

MAR08-2007-006909

Abstract for an Invited Paper
for the MAR08 Meeting of
the American Physical Society

Measurements of the Chemical Composition of Atmospheric Nanoparticles¹

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The Thermal Desorption Chemical Ionization Mass Spectrometer (TDCIMS) is an instrument that is capable of measuring the chemical composition of particles as small as 4 nm. It accomplishes this with a sensitivity that makes it possible to measure the molecular composition of nanoparticles at ambient concentrations in the atmosphere. For the past five years, the TDCIMS has been performing measurements of the smallest particles in the atmosphere in order to determine the chemical species and mechanisms responsible for the growth of aerosols formed by nucleation. In this talk I will summarize what we've learned from these measurements, which took place in urban areas (Atlanta and Mexico City), a remote location (the boreal forests of Finland), and regions that are combinations of both (Boulder). With the exception of one study in urban Atlanta, in which sulfur species were seen to dominate, most measurements indicate a crucial role played by organic species in the growth of atmospheric nanoparticles. Positive ion TDCIMS measurements in a variety of locations show the presence of methyl and dimethyl amines in particles as small as 8 nm. Other oxidized organics detected in positive ion TDCIMS measurements are presumed to be alcohols, aldehydes, or ketones. Negative ion TDCIMS measurements show the presence of multifunctional organics with carboxylic acid moieties. Laboratory studies using pure and multi-component aerosols are assisting us in identifying the many ions that were observed during our campaigns. Our measurements suggest that reactions of organic acids and organic bases on particle surfaces or within particles may form organic ions and/or salts in particles. Based on these measurements, we hypothesize that the organic salt formation mechanism may be the dominant mechanism by which nanoparticles grow in the atmosphere.

¹This research was supported by the Office of Science (BER), US DOE, grant DE-FG-02-05ER63997 and by NOAA under contract NA05OAR4310101. NCAR is sponsored by NSF.