

# *Measuring the composition of particulate matter*

*The key to targeted air quality  
management*

*David Green*

MRC  
Centre for Environment & Health



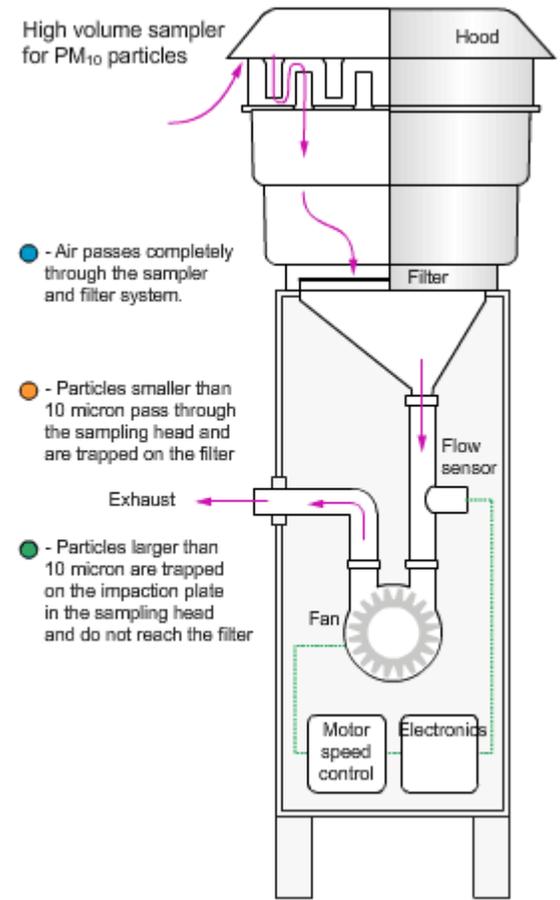
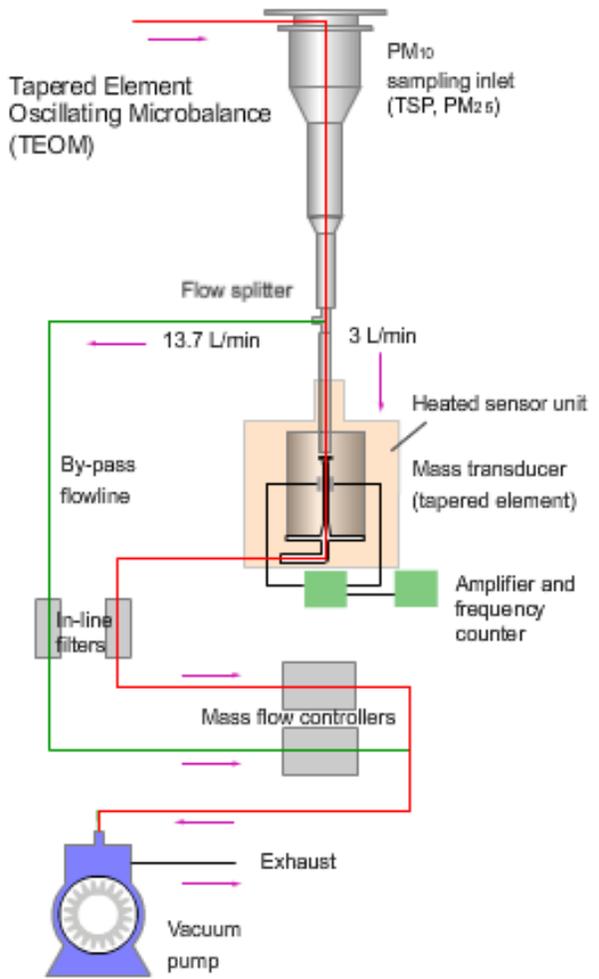
Imperial College  
London



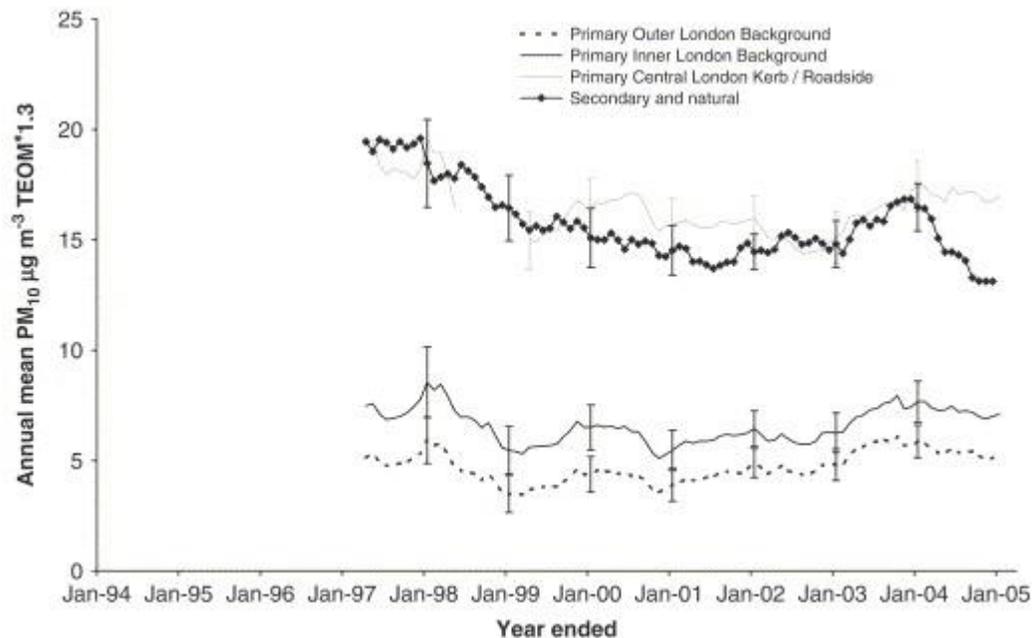
**NIHR**

Health Protection Research Unit in  
Environmental Exposures and Health  
at Imperial College London

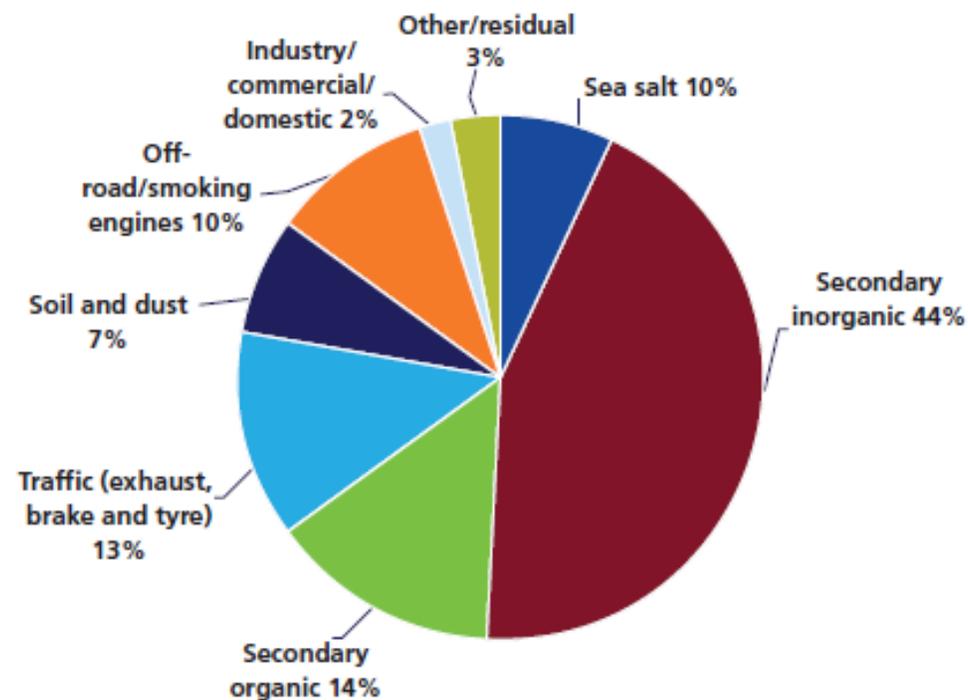
# Measuring PM mass and Chemical Composition



# Measuring PM mass and Chemical Composition



Fuller and Green 2006, Evidence for increasing concentrations of primary PM<sub>10</sub> in London. Atmos. Env.



Yin et al 2004, Pragmatic mass closure study for PM<sub>1.0</sub>, PM<sub>2.5</sub> and PM<sub>10</sub> at roadside, urban background and rural sites. Atmos. Env.

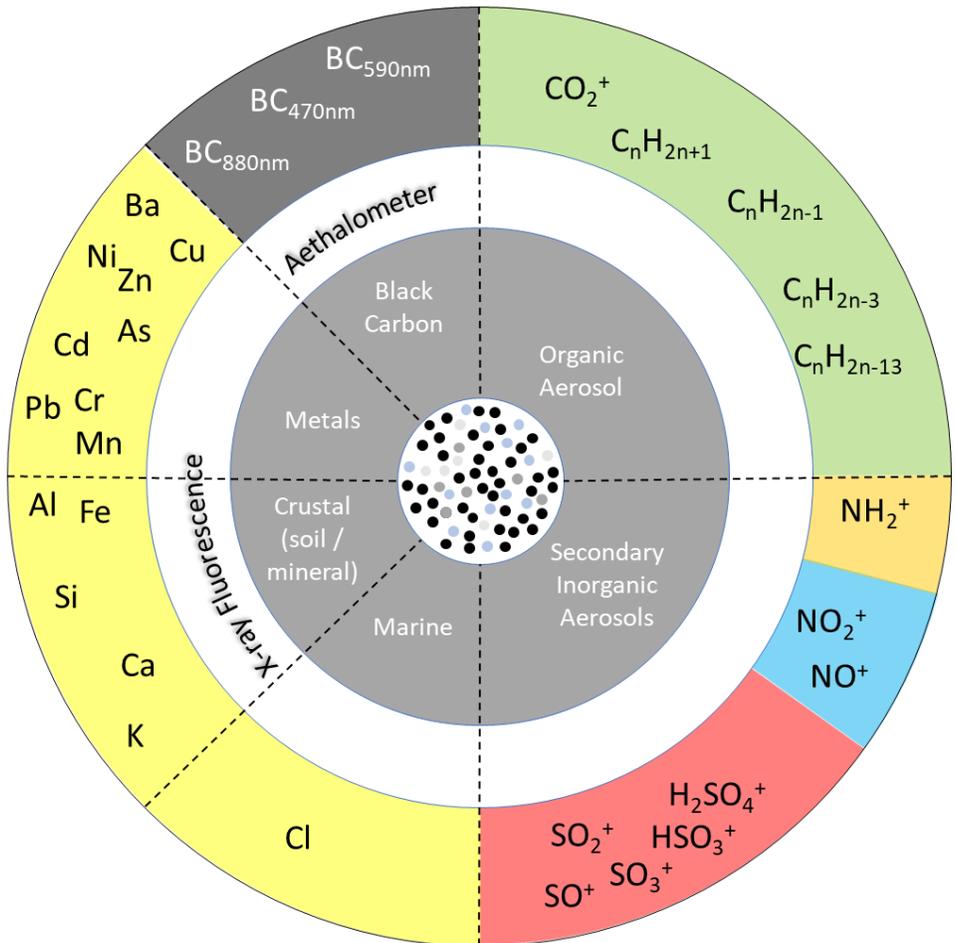
# High Time Resolution Chemical Composition



