ANALYSIS OF THE ATMOSPHERIC BOUNDARY LAYER FLOW OVER MOUNTAINOUS TERRAIN

Carlos Alberto Veiga Rodrigues, Portugal
Supervisors: J.P.A.J. van Beeck, J. Sanz Rodrigo and M.L. Riethmuller

To install a wind power plant, knowledge of the atmospheric flow over the topology must be obtained using field measurements. The state-of-the-art in wind resource assessment consists in applying statistical engineering models to predict the flow field. If by experimental and numerical simulations the flow field would be determined more reliably, the energy production estimation would be more accurate reducing the risk for the investor. The objective of the present work was determine the performance of experimental and numerical simulations in predicting the atmospheric flow over Askervein hill in Scotland, a well known test case for which extensive field measurements were performed in 1982 and 1983.

The experimental simulations were conducted in a low speed open circuit wind tunnel, where the flow had to be modeled to match real atmospheric boundary layer characteristics. A model of the hill was built at 1/7000 scale and a campaign of measurements was performed using Hot Wire and PIV measurement techniques. Experiments were first performed with the rough original surface and after the model surface was smoothed. On the overall the rough model performed better especially in the leeward side with a difference in the speed-up of 5% comparing with field measurements, but the hilltop was underpredicted by 22%.

The numerical simulations were computed with the commercial code FLUENT using the RANS k-ε and k-ω turbulence models. Computations were performed first to reproduce the wind tunnel measurements at wind tunnel scale and in the end to simulate the full scale topography. The results were compared with field measurements and investigations performed in the past, presented in figure 1. As an example of the application to wind turbines sitting, a contour plot of velocity magnitude at a relative height of 50 m is presented in figure 2.

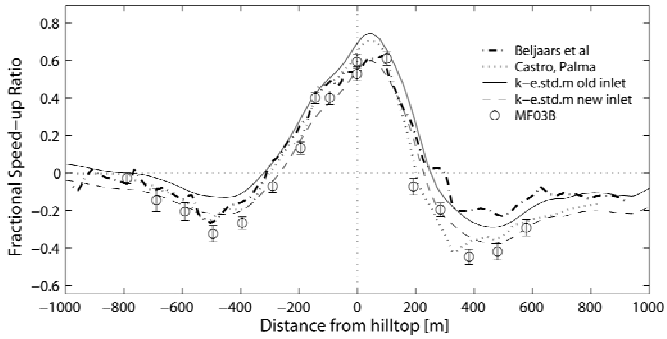

Figure 1: Comparison of numerical results with field measurements and past investigations

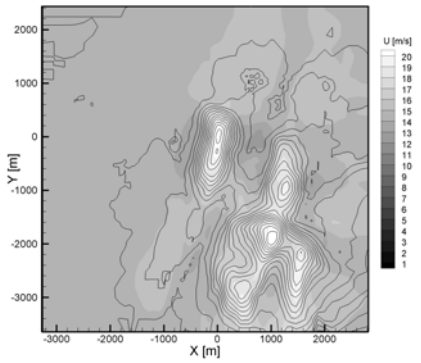

Figure 2: Contour plot of velocity magnitude at a Δz of 50 m.