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Flow structure and induction factor of a lightly loaded wind turbine model in a wind-turbine array boundary layer[1] JOSE LEBRON, Rensselaer Polytechnic Institute, RAUL BAYOAN CAL, Portland State University, HYUNG SUK KANG, The Johns Hopkins University, LUCIANO CASTILLO, Rensselaer Polytechnic Institute, CHARLES MENEVEAU, The Johns Hopkins University — Wind-tunnel experiments are carried out in order to study the structure of the flow within a 3 by 3 array of lightly loaded wind turbine models operating inside of a boundary layer. Particle-Image-Velocimetry measurements are performed in a volume surrounding a wind turbine model located on the center of the last row. Data gathered is used to compute time-averaged mean velocity and turbulence quantities in 18 planes surrounding the wind turbine model, and missing data are obtained through bilinear interpolation in space. The induction factor is estimated by computing the volumetric flux and mean velocities through circles centered at hub-height both upstream and downstream of the wind turbine model. Computation and visualization of the streamtube is performed by tracking the evolution of (virtual) fluid particles that pass through the (interpolated) rotor disk location. The effects of wall blockage, mean velocity shear, and turbulence stresses and mixing on the streamtube geometry are considered.

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Jose Lebron
Rensselaer Polytechnic Institute

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