



## The effect of different carboxylic acids on ice nucleation

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Certain organic compounds have the potential to effectively alter water ice nucleation. Research data of those organic compounds that may affect ice formation in the atmosphere is still insufficient. Among those interesting compounds are the carboxylic acids which are present in the atmosphere due to different reasons. They are formed through ozonolysis of unsaturated organic compounds and are also a major fraction in the humic like substances (HULIS).

The aim of this study is especially to investigate the influence of carboxylic acids on the ice nucleation. Pratt et al.[1] have shown by aerosol mass spectroscopy that carboxylic acids are present in ice clouds but their impact on the nucleation is still unclear. Other organics like pure soot or citric acid are able to suppress the nucleation of ice to a certain extent in laboratory studies. [2], [3]. With the existing informations it is a consequent continuation to further investigate organic acids with different molecular masses and different number of functional groups.

Starting with oxalic acid as the smallest carboxylic acid, several other acids like malonic acid, succinic acid, glutaric acid, tartaric acid, and citric acid have been investigated. For every sample, water in oil emulsion has been prepared which allows the observation of the freezing of defined and isolated droplets. For monitoring the freezing, imaging techniques (ESEM and optical Microscopy) have been applied while for changes of the phase composition X-ray diffraction was suitable.

The results show a clear dependence of the ice nucleation on the acid concentration and on the molar mass. The very appealing microscope images show crystal growth and in some cases phase separation into crystalline and amorphous domains. The X-ray diffraction finds evidence for an astonishing large amount of metastable cubic ice.

- [1] K. Pratt et al. "In situ detection of biological particles in cloud ice-crystals" *Nature Geoscience* 2009, 2, 398-401.
- [2] A. Mangold et al. "Experimental investigation of ice nucleation by different types of aerosols in the aerosol chamber AIDA: implications to microphysics of cirrus clouds" *Meteorologische Zeitschrift*, 2005, 14, 4, 485-497.
- [3] B.J. Murray "Inhibition of ice crystallization in highly viscous aqueous organic acid droplets." *Atmos. Chem. Phys.* 2008, 8, 5423-5433.