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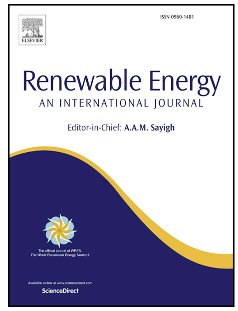

Buoyancy jump at wind turbine wake interface

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Buoyancy jump at wind turbine wake interface

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Abstract

Wake measurements of field installed, scaled-model (diameter, $D = 1.17m$) wind turbine were performed with the purpose of studying the density differences (buoyancy jumps) at the wake-freestream interface for various atmospheric boundary layer (ABL) conditions. It is demonstrated that the density differences create buoyancy jumps or discontinuities greater in magnitude than the background ABL buoyancy. It is shown analytically that the interfacial buoyancy jump will increase with the turbine size and vary significantly with the lateral location within the wake. The existence of the buoyancy jumps is further confirmed by the observed inverse proportionality of the interfacial Richardson number (Ri_B) for stable ABL conditions and constant Ri_B for unstable ABL. Further, the observations show that the wake deficit is highest for stable ABL, followed by neutral and unstable ABL. Additionally, turbulent transport of momentum is found to be the primary source of mean kinetic energy to the wake, corroborating previous studies in wind tunnel under well-controlled conditions.

Keywords: atmospheric stability, wind turbine wakes, interfacial buoyancy jump, wind farm flows

2010 MSC: 00-01, 99-00

1. Introduction

Atmospheric boundary layer (ABL) stratification (ABL stability) is associated with changes in power production of wind farms containing horizontal axis

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