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Vertical Axis Wind Turbine flows using a Vortex Particle-Mesh method: from near to very far wakes[1] STEPHANE BACKAERT[2], PHILIPPE CHATELAIN, GREGOIRE WINCKELMANS, Universite catholique de Louvain (UCL), Institute of Mechanics, Materials and Civil Engineering (iMMC), STEFAN KERN, THIERRY MAEDER, DOMINIC VON TERZI, GE Global Research, WIM VAN REES, PETROS KOUMOUTSAKOS, ETH Zurich, CSElab — A Vortex Particle-Mesh (VPM) method with immersed lifting lines has been developed and validated. The vorticity-velocity formulation of the NS equations is treated in a hybrid way: particles handle advection while the mesh is used to evaluate the differential operators and for the fast Poisson solvers (here a Fourier-based solver which simultaneously allows for unbounded directions and inlet/outlet boundaries). Both discretizations communicate through high order interpolation. The immersed lifting lines handle the creation of vorticity from the blade elements and its early development. LES of Vertical Axis Wind Turbine (VAWT) flows are performed, with a relatively fine resolution (128 and 160 grid points per blade) and for computational domains extending up to $6\,D$ and $14\,D$ downstream of the rotor. The wake complex development is captured in details, from the blades to the near wake coherent vortices, to the transitional ones, to the fully developed turbulent far wake. Mean flow statistics in planes (horizontal, vertical and cross) are also presented. A case with a realistic turbulent wind inflow is also considered. The physics are more complex than for HAWT flows.

[1]Computational resources provided by a PRACE award
[2]Research Assistant (PhD student)

Philippe Chatelain
Universite catholique de Louvain (UCL), iMMC

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