# Overview of ClearfLo: Study of Aerosol Sources and Processing at a Rural Site Southeast of London

L. R. Williams[1], S. Herndon[1], J. Jayne[1], A. Freedman[1],
B. Brooks[1], J. Franklin[1], P. Massoli[1], E. Fortner[1], P. Chhabra[1], M. Zahniser[1], H. Stark[1], T. Onasch[1], D. R. Worsnop[1],
F. Lopez-Hilfiker[2], C. Mohr[2], J. Thornton[2], N. L. Ng[3], L. Xu[3],
B. Knighton[4], M. Dubey[5], A. Aiken[5],
K. Gorkowski[5], S. Liu[5], T. Martin[6], R. Coulter[6], S. Visser[7],
M. Furger[7], P. Zotter[7], and A. Prévôt[7]

[1]Aerodyne Research, Inc., [2]University of Washington, Seattle, [3]Georgia Institute of Technology, [4]Montana State University, [5]Los Alamos National Laboratory, [6]Argonne National Laboratory, [7]Paul Scherrer Institute

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# Why Detling?

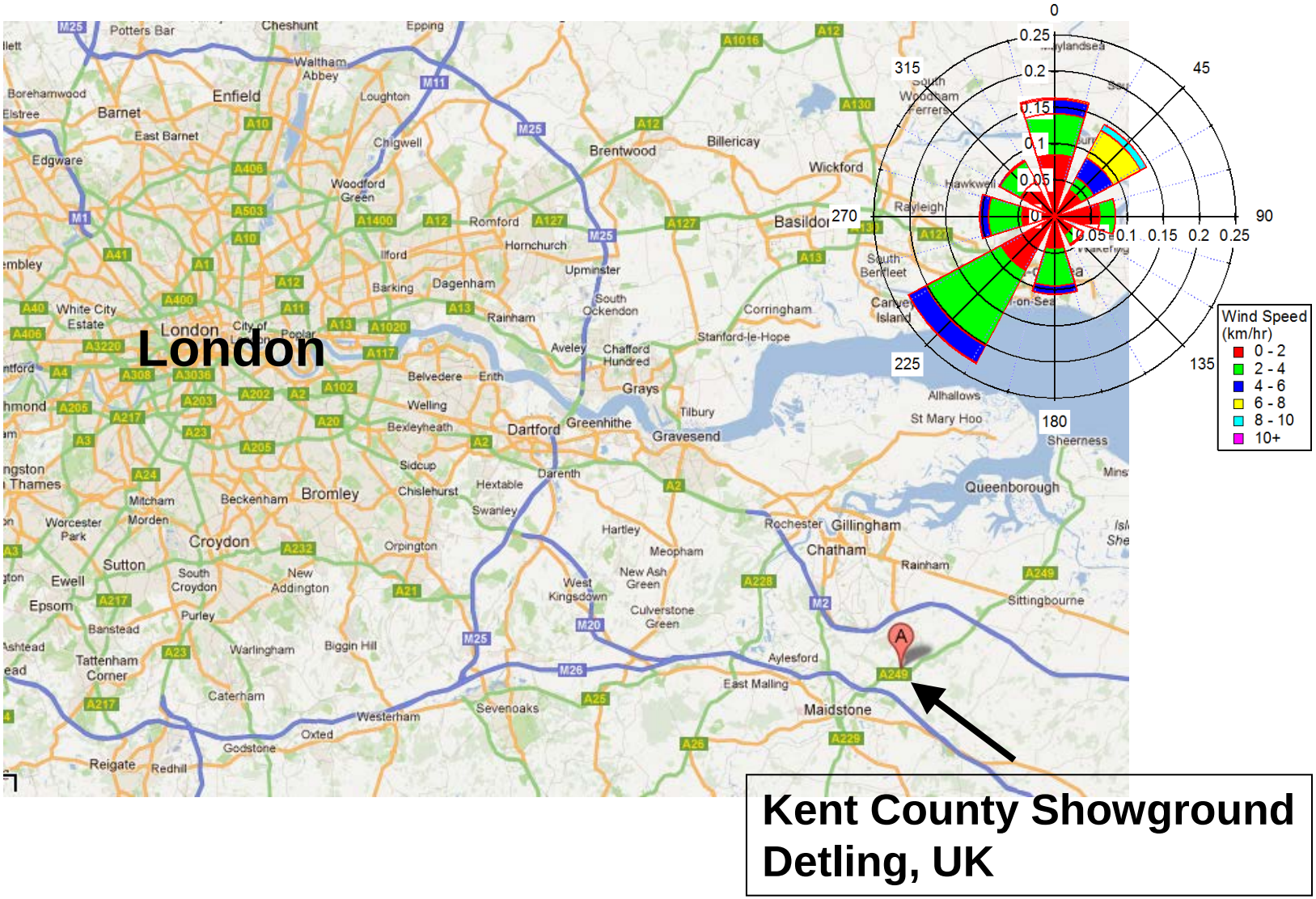
Clean Air for London (ClearfLo)

- Study of London air pollution at an urban street site, an urban background site and rural sites in order to understand transport and aging of the urban plume. Year long measurements plus winter and summer intensives.

Detling Site

- Understand air mass sources and aging, and correlations with London urban measurements.
- Closure between optical properties and chemical composition including black carbon. Absorption enhancement by coatings on black carbon?
- Thermal denuder to study volatility, effects of coatings.

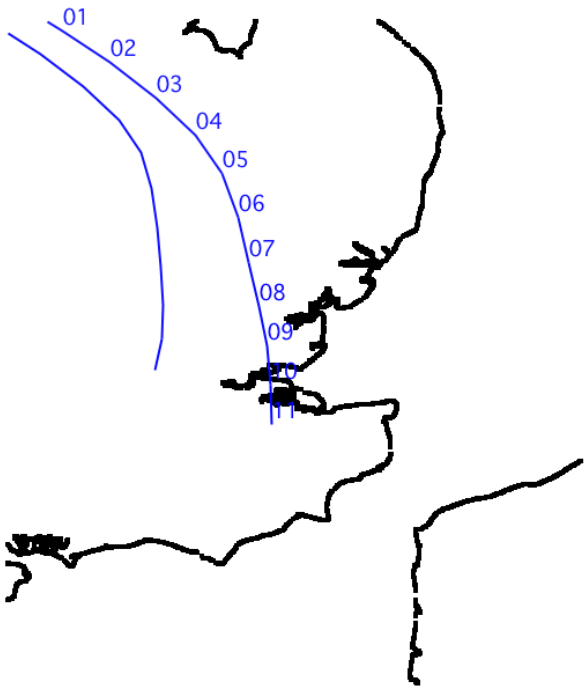
# Clean Air for London (ClearfLo) Winter Intensive Detling Site (Jan-Feb 2012)



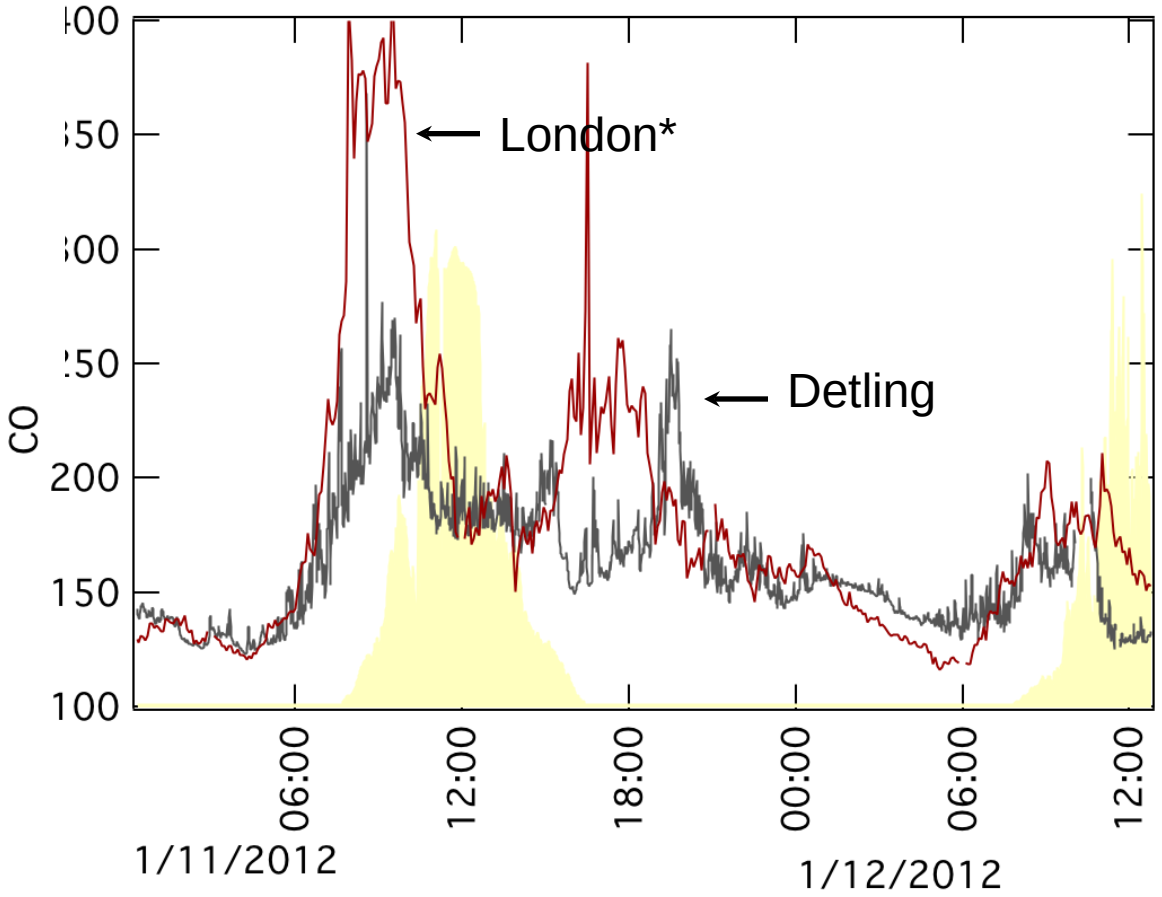
# Instruments at Detling

- **Gas-Phase Measurements:  ARI, MSU**
  - NO, NO2, NOx, O3, N2O, CO2, CO, NH3, HCHO
  - PTR-MS and GC/FID: VOC's
  - MOVI-CI-ToF:  oxygenated HC's
- **Particle Measurements: Ga Tech, U Wash., LANL**
  - HR-ToF-AMS
  - MOVI-CI-ToF: organic acids
  - SMPS, LAS
  - Thermal Denuder
- **Particle Black Carbon/Optical Measurements: ARI, LANL, PSI**
  - SP-AMS, MAAP, SP2, aethalometer
  - CAPS PMex (red and blue), PASS-3, PASS-UV
- **Bulk Particle Measurements: PSI, LANL**
  - High volume filter sampler, rotating drum impactor, SEM filter collector
- **Remote Sensing: ANL**
  - Micro Pulse LIDAR
  - Radiometer
  - SODAR Wind Profiler
  - Surface met

