

High-resolution wind prediction capabilities

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OBJECTIVES

- Develop high-resolution wind prediction capabilities for the Eversource offshore wind facility
- Assess the accuracy of the high-resolution wind prediction system
- Provide recommendations to optimize model configuration and improve forecast skill

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High-resolution wind prediction capabilities

TASKS

Task 1: Extend high-resolution WRF coverage and increase spatial resolution (~200m) to simulate localized winds at the offshore site

- ✓ Model configuration to carry out forecasts out to 48 hours at 200m grid spacing
- ✓ Optimal prediction of winds at 10-m to 200-m above sea level
- ✓ Perform a limited set of retrospective forecast simulations;

Task 2: Performance evaluation of high-resolution wind prediction system

- ✓ Evaluation of the forecast skill for high-res simulations conducted in Task 1
- ✓ Coordination with Dr. Pena's "*Local offshore wind analysis*" for wind observations that will be used to evaluate the high-res weather simulations
- ✓ Coordination with Dr. Matheou's "*High-fidelity wind farm simulations*" that will utilize winds from the high-res model outputs
- ✓ Recommendations to improve wind speed forecast skill and optimize model performance for future real-time applications



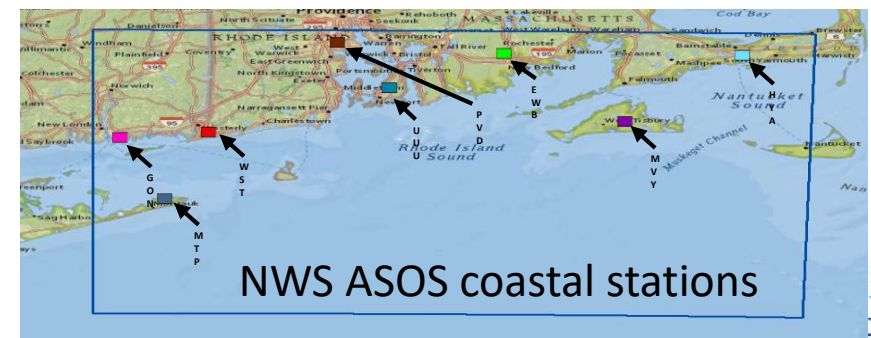
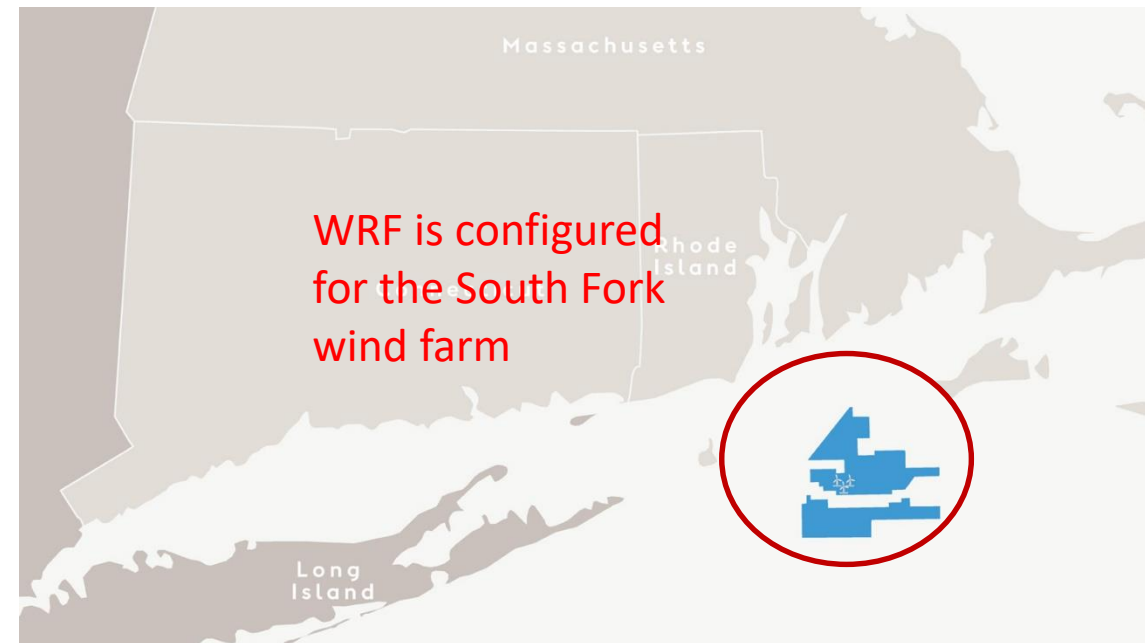
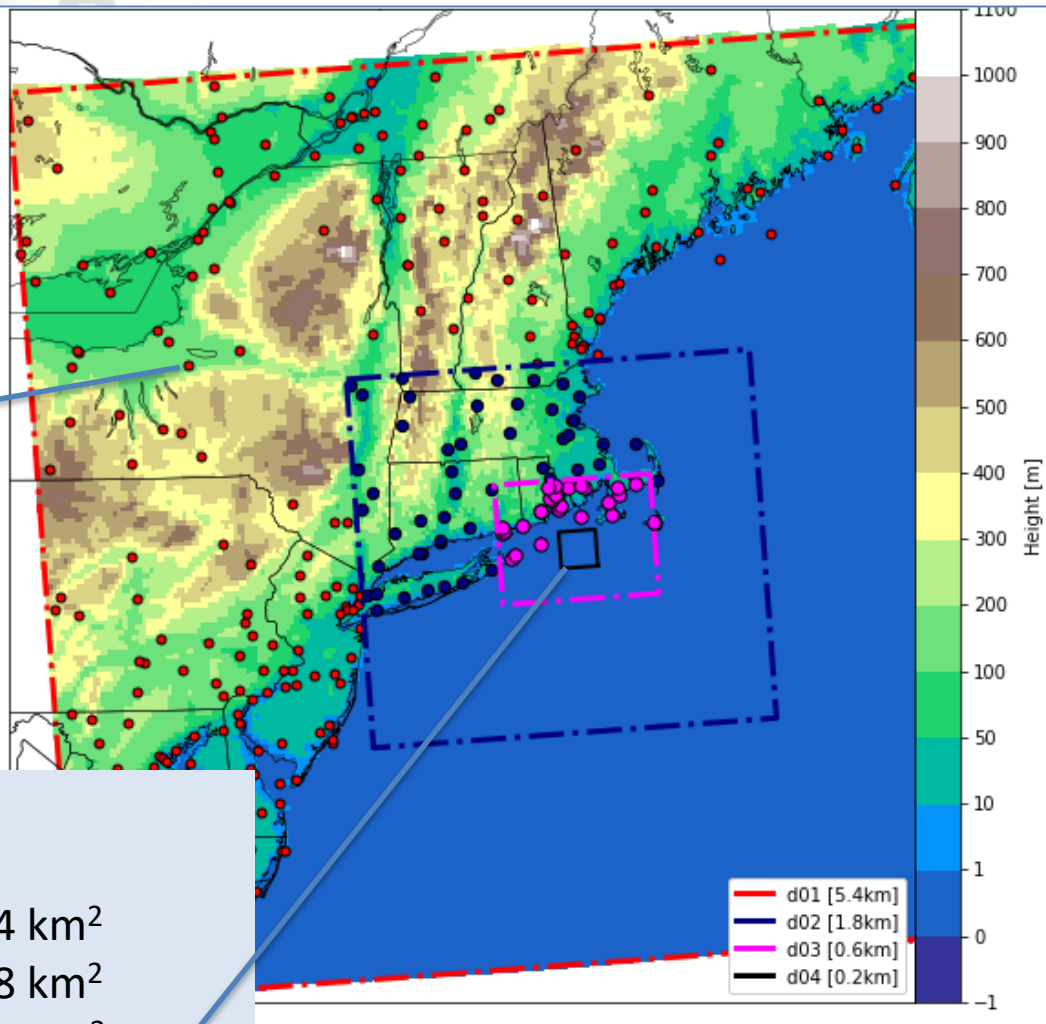
High-resolution wind prediction capabilities

