

MAGIC

Envisaging a world with greener cities

Partners Meeting

Research Update:
Wind Tunnel Experiments

20 September 2018
Downing College

Aim

MAGIC

Envisaging a world with greener cities

Reduced scale physical modelling of London South Bank

- Develop understanding of urban flow phenomena specific to LSB site
- Provide measurements of
 - wind and turbulence
 - pollutant concentration
 - surface pressure
- Obtain good spatial and temporal coverage



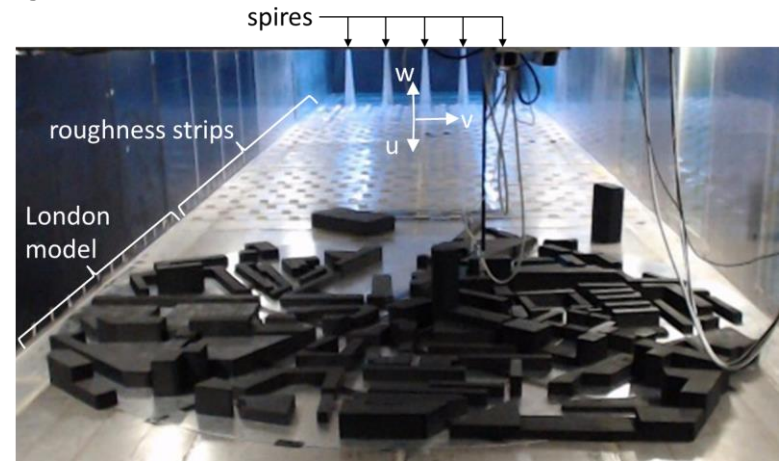
Outline

MAGIC

Envisaging a world with greener cities

1:200 scale model of London South Bank

- External wind
- Dispersion of ground-level pollutant emissions
- Wind-driven natural ventilation
- Influence of tall buildings



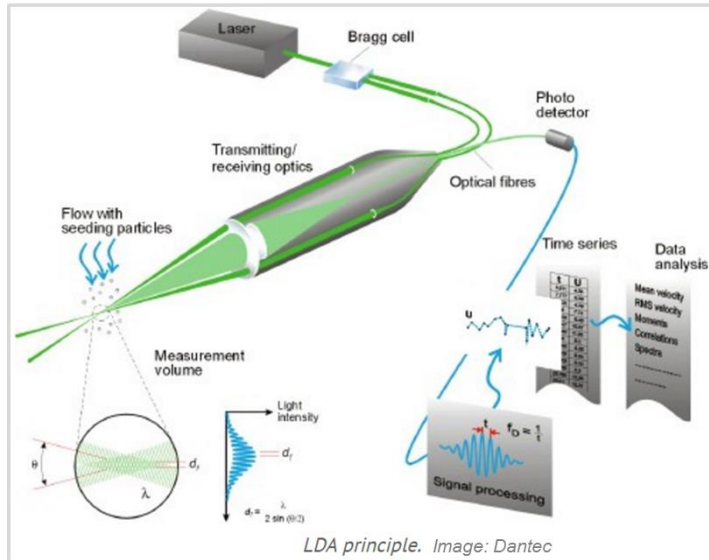
Techniques

MAGIC

Envisaging a world with greener cities

Wind velocity measurement

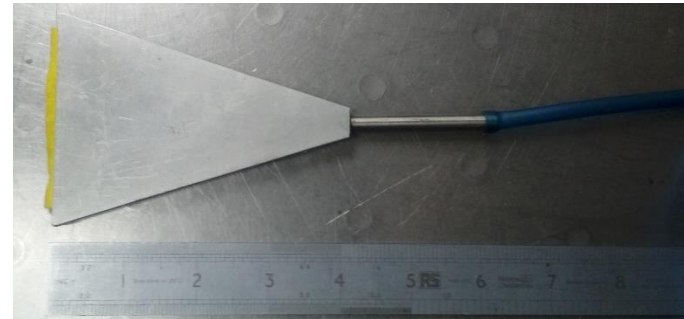
Pointwise sampling of u , v and w



Pollutant gas simulation

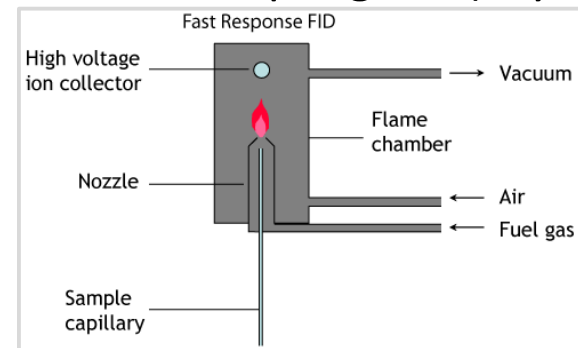
Propane-air release ($\approx 1\%$ vol. C_3H_8)

