NPL
National Physical Laboratory

Heavy Metals and PCN&BC Air Quality Networks 2025

Katie Williams

Kaite.Williams@npl.co.uk

Overview

- Introduction to NPL and AQAM
- Introduction to UK Air Quality Monitoring Networks
- Air Quality Monitoring Networks run by NPL
- Air Quality data

National Physical Laboratory

The UK's National Measurement Institute:

- Founded in 1900
- Based in Teddington, London
- More than 1,000 specialists in measurement science (~20 in air quality and aerosol metrology)
- Purpose built laboratory campus
- Operated and owned by the Department for Science, Innovation and Technology


NPL
SI

Air Quality and Aerosol Metrology Group

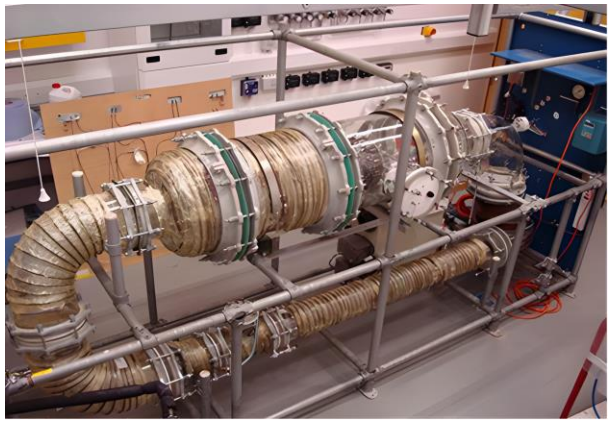
- Deliver world-leading research into the accurate and traceable measurements and characterisation of air pollutants and aerosols.
- Inform domestic and international policy to protect public health and the environment.

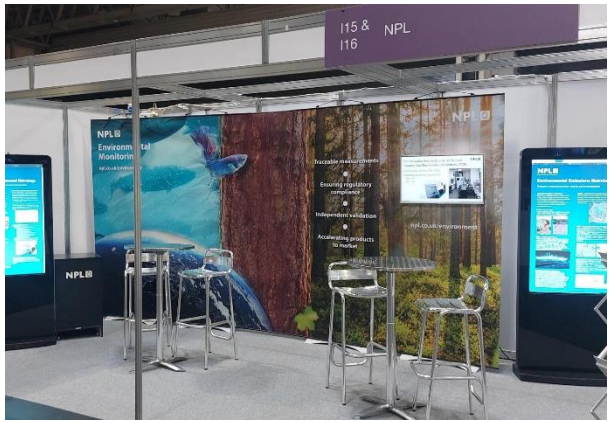
- Research and development
- Measurements for industry
- Supporting policy and regulation
- Thought leadership and knowledge transfer

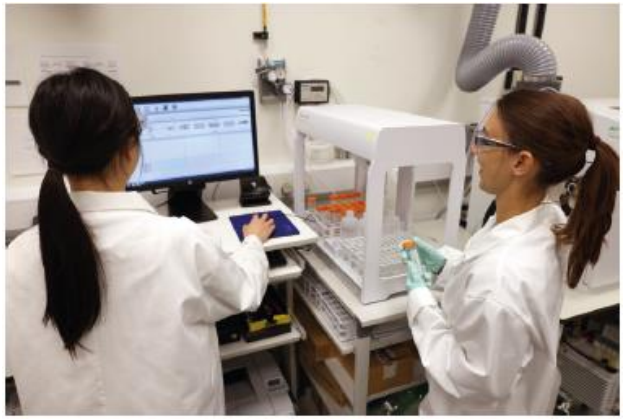
AQAM Measurement Services

NPL is UKAS ISO 17025 accredited and provides:

- High-purity analysis of trace elements using inductively coupled plasma mass spectrometry
- Controlled atmosphere test facility (CATFAC) for validating the performance of diffusive and pumped samplers
- SI traceable calibration for the following:
  - Condensation Particle Counter
  - Faraday Cup Electrometer
  - Differential Mobility Analyzer
  - Ozone photometer to the International Reference Standard
  - Volatile Particle Remover







UK ambient air quality monitoring networks - Purpose

- Measuring the exposure of the general population to a variety of toxic compounds
- Assessing compliance with legislative limits
- Informing policy development
- Assessing the effectiveness of abatement strategies

UK ambient air quality monitoring networks - background

- The UK Government has legally binding limits for air pollutants (Air Quality Standards Regulations 2010).

