ClearfLo: Study of Aerosol Sources and Processing at a Rural Site Southeast of London, January-February, 2012

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Acknowledgements:

US Department of Energy Atmospheric System Research Program and SBIR Program

UK Natural Environment Research Council

ClearfLo Project

Ashley Williamson (DOE), Amon Haruta (LANL), David Green, Roger Moore (Kent Showgrounds)

Motivation: Black Carbon

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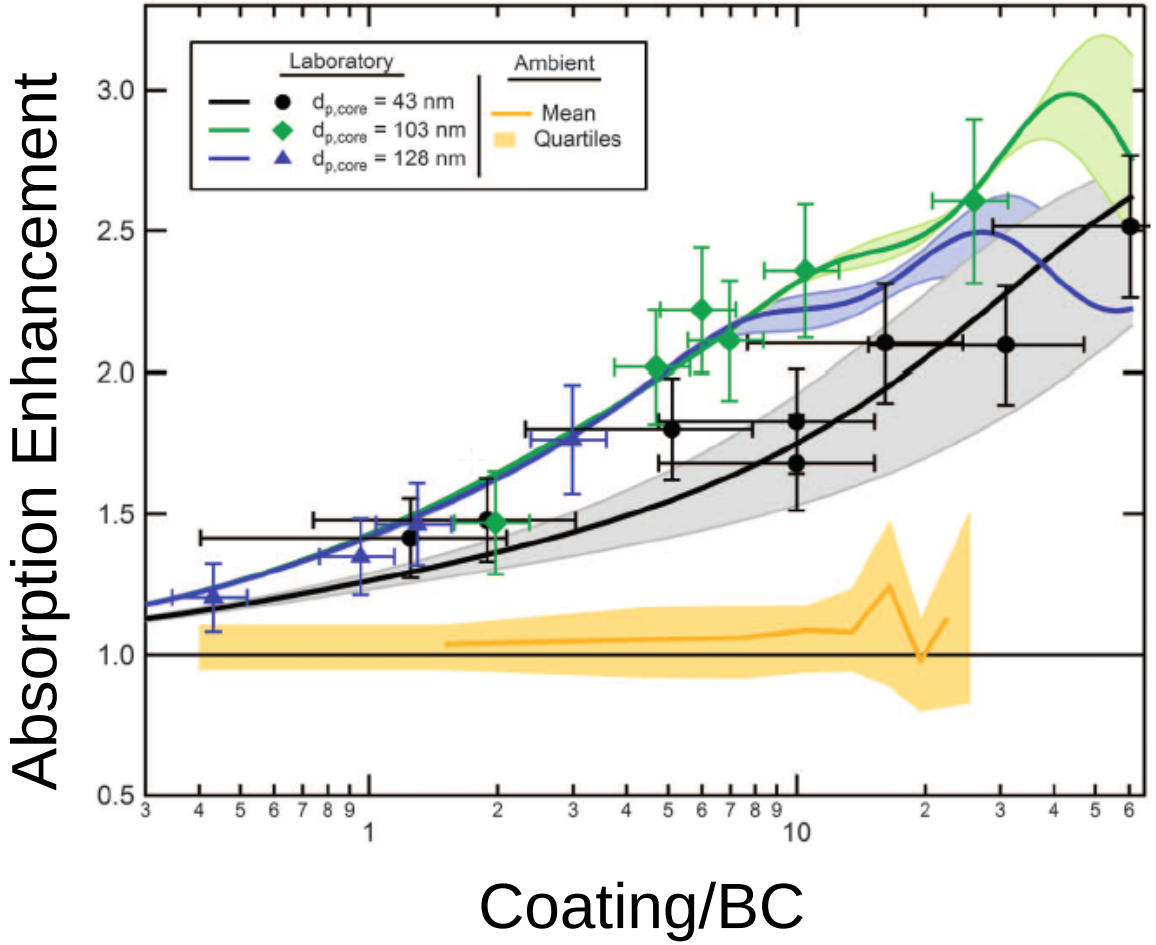
- Black carbon (BC) – positive climate forcing
- Effects of coatings not well understood
- Absorption enhancement?



