

National Engineers Week

Distinguished Lecture

ERIK JONSSON SCHOOL OF ENGINEERING & COMPUTER SCIENCE
THE UNIVERSITY OF TEXAS AT DALLAS



Thursday, February 21, 2013, 11:00 A.M.
TI Auditorium (ECSS 2.102)

*The Importance of Large Scales of Turbulence
in the Energy Entrainment of Wind Arrays*

Luciano Castillo, PhD

Don-Kay-Clay Cash Distinguished Engineering Chair in Wind Energy
Executive Director/President of the National Wind Resource Center (NWRC)
Professor, Mechanical Engineering Department
Texas Tech University

Abstract

During the first portion of this seminar, extensive PIV data collected from a scaled down 3 blade, 3 x 5 turbine array is shown. In order to understand how large-scales motions play a role in providing mean kinetic energy (MKE) to the array, low dimensional tools based on a proper orthogonal decomposition (POD) are used to analyze the spatially developing velocity field inside the scaled array. From this analysis, modal decomposition of the Reynolds stresses and fluxes of the MKE are constructed. Thus, from these modal expansions it is established that low order modes have large contributions to Reynolds shear stress regardless of analysis domain. In addition, it will be shown that mean kinetic energy transport resulting from Reynolds shear stress typically serves to bring energy into the array while transport terms associated with Reynolds wall-normal stress typically removes energy from the array. Furthermore, it will be shown that the sum of the first 13 modes for the mean fluxes contributes 75% of the total Reynolds shear stress in the domain.

During the second part of the seminar, preliminary PIV results from scaled down experiments of 2 blades versus 3 blades arrays subject to similar conditions in a wind tunnel will be presented. Of primary importance from this data are the differences which exist in the entrainment patterns between 2 and 3 bladed turbine arrays. Finally, a prototype of a wind farm will be shown as means for future collaborations between UMN and TTU. In general, this seminar will stress the importance of understanding turbulence in wind energy.

Bio

Luciano Castillo is the Don-Kay-Clay Cash Distinguished Engineering Chair in Wind Energy and the Executive Director/President of the National Wind Resource Center (NWRC) at Texas Tech University. After spending 12 years at Rensselaer Polytechnic Institute he joined the ME department at TTU in 2011. His research in turbulence using experimental techniques, direct numerical simulations and multi-scale asymptotic analysis has injected new ideas in turbulent boundary layers and improved our understanding of the effects of initial conditions on large scale turbulence, particularly on wind energy performance. Some of his awards include: the *NASA Faculty Fellowship*, the *Martin Luther King Faculty Award*, and the *Robert T. Knapp Award* on complex flows from the ASME among others. He published over 100 articles including a seminal paper on turbulent boundary layers and scaling laws.

Visit us at ecs.utdallas.edu.

THE
JONSSON
SCHOOL