

Ambient Measurements of Sulfuric Acid, Ammonia and Aerosol Size in Kent, Ohio

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In order to investigate how aerosol precursors affect aerosol nucleation and which nucleation mechanisms dominate in the lower troposphere, we have conducted long-term, ground-based observations of aerosol size and precursors (sulfuric acid and ammonia) in Kent, OH. At present, there are a very limited number of simultaneous measurements of these two major aerosol precursors and aerosol size at the ground level.

Kent is a college town with a population of about 30,000, located in Northeastern Ohio. Kent is less polluted compared to EPA SuperSites (e.g., Atlanta, Pittsburgh, and Detroit) where typically new particle formation studies were made, but is also surrounded by three urban cities within 80 km. Ohio is also famous for the gray sky due to haze in winter. Northeastern Ohio has rich vegetation with numerous large forests and farms and has many natural lakes.

Particles are sampled from a near isokinetic, laminar flow aerosol sampling inlet with an electrically grounded stainless tube from a window in our lab (room 304 of Williams Hall at the Kent State University main campus). Particle concentrations are measured with two scanning mobility particle sizers (SMPS, TSI) consisting of a differential mobility analyzer (NDMA, TSI 3080) and a condensation particle counter (CPC, TSI 3772) and consisting of a differential mobility analyzer (DMA, TSI 3080) and a condensation particle counter (CPC, TSI 3776). These two sets of SMPSs together cover the ambient aerosol size range from 2.5-1000 nm.

In parallel to a butanol CPC, we also run a water CPC to identify the relative amount of sulfuric acid vs. organic compounds in small particles. Previously we made comparisons with water CPC and butanol-CPC and found that the water-CPC concentrations about 8 times higher than the butanol-CPC concentrations for pure sulfuric acid particles, whereas when sampling the laboratory room air, the concentrations measured from WCPC were only ~ 7% higher than those measured by the butanol-CPC CPC [Young et al., 2008].

Two chemical ionization mass spectrometers are used to measure H_2SO_4 and NH_3 simultaneously. For H_2SO_4 , we use an atmospheric pressure ion-molecule reaction with negative NO_3^- ions and detection limit of H_2SO_4 is as low as $1 \times 10^5 \text{ cm}^{-3}$. For NH_3 , we use low pressure positive proton transfer ion chemistry using protonated acetone or ethanol ions and the background concentration of ammonia detection is < 0.1 ppbv. Temperature and RH are monitored simultaneously.

New particle formation observed in Kent showed the highest frequency in summer (>50%) and the lowest frequency in winter (<10%). Aerosol growth rates measured during new particle formation events ranged from 5-10 nm hour⁻¹. Sulfuric acid concentrations were higher during the summer (at the 10^7 cm^{-3} range at noontime) than in winter (10^6 cm^{-3}) and this trend seemed to be correlated with the measured frequency and magnitude of new particles. Ammonia concentrations measured during the winter were at the sub ppbv level (i.g., 10^9 cm^{-3}). Surface areas were not strongly anti-correlated to new particle concentrations. From these results, we conclude that sulfuric acid is important for aerosol formation but other ternary species are also necessary.

In this presentation, we will discuss how aerosol nucleation and growth rates are correlated to sulfuric acid and ammonia concentrations and how atmospheric conditions (sun flux, precipitation, and air mass history etc.) affect aerosol nucleation.

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Young, L.-H., Benson, D. R., Kameel, F. R., Pierce, J. R., Juninnen, H., Kulmala, M., Lee, S.-H., Laboratory studies of sulfuric acid and water binary homogeneous nucleation: Evaluation of laboratory setup and preliminary results, *Atmos. Chem. Phys.* 8, 1-20 (2008).