Ricardo
Energy & Environment

Air Quality Sensors – Real World Practicalities

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IAPSC, Telford 22 Nov 18

My presentation

- A reminder
- The issues
- An update
- Standardisation
- The future?

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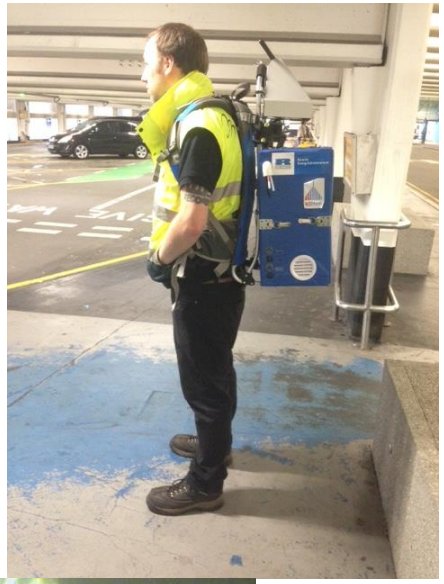
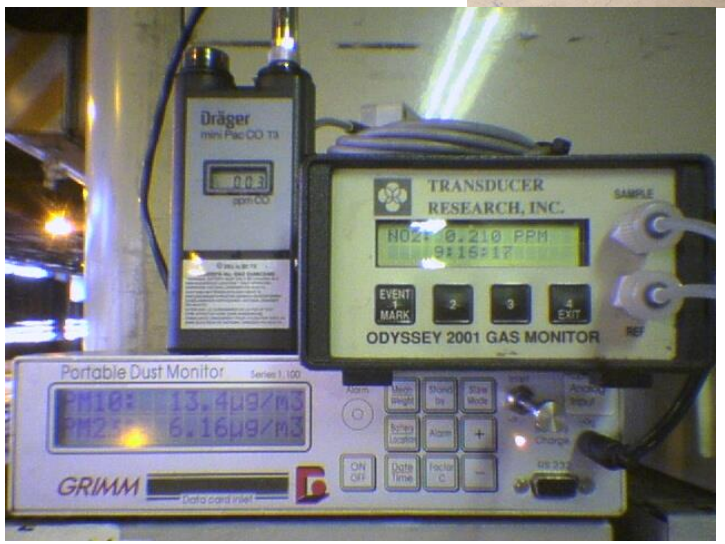
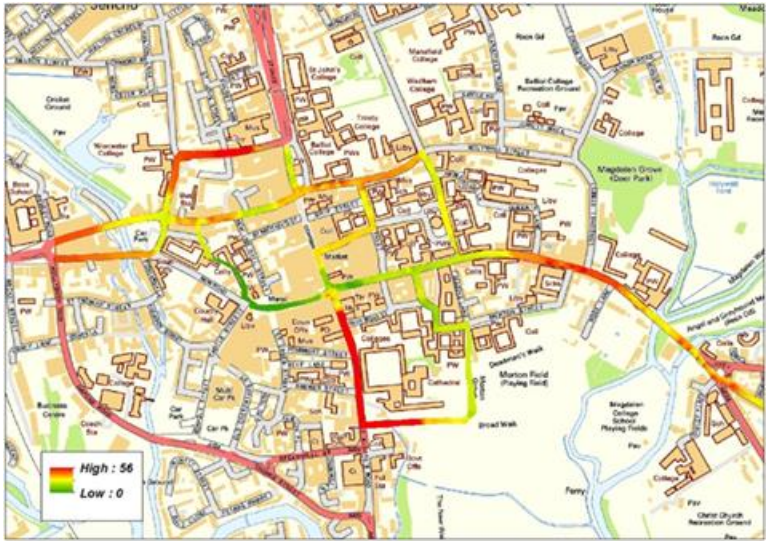
Sensors – A reminder

We've been interested in pervasive sampling for many years:







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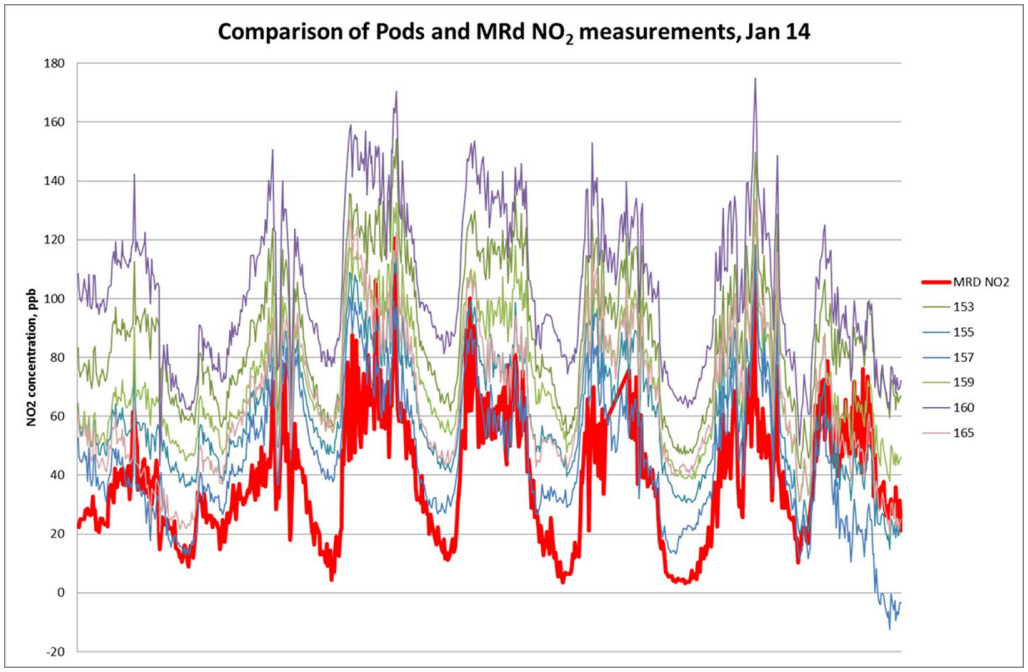
Sensors – A reminder

And I talked to IAPSC way back in June 2014:



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The issues

- Still on the upslope of the development curve
- Sensors aren’t specific
- Sensitive to T, RH, other gases
- PM sensors limited and make many assumptions
- Sensors can be neither accurate or precise
- Can’t “calibrate” them in a conventional sense
- Mid to long term drift not quantified
- Limited life expectancy (2 years max)
- Many system providers won’t share processing IP

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What is important to us as users?

