Geophysical Research Abstracts
Vol. 14, EGU2012-1949, 2012
EGU General Assembly 2012


# Large-eddy simulation of flows over idealized urban areas in thermal stratification

Mr. Chan and Dr. Liu
Mechanical Engineering, The University of Hong Kong, Hong Kong

Large-eddy simulation (LES) equipped with the one-equation subgrid-scale model was employed to investigate the mean wind and turbulence over idealized two-dimensional (2D) street canyons in various thermal stratifications. The prevailing wind is driven by a background pressure gradient above the roof level that is perpendicular to the axis of street canyons. The building-height-to-street-width (aspect) ratio is kept unity so the flows fall into the skimming flow regime. Cyclic boundary conditions are assigned to the domain inlet and outlet, simulating the infinite horizontally homogenous building structures. The buoyancy force is modeled by Boussinesq approximation.

Building geometry is the key factor governing the wind flow behaviors aloft. Its effects on the flow structures in isothermal conditions are widely studied. Whereas, thermal stratification, which is caused by the temperature difference between the urban fabrics and the prevailing wind, plays another important role in the wind flow behaviors. The presence of buoyancy force drives/suppresses convective flows that substantially modify the vertical transport processes. In stable stratification, e.g. nighttime, a cooler urban surface favors subsidence that reduces turbulence intensities subsequently. While in unstable stratification, e.g. daytime, a hotter urban surface induces buoyancy and convective current that in turn promotes turbulence.

In isothermal conditions, it is well known that the mean flows exhibit a log-law region over an aerodynamically smooth surface where the mean wind profile is in a logarithmic form (law of the wall). The logarithmic wind profile is also observed over homogenously rough surfaces, such as the idealized two-dimensional street canyons used in this study.

However, in thermal stratification (both stable and unstable), the mean wind profile deviates from the isothermal one whose extent depends on the intensity of thermal stratification compared with the mean wind (measured by the Richardson number). For the cases in slightly unstable stratification, the deviation is mild such that the conventional log-law can be modified to account for the effects of thermal stratification in a reasonable manner.