OSW Consortium 2 – Validated National Offshore Wind Resource Dataset with Uncertainty Quantification

Cooperative Research and Development Final Report

CRADA Number: CRD-19-16351

NREL Technical Contact: Nicola Bodini

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

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Contract No. DE-AC36-08GO28308

Technical Report
NREL/TP-5000-90394
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NOTICE

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Cooperative Research and Development Final Report

Report Date: June 20, 2024

In accordance with requirements set forth in the terms of the CRADA agreement, this document is the CRADA final report, including a list of subject inventions, to be forwarded to the DOE Office of Scientific and Technical Information as part of the commitment to the public to demonstrate results of federally funded research.

Parties to the Agreement: New York State Energy Research and Development Authority

CRADA Number: CRD-19-16351

CRADA Title: OSW Consortium 2 – Validated National Offshore Wind Resource Dataset with Uncertainty Quantification

Responsible Technical Contact at Alliance/National Renewable Energy Laboratory (NREL):

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Sponsoring DOE Program Office(s): Office of Energy Efficiency and Renewable Energy (EERE), Wind Energy Technologies Office

Joint Work Statement Funding Table showing DOE commitment:

Estimated Costs	NREL Shared Resources a/k/a Government In-Kind NREL	NREL Shared Resources a/k/a Government In-Kind PNNL
Year 1	$0	$0
Year 2	$222,455	$63,202
Year 3	$610,721	$157,213
Years 4-7	$334,473	$63,104
TOTALS	$1,167,649.00	$283,429

Executive Summary of CRADA Work:

This research has led to the development of the 2023 National Offshore Wind data set (NOW-23), which offers the latest wind resource information for offshore regions in the United States. NOW-23 supersedes, for its offshore component, the Wind Integration National Dataset (WIND) Toolkit, which was published a decade ago and is currently a primary resource for wind resource assessments and grid integration studies in the contiguous United States. By incorporating advancements in the Weather Research and Forecasting (WRF) model, NOW-23 delivers an updated and cutting-edge product to stakeholders. As part of this project, we also developed a summary of the uncertainty quantification in NOW-23, along with NOW-WAKES, a 1-year post-construction data set that quantifies expected offshore wake effects in the US Mid-Atlantic lease areas. Stakeholders can access the NOW-23 data set at https://doi.org/10.25984/1821404.

CRADA benefit to DOE, Participant, and US Taxpayer:

- Assists laboratory in achieving programmatic scope, and/or
- Enhances the laboratory's core competencies, and/or
- Enhances U.S. competitiveness by utilizing DOE developed intellectual property and/or capabilities.

Summary of Research Results:

Task 0: Project Management and Progress Reporting

We completed all the requirements listed in the agreement, including:

- Quarterly periodic Progress Reports.
- Quarterly Expert Advisory Committee meetings
- Quarterly reports of feedback from the Expert Advisory Committee
- Brief report summarizing the Kick-off Meeting and Minutes
- Brief report summarizing the Completion Meeting and Minutes
- Annual Metrics Reports.

Task 1: Develop Wind Resource Product for North Atlantic, Mid Atlantic, Great Lakes, Pacific and California Regions

To create the 2023 National Offshore Wind (NOW-23) data set, we adopted a regionally phased approach. For each offshore region (as shown in Figure 1), we gathered available observations (whenever available), performed a separate numerical simulation, whose setup was selected (in most regions) through validation against available observations, including lidars, so that the model was customized to account for regionally unique wind resource phenomena.

For the Mid-Atlantic region, we considered 16 different model setups, which constitutes a mesoscale model ensemble. To select the best-performing model setup in the region, which was then used for the long-term NOW-23 data set, we validated the modeled ensemble members against observations collected by the three floating lidars in the region. The validation results allowed us to determine the best performing model setup, which was used for the long-term NOW-23 simulation, which covers the period from 1 January 2000 to 31 December 2020. We note that additional details on the validation are provided in Pronk et al. (2022).

For the Great Lakes and California, observations from local lidars were used to validate the mesoscale model ensemble and select the model configuration to use to produce the 20+ year period. On the other hand, no publicly available hub height offshore wind speed observations exist in the North Pacific and Hawaii domains. Therefore, the model setup chosen for these regions was based on the results obtained in the other regions, with no additional validation against observations.

Data for all regions, available at high spatial and temporal resolution over 20+ years, have been published in the NOW-23 data portal by leveraging Amazon Web Services, and have been documented and disseminated in Bodini et al., 2024.

A promising offshore wind resource is often located near large population centers so that a rapid wind plant development is expected. However, wind turbines and wind plants generate wakes, which are regions of reduced wind speed that may negatively impact downwind turbines and plants. As part of the NOW-23 data set, we developed a "post-construction" data set, named NOW-WAKES, which is a 1-year data set to model and assess the impact of offshore wakes from the upcoming wind plants in some of the lease and call areas in the Mid-Atlantic region. The results of this analysis are described in detail in Rosencrans et al. (2023) and Rybchuk et al. (2022).

