Geophysical Research Abstracts
Vol. 19, EGU2017-13584-1, 2017
EGU General Assembly 2017

Counter-rotating vortex pairs in the wake of a vertical axis wind turbine

Vincent Rolin and Fernando Porté-Agel
EPFL, WIRE, ENAC-IIE, Lausanne, Switzerland (vincent.rolin@epfl.ch)

Despite the rising popularity of vertical axis wind turbines, or VAWTs, the wakes behind these machines is much less well understood than those behind horizontal axis wind turbines, or HAWTs. A thorough understanding of wakes is important as they can cause turbines in wind farms to produce less power than anticipated and increase the fatigue loading on turbines due to vibrations. In order to gain a deeper understanding of the wake behind a vertical axis wind turbine in atmospheric flow stereo-PIV is implemented in a boundary-layer wind tunnel to produce snapshots of the 3-component velocity field in the wake at various downstream positions. The boundaries of the wake are readily observed due to the high velocity gradients and turbulence present here. Two pairs of counter-rotating vortices similar to those in the wake of yawed HAWTs are also observed. An examination of the momentum fluxes behind the turbine demonstrates that the mean flow induced by these vortices entrains a large quantity of momentum from the unperturbed boundary layer flow above the wake. This effect proves to play an even more significant role than turbulence in reintroducing momentum into the wake. In order to comprehend why the VAWT produces these vortices we modify the double-multiple stream-tube model typically used to predict VAWT performance to incorporate crosswind forces. The similarity between VAWT and yawed HAWT wakes is found not to be coincidental as both cases feature rotors which exert a lateral thrust on the incoming wind which leads to the creation of counter-rotating vortex pairs.