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Novel Approach for Evaluating Secondary Organic Aerosol from Aromatic Hydrocarbons: SOA Yield and Chemical Composition

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Aromatic hydrocarbons account for 20%-30% of urban atmospheric VOCs and are major contributors to anthropogenic secondary organic aerosol (SOA). However, prediction of SOA from aromatic hydrocarbons as a function of structure, NO_x concentration, and OH radical levels remains elusive. Innovative SOA yield and chemical composition evaluation approaches are developed here to investigate SOA formation from aromatic hydrocarbons. SOA yield is redefined in this work by adjusting the molecular weight of all aromatic precursors to the molecular weight of benzene (Yield'= $\text{Yield}_i \times (\text{MW}_i/\text{MW}_{Benzene})$; i: aromatic hydrocarbon precursor). Further, SOA elemental ratio is calculated on an aromatic ring basis rather than the classic mole basis. Unified and unique characteristics in SOA formed from aromatic hydrocarbons with different alkyl groups (varying in carbon number and location on aromatic ring) are explored by revisiting fifteen years of UC Riverside/CE-CERT environmental chamber data on 129 experiments from 17 aromatic precursors at urban region relevant low NO_x conditions (HC:NO 11.1-171 ppbC:ppb). Traditionally, SOA mass yield of benzene is much greater than that of other aromatic species. However, when adjusting for molecular weight, a similar yield is found across the 17 different aromatic precursors. More importantly, four oxygens per aromatic ring are observed in the resulting SOA regardless of the alkyl substitutes attached to the ring, which majorly affect H/C ratio in SOA. Therefore, resulting SOA bulk composition from aromatic hydrocarbons can be predicted as $C_{6+n}H_{6+2n}O_4$ (n: alkyl substitute carbon number). Further, the dominating role of the aromatic ring carbons is confirmed by studying the chemical composition of SOA formed from the photooxidation of an aromatic hydrocarbon with a ^{13}C isotopically labeled alkyl carbon. Overall, this study unveils the similarity in SOA formation from aromatic hydrocarbons enhancing the understanding of SOA formation from anthropogenic sources.