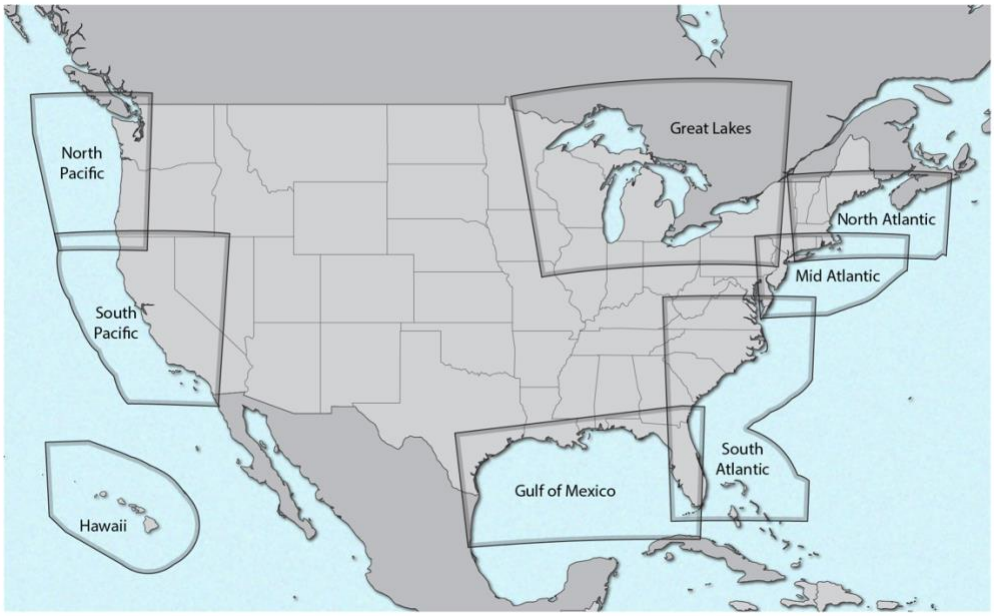

Figure 1: map of the regional domains for the NOW-23 data set.

Task 2: Develop Wind Resource Product for Maine and Gulf of Mexico

The same approach followed in Task 1 was also followed to develop the long-term wind resource data for Maine and the Gulf of Mexico.

We leveraged the validation results from the Mid-Atlantic region to infer conclusions about the model setup to use for the long-term wind resource modeling in the adjacent North Atlantic region, where we only had access to very limited hub-height lidar observations of wind speed. For the Gulf of Mexico, a proper model ensemble was created and validated against observations of wind speed collected by three lidars owned by Shell, south of the Louisiana coast (results of the validation are shown in Figure 2). Our validation allowed to select the best performing model setup, which is used for the long-term NOW-23 simulation.

Data for these two regions, available at high spatial and temporal resolution over 20+ years, have been published in the NOW-23 data portal by leveraging Amazon Web Services, and have been documented and disseminated in Bodini et al., 2024.

