Large Eddy Simulation of Vertical Axis Wind Turbine wakes; Part I: from the airfoil performance to the very far wake PHILIPPE CHATELAIN, MATTHIEU DUPONCHEEL, DENIS-GABRIEL CAPRACE, Universite catholique de Louvain, YVES MARICHAL, Wake Prediction Technologies, GREGOIRE WINCKELMANS, Universite catholique de Louvain — A vortex particle-mesh (VPM) method with immersed lifting lines has been developed and validated. Based on the vorticityvelocity formulation of the NavierStokes equations, it combines the advantages of a particle method and of a mesh-based approach. The immersed lifting lines handle the creation of vorticity from the blade elements and its early development. Large-eddy simulation (LES) of vertical axis wind turbine (VAWT) flows is performed. The complex wake development is captured in detail and over up to 15 diameters downstream: from the blades to the near-wake coherent vortices and then through the transitional ones to the fully developed turbulent far wake (beyond 10 rotor diameters). The statistics and topology of the mean flow are studied with respect to the VAWT geometry and its operating point. The computational sizes also allow insights into the detailed unsteady vortex dynamics and topological flow features, such as a recirculation region influenced by the tip speed ratio and the rotor geometry.

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