Radiative Absorption Enhancements Due to the Mixing State of Atmospheric Black Carbon, Cappal et al., Science 337, 1078, 2012

Clean Air for London (ClearfLo) Winter Intensive Detling Site (Jan-Feb 2012)

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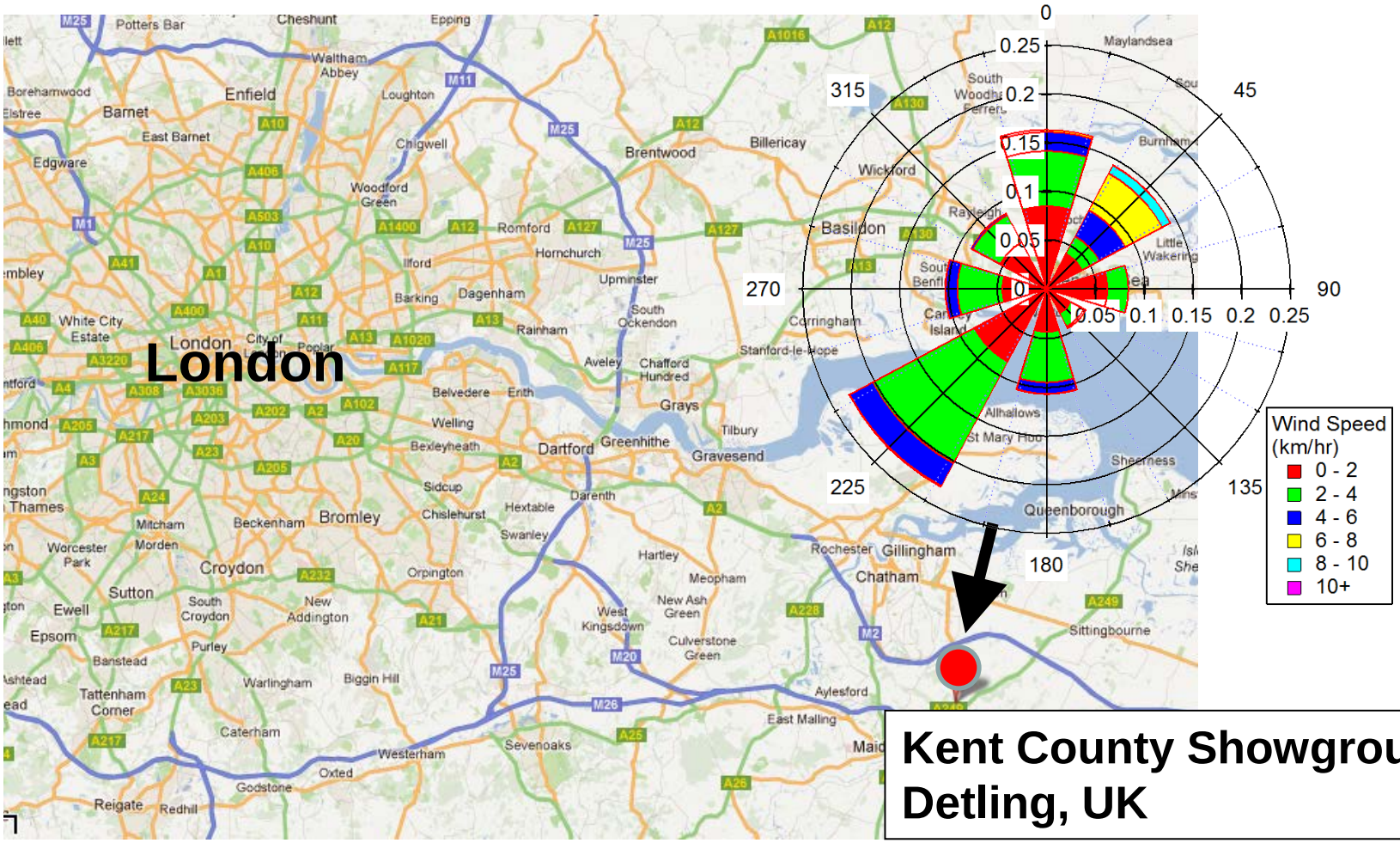

Key Accomplishments

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- Chemical, physical and optical characterization of PM from local and regional sources.
- Particulate matter (PM) and gases in London and region (urban increment).
- Optical properties and chemical coatings on black carbon containing particles, including absorption enhancement.
- First deployment of chemical ionization instrument (MOVI-CI-TOFMS) to measure both particle-phase and gas-phase organic acids.
- Residential solid fuel burning source.