Aethalometer (AE33)

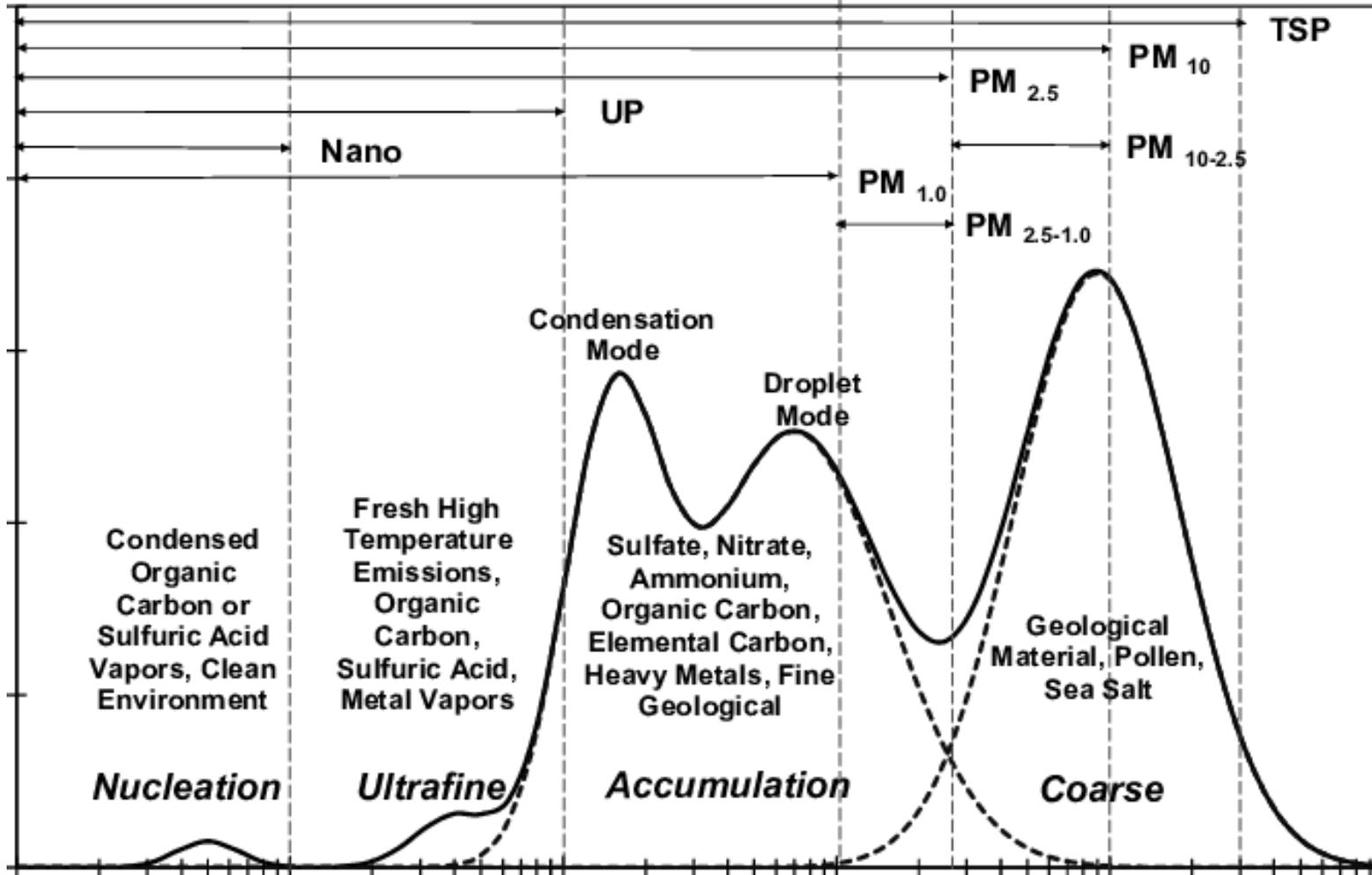


XACT 625i



Aerosol Chemical Speciation Monitor (ACSM).

