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The Fluids Physics Challenges of Very Large Wind Turbines¹ NICK JOHNSON, KELSEY SHALER, BEN ANDERSON, EMMANUEL BRAN-LARD, SHREYAS ANANTHAN, GANESH VIJAYAKUMAR, PIETRO BOR-TOLOTTI, National Renewable Energy Laboratory — A recent publication in Science has identified aerodynamics as a grand challenge for the continued growth and development of wind turbines. Current design practice uses blade element momentum (BEM) theory to derive blade forces from aerodynamic inputs. BEM is computational efficiency and has been used for the majority of blade designs, but it does have limitations. The assumptions used by BEM are challenged by modern and future wind turbine blades where lengths exceed 100m. As blades get more flexible, and include bend-twist coupling effects, the ability to accurately model unsteady aerodynamics is more important than ever. Recent advances in high-performance computing can give important insights into the phenomena. Large very flexible blades have large out of plane deflections that violate BEM assumptions. Recent studies at the National Renewable Energy Laboratory have been conducted using vortex methods to quantify these effects on the loads of large highly flexible blades and compare results to BEM. Further, vortex methods may be used to understand the interaction of these very flexible blades with their own wakes. This talk will give an overview of the current state-of-the-art in wind turbine blade aerodynamic modeling and will highlight current challenges and areas of recent and future work.

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