EFFECT OF HEAT FLUX ON POLLUTANT DISPERSION IN AN URBAN STREET CANYON

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The characteristic wind flow pattern in an urban street canyon can generally be classified into three regimes by the canyon aspect ratio according to Oke's [1] classification. It has been shown by numerical simulation that the flow regime can be affected by inflow wind speed (Reynolds number), and this in turns affect the pollutant dispersion pattern [2]. On the other hand, in a typical street canyon, thermal effects arising from solar irradiation and urban heat are also expected to contribute to wind dispersion mechanisms. Therefore, apart from aspect ratio and inflow wind speed, the effect of heat flux may also be significant on pollutant dispersion.

In this paper, we attempt to study computationally the thermal effect on the wind flow and pollutant dispersion within an urban street canyon by solving the conservation equations using large eddy simulations (LES). The resultant LES equations are computed by using finite difference method with maker and cell discretisation scheme. The effect of heat flux on pollutant dispersion in an urban street canyon with fixed aspect ratio 1 and a cross-wind attack is investigated under four different heating configurations (windward heating, leeward heating, ground heating, and walls and ground heating). For each heating configuration, the Reynolds number is varied from 400 to 3,000 and the Grashof number is varied from 80,000 to 800,000. The retention value (ratio of pollutant remains inside canyon to total pollutant emitted) is used to compare the effect of heating on pollutant dispersion under each heating configuration with the case of no heating.

Numerical results show that both the wind flow pattern and the pollutant dispersion pattern depend not only on the canyon aspect ratio and inflow wind speed, but also on the strength of heating and the heating configuration. There is very minute change in the wind flow and pollutant dispersion pattern for the case of leeward, ground and walls and ground heating. However for windward heating, a main vortex rotating in the clockwise direction inside the canyon is first weakened by the buoyancy effect near the windward wall, the pollutant accumulated near the leeward wall is therefore decreased. As the strength of heating is increased gradually, a second vortex rotating in the anti-clockwise is formed near the windward wall. This causes the pollutant to start to accumulate near the windward wall. A further increase in heating cause the formation of a third vortex clockwise-rotating above the second one, the pollutant accumulated near the windward wall is therefore increased, leading to increase in retention value. It is thus shown that urban heat or solar radiation can play a significant part in pollutant dispersion within an urban street canyon

References

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