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Low-order representations of a wind turbine array boundary layer via double POD NICHOLAS HAMILTON, Portland State University, MURAT TUTKUN, Institute for Energy Technology, University of Oslo, RAÚL BAYOÁN CAL, Portland State University — Experimental data from stereo particle image velocimetry enables access to the full Reynolds stress tensor in planes parallel to the scale-model turbine rotor. Proper orthogonal decomposition (POD) is applied to isolate structures in the wake. Modes resulting from the decomposition indicate that structures evolve along the streamwise coordinate. Secondary application of the POD, double proper orthogonal decomposition (DPOD), is applied to modes of common rank yielding a refined set of projections. The DPOD describes sub-modal organization in terms of projections of POD modes common to the span of the wake, followed by a series of spatially explicit corrections. Sub-modal structures that persist through the wake combine linearly with amplitudes and account for the evolution of the POD modes. Eigenvalues from the DPOD indicate that the wind turbine wake can be described with a very small subset of the original mode basis. The truncated basis of sub-modes represents a total reduction to 0.015% of the original degrees of freedom in the wake. Low-order description of the stress tensor is corrected to account for energy excluded from the truncated basis. Root-mean-square error associated with low-order statistics is less than 15% for normal stresses and 3% for shear stresses.

Nicholas Hamilton
Portland State University

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