MRC-PHE
Centre for Environment & Health

Public Health England | MRC Medical Research Council | Imperial College London | King's College London

Particulate Matter
Real-time episode composition

2nd July 2015

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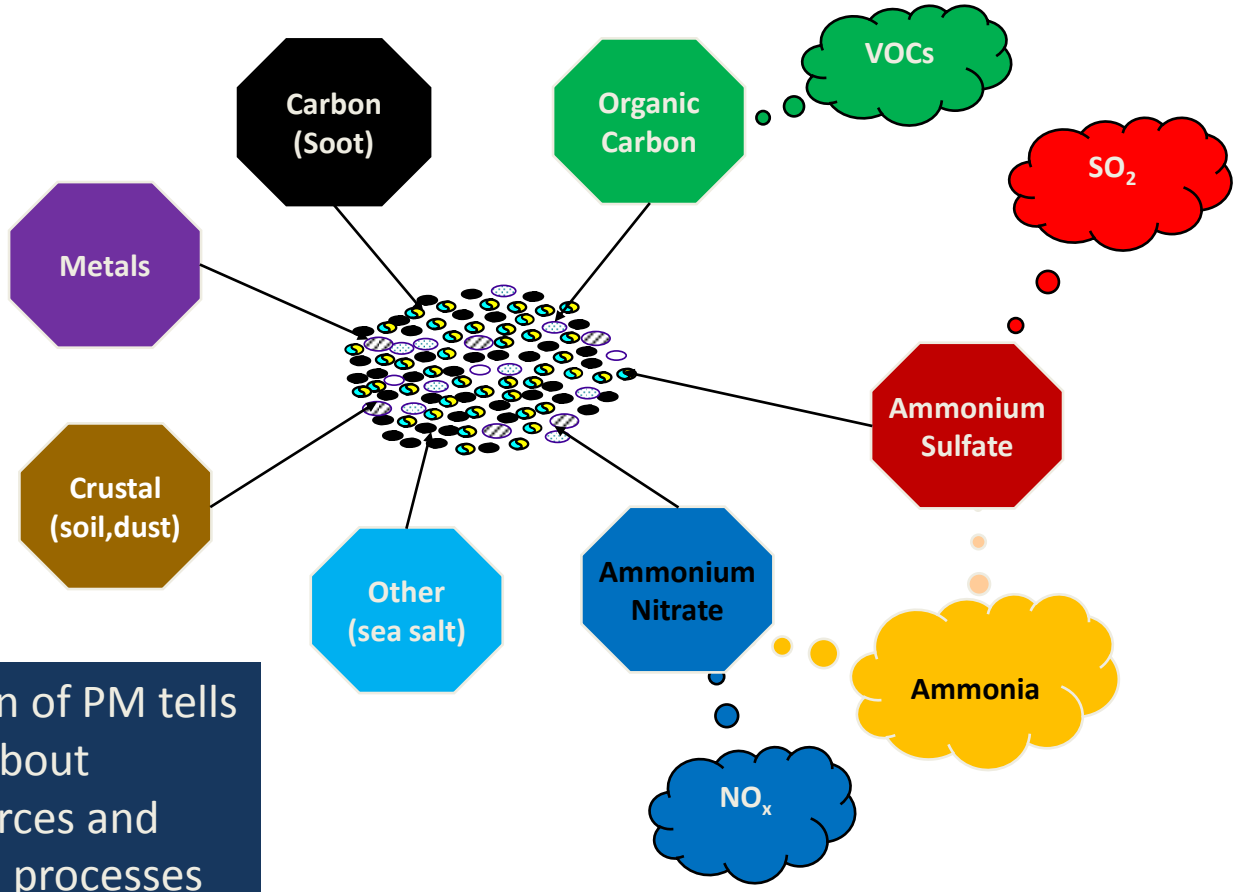
SOURCES
TRANSFORMATION & TRANSPORT
REMOVAL
EFFECTS
DISPERSION
PREVAILING WINDS
PHOTOCHEMISTRY
CLOUD PROCESSES
CHEMICAL TRANSFORMATIONS
LIGHTNING
VERTICAL MIXING
FIRES
VISIBILITY
WET DEPOSITION
DRY DEPOSITION
INDUSTRY
AGRICULTURE
TRANSPORT
BIOGENIC SOURCES
ESTUARIES
CULTURAL RESOURCES
HUMAN HEALTH
AQUATIC ECOSYSTEMS
SOILS
SOILS
GROUND WATER

PM Composition

Primary Particles (directly emitted)

Secondary Particles (from precursor gases)



Composition of PM tells us about the sources and formation processes

Why is understanding the chemical composition important?

- Health effects
  - At a population level - not yet enough evidence to identify differences in the effects of particles with different chemical compositions
  - Evidence for the hazardous nature of combustion-related PM is more consistent than that for PM from other sources
  - PAH's, metals and inorganic salts which are emitted alongside black carbon are currently seen as responsible for health effects
- Climate
  - Effects of black carbon (as well as other PM) on climate change

