TURBULENT ORGANIZED STRUCTURE WITHIN AND ABOVE BUILDING ARRAYS DERIVED FROM LES AND OUTDOOR SCALE MODEL

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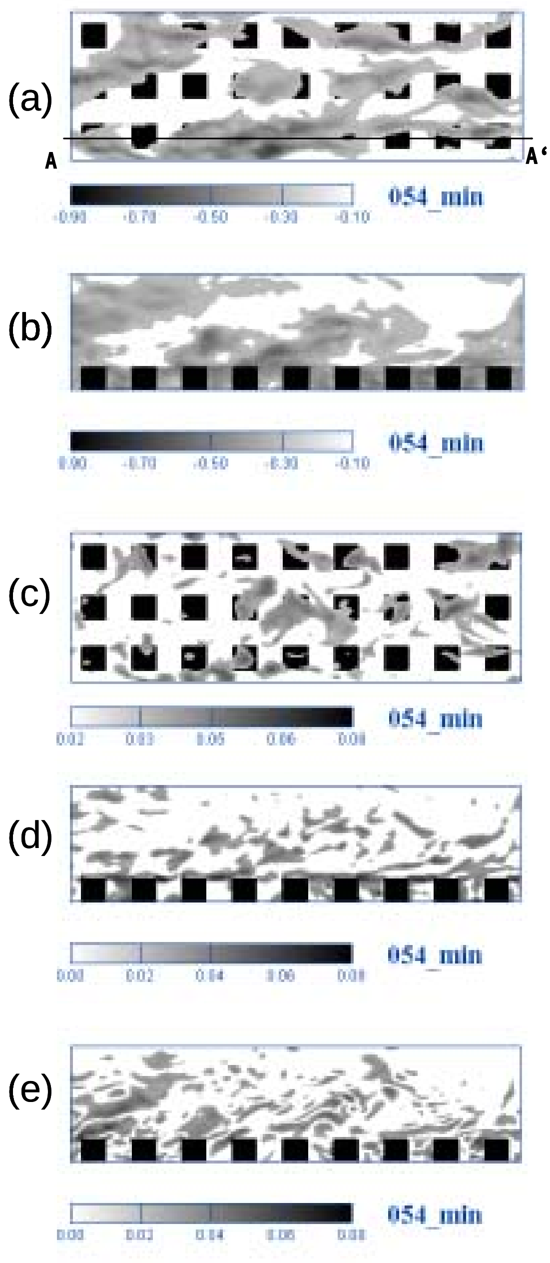
ABSTRACT

Turbulent organized structures within and above building arrays were investigated using a large eddy simulation (LES) model for a city (LES-CITY). Square and staggered building arrays produced contrasting behavior in terms of turbulence that roughly corresponded to the conventional classification of 'D-type' and 'K-type' roughness, respectively. (1) The drag coefficients at the building heights for staggered arrays were sensitive to building area density, but those for square arrays were not. (2) The relative contributions of ejections to sweeps (S2/S4) at the building height for square arrays were sensitive to building area density and nearly equaled or exceeded 1.0 (ejection dominant), but those for staggered arrays were insensitive to building area density and were mostly below 1.0 (sweep dominant). (3) Streaky patterns of longitudinal low speed regions (i.e., low speed streaks) existed in all flows regardless of array type. Height variations of the buildings in the square array drastically increased the drag coefficient and modified the turbulent flow structures. The mechanism of D-type and K-type urban-like roughness flows and the difference from vegetation flows are discussed.

Contributions from Comprehensive Outdoor Scale Model experiments (COSMO) for urban climate were also presented. COSMO was designed to investigate the scale similarity of turbulence, energy balance and related physical parameters, and turbulent organized structure in urban roughness sublayer. 60 thermocouples and 8 compact sonic anemometers aligned in lateral direction at 2H (H; cube height) successfully detected the very large scale motion of U, which resemble those simulated by LES-CITY.

Figure



Instantaneous images of turbulent organized structures for the square cube array with area density = 0.25. The flow is left to right. (a) horizontal cross-section of low speed streaks, which is defined as the region where the streamwise velocity fluctuation is negative, (b) vertical cross-section of low speed streaks, (c) horizontal cross-section of spanwise vorticity component, (d) vertical cross section of spanwise vorticity component, and (e) vertical cross-section of streamwise vorticity component. The position of y for the cross-section in (b), (d) and (e) is indicated by A-A' in (a).

REFERENCES

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