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RANS simulations of wind turbine wakes: optimal tuning of turbulence closure and aerodynamic loads from LiDAR and SCADA data.¹ STEFANO LETIZIA, MATTEO PUCCIONI, LU ZHAN, Univ of Texas, Dallas, FRANCESCO VIOLA, Ecole Polytechnique Federale de Lausanne (EPFL), SI-MONE CAMARRI, Univ of Pisa, GIACOMO VALERIO IUNGO, Univ of Texas, Dallas — Numerical simulations of wakes produced by utility-scale wind turbines still present challenges related to the variability of the atmospheric conditions and, in the most of the cases, the lack of information about the geometry and aerodynamic performance of the wind turbine blades. In order to overcome the mentioned difficulties, we propose a RANS solver for which turbine aerodynamic forcing and turbulence closure are calibrated through LiDAR and SCADA data acquired for an onshore wind farm. The wind farm under examination is located in North Texas over a relatively flat terrain. The experimental data are leveraged to maximize accuracy of the RANS predictions in terms of wake velocity field and power capture for different atmospheric stability conditions and settings of the wind turbines. The optimization of the RANS parameters is performed through an adjoint-RANS formulation and a gradient-based procedure. The optimally-tuned aerodynamic forcing and turbulence closure are then analyzed in order to investigate effects of the atmospheric stability on the evolution of wind turbine wakes and power performance. The proposed RANS solver has low computational costs comparable to those of wake engineering models, which make it a compelling tool for wind farm control and optimization.

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