- Air quality networks are used to assess compliance against this legislation.

- The Environment Agency contracts the operation of UK air quality monitoring networks on behalf of Defra.

Department for Environment Food & Rural Affairs

Environment Agency

Department for Environment Food & Rural Affairs
UK AIR
Air Information Resource

uk-air.defra.gov.uk

Air quality networks operated by NPL

- Heavy Metals Network
- Particle concentration and numbers Network
- Black Carbon Network

UK Heavy Metals Monitoring Network – what is measured

- Legislated Metals:
  - **PM_{10} fraction of ambient air**: Arsenic, Cadmium, Lead, and Nickel
  - **Deposition** (precipitation): Arsenic, Cadmium, Nickel, and Mercury

- PM_{10} = particulate matter with a diameter of 10 µm or less

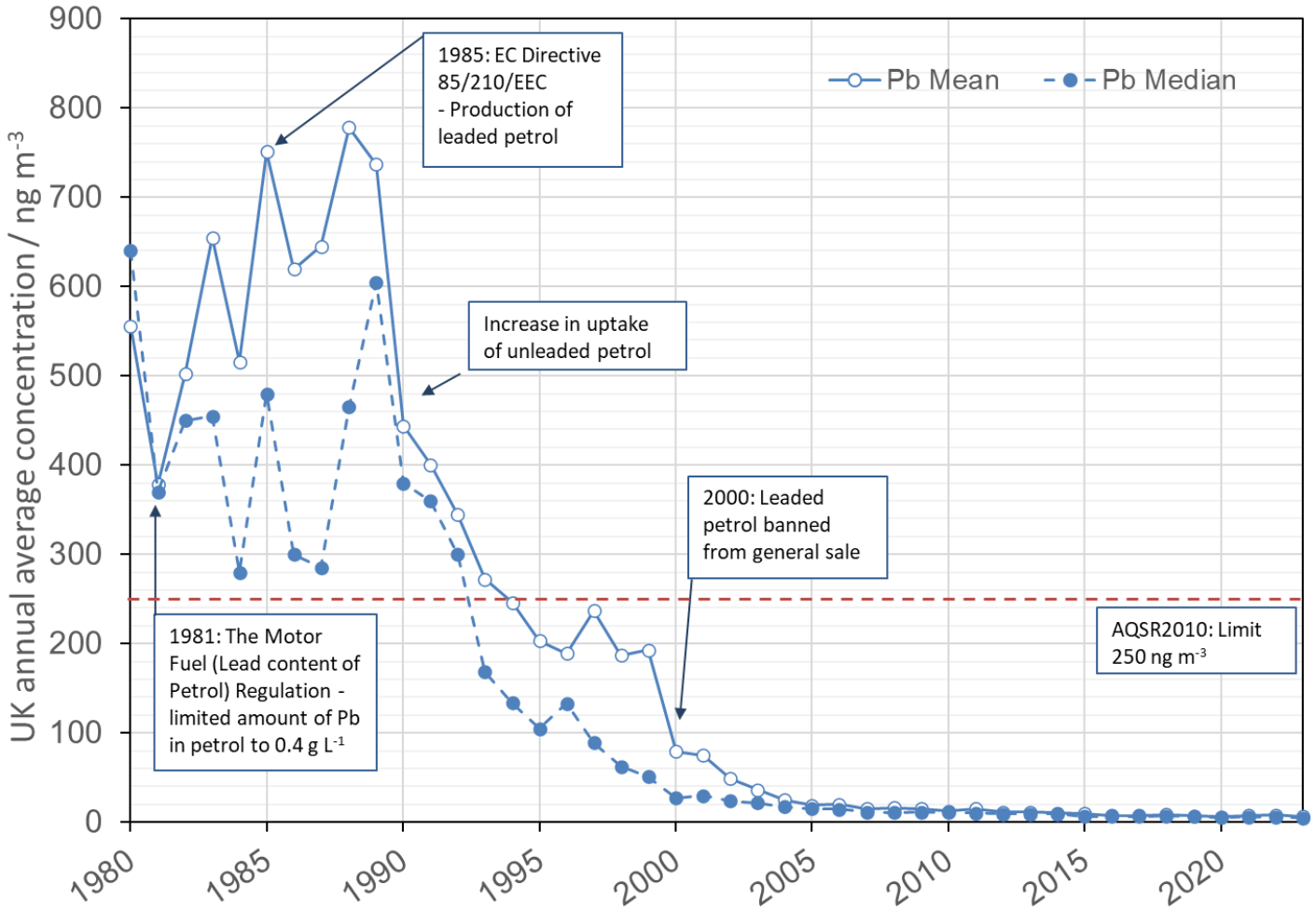
- Research, other metals of interest:
  - **PM_{10} fraction of ambient air**: Cr, Cu, Co, Fe, Mn, V, Se and Zn
  - **Deposition:** Al, Ba, Be, Co, Cr, Cs, Cu, Fe, Li, Mn, Mo, Pb, Rb, Sb, Se, Sn, Sr, Ti, U, W, V, and Zn

