Impact of nighttime aging on optical properties of toluene secondary organic aerosol

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Toluene is known as an important precursor of anthropogenic secondary organic aerosol (SOA) in the troposphere. In the atmosphere, toluene is mainly oxidized by OH radical to generate gaseous oxidation products in addition to SOA. Whereas OH aging of the toluene-SOA will be negligible under dark conditions after sunset, a part of these oxidation products in gas-phase and/or SOA can be further oxidized with NO_3 or O_3 even in the nighttime. The SOA generated during OH oxidation of toluene in the presence of NO_x is known to have significant light absorption at the ultraviolet and shorter visible wavelengths (*i.e.*, known as brown carbon) [*e.g.*, Nakayama et al. 2013] and possibly contributes to the radiation balance and photochemical reactions in the atmosphere. In this work, the impact of NO_3 and O_3 aging on wavelength-dependent optical properties of the toluene SOA has been studied.

The SOA was generated during OH oxidation of toluene in the absence of NO_x in a 6 m^3 stainless steel photochemical chamber with Teflon coating. As sources of OH, either of photolysis of H_2O_2 or ozonolysis of tetramethylethylene was used. After enough amounts of SOA were generated, N_2O_5 (precursor of NO_3), O_3, or NO_2 was injected to the chamber under dark conditions. The NO_2 injection experiment was conducted to confirm the possible effects of NO_2 reactions, because both of NO_3 and NO_2 were generated during thermal decomposition of N_2O_5. Temporal variations of the optical properties of the SOA were measured by two photoacoustic spectrometers (absorption and scattering at 375, 405, 532, 781 nm) and a cavity ring-down spectrometer (extinction at 532 nm). Chemical properties and size distributions of SOA were measured by an Aerodyne aerosol mass spectrometer and a scanning mobility particle sizer, respectively. Gaseous reactants and products were monitored by a Fourier transform-infrared spectrometer and a proton transfer reaction time-of-flight mass spectrometer.

Mass concentrations of toluene-SOA were significantly enhanced and nitrocresols and nitrosalicylic alcohols were generated after NO_3 aging, but no clear enhancement was observed after O_3 aging [Ramasamy et al. 2019]. The toluene-SOA did not show light absorption properties at all wavelengths studied before NO_3 or O_3 aging. Significant light absorption was observed after NO_3 aging at 375 and 405 nm, but neither O_3 nor NO_2 additions. Nitro-aromatic compounds such as nitrocresols and nitrosalicylic alcohols generated from cresols during NO_3 aging are considered to be responsible for the observed light absorption. In the presentation, the atmospheric implications of the results will also be discussed.

References

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