- Continuous diffuse release



Tracer concentration measurement

- Pointwise sampling of $c(x, y, z, t)$



Comparison with Fluidity: Wind field



Laetitia Mottet

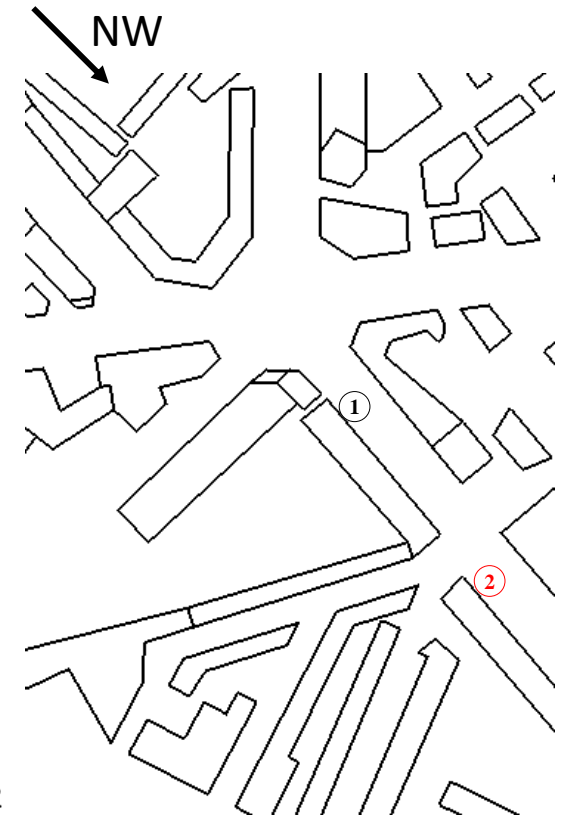
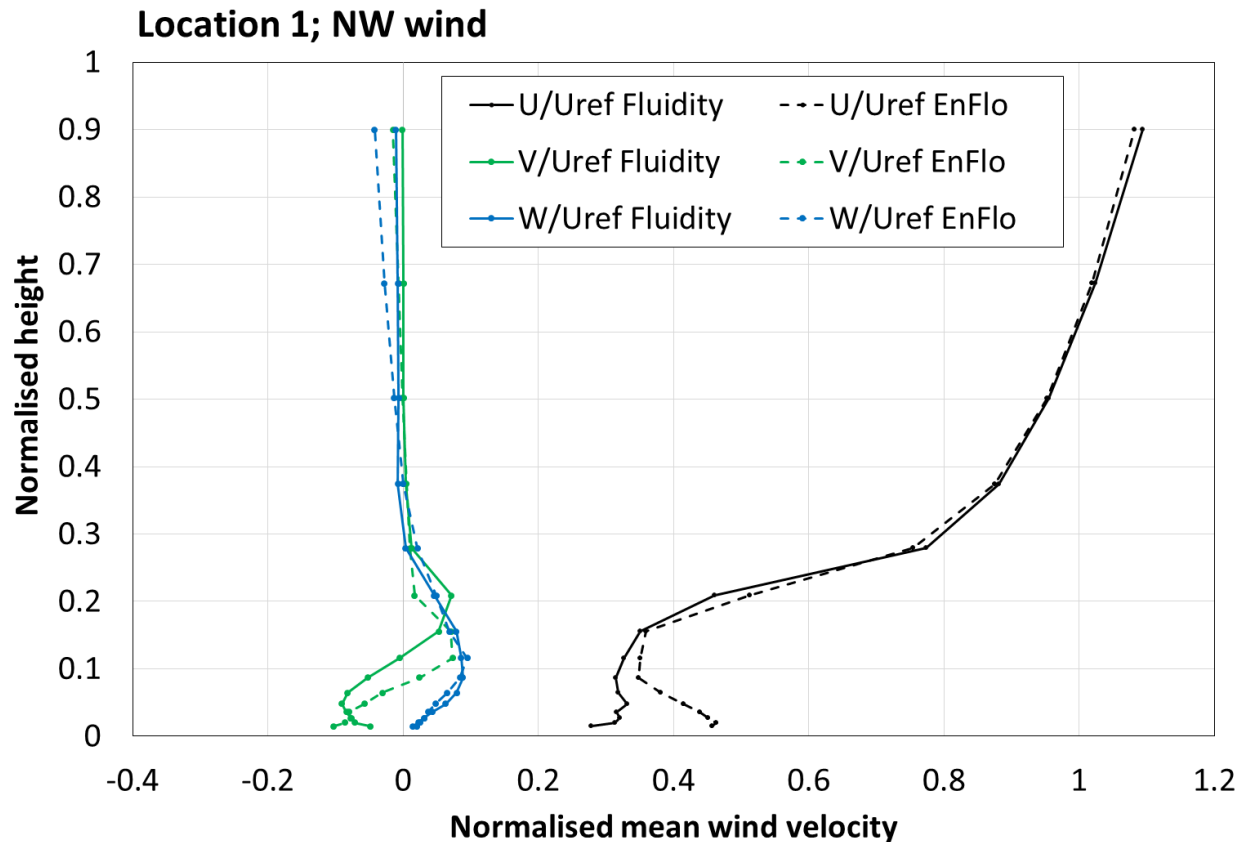


Dunhui Xiao

MAGIC

Envisaging a world with greener cities

Xiao *et al.* (Building and Environment, in review)



