FUTURE

Fluid dynamics of urban tall-building clusters for resilient built environments

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- Plan
- Communications

University of Surrey
University of Reading
University of Southampton
EPSRC Engineering and Physical Sciences Research Council

587 tall buildings of 20 storeys or more →
proposed, approved or under construction in London.

Average height → 29 storeys (more than 100 m).

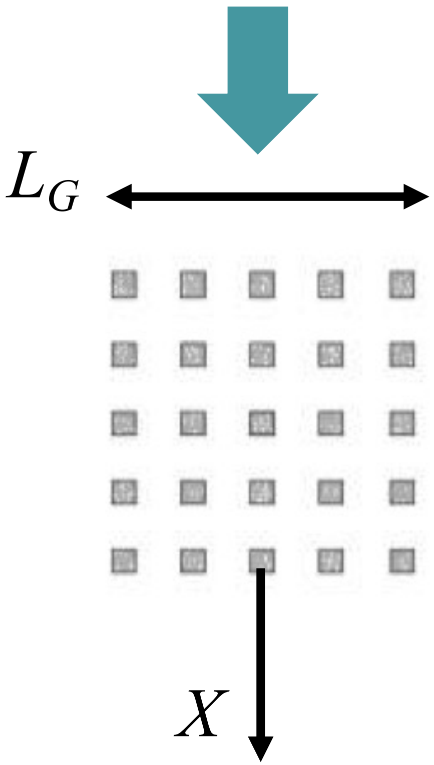
Vast majority located within TfL Travel Zones 1 and 2.

NLA, New London Architecture, 2020

Some background

Three presentations follow that describe prior work at Reading (field), Southampton (numerical) and Surrey (wind tunnel).

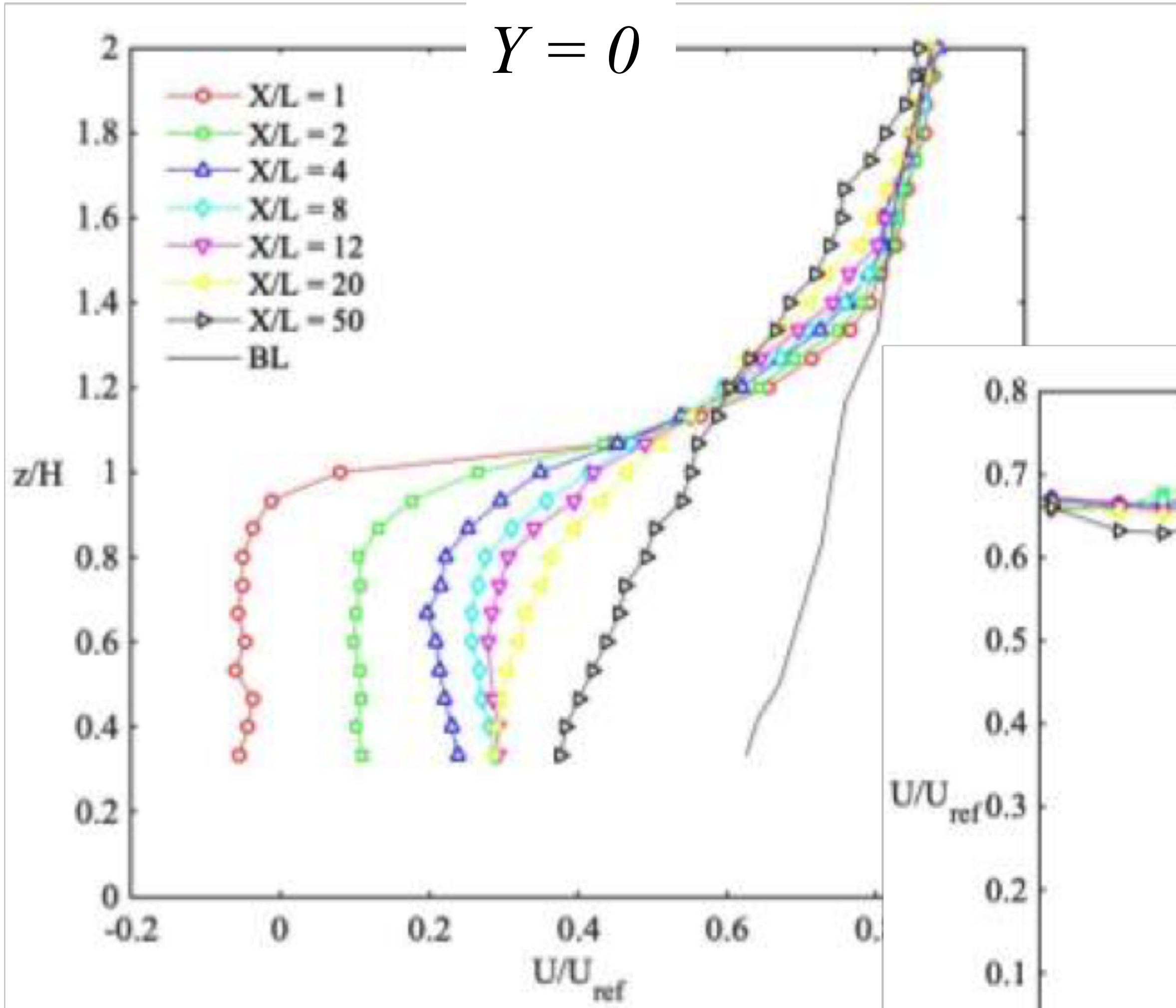
Example (from wind tunnel work) to illustrate the issues:



