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Size-resolved aerosol chemical analysis of extreme haze pollution events during early 2013 in urban Beijing, China

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Using size-resolved filter sampling and chemical characterization, high concentrations of water-soluble ions, carbonaceous species and heavy metals were found in both fine ($PM_{2.1}$) and coarse ($PM_{2.1-9}$) particles in Beijing during haze events in early 2013. Even on clear days, average mass concentration of ultrafine particles ($PM_{1.1}$) was several times higher than that previously measured in most of abroad urban areas. A high concentration of particulate matter on haze days weakens the incident solar radiation, which reduces the generation rate of secondary organic carbon in ultrafine particles. We show that the peak mass concentration of particles shifted from 0.43-0.65 μm on clear days to 0.65-1.1 μm on lightly polluted days and to 1.1-2.1 μm on heavily polluted days. The peak shifts were also found for the following species: organic carbon, elemental carbon, NH_4^+, SO_4^{2-}, NO_3^-, K, Fe, Cu, Zn, Cd and Pb. Our findings demonstrate that secondary inorganic aerosols (36%) and organic matter (26%) dominated the fine particle mass on heavily polluted days, compared to 29% and 18%, respectively, on clear days. However, anthropogenic chemical species also substantially accumulated in the coarse mode, which suggests that particles with a diameter larger than 2.1 μm cannot be neglected during severe haze events.