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Characteristics of Submicron Aerosols in 2013 summer of Beijing

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To characterize the air pollution of North China Plain of China, CAREBEIJING-2013 field campaign (Campaigns of Air quality REsearch in BEIJING and surrounding region) was conducted in summer of 2013. Submicron aerosols were measured at an urban site PKU (Peking University, 39°59'21"N, 116°18'25"E) from July 28^{th} to September 31^{st} 2013. A suite of integrated instruments was used to measure the size distribution, effective density and hygroscopicity of ambient particles. The chemical composition of submicron particles were measured by using an Aerodyne High-Resolution Time-of-Flight Aerosol Mass Spectrometer (HR-ToF-AMS) (Billerica, MA, USA). The average $PM_{2.5}$ concentration was 73.0$\pm$70.7 μg m^{-3} during the measurement. The particulate pollution showed distinct 4-7 days cycles controlled by the meteorological conditions. Each cycle started with low $PM_{2.5}$ mass concentrations ($<$20 μg m^{-3}), since the air mass was from relatively clean mountainous area. The particle number concentrations were high, but and the sizes were small ($<$30 nm) at this stage, which can be explained by the new particle formation. In the succeeding days, both the particle mass and size continuously increased. The $PM_{2.5}$concentration increased rapidly by $>$60 μg day^{-1}, and the particle mean diameter grew to $>$100 nm. It is interesting to note that the mean diameters showed similar trend to $PM_{2.5}$ mass concentrations, indicating the particle pollution attributed to the growth of the newly formed small particles. During the measurement, the average particle densities are between 1.3-1.5 g cm^{-3}, indicating organics and sulfate were dominant in the particles. The densities of smaller particles, i.e. 46 nm, 81nm, showed single peak at 1.3-1.5 g cm^{-3}, indicating the particles are internal mixed sulfate and organics. While the 150nm and 240 nm particle densities exhibited bimodal distribution with an additional small peak at $\sim$1.1 g cm^{-3}, which is considered as external mixed organic particles or aged soot particles. The particle hygroscopic growth factor for all the measured sizes at RH of 90% showed bimodal distribution, attributing to external mixed organics (or aged soot) and internal mixed organics and sulfate. Both the density and HGF were higher than Tijuana, but similar to Houston. PMF (Positive Matrix Factorization) model was deployed to quantify the contributions of different mixing state particles. Internal mixed organics and sulfate were dominant in the ambient particles in Beijing.