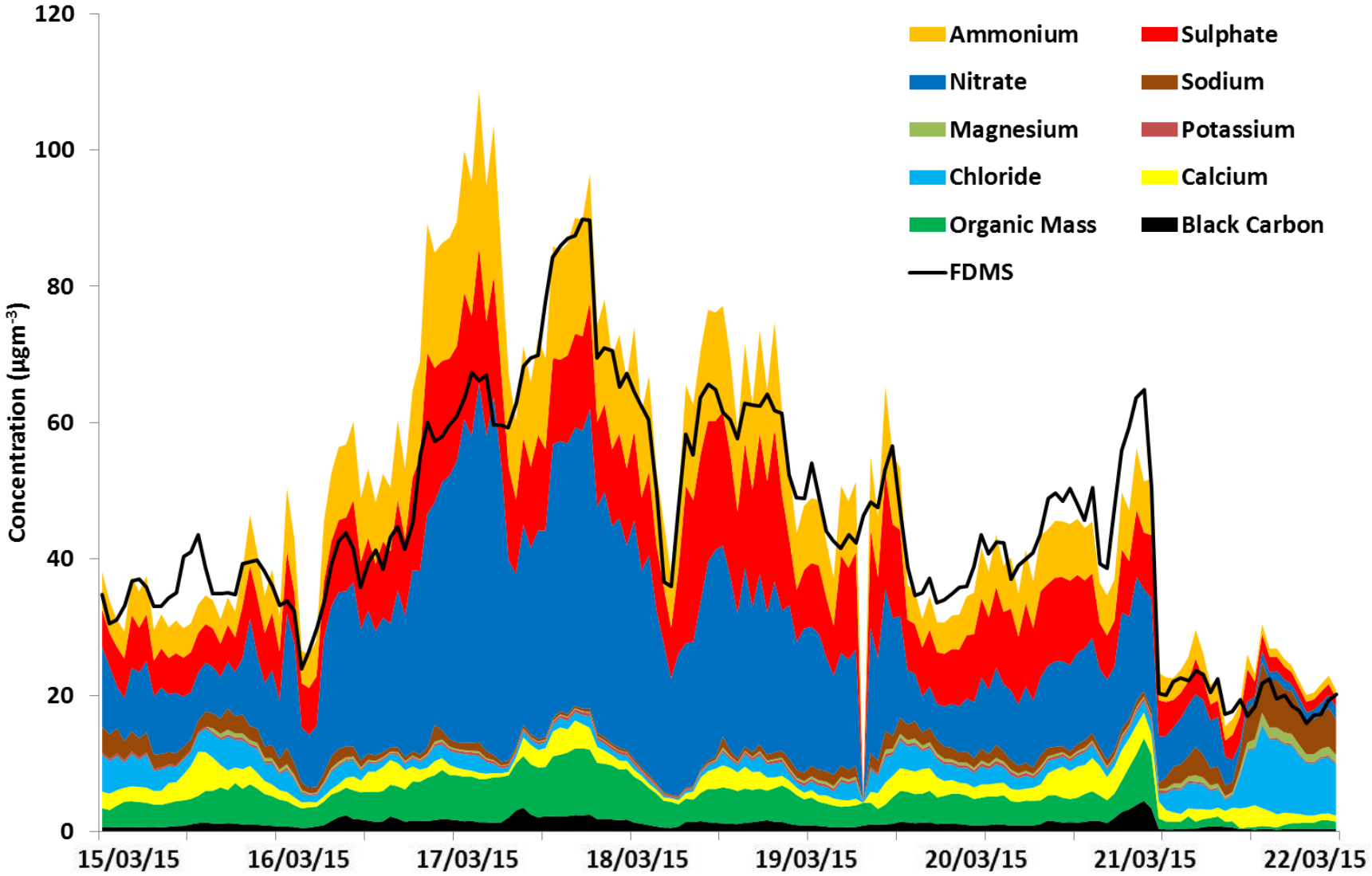
Why is understanding the chemical composition important?

- Source identification and quantification
  - Problematic due to consistent effects of meteorology and correlation of many source emissions
  - Finer detail offered by chemical composition allows sources to be separated and quantified
  - High time resolution allows links to meteorology and activity data
  - Quantify known and identify new sources
- Policy
  - Source apportionment leads to better targeting of policy
  - Used to assess the efficacy of policy

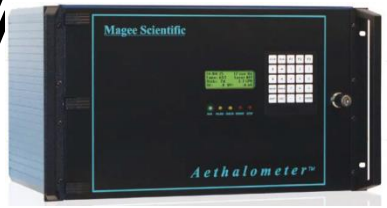
Why are episodes important?

- Health effects
  - good evidence of the effects of short-term exposure to PM_{10} on respiratory health
  - heightened severity of symptoms and increased hospital admissions in asthmatics and (COPD) patients
  - Evidence of health effects associated with short and/or long-term elevations in PM
- Regulation
  - Daily PM_{10} limit value
    - No more than 35 days > 50 μgm^{-3} in a calendar year
    - Natural contributions
    - Winter-sanding or -salting of roads

Episodes – on the frontier



PM Composition Measurement



Aethalometer

$PM_{2.5}$

Carbon (Soot)

Organic Carbon

Aerosol Mass Spectrometry

PM_1

Metals

X-Ray Fluorescence

PM_{10}

$PM_{2.5}$

Crustal (soil,dust)

Other (sea salt)

Ammonium Sulfate

Ammonium Nitrate

Ammonia

NO_x

Gas

Particle

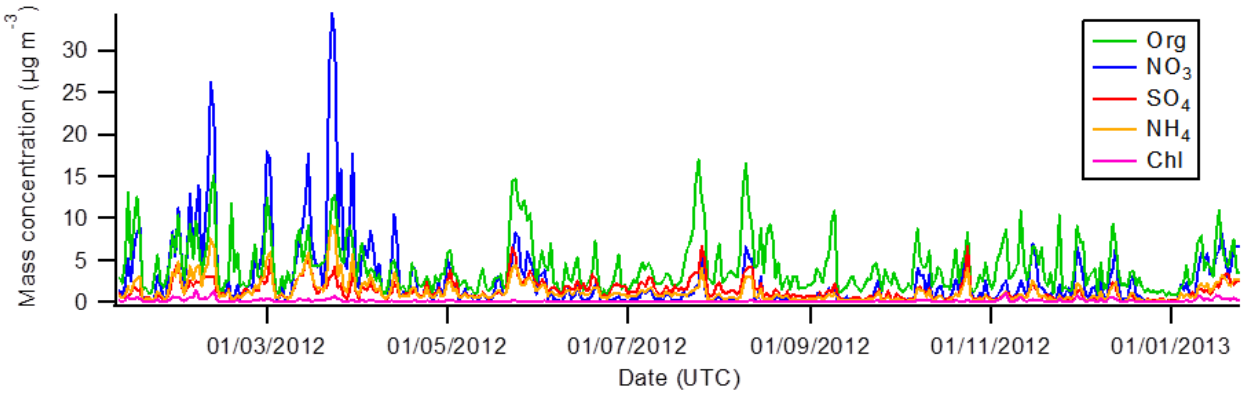
Ion Chromatography

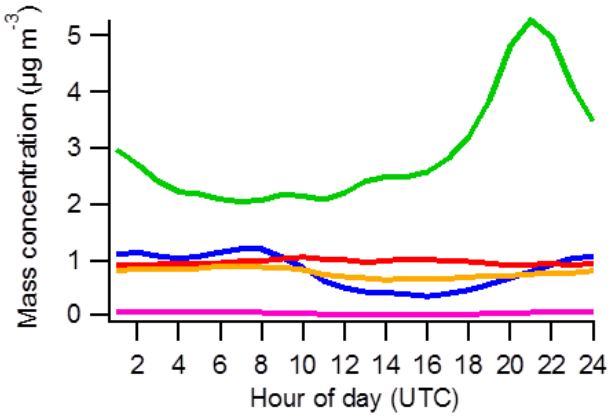
PM_{10}

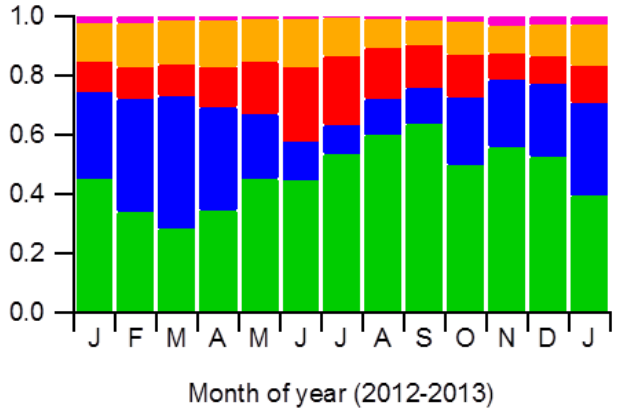

Measurements

AMS 2012 North Kensington

- NERC ClearfLo study funds (with Defra support) funds 12 months measurement AMS campaign at North Kensington
- Coincided with European wide campaign

