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Comprehensive airborne characterization of aerosol from a major bovine source

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Abstract. We report an extensive airborne characterization of aerosol downwind of a massive bovine source in the San Joaquin Valley (California) on two flights during July 2007. The Center for Interdisciplinary Remotely-Piloted Aircraft Studies (CIRPAS) Twin Otter probed chemical composition, particle size distribution, mixing state, sub- and supersaturated water uptake behavior, light scattering properties, and the interrelationship between these parameters and meteorology. Total $PM_{1.0}$ levels and concentrations of organics, nitrate, and ammonium were enhanced in the plume from the source as compared to the background aerosol. Organics dominated the plume aerosol mass (~56–64%), followed either by sulfate or nitrate, and then ammonium. Particulate amines were detected in the plume aerosol by a particle-into-liquid sampler (PILS) and via mass spectral markers in the Aerodyne C-ToF-AMS. Amines were found to be a significant atmospheric base even in the presence of ammonia; particulate amine concentrations are estimated as at least 14–23% of that of ammonium in the plume. Enhanced sub- and supersaturated water uptake and reduced refractive indices were coincident with lower organic mass fractions, higher nitrate mass fractions, and the detection of amines. The likelihood of suppressed droplet growth owing to kinetic limitations from hydrophobic organic material is explored. After removing effects associated with size distribution and mixing state, the normalized activated fraction of cloud condensation nuclei (CCN) increased as a function of the subsaturated hygroscopic growth factor, with the highest activated fractions being consistent with relatively lower organic mass fractions and higher nitrate mass fractions. Subsaturated hygroscopic growth factors for the organic fraction of the aerosol are estimated based on employing the Zdanovskii-Stokes Robinson (ZSR) mixing rule. Representative values for a parameterization treating particle water uptake in both the sub- and supersaturated regimes are reported for incorporation into atmospheric

models.

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