Analyte	Limit value / ng m^{-3}
Pb	250
Ni	20
As	6
Cd	5

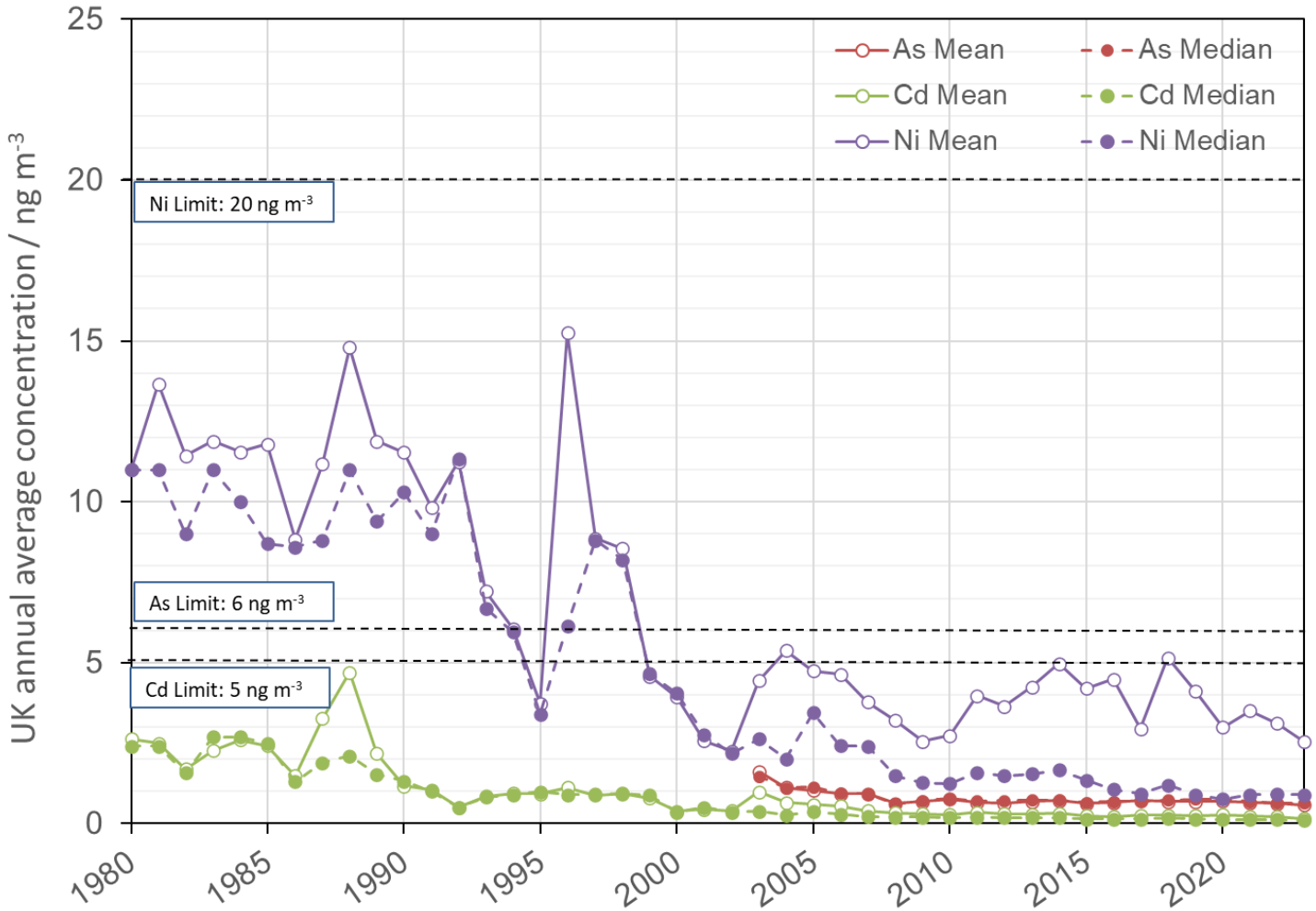
UK Heavy Metals Monitoring Network

- Operating since 2000; currently 24 sites.
- Mixture of rural background, urban background, traffic, and industrial sites.
- Similar services provided to Local Authorities.
- Links to other projects: eDNA

