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The Impact of PM-Based Regulations on the Concentration and Sources of Fine Organic Carbon in the Los Angeles Basin from 2005 to 2015

Authors : Abdulmalik Altuwayjiri, Milad Pirhadi, Sina Taghvaee, Constantinos Sioutas

Abstract : A significant portion of $PM_{2.5}$ mass concentration is carbonaceous matter (CM), which majorly exists in the form of organic carbon (OC). Ambient OC originates from a multitude of sources and plays an important role in global climate effects, visibility degradation, and human health. In this study, positive matrix factorization (PMF) was utilized to identify and quantify the long-term contribution of $PM_{2.5}$ sources to total OC mass concentration in central Los Angeles (CELA) and Riverside (i.e., receptor site), using the chemical speciation network (CSN) database between 2005 and 2015, a period during which several state and local regulations on tailpipe emissions were implemented in the area. Our PMF resolved five different factors, including tailpipe emissions, non-tailpipe emissions, biomass burning, secondary organic aerosol (SOA), and local industrial activities for both sampling sites. The contribution of vehicular exhaust emissions to the OC mass concentrations significantly decreased from 3.5 μg/m³ in 2005 to 1.5 μg/m³ in 2015 (by about 58%) at CELA, and from 3.3 μg/m³ in 2005 to 1.2 μg/m³ in 2015 (by nearly 62%) at Riverside. Additionally, SOA contribution to the total OC mass, showing higher levels at the receptor site, increased from 23% in 2005 to 33% and 29% in 2010 and 2015, respectively, in Riverside, whereas the corresponding contribution at the CELA site was 16%, 21% and 19% during the same period. The biomass burning maintained an almost constant relative contribution over the whole period. Moreover, while the adopted regulations and policies were very effective at reducing the contribution of tailpipe emissions, they have led to an overall increase in the fractional contributions of non-tailpipe emissions to total OC in CELA (about 14%, 28%, and 28% in 2005, 2010 and 2015, respectively) and Riverside (22%, 27% and 26% in 2005, 2010 and 2015), underscoring the necessity to develop equally effective mitigation policies targeting non-tailpipe PM emissions.

Keywords : $PM_{2.5}$, organic carbon, Los Angeles megacity, PMF, source apportionment, non-tailpipe emissions
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