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Dynamic Stall of an Experimental Wind Turbine Blade

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Dynamic stall of an experimental wind turbine blade

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To understand the complex flow phenomena over wind turbine blades during stall development, a scaled three-dimensional non-rotating blade model is designed to be dynamically similar to a rotating full-scale NREL 5 MW wind turbine blade. A time-resolved particle imagevelocimetry(PIV) investigation of flow behavior during the stall cycle examines the processes of stall development and flow reattachment. Proper orthogonal decomposition (POD) and vortex detection techniques are applied to the PIV fields to quantify relevant flow characteristics such as vortex size, separation angle, and separation point throughout a dynamic pitching cycle. The behavior of the POD coefficients provides time scales for the transitional stages which are quantified and compared, revealing that transition from attached flow to full stall is delayed to higher angles of attack and occurs at a higher rate than the transition from full stall to attached flow. The instantaneous flow fields are then reconstructed using the first four POD modes to demonstrate their prominent roles throughout the stall cycle and their ability to capture the general separation behavior over the blade surface.

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Key Topics

Rotating flows
53.0

Aerodynamics
20.0

Wind turbines
19.0

Velocimetry
8.0

Boundary element methods
6.0

IPC Codes:

F03D

Wind motors

F15D

[Fluid dynamics, i.e. methods or means for influencing the flow of gases or liquids, Fluid dynamics, i.e. methods or means for influencing the flow of gases or liquids, Fluid dynamics, i.e. methods or means for influencing the flow