Question	Answer
Can I use sensors instead of “proper” monitoring?	
Can I use sensors instead of diffusion tubes?	
Can I use sensors to identify hotspots?	
Can I use sensors to improve modelling data?	
What about mobile measurements?	
Can I use sensors to assess mitigation strategies?	
Can I use sensors at schools, indoors, in-car, etc?	
Can I “fit and forget”?	
Others?	

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Monitoring Legislation

- EU / National Legislation

Reference (or Equivalent) / Indicative

Uncertainties:

- NO_2 ±15% / 25%
- PM ±25% / 50%

(at the region of the LV)

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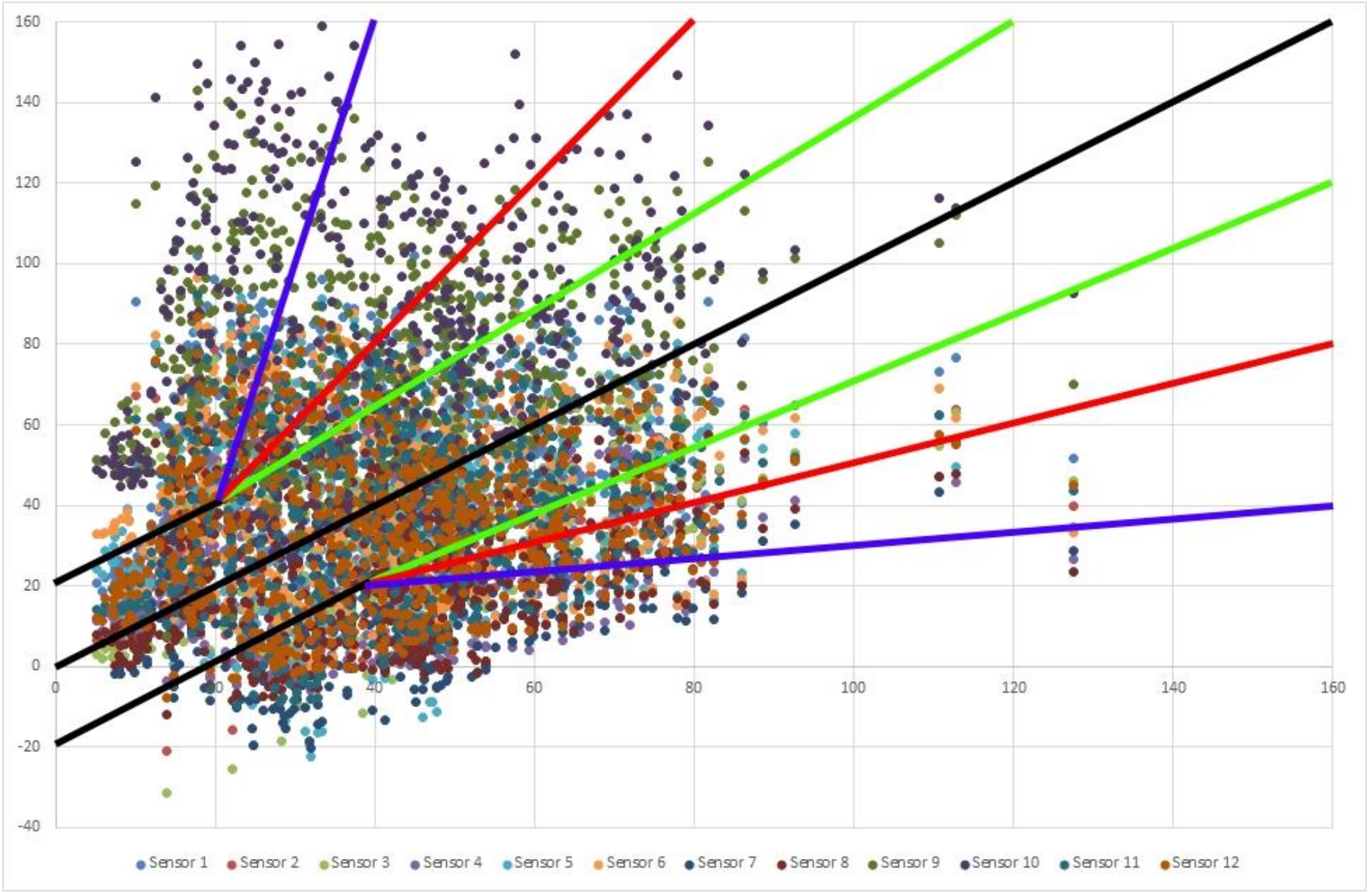
Data from 2014



