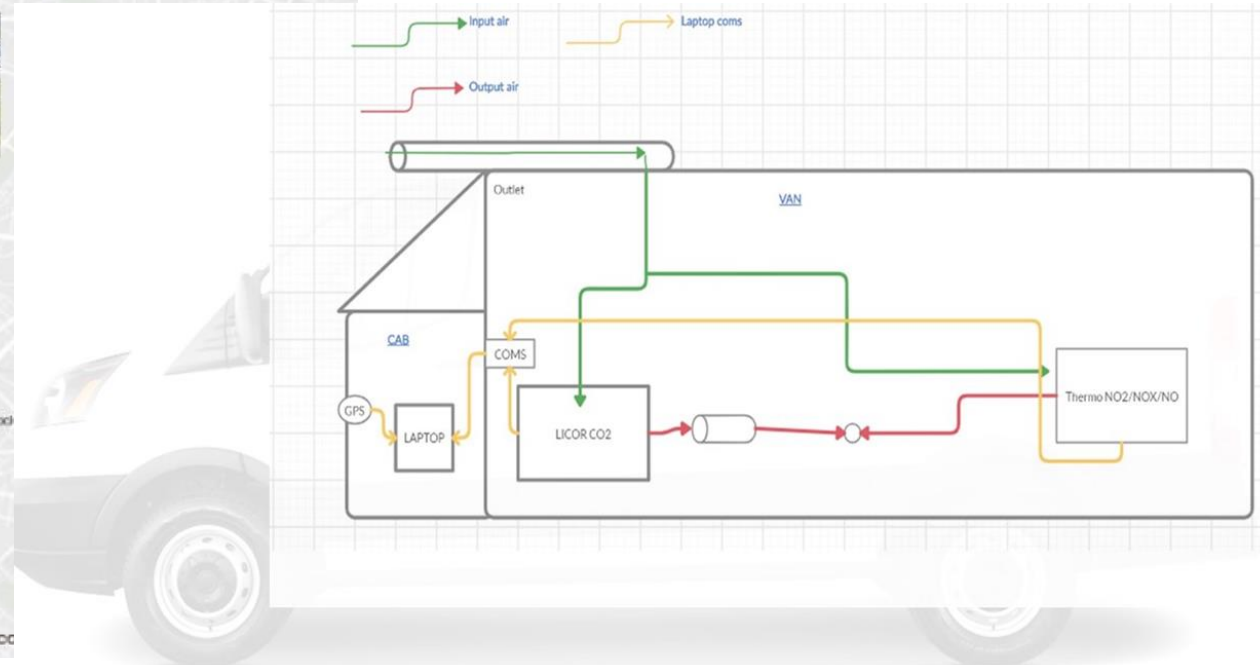# Strand 1-Observations

Dr Zongbo Shi, Professor Lee Chapman, Dr Daniel Rooney, Nicole Cowell

WM-AIR
CLEAN AIR SCIENCE FOR
THE WEST MIDLANDS

Mobile measurements

- Fornightly measurements of CO_2, NO_x, NO & NO_2
- PM measurements being introduced.
- The route follows the A38, loops the ring road before returning back to campus
- Also stops at the QE hospital & BAQS.

Preliminary results - van

- Highest mean levels of NO_2 and CO_2 were recorded on average in the stretch of the A38 including the Queensway tunnels (between Belgrave Middleway and Dartmouth Circus).

