

Effects of blockage on dispersion in urban canyons

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Summary report

The full DAPPLE model was installed in the EnFlo wind tunnel for wind directions of -45 degrees (site SW) and -90 degrees (site S). A source was positioned in York Street at the location used in the 2003 field experiment. Initial tests showed that dispersion behaviour was insensitive to emission rate (2 to 4 l/min) and tunnel speed (1.5 to 2.5 m/s). Mean concentrations were measured at ground level along the centre-lines of the following streets: Gloucester Place, Upper Montagu Street (and Balcombe Street), Salisbury Place (and Bickenhall Street), Marylebone Road, Melcombe Street (and Dorset Square) and York Street; street names in parenthesis denote continuation of the associated street. See Fig 1 for the place names etc. and Fig 2 for the model layout.

For each wind direction, dispersion data were obtained in the base case (the standard model) and then a number of other cases in which individual streets were fully blocked (to roof level). Blockages were located at intersections and selected to make a significant change to the local flow patterns in areas directly affecting dispersion behaviour. See Fig 3 for the blockage locations. Three locations were used for the -90 degrees wind direction, separately at A, B and C, then all three combined; two locations were used for the -45 degrees wind direction, separately at A and D, then the two combined. Results are plotted as profiles of non-dimensional concentration (CUA/Q , with U the reference speed, and $A = H^2$) along the individual streets in Figures 4 and 5.

On the whole, the changes due to introducing the blockages are modest or negligible. For the -45 degrees wind direction, blockage at A (Upper Montagu Street) has some effect in Gloucester Place (near the intersection with York Street) and in York Street. For the -90 degrees wind direction, there is some irregular effect in all cases in Gloucester Place (near the intersection with York Street) and in Upper Montagu Street (but only when all three blockages are in place).

None of the perturbations imposed on the flow radically changed the dispersion behaviour. However, for the -90 degrees direction it is clear that a large fraction of the emission was carried above roof level downwind of the source street (York St), something confirmed by direct measurement of concentrations above roof level. This implies that a model would have to include downward transfer to represent this case correctly. It is perhaps unwise to draw too many other conclusions from this brief study, except to note that the issues raised need to be investigated in more detail.



Figure 1. Site-map



Figure 2. Full DAPPLE model.

