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Organic nitrogen in clouds and precipitation

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Ammonium and nitrogen are well known as important contributors to the chemical composition of aerosol particles, clouds, and precipitation. Elevated particulate matter concentrations, visibility degradation, and increases in nitrogen deposition to sensitive ecosystems are all consequences of increased anthropogenic emissions of nitrogen oxides and ammonia. Not all atmospheric nitrogen, however, occurs in inorganic forms. Organic nitrogen, which occurs in oxidized, reduced, and biological forms, is also emitted to and produced in the atmosphere. Potentially important sources of organic nitrogen include agricultural emissions of reduced forms of organic nitrogen, biological emissions of free and combined amino acids, direct emissions from combustion processes including wildfires, and atmospheric reactions of nitrogen oxides and organic matter. Unfortunately, our knowledge of the abundance of organic nitrogen, its chemical speciation, and the relative importance of potential sources and sinks remains extremely limited.

We report here on observations of organic nitrogen in fogs and precipitation. Observations come from a series of studies in the United States looking at pollutant processing by radiation fogs in California and at nitrogen transport and wet deposition in the Rocky Mountains of Colorado. Total nitrogen concentrations are in the millimolar range in California fogs and approximately two orders of magnitude lower in Rocky Mountain precipitation. Although the two environments are quite different, studies in both locations reveal substantial fractional inputs by organic nitrogen. Work

is currently ongoing to examine the forms of organic nitrogen in samples from both environments. Applied methods include sample analysis by GC/MS, LC/MS, and IC plus sample atomization followed by high resolution time-of-flight aerosol mass spectrometer measurement of non-volatile droplet residues. Observed compounds cover a wide range of molecular weights, up to and exceeding 1000 Da, with many of the organic compounds observed including nitrogen. Highlights of these measurements will be presented and discussed in the context of atmospheric sources and sinks of organic nitrogen.