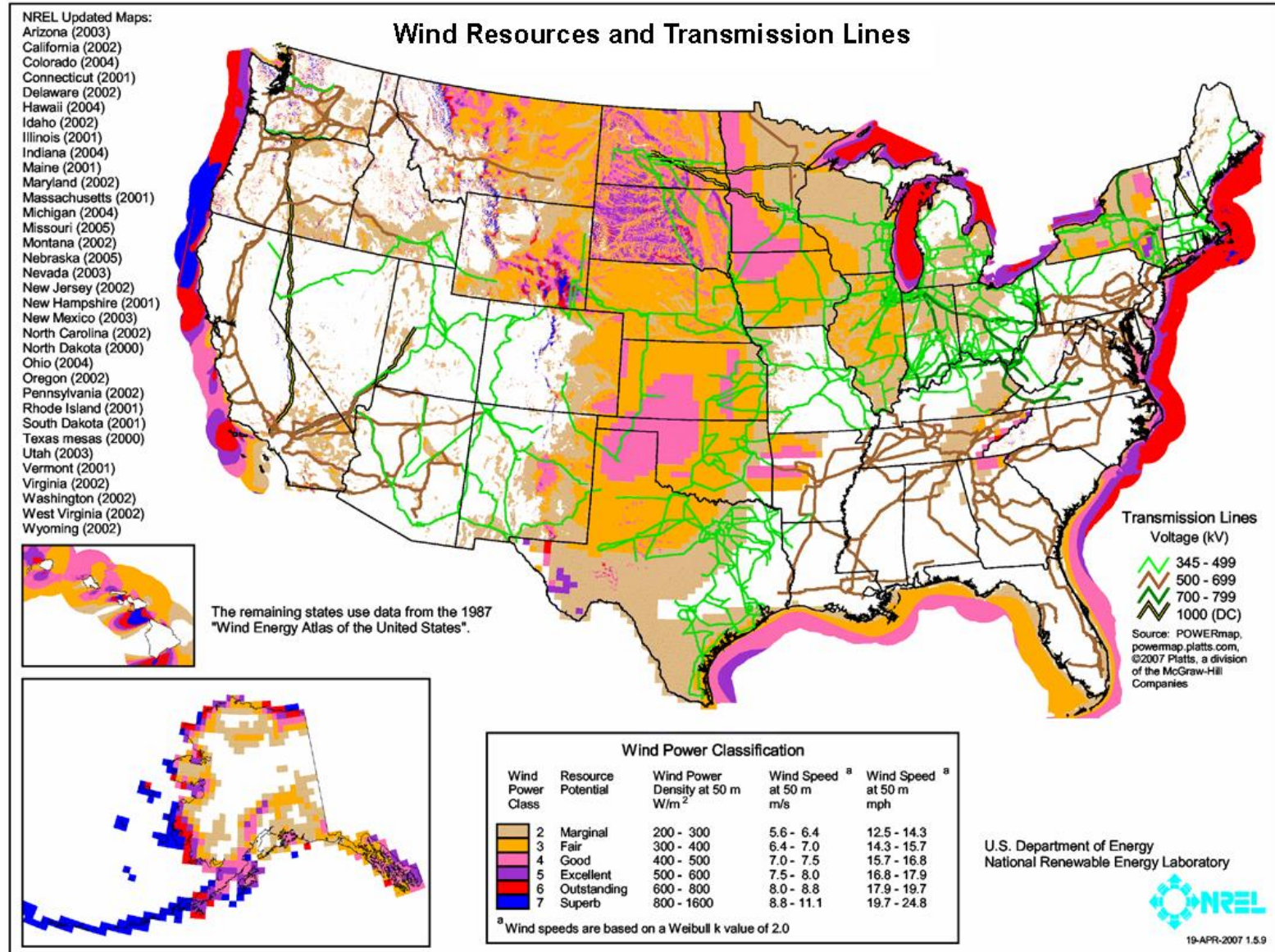


# Loads Analysis of Floating Offshore Wind Turbines

By Gordon Stewart

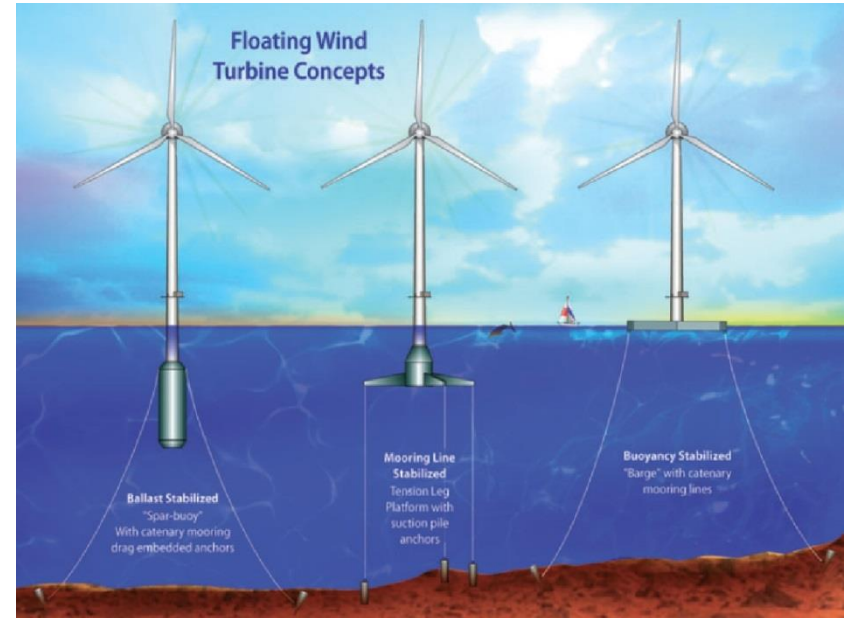


# Offshore Wind Resources



# Floating Offshore Wind Turbines (FOWTs)

- Can be placed over deep (>50m) water, allows for placement far from shore out of sight
- Possibility of being assembled in port and towed out
- Increased costs associated with support platform, operation and maintenance, and power transmission



