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Canopy wake measurements using multiple scanning wind LiDARs

Corey D. Markfort (1,2), Fernando Carbajo Fuertes (1), Giacomo Valerio Iungo (1), Heinz Stefan (2), and Fernando Porté-Agel (1)

(1) Wind Engineering and Renewable Energy Laboratory (WIRE), École Polytechnique Fédérale de Lausanne (EPFL), Switzerland (corey.markfort@epfl.ch), (2) Saint Anthony Falls Laboratory, University of Minnesota, Minneapolis, MN, USA

Canopy wakes have been shown, in controlled wind tunnel experiments, to significantly affect the fluxes of momentum, heat and other scalars at the land and water surface over distances of ∼O(1 km), see Markfort et al. (EFM, 2013). However, there are currently no measurements of the velocity field downwind of a full-scale forest canopy. Point-based anemometer measurements of wake turbulence provide limited insight into the extent and details of the wake structure, whereas scanning Doppler wind LiDARs can provide information on how the wake evolves in space and varies over time.

For the first time, we present measurements of the velocity field in the wake of a tall patch of forest canopy. The patch consists of two uniform rows of 35-meter tall deciduous, plane trees, which border either side of the Allée de Dorigny, near the EPFL campus. The canopy is approximately 250 m long, and it is 35 m wide, along the direction of the wind. A challenge faced while making field measurements is that the wind rarely intersects a canopy normal to the edge. The resulting wake flow may be deflected relative to the mean inflow. Using multiple LiDARs, we measure the evolution of the wake due to an oblique wind blowing over the canopy. One LiDAR is positioned directly downwind of the canopy to measure the flow along the mean wind direction and the other is positioned near the canopy to evaluate the transversal component of the wind and how it varies with downwind distance from the canopy. Preliminary results show that the open trunk space near the base of the canopy results in a surface jet that can be detected just downwind of the canopy and farther downwind dissipates as it mixes with the wake flow above. A time-varying recirculation zone can be detected by the periodic reversal of the velocity vector near the surface, downwind of the canopy. The implications of canopy wakes for measurement and modeling of surface fluxes will be discussed.