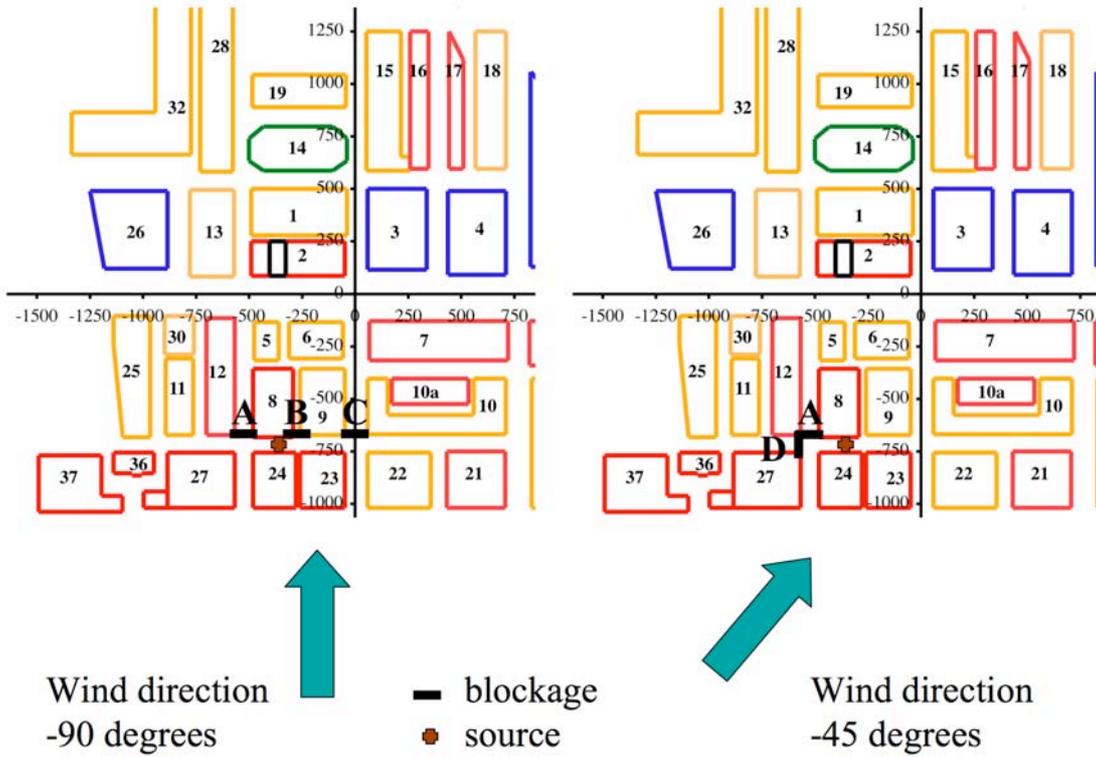


Figure 3. Source and blockage locations

Wind direction -45 degrees

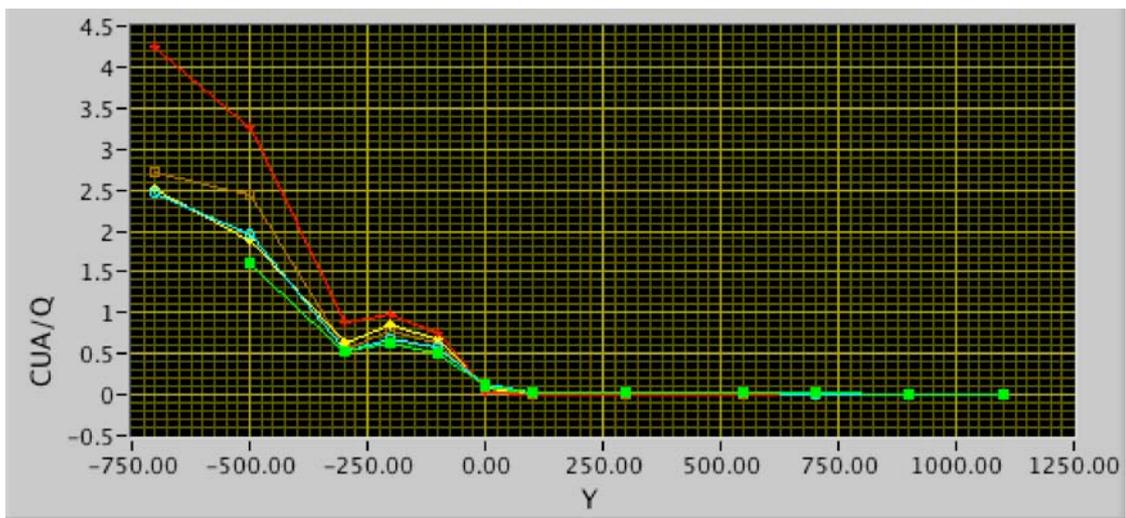


Figure 4a. Wind direction -45 degrees, Gloucester Place (green & blue, base; red, blockage at A; yellow, D; brown, A & D)

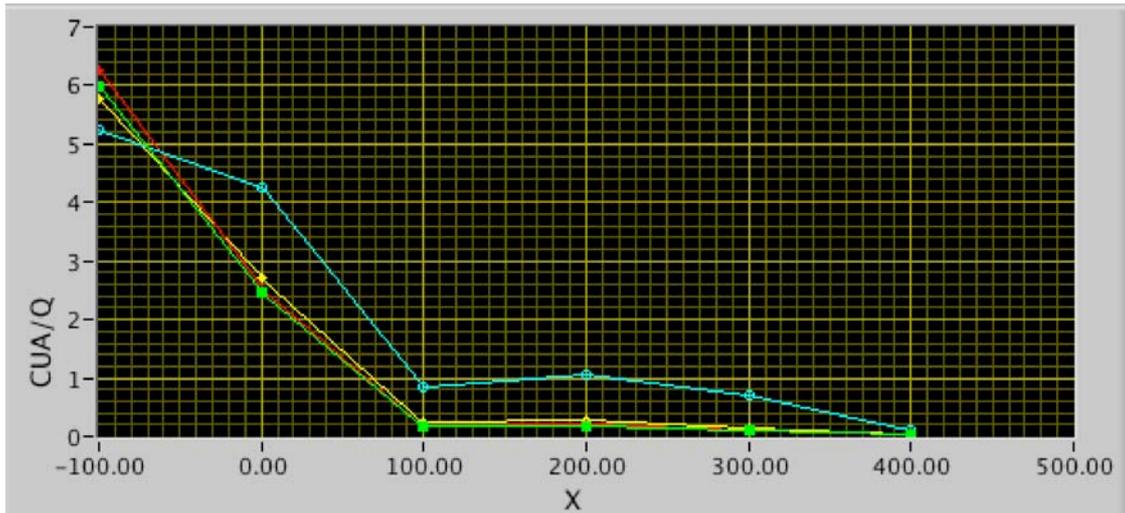


Figure 4b. Wind direction -45 degrees, York Street
(green, base; blue, blockage at A; red, D; yellow, A & D)

