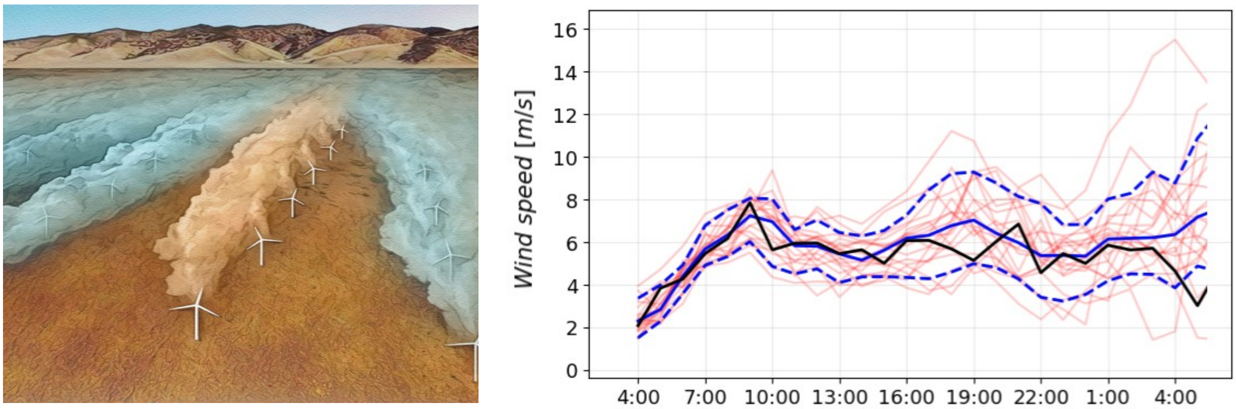
Master Thesis

Developing a probabilistic wake steering model for controlling purposes



Caption: Left: Visualization of wind turbine wake (Source: revolution-green.com)
Right: Example of ensemble forecast. Deterministic run (black), ensembles (red), ensemble median (blue solid) and confidence interval (blue dashed)

Turbines are currently individually controlled without considering their negative effects on surrounding turbines. In an attempt to mitigate this effect, active wake steering by intentional yaw misalignment has recently received a lot of attention. In this approach, the upwind turbine is misaligned to the inflow wind direction, resulting in a deflection of the wake away from a downstream turbine, as illustrated in the figure above.

To apply this in the field, turbines are controlled by an algorithm seeking the yaw angle that results in the optimal solution (= max power production) for a given condition. These control algorithms are based on computationally cheap wake models, which are often simplifications of more complex models.

These wake models use online field measurements, such as wind direction, wind speed and turbulence intensity, as input variables to describe the atmospheric condition. However, field measurements are always subject to uncertainty which leads to erroneous wake estimates.

The goal of this project is to develop a probabilistic model from a wake steering model recently developed at ForWind. Running this model several times with slightly different input variables will generate ensembles as illustrated in the figure above. These ensembles can subsequently be used to develop a probabilistic model, which should be more accurate than the original wake model. This all while keeping the computional expenses to a minimum.

Requirements:

1. Good programming skills (Python, Matlab) are essential
2. Experience with ensemble or probabilistic forecasting is beneficial
3. Interest in problems related to wind energy

Begin: As soon as possible
Duration: 6 months

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