# Urban Increment: London vs Detling



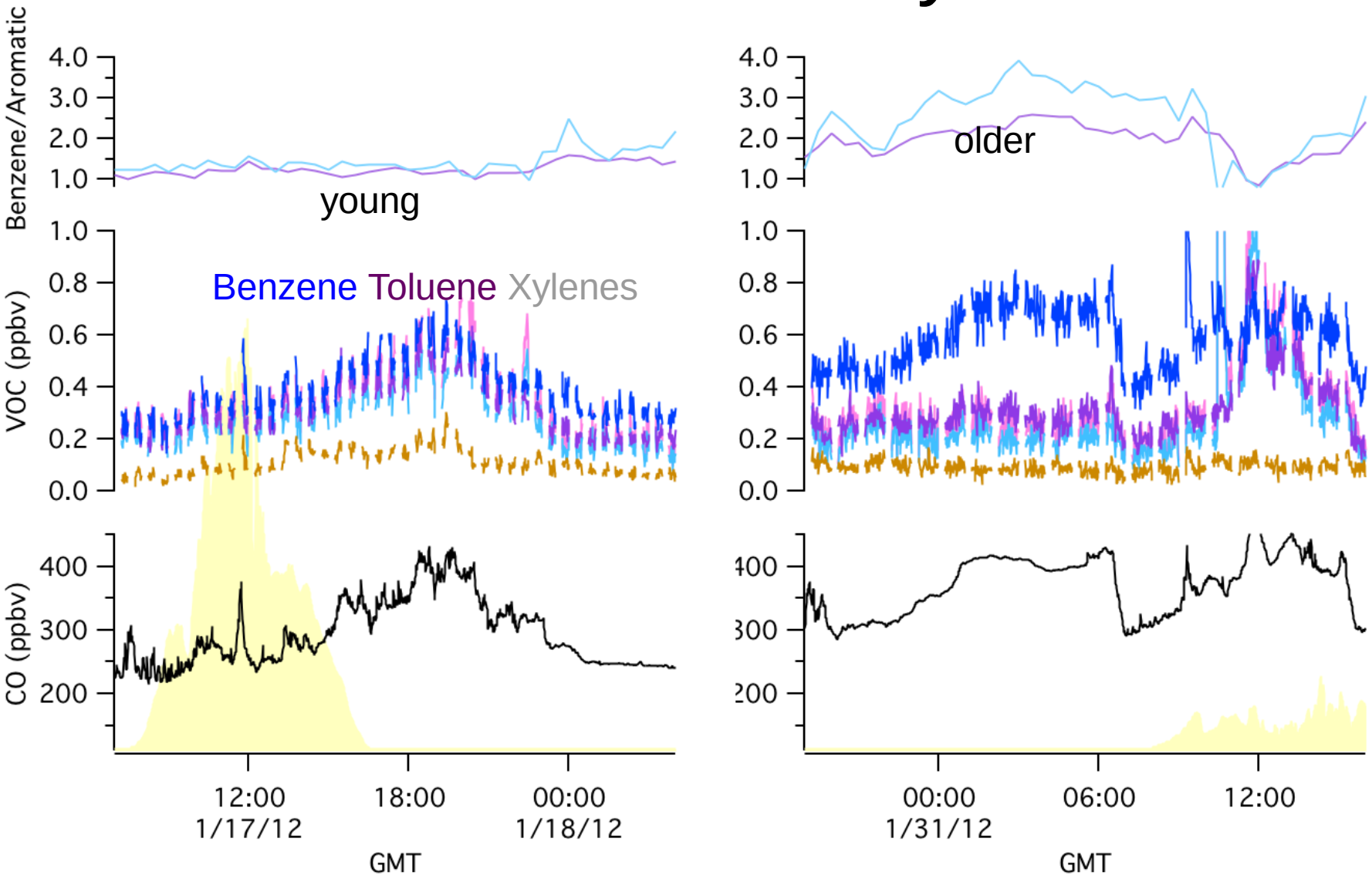

Hybrid Single Particle Lagrangian Integrated Trajectory HYSPLIT




CO (and NOx, CO2 and selected VOC) indicate urban increment.

*North Kensington London CO data from James Lee, York

# Air Mass Age: Benzene to Toluene, CO Variability




VOC Ratios: Photoclock

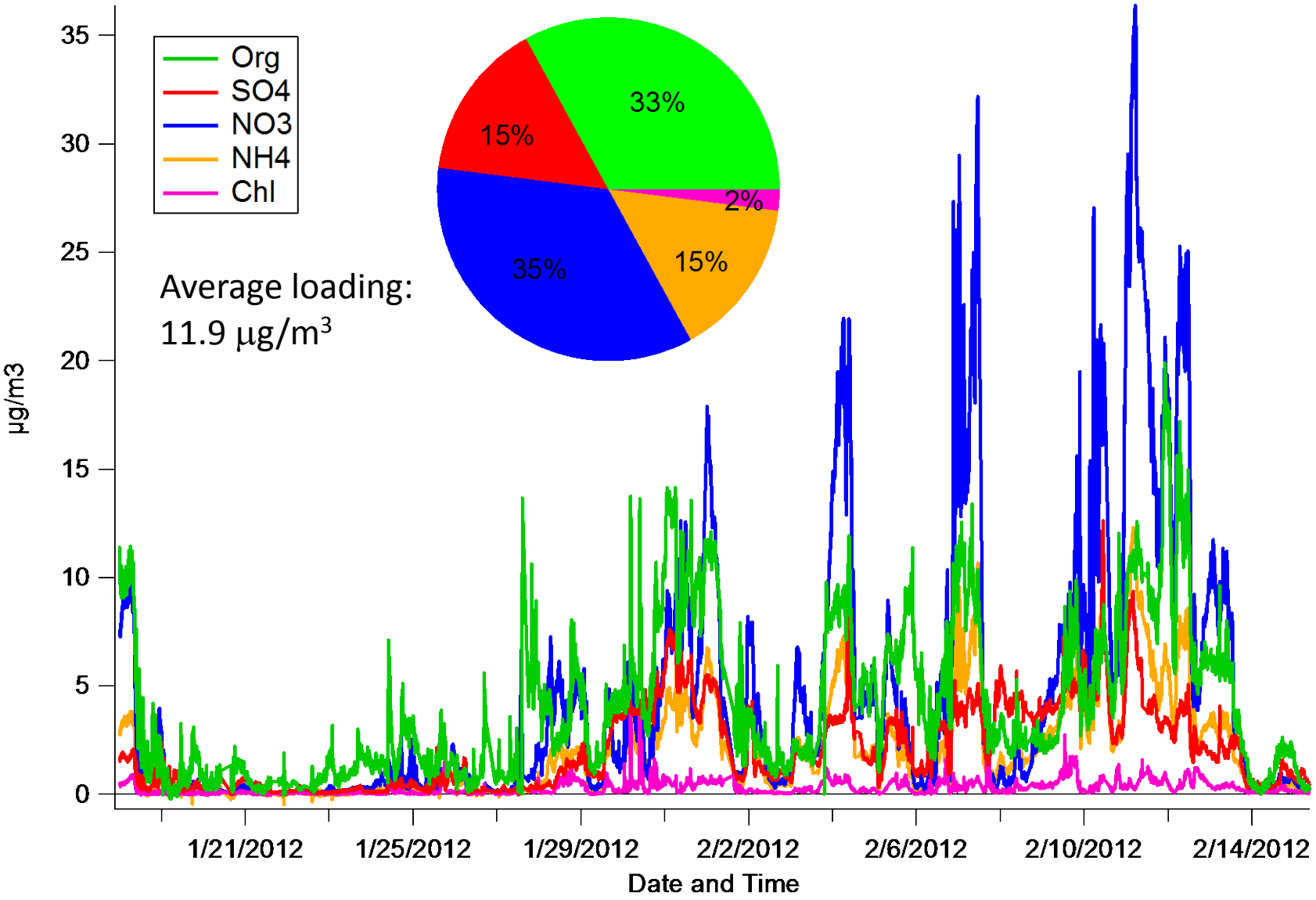
# Particle Size and Composition

- HR-AMS (Sally Ng, Ga Tech) – high resolution mass spectra of non-refractory PM1, size distributions
- SP-AMS (Aerodyne) – same as HR-AMS PLUS black carbon!
- MOVI-CI-TOFMS (Claudia Mohr, University of Washington, Seattle) – chemical ionization of BOTH gas-phase and particle-phase organics
- Thermal denuder – volatility of PM

