Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Dynamics of helical vortices behind a wind turbine in a stratified atmosphere XUERUI MAO, Faculty of engineering, the University of Nottingham, FAZLE HUSSAIN, Department of Mechanical Engineering, Texas Tech University, — The wind turbine wake features helical vortices, which are shed from the tips of blades and inflict undesirable fatigue loading on downstream turbines. Prior studies of helical vortices focused on their hydrodynamic instabilities and the following breakup in the neutrally stable, isothermal atmospheres in which the buoyancy force is balanced by gravity. However, the atmosphere is typically mostly unstable during the day and mostly stable at night, but is seldom neutral. The present numerical work addresses the development of helical vortices in a thermally stratified atmosphere and also concentrates on the stable condition which is typical for offshore applications. The Boussinesq approximation is invoked to account for the thermal stratification effect, and an actuator line model is adopted for the turbine blades. In our direct numerical simulations, the helical vortices are found to be increasingly elliptic downstream and subsequently interact with the hub vortex to produce a new mode of breakup into turbulence. Such elliptic structures increase the width of the wake and subsequently the interaction between aligned turbines in large-scale offshore wind farms.

Xuerui Mao
Univ of Nottingham

Date submitted: 01 Aug 2017 Electronic form version 1.4