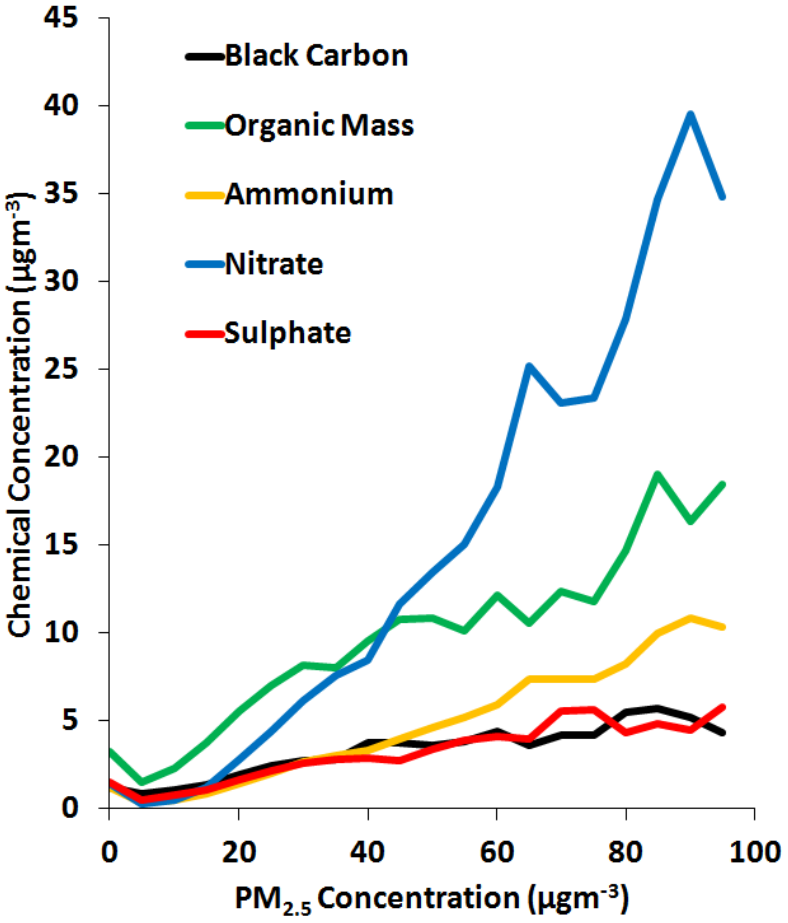


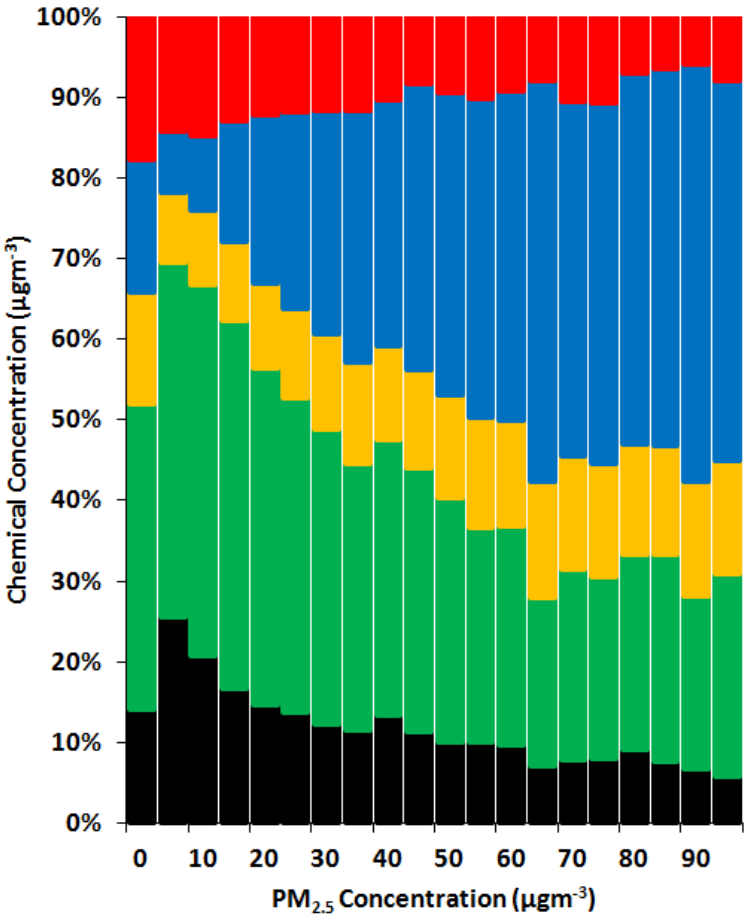




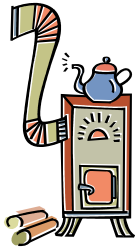
Young et al (2015) Investigating the annual behaviour of submicron secondary inorganic and organic aerosols in London. Atmos. Chem. Phys., 15, 6351–6366, 2015.