Comparison with Fluidity: Wind field



Laetitia Mottet



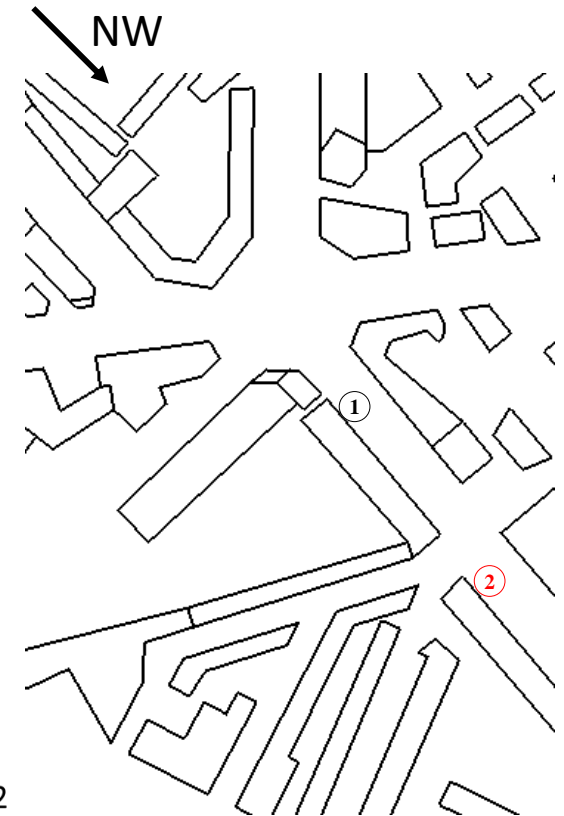
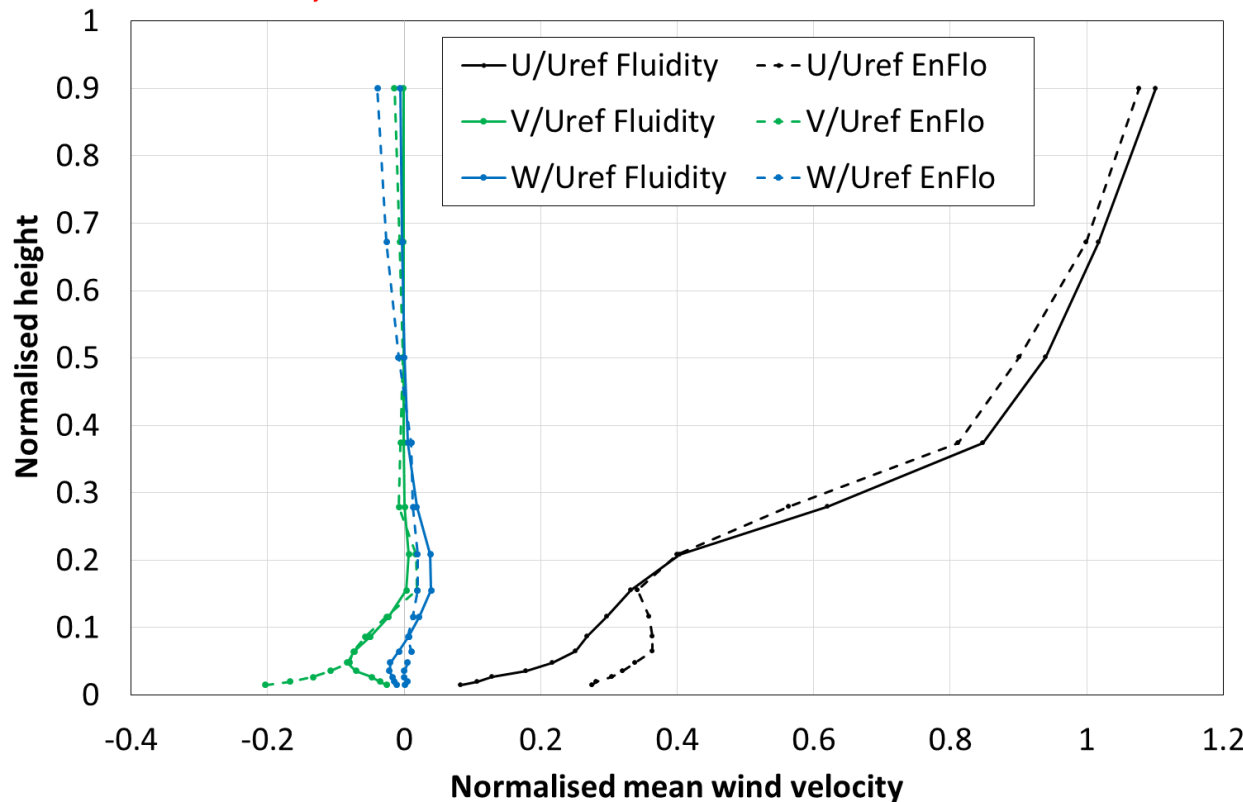
Dunhui Xiao

MAGIC

Envisaging a world with greener cities

