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Direct and indirect photochemical aging of organic aerosol components as a function of temperature

Magdalena Vallon, Linyu Gao, Junwei Song, Feng Jiang, and Harald Saathoff
Karlsruhe Institute of Technology, Germany (magdalena.vallon@kit.edu)

The chemical composition of aerosols, in both gas and particle phase, is an important factor regarding their properties influencing air quality, weather, climate, and human health. Organic compounds are a major fraction of atmospheric aerosols and their composition depends on chemical processing by atmospheric oxidants and photochemical reactions. These processes are complex due to the abundance of potential reactions and rarely studied over a wider range of atmospheric temperatures. To achieve a better understanding of three different photochemical processes relevant for the atmosphere as well as the capabilities to investigate such processes in our simulation chamber we studied three different organic aerosol systems between 213 K and 293 K in the AIDA simulation chamber at the Karlsruhe Institute of Technology. With the first system we studied the direct photolysis of 2,3-pentanedion which is a typical carbonyl compound emitted by the food industry but also by trees. In the second system we studied the depletion of pinic and pinonic acid by radicals formed through photolysis of an iron oxalate complex, which acts as the photosensitizer in this system, all present in aqueous aerosol particles. Furthermore, we studied the photolysis of a nitrogen heterocycle in aerosol particles, which can form in the atmosphere by the reaction of dicarbonyls and shows strong absorption in the visible [1].

Photochemical reactions were studied using a new LED light-source simulating solar radiation in the UV and visible. The organic aerosols were generated by nebulizing aqueous solutions containing the aerosol components. The aerosols were analysed by a high-resolution time-of-flight aerosol mass spectrometer (HR-ToF-AMS), a proton transfer mass spectrometer (CHARON-PTRMS) and a high–resolution time-of-flight chemical ionization mass spectrometer (FIGAERO-HR-ToF-CIMS). The latter two allow to study the composition of gas phase and particle phase separately.

In this presentation, we will discuss the changes that these organic compounds undergo in gas and particle phase, during photochemical aging at temperatures between 213 and 293 K.

[1] C. J. Kampf, A. Filippi, C. Zuth, T. Hoffmann and T. Opatz, Secondary brown carbon formation via the dicarbonyl imine pathway: nitrogen heterocycle formation and synergistic effects, Phys. Chem. Chem. Phys, 2016, 18, 18353