Organic Aerosol Formation Photoenhanced by the Formation of Secondary Photo-sensitizers in ageing Aerosols

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Humankind is facing a changing environment possibly due to anthropogenic stress on the atmosphere. In this context, aerosols play a key role by affecting the radiative climate forcing, hydrological cycle, and by their adverse effect on health (Harrison et al., 2000). The role of organic compounds in these processes is however still poorly understood because of their massive chemical complexity and numerous transformations. This is particularly true for Secondary Organic Aerosol (SOA), which are produced in the atmosphere by organic gases.

Traditionally, the driving forces for SOA growth is believed to be the partitioning onto aerosol seeds of condensable gases, either emitted primarily or resulting from the gas phase oxidation of organic gases (Volkamer et al. 2009). However, even the most up-to-date models based on such mechanisms cannot account for the SOA mass observed in the atmosphere, suggesting the existence of other, yet unknown formation processes. The present study shows experimental evidence that particulate phase chemistry produces photo-sensitizers that lead to photo-induced formation and growth of secondary organic aerosol in the near UV and the presence of volatile organic compounds (VOC) such as terpenes (Monge et al. 2012).

By means of an aerosol flow tube reactor equipped with Scanning Mobility Particle Sizer (SMPS) having Kr-85 source aerosol neutralizer, Differential Mobility Analyzer (DMA) and Condensation Particle Sizer (CPC), we identified that traces in the aerosol phase of glyoxal chemistry products, as is explained in Gallway et al., and Yu et al.,(Galloway et al. 2009; Yu et al. 2011), namely imidazole-2-carboxaldehyde (IC) is a strong photo-sensitizer when irradiated with near-UV. In the presence of volatile organic compounds such as terpenes, this chemistry leads to fast aerosol growth. (Aregahegn et al., submitted, 2013).

Furthermore, the influence of pH, type and concentration of VOCs, composition of seed particles, relative humidity and irradiation intensity on particle growth were studied.

SOA growth was favored with VOCs containing tertiary unsaturated carbons.Thus, Due to the presence of exocyclic and endocyclic unsaturated tertiary carbon, limonene was observed to lead to an efficient SOA formation and growth. This novel photo-sensitizer, IC, contributed to more than 30% of SOA growth in 19min irradiation time in the presence of terpenes in the system, depending linearly with the irradiation intensity. These results demonstrate that, upon ageing, organic aerosols can produce photo-sensitizers which auto-photo-catalyses their SOA growth.

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