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Hygroscopic growth and activation of uncoated and coated soot particles and their relation to ice nucleation

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Measurements of the hygroscopic growth (HTDMA, LACIS-mobile), activation behavior (DMT-CCNC) - scope of this paper - and ice nucleation (AIDA chamber) were performed to estimate the cloud-forming potential of pure and coated soot particles. Globally, soot particles contribute up to 2.5 % to the atmospheric aerosol. In the framework of the investigations described here, soot particles were generated either applying a graphite-spark-generator (GFG1000) or a flame-soot-generator (Mini-CAST). With respect to the hygroscopic growth and activation behavior, the influences of the carrier-gas (GFG-soot), the OC-content (CAST-soot) and of different coating materials were investigated.

Differences in the hygroscopic growth and activation behavior of GFG generated soot particles were found for the two carrier-gases considered. If nitrogen was used, neither hygroscopic growth nor activation were observed. In contrast, when argon was used, particles featured a slight hygroscopic growth and were easier to activate. Hygroscopic growth increases with decreasing OC-content of the CAST-soot, up to growth factor 1.04 at 98.4 % relative humidity. Lower OC-contents also result in the particles being activated more easily.

Coating with sulfuric acid enhances the hygroscopic growth and activation behavior of CAST-soot for different OC-contents. If the soot (GFG & CAST) was coated with dicarboxylic acids (oxalic and succinic acid), no enhancement of hygroscopic growth and activation was observed. This is most likely due to evaporation of the coating material.

In comparison to the hygroscopic growth and activation behavior, the same trends were observed in the ice-nucleation behavior. That is, the more active a particle is as cloud condensation nuclei, the better it functions as ice nuclei. GFG-soot with argon as carrier-gas acts as a better ice nuclei than GFG-soot with nitrogen. For the CAST-soot the ice-nucleation activity decreases with increasing OC-content. Coating with sulfuric acid increases the ice-nucleation ability of CAST-soot.