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Regional source identification of atmospheric aerosols in Beijing based on sulfur isotopic compositions

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65 daily $PM_{2.5}$ (aerosol particle with aerodynamic diameter less than 2.5 μm) samples were collected from an urban site in Beijing in four months representing the four seasons between September 2013 and July 2014. Inorganic ions, organic/elemental carbon and stable sulfur isotopes of sulfate aerosols were analyzed systematically. The "fingerprint" characteristics of the stable sulfur isotopic composition, together with trajectory clustering modeled by HYSPLIT-4 and potential source contribution function (PSCF), were employed for identifying potential regional sources. Results obviously exhibited the distinctive seasonality for various aerosol speciation associated with $PM_{2.5}$ in Beijing with sulfate, nitrate, ammonium, organic matter, and element carbon being the dominant species. Elevated chloride associated with higher concentration of organics were found in autumn and winter, due to enhanced coal combustion emissions. The δ^{34}S values of Beijing aerosol samples ranged from 2.94‰ to 10.2‰ with an average value of 6.18$\pm$1.87‰ indicating that the major sulfur source is direct fossil fuel burning-related emissions. Owning to a temperature-dependent fractionation and elevated biogenic sources of isotopically light sulfur in summer, the δ^{34}S values had significant seasonal variations with a winter maximum (8.6‰)and a summer minimum (5.0‰). The results of trajectory clustering and the PSCF method demonstrated that higher concentrations of sulfate with lower sulfur isotope ratios (4.83‰) were associated with air masses from the south, southeast or east, whereas lower sulfate concentrations with higher δ^{34}S values (6.69‰) when the air masses were mainly from north or northwest. These results suggested two main different kinds of regional coal combustion sources contributed to the pollution in Beijing.