Xiao *et al.* (Building and Environment, in review)

Location 2; NW wind



Comparison with Fluidity: Wind field



Laetitia Mottet

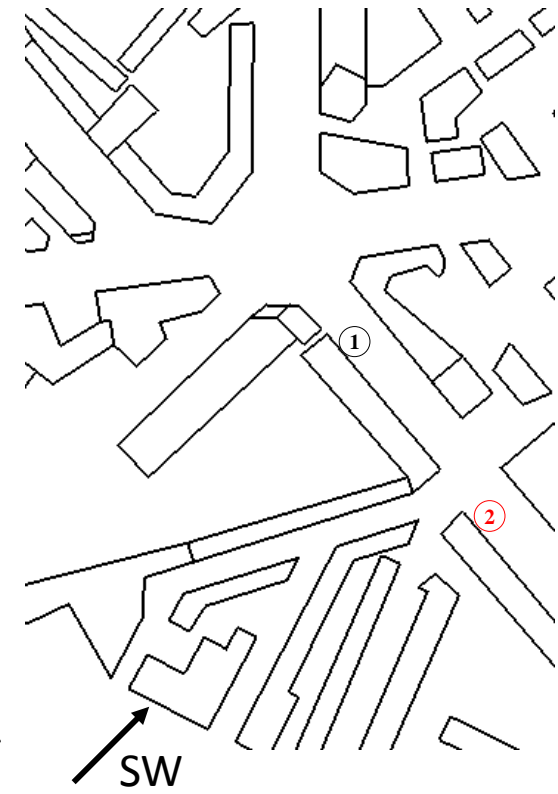
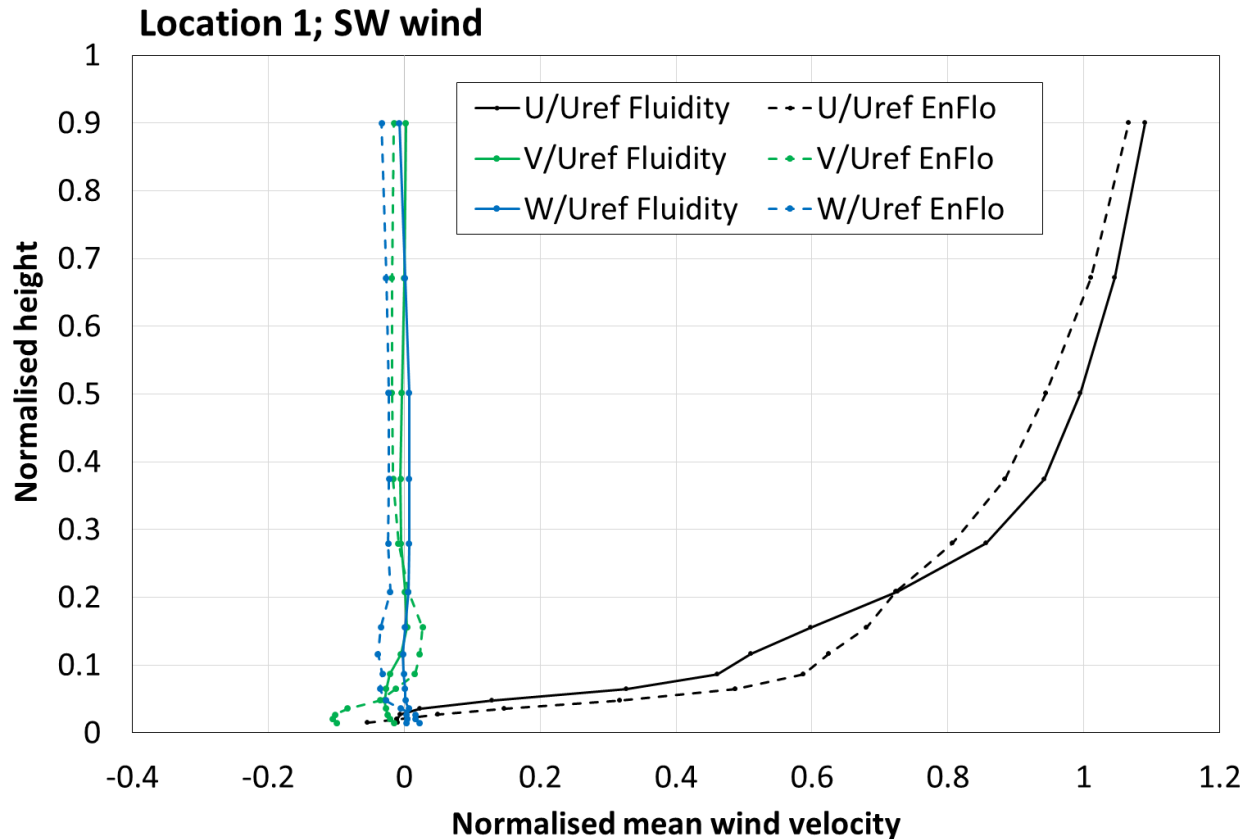