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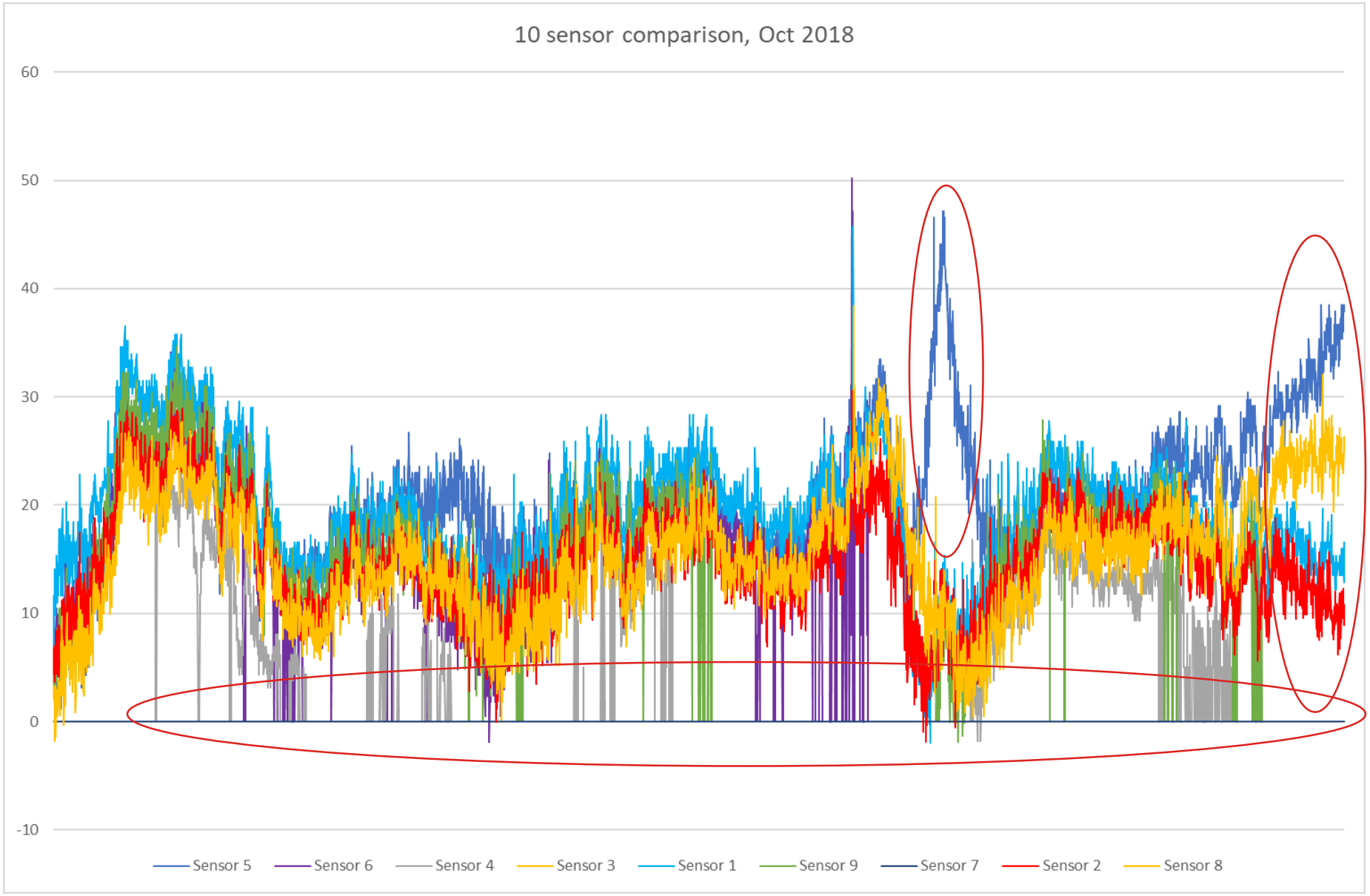
Data from 2018 (1)



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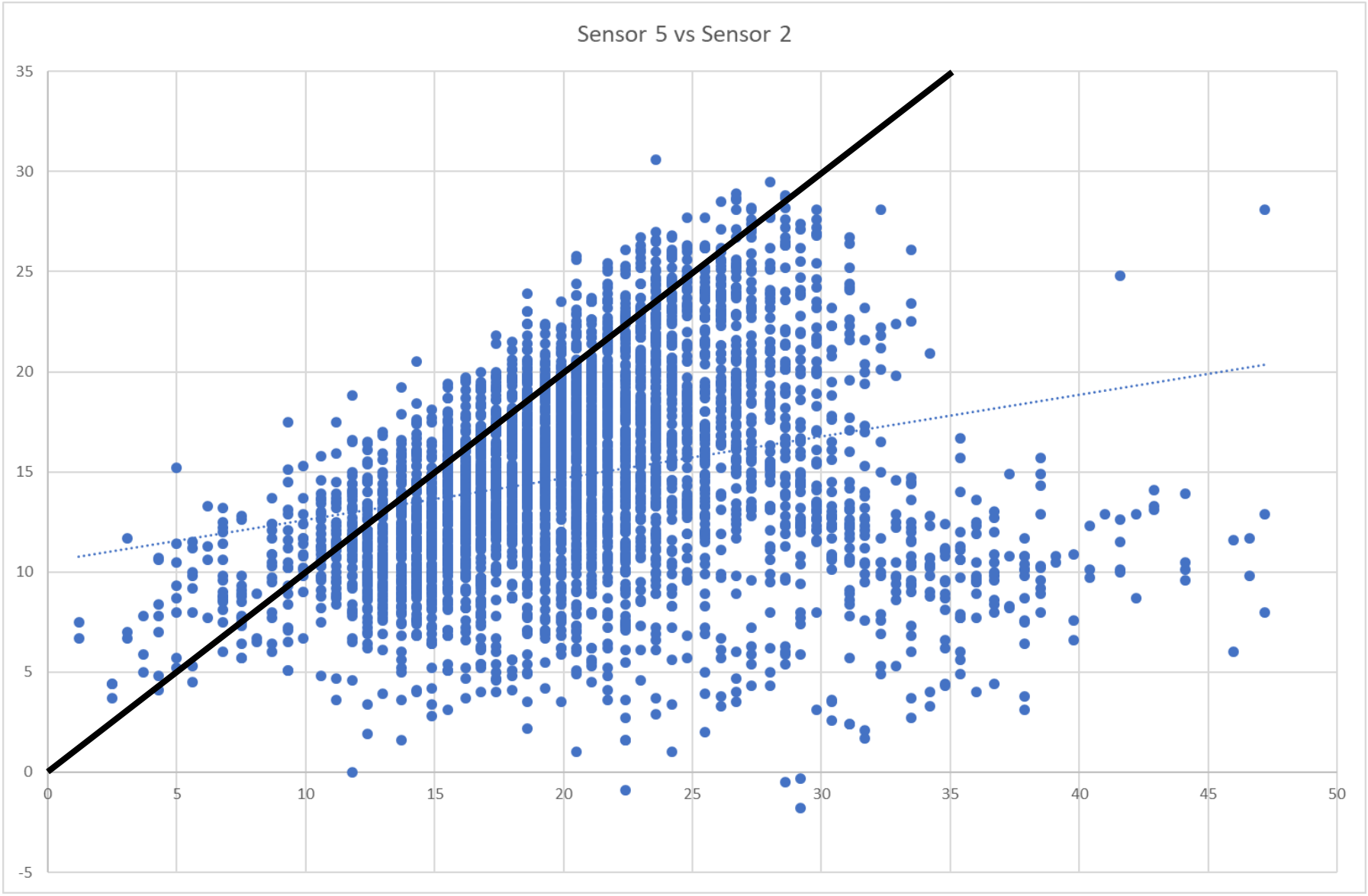
Data from 2018 (2)



