CASE STUDY: MODEL-OBSERVATIONAL COMPARISON FOR THE THIRD WIND FORECAST IMPROVEMENT PROJECT

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MOTIVATION

Numerical weather models play an important role in forecasting future weather conditions. They are a useful tool for meteorologists that can help them understand physical processes at local, regional, and global scales. The third edition of the Wind Forecasting Improvement Project (WFIP3) allows us to examine one application of numerical weather prediction by comparing model data to observational data, applying weather forecasts to wind energy applications.

- WFIP3 focuses on understanding and forecasting our offshore wind resources exploring how oceanic and atmospheric processes affect ideal wind energy generation conditions.
- The goal is to use several deployed sensors focused on measuring low-level winds and boundary layer characteristics, with the objective of comparing with numerical weather models.
- This new insight may lead to improvements in model wind forecasting and improved energy/power output forecasts.
- Three observation sites and instruments are used --- a radar wind profiler (RWP, from NOAA) on the southeastern coast of Rhode Island, another RWP at Block Island, RI (from Argonne National Laboratory), and a sodar at Nantucket, MA (from Argonne National Laboratory). Data from these sites will be compared to operational weather models.
- This project focuses on comparison to NOAA's High Resolution Rapid Refresh (HRRR) model.



METHODS

Cases studies were chosen based on model performance using a range of dates between 17 April and 15 May 2024. Here the focus will be on 3 May 2024, where the HRRR showed both periods of accuracy and inaccuracy throughout the day. Comparison plots as well as model error plots for wind speed (difference between model and observed speeds) were created for each of the three sites, while surface and upper-air maps were analyzed to visualize atmospheric processes. Model bias and root mean square error (RMSE) were also calculated for each site. Model bias was calculated by averaging the model error, while RMSE was calculated by taking the square root of the mean squared model error.

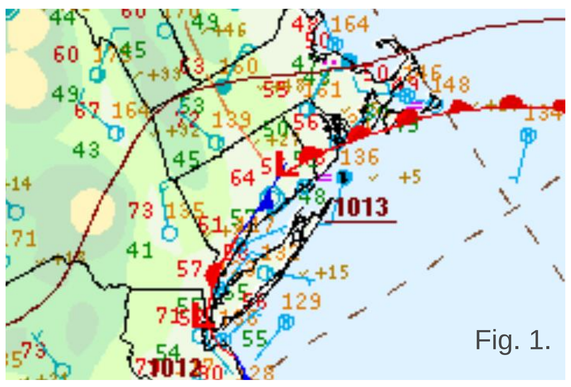


Fig. 1.

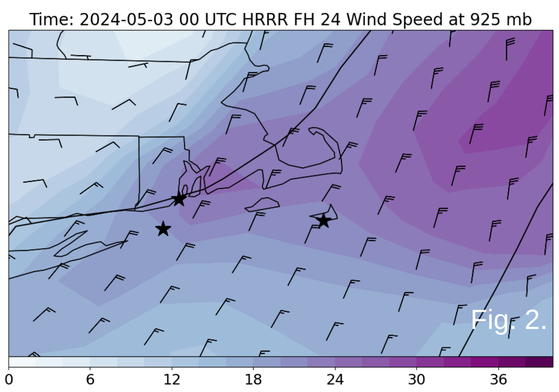


Fig. 2.

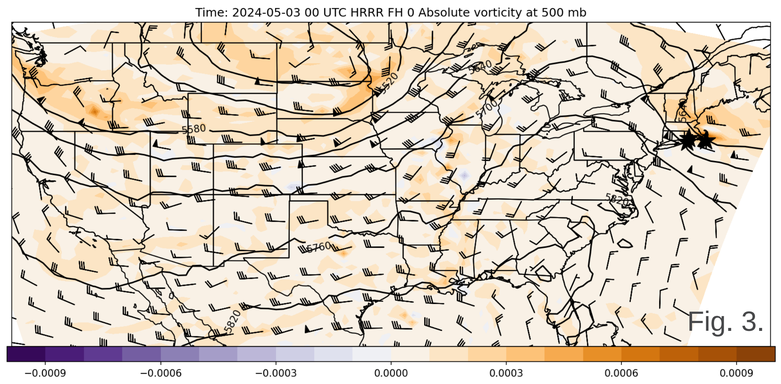


Fig. 3.

Safety Statement:
Online safety measures for this project included creating an Atmosphere to Electrons account to safely access the WFIP3 data. Requesting files includes disclosing organization name and reason for the request to prevent anyone from accessing the files with malicious intent.

