

A wide-angle photograph of the Earth as seen from space, showing the curvature of the planet, the blue atmosphere, and white clouds over a dark landmass.

Spotlight on Local Air Quality New Technology and Tools

09 May 2023

Spotlight on Local Air Quality: An Introduction

- Welcome!
- Local authority (and their air quality partners) only webinar
- Free!
- Interactive
- Current topics
- Who are the presenters?

Jo Davies



Stephen Stratton



James Southgate



Louisa Kramer



AGENDA

Air Quality Sensors

The benefits of QC

Public Engagement & Pollution Forecasting

Air Quality Data & Reporting

The phase out of 3G and 2G

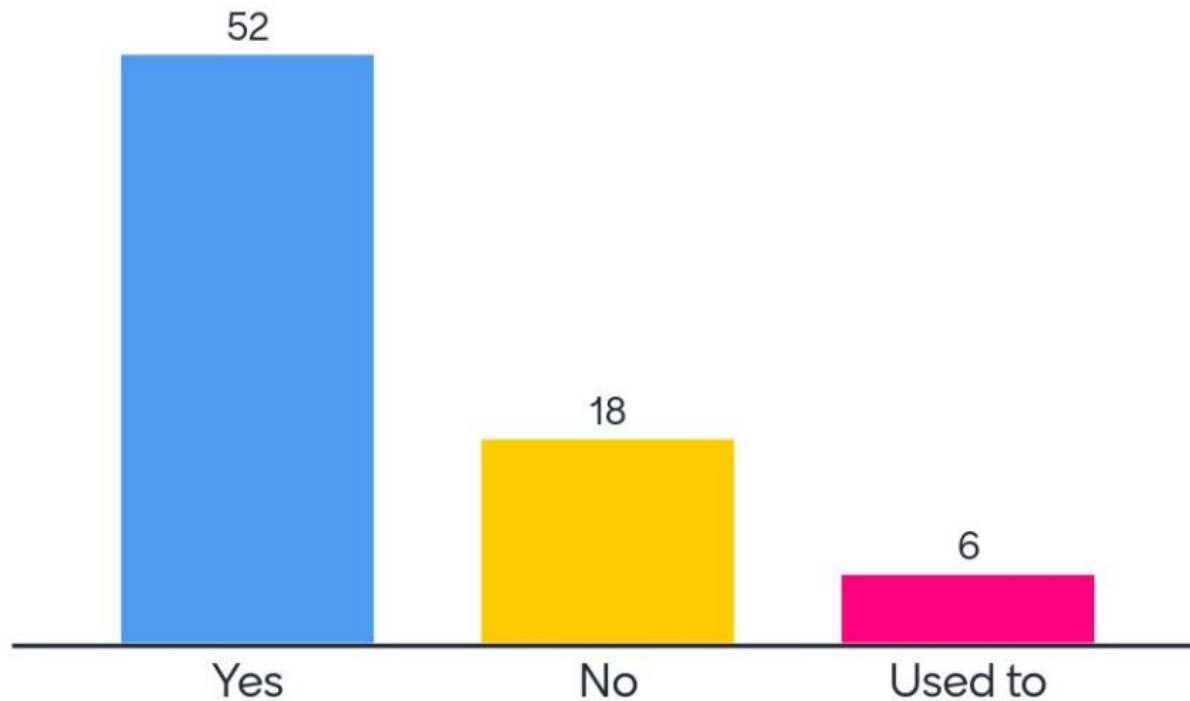
Close



Air Quality Sensors

Stephen Stratton – Ricardo EE

Do you have any sensors deployed currently within the LA



Air quality sensors are an indicative measurement technique

What does this mean?

- Higher uncertainty associated with the measurements, typically $\pm 25\%$ or greater for gaseous pollutants and $\pm 50\%$ or greater for particulate matter (PM). Compare this to the measurement uncertainty for reference monitoring, which should meet $\pm 15\%$ for gases and $\pm 25\%$ for PM **with appropriate quality control (QC)**.
- Cannot be used to conclude that air quality standards have been exceeded, only that there is an indication the standards could have been exceeded.
- Can be used for investigating trends **with appropriate QC**.
- Where reference data are available, policy development and mitigation strategies would not be based only on indicative monitoring but would use this data in combination with more accurate reference monitoring.

What do we mean by Sensor Technology?

Sensor:

- a component that responds to a range of pollutants in a certain way.
- Have the capability to measure high time resolution data

Sensor system or “low-cost” sensor (LCS):

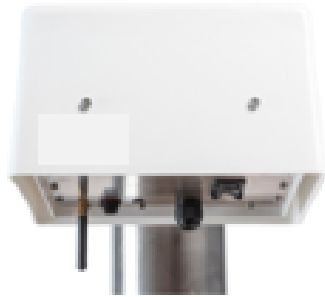
- a compact unit built with
- multiple sensors
- NO₂, NO, CO, SO₂, PM (PM₁, PM_{2.5} and PM₁₀), O₃, CO₂, H₂S, TVOC
- Controlling firmware/hardware
- Telemetry
- Met (wind, humidity, pressure, Temp.)
- Power supply

Reference analyser – an instrument with tested and quantified performance, that usually requires a lot of infrastructure.

Passive monitoring – diffusion tubes



Lots of choice!



Standards

- Working Group 42 developing standards for testing air quality sensor systems – Tech spec for gaseous sensors published (TS 17660-1:2021*), which defines three classes:
 - Class 1 ($\pm 25\%$) - Indicative
 - Class 2 ($\pm 75\%$) - Objective estimation
 - Class 3 ($\pm 200\%$) - Non-regulatory
 - Combination of lab and field tests
- Technical Document for PM (Part 2) due to be published 2024 (possibly)
- MCERTS for PM – EN BS 16450**
- We have a Tech Spec but no LCS tested yet...

*Air quality - Performance evaluation of air quality sensor systems - Part 1: Gaseous pollutants in ambient air

**Ambient air — Automated measuring systems for the measurement of the concentration of particulate matter (PM₁₀; PM_{2.5})



Points to consider when procuring sensors

Evidence of **independent** sensor performance evaluation:

- MCERTS - <https://www.csagroup.org/en-gb/services/mcerts/mcerts-product-certification/mcerts-certified-products/mcerts-certified-products-indicative-ambient-particulate-monitors/>
 - <https://airparif.shinyapps.io/ChallengeResultsEN/>
 - <http://www.aqmd.gov/aq-spec/evaluations>
-
- Maintenance requirements:
 - Power (battery, solar, mains)
 - Sensor life span
 - What's included in the sensor maintenance package
 - Replacement of sensors – additional cost?
 - Subscription service – everything included?
 - Data storage and accessibility
 - Calibration requirements
 - Size and weight – weights can range from 100g – 20kg



Points to consider when procuring sensors

What are you using the sensor for?

- Investigating absolute concentrations able to demonstrate precision and accuracy
- Policy development (LAQM) – need to be able to demonstrate precision and / or accuracy
- Educational / raising awareness – doesn't necessarily need to demonstrated precision / accuracy

Price and length of use:

- Range of cost: £500 - £20,000
- Cheaper sensor system with annual subscription may end up costing more than a more expensive system over a long period of time.