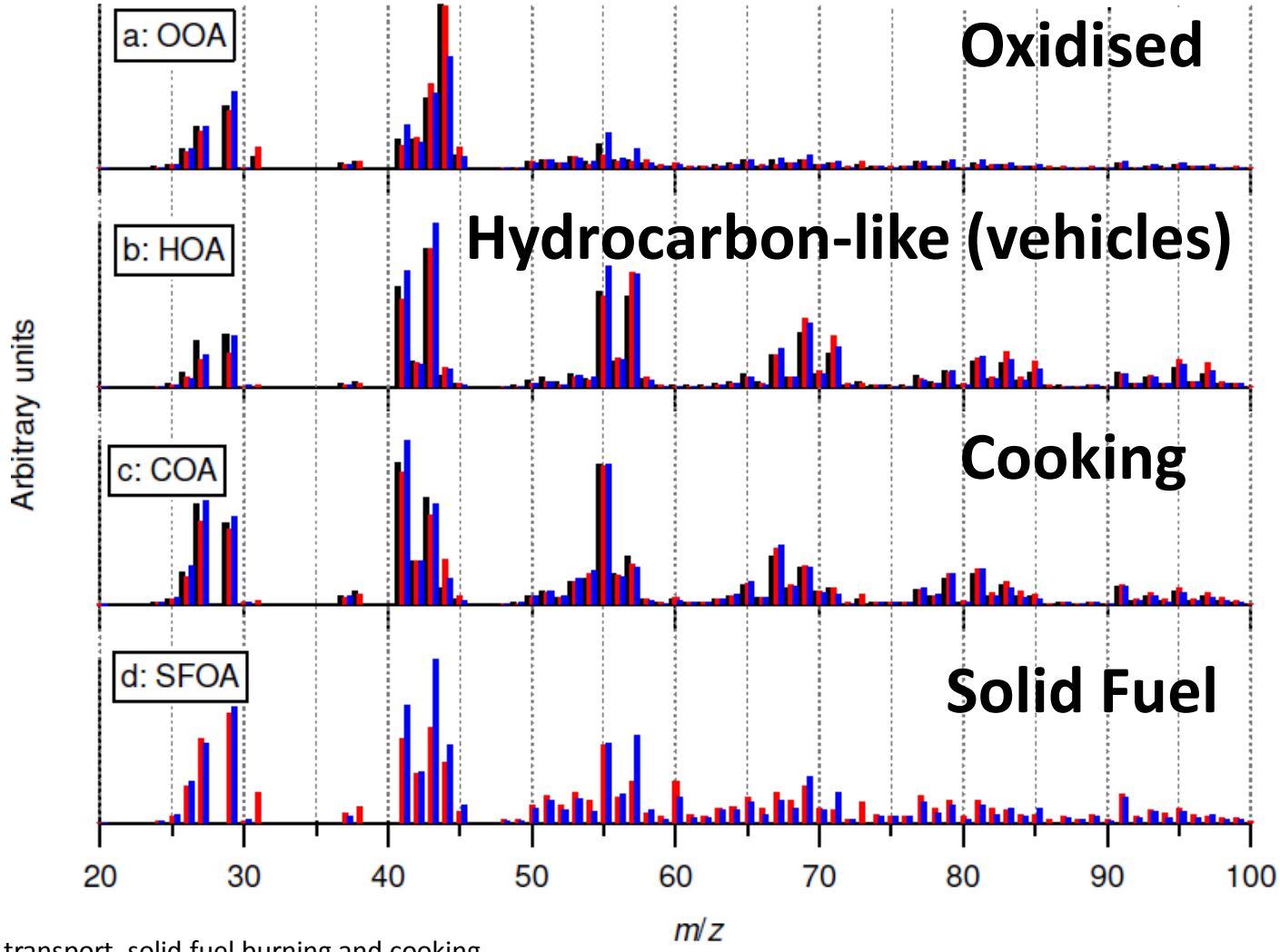
$PM_{2.5}$ Episode Composition at Kerbside 2012





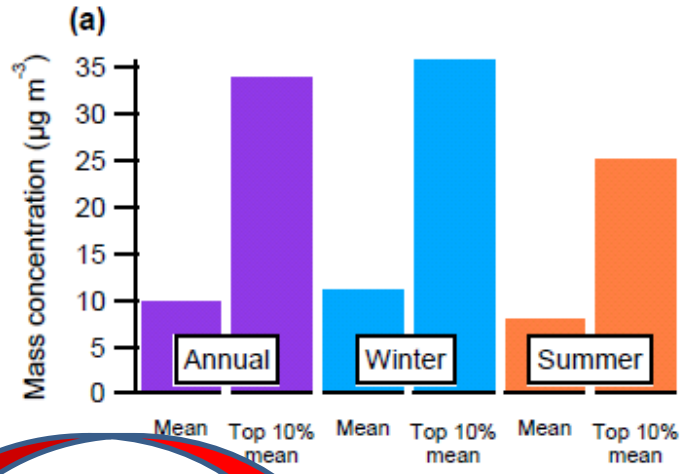
Source Apportionment of Organic Mass

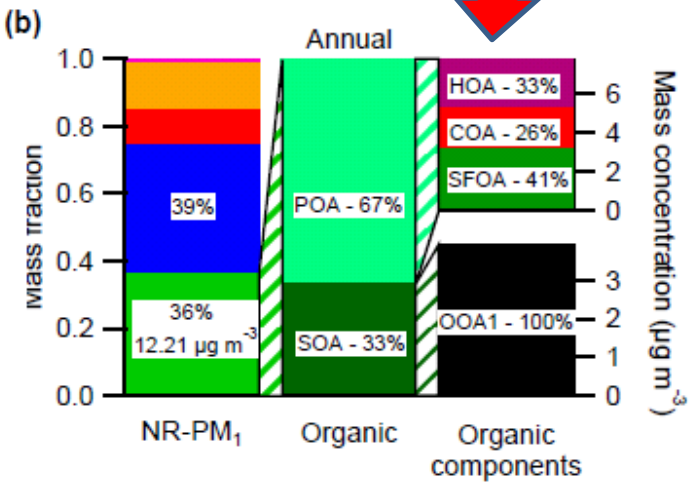




Allan et al (2010) Contributions from transport, solid fuel burning and cooking to primary organic aerosols in two UK cities. Atmos. Chem. Phys., 10, 647–668, 2010.