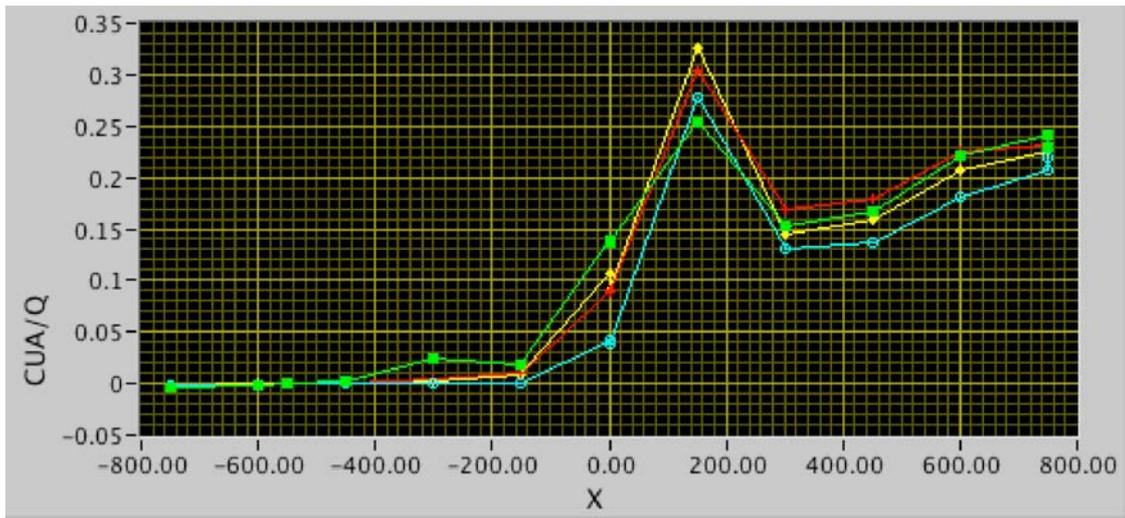


Figure 4c. Wind direction -45 degrees, Marylebone Road
(green, base; blue, blockage at A; red, D; yellow, A & D)

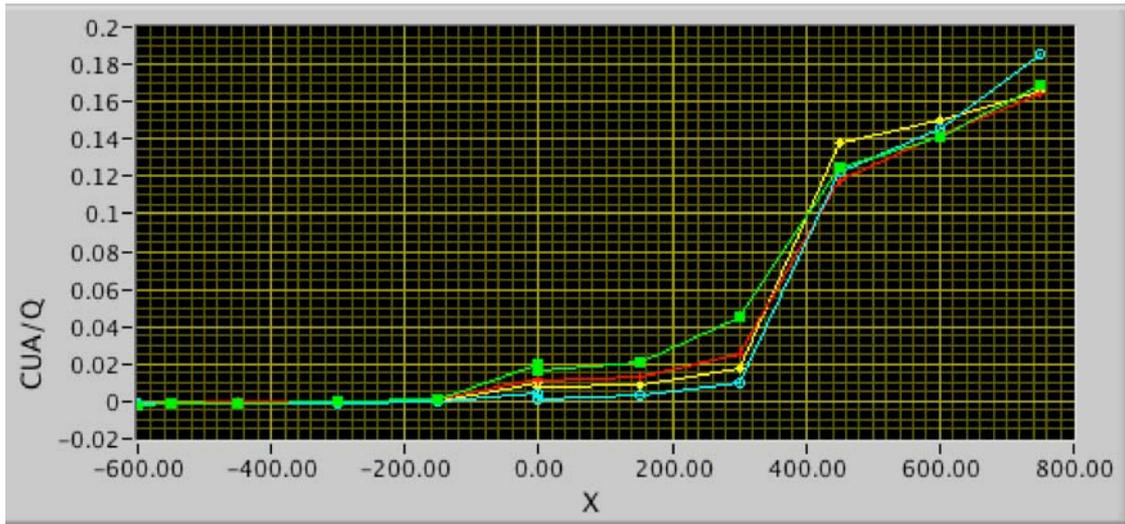


Figure 4d. Wind direction -45 degrees, Melcombe Street
(green, base; blue, blockage at A; red, D; yellow, A & D)