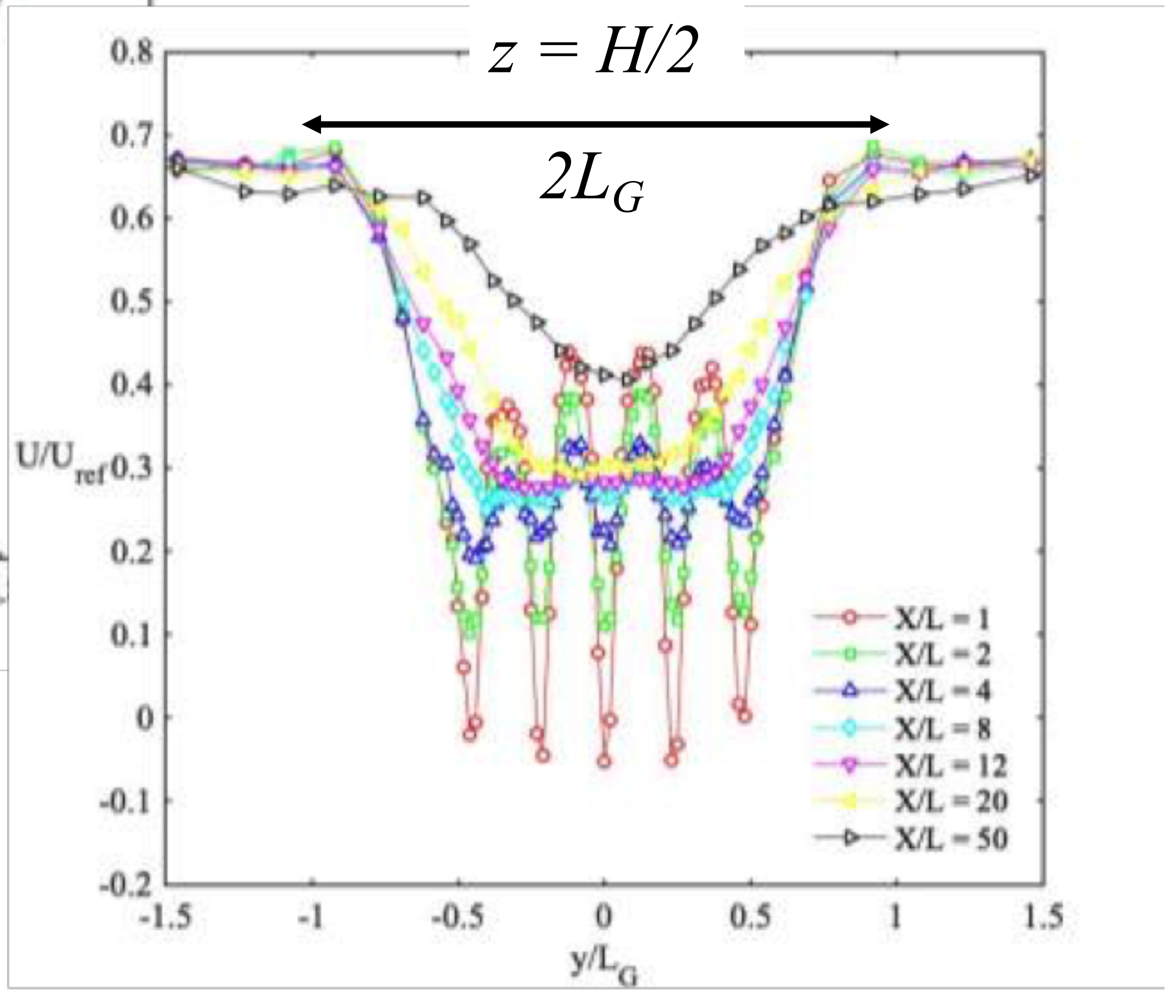
5 x 5 array
$\lambda_p = 11\%$

Individual block shape
$(L, L, H) \rightarrow 1 \times 1 \times 6$
$H/\delta \sim 0.24$
$L_G/H = 2.17$