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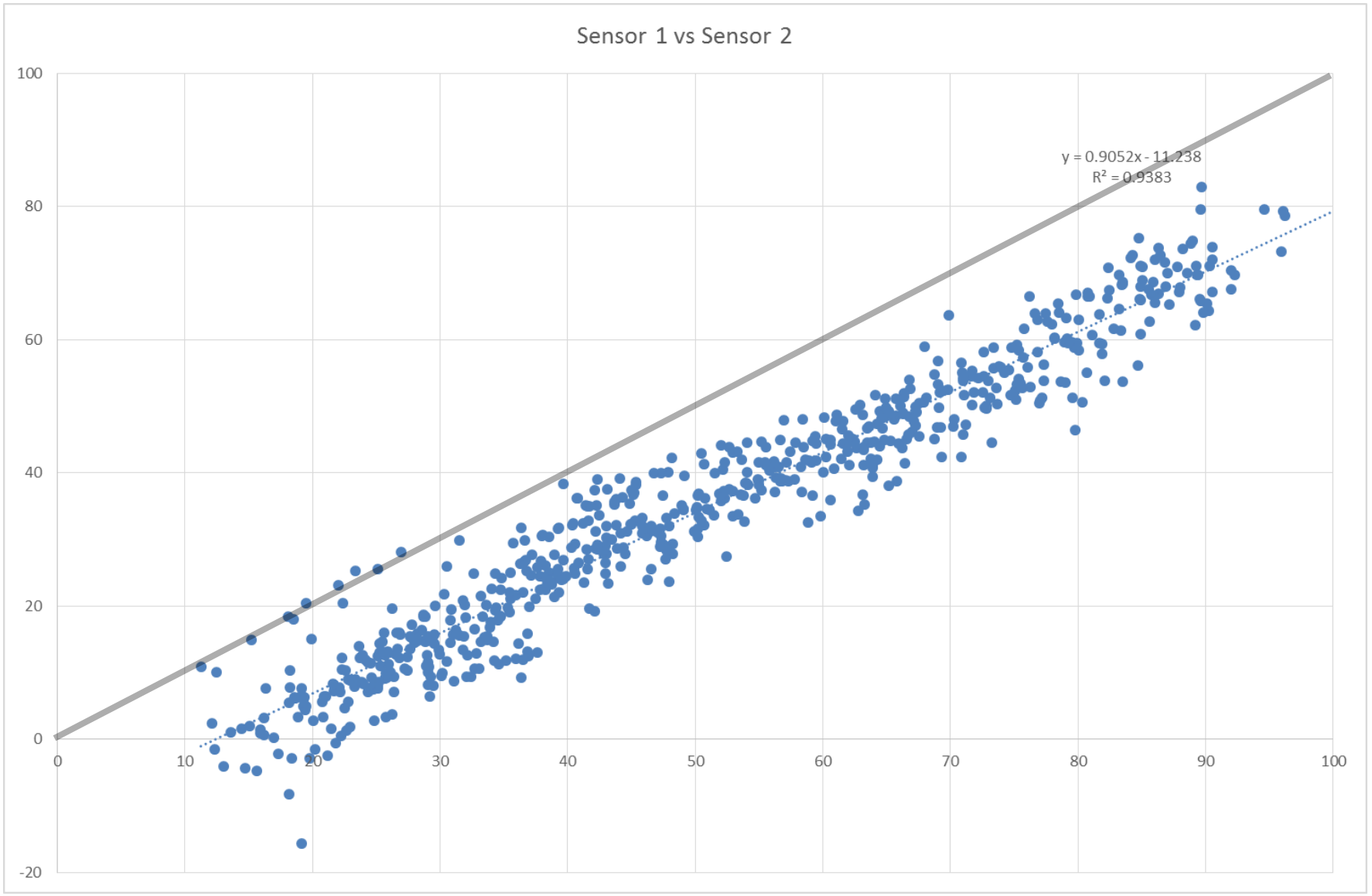
Data from 2018 (3)



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Development of performance testing – CEN WG42 activity

- WG42 investigating how to test sensors
- Not working in isolation: wide consultation with interested parties
- Main challenges:
  - Cost of testing vs price of sensors
  - Test sensors? Test end products?
  - Time required for test programme
  - Speed of sensor development
  - Where / when to test? Hot/Cold/Wet/Dry/UB/Traffic/Industrial
  - Software or algorithm updates
  - An EN specification document is still at least 2 years from completion! (but…)

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Development of performance testing – fitness for purpose.

