Solution of the Fokker-Planck equation in a wind turbine array boundary layer. (English)

Summary: Hot-wire velocity signals from a model wind turbine array boundary layer flow wind tunnel experiment are analyzed. In confirming Markovian properties, a description of the evolution of the probability density function of velocity increments via the Fokker-Planck equation is attained. Solution of the Fokker-Planck equation is possible due to the direct computation of the drift and diffusion coefficients from the experimental measurement data which were acquired within the turbine canopy. A good agreement is observed in the probability density functions between the experimental data and numerical solutions resulting from the Fokker-Planck equation, especially in the far-wake region. The results serve as a tool for improved estimation of wind velocity within the array and provide evidence that the evolution of such a complex and turbulent flow is also governed by a Fokker-Planck equation at certain scales.

MSC:
60J20 Applications of Markov chains and discrete-time Markov processes on general state spaces (social mobility, learning theory, industrial processes, etc.)
60H30 Applications of stochastic analysis (to PDEs, etc.)
35Q84 Fokker-Planck equations
76F55 Statistical turbulence modeling

Keywords:
wind energy; stochastic analysis; Fokker-Planck equation; Markov properties; turbulence

Full Text: DOI

References:
Einstein, A., Über die von der molekularkinetischen theorie der wärme geforderte bewegung von in ruhenden flüssigkeiten suspendierten teilchen, Ann. Phys., 322, 549-560, (1905) · Zbl 36.0975.01


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