Speak to other local authorities about their experience



Example of Lab Evaluation – Plumelabs Flow 2



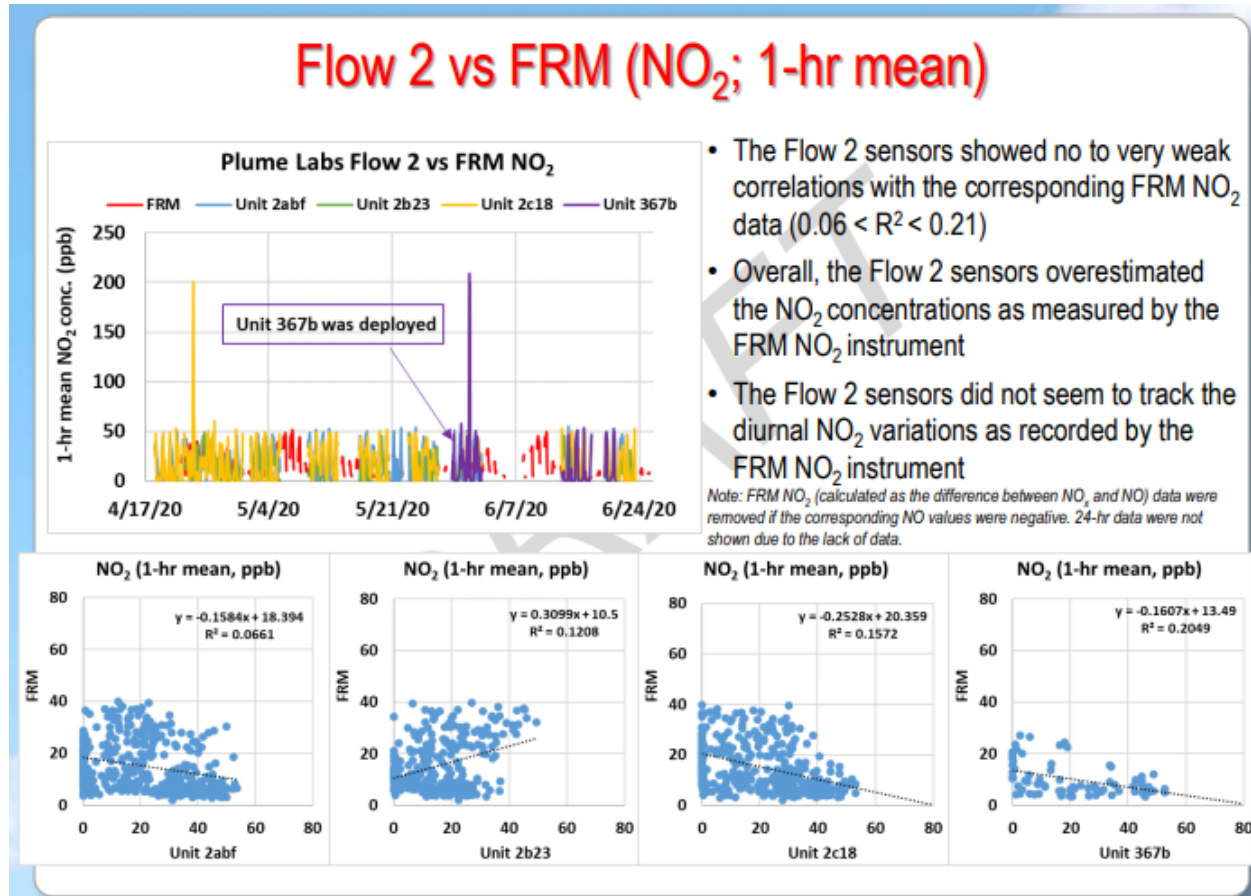
NO2

	Median	Lowest	Highest
Slope	0.88	0.83	0.94
Intercept ($\mu\text{g}/\text{m}^3$)	14.6	-10.9	25.3
R (%)	96.0%	84.4%	98.5%
MAE ($\mu\text{g}/\text{m}^3$)	36.4	29.2	42.3
Inter-Flow average correlation	> 95%		

Table 1: NO2 performance evaluation

<https://drive.google.com/file/d/1KLe72CT1bPLIYIfo74y2hN5Mca7bGose/view>

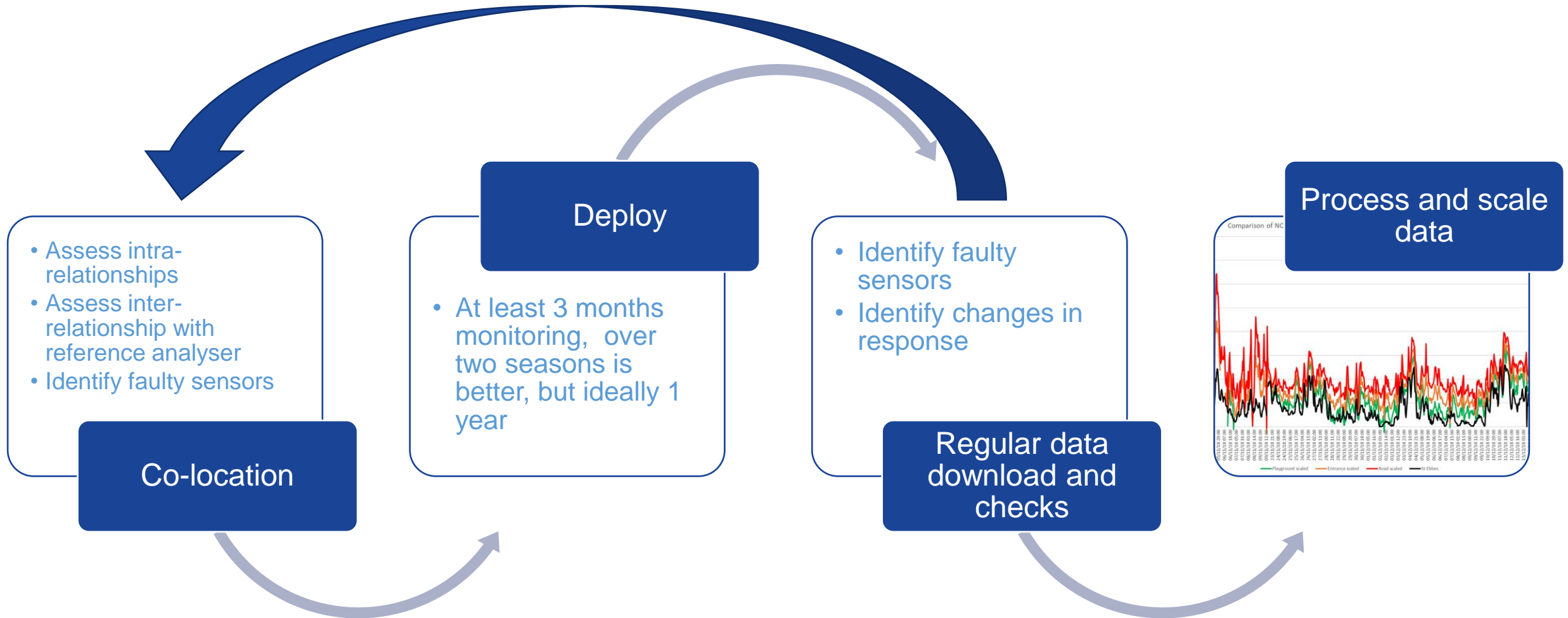
Example of Independent Field Evaluation – Plumelabs Flow 2