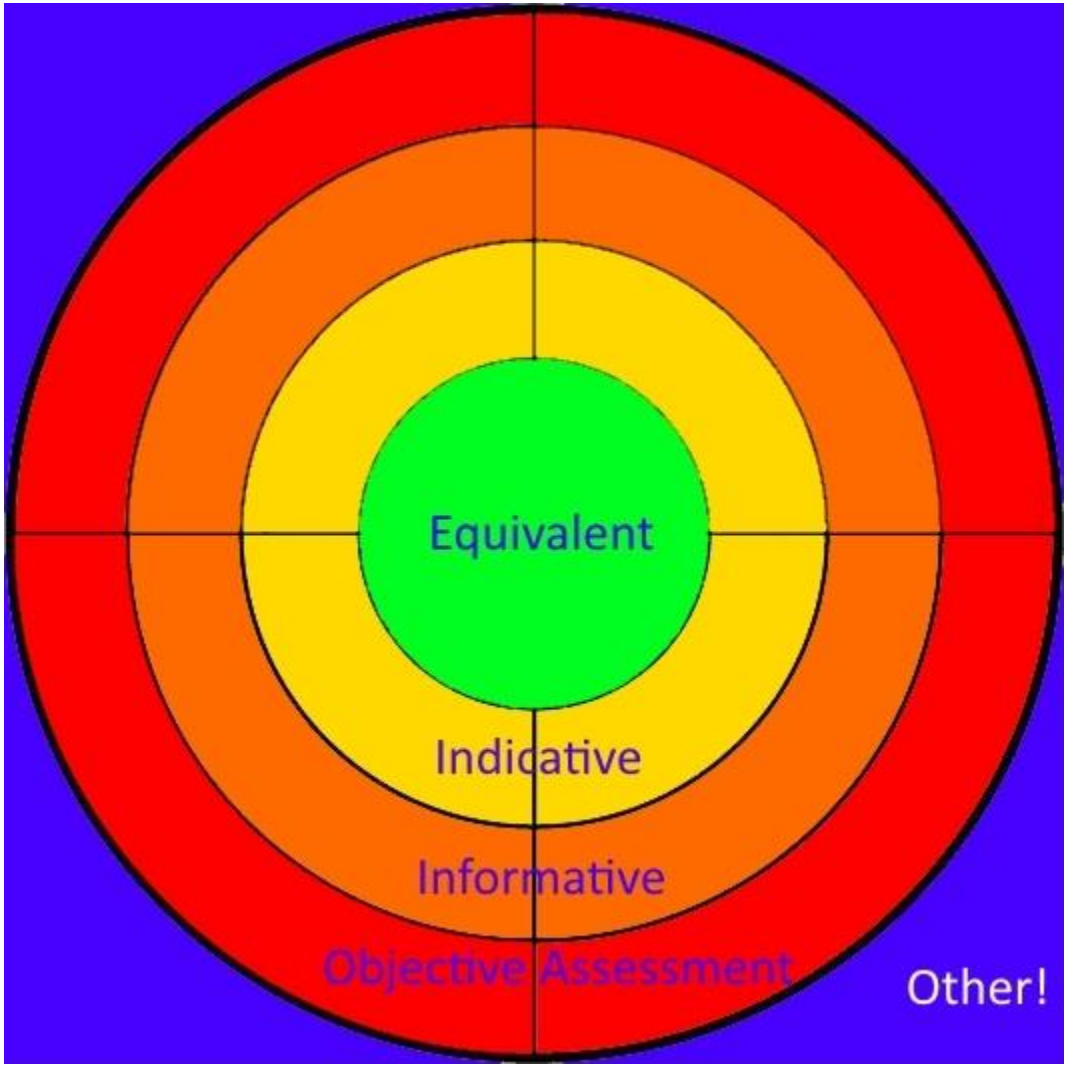
Test programme needs to allow us to categorise performance.

Already exists for Equivalence (and type testing for reference devices)

Exists for Indicative (Class 1)

Exists for Objective Assessment (Class 3)

Need description for Informative (Class 2)



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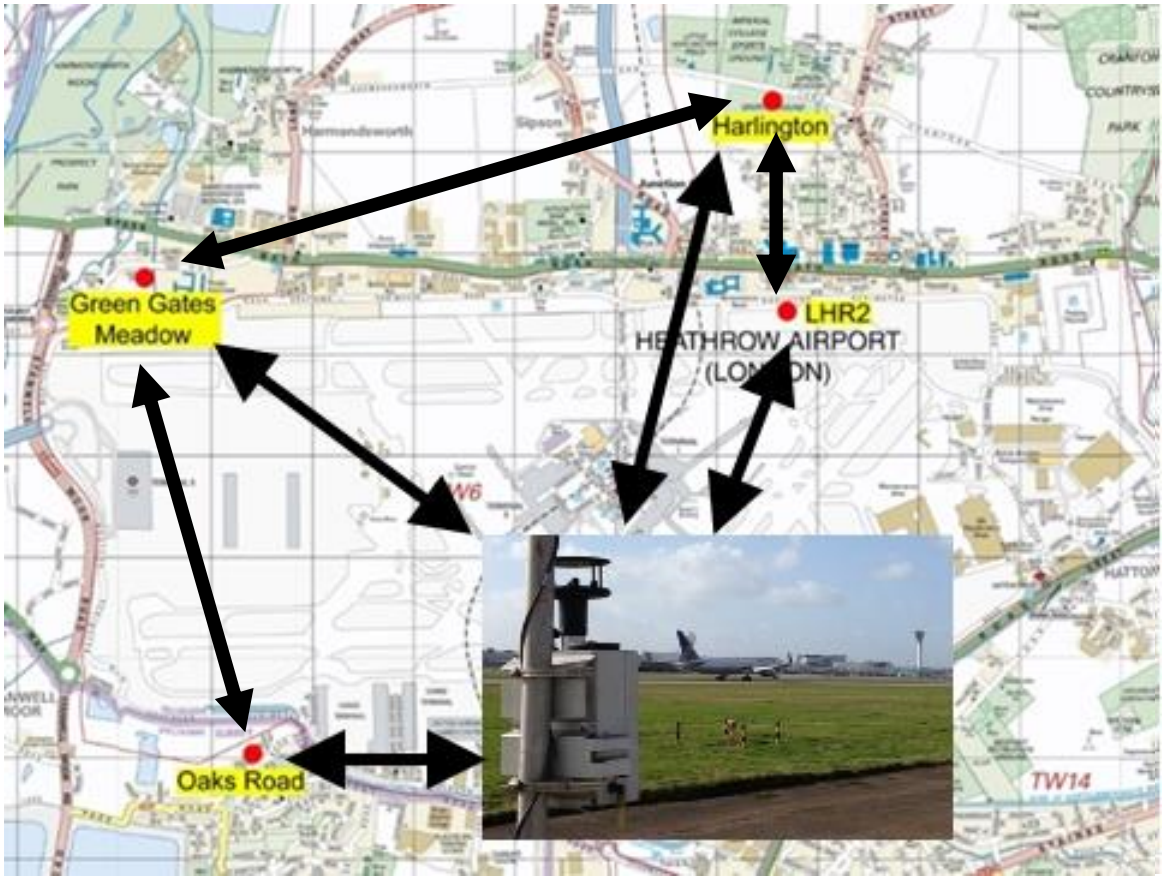
Ongoing sensor QC – suggestions to nail characterisation

