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Analytical expression for the wind profile over forests

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It has been a long known fact that within the rougness sublayer the standard Monin-Obukhov similarity expressions fail. A new analytical expression for the mean wind profile within and above forests has been developed.
While higher order models and more advanced tools are important for wind energy site assessments simple analytical expressions are important to understand the physics. Analytical models can also be used for initialization and closure in higher order models or to give the wind in sound propagation models.
The new expression has been developed with focus on the shear instability that is believed to cause the enhanced flux of momentum near the tree tops in forest flows. Corrections for the standard dimensionless gradient expression are proposed. The new flux-gradient expression is integrated analytically to find the mean wind speed. Connections between important length scales such as the forest height, the roughness length and the displacement height is made.
Comparisons of wind profiles from the model to measurements from three different forest sites are made. The results show that the model can predict the mean wind profile in different stratification and is able to represent different forest densities.