Dunhui Xiao

MAGIC

Envisaging a world with greener cities

Xiao *et al.* (Building and Environment, in review)



Comparison with Fluidity: Wind field



Laetitia Mottet



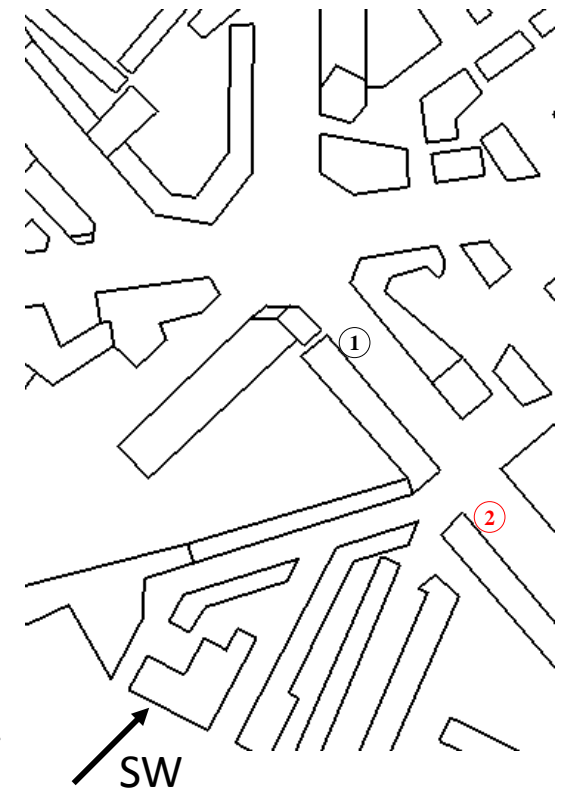
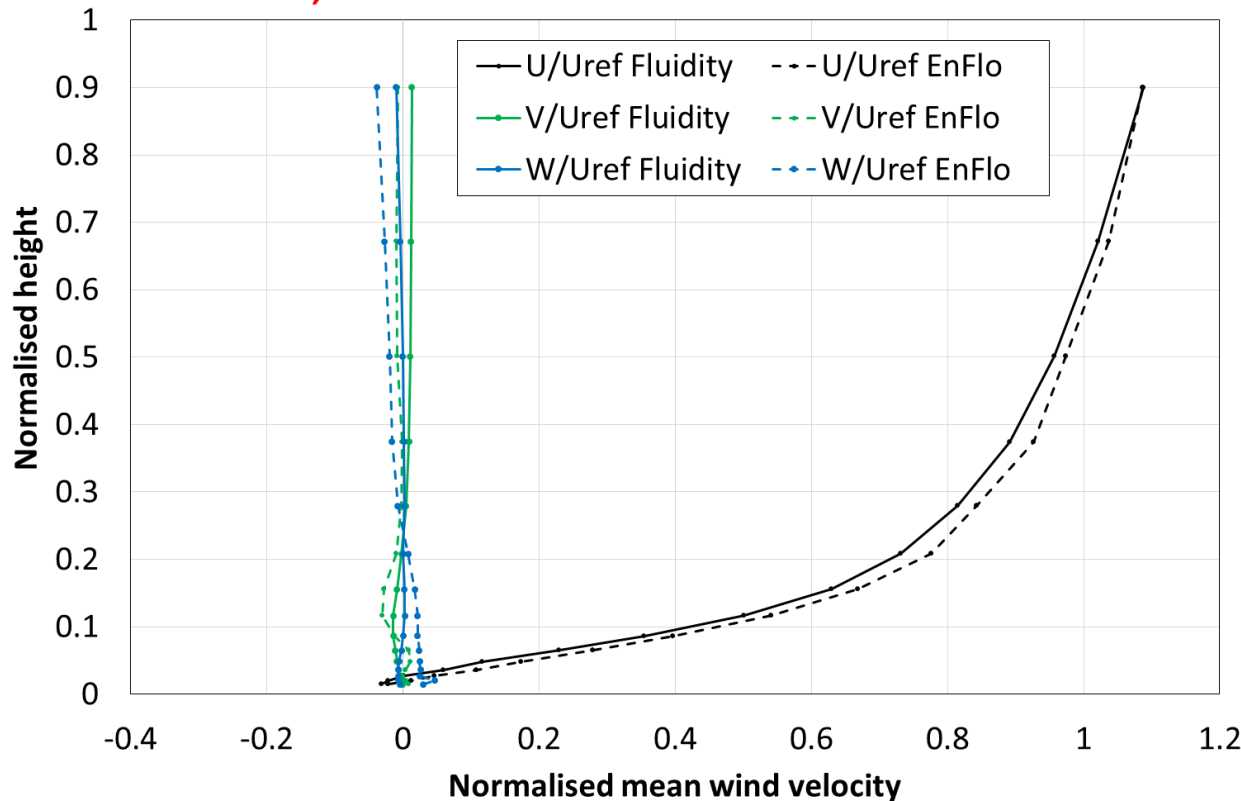
Dunhui Xiao