<http://www.aqmd.gov/docs/default-source/aq-spec/field-evaluations/plume-labs-flow-2---field-evaluation.pdf?sfvrsn=8>

QC Process

Change in response, repaired or replaced



Case Study – Luton Council

Example of services provided:

- High-level overview of market-ready commercial air quality sensor capabilities, setting out the pros and cons of each
- Site survey and sensor installation.
- QA/QC
- Data management
- Air quality alerts
- Near real-time data dissemination
- Monthly reporting with analysis

“Ricardo’s advice in the scoping stages of the project was particularly useful in helping to firm up exactly what we needed, as was the fact that the team was able to offer instruments from a variety of manufacturers.”

Andrew Loosley, Technical Officer (Environmental Protection), Luton Council

<https://www.ricardo.com/en/case-studies/ricardo-qaqc-of-air-quality-sensor-data-provides-reliable-results-for-luton-council>

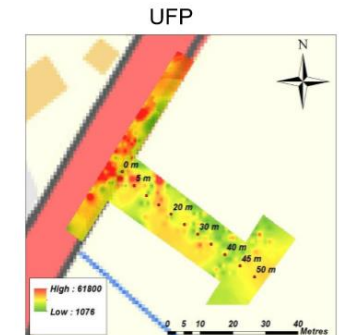
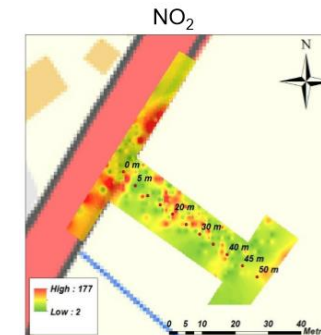
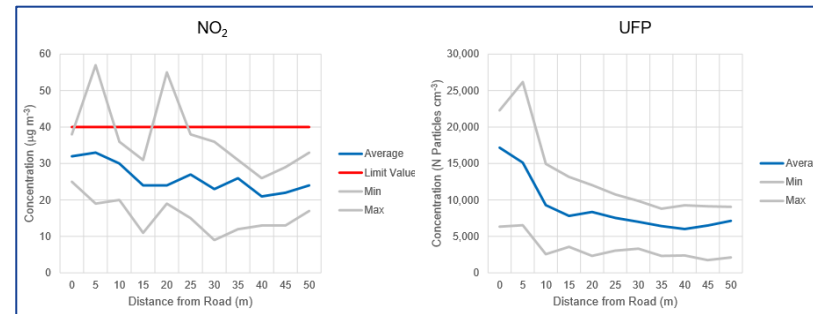
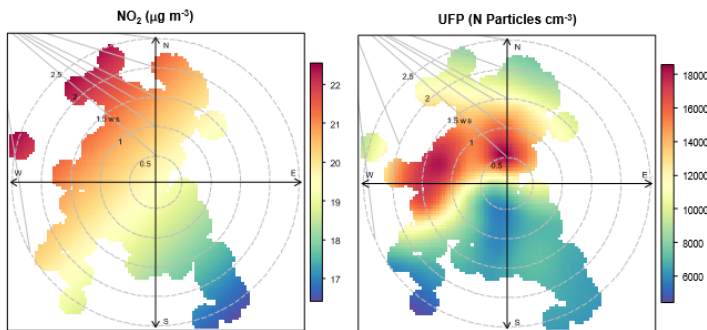
Other examples of sensor use

- Investigating indicated exceedances:
 - Outlier diffusion tube(s) exceeding objective, but why?
 - Source identification through high resolution data analysis (e.g. diurnals)

https://www.fife.gov.uk/_data/assets/pdf_file/0027/416457/Fife_Annual_Progress_Report_2022_Issue_2_Final_Updated_1.pdf

- Pre and post air quality improvement measures
- Alternative baseline monitoring for large scale developments
- Investigate drop off in NO₂ concentrations from roadside within a SSSI site

https://airquality.gov.wales/sites/default/files/documents/2018-03/08_NickRand%26OliverMatthews_Traffic_Impact_on_Ecology.pdf



Any Questions?



The importance of QA/QC Audits

Benefits

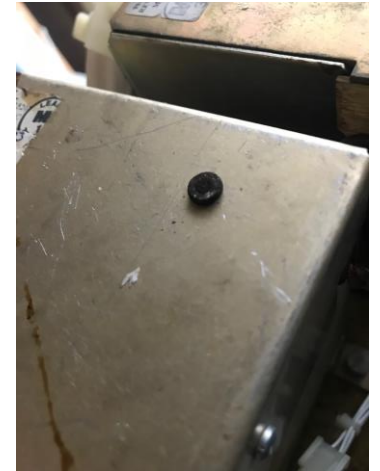
- Improved quality data
- Instrument longevity
- In line with [Defra Technical Guidance](#) best practice

Example of site not previously audited



- Found black filter and pump full of corrosion
- Found pressure sensor was unplugged, causing the flow rate failure
- When plugged in, pressure sensor found to be faulty

Ricardo's independent QA/QC audit highlighted faults with the analyser, improving data reliability and validity.

