SAFL Seminar Series
Distinguished Speaker

Wednesday, December 14, 2011, 3:30pm

St. Anthony Falls Laboratory Auditorium

Interactions between Atmospheric Turbulence and Wind Turbine Loadings from Large-Eddy Simulation of the Atmospheric Boundary Layer Coupled with AeroDyn

James G. Brasseur

Department of Mechanical Engineering

Pennsylvania State University

There exist a number important design and control issues in future generations of commercial wind turbines that can benefit from deeper understanding and more precise predictions of the interactions that take place between the turbulence in the lower atmospheric boundary layer (ABL) and the space-time variations in stresses on the blade surfaces. In particular, the more energetic turbulent motions in the surface layer, the region dominated by commercial wind turbines, are of order the rotor disk in scale. As these atmospheric eddies sweep through the rotor disk, they change the magnitude and the angle-of-attack of the incoming velocity vector relative to the rotating blades, leading to rapid changes in blade surface boundary layer structure, large variability in surface stresses and, rapid changes in torque loadings that pass into the gearbox. The consequences include blade fatigue and gearbox failure. I shall discuss a current NSF-funded research program aimed at understanding the complex relationships between atmospheric turbulence and wind turbine using large-eddy simulation of the ABL coupled to a BEM model AeroDyn, and current efforts towards full CFD of blade loadings.