MAGIC

Envisaging a world with greener cities

Xiao *et al.* (Building and Environment, in review)

Location 2; SW wind



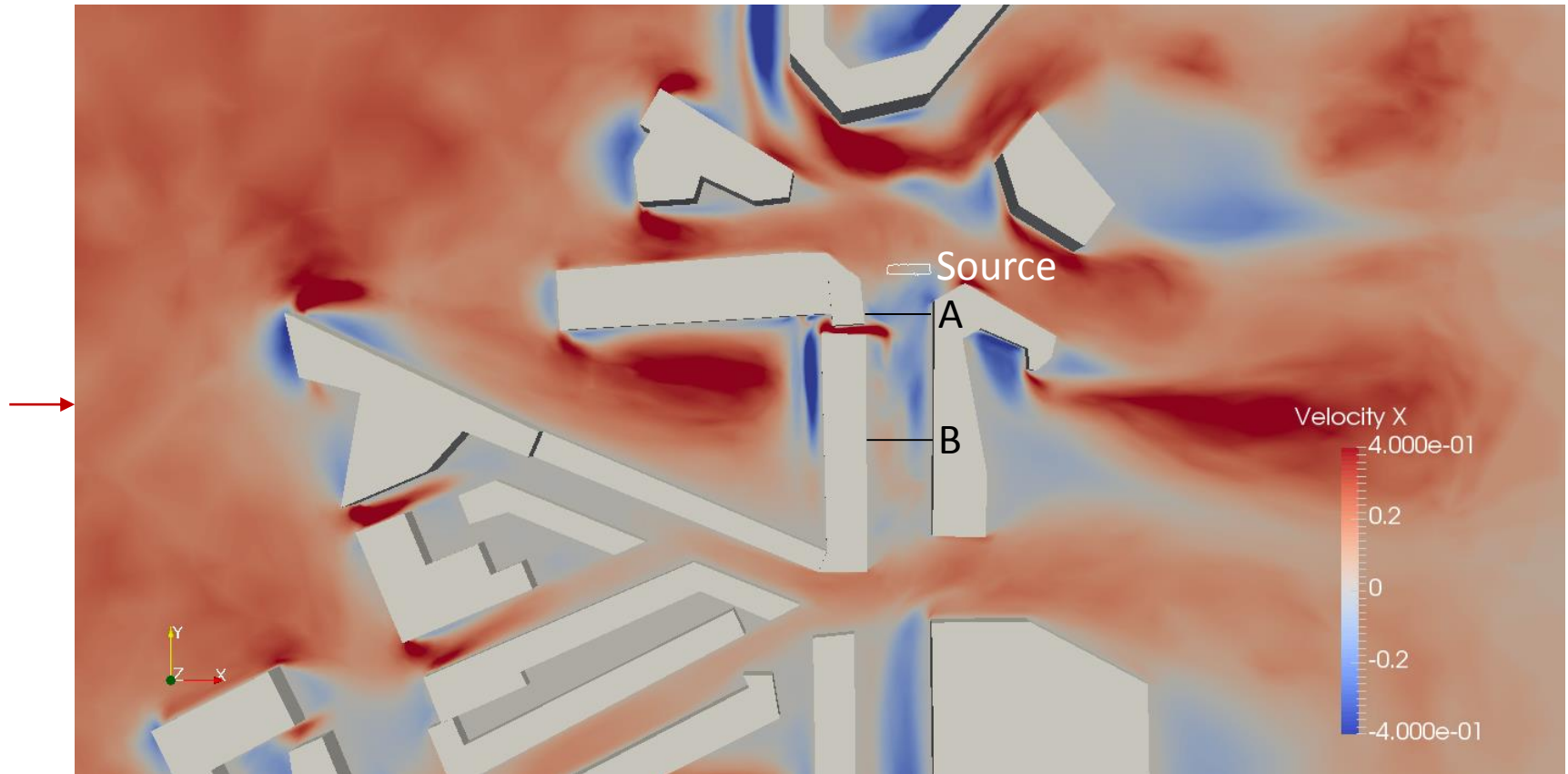
Comparison with Fluidity: Tracer dispersion