- The mean value for NO_2 reached 92 µg m^{-3} in the A38 Queensway stretch, over 8x higher than what was recorded in the urban background (UoB campus).
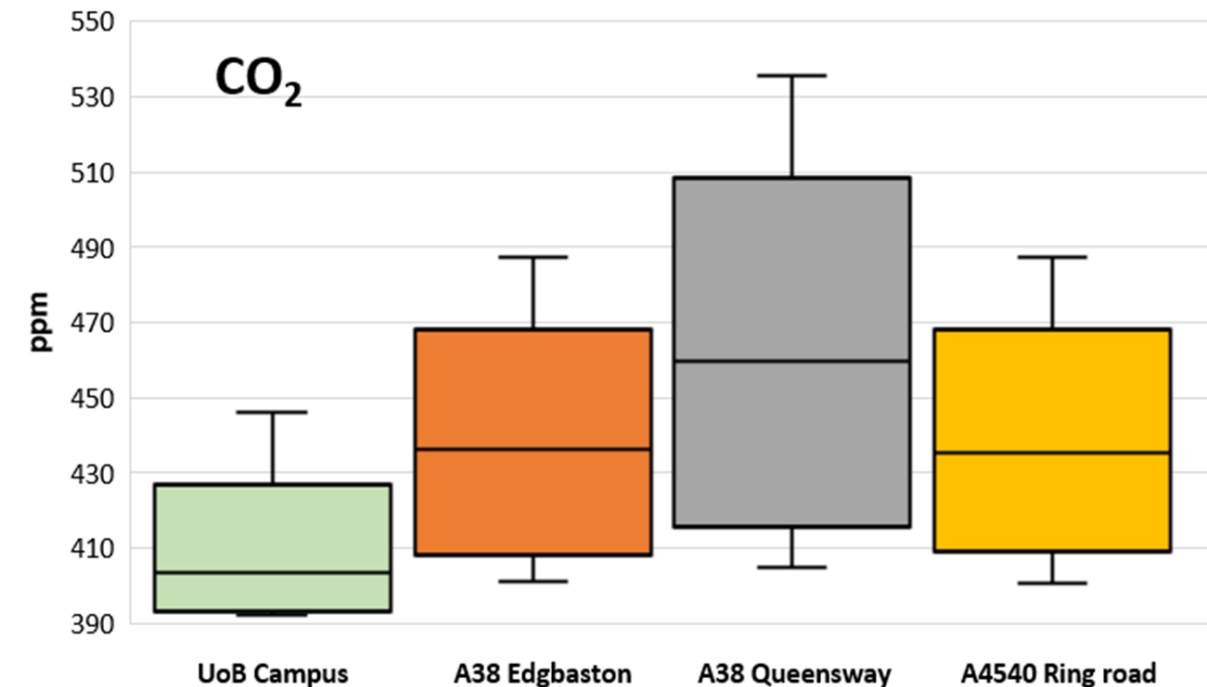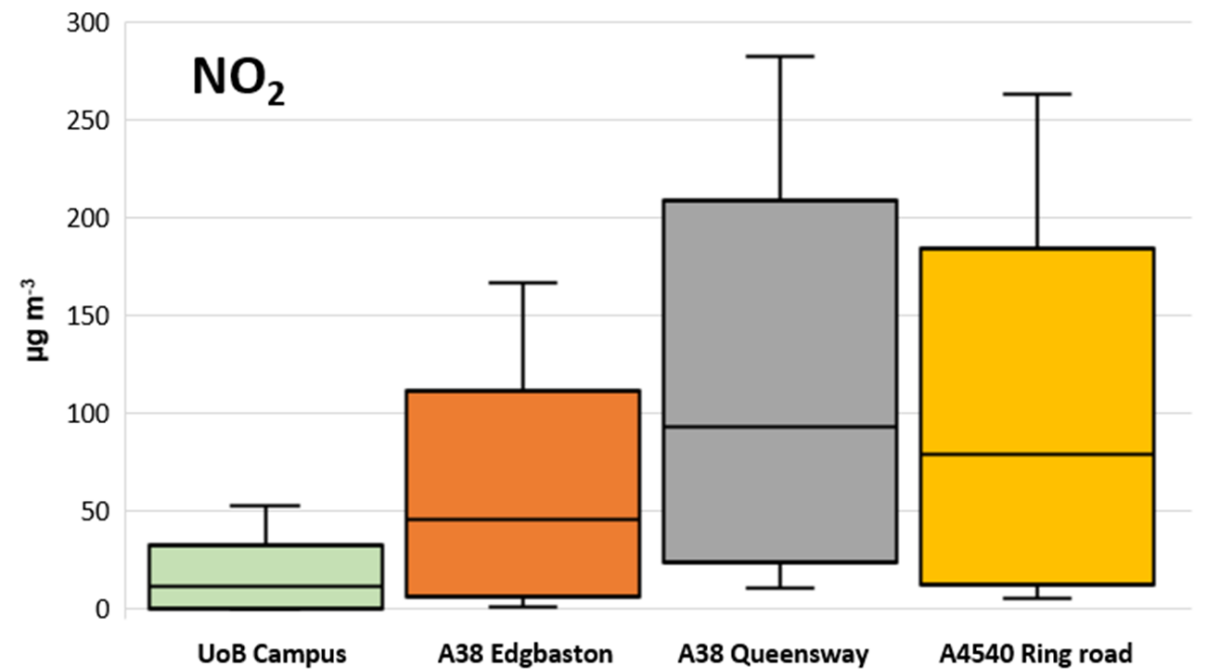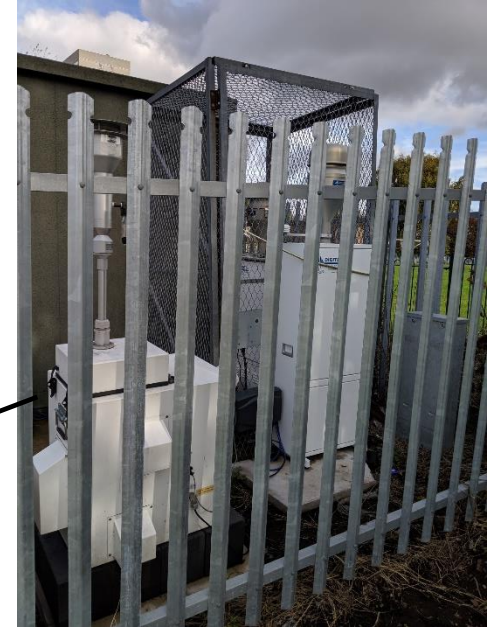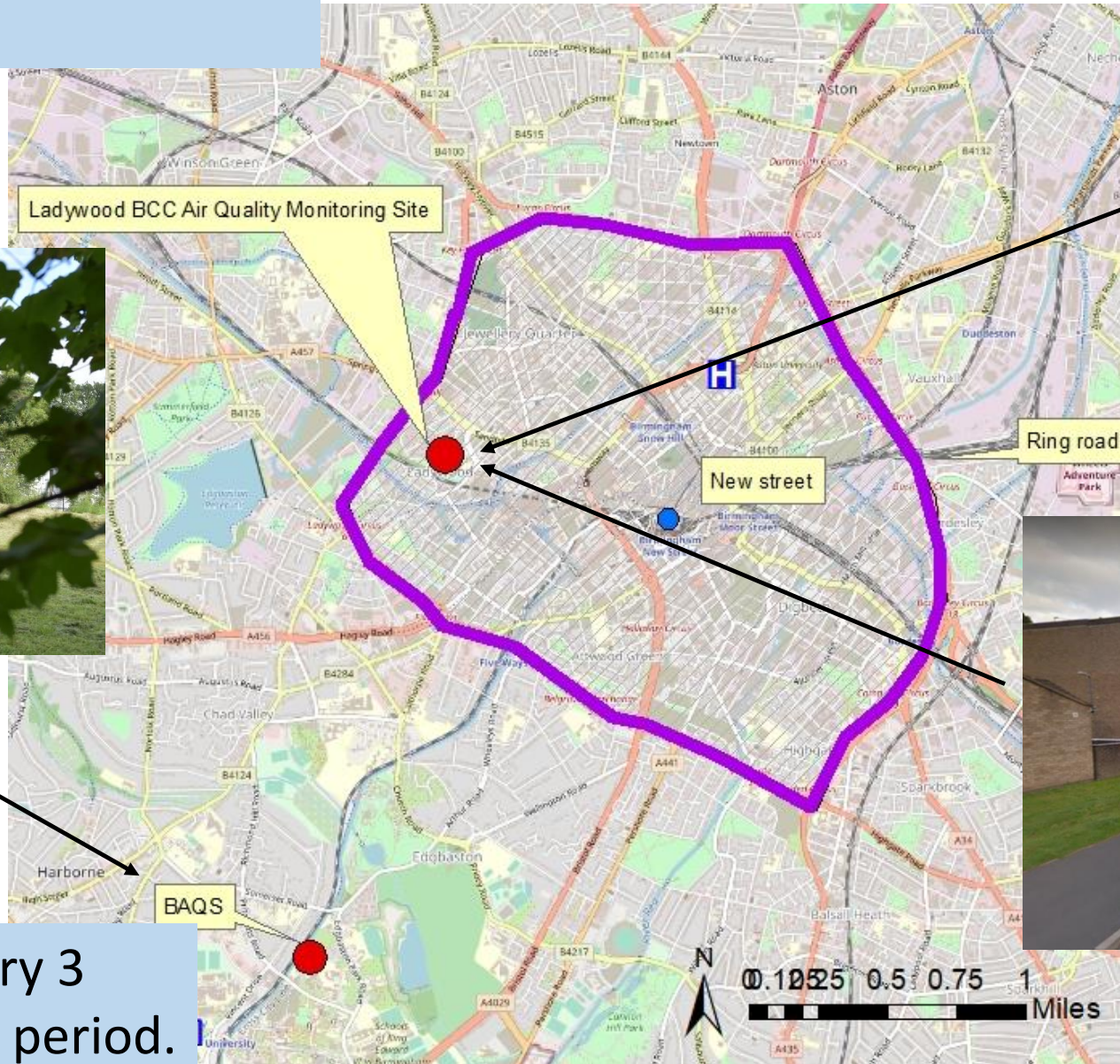
Preliminary results