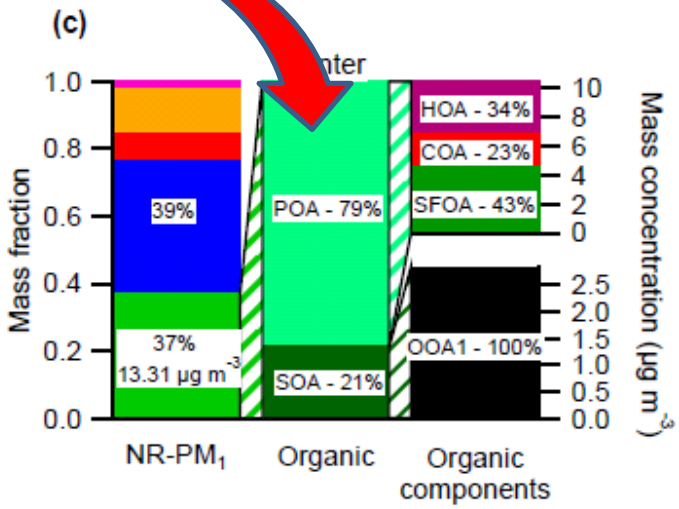
North Kensington Organic Mass 2012

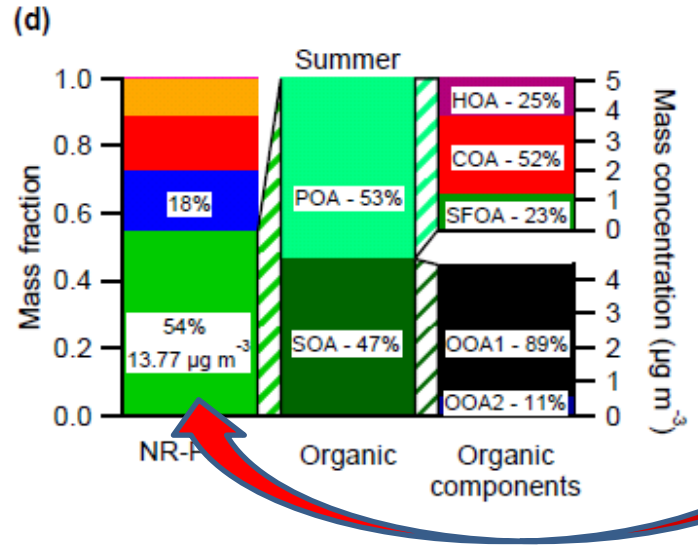




3 primary sources

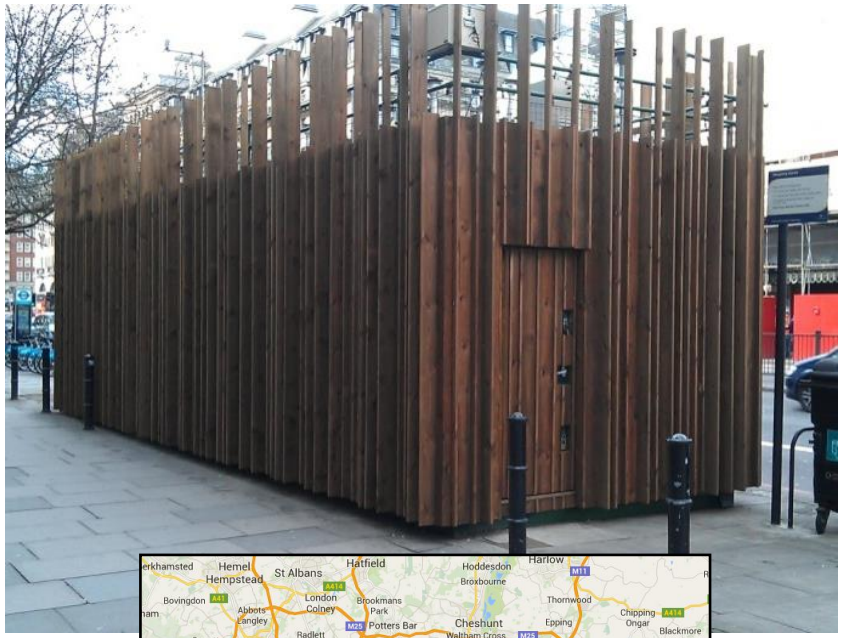
Primary dominant

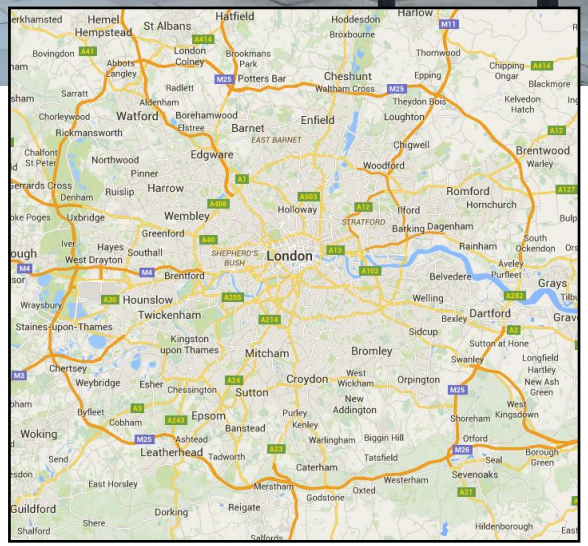




54% Organic Mass

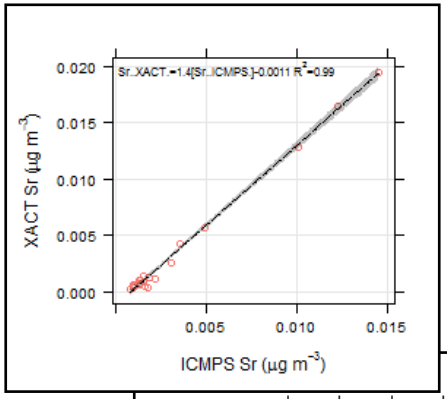
Marylebone Road Campaign

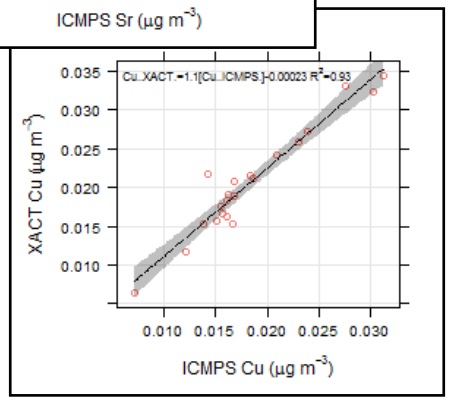




- Testing new XRF
  - Analyse both PM_{10} and $PM_{2.5}$
  - Compare XRF to NIST traceable filter measurements
- Test full analysis suite at fixed location
- Standardise operational procedures
- Develop data analysis techniques
- Two periods
  - $PM_{2.5}$ 16th Oct- 17th Nov 2014
  - PM_{10} 4th December onwards
- Data analysis still at an early stage

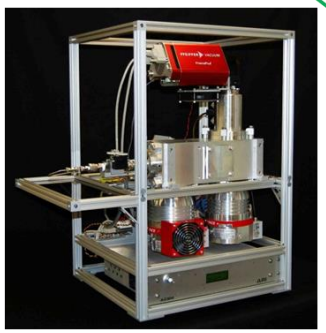
Marylebone Road Configuration





Aethalometer

Carbon (Soot)



