An Analytical Model for the Effect of Vertical Wind Veer on Wind Turbine Wakes

In this study, an analytical wake model for predicting the mean velocity field downstream of a wind turbine under veering incoming wind is systematically derived and validated. The new model, which is an extended version of the one introduced by Bastankhah and Porté-Agel, is based upon the application of mass conservation and momentum theorem and considering a skewed Gaussian distribution for the wake velocity deficit. Particularly, using a skewed (instead of axisymmetric) Gaussian shape allows accounting for the lateral shear in the incoming wind induced by the Coriolis force. This analytical wake model requires only the wake expansion rate as an input parameter to predict the mean wake flow downstream. The performance of the proposed model is assessed using the large-eddy simulation (LES) data of a full-scale wind turbine wake under the stably stratified condition. The results show that the proposed model is capable of predicting the skewed structure of the wake downwind of the turbine, and its prediction for the wake velocity deficit is in good agreement with the high-fidelity simulation data.

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