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Thermodynamic properties and cloud droplet activation of a series of oxo-acids

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Submicron sized aerosol particles in the Earth's atmosphere influence visibility, human health, and global climate (IPCC, 2007). The organic mass fraction of the atmospheric aerosol has been estimated at 20-90% of the total aerosol mass mass (Kanakidou et al., 2005). Many of the organic species found in the particle phase in the atmosphere are produced via the oxidation of biogenic hydrocarbon emissions such as terpenes and sesquiterpenes (Hallquist et al. 2009).
We have investigated the thermodynamic properties of four aliphatic oxo-dicarboyxlic acids identified or thought to be present in atmospheric particulate matter: oxosuccinic acid, 2-oxoglutaric acid, 3-oxoglutaric acid, and 4-oxopimelic acid. The compounds were characterized in terms of their cloud condensation nuclei (CCN) activity, vapor pressure, density, and tendency to decarboxylate in aqueous solution. We deployed a variety of experimental techniques and instruments: a CCN counter, a Tandem Differential Mobililty Analyzer (TDMA) coupled with a laminar flow tube (Bilde, 2003), and liquid chromatography/mass spectrometry (LC/MS). Generally, the presence of the oxo functional group causes the vapor pressure of the compounds to diminish by an order of magnitude with respect to the parent dicarboxylic acid, and it tends to increase the CCN activity. Dicarboxylic acids with an oxo-group in the -position were found to decarboxylate in aqueous solution.

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