Transformation of Diesel Soot Investigated in a Smog Chamber

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10CA.3
Characterization of Black Carbon Containing Particles Measured by the Soot Particle Aerosol Mass Spectrometer on Board the R/V Atlantis during the 2010 CalNex Study. TIMOTHY ONASCH, Paola Massoli, Shao-Meng Li, Katherine Hayden, Christopher Cappa, Ibraheem Nuaanman, Donna Sueper, Douglas Worsnop, *Aerodyne Research, Inc.*

Black carbon (BC) containing particles formed in combustion processes are strong light-absorbers with climate forcing impacts and have a complex nature which makes their characterization (microphysical, chemical and optical) challenging. Detailed measurements of the mass, size, chemical composition, and optical properties of BC-containing particles were made as part of the CalNex 2010 study onboard the R/V Atlantis. The Atlantis was deployed to characterize inflowing and outflowing air masses along the California coast and to assess emissions from sources (e.g. ships) in coastal waters and urban ports.

We deployed a suite of particle instruments sampling behind a thermal denuder on a common inlet to investigate aerosol volatility and absorption enhancement due to BC particle coatings. Measurements obtained using an Aerodyne Soot Particle Aerosol Mass Spectrometer (SP-AMS) provided mass, size, and chemical composition of BC-containing particles. We present several cases of coastal pollution outflow events (morning and afternoon) as the R/V Atlantis often sampled air masses as they moved offshore from Santa Monica and Monterey Bays. We track changes in size, mass, volatility, and chemical composition of BC-containing particles as a function of atmospheric aging, with implications for their optical properties. We also characterized black carbon emissions from ship plumes encountered during the deployment.

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Transformation of Diesel Soot Investigated in a Smog Chamber. JOAKIM PAGELS, Axel Eriksson, Jenny Rissler, Jonathan Carlsson, Cerina Wittbom, Erik, Z Nordin, Patrik Nilsson, Pontus Roldin, Birgitta Svenningsson, Erik Swietlicki, *Lund University, Lund, Sweden*

Atmospheric processing of soot particles ultimately leads to transformation of the agglomerated soot structure to close to spherical particles with an embedded elemental carbon core. These processes affect climate (e.g. optics and cloud formation) and health relevant properties but the dynamics and time scales of the processes are poorly known. In this work we investigated the transformation of diesel soot using photo-oxidation studies in a smog chamber.

The experiments were conducted in a 6 m3 Teflon (FEP) smog chamber, using black lights to initiate OH-chemistry. Diesel exhaust from an idling Euro II light duty vehicle was injected using a heated inlet. Varying concentrations of the secondary organic aerosol (SOA) precursors toluene and m-xylene were injected to the smog chamber to investigate different degrees of aging. The composition of the soot core, its coatings and the vacuum aerodynamic size distribution was analyzed with a Soot Particle Aerosol Mass Spectrometer (SP-AMS) (Aerodyne Inc.). The soot morphology and size dependent condensed mass fraction was investigated using a Differential Mobility Analyzer-Thermo Denuder-Aerosol Particle Mass Analyzer and TEM.

During condensation of SOA the effective density increased from values typical for fresh diesel agglomerates to 1.4 g/cm3 asymptotically, indicating that the agglomerates had been transformed to near spherical particles. The results have been summarized in a parameterization of the dependence of particle morphology (dynamic shape factor and effective density) on the condensed mass fraction and particle size during aging in the smog chamber. Humidifying the particles from the smog chamber to 90% RH using a hygroscopic tandem DMA, showed that uptake of water vapor leads to progressed compaction of the soot core at certain stages of aging.

Vacuum aerodynamic sizes of soot fragments detected with the SP-AMS increased with aging in the smog chamber. These results were compared with recent field measurements in a street canyon in Copenhagen which show one vacuum aerodynamic size mode consistent with fresh agglomerated soot and another mode of larger soot containing particles consistent with aged compacted particles.