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Hub vortex helical instability as the origin of wake meandering in the lee of a model wind-turbine FRANCESCO VIOLA, LFMI-EPFL Lausanne, GIACOMO VALERIO IUNGO, WIRE-EPFL Lausanne, SIMONE CAMARRI, DIA - Università di Pisa, FERNANDO PORTE-AGEL, WIRE-EPFL Lausanne, FRANCOIS GALLAIRE, LFMI-EPFL Lausanne — Wind tunnel measurements were performed for the wake produced by a three-bladed wind turbine immersed in uniform flow. These tests show the presence of a vorticity structure in the near wake region mainly oriented along the streamwise direction, which is denoted as hub vortex. The hub vortex is characterized by oscillations with frequencies lower than the one connected to the rotational velocity of the rotor, which are ascribed to wake meandering by previous works. This phenomenon consists in transversal oscillations of the wind turbine wake, which are excited by the shedding of vorticity structures from the rotor disc acting as a bluff body. In this work temporal and spatial linear stability analyses of a wind turbine wake are performed on a base flow obtained through time-averaged wind tunnel velocity measurements. This study shows that the low frequency spectral component detected experimentally is the result of a convective instability of the hub vortex, which is characterized by a counter-winding single-helix structure. Simultaneous hot-wire measurements confirm the presence of a helicoidal unstable mode of the hub vortex with a streamwise wavenumber roughly equal to the one predicted from the linear instability analysis.

Simone Camarri
Dipartimento di Ingegneria Aerospaziale - Università di Pisa

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