Field observations\textsuperscript{1} and modelling\textsuperscript{2} of tall building wakes

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(urbisphere project)
Doppler lidars – ideal for measuring urban winds

Doppler effect: frequency shift proportional to velocity

- Wind, turbulence, particulate pollution at ranges typically out to a few km’s
- Eye-safe (1.5 μm, pulsed)
- Gate length 18 m
- Integration time: 2 s (20k pulses)

E.g.
Barlow et al. 2011 ACP turbulence profiles
Drew et al. 2013 JWEIA wind profiles over London

HALO Photonics Streamline

London, September 18 2019
Horizontal scanning

- Plan Position Indicator (PPI) horizontal scan
- “slice” through building wakes

Scan around tall buildings in central London, Sensor at: London Southbank University site (MAGIC project)

Building wakes analysis paper
Natalie Theeuwes et al., in prep.
FUTURE Project: Collaboration with urbisphere - Berlin field campaign

Berlin field campaign 2021-22

- **Aim:** Impact of city on urban-and regional-scale boundary layer

- **Observations:**
  - boundary layer depth/winds
  - surface heat flux
  - microclimate, radiation aerosol, clouds
  - digital surface model
  - satellite data

- **Methods:**
  - micro/mesoscale modelling
  - socio-economic analysis

http://urbisphere.eu/index.html
FUTURE Project: Berlin **dual** lidar wake observations

- **TUCC site, TU-Berlin lidar**
- **Tall building clusters**
- **SCHO site Reading lidar**

**Deployed:** (28/06/22 – 19/09/22)
- PPI horizontal scan – every 5 mins

**Other scans:**
- boundary layer depth:
  - *time variation*
  - *spatial variation*
- aerosol layering
- wind profile
- turbulence profile
View from SCHO site, looking WNW

SCHO site:
- Sensor height: 87 - 92 m above sea level
- Building cluster extent approx. 280° → 295°
View from TUCC site, looking SE

TUCC site:
- Sensor height: 80 - 82 m above sea level
- Building cluster extent approx. 140° → 160°
Horizontal PPI scans from SCHO

NW wind direction

range m

azimuth ° from N

radial velocity ms⁻¹
Horizontal PPI scans from SCHO

NW wind direction

velocity deficit in wakes

azimuth ° from N
Next steps

- Welcome Matt Clements! PDRA@ Reading!

- Data analysis:
  QAQC: 68 days data from both lidars (19.5k PPI scans!)
  Analysis of wind direction, weather conditions
  Co-locating buildings and velocities

- Ensemble wake analysis:
  Ex: comparing velocity deficit in neutral conditions with ADMS model wake
  (Theeuwes et al., in prep)
Using Doppler lidars to measure turbine wakes

DWLs in use since 2010
Example: CWEX-13 campaign, Bodini et al. (2017) AMT