- Highest single NO_2 measurement of 622 µg m^{-3} was recorded on the NE section of the A4540 ring road.

- The highest CO_2 concentration of 651 ppm was recorded in the Queensway tunnels, reflecting the high abundance of slow moving traffic & limited mixing.

Filter sampling

Ladywood BCC Air Quality Monitoring Site
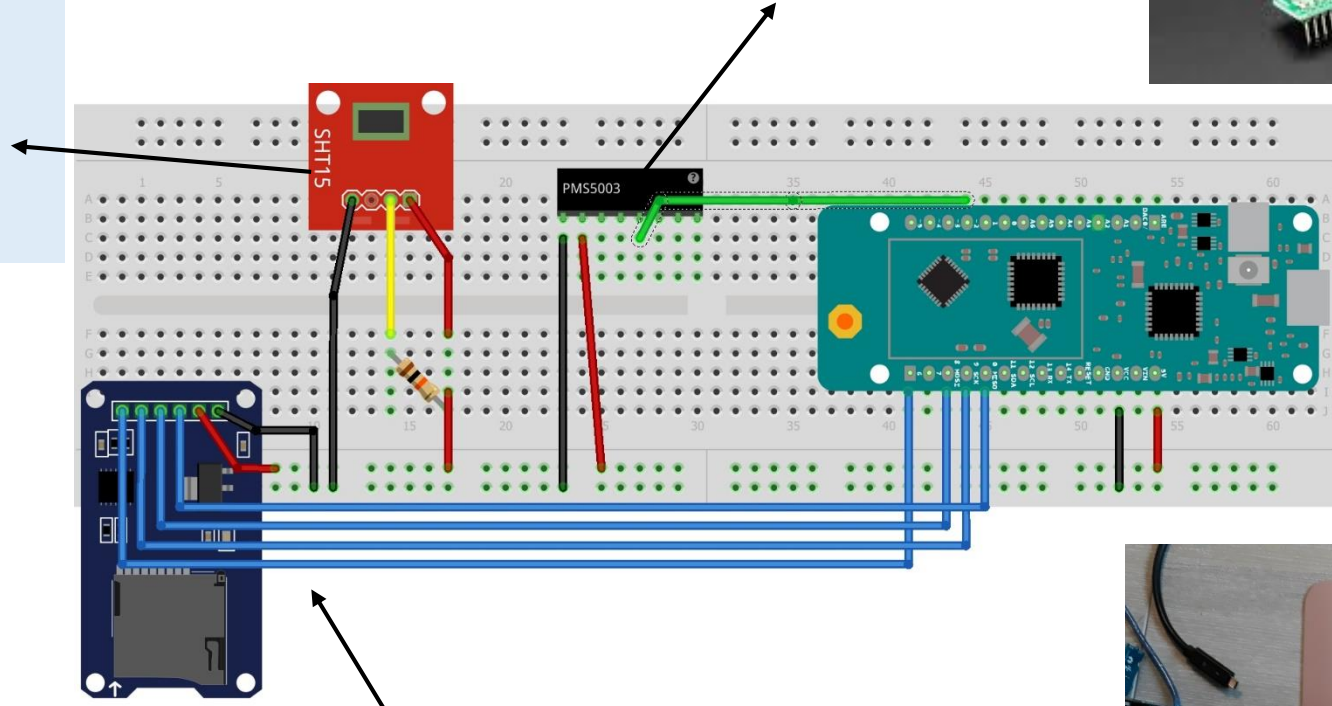
Ring road

