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Coupled wake boundary layer model of windfarms[1] RICHARD STEVENS, DENNICE GAYME, CHARLES MENEVEAU, Johns Hopkins University — We present a coupled wake boundary layer (CWBL) model that describes the distribution of the power output in a windfarm. The model couples the traditional, industry-standard wake expansion/superposition approach with a top-down model for the overall windfarm boundary layer structure. Wake models capture the effect of turbine positioning, while the top-down approach represents the interaction between the windturbine wakes and the atmospheric boundary layer. Each portion of the CWBL model requires specification of a parameter that is unknown a-priori. The wake model requires the wake expansion rate, whereas the top-down model requires the effective spanwise turbine spacing within which the model's momentum balance is relevant. The wake expansion rate is obtained by matching the mean velocity at the turbine from both approaches, while the effective spanwise turbine spacing is determined from the wake model. Coupling of the constitutive components of the CWBL model is achieved by iterating these parameters until convergence is reached. We show that the CWBL model predictions compare more favorably with large eddy simulation results than those made with either the wake or top-down model in isolation and that the model can be applied successfully to the Horns Rev and Nysted windfarms.

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