Fig. 4

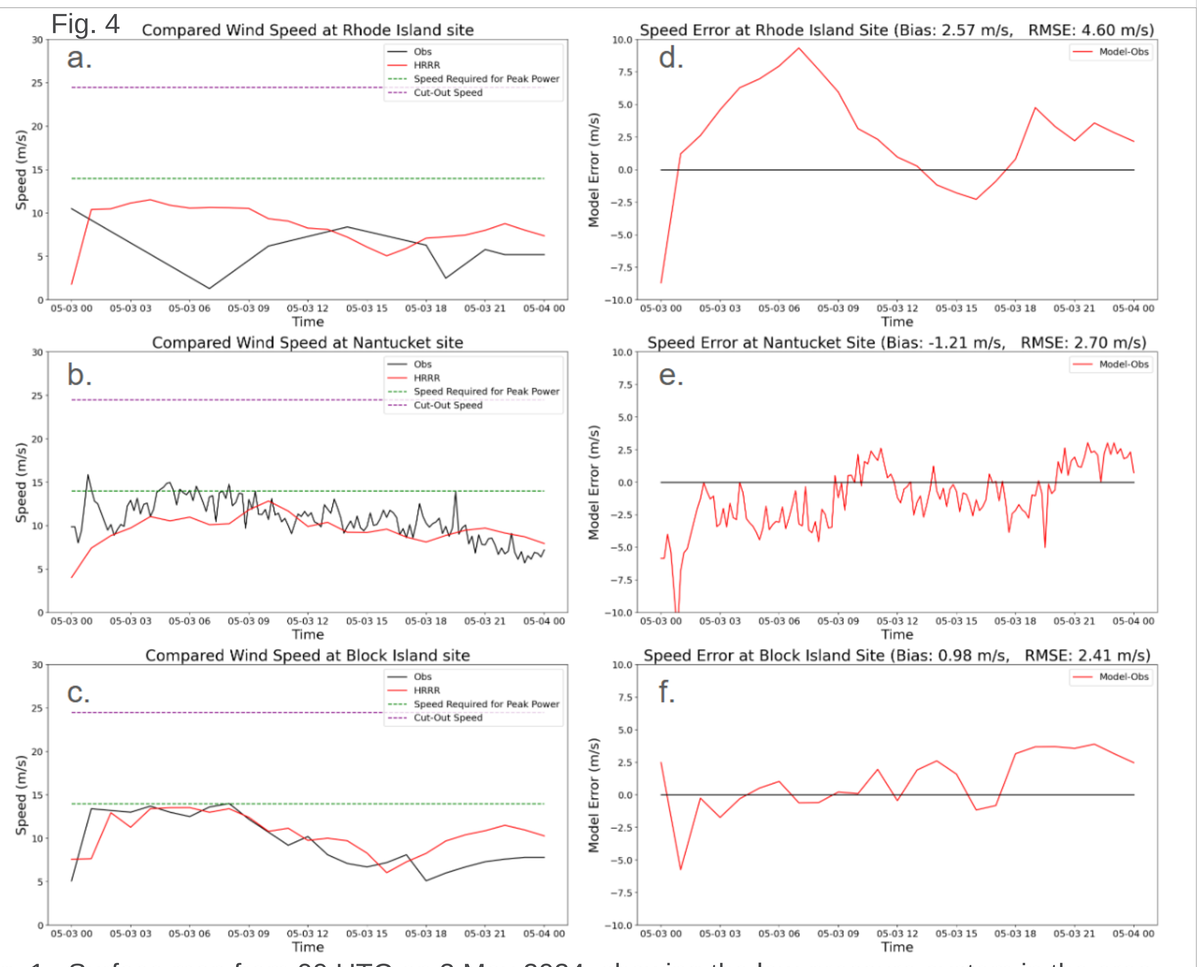


Fig. 1. Surface map from 00 UTC on 3 May 2024, showing the low-pressure system in the area.
Fig. 2. Map showing 925 mb winds from the 00 UTC HRRR on 3 May 2024, 24 hours out. The map shows the low-level jet nearby.
Fig. 3. CONUS map showing the general synoptic pattern using 500 mb absolute vorticity, geopotential heights, and wind barbs for 00 UTC on 3 May 2024.
Fig. 4. Model comparison charts for 3 May 2024. Compared speed at Rhode Island site (a), Nantucket sodar site (b), and Block Island site (c), model error at Rhode Island site (d),Nantucket sodar site (e), and Block Island site (f).

DISCUSSION

- Based on the results from this day alone, the HRRR seems to have some inaccuracies with the wind speeds when a surface low moves through the area, which was shown early in the period (Fig. 1, Fig.4d-f).
- Additionally, the model forecasted a weak low-level jet towards the end of the period that didn't quite verify (Fig. 2, Fig. 4d-f).
- The Rhode Island RWP from Argonne is an older device with lower sensitivity, which likely partially played a factor in the large error shown in the first half of the period.
- Fig 4. shows the HRRR performing best towards the middle of the period.

FUTURE DIRECTIONS

- Observations for the WFIP3 project continue until October 2025. The project will continue to compare these observations to HRRR data to further examine what atmospheric and/or oceanic processes contribute to inaccuracies in its forecasts.
- The WFIP3 project includes more instrumentation than just radar wind profilers and sodars for measurements. Instruments such as Doppler lidars are also included. The next step would be to compare these additional sites to model data, and then to the already-included sites which may help to see more differences in site-to-site winds. This could help improve observations of smaller-scale processes that numerical models don't always forecast.

Atmosphere to Electrons (A2e). 2024. wfip3/rhod.rwp.z01.00. Maintained by A2e Data Archive and Portal for U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. DOI: 10.21947/2229548. Accessed: 28 06 2024.
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ABSTRACT

The third edition of the Wind Forecasting Improvement Project (WFIP3) is one application of numerical weather prediction (NWP) that compares model data to observational data, focusing on improving NWP applications to wind energy applications offshore of the Northeast. The project deals with exploring offshore wind resources and seeing what oceanic and atmospheric processes affect the availability of it. Funded by the Department of Energy (DOE), this project aims to use several deployed sensors to measure low-level winds (i.e., closer to the hub height of a wind turbine) and boundary layer characteristics. The goal is to better understand the oceanic and atmospheric processes which impact wind energy applications, as well as have a comparison to numerical model data. This improved understanding might improve inaccuracies in wind fields in numerical weather prediction, enabling improved models for wind energy and power output applications.

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