Uptake of glyoxal by organic and inorganic seed aerosols: Optical, physical and chemical properties of the product aerosols

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Constraining the optical properties of secondary organic aerosol (SOA) is a major challenge since they often consist of a mixture of several components with various internal structures, including homogeneous mixtures and core/shell structures. The importance in understanding the optical properties of aerosols is their effect on the magnitude and uncertainty of Earth's total radiative forcing and climate change. SOA form by the condensation of less-volatile gaseous compounds onto pre-existing aerosols, and by heterogeneous and multi-phase reactions.

The heterogeneous reaction between glyoxal gas and three atmospheric aerosol types; ammonium sulfate (AS), glycine and glycine-AS 1:100 was studied. The optical extinction cross section at λ=355nm and mobility size increased following the reaction under a broad range of RH values (30-90%), indicating that the reaction is relevant for a wide range of atmospheric conditions.

We propose that at low RH values, below the deliquescence point, the reactions occur in interfacial monolayers of water, supporting previous findings about the importance of interfacial water in heterogeneous.

The reactions exhibit a trend of increasing growth in physical and optical cross sections with decreasing seed aerosol size, as well as a clear dependence on ambient RH values (Figure 1). For small particles with near-zero extinction efficiency (Q_{ext}) values, the reaction induces the greatest increase in optical extinction cross section (up to 2 orders of magnitude enhancement) due to a combined effect of changes in optical properties and in size, resulting in a change in the location on the Mie curve.

AMS analyses of the reactions show that the main reaction products are glyoxal oligomers, and a small contribution from the formation of various C-N compounds, identified as imidazoles.

Our results suggest that unlike previously postulated, the reactions at RH values below deliquescence occur on interfacial water layers and their optical enhancement is mainly due to enhanced scattering and geometric cross section growth.

This study contributes to the understanding of the effect of the reactions on the optical properties of the aerosols in the atmosphere by demonstrating that the heterogeneous reactions between abundant atmospheric components may alter the aerosols' optical, physical and chemical properties on short timescales (~ 1 hour) and may have substantial implications on the radiative effects of these aerosols.