MAGIC

Envisaging a world with greener cities

MAGIC Cambridge Test Site

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Outline

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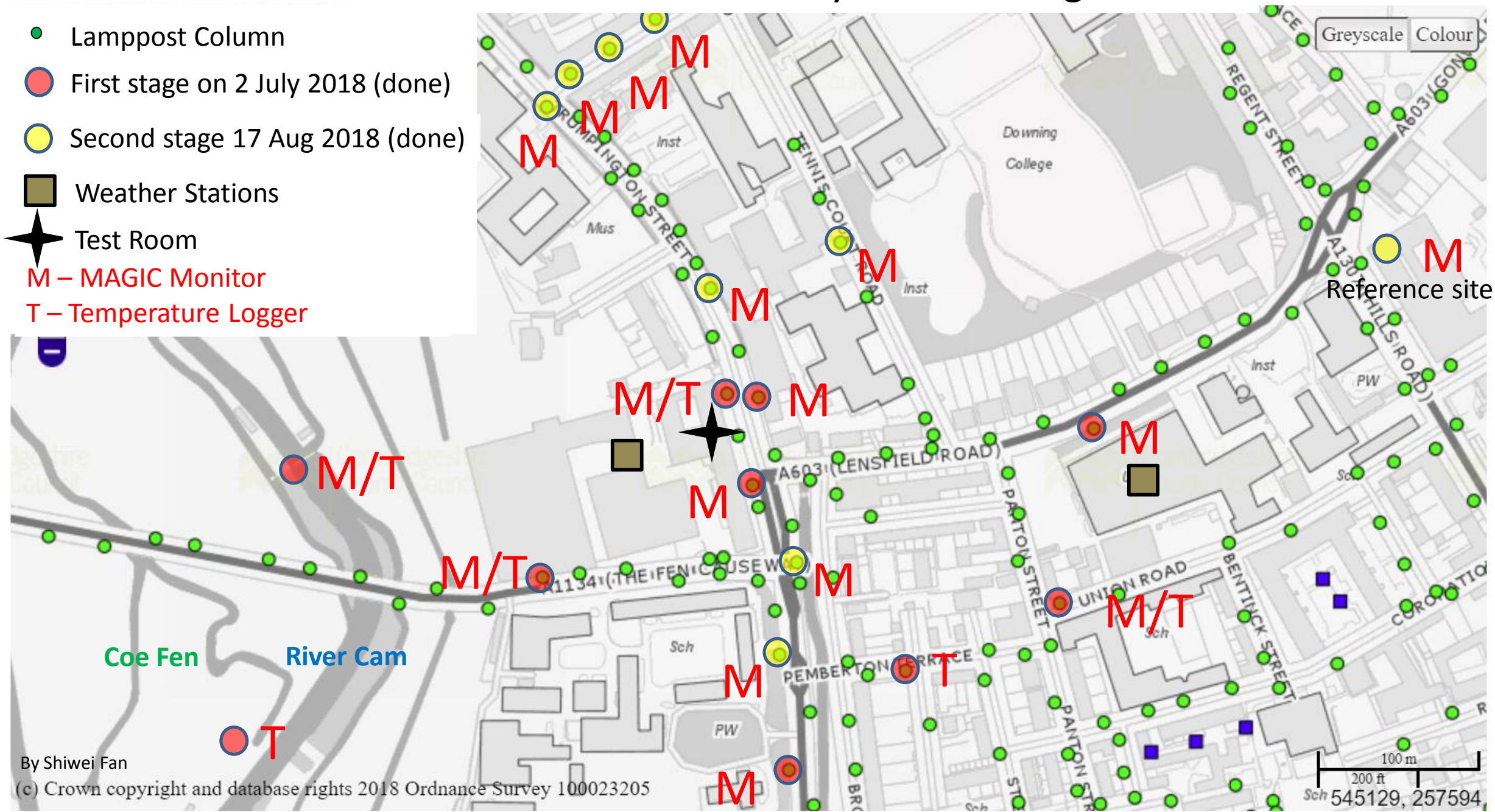
- Monitoring
  - Deployment map
  - Monitors
    - ✓ New MAGIC monitors
    - ✓ Outdoor temperature sensors
    - ✓ Weather station and pyranometer
- Results
  - Weather data
  - Outdoor temperatures
  - Outdoor pollutants
  - Indoor CO_2
  - Controlled test
- Summary

MAGIC Field Study at Cambridge



New MAGIC Monitors

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NO_2

CO

CO_2

- Doubled the memory size, 3 months@30 seconds and 6 months@1minute
- Improved signal to noise ratio with new firmware
- Improved reliability by removing onboard serial to USB chip
- Features: low-power, battery powered, and portable

Outdoor Temperature Sensors

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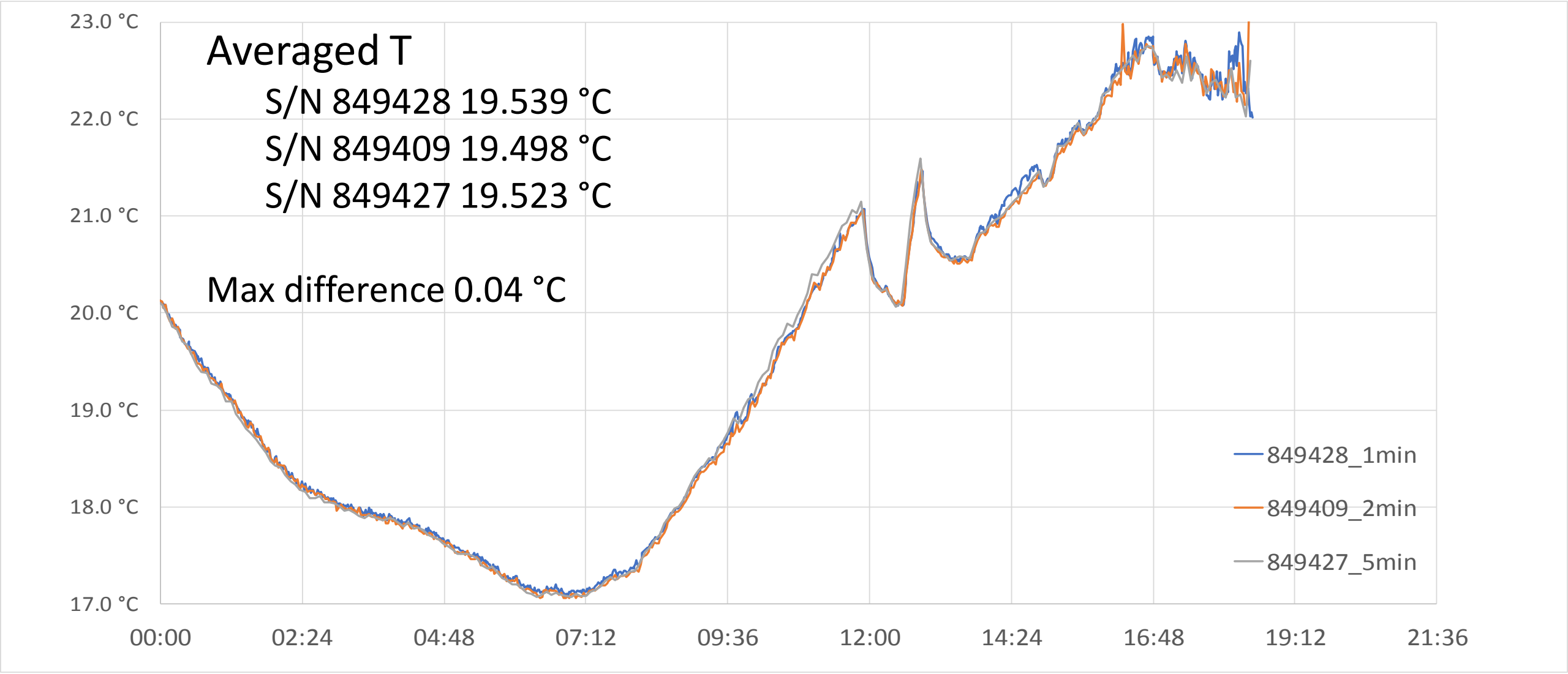
- Reduce impact from solar radiation with Stevenson screens
- Optimized sensor placement to improve performance

