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The Area Localized Coupled Model for Analytical Mean Flow Prediction in Arbitrary Wind Farm Geometries[1] GENEVIEVE M. STARKE, CHARLES MENEVEAU, Johns Hopkins University, JENNIFER KING, National Renewable Energy Laboratory, DENNICE F. GAYME, Johns Hopkins University
— We introduce the Area Localized Coupled (ALC) model, which extends earlier approaches that couple classical wake superposition and atmospheric boundary layer models to enable applicability to arbitrary wind-farm layouts. Coupling wake and top-down boundary layer models is particularly challenging since the latter requires averaging over planform areas associated with certain turbine-specific regions of the flow. The ALC model uses Voronoi tessellation with a cell around each turbine and a developing internal boundary layer description over Voronoi cells upstream of each turbine. Coupling is achieved by enforcing a minimum least-square-error in mean velocity in each cell between the top-down model and a given wake model (e.g. Jensen or Gaussian model). The ALC model, using a wake model with a top-hat to Gaussian profile, is applied to two wind farm geometries and compared with LES data for a circular wind farm generated at NREL using SOWFA, and a farm that has half of the turbines arranged in an array and the other half randomly distributed simulated using LESGO from JHU. The ALC model is shown to produce improved generated power predictions for both the farm and individual turbines over prevailing approaches for a range of wind inflow directions.

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