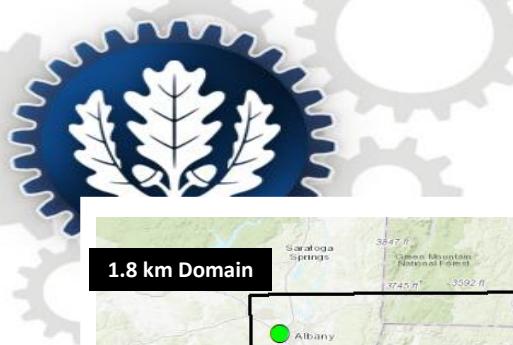
Project Timetable and Milestones

Date	Activity Reports	Milestones	Related Tasks
11/2019	Project kick off	Discussion of the project plan and deliverables	All
06/2020	Report on the configuration and preparation of simulations with the high-res wind prediction system	High-res wind prediction system	1.1, 1.2 (prelim)
12/2020	Report on retrospective forecast runs and performance evaluation of the high-res wind prediction system	Performance evaluation of high-res wind predictions for the area of interest	1.2, 2.1, 2.2
06/2021	Final report that includes: acceptance criteria and overall performance evaluation of the wind forecasting including recommendations for future improvements and further system development.	Final report	All

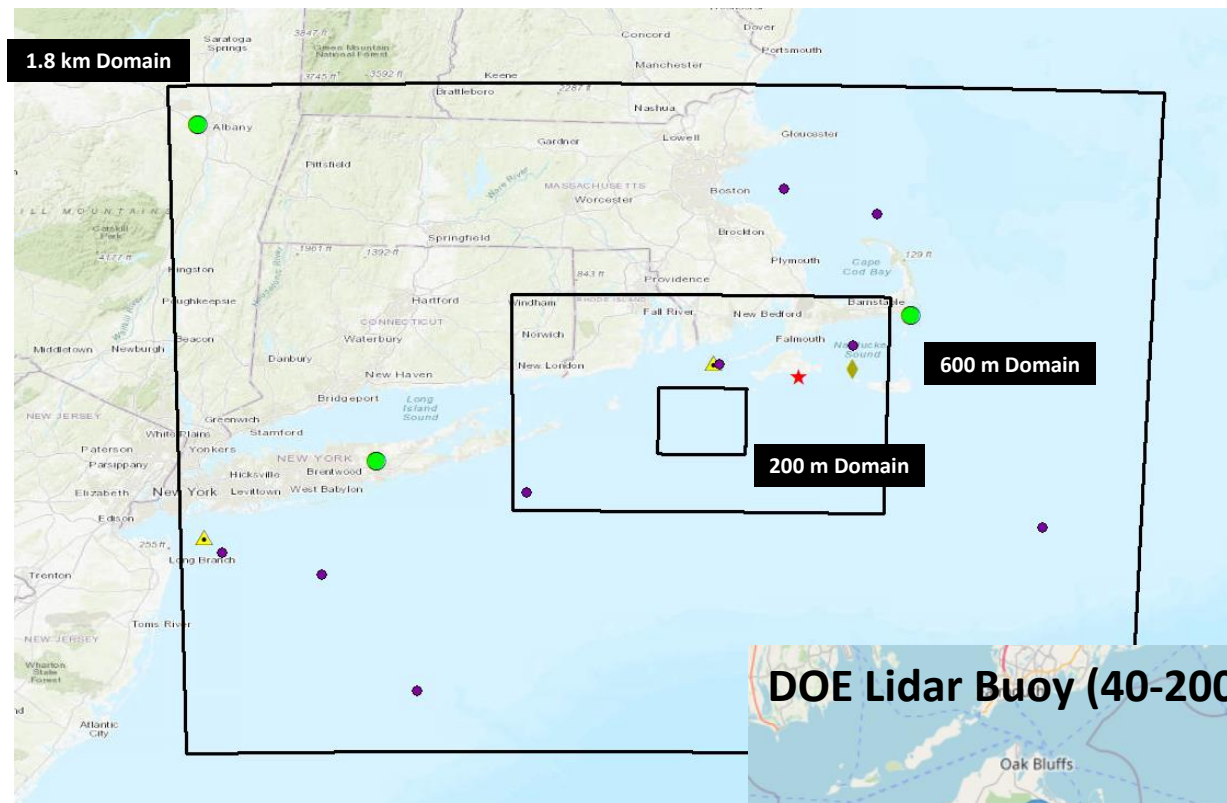


Modeling domain

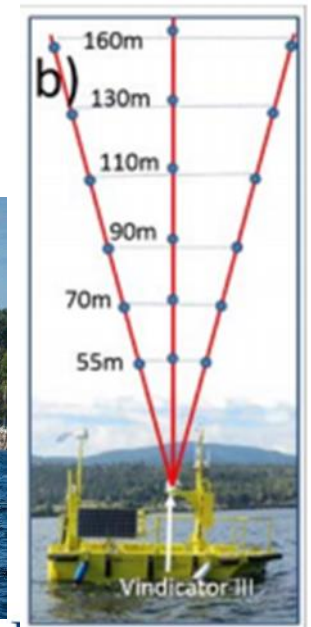
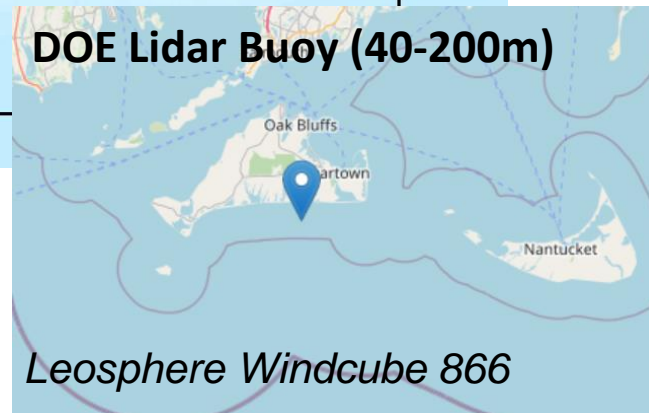
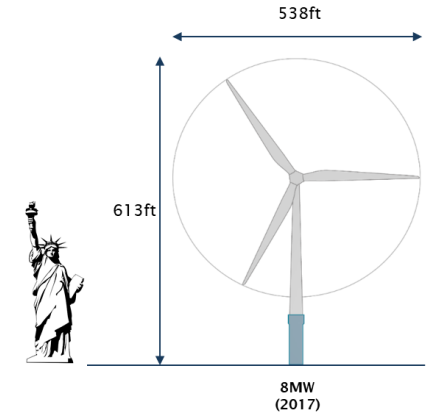




