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Secondary organic aerosols from aromatic hydrocarbons and their contribution to fine particulate matter in Atlanta, Georgia

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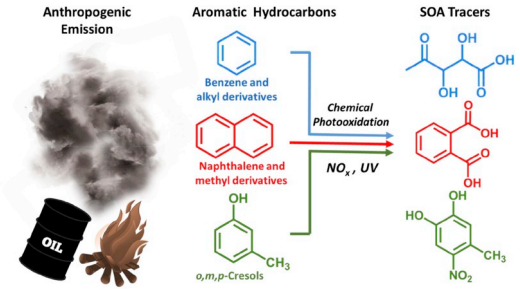
HIGHLIGHTS

- Secondary organic aerosol (SOA) tracers from 13 aromatic VOC were quantified.
- The SOA tracer model was extended and applied in Atlanta, Georgia.
- Mono- and di-aromatic VOC contributed 32% of organic carbon in summer 22% in winter.
- Biomass burning impacts on SOA were indicated by nitroaromatics from cresols.

GRAPHICAL ABSTRACT



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ABSTRACT

Tracers of secondary organic aerosols (SOA) from thirteen aromatic hydrocarbons were quantified in laboratory smog chamber experiments. Class-specific SOA tracers emerged, including 2,3-dihydroxy-4-oxo-pentatonic acid (DHOPA) from monoaromatic volatile organic compounds (VOCs), phthalic acid from naphthalene and 1-methylnaphthalene, and methyl-nitrocatechol isomers from o,m,p-cresol oxidation. Organic carbon mass fractions (f_{SOC}) for these and other tracers were determined and extend the SOA tracer method widely used to apportion biogenic secondary organic carbon (SOC). The extended SOA tracer model was applied to evaluate the sources of SOC in Atlanta, GA during summer 2015 and winter 2016 after modifying the chamber-derived f_{SOC} values to reflect SOA yields and local VOC levels (f_{SOC}'). Monoaromatic, diaromatic, and cresol SOC contributed an average of 24%, 8%, and 0.12% of organic carbon (OC) mass during summer and 17%, 5%, and 0.27% during winter, respectively. Cresol SOC peaked during winter and was highly correlated with levoglucosan ($r = 0.83$, $p < 0.001$), consistent with its' precursors originating from biomass burning. Together, aromatic, biogenic, and biomass burning derived SOC accounted for an average of 77% and 28% of OC in summer and winter, respectively. The new understanding of SOA composition from aromatic VOCs advances the tracer-based method by including important precursors of SOC and enables a better understanding of the sources of atmospheric aerosol.

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