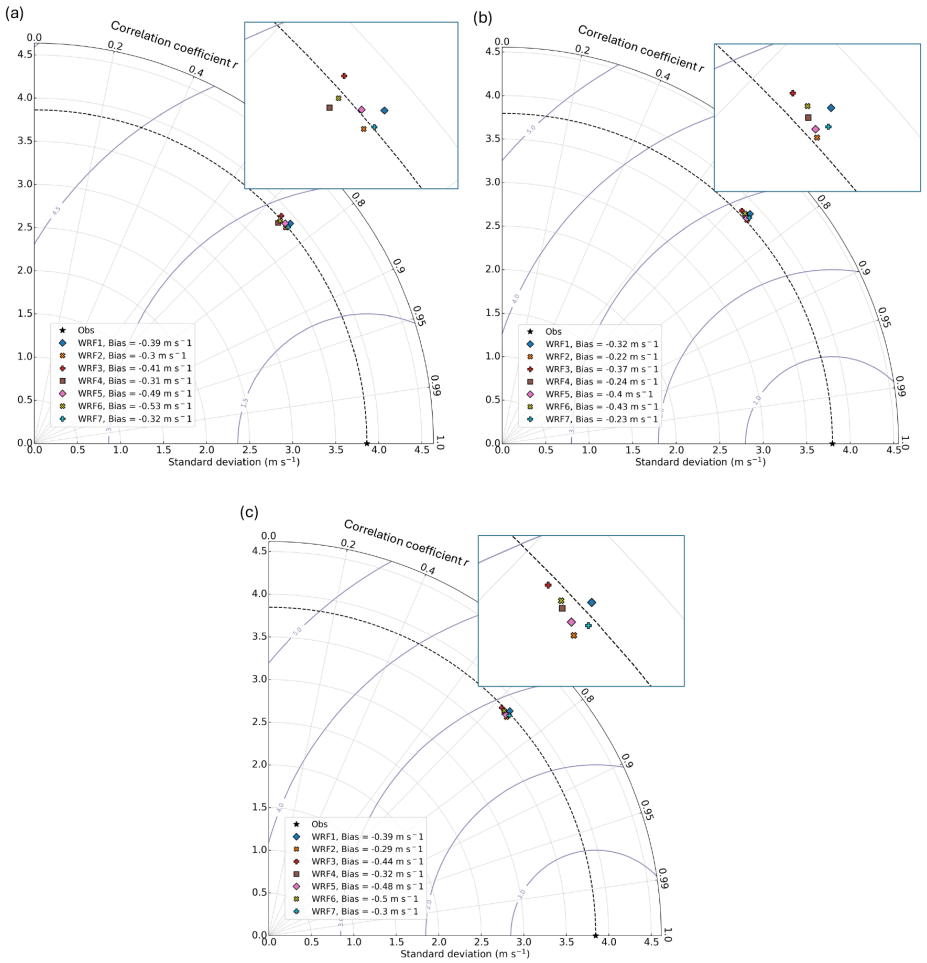

Figure 2: results of the NOW-23 model validation in the Gulf of Mexico region.

Task 3: Develop Wind Resource Product for South Atlantic, and Uncertainty Quantification for North Atlantic

The same approach was also followed to produce the wind resource data set for the South Atlantic region. A mesoscale model ensemble was validated against observations collected by a U.S. Department of Energy (DOE) lidar located off the Virginia coast. Based on the results of our validation analysis across all considered atmospheric variables, we ran the best-performing model setup in this region for the NOW-23 long-term simulation.

Data for this final region, available at high spatial and temporal resolution over 20+ years, have been published in the NOW-23 data portal by leveraging Amazon Web Services, and have been documented and disseminated in Bodini et al., 2024. Figure 3 shows the modeled mean wind speed from the NOW-23 data set across all modeled regions.

As mentioned, NOW-23 is a modeled data set, and, as such, it comes with inherent, unavoidable uncertainty. As part of the NOW-23 development, significant effort was undertaken to provide stakeholders with this uncertainty information. We tackled this aspect from different points of view, which are summarized in Bodini et al., 2022 and 2023.

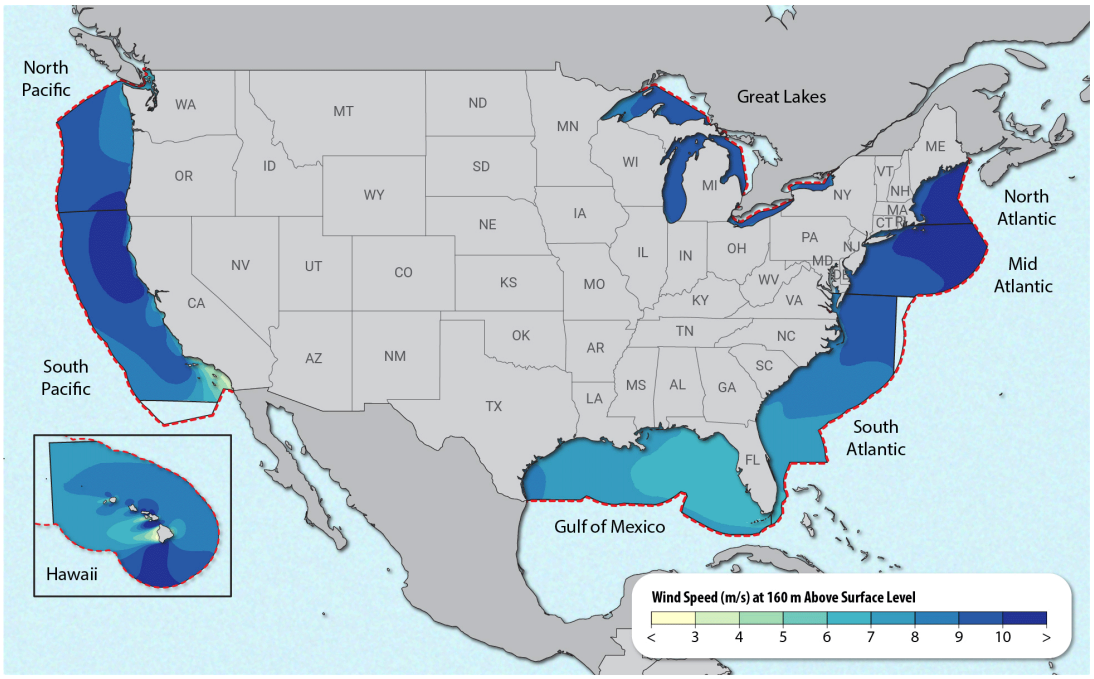

Figure 3: mean long-term wind speed at 160 m from the NOW-23 data set.

Task 4: Final Report

This report serves to meet the requirement for the CRADA Final Report with preparation and submission in accordance with the agreement.

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Subject Inventions Listing:

None.

ROI#:

None.