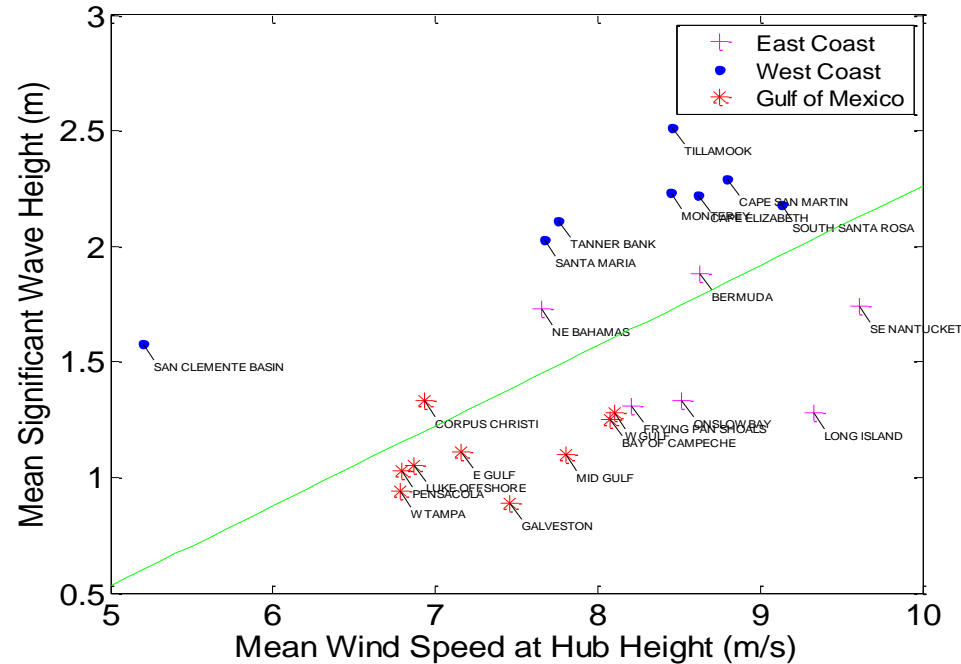
## Research Questions

---

- What are the metrological/ocean conditions that floating wind turbines will experience in the U.S.?
- How long do simulations of floating wind turbines need to be to be accurate?
- What are the effects of wind/wave misalignment on floating wind turbines?
- Can the shapes of offshore wind farms be optimized to reduce avian impacts?

