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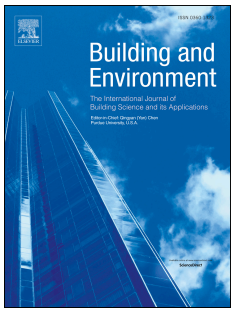

A simplified benchmark of ultrafine particle dispersion in idealized urban street canyons: a wind tunnel study

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A SIMPLIFIED BENCHMARK OF ULTRAFINE PARTICLE DISPERSION IN IDEALIZED URBAN STREET CANYONS: A WIND TUNNEL STUDY

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Equation Chapter 1 Section 1

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Abstract

The paper proposes a benchmark for computational fluid-dynamic models of ultrafine particle (particles' diameter lower than 100 nm) dispersion in urban street canyons. In particular, an on-scale symmetric street canyon was designed and settled in a wind tunnel considering a perpendicular wind condition. An experimental campaign was carried out to: i) investigate the fluid-dynamic conditions inside the canyon through a Particle Image Velocimetry (PIV), ii) evaluate the uncertainty budget of the PIV measurements, iii) design proper particle injection and sampling systems in the street canyon not influencing the fluid-dynamic conditions of the canyon itself; iv) provide particle number concentration profiles at different sections of the canyon (at different heights on both the canyon facades and at a background level) through ultrafine particle generation (Submicrometer Aerosol Generator 3940, TSI Inc.) and measuring devices (CPC 3775 and SMPS 3936, TSI Inc.).

The study can be considered the very first attempt to set a benchmark for ultrafine particle dispersion in street canyons through wind tunnel systems.

Keywords:

Street canyon, Ultrafine particles, Particle Image Velocimetry (PIV), Wind Tunnel, Pollutant dispersion in urban areas, CFD benchmark.

1. Introduction

The specialized cancer agency of the World Health Organization, the International Agency for Research on Cancer (IARC), recently classified outdoor air pollution as carcinogenic to humans [1]. In particular, for the first time, particulate matter (PM), a major component of outdoor air pollution, was "evaluated separately and classified as carcinogenic to humans" (Group 1, Beelen, Raaschou-Nielsen [2]) since an increasing risk of lung cancer with increasing levels of exposure to PM and air pollution was found whatsoever the PM chemical composition. Moreover, scientific evidences also allowed to recognize the PM as responsible of cardiovascular death due to long-term exposures [3, 4].