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Near-wake instability and sensitivity analysis of wind turbines immersed in the atmospheric boundary layer FRANCESCO VIOLA, LFMI-EPFL, GIACOMO VALERIO IUNGO, WIRE-EPFL, SIMONE CAMARRI, DICI - UNIPI, FERNANDO PORTÉ-AGEL, WIRE-EPFL, FRANÇOIS GALLAIRE, LFMI-EPFL — In wind farms, the separation distance among wind turbines is mainly determined by the downstream recovery of wind turbine wakes, which affects in turn power production and fatigue loads of downstream turbines. Thus, the optimization of a wind farm relies on the understanding of the single wake dynamics and a better characterization of their interactions within the atmospheric boundary layer (ABL). This work is focused on the stability analysis of vorticity structures present in wind turbine wakes. In order to take into account the effects of a non-uniform incoming wind investing the turbine, a 3D local stability analysis is performed on the non-axisymmetric swirling wake prevailing at different downstream stations. Different wind shear and veer of the incoming wind can now be investigated, together with a 3D non-isotropic turbulent velocity field. This procedure enables to perform stability analysis of wind turbine wakes for wind conditions very similar to the ones experienced in reality. The present analysis is carried out on wind tunnel data acquired in the wake of a down-scaled three-bladed wind turbine. The Reynolds stresses are taken into account via eddy-viscosity models calibrated on the experimental data. Furthermore, the effect of an external perturbation in the wake flow is investigated through linear sensitivity. This analysis represents a preliminary step for control of wind turbine wakes, and optimization of wake interactions and power harvesting.

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