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Secondary Organic Aerosol Formation from Glyoxal: Effects of Seed Aerosol on Particle Composition

Jay Slowik (1), Eleanor Waxman (2), Sean Coburn (2), Felix Klein (1), Theodore Koenig (2), Manuel Krapf (1), Nivedita Kumar (1), Siyuan Wang (2), Urs Baltensperger (1), Josef Dommen (1), Andre Prévôt (1), Rainer Volkamer (2,3), and the Glyoxal-2013 Team

(1) Laboratory of Atmospheric Chemistry, Paul Scherrer Institute, Villigen PSI, Switzerland, (2) Department of Chemistry and Biochemistry, University of Colorado, Boulder, CO, USA, (3) Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder, CO, USA, (4) Inorganic and Analytical Chemistry, Johannes Gutenburg-Universität Mainz, Mainz, Germany, (5) Institute for Marine and Atmospheric Research Utrecht, Utrecht University, Utrecht, Netherlands, (6) Multiphase Chemistry, Max Planck Institute for Chemistry, Mainz, Germany, (7) Environmental Molecular Sciences Laboratory, Pacific Northwest National Laboratory, Richland, WA, USA, (8) IRCELYON, University of Lyon, France, (9) Department of Earth and Environmental Sciences, University of Milano Bicocca, Milan, Italy, (10) Department of Chemistry & Division of Environment, Hong Kong University of Science & Technology, Kowloon, Hong Kong

Conventional models of secondary organic aerosol (SOA) production neglect aqueous-phase processing mechanisms, thereby excluding potentially important SOA formation pathways. These missing pathways may be an important factor in the inability of current models to fully explain SOA yields and oxidation states. Molecules identified as important precursors to SOA generated through aqueous-phase include glyoxal, which is an oxidation product of numerous organic gases. Glyoxal SOA formation experiments were conducted in the PSI smog chamber as a function of seed composition, relative humidity (RH, 60 to 85%), and the presence/absence of gaseous ammonia, affecting particle acidity. In a typical experiment, the chamber was filled with the selected seed aerosol (NaCl, (NH4)2SO4, $NaNO_3$, or K2SO4), after which glyoxal was generated by the brief (i.e. a few minutes) exposure of acetylene to UV light. The experiment was then allowed to proceed undisturbed for several hours. Each experiment consisted of several UV exposures, followed by a dilution phase at constant RH to investigate the gas/particle partitioning behavior of the generated SOA. Gas-phase glyoxal was monitored by an LED-CE-DOAS system, while the particle composition was measured using online aerosol mass spectrometry (Aerodyne HR-ToF-AMS) and offline analysis of collected filter samples. SOA composition was observed to depend strongly on seed type, with increased imidazole formation evident during experiments with (NH4)2SO¬4 and K2SO4 seeds relative to those with NaCl and $NaNO_3$. Additionally, experiments conducted in the presence of ammonia showed large enhancements in both imidazole content and total SOA yield. Analysis of mass spectral markers indicates reversible uptake of glyoxal but irreversible particle-phase production of the imidazole-containing SOA. Positive matrix factorization (PMF) using the Multilinear Engine (ME-2) was applied to the AMS mass spectral time series to quantify factors related to reaction progress and product formation (e.g. glyoxal and different types of irreversibly-generated SOA). We will discuss glyoxal SOA yields and product distributions in terms of seed composition and ammonia effects.