Chemical Characterization of the Ambient Organic Aerosol Soluble in Water Part 1: Isolation of Hydrophobic and Hydrophilic Fractions

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ABSTRACT

Group separation of fine particles soluble in water provides unique insights into the sources of organic carbon (OC). XAD-8 resin coupled with a Total Organic Carbon analyzer allows for direct quantification of the hydrophilic and hydrophobic fractions of water-soluble OC (WSOC). Experiments show that hydrophilic compounds that penetrate XAD-8 with near 100% efficiency include saccharides, amines, and carbonyls and aliphatic mono-/di-/oxocarboxylic acids with less than 4 or 5 carbons. Hydrophobic compounds retained by XAD-8 include aromatic acids, phenols, organic nitrates, cyclic acids, and carbonyls and mono-/dicarboxylic acids with greater than 4 or 5 carbons. However only aromatic compounds (or aromatic-like compounds with similar hydrophobic properties) can subsequently be extracted from XAD-8 with high efficiency. By coupling a Particle-into-Liquid Sampler with this technique, on-line measurements of WSOC, hydrophilic, and hydrophobic WSOC are possible. Urban measurements from St. Louis and Atlanta, on a carbon mass basis, show an increase in the mean WSOC fraction from winter (51%) to summer (61%), due to increases in the hydrophilic fraction from 25 to 35% of OC. During a summer Atlanta PM event, WSOC and hydrophilic WSOC were 75% and 47% of OC, respectively, consistent with the view of an increasing contribution from winter to summer of oxygenated polar compounds, possibly from secondary organic aerosol production, and that these compounds account for an even larger fraction of OC during a stagnation event when local emissions dominate. A companion paper describes a method to further group speciate these fractions.