Geophysical Research Abstracts
Vol. 12, EGU2010-12280, 2010
EGU General Assembly 2010

Flow structure around a 2-D surface-mounted rectangular cylinder in neutral and stable atmospheric boundary layers

Wei Zhang (1), Leonardo P. Chamorro (1), Fernando Porté-Agel (1,2)

(1) Saint Anthony Falls Laboratory, Department of Civil Engineering, University of Minnesota, Minneapolis, MN 55414, USA (wzhang@umn.edu), (2) School of Architecture, Civil and Environmental Engineering, Ecole Polytechnique Fe'de'rale de Lausanne, CH-1015 Lausanne, Switzerland (fporte@umn.edu)

Topography is known to have an important effect on local and regional fluxes of heat and momentum in stably stratified atmospheric boundary layers. Understanding this effect is far from complete owing to the limited number of experimental data sets currently available. Such data sets are also needed for validation of numerical models such as Large-Eddy Simulation (LES). In this study, a comprehensive set of experiments were conducted at the Saint Anthony Falls Laboratory atmospheric boundary-layer wind tunnel to study the flow around a 2-D surface-mounted rectangular cylinder in neutral and stably stratified boundary layers. The 2-D rectangular cylinder, with an aspect ratio (W/H) of 2:1, was fully embedded in the surface layer (H/$\approx$0.12). Thermal stratification conditions were achieved by controlling the temperature of both the air flow and the test section floor surface. High resolution Particle Image Velocimetry (PIV) was used to map the detailed vortical structure in the range of x=-1.5H-8H and y=0-2H, while a triple-wire (x-wire and cold wire) anemometer was employed to evaluate the flow statistics relatively far away from the rectangular cylinder (x=8H-24H). The flow is featured by a small re-circulation in front of the rectangular cylinder, a separation bubble above the top, and a large re-circulation behind it. Besides the mean flow pattern, turbulence statistics, including the turbulent fluxes, turbulent kinetic energy (T.K.E.) and Reynolds shear stress are discussed. Emphasis is put on the effects of the thermal stratification on the vortical structures around the 2-D surface-mounted rectangular cylinder by comparing them in neutral and stable boundary layers. This work will hopefully enhance our understanding of the thermal effects on the atmospheric boundary layer flow over complex topography, and provide a reliable data base for validating and improving LES modeling.