ERPem
Edinburgh Research Partnership in Engineering and Mathematics
http://www.erp.ac.uk

Energy

Wind turbine wake modelling in complex terrain

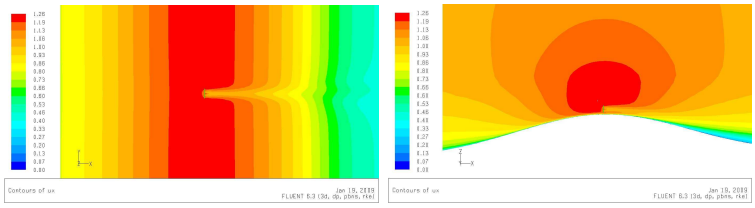
Alexandros Makridis, John Chick, David Ingram

Introduction

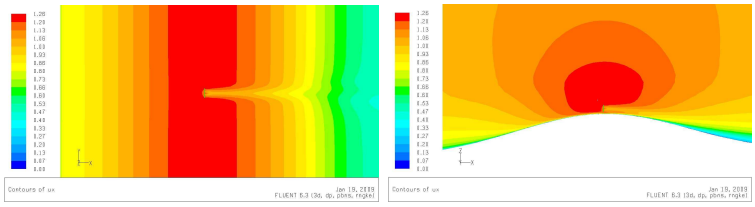
Onshore wind farms usually consist of a number of horizontal axis wind turbines (WTs) closely spaced in clusters and they are often sited on complex terrain. The operation of a WT in a wind farm will inevitably affect the others in its vicinity due to velocity deficit and increased level of turbulence in its wake.

This project involves the use of Fluent 6.3 commercial CFD code and the Virtual Blade Model (VBM) to study the wake of a WT at the top of an ideal Gaussian hill. Three different turbulence models are considered: realizable k-ε, RNG k-ε and the Reynolds Stress Model (RSM).

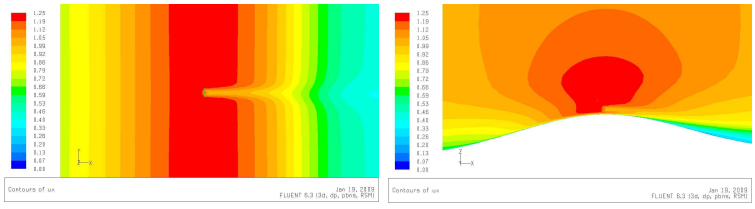
Comparison of results from these different turbulence models is presented. Realizable and RNG k-ε models are based on the assumption of isotropic turbulence. RSM can account for the anisotropy of atmospheric turbulence by solving transport equations for each of the Reynolds stresses. It thus enables significantly greater accuracy in applying proper inlet turbulence conditions and predicting the wake velocity deficit and increase in turbulence intensity downstream of the turbine.



i. Realizable k-ε



ii. RNG k-ε



iii. RSM

Figure 1: Contour plots of non-dimensionised x-velocity $u_x = \frac{U_x}{U_\infty}$

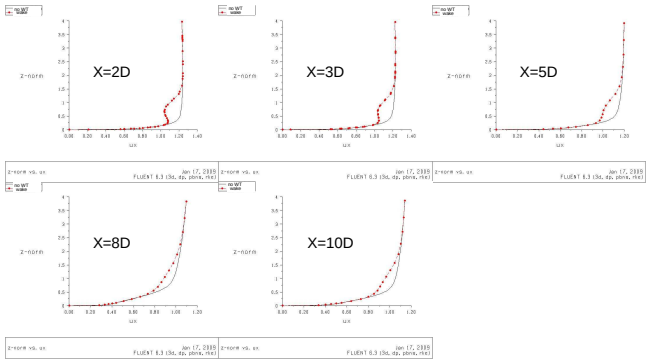


Figure 2: Vertical variation of mean velocity on wake centerline (y=0) with realizable k-ε model

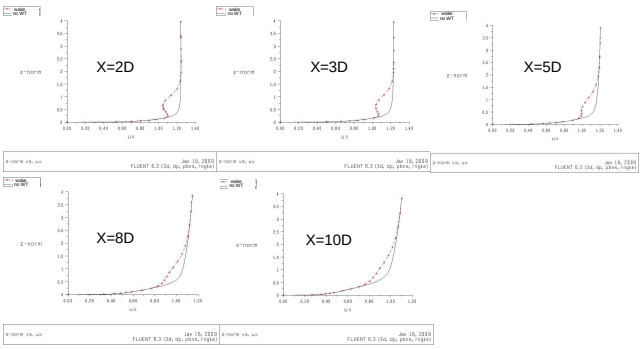


Figure 3: Vertical variation of mean velocity on wake centerline (y=0) with RNG k-ε model

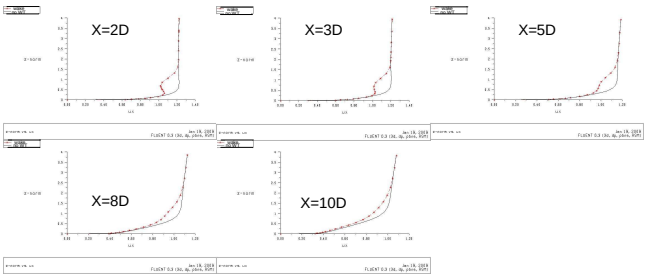


Figure 4: Vertical variation of mean velocity on wake centerline (y=0) with RSM

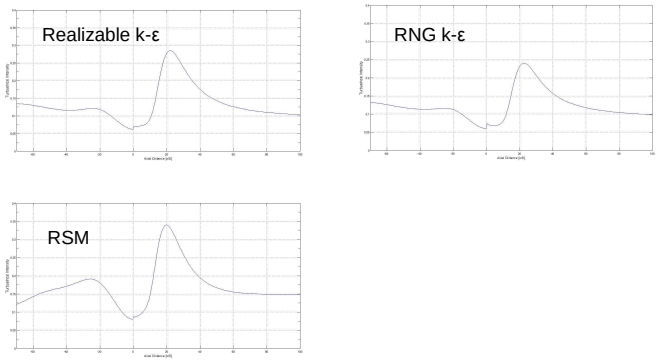


Figure 5: Variation of turbulence intensity at the hub height (y=0)

Contact: a.makridis@ed.ac.uk This work is supported by IKY (Greek State Scholarship foundation)