Aerosol Mass Spectrometry

Organic Carbon

X-Ray Fluorescence

Metals

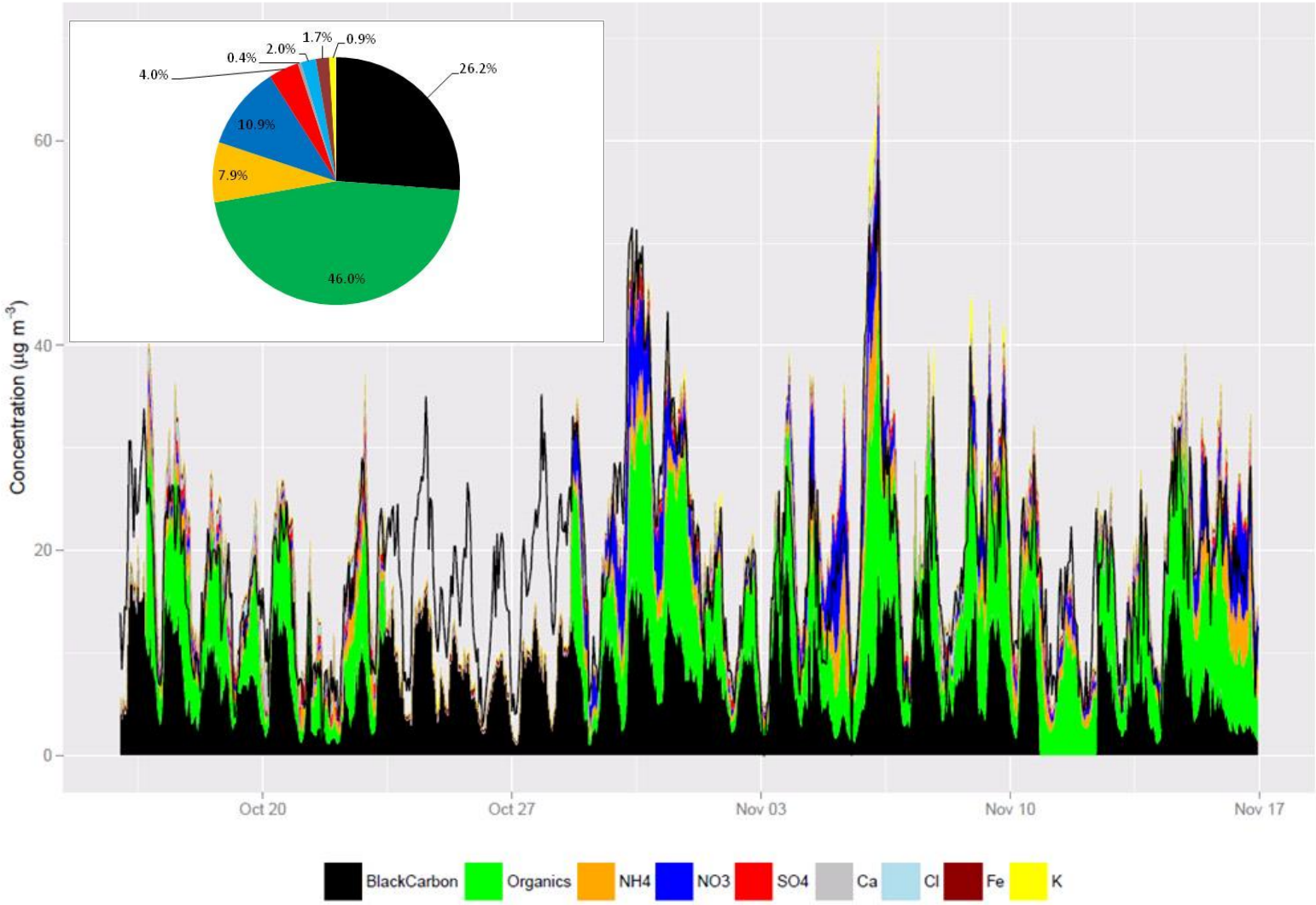
Crustal (soil,dust)

Other (sea salt)

