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Sunlight-initiated formation of organosulfates and surfactants in atmospheric aerosols

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It is now well established that many aerosols in the atmosphere contain internal mixtures of organic compounds and inorganic salts, such as sulfate, ammonium, and nitrate. Recently, ammonium salts were shown to trigger important chemical transformations of the organic compounds in aerosols. In this presentation, we show that sulfate salts would play similar roles by producing sulfate radicals, SO4-, when exposed to UV light (280-320 nm). Biogenic hydrocarbons in irradiated sulfate solutions were thus found to produce the same organosulfates as identified in aerosols, that we established by the high-resolution tandem mass spectrometric analyses (ESI-MSMS) of over 35 reactions products. These reactions also produced other organosulfates found previously in aerosols, but for which no structure or origin could be proposed until now. With a typical lifetime of 9 h instead of 4600 days for esterifications, these radical reactions would be a more plausible formation pathway for organosulfates in atmospheric aerosols.

These reactions also produced efficient surfactants, proposed to be long-chain organosulfates analogous to those identified in our experiments. The Köhler curves obtained for some of our reaction mixtures showed that exposure to sunlight should increase the cloud condensation nuclei (CCN) properties of mixed organic/sulfate particles, which could explain previous observations of CCN numbers correlated with photochemistry in the atmosphere.

These new processes confirm the important role of inorganic material towards organic compounds in aerosols and imply that organosulfates might not only be indicators for the chemical processing (or “photochemical aging”) of aerosols but also for their elevated CCN activity.