High Resolution Aerosol Mass Spectrometer (HR-AMS)

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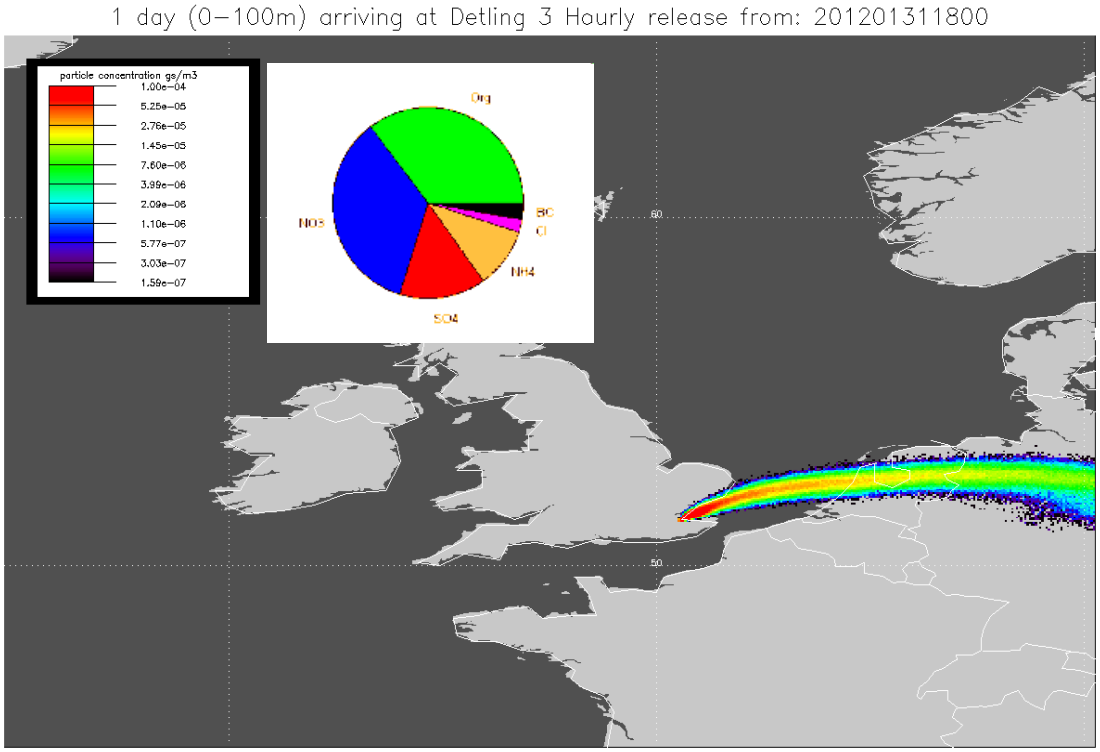
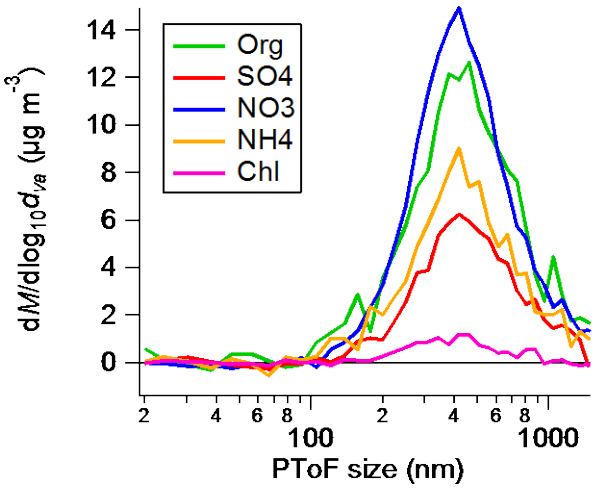
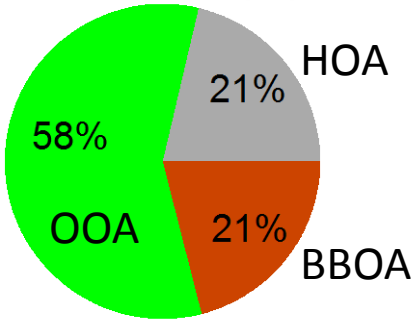
- Size-resolved chemical composition
- Organics, nitrate, sulfate, ammonia, chloride (~ 600 C)
- Positive Matrix Factorization on organic mass spectra
- NAME 24 hr backtrajectories (Zoe Fleming, U. Leicester)







