Classifying Vertical Wind Speed Profiles for Offshore Wind Resource and Power Assessment

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To justify the economic viability of a potential offshore wind energy project, an accurate assessment of the site-specific wind resource, thus expected energy yield, is required prior to wind farm construction. Unfortunately, uncertainties during this assessment exist, due in-part to limited offshore wind measurements throughout a turbine's rotor-layer (~40-200m) and related uncertainties predicting a turbine's available power. To better understand these uncertainties in the Mid-Atlantic USA, Doppler wind lidar and other met-ocean measurements were collected offshore within Maryland's Wind Energy Area from July-August 2013. Given the diversity of vertical wind speed profile (VWP) observations, 10-minute mean VWPs are classified based on the goodness-of-fit to several mathematical expressions. Results suggest a low-level wind maximum as the most frequent VWP *type* (>30%), while only ~15% resembled industry-standard logarithmic-like wind profiles. Rotor-Equivalent Wind (REW) turbine power estimation techniques, which account for the superposition of several wind parameters, are evaluated to elucidate the impact of VWP *types* on available turbine power estimates. On average, REW estimates demonstrate higher available power compared to industry-standard hub-height (100m), power law extrapolation, and Numerical Weather Prediction estimates. Finally, relationships between the mesoscale meteorological environment and VWP *types* are explored using nearby buoy and model/reanalysis datasets.