NVESTIGATION OF TURBULENCE AND DISPERSION IN URBAN ENVIRONMENT: LABORATORY EXPERIMENTS, FIELD MEASUREMENTS AND NUMERICAL SIMULATIONS

Abstract

The study of turbulence and dispersion phenomena in urban environment is a topic of primary importance as the rapid growth of the population living in large cities has led to the increase of air pollution in urban areas, causing degradation of environmental quality and human comfort. In order to provide an analysis as detailed and complete as possible, three typical approaches have been considered: laboratory experiments, in situ measurement campaigns and numerical simulations.

Laboratory experiments were conducted by reproducing a neutral stratified boundary layer in a close loop water-channel, considering two and three-dimensional canopies with different geometries. Attention has been paid to the analysis of turbulence and to the vertical profiles of the Eulerian and Lagrangian time scales of the turbulence. Dispersion from point and linear sources was investigated in order to reproduce emission from chimneys and traffic, emitting a passive, non-buoyant tracer at a constant rate. Laboratory experiments were also used to estimate a vertical profile of the turbulent Schmidt number.

Seasonal field campaigns were carried out in the frame of the VIEPI (Integrated Evaluation of Indoor Particulate Exposure) project in the Department of Physics in order to evaluate the infiltration factors of particulate matter in indoor environment. The so-collected data were also used for the validation of numerical dispersion models in indoor environments.

Computational Fluid Dynamics were used to directly simulate realistic building arrangements and complex configurations. First of all, a mesoscale characterization has been carried out using WRF model. Secondly, Ansys FLUENT model was used for the microscale characterization of both outdoor and indoor environments to assess fluid-dynamic conditions and the consequent natural ventilation and infiltration/exfiltration phenomena.