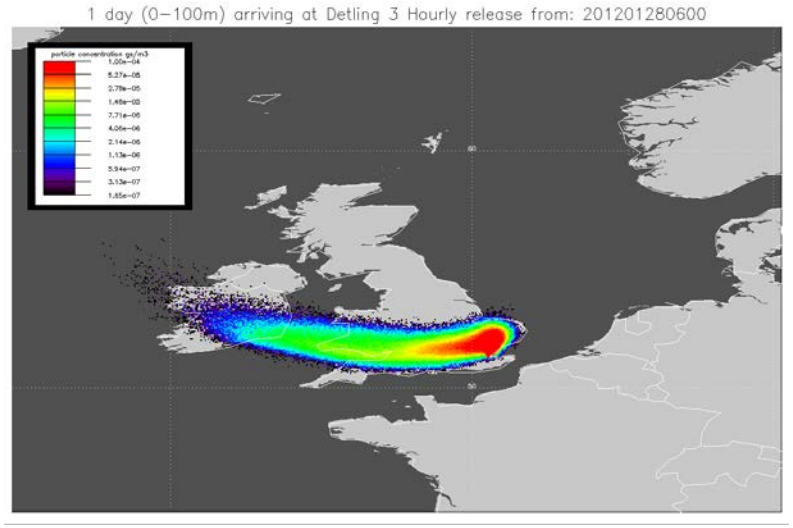
# PM1 Sources

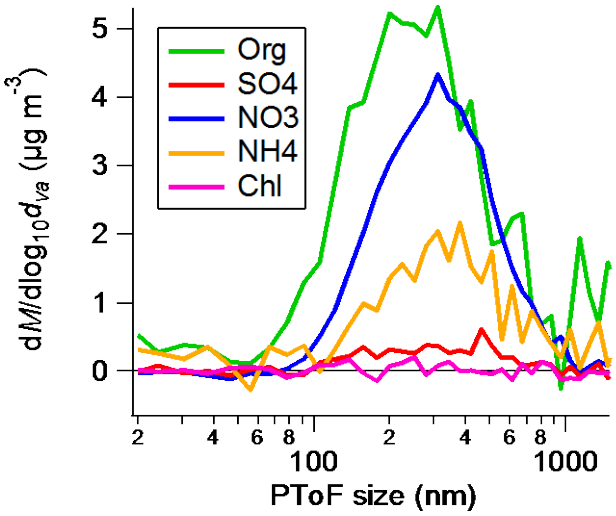
- HR-AMS – thermal vaporization, electron impact ionization, high resolution mass spectrometry
  - Measures non-refractory (vaporizes at < 600 C)
- Positive Matrix Factorization (PMF) - covariance of mass spectral features
  - Organic MS
  - Distinct factors
- Identify sources with:
  - PMF factor
  - air mass source (Hysplit and NAME back trajectories)
  - local wind direction (local sources)

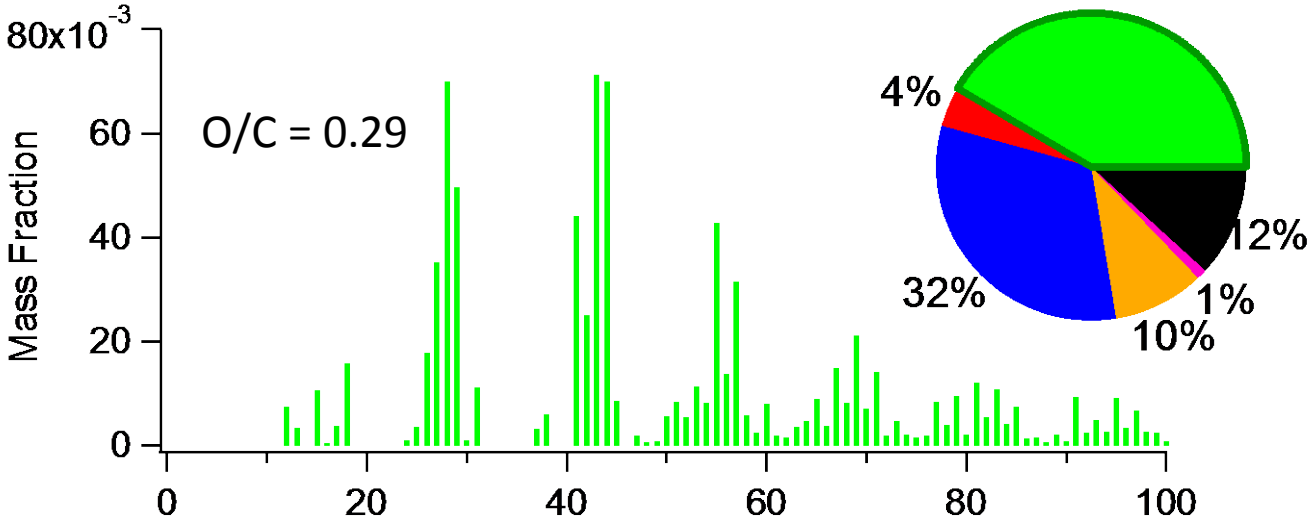
# Ga Tech HR-AMS: Chemically speciated PM1



