EMS Annual Meeting Abstracts
Vol. 9, EMS2012-364-2, 2012
12th EMS / 9th ECAC

Simulating wind and turbulence profiles in and above a forest canopy using the MIUU mesoscale model

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Due to increasing wind turbine hub heights, there is a growing interest for placing wind turbines in forested areas. Yet, at higher heights the physics controlling the flow change and the height of the atmospheric boundary layer becomes an important factor.

Numerical weather prediction models usually have an elaborate description of the boundary layer, but treat forest as a bulk layer with the lowest model level being situated at the displacement height plus the roughness length. At this height the wind speed is simply set to zero. This approach, however, does not give any information on the flow within the forest.

In this study, an approach that is widely used in CFD models is implemented in the MIUU mesoscale model. Hence, forest canopies are modelled via resistance terms where the forces due to the canopy are represented by an additional drag term in the momentum equations for the horizontal wind components.

The effect of the canopy on turbulence is accounted for by two additional terms in the prognostic equation for the turbulent kinetic energy. One term accounts for the production of turbulence due to the additional drag force from the forest. The other term represents the destruction of turbulence within the forest. New research shows that the latter term seems to be dominating by far.

The results from model runs are compared to wind measurements from within and above a typical Swedish forest. Predictions of turbulent kinetic energy are compared to measurements from Sonic anemometers at several levels within and above the forest canopy.