Formation of low molecular weight mono- and di-carboxylic acids and related compounds from photochemical oxidation of stearic and linoleic acids in aqueous-phase

Chandra Mouli Pavuluri1, Subba Rao Devineni1, Zhanjie Xu1, Kimitaka Kawamura2, Pingqing Fu1, Yan-Lin Zhang3, and Cong-Qiang Liu1

1Tianjin University, Institute of Surface-Earth System Science, Tianjin 300072, China (cmpavuluri@tju.edu.cn)
2Chubu Institute for Advanced Studies, Chubu University, Kasugai 487-8501, Japan
3Yale-NUIST Center on Atmospheric Environment, Nanjing University of Information Science and Technology, Nanjing 10044, China

Secondary organic aerosols (SOA) that account for a substantial and often a dominant fraction of total OA mass are formed by photooxidation of various precursors derived from anthropogenic and biogenic sources in the atmosphere. They have serious impacts on the Earth’s climate system directly by scattering and absorbing solar radiation and indirectly by acting as cloud condensation nuclei, and adverse effects on human health. In recent times, considerable attention has been paid on laboratory studies, preferably in gas-phase, in order to understand the chemistry of SOA formation. However, the studies on SOA formation in aqueous phase are limited, which are mainly focused on high abundant volatile organic compounds (e.g., isoprene) and/or their oxidation products, but not on fatty acids (except oleic acid). To better understand the air-water interface photochemistry of fatty acids and their transformations to lower homologous monoacids and more oxygenated species such as diacids and related compounds in atmospheric waters (fog, cloud and aqueous aerosol), we conducted batch UV irradiation experiments on a saturated (stearic acid, C18H36O2) and an unsaturated (linoleic acid, C18H32O2) fatty acids for different time periods (age, 0-120 h) in aqueous-phase. All the irradiated samples were analyzed for measurements of mono- and di-acids, oxoacids and α-dicarbonyls. We found high abundances of monoacids followed by diacids, pyruvic acid and α-dicarbonyls in less aged samples, whereas C3 and C4 diacids were abundant in the more aged samples. Our results imply that the photochemical oxidation of fatty acids and subsequent transformations of the product species in atmospheric waters are significant and their contribution to more oxygenated SOA is increased with aging in the atmosphere.
