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Kelly, Mark C.; Gryning, Sven-Erik; Ejsing Jørgensen, Hans

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FROM M-O THEORY TOWARD LONG-TERM MEAN WIND PROFILES

Mark Kelly (Risø DTU, Wind Energy, Denmark)
Sven-Erik Gryning, Denmark (1) Hans E. Jørgensen, (1)
(1) Risø DTU

We have systematically developed forms for climatalogical-mean wind profiles based on Monin-Obukhov similarity theory. This is accomplished through development of a probabilistic formulation for the relevant scaling variables (e.g. stability) and consequent analytical adaptation of similarity theory to mean application. The theory is extended to incorporate generalized <i>"tall"</i> profile forms, which apply at heights beyond the limits of M-O similarity.

An increasing amount of research and observations have shown that Monin-Obukhov (M-O) similarity theory is not applicable for wind profiles above the atmospheric surface layer. Further, M-O theory is not generally valid for long-term mean profiles (such as yearly-mean <i>U(z)</i> used for wind energy estimates), and its validity decreases with increasing height away from the surface. Stable-stratification conditions tend to have a stronger influence upon the wind than unstable conditions, with the collective nonlinear effect of both causing long-term mean profiles to deviate from M-O theory. Above the atmospheric surface layer dominated by ground effects, other influences--such as the height and strength of the temperature inversion which `caps´ the atmospheric boundary layer--have an effect upon both conventional (i.e. 10-minute average) and yearly-mean wind profiles and wind statistics.

We develop an analytical formulation for the dominant stability distributions prevailing in the atmospheric surface layer under most conditions, which in turn allows us to derive a form for the mean wind profile based on Monin-Obukhov similarity theory. The modeled stabilities agree well with measurements at a number of sites. The mean profile form is then extended to include the influence of the top of the atmospheric boundary layer by generalizing and adapting the form of Gryning <i> et al.</i> (2007). The resultant mean tall profile form agrees well with observations, and the general theory is amenable to extension of the derived mean profiles to include other effects. Implementation of the mean tall-profile theory is discussed within the context of limited observations taken from the upper atmospheric boundary layer.