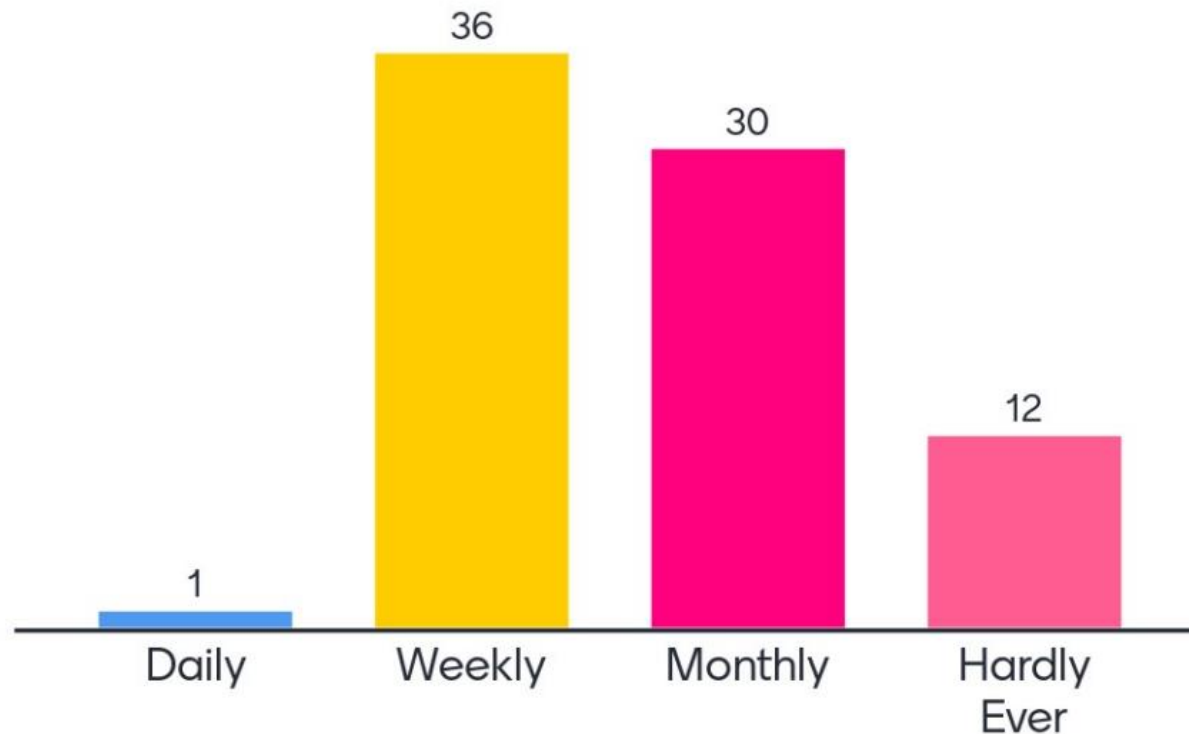




Public Engagement & Pollution Forecasting

James Southgate – Ricardo EE

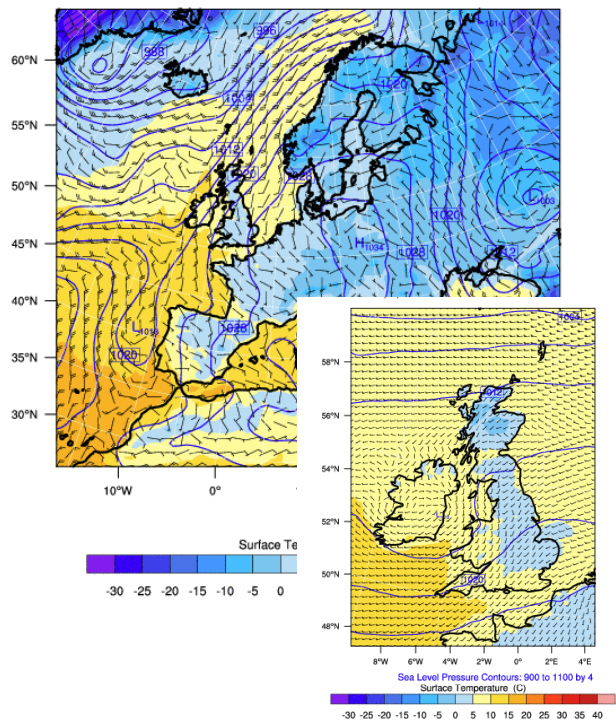
How often are you contacted by members of the public on air quality issues or enquiries?



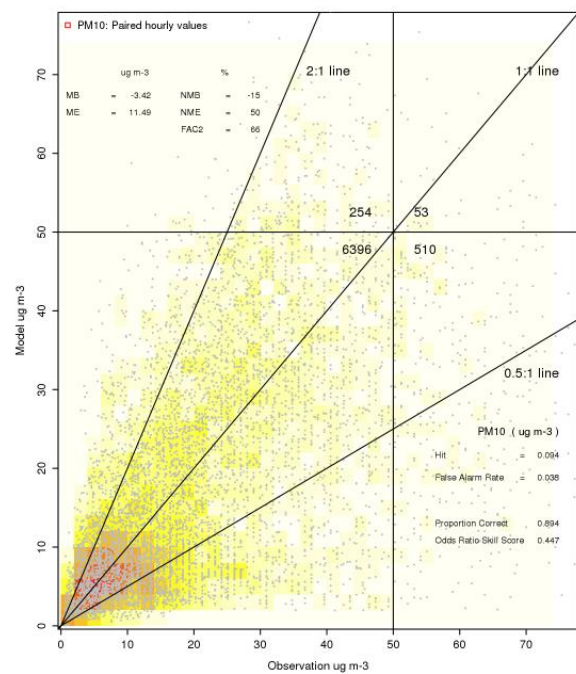
Public Engagement & Pollution Forecasting

- Air quality models can be used to **predict air quality concentrations** at different **spatial locations** or **temporal resolutions**
 - **Short-term estimates** e.g., few days into the future
 - **Long-term estimates** e.g., several years into the future
- AQ models require detailed **input data** in order to produce estimations
 - Sources and level of pollutant release
 - Meteorology
 - Local monitoring data
 - Terrain/urban morphology
- The information can be produced through structured, science led/peer reviewed processes, enabling public **CONFIDENCE** in the information