Lab Test Results



Outdoor Deployment

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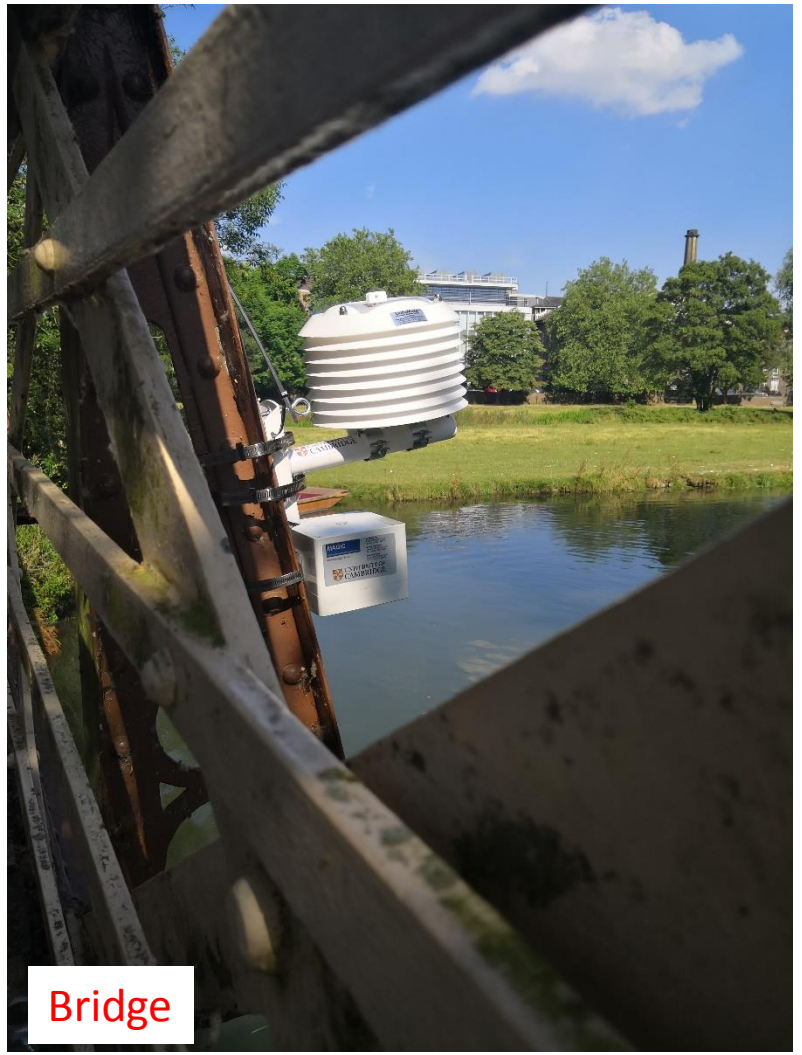
Union Rd


Park


Bridge

- First stage: 8 MAGIC monitors and 6 temperature monitors on 2 July 2018
- Second stage: 10 MAGIC monitors on 17 August 2018

Weather Stations and Pyranometer

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Baker

Chemistry

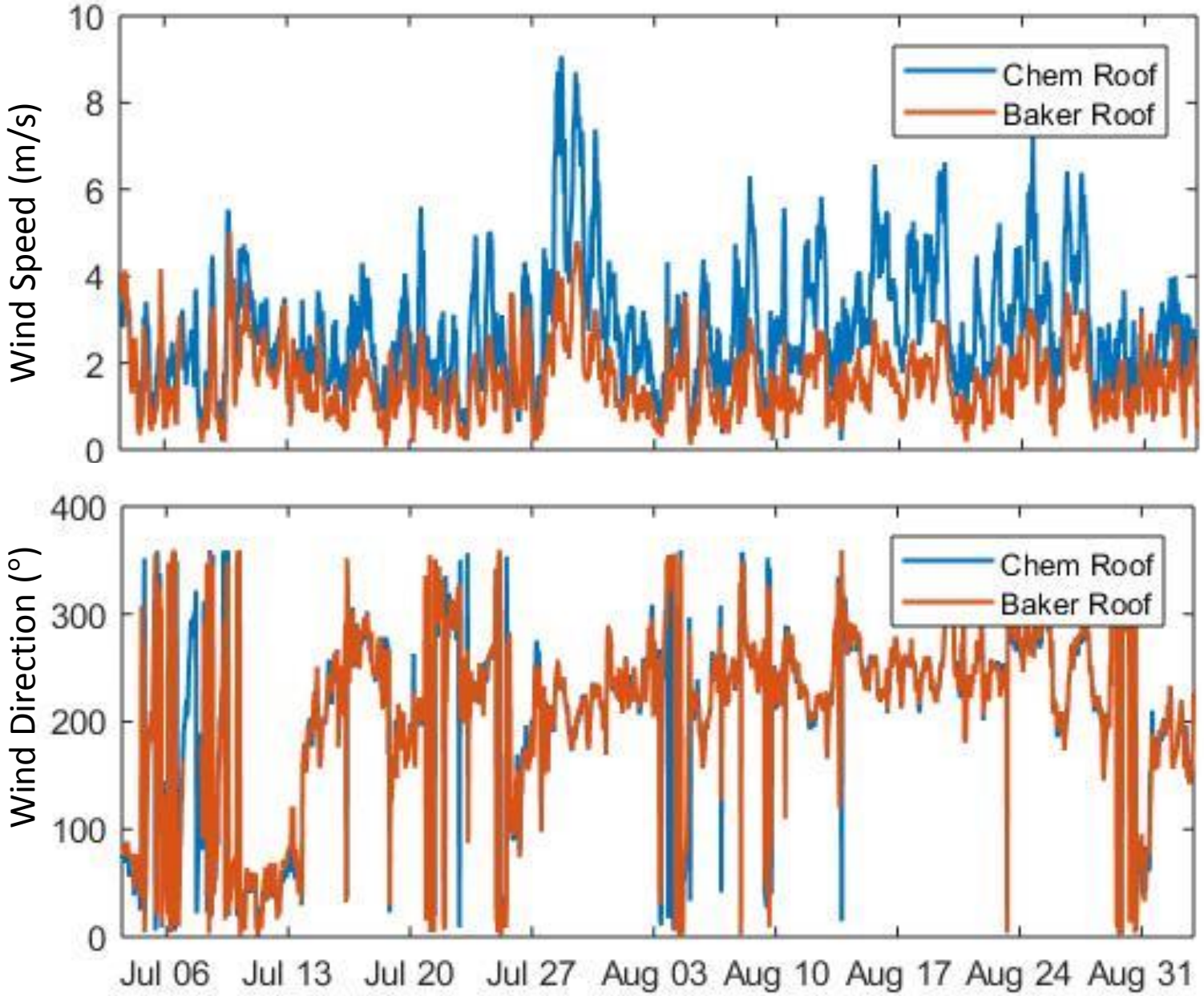
- Weather station and pyranometer
  - Transported back from LSBU
  - Installed on the roof of Baker building
  - Close to the test room
  - Operating from 3 July 2018
- Data access to Chemistry weather data

Pyranometer @ Jiyun Song

Results - Weather Data

- Wind speed at Baker building roof is lower than that at Chemistry building roof

