On the extension of the wind profile over homogeneous terrain beyond the surface boundary layer

Analysis of profiles of meteorological measurements from a 160 m high mast at the National Test Site for wind turbines at H φ vs φ re (Denmark) and at a 250 m high TV tower at Hamburg (Germany) shows that the wind profile based on surface-layer theory and Monin-Obukhov scaling is valid up to a height of 50-80 m. At higher levels deviations from the measurements progressively occur. For applied use an extension to the wind profile in the surface layer is formulated for the entire boundary layer, with emphasis on the lowest 200-300 m and considering only wind speeds above 3 m s(-1) at 10 m height. The friction velocity is taken to decrease linearly through the boundary layer. The wind profile length scale is composed of three component length scales. In the surface layer the first length scale is taken to increase linearly with height with a stability correction following Monin-Obukhov similarity. Above the surface layer the second length scale (L-MBL) becomes independent of height but not of stability, and at the top of the boundary layer the third length scale is assumed to be negligible. A simple model for the combined length scale that controls the wind profile and its stability dependence is formulated by inverse summation. Based on these assumptions the wind profile for the entire boundary layer is derived. A parameterization of L-MBL is formulated using the geostrophic drag law, which relates friction velocity and geostrophic wind. The empirical parameterization of the resistance law functions A and B in the geostrophic drag law is uncertain, making it impractical. Therefore an expression for the length scale, L-MBL, for applied use is suggested, based on measurements from the two sites.

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