Wake velocity profiles

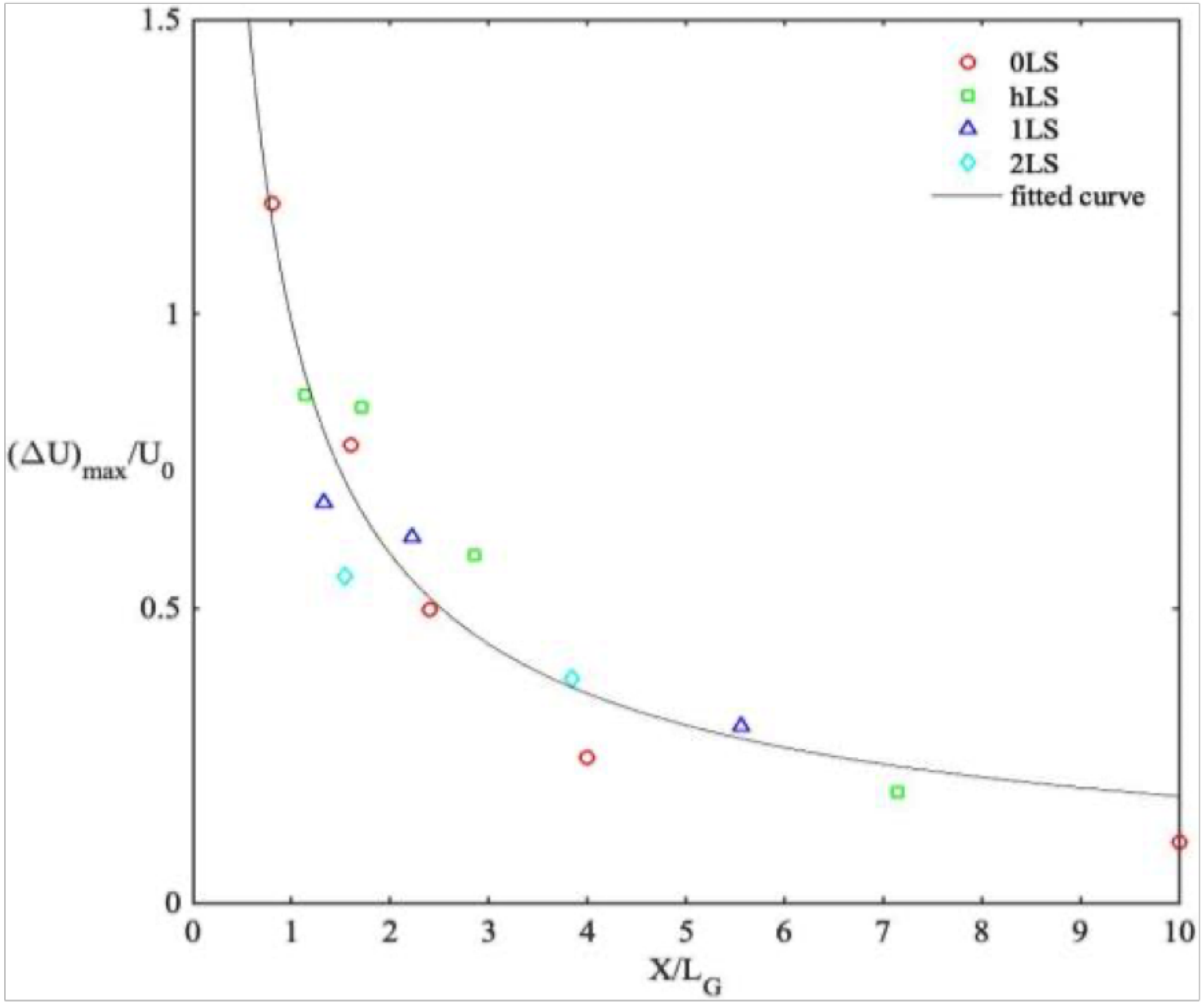


X/L = 50
→ X/H = 8.3



H = 100 m
→ X = 0.83 km
→ $2L_G = 0.43$ km

Velocity deficit decay



15% at $10L_G$

For case illustrated

$10L_G \sim 22H$
$= 2.2$ km

for $H = 100$m

Wake structure behind small groups of tall buildings
Siu Hin Choi
University of Surrey, 2020

Implications

Boundary layer structure strongly perturbed over a large region downwind of a cluster of tall buildings.

Flow conditions become highly heterogenous.

Serious consequences at all scales from the micro to the city.

Aims of the FUTURE project

… to develop a set of tools and guidelines that can be readily used
… to estimate the spatial extent and magnitude of the effects of clusters of tall buildings on the wind field, temperature field, and dispersion conditions.

These impacts persist over distances that are many times greater than the height of the buildings.

→ from the micro to the city scale

Objectives

1. Understand the magnitude and spatial scale of the effects of a cluster of tall buildings; their impact on wind, dispersion, and temperature fields.
2. Identify main parameters that govern the extent and character of the near and far fields within the wake.
3. Assess what can be said generically (i.e. modelled) and what remains site-specific.
4. Develop fast analytical models that describe the behaviour of wakes downstream of groups of tall buildings.
5. Collate this information within a set of guidelines and tools publicly available to professionals, regulators, and policymakers.

Strategy - WP1 & 2

WP1: Idealised clusters of tall buildings in neutral atmospheric conditions (lead: ZX, Southampton)

LES and wind tunnel
Aligned arrays with idealised geometry, based on Barbican Centre and Gherkin Cluster (1x1, 3x3, 5x5, 7x7, 9x9).