# Particle Size Distribution

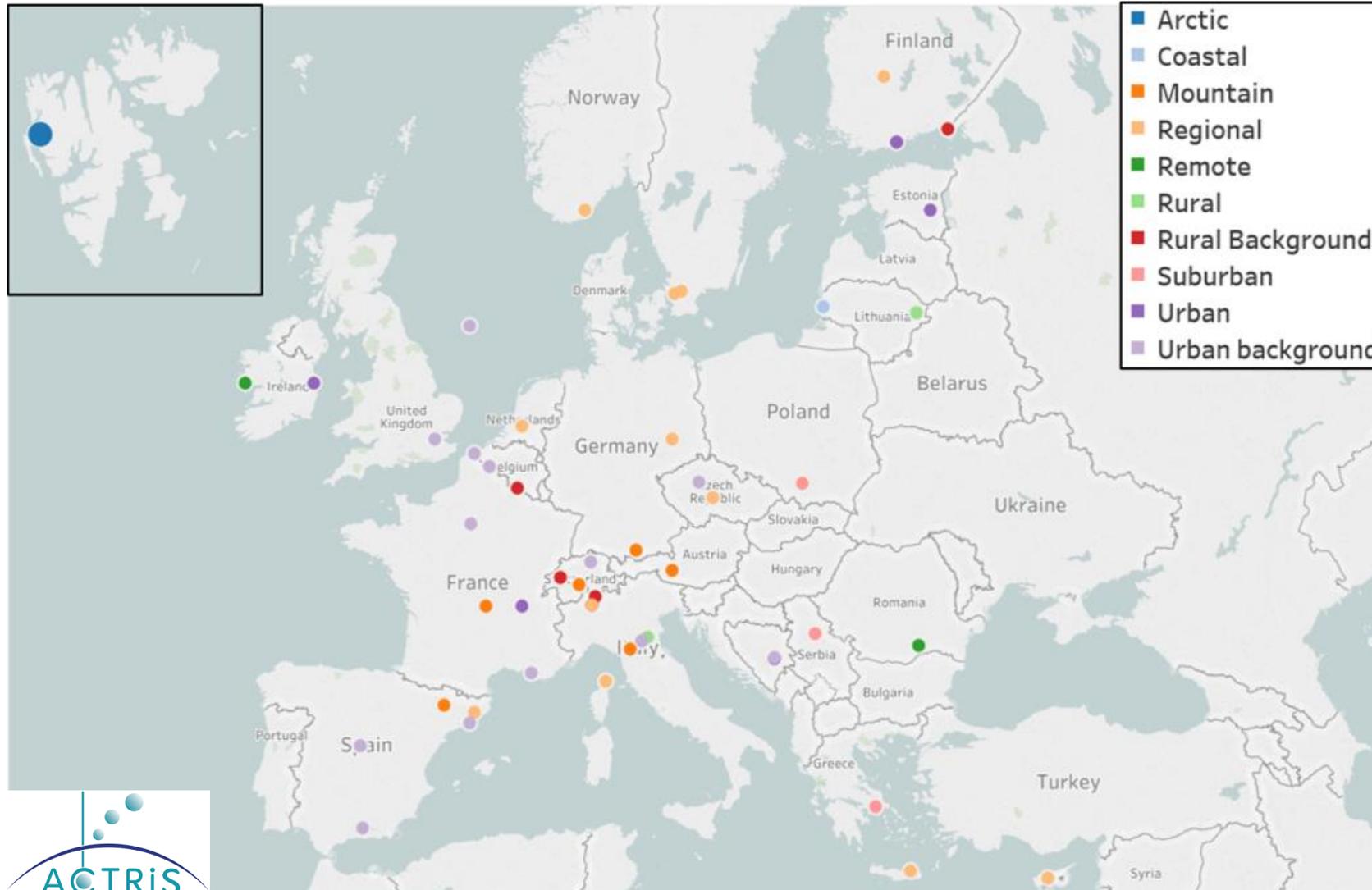


Scanning Mobility Particle Sizer  
10-800nm

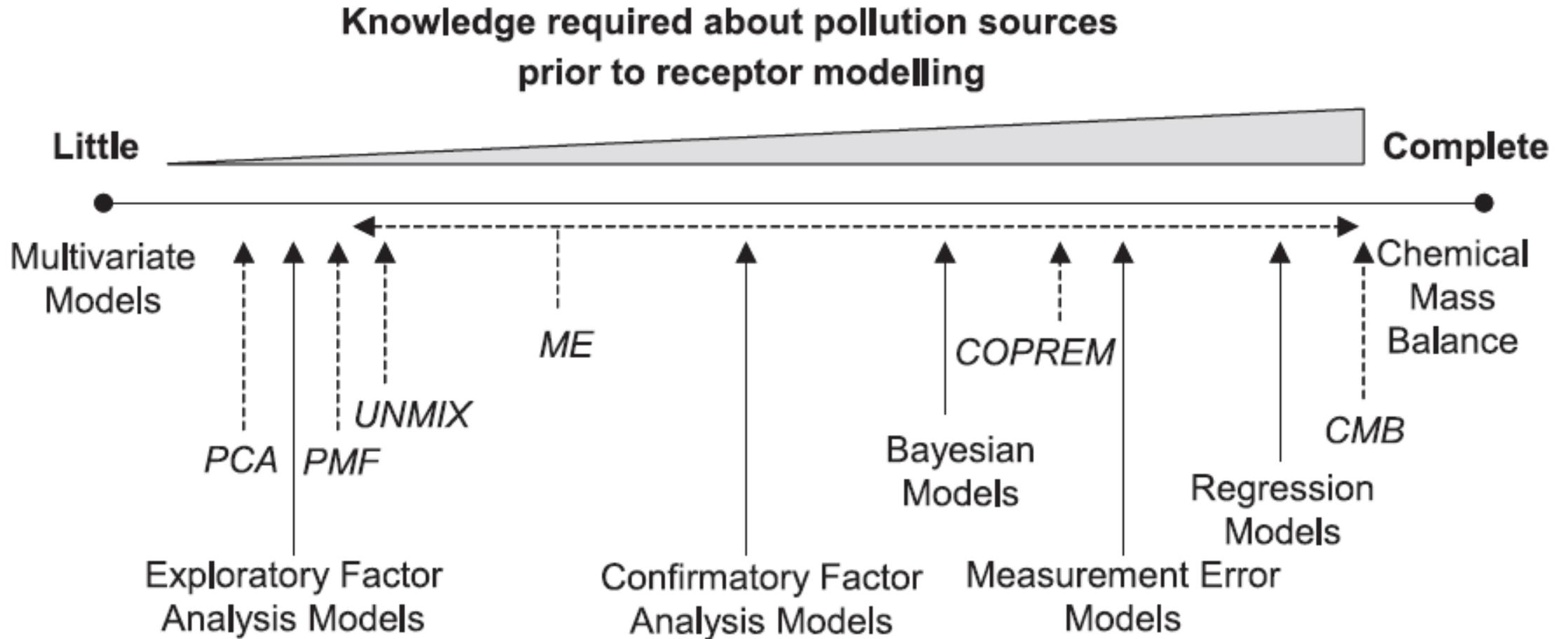
# Supersites



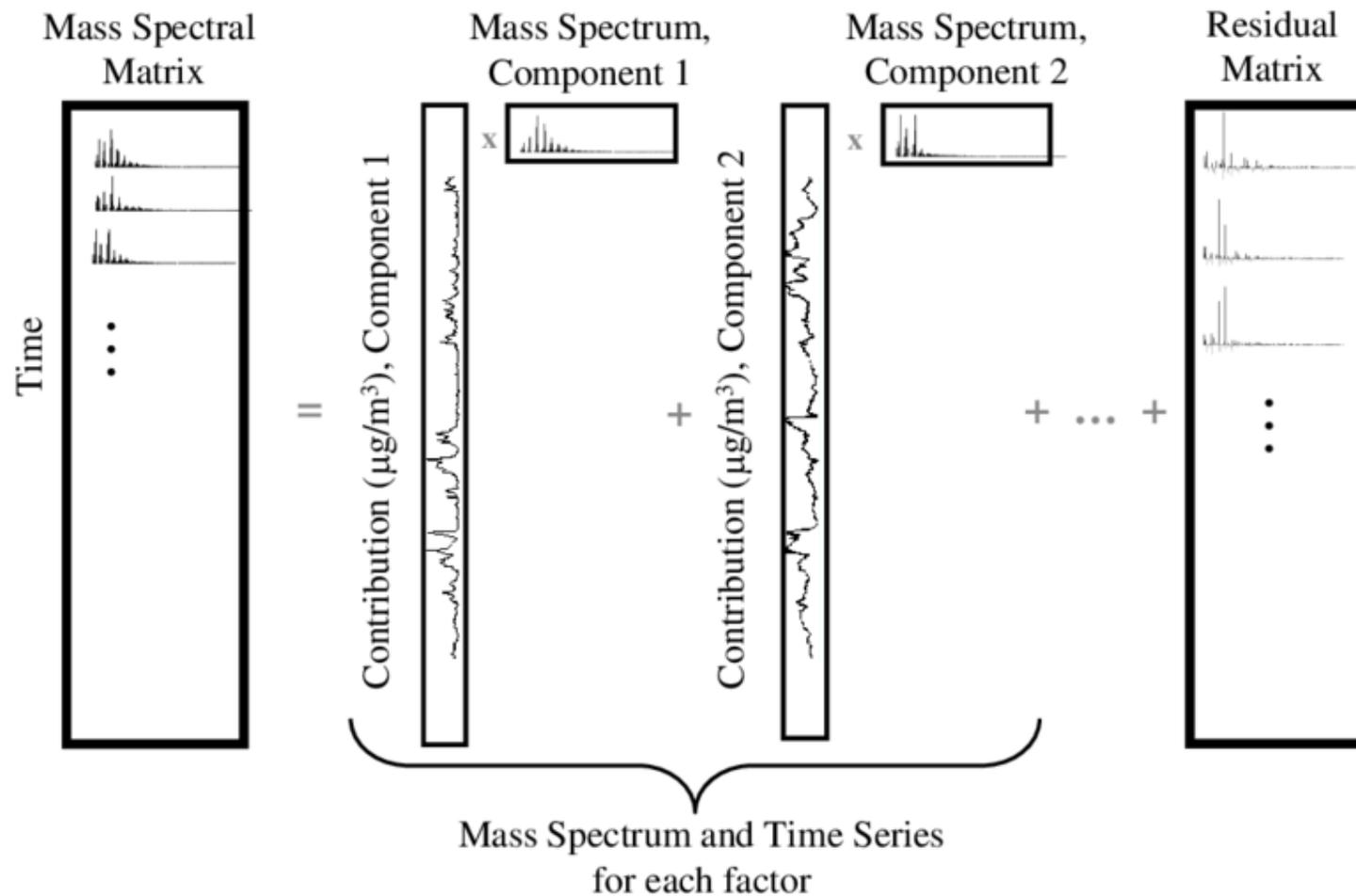
# Aerosol Mass Spectrometers in Europe



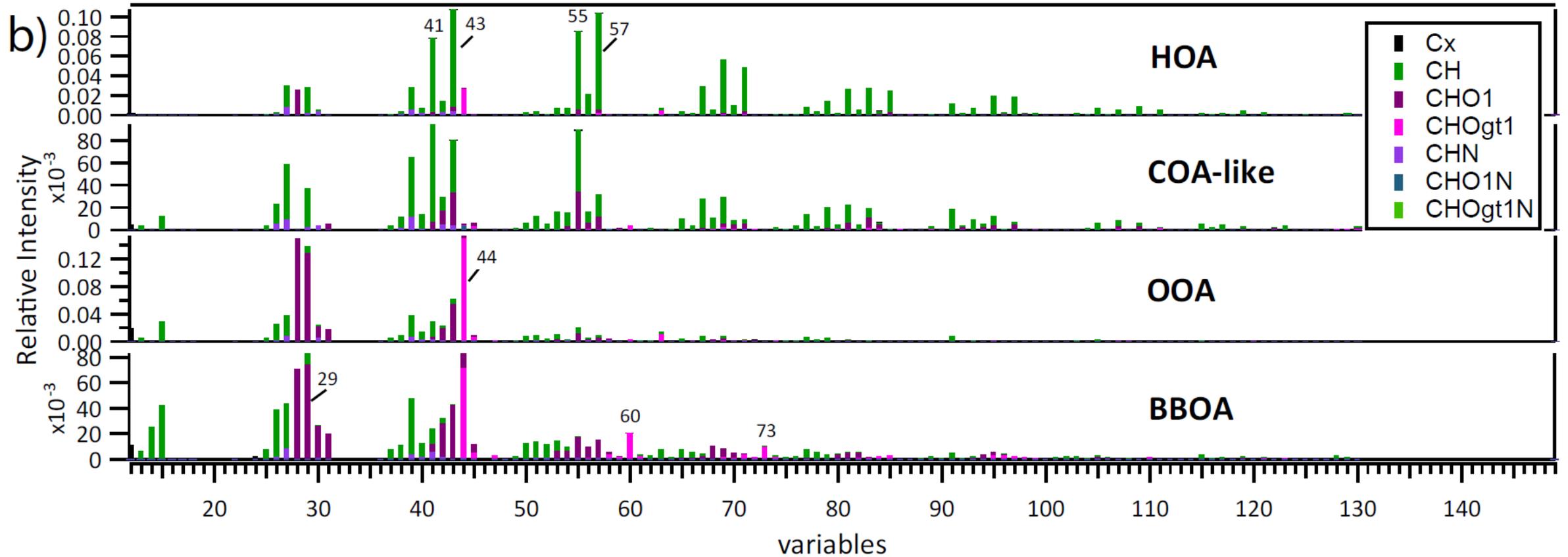
# Receptor Modelling



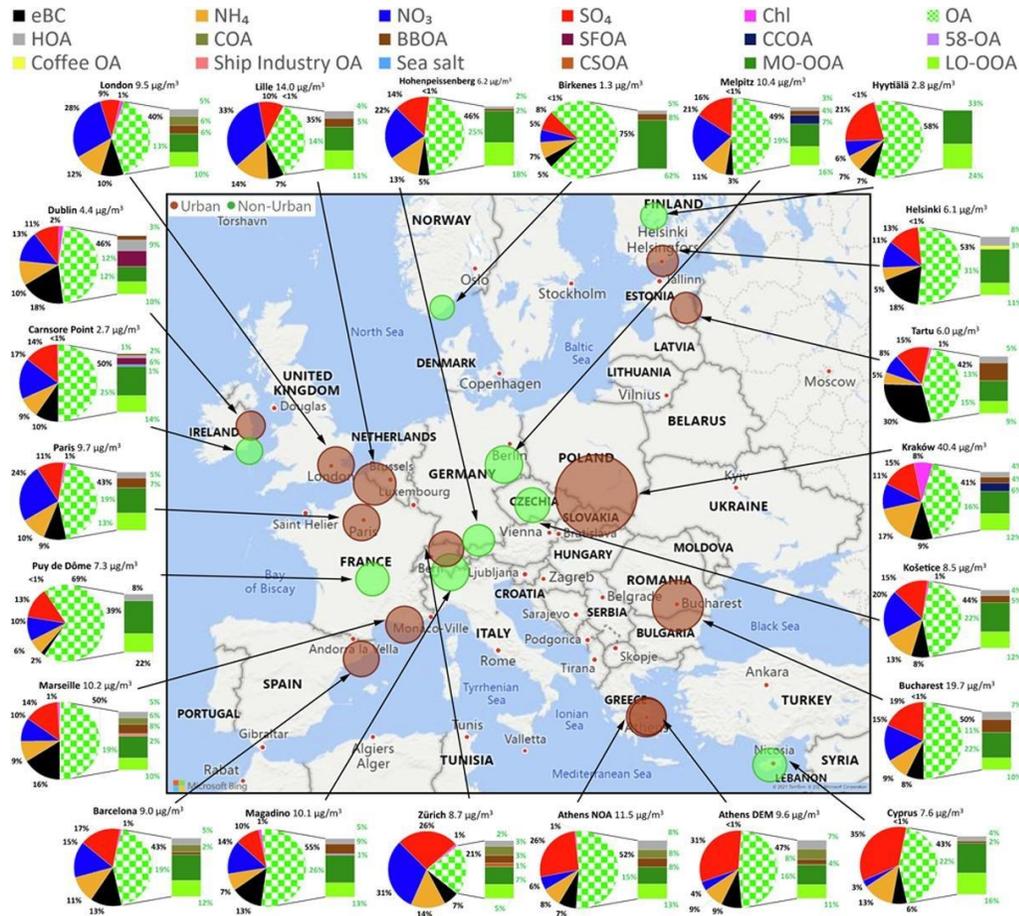
# Positive Matrix Factorisation (PMF)