UK Heavy Metals Monitoring Network – Lead data



UK Heavy Metals Monitoring Network – Arsenic, Cadmium, and Nickel data

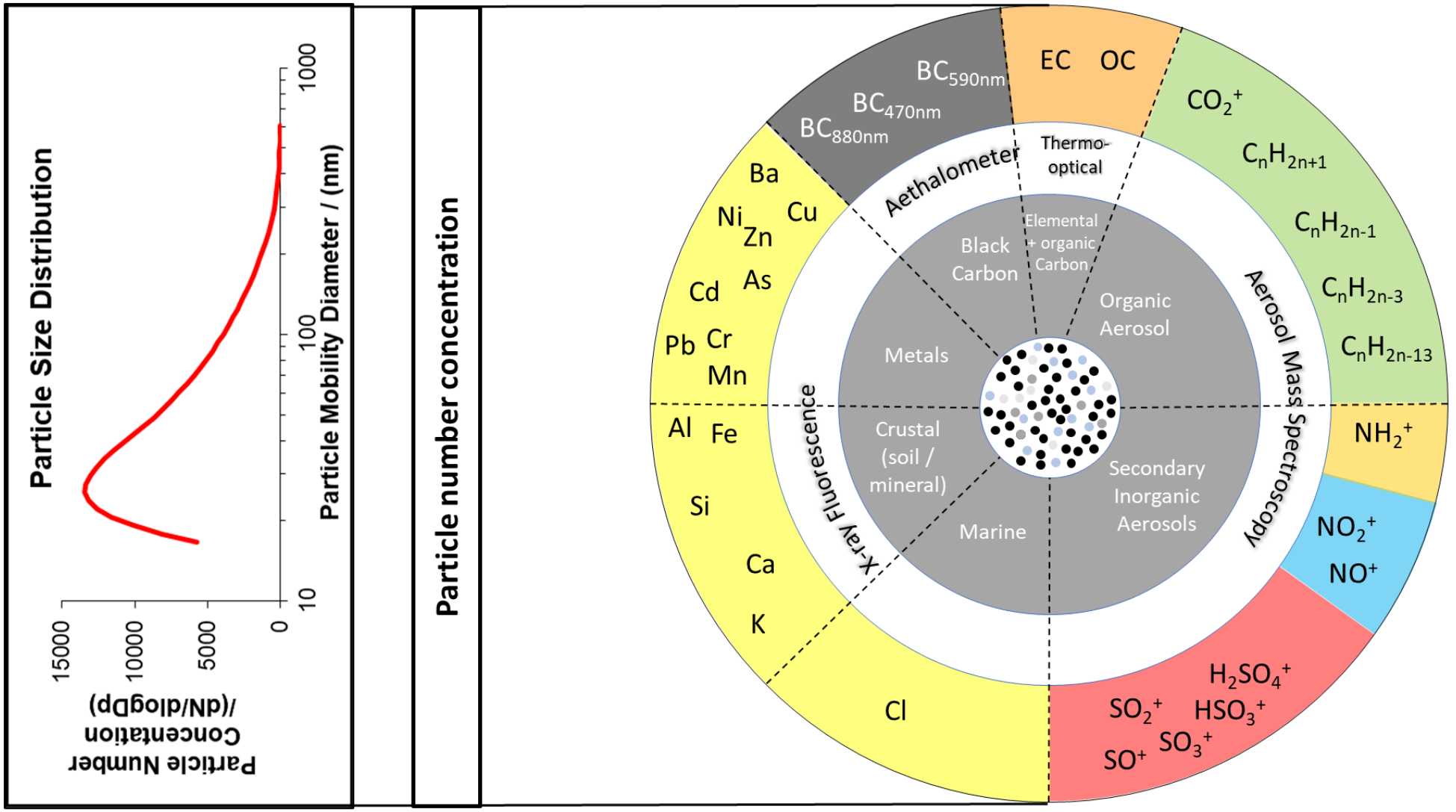


UK Particle Concentration and Numbers Network

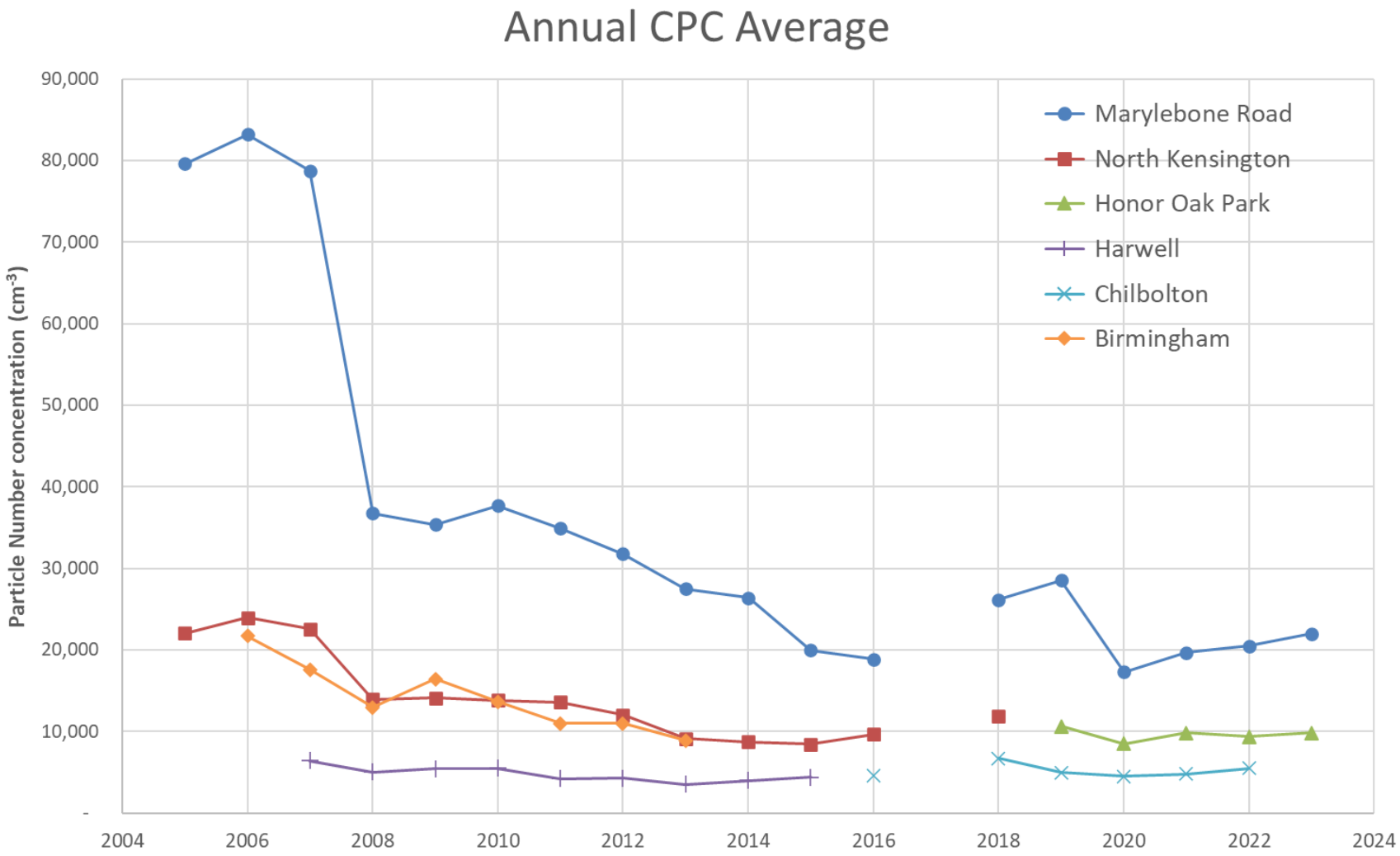
Measurand	Equipment
Particle number concentration	Condensation Particle Counter (CPC)
Particle size distribution	Scanning Mobility Particle Sizer (SMPS)
Ammonium, nitrate, sulfate, and organic compounds	Aerosol Chemical Speciation Monitor (ACSM)
40 elements	X-ray fluorescence analyser (XRF)
Organic carbon and elemental carbon (OC/EC)	Ambient air sampler and thermal/optical carbon analyser

