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Large-eddy simulation of atmospheric boundary layer flow through wind farms FERNANDO PORTE-AGEL, YU-TING WU, VALERIO IUNGO, Ecole Polytechnique Federale de Lausanne (EPFL), Switzerland, HAO LU, University of Minnesota, USA — Simulating atmospheric boundary layer flow and its interactions with wind turbines is of great importance for optimizing the design (layout) and overall efficiency of wind farms. This presentation focuses on recent efforts to develop and validate a large-eddy simulation (LES) framework for wind energy applications. The subgrid-scale fluxes of momentum and heat are parameterized using tuning-free Lagrangian scale-dependent dynamic models (Stoll and Porte-Agel 2006). The turbine-induced forces are parameterized using two types of models: an actuator disk model that allows for non-uniform distribution of the forces and includes rotational effects (Wu and Porte-Agel 2011); and an actuator line model that distributes the forces on lines that follow the position of the blades. The LES code is validated against wind-tunnel measurements collected with hot-wire anemometry inside and above a large model wind farm. The characteristics of the wind farm wakes simulated with the proposed LES framework, and particularly the spatial distribution of the velocity deficit and turbulence intensity, are in good agreement with the measurements. Finally, in order to extend the LES validation to field conditions, results are presented from a field experiment aiming to characterize wind-turbine wakes using three scanning wind LiDARs.

Fernando Porte-Agel
Ecole Polytechnique Federale de Lausanne (EPFL), Switzerland

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