# Typical Aerosol Mass Factor Profiles



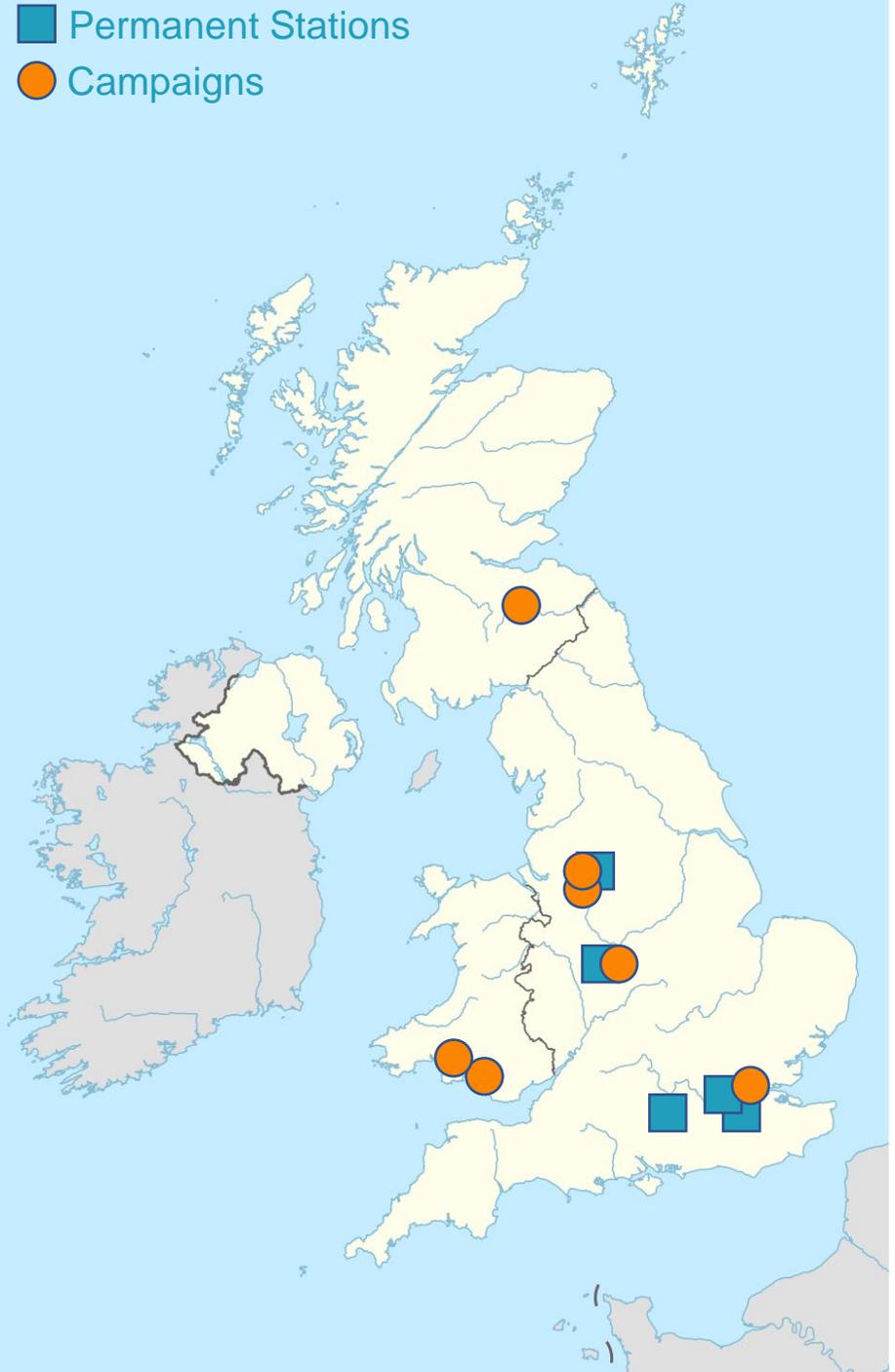
# Aerosol Mass Spectrometer PMF in Europe



- London 9.5  $\mu\text{g m}^{-3}$  PM<sub>1</sub>
- 10% Elemental Carbon
  - Diesel & wood burning
- 50% Secondary Inorganic Aerosols
  - Combustion & agriculture
- 40% Organic Aerosols
  - 5% Vehicles
  - 6% Wood Burning
  - 6% Cooking
  - 23% Secondary Organic Aerosols