Sally Ng, Lu Xu, Ga Tech

HR-AMS: Non-refractory PM1

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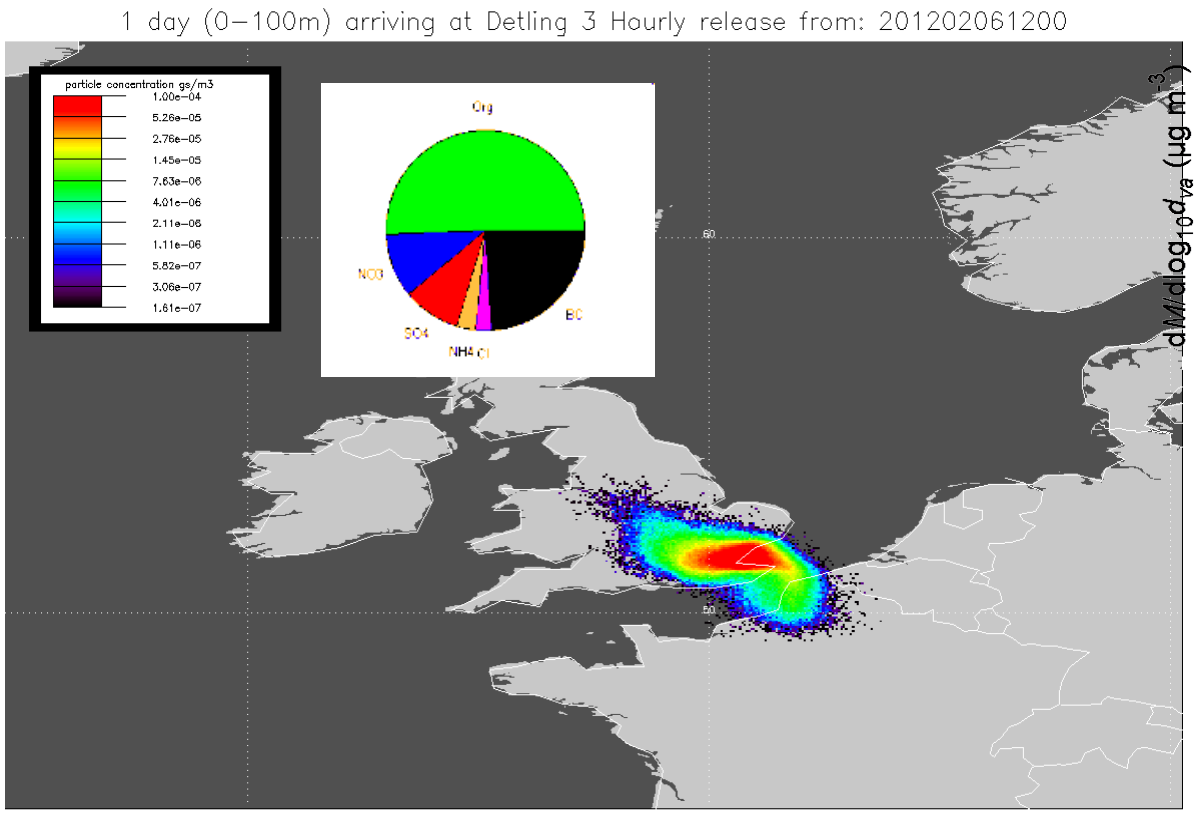