New street

BAQS
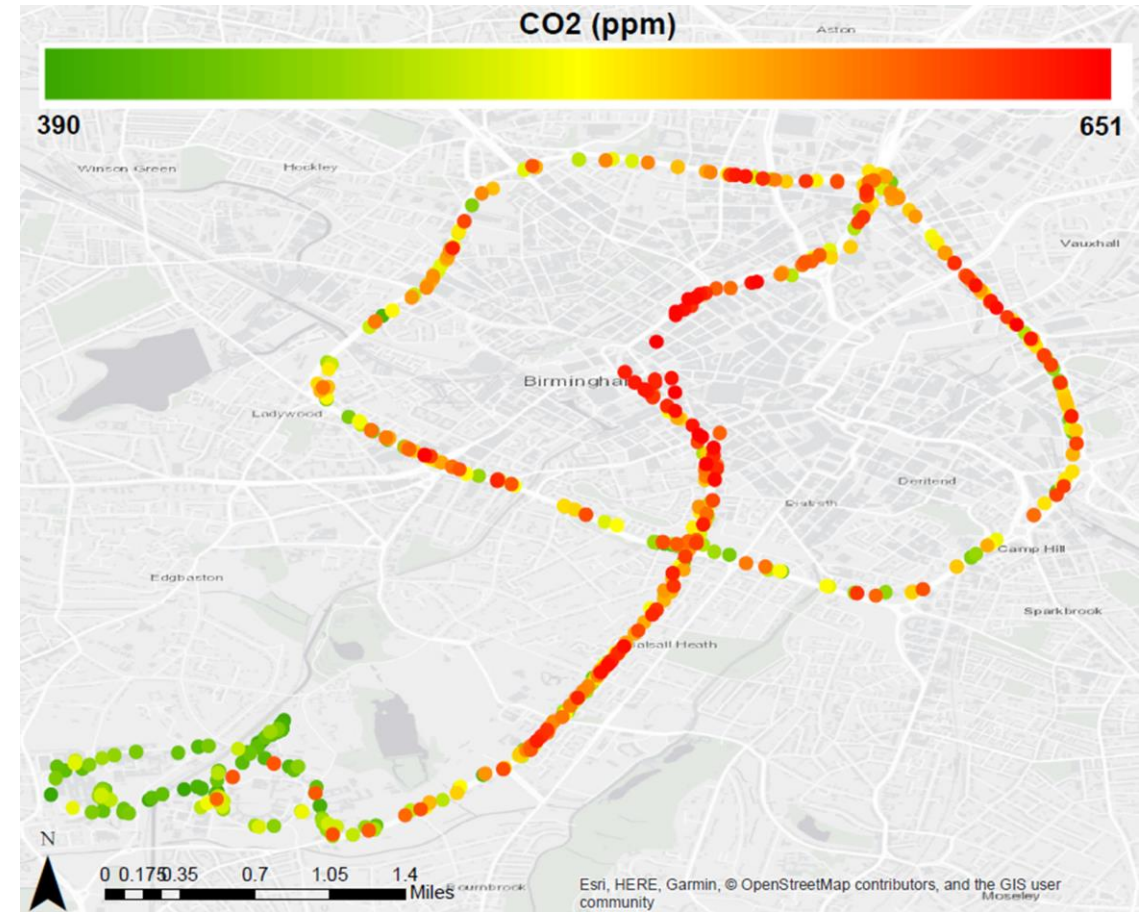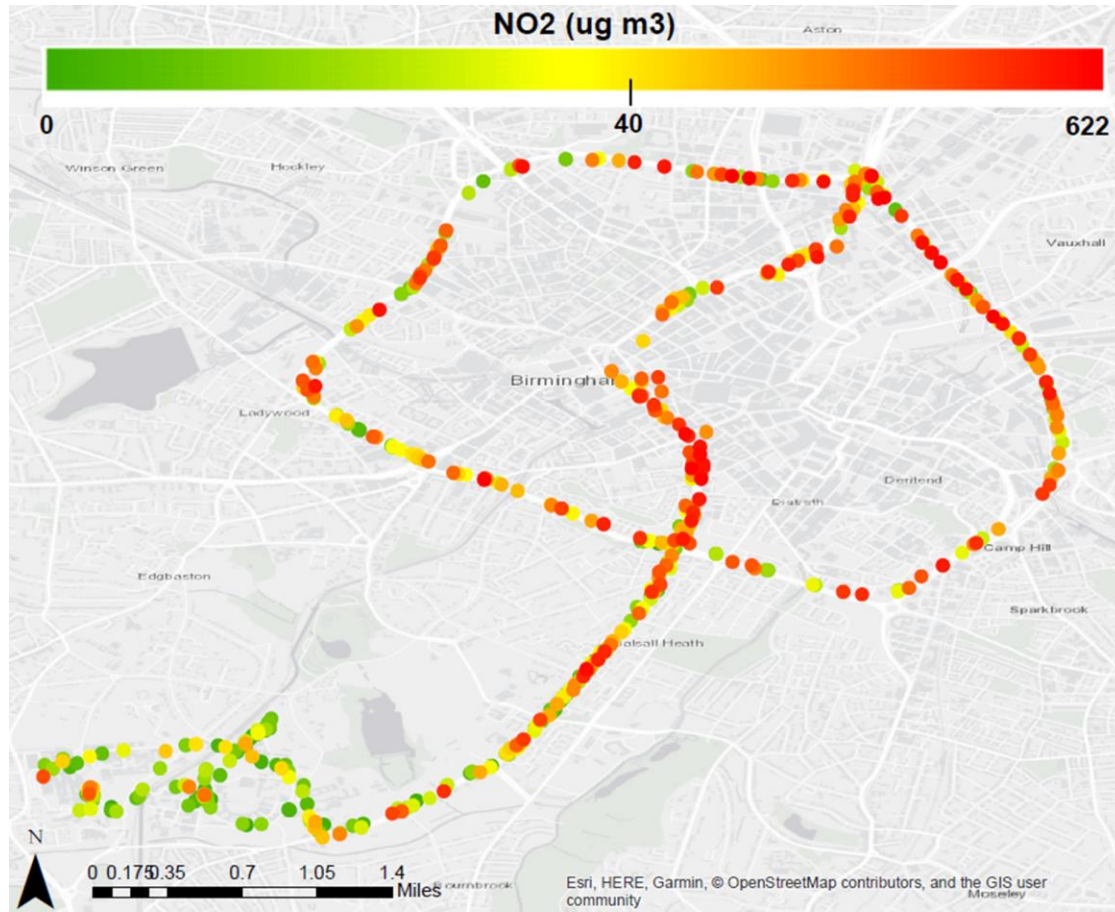
Both sites sample every 3 days for a full 24 hour period.