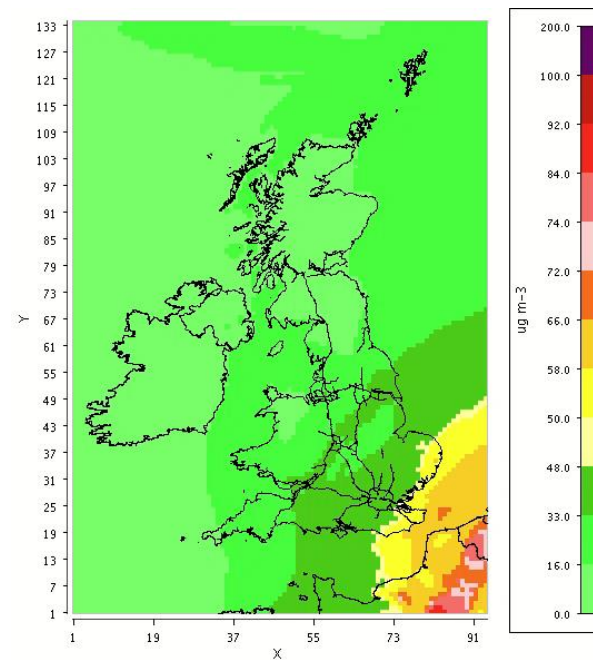
Forecasting air quality



Model input phase



Model verification



February 17, 2023 00:00:00 UTC
Min (7, 45) = 1.0, Max (62, 1) = 90.6

Pollutant dispersion results

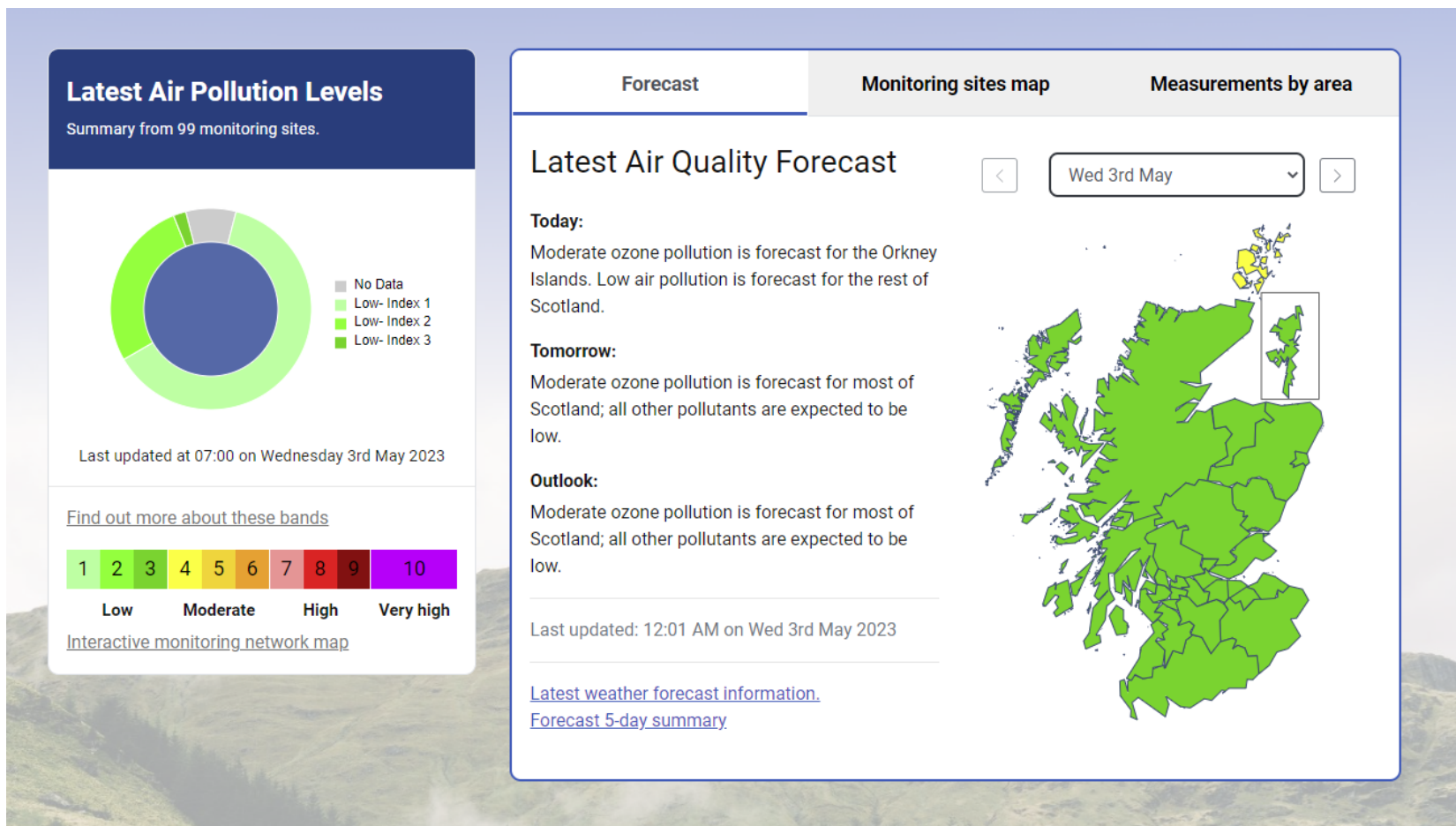
Examples of inputs

- Meteorological
- Emission sources
- Monitoring data

Forecasting air quality

Air Quality Forecast

- Issued **daily**
- Covers the forthcoming **5 days**
- **Communicated** via
 - Website
 - Email
 - Social media / Twitter



Forecasting air quality – public engagement

Forecast
Monitoring sites map
Measurements by area

Latest Air Quality Forecast

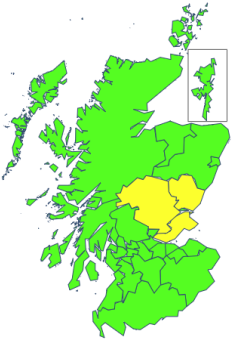
Today:
Low air pollution for all areas of Scotland with a risk of moderate PM levels in Fife, Perth & Kinross and Angus.

Tomorrow:
Low air pollution is forecast across Scotland

Outlook:
Levels of air pollution are expected to be Low across the outlook period, possibility of elevated PM levels in Fife, Perth & Kinross and Angus. Strengthening winds from the west should bring good dispersion conditions by the end of the week.

Last updated: 12:01 AM on Wed 15th February 2023

[Latest weather forecast information](#)
[Forecast 5-day summary](#)



Local Authority	Today 15th Feb	Thu 16th Feb	Fri 17th Feb	Sat 18th Feb	Sun 19th Feb
Aberdeen City	Low (2)	Low (2)	Low (2)	Low (2)	Low (2)
Aberdeenshire	Low (2)	Low (2)	Low (2)	Low (2)	Low (2)
Angus	Moderate (4)	Low (2)	Low (2)	Low (2)	Low (2)
Argyll and Bute	Low (2)	Low (2)	Low (2)	Low (2)	Low (2)
Clackmannanshire	Low (2)	Low (2)	Low (2)	Low (2)	Low (2)

←
Air Quality Scotland

7,192 Tweets



Air Quality Scotland

@scotairquality

Official feed for Air Quality in Scotland from the Scottish Gov. Latest info on air pollution & health advice. Email info@scottishairquality.co.uk or visit scottishairquality.co.uk 📅 Joined December 2013

32 Following 1,024 Followers

Tweets
Tweets & replies
Media
Likes



Air Quality Scotland @scotairquality · 3h

Latest Wed 9am: Low air pollution measured across Scotland. [#scotair](https://bit.ly/NnLgcb)

...

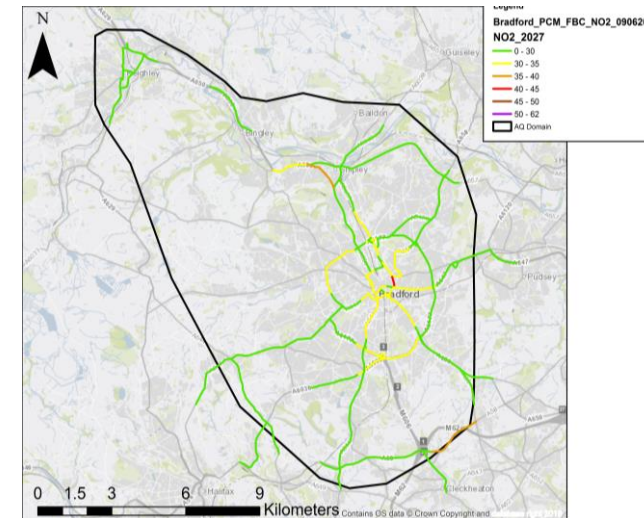
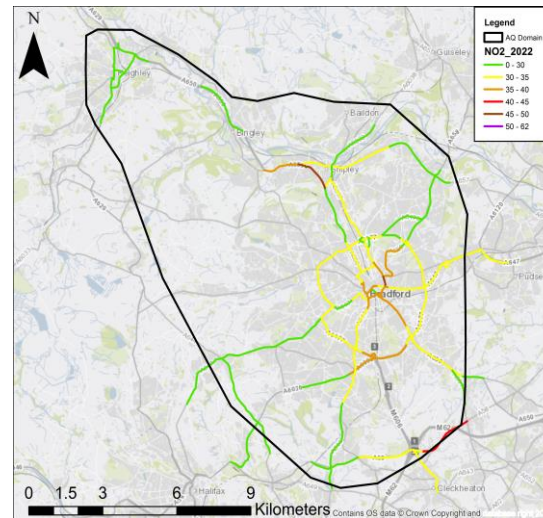
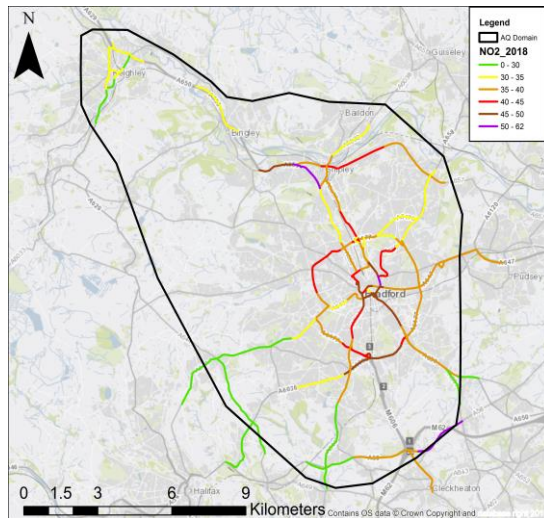


