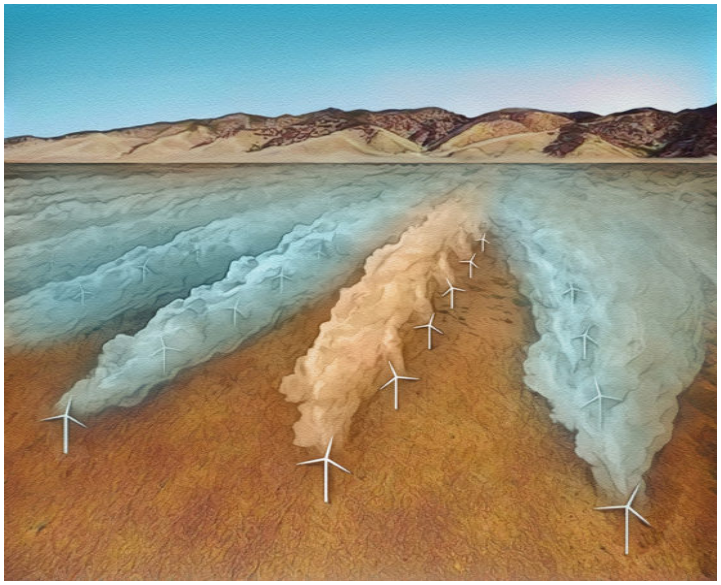
**Master thesis**

# Impacts of a heterogeneous surface on site conditions in Large Eddy Simulations



**Caption: Visualization of wake steering**
Source: https://revolution-green.com/

Large Eddy Simulations (LES) are nowadays intensively used to study atmospheric flow close to the surface. LES are mathematical models explicitly solving most of the atmospheric turbulence and only parameterizing turbulence at the smallest scales. There are numerous fields in which LES can be applied, one of them being the field of wind energy research.

In LES it is common practice to simplify the surface characteristics (e.g. surface roughness) by assuming homogeneous parameters throughout the domain, often dependent on vegetation characteristics. Although convenient, this does not accurately reflect the complex heterogeneity of a realistic site. Therefore, local variability due to topography or blockage by vegetation are often ignored. Next to its effect on the vertical wind velocity, blockage also leads to stronger wind shear and therefore the generation of turbulence. As a result, by ignoring small scale variability, numerical simulations often underestimate the turbulence intensity, which in turn affects the turbine wake characteristics. While for some conceptual studies assuming homogeneity is justified, it often introduces a large source of uncertainty in the model results when comparing to observational data.

Currently, an extensive field campaign is carried out. During this field campaign, the effect of yaw misalignment on the shape, position and intensity of the wake will be studied and related to boundary layer characteristics like atmospheric stability. In this respect, several case studies should be reproduced by LES simulations using PALM to study related dynamics in more detail. An important task lies in replicating the site-specific heterogeneity in PALM. This includes moderately complex topography (hilly terrain) and sparse vegetation (bushes and trees) by for instance activating the available canopy model. When successful, this can be extended by accounting for seasonality by for instance including a land surface and radiation model.

The goal of this project is to accurately represent the small-scale terrain variability of the field campaign site in the PALM LES model. This includes identifying the most relevant variables and determining their values for this particular location. This should be done in a systematic manner, which can easily be reproduced for other sites in the future.

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| **Requirements:**<br><br>1. Basic knowledge of numerical simulations<br>2. Programming skills are beneficial<br>3. Interest in problems related to renewable energy | **Begin:** As soon as possible<br>**Duration:** 6 months<br>**Contact:** Luuk Sengers<br>+49 (0) 441 798 5076<br>balthazar.sengers@uni-oldenburg.de<br><br>Dr. Gerald Steinfeld<br>+49 (0) 441 798 5073<br>gerald.steinfeld@uni-oldenburg.de |