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LES Generated Turbulent Inflow Fields from Mesoscale Modelling Driven by LiDAR Measurements

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Modeling the wind inflow for airborne wind energy applications is subject to many uncertainties due to the lack of reliable high resolution measurements or simulations. This study aims at reducing these uncertainties by generating an inflow database adapted from simulations and long term Light Detection And Ranging (LiDAR) measurements.

The Fraunhofer Institute for Wind Energy and Energy System Technology (IWES) recently completed a LiDAR measurement campaign in northern Germany [1]. During 2015 and 2016 wind velocities of up to 1000 meters at two on-shore locations were measured to assess the energy yield potential of airborne wind energy systems. Ilona Bastigkeit will present the outcome of this campaign in a separate talk.

These measurements, together with data from the European Reanalysis (ERA) database ERA-Interim [2], were implemented into Weather Research and Forecasting (WRF) [3], a numerical mesoscale weather reanalysis tool. We investigate wind and weather data in the temporal scale of minutes and a spatial resolution in the order of kilometers. They shine a light on the wind variability and the occurrence of extreme weather events and calms. This allows for preliminary siting, yield assessment and an estimation of downtime.

Results from these large scale reanalyzes serve as input into high resolution Large-Eddy-Simulations (LES) using the Parallelized Large-Eddy Simulation Model for Atmospheric and Oceanic Flows (PALM) [4]. These high resolution simulations provide an insight into high frequency turbulence distribution which can not be provided by remote sensing technologies such as LiDAR.

Simulations and measurements are compared in terms of mean wind speeds and direction, profile shape and statistical variability. Together they offer a comprehensive data set which can be used for inflow modeling for control, optimization or load estimation.

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