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Thermal Optical Detection of Controlled Combustion Aerosol with a Carbon Analyzer

Min-Suk Bae (1,2), James Schwab (2), Wei-Nai Chen (3), Brian Frank (4), Aaron Pulaski (4), Min-Hwa Lim (1), Ji-Ah Kim (1), and Kenneth Demerjian (2)

(1) Environmental Engineering, Mokpo National University, Republic Of Korea (minsbae@hotmail.com), (2) Atmospheric Sciences Research Center, University at Albany, State University of New York, Albany, NY 12203, USA, (3) Research Center for Environmental Changes, Academia Sinica, Taipei, Taiwan, (4) Air Resources Division, New York State Department of Environmental Conservation, Albany, NY, USA

Spectrothermography, which can be defined as the measurement of thermally evolved carbon from heated aerosol samples, is an established technique for carbonaceous content of aerosols and partitioning the carbon into broad classes, minimally OC ("organic" carbon) and EC ("elemental" carbon).
We used a Combustion Aerosol Standard (CAST) system to generate the controlled combustion aerosol from a propane burner. By adjusting the flame mixtures we were able to create aerosol generated by lean and rich flames, with large differences in the amount of particulate matter produced, and in the EC/OC ratios in these flame exhaust plumes. In addition to the "pure" combustion aerosol, we created a number of synthetically mixed aerosols by incorporating a range of organic/inorganic compounds into combustion aerosols including NaCl, levoglucosan, ammonium bisulfate, and phthalic acid. The mixed aerosol experiments were designed to evaluate matrix effects on the thermal evolution of the organic species and the split time between OC and EC. In addition, we present patterns of carbon evolution as a function of temperature for many of these same compounds (specifically sucrose, NaCl, levoglucosan, ammonium bisulfate, phthalic acid and powdered black carbon) by direct injection of dissolved compound or suspensions onto filters followed by analysis with our real time SUNSET ECOC instrument. We used four different temperature protocols to collect thermograms for the carbon-containing compounds. Three methods have been widely used for thermal optical measurement of carbonaceous aerosol – the NIOSH 5040 method used by the EPA Speciation Trends Network; the IMPROVE method; and a simplified version of the NIOSH method used for the real time Sunset ECOC instrument. We also developed an ASRC method (8 temperature steps in He and 3 temperature steps in He/O2) which showed a greater separation of the thermographical peaks compared to the other three methods.