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A tracer experiment to study near-source dispersion of heavy particles within a vegetated urban canopy layer

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Within the urban canopy layer, concentration fields of particulate matter exhibit remarkable micro-scale variations - especially near emission sources. For urban air quality and emergency response applications it is therefore important to properly predict airflow at scales of blocks and buildings. However, to date most experimental and numerical studies on airflow and dispersion of gaseous air pollutants and particulates in cities have focussed on street canyon or roof-level releases within dense urban areas that lack significant vegetation and generally exhibit a skimming flow regime.

Here, we report on a series of to-date unique tracer release experiments to study the role of urban form and vegetation on turbulent dispersion in a medium density urban canopy layer where trees are taller than buildings. The study area, located in Vancouver, Canada is characterised by detached buildings (h = 5.3 m, 12.8 Bldg./ ha) and significant vegetation (19.2 trees / ha, h = 8.4 m for deciduous and h = 11.1 m for coniferous trees). In the past, this area has been the focus of several numerical and experimental studies into urban meteorology and airflow in cities.

During a total of 12 tracer release experiments, fluorescing microspheres ($\sim$30 μm) were released from near ground point sources under specific flow conditions. In each release, a continuous source with ultrasonic atomizer nozzles was run for 20 minutes. The emission source and samplers were arranged in three different configurations: upwind of two 4-way intersections with different heights of street trees, and mid-block along a street canyon with lines of tall trees on both sides of the street. Particles were collected at 50 locations at a height of 1.5 m (0.28 h) in distances between 20 to 200 m ($\sim$4 to 40 h) from the release point using rotating impaction traps.

Simultaneously, instantaneous wind fields were recorded using an array of ground-level 2D-sonic anemometers inside the canopy, with 3D-sonic anemometers above roof level using a mobile and a permanent mast (at 2.5 and 5.5 h). The observed plume distributions indicate a strong impact of local urban form and vegetation with channeling in the near source region and a high degree of sensitivity to above-roof wind direction. Initial comparisons to particle dispersion models with and without vegetation representation will quantify the relevance of vegetation on dispersion and deposition of particles.