OFFSHORE OBSERVATIONAL SITES



- NDBC Buoy Stations
- ▲ NDBC CMAN Station
- Sounding Stations
- ★ Lidar Buoy Station
- ◆ IMPOWR Tower Station



NOTE: We still lack observations in the high-resolution domain

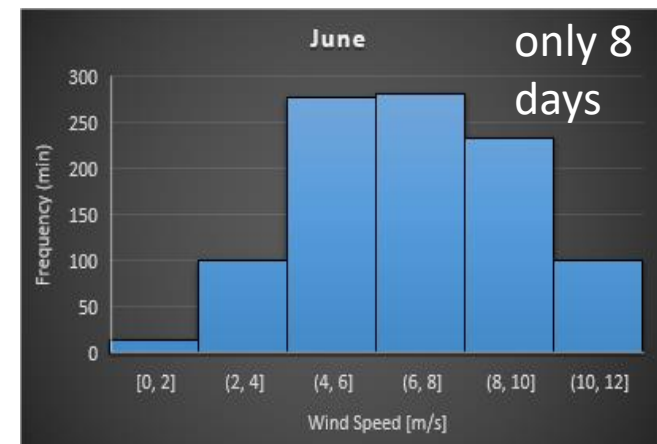
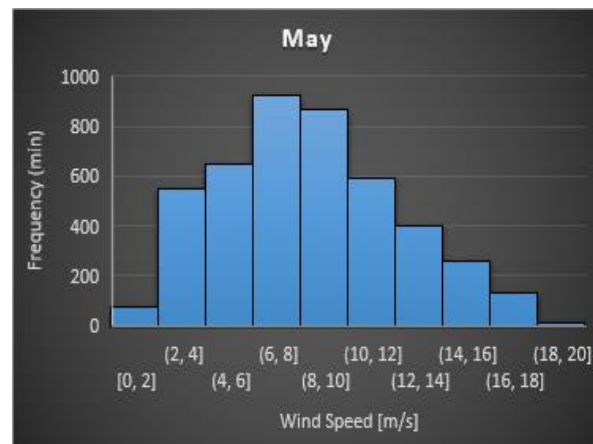
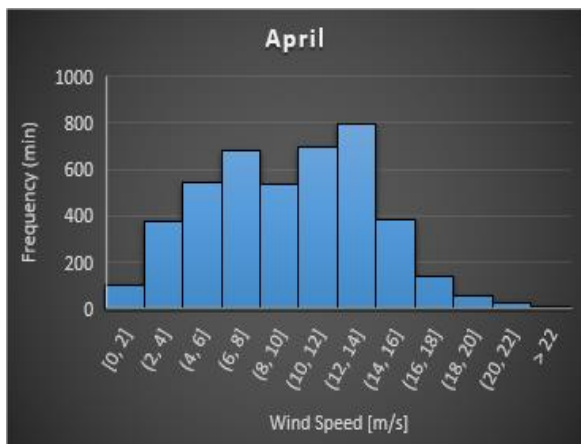
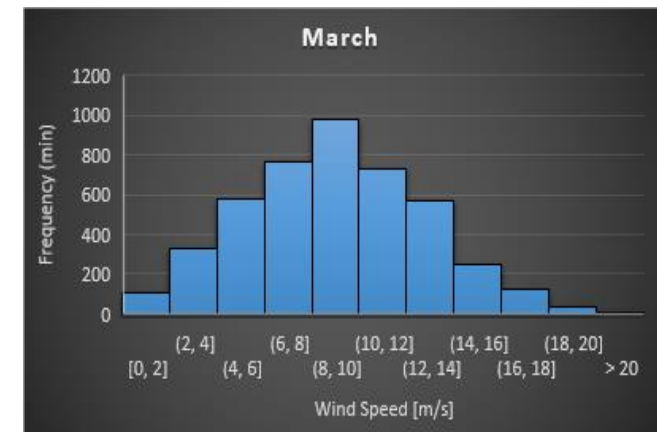
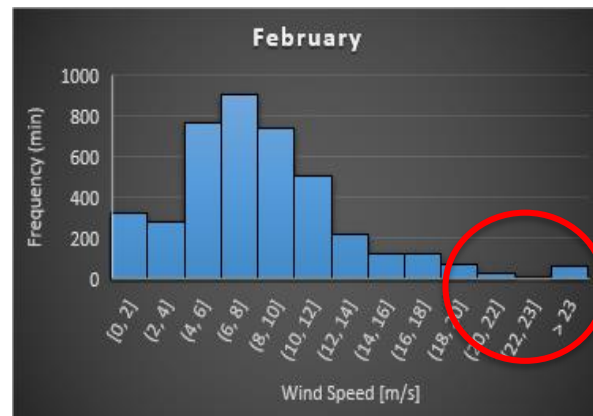
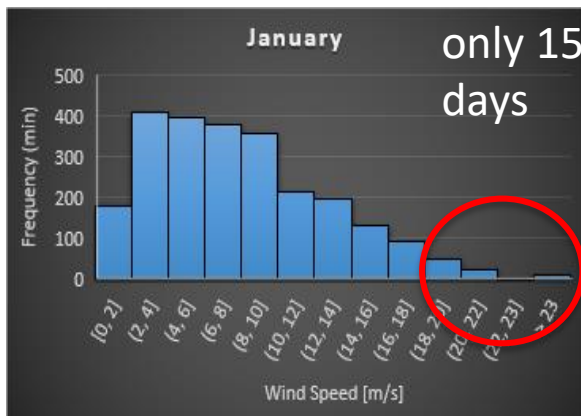


