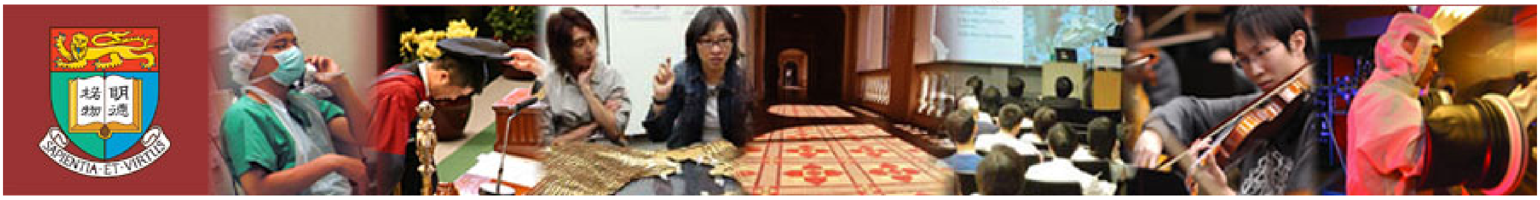

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Citation	The 2011 General Assembly of the European Geosciences Union (EGU), Vienna, Austria, 3-8 April 2011. In Geophysical Research Abstracts, 2011, v. 13, EGU2011-2016
Issued Date	2011
URL	http://hdl.handle.net/10722/140369
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Geophysical Research Abstracts
Vol. 13, EGU2011-2016, 2011
EGU General Assembly 2011

Pollutant Removal, Dispersion and Entrainment over Two-Dimensional Idealized Street Canyons: an LES Approach

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The pollutant transport over flat terrain is well understood. However, its mechanism and plume dispersion over urban areas remain as open questions. This study is therefore conceived to examine how urban morphology modifies the pollutant removal, dispersion, and entrainment over urban areas. An idealized computational domain, which consists of 12 identical street canyons of unity aspect ratio (AR), is employed. The large-eddy simulation (LES) is used to resolve the turbulent flows and pollutant transport in the urban boundary layer (UBL). An area source of uniform pollutant concentration is applied on the ground of the first street canyon.

The LES shows that inside the first street canyon, where pollutant is prescribed, the ground-level pollutants are carried to roof level by the re-circulating flows. In the other canyons, the pollutant distributions are rather uniform. The mean component of vertical pollutant flux along the roof level shows that the mean wind carries the pollutant away and back into the canyons simultaneously result in almost zero net pollutant removal effect. This implies the mean wind does not contribute much for pollutant removal. Different from the mean component, the fluctuating component has a large removal effect for the first canyon, but has very small effect on other canyons, demystifies that pollutant removal is mainly governed by atmospheric turbulence only when source is present. Right above the roof level, narrow high-speed air masses in the streamwise flows and intensive downdrafts are found in the shear layer. Differing from the flows over a smooth surface, the maximum turbulence intensities peak near the top of the building roughness that provides the turbulent for pollutant removal. Atmospheric flows slow down rapidly in the wake behind leeward building, suggesting the momentum entrainment into the street canyons. The decelerating streamwise flows in turn lead to upward flows that carry pollutants away from the street canyons, illustrating the basic pollutant removal mechanism in the skimming flow regime.

In the UBL, the pollutant disperses rapidly over the buildings exhibiting approximately a Gaussian-plume form. The vertical pollutant profiles achieve a self similarity behavior as Gaussian-plume in the downstream region. Discrepancy has been found when comparing the vertical pollutant distributions with others ARs, which implying AR is an important factor that affecting the plume dispersion in the UBL. Future work will focus on examining the pollutant profiles of different ARs in order to establish a general rule for the relationship between plume profiles and street canyon AR.