



Investigating the Impact of Turbine Control on Turbine Wakes using Advanced Doppler Radar Measurements

Brian D. Hirth, John L. Schroeder, W. Scott Gunter, and Jerry G. Guynes
National Wind Institute, Texas Tech University, Lubbock, TX, USA

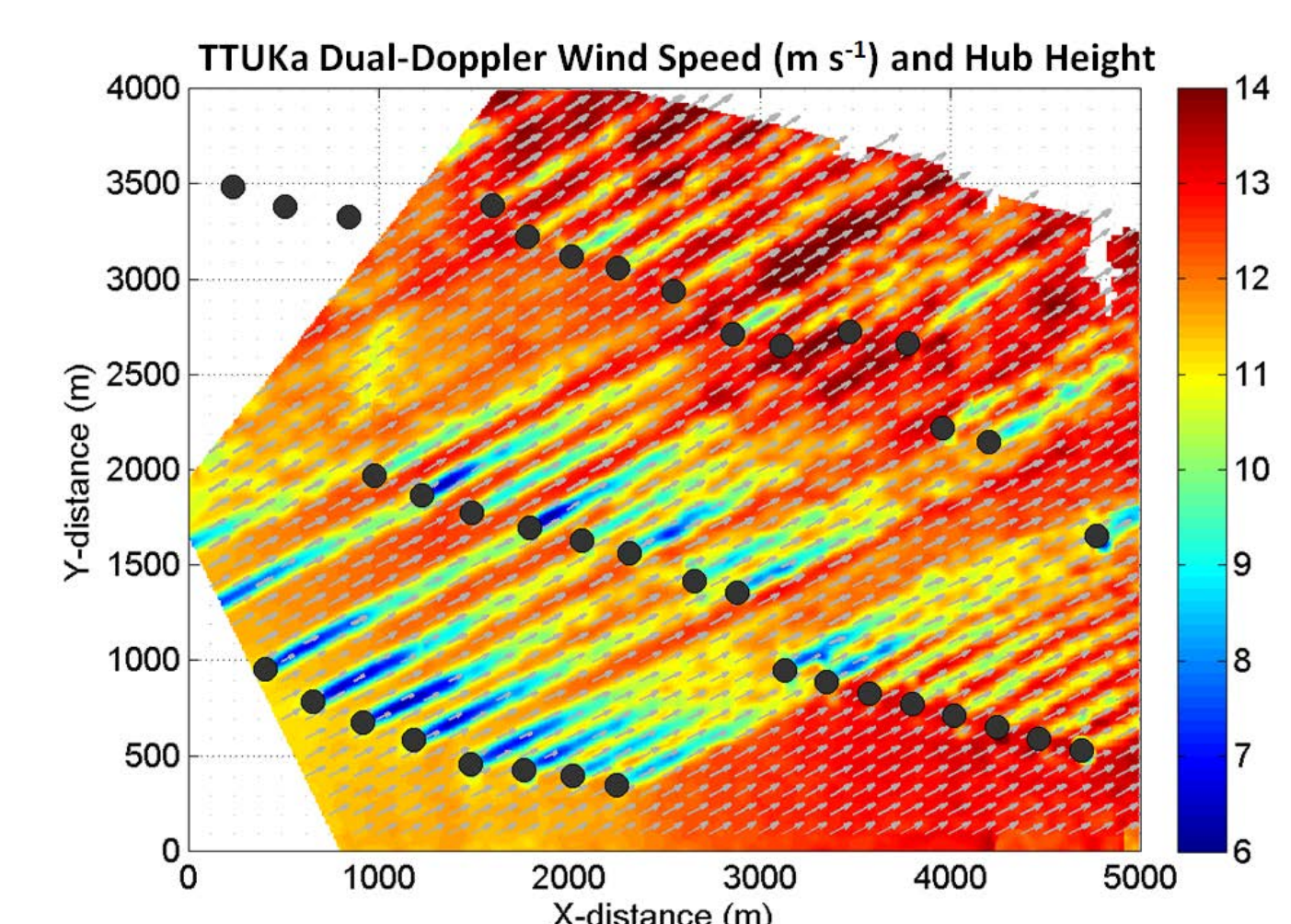
Purpose:

Turbine-to-turbine interaction has been widely accepted as a significant contributor to the underperformance of modern wind plants. This negative interaction is compounded by the fact that individual turbines within a wind plant operate autonomously with no understanding of the surrounding wind field, including upstream turbine wakes. The availability of real-time, comprehensive wind maps detailing the complex flows throughout a wind plant would allow future turbine control systems to more adequately respond to existing flow conditions, including the implementation of intelligence on individual turbine operations to better the efficiency of the plant as a whole.