- Wind direction is almost identical at Baker and Chemistry building roofs



Results - Weather Data

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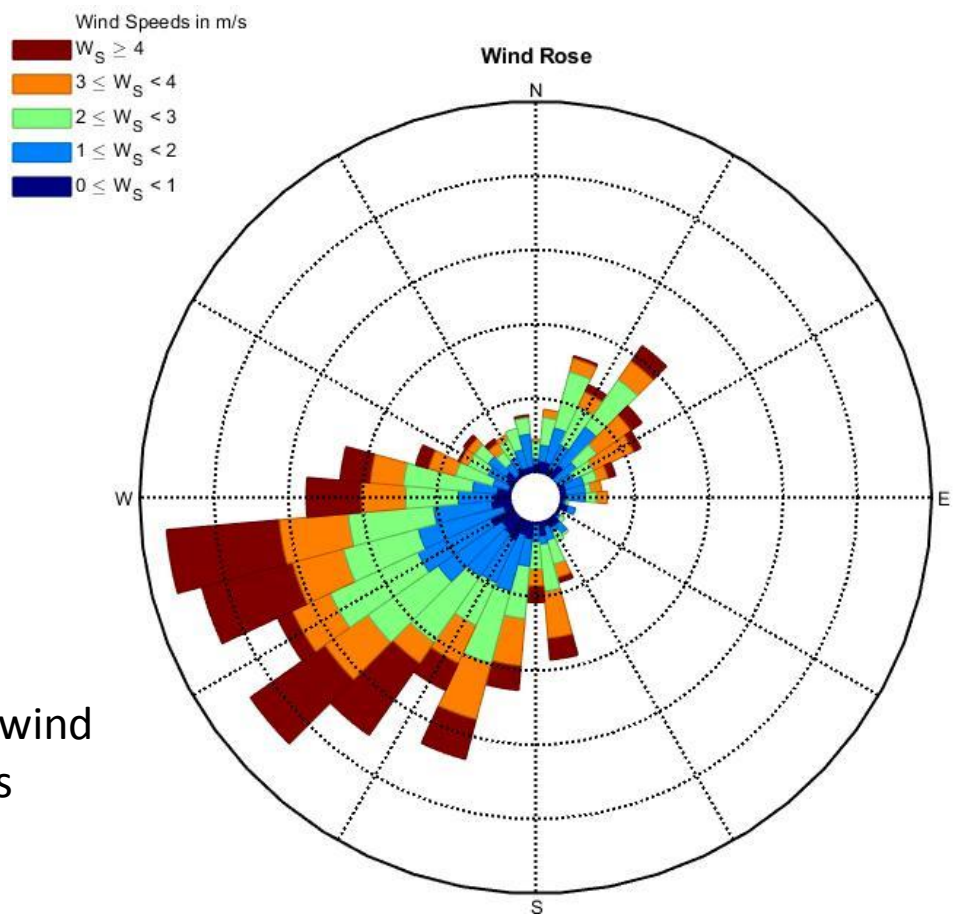
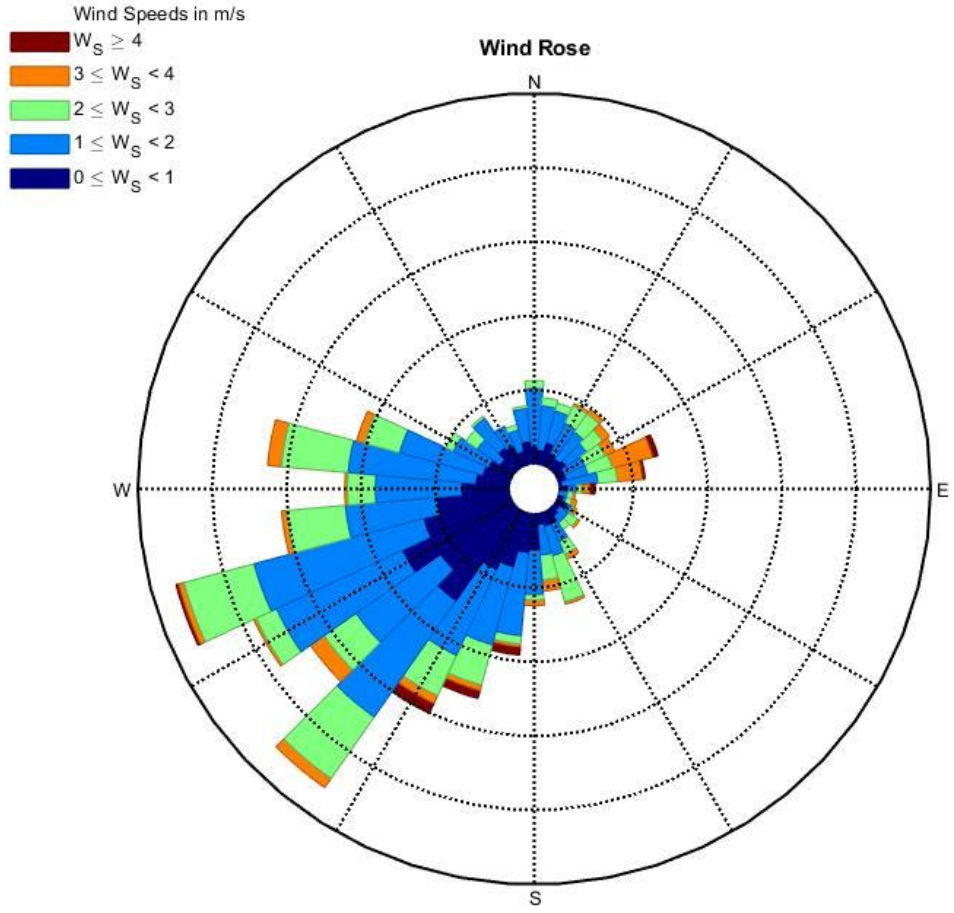