Air Quality Scotland @scotairquality · 23h

Forecast Wed: Low air pollution across Scotland, with a risk of moderate levels in the east. bit.ly/1hbUoN4 #scotair

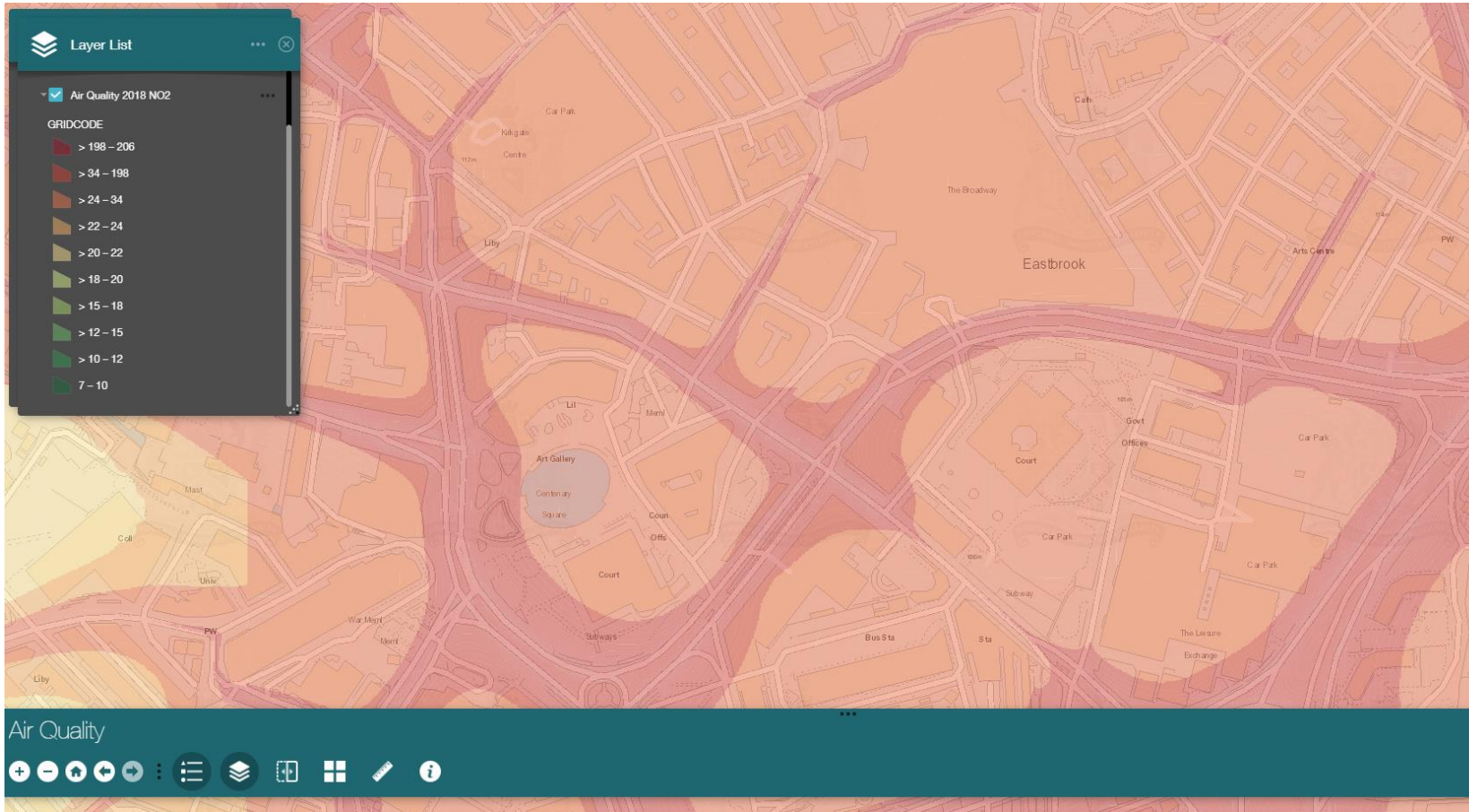
Forecasting air quality

- Ricardo Energy and Environment have worked with Bradford Metropolitan District Council to evaluate the potential impacts of the implementation of a Clean Air Zone against other potential options.



Typically this information is produced in a **bulky paper based format**, which although informative, is **not always quickly understood** by the general public

Public Engagement



<https://www.bradford.gov.uk/breathe-better-bradford/breathe-better-bradford/>

Public Engagement & Pollution Forecasting summary

In summary, air quality data can be communicated digitally to:

- To help **inform near future decisions** such as whether it is appropriate to carry out a high pollutant release activity or for a vulnerable person to have prolonged exposure to poor air quality
- To enable policy makers and the wider public understand the potential **long term** impacts of a proposed action with the potential to adversely impact air quality.
- Both these outputs can
 - Provide policy makers with the information required to make robust and informed decisions
 - Enable clear and accessible reporting, helping the public to understand the decisions made by public bodies

Any Questions?

