A refined source apportionment study of atmospheric PM2.5 during winter heating period in Shijiazhuang, China, using a receptor model coupled with a source-oriented model

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With the intensification of Chinese source control of air pollution, there is an urgent need for refined and rapid source apportionment techniques. A refined source apportionment method was constructed based on an off-line sampling dataset using a receptor model coupled with a source-oriented model, and the method was implemented in Shijiazhuang during the heating period. The refined results for source apportionment mainly included temporal, spatial, and source-category refinement data. The results indicated that the mean concentration of PM$_{2.5}$ during the heating period was 96 μg/m$^3$. Organic carbon (OC) and NO$_3^-$ were found to be the dominant species of PM$_{2.5}$ during the study. A high correlation was detected between elemental carbon (EC) and NO$_3^-$ on polluted days, which was suggestive of the stagnant condition that accumulates EC and nitrate simultaneously. Secondary particle formation greatly promoted the occurrence of haze events. Secondary sources (34.9%), vehicle exhaust (18.6%), coal combustion (20.0%), industrial emissions (9.2%), crustal dust (9.7%), and biomass burning (7.6%) were the major sources during the heating period. The contributions of secondary sources and vehicle exhaust increased on polluted days, while those of coal combustion, industrial emissions and crustal dust decreased significantly. The contribution percentage of secondary sources from the southeast direction was basically the highest, while those of vehicle exhaust from the northwest or southeast directions were relatively higher as well, likely due to the distribution of traffic arteries. Based on the refined results for the source-category assessment, we found that the heating boilers (17.0%), non-road mobile (13.8%), diesel vehicles (10.4%), residential combustion (6.7%), road dust (5.5%), and architectural material industry (4.9%) were the major contributors to PM$_{2.5}$. There was some uncertainty in the distribution proportions of the refined results, which were derived based on the emission inventory and the results of CALPUFF model.


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