WIND SIMULATION ON COMPLEX TERRAINS: ABOUT THE DEPENDENCIES ON INLET FLOW ORTHOGONALITY

UNIVERSITY OF PERUGIA
Department of Industrial Engineering

castellani@unipg.it

F.Castellani, A. Vignaroli, A.R. Gravdahl

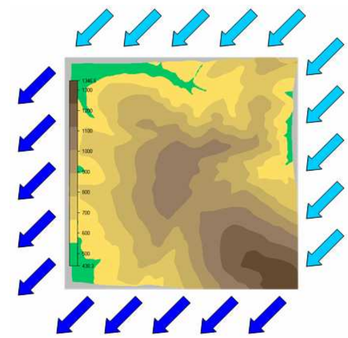
VECTOR AS

info@windsim.com

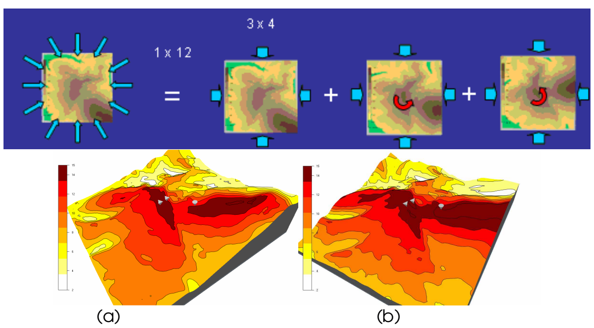
Summary

Modelling the wind field in complex terrain is very difficult for the strong influences of local orography. Recently CFD models that are able to solve the Navier-Stokes equation were applied with good results and their use is going to become wider. However CFD simulations need a large number of parameter to be defined to set-up the boundary and initial conditions. The meanings and the way to manage all this parameters are still under investigation through experimental data collection and tests.

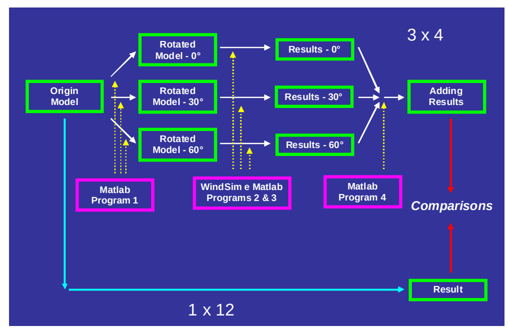
One fundamental step is the choice of the inlet and outlet boundary conditions; usually the wind field calculations are performed with different wind direction using the same calculation domain.
A CFD simulation of the natural wind ventilation of a squared domain in complex terrain is usually performed making several runs of the solver in order to cover all the possible directions of the wind vector. A good ratio between simulation time and accuracy is to divide 360° into 12 sectors of 30° each. Working on a rectangular domain, inlet and outlet condition will be different for orthogonal and non orthogonal directions.
The simulation of wind blowing from North can be compared to the flux of a fluid into a squared section pipe, where the upper and the boundary boarder are considered as friction-less walls.
A non orthogonal wind vector doesn't find on his path such a pipe and the boundary conditions to adopt are different. Two inlets and two outlet and the decomposition of the wind vector is necessary.

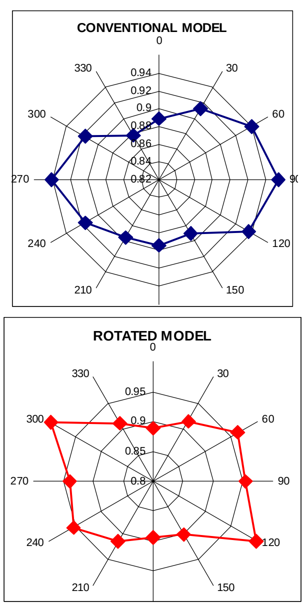


In present work a method to use only one way to simulate the wind field was elaborated and put in operation. Such method use only orthogonal simulations rotating the domain to simulate non-orthogonal situations. The results were compared with those from the "traditional method". To run the new method was necessary to develop three Matlab programs: 1)DTM Rotation - 2)Wind Rose Rotation - 3)Objects Rotation; 3)De-Rotation and Sum of Results.



Average wind speed distribution - conventional model (a) - rotated model (b)





Rotor energy content distribution

Conclusions

What we can notice from the analysis of the results is a different behaviour of the code between the two way of simulation: modelling a skewed flow using two inlet or using one inlet rotating the DTM produces in some cases different results. The analysis of the rotor energy content for a turbine operating inside the domain (complex terrain environment) showed a different sensitiveness of the two method to the local orography.
Running the two methods on a test case a gap of about 6% on the energy production estimation was discovered; at the same time also the distribution of the wind module and the shape of the wind profiles are different.
The convergence of the calculation is similar but the wind component on the main direction is less stable on orthogonal models.
The results demonstrate that a deep analysis on the settings of boundary conditions is recommended in order to improve the numerical simulations.