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成都城区$PM_{2.5}$季节污染特征及来源解析

Seasonal variations and source apportionment of $PM_{2.5}$ at urban area of Chengdu

关键词：成都 $PM_{2.5}$ 碳气溶胶 水溶性无机离子 源解析

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摘要：于2009—2010年各季节典型月在成都城区采集了大气$PM_{2.5}$样品,对$PM_{2.5}$的质量浓度及其主要化学成分(含碳组分、水溶性无机离子和元素)进行了测定. 结果显示:成都城区$PM_{2.5}$平均质量浓度高达(165.1±85.1)μg·m^{-3},是国家环境空气质量标准年均$PM_{2.5}$限值的4.7倍. OC、EC和水溶性二次离子(SO_4^{2-},NO_3^-和NH_4^+)的平均浓度分别为(22.6±10.2)μg·m^{-3},(9.0±5.4)μg·m^{-3}和(62.8±44.3)μg·m^{-3},分别占$PM_{2.5}$浓度的13.7%、5.5%和38.0%. $PM_{2.5}$及其主要化学成分浓度季节特征明显,即秋冬季高于春夏季. 利用正交矩阵因子分析(PMF)对成都城区$PM_{2.5}$的来源进行解析,结果表明,土壤尘及扬尘、生物质燃烧、机动车源和二次硝酸盐/硫酸盐的贡献率分别为14.3%、28.0%、24.0%和31.3%. 就季节变化而言,生物质燃烧源贡献率在四个季节均维持在较高水平;土壤尘及扬尘的贡献率在春季显著提高;机动车源的贡献率在夏季中表现突出;而二次硝酸盐/硫酸盐的贡献率在秋冬季中则最为显著.

Abstract: Daily $PM_{2.5}$ samples were collected from 2009 to 2010 during a typical month of each season at an urban site of Chengdu. The mass concentration and chemical compositions (including carbonaceous species, water-soluble inorganic ions and elements) of $PM_{2.5}$ were determined. The results showed that the average $PM_{2.5}$ mass concentration was (165.1±85.1) μg·m^{-3}, which was 4.7 times the annual $PM_{2.5}$ National Ambient Air Quality Standard of China. The average concentrations of OC, EC and total secondary inorganic ions (SO_4^{2-}, NO_3^- and NH_4^+) were (22.6±10.2) μg·m^{-3}, (9.0±5.4) μg·m^{-3} and (62.8±44.3) μg·m^{-3}, accounting for 13.7%, 5.5% and 38.0% of $PM_{2.5}$ mass concentration, respectively. Higher levels of $PM_{2.5}$ mass concentration and their major chemical compositions were found in autumn and winter compared to those found in spring and summer. Positive Matrix Factorization (PMF) model was performed to identify the sources of $PM_{2.5}$ at urban Chengdu. Four sources significantly contributing to the observed $PM_{2.5}$ were: soil dust and fugitive dust, biomass burning, vehicle emissions and secondary nitrate/sulfate, with the contributions of 14.3%, 28.0%, 24.0% and 31.3% to $PM_{2.5}$ mass concentration, respectively. These four sources exhibited distinct seasonal patterns: the relative contribution of biomass burning to total $PM_{2.5}$ was relatively high for all seasons;the relative contribution of soil dust and fugitive dust increased significantly during spring;vehicle emissions contributed significantly during summer;and the highest relative contribution to $PM_{2.5}$ during autumn and winter was secondary nitrate/sulfate factor.

Key words: Chengdu $PM_{2.5}$ carbonaceous aerosol water-soluble inorganic ions source apportionment

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