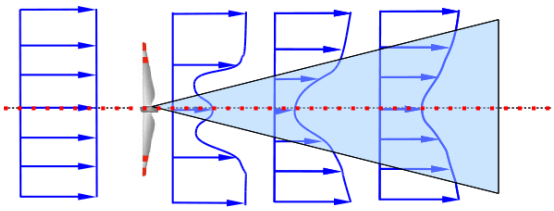
Bachelor thesis: "Validation of an engineering model of the near wake wind field of wind turbines based on nacelle based lidar measurements"

Bachelorarbeit: „Validierung eines Ingenieurmodels des Windfelds des nahen Nachlaufs von Windenergieanlagen anhand Gondel basierten Lidar Messungen"



Sketch lidar measurement and deterministic wind field in the near wake

Engineering wake models are applied today in assessment tasks where fast calculations are needed. For instance, in an early stage of wind farm layout optimisation and wind turbine loading calculation in wind farms.
At present, there is an increasing need for direct validation of such models, since most of them have been developed/validated indirectly. Mainly, based on power measurements of downstream wind turbines, instead of wind flow measurements. This is a consequence of the lack of a proper measurement technique. Today this is possible with lidar systems and at ForWind – Uni Oldenburg we are performing analysis of unique measurements at the offshore testfield alpha ventus. Based on these measurements, different wake models are to be validated. In this Bachelor thesis the aim is to test the empirical model of the near wake proposed by Ainslie[1], This is widely used in the industry for wind farming purposes.

Scope

During this project analysis are performed of near wake measurements of a 5 MW wind turbine at the offshore test field alpha ventus. The measurements are performed with a nacelle based lidar in a two-dimensional scanning strategy. Wind turbine, meteorological and lidar data have to be synchronized, checked and selected properly for model validation purposes. The data which have been collected since April 2011 are stored in a MySQL data base for which a matlab interface is given. Therefore analysis routines are to be developed in this language to observe the wake characteristics under different atmospheric and wind turbine operational conditions. In a further step the modelling of the near wake wind profile proposed by Ainslie has to be tested. Finally corrections to the model have to be proposed in case it is needed. As an optional task, a first test can be done for the applicability of the model for a turbine of smaller size. This could be done by analysis of an available LES simulation of a smaller turbine.

Work steps (Suggestion)

- Elaborate work plan and thesis outline
- Literature research and self-study of lidar measurements, wake modelling with the Ainslie model
- Selection of proper data for validation and calculation of deterministic near wake wind fields in fixed and moving frame of reference
- Comparison with model and device of empirical model improvement if needed
- (optional) Comparison of results with LES simulation

Requirements

- Basic knowledge of fluid dynamics and wind turbine aerodynamics
- Programming skills in Matlab. MySQL experience would be a plus

[1] Ainslie, J. F., Calculating the flowfield in the wake of wind turbines, *Journal of Wind Engineering and Industrial Aerodynamics*, 1988, *27*, 213-224

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