Ongoing assessment probably more important than certification…

Ideas include:

- All sensors regularly assessed against a true reference station
- One sensor regularly assessed against a reference station, then used as a transfer standard at other sensor locations
- Regular co-location checks of sensor against sensor
- Use of advanced processing protocols to compare sensor responses and scale datasets (more later)



Once you have comparison data, you can start to challenge and use the measurements

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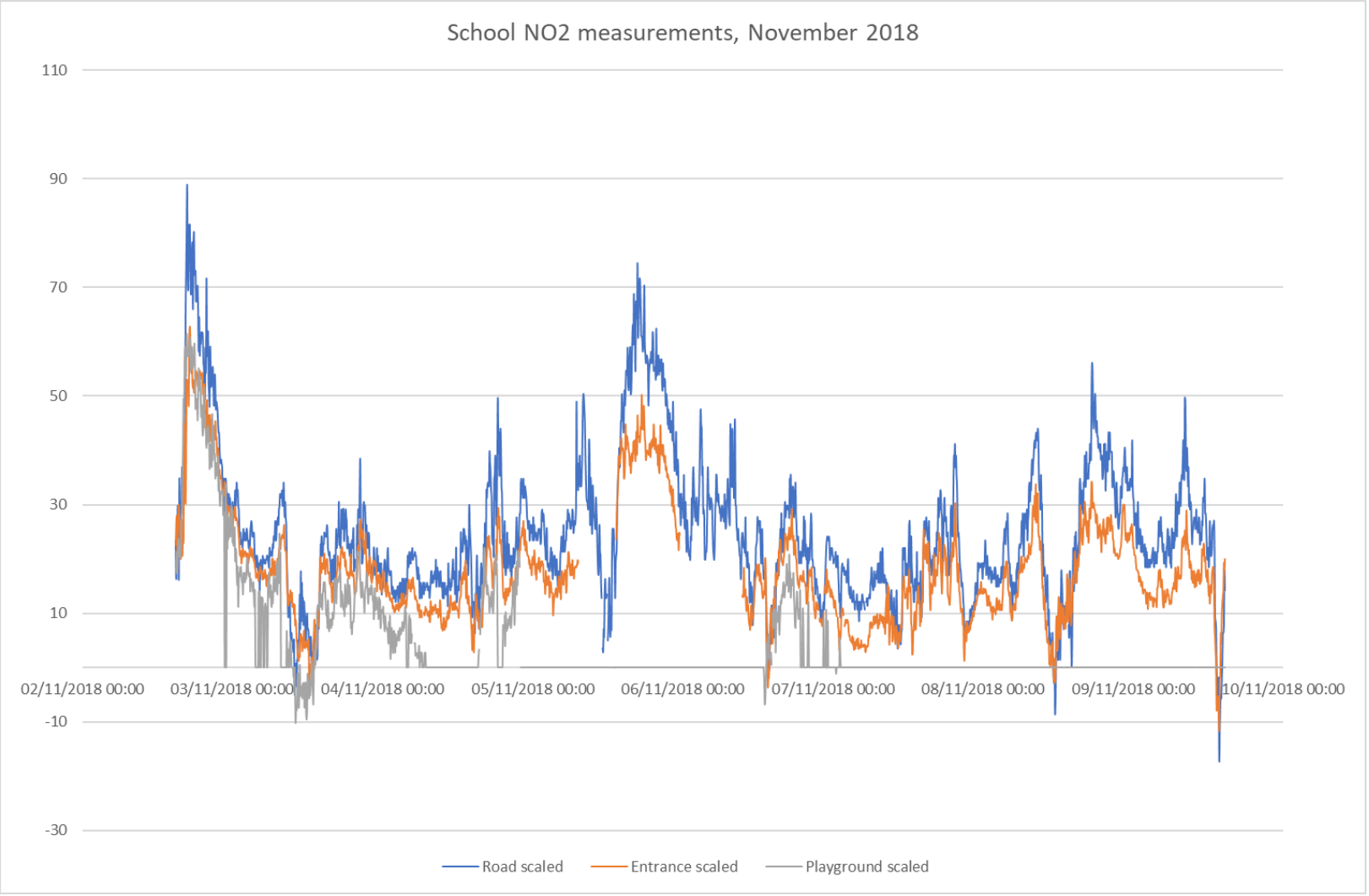
Data from 2018 (4)



Averages:

Road 27ppb

Entrance 20ppb

Playground 16ppb

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Standardisation - A Lot To Do!

- Categorise: Citizen science / screening / traffic management / equivalent?
- Define performance parameters, make sure appropriate for each category
- Lab tests?
- Field Tests?
- Seasonal / Location issues?
- Ongoing QC?
- Stability over time?

- How to encapsulate all this into a certificate!

- PRICE!

WMO draft guidance for sensors:

Use of AQ sensors potentially provides a huge opportunity to enhance the power of ambient monitoring data and its use to fulfil a number of purposes.

However, understanding exactly what purpose the data will serve is critical in designing the approach to deploying sensors.

Data quality is a critical issue and using sensors alongside conventional monitoring techniques is extremely helpful.

There are no existing standards for the vast majority of AQ sensing techniques and therefore interpretation of data requires careful consideration and understanding of uncertainties.