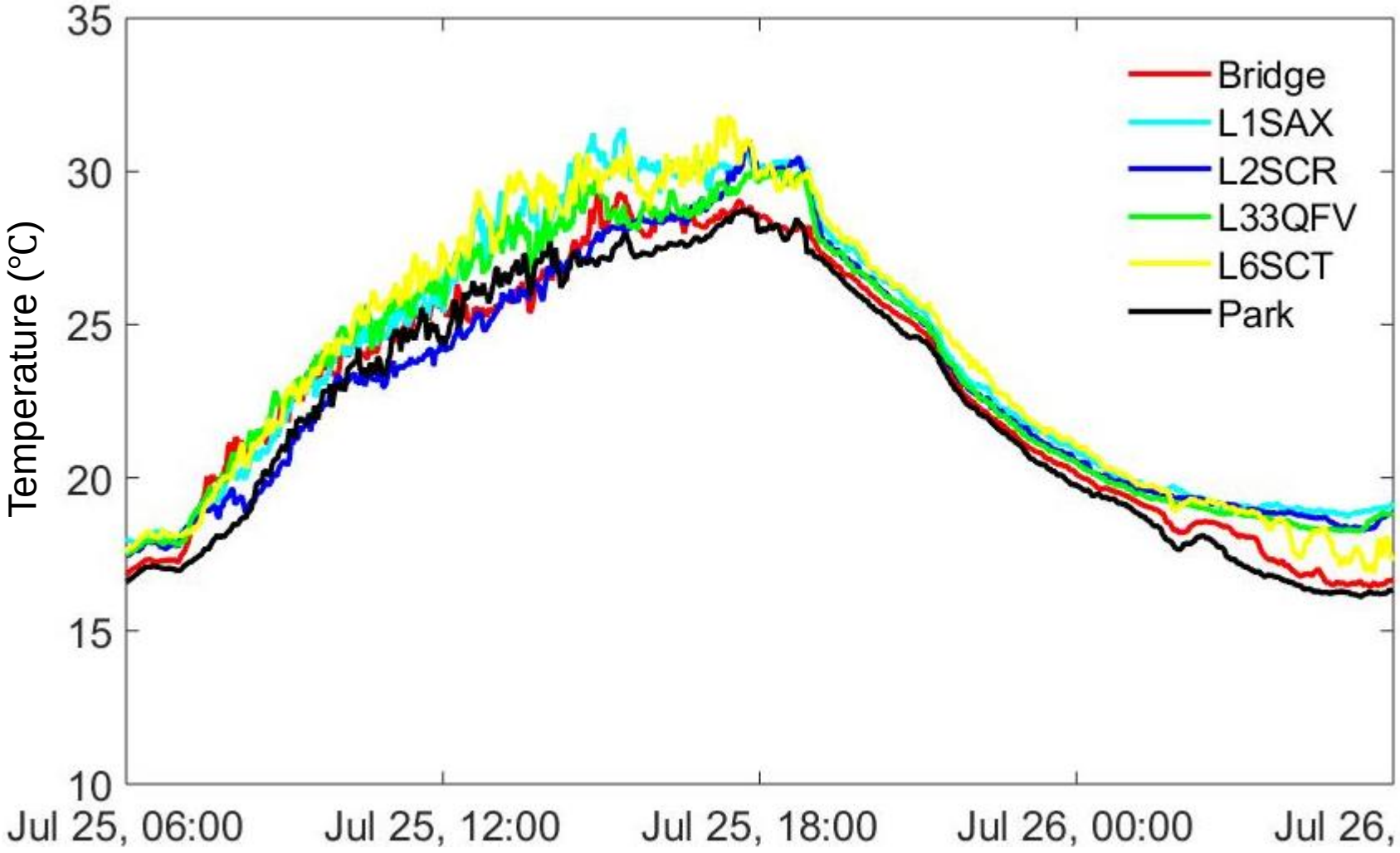
Prevailing wind direction is southwest

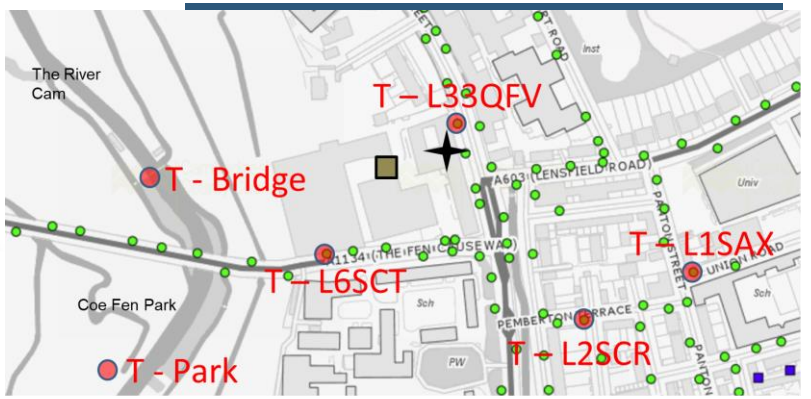
Chemistry Building Roof



Baker Building Roof

Outdoor Temperatures

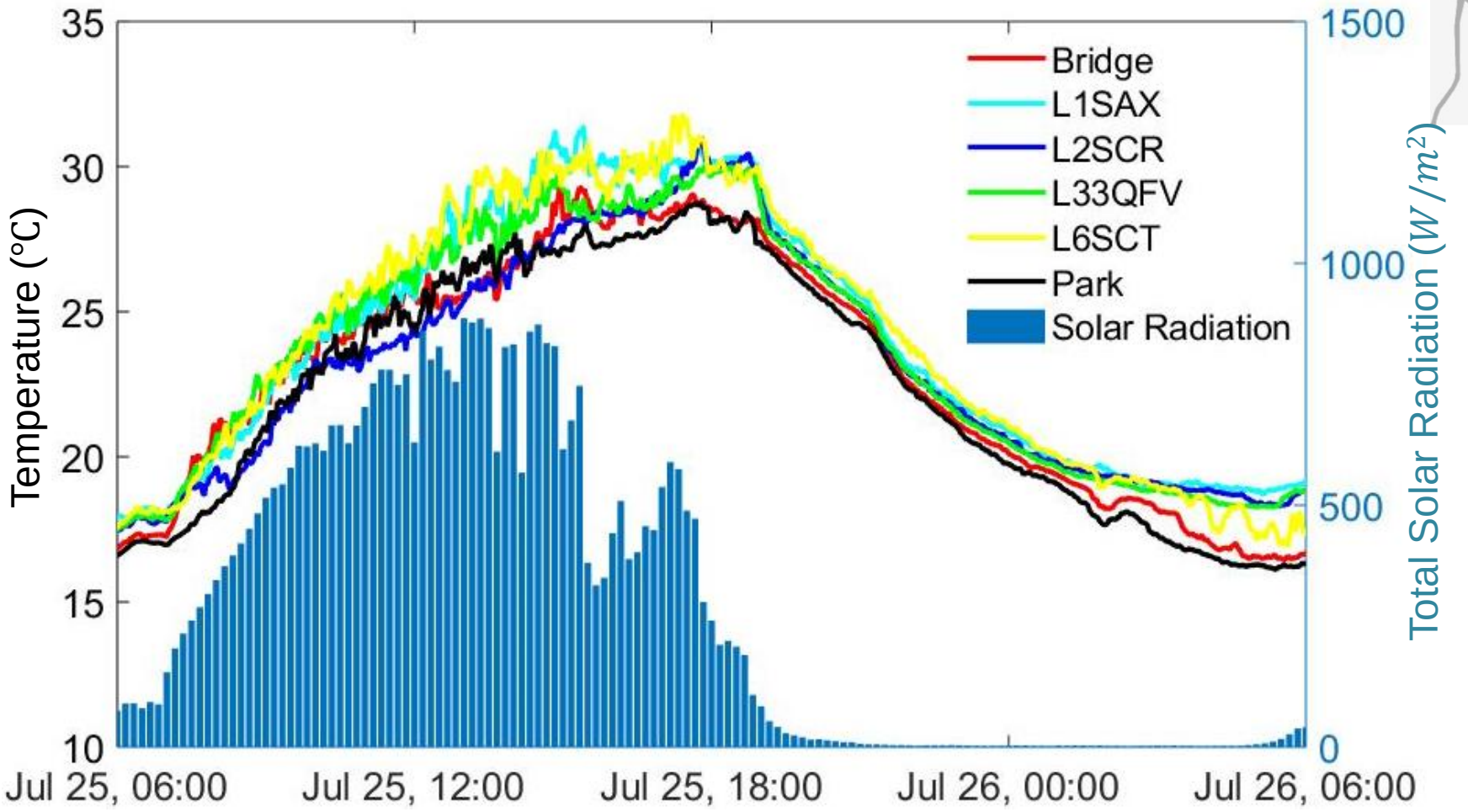


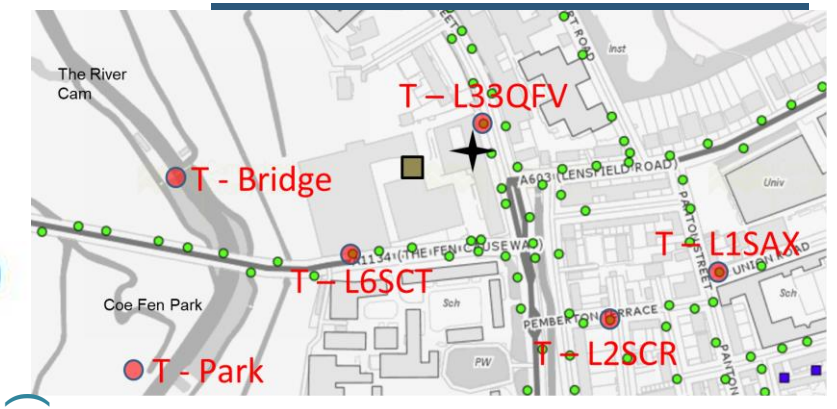


Temperatures in the park and on the bridge are lower than others

Sky view factor?