# NAME backtrajectories: Air mass from London

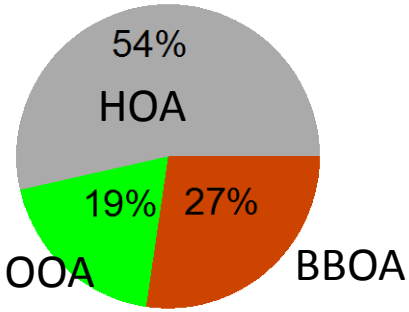


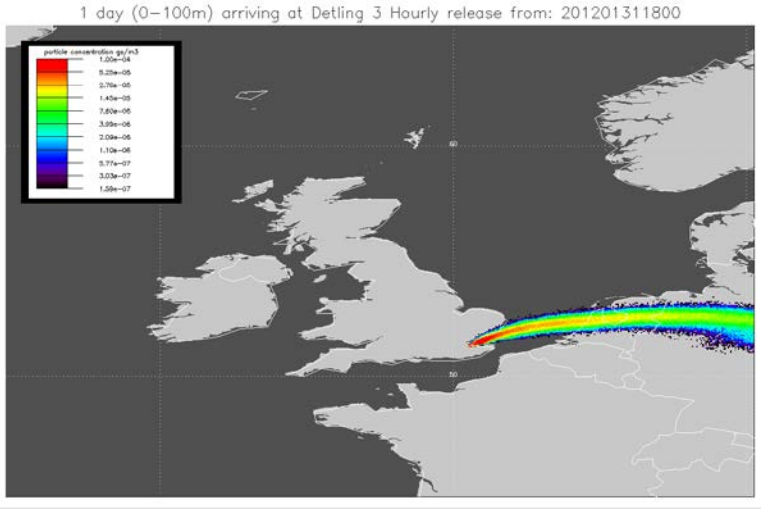


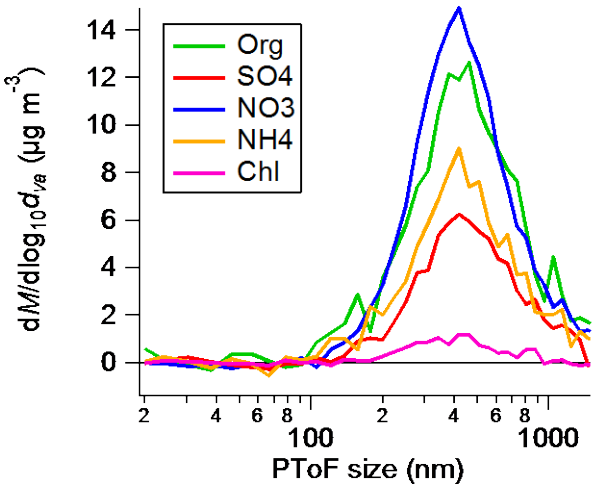


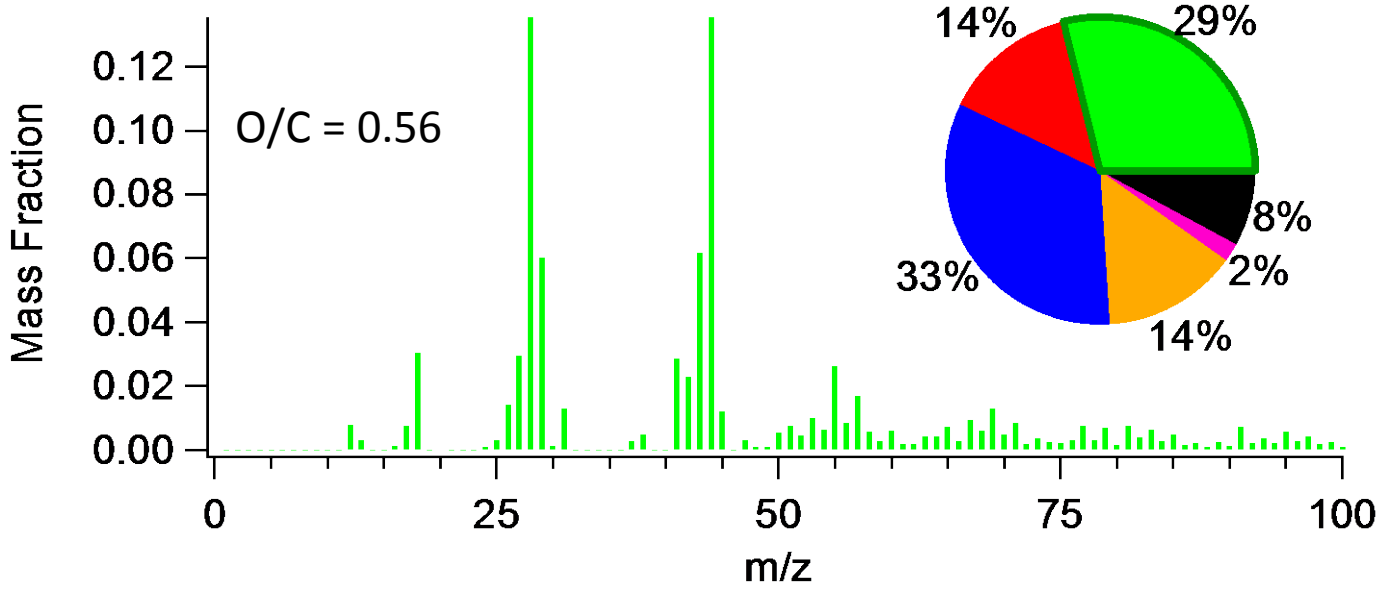



Not very oxidized
Dominated by HOA

# NAME backtrajectories: Air Mass from Benelux

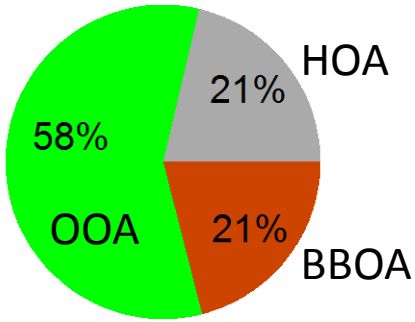






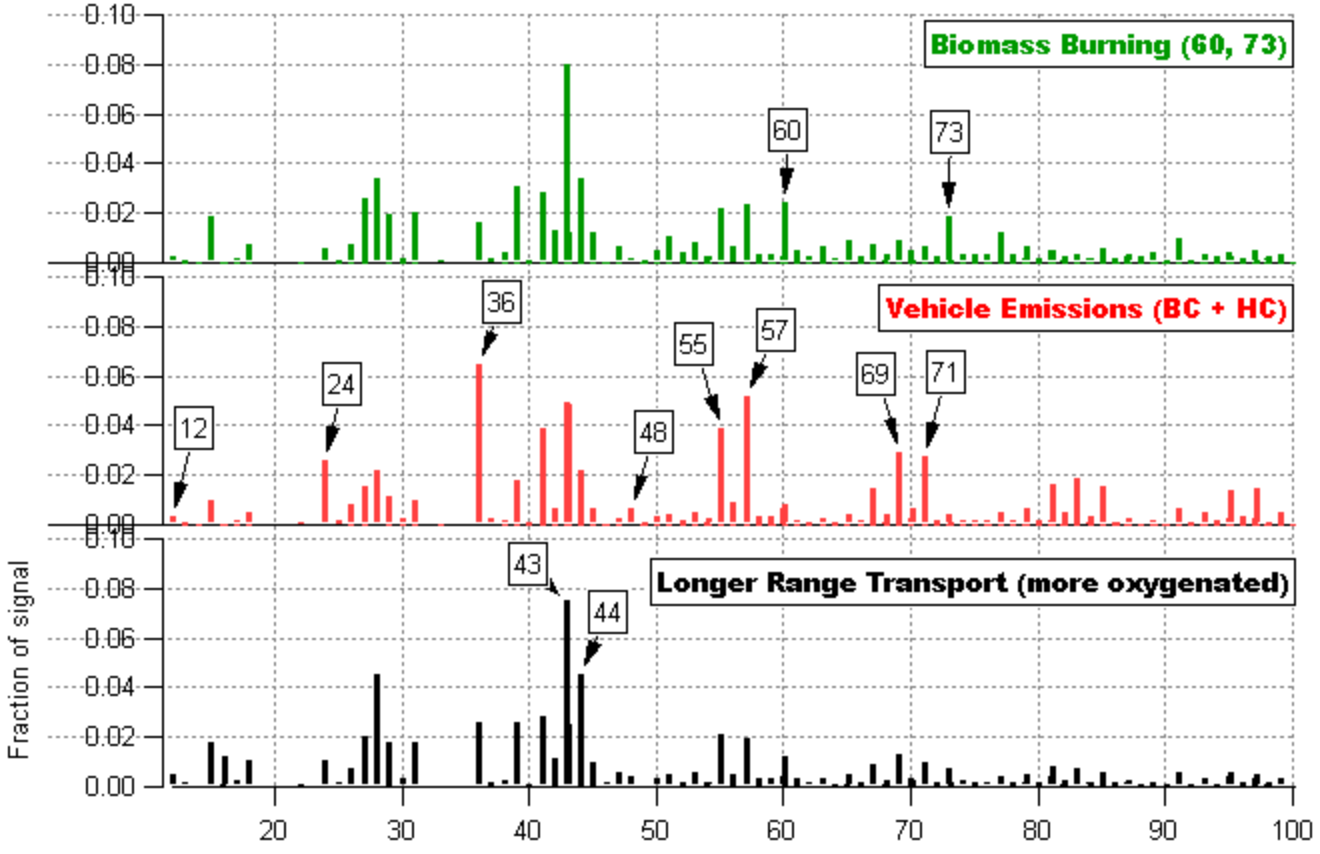


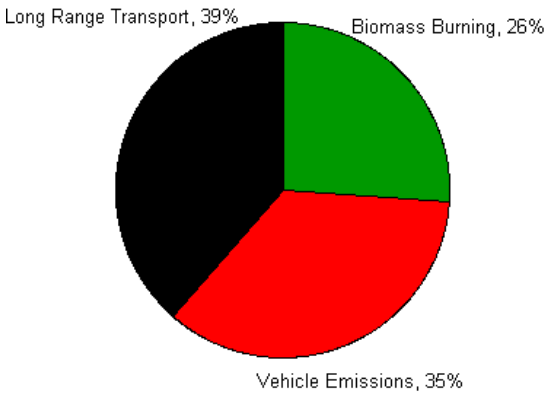

Highest loadings
Fairly oxidized
Dominated by OOA

# Black Carbon Sources

- SP-AMS with laser vaporization only (2/5 – 2/15/2012)
  - Measures black carbon containing particles only
  - Plus non-refractory coatings, ~30% of total NR
- Positive Matrix Factorization (PMF)
  - Organic MS + BC
  - Distinct factors
- Identify sources with:
  - PMF factor
  - air mass source (Hysplit and NAME back trajectories)
  - local wind direction (local sources)

# 3 Factor Solution

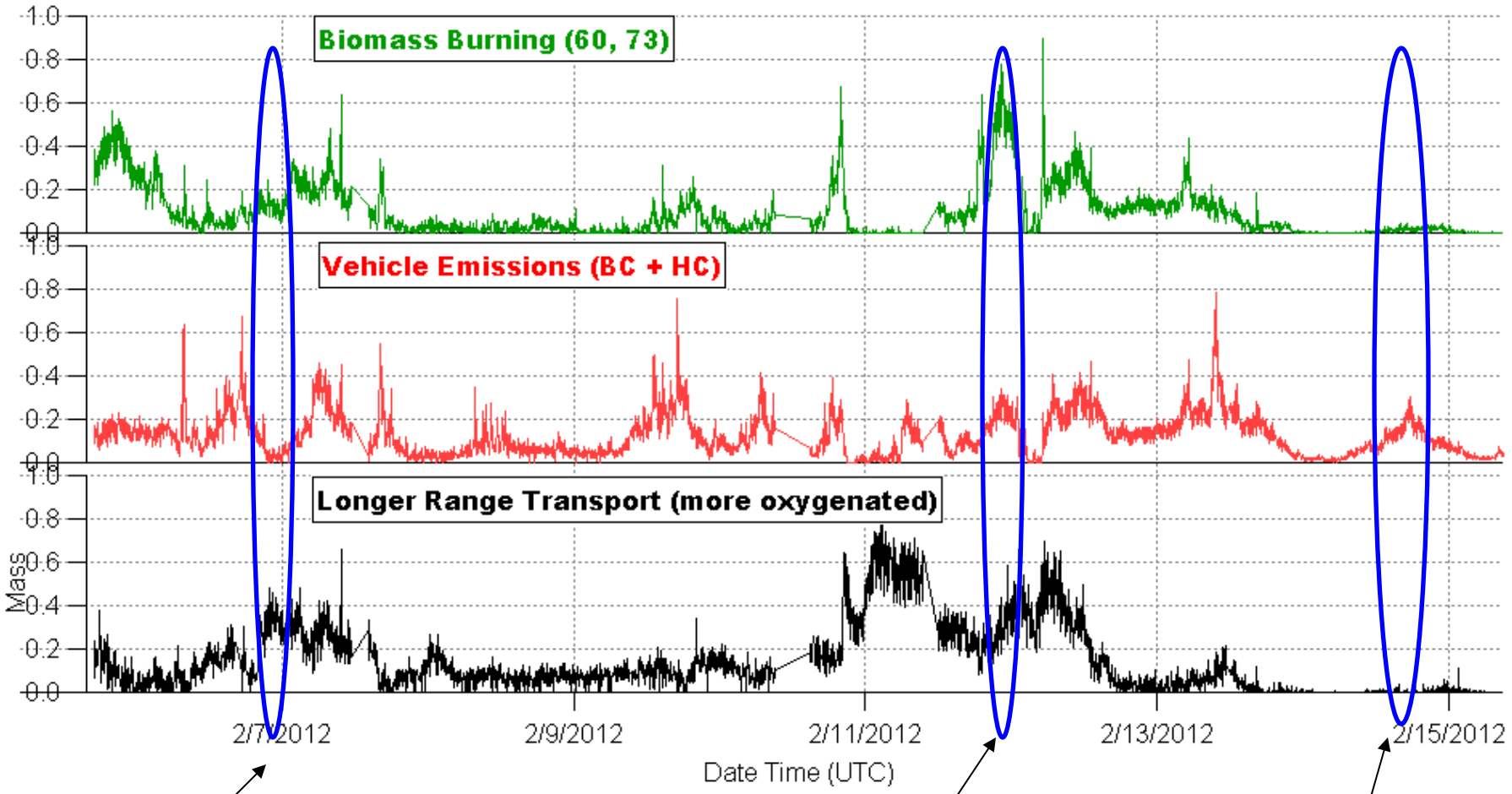



Contribution of each factor to total 2/5-2/15/2012.