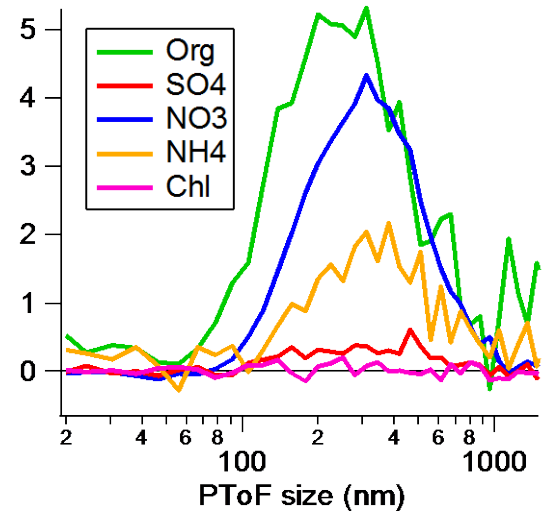

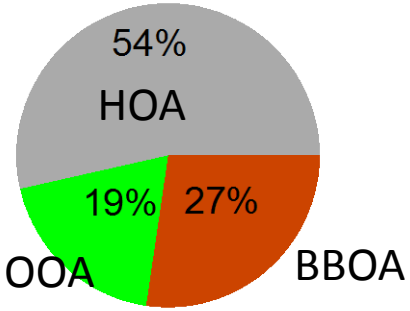

Urban Increment

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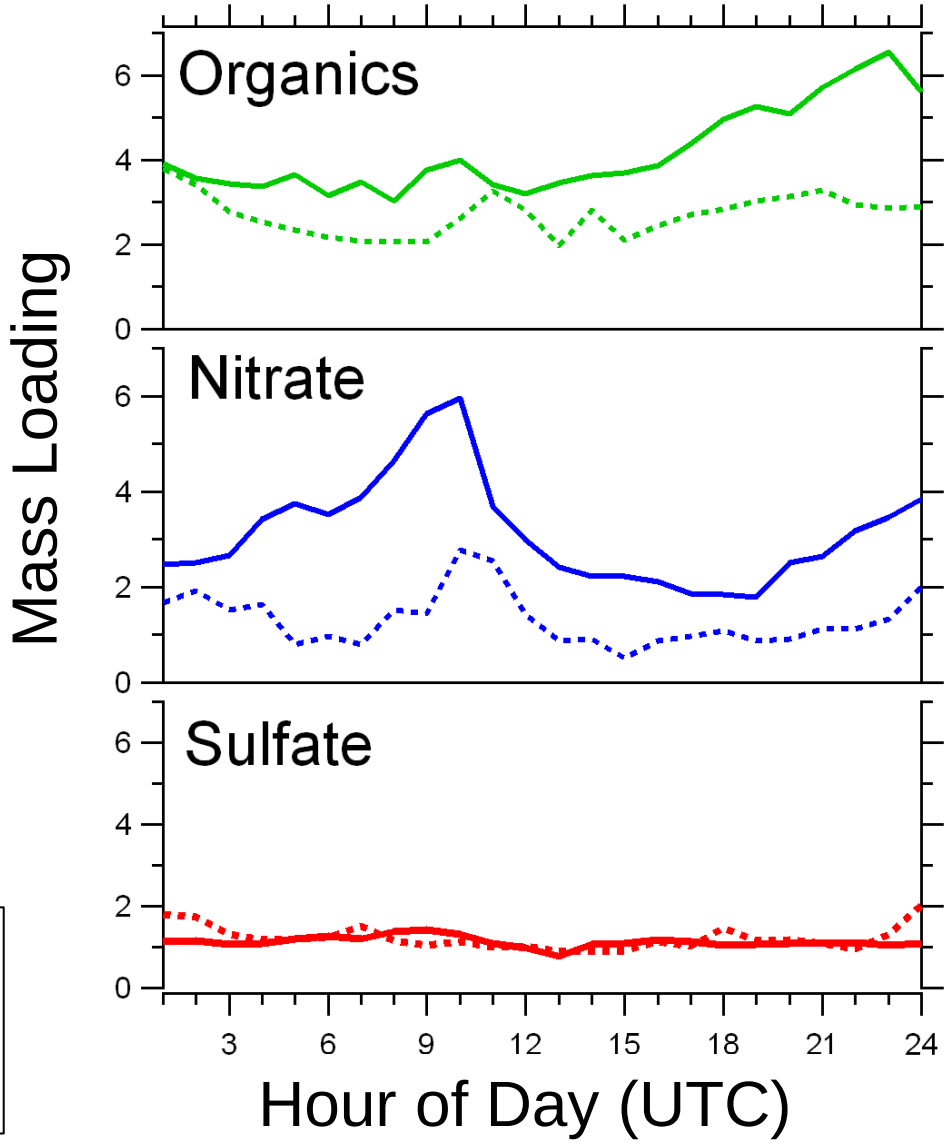
- Diurnal Median PM1 at North Kensington and Detling.
- Sulfate – regional
- Nitrate – traffic souces
- Organic – residential solid fuel burning sources