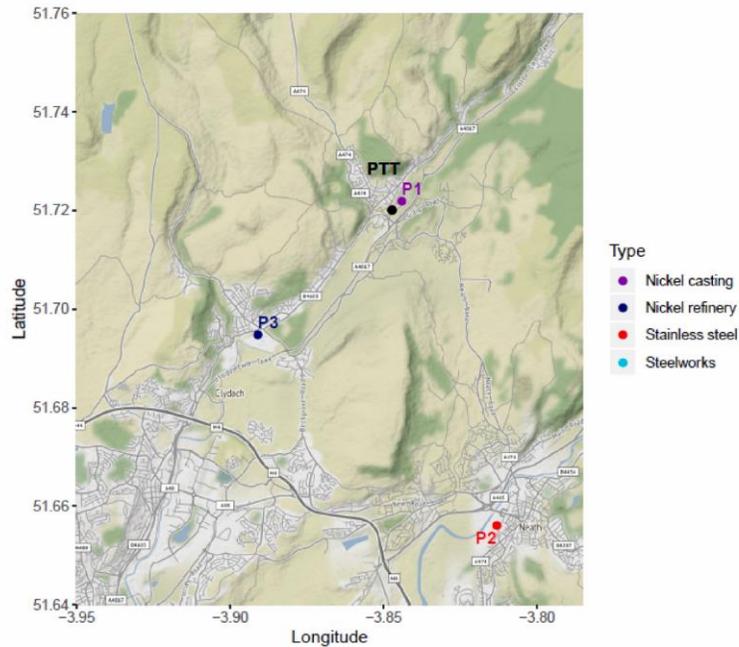
■ Permanent Stations

● Campaigns

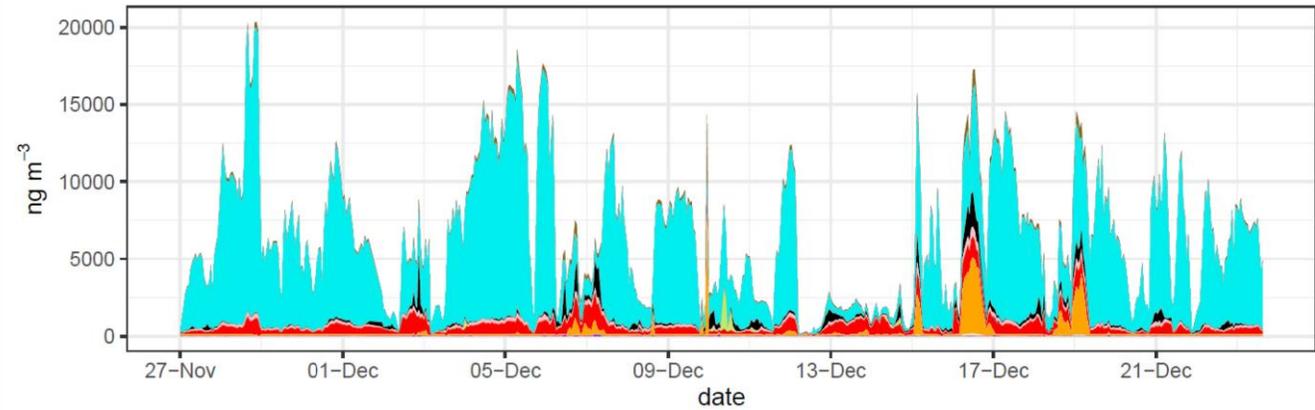


# Pontardawe Nickel Refinery

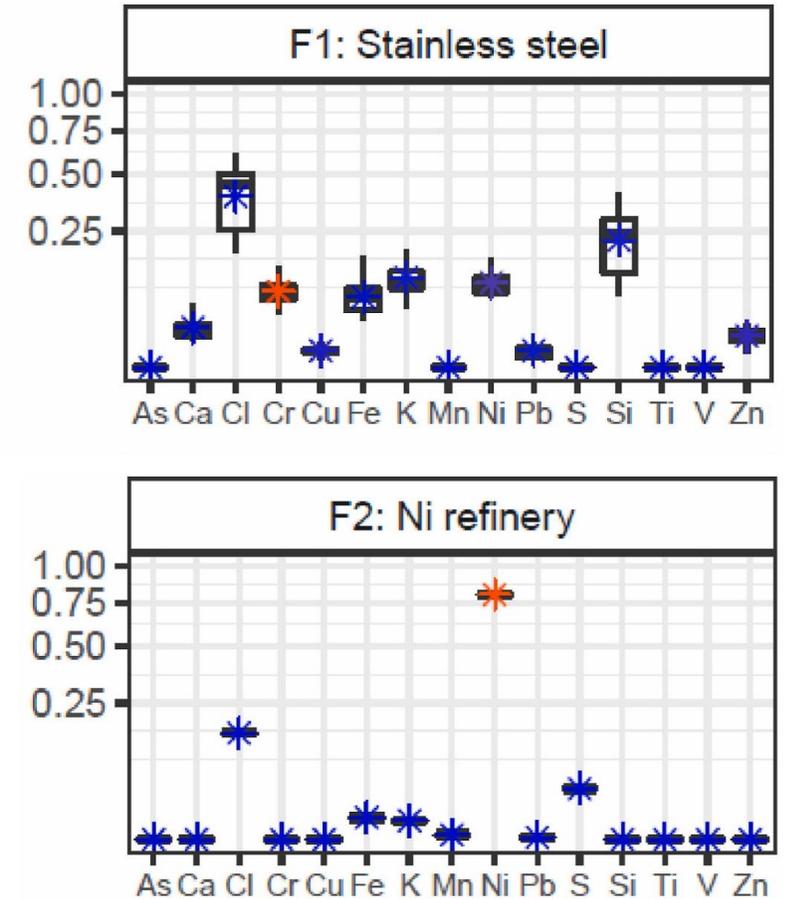
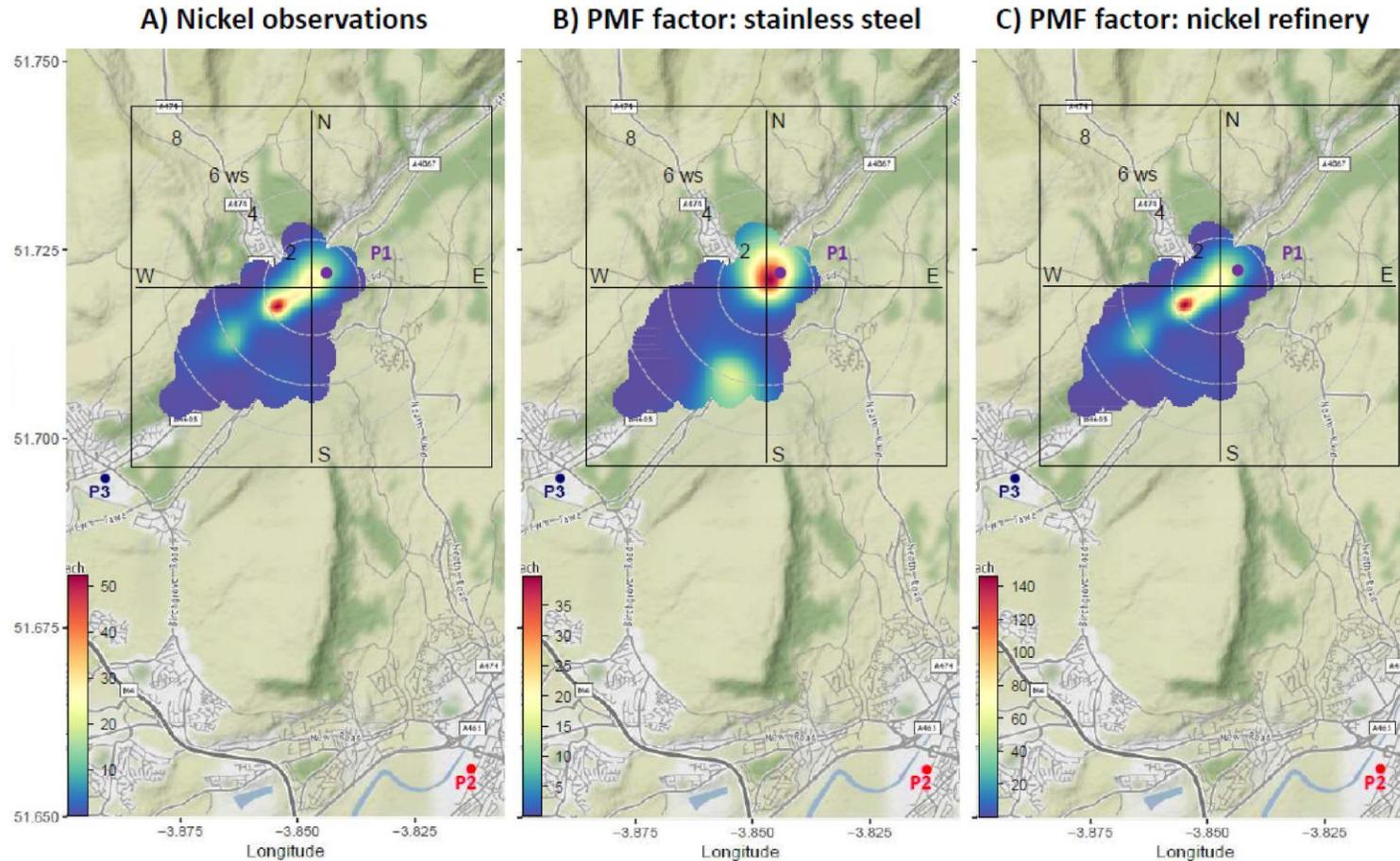
Pontardawe study area



Pontardawe campaign

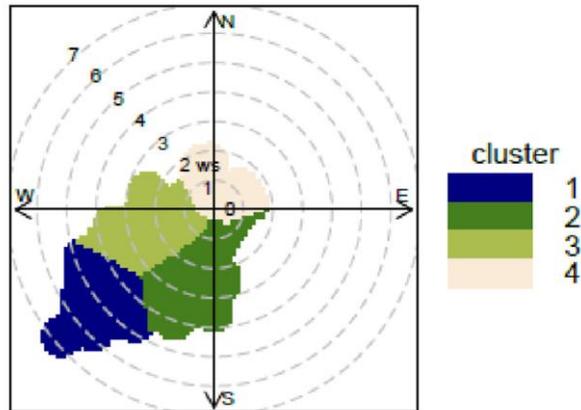


# Receptor Modelling Results

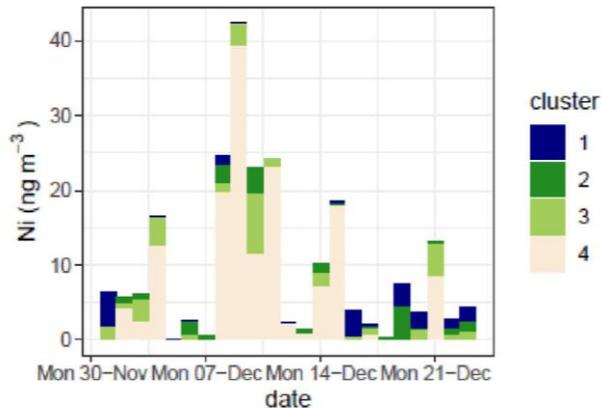


# Cluster Analysis Results

A. Cluster stainless steel



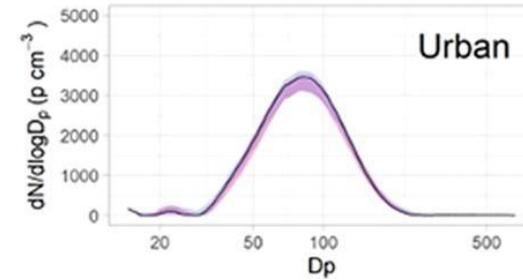
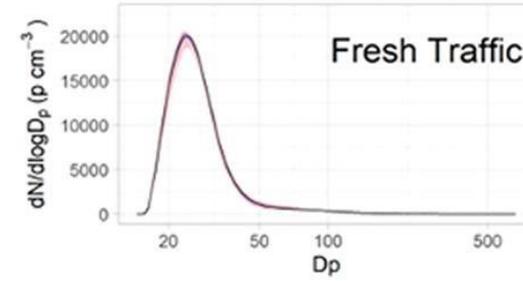
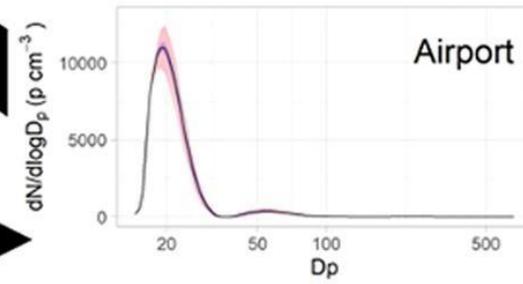
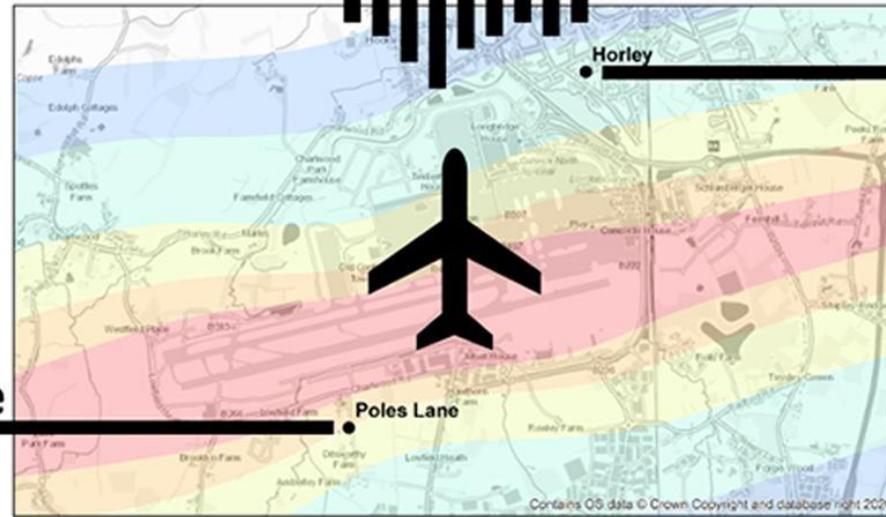
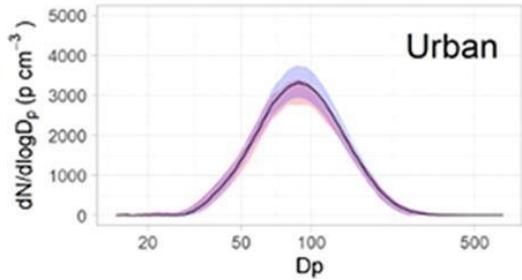
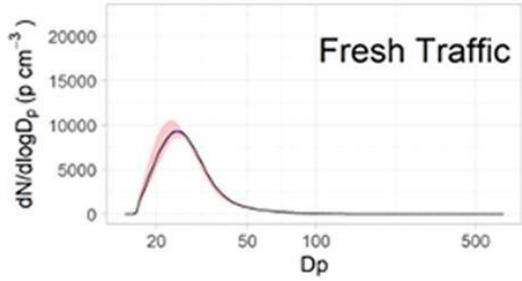
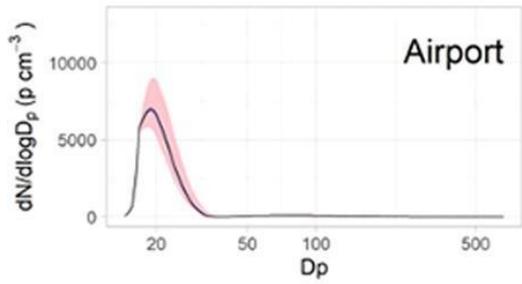
B. Ni apportionment from stainless steel



Source	Mean Ni (ng m <sup>-3</sup> )	Cluster #	Sector (industry)	Contribution to factor (%)	Contribution to Ni (%)
Stainless-steel	2	1 + 3	SW	21.5	2.1
		2	S (P3)	12.5	1.2
		4	N (P1)	49.9	6.6
Nickel refinery	18.1		P2		90.1

Majority of the Ni PM<sub>10</sub> concentrations (>90%) were attributed to the nickel refinery

