Black Carbon Containing Particles at a Rural Site Southeast of London: ClearfLo Winter IOP Detling Site

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], M. R. Canagaratna[1], D. R. Worsnop[1], F. Lopez-Hilfiker[2], C. Mohr[2], J. Thornton[2], N. L. Ng[3], L. Xu[3], W. 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. S. H. Prévôt[7]

[1]Aerodyne Research, Inc., Billerica, MA 01821, USA
[2]Department of Chemistry, University of Washington, Seattle, WA 98195, USA
[3]School of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta, GA, 30332, USA
[4]Department of Chemistry and Biochemistry, Montana State University, Bozeman, MT 59717, USA
[5]Earth and Environmental Sciences Division, Los Alamos National Laboratory, Los Alamos, NM, 87545, USA
[6]Environmental Science Division, Argonne National Laboratory, Argonne, IL 60439, USA
[7]Laboratory of Atmospheric Chemistry, Paul Scherrer Institute, Villigen PSI, Switzerland
Keywords: aerosol chemistry, atmospheric black carbon, urban aerosols
Presenting author email: Williams@aerodyne.com

Clean Air for London (ClearfLo) is a large, multidisciplinary study of the London urban atmosphere aimed at understanding the relationships between surface meteorology, gas-phase composition and particulate matter at a city street site, a city background site (away from local traffic sources) and at rural locations that sample the outflow from the London urban area. During the winter intensive (January to February, 2012) we deployed a suite of instruments at a rural site southeast of London in Detling, UK.

Data were collected through several co-located inlets mounted on a 9 m tower. Real-time particle instruments included an Aerodyne high-resolution time-of-flight mass spectrometer (HR-AMS), an Aerodyne soot particle mass spectrometer (SP-AMS), a multi-angle absorption photometer (MAAP), photo-acoustic soot spectrometers (PASS), a scanning mobility particle sizer (SMPS), cavity enhanced phase-shift particle extinction monitors (CAPS PMex), and a single particle soot photometer (SP2). Particle properties were measured with and without a thermal denuder (TD) in order to understand the effect of coatings on optical properties. Bulk particle chemistry was measured with filter samplers and a rotating drum impactor.

Gas phase measurements included air mass tracers (CO, CO_2, O_3, NO_x) and volatile organic compounds using a proton-transfer reaction mass spectrometer (PTR-MS). The micro-orifice volatilization impactor chemical ionization time-of-flight mass spectrometer (MOVI-CI-TOFMS), a recently developed chemical ionization instrument that measures organic acids in both the gas-phase and the particle-phase, was also deployed.

Over the course of the campaign, sampled air masses were of local (A249 motorway 200 m south of the site), regional (London to the northwest, industrial areas north of the site, or Maidstone city southwest of the site) or continental (mainland Europe) origin. Air mass origins were determined from back trajectories calculated by University of Leicester with the UK Met Office NAME dispersion model and from local wind speed and direction.

This talk will focus on black carbon containing particles measured at Detling. The SP-AMS instrument made in situ measurements of the chemical composition and size distributions of black carbon containing particles, both the black carbon component and any coatings. The mass spectra were analyzed with positive matrix factorization (PMF) yielding three factors. The first factor has dominant peaks at m/z 60 and 72, indicative of solid fuel burning. The second factor has a mass spectrum suggesting hydrocarbons, while the third factor has a mass spectrum associated with oxygenated organics and more aged aerosol particles. Figure 1 shows the time trends for the three factors. Time periods that are dominated by one factor are circled in blue and will be discussed in more detail. Connections between the chemical, microphysical, and optical properties of the aerosol particles in the different air masses will be presented.

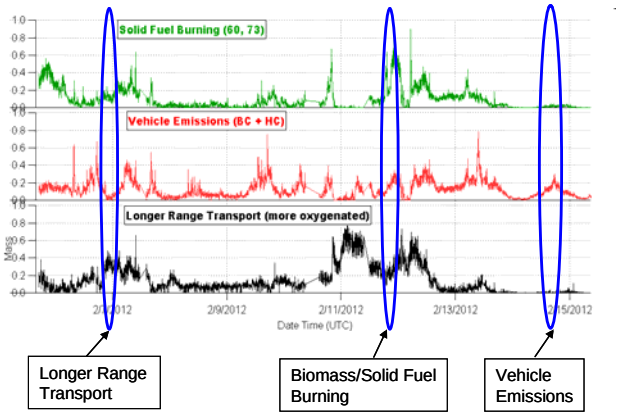

Figure 1. Time trends for PMF factors whose mass spectra suggest solid fuel burning, vehicle emissions and longer range transport sources.

Acknowledgements: This project was supported by the US Department of Energy Atmospheric System Research Program (Award No. DE-SC0006002) and the UK Natural Environment Research Council.