Offshore Wind Speed Evaluation

(using DOE's lidar buoy data: Jan-June 2020)

Lidar Buoy Data [at 40m height]

20 m/s =
50 mph



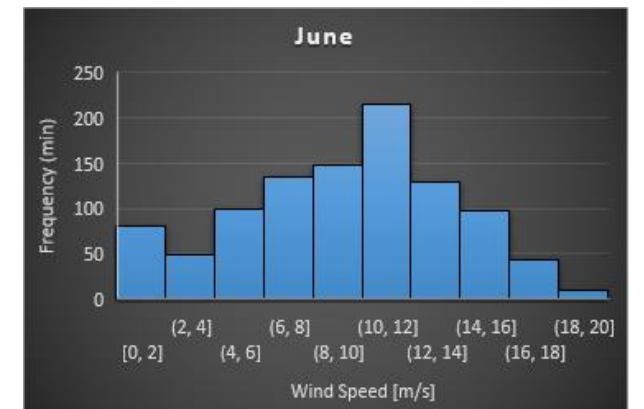
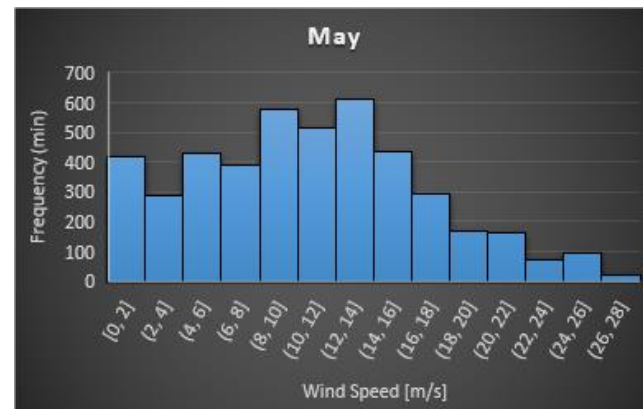
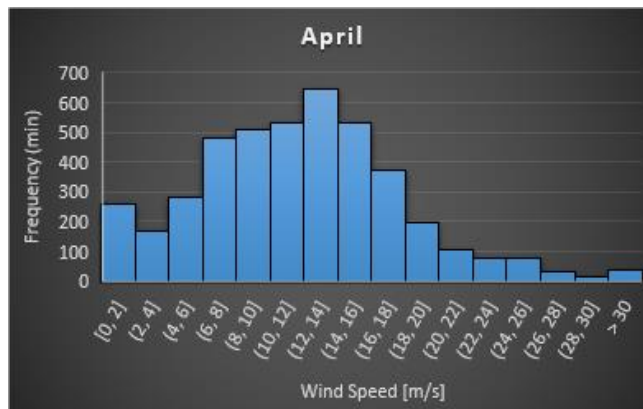
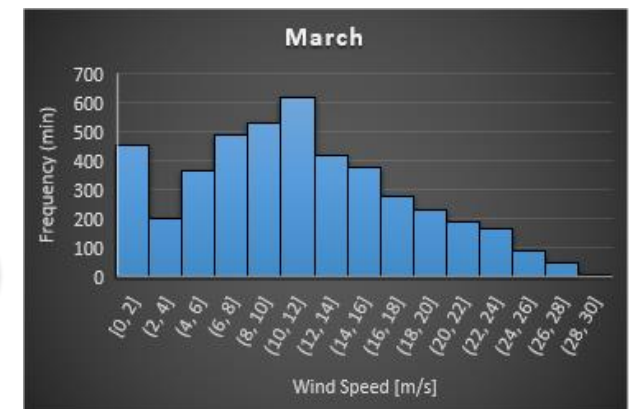
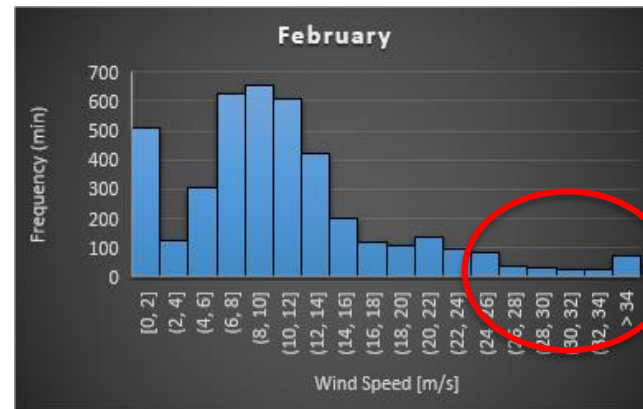
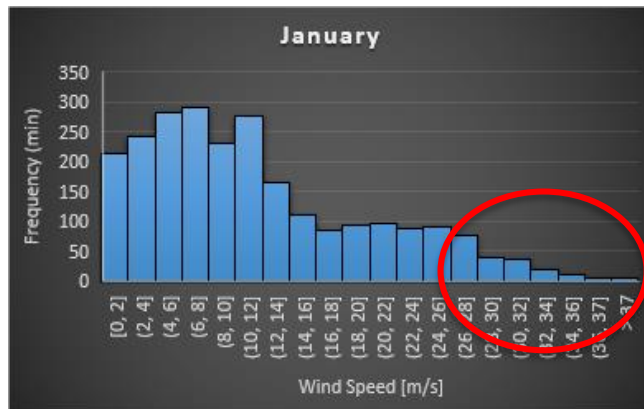
Gale winds:
39-46 mph



