Relative Impacts of Environmental Factors on Finite Offshore Wind Farms

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INTRO

Computationally inexpensive yet accurate methods for simulating offshore wind farms are important to siting, design, forecasting, and operations. This study investigates what environmental factors, including both atmospheric and oceanic phenomena, are most important for offshore wind farms.

METHODS

A computational fluid dynamics (CFD) framework was developed to simulate full-scale offshore wind farms. This framework was used to gather data with two different wave models: one that represents the waves as static roughness elements and one that represents waves as dynamic, traveling structures including complete wave spectra.

RESULTS

The dynamic wave spectrum model resulted in lower wind velocities throughout the farm, indicating a smaller available power than the static roughness model would suggest. The dynamic wave spectrum drag model additionally predicted larger wind shear exponents and turbulence intensity across the turbine rotors.

DISCUSSION

Representing waves with a model that is aware of the dynamic nature of waves significantly changes the power and loading predictions for turbines in an offshore wind farm without incurring additional computational cost. Future steps include comparing the impacts of specific parameters (e.g., turbulence intensity, wave age, boundary layer stability) to understand which environmental parameters are most important.

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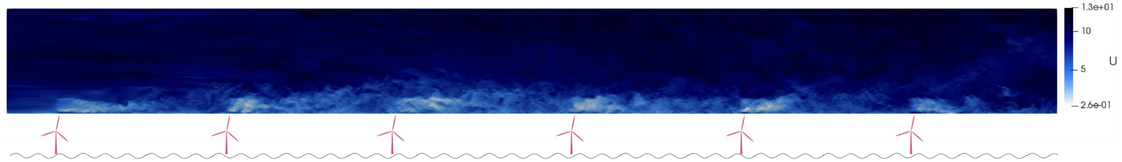
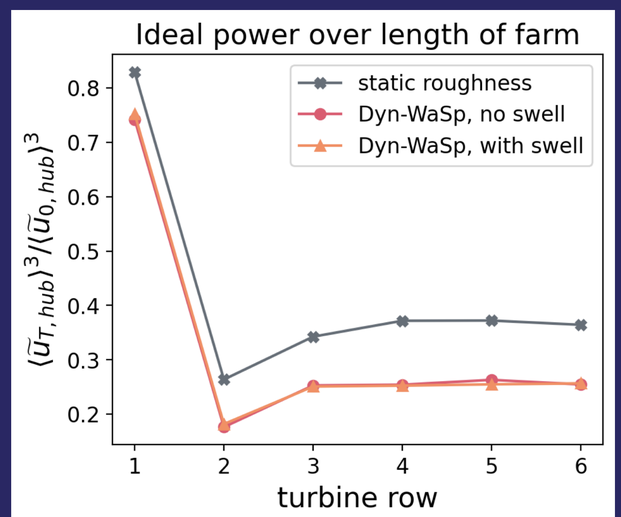


- **Modeling waves as static roughness overpredicts available power and underpredicts loading experienced by offshore wind turbines**
- **Dynamic waves can be modeled at similar computational cost**



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