ARCVERA RENEWABLES

IPF24 INTERNATIONAL PARTNERING FORUM
22-25 APRIL 2024 NEW ORLEANS, LA

A Unified Wind Dataset for Offshore Metocean Analysis and Wind Resource Assessment

Mark Stoelinga and Dan Bernadett

Motivation

- A preconstruction study for an offshore wind project typically involves two largely separate efforts: a Wind Energy Assessment (WEA), and a Metocean Analysis.
- Each requires wind climate information, but the requirements of the wind data for each study differ (see below).
- As a result, the Metocean and WEA teams often select different wind input datasets and proceed with their studies independently.
- At the completion of both studies, an "alignment check" is made to confirm that the wind climates assumed in the two studies do not significantly differ, but this can lead to difficult adjustments to the completed studies.

Goal: Use a customized mesoscale Weather Research and Forecast (WRF) model to produce a "Unified WRF Dataset" that meets the requirements of both the WEA and Metocean studies, so that the two studies are "pre-aligned" on the important input of the wind climate. Project being studied is the IJmuiden Ver Wind Farm Zone, in the North Sea, west of the Netherlands.

Contrasting Requirements of Wind Climate Data

Metocean:

- **Broad areal coverage**, to drive the hydrodynamic, current, and wave models.
- Focus is on **10-meter wind** speeds and directions
- Winds need to be accurate **under extreme conditions (storms)**

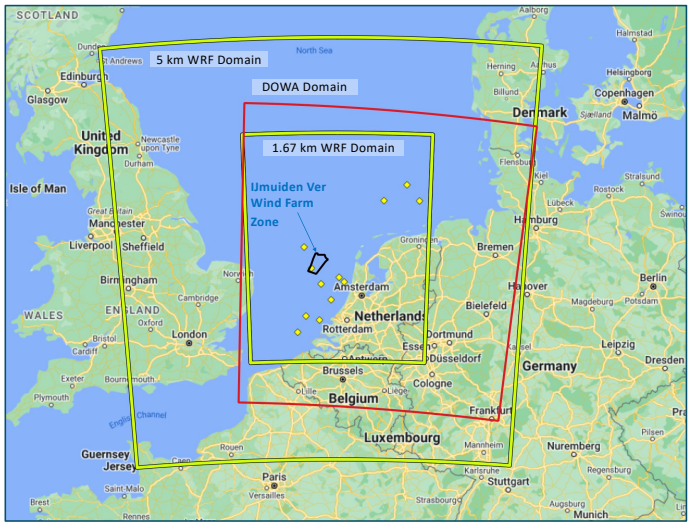
Wind Energy Assessment:

- Sufficiently **high resolution (< 2 km)** is needed to capture coastal effects and gradients in mean wind speed
- Focus is on rotor-layer winds (30-300 meters), especially at **hub height (160 m)**
- Winds need to be accurate in terms of long-term statistics **(mean and distribution)**

Team: The effort was conceived of and sponsored by the Netherlands Enterprise Agency (Rijksdienst voor Ondernemend Nederland, or RVO). A consortium of companies (see bottom of poster), led by DHI, collaborated on the Metocean and WEA studies, with ArcVera taking the lead on the development of the Unified WRF Dataset.

Unified-WRF Model Configuration:

- Domains and grid spacing
  - Outer Grid: 5 km (eastern English Channel, North Sea to 56.6° N)
  - Inner Grid: 1.67 km (Netherlands offshore waters)
- Length: 44 years (1979 – 2022), with simulations run in 5-day pieces
- Output frequency: 10 minutes
- Initial and boundary conditions
  - ERA5 reanalysis (0.25-degree grid), with continuous interior domain nudging
- Post-processed bias correction
  - 12 offshore measurement sites with at least one year of unwaked measurement (see yellow dots on map below, and table to right)
- Modified ocean surface physics
  - Hybrid drag formulation that retains good WRF performance at low to moderate wind speeds, but allows higher speeds (removing low bias) under storm (high-wind) conditions
- Publicly available output (44 years, 10-minute frequency, full inner model domain, 10 heights)

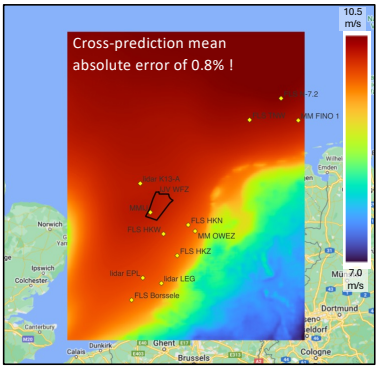


Measurement Sites for Bias Correction

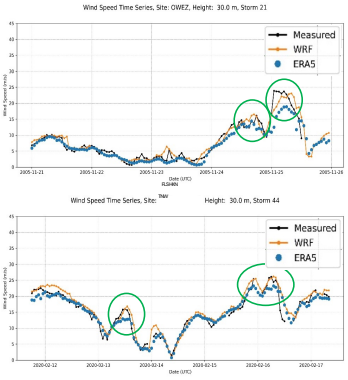
(periods shown are when unwaked measurements were available)

Site	Start Date	End Date	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
		Year --->																			
MM FINO 1	2004-02-01	2008-12-31																			
MM OWEZ	2005-07-01	2006-07-02																			
MMIJ	2012-01-01	2016-01-01																			
FLS Borssele	2016-02-12	2017-02-12																			
lidar LEG	2016-01-01	2018-12-31																			
FLS HKZ	2016-06-05	2018-06-04																			
lidar EPL	2016-07-01	2018-12-31																			
lidar K13-A	2016-11-02	2022-01-01																			
FLS HKN	2017-04-10	2019-04-10																			
FLS HKW	2019-02-05	2021-02-12																			
FLS TNW	2019-06-19	2021-06-20																			
FLS N-7.2	2020-05-20	2021-05-04																			

Long-Term Mean Wind Speed at 160 m



Examples of Improved Simulated Storm Peak Winds



Conclusions

- RVO / DHI Consortium has produced a Unified-WRF Model Dataset, optimized to support both Metocean and Wind Resource Assessment
- The dataset is on a 1.67-km grid, with 44 years of 10-minute output
- The dataset matches extreme wind peaks well → important for Metocean modeling and applications
- Nearly unbiased, with high hourly correlation, and closely matching the distribution of long-term measured winds offshore → important for WEA
- Full dataset available from DHI's Met Ocean on Demand (MOOD) data portal

DHI The expert in WATER ENVIRONMENTS | OWC An ABL Group Company | ARCVERA RENEWABLES | Rijksdienst voor Ondernemend Nederland (RVO) | ProPlanEn Wind Energy Advisory | INNOSEA Part of OWC | C2WIND