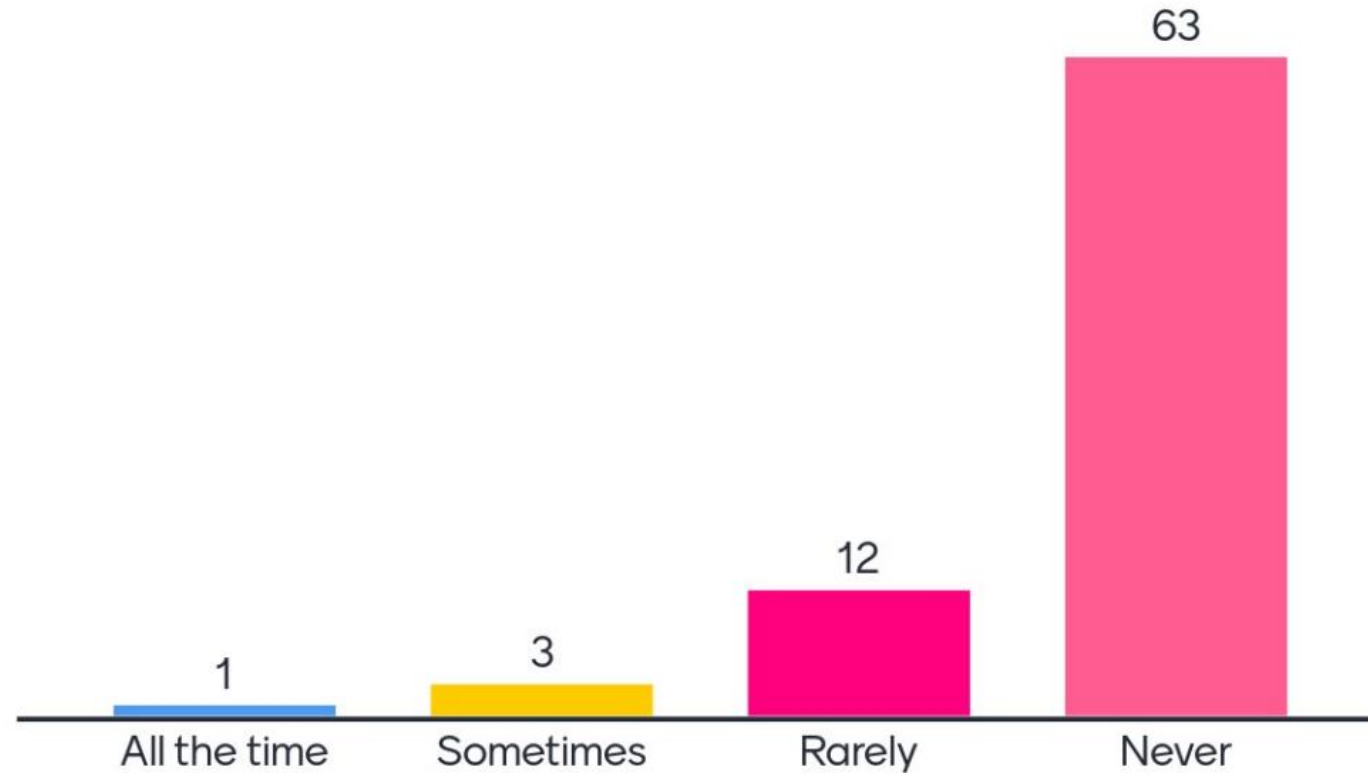




Air Quality Data & Reporting

Louisa Kramer – Ricardo EE

How often do you use OpenAir or R?



R and openair

Excel is not necessarily the best tool to use to process and analyse air quality data.

Statistical programming software like R have more functionality with work pipelines more easily set up, and more repeatable:

- <https://www.r-project.org/>
- <https://www.rstudio.com/products/rstudio/download/>

Openair is a library specifically developed for analysing air quality data:

- <https://davidcarslaw.github.io/openair/>
- https://bookdown.org/david_carslaw/openair/

Other useful libraries:

- openairmaps # library for plotting polar plots on maps
- dplyr # library for manipulating data frames
- plotly # library for interactive plotting
- leaflet # library for mapping

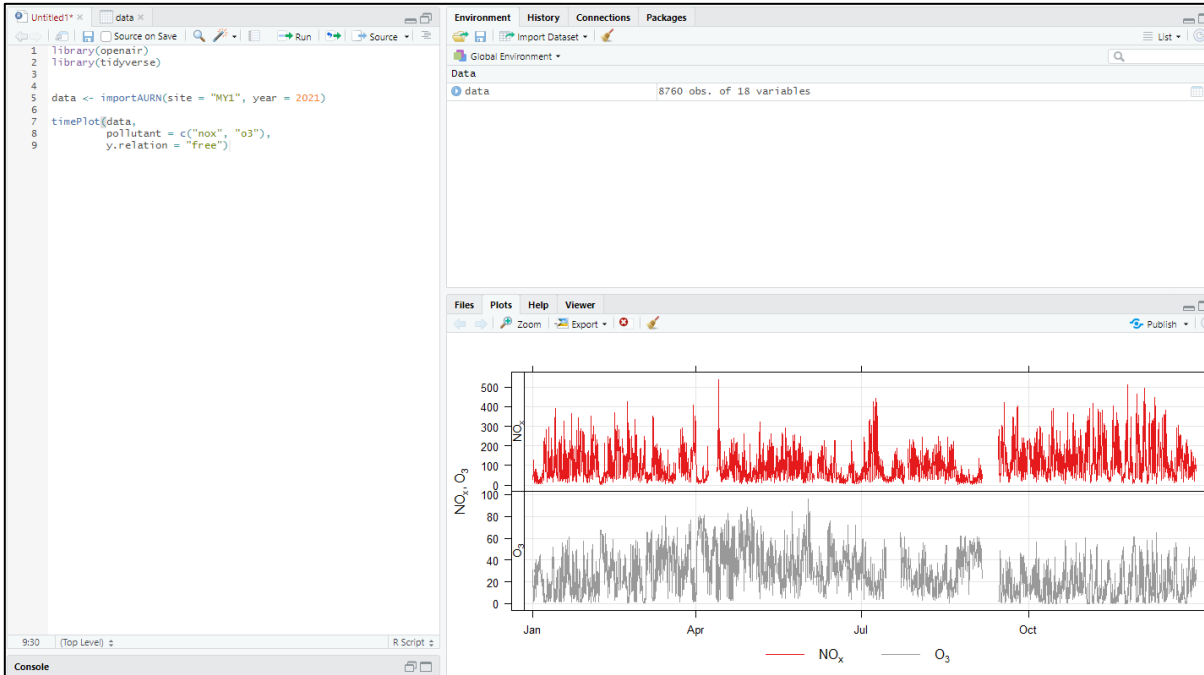
Ricardo can provide training:

[https://ee.ricardo.com/air-quality/training-and-capacity-building/openair-and-r-masterclass-\(in-person-training\)](https://ee.ricardo.com/air-quality/training-and-capacity-building/openair-and-r-masterclass-(in-person-training))



Analysing AQ data - openair

Openair functions can be run either as a script in R, or by using the openair tools on specific UK Air Quality Websites (UKAir, Air Quality in Wales, Air Quality in Scotland).



Openair - Summary Plot

Choose your options below and as you select each one, the other options will update themselves. If help text is available for each input, click the "help" link on the side.

