Project: **890**

Project title: **Austauschprozesse in der Atmosphärischen Grenzschicht**

Project lead: **Josef Schröttle**

Report period: **1.1.2014 - 31.12.2015**

Text: maximum of two pages including figures.

We employed the geophysical flow solver EULAG (Prusa, 2008). This project studies momentum fluxes and heat fluxes in the Earth's surface layer. This involves process studies with highly resolved large-eddy simulations (LESs) and leads to parameterizations[1] for larger scale models.

Wind turbine wake dynamics

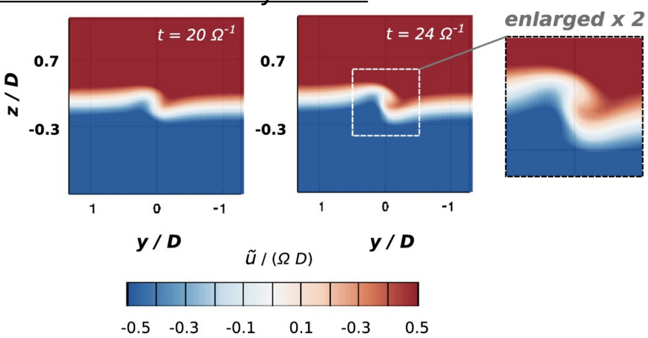

Figure 1: The vortex deforms the vertical shear in the streamwise velocity, as the instability evolves (Schröttle et al., 2015).

The wake vortex of a wind turbine in strong shear was studied with LESs in combination with a theoretical analysis (Schröttle et al. 2015). We found an instability of this vortex for the given flow configuration. These idealized studies are a basis for LESs of the momentum and heat transport of the wind turbine wake vortex above complex three dimensional terrain. Work with different sophisticated wind turbine parameterizations was presented during a workshop at ECMWF by Englberger (2014).

Urban flow

Flow through a complex geometry was studied exemplary for the fractal Sierpinski triangle. The triangle represents a complex urban geometry as porous medium in a two-dimensional manner as observed from satellite images. The flow through this porous medium follows a Darcy law for high Reynolds numbers as published by Gisinger et al. (2015) as a result of Mrs. Sonja Gisinger's Master thesis. Kevin Bachmann's Master thesis followed this approach and found the validity of this modified Darcy's Law for a model city with realistic length scales of urban geometry.

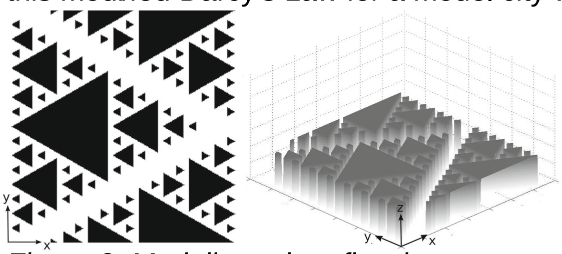

Figure 2: Modeling urban flow by representing the urban area with a Sierpinski fractal (Gisinger et al., 2015).

Forest turbulence

Pioneering LESs of forest canopy flow in neutral and unstably stratified flow were conducted by Shaw & Schumann (1992). Highly resolving numerical simulations representing individual tree elements followed by Schröttle & Dörnbrack (2013). Meanwhile the structure of real trees was retrieved (Bienert, 2010) and is available for numerical simulations. The flow and turbulence

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1 Due to necessary model development the available computing time was not fully used in 2014 but overused in 2015.

statistics through these quasi realistic tree structures was compared with flow through and around, e.g., a bluff body tree (Schröttle 2015, submitted). Results from this paper were presented by Schröttle (2014).

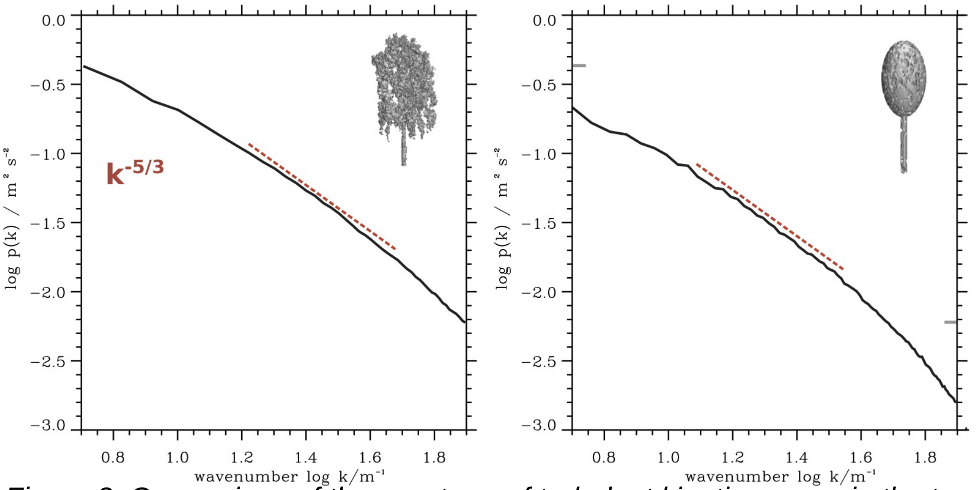

Figure 3: Comparison of the spectrum of turbulent kinetic energy in the tree crown space of a quasi realistic tree structure and a bluff body tree flow (Schröttle, 2015)

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