WIMPY PRACE project 20200255444 - Wind Turbines Multi Physics

- Novelty / originality of the science / research project.:
  The objective of this PRACE project is to use LES to improve numerical simulations of wind farms and get valuable data that will both help to understand the physics of the flow across a farm and to give more knowledge on the FSI at the rotor level.
- The need for HPC to accomplish the results and the way this is highlighted:
  Dynamic mesh adaptation algorithms for unstructured grids enable a reduction of the overall number of cells in the fluid domain, by decreasing the cell size only where it is required to correctly capture the small vortices, especially in the wake region. However, the simulations of very refined wakes and of full wind farms proposed in this work are still very expensive and require High-Performance Computing solutions.
- The forward-looking achievements in scientific discoveries or in innovation in industry that should lead to solutions for society's grand challenges:
  To give a better understanding of the mono-rotor wake via a scale-by-scale flow analysis + use this better knowledge of the physics of wakes to further develop and optimize engineering models used to design wind turbines + highlight the necessity to use aero-elastic solvers when studying wakes interactions by showing the impact on the turbine loads + To demonstrate the gain obtained through the mesh adaptation strategy, especially when dealing with a large number of wind turbines

Publications linked to the project:

- Félix Houtin-Mongrolle, Pierre Bénard, Ghislain Lartigue, Vincent Moureau. A level-set framework for the wind turbine wake analysis: from high-fidelity unsteady simulations to 1D momentum theory. *Journal of Physics: Conference Series*, IOP Publishing, 2021, 1934 (1), pp.012011. ⟨10.1088/1742-6596/1934/1/012011⟩
- Simone Gremmo, Etienne Muller, Félix Houtin-Mongrolle, Bastien Duboc and Pierre Bénard, Rotor-wake interactions in a wind turbine row: a multi-physics investigation with large eddy simulation, TORQUE Conference, Delft, Netherlands, 2022
- U. Vigny, P. Benard, P. Tene Hedje, F. Houtin-Mongrolle, L. Bricteux, S. Zeoli, Adaptive mesh refinement to capture wind turbine wakes using Large Eddy Simulation, TORQUE Conference, Delft, Netherlands, 2022