Low cost PM sensors

Plantower PMS5003
-detects PM1/2.5/10
with breakout board

SHT85
-temperature/humidty sensor
- ±0.1 °C, ±1.5 %RH accuracy

Microcontroller
-has sigfox connectivity
-low power board
- an IoT approach
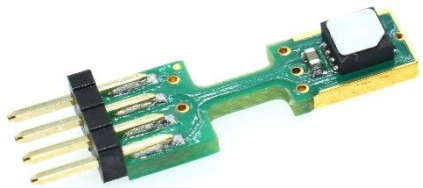
SD card & reader
-back up data
~£5 for adapter +
cost of SD card
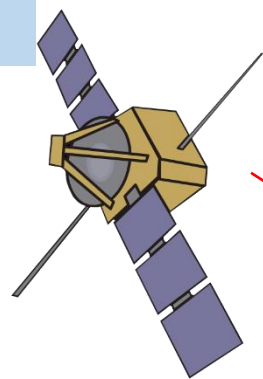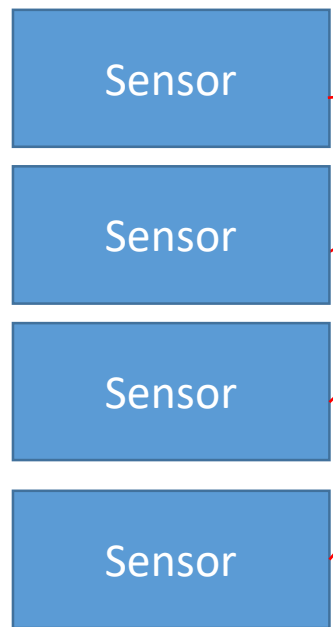
Extra costs:
-Housing & radiation shield
-Power leads
-Wiring

Low cost PM sensors- communication

- Internet of things (IoT) approach allows the machines to do the work for us, collecting and sending all data to a back end for download or processing.

- Low Power Wide Area Networks (LPWAN) such as Sigfox cost around £14 a year. A sim card with data can cost more than this for 1 month!
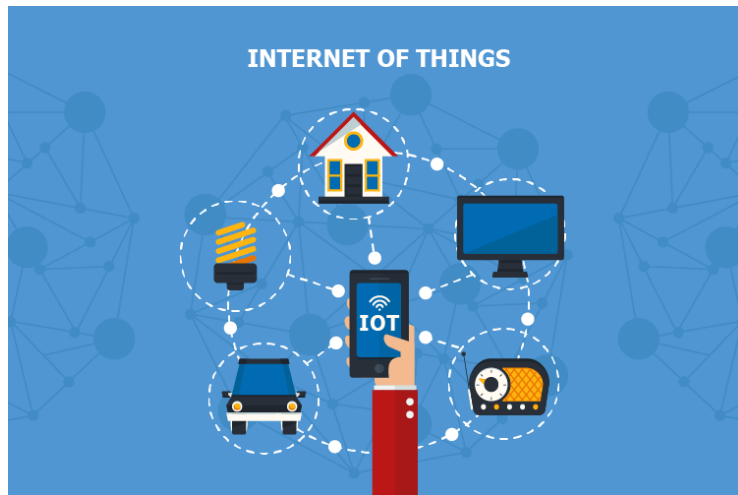
How Sigfox LPWAN communication works