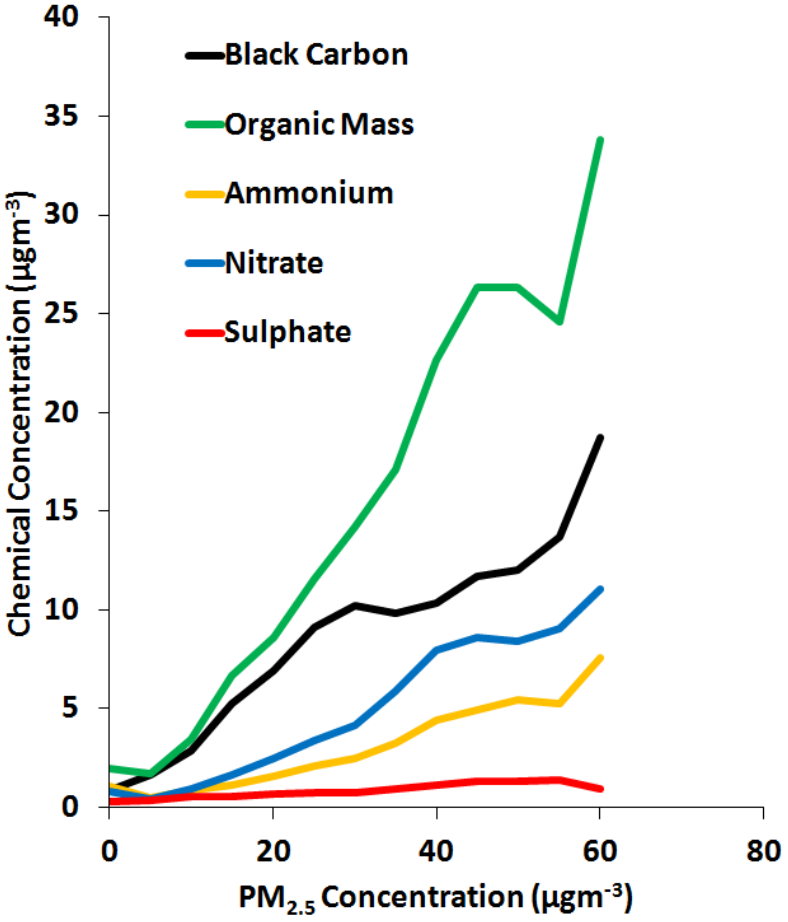
Ammonium Nitrate

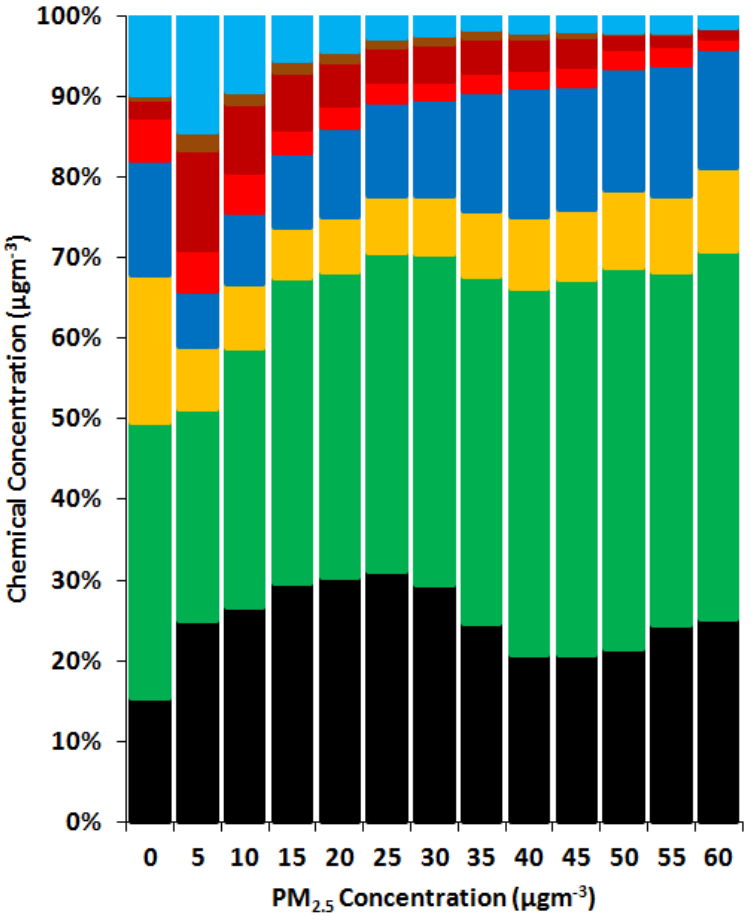
Ammonium Sulfate

Chemical Composition

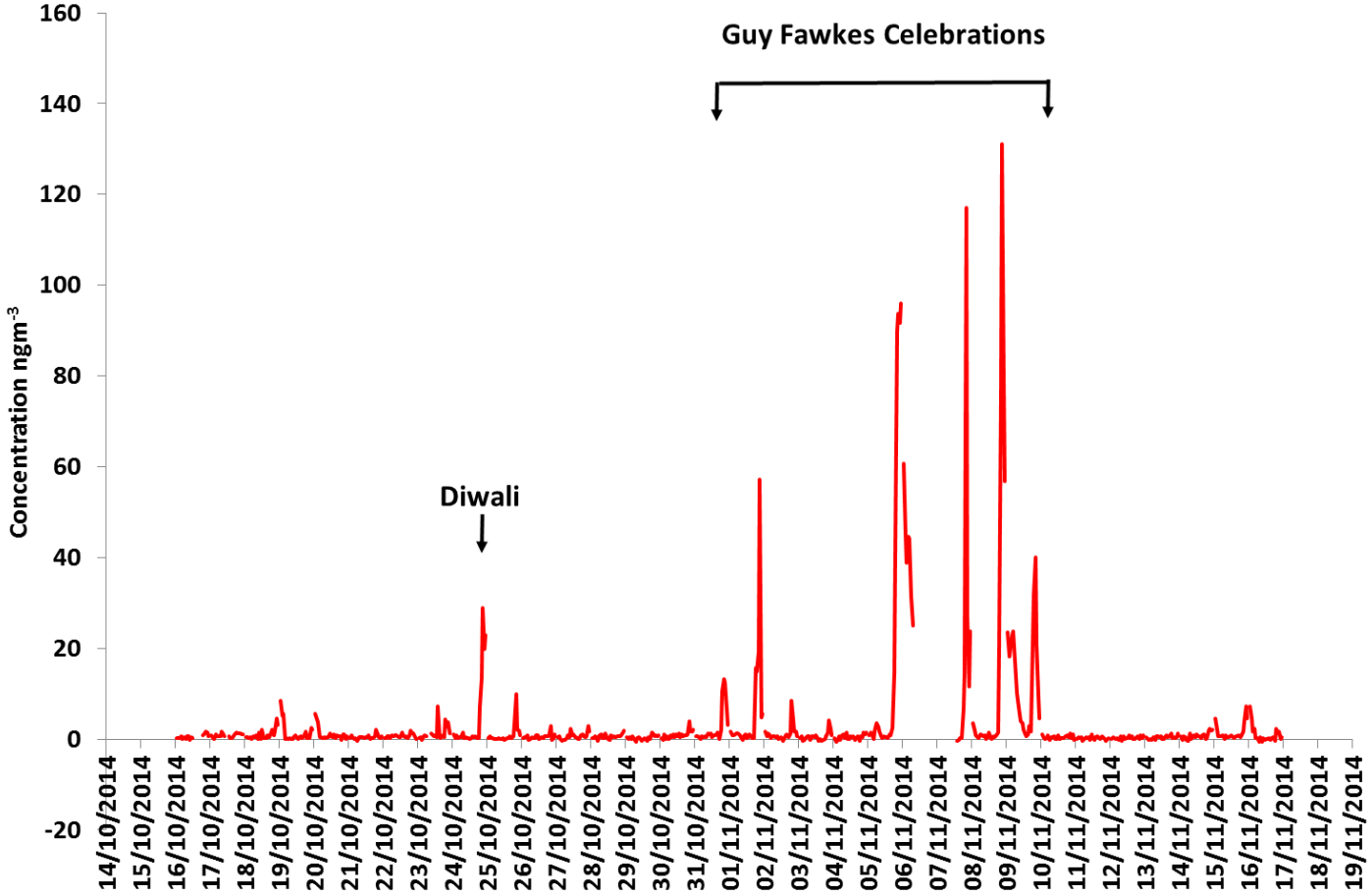


PM Episode Composition at Kerbside 16th Oct 14 - 7th Jan 15

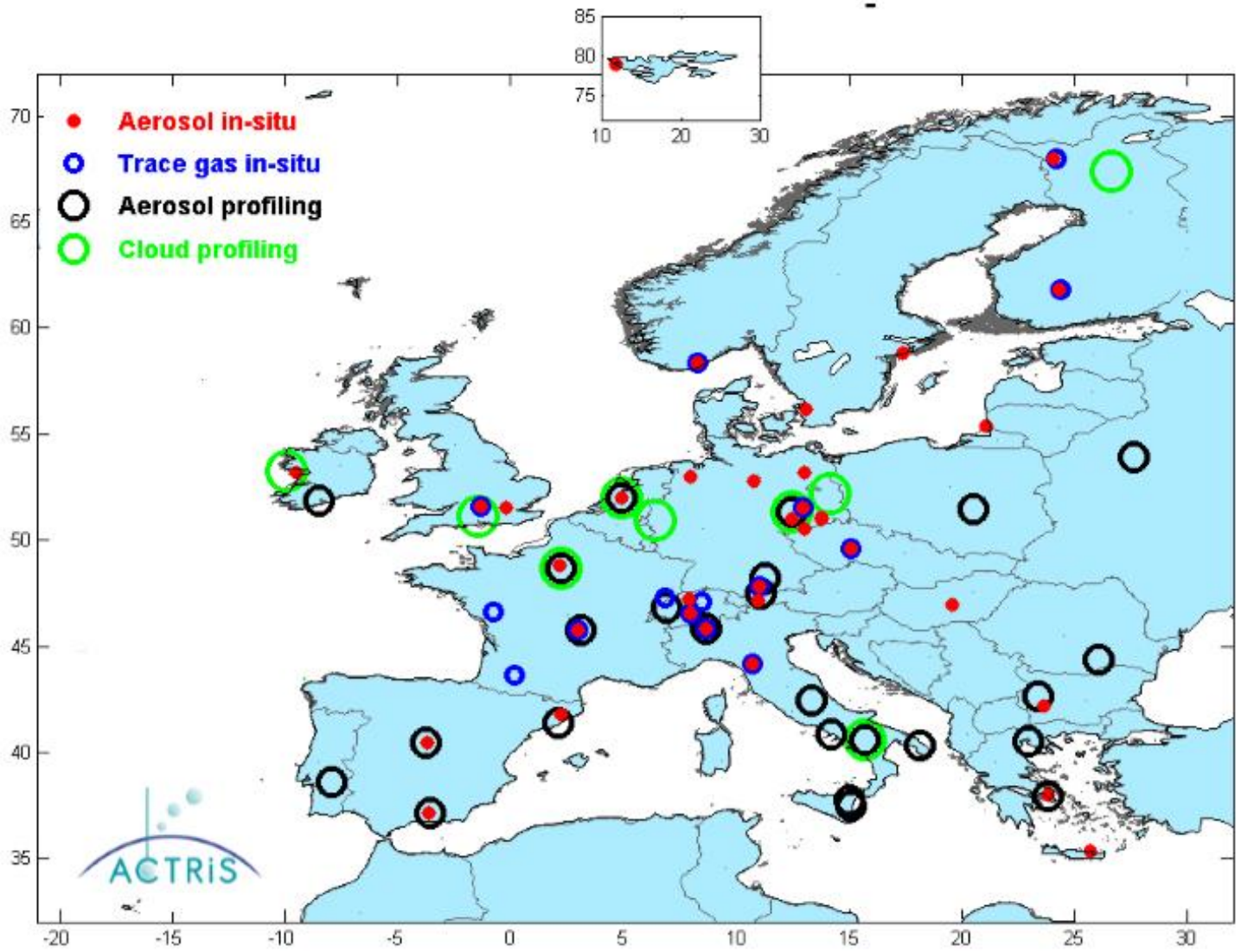




What can trace element composition tell us about episodes?



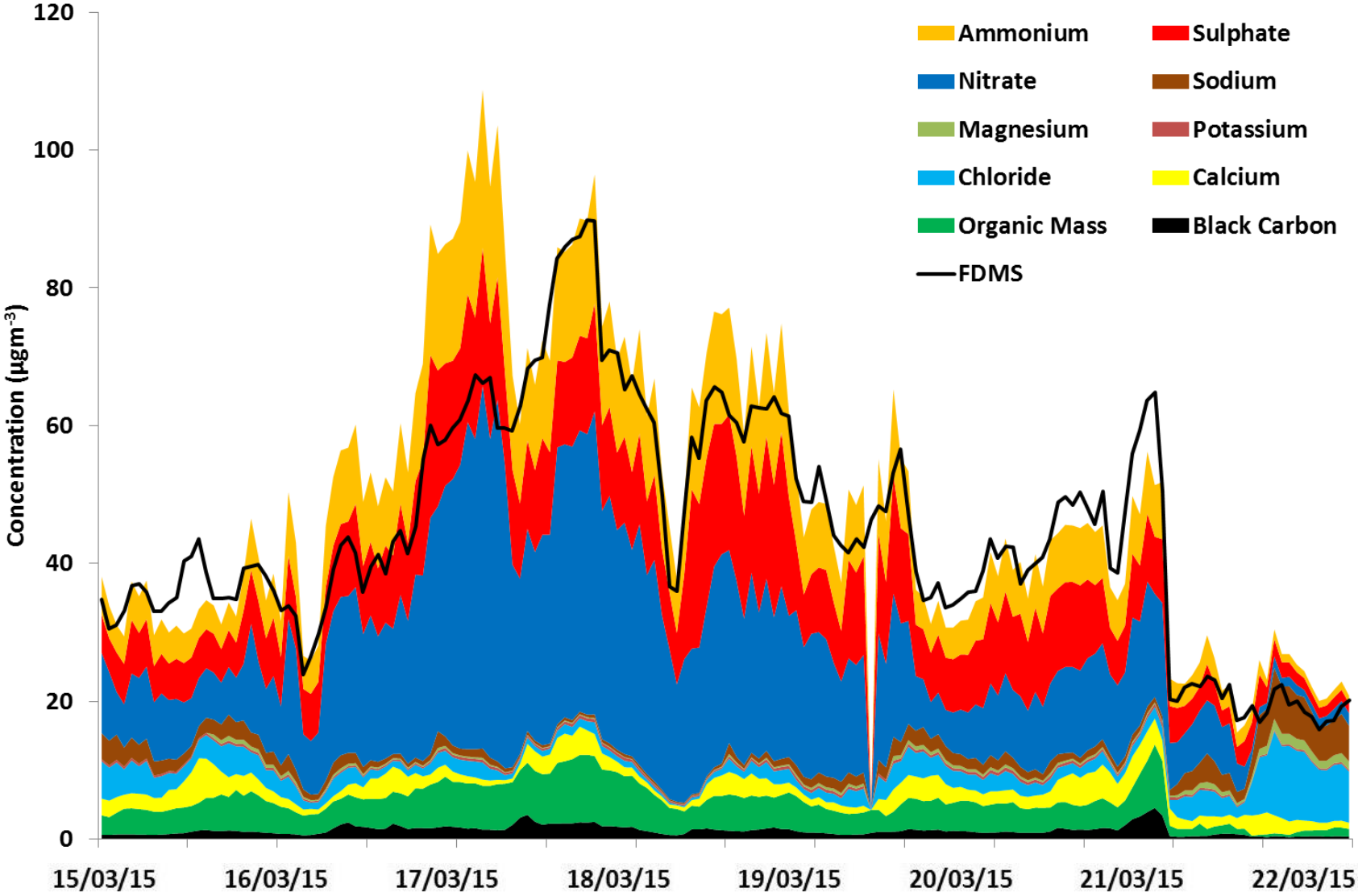
European Context - ACTRIS Network



Measuring episodes at high time resolution

- Measurements every hour or less
- Encompasses complete range of $PM_{2.5}$ and PM_{10} components (carbonaceous, inorganic, metallic and mineral)
  - Capable of identifying diverse range of sources (vehicles, industrial, secondary, fugitive)
- Links into established and rapidly developing receptor modelling / source apportionment analysis
- Automated analysis
  - No need for laboratory analysis
  - Faster turn around of results
  - Provide real time dissemination

Real time dissemination



Acknowledgements

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- King's College London (Anja Tremper, Max Priestman, Anna Font & Gary Fuller)
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  - Defra – Black Smoke Network, Particle Number and Composition Network, Automatic London Network

Thank you for listening