

Can rotor tilt improve wind farm power production?

Description

The performance of wind farms is strongly impacted by wake losses. Low velocity but highly turbulent wakes of upstream wind turbines pollute the inflow of turbines positioned downstream, lowering their power output. One recently explored method for reducing such losses involves tilting the turbine rotors [1, 2]; see Figure 1. Misaligning a turbine's rotor with respect to the incoming flow decreases that turbine's power output. However, it also deflects its wake away from downstream turbines, which increases their performance. Whether the net effect of tilting the rotors ends up being beneficial, depends on the turbine layout of the wind farm and the employed tilt strategy. For example, a uniform static rotor tilt was shown to be beneficial in aligned turbine configurations, but not in staggered ones. This raises the question whether wind farm power output can be optimized, by employing more sophisticated tilt strategies, and how these strategies should be tuned to turbine layout.

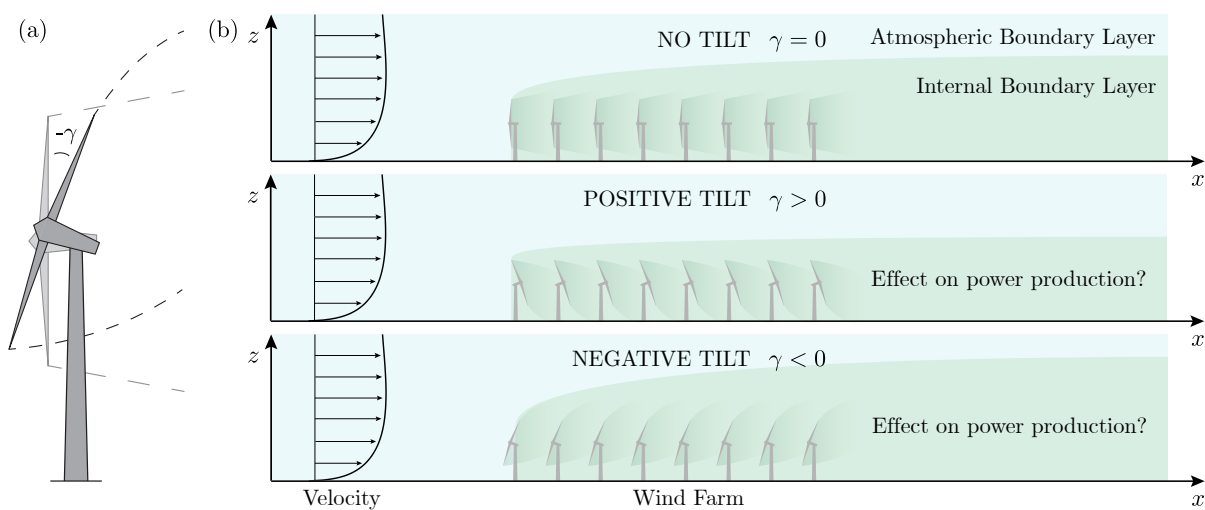


Figure 1: (a) Wind turbine at a negative tilt angle γ . (b) Wind farms with different tilt strategies.

Assignment

You will use state of the art Large Eddy Simulations (LES) to explore the effects of different tilt strategies on aligned and/or staggered wind farms. The LES code is written and validated already, and has been used extensively by our group to study wind turbine wakes and interactions with the atmosphere. The assignment will involve thinking up tilt strategies, setting up and running the simulations on a supercomputer, post-processing the output data, and reporting the results.

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References

- [1] J. Annoni, A. Scholbrock, M. Churchfield, and P. Fleming. Evaluating tilt for wind farms. *Proc. of the American Control Conf. (Seattle)*, pages 717–722, 2017. doi:10.23919/ACC.2017.7963037.
- [2] C. Cossu. Evaluation of tilt control for wind-turbine arrays in the atmospheric boundary layer. *Wind Energy Sci.*, 6(3):663–675, 2021. doi:10.5194/wes-6-663-2021.