Measurements of Turbulence Profiles with Scanning Doppler Lidar for Wind Energy Applications

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The generation of statistically accurate profiles of turbulence metrics is difficult because of the intermittent nature of turbulence, especially for the high turbulence conditions of interest to wind energy research. High quality profiles of mean and turbulent statistics of the wind field can be produced using a scanning Doppler lidar. Careful corrections for the spatial filtering of the wind field by the lidar pulse produce turbulence estimates equivalent to point sensors but with the added advantage of a larger sampling volume to increase the statistical accuracy of the estimates. For a well designed lidar system, this permits accurate estimates of the key turbulent statistics over smaller processing domains and with sufficiently short observation times to monitor rapid changes in atmospheric conditions. These measurement capabilities are ideally suited for optimal operation of wind farms and also for improved resource assessment of potential sites.

Results are presented from a field campaign at the National Wind Technology Center (NWTC) of the National Renewable Energy Laboratory (NREL). Doppler lidar derived profiles of mean and turbulent quantities are compared with nearby tower data for a high wind condition that is near the peak power production regime for modern wind turbines. The fundamental issues for three dimensional atmospheric measurements are discussed in the context of wind energy applications.