Offshore Wind Speed Evaluation

(using DOE's lidar buoy data: Jan-June 2020)

Lidar Buoy Data [at 200m height]





WRF high-res simulated cases

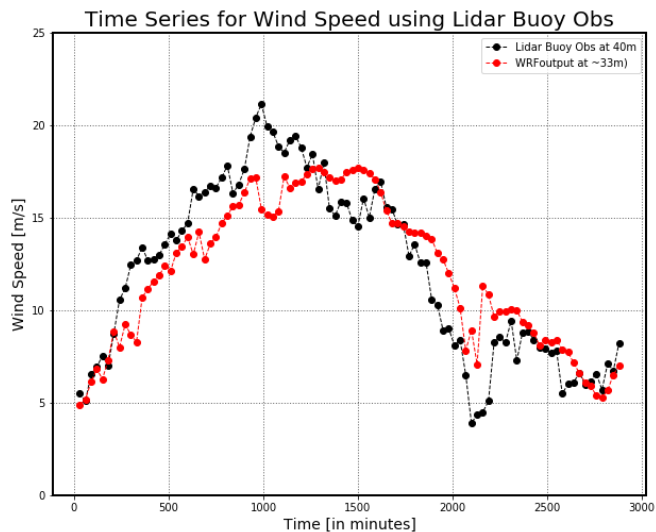
Low Pressure System	Cold front	Fair Weather Events
December 14-16, 2013	February 13-15, 2020	September 27-29, 2013
October 28-30, 2017	April 12-14, 2020	February 22-24, 2020
January 31-February 2, 2020		May 12-14, 2020
March 6-8, 2020		May 20-22, 2020
April 23-25, 2020		



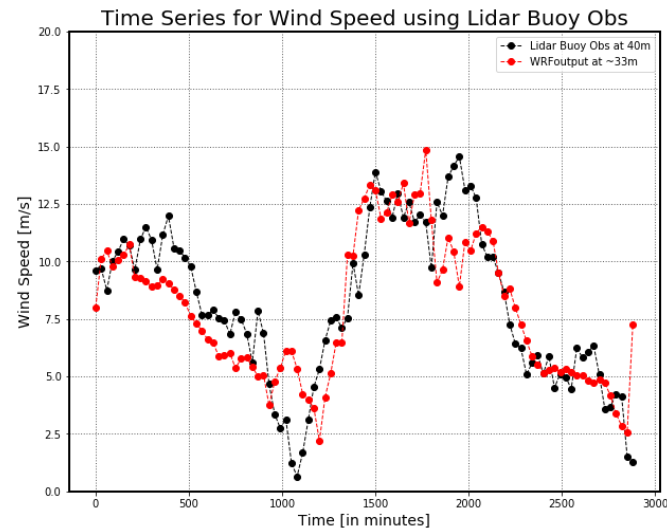
Offshore Wind Speed Evaluation (using DOE's lidar buoy data @40m)