Meteorology, air quality, and health in London: The ClearfLo project, Bohnenstengel et al., submitted to BAMS, 2013.

Soot-Particle Aerosol Mass Spectrometer (SP-AMS)

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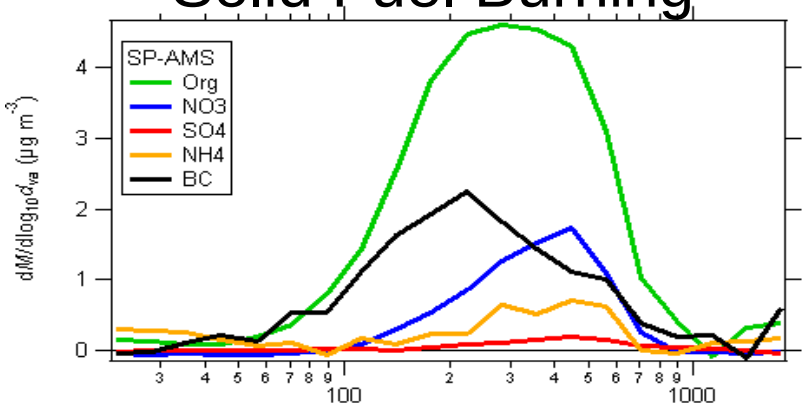
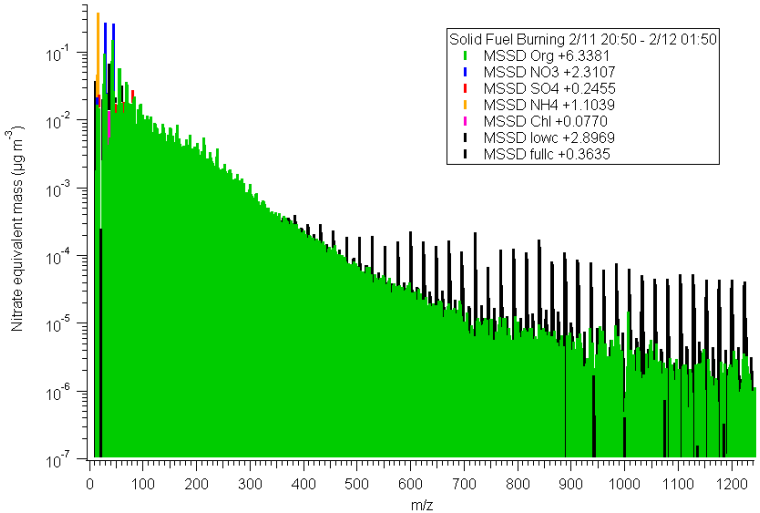
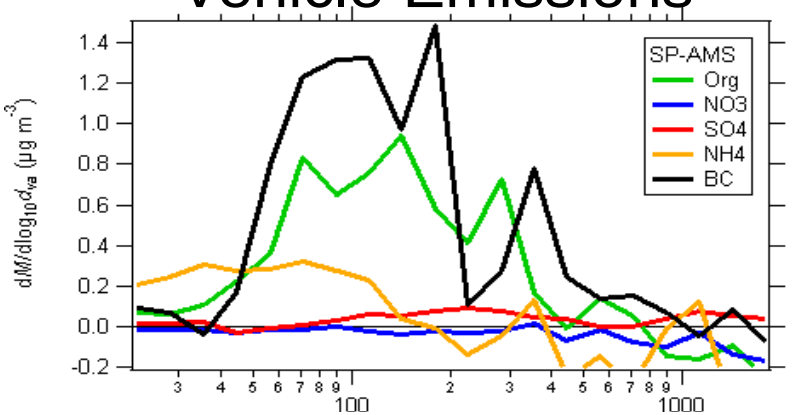
- SP2 laser in detection region of HR-AMS
- BC plus associated coatings