# Metoccean Conditions

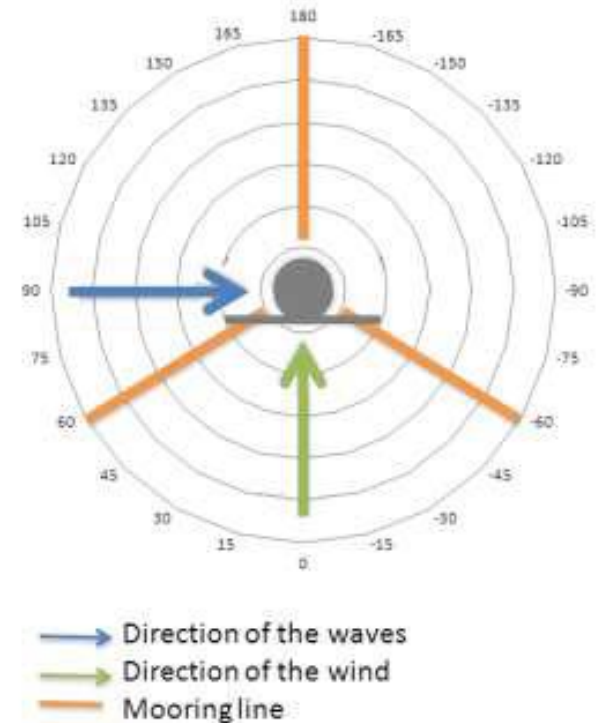
- Data downloaded from the National Data Buoy Center from NOAA.
- Sites must have wind speed, wind direction, significant wave height, wave peak spectral period, and wave direction
- Over 200 years total of hourly data; created a representative site for East Coast, Gulf of Mexico, and West Coast.



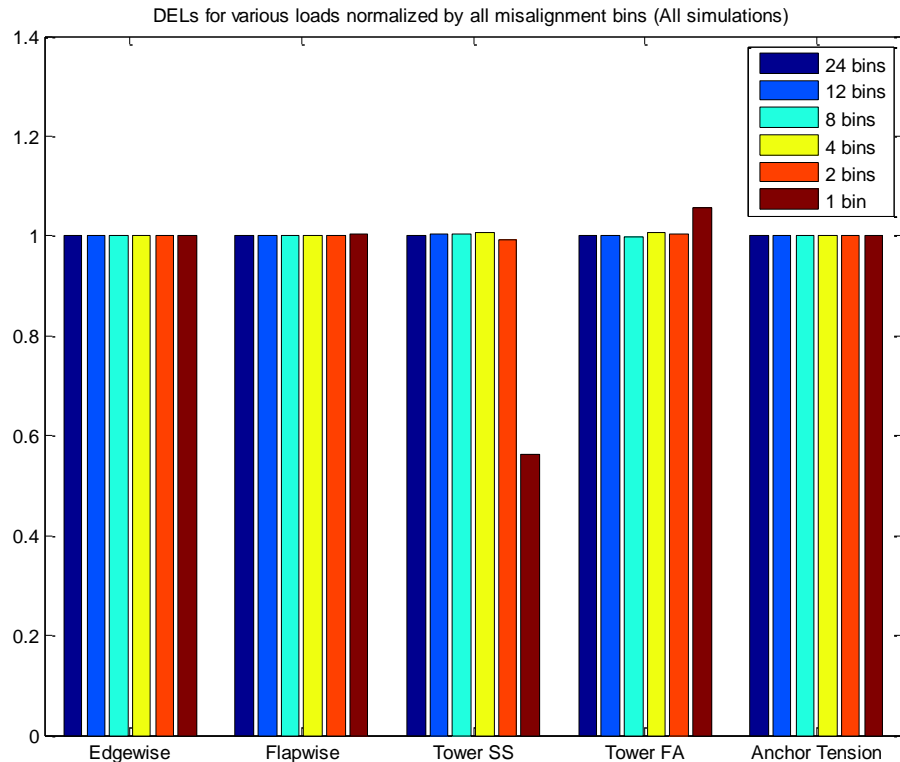
This data will be published in a open source format for future use