Overall knowledge in this area is quite low and if any new studies can seek to add to this as part of work undertaken it would be very useful.

http://www.wmo.int/pages/prog/arep/gaw/documents/Draft_low_cost_sensors.pdf

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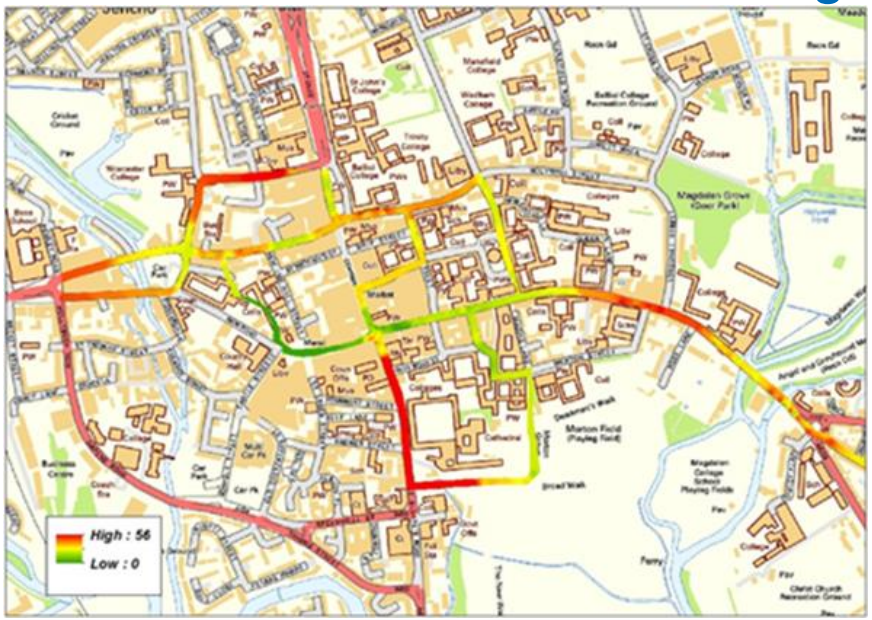
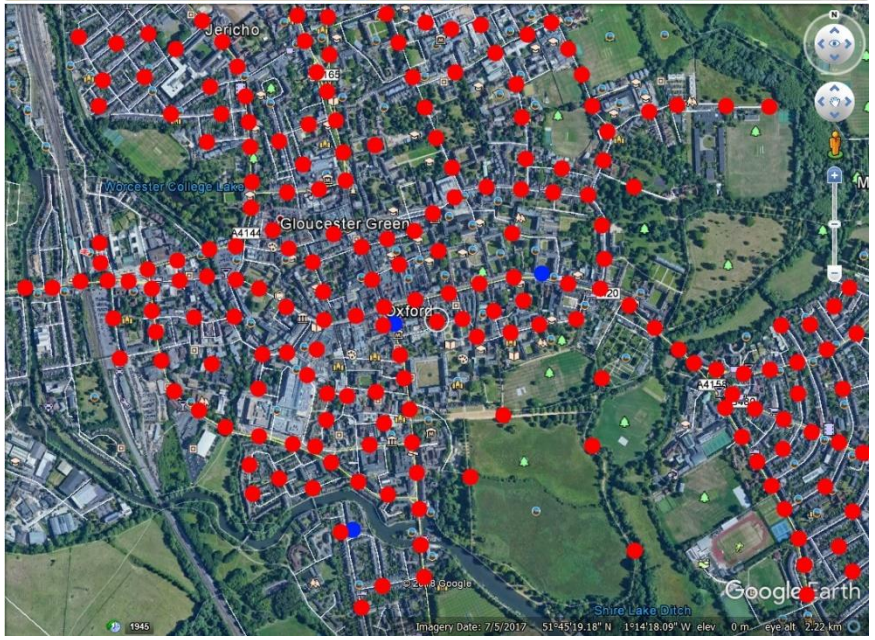
An alternative? Machine learning / training





- Sensors of the same type typically behave similarly when exposed to the “same” weather.
- Means it might be possible to look at large networks of sensors and bulk process them for baseline and response profiles
- Consistent internal QC – will be useful for building detailed pollution maps / clean routes to work, mitigation strategies etc.
- But: serious processing / communications requirements – not cheap.

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User experiences?

- Have you used sensor systems in anger?
- What are your experiences?
- Highs?
- Lows?
- Lessons learned?

- Defra keen to understand your experiences and develop guidance (parallel to WG42) for a handbook

Please send feedback to:

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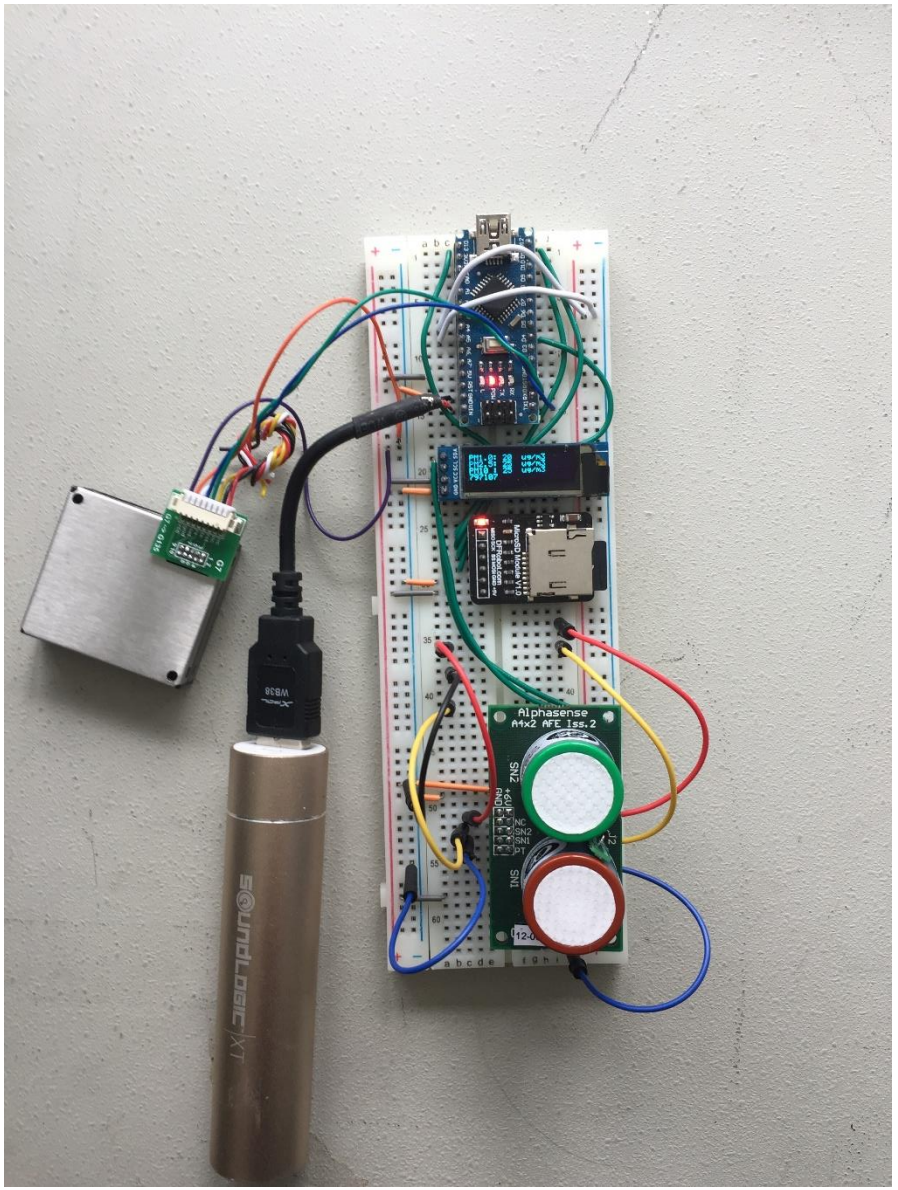
- nick.martin@npl.co.uk