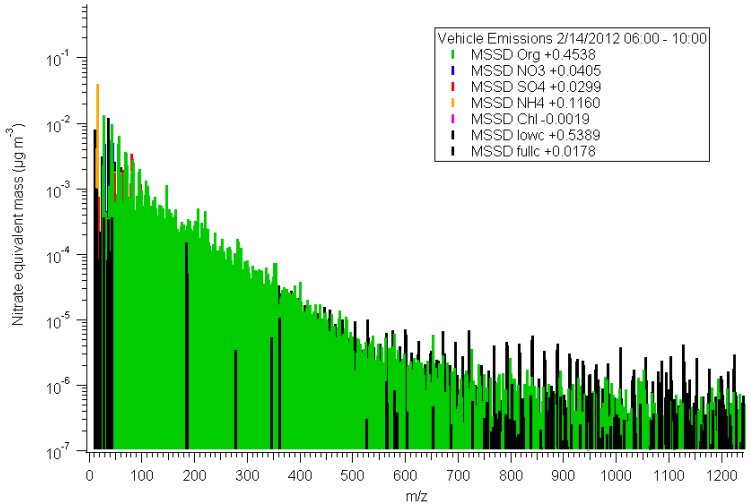
Solid Fuel Burning





Vehicle Emissions





Optical Properties/Thermal Denuder

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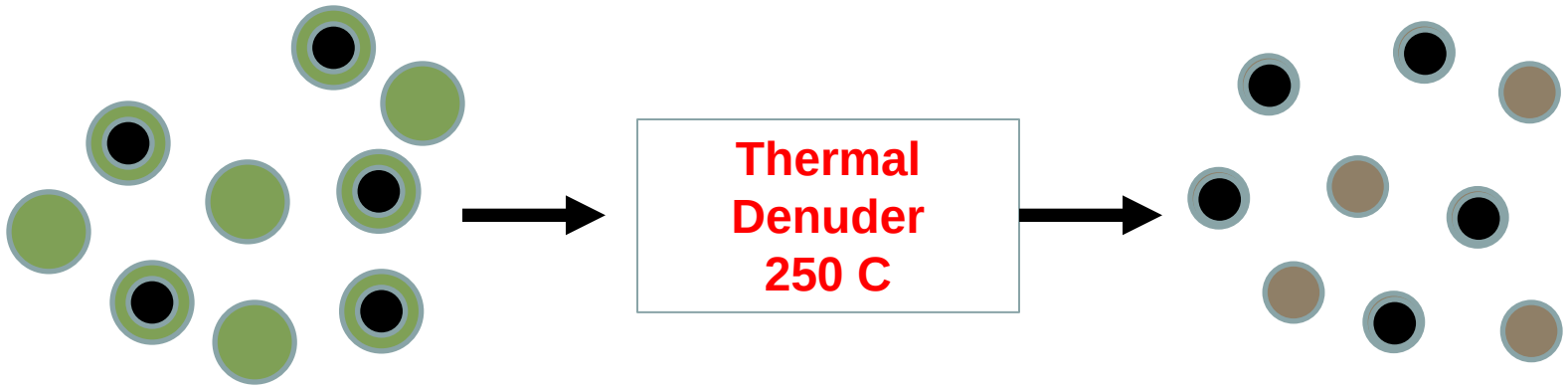
- Enhanced absorption by BC containing particles due to coatings
- Absorption by brown carbon (BrC)
- Not observed in CalNex/CARES (Cappa et al., Science 2012), observed in biomass burning plumes (Lack et al., PNAS 2012)



PASS – absorption at 3 wavelengths
SP2 – BC size and number
SP-AMS – BC coating thickness and chemical composition

Absorption Enhancement

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Absorption Enhancement

405 nm

781 nm

Figure removed for posted version.

Coating/BC

Coating/BC

Light absorption enhanced by internally mixed black carbon from diesel and wood combustion, Liu et al., in preparation.