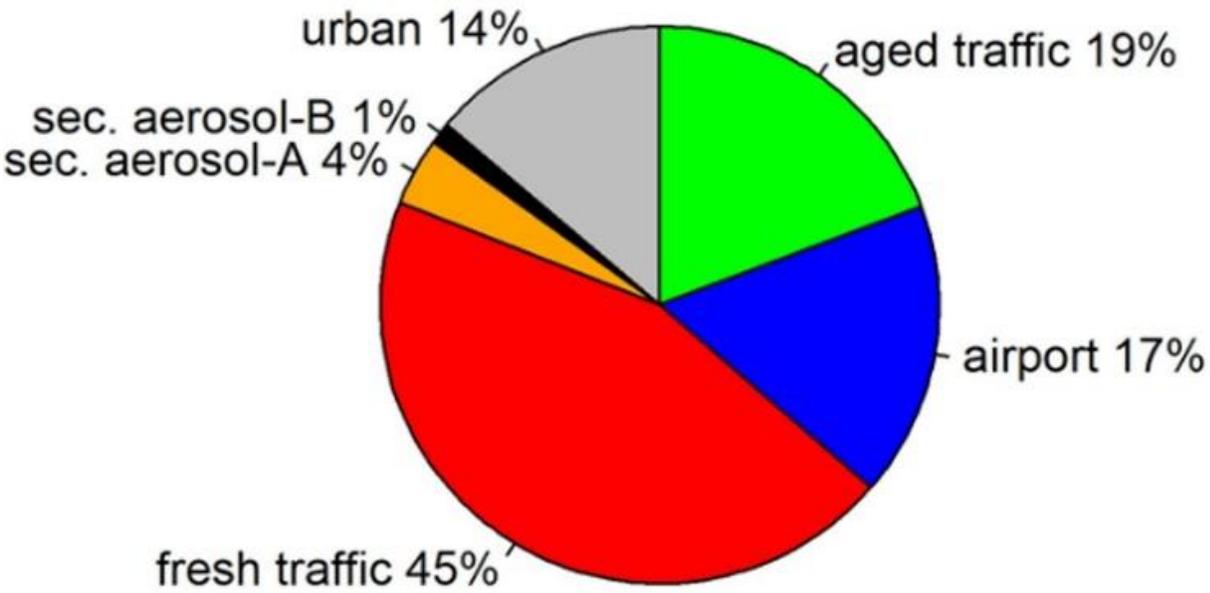
# Sources of sub-micrometre particles and noise around Gatwick airport



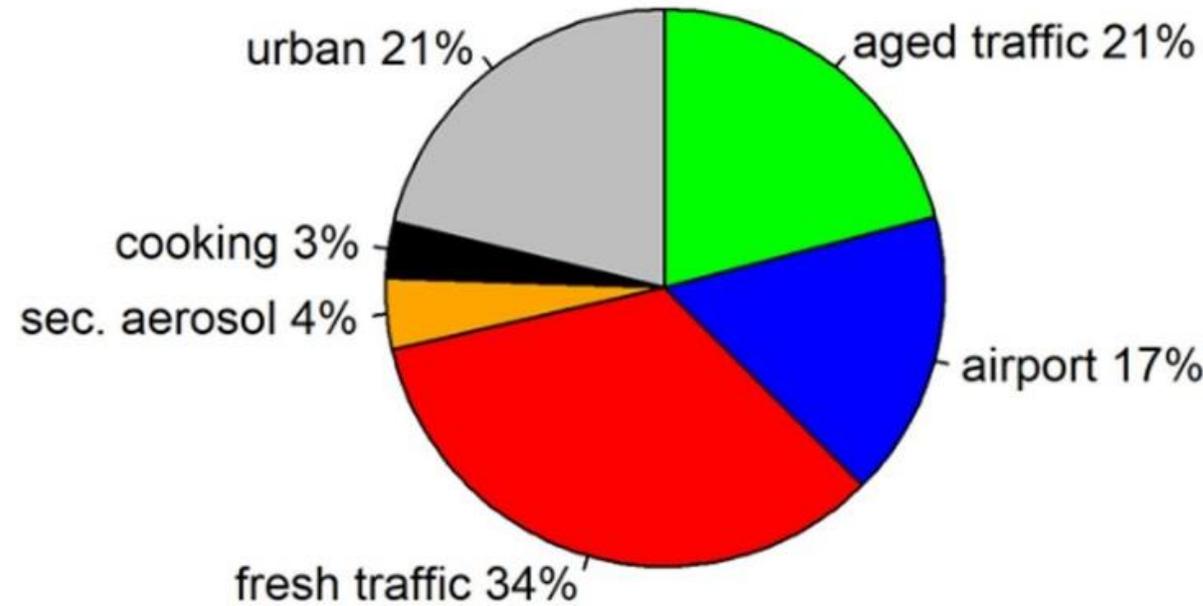
Lden 5dB(A) noise contours for 2011(CAA)

# Source of sub-micrometer particles around Gatwick

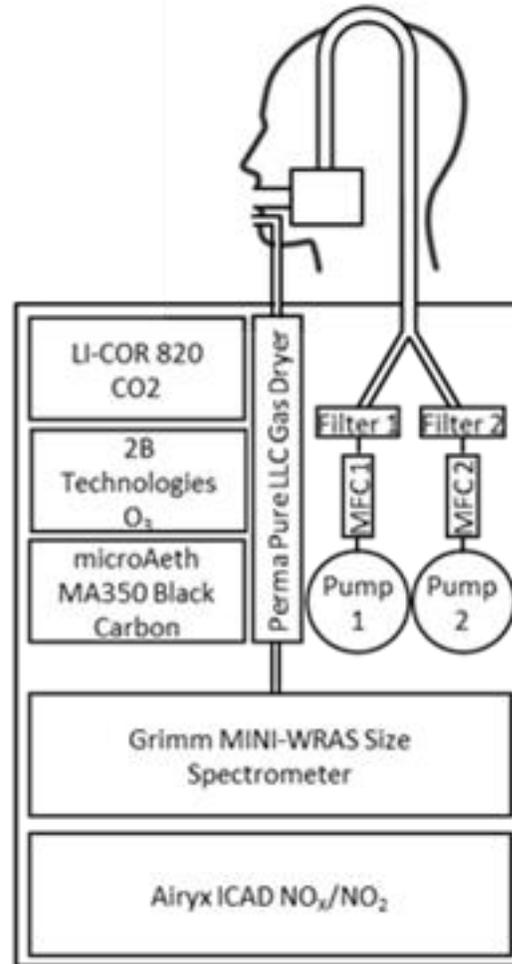
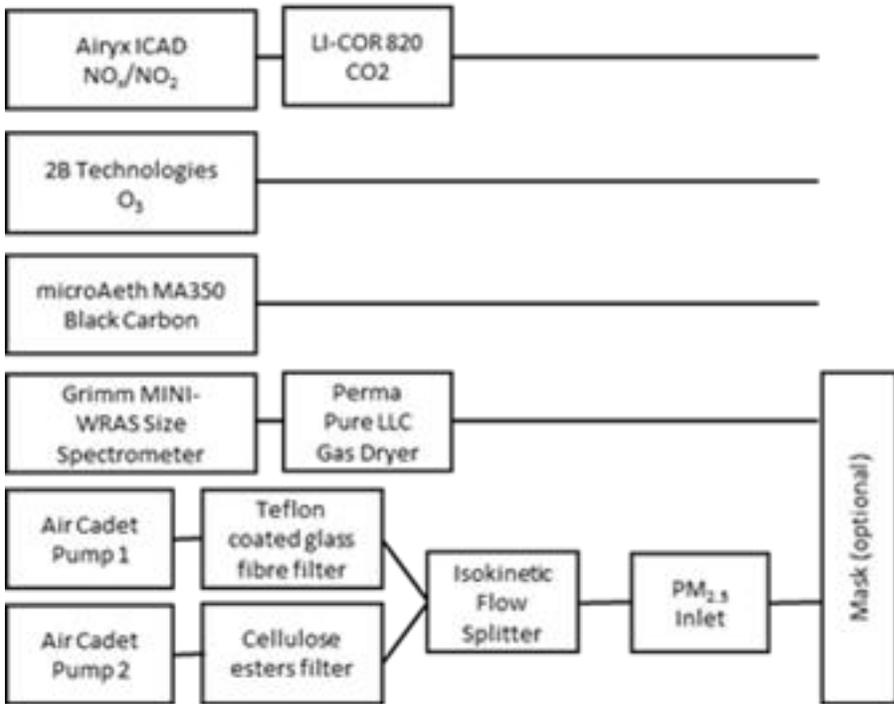
Horley