[Learn about the Summary Plot tool and its usage](#)

[Reset Search Options](#)

Site Name

[Help](#)

Variables
You can select a maximum of 10 variables

- Ozone
- Nitric oxide
- Nitrogen dioxide
- Nitrogen oxides as nitrogen dioxide

[Help](#)

- [Openair - data analysis tool](#)
- [Data definitions](#)
- [Summary Plot](#)
- [Smooth Trend](#)
- [Time Variation](#)
- [TheilSen](#)
- [Time Plot](#)
- [Trend Level](#)
- [Polar Plot](#)
- [Wind/Pollution Rose](#)
- [Polar Annulus](#)
- [Scatter Plot](#)
- [Polar Frequency](#)
- [Calendar Plot](#)

Interactive reporting

Interactive reports (using Rmarkdown) provide readers with the ability to interact with the plots and data within the report

The report is easily navigable and contains features such as:

- Ability to zoom into maps and to select different layers and markers.
- Tables that can be sorted by a column, or filtered to show certain information.
- Time series plots which allow the reader to zoom into a specific time window and obtain time/date stamps and values by hovering the mouse over the plot.
- “Tabs” to enable plots of many different species/sites to be shown in one report

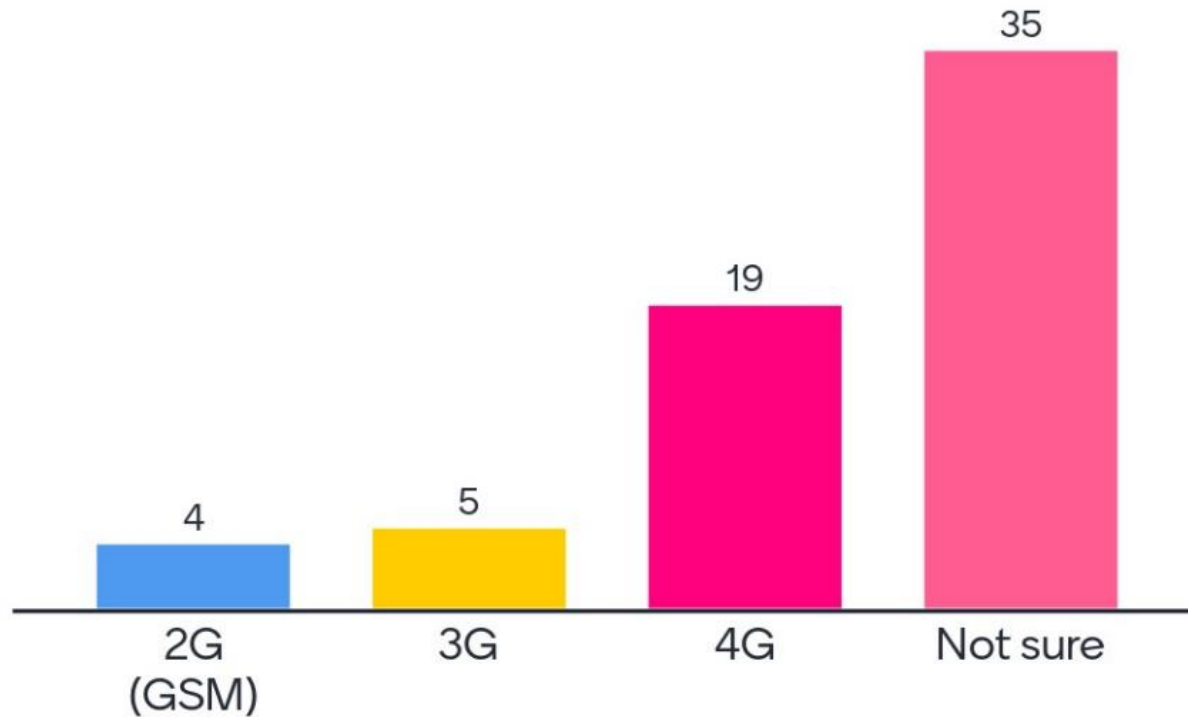
Many examples of the interactive reports Ricardo produces can be found on the AQE website here:

<https://www.airqualityengland.co.uk/>

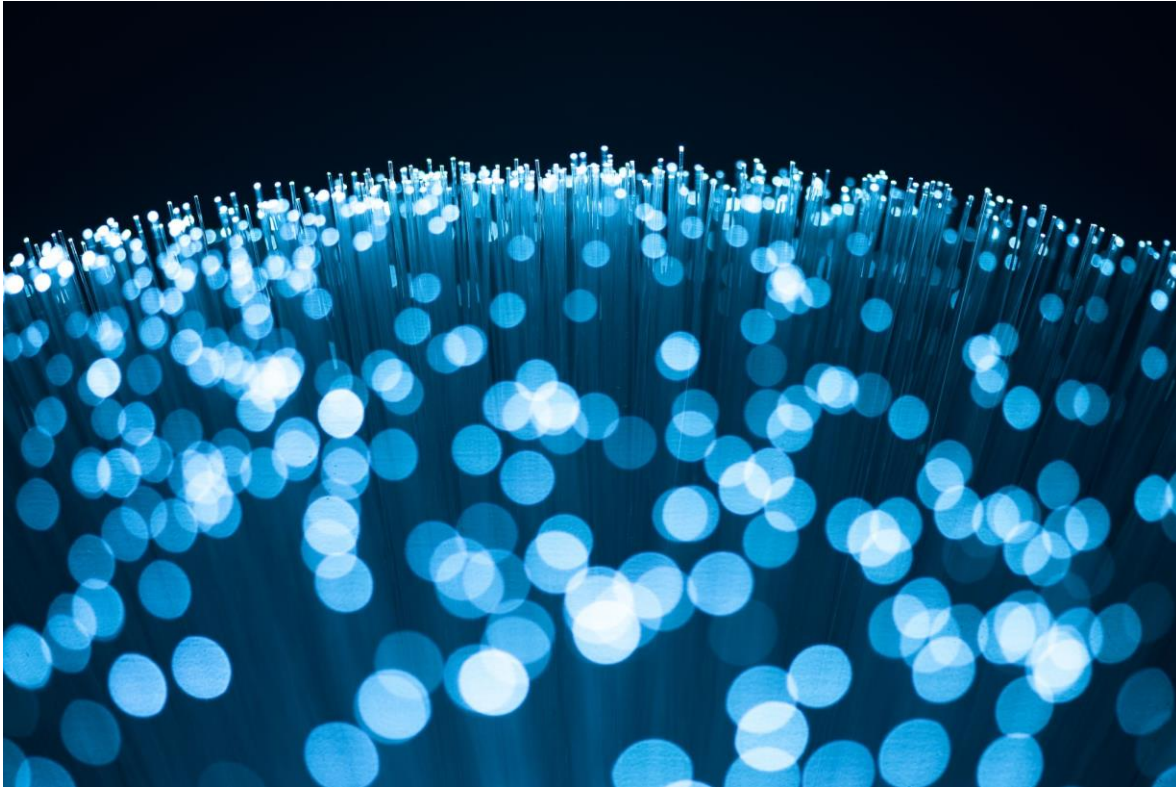
Any Questions?



What network do your analysers currently operate on



The Phase out of 3G and 2G



DON'T PANIC!

Gradual phase out over 2023/24 for 3G

Phase out up to 2033 for 2G

Upgrades of comms to ensure longevity of data management

4G Comms solutions

Thank you for joining us!