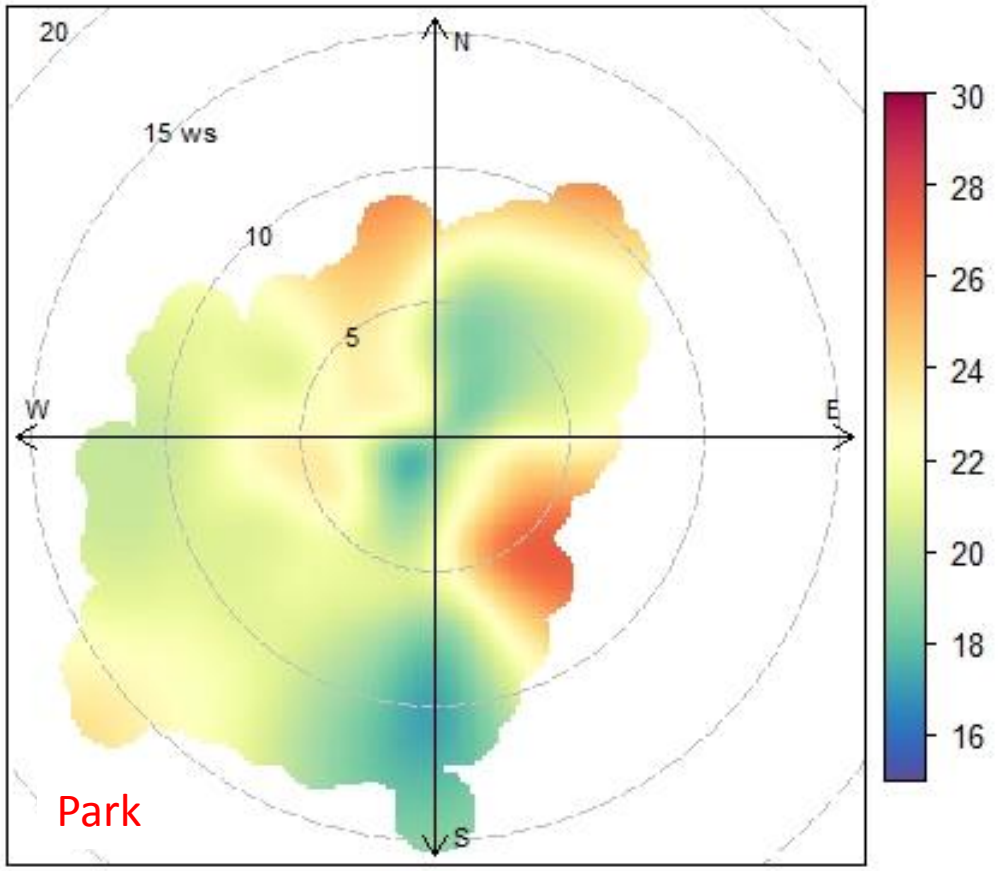
Outdoor Temperatures

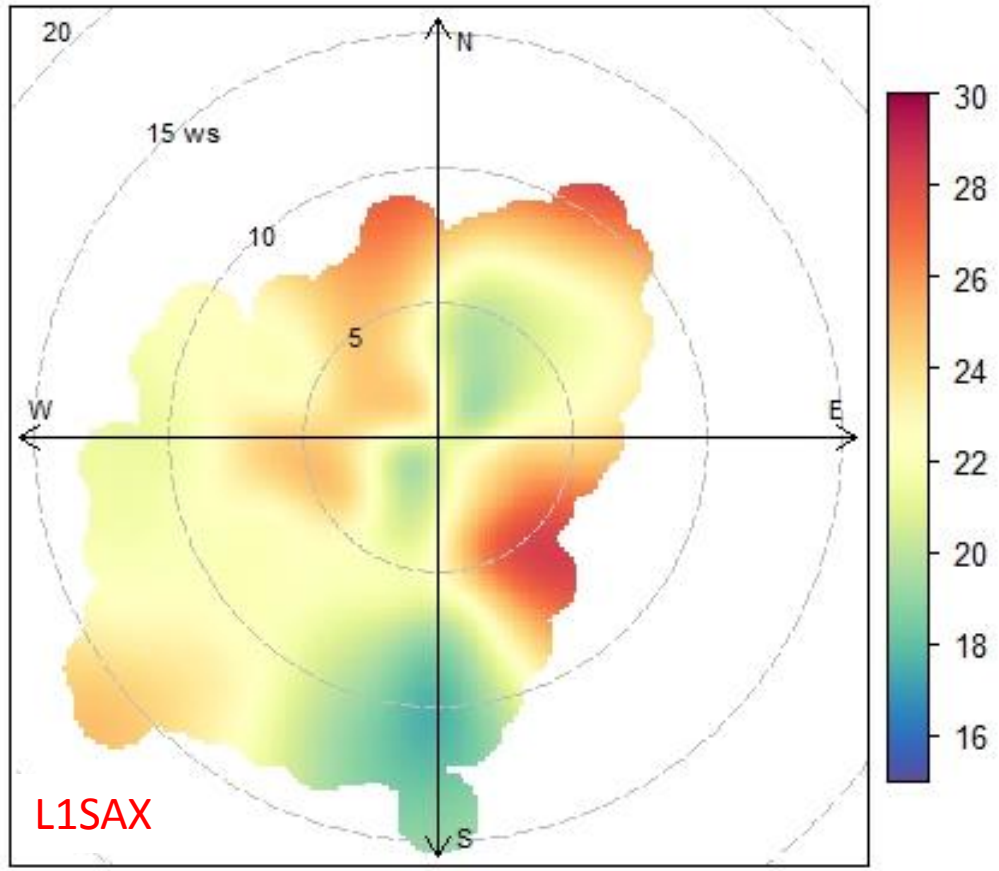




Temperature is obviously related to solar radiation – it rises from sunrise, peaks at sunset and then gradually decreases overnight

Outdoor Temperatures





Outdoor Hourly Averaged CO

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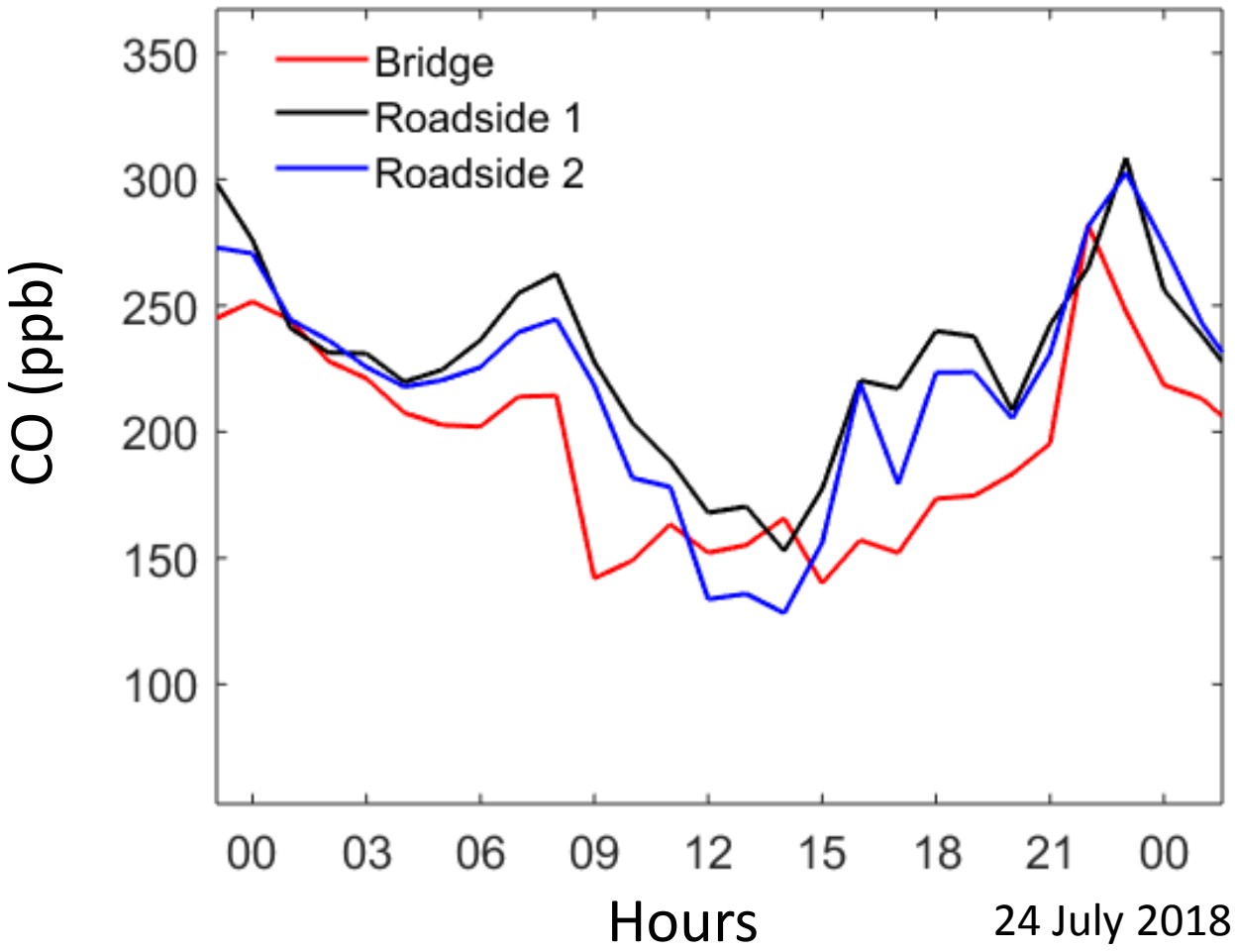
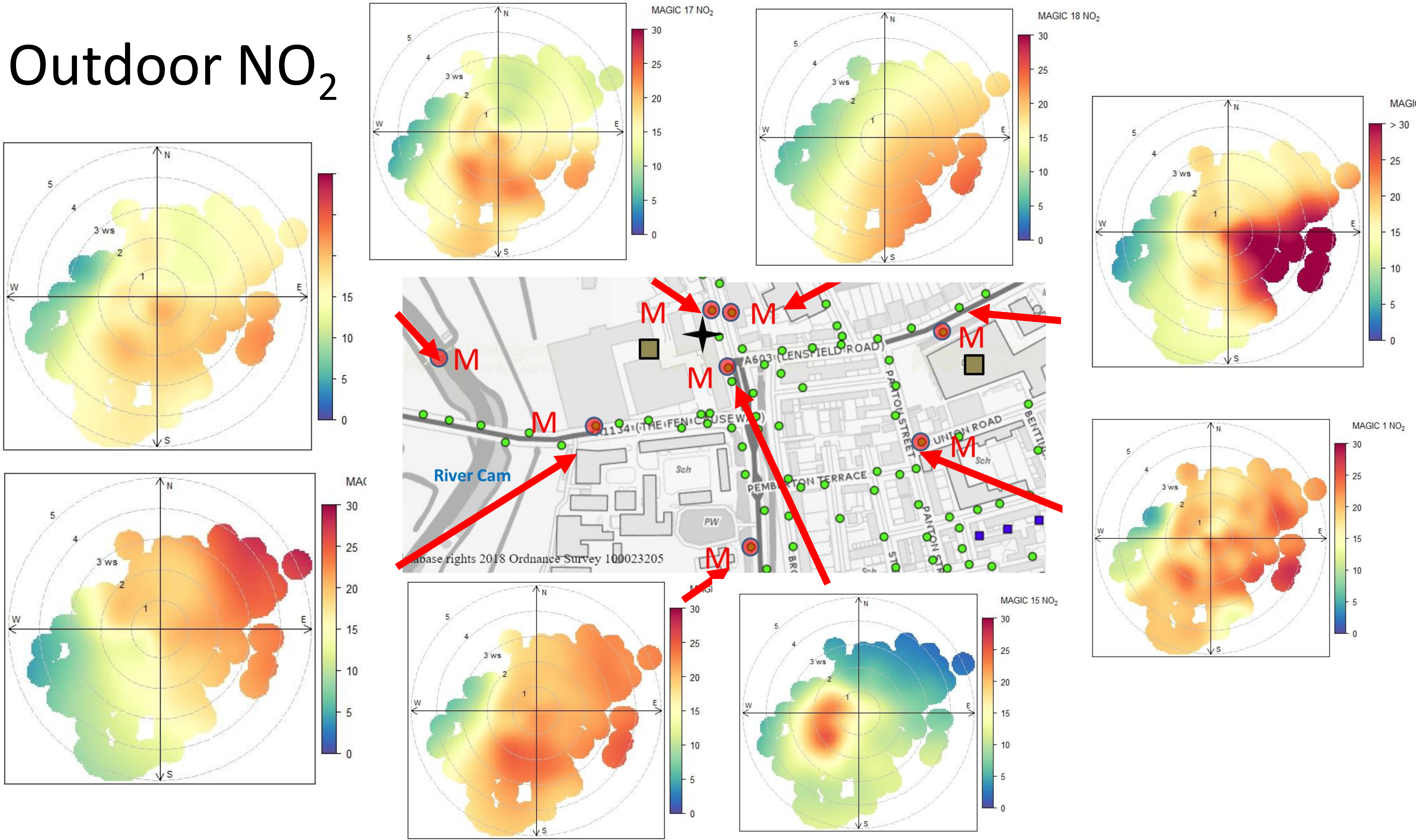