Poles Lane



# Mobile Reference Station (MoRS)



# Air Quality Onboard Trains



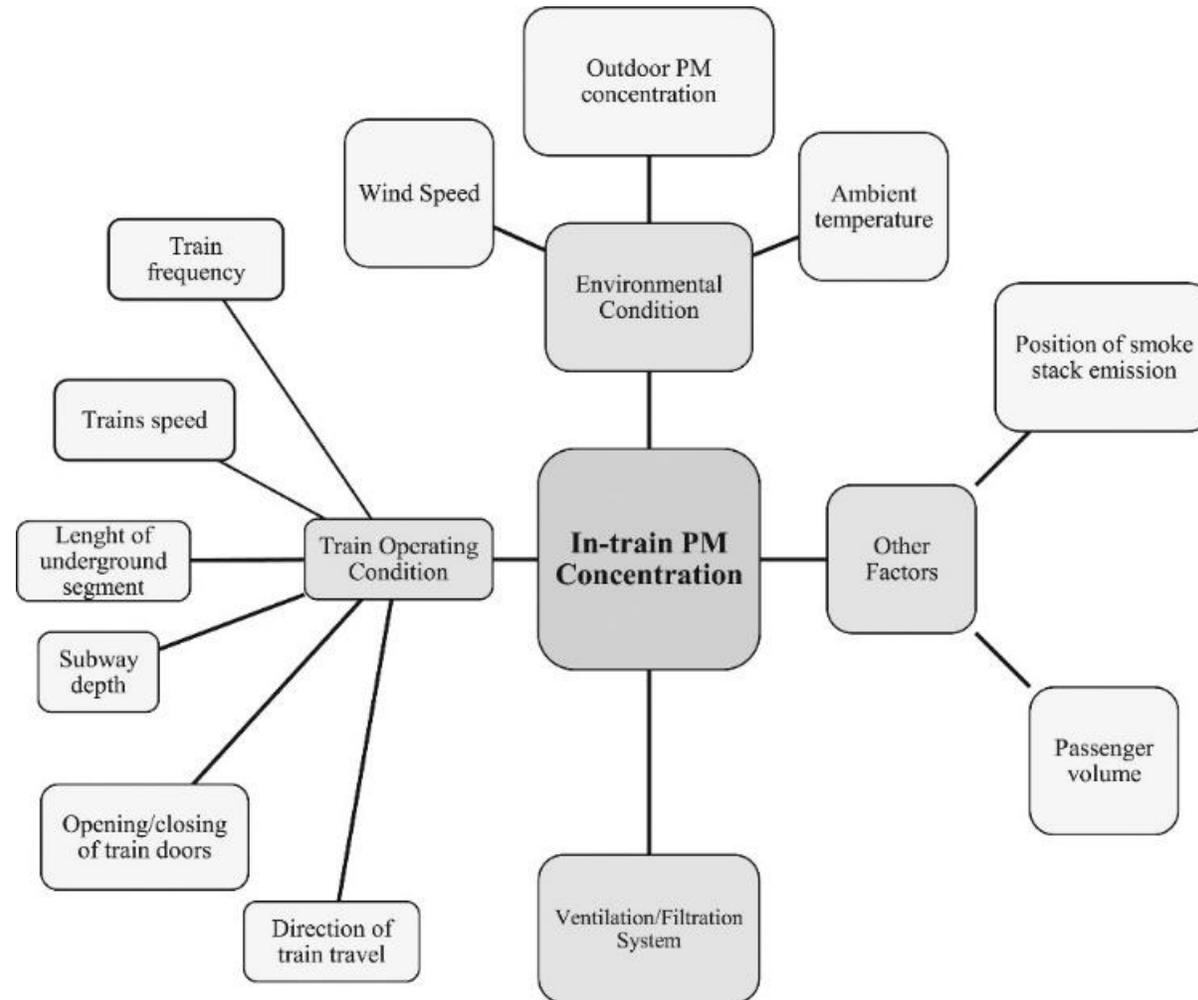
## Research in Brief

CLEAR: Analysis of Air Quality Onboard Trains  
T1188



Train Class	Route
Class 800	Paddington-Bristol Temple Meads
Class 185	York - Redcar
Class 221	Euston-Birmingham New St.
Class 230	Bletchley-Ridgmont/Bedford
Class 159	London Waterloo - Salisbury
Class 220	Birmingham - Reading
Class 220	Birmingham New St. - Manchester
Class 168	Marylebone-Birmingham Snowhill
Class 43	St Pancras-Nottingham
Class 156	Manchester - Buxton
Class 172	Birmingham Snow Hill - Stratford
Class 195	Manchester - Liverpool
Class 68	York - Scarborough
Class 755	Ipswich-Cambridge

# Air Quality Onboard Trains

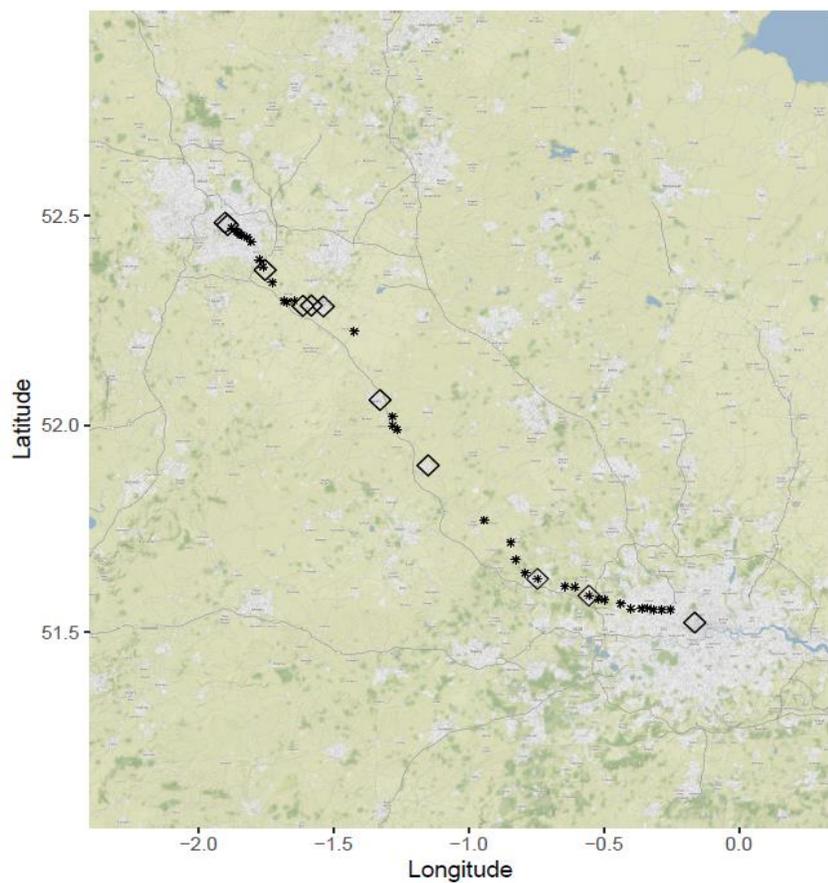


Factors affecting the in-train particulate matter concentration (Adapted from: Otuyo et al., 2022)

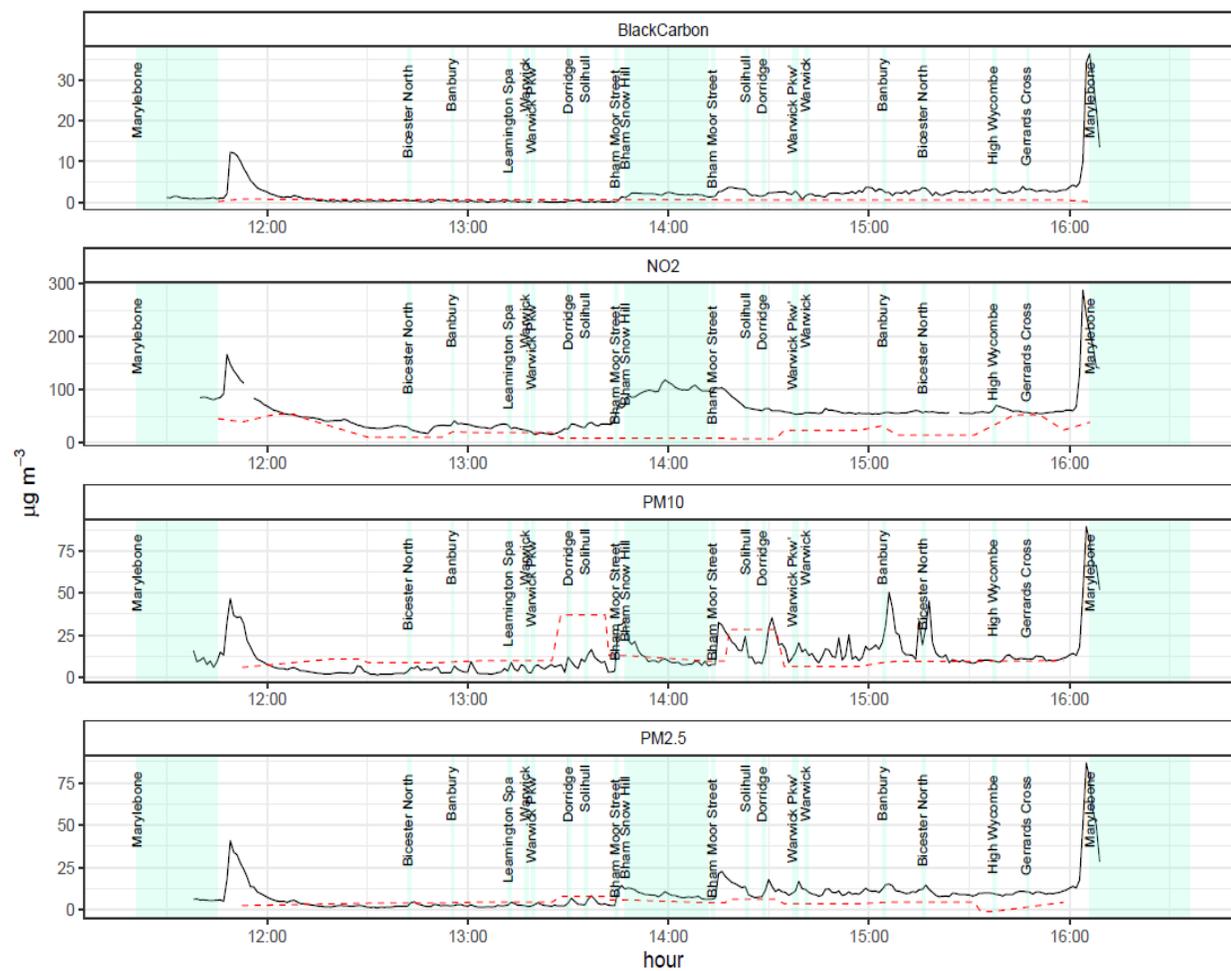
# London Marylebone - Birmingham Snow Hill

