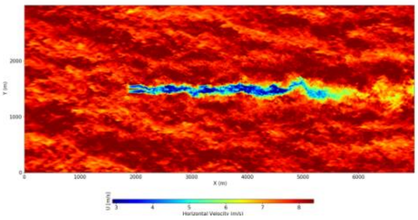
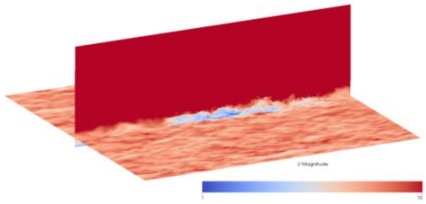
Post-doctoral position : Data-driven machine learning techniques for wind farm scale flow simulations





In order to better understand the flow physics in a wind farm, detailed flow simulations need to be computed with enough precision. Currently, only high-fidelity Navier-Stokes based Large-Eddy-Simulation (LES) solvers are able to accurately compute such flows and are therefore used rather extensively in the wind energy community. However, due to their high computational cost, only canonical cases are considered (a single to a few turbines). Full wind farm simulations have only been performed either for demonstration purposes or by employing mesh resolutions that are not sufficient to accurately represent the flow physics.

The aim of this post-doctoral work is to investigate the potential of model-based machine-learning techniques to reduce the computational cost of high fidelity, wind farm scale simulations. We will in particular study how model reduction techniques can be coupled to LES flow simulations to lower the computational cost while maintaining the accuracy of the results. The main idea is to assemble a farm simulation by collating several single wind turbine models and an appropriate propagation model that can be a full high-fidelity LES model where, however, the relevant physical scales are significantly larger compared to the phenomena taking place near the windmill. This approach has been explored in the literature and it has the potential to scale up to complex time-dependent 3D applications [1-4]. The post-doc should initially focus on one single wind turbine interacting with the atmospheric boundary layer, using the SOWFA library (OpenFOAM) to generate high-fidelity LES simulations along with an actuator-line model for the wind turbine. Then a predictive model for this single unit will be trained using realistic environmental conditions and validated in the fully coupled configuration to serve a base for the farm configuration.

A strong background in applied mathematics, scientific computing and fluid mechanics is expected. Good programing skills are required. A first experience in software development in the field of wind energy would be appreciated.
This position is opened for 18 months. The candidate should have defended his PhD thesis after September 2019. He/she will be based in Bordeaux and work within the Memphis Team at Inria Bordeaux – Sud Ouest in collaboration with IFPEN. Short stays and visits will also be planned within the Applied Mathematics and Fluid Mechanics departments at IFPEN in Rueil-Malmaison. The salary is 2200€ net.

[1] M.R. Buffoni, H. Telib, A. Iollo. Iterative methods for model reduction by domain decomposition. Computers & Fluids. Vol. 38, pp. 1160-1167, 2009.
[2] M. Bergmann, A. Ferrero, A. Iollo, E. Lombardi, A. Scardigli, H. Telib. A zonal Galerkin-free POD model for incompressible flows. Journal of Computational Physics, Volume 352, pp. 301-325. 2018.
[3] A. Ferrero, A. Iollo, F. Larocca. Global and local POD models for the prediction of compressible flows with DG methods. International Journal for Numerical Methods in Engineering, DOI: 10.1002/nme.5927, 2018.
[4] S. Riffaud, M. Bergmann, C. Farhat, A. Iollo, Grimberg. S. The DGDD Method for Reduced-Order Modeling of Conservation Laws. Submitted.