# Wind/Wave Misalignment

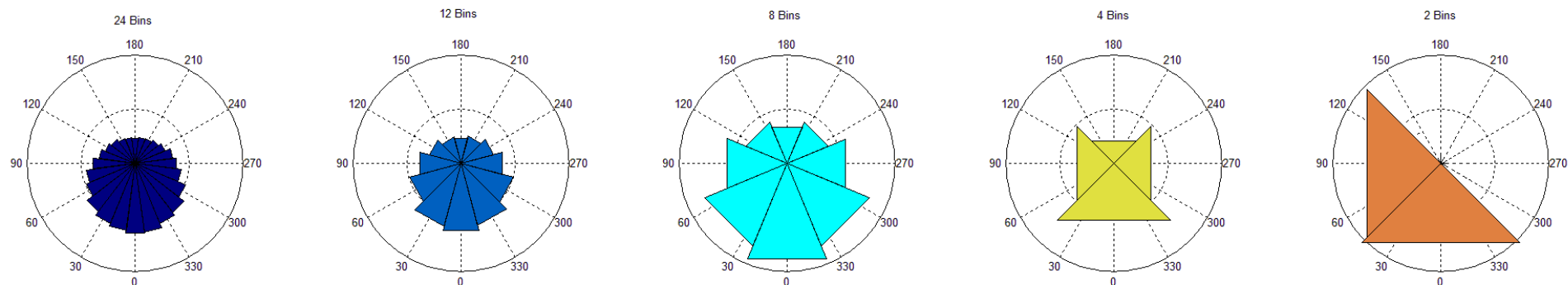
- While wind and wave directions are correlated, all ocean sites experience some degree of misalignment
- Greater compliance of a floating platform compared to fixed-bottom substructures can lead to more wave-induced motion in FOWT
- This, coupled with the lack of side-to-side aerodynamic damping, may cause increased loading



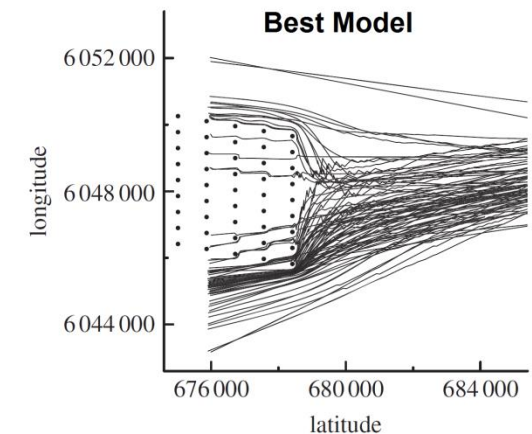
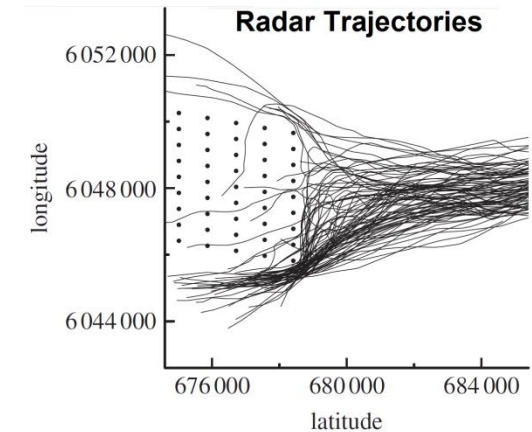
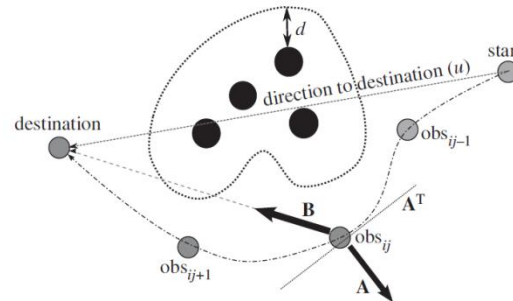
# Fatigue Loads – Misalignment



- Increasing the bin size of the misalignment bins (equivalent to reducing the number of bins) has very little effect on loads, except for 1 direction
- Using only the  $0^\circ$  bin drastically under-predicts side-to-side tower loads and over-predicts tower fore-aft loads



# Avian Micro-siting Optimization



Masden et al. (2012) used radar data from the Nysted offshore wind farm to create a model that simulates trajectories of flocks of common eider

## Preliminary Results from Genetic Algorithm

- For a proof-of-concept, a genetic algorithm is used to optimize the placement of 100 wind turbines in the farm.
- 30 random wind farms are used for an initial population, and the GA is allowed to run for 50 iteration.
- This movie shows the best solution at each iteration.