- CO at different locations have similar trends
- CO looks lower in the park/river however this may be due to sensor calibration
- CO peaks at morning and evening rush hours are observed; the maximum CO occurs in late evening
- Boundary layer height may contribute to low concentration at noon
- Meteorological conditions

Outdoor NO_2



MAGIC 17 NO2
MAGIC 18 NO2
MAGIC 1 NO2
MAGIC 15 NO2
M
River Cam
A603 (LENSFIELD ROAD)
A1134 (THE FEN CAUSEWAY)
PANTON STREET
UNION ROAD
PEMBERTON TERRACE
Sch
PW
rights 2018 Ordnance Survey 100023205

Indoor Deployment at Architecture Cambridge

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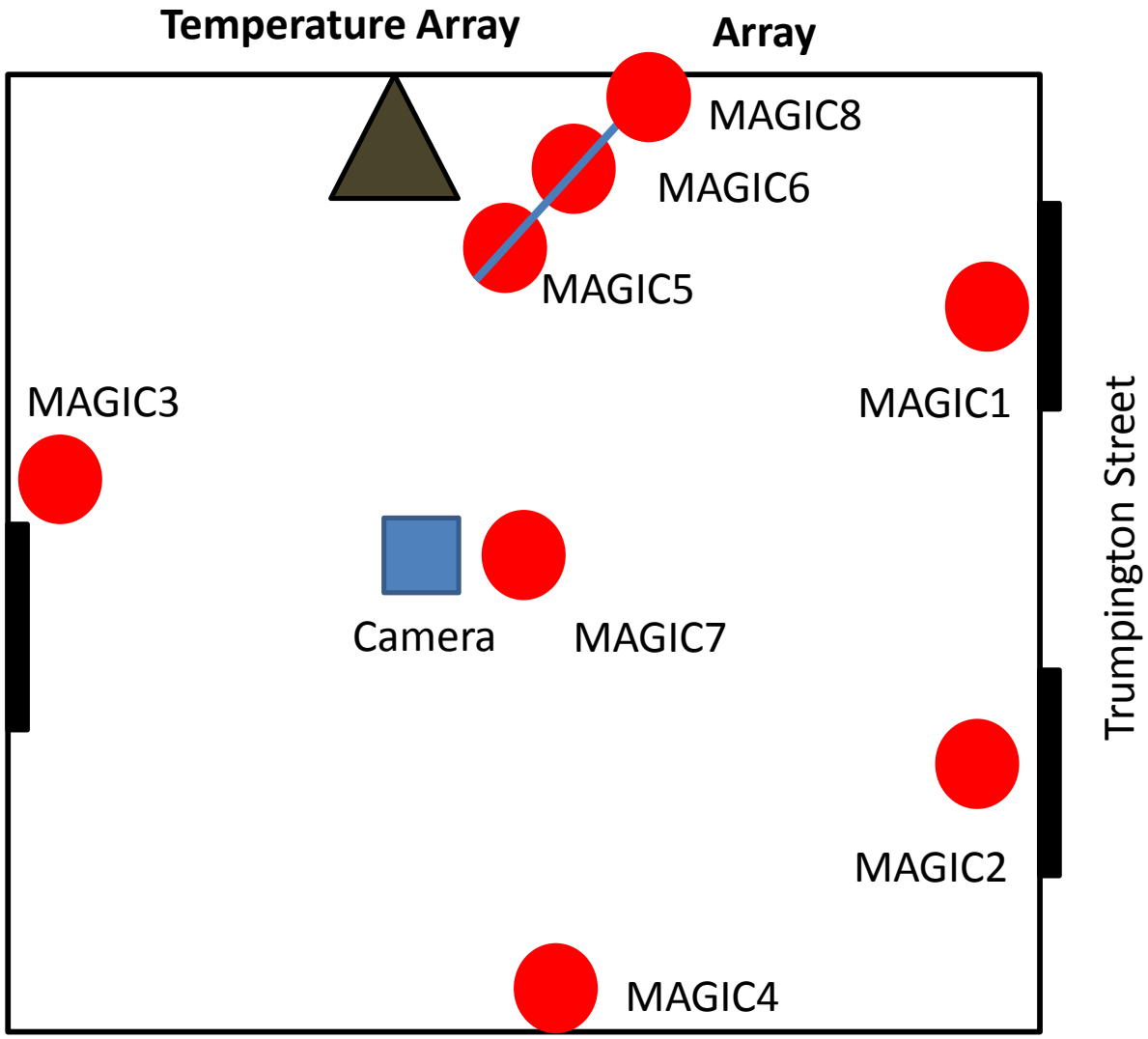

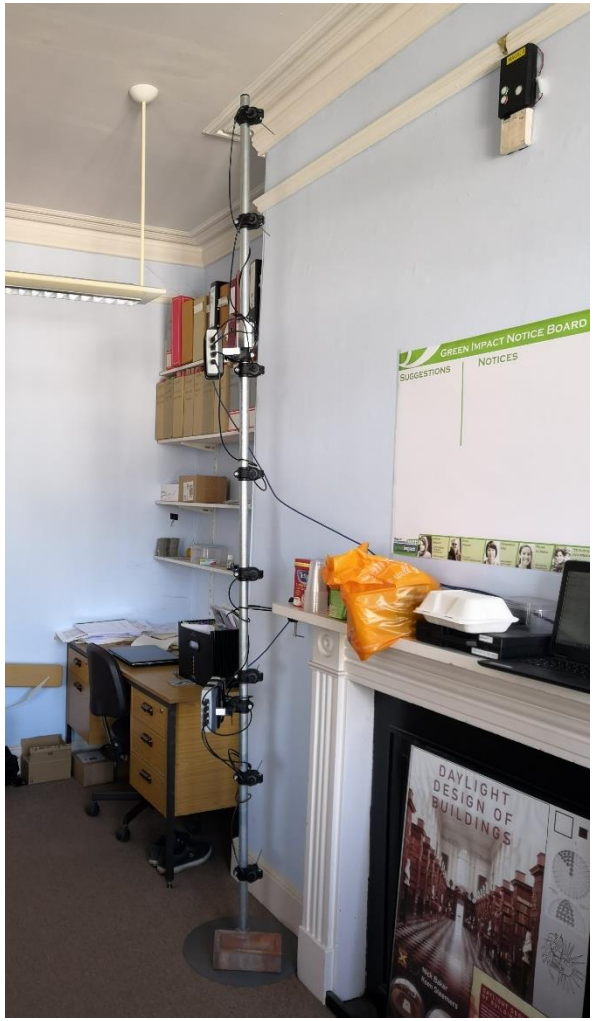

- Multiple sensors to account for non-homogeneous CO_2 distribution
- Camera to monitor people number and window positions