This work investigates the impact of adjusting individual turbine control on the resulting wake structure. Wind field visualization is provided by the Texas Tech University (TTU) Ka-band research radar systems during periods of turbine control changes.

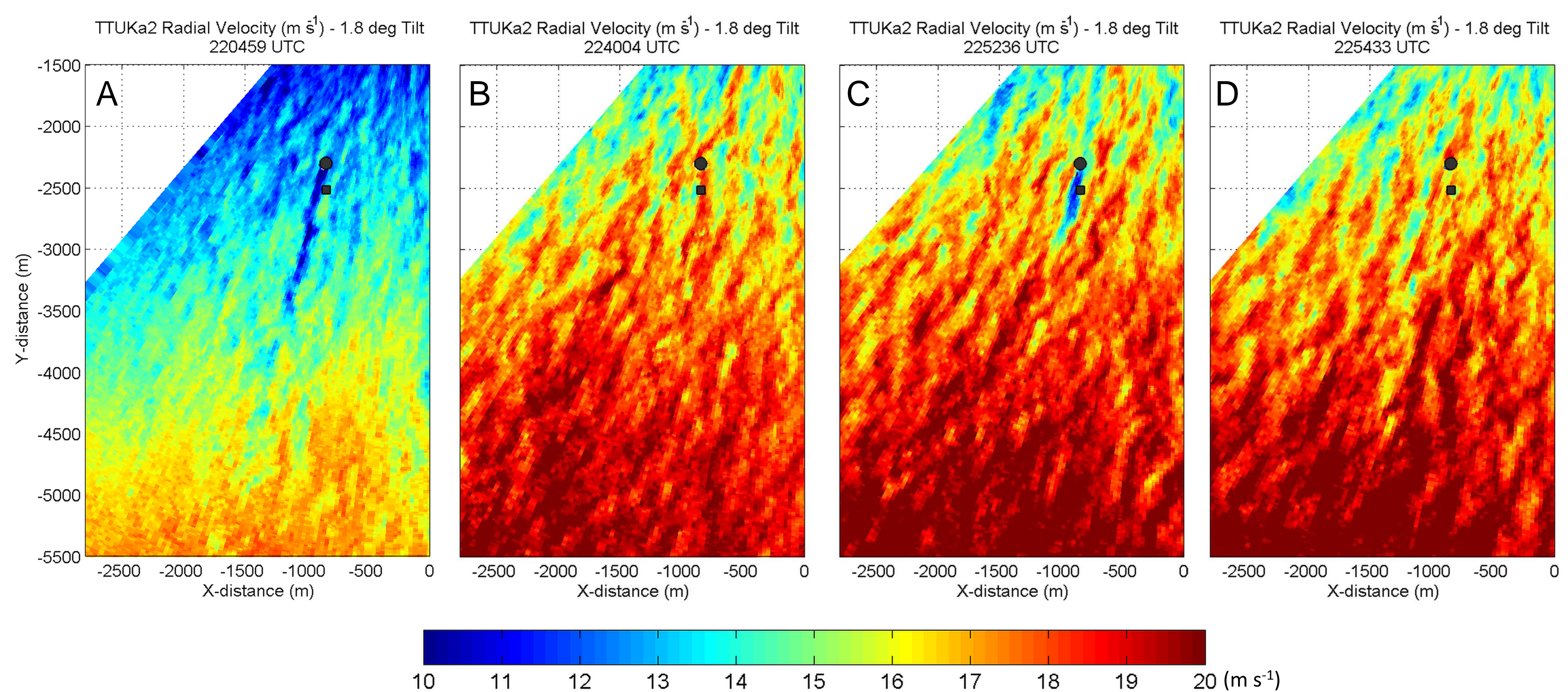
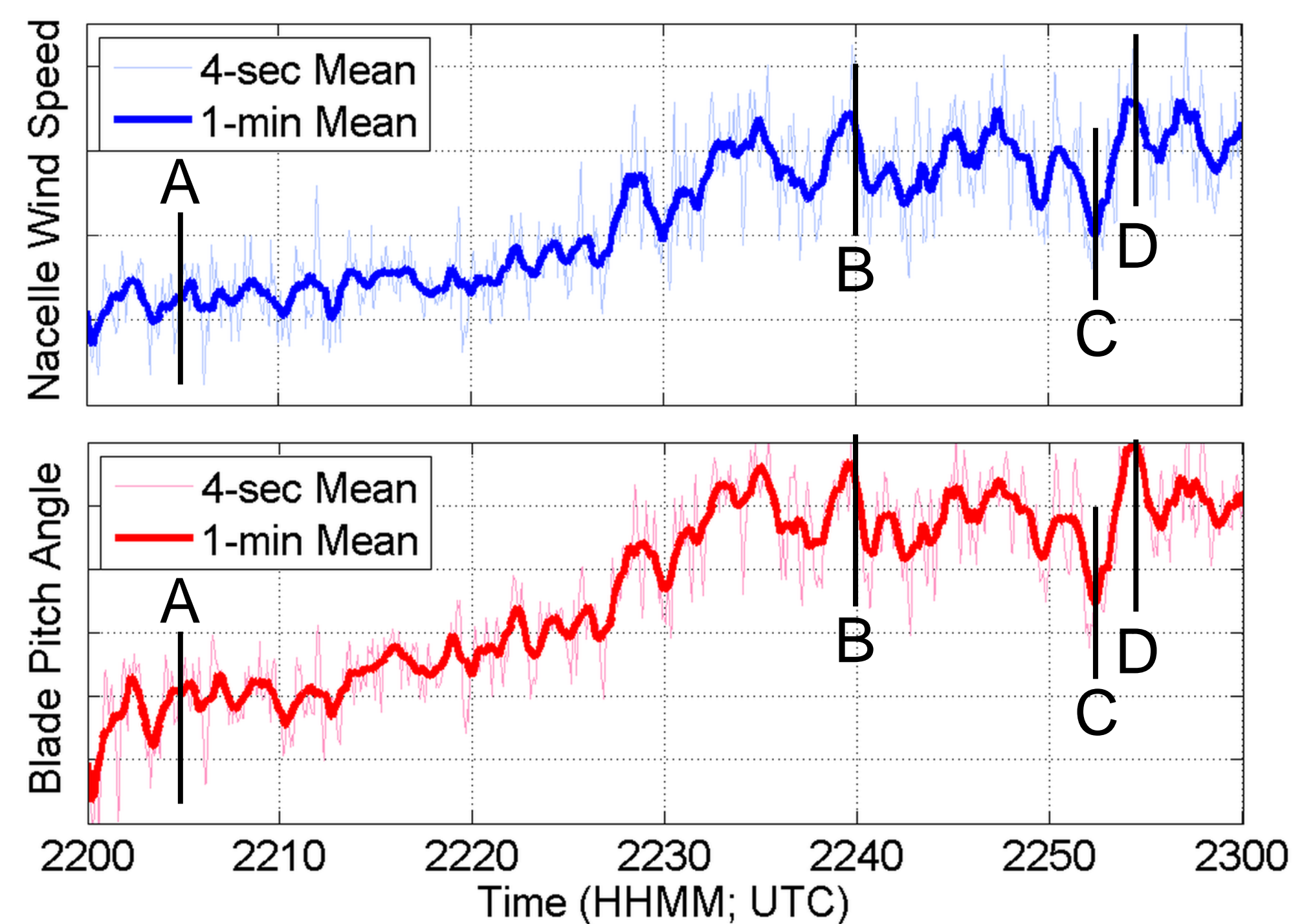
TTUKa Radar Systems:

The TTUKa radars were designed to measure small-scale atmospheric phenomena. Both radar systems take advantage of specialized pulse-compression frequency modulation techniques which allow for excellent along-beam range resolution (9-15 m). Each radar maintains a narrow half-power beamwidth of 0.33°. The TTUKa radars have been deployed in wind plants (bottom left) to document complex flows and turbine-to-turbine interaction (bottom right).



Changes in Turbine Pitch:

Small changes in turbine pitch have been found to yield significant changes in wake structure on short time scales, when merging operational turbine data with 4-second TTUKa horizontal PPI scans.



Changes in Turbine Yaw:

Manual offset of turbine yaw has been shown to yield a wake deflection such that a downstream turbine initially experiencing wake as its inflow is provided an improved inflow condition. TTUKa measured radial velocity and spectrum width from a turbine under normal operation are compared to measurements where the lead row turbine has been manually yawed 20° clockwise from its normal operational position.

Ongoing projects with established industry partners will expand upon these initial data collection efforts to assess the impact of manual turbine control on turbine wakes and the complex flows within wind plants.