Low Pressure System

March 6-8, 2020



April 23-25, 2020

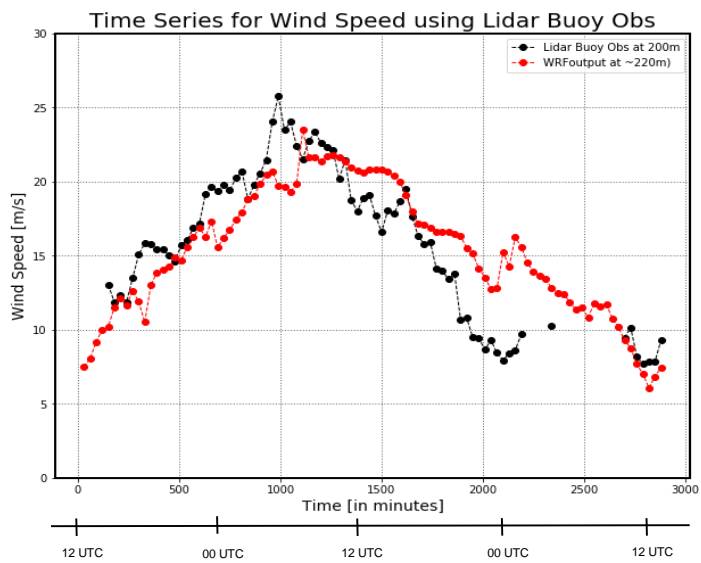




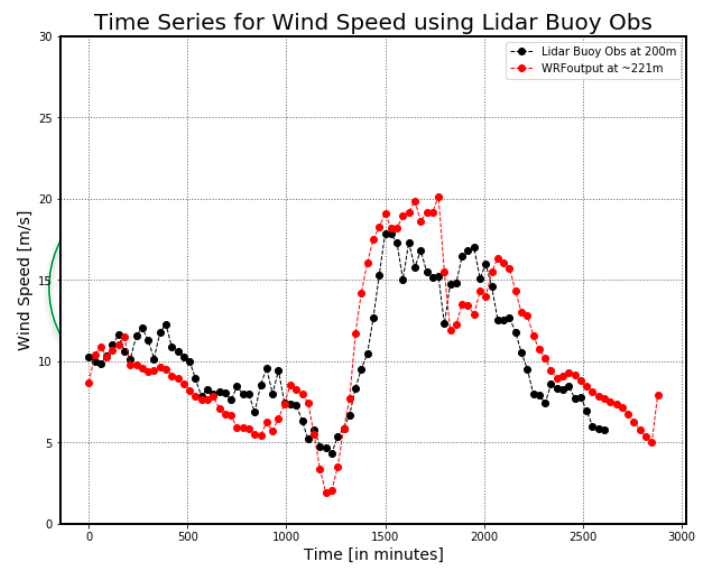
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Low Pressure System

March 6-8, 2020



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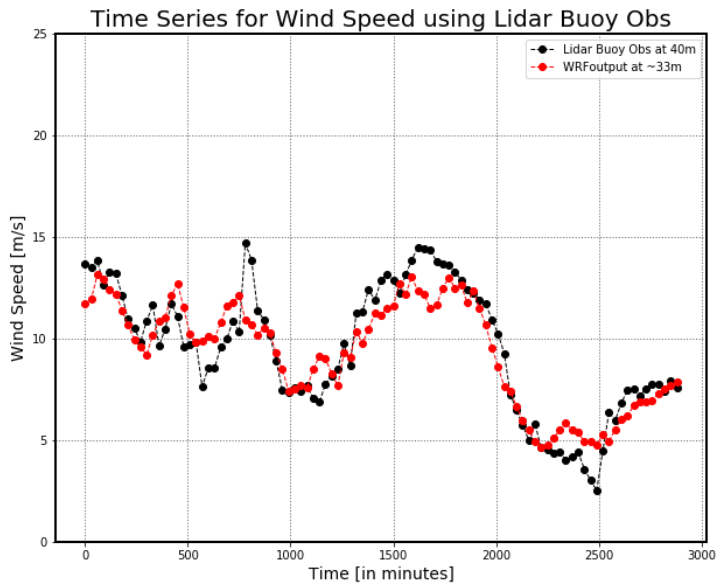




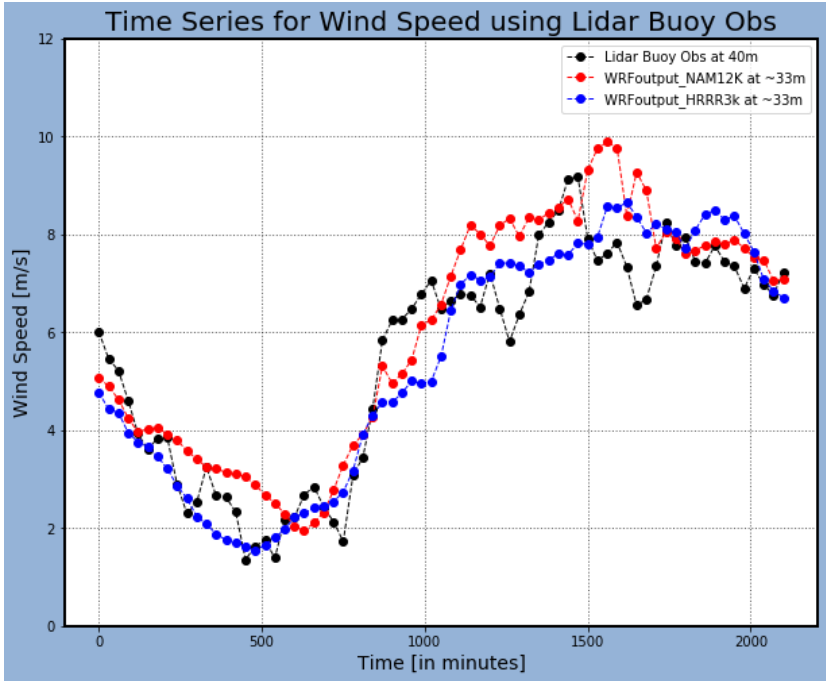
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Fair Weather