15-Jan-2020: Marylebone to Birmingham Snow Hill  
Class 168

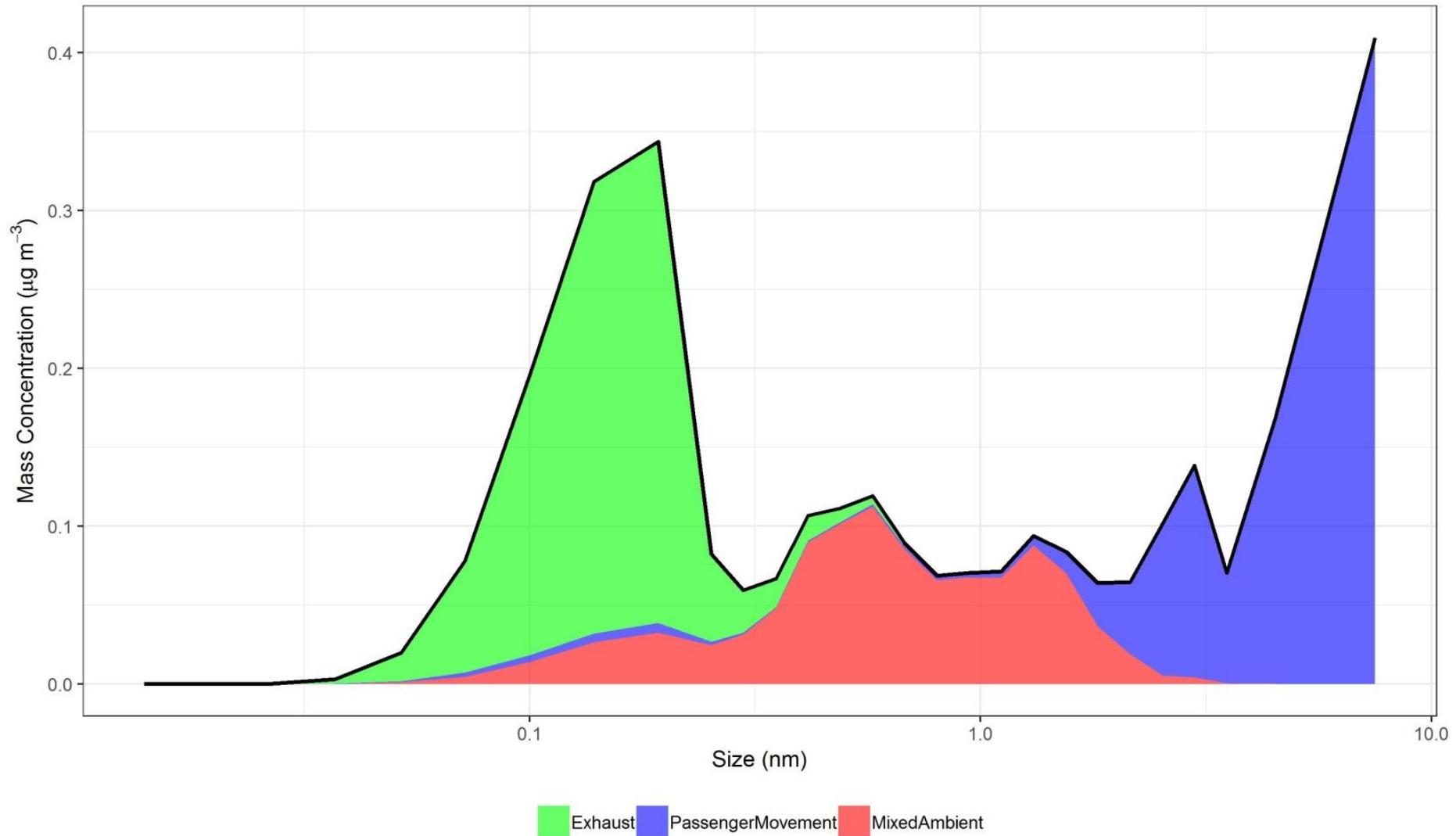
stop \* no  $\diamond$  yes



15 Jan 2020: Marylebone to Birmingham Snow Hill  
Class 168

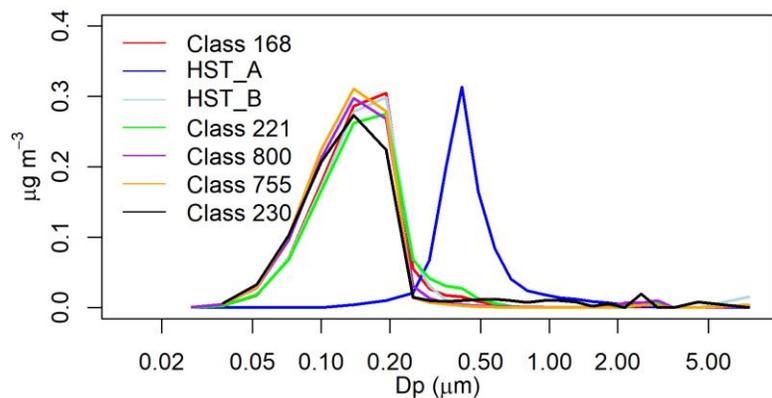


# Source Apportionment of Particle Size Distribution

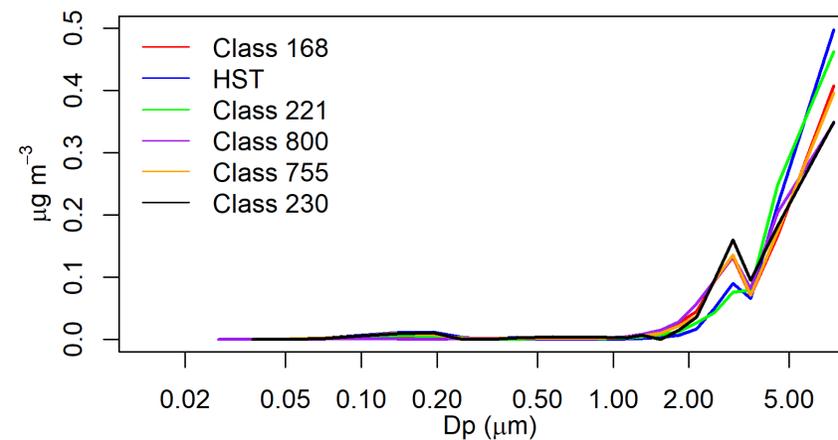


# Source Factors

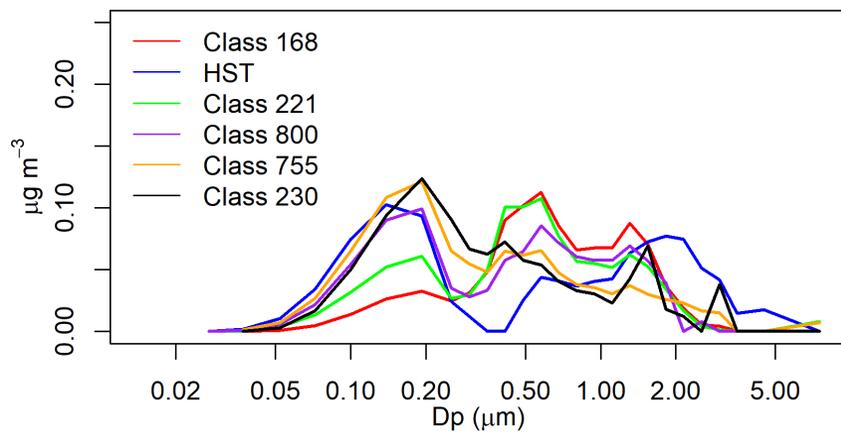
## Exhaust



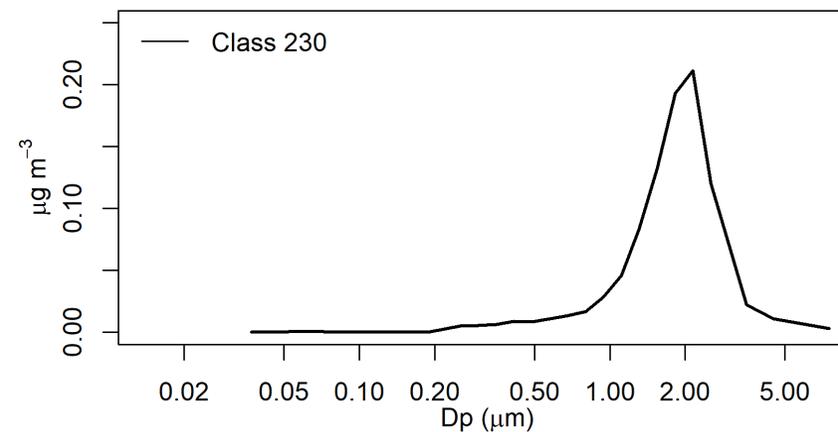
## Passenger Movement



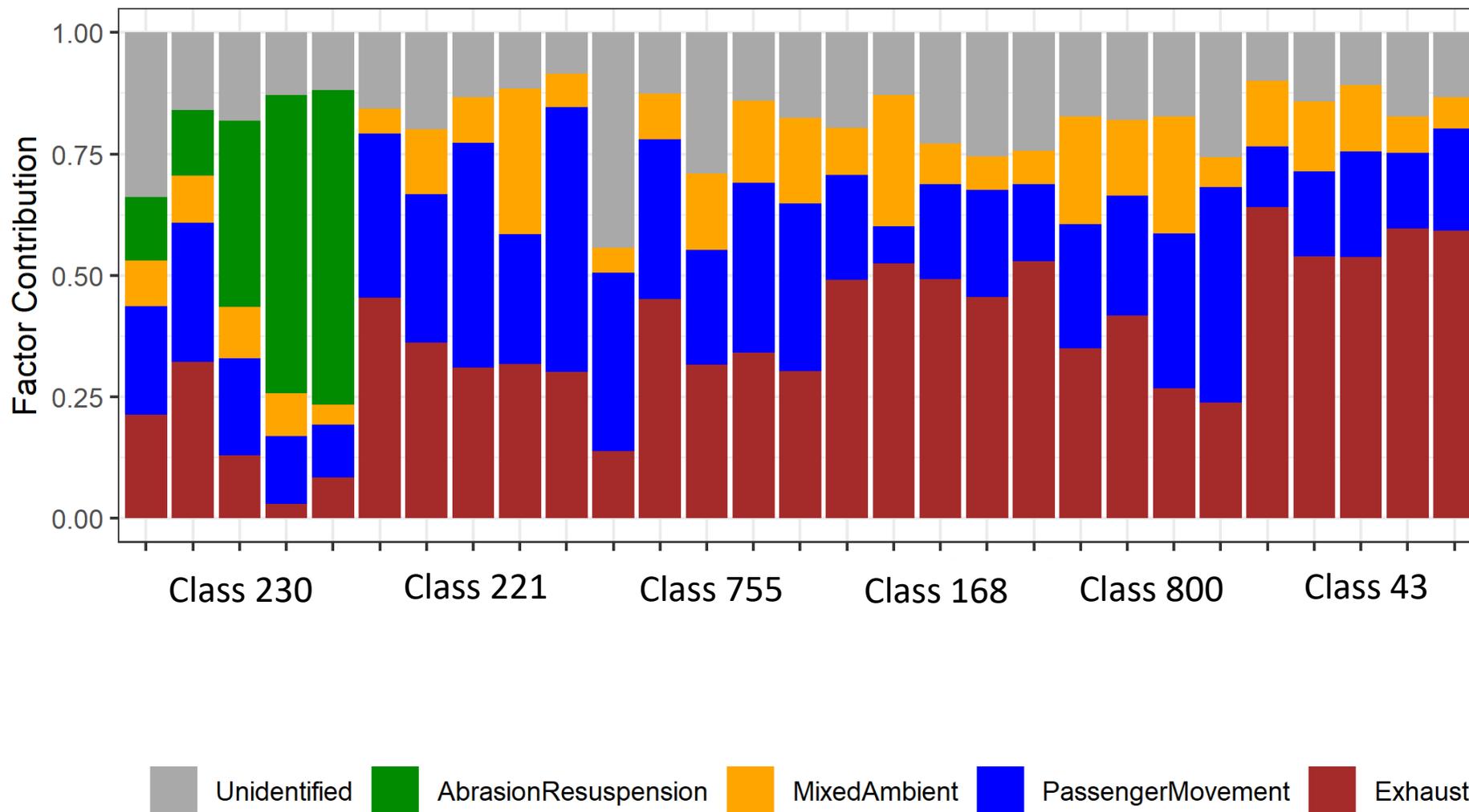
## Mixed Ambient



## Abrasion Resuspension



# Contribution of the source factors



# Why is it important to measure composition of particulate matter?

- Improved understanding of environmental and health impact
- Understanding source contributions improves
  - Stakeholder understanding
  - Toxicological and epidemiological health studies
  - Targeted abatement policies

# Thank you for listening



Contact details/for more information

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