

The American WAKE Experiment: Observations of Wind Farm/Atmosphere Interactions

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Background/Objectives. The two-way interactions between wind farms and the atmosphere are poorly understood. Although these interactions may take a few different forms, such as wind farm blockage and triggering of gravity waves, the best known and arguably most significant interactions involve wakes (regions of reduced wind speed and increased turbulence downwind of a wind turbine or wind farm). Within a wind farm, turbine-to-turbine wake interactions have uncertainty levels of 20-50% according to current industry models. Furthermore, recent studies have found that the aggregated wake effect of a wind farm may be detectable as far as 30 km downstream. The current lack of understanding of wind farm—atmosphere interactions can lead to unexpected shortfalls in wind farm performance and prevents robust predictions of the impacts of windfarms on the microclimate of their surroundings.

Approach/Activities. The American WAKE experiment (AWAKEN), an ongoing field campaign within and around commercial-scale wind farms in northern Oklahoma, seeks to provide crucial data for characterizing atmosphere—wind farm interactions. Instrumentation deployed by a multi-institutional team measures key variables of atmospheric state as well as turbine performance data. Additionally, the proximity of the AWAKEN sites to the Atmospheric Radiation Measurement (ARM) program's Southern Great Plains facilities allows AWAKEN's data to be evaluated in the context of a multi-decade climate record.

Results/Lessons Learned. We will discuss the goals and approaches of AWAKEN and present analyses of the first 6 months of observations. We address the challenges of the high degree of coordination required for a successful multi-institution deployment. By enhancing fundamental knowledge of wind-farm—atmosphere interactions and improving modeling tools, AWAKEN will help to enable optimal wind farm design and operation even as atmospheric conditions may change in a changing climate.