Final Report: " Growth Rates of Freshly Nucleated Particles"

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Overview of achievements.

Our proposal for this project identified the following objectives. Our ccomplishments are summarized along with the enumerated objectives.

(1) TDCIMS Instrumentation Development. We will replace the existing ^{210}Po alpha source with a corona source for the ions used in the unipolar nanoparticle charger. We will also explore methods to eliminate ion-induced nucleation in ^{210}Po bipolar chargers.

Achievements (including papers on improved instrumentation for measuring sub-10 nm particles): McMurry et al. (2009), Iida et al (2008a), Kuang et al. (2012b). Stolzenburg and McMurry (2008), McMurry et al (2011), Held et al (2008), Smith et al. (2008)

(2) Atmospheric Field Observations during the DOE "clear air" intensive field campaign. We will measure nanoparticle physical properties (size distributions with SMPS), physical/chemical properties (volatility and hygroscopicity nano-TDMA), cloud condensation nuclei (CCN) concentrations (DMT continuous flow CCN counter) and chemical composition (TDCIMS). We will aim to understand chemical processes responsible for nanoparticle growth rates and to quantify the impact of NPF on cloud condensation nuclei concentrations.

Achievements (including work on improved models for atmospheric growth rates): Iida et al. (2006), Iida et al. (2008b), Jiang et a. (2011 abc), Kuang et al. (2009), Kuang et al. (2010), Kuang et al. (2012a), Mikkonen et al. (2011a), Mikkonen et al. (2011b), Smith et al. (2007), Smith et al. (2010), Hamed et al (2011)

(3) Laboratory Studies. Laboratory studies aimed at elucidating the chemical mechanisms that contribute to high nanoparticle growth rates will be carried out. These studies include:

(i) Uptake and gas/particle partitioning of aliphatic amines onto seed particles of varying acidities;

(ii) Uptake and gas/particle partitioning of mono and di-carboxylic acids onto seed particles of varying acidities;

(iii) Uptake and gas/particle partitioning of organonitrates onto seed particles of varying acidities;

(iv) Measurement of the TDCIMS response to peroxy compounds; nitric, sulfuric, and carboxylic acid esters; and organonitrates;

(v) The formation of organosulfates from pinonaldehyde.

Achievements: Grose et al. (2006), Smith et al. (2010), Hao et al. (2009), Hao et al. (2011), Zhao et al. (2011)

(4) Thermodynamic Model for Nanoparticle Composition. A model for nanoparticle growth rates is needed. Before this can be done, we need to understand factors that influence their equilibrium composition. Based on TDCIMS measurements we believe that organic acids and bases are major constituents of nanoparticles. We plan to study the thermodynamic properties of organic ions and salts formed from such compounds. The modeling work will be done in parallel with and supported by experimental studies of vapor pressures and particle composition.

Achievements: Barsanti et al (2009), Barsanti et al. (2011)

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