**Data collection methods**

Taken from Gough (2017). Full-scale data also used in (King et al., 2017)

Bounding area 53,0,52,-1

Collected at Silsoe UK.

Data description

All 30 minute averaged data taken during the Refresh Cube Campaign (RCC) at Silsoe using the 6 m^3 test structure at the site and eight other 6 m^3 straw cubes undertaken as part of the PhD work of Gough (2017) and forms the full-scale experiments of the REFRESH project.

The data-set is split into two sections: an isolated cube and the array case with three different opening set-ups being undertaken for both array and isolated.

The array was in place October 2014 to April 2015, and the cube was isolated from May 2015 to July 2015.

Details of the experimental set-ups are available in publications.

The data contained within this document are 30 minute averaged and quality controlled using code previously used for the ACTUAL project.

The data set contains wind speeds, wind directions, internal and external temperatures, surface pressures, CO2 concentrations and ventilation rates calculated from the pressure difference methods. Internal and external measurements are included for the flow.

Velocity measurements

Seven 3-axis Gill R3-50 sonic anemometers, measuring three-component wind velocity and direction, were deployed: two within the cube itself and five outside. The two sonic anemometers closest to the instrumented cube and two internal sonic anemometers were mounted on masts, with the centre of the sonic anemometer at 3.5 m above ground level (in line with the opening centre). The Channel mast sonic anemometer was at 2.9 m (maximum height for the equipment) and logged at 20 Hz. All others were logged simultaneously at 10 Hz to a MOXA UC 7410 Plus fan-less compact computer.

Pressure measurements

The cube surface pressure was measured using pressure taps: 7 mm holes located centrally on 0.6 m2 steel panels, which were mounted flush onto the cube cladding. Pressure signals were transmitted pneumatically, using 6 mm internal diameter plastic tubes to transducers within the cube. The individual transducers meant that the pressure tap measurements were simultaneous at 10 Hz. The pressure differential sensors for pressure taps 1-16 were Honeywell 163PC01D75 differential pressure sensors with a range of -2.5 to 2.5 inches of H2O (~-498-498 Pa). Pressure taps 17-32 were Honeywell 163PC01D76 differential pressure sensors with a range of -5 to 5 inches of H2O (~-1245- 1245 Pa). All pressure sensors had a manufacturer stated response time of 1 ms.

30 external pressure taps and 2 internal pressure taps were used. The internal pressure measurements were located under the openings. The 30 external pressure taps used were split across the four faces, four on the roof, four in a horizontal array on the centre line across the North and South faces and nine on the front and back faces, with five of those in a vertical array down the centre and four in a horizontal array at half building height.

Temperature measurements

Temperature measurements inside the cube allowed determination of thermal stratification, and along with the external temperatures, the thermally-driven ventilation component. External temperature was measured on the Channel mast using a Vaisala WXT520 weather station (manufacturer’s stated error at an air temperature of 20 °C = ± 0.3 °C), which was positioned to minimise solar gains. Internal temperatures were measured at 24 points at 10 Hz using RS components K-type 1/0.2 mm diameter thermocouples (measurement range -75 °C to 250 °C). Sampling at 10 Hz allowed for the average to be taken of a large number of samples, leading to a reasonably accurate mean half-hourly value.

Eight thermocouples were horizontally strung between the windows at a height of 3 m. The other 16 were in four vertical profiles of four thermocouples, put at varying heights and limited in height to being below 4 m due to access limitations. The size of the thermocouple errors (0.45 % ± 2 °C, junction plus thermocouple) are unsuitable for measuring instantaneous fluctuations in temperature (Kaimal and Finnigan, 1993).

Tracer gas measurements

An open path LI-COR LI-7500 located on the channel mast was used to measure external CO2, which varied between 365 and 450 ppm (95 % between 371 and 403 ppm) over the entire experimental period. The LI-COR LI-7500 was located sufficiently far away from the cube to ensure that the CO2 from tracer gas releases did not have an effect.

Three synchronised Senseair K30 FR 2 Hz CO2 (hereafter K30) NDIR sensors measured internal CO2, enclosed in boxes to reduce moisture, but to still allow sufficient airflow. The sensors did not drift. The ‘East’ sensor (E) was positioned under the east opening (1 m from the wall, 2.75 m above the ground). The ‘Low’ sensor (L) was hung under the steel girder of the east wall, (1 m from the North-East corner of the cube, 0.3 m above the ground) to help understand infiltration effects on the ventilation rate. The ‘Middle’ sensor (M) was 3 m above the ground at the centre-point of the Northern wall (~ 0.5 m from the wall).

Nine inlet pipes were used to release the tracer evenly throughout the cube. A large desk fan (estimated effective range: 4 m horizontally, 2 m vertically) was used to improve mixing. Eight outlets were 3 m above floor level. One outlet was placed at floor level in the centre of the room and had a pipe length (outlet to regulator) of 2.2 m, whereas all others were 3.1 m. The CO2 was heated by the regulator (~ 10 °C) to prevent the outlet freezing.

Data preparation

Post processing of the data followed the methodology of (Barlow et al., 2014) and (Wood et al., 2010)

The sonic anemometers were inter-compared before and after the experiment. As no drift and minimal differences were observed, no inter-instrument corrections are made.

All thermocouples and the WXT were calibrated and corrected (on average < 0.5 °C) for instrument bias at the start and end of the experiment using an environmental chamber (Design Environmental Delta 190H) over a -20 °C to 50 °C range, accounting for hysteresis effects due to instrumental time response.

References

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