MAGIC

Envisaging a world with greener cities



Huw Woodward

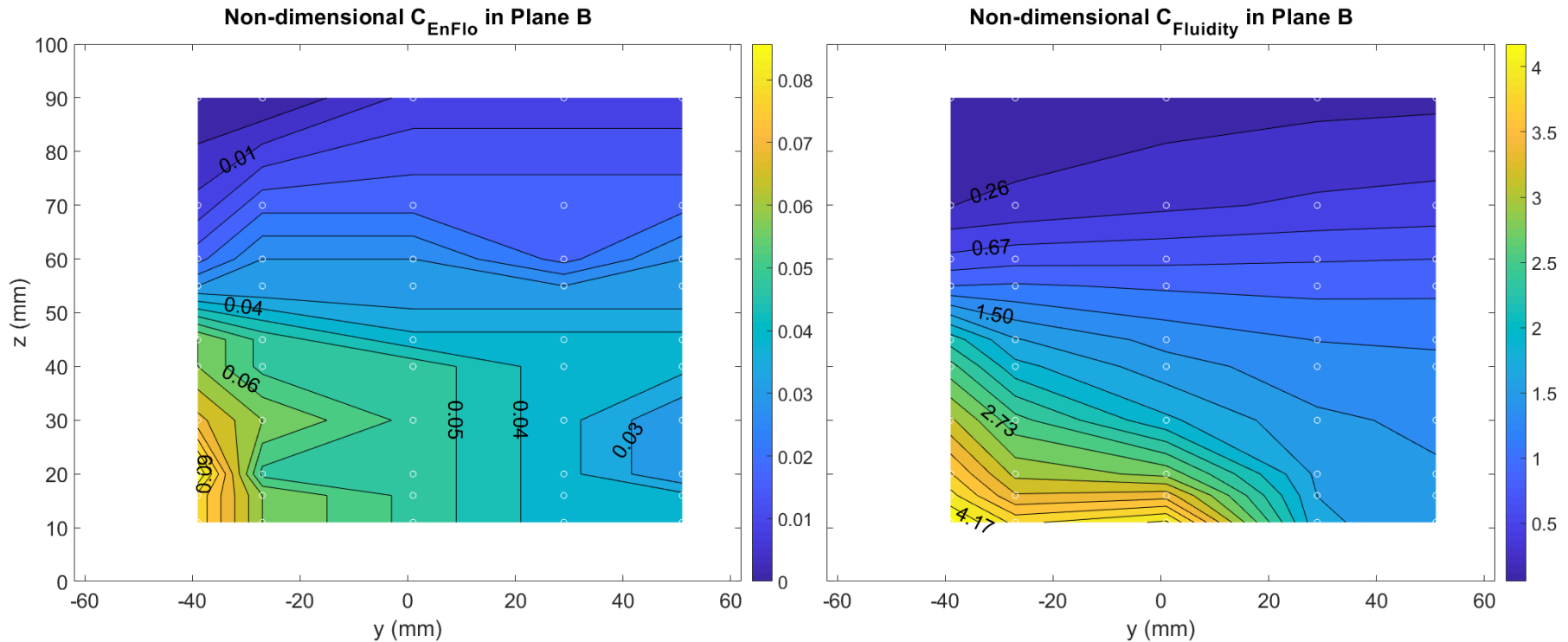


$z = 0.005 \text{ mm (1 m FS); } t = 41.8 \text{ s}$

Comparison with Fluidity: Tracer dispersion

MAGIC

Envisaging a world with greener cities



Wind-driven ventilation

MAGIC

Envisaging a world with greener cities



D Birch



P Nathan



A Wells



M Choi

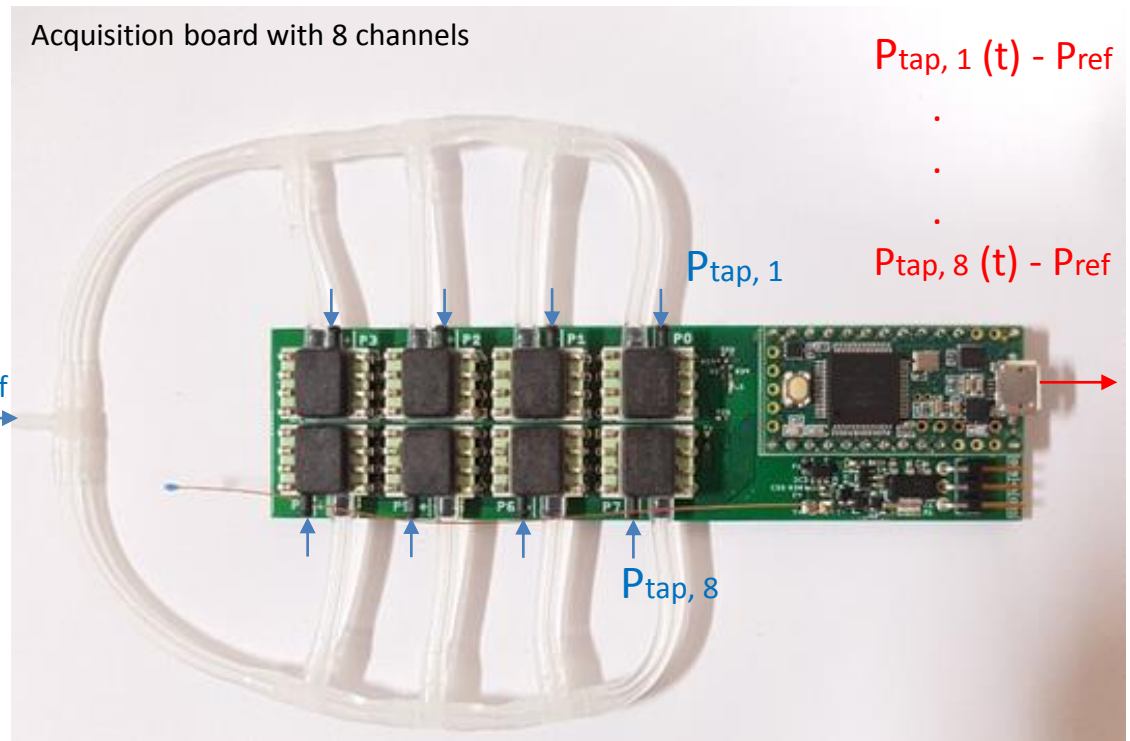


P Hayden



A Robins

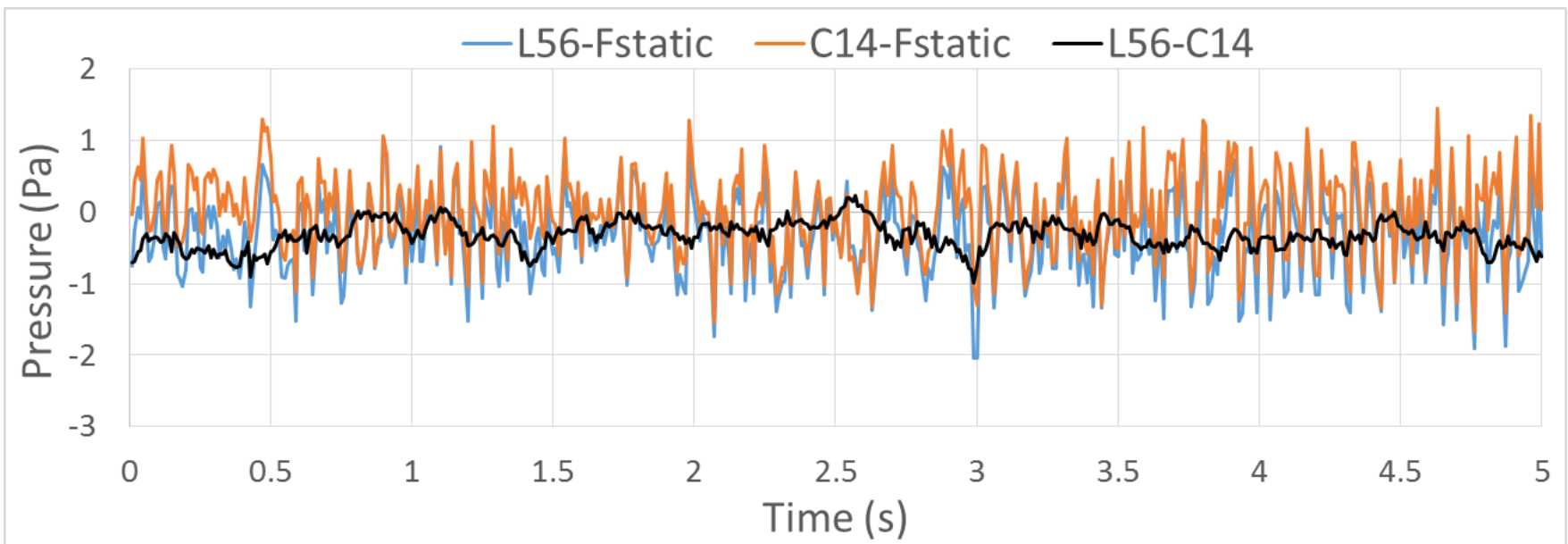
Development of differential pressure measurement system