Device 1D8E99 - Messages

From date [   ]

To date [   ]

page 1

Time	Data / Decoding	LQI
2019-03-29 15:41:04	4414bb1b294100	▁▃▅▇
2019-03-29 15:25:51	4414bb1b7d4300	▁▃▅▇
2019-03-29 15:25:44	4414bb1bd145001e001a0038	▁▃▅▇

The message is sent to the backend in the form of hexadecimal

An API request calls the data, runs a script and processes it into a readable CSV file

Sensors use reclaimed cellular network to send message

Untitled - Notepad

File Edit Format View Help

2019:03:29,15:41,15.3,27,
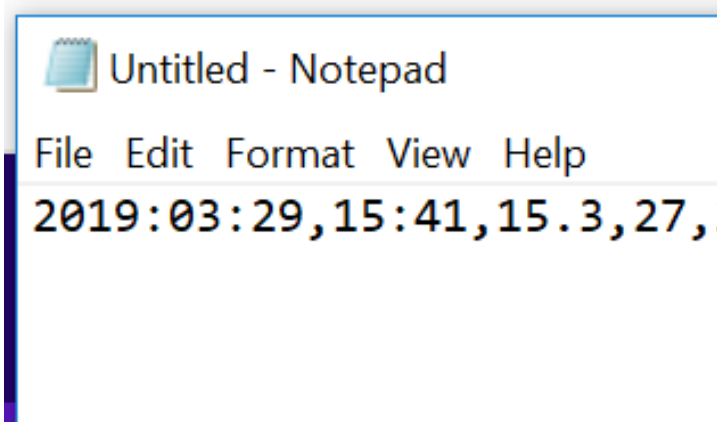
Sensors connected to the sigfox network. Work is currently being carried out to develop a server which decodes and processes this data into a user friendly format.

Plantower PMS sensors evaluated in recent literature - a good agreement with reference instruments but highly dependent on RH.

