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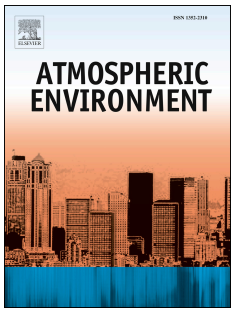

An assessment indicator for air ventilation and pollutant dispersion potential in an urban canopy with complex natural terrain and significant wind variations

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An assessment indicator for air ventilation and pollutant dispersion potential in an urban canopy with complex natural terrain and significant wind variations

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Abstract

In an urban planning context, an assessment indicator for evaluating a city's dispersion potential is beneficial, especially if the city has a complex natural terrain and significant wind variations. A study was conducted to implement an urban canopy drag indicator, taking site wind variation into account by involving both wind speed and direction in the calculations. Hong Kong (HK) was taken as an example due to its complicated natural topography and wind characteristics. A spatial distribution of an urban canopy drag over HK was determined based on wind data from 2004. The urban canopy drag values in three highly urbanized areas in HK, including Kowloon West, Kowloon East and Hong Kong Island North, were obtained and are discussed in detail. A fluid particle tracking program was developed and applied to identify the major wind paths in Kowloon West, with an area of approximately 5.5 × 6 km as an example. We analyze the diurnal variation in the dispersion times and the major wind paths in the region during both summer and winter. Our results estimated that the horizontal dispersion times of Kowloon West during both winter and summer were approximately 20 minutes. By combining the wind paths from both seasons, we identified several major wind paths and critical ventilation areas in Kowloon West. This paper demonstrates the potential use of an urban canopy drag indicator for assessing air ventilation and pollutant dispersion in a city planning context.

1. Introduction

Air pollution is a common problem in urban environments, particularly in cities with a high building density such as Hong Kong (HK). In addition to emission reduction, sufficient pollutant dispersion potential driven by air ventilation is critical for ensuring good air quality in a city. Because air ventilation is significantly affected by building morphology (Edussuriya et al., 2011), the effect of building morphology must be evaluated to tackle the problem of air pollution in urban areas.

The influences of building morphology on air ventilation and air quality in urban canopies have been extensively studied using computational fluid dynamics (CFD) (Hanna et al., 2006, Tseng et al., 2006, Patnaik et al., 2007, Neofytou et al., 2008, Baik et al., 2009, Pontiggia et al., 2010; Pontiggia et al., 2011; Xie and Castro, 2009, Xie, 2011 ; Liu et al., 2011) and wind tunnels (Kanda et al., 2011; Williams and

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