Mass spectra of 3 factors for BC + organic coatings.

# Compare Hysplit back trajectories, local wind direction and PMF factors to identify BC sources.

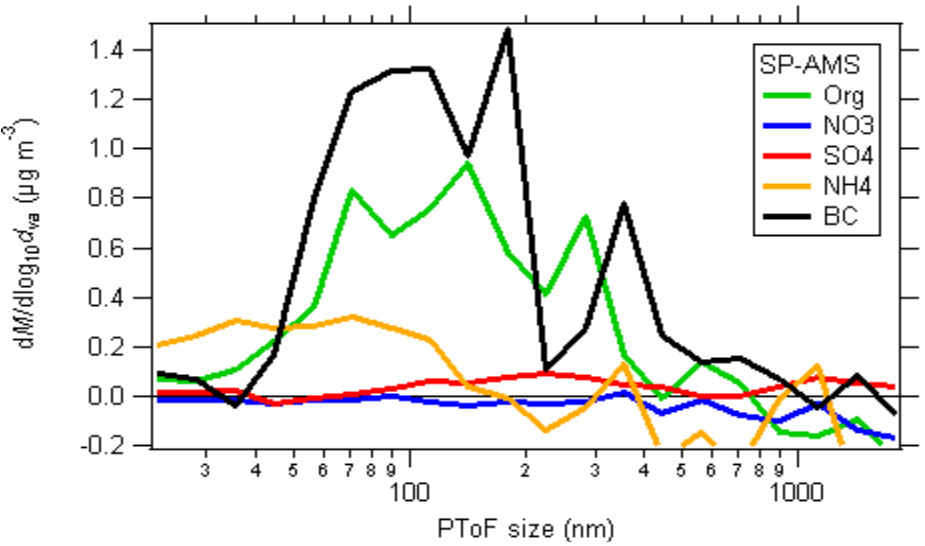


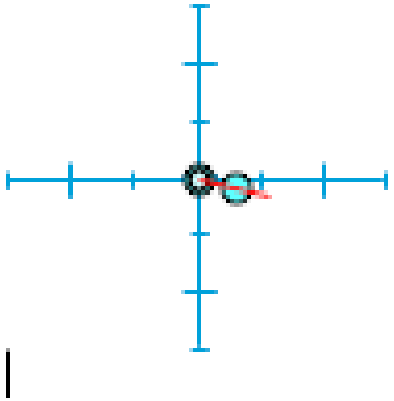

Longer Range Transport

Biomass/Solid Fuel Burning

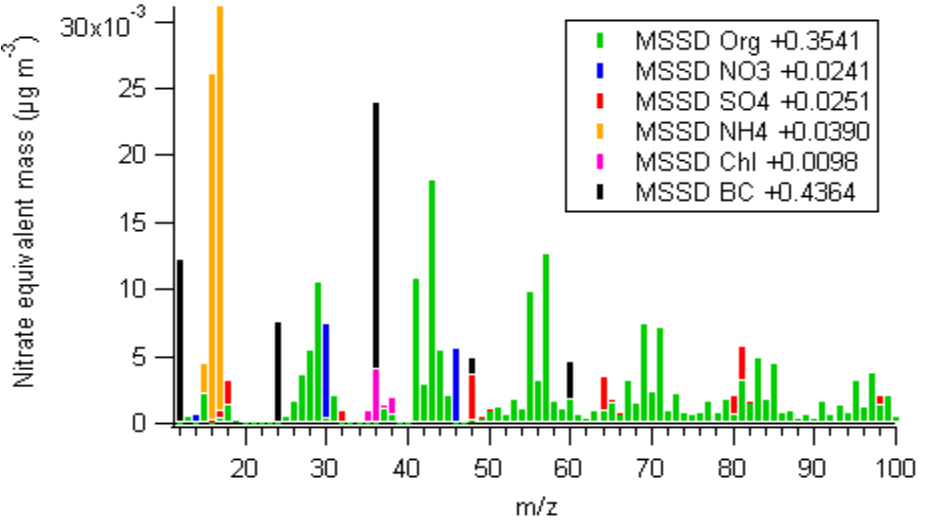
Vehicle Emissions

# Vehicle Emissions

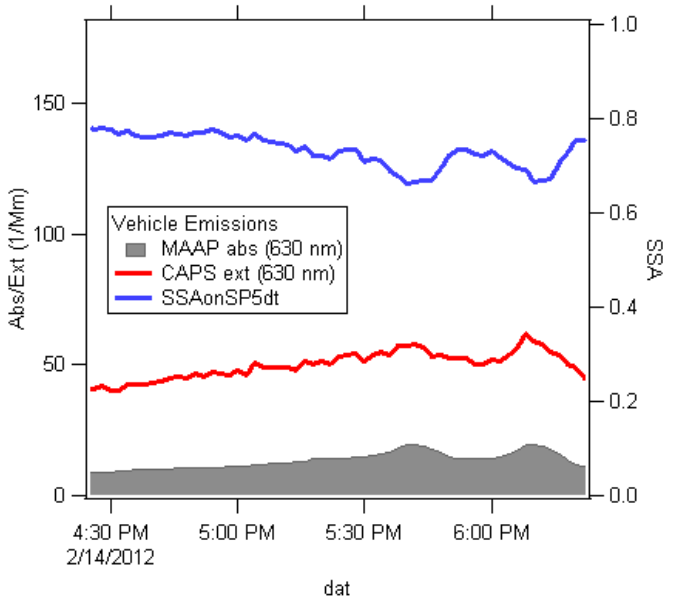


Local wind from roadway to SE

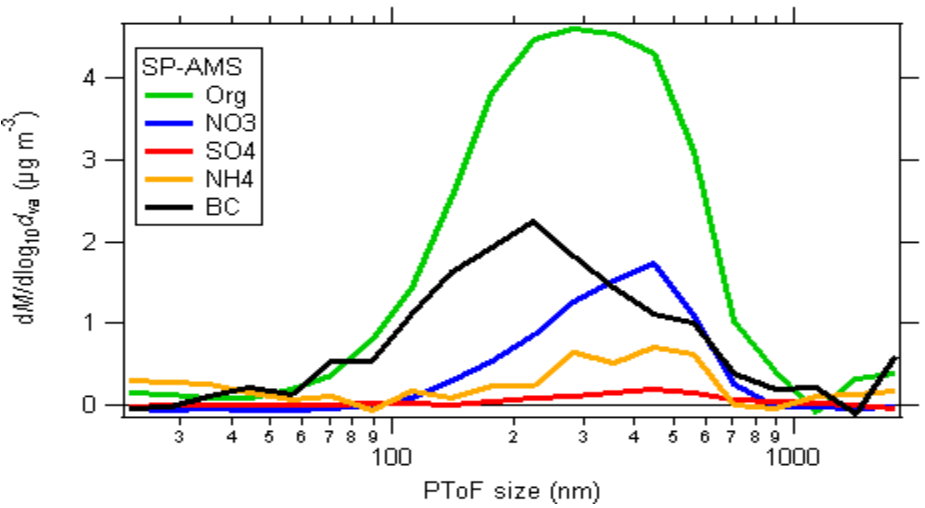


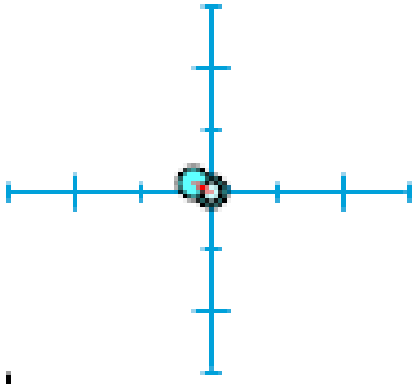

SP-AMS BC + coatings size distribution. Smaller size mode, less coating on BC, hydrocarbon like coating.