May 12-14, 2020



May 20-22, 2020

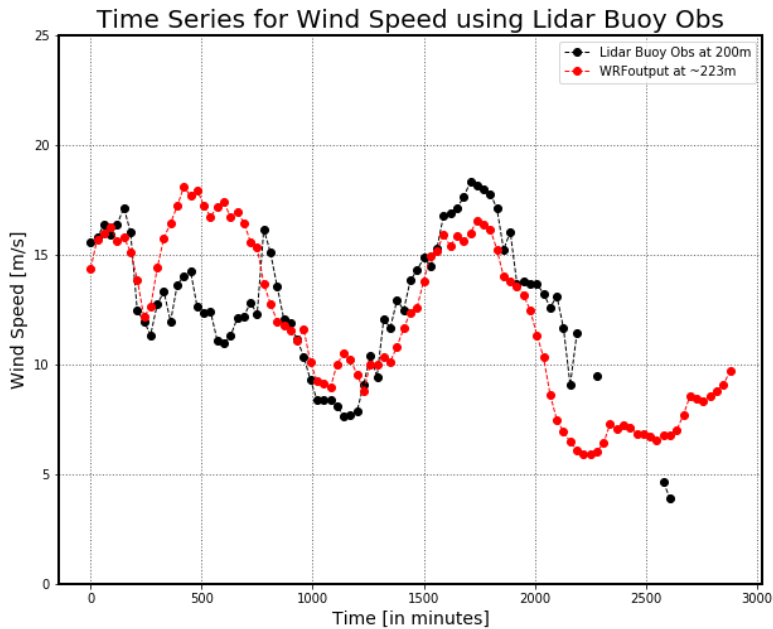




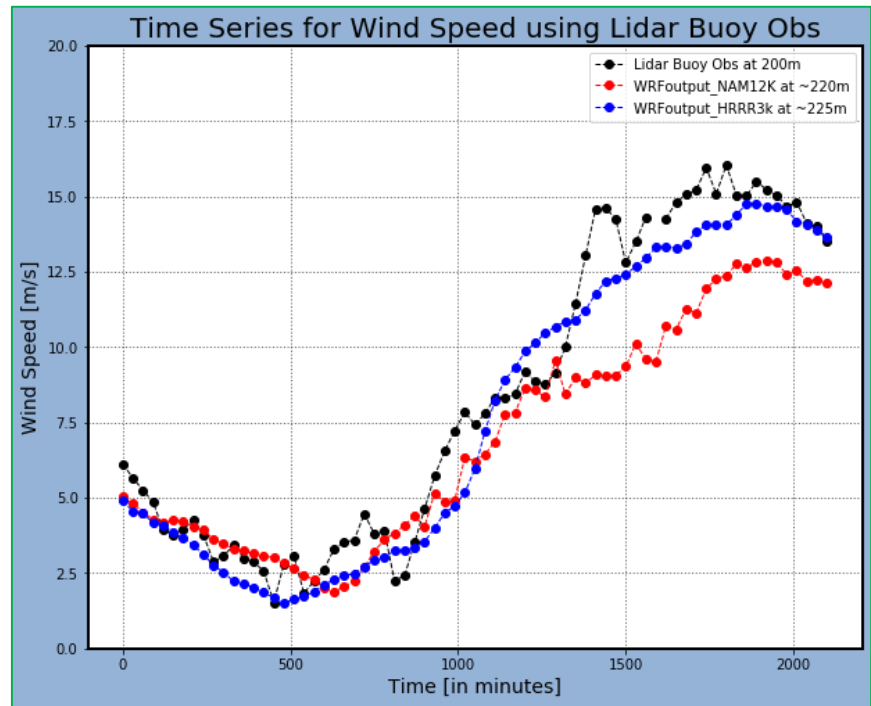
Offshore Wind Speed Evaluation (using DOE's lidar buoy data @200m)

Fair Weather

May 12-14, 2020



May 20-22, 2020





SUMMARY and NEXT STEPS

- The onshore evaluation reveals that the model is performing well in predicting surface wind speed but systematically over-predicts wind gust
- Vertical wind speed evaluation using soundings showed good agreement between model and observations with discrepancies (up to 10m/s bias) at 500 and 300hPa levels that need further examination (not shown here)
- Wind speed prediction is in very good agreement with DoE's lidar buoy off Martha's Vineyard at most vertical levels (40-200m). Variations appear at the 200m level but a new configuration reveals a significant improvement that is still under investigation

Next Steps

- Continue testing of the HRRR/WRF configuration for all case studies
- Run sensitivity tests to optimize model performance for offshore wind prediction
- Test computational time and performance for a real-time operational high-res wind speed prediction