Temperature Array @ Megan Davies Wykes

Indoor CO_2

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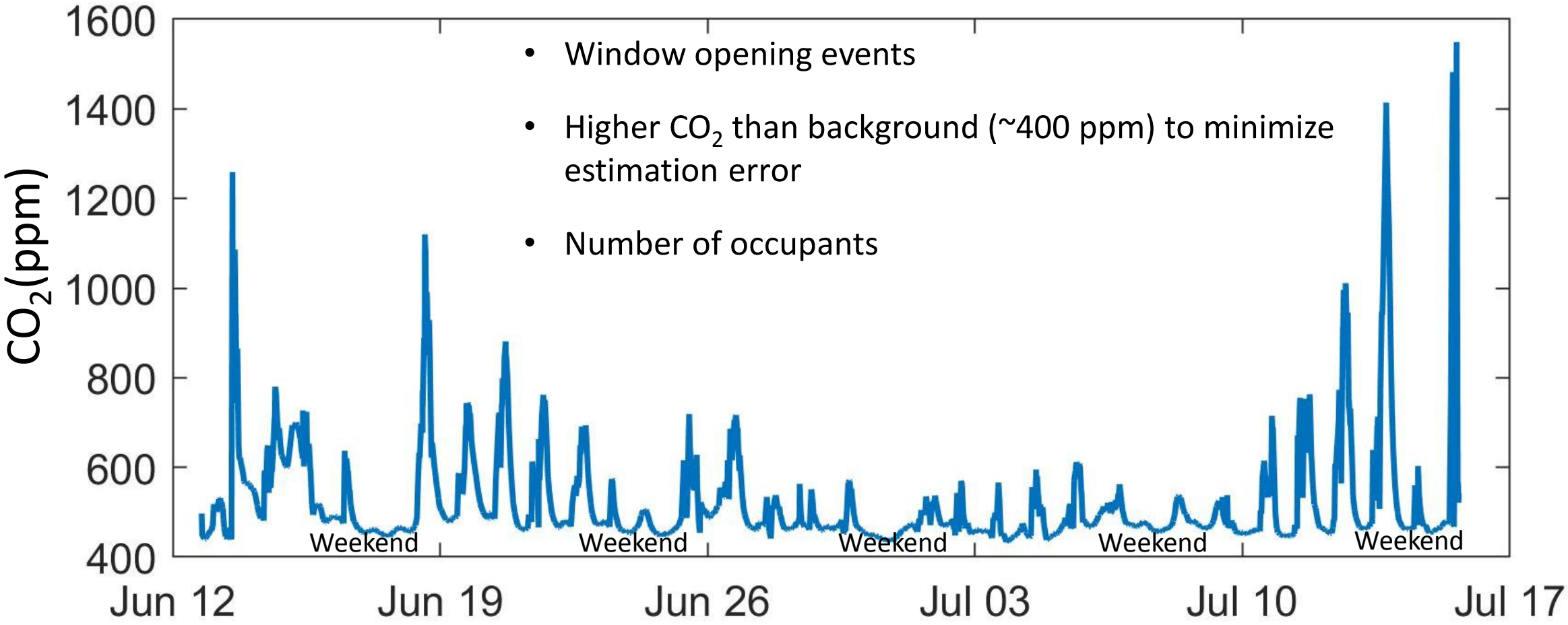

- Window opening events
- Higher CO_2 than background (~400 ppm) to minimize estimation error
- Number of occupants

Controlled Test

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- Controlled tests on single-sided ventilation only
- Ultrasonic anemometer for wind speed/direction (4Hz)
- Decay method to estimate ventilation rates

Ventilation Rate from CO_2

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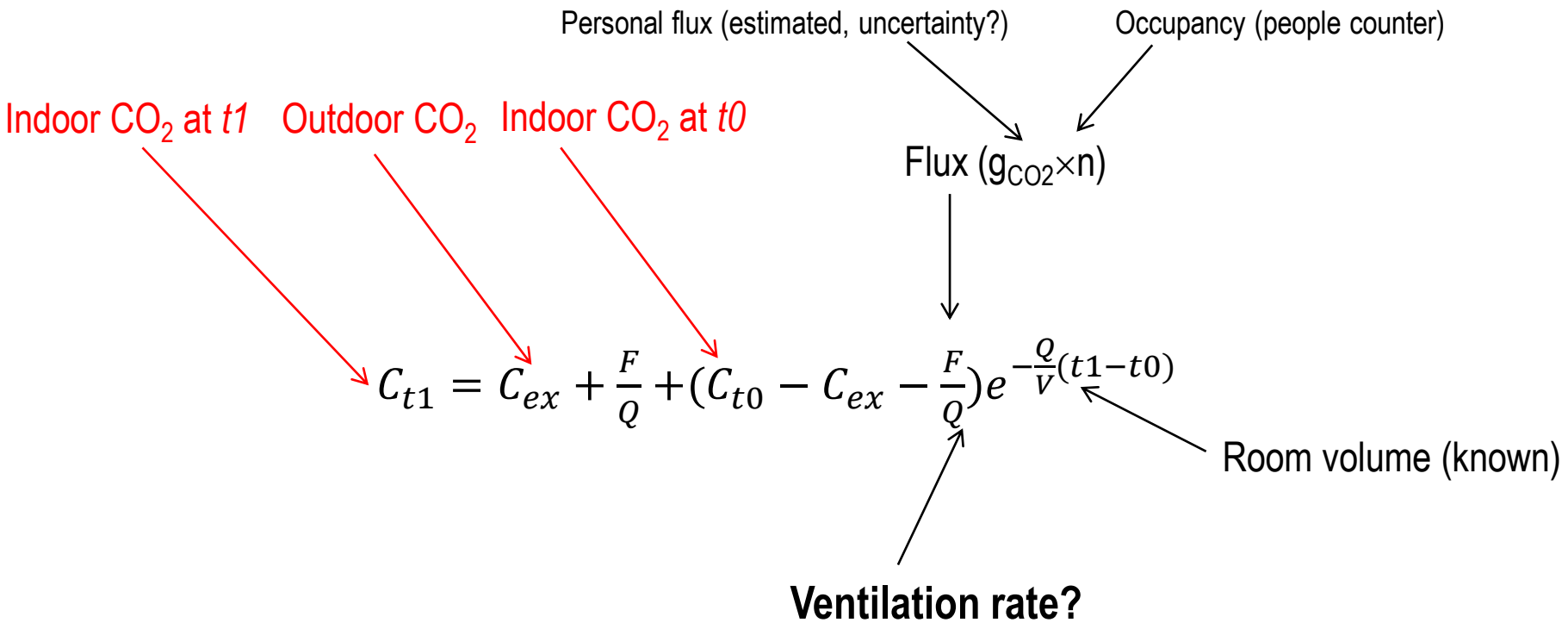

CO_2 generation rate depends on metabolic rate or level of physical activity and skin area

Controlled Test

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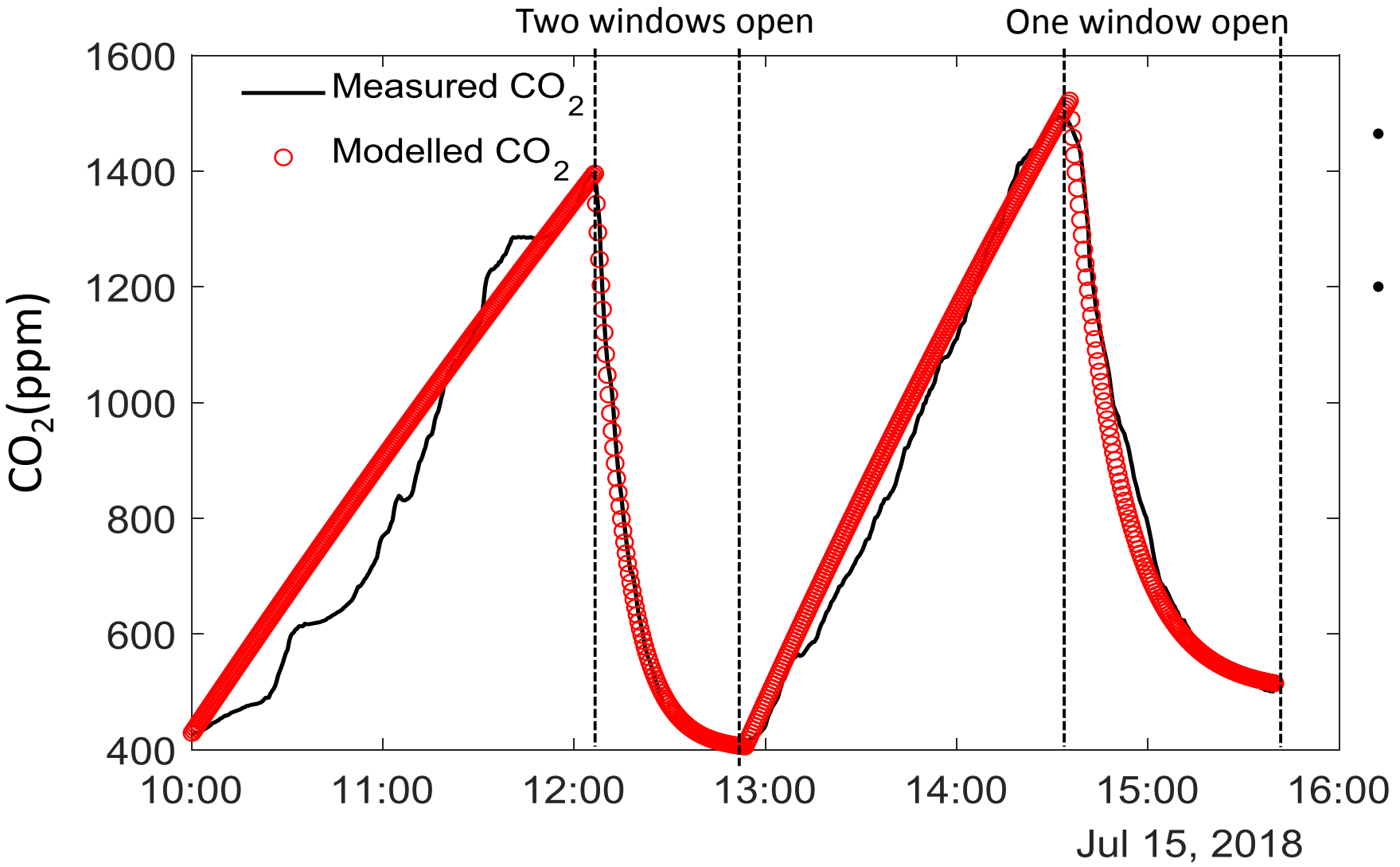
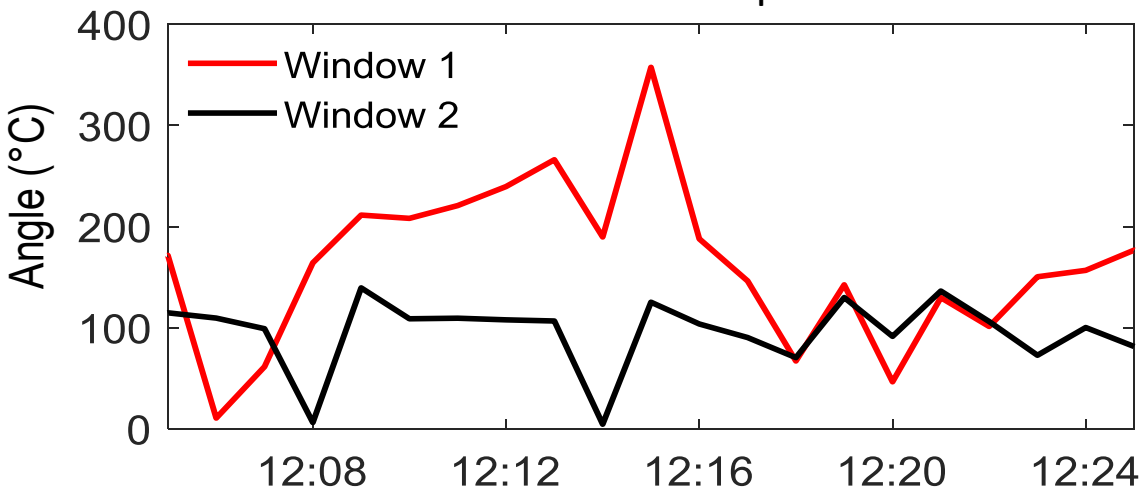


