

The impact of atmospheric conditions on wind farm wakes

The number of wind farms is expanding due to the increasing demand for renewable energy. Especially in offshore regions, several wind farms are constructed in the direct vicinity of other wind farms. Depending on the wind farm size and layout and the prevailing atmospheric conditions, the wakes of the individual wind turbines might merge and form a wind wake [1, 2, 3, 4]. Wind farm wakes have been measured up to 55 km downstream of a wind farm [2,5], emphasizing the importance of studying the interaction between wind farms. In contrast to field measurements, numerical simulations provide the ability to study the flow under well-controlled and reproducible conditions. The simulations allow for a better physical understanding of the development of wind farm wakes and how atmospheric flow conditions affect this process. Large Eddy Simulations (LES) have been shown to accurately capture wake interaction in different atmospheric conditions [6,7]. LES resolve large-scale flow features in an atmospheric boundary layer, and small-scale turbulence is parameterized using a sub-grid scale model. In this study, we will use LES to study the wake behind wind farms of different sizes. Inflow conditions will be changed systematically, and their influence on the size and strength of the wind farm wake will be documented. Finally, the results will be used to validate and optimize prevailing engineering models that are used to predict the recovery of wind farm wakes. The optimization of engineering models is essential for the sustainable planning of new wind farms in the vicinity of existing wind farms.

This study will be part of the wind farm project in the Physics of Fluids group of the University of Twente in the Netherlands (<https://pof.tnw.utwente.nl/>). The project will be performed under the supervision of Anja Stieren (PhD candidate) and Richard Stevens (Assoc. Professor) [8]. For further information see <https://stevensrjam.github.io/Website/>.

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Figure 1: Visualization of Large Eddy Simulations of a wind farm by Srinidhi N. Gadde [9]

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