

Measurements of Aerosol Non-Refractory Chemical Composition for SENEX

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A key aspect of the SENEX project is to quantify the abundance and chemical composition of atmospheric aerosol particles above the Southeastern United States. To accomplish this, we use a semi-custom Compact Time-of-Flight Aerosol Mass Spectrometer or C-ToF-AMS with a light scattering (LS) module (Aerodyne Research Inc., Billerica, MA).

The general operation of AMS instruments has been described elsewhere [*Jayne et al.*, 2000; *Allan et al.*, 2003; *Jimenez et al.*, 2003; *Canagaratna et al.*, 2007]. Briefly, particles are transmitted into the AMS detection region using an aerodynamic focusing lens, where they impact an inverted-cone porous-tungsten vaporizer typically held at ~ 600 °C, and volatilize, with the vapors being analyzed by electron ionization mass spectrometry. The C-ToF-AMS system deployed here employs a long aerosol time-of-flight drift region and a compact-time-of-flight mass spectrometer, which combined has high size-resolution and high sensitivity for individual particle mass spectral signals [*Drewnick et al.*, 2005; *DeCarlo et al.*, 2006]. Particles between 100 and 700 nm vacuum aerodynamic diameter are sampled with 100% efficiency through the specific aerodynamic focusing lens used here and the custom pressure-controlled inlet designed for airborne operation [*Liu et al.*, 1995; *Bahreini et al.*, 2008]. Details on calibration, data collection and data processing are described elsewhere [*Allan et al.*, 2004; *Bahreini et al.*, 2009; *Middlebrook et al.*, 2012].

The LS module has been previously used by other investigators in a few laboratory and field studies [*Cross et al.*, 2007; *Cross et al.*, 2009; *Slowik et al.*, 2010; *Liu et al.*, 2012]. Here it will be deployed for the first time on an airborne platform. The LS module consists of a 405 nm, continuous laser beam directed at the end of the aerosol time-of-flight drift region before particles impact on the vaporizer, an ellipsoidal mirror for collecting scattered light from particles passing through the laser beam, and a photomultiplier tube for detecting and measuring the scattered light. The data acquisition software uses the scattered light signal to trigger saving mass spectra for that individual particle.

One important factor for particle detection efficiency in the AMS instrument is efficient evaporation after particle impactation on the vaporizer, where inefficient evaporation is commonly

referred to as particle “bounce” [Matthew *et al.*, 2008; Middlebrook *et al.*, 2012]. To provide a direct measurement of this factor for ambient aerosols, particles must be large enough to scatter light in the instrument (for the current system ~100 nm in diameter), provide enough signal from the single particle mass spectra to detect them, and evaporate in 3 ms or less. It is expected that the new LS module will provide a quantitative measure of the particles that are not detected due to “bouncing” on the vaporizer.

Table 1: Performance characteristics of the NOAA ESRL LS-C-ToF-AMS.

Standard AMS data products	Non-refractory, submicron sulfate, nitrate, chloride, ammonium, and organic mass concentrations
Data Acquisition Rate	10 s averages
Detection Limits	0.02, 0.015, 0.015, 0.1, and 0.15 $\mu\text{g sm}^{-3}$, respectively
Accuracy	Typically $\pm 30\%$

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