Wind-driven ventilation

MAGIC

Envisaging a world with greener cities



Comparison with Fluidity: Surface pressure

MAGIC

Envisaging a world with greener cities

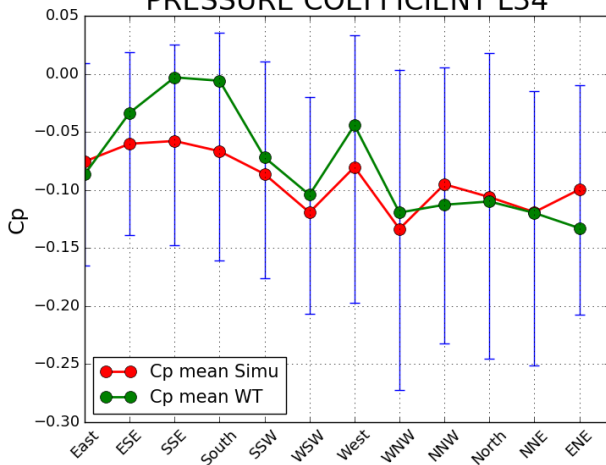


Laetitia Mottet



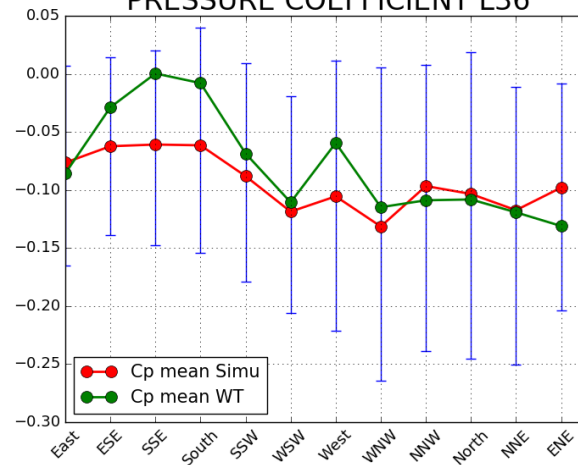
Jiyun Song

PRESSURE COEFFICIENT L34

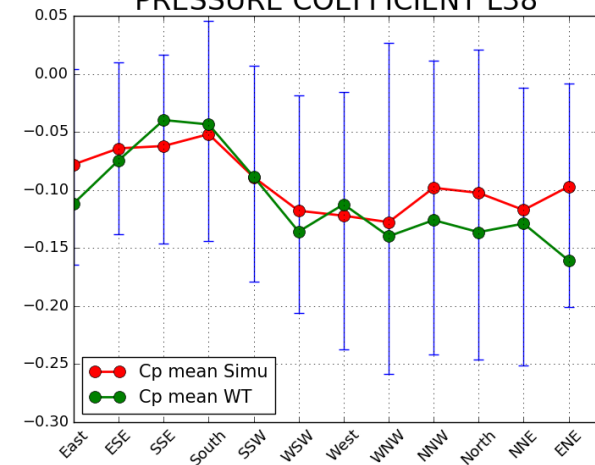


Wind direction

PRESSURE COEFFICIENT L36



PRESSURE COEFFICIENT L38



Comparison with Fluidity: Surface pressure

MAGIC

Envisaging a world with greener cities

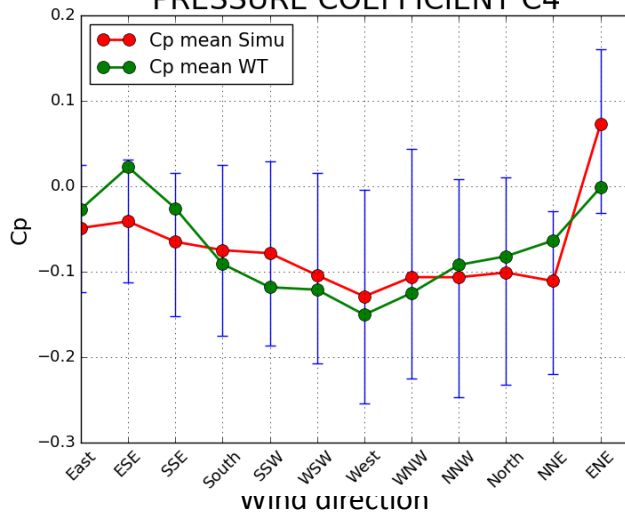


Laetitia Mottet

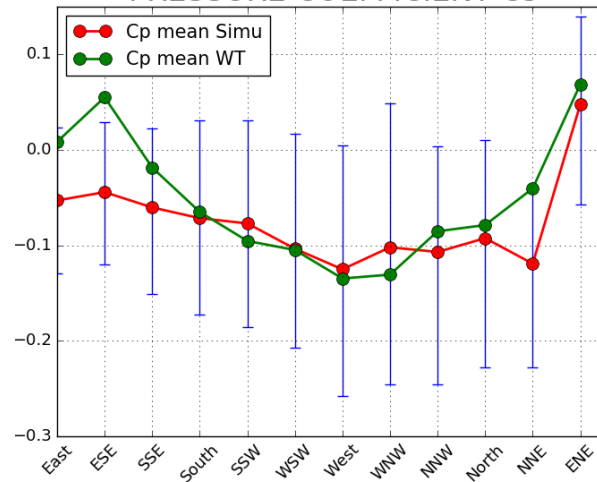


Jiyun Song

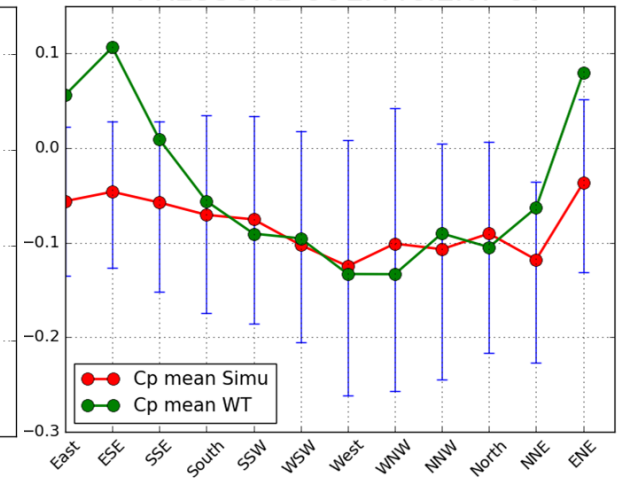
PRESSURE COEFFICIENT C4



PRESSURE COEFFICIENT C5

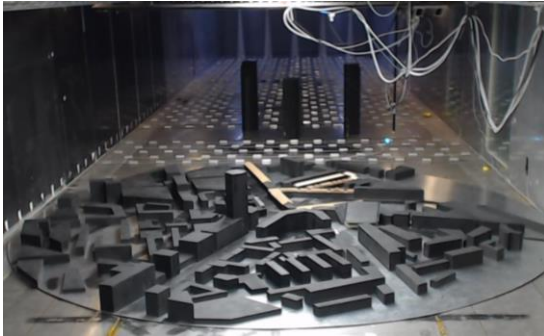


PRESSURE COEFFICIENT C6



Tall buildings

Full
lateral
spacing



Half
lateral
spacing



3 tall
buildings
removed



MAGIC

Envisaging a world with greener cities



M Carpentieri



L Beaton

Carpentieri *et al.* (ICUC10 Conference, New York, Aug 2018)
Impact of Tall Buildings on Flow and Dispersion in Urban Areas
<https://ams.confex.com/ams/ICUC10/meetingapp.cgi/Paper/342593>

Beaton and Carpentieri (UK WES Conference, Leeds, Sep 2018)
How the geometry of tall buildings influence airflow in the leeward region and its impact on air quality



Hertwig *et al.* (Boundary Layer Meteorology, in review)

Summary

MAGIC

Envisaging a world with greener cities

- Comparison of EnFlo and Fluidity simulations
 - Match of vertical profile shape for U
 - Wind speeds tend to be somewhat underpredicted near walls
 - Higher resolution computational grid
 - Concentrations tend to be overpredicted
 - Sensitive to alignment
 - Agreement on P at test room over full range of wind directions
 - Consistent trends but small signal in significant noise → large uncertainty
- Improved $p(t)$ measurement
 - Optimized tubing system between taps and transducers
 - Added insulating sheath over the reference tube
 - Calibrate more frequently to minimise drift
- Tall buildings and other topics

Ongoing/future work

MAGIC

Envisaging a world with greener cities

- Pressure measurements
 - Repeat double-width London Rd measurement
- Complete an inverse dispersion study
 - fixed receptor at Clarence Centre test room (London Road side)
 - street level point sources
 - identify 'footprint' for various wind directions
- Explore effects of boundary layer conditions
 - Repeat selected flow and dispersion experiments in
 - slightly stable ($Ri = 0.21$; tall spires)
 - slightly unstable ($Ri = -1.5, -0.5$; short spires) conditions
 - include neutral flow runs with no spires
- Design and build Cambridge model
 - Agree on simplified building geometry
 - Design for warm/cool regions and varying terrain
 - Generate drawings and fabricate

MAGIC

Envisaging a world with greener cities

Thanks for your attention

Questions?

Managing Air for Green Inner Cities
(MAGIC)

Web: www.magic-air.co.uk

Email: admin@magic-air.co.uk

Tel: 01223 336494