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THE UNIVERSITY OF HONG KONG

SEMINAR

Turbulent Transport Mechanism in the Roughness Sublayers over Idealized Urban Areas

Date: 18 April, 2023 (Tuesday)
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Venue: Room 7-34, Haking Wong Building, HKU

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Abstract:

Turbulence dynamics in the roughness sublayer (RSL) are significantly different from those in the inertial sublayer (ISL) of the atmospheric surface layer (ASL) over urban areas. The drag coefficient C_d (= $2u_\tau^2/U_\infty^2$) is a crucial parameter measuring the interaction among the dynamics, transport, and urban morphology. Therefore, it is adopted as a critical parameter to compare RSL flow behavior in this study. Wind tunnel experiments are conducted to investigate the aerodynamic drag in response to different configurations of roughness elements and the transport processes. Statistics and spectral analysis are used to elucidate the RSL turbulent transport mechanism. Unlike the ISL ones, RSL flows are heterogeneous that are influenced by individual roughness elements. Quadrant analysis and tilt angle are used to examine the impact of drag on the RSL transport efficiency. It is evident that RSL transport is more efficient over rougher surfaces. Moreover, power spectrum and cospectrum reveal the mechanism of how C_d modifies transport efficiency. A secondary peak of cospectrum of streamwise and vertical fluctuating velocities, which is attributed to the small motion scales, is unexpectedly found in the logarithmic region but not in the power spectra of turbulence kinetic energy (TKE). It is thus suggested that the drag over rough surfaces enhances the RSL mixing and transport processes. Amplitude (AM) and frequency (FM) modulations indicate that the large and small motions are positively correlated in the RSL which are amplified over rougher surfaces. Furthermore, the RSL TKE production increases with decreasing C_d at the expense of weakened TKE entrainment. These findings collectively formulate the basic RSL transport mechanism over urban areas.

ALL INTERESTED ARE WELCOME

For further information, please contact Dr. C.H. Liu at 3917 7901.