Wind direction -90 degrees

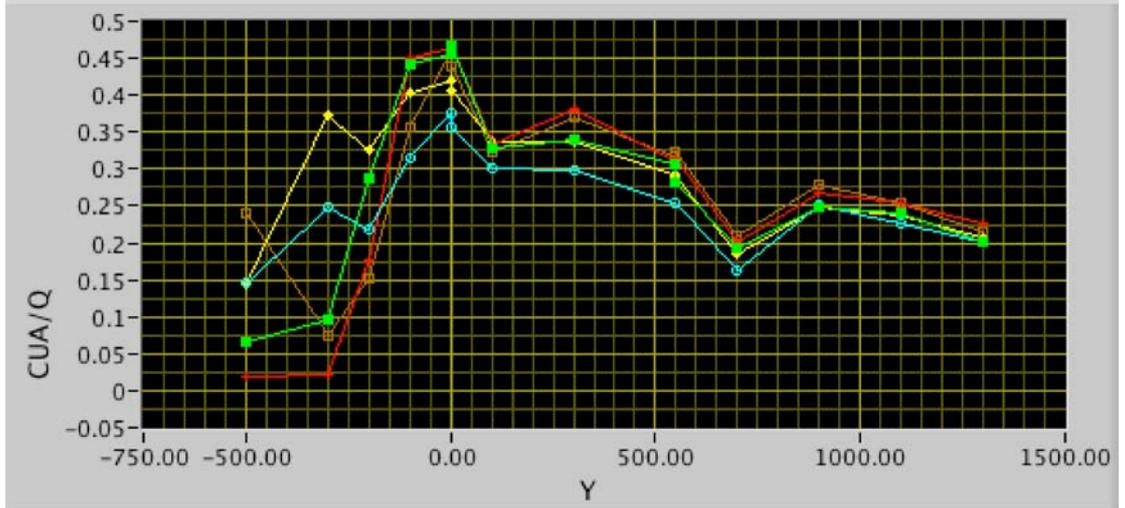


Figure 5a. Wind direction -90 degrees, Gloucester Place
(red, base; brown, blockage at A; green, B; yellow, C; blue, A, B & C)

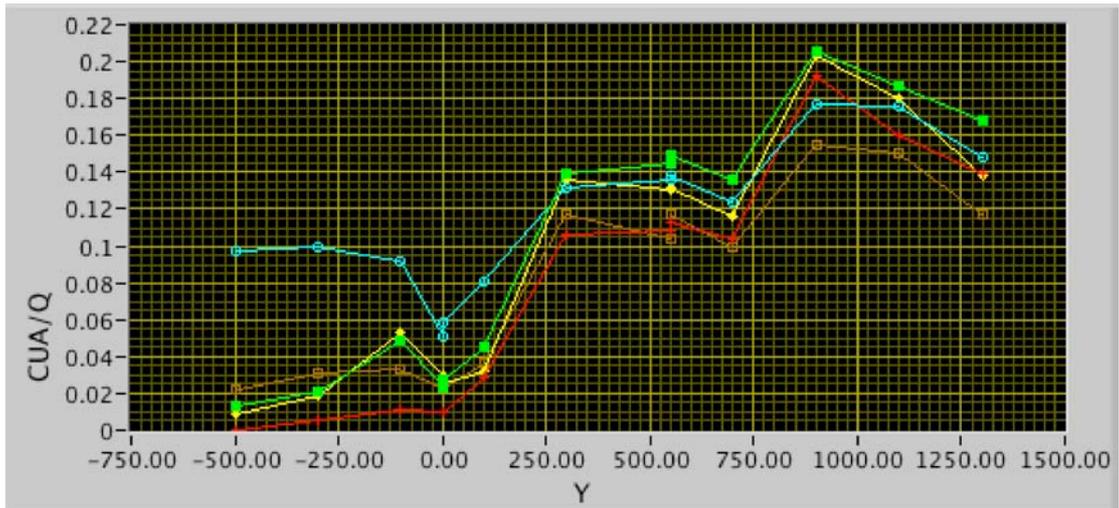


Figure 5b. Wind direction -90 degrees, Upper Montagu Street
 (red, base; brown, blockage at A; green, B; yellow, C; blue, A, B & C)

