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# Atmosphere-Wind Turbine Interactions: Measurements and Simulations of Wind Turbine Wakes

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With tremendous growth in wind energy, questions regarding the meteorological impacts of wind energy have grown. Wind turbines extract energy from the incoming flow, generating a "wake," or region behind the rotor characterized by reduced wind speed and increased turbulence. These reduced wind speeds undermine the power generation of downwind wind turbines, while the enhanced turbulence within the wake causes increased fatigue loads on downwind turbines. Wind farms can be optimized by wake manipulation, but such approaches require predictive tools that incorporate the rapidly-growing body of knowledge of the dependencies of wind turbine wakes on atmospheric stability and wind variability.

Our group has observed turbine wakes from multi-MW turbines with profiling lidar, scanning Doppler lidar, towers, and a tethered lifting system. We have also developed methods for representing the effects of clusters of wind turbines in mesoscale and large-eddy simulation models, and use observational datasets to validate and improve these simulation capabilities. This presentation will characterize wind turbine wakes based on our observations. We will present simulations of potential regional impacts of wind farms, including the diurnal and seasonal variability of these impacts.