Effects of crowd density on scalar dispersion in indoor spaces

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Indoor air quality is important as we spend approximately 93% of our time indoors. Recent studies have focused on the turbulent diffusivity of people walking in corridors[1] and characterising the diffusion coefficient of a mechanically-ventilated empty room[2]. In this study, we focus on the effects of crowd density on the turbulent scalar fluxes and diffusivity. Our end goal is to ground fast mathematical models that can predict scalar dispersion to empirical observations of flow phenomenon, enabling security or station managers make critical and timely decisions to deal with air pollution incidents.

Simultaneous particle-image velocimetry (PIV) and planar laser-induced fluorescence (PLIF) measurements of a 1:60 scaled room model was performed by immersing the model in UoS's flume to achieve an equivalent air change rate of ACPH=2.8. Rhodamine 6G dye was used as the scalar tracer and isokinetically released in the middle of the room. The concentration was measured by adopting a PLIF calibration procedure[3]. To replicate the mechanical turbulence of human activities, arrays of 8 mm diameter cylinders with area porosity of A=0.01 to 0.1 were systematically added to one side of the room and traversed at Re=2560 with a stepper motor.

Figure 1(a) shows the crowd motion reduces far-field mean concentrations particularly for the crowd-occupied region. This is attributed to improved turbulent mixing, with crowd motion observed to increase the flux magnitudes and also introducing downward flux near the source (Fig. 1(b)). We aim to discuss the mean concentrations, turbulent fluxes and diffusivity tensor for three different crowd densities.

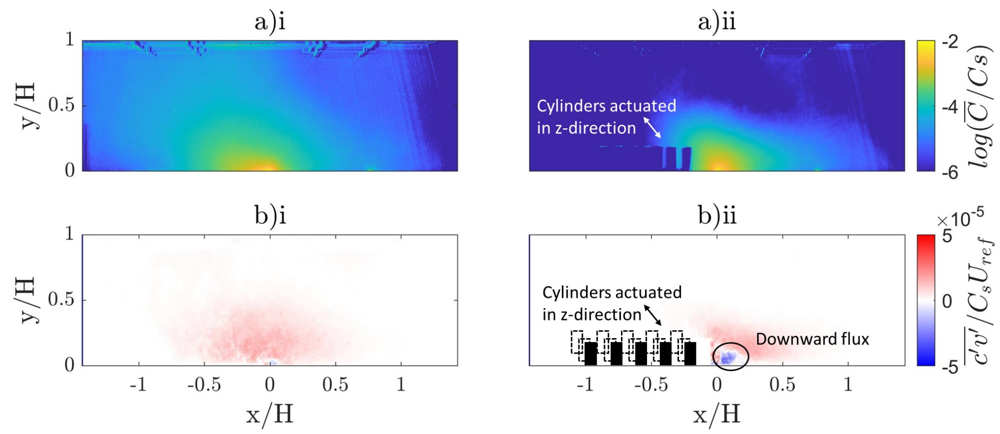

Figure 1: (a) Mean concentrations and (b) vertical turbulent scalar fluxes of the (i) baseline and (ii) crowded (A=0.1) rooms.

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[1] Mingotti et al., *J. Fluid Mech* **903**, A52 (2020).
[2] Foat et al., *Build. Environ.* **169**, 106591 (2020).
[3] Lim et al., *Exp. Fluids* **63**, 92 (2022).