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Global modeling of secondary organic aerosol formation from aromatic hydrocarbons: high- vs. low-yield pathways

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Abstract. Formation of SOA from the aromatic species toluene, xylene, and, for the first time, benzene, is added to a global chemical transport model. A simple mechanism is presented that accounts for competition between low and high-yield pathways of SOA formation, wherein secondary gas-phase products react further with either nitric oxide (NO) or hydroperoxy radical (HO₂) to yield semi- or non-volatile products, respectively. Aromatic species yield more SOA when they react with OH in regions where the [NO]/[HO₂] ratios are lower. The SOA yield thus depends upon the distribution of aromatic emissions, with biomass burning emissions being in areas with lower [NO]/[HO₂] ratios, and the reactivity of the aromatic with respect to OH, as a lower initial reactivity allows transport away from industrial source regions, where [NO]/[HO₂] ratios are higher, to more remote regions, where this ratio is lower and, hence, the ultimate yield of SOA is higher. As a result, benzene is estimated to be the most important aromatic species with regards to global formation of SOA, with a total production nearly equal that of toluene and xylene combined. Global production of SOA from aromatic sources via the mechanisms identified here is estimated at 3.5 Tg/yr, resulting in a global burden of 0.08 Tg, twice as large as previous estimates. The contribution of these largely anthropogenic sources to global SOA is still small relative to biogenic sources, which are estimated to comprise 90% of the global SOA burden, about half of which comes from isoprene. Uncertainty in these estimates owing to factors ranging from the atmospheric relevance of chamber conditions to model deficiencies result in an estimated range of SOA production from aromatics of 2–12 Tg/yr. Though this uncertainty range affords a significant anthropogenic contribution to global SOA, it is evident from comparisons to recent observations that additional pathways for production of anthropogenic SOA still exist beyond those accounted for here. Nevertheless, owing to

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differences in spatial distributions of sources and seasons of peak production, regions exist in which aromatic SOA produced via the mechanisms identified here are predicted to contribute substantially to, and even dominate, the local SOA concentrations, such as outflow regions from North America and South East Asia during the wintertime, though total modeled SOA concentrations there are small ($\sim 0.1 \mu\text{g}/\text{m}^3$).

■ [Final Revised Paper](#) (PDF, 3593 KB) ■ [Discussion Paper](#) (ACPD)

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