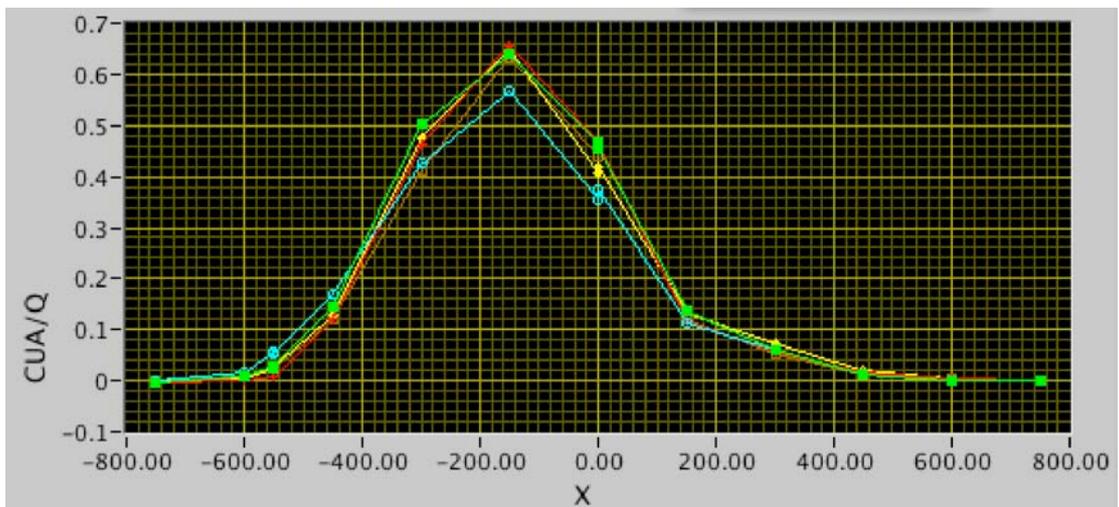


Figure 5c. Wind direction -90 degrees, Marylebone Road
 (red, base; brown, blockage at A; green, B; yellow, C; blue, A, B & C)

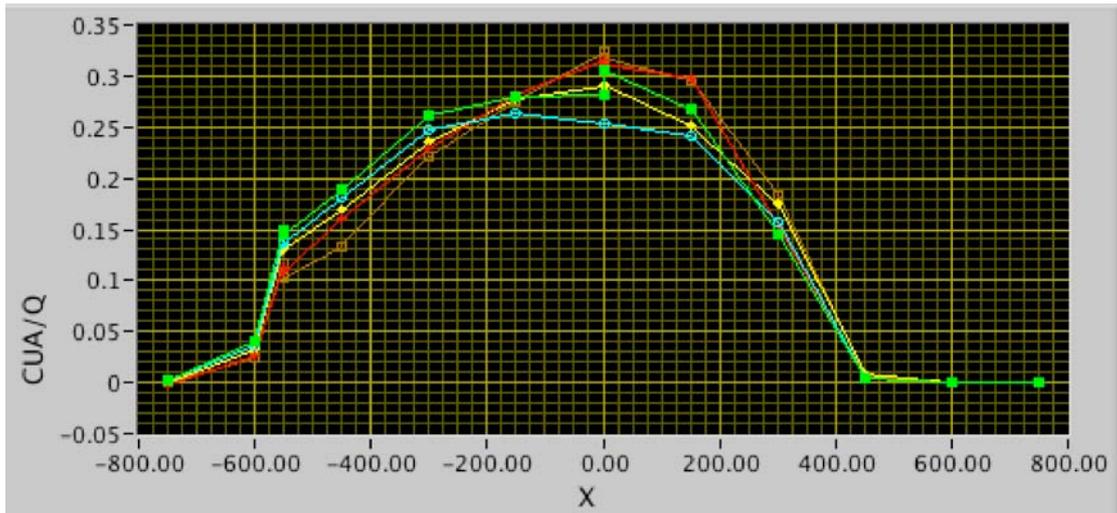


Figure 5d. Wind direction -90 degrees, Melcombe Street
(red, base; brown, blockage at A; green, B; yellow, C; blue, A, B & C)