WP2: Idealised clusters of tall buildings in non-neutral atmospheric conditions (lead: AR, Surrey)

LES and wind tunnel
Wake development and interactions dependence on wind direction and surface morphology conditions (idealised building height/shapes of WP1 to more realistic geometries).

Strategy - WP3 & 4

WP3: Realistic clusters of TBs in all atmospheric conditions (lead: JB, Reading).

LES, full-scale and wind tunnel
Characterise wake flows around tall building clusters in central London. Compare/contrast wake characteristics with those of idealised building geometries in a range of atmospheric stabilities.

WP4: Model parametrisation and application guidelines (lead: OC, Reading).

LES, full-scale, wind tunnel work and modelling
Formulate and evaluate new Urban Canopy Parameterisation that includes tall buildings and non-neutral meteorology.

Year 1 plan

Deliverable	Q1	Q2	Q3	Q4	Yr 2→
1.1 Cluster size and packing density study					
1.2 LES validation					
1.3 Height variability and δ/h study					
2.1 Effect of stratification					
2.2 Effects of morphology and wind direction					
2.3 LES validation in stable/unstable conditions					
3.1 Field work planning					
3.2 Results of field measurements					
3.3 Comparison with LES and wind tunnel work					
4.1 Model formulation					
4.2 Model calibration (cf. LES and wind tunnel)					
4.3 Evaluation with field results					
4.4 Develop guidelines					
4.5 Final report					

Communications

Team meetings	quarterly
Workshops	Year 1; project end
Partner meetings (RWDI, Dstl, City of London, Met Office, Cambridge)	
	six-monthly (to be agreed)
Networks	UFM, LEVN, NWTF, NCAS
Collaboration	MAGIC
Website	www.surrey.ac.uk/research-projects/future

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