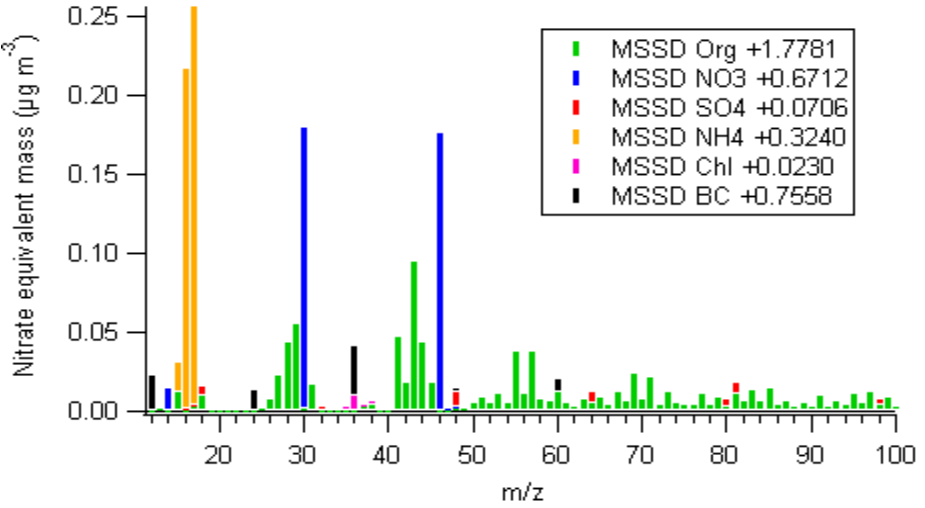

Abs higher, ext and SSA lower

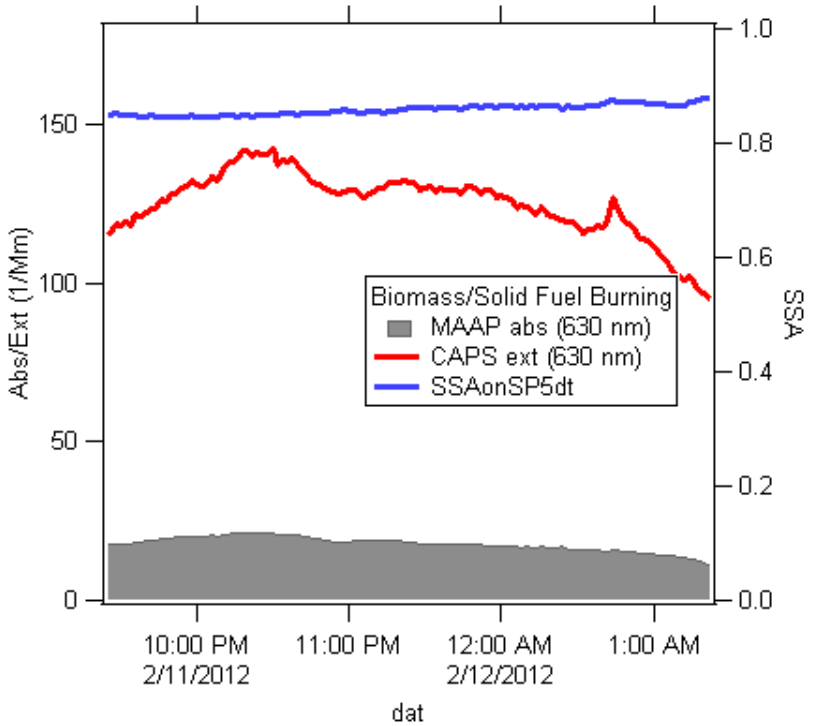
# Biomass/Solid Fuel Burning



Local wind speed low.

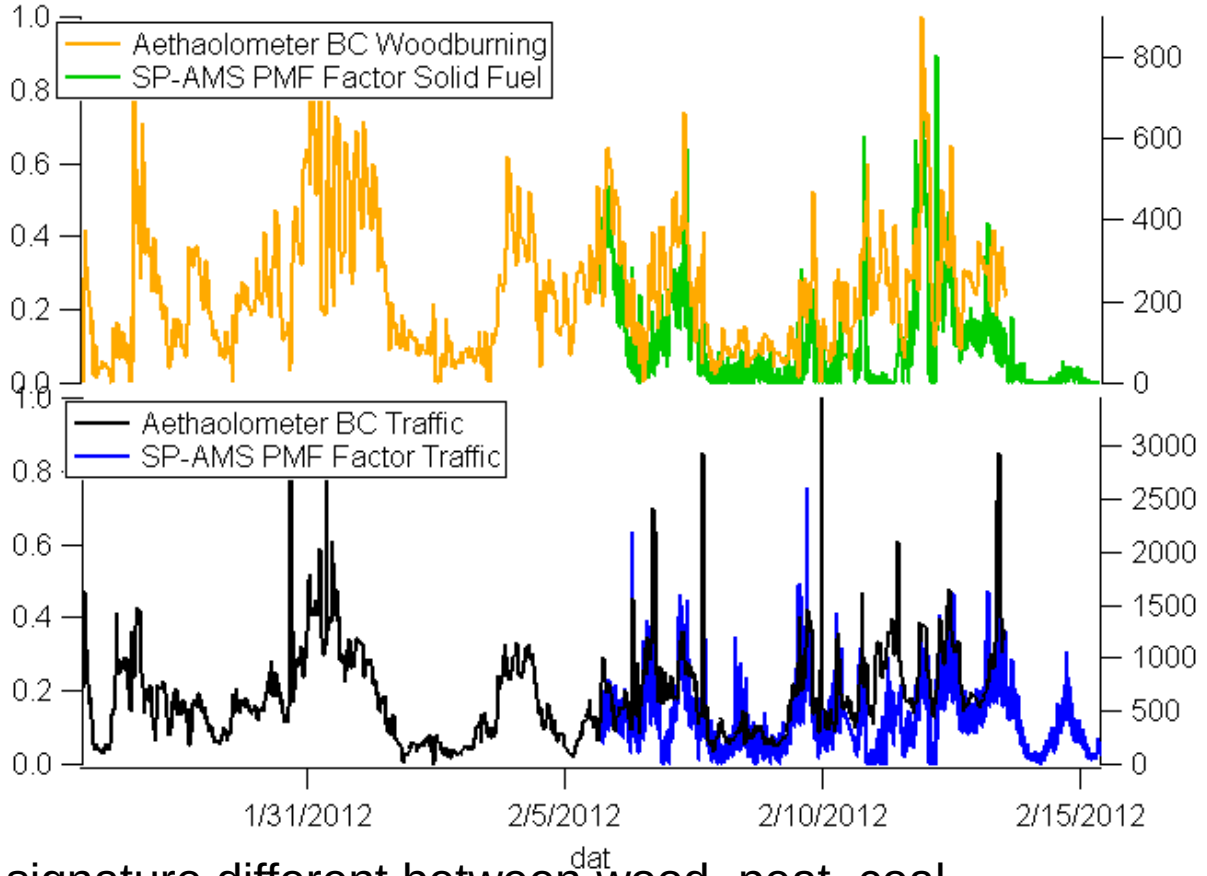



SP-AMS BC + coatings size distribution and MS.
Larger size than vehicle emissions.

# Compare BC coating factors with aethalometer

- Winter Seasonal Source: BC from solid fuel burning for home heating.vs BC from traffic.



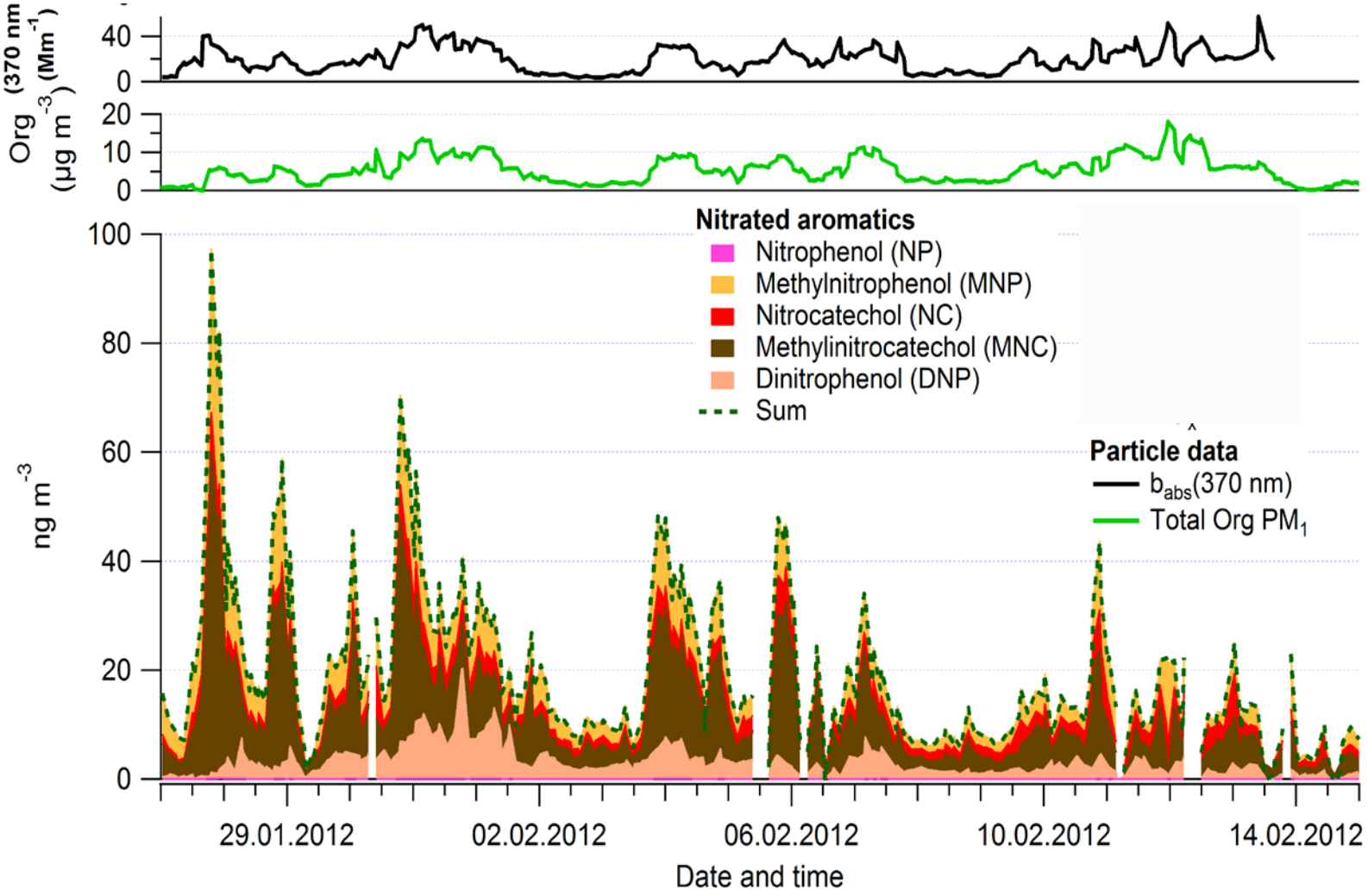

- Carbon signature different between wood, peat, coal.

Aethalometer data from Peter Zotter, PSI

# Nitrated Aromatics in Particle Phase

- MOVI-CI-TOFMS – chemical ionization to measure organics
- Alternates between
  - Gas-phase measurement
  - Collecting and desorbing particles
- High resolution mass spectrometer
- Different reagent ions target different chemical classes.
- Analysis in progress – 100’s of species to investigate.