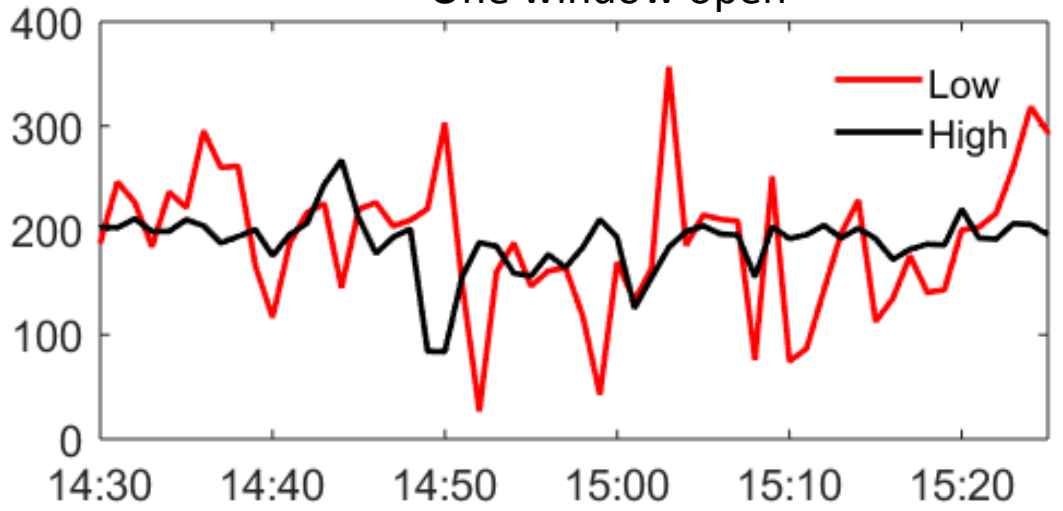
- Two window open: Q = 185 L/s
  One window open: Q = 128 L/s
- Ventilation rate is larger with two windows open than that with one window open

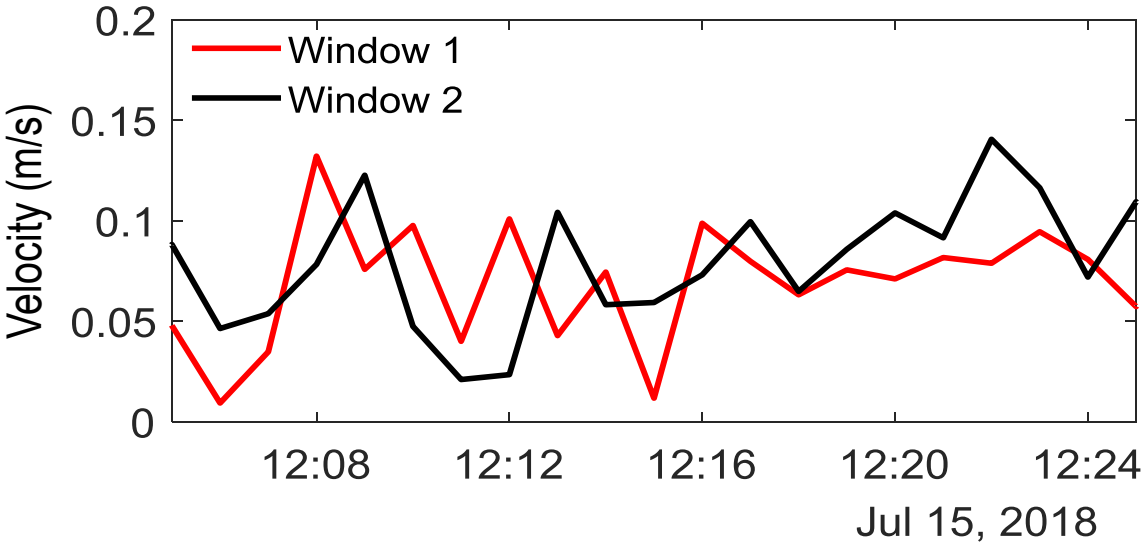
Controlled Test

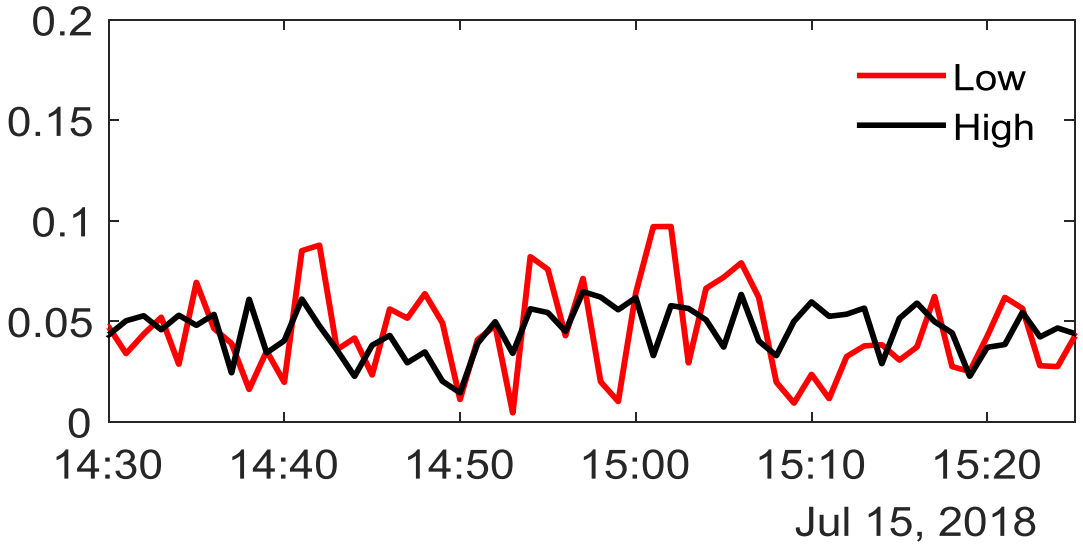
Two windows open



One window open







Summary

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- Completed deployments of indoor and outdoor monitors; interpretation is ongoing
- Significantly lower temperatures are observed at green and blue spaces – sky view factor? meteorology?
- Outdoor pollutant distribution is influenced by street layout; street canyon effect is observed
- A trial controlled test was carried out

Future work

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- More controlled tests with traffic monitoring added are planned
  - Simultaneous indoor and outdoor pollutants monitoring
  - Controlled indoor tests with window openings to estimate ventilation rates
  - Indoor and outdoor exchange during window opening events
  - Collect traffic data for traffic modelling