Project: **890** Project title: **Austauschprozesse in der Atmosphärischen Grenzschicht** Project lead: **Josef Schröttle** Report period: **2016-01-01 to 2016-12-31** *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 for larger scale models.

Wind turbine wake above a forest

A novel inflow method was constructed for large-eddy simulations. The method allows to simulate fully turbulent flow upstream of a wind turbine with two hydrodynamic solver *a* and *b* (*Figure 1*). The upstream flow is fully independent of the wake flow downstream of the wind turbine. The inflow boundary of solver *b* exactly reproduces the fully turbulent flow fields of solver *a*. With the novel methodology, different classes of turbulence (e.g. stratified forest boundary-layer or neutral plane wall boundary-layer turbulence) can be simulated upstream of the wind turbine.



Figure 1: Our novel approach solves two hydrodynamic solvers in one code. Solver a (left) has cyclic boundaries in streamwise and lateral direction, while solver b (right) incorporates the full flow fields (symbolic gray slice at center plane) of solver a as time and space dependent inlet boundary condition upstream of the wind turbine wake. The wind turbine has a hub height of z_{hub} and rotor diameter D. The inlet boundary layer in this sketch has a height H.

The novel methodology was successfully applied for the fully turbulent forest and neutral plane wall boundary layer large-eddy simulations. The simulated moments for turbulent transport of first, second and third order agree with previous large-eddy simulations (Shaw & Schumann 1992, Porté-Agel et al. 2000) and measurements in field experiments (Patton 1997). The simulations results reveal a significantly shorter developed wind turbine wake in the forest boundary layer. Furthermore, the wake is vertically more asymmetric in the forest boundary layer compared to the neutral plane wall boundary layer.

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