Atmospheric Oxidation Products Pertinent to New Particle Formation

Jun Zhao[1], Coty Jen[2], Mark R. Stolzenburg[2], James N. Smith[3], and Peter H. McMurry[2]

[1]*Department of Atmospheric Sciences, School of Environmental Science and Engineering, Sun Yat-sen University, Guangzhou, Guangdong, China*
[2]*Department of Mechanical Engineering, University of Minnesota, Minneapolis, Minnesota, USA*
[3] *Atmospheric Chemistry Division, National Center for Atmospheric Research, Boulder, Colorado, USA*

Nanoparticles formed by nucleation and their subsequent growth to cloud condensation nuclei may significantly affect cloud formation and global climate. Atmospheric boundary layer nucleation rates are usually well correlated with gas-phase sulfuric acid, though sulfuric acid (plus water) alone cannot explain the high formation and growth rates of new particles that are routinely observed. Thus far, several other species including ammonia, amines, and, more recently, highly oxidized organic compounds have been identified as the key contributors to new particle formation and early growth. Here we present results from the 2013 Southern Great Plains New Particle Formation Study (2013 NPFS), which took place at a remote continental site in the US. The atmosphere at the site is impacted by large-scale industrial agriculture and petroleum extraction. The measurements provide concentrations of gaseous species (100-500 amu) and particles (2-500 nm) measured by the Cluster CIMS and scanning mobility particle sizers, respectively. In contrast to our 2009 Cluster CIMS measurements in Atlanta (NCCN09), signals for sulfuric acid clusters larger than dimer were mostly below detection limits due to interferences of organic compounds. We hence developed an analytical method to divide the signal of each species into two components: one associated with the formation of sulfuric acid and the other with malonic acid, a representative secondary organic gas phase product. Sulfuric acid and malonic acid followed distinctly different diurnal profiles. With this method, we found that several high molecular weight oxidation products that were highly correlated to the formation of new particles (<10nm) by comparing the cases between nucleation events and non-events. Climatic effects of new particle formation from various locations will be discussed.

Key words: Sulfuric acid, New particle formation, Atmospheric Nucleation, Highly oxidized organic compounds, Radiative forcing