

Revealing the chemical processes governing the evolution of particle oxidation products from naphthalene OH initiated oxidation

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Secondary organic aerosols (SOAs) are known to substantially influence the climate by absorbing or scattering solar radiation or promoting cloud formation. The uncertainties regarding the formation of SOAs make their contribution to the Earth's radiative forcing difficult to quantify. SOAs can be formed from the oxidation of either primary organic aerosols (POAs) or volatile organic compounds (VOCs). In this study, the oxidation of one of the most important anthropogenic VOC, naphthalene, has been studied in a 9m³ Teflon chamber to better understand the chemical mechanisms occurring in the atmosphere. Naphthalene was mixed with tetramethylethylene (TME) and O₃, resulting in hydroxyl radicals' oxidation of the VOC, both with and without UV lights. The OH-initiated oxidation of naphthalene resulted in monomers and dimers in dark conditions in both particle and gas phases. Particle-phase chemistry and gas-phase chemistry were studied using an extractive electrospray ionization time-of-flight (EESI-ToF) mass spectrometer and a chemical ionization orbitrap (CI-Orbitrap) mass spectrometer respectively. Under UV lights, a decrease in the production of dimers with 20 carbon atoms was observed. Meanwhile, an increase in the production of dimers exhibiting a shorter carbon skeleton occurred, indicating that photolysis of the C20 compounds yields the fragmentation of dimeric compounds. A similar increase in the production of C6-C9 monomers was observed, indicating that photolysis of the C10 monomers most likely happened as well. In presence of lights, gas-phase compounds' chemistry remained stable while particle-phase chemistry evolved, the production of high molecular compounds, including dimeric species, increased and the production of monomers decreased over time. These observations were also observed in a similar experiment in which naphthalene reacted with OH radicals produced from HONO photolysis, which resulted in both nitrogen (N-) and non-nitrogen-containing species. As the experiment went on, the production of non-N-containing monomers decreased as the production of non-N-containing dimers increased, as in the first experiment. A similar trend was also observed between N-containing monomers and N-containing dimers, the former presumably undergoing oligomerization to form the latter. This study explores the chemical processes occurring within particle-phase that could help better understand the evolution of the oxidation products