10th PhD Seminar on Wind Energy in Europe
28-31 October 2014, Orléans, France

Development of a wind farm tool with an advanced actuator disk model

M. Moens[1], M. Duponcheel[1], G. Winckelmans[1], P. Chatelain[1]

[1]Université catholique de Louvain, Institute of Mechanics Materials and Civil Engineering, B-1348 Louvain-la-Neuve Belgium, maud.moens@uclouvain.be , matthieu.duponcheel@uclouvain.be, gregoire.winckelmans@uclouvain.be , philippe.chatelain@uclouvain.be

ABSTRACT

The present project aims at improving the level of fidelity of unsteady wind farm scale simulations through an effort on the representation and the modeling of the rotors. The chosen tool for the simulations is a Fourth Order Finite Difference code, developed at Université catholique de Louvain [1]; this solver implements Large Eddy Simulation (LES) approaches. The wind turbines are modeled as advanced actuator disks : these disks are coupled with the Blade Element Momentum method (BEM method) and also include the turbine dynamics and controller.
A special effort is made here at reproducing the specific wake behaviors. Wake decay and expansion are indeed initially governed by vortex instabilities. This is an information that cannot be obtained from the BEM calculations. We thus aim at achieving this by matching the large scales of the actuator disk flow to high fidelity wake simulations performed by a Vortex Particle-Mesh method [2]. It is obtained by adding a controlled excitation at the disk.
We apply this tool to the investigation of atmospheric turbulence effects on the power production and on the wake behavior at a wind farm level. The inflow velocity is then completed with a turbulent velocity field, computed beforehand by means of LES of atmospheric turbulence.

ACKNOWLEDGMENT

We gratefully acknowledge the support of GDF Suez for the fellowship of Mrs Maud Moens.

REFERENCES

[1] M. Duponcheel, L. Bricteux, M. Manconi, G. Winckelmans, Y. Bartosiewicz, “Assessment of RANS and improved near-wall modeling for forced convection at low Prandtl numbers based on LES up to Ret = 2000”, International Journal of Heat and Mass Transfer, 75 (2014), pp. 470-482.

[2] P. Chatelain, S. Backaert, G. Winckelmans, S. Kern, “Large eddy simulation of wind turbine wakes” In W. Rodi (Ed.), Proceedings of The 9th International Symposium on Engineering Turbulence Modelling and Measurements (ETMM-9), June 6-8, 2012, Thessaloniki, Greece, of Flow, Turbulence and Combustion. ERCOFTAC, Springer, Vol. 91 (2013), pp. 587-605.