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Chemical Characterization and Source Apportionment of Particulate Matter in Lahore, Pakistan

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Lahore, Pakistan is a rapidly growing megacity with a population approaching 10 million. A significant issue affecting many of the world's megacities is extremely high levels of air pollution associated with transportation, solid fuel combustion, and industrial sources. High ambient concentrations of particulate matter (PM), as well as high levels of toxic components of PM, have been linked to increased mortality and morbidity. Although much focus has been directed at particulate matter mass, in many developing and underdeveloped nations, the adverse health impacts of high levels of PM are further enhanced by the high concentrations of toxic components in PM. To address these issues is Lahore, a measurement campaign of fine (PM2.5) and coarse (PM10-2.5) particulate matter was conducted for the 2007 calendar year, which included measurements of particle mass, detailed chemical composition of PM and source apportionment calculations.

Annual average PM2.5 and PM10 concentrations were measured to be 194 μg m-3 and 336 μg m-3, respectively, with daily 24-hour maximum concentrations of 410 μg m-3 and 650 μg m-3 for PM2.5 and PM10, respectively. PM2.5 and PM10 samples were analysed for organic and elemental carbon, organic species, ionic species, elemental composition, water soluble elements and biological activity using a macrophage ROS assay. The coarse mode was dominated by crustal dust components, while the fine fraction was dominated by carbonaceous aerosols. The PM10 elemental composition data, which included data for toxic metals, was processed using principle component analysis to determine likely source categories. Seven factors were identified explaining 91% of the variance of the measured components. The factors included a number of industrial sources, re-suspended soil, mobile sources, and regional secondary aerosol. Source contributions to the organic carbon (OC) component of the PM2.5 fraction were identified using organic tracer species and chemical mass balance modelling. Over half of the PM2.5 OC was attributed to non-catalyzed motor vehicle emissions on an annual basis. Other important contributions to OC originated from biomass burning, diesel engines and residual fuel oil combustion, as well as secondary organic aerosol. In addition, ROS activity was found to be associated with the very high concentrations of metals found in PM2.5 and PM10 in Lahore. An overview of the results will be presented.