Insight into evolutionary processes and sources of high-nitrate haze episodes in Beijing, spring 2012

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Rare and consecutive high-nitrate haze pollution episodes were observed in Beijing in spring 2012. This study presents detailed characterization of the sources and evolutionary mechanisms of this haze pollution, and focuses on an episode that occurred between 15 and 26 April. Submicron aerosol species were found to be substantially elevated during haze episodes, and nitrates showed the largest increase and occupation (average: 32.2%) in non-refractory submicron particles (NR-PM_1), which did not occur in other seasons as previously reported. The haze episode (HE) was divided into three sub-episodes, HEa, HEb, and HEc. During HEa and HEc, a shallow boundary layer, stagnant meteorological conditions, and high humidity favored the formation of high nitrate concentrations, which were mainly produced by three different processes—daytime photochemical production, gas-particle partitioning, and nighttime heterogeneous reactions—and the decline in visibility was mainly induced by NR-PM_1. However, unlike HEa and HEc, during HEb, the main contribution of high nitrates was from the transport of haze from the southeast of Beijing—the transport pathway was observed at ~800–1000 m by aerosol Lidar—and the decline in visibility during HEb was primarily caused by $PM_{2.5}$. Our results provide useful information for air quality improvement strategies in Beijing during spring.