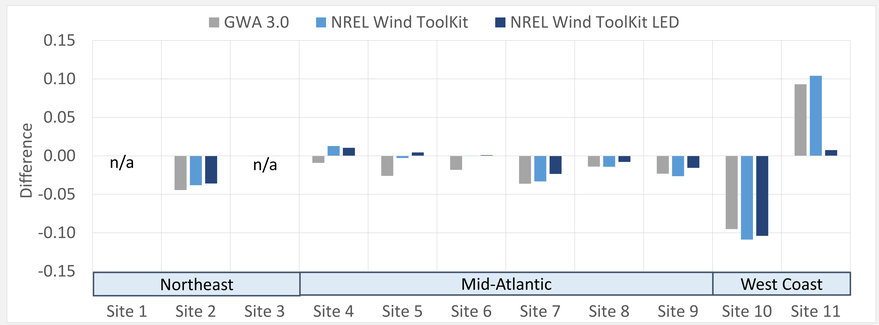
+ model overprediction
- model under prediction



ANNUAL AVERAGE WIND SHEAR (α)

Difference between measured annual wind shear (α) and mesoscale model wind shear.

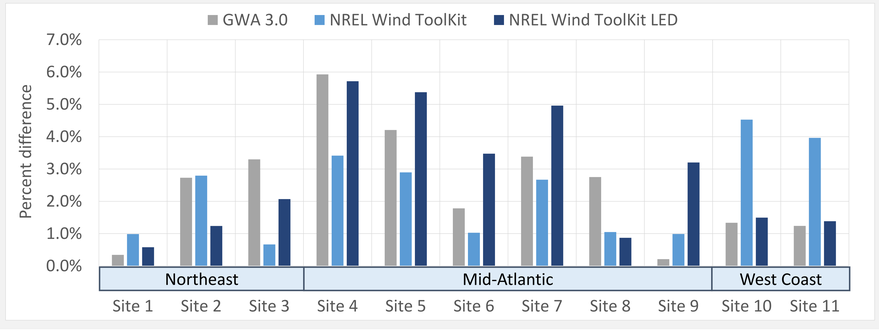
+ model overprediction
- model under prediction



WIND SPEED VARIATION / SPEED-UP

Wind speed variation (or speed-up) between a site vs. other sites comparing measured vs. mesoscale model relationship.

Higher difference means more variation in measured data vs. modeled.



Conclusions

- The NREL Wind ToolKit LED predicts the overall wind resource better than GWA 3.0 and older NREL Wind ToolKit. However, newer is not always better based on results for the two west coasts sites.
- Annual average wind speed estimates tend to be underpredicted by the models compared to measured data for the east coast sites and over-estimated for the west coast.
- Shear estimated by the models is generally good when compared to the measured data and similar differences are observed between all three model datasets.
- The two west coast sites tend to have the largest differences in modelled wind speed and shear compared to measurements.
- The assessment of the variation in wind speed between sites is limited given available data however, no strong consistent trend is observed between model datasets.
- The model datasets generally underestimate the variation between sites.
- Understanding the wind speed and direction frequency distribution are important parameters in modeling wind resource and energy that are not considered in this study.

References

Global Wind Atlas 3.0

Global Wind Atlas 3.0, a free, web-based application developed, owned and operated by the Technical University of Denmark (DTU). The Global Wind Atlas 3.0 is released in partnership with the World Bank Group, utilizing data provided by Vortex, using funding provided by the Energy Sector Management Assistance Program (ESMAP). For additional information: https://globalwindatlas.info

NREL WIND ToolKit & NREL WIND ToolKit LED

https://www.nrel.gov/grid/wind-toolkit.html

Draxl, C., B.M. Hodge, A. Clifton and J. McCaa. 2015. Overview and Meteorological Validation of the Wind Integration National Dataset Toolkit (Technical Report, NREL/TP-5000-61740). Golden, CO: National Renewable Energy Laboratory.

Draxl, C., B.M. Hodge, A. Clifton, and J. McCaa. 2015. "The Wind Integration National Dataset (WIND) Toolkit." Applied Energy 151: 355366.

Lieberman-Cribbin, W., C. Draxl, and A. Clifton. 2014. Guide to Using the WIND Toolkit Validation Code (Technical Report, NREL/TP-5000-62595). Golden, CO: National Renewable Energy Laboratory.

King, J., A. Clifton, and B.M. Hodge. 2014. Validation of Power Output for the WIND Toolkit (Technical Report, NREL/TP-5D00-61714). Golden, CO: National Renewable Energy Laboratory.

Contact Information

Josiah Mault, Principal at The Renewables Consulting Group (RCG)
Josiah.Mault@thinkrcg.com