# Nitrated aromatics in particle phase: solid fuel burning aerosol

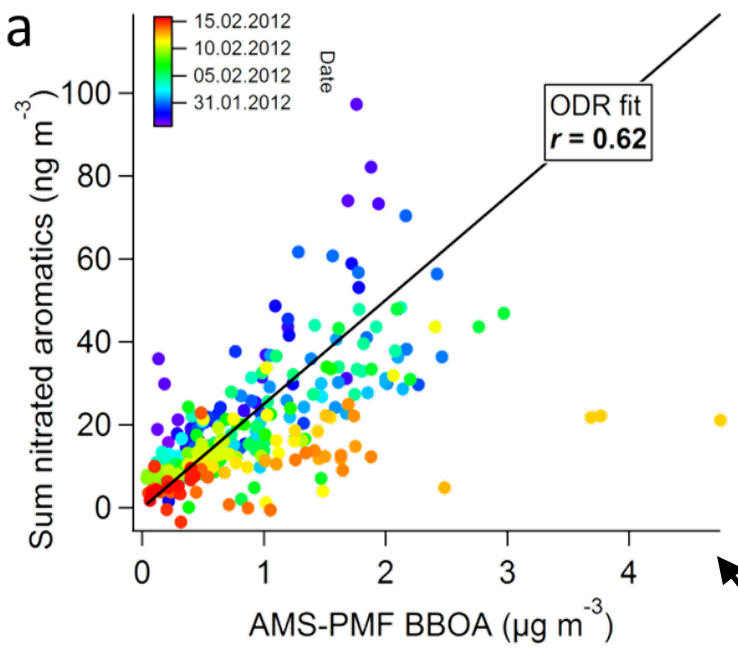


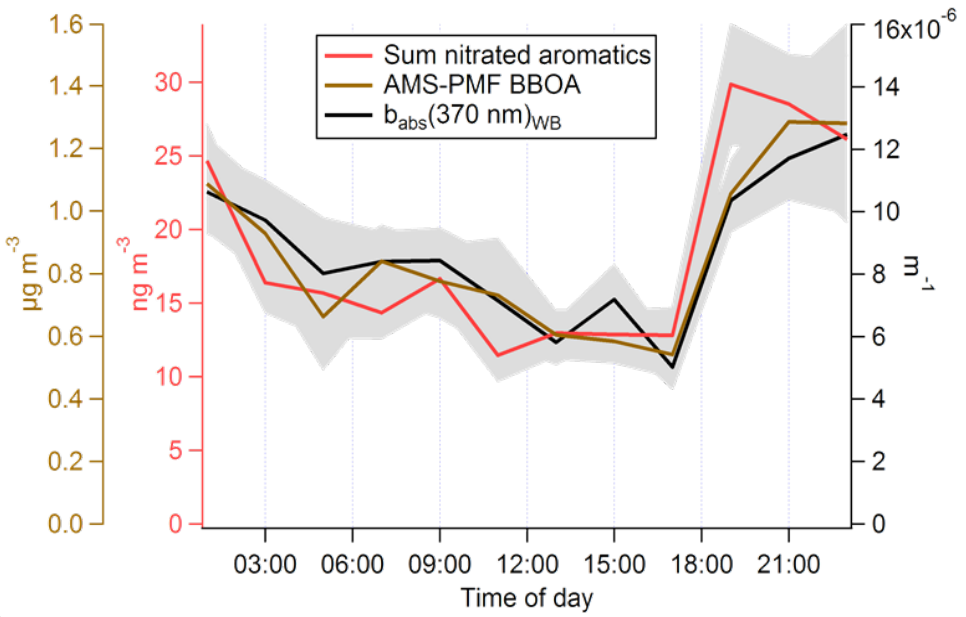

PSI aethalometer

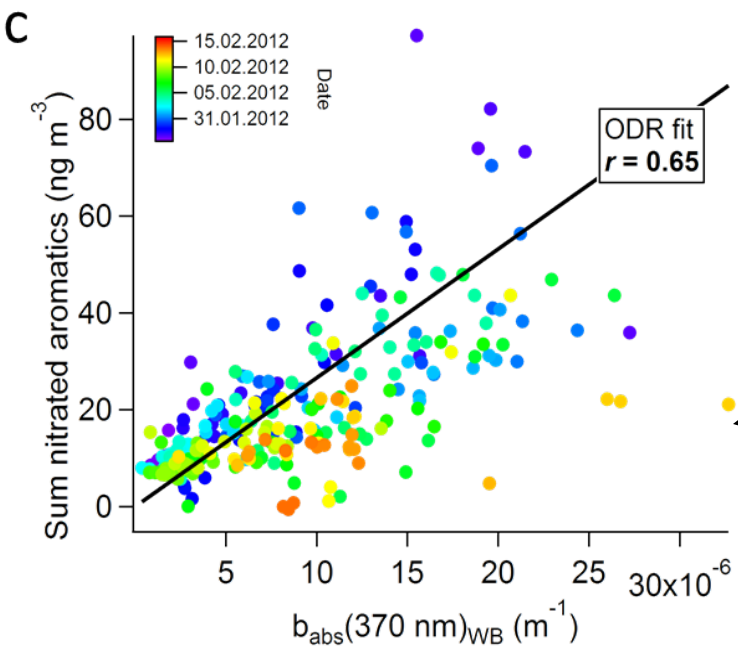
Ga Tech HR-AMS

Nitrated aromatics in particle phase measured with CIMS

"Contribution of nitrated aromatics to wood burning brown carbon light absorption in Detling, UK during winter time," Mohr et al., ES&T, 2013.