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Applications

Question	Answer
Can I use sensors instead of proper monitoring?	**No**
Can I use sensors instead of diffusion tubes?	**Maybe**
Can I use sensors to identify hotspots?	**Yes**
Can I use sensors to improve modelling data?	**Maybe**
What about mobile measurements?	**Yes**
Can I use sensors to assess mitigation strategies?	**Maybe**
Can I use sensors at schools, indoors, in-car, etc?	**Yes**
Can I “fit and forget”?	**No**

But: You’ll still need to keep a keen eye on QA/QC

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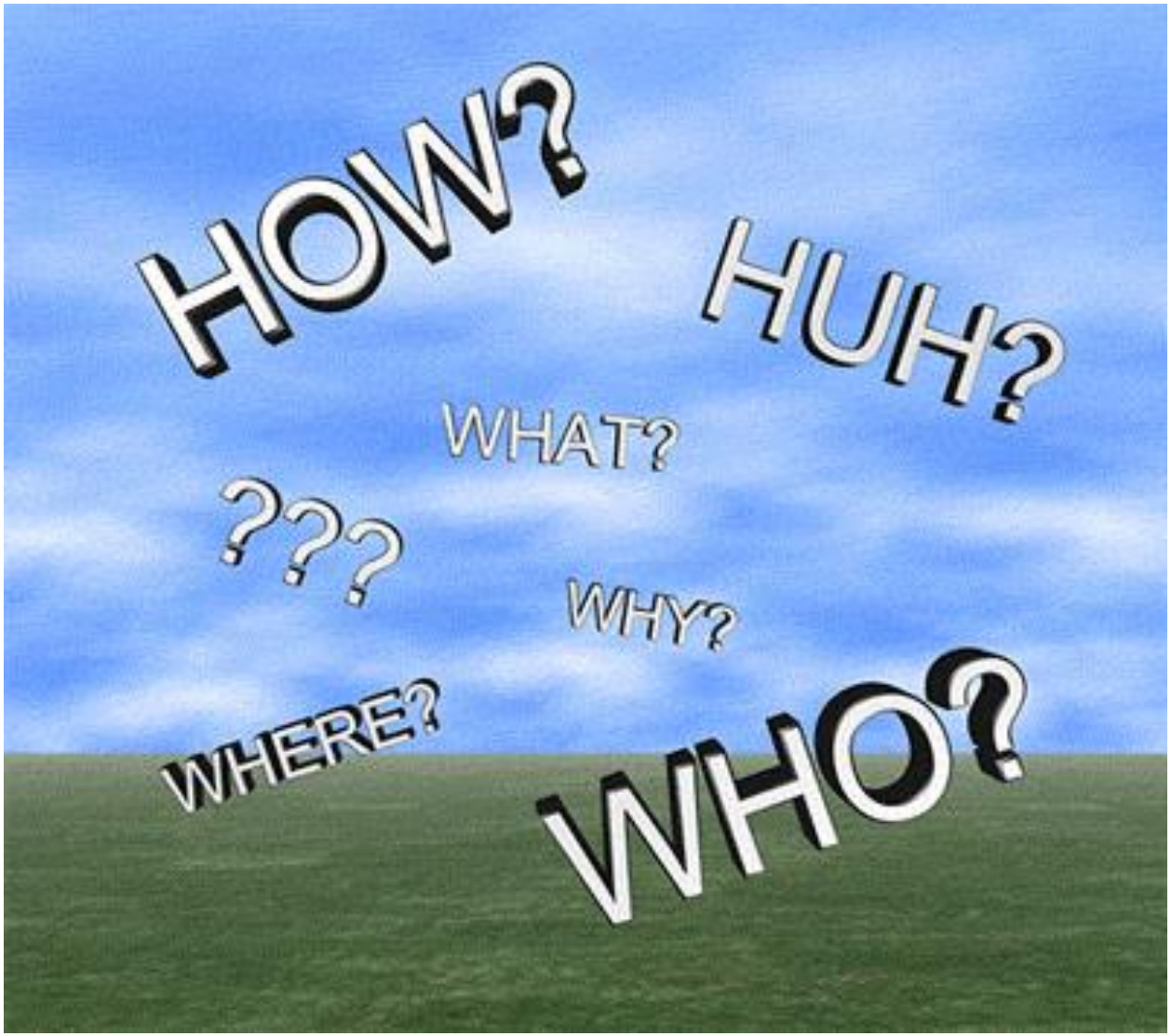
Thank you!



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