MOVI-CI-TOFMS

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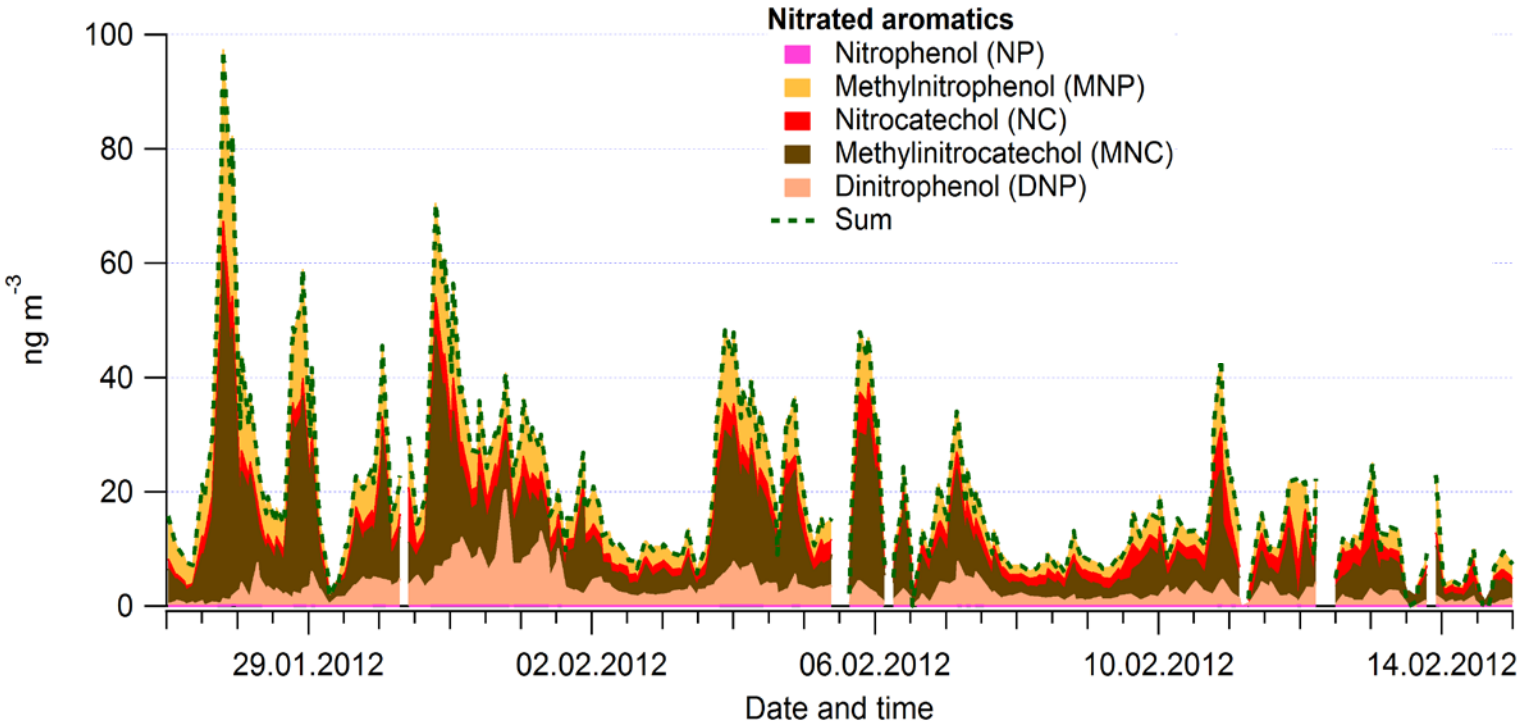
- MOVI – Alternates collection of gas-phase and particle-phase
- CI – Chemical ionization selective for organic acids
- First field deployment



Contribution of Nitrated Phenols to Wood Burning Brown Carbon Light Absorption in Detling, United Kingdom during Winter Time, Mohr et al., EST, 47, 6316−6324, 2013.

Summary

- Radiation measurements (MPL, SODAR, MFRSR)
- Demonstrated absorption enhancement
- First field deployment of MOVI-CI-TOFMS, now FIGAERO
- Detling analysis almost complete
- Compare with urban London data
- Journal articles in progress
- Modelers?
- Questions?

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