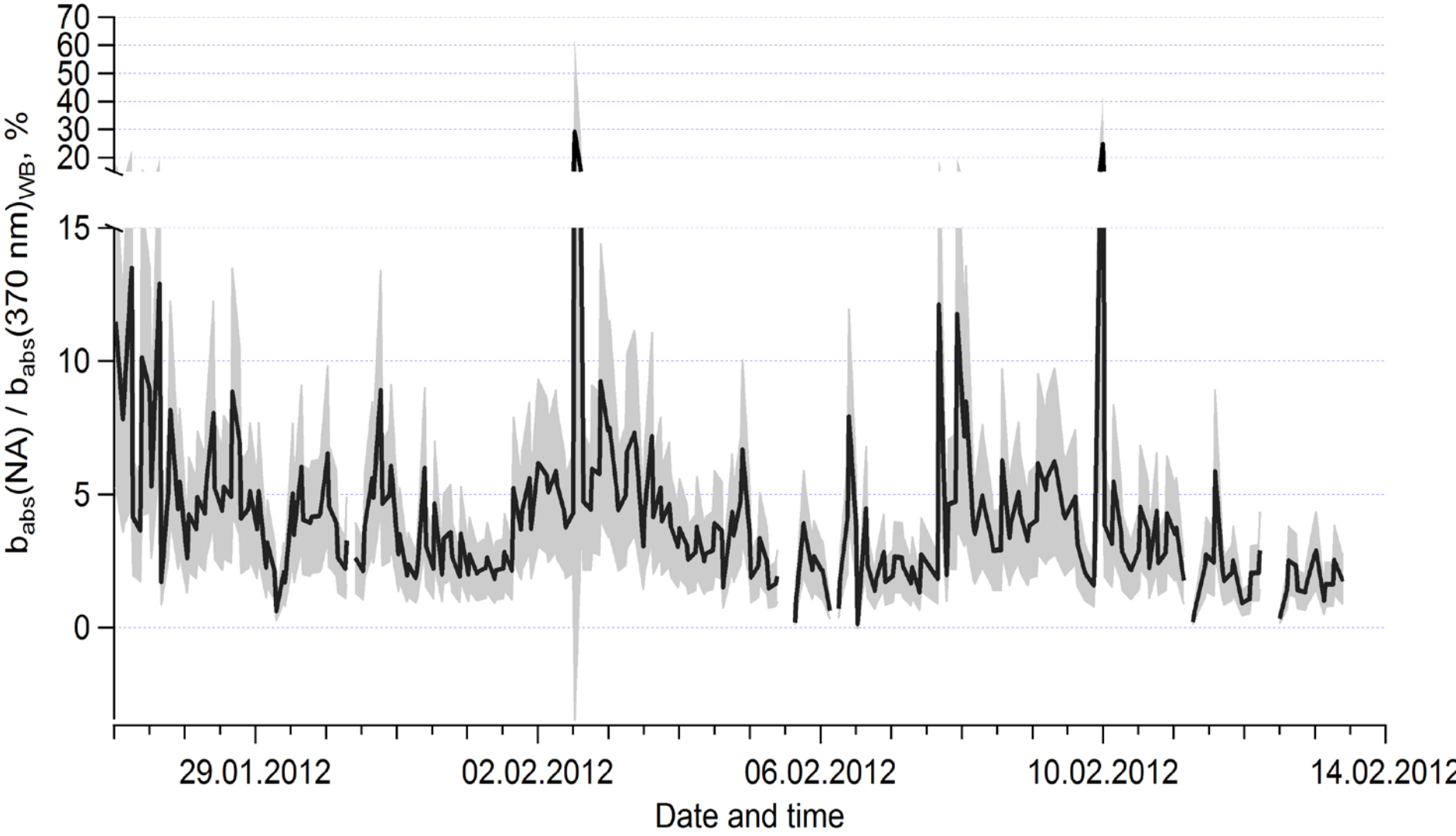


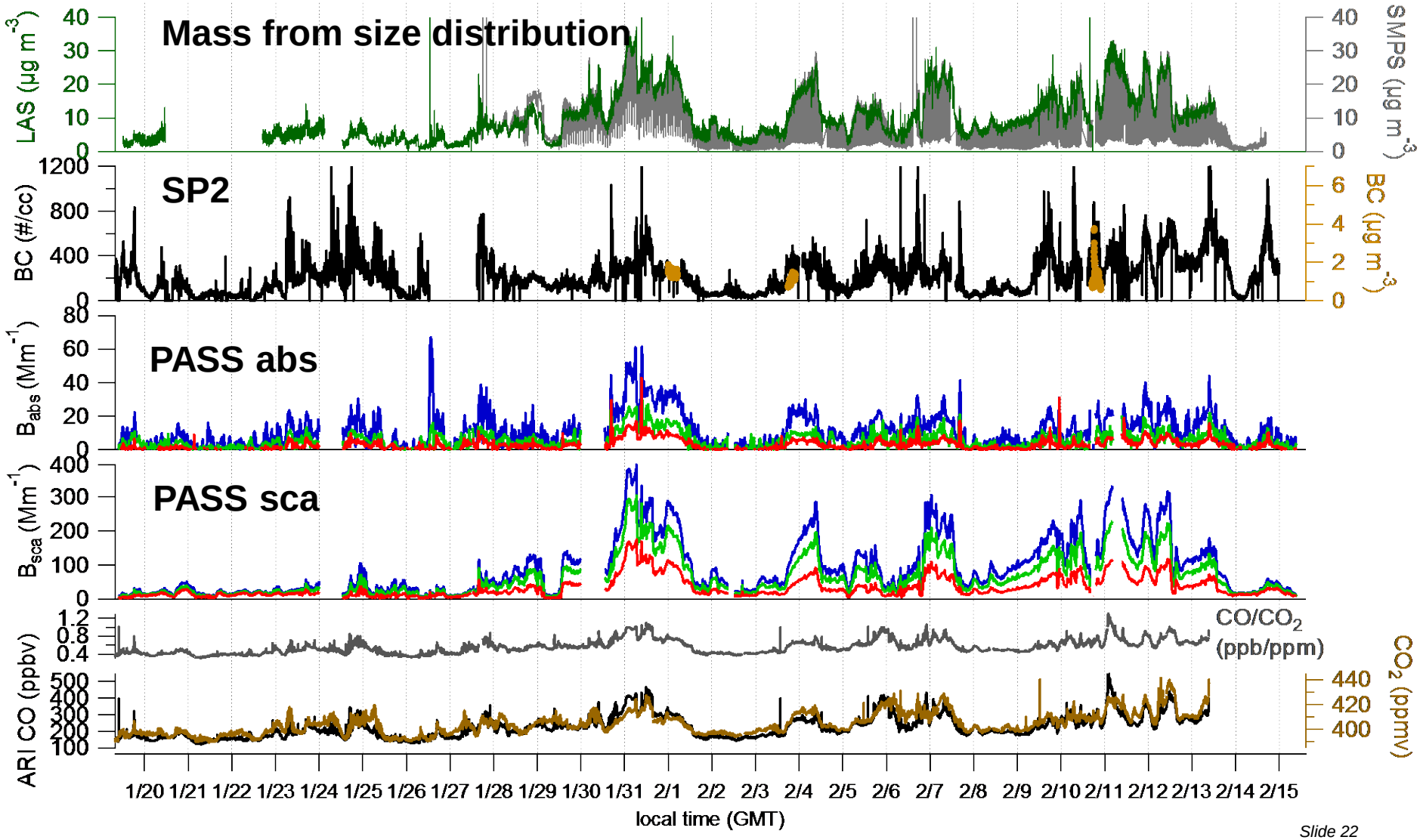

Sum of nitrated aromatics vs OA from biomass burning based on PMF analyses of AMS data.

Sum of nitrated aromatics vs fraction of babs measured with an aethalometer at 370 nm from wood burning (babs(370 nm)WB).

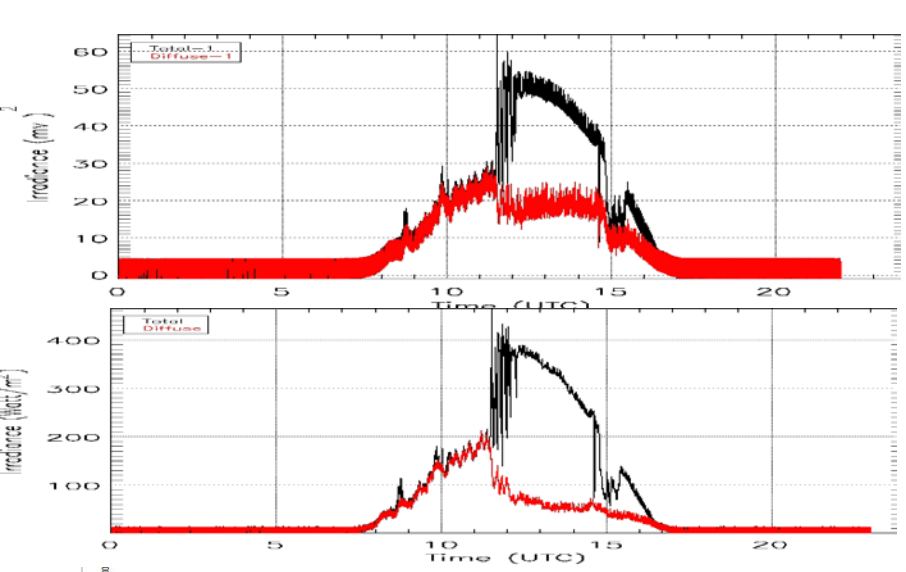


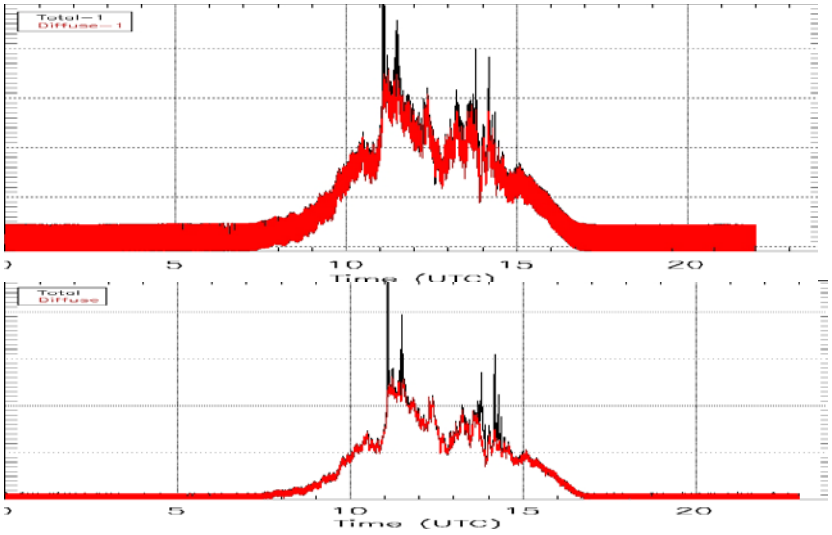

Absorption at 370 nm by nitrated aromatics (from literature values) relative to absorption by woodburning organics (derived from aethaolmeter data)

# Los Alamos National Lab: Optical Properties



# Argonne National Lab: Feb 03-04, 2012



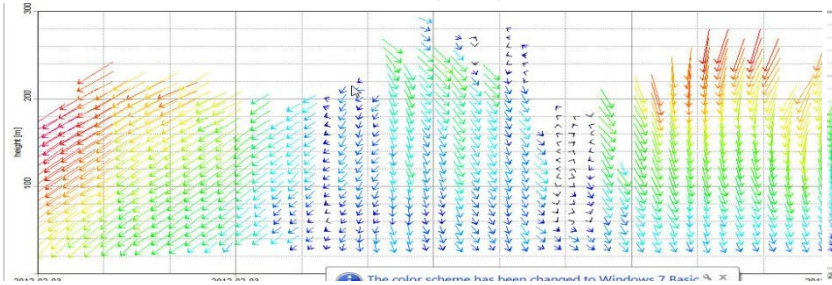

**mfrsr**

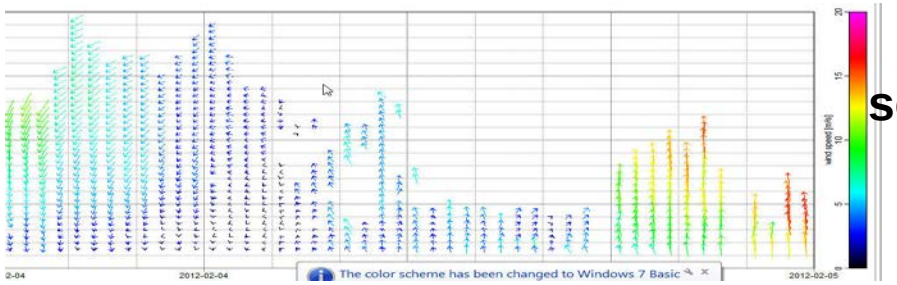




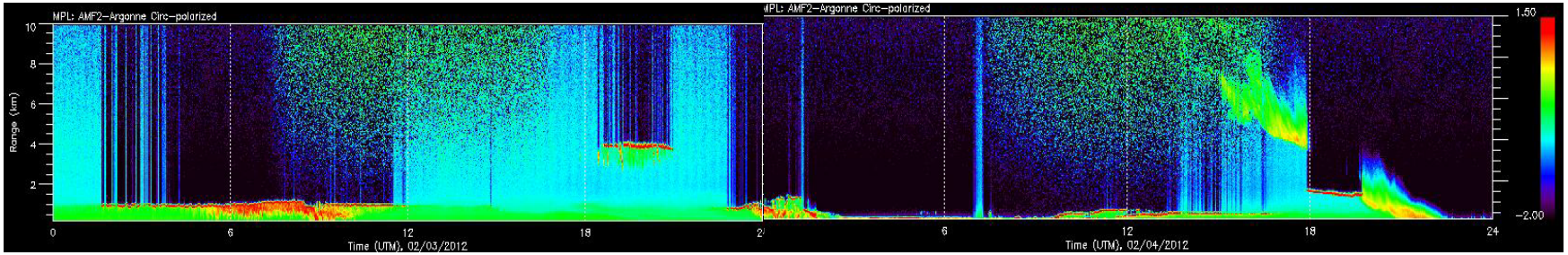


**SPN1**




**sodar**




**MPL**