Jayaratne et al., 2018

Sayahi et al., 2019
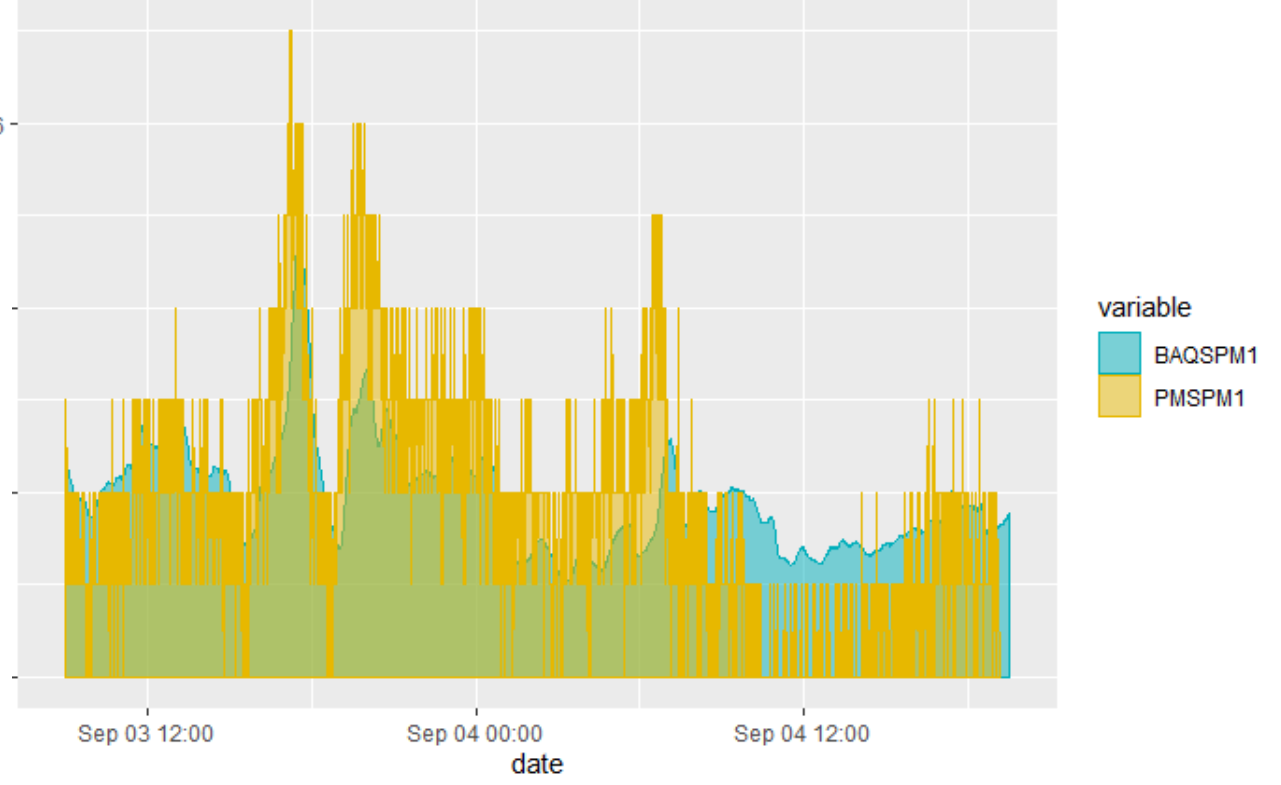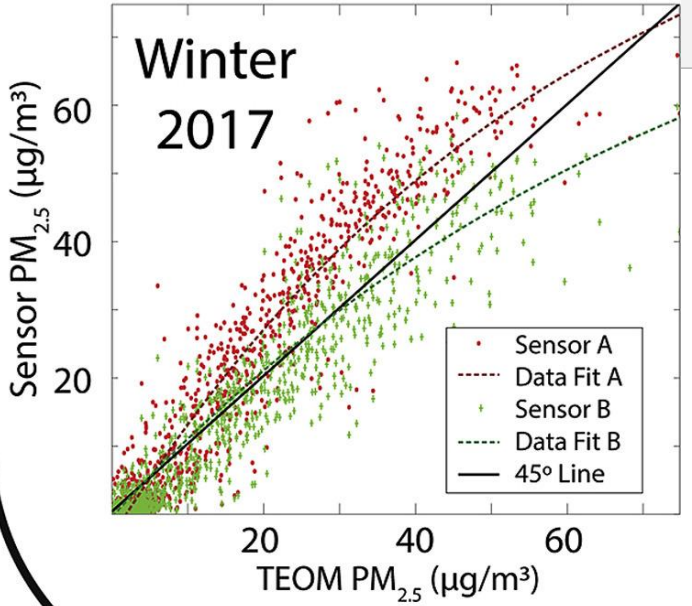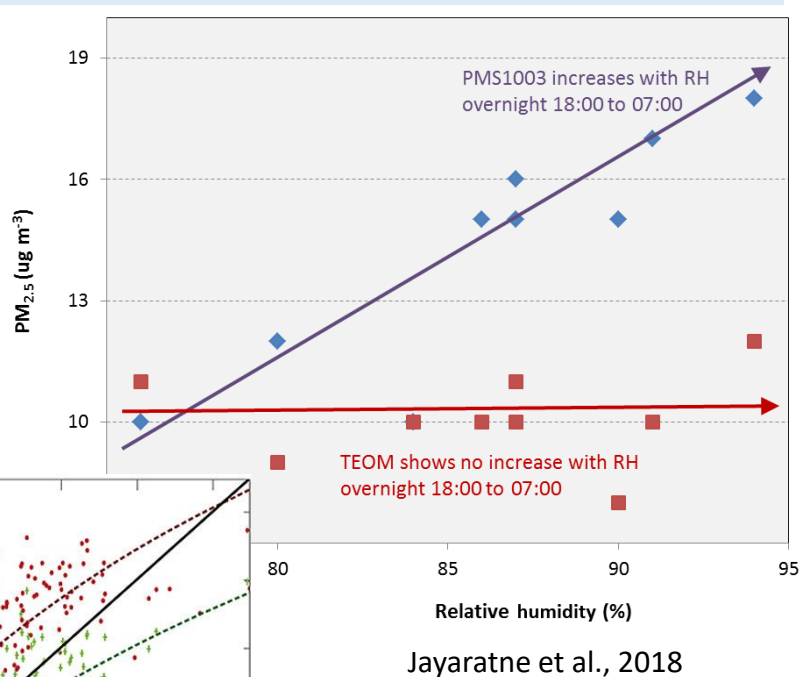
Co-locating sensors next to FIDAS: the PMS follows trends seen in reference instrument data, but can be inaccurate as meteorological conditions change throughout the diurnal cycle. Calibration will be made following Crilley et al., in 2018 at BAQS to create a correction factor for RH.

Next steps:

Van:
- Include regular PM monitoring
- Start a small loop that goes through residential area within and outside of ring road
- Apply impact of meteorology to results

Low cost sensors:
- Developing server to process/present data from servers
- Correction factor developed
- Locations for sensor deployment
- Long term sensor at BAQS to keep an eye on drift

PM source apportionment:
- Sampling
- Start offline analysis