Geophysical Research Abstracts
Vol. 21, EGU2019-2143, 2019
EGU General Assembly 2019

Synergistic effect of regional and local sources on the nitrate aerosol partitioning driven by aerosol water in Seoul, South Korea

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Air quality in Seoul, one of the highly populated megacities in East Asia, is not only affected by local emissions but also largely by episodic long-range transport of air pollutants from China. Although severe haze episodes in Seoul have been regarded as a result of the combined effect of local and remote sources in the stagnant condition, the detailed chemical mechanisms and the dynamics with meteorological conditions for such haze development are still in vague. In this study, we explored an important role of aerosol water enhancing nitrate partitioning in the case of the combination of long-range transport and local stagnant condition by utilizing ~200 daily $PM_{2.5}$ chemical composition data intermittently measured from October 2012 to June 2014 together with the ISORROPIA II thermodynamic model. Using the daily average residence time of the HYSPLIT backward trajectories over the local source area (the Seoul Metropolitan Area) and the remote source areas (the North China Plain and the Yangtze River Delta), the $PM_{2.5}$ sampling dates were classified into the local, remote, and combined source cases. Our results show that the remote and combined source groups are characterized by inorganic-rich wet particles, while the $PM_{2.5}$ samples during the local source cases are organic-rich and aerosol water-short. As indicated by previous studies in China, the more inorganic fraction in $PM_{2.5}$, the more aerosol water fraction, especially for the remote and combined source group. In terms of the meteorological factor, the temperature for the remote and combined source groups are generally lower than that for the local source group because the long-range transport from China occurs in the cold season. The nitric acid–nitrate partitioning analysis based on the thermodynamic model for different groups reveals that both the lower temperature and the higher aerosol water content enhanced nitrate uptake during the combined source cases. Our results indicate a synergistic effect of long-range transport and local high NO_x condition on the haze pollution in Seoul.