Center for Environmental & Applied Fluid Mechanics

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"Harnessing Fluid Mechanics for the Development of Next-Generation Wind Energy Systems"

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Abstract: Wind turbines are becoming significantly larger, with utility scale wind turbine tower heights exceeding 100 meters and diameters of hundreds of meters, especially in offshore conditions. These massive new machines face efficiency and reliability challenges because they operate in a way that defies the assumptions used in the classical theories that they have been designed with. Addressing these challenges requires a new modeling framework that integrates high-fidelity simulations, high-performance computing, artificial intelligence, and experimental validation, all grounded in fundamental fluid mechanics. In this talk, we will discuss advancements in wind energy modeling for computational fluid dynamics and how the fundamentals of fluid mechanics can be used to augment wind energy extraction of wind turbines and wind plants. We will particularly focus on the development of the curled wake model used to predict wind turbine wakes in yaw. A special emphasis will be given on the assumptions, simplifications and fluid mechanics concepts used to develop this simplified 3D model in view of flow control for wake steering. We will also discuss next steps in the modeling framework and how it can be used to improve wake steering technologies.

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