- Network started 2001
- Research and compliance
- Focus on $PM_{2.5}$
- Source apportionment, sources of pollution

UK Particle Concentration and Numbers Network



PCN Network – Particle Number Concentration



UK Black Carbon Network

- Continuation of historical black smoke dataset (which dates back to the 1920s).
- Measurement of black carbon concentrations at 15 sites using 7-channel aethalometers.
- Sites are focussed in areas of high solid fuel burning .
- IR channel indicates the concentration of black carbon; UV channel indicates the presence of aromatic organic compounds

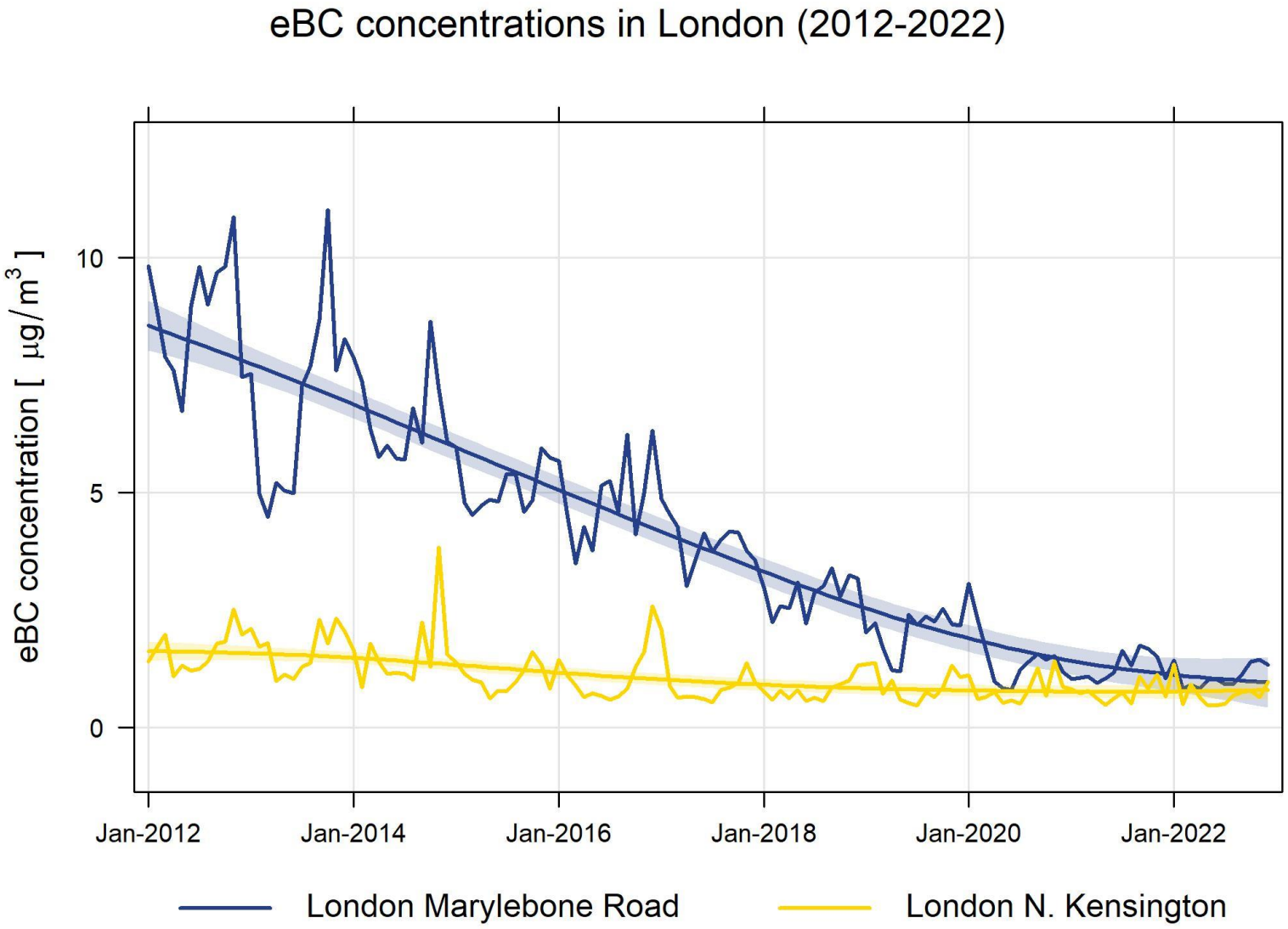
UK Black Carbon Network

- The Environmental Targets (fine particulate matter) (England) Regulations 2023
- Two $PM_{2.5}$ targets for England to be met by the end of 2040.
  - Annual mean concentrations of $PM_{2.5}$ to be 10 µg m^{-3} or lower
  - Population exposure to $PM_{2.5}$ to be reduced by 35% compared to 2018 levels
- 10 new sites added (+1 for equivalence)

UK Black Carbon Network

- 7 new sites still to be added.

BC data


eBC concentrations in London (2012-2022)
eBC concentration [µg/m3]
10
5
0
Jan-2012
Jan-2014
Jan-2016
Jan-2018
Jan-2020
Jan-2022
London Marylebone Road
London N. Kensington

Key Points

- NPL can assist with measurements and measurement challenges for air pollution and aerosols.
- Air Quality Monitoring Networks exist and provide a wealth of data which is publicly available.

Acknowledgements

- The funding of the UK Heavy Metals and the Particle Concentration and number & Black Carbon networks by the Environment Agency and the UK Department for Environment, Food and Rural Affairs is gratefully acknowledged.

References

- National physical laboratory website, https://www.npl.co.uk/
- UK AIR, Air Information Resource, https://uk-air.defra.gov.uk/
- National Atmospheric Emissions Inventory, www.naei.org.uk
- The Air Quality Standards Regulations 2010 (UK SI 2010/1001). Available at https://www.legislation.gov.uk/uksi/2010/1001/contents
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- Ciupek, K; Tompkins, J; Williams, K; Brown, A; Robins, C; Allerton, J; McGhee, E; Kantilal, V; Walker, D; Bradshaw, C; Lilley, A; Butterfield, D; Brown, R J C; Priestman, M; Tremper, A; Ek, D; Green, D (2024) Airborne particle concentrations, particle numbers, and black carbon in the United Kingdom - annual report 2023. NPL Report. ENV 57

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