EMS Annual Meeting Abstracts
Vol. 12, EMS2015-348, 2015
15th EMS / 12th ECAM

Large eddy simulation application with the mesoscale model RAMS for wind Energy studies in complex terrain: a study of the Askervein hill

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The Regional Atmospheric Modeling System (RAMS) is designed to simulate atmospheric flow features of characteristic time scales from hours to seconds. Atmospheric Models such as RAMS can be an accurate tool for the study of mean flow at wind turbine characteristic length scale. Advantages of using mesoscale models are numerous. This includes stability effects and large scale wind variability with the use of a dynamic equation for the potential temperature, radiation schemes and two-way interactive nesting.
In complex terrain, there is a need for improving mean flow and turbulence characteristics estimations. Current studies with Atmospheric models have shown some deficiencies in estimating the wind speed and Turbulent Kinetic Energy (TKE). This can be attributed to coarse horizontal resolution and the parametrization used for the vertical diffusion (such as the Mellor Yamada Level 2.5). Following this statement, there is a clear need to develop techniques regarding the estimation of wind flow characteristics at wind turbine scale. For this purpose, Large Eddy Simulation (LES) is used to resolve microscale turbulence.
In this work, we will discuss LES in complex terrain with the mesoscale model RAMS. This includes the implementation of dynamic sub-filter scale models and the set-up of proper inflow boundary conditions. Results are compared with Askervein hill experimental data for the case of a neutral flow crossing the hill perpendicularly to its major axis. Additionally, we will explain the benefits of LES for applications related to wind energy. This will include the impact of the near wall anisotropic characteristics of the turbulence and its variation in complex terrain. The role of large scale structures (at ABL scale) and their impact on wind turbines will be also discussed.